# CARRASQUILLO ASSOCIATES, LTD.

**MATERIALS, CONSTRUCTION, AND**

**STRUCTURAL CONSULTANTS**

TBPE Reg. F-3467

5113 SOUTHWEST PARKWAY, STE. 250
AUSTIN, TX 78735


October 16, 2018

Mr. Manuel Mata
Director de Complejo
AES Puerto Rico, L.P.
PO Box 1890
Guayama, PR 00785

**RE: Investigation into the existing Agremax Storage Pile at AES-PR**
**Title 40: Protection of the Environment: Part 257 – Criteria for Classification of Solid Waste Disposal and Practices**

Dear Mr. Mata:

Presented herein are the results of Carrasquillo Associates' (CA) investigation into determining if the Agremax Storage Pile at the AES – PR Power Plant located in Guayama, PR, meets the requirements in the regulation in Title 40: Protection of the Environment, Part 257 – Criteria for Classification of Solid Waste Disposal and Practices. Review of the regulation revealed that the applicable section of the Part 257 – Criteria for Classification of Solid Waste Disposal and Practices regulation applicable to the Agremax Storage Pile at AES-PR is Subpart D-Standard for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments, §257.64, Unstable Areas.

The investigation included, among others, a detailed analysis of the applicable regulations, detailed inspection of the Agremax Storage Pile, geotechnical sampling, testing and analysis of the landfilled material and subsurface soil, topographical evaluation, and an engineering assessment of the geotechnical characteristics of the site. As stated in §257.64, Unstable Areas, the following factors were addressed in the investigation into the adequacy of the Agremax Storage Pile at AES-PR.

These include:

- On-Site or local soil conditions that may result in significant differential settling,
- On-site or local geological or geomorphologic features,
- On-site or local human-made features or events (both surface and subsurface), and
- Slope stability and mass movements.

The geotechnical laboratory testing program included the following:

- Soil Classification,
- Consolidation Tests,
- Triaxial Tests,
- Direct Shear Testing, and
- Modified Proctor Compaction Testing.

Details of the geotechnical investigation conducted are included in the report from Mr. Carlos R. Sierra Del Llano, MSCE, PE, with Jaca & Sierra Testing Laboratories dated October 15, 2018, titled ON THE GEOTECHNICAL EXPLORATION CONDUCTED AT THE SITE OF THE EXISTING AGREMAX STORAGE PILE AT AES FACILITIES, GUAYAMA, PR. (Copy attached)

The results of the investigation reported herein indicate that the Agremax Storage Pile at the AES-PR Facilities in Guayama, PR, meets the requirements in the regulation Part 257 "Criteria for Classification of Solid Waste Disposal and Practices", Subpart D "Standard for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" of the code of Federal Regulations, also known as CFR Rule.

If you have any questions regarding this letter, please do not hesitate to contact CA at 512-358-7020.

Submitted by:

Ramón L. Carrasquillo, Ph.D., P.E.
President, Carrasquillo Associates, LTD

W/attachments

**CERTIFICATION**

The results of the investigation reported herein indicate that the Agremax Storage Pile at AES-PR meets the requirements of 40 CFR 257.64 (a). I certify that this document was prepared by me or under my supervision or direction and that I am a professional engineer under the laws of Puerto Rico.
Date: October 16, 2018

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

# *REPORT*

**ON THE GEOTECHNICAL EXPLORATION CONDUCTED AT THE SITE OF THE EXISTING AGREMAX STORAGE PILE, AES FACILIITES GUAYAMA, PR**

***Submitted to:***

*Ramon Carrasquillo, PhD*

Carrasquillo and Associates

***Prepared by:***

Carlos R. Sierra Del Llano MSCE, PE

***Date:***

October 15, 2018

***Job No. 7899 Rev A***

CARLOS SIERRA DEL LLANO
INGENIERO LICENCIADO
LIC.#18664
PUERTO RICO

# Table of Contents:




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JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

**GEOTECHNICAL REPORT**

**ON THE EXPLORATION PERFORMED**
**AT THE SITE OF THE AGREMAX STORAGE PILE**
**AT AES FACILITIES, GUAYAMA, PR**

## 1.0 INTRODUCTION:

*Jaca & Sierra Engineering, PSC* was contracted by *Carrasquillo Engineering Services Group* to perform site investigations in order to address the "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" as specified in Subpart D of the "Criteria for Classification of Solid Waste Disposal Facilities and Practices" of the Code of Federal Regulation, which is part of the federal regulations known as the CFR Rule.

The exploration program was directed to obtain subsurface soil information to evaluate unstable areas as specified in sections 257.64 of these Code of Regulations.

This geotechnical report has been prepared for the exclusive use of the owner, their architects, engineers and others involved in the evaluation of the "Criteria for Classification of Solid Waste Disposal Facilities and Practices".

## 2.0 SCOPE OF WORK:

### 2.1 Geotechnical Drilling:

The field exploration consisted of drilling *five (5)* borings located along the perimeter and within the Agremax storage pile. The borings were drilled to a depth of 25 to 60 ft below existing ground surface (B.E.G.S.). Boring locations are shown on Appendix A and Boring logs on Appendix B of this report.

In situ testing and soil sampling was achieved by means of the universally adopted Standard Penetration Test (SPT) and split spoon sampler method according to ASTM D 1586. Subsurface drilling was executed by means of the power auger method as per ASTM D 1452 using a CME-55 drill rig to drive a 2.25 inches I.D. helical auger into the ground.

Collected soil samples throughout the investigation were delivered to our laboratory to perform analyses of moisture content, unconfined compressive strength, and soil classifications. The data collected was eventually used to formulate the engineering recommendations provided in this report.

### 2.2 Laboratory Testing:

The following laboratory tests were performed to evaluate the requirements of sections 257.62 through 257.64 of the Code of Regulations:

- Consolidation tests (3);

- Triaxial test on remolded Aggremax sample (1);
- Direct Shear test (3);
- Modified Proctor Compaction test (3);
- and Soil Classifications (3).

## 3.0 Geotechnical Evaluation:

Per contracted scope of work, this geotechnical investigation is intended and limited to address section 257.64 of Subpart D of the "Criteria for Classification of Solid Waste Disposal Facilities and Practices" of the Code of Federal Regulations. This section states the following:

*"An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates…that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."*

Based on the above requirement, our evaluation is limited to the definition of unstable areas for the existing Agremax Storage Pile.

### 3.1 Unstable Areas:

The CFR rule definition of unstable area on section257.53 is quoted as follows:

*"Unstable area means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity, including structural components of some or all of the*

*CCR unit that are responsible for preventing releases from such unit. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains"*

The term poor foundation conditions is defined as follows:

*"Poor foundation conditions mean those areas where features exist which indicate that a natural or human-induced event may result in inadequate foundation support for the structural components of an existing or new CCR unit. For example, failure to maintain static and seismic factors of safety as required in §§257.73(e) and 257.74(e) would cause a poor foundation condition."*

Based on the above definitions, our report will address the following:

- On-site or local soil conditions that may result in significant differential settling;
- On-site or local geologic or geomorphologic features;
- On-site or local human-made features or events (both surface and subsurface).
- Slope stability and mass movements.

### 3.1.1 Total and Differential Settlements:

Three (3) exploratory borings were performed along the perimeter of the Agremax storage pile to uncover the subsurface soil stratigraphy beneath the unit. The borings revealed a medium-to-stiff fill layer composed of a mixture of Agremax and clayey soils

that extends to approximately 15 ft beneath existing ground surface. The fill layer is followed by a soft to medium clayey layer described as silty clay with some sand that extends to about 24 ft before transitioning to a medium-to-stiff clay.

A total of three (3) shelby tube undisturbed soil samples were retrieved from the clayey layer to perform tests that assisted in determining the magnitude of consolidation of the compressible soils. The undisturbed samples were obtained from Boring no.2 at 20-22 ft and from Boring no.3 at 14-16 ft and 24-26 ft.

Consolidation tests were performed on the undisturbed soil samples following ASTM D2435. To evaluate the differential settlement within the footprint area of the Agremax storage pile, the magnitude of settlement at the center of the deposit was compared to the magnitude of settlement at a corners. To consider the most critical scenario, the center of the area was assumed to have a soil profile similar to boring no.3 where soft to medium clay soils extend to about 49 ft, while the soil profile at the corner was assumed to be similar to Boring no.1 where the compressible soils extend to about 24 ft beneath existing ground surface.

With these assumptions the magnitude of total settlement at the center of the Agremax storage pile resulted in approximately 14 inches and the magnitude of settlement at the corner of the structure resulted in 5 inches, for a differential settlement of 9 inches. Considering a distance of 300 ft measured from the center of the storage pile

towards Boring no.1, a differential settlement of 9 inches results in an angular distortion of approximately 0.14 degrees (1:400). This magnitude of angular distortion can be considered as tolerable for this particular structure, over such the significant distance of 300 ft. Based on our observations during the site visit, there are no signs of significant displacements or cracks on the area of the stockpile.

In consideration of the above described analysis and observations it is our opinion that the facility is in compliance with 257.64 section for existing structures in what relates to settlement.

### 3.1.2 Geologic and Geomorphologic Features:

The site's near surface geology is mainly "Qf" deposit, which corresponds to alluvial fans. This alluvial deposit was encountered at about 14 ft below existing ground surface and continued throughout the final drilled depth of 60 ft. The deposit was mainly described as clayey silt with some sand and varied between soft to stiff consistency. A detailed description of the geological formation on site is included below, along with an illustration of the USGS geological map for the Central Aguirre quadrangle[1].

[1] Henry L. Berryhill, Jr. (1960) Geology Map of Central Aguirre, PR-Map I 318, U.S. Geological Survey, U.S. Department of Interior, Washington, D.C.


**Figure 1: USGS Geology Map - Central Aguirre Quadrangle**

- **Qf:** (Alluvial fans) – *"Unconsolidated stratified clay, silt, sand, gravel, cobbles ad boulders; cobbles and boulders mainly in the northern part of alluvial fans; clay, silt, and sand are predominant components of southern half to one-third of fans; areas high in salt, Qfs."*

This site does not have karst related geology or karst features as defined in the CFR rule. Also there are no existing geologic hazards such as landslide zones prone to mass movements or rock fall. The sites near surface geologic features, as described above, do not represent an unstable condition for the Agremax Storage Pile's perimeter.

### 3.1.3 Human-made Features or events:

Between the dates of site reconnaissance (September 6th, 2018) and conclusion of field work (September 11th, 2018) no human-made features could be identified on site that could represent an unstable condition or that possess a threat to the stability of the structure.

