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REPORT ON A PRELIMINARY GEOTECHNICAL INVESTIGATION PERFORMED FOR: PORTOFINO DEVELOPMENT PROJECT, MUNICIPALITY OF NAGUABO, PUERTO RICO

PIM-03-048

Prepared to:

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1.0 Introduction

This report contains the findings and recommendations of a preliminary geotechnical investigation performed for the Portofino Development Project. The project consists in the construction of four hundred (400) resort like villas and a fifty (50) room hotel on an eighty (80) *cuerdas* property, next to the PR-105 of the Húcares Ward, Municipality of Naguabo, Puerto Rico. This project also accounts with neighborhood and recreational facilities, access control, parking areas, and other infrastructure features.

The investigation was conducted in general accordance with the scope of services included in our proposal dated on June 27, 2003. The proposal was submitted to Mr. Federico Togni, from P.R. One, Inc., Project Owners, and was authorized on July 09, 2003. Project number PIM-03-048 was assigned to this job.

The main purpose of this investigation was to analyze the existing subsoil conditions and to determine the typical soil parameters required for the design and construction of the project. This preliminary geotechnical report makes reference to topographic site plans provided by Mr. Togni.

For the above purposes a series of field and laboratory procedures were performed. The field activities began with site visits to visually inspect the Project's area and the drilling crew accessibility. With this, a group of exploratory borings were assigned and completed. These borings were located in the field by approximate tape measurements. The location of the boreholes is also described in Figure 3 of the Appendix A of this report.

Both field and laboratory procedures are thoroughly discussed further ahead in this document.

Based on this background, this report contains information regarding the following topics:

a. Site Description
b. Scope of Field and Laboratory Work
c. Geologic Description
d. Soil Conditions
e. Site Development
f. Support Mechanisms
g. Settlement Analysis
h. Underground Utilities
i. "On Site" Construction Problems

2.0 Site Description

The project site is located to the southeast of the Naguabo downtown area, next to the Húcares Community and the Bahía de Lima. The site is limited to the north by the Punta Lima Municipal road, to the east by the mentioned Húcares Community, to the west by the Punta Lima sector and to the south by the Vieques Passage and the Caribbean Sea. Figure 1 of Appendix A shows the site location using the Topographic Map of the Naguabo Quadrangle (USGS, 1982).

According to this reference and confirmed by site inspections performed by our laboratory personnel, the site can be described as mountainous terrain with considerable surface changes produced by two (2) hills that lie to the west and center of the site. Maximum elevations at the top of the westernmost mountain reached 50-meters, while in the center hill about 40 meters. The lower elevations of the site were close to sea level elevation at the beach area (south of the property). In addition a mangrove area was also observed at the south. Other topographic features includes two (2) alluvial valleys through which two (2) gullies cross the property from northwest toward the southeast. The elements discharge at the Bahía Lima.

The final grading information was not available at this time. However, given the above discussed topography, it shall be expected that considerable earth movement activities will take place during construction.

Based on this, we will provide some general site development recommendations that shall govern the related field activities to be performed by the awarded Contractor. If any of the proposed grading elevations or building locations change, we recommend that a final set of site and foundation drawings be submitted to us for comments prior to the bidding process. All of these recommendations are subject to modifications in a final geotechnical investigation.

3.0 Scope of Field and Laboratory Work

A total of seven (7) explorations were initially assigned but given some difficulties with the access conditions, only six (6) were completed for the investigation. Appendix Figure 3 shows the planimetry of the subject area including the test boring locations.

The borings were performed using a Central Mine Equipment 45-B trailer mounted drill rig. These explorations reached depths of up to twenty (20) feet measured from the existing surface elevations. The hollow stem auger method was applied for these procedures. Lynac split spoons were used as samplers and testing probes. The boreholes were sampled using a discrete sampling method.

The Standard Penetration Test (SPT) was also applied during the boring advancement process. These were performed in accordance with ASTM procedure D-1586, *Penetration Test and Split Barrel Sampling of Soils*. This test serves to estimate the "in situ" density or consistency of the explored material. A total of thirty-one (31) SPT's were completed in this work.

The recovered soil samples were then preserved and transported to our laboratory. These were visually and manually inspected and described as per ASTM procedure D-2488, *Description and Identification of Soils (Visual-Manual Procedure)*. All samples were tested for moisture content and, pending on their composition, for unconfined resistance using pocket penetrometers or compression frames.

As per criteria of the assigned Geotechnical Engineer, four (4) samples were selected for determination of their soil index properties.

The soil index properties were determined after applying ASTM procedure D-4318, *Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*. The grain size distribution for the samples were assessed using ASTM procedure D-422, *Test Method for Particle-Size Analysis of Soils*. Both of the aforementioned standards were then used to classify the samples as per the Unified Soil Classification System (USCS). The latter represents test method ASTM D-2487, *Standard Practice for Classification of Soils for Engineering Purposes*.

All of the recollected field and laboratory data was evaluated in order to provide with the recommendations for the proposed Project.

A detailed description of field and laboratory procedures is included in the Appendix.

4.0 Geologic Description of the Site

According to the Geologic Map of the Naguabo and Part of Punta Puerca Quadrangles, prepared by John W. M'Gonigle (U.S. Geological Survey, 1979), three (3) map units can be encountered within the project site. These are, Qaf, Kd, and b-d-f. A description of these types of soils read as follows:

1. Qaf: Alluvium and Fanglomerate (Holocene and Pleistocene)

   "Unconsolidated to weakly consolidated, poorly to well sorted, clay to boulder size material in fans and in stratified alluvial valley fill deposits. Locally terraced; includes slope wash, small landslides and channel fill deposits. Gradational into units mapped as predominantly alluvium, alluvial plain, and terraced deposits. Thickness locally more than 25 m."

2. Kd: Daguao Formation (Lower Cretaceous)

   "Interbedded volcanic breccia, lava, and subordinate volcanic sandstone and crystal tuff. The volcanic breccia is medium gray, massive, and is composed of clasts of dark gray irregularly shaped subangular to subrounded granule to cobble size porphyritic andesite lava in a medium gray coarse grained plagioclase and clinopyroxene crystal tuff matrix. The breccia units are commonly cut by fine grained and porphyritic lava dikes. Breccia beds are generally exposed only in artificial excavations, and float on natural slopes consists largely of lava clasts. Lavas are principally medium dark gray andesites with a pilotaxitic texture and andesine clasts commonly more than 5 cm in diameter, either welded together or in a matrix of sheared andesite. Some dark greenish gray, very fine grained flows are also autobrecciated. Typical massive tuff breccia can be seen in housing excavations just northwest of Daguao; good breccia and lava exposures can be found along the coast southeast of Húcares. Coarse autoclastic lavas may be found throughout the section in the ridge directly west of Ensenada Honda and Langley Drive, on the Roosevelt Roads Naval Reservation. Dark to medium gray volcanic sandstone and tuffs are usually laminated to thin bedded and graded, and are locally crossbedded. A few crystal tuffs are hornblende rich; most sandstone and tuffs are composed of plagioclase and clinopyroxene grains like the matrix of the massive volcanic breccias, and fairly commonly are calcareous. The sandstone and tuffs generally form units only a few meters thick in the western part of the mapped area. Notably thicker sequences in the east are shown by diagonal lines. Thick sequences of thin bedded to laminated tuff are well exposed along the coast from Punta Algodones to Punta Cascajo, on the Roosevelt Roads Naval reservation. Rocks of the Daguao Formation are commonly epidotized and chliritized in varying degrees. Volcaniclastic hornfels (Kdh) occurs in one area north of Daguao, south of the keratophyre stocks (TKk). The formation interfingers with the overlying Figuera Lava in a few places; its base is not exposed. The thickness of the Daguao is estimated to be on the order of 1000 to 1500 meters."

3 b-d-f: Dikes (Tertiary? and upper Cretaceous?)

> *"(b), Dark gray fine grained andesitic dikes, locally potphyritic with plagioclase and /or pyroxene phenocrysts; (f), light gray, fine to medium grained aplite dikes and associated quartz veins; (d), light to medium light gray and brown medium grained hornblende quartz diorite and hornblende granodiorite dikes locally bearing bipyramidal quartz phenocrysts, and fine grained quartz bearing dacite dikes. Bipyramidal quartz phenocrysts are especially prevalent along the coast near Húcares."*

Please refer to Figure 2 for the project location within the USGS Geologic Map.

5.0 Soil Conditions and Properties

The results of the performed geotechnical investigation are consistent with the afore presented geologic description. The site materials were sampled mainly as highly weathered rock sampled as admixtures of clay, silt, and sand (clayey sand, sandy clay, sandy silt) derived from the Daguao Formation. The samples showed different brown and yellow tones. Fractured rock described as gravel was observed within some samples. The gravel particles showed an angular shape with coarse to fine grain sizes. Its color was mainly gray. It is probable that this material was part of the dikes present at the area.

Boring 4 revealed the presence of Alluvial and Fanglomerate materials. They were sampled as alternate layers of clayey sand, gravel, and clay were uncovered. These samples showed a fill like structure. Their colors varied from yellow, brown, gray, and black. Roots and organics were also noted at some samples. These soils are the product of the past flood events of the ravines that as mentioned cross the project area. They were formed by the sediment deposition and old landslide materials carried from the surrounding mountains. The encountered thickness was about 13.5 feet.

For these soil profiles, a series of Standard Penetration Tests were performed during the field exploration. This test describe the Relative Density/Cohesiveness of the soil by means of the "N-value", which denotes the number of blows required to penetrate one (1) foot of material under controlled conditions. Please refer to the Appendix Section of Field Procedures for further penetration test details.

The recorded N-values ranged between thirteen (13) blows per foot and refusal values. The refusal term refers to the achievement of more than fifty (> 50) blows per a sampler advancement of six (6) inches or less. These results showed that the more fine grained matrices were in a stiff to hard consistency, while the more granular showed medium to very dense state of relative density. At this time the soils showed good strength properties. However these properties must be confirmed by a final geotechnical investigation, specially at those areas on which alluvial soils are expected to be present.

Another strength measuring analysis of soils is the Unconfined Compressive Strength (UCS). There are several means or tests from where UCS values can be obtained. These are applied in function of the nature and dimensions of the recollected samples. Due to the granular composition of most samples, no UCS tests were completed.

In regards to the water content levels for these materials, the recorded values ranged between 1% and 21%. Its variance will be in function of the sample composition and the groundwater table position.

5.1 Groundwater Conditions

The groundwater table was not registered at the time of exploration in any of the borings. However, please notice that the groundwater conditions are likely to change and that these readings are just an approximation. The groundwater table position varies in function of a series of soil and environmental properties that include topography, permeability, and weather features among others. For more precise recordings, a series of observation wells and / or piezometer must be installed and monitored for a considerable period of time. These procedures are out of the scope of this study.

5.2 Additional Laboratory Tests

A series of laboratory procedures were performed on a selected representation of boring samples recollected from the site. These tests determine the soil indexes that characterize the site profile. Among the tests performed are the Atterberg Limits and the Soil Sieve Analysis. These were then used to classify the materials as per the Unified Soil Classification System (USCS). Table 1 describes the accomplished results.

