ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

GEOTECHNICAL ENGINEERING INVESTIGATION

PROPOSED BELLE TIRE STORE
8 MILE ROAD & HAGGERTY ROAD
NORTHVILLE, MI

ATC PROJECT NO. N331481503

January 29, 2016

PREPARED FOR:

ENRIGHT ARCHITECTS, PLLC
P.O. BOX 7285
BLOOMFIELD HILLS, MI 48302

ATTENTION: MR. CHRIS ENRIGHT, NCARB

January 29, 2016

Enright Architects, PLLC
P.O. Box 7285
Bloomfield Hills, MI 48302

Attention: Mr. Chris Enright, NCARB

Re: **Geotechnical Engineering Investigation**
Proposed Belle Tire
8 Mile Road and Haggerty Road
Northville, Michigan
ATC Project No. N331481601

Dear Mr. Enright:

Submitted herewith is the report of our geotechnical engineering investigation for the referenced project. This study was authorized in accordance with the Belle Tire Request Number R16406.

This report contains the results of our field and laboratory testing program, an engineering interpretation of this data with respect to the currently available project characteristics and recommendations for use in the design and construction of foundation and other earth-connected phases of this project. We wish to remind you that we will store the samples for 30 days after which time they will be discarded unless you request otherwise.

We appreciate the opportunity to be of service to you on this project. If we can be of any further assistance, or if you have any questions regarding this report, please do not hesitate to contact either of the undersigned.

Sincerely,
ATC Group Services

STATE OF MICHIGAN
KARA M. GRISAMER
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LICENSED PROFESSIONAL ENGINEER

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Table of Contents

1 PURPOSE AND SCOPE

The purpose of this study was to determine the general subsurface conditions at the project site by drilling seven soil test borings and to evaluate this data with respect to foundation concept and design for the proposed Belle Tire Store. We also included an evaluation of the site with respect to potential construction problems and recommendations for dealing with earthwork and quality control during construction.

2 PROJECT CHARACTERISTICS

The proposed automotive service store will be constructed on the south side of 8 Mile Road just west of Haggerty Road in Northville, Michigan. The general location of the project site is shown on the Vicinity Map (Figure 1 in the Appendix). The ground surface at the site appears to slope from the north to the south with an approximate 15 foot elevation change across the site.

It is our understanding that the proposed Belle Tire building will be a single-story, steel frame structure that will have a slab-on-grade floor and no basement levels and plan area of approximately 10,000 square feet. There will be parking lots and drive lanes surrounding the building. Due to the nature of the existing site grade, it is unknown how the steep elevation change will be adjusted for final grades. We have assumed no more than no more than four feet of grade-raise fill or cut will be required to establish the finish floor elevation at the building location in the center of the site. The general layout of the project site is shown on the Boring Plan (Figure 2 in the Appendix).

Details regarding structural loads are not available at this time; however, for the purpose of this study it has been assumed that the maximum column, wall and floor loads will not exceed about 80 kips/column, 4 kips/lin. ft and 150 lbs/sq. ft, respectively. No unusual loading conditions or settlement restrictions have been specified.

3 SUBSURFACE CONDITIONS

The general subsurface conditions were investigated by drilling five test borings to depths ranging from 15 to 20 ft at the approximate locations shown on the Boring Plan (Figure 2 in the Appendix).The subsurface conditions disclosed by the field investigation are summarized in the following paragraphs. Detailed descriptions of the subsurface conditions encountered in each test boring are presented on the Test Boring Logs in the Appendix. The letters in parentheses following the soil descriptions are the soil classifications in accordance with the Unified Soil Classification System. It should be noted that the stratification lines shown on the soil boring logs represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths.

The test borings disclosed a surficial layer of topsoil up to a depth of 5 inches. Underlying the surficial materials in Borings B-1 and B-3, miscellaneous possible fill materials that consisted of brown or mottled brown clays and sands with varying amounts of silt, sand, and gravel were encountered to depths approximately three feet below existing ground surface.

Underlying the surface or possible fill materials, the test borings typically revealed medium stiff to hard brown and gray clays (CL) with varying amounts of silt, sand, sand lenses, and gravel to the boring termination depths ranging from 15 to 20 feet below the existing ground surface (bgs). A seam of gray

medium dense silty sand (SM) was noted in boring B-5 at approximately 6.5 to 9.0 feet (bgs). The consistencies of the cohesive soils and density of the granular soils as described above and on the borings logs were estimated based on the results of the standard penetration test (ASTM D-1586).

Ground water observations were made during the drilling operations by noting the depth of water on the drilling tools and in the open boreholes following withdrawal of the drilling augers. Groundwater was encountered in borings B-3 through B-5 at depths ranging from 6.5 to 7.0' below the existing ground surface during drilling operations. No groundwater was noted at the completion at any boring location. It must be noted that short term ground water level observations in test borings are not necessarily a reliable indication of the ground water level, and that fluctuations in the level of the ground water should be expected due to variations in rainfall and other factors. It is also possible that "perched" ground water may be encountered at various depths and locations across the site above the hydrostatic ground water level. Water is often trapped within old miscellaneous fill materials, abandoned utilities, utility trenches, etc. and although the amount of such water is usually not significant, it is important to recognize that such ground water may be encountered at various depths and locations.

4 DESIGN RECOMMENDATIONS

The following design recommendations have been developed on the basis of the previously described project characteristics (Section 2.0) and subsurface conditions (Section 3.0). If there is any change in these project criteria, including project location on the site, a review should be made by this office.

4.1 Spread Footings

Our findings show that the proposed Belle Tire building can be supported on shallow spread footings provided and unsuitable natural soils as well as all old possible fill and remnants of previous construction are removed from beneath the existing building areas. Footings that bear on firm natural soil (or on well-compacted engineered fill that is placed over firm natural soil) can be designed for a net allowable soil bearing pressure of 3,000 lbs./sq. ft. for column (square type) and 3,000 lbs./sq.ft. wall (strip type) footings respectively. It is extremely important that the soil at the base of each footing excavation be carefully observed and evaluated as described in Section 5.3 so that any unsuitable materials can be identified and removed and to verify the verify that the footings will bear on suitable materials. Depending on the final finish floor elevation, it is possible that undercutting of the foundations may be necessary in areas where possible undocumented fill is present.

In using net pressure, the weight of the footing and backfill over the footing including the weight of the floor slab need not be considered; hence, only loads applied at or above the finished floor need to be used for dimensioning the footings. Wall footings should be at least 12 in. wide and column footings should be at least 2 ft. wide for bearing capacity considerations.