### 3.1.4 Slope Stability

The applicable CFR Rule for slope stability verification for the Agremax Storage pile is 257.73(e)- Structural integrity criteria for existing CCR surface impoundments; which requires the following:

*"(e) Periodic safety factor assessments. (1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions…"*

*"(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.*

*(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.*

*(iii) The calculated seismic factor of safety must equal or exceed 1.00."*

Slope stability was modeled with Slope w software for various critical profiles taken from the existing topography drawings prepared by Agrim. Julio C. Soto CSP, per

drawings dated Sept. 17, 2018, which are enclosed in this report. Data from the field and laboratory tests was incorporated into the model. In consideration of the cohesion that develops from cementing of particles that occurs from the Agremax installation process, the high friction angles and relatively light weight nature of the CCR material (max density ranging from 70 to 80 pcf), the slopes were found to have a Factor of Safety (FS) of over 1.5 for static condition and 1.1 for seismic. These FS values exceed requirements of CFR rule 257.73(e) and standard of practice for geotechnical engineering.

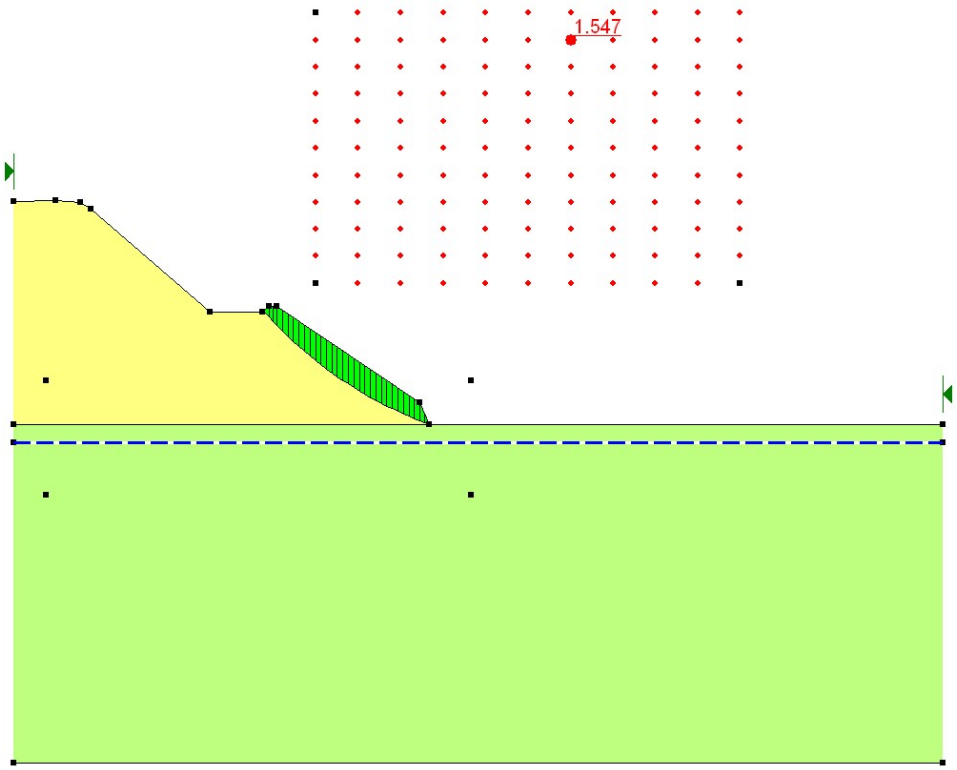


**Figure 2:** Static condition slope stability analysis.

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## 4.0 CONCLUSION:

Based on the herein presented findings and the requirements of section 257.64, it is our professional opinion that the existing Agremax Storage Pile is in compliance with the location restriction requirements of unstable areas, as described in 40 CFR subsections 257.64(a) and 257.64(b).

## 5.0 ADDITIONAL COMMENTS:

This report is based on our evaluation of the site conditions at the time of the engineer visits, field investigations and information made available to us at the time this report was prepared.

The herein given recommendations are based on test borings performed on spots, which are considered as representative of the subsoil conditions within the project site. It is our opinion that these investigation, laboratory testing and engineering assessment has been made in accordance to geotechnical standards of practice.

We wish to thank you for the opportunity of preparing this geotechnical engineering report.

Respectfully submitted,
**JACA & SIERRA ENGINEERING, PSC.**

*Carlos R. Sierra Del Llano, MSCE, PE*

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Testing Laboratories
Geotechnical Engineers

*Enclosures*

## REFERENCES

Henry L. Berryhill, Jr. (1960) Geology Map of Central Aguirre, PR-Map I 318, U.S. Geological Survey, U.S. Department of Interior, Washington, D.C.

## CERTIFICATION

The demonstration herein meets the requirements of 40 CFR 257.64 (a). I certify that this document was prepared by me or under my supervision and that I am a registered professional engineer under the laws of Puerto Rico.

Certified by: Carlos R. Sierra Del Llano, MSCE, PE

Date: 10-15-18

# Appendix A:

Boring Locations Plan





## PLANO DE LOCALIZACIÓN

ESCALA = 1 : 20,000

### NOTAS:

1 – LOS CONTROLES HORIZONTALES USADOS EN ESTE MAPA ESTÁN REFERIDOS A NAD83 (NA2011) EPOCH 2010.

2 – TODAS LAS DISTANCIAS ESTAN EN METRO A MENOS QUE SE INDIQUE LO CONTRARIO.

3 – EL TRABAJO FUE REALIZADO CON 4 UNIDADES TRIMBLE CON TECNOLOGÍA GPS.

4 – EL CONTROL VERTICAL ESTÁ REFERIDO A UN NIVEL ARBITRARIO PARA EL PROYECTO, NO ESTA REFERIDO A NINGÚN SISTEMA PREVIAMENTE ESTABLECIDO.

### LEYENDA:

- 5 — CONTORNO DE NIVEL A 1.00 METRO
- CONTORNOS DE NIVEL A 0.50 METRO
- B2 "BORING"
- CAMINO EN TIERRA
- MURO PEQUEÑO
- 4.75 ELEVACIONES

### CERTIFICACIÓN

JULIO C. SOTO SERRANO
Agrimensor Licencia num. 9633

| | |
|---|---|
| Dib. Cadd por: | JOA |
| Fecha : | 17 DE SEPT. DE 2018 |
| Escala : | 1:500 |
| Proy. Num. : | JCS1836F |
| Hoja Num. : | 1 de 1 |

# PLANO TOPOGRÁFICO DE DEPOSITO DE MATERIAL

EN LAS FACILIDADES DE

## AES PUERTO RICO, LP

BARRIO JOBOS, GUAYAMA, PUERTO RICO


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JCS
Servicios de Agrimensura
Agrimensor Lic. 9633
Avenida Emérito Estrada Rivera Num.1490
San Sebastián, Puerto Rico
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Puerto Rico 00685

# **Appendix** B:

## Boring Logs

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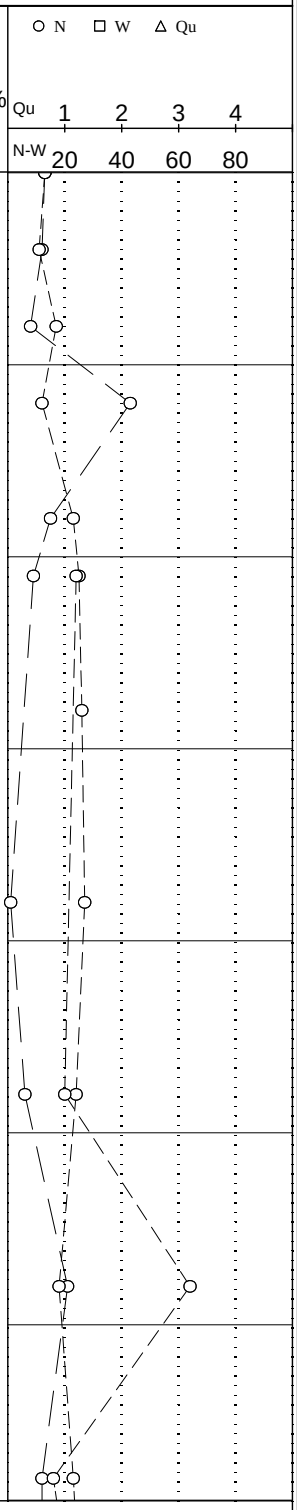
# SUBSURFACE EXPLORATION LOG

**BORING No.:** 1

| | | | |
|---|---|---|---|
| **PROJECT:** AES | | **JOB:** 7899 | **SHEET** 1 **OF** 2 |
| **LOCATION:** Guayama, PR | | **DRILLER/DRILL RIG:** Carlos I. Diaz / CME-55 | |
| **COORDINATES:** | | **DATE STARTED:** 9-10-18 | **DATE COMPLETED:** 9-10-18 |
| **DESCRIPTION BY:** Manuel Candelario | | **SURFACE ELEVATION (ft):** | |
| **GROUNDWATER (ft):** | **Initial:** 4 **Final:** 3.5 | **ENGINEER:** Manuel Candelario | |
| **DRILLING METHOD:** Hollow-Stem Auger 2.25" ID | | **TOTAL DEPTH (ft):** 50.5 | |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | | | | | | | | | | |
| 0.00 | 0 | FILL: clayey silt with sand some gravel, medium to stiff, yellowish brown | | S-1 | | 4<br>6<br>7 | 13 | 13 | | | |
| | | | | S-2 | | 6<br>6<br>6 | 12 | 11 | | | |
| | 5 | | | S-3 | | 4<br>4<br>4 | 8 | 17 | | | |
| -6.00 | | 6 | | | | | | | | | |
| | | FILL: gravel some clayey sand, dense, grayish brown | | S-4 | | 18<br>21<br>22 | 43 | 12 | | | |
| -10.00 | 10 | 10 | | S-5 | | 10<br>8<br>7 | 15 | 23 | | | |
| | | SILTY CLAY some sand, medium to stiff, grayish brown | | S-6 | | 3<br>4<br>5 | 9 | 25 | 1.2 | | |
| -14.00 | | 14 | | | | | | | | | |
| | 15 | SANDY CLAY, very soft, grayish brown | | S-7 | | WH<br>WH<br>WH | WH | 26 | | | |
| | 20 | | | S-8 | | WH<br>WH<br>1 | 1 | 27 | | | |
| -24.00 | | 24 | | | | | | | | | |
| | 25 | SILTY CLAY some sand, medium to stiff, yellowish brown, reddish brown | | S-9 | | WH<br>3<br>3 | 6 | 24 | 1.0 | | |
| | 30 | | | S-10 | | 5<br>10<br>11 | 21 | 18 | 3.2 | | |
| | | | | S-11 | | 3 | 12 | 23 | 0.8 | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
"Qu" - Unconfined Compressive Strength in tons per square foot.
"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
"WH" - Sample was recovered by advancing the sampler with the weight of the hammer.
"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

