Subsurface Exploration and
Geotechnical Engineering Evaluation
Proposed Parking Garage Structure
2 S. Orlando Avenue
Cocoa Beach, Florida

Ardaman & Associates, Inc.

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Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

November 22, 2022
File No. 22-23-5260

City of Cocoa Beach
2 S. Orlando Avenue
Cocoa Beach, Florida 32932

Attention: Mr. Wayne Carragino

Subject: Subsurface Exploration and
Geotechnical Engineering Evaluation
Proposed Parking Garage Structure
2 S. Orlando Avenue
Cocoa Beach, Florida

Dear Mr. Carragino:

As requested, we have completed a subsurface exploration and geotechnical engineering evaluation for the subject project. The purposes of performing this exploration were to obtain soil stratigraphy data within the parking garage structure area and to provide recommendations for site preparation and deep pile foundation support. This report documents our findings and presents our engineering recommendations.

SITE LOCATION AND SITE DESCRIPTION

The site for the proposed parking garage structure is located a short distance southwest of the S. Orlando Avenue and Minutemen Causeway intersection in Cocoa Beach, Brevard County, Florida (Section 15, Township 25 South, Range 37 East). The general site location is shown superimposed on the Cocoa Beach, Florida USGS quadrangle map presented on Figure 1.

The south portion of the project site is developed with concrete parking areas. The north portion of the site is developed with a stormwater retention pond.

PROPOSED CONSTRUCTION AND GRADING

It is our understanding that the proposed construction consists of a 3-level (including ground-level), pre-cast concrete parking garage. The structure will have plan dimensions of approximately 200 feet by 110 feet based on a preliminary site plan provided by the client.

We have assumed that approximately 1 foot of fill will be placed to raise the structure area to final elevation. If actual fill height exceeds 1 foot, then the recommendations in this report may not be valid.

REVIEW OF SOIL SURVEY MAPS

Based on the 1974 Soil Survey for Brevard County, Florida, as prepared by the U.S. Department of Agriculture Soil Conservation Service, the project site is located in an area mapped as the

"Urban land" soil series. A description of this soil type, as obtained from the Soil Survey, is provided below.

Urban land (Ur):

Urban land consists of areas that are 60 to more than 75 percent covered with streets, buildings, large parking lots, shopping centers, industrial parks, airports and related facilities. Unoccupied areas, mostly lawns, parks, vacant lots, and playgrounds, are Astatula, Paola, Myakka, St. Lucie, Immokalee, Pomello, Cocoa, and Canaveral soils in tracts too small to be mapped separately.

FIELD EXPLORATION PROGRAM

SPT Borings

The field exploration program included performing four Standard Penetration Test (SPT) borings (Borings TH-6 through TH-9) within the proposed "footprint" of the parking garage structure. Due to the potential presence of underground utilities in the area, the top 4.5 feet of each boring was drilled using a 3-inch diameter, hand-held bucket auger. Then, below 4.5 feet, the borings were advanced to a depth of 125 feet below the existing ground surface using the methodology outlined in ASTM D-1586. A summary of the SPT field procedure is included in Appendix I. Split-spoon soil samples recovered during performance of the borings were visually classified in the field and representative portions of the samples were transported to our laboratory in sealed sample jars.

The groundwater level at the boring locations was measured during drilling. Upon completion, the borings were grouted with neat cement grout and Baroid-41 weighting material.

Test Locations

The approximate locations of the borings are schematically illustrated on a site plan shown on Figure 2. These locations were determined in the field by estimating distances from existing site features and should be considered accurate only to the degree implied by the method of measurement used.

LABORATORY PROGRAM

Representative soil samples obtained during our field sampling operation were packaged and transferred to our laboratory for further visual examination and classification. The soil samples were visually classified in general accordance with the Unified Soil Classification System (ASTM D-2488). The resulting soil descriptions are shown on the soil boring profiles presented in Appendix II.

GENERAL SUBSURFACE CONDITIONS

General Soil Profile

The results of the field exploration and laboratory programs are graphically summarized on the soil boring profiles presented in Appendix II. The stratification of the boring profiles represents our interpretation of the field boring logs and the results of laboratory examinations of the recovered samples. The stratification lines represent the approximate boundary between soil types. The actual transitions may be more gradual than implied.

The results of the borings indicate the following general soil profile at the proposed parking garage structure location:

Depth Below Ground Surface (feet)	Description (Unified Soil Classification)
0 to 22.5	Loose to medium dense fine sand (SP)
22.5 to 27.5	Medium dense to dense fine sand (SP)
27.5 to 42.5	Loose to medium dense fine sand (SP), fine sand with silt (SP-SM), and clayey fine sand (SC).
42.5 to 77.5	Very soft to firm clay (CH) and very loose to loose clayey fine sand (SC)
77.5 to 125	Loose to medium dense silty fine sand (SM), clayey fine sand (SC), and partially cemented sand and shell. Also stiff clay (CL, CH)

Various amounts of shell and partially-cemented sand and shell were encountered in the soil samples collected from the borings. The above soil profile is outlined in general terms only. Please refer to Appendix II for soil profile details.

Groundwater Level

The groundwater level was measured in the boreholes during drilling. As shown on the soil boring profiles in Appendix II, groundwater was encountered in the borings at depths ranging from approximately 3.5 to 4.2 feet below the existing ground surface on the date indicated. Fluctuations in groundwater levels should be anticipated throughout the year primarily due to seasonal variations in rainfall and other factors that may vary from the time the borings were conducted.

