PRELIMINARY
SUBSOIL INVESTIGATION PROPOSED
PEÑONES DE MELONES TOURIST
DEVELOPMENT
CABO ROJO, PUERTO RICO

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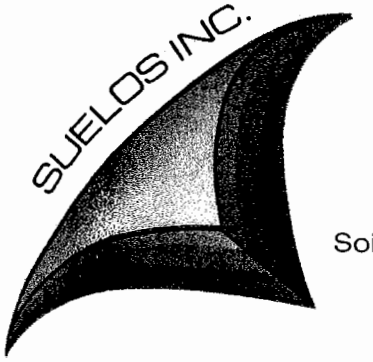

Soil & Construction Materials Laboratories and Environmental Drilling Services

PRELIMINARY
SUBSOIL INVESTIGATION PROPOSED
PEÑONES DE MELONES TOURIST DEVELOPMENT
CABO ROJO, PUERTO RICO

MR. CARLOS RODRIGUEZ-OWNER
P/C: MIGUEL CALZADA, ARQUITECTOS
Prepared for

Borings Performed & Supervised by
Suelos, Incorporated

Submitted on May 24, 2007
Job No. 3876.rep

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May 24, 2007

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PRELIMINARY SUBSOIL INVESTIGATION PROPOSED PEÑONES DE MELONES TOURIST DEVELOPMENT CABO ROJO, PUERTO RICO

1.0 INTRODUCTION

This report presents the results of a preliminary subsoil exploration conducted at the site for the proposed housing development called **Peñones de Melones, Cabo Rojo, Puerto Rico**.

The preliminary exploration was undertaken at the request of **Arch. Miguel Calzada**, on behalf of Desarolladores Isleños, according to the terms and conditions stated in our approved proposal dated March 7, 2007 and additional letter of March 27, 2007.

2.0 SCOPE OF INVESTIGATION

The exploration was geared towards the following purposes:

- To conduct a site geological assessment.
- Drill 10 boreholes throughout the farm to obtain representative soil samples for visual inspection and appropriate laboratory tests.
- Provide preliminary guidelines on cut areas slope ratios.
- Provide Preliminary allowable bearing pressures for cut materials and artificial fills.
- Adequacy of cut materials for use as artificial fills.
- Guidelines for in-situ materials to be used as backfill for retaining walls.

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Having the scope of work of the investigation properly defined, the following section describes and summarizes the existing field conditions at the time the exploration was performed.

3.0 SITE LOCATION AND GENERAL PROJECT DESCRIPTION

The site where the proposed **Peñones de Melones Development** is to be constructed is located at Sector Peñones de Melones ward in the southwestern portion of Puerto Rico within the municipality of Cabo Rojo. **Figure 1**, shows a composite of the Cabo Rojo and Puerto Real 7.5 minute series topographic quadrangles showing an approximate location of the farm.

The topography of the area consists of a ridge of north facing rolling hills dissected by several fingers of previous natural drainage swales.

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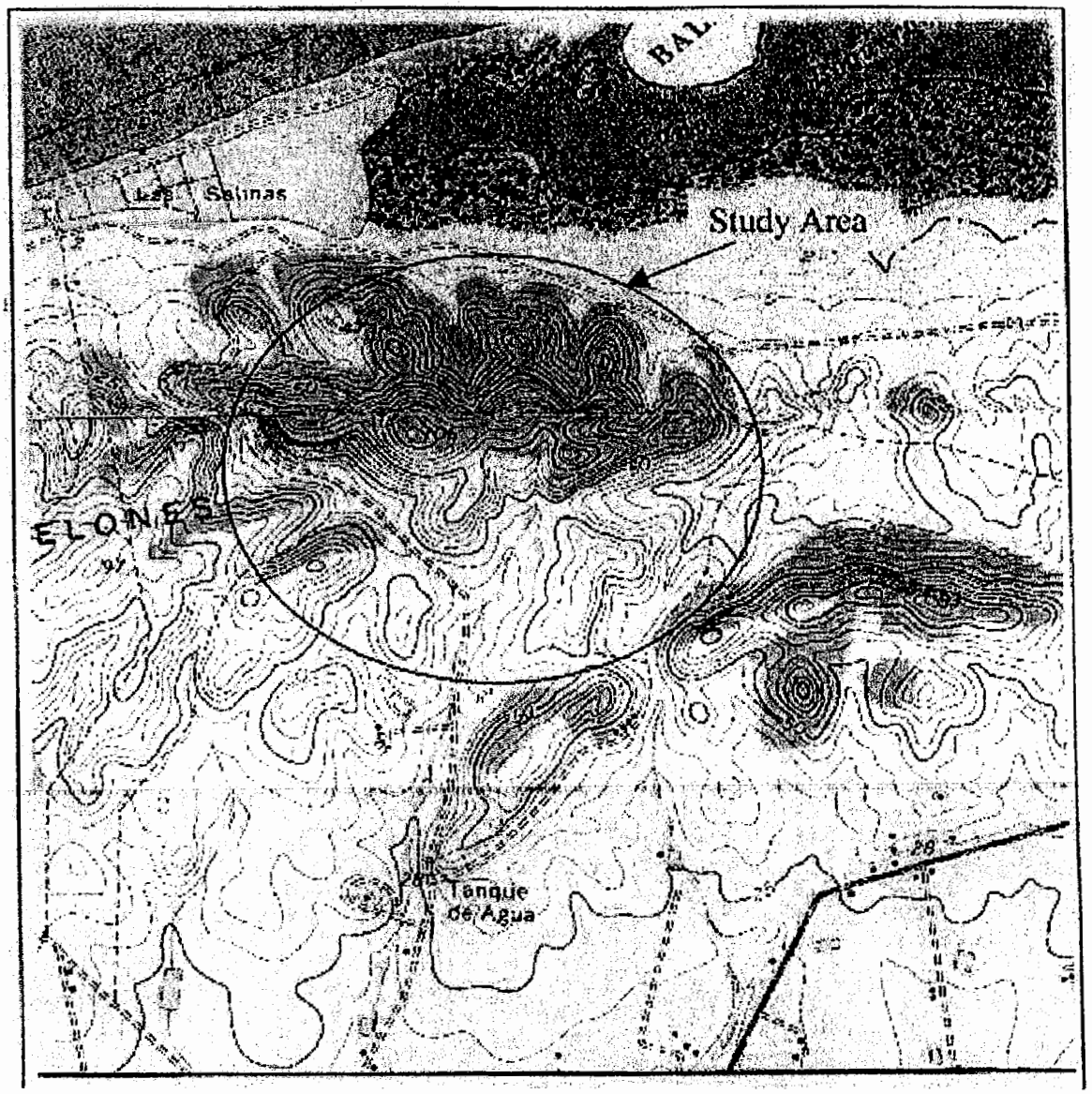

Figure 2 is a copy of a preliminary project layout plan showing the proposed development, along with the borings drilled for the exploration.

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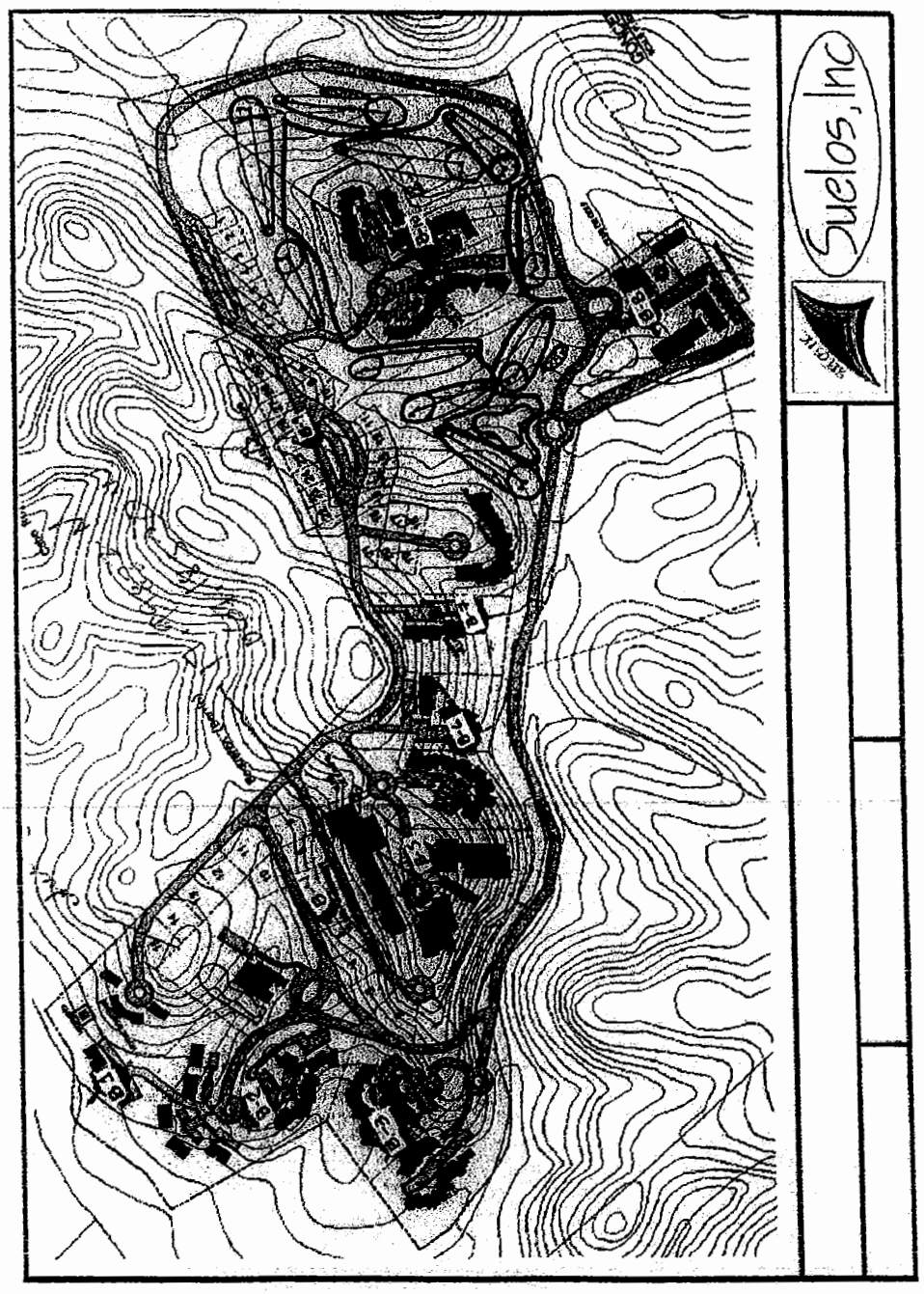

Figure 2

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According to the set of preliminary layout plan prepared by Desarolladores Isleños, the site will mostly be located on the top of the ridge of rolling hills, however there will be cut and fill earthwork procedures required, particularly along the borders of the proposed project, (refer to **Figure 2**).

As of the preparation of this report we do not having existing or final grade information. Judging from the topographic quadrangles it seems there is a difference in elevation of approximately 50 to 60 meters from the lowest portions of the farm to the highest.

As of the preparation of this preliminary report, we have not observed creeks or ponds within the proposed development property boundaries. The north flank of the rolling hills at one point were very active in draining runoff waters and incisions were made in the geologic past to these rolling hills, (refer to **Figure 3** between borings no. 1 and 2), but these are no longer active erosion features, except due to immediate rainfall.

4.0 WORK PERFORMED

Ten (10) borings were drilled within the farm as indicted in **Figures 2** and **3**. The borings were drilled to depths varying from 15 to 45 feet within the premises of the referenced farm. The test holes were advanced using the Power Auger Method and rock rotatory method. The approximate boring locations are shown in the enclosed **Figure 2**.

To conduct the drilling procedures a CME 45 Model drilling rig was mobilized to the project site. Due to the inaccessibility of the site, several access trails had to be made in order to reach the boring locations.

During the field work, soil samples were collected through 1-⅜ inch I.D. Split Spoon Sampler according to ASTM Standard D-1586-84, and diamond bit rotatory barrels to sample rock specimens. All the soil and rock specimens gathered from the sampling operations were secured in air-tight jars or wood boxes, and transferred to our laboratory for the pertinent tests. Among the tests

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conducted on the samples were Natural Moisture Contents, Atterberg Limits, and Unconfined Compressive Strength values (soil samples only). Additionally, several Classification Tests were conducted in order to determine the quality of the in-situ soil and weathered rock to be used as fill material.

The laboratory and field data were then evaluated in order to submit preliminary recommendations (as listed above) for the planing and designing phases tourist development.

5.0 GENERAL SITE REQUIREMENTS

As previously mentioned, according to the preliminary plan prepared by Desarolladores Isleños, the site will mostly be located on the top of the ridge of rolling hills, however the will be cut and fill earthwork procedures required, particularly along he borders of the proposed project. Reportedly he project will consist of villas clusters, a club house, and golf course facilities, all interconnected by a system of winding roads and cul-de-sacs, (refer to **Figure 2**).

In general, and depending on the existing and final grading plan used for this project, it seems that cut operations will be required within the central and higher portions of the rolling hills, while fills may be required along the boundaries of the proposed development.

Filling operations should be mostly scheduled at the lowlands, and sloping grounds.

The necessity for cuts and the construction of large fill embankments constitute two of the most important foundation aspects in this particular project. For this reason, special attention must be given to these items, not only during the design and construction of the project, but also in the long term behavior of man made cuts and the subsequent performance of the artificial fills.

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A final Grading Plan shall be submitted, as part of the information for the Final Geotechnical Exploration, including the preparation of multiple transverse sections across cut areas, fill areas, and cut and fill areas. The purpose of this requirement is to analyze the slope stability of these cut-slopes, fill slopes, cut and fill slopes, and retaining structures. This is one of the most important aspect in this type of development.

6.0 PRELIMINARY GEOLOGICAL CONDITIONS OF THE SITE

The purpose of this geologic reconnaissance was to record and observe the geologic conditions of the area of interest. In order to survey the area, ten borings were opened at strategic locations based on the proposed location of the main buildings.

The topography of the general area is characterized by a series of rolling hills from which some are of high relief, valleys, and plains mostly towards the northern and south-southeastern portions of the property. The topography appears to control the surface drainage of the area. Though the geologic map acknowledges the presence of two small creeks, one near the center of the property draining south and another draining north at the eastern limit, during our site visit no running water was observed at these locations. However, an apparently intermittent creek that is not clear if it is natural or man made collects runoff from the adjacent valleys and delimits most of the southern portion of the property.

According to the Geologic Map of the Cabo Rojo and Pargüera Quadrangles, the study area should consist of three different geologic deposits/formations: Alluvial Deposits (Qal), the lower member of the Pargüera Limestone (Kpl) and Melones Limestone (Km). These last two formations have been separated by a northeast-southwest trending fault. As a result the lower member of the Pargüera Limestone should be present north of the fault and the Melones Limestone south from it. **Figure 3** is a composite portion of the Cabo Rojo and Puerto Real USGS 7.5 minute series topographic maps.