Table 1. Classification Tests Results

Sample ID + Location	Description	LL (%)	PL (%)	PI (%)	% Gravel	% Sand	% Fines	USCS
Sam. #2 - Bor. #2	Dark yellowish brown sandy fat clay	70	21	49	11.8	30.4	57.8	CH
Sam. #3 - Bor. #2	Strong brown lean clay	38	18	20	1.4	13.0	85.6	CL
Sam. #3 - Bor. #4	Dark yellowish brown and dark gray clayey sand	50	20	30	14.4	43.5	42.1	SC
Sam. #2 - Bor. #6	Pale yellow and gray silt with sand	43	30	13	2.6	21.3	76.1	ML

Note: LL= Liquid Limit, PL= Plastic Limit, PI= Plasticity Index, NV= Non Viscous, NP= Non Plastic

As a summary, the test results indicate that the soils consisted of clay, sand, and silt admixtures sometimes with gravel as secondary element. The USCS classifications were CH, CL, SC, and ML.

Note that these results shall be considered as preliminary given the limitations in sample size and in the recollection process. For more representative tests, test pits shall be performed at the site.

For a detailed description and stratigraphy of the soils encountered at the explored locations, including results of both field and laboratory tests performed, refer to the Subsurface Exploration Logs at the Appendix at the end of this report.

6.0 Conclusions

After reviewing all of the available information regarding the existing subsoil conditions, the site's topography, and the scheduled structural elements; the following conclusions can be distinguished:

a. That the proposed project is feasible from a geotechnical standpoint and that it can be constructed without the arising of any significant soil related problem, if and when, the included recommendations are correctly interpreted and applied.

b. That the site materials can be categorized by their origin mainly as highly weathered materials sampled as admixtures of clay, sand, and silt derived from underlying Daguao Formation. Some gravel particles were observed in the samples, probably as part of the dikes present within the formation. Boring #4 also revealed the presence of alluvial materials.

c. That, generally, the site's materials provided with good strength parameters. However, due to the presence of alluvial soils special care must be observed to address the possibility of encountering unconsolidated soils. The resistance and compressibility properties of these soils must be confirmed by a final geotechnical investigation specially at probable alluvial zones.

d. That the project will require some earth movement activities. Depending on their scope, these activities can be achieved using heavy earth movement equipment like track-type tractors, excavators, loaders, scrappers and hydraulic power tools.

e. That the magnitude and complexity of the expected site development tasks will require a close supervision by a Geotechnical Engineer and his designated technician. Therefore, the related engineering and laboratory testing services shall be retained to observe all earthworks activities of this project.

7.0 Preliminary Recommendations

With the conclusions in mind, we will provide with the corresponding site development and foundations recommendations, as deemed necessary for this project. Again, these shall be properly considered and applied, along with other important information included in this report.

7.1 Site Development Recommendations

7.1.1 Building Pad Areas

Site Preparation, Top Soil Stripping, and Demucking

Prior to the development of any structure or fill deposit, the complete earthwork areas must be properly cleaned and grubbed. No surface vegetation, debris, or any foreign matter can remain on site at this stage.

After the clearing and grubbing activities are finished, we recommend that surveying measurements be established in order to determine the planimetry and existing grading conditions of the site prior to the commencement of any earth movement task. These measurements will assist in the determination of top soil stripping, cut, and fill volumes within building and paving areas.

The top soil stripping activities shall consider the complete removal of all exposed material containing organic matter. The thickness of the this soil layer average at this time about 6-inches. This latter average thickness should be further addressed in the field to confirm the amount of stripping required.

The extension of the top soil stripping tasks will be mainly determined by field supervision (Geotechnical Engineer and/or his representative), in coordination with contractors and owners. Therefore, we recommend that for bidding purposes the shown thickness be preliminary considered to estimate costs. However, since actual volumes of top soil stripping/demucking will be determined in the field, unit costs shall be attached for these activities. Note also that given the presence of alluvial/fanglomerate soils, detrimental materials can be encounter and if found their removal is a must.

Proof Rolling

Once the top soil has been stripped, the exposed areas shall be properly proof rolled in order to prepare the natural terrain to receive the design fill, if any. The same conditions apply to those cut areas that achieve final grading elevations.

Proof rolling basically consists of compacting the exposed earthwork surfaces using a loaded heavy tractor, truck or roller (20-ton recommended). The compaction effort must be distributed in passes that run in all directions (north-south, east-west). **At least eight (8) passes of compaction with this equipment are recommended for each building/paving segment.**

These activities must also be fully supervised by the Geotechnical Engineer and/or his representative, in order to detect any weak spot, which shall be removed and replaced following the specifications for backfill and fill materials.

Cut Procedures

The following recommendations shall be considered for the cuts required to achieve the final grading elevations.

The rippability of the terrain suggests that track-type heavy earth movement equipment like tractors, loaders, excavators, assisted scrappers, and hydraulic power tools could adequately perform the stripping and cut related task.

In the event that any detrimental soft soil is uncovered during the cut operations, its full removal and replacement with a new fill material is a must. The latter must be properly certified by a Geotechnical Engineer prior to its placement.

Permanent cut slopes shall have a 1.5 Horizontal : 1.0 Vertical steepness. The same drainage specifications that shall be established for fill slopes apply here. Special attention shall be given to the appearance of bedding planes or joints unfavorable to the cuts. Field inspection from an experienced Geotechnical Engineer is a must to certify the long-term slope stability.

Excess cut materials can not be used as fill soils for structural areas unless they comply with the specified fill materials requirements. Note that preliminary classification tests performed for the obtained samples showed that the site material can not be used as fill. However, due to the existence of gravel deposits and sandy materials the use of the cut material as a fill will be subject to criteria of the and approval of Resident Geotechnical Engineer. Other appropriate deposit locations for the excess soil may be along green areas, and others.

Backfill and Fill Materials

If fill material is required, we recommend to use one that complies the following properties:

1. Percent Passing U.S. Sieve #200: 35 percent maximum
2. Liquid Limit: 40 maximum
3. Plastic Index: 11 minimum
4. Inert Material (Non-Expansive)

All materials must be properly tested, certified, and approved by a Geotechnical Engineer prior to its use.

Fill Deposit Construction

Once the earthwork area is proof rolled, and a fill material has been approved, the projected fill deposit activities may commence, as required.

The filling procedures must be performed in a sequential order. The placing of material shall follow a positive slope, where, lower grounds must be worked before higher ones.

The structural fill shall be constructed in layers not exceeding a ten (10) inch thickness (loose measure). Each layer shall be individually spread, compacted, tested, and certified by a Geotechnical Engineer. For the type of materials encountered during the field exploration, vibrating compaction equipment may be the most adequate.

The passing criteria for the field density tests shall be established as a comparison between the maximum dry density of the fill material, determined by a Modified Proctor Curve (ASTM D-1557), and the compaction effort achieved in the fill. As a minimum, the field effort shall be enough to achieve 95% percent of the maximum dry density for each fill material. The Contractor shall be responsible for providing sufficient and capable equipment for achieving these compaction activities in a timely and effective manner.

It is important to maintain the thickness of a fill deposit as uniform as possible. Differential soil responses to the applied loads can occur when having uneven fill thickness under a structure. As a criteria, fill thickness shall not vary by more than three (3) feet under a same independent structural unit. Uniform fill areas shall consider the footprint of the structures plus a minimum of six (6) feet strip around their perimeters.

When filling on natural slopes, the corresponding benching procedures shall be observed in order to step-in the fill embankment into the natural terrain. Applicable benching criteria as per terrain slopes are included in the Appendix of this report.

The fill procedures shall be performed at the early stages of construction. This will allow some time for the stabilization of the subsoil and the materials that conform the embankment.

Intermediate and final grade elevations and slopes shall provide all earthworks of correct ways of drainage. The accumulation of water over the area diminishes the effect of the soil compaction effort.

All fill slopes shall maintain a maximum 2 Horizontal : 1 Vertical steepness at all times. Again proper drainage ways shall be established in these slopes to avoid runoff water across their faces. These measures shall include gutters, drainage pipes, and spillways. Also, it is recommend the seeding of grass, or any other dense vegetation to assist in controlling erosion along the slope face. Please consult a landscape professional for further recommendations. Also, no structure shall be located closer than a fifteen (15) feet distance from cut or fill slopes edges.

7.1.2 Paving Areas

Any type of flexible pavement can be used for access roads and streets, following the typical specifications of the Puerto Rico Highway Authority. Conservative estimated values of fifteen (15) for the CBR can be used in the preliminary design. However, these assumed values must be revised by means of either a field or laboratory California Bearing Ratio test.

Waste disposal and/or truck loading zones must be designed in accordance to heavy loads, instead of light load vehicles. These measures shall diminish the events of pavement cracking and failure.

7.1.3 Underground Utilities and Excavations

Trenches for underground utilities and excavations can be constructed using heavy earth movement excavating equipment in almost vertical cuts with enough short term stability (under dry conditions) to allow for the installation of pipes.

It is very important to maintain a safe working environment throughout the construction process. Special considerations and good judgment must be practiced on those excavations exceeding a four (4) feet (1.22 m) depth. In any case, when people is working in trenches over this depth, sheeting protection shall be supplied.

Backfilling of trenches shall be performed by layers of six (6") (0.15 m) in thickness, with the appropriate control parameters. This material must be compacted to not less than ninety percent (90%) of the backfill material maximum dry density, obtained from a Soil Compaction Test, to be made in conformity with the ASTM D-1557 standard procedures.

7.2. Structural Foundation Parameters

7.2.1 Building Foundations

The encountered soil conditions showed that the proposed structures can be constructed using any shallow foundation system as the support mechanism. This includes the use of spread footing, continuous, combined footings, or mat foundation (monolithic slab with turned down footings). If spread footings are selected, we recommend that they be tied together using grade beams. This will provide more rigidity to the foundation system.

With this, an Allowable Bearing Capacity of 3,500 pounds per square foot shall be considered in their design. The minimum depth of foundation for this capacity is 2.0 feet from the lowest, adjacent, grade elevation, except in the case of a mat foundation that shall be equal to the mat thickness. The bottom of the footing excavations must be dry, clean, free of loose materials, construction debris, and cut up to a visually firm material.

If the use of a mat foundation is selected as the support mechanism of the proposed structures, we recommend a Modulus of Subgrade Reaction, Ks, of 150 pci.

These bearing recommendations are based on the assumption that the whole structure will be resting on uniform material (complete fill or complete cut). No structure shall partly rest on cut and fill soils. As note in the site plans this condition exists at the Building F area. In this case, the building pad must be over-excavated in order to develop a uniform fill in the area or the footing must be embedded into the natural material to avoid any potential differential displacement.

Design and construction procedures must consider a possible immediate total settlement of nearly one (1) inch. This deformation shall be mainly achieved during construction. Therefore, we recommend a per stage, load increase of each of the structures until reaching final design loads. This shall avoid the rapid overload of the supporting terrain. Similarly, we recommend that the utility connections be performed at the later stages of construction. This procedure is likely to reduce the possible deformations that the structure may suffer given a subsoil matrix rearrangement.

Due to the relatively low levels registered for the groundwater table, no dewatering measures are expected in this Project. Nevertheless, if such conditions arise, the use of common water pumps shall be enough to provide a working environment.