It is noted that artesian groundwater conditions, evident by groundwater flow above the ground surface, were encountered at each of the boring locations when attempting to collect the soil samples at the 70-foot or 75-foot depth intervals. The artesian groundwater flow was observed to be significant at each boring location.

NORMAL SEASONAL HIGH GROUNDWATER LEVEL

The normal seasonal high groundwater level each year is the level in the August-September period at the end of the rainy season during a year of normal (average) rainfall. The water table elevations associated with a higher than normal rainfall and in the extreme case, flood, would be higher to much higher than the normal seasonal high groundwater level. The normal high water levels would more approximate the normal seasonal high groundwater levels.

The seasonal high groundwater level is affected by a number of factors. The drainage characteristics of the soils, the land surface elevation, relief points such as drainage ditches, lakes, rivers, swamp areas, etc., and distance to relief points are some of the more important factors influencing the seasonal high groundwater level.

In addition to evaluating the conditions above, we have reviewed annual precipitation data available from the Melbourne Office of the National Weather Service. Based on this data, the annual rainfall to date in Brevard County is approximately 41.9 inches, which is approximately 0.6 inches below normal for this time of year.

Based on our interpretation of the site conditions using our boring logs, we estimate the normal seasonal high groundwater level at the boring locations to be approximately at the groundwater levels measured at the time of our field exploration.

ENGINEERING EVALUATION AND RECOMMENDATIONS

General

The results of our exploration program indicate that, with proper site preparation as recommended in this report, the existing soils are suitable for supporting the proposed parking garage structure on a deep, driven pile foundation system.

As previously noted, significant artesian groundwater conditions were encountered at the project site shortly after penetrating the very soft clay soils. Due to these artesian groundwater conditions and the depth of the soft clay, we recommend that auger cast piles not be considered for this project. Additionally, deep soil improvement that penetrates the very soft clay soils may be problematic due to the significant artesian groundwater conditions.

The following are our recommendations for overall site preparation and foundation support which we feel are best suited for the proposed structure and existing soil conditions. The recommendations are made as a guide for the design engineer, parts of which should be incorporated into the project's specifications.

Stripping and Grubbing

The "footprint" of the proposed parking garage structure, plus a minimum margin of 5 feet, should be stripped of all surface vegetation, stumps, debris, asphalt, concrete, organic topsoil or other deleterious materials, as encountered. Buried utilities should be removed or plugged to eliminate conduits into which surrounding soils could erode.

After stripping, the site should be grubbed or root-raked such that roots with a diameter greater than ½ inch, stumps, or small roots in a dense state, are completely removed. The actual depth(s) of stripping and grubbing must be determined by visual observation and judgment during the earthwork operation.

All existing foundations, slabs and any other underground structures should be removed from the proposed construction areas. If pipes or any collapsible or leak prone utilities are not removed or completely filled (with grout or concrete), they might serve as conduits for subsurface erosion resulting in excessive settlements. Over-excavated areas resulting from the removal of underground structures and unsuitable materials should be backfilled in accordance with the fill soils section of this report.

It has been our experience that soils surrounding existing buildings and pavement sometimes contain pockets of construction debris or other deleterious materials requiring removal and replacement with compacted clean fine sands. Therefore, we strongly recommend that the stripped surface be inspected by Ardaman & Associates, Inc.

Proof-rolling

We recommend proof-rolling the cleared surface to locate any unforeseen soft areas or unsuitable surface or near-surface soils, to increase the density of the upper soils, and to prepare the existing surface for the addition of the fill soils (as required). Proof-rolling of the structure area should consist of at least 10 passes of a compactor capable of achieving the density requirements described in the next paragraph. Each pass should overlap the preceding pass by 30 percent to achieve complete coverage. If deemed necessary, in areas that continue to "yield", remove all deleterious material and replace with clean, compacted sand backfill. The proof-rolling should occur after cutting and before filling.

A density equivalent to or greater than 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value for a depth of 2 feet in the parking garage area must be achieved beneath the stripped and grubbed ground surface. Additional passes and/or overexcavation and recompaction may be required if these minimum density requirements are not achieved. The soil moisture should be adjusted as necessary during compaction.

Care should be exercised to avoid damaging any neighboring structures while the compaction operation is underway. Prior to commencing compaction, occupants of adjacent structures should be notified and the existing condition (i.e. cracks) of the structures documented with photographs and survey (if deemed necessary). If requested, Ardaman & Associates could assist with pre- and post-construction surveys of existing structures and with vibration monitoring during construction. Compaction should cease if deemed detrimental to adjacent structures, and Ardaman & Associates should be notified immediately. Heavy vibratory compaction equipment should not be used within 200 feet of existing structures.

Suitable Fill Material and the Compaction of Fill Soils

All fill soil should be free of organic materials, such as roots and vegetation. We recommend using fill with less than 12 percent by dry weight of material passing the U.S. Standard No. 200 sieve size. The fine sand and fine sand with silt (Strata Nos. 1 and 2 without roots, as shown on the soil boring profiles presented in Appendix II) are suitable for use as fill soil and, with proper moisture control, should densify using conventional compaction methods. Soils with more than 12 percent passing the No. 200 sieve can be used in some applications, but will be more difficult to compact due to their inherent nature to retain soil moisture.

All structural fill should be placed in level lifts not to exceed 12 inches in uncompacted thickness. Each lift should be compacted to at least 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value. The filling and compaction operations should continue in lifts until the desired elevation(s) is achieved. If hand-held compaction equipment is used, the lift thickness should be reduced to no more than 6 inches.

