CTI and Associates, Inc.

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February 11, 2015

Ms. Amy Kuras, Landscape Architect
City of Ann Arbor Parks and Recreation Services
301 E. Huron Street
Ann Arbor, Michigan 48104

RE: Geotechnical Investigation
Proposed Tennis and Basketball Court Replacement – Various Parks
Ann Arbor, Michigan
CTI Project No. 3152040005

Dear Ms. Kuras:

CTI and Associates, Inc. (CTI) has completed a geotechnical evaluation for the proposed replacement of tennis and basketball courts in various parks in Ann Arbor, Michigan. The purpose of our investigation was to determine the general subsurface conditions at the locations of the existing tennis and basketball courts at four parks and to provide recommendations regarding support of the tennis and basketball court pavement. Our evaluation was performed in general accordance with the scope of services outlined in the CTI Proposal No. 115PRO2040-009 dated January 15, 2015 and authorized by Ms. Amy Kuras, Landscape Architect, City of Ann Arbor Parks and Recreation Services on January 26, 2015.

In general, the soil borings revealed loose to medium dense sand with varying amounts of silt and clay and stiff to hard clay layers. Within Boring AP-1, the near-surface clay layer contained trace amounts of organics. Fill material containing trace amounts to some organics were encountered within HP-2, S-1 and SB-1 to depths of 2½ to 4½ feet below the existing site grades. Apparently native clayey sand containing trace amount of organics was encountered below a fill layer to the final explored depth of SB-1. Due to the amount of fines (silt and clay) observed in the encountered soils, we anticipate the site to have poor drainage characteristics. The encountered subgrade soils may be sensitive to changes in moisture, which could adversely affect the subgrade stability. The following sections detail the findings of the soil borings and provide recommendations for subgrade improvement and pavement support.

SITE AND PROJECT DESCRIPTION

In total, seven soil borings were performed in four parks – Allmendinger Park, Hunt Park, Sylvan Park and Sugarbush Park. All four parks are located within Ann Arbor, Michigan. Allmendinger Park is located at 651 Pauline Boulevard, between Hutchins Avenue and Edgewood Avenue. Hunt Park is located at 960 Spring Street, between Sunset Road and West Summit Street. Sylvan Park is located at 3613 Eli Drive. Sugarbush Park is located at 3266 Rumsey Drive, between Georgetown Boulevard and Yellowstone Drive. The proposed development areas in all four parks are listed in Table 1.

Table 1. Project Development Area

Name of park	Area of development	# of soil borings	Park section	Closest intersection
Allmendinger	Tennis and basketball courts	2	Northeast	Edgewood Ave and Pauline Blvd
Hunt	Tennis and basketball courts	2	Center	Daniel St and Brookridge Rd
Sylvan	Tennis court	1	Northwest	Margaret Dr and Darrow Dr
Sugarbush	Double tennis court	2	Center	Rumsey Dr and Georgetown Blvd

In three of the four parks, the borings were performed within the limits of the existing tennis and basketball courts. The double tennis court in Sugarbush Park had restricted access due to the presence of a perimeter fence and berm. Therefore, the soil borings in Sugarbush Park were performed outside of the pavement area. The existing tennis and basketball courts surfaces consist of asphalt pavement. The age of the pavement was not provided to CTI. During a site visit on January 26, 2015, snow was observed to cover all pavement areas so an assessment of the existing pavement conditions was not possible.

Based on the provided information, CTI understands that the proposed project will include the complete replacement of the tennis courts in all four parks and the basketball courts in two of the four parks. The basketball court at Allmendinger Park will be relocated approximately 10 feet south and 30 feet east of its present location. It is anticipated that the overall layout and dimensions of the remaining new courts will approximately match that of the existing courts. We anticipate that a pavement section consisting of 3 inches of asphalt over 8 inches of aggregate base material will be used in the design of the new courts.

INVESTIGATION PROCEDURES

Field Investigation

Our field investigation consisted of drilling seven test borings extending to a depth of 5 feet below the existing pavement surface, for a total of 35 lineal feet of drilling. The boring locations were selected by CTI personnel based on recommendations provided by City of Ann Arbor Parks and Recreation Services personnel. Aerial maps depicting the approximate boring locations are shown on the Boring Location Plans included with this report.

The drilling operations were performed by Brax Drilling personnel under the direction of CTI on January 27, 2015 utilizing a rotary head drilling rig. The soil borings were advanced using continuous flight solid-stem augers with a diameter of 4¼ inches. Soil samples were obtained at intervals of 2½ feet to the explored depths of the borings by the Standard Penetration Test Method (ASTM D1586), whereby a 2-inch outside diameter split-barrel sampler is driven into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler is generally driven three successive 6-inch increments, with the number of blows for each increment being recorded. The number of blows required to advance the sampler the second and third 6-inch increment is termed the Standard Penetration Resistance, N. The soil samples obtained with the split-barrel sampler were sealed in glass jar containers and transported to our laboratory for further classification and testing. After completion of the drilling operations, the boreholes were backfilled with excavated soil (i.e. auger cuttings). Boring performed through existing pavement were also patched with asphalt cold patch.

The laboratory testing program determined the general soil classification and physical properties of recovered samples. All laboratory testing was performed in general accordance with applicable ASTM test method standards. The laboratory testing program consisted of visually classifying each collected soil sample in general accordance with the Unified Soil Classification System (USCS), and natural moisture content and loss-on-ignition (organic content) testing of selected samples. The unconfined compressive strength of selected cohesive samples was also estimated based on the resistance to a calibrated spring-loaded hand penetrometer. The results of all laboratory tests are indicated on the boring logs at the depths from which the samples were obtained.

