SUBSOIL EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT FOR NEW PAVEMENT AT TRIBUNAL SUPREMO DE PUERTO RICO SAN JUAN, PUERTO RICO

SUBSOIL EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT FOR NEW PAVEMENT AT TRIBUNAL SUPREMO DE PUERTO RICO SAN JUAN, PUERTO RICO

Coleman-Davis Pagán, Arquitectos
DESIGNERS

Geotechnical Engineering Services, PSC
GEOTECHNICAL CONSULTANTS

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Job No. 223973

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SUBSOIL EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT FOR NEW PAVEMENT AT TRIBUNAL SUPREMO DE PUERTO RICO SAN JUAN, PUERTO RICO

1.0 INTRODUCTION

A new pavement is being planned around the old fountain found within the premises of the Tribunal Supremo de Puerto Rico, in San Juan, Puerto Rico. As per the request of the office of Coleman-Davis Pagán, Arquitectos, designers of the project, GEOTECHNICAL ENGINEERING SERVICES, PSC, performed a subsoil exploration at the site of the reference project.

The purpose of the exploration was to establish the physical properties of the underlying subsurface soils' formation in order to evaluate and recommend the soil parameters required for the design of the new pavement. This report presents the results of the subsurface exploration performed at the site, following the terms and conditions contained in our accepted proposal.

2.0 SITE LOCATION AND PROJECT DESCRIPTION

The site of the new pavement is located around the old fountain found within the Tribunal Supremo de Puerto Rico premises, which is located at De la Constitución Avenue (PR-26), Lot 8, Puerta de Tierra Sector, San Juan, Puerto Rico. **Figure 1**, shows a Google Earth aerial photo, with the site location depicted on it. Topography at site is leveled, although upgraded in the past, and it is covered with rigid tiles. Part of the project site meets the property limit of the Luis Muñoz Rivera Park, which is a little higher in elevation than the pavement under evaluation, and it seems that water surface run-off over the paved area. Due to the high permeability of the sandy soils found in our subsoil exploration, groundwater level might rise closer to the surface, affecting the pavement respond to traffic.

3.0 WORK PERFORMED

Two (2) borings were drilled to cover the proposed pavement area to a depth of 10 feet. **Figure 2**, shows photos of the site, with the drilling equipment positioned at each borehole location.

Routine laboratory tests were conducted on most of the soil samples secured, according the applicable ASTM Designations. The data was then evaluated in order to prepare the foundations recommendations for the proposed pavement.

4.0 SUBSOIL CONDITIONS

Borings revealed an old fill layer consisting of poorly graded sand with little gravel. Colors of samples varied from dark olive to gray. Relative density varied from medium to dense. This old fill crust extends to a depth of 1 foot at Boring 1 and to a depth of 2 feet at Boring 2.

Underlaying the fill crust, an in-situ horizon consisting of silty sand, fine to coarse grained, was encountered. Colors of samples varied from dark olive brown, dark olive, pale gray to gray, and red. Relative density, based on corrected Standard Penetration Test N-values, varied from very loose to medium dense. This horizon extends to a depth of 6 feet at Boring 2, and to the full depth drilled at Boring 1.

At Boring 2, from 6 to 10 feet, a layer of sandy clayey silt, was encountered. Colors of samples varied from pale olive to pale gray. Consistency varied from stiff to very stiff. The natural moisture content of the samples secured ranged from 12 to 16 percent, while the unconfined compressive strength value measured was 2.0 tons per square foot.

5.0 GROUNDWATER

Groundwater level was detected within the range of depth drilled at 3 feet deep. However, it seems that this level goes up during rain events, due to the surface run-off coming from the Luis Muñoz Rivera Park, and due to the high permeability of the underlaying sands at the pavement area.

6.0 GENERAL

The above information is a general description of the subsoil conditions at the site. For detailed information on the soil characteristics at and along the boreholes, at the time and under the conditions these were drilled, refer to the boring logs which are included on an Appendix to this report. The depths mentioned in this report, unless otherwise specified, are referred to the existing ground surface elevations prevailing during the drilling phase of this project.