Foundation Support by Deep, Driven Pile Foundations

The very soft clay encountered on the project site between the depths of approximately 42.5 feet and 72.5 to 77.5 feet below existing ground surface creates the potential for excessive total and differential settlements for the parking garage structure. Also, artesian pressures were found in all four borings below the depths of 70 to 75 feet with the water rising above the ground surface in each borehole. Due to these conditions, recommendations for deep, driven pile foundations for the structure are provided below.

We have analyzed allowable compressive capacities for 12-inch and 14-inch prestressed, precast concrete (PPC) piles for the support of the parking garage structure. Static pile capacities were estimated utilizing SPT N-values from Borings TH-6 through TH-9 for this study. The calculations incorporate a factor of safety of 2 for both the side friction and mobilized end bearing. A summary of the results of the axial pile capacities analyses versus tip depths are presented in the following table. These capacities are based on a minimum pile spacing of 3.0 times the width of the pile measured center-to-center. If pile spacing is less, pile capacity will be reduced.

Pile Type	Estimated Tip Depth[1] (feet)	Allowable Axial Compressive Capacity[2] (tons)
12" PPC	105	38
	110	50
	115	65
14" PPC	100	32
	105	48
	110	62
	115	85

Notes:
1. Estimated tip depth is measured from existing ground surface at the boring locations.
2. Capacities presented above have been adjusted to account for estimated downdrag – A-Pile FHWA Method.

Pile tip depths presented above are estimates based on the results of our analyses. The actual pile lengths and capacities may be higher or lower than estimated and will be determined during driving. Uplift capacities of the piles are anticipated to be at least 50 percent of the compressive capacities presented above.

We recommend performing a test pile program at the beginning of pile construction consisting of a minimum of two piles instrumented with a Pile Driving Analyzer (PDA). The data will be used to evaluate hammer-driving system performance, pile stresses during driving, pile structural integrity, and finalization of allowable axial pile capacity. This test pile data will also be useful for estimating production pile lengths.

At least 10 days prior to initiation of pile driving, the pile driving contractor will need to provide the Geotechnical Engineer (Ardaman & Associates, Inc.) with the following information regarding the proposed piles and pile driving system:

A. Manufacturer's specifications of the proposed hammer including all modifications.
B. Description and dimensions of the capblock material.
C. Description and dimensions of all cushion material.
D. Plans showing dimensions and details of construction of any followers to be used.
E. Any additional pertinent information necessary for wave equation analysis.

The Contractor should perform his own wave equation analysis to determine the capability of the proposed pile driving equipment and should include the results of these analyses along with the above information.

As specified in Revised FDOT Specification Section 455, piles should not be driven beyond practical refusal (20 blows per inch). The piles used on this project should conform to the latest FDOT Standard Specification regarding precast, prestressed concrete piles. Piles should be driven with a steam, air, hydraulic, or diesel hammer. At all times, the hammer should be operated at the chamber pressure and speed recommended by the manufacturer. Pile driving should be as continuous an operation as possible and should proceed without stopping over the last 10 feet of penetration. Pile redrives and/or set checks should be performed as necessary or deemed prudent. Should the contractor change hammers or procedures such that the energy delivered to the production pile is different than that of the test piles, the engineer should be contacted. Additional PDA tests may be required and the driving criteria modified.

During driving, pile driving records should be kept for each pile detailing pertinent information such as the pile type, pile length, date driven, and blow count per foot. The capacity of each pile should be reviewed based on its final tip elevation and driving record. We recommend that pile driving operations be continuously monitored by an Ardaman & Associates' geotechnical engineer or his representative.

It is noted that during pile driving, vibration may cause settlement/displacement in existing nearby structures. Care should be exercised to avoid damaging any neighboring structures while the compaction operation is underway. Pile driving may also create excessive noise that could be problematic for activities at the project site. Prior to commencing compaction, occupants of adjacent structures should be notified and the existing condition (i.e. cracks) of the structures documented with photographs and survey (if deemed necessary). Pre-construction condition surveys of nearby structures should be considered due to the proximity of the nearby structures. Ardaman & Associates would be pleased to provide this service.

Subgrade Compaction Requirements

Compaction beneath all slabs on grade should be verified for a depth of 12 inches and meet the 95 percent criteria (modified Proctor, ASTM D-1557).

Slab Moisture Reducer

Precautions should be taken during the slab construction to reduce moisture entry from the underlying subgrade soils. Moisture entry can be reduced by installing a membrane between the subgrade soils and floor slab. Care should be exercised when placing the reinforcing steel (or mesh) and slab concrete such that the membrane is not punctured. We note that the membrane alone does not prevent moisture from occurring beneath or on top of the slab.

If interior columns are isolated from the floor slab, an expansion joint should be provided around the columns and sealed with a water-proof sealant

Dewatering

If the control of groundwater is required to achieve the necessary stripping, excavation, proof-rolling, filling, compaction, and any other earthwork, sitework, and/or foundation subgrade preparation operations required for the project, the actual method(s) of dewatering should be determined by the contractor. Dewatering should be performed to lower the groundwater level to depths that are adequately below excavations and compaction surfaces. Adequate groundwater level depths below excavations and compaction surfaces vary depending on soil type and construction method and are usually 2 feet or more. Dewatering solely with sump pumps may not achieve the desired results.

QUALITY ASSURANCE

We recommend establishing a comprehensive quality assurance program to verify that all site preparation and foundation construction is conducted in accordance with the appropriate plans and specifications. Materials testing and inspection services should be provided by Ardaman & Associates.

