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Report of Geotechnical Exploration

Security Main Gate Project
NASA Plum Brook Station
Scheid Road, Sandusky, Ohio

TesTech file number: 27436

Prepared for:

Emersion Design, LLC
1776 Mentor Avenue, M.L. 216
Cincinnati, Ohio 45212
1-28-11

Geotechnical Engineering
Materials Testing/Inspection

TESTECH

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January 28, 2011

Mr. Robert L. Knight, AIA, LEED AP
Emersion Design, LLC
1776 Mentor Avenue, M.L. 216
Cincinnati, Ohio 45212

Re: Report of Geotechnical Exploration for the Proposed Security Main Gate Project on Scheid Road, NASA Plum Brook Station, Sandusky, Ohio

TesTech File Number: 27436

Dear Mr. Knight:

TesTech, Inc. is pleased to submit the findings of the geotechnical exploration services conducted for the proposed Security Main Gate Project on Scheid Road at NASA Plum Brook Station in Sandusky, Ohio. We are pleased to transmit herewith two (2) copies of our report.

The purpose of the subsurface investigation was to explore the subsurface conditions at the project site and to evaluate the subsurface materials in supporting the proposed design and construction of an approximately 4,188 square foot (sf) security building and inspection canopy structures with associated parking, drive and roadway pavement. Building load conditions, at the present time, of 5 to 15 kips for column loads and 0.5 to 1.4 kips for wall loads, have been considered in the recommendations. Pavement load conditions (Equivalent 18 kips Single Axle Loads - ESALs) have been assumed for the project of 50,000 for standard duty and 300,000 for heavy duty and have been considered in the recommendations.

This report presents the project site description, field and laboratory testing procedures, subsoil conditions at the boring locations, laboratory test results and soil boring logs. Recommendations with respect to appropriate foundation type(s), soil bearing capacity, settlement analysis, pavement section design, material compaction requirements, groundwater conditions and dewatering methods, infiltration rates and general site development are presented in this report.

Assessment of site environmental conditions, including the detection of pollutants in the soil or groundwater, and delineation of jurisdictional wetlands were beyond the scope of this exploration. However, had any contaminated soils been encountered or any peculiar odors detected, the client would have been notified immediately.

Site Description

The project site is presently an undeveloped agricultural field and an existing roadway at the fenced perimeter of the Plum Brook Station facility. The project site is bounded by agricultural land to the north and south, US 250 to the east and NASA Plum Brook Station to the west. The project site has relatively flat topography and drains along the existing roadway. The proposed building and respective canopies will be constructed on and north of the existing roadway.

Field Investigations

The geotechnical field exploration was conducted by **TesTech** on January 17, 18 and 19, 2011. The subsurface investigation consisted of the drilling of fifteen (15) total soil borings and four (4) test borings. Five (5) of the borings, designated as B-1 through B-4 and B-15, located within the proposed security building were drilled to a maximum termination depth of 20.0 feet below the existing ground surface. The ten (10) soil borings in the area of the proposed parking, drive and roadway pavements, designated as B-5 through B-14, were drilled to a maximum termination depth of 10.0 feet below the existing ground surface. The four (4) test borings were drilled to a maximum termination depth of 4.0 feet below the existing ground surface and field percolation tests performed.

Locations for all soil borings were assigned by **TesTech** and the client and staked on-site by the project civil engineer. The boring locations as staked in the field are shown in the attached Boring Location Plan.

The borings were drilled utilizing hollow stem augers powered by a truck mounted drill rig at the boring locations. Standard Penetration Testing (SPT), utilizing a split spoon sampler, was conducted at 2.5-foot intervals to 10 feet and at 5.0-foot intervals thereafter. The samples were sealed in jars to prevent moisture loss, labeled and transported to the **TesTech** Laboratory for visual classification by the Geotechnical Engineer and laboratory testing.

The groundwater conditions were monitored during drilling, immediately and 24 hours upon completion of drilling and removal of augers. The holes were backfilled with cuttings after the final groundwater readings were obtained. The individual groundwater levels are recorded in the boring logs attached to the report.

Subsurface Conditions

The subsurface conditions encountered at the boring locations consisted of 12.0 to 14.0 inches of topsoil and pavement sections consisting of 5.0 to 6.0 inches of asphalt and 6.0 to 8.0 inches of gravel base. The topsoil was underlain by native clay and sand soils while the pavement was underlain by clay fill soils which were underlain by native clay and sand soils.

Clay fill soils were encountered beneath the pavement sections in seven (7) of the fifteen (15) borings to approximate depths of 2.0 to 3.0 feet below the existing ground surface. SPT blow counts (N values) in the clay fills ranged from 7 to 20 blows per foot (bpf) indicating a medium stiff to very stiff consistency. Moisture content in the clay fills varied from 17.7 to 20.6 percent. The clay fill soils were classified as CL under the Unified Soil Classification System (USCS).

Beneath the topsoil and clay fill soils, native silty sand and clayey sand soils were encountered in seven (7) of the fifteen (15) soil borings to depths between 1.0 to 5.5 feet below the existing ground surface. SPT N values in the sands ranged from 2 to 20 bpf corresponding to a very loose to medium dense condition. Moisture content in the sands varied from 20.3 to 29.7 percent. The sand soils were classified as SM and SC under the USCS.

Beneath the topsoil, clay fills and sand soils, native clay soils were encountered in all of the soil borings to depths between 1.0 to 16.0 feet below the existing ground surface. SPT N values in the clays ranged from 5 to 33 bpf indicating a soft to hard consistency. Moisture content in the clays varied from 10.7 to 27.0 percent. The clay soils were classified as CL and CL-ML under the USCS.

Beneath the native clay soils, weathered shale was encountered in five (5) of the fifteen (15) soil borings to depths between 15.0 to 19.0 feet below the existing ground surface. Weathered limestone bedrock was also encountered in the same soil borings at depths between 17.5 to 20.0 feet below the existing ground surface, the maximum boring termination depth.

Generalized descriptions of the subsurface conditions encountered at the project site are given above. More detailed descriptions are given in the attached individual boring logs. It should be noted that the stratification lines shown on the soil boring logs do not represent exact geological planes but approximate transitions between soil types. In-situ stratum changes could occur gradually, abruptly, or at slightly different depths.

Groundwater was encountered and/or measured in seven (7) of the fifteen (15) soil borings during drilling, immediately after and 24 hours upon completion of the drilling operations and removal of the augers. Groundwater was encountered at depths between 2.6 to 9.5 feet below the existing ground surface. The groundwater conditions observed, or lack thereof, reflect the conditions at the time of our exploration only. Fluctuations of the groundwater table should be expected to occur both seasonally and annually due to variations in rainfall, evaporation, transpiration, construction activities, and other site-specific factors. Contractors should be prepared to control surface and groundwater during construction.

Five (5) field DCP tests were also performed on the subgrade soil beneath the existing roadway pavement section. The tests were performed a random locations selected by the geotechnical engineer and the data was used to calculate field or in place CBR values for the subgrade soils. The results of the field DCP tests are provided in Table 1.

Table 1 DCP Test Results

Location	DCP Blows for 5.25"	DCP Index (mm/blow)	Field CBR
B-09	46	14	**15**
B-10	37	18	**11**
B-12	29	23	**9**
B-13	30	22	**9**
B-14	33	20	**10**
Average Field CBR from DCP Tests = 10.8			

Note: Standard DCP uses a 15-pound hammer falling 20 inches.

Laboratory Investigations

Forty-one (41) moisture content tests per ASTM D 2216, seven (7) Atterberg Limits tests per ASTM D 4318, and five (5) sieve analysis test per ASTM D 422 & ASTM D 1140 were conducted on selected representative split spoon samples. The test results are provided in the attachments. The following tables list the Atterberg Limits and sieve analysis test results.

Table 2 Atterberg Limits Test Results

Boring No.	Sample Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
B-05	6.0 – 7.5	28	17	11
B-02	3.5 – 5.0	*NV	*NP	*NP
B-04	3.5 – 5.0	22	16	6
B-06	6.0 – 7.5	31	18	13
B-07	3.5 – 5.0	35	18	17
B-12	3.5 – 5.0	22	15	7
B-05, B-06, B-07, B-12 (bulk sample)	1.0 – 5.0	28	14	14

*NV = No Value and NP = Non-Plastic

Table 3 Sieve Analysis Test Results

Boring No.	Sample Depth (ft)	% Gravel	% Sand	% Silt	% Clay	USCS
B-02	3.5 – 5.0	1.1	53.9	38.3	6.7	SM
B-04	3.5 – 5.0	0.2	34.8	42.5	22.5	CL-ML
B-06	1.0 – 2.5	0.5	68.3	16.6	14.6	SM
B-15	3.5 – 5.0	2.4	47.2	22.1	28.3	CL-ML
B-05, B-06, B-07, B-12 (bulk sample)	1.0 – 5.0	0.4	37.9	29.3	32.4	CL

Two (2) bag samples of subgrade materials were obtained from near surface soils at the locations of borings B-5, B-6, B-7 and B-12. The bag samples were combined to form one bulk sample which was tested for Standard Proctor and soaked California Bearing Ratio (CBR) tests. The test results for the Standard Proctor and CBR tests are listed in Table 4.

It should be noted that the CBR value listed in Table 4 is the interpolated value at 98 percent compaction of the maximum dry density per the Standard Proctor test (ASTM D-698). It is imperative that the on-site construction follows the compaction criteria required in this report in order for the pavement subgrade to achieve enough strength and support for traffic loading.

Table 4 Standard Proctor and CBR Test Results

Sample No.	Depth (ft)	Soil Description	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	CBR (%)
B-5, B-6, B-7, B-12 (bulk sample)	2.0 – 5.0	Sandy Lean Clay	114.0	14.3	3.6

Engineering Recommendations

Based on the interpretation of the standard penetration resistance tests, analysis of the laboratory test results, available information provided by the client, and our engineering evaluation of the subsurface conditions, it is our opinion that the site is suitable for the development of the proposed storage building and drives. It is also our professional opinion that shallow foundation systems consisting of conventional spread and continuous wall footings can be designed for the proposed building to bear on the in situ soils and/or compacted engineered fill.

Provided the recommendations presented herein are incorporated into the design and construction of the foundations, **a net allowable bearing pressure of 2,000 pounds per square foot** (psf) can be used in designing continuous wall and conventional spread footings bearing on the in-situ soils and/or compacted engineered fill with a bearing elevation of 642.00 or above. Should a bearing elevation below the 642.00 elevation be incorporated into the foundation design, **a net allowable bearing pressure of 2,500 psf** can be used in designing continuous wall and conventional spread footings.

In case of building loads allowing for smaller footing sizes, it is recommended that continuous and column footings still be designed with minimum widths of 18 inches and 36 inches, respectively, for the building. These minimum widths are recommended to provide a margin of safety against a local shear or punching shear failure.

We recommend that all wet, loose, soft and organic soils should be undercut from the foundation areas and replaced with suitable compacted engineered fills or lean concrete. **It is important that the soil for footing support be examined to confirm that the net allowable bearing capacity of the soil meets or exceeds the recommended design allowable bearing capacity.**

Exterior footings should bear at a minimum depth of 42 inches below the existing grade or the

local frost depth; whichever is deeper, below finished grade to reduce the potential for frost heave.

Maximum total and differential settlements are expected to be on the order of 1-inch and ½-inch, respectively, if the recommended site preparation and foundation systems are used.

Slab-on-grade for the proposed building should be constructed on a 6-inch mat of granular material such as ODOT 304 crushed aggregate, placed over the in-situ soils and/or compacted engineered fill for uniform support and lateral drainage. A subgrade modulus of 130 pounds per cubic inch (pci) is recommended for the structural design. Adequate construction joints should be provided to accommodate minimal differential movements.

It is recommended that the Geotechnical Engineer is retained to observe the site preparation process and document the foundation excavations as well as check compaction of the foundation subgrade and backfill. Significant deviations from the specified or anticipated conditions should be reported to the owner's representative and to the foundation designer.

Pavement Recommendations

New Pavements

Recommended flexible pavement sections on the following page were based on a subgrade consisting of the existing soils with an average laboratory CBR value of 3.6. Recommended rigid pavement sections were designed based on an effective modulus of subgrade reaction value of 120 pci for a minimum 8.0-inch subbase after considering the loss of support.

It is recommended that the concrete used in the rigid pavement section have a Modulus of Rupture of 600 psi (4,000 psi strength). Maximum joint spacing of thirty times the thickness of the concrete section is recommended as per ACI. All joints, including saw cut joints and expansion or construction joints should be cleaned and sealed.

AASHTO design guidelines for local road design, Asphalt Pavement Design and Construction Guide by Flexible Pavement of Ohio, Iowa Asphalt Paving Design Guide by the Asphalt Paving Association of Iowa pavement design manuals and the Ohio Department of Transportation pavement design manuals were used to assist in the design. The following pavement sections for the parking drive areas are recommended based on a design life cycle of 20 years, a terminal serviceability of 2.0, a reliability of 85%, a initial serviceability of 4.2, a standard deviation of 0.45 for flexible pavement and 0.39 for rigid pavement, a laboratory CBR value of 3.6 for subgrade soils and minimum design Equivalent 18 kips Single Axle Loads (ESALs) of 50,000 for standard duty and 300,000 for heavy duty, based upon our previous experiences with similar projects.

It should be mentioned that if the actual traffic loading condition (ESALs) for the drive areas is greater than above noted ESALs, the Geotechnical Engineer should be notified for the redesign of the provided pavement sections below.

Prime coat will be required if the aggregate subbase material (ODOT 304) is exposed to adverse weather and construction traffic for more than 48 hours.

Flexible Pavement Section (Standard-Duty):

1.0-inch	Surface Course (ODOT 448, Type I, PG64-22)
2.5-inch	Intermediate Course (ODOT 448, Type II, PG64-22)
8.0-inch	Aggregate Base (ODOT 304)

Flexible Pavement Section (Heavy-Duty):

1.0-inch	Surface Course (ODOT 448, Type I, PG64-22)
2.0-inch	Intermediate Course (ODOT 448, Type II, PG64-22)
2.5-inch	Base Course (ODOT 301)
8.0-inch	Aggregate Base (ODOT 304)

Rigid Pavement Section:

6.0-inch Concrete (ODOT 452)
8.0-inch Aggregate Base (ODOT 304)

It should be noted that if a different borrow material is used for the pavement subgrade or modification of the existing material be preformed, the soil modification mix design should be based on obtaining a minimum subgrade soil strength. A CBR test should be performed on the new or modified material. It is the contractor's responsibility to test the CBR value and/or provide a soil modification mix design for the materials chosen for use. Should a different borrow material or soil modifications be used for the pavement subgrade, a minimum CBR of 6.0 is recommended for the new/modified material. The design of the pavement sections for materials with a minimum CBR of 6.0 are as follows.

