ABC Water and
Stormwater District
Forest Lawn
Stormwater Park,
Boardman Township,
Mahoning County,
Ohio

Geotechnical Subsurface Investigation

ABC Water and
Stormwater District
Youngstown, Ohio

September 2023

CT Project No. 231566

CT Consultants, Inc.
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September 21, 2023 CT Project No. 231566

ABC Water and Stormwater District
Jason Loree, Board Member
P.O. Box 3554
8299 Market Street
Youngstown, Ohio 44512

Re: Geotechnical Subsurface Investigation
Proposed Forest Lawn Stormwater Park
Boardman Township, Mahoning County, Ohio

Dear Mr. Loree:

Following is the report of our geotechnical subsurface investigation performed by CT Consultants, Inc. (CT) for the referenced project conducted for Boardman Township, Ohio. CT was selected through a public qualifications-based selection in October 2021, and our Statement of Qualification (SOQ)/proposal was submitted on 04-05-2023. Authorization was approved on 04-18-2023 by ABC Water and Stormwater District Resolution No. 23-04-18-06.

This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, and our recommendations for the design and construction of foundations, floor slabs, and pavements.

Should you have any questions regarding this report or require additional information, please contact our office.

Respectfully,

CT Consultants, Inc.

NEGOSLAV TOSANOVIC
E-78355

Negoslav Tosanovic, P.E.
Geotechnical Project Manager

Curtis E. Roupe, P.E.
Vice President

H:\2023\231566\PHASE\03 Geotechnical\Reports and Other Deliverables

GEOTECHNICAL SUBSURFACE INVESTIGATION
FOREST LAWN STORMWATER PARK
BOARDMAN TOWNSHIP, MAHONING COUNTY, OHIO

FOR

ABC WATER AND STORMWATER DISTRICT
MAHONING COUNTY
BOARDMAN TOWNSHIP, OHIO

SUBMITTED

OCTOBER 12, 2023
CT PROJECT NO. 231566

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APPENDICES

1.0 INTRODUCTION

This final geotechnical subsurface investigation report has been prepared for the proposed improvements at the subject property to mitigate the flooding in extreme events occasion and to sufficiently collect and eliminate the surfacing storm water. The site is located in Boardman Township, Ohio, bounded by Market Street, Erskin Avenue, Southern Boulevard, and Meadowbrook Avenue, as shown on the attached Site Location Map (Plate 1.0).

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures, presents the findings, discusses our evaluations and conclusions, and provides our design and construction recommendations for foundations and pavements, as well as installation of underground utilities.

This study was performed in accordance with CT Consultants SOQ/Proposal submitted 04-05-2023. Authorization was approved on 04-18-2023 by ABC Water and Stormwater District Resolution No. 23-04-18-06.

The purpose of this investigation was to evaluate the subsurface conditions and laboratory data relative to the design and construction of foundations, building slabs, and pavements, as well as installation of underground utilities, at the referenced site. To accomplish this, 10 test borings, five field percolation tests, field and laboratory soil testing, and a geotechnical engineering evaluation of the test results were performed.

This report includes:

> A description of the subsurface soil and groundwater conditions encountered in the borings.

> Design recommendations for foundations, floor slabs, and pavements related to the proposed development.

> Recommendations concerning soil- and groundwater-related construction procedures such as site preparation, earthwork, foundation and pavement construction, underground utility installation, and related field testing.

This investigation did not include an environmental assessment of the subsurface materials at this site.

2.0 INVESTIGATIVE PROCEDURES

This subsurface investigation included ten (10) test borings designated as B-1 through B-10 drilled by CT Consultants' subcontractor Ridgeway Drilling, Inc. on September 5, 2023, to the depths between 10 and 20 feet below existing grades. Also, at five separate locations where permeable pavement or BMPs are being considered, field percolation tests designated as PT-1 through PT-5 were performed at depths between 2 and 3 feet below the surface existed at the time of drilling. The test borings and percolation tests were located in the field based on a CT plan drawing, dated March 8, 2022. The approximate locations of the borings, percolation tests, and existing site features are shown on the Test Boring Location Plan (Plate 2.0). Additionally, the test boring locations are summarized in the following table.

Table 2.0 Test Boring Locations

Boring/Percolation Test Number	General Location	Proposed Development
B-1 and B-9	Midpoints of the north and south side of the property, in vicinity of the inner edge of the future trail	Stream Outlet and Inlet Culverts
B-2 and B-10	Approximate north and south third of the eastern site side; north and south Sanitary Sewer line elbows	Sanitary Sewer Relocation
B-3 and B-8	Southwest corner of the area rounded with entry loop drive	Parking Lot
B-4	Center of the area rounded with the entry loop drive	Building/Pavilion
B-5	Midpoint of the western third of the property	Boardwalk Overlook with Arbor
B-6	Approximate center of the site	Flood Plain Overflow areas; Central/BMP
B-7	Approximate midpoint of the eastern third of the site	Overlook
PT-1 and PT-5	Approximate north and south side of the western third of the site which coincide with north and south edge of the old school buildings.	Turnarounds
PT-2	Approximate midpoint of the eastern third of the site.	Flood Plain Overflow areas; Central/MBP
PT-3	Southwest corner of the area rounded with entry loop drive	Parking Lot
PT-4	Immediately west of entry loop drive	Pavilion runoff area

The test borings were performed in general accordance with geotechnical investigative procedures outlined in ASTM Standard D 6151. The test borings performed during this investigation were drilled with a track-mounted drill rig utilizing 2¼-inch inside diameter hollow stem augers. Borings B-7, B-8, B-9, and B-10 were terminated shallower than planned due to encountered auger refusal caused by bedrock, coal, or very hard/very dense lean clay/silty sand with bedrock fragments at respective depths of 9.7, 14.1, 19.4 and 14.6 feet below existing grades. The remaining borings were terminated at the planned depths and percolation tests are performed as planned.

During auger advancement, soil samples were generally collected at 2½-foot intervals to a depth of 10 feet, and at 5-foot intervals thereafter. Split-spoon (SS) samples were obtained by the Standard Penetration Test (SPT) Method (ASTM D 1586), which consists of driving a 2-inch outside diameter split-barrel sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three successive 6-inch increments with the number of blows per increment being recorded. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance (N-value) and is presented on the Logs of Test Borings attached to this report. The samples were sealed in jars and transported to our laboratory for further classification and testing.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils.

This subsurface investigation included five field percolation tests, designated PT-1 through PT-5, which were performed on September 5, 2023, by Ridgeway Drilling under CT's direction. The percolation test sites were located in the field by CT, based on a CT plan drawing, dated March 8, 2022. The test locations were prepared using an ATV-mounted drilling rig and 2¼-inch inside diameter hollow-stem augers, which resulted in a borehole diameter of approximately 6 inches. The bottom of the percolation test holes was extended to depths of 1 to 3 feet below existing grade. The sides and bottom of the percolation test holes were scarified, and then the boreholes were filled with water to saturate the subsoils and initiate the test. Additional discussion regarding the percolation test is presented in Section 4.4.

All of the recovered samples of the subsoils were visually or manually classified in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 and D 2488) and selected samples tested in our laboratory for moisture content (ASTM D 2216). Dry density determinations and unconfined compressive strength tests (ASTM D 2166) were also performed on selected samples. Unconfined compressive strength estimates were obtained for the remaining intact cohesive samples using a calibrated hand penetrometer.

A particle size analysis (ASTM D 6913 and D 7928) and an Atterberg Limits test (ASTM D 4318) were performed on representative samples collected from the hole bottom of all five percolation test locations to determine soil classification and soil index properties, as well as surfacing (SS-1) samples from Borings B-2, B-5 and B-8 for pavement subgrade evaluations. The test results are presented in Appendices A through D attached to this report.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of test borings made at specific locations, especially at previously developed sites. Therefore, it is essential that a geotechnical engineer be retained to provide soil engineering services during the site preparation and excavation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.0 PROPOSED CONSTRUCTION

It is our understanding that the project consists of improvement of the 930± x 690± feet area located to the east of the Market Street and limited with the rows of residential houses along the Erskine and Meadowbrook Avenues and Southern Boulevard located close to the north, south and east property limits, respectively. The site of the proposed improvement is generally located on the east of the Market Street and 1.13 miles north of the Boardman Poland Road (SR 224) in Boardman Township, Ohio.

The subject site was previously occupied with school buildings which were recently demolished. Per Google Earth imagery from May 9, 2022, the site was still occupied at the time with the school buildings. Topographically, ground surface at that time was sloped down from the east and the west toward central ditch/depression area aligned in north-south direction with elevation difference of 12 to 24 feet across the site. Elevations of 1054, 1059 and 1066 are estimated at north end, midpoint, and south end of the subject site along Market Street with elevation of 1042± along the dich line. However, based on the drillers photos made during the drilling process and recent verbal communication with them, currently, the site is cleared from the school structures and appears to be relatively flat and level with grass covered surface; a U-shaped entry loop drive is still in the place and a large tree is noticed at the entrance to the property. The quantity of fill, if any, placed on the site during or after the demolition process to establish the current grade is uncertain.

Main features of the proposed site development include the new, relatively small Pavilion building located at the entrance to the property with an adjacent small parking lot to the south. The vehicle entry/exit loop drive will partially serve as parking. An approximately 10-foot-wide paved trail is planned from the site entrances and circumnavigates the central park area. This trail is connected by turnarounds and entrance driveways to the streets located north and south of the site. At midpoint of the west and east sides of the trail loop a Boardwalk Overlook with Arbor and Overlook seating are planned, respectively. The latest structure might have incorporated a short and no more than three feet tall retaining wall. In the center of the site is designed horseshoe-shaped, daylighted and relocated stream bed with inlet and outlet culverts on the south and north side of the property, respectively. The existing sanitary lane aligned in south-north direction at the central portion of the site is planned to be relocated to the eastern portion of the property generally following the future paved trail alignment. Within the stream curves, three floodplain overflow areas are planned. Overall, the area is fulfilled with landscaping features such as low mounds, meadows, trees, and bushes.

Structural loads were not available at the time of preparing this report but are assumed to be light to moderate in magnitude. Maximum column loads are assumed to be 30 kips and maximum wall loads are assumed to be 2,000 pounds per lineal foot (plf). As mentioned above, the project includes design of light pavilion building structure and two, three-sided, pre-cast box concrete culverts.

The existing entry car loop drive and the future parking lot, pedestrian trail, a single lane walks and access drives with turnarounds are anticipated to consist of flexible (asphalt) sections or/and rigid (concrete) sections. The turnarounds and parking lot at the entrances to the site are planned as permeable pavement depending on the percolation testing results. Traffic loads and volumes were not available at the time of preparing this report.

It is anticipated that final site grades will approximate currently existing grades. However, it is assumed that some site grading was performed as a result of demolition activities, including potential fill in the central area, basement, and any other underground cavities (such as boiler room), which are commonly present on these types of sites. Therefore, there is potential for the presence of deeper undocumented fill soils being encountered at the site.

4.0 GENERAL SITE AND SUBSURFACE CONDITIONS

4.1 General Site Conditions

At the time of our investigation, the site of the future construction was open, relatively flat and level with grass at the surface. Asphalt pavement at the surface was observed on the U-shaped entry drive on the west side of the property.

The surface materials encountered in nearly all the borings consisted of topsoil generally varying in thickness from approximately 6 to 18 inches. In Boring B-5, no discernible topsoil at the surface was observed.

Below the topsoil in Borings B-1, B-5, B-7, B-9, and B-10 cohesive and granular existing fill extending was encountered to depths ranging from 3½ to 6 feet below the surface. Non-soil materials within the fill included gravel, crushed stone, concrete fragments, and organics, in some to trace quantities.

The cohesive existing fill materials consisted of sandy silt, lean clay, and silty clay. SPT N-values ranged from 5 to 9 blows per foot, indicating medium stiff to stiff consistency. Moisture contents ranged from 15 to 21 percent.

The granular existing fill materials consisted of crushed stone and clayey sand. SPT N-values ranged from 5 to 8 bpf, indicating loose compactness. Moisture contents ranged from 15 to 18 percent.

4.2 General Soil Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface materials and existing fill materials consisted of predominantly cohesive soils with intermittent layers of granular material, underlain by bedrock.

Underlying the cohesive/cohesionless existing fill materials in the above-mentioned borings and at the reminder of the borings starting below the topsoil, were encountered cohesive naturally deposited soils extending to depths ranging from 8.5 to 20.0 feet. Penetrated soils in this stratum were sandy silt (ML), lean clay (CL) and silty clay (CL-ML). Intermittent layer of granular soil silty sand (SM) or Clayey Sand (SC) was detected in borings B-3, B-4 and B-6 at respective depths of 8.5 to 13.5 feet, 3.5 to 6.0 and 6.0-8.5 feet; in boring B-10 this type of granular soil was detected at the depth of 8.5 to 13.5 feet underlining this stratum and extending to the bedrock. Cohesionless, granular material was also encountered close to termination depths in borings B-7. Boring B-2, B-9 and B-10 were encountered shale bedrock at the depth of 13.5 feet below the grade extending to the termination depth with exception of boring B-9 which is terminated in coal detected in the last (SS-5) sample. SPT N-values ranged from 4 to 24 bpf, indicating soft to very stiff consistency; one sample (SS-5) with hard consistency was detected in boring B-9. In cohesionless, granular materials recorded N-values were 5-26 bpf determining loose to medium dense compactness. Note that cohesionless material at the termination depth in boring B-7 has 75+ bps and it is ranged as material with very dense compactness. Moisture contents ranged from 9 to 29; 9-26 and 4-13 percent for cohesive, cohesionless and shale bedrock materials, respectively.

For representative samples from Percolation Test PT-1through PT-5 for the samples collected from the bottom of the testing holes (depths between 2 and 3 feet below the surface), based on the results of gradation and index property testing, a USCS sandy silty clay (CL-ML) was classified at PT-1, while in the samples PT-2 through PT-5 sandy lean clay (CL) designation was determined.

Additional descriptions of the stratigraphy encountered in the borings are presented on the Logs of Test Borings.

4.3 Groundwater Conditions

Groundwater was initially encountered during drilling in 7 of the borings at depths ranging from 4 to 13 feet below existing grades; no groundwater was detected in boring B-3, B-7 and B-9. Groundwater was observed upon completion of drilling in 5 borings at depths ranging from 5 to 13 feet; holes B-3, B-4, B-5, B-7, and B-9 were observed dry at completion. It should be noted that each of the borings was drilled and backfilled within the same day. As such, stabilized water levels may not have occurred over this limited time period. Instrumentation was not installed to observe long-term groundwater levels.

Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that the “normal” groundwater level at the site may generally be encountered at depths of approximately 5 feet or greater below existing grade. However, it should be noted that groundwater elevations can fluctuate with seasonal and climatic influences.

4.4 Field Percolation Test Results

This subsurface investigation included five field percolation tests, designated PT-1 through PT-5, which were performed on September 5, 2023, by Ridgeway Drilling under CT’s direction. The percolation test sites were located in the field by CT engineer, based on the testing location plan. The test locations were prepared using an ATV-mounted drilling rig and 2¼-inch inside diameter hollow-stem augers, which resulted in a borehole diameter of approximately 6 inches. The bottom of the percolation test holes was extended to a depth of 2 feet below existing grade except PT-2 which was performed at the depth of 3 feet below the grade.

The percolation test holes encountered cohesive, fine-grained soils consisting of sandy lean clay at four locations; an exception was testing PT-1 where sandy silty clay was detected at the testing depth. The sides and bottom of the percolation test holes were scarified, and then the boreholes were filled with water to saturate the subsoils and initiate the tests.

All five testing holes were filled with water for two hours to generate soil saturation and produce saturated water flow. Then, test holes were leveled with water and monitored for water level drop; readings were made every 30-minute increments for a total of 300 minutes (5 hours). During the 5-hours reading period at all five testing locations non-measurable water drop was observed; water level was the same all the time without any change.

The USDA Natural Resources Conservation Service (NRCS) Web Soil Survey indicates that the upper profile soils at the site are mapped as Fitchville (FIB), Jimtown (JwB), Rittman (RuB) and Sebring (Sg) and Wadsworth (WbB) soils. The Fitchville soils consist of very deep, somewhat poorly drained soils formed in stratified Wisconsinan age glaciolacustrine sediments on terraces in valleys on till plains and lake plains. The Jimtown soils consist of very deep, somewhat poorly drained soils formed in outwash deposits on stream terraces, outwash terraces, outwash plains, and beach ridges. The Rittman soils consist of very deep, moderately well drained soils formed in Wisconsinan age low lime till on plains. The Sebring series consists of very deep, poorly drained soils formed in stratified Wisconsinan age glaciolacustrine sediments on slackwater terraces on lake plains and some local areas on till plains. The Wadsworth series consists of very deep, somewhat poorly drained soils formed in Wisconsinan age till on till plains. Some pedons have a thin mantle of loess or other silty material.

Each of the mapped soils are considered to be poor to moderately drained. Ranges of permeability values published for the upper profile soils are summarized in the following table.