As a minimum, an on-site engineering technician should monitor all stripping and grubbing to verify that all deleterious materials have been removed and should observe the proof-rolling operation to verify that the appropriate number of passes are applied to the subgrade. In-situ density tests should be conducted during filling activities and below all slabs on grade to verify that the required densities have been achieved. In-situ density values should be compared to laboratory Proctor moisture-density results for each of the different natural and fill soils encountered.

The installation of test and production piles should be monitored full-time by a representative of Ardaman & Associates. Finally, we recommend inspecting and testing the construction materials for the foundations and other structural components.

CLOSURE

The analyses and recommendations submitted herein are based on the data obtained from the soil borings presented on Figure 2 and in Appendix II. This report does not reflect any variations which may occur adjacent to or between the boring locations. The nature and extent of the variations between the boring locations may not become evident until during construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report after performing on-site observations during the construction period and noting the characteristics of the variations. This study does not include an evaluation of the environmental (ecological or hazardous/toxic material related) condition of the site and subsurface.

This report has been prepared for the exclusive use of the City of Cocoa Beach in accordance with generally accepted geotechnical engineering practices. In the event any changes occur in the design, nature, or location of the proposed structure, we should review the applicability of conclusions and recommendations in this report. We recommend a general review of final design and specifications by our office to verify that earthwork and foundation recommendations are properly interpreted and implemented in the design specifications. Ardaman & Associates should attend the pre-bid and preconstruction meetings to verify that the bidders/contractor understand the recommendations contained in this report.

We are pleased to be of assistance to you on this phase of the project. When we may be of further service to you or should you have any questions, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

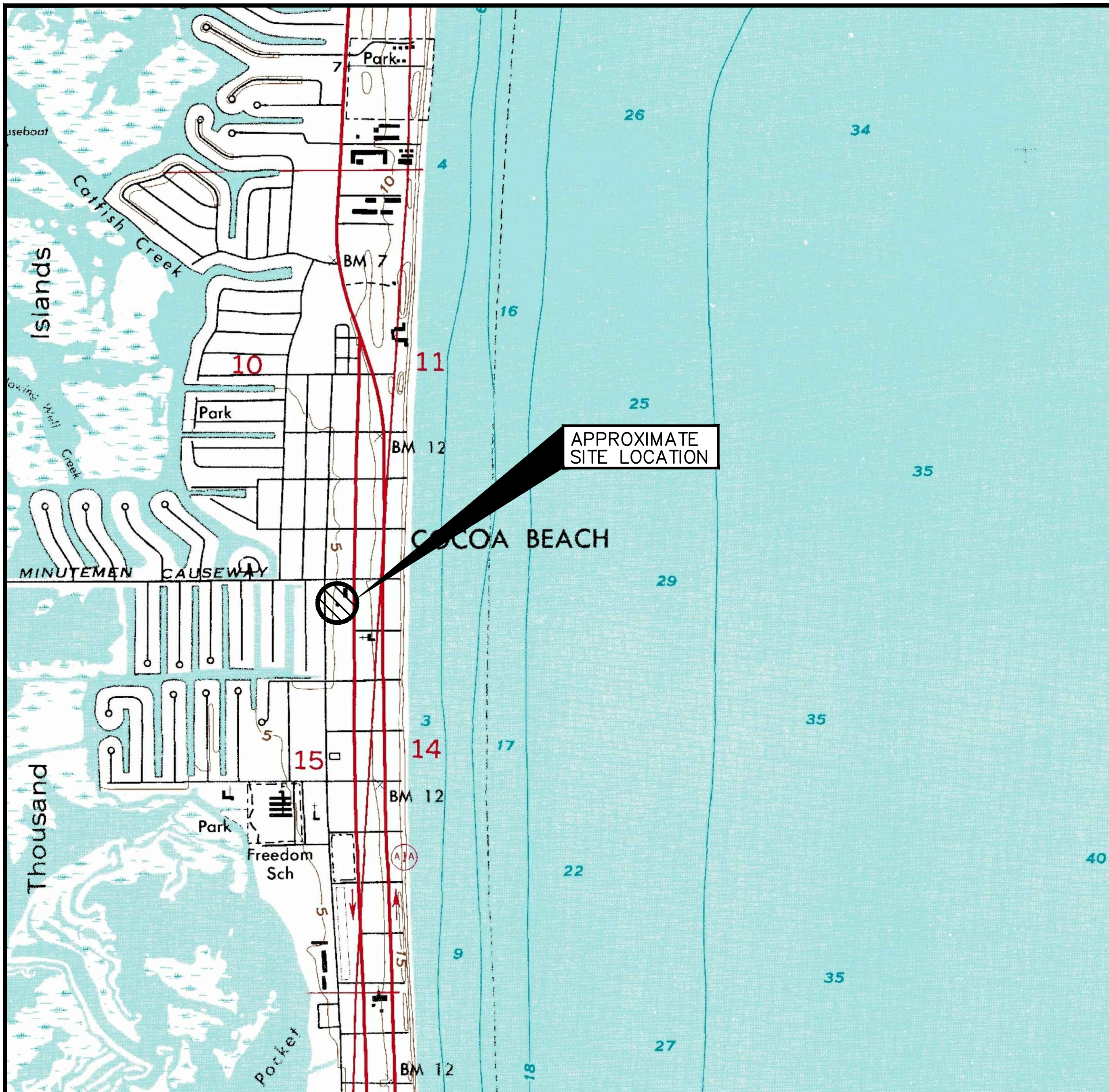
Janie C. Ross
Assistant Project Engineer

Jason P. Manning, P.E.
Branch Manager
Florida License No. 53265

THIS DOCUMENT HAS BEEN DIGITALLY SIGNED AND SEALED BY:
Jason P. Manning, P.E.
Digitally signed by Jason P. Manning, P.E.
Date: 2022.11.22 14:46:26 -05'00'
PRINTED COPIES OF THIS DOCUMENT ARE NOT CONSIDERED SIGNED AND SEALED. THIS SIGNATURE MUST BE VERIFIED ON ANY ELECTRONIC COPIES.