Initial G.W. Depth
Final G.W. Depth

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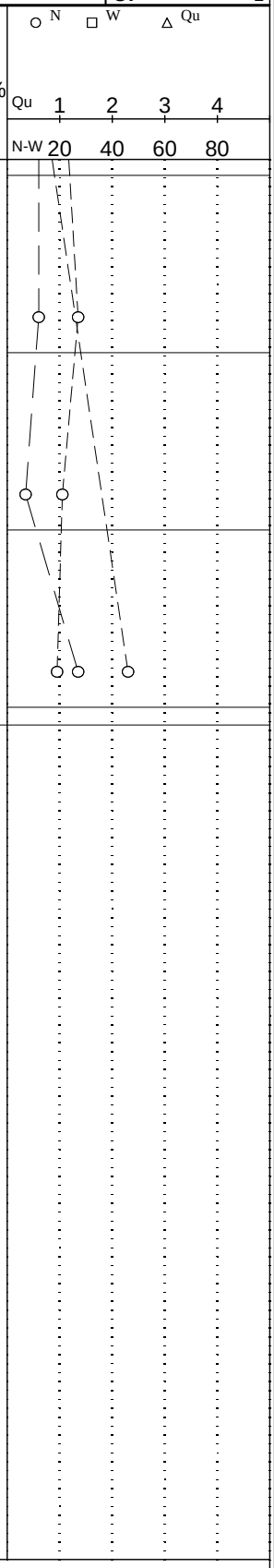
# SUBSURFACE EXPLORATION LOG

**BORING NUMBER: 1**

## BORING LOG (CONT. SHEET)

| PROJECT | JOB | SHEET | OF |
|---|---|---|---|
| AES | 7899 | 2 | 2 |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.00 | | | | | | | | | | |
| | 35 | | | | | 5<br>7 | | | | | |
| -39.00 | | 39 | | | | | | | | | |
| | 40 | CLAYEY SAND with gravel, loose to medium, very stiff, reddish brown, reddish yellow | | S-12 | | 3<br>6<br>6 | 12 | 27 | | | |
| | 45 | | | S-13 | | 3<br>3<br>4 | 7 | 21 | | | |
| -49.00 | | 49 | | | | | | | | | |
| | 50 | SILTY CLAY some sand trace gravel, very stiff, reddish brown, reddish yellow | | S-14 | | 6<br>11<br>16 | 27 | 19 | 2.3 | | |
| | 55 | | | | | | | | | | |
| | 60 | | | | | | | | | | |
| | 65 | | | | | | | | | | |
| | 70 | | | | | | | | | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
"Qu" - Unconfined Compressive Strength in tons per square foot.
"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
"WH" - Sample was recovered by advancing the sampler with the weight of the hammer.
"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

▽ Initial G.W. Depth
▼ Final G.W. Depth

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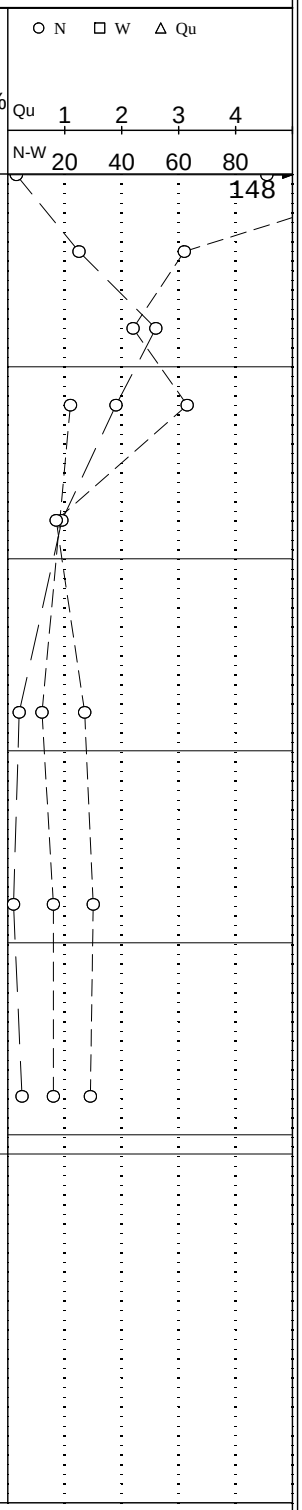
# SUBSURFACE EXPLORATION LOG

**BORING No.:** 2

| | | | |
|---|---|---|---|
| **PROJECT:** AES | | **JOB:** 7899 | **SHEET** 1 **OF** 1 |
| **LOCATION:** Guayama, PR | | **DRILLER/DRILL RIG:** Carlos I. Diaz / CME-55 | |
| **COORDINATES:** | | **DATE STARTED:** 9-8-18 | **DATE COMPLETED:** 9-8-18 |
| **DESCRIPTION BY:** Manuel Candelario | | **SURFACE ELEVATION (ft):** | |
| **GROUNDWATER (ft):** **Initial:** 10 **Final:** | | **ENGINEER:** Manuel Candelario | |
| **DRILLING METHOD:** Hollow-Stem Auger 2.25" ID | | **TOTAL DEPTH (ft):** 25.5 | |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | | | | | | | | | | |
| | 0 | Aggremax 0 | | S-1 | | 1 1 2 | 3 | 148 | | | |
| | | | | S-2 | | 3 11 14 | 25 | 62 | | | |
| | 5 | | | S-3 | | 13 28 24 | 52 | 44 | | | |
| | | | | S-4 | | 18 18 20 | 38 | 63 | 1.1 | | |
| | 10 ▽ | CLAYEY SILT with sand mixed with aggremax, very stiff, yellowish brown, reddish brown | | S-5 | | 8 10 9 | 19 | 17 | | | |
| -14.00 | | 14 | | | | | | | | | |
| | 15 | SILTY CLAY some sand, soft to medium, yellowish brown, brownish gray | | S-6 | | 2 1 3 | 4 | 27 | 0.6 | | |
| | 20 | | | S-7 | | WH WH 2 | 2 | 30 | 0.8 | | |
| | 25 | | | S-8 | | 1 2 3 | 5 | 29 | 0.8 | | |
| | 30 | | | | | | | | | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
"Qu" - Unconfined Compressive Strength in tons per square foot.
▽ Initial G.W. Depth
▼ Final G.W. Depth
"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
"WH" - Sample was recovered by advancing the sampler with the weight of the hammer.
"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

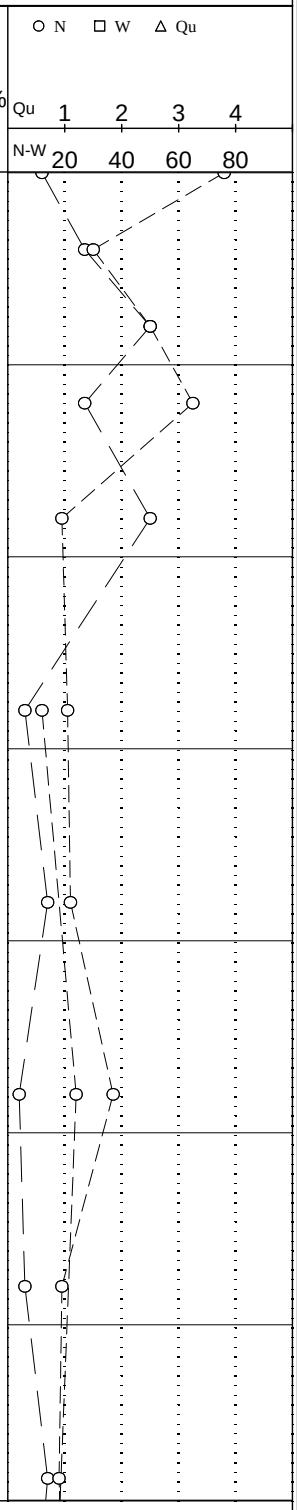
JACA & SIERRA Testing Laboratories Geotechnical Engineers

# SUBSURFACE EXPLORATION LOG

**BORING No.:** 3

| | | | |
|---|---|---|---|
| **PROJECT:** AES | | **JOB:** 7899 | **SHEET** 1 **OF** 2 |
| **LOCATION:** Guayama, PR | | **DRILLER/DRILL RIG:** Carlos I. Diaz / CME-55 | |
| **COORDINATES:** | | **DATE STARTED:** 9-7-18 | **DATE COMPLETED:** 9-7-18 |
| **DESCRIPTION BY:** Manuel Candelario | | **SURFACE ELEVATION (ft):** | |
| **GROUNDWATER (ft):** | **Initial:** 7.5 **Final:** | **ENGINEER:** Manuel Candelario | |
| **DRILLING METHOD:** Hollow-Stem Auger 2.25" ID | | **TOTAL DEPTH (ft):** 60.5 | |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | | | | | | | | | | |
| | 0 | FILL: clayey silt with sand trace gravel, stiff to very stiff, grayish brown | | S-1 | | 4 6 6 | 12 | 76 | | | |
| | | | | S-2 | | 10 11 16 | 27 | 30 | | | |
| -4.00 | 4 | | | | | | | | | | |
| | 5 | Aggremax | | S-3 | | 9 50 | 50 | 50 | | | |
| | | | | S-4 | | 23 16 11 | 27 | 65 | | | |
| | 10 | | | S-5 | | 12 50/2" | 50/2" | 19 | | | |
| -14.00 | 14 | | | | | | | | | | |
| | 15 | SILTY CLAY some sand, medium, grayish brown | | S-6 | | 3 3 3 | 6 | 21 | 0.6 | | |
| -19.00 | 19 | | | | | | | | | | |
| | 20 | SAND some silt trace gravel, medium, gray | | S-7 | | 4 6 8 | 14 | 22 | | | |
| -24.00 | 24 | | | | | | | | | | |
| | 25 | SILTY CLAY some sand, soft to medium, brownish gray | | S-8 | | 2 2 2 | 4 | 37 | 1.2 | | |
| | | | | S-9 | | 2 2 4 | 6 | 19 | | | |
| | 30 | | | | | | | | | | |
| | | Do... stiff, yellowish brown | | S-10 | | 3 | 14 | 18 | | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
"Qu" - Unconfined Compressive Strength in tons per square foot.
"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
"WH" - Sample was recovered by advancing the sampler with the weight of the hammer.
"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

Initial G.W. Depth
Final G.W. Depth

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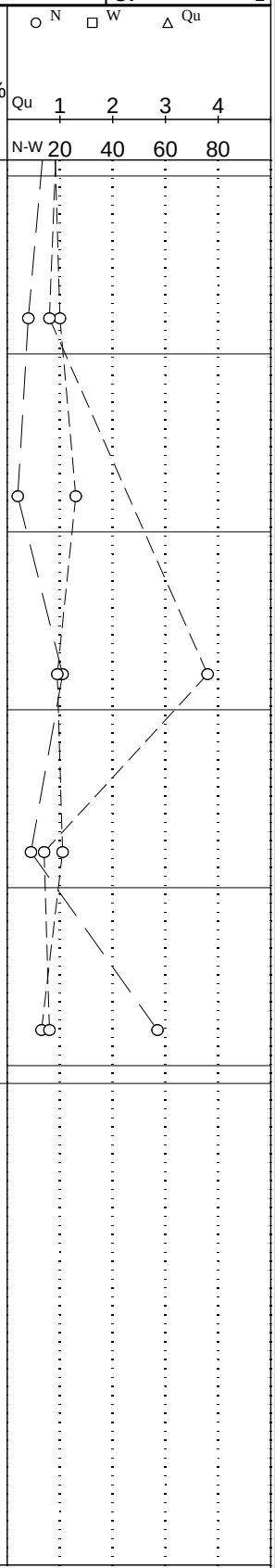
# SUBSURFACE EXPLORATION LOG