		Table 4.4 Published Permeability Values			
Soil Type	Depth (inches)	USDA Texture	USCS Soil Type	Saturated Hydraulic Conductivity (micrometer per second) L-H/R	Permeability (Inches per hour) Low – High/ Representative Values
Fitchville -FIB	0-8	Silt Loam	Sandy Silt (CL-ML), Silty Clay (CL)	1.0-10.0/ 5.5	0.14 - 1.41/ **0.78**
	8-12	Silt Loam, Silty Clay Loam		1.0-10.0/ 5.5	0.14 – 1.41/ **0.78**
	12-38	Silt Loam, Silty Clay Loam	Silty Clay (CL)	1.0-10.0/ 2.0	0.14 – 1.41/ **0.28**

	38-45	Silt Loam, Silty Clay Loam		1.0-10.0/ 2.0	0.14 – 1.41/ **0.28**
	45-72	Silt Loam, Silty Clay Loam, Stratified Silt Loam to Silty Clay Loam	Silty Clay (CL)	1.0-10.0/ 3.5	0.14 – 1.41/ **0.50**
Jimtown-JwB	0-9	Loam	Sandy Silt, (ML), Silty Sand (SM)	4.23-14.11/ 9.17	0.60 – 2.00/ **1.30**
	9-30	Gravely Loam, Gravely Sand	Silty Gravel, Silty Sand (GM, SM), Sandy Silt, (ML)	4.23-14.11/ 9.17	0.60 – 2.00/ **1.30**
	30-60	Stratified loamy Sand to gravely sandy loam to fine sandy loam	Silty Sand, Silty Gravel, Silty Sand and Gravel, (GM, GW-GM, SM, SW-SM)	42.34-141.14/ 84.86	6.00 – 20.00/ **12.03**
Rittman-RuB	0-8	Silt Loam	Silty Clay, Sandy Silt (CL, CL-ML, ML)	1.30-1.50/ 1.40	0.18 – 0.21/ **0.20**
	8-11	Silt Loam, Silty Clay Loam, Clay Loam	Silty Clay, Sandy Silt (CL, CL-ML)	1.30-1.50/ 1.40	0.18 – 0.21/ **0.20**
	11-23	Clay Loam, Silty Clay Loam, Silt Loam	Silty Clay (CL)	1.35-1.60/ 1.45	0.19 – 0.23/ **0.21**
	23-42	Clay Loam, Silty Clay Loam, Silt Loam, Loam	Silty Clay, Silty Sand (CL, SC)	1.65-1.90/ 1.70	0.23 – 0.27/ **0.24**
	42-49	Clay Loam, Silty Clay Loam, Silt Loam, Loam	Silty Clay, Silty Sand (CL, SC)	1.55-1.85/ 1.70	0.22 – 0.26/ **0.24**
	49-70	Loam, Silt Loam, Silty Clay Loam, Clay Loam,	Silty Clay, Silty Sand (CL, SC)	1.55-1.85/ 1.70	0.22 – 0.26/ **0.24**
Sebring-Sg	0-9	Silt Loam	Silty Clay, Sandy Silt (CL, ML)	1.20-1.45/ 1.30	0.17 – 0.21/ **0.18**
	9-14	Silt Loam	Silty Clay, Sandy Silt (CL, ML)	1.25-1.50/ 1.45	0.18 – 0.22/ **0.21**
	14-38	Silt Loam, Silty Clay Loam	Silty Clay, Lean Clay (CL, CH)	1.40-1.65/ 1.55	0.20 – 0.23/ **0.22**
	38-44	Silt Loam, Silty Clay Loam	Silty Clay (CL)	1.40-1.65/ 1.55	0.20 – 0.23/ **0.22**
	44-72	Silt Loam, Silty Clay Loam, Stratified Sandy Loam to Loam	Silty Clay, Sandy Silt (CL, CL-ML)	1.40-1.65/ 1.60	0.20 – 0.23/ 0.23
Wadsworth-WbB	0-8	Silt Loam	Silty Clay, Sandy Silt (CL, CL-ML)	1.0-10.0/ 5.5	0.14 - 1.41/ **0.78**
	8-13	Silt Loam, Silty Clay Loam	Silty Clay (CL)	1.0-10.0/ 5.5	0.14 - 1.41/ **0.78**
	13-23	Silty Clay Loam, Silt Loam, Clay Loam	Silty Clay (CL)	1.0-10.0/ 5.5	0.14 - 1.41/ **0.78**
	23-42	Silt Loam, Clay Loam, Silty Clay Loam,	Silty Clay, Silty Sand (CL, SC)	0.01-1.0/ 0.1	0.001- 0.142/ **0.014**
	42-51	Silty Clay Loam, Loam, Silt Loam, Clay Loam	Silty Sand, Silty Clay (SC, CL)	0.01-1.0/ 0.1	0.001- 0.142/ **0.014**
	51-74	Loam, Clay Loam, Silty Clay Loam, Silt Loam,	Silty Clay, Silty Sand (CL, SC)	0.01-1.0/ 0.1	0.001- 0.142/ **0.014**

L-Expected Low Value, H- Expected High Value, R- Representative Value

The published data indicates low permeability for the on-site cohesive soils above the test depth. Based on the results of our field percolation test (non-recordable values, zero water drop and no water level movement/drop noticeable by human eye), correlations with grain size, and published permeability values, **we recommend a sensitivity analysis be performed using: 1.3 inches per hour in the vicinity of PT-1 and PT-5; 0.18 inches per hour in vicinity of PT-2 and 0.20 inches per hour in the vicinity of PT-3 and PT-4.**

5.0 DESIGN RECOMMENDATIONS

The following conclusions and preliminary recommendations are based on our understanding of the proposed construction and on the data obtained during the field investigation. If the project information or location as outlined is incorrect or should change significantly, a review of these preliminary recommendations should be made by CT. These preliminary recommendations are subject to additional geotechnical exploration and analysis for final design, and are also contingent on satisfactory completion of the recommended site and subgrade preparation and fill placement operations described in Section 6.0, "Construction Recommendations."

5.1 Shallow Foundations

Per the available plans relatively light at-grade structures are designed for the subject improvement. It's consisted of Pavilion Building and Boardwalk Overlook which will be elaborated in the following section 5.1.1. Separate elaboration will be given in section 5.1.2 for three-sided culvert foundation.

5.1.1 Building and Boardwalk Overlook Foundation

Based on the field and laboratory test results, exterior foundation excavations for Pavilion building (borings B-3 and B-4), Boardwalk Overlook (borings B-5) and Overlook Seating (boring B-7) at a depth of 42 inches (minimum required depth for protection from frost penetration) and shallower interior foundation excavations are anticipated to encounter predominantly stiff sandy silt or loose silty sand (N-value of 9 and 6), stiff sandy lean clay (N-value of 10), medium stiff lean clay (N-value of 8), respectively, as well as existing fill materials. The native cohesive and granular soils are considered generally suitable for support of the proposed foundations. However, loose granular soils exposed at foundation bearing elevation will require in-place densification to provide a consistent bearing stratum and reduce post-construction settlement. Foundation bearing materials may also consist of new engineered fill utilized to achieve design grades.

Based on Borings B-1,B-5, B-7 and B-10, cohesive existing fill materials may also be encountered at foundation bearing elevations, depending on site grading. Where existing fill materials are encountered at the foundation subgrade elevation, they must be over-excavated and replaced with new engineered fill as described below.

Where the excavated subgrade reveals loose granular soils at footing bearing elevation, in-place modification must be performed using a backhoe-mounted vibratory compactor (hoe-pac) or similar equipment to achieve a consistent bearing stratum. Suitable compaction/bearing of foundation soils can be verified as:

> Exhibiting a compacted (in-situ) dry density of at least 100 percent of the maximum dry density determined by Standard Proctor (ASTM D 698) laboratory compaction,

> A dynamic cone penetrometer (DCP) reading of at least 8 blows per increment (average over three increments), or

> Other methods to demonstrate an equivalent SPT N-value of 10 bpf or greater.

Where existing fill materials are encountered, if unsuitable foundation soils that cannot be suitably modified in place are encountered during foundation installation, or if other unsuitable foundation materials are encountered, over-excavation should extend through these materials to suitable bearing soils. The base of the over-excavation should be widened one foot for every foot of depth below the planned bearing depth, with the over-excavation centered along the footing. The over-excavated areas should be backfilled with dense-graded aggregate, placed in controlled lifts, and compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor). Alternatively, the over-excavated areas could be backfilled with lean concrete having a minimum compressive strength of 1,500 pounds per square inch (psi) or other flowable controlled-density fill having a minimum compressive strength of 300 psi. If foundations will be placed at the base of the over-excavation or the lean concrete fill option will be utilized, widening the footing over-excavation will not be required. If the controlled-density fill option is utilized, the footing over-excavation shall be widened as discussed above.

Following the satisfactory completion of the site preparation and footing excavation inspections outlined in Section 6.0 of this report, the proposed structure may be supported on a conventional shallow spread foundation system consisting of wall (strip) and/or column (square) footings. Shallow foundations may be designed utilizing a net allowable bearing pressure of 2,000 pounds per square foot (psf) for strip and square footings. In using a net allowable soil pressure, the weight of the footings, backfill over the footings or floor slabs need not be included in the structural loads for dimensioning footings. The bearing materials should be field verified as being native cohesive soils that exhibit suitable consistency as described above, native cohesive soils with a minimum unconfined compressive strength of 2,000 psf, or properly placed and compacted new engineered fill.

Due to the encountered existing fill materials, we strongly recommend that the bearing surface at the bottom of all footing excavations be inspected during construction by a CT geotechnical engineer or qualified representative. Inspection should be performed to verify that the exposed soil conditions at the bearing elevations are consistent with the subsurface conditions encountered in the test borings. Additionally, the presence of our engineer will help facilitate the timely remediation of unsuitable soil conditions. If the results of hand penetrometer, DCP, or other strength tests indicate the exposed soil conditions are not suitable for the design bearing pressure, it may be necessary to modify the bearing soils in-place, increase the footing size to accommodate the lower bearing strengths, or over-excavate and backfill with engineered fill or flowable fill.

All exterior footings and footings in unheated areas should be constructed at a minimum frost penetration depth of 42 inches below finished exterior grades. Interior footings may bear at a convenient depth below the floor slab, provided they are supported on compacted native soils as described above, or properly placed and compacted new engineered fill. Wall (strip) footings should be at least 18 inches wide, and column (square) footings should be at least 30 inches square, regardless of sizing based on design loads and the allowable bearing pressure.

During the final design investigation, the design bearing pressure may be refined with consideration to conditions encountered in final design borings, finish floor elevation, and design loads such that total settlement associated with the structure should not exceed 1 inch and differential settlement should not exceed ¾ inch with proper foundation inspection techniques.

5.1.2 Three-sided Culvert Foundation

Consideration is being given to using three-sided, pre-cast concrete box culvert; it is expected that system will be no more than 10 feet deep. Recommendations are provided below for evaluation of foundations for the culvert, culvert walls, and headwalls associated with the culvert.

Culvert foundations should bear at least 3½ feet below finished grades to provide protection from frost penetration. Deeper embedment may be required depending on scour considerations. Lacking detailed drawings, we are assuming that culvert bearing elevation will be in the range between 3.5 and 8.5 feet below the grade.

Based on the conditions encountered in Borings B-1 and B-9 drilled at the culverts' locations, the soils at this bearing elevation are anticipated to consist of medium stiff to hard cohesive soil with N-values of 6 to 13 and 5 to 41, respectively. Note that this soil strength is evaluated throughout upper portion of the soil profile to the depth of 8.5 feet below the grade. Note that at a depth of 3.5 feet, SPT testing was not performed, and N-values are not available due to Shelby tube samples extraction. However, pocket penetrometer readings of 3.5 tsf and 1.45 tsf taken on the sample at 3.5 feet depth are indicators of very stiff to stiff soil consistency within this soil stratum. Lacking design culvert details, we are recommending that shallow culvert foundations may be designed utilizing a net allowable bearing pressure of 1,500 pounds per square foot (psf) if bearing depth is at or shallower than five feet below the grade existed at the time of subsoil exploration; or 2,000 psf if structure bears at a depth deeper than five feet. In using a net allowable soil pressure, the weight of the footings, backfill over the footings need not be included in the structural loads for dimensioning footings. The bearing materials should be field verified as being native cohesive soils that exhibit suitable consistency as described above, native cohesive soils with a minimum unconfined compressive strength of 1,500/2,000 psf, or properly placed and compacted new engineered fill. The borderline soft to medium stiff cohesive soils are considered generally suitable for support of spread footing foundations using a relatively low allowable bearing capacity. If very soft cohesive soils are encountered, they will require removal and replacement with new granular engineered fill as described below. Additionally, if sediment is present at the foundation bearing elevation, it will require over-excavation and replacement with new granular engineered fill.

If sediment, very soft native cohesive soils, or other unsuitable foundation bearing soils are encountered, over-excavation should extend through these materials to suitable bearing soils, with widening of the footing over-excavation as described below. The base of the over-excavation should be widened one foot for every foot of depth below the planned bearing depth, with the over-excavation centered along the footing. The over-excavated areas should be backfilled with dense-graded aggregate, placed in controlled lifts, and compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor). Alternatively, the over-excavated areas could be backfilled with lean concrete having a minimum compressive strength of 1,500 pounds per square inch (psi) or other flowable controlled-density fill having a minimum compressive strength of 300 psi. If foundations will be placed at the base of the over-excavation or the lean concrete fill option will be utilized, widening the footing over-excavation will not be required. If the controlled-density fill option is utilized, the footing over-excavation shall be widened as discussed above.

We strongly recommend that the bearing capacity at the bottom of all footing excavations be checked during construction by a CT geotechnical engineer or qualified representative to verify that the exposed soil conditions at the bearing elevations are consistent with the subsurface conditions encountered in the test borings, and that unsuitable materials have been over-excavated and replaced with properly placed new engineered fill. Additionally, the presence of our engineer will help facilitate the timely remediation of unsuitable soils. If the results of hand penetrometer or other strength tests indicate the exposed soil conditions are less favorable than those indicated by the borings, it may be necessary to increase the footing size to accommodate the lower bearing strengths, or to over-excavate and backfill with new engineered fill.

If foundation excavations will not be concreted the same day as excavation occurs, we recommend that a thin mat of lean concrete be placed over the cohesive bearing soils to protect the bearing surface from groundwater seepage and/or construction.

Culvert and headwall footings should be at least 24 inches wide. For shallow foundations, overturning and sliding stability due to wall backfill should also be considered for the headwalls, and wider footings may be needed to satisfy stability for these loading conditions. Additionally, scour/erosion protection of the shallow foundations should be considered.

Headwall foundations should be designed in accordance with the recommendations presented in Section 5.1.1.

For culvert walls and headwalls that are restrained from rotation and are considered rigid and non-yielding, lateral earth pressure should be assumed for at-rest conditions. It is anticipated that excavated on-site cohesive soils will be utilized for the majority of the backfill behind the new walls. For these soils, an at-rest earth pressure coefficient (k_o) of 0.750 should be used in determining the lateral pressure acting on the walls, along with a total (moist) soil unit weight of 130 pounds per cubic foot (pcf). Alternatively, an equivalent fluid weight of 98 pcf may be used for the at-rest case design. If lower at-rest earth pressures are preferred for structural reasons or to improve overturning/sliding stability, we recommend that a select, free-draining granular fill (such as No. 57 or 67 stone) be utilized for the entire wall backfill zone. For these granular fill types, k_o may be taken as 0.35, and the soil unit weight may be assumed as 120 pcf. Alternatively, an equivalent fluid weight of 42 pcf may be used for these granular fills.

Headwalls that are not restrained at the top of the wall may be designed for active lateral earth pressure condition. If the on-site cohesive soils are utilized for the backfill behind the headwalls, a k_a value of 0.600 may be used for design along with a soil unit weight of 130 pcf or alternatively, an equivalent fluid weight of 78 pcf may be used. If a free-draining granular fill is utilized, a k_a value of 0.21 may be used for design along with a soil unit weight of 120 pcf, or alternatively, an equivalent fluid weight of 25 pcf may be used.

It should also be noted that these earth pressures do not include hydrostatic pressures that may result from elevated groundwater conditions above the normal waterway level. We recommend that consideration be given to headwall drainage to prevent build-up of unbalanced hydrostatic pressures behind the walls. We recommend that headwalls greater than 4 feet in height include a minimum 2-foot granular drainage zone behind the wall, in combination with wall weep holes and/or longitudinal foundation drainpipe at the base of the wall footing that is free to drain by gravity discharge. Otherwise, the wall design should consider an appropriate resistance factor based on flood elevations or other seasonal groundwater conditions.

Additionally, the earth pressures indicated above are based on a level backfill condition behind the headwall. However, if there are areas where appreciable sloping backfill is required near the top of the wall, surcharge loading or equivalent higher earth pressure coefficients should be evaluated, based on backfill material, backfill slope, and proximity to the wall. In general, 50 percent of the vertical surcharge load may be assumed for lateral loading in the design of the wall.

Culverts should be backfilled concurrently with nearly equal fill heights on both sides to avoid inducement of overturning or sliding instability. Headwall footings should also be checked for sliding stability. We recommend that passive pressure be considered negligible at the toe of the headwall due to the potential for erosion and/or freeze-thaw behavior that would significantly reduce reliance on passive earth pressure.

5.2 Subgrades

5.2.1 Existing Subgrade

The subgrades that would result upon the satisfactory completion of the site preparation as described in Section 6.0 of this report are considered generally suitable for support of the proposed floor slabs and pavements. Based on field and laboratory data developed during this investigation, the subgrade soils consist of cohesive existing fill materials and native cohesive soils. Laboratory analysis performed for representative samples from Borings B-2 (SS-1), B-5 (SS-1) and B-8 (SS-1), as well as visual descriptions of the upper soil profile, indicate that the cohesive subgrade soils may be generally classified as Group A-4a and A-6a in accordance with the Ohio Department of Transportation (ODOT) system of soil classification. The cohesive soils are considered fair to poor as subgrade materials because they have relatively low permeabilities and a high percentage of silt and clay particles, which makes them susceptible to moisture, frost penetration and frost heave.

At the time of this investigation, moisture contents in the upper 2½ feet of the subgrade soils generally ranged from approximately 14 to 26 percent. These moisture contents are estimated to vary from near to significantly above the expected optimum moisture contents for these soils. Some remedial action should be anticipated to adjust the moisture contents of the existing materials and achieve proper compaction of the subgrade, particularly during wet seasonal periods. Remedial action should also be anticipated for loose granular soils encountered within the vicinity of Boring B-9.

5.2.2 Modified Subgrade

Although not anticipated to be prevalent, if soils are dry of optimum, water should be uniformly mixed into the subgrade. More likely to be present at this site are soils that are wet of optimum. Where soils wet of optimum are encountered, lowering the moisture content by scarification and aeration (discing and exposure to sun and wind) may be required. However, this may not be feasible if construction occurs during wet seasonal conditions. Very moist to wet soils will "pump" under the operation of heavy equipment, resulting in deep rutting and perhaps rendering the operation of grading and paving equipment difficult or impossible.