Ross T. McGillivray P.E.
Senior Consultant
Florida License No. 17920

JCR/JPM/RTM/dk



SECTION 15
TOWNSHIP 25 SOUTH
RANGE 37 EAST

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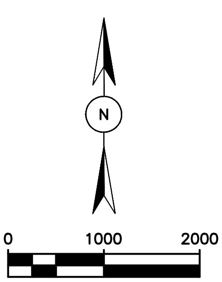

SCALE: — 1"=2000'

QUADRANGLE LOCATION

SITE LOCATION MAP

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SUBSURFACE SOIL EXPLORATION
PARKING GARAGE STRUCTURE
COCOA BEACH, FLORIDA

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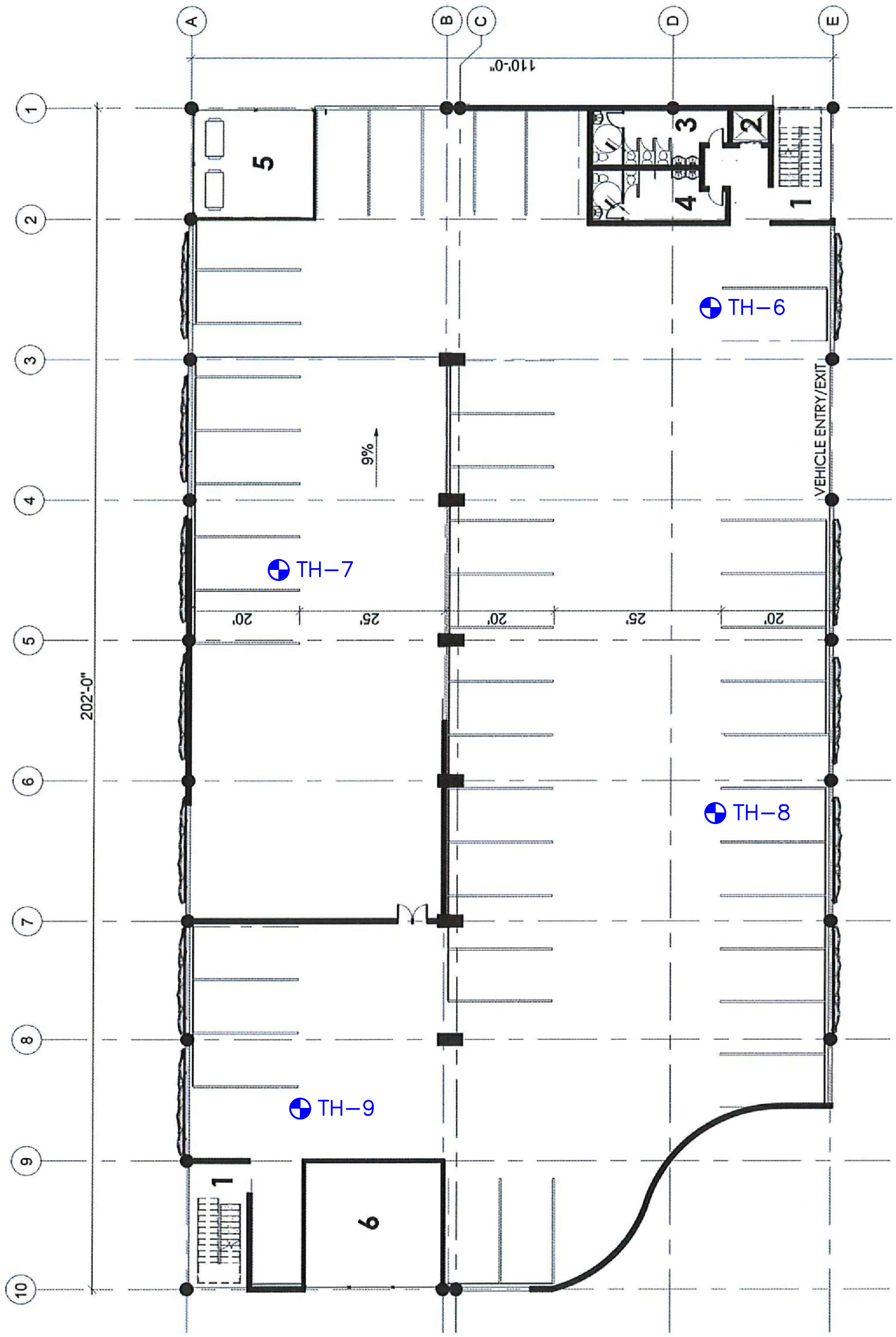

LEGEND

TH STANDARD PENETRATION TEST (SPT) BORING LOCATION

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SCALE: — 1"=30'

BORING LOCATION PLAN

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SUBSURFACE SOIL EXPLORATION
PARKING GARAGE STRUCTURE
COCOA BEACH, FLORIDA

