GEOTECHNICAL EVALUATION REPORT

LAKETRAN – PARK N RIDE
WICKLIFFE, OHIO

SME Project Number: 083625.00
March 2, 2020

SME

9375 Chillicothe Road
Kirtland, OH 44094-8501

T (440) 256-6500

www.sme-usa.com

March 2, 2020

Mr. Peter J. Formica, PE
CT Consultants, Inc.
8150 Sterling Court
Mentor, Ohio 44060

Via E-mail: pformica@ctconsultants.com (PDF file)

RE: Geotechnical Evaluation Report
Laketran – Park N Ride
29610 Lakeland Boulevard
Wickliffe, Ohio
SME Project No. 083625.00

Dear Mr. Formica:

We have completed the geotechnical evaluation for the Laketran Park N Ride located in Wickliffe, Ohio. This report presents the results of our observations and analyses, and our geotechnical and pavement engineering recommendations based on the information disclosed by the borings.

We appreciate the opportunity to be of service. If you have questions or require additional information, please contact me.

Sincerely,

SME

Alison K. Frye Mar 3 2020 9:54 AM

Alison K. Frye, PE DocuSign
Project Engineer

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1. INTRODUCTION

This report presents the results of the geotechnical evaluation performed by SME for the Laketran Park N Ride project. We performed this evaluation in general accordance with the scope of services outlined in SME Proposal No. P00270.20, dated January 28, 2020. Our services for this evaluation were authorized by Peter Formica with CT Consultants.

To assist with our evaluation and preparation of this report, CT Consultants provided SME with a Site Layout Plan, dated January 31, 2020.

1.1 SITE CONDITIONS

The project site consists of an existing Laketran Park N Ride facility located at 29610 Lakeland Boulevard, in Wickliffe, Ohio. At the time of our field exploration, the site included a concrete paved parking lot and driveways with a bus stop shelter. Based on Google Earth imagery and our site observations, the existing ground surface ranges from about elevations 646 to 649 feet throughout the site.

1.2 PROJECT DESCRIPTION

The proposed project consists of the construction a single-story, slab-on-grade bus station building with a plan area of about 2,000 square feet. The building will also have an illuminated sign extending upwards from the roof of the building. Specific structural loading information has not been provided to us at this time. We have assumed the design structural loads will include maximum column loads of 100 kips and maximum wall loads of 3 kips per linear foot.

The project will also consist of the reconstruction of the driveways and sections of the parking lot. You informed us that the surfacing will consist of concrete, and the anticipated traffic loading will include primarily buses and passenger vehicles. The daily bus traffic will include an average of four buses per hour between the hours of 6 A.M. and 8 P.M., as well as two additional buses at the start and end of each day. We expect relatively minor earthwork (cuts and fills of 2 feet or less) will be required to achieve final subgrade levels in the proposed building and pavement areas.

The preceding discussion represents our understanding of the proposed project and is an important part of our engineering interpretation. If this understanding is not correct or if project plans change, we should be given the opportunity to review our recommendations.

2. EVALUATION PROCEDURES

2.1 FIELD EXPLORATION

The field exploration included five borings, with depths extending between 6.7 and 14.4 feet, at locations selected by SME to be representative of the planned building and pavements. Two borings were drilled near the corners of the planned bus station building, and three borings were drilled within the pavements areas. Pavement cores were performed at the three pavement boring locations.

SME marked the boring locations at the site referenced to existing site features. The approximate boring locations and ground surface elevations are shown on the Boring Location Diagram (Figure No. 1) in Appendix A. Ground surface elevations were measured using a hand level, using an existing storm drain cover as a benchmark.

The borings were drilled and sampled using a truck-mounted rotary drill rig. The borings were advanced using hollow-stem augers, and included soil sampling based upon the Split-Barrel Sampling procedure. Recovered split-barrel samples were sealed in glass jars.

Groundwater level observations in the boreholes were recorded during and immediately after completion of each boring. The boreholes were backfilled with auger cuttings and capped with concrete after completion and collection of groundwater readings. Therefore, long-term groundwater levels were not obtained from the borings.

Soil samples recovered from the field exploration were delivered to the SME laboratory for further evaluation and testing.

2.2 LABORATORY TESTING

The laboratory testing program consisted of visually classifying the recovered soil samples in accordance with ASTM D-2488. Moisture content and hand-held penetrometer tests were performed on portions of the more cohesive samples. An Atterberg limits test was completed on the sample obtained from 3.5 to 5 feet at B3. Phenolphthalein reaction testing was performed on the upper 3.5 feet of all five boring samples. This test is used as a basic means of evaluating whether soils have been treated with lime or cement. The test consists of adding a few drops of phenolphthalein to a stabilized/treated soil sample. For lower pH materials such as cement, the material will turn red-pink. The Laboratory Testing Procedures in Appendix B provides general descriptions of the laboratory tests. Based on the laboratory testing, we developed a soil description and assigned a Unified Soil Classification System (USCS) group symbol to each of the soil strata encountered.

Upon completion of the laboratory testing, boring logs were prepared that include information on materials encountered, penetration resistances, pertinent field observations made during drilling operations, and the results of the laboratory testing. The boring logs are included in Appendix A. Explanations of symbols and terms used on the boring logs are provided on the Boring Log Terminology sheet included in Appendix A. The soil descriptions included on the logs were developed from the visual classifications.

Soil samples retained over a long time, even sealed in jars, are subject to moisture loss and are no longer representative of the conditions initially encountered in the field. Therefore, soil samples are normally retained in our laboratory for 60 days and are then disposed of unless we are instructed otherwise.

3. SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

The subsurface profile may be generalized as consisting of concrete pavement, underlain by cement stabilized lean to fat clay fill and natural fat clays, ending in gray shale.

The existing pavement sections consist of 4 ¾ to 10 inches of steel reinforced concrete underlain by cement stabilized lean clay fill. 2 to 4 inches of crushed limestone aggregate base were encountered in borings B3 and B4. The cement stabilized fill extended to depths between 1 and 5 feet below the existing ground surface. Below the pavement and fill, we encountered fat gray, red, and light brown clay with varying amounts of shale and organics. The fat clays had stiff to very stiff consistencies and extend to depths between 4 and 7 feet below the existing ground surface. Gray shale with very soft to medium hard consistency was encountered below the fat clay to the explored depths of the borings. We did not observe shale at boring B3.

3.2 GROUNDWATER CONDITIONS

Groundwater was not encountered during and/or upon completion of drilling at the borings.

A long time can be required for groundwater levels to reach equilibrium in small diameter boreholes, particularly in low permeability clay soils. Long term monitoring of groundwater levels may provide a more accurate estimate of the static groundwater level at this site. Hydrostatic groundwater levels and perched groundwater levels should be expected to fluctuate throughout the year, based on variations in precipitation, evaporation, run-off, and other factors. The groundwater conditions indicated by the borings represent conditions at the time the readings were taken. The actual groundwater conditions at the time of construction may vary from those reported on the boring logs. Expect perched water above the low-permeability clays or in granular seams within the fill and native clays.

4. ANALYSIS AND RECOMMENDATIONS

4.1 SITE PREPARATION AND EARTHWORK

4.1.1 SITE SUBGRADE PREPARATION

The planned building will be located within existing parking lot pavement, sidewalks, driveways, and landscape islands. The existing pavements, curbs, and bus stop should be removed. After demolition, the proposed construction area should be cleared of debris, concrete, vegetation, and topsoil to expose suitable underlying inorganic subgrade soils. Based on the boring information, we expect clay fill or undisturbed fat clay will be exposed after clearing and stripping the project site. The existing clay fill has been treated with cement and therefore may be difficult to cut and/or grade as necessary. As the upper clays have been chemically modified, they are considered to have been placed in a controlled manner.

The proposed building and pavement areas and areas to receive engineered fill should be cleared of existing pavements, topsoil, vegetation, brush, trees, tree roots, and other deleterious materials to expose suitable underlying inorganic subgrade. Existing utilities within the proposed building footprint (if any) should be rerouted around the proposed building. We recommend abandoned utilities be removed and the excavations backfilled with granular engineered fill to establish the design subgrade level. Alternatively, utilities may remain in place provided they are fully grouted and are located at least 2.5 feet below final design subgrade elevations. Consider this option only in parking areas. Completely remove all below-grade structures from previous construction within the proposed bus station footprint.

After stripping the existing pavements and topsoil, SME should review the exposed subgrade for unsuitable soils, such as those containing organics, boulders, or debris. Undercuts recommended by SME should be backfilled with engineered fill until a uniform subgrade is established. Once the subgrade has been uniformly compacted, proofroll the subgrade in the presence of a representative from SME. The purpose of the proofroll is to locate areas of soft or disturbed subgrade. Yielding soils encountered during proofrolling that cannot be improved in-place by additional rolling should be removed and replaced with engineered fill. We recommend proofrolling with a fully-loaded, tandem-axle truck or other suitable-sized pneumatic-tire construction equipment.

After the exposed subgrade is proofrolled and improved as needed, and after the surface is thoroughly compacted, engineered fill may be placed on the exposed subgrade to establish final design subgrade levels. See Section 4.1.3 of this report for material and compaction requirements for engineered fill.

The site soils consist primarily of chemically modified and high plasticity clays. High plasticity clays are easily disturbed, and can become unstable when subjected to wet conditions and construction traffic. Conventional moisture conditioning in the form of disking and aeration is not feasible for these soils. Therefore, we recommend the contractor be prepared to chemically modify the clay subgrade using quick lime and/or cement, be prepared to implement significant undercuts, or a combination thereof.