Soil and groundwater conditions observed in the test borings have been evaluated and are presented on the boring logs included in the Appendix. To aid in understanding the data presented on the boring logs, "General Notes for Soil Classification," describing nomenclature used in soil descriptions, are also included in the Appendix. The soil descriptions reported on the test boring logs are based upon field logs prepared by experienced drillers with modifications made based on the results of laboratory testing and engineering review.

SUBSURFACE CONDITIONS

Soil Conditions

Allmendinger Park

Borings AP-1 and AP-2 were performed within Allmendinger Park. Boring AP-1 was located near the center of the existing tennis court and AP-2 was located approximately near the center of the proposed basketball court. The encountered pavement section consisted of 4 to 5 inches of asphalt pavement underlain by 6 inches of aggregate base material. Below the pavement sections, apparently native clay was encountered to the final explored depth of 5 feet. At boring AP-1, the encountered clay layer contained trace amounts of organics to a depth of 3½ feet. In the absence of foreign debris, it is difficult to distinguish between native soils and relatively clean fill soils in a small diameter borehole.

Standard Penetration Test (SPT) resistances (N-values) within the cohesive soils ranged from 9 to 30 blows per foot. The unconfined compressive strength of the encountered clay samples ranged from 3,500 pounds per square foot (psf) to over 9,000 psf, indicating stiff to hard consistencies. The moisture contents of representative native clay samples ranged from approximately 13 to 24 percent. The clay samples generally appeared to be in a moist condition when examined in the laboratory.

Hunt Park

Borings HP-1 and HP-2 were performed within Hunt Park. Borings HP-1 and HP-2 were located near the centers of the existing tennis and basketball courts, respectively. The encountered pavement section consisted of 4 to 5 inches of asphalt pavement underlain by 7 to 8 inches of aggregate base material.

At the location of HP-2, an 18-inch thick layer of clayey topsoil fill with occasional pieces of concrete was encountered below the pavement section. Loss-on-Ignition testing indicated that the clayey topsoil fill material encountered within HP-2 had an organic content of approximately 3.2 percent. Below the topsoil fill encountered within HP-2 and below the pavement section encountered at HP-1, apparently native silty, clayey sand was encountered. The sand extended to a depth of approximately 3½ feet within HP-1 and to the final explored depth of HP-2. The sand layer was underlain by clay to the final explored depth of HP-1.

N-values within the silty, clayey sand layer ranged from 6 to 10 blows per foot, indicating loose to medium dense relative densities. The granular samples appeared to be in a moist to wet condition when examined in the laboratory.

An N-value of 7 blows per foot was recorded within the encountered clay layer at HP-1. The unconfined compressive strength of the encountered native clay sample was approximately 2,500 psf, indicating a stiff consistency. The moisture content of the representative native clay sample was approximately 20 percent. The clay samples generally appeared to be in a moist condition when examined in the laboratory.

Sylvan Park

Boring S-1 was located near the center of the existing tennis court in Sylvan Park. A small creek was observed approximately 40 feet west of the boring location. The encountered pavement section consisted of approximately 4 inches of asphalt pavement underlain by 6 inches of aggregate base material. Below the pavement section, clayey topsoil fill resembling peat was encountered to a depth of 4½ feet. Loss-on-Ignition testing indicated that the clayey topsoil fill material encountered within boring S-1 had an organic content of approximately 5.5 percent. The clayey topsoil fill/possible peat layer was underlain by a gray clay layer extending to the final explored depth of 5 feet.

An N-value of 6 blows per foot was recorded within the clay layer. The unconfined compressive strength of the encountered native clay was approximately 4,500 psf, indicating a very stiff consistency. The moisture content of the native clay sample was approximately 18 percent. The soil samples generally appeared to be in a moist condition when examined in the laboratory.

Sugarbush Park

Due to restricted access to the double tennis court in Sugarbush Park, borings SB-1 and SB-2 were located outside of the pavement area. SB-1 was performed approximately 6 feet north of the northwest corner and SB-2 was performed approximately 7 feet south of the southeast corner of the existing tennis court fence. Approximately 4 to 6 inches of topsoil was encountered at the boring locations. At the location of boring SB-1, clay fill containing trace amounts of organics and pieces of concrete was encountered to a depth of 4 feet below the existing ground surface. Loss-on-Ignition testing indicated that the clay fill materials encountered within SB-1 had an organic content of approximately 2.5 percent. The clay fill was underlain by an apparently native clayey sand layer containing trace amount of organics. An N-value of 7 blows per foot was recorded within the native clayey sand, indicating a loose relative density. The sand sample appeared to be in a moist condition when examined in the laboratory.

The topsoil encountered at the location of boring SB-2 was underlain by apparently native clay to the final explored depth of 5 feet. N-values within the cohesive soil layer ranged from 14 to 25 blows per foot. The unconfined compressive strength of the native clay samples ranged from 8,000 psf to over 9,000 psf, indicating a hard consistency. The moisture contents of representative native clay samples ranged from approximately 13 to 18 percent. The clay samples generally appeared to be in a moist condition when examined in the laboratory.

The stratification depths shown on the soil boring logs represent the soil conditions at the specific boring locations. Variations in the soil conditions may occur between and/or beyond the boring locations.

Groundwater Conditions

The drillers looked for indications of groundwater seepage both during and after drilling. At one boring location in Hunt Park, HP-2, groundwater was encountered at an approximate depth of

4.8 feet. Collapse of the borehole upon removal of the auger precluded accurate measurement of the groundwater level following drilling operations. Groundwater seepage was not observed either during or after the drilling operations within any of the remaining borings.