Therefore, other methods of subgrade modification may be required in areas of high moisture content. Modification may be achieved by undercutting and replacement with granular subbase (possibly in combination with a geotextile separation layer or geogrid reinforcement), mixing stone into the subgrade, or treating the subgrade with cement. The method of subgrade modification should be determined at the time of construction (See Section 6.1, "Construction Recommendations - Site and Subgrade Preparation").

5.3 Floor Slabs

It should be noted that the conditions of the existing fill materials encountered in the borings are generally suitable for support of floor slabs, provided they are properly prepared as described in Section 6.1 of this report. However, as in any case of existing fills of unknown origin, there is potential for variable and less favorable conditions between boring locations that increase the risk for settlement of the floor slab. If this risk is unacceptable, partial or full depth removal of the existing fill materials would be required.

It is recommended that all floor slabs be “floating”, that is, fully ground supported and not structurally connected to walls or foundations. This is to reduce the possibility of cracking and displacement of the floor slabs because of differential movements between the slab and the foundation. Such movements could be detrimental to slabs that are rigidly connected to the foundations. There may be certain areas where it will be difficult or impractical to make the slab floating. In such areas, it may be necessary to increase the slab thickness and reinforcement to prevent the foundation from cracking the slab and settling independently.

For properly prepared Group A-6a or better subgrade soils, a modulus of subgrade reaction (k) of 150 pounds per cubic inch (pci) may be used for floor slab design. It is recommended that the floor slab be supported on a minimum 6-inch layer of relatively clean granular material such as sand and gravel or crushed stone. This is to help distribute concentrated loads and provide more uniform subgrade support beneath the slab.

5.4 Flexible (Asphalt) Pavement

Based on the results of the gradation analyses as well as visual classification of the recovered samples, we recommend a subgrade CBR value of 6 percent for the Group A-6a or better soils. This CBR value is based on subgrade compacted to at least 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor) or verified as stable through proof rolling.

It should be noted that we are not privy to the design traffic loads or intended design life. During final design, the subgrade support recommendations indicated herein (and in the final investigation report) should be reviewed by the site engineer in conjunction with the design traffic criteria to determine the required pavement sections. In any case, we recommend the light-duty pavement cross-section consist of at least 3 inches of asphalt underlain by 6 inches of aggregate base for even the lightest-duty pavements based on our experience regarding environmental exposure and reasonable serviceability. For the same reason, we recommend the heavy-duty pavement cross-section (at a minimum, for any bus drive lanes) consist of at least 4 inches of asphalt underlain by 8 inches of aggregate base.

All paving operations should conform to Ohio Department of Transportation (ODOT) specifications. The pavement and subgrade preparation procedures outlined in this report should result in a reasonably workable and satisfactory pavement. It should be recognized, however, that all flexible pavements need repairs or overlays from time to time as a result of progressive yielding under repeated traffic loads for a prolonged period of time, as well as exposure to weather conditions.

5.5 Rigid (Concrete) Pavement

For properly prepared Group A-6a or better subgrade soils, a modulus of subgrade reaction (k) of 150 pounds per cubic inch (pci) may be used for rigid pavement design. A concrete pavement section is recommended in the areas of repetitive turning, site exit and entrance aprons, and trash enclosure areas (including where the truck parks while servicing the container). These sections should consist of a minimum of 6 inches of reinforced, air-entrained concrete with a minimum compressive strength of 3,500 psi underlain by a minimum of 6 inches of a dense-graded granular base. The pavement section should be supported on a subgrade compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor) or verified as stable through proof rolling. All paving operations should conform to the State of Ohio Department of Transportation (ODOT) specifications.

5.6 Pavement Drainage

Based on the poorly drained nature of the cohesive and silty granular subgrade soils, it is anticipated that surface water infiltration may collect in the aggregate base course. Without adequate drainage, water will remain in the base for extended periods of time, creating localized wet, soft pockets. The presence of these pockets will increase the likelihood that pavement distress (cracking, potholes, etc.) will develop. Drainage features may include grading the subgrade surface to slope downward to the outside edge of pavements and/or providing longitudinal edge drains connected to storm sewers or other outlets. A system of “finger drains” could also be installed near catch basins within the pavement areas to collect surface water, thus reducing the possibility of freeze-thaw effects on the pavement.

5.7 Groundwater Control and Drainage

As stated previously, groundwater was encountered during drilling and observed upon completion of drilling at depths of 5 to 13 feet below existing grades.

Based on the limited data available, such as the soil characteristics and the groundwater conditions encountered in the borings, it is our opinion that the “normal” groundwater level may be encountered at depths of 5 feet or lower below existing grades. It is our experience that adequate control of groundwater seepage or surface water run-off into shallow excavations should be achievable by minor dewatering systems, such as pumping from prepared sumps. If deeper excavations are required that extend below the groundwater table, installation of well points may be required in addition to pumping from preparation sumps. In the event excessive seepage is encountered during construction, CT may be notified to evaluate whether other dewatering methods are required.

5.8 Excavations and Slopes

The sides of temporary excavations for building foundations, underground utility installation, and other construction should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) standards must be followed. It is the responsibility of the installation contractor to develop appropriate installation methods and specify pertinent equipment prior to commencement of work, and to obtain the services of a geotechnical engineer to design or approve sloped or benched excavations and/or lateral bracing systems as required by OSHA criteria.

Where existing buildings, structures, roadways, or underground utilities are located within a distance from the excavation equal to approximately twice the depth of the excavation, an adequate system of sheet piling, lateral bracing, or an alternate construction procedure may be required to prevent lateral movements that may cause settlement of structures or embankment failures. Any retaining system proposed by the contractor should be reviewed by a CT geotechnical engineer prior to approval for installation and use.

The soils encountered in the test borings are classified as the following OSHA Type soils:

> OSHA Type A soils (cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),

> OSHA Type B soils (cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf), and

> OSHA Type C soils (fill materials, granular soils, and cohesive soils with unconfined compressive strengths of 1,000 psf or less).

For temporary excavations in Type A, B, and C soils, side slopes should be constructed no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. For situations where an excavation encounters a lower strength soil underlying a higher strength soil, the slope of the entire excavation is governed by the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

For permanent excavation slopes, we recommend that grades be no steeper than 3H:1V without a more extensive geotechnical evaluation of the proposed construction plans and site conditions.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Site and Subgrade Preparation

Prior to proceeding with construction operations, all pavements, root systems, vegetation, and other deleterious non-soil materials should be removed. Suitable topsoil may be stockpiled for later use in landscaped areas. Typically, soils with more than 5 percent organics are not recommended as subgrade soils in structure and pavement areas, but dark colored soils having the appearance of topsoil with only trace “root hairs” of 5 percent or less may not necessarily require stripping. For these “transitional” soils, the actual moisture content and subgrade stability under proof-rolling operations is more critical than the color in determination of the amount of stripping or subgrade undercut. The actual amount of required stripping should be determined in the field by a geotechnical engineer or qualified representative.

Due to the existing development at the site, the proof rolling and preparation of this site will require careful inspection. We have to note that the existing structures demolition was done recently, and we assume there were basement and boiler room underground cavities which were backfilled. With unknown quantity and quality of placed backfill and possible fill to reach the current site grading, the proof roll testing is crucial. Also, the completeness of the removal of demolished existing structural elements is unknown to us. Thusly, if visible or detected during the proof roll testing or later during the excavation for footer construction, all existing rigid elements, such as footer and wall pieces, pipes, manholes, larger floor slab segments, etc., must be completely removed from within the building area and from within the top two feet below the subgrade in the pavement areas to avoid stress concentration and pinching points through the pavement. Voids remaining after footing removal and utility trench abandonment, and other exposed excavations should be backfilled with engineered fill, placed in controlled lifts, and tested for suitable compaction in accordance with the criteria in Section 6.2 of this report. If such excavations are randomly filled or graded without compaction control, excessive differential settlement could occur.

Upon completion of stripping and clearing, the areas intended to support floor slabs, pavements and new fill should be carefully inspected by a geotechnical engineer. The engineer should observe proof-rolling of the cohesive subgrades utilizing a 20- to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight. The truck should make a minimum of two passes in each of two perpendicular directions covering the proposed development area, with additional passes as necessary to achieve required compaction and/or subgrade stabilization. The purpose of proof rolling the cohesive subgrades is to locate any weak, soft, or excessively wet soils that may be present at the time of construction.

Any unsuitable materials observed during the inspection and proof-rolling operations should be undercut and replaced with compacted fill or stabilized in place utilizing conventional remedial measures such as discing, aeration, and recompaction. Once the site has been proof-rolled, inspected, and stabilized, the proof-rolled or inspected subgrades should not be exposed to wet conditions. It should be recognized that during periods of wet weather, the clayey soils that will be exposed at design subgrades will tend to pond water for short periods of time, with the potential to deteriorate the prepared subgrade.

The results of the inspection and proof-rolling operations will be partially dependent on construction operations, the moisture content of the soil, and the weather conditions prevalent at the time. If pumping or rutting is encountered and difficulty is experienced in the operation of construction equipment, CT should be notified in order to determine which method of subgrade modification may be best suited for the conditions encountered. Should such conditions be experienced, we may recommend that a small test area be used to determine the necessary depth of undercutting and stone replacement or other remedial action necessary to achieve a stable subgrade condition.

6.2 Fill

Material for engineered fill or backfill required to achieve design grades may consist of any non-organic soils having a maximum dry density as determined by the Standard Proctor (ASTM D 698) of 90 pounds per cubic foot (pcf) or greater. To maintain the recommended subgrade support values (CBR value and k-value) presented in this report, new engineered fill within 36 inches of subgrade elevation should consist of ODOT A-7-6 or better soils. On-site soils may be used as engineered fill materials provided that they are free of organic matter, debris, excessive moisture, and rock or stone fragments larger than 3 inches in diameter. Depending on seasonal conditions, the on-site soils may be wet of optimum and may require scarification and aeration to achieve satisfactory compaction. The on-site granular soils should be generally favorable for drying. If the construction schedule does not allow for scarification and aeration activities, it may be more practical or economical to utilize imported granular fill.

Fill should be placed in uniform layers no more than 8 inches thick (loose measure) and adequately keyed into stripped and scarified soils. All fill within the building areas and pavement subgrades should be compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor).

The upper soil profile at the site mostly consists of cohesive and occasionally granular soils. Additionally, subgrades may consist of new engineered fill utilized to achieve design grades. The contractor should be prepared to use a sheepsfoot roller to provide effective compaction of the cohesive materials. For granular soils and granular engineered fill, a vibratory, smooth-drum roller would provide effective compaction of these materials. In narrow utility or footing excavations, the on-site cohesive soils may be difficult to compact; therefore, a clean granular material may be required in these areas.

Scarified subgrade soils and all fill material should be within 3 percent of the optimum moisture content to facilitate compaction. Furthermore, fill material should not be frozen or placed on a frozen base. It is recommended that all earthwork and site preparation activities be conducted under adequate specifications and properly monitored in the field by a qualified geotechnical testing firm.

6.3 Foundation Excavations

As mentioned in Section 5.1, foundation excavations should have a detailed inspection performed for each foundation. A geotechnical engineer or qualified representative should perform these inspections to verify that the exposed materials are similar to those encountered in the borings and that engineered fill has been properly placed and compacted such that it is capable of supporting the design bearing pressure.

We recommend that the foundation excavations be concreted as soon as practical after they are excavated and that water not be allowed to pond in any excavation. If it is necessary to leave the bearing surface open for any extended period of time, we recommend that a thin mat of lean concrete be placed over the bottom of the excavation to reduce damage to the surface from weather or construction. Foundation concrete should not be placed on frozen or saturated subgrade.

Additional foundation subgrade inspection and preparation recommendations are provided in Section 5.1.

7.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation of foundation and pavement design and construction conditions, as well as underground utility installation conditions, has been based on our understanding of the site, as well as the data obtained during our field investigation. The general subsurface conditions were based on interpretation of the subsurface data obtained in widely-spaced borings. Regardless of the thoroughness of a subsurface investigation, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions.

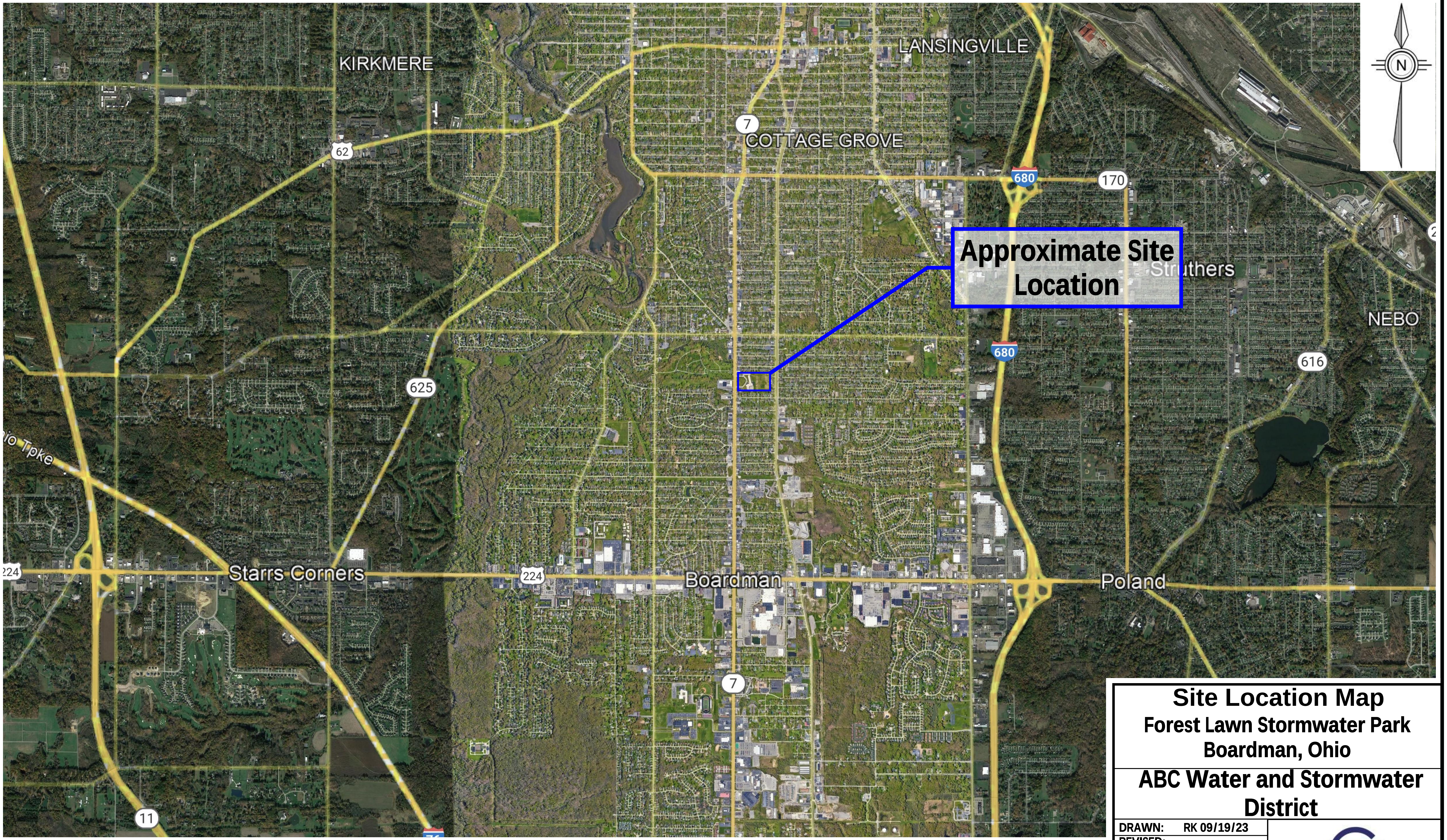
The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Therefore, experienced geotechnical engineers should observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, CT assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. CT is not responsible for the conclusions, opinions, or recommendations of others based on this data.

Plates

Plate 1.0 Site Location Map
Plate 2.0 Test Boring Location Plan



Notes: Aerial Basemap obtained From Google Earth and dated 05/09/2022.

Site Location Map

Forest Lawn Stormwater Park
Boardman, Ohio

ABC Water and Stormwater District

DRAWN: RK 09/19/23
REVISED: ---
Project No.: 210855
Drawing No.:
Plate 1.0

100 YEARS
LEADING THROUGH the next 100 years
www.ctconsultants.com

Legend:

B-1 ⊕ Approximate Test Boring Location

PT-1 ▚ Approximate Percolation Test Location

0' 30' 60'

N

Notes: Aerial Basemap obtained From Google Earth and dated 05/09/2022

Test Boring Location Plan

Forest Lawn Stormwater Park
Boardman, Ohio

ABC Water and Stormwater District

DRAWN:	RK 09/19/23
REVISED:	---
Project No.:	210855
Drawing No.:	Plate 2.0

APPENDIX A

Logs of Test Borings

CT Consultants, Inc.
1915 N 12th Street
Toledo Ohio 43604
Telephone: (419)324-2222

BORING NUMBER B-1

PAGE 1 OF 1

CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH
DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Pete
RIG NO. D50
GROUND ELEVATION 0 ft
DRILLING METHOD HSA
GROUND WATER LEVELS:
DATE STARTED 9/5/23
COMPLETED 9/5/23
∇ **AT TIME OF DRILLING** 6.5 ft / Elev -6.5 ft
LOGGED BY KKC
CHECKED BY KCH
▼ **AT END OF DRILLING** 13.0 ft / Elev -13.0 ft
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 / ▲ SPT N VALUE ▲ 20 40 60 80
0	0		TOPSOIL - 8 Inches 0.7'						
			FILL - Moist Medium Stiff Brown SANDY SILT w/Trace Gravel 3.0'	SS 1	100	5-3-3 (6)	2.75		15
			FILL - Moist Brown LEAN CLAY w/Sand, Trace Gravel, and Organics 4.0'	ST 1	42		3.50		18
			FILL - Moist Gray CRUSHED STONE w/Fabric Liner 4.5'						
-5	5		Moist Stiff Brown/Gray LEAN CLAY w/Sand and Trace Gravel (CL) ∇ 8.5'	SS 2	78	5-5-5 (10)	0.64	113	19
-10	10		Moist Stiff Gray SILT w/Sand and Trace Gravel (ML) ▼ 13.5'	SS 3	100	5-6-7 (13)	1.76	120	14
-15	15		Moist Very Stiff Gray LEAN CLAY w/Sand and Trace Gravel (CL)	SS 4	100	5-8-10 (18)	NI	119	15
-20	20		20.0'	SS 5	39	6-9-11 (20)	1.50		
			Bottom of hole at 20.0 feet.						

