APPENDIX B:

SOIL BORINGS

January 20, 2020

Project 13300.20 R01

Ms. Sarah Close, LEED AP, RLA
City of Madison Parks Division
City-County Building, Room 104
210 Martin Luther King, Jr. Boulevard
Madison, Wisconsin 53703-3342

Subject: Geotechnical Exploration and Analyses Report
Proposed Playground Structure
Galaxy Park
132 Milky Way
City of Madison
Dane County, Wisconsin

Dear Ms. Close:

We have completed the requested exploration consisting of the performance of one soil boring and associated laboratory testing. The purpose of this boring was to obtain information about the soil, bedrock, and water conditions at the boring location. We present our findings and preliminary comments and recommendations in the enclosed *Geotechnical Exploration and Analyses Report* for the subject project.

Respectfully submitted,

SOILS & ENGINEERING SERVICES, INC.

Craig M. Bower, P.E.

CMB:DER:cmb

Enclosure

Delivered by email: SClose@cityofmadison.com

GEOTECHNICAL EXPLORATION AND ANALYSES REPORT

PROPOSED PLAYGROUND STRUCTURE
GALAXY PARK
132 MILKY WAY
CITY OF MADISON
DANE COUNTY, WISCONSIN
SES Project Number 13300.20

Prepared By

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Craig M. Bower, P.E.

WISCONSIN
CRAIG M.
BOWER
E-26676
COTTAGE GROVE
WIS.
1/20/20
PROFESSIONAL ENGINEER

Submitted To

City of Madison Parks Division
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Phone: (608) 261-4281

Ms. Sarah Close, LEED AP, RLA

January 20, 2020

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I. INTRODUCTION

This *Geotechnical Exploration and Analyses Report* summarizes the findings of the geotechnical exploration, laboratory tests, and geotechnical engineering analyses performed for the design and construction of a new playground structure for Galaxy Park located at 132 Milky Way in the City of Madison in Dane County, Wisconsin. We completed this work under the general direction of City of Madison Parks Division who established the general scope of the work.

The intent of this preliminary report is to: (1) convey the geotechnical information obtained from one soil boring; (2) present the results of laboratory and field tests; (3) present our comments and recommendations for site filling; and (4) present our comments and recommendations for the design and construction of the proposed improvements. We recommend City of Madison Parks Division employ Soils & Engineering Services, Inc. to make observations and perform tests at the time of excavation and construction of the proposed improvements to verify the subsurface conditions encountered by the exploration performed, and to validate our comments, analyses, and recommendations presented in this report for the subject improvements.

II. PROJECT DESCRIPTION

The project consists of the construction of a new playground structure for Galaxy Park located at the southwest intersection of Milky Way and Jackson Quarry Lane in the City of Madison in Dane County, Wisconsin.

III. GEOTECHNICAL EXPLORATION

The geotechnical field exploration consisted of the performance of one soil boring (designated Boring 1).

A. Boring Location

We located Boring 1 as close to the requested location as possible. We show the boring location on the Location Sketch, Drawing 13300.20-1, enclosed in Appendix A.

B. Boring Elevations

We did not determine the ground surface elevation at the boring location after completion of the drilling and sampling. We set the ground surface at 0 feet of depth

for the soil boring on the Boring Log Record enclosed in Appendix A. We plotted the Boring Log Record with depth scales for reference.

C. Drilling and Sampling Procedures

We drilled and sampled the boring to a depth of 13.8 feet below existing grade.

We used 2¼-inch-inside-diameter hollow-stem augers (HSA) for the boring to maintain an open borehole as we advanced the boring to the termination depth. As we advanced the borehole of this boring, we obtained soil samples at 2½-foot intervals starting at a depth of 1-foot below the ground surface and continued to a depth of 10 feet. We increased the sampling interval to 5 feet from a depth of 10 feet to the boring termination depth. We performed this sampling using a 2-inch-outside-diameter split-barrel sampler according to ASTM Designation D1586. We visually identified the recovered soils in general compliance with the Unified Soil Classification System (USCS) identification procedures as defined in ASTM Designation D2488.

Please refer to the Boring Log Record enclosed in Appendix A for additional information regarding the drilling and sampling of this boring. We provide information pertinent to the Boring Log Record on the Notes and Legend Record enclosed in Appendix A.

D. Subsurface Stratigraphy

In general terms, we characterize the soil stratigraphy encountered at Boring 1 as fill material overlying native soil strata. This boring did encounter bedrock within the depth drilled.

Boring 1 encountered 4 inches of dark brown LEAN CLAY (CL) FILL TOPSOIL over 14 inches of dark yellowish-brown LEAN CLAY (CL) FILL over 18 inches of brownish-red fine to medium POORLY-GRADED SAND WITH GRAVEL (SP) FILL.

Below the fill material, the boring encountered a native soil strata consisting of red and brown fine POORLY-GRADED SAND WITH SILT (SP-SM) over brown fine to medium SILTY SAND WITH GRAVEL (SM) GLACIAL TILL with trace to some gravel.

Below the native soil strata, the boring encountered slightly- to moderately-weathered reddish-yellow SANDSTONE bedrock.

Please refer to the Boring Log Record enclosed in Appendix A for a further description of the fill material, native soil strata, and bedrock encountered at the location of Boring 1.

E. Subsurface Water

Our drilling crew found the borehole of the boring performed to be caved and dry at a depth of 11.8 feet at the completion of the drilling and sampling at this boring.

We expect the subsurface (groundwater) levels to fluctuate as influenced by precipitation, snowmelt, surface water runoff, and other hydrological and hydrogeological factors. The groundwater level at the time of construction of the subject project may be higher or lower than the groundwater level encountered on the day that we performed the boring.

IV. LABORATORY AND FIELD TESTS

A. Laboratory Tests

We performed laboratory tests on a portion of selected split-barrel soil samples to determine the physical properties of the fill material and underlying native soil strata encountered at the boring location. The laboratory tests on the selected material from the split-barrel soil samples consisted of determining the moisture content (MC), Atterberg limits (liquid limit [LL] and plastic limit [PL]), the percentage of soil particles passing the No. 200-mesh sieve (P_{200}), and particle size distribution analysis.

We include the laboratory test results obtained for this report on the Boring Log Record and Laboratory Test Result Records (Figures 1 and 2) enclosed in Appendix A. We used the results from the Atterberg limits, P_{200}, and particle size distribution tests to confirm or modify the USCS soil identifications in general compliance with USCS classification procedures as defined in ASTM Designation D2487.

B. Field Tests

The field tests consisted of the performance of the standard penetration resistance test (SPT) for Boring 1. We performed the SPT during the sampling procedure at this boring. It consists of driving the split-barrel sampler up to 18 inches with a 140-pound hammer weight falling 30 inches. From the SPT, we obtain the N-value which is the sum of the number of blows required to drive the split-barrel sampler the last 12 inches or portion thereof as noted on the Boring Log Record.

We include the field test results obtained for this report on the Boring Log Record enclosed in Appendix A.

C. Test Results Discussion

The laboratory and field tests indicated the following:

- The dark yellowish-brown LEAN CLAY (CL) FILL is in a moist relative moisture condition and of stiff consistency.
- The brownish-red fine to medium POORLY-GRADED SAND WITH GRAVEL (SP) FILL is in a moist relative moisture condition and in a very loose state of relative density.
- The red and brown fine POORLY-GRADED SAND WITH SILT (SP-SM) is in a moist relative moisture condition and in a loose state of relative density.
- The brown fine to medium SILTY SAND WITH GRAVEL (SM) GLACIAL TILL with trace to some gravel is in a moist relative moisture condition and in a medium dense state of relative density.
- The slightly- to moderately-weathered reddish-yellow SANDSTONE bedrock is in a moist relative moisture condition and in a very dense state of relative density

We utilized the laboratory and field test results in our evaluation of the soils for the determination of design parameters, and to provide comments and recommendations for the design and construction of the subject project.

V. CONCLUSIONS

We offer the following general comments regarding the soils encountered by the boring:

- The boring encountered 4 inches of fill topsoil.
- Below the fill topsoil, Boring 1 encountered low to moderate strength cohesive fill over low strength granular fill.

- Below the fill material, Boring 1 encountered low to moderate strength native granular soil over high strength bedrock.

Based on the soil information obtained, construction of a playground structure for the proposed park is feasible.

VI. COMMENTS AND RECOMMENDATIONS

Based on the soil boring information and laboratory tests performed, we offer the following comments and recommendations regarding the design and construction of the Proposed Playground Structure for Galaxy Park located on Milky Way in the City of Madison, Dane County, Wisconsin.

A. Shallow Spread Footing Foundation Support

We recommend the excavation to accommodate a shallow spread footing be accomplished using a standard hydraulic backhoe equipped with a cleaning bucket to minimize disturbance to the soils at the bottom of the excavations. A cleaning bucket (a.k.a., "sand" or "ditch" bucket) is a standard bucket equipped with a continuous cutting edge which can be fabricated by bolting or welding a flat steel plate in front of the cutting teeth of a toothed bucket.

To protect against frost heave, we recommend the bottom of spread footings be placed at a depth of 4 feet or lower below the finished grade elevation.

We recommend an allowable bearing capacity of 2,000 pounds per square foot (psf) be used for foundation support of the new playground structure resting on spread footings founded in the native granular soils.

We estimate that total footing settlement should be less than 1-inches and differential settlement should be less than 0.03 inches per foot of horizontal distance between two points of reference for the recommended allowable bearing capacity.

B. Drilled Shafts (Piers) Foundation Support

We recommend drilled shafts be drilled using temporary water-tight casing, that the bottom of the shafts be cleaned of all loose material, and that the concrete be placed using a tremie from the bottom of the shaft and upward.

The design of the drilled shaft should be based on end bearing only (i.e., skin friction should be ignored). We recommend the following end bearing pressures:

Depth below existing grade	Allowable End Bearing Pressure
4 feet or less	2,000 psf
4 to 7 feet	3,000 psf
7 to 11 feet	5,000 psf
11 feet or greater	30,000 psf

We estimate that total footing settlement should be less than 1-inches and differential settlement should be less than 0.03 inches per foot of horizontal distance between two points of reference for the recommended allowable end bearing pressures.

C. Landscaped Area Fill

We recommend the material used to raise the grade below landscaped areas be placed in maximum 12-inch-thick loose layers and compacted to at least 88 percent of the maximum dry density determined for the material according to ASTM Designation D1557. Improper or poor densification of the fill material placed in landscaped areas could result in settlement of the soils and subsequent depressions in the landscaped area surface.

D. Site Grading Recommendations

Surface water from precipitation runoff if allowed to accumulate within the construction area can cause problems with construction. The contractor should grade the site to drain surface water away from the construction areas. Water accumulations in the construction area should be promptly removed. Any soil softened, loosened or disturbed by water should be excavated, removed and replaced with compacted granular fill material or coarse crushed stone. Temporary surface water diversion structures, such as ditches and berms, could be constructed in areas where surface water drainage into the work area is encountered.

E. Project Safety

Safety precautions, such as those required by OSHA and the Wisconsin Department of Safety and Professional Services, should be followed throughout the entire construction of the proposed project. They include, but are not limited to, the proper sloping and/or support of excavation sidewalls and adjacent embankments, roadways, access ramps, sidewalks, utility lines, towers, and/or buildings.

VII. CLOSING COMMENTS

Soils & Engineering Services, Inc. prepared this report for the exclusive use of the City of Madison Parks Division to aid in the design of the proposed construction of a new playground structure for Galaxy Park located at 132 Milky Way in the City of Madison in Dane County, Wisconsin. The recommendations in this report are based on the project information provided to our office. Soils & Engineering Services, Inc. should review any changes in the nature, design, or location of the proposed improvements after submittal of this *Geotechnical Exploration and Analyses Report* to revise the recommendations in the report, if necessary. The nature and extent of soil or groundwater variations may not become evident until the time of excavation or construction of the subject project. If soil or groundwater variations are evident at the time of excavation or construction, it will be necessary for Soils & Engineering Services, Inc. to re-evaluate the soil and groundwater, and other site conditions, which may result in the revision of our recommendations in this report.

