A REPORT ON SOIL INVESTIGATIONS AT THE SITES OF SIREN SYSTEM (EWANS) IN JAMAICA

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1.0 INTRODUCTION

1.1. Authority

NHL Engineering Ltd. submitted a proposal for soil investigations for the investigation of the sites for the Emergency Siren Development Project throughout parts of the island. Our proposal was accepted and a package of 3 distributed areas located across the island was issued. This report is specific to the sites in St. Catherine and Portland.

The field investigation commenced on April 21 and was completed on May 1, 2016.

This report contains the results of the work done; the conclusions drawn; and the recommendations made regarding the main areas of engineering concerns as defined by the scope of this investigation.

1.2. Scope of Work

NHL Engineering Limited was to arrange:

i) The field exploration based on the proposed test location point and
ii) The laboratory testing programme, which in our judgment, was necessary to provide a satisfactory basis for evaluating the site for the design of the steel tower foundations and other infrastructural elements on site.

On completion, a report presenting the results obtained, together with our recommendations for the appropriate design parameters should be submitted to the Client.

1.3. Project Description

1. SITES LOCATION:

Old Harbour Bay

The general location of the four (4) locations can be seen in the report Appendices. The sites are located in Narine Lane, Old Harbour Bay Fishing Village, Black Wood Gardens and New Old Harbour Village in Old Harbour Bay, St. Catherine. The area is two fold in deposition history; it forms part of an alluvium along with intrusions of the white limestone deposits in the hilly regions. Insitu subsoil materials in the area were therefore likely to be a mixture of Clays, Sands and Gravels in varying mixed proportion as well as the Newport Formation which comprises mainly of white Limestone Group. This group is generally fractured, fossilerous and are usually overlain by residual soils typically silts and clays.

PLATE 1 – Picture showing the existing topography in the vicinity of borehole **#SIR 001**

PLATE 2 – Picture showing the existing topography in the vicinity of borehole **#SIR 002**

PLATE 3 – Picture showing the existing topography in the vicinity of borehole **#SIR 003**

PLATE 4 – Picture showing the existing topography in the vicinity of borehole **#SIR 004**

Bog Walk

The general location of the five (5) locations can be seen in the report Appendices. The sites are located in Bog Walk, Kent Village, Steep Slope, Dam Head Tower and Angel's Round-A-Bout in Bog Walk, St. Catherine. Due to access issues at the Steep Slope Site, this location will not undergo a field investigated. The site generally forms part of the Newport, Formation which comprises mainly of white Limestone Group. This group is generally fractured, fossilerous and are usually overlain by residual soils typically silts and clays.

Alluvial soils such as clays, silts sands and gravels are also quite prevalent in the areas in close proximity to past and present river systems.

PLATE 5 – Picture showing the existing topography in the vicinity of borehole **#SIR 005**

PLATE 6 – Picture showing the existing topography in the vicinity of borehole **#SIR 006**

PLATE 7 – Picture showing the existing topography in the vicinity of borehole **#SIR 007**

PLATE 8 – Picture showing the existing topography in the vicinity of borehole **#SIR 008**

PLATE 9 – Picture showing the existing topography in the vicinity of borehole **#SIR 009**

Port Maria

The general location of the six (6) sites can be seen in the report Appendices. The sites are located in Castel Gardens, the Parish Council, in the Town Center, RADA Office, Clembhards Park and Trinity in Port Maria, Portland. Due to access issues with the RADA Office Site no field investigation will be done at this site, a desk study is proposed.

The general area is also characterized by the Walderston- Brown's Town Formation, which entails a mixture of Shales and Sandstones. The upper soils are likely to be alluvial, consisting of a mixture of Clays, Sands and Gravels in varying mixed proportion.

PLATE 10 – Picture showing the existing topography in the vicinity of borehole **#SIR 010**

PLATE 11 – Picture showing the existing topography in the vicinity of borehole **#SIR 011**

PLATE 12 – Picture showing the existing topography in the vicinity of borehole **#SIR 012**

PLATE 13 – Picture showing the existing topography in the vicinity of borehole **#SIR 013**

PLATE 14 – Picture showing the existing topography in the vicinity of borehole **#SIR 014**

PLATE 15 – Picture showing the existing topography in the vicinity of borehole **#SIR 015**

2. Superstructures:

According to the information obtained from the client, it is proposed to construct poles housing the sirens for the sites comprising of reinforced steel framed/tubular or reinforced precast concrete conical column. The investigation will seek therefore to consider foundation requirements for both types based on the anticipated critical lateral or vertical design loads.

2.1. Proposed Programme

The proposed investigation will seek to establish the following;

- i) The insitu density of the soils on site.
- ii) Soil stratification and distribution across the site including depth to bedrock (if necessary).
- iii) The design parameters relevant to the design of the anticipated structural and infrastructural elements required on site.

The field investigation entailed the drilling of one (1) borehole at each of the thirteen (13) locations. The Boreholes were to be taken to a maximum depth of 35ft (10.7m).

The methods of drilling and sampling were in accordance with the Standard Penetration Testing specifications, using the Split Spoon Sampling technique. The boreholes were to be used to recover representative samples of the soil for examination by the Soils Engineer and for the carrying out of the laboratory testing programme. These results were to be use along with site deductions during the sampling exercise and intuitive knowledge of the deposition history of the area, to arrive at a reasonable presumptive profile and subsequently a design profile across the site.

It was envisaged that laboratory testing would not include more than the conventional Classification and Index Tests, if however the information was insufficient to predict fairly accurately the required designed parameters, other tests would be specified (one dimensional consolidation).

2.2. Anticipated Design Approach

Given the nature of the proposed structures and projected uses, the pertinent loading conditions to be considered at all 15 locations are:

- i) Uplifting and overturning due to hurricane design wind speed and
- ii) Settlement of the foundation (mass concrete mat) in the upper clayey strata

The adjustment to depth and type of foundation should account for (i) and (ii) above,
And will depend on soil type and structure/loading type at the specific location

In general shallow foundation should be appropriate for all sites under steady load condition. Macro instability should however be analyzed under seismic loading conditions for shallow foundations.

2.3. Soil Boring & Sampling

1. Methodology:

The borings were made by NHL Drillers using a truck mounted CME Drill Rig, with a 160 mm hollow stem auger string. Sampling was done with a Split Spoon in accordance with Standard Penetration Testing specifications, using a Cathead Hammer (N_{55} values). In general, S.S samples were taken at 0.76 metre intervals of depth to the first 3 metres and thereafter at 1.5 metre interval to the maximum depth. The field logs are shown in the (Appendix II).

2. Discussion of results:

The results of the field and laboratory tests are shown in the appendix.

Old Harbour:

The soils encountered across the Old Harbour Bay were predominantly Very Stiff Clays. Insitu densities were generally in the Firm/Very Loose to Very Stiff/Dense range. No Refusal on the auger was encountered in any of the boreholes.

Water table was only encountered in one hole at approximately 2m below existing ground level in one of the Old Harbour Bay sites.

Bog Walk:

The soils encountered across the Bog Walk Sites were predominantly Very Dense Sands Cobbles & Boulders. Insitu densities were generally in the Compact/Firm to Very Dense/Hard range. Refusal was encountered on the auger in two (2) of the boreholes.

No water table was encountered below existing ground level at any of the Bog Walk sites.

Port Maria:

The soils encountered across the Port Maria Sites were predominantly Firm Clays. Insitu densities were generally in the Very Soft/Compact to Very Stiff/Very Dense range. No Refusal on the auger was encountered in any of the boreholes.

Water table was encountered at variable depths, about 2+m below existing ground level at the Port Maria sites.

3.0 LABORATORY TEST RESULTS

The soils encountered were predominantly of the cohesive fraction. Forty one (41) samples were selected for testing; seventeen (17) Grainsize Distribution Tests and twenty four (24) Index Testings were done on the samples recovered. The chosen samples are, to the best of the engineer's judgment, representative of the samples recovered from the boreholes.

3.1. Classification & Index Testing:

1. Grainsize Distribution:

Figures 3.1 shows the grainsize distribution envelopes of the samples tested. The figure indicates that the samples have gradation that falls essentially into two significant groups. The following is the group descriptions:

1) Group A – the Graded Coarse to Fine Sands plus some Gravels & Clays
2) Group B – the Clays and Sands plus little Gravels

2. Soil Plasticity:

Appendix II gives a listing of the Atterberg Limits for the samples tested. The results indicate that the soils classified as Inorganic Clays of Medium to High Plasticity; the Liquid Limits ranged between 50.0% and 84.8%; the Plastic Limits between 23.6% and 30.5%; and the Moisture Contents between 9.0% and 24.0%. Based on these results, it is expected that the majority of these soils will exhibit moderate to high swell/shrinkage and compressibility. Given however their frequency of occurrence within the depths explored, it is expected that they will not have a significant impact on the design of the foundation soils and other infrastructural elements on site.

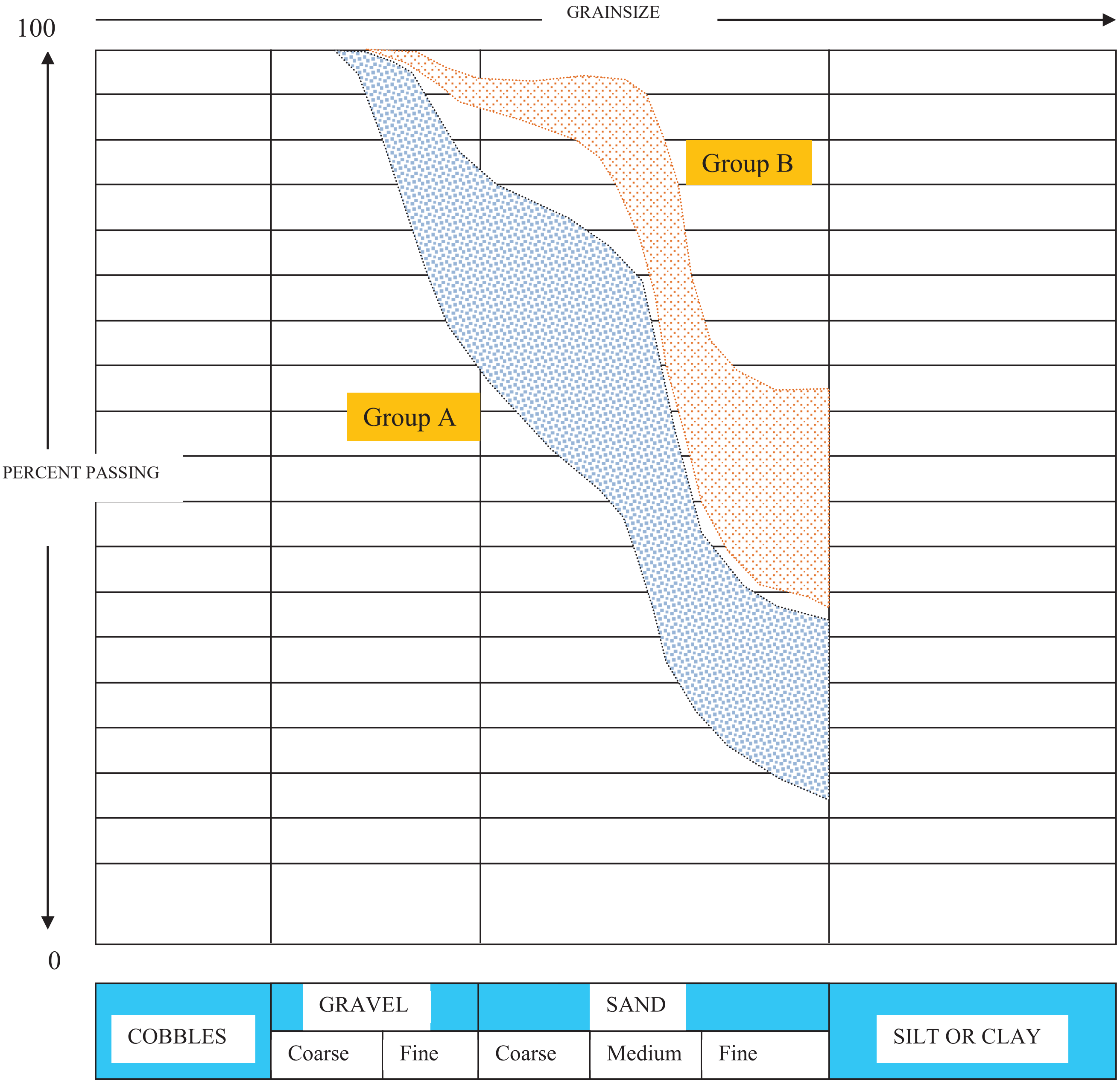


FIGURE 3.1 - GRADATION ENVELOPE – IMPROVEMENT OF EMERGENCY COMMUNICATION SYSTEMS IN JAMAICA (OLD HARBOUR BAY)

4.0 GEOTECHNICAL DISCUSSION

4.1. Presumptive Soil Profile

The Presumptive profiles shown are an extrapolation of the borehole information along with an understanding of the deposition history of the soils in the area. The profile boundaries shown are presumptive and should be viewed only as approximate representations of the insitu soil condition on site.