CT Consultants, Inc.
1915 N 12th Street
Toledo Ohio 43604
Telephone: (419)324-2222

BORING NUMBER B-2

PAGE 1 OF 1

CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH
DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Pete
RIG NO. D50
GROUND ELEVATION 0 ft
DRILLING METHOD HSA
GROUND WATER LEVELS:
DATE STARTED 9/5/23
COMPLETED 9/5/23
▽ **AT TIME OF DRILLING** 5.0 ft / Elev -5.0 ft
LOGGED BY KKC
CHECKED BY KCH
▼ **AT END OF DRILLING** 13.0 ft / Elev -13.0 ft
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 / ▲ SPT N VALUE ▲ 20 40 60 80
0	0		TOPSOIL - 8 Inches 0.7'						
			Moist Medium Stiff Brown LEAN CLAY w/Sand and Trace Gravel (CL)	SS 1	100	2-2-3 (5)	2.00		26
			3.5'						
			Moist Stiff Brown LEAN CLAY w/Sand and Trace Gravel (CL)	SS 2	100	3-4-7 (11)	3.75		20
-5	5		▽						
				SS 3	100	3-5-6 (11)	3.00		15
			8.5'						
			Moist Medium Stiff Gray LEAN CLAY w/Sand and Trace Gravel (CL)	SS 4	100	3-3-5 (8)	1.75		13
-10	10								
			▼ 13.5'						
			Moist Dense Gray WEATHERED SHALE w/Clay and Sand	SS 5	100	10-11-30 (41)	NP		13
-15	15		15.0'						
			Bottom of hole at 15.0 feet.						

CT Consultants, Inc.
1915 N 12th Street
Toledo Ohio 43604
Telephone: (419)324-2222

BORING NUMBER B-3

PAGE 1 OF 1

CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Cary

RIG NO. D50

GROUND ELEVATION 0 ft

DRILLING METHOD HSA

GROUND WATER LEVELS:

DATE STARTED 9/5/23

COMPLETED 9/5/23

AT TIME OF DRILLING None

LOGGED BY KKC

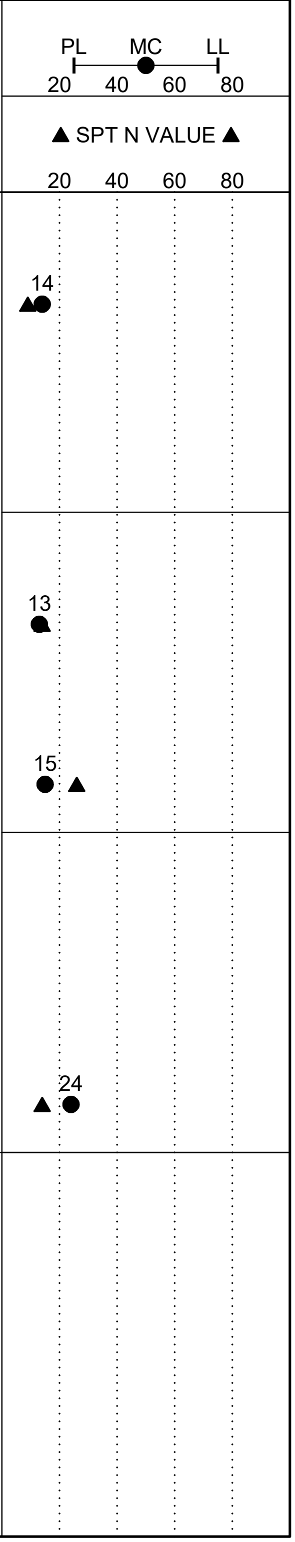
CHECKED BY KCH

AT END OF DRILLING None

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)
0	0		TOPSOIL - 6 Inches 0.5'					
			Moist Stiff Brown SANDY SILT w/Trace Gravel (ML)	SS 1	67	3-4-5 (9)	4.00	
				ST 1	100			
-5	5							
			8.5'	SS 2	94	3-6-8 (14)	4.50	
			Moist Medium Dense Brown SILTY SAND w/Gravel (SM)	SS 3	100	5-9-17 (26)	NP	
-10	10		13.5'					
			Moist Stiff Gray LEAN CLAY w/Sand (CL) 15.0'	SS 4	100	5-5-9 (14)	3.75	
-15	15		Bottom of hole at 15.0 feet.					



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BORING NUMBER B-4

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CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH
DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Cary
RIG NO. D50
GROUND ELEVATION 0 ft
DRILLING METHOD HSA
GROUND WATER LEVELS:
DATE STARTED 9/5/23
COMPLETED 9/5/23
∇ **AT TIME OF DRILLING** 13.0 ft / Elev -13.0 ft
LOGGED BY KKC
CHECKED BY KCH
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft) 0	DEPTH (ft) 0	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
			TOPSOIL - 7 Inches 0.6'						
			Moist Stiff Brown SANDY SILT w/Trace Gravel (ML)	SS 1	78	5-6-6 (12)	4.00		15
			3.5'						
			Moist Loose Brown SILTY SAND w/Trace Gravel (SM)	SS 2	89	3-3-3 (6)	NP		14
-5	5								
			6.0'						
			Moist Stiff Brown SANDY SILT w/Trace Gravel (ML)	SS 3	89	4-4-8 (12)	2.50	114	14
			@8.5': Gray, w/Trace Shale Fragments	SS 4	78	5-7-8 (15)	3.43	120	11
-10	10								
		∇							
				SS 5	78	5-6-7 (13)	3.24	123	10
-15	15								
			@18.5': Very Stiff	SS 6	67	6-6-11 (17)	4.25		15
-20	20		20.0'						
			Bottom of hole at 20.0 feet.						

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CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Pete

RIG NO. D50

GROUND ELEVATION 0 ft

DRILLING METHOD HSA

GROUND WATER LEVELS:

DATE STARTED 9/5/23

COMPLETED 9/5/23

∇ **AT TIME OF DRILLING** 7.0 ft / Elev -7.0 ft

LOGGED BY KKC

CHECKED BY KCH

AT END OF DRILLING None

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
0	0								
			FILL - Moist Loose Brown CLAYEY SAND w/Concrete Fragments and Trace Organics						
				SS 1	50	5-5-3 (8)	NP		15
			3.5'						
			Moist Stiff Brown SANDY LEAN CLAY w/Trace Gravel (CL)	SS 2	94	5-5-5 (10)	1.47	108	20
-5	5								
			∇	SS 3	100	5-6-9 (15)	4.50		17
			8.5'						
			Moist Very Stiff Brown SANDY SILT w/Trace Gravel (ML)	SS 4	94	7-9-15 (24)	4.50		16
-10	10		10.0'						
			Bottom of hole at 10.0 feet.						

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CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Pete

RIG NO. D50

GROUND ELEVATION 0 ft

DRILLING METHOD HSA

GROUND WATER LEVELS:

DATE STARTED 9/5/23

COMPLETED 9/5/23

▽ **AT TIME OF DRILLING** 6.0 ft / Elev -6.0 ft

LOGGED BY KKC

CHECKED BY KCH

▼ **AT END OF DRILLING** 7.0 ft / Elev -7.0 ft

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 / ▲ SPT N VALUE ▲ 20 40 60 80
0	0								
			TOPSOIL - 18 Inches 1.5'						
			Moist Medium Stiff Brown SANDY SILT w/Trace Gravel and Organics (ML) (Noted as Possible Fill) 3.5'	SS 1	50	3-2-3 (5)	2.50		18
-5	5		Moist Medium Stiff Brown LEAN CLAY w/Sand and Trace Gravel (CL) 6.0'	SS 2	78	2-1-5 (6)	1.00		29
		▽	Moist Loose Gray/Brown CLAYEY SAND w/Gravel and Trace Organics (SC) 7.0'	SS 3a	92	5-5	NP		15
		▼	Moist Loose Brown SILTY SAND w/Gravel (SM) 8.5'	SS 3b	83	5	NP		16
-10	10		Moist Very Stiff Brown/Gray SANDY SILT w/Trace Gravel and Shale Fragments (ML) 10.0'	SS 4	94	7-8-11 (19)	4.50		14
			Bottom of hole at 10.0 feet.						

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BORING NUMBER B-7

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CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Pete

RIG NO. D50

GROUND ELEVATION 0 ft

DRILLING METHOD HSA

GROUND WATER LEVELS:

DATE STARTED 9/5/23

COMPLETED 9/5/23

AT TIME OF DRILLING None

LOGGED BY KKC

CHECKED BY KCH

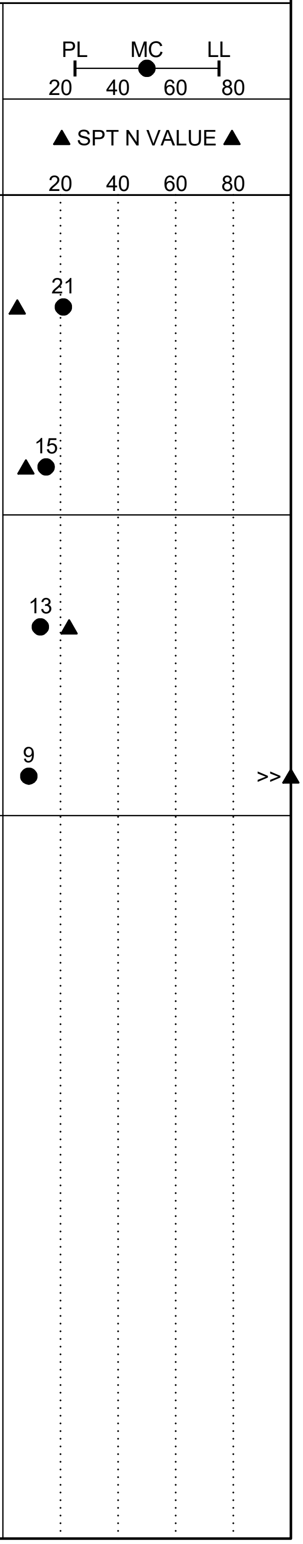
AT END OF DRILLING None

NOTES Split spoon refusal encountered at a depth of 9.7 feet.

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)
0	0							
			TOPSOIL - 9 Inches 0.8'					
			FILL - Moist Medium Stiff Gray/Brown LEAN CLAY w/Sand, Trace Crushed Stone, and Organics 3.5'	SS 1	44	2-2-3 (5)	1.75	
			Moist Medium Stiff Brown LEAN CLAY w/Sand and Trace Gravel (CL) 6.0'	SS 2	67	3-4-4 (8)	0.92	115
-5	5							
			Moist Very Stiff Gray LEAN CLAY w/Sand and Shale Fragments (CL) 8.5'	SS 3	100	12-14-9 (23)	1.13	122
			Moist Very Dense Gray SILTY SAND w/Shale Fragments (SM) 9.7'	SS 4	86	9-15-50/2"	NP	

Bottom of hole at 9.7 feet.



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BORING NUMBER B-8

PAGE 1 OF 1

CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH
DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Cary
RIG NO. D50
GROUND ELEVATION 0 ft
DRILLING METHOD HSA
GROUND WATER LEVELS:
DATE STARTED 9/5/23
COMPLETED 9/5/23
▽ **AT TIME OF DRILLING** 6.0 ft / Elev -6.0 ft
LOGGED BY KKC
CHECKED BY KCH
▼ **AT END OF DRILLING** 5.0 ft / Elev -5.0 ft
NOTES Split spoon refusal encountered at a depth of 14.1 feet.
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL (20 40 60 80) / ▲ SPT N VALUE ▲ (20 40 60 80)
0	0	TOPSOIL - 8 Inches						
		0.7'						
		Moist Soft Brown SANDY LEAN CLAY w/Trace Gravel (CL)	SS 1	67	3-2-2 (4)	2.25		16
			ST 1	92		0.72	108	17
-5	5	▼						
		▽ 6.0'						
		Moist Very Stiff Brown LEAN CLAY w/Sand and Trace Gravel (CL)	SS 2	100	5-8-9 (17)	NI		23
		@8.5': Stiff	SS 3	100	3-5-4 (9)	0.75		18
-10	10							
		13.5'						
		Moist Very Hard Gray/Brown LEAN CLAY w/Sand and Trace Shale Fragments (CL)	SS 4	100	6-50/1"	2.00		18 >>▲
		14.1'						

Bottom of hole at 14.1 feet.

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BORING NUMBER B-9

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CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

DRILLING CONTRACTOR Ridgeway Drilling, Inc. Zack Pete

RIG NO. D50

GROUND ELEVATION 0 ft

DRILLING METHOD HSA

GROUND WATER LEVELS:

DATE STARTED 9/5/23

COMPLETED 9/5/23

AT TIME OF DRILLING None

LOGGED BY KKC

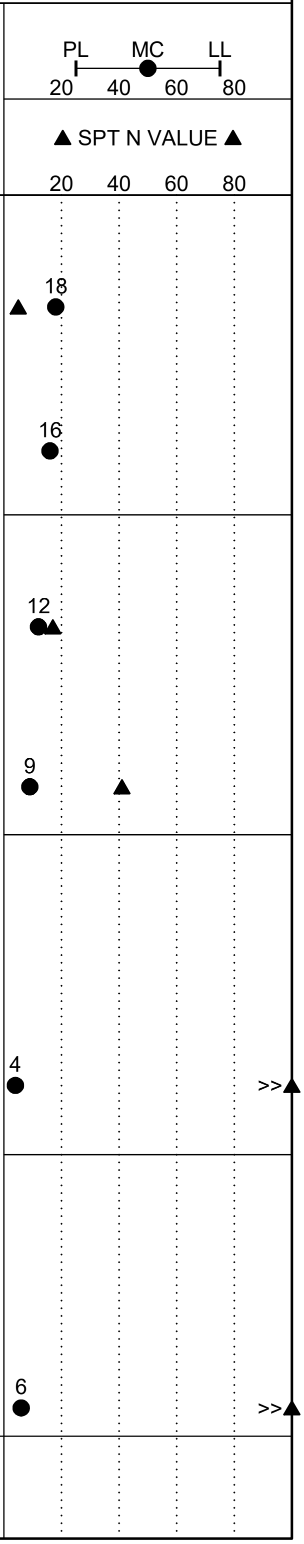
CHECKED BY KCH

AT END OF DRILLING None

NOTES Split spoon refusal encountered at a depth of 19.4 feet.

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)
0	0	TOPSOIL - 14 Inches 1.2'					
		FILL - Moist Loose Brown SILTY SAND w/Traec Crushed Stone 3.0'	SS 1	22	2-2-3 (5)	NP	
-5	5	Moist Medium Stiff Brown SANDY LEAN CLAY w/Trace Gravel and Organics (CL) 6.0'	ST 1	42		1.45	111
		Moist Very Stiff Brown SILTY CLAY w/Sand and Shale Fragments (CL-ML) 8.5'	SS 2	78	5-8-9 (17)	4.50	
-10	10	Moist Hard Dark Brown SANDY SILT w/Shale Fragments (ML) 13.5'	SS 3	83	11-18-23 (41)	NI	
-15	15	Moist Very Dense Gray WEATHERED SHALE 18.5'	SS 4	100	40-50/4"	NP	
		Moist Very Dense Black WEATHERED COAL 19.4'	SS 5	91	25-50/5"	NP	
		Bottom of hole at 19.4 feet.					



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BORING NUMBER B-10

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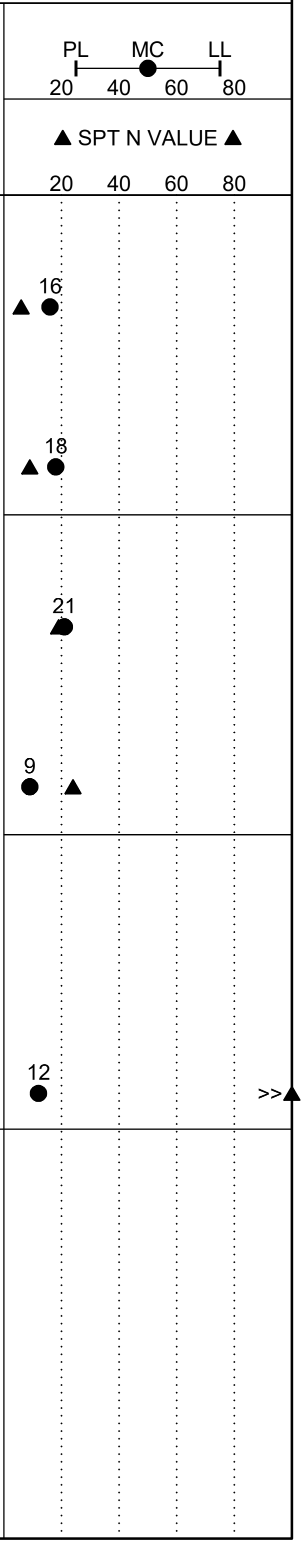
CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH
DRILLING CONTRACTOR Ridgeway Drilling, Inc. Pete Zack
RIG NO. D50
GROUND ELEVATION 0 ft
DRILLING METHOD HSA
GROUND WATER LEVELS:
DATE STARTED 9/5/23
COMPLETED 9/5/23
▽ **AT TIME OF DRILLING** 4.0 ft / Elev -4.0 ft
LOGGED BY KKC
CHECKED BY KCH
▼ **AT END OF DRILLING** 7.0 ft / Elev -7.0 ft
NOTES Split spoon refusal encountered at a depth of 14.6 feet.
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	MC
0	0		TOPSOIL - 12 Inches 1.0'						
			FILL - Moist Medium Stiff Brown SILTY CLAY w/Sand and Trace Gravel 3.5'	SS 1	89	3-2-4 (6)	4.25		16
-5	5		▽ FILL - Moist Stiff Brown LEAN CLAY w/Sand, Trace Gravel, and Brick Fragments 6.0'	SS 2	100	4-4-5 (9)	1.33	114	18
			Moist Very Stiff Brown SILTY CLAY w/Sand, Trace Gravel, and Organics (CL) ▼ 8.5'	SS 3	78	6-8-11 (19)	0.38	119	21
-10	10		Moist Medium Dense Gray SILTY SAND w/Shale Fragments (SM) 13.5'	SS 4	89	16-13-11 (24)	NP		9
			Moist Very Dense Gray WEATHERED SHALE 14.6'	SS 5	92	10-35-50/1"	NP		12
			Bottom of hole at 14.6 feet.						