The groundwater conditions discussed herein and indicated on the soil boring logs represent those encountered at the time of the field investigation. The groundwater levels, including perched groundwater accumulations, should be expected to fluctuate seasonally, based on variations in precipitation, evaporation, surface run-off and other factors not evident at the time of our investigation.

The above soil and groundwater conditions represent a generalized summary of the subsurface conditions and material characteristics. The individual boring logs and Boring Location Plan should be reviewed for specific information and details relating to specific areas of the site.

ANALYSIS AND RECOMMENDATIONS

Soils containing trace amounts of organics were encountered within at least one boring in each of the four parks. Within Boring AP-1, the near-surface clay layer contained trace amounts of organics. Fill material containing trace amounts to some organics were encountered also within HP-2, S-1 and SB-1 to depths of 2½ to 4½ feet below the existing site grades. Apparently native clayey sand containing trace amounts of organics was encountered below a fill layer to the final explored depth of SB-1. The presence and thickness of fill is anticipated to vary across the proposed development areas in all four parks. The Owner may elect to support the tennis and basketball court pavements over the existing fill materials. However, the Owner must be willing to accept an elevated risk of pavement distress if the existing fill soils are not entirely removed from the pavement areas.

Subgrade Preparation

At the start of earthwork operations, the existing pavement and any other deleterious materials are to be stripped from the new pavement areas. The thickness of the existing pavement and near surface fill layer (where present) should be expected to vary across the site. The depth of unsuitable soil removal should be determined by a representative of CTI at the time of stripping and rough grading.

Proper evaluation and conditioning (if necessary) of the subgrade should be performed prior to any engineered fill placement. After stripping and excavating to the proposed subgrade level, and after removing any unsuitable materials, the rough graded pavement area should be proofrolled with a loaded tandem-axle dump truck or similar rubber-tired vehicle. The purpose of the proofrolling operations is to locate areas of excessively loose, soft or weak subgrade soils which may be present at the time of construction. Soils that are observed to rut or deflect excessively during proofrolling should be stabilized by conventional methods such as disking, drying and re-compacting.

If it is not feasible to dry and re-compact the unsuitable subgrade soils due to unfavorable weather conditions, scheduling, etc., it may be necessary to remove such soils and replace them with engineered fill. The thickness of the undercut will depend on the severity of the unstable soils encountered at specific locations. A layer of crushed aggregate may be necessary to stabilize the subgrade before placement of the selected engineered fill material. The use of a geotextile separator below the crushed aggregate layer should also be considered to provide additional subgrade stability.

It should be noted that the actual locations and depths of any undercutting and/or stabilization should be established in the field at the time of construction. The extent to which yielding subgrades may be a problem is difficult to predict beforehand since it is dependent upon several factors including seasonal conditions, precipitation, construction practices, etc.

Once the site has been evaluated, proofrolled and/or stabilized, the inspected area should not be allowed to remain exposed to wet conditions more than one day or subjected to construction traffic, otherwise a re-evaluation should be made. The site earthwork operations should be carried out during a period of dry weather, if possible. This should minimize potential subgrade problems, although they may not be eliminated. The severity of subgrade instability will depend to a high degree on the weather conditions prevailing during construction.

Engineered Fill Placement and Compaction

After subgrade preparation and observation have been completed, engineered fill placement may begin. Any fill placed below the proposed pavement areas should be an approved material that is free of topsoil, organics, frozen soil or any other unsuitable material.

If clay soils or granular soils containing greater than 12 percent clay are used as fill, close moisture content control will be required to achieve the recommended degree of compaction. Cohesive fill materials should be low to medium in plasticity, with a liquid limit less than 40 and plasticity index less than 20. It should be noted that wet cohesive soils are difficult to compact and that the specified compaction may not be achieved. Wet cohesive soils may require drying or mixing with dry soil to facilitate compaction. If water must be added to dry soil, it should be uniformly applied and thoroughly mixed into the soil by disking or scarifying.

Existing soils containing organic material is not considered suitable for reuse as engineered fill. Existing soils that are free of organics may be used as engineered fill, provided they meet the Owner’s requirements.

The engineered fill should be placed in uniform horizontal layers not exceeding 8 to 12 inches in loose thickness for clean granular soils and 4 to 6 inches in loose thickness for clay soils (or clayey granular soils exhibiting cohesive characteristics), depending on the type and size of compaction equipment used. The lift thickness for sands that have an appreciable amount of fines should be decreased accordingly. The engineered fill should be compacted to achieve a density of not less than 95 percent of the maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D1557). Also, the upper 12 inches of the subgrade soils should be compacted, prior to any fill placement, to achieve a density of not less than 95 percent of the maximum dry density as determined by the Modified Proctor test. The as-compacted moisture content of the engineered fill should be within 2 to 3 percent of the optimum moisture content for the soil, as determined by the Modified Proctor test. The placement and testing of engineered fill should be observed and properly documented in the field by CTI.

We recommend that the contract specifications include provisions for moisture conditioning of any on-site soils that are to be used as engineered fill. Some of the native soils may require moisture conditioning to allow for proper compaction. The success of aeration and drying of clay soils will be dependent on the time of year, the prevailing weather conditions and the contractor’s effort. During cold and/or wet periods of the year, the saturated or disturbed clay soils will be more difficult to dry. In this case, the contractor may have to use drier on-site soils or imported sand.

If site grading or other construction activity is planned during cold weather, it is recommended that proper winter construction practices are followed. All snow and ice should be removed from cut and fill areas prior to grading. Frozen materials should not be used as engineered fill and no new fill, footings, or pavement should be placed on soils that are frozen or contain frozen material.