Old Harbour Bay

The subsoil layers applicable for evaluating engineering behavior and construction concerns can be characterized as five (5) distinct types found on the different sites in this area (see typical site profiles below). The type is as follows:

A) TYPE 1

1) Loose - Compact SANDS + Some Gravels
Depth Range; Variable 0-10.7+m
Average $N_{55} = 6$
Borehole - # 002, 003 & 004

B) TYPE 2

2) Very Stiff CLAYS
Depth Range; Variable 2.3-10.7+m
Average $N_{55} = 15$
Borehole - # 002, 003 & 004

C) TYPE 3

3) Firm – Stiff CLAYS
Depth Range; Variable 0-10.7+m
Average $N_{55} = 9$
Borehole - # 001 & 003

D) TYPE 4

4) Very Loose SANDS
Depth Range; Variable 1.5-6m
Average $N_{55} = 2$
Borehole - # 002

E) TYPE 5

5) Very Soft CLAYS
Depth Range; Variable 3-5m
Average N_{55} = 1
Borehole - # 002

BogWalk

The subsoil layers applicable for evaluating engineering behavior and construction concerns can be characterized as five (5) distinct types found on the different sites in this area (see typical site profiles below). The type is as follows:

A) TYPE 6

1) Very Dense Calcareous COBBLES & BOULDERS + Some Sands
Depth Range; Variable 0-2.1m
Average N_{55} = 40
Borehole - # 006, 008 & 009

B) TYPE 3

2) Firm – Stiff CLAYS
Depth Range; Variable 0-10.7+m
Average N_{55} = 15
Borehole - # 0005 & 009

C) TYPE 2

3) Very Stiff – Hard CLAYS
Depth Range; Variable 0-10.7+m
Average N_{55} = 40
Borehole - # 006 & 009

D) TYPE 7

4) Medium – Hard Porous Limestone Rock
Depth Range; Variable 1.5-3.7+m
Borehole - # 006 & 008

E) TYPE 1

5) Compact SANDS
Depth Range; Variable 2.3-9.1m
Average N_{55} = 10
Borehole - # 009

Port Maria

The subsoil layers applicable for evaluating engineering behavior and construction concerns can be characterized as five (5) distinct types found on the different sites in this area (see typical site profiles below). The type is as follows:

A) TYPE 3

1) Firm – Stiff CLAYS
   Depth Range; Variable 0-10.7+m
   Average N_{55} = 5
   Borehole - # 011, 014 & 015

B) TYPE 5

2) Very Soft - Soft CLAYS
   Depth Range; Variable 0-10.7+m
   Average N_{55} = 15
   Borehole - # 011, 012, 014 & 015

C) TYPE 2

3) Very Stiff CLAYS
   Depth Range; Variable 7.6-10.7+m
   Average N_{55} = 15
   Borehole - # 012 & 014

D) TYPE 1

4) Compact Calcareous SANDS + Some Gravels
   Depth Range; Variable 0-10m
   Average N_{55} = 12
   Borehole - # 010 & 011

E) TYPE 6

5) Very Dense Calcareous Gravelly SANDS + Some Gravels
   Depth Range; Variable 4.6-7.6m
   Average N_{55} = 50
   Borehole - # 010 & 011

Old Harbour Site:

Generally the Types 5 and 4 soils will exhibit significant settlement especially the Type 5 Soils. These soils will require modification or replacement. The Type 4 soils can be modified with mechanical compaction when they are close to the surface. The Type 4 soils however will need to be replacing part and or reinforced using geogrid to mitigate settlement.

In the case of the Types 3 and 2 soils, seasonal swell shrinkage could be problematic; deepening the footings and or soil replacement should mitigate the problems.

Port Maria Site:

Boreholes 12 and 14 show significant presence of the Type 5 soils (very soft clays). These soils will need replacement and reinforcement with geogrid. Passive resistance of these soils will be very low and lateral stability could be a major problem. The use of short bored piles is an option.

The soils at Location 13 (inaccessible) appear subjectively to be calcareous sands and gravels and are therefore likely to be similar in properties to the Type 1 soils summarized below. The assumption in that location is that lateral restraint is offered by the retaining wall along the slope in the vicinity of the proposed location.

BogWalk Site:

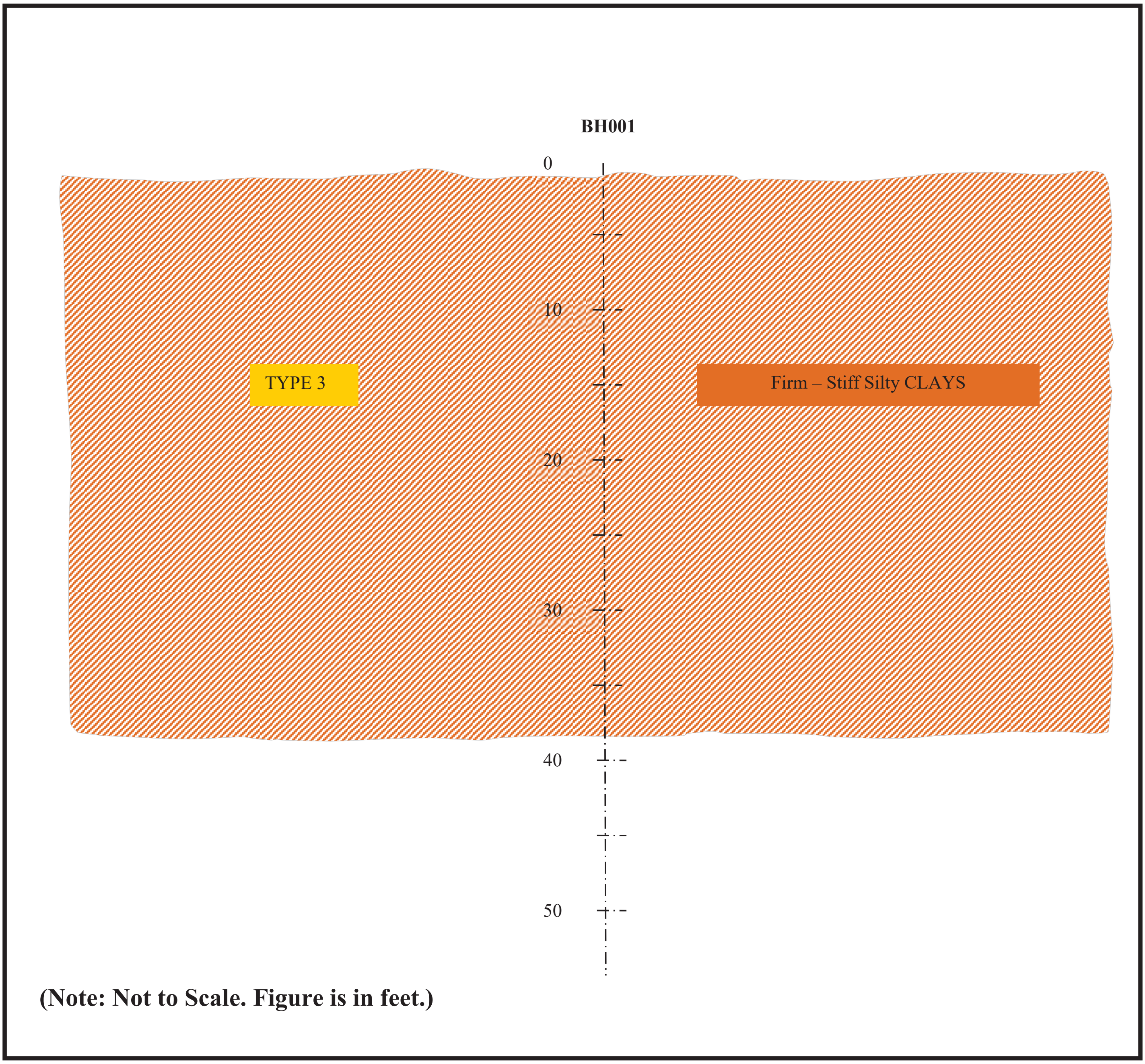
The soils in this area are generally good foundation soils and are not anticipated to present any significant problems. In areas where the Type 3 soils were encountered foundation deepening could be sufficient. To satisfy the requirements for lateral loading, the required depth of the foundation could mitigate swell shrinkage issues.

The site at Location 7 was inaccessible by our testing equipment. Based on our visual assessment the area is comprised of predominantly limestone rock. The outcroppings appear quite fractured and the RQDs are likely to be fairly low. The properties are therefore similar to that of the Type 7 soils summarized below and are recommended for foundation design purposes.

In general for all 3 locations, overturning will however govern the design of the footing. The passive resistance of the soil and the weight of the foundation and the soil above it will be the stabilizing forces in this design. Both problems will have to be accounted for in design.

For locations requiring soil replacement, it is recommended that a compact granular layer of soil placed below the footing to dissipate pore pressure development during saturated conditions. In addition use a stiff mat for the tower to mitigate settlement problems. The depth and size of the mat shall be chosen to ensure macro stability of the tower.

Old Harbour Bay



(Note: Not to Scale. Figure is in feet.)

FIGURE 4.1 - Presumptive Profile – BOREHOLES **#001**

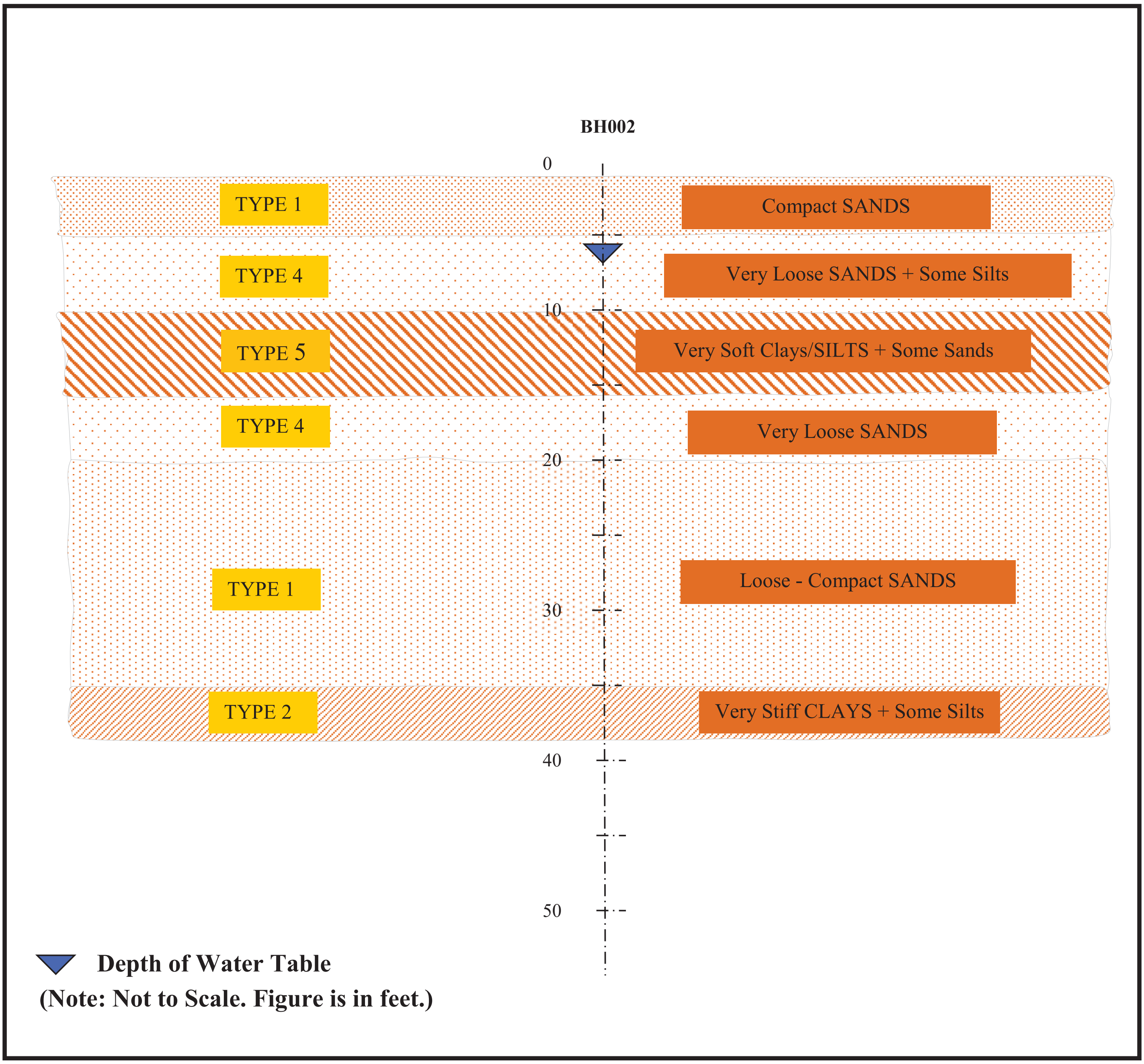
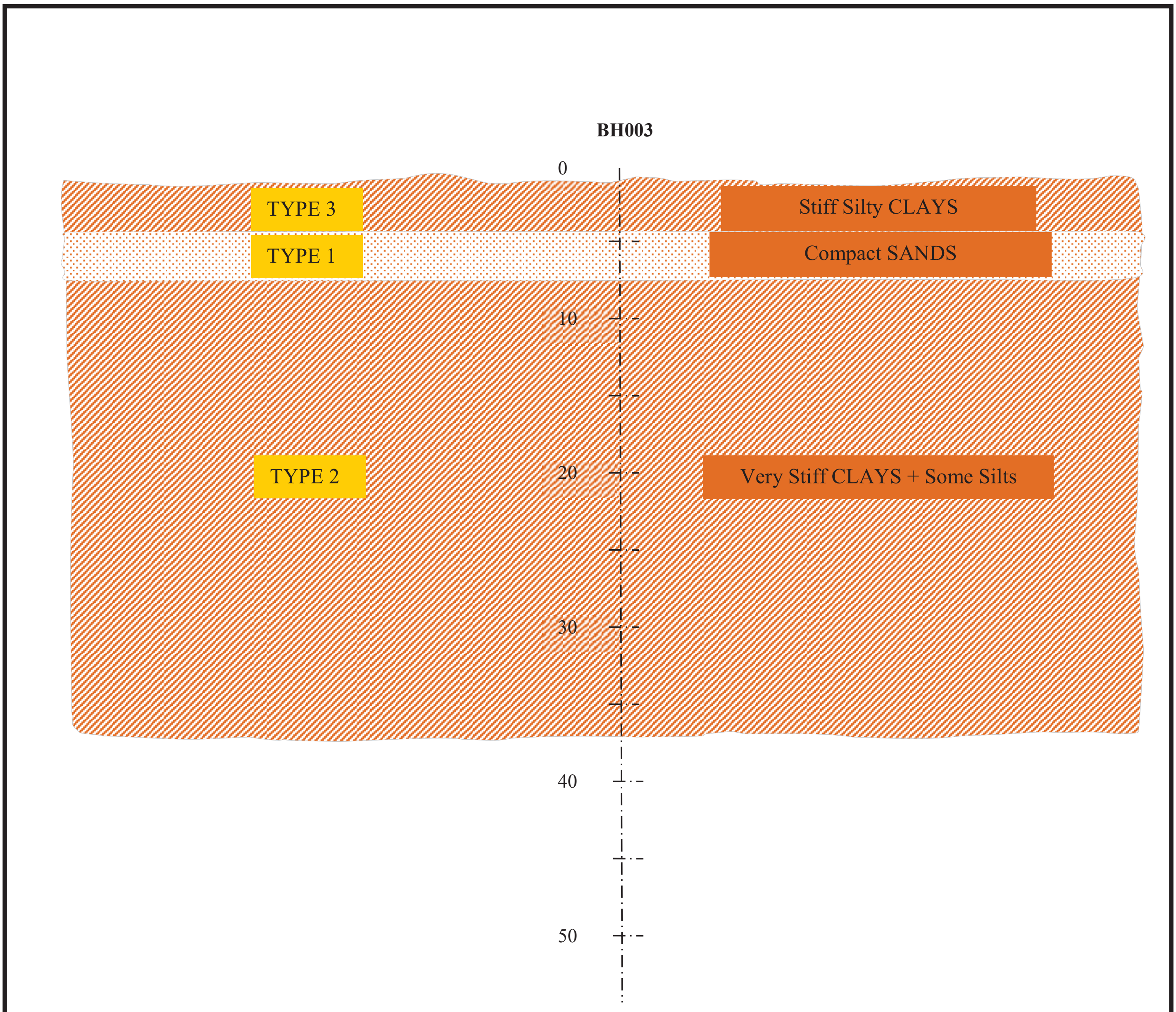
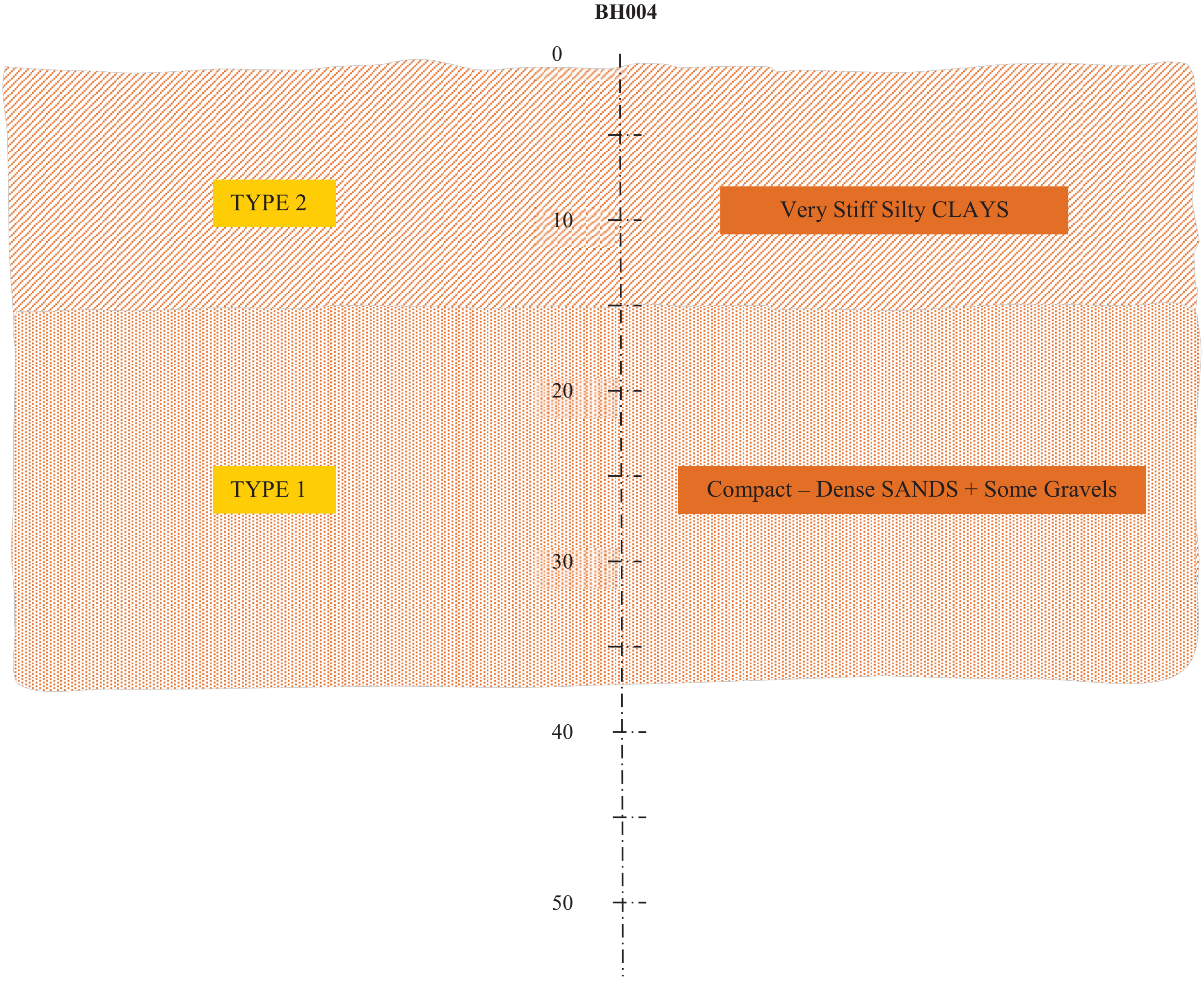