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BORING NUMBER PT-1

PAGE 1 OF 1

CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH
DRILLING CONTRACTOR Ridgeway Drilling, Inc. Pete Zack
RIG NO. D50
GROUND ELEVATION 0 ft
DRILLING METHOD HSA
GROUND WATER LEVELS:
DATE STARTED 9/5/23
COMPLETED 9/5/23
AT TIME OF DRILLING None
LOGGED BY KKC
CHECKED BY KCH
AT END OF DRILLING None
NOTES
4hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
0	0								
			TOPSOIL - 12 Inches 1.0'						
		▨	Moist Brown SANDY SILTY CLAY w/Trace Gravel (CL-ML) 2.0'	GB 1	100				
			Bottom of hole at 2.0 feet.						15 ●

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BORING NUMBER PT-2

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CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

DRILLING CONTRACTOR Ridgeway Drilling, Inc. Pete Zack

RIG NO. D50

GROUND ELEVATION 0 ft

DRILLING METHOD HSA

GROUND WATER LEVELS:

DATE STARTED 9/5/23 **COMPLETED** 9/5/23

AT TIME OF DRILLING None

LOGGED BY KKC **CHECKED BY** KCH

AT END OF DRILLING None

NOTES

4hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft) 0	DEPTH (ft) 0	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
			TOPSOIL - 12 Inches 1.0'						
			Moist Brown SANDY LEAN CLAY w/Trace Gravel and Organics (CL) 3.0'	GB 1	150				15
			Bottom of hole at 3.0 feet.						

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BORING NUMBER PT-3

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CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

DRILLING CONTRACTOR Ridgeway Drilling, Inc. Pete Zack

RIG NO. D50

GROUND ELEVATION 0 ft

DRILLING METHOD HSA

GROUND WATER LEVELS:

DATE STARTED 9/5/23

COMPLETED 9/5/23

AT TIME OF DRILLING None

LOGGED BY KKC

CHECKED BY KCH

AT END OF DRILLING None

NOTES

4hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft) 0	DEPTH (ft) 0	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL ● MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
		⁘	TOPSOIL - 12 Inches 1.0'						
		▨	Moist Dark Brown SANDY LEAN CLAY w/Trace Gravel and Organics (CL) 2.0'	✋ GB 1	100				
			Bottom of hole at 2.0 feet.						
									23 ●

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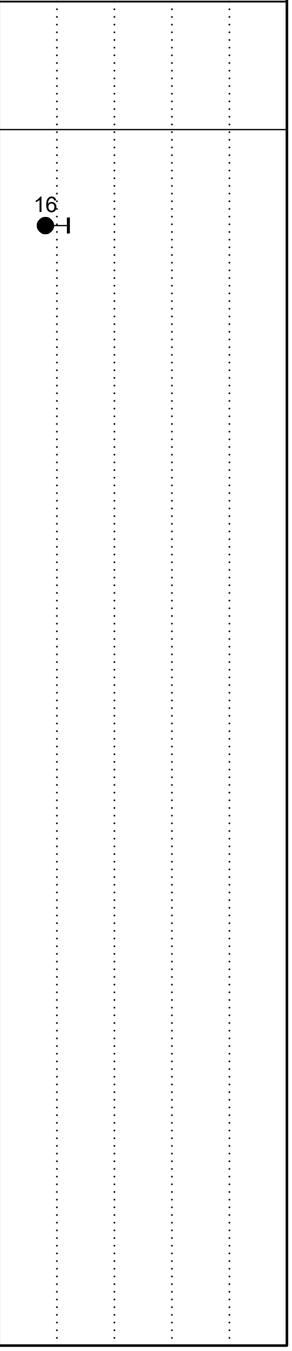
BORING NUMBER PT-4

PAGE 1 OF 1

CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH
DRILLING CONTRACTOR Ridgeway Drilling, Inc. Pete Zack
RIG NO. D50
GROUND ELEVATION 0 ft
DRILLING METHOD HSA
GROUND WATER LEVELS:
DATE STARTED 9/5/23 **COMPLETED** 9/5/23
AT TIME OF DRILLING None
LOGGED BY KKC **CHECKED BY** KCH
AT END OF DRILLING None
NOTES
4hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
0	0								
			TOPSOIL - 12 Inches 1.0'						
			Moist Brown SANDY LEAN CLAY w/Trace Gravel (CL) 2.0'	GB 1	100				16
			Bottom of hole at 2.0 feet.						



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BORING NUMBER PT-5

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CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

DRILLING CONTRACTOR Ridgeway Drilling, Inc. Pete Zack

RIG NO. D50

GROUND ELEVATION 0 ft

DRILLING METHOD HSA

GROUND WATER LEVELS:

DATE STARTED 9/5/23

COMPLETED 9/5/23

AT TIME OF DRILLING None

LOGGED BY KKC

CHECKED BY KCH

AT END OF DRILLING None

NOTES

4hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
0	0								
		░	TOPSOIL - 12 Inches 1.0'						
		▨	Moist Brown/Gray SANDY LEAN CLAY w/Trace Gravel (CL) 2.0'	GB 1	100				
			Bottom of hole at 2.0 feet.						18 ●⊢

APPENDIX B

Legend Key

LEGEND KEY

Unified Soil Classification System Soil Symbols

GW - WELL GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.

GP - POORLY GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.

GM - SILTY GRAVEL Includes Gravel-Sand-Silt mixtures.

GC - CLAYEY GRAVEL Includes Gravel-Sand-Clay mixtures.

SW - WELL GRADED SAND Includes Gravelly Sands, little or no fines.

SP - POORLY GRADED SAND Includes Gravelly Sands, little or no fines.

SM - SILTY SAND Includes Sand-Silt mixtures.

SC - CLAYEY SAND Includes Sand-Clay mixtures.

ML - SILT Includes Silt with Sand and Sandy Silt.

CL - LEAN CLAY Includes Sandy Lean Clay and Lean Clay with Sand and Gravel.

MH - ELASTIC SILT Includes Sandy Elastic Silt and Elastic Silt with Sand.

CH - FAT CLAY Includes Sandy Fat Clay and Fat Clay with Sand.

CL-ML - SILTY CLAY Includes Clayey Silt of low plasticity.

OL - ORGANIC SILT and ORGANIC CLAY of low plasticity.

OH - ORGANIC SILT and ORGANIC CLAY of medium to high plasticity.

Pt - PEAT Includes humus, swamp and other soils with high organic content.

FILL MATERIAL - Includes controlled and non-controlled soil and non-soil materials.

TOPSOIL

ASPHALT - Bituminous Asphalt

CONCRETE - Includes broken concrete rubble.

Shale

Weathered Shale

Sandstone

Weathered Sandstone

Coal

Sample Symbols

SS - Split Spoon

ST - Shelby Tube

RC - Rock Core

GS - Geoprobe Sleeve

AU - Auger Cuttings

GB - Grab

Notes:

1. Exploratory borings were drilled during on September 5, 2023, using 2¼-inch diameter hollow-stem augers.
2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.
3. The test borings and percolation tests were located in the field based on CT plan drawing, dated March 8, 2022.
4. Unconfined Compressive Strength (tsf):
   NP = Non-Plastic
   NI = Not Intact

APPENDIX C

Tabulation of Laboratory Test Data

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SUMMARY OF LABORATORY RESULTS

CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1	1.0							15.0			
B-1	3.0							18.3			
B-1	6.0							18.6	112.9		
B-1	8.5							13.7	119.5		
B-1	13.5							14.8	119.0		
B-2	1.0	36	22	14	9.5	74	CL	25.7			
B-2	3.5							19.7			
B-2	6.0							14.7			
B-2	8.5							12.7			
B-2	13.5							13.0			
B-3	1.0							14.0			
B-3	6.0							13.3			
B-3	8.5							15.2			
B-3	13.5							24.1			
B-4	1.0							14.6			
B-4	3.5							13.8			
B-4	6.0							13.7	114.5		
B-4	8.5							10.9	119.8		
B-4	13.5							10.1	122.5		
B-4	18.5							14.9			
B-5	1.0	29	20	9	25	39	SC	15.3			
B-5	3.5							19.7	107.6		
B-5	6.0							16.5			
B-5	8.5							16.2			
B-6	1.0							18.1			
B-6	3.5							28.9			
B-6	6.0							14.9			
B-6	7.0							16.0			
B-6	8.5							13.7			
B-7	1.0							20.7			
B-7	3.5							15.4	115.4		
B-7	6.0							13.1	121.8		
B-7	8.5							8.9			
B-8	1.0	28	18	10	9.5	63	CL	16.3			
B-8	3.0							16.9	107.8		
B-8	6.0							22.9			
B-8	8.5							17.6			
B-8	13.5							17.8			
B-9	1.0							18.4			
B-9	3.0							16.0	110.5		
B-9	6.0							12.5			
B-9	8.5							9.1			
B-9	13.5							4.1			

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SUMMARY OF LABORATORY RESULTS

CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-9	18.5							6.0			
B-10	1.0							15.9			
B-10	3.5							17.5	113.6		
B-10	6.0							20.9	119.0		
B-10	8.5							9.4			
B-10	13.5							12.5			
PT-1	3.5	22	16	6	12.5	53	CL-ML	15.4			
PT-2	3.5	27	18	9	12.5	55	CL	15.0			
PT-3	3.5	30	17	13	9.5	67	CL	23.4			
PT-4	3.5	24	15	9	12.5	54	CL	16.1			
PT-5	3.5	28	17	11	9.5	63	CL	17.7			

APPENDIX D

Laboratory Test Results

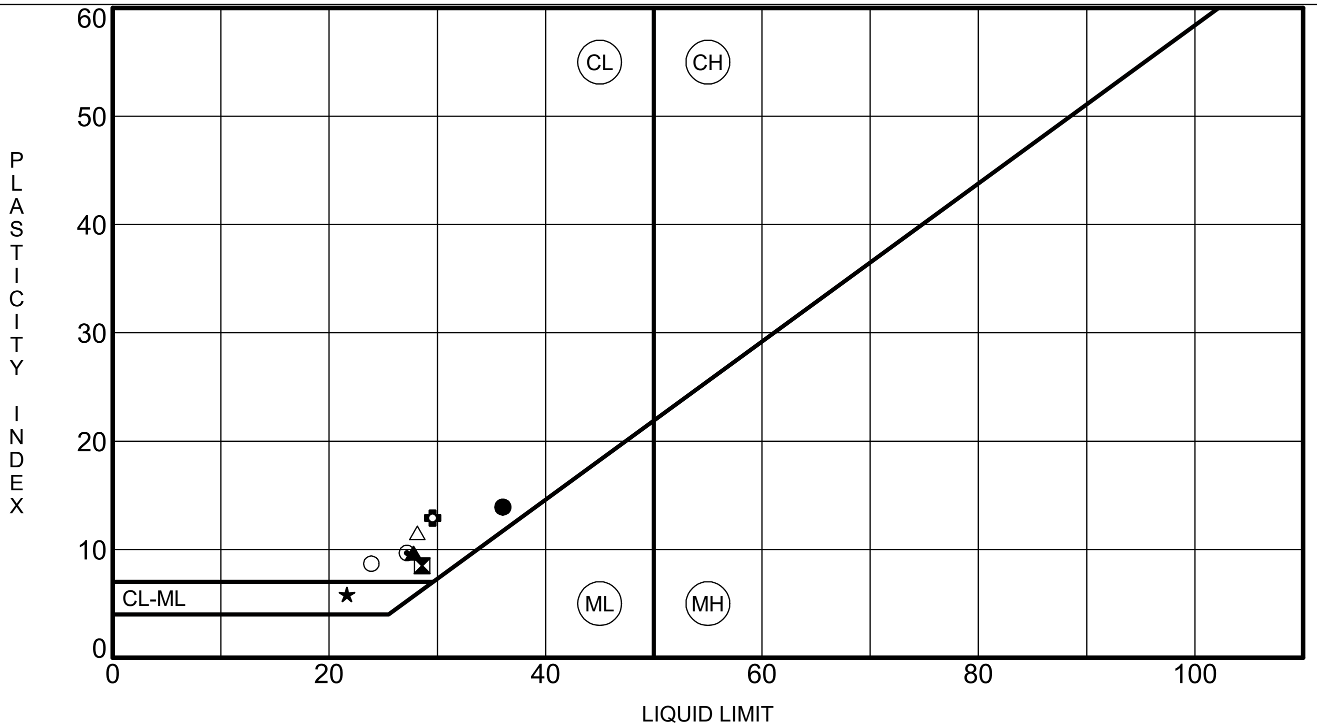
ATTERBERG LIMITS' RESULTS

CLIENT ABC District and Stormwater District

PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH



Specimen Identification			LL	PL	PI	Fines	Classification
●	**B-2**	**1.0**	**36**	**22**	**14**	**74**	**LEAN CLAY with SAND (CL)**
⧗	**B-5**	**1.0**	**29**	**20**	**9**	**39**	**CLAYEY SAND with GRAVEL (SC)**
▲	**B-8**	**1.0**	**28**	**18**	**10**	**63**	**SANDY LEAN CLAY (CL)**
★	**PT-1**	**3.5**	**22**	**16**	**6**	**53**	**SANDY SILTY CLAY (CL-ML)**
⊙	**PT-2**	**3.5**	**27**	**18**	**9**	**55**	**SANDY LEAN CLAY (CL)**
✿	**PT-3**	**3.5**	**30**	**17**	**13**	**67**	**SANDY LEAN CLAY (CL)**
○	**PT-4**	**3.5**	**24**	**15**	**9**	**54**	**SANDY LEAN CLAY (CL)**
△	**PT-5**	**3.5**	**28**	**17**	**11**	**63**	**SANDY LEAN CLAY (CL)**

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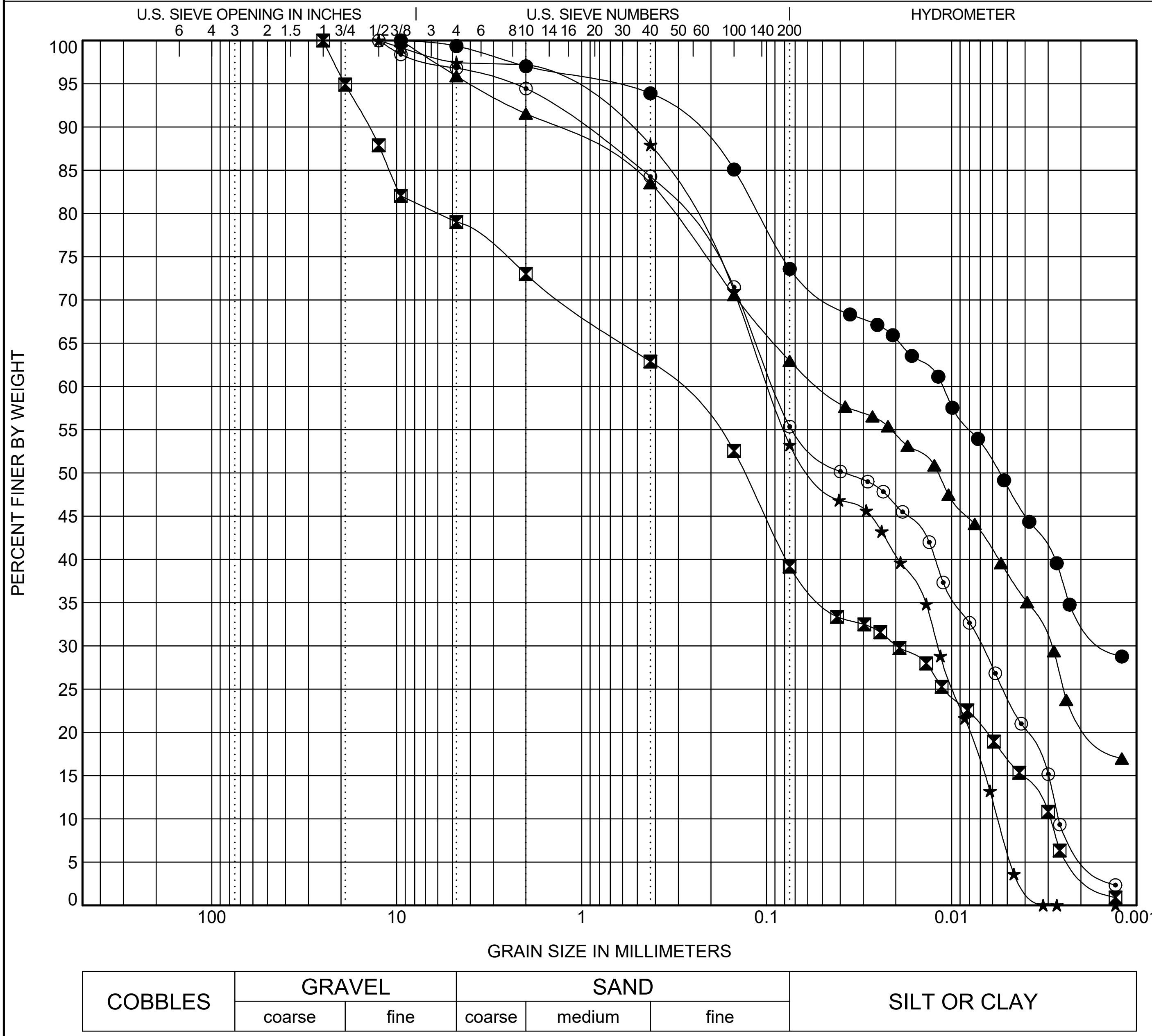
GRAIN SIZE DISTRIBUTION