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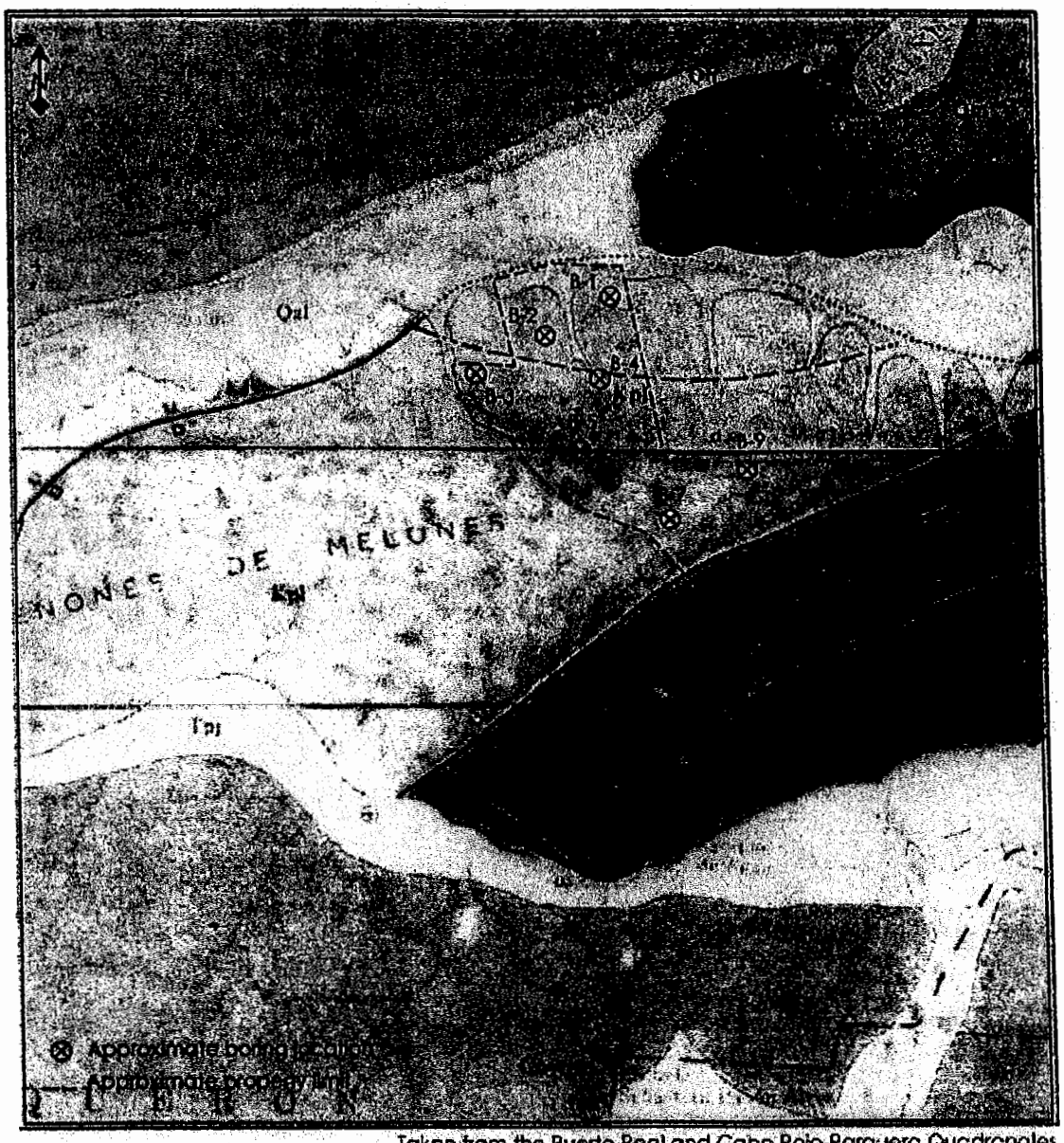

Taken from the Puerto Real and Cabo Rojo-Parguera Quadrangles

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Based on site visits and sampled materials it was corroborated that the area consists of apparently three different geologic deposits/formations. The alluvial deposits were found in plains of the northern most portion of the property in addition to other areas. These deposits consist of silty clay to clayey silt with minor amounts of sand and gravel.

Even though the lower member of the Pargüera Limestone and Melones Limestone are very similar in its deposits, the base of the lower member of the Pargüera Limestone consists of a volcaniclastic conglomerate overlaid by mudstones and limestone (calcarenite), which were found on the majority of the borings.

Whereas the Melones Limestone appears to be present on the samples collected in boring no. 10 and partially in boring 8, which may be located in a shear zone between the formations. Though a series of faults have been previously identified in the area and due to the similarities within the formations, the specific contacts between these two formations are doubtful. However, no surficial evidence was found to locate or assume that there has been any obvious recent movement of the mapped fault. Additionally, the geologic map shows Tertiary deposits not affected by it and partially covering sections, which strongly suggests that there has been no movement since the Tertiary period.

7.0 SUBSOIL CONDITIONS

The subsurface materials encountered during the borehole exploration are generally consistent from borehole to borehole, with the exception of perhaps boring no. 1, where clayey alluvial material (as opposed to weathered rock and rock found in most of the borings) was encountered. Boring no. 1 was drilled in the lowest elevation towards the north, within the alluvial plan of the Peñones de Melones rolling hills.

The subsurface conditions interpreted from the boreholes are summarized below.

For a detail index and physical properties of the soil and rock samples the reader should review the logs presented as an Appendix to this report.

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7.1 Alluvial Horizon Boring No. 1

This boring, drilled at the foothills of the Peñones de Melones rolling hills, consists of a brown to reddish brown, very stiff to hard silty clay and or clayey silt with traces of sand, and traces of fragmented gravel inclusions. SPT values range between 13 and 45 blows per foot, while Natural Moisture Content ranged between 15 and 31 percent, and Unconfined Compressive Strength values range from 1.75 to 3.6 tons per square foot.

This horizon was drilled from the ground surface to a depth of 45.5 feet in boring no.1

7.2 First Horizon Rolling Hills (Natural Fill)

This horizon was not found on boring no. 1. It consist of a brown to reddish brown sandy silt, and silty with abundant traces of fragmented rock pieces, and with some topsoil mixed in SPT values range from 9 to 40 blows per foot, while Unconfined Compressive Strength values (on clay samples) range from 0 to 4.5 tons per square foot, and Natural Moisture Content ranges from with 20's and 30's. This horizon consists most likely of an natural fill layer, probably the natural degradation (in-situ) of the underlying natural formations. This horizon is from 2 to 4 feet thick.

7.3 Second Horizon Rolling Hills (Pargüera Limestone)

Below the natural fill we found a horizon consisting of an extremely weathered limestone of the Pargüera Limestone and it as sampled as a grayish brown, medium to dense, calcareous, fine sandy silt. SPT values range from 18 to 29 blows per foot, while Natural Moisture Content range from 3 to 14 percent.

It consists of the weathered portion of the limestone formations and it was found to a depth of 17 feet in boring no. 2, and 14 feet in boring no. 5. The other borings revealed a harder or denser consistency limestone.

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7.4 Third Horizon Rolling Hills (Pargüera Limestone)

This horizon consists of a fresher state of the previous horizon. It consists and was sampled as a grayish brown, very dense sandy silt and fragmented rock (broken by the sampling procedure). SPT values were over 50 blows per foot, and Natural Moisture Content was in the lo tens. It was drilled to 6 feet in boring no. 8, 35 feet in borings no. 9 and 10.

7.5 Fourth horizon Rolling Hills

This horizon as sampled on borings no. 2, 3, 4,5,6, 7 and 8. It consists of a grayish brown, fragmented mudstone and sandstone, occasionally volcanic conglomerate, with SPT over 50 blows per 3 inches and sometimes requiring rock coring drilling techniques.

The rock cores had RQD values of 52 in boring no. 3, 21 in boring no. 5, 29 in boring no. 6, and 7 in boring no. 8. The range is quite wide in the sense that RQD values revealed fractured rock (RQD of 52) to intensely fractured rock (RQD of 7). The horizon was drilled to the end of the boring drilled.

8.0 PRELIMINARY GROUNDWATER AND DEWATERING CONSIDERATIONS

A stabilized groundwater table was only found on boring no. 1 at a depth of approximately 30 feet. This boring was located of the old alluvial plains. The other borings were drilled on higher grounds within the Peñones de Melones rolling hills and groundwater was not observed on the remaining borings no. 2 through 9 during the performance of the exploration. Accordingly, we do not foresee the necessity for an intricate dewatering system for controlling groundwater. Nevertheless, we do wish to remind the contractor that whenever changes in the topography of a site are made, changes in the groundwater characteristics of the region frequently occur. Such conditions are difficult to detect within the normal scope of time of the exploration. Usually, springs are detected during the construction period, when cuts, excavations or ground surface stripping are made.

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(a.1) Stripping Operations

Prior to the commencement of any cut or fill operation, the areas were the lots are to be established and fill is to be deposited, should be stripped and the existing topsoil removed. The thickness of the topsoil average 2 ft at the lowland and bottoms of gullies. Areas with thicker topsoil layer may also be encountered.

The removal of vegetation and top soil (as well as any other organic soil, weak material or remnant debris) shall be performed under the direct supervision of a Geotechnical Engineer or his representative. The aerial extension and actual depth of removal shall be established by the Soils Engineer at the field.

(a.2) Fill Type Requirements

Most of the materials within the upper 5 to 6 feet of the existing borings no. 2 through 10 classify as shown on Table I.

TABLE I

Classifications Upper 5.5 Feet Soil Materials

Boring No.	Sample No.	Depth (ft)	WL	WP	PI	USCS	AASHTO
2	2	1.5 to 3.0	32	15	17	CL	A-6 (6)
4	2	1.5-3.0	40	21	19	SC	A-2-6 (2)
5	2	1.5-3.0	40	24	16	CL	A-6 (6)
6	4	4-5.5	44	25	19	CL	A-7-6
7	2	1.5-3.0	47	25	22	CL	A-7-6 (15)
7	3	4-5.5	62	27	35	CH	A-7-6 (33)
8	1	0-1.5	38	22	16	SC	A-2-6 (1)
9	2	1.5-3.0	np	np	np	SM	A-4 (0)

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Boring No.	Sample No.	Depth (ft)	WL	WP	PI	USCS	AASHTO
9	4	6-7.5	35	22	13	CL	A-4 (2)
10	1	0-1.5	28	20	8	SM	A-4 (0)
10	2	1.5-3	np	np	np	CL	A-6 (9)
10	3	4-5.5	30	21	9	CL	A-4 (3)

The upper 5 to 6 feet (approximately) of the existing soils in the borings drilled throughout the rolling hills revealed materials ranging from A-2-6 to A-7-6 materials following AASHTO, most of them however, classifying within the A-4, A-6, and A-7-6 materials.

Except for the A-7-6 and A-6 soils, the other materials may be preliminarily used on non-sloping fill situations, like under discrete structures, not on sloping grounds, below sports courts, pavements, or in green areas.

These are preliminarily excluded from being used for slopes, backfill for retaining structures, or fills under structures having fill thickness of over 3 feet.

The topsoil of the site has to mechanically separated from these materials. The top soils (most ly found on the first samples of most borings) are not suitable for backfill or structural backfill, other than being used as topsoil for planting purposes.

Most of the material delivered from parent rock (severely to high weathered layer) has been classified as shown on Table II.

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TABLE II

Classification Weathered Rock Materials

Boring no.	Sample	Depth (ft)	WL	WP	PI	USCS	AASHTO
2	6, 7, 8	15-25'	np	np	np	SM	A-1-b
4	5, 6, 7	9-20'	48	28	20	SM	A-2-7
7	5, 6, 7	9-20'	np	np	np	SM	A-4
8	3, 4, 5	4-10'	np	np	np	SM	A-2-4
9	5, 6, 7	9-20'	45	22	23	SC	A-7-6 (5)

These materials have classifies mainly as SM A-1-b to A-2-7 with one sample classifying as an A-7-6. When properly processed these may be used preliminarily as fills under structures, limited sloping conditions, and behind retaining walls, as base course for pavements. (Except for A-7-6 soils).

The final determination for the use of these types of materials will depend on the final grading plans and transverse sections, where detailed slope stability analyzes and settlement analyzes will be made to investigate the adequacy of such materials.

The original first intention would be to attempt to balance out the cuts and fills requirements. However, this often is unattainable due to the required volumes of select fills. Therefore the owners preliminarily shall not discard the possibility of having to import some materials to used as fills, particularly if the intention of the designer is not to conduct extensive or deep cuts on the existing farm. The latter will leave only for the use of the upper layers of existing soil materials, and would preclude these of the weathered rock materials (these often yield better quality fill materials).

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(a.3) Preliminary Fill Deposition and Monitoring Requirements

It is necessary to conduct the filling operations under very controlled conditions, and under the supervision of a Soils Engineer from this office, or his representative.

Under controlled conditions, an earthfill construction is performed by placing the fill in layers not exceeding 10 inches in thickness and imparted with a minimum degree of compaction of 95% of the fill material maximum dry density, as obtained from a Modified Proctor Test.

Prior to the construction of the fill embankments, every slope surface to be filled should be stepped in order to key-in the fill. Under no circumstances the fill should be placed over a sloping ground surface without first preparing the ground as shown on **Figure 4**.

Refer to the section entitled **"Filling on Existing Hillside Slopes"** for additional and detailed recommendations on this topic.

(a.4) Preliminary Rippability Characteristics of In-situ Soils

Based on the N-values recorded at proposed cut areas, and excluding boring no. 1, the soil material found to an average depth of 10 feet can be excavated using conventional dozers. This material exhibits an estimated degree of ripping effort that varies from easy to medium.

Below 10 feet deep, most N-values obtained refusal with counts over 100 bpf. This material exhibits an estimated degree of ripping effort that varies from medium to difficult, where tandem ripping pre-splitting and blasting may be necessary.

The following Table III contains general rippability characteristics for each boring where conventional equipment can be use for medium rippability efforts.

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TABLE III

Boring No.	Estimated Depth to Medium Rippability (feet)
1	Greater than 10 feet
2	10
3	4
4	8
5	6
6	8
7	14
8	4
9	8
10	12

Table IV shows the depths estimated were hard to very hard ripping efforts may e necessary, with the inclusion tandem ripping, pre-splitting, and blasting. This zone may have nucleus of fresher rock within.

TABLE IV

Boring No.	Estimated Depth to Hard Rippability (feet)
2	17 to 35.5
3	4 to 10
4	8 to 35
5	4 to 19
6	6 to 16.5

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Boring No.	Estimated Depth to Hard Rippability (feet)
7	8 to 35.5
8	4 to 23
9	8
10	12 to 35.5

It should be mentioned, however, that always exists the probability of encountering large boulders, or nucleus of more consolidated materials exhibiting very hard ripping efforts. **Therefore, it is mandatory that the contractor make visits and tests in the field, particularly with equipment he considers suitable for the cut and/or excavation operations, in order to establish the rippability characteristics of the ground mass and the other requirements necessary to perform the cuts.**

The information given above should be used only as a guide to estimate preliminary costs of the excavation works and shall not be used as the only source of information to base contract bids. **To more accurately establish and evaluate rippability characteristics, seismic refraction surveys are strongly and must be recommended. These specific studies are very valuable for actual prediction of cutting procedures.**

Section (B): PRELIMINARY CUT/FILL SLOPE REQUIREMENTS

Cut slopes 2.0 H : 1.0 V with benches every 20 ft of rise (minimum width of benches should be 3 meters) and 2H:1V fill slopes (using A-2-4 material or better). Where a cut slope is made on residual soils (upper 5 to 10 ft), however, the geometry should kept at 3H:1V.

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(b.1) Filling on Existing Hillside Slopes

Where fills are made on hillsides, the slopes of the original ground upon which the fill is to be placed, shall be plowed or scarified deeply, until reaching the competent saprolitic materials. **Under no circumstance new fills should be placed on hillsides without first removing the residual clayey soils**. In addition, where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical, the ground surface shall be steeped or benched in accordance to the following criteria as shown on Table V.

TABLE V

Slope Ratio of Existing Ground	Maximum Vertical Spacing of Benches	Minimum Width of Surface benches
5H:1V	0.5 mts	2 mts
4H:1V	1 mts	2 mts
3H:1V	1 mts	3 mts
2H:1V	2 mts	3 mts
1H:1V and steeper	2 mts	3 mts

These requirements might be slightly varied by the observing Soils Engineer (or his representative on a full time basis), depending on actual field conditions.

(b.2) Run-off Waters

Run-off waters will not be permitted to drain off the face of the exposed cuts. To prevent the run-off from spilling over the face of the cuts, longitudinal concrete drainage swales will be provided at the cutslope benches previously recommended in this report. The drainage swales will be provided with proper gradients so as to properly dispose the surface run-off through the swales and into properly designed outlets. Where no benches are required for the cut slope (for cut slopes

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less than 20 ft high), the construction of the concrete swales immediately adjacent to the top of the cut and one at the cut toe shall be performed.

Regarding the exposed cut slope faces several additional measures shall be evaluated in order to further minimize erosion. This is discussed in detail further in this report.

Section (C): PRELIMINARY FOUNDATION RECOMMENDATIONS

(c.1) Dwelling at Cut Sectors

Due to the very good soil conditions expected at cut areas (competent saprolitic soils will be exposed) no bearing or settlement problems are expected. After cutting operations are concluded, the exposed surface should be proof-rolled with a 20 ton vibratory roller under the supervision of the Geotechnical Engineer. Any weak spots observed during the proof rolling operations shall be removed and replaced with selected material.

The residential structures shall be cast over a slab mat foundation thickened under the locations of the bearing walls and/or columns. Under this criterion, an allowable soil bearing pressure of 3,500 psf can be assigned to the in-situ soils for the design of the mat by the rigid method. A soil modulus of 130 pci can be used if an elastic design is used for the mat. A vapor barrier membrane should be placed beneath the mat foundation. It is customary to use a key or apron along the outside perimeter of the slab-mat. This key serves to prevent erosion, moisture changes and to provide confinement of the material under the structure.