7.0 DISCUSSION

Based on the actual condition of the tiles acting as pavement at the area, the difference in thickness of the granular fill found, the very loose to medium dense relative density of the in-situ sands, and the high groundwater levels at the site (suspected to be higher), is evidence that the area needs a subsurface treatment to improve the service condition of the new pavement.

The first issue to solve, is the migration of water (surface and underground) from the Luis Muñoz Rivera park to the pavement area. An interceptor drain shall be constructed to collect the horizontal migration of groundwater. This new drain, should be at least 3 feet deep.

After the remotion of the existing pavement, an undercut of at least 2.5 feet deep shall be performed at the entire footprint area to remove the old fills and part of the in-situ sands. Then, the exposed surface shall be proof rolled with at least a 15-tons smooth wheel roller, in order to detect unstable zones, that would need additional remotion. After proof rolling, the exposed surface shall be covered with a geotextile, such as; Mirafi HP370, Mirafi RS380i, or stronger product, to improve the bearing surface. In order to control groundwater seeping into the excavation, the bottom 1.5 feet of excavation shall be backfilled with 1, 2, or 3-inches clean angular gravel, over the geotextile. Then, the angular gravel, should be cover by the same geotextile (Mirafi HP370, Mirafi RS380i, or stronger product), to separate the clean aggregate from the upgrading selected fill (A-2-4, A-1-b, or A-1-a, based on AASHTO Soil Classification System) until reaching the finish grade elevation.

It is of paramount importance that all drainage at the new pavement area, be detour away from the project area. As part of the design of the new pavement, a drainage shall be constructed at the side of the pavement facing the Luis Muñoz Rivera Park, to collect surface run-off and intercept groundwater flows, prior to reach the new pavement. The new interceptor drainage shall be at least 3 feet deep.

General recommendations for excavations and earthwork operations, as well as erosion protection, to be followed by the contractor during construction are provided in the next section.

8.0 ENGINEERING RECOMMENDATIONS

8.1 Pavement

After the subsurface improvements presented in the Discussion Section, which include a minimum 30 inches undercut of the old fills and/or in-situ sands, and improve the bearing surface with layers of geotextile and clean gravel, the following is a summary of recommendations that should be considered when developing the new pavement.

The subbase material should resemble the characteristics of an A-2-4 material. It should have a minimum thickness of 8 inches. The A-2-4 shall be overlaid by a minimum 4-inch thick base of A-1-a material. For design, California Bearing Ratio (CBR) values of 18 and 35 should be assigned to the A-2-4 sub-base and the A-1-a base, respectively. A CBR value higher than 8 should not be assigned to the subgrade material (in-situ sands to remain at the bottom of the 2.5-foot excavation).

For the design of a rigid pavement, modulus of subgrade reactions of 200 and 300 pci can be assigned to the A-2-4 sub-base and the A-1-a base, respectively.

The A-2-4 material (subbase) shall have a minimum thickness of 8 inches or more if required by the pavement design criteria.

The base and subbase material shall be compacted to 95 percent of their Modified Proctor maximum dry density in lifts of 6 inches.

The thickness of the asphalt pavement shall also be determined by the pavement design criteria. However, a minimum thickness of 4 inches is recommended.

Proper grading and an efficient drainage system shall be provided to the new pavement so as to avoid stagnant water and subgrade saturation.

8.2 General Earthwork Recommendations

Earthwork conducted at the site should follow the general guidelines provided below.

8.2.1 Site Preparation

1. Clearing and Grubbing

The site should be cleared of all surface and subsurface deleterious materials, including trees, brush, stumps, logs and tree roots, garbage, construction debris, buried utility lines, structures, old slabs, old footings, pavements, etc.