Please read the *Important Information about This Geotechnical-Engineering Report* advisory sheet enclosed in Appendix B which provides comments about how to interpret and use this *Geotechnical Exploration and Analyses Report* for the Proposed Playground Structure project.

Soils & Engineering Services, Inc. should review the final design and specification documents for this project to verify that our recommendations regarding the proposed improvements are interpreted correctly and implemented in the design of the subject project as they are intended. We recommend that Soils & Engineering Services, Inc. be present at the time of construction to observe compliance with the design concept and specifications, and to provide recommendations to modify the design if subsurface conditions differ from those anticipated prior to construction. It is important that the exposed soil strength, degree of compaction, and other soil properties required be confirmed and/or determined at the time of excavation and construction activities for the subject project.

The recommendations provided in this report are based on our identification/classification and interpretation of the soils and information given on the Boring Log Record, and may not be based solely on the contents of the driller's field log.

Soils & Engineering Services, Inc. prepared this report for the subject project in accordance with generally accepted geotechnical engineering practices at this time. Soils & Engineering Services, Inc. offers no other expressed or implied warranty.

Soils & Engineering Services, Inc. will store the soil samples obtained from the soil boring performed for this project for a period of 60 calendar days after the date of this report. Please advise us if we should extend this period.

We recommend that this *Geotechnical Exploration and Analyses Report*, in its entirety, be made available to bidding contractors or subcontractors for information purposes. The Appendices, Boring Log Record, and/or other attachments referenced in this report should not be separated from the text of this report. This report should be considered invalid if used for purposes other than those described herein.

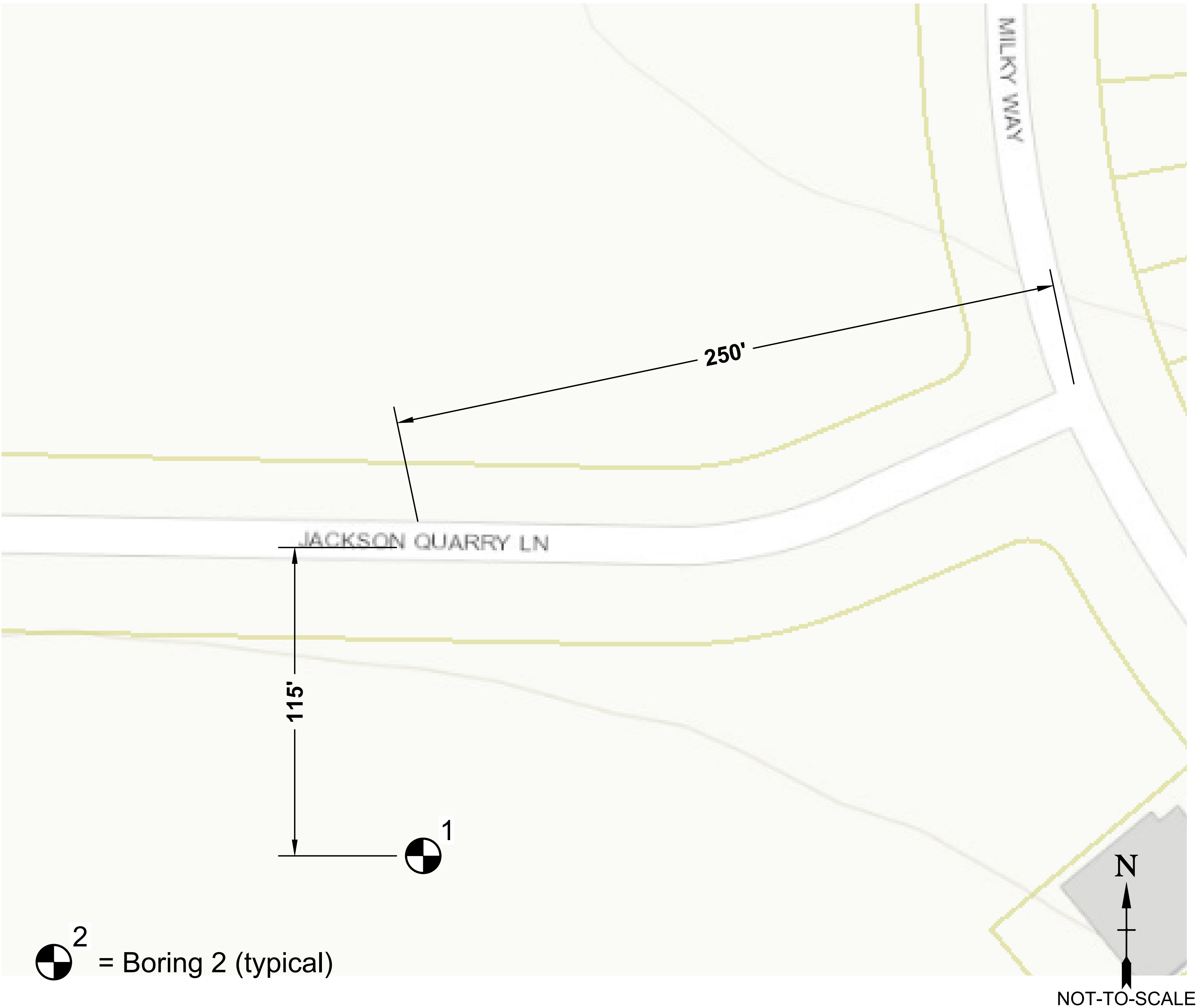
Soils & Engineering Services, Inc. respectfully submits this *Geotechnical Exploration and Analyses Report*, dated January 20, 2020, to the **City of Madison Parks Division**.

APPENDIX A

Appendix A Contents

- Location Sketch, Drawing 13300.20-1
- Notes and Legend Record for Boring Log Record
- Boring Log Record for Boring 1
- Laboratory Test Result Records, Figures 1 and 2

Base drawing obtained from Dane County Land Information Office DCiMap Portal on November 14, 2019.



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LOCATION SKETCH
Proposed Playground Structure
Galaxy Park
132 Milky Way
City of Madison, Dane County, Wisconsin

DRAWING
13300.20-1

Created on 11/14/2019 Revised on

NOTES

1. The boundary lines between different soil strata, as shown on the Boring Log Record, are approximate and may be gradual.

2. The boring field log contains a description of the soil conditions between samples based on the equipment performance and the soil cuttings. The Boring Log Record contains the description of the soil conditions as interpreted by a geotechnical engineer and/or a geologist after review of the boring field logs and soil samples and/or laboratory test results.

3. We define "Caved Level" as the depth below the existing ground surface at a boring location where the soils have collapsed into the borehole following removal of the drilling tools.

4. We define "Water Level" as the depth below the existing ground surface at a boring location to the level of water in the open borehole at the time indicated unless otherwise defined on the Boring Log Record.

5. We define "at completion" for a boring as being the time when our drilling crew has completed the removal of all drilling tools from the borehole.

6. The Notes and Legend Record and the Boring Log Record are a part of the Geotechnical-Engineering Report. The Geotechnical-Engineering Report should be included in the bidding or reference documents.

RELATIVE PERCENTAGE TERMS

no	0%
trace	<5%
few	5 to <10%
little	10 to <30%
some	30 to < 50%

TEST RESULTS LEGEND

MC = Moisture Content, % moisture by weight
LL = Liquid Limit, % moisture by weight
PL = Plastic Limit, % moisture by weight
PI = Plasticity Index, % moisture by weight
P_{200} = % Passing the No. 200-mesh Sieve

RELATIVE MOISTURE TERMS AT TIME OF SAMPLING

Frozen or F = Frozen material
Dry = Dusty, dry to touch, absence of moisture
Moist or M = Damp to touch, no visible water
Wet or W = Visible free water

DRILLING METHODS LEGEND

HSA = Continuous flight hollow-stem augers

SAMPLER TYPE LEGEND

Grab sample

2-inch-outside-diameter, split-barrel sampler

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NOTES AND LEGEND RECORD
Proposed Playground Structure
Galaxy Park
132 Milky Way
City of Madison, Dane County, Wisconsin

13300.20

General Location:

Boring 1

LATITUDE: —	LONGITUDE: —	COUNTY: Dane	SECTION: 2	CREW CHIEF: SWK	DRILL RIG: Geoprobe	PAGE: 1 of 1
NORTHING: —	EASTING: —	TOWNSHIP: (Blooming Grove) 7 N	¼: SW	LOG REVIEW: CMB	HAMMER TYPE (EFFICIENCY): Automatic (80%)	TOTAL DEPTH: 13'-9"
STATION: —	OFFSET: —	RANGE: 10 E	¼ ¼: NE	LOG QC: CMB	DATE STARTED: 11/07/2019	DATE COMPLETED: 11/07/2019

DEPTH (feet)	Material Description	N-Value	Test Results	Sampler Type / Recovery / Remarks
0	***LEAN CLAY (CL)*** *— medium plasticity, dark brown, moist,* ***FILL TOPSOIL****-[4" thick]*			M
	LEAN CLAY (CL) *— medium plasticity, dark yellowish-brown, moist, stiff consistency,* ***FILL****-[14" thick]*	4	MC=15.1; LL=27 PL=14	M
3	***POORLY-GRADED SAND WITH GRAVEL (SP)*** *— fine to medium grained, brownish-red, moist, very loose relative density,* ***FILL****-[18" thick]*	8	MC=3.8 P_{200}=15.4	M
	POORLY-GRADED SAND WITH SILT (SP-SM) *— fine grained, non-plastic to low plasticity fines, red and brown, moist, loose relative density*			
6	***SILTY SAND WITH GRAVEL (SM)*** *— fine to medium grained, non-plastic to low plasticity fines, brown, moist, medium dense relative density,* ***GLACIAL TILL****, trace to some gravel*	13		M
9		11		M
12	***SANDSTONE*** *— slightly- to moderately-weathered, reddish-yellow, moist, very dense relative density* (Caved / Dry at 11'-9"); Firm drilling, 11'-0" to 13'-6"	100/3"		M
15				
18				

WATER LEVEL LEGEND	OTHER LEVEL LEGEND
D 11'-9" Dry at completion	Caved 11'-9" Caved at completion

DRILL METHOD	TOOL SIZE	CASING SIZE	DRILL FLUID	DEPTH FROM	DEPTH TO	HOLE DIA
HSA	2 ¹/₄"	—	None	0'-0"	13'-9"	6.3"

SAMPLING METHOD(S): ASTM D1586

SURFACE PATCH: —

BACKFILL: Auger Cuttings, Bentonite Chips, Caved Soil

The Notes and Legend Record is considered a part of this Boring Log Record.