Note that the coefficient of subgrade reaction (**K1**) is applicable for a one-foot square loaded area. The coefficient (**K**) to be used for designing the actual slab depends on the length (**L**) and the width (**B**) of the actually loaded area.

The value of "**K**" for a given size of foundation **B x L** can be obtained by using the following equation developed for foundations in sandy soils.

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$$K = K1\ ((B+1)/2B)^2$$

Given in P.C.I.

Where:

B = Width in feet of the actually Loaded Square Area

K1 = Coefficient of subgrade reaction for footings measuring 1ft x 1ft

The value of (**K**) above given is based on our experience on the type of soil expected at the project site (vary from cut to fill). For a more accurate value, field plate bearing tests would have to be made. But, for all practical purposes the estimated value can be safely used.

(c.2) Structures on Fill

A slab-mat type of foundation is also recommended for those dwelling structures to be laid entirely over fill areas.

Similar to the recommendations given for the structures at cut sectors, dwellings placed over fill shall be cast over a mat of select soil having the qualities of an A-2-4 material, placed and compacted. An allowable soil bearing pressure of 2,000 psf shall be used for design purposes (rigid method). For the approximate elastic design a modulus of sub-grade reaction of 110 pci shall be utilized.

(c.3) Structures on Cut and Fill

No structure is to lie partly on cut and partly on fill since differential movements may occur accompanied by cracks and distress in the structure (due to grounds with different compressibility characteristics). Any sector exhibiting this topographic condition will require an over excavation

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at the cut area such that a 1 meter maximum fill thickness difference is maintained below the structure footprint.

(c.4) Design Parameters for Retaining Walls

For the construction of retaining walls on fill, the project may preliminarily consider the use of either the cantilever type of retaining wall or modular systems (like the **KEYSTONE** or **MESA** Wall) **at areas requiring up to 3 meters high walls**.

For the construction of **walls on cut**, the designer may consider cantilever concrete walls to avoid large volume cuts typically associated with modular systems (reinforced zone).

When dimensioning the base of the retaining walls, the designer shall use the allowable soil bearing pressure given in the following Table VI.

TABLE VI
Strength Parameters for Foundation Soils

Retaining Wall Location	Df, ft	fb, psf	c, psf	ϕ, Degrees	Γn, pcf
At Cut Areas①	3 ft	3,500	0	34	138
At Fill Areas②	3 ft	2,000	0	32	135
At Deep Cut Areas③	3 ft	5,000	0	36	138

① Provided the cut is 7 ft deep (or deeper) measured from existing ground surface.

② At fill or cut areas < 7 ft deep. Fill A-2-4 or better.

③ Provided the cut is 20 ft deep (or deeper) measured from existing ground surface (see Cross Section FF).

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Df	=	Min. depth of footing measured from proposed finished grade
fb	=	Allowable soil bearing
c	=	Unit cohesion at foundation level
ϕ	=	Angle of internal friction for foundation soils
Γn	=	Moist unit weight of soil

In-situ rocky material may be preliminarily considered as backfills for walls provided they classify as A-2-4 or A-1 Soils.

The actual footing depth for the wall can be increased to provide an adequate safety factor against overturning or sliding, if necessary by the designer's computations.

The coefficient of passive earth pressure (**Kp**) as well as the coefficient active earth pressure (**Ka**) may be computed using the following formula:

$$K_p = \tan^2 (45 + \phi/2) = 1/k_a$$

$$K_a = \tan^2 (45 - \phi/2)$$

Since the walls need to be backfilled with good quality fill material, the soil parameters included in **Table VII** shall be used compute the earth pressure to act behind the walls (based on the type of backfill used):

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TABLE VII

Typical Properties of Compacted Materials Allowed Behind Non-Critical Walls

Group Symbol	Soil Type	Γ, pcf	c, psf	ϕ, degree	k, ft/m
GW (A-1-a)	well graded clean gravels, gravel-sand mixtures	130	0	34°	0.05
GP (A-1-a)	poorly graded clean gravels gravel-sandy-mix	125	0	34°	0.10
GM (A-1-b)	silty gravels poorly graded gravel-sand-silt	130	neglect	33°	greater than 0.000001
GC (A-2-4)	clayey gravels, poorly graded gravel-sand-clay	130	neglect	32°	greater than 0.000001
SW (A-3)	well graded clean sand, gravelly sands	125	0	30°	greater than 0.0000001
SP (A-3/A-1-b)	poorly graded clean sands, sand-gravel mix	120	0	30°	greater than 0.001
SM (A-2-4)	silty sands poorly graded sand-silt mix	125	neglect	28°	0.00005

***Approximate AASHTO Classification**

Γ = approx. dry unit weight

c = unit cohesion

ϕ = angle of internal friction

K = coefficient of permeability

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It should be understood that the previous soil parameters are based on our experience and existing empirical relationships. For more precise values, special laboratory tests to such end would have to be made.

The wedge formed by the backfill behind the retaining wall shall be sufficiently large so as to extend beyond the limit delimited by the failure wedge of the Coulomb's earth pressure theory (active case). That is, the select material used for backfilling the walls must extend farther than the line which makes an angle of $45-\phi/2$ with the horizontal.

The stability of the walls against sliding must satisfy factor of safety of not less than 1.5. Sliding must be resisted by the shear between the soil and the base of the wall.

The shearing resistance parameters used to estimate the safety factor will depend on the character of the soil at the base of the wall. Refer to **Table VI** for parameters on foundation soils.

It is important to point out that all surfaces at the base must be roughened and dry before the concrete is placed. If required, the resistance to sliding can be increased by a concrete key that projects into the soil below the base. This key will increase the passive resistance against sliding.

For overturning considerations, the wall base must be dimensioned in such a way that the resultant of all the forces acting on the supporting wall must intersect the base within its middle third. This is true for pure Cantilever Walls only.

The material used for backfilling retaining walls shall be of an A-2-4 type, or better (as shown in **Table VII**). This material has a high shearing resistance and good drainage. The use of soft backfills behind the walls produce high horizontal pressures. We do not recommend the use of such material as backfill for the retaining walls.

Great care is required to avoid over compaction behind the retaining wall, otherwise, the wall may be displaced or over stressed. The Designer shall also verify the design against dynamic loadings such as, those of Earthquakes. The recommended allowable bearing pressures may be increased by 33 percent during these events evaluations.

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For designing the retaining walls under earthquake loading, the additional forces resulting from ground acceleration shall be added to the pressures obtained for the static condition. The earth pressure coefficient for dynamic increase in lateral force can be approximated as 75 percent of **kh**, **kh** being the expected horizontal acceleration in **g's**. That is, for a given wall subjected to an active **"static "** pressure **(Pa)** equal to $\mathbf{0.5 \cdot \gamma \cdot H^2 \cdot Ka}$, the combined effect of static and dynamic force **(Pae)** would be $\mathbf{(0.5 \cdot \gamma \cdot H^2 \cdot Ka) + (0.5 \cdot \gamma \cdot H^2 \cdot 75\% \, kh)}$.

11.0 GENERAL COMMENTS

It is important to point out that this report contains preliminary and general guidelines that can be used for conceptual design and for the actual process of preparing the site layout and its grading. We are in the best position to assess the designers in obtaining the final grading most suitable for the project.

For the project to be designed in its final stages, it will be required that the final geotechnical exploration be made. This shall be made after adequate information is submitted to us in the form of:

1) **Site existing topography.**

2) **Final layout of the project.**

3) **Final grading versus existing grading of the project.**

4) **Multiple transverse sections across key alignment showing worst and best geometric conditions for slope stability analyzes.**

5) **Type of proposed structures (single versus multi stories).**

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6) **Expected loading conditions.**

7) **Planing and location of retaining structures.**

8) **Transverse sections across worst and best conditions using retaining structures or slope stability analyzes.**

9) **Additional boreholes to be drilled as required by proposed final grading.**

This report is preliminary in nature and shall not be used towards the design of any portion of this project without the performance of the final geotechnical exploration and report.

The standard procedures followed during the drilling of the test borings are discussed in the Appendix to this soil report.

Respectfully submitted,

CARLOS RODRIGUEZ MOLINA, P.G., P.E., M.S.
Geotechnical Engineer for SUELOS, INC.

mgn

Reference No. 3876.rep

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APPENDIXES

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Appendix No. 1

General

Comprised in this report is a description of the project as made known to **SUELOS, INC**. 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.

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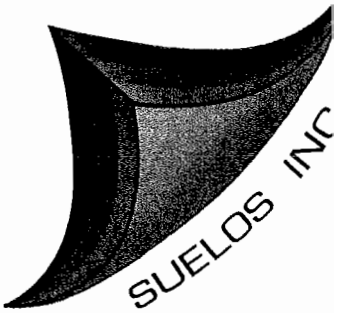

Appendix No. 2

Field and Laboratory Work

Field exploration was made by **SUELOS, INC.**, a private laboratory to the services of these Consultants. 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

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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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SOIL CLASSIFICATION TESTS

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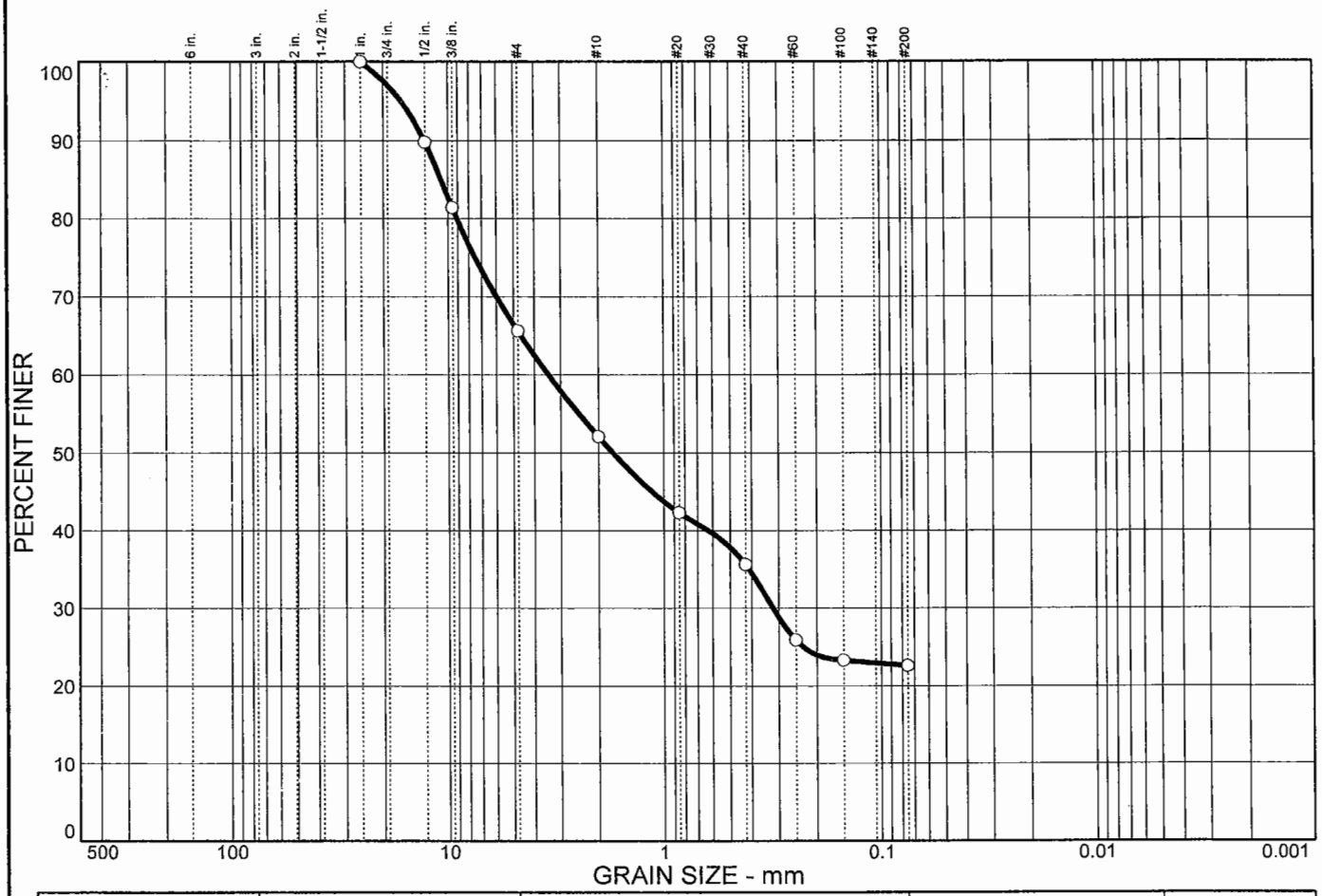
Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	34.4	43.0	22.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
1/2 in.	89.8		
3/8 in.	81.4		
#4	65.6		
#10	52.1		
#20	42.3		
#40	35.6		
#60	25.9		
#100	23.3		
#200	22.6		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 10.7 D_{60}= 3.42 D_{50}= 1.71
D_{30}= 0.317 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

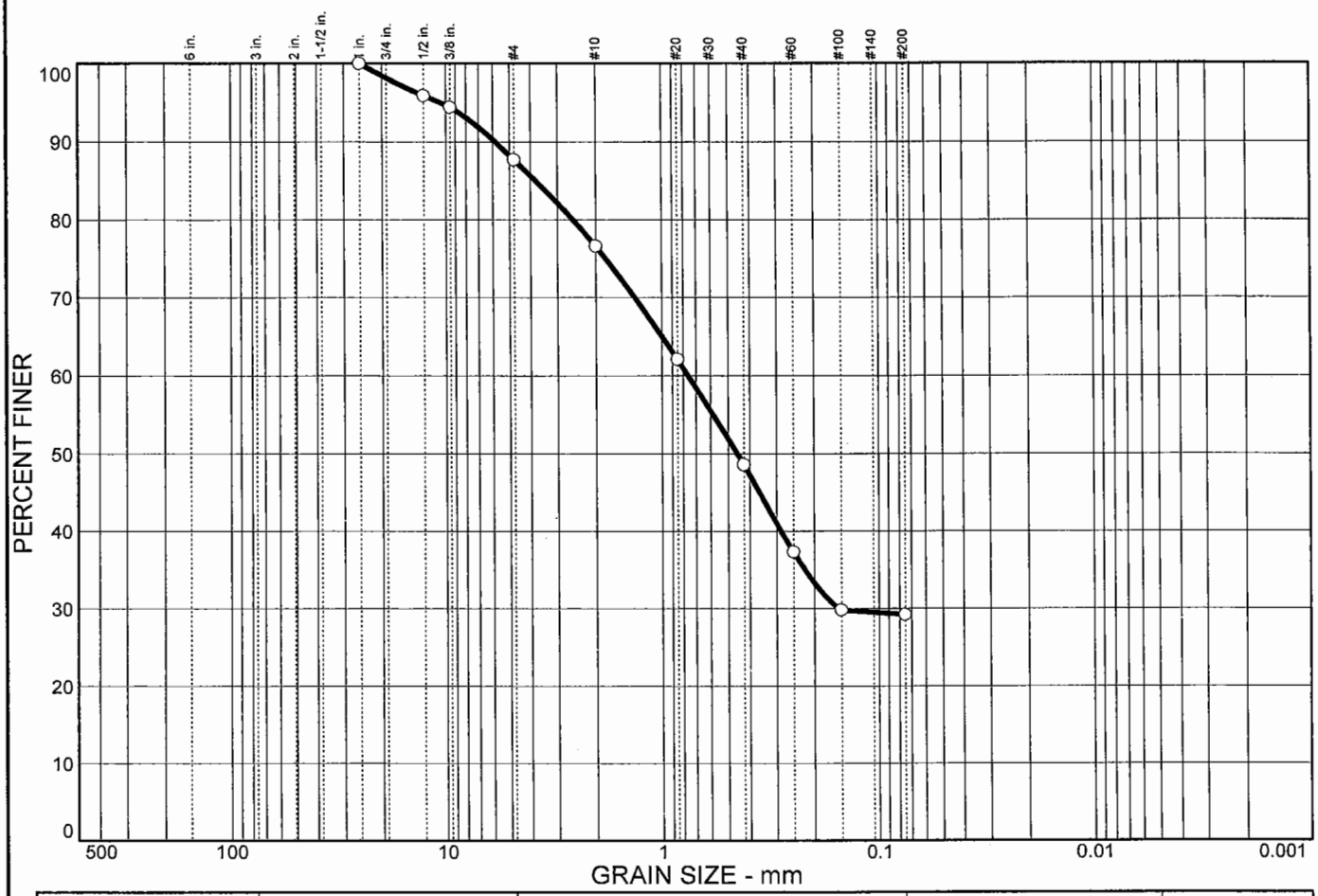
Remarks

Sample No.: 6,7,8 **Source of Sample:** B-2 **Date:** 23/May/07
Location: **Elev./Depth:** 15.0'-25.5'

SUELOS, INC.