2. Stripping/Excavation

After clearing the site, should be stripped to sufficient depth to remove old fills and partially poor bearing soils (approx. 30 inches).

However, actual depth of removal should be determined directly at the field during earthwork operations. Any rubbish, organic, or other deleterious material encountered during excavation operations will be removed to its full depth, disposed and excavation backfilled under controlled conditions as specified further in this section.

3. Fill Areas/Proof Rolling

Prior to placing any needed fill in the area, an inspection of the area is to be made by a Geotechnical inspector. Proof rolling with at least a 15 tons smooth wheel roller, under the presence of a Geotechnical Engineer or his representative, shall be used to detect the presence of soft spots. Any soft spot detected shall be completely removed, and replaced with selected fill properly compacted. After proof rolling operations the 30 inches undercut area, shall be covered with a geotextile Mirafi HP 370, Mirafi RS380i, or stronger product.

In order to control groundwater seeping into the excavation, the bottom 1.5 feet of excavation shall be backfilled with 1, 2, or 3-inches clean angular gravel, over the geotextile. Then, the angular gravel, should be cover by the same geotextile (Mirafi HP370, Mirafi RS380i, or stronger product), to separate the clean aggregate from the upgrading selected fill.

4. Compaction

The fill should be compacted that the dry unit weight of the compacted material is equal to or greater than ninety-five (95) percent of the maximum unit dry weight of material compacted in the laboratory under Modified Proctor Compaction Test. It should be the responsibility of the Resident Engineer to instruct the Soils Engineer retained by the owner on a consultative basis to determine the optimum moisture and corresponding dry density of every type of fill material to be used by the contractor in order to properly evaluate the percentage of compaction of the fill material.

5. Equipment Procedure

The contractor should employ suitable equipment, to obtain the required percentage of compaction. The number of passes of the equipment over each section of the work surface shall be determined in the field. However, the Soils Engineer shall determine the density of the fill material after the compaction of each eight (8) inch layer, and the contractor shall not place any additional fill until the preceding compacted layer has been found to fulfill the aforementioned requirements. Each successive pass should overlap the preceding adjacent pass by ten (10) percent. Roller passes made on material in unsuitable condition will not be considered in judging compliance with our recommendations. In case the Contractor fails to obtain the required compaction energy, he must get the appropriate type of equipment to comply with this compaction criterion.

6. Moisture Content

The moisture content of the fill material, prior to compaction, should be within the limits of 4% less than or 4% greater than the optimum, as determined by the Modified Proctor Test.

The acceptability of the compaction will be established by tests (state weathered at Contractor's or Owner's expense). The unit weight of compacted material will be established by in-place density tests conducted by the Soils Consultant (at the Resident Engineer's request) by nuclear testing procedures, according to ASTM requirements.

Additional tests to establish or confirm maximum Proctor Density, optimum moisture content and percentage stone content will be performed as required by working conditions.

8.2.2 Fill Material

Samples of all potential sources of fill must be submitted to the soil laboratory to establish their adequacy. Borrow materials for fill should consist of essentially granular material (GM, SW, SP, SM, or SC, Unified Soil Classification System; or A-2-4, A-1-b, A-1-a, AASHTO Classification System), as approved by the Geotechnical Engineer. These should be free from vegetable matter and should not contain rocks having a dimension greater than six (6) inches.

8.3 Drainage Guidelines and Recommendations

A drainage system should be developed to control storm water run-off that may enter from outside or fall within the new pavement. Basically, the drainage system should consist of interconnected components that ultimately discharge all collected flow to areas immediately upstream of the culvert outlets.

The hydrologic and hydraulic analysis will govern the shape and size of the various drainage components and shall be determined by the designer.

Likewise, roadway under drain systems should be considered to receive any water that may infiltrate through the surface of pavement structure or the shoulders. The system will also receive any sub-surface water that may occur in the subgrade resulting from collecting condensation.

As part this design, the 3 feet deep drainage structure at the limit between the pavement and the Luis Muñoz Rivera Park, shall be included.

