DRIESENGA & ASSOCIATES, INC.
Engineering · Surveying · Testing

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April 13, 2022 *via electronic mail*

Mr. Kevin Drozin
MS CONSULTANTS, INC.
2221 Schrock Road
Columbus, Ohio 43229

Re: Geotechnical Report
Tim Horton's
19353 Vernier Road, Harper Woods, Michigan
Driesenga & Associates, Inc. Project No 2220073.3A

Dear Mr. Drozin:

Driesenga & Associates, Inc. is pleased to submit the attached report of subsurface exploration performed for the above-referenced project. The report presents the exploration procedures, subsurface conditions encountered, and our recommendations for development of the site with respect to proposed earthwork, foundation construction, and pavement design. As the project nears construction you can contact Dennis Snyder at 616-432-7472 in our local office to provide a quote for construction materials testing and survey needs.

Proper execution of our recommendations will affect the design, construction and performance of the structure and related facilities, and the potential associated risks involved. Therefore, the issues and recommendations presented in this report should be discussed with the project team, including Driesenga & Associates, Inc. This will increase the likelihood that the issues are understood and our recommendations are applied in a manner consistent with the project budget, tolerance of risk, and expectations for performance and maintenance.

We appreciate the opportunity to be of service to you. If you have any questions concerning this report, or if we can be of further service as design and construction progresses, please contact our office.

Sincerely,
DRIESENGA & ASSOCIATES, INC.

Michael Stork
Senior Project Geologist

Musana Nabil
Senior Project Engineer

Randy Pail, P.E
Director of Geotechnical Engineering

GEOTECHNICAL REPORT

SITE:

TIM HORTON'S
19353 VERNIER ROAD
HARPER WOODS, MICHIGAN

April 13, 2022
PROJECT NO. 2250073.3A

PREPARED FOR:

MS CONSULTANTS, INC.
2221 SCHROCK ROAD
COLUMBUS, OHIO 43229

Prepared by:

DRIESENGA & ASSOCIATES, INC.

Engineering · Surveying · Testing

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APPENDICES

1.0 INTRODUCTION

1.1 LOCATION

This report presents the results of the geotechnical investigation completed for the proposed Tim Horton's. The site is located at 19353 Vernier Road, Harper Woods, Michigan as shown on Figure 1 – Site Location (Appendix A). The property is situated on the northwest corner of the intersection of Vernier Road and Beaconsfield Road, in an area of primarily residential and commercial development.

1.2 PURPOSE

The purpose of this investigation was to determine the subsurface profile, the engineering characteristics of the subsurface soils, and to provide recommendations in regard to the proposed design and construction based on our interpretation of the test results. This report was prepared in general accordance with our proposal dated February 3, 2022, as authorized by MS Consultants, inc. in a subcontract agreement dated February 4, 2022.

1.3 SCOPE

The field exploration to estimate engineering characteristics of the site soils included performing a site reconnaissance, advancing the soil borings, performing standard penetration tests, and recovering split-spoon samples. Soil boring locations were determined in the field by measuring from existing site features. Existing ground surface elevations were not provided and obtaining them was beyond the scope of this investigation.

Two (2) soil borings, designated SB-1 to SB-2, were advanced in the vicinity of the proposed building on March 26, 2022, at the approximate locations shown on Figure 2 - Boring Locations (Appendix A). The soil borings were advanced with hollow-stem augers to a depth of fifteen (15) feet below the ground surface. During drilling, soil samples were collected from split-spoon sampling via standard penetration testing (ASTM method D 1586) at intervals of 2.5 feet to a depth of 10 feet, and intervals of 5 feet from a depth of 10 feet to the end of each boring. The soil boring logs are contained in Appendix B. The field and laboratory procedures are described in Appendix C.

1.4 DESIGN INFORMATION

We understand the project site is currently occupied by a vacant building and associated pavement. Construction will consist of demolition of the existing building and construction of a Tim Horton's building. It is understood the proposed Tim Horton's is to be a one-story wood or steel stud framed structure with poured concrete footings and masonry block foundation walls. We anticipate the new building to be approximately 1,590 square feet in plan area and finished floor elevation of 595.25 and approximately occupy the area of the existing vacant building. A concrete patio is planned to the south of the proposed structure and parking areas are planned to the south, west and north of the proposed structure.

Structural load information was not available as of the time of this report, but should be provided to Driesenga & Associates, Inc. for review in light of the recommendations contained herein as soon as available. For calculation purposes, maximum loads of 2,500 pounds per lineal foot of wall and 30 kips per column were assumed. Understanding that the new construction will not include any basement areas, exterior footing depths are assumed to be a minimum of 3.5 feet below the final ground surface elevation.

We have assumed maximum tolerable settlements of 1 inch total and ½ inch differential. We anticipate maximum cut and fill sections to be on the order 1 to 2 feet to establish site grades. Any significant deviation from these assumptions should be brought to the attention of Driesenga & Associates, Inc. as soon as possible.