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APPENDIX I

Standard Penetration Test Boring Procedure

STANDARD PENETRATION TEST

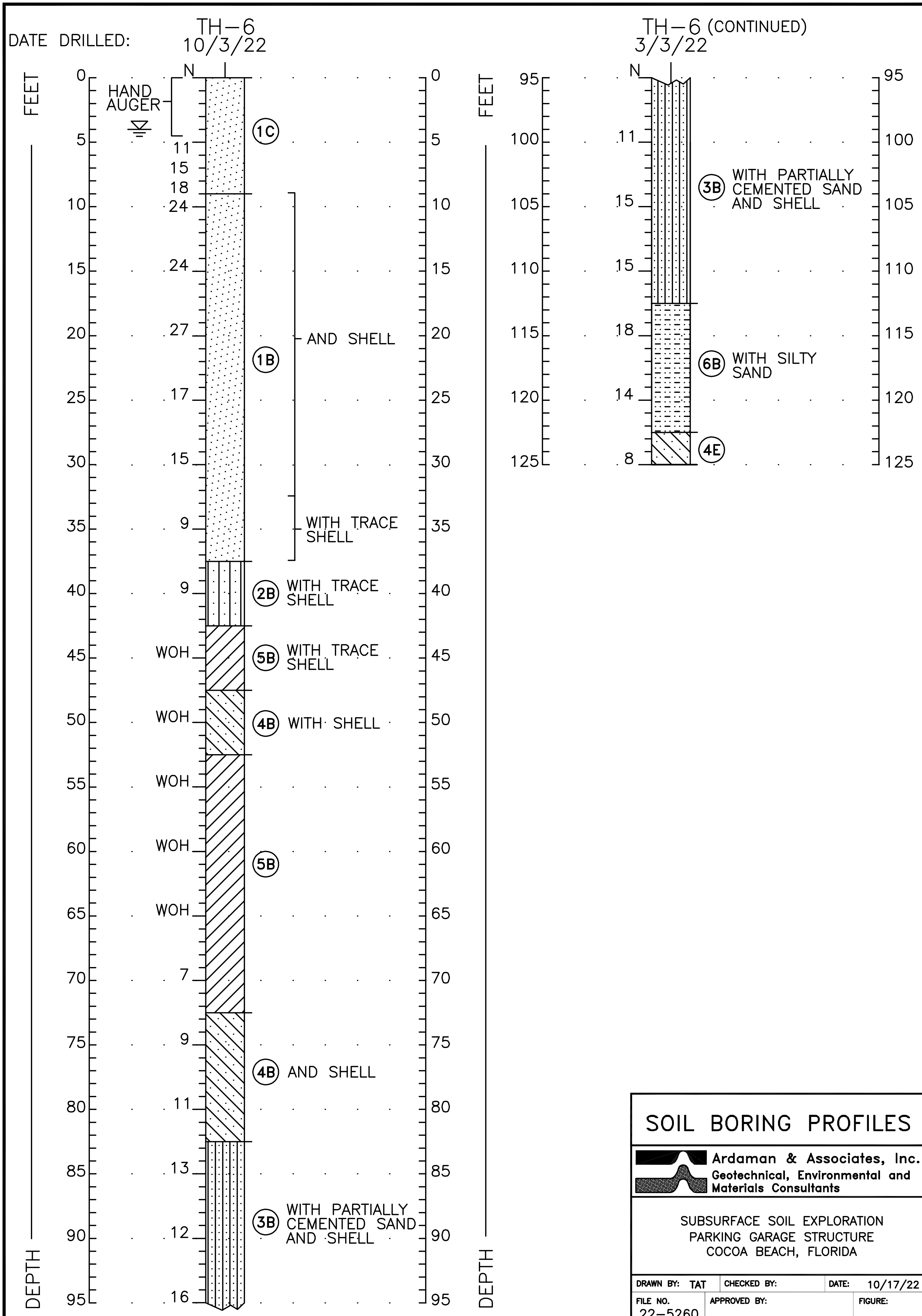
The standard penetration test is a widely accepted test method of *in situ* testing of foundation soils (ASTM D 1586). A 2-foot long, 2-inch O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 30 inches. The number of blows needed for each 6 inches of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch increments of penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual examination and classification of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load.

The tests are usually performed at 5-foot intervals. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is a bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, NX-size flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid.

Representative split-spoon samples from the soils at every 5 feet of drilled depth and from every different stratum are brought to our laboratory in air-tight jars for further evaluation and testing, if necessary. Samples not used in testing are stored for 30 days prior to being discarded. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed, if necessary, and backfilled.