All exterior footings and footings in unheated areas should be located at a depth of at least 3.5 ft below the final exterior grade for frost protection. Interior footings can be located at nominal depths below the finished floor provided the topsoil and other unsuitable materials are removed at the footing locations.

Provided that the footings are designed as prescribed herein and the footing excavations are evaluated as outlined in Section 5.3, it is estimated that the total and differential foundation settlements should not exceed about 1 ½" in. and 1 in., respectively. Careful field control will contribute substantially to minimizing the settlements.

Based on geologic mapping and the results of the test borings, it is our opinion that the subsurface conditions at this site meet the criteria for Site Class D based on Sections 1613.5.2 and 1613.5.5 of the 2009 Michigan Building Code.

Uplift forces on the footings can be resisted by the weight of the footings and the soil material that is placed over the footings. It is recommended that the soil weight considered to resist uplift loads be limited to that immediately above and within the perimeter of the footings (unless a much higher factor of safety is used). A total soil unit weight of 110 lbs/cu.ft can be used for the backfill material placed above the footings, provided it is compacted as recommended in Section 5.2. It is also recommended that a factor of safety of at least 1.3 be used for calculating uplift resistance from the footings (provided only the weight of the footing and the soil immediately above it are used to resist uplift forces).

Lateral forces on a shallow spread footing can be resisted by the passive lateral earth pressure against the side of the footing and by friction between the subgrade soil and the base of the footing. An allowable passive pressure of 600 lbs/sq.ft can be used for that portion of the footing that is below a depth of 2.5 ft below the final exterior grade (no portion of the footing above this depth should used for lateral resistance). An allowable coefficient of friction (between the base of the footing and the underlying soil) of 0.2 (based on a factor of safety of 1.5) can be used in conjunction with the minimum downward load on the base of the footing.

4.2 Floor Slabs

Floor slab can be supported on firm existing soils or on new compacted structural fill after the removal of the upper soils if undesirable materials are encountered. The slab subgrade should be prepared and inspected as described in Section 5.1 of this report.

It is recommended that all floor slabs be "floating", that is, fully ground supported and not structurally connected to walls or foundations. This is to minimize the possibility of cracking and displacement of the floor slab because of differential movements between the slab and the foundation. Although the movements are estimated to be within the tolerable limits for structural safety, such movements could be detrimental to the slab if they were rigidly connected to the foundation.

It is furthermore recommended that the floor slab be supported on a 6 in. thick (minimum) layer of relatively clean granular material such as sand and gravel or crushed stone. This is to help distribute concentrated loads and equalize moisture conditions beneath the slab. Provided that a minimum of 6 in. of granular material is placed below the slab, a modulus of subgrade reaction (k_{30}) of 100 lbs/cu. in. can be used for design of the floor slab.

4.3 Pavement

Details regarding site grading in pavement areas are not available at this time; however, depending upon grading requirements and seasonal conditions, it is possible that the pavement subgrade in some areas will be wet, soft or yielding at the time of construction (particularly in cut areas). If at the time of construction the subgrade is found to be excessively wet, soft or yielding, it may be possible to stabilize the subgrade soils by discing, aerating and recompacting. However, if it is not possible to improve the subgrade soils in this manner because of weather conditions, scheduling, or other conditions (which is often the case), it is recommended that the subgrade soils be improved or modified using either chemical stabilization (i.e., quicklime or a suitable lime by-product), mechanical stabilization (i.e., a geogrid with additional crushed limestone placed over the subgrade), or removal of the unsuitable soils and replacement with crushed limestone or suitable fill soils determined to be appropriate by the geotechnical engineer. The best method for stabilizing the pavement subgrade should be determined in the field at the time of construction based upon the actual field conditions, soil type encountered at the locations requiring stabilization, the size of the areas requiring stabilization, and the construction schedule. We recommend dumpster pads, including the area in front of the pads which will support the garbage trucks front tires, consist of 8 inches of reinforced concrete.

The pavement subgrade surface should be uniformly sloped to facilitate drainage through the granular base and to avoid any ponding of water beneath the pavement. The storm water catch basins in

pavement areas should be designed to allow water to drain from the aggregate base into the catch basins. At a minimum, subsurface trench drains should be included that extend out at least 20 ft from the catchbasins in at least four directions.

Based on the results of the classification tests and our experience with similar soils, a resilient modulus value of 5,000 lbs./sq.in. has been estimated for use in pavement design for the clayey subgrade soils encountered at this site. The subgrade soils should be prepared and inspected as described in Sections 5.1 and 5.2 of this report.

The following report sections outline recommendations for asphalt and concrete pavements for automobile parking areas and truck zones. It is important to note that the recommendations for the automobile parking areas are based on the assumption that these areas will not be subject to any heavy truck traffic. Therefore, in areas where truck traffic cannot be controlled (i.e., driveways), it is suggested that the thicker pavement section be utilized. Since these recommendations are based on estimated traffic loading conditions, it is recommended that they be verified when the actual anticipated traffic conditions become available.

4.3.1 Asphalt Pavement

Based on a resilient modulus value of 5,000 lbs./sq.in., a design period of 15 years and the conditions encountered at the site, the following asphalt pavement sections are recommended:

Automobile Parking Areas	3 in. of asphaltic concrete over 8 in. of compacted aggregate base.
Driveway Areas and Truck Zones	5 in. of asphaltic concrete over 10 in. of compacted aggregate base.

The aggregate base should consist of well-compacted crushed limestone or crushed natural aggregate that meets the requirements for Michigan Department of Transportation (MDOT) 21AA dense graded aggregate and placed on a stable subgrade. The hot mix asphalt (HMA) pavement should be constructed in accordance with the 2012 MDOT Standard Specifications for Asphalt. The HMA mix design should be in accordance with MDOT Standard Specifications for Hot Mix Asphalt or an approved alternate.

4.3.2 Concrete Pavement

Concrete pavement thicknesses were determined from methods developed by the Portland Cement Association (PCA), the American Association of State Highway and Transportation Officials (AASHTO) and the American Concrete Institute (ACI). These methods are based on the subgrade being firm, well-compacted and non-pumping and all joints being properly designed, located and sealed to minimize moisture seepage into the subgrade. It is also important that proper concrete curing practices be employed and that traffic will not be allowed until the concrete has had sufficient time to cure.

For design calculation purposes, the compressive strength of the concrete was assumed to be at least 4,000 lbs/sq. in. (or a modulus of rupture of at least 625 lbs/sq. in.) and the modulus of subgrade reaction (k30) was estimated to be 100 lbs/cu. in.