9.0 ADDITIONAL COMMENTS

The services of a P.R. licensed Soils Engineer should be retained during the excavation and foundation phases of the work. This is to observed compliance with the specifications or recommendations and to allow design changes in the event that sub-surface conditions differ from that anticipated prior to starting the construction program. The Soils Engineer selected for this purpose, should receive copy of all plans and report, evaluate them and recommend variations or additional studies, as the deems necessary for thus assuming technical responsibilities of the solutions herein recommended. Copies of this report are furnished only to provide the factual data which were gathered and which were summarized in the report.

The analysis and recommendations submitted in this report are based in part upon the data obtained from the soil borings made. The nature and extent of variations between the borings may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.

In the event that any changes in the nature, design or location of the facilities planned, the conclusions and recommendations contained in this report shall not be considered valid, unless the changes are reviewed and conclusions of this report modified or confirmed in writing.

The soil and foundation engineering report has been prepared for this project by Geotechnical Engineering Services, PSC. This report was for design purposes only and may not be sufficient to prepare an accurate bid. Contractors wishing copies of the report may secure them from owner with the understanding that its scope is limited to design consideration. It is recommended that the soil foundation engineer be provided the opportunity for a general review of final design and specifications in order to verify that the earthwork and foundation recommendations were properly interpreted and implemented in the design and specifications. If the soil and foundation engineer is not allowed the opportunity of making this recommended review, he can assume no responsibility for misinterpretation of his recommendations. The standard procedure followed during the drilling of the test borings are discussed in detail in the appendix to this soil report.

This report has been prepared taking into consideration the design factors presently known to us. The project designers should be alert of any item that might have been overlooked, that could require clarification or that may need additional recommendations to those discussed herein.

Respectfully submitted,

ANIEL GRILLASCA RODRÍGUEZ, M.E.C.E., P.E.
GEOTECHNICAL ENGINEER

AGR**Reference No. 223973**
October 28, 2022

APPENDIXES

APPENDIX NO. 1
GENERAL

Comprised in this report is a description of the project as made known to GES, Geotechnical Engineering Services, PSC and details of the project with pertinent recommendations for the design of foundations and other earth related structures. It should be considered that the design recommendations are relative to the project aspects discussed and subject to the limitations imposed by all practical considerations in the determination of subsoil conditions.

The field and laboratory data shown in boring logs represent subsoil conditions encountered at the borehole proper. The analysis and conclusions herein presented and discussed are based on such results and on a reasonable interpolation of subsoil characteristics. Whenever cross-sections with a schematic representation of the interpreted subsoil stratification between borings are included, the same should not be taken to represent true intermediate conditions but are rather given for general comparison purposes only.

Copy of this report should be made available to the Project Designers for their information and guidance, as well as to the Contractor and Resident Engineer, in order to secure maximum protection in the case of possible unexpected variations. Any such variations as well as any changes or modifications to the scope of project described after submittance of this report shall be notified by writing to these Consultants in order to evaluate same and decide upon the need to alter or modify the recommendations given.

PMB 343 WINSTON CHURCHILL 138 SAN JUAN, P.R. 00926-6013 787-648-2224/ges_grillasca@yahoo.com

APPENDIX NO. 2

FIELD AND LABORATORY WORK

The field work consisted of a visual observation of the area and existing structures at the site, if any, and of performance of test borings as indicated.

Test borings were made in accordance to the "Standard Penetration Test and Split-Spoon Sampling of Soils Method" as proposed by the Standards of the American Society for testing and Materials Designation ASTM D-1586, Latest Revision.

The testing hole is bored either by manual and mechanical augers or by driving a 2.5 inch inside diameter casing into the ground which is washed clean internally each time a soil sample is to be secured below its reach. While sampling, the Standard Penetration Test is performed and the "N" values recorded. This is the number of blows required to drive the split-spoon sampler 12 inches into the ground using a 140 lbs. hammer with a free fall of 30 inches.