4.1.2 SUBGRADE PREPARATION FOR FLOOR SLABS

We anticipate the final floor slab subgrade for the proposed building will consist of suitable existing fill or engineered fill placed over suitable natural soils. Due to the high plasticity of the existing natural clays below the fill, these soils are not suitable for support of floor slabs without chemical modification. The untreated clays are subject to shrinkage (settlement) and swell (heave) with changes in moisture contents. Although the existing chemically modified clays may remain in place within the proposed building footprint, do not raise grades within the building footprint with existing on-site clays. Import granular fill to the site to establish site grades within the proposed bus station.

Prior to the placement of aggregate levelling course for floor slabs, the exposed subgrade should be evaluated and tested by SME to identify areas where the subgrade has been disturbed due to placement of underground utilities, precipitation and/or construction activities. Soft or disturbed soils should be re-compacted in-place or removed and replaced with engineered fill.

We recommend 6 inches of the slab base consist of an approved ODOT No. 57 or No. 8 crushed limestone to provide a leveling surface for construction of the slab and a moisture capillary break between the slab and the underlying soils. Alternately, an approved ODOT #304 with a modified gradation as discussed in Section 4.5 may be used in lieu of the granular material to provide improved stability and greater protection of the subgrade, which could be beneficial if the construction occurs during periods of adverse (cold and wet) weather or if the subgrade will be exposed for a prolonged period of time.

A vapor retarder is recommended below floor slabs that are to receive an impermeable floor finish/seal or a floor covering that would retard vapor transmission. The location of the vapor retarder (relative to the subbase) should be determined by the Architect/Engineer based on the intended floor usage, planned finishes, and ACI recommendations.

Slabs should be separated by isolation joints from structural walls and columns to permit relative movement. A minimum of 6 inches of engineered fill between the bottom of the slab and the top of the shallow foundations below is recommended.

We recommend the slab-on-grade subgrade soils be protected from frost action during winter construction. Any frozen soils must be thawed and compacted, or removed and replaced prior to slab-on-grade construction.

If possible, do not place underslab utilities at this site. Utilities are typically backfilled with well-draining granular soil. On a predominantly clayey site, water will tend to accumulate in granular trench backfill, slowly rehydrating the clays over time and resulting in localized swelling, or “speed bumps” within the building footprint. Cap utility trench and foundation wall backfill at the surface within a minimum of 18 inches of chemically modified clay soil. Where utilities penetrate foundation walls, seal the annulus between the utility and concrete with Cetco Akwaswell or similar.

4.1.3 ENGINEERED FILL REQUIREMENTS

Any fill placed within structural areas, including utility trench backfill, should be an approved material, free of frozen soil, organics, over-sized materials, or other deleterious materials. Fill placed in structural areas should be spread in uniform horizontal layers with loose layer thickness appropriate to the type of equipment used to achieve compaction and not exceeding 10 inches in loose thickness. The fill should be compacted to a minimum of 98 percent of the maximum dry density as determined in accordance with the Standard Proctor test. Fill placed below the bottom of foundation elevation or within the top 12 inches of the pavement and floor slab subgrade should be compacted to a minimum of 100 percent of the maximum dry density as determined in accordance with the Standard Proctor test, ASTM D698. The fill lift thickness should be adjusted for the specific compaction equipment used so the required compaction is achieved throughout the entire lift.

Based on the information from the borings, the existing fill consists of chemically modified high-plasticity clays with elevated moisture contents. Clays should be placed within 2 percent of their optimum moisture content to facilitate compaction. For these soils, moisture conditioning would result in in-situ moisture contents well below their estimated plastic limits. Either import granular fill to establish grades within the building footprint or chemically modify the site clays. For this site, a combination of quick lime and cement stabilization could be required to adequately address the existing clays. Due to the elevated liquid limits and plasticity indices, lime kiln dust should not be used to chemically modify the site clays. SME can assist with chemical modification mix designs and/or provide construction-phase observation and testing should you wish to further explore chemical modification.

In confined areas, in areas where drainage is required, and in areas where compaction is accomplished primarily by smaller, hand-operated equipment, an approved ODOT Type II structural backfill material should be used as backfill. Thinner lifts will be required to achieve suitable compaction of the backfill in areas where smaller walk-behind type compactors are used.

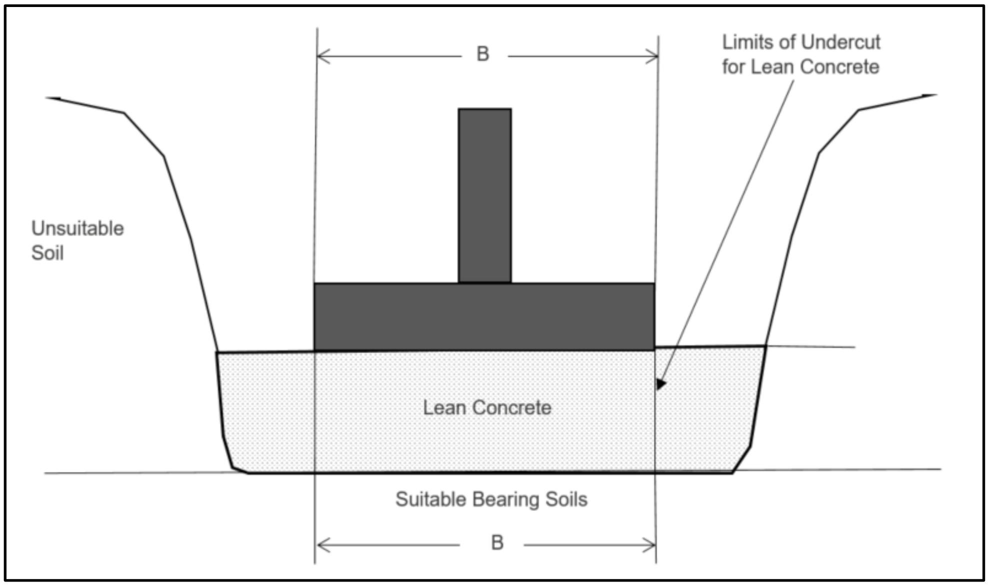
4.2 FOUNDATIONS

Shallow spread foundations are recommended for support of the proposed bus station. We recommend using a maximum net allowable soil bearing pressure of 4,000 pounds per square-foot (psf) to design shallow isolated (column) and continuous (wall) foundations supported on shale, suitably prepared existing site soils, or newly placed engineered fill placed over suitable existing site soils. Extending foundations through the upper clays to bear on the native shales will provide a moderate level of protection for differential foundation movement associated with construction of foundations in the elevated plasticity clays. Based on the borings, suitable shale is anticipated around 6 feet below the existing ground surface.

Foundations should be situated a minimum of 42 inches below final site grades in unheated areas for protection against frost action during normal winters. Interior foundations in heated areas can be constructed at shallower levels. However, the foundations and proposed bearing soils should be protected from freezing during construction if work occurs in the winter months.

Once each foundation area is exposed, SME must observe and test foundation subgrade conditions to verify suitable soils are encountered, or improvements are performed as needed, prior to foundation construction. Unsuitable soils must either be mechanically improved (i.e., compacted) in-place, chemically modified, or removed and replaced with engineered fill.

Unsuitable and disturbed soils must be undercut to expose suitable site soils or shale below. The foundation can then be constructed to bear at the lower undercut level, or the design foundation bearing elevation can be reestablished using engineered fill or crushed aggregate. In cases where the foundation bearing elevation will be reestablished, oversize the foundation undercuts laterally and backfill them with lean concrete as shown on the Typical Foundation Undercutting Diagram below.



Because the soils are predominately clay, we anticipate that the foundations can be excavated as “neat” trenches. However, if sloughing and caving occurs such that the sidewalls cannot be maintained, we recommend sloping back the foundation excavations and vertically forming the sides of the foundations to maintain vertical foundation side-walls and reduce the risk of frost movements associated with foundation sides that “mushroom out” near the top, forming “frost lips”. Any caved soils should be removed from the foundation bearing surfaces before placing concrete. Foundation concrete should be placed as soon as foundation excavations have been completed, and the design bearing pressure is verified to reduce the potential for disturbance of the foundation bearing surface.

For bearing capacity and settlement considerations, we recommend continuous (wall) foundations have a minimum width of 18 inches and isolated (column) foundations have a minimum dimension of 30 inches. In cases where structural loading is light, the minimum recommended foundation size, and not the design bearing pressure, may govern the size of the foundation.

4.3 CONSTRUCTION CONSIDERATIONS

The site soils (native and chemically modified) exhibit high plasticity traits, and are at risk of volume changes with moisture changes. For the lightly loaded structure, we do not expect it will be necessary to extend foundations through conventional “active zones” – typically 8 to 10 feet. By implementing certain design and maintenance features, the risk of differential movement associated with construction over higher plasticity clays can be adequately addressed without the need to extend foundations deeper. We previously stated clay fill should not be placed within the building footprint, and indicated utility penetrations through foundation walls should be sealed, and utility and foundation wall backfill should consist of 18 inches of chemically modified clays at the surface/design subgrade level. Other common methods to reduce the risk of differential movement associated with construction over high plasticity clays include the following:

- Establish site grades to slope away from the face of the building, and if possible, install hardscape (pavement and sidewalks) directly adjacent to the building.
- Tie downspouts in to the stormwater system, or adequately direct downspouts and scuppers away from the building.
- Limit foundation plantings to smaller trees and plants with low moisture requirements. Trees should be placed no closer to the building than 1.5 times their height at maturity.
- Differential settlement is often most noticeable at entry points. Consider “frost resistant” stoops and entrances, and consider drainage trays at primary entrance/exit points.