2.0 SITE CONDITIONS

2.1 GENERAL

The stratification of the soils, as shown on the soil boring logs in Appendix B, represents the soil conditions at the actual soil boring locations. Variations may occur away from or between the soil borings. Stratigraphic lines shown on the soil boring logs represent the approximate boundary between the soil types, but the transition may be gradual. They are not intended to show exact depths of change from one soil type to another. In addition, changes in soil type may occur between the sample intervals that are consequently not observed by the driller.

The soil boring logs in Appendix B include the drilling method, materials encountered, penetration resistances, and pertinent field observations made during the drilling operations along with the results of the laboratory testing.

2.2 SURFACE CONDITIONS

The subject property is currently occupied by an approximately 2,820 square foot, single story slab-on-grade building with surrounding parking areas. The vacant building will be demolished to make way for the new Tim Horton's. Asphalt pavement with isolated areas of greenbelt, islands, and associated trees surround the vacant building. The overall site is slightly sloped downward from north to south, there being approximately 1 to 2 feet of fall over the entire site.

2.3 DESCRIPTION OF SUBSURFACE SOILS

Surface materials encountered at the site generally consist of 5 inches of asphalt underlain by 3 to 25 inches of sand and gravel base. The surface materials are underlain by very loose to loose sand fill, with varying amounts of gravel and organics, to depths ranging between 5 to 8 feet. Medium stiff to stiff, gray and brown, silty clay was encountered beneath the sand fill and extended to the explored depth of fifteen (15) feet below the ground surface.

Hand Penetrometer tests were performed on representative portions of cohesive soil samples to obtain an indication of the unconfined compressive strength of the material. As indicated on the soil boring logs, the estimated unconfined compressive strength ranged from 0.75 to 2.0 tons per square foot (tsf).

The estimated group symbol, according to the USCS, is shown in the USCS column just before the textural description of the various strata on the soil boring logs in Appendix B.

2.4 GROUNDWATER OBSERVATIONS

Groundwater was encountered at a depth of approximately 3 to 4 feet in the sand layer. Considering the primarily native clay soils, the encountered groundwater is considered to be "perched" groundwater trapped within the sand layers or strata that exist at the site. Hydrostatic groundwater levels and the elevations and volumes of groundwater should be expected to fluctuate throughout the year, based on variations in precipitation, evaporation, run-off, and other factors. The groundwater levels (or lack thereof) indicated by the soil borings and presented in this section represent conditions at the time the readings were taken. The actual groundwater levels at the time of construction may vary.

Groundwater measurements were collected during drilling and attempted shortly after completion of the drilling operations. After drilling and collection of groundwater readings, the boreholes were backfilled with auger cuttings and the surface was repaired approximating previous conditions. Since the boreholes were backfilled shortly after drilling, long-term groundwater level information is not available from the soil borings. To obtain long-term groundwater levels, groundwater observation wells would be required.

2.5 SEISMIC SITE CLASS

The proposed building's seismic class was determined for use in the structural design of the proposed project. Soils information was obtained from the soil borings completed on-site, as well as information obtained from the "Soil Survey of Wayne County" by the United States Department of Agriculture, the "Quaternary Geology of Michigan" completed by W.R. Farrand, the USGS Topographic Quadrangle and the Hydrogeologic Atlas of Michigan. It is assumed that the proposed structure falls under Building Class II according to the 2015 Michigan Building Code (MBC) Table 1604.5. Based on this information it is our determination that seismic site class D be used according to the ASCE 7 – Table 20.3-1 for structural calculations.

2.6 LIMITATIONS

Soil and groundwater conditions have been observed and interpreted at the soil boring locations only. This information has been used as the basis for our analyses and the recommendations that follow. Although we have allowed for minor variations in subsurface conditions in the development of our recommendations, conditions can vary away from and between soil boring locations. Should this become evident during construction, we should be contacted to review our recommendations. This geotechnical evaluation and report were prepared for geotechnical purposes only. We did not perform environmental related borings or analytical tests.

3.0 RECOMMENDATIONS

3.1 SITE PREPARATION

To increase the likelihood that the recommended allowable soil bearing capacities are achieved and tolerable settlements are not exceeded, the recommendations contained herein should be followed. Within the building footprint and any areas to receive fill, all existing building material, topsoil, old fill, organic-containing material, frozen soil and other unsuitable material should be removed. The clearing should extend a minimum of 5 feet beyond the limits of proposed building and pavement areas and areas to receive structural fill.

It is strongly recommended that the building pad subgrade area be evaluated by Driesenga & Associates, Inc. after the area has been cleared and stripped. This evaluation may be performed by proofrolling with a loaded tandem axle dump truck or another method selected by the geotechnical engineer. To identify any areas of soft subgrade soil. Where soft subgrade soils are encountered, remedial actions as recommended by the geotechnical engineer will be required.