CLIENT ABC District and Stormwater District
PROJECT NAME Forest Lawn Stormwater Park
PROJECT NUMBER 231566
PROJECT LOCATION Mahoning County, OH



Specimen Identification			USCS Classification	LL	PL	PI	Cc	Cu
●	**B-2**	**1.0**	**LEAN CLAY with SAND (CL)**	**36**	**22**	**14**		
⊠	**B-5**	**1.0**	**CLAYEY SAND with GRAVEL (SC)**	**29**	**20**	**9**	**0.4**	**108.8**
▲	**B-8**	**1.0**	**SANDY LEAN CLAY (CL)**	**28**	**18**	**10**		
★	**PT-1**	**3.5**	**SANDY SILTY CLAY (CL-ML)**	**22**	**16**	**6**	**0.3**	**17.4**
⊙	**PT-2**	**3.5**	**SANDY LEAN CLAY (CL)**	**27**	**18**	**9**	**0.2**	**34.7**

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-2**	**1.0**	**9.5**	**0.011**	**0.001**		**0.6**	**25.8**	**25.0**	**48.5**
⊠	**B-5**	**1.0**	**25**	**0.318**	**0.02**	**0.003**	**21.0**	**39.8**	**22.1**	**17.1**
▲	**B-8**	**1.0**	**9.5**	**0.051**	**0.003**		**4.1**	**32.9**	**24.4**	**38.5**
★	**PT-1**	**3.5**	**12.5**	**0.098**	**0.012**	**0.006**	**2.6**	**44.2**	**46.9**	**6.3**
⊙	**PT-2**	**3.5**	**12.5**	**0.092**	**0.007**	**0.003**	**3.2**	**41.4**	**31.2**	**24.2**

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GRAIN SIZE DISTRIBUTION

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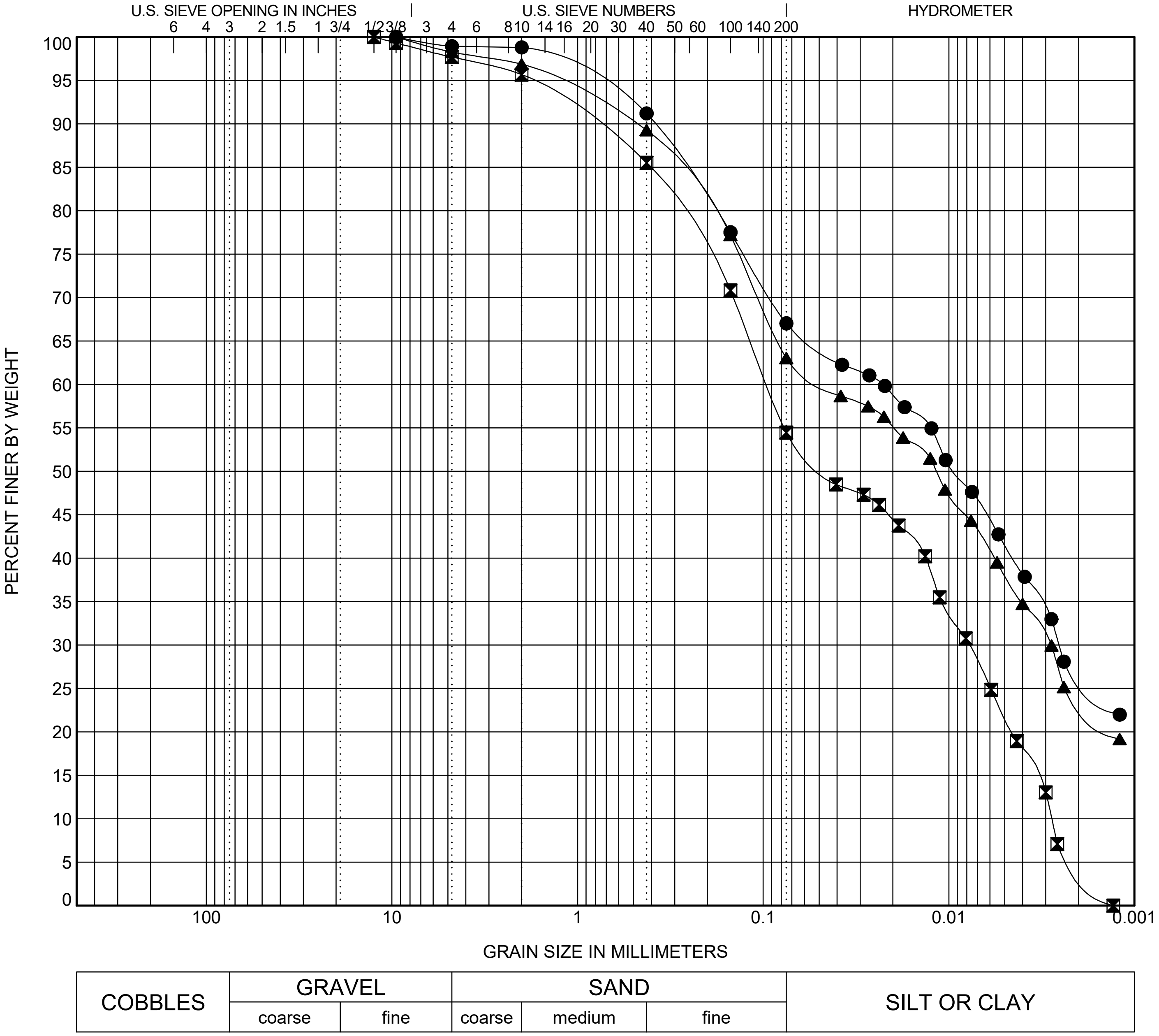
PROJECT NAME Forest Lawn Stormwater Park

PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH



Specimen Identification		USCS Classification	LL	PL	PI	Cc	Cu
● **PT-3**	**3.5**	**SANDY LEAN CLAY (CL)**	**30**	**17**	**13**		
☒ **PT-4**	**3.5**	**SANDY LEAN CLAY (CL)**	**24**	**15**	**9**	**0.2**	**34.0**
▲ **PT-5**	**3.5**	**SANDY LEAN CLAY (CL)**	**28**	**17**	**11**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **PT-3**	**3.5**	**9.5**	**0.023**	**0.003**		**1.1**	**31.9**	**25.5**	**41.6**
☒ **PT-4**	**3.5**	**12.5**	**0.095**	**0.008**	**0.003**	**2.3**	**43.2**	**32.7**	**21.7**
▲ **PT-5**	**3.5**	**9.5**	**0.047**	**0.003**		**1.7**	**35.2**	**25.0**	**38.1**

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UNCONFINED COMPRESSION TEST

CLIENT ABC District and Stormwater District

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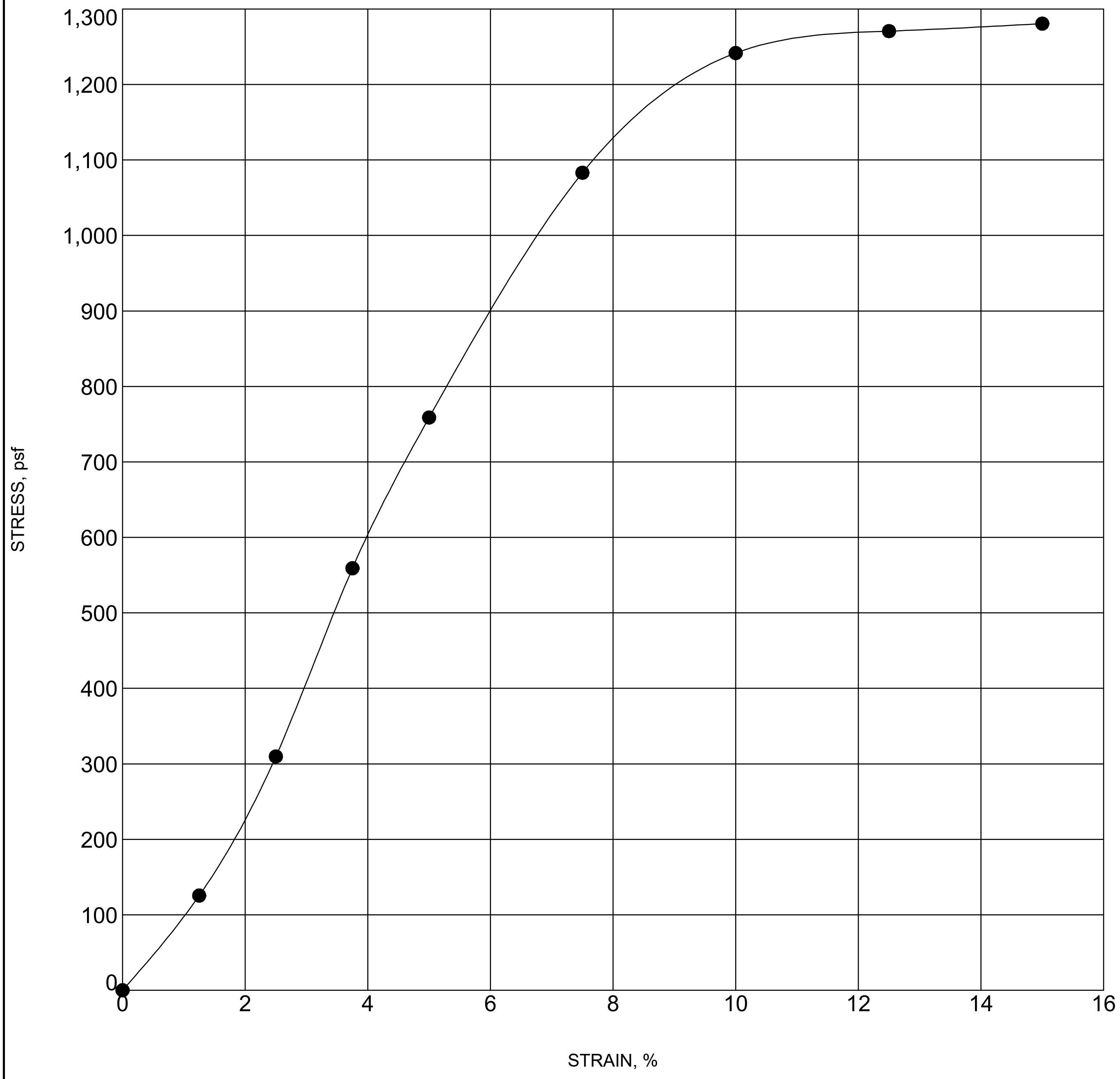
PROJECT NUMBER 231566

PROJECT LOCATION Mahoning County, OH



	Specimen Identification		Classification	γ_d	MC%
●	**B-1**	**6.0**		**113**	**19**

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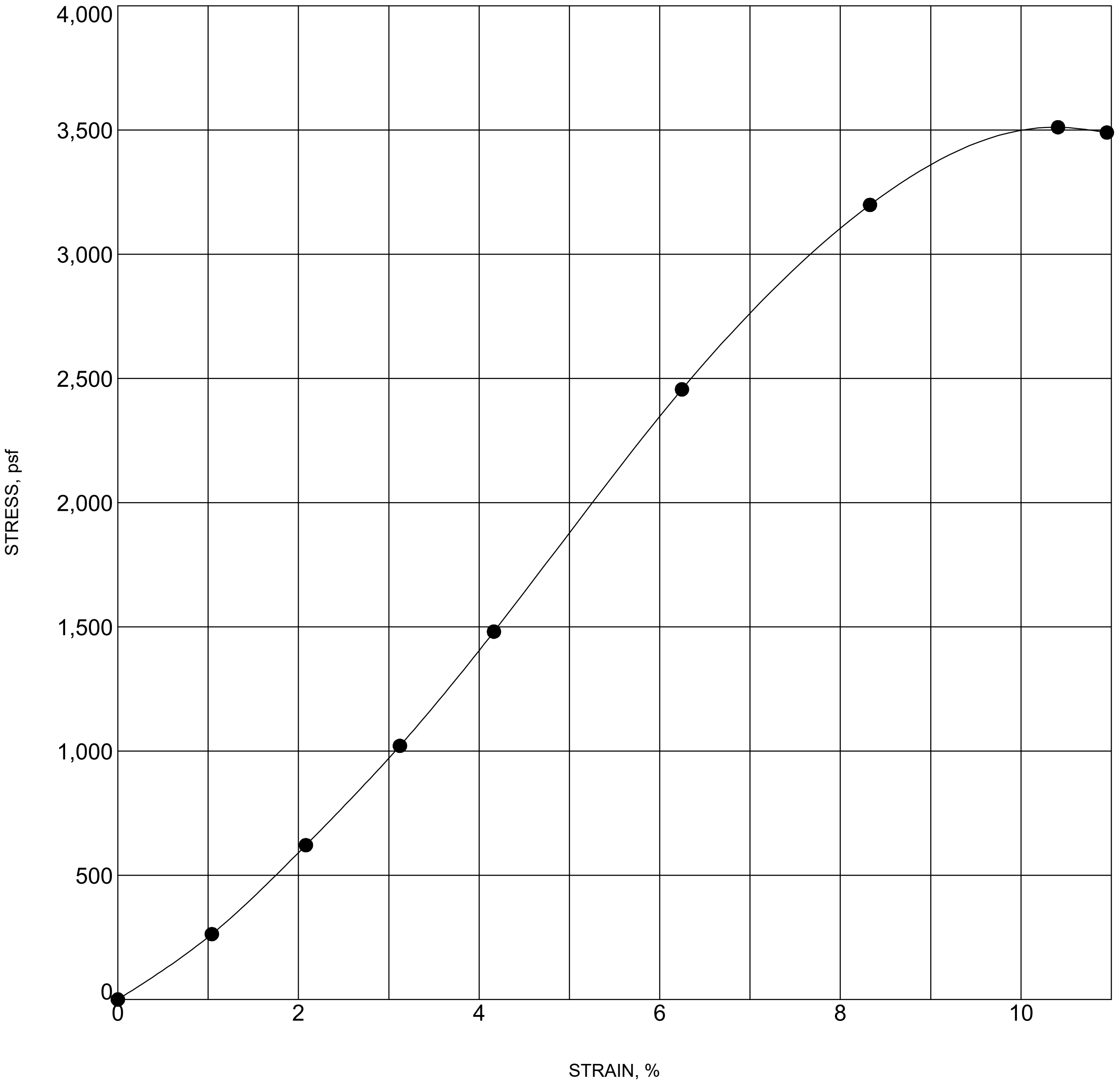

Specimen Identification			Classification	γ_d	MC%
●	**B-1**	**8.5**		**119**	**14**

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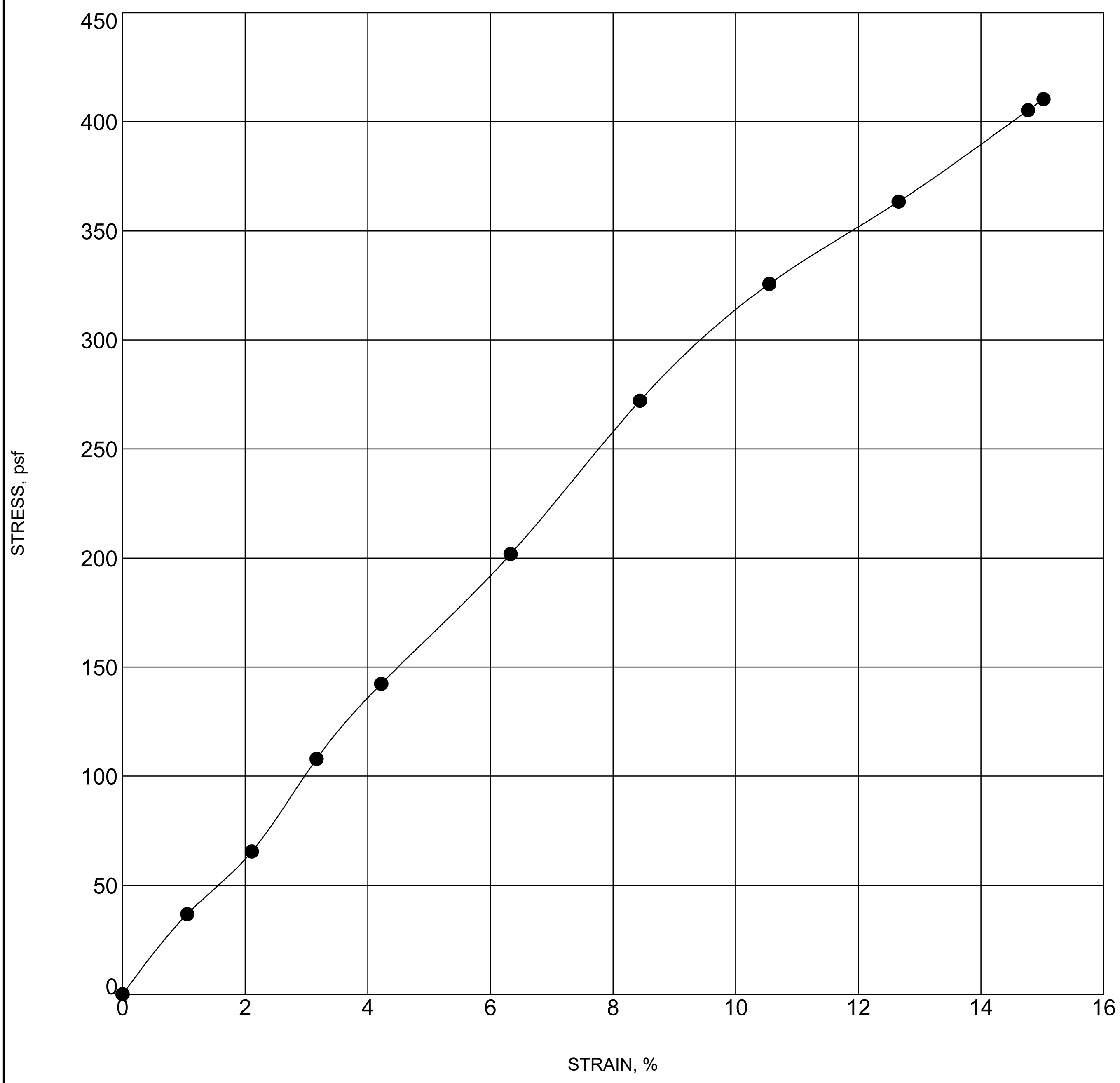

