Professional Service Industries, Inc.
5555 Canal Rd., Cleveland, OH 44125
(216) 447-1335 (P) & (216) 642-7008 (F)

May 9, 2024

To: Mr. Andrew Torowski
Architect
CT Consultants, Inc.
8150 Sterling Court
Mentor, OH 44060

Re: Geotechnical Engineering Services Report
Proposed Terminal Building
Lake County Executive Airport
1969 Lost Nation Road
Willoughby, Lake County, OH 44094
PSI Project No.: 0142-2816

Dear Mr. Torowski:

Per your request, Professional Service Industries, Inc. (PSI) is pleased to submit this Geotechnical Engineering Services Report for the above referenced project. The results of this exploration, together with our recommendations, are to be found in the accompanying report.

After the plans and specifications are complete, PSI should review the final design and specifications in order to verify that the earthwork and recommendations are properly interpreted and implemented. **It is considered imperative that the Geotechnical Engineer and/or its representative be present during earthwork operations and foundation installations to observe the field conditions with respect to the design assumptions and specifications. PSI will not be held responsible for interpretations and field quality control observations made by others.**

If you have any questions pertaining to this report, please contact our office at (216) 447-1335. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you and your organization on this and future projects.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.

Zaineddin Obeid
Project Manager

Joseph Corrigan, P.E.
Geotechnical Department Manager

Reviewed by: Reda Bakeer, Ph.D., D.GE, F.ASCE
Chief Engineer

Subsurface Exploration Report

For the Proposed

Terminal Building
Lake County Executive Airport
1969 Lost Nation Road
Willoughby, Lake County, OH 44094

Prepared for

CT Consultants, Inc.
8150 Sterling Court
Mentor, OH 44060

Prepared by

Professional Service Industries, Inc.
5555 Canal Road
Cleveland, OH 44125

PSI Project No. 0142-2816

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1 PROJECT INFORMATION

1.1 PROJECT AUTHORIZATION

This Geotechnical Engineering Services Report presents the results of a subsurface exploration and geotechnical evaluation associated with the proposed terminal building to be constructed at the Lake County Executive Airport located at 1969 Lost Nation Road in the City of Willoughby, Lake County, Ohio. PSI's services for this project were performed in accordance with PSI Proposal No. 0142-420392, dated March 6, 2024. Authorization to perform this exploration and analysis was in the form of signed agreement Form, with CT Consultants, on March 12, 2024.

1.2 PROJECT DESCRIPTION

Based on the provided information, it is our understanding that the proposed project involves the construction of a two-story terminal building measuring approximately 5,225 square feet in plan. It is understood that the proposed building will be a slab-on-grade structure supported on a conventional shallow foundation system (i.e., spread footings or monolithic mat). The proposed project will also include a paved area with 25 parking spaces and access drives to Lost Nation Road to the west and an entrance driveway to Airport Taxiway A to the east.

No structural loading information was provided to PSI at the time of report preparation regarding the proposed building. Therefore, PSI has necessarily assumed that they will be nominal and typical of local airport facilities in terms of type, size, use, and construction materials. While not known with certainty, it is believed likely that maximum column, wall, and floor loads of the proposed building will be on the order of approximately 80 kips, 5 kips per linear foot, and 100 psf, respectively. It is further assumed that the parking areas will be restricted to light traffic consisting of automobiles, vans, and pickup trucks while some designated areas and the drives will be subjected to occasional truck traffic (i.e., buses, delivery trucks, garbage trucks, fire engines, etc.).

No topographic information or finished grading information was available at the time of this report submittal. However, based on the approximate topographic information gleaned from the publicly available Google Earth imagery, the existing ground surface within the overall project site is relatively flat with a grade difference of about 1 foot (from about Elev. 620 ft. MSL to Elev. 619 ft. MSL). Therefore, it is believed likely that cut/fill operations on the order of less than about ±1 foot will be needed to achieve the finished floor elevation (FFE) of the new building. Additionally, mild surface grading is also anticipated within the pavement improvement areas to assure proper surface water and rainwater runoff drainage, collection, discharge, and disposal.

The geotechnical recommendations and general construction guidelines presented in this report are based on the foregoing project information and assumptions, the proposed building and pavement improvement locations and orientations on the project site, and the subsurface materials detected at the exploration locations as described in this report. If any of the information we have been given or have assumed is incorrect, please inform PSI in advance and in writing so that we may amend the recommendations presented accordingly. PSI will not be responsible for the implementation of its recommendations and general guidelines when it is not notified in advance and in writing of any pertinent changes in the project.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to explore the subsurface conditions within the subject site and offer geotechnical related recommendations and parameters for possible use by others in the design of the foundation system and floor slab of the building, and the pavement improvements along with general guidelines regarding site preparation, and other construction considerations. Our scope of work for this project included performing a site reconnaissance and field exploration, completing a laboratory testing program, and submitting results of our engineering analysis and evaluation of the subsurface materials encountered at the exploration locations. More specifically, the filed exploration consisted of drilling and sampling a total of five (5) soil test borings at random and readily accessible locations within the subject site.

The scope of services for the geotechnical exploration did not include an environmental assessment for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors, colors or unusual or suspicious items or conditions are strictly for the information of the Client. PSI's scope also did not include any service to investigate or detect the presence of moisture, mold, or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence or the amplification of the same. The Client should be aware that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. The Client should also be aware that site conditions are outside of PSI's control, and that mold amplification will likely occur, or continue to occur, in the presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or reoccurrence of mold amplification.

2 SITE AND SUBSURFACE CONDITIONS

2.1 SITE LOCATION AND DESCRIPTION

The site of the proposed terminal building is situated within the Lake County Executive Airport located at 1969 Lost Nation Road in the City of Willoughby, Lake County, Ohio, with its approximate center having the coordinates of Lat/Long: 41.6835°/-81.3994°.

The project site is currently undeveloped with the exception of a paved access driveway from Lost Nation Road to the airport, which will be removed and relocated to the south as part of the planned construction. According to the publicly available historical aerial photos, it appears that the area just north of the project site has been previously developed with two airplane hangars and associated pavement improvements since at least 1955, which were removed by 2000. The general conditions within the subject area have remained essentially unchanged since that time. Based on the approximate topographic information gleaned from the publicly available Google Earth imagery, the existing ground surface within the overall project site is relatively flat with a grade difference of about 1 foot (from about Elev. 620 ft. MSL to Elev. 619 ft. MSL). Surface runoff drainage within the project site appeared to be fair at the time of the field drilling operations. PSI recommends that any existing or abandoned utility lines within the subject site be checked and marked prior to commencing with the planned construction activities.

It should be noted that the foregoing discussions are provided for information purposes only as PSI's scope of services for this geotechnical investigation did not include performing an environmental site assessment (ESA) or a detailed review of the former use and developmental history of the site. In addition, approximate elevations are used in the publicly available historical images posted on Google Earth and other electronic platforms which may include some time gaps and unclear images. Therefore, the foregoing information should not be exclusively relied on to establish the developmental history of the site and its former uses or present grades which should be based on other precise means and examination of official records. This is beyond the geotechnical scope of our services. The publicly available image included in the *Appendix* should be used for general guidance and reviewed with other official records for consideration in the structural, civil and drainage design plans of the project.

2.2 GEOTECHNICAL SUBSURFACE CONDITIONS

The subsurface conditions at the project site were explored with a total of five (5) soil test borings drilled at random and readily accessible locations. They included borings B-1 through B-3 drilled within the footprint of the proposed building to approximately 25 feet below the existing surface grades at their respective locations and borings B-4 and B-5 drilled within the pavement improvement areas to about the 10-foot depth. The locations for the test borings were selected and located in the field by PSI and adjusted, as needed, to account for site access and/or presence of utilities. The locations for the test borings were identified in the field relative to existing site features and using a handheld recreational-grade GPS unit. Furthermore, the present ground surface elevation and coordinates at each boring location were not surveyed in the field (outside our scope of geotechnical services) and was estimated from Google Earth. Therefore, the coordinates and elevations indicated on the Boring Logs and the Boring Location Plan presented in the ***Appendix*** should be considered approximate.