We understand the existing building will be demolished as part of the project. In addition, historical photos circa 1951 show what appears to be a building in the area of the current structure that will be demolished. Any existing foundations, floor slabs, utilities, and other below-grade structures from previous construction should be completely removed from the footprint of the proposed building. In proposed pavement areas, existing utilities and other below-grade structures should be removed to at least 2.5 feet below the final subgrade level. Alternatively, utilities can be left in place below pavement areas if the void space of the utility is completely grouted. Depressions or excavations from the demolition and removal operations should be backfilled with granular structural fill meeting the requirements of MDOT Class II sand compacted in accordance with the recommendations below.

Existing fill was encountered in the soil borings and extended about 8 feet below the existing ground surface. Without documentation of the placement of the fill, we consider it to be "uncontrolled fill." If documentation of the existing fill is available, we would be pleased to review it to determine its suitability of slab, pavement, and/or structural fill support.

Deeper and/or looser uncontrolled fill may be encountered at the site, particularly adjacent to existing or former structures, or in the vicinity of existing utilities. The existing fill ***may*** be suitable for support of slabs, pavements, and/or structural fill after additional evaluation and special preparation and only where it is not underlain by buried topsoil or other organic, deleterious or otherwise unsuitable soils and the owner accepts the risks in doing so. Some of the soil samples in the existing fill contained organics. Existing fill with excessive organics (over 4%), voids or debris should be removed and replaced with structural fill. Test pits should be performed to identify unsuitable fill. The test pits could be performed prior to construction. However, suitability of the existing fill will need to be determined on a case-by-case basis during construction. The remaining fill, after removing unsuitable fill, is anticipated to be suitable to support floor slabs, pavements and structural fill, provided an increased risk of unsatisfactory performance is acceptable. We believe the risk of unsatisfactory performance such as cracking and settlement associated with the construction of slabs-on-grade and pavements on or above the existing fill is relatively low after preparation.

Ultimately, if the risk of poor slab and/or pavement performance is not acceptable, complete removal of the existing fill and replacement with structural fill should be performed. Based on the soil borings, the existing fill could extend 8 feet or more below the existing ground surface. If performed, the removal of the existing fill should extend a minimum of 10 feet beyond the edges of the proposed building, or laterally on a two vertical to one horizontal slope from the bottom outside edge of the foundation, whichever is greater. This action should reduce the amount and depth of undercutting during foundation construction since the unsuitable fill and any unsuitable soils directly beneath fill would be removed. For this case, the test pit evaluation would not be necessary. However, a test pit evaluation could be performed to provide a better estimate of the nature, depth and extent of the existing fill.

Upon removal of old fill, the existing native clay soils are anticipated to be medium stiff with an estimated unconfined compressive strength of 0.75 tsf as tested by hand penetrometer, and moisture contents in the range of 265 to 28%. These soils will likely require some degree of undercut or stabilization prior to backfilling over.

Trees and landscaping plants were located in greenbelt areas nearby to where the anticipated new Tim Horton's will be constructed when this investigation was conducted. Large trees may have relatively widespread root structures and related organic veins. The earthwork activities within the building and pavement areas should include complete removal of the tree roots and organic veins.

The contractor should remove standing water from the subgrade and prevent surface water from reaching the footing excavations and the prepared subgrade. In addition, construction traffic should use haul roads and should not haphazardly traffic the site. Subgrade soils that become disturbed should be removed and replaced with structural fill or crushed aggregate. Under wet weather conditions, the subgrade may be protected by placing crushed aggregate on the exposed subgrade.

It is recommended that any fill materials be placed in or near horizontal maximum 8-inch-thick loose lifts and compacted to a minimum of 95% of Modified Proctor MDD, or 98% of Michigan Cone MDD. If a vibratory roller is used for compaction, the loose lift thickness may be increased to 12 inches. Soils used for structural fill should consist of clean sand meeting SW or SP classification in accordance with USCS criteria.

3.2 FOUNDATIONS

Considering the subsurface conditions on this site and the assumed proposed construction, it is acceptable for the proposed facility to be supported on conventional spread footings. Footings bearing on newly placed structural fill placed over suitable native soils or directly on the native clay (if suitable) may be designed for a maximum net allowable soil bearing pressure of 2,000 psf. ***The footings should not be placed on the existing fill material. We recommend that the footings to be placed on properly compacted and approved sand fill.***

To attain the recommended bearing pressure where foundations bear on clay soils, improvement and/or stabilization of the foundation subgrade may be required in some areas. The soil conditions may vary from those disclosed by the soil borings and undercuts may be required. The amount of improvement will depend on the finished floor elevation, the amount of disturbance during earthwork operations, and the soil and groundwater conditions at the foundation bearing level(s). We do not anticipate compaction of the clay soils will be effective and improvements may include mixing a layer of coarse crushed aggregate into the subgrade. If the subgrade conditions cannot be improved either by compaction or mixing in crushed aggregate, the unsuitable soil should be removed and replaced with structural fill. In areas where undercutting is required, the undercut should extend laterally on a two vertical to one horizontal slope from the edge of the footing.