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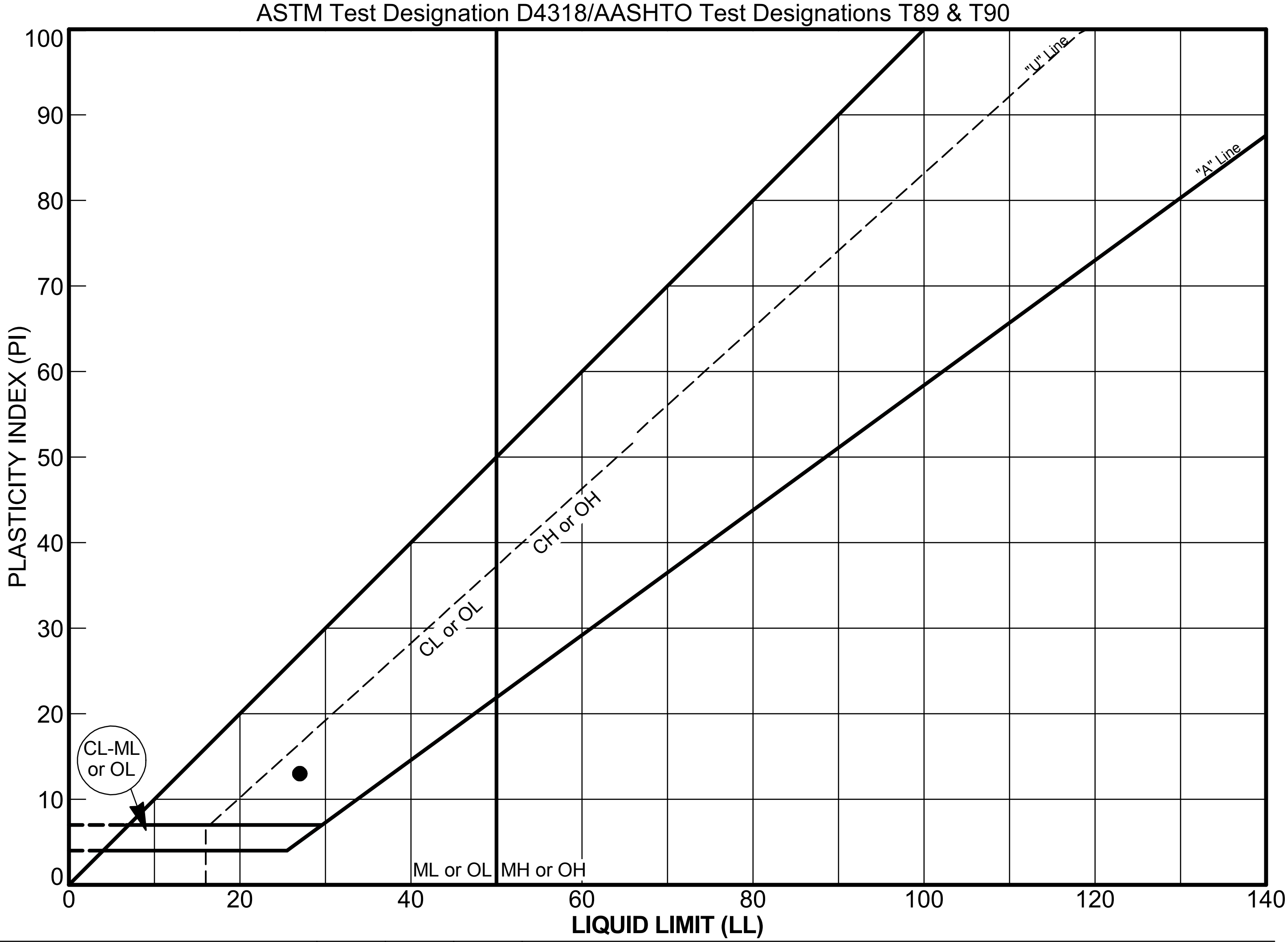
BORING LOG RECORD
Proposed Playground Structure
Galaxy Park
132 Milky Way
City of Madison, Dane County, Wisconsin

13300.20

ATTERBERG LIMITS TEST REPORT

ASTM Test Designation D4318/AASHTO Test Designations T89 & T90



	Specimen Identification	LL	PL	PI	Sample Classification
●	**Boring 1, 1'-5" Depth**	**27**	**14**	**13**	***LEAN CLAY (CL)*** *— medium plasticity, dark yellowish-brown, moist,* ***FILL***

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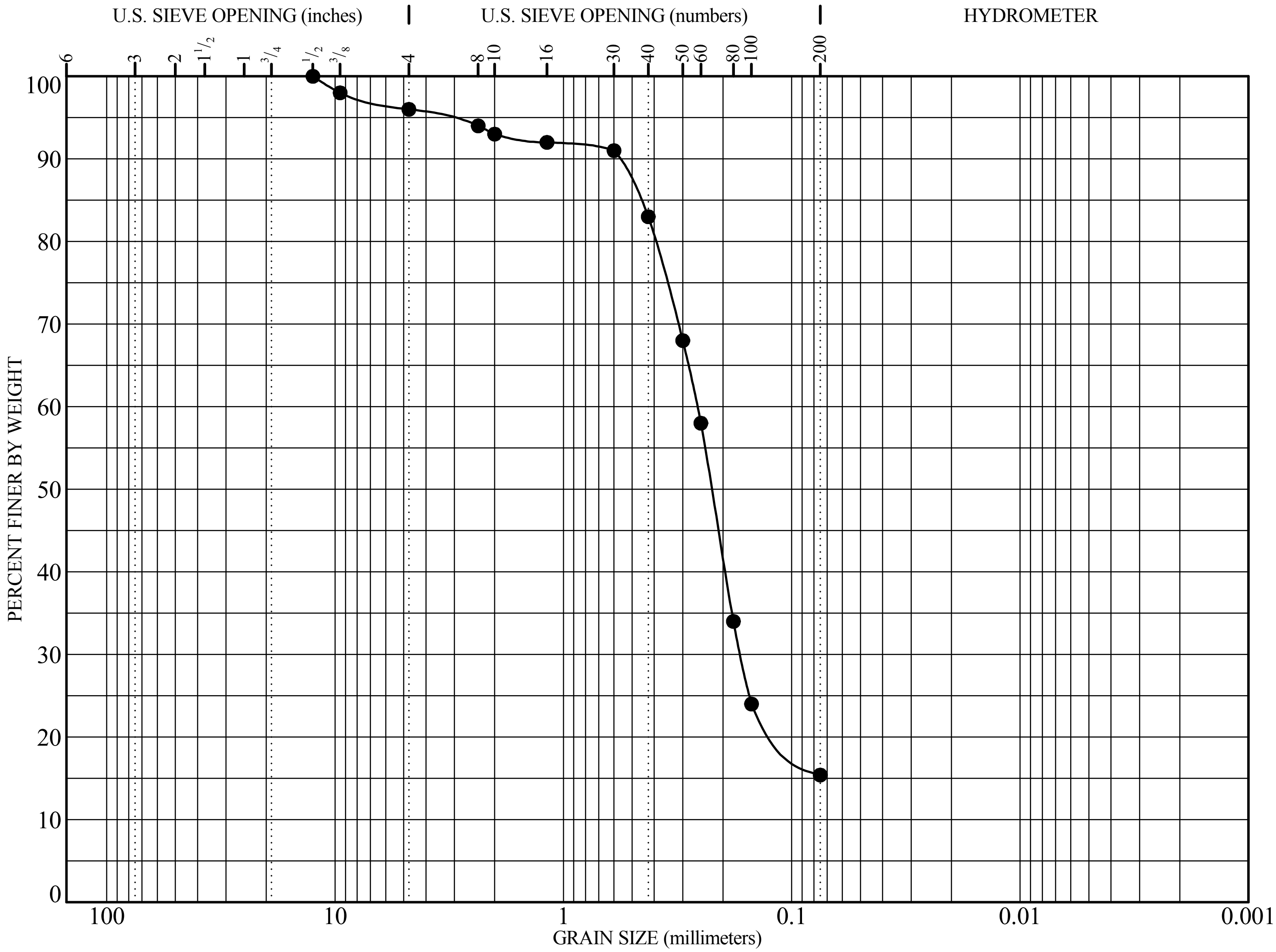
LABORATORY TEST RESULT RECORD
Proposed Playground Structure
Galaxy Park
132 Milky Way
City of Madison, Dane County, Wisconsin

13300.20

FIGURE 1

Printed on 1/20/2020

PARTICLE SIZE DISTRIBUTION ANALYSIS REPORT



	COBBLES (%)	GRAVEL (%)		SAND (%)			FINES (%)	
		coarse	fine	coarse	medium	fine	SILT (%)	CLAY (%)
●	**0**	**0**	**4**	**3**	**10**	**68**	**15.4**	

Sieve Size	Percent Finer ●		
1/2-inch	**100**		
3/8-inch	**98**		
#4	**96**		
#8	**94**		
#10	**93**		
#16	**92**		
#30	**91**		
#40	**83**		
#50	**68**		
#60	**58**		
#80	**34**		
#100	**24**		

Sieve Size	Percent Finer ●		
#200	**15.4**		

	Grain Size (mm)			Coefficients	
	D_{60}	D_{30}	D_{10}	C_c	C_u
●	**0.26**	**0.17**			

	Sample Information
●	Boring 1, 3'-9" Depth: ***SILTY SAND (SM)*** *— fine to medium grained, non-plastic to low plasticity fines, red and brown, moist, loose relative density, trace gravel*

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LABORATORY TEST RESULT RECORD
Proposed Playground Structure
Galaxy Park
132 Milky Way
City of Madison, Dane County, Wisconsin

13300.20
FIGURE 2

APPENDIX B

Appendix B Contents

- *Important Information about This Geotechnical-Engineering Report* advisory

Important Information about This

Geotechnical-Engineering Report

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

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

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

everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

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

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

Geotechnical-Engineering Services are Performed

and imes

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

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

Do not rely on this report if your geotechnical engineer prepared it:

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

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

Read this Report in Full

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

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

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

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

This Report's Recommendations Are

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

This Report Could Be Misinterpreted

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

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

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are <u>Not</u> Covered

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

Obtain Professional Assistance to Deal with

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

GEOPROFESSIONAL
BUSINESS
ASSOCIATION

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Soils & Engineering Services, Inc.

January 20, 2020

Project 13300.22 R01

Ms. Sarah Close, LEED AP, RLA
City of Madison Parks Division
City-County Building, Room 104
210 Martin Luther King, Jr. Boulevard
Madison, Wisconsin 53703-3342

Subject: Geotechnical Exploration and Analyses Report
Proposed Playground Structure
Morrison Park
1451 Morrison Street
City of Madison
Dane County, Wisconsin

Dear Ms. Close:

We have completed the requested exploration consisting of the performance of one soil boring and associated laboratory testing. The purpose of this boring was to obtain information about the soil, bedrock, and water conditions at the boring location. We present our findings and preliminary comments and recommendations in the enclosed *Geotechnical Exploration and Analyses Report* for the subject project.

Respectfully submitted,

SOILS & ENGINEERING SERVICES, INC.

Craig M. Bower, P.E.

CMB:DER:cmb

Enclosure

Delivered by email: SClose@cityofmadison.com

Geotechnical Exploration and Analyses Report

Proposed Playground Structure
Morrison Park
1451 Morrison Street
City of Madison
Dane County, Wisconsin

SES Project Number 13300.22

Prepared By

Soils & Engineering Services, Inc.
1102 Stewart Street
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phone: (608) 274-7600
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Craig M. Bower, P.E.

WISCONSIN
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E-26676
COTTAGE GROVE
WIS.
1/20/20
PROFESSIONAL ENGINEER

Submitted To

City of Madison Parks Division
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Madison, Wisconsin 53703-3342
Phone: (608) 261-4281

Ms. Sarah Close, LEED AP, RLA

January 20, 2020

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LIST OF APPENDICES

I. INTRODUCTION

This *Geotechnical Exploration and Analyses Report* summarizes the findings of the geotechnical exploration, laboratory tests, and geotechnical engineering analyses performed for the design and construction of a new playground structure for Morrison Park located at 1451 Morrison Street in the City of Madison in Dane County, Wisconsin. We completed this work under the general direction of City of Madison Parks Division who established the general scope of the work.

The intent of this preliminary report is to: (1) convey the geotechnical information obtained from one soil boring; (2) present the results of laboratory and field tests; (3) present our comments and recommendations for site filling; and (4) present our comments and recommendations for the design and construction of the proposed improvements. We recommend City of Madison Parks Division employ Soils & Engineering Services, Inc. to make observations and perform tests at the time of excavation and construction of the proposed improvements to verify the subsurface conditions encountered by the exploration performed, and to validate our comments, analyses, and recommendations presented in this report for the subject improvements.

II. PROJECT DESCRIPTION

The project consists of the construction of a new playground structure for Morrison Park located at the southeast intersection of Rogers Street and Morrison Street in the City of Madison in Dane County, Wisconsin.

III. GEOTECHNICAL EXPLORATION

The geotechnical field exploration consisted of the performance of one soil boring (designated Boring 1).

A. Boring Location

We located Boring 1 as close to the requested location as possible. We show the boring location on the Location Sketch, Drawing 13300.22-1, enclosed in Appendix A.

B. Boring Elevations

We did not determine the ground surface elevation at the boring location after completion of the drilling and sampling. We set the ground surface at 0 feet of depth

for the soil boring on the Boring Log Record enclosed in Appendix A. We plotted the Boring Log Record with depth scales for reference.