The soil test borings were advanced utilizing 2¼ inch inside diameter, hollow stem auger drilling methods. During the test boring sampling procedure, the Standard Penetration Test (SPT) was performed at regular intervals to obtain the SPT resistance (N-value) of the soil. The SPT resistance (N-value) is defined as the number of blows ("blow counts") of a 140-pound hammer free falling 30 inches, required to advance the split-spoon sampler 1 foot into the soil at each sampling increment. The sampler is lowered to the bottom of the drill hole and the number of blows recorded for each of 3 successive increments of 6-inch penetration. The "N-value" is obtained by adding the second and third incremental blow count results. The results of the SPT indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile constituents. Select soil samples were later tested in the laboratory to obtain soil material properties for the foundation recommendations. Drilling, sampling, and laboratory testing were accomplished in general accordance with the applicable ASTM standard procedures.

The types of subsurface materials encountered in the test borings have been visually classified in general accordance with the Unified Soil Classification System (USCS/ASTM). Results of the visual classifications, Standard Penetration Test (SPT), natural moisture content tests, Atterberg Limits tests, grain size tests, and groundwater level observations are presented on the Boring Logs given in the ***Appendix*** of this report. Representative samples of the soils were placed in sample jars and are presently stored in our laboratory for further analysis, if requested. Unless notified to the contrary, all samples will be disposed of after 60 days following the date of this report.

2.2.1 SURFACE COVER

The surface cover at test boring locations B-1 through B-5 consisted of a topsoil layer measuring approximately 6 to 10 inches in thickness. The surface cover type and thickness may vary throughout the site and away from the boring locations.

2.2.2 NATIVE SOILS

Underlying the topsoil layer, native cohesive soils were encountered at all test boring locations (B-1 through B-5) and extended down to their planned termination depths of about 10 and 25 feet below the existing surface grade at their respective locations (to about Elev. 594 feet MSL to Elev. 609 feet MSL). The native cohesive soils encountered at the exploration locations consisted primarily of alternating intervals of medium stiff to very stiff lean clay (CL) with varying amounts of sand, gravel, and rock fragments. The tested samples of the native cohesive soils exhibited natural moisture contents ranging from 15 to 28 percent.

The foregoing subsurface description of a generalized nature is provided to highlight the major strata encountered at the exploration locations at the time of our field activities. The Boring Logs included in the ***Appendix*** should be reviewed for specific information at the individual boring locations. The stratifications shown on the Boring Logs represent the conditions only at the actual exploration locations. Variations may occur and should be expected between the boring locations. The stratifications represent the approximate boundary between the subsurface materials, and the transition may be gradual or not clearly defined. This is particularly important along the site boundaries materials (e.g., boring B-1) and within the area of a former structure (e.g., boring B-5) which may possibly include undocumented fill materials, remnants of structural elements, abandoned utilities, and/or debris of varying character, depth interval, lateral extent, and geotechnical engineering properties. It is also common that existing fill materials and native soils encountered within the general geographical area of the subject site contain large rock fragments (i.e., boulders or cobbles).

2.3 GROUNDWATER LEVEL MEASUREMENTS

No free water or groundwater was encountered in any of the relatively shallow test borings during drilling and immediately after completion of our field operations. Since the subject site is located within the Lake County Airport, which is an active facility, the soil test boreholes had to be backfilled and grouted immediately upon completion of drilling as per the applicable regulatory requirements for safety purposes. Therefore, long-term groundwater level measurements were not taken.

It should be noted that groundwater level fluctuates seasonally as a function of rainfall, snowmelt, prolonged drought periods, and ambient conditions as well as water levels in any nearby water bodies (e.g., Lake Erie) or drainage features. During a time of year or weather different from the time of drilling (April 2024), there may be a considerable change in the groundwater table elevation. Furthermore, the water level in a borehole is often not representative of the actual groundwater level, because it remains open for a relatively short period particularly when drilled within mostly cohesive soils. Also, a perched water condition could also develop within some parts of the site when rainwater becomes entrapped within the topsoil and/or any near surface existing fill materials and/or native more granular soil interval underlain or surrounded by essentially impervious native cohesive soils. Therefore, we recommend that the Contractor determine and monitor the prevailing groundwater level at the time of construction to evaluate its impact on the construction procedures particularly if they include deep excavations that could remain open for an extended period. The maximum frost penetration depth was estimated to be about 3½ to 4 feet below the surrounding exterior surface grades within the general geographical area of the subject site.

3 EVALUATION AND RECOMMENDATIONS

3.1 SITE PREPARATION AND EARTHWORK CONSTRUCTION

It is our opinion that the means, methods, and sequence of the proposed construction, including site preparation and site and personnel safety, should be the responsibility of the Contractor, who should specialize in this type of work. However, general geotechnical related guidelines are offered herein in this regard for guidance and possible consideration. Prior to construction, good and positive drainage, collection, discharge, and disposal of surface water and rainwater runoff should be established throughout the construction area and should be maintained throughout the construction period and service life of the facility. The construction drainage plan should account for the drainage patterns within the geographical area of the site, existing and finished design grades, civil and drainage plans, land usage, surface cover, etc.

Following the site clearing, stripping, and undercutting, and prior to placing any structural fill to raise and/or level the existing site grades, the exposed subgrade should be critically proof-roll tested with a loaded 20-ton tandem-axle dump truck until the grade offers a relatively unyielding surface. Areas of excessive yielding or pumping, as observed by a PSI representative, should be excavated, and backfilled with compacted structural fill and/or the unstable soils can be stabilized by choking the exposed bearing surface with crushed limestone or similar coarse aggregate. After the existing subgrade materials are excavated to design grade, proper control of subgrade compaction and the placement and compaction of new fill materials should be observed and tested by a representative of PSI.

Careful visual control of clearing and stripping operations should be maintained to assure that all deleterious materials are removed. The extent to which deleterious materials are to be removed should be determined in the field following visual observation of the exposed subgrades. Subsequent to the site area clearing and stripping, all structural subgrade sectors should be subjected to critical proof-roll testing operations and careful observation of subgrade reactions. Any sectors that exhibit instability are to be undercut or stabilized to such depths as may be necessary to assure satisfactory supporting properties. The undercut areas shall be backfilled with approved fill materials, placed, and compacted under carefully controlled procedures as described in this report.

Careful attention will be required in fine grading the subgrade surfaces in order to eliminate undulations and depressions that would tend to collect water. The pavement subgrade surface should be graded in a manner such that positive drainage towards the pavement edges and/or drainage systems will be insured.

Throughout the course of the earthwork operations, surface grades are to be maintained to facilitate positive drainage within the construction area and to prevent inundation of either the existing subgrade or new fill material. No water should be allowed to be impounded on the subgrade surfaces during this time.

It is recommended that the site preparation, proof-roll testing, and earthwork activities should be performed during a period of dry weather, which can significantly reduce the required extent of soil stabilization, drainage, and surface repairs.

During site preparation, fill piles, burn pits, trash pits or other isolated disposal areas may be encountered. All too frequently such buried material occurs in isolated areas outside boring locations. Any such material encountered during site work or pavement construction should be excavated, removed from the site, and backfilled with compacted structural fill.

3.2 DRAINAGE CONTROL

A permanent perimeter curb drains, and lateral underdrain system should be installed within the pavement areas. It is important to provide “positive” site drainage across and off the pavement areas. The new pavement surface needs to provide positive drainage to the sites existing storm water inlets or discharge points and water should not be allowed to collect or pond in landscaped areas adjacent to pavement areas.

Clean gravel, free from clay or foreign debris, shall be placed first along the bottom of the excavated subgrade trench. To prevent migration of fines into the clean gravel, the gravel should be wrapped in a non-woven filter fabric. Compaction of the clean gravel should be visually inspected to provide an unyielding surface.

A 4-inch diameter ADS Drain Guard with sock should be installed within the excavated trench to a minimum depth of 42 inches below the top of the pavement. A granular material should then be backfilled and compacted to at least 95 percent maximum dry unit weight according to ASTM D 698 and within 2 percent of the optimum moisture content. The granular material around the drainage members is to terminate in direct contact with the aggregate base course of the pavement. Compaction of the granular fill should be performed using mechanical rammer or tampers to avoid overstressing the ADS Drain Guard. Infiltration of water into excavations, ponding of water on finished subgrade, or softening or damaging of the bearing materials due to rain or water accumulation should be prevented.