Prior to concrete placement, the bearing surface should be free of loose soil and standing water. The contractor should avoid stockpiling excavated materials immediately adjacent to the excavation walls. It is recommended that stockpiled materials be kept back from the excavation a minimum distance equal to half the excavation depth to prevent surcharging the excavation walls.

Total and differential settlement of foundations properly designed and constructed based on our recommendations are not expected to exceed 1 inch and ½ inch, respectively.

3.3 FLOORS

The soil below the floor slab should be prepared in accordance with the recommendations in Section 3.1. A noncohesive soils mat such as MDOT Class II sand should be provided directly below the floor slabs. The mat should be a minimum of 8 inches in thickness and compacted to a minimum of 95% of Modified Proctor MDD.

The floor slab should be suitably reinforced and proper joints should be provided at the junctions of the slab and foundation system so that a small amount of independent movement can occur without causing damage. A minimum of 6 inches of structural fill should be provided between the bottom of the slab and the top of the shallow spread footing below. Otherwise, other arrangements should be made to allow for potential relative settlements, such as grade beams, thickened slabs with appropriate reinforcing steel or other appropriate details. A modulus of subgrade reaction of 150 pci should be used in the design of slabs-on-grade.

3.4 GROUNDWATER CONTROL

Groundwater was initially encountered at depths ranging from 4.0 feet to 5.0 feet below the existing ground surface. Upon completion of the borings, groundwater was measured at depths ranging from 2.0 to 3.0 feet. Given that groundwater was present at two (2) feet below existing grade after drilling and considering footings will be placed at least 42 inches below existing grade and old fill removal could extend to depths of up to 8 feet, dewatering will be necessary during footing excavation and old fill removal. An extensive gravity drainage system, well points, or other dewatering procedures may be required, depending on the volume of groundwater encountered. Concrete should not be poured in footing excavations containing water. Upon removal of any trapped water, the soils should be reviewed by a geotechnical engineer and any soft areas replaced with structural fill per Section 3.1, as necessary.

Hydrostatic groundwater levels and the elevations and volumes of groundwater should be expected to fluctuate throughout the year, based on variations in precipitation, evaporation, run-off, and other factors. The groundwater levels indicated by the soil borings and presented in this section represent conditions at the time the readings were taken. The actual groundwater levels at the time of construction may vary.

Perimeter foundation drains should be installed along foundations where interior finished floor elevations are lower than perimeter grades, or where exterior grades slope toward the building. In addition, all roof drains should be diverted to downspouts which carry water away from foundations and supporting walls.

3.5 TEMPORARY EXCAVATION STABILITY

If excavations are anticipated for the proposed structure and/or utilities, shoring and bracing or flattening (laying back) of the slopes may be required to obtain a safe working environment. Excavations should be sloped or shored in accordance with local, state and federal regulations, including OSHA (CFR Part 1926) excavation trench safety standards. We recommend that all excavated soils be placed away from the edges of the excavation at a distance equaling or exceeding the depth of the excavation. In addition, surface runoff water should be diverted away from the crest of the excavated slopes to prevent erosion and sloughing.

Localized areas of soft or unsuitable soils not detected by our borings or in unexplored areas may be encountered once construction begins. Vertical cuts in these soils may be unstable and may present a significant hazard because they can fail without warning. Therefore, temporary construction slopes greater than 5 feet high should not be steeper than one horizontal to one vertical (1H: 1V) and excavated material should not be placed within 10 feet of the crest of any excavated slope.

Unbraced excavations may experience some minor localized instability (i.e., sloughing). To reduce potential sloughing, excavated slopes should be covered with plastic for protection from rainfall and moisture changes. It should be emphasized that continuous observations by personnel from our office are important during trenching or excavation operations at the site.

4.0 GENERAL COMMENTS

If significant changes are made in the plans and specifications or location of the proposed structure, a consultation should be arranged to review such changes with respect to the prevailing soil conditions. It may then be necessary to submit supplementary recommendations. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of Driesenga & Associates, Inc.

Driesenga & Associates, Inc. should be afforded the opportunity to review the project design drawings and specifications to verify the factors affecting subgrade and foundation performance comply with our recommendations.

It is recommended that the services of Driesenga & Associates, Inc. be engaged to observe excavation for the footings and to test and evaluate the soils in the footing excavations prior to placement of foundations in order to determine that the soils have the required bearing capacities. Monitoring and testing should also be performed to verify that suitable materials are used for controlled fills and that they are properly placed and compacted.

This report and any future reports or addenda performed for this site should be supplied to potential bidders prior to them submitting their proposals. We also recommend the construction contract include provisions for dealing with differing conditions. Contingency funds should be reserved for potential problems during earthwork and foundation construction.