Pavement Recommendations

The subgrade soils should be prepared in accordance with the recommendations of this report. We recommend that a woven geotextile separator be placed below the aggregate base course. This will prevent migration of the subgrade soils into the aggregate base course, provide additional subgrade stability and improve pavement durability.

The long-term performance of the tennis and basketball court pavement will typically be a function of the quality of the subgrade soil at the time of construction, drainage provisions and the quality, thickness and strength of the overall pavement section. The most critical portion of the subgrade is the 3 feet immediately beneath the pavement section, which provides the primary strength needed for pavement section support. Soils in a saturated condition, uncontrolled fill and/or organic materials present within the upper 2 to 3 feet of the pavement subgrade will be detrimental to pavement performance if the design does not account for this substandard soil condition, especially during the spring freeze-thaw cycles.

Our analysis is based on the 1993 American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures. We have developed preliminary pavement designs based on assumed design parameters regarding pavement usage and design life, the soils encountered in the test borings, and the assumption that the subgrade will be prepared as recommended in this report. Table 2 summarizes the minimum flexible pavement cross section recommended for the proposed tennis and basketball courts pavements.

Table 2. Tennis and Basketball Court Pavement Section

Layer	Material	Thickness (inches)
Bituminous Surface	MDOT 13A	1.5
Bituminous Leveling	MDOT 13A	1.5
Aggregate Base Course	MDOT 21AA crushed limestone	8.0

The pavement system should be properly drained to reduce the potential for weakening the subgrade. Provisions should be made to prevent surface run-off water from accumulating within the aggregate base course of the pavement, such as grading the surrounding ground to drain away from the pavement and into drainage ditches or drains. Some modification of the existing berm at Sugarbush Park may be necessary to provide an adequate drainage path. The pavement and underlying subgrade should be suitably crowned or sloped to promote effective surface drainage, reduce water infiltration into the base course and prevent water ponding. Typical sloping for tennis courts is a minimum of 1 percent slope from side to side. A perimeter drainage system is recommended. The perimeter drainage system should be installed in a trench located outside the perimeter of the pavement, at or slightly below the design subgrade elevation of the tennis and basketball courts (at or below the bottom of the aggregate base course). The drainage system should consist of a perforated pipe tied into the storm sewer system. The perforated pipe should be protected with free-draining coarse aggregate material and filter fabric.

It should be recognized that all pavements require regular maintenance and occasional repairs to keep them in a serviceable condition. Of particular value is timely sealing of joints and cracks, which if left un-repaired, can serve to permit water to enter the pavement section and cause rapid deterioration of the pavement during freeze-thaw cycles. The need for such routine maintenance and repair is not necessarily indicative of premature pavement failure. However, if appropriate maintenance and repairs are not performed on a timely basis, the serviceable life of the pavement can be reduced significantly. We recommend that a maintenance plan be developed (if one does not already exist) such that the paved sports courts are inspected for cracking in both the Spring and the Fall of each year. This plan should contain guidelines for proper pavement maintenance and repair.

GENERAL COMMENTS

The evaluations and recommendations discussed in this report are based on the provided site information and the soil conditions encountered in the test borings performed at the approximate locations indicated on the attached Boring Location Plans and on the date indicated on the boring logs.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance, please contact our office.

Sincerely,

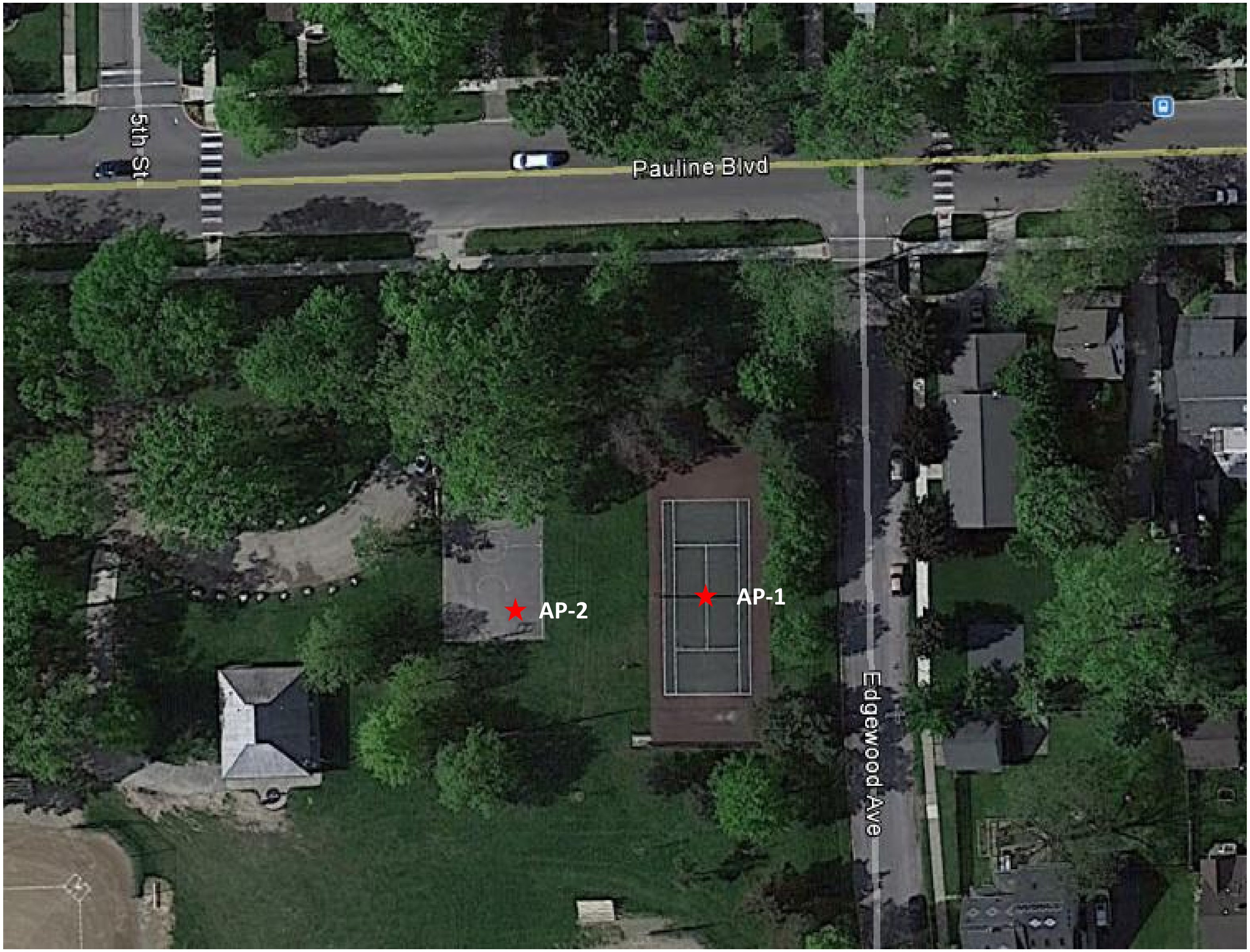
CTI and ASSOCIATES, INC.