Based on this information, the following concrete pavement sections were determined:

Automobile Parking Areas	5 in. of concrete over a 4” well-compacted aggregate base placed over well-compacted non-pumping subgrade.
Driveway Areas and Truck Zones	8 in. of concrete over a 4” well-compacted aggregate base placed over well-compacted non-pumping subgrade.

The performance of the concrete paving section is highly dependent on controlling the pumping of the subgrade soils. It is important that surface drainage be controlled to prevent water from ponding in pavement areas.

4.4 Site Grading and Drainage

Proper surface drainage should be provided at the site to minimize any increase in moisture content of the foundation soils. The exterior grade should be sloped away from the structure to prevent ponding of water and downspouts/ roof drains should be piped sufficiently away from the structure. Because of the general nature of the clay soil at this site, areas designed for sand backfill should have additional drains to transport water from the sand backfill to the storm water system. This can prevent the “bathtub effect” of the sand holding water and possibly raising the moisture in the adjacent clay above the plastic or liquid limit.

5 GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS

Since this investigation identified actual subsurface conditions only at the test boring locations, it was necessary for our geotechnical engineers to extrapolate these conditions in order to characterize the entire project site. Even under the best of circumstances, the conditions encountered during construction can be expected to vary somewhat from the test boring results and may, in the extreme case, differ to the extent that modifications to the foundation recommendations become necessary. Therefore, we recommend that ATC be retained as a geotechnical consultant throughout the earth-related phases of this project to correlate actual soil conditions with test boring data, identify variations, conduct additional tests that may be needed and recommend solutions to earth-related problems that may develop.

5.1 Site Preparation

All areas that will support floor slab and pavements should be properly prepared. After the rough grade has been established in cut areas and prior to placement of fill in all fill areas, the exposed subgrade should be carefully observed by the geotechnical engineer or a qualified soils technician by probing and testing as needed. The exposed subgrade should furthermore be evaluated by proofrolling with suitable equipment to check for pockets of soft material hidden beneath a thin crust of better soil. Any remnants of previous construction, old fill, and organic materials still in place, frozen, wet, soft or loose, and other undesirable materials should be removed and replaced with engineered fill as outlined in section 5.2. Any unsuitable materials thus exposed should be removed and replaced with well-compacted, engineered fill as outlined in Section 5.2.

Care should be exercised during the grading operations at the site. Due to the nature of the near surface soils, the traffic of construction equipment may create pumping and general deterioration of the shallower soils, especially if excess surface water is present. The grading should therefore be done during a dry season, if at all possible.

5.2 Fill Compaction

All engineered fill beneath floor slab, pavements and over footings should be compacted to a dry density of at least 95 percent of the modified Proctor maximum dry density (ASTM D-1557). The compaction should be accomplished by placing the fill in about 8 in. (or less) loose lifts and mechanically compacting each lift to at least the specified minimum dry density. Field density tests should be performed on each lift as necessary to document moisture conditions and the actual compaction that is being achieved.

Compaction of any fill by flooding is not considered acceptable. This method will generally not achieve the desired compaction and the large quantities of water will tend to soften the foundation soils. All soils encountered in the test borings made at this site are considered suitable as general fill material with the exception of the topsoil. Depending on seasonal conditions, the need for some aeration of some soils may be required before they can be placed and compacted to the specified density. New engineered fill should consist of natural soil that is free of organic material, debris, and particles larger than 3 inches in size. Depending on the seasonal conditions, the need for some aeration of some soils may be required before they can be placed and compacted to the specified density.

If sand backfill is used within the hard clay grade, underdrains should be placed to drain the utility trenches or other excavations directly to the storm water system. Other sand seams or lenses may need additional underdrains if they are adjacent to excavations. If the sand backfill is not drained, the fill will hold water and lose strength because the water will not be able to drain through the hard clay. The underdrains should take the water directly to storm structures in order to function properly.

5.3 Foundation Excavations

The soil at the base of each foundation excavation should be observed and evaluated by a geotechnical engineer or a qualified geotechnical technician working under the direction of the geotechnical engineer. All old fill materials, remnants from previous construction and all loose, soft, or otherwise undesirable material must be removed within the building footprint and foundation locations of the proposed Belle Tire Store so that the footings will bear on satisfactory material. Any loose, very soft or otherwise undesirable materials that are encountered should be removed and replaced with engineered fill. At the time of such observation, it will be necessary to make hand auger borings or use a hand penetration device in the base of the foundation excavation to evaluate the soils below the base. The necessary depth of foundation penetration will be established by the geotechnical engineer or technician.

Where undercutting is required to remove unsuitable materials, the proposed footing elevation may be re-established by backfilling after all undesirable materials have been removed. The undercut excavation beneath each footing should extend to suitable bearing soils and the dimensions of the excavation base should be determined by imaginary planes extending outward and downward on a 2 (vertical) to 1 (horizontal) slope from the base perimeter of the footing (See Figure 3 in the Appendix). The entire excavation should then be refilled with engineered fill. The engineered fill should be limited to well-graded sand and gravel or crushed stone (e.g., MDOT 6AA crushed limestone) compacted to the minimum dry density recommended in Section 5.2; or lean concrete may be used. Special care should be exercised to remove any sloughed, loose or soft materials near the base of the excavation slopes. In addition, special care should be taken to “tie-in” the compacted fill with the excavations slopes with benches as necessary. This is to insure that no pockets of loose or soft materials will be left in place along the excavation slopes below the foundation bearing level.

All existing facilities (such as utilities, streets, etc.) that will remain should be suitable protected from undermining due to excavation for the project. Depending on the relative depths and locations of the existing facilities and the excavation, bracing or underpinning may be needed. All federal, state, and local safety regulations should be followed in this regard.

Soils exposed in the bases of all satisfactory foundation excavations should be protected against any detrimental change in condition such as from disturbance, rain and freezing. Due to the silty nature of the soils at this site, otherwise stable soils can easily be disturbed and can deteriorate due to construction activities and excess moisture and thus exposure should be limited. Surface run-off water should be drained away from the excavation and not allowed to pond. If possible, all footing concrete should be placed the same day the excavation is made. If this is not practical, the footing excavations should be adequately protected.

5.4 Construction Dewatering

At the time of our investigation, the ground water levels appeared to be below the anticipated footing excavation depths. However, “perched” ground water may be encountered where sand seams or lenses are present within the clay layers (as in borings B-3 through B-5). Therefore, depending on the seasonal conditions, some seepage into excavations should be expected. It is anticipated that such seepage could be controlled through conventional methods, however, water should not be pumped directly from an excavation terminating in saturated sand since this will result in a deterioration of the excavation base. Therefore, it will be necessary to pump from a sump located outside the footing excavation. The best dewatering system for each case must be determined at the time of construction based upon actual field conditions. This method will not be effective for any excavation that extends below the actual ground water level. In this case, it would be necessary to pump from wells or well points in order to depress the ground water level.