FIGURE 4.2 - Presumptive Profile – BOREHOLES **#002**



(Note: Not to Scale. Figure is in feet.)

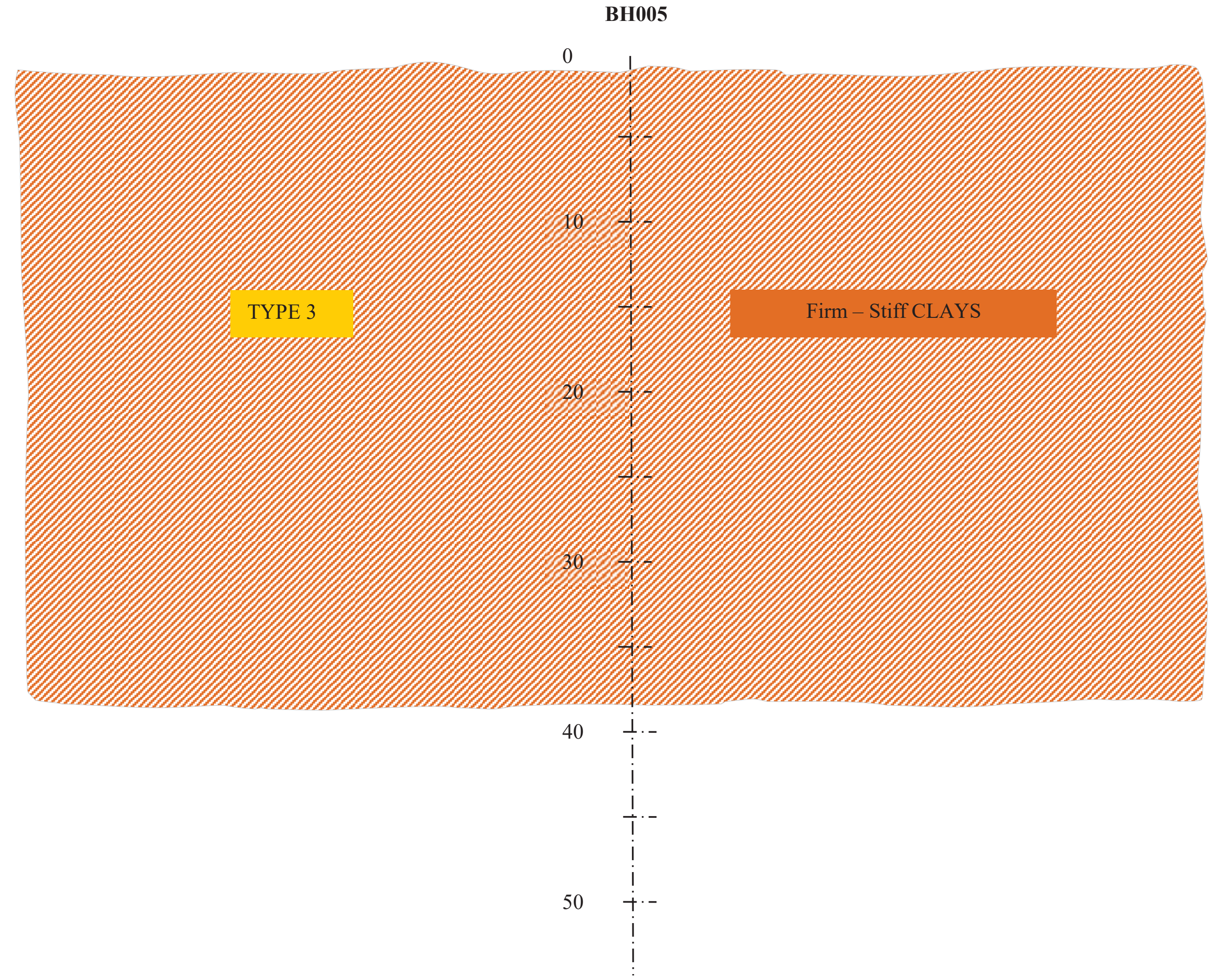
FIGURE 4.3 - Presumptive Profile – BOREHOLES **#003**



(Note: Not to Scale. Figure is in feet.)

FIGURE 4.4 - Presumptive Profile – BOREHOLES **#004**

Bog Walk



(Note: Not to Scale. Figure is in feet.)

FIGURE 4.5 - Presumptive Profile – BOREHOLES **#005**

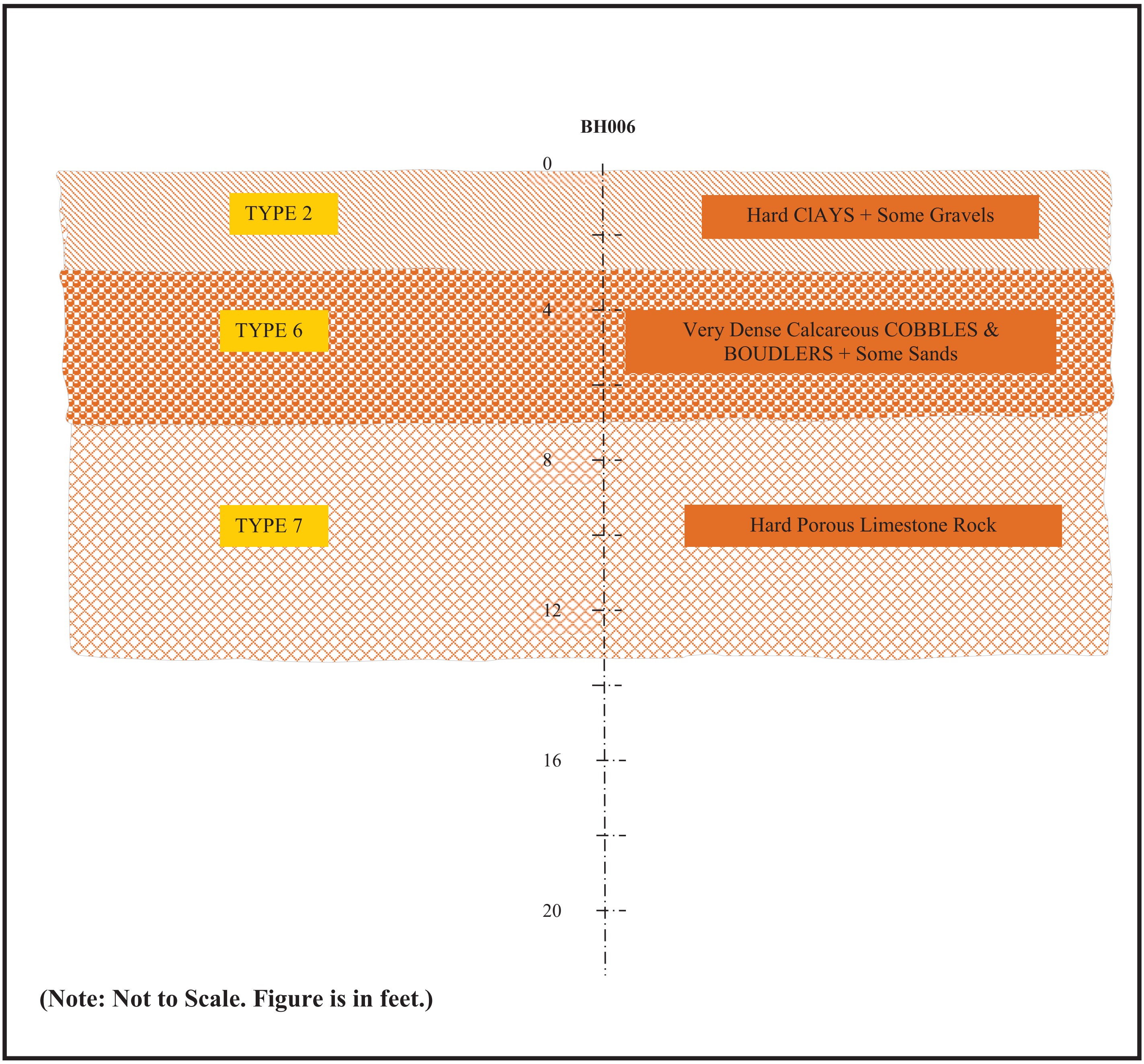
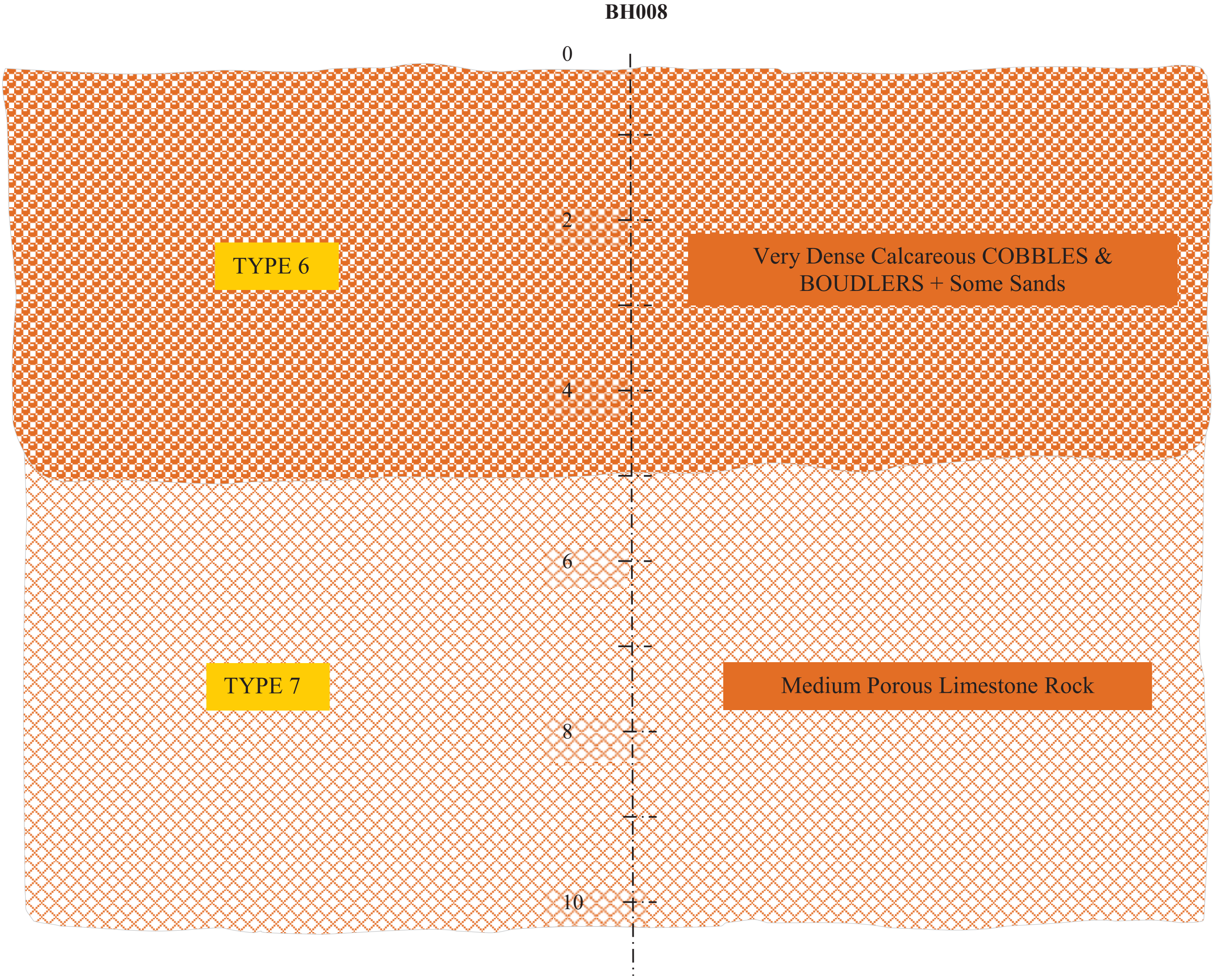