Flexible Pavement Section (Standard-Duty):

1.0-inch	Surface Course (ODOT 448, Type I, PG64-22)
1.5-inch	Intermediate Course (ODOT 448, Type II, PG64-22)
8.0-inch	Aggregate Base (ODOT 304)

Flexible Pavement Section (Heavy-Duty):

1.0-inch	Surface Course (ODOT 448, Type I, PG64-22)
3.0-inch	Intermediate Course (ODOT 448, Type II, PG64-22)
8.0-inch	Aggregate Base (ODOT 304)

Rigid Pavement Section:

5.0-inch Concrete (ODOT 452)
8.0-inch Aggregate Base (ODOT 304)

It should be noted that the proposed pavement sections are based on subsoil conditions encountered during this exploration and assumed traffic loads as previously described. As mentioned previously, if any changes in these design conditions are made, the Geotechnical Engineer should be notified for revision to the recommended pavement sections accordingly.

Existing Pavements and Overlays

Based on our engineering evaluation, interpretation of the standard penetration resistance tests, analysis of the laboratory results, interpretation of the field DCP tests, and our experiences with similar projects, we recommend a CBR value of 6.0 from the field DCP tests at 98% of the maximum dry density per the Standard Proctor test (ASTM D-698) for existing pavement and overlay design.

It is recommended that a minimum of 1.0 inch of asphalt overlay for the existing pavement areas be applied. Prior to the overlay, we recommend that the existing asphalt pavement be milled to a minimum depth of 1.0 inch with a milling machine or as required to achieve positive drainage, as well as match the proposed and/or existing grades with the asphalt overlay.

Longitudinal and transverse cracking of greater than ¼ inch wide should be cleaned with hot air wand and sealed at least 1 inch in depth before placing the overlay. All alligator cracking that has an apparent network or pattern with or without spall should be removed and replaced with new asphaltic concrete. All depressions should be filled with a leveling course prior to the final overlay. We recommend that all these repairs should be performed prior to the final asphalt overlay. Details of the overlay pavement section are as follows.

Existing Pavement Overlay Section:

1.0-in. Surface Course (ODOT 448, Type 1, PG64-22)
Asphalt Cement Tack Coat
Existing Milled Asphalt Pavement - 1.0-in. minimum

The application rate of the tack coat is 0.25 gal/yd^2. It should be noted that the proper installation of the asphalt cement tack coat is crucial to the life of the overlay.

All pavement and adjacent areas should be designed to slope away from the construction area to prevent ponding of water. For pavement drainage, a minimum transverse slope of 2.0% for the pavement surface should be applied each way from the centerline. Adequate side drains and subsurface drainage system should be suitably designed to prevent subgrade saturation.

Seismic Recommendations

In general, Ohio lies on the periphery of the New Madrid Seismic Zone, which includes Ohio and adjacent states. Earthquakes originating in Ohio are believed to be shallow-focus events and result from ancient, buried zones of weakness in the Earth's crust. Faults within these zones do not typically reach the surface, which limits the ability to map the zones or more accurately predict a potential for earthquake.

According to Uniform Building Code (UBC) Chapter 16, Figure 16-2, the proposed site appears to be located in seismic zone 1. Based on the average Standard Penetration Test blow counts per foot - N value of approximately 30 from the deepest boring (20 feet) and the site soil profile analysis, the soil profile type is assigned as S_D according to Uniform Building Code. Accordingly, the site is classified as Site Class 'D' by International Building Code 2006.

Due to the shallow bedrock and stiff soil profile, we do not anticipate the project site to have any potential for liquefaction during an earthquake event.

Infiltration Recommendations

Due to the low permeability rates for the silty and sandy clay and clayey sand soils the field permeability tests were extended from one hour to two hour durations. The permeability testing was performed at a depth of 4 feet below existing grade at the four TB- test bore locations. It is our understanding that the proposed infiltration basins are needed for water quantity and quality control.

Based on the field observations, the intended use of the infiltration basins, the groundwater table elevation, the soil characteristics of the Plumbrook fine sandy loam and the field percolation rates; it is our opinion that the project site is not suitable for the proposed infiltration basins. The soils may be used for the proposed infiltration basins if the required stormwater volume can infiltrate within the require time frame using the infiltration rates indicated within this report. The infiltration rates based on the results of the field permeability tests are summarized for the average water drops at 6-minute intervals for each test bore in the following table.

Table 5 Percolation and Infiltration Rates

Test Hole Number	Soil Type Encountered	Avg. 6-minute Drop in Water Level (in)	Percolation Rate (min/in)	**Infiltration Rate (in/hr)**
TB-1	Sandy Clay (CL)	0.013	450.00	**0.13**
TB-2	Sandy Clay (CL)	0.043	141.03	**0.43**
TB-3	Sandy Clay (CL)	0.017	357.14	**0.17**
TB-4	Clayey Sandy (SC)	0.080	74.63	**0.80**

Drainage

All pavements should be sloped adequately and away from the proposed building to prevent ponding of water. The site drainage should be such that the run-off onto adjacent property is controlled properly. In addition, surface runoff from adjacent areas should not be allowed to enter the construction site. Water should never be allowed to stand on or around the foundations prior to backfill.

It should be emphasized that suitable drainage is critical to maintaining good foundation and pavement conditions. Catch basins with finger drains are recommended for the new pavement areas in addition to edge drains and/or subdrains especially if adjacent areas are at higher elevations or heavily irrigated.

Earthwork Recommendations

Typically, late spring to early fall is the time frame when weather conditions are most favorable for earthwork in the project area. Earthwork activities undertaken during the wetter portions of the year typically encounter substantial difficulties associated with snow and rain.

Positive surface drainage should be maintained to prevent the accumulation of water at all times. The stripping and excavation operations should be performed in a manner consistent with good erosion and sediment control practice. If the exposed subgrade becomes excessively wet or frozen, or if conditions are encountered different from those described previously in this report, the Geotechnical Engineer should be contacted.

Once the topsoil, unsuitable fills (non-engineered fills, soft fills, fills containing deleterious materials and organic matter not meeting the bearing capacity requirements as specified herein), abandoned structures or utilities, soft, loose and wet soils are removed, the exposed subgrade should then be proof-rolled. Proof-rolling should be done to determine if any wet or soft zones or unsuitable soils/fill are present and to ensure a suitable base for the placement of possible additional fill. The proof-rolling should be performed after a suitable period of dry weather to avoid degrading an otherwise acceptable subgrade. For clay soils, the proof-rolling test should be conducted with a fully loaded tandem-axle dump truck of at least 30-ton weight with a tire inflation pressure of 120 psi passing over the subgrade area. For sand soils, the proof-rolling test should be conducted with at least a 50-ton roller with a tire inflation pressure of 150 psi. The proof-rolling test results are acceptable for a maximum period of 48 hours or the next precipitation event, whichever comes first.

Organic, soft, loose and wet soils/fill should be removed (undercut), modified, and re-compacted or replaced with compacted engineered fill. Modification may include scarifying the subgrade to aerate the soft, loose or wet soils/fill and/or the addition of lime and cement. Field conditions will dictate the method used in modifying soft, loose and wet subgrade soils. The depth of any undercut should be determined in the field by the Geotechnical Engineer or construction inspector during proof-rolling operations.

In the proposed areas of construction, the exposed soils/fill should be compared with those encountered in the soil test borings. The soils and fill materials beneath the foundation excavations should be tested with a Dynamic Cone Penetrometer (DCP), hand auger and pocket penetrometer to a minimum depth of three (3) feet. This test is necessary to discover if compressible soils or unsuitable fills are present underneath the foundation elevations. All soft, loose and wet soils or otherwise unsuitable fill materials must be removed (undercut) from the foundation areas and replaced with compacted engineered fill, approved cohesive materials or lean concrete with design strength of 1,500 psi at 28 days.

The depth of any undercut should be determined in the field by the Geotechnical Engineer. The foundation bearing areas should be nearly level with a maximum slope of less than 10 degrees. Foundation concrete should be placed the same day or as soon as practicable after excavation, compaction and inspection. The Geotechnical Engineer should be consulted for the detailed recommendations pertaining to site conditions.

All structural areas should be stripped and cleared of topsoil. The limits of the surface preparation should be the footprint of the building plus no less than 10 feet beyond the edges of the footprint. Deleterious materials from the clearing operations should be removed from the site and disposed of at a legal dumpsite. The topsoil can be stockpiled and re-used in landscaped areas.

All structures, utilities, leachate facilities, etc. within the proposed building footprint should be completely removed and the resulting excavations backfilled with compacted engineered fill. Where necessary, pipes may be left in place and grouted.

The pavement subgrade should be suitably compacted to at least 98% of ASTM D 698 (Standard Proctor). Soft, loose, wet and deleterious materials should be undercut and replaced with engineered fill. Existing utilities within 3 feet below the proposed subgrade should be removed and replaced with compacted engineered fill within the pavement area.

All engineered fills should be compacted to at least 98% of the maximum dry density determined by Standard Proctor test ASTM D-698. The moisture content of the fill materials should be controlled within ±3% percent of the optimum moisture content per the Standard Proctor Test. The fill materials should be placed in no more than 8 inches horizontal loose lifts. A maximum loose lift thickness of 4 inches should be used when working in confined areas using hand-operated equipment.

Groundwater Considerations

Based on the site exploration results as observed at the time of our drilling operations, groundwater may pose construction problems for shallow or deep excavations. It is the contractor's responsibility to dewater the site for foundations and any other excavations involved during construction. A sump and pump system is recommended for site dewatering of shallow foundation excavations. A well-point system may be required for deep excavations.

Dewatering should be performed in a manner that will not disturb or loosen the subgrade soils. Sumping should not be conducted in foundation subgrade areas. Runoff water entering the excavations should be intercepted outside of the subgrade areas. If water intrusion or exposure softens the bearing soils, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of the concrete.

Excavations Safety

Excavations deeper than 4 feet should have stairways, ladders or ramps as safe means of egress from the trench and sides of excavations deeper than 5 feet should be either sloped back for safety, or a sheeting and bracing system should be used. All excavations should comply with the requirements of OSHA 29 CFR, Part 1926 Sub Part P, "Excavations and Trenches". This document states that safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the project specifications.

Limitations of Liability

Conclusions and recommendations presented in this report are based upon the available soil information, currently accepted engineering principles, and available information provided by Emersion Design, Advanced Engineering Consultants, Barge Waggoner Sumner & Cannon, Inc. and NASA. **TesTech** should be notified of any revisions to the scope of this project so that these revisions may be evaluated against the subsurface conditions. Should it be necessary to revise the recommendations outlined in this report, **TesTech** will submit a written report to address any necessary changes to the foundation, pavement and earthwork recommendations. No other warranties, expressed or implied, are made.

The soils and bedrock encountered in the borings varied between boring locations. Other discontinuities in soil and rock type and geology may exist, including abrupt strata changes and soil and rock strength variations. The extent of these variations may not be fully determined from the borings or site reconnaissance. Additional variations may not become apparent until mass excavation commences. It is recommended that the owner retains the services of **TesTech** to observe the construction of foundations and verify the bearing capacity of the soils encountered during foundation construction, as well as monitor the placement of fills and backfill. If not retained to perform these services, **TesTech Inc.** cannot be held responsible for the impact that any differing conditions may have on the performance of the project.

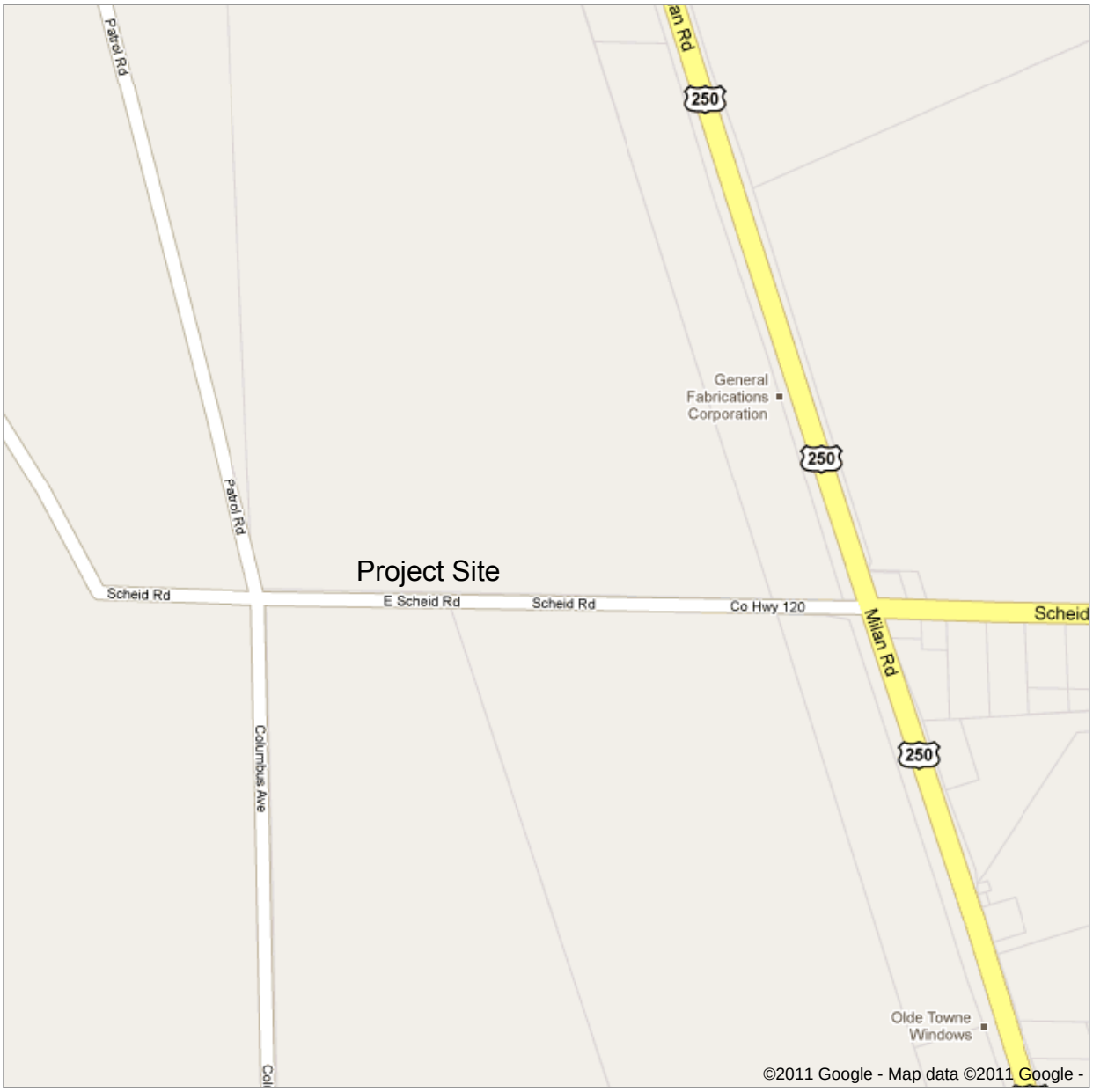
We appreciate the opportunity to offer these services. If you have any questions regarding this report or if we may be of further assistance to you, please contact our office at 937-435-3200.