6 FIELD INVESTIGATION

Five test borings were drilled at the locations shown on the Boring Plan (Figure 2 in the Appendix). The borings were extended to a depths of approximately 15 to 20 ft. (bgs). Split-spoon samples were obtained by the standard penetration test procedures (ASTM D-1586) at 2.5 to 5 ft intervals.

Logs of all borings, which show visual descriptions of all soil strata encountered using the Unified Soil Classification System, are included in numerical order in the Appendix. Ground water observations, sampling information and other pertinent field data and observations are also included. In addition, a "Field Classification System for Soil Exploration" document defining the terms and symbols used on the logs and explaining the standard penetration test procedure is provided immediately following the boring logs.

7 LABORATORY INVESTIGATION

The disturbed samples were inspected and classified in accordance with the Unified Soil Classification System and the boring logs were edited as necessary. To aid in classifying the soils and to determine general soil characteristics, natural moisture content tests and an Atterberg Limit test were performed on selected samples. The results of these tests are included on the Test Boring Logs in the appendix.

8 LIMITATIONS OF STUDY

An inherent limitation of any geotechnical engineering study is that conclusions must be drawn on the basis of data collected at a limited number of discrete locations. The recommendations provided in this report were developed from the information obtained from the test borings that depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. The nature

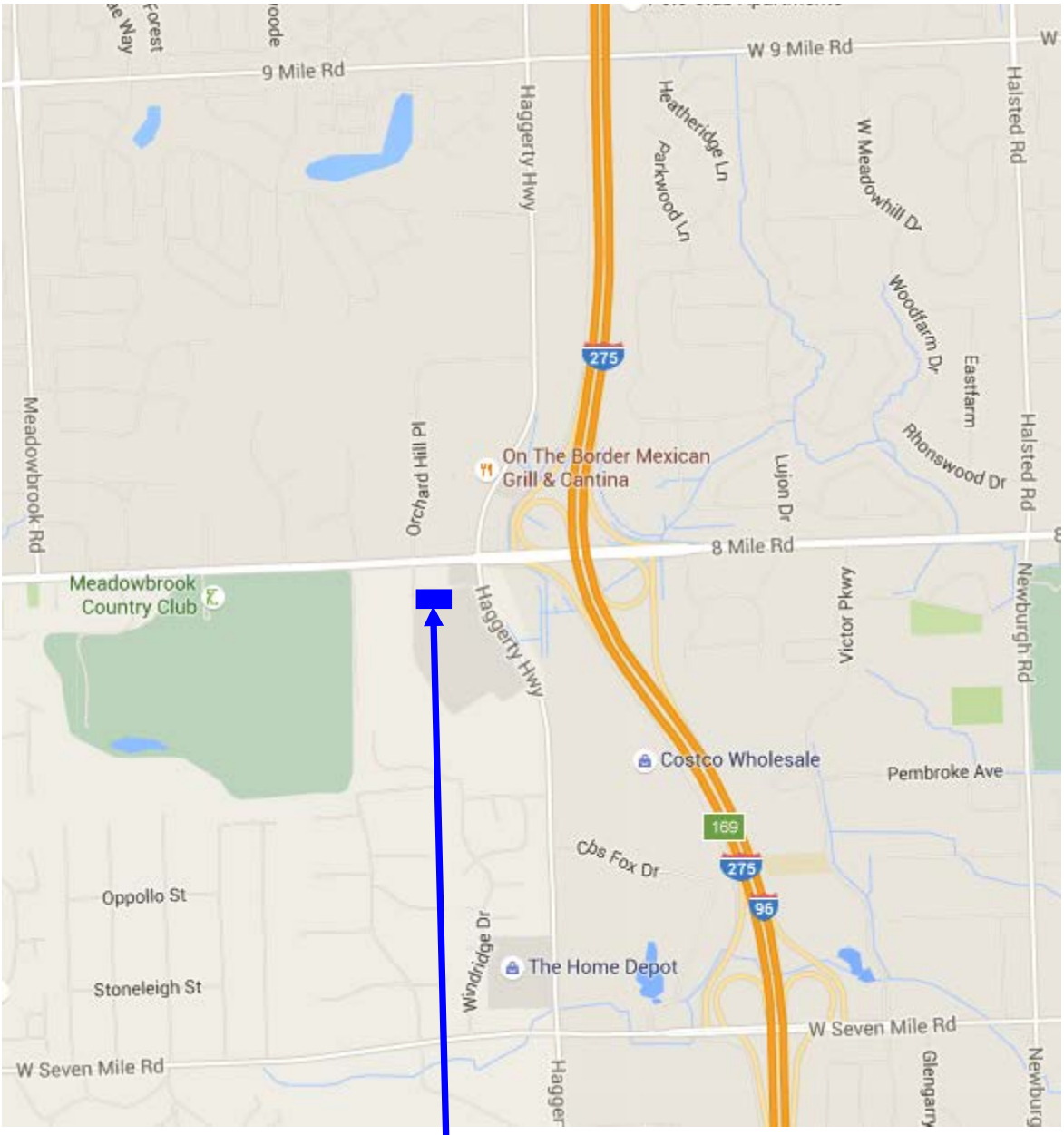
and extent of variations between the borings may not become evident until the course of construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report after performing on-site observations during the excavation period and noting the characteristics of any variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. This company is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploration and laboratory test data presented in this report.

The scope of our services does not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, ground water or surface water within or beyond the site studied.

ATC assumes no responsibility for any construction procedures, temporary excavations (including utility trenches), temporary dewatering or site safety during or after construction. The contractor will be solely responsible for all construction procedures, construction means and methods, construction sequencing and for safety measures during construction. All applicable federal, state and local laws and regulations regarding construction safety must be followed, including current Occupational Safety and Health Administration (OSHA) Regulations including OSHA 29 CFR Part 1926 “Safety and Health Regulations for Construction”, Subpart P “Excavations”, and/or successor regulations. The Contractor is solely responsible for designing and constructing stable, temporary excavations and should brace, shore, slope, or bench the sides of the excavations as necessary to maintain stability of the excavation sides and bottom.

Appendix



SOURCE: This Site Location Map is based on maps prepared by others.