Groundwater seepage into excavations from the perched groundwater may occur but is generally not anticipated to be a significant factor during construction. However, depending upon the time of year of construction, some accumulation from precipitation, surface runoff or seepage from perched groundwater could be encountered. We anticipate standard sump pit and pumping procedures should be adequate to control these accumulations.

For trench and excavation safety purposes, the soils encountered should be considered OSHA Type A. Excavations in this soil type should be 1 feet horizontally per one foot of vertical excavation (3/4H:1V) if not shored. Flatter slopes will be required if perched water is encountered or storm water runoff results in sloughing and caving of excavation sidewalls. The contractor must provide a safely sloped excavation or an adequately constructed and braced shoring system in accordance with federal, state and local safety regulations for individuals working in an excavation that might expose them to the danger of moving ground. If material is stored or heavy equipment is operated near an excavation, stronger shoring must be used to resist the extra pressure due to the superimposed loads.

5. PRELIMINARY PAVEMENT RECOMMENDATIONS

Based upon the limited information currently available, we anticipate the new pavement will consist of conventional (standard-duty) concrete for parking stalls and passenger vehicle drives, and heavy-duty concrete pavement for the bus access drives.

Based on the information provided by CT Consultants, we have assumed cuts and fills less than 2 feet for the pavement areas. For purposes of this report, we have assumed the final site grades around the pavement perimeter will slope away from the new pavements.

As the final paving plan is not yet available, consider the pavement recommendations preliminary and subject to change based on actual pavement locations, traffic conditions, final grades, site drainage, etc.

5.1 PAVEMENT DESIGN CRITERIA

The pavements for this project were preliminarily designed based on our experience with sites with similar subgrade conditions while using the design parameters in the table below and the AASHTO Guide for Design of Pavement Structures. In addition, ESALs were calculated based on the following traffic information from CT Consultants

TABLE NO. 1: TRAFFIC INFORMATION

VEHICLE TYPE	DAILY COUNT	AXLE CONFIGURATION AND WEIGHT	
		FRONT AXLE	REAR AXLE
LakeTran Bus	56	Single, 16 kips	Tandem 32.5 kips
Park N' Ride Bus (Concrete)	4	Single, 16 kips	Tandem 32.5 kips

TABLE NO. 2: DESIGN PARAMETERS

PARAMETER	VALUE
Design Period	20 years
Standard-Duty Traffic (Concrete)	100,000 ESALs
Heavy Duty Traffic (Concrete)	1,020,000 ESALs
Design Reliability	85%
CBR, average	4.0
Standard Deviation	0.35 (rigid pavements)

PARAMETER	VALUE
Modulus of Subgrade Reaction (Concrete)	150 pounds per square inch (psi)
Initial Serviceability Index	4.25
Terminal Serviceability Index	2.25
Drainage Coefficient (aggregate base)	1.0
Concrete Flexural Strength	600 psi
Concrete Modulus of Elasticity	2,000,000 psi
Load Transfer Coefficient	2.00

NOTES: We request the Owner and project team review the assumed traffic count values and provide comments/questions regarding traffic conditions. If there are differences with the assumed traffic count and anticipated design conditions, we may need to alter the pavement section thicknesses and recommendations.

5.2 SUBGRADE CONDITIONS AND SUBGRADE PREPARATION

Based on the borings performed for this project in the existing proposed pavement areas, the general subgrade conditions are expected to consist mostly of existing cement-treated lean to flat clay fill. Areas of existing greenbelt (non-paved areas currently) are anticipated to be paved for this current program. SME did not perform soil borings in the greenbelt areas. We anticipate those areas will consist of un-treated fat clay. We recommend that these areas be visually reviewed by SME once they are exposed to develop a suitable improvement program, as these areas are anticipated to be limited in size, and as such cement treatment as an improvement technique may not be cost effective.

In general, subgrade preparation for the pavement should follow the recommendations in Section 4.1 of this report. We recommend the criteria for the proofroll be a maximum of 1/2 inch of deflection or rutting below the aggregate base layer, and a maximum 1/4 inch of deflection or rutting on the aggregate base layer. Site-specific conditions may require adjusting the proofroll criteria, which would only be considered if agreed upon in writing by the Owner and Engineer.

We recommend the subgrade preparation and the aggregate base layer installation extend out to at least 12 inches beyond the edge of pavement or back of curbs to provide support for the outer edges of pavement. Protect utilities, curbs, and other existing structures to remain.

Prior to the placement of the aggregate base, we recommend fine-grading the subgrade to slope downward toward the stormwater drainage structures. Fine-grading of the underlying subgrade will be critical to minimize low-spots below the aggregate base where water can pond, likely resulting in moisture changes and undesirable early pavement distress. Fine-grading the subgrade is important for drainage of perched groundwater, and to achieve a uniform thickness of base course to be placed throughout each of the pavement sections. Difficulty in performance of the fine grading task is anticipated for the cement treated subgrade. However, we do strongly recommend that care be exercised during this task to help reduce or eliminate low spots where water can accumulate and cause long-term softening of the subgrade soils.   Also, we recommend installing underdrains at/through low-spots in the prepared subgrade to facilitate drainage of perched groundwater. See Section 5.4 for additional information regarding drainage.

5.3 RECOMMENDED PRELIMINARY PAVEMENT SECTIONS

The recommended layer materials refer to standard material designations listed in the latest edition of the “Construction and Materials Specifications” prepared by the Ohio Department of Transportation (ODOT). Typical routine maintenance such as crack sealing, patching, joint sealing (concrete pavements), spall repairs and localized slab replacement (concrete pavements), and overlays should be anticipated and performed over the service life of the pavement system.

5.3.1 PORTLAND CEMENT CONCRETE PAVEMENT SECTION AND MATERIALS

When using a concrete pavement section, we recommend utilizing a plain jointed concrete pavement for the proposed Portland cement concrete pavement areas. The tables below present the layer materials and thickness recommendations for the PCC pavement sections.

TABLE NO. 3: STANDARD-DUTY PORTLAND CEMENT CONCRETE –MATERIALS AND LAYERS

LAYER	MATERIAL	MINIMUM THICKNESS (INCHES)
Surface	ODOT Class C Portland Cement Concrete	6.0
Aggregate Base	ODOT 304 Crushed Limestone*	6.0

*See Section 5.3.2 (Aggregate Base Material Recommendations) for material details

TABLE NO. 4: HEAVY-DUTY PORTLAND CEMENT CONCRETE –MATERIALS AND LAYERS

LAYER	MATERIAL	MINIMUM THICKNESS (INCHES)
Surface	ODOT Class C Portland Cement Concrete	8.0
Aggregate Base	ODOT 304 Crushed Limestone*	6.0

*See Section 5.3.2 (Aggregate Base Material Recommendations) for material details

Gravel or slag aggregates should not be allowed in the concrete coarse aggregate. We recommend ASTM C1567 to determine the potential of Alkali Silica Reactivity (ASR). The blend should provide less than 0.1 percent of expansion following 14 days of immersion. The mix design should contain the results of the ASTM C1567 test program. Ground granulated blast furnace slag (GGBFS) may be used as a mitigation agent for ASR at cement replacement rate of 20 to 40 percent. The cement type should be Type 1 with air content specified at 5 to 8 percent. The minimum specified unconfined compressive strength should be 4,000 psi at 28 days.

Contraction joints should be spaced at a maximum of 15 feet, based on the design thickness of 8 inches and a maximum of 10 feet, based on the design thickness of 6 inches. The length to width ratio (slenderness ratio) of slabs should not exceed 1.25. We recommend 1.25-inch diameter, 18-inch long smooth epoxy coated dowel bars spaced 12 inches apart at contraction joints. We recommend tie bars be No. 5, 30-inch long epoxy coated deformed bars spaced 30 inches apart at longitudinal joints. Tie bars should not be placed within 15 inches of contraction joints so they do not interfere with joint movement. Tie bars and dowel bars should be epoxy coated and installed mid-depth within the slabs in accordance to ODOT requirements. Expansion and isolation joints need to be incorporated in the final joint layout plan by the design engineer and should take into account the overall pavement layout (phasing) and the site civil design. The contractor should be required to submit a pavement installation and jointing plan to the design engineer for review and approval prior to proceeding with the concrete pavement installation.

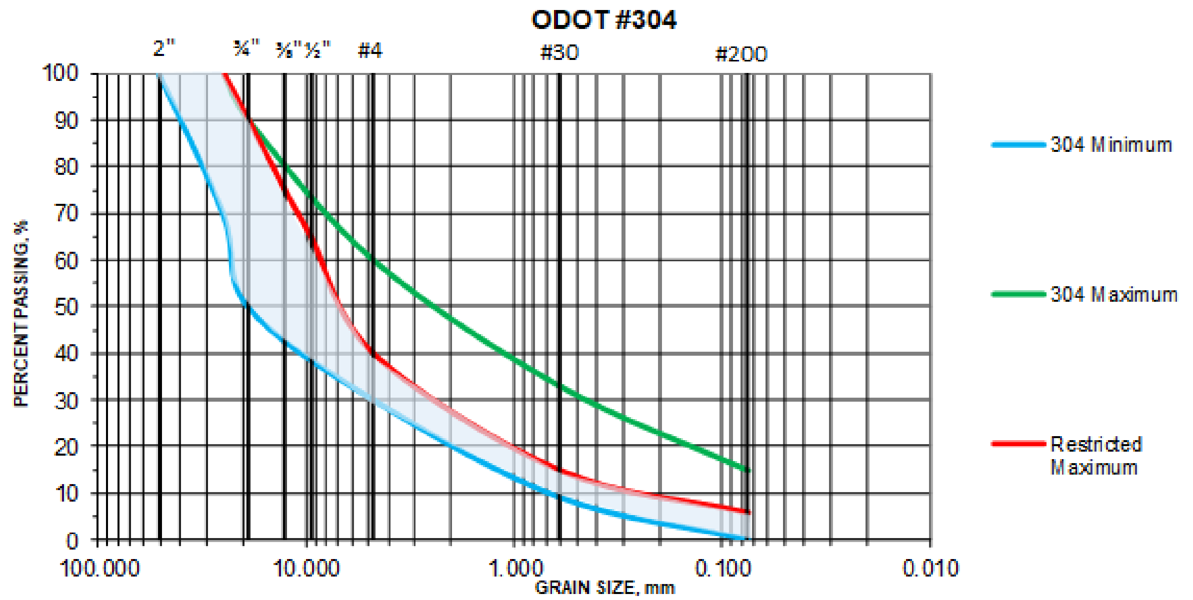
We recommend a broom finish and installation of a uniform curing compound meeting requirements of ASTM C309 Type 2 at a rate of one gallon per 225 square feet. Saw cutting should be completed as soon as possible after concrete placement depending upon the weather temperature and without damaging the finish of the pavement. We recommend a saw cut depth of 2.5 inches. We recommend joints be sealed with hot poured rubber per ODOT requirements.