3.3 STRUCTURAL FILL

Good-quality materials selected for use as structural fill should not contain more than 5 percent by weight of organic matter, waste construction debris, or other deleterious or objectionable materials. Fill materials should have a standard Proctor maximum dry density of (ASTM D-698) greater than 110 pounds per cubic foot (pcf), an Atterberg Liquid Limit of less than 40, a Plasticity Index of less than 15, and a maximum particle size of 3 inches or less. Structural fill should consist of non-expansive and non-frost-susceptible materials. Pyritic and/or potentially expansive materials, such as mine tailings, slag, shales fragments and soil mixed with more than 5 percent of shale fragments, should not be used as structural fill material. All fill and bedding materials shall meet the project specifications and conform with the requirements of the applicable building codes, local municipalities, and other governing agencies.

Based on the results of the boring explorations, the on-site native soils that classify as CL as per the USCS/ASTM classifications and satisfy the foregoing requirements could be used as structural fill. Otherwise, the on-site native soils that do not satisfy the structural fill requirements could be used as general fill and in landscaping areas. If the on-site soils are used for fill, close moisture content control will be required to achieve the recommended degree of compaction. PSI anticipates that disking and aerating the soils during a warm, dry period may be necessary to lower the moisture content. If structural fill placement must proceed during a wet or cool time of the year, it may likely be infeasible to re-use the on-site soils as structural fill and imported fill materials would be required. If wet or cool season earthwork is necessary, we recommend the use of imported fill materials such as ODOT No. 304 crushed aggregate.

Sand and gravel with less than 10 percent fines (smaller than #200 sieve opening) by weight will have negligible potential for frost heave and should be specified for support of the slab. It should be noted that the moisture-density compaction curve for non-frost-susceptible (NFS) granular fill will not be sensitive to placement moisture.

Accordingly, the density defined for an energy corresponding to ASTM D-698 should be used for control of NFS fill placement.

Structural fill materials should be placed and compacted in individual lifts of 8 inches or less loose measurement. Within small excavations such as in utility trenches, around manholes, or behind retaining walls, we recommend the use of smaller, hand or remote-guided equipment. Loose lift thicknesses of 4 inches or less are recommended when using such equipment.

A representative of PSI should observe fill placement operations and perform density tests concurrently to indicate if the specified compaction is being achieved. The fill should be evaluated in accordance with the requirements listed in the following table.

MATERIAL TESTED	PROCTOR TYPE	MINIMUM % DRY DENSITY	PLACEMENT MOISTURE CONTENT RANGE*1	FREQUENCY OF TESTING
Structural Cohesive Fill (Clay)	Standard	98%	-1 to +3 %	1 per 2,500 ft^2 / lift*2
Structural Granular Fill (Sand)	Standard	98%	-2 to +2 %	1 per 2,500 ft^2 / lift*2
Existing Fill (Non-load bearing)	Standard	90%	-3 to +3 %	1 per 2,500 ft^2 / lift*2
Utility Trench Backfill	Standard	95%	-1 to +3 %	1 per 150 lineal ft. / lift

Tested fill materials that do not achieve either the required dry density or moisture content range shall be recorded, the location noted, and reported to the Contractor and Owner. A re-test of that area should be performed after the Contractor performs remedial measures.

Representative samples of the proposed fill materials should be collected at least one week prior to the start of the filling operations. The samples should be tested to determine the maximum dry density, optimum moisture content, particle size distribution and plasticity characteristics. These tests are needed to determine if the material is acceptable as structural fill and for quality control during the compaction process.

Fill materials should be placed and compacted in individual lifts of 8 inches or less loose measurement. Within small excavations such as in utility trenches, around manholes, or behind retaining walls, we recommend the use of smaller, hand- or remotely-guided equipment. Loose lift thicknesses of 4 inches or less are recommended when using such equipment.

3.4 EXISTING UTILITIES

Some underground utility lines, septic tanks, grease traps, etc. may also be present in the formerly developed part of the site which could pose some potential concerns including:

- Possible interference with a structural foundation
- A pipeline could form a conduit for water to migrate or flow under and/or around a structure foundation particularly if cracked.
- Future deformation or collapse of the pipeline could result in differential or localized settlement within its vicinity.

- Future excavations to remove a pipeline could impact a constructed structure foundation.

In view of the foregoing concerns, effort should be made to determine the alignment and conditions of all existing below grade structures either via site inspections, examination of public records, or nondestructive methods, such as Ground Penetrating Radar (GPR), prior to commencing with construction. Once a below grade structure is detected, its alignment should be checked for any possible conflict with the proposed construction. If such conflict exists, the below grade structure within the conflict area should be abandoned, excavated, removed, and backfilled with compacted structural fill material as per the project specifications. Alternatively, a given pipeline segment could be filled (i.e., plugged) with grout to minimize the potential for future ground settlement in case it does deteriorate or collapse with time. Plugging or removing the pipeline would eliminate the potential for water flow or migration into a structure foundation area and into the areas where near surface swelling soils exist. With regard to any water well or septic tank well, it should be plugged and abandoned in accordance with the requirements of the local municipalities and other governing agencies.

3.5 FOUNDATION RECOMMENDATIONS

Based on results of test borings B-1 through B-3 made within the footprint of the proposed terminal building and geotechnical laboratory testing, the analysis indicates that the proposed building could be founded on a conventional shallow foundation system consisting of individual isolated (square) and/or continuous (wall) spread footings, a floor slab and grade beams bearing on well-drained, stiff or better, native cohesive soils or good-quality controlled-compacted structural fill. This assumes that the subgrade is well-drained, undisturbed, and competent and positive drainage, collection, discharge, and disposal of surface water and rainwater runoff have been established throughout the construction area and are maintained throughout the construction period and the design life of the structure.

The medium-stiff Lean Clay (CL) soils encountered in the upper 8.5 feet of boring B-1 are considered low-strength and may not be suitable for bearing the anticipated loads of the terminal building structure. PSI recommends that these soils in the vicinity of B-1 be removed to a depth of 8.5 feet below existing grade and replaced with good-quality, controlled-compacted fill material, in accordance with our recommendations given in ***Section 3.3*** of this report. If poor-quality, low-strength, or otherwise unsuitable soils are encountered during earthwork and site preparation, such soils should be addressed in accordance with the recommendations given in ***Sections 3.1, 3.2, and 3.3*** of this report.

Shallow foundations supporting the proposed terminal building , bearing on native cohesive soils (CL) having at least stiff consistency or good-quality controlled-compacted structural fill, can be designed utilizing allowable soil bearing pressures of **2,500 psf** and **2,000 psf** for square spread footings up to 6 feet wide and continuous or wall footings up to 3 feet wide, respectively, to assure a sufficient factor of safety against experiencing a general shear failure in the underlying foundation soils and to limit long-term settlements to tolerable values.

This assumes that our recommendations and discussions given in ***Sections 3.1*****,** ***3.2, 3.3*****, and** ***3.4*** of this report are fully recognized and implemented in the design and during construction. Foundations supporting individual columns of the building should have a minimum width/length of 36 inches, and continuous wall foundations should have a minimum width of 18 inches. All perimeter foundation must be placed at a minimum depth of 3½ to 4 feet below the exterior finished grades in order to protect against frost action. Interior foundations in the heated areas should bear at a depth of at least 18 inches below the underside of the floor slab.

Footing bearing surfaces are to be critically inspected and tested to verify its conformance and compatibility with subsurface exploration data, and to assure that the recommended bearing capacity is being achieved. It is recommended that a representative of PSI be present at the site throughout foundation excavation and construction.

Extreme care should be taken to prevent weakening of the foundation bearing materials because of prolonged atmospheric exposure, construction activity disturbance or an increase in moisture content. In the event an overnight delay in concrete placement is anticipated, the foundation excavations should terminate approximately 6 inches above final grade, and subsequently be excavated to final grade immediately before placement of concrete.