Client:
Project: Peñones Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	12.3	58.5	29.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.5 in.	95.9		
.375 in.	94.4		
#4	87.7		
#10	76.6		
#20	62.1		
#40	48.6		
#60	37.3		
#100	29.8		
#200	29.2		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= 28 LL= 48 PI= 20

Coefficients

D_{85}= 3.77 D_{60}= 0.758 D_{50}= 0.454
D_{30}= 0.154 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-7(1)

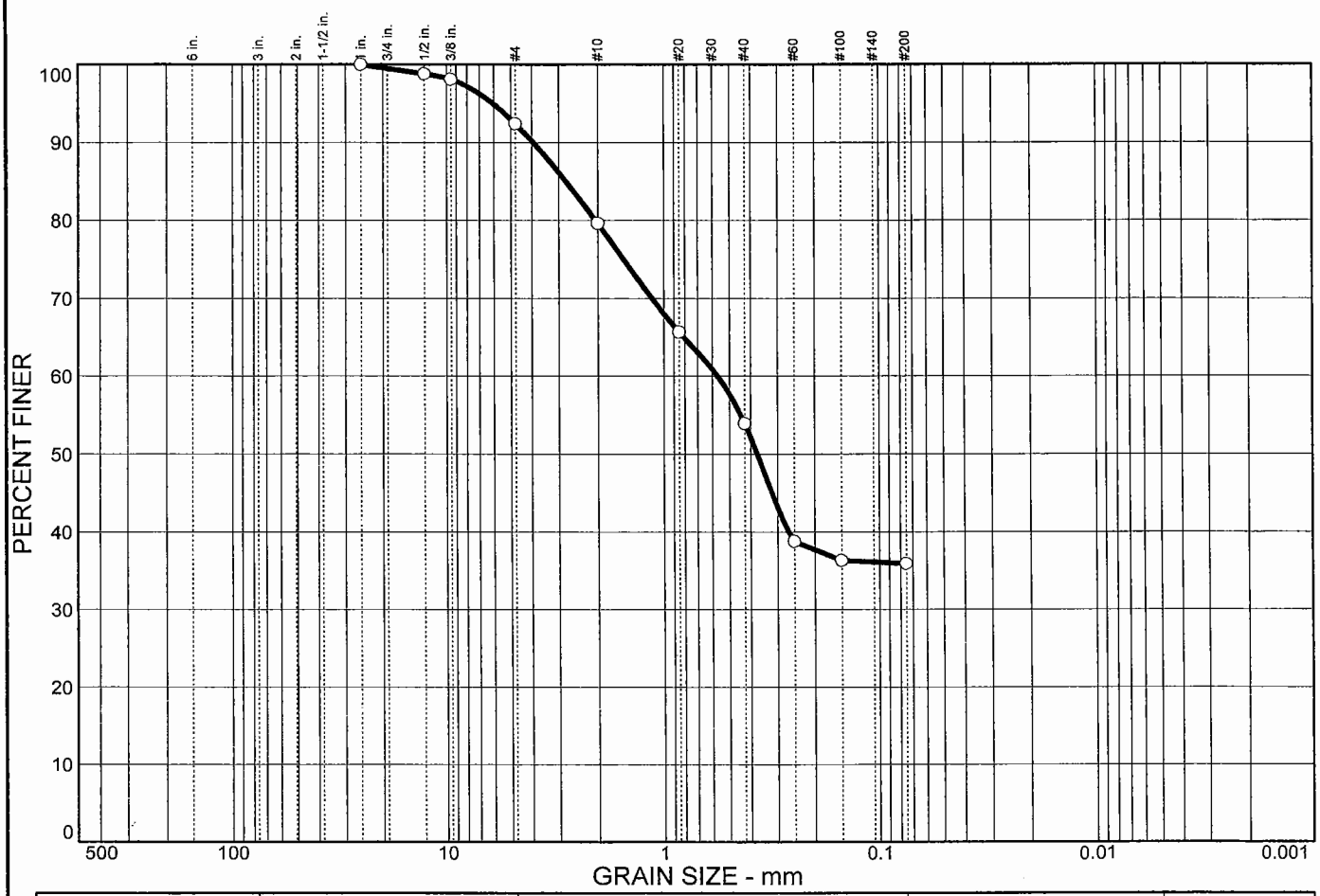
Remarks

Sample No.: 5,6,7 **Source of Sample:** B-4 **Date:** 23/Mayt/07
Location: **Elev./Depth:** 9.0'-20.5'

SUELOS, INC.

Client:
Project: Peñones Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.6	56.5	35.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
1/2 in.	98.8		
3/8 in.	98.1		
#4	92.4		
#10	79.6		
#20	65.7		
#40	53.9		
#60	38.8		
#100	36.3		
#200	35.9		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.79 D_{60}= 0.566 D_{50}= 0.373
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

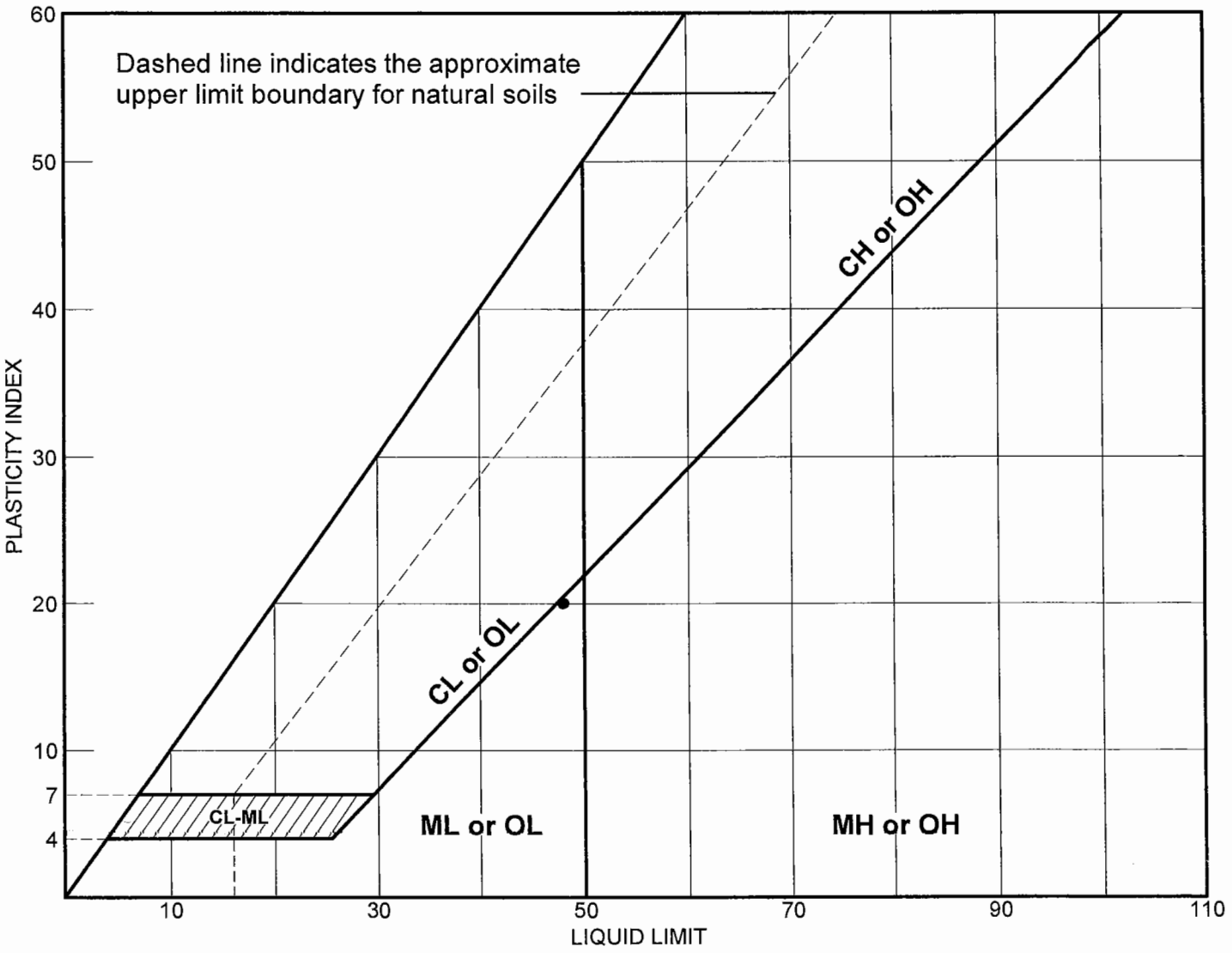
Remarks

Sample No.: 5,6,7 **Source of Sample:** B-7 **Date:** 23/May/07
Location: **Elev./Depth:** 9.0'-20.5'

SUELOS, INC.

Client:
Project: Peñones Cabo Rojo
Project No: **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-4	5,6,7	9.0'-20.5'		28	48	20	SM

LIQUID AND PLASTIC LIMITS TEST REPORT

SUELOS, INC.

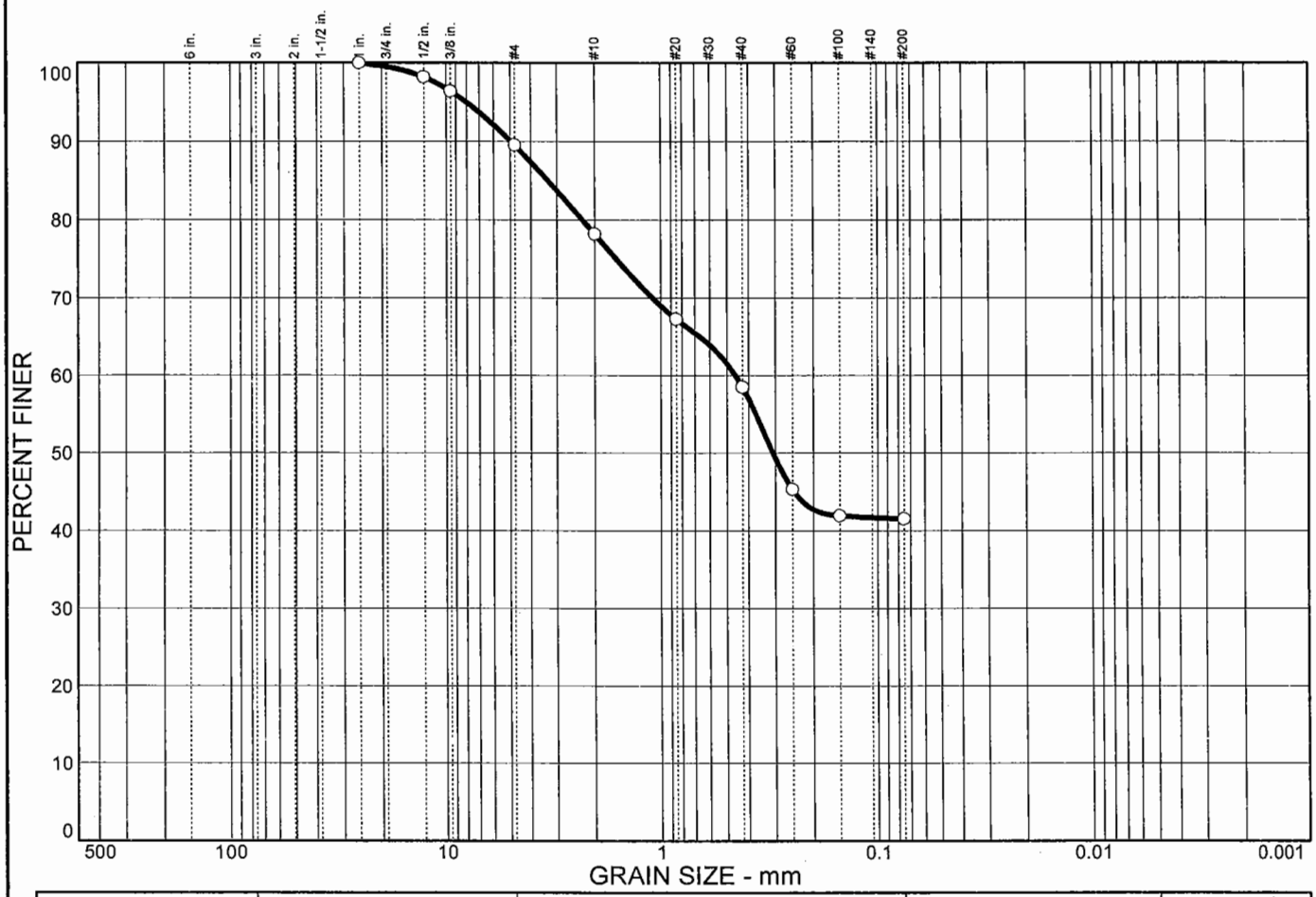
Client:

Project: Peñones Cabo Rojo

Project No.:

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	10.5	48.0	41.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
1/2 in.	98.2		
3/8 in.	96.4		
#4	89.5		
#10	78.2		
#20	67.3		
#40	58.5		
#60	45.3		
#100	41.9		
#200	41.5		

* (no specification provided)

Soil Description

Clayey sand

Atterberg Limits

PL= 22 LL= 45 PI= 23

Coefficients

D_{85}= 3.31 D_{60}= 0.457 D_{50}= 0.307
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(5)

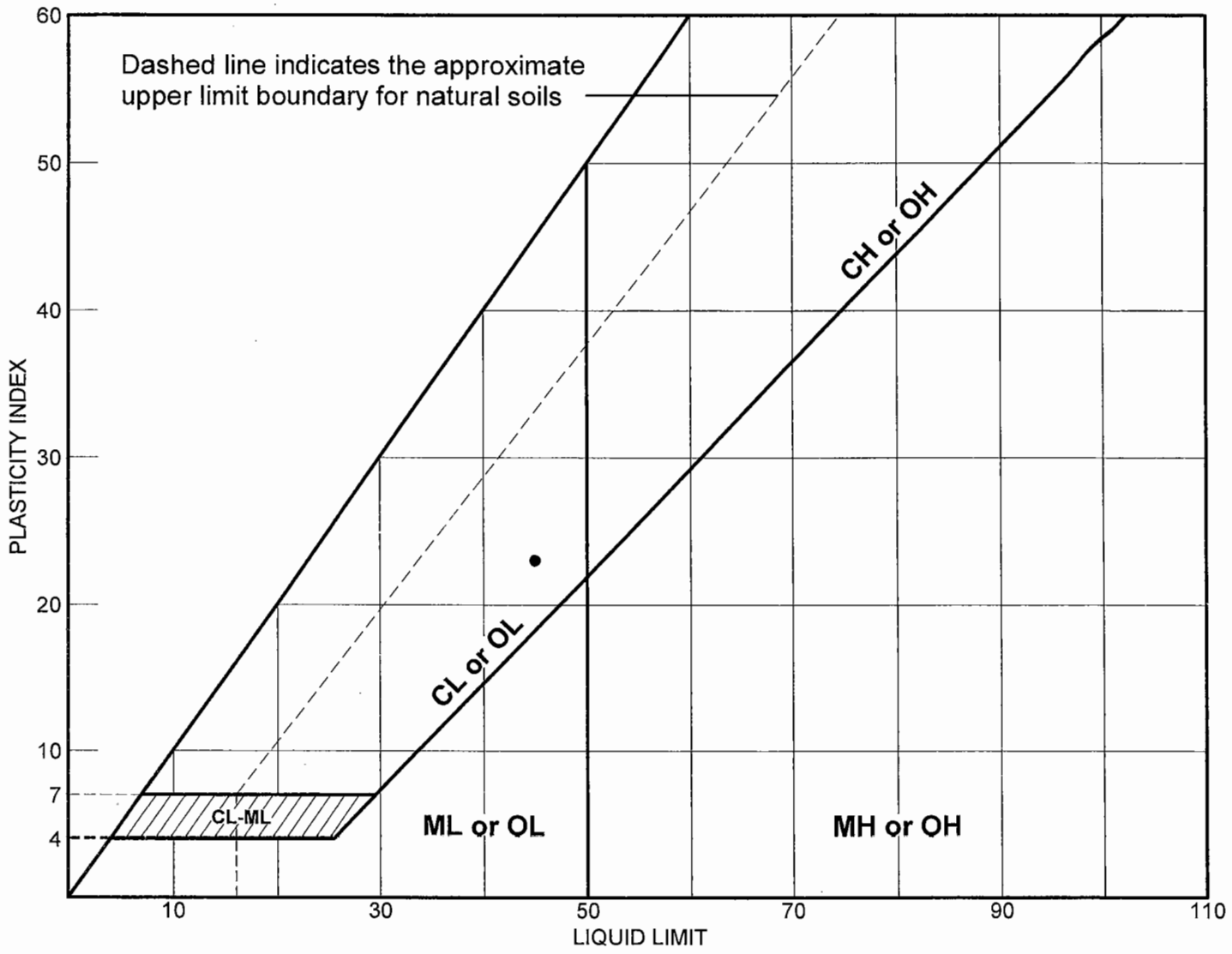
Remarks

Sample No.: 5,6,7 **Source of Sample:** B-9 **Date:** 23/May/07
Location: **Elev./Depth:** 9.0-20.5'

SUELOS, INC.