5.3.2 AGGREGATE BASE MATERIAL RECOMMENDATIONS

For underdrains to function properly, it is necessary for the aggregate base beneath the pavements to be free draining. This is not the case with virtually all of the locally available ODOT item #304 crushed aggregate because of the high percentages of fine size particles allowed by the specification. We recommend that a restricted blend of 304 base material be used which is marketed as “Modified 304” in order to provide the required permeability. The final blend used will fall within the broader ODOT #304 specification but restricts or limits the sizes used to produce a more drainable 304. The gradation of the base used should fall between the “Restricted Maximum” and the standard “304 Minimum” as shown in Table No. 5 and the following graph. Before any pavement base materials are delivered to the jobsite, they should be sampled at the source and the material approved in advance by the geotechnical engineer.

TABLE NO. 5: RESTRICTED ODOT #304 CRUSHED AGGREGATE BASE

SIEVE	SIZE, mm	ODOT ITEM #304 SPECIFICATION		RESTRICTED ODOT ITEM #304 MAX
		MIN	MAX	
2”	50.80	100	--	--
1”	25.00	70	100	100
¾”	19.00	50	90	90
½”	12.70	--	--	75
3/8”	9.50	--	--	65
No. 4	4.75	30	60	40
No. 30	0.60	9	33	15
No. 200	0.075	0	15	6.0



ODOT Item #304 and Restricted ODOT #304 Maximum

5.4 DRAINAGE

Pavement subgrades should be graded to eliminate surface depressions and sloped to promote drainage of the granular base, without areas that will pond water. We recommend that underdrains be installed along the perimeter and internal to pavement areas. Underdrains installed in stabilized subgrade should extend below the stabilized mat. The aggregate backfill for the undrains should extend to the bottom of aggregate base elevation.

The underdrain inverts should set at least three feet below the pavement surface. A 6-inch diameter perforated PVC pipe should be placed at the bottom of the trench, and the trench backfilled with ODOT #57 crushed limestone or washed gravel. The backfill should extend up to the bottom of and maintain contact with the free-draining, aggregate base material. Backfill for the underdrains should be spread in horizontal lifts not exceeding 12 inches in loose thickness, with each lift being consolidated until no further densification is observed.

5.5 CONSTRUCTION NOTES

To provide adequate service life and protect the pavement investment, we present the following construction notes. These notes need to be included in the project specifications and we recommend they be implemented during the construction activities:

1. Earthwork and pavement construction must be performed in accordance with the 2016 ODOT Standard Specifications for Construction unless otherwise noted in this letter.

2. Earthwork and pavement construction is recommended during the summer months of June through September. For subgrades which are not chemically stabilized, summer conditions are preferred to allow for more efficient discing and drying of the clay subgrade and reduce the potential for disturbance of the subgrade soils due to relatively cold temperatures and precipitation. Remove any existing topsoil, organic soils, unsuitable fill and other undesirable materials to expose a suitable subgrade. Tree roots must be removed. Existing structures (if encountered) must be removed and replaced with engineered fill a minimum of 3 feet below the proposed pavement layer to provide a uniform subgrade.

3. Excavate to the depth of the final subgrade elevation to allow for grade changes and the placement of the recommended pavement system.

4. On site fill material can be used if the specified compaction requirements can be achieved. If on site material is used, it must be clean and free of frozen soil, organics, or other unsuitable materials.

5. The top 12 inches of the exposed subgrade as well as individual fill layers shall be compacted to achieve a minimum of 100 percent of the Standard Proctor maximum dry density (ASTM D698). Manipulate the moisture content to within (plus or minus) 2 percentage points of optimum moisture.

6. The pavement subgrade in the existing greenbelt area will likely consist of fat clay that is not chemically stabilized. These soils may require additional improvements, including, but not limited to moisture conditioning, recompaction, undercuts, and chemical modification.

7. The final subgrade shall be thoroughly proofrolled using a loaded tandem axle truck under the observation of a geotechnical/pavement engineer. Loose or yielding areas that cannot be mechanically stabilized must be removed and replaced with engineered fill or as dictated by field conditions and recommended by a geotechnical/pavement engineer.

8. The aggregate base shall be compacted to achieve a minimum of 100 percent of the Standard Proctor maximum dry density. The base and subgrade compaction must extend a minimum of 12 inches beyond the paved edge or back of new concrete curb.

9. Concrete shall conform the requirements of the ODOT Class C concrete specification.

10. Final pavement elevations shall be designed to provide positive surface drainage. A minimum surface slope of 1.5 percent is recommended.

11. Install interceptor drains along the perimeter of paved areas were runoff from higher ground would flow towards the pavement. Finger drains must be installed at catch basins and gutter inlets, and interior of large pavement areas.

6. SIGNATURES

Report Prepared By (Geotechnical):

Tom Olding
Tom Olding
Mar 2 2020 12:05 PM

Thomas P. Olding, EIT
Staff Engineer

Report Reviewed By (Geotechnical):

Laurel M Johnson
Laurel Johnson
Mar 2 2020 12:16 PM

Laurel M. Johnson, PE (MI)
Senior Consultant

Report Prepared By (Pavement):

Alison K Frye

STATE OF OHIO
ALISON K.
FRYE
E-82980
REGISTERED
PROFESSIONAL ENGINEER

Mar 3 2020 9:55 AM

Alison K. Frye, PE
Project Engineer

Report Reviewed By (Pavement):

Anthony B. Thomas
Mar 2 2020 1:53 PM

Anthony B. Thomas, PE (MI)
Senior Consultant

APPENDIX A

BORING LOCATION DIAGRAM (FIGURE NO. 1)
BORING LOG TERMINOLOGY
BORING LOGS (B1 THROUGH B5)
PAVEMENT CORE LOG (B3 THROUGH B5)
LIQUID LIMIT, PLASTIC LIMIT & PLASTICITY INDEX

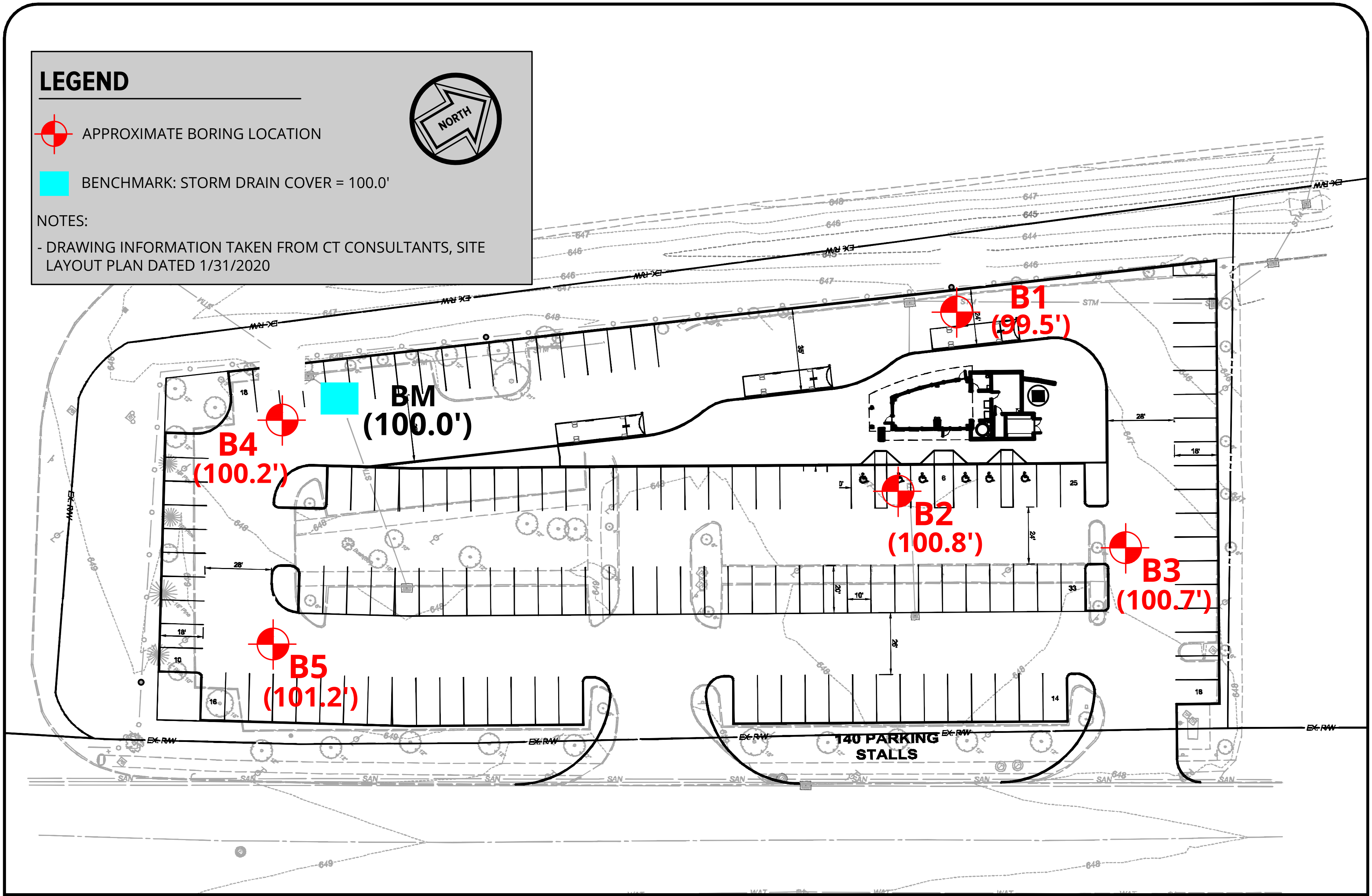
LEGEND

🟥 APPROXIMATE BORING LOCATION

🟦 BENCHMARK: STORM DRAIN COVER = 100.0'