FIGURE 4.6 - Presumptive Profile – BOREHOLES **#006**



(Note: Not to Scale. Figure is in feet.)

FIGURE 4.7 - Presumptive Profile – BOREHOLES **#008**

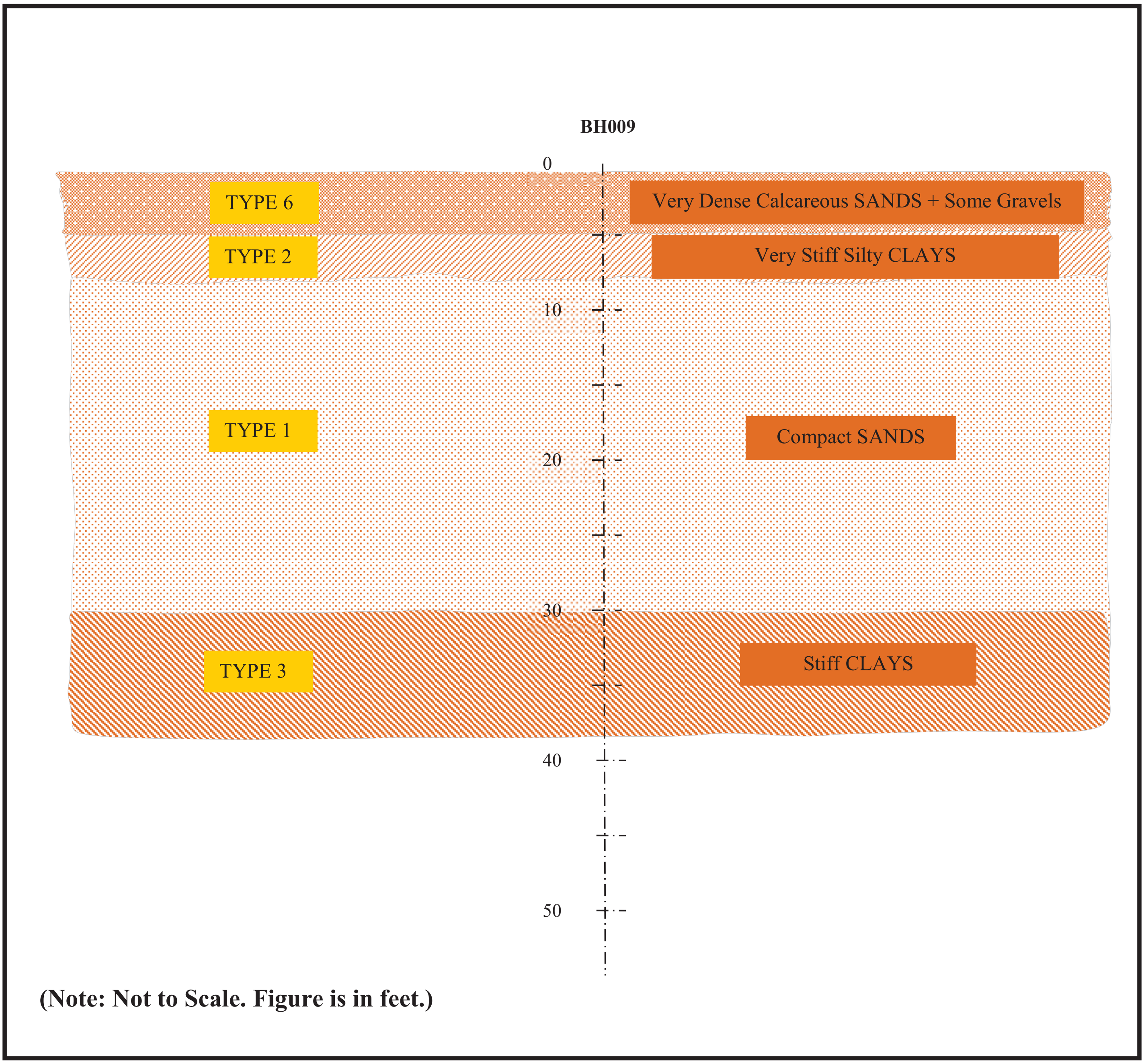
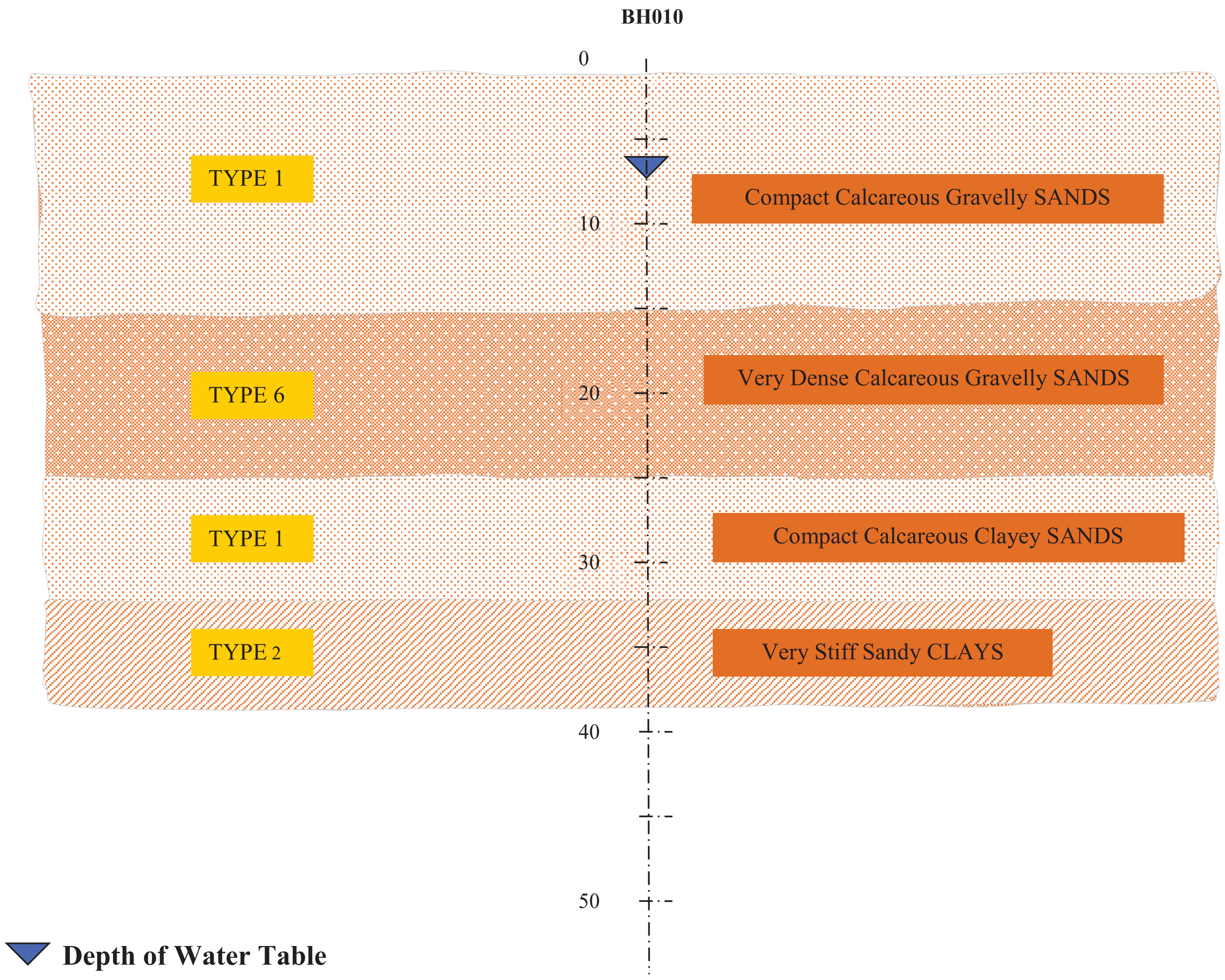


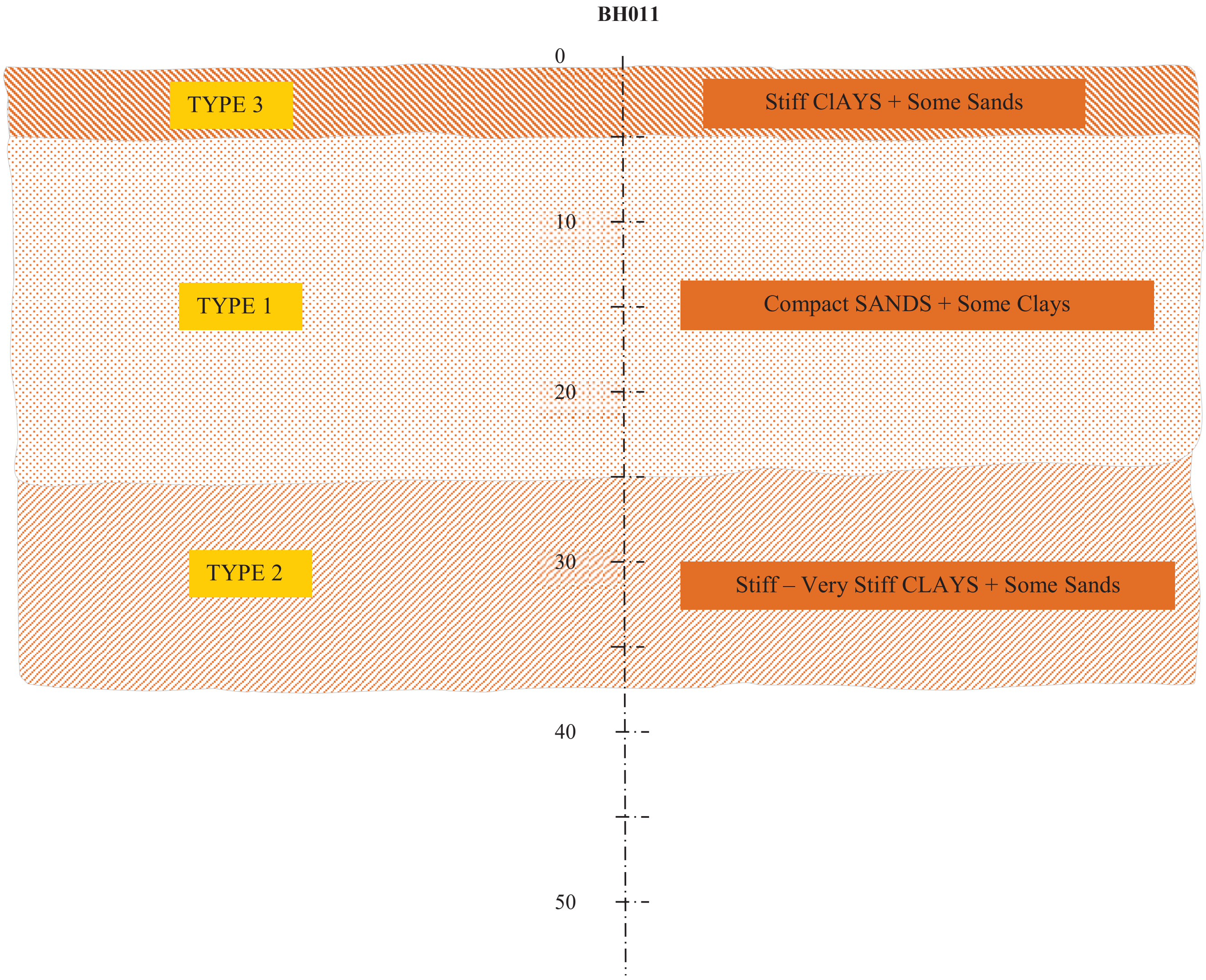
FIGURE 4.8 - Presumptive Profile – BOREHOLES **#009**

Port Maria



(Note: Not to Scale. Figure is in feet.)

FIGURE 4.9 - Presumptive Profile – BOREHOLES **#010**



(Note: Not to Scale. Figure is in feet.)