This report was for geotechnical purposes only. We did not sample for environmental purposes or perform any analytical testing. However, the contractor should be prepared to handle environmental conditions encountered at this site that may affect the excavation, removal, or disposal of soil; dewatering of excavations; and health and safety of workers. Any Environmental Assessment reports prepared for this property should be made available for review by bidders and the successful contractor.

This report has been prepared solely for the use of the client for the project specifically described in this report. This report cannot be relied upon by other parties not involved in this project, unless written permission is granted by Driesenga & Associates, Inc. If this report or any of its contents are utilized by parties other than our original client and the project team members, Driesenga & Associates, Inc. can not be held responsible for the suitability of the field exploration, scope of services, or recommendations made for the new project. Driesenga & Associates, Inc. also is not responsible for the interpretation of our soil boring logs and the recommendations provided herein by other parties.

Driesenga & Associates, Inc. will evaluate this report for other parties and developments at this site, provided our original Client agrees to release this information in writing. However, before this report can be relied upon by other parties. Driesenga & Associates, Inc. must review the proposed development since the new project will likely require additional field exploration, laboratory tests, analysis, and modifications to our recommendations to adequately address the needs of the new project.

APPENDIX A

·FIGURE NUMBER 1 – SITE LOCATION·

·FIGURE NUMBER 2 – BORING LOCATIONS·

N
W E
S

Scale: NTS

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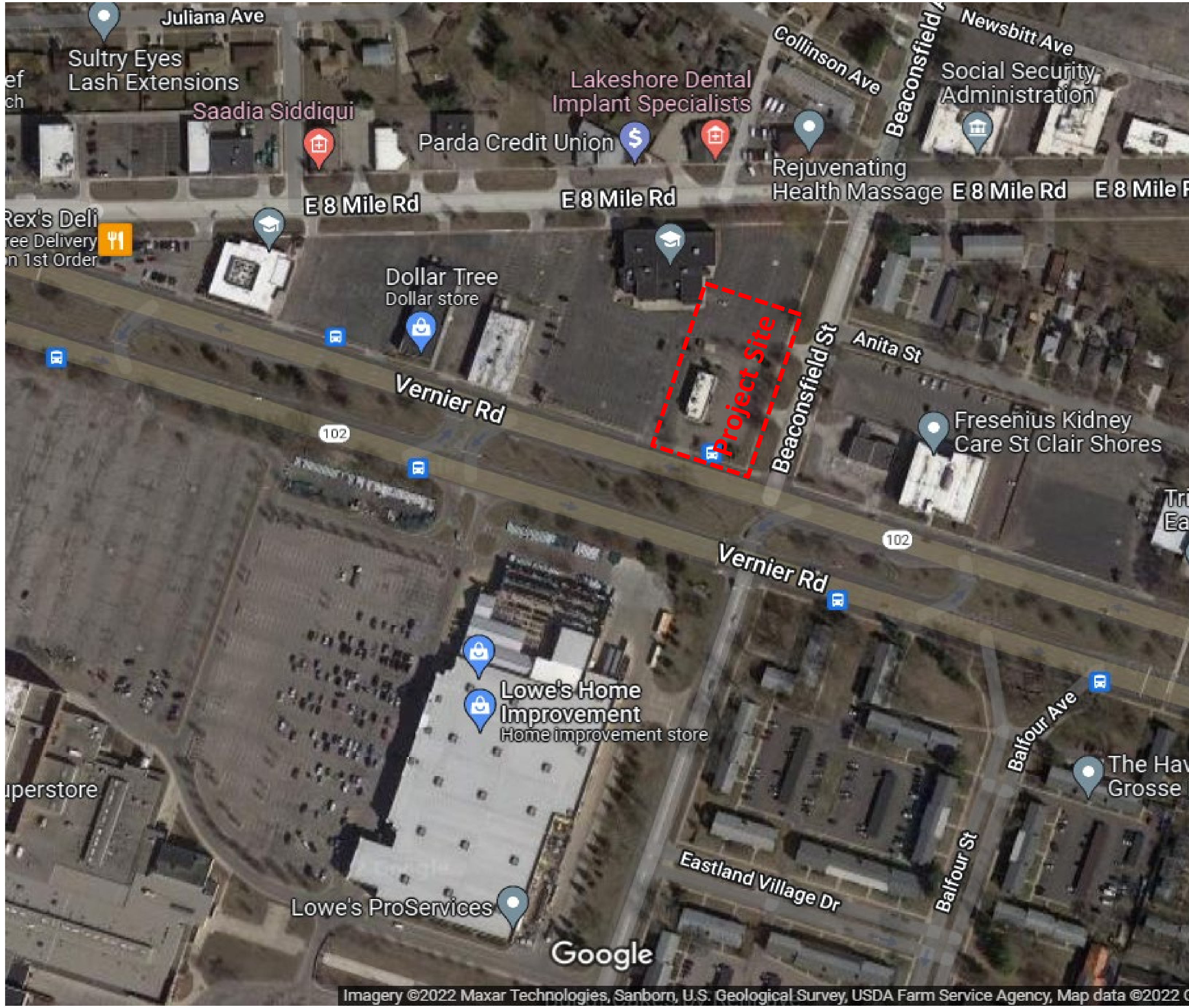