	Specimen Identification		Classification	γ_d	MC%
●	**B-1**	**13.5**		**119**	**15**

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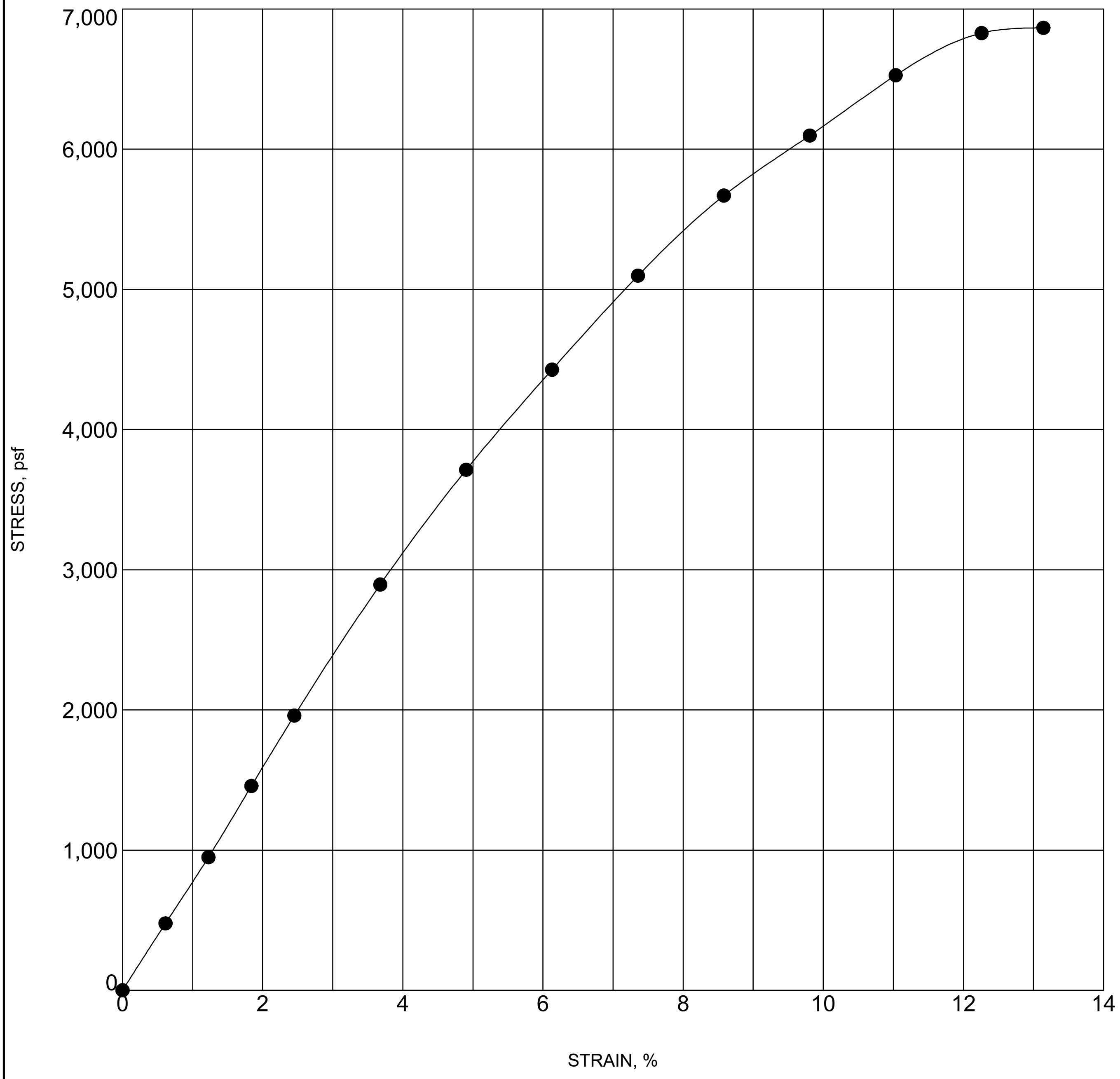

	Specimen Identification		Classification	γ_d	MC%
●	**B-4**	**8.5**		**120**	**11**

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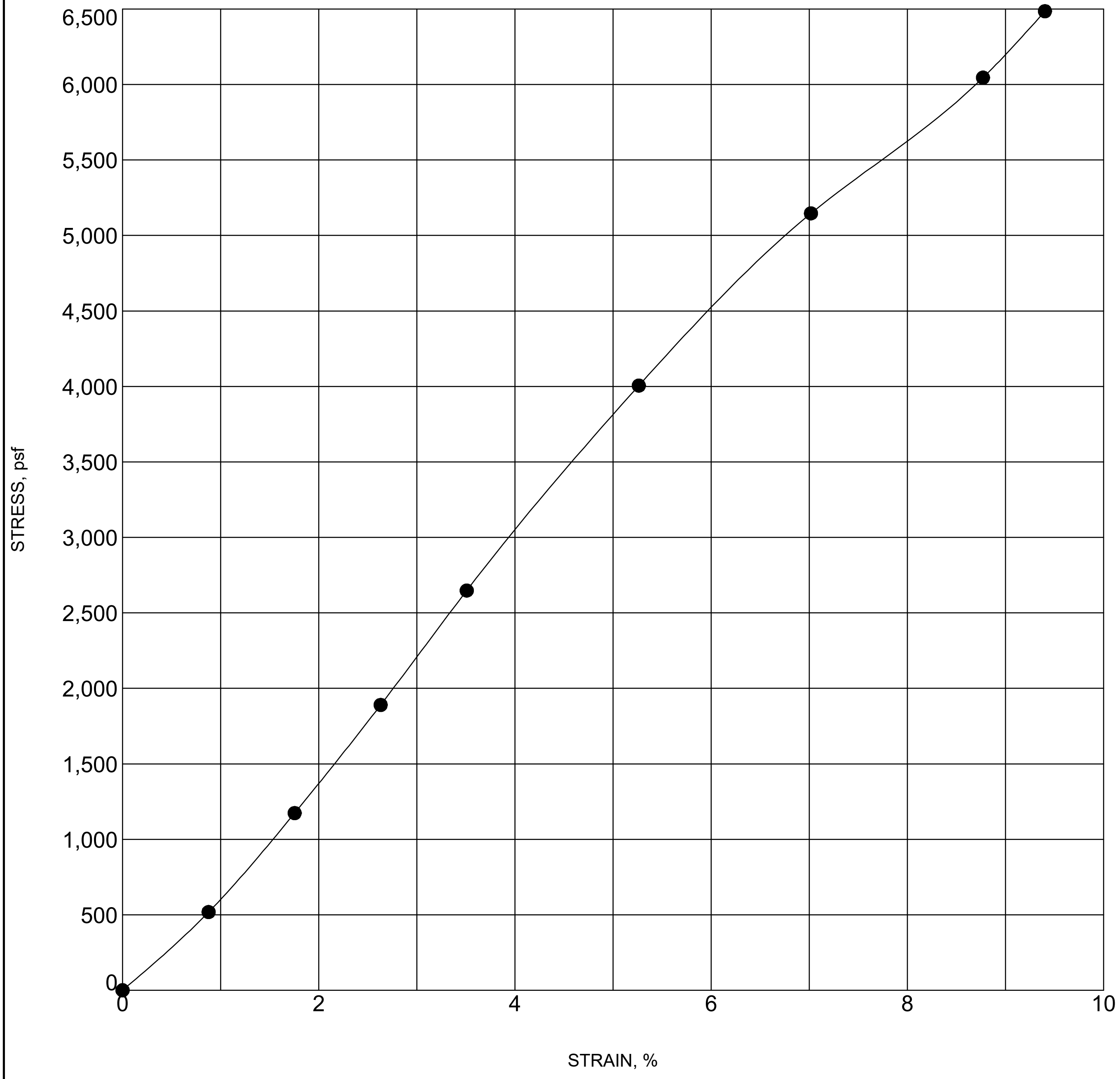

	Specimen Identification		Classification	γ_d	MC%
●	**B-4**	**13.5**		**123**	**10**

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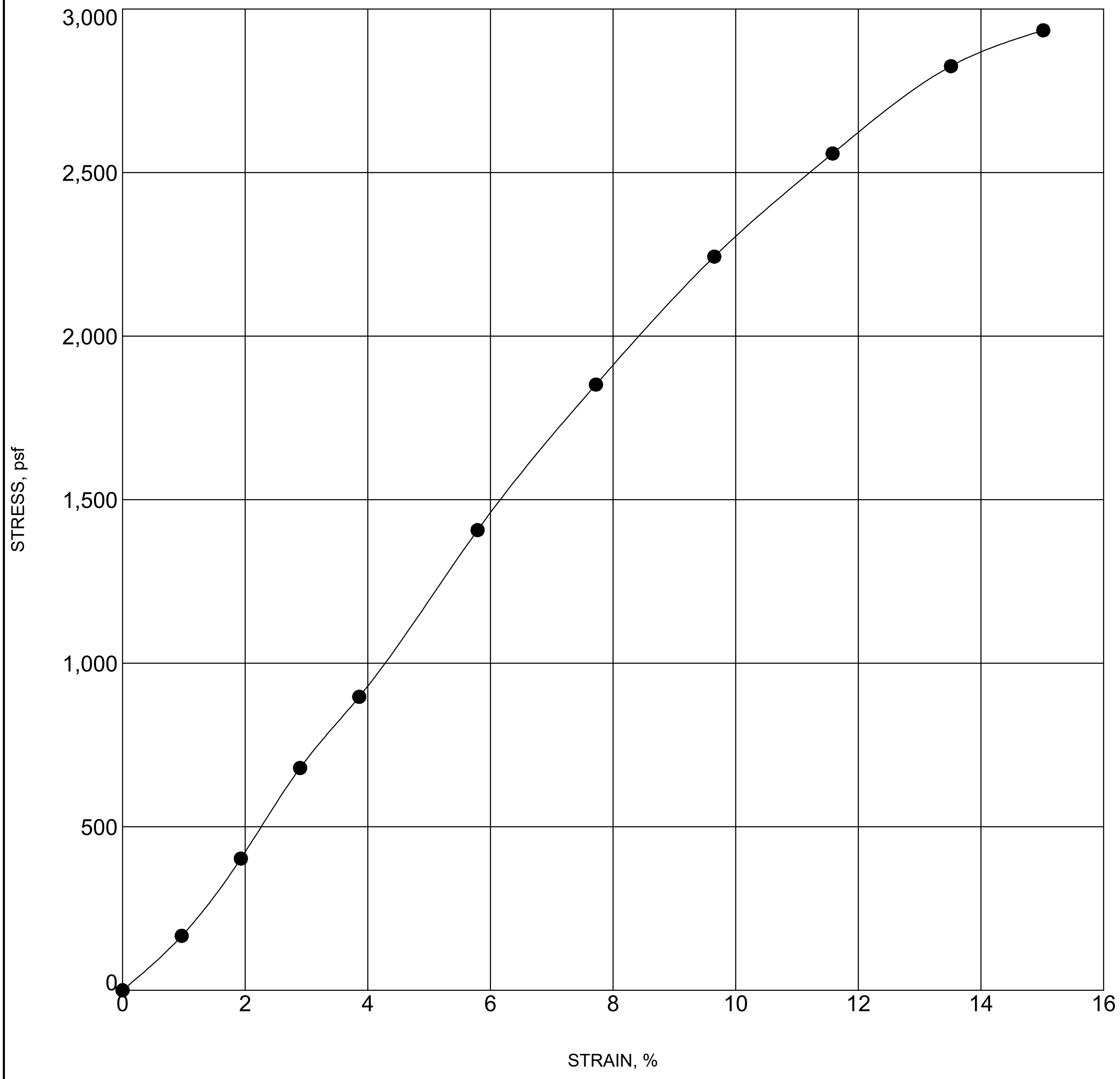

	Specimen Identification		Classification	γ_d	MC%
●	**B-5**	**3.5**		**108**	**20**

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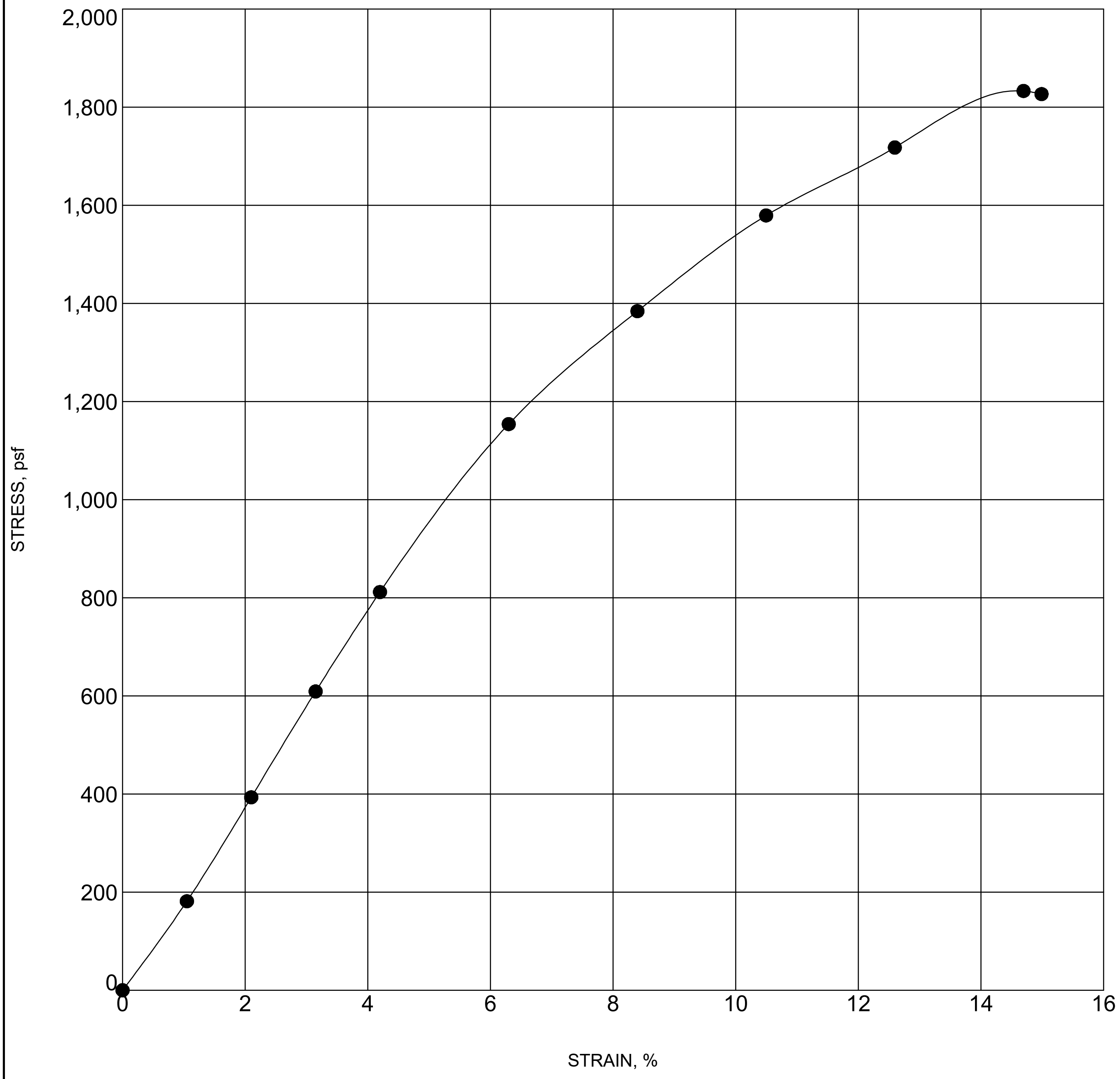

Specimen Identification			Classification	γ_d	MC%
●	**B-7**	**3.5**		**115**	**15**