C. Drilling and Sampling Procedures

The exploration plan was to complete Boring 1 to a depth of 10 feet below existing grade. We drilled and sampled the boring to the planned depth.

We used 2¼-inch-inside-diameter hollow-stem augers (HSA) for the boring to maintain an open borehole as we advanced the boring to the termination depth. As we advanced the borehole of this boring, we obtained soil samples at 2½-foot intervals starting at a depth of 1-foot below the ground surface and continued to the boring termination depth. We performed this sampling using a 2-inch-outside-diameter split-barrel sampler according to ASTM Designation D1586. We visually identified the recovered soils in general compliance with the Unified Soil Classification System (USCS) identification procedures as defined in ASTM Designation D2488.

Please refer to the Boring Log Record enclosed in Appendix A for additional information regarding the drilling and sampling of this boring. We provide information pertinent to the Boring Log Record on the Notes and Legend Record enclosed in Appendix A.

D. Subsurface Stratigraphy

In general terms, we characterize the soil stratigraphy encountered at Boring 1 as topsoil overlying native soil strata. This boring did not encounter bedrock within the depth drilled.

Boring 1 encountered 18 inches of dark brown SANDY SILT (ML) TOPSOIL over a native soil strata consisting of light brown fine POORLY-GRADED SAND WITH SILT (SP-SM) over brown fine POORLY-GRADED SAND (SP) over dark brown fine POORLY-GRADED SAND WITH SILT (SP-SM) with trace shells over gray fine SILTY SAND (SM).

Please refer to the Boring Log Record enclosed in Appendix A for a further description of the topsoil and native soil strata encountered at the location of Boring 1.

E. Subsurface Water

Our drilling crew found the borehole of the boring performed to be caved and moist at a depth of 3.8 feet at the completion of the drilling and sampling at this boring. We anticipate the water level is in close proximity to this depth based on the moisture condition of the soil samples recovered.

The United States Geological Survey Water Resources in conjunction with the Dane County Land and Resources Department records the stage of Lake Monona at Brittingham Park.[1] The reported stage of Lake Monona on the day that we performed Boring 1 is as follows:

Date	Elevation (feet)		
	Minimum Stage	**Maximum Stage**	**Average Stage**
12/6/2019	845.97	846.00	846.04

The Dane County Land Information Office interactive mapping website (DCiMap) indicates the ground surface elevation for Morrison Park ranges from approximately 845 feet at Lake Mendota to approximately 851.5 feet at Morrison Street.[2] The ground surface elevation in the vicinity of Boring 1 is approximately 850 to 851 feet, which indicates that groundwater would be approximately 4 to 5 feet below existing grade.

We expect the subsurface (groundwater) levels to fluctuate as influenced by precipitation, snowmelt, surface water runoff, the stage of Lake Monona, and other hydrological and hydrogeological factors. The groundwater level at the time of construction of the subject project may be higher or lower than the groundwater level encountered on the day that we performed the boring.

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[1] USGS Current Conditions for USGS 05429000 LAKE MONONA AT MADISON, WI, accessed 10 January 2020, https://waterdata.usgs.gov/wi/nwis/uv?cb_00065=on&format=rdb&site_no=05429000&period=&begin_date=2019-12-06&end_date=2019-12-06

[2] DCiMap, Dane County Land Information Office, accessed 10 January 2020, dcimapapps.countyofdane.com/dcmapviewer/.

IV. FIELD TESTS

A. Field Tests Performed

The field tests consisted of the performance of the standard penetration resistance test (SPT) for Boring 1. We performed the SPT during the sampling procedure at this boring. It consists of driving the split-barrel sampler up to 18 inches with a 140-pound hammer weight falling 30 inches. From the SPT, we obtain the N-value which is the sum of the number of blows required to drive the split-barrel sampler the last 12 inches or portion thereof as noted on the Boring Log Record.

We include the field test results obtained for this report on the Boring Log Record enclosed in Appendix A.

B. Test Results Discussion

The field tests indicated the following:

- The light brown fine POORLY-GRADED SAND WITH SILT (SP-SM) is in a moist to wet relative moisture condition and in a loose state of relative density.
- The brown fine POORLY-GRADED SAND (SP) is in a wet relative moisture condition and in a very loose state of relative density.
- The dark brown fine POORLY-GRADED SAND WITH SILT (SP-SM) with trace shells is in a wet relative moisture condition and in a medium dense state of relative density.
- The gray fine SILTY SAND (SM) is in a wet relative moisture condition and in a medium dense state of relative density.

We utilized the laboratory and field test results in our evaluation of the soils for the determination of design parameters, and to provide comments and recommendations for the design and construction of the subject project.

V. CONCLUSIONS

We offer the following general comments regarding the soils encountered by the boring:

- The boring encountered 18 inches of topsoil.

- Below the topsoil, Boring 1 encountered very low to moderate strength native granular soil.

Based on the soil information obtained, construction of a playground structure for the proposed park is feasible.

VI. COMMENTS AND RECOMMENDATIONS

Based on the soil boring information and laboratory tests performed, we offer the following comments and recommendations regarding the design and construction of the Proposed Playground Structure for Morrison Park located on Morrison Street in the City of Madison, Dane County, Wisconsin.

A. Shallow Spread Footing Foundation Support

We recommend the excavation to accommodate a shallow spread footing be accomplished using a standard hydraulic backhoe equipped with a cleaning bucket to minimize disturbance to the soils at the bottom of the excavations. A cleaning bucket (a.k.a., "sand" or "ditch" bucket) is a standard bucket equipped with a continuous cutting edge which can be fabricated by bolting or welding a flat steel plate in front of the cutting teeth of a toothed bucket.

To protect against frost heave, we recommend the bottom of spread footings be placed at a depth of 4 feet or lower below the finished grade elevation.

We recommend an allowable bearing capacity of 2,000 pounds per square foot (psf) be used for foundation support of the new playground structure resting on spread footings founded in the native granular soils.

We estimate that total footing settlement should be less than 1-inches and differential settlement should be less than 0.03 inches per foot of horizontal distance between two points of reference for the recommended allowable bearing capacity.

B. Drilled Shafts (Piers) Foundation Support

We recommend drilled shafts be (1) drilled using temporary water-tight casing and/or drilling fluid to maintain an open hole, (2) that the bottom of the shafts be cleaned of all loose material, and (3) that the concrete be placed using a tremie from the bottom of the shaft and upward. We anticipate that a drilled shaft will fill with water. The drilling fluid should be properly designed for drilled shaft construction.

The design of the drilled shaft should be based on end bearing only (i.e., skin friction should be ignored). We recommend the following end bearing pressures:

Depth below existing grade	Allowable End Bearing Pressure
9 feet or less	2,000 psf
9 feet or greater	10,000 psf

We estimate that total footing settlement should be less than 1-inches and differential settlement should be less than 0.03 inches per foot of horizontal distance between two points of reference for the recommended allowable end bearing pressures.

C. Helical Screw Pile Foundation Support

Helical screw piles consist of one to several helical flights welded to a hollow steel pipe shaft. They are installed by turning the pile into the ground similar to a screw being turned into a piece of wood.

The ultimate compression and tension capacity of a helical screw pile is dependant upon the shaft diameter, the distance between adjacent helical screw piles, the diameter of the flights of the helical screw piles, the elevation of the helical screw pile tip, and the strength of the soil strata. If lateral resistance is required, the helical screw piles can be installed at an angle from the vertical. The final design of helical screw piles is proprietary and is completed by a professional engineer using the design equations and procedures specified by the manufacturer of the helical screw piles selected for use on a project.

We recommend the bottom helix for a helical screw pile be located at least 9 feet below the finished ground surface using the following soil parameters and a factor of safety of 2.0 be used to design the helical screw piles:

Depth Below Existing Grade (feet)	Estimated Soil Parameters		
	Moist Density (pcf)	Friction Angle, φ (degrees)	Cohesion (psf)
0.0 to 9.0	110	25	0
> 9.0	120	35	0

D. Landscaped Area Fill

We recommend the material used to raise the grade below landscaped areas be placed in maximum 12-inch-thick loose layers and compacted to at least 88 percent of the maximum dry density determined for the material according to ASTM Designation D1557. Improper or poor densification of the fill material placed in landscaped areas could result in settlement of the soils and subsequent depressions in the landscaped area surface.

E. Site Grading Recommendations

Surface water from precipitation runoff if allowed to accumulate within the construction area can cause problems with construction. The contractor should grade the site to drain surface water away from the construction areas. Water accumulations in the construction area should be promptly removed. Any soil softened, loosened or disturbed by water should be excavated, removed and replaced with compacted granular fill material or coarse crushed stone. Temporary surface water diversion structures, such as ditches and berms, could be constructed in areas where surface water drainage into the work area is encountered.

F. Project Safety

Safety precautions, such as those required by OSHA and the Wisconsin Department of Safety and Professional Services, should be followed throughout the entire construction of the proposed project. They include, but are not limited to, the proper sloping and/or support of excavation sidewalls and adjacent embankments, roadways, access ramps, sidewalks, utility lines, towers, and/or buildings.

VII. CLOSING COMMENTS

Soils & Engineering Services, Inc. prepared this report for the exclusive use of the City of Madison Parks Division to aid in the design of the proposed construction of a new playground structure for Morrison Park located at 1451 Morrison Street in the City of Madison in Dane County, Wisconsin. The recommendations in this report are based on the project information provided to our office. Soils & Engineering Services, Inc. should review any changes in the nature, design, or location of the proposed improvements after submittal of this *Geotechnical Exploration and Analyses Report* to revise the recommendations in the report, if necessary. The nature and extent of soil or groundwater variations may not become evident until the time of excavation or construction of the subject project. If soil or groundwater variations are evident at the time of excavation or construction, it will be necessary for Soils & Engineering Services, Inc. to re-evaluate the soil and groundwater, and other site conditions, which may result in the revision of our recommendations in this report.

Please read the *Important Information about This Geotechnical-Engineering Report* advisory sheet enclosed in Appendix B which provides comments about how to interpret and use this *Geotechnical Exploration and Analyses Report* for the Proposed Playground Structure project.

Soils & Engineering Services, Inc. should review the final design and specification documents for this project to verify that our recommendations regarding the proposed improvements are interpreted correctly and implemented in the design of the subject project as they are intended. We recommend that Soils & Engineering Services, Inc. be present at the time of construction to observe compliance with the design concept and specifications, and to provide recommendations to modify the design if subsurface conditions differ from those anticipated prior to construction. It is important that the exposed soil strength, degree of compaction, and other soil properties required be confirmed and/or determined at the time of excavation and construction activities for the subject project.

The recommendations provided in this report are based on our identification/classification and interpretation of the soils and information given on the Boring Log Record, and may not be based solely on the contents of the driller's field log.

Soils & Engineering Services, Inc. prepared this report for the subject project in accordance with generally accepted geotechnical engineering practices at this time. Soils & Engineering Services, Inc. offers no other expressed or implied warranty.

Soils & Engineering Services, Inc. will store the soil samples obtained from the soil boring performed for this project for a period of 60 calendar days after the date of this report. Please advise us if we should extend this period.