FIGURE 4.10 - Presumptive Profile – BOREHOLES **#011**

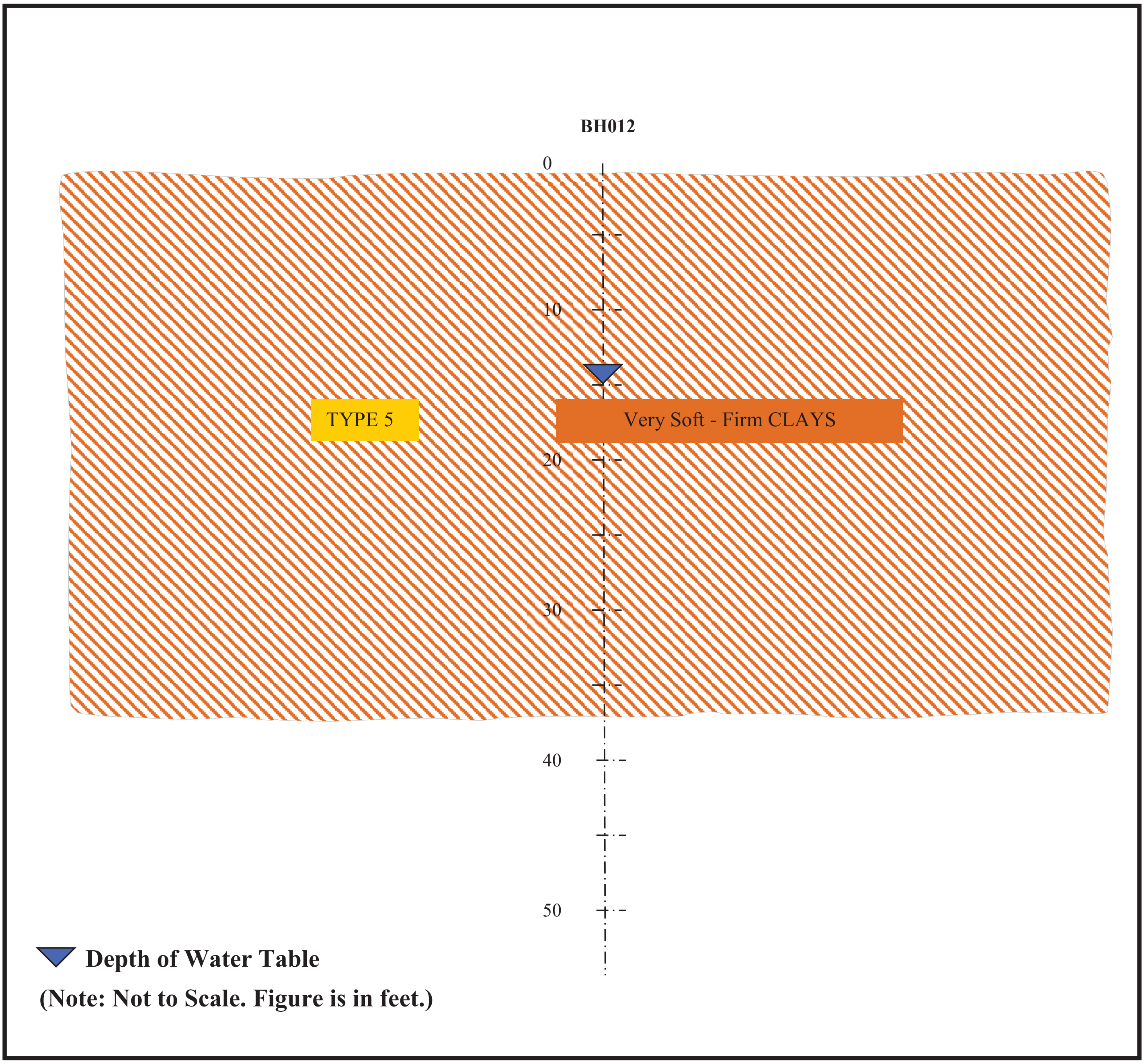


FIGURE 4.11 - Presumptive Profile – BOREHOLES **#012**

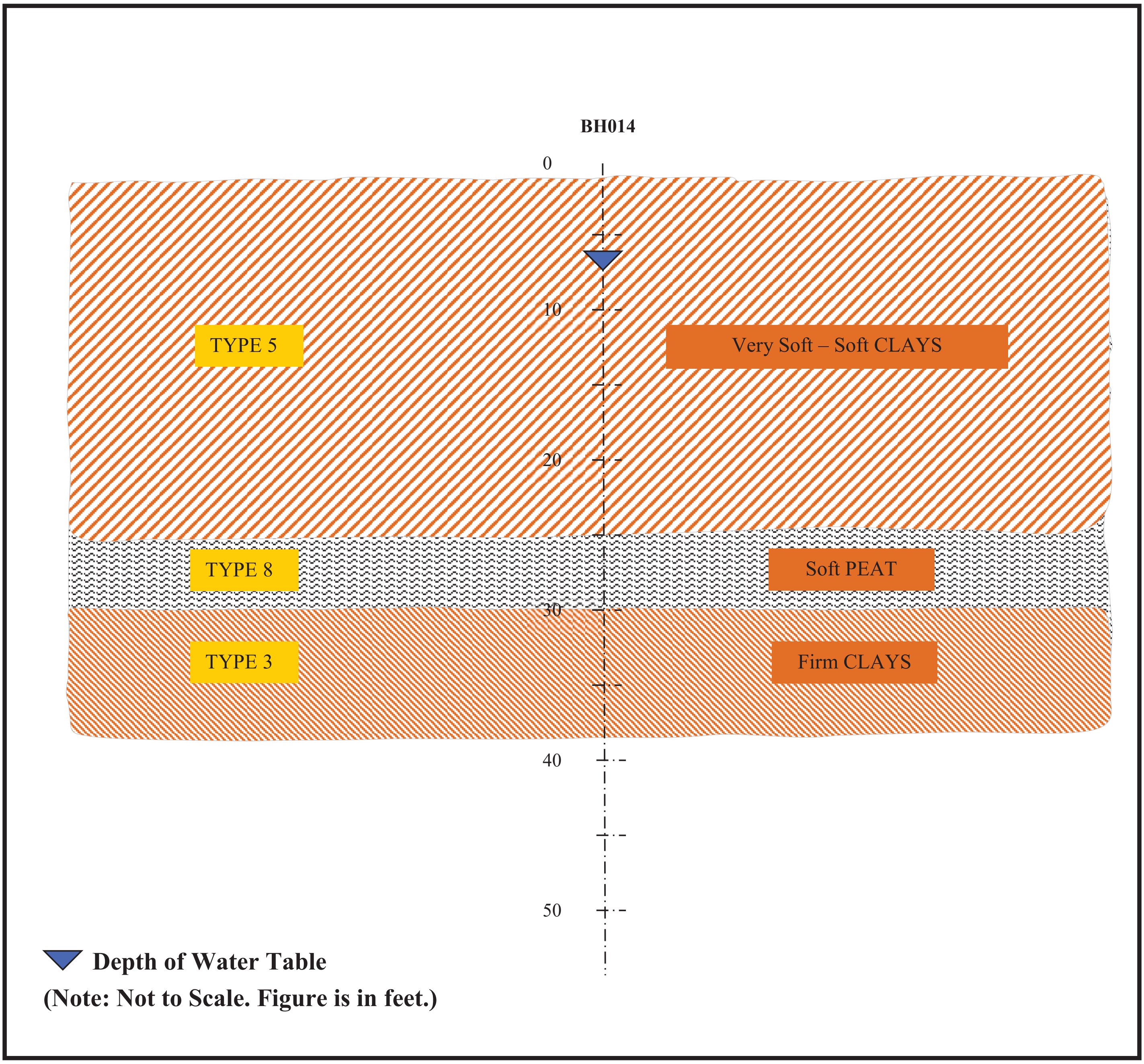


FIGURE 4.12 - Presumptive Profile – BOREHOLES **#014**

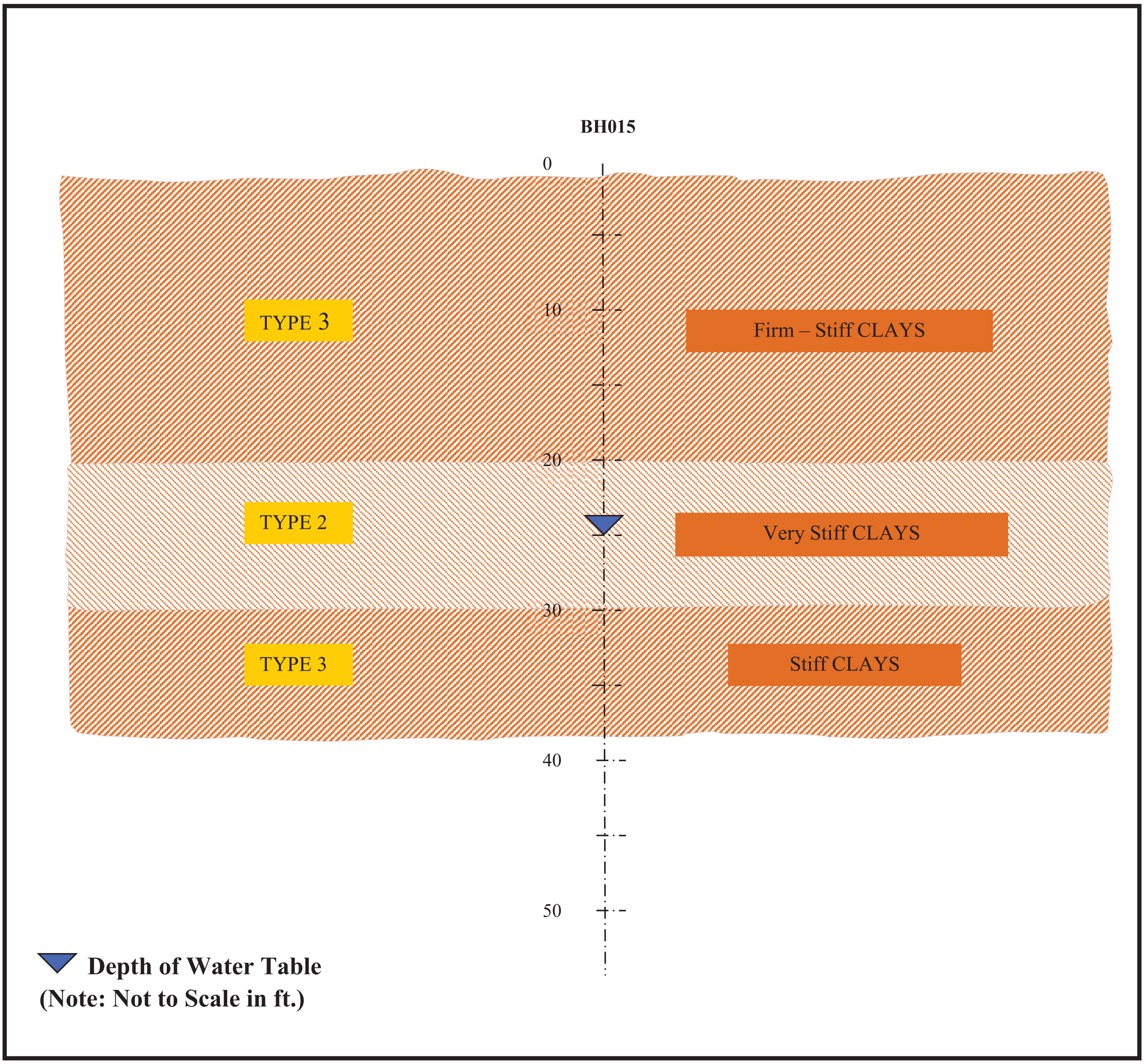


FIGURE 4.13 - Presumptive Profile – BOREHOLES **#015**

4.2. Bearing Capacity

4.2.1. Shear Considerations:

Note, if soil modification is chosen and the densities are verified; apply a multiplying factor of 1.25 to relevant bearing values.

Also note that Ultimate values are given for the insitu soils. A Factor Of Safety of 3 for maximum safe load capacity is recommended based on the high variability and compressibility of the soils on site.

TYPE 1 SOILS – Compact SANDS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profiles shown below, the recommended value for this parameter is:

i) $Ks = 7974*(1-0.4*B/L)*B$ kN/m^3

The Ultimate Bearing Capacity and other relevant parameters recommended on these soils are:

i) $Q_{ult.} = 395.09*(1+0.34*B/L)*(1+0.18*D/B)$ kPa

TYPE 2 SOILS – Very Stiff CLAYS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profile shown in Figure 4.1 – 4.13, the recommended value for this parameter is:

i) $Ks = 12483*(1+0.2*B/L)$ kN/m^3

The ultimate bearing capacity and other relevant parameters recommended for these soils are:

i) $Q_{ult.} = 312.07*(1+0.20*B/L)*(1+0.2*D/B) + 15.45$ kPa

TYPE 3 SOILS – Firm – Stiff CLAYS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profile shown in Figure 4.1 – 4.13, the recommended value for this parameter is:

i) $Ks = 8399*(1+0.2*B/L)$ kN/m^3

The ultimate bearing capacity and other relevant parameters recommended for these soils are:

i) $Q_{ult.} = 209.96*(1+0.20*B/L)*(1+0.2*D/B) + 15.45$ kPa

TYPE 4 SOILS – Very Loose SANDS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profiles shown in Figures 4.1 – 4.13, the recommended value for this parameter is:

i) $Ks = 4198*(1-0.4*B/L)*B$ kN/m^3

1The Ultimate Bearing Capacity and other relevant parameters recommended on these soils are:

i) $Q_{ult.} = 251.23*(1+0.30*B/L)*(1+0.17*D/B)$ kPa

TYPE 5 SOILS – Soft – Very Soft CLAYS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profile shown in Figure 4.1 – 4.13, the recommended value for this parameter is:

i) $Ks = 4104*(1+0.2*B/L)$ kN/m^3

The ultimate bearing capacity and other relevant parameters recommended for these soils are:

i) $Q_{ult.} = 102.6*(1+0.20*B/L)*(1+0.2*D/B) + 15.45$ kPa

TYPE 6 SOILS – Very Dense SANDS/COBBLES & BOULDER + Some Gravels

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profiles shown in Figures 4.1 – 4.13, the recommended value for this parameter is:

i) Ks = 12351*(1-0.4*B/L)*B kN/m^3

The Ultimate Bearing Capacity and other relevant parameters recommended on these soils are:

i) $Q_{ult.}$ = 541.27*(1+0.38*B/L)*(1+0.19*D/B) kPa

TYPE 7 SOILS – Highly fractured Medium Limestone Rock Modeled As Very Dense Gravels and Sands

a) Mat/Raft Footing

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profiles shown in Figures 4.1 – 4.13, the recommended value for this parameter is:

i) Ks = 40936*(1-0.4*B/L)*B kNm^3

b) Raft Pad/Beam Footing

The Ultimate Bearing Capacity and other relevant parameters recommended on this site are:

i) $Q_{ult.}$ = 1291.77*(1+0.49*B/L)*(1+0.22*D/B) kPa

TYPE 8 SOILS – PEATY SOILS

Ignore Soil Contribution

Where,

Q_{ult} is the Ultimate Bearing Capacity, kPa
Ks is the Modulus of Subgrade Reaction, kN/m^3
D is the Depth of footing, m
B is the Width of footing, m
L is the Length of footing, m

TABLE 4.1 - SUMMARY OF SOIL BEARING CAPACITIES

LOCATION IDENTIFICATION	ULTIMATE BEARING CAPACITY 1mx1m; D=0.5	ULTIMATE BEARING CAPACITY 1mx1m;D=1	Allowable Bearing Capacity 1mX1m; D=0.5	Allowable Bearing Capacity 1mX1m; D=1
BOREHOLE	KPa	KPa	KPa	KPa
001	292.6	317.8	97.5	105.9
002	354.4	382.1	118.1	127.4
003	292.6	317.8	97.5	105.9
004	427.4	464.8	142.5	154.9
006	817.9	888.9	272.6	296.3
007	817.9	888.9	272.6	296.3
008	817.9	888.9	272.6	296.3
009	427.4	464.8	142.5	154.9
010	577.7	624.7	192.6	208.2
011	292.6	317.8	97.5	105.9
012	150.9	163.2	50.3	54.4
013	817.9	888.9	272.6	296.3
014	150.9	163.2	50.3	54.4
015	292.6	317.8	97.5	105.9

Bearing Capacity at No. 005 and No.013 sites are presumed to be following.