Figure Number: 1

Site Location

Project Name:

Tim Horton's – Harper Woods

Project Number:

2220073.3A

Project Location:

19353 Vernier Road
Harper Woods, Michigan

Date: 3/21/22
Sheet: 1 of 1
Modified by: BT

Scale: NTS

DRIESENGA & ASSOCIATES, INC.
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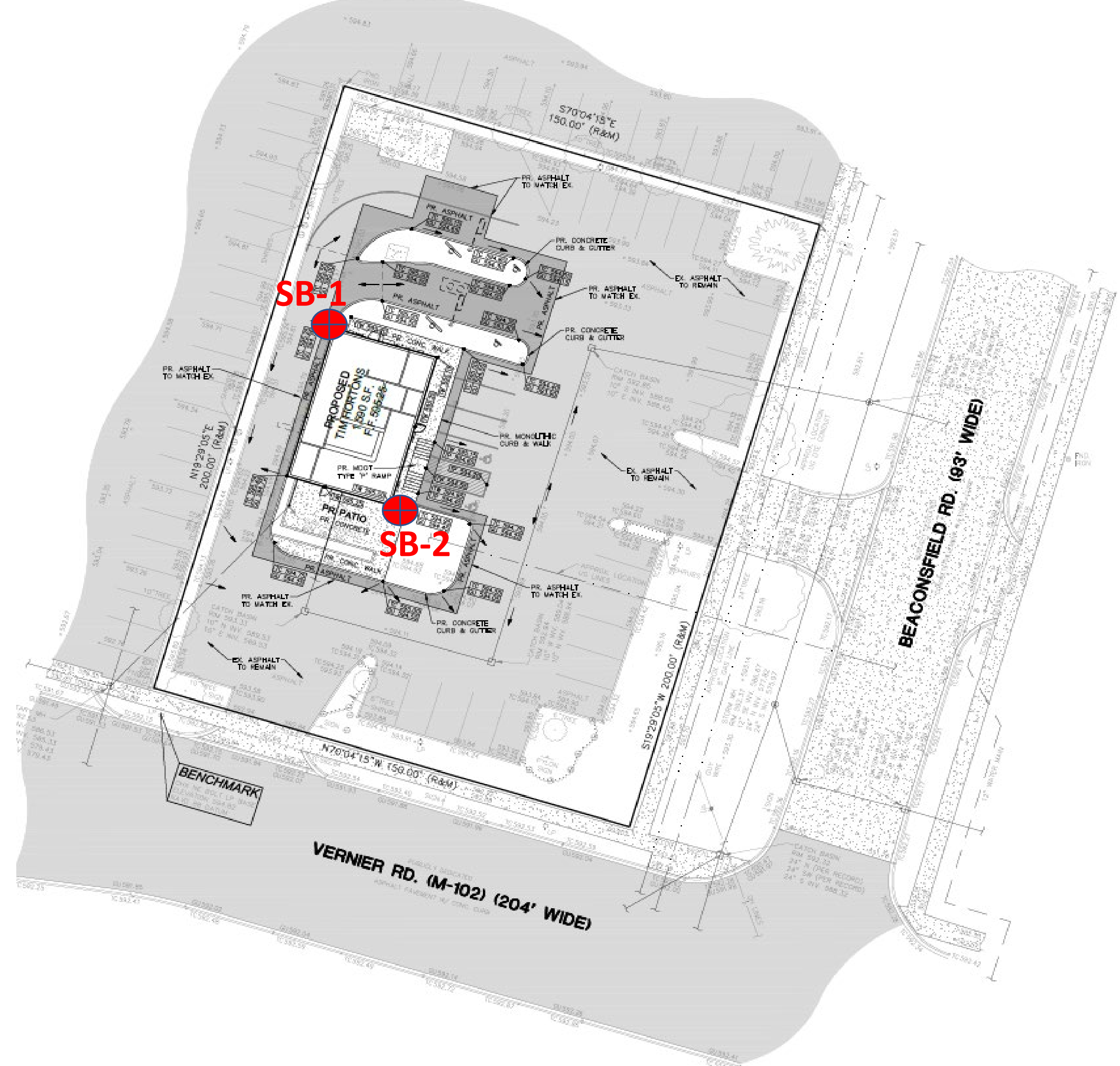
Figure Number: 2
Boring Locations

Project Name:
Tim Horton's – Harper Woods

Project Number:
2220073.3A

Project Location:
19353 Vernier Road
Harper Woods, Michigan

Date: 3/21/22
Sheet: 1 of 1
Modified by: BT



APPENDIX B
·SOIL BORING LOGS·

DRIESENGA & ASSOCIATES, INC.
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SB-01

Project: Tim Horton's - Harper Woods
19353 Vernier Road
Harper Woods, Michigan

Project No. 2220073.3A

Client Name: ms consultants, inc.