NOTES:

- DRAWING INFORMATION TAKEN FROM CT CONSULTANTS, SITE LAYOUT PLAN DATED 1/31/2020



No.	Revision Date	Date	02/06/20
1	02/25/20	Drawn By	KMP
		Checked By	AKF
		Scale	NTS
		Project	083625.00

BORING LOCATION PLAN
LAKETRAN PARK N RIDE
29610 LAKELAND BLVD.
WICKLIFFE, OHIO

SME

www.sme-usa.com

Figure No. 1

SME

BORING LOG TERMINOLOGY

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOIL (more than 50% of material is larger than No. 200 sieve size.)			
	Clean Gravel (Less than 5% fines)		
GRAVEL More than 50% of coarse fraction larger than No. 4 sieve size	▨	GW	Well-graded gravel; gravel-sand mixtures, little or no fines
	▨	GP	Poorly-graded gravel; gravel-sand mixtures, little or no fines
	Gravel with fines (More than 12% fines)		
	▨	GM	Silty gravel; gravel-sand-silt mixtures
	▨	GC	Clayey gravel; gravel-sand-clay mixtures
	Clean Sand (Less than 5% fines)		
SAND 50% or more of coarse fraction smaller than No. 4 sieve size	▨	SW	Well-graded sand; sand-gravel mixtures, little or no fines
	▨	SP	Poorly graded sand; sand-gravel mixtures, little or no fines
	Sand with fines (More than 12% fines)		
	▨	SM	Silty sand; sand-silt-gravel mixtures
	▨	SC	Clayey sand; sand–clay-gravel mixtures
FINE-GRAINED SOIL (50% or more of material is smaller than No. 200 sieve size)			
SILT AND CLAY Liquid limit less than 50%	▨	ML	Inorganic silt; sandy silt or gravelly silt with slight plasticity
	▨	CL	Inorganic clay of low plasticity; lean clay, sandy clay, gravelly clay
	▨	OL	Organic silt and organic clay of low plasticity
SILT AND CLAY Liquid limit 50% or greater	▨	MH	Inorganic silt of high plasticity, elastic silt
	▨	CH	Inorganic clay of high plasticity, fat clay
	▨	OH	Organic silt and organic clay of high plasticity
HIGHLY ORGANIC SOIL	▨	PT	Peat and other highly organic soil

OTHER MATERIAL SYMBOLS

- ■ Topsoil
- □ Void
- ▨ Sandstone
- ▨ Asphalt
- ▨ Glacial Till
- ▨ Siltstone
- ▨ Base
- ■ Coal
- ▨ Limestone
- ▨ Concrete
- ▨ Shale
- ▨ Fill

LABORATORY CLASSIFICATION CRITERIA

GW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}^{\ 2}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with PI greater than 7	
SW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{D_{30}^{\ 2}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with PI greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent……………………….……..GW, GP, SW, SP
More than 12 percent…………………….……..GM, GC, SM, SC
5 to 12 percent……………..……..Cases requiring dual symbols

- SP-SM or SW-SM (SAND with Silt or SAND with Silt and Gravel)
- SP-SC or SW-SC (SAND with Clay or SAND with Clay and Gravel)
- GP-GM or GW-GM (GRAVEL with Silt or GRAVEL with Silt and Sand)
- GP-GC or GW-GC (GRAVEL with Clay or GRAVEL with Clay and Sand)

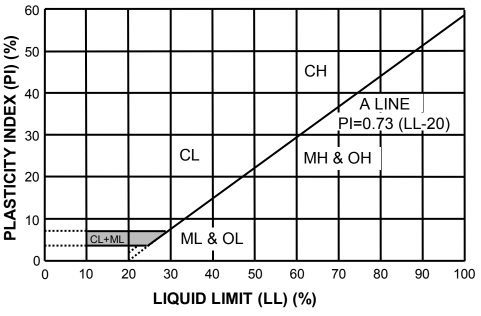
If the fines are CL-ML:

- SC-SM (SILTY CLAYEY SAND or SILTY CLAYEY SAND with Gravel)
- SM-SC (CLAYEY SILTY SAND or CLAYEY SILTY SAND with Gravel)
- GC-GM (SILTY CLAYEY GRAVEL or SILTY CLAYEY GRAVEL with Sand)
- GM-GC (CLAYEY SILTY GRAVEL or CLAYEY SILTY GRAVEL with Sand)

PARTICLE SIZES

Boulders	-	Greater than 12 inches
Cobbles	-	3 inches to 12 inches
Gravel- Coarse	-	3/4 inches to 3 inches
Fine	-	No. 4 to 3/4 inches
Sand- Coarse	-	No. 10 to No. 4
Medium	-	No. 40 to No. 10
Fine	-	No. 200 to No. 40
Silt and Clay	-	Less than (0.0074 mm)

PLASTICITY CHART



VISUAL MANUAL PROCEDURE

When laboratory tests are not performed to confirm the classification of soils exhibiting borderline classifications, the two possible classifications would be separated with a slash, as follows:

For soils where it is difficult to distinguish if it is a coarse or fine-grained soil:

- SC/CL (CLAYEY SAND to Sandy LEAN CLAY)
- SM/ML (SILTY SAND to SANDY SILT)
- GC/CL (CLAYEY GRAVEL to Gravelly LEAN CLAY)
- GM/ML (SILTY GRAVEL to Gravelly SILT)

For soils where it is difficult to distinguish if it is sand or gravel, poorly or well-graded sand or gravel; silt or clay; or plastic or non-plastic silt or clay:

- SP/GP or SW/GW (SAND with Gravel to GRAVEL with Sand)
- SC/GC (CLAYEY SAND with Gravel to CLAYEY GRAVEL with Sand)
- SM/GM (SILTY SAND with Gravel to SILTY GRAVEL with Sand)
- SW/SP (SAND or SAND with Gravel)
- GP/GW (GRAVEL or GRAVEL with Sand)
- SC/SM (CLAYEY to SILTY SAND)
- GM/GC (SILTY to CLAYEY GRAVEL)
- CL/ML (SILTY CLAY)
- ML/CL (CLAYEY SILT)
- CH/MH (FAT CLAY to ELASTIC SILT)
- CL/CH (LEAN to FAT CLAY)
- MH/ML (ELASTIC SILT to SILT)
- OL/OH (ORGANIC SILT or ORGANIC CLAY)

DRILLING AND SAMPLING ABBREVIATIONS

2ST	–	Shelby Tube – 2" O.D.
3ST	–	Shelby Tube – 3" O.D.
AS	–	Auger Sample
GS	–	Grab Sample
LS	–	Liner Sample
NR	–	No Recovery
PM	–	Pressure Meter
RC	–	Rock Core diamond bit. NX size, except where noted
SB	–	Split Barrel Sample 1-3/8" I.D., 2" O.D., except where noted
VS	–	Vane Shear
WS	–	Wash Sample

OTHER ABBREVIATIONS

WOH	–	Weight of Hammer
WOR	–	Weight of Rods
SP	–	Soil Probe
PID	–	Photo Ionization Device
FID	–	Flame Ionization Device

DEPOSITIONAL FEATURES

Parting	–	as much as 1/16 inch thick
Seam	–	1/16 inch to 1/2 inch thick
Layer	–	1/2 inch to 12 inches thick
Stratum	–	greater than 12 inches thick
Pocket	–	deposit of limited lateral extent
Lens	–	lenticular deposit
Hardpan/Till	–	an unstratified, consolidated or cemented mixture of clay, silt, sand and/or gravel, the size/shape of the constituents vary widely
Lacustrine	–	soil deposited by lake water
Mottled	–	soil irregularly marked with spots of different colors that vary in number and size
Varved	–	alternating partings or seams of silt and/or clay
Occasional	–	one or less per foot of thickness
Frequent	–	more than one per foot of thickness
Interbedded	–	strata of soil or beds of rock lying between or alternating with other strata of a different nature

CLASSIFICATION TERMINOLOGY AND CORRELATIONS

Cohesionless Soils

Relative Density	**N-Value (Blows per foot)**
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	50 to 80
Extremely Dense	Over 80

Cohesive Soils

Consistency	**N-Value (Blows per foot)**	**Undrained Shear Strength (kips/ft^2)**
Very Soft	0 - 2	0.25 or less
Soft	2 - 4	0.25 to 0.50
Medium	4 - 8	0.50 to 1.0
Stiff	8 - 15	1.0 to 2.0
Very Stiff	15 - 30	2.0 to 4.0
Hard	> 30	4.0 or greater

Standard Penetration 'N-Value' = Blows per foot of a 140-pound hammer falling 30 inches on a 2-inch O.D. split barrel sampler, except where noted.