**BORING NUMBER: 3**

## BORING LOG (CONT. SHEET)

| PROJECT | JOB | SHEET | OF |
|---|---|---|---|
| AES | 7899 | 2 | 2 |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.00 | | | | | | | | | | |
| | 35 | | | | | 6<br>8 | | | | | |
| | 40 | Do... some sand, soft to medium, yellowishbrown, reddish brown | | S-11 | | 3<br>3<br>5 | 8 | 20 | 0.8 | | |
| | 45 | | | S-12 | | WH<br>2<br>2 | 4 | 26 | | | |
| | 50 | Do... stiff to hard yellowish brown | | S-13 | | 6<br>7<br>14 | 21 | 19 | 3.8 | | |
| | 55 | | | S-14 | | 3<br>3<br>6 | 9 | 21 | 0.7 | | |
| | 60 | | | S-15 | | 22<br>28<br>29 | 57 | 13 | 0.8 | | |
| | 65 | | | | | | | | | | |
| | 70 | | | | | | | | | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
"Qu" - Unconfined Compressive Strength in tons per square foot.
"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
"WH" - Sample was recovered by advancing the sampler with the weight of the hammer.
"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

▽ Initial G.W. Depth
▼ Final G.W. Depth

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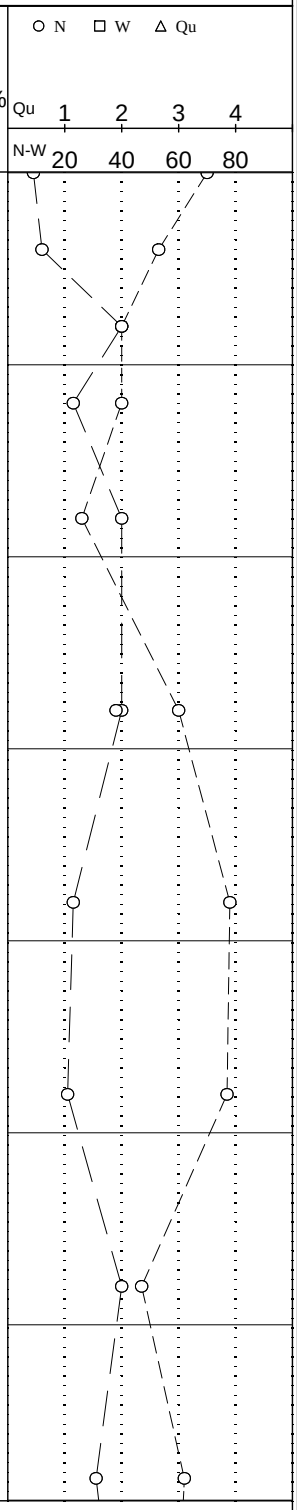
# SUBSURFACE EXPLORATION LOG

**BORING No.:** 4

| | | | |
|---|---|---|---|
| **PROJECT:** AES | | **JOB:** 7899 | **SHEET** 1 **OF** 2 |
| **LOCATION:** Guayama, PR | | **DRILLER/DRILL RIG:** Carlos I. Diaz / CME-55 | |
| **COORDINATES:** | | **DATE STARTED:** 9-11-18 | **DATE COMPLETED:** 9-11-18 |
| **DESCRIPTION BY:** Manuel Candelario | | **SURFACE ELEVATION (ft):** | |
| **GROUNDWATER (ft):** **Initial:** Not Found **Final:** | | **ENGINEER:** Manuel Candelario | |
| **DRILLING METHOD:** Hollow-Stem Auger 2.25" ID | | **TOTAL DEPTH (ft):** 50.5 | |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | | | | | | | | | | |
| | 0 | Aggremax 0 | | S-1 | | 3<br>5<br>4 | 9 | 70 | | | |
| | | | | S-2 | | 3<br>4<br>8 | 12 | 53 | | | |
| | 5 | | | S-3 | | 7<br>25<br>40/2" | 40/2" | 40 | | | |
| | | | | S-4 | | 9<br>14<br>9 | 23 | 40 | | | |
| | 10 | | | S-5 | | 34<br>40/1" | 40/1" | 26 | | | |
| | | | | S-6 | | 22<br>16<br>40/4" | 40/4" | 60 | 1.9 | | |
| | 15 | | | | | | | | | | |
| | | | | S-7 | | 4<br>8<br>15 | 23 | 78 | | | |
| | 20 | | | | | | | | | | |
| | | | | S-8 | | 5<br>8<br>13 | 21 | 77 | | | |
| | 25 | | | | | | | | | | |
| | | | | S-9 | | 28<br>40/2" | 40/2" | 47 | | | |
| | 30 | | | | | | | | | | |
| | | | | S-10 | | 7 | 31 | 62 | | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
"Qu" - Unconfined Compressive Strength in tons per square foot.
"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
"WH" - Sample was recovered by advancing the sampler with the weight of the hammer.
"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

▽ Initial G.W. Depth
▼ Final G.W. Depth

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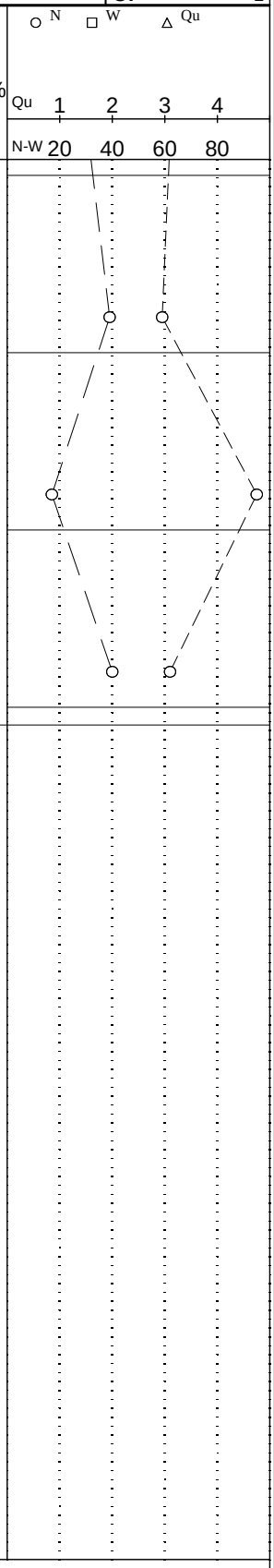
# SUBSURFACE EXPLORATION LOG

**BORING NUMBER: 4**

## BORING LOG (CONT. SHEET)

| PROJECT | JOB | SHEET | OF |
|---|---|---|---|
| AES | 7899 | 2 | 2 |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.00 | | | | | | | | | | |
| | 35 | | | | | 12<br>19 | | | | | |
| | | | | S-11 | | 8<br>16<br>23 | 39 | 59 | | | |
| | 40 | | | | | | | | | | |
| | | | | S-12 | | 4<br>4<br>13 | 17 | 95 | | | |
| | 45 | | | | | | | | | | |
| | | | | S-13 | | 7<br>27<br>40/2" | 40/2" | 62 | | | |
| | 50 | | | | | | | | | | |
| | 55 | | | | | | | | | | |
| | 60 | | | | | | | | | | |
| | 65 | | | | | | | | | | |
| | 70 | | | | | | | | | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
"Qu" - Unconfined Compressive Strength in tons per square foot.
"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
"WH" - Sample was recovered by advancing the sampler with the weight of the hammer.
"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

▽ Initial G.W. Depth
▼ Final G.W. Depth

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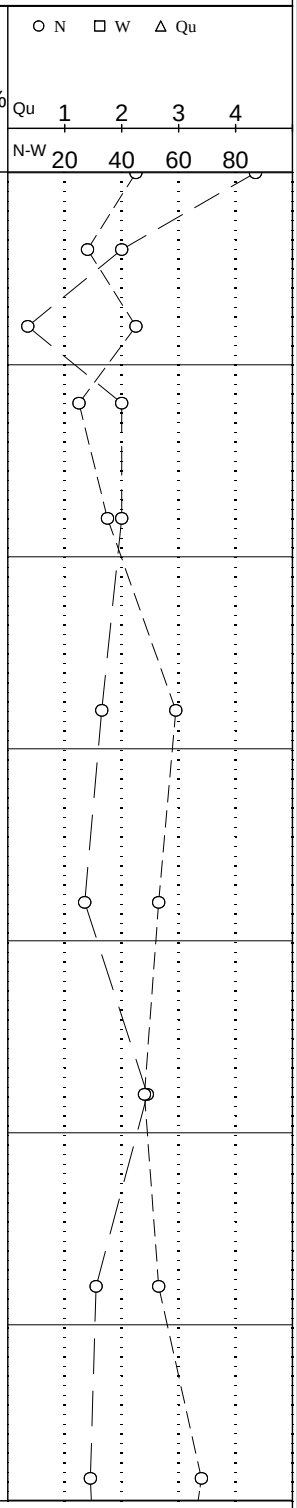
# SUBSURFACE EXPLORATION LOG

**BORING No.:** 5

| | | | |
|---|---|---|---|
| **PROJECT:** AES | | **JOB:** 7899 | **SHEET** 1 **OF** 2 |
| **LOCATION:** Guayama, PR | | **DRILLER/DRILL RIG:** Carlos I. Diaz / CME-55 | |
| **COORDINATES:** | | **DATE STARTED:** 9-11-18 | **DATE COMPLETED:** 9-11-18 |
| **DESCRIPTION BY:** Manuel Candelario | | **SURFACE ELEVATION (ft):** | |
| **GROUNDWATER (ft):** **Initial:** Not Found **Final:** | | **ENGINEER:** Manuel Candelario | |
| **DRILLING METHOD:** Hollow-Stem Auger 2.25" ID | | **TOTAL DEPTH (ft):** 50.5 | |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | | | | | | | | | | |
| | 0 | Aggremax 0 | | S-1 | | 8<br>42<br>45 | 87 | 45 | | | |
| | | | | S-2 | | 40/3" | 40/3" | 28 | | | |
| | 5 | | | S-3 | | 3<br>3<br>4 | 7 | 45 | | | |
| | | | | S-4 | | 40/5" | 40/5" | 25 | | | |
| | 10 | | | S-5 | | 33<br>40/2" | 40/2" | 35 | | | |
| | 15 | | | S-6 | | 8<br>12<br>21 | 33 | 59 | | | |
| | 20 | | | S-7 | | 5<br>7<br>20 | 27 | 53 | | | |
| | 25 | | | S-8 | | 6<br>12<br>37 | 49 | 48 | | | |
| | 30 | | | S-9 | | 16<br>16<br>15 | 31 | 53 | | | |
| | | | | S-10 | | 12 | 29 | 68 | | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
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"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
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"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