APPENDIX II

Soil Boring Profiles



SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PARKING GARAGE STRUCTURE
COCOA BEACH, FLORIDA

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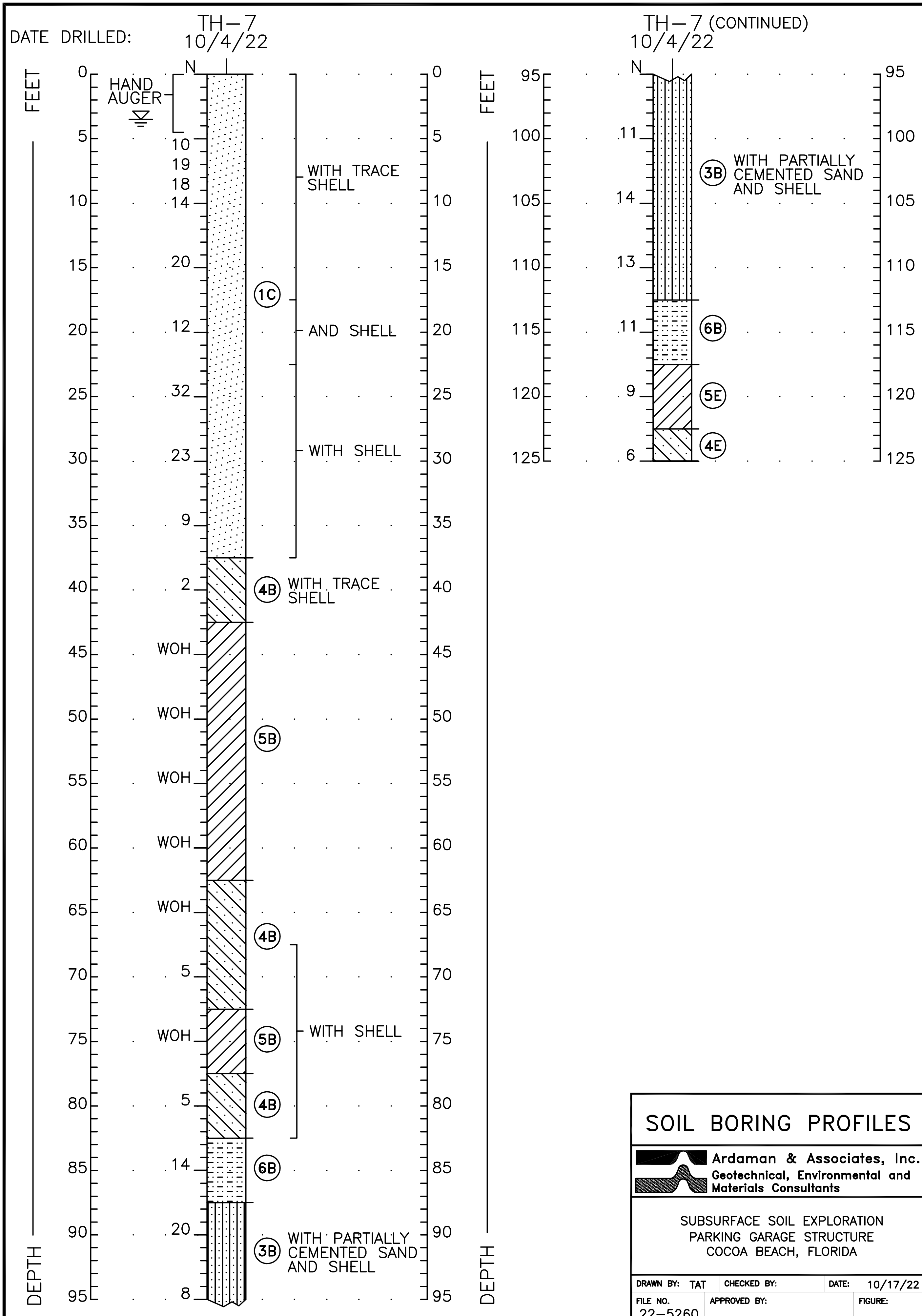
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SOIL BORING PROFILES
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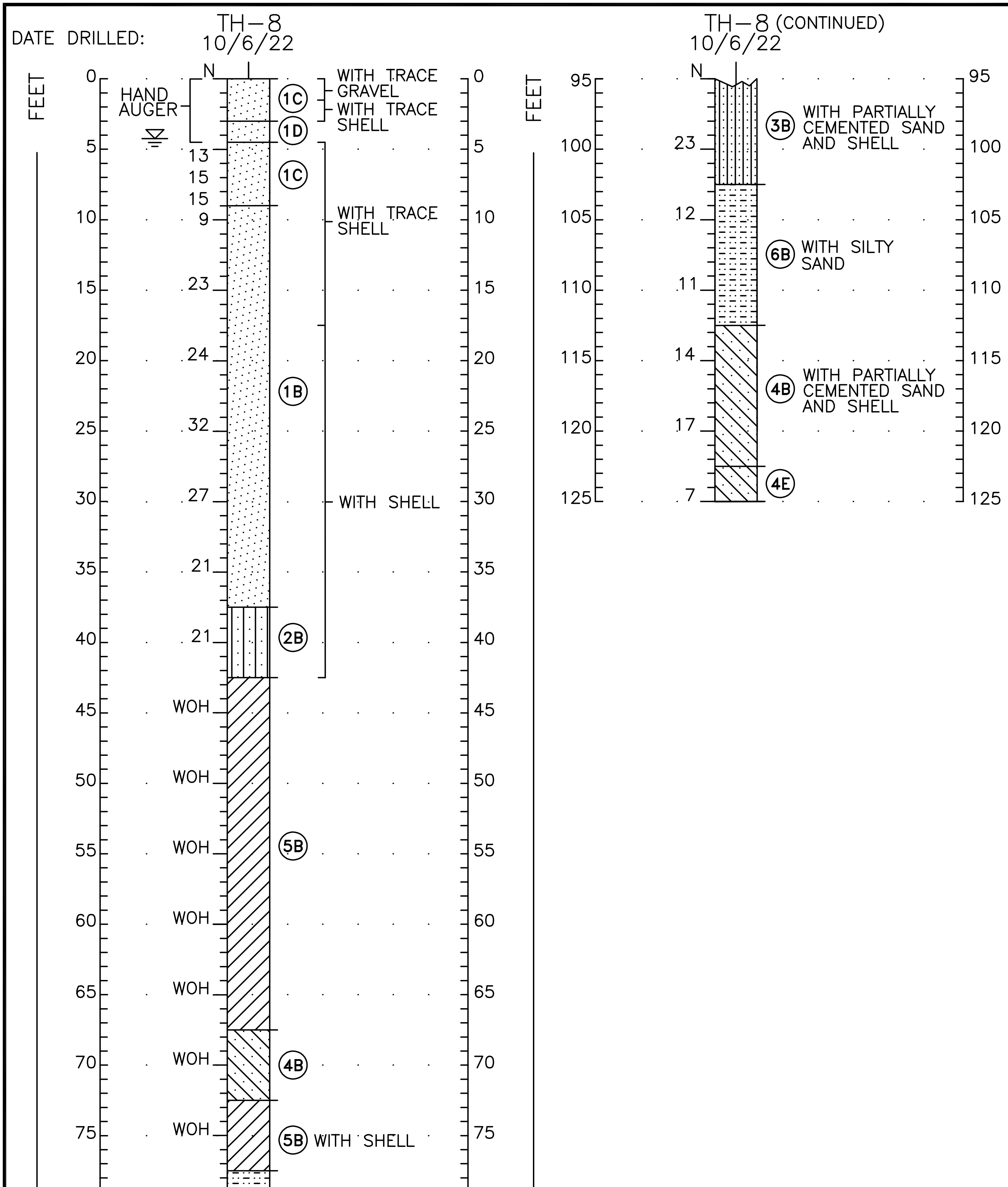