The value gives an indication of the consistency of cohesive soils and the relative density of granular soils as shown in the following table:

COHESIVE SOILS

"N" VALUES	CONSISTENCY	UNCONFINED COMP. STRENGTH (TSF)
less than 2	Very soft	less than 0.25
2 - 4	soft	0.25 - 0.50
4 - 8	medium	0.50 - 1.00
8 - 15	stiff	1.00 - 2.00
15 - 30	very stiff	2.00 - 4.00
over 30	hard	over 4.00

GRANULAR SOILS

"N" VALUES	RELATIVE DENSITY
0 - 5	very loose
5 - 10	loose
10 - 30	medium
30 - 50	dense
over 50	very dense

Depth of water surface shown on logs indicate the phreatic level found either prior to use of any casing and water or taken 24 hours after the test borings was completed and the casing, if any, is pulled out. The information given, unless otherwise indicated, is not a adequate for study of deep excavations and is only to be used as an approximate level in the study of a normal foundation of the project. Phreatic or underground water levels may vary with seasonal rainshower variations thus water may appear where none is shown and the reader of this report should be aware of this fact. For excavations where ground water levels are of utmost importance special studies consisting of long range observations on installed wellpoint-type devices should be performed. Where deep excavations are contemplated, as in pumping stations, study of artesian or sub-artesian aquifers should be made by means of deep test borings and pumping tests.

DIAMOND CORE DRILLING

Whenever drilling through rock is necessary the same is made following the "Diamond Core Drilling for Site Investigation" method as proposed by the standards of the American Society for Testing and Materials Designation ASTM D-2113-L.R. In general a double tube core barrel with diamond bit is rotated under pressure into the rock. The drilled rock enters into the barrel using circulating water as cooling agent. At intervals of 2 to 5 feet the barrel is lifted and the core is removed. The length of each core run as well as the length of the core recovered is noted.

LABORATORY WORK

Water Contents

The natural moisture content was determined for all samples, except for those with high percentage of gravel or coarse sand.

The tests follow standards of the American Society for Testing and Materials ASTM Designation D-2216, Latest Revision. The water or moisture content of a given soil mass is by definition the ratio of the weight of water to the oven dry weight of the soil, expressed as a percentage.

Unconfined Compression Tests

All suitable samples of cohesive soil recovered from the split-spoon sampler were tested in unconfined compression. The ratio of the maximum load required for failure to the corrected cross sectional area of the sample expressed in tons per square foot is defined as the unconfined compressive strength.

Examination and Description

Soil samples are classified according to their constituents, the following terminology used to denote the approximate percentage by weight of each component.

DESCRIPTION TERM	PERCENT BY WEIGHT
Trace	1 - 10
Little to some	10 - 20
Sandy, silty clayey	20 - 35
And	35 - 50

The examined samples are related into one of the following main groups; boulders, gravel, sand, clay, and silt. On peat, the presence of the decomposed and partly decomposed vegetable matter, is used for identification. The differentiation between a clay and a silt is based on the presence or lack of plasticity, dilatancy and dry strength rather than on grain size. The description of the soil includes: color, odor, minerals, presence of foreign matter, geological history, etc. These descriptions as well as the results of the laboratory testing are used in grouping similar samples into a stratigraphic unit as shown on the final boring logs. Therefore, the data on subsurface exploration logs represent subsoil conditions at the precise locations of the boreholes only.