▽ Initial G.W. Depth
▼ Final G.W. Depth

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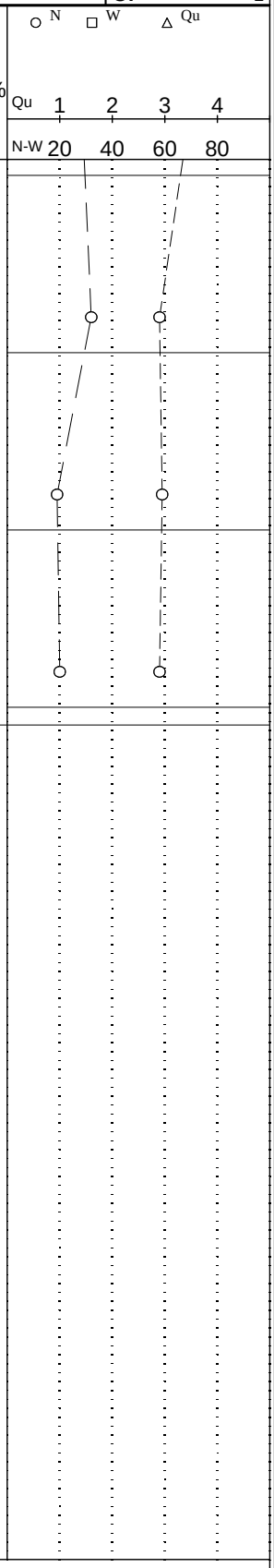
# SUBSURFACE EXPLORATION LOG

**BORING NUMBER: 5**

## BORING LOG (CONT. SHEET)

| PROJECT | JOB | SHEET | OF |
|---|---|---|---|
| AES | 7899 | 2 | 2 |

| ELEV (ft) | DEPTH (ft) | DESCRIPTION | LEGEND | SAMPLE NO. | TYPE | BLOWS | SPT N | W | Qu | RC | RQD% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.00 | | | | | | | | | | |
| | 35 | | | | | 15<br>14 | | | | | |
| | | | | S-11 | | 8<br>13<br>19 | 32 | 58 | | | |
| | 40 | | | | | | | | | | |
| | | | | S-12 | | 5<br>7<br>12 | 19 | 59 | | | |
| | 45 | | | | | | | | | | |
| | | | | S-13 | | 6<br>8<br>12 | 20 | 58 | | | |
| | 50 | | | | | | | | | | |
| | 55 | | | | | | | | | | |
| | 60 | | | | | | | | | | |
| | 65 | | | | | | | | | | |
| | 70 | | | | | | | | | | |




"N" - Number of blows required to drive the sampling spoon a distance of 12 in. with a 140 lbs hammer falling 30 in.
"W" - Natural Moisture Content in percentage of dry weight.
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"Rc" - Core recovery in percent for each successive run. "RQD" - Rock quality designation.
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"P" - A "P" in the Unconfined Compressive Strength test indicates the use of the pocket Penetrometer.

▽ Initial G.W. Depth
▼ Final G.W. Depth

# Appendix C:

## Laboratory Test Results

# Particle Size Distribution Report


| % COBBLES | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 0.0 | 38.3 | 61.7 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| #4 | 100.0 | | |
| #10 | 100.0 | | |
| #40 | 88.0 | | |
| #100 | 69.3 | | |
| #200 | 61.7 | | |

* (no specification provided)

**Material Description**

Sandy silt.
Aggremax Grab

**Atterberg Limits**

PL= NP LL= NP PI= NP

**Coefficients**

$D_{85}$= 0.355 $D_{60}$= $D_{50}$=
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= ML AASHTO= A-4(0)

**Remarks**

Tested by: L. Medina
Checked by: Manuel Candelario Cosme, MSCE, PE

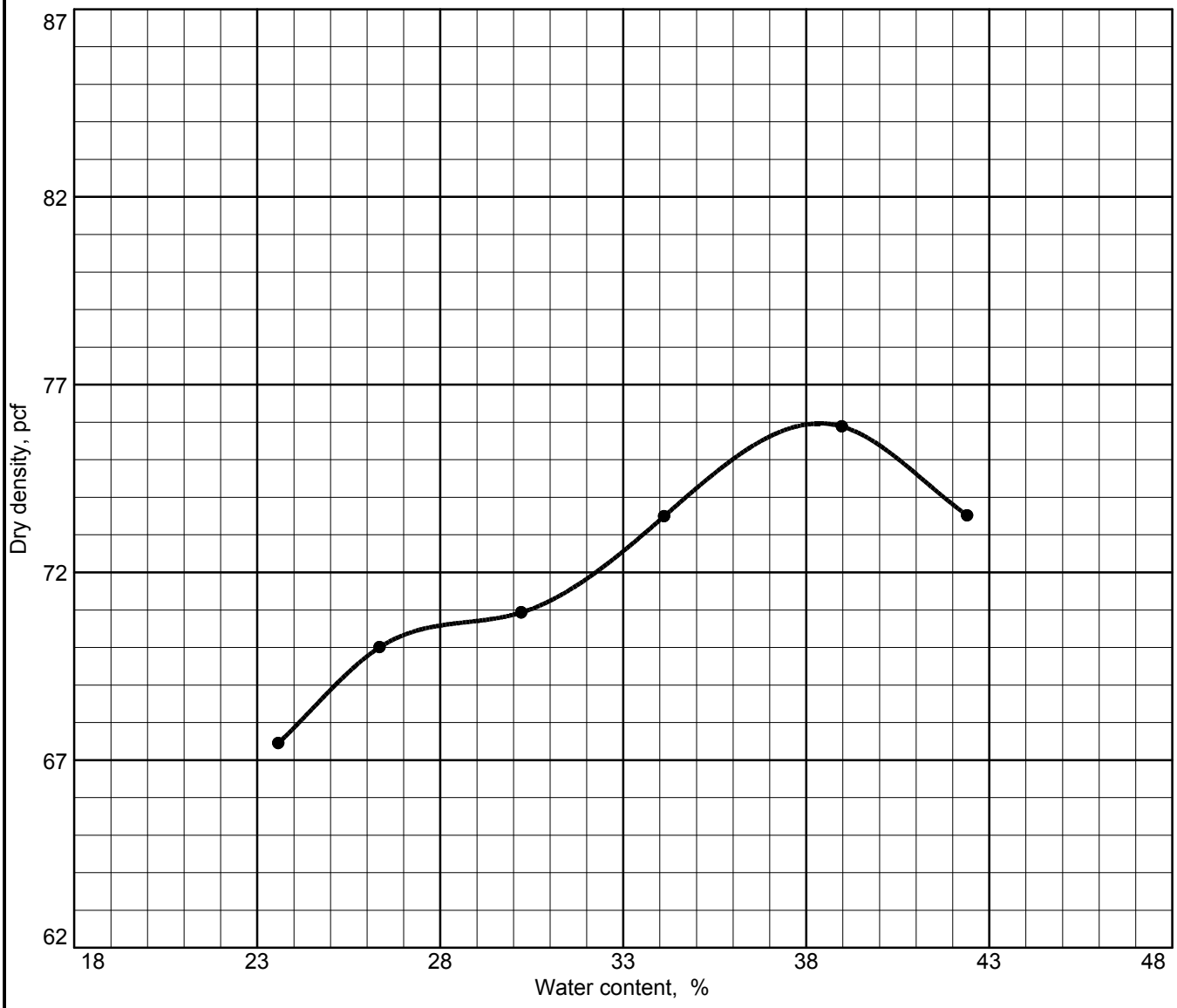
**Sample No.:** Bo. 1 **Source of Sample:** Project Site **Date:** 9/10/18
**Location:** Guayama, PR Source Sample: Project Site **Elev./Depth:**

**JACA & SIERRA TESTING LABORATORIES**
**San Juan, Puerto Rico**

**Client:** Carrasquillo Engineering Services
**Project:** CDR Landfill at AES, Guayama, PR

**Project No:** 7899 **Figure**

# COMPACTION TEST REPORT




Test specification: ASTM D 1557-00 Method C Modified

| Elev/ Depth | Classification | | Nat. Moist. | Sp.G. | LL | PI | % > 3/4 in. | % < No.200 |
|---|---|---|---|---|---|---|---|---|
| | USCS | AASHTO | | | | | | |
| | ML | A-4(0) | | | NP | NP | 0.0 | 61.7 |

| TEST RESULTS | MATERIAL DESCRIPTION |
|---|---|
| Maximum dry density = 76.0 pcf<br>Optimum moisture = 38.4 % | Sandy silt.<br>Aggremax Grab |