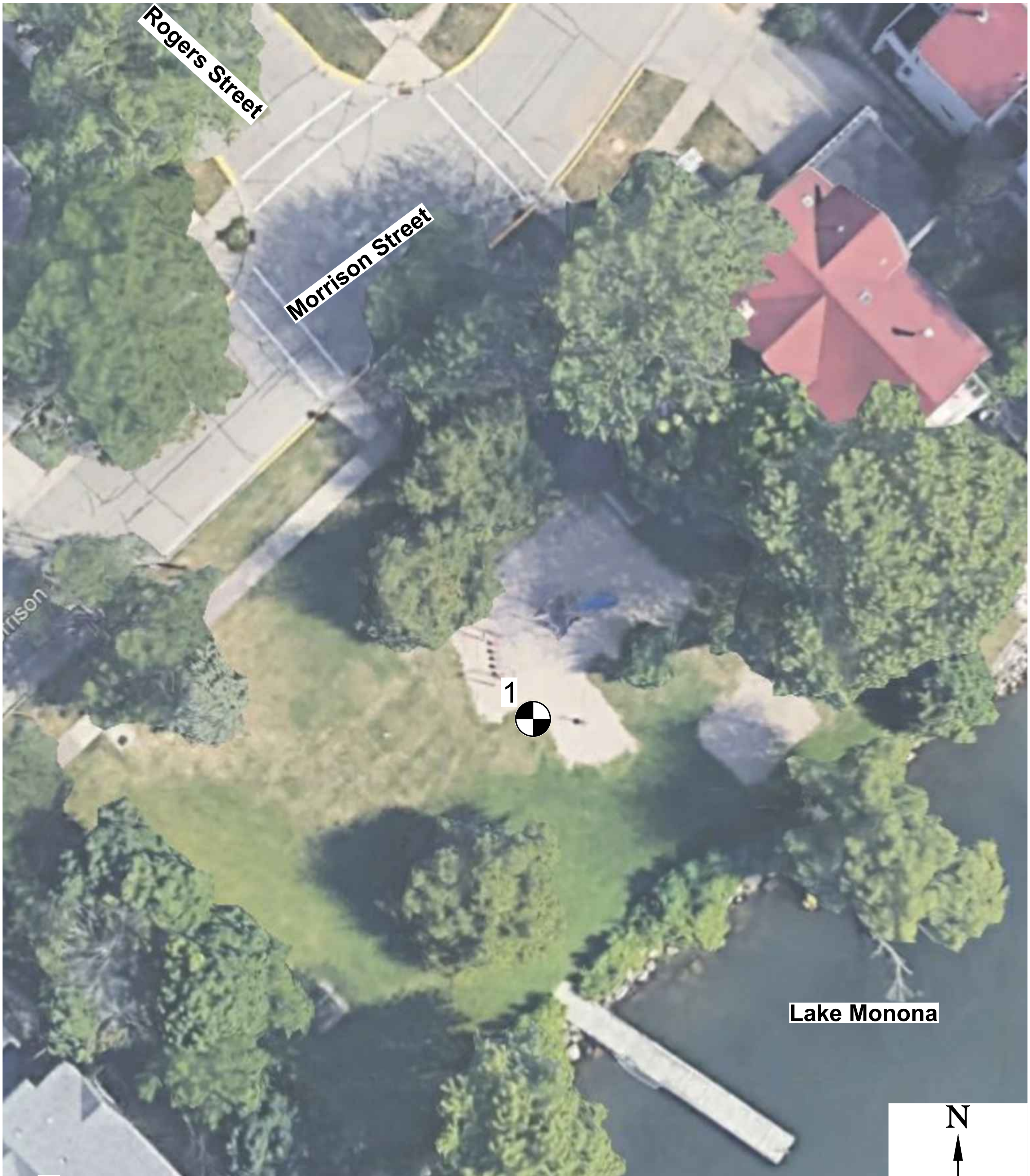
We recommend that this *Geotechnical Exploration and Analyses Report*, in its entirety, be made available to bidding contractors or subcontractors for information purposes. The Appendices, Boring Log Record, and/or other attachments referenced in this report should not be separated from the text of this report. This report should be considered invalid if used for purposes other than those described herein.

Soils & Engineering Services, Inc. respectfully submits this *Geotechnical Exploration and Analyses Report*, dated January 20, 2020, to the **City of Madison Parks Division**.

APPENDIX A

Appendix A Contents

- Location Sketch, Drawing 13300.22-1
- Notes and Legend Record for Boring Log Record
- Boring Log Record for Boring 1



Map Source: "Morrison Park, Madison, WI." Google Earth. October 2018 Aerial. Accessed December 16, 2019.

= Boring 2 (typical)

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CONSULTING CIVIL ENGINEERS SINCE 1966

LOCATION SKETCH
Proposed Playground Structure
Morrison Park
1451 Morrison Street
City Of Madison, Dane County, Wisconsin

DRAWING
13300.22-1

Created on 12/16/2019 Revised on

NOTES

1. The boundary lines between different soil strata, as shown on the Boring Log Record, are approximate and may be gradual.

2. The boring field log contains a description of the soil conditions between samples based on the equipment performance and the soil cuttings. The Boring Log Record contains the description of the soil conditions as interpreted by a geotechnical engineer and/or a geologist after review of the boring field logs and soil samples and/or laboratory test results.

3. We define "Caved Level" as the depth below the existing ground surface at a boring location where the soils have collapsed into the borehole following removal of the drilling tools.

4. We define "Water Level" as the depth below the existing ground surface at a boring location to the level of water in the open borehole at the time indicated unless otherwise defined on the Boring Log Record.

5. We define "at completion" for a boring as being the time when our drilling crew has completed the removal of all drilling tools from the borehole.

6. The Notes and Legend Record and the Boring Log Record are a part of the Geotechnical-Engineering Report. The Geotechnical-Engineering Report should be included in the bidding or reference documents.

RELATIVE PERCENTAGE TERMS

no	0%
trace	<5%
few	5 to <10%
little	10 to <30%
some	30 to < 50%

TEST RESULTS LEGEND

RELATIVE MOISTURE TERMS AT TIME OF SAMPLING

Frozen or F = Frozen material
Dry = Dusty, dry to touch, absence of moisture
Moist or M = Damp to touch, no visible water
Wet or W = Visible free water

DRILLING METHODS LEGEND

HSA = Continuous flight hollow-stem augers

SAMPLER TYPE LEGEND

Grab sample

2-inch-outside-diameter, split-barrel sampler

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NOTES AND LEGEND RECORD
Proposed Playground Structure
Morrison Park
1451 Morrison Street
City of Madison, Dane County, Wisconsin

13300.22

General Location:

Boring 1

LATITUDE: —	LONGITUDE: —	COUNTY: Dane	SECTION: 7	CREW CHIEF: SWK	DRILL RIG: Geoprobe 7822DT	PAGE: 1 of 1
NORTHING: —	EASTING: —	TOWNSHIP: (Blooming Grove) 7 N	¼: —	LOG REVIEW: CMB	HAMMER TYPE (EFFICIENCY): Automatic (80%)	TOTAL DEPTH: 10'-0"
STATION: —	OFFSET: —	RANGE: 10 E	¼ ¼: —	LOG QC: CMB	DATE STARTED: 12/06/2019	DATE COMPLETED: 12/06/2019

DEPTH (feet)	Material Description	Test Results (N-Value)	Sampler Type / Recovery / Remarks
0 – 1.5	***SANDY SILT (ML)*** *— non-plastic to low plasticity, dark brown, moist,* ***TOPSOIL-*** [18" thick]		M; M
1.5 – 3	***POORLY-GRADED SAND WITH SILT (SP-SM)*** *— fine grained, non-plastic to low plasticity fines, light brown, moist to wet, loose relative density*	8	M
3 – 8	***POORLY-GRADED SAND (SP)*** *— fine grained, brown, wet, very loose relative density*	4; 1/9" 1/9"	W; W
8	Firmer drilling at 8'-0"		
8 – 9.5	***POORLY-GRADED SAND WITH SILT (SP-SM)*** *— fine grained, non-plastic to low plasticity fines, dark brown, wet, medium dense relative density, trace shells*	33	W
9.5 – 10	***SILTY SAND (SM)*** *— fine grained, non-plastic to low plasticity fines, gray, wet, medium dense relative density*		W

WATER LEVEL LEGEND	OTHER LEVEL LEGEND
3'-10" Moist at completion	3'-10" Caved at completion

DRILL METHOD	TOOL SIZE	CASING SIZE	DRILL FLUID	DEPTH FROM	DEPTH TO	HOLE DIA
HSA	2 1/4"	—	None	0'-0"	10'-0"	6.3"

SAMPLING METHOD(S): ASTM D1586

SURFACE PATCH: —

BACKFILL: Auger Cuttings, Bentonite Chips, Caved Soil

The Notes and Legend Record is considered a part of this Boring Log Record.

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BORING LOG RECORD
Proposed Playground Structure
Morrison Park
1451 Morrison Street
City of Madison, Dane County, Wisconsin

13300.22

APPENDIX B

Appendix B Contents

- *Important Information about This Geotechnical-Engineering Report* advisory

Important Information about This

Geotechnical-Engineering Report

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

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

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

everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

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

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

Geotechnical-Engineering Services are Performed

and imes

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

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

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

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

Read this Report in Full

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

You Need to Inform Your Geotechnical Engineer About Change

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

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

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

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

This Report's Recommendations Are

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

This Report Could Be Misinterpreted

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

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

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

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

Obtain Professional Assistance to Deal with

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

GBA GEOPROFESSIONAL BUSINESS ASSOCIATION

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Soils & Engineering Services, Inc.

January 20, 2020

Project 13300.23 R01

Ms. Sarah Close, LEED AP, RLA
City of Madison Parks Division
City-County Building, Room 104
210 Martin Luther King, Jr. Boulevard
Madison, Wisconsin 53703-3342

Subject: Geotechnical Exploration and Analyses Report
Proposed Playground Structure
Orlando Bell Park
2274 South Thompson Drive
City of Madison
Dane County, Wisconsin

Dear Ms. Close:

We have completed the requested exploration consisting of the performance of one soil boring and associated laboratory testing. The purpose of this boring was to obtain information about the soil, bedrock, and water conditions at the boring location. We present our findings and preliminary comments and recommendations in the enclosed *Geotechnical Exploration and Analyses Report* for the subject project.

Respectfully submitted,

SOILS & ENGINEERING SERVICES, INC.

Craig M. Bower

Craig M. Bower, P.E.

CMB:DER:cmb

Enclosure

Delivered by email: SClose@cityofmadison.com

GEOTECHNICAL EXPLORATION AND ANALYSES REPORT

PROPOSED PLAYGROUND STRUCTURE
ORLANDO BELL PARK
2274 SOUTH THOMPSON DRIVE
CITY OF MADISON
DANE COUNTY, WISCONSIN
SES Project Number 13300.23

Prepared By

Soils & Engineering Services, Inc.
1102 Stewart Street
Madison, Wisconsin 53713-4648
phone: (608) 274-7600
e-mail: soils@soils.ws

Craig M. Bower, P.E.

WISCONSIN
CRAIG M. BOWER
E-26676
COTTAGE GROVE, WIS.
1/20/20
PROFESSIONAL ENGINEER

Submitted To

City of Madison Parks Division
City-County Building, Room 104
210 Martin Luther King, Jr. Boulevard
Madison, Wisconsin 53703-3342
Phone: (608) 261-4281

Ms. Sarah Close, LEED AP, RLA

January 20, 2020

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LIST OF APPENDICES

I. INTRODUCTION

This *Geotechnical Exploration and Analyses Report* summarizes the findings of the geotechnical exploration, laboratory tests, and geotechnical engineering analyses performed for the design and construction of a new playground structure for Orlando Bell Park located at 2274 South Thompson Drive in the City of Madison in Dane County, Wisconsin. We completed this work under the general direction of City of Madison Parks Division who established the general scope of the work.

The intent of this preliminary report is to: (1) convey the geotechnical information obtained from one soil boring; (2) present the results of laboratory and field tests; (3) present our comments and recommendations for site filling; and (4) present our comments and recommendations for the design and construction of the proposed improvements. We recommend City of Madison Parks Division employ Soils & Engineering Services, Inc. to make observations and perform tests at the time of excavation and construction of the proposed improvements to verify the subsurface conditions encountered by the exploration performed, and to validate our comments, analyses, and recommendations presented in this report for the subject improvements.

II. PROJECT DESCRIPTION

The project consists of the construction of a new playground structure for Orlando Bell Park located on South Thompson Drive in the City of Madison in Dane County, Wisconsin.

III. GEOTECHNICAL EXPLORATION

The geotechnical field exploration consisted of the performance of one soil boring (designated Boring 1).

A. Boring Location

We located Boring 1 as close to the requested location as possible. We show the boring location on the Location Sketch, Drawing 13300.23-1, enclosed in Appendix A.

B. Boring Elevations

We did not determine the ground surface elevation at the boring location after completion of the drilling and sampling. We set the ground surface at 0 feet of depth

for the soil boring on the Boring Log Record enclosed in Appendix A. We plotted the Boring Log Record with depth scales for reference.