Respectfully yours,
TesTech, Inc.

Jonathan J. Pickering, P.E.
Senior Geotechnical Engineer

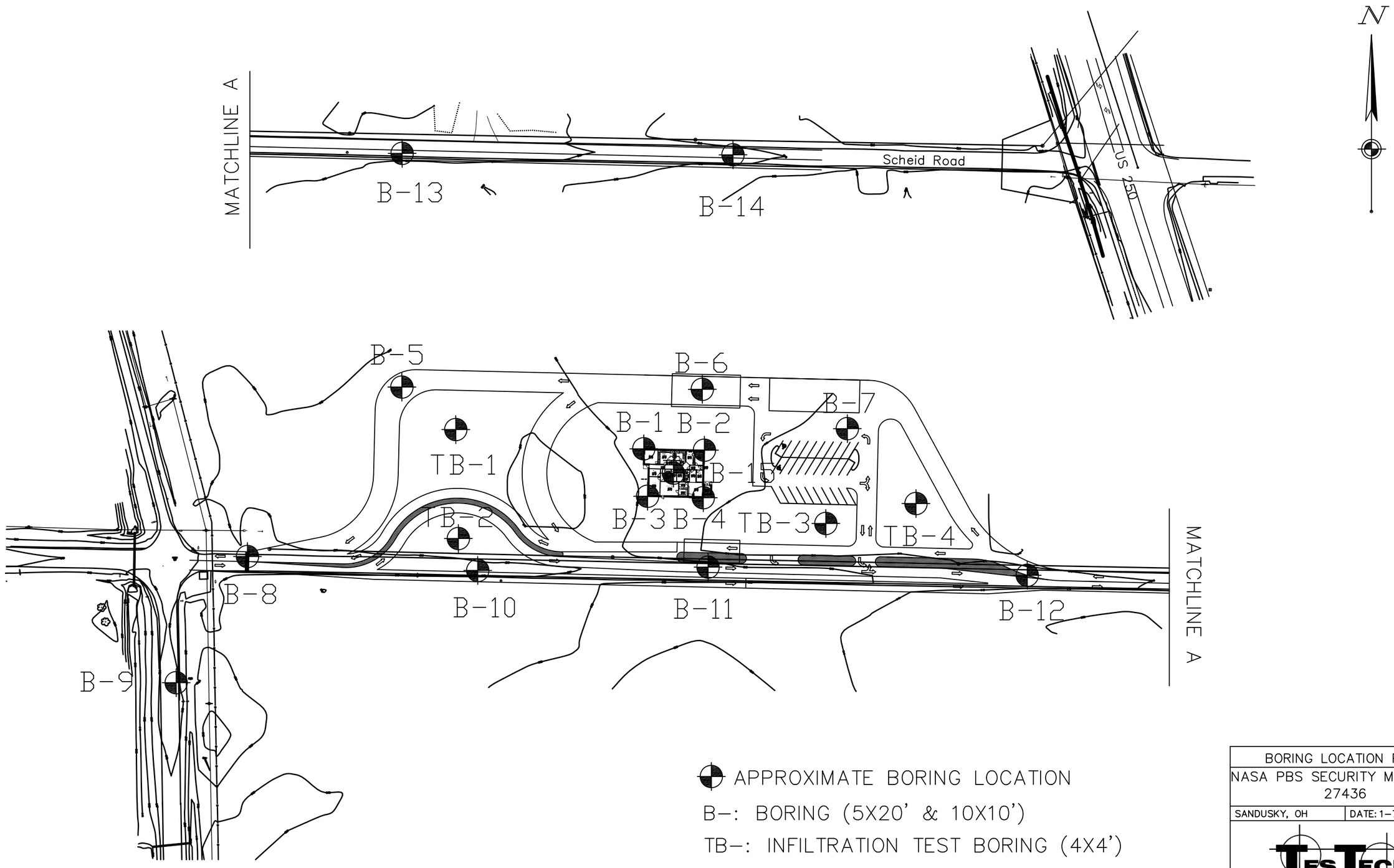
Attachments

Site Location Map
Boring Location Plan
Boring Log Legend
Logs of Test Borings
Laboratory Test Results
Unified Soil Classification System
Perimeter Drain Detail



SITE LOCATION MAP

NASA Plum Brook Station



APPROXIMATE BORING LOCATION

B-: BORING (5X20' & 10X10')

TB-: INFILTRATION TEST BORING (4X4')

TOTAL: 15 BORINGS FOR 200 TOTAL FEET &
4 TEST BORINGS FOR 16 TOTAL FEET

BORING LOCATION PLAN	
NASA PBS SECURITY MAIN GATE 27436	
SANDUSKY, OH	DATE: 1-7-11

TesTech, INC.

BORING LOG LEGEND AND BORING LOGS

- ASPHALT
- BEDROCK
- BOULDERS AND COBBLES
- BRECCIA
- HIGH PLASTIC CLAY
- LOW PLASTIC CLAY
- CHALK
- CONCRETE
- CORAL
- FILL
- LOW TO HIGH PLASTICITY CLAY
- LOW PLASTICITY SILTY CLAY
- LOW PLASTICITY GRAVELY CLAY
- LOW PLASTICITY SANDY CLAY
- COAL
- CLAYEY GRAVEL
- SILTY GRAVEL
- POORLY-GRADED GRAVEL
- GYPSUM
- LIMESTONE
- PLASTIC SILT
- SILT
- GRAVELY SILT
- SANDY SILT
- HIGH PLASTICITY ORGANIC SILT OR CLAY
- LOW PLASTICITY ORGANIC SILT OR CLAY
- PEAT
- SANDSTONE
- CLAYEY SAND
- POORLY-GRADED GRAVEL WITH SILT
- POORLY-GRADED SANDY GRAVEL
- WELL-GRADED GRAVEL
- WELL-GRADED GRAVEL WITH CLAY
- WELL-GRADED GRAVEL WITH SILT
- WELL-GRADED SANDY GRAVEL
- SHALE
- SILT STONE
- SILTY SAND
- POORLY-GRADED SAND
- POORLY-GRADED SAND WITH CLAY
- POORLY-GRADED SAND WITH SILT
- POORLY-GRADED GRAVELY SAND
- WELL-GRADED SAND
- WELL-GRADED SAND WITH CLAY
- WELL- GRADED SAND WITH SILT
- WELL-GRADED GRAVELY SAND
- GLACIAL TILL
- TOPSOIL
- BASALT
- POORLY-GRADED GRAVEL WITH CLAY

BORING LOG LEGEND

TESTECH
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LOG OF TEST BORING

BORING NO.: B-01 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: HSA RIG TYPE:

DATE STARTED: 1-18-11 COMPLETED: 1-18-11
TEMPERATURE/WEATHER: Cloudy
STATION: OFFSET:
ELEVATION: 646.0 LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL							
645.0	1	1.5		Medium Stiff Brown SANDY CLAY, moist (CL)	1	SS	1 2.5	3-4-5	9	21.5	1.75
643.5	2, 3, 4, 5	3.5		Medium Stiff Brown SANDY CLAY, trace gravel, moist (CL)	2	SS	3.5 5	3-3-4	7		3.0
640.0	6, 7, 8, 9, 10, 11, 12	6.5		Stiff Gray CLAY, moist (CL)	3	SS	6 7.5	6-6-7	13	21.6	2.75
					4	SS	8.5 10	5-8-8	16	21.7	
633.5	13, 14, 15	3.5		Very Stiff Gray SILTY CLAY, trace gravel, few sand, moist (CL-ML)	5	SS	13.5 15	8-9-13	22		4.5
630.0	16, 17, 18	2.5		Weathered SHALE							
627.5	19	1.5		Weathered LIMESTONE BEDROCK	6	SS	18.5 18.58	50/ 1"	>50		
626.0	20, 21			Boring Terminated at 20.0 feet							

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/18/11	11:20	8.5			8 ▽
1/18/11	11:30	18.5	15		8 ▼
					▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: B-02 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: HSA RIG TYPE:

DATE STARTED: 1-18-11 COMPLETED: 1-18-11
TEMPERATURE/WEATHER: Cloudy
STATION: OFFSET:
ELEVATION: 645.5 LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL							
644.5	1			Medium Stiff Brown Sandy CLAY, moist (CL)	1	SS	1 2.5	3-3-4	7	21.5	1.5
	2	2.0									
642.5	3			Medium Dense Brown SILTY SAND, moist (SM)	2	SS	3.5 5	3-5-6	11	25	
	4	2.5									
	5										
640.0	6			Medium Dense Gray SILTY SAND, moist (SM) ▼	3	SS	6 7.5	7-9-11	20		
	7	2.5									
637.5	8			Stiff Gray SILT, few sand, moist (ML)	4	SS	8.5 10	4-6-8	14	20.3	3.0
	9										
	10	4.0									
	11										
633.5	12			Hard Gray SILTY CLAY, trace sand, moist (CL-ML)							
	13										
	14	3.5			5	SS	13.5 15	5-13-20	33		2.0
	15										
630.0	16			Weathered SHALE							
	17	3.0									
	18										
627.0	19	1.5		Weathered LIMESTONE BEDROCK	6	SS	18.5 18.58	50/ 1"	>50		
625.5	20			Boring Terminated at 20.0 feet							
	21										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/18/11	9:00	18.5			NONE ▽
1/18/11	9:10	18.5	7		6 ▼
					▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: B-03 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: HSA RIG TYPE:

DATE STARTED: 1-18-11 COMPLETED: 1-18-11
TEMPERATURE/WEATHER: Cloudy
STATION: OFFSET:
ELEVATION: 646.0 LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL							
645.0	1			Loose Brown Clayey SAND, moist (SC)	1	SS	1 2.5	2-1-4	5		
	2										
	3	4.5			2	SS	3.5 5	1-3-7	10	29.7	
	4										
	5										
640.5				Stiff Gray SILTY CLAY, few sand, moist (CL-ML)							
	6				3	SS	6 7.5	5-5-7	12		3.25
	7	2.5		▼							
638.0	8			Stiff Gray SILTY CLAY, trace gravel, few sand, moist (CL-ML)							
	9				4	SS	8.5 10	3-5-7	12	21.8	3.0
	10	4.0		▽							
	11										
634.0	12			Very Stiff Gray SILTY CLAY, few sand, little gravel, moist (CL-ML)							
	13										
	14	3.0			5	SS	13.5 15	9-10-13	23	10.7	2.75
631.0	15			Weathered SHALE							
	16										
	17	4.0									
	18										
					6	SS	18.5 18.58	50/ 1"	>50		
627.0	19			Weathered LIMESTONE BEDROCK							
		1.0									
626.0	20			Boring Terminated at 20.0 feet							
	21										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/18/11	12:10	18.5			10 ▽
1/18/11	12:20	18.5	10		7 ▼
					▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: B-04 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: HSA RIG TYPE:

DATE STARTED: 1-17-11 COMPLETED: 1-17-11
TEMPERATURE/WEATHER: Cloudy
STATION: OFFSET:
ELEVATION: 645.3 LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL							
644.3	1	0.5		Loose Brown Clayey SAND, moist (SP)	1	SS	1 2.5	3-3-3	6	23.4	2.25
643.8	2	1.5		Medium Stiff Brown Sandy CLAY, moist (CL)							
642.3	3	1.5		Medium Stiff Brown SILTY CLAY, few sand, moist (CL-ML)	2	SS	3.5 5	2-3-4	7	25.4	2.5
640.8	4	1.0		Loose Brown Clayey SAND, moist (SP)							
639.8	5	10.0		Stiff Gray SILTY CLAY, few sand, moist (CL-ML)	3	SS	6 7.5	5-7-7	14	21.0	2.0
	6				4	SS	8.5 10	4-7-7	14		2.0
	7										
	8										
	9										
	10										
	11										
	12										
	13										
	14				5	SS	13.5 15	3-5-10	15		
	15										
629.8	16	2.5		Weathered SHALE							
	17										
627.3	18	2.0		Weathered LIMESTONE BEDROCK	6	SS	18.5 18.04	50/ 0"	>50		
	19										
625.3	20			Boring Terminated at 20.0 feet							
	21										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/17/11	16:55	18.5			6.5 ▽
1/17/11	17:05	18.5	14		9.5 ▼
					▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: B-05 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-17-11 COMPLETED: 1-17-11
TEMPERATURE/WEATHER: Cloudy, 28 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL (12")							
	1	0.5		Loose SILTY SAND, moist (SM)	1	SS	1 2.5	3-3-3	6	18.8	
	2	4.5		Medium Stiff Brown Sandy CLAY, moist (CL)	2	SS	3.5 5	2-2-4	6		
	6	1.5		Stiff Brown Sandy CLAY, moist (CL)	3	SS	6 7.5	7-5-7	12	24.2	3.25
	8	2.5		Very Stiff Gray SILTY CLAY, little gravel, moist (CL-ML)	4	SS	8.5 10	11-14-15	29	11.9	4.5
	10			Boring Terminated at 10.0 feet							

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/17/11	16:00	8.5			NONE ▽
1/17/11	16:10	8.5	7.0		6.0 ▼
1/18/11	16:00	8.5	7.0		3.6 ▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

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LOG OF TEST BORING

BORING NO.: B-06 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-18-11 COMPLETED: 1-18-11
TEMPERATURE/WEATHER: Cloudy, Rainy 37 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL (12")							
	1	3.0		Loose Brown SILTY SAND, moist (SM)	1	SS	1 2.5	2-2-3	5	21.2	
	4	0.5		Very Loose Brown SILTY SAND, little gravel, moist (SM)	2	SS	3.5 5	2-1-1	2	22.5	
	6	3.0		Medium Stiff Gray SILTY SAND, few sand & gravel, moist (CL-ML)	3	SS	6 7.5	2-3-3	6		1.0
	9	2.5		Stiff Gray SILTY CLAY, moist (CL-ML)	4	SS	8.5 10	4-6-8	14	23.4	3.25
	10			Boring Terminated at 10.0 feet							