Ramya Rajan, EIT
Staff Engineer

Theresa M. Marsik, P.E., LEED AP
Senior Project Engineer

Attachments - Boring Location Plans (Figures 1 through 4)
Boring Logs
Summary of Laboratory Test Results
General Notes for Soil Classification

N



DRAWING REPRODUCED FROM GOOGLE EARTH IMAGE

★ - Approximate Boring Location

SCALE	As Shown
PROJECT NO.	3152040004
FILE NAME	AAP2015.PPT
DATE	2-9-2015

BORING LOCATION PLAN

PROPOSED TENNIS AND BASKETBALL COURT REPLACEMENT–VARIOUS PARKS
ALLMENDINGER PARK
ANN ARBOR, MICHIGAN

Figure 1

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DRAWING REPRODUCED FROM GOOGLE EARTH IMAGE

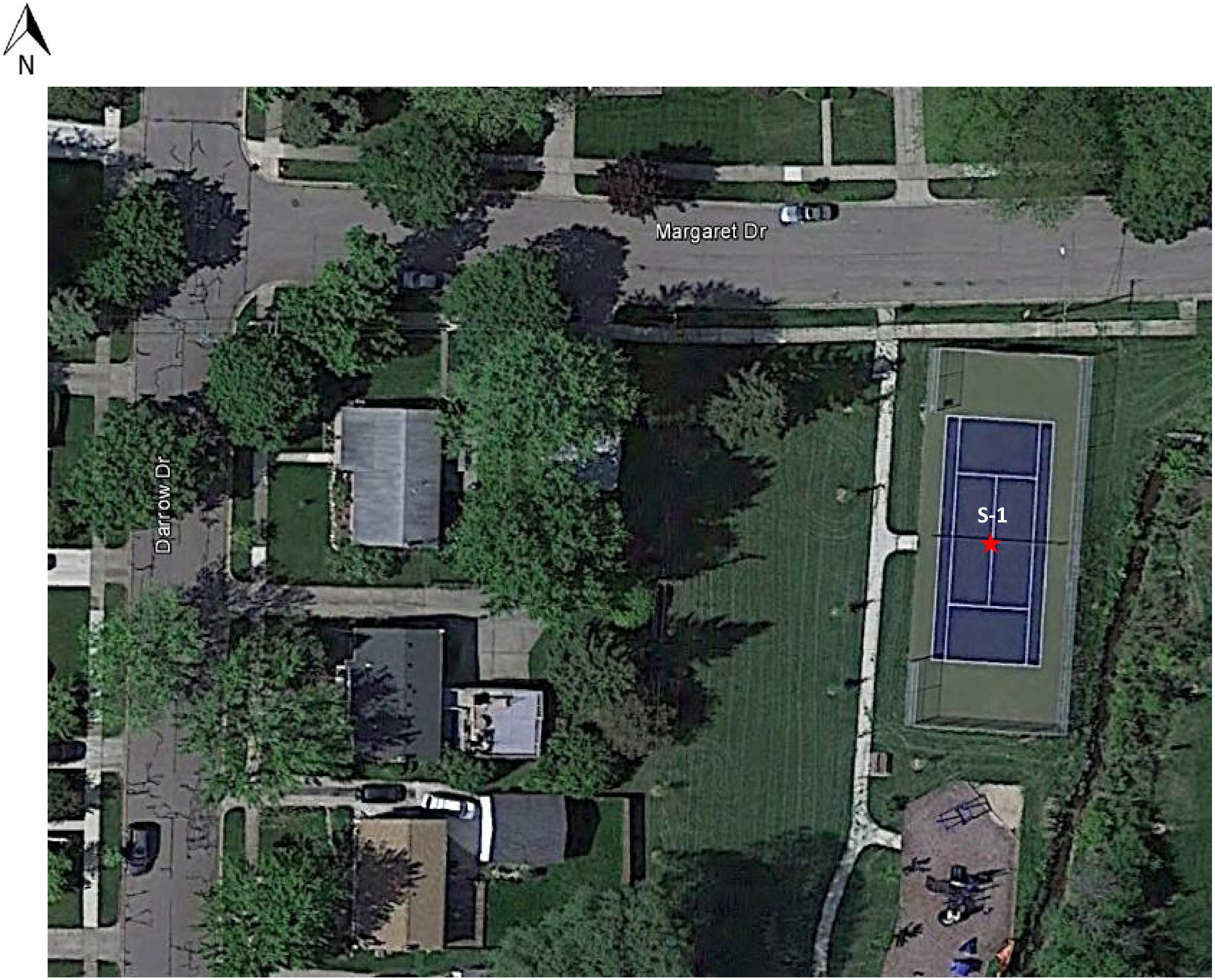
★ - Approximate Boring Location

SCALE	As Shown
PROJECT NO.	3152040004
FILE NAME	AAP2015.PPT
DATE	2-9-2015

BORING LOCATION PLAN