SOIL BORING PROFILES

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SUBSURFACE SOIL EXPLORATION
PARKING GARAGE STRUCTURE
COCOA BEACH, FLORIDA

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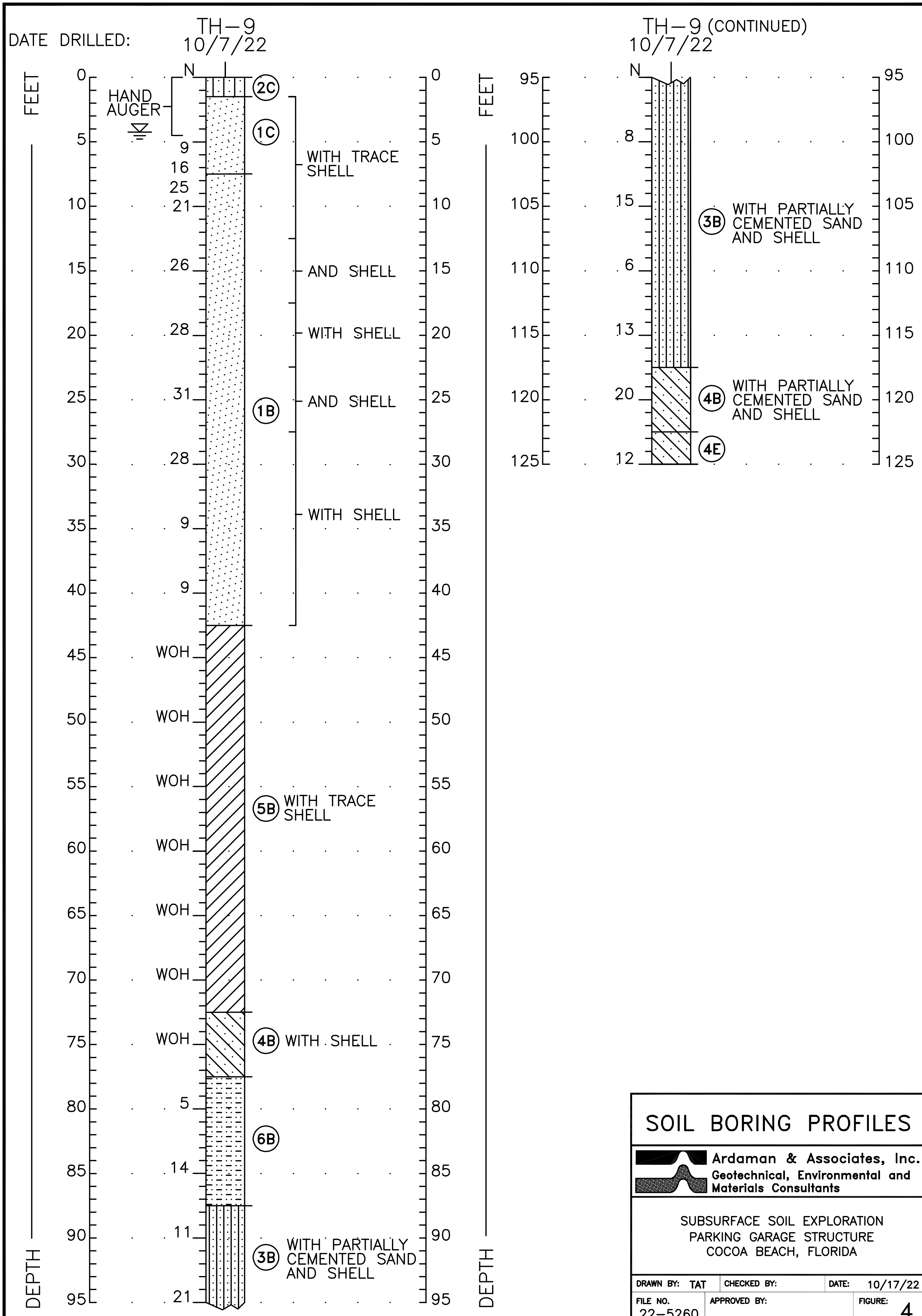

SOIL BORING PROFILES

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SUBSURFACE SOIL EXPLORATION
PARKING GARAGE STRUCTURE
COCOA BEACH, FLORIDA

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