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/18/11	12:30	8.5			NONE ▽
1/18/11	12:40	8.5	7.0		6.0 ▼
1/19/11	13:05	8.5	7.0		2.6 ▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: B-07 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-18-11 COMPLETED: 1-18-11
TEMPERATURE/WEATHER: Cloudy, Rainy 35 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.2		TOPSOIL (14")							
	1			Medium Stiff Brown CLAY, few sand, moist (CL)	1	SS	1 2.5	2-3-3	6	25.0	1.75
	2	2.3									
	3										
	4	1.5		Soft Brown SILTY CLAY, few sand, moist (CL-ML)	2	SS	3.5 5	2-2-3	5	22.3	
	5			Stiff Gray SILTY CLAY, trace sand, moist (CL-ML)							
	6				3	SS	6 7.5	5-7-6	13	22.6	2.25
	7	3.5									
	8										
	9	1.5		Very Stiff Gray SILTY CLAY, moist (CL-ML)	4	SS	8.5 10	6-7-10	17		2.50
	10			Boring Terminated at 10.0 feet							
	11										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/18/11	13:00	8.5			NONE ▽
1/18/11	13:10	8.5	6.0		5.0 ▼
1/19/11	13:15	8.5	6.0		3.0 ▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: B-08 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-19-11 COMPLETED: 1-19-11
TEMPERATURE/WEATHER: Snow, 22 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		0.4		ASPHALT (5")							
		0.7		GRAVEL BASE (8")							
	1	1.4		Medium Stiff Brown & Black Sandy CLAY FILL, moist (CL)	1	SS	1 2.5	3-3-4	7	19.4	
	2										
	3	2.5		Soft Brown Sandy CLAY, moist (CL)	2	SS	3.5 5	4-3-2	5		3.0
	4										
	5	2.5		Medium Stiff Brown & Gray SILTY CLAY, moist (CL-ML)	3	SS	6 7.5	3-2-5	7	25.1	
	6										
	7	2.5		Stiff Gray SILTY CLAY, moist (CL-ML)	4	SS	8.5 10	5-7-8	15		3.0
	8										
	9										
	10			Boring Terminated at 10.0 feet							
	11										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/19/11	10:55	8.5			NONE ▽
1/19/11	11:05	8.5	8.0		NONE ▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

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LOG OF TEST BORING

BORING NO.: B-09 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-19-11 COMPLETED: 1-19-11
TEMPERATURE/WEATHER: Snow, 20 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		0.5		ASPHALT (6")							
		0.7		GRAVEL BASE (8")							
	1	1.3		Very Stiff Brown CLAY FILL, moist (CL)	1	SS	1 2.5	7-10-10	20		
	2	2.5		Medium Stiff Silty Sandy CLAY, trace gravel, moist (CL)	2	SS	3.5 5	4-3-3	6	22.6	
	3										
	4										
	5	2.5		Stiff Brown CLAY, little sand, moist (CL)	3	SS	6 7.5	4-4-6	10	23.5	1.75
	6										
	7										
	8	2.5		Stiff Gray SILTY CLAY, trace gravel, moist (CL-ML)	4	SS	8.5 10	5-7-9	16	21.7	3.75
	9										
	10			Boring Terminated at 10.0 feet							
	11										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/19/11	11:40	8.5			NONE ▽
1/19/11	11:50	8.5	8.5		NONE ▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

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LOG OF TEST BORING

BORING NO.: B-10 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-19-11 COMPLETED: 1-19-11
TEMPERATURE/WEATHER: Cloudy, Snow 22 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		0.5		ASPHALT (6")							
		0.5		GRAVEL BASE (6")							
	1	2.0		Medium Stiff Brown & Dark Gray Sandy CLAY FILL, moist (CL)	1	SS	1 2.5	4-4-3	7	20.6	
	3	2.5		Medium Stiff Dark Gray SILTY CLAY, moist (CL-ML)	2	SS	3.5 5	3-3-3	6	23.2	
	6	2.0		Soft Brown SILTY CLAY, little sand, moist (CL-ML)	3	SS	6 7.5	3-2-3	5		
	8	2.5		Medium Stiff Gray SILTY CLAY, moist (CL-ML)	4	SS	8.5 10	4-4-5	9		
	10			Boring Terminated at 10.0 feet							
	11										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/19/11	10:30	8.5			NONE ▽
1/18/11	10:40	8.5	8.0		NONE ▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

TesTech, Inc
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PHONE: 937-435-3200 FAX: 937-291-6549

LOG OF TEST BORING

BORING NO.: B-11 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-19-11 COMPLETED: 1-19-11
TEMPERATURE/WEATHER: Cloudy, Snow 25 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		0.5		ASPHALT (6")							
		0.5		GRAVEL BASE (6")							
	1	1.5		Medium Stiff Dark Gray Sandy CLAY FILL, with gravel, moist (CL)	1	SS	1 2.5	5-4-4	8	17.7	
	2										
	3	2.5		Soft Brown & Gray Sandy CLAY, moist (CL)	2	SS	3.5 5	2-2-2	4		
	4										
	5	2.5		Soft Brown & Gray Sandy CLAY, few sand, moist (CL)	3	SS	6 7.5	2-2-3	5	24.9	
	6										
	7										
	8	2.5		Stiff Gray SILTY CLAY, with gravel, moist (CL-ML)	4	SS	8.5 10	3-5-7	12		
	9										
	10			Boring Terminated at 10.0 feet							
	11										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/19/11	9:30	8.5			NONE ▽
1/19/11	9:40	8.5	7.0		NONE ▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

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LOG OF TEST BORING

BORING NO.: B-12 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-19-11 COMPLETED: 1-19-11
TEMPERATURE/WEATHER: Cloudy, 25 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	SAMPLE TYPE REC	SAMPLE DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		0.5		ASPHALT (6")							
		0.6		GRAVEL BASE (7")							
	1	1.4		Medium Stiff Brown & Black Sandy CLAY FILL, moist (CL)	1	SS	1 2.5	6-5-4	9		
	2										
	3			Medium Dense Brown SILTY SAND, moist (SM)							
	4	3.5			2	SS	3.5 5	6-8-7	15	24.1	
	5										
	6			Medium Dense Brown & Gray SILTY SAND, moist (SM)	3	SS	6 7.5	6-8-12	20		
	7	1.5									
	8			Medium Stiff Gray SILTY CLAY, moist (CL-ML)							
	9	2.5			4	SS	8.5 10	2-3-5	8	23.2	1.75
	10			Boring Terminated at 10.0 feet							
	11										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/19/11	9:00	8.5			NONE ▽
1/19/11	9:10	8.5	4.0		NONE ▼
					▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: B-13 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-18-11 COMPLETED: 1-18-11
TEMPERATURE/WEATHER: Cloudy, 34 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		0.5		ASPHALT (6")							
		0.5		GRAVEL BASE (6")							
	1	1.0		Stiff Brown & Black Sandy CLAY FILL, moist (CL)	1	SS	1 2.5	6-5-6	11	18.5	
	2	3.0		Medium Stiff Brown & Gray CLAY, little sand, moist (CL-ML)	2	SS	3.5 5	3-3-3	6	24.4	1.5
	5	2.5		Stiff Brown & Gray SILTY CLAY, moist (CL-ML)	3	SS	6 7.5	6-8-8	16		3.0
	8	2.5		Stiff Gray SILTY CLAY, moist (CL-ML)	4	SS	8.5 10	4-5-5	10	27.0	
	10			Boring Terminated at 10.0 feet							
	11										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/18/11	17:30	8.5			NONE ▽
1/18/11	17:40	8.5	8.0		NONE ▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

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LOG OF TEST BORING

BORING NO.: B-14 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: 2.25 HSA RIG TYPE:

DATE STARTED: 1-18-11 COMPLETED: 1-18-11
TEMPERATURE/WEATHER: Cloudy, 36 Degrees
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		0.5		ASPHALT (6")							
		0.7		GRAVEL BASE (8")							
	1	1.3		Stiff Brown & Black Sandy CLAY FILL, moist (CL)	1	SS	1 2.5	6-6-5	11		
	2										
	3	3.0		Stiff Brown & Gray SILTY CLAY, trace gravel, moist (CL-ML)	2	SS	3.5 5	3-4-6	10	21.2	3.5
	4										
	5										
	6	2.0		Very Stiff Brown & Gray SILTY CLAY, little gravel, moist (CL-ML)	3	SS	6 7.5	10-12-16	28	17.4	4.25
	7										
	8	2.5		Very Stiff Gray SILTY CLAY, little gravel, moist (CL-ML)	4	SS	8.5 10	10-11-13	24		4.5
	9										
	10			Boring Terminated at 10.0 feet							
	11										

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/18/11	16:50	8.5			NONE ▽
1/18/11	17:00	8.5	8.0		NONE ▼
					▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: B-15 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP: CB MM
BORING METHOD: HSA RIG TYPE:

DATE STARTED: 1-18-11 COMPLETED: 1-18-11
TEMPERATURE/WEATHER: Cloudy
STATION: OFFSET:
ELEVATION: 645.2 LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	SAMPLE DESCRIPTION	SAMPLE NO.	TYPE REC	DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0	TOPSOIL							
644.2	1		Loose Brown Silty SAND, moist (SM)	1	SS	1 2.5	3-3-3	6		
	2	3.0								
	3									
641.2	4		Medium Stiff Brown Silty Sandy CLAY, few gravel, moist (CL-ML)	2	SS	3.5 5	2-2-5	7	22.4	1.0
	5	2.0								
639.2	6		Stiff Gray Silty CLAY, moist (CL-ML)	3	SS	6 7.5	5-7-8	15	23.1	2.5
	7	1.5								
637.7	8		Very Stiff SILTY CLAY, moist (CL-ML)							
	9			4	SS	8.5 10	7-8-10	18		3.75
	10	4.5								
	11									
633.2	12		Very Stiff Gray SILTY CLAY, trace gravel, moist (CL-ML)							
	13									
	14	3.5		5	SS	13.5 15	7-9-11	20	11.6	4.5
	15									
629.7	16		Weathered SHALE							
	17	2.0								
627.7	18		Weathered Limestone Bedrock							
	19	2.5		6	SS	18.5 18.04	50/ 0"	>50		
625.2	20		Boring Terminated at 20.0 feet							
	21									

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
1/18/11	10:30	10			6 ▽
1/18/11	10:40	18.5	16		6 ▼
					▼

Remarks:

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

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LOG OF TEST BORING

BORING NO.: TB-01 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP:
BORING METHOD: RIG TYPE:

DATE STARTED: COMPLETED:
TEMPERATURE/WEATHER:
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	SAMPLE TYPE REC	SAMPLE DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL (12")							
	1			Silty Sandy CLAY, moist (CL)							
	2										
		3.0									
	3										
	4			Boring Terminated at 4.0 feet							

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
					▽
					▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

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LOG OF TEST BORING

BORING NO.: TB-02 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP:
BORING METHOD: RIG TYPE:

DATE STARTED: COMPLETED:
TEMPERATURE/WEATHER:
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	SAMPLE TYPE REC	SAMPLE DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL (12")							
	1			Silty Sandy CLAY, moist (CL)							
	2										
		3.0									
	3										
	4			Boring Terminated at 4.0 feet							

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
					▽
					▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

TesTech, Inc
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LOG OF TEST BORING

BORING NO.: TB-03 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP:
BORING METHOD: RIG TYPE:

DATE STARTED: COMPLETED:
TEMPERATURE/WEATHER:
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	SAMPLE TYPE REC	SAMPLE DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL (12")							
	1			Silty Sandy CLAY, moist (CL)							
	2										
		3.0									
	3										
	4			Boring Terminated at 4.0 feet							

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
					▽
					▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

TesTech, Inc
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LOG OF TEST BORING

BORING NO.: TB-04 (Sheet 1/1)

CLIENT: NASA
PROJECT: Plumbrook Station
LOCATION: Sandusky, Ohio
PROJECT NO: 27436 DRILLER/INSP:
BORING METHOD: RIG TYPE:

DATE STARTED: COMPLETED:
TEMPERATURE/WEATHER:
STATION: OFFSET:
ELEVATION: LINE:
CORE SIZE: HAMMER:

ELEV. (FEET)	DEPTH SCALE (FEET)	LAYER THICK-NESS	GRAPHIC LOG	SAMPLE DESCRIPTION	SAMPLE NO.	SAMPLE TYPE REC	SAMPLE DEPTH (FEET)	BLOWS PER 6 INCHES	SPT N	M/C (%)	PP* (tsf)
		1.0		TOPSOIL (12")							
	1	3.0		Silty Clayey SAND, moist (SC)							
	2										
	3										
	4			Boring Terminated at 4.0 feet							

* Pocket Penetrometer Reading - Unconfined Compressive Strength, Tons/Sq.Ft.