BORING B1

PAGE 1 OF 1

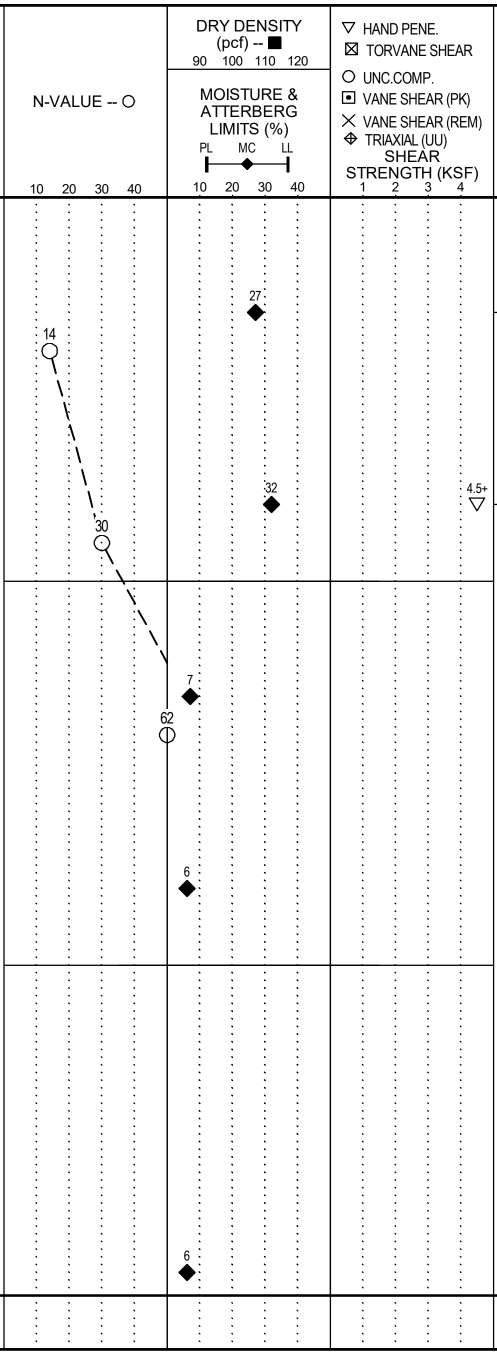
PROJECT NAME: Laketran - Park N Ride
PROJECT NUMBER: 083625.00
CLIENT: CT Consultants, Inc.
PROJECT LOCATION: Wickliffe, Ohio

DATE STARTED: 2/12/20
COMPLETED: 2/12/20
BORING METHOD: 3-3/4" Hollow-Stem Auger
DRILLER: RH/RM
RIG NO.: 293-CME55/CPT-TRK
LOGGED BY: TPO
CHECKED BY: AKF

SURFACE ELEVATION: 99.5 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE	MOISTURE (%)	SHEAR STRENGTH (KSF)	REMARKS
99.0	0.5	6 inches CONCRETE							
96.5	3.0	FILL- LEAN to FAT CLAY- Brown- Stiff (CL)	SB1	8	15 7 7	14	27		Cement-treated
93.5	6.0	Fill- LEAN to FAT CLAY with Shale Fragments- Gray and Brown- Very Stiff to Hard (CL)	SB2	5	6 11 19	30	32	4.5+	Cement-treated
85.2	14.3	SHALE- Gray- Very Soft to Medium Hard	SB3	15	12 18 44	62	7		
			SB4	10	12 50/6"		6		
			SB5	10	36 50/4"		6		

END OF BORING AT 14.3 FEET.



GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

	DEPTH (FT)	ELEV (FT)
CAVE-IN OF BOREHOLE AT:	12.5	87.0

BACKFILL METHOD: Auger Cuttings capped with Concrete & EPCO Hole Plug

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING B2

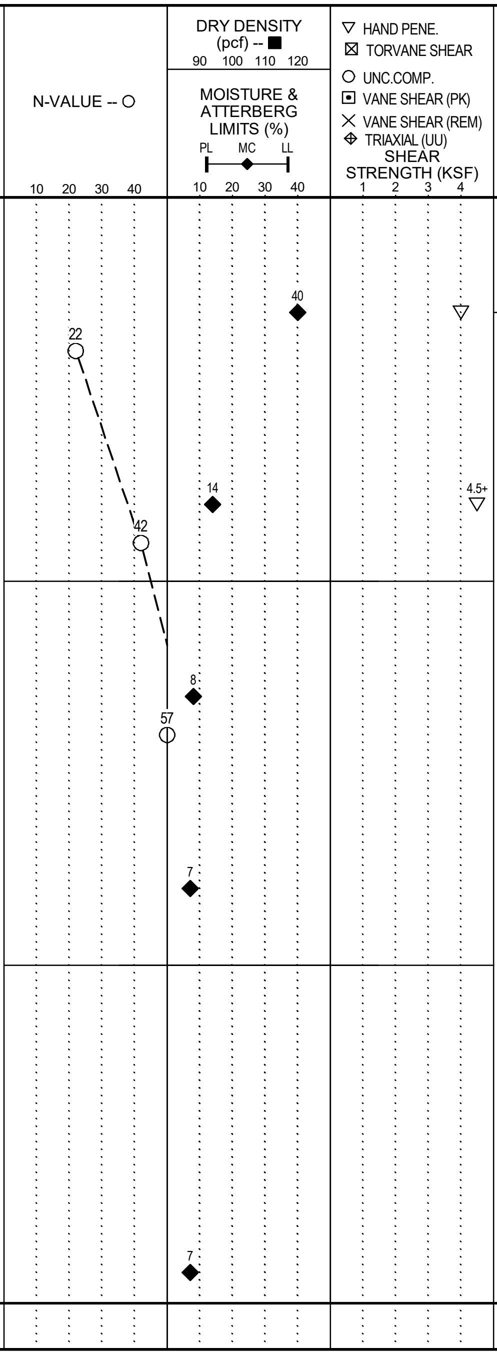
PAGE 1 OF 1

PROJECT NAME: Laketran - Park N Ride
PROJECT NUMBER: 083625.00
CLIENT: CT Consultants, Inc.
PROJECT LOCATION: Wickliffe, Ohio
DATE STARTED: 2/12/20
COMPLETED: 2/12/20
BORING METHOD: 4" Solid Stem Auger
DRILLER: RH/RM
RIG NO.: 293-CME55/CPT-TRK
LOGGED BY: TPO
CHECKED BY: AKF

SURFACE ELEVATION: 100.8 FT

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE	MOISTURE (%)	SHEAR STRENGTH (KSF)	REMARKS
0.5	6 inches CONCRETE	100.3							
3.0	FILL- LEAN to FAT CLAY- Brown and Gray- Very Stiff (CL)	97.8	SB1	18	10 10 12	22	40	▽	Cement-treated
6.0	SHALE with Clay Seams- Brown and Gray- Very Soft	94.8	SB2	18	11 18 24	42	14	▽ 4.5+	
8.0	SHALE- Gray- Very Soft	92.8	SB3	18	12 21 36	57	8		
14.4	SHALE- Gray- Medium Hard to Soft	86.4	SB4	9	19 50/4"		7		
			SB5	10	29 50/5"		7		

END OF BORING AT 14.4 FEET.



GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

	DEPTH (FT)	ELEV (FT)
CAVE-IN OF BOREHOLE AT:	13.5	87.3

BACKFILL METHOD: Auger Cuttings capped with Concrete & EPCO Hole Plug

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING B3

PAGE 1 OF 1

PROJECT NAME: Laketran - Park N Ride

PROJECT NUMBER: 083625.00

CLIENT: CT Consultants, Inc.

PROJECT LOCATION: Wickliffe, Ohio

DATE STARTED: 2/12/20

COMPLETED: 2/12/20

BORING METHOD: 4" Solid Stem Auger

DRILLER: RH/RM

RIG NO.: 293-CME55/CPT-TRK

LOGGED BY: TPO

CHECKED BY: AKF

DRY DENSITY (pcf) -- ■ 90 100 110 120

▽ HAND PENE.
☒ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⟡ TRIAXIAL (UU)

ELEVATION (FEET)	DEPTH (FEET)	SYMBOLIC PROFILE	SURFACE ELEVATION: 100.7 FT PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE -- ○ 10 20 30 40	MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40	SHEAR STRENGTH (KSF) 1 2 3 4	REMARKS
99.9	0.8		10 inches CONCRETE							
99.7	1.0		2 inches AGGREGATE BASE- Crushed Limestone							
97.7	3.0		FILL- LEAN to FAT CLAY- Trace Organics- Brown and Gray- Very Stiff (CL)	SB1	18	9 12 14	26	38	4.5+	Cement-treated
				SB2	18	8 8 9	17	36 >> 53		Cement-treated
93.7	7.0		FAT CLAY- Some Shale Seams- Trace Organics- Gray, Red, and Brown- Very Stiff to Stiff (CH)	SB3	18	5 7 14	21	25		
				SB4	18	5 6 8	14	27		

END OF BORING AT 7.0 FEET.

GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

	DEPTH (FT)	ELEV (FT)
CAVE-IN OF BOREHOLE AT:	6.0	94.7

BACKFILL METHOD: Auger Cuttings capped with Concrete & EPCO Hole Plug

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING B4

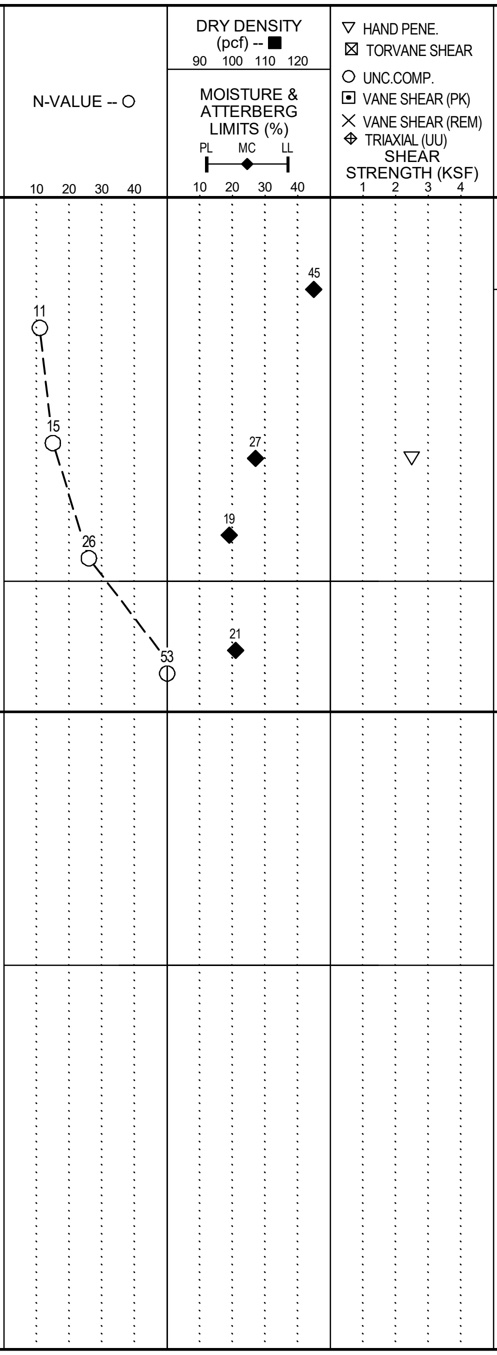
PAGE 1 OF 1

PROJECT NAME: Laketran - Park N Ride
PROJECT NUMBER: 083625.00
CLIENT: CT Consultants, Inc.
PROJECT LOCATION: Wickliffe, Ohio
DATE STARTED: 2/12/20
COMPLETED: 2/12/20
BORING METHOD: 4" Solid Stem Auger
DRILLER: RH/RM
RIG NO.: 293-CME55/CPT-TRK
LOGGED BY: TPO
CHECKED BY: AKF

SURFACE ELEVATION: 100.2 FT

DEPTH (FEET)	PROFILE DESCRIPTION	ELEVATION (FEET)
0.4	4-3/4 inches CONCRETE	99.8
0.7	4 inches AGGREGATE BASE- Crushed Limestone	99.5
2.0	FILL- LEAN to FAT CLAY- Some Sand-Brown- Stiff (CL)	98.2
4.0	FAT CLAY- Gray, Red, and Light Brown- Stiff to Very Stiff (CH)	96.2
6.7	SHALE with Clay Seams- Brown and Gray- Very Soft	93.5
	END OF BORING AT 6.7 FEET.	

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE	MOISTURE (%)	REMARKS
SB1	12	9 5 6	11	45	Cement-treated
SB2	18	5 7 8	15	27	
SB3	18	5 10 16	26	19	
SB4	18	10 23 30	53	21	



GROUNDWATER & BACKFILL INFORMATION		
GROUNDWATER WAS NOT ENCOUNTERED		
	DEPTH (FT)	ELEV (FT)
CAVE-IN OF BOREHOLE AT:	6.0	94.2
BACKFILL METHOD:	Auger Cuttings capped with Concrete & EPCO Hole Plug	

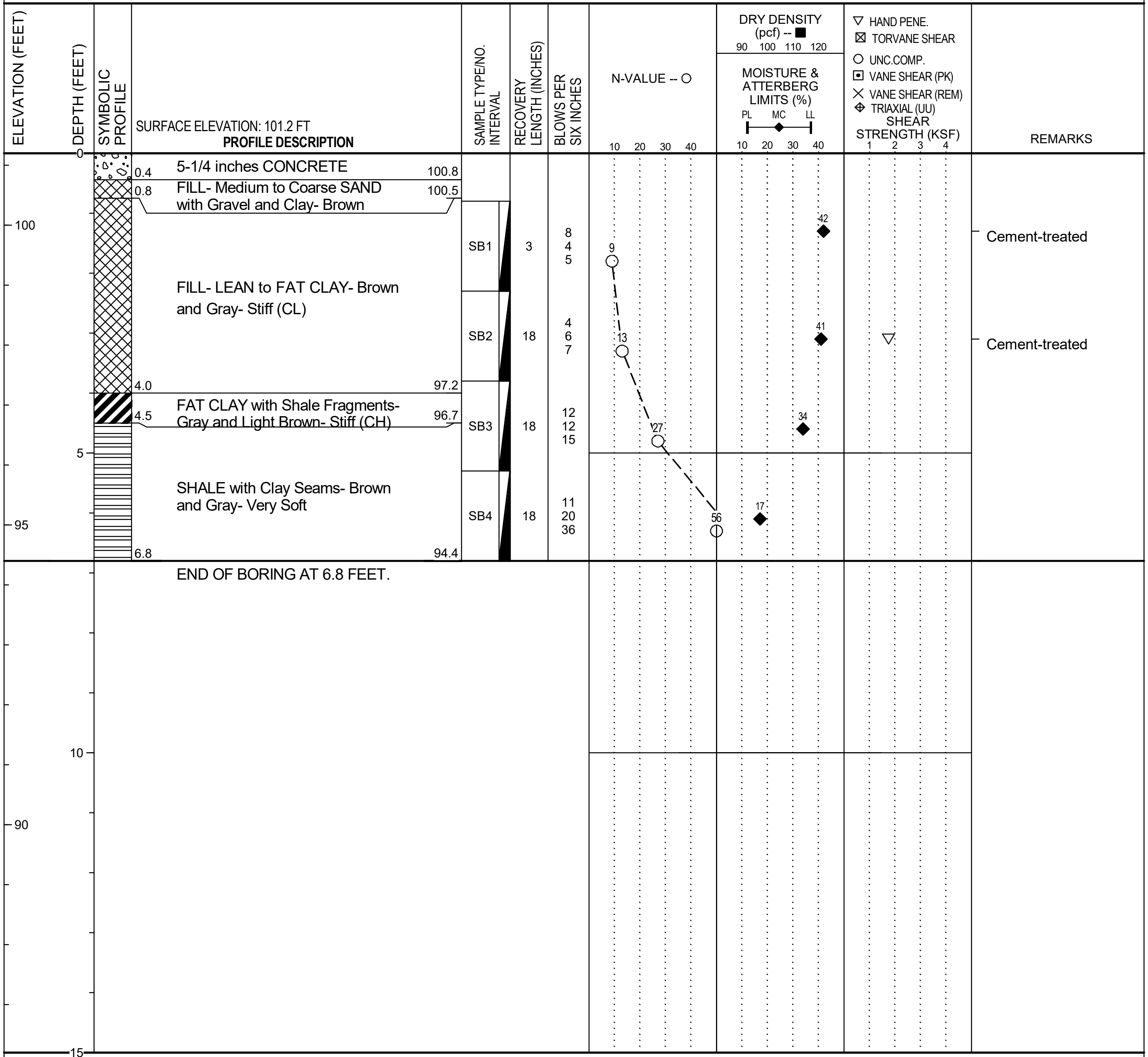
NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING B5

PAGE 1 OF 1

PROJECT NAME: Laketran - Park N Ride
PROJECT NUMBER: 083625.00
CLIENT: CT Consultants, Inc.
PROJECT LOCATION: Wickliffe, Ohio

DATE STARTED: 2/12/20
COMPLETED: 2/12/20
BORING METHOD: 4" Solid Stem Auger
DRILLER: RH/RM
RIG NO.: 293-CME55/CPT-TRK
LOGGED BY: TPO
CHECKED BY: AKF



Depth (ft)	Elev. (ft)	Profile Description	Sample	Recovery (in)	Blows per 6 in	N-Value	Moisture (%)	Remarks
0.4	100.8	5-1/4 inches CONCRETE						
0.8	100.5	FILL- Medium to Coarse SAND with Gravel and Clay- Brown						
4.0	97.2	FILL- LEAN to FAT CLAY- Brown and Gray- Stiff (CL)	SB1	3	8 4 5	9	42	Cement-treated
			SB2	18	4 6 7	13	41	Cement-treated
4.5	96.7	FAT CLAY with Shale Fragments- Gray and Light Brown- Stiff (CH)	SB3	18	12 12 15	27	34	
6.8	94.4	SHALE with Clay Seams- Brown and Gray- Very Soft	SB4	18	11 20 36	56	17	

END OF BORING AT 6.8 FEET.