C. Drilling and Sampling Procedures

We drilled and sampled the boring to a depth of 14.3 feet below existing grade.

We used 2¼-inch-inside-diameter hollow-stem augers (HSA) for the boring to maintain an open borehole as we advanced the boring to the termination depth. As we advanced the borehole of this boring, we obtained soil samples at 2½-foot intervals starting at a depth of 1-foot below the ground surface and continued to a depth of 10 feet. We increased the sampling interval to 5 feet from a depth of 10 feet to the boring termination depth. We performed this sampling using a 2-inch-outside-diameter split-barrel sampler according to ASTM Designation D1586. We visually identified the recovered soils in general compliance with the Unified Soil Classification System (USCS) identification procedures as defined in ASTM Designation D2488.

Please refer to the Boring Log Record enclosed in Appendix A for additional information regarding the drilling and sampling of this boring. We provide information pertinent to the Boring Log Record on the Notes and Legend Record enclosed in Appendix A.

D. Subsurface Stratigraphy

In general terms, we characterize the soil stratigraphy encountered at Boring 1 as topsoil overlying native soil strata. This boring did not encounter bedrock within the depth drilled.

Boring 1 encountered 6 inches of black LEAN CLAY (CL) TOPSOIL over a native soil strata consisting of brown LEAN CLAY (CL) over gray and brown mottled LEAN CLAY (CL) over gray LEAN CLAY (CL) over brown fine to coarse POORLY-GRADED SAND WITH GRAVEL (SP/GP).

Please refer to the Boring Log Record enclosed in Appendix A for a further description of the topsoil and native soil strata encountered at the location of Boring 1.

E. Subsurface Water

Our drilling crew found the borehole of the boring performed to have a water level at a depth of 2.8 feet and was caved at a depth of 9.9 feet at the completion of the drilling and sampling at this boring.

We expect the subsurface (groundwater) levels to fluctuate as influenced by precipitation, snowmelt, surface water runoff, and other hydrological and hydrogeological factors. The groundwater level at the time of construction of the subject project may be higher or lower than the groundwater level encountered on the day that we performed the boring.

IV. LABORATORY AND FIELD TESTS

A. Laboratory Tests

We performed laboratory tests on a portion of selected split-barrel soil samples to determine the physical properties of the fill material and underlying native soil strata encountered at the boring location. The laboratory tests on the selected material from the split-barrel soil samples consisted of determining the moisture content (MC), Atterberg limits (liquid limit [LL] and plastic limit [PL]), wet and dry densities (γ_w and γ_d), and unconfined compressive strength (q_u). In addition to the above tests, we tested some of the cohesive soils for approximate unconfined compressive strength (q_p) using a spring penetrometer.

We include the laboratory test results obtained for this report on the Boring Log Record and Laboratory Test Result Records (Figures 1 and 2) enclosed in Appendix A. We used the results from the Atterberg limits and q_u tests to confirm or modify the USCS soil identifications in general compliance with USCS classification procedures as defined in ASTM Designation D2487.

B. Field Tests

The field tests consisted of the performance of the standard penetration resistance test (SPT) for Boring 1. We performed the SPT during the sampling procedure at this boring. It consists of driving the split-barrel sampler up to 18 inches with a 140-pound hammer weight falling 30 inches. From the SPT, we obtain the N-value which is the sum of the number of blows required to drive the split-barrel sampler the last 12 inches or portion thereof as noted on the Boring Log Record.

We include the field test results obtained for this report on the Boring Log Record enclosed in Appendix A.

C. Test Results Discussion

The laboratory and field tests indicated the following:

- The brown LEAN CLAY (CL) is in a moist relative moisture condition and of stiff consistency.
- The gray and brown mottled LEAN CLAY (CL) is in a moist relative moisture condition and of medium to very soft consistency.
- The gray LEAN CLAY (CL) over is in a moist relative moisture condition and of very soft to soft consistency.
- The brown fine to coarse POORLY-GRADED SAND WITH GRAVEL (SP/GP) is in a moist relative moisture condition and in a very dense state of relative density.

We utilized the laboratory and field test results in our evaluation of the soils for the determination of design parameters, and to provide comments and recommendations for the design and construction of the subject project.

V. CONCLUSIONS

We offer the following general comments regarding the soils encountered by the boring:

- The boring encountered 6 inches of topsoil.
- Below the topsoil, Boring 1 encountered very low to low strength native cohesive soil over moderate to high strength native granular soil.

Based on the soil information obtained, construction of a playground structure for the park is feasible. Settlement of the playground structure should be anticipated if supported on a shallow foundation system consisting of spread footings or short drilled shafts (piers) founded in the very low to low strength native cohesive soil strata. To minimize the settlement of the structure, supporting the structure on a deep foundation system of drilled shafts or helical screw piles founded in the moderate to high strength native granular soil would transfer the structure loads below the native cohesive strata.

VI. COMMENTS AND RECOMMENDATIONS

Based on the soil boring information and laboratory tests performed, we offer the following comments and recommendations regarding the design and construction of the proposed improvements for Orlando Bell Park located on South Thompson Drive in the City of Madison, Dane County, Wisconsin.

A. Shallow Spread Footing Foundation Support

Based on Boring 1, dewatering may be needed to provide a dry excavation in order to construct a spread footing. We recommend the excavation to accommodate a shallow spread footing be accomplished using a standard hydraulic backhoe equipped with a cleaning bucket to minimize disturbance to the soils at the bottom of the excavations. A cleaning bucket (a.k.a., "sand" or "ditch" bucket) is a standard bucket equipped with a continuous cutting edge which can be fabricated by bolting or welding a flat steel plate in front of the cutting teeth of a toothed bucket.

To protect against frost heave, we recommend the bottom of spread footings be placed at a depth of 4 feet or lower below the finished grade elevation.

We recommend an allowable bearing capacity of 1,000 pounds per square foot (psf) be used for foundation support of the new playground structure resting on spread footings founded in the native cohesive soils.

We estimate that total footing settlement should be less than 2-inches and differential settlement should be less than 0.1 inches per foot of horizontal distance between two points of reference for the recommended allowable bearing capacity.

B. Drilled Shafts (Piers) Foundation Support

We recommend drilled shafts be drilled using temporary water-tight casing, that the bottom of the shafts be cleaned of all loose material, and that the concrete be placed using a tremie from the bottom of the shaft and upward. We anticipate that a drilled shaft extending to the native granular soil will fill with water. Therefore, we recommend drilled shafts extending to this depth be drilled with a drilling fluid to maintain an open hole. The drilling fluid should be properly designed for drilled shaft construction.

The design of the drilled shaft should be based on end bearing only (i.e., skin friction should be ignored). We recommend the following end bearing pressures, estimated total settlement, and estimated differential settlement per foot of horizontal distance between two points of reference be used in the shaft design:

Depth below existing grade	Allowable End Bearing Pressure	Settlement	
		Total	Differential
12 feet or less	1,000 psf	2 inches or less	0.1 inches or less
12 to 14 feet	5,000 psf	1 inches or less	0.03 inches or less
14 feet or greater	10,000 psf		

C. Helical Screw Pile Foundation Support

Helical screw piles consist of one to several helical flights welded to a hollow steel pipe shaft. They are installed by turning the pile into the ground similar to a screw being turned into a piece of wood.

The ultimate compression and tension capacity of a helical screw pile is dependant upon the shaft diameter, the distance between adjacent helical screw piles, the diameter of the flights of the helical screw piles, the elevation of the helical screw pile tip, and the strength of the soil strata. If lateral resistance is required, the helical screw piles can be installed at an angle from the vertical. The final design of helical screw piles is proprietary and is completed by a professional engineer using the design equations and procedures specified by the manufacturer of the helical screw piles selected for use on a project.

We recommend the bottom helix for a helical screw pile be located at least 14 feet below the finished ground surface using the following soil parameters and a factor of safety of 2.0 be used to design the helical screw piles:

Depth Below Existing Grade (feet)	Estimated Soil Parameters		
	Moist Density (pcf)	Friction Angle, φ (degrees)	Cohesion (psf)
0.0 to 12.0	125	0	100
> 12.0	120	38	0

D. Landscaped Area Fill

We recommend the material used to raise the grade below landscaped areas be placed in maximum 12-inch-thick loose layers and compacted to at least 88 percent of the maximum dry density determined for the material according to ASTM Designation D1557. Improper or poor densification of the fill material placed in landscaped areas could result in settlement of the soils and subsequent depressions in the landscaped area surface.

E. Site Grading Recommendations

Surface water from precipitation runoff if allowed to accumulate within the construction area can cause problems with construction. The contractor should grade the site to drain surface water away from the construction areas. Water accumulations in the construction area should be promptly removed. Any soil softened, loosened or disturbed by water should be excavated, removed and replaced with compacted granular fill material or coarse crushed stone. Temporary surface water diversion structures, such as ditches and berms, could be constructed in areas where surface water drainage into the work area is encountered.

F. Project Safety

Safety precautions, such as those required by OSHA and the Wisconsin Department of Safety and Professional Services, should be followed throughout the entire construction of the proposed project. They include, but are not limited to, the proper sloping and/or support of excavation sidewalls and adjacent embankments, roadways, access ramps, sidewalks, utility lines, towers, and/or buildings.

VII. CLOSING COMMENTS

Soils & Engineering Services, Inc. prepared this report for the exclusive use of the City of Madison Parks Division to aid in the design of the proposed construction of a new playground structure for Orlando Bell Park located at 2274 South Thompson Drive in the City of Madison in Dane County, Wisconsin. The recommendations in this report are based on the project information provided to our office. Soils & Engineering Services, Inc. should review any changes in the nature, design, or location of the proposed improvements after submittal of this *Geotechnical Exploration and Analyses Report* to revise the recommendations in the report, if necessary. The nature and extent of soil or groundwater variations may not become evident until the time of excavation or construction of the subject project. If soil or groundwater variations are evident at the time of excavation or construction, it will be necessary for Soils & Engineering Services, Inc. to re-evaluate the soil and groundwater, and other site conditions, which may result in the revision of our recommendations in this report.

Please read the *Important Information about This Geotechnical-Engineering Report* advisory sheet enclosed in Appendix B which provides comments about how to interpret and use this *Geotechnical Exploration and Analyses Report* for the Proposed Playground Structure project.

Soils & Engineering Services, Inc. should review the final design and specification documents for this project to verify that our recommendations regarding the proposed improvements are interpreted correctly and implemented in the design of the subject project as they are intended. We recommend that Soils & Engineering Services, Inc. be present at the time of construction to observe compliance with the design concept and specifications, and to provide recommendations to modify the design if subsurface conditions differ from those anticipated prior to construction. It is important that the exposed soil strength, degree of compaction, and other soil properties required be confirmed and/or determined at the time of excavation and construction activities for the subject project.

The recommendations provided in this report are based on our identification/classification and interpretation of the soils and information given on the Boring Log Record, and may not be based solely on the contents of the driller's field log.

Soils & Engineering Services, Inc. prepared this report for the subject project in accordance with generally accepted geotechnical engineering practices at this time. Soils & Engineering Services, Inc. offers no other expressed or implied warranty.

Soils & Engineering Services, Inc. will store the soil samples obtained from the soil boring performed for this project for a period of 60 calendar days after the date of this report. Please advise us if we should extend this period.

We recommend that this *Geotechnical Exploration and Analyses Report*, in its entirety, be made available to bidding contractors or subcontractors for information purposes. The Appendices, Boring Log Record, and/or other attachments referenced in this report should not be separated from the text of this report. This report should be considered invalid if used for purposes other than those described herein.