**Project No.** 7899 **Client:** Carrasquillo Engineering Services

**Project:** CDR Landfill at AES, Guayama, PR

**Date:** 9/7/18

● **Location:** Guayama, PR Source Sample: Project Site

**JACA & SIERRA TESTING LABORATORIES**

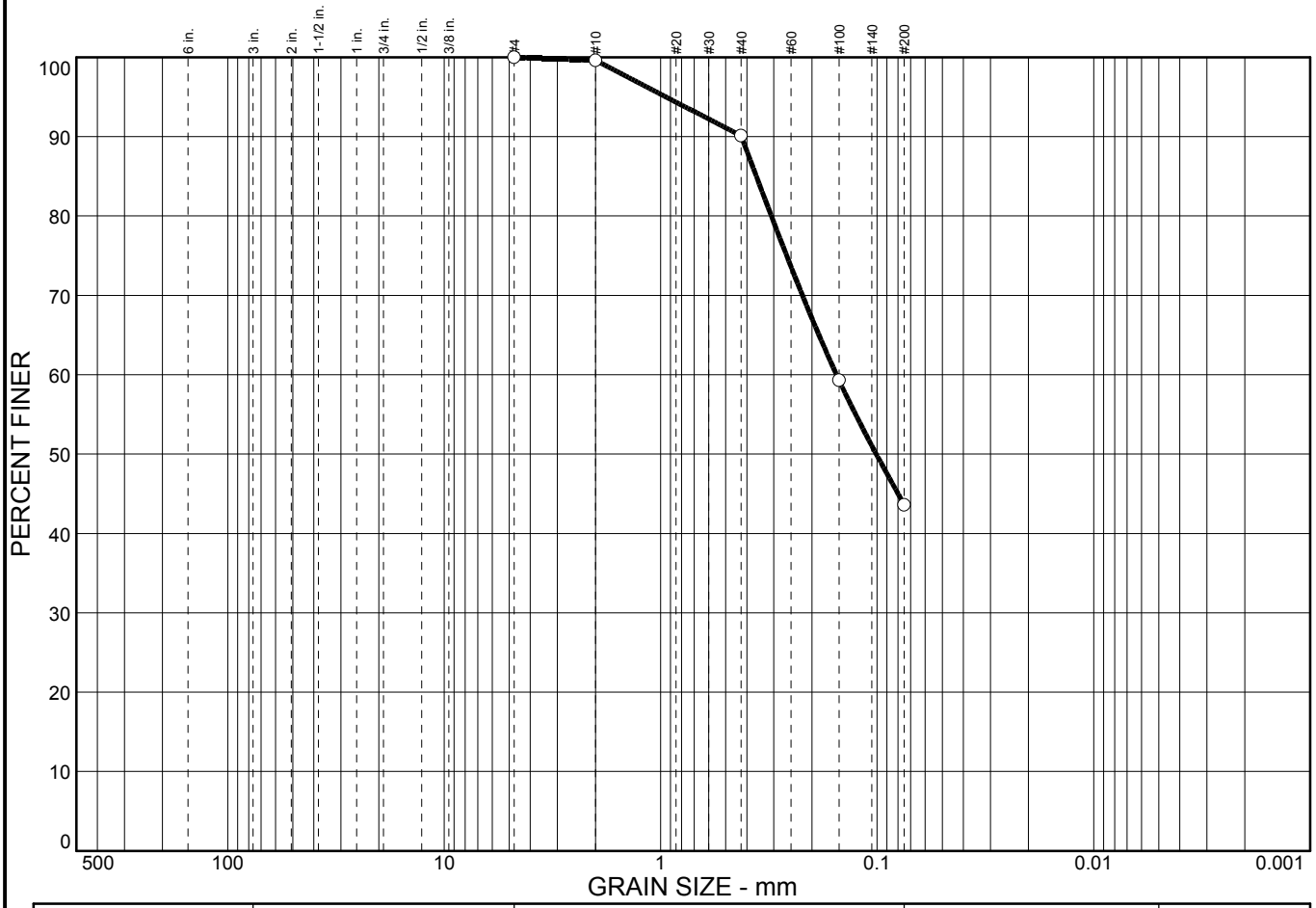
**San Juan, Puerto Rico**

**Remarks:**

Tested by: F. Santos
Checked by: Rommel Cintron Aponte, MSCE, PE
Job No.: 7899

**Figure**

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 0.0 | 56.4 | 43.6 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| #4 | 100.0 | | |
| #10 | 99.6 | | |
| #40 | 90.1 | | |
| #100 | 59.3 | | |
| #200 | 43.6 | | |

* (no specification provided)

**Material Description**

Clayey sand.

**Atterberg Limits**

PL= 17 LL= 27 PI= 10

**Coefficients**

$D_{85}$= 0.362 $D_{60}$= 0.154 $D_{50}$= 0.101
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= SC AASHTO= A-4(1)

**Remarks**

Tested by: L. Medina
Checked by: Manuel Candelario Cosme, MSCE, PE

**Sample No.:** Bo. 2 **Source of Sample:** Project Site **Date:** 9/11/18
**Location:** Guayama, PR **Elev./Depth:** 20-22'

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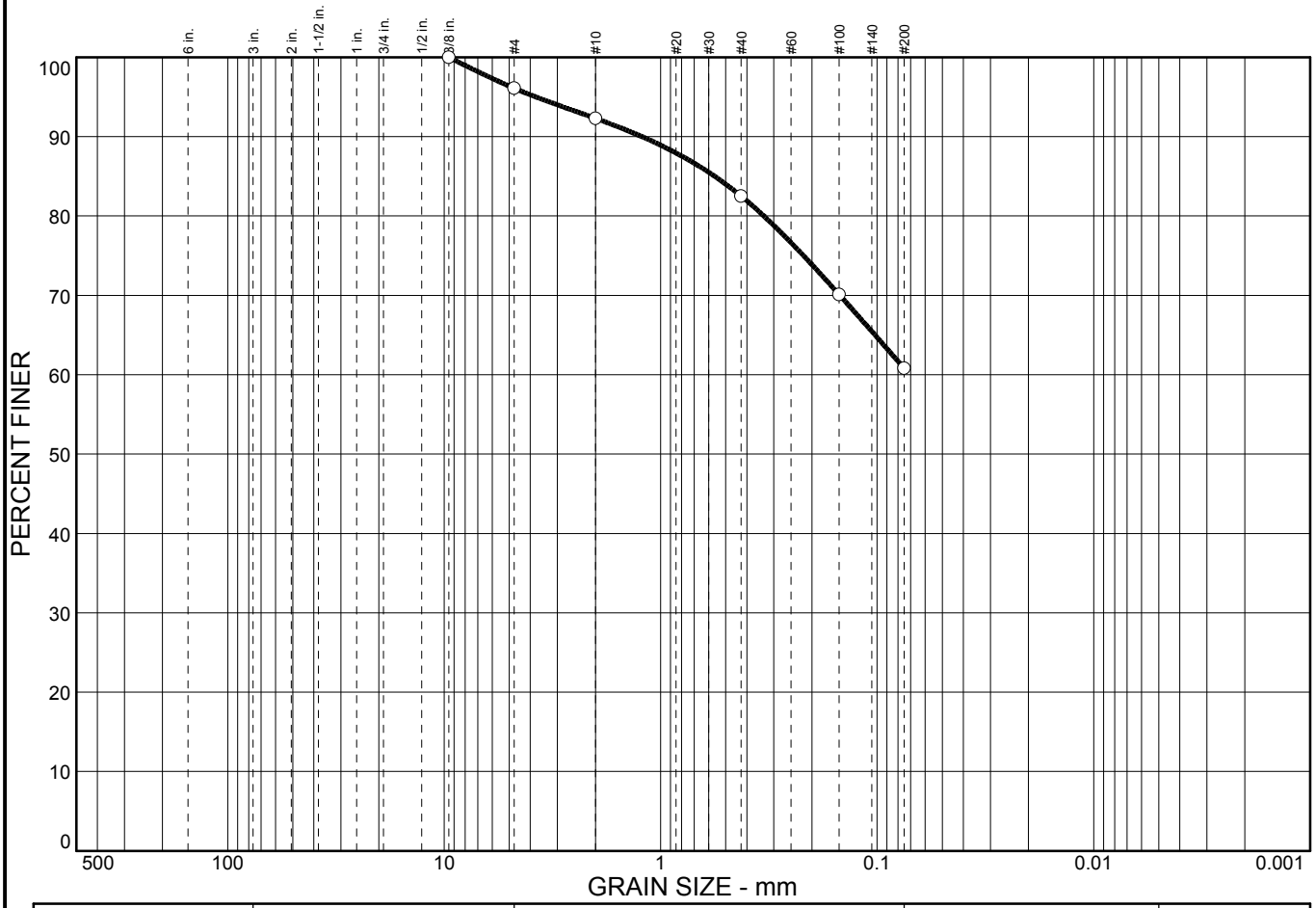
**San Juan, Puerto Rico**

**Client:** Carrasquillo Engineering Services
**Project:** CDR Landfill at AES, Guayama, PR

**Project No:** 7899 **Figure**

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 3.9 | 35.3 | 60.8 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| .375 in. | 100.0 | | |
| #4 | 96.1 | | |
| #10 | 92.3 | | |
| #40 | 82.5 | | |
| #100 | 70.1 | | |
| #200 | 60.8 | | |

* (no specification provided)

**Material Description**

Sandy lean clay.

**Atterberg Limits**

PL= 16 LL= 32 PI= 16

**Coefficients**

$D_{85}$= 0.563 $D_{60}$= $D_{50}$=
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= CL AASHTO= A-6(7)

**Remarks**

Tested by: A. Perez
Checked by: Manuel Candelario Cosme, MSCE, PE

**Sample No.:** Bo. 3 **Source of Sample:** Project Site **Date:** 9/17/18
**Location:** Guayama, PR **Elev./Depth:** 14-16'

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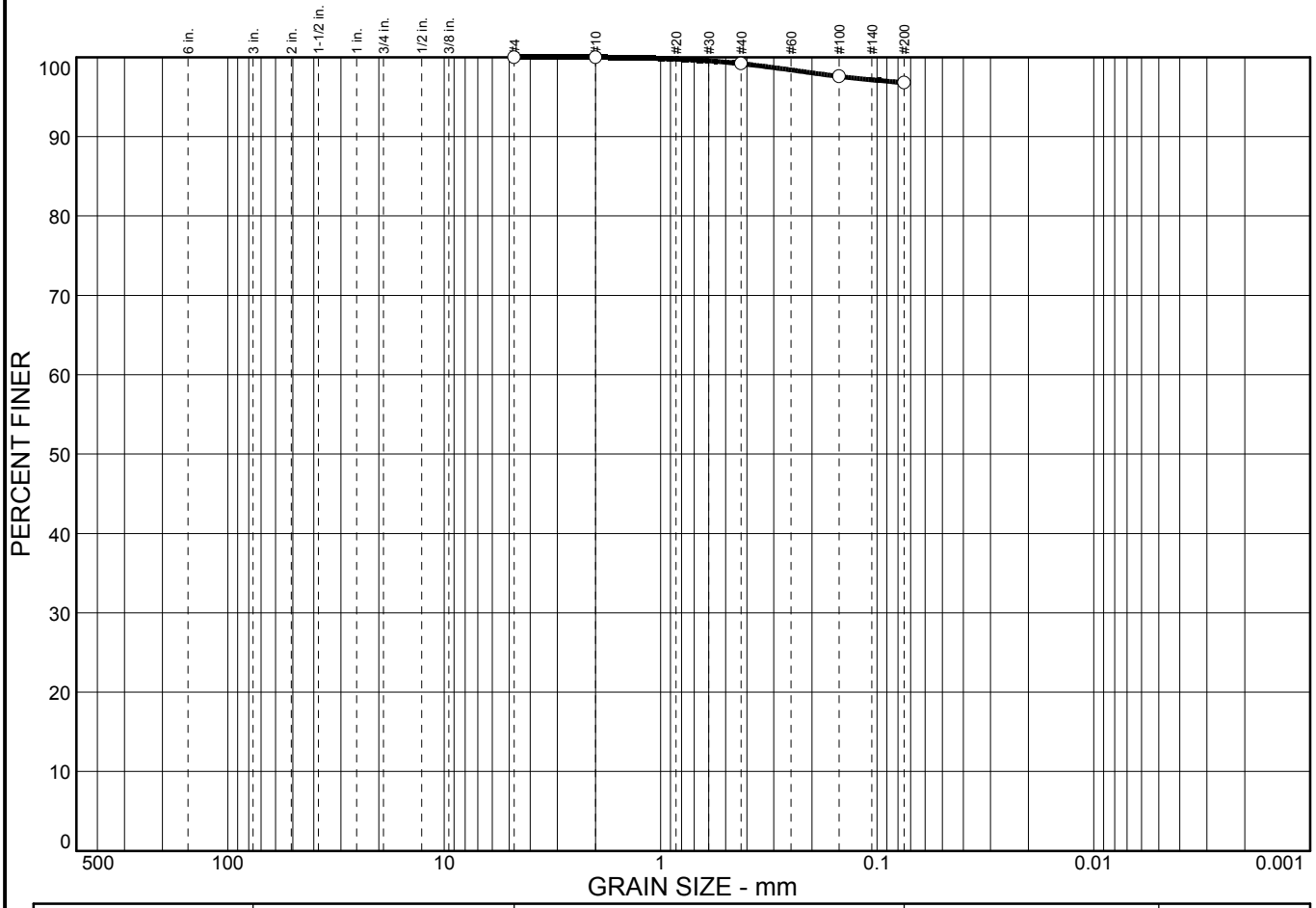
**San Juan, Puerto Rico**

**Client:** Carrasquillo Engineering Services
**Project:** CDR Landfill at AES, Guayama, PR

**Project No:** 7899 **Figure**

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 0.0 | 3.2 | 96.8 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| #4 | 100.0 | | |
| #10 | 100.0 | | |
| #40 | 99.2 | | |
| #100 | 97.6 | | |
| #200 | 96.8 | | |

* (no specification provided)

**Material Description**

Fat clay.