Client:
Project: Peñones Cabo Rojo
Project No: **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-9	5,6,7	9.0-20.5'		22	45	23	SC

LIQUID AND PLASTIC LIMITS TEST REPORT

SUELOS, INC.

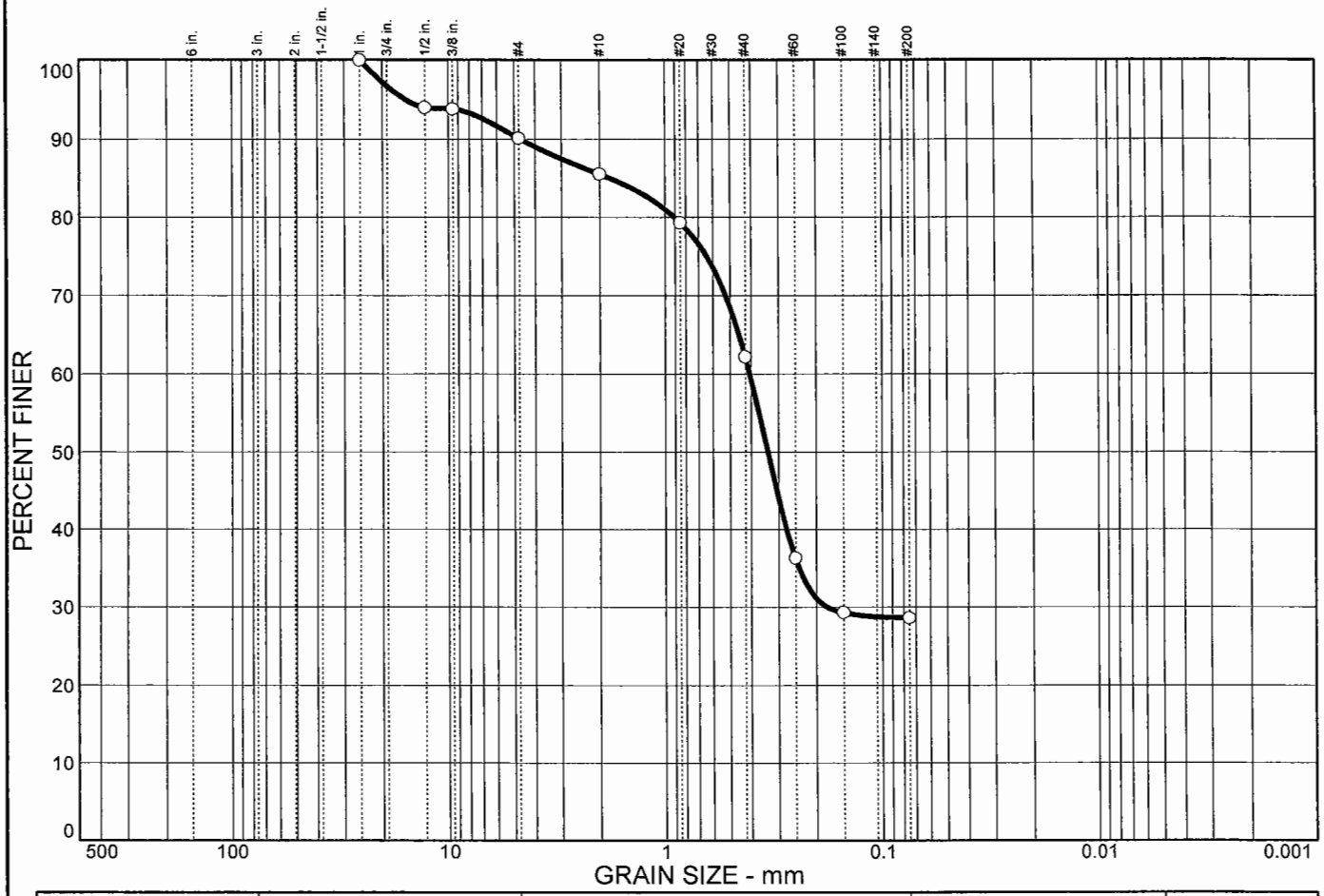
Client:

Project: Peñones Cabo Rojo

Project No.:

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	9.9	61.5	28.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
1/2 in.	94.0		
3/8 in.	93.8		
#4	90.1		
#10	85.5		
#20	79.3		
#40	62.2		
#60	36.3		
#100	29.3		
#200	28.6		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.81 D_{60}= 0.406 D_{50}= 0.335
D_{30}= 0.178 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

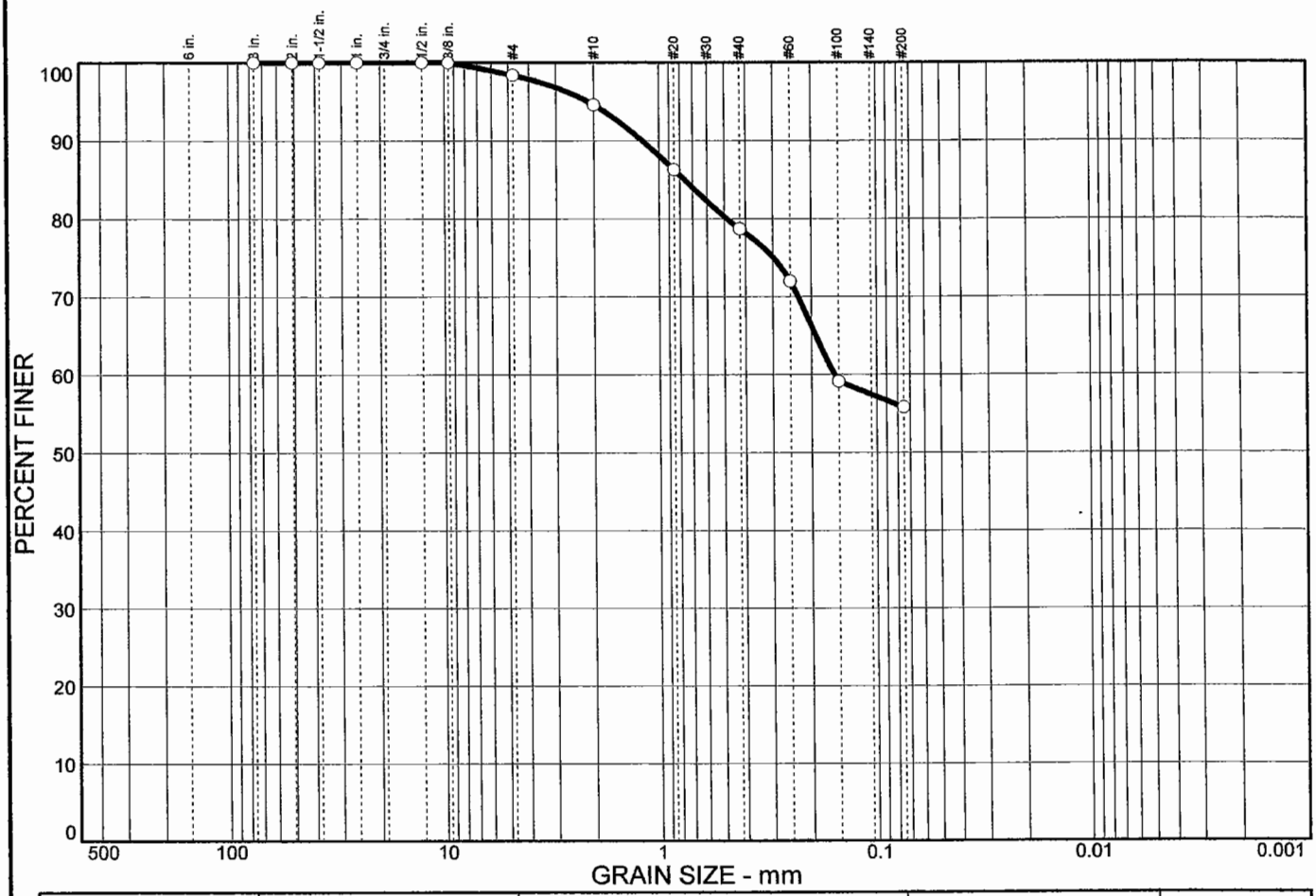
Remarks

Sample No.: 3,4,5 **Source of Sample:** B-8 **Date:** 23/May/07
Location: **Elev./Depth:** 4.0'-10.5'

SUELOS, INC.

Client:
Project: Peñones Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.6	42.6	55.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	98.4		
#10	94.6		
#20	86.3		
#40	78.7		
#60	72.0		
#100	59.1		
#200	55.8		

* (no specification provided)

Material Description

Sandy lean clay

Atterberg Limits

PL= 15 LL= 32 PI= 17

Coefficients

D_{85}= 0.759 D_{60}= 0.157 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(6)

Remarks

Sample No.: 2 **Source of Sample:** B-2 **Date:** 5/15/07
Location: **Elev./Depth:** 2 - 3.5'

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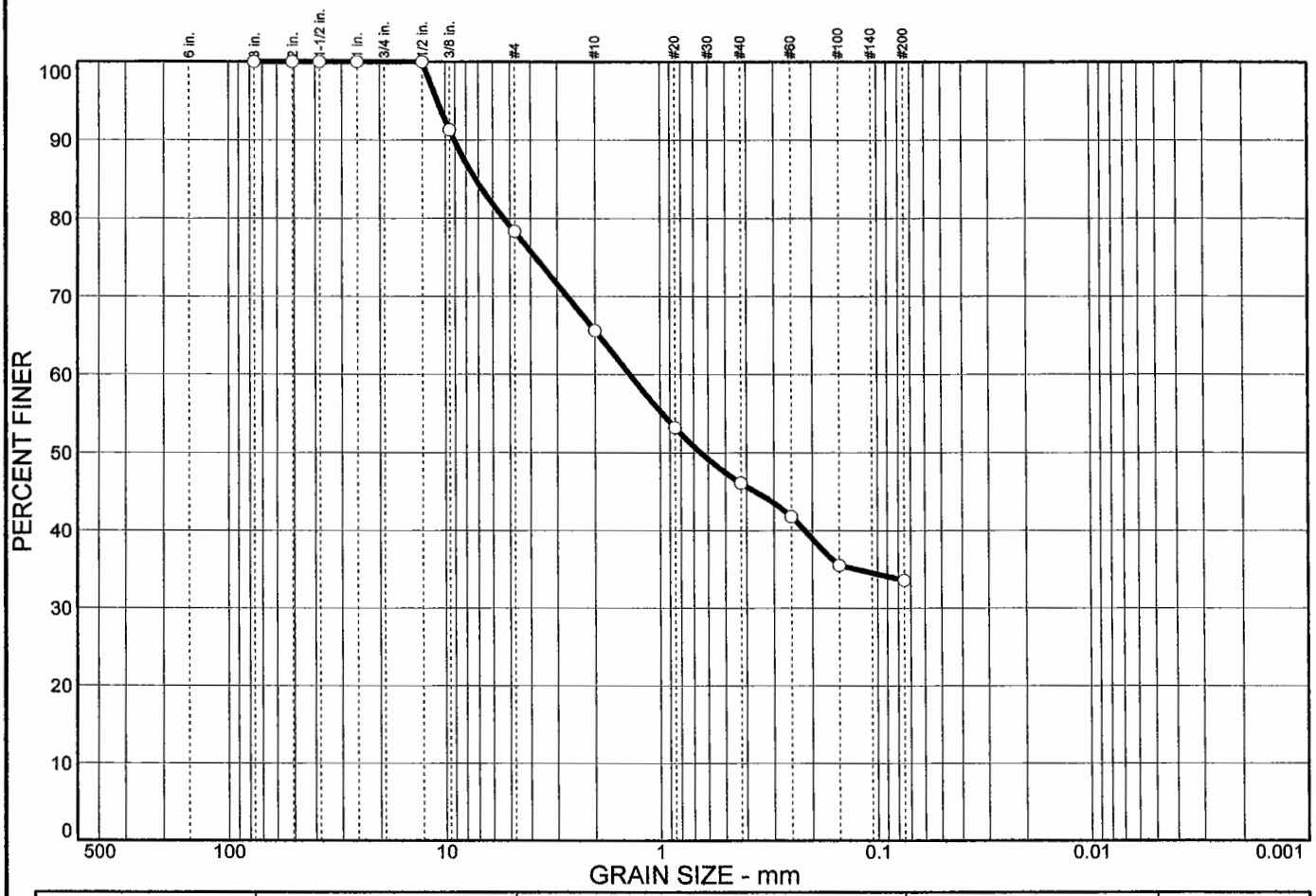
San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	21.7	44.7	33.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	91.3		
#4	78.3		
#10	65.6		
#20	53.2		
#40	46.1		
#60	41.8		
#100	35.5		
#200	33.6		

* (no specification provided)

Material Description

Clayey sand with gravel

Atterberg Limits

PL= 21 LL= 40 PI= 19

Coefficients

D_{85}= 7.21 D_{60}= 1.38 D_{50}= 0.648
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(2)

Remarks

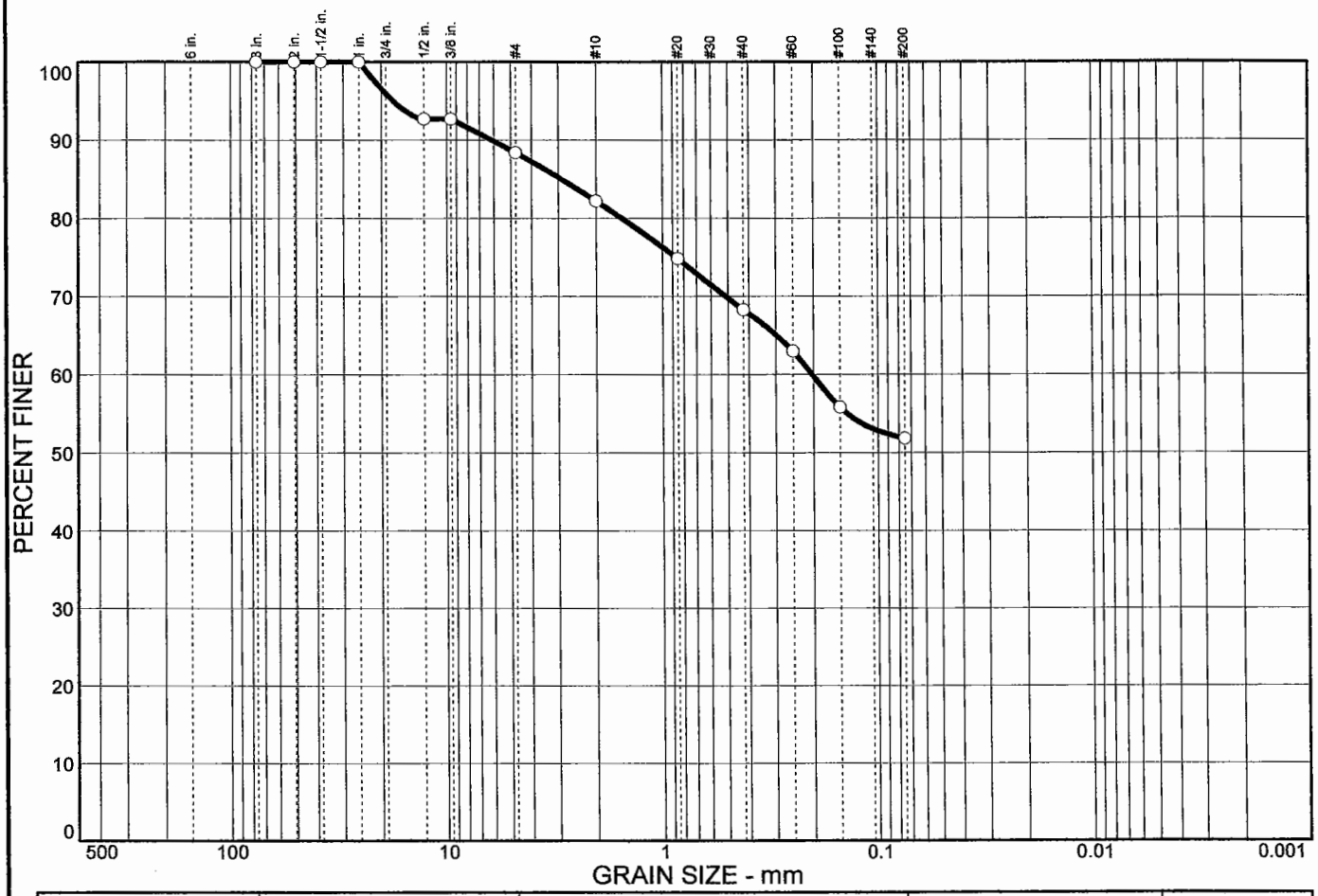
Sample No.: 2 **Source of Sample:** B-4 **Date:** 5/15/07
Location: **Elev./Depth:** 2 - 3.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.6	36.6	51.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	92.7		
.375 in.	92.7		
#4	88.4		
#10	82.2		
#20	74.8		
#40	68.3		
#60	63.0		
#100	55.8		
#200	51.8		