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FIGURES

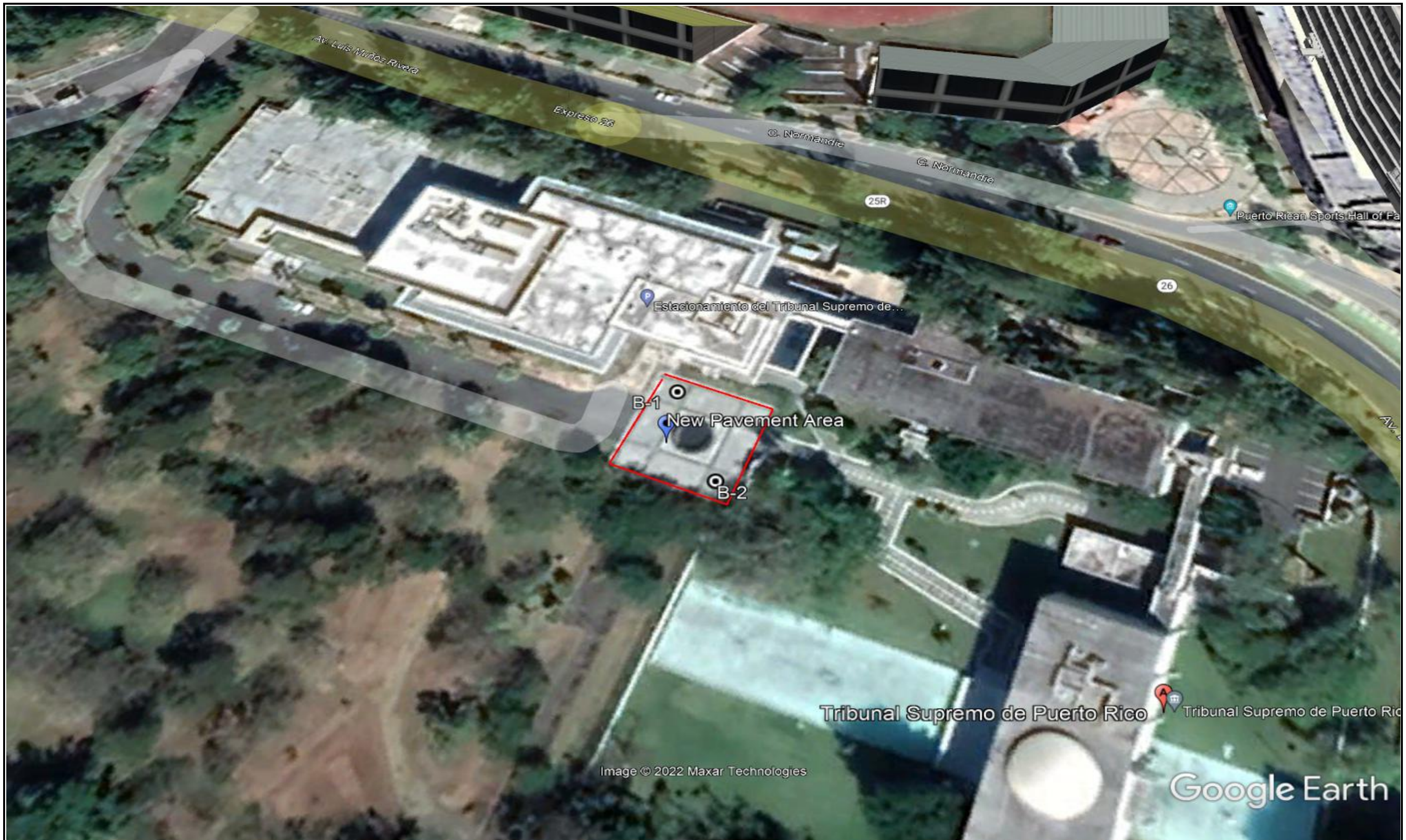

FIGURE 1 - SITE LOCATION ON GOOGLE EARTH PHOTO
NEW PAVEMENT AT TRIBUNAL SUPREMO DE PUERTO RICO
SAN JUAN, PUERTO RICO

GES
Geotechnical Engineering Services, PSC

BORING # 1

BORING # 2

FIGURE 2 - BORINGS 1 & 2 LOCATION PHOTOS
NEW PAVEMENT AT TRIBUNAL SUPREMO DE
PUERTO RICO, SAN JUAN, PUERTO RICO

GES

Geotechnical Engineering Services, PSC

BORING LOGS

BORING LOGS

The description of subsurface profile and results of field and laboratory tests, as enclosed, pertain to conditions actually encountered at the borings location proper and at the depths indicated. Profile tracings between borings, when given, represent a reasonable interpolation of subsoil characteristics and should not be taken to indicate true intermediate conditions.