**Atterberg Limits**

PL= 26 LL= 57 PI= 31

**Coefficients**

$D_{85}$= $D_{60}$= $D_{50}$=
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= CH AASHTO= A-7-6(35)

**Remarks**

Tested by: A. Perez
Checked by: Manuel Candelario Cosme, MSCE, PE

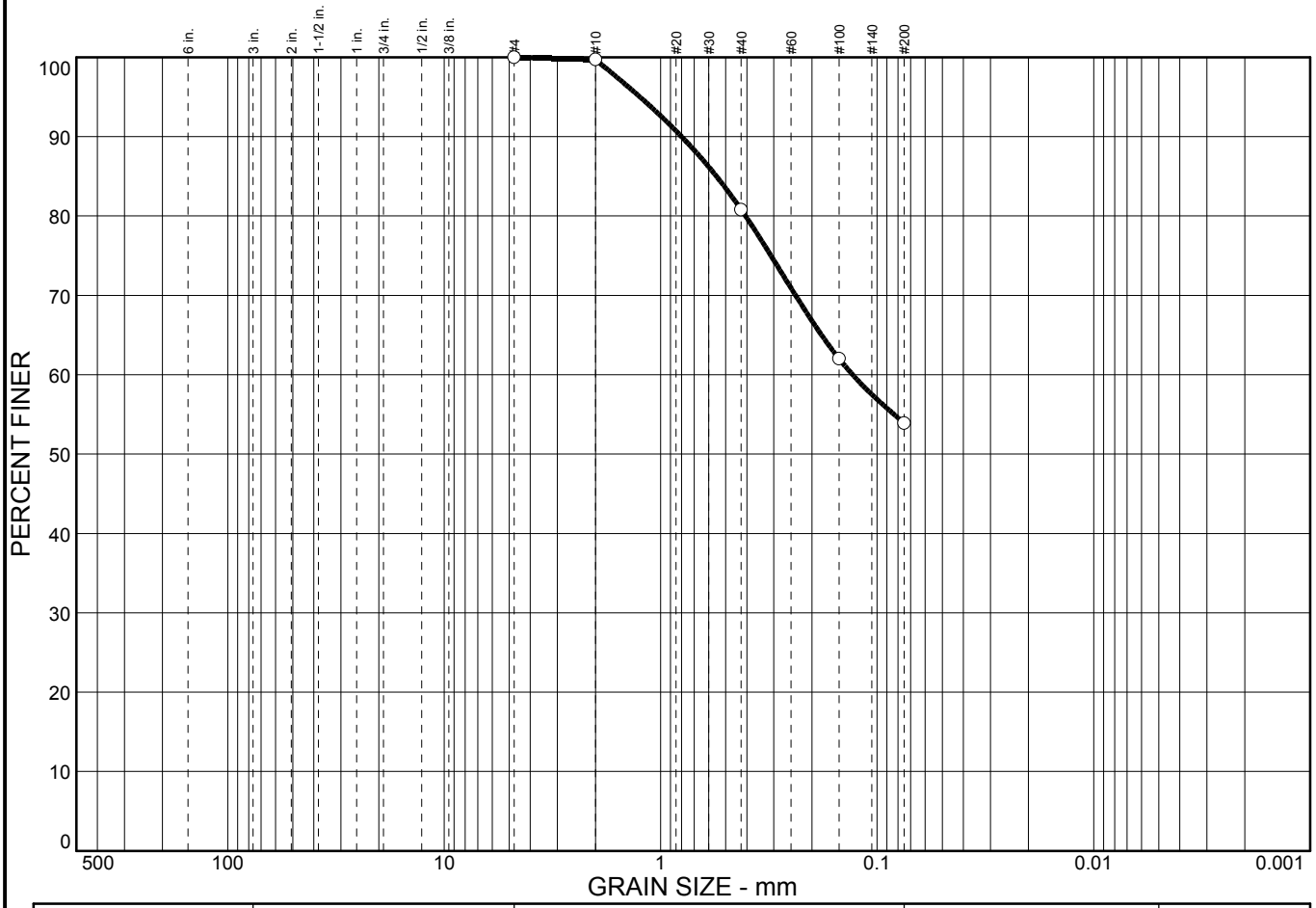
**Sample No.:** Bo. 3 **Source of Sample:** Project Site **Date:** 9/17/18
**Location:** Guayama, PR **Elev./Depth:** 24-26'

**JACA & SIERRA TESTING LABORATORIES**
**San Juan, Puerto Rico**

**Client:** Carrasquillo Engineering Services
**Project:** CDR Landfill at AES, Guayama, PR

**Project No:** 7899 **Figure**

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 0.0 | 46.1 | 53.9 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| #4 | 100.0 | | |
| #10 | 99.7 | | |
| #40 | 80.8 | | |
| #100 | 62.0 | | |
| #200 | 53.9 | | |

* (no specification provided)

**Material Description**

Sandy silt.
Aggremax Grab

**Atterberg Limits**

PL= NP LL= NP PI= NP

**Coefficients**

$D_{85}$= 0.553 $D_{60}$= 0.130 $D_{50}$=
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= ML AASHTO= A-4(0)

**Remarks**

Tested by: L. Medina
Checked by: Manuel Candelario Cosme, MSCE, PE

**Sample No.:** Bo. 4 **Source of Sample:** Project Site **Date:** 9/10/18
**Location:** Guayama, PR Source Sample: Project Site **Elev./Depth:**

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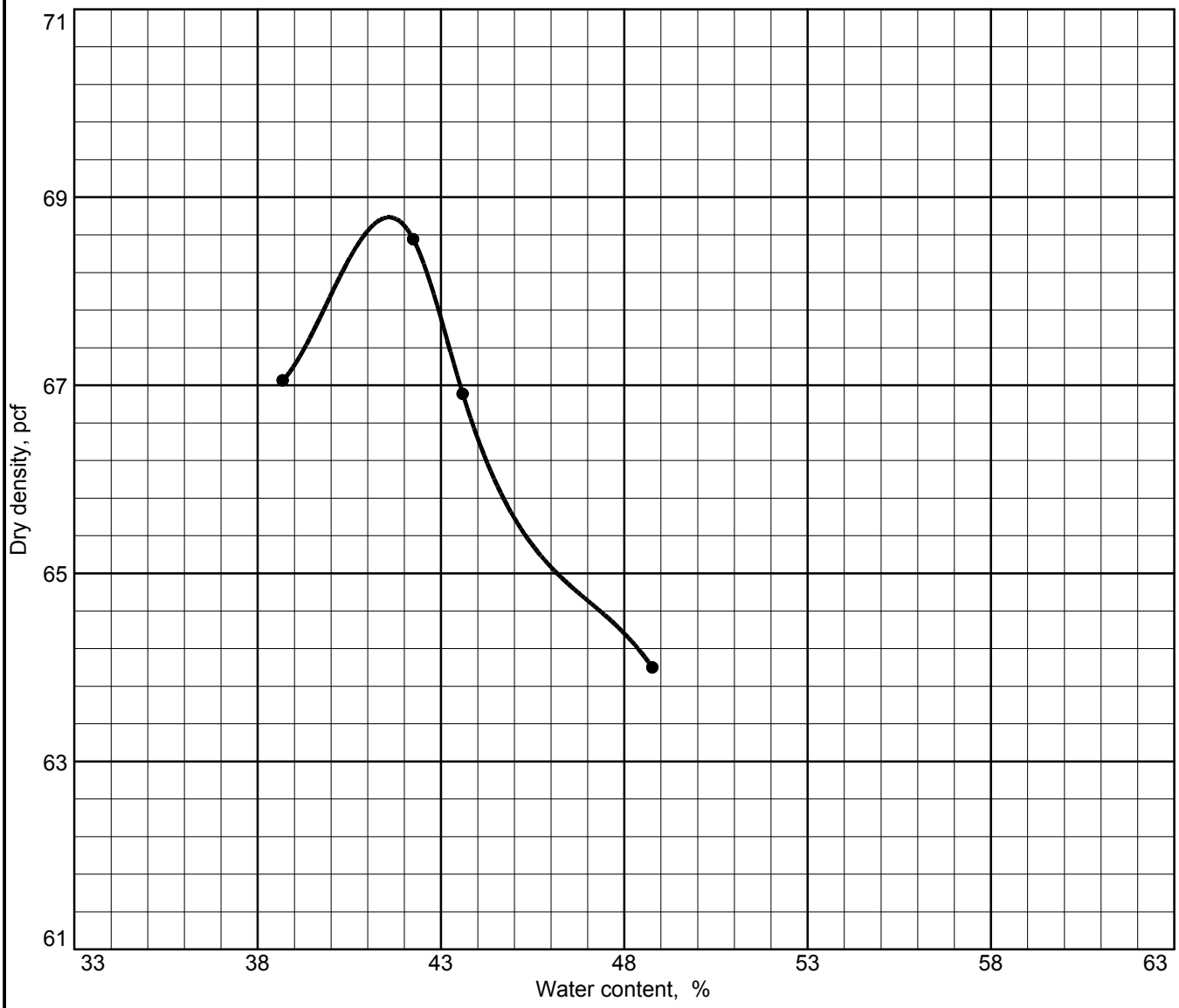
**San Juan, Puerto Rico**