*1 No.005 date is not described in this table. Each bearing capacity is presumed the same as No.003 that hall be calculated from same soil type.

*2 Boring is machine cannot enter into No.13. This site presumed to have minimum bearing capacity in this table from sight.

TABLE 4.2 - **SUMMARY OF SOIL PARAMETERS**

LAYER IDENTIFICATION	TYPE 1 SOILS	TYPE 2 SOILS	TYPE 3 SOILS	TYPE 4 SOILS
Bulk Unit Weight KN/m3	16.1	19.3	19.3	15.3
Submerged Unit Weight	9.2	9.5	9.5	8.7
Compression Index				
Void Ratio				
Undrained Cohesion (KPa)		60.7	40.8	
Drained Cohesion (KPa)				
Effective PHI/PHI	33.1	18	15	29.7
Relative Density	49.9			19.0
Ka	0.293	0.691	0.741	0.338
Kp	3.409	1.447	1.349	2.957
Permeability Coef. (k)				

TABLE 4.3 - **SUMMARY OF SOIL PARAMETERS**

LAYER IDENTIFICATION	TYPE 5 SOILS	TYPE 6 SOILS	TYPE 7 SOILS	TYPE 8 SOILS
				IGNORE
Bulk Unit Weight KN/m3	19.3	16.6	18.5	
Submerged Unit Weight	9.5	9.5	10.0	
Compression Index				
Void Ratio				
Undrained Cohesion (KPa)	20.0			
Drained Cohesion (KPa)				
Effective PHI/PHI	6	35.6	41.5	
Relative Density		69.5	100	
Ka	0.895	0.266	0.203	
Kp	1.117	3.756	4.923	
Permeability Coef. (k)				

4.3. Seismic Considerations

Information obtained from available seismic risk map for Jamaica indicates that the spectral acceleration for short periods/two second periods with 5% damped acceleration response spectrum for the maximum considered earthquake with a 2% probability of exceedance in 50 years, was deduced as S_1 =0.3g. According to the IBC code (2003) and the UBC (1997) code, the sites vary in classifications from Classes C to E from the fractured limestones to the soft Clays respectively.

4.4. Liquefaction Considerations

In a seismic event, the stresses developed on an element of soil are usually cyclic in nature. The manner in which soils response to these stresses is dependent on a number of factors, including but not limited to, insitu density (relative density), water table conditions, grainsize distribution and shape. For example, loose saturated sands having a contractive structure and subjected to shear deformation might develop very high pore water pressures and lose virtually all their resistance to deformation. This condition where a static (peak) or cyclic load leads to high pore or residual pressures that reduces the effective confining pressures to very low values or where the confining pressures becomes equal to the effective pore pressures leading to large deformation is called liquefaction.

The potential for a soil to liquefy has been determined to be dependent on the cyclic stress ratio τ_h/σ', where τ_h is the average horizontal shear stress induced by an earthquake and σ' is the initial effective overburden pressure on the soil layer involved.

The Type 1 soils (encountered below the water table at Location 2, in Old Harbour) appear susceptible to liquefaction based only on its relative density, its grainsize distribution however shows fines content (retained #200 sieve size) of over 35%. Typically soils with over 20% fines content, rarely liquefies.

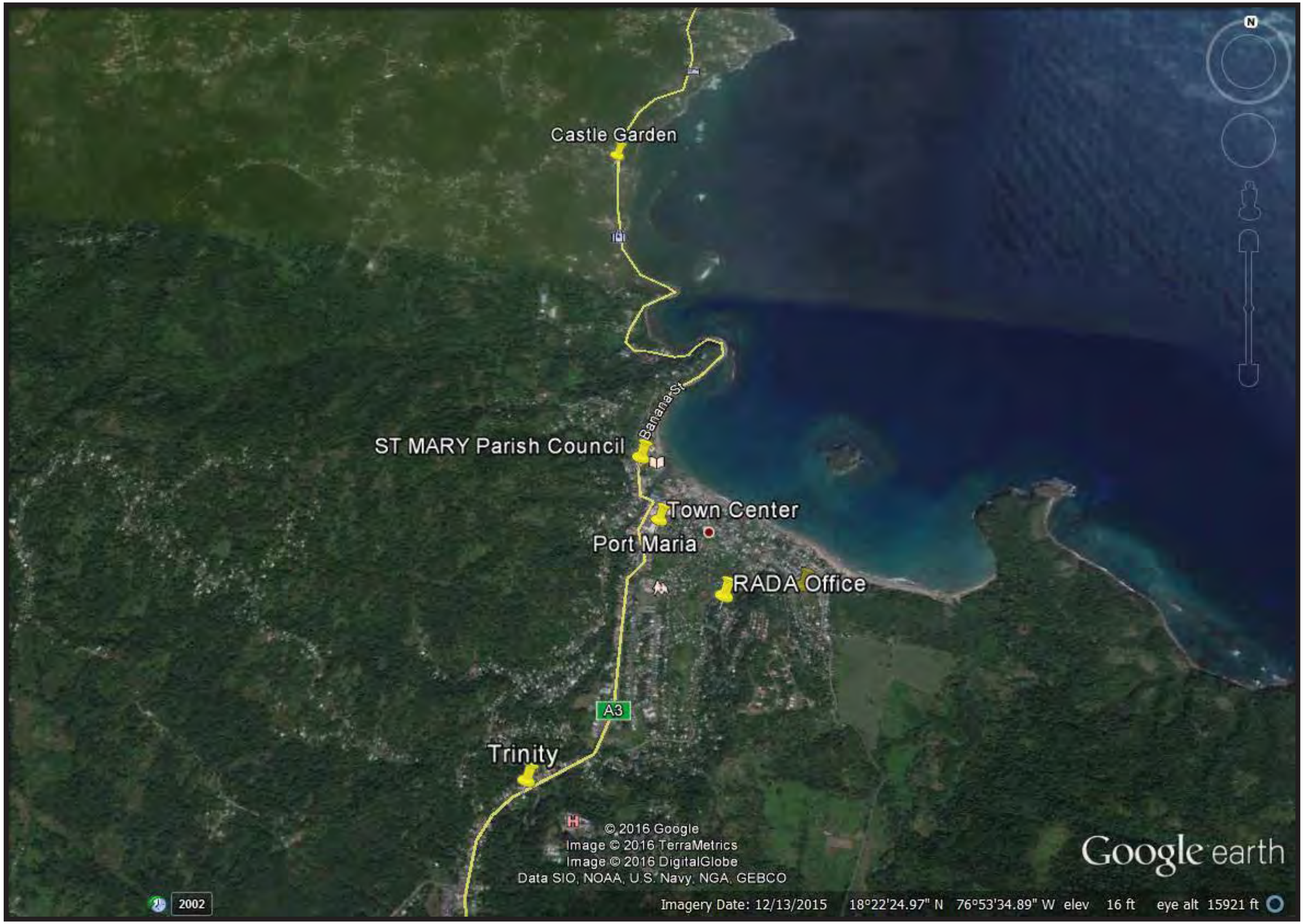
NHL ENGINEERING LIMITED

Dr. Carlton Hay
PhD., M.Sc. M.A.S.C.E.
Registered Professional Engineer (PE)
Geotechnical Engineering

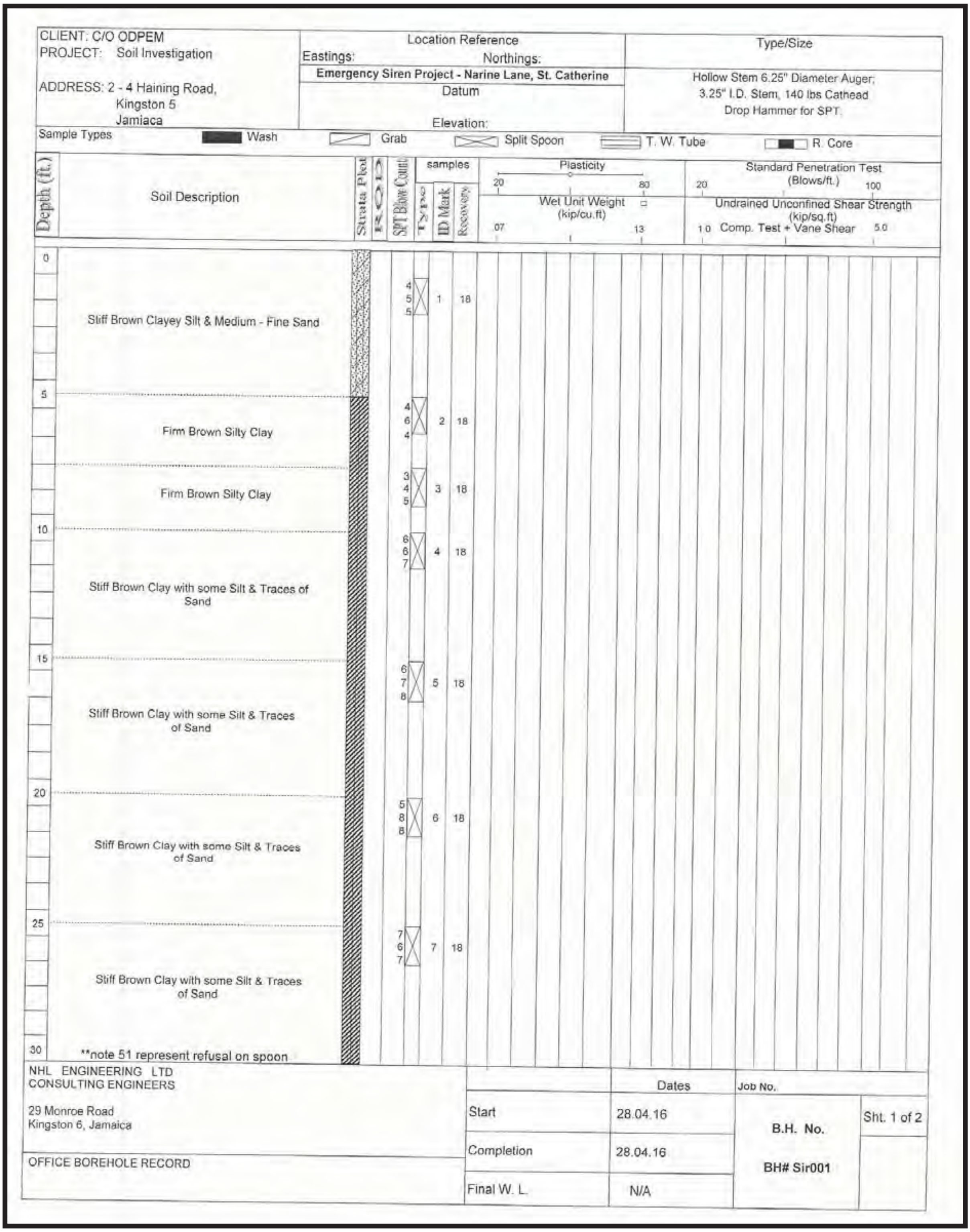
Appendix I - Site Location Plan and Test Location Plan (Old Harbour Bay)

Site Location Plan and Test Location Plan (Bog Walk)

Site Location Plan and Test Location Plan (Port Maria)



Appendix II - Soil Boring Log



CLIENT: C/O ODPEM
PROJECT: Soil Investigation
ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings:
Northings:
Emergency Siren Project - Narine Lane, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT

Sample Types: Wash, Grab, Split Spoon, T. W. Tube, R. Core

Plasticity: 20 – 80
Wet Unit Weight (kip/cu.ft): 07 – 13
Standard Penetration Test (Blows/ft.): 20 – 100
Undrained Unconfined Shear Strength (kip/sq.ft): 1.0 – 5.0; Comp. Test + Vane Shear

Depth (ft.)	Soil Description	SPT Blow Count	ID Mark	Recovery
0	Stiff Brown Clayey Silt & Medium - Fine Sand	4 5 5	1	18
5	Firm Brown Silty Clay	4 6 4	2	18
	Firm Brown Silty Clay	3 4 5	3	18
10	Stiff Brown Clay with some Silt & Traces of Sand	6 6 7	4	18
15	Stiff Brown Clay with some Silt & Traces of Sand	6 7 8	5	18
20	Stiff Brown Clay with some Silt & Traces of Sand	5 8 8	6	18
25	Stiff Brown Clay with some Silt & Traces of Sand	7 6 7	7	18
30	**note 51 represent refusal on spoon			

