ENVISION
CONSULTANTS LTD

DESKTOP GEOTECHNICAL STUDY – PROPOSED RESIDENTIAL DEVELOPMENT

6409 First Line, Fergus, Ontario

Project #: 24-0727
Prepared for: RBS & EJS Fergus Limited Partnership
Date : January 27, 2025

Report Version: 01

6415 Northwest Drive
Units 37-40
Mississauga, ON L4V 1X1

envisionconsultants.ca

January 27, 2025

RBS & EJS Fergus Limited Partnership
3700 Steeles Avenue West, Suite 800
Vaughan, ON L4L 8M9

Attention: Herthana Siva, Manager, Development
Sent via email: hsiva@sorbara.com

SUBJECT: DESKTOP GEOTECHNICAL STUDY – PROPOSED RESIDENTIAL DEVELOPMENT, 6409 FIRST LINE, FERGUS, ONTARIO

EnVision Consultants Ltd. is pleased to present the enclosed Desktop Geotechnical Study – Proposed Residential Development for the above-noted project.

We thank you for utilizing EnVision for this assignment. If there are any questions regarding the enclosed report, please do not hesitate to contact us.

Yours sincerely,

Draft

Tim Yu, P.Eng.
Project Engineer
tyu@envisionconsultants.ca

QUALITY MANAGEMENT

ISSUE	FIRST ISSUE		
PROJECT NUMBER	24-0727		
PROJECT REFERENCE	Desktop Geotechnical Study – Proposed Residential Development, 6409 First Line, Fergus, Ontario		
VERSION NO.	01		
REMARKS	Draft Report		
PREPARED BY	Tim Yu		
SIGNATURE	DRAFT		
REVIEWED BY	Scott Peaker		
SIGNATURE	DRAFT		
DATE	January 27, 2025		

The original of this digital file will be kept by EnVision for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of EnVision, its integrity cannot be assured. As such, EnVision does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient

TABLE OF CONTENTS

FIGURES

LIST OF APPENDICES

1. INTRODUCTION & BACKGROUND

EnVision Consultants Ltd. (EnVision) was retained by RBS & EJS Fergus Limited Partnership (the 'Client') to undertake a desktop geotechnical study in support of the proposed Official Plan Amendment (OPA) for a residential site development. The project site is located at 6409 First Line, Fergus, Ontario (the 'Site').

The project site is an irregularly shaped parcel of land covering an area of approximately 39.0 hectares (96.4 acres). It is located northwest of the intersection of Bellwood Road (Wellington Road 19) and 1st Line. The desktop study project area is illustrated on the attached Figure 1.

It is understood that the proposed development will primarily consist of residential housing, occupying approximately two-thirds of the project site, predominately on the eastern side of the property. A proposed stormwater management (SWM) pond will be located in the southwestern corner of the Site. The development will be accessed by means of an internal road network and with typical utilities (watermain, storm, sanitary sewers and dry utilities). The western portion of the site, which is traversed by a tributary of the Grand River, falls within the area regulated by the Grand River Conservation Authority.

The purpose of this desktop study is to review and broadly evaluate the geotechnical conditions at or near the proposed Site based on existing published information and available data reports. This is to further understand the physiographic setting, regional geology, and groundwater conditions of the project Site, to identify key geotechnical risks, and to assist in the scoping of future geotechnical, geo-environmental and hydrogeological site investigation work.

This report presents the results of our review of the available background information, which should be read in conjunction with the *General Comments and Limitations of Report* (Section 6). The readers' attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report. The interpretation and findings described in this report pertain to the specific project contemplated and are not applicable to any other project or site location.

2. SOURCES REVIEWED

Information regarding the local and regional subsurface ground and groundwater conditions was obtained from the Open Data Ontario public record GIS and the following sources:

1. Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV.
2. Armstrong, D.K. and Dodge, J.E.P. 2007. Paleozoic geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release-Data 219.
3. Gao, C., Shirota, J., Kelly, R. I., Brunton, F.R., van Haaften, S. 2006. Bedrock topography and overburden thickness mapping, southern Ontario; Ontario Geological Survey, Miscellaneous Release-Data 207.
4. Geotechnical Investigation – proposed residential subdivision, Garafraxa Street and Gartshore Street, Town of Fergus, Ontario, by Terraprobe Ltd., for Sorbara Development Group, December 3, 2007. *This project involved site investigation of a proposed residential development site with a plan area of approximately 37 acres, located southwest of the current study area and is bounded by Garafraxa Street East to the south and Gartshore Street to the west. This investigation program involved drilling twelve (12) boreholes to depths ranging from 3.0m to 8.1m below ground surface. Standpipe piezometers were installed in all boreholes. Subsurface conditions revealed from these boreholes generally consisted of topsoil at the surface, overlying mostly loose sandy fill materials, which were underlain by predominantly compact cohesionless deposits with silt to sand textures. Groundwater levels were found to range from 1.0m to 3.6m below the ground surface.*

3. PHYSIOGRAPHIC SETTING & REGIONAL GEOLOGY

According to Chapman and Putnam (2007), the site is located within the physiographic region known as the Guelph Drumlin Field, which was shaped by the retreat and movement of the Laurentide Ice Sheet during the last glaciation. Drumlins are streamlined hills formed of glacial till, with their long axes oriented in the direction of ice flow. These features typically range in size from hundreds to thousands of meters in length and vary in height from a few meters to over 50 meters. In the Guelph Drumlin Field, drumlins are often composed of compacted glacial tills, which include a mixture of clay, silt, sand, gravel, and boulders. Water infiltration and runoff in these areas are influenced by the composition and permeability of the glacial deposits, which can vary widely.

3.1. REGIONAL GEOLOGY

According to the Ontario Geological Survey mapping, as reproduced in Figure 3, the study area is dominated by glacio-fluvial deposits (coarse grained soils including sands, gravels, cobbles and boulders), identified in light yellow colour (geological unit 7a) on Figure 3. Glacio-fluvial deposits are sediments transported and deposited by meltwater streams flowing from glaciers. These deposits predominantly consist of coarse-grained materials such as sands and gravels, with occasional inclusions of finer particles like silts.

Ice-contact stratified deposits (geological unit 6, shown in dark yellow on Figure 3) are located in the northwestern and southeastern corners of the site. These deposits are sedimentary accumulations formed in direct contact with glacier ice, typically within or near glacial environments. They are generally composed of poorly to moderately sorted sands, gravels, and cobbles, with finer materials such as silts and clays occasionally interlayered among the coarser sediments.

According to the Ontario Geological Survey mapping (Armstrong, 2007), the bedrock at the site is predominantly sandstone, shale, dolostone and siltstone of the Guelph Formation, as shown in Figure 4. The bedrock surface is expected to lie approximately 15m to 25m below the existing grade.

3.2. GROUNDWATER WELL DATABASE

The site generally slopes westerly and southwesterly to the adjacent watercourse. Shallow groundwater flow is influenced by the local topography, with recharge occurring in the upland areas and discharge taking place in the low-lying area of the Grand River tributary, which traverses the western portion of the site.

Based on a review of the Ministry of the Environment, Conservation and Parks (MECP) water well database, approximately twenty-three (23) water well records were identified within an approximate 100 m radius of the site, with water levels reported varying from 5m to 40m below ground surface. The approximate locations of these water wells near the proposed study area are shown in Figure 5. The well information is provided in Appendix A.

Of the twenty-three (23) well records, fifteen (15) were designated as water supply wells, four (4) were designated as monitoring/observation or test wells, and four (4) were designated as abandoned.

A more detailed discussion of local groundwater usage is included in the hydrogeological desktop study, provided under separate cover.

Water wells at the greatest risk of interference from construction dewatering are shallow overburden wells located in close proximity to Garafraxa Street East where watermain and sanitary sewer trenching will occur and dewatering is expected to be required. Some deeper overburden wells with pumps set at shallow depths could also be impacted; however, such interference may be mitigated by lowering the pump settings within the well. The radius of influence of construction dewatering will depend on the aquifer's hydraulic conductivity, thickness, and the rate of dewatering pumping.

3.3. SITE AND SURROUNDINGS DESCRIPTION

The study area primarily consists of farmsteads and agricultural lands, with woodlands and wetlands located on the western side of the site. A tributary of the Grand River traverses the western corner of the site which is regulated by the Grand River Conservation Authority.

4. EXISTING GEOTECHNICAL AND HYDROGEOLOGICAL INFORMATION

4.1. GEOTECHNICAL INVESTIGATION – PROPOSED RESIDENTIAL SUBDIVISION, GARAFRAXA STREET AND GARTSHORE STREET, TOWN OF FERGUS, ONTARIO

Terraprobe Limited (Terraprobe) conducted a geotechnical investigation in 2007 for Sorbara Development Group for a proposed residential subdivision at Garafraxa Street and Gartshore Street in the town of Fergus, Ontario. The investigation report is attached in Appendix B. This project location lies southwest of the current study area. Twelve (12) boreholes were advanced to depth of 3.0m to 8.1m below the ground surface. Standpipe piezometers were installed in all boreholes upon drilling completion for the longer-term monitoring of groundwater.

A layer of topsoil, ranging in thickness from 110mm to 260mm was encountered at the ground surface at all borehole locations. Below the topsoil, fill materials consisting of loose to compact sandy silt to silty sand to sand with trace gravel, trace clay and organic inclusions which extended to depths ranging from 0.8m to 2.3m below the existing ground surface. Below the fill materials, native soils consisted of sand, sand and silt, silty sand, silt and sandy silt were encountered in all boreholes except BH11 and BH12 and extended beyond the depths of the investigation in boreholes BH1, BH2, BH4 to BH7, and BH9. Standard Penetration Tests (SPTs) conducted within these cohesionless deposits indicate a loose to dense state of compactness, but generally compact state of packing. Cohesionless glacial tills of silt and sandy silt textures were also encountered below fill and/or native silt and sand deposits in boreholes BH1, BH3, BH8, BH10, BH11 and BH12 and extending beyond the termination depth of boreholes BH3, BH8, BH10 to BH12.

The groundwater levels measured within the twelve (12) piezometers approximately one week following the drilling completion were found to be at depths of 1.0m to 3.6m below the existing ground surface, corresponding to elevations 416.1m to 421.8m.

5. GEO-HAZARDS & RECOMMENDATIONS FOR SITE INVESTIGATION

5.1 OVERVIEW OF SUBSURFACE CONDITIONS

It is understood that the proposed development at the Site will take place primarily in the northeastern portion of the site. The development will primarily consist of residential housing, internally serviced roads, and associated utilities, including watermains, sanitary and storm sewers. A stormwater management pond will be constructed in the southwestern portion of the site.

The subsurface conditions at the Site typically include topsoil, modern fill, underlain by glacio-fluvial and ice-contact stratified loose to dense cohesionless silty/sandy deposits (silt, sandy silt to silty sand, and sand) and compact to very dense cohesionless glacial tills of sandy silt to silt textures. Occasional cobbles and boulders are expected to be present within the glacial till. The groundwater table is relatively shallow and lies a few metres (1.0m to 3.6m) below grade, generally mimicking the topography of the ground above.

The anticipated predominant strata, consisting of glacio-fluvial sands are expected to be in a compact state of packing and these will form adequate foundation materials for conventional residential construction where such excavations will remain above the groundwater table. Below the groundwater table, dewatering measures will be required to in order to excavate basements and utility trenches. In the absence of effective dewatering measures, loss of ground (i.e., caving/sloughing) conditions are expected to occur and destruction of foundation bearing resistance could occur in structure foundation excavation bases. As such, good knowledge of the position of the groundwater table across the site is essential for construction planning and costing purposes.

Ice-contact stratified deposits may contain cobbles and boulders which may pose construction difficulties for trenching and excavations.

AS mentioned above, the cohesionless glacio-fluvial and ice-contact stratified deposits have poor stand-up time and may be prone to sloughing in unsupported trenches and excavations. Additionally, due to the relatively high permeability nature of these deposits, groundwater seepage will be expected and therefore, an elaborate dewatering procedure such as closely spaced vacuum or eductor well points will be required if trenching and excavation below the groundwater level.

Due to the low clay content in glacio-fluvial and ice-contact stratified deposits, these cohesionless materials are highly susceptible to erosion, especially during heavy rainfall or high-water flow events. Slope stability and erosion analyses may be required for areas of proposed development located near the tributaries of the Grand River. For the proposed stormwater management pond, a Geosynthetic Clay Liner (GCL) or Geomembrane (GM) liner will be necessary to serve as a hydraulic barrier along the pond's side slopes and base to minimize hydraulic communication between the local groundwater and pond water. EnVision recommends that site investigation work and groundwater table monitoring be completed *before determining the location and base elevation of the stormwater management pond* since groundwater is expected to play a critical role in the design and construction of these facilities.

Domestic water supply wells located south of the site, across Garafraxa Street East, may potentially be affected by construction dewatering activities depending on the proposed excavation depths, local groundwater levels, aquifer hydraulic conductivity, thickness, and the rate of dewatering pumping. A detailed hydrogeologic study and impact assessment is required in this regard.

5.2 RECOMMENDATIONS FOR PRELIMINARY SITE INVESTIGATION

To further understand the subsurface soil and groundwater conditions at the Site, the following preliminary site investigation scope is proposed in order to assist in advancing the planning of the development. A more detailed second phase of site investigation will likely be needed at later stages after the site plan has been developed and the location of the SWM pond has been determined.

Typically, the geotechnical/hydrogeological borings would be sampled at continuous (0.76m) intervals to a depth of 5 m and at every 1.5 m thereafter, in accordance with the ASTM D1586 Standard Penetration Test (SPT) using a split spoon sampler. This will assist to determine the SPT 'N' values for the overburden soils, which are important in assessing relative density/stiffness, as well as for identifying samples for which soil index property testing will be required.

Proctor testing soil samples should be retrieved from bulk auger samples to assess geotechnical quality of excavated soil for backfilling purposes.

The location and depth of monitoring wells will also be based on potential contamination areas and depths based on the APU findings. Monitoring of groundwater levels and fluctuations in groundwater level should be made in these wells at regular intervals over the course of one year, preferably using auto-reading transducers. Single well response testing should be carried out within each monitoring well in order to estimate the formation hydraulic conductivity. Each monitoring well should also be sampled and tested for environmental quality relative to the prevailing storm and sanitary sewer use by-law. The monitoring wells, along with the boreholes (between sampling intervals), should be screened for the presence of methane gas and hydrogen sulphide.

The geotechnical laboratory testing program should include index testing of soil samples including moisture content determinations, grain size analyses, Standard Proctor moisture-density testing, along with Atterberg consistency limits (if clayey soils are encountered).

As part of detailed design related site investigations, an assessment of temporary construction dewatering requirements will need to be undertaken. Included in this assessment, a groundwater interference study should be carried out. Additionally, geotechnical impacts (i.e., dewatering-induced consolidation settlement) will also need to be assessed.

It is recommended that the project Site be screened for historical landuse to identify past and present business operations that have the potential to have impacted overburden soil environmental quality. This work could be in the form of an APU (Assessment of Past Uses) as required under O.Reg. 406/19. Boring locations should also take into consideration any higher risk land use activities as identified in the APU (Assessment of Past Uses) as required under O.Reg. 406/19. Environmental soil quality testing is required at the location of proposed residential dwellings and associated linear infrastructure.

Since the Site has been previously developed for farm usage, subsequent phases of site investigation should include assessment of the potential for:

- Existing septic tile fields;
- Existing agricultural subdrainage (field tile) networks;
- Legacy on-site waste disposal pits/dumps/piles and imported fill;
- Use of pesticides and herbicides;
- Existing wells requiring decommissioning;
- Existing and abandoned fuel storage tanks and fueling areas.

6. GENERAL COMMENTS AND LIMITATIONS OF REPORT

This is a high level, broad brush desktop geotechnical study intended to be used only in the relative assessment of candidate alignments. This report does not present design or construction recommendations. Detailed design stage site investigation work (boreholes, test pits, monitoring well installations, laboratory testing) and associated geotechnical analyses and reporting are required. This report in no way obviates the need for such future work.

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to EnVision at the time of preparation. Unless otherwise agreed in writing by EnVision Consultants Ltd. it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EnVision Consultants Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

6.1 SIGNATURES

Prepared by

Draft

Tim Yu, P.Eng.
Geotechnical Engineer
tyu@envisionconsultants.ca

Reviewed by

Draft

Scott Peaker, M.A.Sc., P.Eng.
Geotechnical Lead
speaker@envisionconsultants.ca

6.2 QUALIFIER

EnVision prepared this report solely for the use of the intended recipient in accordance with the professional services agreement. In the event a contract has not been executed, the parties agree that

the EnVision General Terms and Conditions, which were provided prior to the preparation of this report, shall govern their business relationship.

The report is intended to be used in its entirety. No excerpts may be taken to be representative of the findings in the assessment. The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the report are based on the observations and/or information available to EnVision at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by EnVision and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

EnVision disclaims any obligation to update this report if, after the date of this report, any conditions appear to differ significantly from those presented in this report; however, EnVision reserves the right to amend or supplement this report based on additional information, documentation or evidence.

EnVision makes no other representations whatsoever concerning the legal significance of its findings. The intended recipient is solely responsible for the disclosure of any information contained in this report. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. EnVision does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report.

EnVision has provided services to the intended recipient in accordance with the professional services agreement between the parties and in a manner consistent with that degree of care, skill and diligence normally provided by members of the same profession performing the same or comparable services in respect of projects of a similar nature in similar circumstances. It is understood and agreed by EnVision and the recipient of this report that EnVision provides no warranty, express or implied, of any kind. Without limiting the generality of the foregoing, it is agreed and understood by EnVision and the recipient of this report that EnVision makes no representation or warranty whatsoever as to the sufficiency of its scope of work for the purpose sought by the recipient of this report.