Ground Water Observations:

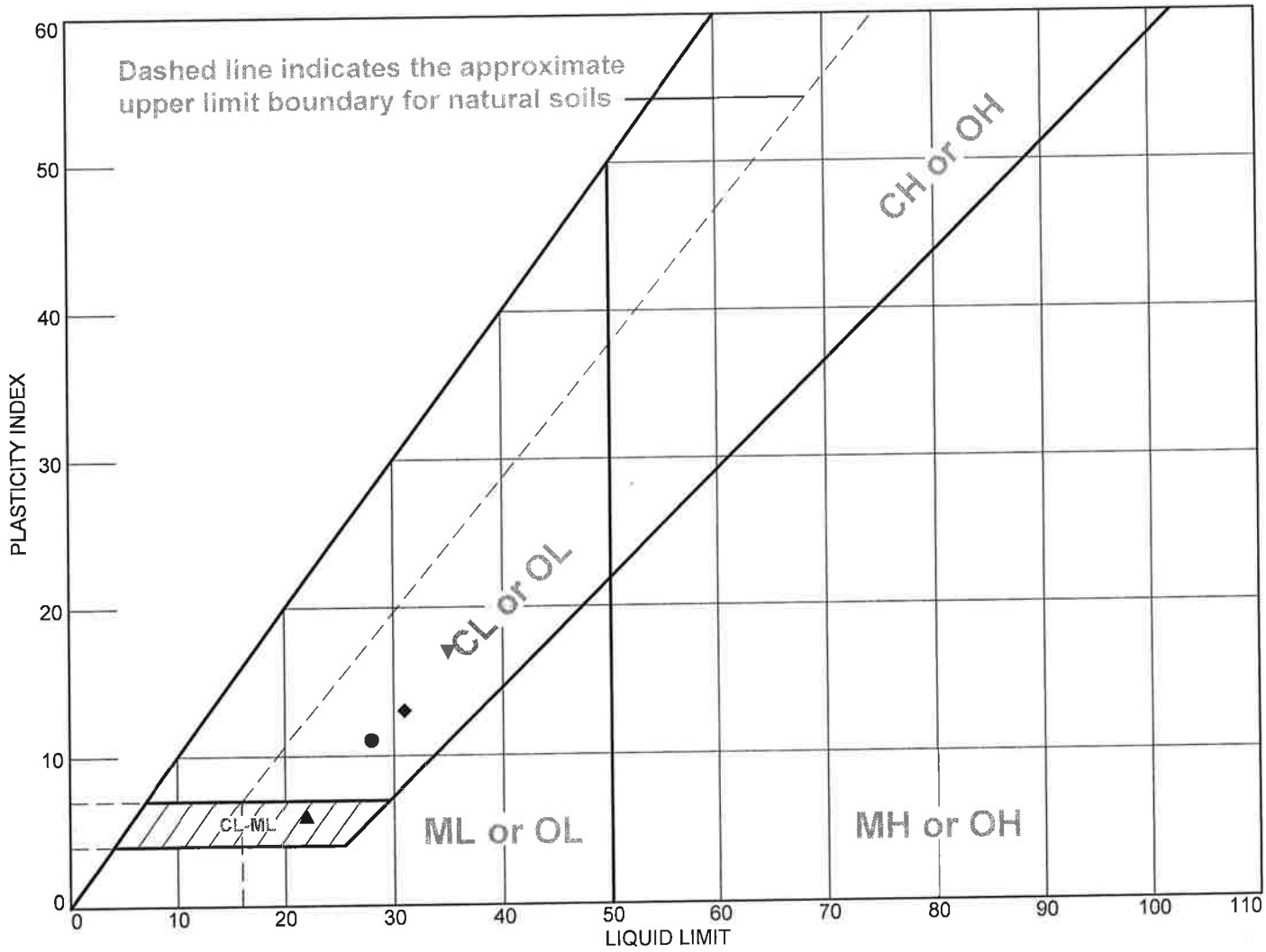
DATE	TIME	CASING DEPTH	CAVE-IN	BAILED	WATER LEVEL
					▽
					▼
					▼

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casings
MD - Mud Drillings

SAMPLE TYPE
SS - Split Spoon
ST - Shelby Tube
CA - Continuous Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Remarks:

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	gray silty CLAY (visual)	28	17	11			
■	brown silty SAND	NV	NP	NP	91.3	45.0	SM
▲	brown sandy, silty CLAY	22	16	6	94.2	65.0	CL-ML
◆	gray/brown silty CLAY (visual)	31	18	13			
▼	brown silty CLAY (visual)	35	18	17			

Project No. 27436 **Client:** AEC-Emersion

Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio

● **Location:** B-1, S-3 **Depth:** 6.0' - 7.5' **Sample Number:** 0117

■ **Location:** B-2, S-2 **Depth:** 3.5' - 5.0' **Sample Number:** 0117

▲ **Location:** B-4, S-2 **Depth:** 3.5' - 5.0' **Sample Number:** 0117

◆ **Location:** B-9, S-3 **Depth:** 6.0' - 7.5' **Sample Number:** 0117

▼ **Location:** B-13, S-2 **Depth:** 3.5' - 5.0' **Sample Number:** 0117

Remarks:

● Date Received: 1/20/11
Lab No.: 0117

▲ Date Received: 1/20/11
Lab No.: 0117

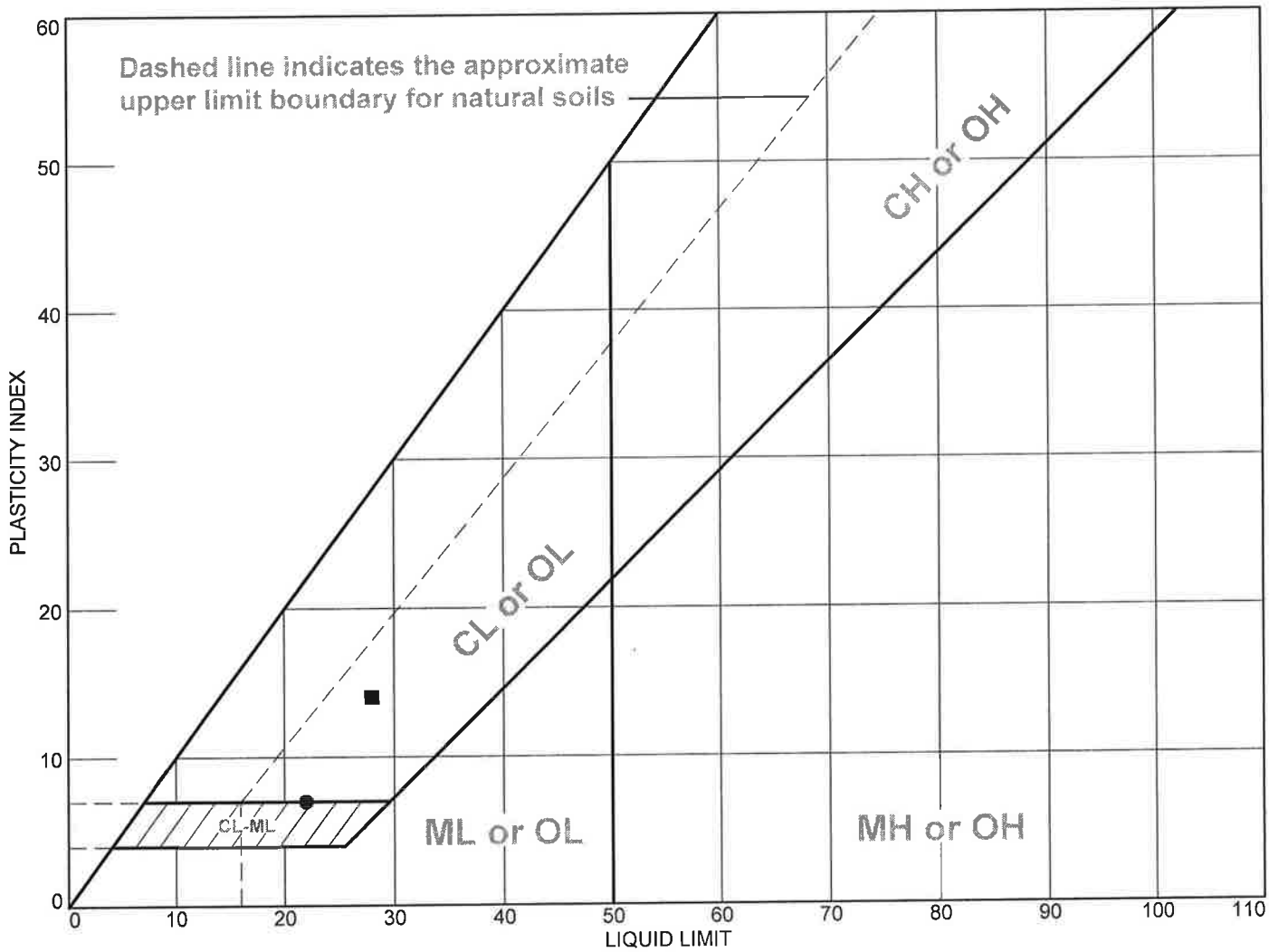
◆ Date Received: 1/20/11
Lab No.: 0117

▼ Date Received: 1/20/11
Lab No.: 0117

TESTECH

File No

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	brown sandy, silty CLAY	22	15	7	89.9	50.4	CL-ML
■	brown sandy lean CLAY	28	14	14	94.9	61.7	CL

Project No. 27436 **Client:** AEC-Emersion

Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio

● **Location:** B-15, S-2 **Depth:** 3.5' - 5.0' **Sample Number:** 0117

■ **Location:** Bag Sample #1 (B-5, 6, 7, 12) **Sample Number:** 0117

Remarks:

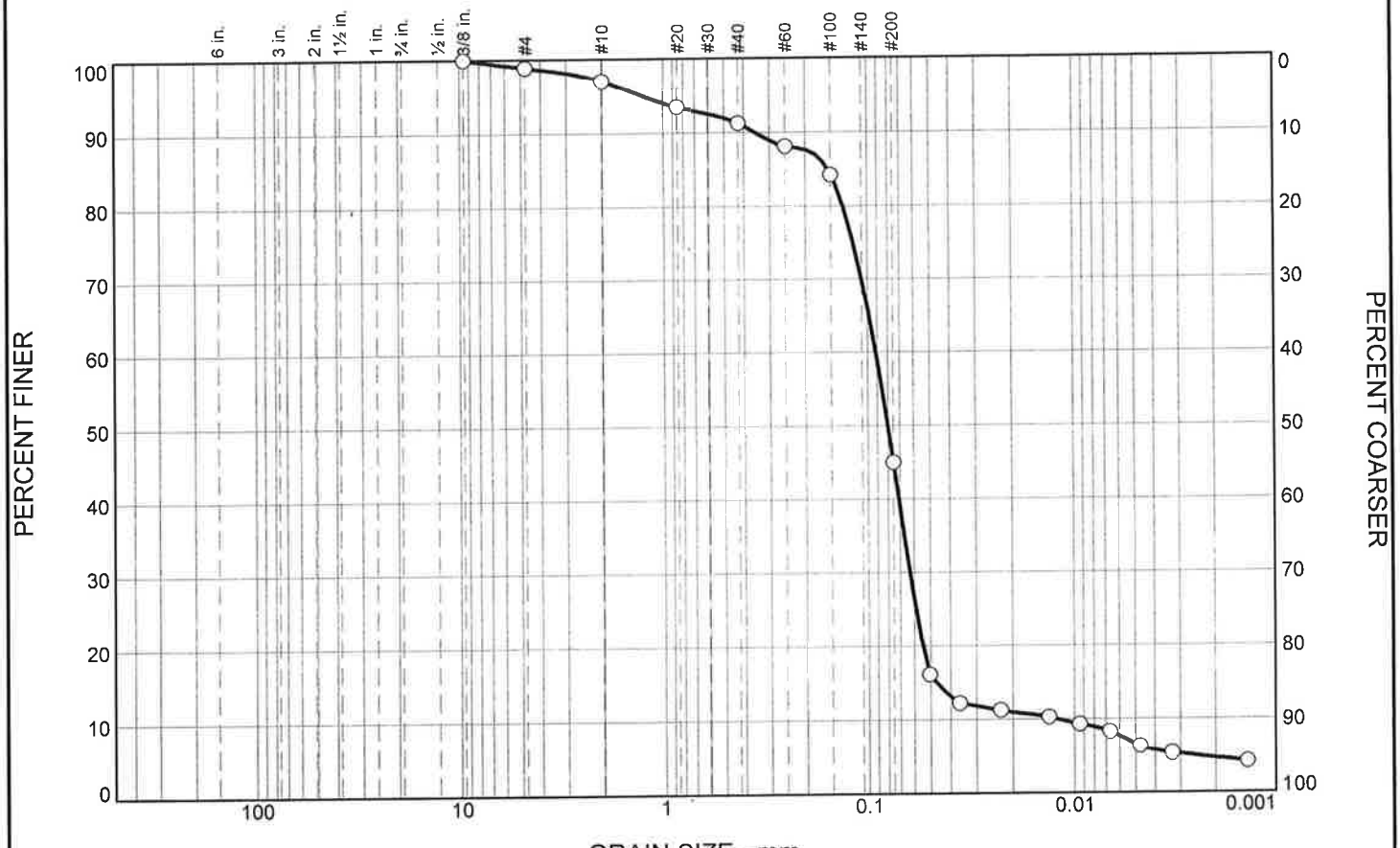
● Date Received: 1/20/11
Lab No.: 0117

■ Date Received: 1/20/11
Lab No.: 0117

TESTECH

File No

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	1.9	5.7	46.3	38.3	6.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.9		
#10	97.0		
#20	93.4		
#40	91.3		
#60	88.1		
#100	84.2		
#200	45.0		

* (no specification provided)

Material Description

brown silty SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.3505 D_{85}= 0.1555 D_{60}= 0.0913
D_{50}= 0.0798 D_{30}= 0.0627 D_{15}= 0.0468
D_{10}= 0.0119 C_u= 7.64 C_c= 3.61

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Date Received: 1/20/11
Lab No.: 0117

Location: B-2, S-2
Sample Number: 0117 **Depth:** 3.5' - 5.0' **Date:** 1/28/11

TESTECH

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project No: 27436 **File No**

GRAIN SIZE DISTRIBUTION TEST DATA

1/28/2011

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project Number: 27436
Location: B-2, S-2
Depth: 3.5' - 5.0'
Sample Number: 0117
Material Description: brown silty SAND
Date: 1/28/11
PL: NP
LL: NV
PI: NP
USCS Classification: SM
AASHTO Classification: A-4(0)
Testing Remarks: Date Received: 1/20/11
Lab No.: 0117

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
300.03	14.64	0.00	.375	0.00	100.0	0.0
			#4	3.25	98.9	1.1
			#10	8.42	97.0	3.0
50.19	0.00	0.00	#20	1.88	93.4	6.6
			#40	2.99	91.3	8.7
			#60	4.62	88.1	11.9
			#100	6.65	84.2	15.8
			#200	26.94	45.0	55.0

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 97.0
Weight of hydrometer sample =50.187
Hygroscopic moisture correction:
Moist weight and tare = 54.17
Dry weight and tare = 54.08
Tare weight = 34.58
Hygroscopic moisture = 0.4%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.5	13.0	8.3	0.0134	13.0	14.2	0.0504	16.1	83.9
2.00	21.5	11.0	6.3	0.0134	11.0	14.5	0.0361	12.2	87.8
5.00	21.5	10.5	5.8	0.0134	10.5	14.6	0.0229	11.2	88.8
15.00	21.5	10.0	5.3	0.0134	10.0	14.7	0.0132	10.3	89.7
30.00	21.5	9.5	4.8	0.0134	9.5	14.7	0.0094	9.3	90.7
60.00	21.5	9.0	4.3	0.0134	9.0	14.8	0.0067	8.3	91.7
120.00	21.5	8.0	3.3	0.0134	8.0	15.0	0.0047	6.4	93.6
250.00	21.5	7.5	2.8	0.0134	7.5	15.1	0.0033	5.4	94.6
1440.00	21.0	7.0	2.2	0.0135	7.0	15.1	0.0014	4.2	95.8