Again, all of the presented foundation recommendations are subject to confirmation by a final geotechnical which will eventually govern the earthwork and foundation activities of the project.

8.0 Report Limitations

This report has been prepared for the exclusive use of P.R. One, Inc. and its designing team associated to this specific project. It was prepared in accordance with the generally accepted local geotechnical engineering practices, no other warranty is expressed or implied.

Furthermore, this report is based on the design considerations presently known to us. Project designers must be aware of this situation to check if any important design parameter has been overlooked, or requires additional clarification.

The evaluation and recommendations included in this document are based upon the data collected from the field and laboratory testing activities, and from our site visit observations. However some variations to the conditions described in this report may not become evident until the time of construction. If such is the case, the resident Geotechnical Engineer must assess the situation, confirm the recommendations included in this report or modify them according to his own judgment.

If changes are made in the nature, design or location of the proposed structures, the conclusions and recommendations contained in this report shall not be considered as valid unless the changes are reviewed, and the recommendations are adjusted or confirmed in writing by PIM Geotechnical Consultants, Inc.

We shall be provided with the opportunity to review final site and foundation drawings in order to ascertain whether our recommendations have been correctly interpreted and implemented.

Respectfully Submitted,
PIM Geotechnical Consultants, Inc.

Ian Carlo Serna, M.C.E., P.E.
Geotechnical Engineer

APPENDIX A - Figures

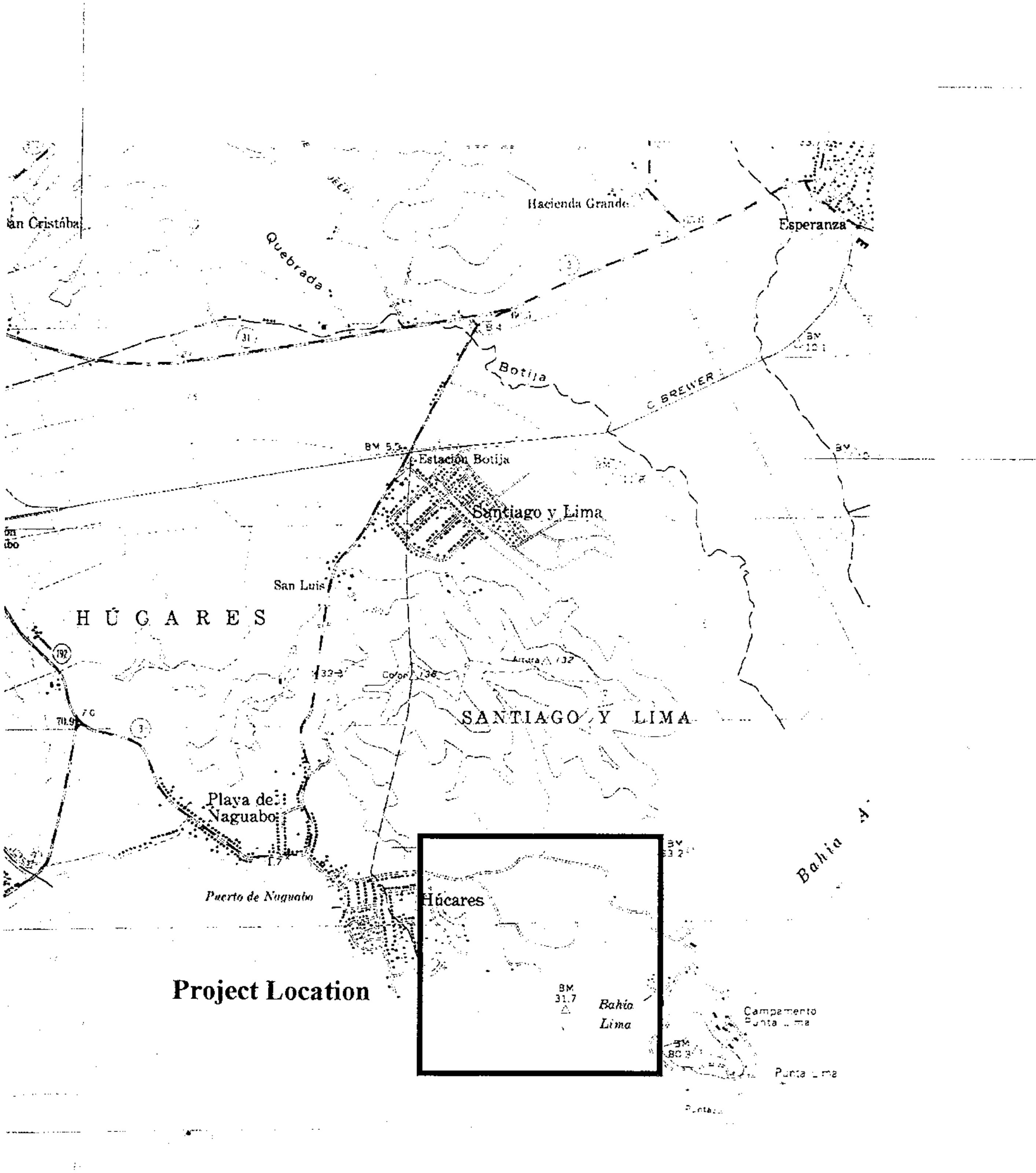


Figure #1 – Topographic Map of the Naguabo Quadrangle, Puerto Rico (USGS-1982)

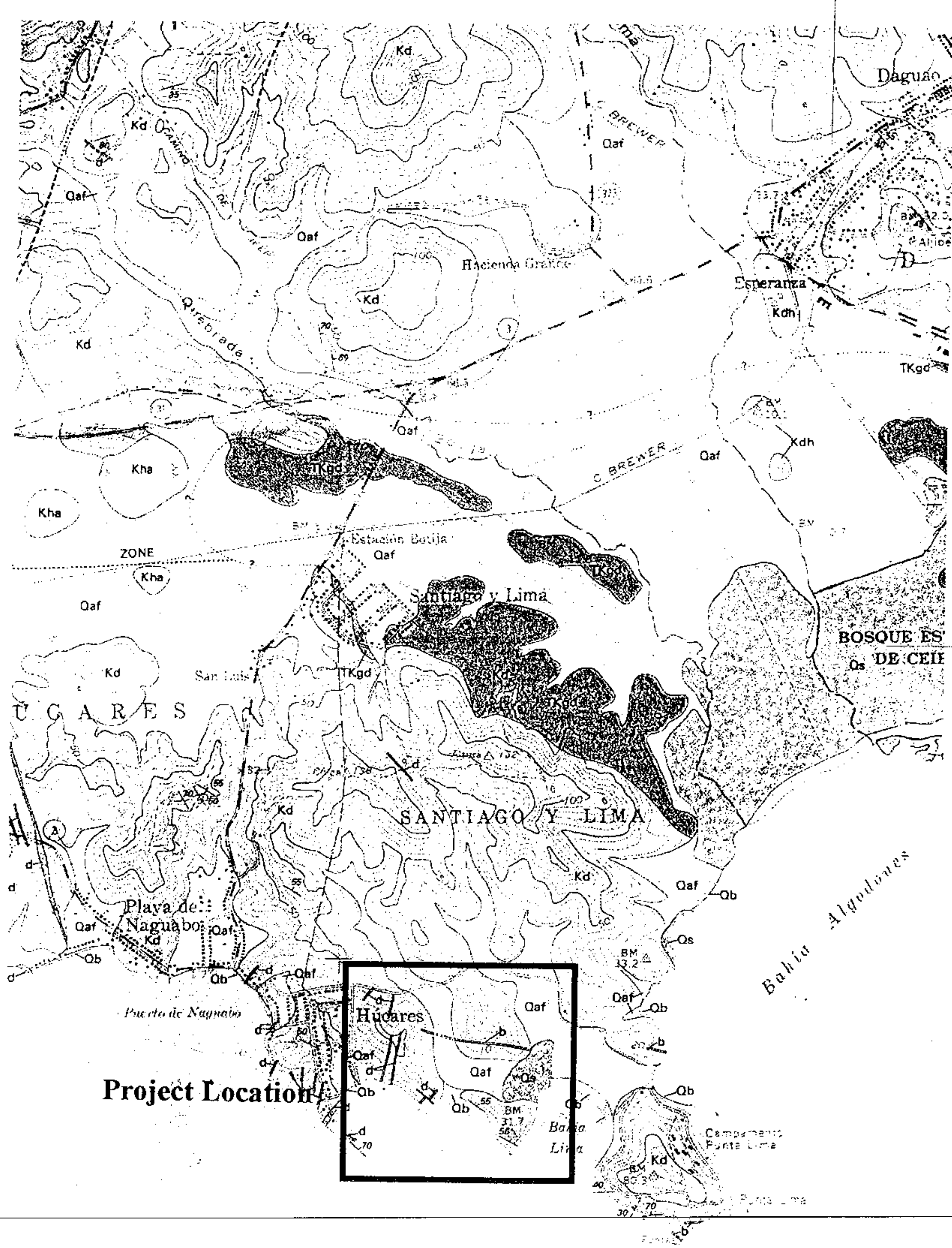
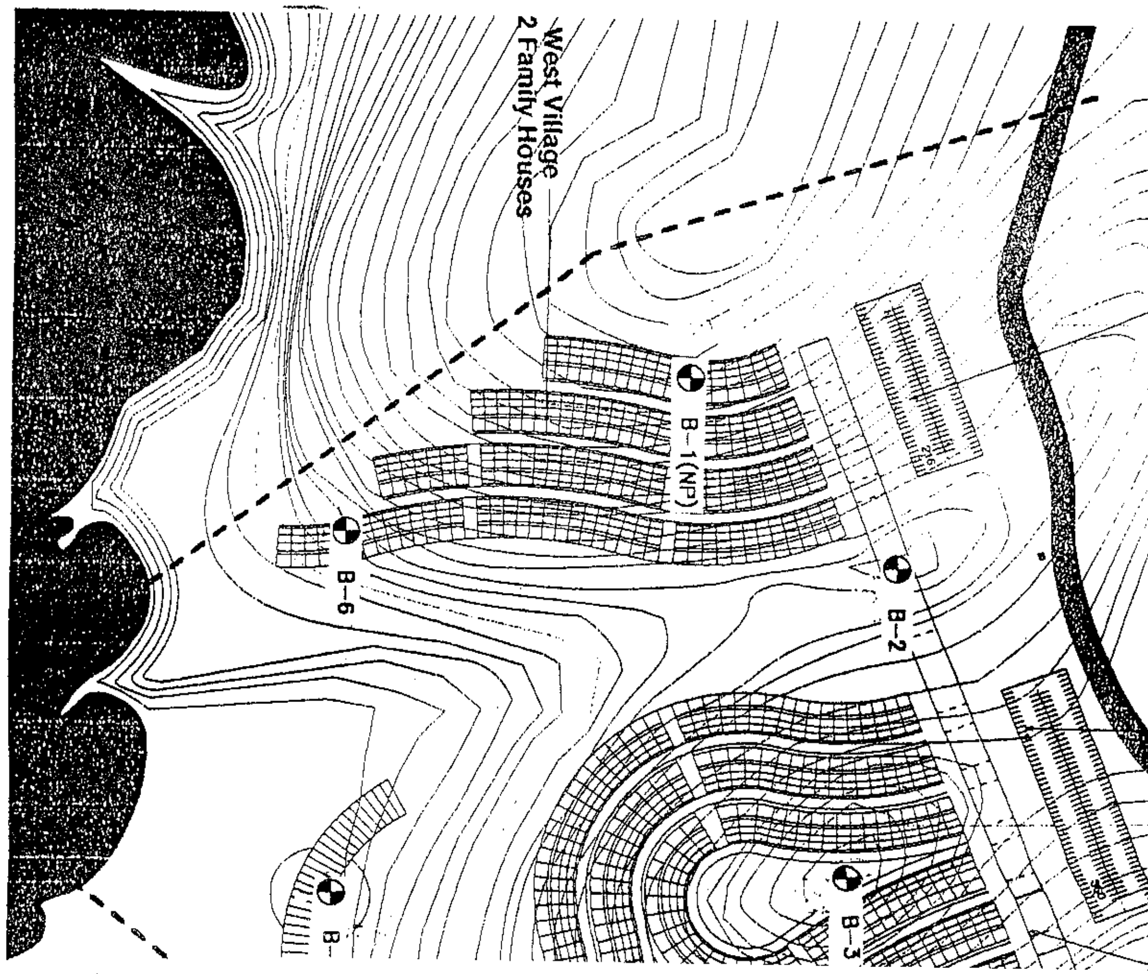