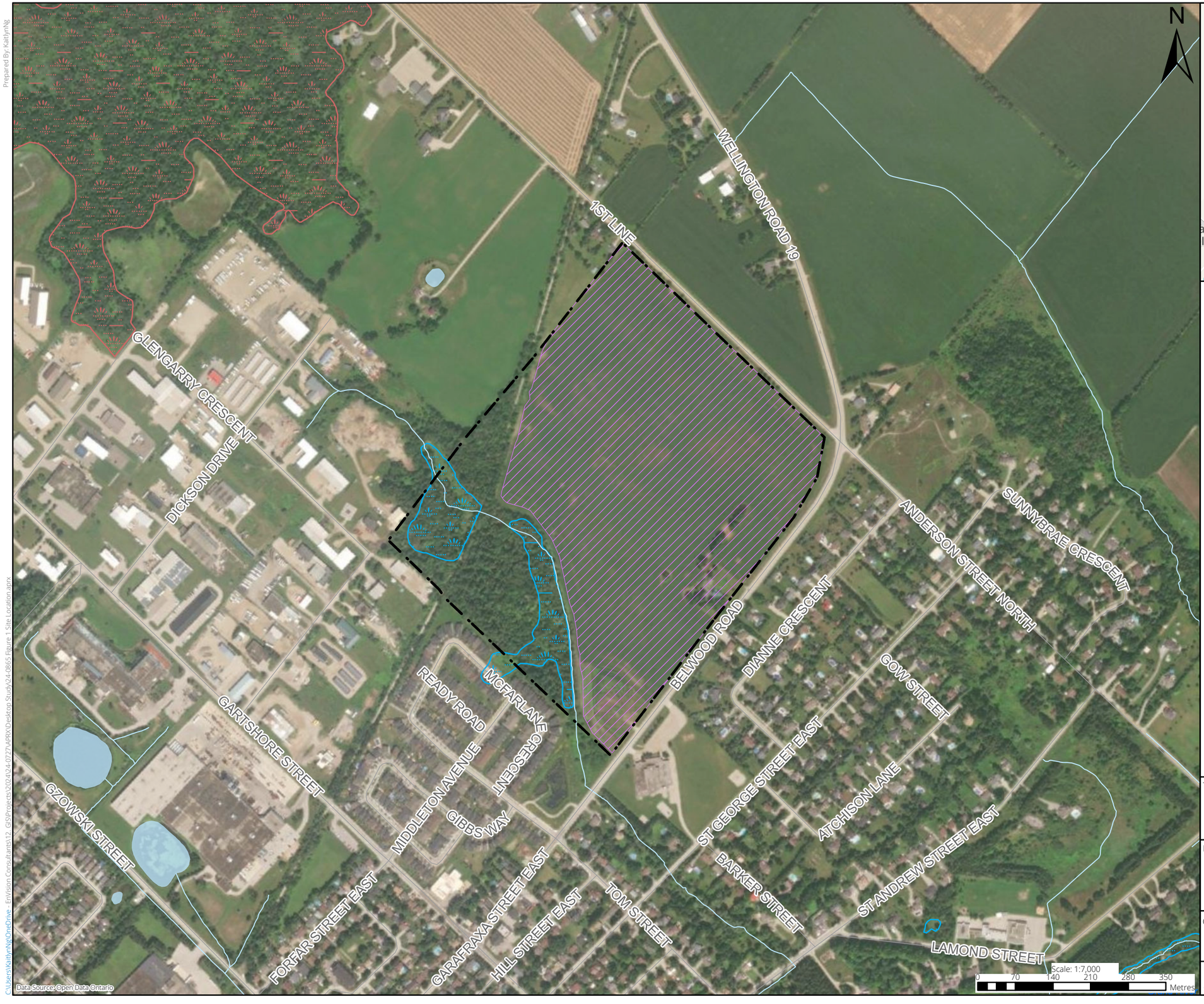
In preparing this report, EnVision has relied in good faith on information provided by others, as noted in the report. EnVision has reasonably assumed that the information provided is correct and EnVision is not responsible for the accuracy or completeness of such information.

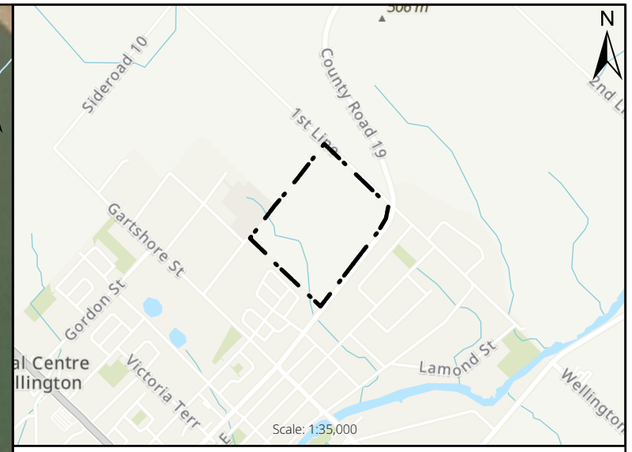
Unless otherwise agreed in writing by EnVision, the Report shall not be used to express or imply warranty as to the suitability of the site for a particular purpose. EnVision disclaims any responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions /or costs.

This limitations statement is considered an integral part of this report.

FIGURES

Prepared By: KaitlynNg





LEGEND

- STUDY AREA
- RESIDENTIAL DEVELOPMENT AREA
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND

TITLE

STUDY AREA

PROJECT

GEOTECHNICAL DESKTOP STUDY
6409 FIRST LINE
FERGUS, ONTARIO

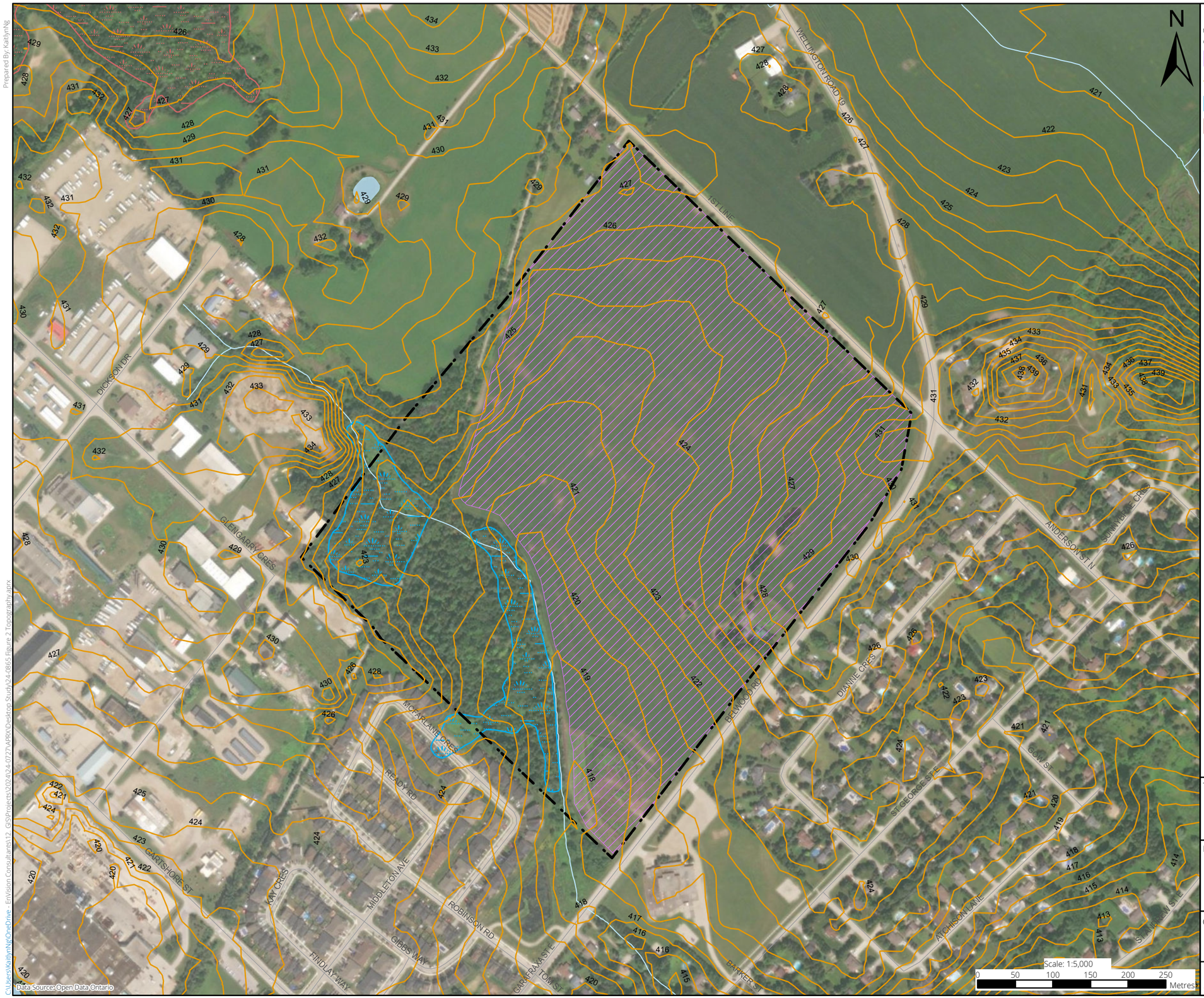
CLIENT

RBS & EJS FERGUS LIMITED PARTNERSHIP

PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0727	JANUARY 2025	KN	TY	1

C:\Users\KaitlynNg\OneDrive - Envision Consultants\12_GIS\Projects\2024\24-0727\APRX\Desktop Study\24-0865 Figure 1 Site Location.aprx

Prepared By: KaitlynNg



LEGEND

- STUDY AREA
- RESIDENTIAL DEVELOPMENT AREA
- 1 m TOPOGRAPHIC CONTOURS (mASL)
- UNEVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- WATERBODY
- WATERCOURSE

TITLE

TOPOGRAPHY

PROJECT

GEOTECHNICAL DESKTOP STUDY
6409 FIRST LINE
FERGUS, ONTARIO

CLIENT

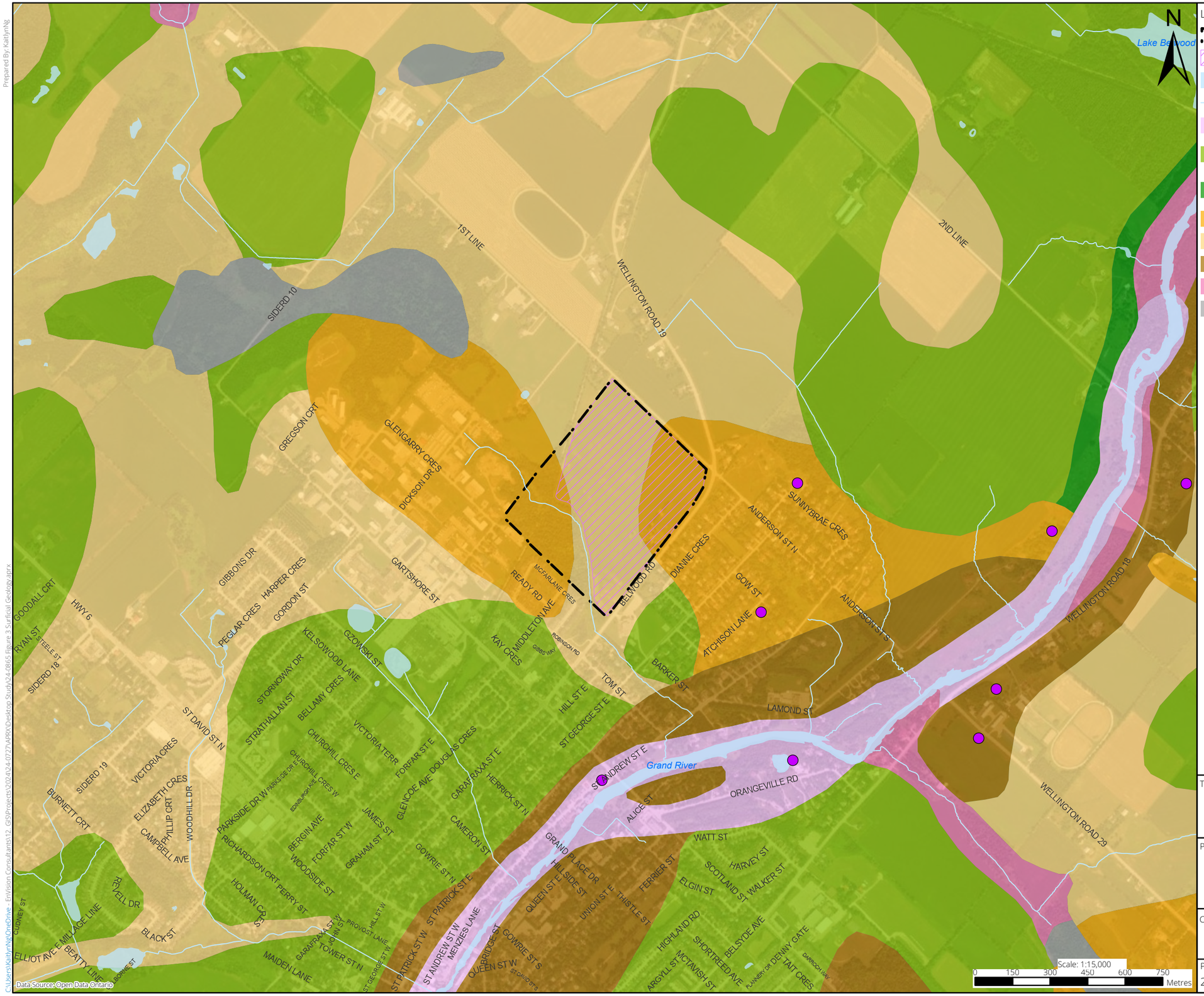
RBS & EJS FERGUS LIMITED PARTNERSHIP

PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0727	JANUARY 2025	KN	TY	2

C:\Users\KaitlynNg\OneDrive - EnVision Consultants\12_GIS\Projects\2024\24-0727\ARP\Desktop Study\24-0865 Figure 2 Topography.aprx

Prepared By: KaitlynNg

C:\Users\KaitlinNg\OneDrive - EnVision Consultants\12. GIS\Projects\2024\24-0727\ARX\Desktop Study\24-0865 Figure 3 Surficial Geology.aprx



LEGEND

- STUDY AREA
- RESIDENTIAL DEVELOPMENT AREA
- WATERBODY
- WATERCOURSE
- 3: PALEOZOIC BEDROCK
- 5B: STONE-POOR, CARBONATE-DERIVED SILTY TO SANDY TILL
- 5D: GLACIOLACUSTRINE-DERIVED SILTY TO CLAYEY TILL
- 6: ICE-CONTACT STRATIFIED DEPOSITS
- 7A: GLACIOFLUVIAL DEPOSITS - SANDY
- 7B: GLACIOFLUVIAL DEPOSITS - GRAVELLY
- 19: MODERN ALLUVIAL DEPOSITS
- 20: ORGANIC DEPOSITS
- OGS PIT

TITLE

SURFICIAL GEOLOGY

PROJECT

GEOTECHNICAL DESKTOP STUDY
6409 FIRST LINE
FERGUS, ONTARIO

CLIENT

RBS & EJS FERGUS LIMITED PARTNERSHIP

PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0727	JANUARY 2025	KN	TY	3

Prepared By: KaitlynNg

C:\Users\KaitlynNg\OneDrive - EnVision Consultants\12 - GIS\Projects\2024\24-0727\APRX\Desktop Study\24-0865 Figure 4 Overburden Thickness.aprx

N

LEGEND

- STUDY AREA
- RESIDENTIAL DEVELOPMENT AREA
- WATERCOURSE
- WATERBODY
- OVERBURDEN THICKNESS (m)
- GUELPH FORMATION

Lake Belwood

Grand River

1ST LINE
2ND LINE
SIDEROAD 10
SIDEROAD 18
SIDEROAD 19
WELLINGTON ROAD 19
WELLINGTON ROAD 18
WELLINGTON ROAD 29
HIGHWAY 6
GREGSON COURT
GLENGARRY CRESCENT
DICKSON DRIVE
GIBBONS DRIVE
GORDON STREET
BARTLSMORE STREET
KELSOWOOD LANE
GZOWSKI STREET
ANNANDALE LANE
ST DAVID STREET NORTH
STRATHALLAN STREET
PARKSIDE DRIVE EAST
BELLAMY CRESCENT
VICTORIA CRESCENT
EDINBURGH AVENUE
BERGIN AVENUE
PARKSIDE DRIVE WEST
WOODHILL DRIVE
ELIZABETH CRESCENT
CAMPBELL AVENUE
BURNETT COURT
JAMES STREET
FORFAR STREET EAST
GARAFRAXA STREET EAST
DOUGLAS CRESCENT
KAY CRESCENT
MIDDLETON AVENUE
ROBINSON ROAD
HILL STREET EAST
ST GEORGE STREET EAST
TOM STREET
ST PATRICK STREET EAST
ST ANDREW STREET EAST
HERRICK STREET NORTH
ALICE STREET
ORANGEVILLE ROAD
CAMERON STREET
GOWRIE STREET NORTH
WOODSIDE STREET
PERRY STREET
HOLMAN CRESCENT
REVELL DRIVE
BLACK STREET
MILLAGE LINE
BEATTY LINE
GARAFRAXA STREET WEST
HILL STREET WEST
PROVOST LANE
ST DAVID STREET SOUTH
QUEEN STREET EAST
UNION STREET EAST
HILLSIDE STREET
THISTLE STREET
ELGIN STREET
SCOTLAND STREET
HARVEY STREET
WATT STREET
WALKER STREET
BELSYDE AVENUE
DENNY GATE
DARROCH WAY
FLANNERY DRIVE
MCTAVISH STREET
HIGHLAND ROAD
DIANNE CRESCENT
GOW STREET
SUNNYBRAE CRESCENT
ANDERSON STREET NORTH
ATCHISON LANE
BARKER STREET
LAMOND STREET

Data Source:
1. Ontario Open Data
2. Armstrong, D.K. and Dodge, J.E.P. 2007. Paleozoic geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 219
3. Gao, C., Shirota, J., Kelly, R.I., Brunton, F.R., van Haaften, S. 2006. Bedrock topography and overburden thickness mapping, southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 207.