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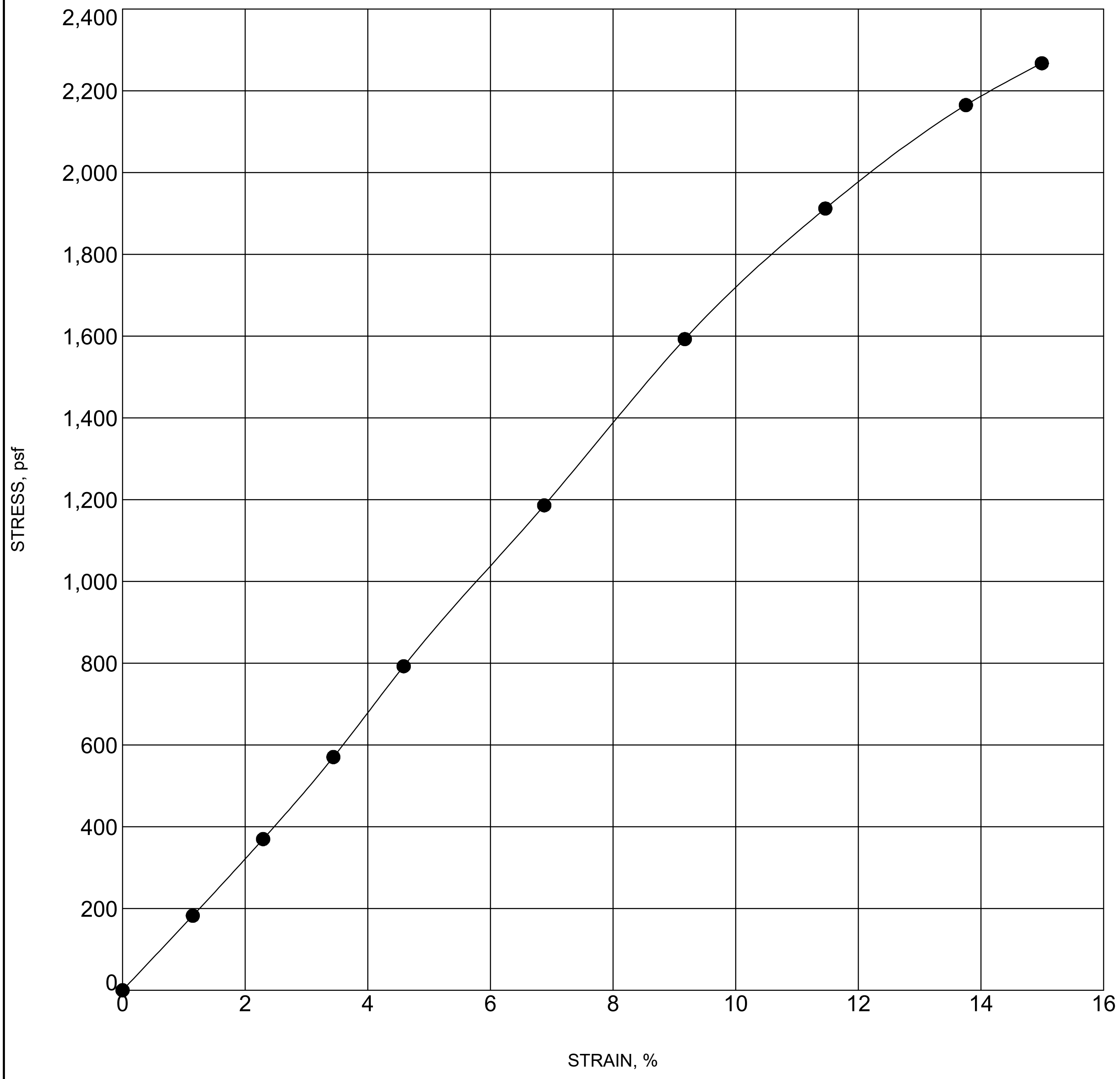

	Specimen Identification		Classification	γ_d	MC%
●	**B-7**	**6.0**		**122**	**13**

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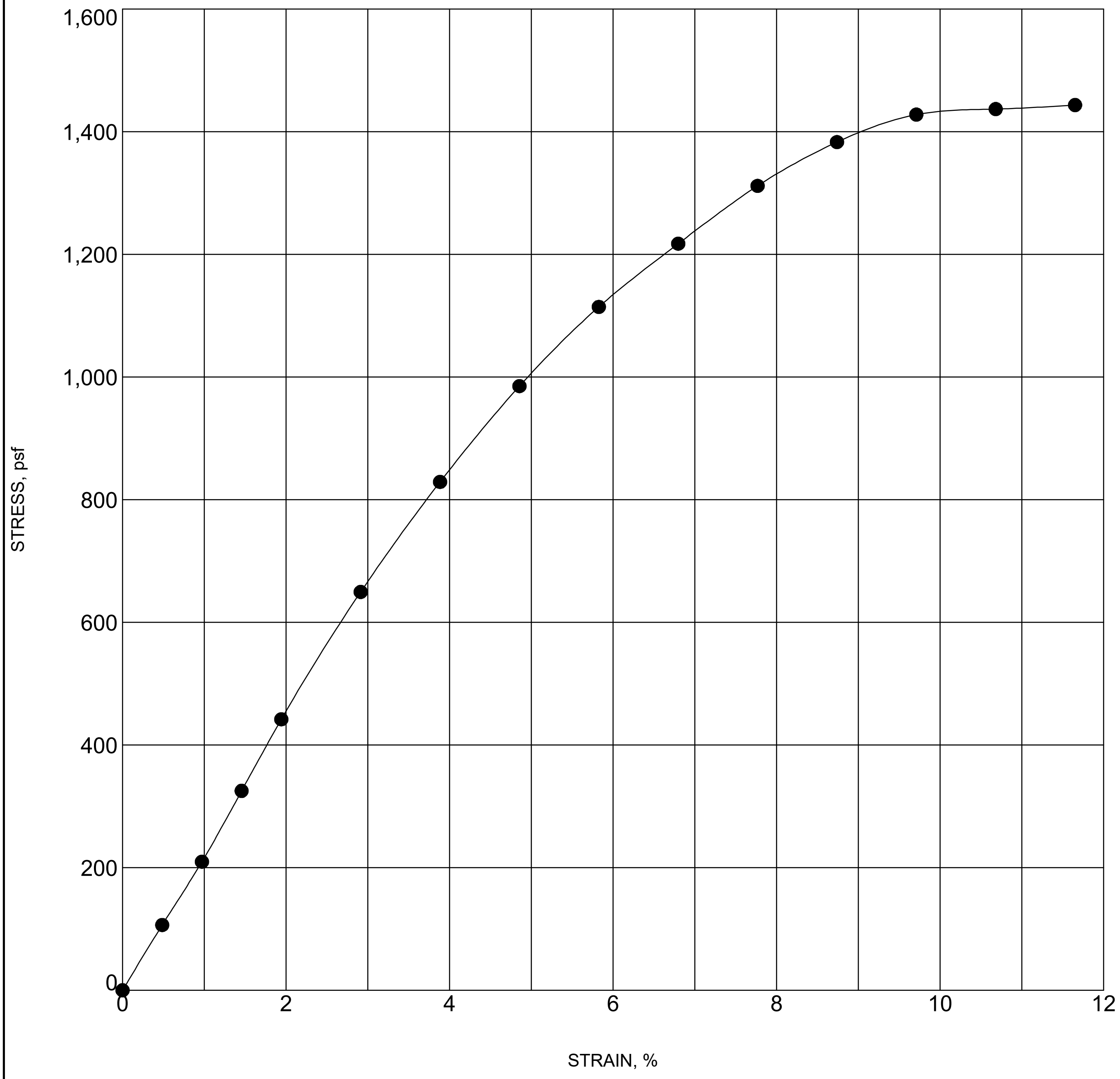

	Specimen Identification	Classification	γ_d	MC%
●	B-8 3.0		108	17

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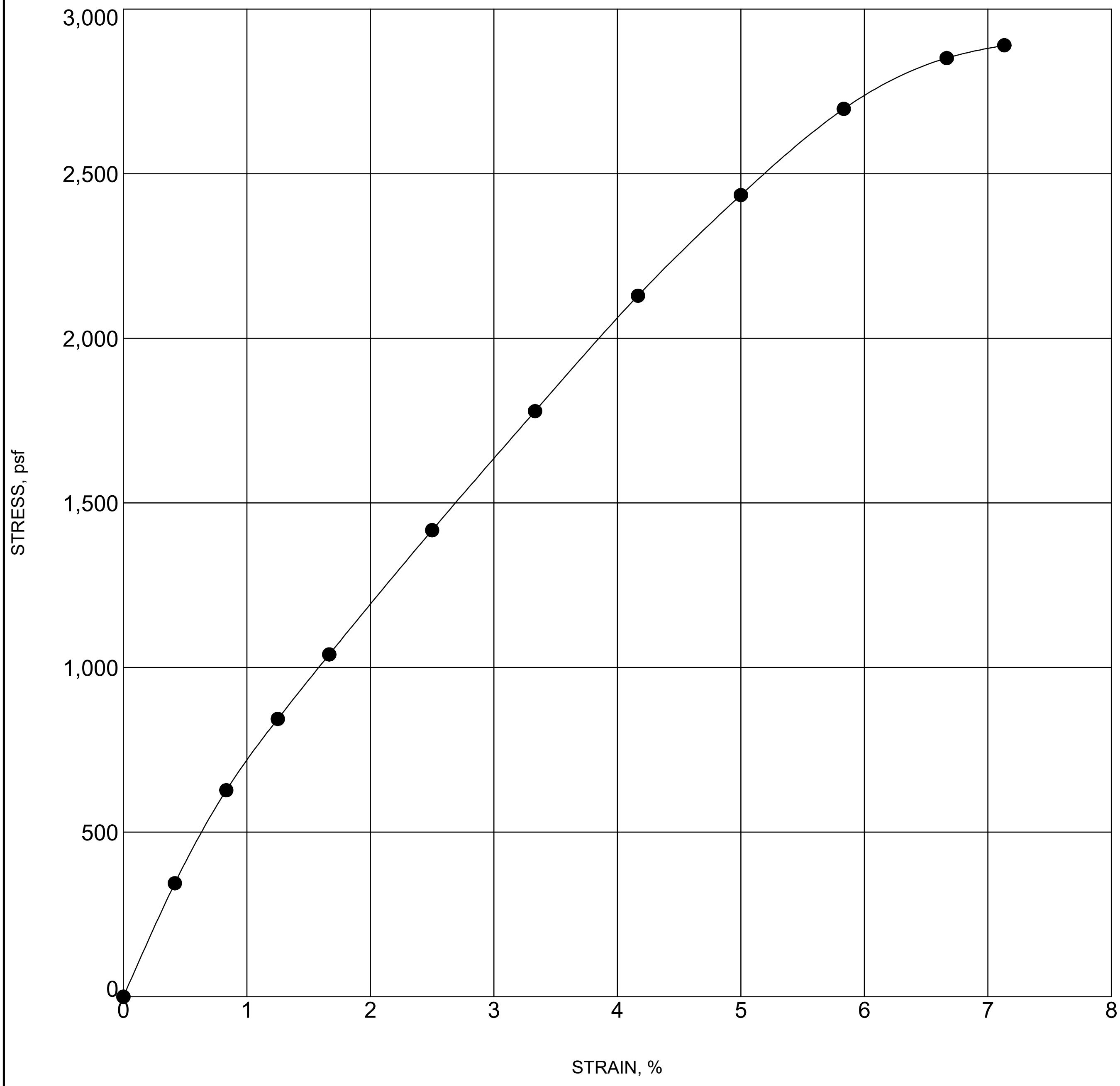

	Specimen Identification		Classification	γ_d	MC%
●	**B-9**	**3.0**		**110**	**16**

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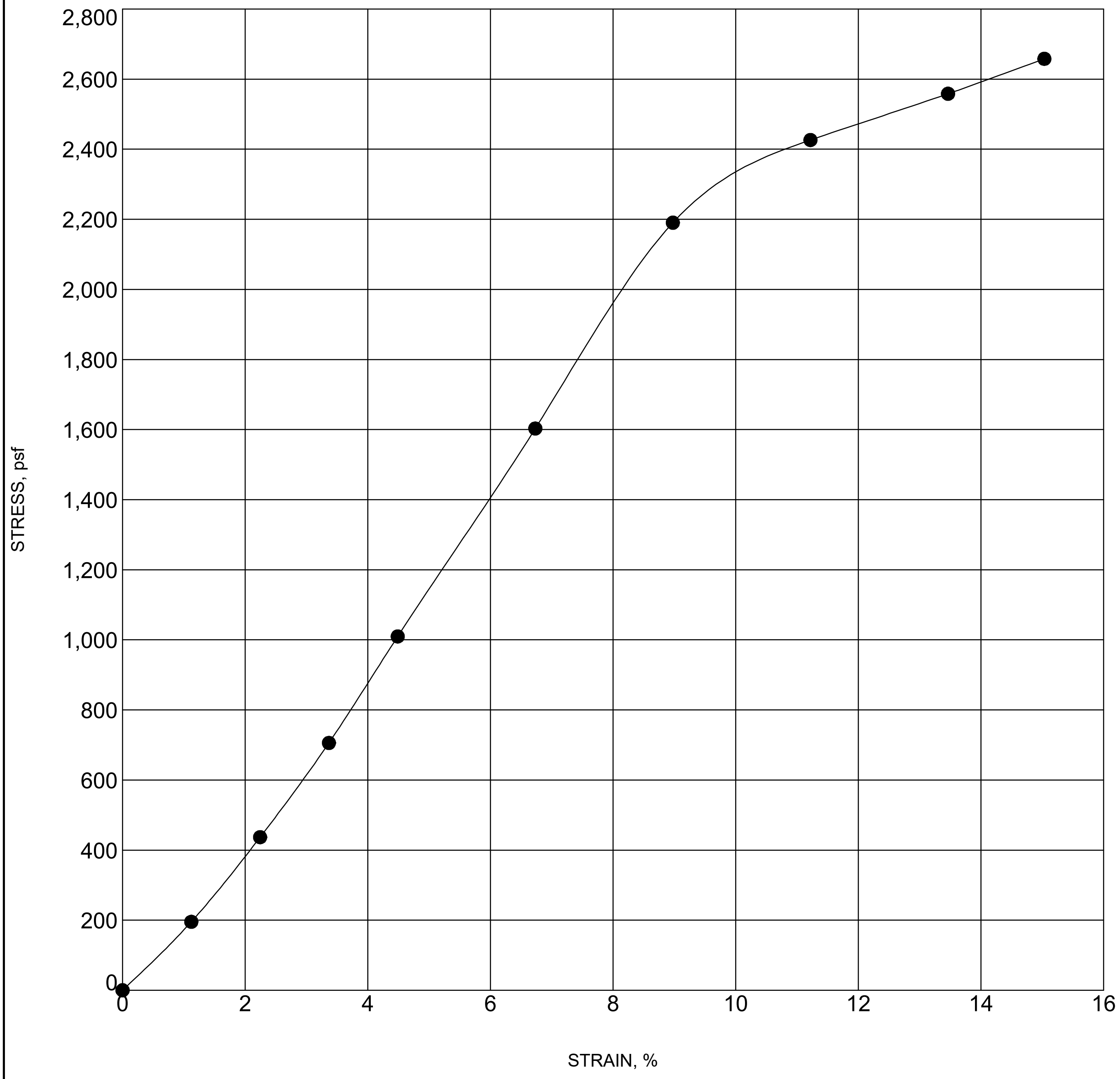

	Specimen Identification		Classification	γ_d	MC%
●	**B-10**	**3.5**		**114**	**18**

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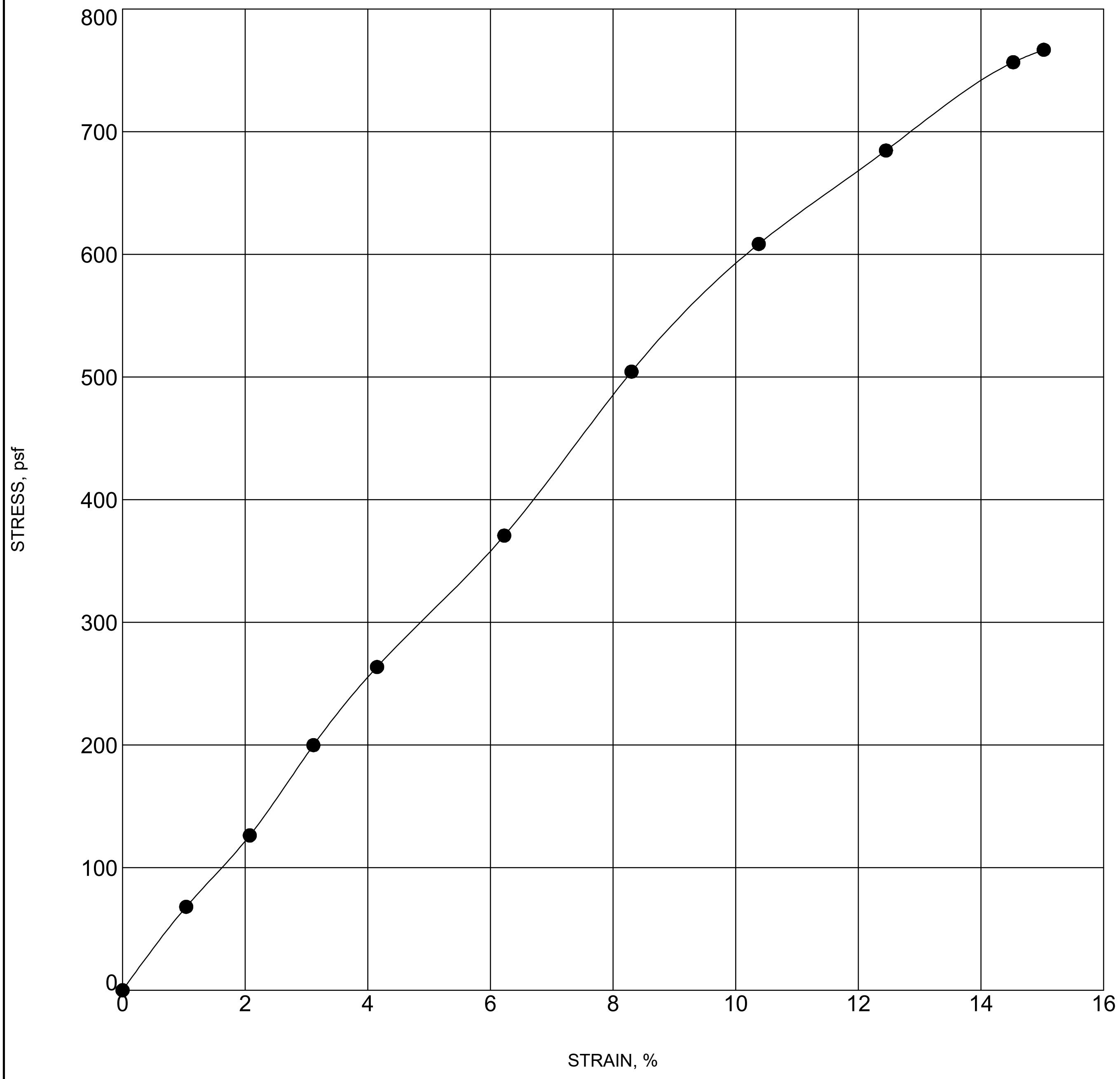

	Specimen Identification		Classification	γ_d	MC%
●	**B-10**	**6.0**		**119**	**21**