Figure #2 – Geologic Map of the Naguabo and Part of the Punta Puerca Quadrangles, Puerto Rico (USGS-1979)



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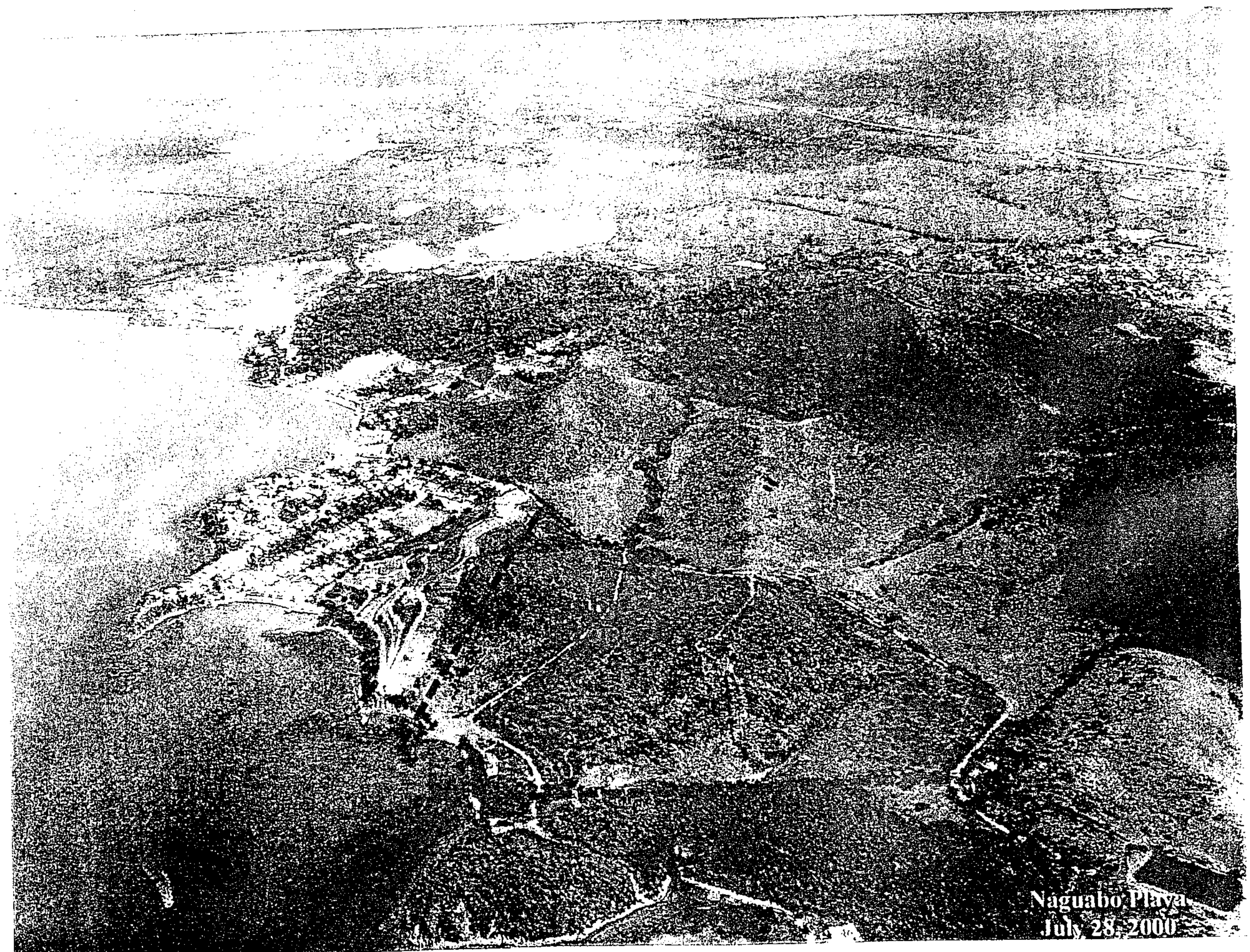

Naguabo Playa
July 28, 2000

APPENDIX B - Controlled, Compacted Fill Specifications

CONTROLLED, COMPACTED FILL SPECIFICATION

A. SITE PREPARATION

a. **Clearing and Grubbing** - Within the earthwork areas, all trees, bushes, stumps, logs and tree roots shall be removed and properly disposed of.

b. **Stripping** - Stripping shall be conducted in all excavation and fill areas. Topsoil shall be removed to a depth of 1 foot and shall be stockpiled for use along the green areas of the finished grading. Any artificial fill or rubbish, organic, or other deleterious material encountered in the stripping operation shall be removed to its full depth and disposed of.

c. **Fill Areas** - Prior to placing fill in any area, grading shall be performed as required to provide for drainage. When the fill areas have been prepared **THE NATURAL GROUND SURFACE SHALL BE COMPACTED** (Proof Rolled) by methods specified for compaction of fill.

B. PLACEMENT AND PREPARATION OF FILL

a. **Source** - Material from required cut may be used for construction of fill, unless otherwise specified. If said material is not enough to complete the required fill, the Contractor shall select a source of material and must obtain approval of the material prior to placement as fill from a Soils Engineer.

b. **Sequence and Operations** - Filling shall begin in the lowest section of the area. The fill shall be spread in layers as hereinafter specified. The surface of each layer shall be approximately level but will be provided with sufficient longitudinal and transverse slope to provide for runoff of surface water from every point. Filling shall be conducted so that no obstruction to drainage from other sections of the fill area is created at any time.

c. **Layer Construction** - The fill deposit shall be spreaded in approximately level layers measuring about 12" in thickness prior to compaction.

d. **Condition** - Each layer of fill shall be inspected prior to compaction. All roots, vegetation, or debris shall be removed. Stones larger than 6" in diameter shall be removed or broken. The water content of each layer shall be determined to be suitable for compaction or shall be brought to a suitable condition by measures hereinafter described. Material incorporated in the fill which is not in satisfactory condition shall be subject to rejection and removal.

C. FILLING ON SLOPES

Where fills have to be made on existing slopes, it shall be plowed or scarified deeply, or where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical, the bank shall be stepped or benched in accordance to the following criteria:

Slope ratio of existing ground surface	Maximum Vertical Spacing benches (mts)	Minimum width of benches (mts)
5H:1V	1	3
4H:1V	1	3
3H:1V	1	3
2H:1V	2	4
1H:1V	2	2

D. CUT SLOPES

Slopes that have a vertical height exceeding 25 ft. shall be benched to provide with breaks in the high areas. This will also help in intercepting surface water and assist on the maintenance work on the slopes. Slope benches shall be at intervals of 15 ft. vertical height. The benches shall be six (6) feet wide with their surface slightly inclined to intercept surface water from slopes and to carry it in paved drainage ways at suitable gradient to proper cut falls.

The embankments adjacent to the river or bodies of water, which may be subject to floods during intensive period of rain shall be protected from mayor erosive and seepage forces. The earth fill operations and foundation works, in general, shall be done only under the direct supervision of a Soils Engineer. If the soil inspection service is not awarded to us, the selected Soils Engineer shall receive a copy of this report, evaluate the same and adopt it as his own, or request additional soil data to verify the foundation recommendations or modify them in accordance to his personal knowledge and judgment.

E. COMPACTION

a. **Equipment and Operating Procedure** - The contractor shall describe the type or types of compaction equipment he proposes to furnish for use. If in opinion of the soils engineer, any proposed type is considered unsuitable or inadequate, the contractor shall be required to select and furnish an alternative approved type or to demonstrate by field trial that the originally proposed type will perform in a satisfactory manner. To the least, a vibratory compactor with a minimum static at-drum weight of ten (10) tons shall be required, unless otherwise specified.

The compaction equipment shall be operated so as to make a **MINIMUM** of three (3) passes over each layer of fill. The number of passes complying with the specified minimum shall be determined in the field. Each successive pass shall overlap the adjacent pass by not less than 10 %. Similarly, each succeeding proof rolling effort shall be made in a direction perpendicular to the prior compacting effort. Passes made over material in unsuitable condition will not be considered in judging compliance.

b. **Moisture Control** - Compaction shall be performed only when the fill material is in approved condition of moisture content. The approved condition shall be 4% less to 2% more than the optimum moisture content established by laboratory compaction tests. The contractor shall furnish equipment for modifying the moisture content of the fill material and at times when the moisture content is not within the specified range, shall operate such equipment so as to achieve the necessary correction with minimum loss of time. The addition of water shall be accomplished by methods, which will distribute the added water evenly and in a controlled manner over the fill. Reduction in water content shall be accomplished by methods with are effective for promoting aeration of the fill material. No fill shall be placed until approved types of equipment for aeration and for addition of water are on job and demonstrated to be satisfactory operating condition.

c. **Compaction Requirement and Testing** - Compaction of the fill material shall continue until the dry unit weight of the fill reaches **a value not less than 95 %** of the maximum dry unit weight attained in a laboratory compaction test performed under the specifications of ASTM D 1557. Similarly, the latter tests shall be used for establishing the optimum moisture content of the fill material. At least one laboratory compaction test shall be performed for each distinctive type of material to be used as fill. In each layer of fill, at least one in-place moisture density determination shall be made for each 2,500 SF. of layer area. If the percentage compaction at any point is found to be unacceptable, additional compaction with or without modification of the field moisture content as directed, shall be performed and a second moisture density determination made. This procedure shall be repeated until satisfactory compaction is obtained. All testing required, including the additional tests in areas where compaction is found to be unacceptable, shall be performed by an approved, established laboratory. Test certificates shall be submitted promptly. Should any certificate indicate inadequate compaction, the contractor shall remove any and all material which has been placed above the layer in which the certificated test was performed and subsequently reconstruct this section of the fill in an approved manner.