Scale: 1:15,000
0 150 300 450 600 750 Metres

TITLE
BEDROCK GEOLOGY AND OVERBURDEN THICKNESS

PROJECT
GEOTECHNICAL DESKTOP STUDY
6409 FIRST LINE
FERGUS, ONTARIO

CLIENT
RBS & EJS FERGUS LIMITED PARTNERSHIP

PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0727	JANUARY 2025	KN	TY	4

Prepared By: KaitlynNg

LEGEND

- STUDY AREA
- 100 m STUDY AREA
- RESIDENTIAL DEVELOPMENT AREA
- WATERBODY
- WATERCOURSE

MECP WATER WELL RECORD

- UNKNOWN
- ABANDONED
- ALTERATION
- OBSERVATION WELL
- TEST HOLE
- WATER SUPPLY

TITLE

MECP WATER WELL LOCATIONS

PROJECT

GEOTECHNICAL DESKTOP STUDY
6409 FIRST LINE
FERGUS, ONTARIO

CLIENT

RBS & EJS FERGUS LIMITED PARTNERSHIP

PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0727	JANUARY 2025	KN	TY	5

C:\Users\KaitlynNg\OneDrive - Envision Consultants12_GIS\Projects\2024\24-0727\ARP\Desktop Study\24-0865 Figure 5 MECP Well Locations.aprx

APPENDIX A:

MECP Water Well Inventory Water Well Data

MECP Water Well Records

Well Record #

6703979 — Lot 008 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 7/2/1971 (DD/MM/YYYY) — Elev (masl) — Easting 550724 — Northing 4841623

/ Domestic — Water Supply — UTM RC 4 — margin of error : 30 m - 100 m

Water Found 45.7 (mbgs) (masl) FRESH

Casing Diameter 4 inch — Casing Material: STEEL

Top of Screen (mbgs) — Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	5.2	(mbgs)	(masl)
Pumping WL	9.1	(mbgs)	(masl)
Pump Rate	31.8	(LPM)	3 / 0
Spec. Cap.	8.03	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
6.1			CLAY / MEDIUM SAND /
24.4			HARDPAN /
27.4			GRAVEL /
47.2		GREY	LIMESTONE /

6704630 — Lot 007 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 5/31/1973 (DD/MM/YYYY) — Elev (masl) — Easting 550914 — Northing 4840883

/ Domestic — Water Supply — UTM RC 4 — margin of error : 30 m - 100 m

Water Found 39.6 (mbgs) (masl) FRESH

Casing Diameter 4 inch — Casing Material: STEEL

Top of Screen (mbgs) — Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	9.1	(mbgs)	(masl)
Pumping WL	10.7	(mbgs)	(masl)
Pump Rate	36.4	(LPM)	4 / 0
Spec. Cap.	23.86	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
9.1			CLAY / SAND /
11.9			HARDPAN / GRAVEL /
39.6		GREY	LIMESTONE /

6705526 — Lot 008 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 5/18/1975 (DD/MM/YYYY) — Elev (masl) — Easting 550714 — Northing 4841573

/ Domestic — Water Supply — UTM RC 5 — margin of error : 100 m - 300 m

Water Found 45.7 (mbgs) (masl) FRESH

Casing Diameter 4 inch — Casing Material: STEEL

Top of Screen (mbgs) — Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	7.3	(mbgs)	(masl)
Pumping WL	10.7	(mbgs)	(masl)
Pump Rate	31.8	(LPM)	3 / 30
Spec. Cap.	9.49	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6		BLACK	TOPSOIL /
3.0		YELLOW	CLAY /
9.1		BROWN	CLAY / STONES /
18.3		GREY	HARDPAN /
26.8		GREY	STONES / HARDPAN / GRAVELLY
45.7		GREY	LIMESTONE /

6705846 — Lot 009 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 10/17/1975 (DD/MM/YYYY) — Elev (masl) — Easting 550664 — Northing 4841623

/ Domestic — Water Supply — UTM RC 5 — margin of error : 100 m - 300 m

Water Found 35.1 (mbgs) (masl) FRESH

Casing Diameter 4 inch — Casing Material: STEEL

Top of Screen (mbgs) — Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	12.2	(mbgs)	(masl)
Pumping WL	22.9	(mbgs)	(masl)
Pump Rate	31.8	(LPM)	2 / 10
Spec. Cap.	2.98	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.6			TOPSOIL /
3.0		BROWN	CLAY / STONES /
12.5		GREY	HARDPAN / BOULDERS /
13.4		GREEN	BOULDERS / HARD /

07-Jan-25

Record Count 4

Well Record #

21.6	GREY	HARDPAN /	BOULDERS	/
24.7	BLACK	GRAVEL /	SAND	/
36.6	GREY	LIMESTONE /		/

6706006 **Lot 007 Conc 02 WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 5/11/1976 DD/MM/YYYY

Elev (masl) Easting 551214 Northing 4841223

/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m

Water Found 67.1 (mbgs) (masl) FRESH

Casing Diameter 4 inch Casing Material: STEEL

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	24.4	(mbgs)	(masl)
Pumping WL	45.7	(mbgs)	(masl)
Pump Rate	36.4	(LPM)	1 / 20
Spec. Cap.	1.70	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions	
0.0					
18.3		BROWN	SAND /		/
21.3			CLAY /		/
30.2			GRAVEL /	CLAY	/
33.2		BROWN	SANDSTONE /		/
69.2		GREY	LIMESTONE /		/

6707270 **Lot 008 Conc 02 WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 4/21/1980 DD/MM/YYYY

Elev (masl) Easting 551164 Northing 4841373

/ Domestic Water Supply UTM RC 5 margin of error : 100 m - 300 m

Water Found 39.6 (mbgs) (masl) FRESH

Casing Diameter 5 inch Casing Material: STEEL

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	27.1	(mbgs)	(masl)
Pumping WL	27.4	(mbgs)	(masl)
Pump Rate	27.3	(LPM)	2 / 0
Spec. Cap.	89.49	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions	
0.0					
3.7		BROWN	SAND /		/
9.4		BROWN	CLAY /		/
29.3		GREY	CLAY /	HARDPAN	/ LAYERED
75.9		GREY	LIMESTONE /		/

6708122 **Lot 009 Conc 02 WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 6/13/1984 DD/MM/YYYY

Elev (masl) Easting 550793 Northing 4841651

/ Domestic Water Supply UTM RC 3 margin of error : 10 - 30 m

Water Found 52.7 (mbgs) (masl) FRESH

Casing Diameter 4 inch Casing Material: STEEL

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	20.1	(mbgs)	(masl)
Pumping WL	25.9	(mbgs)	(masl)
Pump Rate	22.7	(LPM)	3 / 30
Spec. Cap.	3.92	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color		Soil Descriptions	
0.0					
0.6		BLACK	TOPSOIL /		/
3.0		YELLOW	CLAY /		/
6.1		BROWN	SAND /		/
15.2		BROWN	HARDPAN /		/
21.3		BROWN	GRAVEL /	STONES	/
27.4		BROWN	GRAVEL /	STONES	/
52.7		GREY	LIMESTONE /		/

Well Record #

6708742 — **Lot 007 Conc 01** — **WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 11/24/1986 (DD/MM/YYYY) | Elev (masl) | Easting 550872 | Northing 4840734 | / Public | Water Supply | UTM RC 3 | margin of error : 10 - 30 m

Water Found 35.1 (mbgs) (masl) FRESH

Casing Diameter 5 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	9.1	(mbgs)	(masl)
Pumping WL	11.6	(mbgs)	(masl)
Pump Rate	68.2	(LPM)	3 / 0
Spec. Cap.	27.97	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
1.2		BROWN	FILL / /
4.0		BROWN	CLAY / STONES /
19.8		GREY	CLAY / /
38.1		GREY	ROCK / LIMESTONE /

6711828 — **Lot 014 Conc** — **WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 9/26/1995 (DD/MM/YYYY) | Elev (masl) | Easting 551110 | Northing 4841039 | / Domestic | Water Supply | UTM RC 3 | margin of error : 10 - 30 m

Water Found 73.2 (mbgs) (masl) FRESH

Casing Diameter 6 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	26.5	(mbgs)	(masl)
Pumping WL	35.7	(mbgs)	(masl)
Pump Rate	90.9	(LPM)	1 / 0
Spec. Cap.	9.94	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
3.0		BROWN	CLAY / STONES /
9.1		BROWN	CLAY / SAND /
24.4		GREY	CLAY / GRAVEL / SAND
26.5		BROWN	SAND / GRAVEL /
33.5		BROWN	ROCK / /
51.8		GREY	ROCK / /
99.1		BROWN	ROCK / /
103.6		BROWN	ROCK / /

6712311 — **Lot 020 Conc 16** — **FERGUS TOWN / WELLINGTON**

Date 11/8/1996 (DD/MM/YYYY) | Elev (masl) | Easting 550248 | Northing 4841072 | / Industrial | Water Supply | UTM RC 3 | margin of error : 10 - 30 m

Water Found 51.2 (mbgs) (masl) FRESH

Casing Diameter 6 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	22.9	(mbgs)	(masl)
Pumping WL	30.5	(mbgs)	(masl)
Pump Rate	36.4	(LPM)	1 / 0
Spec. Cap.	4.77	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
6.1		BROWN	CLAY / SAND / STONES
34.7		GREY	CLAY / STONES / HARD
51.2		BROWN	ROCK / HARD /

6712377 — **Lot 020 Conc 16** — **FERGUS TOWN / WELLINGTON**

Date 10/2/1997 (DD/MM/YYYY) | Elev (masl) | Easting 550270 | Northing 4841050 | / Industrial | Water Supply | UTM RC 3 | margin of error : 10 - 30 m

Water Found 57.0 (mbgs) (masl) FRESH

Casing Diameter 6 inch | Casing Material: STEEL

Top of Screen (mbgs) | Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	41.8	(mbgs)	(masl)
Pumping WL	45.7	(mbgs)	(masl)
Pump Rate	68.2	(LPM)	1 / 0
Spec. Cap.	17.21	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
6.4		BROWN	CLAY / SAND / STONES
32.0		GREY	CLAY / STONES / HARD
57.0		BROWN	ROCK / HARD /

Well Record #

6712546 Lot Conc **WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 5/7/1998 DD/MM/YYYY

Elev (masl) Easting 551020 Northing 4840983

/ Domestic Water Supply UTM RC 3 margin of error : 10 - 30 m

Water Found 74.7 (mbgs) (masl) FRESH

Casing Diameter 6 inch Casing Material: STEEL

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	30.8	(mbgs)	(masl)
Pumping WL	31.7	(mbgs)	(masl)
Pump Rate	113.7	(LPM)	1 / 0
Spec. Cap.	124.29	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
15.2		BROWN	CLAY / SAND /
25.9		GREY	CLAY / SAND / GRAVEL
27.1		BROWN	SAND / GRAVEL /
35.1		BROWN	ROCK / LIGHT-COLOURED /
53.3		GREY	ROCK / /
99.1		BROWN	ROCK / LIGHT-COLOURED /
103.6		BROWN	ROCK / /

7047185 Lot 009 Conc 02 **WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 6/22/2007 DD/MM/YYYY

Elev (masl) Easting 550735 Northing 4841331

/ Abandoned-Supply UTM RC 3 margin of error : 10 - 30 m

Water Found (mbgs) (masl)

Casing Diameter Casing Material:

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing?

SWL		(mbgs)	(masl)
Pumping WL		(mbgs)	(masl)
Pump Rate		(LPM)	/
Spec. Cap.		(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
			/ /

7050304 Lot 007 Conc 01 **WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 8/21/2007 DD/MM/YYYY

Elev (masl) Easting 551024 Northing 4840932

/ Domestic Water Supply UTM RC 3 margin of error : 10 - 30 m

Water Found 57.0 (mbgs) (masl) FRESH

Casing Diameter 16 cm Casing Material: STEEL

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing? N

SWL	28.5	(mbgs)	(masl)
Pumping WL	30.5	(mbgs)	(masl)
Pump Rate	28.0	(LPM)	1 / 0
Spec. Cap.	13.53	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.3		BROWN	TOPSOIL / /
13.4			SAND / /
30.2			CLAY / SAND /
46.0		GREY	LIMESTONE / /
46.4		BROWN	LIMESTONE / /
58.0		GREY	LIMESTONE / /

7051830 Lot 007 Conc 01 **WEST GARAFRAXA TOWNSHIP / WELLINGTON**

Date 10/16/2007 DD/MM/YYYY

Elev (masl) Easting 550985 Northing 4840899

/ Domestic Water Supply UTM RC 3 margin of error : 10 - 30 m

Water Found 36.6 (mbgs) (masl) FRESH

Casing Diameter Casing Material:

Top of Screen (mbgs) Bottom of Screen (mbgs)

Screen Interval (m)

Flowing?

SWL	17.7	(mbgs)	(masl)
Pumping WL	22.9	(mbgs)	(masl)
Pump Rate	45.5	(LPM)	1 /
Spec. Cap.	8.77	(LPM/m)	Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
5.5		BROWN	CLAY / SAND /
22.9		GREY	CLAY / STONES /
27.7		GREY	CLAY / GRAVEL /
36.6		BROWN	ROCK / /

Well Record #

7113218 — Lot 007 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 7/23/2008 (DD/MM/YYYY) | Elev (masl) | Easting 551053 | Northing 4840968 | / Domestic | Water Supply | UTM RC 3 | margin of error : 10 - 30 m | Water Found 60.0 (mbgs) (masl) | Untested

Casing Diameter 16 cm | Casing Material: STEEL | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? | SWL 29.1 (mbgs) (masl) | Pumping WL 30.5 (mbgs) (masl) | Pump Rate 38.0 (LPM) 1 / 0 | Spec. Cap. 27.54 (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
0.4		BROWN	TOPSOIL / /
11.9			SAND / /
30.2			CLAY / GRAVEL / SAND
60.4		GREY	LIMESTONE / /

7175609 — Lot 008 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 12/13/2011 (DD/MM/YYYY) | Elev (masl) | Easting 550352 | Northing 4841093 | / Monitoring | Observation Wells | UTM RC 4 | margin of error : 30 m - 100 m | Water Found (mbgs) (masl)

Casing Diameter 5.1 cm | Casing Material: PLASTIC | Top of Screen 1.6 (mbgs) | Bottom of Screen 2.9 (mbgs) | Screen Interval 1.3 (m)

Flowing? | SWL (mbgs) (masl) | Pumping WL (mbgs) (masl) | Pump Rate (LPM) / | Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
2.9		BROWN	SAND / STONES / SILT

7175611 — Lot 008 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 12/13/2011 (DD/MM/YYYY) | Elev (masl) | Easting 550331 | Northing 4841083 | / Monitoring | Observation Wells | UTM RC 4 | margin of error : 30 m - 100 m | Water Found (mbgs) (masl)

Casing Diameter 5.1 cm | Casing Material: PLASTIC | Top of Screen 3.0 (mbgs) | Bottom of Screen 6.2 (mbgs) | Screen Interval 3.2 (m)

Flowing? | SWL (mbgs) (masl) | Pumping WL (mbgs) (masl) | Pump Rate (LPM) / | Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
6.2		BROWN	SAND / STONES / SILT

7335159 — Lot 008 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 4/25/2019 (DD/MM/YYYY) | Elev (masl) | Easting 550668 | Northing 4840685 | / Monitoring | Observation Wells | UTM RC 4 | margin of error : 30 m - 100 m | Water Found (mbgs) (masl)

Casing Diameter 5.1 cm | Casing Material: PLASTIC | Top of Screen 6.6 (mbgs) | Bottom of Screen 8.1 (mbgs) | Screen Interval 1.5 (m)

Flowing? | SWL (mbgs) (masl) | Pumping WL (mbgs) (masl) | Pump Rate (LPM) / | Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
2.3		BROWN	SAND / SILT / SOFT
4.7		BROWN	SAND / SILT / HARD
8.1		GREY	SILT / CLAY / DENSE

7339497 — Lot 008 Conc 01 — WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 4/5/2019 (DD/MM/YYYY) | Elev (masl) | Easting 550448 | Northing 4840934 | / | Abandoned-Other | UTM RC 4 | margin of error : 30 m - 100 m | Water Found (mbgs) (masl)

Casing Diameter | Casing Material: | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? | SWL (mbgs) (masl) | Pumping WL (mbgs) (masl) | Pump Rate (LPM) / | Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			

Well Record #

7339498 Lot Conc FERGUS TOWN / WELLINGTON

Date 4/5/2019 DD/MM/YYYY | Elev (masl) | Easting 550569 | Northing 4840705 | / | Abandoned-Other | UTM RC 4 margin of error : 30 m - 100 m | Water Found (mbgs) (masl) | Casing Diameter | Casing Material: | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? / SWL (mbgs) (masl) / Pumping WL (mbgs) (masl) / Pump Rate (LPM) / Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			

/ /

7390690 Lot 009 Conc 01 WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 5/20/2021 DD/MM/YYYY | Elev (masl) | Easting 550488 | Northing 4841268 | / Monitoring | Observation Wells | UTM RC 4 margin of error : 30 m - 100 m | Water Found (mbgs) (masl) | Casing Diameter 1.5 inch | Casing Material: PLASTIC | Top of Screen 4.6 (mbgs) | Bottom of Screen 6.1 (mbgs) | Screen Interval 1.5 (m)

Flowing? / SWL (mbgs) (masl) / Pumping WL (mbgs) (masl) / Pump Rate (LPM) / Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			
6.1		BROWN	SAND /

7434322 Lot 009 Conc 01 WEST GARAFRAXA TOWNSHIP / WELLINGTON

Date 10/27/2022 DD/MM/YYYY | Elev (masl) | Easting 550488 | Northing 4841268 | / Monitoring | Abandoned-Other | UTM RC 4 margin of error : 30 m - 100 m | Water Found (mbgs) (masl) | Casing Diameter | Casing Material: | Top of Screen (mbgs) | Bottom of Screen (mbgs) | Screen Interval (m)

Flowing? / SWL (mbgs) (masl) / Pumping WL (mbgs) (masl) / Pump Rate (LPM) / Spec. Cap. (LPM/m) Hour / Minute

Depth (m)	Elev (masl)	Color	Soil Descriptions
0.0			

/ /

APPENDIX B:

Geotechnical Investigation Report – Proposed Residential Subdivision, Garafraxa Street and Gartshore Street, Town of Fergus, Ontario

FAX TRANSMITTAL

TERRAPROBE LIMITED
Consulting Geotechnical Engineers & Hydrogeologists
Construction and Materials Inspection and Testing

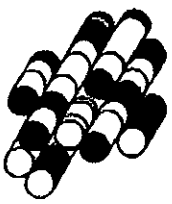
10 Bram Court
Brampton, Ontario
L6W 3R6
Tel:(905)796-2650; Fax:(905)796-2250
brampton@terraprobe.ca

Date: December 3, 2007 **Our File Number: 1-07-2324**

To:	**Sorbara Development Group**		
Attention:	**Mr. Andy Margaritis**		
Fax No.:	**1-905-850-~~6166~~ 6884**	**No. of Pages (incl. transmittal):**	**46**
Subject:	**DRAFT GEOTECHNICAL INVESTIGATION PROPOSED RESIDENTIAL SUBDIVISION GARAFRAXA STREET & GARTSHORE STREET TOWN OF FERGUS, ONTARIO**		
Message:	**Please find attached a Draft copy of the above noted Report for your review and comments. Please note that the draft copy of this report is for discussion purposes only. There may be revisions to the content, recommendations, and information, provided in this report Should you have any questions, please do not hesitate to call.**		

From: **Mr. B. Singh, M.A.Sc., P. Eng.**
Associate

Should you have any problems with this transmittal, please call and ask for Carol.



Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing

DRAFT
(FOR DISCUSSION PURPOSES ONLY)
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL SUBDIVISION
GARAFRAXA STREET & GARTSHORE STREET
TOWN OF FERGUS
ONTARIO

Prepared for: Sorbara Development Group
3700 Steeles Ave. West, Suite 800
Vaughan, ON L4L 8M9

Attention: Mr. Andy Margaritis

File No. 1-07-2324
October 25, 2007

Distribution:

1 Copy - Sorbara Development Group
1 Copy - Terraprobe Limited, Brampton

TABLE OF CONTENTS

ATTACHMENTS

Abbreviations, Terminology and General Information, Engineered Fill Earthworks Specifications

1. INTRODUCTION

Terraprobe Limited was retained by Sorbara Development Group to conduct a geotechnical investigation for the proposed residential subdivision at Garafraxa Street & Gartshore Street in the town of Fergus, Ontario. The legal description of the property is Part of Lot 8, Concession 1, Township of Centre Wellington. The proposed development will be serviced with municipal water and sewage systems. The property is known as East Wood Property and comprises approximately 37 acres, and is located just north of Garafraxa Street (Wellington Road No. 19) and east of Gartshore Street, within the urban boundary of the Town of Fergus as depicted in Figure 1.

The purpose of this investigation was to determine the subsurface conditions across the site and provide geotechnical engineering recommendations for design of foundations, basement drainage, earthwork, pipe bedding and pavement structure. In addition, comments are also included on pertinent construction aspects excavation, backfill, ground water and installation of underground utilities.

2. SITE AND PROJECT DESCRIPTION

The property is known as East Wood Property, and is located just north of Garafraxa Street (Wellington Road No. 19) and east of Gartshore Street, within the urban bound of the Town of Fergus, Ontario. The parcel is roughly rectangular in shape with a plan area of approximately 37 acres. The site is gently rolling to sloping, and generally drops towards the south and southeast, towards ~~the valley~~ the valley of the Grand River.

The site consists mostly of agricultural fields currently under cultivation by a tenant farmer with soy and wheat crops, and vegetated/tree areas in the southwest corner and along the north and east property lines, adjacent to the Elora-Cataract Trail and the Creek.