* (no specification provided)

Material Description

Sandy lean clay

Atterberg Limits

PL= 24 LL= 40 PI= 16

Coefficients

D_{85}= 2.90 D_{60}= 0.203 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(6)

Remarks

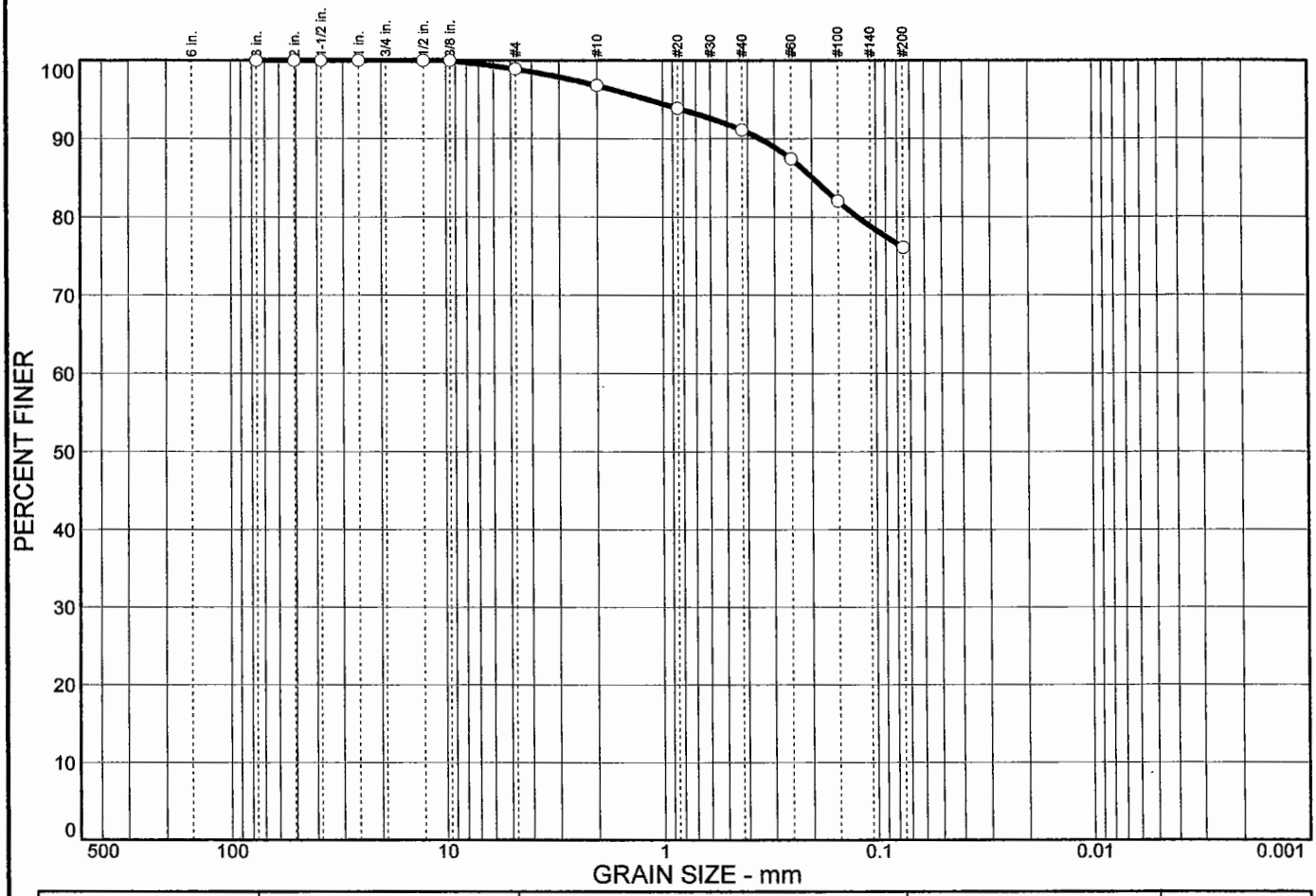
Sample No.: 2 **Source of Sample:** B-5 **Date:** 5/15/07
Location: **Elev./Depth:** 2 - 3.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.1	22.8	76.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	98.9		
#10	96.8		
#20	93.9		
#40	91.1		
#60	87.4		
#100	82.0		
#200	76.1		

* (no specification provided)

Material Description

Lean clay with sand

Atterberg Limits

PL= 25 LL= 44 PI= 19

Coefficients

D_{85}= 0.198 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(15)

Remarks

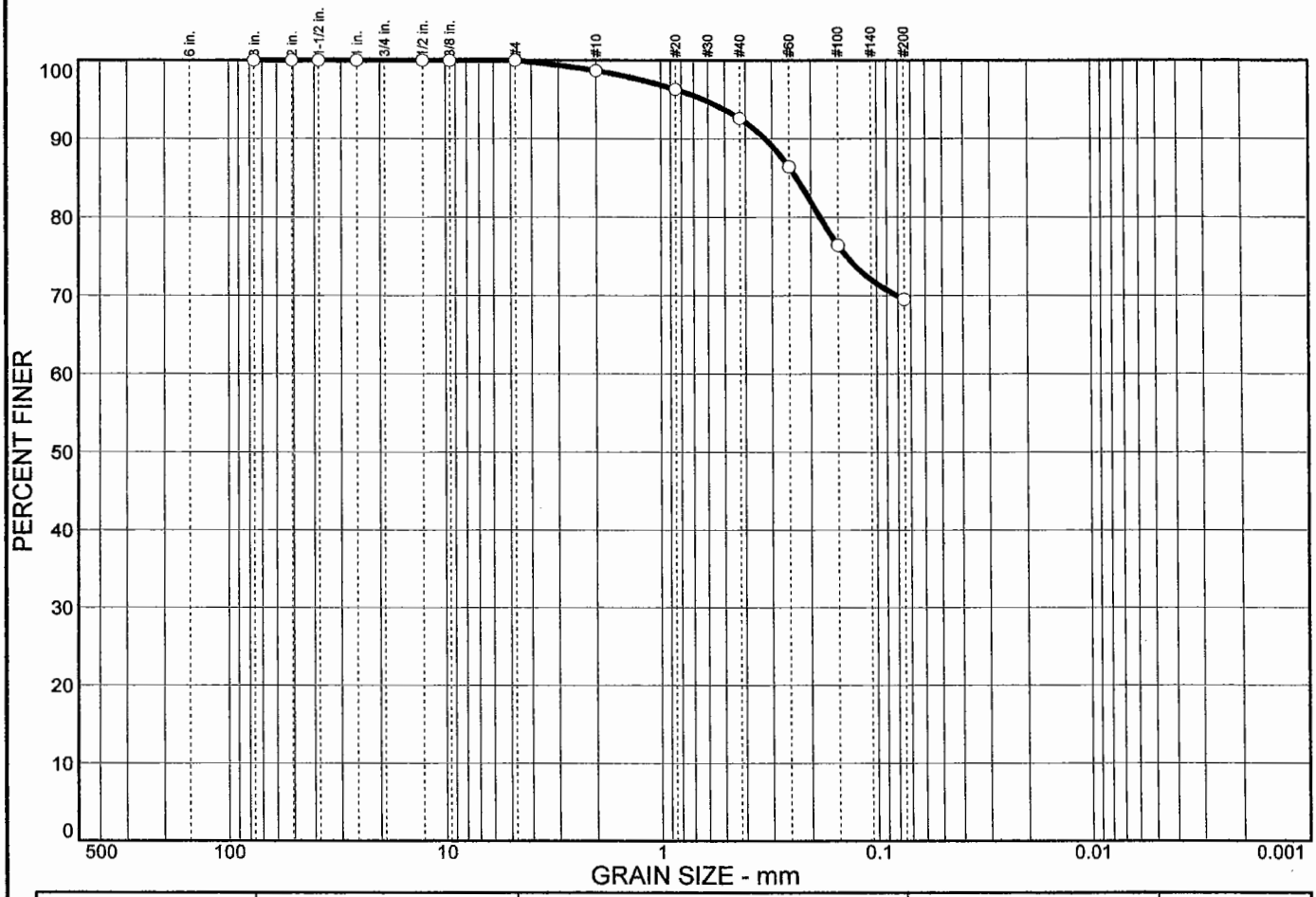
Sample No.: 4 - 5.6' **Source of Sample:** B-6 **Date:** 5/11/07
Location: **Elev./Depth:**

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	30.5	69.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	100.0		
#10	98.7		
#20	96.3		
#40	92.6		
#60	86.4		
#100	76.4		
#200	69.5		

* (no specification provided)

Material Description

Sandy lean clay

Atterberg Limits

PL= 25 LL= 47 PI= 22

Coefficients

D_{85}= 0.232 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(15)

Remarks

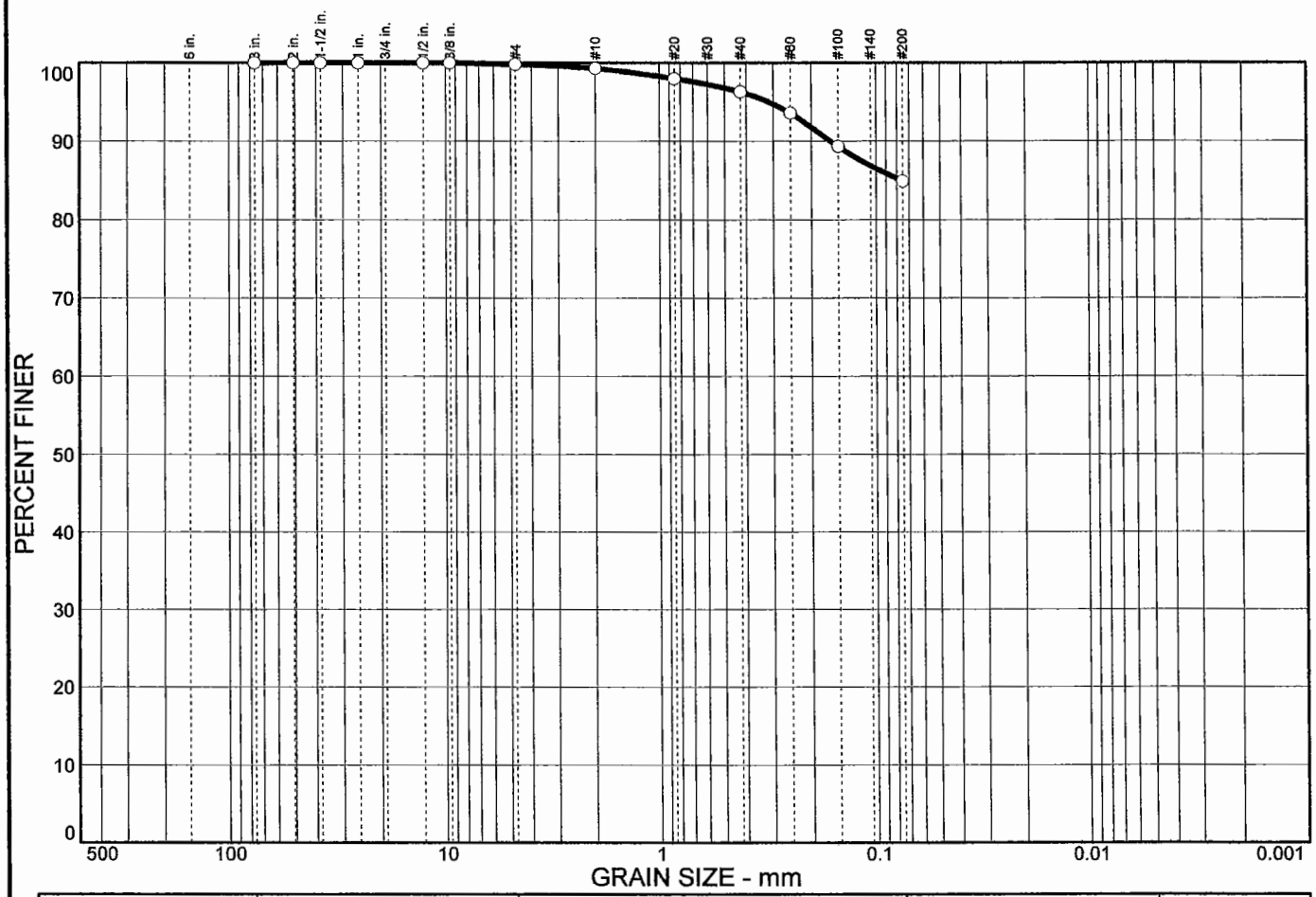
Sample No.: 2 **Source of Sample:** B-7 **Date:** 5/15/07
Location: **Elev./Depth:** 2 - 3.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	14.9	84.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	99.8		
#10	99.3		
#20	98.0		
#40	96.3		
#60	93.6		
#100	89.3		
#200	84.9		

* (no specification provided)

Material Description

Fat clay with sand

Atterberg Limits

PL= 27 LL= 62 PI= 35

Coefficients

D_{85}= 0.0764 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(33)