F. PROTECTION OF FILL DURING CONSTRUCTION PERIOD

Layer placement and thickness shall be controlled so that no pounding of water can occur on any working surface. This shall be accomplished without at any time exceeding the specified maximum layer thickness. In addition to performing the grading operations necessary to insure unobstructed run-off at all times from every point on the working surface, the contractor shall be required to seal the working surface at the close of each day's operation and when practical, prior to rainfall. Sealing shall be accomplished by rolling the surface with a smooth wheel roller of approved design and weight. No fill shall be placed until an approved roller of this type is delivered to the job and demonstrated to be in working condition.

APPENDIX C – Field Procedures

FIELD PROCEDURES

A. STANDARD PENETRATION TEST

The borings were made by the Auger Drilling Method. The Auger Drilling Method consist of the powered turning of a continuous flight hollow stem auger 6" O.D. and 2 1/2" I.D. into the soil to a desired depth or elevation. The auger is used to advance and case the test hole simultaneously. It is used with a center rod and plug assembly at its lower end. The plug assembly is held in-place by the cap inside drill rod and is coupled to the auger and its assembly to the rotating spindle on the drill rig, thus preventing dirt from entering the mouth of the auger.

Once the desired depth or level for sample is reached, the plug is retracted by withdrawing the center rod to permit lowering of the sampler or core barrel, as the case may be, through the auger. After the sampler is retracted, the plug is reinserted and held in-place by the center rod, another auger section is connected to the first, together with one additional center rod to secure the plug to the cap, and the hole is advanced.

This procedure is repeated until the desired depth of exploration is reached. The auger can always be stopped at any depth level to allow normal sampling practice.

Soil samples are secured from the bottom of the hole by means of a 1 3/8" I.D. (2" O.D.) Split Spoon Sampler. While securing the soil samples, the standard penetration test is performed and the "N" values obtained.

The N-value is the number of blows required to drive the sampling spoon at a distance of one (1) foot into the ground with a 140 pounds hammer falling 30 inches.

The "N" value gives an indication of the consistency of cohesive soils and the state of packing of granular soils as follows:

COHESIVE SOILS

"N" Values (Blows / foot)	Consistency	Uncofined Compression Strength (tsf)
Less than 2	Very Soft	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
More than 30	Hard	4.00

GRANULAR SOILS

"N" Value (Blows / foot)	Relative Density
0 – 5	Very Loose
5 – 10	Loose
10 – 30	Medium Dense
30 – 50	Dense
Over 50	Very Dense

B. 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 a 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.

C. CALIFORNIA BEARING RATIO

The California Bearing Ratio is a procedure intended to describe the shearing resistance of a material. It is commonly performed on the base, subbase, and subgrade elements of a paved structure. This test can be developed in any of a series of standardized procedures whose their distinctive characteristic is based on sample integrity. These procedures are: laboratory CBR (remolded samples), undisturbed sampling, and in-field tests. Nevertheless, the product of all of these techniques provides the same output.

Commonly, the in-field procedures are performed when the subgrade material is expected to maintain its intrinsic properties throughout the life span of its corresponding pavement. This is typical for parking areas.

The CBR is basically a comparison ratio between the in-question shearing resistance of a material versus the established standard resistance of a crushed rock sample. The latter were established by empirical methods and are readily available. This resistance is measured by pushing a standard plunger (1.95 inches in diameter) into the material at a specified rate, and then reading the load increments at certain displacement intervals (usually 0.025 or 0.050 inches). Then the 0.1 and 0.2 inches readings are compared to the empirical crushed rock values an its ratio is the CBR (expressed as an integer number and not as a percent).

APPENDIX D – Laboratory Work

LABORATORY WORK

A. IDENTIFICATION OF SOILS

Soil samples are classified according to their constituents and the following terminology is used to denote the percentage by weight of each component:

DESCRIPTIVE TERM:	RANGE OF PROPORTION (%):
Trace	1 - 10
Little to Some	10 - 20
Adjective (sandy, silty, clayey)	20 - 35
And	35 - 50

Granular soils are those materials consisting of boulders, gravel, sand, and non-plastic silt, either separately or in combination.

Boulders are the constituents with an average diameter larger than 3 inches. Gravel ranges from fine (No. 10 sieve) to coarse (3 inches sieve). Sand particles are those passing No. 10 sieve and retained on the No. 200 mesh. The silt particles range from 0.06 to 0.002 mm.

Cohesive soils are those soils that possess characteristics of cohesiveness and plasticity. They may be granular soils as described above with the addition of clay or organic silt, which causes cohesion and plasticity or may be clay or organic silt with no coarse components.

The clay fraction is composed of clay minerals and in general has an average particle diameter of less than 0.002 mm. The organic silt fraction is that portion with an average particle diameter of less than 0.06 mm. The clay and organic silt may occur separately or in conjunction. Both materials will exhibit plastic qualities within a certain range of water content, but the range will be greater in the case of clay. The organic silt has a more granular appearance than the clay.

Besides determining the constituents and color, each sample is carefully examined for stratification, presence of secondary structures, shells, fibrous or disseminated peat, plasticity, etc.

B. NATURAL WATER CONTENT

The natural water content is determined by finding the quantity of water present in the voids of the soil specimen in the natural condition and dividing it by the dry weight of the sample.

The weight of the water is determined by subtracting the weight of a soil specimen in its natural conditions from the weight of the specimen after been dried in an oven at 105 C, until a constant weight is reached.

C. UNCONFINED COMPRESSION TEST

The cohesive soil specimens obtained from split spoon samples cannot be considered as undisturbed samples, nevertheless, their unconfined compressive strength can be easily determined to obtain some information as to the shearing strength of the material.

Unconfined compressive strength tests were performed subjecting the soil samples 3 inches high by 1.5 inches in diameter to axial deflection at a constant load and measuring the resisting stress developed in the soil.

The load on the samples was applied and the deflection recorded on a strain dial calibrated in thousands of an inch.

D. ATTERBERG LIMITS

When clay minerals are present in fine-grained soil, that soil can be remolded in the presence of some moisture without crumbling. This cohesive nature is due to the adsorbed water surrounding the clay particles. Hence, at very low moisture content the soil behaves more like a solid, and at high moisture level as a liquid. This is the basis of the Atterberg limits, which divides the physical states of a soil sample using its moisture content as the characterization parameter.

The Liquid Limit is the point of transition between the plastic and liquid states. It is obtained by using a device consisting of a brass cup and a hard rubber base. The brass cup can be dropped on the base by a cam operated by a crank. Soil paste is placed on the cup. A groove is cut at the center of the soil pat, using the standard grooving tool. Then the cup is lifted and dropped from a height of 0.3937 inches. The moisture content, in percent, required to close a distance of 0.5 inches along the bottom of the groove after 25 blows is defined as the liquid limit.

The Plastic Limit, which is the transition point between the semi-solid and plastic states, is defined as the moisture content, in percent, in which the soil, when rolled into threads of 1/8 inch in diameter, crumbles.

APPENDIX E - Boring Logs & Laboratory Testing Results

Ponce I & M Engineering Laboratory, Inc.

SUBSURFACE EXPLORATION LOG

BORING NO. 02
SHEET 1 **OF** 1
LOCATION SEE SKETCH
CODE NO. PIM-03-048

PROJECT PORTOFINO DEVELOPMENT, NAGUABO, P.R.
DRILLING METHOD: HOLLOW STEM AUGER
DRILL MACHINE CME 45B **DRILLED BY** L.J. IRIZARRY
HAMMER: WT 140# **DROP** 30" **TYPE** SAFETY
DEPTH OF WATER: N/A **FT. AFTER COMPLETION**
______ **FT.** ______ **HOURS AFTER COMPLETION**

DATE STARTED 07/29/03
DATE COMPLETED 07/29/03
GROUND ELEV. N/A
DEPTH OF HOLE 15
LOGGED BY I. CARLO

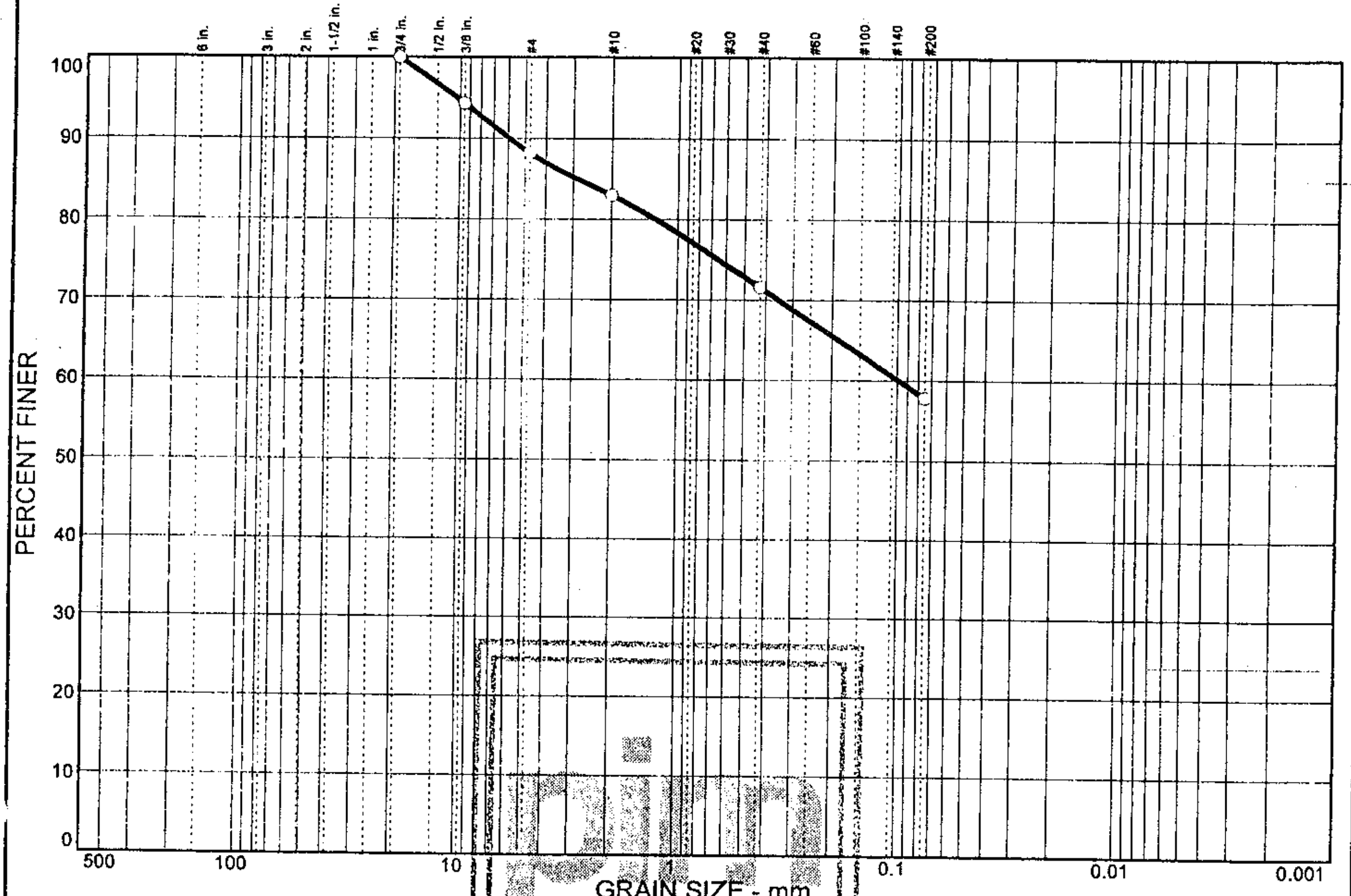
(FT)	SAMPLE NO.	LENGTH/ RECOVERY	SPT N-VALUE	R.Q.D.	SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA	MATERIAL DESCRIPTION	U.S.C.S. DESIGNATION	%<#200	MOISTURE CONTENT W_n	W_L	W_P	I_p	STRENGTH (TSF) q_u*	(x) ſ**
	1	7/18	13		2/6" 7/6" 6/6"	2" TOP SOIL: underlaid by dark yellowish brown, clay, some sand, some gravel, occ. roots and organics.			18					
	2	16/18	17		4/6" 8/6" 9/6"	CLAY: dark yellowish brown, very stiff, some sand.	CH	57.8	16	70	21	49		
	3	16/16	REF.		12/6" 30/6" 50/4"	HIGHLY WEATHERED ROCK: broken into clayey sand to sandy clay, hard, strong brown, trace gravel.	CL	35.6	10	38	18	20		
	4	18/18	59		16/6" 30/6" 29/6"	...			14					
	5	15/15	REF.		9/6" 25/6" 50/3"	...			18					
						END OF BORING - 15.0 FT.								