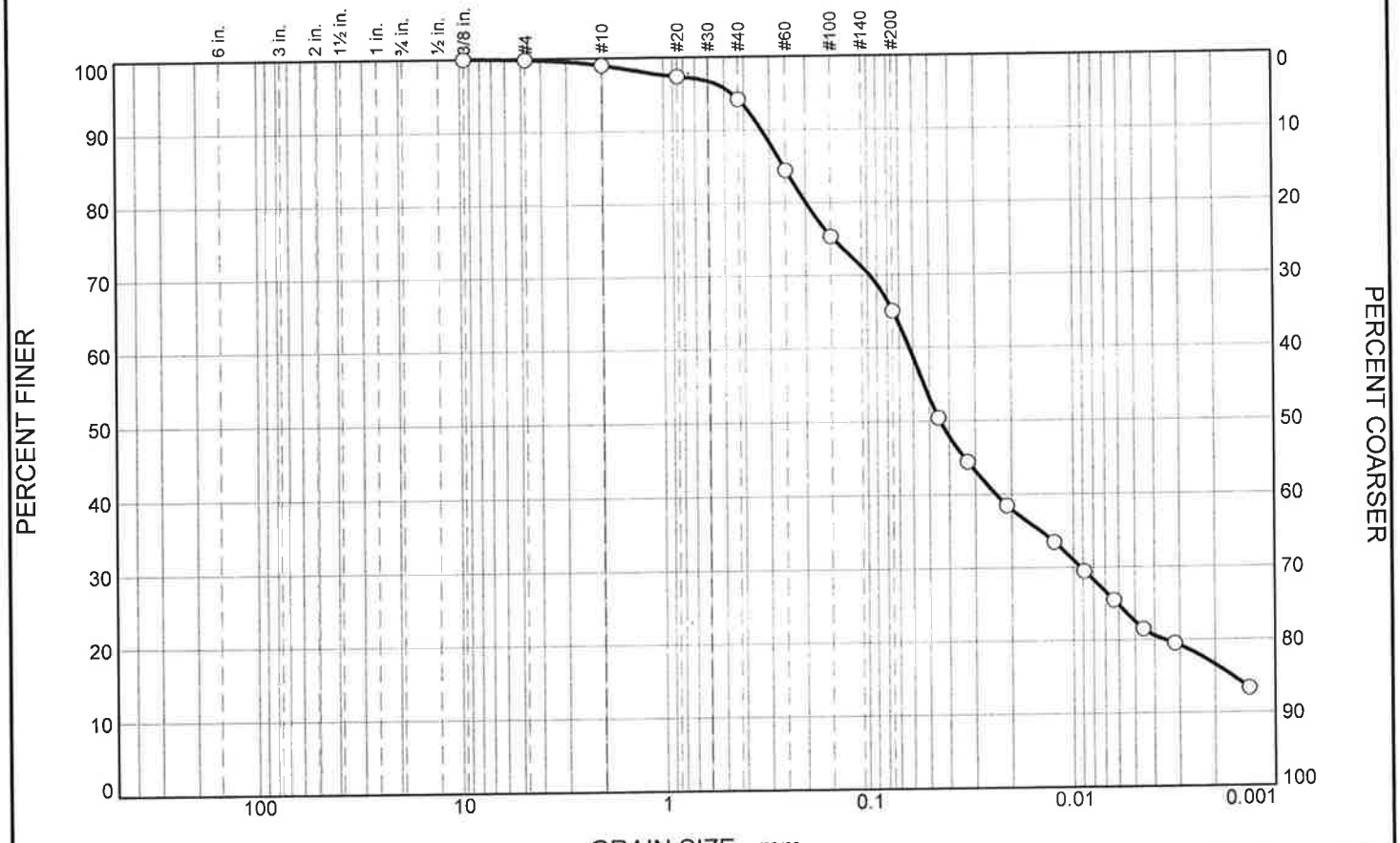
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.1	1.1	1.9	5.7	46.3	53.9	38.3	6.7	45.0

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0119	0.0468	0.0545	0.0627	0.0798	0.0913	0.1313	0.1555	0.3505	1.2577

Fineness Modulus	C_u	C_c
0.43	7.64	3.61

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.8	4.8	29.2	42.5	22.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.8		
#10	99.0		
#20	97.4		
#40	94.2		
#60	84.5		
#100	75.3		
#200	65.0		

* (no specification provided)

Material Description

brown sandy, silty CLAY

Atterberg Limits

PL= 16 LL= 22 PI= 6

Coefficients

D_{90}= 0.3281 D_{85}= 0.2567 D_{60}= 0.0627
D_{50}= 0.0444 D_{30}= 0.0092 D_{15}= 0.0016
D_{10}= C_u= C_c=

Classification

USCS= CL-ML AASHTO= A-4(1)

Remarks

Date Received: 1/20/11
Lab No.: 0117

Location: B-4, S-2
Sample Number: 0117 **Depth:** 3.5' - 5.0' **Date:** 1/28/11

TESTECH

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project No: 27436 **File No**

GRAIN SIZE DISTRIBUTION TEST DATA

1/28/2011

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project Number: 27436
Location: B-4, S-2
Depth: 3.5' - 5.0'
Sample Number: 0117
Material Description: brown sandy, silty CLAY
Date: 1/28/11
PL: 16
LL: 22
PI: 6
USCS Classification: CL-ML
AASHTO Classification: A-4(1)
Testing Remarks: Date Received: 1/20/11
Lab No.: 0117

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
398.08	27.74	0.00	.375	0.00	100.0	0.0
			#4	0.56	99.8	0.2
			#10	3.60	99.0	1.0
50.16	0.00	0.00	#20	0.83	97.4	2.6
			#40	2.44	94.2	5.8
			#60	7.38	84.5	15.5
			#100	12.00	75.3	24.7
			#200	17.22	65.0	35.0

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.0
Weight of hydrometer sample =50.158
Hygroscopic moisture correction:
Moist weight and tare = 49.09
Dry weight and tare = 48.91
Tare weight = 30.29
Hygroscopic moisture = 1.0%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.5	30.0	25.3	0.0134	30.0	11.4	0.0452	50.4	49.6
2.00	21.5	27.0	22.3	0.0134	27.0	11.9	0.0326	44.4	55.6
5.00	21.5	24.0	19.3	0.0134	24.0	12.4	0.0211	38.5	61.5
15.00	21.5	21.5	16.8	0.0134	21.5	12.8	0.0124	33.5	66.5
30.00	21.5	19.5	14.8	0.0134	19.5	13.1	0.0089	29.5	70.5
60.00	21.5	17.5	12.8	0.0134	17.5	13.4	0.0063	25.5	74.5
120.00	21.5	15.5	10.8	0.0134	15.5	13.8	0.0045	21.5	78.5
250.00	21.5	14.5	9.8	0.0134	14.5	13.9	0.0032	19.5	80.5
1440.00	21.0	11.5	6.7	0.0135	11.5	14.4	0.0013	13.3	86.7

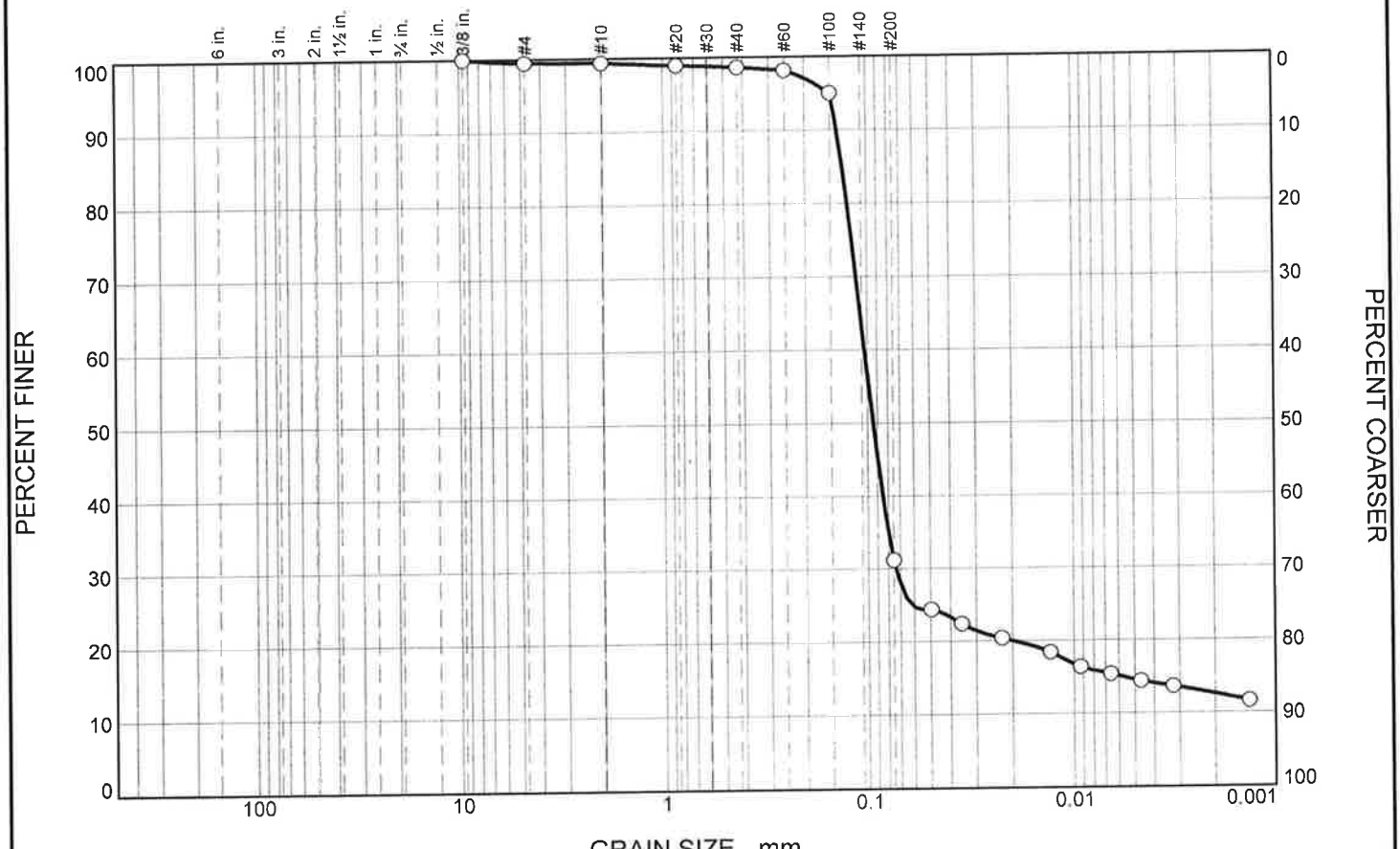
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.2	0.2	0.8	4.8	29.2	34.8	42.5	22.5	65.0

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0016	0.0035	0.0092	0.0444	0.0627	0.1994	0.2567	0.3281	0.4558

Fineness Modulus
0.43

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.1	0.8	67.4	16.6	14.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.5		
#10	99.4		
#20	98.9		
#40	98.6		
#60	98.1		
#100	95.0		
#200	31.2		

* (no specification provided)

Material Description

brown silty, clayey SAND (visual)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1390 D_{85}= 0.1309 D_{60}= 0.1030
D_{50}= 0.0938 D_{30}= 0.0733 D_{15}= 0.0058
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Date Received: 1/20/11
Lab No.: 0117

Location: B-6, S-1
Sample Number: 0117 **Depth:** 1.0' - 2.5' **Date:** 1/28/11

TESTECH

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project No: 27436 **File No**

GRAIN SIZE DISTRIBUTION TEST DATA

1/28/2011

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project Number: 27436
Location: B-6, S-1
Depth: 1.0' - 2.5'
Sample Number: 0117
Material Description: brown silty, clayey SAND (visual)
Date: 1/28/11
Testing Remarks: Date Received: 1/20/11
Lab No.: 0117

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
310.50	14.58	0.00	.375	0.00	100.0	0.0
			#4	1.52	99.5	0.5
			#10	1.72	99.4	0.6
50.02	0.00	0.00	#20	0.24	98.9	1.1
			#40	0.41	98.6	1.4
			#60	0.64	98.1	1.9
			#100	2.22	95.0	5.0
			#200	34.33	31.2	68.8

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.4
Weight of hydrometer sample =50.024
Hygroscopic moisture correction:
Moist weight and tare = 53.93
Dry weight and tare = 53.79
Tare weight = 34.58
Hygroscopic moisture = 0.7%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.0	17.0	12.2	0.0135	17.0	13.5	0.0495	24.4	75.6
2.00	21.0	16.0	11.2	0.0135	16.0	13.7	0.0352	22.4	77.6
5.00	21.0	15.0	10.2	0.0135	15.0	13.8	0.0224	20.4	79.6
15.00	21.0	14.0	9.2	0.0135	14.0	14.0	0.0130	18.4	81.6
30.00	21.0	13.0	8.2	0.0135	13.0	14.2	0.0093	16.4	83.6
60.00	21.0	12.5	7.7	0.0135	12.5	14.2	0.0066	15.4	84.6
120.00	21.0	12.0	7.2	0.0135	12.0	14.3	0.0047	14.4	85.6
250.00	21.5	11.5	6.8	0.0134	11.5	14.4	0.0032	13.6	86.4
1440.00	21.5	10.5	5.8	0.0134	10.5	14.6	0.0013	11.6	88.4