According to the proposed development plan the stormwater management facilities will be located in the south-east corner of the property just west of the creek. The pond will be located outside the creek buffer as identified by the GRCA.

3. FIELD PROCEDURE

The field investigation was conducted on September 19 and 20, 2007, and consisted of drilling and sampling a total of twelve (12) boreholes, extending to depths ranging from 3.0 m to 8.1 m below ground surface.

The boreholes were staked in the field by Terraprobe Limited in relation to existing features. The ground surface elevations at borehole locations were obtained using Local Benchmark No. 1 located at the southwest face of a hydro pole, which is located approximately 7.5 m north and 7.3 m east of the centre line of road at the intersection of Forfar Street and Gartshore Street, with a marked elevation of 424.43 m. The locations of the boreholes are shown on the borehole location plan (Figure 2).

The borings were made using a bombardier drill rig supplied and operated by Groundwork Drilling Inc. Drilling was conducted under the full time supervision of a member of Terraprobe's field engineering staff who directed the drilling, sampling and in situ testing operations and logged the boreholes. The results of the boreholes are presented in the Log of Boreholes in Appendix A.

Representative samples of the strata penetrated were obtained at varying depths from the boreholes, using a split-barrel sampler advanced by a 63.5 kg hammer dropping approximately 760 mm. The results of these Penetration Tests are reported as "N" values on the borehole logs at corresponding depths.

Samples obtained from the boreholes were inspected in the field, sealed in clean plastic containers and transferred to Terraprobe's laboratory for further detailed examination by a geotechnical engineer. Geotechnical laboratory testing consisted of water content determination on all samples and select samples (Borehole 1, Sample 3, Borehole 2, Sample 6, Borehole 3, Sample 4B, Borehole 7, Sample 4 and Borehole 8, Sample 4) were subjected to grain size distribution tests.

Water level observations were made during drilling and in the open boreholes immediately after completing the drilling operations. The boreholes were also instrumented with a standpipe piezometer to permit longer term groundwater level monitoring.

4. SUBSURFACE CONDITIONS

The results of the individual boreholes are summarized below and recorded on the accompanying Borehole Logs. This summary is intended to correlate this data to assist in the interpretation of the subsurface conditions at the site.

It should be noted that the soil conditions are confirmed at the borehole locations only and conditions may vary between and beyond the boreholes. The boundaries between the various strata as shown on the logs and sections are based on a non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of geologic change.

In summary, the boreholes encountered a surficial topsoil layer typically underlain by earth fill/disturbed native materials which were in turn underlain by undisturbed native soils. The native soils extended to the full depth of investigation at all borehole locations.

4.1 Topsoil

A surficial topsoil layer varying in thickness from about 110 mm (Borehole 4) to about 260 mm (Borehole 2, 6 and 7) was encountered at all borehole locations. The topsoil was dark brown to black in colour and consisted of a sandy soil matrix.

It must be noted that the data provided here pertaining to the topsoil thickness is confirmed at the respective borehole locations only, and may vary between and beyond the boreholes. Further, the above data may not be sufficient for estimating the topsoil quantities and/or associated stripping costs.

4.2 Earth Fill

The earth fill materials were encountered in all boreholes extending to depths of about 0.8 m (Boreholes1, 2, 3, 5, 6, 7, 8, 10, 11 and 12) to about 2.3 m (Borehole 4 and 9) below existing grades. The earth fill materials consisted of sandy silt to silty sand to sand with trace amounts of gravel, clay, organics and rootlets.

The Standard Penetration Test results ('N' Values) obtained within the earth fill material varied from 3blows to 13 blows per 300 mm of penetration, suggesting a very loose to compact relative density.
Measured moisture contents for the samples obtained from this soil stratum typically ranged between 4 percent and 28 percent by weight, indicating the soils to be in a damp to moist to very moist condition.

4.3 Native Soil

The topsoil and earth fill materials encountered in the boreholes were underlain by undisturbed native soil deposit which extended to the full depth of investigation at each borehole location. The composition of the native soils encountered in the boreholes generally varied from sand to silt and silt till soils.

4.3.1 Silt to Sandy Silt Till

In boreholes 1, 3, 11and 12 sandy silt till deposits were encountered underlaying fill and native silt deposit. Sandy silt till deposits in borehole 3,11 and 12 extended beyond the depths of the investigation. Silt Till was encountered in Borehole 10 at a depth of 6.1 to 6.3 m below grade and extended beyond the depth of

investigation. Random deposits of cobbles and boulders can also be expected in till soils due to their mode of deposition.

The Standard Penetration Test results ('N' Values) within the native silt to sandy silt glacial till soil varied from 16 blows to over 67 blows per 300 mm of penetration and 50 blows per 80 to 150 mm of penetration, suggesting a compact to very dense relative density.

Measured moisture contents for the samples obtained from these soils typically ranged between 8 percent and 19 percent by weight indicating these soils to be typically in a damp to moist condition.

4.3.2 Sand, Sand and Silt to Silty Sand

In boreholes 1, 2, 3, 5, 6, 7, 8, 9 and 10 sand, sand and silt to silty sand deposits were encountered underlaying fill, glacial till or sandy silt layer. Sand , sand and silt to silty sand deposits in borehole 1, 5, 7, and 9 extended beyond the depths of the investigation.

The Standard Penetration Test results ('N' Values) within the native sand, sand and silt to silty sand deposits varied from 8 blows to 36 blows per 300 mm of penetration, suggesting a loose to dense (typically compact) relative density.

Measured moisture contents for the samples obtained from these soils typically ranged between 5 percent and 26 percent by weight indicating a moist to wet condition.

4.3.3 Silt and Sandy Silt

In borehole 2, 3, 4, 5, 6, 7, 8, and 10 silt and sandy silt deposit was encountered interbedded with sand, silty sand and silt and sand layers. Silt and sandy silt deposits in borehole 2, 4 and 6 extended beyond the depths of the investigation.

The Standard Penetration Test results ('N' Values) within the native silt and sandy silt deposits varied from 8 blows to 47 blows per 300 mm of penetration, suggesting a loose to dense (typically compact) relative density.

Measured moisture contents for the samples obtained from these soils typically ranged between 9 percent and 27 percent by weight indicating a moist to wet condition.

4.4 Ground Water

The depth of ground water seepage in each of the boreholes was measured immediately following the drilling. Water levels were also measured in the standpipe piezometers installed in Boreholes on September 26, 2007, about one week following the drilling. The water levels measured at the time of drilling and subsequent visit are summarized as follow:

Bore-hole No.	Depth of Boring below ground level (m)	Depth to Cave below ground level (m)	Water level at the time of drilling, below ground level (m)	Water level on September 26, 2007, below ground level/Elev. (m)
1	4.3	2.7	2.4	2.7/421.7
2	8.1	open	dry	1.9/421.2
3	4.3	open	dry	2.8/421.8
4	4.3	3.5	3.4	3.6/421.3
5	8.1	2.1	2.1	1.7/421.3
6	3.0	open	1.5	1.2/419.9
7	6.6	4.0	1.5	1.0/420.2
8	4.3	open	dry	2.8/421.4
9	6.6	3.7	3.7	3.5/420.2
10	6.3	1.8	1.8	1.8/419.6
11	3.0	open	dry	1.6/416.8
12	6.2	open	dry	2.3/416.1

It should be noted that the ground water levels indicated above may fluctuate seasonally depending on the amount of precipitation and surface runoff.

5. DISCUSSION AND RECOMMENDATIONS

The following discussion and recommendations are based on the factual data obtained from this investigation and are intended for use of the owner and the design engineer. Contractors bidding or providing services on this project should review the factual data and determine their own conclusions regarding construction methods and scheduling.

This report is provided on the basis of these terms of reference and on the assumption that the design features relevant to the geotechnical analyses will be in accordance with applicable codes, standards and guidelines of geotechnical engineering practice. The pertinent sections of Ontario Building Code may require additional considerations beyond the recommendations provided in this report and should be referred. If there are any changes to the site development features or any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Terraprobe should be retained to review the implications of these changes with respect to the contents of this report.

5.1 Foundations

As noted previously, the boreholes encountered a surficial topsoil layer underlain by a stratum of earth fill materials extending to depths of about 0.8 m to as much as about 2.3 m (Borehole 4 and 9) below existing grades. The undisturbed native soils (predominantly consisted of silt to sandy silt till, sand, sand and silt to silty sand) were encountered underlying the earth fill materials at all borehole locations.

The topsoil, and earth fill materials are considered to be unsuitable to support the foundations. The undisturbed native soils encountered underlying the earth fill materials are considered suitable for the support of the proposed foundations.

5.1.1 Spread Foundations on Native Soils

It is understood that single and double storey residential dwellings are proposed and it is envisaged that the houses will comprise of a single level basement. At this site spread/strip footings can be founded on the native, undisturbed compact to dense silt to sandy silt till, silt and sandy silt, sand, sand and silt to silty sand. The recommended founding depths and geotechnical resistances for spread/strip footings founded on undisturbed competent natural soils are tabulated below.

Geotechnical Resistances at Borehole Locations

BH No.	Existing Ground Surface Elev. (m)	Highest (Bottom) of Footing Below Existing Ground Surface (m)	Highest (Bottom) of Footing Elevation (m)	Factored Geotechnical Resistance at U.L.S. (kPa)	Bearing Resistance at S.L.S. (kPa)	Subgrade Material
1	424.4	Below 0.8	Below 423.6	300	200	Sandy Silt Till
2	423.2	Below 0.8	Below 422.4	225	150	Sand
3	424.6	Below 0.8	Below 423.8	300	200	Sand
4	424.9	Below 2.3	Below 422.6	225	150	Sandy Silt
5	423.0	Below 0.8	Below 422.2	225	150	Sand
6	421.2	Below 0.8	Below 420.4	225	150	Sand
7	421.2	Below 0.8	Below 420.4	225	150	Sand
8	424.2	Below 0.8	Below 423.4	300	200	Sandy Silt
9	423.8	Below 2.3	Below 421.5	225	150	Sand
10	421.4	Below 0.8	Below 420.6	300	200	Sand
11	418.4	Below 0.8	Below 417.6	225	150	Sandy Silt Till
12	418.4	Below 0.8	Below 417.6	225	150	Sandy Silt Till

The geotechnical resistances quoted above are for concentric, vertical loads only. The SLS values quoted above corresponds to a settlement of up to 25 mm assuming that the founding soils will be undisturbed during construction.

5.1.2 Foundations on Engineered Fill

It is understood that construction of engineered fill may be required to raise the ambient grades within some of the low lying areas of the site.

The engineered fill refers to earth fill designed and constructed with the full-time inspection and testing, so as to support the building foundations without excessive settlement. Construction of engineered fill should only be conducted under the full-time engineering guidance and supervision.

Prior to the placement of the engineered fill, it is recommended that the topsoil and/or existing earth fill/disturbed native materials be stripped from beneath and beyond the proposed foundation envelopes (minimum of 2 m beyond), and that the subgrade be proof-rolled. Any soft or wet areas which deflect

excessively during proof rolling, should be sub-excavated and replaced with suitably compacted clean earth fill in lifts of 150 mm or less.

The engineered fill should consist of clean earth, free from any organic or deleterious matter. The existing earth fill/disturbed native materials may be utilized as engineered fill provided these soils are not too wet for efficient compaction and do not contain excessive organic or topsoil inclusion. It should be noted that the transitional zone of the topsoil and the underlying native soils/earth fill materials (upper 0.3 m to 0.6 m), typically contains relatively higher amounts of organic and topsoil inclusion and high in-situ moisture content. The selection of engineered fill material should be conducted under the guidance of a geotechnical engineer. The materials containing excessive amounts of organics could either be discarded or used for landscaping purposes. The native soils in general, can be utilized as engineered fill provided these soils are not too wet for efficient compaction and do not contain excessive organic inclusion. The moisture content of the engineered fill material should be within two percent of the optimum moisture content.

The engineered fill materials should be placed in lifts of 150 mm or less, and compacted to 100 percent Standard Proctor Maximum Dry Density (SPMDD). The engineered fill should extend for a distance of at least 2 m beyond the perimeter of the foundation envelopes as measured at the founding level, and should extend downwards from this point at a 1 to 1 (horizontal to vertical) slope, to the original ground. In addition, the fill should extend to an elevation of at least 0.6 m above the proposed foundation elevation. This is to ensure that the foundations are placed on the engineered fill both in plan and elevation. The engineered fill must be provided with a minimum of 1.2 m of earth cover or equivalent insulation to provide adequate frost protection.

The placement and inspection of the engineered fill must be conducted under the full time supervision of a qualified geotechnical engineer. Provided the engineered fill is placed and compacted as indicated previously, a footing bearing on engineered fill may be designed for the following concentric, vertical geotechnical resistances:

Factored ULS	–	225 kPa
SLS	–	150 kPa.

The geotechnical resistances quoted above are for concentric, vertical loads only. For footings designed on the basis of the geotechnical resistance values given above, total settlement under a footing is expected to not exceed 25 mm.

It should be noted that for houses placed on engineered fill, nominal reinforcing steel is recommended in the foundation walls. The reinforcing steel should consist of two (2) continuous 15 M bars at the top of the foundation wall and two (2) continuous 15 M bars at the bottom. The enclosed Figure 3 provides details of the recommended reinforcing steel. A copy of "Engineered Fill Earthworks Specifications" is enclosed in the appendix section of this report for reference purposes. These specifications should be included in the earthworks contract.

5.1.3 Placement of Footings and Floor Slab

It is recommended that the minimum width for the conventional spread strip footings be at least 450 mm, and the minimum size of the individual column footings be 900 mm x 900 mm for footings supported on

undisturbed native soils. The footing sizes for housing and small buildings are stipulated in the Ontario Building Code (2006), Part 9, Section 9.15.3 and should be referred. In case of footings supported on engineered fill, the minimum width for the conventional spread strip footings should be at least 600 mm, and the minimum size of the individual column footings be 1000 mm x 1000 mm regardless of loading considerations. All exterior foundations, or foundations in unheated areas should be provided with a minimum soil cover of 1.2 m or equivalent insulation, for frost protection. However, it is anticipated that basement foundations placed on the competent native soils could be greater than minimum depth required for the frost protection.

It is recommended that all excavated footing bases must be evaluated by a qualified geotechnical engineer to ensure that the founding soils exposed at the excavation base are consistent with the design bearing pressure intended by the geotechnical engineer.

Prior to pouring concrete for the footings, the footing areas should be cleaned of all deleterious materials such as topsoil, fill, softened, disturbed or caved materials, as well as any standing water. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided.

The native soils and engineered fill material tend to weather and deteriorate rapidly on exposure to the atmosphere or surface water. Footing excavations which remain open for an extended period of time should be protected by a skim coat of lean concrete.

Concrete floor slabs should be placed on at least 150 mm of granular base (OPSS Granular "A" or 19 mm crusher run limestone) compacted to a minimum of 98 percent SPMDD. Prior to the placement of the granular material, the subgrade should be proof rolled with a heavy rubber tire equipment. Any subgrade areas which deflects excessively must be subexcavated and backfilled with suitable compacted clean earth fill materials. Similarly, any soft or wet areas should also be subexcavated and be backfilled with suitably compacted clean earth fill. The granular base should be placed either on undisturbed native subgrade or clean earth fill compacted to at least 98 percent SPMDD.

5.2 Earth Pressure Design Parameters

Walls or bracings subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following equation:

$$P = K [\gamma (h-h_w) + \gamma' h_w + q] + \gamma_w h_w$$

where:

P = the horizontal pressure at depth, h (m)
K = the earth pressure coefficient,
h_w = the depth below the ground water level (m)
γ = the bulk unit weight of soil, (kN/m^3)
γ' = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)
q = the complete surcharge loading (kPa)

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall, this equation can be simplified to:

$$P = K[\gamma h + q]$$

This equation assumes that free-draining granular backfill is used and positive drainage is provided to ensure that there is no hydrostatic pressure acting in conjunction with the earth pressure.

Resistance to sliding of earth retaining structures is developed by friction between the base of the footing and the soil. This friction (R) depends on the normal load on the soil contact (N) and the frictional resistance of the soil ($\tan \phi$) expressed as: $R = N \tan \phi$. This is an ultimate resistance value and does not contain a factor of safety.

Passive earth pressure resistance is generally not considered as a resisting force against sliding for conventional retaining structure design because a structure must deflect significantly to develop the full passive resistance.

The appropriate values for use in the design structures subject to unbalanced earth pressures at this site are tabulated as follows:

Parameter	Definition	Units
ϕ	internal angle of friction	degrees
γ	bulk unit weight of soil	kN/ m^3
K_a	active earth pressure coefficient (Rankin)	dimensionless
K_o	at-rest earth pressure coefficient (Rankin)	dimensionless
K_p	passive earth pressure coefficient (Rankin)	dimensionless

Stratum/Parameter	Φ	γ	K_a	K_o	K_p
Glacial Till (Silt to Sandy Silt)	32	22.0	0.30	0.47	3.22
Sandy/Clayey Silt or Similar Fill	30	19.5	0.35	0.50	3.00
Compact Granular Fill	32	21.5	0.30	0.47	3.22
Sand/Silty Sand	32	20.5	0.30	0.47	3.22

5.3 Basement Drainage

To assist in maintaining basements dry from seepage, it is recommended that exterior grades around the buildings be sloped away at a 2 percent gradient or more, for a distance of at least 1.2 m. As well, perimeter foundation drains should be provided, consisting of perforated pipe with filter cloth and surrounded by a granular filter (minimum 15 cm thick) and freely outletting. The granular filter should consist of OPSS HL 8 Coarse Aggregate (refer to Figure 4&5).

The basement wall backfill for a minimum lateral distance of 0.6 m out from the wall should consist of free-draining granular material (OPSS Granular 'B'), or provided with a suitable alternative drainage cellular media.

Basements should be established above the ground water table in sand and silty sand areas. If basements are placed within 0.5 metres of ground water table , then in addition to the above recommended perimeter drainage, the provision of a sub-floor drainage system installed beneath the basement floor is required in the areas where wet silt/sand soils are encountered at the basement floor subgrade level. The sub-floor drainage system should consist of perforated pipes located at a distance of about 4.0 m centre to centre (Figure 4 & 5). The perimeter foundation and sub-floor drains may be outlet to a municipal sewer (if permissible), or other suitable discharge point under gravity flow, or connected to a sump located in the lowest level of the basement, and the water be pumped up to a sewer or other suitable discharge point. The perimeter and sub-floor drain installation and outlet should conform to the applicable code provisions.

The size of the sump pit should be adequate to accommodate the anticipated water seepage, and the sub-floor drainage system should be designed to prevent the possibility of back-flow. A duplex pumping arrangement (main pump with a provision of a backup pump) on emergency backup power is recommended.

5.4 Earthquake Design Parameters

The Ontario Building Code (2006) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification.

The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the Ontario Building Code (2006). The classification is based on the determination of the average shear wave velocity in the top 30 metres of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated on the basis of rational analysis of undrained shear strength (s_u) or penetration resistance (N-values). The equations used for determining these parameters are:

$$\upsilon_{s-avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{\upsilon_{si}}} \qquad S_{u-avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{s_{ui}}} \qquad N_{avg} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{N_i}}$$

Shear Wave Velocity | **Undrained Shear Strength** | **SPT N-values**

At this site for seismic design purposes, the weighted Average Standard Penetration Resistance can be taken as between 15 and 50 blows per 300 mm. On this basis, the site designation for seismic analysis is Class D, according to Table 4.1.8.4.A of the Ontario Building Code (2006). Tables 4.1.8.4.B and 4.1.8.4.C. of the same code provide the applicable acceleration (Fa) and velocity (Fv) based site coefficients which are tabulated below.