Notes:

N -	***Number of blows required to drive the sampling spoon a distance of 12" with a 140 lbs hammer falling 30"***
NW -	***No water***
WH -	***Weight of hammer***
WR -	***Weight of Rods***
W -	***Natural moisture content in % of dry weight***
qu -	***Unconfined compressive strength in tons/sq ft***
**** -***	***penetrometer value***

Geotechnical Engineering Services, PSC

Geotechnical Engineering Services, PSC

Geotechnical Engineering Services, PSC	Date: 10/12/22	Elevation:
	Boring No.: 1	Code No.:
Project Name: New Pavement at Tribunal Supremo de Puerto Rico San Juan, Puerto Rico	Location: PR-26	Water Table: 3'
	Drill Machine: CME-55	Our Job No.: 223973

Depth (ft.)	Sampler Type	Sample No.	Sample Length (in.)	Sample Recovery (in.)	Blows/6"	SPT N-Value	RQD %	W_n %	W_p %	W_l %	I_p %	USCS Class.	Soil Pattern	Description	Qu (tsf)
														Fill - Poorly graded sand, little gravel, gray.	
	*	1	24		13-17-15-13	32		10						Silty sand, fine to medium grained, dark olive brown.	
	*	2	24		9-9-7-7	16		15						Same as above, medium to coarse grained, dark olive, red.	
5	*	3	24		4-5-6-8	11		16						Same as above, dark gray spots.	
	*	4	24		6-12-20-18	32		15						Same as above, coarse grained, pale gray, gray.	
10	*	5	24		14-13-14-16	27		13						Same as above, dark reddish brown spots.	
														End of boring at 10 feet.	
15															
20															
25															
30															
35															
40															
45															

Comments: * Split Spoon Sampler
N.D. - Not Detected

Hammer Weight: 140 #	Page 1 of 1	Sampler Size: 2' x 2" O.D.	Foreman: J.L. Rodriguez

Geotechnical Engineering Services, PSC

Geotechnical Engineering Services, PSC

Geotechnical Engineering Services, PSC	Date: 10/12/22	Elevation:
	Boring No.: 2	Code No.:
Project Name: New Pavement at Tribunal Supremo de Puerto Rico San Juan, Puerto Rico	Location: PR-26	Water Table: 3'
	Drill Machine: CME-55	Our Job No.: 223973

Depth (ft.)	Sampler Type	Sample No.	Sample Length (in.)	Sample Recovery (in.)	Blows/6"	SPT N-Value	RQD %	W_n %	W_p %	W_l %	I_p %	USCS Class.	Soil Pattern	Description	Qu (tsf)
	*	1	24		12-13-15-15	28		7						Fill - Poorly graded sand, little gravel, dark olive, gray.	
	*	2	24		15-16-12-13	28		12						Silty sand, fine to coarse grained, olive, red traces.	
5	*	3	24		5-5-4-3	9		15						Same as above, silt pockets.	
	*	4	24		3-4-5-8	9		16						Sandy clayey silt, pale olive, pale gray.	2.0
10	*	5	24		8-12-15-20	27		2						Same as above.	
														End of boring at 10 feet.	
15															
20															
25															
30															
35															
40															
45															

Comments: * Split Spoon Sampler
N.D. - Not Detected

Hammer Weight: 140 #	Page 1 of 1	Sampler Size: 2' x 2" O.D.	Foreman: J.L. Rodriguez

MSC 343, SAN JUAN, P.R. 00926-6023 PHONE NO. (787) 648-2224 FAX NO. (787) 755-6643