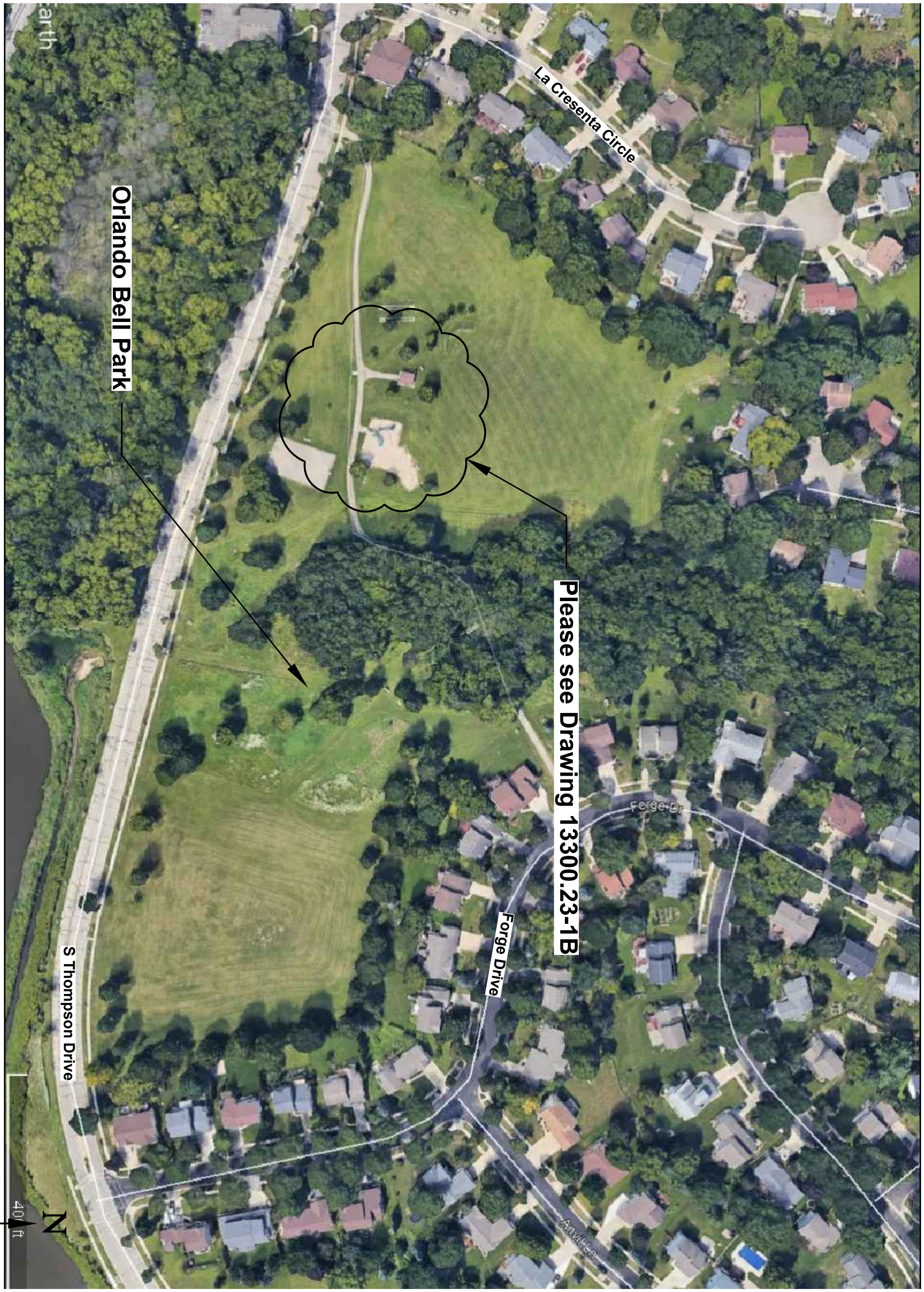
Soils & Engineering Services, Inc. respectfully submits this *Geotechnical Exploration and Analyses Report*, dated January 20, 2020, to the **City of Madison Parks Division**.

APPENDIX A

Appendix A Contents

- Location Sketch, Drawing 13300.23-1
- Notes and Legend Record for Boring Log Record
- Boring Log Record for Boring 1
- Laboratory Test Result Records, Figures 1 and 2

Map Source: "S Thompson Drive, Madison, WI." Google Earth. October 3, 2018 Aerial. Accessed November 15, 2019.



2 = Boring 2 (typical)

N

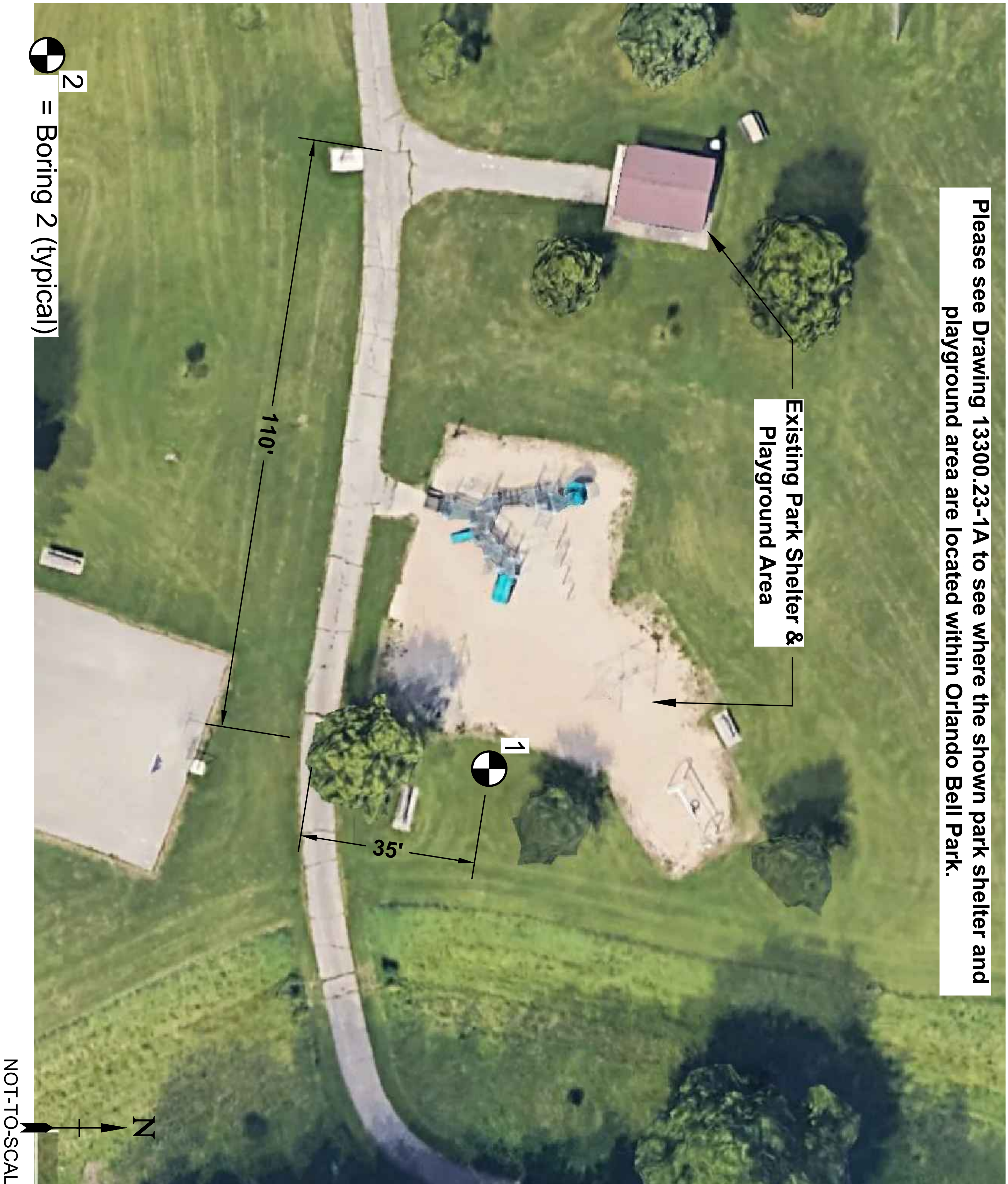
NOT-TO-SCALE

Soils & Engineering Services, Inc. 1102 STEWART STREET • MADISON, WISCONSIN 53713 Phone: 608-274-7600 • 888-866-SOIL (7645) Fax: 608-274-7511 • Email: soils@soils.ws CONSULTING CIVIL ENGINEERS SINCE 1966	**LOCATION SKETCH** Proposed Playground Structure Orlando Bell Park 2274 S Thompson Drive City of Madison, Dane County, Wisconsin

DRAWING 13300.23-1A

Created on 11/15/2019 Revised on

Map Source: "S Thompson Drive, Madison, WI." Google Earth. October 3, 2018 Aerial. Accessed November 15, 2019.



Soils & Engineering Services, Inc.	LOCATION SKETCH	DRAWING
1102 STEWART STREET • MADISON, WISCONSIN 53713 Phone: 608-274-7600 • 888-866-SOIL (7645) Fax: 608-274-7511 • Email: soils@soils.ws CONSULTING CIVIL ENGINEERS SINCE 1966	Proposed Playground Structure Orlando Bell Park 2274 S Thompson Drive City of Madison, Dane County, Wisconsin	13300.23-1B

Created on 11/15/2019 Revised on

NOTES

1. The boundary lines between different soil strata, as shown on the Boring Log Record, are approximate and may be gradual.

2. The boring field log contains a description of the soil conditions between samples based on the equipment performance and the soil cuttings. The Boring Log Record contains the description of the soil conditions as interpreted by a geotechnical engineer and/or a geologist after review of the boring field logs and soil samples and/or laboratory test results.

3. We define "Caved Level" as the depth below the existing ground surface at a boring location where the soils have collapsed into the borehole following removal of the drilling tools.

4. We define "Water Level" as the depth below the existing ground surface at a boring location to the level of water in the open borehole at the time indicated unless otherwise defined on the Boring Log Record.

5. We define "at completion" for a boring as being the time when our drilling crew has completed the removal of all drilling tools from the borehole.

6. The Notes and Legend Record and the Boring Log Record are a part of the Geotechnical-Engineering Report. The Geotechnical-Engineering Report should be included in the bidding or reference documents.

RELATIVE PERCENTAGE TERMS

no	0%
trace	<5%
few	5 to <10%
little	10 to <30%
some	30 to < 50%

TEST RESULTS LEGEND

q_p = Penetrometer reading, $^{ton}/_{ft^2}$
MC = Moisture Content, % moisture by weight
LL = Liquid Limit, % moisture by weight
PL = Plastic Limit, % moisture by weight
PI = Plasticity Index, % moisture by weight
q_u = Unconfined Compressive Strength, $^{ton}/_{ft^2}$
γ_w = Wet Density, $^{lb}/_{ft^3}$
γ_d = Dry Density, $^{lb}/_{ft^3}$

RELATIVE MOISTURE TERMS AT TIME OF SAMPLING

Frozen or F = Frozen material
Dry = Dusty, dry to touch, absence of moisture
Moist or M = Damp to touch, no visible water
Wet or W = Visible free water

DRILLING METHODS LEGEND

HSA = Continuous flight hollow-stem augers

N-VALUE LEGEND

WH = Weight of hammer and sampling rods.