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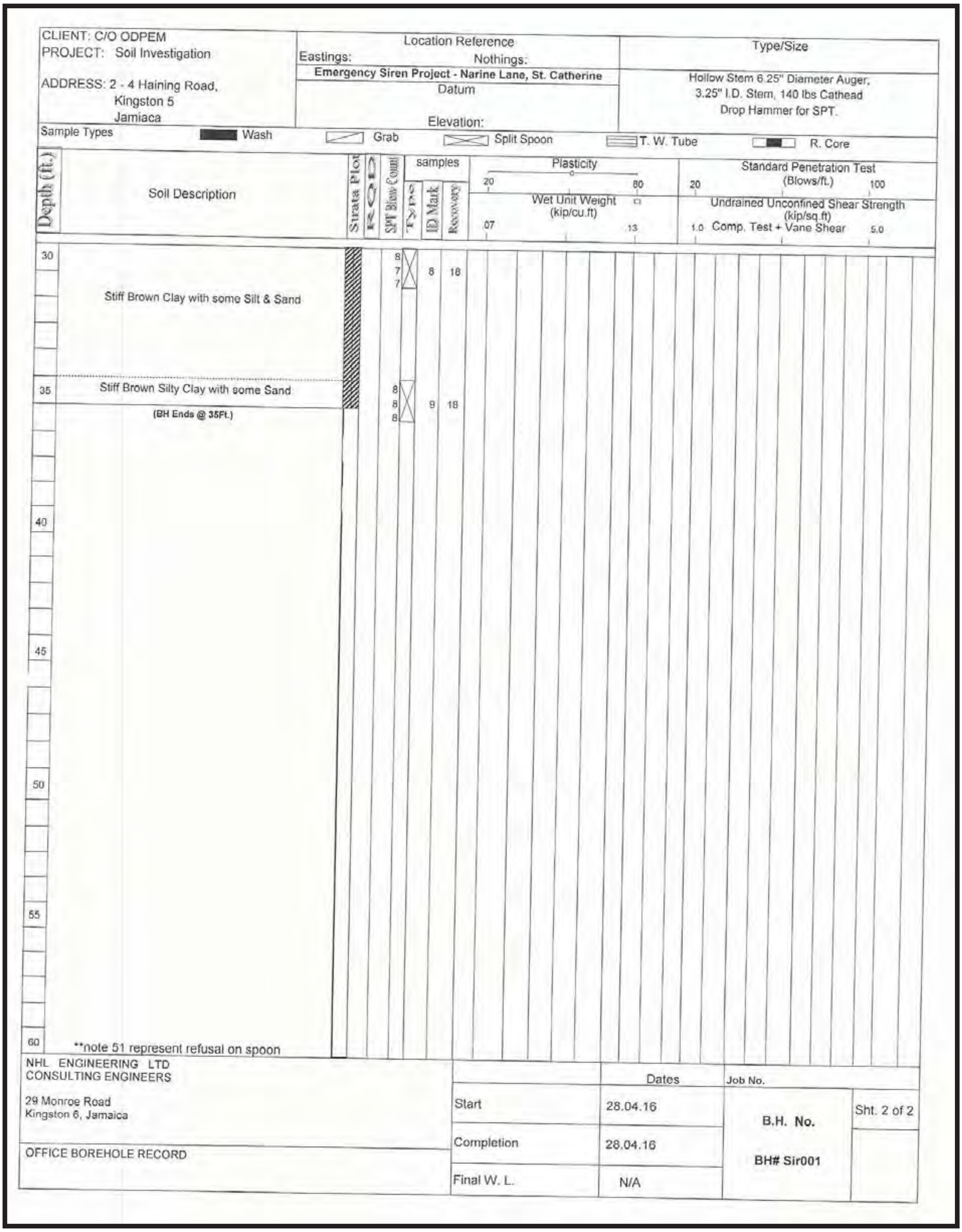
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates
Start	28.04.16
Completion	28.04.16
Final W. L.	N/A

Job No.
B.H. No. BH# Sir001
Sht. 1 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Nothings:
Emergency Siren Project - Narine Lane, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger,
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ▱ Grab ⊠ Split Spoon ☰ T. W. Tube ◧ R. Core

Plasticity 20 – 80; Wet Unit Weight (kip/cu.ft) 07 – 13
Standard Penetration Test (Blows/ft.) 20 – 100; Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear 1.0 – 5.0

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	Type	ID Mark	Recovery
30	Stiff Brown Clay with some Silt & Sand	▨		8 7 7	⊠	8	18
35	Stiff Brown Silty Clay with some Sand	▨		8 8 8	⊠	9	18
	(BH Ends @ 35Ft.)						
40							
45							
50							
55							
60	**note 51 represent refusal on spoon						

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Kingston 6, Jamaica

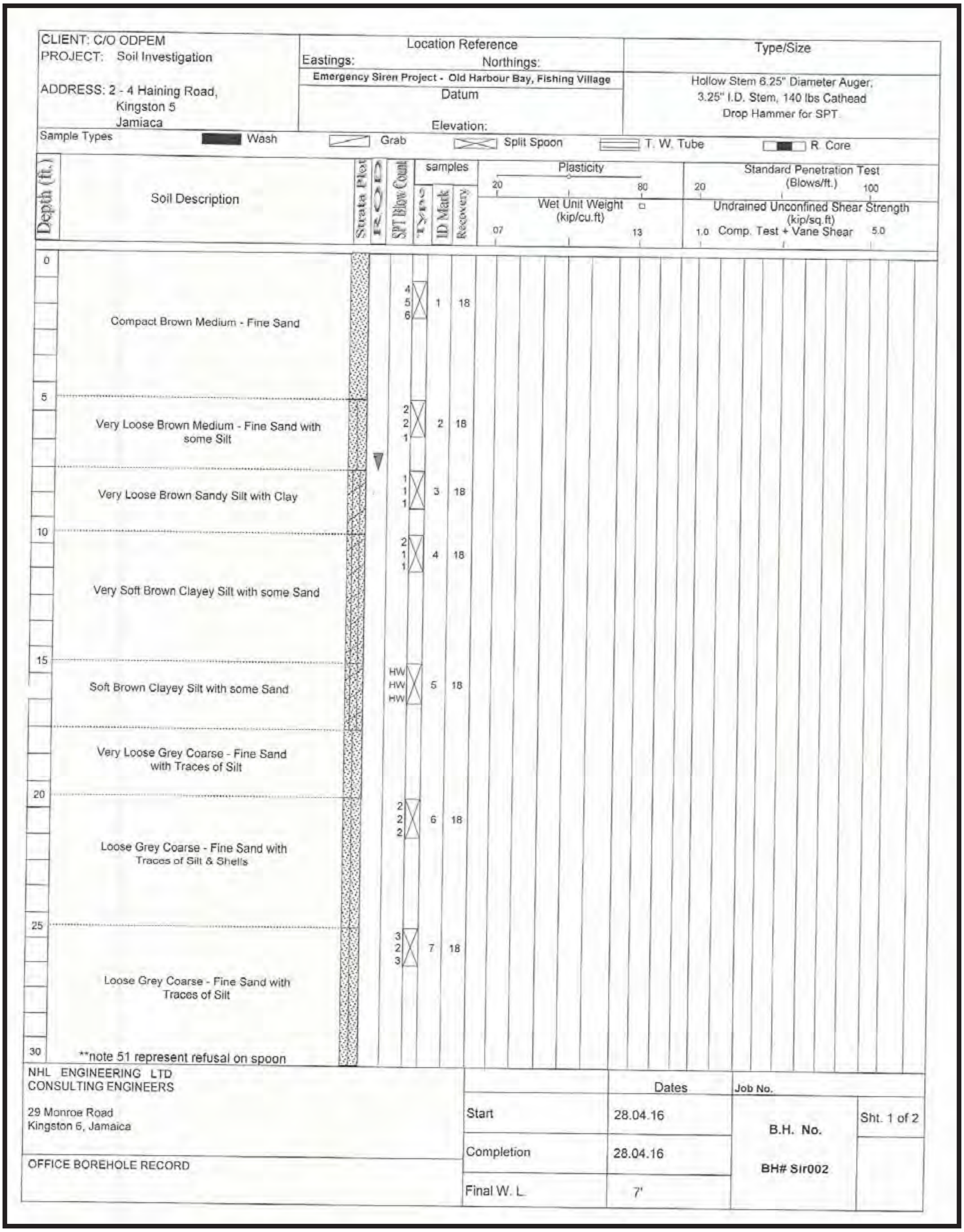
OFFICE BOREHOLE RECORD

	Dates
Start	28.04.16
Completion	28.04.16
Final W. L.	N/A

Job No.

B.H. No.
BH# Sir001

Sht. 2 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Northings:
Emergency Siren Project - Old Harbour Bay, Fishing Village
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ▭ Grab ☒ Split Spoon ☰ T. W. Tube ▣ R. Core

Depth (ft.)	Soil Description	SPT Blow Count	Type	ID Mark	Recovery
0	Compact Brown Medium - Fine Sand	4 5 6	☒	1	18
5	Very Loose Brown Medium - Fine Sand with some Silt	2 2 1	☒	2	18
	Very Loose Brown Sandy Silt with Clay	1 1 1	☒	3	18
10	Very Soft Brown Clayey Silt with some Sand	2 1 1	☒	4	18
15	Soft Brown Clayey Silt with some Sand	HW HW HW	☒	5	18
	Very Loose Grey Coarse - Fine Sand with Traces of Silt				
20	Loose Grey Coarse - Fine Sand with Traces of Silt & Shells	2 2 2	☒	6	18
25	Loose Grey Coarse - Fine Sand with Traces of Silt	3 2 3	☒	7	18
30	**note 51 represent refusal on spoon				

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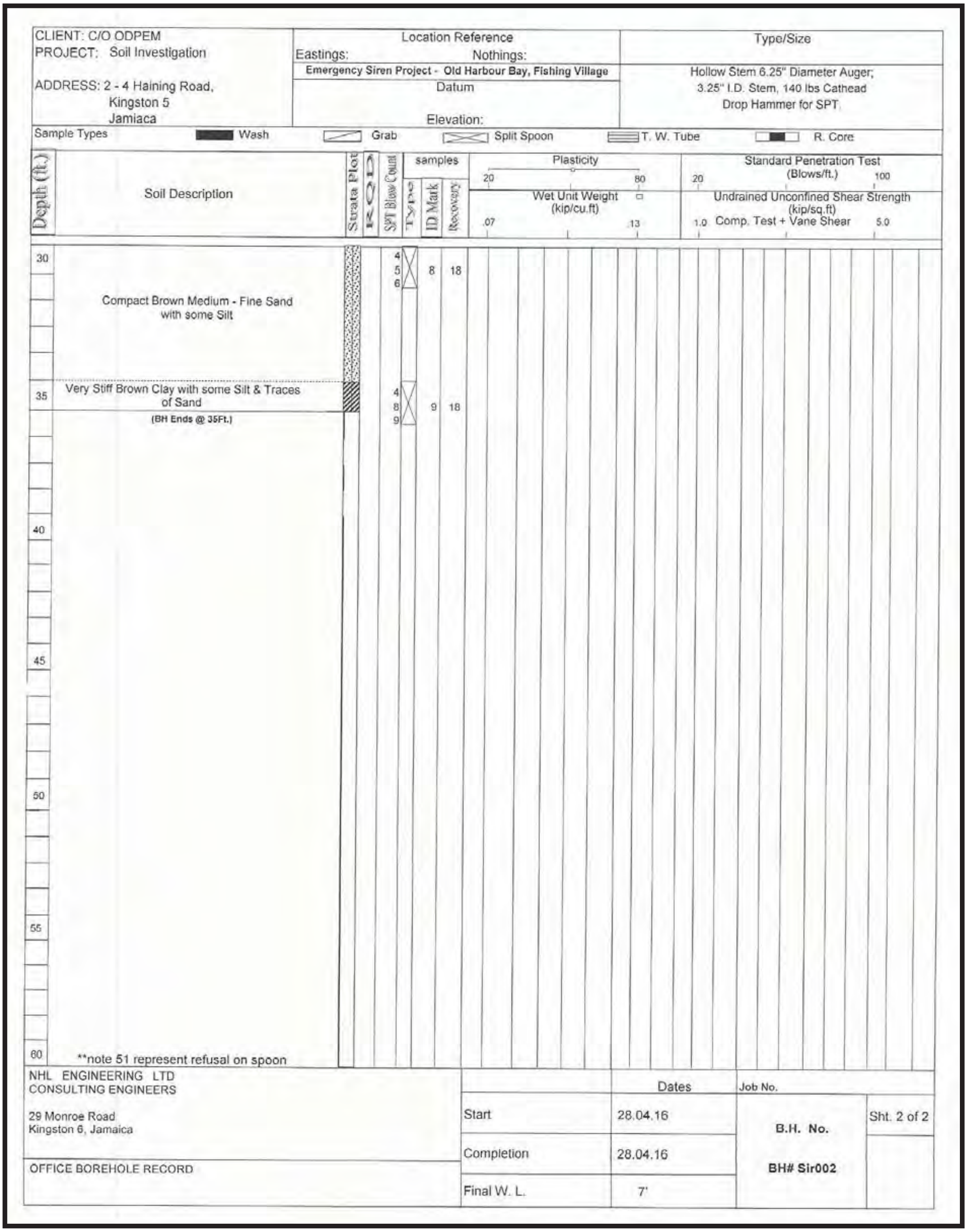
OFFICE BOREHOLE RECORD

	Dates
Start	28.04.16
Completion	28.04.16
Final W. L.	7'

Job No.