Site Class	Values of F_a				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
D	1.3	1.2	1.1	1.1	1.0

Site Class	Values of F_v				
	$S_a(1.0) \leq 0.1$	$S_a(1.0) = 0.2$	$S_a(1.0) = 0.3$	$S_a(1.0) = 0.4$	$S_a(1.0) \geq 0.5$
D	1.4	1.3	1.2	1.1	1.1

It should be noted that the above site seismic designation is estimated on the basis of rational analysis of penetration resistance (N-Values) with assumed N-Values for the soil stratigraphy beneath the investigation depth. Alternatively, a site specific Multichannel Analysis of Surface Waves (MASW) may be conducted to determine the average shear wave velocity in the top 30 metres of the site stratigraphy to establish the site designation for seismic analysis.

5.5 Excavations

The borehole data indicate that earth fill materials, silt to sandy silt, silty sand, sand and sand and silt soils would be encountered in the excavations. Excavations must be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. These regulations designate four broad classifications of soils to stipulate appropriate measures for excavation safety.

TYPE 1 SOIL

a. is hard, solid, only able to be penetrated by a small sharp object with difficulty;

b. can only be excavated by mechanical equipment;

c. shows no sign of visible cracks after excavation;

d. exhibits a dry, shiny appearance after excavation; and

e. possesses a low moisture content and a high degree of internal strength.

TYPE 2 SOIL

a. cracks or crumbles;

b. can be penetrated by small sharp objects easily;

c. can be excavated by hand tools with moderate difficulty;

d. exhibits signs of surface cracking;

e. exhibits a damp appearance after excavation; and

f. possesses a low to medium moisture content and a medium degree of internal strength.

TYPE 3 SOIL

a. is loose, soft, sandy, or previously excavated;

b. can be excavated with hand tools easily;

c. will run easily into a well defined conical pile if dry;

d. will flow or shift unless supported if wet; and

e. possesses a low degree of internal strength.

TYPE 4 SOIL

a. is wet or muddy;

b. will run easily or flow unless completely supported immediately after excavation;

c. exerts substantial fluid pressure upon its supporting system; and

d. possesses almost no internal strength.

The earth fill soils, sand to silty sand, silt to sandy silt and sand and silt soils encountered in the boreholes are classified as Type 3 soil above and Type 4 soil below the prevailing groundwater level, the undisturbed native glacial till (silt to sandy silt) soils would be classified as Type 2 soil above the ground water table and Type 3 soil below the ground water table, under these regulations.

Where workmen must enter excavations advanced deeper than 1.2 m, the trench walls should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates maximum slopes of excavation by soil type as follows:

Soil Type	Base of Slope	Maximum Slope Inclination
1	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
2	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
3	from bottom of trench	1 horizontal to 1 vertical
4	from bottom of trench	3 horizontal to 1 vertical

Minimum support system requirements for steeper excavations are stipulated in the Occupational Health and Safety Act and Regulations for Construction Projects, and include provisions for timbering, shoring and moveable trench boxes.

Water seepage was encountered in Borehole 1, 4, 5,6, 7, 9 and 10 upon completion of drilling. Further, water levels were noted to be within 1.0 m to 3.5m below grade in the standpipe piezometers. Wet sand, sand and silt, sandy silt and silt were encountered in Borehole 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 at depths from 0.8 to 3.0 m. Therefore, water seepage into the excavation is expected in these borehole locations. For excavations extending below the prevailing ground water table (if required), within the silt/sand deposit, it will be necessary to lower the groundwater level (at least 1 metre below the excavation base) prior to and during the construction, and therefore, more rigorous de-watering system (i.e. well points or deep well) will be required

In Borehole 11and 12 where full depth of sandy silt glacial till soils with some amount of clay were encountered and no seepage was observed during and completion fo drilling. Groundwater seepage should be relatively less in this location. The ground water seepage form the relatively less permeable till soils may emanate from the earth fill materials, or sand/silt lenses, seams and pockets generally found within the glacial till deposit. The groundwater seepage should diminish slowly and can be controlled by continuous pumping from a conventional sump and pump arrangement at the base of the excavation. The same technique can be applied within the upper glacial till zone in borehole location 1. This can best be assessed by carrying out trial excavations (test pits) prior to, or during the tender period.

The soils describe at this site are considered to be suitable for excavation using trenching and excavating equipment, such as backhoes normally used by contractors for sewer installation. Excavation should be undertaken in accordance with OPSS 514. Till soil inherently contain cobbles and boulders and the contract documents must identify this fact to bidders.

5.6 Storm Water Management Ponds

Borehole 11 and 12 are located in the general vicinity of the storm water management pond. These two borcholes show a subsurface stratigraphy consisting of surficial sandy silt fill underlain by sandy silt glacial till.

It is likely that the base and sides of the pond will consists of sandy silt till. The estimated coefficients of permeability of the sandy silt till range from 10^{-4} to 10^{-5} cm/sec.

Ground water table is 1.6 to 2.3 metres below existing grades in boreholes 11 and 12 respectively. Groundwater seepage should be relatively less in sandy silt till in this location. The ground water seepage form the relatively less permeable till soils may emanate from the earth fill materials, or sand/silt lenses, seams and pockets generally found within the glacial till deposit. The groundwater seepage should diminish slowly and can be controlled by continuous pumping from a conventional sump and pump arrangement at the base of the excavation.

Katie proposed 5:1

Design side slopes of about 4H:1V are considered to be stable at this site. Steeper slopes may be achieved, however specific information is required regarding pond location and configuration.

Slope surfaces and all exposed areas (where applicable) must be provided with suitable ground cover or erosion protection. The slope surface should be provided with a thin layer of topsoil (minimum 100 mm thick) and

should be hydro-seeded with a grass mixture and mulch. Alternatively, staked sod could be used. If seeded, the surface cover of topsoil and seeding may require periodic maintenance (due to surface erosion) until the vegetation becomes well established. It is recommended that erosion netting be staked on the outside slope (where applicable) for erosion protection (and inside slope which is above water level).

Periodic fluctuations in the pond water level will result in bare slopes being exposed for several days to weeks or months. The bare slopes will be susceptible to minor sheet and rill erosion over extended periods of exposure. Occasional maintenance and repair of the bare inside slopes of the pond (and removal of accumulated sediment in the base) will be required. A rip rap or gravel lining of the pond inside slopes would reduce the amount of maintenance.

5.7 Backfill

As noted previously, the transitional zone of the topsoil and the underlying earthfill or native materials (upper 0.3 m to 0.6 m) typically contain relatively higher amounts of organic and topsoil inclusion. Therefore, it is recommended that the selection and sorting of the soils to be used as engineered fill and/or backfill should be supervised by a geotechnical engineer. The earth fill materials which contain excessive amounts of topsoil and/or organic and exhibit a higher in-situ moisture content should not be reused as engineered fill, or backfill in settlement sensitive areas, such as trench backfill, beneath floor slabs and driveways. However, this material may be stockpiled and reused for landscaping purposes.

Based on the results of the subsurface investigation, the native soils, are generally considered suitable for reuse as backfill provided these soils are not too wet to achieve specified compaction. Further, earth fill materials with in-situ moisture content close to the optimum water content and free of deleterious materials and organics, may also be used for backfilling purposes. It should be noted that there may be some relatively wetter zones within earth fill materials. Further, native silt/sand soils may also be too wet to compact to specified densities. Any soil materials with in-situ moisture content of more than 2 percent above the optimum moisture content could be put aside to dry, or could be tilled to reduce the moisture content so that it can be effectively compacted. Alternatively, materials of higher moisture content could be wasted and be replaced with imported material which can be readily compacted. It should be noted that soils encountered on the site are not free draining, therefore, earthworks will be difficult to carry out in wet seasons such as spring and fall.

In settlement sensitive areas such as beneath floor slabs, pavements, the backfill should consist of clean earth and should be placed in lifts of 150 mm thickness or less and heavily compacted to a minimum of 95 percent

SPMDD at a water content close to optimum. The soils encountered on site will be best compacted with a heavy sheepsfoot type roller.

5.8 Trench Clay Plugs & Cutoff Collars

Clay plugs are usually installed in trenches to protect the groundwater and to prevent its lowering due to the "French Drain" effect of the granular bedding and backfill material. If the invert of the trench is below the water table and local drawdown of the groundwater level cannot be tolerated for environmental reasons then clay plugs can be installed within the granular bedding and the granular zones of backfill material.

Clay plugs should be placed in the trenches at 50 m intervals along the full length of the trench, where the invert of the trench is below the water table. The plug should be 1 m thick measured along the pipe, and should completely replace the granular bedding and sand backfill placed above the springline and the obvert of the sewer. The clay plugs must be compacted to 95% SPMDD.

Material used for the clay plugs should contain not less than 15% particles finer than 2 microns and should have a coefficient of permeability less than 10^{-6} cm/s.

Alternatively, cut off collars can be installed around the pipe barrel to achieve the same effect. Collars should not be placed closer than 1 m to a pipe joint and precautions should be taken to ensure that 95% compaction is achieved around the collars. Watertight connections are required between the collar and the pipe wall.

5.9 Pipe Bedding

The undisturbed native materials will be suitable for support of buried services on conventional well graded granular base material. Where disturbance of the trench base has occurred, such as due to groundwater seepage, or construction traffic, the disturbed soils should be subexcavated and replaced with suitably compacted granular fill.

Granular bedding material should consist of a well graded, free draining soil, such as OPSS Granular "A" or 19 mm Crusher Run Limestone or its equivalent as per the pertinent City/Region specifications. The bedding material should be placed in 150 mm lifts and compacted to a minimum of 95 percent SPMDD or vibrated/tamped to a dense state in case of a clear stone material.

A clear stone type bedding may be considered, however, such bedding should be used in conjunction with a suitable geotextile filter where silt/sand subgrades are encountered. Otherwise without proper filtering, there may be entry of fines from the native soils into the bedding. This loss of ground could result in loss of support to the pipes and possible future settlements. Where the trench base consists of clayey soils, a geotextile filter is not required.

5.10 Pavement Design

The pavement subgrade in the proposed development is expected to consist of native soils and fill materials. These soils may be utilized for subgrade preparation provided they do not contain excessive amounts of organics and deleterious materials, and their in-situ moisture content is within 2% of their optimum moisture content. The pavement subgrade should be proof-rolled with a heavy rubber tire vehicle and any loose, soft, wet or unstable areas should be sub-excavated, and backfilled with clean earthfill material placed in 150 mm lifts and compacted to a minimum of 98% SPMDD.

For preliminary design purposes the following flexible pavement thicknesses are recommended for different types of roads:

MATERIAL	MINIMUM THICKNESS (mm) (Local Roads)	MINIMUM THICKNESS (Minor Collector) (mm)	MINIMUM THICKNESS (Arterial Roads) (mm)
Surface Course - HL3 Asphaltic Concrete (OPSS 1150) with PG asphalt cement (OPSS 1101) and relevant City specifications)	40	50	50
Binder Course - HL8 Asphaltic Concrete (OPSS 1150) with PG asphalt cement (OPSS 1101) and relevant City specifications)	60	75	75
Granular "A" or 19 mm crushed limestone base (OPSS 1010 and relevant City specifications)	150	150	150
Granular "B" or 50 mm crushed limestone sub-base (OPSS 1010 and relevant City specifications)	300	450	450

The granular materials should be placed in lifts 150 mm thick or less and be compacted to a minimum of 100 percent and 98 percent SPMDD for granular base and granular sub-base, respectively. Asphalt materials should be rolled and compacted as per OPSS 310. The granular and asphalt pavement materials and their

placement should conform to OPSS Forms 310, 501, 1010 and 1150 and the pertinent City specifications. Further, it is recommended that City and other pertinent specifications should be referred for use of higher grades of asphalt cement for asphaltic concrete where applicable.

The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (preferably at a minimum grade of two percent) to provide effective drainage toward subgrade drains. Grading adjacent to the pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement. Continuous pavement subdrains should be provided along both sides of the roads and drained into respective catchbasins to facilitate drainage of the subgrade and the granular materials. The subdrain invert should be maintained at least 0.3 m below subgrade level (Figure 6).

6. LIMITATIONS AND RISK

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. A comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions.

The discussion and recommendations are based on the factual data obtained from the investigation and are intended for use by the owner and its retained designers in the design phase of the project. Since the project is still in the design stage, all aspects of the project relative to the subsurface conditions cannot be anticipated. Terraprobe should review the design drawings and specifications prior to the construction of this work. If there are changes to the project scope and development features the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant to the revised project or complete. Terraprobe should be retained to review the implications of changes with respect to the contents of this report.
The investigation at this site was conceived and executed to provide information for project design. It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could have an effect on construction costs, techniques, equipment, and scheduling. Contractors bidding on or undertaking work on this project should therefore, in this light, be directed to decide on their own investigations, as well as their own interpretations of the factual investigation results. They should be cognizant of the risks implicit in subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