C.S. - UNIFIED SOIL CLASSIFICATION SYSTEM DESIGNATION.
D. - ROCK QUALITY DESIGNATION, IN PERCENT.
W_L, W_P AND I_p - NATURAL WATER CONTENT, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
EFUSAL
CONFINED COMPRESSION STRENGTH; REPORTED VALUES OBTAINED FROM:
A. POCKET PENETROMETER
B. SPRING TEST
C. UNCONFINED COMPRESSION TEST
D. TRIAXIAL TEST
E. VANE TEST

** ſ - EFFECTIVE INTERNAL FRICTION ANGLE; REPORTED VALUES OBTAINED FROM:
1. DIRECT SHEAR TEST REPORTING PEAK VALUE, ſ
2. DIRECT SHEAR TEST REPORTING RESIDUAL VALUES ſ
3. DIRECT SHEAR TEST REPORTING BOTH ſ AND ſ
4. TRIAXIAL TEST REPORTING RESIDUAL VALUE, ſ
5. TRIAXIAL TEST REPORTING PEAK VALUE ſ
6. TRIAXIAL TEST REPORTING BOTH ſ AND ſ

SAMPLER LEGEND
= AUGER = SPLIT SPOON = ROCK CORE = SHELBY TUBE = NO RECOVERY

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.8	30.4	57.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.375 in.	94.3		
#4	88.2		
#10	83.0		
#40	71.6		
#200	57.8		

* (no specification provided)

Soil Description

Dark yellowish brown sandy fat clay

Atterberg Limits

PL= 21 LL= 70 PI= 49

Coefficients

D_{85}= 2.86 D_{60}= 0.0990 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(25)

Remarks

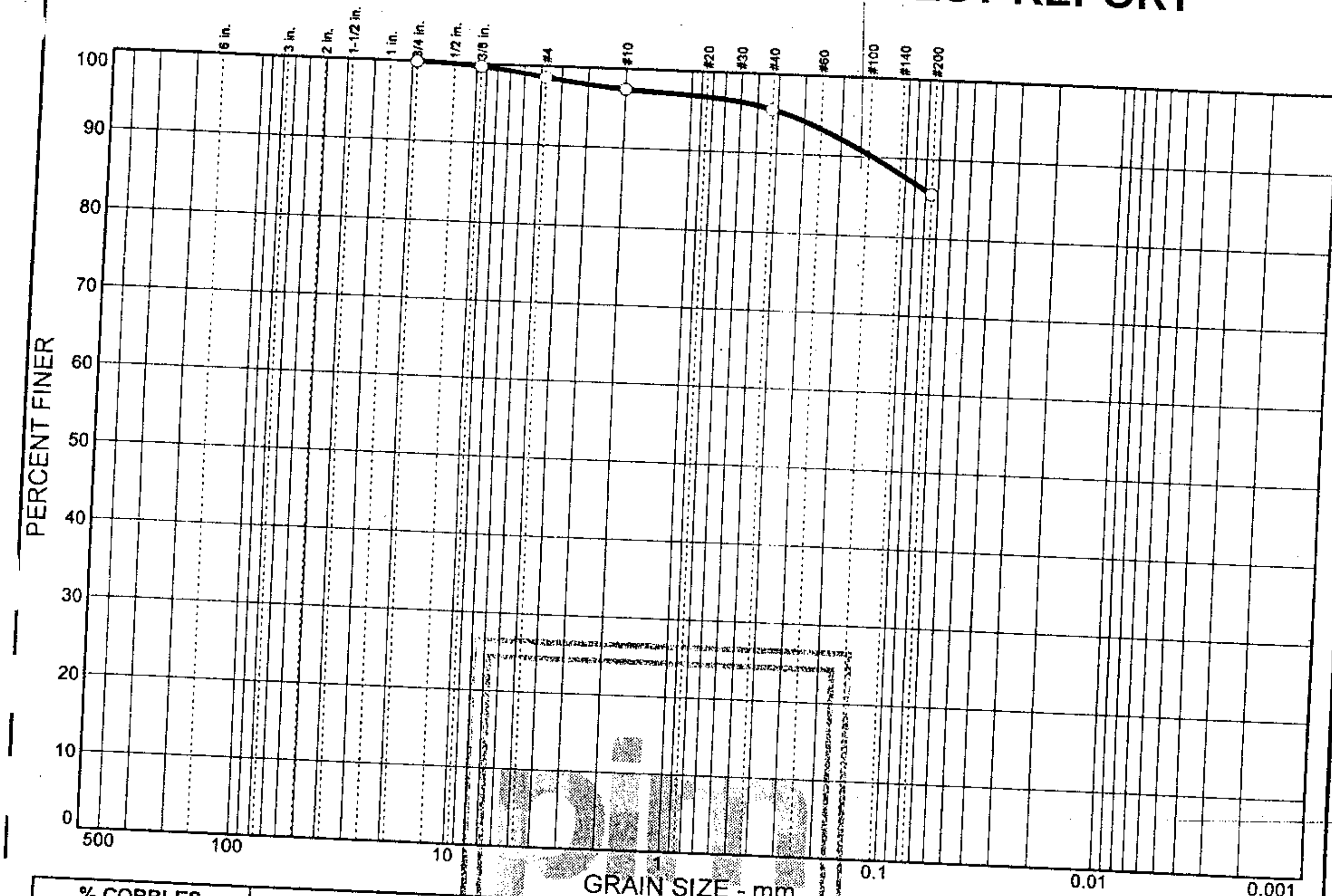
Tested by: J.A. Burgos
Certified by: Ian Carlo Serna, MCE, PE

Sample No.: 2 **Source of Sample:** Boring #2 **Date:** 08/28/03
Location: **Elev./Depth:** 3-4.5ft

Ponce I & M Engineering Lab., Inc.
Tel. (787) 848-2085
Fax. (787) 848-1562

Client: P.R. One, Inc.
Project: Portofino Development
Naguabo, P.R.
Project No: PIM-03-048 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.4	13.0	85.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.375 in.	99.7		
#4	98.6		
#10	97.4		
#40	95.5		
#200	85.6		

* (no specification provided)

Soil Description

Strong brown lean clay

Atterberg Limits

PL= 18 LL= 38 PI= 20

Coefficients

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

Classification

USCS= CL AASHTO= A-6(17)

Remarks

Tested by: R. Colon
Certified by: Ian Carlo Serna, MCE, PE

Sample No.: 3 **Source of Sample:** Boring #2 **Date:** 08/29/03
Location: **Elev./Depth:** 6-7.5ft

ɔnce I & M Engineering Lab., Inc.
Tel. (787) 848-2085
Fax. (787) 848-1562

Client: P.R. One, Inc.
Project: Portofino Development
Naguabo, P.R.
Project No: PIM-03-048

Plate

Ponce I & M Engineering Laboratory, Inc.

SUBSURFACE EXPLORATION LOG

BORING NO. 03
SHEET 1 OF 1
LOCATION SEE SKETCH
CODE NO. PIM-03-048

PROJECT: PORTOFINO DEVELOPMENT, NAGUABO, P.R.
DRILLING METHOD: HOLLOW STEM AUGER
DRILL MACHINE: CME 45B DRILLED BY: L.J. IRIZARRY
HAMMER: WT 140# DROP 30" TYPE SAFETY
DEPTH OF WATER: N/A FT. AFTER COMPLETION
_____ FT. _____ HOURS AFTER COMPLETION

DATE STARTED 07/29/03
DATE COMPLETED 07/29/03
GROUND ELEV. N/A
DEPTH OF HOLE 15
LOGGED BY I. CARLO

DEPTH (FT)	SAMPLE NO.	LENGTH/ RECOVERY	SPT N-VALUE	R.Q.D.	SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA	MATERIAL DESCRIPTION	U.S.C.S. DESIGNATION	%-#200	MOISTURE CONTENT W_n	W_L	W_P	I_P	STRENGTH (TSF) q_u*	(x) ϕ**
0	1	12/18	50		7/6" 23/6" 27/6"	2" TOP SOIL UNDERLAID BY HIGHLY WEATHERED ROCK: sampled as clayey sand dark yellowish brown, very dense, little to some gravel size fragments occ. roots with in the top soil.			11					
	2	6/10	REF.		28/6" 50/4"				14					
5						... sampled as clayey sand and gray gravel, very dense, strong brown.								
	3	4/4	REF.		50/4"	...			3					
	4	3/3	REF.		50/3"	...			1					
	5	3/3	REF.		50/3"	...			4					
						END OF BORING - 15.0 FT.								
20														
25														

S.C.S. - UNIFIED SOIL CLASSIFICATION SYSTEM DESIGNATION.
Q.D. - ROCK QUALITY DESIGNATION, IN PERCENT.
W_n, W_L, W_P AND I_P - NATURAL WATER CONTENT, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
REFUSAL
UNCONFINED COMPRESSION STRENGTH; REPORTED VALUES OBTAINED FROM:

A. POCKET PENETROMETER
B. SPRING TEST
C. UNCONFINED COMPRESSION TEST
D. TRIAXIAL TEST
E. VANE TEST

** ϕ - EFFECTIVE INTERNAL FRICTION ANGLE; REPORTED VALUES OBTAINED FROM:

1. DIRECT SHEAR TEST REPORTING PEAK VALUE, ϕ_p
2. DIRECT SHEAR TEST REPORTING RESIDUAL VALUES ϕ_r
3. DIRECT SHEAR TEST REPORTING BOTH ϕ_p AND ϕ_r
4. TRIAXIAL TEST REPORTING RESIDUAL VALUE, ϕ_r
5. TRIAXIAL TEST REPORTING PEAK VALUE ϕ_p
6. TRIAXIAL TEST REPORTING BOTH ϕ_p AND ϕ_r

SAMPLER LEGEND

= AUGER = SPLIT SPOON = ROCK CORE = SHELBY TUBE = NO RECOVERY

Ponce I & M Engineering Laboratory, Inc.