PROPOSED TENNIS AND BASKETBALL COURT REPLACEMENT–VARIOUS PARKS
HUNT PARK
ANN ARBOR, MICHIGAN

Figure 2



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★ - Approximate Boring Location

SCALE	As Shown
PROJECT NO.	3152040004
FILE NAME	AAP2015.PPT
DATE	2-9-2015

BORING LOCATION PLAN

PROPOSED TENNIS AND BASKETBALL COURT REPLACEMENT–VARIOUS PARKS
SYLVAN PARK
ANN ARBOR, MICHIGAN

Figure 3

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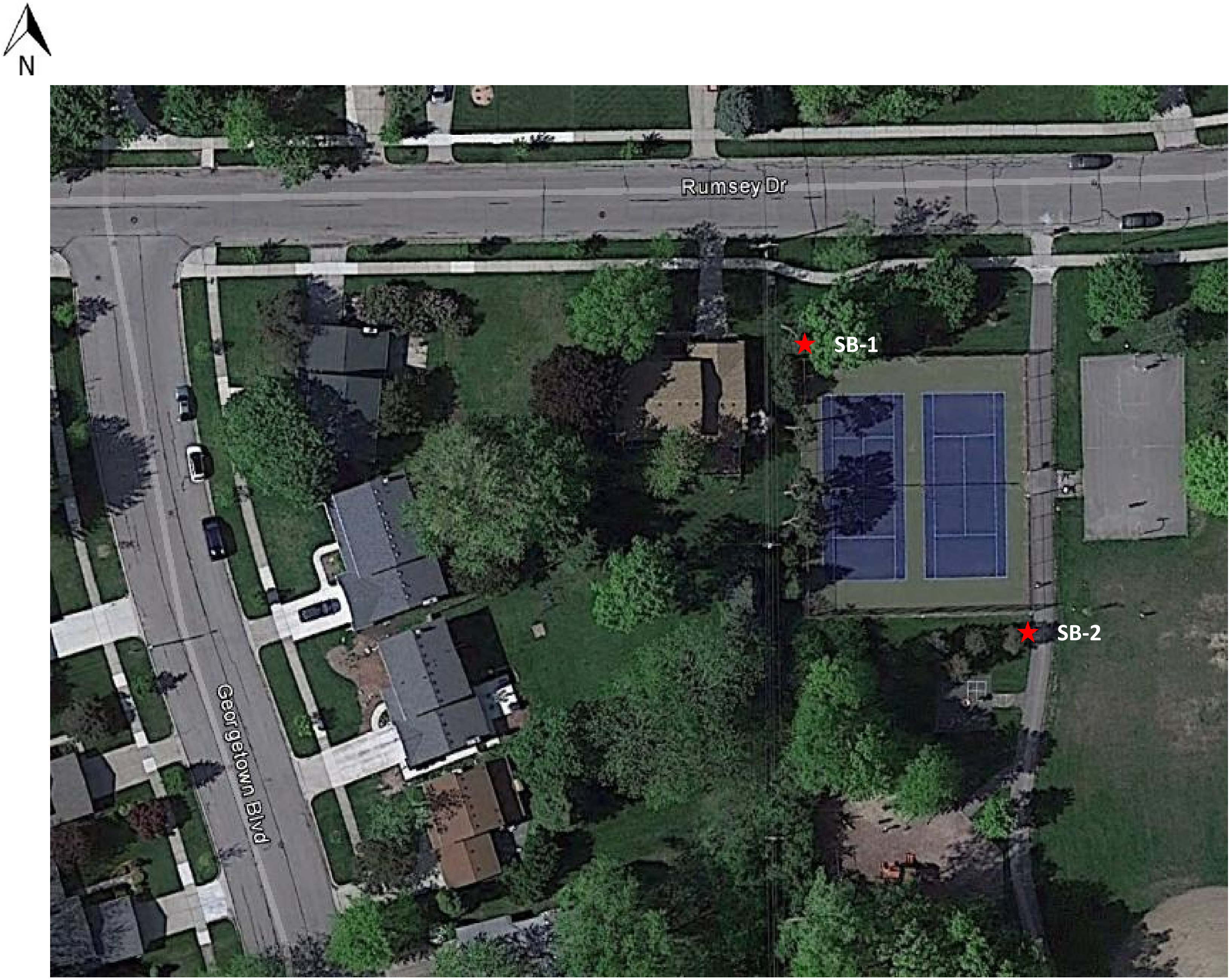


DRAWING REPRODUCED FROM GOOGLE EARTH IMAGE

★ - Approximate Boring Location

SCALE	As Shown
PROJECT NO.	3152040004
FILE NAME	AAP2015.PPT
DATE	2-9-2015

BORING LOCATION PLAN

PROPOSED TENNIS AND BASKETBALL COURT REPLACEMENT–VARIOUS PARKS
SUGARBUSH PARK
ANN ARBOR, MICHIGAN

Figure 4

CTI and Associates, Inc.