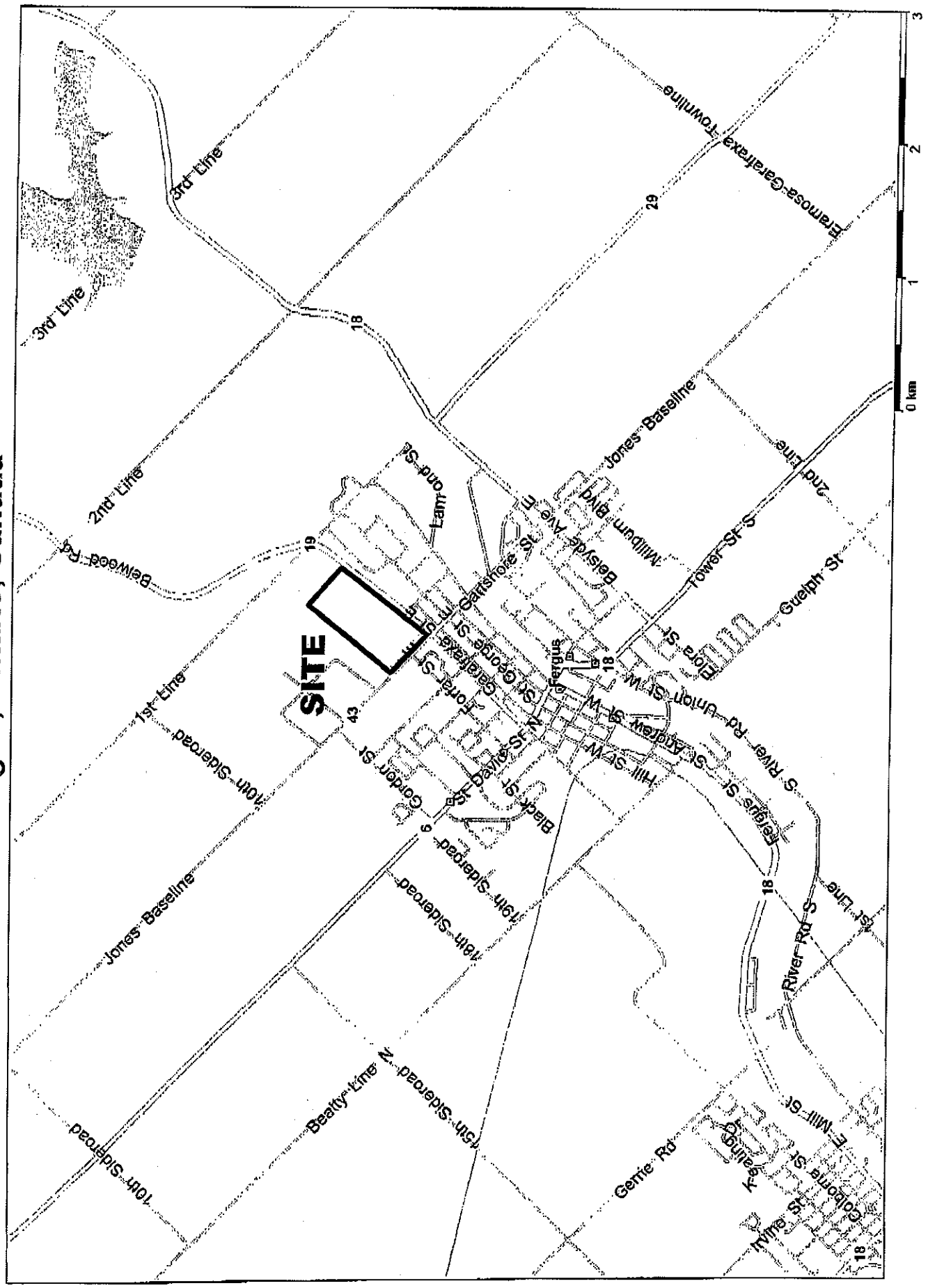
Terraprobe Limited

DRAFT

DRAFT

Madan Talukdar, P. Eng.
Project Engineer

Billy Singh, P. Eng.
Associate

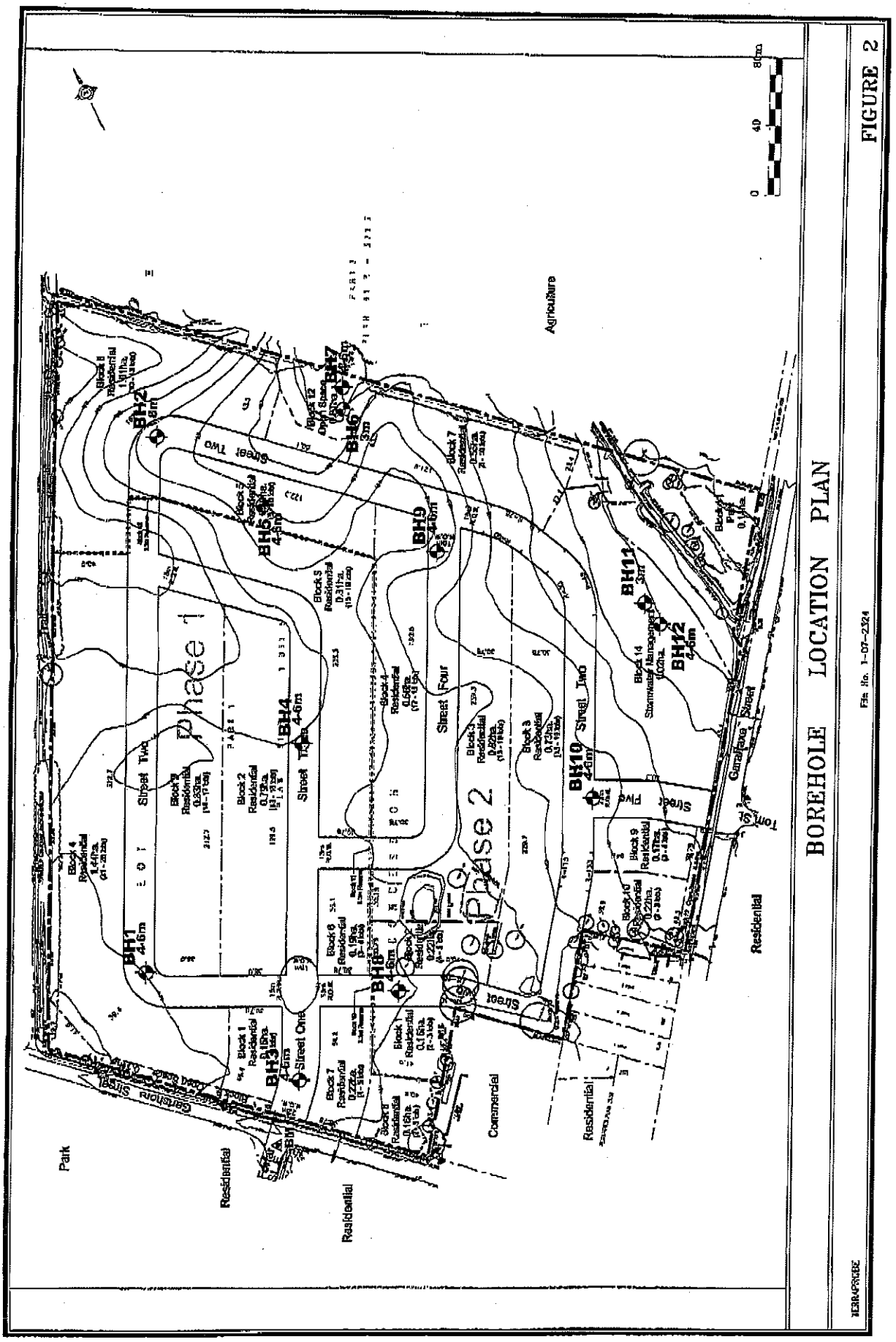


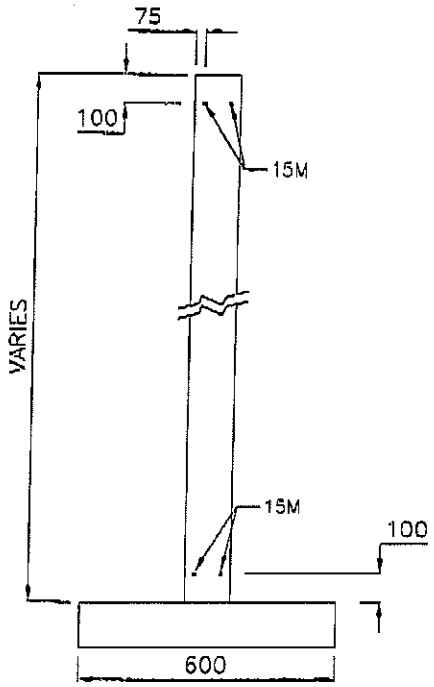
SITE LOCATION PLAN

File No. 1-07-2324

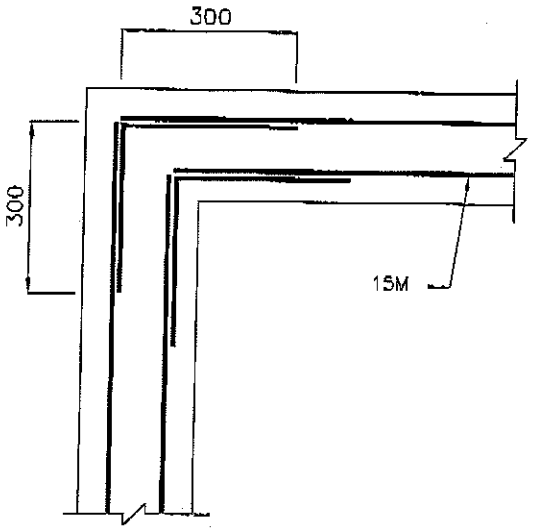
FIGURE 1

TERRAPROBE

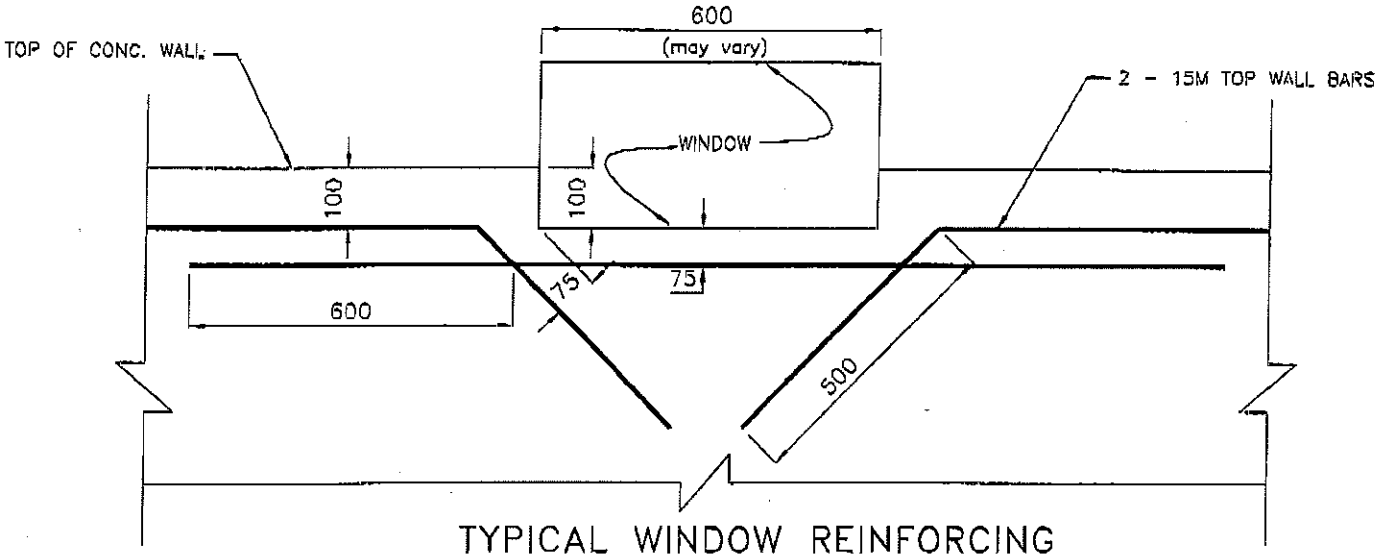

BOREHOLE LOCATION PLAN
FIGURE 2
File No. 1-07-2324
TERRAPROBE
Phase 1
Phase 2
Street One
Street Two
Street Three
Street Four
Street Five
Street Six
Agriculture
Residential
Commercial
Park
BH1
BH2
BH3
BH4
BH5
BH6
BH7
BH8
BH9
BH10
BH11
BH12



TYPICAL
WALL DETAIL
NOT TO SCALE



TYPICAL SPLICING
AT CORNERS
NOT TO SCALE

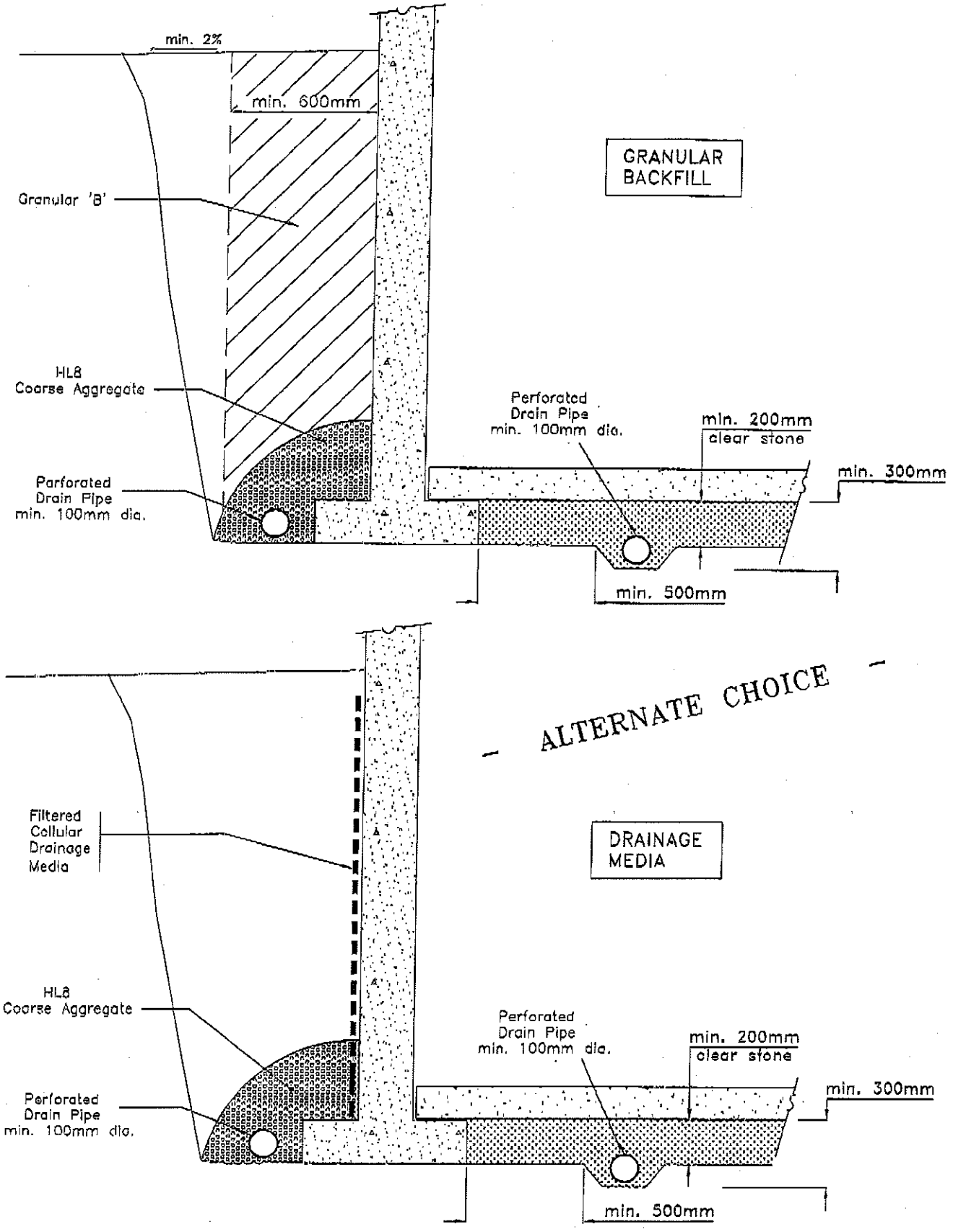


TYPICAL WINDOW REINFORCING
NOT TO SCALE

NOTES:
1. Reinforcing steel C.S.A. G 30.18 M 1992 Grade 400
2. Base of all footing excavations to be inspected and approved prior to placing formwork.
3. All dimensions are in mm.

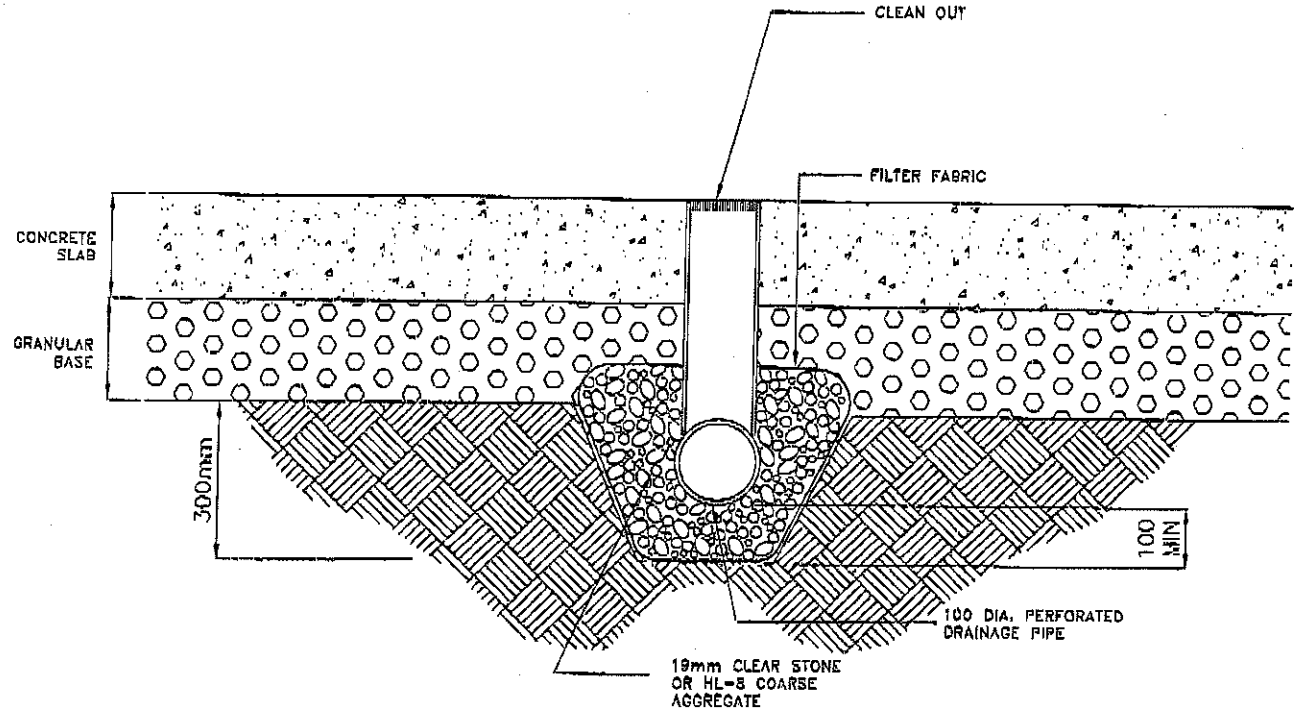
TYPICAL FOUNDATION WALL DETAILS FOR STRUCTURES
ON ENGINEERED FILL

TERRAPROBE File No. 1-07-2324 FIGURE 3

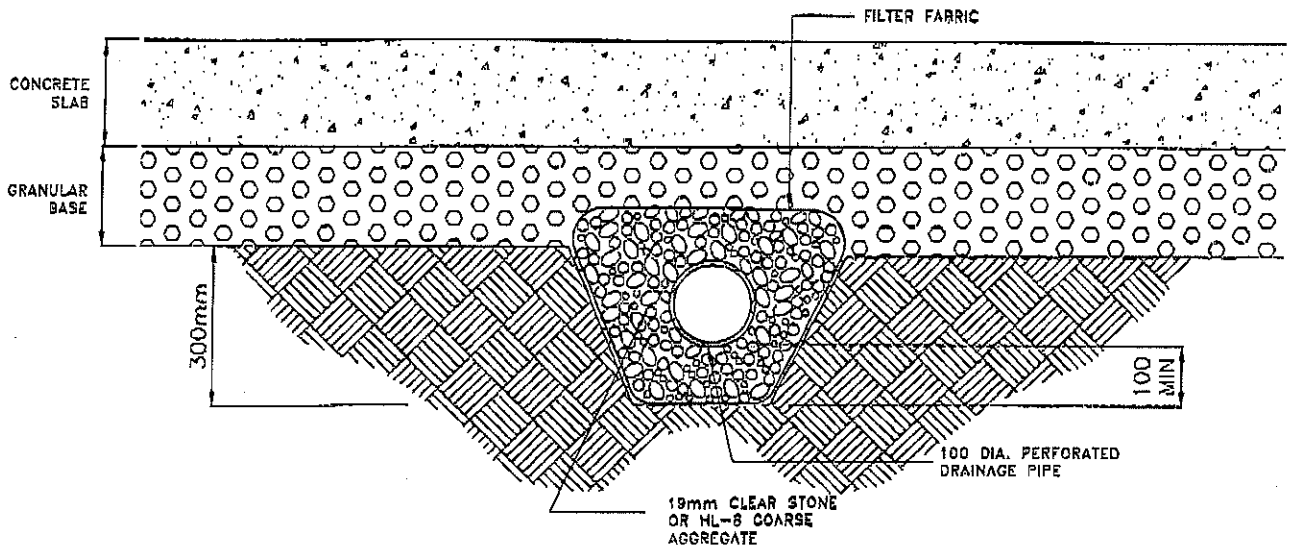


BASEMENT DRAINAGE DETAIL

TERRAPROBE File No. 1-07-2324 FIGURE 4

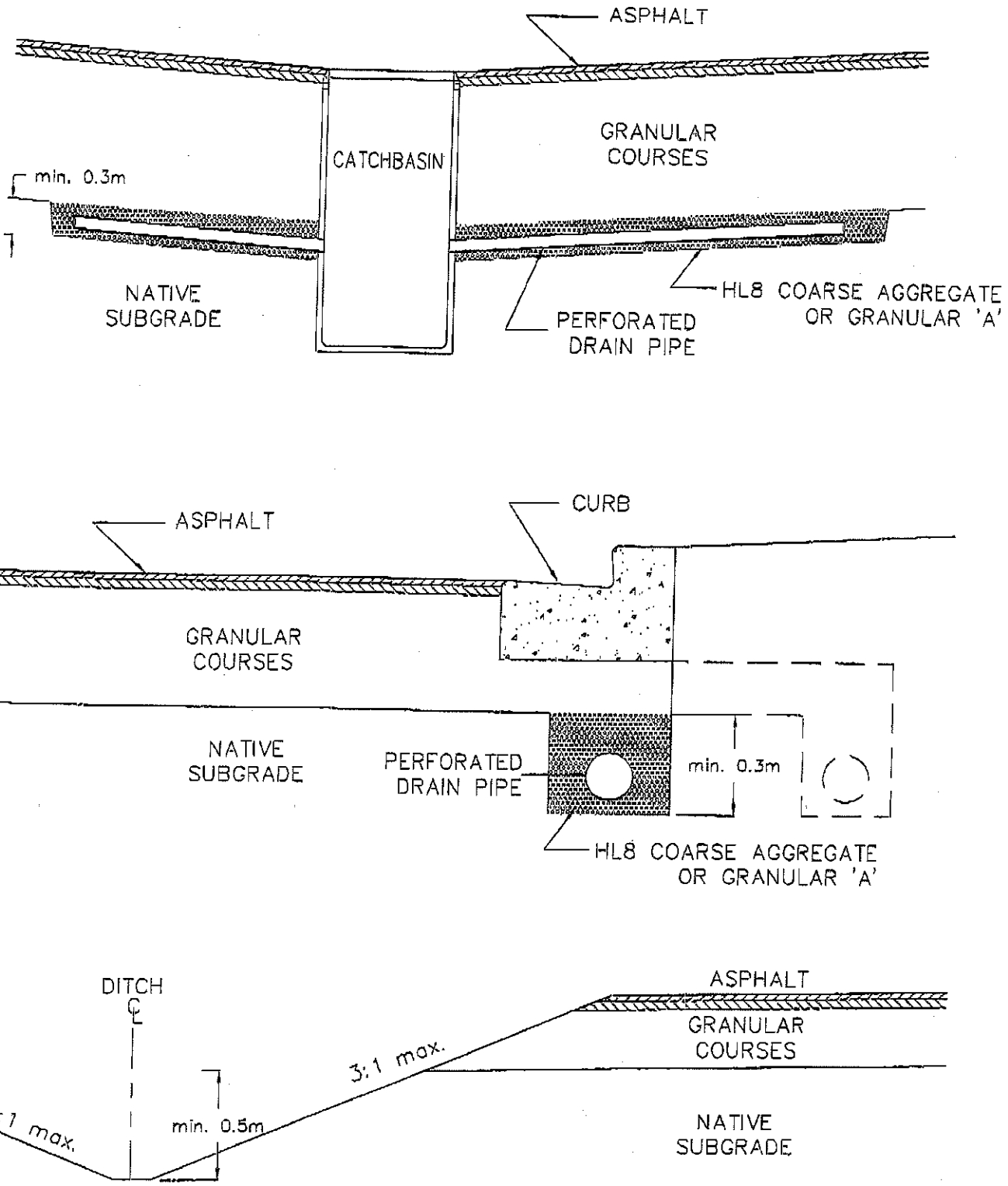


DETAIL A SUBDRAINAGE DETAIL WITH CLEAN-OUT



DETAIL B SUBDRAINAGE TRENCH DETAIL

BASEMENT FLOOR SUBDRAINS



PAVEMENT DRAINAGE ALTERNATIVES

TERRAPROBE File No. 1-07-2324 FIGURE 6

Terraprobe

LOG OF BOREHOLE 1

PROJECT: Eastwood Garafraxa St. & Gartshore St.
DATE: 19 September 2007
LOCATION: Fergus, Ontario
EQUIPMENT: Bombardier
CLIENT: Sorbara Development Group
ELEVATION DATUM: Geodetic
FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES
424.4	Ground Surface				
0.0 / 424.2	175mm TOPSOIL				
0.2 / 423.6	FILL- Silty Sand, trace gravel, clay, with organic matter, rootlets loose, brown, moist		1	SS	9
0.8 / 422.9	SANDY SILT some clay, trace gravel compact, brown, very moist (GLACIAL TILL)		2	SS	17
1.8	SAND some silt to silty, compact, brown, moist		3	SS	24
	very moist		4	SS	27
	wet		5	SS	17
420.1			6	SS	10
4.3	End of Borehole				

ELEVATION SCALE: 424, 423, 422, 421

PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● POCKET PEN. + FIELD VANE × LAB VANE; 20 40 60 80 100

GR.SA.SI.CL 0.88.12.0

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

DRAFT

NOTES:
Borehole was caving at 2.7m and water level at 2.4m upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in piezometer at 2.7m (Elev. 421.7m) on Sept. 26, 2007.