SUBSURFACE EXPLORATION LOG

BORING NO. 04
SHEET 1 **OF** 1
LOCATION SEE SKETCH
CODE NO. PIM-03-048

PROJECT PORTOFINO DEVELOPMENT, NAGUABO, P.R.
DRILLING METHOD: HOLLOW STEM AUGER
DRILL MACHINE CME 45B **DRILLED BY** L.J. IRIZARRY
HAMMER: WT 140# **DROP** 30" **TYPE** SAFETY
DEPTH OF WATER: N/A **FT. AFTER COMPLETION**
_____ **FT.** _____ **HOURS AFTER COMPLETION**

DATE STARTED 07/30/03
DATE COMPLETED 07/30/03
GROUND ELEV. N/A
DEPTH OF HOLE 20
LOGGED BY I. CARLO

DEPTH (FT)	SAMPLE NO.	LENGTH/ RECOVERY	SPT N-VALUE	R.Q.D.	SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA	MATERIAL DESCRIPTION	U.S.C.S. DESIGNATION	%-#200	MOISTURE CONTENT W_n	W_L	W_P	I_P	STRENGTH (TSF) q_u*	(x) φ**
0	1	7/18	28		4/6" 16/6" 12/6"	TOP SOIL: underlaid by very dark brown,clayey sand and bluish gray gravel,medium dense,occ. roots and organics, coarse to fine,rounded to angular.			19					
	2	4/18	41		16/6" 18/6" 23/6"	GRAVEL: yellow to brown,dense,some sand,occ. roots and organics.			11					
-5	3	18/18	36		9/6" 18/6" 18/6"	CLAYEY SAND:dark yellowish brown and dark gray,hard.	SC	42.1	13	50	20	30		
	4	18/18	28		4/6" 14/6" 14/6"	CLAY: black to very dark brown,very stiff,trace gravel.			16					
-15	5	18/18	30		50/6" 15/6" 15/6"	BLUISH GRAY GRAVEL FRAGMENTS SIZE: with strong brown and greenish gray,clay,dense, angular,coarse some sand.			21					
-20	6	3/3	REF.		50/3"	HIGHLY WEATHERED ROCK: sampled as silty sand,grayish brown, very dense. END OF BORING - 20.0 FT.			4					
-25														

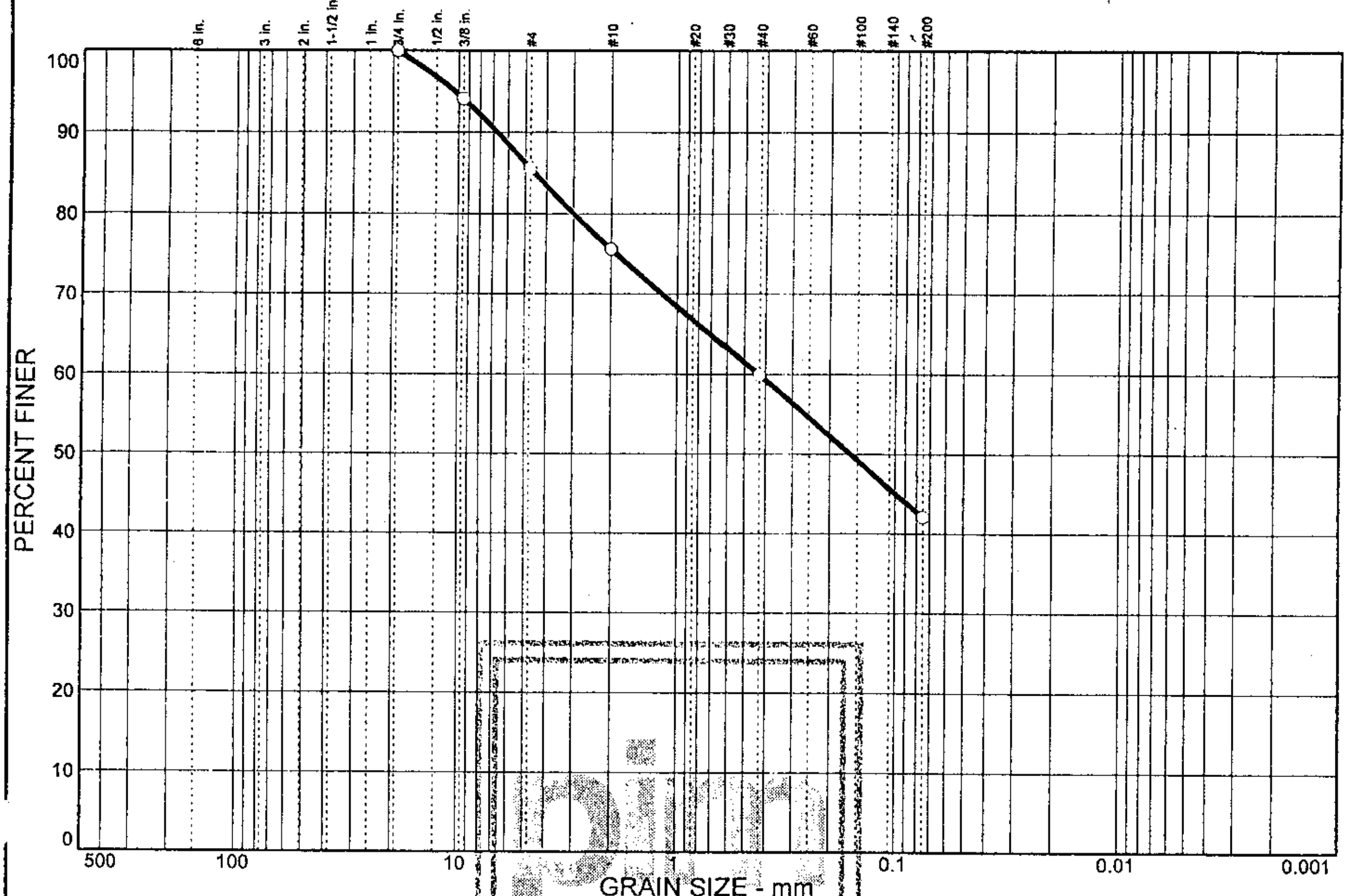
U.S.C.S. - UNIFIED SOIL CLASSIFICATION SYSTEM DESIGNATION.
R.Q.D. - ROCK QUALITY DESIGNATION, IN PERCENT.
W_n, W_L, W_P AND I_P - NATURAL WATER CONTENT, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
R=REFUSAL
* - UNCONFINED COMPRESSION STRENGTH; REPORTED VALUES OBTAINED FROM:
A. POCKET PENETROMETER
B. SPRING TEST
C. UNCONFINED COMPRESSION TEST
D. TRIAXIAL TEST
E. VANE TEST

** φ - EFFECTIVE INTERNAL FRICTION ANGLE; REPORTED VALUES OBTAINED FROM:
1. DIRECT SHEAR TEST REPORTING PEAK VALUE, $φ_p$
2. DIRECT SHEAR TEST REPORTING RESIDUAL VALUES $φ_r$
3. DIRECT SHEAR TEST REPORTING BOTH $φ_p$ AND $φ_r$
4. TRIAXIAL TEST REPORTING RESIDUAL VALUE, $φ_r$
5. TRIAXIAL TEST REPORTING PEAK VALUE $φ_p$
6. TRIAXIAL TEST REPORTING BOTH $φ_p$ AND $φ_r$

SAMPLER LEGEND

= AUGER = SPLIT SPOON = ROCK CORE = SHELBY TUBE = NO RECOVERY

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	14.4	43.5	42.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.375 in.	94.1		
#4	85.6		
#10	75.6		
#40	59.9		
#200	42.1		

* (no specification provided)

Soil Description

Dark yellowish brown and dark gray clayey sand

Atterberg Limits

PL= 20 LL= 50 PI= 30

Coefficients

D_{85}= 4.53 D_{60}= 0.429 D_{50}= 0.161
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

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

Remarks

Tested by: R. Colon
Certified by: Ian Carlo Serna, MCE, PE

Sample No.: 3 **Source of Sample:** Boring #4 **Date:** 08/29/03
Location: **Elev./Depth:** 6-7.5ft

Ponce I & M Engineering Lab., Inc. Tel. (787) 848-2085 Fax. (787) 848-1562	Client: P.R. One, Inc. Project: Portofino Development Naguabo, P.R. Project No: PIM-03-048 Plate

Ponce I & M Engineering Laboratory, Inc.

SUBSURFACE EXPLORATION LOG

BORING NO. 05
SHEET 1 **OF** 1
LOCATION SEE SKETCH
CODE NO. PIM-03-048

PROJECT PORTOFINO DEVELOPMENT, NAGUABO, P.R.
DRILLING METHOD: HOLLOW STEM AUGER
DRILL MACHINE CME 45B **DRILLED BY** L.J. IRIZARRY
HAMMER: WT 140# **DROP** 30" **TYPE** SAFETY
DEPTH OF WATER: N/A **FT. AFTER COMPLETION**
FT. ______ **HOURS AFTER COMPLETION**

DATE STARTED 07/30/03
DATE COMPLETED 07/30/03
GROUND ELEV. N/A
DEPTH OF HOLE 15
LOGGED BY I. CARLO

DEPTH (FT)	SAMPLE NO.	LENGTH/ RECOVERY	SPT N-VALUE	R.Q.D.	SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA	MATERIAL DESCRIPTION	U.S.C.S. DESIGNATION	%<#200	MOISTURE CONTENT W_n	W_L	W_P	I_P	STRENGTH (TSF) q_u*	(x) φ**
0	1	6/18	16		10/6" 6/6" 10/6"	SILTY TO CLAYEY SAND with GRAVEL: light yellowish brown, medium dense, rounded to sub rounded gravel.			6					
	2	7/18	35		10/6" 15/6" 20/6"	HIGHLY WEATHERED ROCK: sampled as yellow to dark yellowish brown and gray gravel and clay; hard/dense some sand, angular, coarse to fine.			6					
5														
	3	6/9	50		40/6" 50/3"	SILTY CLAYEY SAND with GRAVEL: very dense, yellow, bluish gray gravel, fine, angular.			3					
	4	6/10	50		30/6" 50/4"	GRAVEL with SILTY SAND very dense, yellowish and bluish gray, fine, angular to sub rounded.			4					
	5	6/11	50		28/6" 50/5"	... coarse to fine.			8					
15						END OF BORING - 15.0 FT.								
20														
25														

S.C.S. - UNIFIED SOIL CLASSIFICATION SYSTEM DESIGNATION.
Q.D. - ROCK QUALITY DESIGNATION, IN PERCENT.
W_n, W_L, W_P AND I_P - NATURAL WATER CONTENT, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
REFUSAL
UNCONFINED COMPRESSION STRENGTH; REPORTED VALUES OBTAINED FROM:
A. POCKET PENETROMETER
B. SPRING TEST
C. UNCONFINED COMPRESSION TEST
D. TRIAXIAL TEST
E. VANE TEST

** φ - EFFECTIVE INTERNAL FRICTION ANGLE; REPORTED VALUES OBTAINED FROM:
1. DIRECT SHEAR TEST REPORTING PEAK VALUE, φ
2. DIRECT SHEAR TEST REPORTING RESIDUAL VALUES φ
3. DIRECT SHEAR TEST REPORTING BOTH φ AND φ
4. TRIAXIAL TEST REPORTING RESIDUAL VALUE, φ
5. TRIAXIAL TEST REPORTING PEAK VALUE φ
6. TRIAXIAL TEST REPORTING BOTH $φ_p$ AND $φ_r$

SAMPLER LEGEND

= AUGER = SPLIT SPOON = ROCK CORE = SHELBY TUBE = NO RECOVERY

Ponce I & M Engineering Laboratory, Inc.