BORING NUMBER AP-1

CLIENT City of Ann Arbor

PROJECT NAME Ann Arbor Parks

PROJECT NUMBER 3152040005

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 1/27/15 **COMPLETED** 1/27/15

GROUND ELEVATION N/A

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 4-inch Solid Stem Auger

DURING DRILLING None

LOGGED BY A. Rau **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0.0	4 inches of ASPHALT					
	6 inches of SAND AND GRAVEL FILL - brown, moist					
	CLAY (CL) - mottled brown, dark brown and gray; with silt; traces of sand, gravel and organics; occasional hair roots; stiff; moist	SS 1	100	2-4-5 (9)	1.75	24
2.5						
	CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, hard, moist	SS 2	100	6-10-12 (22)	4.5+	19
5.0						

Bottom of borehole at 5.0 feet.
Allmendinger Park

CTI and Associates, Inc.

BORING NUMBER AP-2

CLIENT City of Ann Arbor

PROJECT NAME Ann Arbor Parks

PROJECT NUMBER 3152040005

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 1/27/15 **COMPLETED** 1/27/15

GROUND ELEVATION N/A

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 4-inch Solid Stem Auger

DURING DRILLING None

LOGGED BY A. Rau **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH 4' 11"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0.0		5 inches of ASPHALT						
		6 inches of SAND AND GRAVEL FILL - brown, moist						
		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, hard, moist	SS 1	100	5-8-11 (19)	4.5+	20	
2.5								
			SS 2	100	6-11-19 (30)	4.5+	13	
5.0								

Bottom of borehole at 5.0 feet.
Allmendinger Park

CTI and Associates, Inc.

BORING NUMBER HP-1

CLIENT City of Ann Arbor

PROJECT NAME Ann Arbor Parks

PROJECT NUMBER 3152040005

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 1/27/15 **COMPLETED** 1/27/15

GROUND ELEVATION N/A

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 4-inch Solid Stem Auger

DURING DRILLING None

LOGGED BY A. Rau **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; □ FINES CONTENT (%) □ 20 40 60 80
0.0		4 inches of ASPHALT						
		8 inches of SAND AND GRAVEL FILL - brown, moist						
		SILTY, CLAYEY SAND (SC-SM) - brown, fine, trace gravel, medium dense, moist	SS 1	100	4-4-6 (10)			
2.5								
		CLAY (CL) - brown, with silt, trace sand, stiff, moist	SS 2	100	3-3-4 (7)	1.25	20	
5.0								

Bottom of borehole at 5.0 feet.
Hunt Park

CTI and Associates, Inc.

BORING NUMBER HP-2

CLIENT City of Ann Arbor
PROJECT NAME Ann Arbor Parks
PROJECT NUMBER 3152040005
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 1/27/15 **COMPLETED** 1/27/15
GROUND ELEVATION N/A
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 4-inch Solid Stem Auger
DURING DRILLING 4' 10"
LOGGED BY A. Rau **CHECKED BY** T. Marsik
AFTER DRILLING 4' 10"
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 4' 10"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; ☐ FINES CONTENT (%) ☐ 20 40 60 80
0.0		5 inches of ASPHALT						
		7 inches of SAND AND GRAVEL FILL - brown, moist						
		CLAYEY TOPSOIL FILL - dark brown, occasional concrete pieces, moist Loss-on-Ignition (organic content) = 3.2%	SS 1	100	4-6-8 (14)		22	
2.5		SILTY, CLAYEY SAND (SC-SM) - brown, fine, trace gravel, loose, moist to wet						
			SS 2	100	3-2-4 (6)			
5.0								

Bottom of borehole at 5.0 feet.
Hunt Park

CTI and Associates, Inc.

BORING NUMBER S-1

CLIENT City of Ann Arbor
PROJECT NAME Ann Arbor Parks
PROJECT NUMBER 3152040005
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 1/27/15 **COMPLETED** 1/27/15
GROUND ELEVATION N/A
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 4-inch Solid Stem Auger
DURING DRILLING None
LOGGED BY A. Rau **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 4' 8"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0.0	4 inches of ASPHALT					
	6 inches of SAND AND GRAVEL FILL - brown, moist					
	CLAYEY TOPSOIL FILL (POSSIBLE PEAT) - dark brown, trace sand, moist Loss-on-Ignition (organic content) = 5.5%	SS 1	100	4-4-4 (8)		25
2.5						
		SS 2	100	2-3-3 (6)	2.25	18
5.0	CLAY (CL) - gray, with silt, traces of sand and gravel, very stiff, moist					

Chart column headings:

▲ SPT N VALUE ▲			
15	30	45	60

PL	MC	LL	
10	20	30	40

□ FINES CONTENT (%) □			
20	40	60	80

Bottom of borehole at 5.0 feet.
Sylvan Park

CTI and Associates, Inc.