Remarks

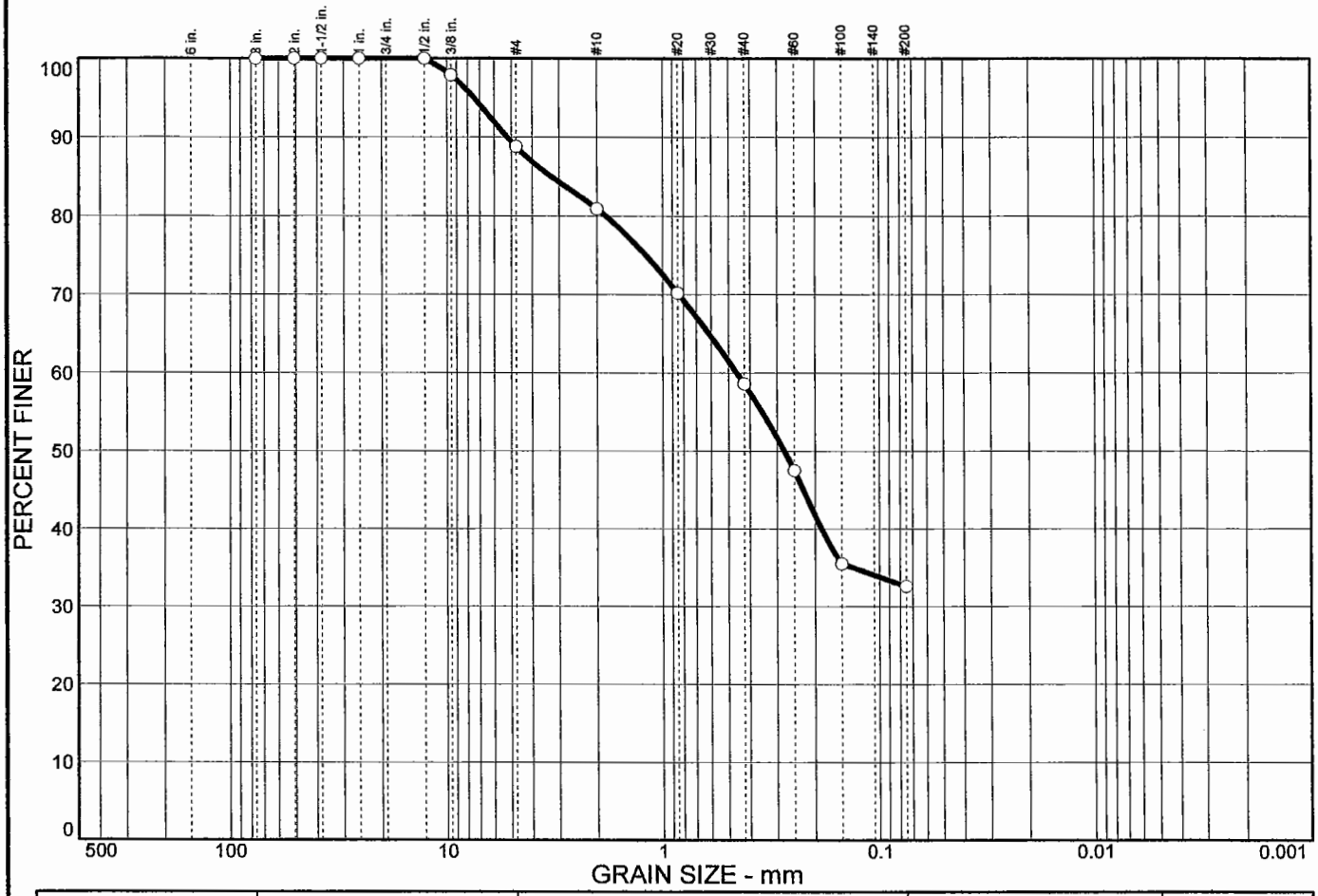
Sample No.: 3 **Source of Sample:** B-7 **Date:** 5/15/07
Location: **Elev./Depth:** 4 - 5.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.2	56.2	32.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	97.9		
#4	88.8		
#10	80.9		
#20	70.2		
#40	58.6		
#60	47.5		
#100	35.5		
#200	32.6		

* (no specification provided)

Material Description

Clayey sand

Atterberg Limits

PL= 22 LL= 38 PI= 16

Coefficients

D_{85}= 3.25 D_{60}= 0.459 D_{50}= 0.278
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

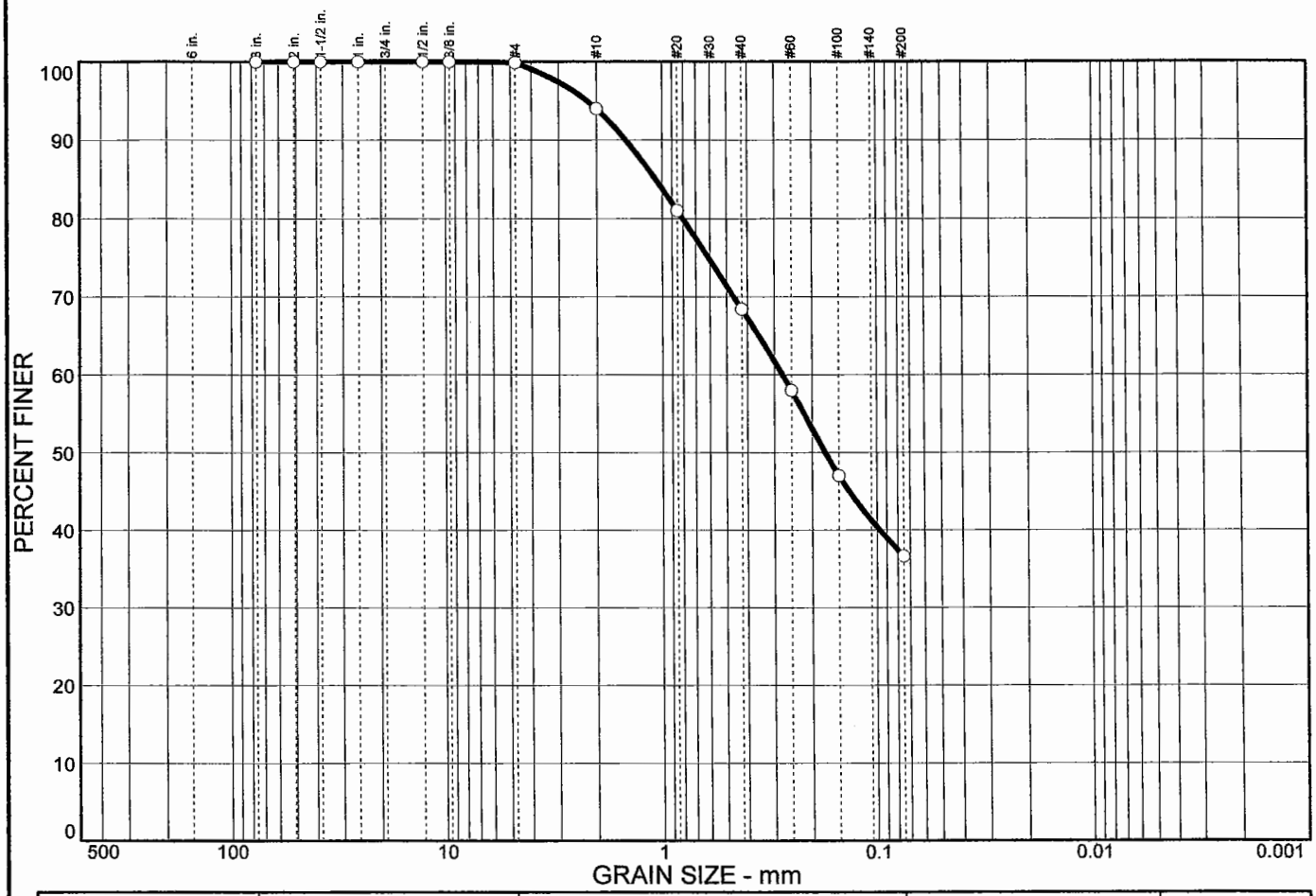
Sample No.: 1 **Source of Sample:** B-8 **Date:** 5/15/07
Location: **Elev./Depth:** 0 - 1.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	63.3	36.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	99.9		
#10	94.0		
#20	81.0		
#40	68.4		
#60	58.0		
#100	47.0		
#200	36.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 1.07 D_{60}= 0.275 D_{50}= 0.174
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

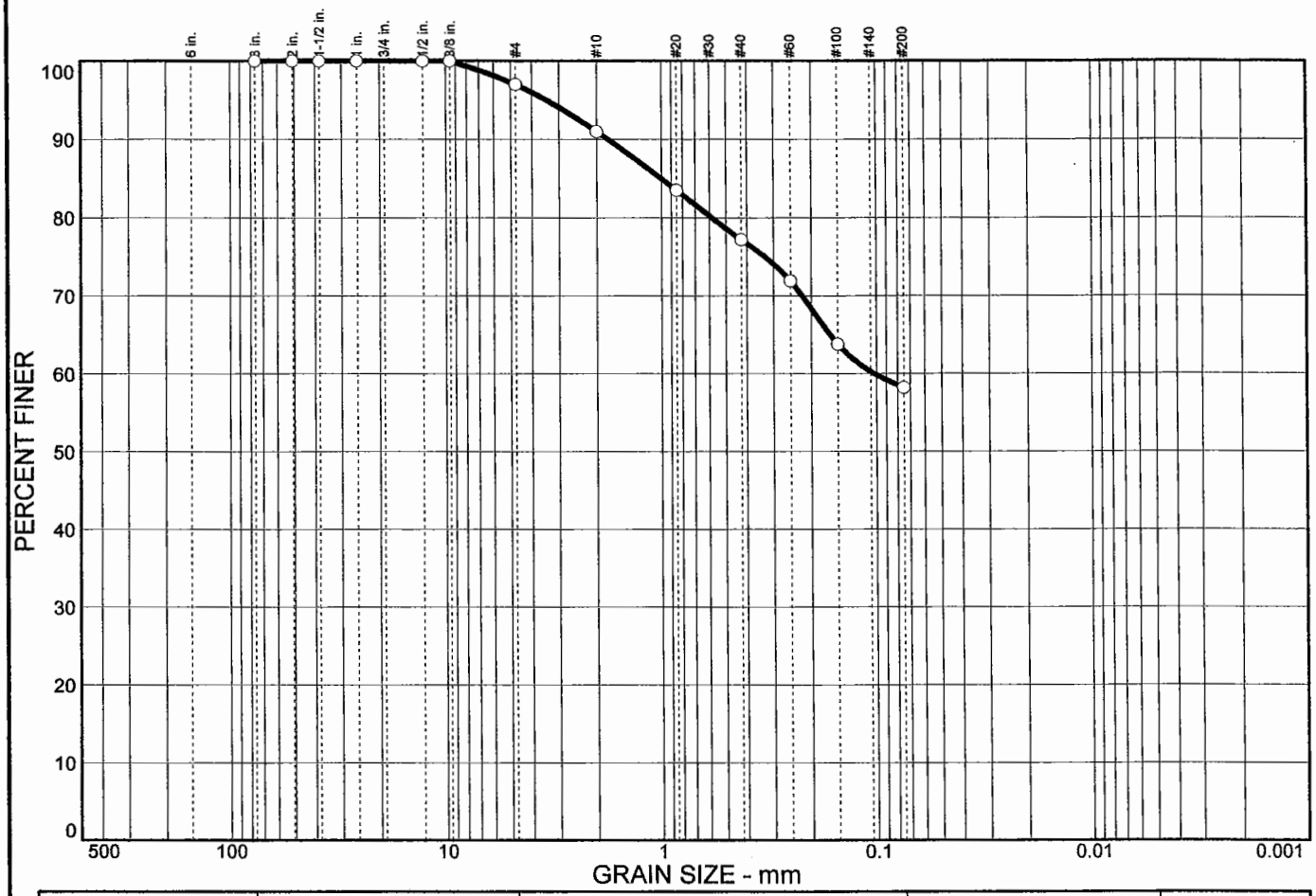
Sample No.: 2 **Source of Sample:** B-8 **Date:** 5/15/07
Location: **Elev./Depth:** 2 - 3.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.0	38.8	58.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	97.0		
#10	91.0		
#20	83.5		
#40	77.2		
#60	71.9		
#100	63.8		
#200	58.2		

* (no specification provided)

Material Description

Sandy lean clay

Atterberg Limits

PL= 20 LL= 28 PI= 8

Coefficients

D_{85}= 1.00 D_{60}= 0.102 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-4(2)

Remarks

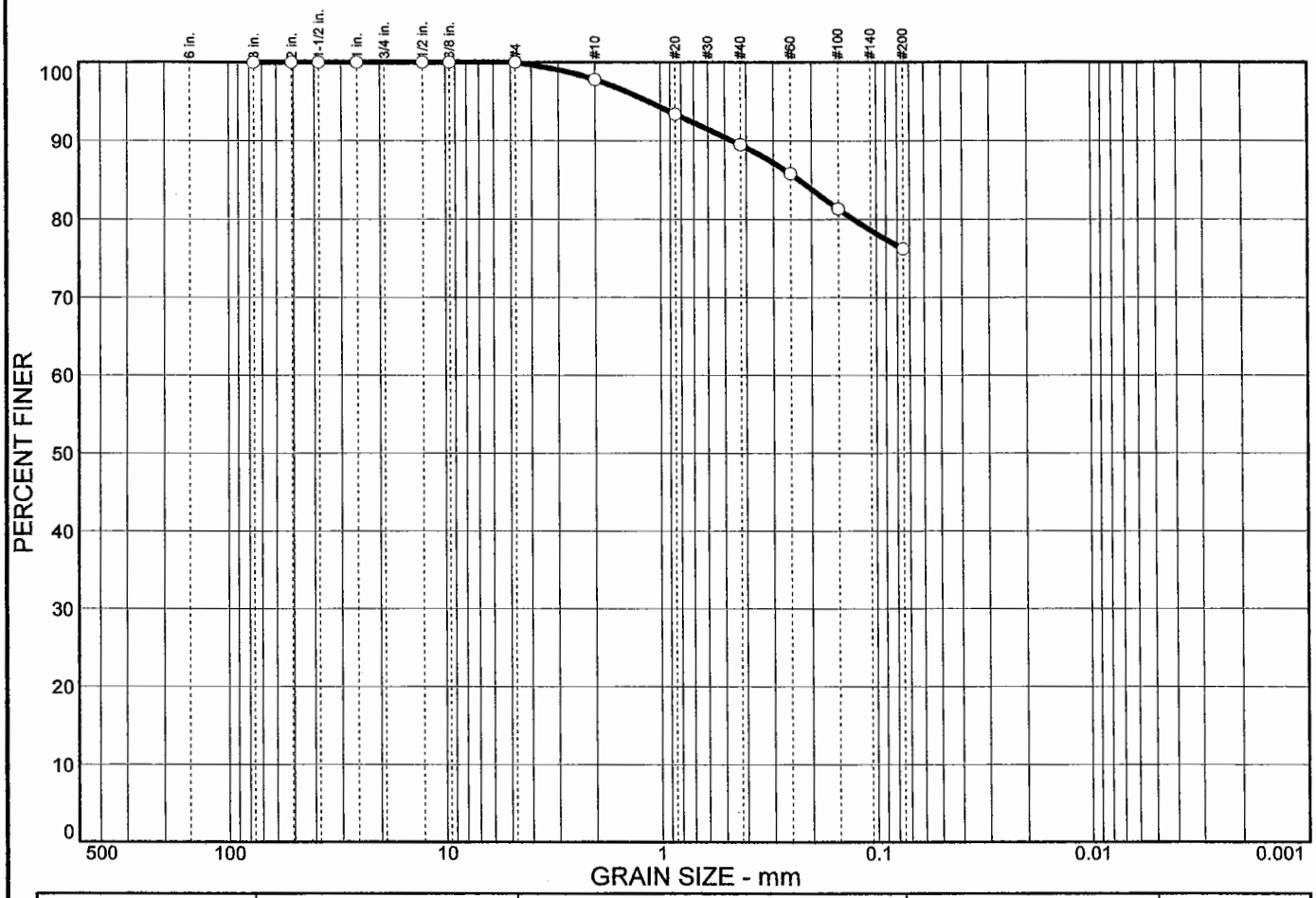
Sample No.: 4 **Source of Sample:** B-9 **Date:** 5/15/07
Location: **Elev./Depth:** 6 - 7.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	23.8	76.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	100.0		
#10	97.8		
#20	93.4		
#40	89.5		
#60	85.8		
#100	81.3		
#200	76.2		

* (no specification provided)

Material Description

Lean clay with sand

Atterberg Limits

PL= 22 LL= 35 PI= 13

Coefficients

D_{85}= 0.227 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(9)

Remarks

Sample No.: 2 **Source of Sample:** B-9 **Date:** 5/15/07
Location: **Elev./Depth:** 2 - 3.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.3	53.7	42.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	95.7		
#10	88.2		
#20	80.2		
#40	73.4		
#60	65.4		
#100	51.8		
#200	42.0		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 1.42 D_{60}= 0.203 D_{50}= 0.138
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