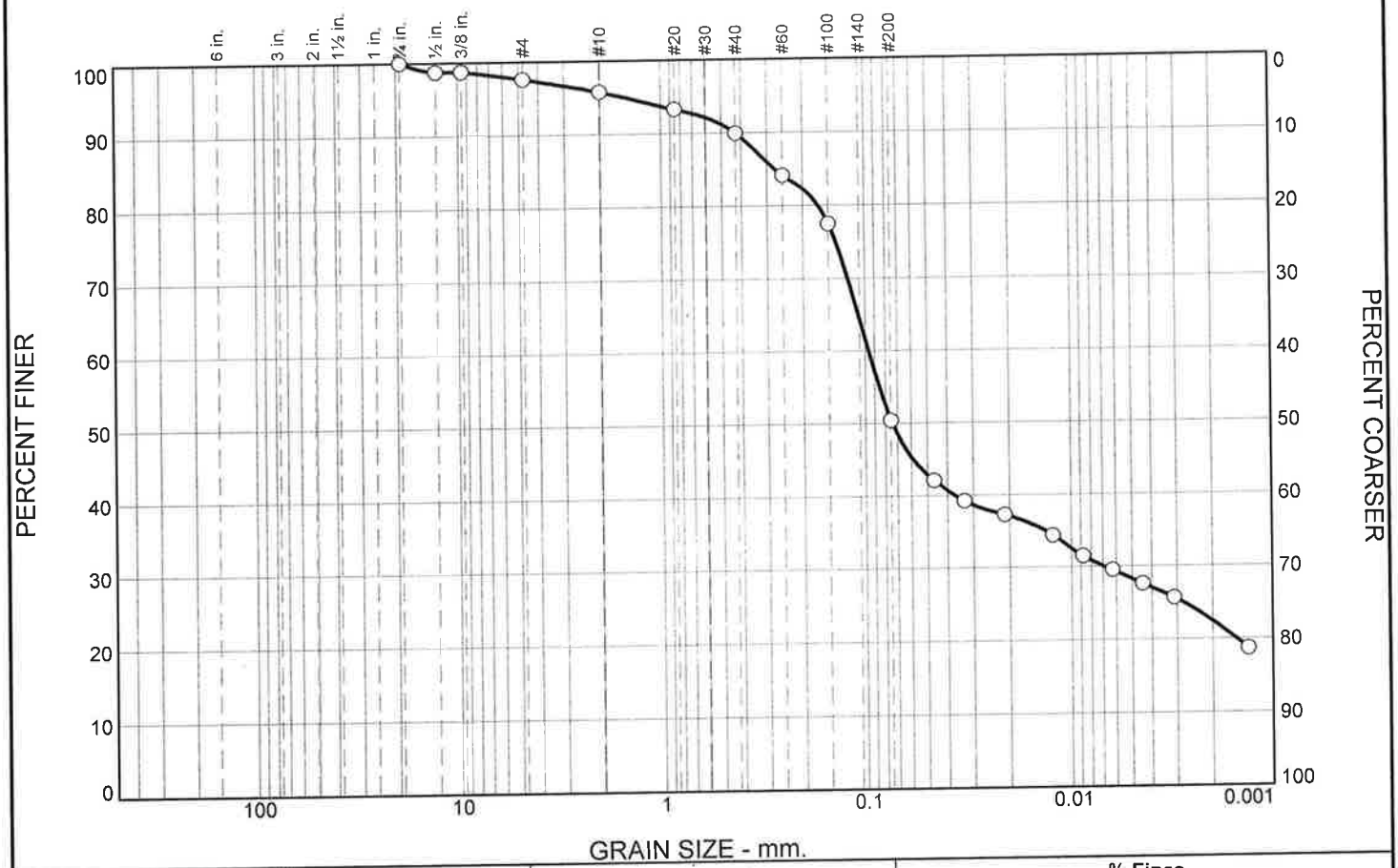
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.5	0.5	0.1	0.8	67.4	68.3	16.6	14.6	31.2

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0058	0.0198	0.0733	0.0938	0.1030	0.1242	0.1309	0.1390	0.1500

Fineness Modulus
0.10

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.4	1.8	5.9	39.5	22.1	28.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	98.7		
.375	98.7		
#4	97.6		
#10	95.8		
#20	93.3		
#40	89.9		
#60	84.1		
#100	77.5		
#200	50.4		

* (no specification provided)

Material Description

brown sandy, silty CLAY

Atterberg Limits

PL= 15 LL= 22 PI= 7

Coefficients

D_{90}= 0.4279 D_{85}= 0.2737 D_{60}= 0.0963
D_{50}= 0.0741 D_{30}= 0.0068 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL-ML AASHTO= A-4(1)

Remarks

Date Received: 1/20/11
Lab No.: 0117

Location: B-15, S-2
Sample Number: 0117 **Depth:** 3.5' - 5.0' **Date:** 1/20/11

TESTECH

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project No: 27436 **File No**

GRAIN SIZE DISTRIBUTION TEST DATA

1/28/2011

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project Number: 27436
Location: B-15, S-2
Depth: 3.5' - 5.0'
Sample Number: 0117
Material Description: brown sandy, silty CLAY
Date: 1/20/11 **PL:** 15 **LL:** 22 **PI:** 7
USCS Classification: CL-ML
AASHTO Classification: A-4(1)
Testing Remarks: Date Received: 1/20/11
Lab No.: 0117

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
373.41	14.35	0.00	.75	0.00	100.0	0.0
			.5	4.54	98.7	1.3
			.375	4.54	98.7	1.3
			#4	8.53	97.6	2.4
			#10	15.11	95.8	4.2
50.23	0.00	0.00	#20	1.31	93.3	6.7
			#40	3.07	89.9	10.1
			#60	6.12	84.1	15.9
			#100	9.60	77.5	22.5
			#200	23.82	50.4	49.6

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 95.8
Weight of hydrometer sample =50.235
Hygroscopic moisture correction:
Moist weight and tare = 54.41
Dry weight and tare = 54.18
Tare weight = 35.95
Hygroscopic moisture = 1.3%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.5	26.5	21.8	0.0134	26.5	11.9	0.0463	42.1	57.9
2.00	21.5	25.0	20.3	0.0134	25.0	12.2	0.0331	39.2	60.8
5.00	21.5	24.0	19.3	0.0134	24.0	12.4	0.0211	37.2	62.8
15.00	21.5	22.5	17.8	0.0134	22.5	12.6	0.0123	34.3	65.7
30.00	21.5	21.0	16.3	0.0134	21.0	12.9	0.0088	31.5	68.5
60.00	21.5	20.0	15.3	0.0134	20.0	13.0	0.0062	29.5	70.5
120.00	21.5	19.0	14.3	0.0134	19.0	13.2	0.0044	27.6	72.4
250.00	21.5	18.0	13.3	0.0134	18.0	13.3	0.0031	25.7	74.3
1440.00	21.0	14.5	9.7	0.0135	14.5	13.9	0.0013	18.7	81.3

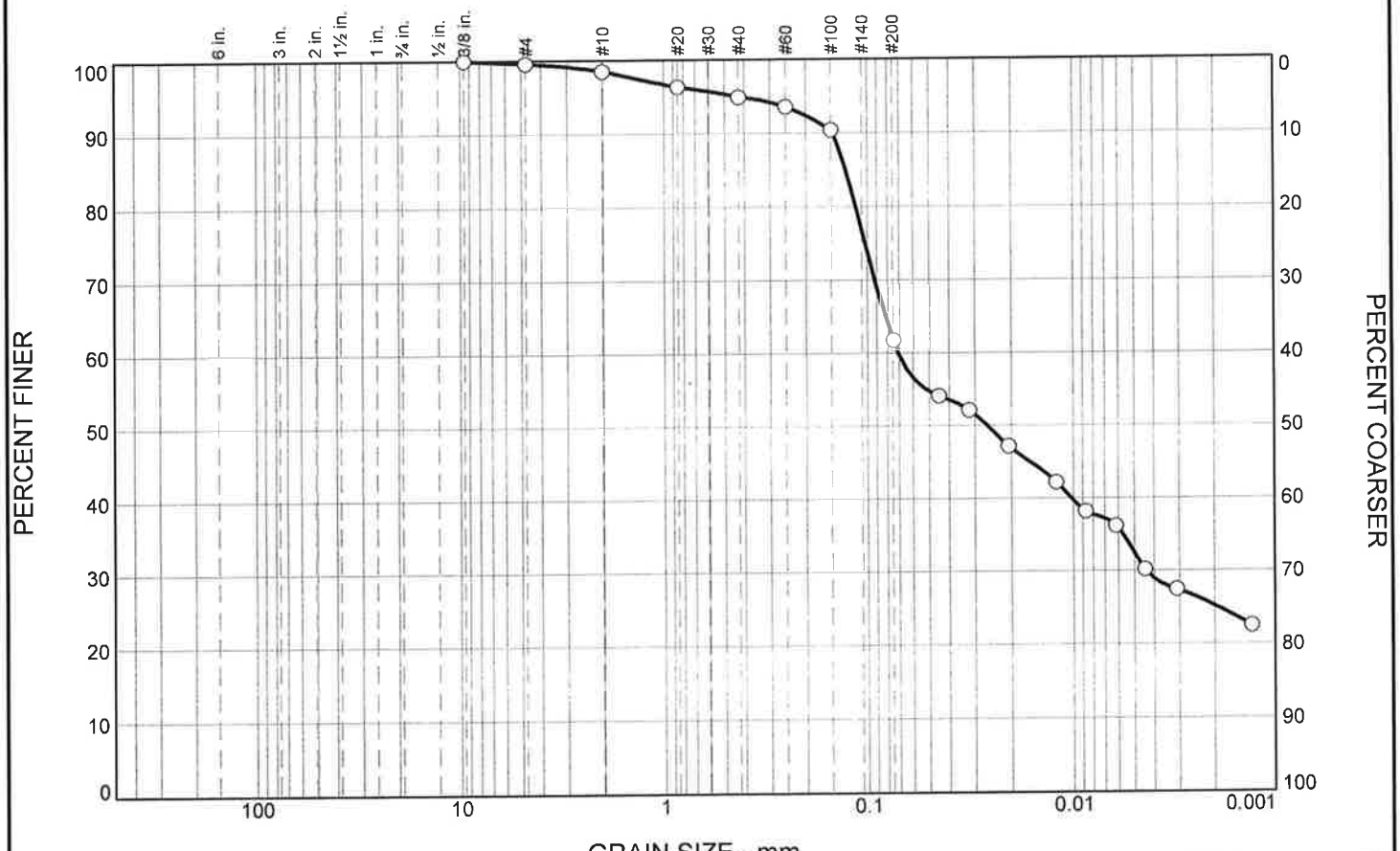
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	2.4	2.4	1.8	5.9	39.5	47.2	22.1	28.3	50.4

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0015	0.0068	0.0741	0.0963	0.1680	0.2737	0.4279	1.5025

Fineness Modulus
0.58

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	1.1	3.6	33.2	29.3	32.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.6		
#10	98.5		
#20	96.3		
#40	94.9		
#60	93.5		
#100	90.4		
#200	61.7		

* (no specification provided)

Material Description

brown sandy lean CLAY

Atterberg Limits

PL= 14 LL= 28 PI= 14

Coefficients

D_{90}= 0.1477 D_{85}= 0.1276 D_{60}= 0.0709
D_{50}= 0.0263 D_{30}= 0.0044 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(6)

Remarks

Date Received: 1/20/11
Lab No.: 0117

Location: Bag Sample #1 (B-5, 6, 7, 12)
Sample Number: 0117

Date: 1/25/11

TESTECH

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project No: 27436 **File No**

GRAIN SIZE DISTRIBUTION TEST DATA

1/28/2011

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio
Project Number: 27436
Location: Bag Sample #1 (B-5, 6, 7, 12)
Sample Number: 0117
Material Description: brown sandy lean CLAY
Date: 1/25/11 **PL:** 14 **LL:** 28 **PI:** 14
USCS Classification: CL **AASHTO Classification:** A-6(6)
Testing Remarks: Date Received: 1/20/11
Lab No.: 0117

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
3129.84	2186.35	0.00	0.375	0.00	100.0	0.0
			#4	4.08	99.6	0.4
			#10	14.11	98.5	1.5
50.06	0.00	0.00	#20	1.10	96.3	3.7
			#40	1.84	94.9	5.1
			#60	2.52	93.5	6.5
			#100	4.12	90.4	9.6
			#200	18.72	61.7	38.3

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 98.5
Weight of hydrometer sample =50.056
Hygroscopic moisture correction:
Moist weight and tare = 66.70
Dry weight and tare = 66.38
Tare weight = 37.23
Hygroscopic moisture = 1.1%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.0	32.0	27.2	0.0135	32.0	11.0	0.0448	54.1	45.9
2.00	21.0	31.0	26.2	0.0135	31.0	11.2	0.0319	52.1	47.9
5.00	21.0	28.5	23.7	0.0135	28.5	11.6	0.0205	47.1	52.9
15.00	21.0	26.0	21.2	0.0135	26.0	12.0	0.0121	42.1	57.9
30.00	21.0	24.0	19.2	0.0135	24.0	12.4	0.0087	38.2	61.8
60.00	21.0	23.0	18.2	0.0135	23.0	12.5	0.0062	36.2	63.8
120.00	21.0	20.0	15.2	0.0135	20.0	13.0	0.0044	30.2	69.8
250.00	21.5	18.5	13.8	0.0134	18.5	13.3	0.0031	27.4	72.6
1440.00	21.5	16.0	11.3	0.0134	16.0	13.7	0.0013	22.5	77.5

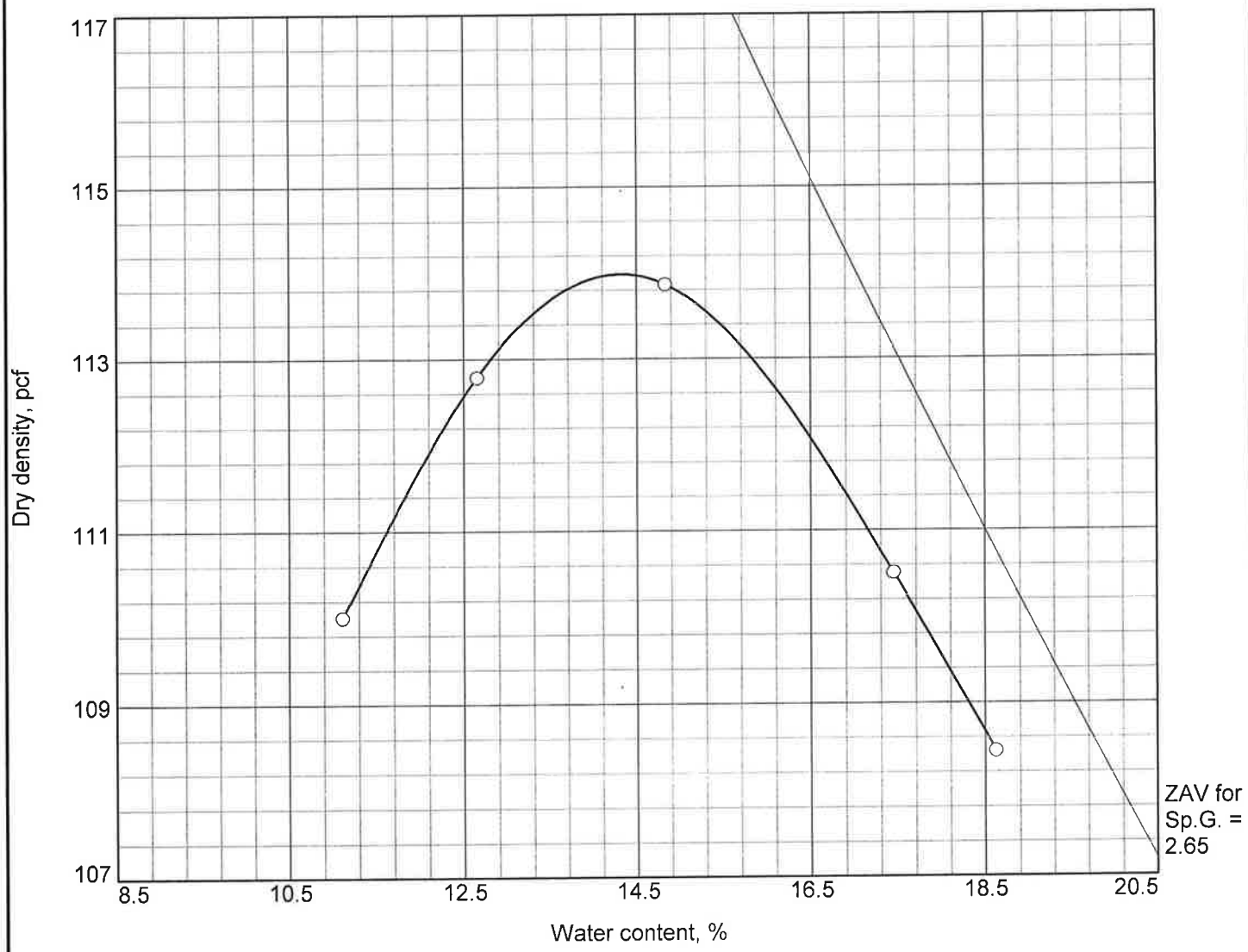
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.4	0.4	1.1	3.6	33.2	37.9	29.3	32.4	61.7