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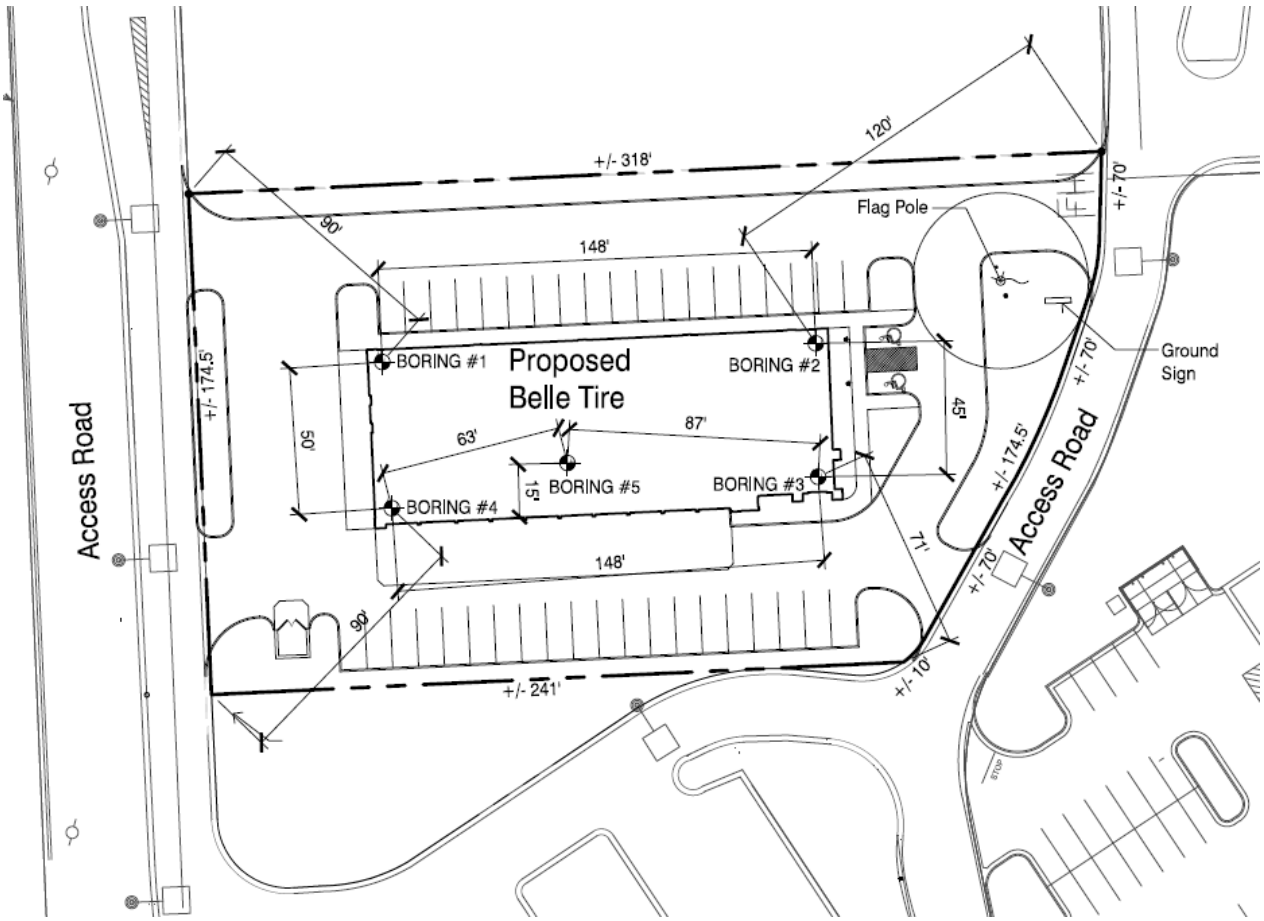
46555 Humboldt Drive
Novi, Michigan 48377

SCALE: NTS

PROJECT NO. N331481601

FIGURE 1
SITE VICINITY MAP
Proposed Belle Tire
8 Mile Road & Haggerty Highway
Northville, Michigan



SOURCE: This Test Boring Location Map is based on Site Plan drawings prepared by others.

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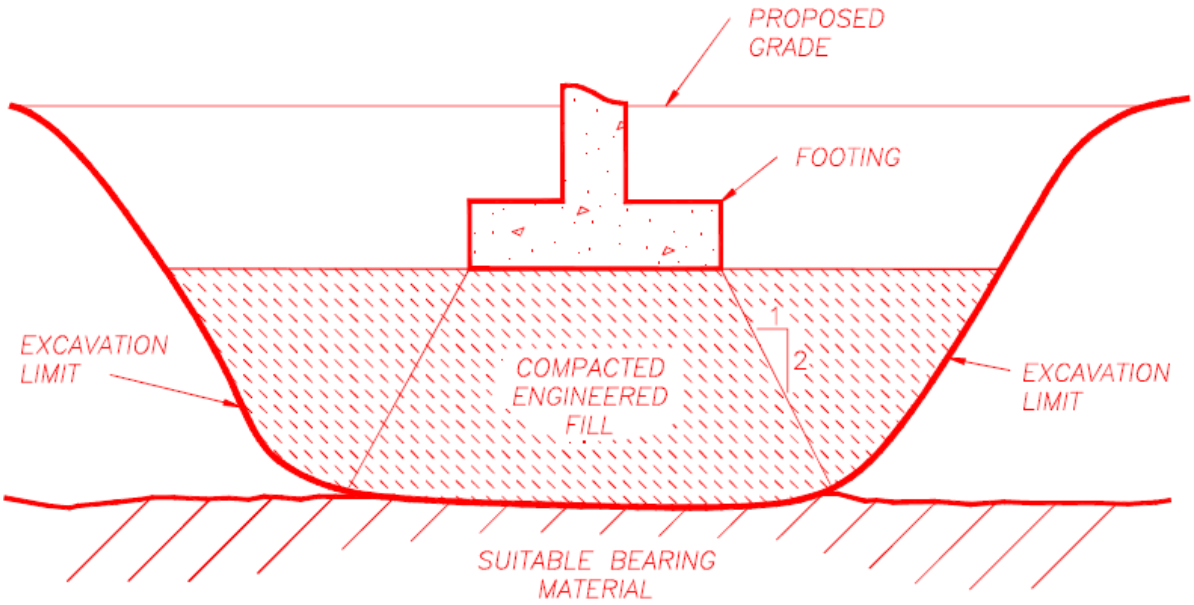
46555 Humboldt Drive
Novi, Michigan 48377

FIGURE 2
BORING LOCATIONS
Proposed Belle Tire
8 Mile Road & Haggerty Highway
Northville, Michigan

SCALE: NTS

PROJECT NO. N331481601



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46555 Humboldt Drive
Novi, Michigan 48377