Based on the anticipated typical structural loads, it is anticipated that total and differential foundation settlements will be on the order of 1-inch and ½-inch, respectively. However, actual settlements will be dependent upon the site preparation quality, structural fill material quality and placement/compaction, depth of the foundation, column spacing, structural loads and other related factors. The structural and architectural designs should include provisions for liberally spaced, vertical control joints to minimize the effects of potential settlement. It is recommended that structure foundation be designed to have sufficient rigidity to minimize detrimental effects of movements due to settlement and variations in the near surface native soil/fill conditions within the footprint of the structure foundation. This could consist of stiffening grade beams tying together the individual foundation elements as deemed necessary by the Structural Engineer.

PSI should be retained to provide observation and testing of construction activities related to structure foundations, earthwork, and related aspects of this project. PSI cannot accept responsibility for conditions that deviate from those described in this report, nor for the performance and testing for this project.

3.6 FLOOR SLAB DESIGN AND CONSTRUCTION

Preparation of floor slab subgrade should be in accordance with recommendations outlined in the Site Preparation and Structural Fill sections of the report. If subsurface materials at the finished subgrade elevations exhibit excessive moisture contents and unstable subgrade conditions, then undercutting and replacement of the objectionable soils should be performed to achieve firm, stable and well-drained subgrade support. Alternatively, the unstable soils can be stabilized by choking the exposed bearing surface with crushed limestone or similar coarse aggregate.

After the soils within the footprint of each building have been prepared as discussed, it is recommended that the subgrade surface be subjected to surface compaction to the extent that a minimum of 12 inches of controlled-compacted material underlying the slab subgrade elevation having a minimum in-place density of 98 percent of the maximum laboratory dry density and should be within ±2 percent of the optimum moisture content, as determined in general accordance with ASTM D-698.

A capillary gravel layer (such as AASHTO #57 or ODOT #304) should be provided between the floor slab and the approved subgrade materials. The gravel layer should have a minimum thickness of 4 inches and should be properly compacted. Also, a vapor barrier is recommended below the floor slab as per ACI specifications. We recommend that a subgrade modulus (k) of 100 pci be used in floor slab design calculations.

Strict field control is to be exercised in finish grading operations in order to assure that subgrade tolerances are maintained. It is particularly important that no low sectors or depressions be allowed to exist within these areas, water may accumulate and lead to serious loss of supporting capacity.

The floor slab should be sufficiently reinforced, as per structural considerations, to make it as rigid as practical to withstand the anticipated service design loads and long-term movements. Proper joints should be provided at the junctions of the slab and foundation system so that a small amount of independent movement can occur without causing damage. Large floor areas should be provided with joints at frequent intervals to compensate for concrete volume changes during curing and temperature changes.

3.7 SEISMIC SITE CLASSIFICATION

Based on table 1615.1.1 of the OBC Building Code, the test boring results and review of the geology in vicinity to the project area, a **Site Classification of 'D'** can be utilized for seismic design.

3.8 PAVEMENT RECOMMENDATIONS

No traffic information was available at the time of this report. However, for this pavement design, we estimated 18-kip ESAL's of 30,000 and 100,000 for the planned Light-Duty Pavement areas and Heavy-Duty Pavement areas, respectively. Also, the anticipated design life is 20 years. Based on the estimated traffic information and CBR value of 4, the pavement design parameters for the proposed development are provided in the following table.

Design Parameters		
	Flexible Pavement	**Rigid Pavement**
Reliability:	80%	80%
Overall Deviation:	0.49	0.39
Design Life (Years):	20	20
Initial Serviceability:	4.5	4.2
Terminal Serviceability:	2.5	2.5
Design CBR	4	--
Subgrade Modulus (k, pci)	--	80

Flexible Pavement

The recommended pavement thickness values are shown in Tables 1 and 2. These design thicknesses assume that a properly prepared subgrade has been achieved.

Table 1: Flexible Pavement Sections (20-Year Design Life)		
Layer	**Light-Duty***	**Heavy-Duty**
Surface Course (ODOT #441 Type 1)	1.5 inches	1.5 inches
Intermediate Course (ODOT #441 Type 2)	2.5 inches	3.5 inches
Aggregate Base Course (ODOT #304)	6.0 inches	6.0 inches

**Parking spaces restricted to automobiles, vans, and light pickup traffic only.*

For parking stalls that allow free movement through them (i.e., no parking block or curbs), we recommend installing the heavy-duty asphalt section. Allowances for proper drainage and proper material selection of base materials are most important for performance of asphaltic pavements. Ruts and birdbaths in asphalt pavement allow for quick deterioration of the pavement primarily due to saturation of the underlying base and subgrade.

Rigid Pavement

The use of concrete for paving has become more prevalent in recent years due to the long-term maintenance cost benefits of concrete compared to asphaltic pavements. Should concrete pavement be utilized, the concrete should be properly reinforced and jointed, and should have a 28-day flexural strength of no less than 650 psi and should be air entrained. Expansion joints should be sealed with a polyurethane sealant so that moisture infiltration into the subgrade soils and resultant concrete deterioration at the joints is reduced.

Table 2: Rigid Pavement Sections

Layer	Light-Duty*	Heavy-Duty
Reinforced Concrete	5.0 inches	7.0 inches
Aggregate Base Course (ODOT #304)	4.0 inches	6.0 inches

** Parking spaces restricted to automobiles, vans, and light pickup traffic only.*

The portions of the site where rigid (PCC) pavements are recommended include the entrance/exit driveway aprons and the dumpster pad enclosure area. A heavy-duty pavement section is recommended for lanes designated for delivery trucks and dumpster pickup areas. **Concrete pavement at least 9 inches thick is recommended for the trash enclosure pads in view of the impact loads and heavy concentrated loads imposed by the front wheels of the garbage truck while lifting the dumpster**. Consideration could also be given to placing a separation geotextile fabric over the prepared subgrade to safeguard against protrusion of the aggregate base into the underlying subgrade and migration of the subgrade fines into the aggregates. This will ensure good drainage and performance of the pavement improvement.

Crushed aggregate base materials should be compacted to at least 98 percent of the standard Proctor (ASTM D 698) maximum dry density near optimum moisture content. The use of Portland cement concrete (PCC) for paving has become more prevalent in recent years based on material costs for concrete vs. bituminous and the long-term maintenance cost benefits of concrete compared to bituminous pavements. If PCC pavement is utilized, the concrete should be properly jointed, have proper load-transfer mechanisms installed, and should have a minimum 28-day compressive strength of 4,000 psi. Expansion and construction joints should be sealed with a polyurethane sealant so that moisture infiltration into the subgrade soils and resultant concrete deterioration at the joints is minimized.

Design for drainage is of the utmost importance to minimize detrimental effects that may shorten the service life of the pavements. The pavement should be crowned or sloped in order to promote effective surface drainage and reduce the risk of water ponding. We recommend a minimum slope of 1.5 percent. In addition, the subgrade should be similarly sloped to promote effective subgrade drainage. We recommend "stub" or "finger" drains be provided around catch-basins and in other low areas of the proposed pavements to limit the accumulation of water on the frost susceptible subgrade soils. Subsurface edge drains/perimeter drains should be provided at curbs. Where no curbs are proposed, ditches should be provided, and the pavement base course should be daylighted through the ditch side slope to facilitate drainage of the base course.

If fill material is needed to establish the required pavement grade, fill placement and compaction must be performed in accordance with the procedures outlined in the *Site Preparation* section of this report. The edges of compacted fill should extend a minimum of 2 feet beyond the edges of the pavement, or a distance equal to the depth of fill beneath the pavement, whichever is greater.

All materials to be employed and field operations required in connection with the contemplated pavement structures should follow recommendations and procedural details as per the Ohio Department of Transportation, Asphalt Institute, and/or American Concrete Institute.