Terraprobe

LOG OF BOREHOLE 2

PROJECT: Eastwood Garafraxa St. & Gartshore St.
DATE: 20 September 2007
LOCATION: Fergus, Ontario
EQUIPMENT: Bombardier
CLIENT: Sorbara Development Group
ELEVATION DATUM: Geodetic
FILE: 1-07-2324

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES
423.2	Ground Surface				
0.0 / 422.9	260mm TOPSOIL		1	SS	5
0.3 / 422.4	FILL - Silty Sand, trace gravel, clay, with organic matter, rootlets loose, dark brown, moist		2	SS	14
0.8	SAND some silt to silty, compact, brown, very moist to wet		3	SS	14
			4	SS	26
			5	SS	23
418.7					
4.5	SANDY SILT loose to compact, greyish brown, wet		6	SS	8
			7	SS	14
415.6					
7.6 / 415.1	SILT - Dilatant, some clay, some sand, trace gravel very moist		8	SS	46
8.1	End of Borehole				

ELEVATION SCALE: 423, 422, 421, 420, 419, 418, 417, 416

PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● POCKET PEN. ⊥ FIELD VANE × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

GR, SA, SI, CL
0, 34, 66, 0

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:
Borehole was open and dry upon completion of drilling.
20 mm ID diameter pelzometer installed.
Water level in pelzometer at 1.95 m (Elev. 421.25m) on Sept. 26, 2007.

Terraprobe

LOG OF BOREHOLE 3

PROJECT: Eastwood Garafraxa St. & Gartshore St. DATE: 19 September 2007

LOCATION: Fergus, Ontario EQUIPMENT: Bombardier

CLIENT: Sorbara Development Group ELEVATION DATUM: Geodetic FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES
424.6 / 0.0	Ground Surface				
424.4 / 0.2	200mm TOPSOIL				
	FILL - Silty Sand, trace gravel, clay, organics, rootlets compact, brown, moist		1	SS	11
423.8 / 0.8	SAND some silt to silty, compact, light brown, moist		2	SS	17
			3	SS	11
	loose, brownish grey, wet below 2.3m				
422.1 / 2.6	SILT - Dilatant, some clay, some sand, trace gravel, loose, brown, wet		4	SS	8
	compact, brownish grey below 3.0m		5	SS	11
420.8 / 3.8	SANDY SILT some clay, trace gravel, very dense, grey, damp to moist (GLACIAL TILL)		6	SS	67
420.3 / 4.3	End of Borehole				

ELEVATION SCALE: 424, 423, 422, 421

PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● POCKET PEN. × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

GS. SA. SI. CL. 1 11 72 16

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

DRAFT

NOTES:
Borehole was open and dry upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in peizometer at 2.8m (Elev 421.8 m) on Sept. 26, 2007.

Terraprobe

LOG OF BOREHOLE 4

PROJECT: Eastwood Garafraxa St. & Gartshore St. DATE: 20 September 2007

LOCATION: Fergus, Ontario EQUIPMENT: Bombardier

CLIENT: Sorbara Development Group ELEVATION DATUM: Geodetic FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES
424.8	Ground Surface				
424.6	110mm TOPSOIL				
0.1	FILL - Sand, some silt, loose, brown, damp		1	SS	9
	moist below 0.75 m		2	SS	3
			3	SS	4
422.8					
2.3	SANDY SILT compact, brownish grey, wet		4	SS	15
			5	SS	16
	brownish grey below 4.0m		6	SS	10
420.6					
4.3	End of Borehole				

ELEVATION SCALE: 424, 423, 422, 421

PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ✣ FIELD VANE ● POCKET PEN. × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:
Borehole was caving at 3.5m and water level at 3.4m upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in peizometer at 3.6m (Elev. 421.3m) on Sept. 26, 2007.

Terraprobe

LOG OF BOREHOLE 5

PROJECT: Eastwood Garafraxa St. & Gartshore St. DATE: 20 September 2007

LOCATION: Fergus, Ontario EQUIPMENT: Bombardier

CLIENT: Sorbara Development Group ELEVATION DATUM: Geodetic FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES
422.8 / 0.0	Ground Surface				
422.8 / 0.0	170mm TOPSOIL				
422.2 / 0.2	FILL - Sand, trace gravel, silt, clay, organics, loose, brown, moist		1	SS	6
	SAND some silt to silty, compact, brownish grey, very moist		2	SS	12
	wet below 1.5m		3	SS	28
	dense below 2.3m		4	SS	36
419.8 / 3.0	SANDY SILT compact, brown, wet		5	SS	20
418.5 / 4.5	SILT - Dilatant, some clay, some sand, trace gravel, compact, grey, wet		6	SS	18
416.8 / 6.1	FINE SAND some silt to silty, loose to compact, brown, wet		7	SS	6
			8	SS	35
414.8 / 8.1	End of Borehole				

ELEVATION SCALE: 420, 422, 421, 420, 419, 418, 417, 416, 415

PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ■ POCKET PEN. × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:
Wet cave at 2.1m upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in peizometer at 1.7m (Elev. 421.3m) on Sept. 26, 2007.

Terraprobe

LOG OF BOREHOLE 6

PROJECT: Eastwood Garafraxa St. & Gartshore St. DATE: 20 September 2007

LOCATION: Fergus, Ontario EQUIPMENT: Bombardier

CLIENT: Sorbara Development Group ELEVATION DATUM: Geodetic FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES
421.2	Ground Surface				
0.0 / 420.9	260mm TOPSOIL		1	SS	6
0.3 / 420.1	FILL - Silty Sand, trace gravel, clay, with organic matter, rootlets, loose, dark brown, moist				
0.8 / 419.7	SAND some silt to silty, compact, brown, wet		2	SS	23
1.5 / 419.9	SANDY SILT compact, brownish grey, wet		3	SS	22
2.3 / 419.2	SILT - Dilatant, trace to some clay, trace to some sand, trace gravel, compact, brown, very moist to wet		4	SS	21
3.0	End of Borehole				

ELEVATION SCALE: 421, 420, 419

PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● POCKET PEN. + FIELD VANE × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:

Borehole was open and water level at 1.5m upon completion of drilling.
20 mm ID diameter pelzometer installed.
Water level in piezometer at 1.25m (Elev. 419.95m) on Sept. 26, 2007.

Terraprobe

LOG OF BOREHOLE 7

PROJECT: Eastwood Garafraxa St. & Gartshore St.
LOCATION: Fergus, Ontario
CLIENT: Sorbara Development Group

DATE: 20 September 2007
EQUIPMENT: Bombardier
ELEVATION DATUM: Geodetic
FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES
421.2	Ground Surface				
0.0 / 420.9	260mm TOPSOIL.		1	SS	6
0.3 / 420.1	FILL - Silty Sand, trace gravel, clay, with organic matter, rootlets, loose, dark brown, moist				
0.8 / 419.7	SAND some silt to silty, compact, brown, wet		2	SS	23
1.9 / 419.9	SANDY SILT compact, brownish grey, wet		3	SS	22
2.3 / 416.7	SILT - Dilatant, trace to some clay, trace to some sand, trace gravel, compact, brown, wet --- grey, wet below 3.0m		4	SS	21
			5	SS	21
4.5 / 414.6	SILTY FINE SAND compact, brownish grey, wet		6	SS	13
			7	SS	22
6.6	End of Borehole				

ELEVATION SCALE: 421, 420, 419, 418, 417, 416, 415

PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● POCKET PEN. × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30

GR.SA.SI.CL.
0 , 3 ,93.4

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:
Borehole was caving at 4.0m and water level at 1.5m upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in piezometer at 1.0m (Elev. 420.2m) on Sept. 26, 2007.

Terraprobe

LOG OF BOREHOLE 8

PROJECT: Eastwood Garrafraxa St. & Gartshore St.
DATE: 19 September 2007
LOCATION: Fergus, Ontario
EQUIPMENT: Bombardier
CLIENT: Sorbara Development Group
ELEVATION DATUM: Geodetic
FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES
424.2	Ground Surface				
424.0 / 0.2	150mm TOPSOIL				
423.4 / 0.8	FILL - Sand, trace gravel, clay, with organic matter, rootlets, compact, brown, moist		1	SS	10
422.7 / 1.5	SANDY SILT compact, brownish grey, very moist		2	SS	24
421.9 / 2.3	SAND some silt to silty, dense, brownish grey, very moist		3	SS	31
420.4 / 3.8	SILT - Dilatant, trace to some clay, trace to some sand, trace gravel, compact, brown, wet		4	SS	16
			5	SS	14
419.9 / 4.3	SANDY SILT trace to some clay, trace gravel, dense, brownish grey, damp (GLACIAL TILL)		6	SS	47
	End of Borehole				

ELEVATION SCALE: 424, 423, 422, 421, 420

PENETRATION RESISTANCE PLOT
20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● POCKET PEN. × LAB VANE
20 40 60 80 100

GR.SA.SI.CL
1 14 ,74,11

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:
Borehole was open and dry upon completion of drilling.
20 mm ID diameter pelzometer installed.
Water level in piezometer at 2.8m (Elev. 421.4m) on Sept. 26, 2007

Terraprobe

LOG OF BOREHOLE 9

PROJECT: Eastwood Garafraxa St. & Gartshore St.
DATE: 20 September 2007
LOCATION: Fergus, Ontario
EQUIPMENT: Bombardier
CLIENT: Sorbara Development Group
ELEVATION DATUM: Geodetic
FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES
423.5	Ground Surface				
423.4	120mm TOPSOIL				
0.1	FILL - Sand, some silt, loose, brown, moist		1	SS	6
	---- reddish brown, damp below 0.75m		2	SS	5
	---- moist below 1.5m		3	SS	5
421.5					
2.3	SAND compact, light brown, moist		4	SS	14
420.8					
3.0	SAND AND SILT TO SILTY SAND trace clay, compact, greyish brown, wet		5	SS	18
			6	SS	27
			7	SS	19
417.2					
6.6	End of Borehole				

ELEVATION SCALE: 423, 422, 421, 420, 419, 418

PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● POCKET PEN. × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:
Wet cave at 3.7m upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in piezometer at 3.55m (Elev. 420.25m) on Sept. 26, 2007

Terraprobe

LOG OF BOREHOLE 10

PROJECT: Eastwood Garafraxa St. & Gartshore St. DATE: 19 September 2007

LOCATION: Fergus, Ontario EQUIPMENT: Bombardier

CLIENT: Sorbara Development Group ELEVATION DATUM: Geodetic FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES
421.4 / 0.0	Ground Surface				
421.3 / 0.2	150mm TOPSOIL				
	FILL - Silty Sand, trace gravel, clay, loose, dark brown, moist		1	SS	7
420.6 / 0.8	SAND some silt to silty, compact, light brown, very moist to wet		2	SS	30
			3	SS	22
	saturated below 2.3m		4	SS	13
418.2 / 3.2	SILT - Dilatant, trace to some clay, trace to some sand, trace gravel, loose, brown, wet		5	SS	9
416.9 / 4.5	SAND some silt, compact, brown, wet		6	SS	14
415.3 / 6.1	SILT - some clay, sand, trace gravel, very dense, brown, damp (GLACIAL TILL)		7	SS	50/15cm
415.1 / 6.3	End of Borehole				

ELEVATION SCALE: 421, 420, 419, 418, 417, 416

PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● POCKET PEN. × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:
Wet cave at 1.8m upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in piezometer at 1.8m (Elev. 419.6m) on Sept. 26, 2007

Terraprobe

LOG OF BOREHOLE 11

PROJECT: Eastwood Garafraxa St. & Gartshore St.
DATE: 20 September 2007
LOCATION: Fergus, Ontario
EQUIPMENT: Bombardier
CLIENT: Sorbara Development Group
ELEVATION DATUM: Geodetic
FILE: 1-07-2324

SOIL PROFILE			SAMPLES			ELEVATION SCALE	PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	ORGANIC VAPOUR	STANDPIPE INSTALLATION OR REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20 40 60 80 100	w_P w w_L	(ppm)	
418.4	Ground Surface									
418.2 0.2	160mm TOPSOIL									
	FILL - Sandy Silt, trace gravel with organic matter, rootlets, compact, dark brown, moist		1	SS	13	418	○ UNCONFINED ● POCKET PEN. + FIELD VANE × LAB VANE	WATER CONTENT (%) 10 20 30		
417.6 0.8	SANDY SILT some clay, trace gravel, compact, brown, very moist (GLACIAL TILL)		2	SS	16					
	---- grey, wet below 1.5m		3	SS	22	417				
			4	SS	42	416				
415.4 3.0	End of Borehole									

NOTES:
Borehole was open and dry upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in piezometer at 1.6m (Elev. 416.8m) on Sept. 26, 2007

Terraprobe

LOG OF BOREHOLE 12

PROJECT: Eastwood Garafraxa St. & Gartshore St.
LOCATION: Fergus, Ontario
CLIENT: Sorbara Development Group

DATE: 20 September 2007
EQUIPMENT: Bombardier
ELEVATION DATUM: Geodetic
FILE: 1-07-2324

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES
418.4	Ground Surface				
0.0 / 418.2	160mm TOPSOIL		1	SS	13
0.2	FILL - Sandy Silt, trace gravel with organic matter, rootlets, compact, dark brown, moist				
417.6			2	SS	16
0.8	SANDY SILT some clay, trace gravel, compact, brown, moist to very moist (GLACIAL TILL)		3	SS	22
	grey		4	SS	42
			5	SS	32
	very dense below 4.5m		6	SS	50/10cm
412.2			7	SS	50/8cm
6.2	End of Borehole				

ELEVATION SCALE: 418, 417, 416, 415, 414, 413

PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● POCKET PEN. × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS

NOTES:
Borehole was open and dry upon completion of drilling.
20 mm ID diameter peizometer installed.
Water level in piezometer at 2.3m (Elev. 416.1m) on Sept. 26, 2007

Terraprobe

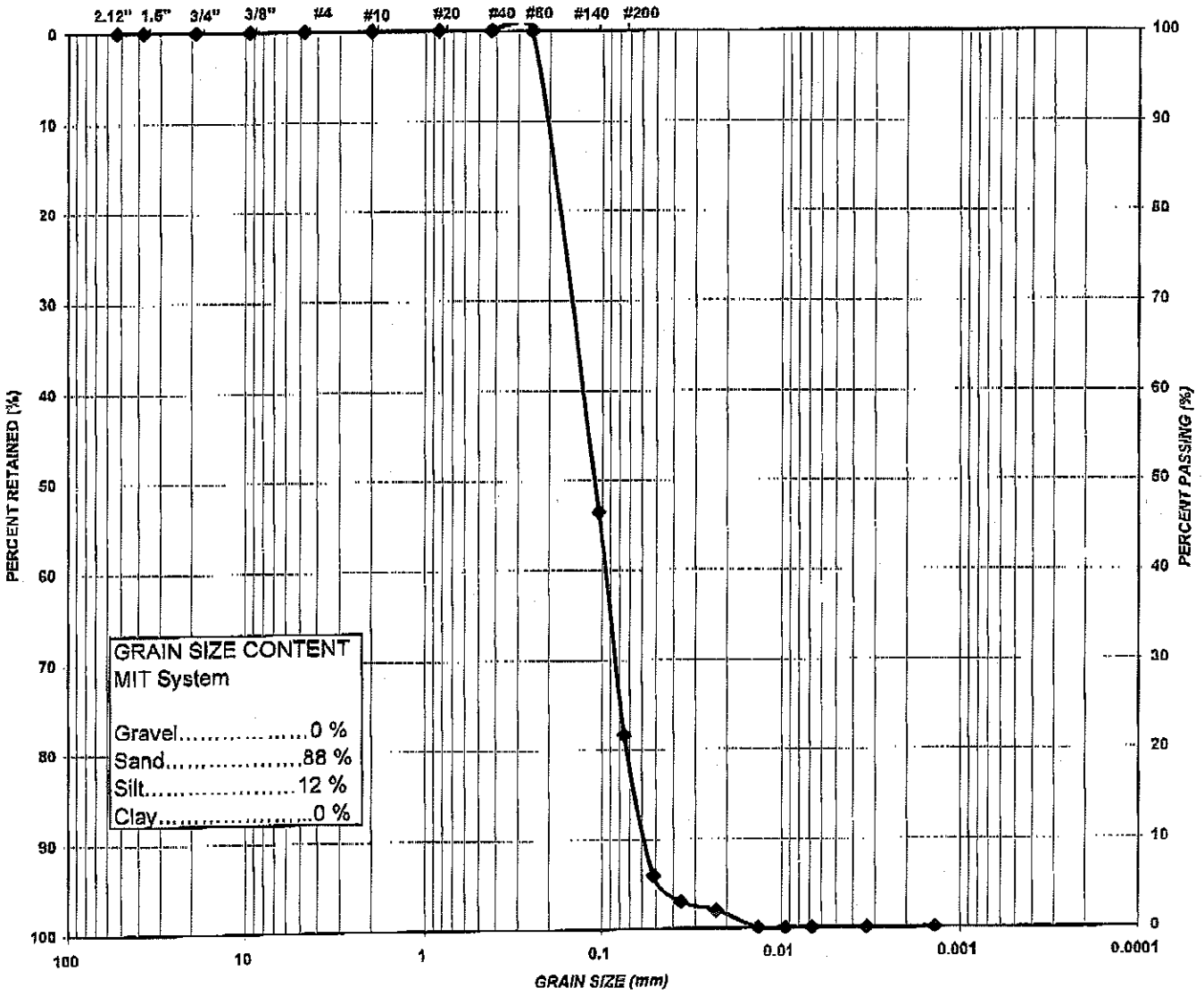
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Eastwood; Garafraxa & Garthshore Streets**
LOCATION: **Fergus, Ontario**
CLIENT: **Sorbara Development Group**
BOREHOLE: **1**
SAMPLE NUMBER: **3**
SAMPLE DEPTH: **1.5 m**
SAMPLE DESCRIPTION: **SAND, some silt**