Date Started	: March 26, 2022	Drilling Company	: Schmidt Drilling
Date Completed	: March 26, 2022	Field Sampling	: M. Schmidt
Hole Diameter	: 2-1/4-inches	Reviewed By	: B. Traore
Drilling Method	: Hollow-Stem Auger	GW Encountered	: 5'
Sampling Method	: Split-Spoon Sampler	GW Completion	: 3'

Water Levels
▼ During Drilling
▽ After Completion

Depth in Feet	Surf. Elev.	USCS	DESCRIPTION
0			ASPHALT - 5 inches
		GW	GRAVEL - 3 inches
		Fill	Fill - Gravelly SAND, very loose to loose, dark brown, fine to coarse grained, clay layer, trace organics, moist to wet.
5		CL	Silty Clay, medium stiff to stiff, gray and brown, trace gravel, wet.
10			
15			

Samples	Blow Count	N Value	Pocket Pen (tsf)	Water Level	Moisture Content %
1	3, 2, 2	4			
				▽ (3')	
2	1, 1, 1	2		▼ (5')	
3	1, 1, 3	4	0.75		26.8
4	3, 3, 6	9	2.0		14.9
5	2, 3, 5	8	1.75		15.6

SB-02

DRIESENGA & ASSOCIATES, INC.
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Project: Tim Horton's - Harper Woods
19353 Vernier Road
Harper Woods, Michigan

Project No. 2220073.3A

Client Name: ms consultants, inc.

Date Started	: March 26, 2022	Drilling Company	: Schmidt Drilling
Date Completed	: March 26, 2022	Field Sampling	: M. Schmidt
Hole Diameter	: 2-1/4-inches	Reviewed By	: B. Traore
Drilling Method	: Hollow-Stem Auger	GW Encountered	: 4'
Sampling Method	: Split-Spoon Sampler	GW Completion	: 2'

Water Levels
▼ During Drilling
▽ After Completion

Depth in Feet	Surf. Elev.	USCS	GRAPHIC	DESCRIPTION	Samples	Blow Count	N Value	Pocket Pen (tsf)	Water Level	Moisture Content %
0				ASPHALT - 5 inches						
		GW		GRAVEL - 25 inches	1	4 14 22	36		▽	
		Fill		Fill - Gravelly SAND, very loose to loose, dark brown, fine to coarse grained, trace organics, moist to wet.	2	5 3 3	6		▼	
5					3	woh woh 1	--			
		CL		Silty Clay, medium stiff to stiff, gray and brown, trace gravel, wet.	4	1 2 4	6	.75		25.9
10										
					5	4 4 6	10	2.0		13.5
15										

APPENDIX C

·FIELD AND LABORATORY PROCEDURES·

FIELD PROCEDURES

The soil borings were performed using a truck-mounted drill rig with an automatic hammer. Split-barrel samples were obtained in the soil below the bottom of the augers in general accordance with the Standard Method for Penetration and Split-Barrel Sampling of Soils. Samples were collected at 2.5 feet intervals to 10 feet below grade, and every 5 feet thereafter. After recovery, the samples were removed from the split-spoon sampler, visually reviewed and classified, placed in glass jars and transported to our laboratory for additional review.

Soil samples stored for extended periods are susceptible to moisture loss and are no longer indicative of the conditions originally encountered in the soil borings. Therefore, soil samples are usually stored in our laboratory for a period of 60 days, unless instructed otherwise.

Soil boring logs were prepared based on field notes and visual classification of the samples in the laboratory. Indicated on each soil boring log is the description of each stratum observed, the approximate depth and/or elevation of each stratum change observed, Standard Penetration Test resistance values, and the observed groundwater levels. The soil boring logs are presented in Appendix B.

LABORATORY PROCEDURES

The laboratory testing program included supplementary visual classification of the samples in general accordance with the Unified Soil Classification System. The following two pages describe the soils classification procedure.

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

Per ASTM D 2487—00
(Based on Unified Soil Classification System)

Soil Description: Secondary Soil Type BASIC SOIL TYPE, Consistency/Relative Density, Color, Supplemental Soil Type, Moisture, Miscellaneous comments.

Ex. Silty SAND, loose, brown, fine to medium, trace gravel, moist.

Secondary Soil Type – adjective for the BASIC SOIL TYPE describing material making up greater than 12% but less than 50% of the primary soil type by weight. For sands this also includes a description of grain size (fine, medium or coarse).

BASIC SOIL TYPE – primary constituent of sample; material making up greater than 50% of the sample by weight. Material is classified by grain size and material properties.

Consistency/Relative Density – a measurement of in-situ consistency or density of cohesive or cohesionless soils, respectively, based upon Standard Penetration Testing blow counts (N) per ASTM D 1586.

Color – visual inspection of soil appearance.

Supplementary Soil Type – a description of any other material that may be mixed with the BASIC SOIL TYPE. Qualifying terms are based on the percentage of the supplementary soil type in the sample by weight.