4 CONSTRUCTION CONSIDERATIONS

It is our opinion that the means, methods, and sequence of the proposed construction, including site preparation and site and personnel safety, should be the responsibility of the Contractor, who should specialize in this type of work. However, general geotechnical related guidelines are offered herein in this regard for possible consideration during construction. Prior to commencing with construction, good and positive drainage, collection, discharge and disposal of surface water and rainwater runoff should be established throughout the site and should be maintained throughout the construction period and the design life of the project. The construction drainage plan should account for the site topography, drainage patterns within the geographical area, required cut and fill operations, presence of miscellaneous fill materials, groundwater level, perched water, site access, and ambient conditions at the time of construction.

It is recommended PSI be retained to provide observation and testing of construction activities involved in the foundations, earthwork, and related activities of this project. PSI cannot accept any responsibility for any conditions which deviated from those described in this report, nor for the performance of the foundations if not engaged to also provide construction observation and testing for this project.

4.1 GROUNDWATER CONTROL AND DRAINAGE

Free groundwater water was not encountered during our field drilling operations. However, It should be noted that groundwater level fluctuates seasonally as a function of rainfall, snowfall, and ambient conditions as well as water levels in any nearby water bodies. During a time of year or weather conditions different from the time of drilling, there may be a considerable change in the groundwater level. Accordingly, a gravity drainage system, sump pump or other conventional dewatering procedure, as deemed necessary by the field conditions, should be implemented throughout construction such that the groundwater is always controlled and maintained at an elevation of at least 2 feet below the excavation bottom. Every effort should be made to keep the excavations dry if water is encountered.

Water should not be allowed to collect near the foundation or floor slab areas of the building either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slab. Overall site area drainage is to be arranged in a manner such that the possibility of water impounding below slab-on-grade areas and over the structural fill is prevented during construction. Groundwater and surface water control, management, and drainage are extremely critical for this project in view of the presence of moisture sensitive near surface native cohesive soils and shale bedrock at the subject site.

4.2 SILTATION CONTROL

The Clean Water Act implemented in 1990 includes a federal permit program called the National Pollutant Discharge Elimination System (NPDES). This program requires that projects sites in excess of 1 acre or are part of a development which exceeds 1 acre be covered under a permit. This typically includes the development of a storm water pollution prevention plan (SWPPP) as well as period inspections (typically once a week plus after significant rainfall). PSI is available to assist with these services.

4.3 PAVEMENT DRAINAGE

A permanent perimeter and lateral underdrain system should be installed within the pavement areas. It is important to provide “positive” site drainage across and off the pavement areas. The new pavement surface needs to provide positive drainage to the sites existing storm water inlets or discharge points and water should not be allowed to collect or pond in landscaped areas adjacent to pavement areas.

Clean gravel, free from clay or foreign debris, shall be placed first along the bottom of the excavated subgrade trench. To prevent migration of fines into the clean gravel, the gravel should be wrapped in a non-woven filter fabric. Compaction of the clean gravel should be visually inspected to provide an unyielding surface.

A 4-inch diameter ADS Drain Guard with sock shall be installed within the excavated trench to a minimum depth of 42 inches below the top of the pavement. A granular material should then be backfilled and compacted to at least 95 percent maximum dry unit weight according to ASTM D 698 and within 2 percent of the optimum moisture content. The granular material around the drainage members is to terminate in direct contact with the aggregate base course of the pavement. Compaction of the granular fill should be performed using mechanical rammer or tampers to avoid overstressing the ADS Drain Guard. Infiltration of water into excavations, ponding of water on finished subgrade, or softening or damaging of the bearing materials due to rain or water accumulation should be prevented.

4.4 SHALLOW EXCAVATIONS

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P." This document was issued to better ensure the safety of workers entering trenches or excavations. It is mandated by this federal regulation that all excavations, whether they be utility trenches, basement excavations or foundation excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced. If they are not followed closely, the owner and the Contractor could be liable for substantial penalties.

The Contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The Contractor's "responsible person" as defined in "CFR Part 1926," should evaluate the soil exposed in the excavations as part of the Contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

We are providing this information solely as a service to our Client. PSI is not assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred. If the excavations are left open and exposed to the elements for a significant length of time, desiccation of the clays may create minute shrinkage cracks which could allow large pieces of clay to collapse or slide into the excavation.

Materials removed from the excavation should not be stockpiled immediately adjacent to the excavation, inasmuch as this load may cause a collapse of the embankment.

4.5 WEATHER CONSIDERATIONS

The soils encountered at this site are known to be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. Care should be exercised during the grading operations at the site. Due to the fine-grained nature of the surficial soils, the traffic of heavy equipment, including heavy compaction equipment, may very well create pumping and a general deterioration of those soils in the presence of water. Therefore, the grading should, if possible, be performed during a dry season. A layer of crushed stone may be required to allow the movement of construction traffic over the site during the rainy season. The Contractor should maintain positive site drainage and if wet/pumping conditions occur, the Contractor will be responsible for over excavating the wet soils and replace them with a properly compacted structural fill. During wet seasons, limestone stabilization may be required to place structural fill.

4.6 UTILITY TRENCHING

Excavation for utility trenches should be performed in accordance with OSHA regulations as stated in 29 CFR Part 1926. It should be noted that utility trench excavations have the potential to degrade the properties of the adjacent subsurface materials. Utility trench walls that are allowed to move laterally can lead to reduced bearing capacity and increased settlement of adjacent structural elements and overlying slabs.

Backfill for utility trenches is as important as the original subgrade preparation or structural fill placed to support a foundation or slab. Therefore, it is imperative that the backfill for utility trenches be placed to meet the project specifications for the structural fill on this project. Backfill should be placed in four to six-inch loose lifts and compacted to a minimum of 95 percent of the Standard Proctor maximum dry density. Compaction testing should be performed for every 200 cubic yards of backfill placed or each lift within 200 linear feet of trench, whichever is less. Backfilling of utility trenches should not be performed with water standing in the trench.

4.7 PAVEMENT CONSTRUCTION

The importance of good drainage cannot be over-emphasized. Construction of the pavement improvement should only be attempted when this subgrade is dry and stable and after good drainage has been established in the area. If these near surface soils are not well drained prior to and during construction, “pumping” may occur which would inhibit proper compaction of the rigid pavement base or flexible pavement subbase. In this case, they would have to be stripped from the site and replaced with pavement base or subbase material. A geotextile fabric could be placed beneath the pavement improvement base or subbase to separate it from the soil subgrade.

It is our opinion that the methods, means and sequence of construction of the pavement improvement are the responsibility of the Contractor who should be experienced in this type of construction. It should be noted that the geotechnical recommendations given herein with regard to asphalt, concrete, base, and subbase thicknesses for the new pavement improvement are based on the traffic conditions analyzed. This includes the recommended total improved thicknesses for areas restricted to automobiles and light truck traffic and for areas also subjected to light concentrations of heavier traffic (delivery trucks, garbage trucks, etc.). However, it should be recognized that the fully or partially constructed pavement improvement may be subjected to heavier construction equipment, such as bulldozers, spreaders, rollers, concrete trucks, dump trucks, etc. Therefore, appropriate measures should be taken by the Contractor in terms of site preparation, base and subbase placement and compaction, selection of paving equipment, etc. to assure the performance of the pavement improvement during and after construction.

4.8 CONSTRUCTION MONITORING

Consideration should be given to the impact of all of the proposed construction activities including demolition or removal of any existing utilities, structural elements, pavement improvements, etc. on the integrity and stability of nearby existing structures, foundation systems, utilities, pavements, etc. A detailed QA/QC program should be developed and strictly followed through the project. This may include performing a thorough preconstruction inspection of the site and structure conditions to document any existing distress, cracks, movements, etc. This could include the use of videotaping, photographs, instrumentation, sensors, geodetic surveys, etc. The QA/QC program should include close monitoring of construction vibrations and movements, stability of excavations, dewatering activities, etc. and their possible impact on the existing building and nearby structures. In this regard, it is recommended that background vibration levels be established in advance of construction. This should be performed over some period to determine the impact of occasional heavy traffic (school buses, garbage trucks, city buses, delivery trucks, etc.). In addition, the selected Contractor should be specialized in this type of construction and should be prepared to take all necessary measures to preserve the conditions and integrity of the existing building and all surrounding elements including the use of any necessary shoring, underpinning, bracing, etc. as needed.