SAMPLER TYPE LEGEND

Grab sample

2-inch-outside-diameter, split-barrel sampler

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NOTES AND LEGEND RECORD
Proposed Playground Structure
Orlando Bell Park
2274 S Thompson Drive
City of Madison, Dane County, Wisconsin

13300.23

General Location:

Boring 1

LATITUDE: —	LONGITUDE: —	COUNTY: Dane	SECTION: 15	CREW CHIEF: SWK	DRILL RIG: Geoprobe	PAGE: 1 of 1
NORTHING: —	EASTING: —	TOWNSHIP: (Blooming Grove) 7 N	¼: SE	LOG REVIEW: CMB	HAMMER TYPE (EFFICIENCY): Automatic (80%)	TOTAL DEPTH: 14'-4"
STATION: —	OFFSET: —	RANGE: 10 E	¼ ¼: NE	LOG QC: CMB	DATE STARTED: 11/07/2019	DATE COMPLETED: 11/07/2019

DEPTH (feet)	Material Description	N-Value	Test Results	Sampler Type / Recovery / Remarks
0 – 0.5	***LEAN CLAY (CL)*** — *medium plasticity, black, moist,* ***TOPSOIL***-[6" thick]			M
0.5 – 3	***LEAN CLAY (CL)*** — *medium plasticity, brown, moist, stiff consistency*	6	q_p=1.4; MC=20.2	M
3 – 5.5	***LEAN CLAY (CL)*** — *medium plasticity, gray and brown mottled, moist, medium consistency*	3	q_p=0.9; MC=26.8; LL=44; PL=18; q_u=0.71; γ_w=126.7; γ_d=99.9	M
5.5 – 8	***LEAN CLAY (CL)*** — *medium plasticity, gray and brown mottled, moist, very soft consistency*	WH/12" 1/6"	q_p=0.1, <0.1; MC=30.6; LL=34; PL=17	M-W
8 – 11.7	***LEAN CLAY (CL)*** — *medium plasticity, gray, moist, very soft to soft consistency*	WH/18"	q_p=0.2, 0.5; MC=23.8; LL=34; PL=17	M-W
11.7 – 14.3	***POORLY-GRADED SAND WITH GRAVEL (SP/GP)*** — *fine to coarse grained, brown, wet, very dense relative density*	35/6" 65/4"		W

WATER LEVEL LEGEND	OTHER LEVEL LEGEND
▼ 2'-10" at completion	9'-11" Caved at completion

DRILL METHOD	TOOL SIZE	CASING SIZE	DRILL FLUID	DEPTH FROM	DEPTH TO	HOLE DIA
HSA	2 ¼"	—	None	0'-0"	15'-0"	6.3"

SAMPLING METHOD(S): ASTM D1586

SURFACE PATCH: —

BACKFILL: Auger Cuttings, Bentonite Chips, Caved Soil

The Notes and Legend Record is considered a part of this Boring Log Record.

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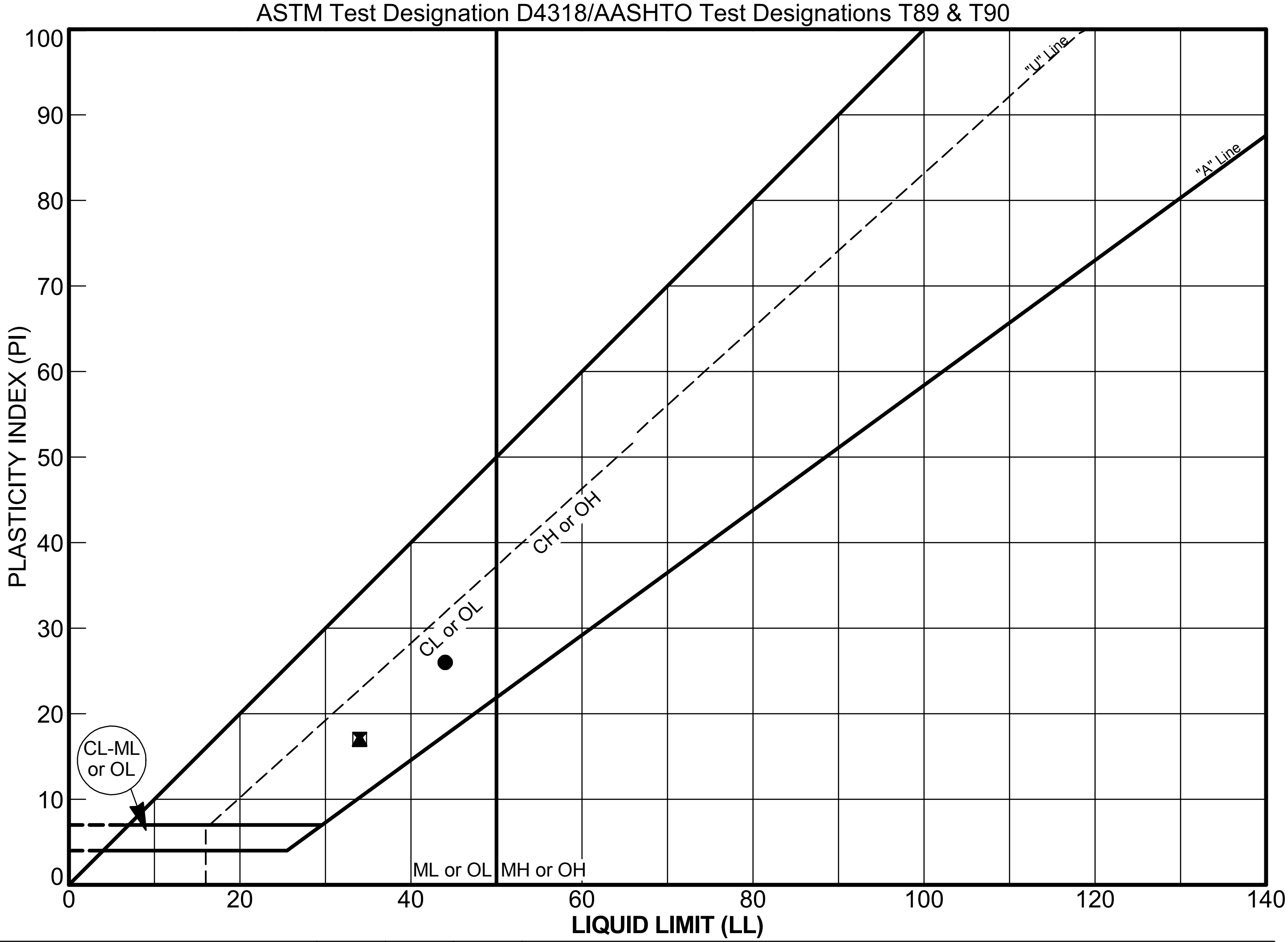
BORING LOG RECORD
Proposed Playground Structure
Orlando Bell Park
2274 S Thompson Drive
City of Madison, Dane County, Wisconsin

13300.23

Printed on 1/20/2020

ATTERBERG LIMITS TEST REPORT

ASTM Test Designation D4318/AASHTO Test Designations T89 & T90



	Specimen Identification	LL	PL	PI	Sample Classification
●	**Boring 1, 4'-3" Depth**	**44**	**18**	**26**	***LEAN CLAY (CL)*** *— medium plasticity, light brownish-gray, moist, medium consistency*
⧗	**Boring 1, 7'-1" Depth**	**34**	**17**	**17**	***LEAN CLAY (CL)*** *— medium plasticity, light gray, moist to wet, very soft consistency*
▲	**Boring 1, 9'-7" Depth**	**34**	**17**	**17**	***LEAN CLAY (CL)*** *— medium plasticity, light gray, moist to wet, very soft to soft consistency*

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LABORATORY TEST RESULT RECORD
Proposed Playground Structure
Orlando Bell Park
2274 S Thompson Drive
City of Madison, Dane County, Wisconsin

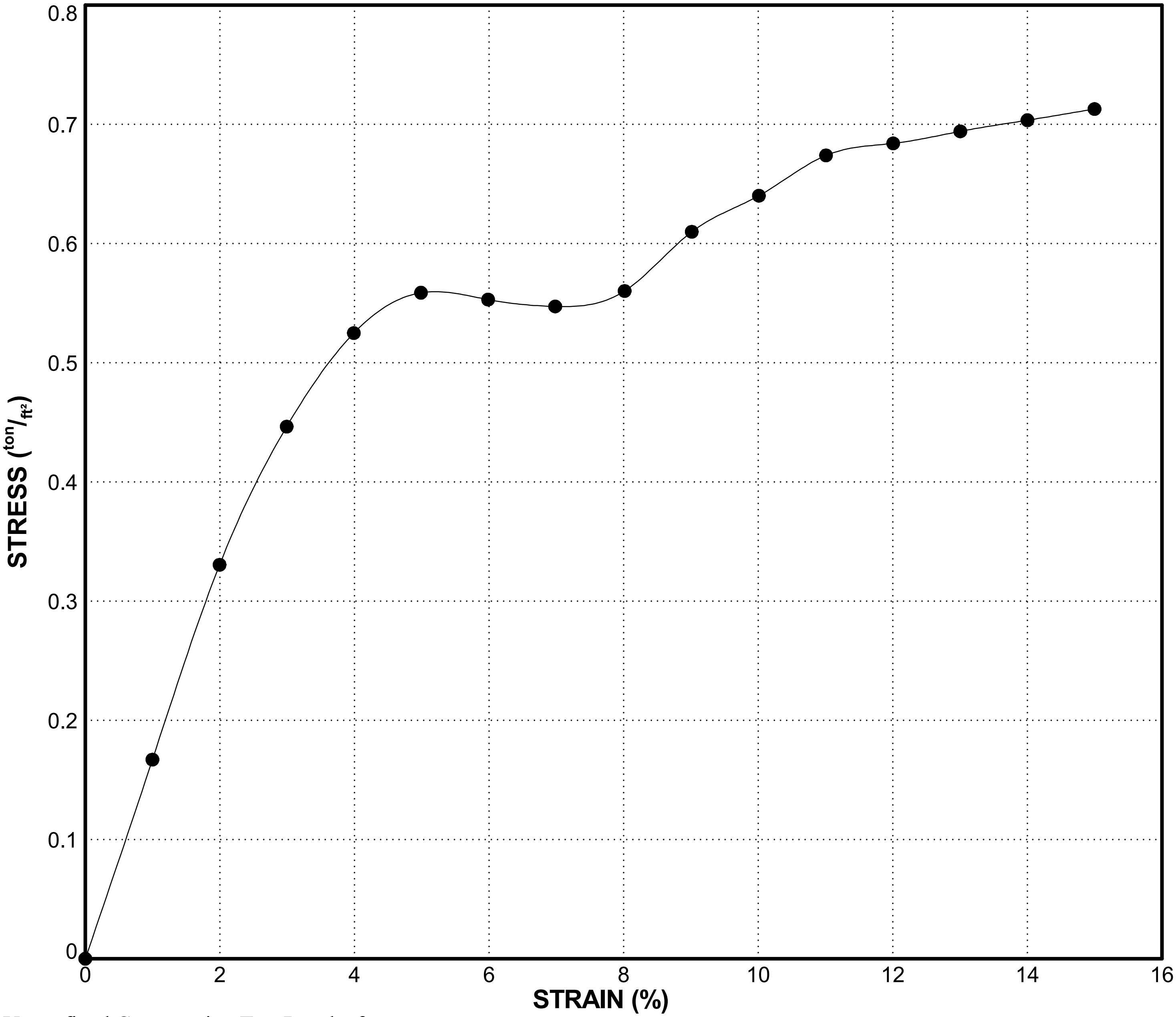
13300.23

FIGURE 1

Printed on 1/20/2020

UNCONFINED COMPRESSION TEST REPORT

ASTM Test Designation D2166



Unconfined Compression Test Results for **Boring 1**

Sample				Diameter (inches)	Height (inches)	H:D Ratio	Wet Density ($^{lb}/_{ft^3}$)	Dry Density ($^{lb}/_{ft^3}$)	MC (%)	Failure Stress ($^{ton}/_{ft^2}$)	Failure Strain (%)
	Identification	Classification	Type								
●	**4'-3" Depth**	***LEAN CLAY (CL)***	**SS2**	**1.339**	**2.907**	**2.2**	**126.7**	**99.9**	**26.8**	**0.71**	**15.0**

SS2=2-inch-outside-diameter, split-barrel sampler

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CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD
Proposed Playground Structure
Orlando Bell Park
2274 S Thompson Drive
City of Madison, Dane County, Wisconsin

13300.23

FIGURE 2

Printed on 1/20/2020

APPENDIX B

Appendix B Contents

- *Important Information about This Geotechnical-Engineering Report* advisory

Important Information about This

Geotechnical-Engineering Report

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

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

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way

exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation

everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

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

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

Geotechnical-Engineering Services are Performed

and imes

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

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

Do not rely on this report if your geotechnical engineer prepared it:

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

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

Read this Report in Full

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

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

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

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

This Report's Recommendations Are

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

This Report Could Be Misinterpreted

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

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

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

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

Obtain Professional Assistance to Deal with

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

GEOPROFESSIONAL BUSINESS ASSOCIATION

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