**Client:** Carrasquillo Engineering Services
**Project:** CDR Landfill at AES, Guayama, PR

**Project No:** 7899 **Figure**

# COMPACTION TEST REPORT




Test specification: ASTM D 1557-00 Method C Modified

| Elev/ Depth | Classification | | Nat. Moist. | Sp.G. | LL | PI | % > 3/4 in. | % < No.200 |
|---|---|---|---|---|---|---|---|---|
| | USCS | AASHTO | | | | | | |
| | ML | A-4(0) | | | NP | NP | 0.0 | 53.9 |

| TEST RESULTS | MATERIAL DESCRIPTION |
|---|---|
| Maximum dry density = 68.8 pcf<br>Optimum moisture = 41.6 % | Sandy silt.<br>Aggremax Grab |

**Project No.** 7899 **Client:** Carrasquillo Engineering Services

**Project:** CDR Landfill at AES, Guayama, PR

**Date:** 9/7/18

● **Location:** Guayama, PR Source Sample: Project Site

**JACA & SIERRA TESTING LABORATORIES**

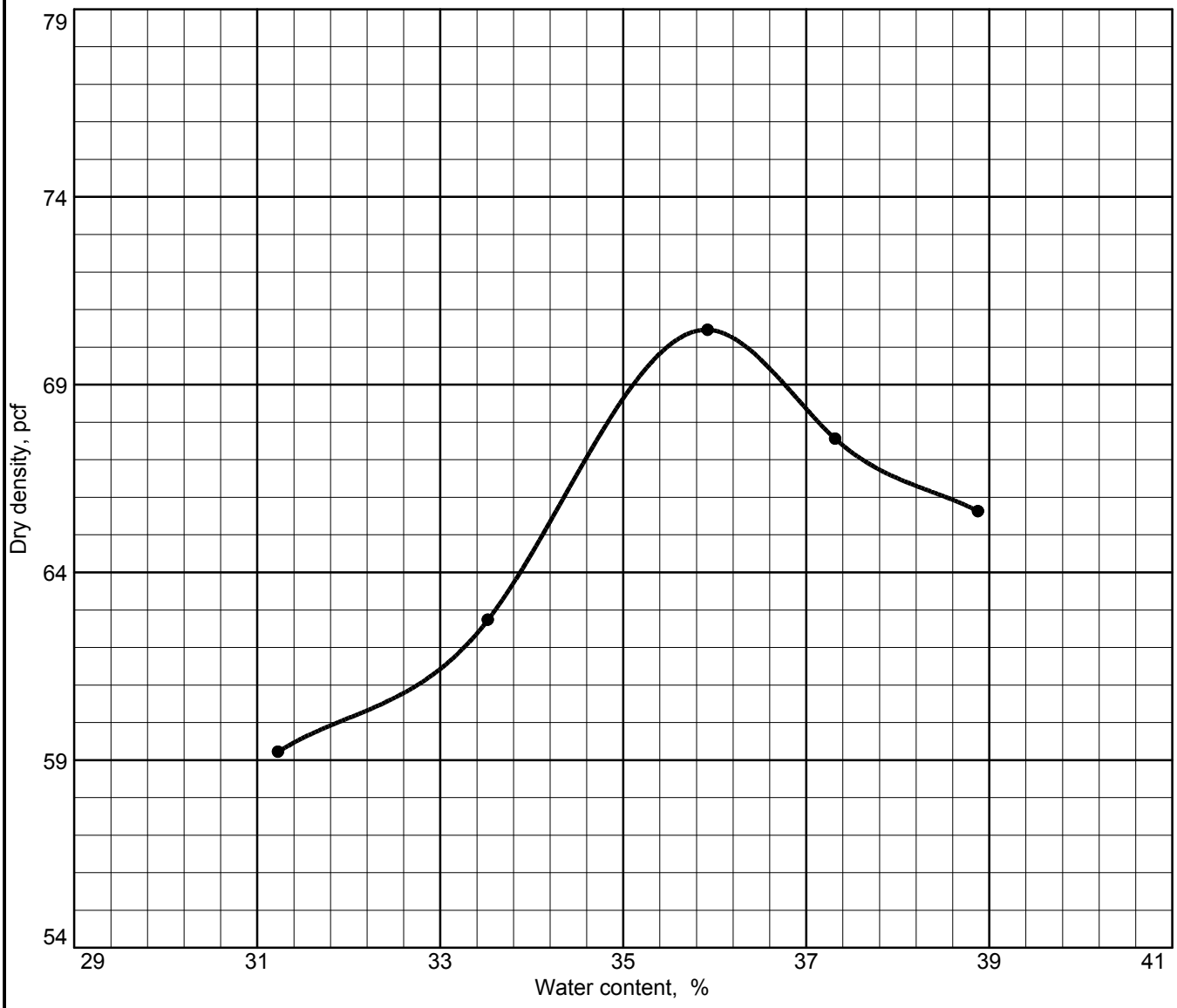
**San Juan, Puerto Rico**

**Remarks:**

Tested by: J. Ortiz/J. Cordova
Checked by: Rommel Cintron Aponte, MSCE, PE
Job No.: 7899

**Figure**

# COMPACTION TEST REPORT




Test specification: ASTM D 1557-00 Method C Modified

| Elev/ Depth | Classification | | Nat. Moist. | Sp.G. | LL | PI | % > 3/4 in. | % < No.200 |
|---|---|---|---|---|---|---|---|---|
| | USCS | AASHTO | | | | | | |
| | SM | A-4(0) | | | NP | NP | 0.0 | 39.5 |

**TEST RESULTS**

Maximum dry density = 70.5 pcf

Optimum moisture = 35.9 %

**MATERIAL DESCRIPTION**

Silty sand.
Aggremax Grab

**Project No.** 7899 **Client:** Carrasquillo Engineering Services

**Project:** CDR Landfill at AES, Guayama, PR

**Date:** 9/7/18

● **Location:** Guayama, PR Source Sample: Project Site

**JACA & SIERRA TESTING LABORATORIES**

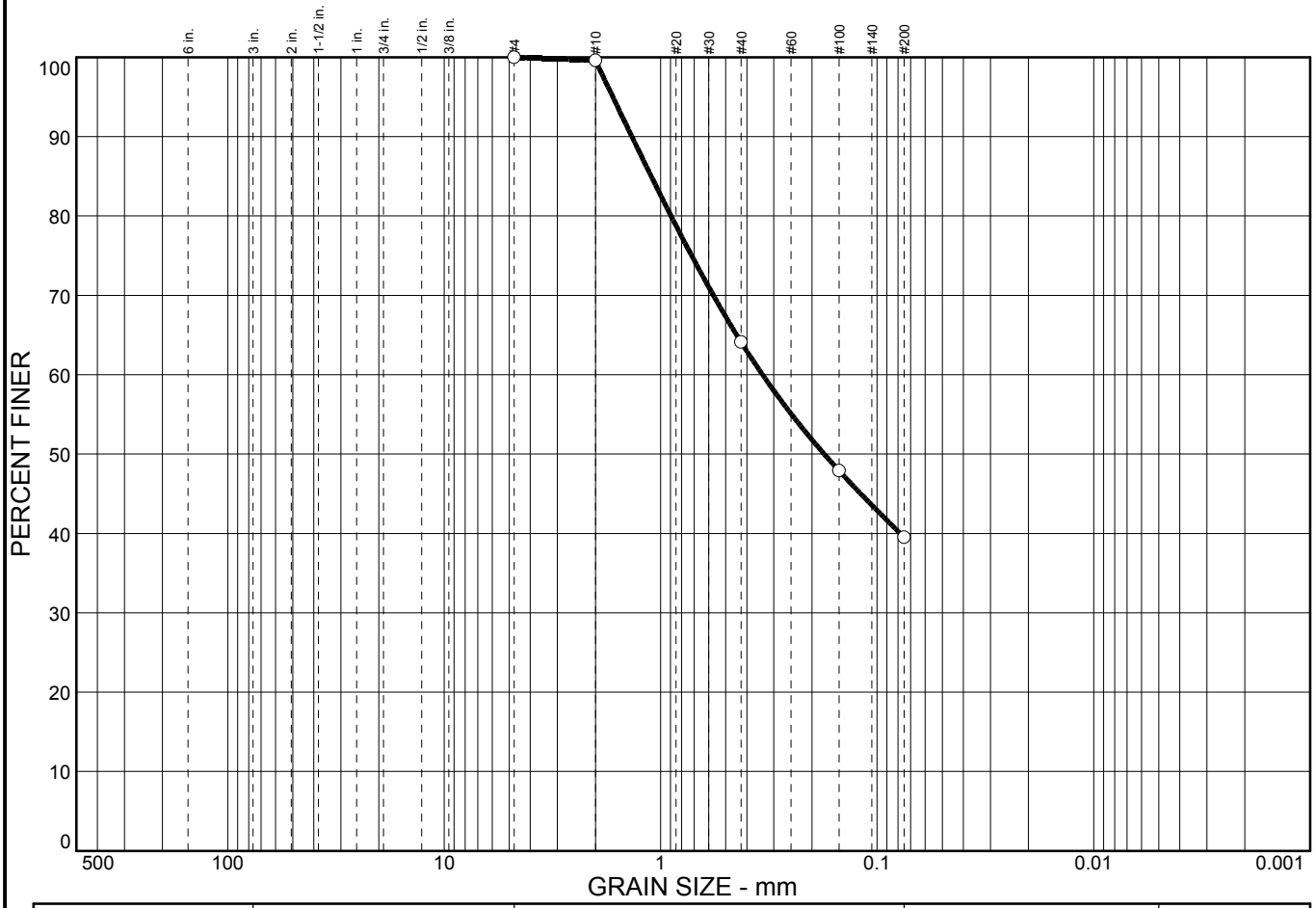
**San Juan, Puerto Rico**

**Remarks:**

Tested by: J. Ortiz/J. Cordova
Checked by: Rommel Cintron Aponte, MSCE, PE
Job. No. 7899

**Figure**

# Particle Size Distribution Report




| % COBBLES | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 0.0 | 60.5 | 39.5 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| #4 | 100.0 | | |
| #10 | 99.6 | | |
| #40 | 64.1 | | |
| #100 | 47.9 | | |
| #200 | 39.5 | | |

* (no specification provided)

**Material Description**

Silty sand.
Aggremax Grab

**Atterberg Limits**

PL= NP LL= NP PI= NP

**Coefficients**

$D_{85}$= 1.11 $D_{60}$= 0.339 $D_{50}$= 0.176
$D_{30}$= $D_{15}$= $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= SM AASHTO= A-4(0)

**Remarks**

Tested by: L. Medina
Checked by: Manuel Candelario Cosme, MSCE, PE

**Sample No.:** Bo. 5 **Source of Sample:** Project Site **Date:** 9/10/18
**Location:** Guayama, PR Source Sample: Project Site **Elev./Depth:**

**JACA & SIERRA TESTING LABORATORIES**
**San Juan, Puerto Rico**

**Client:** Carrasquillo Engineering Services
**Project:** CDR Landfill at AES, Guayama, PR

**Project No:** 7899 **Figure**