We are providing this information solely as a service to our Client. PSI does not assume responsibility for construction site safety or the contractor's or other party’s compliance with local, state, and federal safety or other regulations.

5 GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. Site exploration identifies actual subsurface conditions only at those points where samples are taken. A geotechnical report is based on conditions that existed at the time of the subsurface exploration. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding sections constitute PSI's professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and referenced during this evaluation, and PSI's experience in working with these conditions.

6 REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by CT Consultants, Inc. If there are any revisions to the plans for the proposed facility, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be retained to determine if changes in the recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the geotechnical recommendations for the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are complete, it is recommended that PSI be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and recommendations are properly interpreted and implemented. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of CT Consultants, Inc. for the specific application to the proposed terminal building to be constructed at the Lake County Executive Airport located at 1969 Lost Nation Road in the City of Willoughby, Lake County, Ohio.

APPENDICES

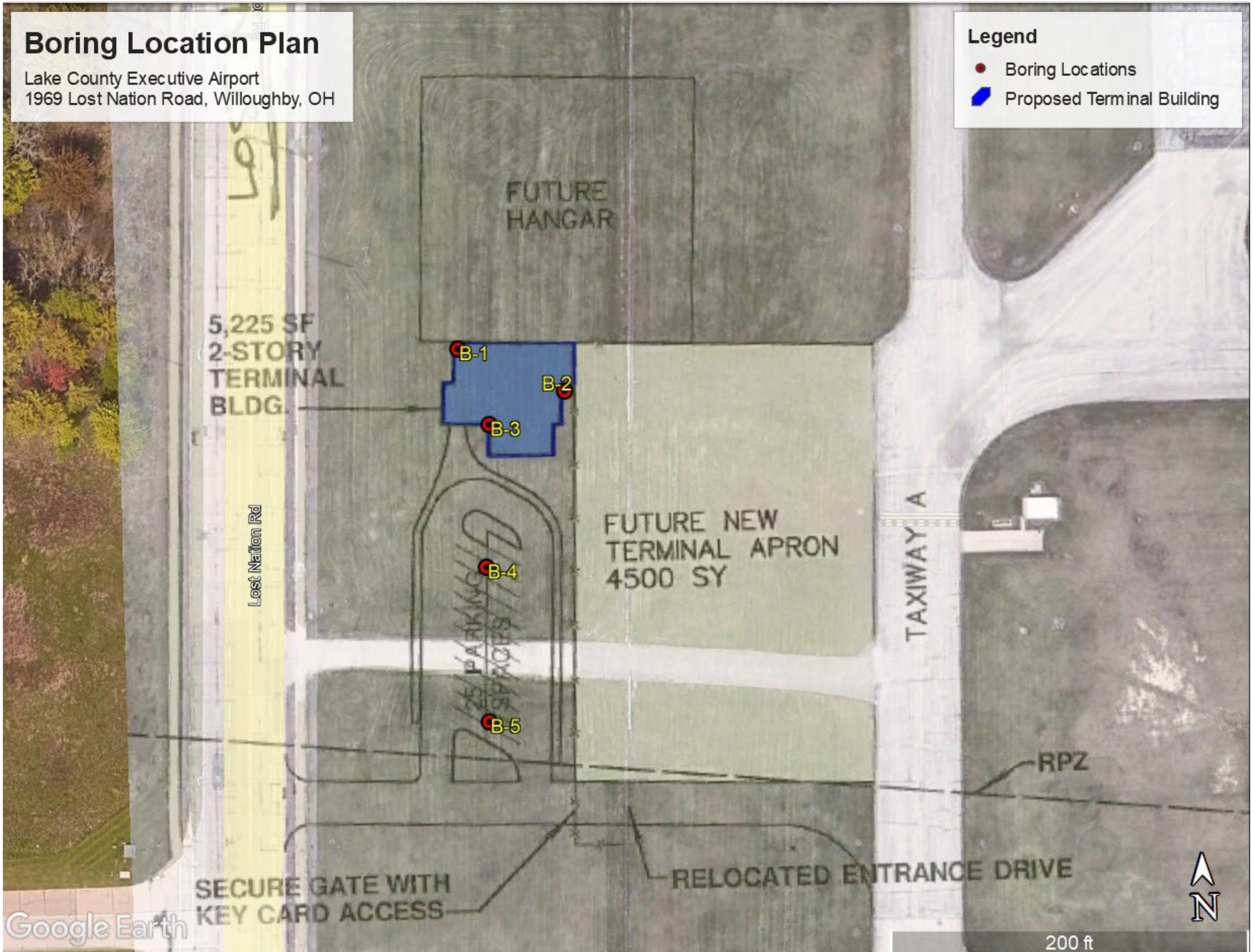
BORING LOCATION PLAN

BORING LOGS

GRAIN SIZE DISTRIBUTION CURVES

ATTERBERG LIMIT TEST RESULTS

GENERAL NOTES & SOIL CLASSIFICATION CHART



intertek psi	Proposed Terminal Building, Lake County Executive Airport 1969 Lost Nation Road, Willoughby, Lake County, OH 44094	Prepared By: ZO	Boring Location Plan
		Date: 5/7/2024	PSI Project No. 0142-2816

BORING B-1

DATE STARTED:	4/23/24	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	4/23/24	**DRILLER:** JJ	**LOGGED BY:** ZO
COMPLETION DEPTH	25.0 ft	**DRILL RIG:**	Truck D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	619 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:	41.683713°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-81.399464°	**EFFICIENCY**	88%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	RB
REMARKS:			

Water

While Drilling	N/A
Upon Completion	N/A
Caved Depth	22 feet

BORING LOCATION:
Building Area

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
619	0			**6" Topsoil**				
				Medium Stiff, Moist, Brown, **Lean CLAY**, Trace Sand, Trace Gravel	CL			
		1	10			2-3-4 N=7	24	
615		2	12			2-3-3 N=6	21	LL = 45 PL = 21 Fines=86.3%
	5							
		3	13			2-2-3 N=5	28	
610		4	12	Stiff to Very Stiff, Moist, Brown, **Lean CLAY**, Trace Sand, Trace Gravel	CL	4-8-9 N=17	16	
	10							
605		5	11			5-6-7 N=13	15	
	15							
				@ 16ft ; Gray				
600		6	13			4-4-5 N=9	16	
	20							
	22			(Caved depth)				
595		7	18			5-5-6 N=11	17	
	25							

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

intertek psi

Professional Service Industries, Inc.
5555 Canal Road
Cleveland, OH 44125
Telephone: (216) 447-1335

PROJECT NO.: 0142-2816
PROJECT: Proposed Terminal Building
LOCATION: 1969 Lost Nation Road
Willoughby, Lake County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	4/23/24	DRILL COMPANY:	PSI, Inc.
DATE COMPLETED:	4/23/24	DRILLER: JJ	LOGGED BY: ZO
COMPLETION DEPTH	25.0 ft	DRILL RIG:	Truck D-50
BENCHMARK:	N/A	DRILLING METHOD:	Hollow Stem Auger
ELEVATION:	619 ft	SAMPLING METHOD:	2-in SS
LATITUDE:	41.683643°	HAMMER TYPE:	Automatic
LONGITUDE:	-81.399229°	EFFICIENCY	88%
STATION: N/A	OFFSET: N/A	REVIEWED BY:	RB
REMARKS:			

Water

While Drilling	N/A
Upon Completion	N/A
Caved Depth	22 feet

BORING LOCATION: Building Area

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
619	0			**9" Topsoil**				
		1	11	Medium Stiff to Stiff, Moist, Brown, **Lean CLAY**, Trace Sand, Trace Gravel	CL	2-3-3 N=6	25	
615	5	2	10			3-4-5 N=9	21	
		3	15			4-4-5 N=9	20	
610	10	4	18	Stiff to Very Stiff, Moist, Brown, **Lean CLAY**, Trace Sand, Trace Gravel	CL	5-7-10 N=17	18	
605	15	5	11	@ 13ft ; Gray		3-4-5 N=9	16	
600	20	6	18			3-4-5 N=9	15	
595	25	7	18			4-4-5 N=9	16	