SUBSURFACE EXPLORATION LOG

BORING NO. 06
SHEET 1 OF 1
LOCATION SEE SKETCH
CODE NO. PIM-03-048

PROJECT PORTOFINO DEVELOPMENT, NAGUABO, P.R.
DRILLING METHOD: HOLLOW STEM AUGER
DRILL MACHINE CME 45B DRILLED BY L.J. IRIZARRY
HAMMER: WT 140# DROP 30" TYPE SAFETY
DEPTH OF WATER: N/A FT. AFTER COMPLETION
_____ FT. _____ HOURS AFTER COMPLETION

DATE STARTED 07/31/03
DATE COMPLETED 07/31/03
GROUND ELEV. N/A
DEPTH OF HOLE 20
LOGGED BY I. CARLO

DEPTH (FT)	SAMPLE NO.	LENGTH/ RECOVERY	SPT N-VALUE	R.Q.D.	SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA	MATERIAL DESCRIPTION	U.S.C.S. DESIGNATION	%<#200	MOISTURE CONTENT W_n	W_L	W_P	I_P	STRENGTH (TSF) q_u*	(x) ϕ**
0	1	12/18	15		6/6" 8/6" 7/6"	SANDY CLAY/CLAYEY SAND: Strong brown, stiff/medium dense, occ. roots.			12					
	2	14/18	40		12/6" 20/6" 20/6"	HIGHLY WEATHERED ROCK: sampled as SILT with SAND, pale yellow and gray, dense, trace gravel, angular, coarse to fine.	ML	76.1	6	43	30	13		
5	3	15/17	REF.		25/6" 40/6" 50/5"	... yellow, very dense.			5					
10	4	8/10	REF.		16/6" 50/4"	... yellow, very dense.			17					
15	5	11/18	31		12/6" 14/6" 17/6"	... yellow, moist.			11					
20	6	10/10	REF.		25/6" 50/4"	... yellow, very dense.			9					
						END OF BORING - 20.0 FT.								
5														

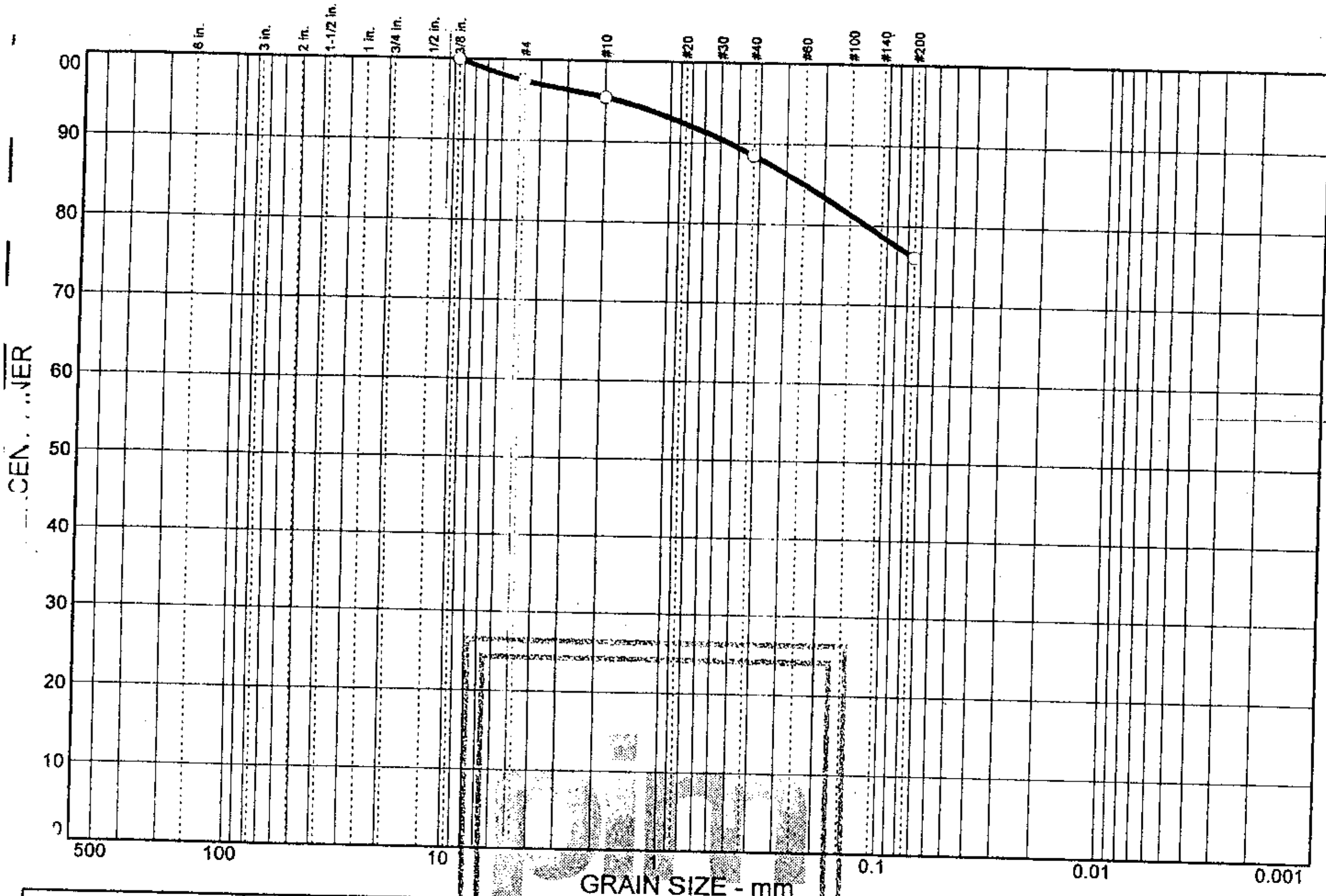
U.S.C.S. - UNIFIED SOIL CLASSIFICATION SYSTEM DESIGNATION.
R.Q.D. - ROCK QUALITY DESIGNATION, IN PERCENT.
W_n, W_L, W_P AND I_P - NATURAL WATER CONTENT, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
REF.=REFUSAL
*q_u - UNCONFINED COMPRESSION STRENGTH; REPORTED VALUES OBTAINED FROM:
A. POCKET PENETROMETER
B. SPRING TEST
C. UNCONFINED COMPRESSION TEST
D. TRIAXIAL TEST
E. VANE TEST

** ϕ - EFFECTIVE INTERNAL FRICTION ANGLE; REPORTED VALUES OBTAINED FROM:
1. DIRECT SHEAR TEST REPORTING PEAK VALUE, $ϕ_p$
2. DIRECT SHEAR TEST REPORTING RESIDUAL VALUES $ϕ_r$
3. DIRECT SHEAR TEST REPORTING BOTH $ϕ_p$ AND $ϕ_r$
4. TRIAXIAL TEST REPORTING RESIDUAL VALUE, $ϕ_r$
5. TRIAXIAL TEST REPORTING PEAK VALUE $ϕ_p$
6. TRIAXIAL TEST REPORTING BOTH $ϕ_p$ AND $ϕ_r$

SAMPLER LEGEND

= AUGER = SPLIT SPOON = ROCK CORE = SHELBY TUBE = NO RECOVERY

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.6	21.3	76.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	97.4		
#10	95.5		
#40	88.5		
#200	76.1		

* (no specification provided)

Soil Description

Pale yellow and gray silt with sand

Atterberg Limits

PL= 30 LL= 43 PI= 13

Coefficients

D_{85}= 0.250 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= A-7-5(11)

Remarks

Tested by: R. Colon
Certified by: Ian Carlo Serna, MCE, PE

Sample No.: 2 Source of Sample: Boring #6 Date: 08/28/03
Location: Elev./Depth: 3-4.5ft

...nce I & M Engineering Lab., Inc.
Tel. (787) 848-2085
Fax. (787) 848-1562

Client: P.R. One, Inc.
Project: Portofino Development
Naguabo, P.R.
Project No: PIM-03-048 Plate

Ponce I & M Engineering Laboratory, Inc.

SUBSURFACE EXPLORATION LOG

BORING NO. 07
SHEET 1 OF 1
LOCATION SEE SKETCH
CODE NO. PIM-03-048

PROJECT: PORTOFINO DEVELOPMENT, NAGUABO, P.R.
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DRILL MACHINE: CME 45B DRILLED BY: L.J. IRIZARRY
HAMMER: WT 140# DROP 30" TYPE SAFETY
DEPTH OF WATER: N/A FT. AFTER COMPLETION
FT. HOURS AFTER COMPLETION

DATE STARTED 07/30/03
DATE COMPLETED 07/30/03
GROUND ELEV.
DEPTH OF HOLE 10.5
LOGGED BY I. CARLO SERNA

DEPTH (FT)	SAMPLE NO.	LENGTH/ RECOVERY	SPT N-VALUE	R.Q.D.	SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA	MATERIAL DESCRIPTION	U.S.C.S. DESIGNATION	%-#200	MOISTURE CONTENT W_n	W_L	W_P	I_P	STRENGTH (TSF) q_u *	(x) f **
0	1	8/18	55		9/6" 25/6" 30/6"	HIGHLY WEATHERED ROCK: sampled as SILTY SAND with GRAVEL, olive, brown and bluish gray, very dense.			5					
	2	10/18	59		18/6" 25/6" 34/6"	...			5					
5	3	0.5/ 0.5	REF.		50/0.5"	...			4					
10	4	5/5	REF.		50/5"	...			7					
						END OF BORING - 10.5 FT.								
15														
20														
25														

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R.Q.D. - ROCK QUALITY DESIGNATION, IN PERCENT.
W_n, W_L, W_P AND I_P - NATURAL WATER CONTENT, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
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C. UNCONFINED COMPRESSION TEST
D. TRIAXIAL TEST
E. VANE TEST

** f - EFFECTIVE INTERNAL FRICTION ANGLE; REPORTED VALUES OBTAINED FROM:
1. DIRECT SHEAR TEST REPORTING PEAK VALUE, f_p
2. DIRECT SHEAR TEST REPORTING RESIDUAL VALUES f_r
3. DIRECT SHEAR TEST REPORTING BOTH f_p AND f_r
4. TRIAXIAL TEST REPORTING RESIDUAL VALUE, f_r
5. TRIAXIAL TEST REPORTING PEAK VALUE f_p
6. TRIAXIAL TEST REPORTING BOTH f_p AND f_r

SAMPLER LEGEND
= AUGER = SPLIT SPOON = ROCK CORE = SHELBY TUBE = NO RECOVERY