BORING NUMBER SB-1

CLIENT City of Ann Arbor
PROJECT NAME Ann Arbor Parks
PROJECT NUMBER 3152040005
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 1/27/15 **COMPLETED** 1/27/15
GROUND ELEVATION N/A
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 4-inch Solid Stem Auger
DURING DRILLING None
LOGGED BY A. Rau **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings
COLLAPSE DEPTH 4' 3"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; □ FINES CONTENT (%) □ 20 40 60 80
0.0		6 inches of brown sandy TOPSOIL FILL						
		CLAY FILL - dark brown, with silt, trace organics, occasional pieces of concrete, moist						
		Loss-on-Ignition (organic content) = 2.5%	SS 1	100	3-4-5 (9)		16	
2.5								
		CLAYEY SAND (SC) - mottled dark brown and gray, fine, trace organics, loose, moist	SS 2	100	3-3-4 (7)			
5.0								

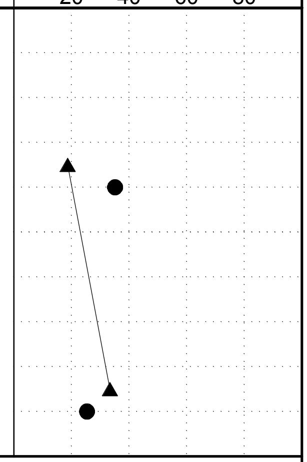
Bottom of borehole at 5.0 feet.
Sugarbush Park. Boring was located 6 feet north of northwest corner of existing tennis court fence.

CTI and Associates, Inc.

BORING NUMBER SB-2

CLIENT City of Ann Arbor
PROJECT NAME Ann Arbor Parks
PROJECT NUMBER 3152040005
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 1/27/15 **COMPLETED** 1/27/15
GROUND ELEVATION N/A
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 4-inch Solid Stem Auger
DURING DRILLING None
LOGGED BY A. Rau **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0.0		4 inches of brown sandy TOPSOIL						
		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, hard, moist						
			SS 1	100	4-5-9 (14)	4.0	18	
2.5								
			SS 2	100	10-10-15 (25)	4.5+	13	
5.0								



Bottom of borehole at 5.0 feet.
Sugarbush Park. Boring was located 7 feet south of southeast corner of existing tennis court fence.

SUMMARY OF LABORATORY RESULTS

CTI and Associates, Inc.

CLIENT City of Ann Arbor **PROJECT NAME** Ann Arbor Parks

PROJECT NUMBER 3152040005 **PROJECT LOCATION** Ann Arbor, Michigan

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Unc. Strength (tsf)	Loss-on-Ignition (%)
AP-1	2.5						CL	24		1.75	
AP-1	5.0						CL	19		4.5+	
AP-2	2.5						CL	20		4.5+	
AP-2	5.0						CL	13		4.5+	
HP-1	2.5						SC-SM				
HP-1	5.0						CL	20		1.25	
HP-2	2.5						FILL	22			3.2
HP-2	5.0						SC-SM				
S-1	2.5						FILL	25			5.5
S-1	5.0						CL	18		2.25	
SB-1	2.5						FILL	16			2.5
SB-1	5.0						SC				
SB-2	2.5						CL	18		4.0	
SB-2	5.0						CL	13		4.5+	

CTI and Associates, Inc.

GENERAL NOTES FOR SOIL CLASSIFICATION

51331 W. Pontiac Trail Wixom, MI 48393 248.486.5100 Main 248.486.5050 Fax

STANDARD PENETRATION TEST: Driving a 2" outside diameter, 1-3/8" inside diameter sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. The sampler is driven three successive 6-inch increments. The number of blows required for the last 12 inches of penetration is termed the Standard Penetration Resistance (N).

GROUNDWATER: Observations are made at the times indicated on logs. Porosity of soil strata, weather conditions and site topography may cause changes in the water levels.

SOIL CLASSIFICATION PROCEDURE: Classification on the logs is generally made by visual inspection. For fine-grained soils (silt, clay and combinations thereof), the classification is primarily based upon plasticity. For coarse-grained soils (sand and gravel), the classification is based upon particle size distribution. Minor soil constituents are reported as "trace" (0-5%), "some" (5-12%) and "with" (12-29%). Where the minor constituents are in excess of 29%, an adjective is used preceding the major constituent name (i.e. for sands containing 35% silt, the soil is classified as silty sand).

PARTICLE SIZE DISTRIBUTION

Boulders	-	Greater than 12 inches average diameter
Cobbles	-	3 inches to 12 inches
Gravel –		
Coarse	-	¾ inches to 3 inches
Fine	-	No. 4 (4.75mm) to ¾ inches
Sand –		
Coarse	-	No. 10 (2.00mm) to No. 4 (4.75mm)
Medium	-	No. 40 (0.425mm) to No. 10 (2.00mm)
Fine	-	No. 200 (0.075mm) to No. 40 (0.425mm)
Silt and Clay	-	Less than 0.075mm, Classification based upon plasticity. Generally silt particles size ranges from 0.005mm to 0.075mm and clay particle size is less than 0.005mm.

CONSISTENCY OF FINE GRAINED SOILS IN TERMS OF UNCONFINED COMPRESSIVE STRENGTH AND N-VALUES

Consistency	Unconfined Compressive Strength (Tons per square foot)	Approximate range of N
Very Soft	Less than 0.25	0 - 2
Soft	0.25 to 0.5	3 - 4
Medium Stiff	0.5 to 1.0	5 - 8
Stiff	1.0 to 2.0	9 - 15
Very Stiff	2.0 to 4.0	16 - 30
Hard	over 4.0	over 31

RELATIVE DENSITY OF COARSE GRAINED SOILS ACCORDING TO N-VALUES

Density Classification	Relative Density, %	Approximate Range of N
Very Loose	0 – 15	0 – 4
Loose	16 – 35	5 – 10
Medium Dense	36 - 65	11 - 30
Dense	66 - 85	31 – 50
Very Dense	86 – 100	over 50

Relative density of cohesionless soils is based upon an evaluation of the Standard Penetration Resistance (N), modified as required for overburden pressure.