GROUNDWATER & BACKFILL INFORMATION

GROUNDWATER WAS NOT ENCOUNTERED

	DEPTH (FT)	ELEV (FT)
CAVE-IN OF BOREHOLE AT:	6.0	95.2

BACKFILL METHOD: Auger Cuttings capped with Concrete & EPCO Hole Plug

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

	 #3 Rebar at 8”	 #3 Rebar between 1.5” and 3”	 #3 Rebar between 2.5” and 3.5”
CORE	B3	B4	B5
CONCRETE, in.	10	4 ¾	5 ¼
BASE, in.	2	4	4
BASE DESCRIPTION	Crushed Limestone	Crushed Limestone	Clayey Sand with Gravel

9375 CHILLICOTHE ROAD, KIRTLAND, OH 44094
PHONE: 440-256-6500 FAX: 440-256-6507

LIQUID LIMIT, PLASTIC LIMIT & PLASTICITY INDEX
ASTM D4318 - A

PROJECT: Laketran - Park N Ride
LOCATION: Wickliffe, Ohio
PROJECT#: 083625.00
DATE: February 17, 2020

DATE OBTAINED: February 12, 2020
SAMPLE NUMBER: SB2
SAMPLE LOCATION: B-3; 3' - 4.5'
SAMPLE DESCRIPTION: Brown FAT CLAY
TECHNICIAN: SM

TEST METHOD: ASTM D4318
METHOD - A

TEST DATA:

LIQUID LIMIT

Point #:	1	2	3
Wet Wt + Tare, g:	43.94	45.70	45.85
Dry Wt + Tare, g:	40.26	42.53	41.68
Tare Wt.:	33.62	36.49	33.41
Water Content:	55.42	52.48	50.42
Number of Blows:	15	26	35

Water Content corrected for method B:	53

PLASTIC LIMIT TEST

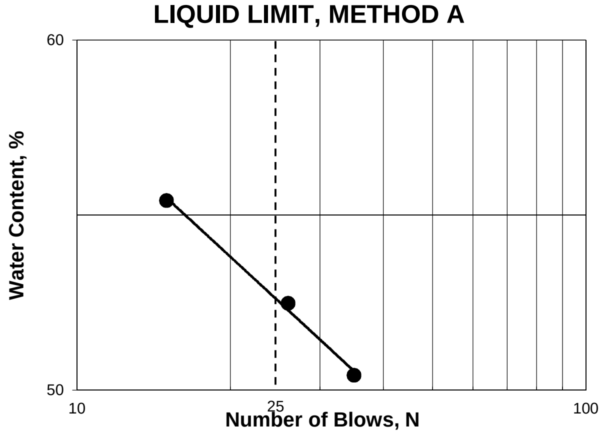
Wet Wt + Tare, g:	40.42	40.06
Dry Wt + Tare, g:	38.98	38.68
Tare Wt, g:	33.39	33.51
Water Content:	25.76	26.69

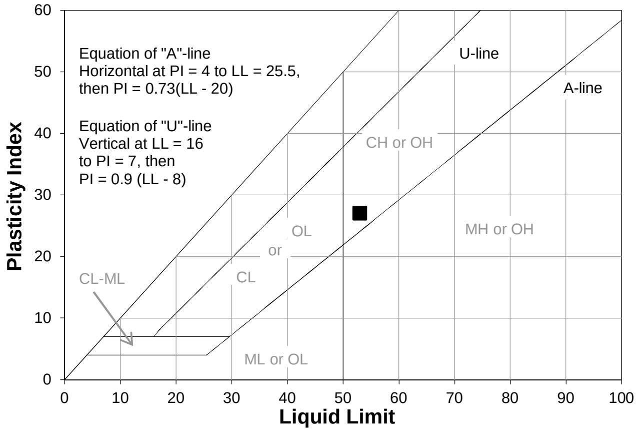
PLASTICITY INDEX

LIQUID LIMIT:	53
PLASTIC LIMIT:	26
PLASTICITY INDEX:	27

CLASSIFICATION: CH

REMARKS: Sample air dried prior to testing





APPENDIX B

IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL ENGINEERING REPORT

GENERAL COMMENTS

LABORATORY TESTING PROCEDURES

Important Information about This

Geotechnical-Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:
- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:
- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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 <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

GEOPROFESSIONAL
BUSINESS
ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

GENERAL COMMENTS

BASIS OF GEOTECHNICAL REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practices to assist in the design and/or evaluation of this project. If the project plans, design criteria, and other project information referenced in this report and utilized by SME to prepare our recommendations are changed, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions and recommendations of this report are modified or approved in writing by our office.

The discussions and recommendations submitted in this report are based on the available project information, described in this report, and the geotechnical data obtained from the field exploration at the locations indicated in the report. Variations in the soil and groundwater conditions commonly occur between or away from sampling locations. The nature and extent of the variations may not become evident until the time of construction. If significant variations are observed during construction, SME should be contacted to reevaluate the recommendations of this report. SME should be retained to continue our services through construction to observe and evaluate the actual subsurface conditions relative to the recommendations made in this report.

In the process of obtaining and testing samples and preparing this report, procedures are followed that represent reasonable and accepted practice in the field of soil and foundation engineering. Specifically, field logs are prepared during the field exploration that describe field occurrences, sampling locations, and other information. Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory and differences may exist between the field logs and the report logs. The engineer preparing the report reviews the field logs, laboratory classifications, and test data and then prepares the report logs. Our recommendations are based on the contents of the report logs and the information contained therein.

REVIEW OF DESIGN DETAILS, PLANS, AND SPECIFICATIONS

SME should be retained to review the design details, project plans, and specifications to verify those documents are consistent with the recommendations contained in this report.

REVIEW OF REPORT INFORMATION WITH PROJECT TEAM

Implementation of our recommendations may affect the design, construction, and performance of the proposed improvements, along with the potential inherent risks involved with the proposed construction. The client and key members of the design team, including SME, should discuss the issues covered in this report so that the issues are understood and applied in a manner consistent with the owner’s budget, tolerance of risk, and expectations for performance and maintenance.

FIELD VERIFICATION OF GEOTECHNICAL CONDITIONS

SME should be retained to verify the recommendations of this report are properly implemented during construction. This may avoid misinterpretation of our recommendations by other parties and will allow us to review and modify our recommendations if variations in the site subsurface conditions are encountered.

PROJECT INFORMATION FOR CONTRACTOR

This report and any future addenda or other reports regarding this site should be made available to prospective contractors prior to submitting their proposals for their information only and to supply them with facts relative to the subsurface evaluation and laboratory test results. If the selected contractor encounters subsurface conditions during construction, which differ from those presented in this report, the contractor should promptly describe the nature and extent of the differing conditions in writing and SME should be notified so that we can verify those conditions. The construction contract should include provisions for dealing with differing conditions and contingency funds should be reserved for potential problems during earthwork and foundation construction. We would be pleased to assist you in developing the contract provisions based on our experience.

The contractor should be prepared to handle environmental conditions encountered at this site, which 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 site should be made available for review by bidders and the successful contractor.

THIRD PARTY RELIANCE/REUSE OF THIS REPORT

This report has been prepared solely for the use of our Client for the project specifically described in this report. This report cannot be relied upon by other parties not involved in the project, unless specifically allowed by SME in writing. SME also is not responsible for the interpretation by other parties of the geotechnical data and the recommendations provided herein.

LABORATORY TESTING PROCEDURES

VISUAL ENGINEERING CLASSIFICATION

Visual classification was performed on recovered samples. The appended General Notes and Unified Soil Classification System (USCS) sheets include a brief summary of the general method used visually classify the soil and assign an appropriate USCS group symbol. The estimated group symbol, according to the USCS, is shown in parentheses following the textural description of the various strata on the boring logs appended to this report. The soil descriptions developed from visual classifications are sometimes modified to reflect the results of laboratory testing.

MOISTURE CONTENT

Moisture content tests were performed by weighing samples from the field at their in-situ moisture condition. These samples were then dried at a constant temperature (approximately 110º C) overnight in an oven. After drying, the samples were weighed to determine the dry weight of the sample and the weight of the water that was expelled during drying. The moisture content of the specimen is expressed as a percent and is the weight of the water compared to the dry weight of the specimen.

HAND PENETROMETER TESTS

In the hand penetrometer test, the unconfined compressive strength of a cohesive soil sample is estimated by measuring the resistance of the sample to the penetration of a small calibrated, spring-loaded cylinder. The maximum capacity of the penetrometer is 4.5 tons per square-foot (tsf). Theoretically, the undrained shear strength of the cohesive sample is one-half the unconfined compressive strength. The undrained shear strength (based on the hand penetrometer test) presented on the boring logs is reported in units of kips per square-foot (ksf).

TORVANE SHEAR TESTS

In the Torvane test, the shear strength of a low strength, cohesive soil sample is estimated by measuring the resistance of the sample to a torque applied through vanes inserted into the sample. The undrained shear strength of the samples is measured from the maximum torque required to shear the sample and is reported in units of kips per square-foot (ksf).

LOSS-ON-IGNITION (ORGANIC CONTENT) TESTS

Loss-on-ignition (LOI) tests are conducted by first weighing the sample and then heating the sample to dry the moisture from the sample (in the same manner as determining the moisture content of the soil). The sample is then re-weighed to determine the dry weight and then heated for 4 hours in a muffle furnace at a high temperature (approximately 440º C). After cooling, the sample is re-weighed to calculate the amount of ash remaining, which in turn is used to determine the amount of organic matter burned from the original dry sample. The organic matter content of the specimen is expressed as a percent compared to the dry weight of the sample.

ATTERBERG LIMITS TESTS

Atterberg limits tests consist of two components. The plastic limit of a cohesive sample is determined by rolling the sample into a thread and the plastic limit is the moisture content where a 1/8-inch thread begins to crumble. The liquid limit is determined by placing a ½-inch thick soil pat into the liquid limits cup and using a grooving tool to divide the soil pat in half. The cup is then tapped on the base of the liquid limits device using a crank handle. The number of drops of the cup to close the gap formed by the grooving tool ½ inch is recorded along with the corresponding moisture content of the sample. This procedure is repeated several times at different moisture contents and a graph of moisture content and the corresponding number of blows is plotted. The liquid limit is defined as the moisture content at a nominal 25 drops of the cup. From this test, the plasticity index can be determined by subtracting the plastic limit from the liquid limit.

Passionate People Building
and Revitalizing our World

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