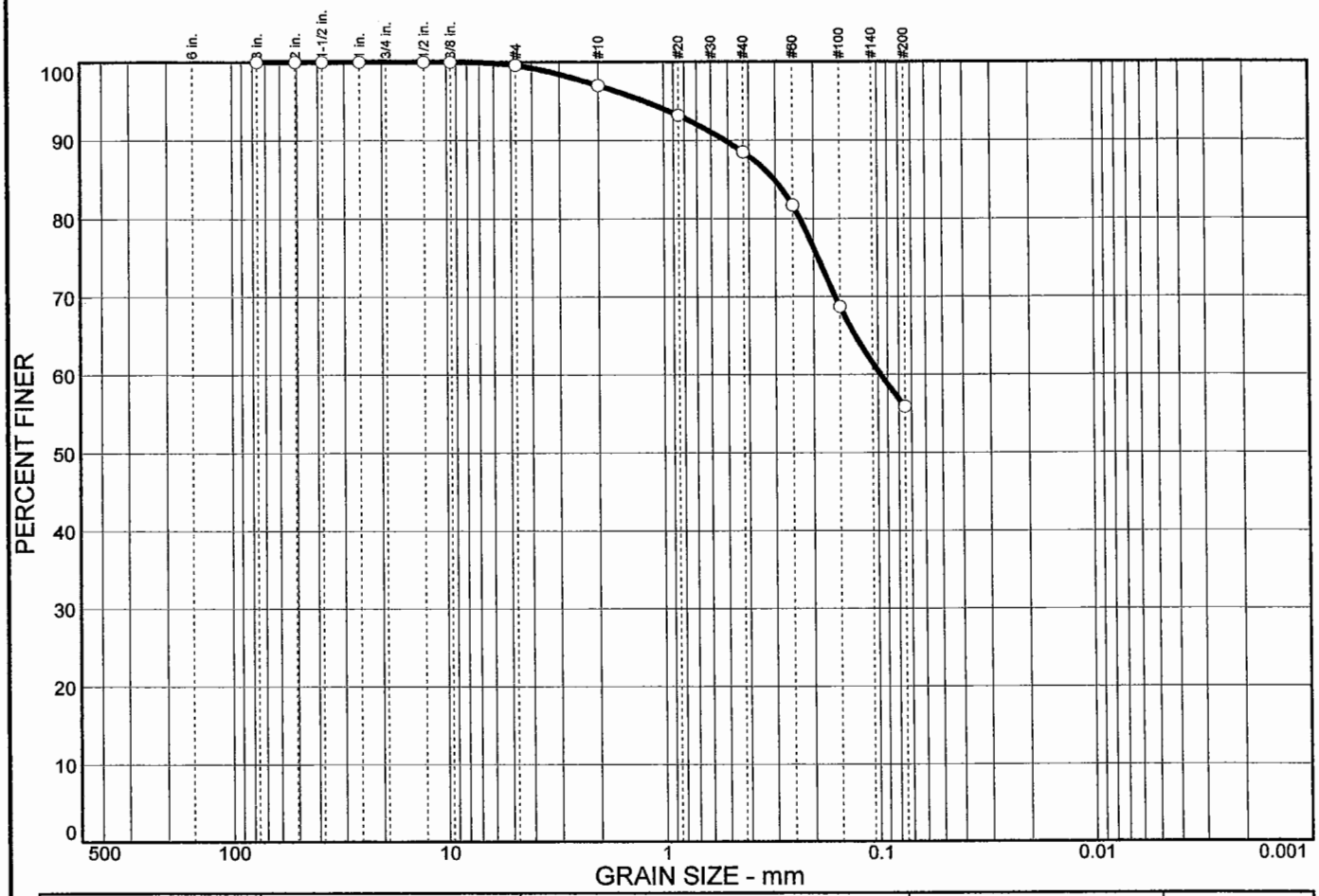
Sample No.: 1 **Source of Sample:** B-10 **Date:** 5/15/07
Location: **Elev./Depth:** 0 - 1.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.4	43.7	55.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1.5 in.	100.0		
1 in.	100.0		
0.5 in.	100.0		
.375 in.	100.0		
#4	99.6		
#10	97.0		
#20	93.2		
#40	88.5		
#60	81.7		
#100	68.7		
#200	55.9		

* (no specification provided)

Material Description

Sandy lean clay

Atterberg Limits

PL= 21 LL= 30 PI= 9

Coefficients

D_{85}= 0.304 D_{60}= 0.0971 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-4(3)

Remarks

Sample No.: 3 **Source of Sample:** B-10 **Date:** 5/15/07
Location: **Elev./Depth:** 4 - 5.5'

SUELOS, INC.

San Juan, Puerto Rico

Client:
Project: Peñones Melones, Cabo Rojo
Project No: **Figure**

BORING LOGS

Calle Chile 258, San Juan, P.R. 00917-2103 Tel. (787) 753-0147 Fax (787) 753-8387

SUELOS INC

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.

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SUELOS INC

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-1
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID	Driller : M. Galvez	Date Started : 4/25/07	WATER LEVEL:	N < 100 = 45.5
Hammer: 140#	Method : Auger	Date Completed: 4/25/07	Date : 4/25/07	N > 100 = 0
Drop : 30"	Drill Type: CME-45	Total Depth : 45.5	Depth: 30'	CORE =

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	89	3-7-6		Brown to reddish-brown very stiff clayey silt-silty clay, little-some rock fragments, trace sand, slightly organic at top, dry (Alluvial)	13		33
	2	56	7-9-11			20		22
	3	89	8-8-13			21		21
	4	67	15-17-21			38		15
10	5	100	8-7-9			16	2.8	31
	6	100	8-5-10		Reddish-brown to yellowish brown and light gray mottled stiff clayey silt, trace sand, dry.	15	3.4	29
20	7	100	9-12-15		- trace-some gravel	27		27
	8	100	14-17-19		- as above	36		
30	9	100	10-15-16			31	1.75	25
	10	100	12-17-14			31	2.25	28
40	11	100	10-13-22		- trace sand	35	3.6	29
	12	100	11-19-26		- trace sand, some rock fragments	45	3.6	27
					END OF TEST HOLE - 45.5 FT			
50								
60								
70								

Moist Cont - × PL ⊢—⊣ LL
N-Values - ○ 25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer falling 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) values are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-2
Job No. 3876
Sheet 1 of 1

Spoon :	1.375" ID	Driller :	M. Galvez	Date Started :	4/25/07	WATER LEVEL:		N < 100 = 12	
Hammer:	140#	Method :	Auger	Date Completed:	4/25/07	Date :		N > 100 = 23.5	
Drop :	30"	Drill Type:	CME-45	Total Depth :	35.5	Depth:	Not found	CORE =	

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	83	3-5-7		Brown to grayish-brown medium dense calcareous fine sandy silt, slightly organic at top, dry.	12		25
	2	72	7-8-10		Limestone: Sampled as grayish-brown medium dense - dense fine sandy silt, dry. (Prob. Parguera Limestone)	18		6
	3	89	6-9-10			19		7
	4	78	11-13-16			29		9
10	5	78	15-37-39			76		9
	6	67	17-35-50/4			85/10		10
20	7	56	41-50/3--		Sandstone: sampled as grayish-brown very dense fragmented rock in a silty sandy matrix, dry.	50/3		6
	8	22	50/5---- --			50/5		6
30	9	33	44-50/4--			50/4		4
	10	17	50/5---- --			50/5		5
					END OF TEST HOLE - 35.5 FT			
40								
50								
60								
70								

Moist Cont - ×
PL ⊢——⊣ LL
N-Values - ○
25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer fallin 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) value are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-3
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID Hammer: 140# Drop : 30"	Driller : M. Galvez Method : Auger Drill Type: CME-45	Date Started : 4/24/07 Date Completed: 4/24/07 Total Depth : 17	WATER LEVEL: Date : Depth: not found	N < 100 = 4 N > 100 = 8 CORE = 5

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	78	6-8-13		Fill: sampled as reddish-brown very stiff silty clay, dry.	21		14
	2	89	7-9-15		- moslty calcareous rock fragments	24		11
	3	22	38-50/3--		Sandstone: sampled as grayish-brown very dense fragmented rock in a silty sandy matrix, trace roots at top, dry. (Prob. Parguera Limestone)	50/3		15
	4	22	50/5---- --			50/5		7
10	5	6	60/2---- --			60/2		4
	6	57		52	Brownish gray volcaniclastic conglomerate, moderately jointed, joints are filled with calcite. RQD = Fair			
20					**END OF TEST HOLE - 17 FT**			
30								
40								
50								
60								
70								

Moist Cont - PL — LL
N-Values - 25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer fallin 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) value are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-4
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID Hammer: 140# Drop : 30"	Driller : M. Galvez Method : Auger Drill Type: CME-45	Date Started : 4/24/07 Date Completed: 4/24/07 Total Depth : 35.5	WATER LEVEL: Date : Depth: not found	N < 100 = 22 N > 100 = 13.5 CORE =

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	89	3-5-8		Fill: sampled as brown stiff silty clay, little sand and gravel, dry.	13	4.5*	21
	2	22	5-6-13		Limestone: sampled as grayish-yellow stiff-very stiff weathered rock in a calcareous silty fine sand, dry. (Prob. Parguera Limestone)	19		14
	3	100	12-11-13			24		6
	4	94	10-12-15			27		11
10	5	83	35-37-30		Mudstone: sampled as grayish-brown to reddish-brown very dense fragmented rock in a fine sandy silty matrix, dry.	67		9
	6	100	16-24-26			50	4.5*	15
20	7	89	19-23-28			51		13
	8	22	50/5---- --			50/5		10
30	9	22	50/5---- --			50/5		12
	10	11	50/3---- --			50/3		10
					END OF TEST HOLE - 35.5 FT			
40								
50								
60								
70								

Moist Cont - × PL ⊢—⊣ LL
N-Values - ○ 25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer fallin 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) value are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-5
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID Hammer: 140# Drop : 30"	Driller : M. Galvez Method : Auger Drill Type: CME-45	Date Started : 5/1/07 Date Completed: 5/1/07 Total Depth : 19	WATER LEVEL: Date : Depth: not found	N < 100 = 10.5 N > 100 = 3.5 CORE = 5

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	17	30-15-19		Limestone: sampled as grayish-yellow medium-very dense rock fragments in a fine sandy silty matrix, slightly organic at top, dry. (Prob. Parguera Limestone)	34		4
	2	78	5-7-13			20		13
	3	56	9-11-50/3			61/9		10
	4	22	50/5----			50/5		11
10	5	17	30-15-19		Weathered Sandstone: sampled as grayish-brown rock fragments in a silty sandy matrix, dry.	34		4
	6	38		21	Sandstone: sampled as brownish-gray rock fragments with some calcareous fragments. RQD=Very poor			
20					**END OF TEST HOLE - 19 FT**			
30								
40								
50								
60								
70								

Moist Cont - ×
PL ⟷ LL
N-Values - ○
25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer falling 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) values are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-6
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID	Driller : M. Galvez	Date Started : 4/26/07	WATER LEVEL:	N < 100 = 8
Hammer: 140#	Method : Auger	Date Completed: 4/26/07	Date :	N > 100 = 2
Drop : 30"	Drill Type: CME-45	Total Depth : 15.5	Depth: not found	CORE = 5

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	67	12-14-18		Fill: sampled as reddish-brown very stiff silty clay with rock fragments, dry.	32		14
	2	89	16-19-21			40		9
	3	72	18-20-21		Reddish-brown to brown clayey silt-silty clay w/trace sand, slightly organic, dry.	41		14
	4	78	30-32-39		Mudstone: sampled as reddish-gray very dense fragmented rock in a sandy silty matrix, dry.	71		8
10	5	11	60/3----		Sandstone: sampled as very dense fragmented rock in a sandy silty matrix, dry.	60/3		2
	6	37		29	Brown volcaniclastic conglomerate, few calcite filled joints and veins. RQD= Poor			
					END OF TEST HOLE - 15.5 FT			
20								
30								
40								
50								
60								
70								

Moist Cont - PL — LL
N-Values - 25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer fallin 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) value are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-7
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID	Driller : M. Galvez	Date Started : 4/27/07	WATER LEVEL:	N < 100 = 17.5
Hammer: 140#	Method : Auger	Date Completed: 4/27/07	Date :	N > 100 = 18
Drop : 30"	Drill Type: CME-45	Total Depth : 35.5	Depth: not found	CORE =

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	78	5-8-8		Brown very stiff silty clay, trace sand, slightly organic at top, dry. (Prob. Alluvial)	16		17
	2	56	9-10-12			22		13
	3	89	20-14-12		Greenish-yellow very stiff silty clay-clayey silt, trace sand, caliche nodules, dry.	26		21
	4	100	15-17-19		- trace small roots	36	4.5*	7
10	5	83	34-35-41		Mudstone: sampled as very dense rock fragments in a sandy silty matrix, dry. (Prob. Parguera Limestone)	76		12
	6	89	36-38-33			71		12
20	7	50	37-50/4--			50/4		9
	8	44	41-50/3--		- mostly grayish-brown fragmented limestone	50/3		13
30	9	22	50/5----- --		- as above	50/5		12
	10	17	50/4----- --			50/4		10
					END OF TEST HOLE - 35.5 FT			
40								
50								
60								
70								

Moist Cont - ×
PL ⊢——⊣ LI
N-Values - ○
25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer fallin 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) value are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-8
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID Hammer: Drop :	Driller : M. Galvez Method : Auger Drill Type: CME-45	Date Started : 4/23/07 Date Completed: 4/30/07 Total Depth : 23	WATER LEVEL: Date : Depth: Not found	N < 100 = 4 N > 100 = 14 CORE = 5

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	89	7-11-13		Grayish-brown medium dense fine sandy silt, slightly organic, dry.	24		5
	2	78	9-14-19		Weathered Limestone: sampled as gray dense fragments in a silty matrix, dry.	33		8
	3	44	37-50/5--		Limestone: sampled as grayish-brown very dense fragmented rock in a silty sandy matrix, dry.	50/5		4
	4	11	50/3---- --			50/3		6
10	5	11	50/2---- --		Sandstone: sampled as grayish-brown very dense rock fragments in a silty matrix, dry.	50/2		4
	6	11	60/3---- --		Mudstone: sampled as grayish-brown fragmented rock in a silty sandy matrix, dry.	60/3		8
20	7	73		7	Highly fractured- jointed varied rock types; cherty limestone at top, gray mudstone, sandstone and at bottom volcaniclastic conglomerate (Prob. shear zone) RQD= Very poor			
					END OF TEST HOLE - 23 FT			

Moist Cont - ×
PL ⊢——⊣ LL
N-Values - ○
25 50 75

30 40 50 60 70

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer falling 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) values are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-9
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID	Driller : M. Galvez	Date Started : 4/30/07	WATER LEVEL:	N < 100 = 8
Hammer: 140#	Method : Auger	Date Completed: 4/30/07	Date :	N > 100 = 27.50
Drop : 30"	Drill Type: CME-45	Total Depth : 35.5	Depth: Not found	CORE =

Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	89	3-3-6		Fill: sampled as brown stiff silty clay with rock fragments, dry	9		21
	2	56	3-4-5		Limestone: sampled as grayish-brown calcareous fragmented rock in a silty sandy matrix, slightly organic at top, dry. (Prob. Parguera Limestone)	9		6
	3	100	7-10-10			20		5
	4	100	9-10-18			28		3
10	5	56	40-50/5--		-few caliche	50/5		9
	6	17	50/4---- --			50/4		8
20	7	22	50/5---- --		- few sandstone fragments	50/5		8
	8	17	50/4---- --			50/4		9
30	9	39	44-50/2--		- mostly fragmented rock	50/2		8
	10	22	50/5---- --		- as above	50/5		11
					END OF TEST HOLE - 35.5 FT			
40								
50								
60								
70								

Moist Cont - ×
PL ⊢——⊣ LI
N-Values - 25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer fallin 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) value are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.

Soil and Construction Materials Laboratory
SUBSURFACE EXPLORATION LOG

PROJECT: PEÑONES DE MELONES, CABO ROJO, PUERTO RICO

BORING NO.: B-10
Job No. 3876
Sheet 1 of 1

Spoon : 1.375" ID Hammer: 140# Drop : 30"	Driller : M. Galvez Method : Auger Drill Type: CME-45	Date Started : 4/20/07 Date Completed: 4/20/07 Total Depth : 35.5	WATER LEVEL: Date : Depth: Not found	N < 100 = 12 N > 100 = 23.5 CORE =
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Depth meters	Samp No.	Recov %	S.P.T. values	RQD %	Description of material	SPT-N values	Qu TSF	Moist Cont%
0	1	72	15-18-20		Limestone: sampled as gray and brownish- gray very dense rock fragments in a silty fine sandy matrix, moderately organic at top, dry. (Prob. Melones Limestone)	38		8
	2	83	17-22-35			57		5
	3	89	15-31-36			67		8
	4	83	17-33-41			74		4
10	5	83	30-34-31			65		3
	6	56	32-50/5--		- sandy	50/5		5
20	7	44	40-50/2--			50/2		5
	8	11	50/3-----			50/3		3
30	9	17	50/4-----		- few calcite veins	50/4		4
	10	11	50/3-----			50/3		7
					END OF TEST HOLE - 35.5 FT			
40								
50								
60								
70								

Moist Cont - × PL ⊢——⊣ LI

N-Values - 25 50 75

"N" values are the number of blows required to drive the sampling spoon a distance of twelve inches with a 140 lbs hammer fallin 30 inches. Natural Moisture Content (2) is expressed in percentage of its dry weight. Unconfined Compressive Strength (Qu) value are expressed in tons per square foot. *Pocket penetrometer values are marked with an asterisk.