Moisture – description of the in-situ moisture content of the sample (dry, moist or wet).

Miscellaneous Comments – anything observed in the sample or in the field that does not fit into the above categories but should be noted (odor, etc.).

CALIBRATED AUTO HAMMER CONSISTENCY/RELATIVE DENSITY				
COHESIONLESS SOILS		**COHESIVE SOILS**		
SPT N-VALUES	**IN-SITU RELATIVE DENSITY**	**SPT N-VALUES**	**SHEAR STRENGTH (PSF)**	**IN-SITU CONSISTENCY**
0-3	VERY LOOSE	0-1	BELOW 250	VERY SOFT
4-8	LOOSE	2-3	250 - 500	SOFT
9-23	MEDIUM DENSE	4-6	500 - 1,000	MEDIUM STIFF
24-38	DENSE	7-12	1,000 - 2,000	STIFF
>38	VERY DENSE	13-25	2,000 - 4,000	VERY STIFF
		>26	OVER 4,000	HARD

SUPPLEMENTAL TEXTURE QUALIFYING TERMS	
DESCRIPTOR	**PERCENTAGE BY WEIGHT**
TRACE	1-10%
LITTLE	10-20%
SOME	20-35%
AND	35-50%

STANDARD HAMMER CONSISTENCY/RELATIVE DENSITY				
COHESIONLESS SOILS		**COHESIVE SOILS**		
SPT N-VALUES	**IN-SITU RELATIVE DENSITY**	**SPT N-VALUES**	**SHEAR STRENGTH (PSF)**	**IN-SITU CONSISTENCY**
0-4	VERY LOOSE	0-2	BELOW 250	VERY SOFT
5-10	LOOSE	3-4	250 - 500	SOFT
11-30	MEDIUM DENSE	5-8	500 - 1,000	MEDIUM STIFF
31-50	DENSE	9-16	1,000 - 2,000	STIFF
>50	VERY DENSE	17-32	2,000 - 4,000	VERY STIFF
		>32	OVER 4,000	HARD

SOIL CLASSIFICATION CHART (Per ASTM D2487)

Criteria for Assigning Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name
COHESIONLESS SOILS More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 Sieve	Clean Gravels Less than 5% fines[C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]	GW	Well-graded gravel[F]
			Cu < 4 and/or 1 > Cc > 3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands More than 50% of coarse fraction retained on No. 4 Sieve	Clean Sands	Cu ≥ 6 and 1 ≤ Cc ≤ 3[E]	SW	Well-graded sand[F]
		Less than 5% fines[D]	Cu < 6 and/or 1 > Cc > 3[E]	SP	Poorly graded sand[F]
		Sands with Fines	Fines classify as ML or MH	SM	Silty sand[G,H,I]
		More than 12% fines[D]	Fines classify as CL or CH	SC	Clayey sand[G,H,I]
COHESIVE SOILS 50% or more passes the No. 200 Sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI ≥ 7 and plots on or above 'A' line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below 'A' line[J]	ML	Silt[K,L,M]
		Organic	Liquid limit - oven dried < 0.75	OL	Organic clay[K,L,M,N]
			Liquid limit - not dried < 0.75		Organic silt[K,L,M,0]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above 'A' line	CH	Fat clay[K,L,M]
			PI plots below 'A' line	MH	Elastic Silt[K,L,M]
		Organic	Liquid limit - oven dried < 0.75	OH	Organic Clay[K,L,M,P]
			Liquid limit - not dried < 0.75		Organic silt[K,L,M,0]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

A Based on the material passing the 3-in. sieve

B If field sample contained cobbles or builders, or both, add "with cobbles or boulders or both" to group name

C Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

D Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

E $Cu = D_{60}/D_{10}$ $Cc = (D_{30})^2/(D_{10} \cdot D_{60})$

F If soil contains ≥ 15% sand, add "with sand" to group name.

G If fines classify as CL-ML, use dual symbol GC-GM or SC-SM

H If fines are organic, add "with organic fines" to group name.

I If soil contains ≥ 15% gravel, add "with gravel" to group name.

J If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant

L If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.

M If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name

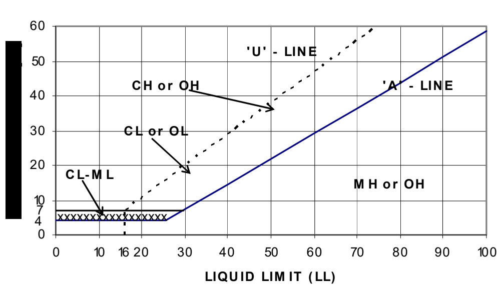
N PI ≥ 4 and plots on or above 'A' line.

O PI < 4 or plots below 'A' line.

P PI plots on or above 'A' line.

Q PI plots below 'A' line.

For classification of fine-grained soils and fine-grained fraction of coarse-grained soils



SIEVE ANALYSIS