FILE NO.: **1-07-2324**
LAB NO.: **1889A**
SAMPLE DATE: **September 19, 2007**
SAMPLED BY: **B.R.**

GRAIN SIZE DISTRIBUTION

U.S. STANDARD SIEVE SIZES



MIT SYSTEM	GRAVEL		COARSE	MEDIUM	FINE	SILT	CLAY
			SAND				
UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY	
	GRAVEL		SAND				

Terraprobe

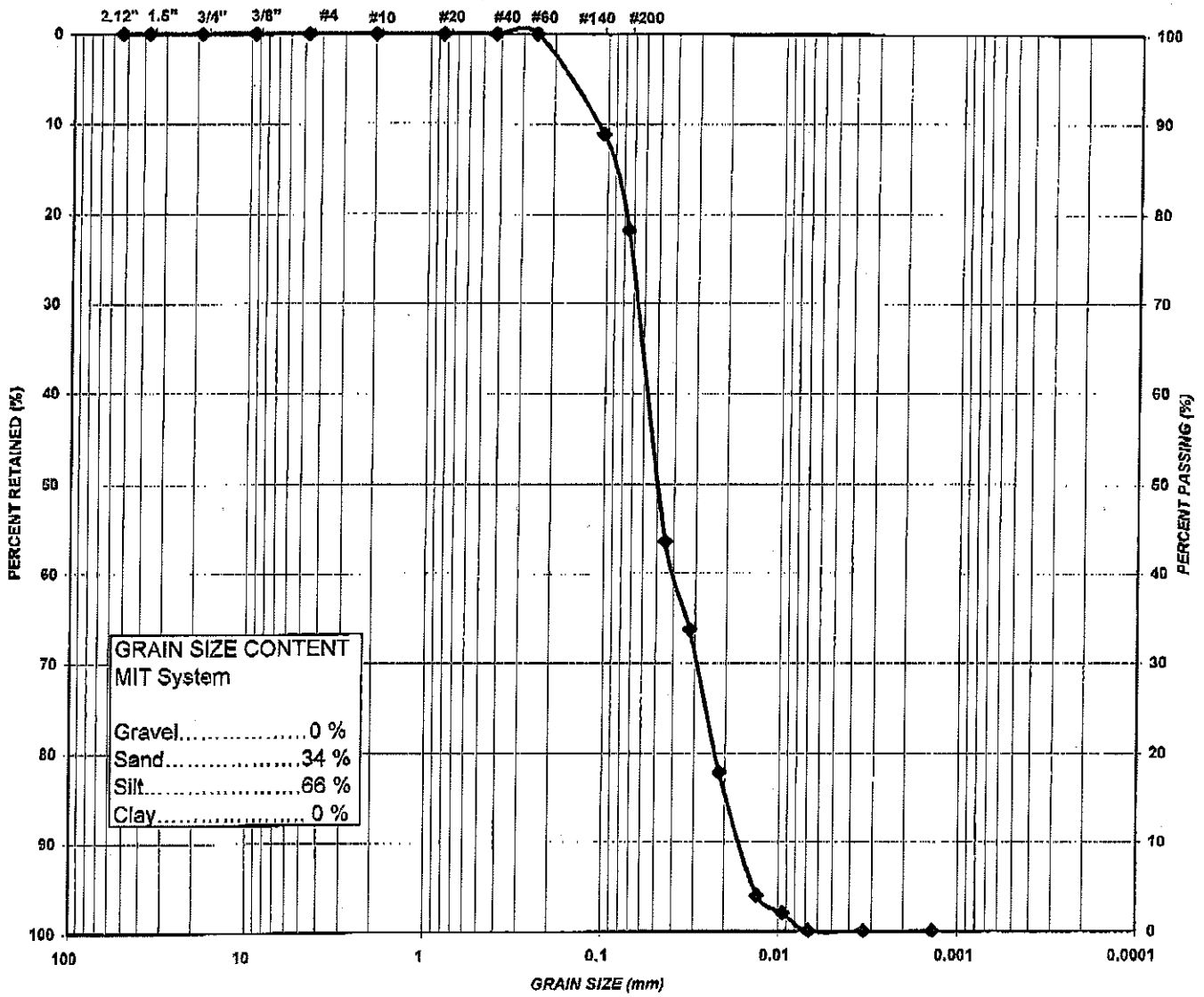
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Eastwood; Garafraxa & Garthshore Streets**
LOCATION: **Fergus, Ontario**
CLIENT: **Sorbara Development Group**
BOREHOLE: **2**
SAMPLE NUMBER: **6**
SAMPLE DEPTH: **4.5 m**
SAMPLE DESCRIPTION: **SANDY SILT**

FILE NO.: **1-07-2324**
LAB NO.: **1889B**
SAMPLE DATE: **September 20, 2007**
SAMPLED BY: **B.R.**

GRAIN SIZE DISTRIBUTION

U.S. STANDARD SIEVE SIZES



MIT SYSTEM	GRAVEL	COARSE	MEDIUM	FINE	SILT	CLAY
		SAND				

UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL		SAND			

Terraprobe

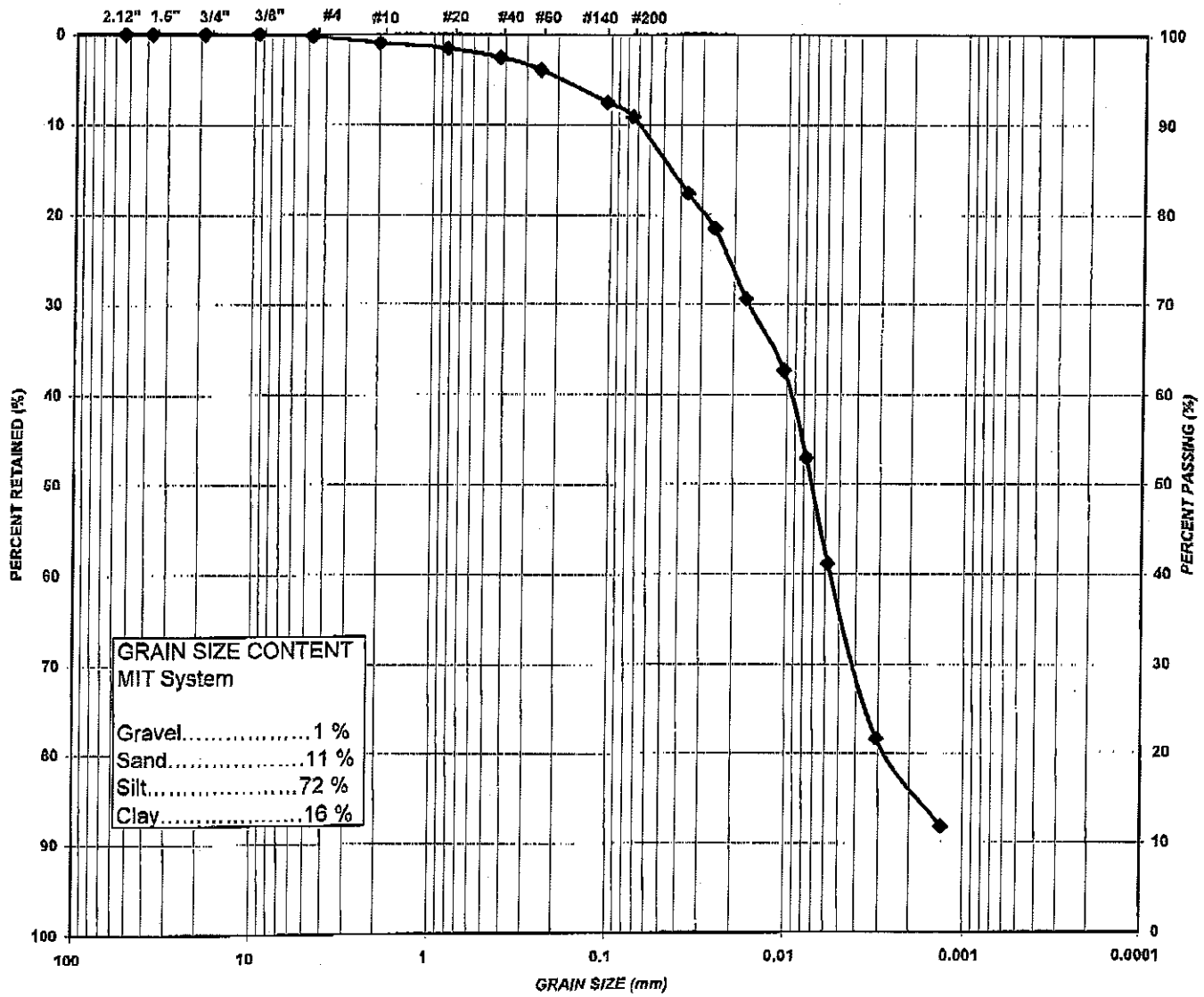
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Eastwood; Garafraxa & Garthshore Streets**
LOCATION: **Fergus, Ontario**
CLIENT: **Sorbara Development Group**
BOREHOLE: **3**
SAMPLE NUMBER: **4B**
SAMPLE DEPTH: **2.6 m**
SAMPLE DESCRIPTION: **SILT, some clay, some sand, trace gravel**

FILE NO.: **1-07-2324**
LAB NO.: **1889C**
SAMPLE DATE: **September 19, 2007**
SAMPLED BY: **B.R.**

GRAIN SIZE DISTRIBUTION

U.S. STANDARD SIEVE SIZES



MIT SYSTEM	GRAVEL	COARSE	MEDIUM	FINE	SILT	CLAY
		SAND				

UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL		SAND			

Terraprobe

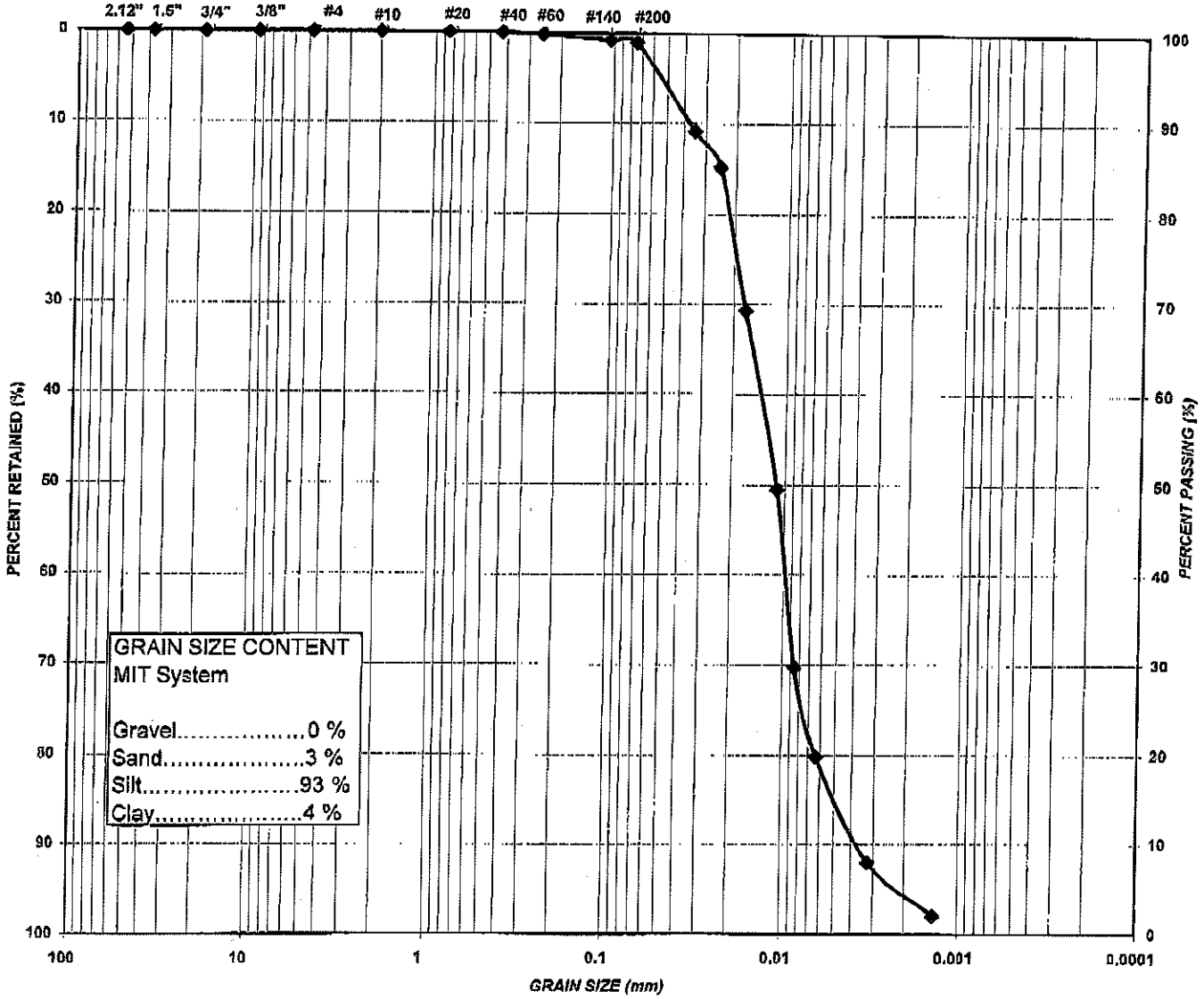
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Eastwood; Garafraxa & Garthshore Streets**
LOCATION: **Fergus, Ontario**
CLIENT: **Sorbara Development Group**
BOREHOLE: **7**
SAMPLE NUMBER: **4**
SAMPLE DEPTH: **2.3 m**
SAMPLE DESCRIPTION: **SILT, trace clay, trace sand**

FILE NO.: **1-07-2324**
LAB NO.: **1889D**
SAMPLE DATE: **September 20, 2007**
SAMPLED BY: **B.R.**

GRAIN SIZE DISTRIBUTION

U.S. STANDARD SIEVE SIZES



MIT SYSTEM	GRAVEL	COARSE	MEDIUM	FINE	SILT	CLAY
		SAND				

UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL		SAND			

Terraprobe

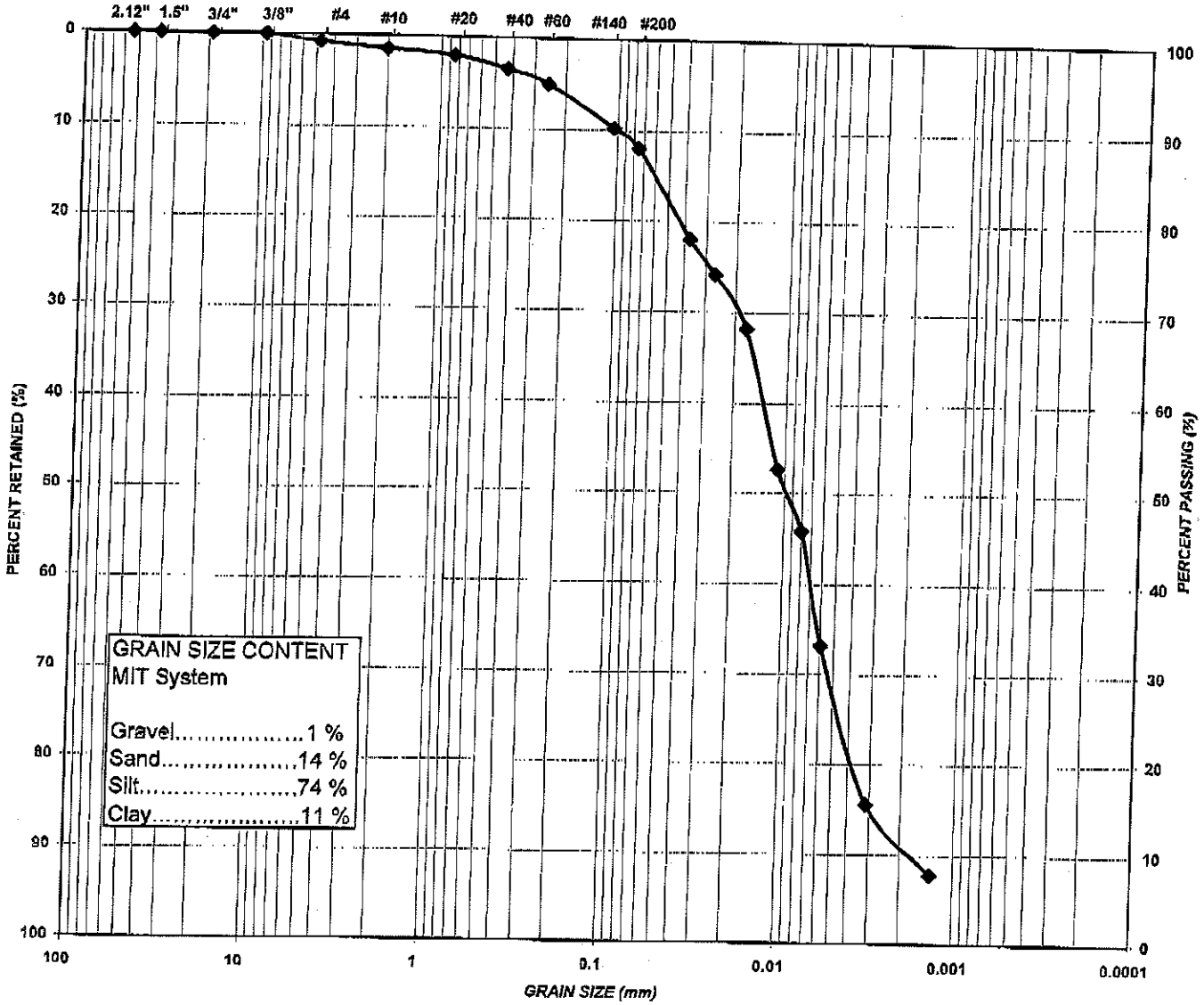
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Eastwood; Garafraxa & Garthshore Streets**
LOCATION: **Fergus, Ontario**
CLIENT: **Sorbara Development Group**
BOREHOLE: **8**
SAMPLE NUMBER: **4**
SAMPLE DEPTH: **2.3 m**
SAMPLE DESCRIPTION: **SILT, some sand, some clay, trace gravel**

FILE NO.: **1-07-2324**
LAB NO.: **1889E**
SAMPLE DATE: **September 19, 2007**
SAMPLED BY: **B.R.**

GRAIN SIZE DISTRIBUTION

U.S. STANDARD SIEVE SIZES



MIT SYSTEM	GRAVEL	COARSE	MEDIUM	FINE	SILT	CLAY
		SAND				

UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL		SAND			