STANDARD PENETRATION TEST DATA: N in blows/ft ◎; × Moisture; PL; LL (0, 25, 50). STRENGTH, tsf: ▲ Qu; ✳ Qp (0, 2.0, 4.0)

Professional Service Industries, Inc.
5555 Canal Road
Cleveland, OH 44125
Telephone: (216) 447-1335

PROJECT NO.: 0142-2816
PROJECT: Proposed Terminal Building
LOCATION: 1969 Lost Nation Road, Willoughby, Lake County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-3

DATE STARTED:	4/23/24	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	4/23/24	**DRILLER:** JJ	**LOGGED BY:** ZO
COMPLETION DEPTH	52.0 ft	**DRILL RIG:**	Truck D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	619 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:	41.683539°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-81.399402°	**EFFICIENCY**	88%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	RB
REMARKS:			

Water

While Drilling	N/A	
Upon Completion	N/A	
Caved Depth	22	feet

BORING LOCATION:
Building Area

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA (N in blows/ft; Moisture; PL; LL; 0–25–50) / STRENGTH, tsf (Qu; Qp; 0–2.0–4.0)	Additional Remarks
619	0					**10" Topsoil**					
						Stiff to Very Stiff, Moist, Brown, **Lean CLAY**, Trace Sand, Trace Gravel	CL				
			SS	1	9			3-4-4 N=8	25		
615			SS	2	9			2-4-5 N=9	20		
	5										
			SS	3	13			5-5-6 N=11	18		
610			SS	4	16			4-8-11 N=19	16		
	10										
						@ 13ft ; Gray					
605			SS	5	13			4-4-5 N=9	16		
	15										
600			SS	6	18			3-4-5 N=9	17		
	20										
595			SS	7	18			4-4-6 N=10	17		
	25										

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5555 Canal Road
Cleveland, OH 44125
Telephone: (216) 447-1335

PROJECT NO.: 0142-2816
PROJECT: Proposed Terminal Building
LOCATION: 1969 Lost Nation Road
Willoughby, Lake County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-4

DATE STARTED:	4/23/24	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	4/23/24	**DRILLER:**	JJ **LOGGED BY:** ZO
COMPLETION DEPTH	10.0 ft	**DRILL RIG:**	Truck D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	619 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:	41.683353°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-81.399315°	**EFFICIENCY**	88%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	RB
REMARKS:			

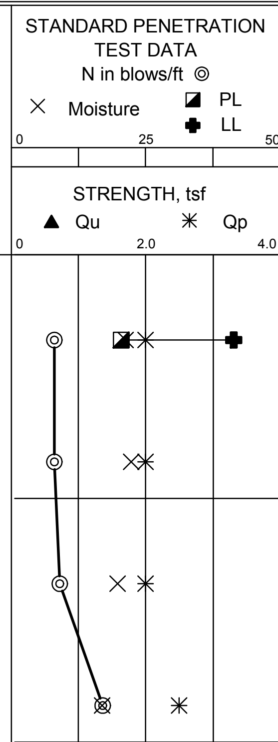
Water

∇	While Drilling	N/A
▼	Upon Completion	N/A
∇	Caved Depth	8 feet

BORING LOCATION:
Pavement Area

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
619	0					**10" Topsoil**				
				1	11	Medium Stiff to Stiff, Moist, Brown, **Lean CLAY with Sand**, Trace Sand, Trace Gravel	CL	2-3-5 N=8	21	LL = 41 PL = 20 Fines=83.0%
615	5			2	11			3-4-4 N=8	22	
				3	14			4-5-4 N=9	20	
610				4	18	Very Stiff, Moist, Brown, **Lean CLAY**, Trace Sand, Trace Gravel	CL	5-8-9 N=17	17	
	10									

STANDARD PENETRATION TEST DATA



Professional Service Industries, Inc.
5555 Canal Road
Cleveland, OH 44125
Telephone: (216) 447-1335

PROJECT NO.: 0142-2816
PROJECT: Proposed Terminal Building
LOCATION: 1969 Lost Nation Road
Willoughby, Lake County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-5

DATE STARTED:	4/23/24	DRILL COMPANY:	PSI, Inc.
DATE COMPLETED:	4/23/24	DRILLER:	JJ
LOGGED BY:	ZO		
COMPLETION DEPTH	10.0 ft	DRILL RIG:	Truck D-50
BENCHMARK:	N/A	DRILLING METHOD:	Hollow Stem Auger
ELEVATION:	620 ft	SAMPLING METHOD:	2-in SS
LATITUDE:	41.683014°	HAMMER TYPE:	Automatic
LONGITUDE:	-81.399538°	EFFICIENCY	88%
STATION:	N/A	OFFSET:	N/A
REVIEWED BY:	RB		
REMARKS:			

Water

While Drilling	N/A
Upon Completion	N/A
Caved Depth	7 feet

BORING LOCATION: Pavement Area

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			**10" Topsoil**				
		1	12	Medium Stiff, Moist, Brown, **Lean CLAY**, Trace Sand, Trace Gravel	CL	2-3-4 N=7	22	
615	5	2	11	Stiff to Very Stiff, Moist, Brown, **Lean CLAY**, Trace Sand, Trace Gravel		4-5-7 N=12	16	
		3	13		CL	6-6-7 N=13	17	
610	10	4	15			9-13-18 N=31	14	

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture; PL; LL
0 25 50
STRENGTH, tsf
▲ Qu; ✳ Qp
0 2.0 4.0

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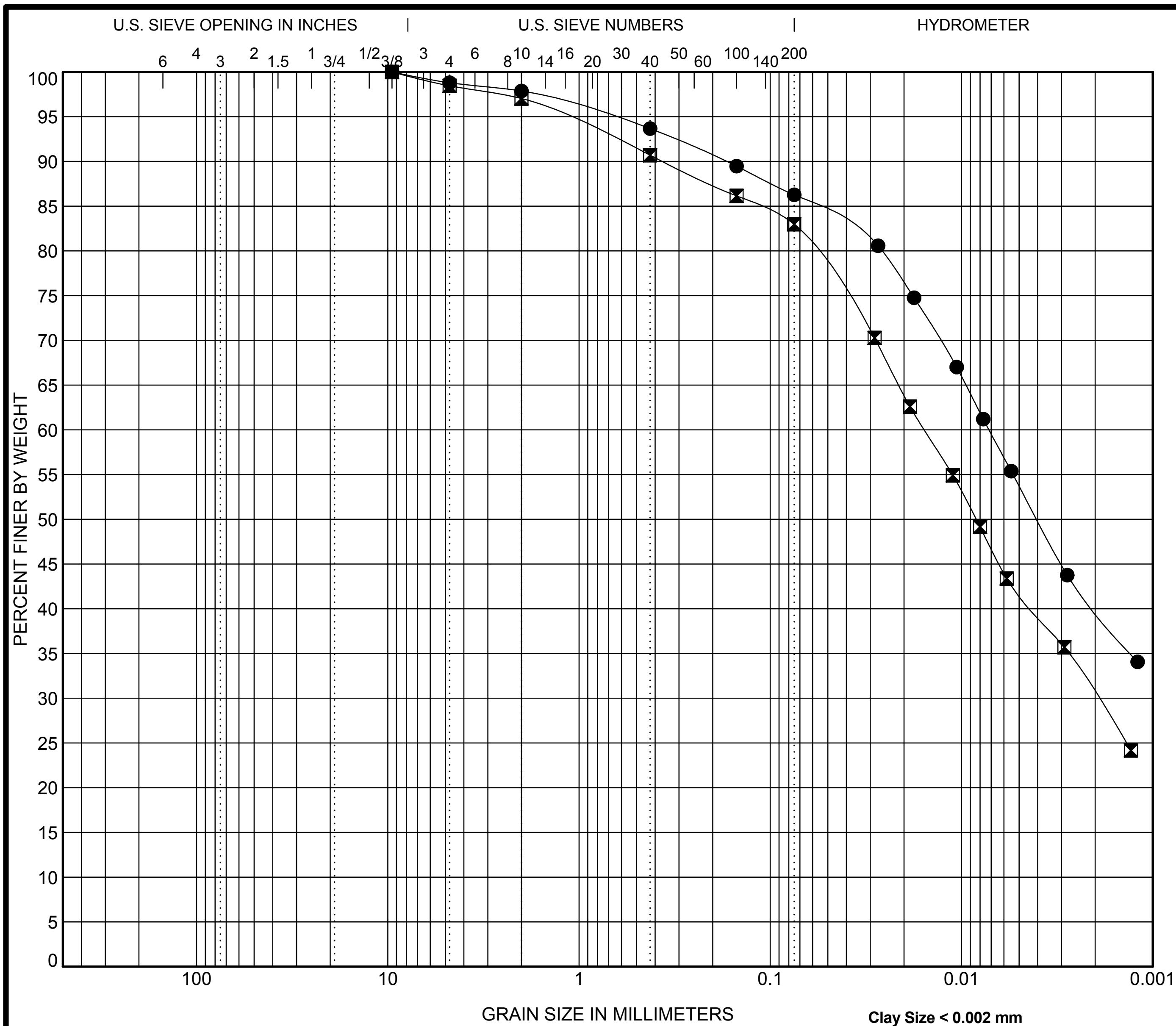
PROJECT NO.: 0142-2816
PROJECT: Proposed Terminal Building
LOCATION: 1969 Lost Nation Road
Willoughby, Lake County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B-1	4.3	**Lean CLAY (CL)**	**45**	**21**	**24**		
⊠ B-4	1.8	**Lean CLAY with Sand (CL)**	**41**	**20**	**21**		