SCALE: NTS

PROJECT NO. N331481601

FIGURE 3
FOOTINGS IN UNDERCUT AREA
Proposed Belle Tire
8 Mile Road & Haggerty Highway
Northville, Michigan

Test Boring Log

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46555 Humboldt Drive, Ste. 100
Novi, MI 48377
Phone: (248) 669-5140
Fax: (248) 669-5147

Project Number: N331481601
Project Name: Proposed Belle Tire

Site Location: 8 Mile Rd & Haggerty Hwy
City: Northville
State: MI
Drilling Method: HSA

Boring Number: B-1
Start Date: 1/14/2016
Completion Date: 1/14/2016

FEET (BLS)	SAMPLE TYPE	SAMPLE INTERVAL (BLS)	BLOW COUNT #/6"	Qp (tsf)	WC (%)	LITHOLOGY DESCRIPTION	COMMENTS
0						0.0' - 0.4' Topsoil	
1						0.4' - 3.0' Brown, Moist, Stiff, Silty CLAY, with trace SAND and trace Gravel (Possible Fill)	
			3				
2	SS	1.0-2.5'	8	4.5			
			7				
3							
			W.O.H				
4	SS	3.5-5.0'	5	4.5	9.5%	3.0' - 6.0' Brown, Moist, Very Stiff, Silty CLAY, with trace Sand and trace Gravel and limestone fragments (CL)	
			12				
5							
6			7				
	SS	6.0-7.5'	14	4.5	7.4%		
7			13				
8							
			12				
9	SS	8.5-10.0'	19	4.5			
			20			6.0' - 15.0' Gray, Moist, Very Stiff to Hard, Silty CLAY, with some fine to medium grained SAND, trace fine Gravel, and limestone fragments (CL)	
10							
11							
12							
13							
			9				
14	SS	13.5-15.0'	14	4.5	7.5%		
			23				
15							
						End of Boring 15.0'	
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

(HA) = HAND AUGER
(MR) = MUD ROTARY
(SS) = SPLIT SPOON
(qP) = Penetrometer Unconfined Compressive Strength
(DS) = DISTURBED SAMPLE
(WC) = WATER CONTENT
bpf = blows per foot

Borehole Water Observations

Encountered:	None
Immediately after:	None
Backfill :	Cuttings

(Rec.) = RECOVERY
(EOB) = END OF BORING
(NR) = NO RECOVERY
(NA) = NOT APPLICABLE

Logged by: JGC
Drawn by: JGC
Checked by: KMG

Drilling Co.: McDowell & Assoc.
Drill Rig Type: CME 45C

Driller: Bob Adams
Assistant: Adam R

Test Boring Log

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46555 Humboldt Drive, Ste. 100
Novi, MI 48377
Phone: (248) 669-5140
Fax: (248) 669-5147

Project Number: N331481601
Project Name: Proposed Belle Tire
Site Location: 8 Mile Rd & Haggerty Hwy
City: Northville
State: MI
Drilling Method: HSA

Boring Number: B-2
Start Date: 1/14/2016
Completion Date: 1/14/2016

FEET (BLS)	SAMPLE TYPE	SAMPLE INTERVAL (BLS)	BLOW COUNT #/6"	Qp (tsf)	WC (%)	LITHOLOGY DESCRIPTION	COMMENTS
0						0.0' - 0.33' Topsoil	
1						0.33' - 2.0' Brown, Moist, Sandy CLAY, with little Silt (CL)	
			6				
2	SS	1.0-2.5'	7	4.5	15.0%		
			7				
3						2.0' - 4.5' Gray, Moist, Stiff to Very Stiff Silty CLAY with trace SAND (CL)	
			13				
4	SS	3.5-5.0'	11	3.5	8.9%		
			10				
5							
6			12			4.5' - 9.0' Gray, Moist, Very Stiff to Hard, Sandy CLAY, with some silt, little fine to coarse Gravel, and gray sand lenses (CL)	
	SS	6.0-7.5'	15	4.5			
7			18				
8							
			12				
9	SS	8.5-10.0'	19	4.5			
			16				
10						9.0' - 13.5' Gray, Moist, Hard, Silty CLAY, with some fine to medium grained Sand, little fine to coarse Gravel, and limestone fragments (CL)	
11							
12							
13							
			9				
14	SS	13.5-15.0'	18	4.5		13.5' - 15.0' Gray, Moist, Hard, Silty CLAY, with some fine to medium grained SAND and trace gravel (CL)	
			21				
15							
16						**End of Boring 15.0'**	
17							
18							
19							
20							
21							
22							
23							
24							
25							

(HA) = HAND AUGER
(MR) = MUD ROTARY
(SS) = SPLIT SPOON
(qP) = Penetrometer Unconfined Compressive Strength
(DS) = DISTURBED SAMPLE
(WC) = WATER CONTENT
bpf = blows per foot

Borehole Water Observations
Encountered: None
Immediately after: None
Backfill : Cuttings

(Rec.) = RECOVERY
(EOB) = END OF BORING
(NR) = NO RECOVERY
(NA) = NOT APPLICABLE

Logged by: JGC
Drawn by: JGC
Checked by: KMG

Drilling Co.: McDowell & Assoc.
Drill Rig Type: CME 45C

Driller: Bob Adams
Assistant: Adam R

Test Boring Log

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

46555 Humboldt Drive, Ste. 100
Novi, MI 48377
Phone: (248) 669-5140
Fax: (248) 669-5147

Project Number: N331481601
Project Name: Proposed Belle Tire
Site Location: 8 Mile Rd & Haggerty Hwy
City: Northville
State: MI
Drilling Method: HSA

Boring Number: B-3
Start Date: 1/14/2016
Completion Date: 1/14/2016

FEET (BLS)	SAMPLE TYPE	SAMPLE INTERVAL (BLS)	BLOW COUNT #/6"	Qp (tsf)	WC (%)	LITHOLOGY DESCRIPTION	COMMENTS
0						0.0' - 0.33' Topsoil	
1						0.4' - 2.5' Brown, Mottled, Moist, Fine to Coarse SAND, with some Silt, and trace fine Gravel (Possible Fill)	
			4				
2	SS	1.0-2.5'	8		8.0%		
			11				
3							
			10				
4	SS	3.5-5.0'	11	4.5	9.8%	2.5' - 7.0' Gray, Moist, Very Stiff, Silty CLAY, with little fine to medium grained Sand, trace fine gravel, and seams of gray silty Sand (CL)	
			14				
5							
6			14				
	SS	6.0-7.5'	23	4.0			G.W. @ 7.0'
7			12				
8							
			9				
9	SS	8.5-10.0'	16	4.5			
			17				
10						7.0' - 15.0' Gray, Moist, Hard, Silty CLAY , with little fine to medium grained Sand, trace fine gravel, and limestone fragments (CL)	
11							
12							
13							
			10				
14	SS	13.5-15.0'	14	4.5	7.3%		
			18				
15							
						End of Boring 15.0'	
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