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
			0.0044	0.0263	0.0709	0.1138	0.1276	0.1477	0.4412

Fineness Modulus
0.24

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	CL	A-6(6)			28	14	0.0	61.7

TEST RESULTS

Maximum dry density = 114.0 pcf

Optimum moisture = 14.3 %

MATERIAL DESCRIPTION

brown sandy lean CLAY

Project No. 27436 **Client:** AEC-Emersion

Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio

Date: 1/21/11

○ **Location:** Bag Sample #1 (B-5, 6, 7, 12) **Sample Number:** 0117

Remarks:

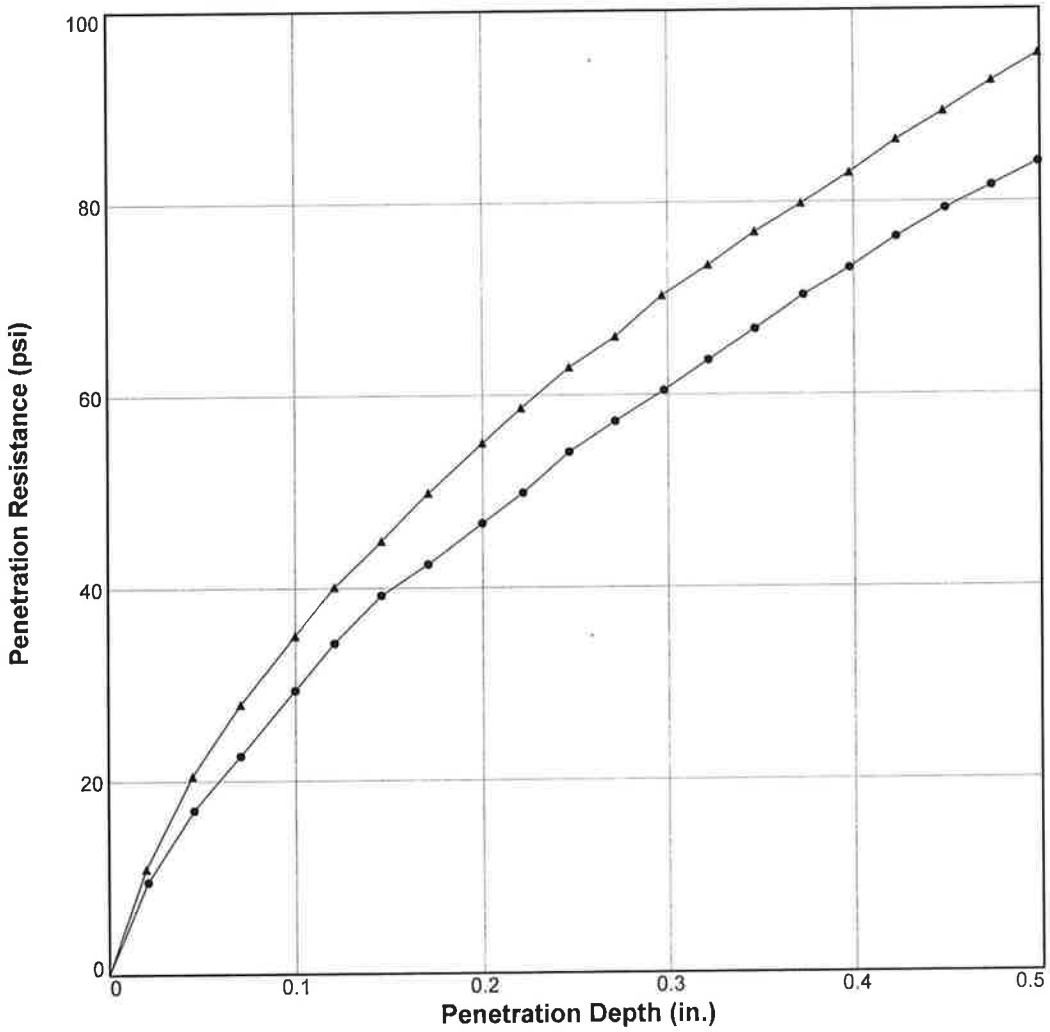
Date Received: 1/20/11

Lab No.: 0117

TESTECH

File No

BEARING RATIO TEST REPORT
ASTM D 1883-07



	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	112.5	98.7	15.9	112.2	98.4	17.4	2.9	3.1	0.000	10	0.2
2 △	111.6	97.9	16.1	111.3	97.6	16.8	3.5	3.7	0.000	10	0.3
3 □											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
brown sandy lean CLAY	CL	114.0	14.3	28	14

Project No: 27436

Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio

Location: Bag Sample #1 (B-5, 6, 7, 12)

Sample Number: 0117

Date: 1/25/11

Test Description/Remarks:

California Bearing Ratio

Date of Instructions: 1/20/11
Lab No.: 0117

TESTECH

File No _____

TesTech, Inc.

ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio

Lab No.: 0117
Project No.: 27436
Date: 1/25/2011

Boring Number	Sample Number	Depth (ft)	Depth (m)	Moisture Content (%)	Comments
B1	1	1.0 - 2.5	0.3 - 0.8	21.5	
B1	3	6.0 - 7.5	1.8 - 2.3	21.6	
B1	4	8.5 - 10.0	2.6 - 3.0	21.7	
B2	1	1.0 - 2.5	0.3 - 0.8	21.5	
B2	2	3.5 - 5.0	1.1 - 1.5	25.0	
B2	4	8.5 - 10.0	2.6 - 3.0	20.3	
B3	2	3.5 - 5.0	1.1 - 1.5	29.7	
B3	4	8.5 - 10.0	2.6 - 3.0	21.8	
B3	5	13.5 - 15.0	4.1 - 4.6	10.7	
B4	1	1.0 - 2.5	0.3 - 0.8	23.4	
B4	2	3.5 - 5.0	1.1 - 1.5	25.4	
B4	3	6.0 - 7.5	1.8 - 2.3	21.0	
B5	1	1.0 - 2.5	0.3 - 0.8	18.8	
B5	3	6.0 - 7.5	1.8 - 2.3	24.2	
B5	4	8.5 - 10.0	2.6 - 3.0	11.9	
B6	1	1.0 - 2.5	0.3 - 0.8	21.2	
B6	2	3.5 - 5.0	1.1 - 1.5	22.5	
B6	4	8.5 - 10.0	2.6 - 3.0	23.4	
B7	1	1.0 - 2.5	0.3 - 0.8	25.0	
B7	2	3.5 - 5.0	1.1 - 1.5	22.3	
B7	3	6.0 - 7.5	1.8 - 2.3	22.6	
B8	1	1.0 - 2.5	0.3 - 0.8	19.4	
B8	3	6.0 - 7.5	1.8 - 2.3	25.1	
B9	2	3.5 - 5.0	1.1 - 1.5	22.6	
B9	3	6.0 - 7.5	1.8 - 2.3	23.5	
B9	4	8.5 - 10.0	2.6 - 3.0	21.7	
B10	1	1.0 - 2.5	0.3 - 0.8	20.6	
B10	2	3.5 - 5.0	1.1 - 1.5	23.2	
B11	1	1.0 - 2.5	0.3 - 0.8	17.7	
B11	3	6.0 - 7.5	1.8 - 2.3	24.9	
B12	2	3.5 - 5.0	1.1 - 1.5	24.1	
B12	4	8.5 - 10.0	2.6 - 3.0	23.2	

TesTech, Inc.

ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Client: AEC-Emersion
Project: Gate Relocation Project, NASA Plum Brook Station - Sandusky, Ohio

Lab No.: 0117
Project No.: 27436
Date: 1/25/2011

Boring Number	Sample Number	Depth (ft)	Depth (m)	Moisture Content (%)	Comments
B13	1	1.0 - 2.5	0.3 - 0.8	18.5	
B13	2	3.5 - 5.0	1.1 - 1.5	24.4	
B13	4	8.5 - 10.0	2.6 - 3.0	27.0	
B14	2	3.5 - 5.0	1.1 - 1.5	21.2	
B14	3	6.0 - 7.5	1.8 - 2.3	17.4	
B15	2	3.5 - 5.0	1.1 - 1.5	22.4	
B15	3	6.0 - 7.5	1.8 - 2.3	23.1	
B15	5	13.5 - 15.0	4.1 - 4.6	11.6	
Bag Sample #1	B-5, 6, 7, 12			17.5	

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS LESS THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	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
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FIND 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

TESTECH, INC.
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DAYTON, OHIO 45458
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Unified Soil Classification System

PARTICLE SIZE IDENTIFICATION

Description	Size
Boulders	· Diameter: 12 inches or larger
Cobbles	· Diameter: 3 to 12 inches
Gravel	· Coarse - 3/4 to 3 inches
	· Fine - 3/4 to No. 4
Sand	· Coarse - No. 10 to No. 4 (Diameter of pencil lead)
	· Medium - No. 40 to No. 10 (Diameter of broom straw)
	· Fine - No. 200 to No. 40 (Diameter of human hair)
Silt and Clay	· Passing No. 200 (Cannot see particles)

RELATIVE PROPORTIONS

Description	Percent by Weight (%)
Trace	0-5
Few	5-10
Little	10-20
Some	20-35
And	35-50

MOISTURE CONDITIONS

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

COHESIVE SOILS (Silt and Clay)

CONSISTENCY

Description	Blows/ft
Very Soft	2
Soft	3-5
Medium Stiff	6-9
Stiff	10-16
Very Stiff	17-30
Hard	>30

PLASTICITY

Degree of Plasticity	Plasticity Index
None	0-4
Slight	5-7
Medium	8-22
High to Very High	Over 22

COHESIONLESS SOIL (Sand, Gravel, and larger)

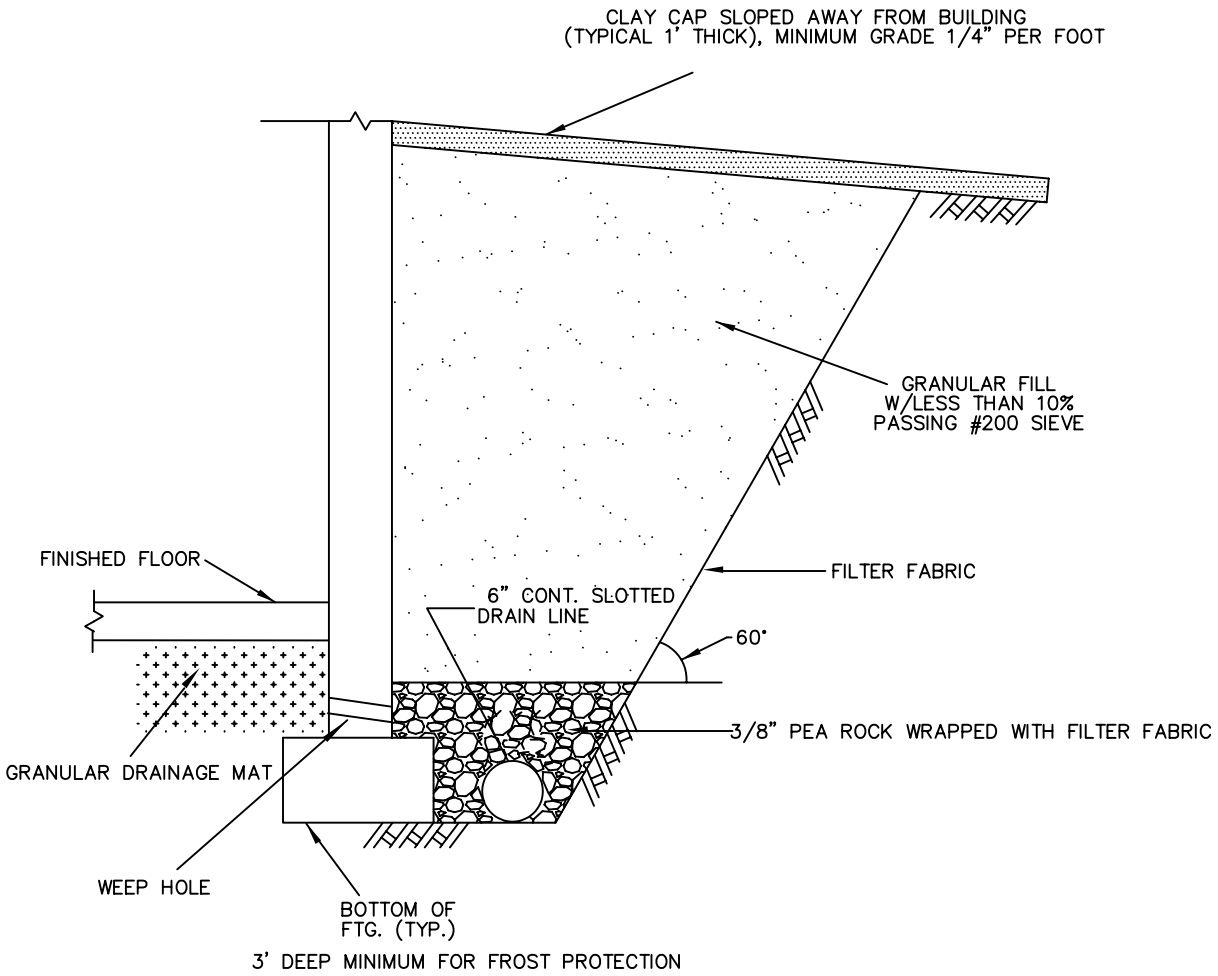
RELATIVE DENSITY

Description	Blows/ft
Very Loose	<4
Loose	4-10
Medium Dense	11-30
Dense	31-50
Very Dense	>50

Soil Classification on Boring Logs is made by visual inspection of samples (as per ASTM D 2487).

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

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



TYPICAL PERIMETER
DRAIN DETAIL
NOT TO SCALE

TYPICAL PERIMETER DRAIN

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