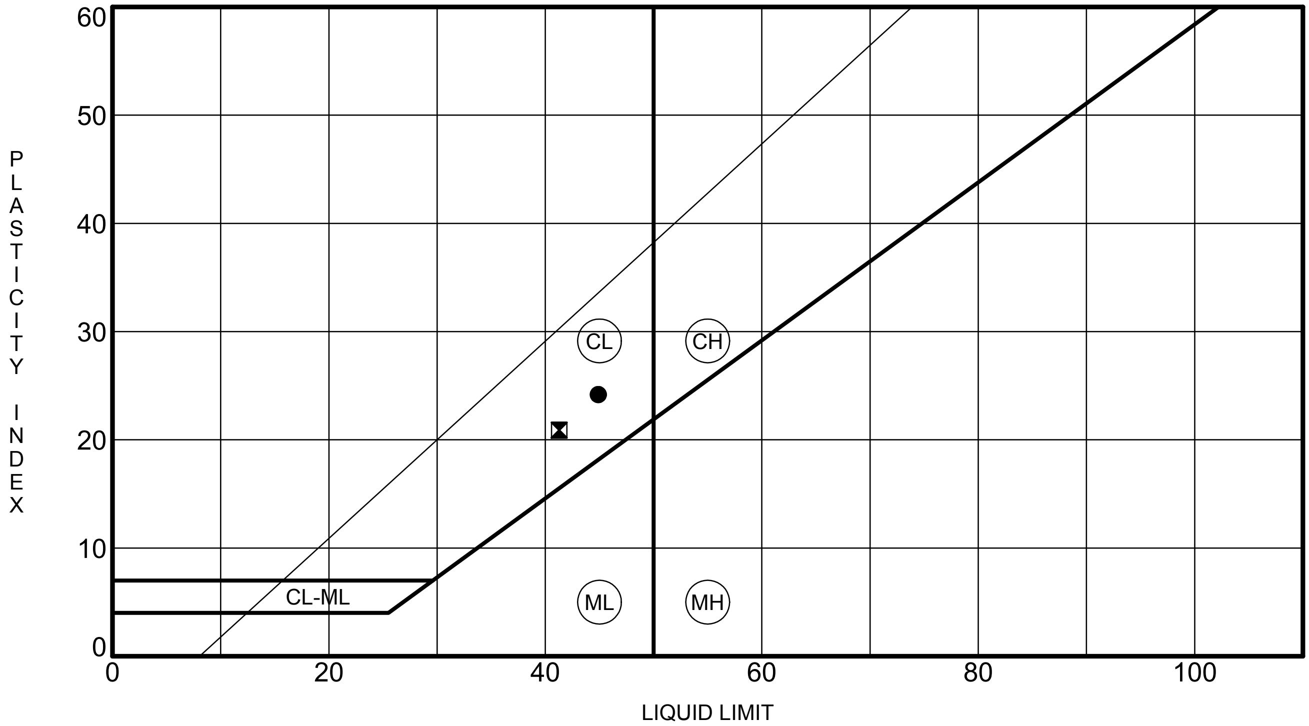
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-1	4.3	**9.5**	**0.007**			**1.2**	**12.5**	**46.4**	**39.9**
⊠ B-4	1.8	**9.5**	**0.016**	**0.002**		**1.6**	**15.5**	**52.6**	**30.4**

intertek psi

Professional Service Industries, Inc.
5555 Canal Road
Cleveland, OH 44125
Telephone: (216) 447-1335
Fax: (216) 642-7008

GRAIN SIZE DISTRIBUTION

Project: Proposed Terminal Building
PSI Job No.: 0142-2816
Location: 1969 Lost Nation Road
Willoughby, Lake County, OH



	Boring	Depth (ft)	LL	PL	PI	Fines	Classification (*Visual)
●	**B-1**	**4.3**	**45**	**21**	**24**	**86.3**	**Lean CLAY (CL)**
⊠	**B-4**	**1.8**	**41**	**20**	**21**	**83.0**	**Lean CLAY with Sand (CL)**

intertek psi
Professional Service Industries, Inc.
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Fax: (216) 642-7008

ATTERBERG LIMIT RESULTS

PSI Job No.: 0142-2816
Project: Proposed Terminal Building
Location: 1969 Lost Nation Road
Willoughby, Lake County, OH

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
BS: Bulk Sample
PM: Pressuremeter
CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
N_{60}: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
Q_u: Unconfined compressive strength, TSF
Q_p: Pocket penetrometer value, unconfined compressive strength, TSF
w%: Moisture/water content, %
LL: Liquid Limit, %
PL: Plastic Limit, %
PI: Plasticity Index = (LL-PL),%
DD: Dry unit weight, pcf
▼,▽,▼: Apparent groundwater level at time noted

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	N - Blows/foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50 - 80
Extremely Dense	80+

ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
Angular:	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular:	Particles are similar to angular description, but have rounded edges
Subrounded:	Particles have nearly plane sides, but have well-rounded corners and edges
Rounded:	Particles have smoothly curved sides and no edges

GRAIN-SIZE TERMINOLOGY

Component	Size Range
Boulders:	Over 300 mm (>12 in.)
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to ¾ in.)
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.40)
Silt:	0.002 mm to 0.075 mm
Clay:	<0.002mm to <0.005 mm depending on agency

PARTICLE SHAPE

Description	Criteria
Flat:	Particles with width/thickness ratio > 3
Elongated:	Particles with length/width ratio > 3
Flat & Elongated:	Particles meet criteria for both flat and elongated

RELATIVE PROPORTIONS OF FINES

Descriptive Term	% Dry Weight
Trace:	< 5%
With:	5% to 12%
Modifier:	>12%

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GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

Q_U - TSF	N - Blows/foot	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

MOISTURE CONDITION DESCRIPTION

Description	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term	% Dry Weight
Trace:	< 15%
With:	15% to 30%
Modifier:	>30%

STRUCTURE DESCRIPTION

Description	Criteria
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided:	Fracture planes appear polished or glossy, sometimes striated

Description	Criteria
Blocky:	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed:	Inclusion of small pockets of different soils
Layer:	Inclusion greater than 3 inches thick (75 mm)
Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample
Parting:	Inclusion less than 1/8-inch (3 mm) thick

SCALE OF RELATIVE ROCK HARDNESS

Q_U - TSF	Consistency
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

ROCK BEDDING THICKNESSES

Description	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

Voids	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

Component	Size Range
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

ROCK QUALITY DESCRIPTION

Rock Mass Description	RQD Value
Excellent	90 -100
Good	75 - 90
Fair	50 - 75
Poor	25 -50
Very Poor	Less than 25

DEGREE OF WEATHERING

Slightly Weathered:	Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered:	Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
Highly Weathered:	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

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