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(DS) = DISTURBED SAMPLE
(WC) = WATER CONTENT
bpf = blows per foot

Borehole Water Observations
Encountered: 7.0'
Immediately after: None
Backfill : Cuttings

(Rec.) = RECOVERY
(EOB) = END OF BORING
(NR) = NO RECOVERY
(NA) = NOT APPLICABLE

Logged by: JGC
Drawn by: JGC
Checked by: KMG

Drilling Co.: McDowell & Assoc.
Drill Rig Type: CME 45C

Driller: Bob Adams
Assistant: Adam R

Test Boring Log

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

46555 Humboldt Drive, Ste. 100
Novi, MI 48377
Phone: (248) 669-5140
Fax: (248) 669-5147

Project Number: N331481601
Project Name: Proposed Belle Tire
Site Location: 8 Mile Rd & Haggerty Hwy
City: Northville
State: MI
Drilling Method: HSA

Boring Number: B-4
Start Date: 1/14/2016
Completion Date: 1/14/2016

FEET (BLS)	SAMPLE TYPE	SAMPLE INTERVAL (BLS)	BLOW COUNT #/6"	Qp (tsf)	WC (%)	LITHOLOGY DESCRIPTION	COMMENTS
0						0.0' - 0.25' Topsoil	
1						0.25' - 2.0' Brown, Moist, Silty CLAY, with trace fine to medium Gravel, occ. rock fragments, and brown sand lenses (CL)	
			7				
2	SS	1.0-2.5'	12	4.5			
			12				
3							
			5			2.0' - 6.5' Brown, Wet, Very Stiff to Medium Stiff, Sandy CLAY, with some Silt, occ. rock fragments, and seams of brown sand (CL)	
4	SS	3.5-5.0'	4	2.0	24.3%		
			4				G.W. @ 5.0'
5							
6			7				
	SS	6.0-7.5'	15	4.5	7.0%		
7			13				
8							
			10				
9	SS	8.5-10.0'	16	4.5			
			15				
10						6.5' - 15.0' Gray, Moist, Very Stiff to Hard, Silty CLAY, with some fine to medium grained Sand, and trace fine to medium gravel (CL)	
11							
12							
13							
			18				
14	SS	13.5-15.0'	21	4.5			
			13				
15							
						End of Boring 15.0'	
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

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(DS) = DISTURBED SAMPLE
(WC) = WATER CONTENT
bpf = blows per foot

Borehole Water Observations

Encountered:	5.0'
Immediately after:	None
Backfill :	Cuttings

(Rec.) = RECOVERY
(EOB) = END OF BORING
(NR) = NO RECOVERY
(NA) = NOT APPLICABLE

Logged by: JGC
Drawn by: JGC
Checked by: KMG

Drilling Co.: McDowell & Assoc.
Drill Rig Type: CME 45C

Driller: Bob Adams
Assistant: Adam R

Test Boring Log

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

46555 Humboldt Drive, Ste. 100
Novi, MI 48377
Phone: (248) 669-5140
Fax: (248) 669-5147

Project Number: N331481601
Project Name: Proposed Belle Tire
Site Location: 8 Mile Rd & Haggerty Hwy
City: Northville
State: MI
Drilling Method: HSA

Boring Number: B-5
Start Date: 1/14/2016
Completion Date: 1/14/2016

FEET (BLS)	SAMPLE TYPE	SAMPLE INTERVAL (BLS)	BLOW COUNT #/6"	Qp (tsf)	WC (%)	LITHOLOGY DESCRIPTION	COMMENTS
0						0.0' - 0.25' Topsoil	
1							
			6			0.25' - 3.5' Brown, Moist, Very Stiff, Silty CLAY, with some	
2	SS	1.0-2.5'	10	4.5	12.0%	sand, and trace fine gravel (CL)	
			10				
3							
			5				
4	SS	3.5-5.0'	5	3.0	12.8%		
			6			3.5' - 6.5' Brown to Variegated, Moist, Stiff, Silty CLAY, with some	
5						Sand, and brown sand lense at 4.75' (CL)	
6			10				G.W. @ 6.5'
	SS	6.0-7.5'	13				
7			10			6.5' - 9.0' Gray, Wet, Medium Dense, Fine to Medium Grained	
						Silty SAND (SM)	
8							
			9				
9	SS	8.5-10.0'	17	4.5			
			24				
10							
11							
12							
13						9.0' - 18.5' Gray, Moist, Hard, Silty CLAY, with fine to medium grained	
			17			Sand, and trace fine to medium Gravel (CL)	
14	SS	13.5-15.0'	27	4.5	7.3%		
			28				
15							
16							
17							
18							
			14				
19	SS	18.5-20.0'	23	4.5		18.5' - 20.0' Gray, Moist, Hard, Silty CLAY, with some sand and	
			24			fine to medium gravel, and trace limestone fragments (CL)	
20							
						End of Boring 20.0'	
21							
22							
23							
24							
25							

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Borehole Water Observations

Encountered:	6.5'	
Immediately after:	None	
Backfill :	Cuttings	

(Rec.) = RECOVERY
(EOB) = END OF BORING
(NR) = NO RECOVERY
(NA) = NOT APPLICABLE

Logged by: JGC
Drawn by: JGC
Checked by: KMG

Drilling Co.: McDowell & Assoc.
Drill Rig Type: CME 45C

Driller: Bob Adams
Assistant: Adam R

FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

NON-COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	-	5 blows/ft or less
Loose	-	6 to 10 blows/ft
Medium Dense	-	11 to 30 blows/ft
Dense	-	31 to 50 blows/ft
Very Dense	-	51 blows/ft or more

Relative Proportions

Descriptive Term	Percent
Trace	1 – 10
Little	11 – 20
Some	21 – 35
And	36 – 50

Particle Size Identification

Boulders	-	8 inch diameter or more	
Cobbles	-	3 to 8 inch diameter	
Gravel	-	Coarse	- 1 to 3 inch
		Medium	- ½ to 1 inch
		Fine	- ¼ to ½ inch
Sand	-	Coarse	2.00mm to ¼ inch (dia. of pencil lead)
		Medium	0.42 to 2.00mm (dia. of broom straw)
		Fine	0.074 to 0.42mm (dia. of human hair)
Silt			0.074 to 0.002mm (cannot see particles)

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency

Very Soft	-	3 blows/ft or less
Soft	-	4 to 5 blows/ft
Medium Stiff	-	6 to 10 blows/ft
Stiff	-	11 to 15 blows/ft
Very Stiff	-	16 to 30 blows/ft
Hard	-	31 blows/ft or more

Plasticity

Degree of Plasticity	Plasticity Index
None to slight	0 – 4
Slight	5 – 7
Medium	8 – 22
High to Very High	over 22

Classification on logs are made by visual inspection of samples.

Standard Penetration Test – Driving a 2.0 in. O.D. 1-3/8 in. I.D. sampler a distance of 1.0 ft into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 in. It is customary for ATC to drive the spoon 6.0 in. to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the test are recorded for each 6.0 in. of penetration on the drill log (example – 6/8/9). The standard penetration test result can be obtained by adding the last two figures (i.e., 8 + 9 = 17 blows/ft). (ASTM D-1586-67).

Strata Changes – In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (——) represents an actually observed change. A dashed line (- - - - -) represents an estimated change.

Ground Water observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs

ATC
ENVIRONMENTAL • GEOTECHNICAL
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Atterberg Limits

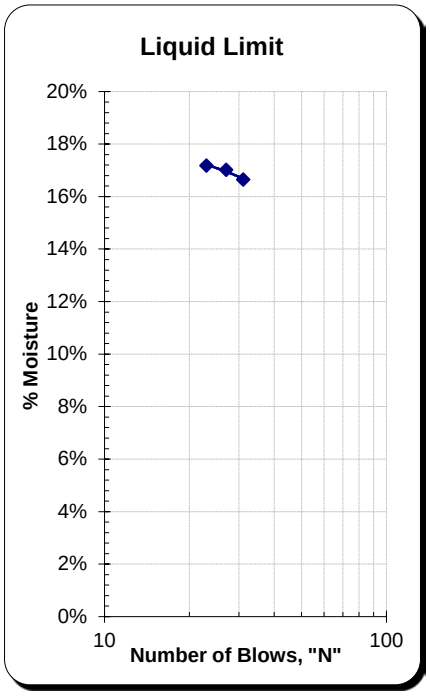
Date Received: 1/15/2016 **Project:** Belle Tire
Sample #: B-3 8.5-10' **Location:** Northville, MI
Project No: N331481601
Source: McDowell & Associates

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

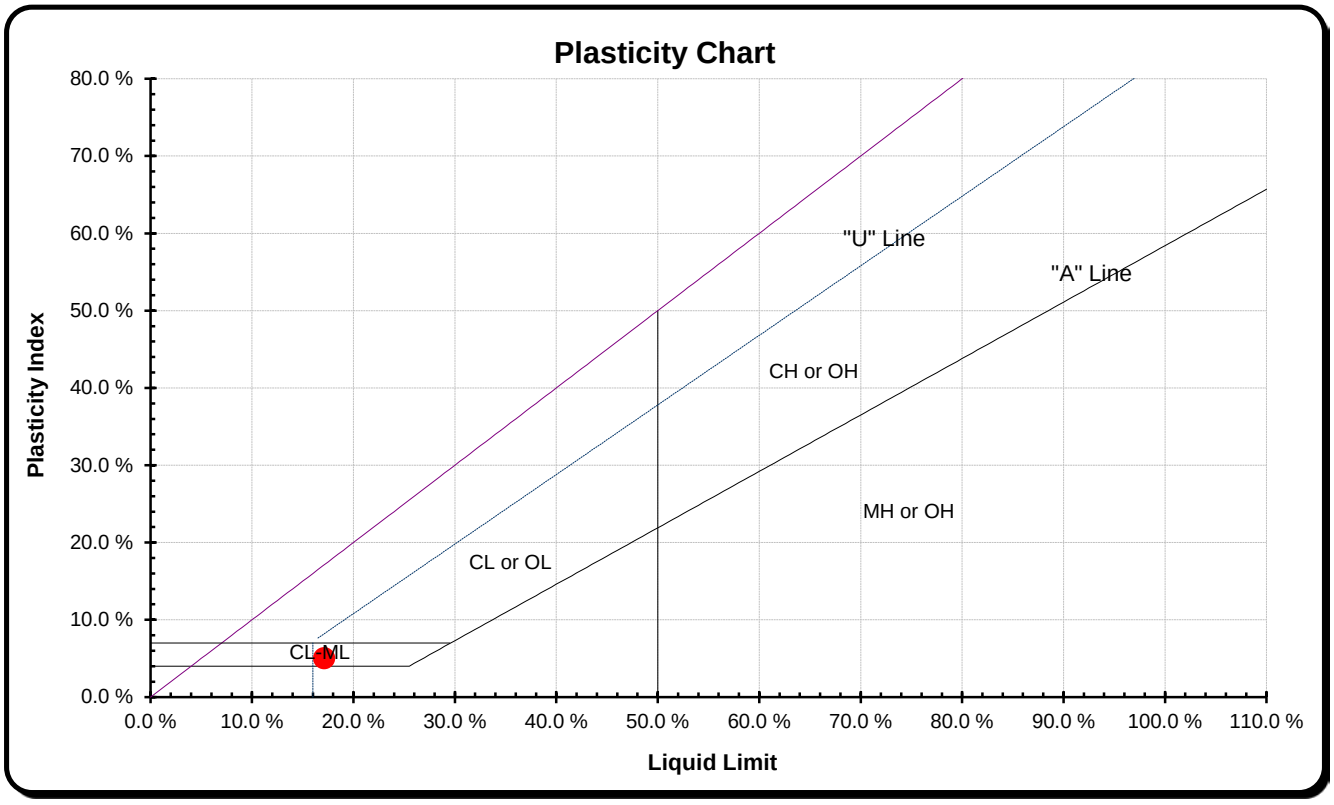
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	22.22	23.72	23.49			
Weight of Dry Soils + Pan:	20.63	21.86	21.69		212.00	
Weight of Pan:	11.08	10.93	11.21			
Weight of Dry Soils:	9.55	10.93	10.48			
Weight of Moisture:	1.59	1.86	1.80			
% Moisture:	16.7 %	17.0 %	17.2 %			
N:	31	27	23			



Liquid Limit @ 25 Blows: 17.1 %
Plastic Limit: 12.0 %
Plasticity Index, I_P: 5.1 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	19.06	22.29				
Weight of Dry Soils + Pan:	18.17	21.10				
Weight of Pan:	10.60	11.40				
Weight of Dry Soils:	7.57	9.70				
Weight of Moisture:	0.89	1.19				
% Moisture:	11.8 %	12.3 %				



Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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