B.H. No.
BH# Sir002

Sht. 1 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Nothings:
Emergency Siren Project - Old Harbour Bay, Fishing Village
Datum

Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT

Sample Types: ■ Wash ▭ Grab ☒ Split Spoon ☰ T. W. Tube ▭ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples			Plasticity 20 80 Wet Unit Weight (kip/cu.ft) .07 .13	Standard Penetration Test (Blows/ft.) 20 100 Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear 1.0 5.0
					Type	ID Mark	Recovery		
30	Compact Brown Medium - Fine Sand with some Silt	░		4 5 6	☒	8	18		
35	Very Stiff Brown Clay with some Silt & Traces of Sand	▨		4 8 9	☒	9	18		
	(BH Ends @ 35Ft.)								
40									
45									
50									
55									
60	**note 51 represent refusal on spoon								

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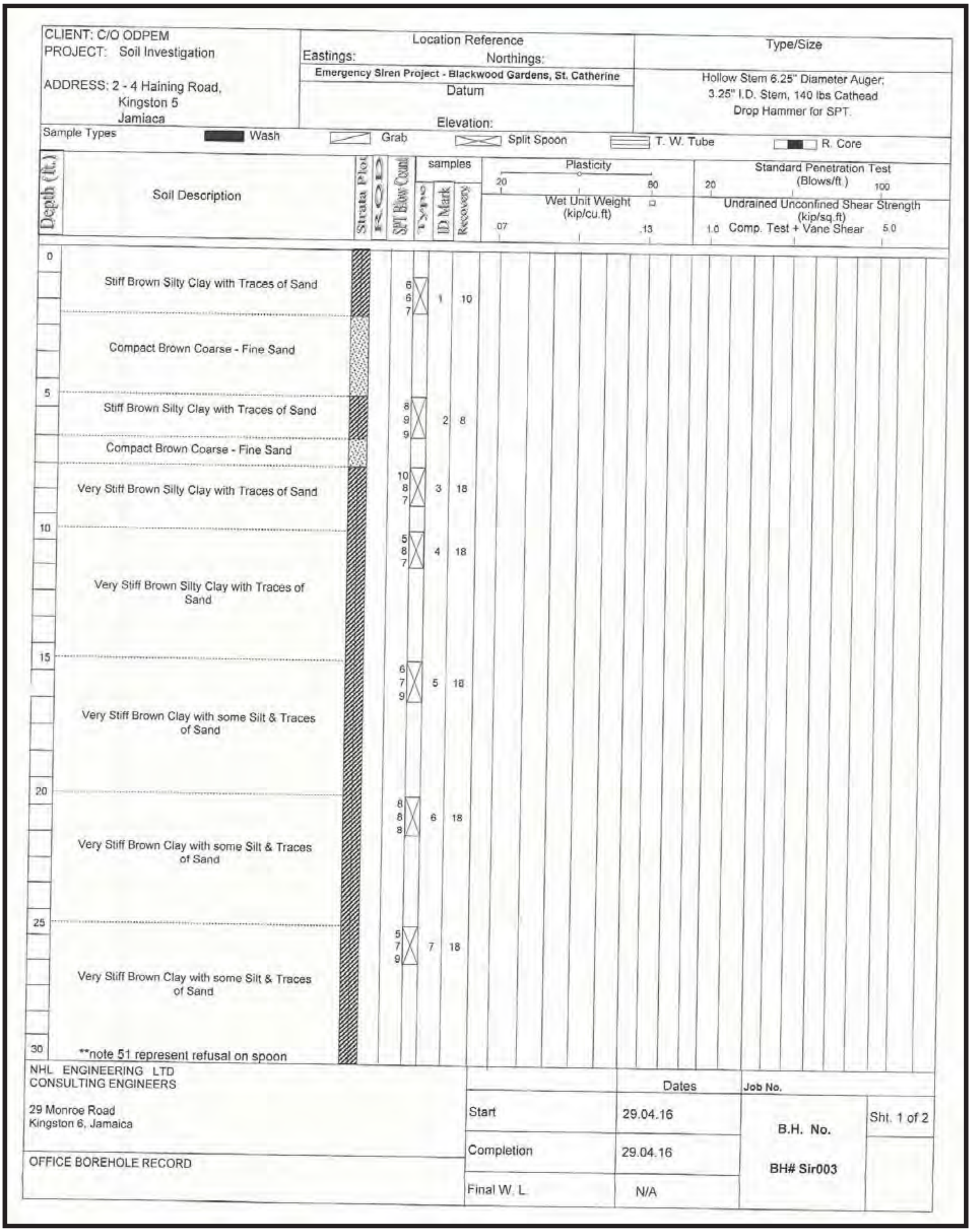
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	28.04.16	B.H. No.	Sht. 2 of 2
Completion	28.04.16	BH# Sir002	
Final W. L.	7'		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Northings:
Emergency Siren Project - Blackwood Gardens, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ◇ Grab ☒ Split Spoon ☰ T. W. Tube ■ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples Type	samples ID Mark	samples Recovery
0	Stiff Brown Silty Clay with Traces of Sand	▨		6 6 7	☒	1	10
	Compact Brown Coarse - Fine Sand	░					
5	Stiff Brown Silty Clay with Traces of Sand	▨		8 9 9	☒	2	8
	Compact Brown Coarse - Fine Sand	░					
	Very Stiff Brown Silty Clay with Traces of Sand	▨		10 8 7	☒	3	18
10	Very Stiff Brown Silty Clay with Traces of Sand	▨		5 8 7	☒	4	18
15	Very Stiff Brown Clay with some Silt & Traces of Sand	▨		6 7 9	☒	5	18
20	Very Stiff Brown Clay with some Silt & Traces of Sand	▨		8 8 8	☒	6	18
25	Very Stiff Brown Clay with some Silt & Traces of Sand	▨		5 7 9	☒	7	18
30	**note 51 represent refusal on spoon						

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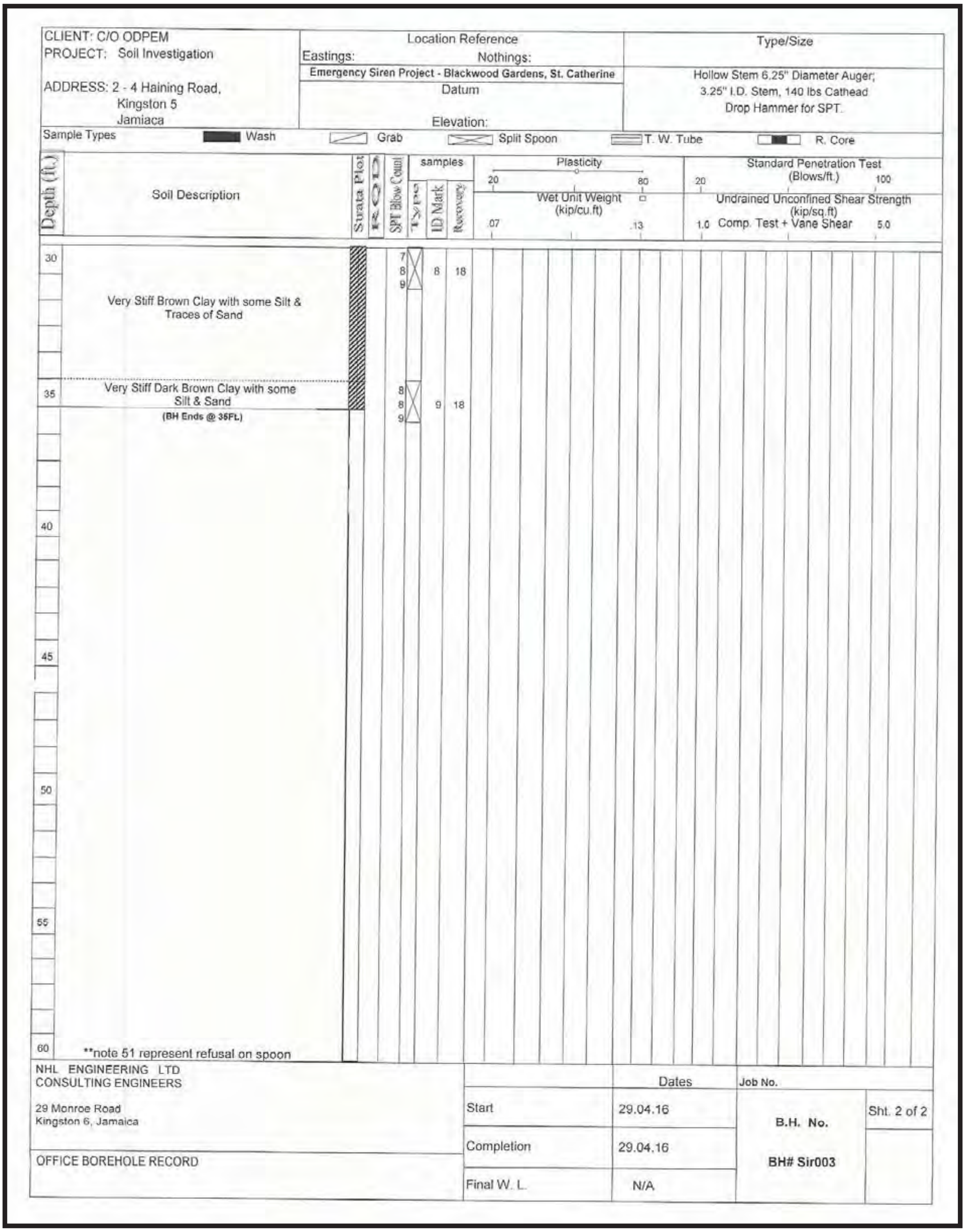
OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	29.04.16	B.H. No.	Sht. 1 of 2
Completion	29.04.16	BH# Sir003	
Final W. L.	N/A		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Nothings:
Emergency Siren Project - Blackwood Gardens, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ▱ Grab ☒ Split Spoon ▤ T. W. Tube ◧ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples Type	samples ID Mark	samples Recovery	Plasticity 20 – 80 Wet Unit Weight (kip/cu.ft) .07 – .13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
30	Very Stiff Brown Clay with some Silt & Traces of Sand	▨		7 8 9	☒	8	18		
35	Very Stiff Dark Brown Clay with some Silt & Sand (BH Ends @ 35Ft.)	▨		8 8 9	☒	9	18		
40									
45									
50									
55									
60									

**note 51 represent refusal on spoon

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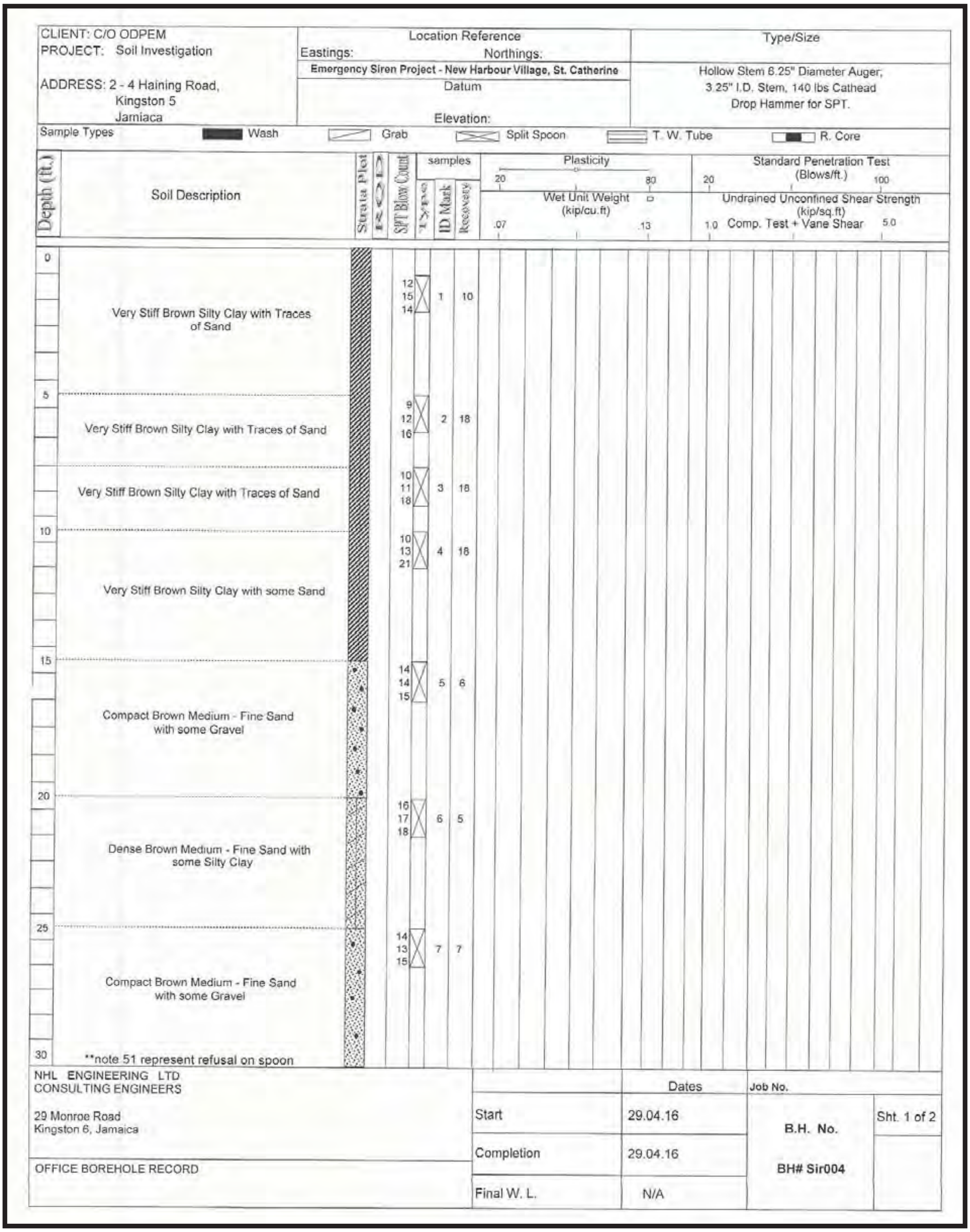
OFFICE BOREHOLE RECORD

	Dates
Start	29.04.16
Completion	29.04.16
Final W. L.	N/A

Job No.

B.H. No.
BH# Sir003

Sht. 2 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings:
Northings:
Emergency Siren Project - New Harbour Village, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 8.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ▱ Grab ⊠ Split Spoon ☰ T. W. Tube ▭ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples: Type	samples: ID Mark	samples: Recovery
0	Very Stiff Brown Silty Clay with Traces of Sand	▨		12 15 14	⊠	1	10
5	Very Stiff Brown Silty Clay with Traces of Sand	▨		9 12 16	⊠	2	18
	Very Stiff Brown Silty Clay with Traces of Sand	▨		10 11 18	⊠	3	18
10	Very Stiff Brown Silty Clay with some Sand	▨		10 13 21	⊠	4	18
15	Compact Brown Medium - Fine Sand with some Gravel	⁘		14 14 15	⊠	5	6
20	Dense Brown Medium - Fine Sand with some Silty Clay	⁘		16 17 18	⊠	6	5
25	Compact Brown Medium - Fine Sand with some Gravel	⁘		14 13 15	⊠	7	7
30	**note 51 represent refusal on spoon						

Plasticity: 20 – 80
Wet Unit Weight (kip/cu.ft): .07 – .13
Standard Penetration Test (Blows/ft.): 20 – 100
Undrained Unconfined Shear Strength (kip/sq.ft): 1.0 – 5.0
Comp. Test + Vane Shear

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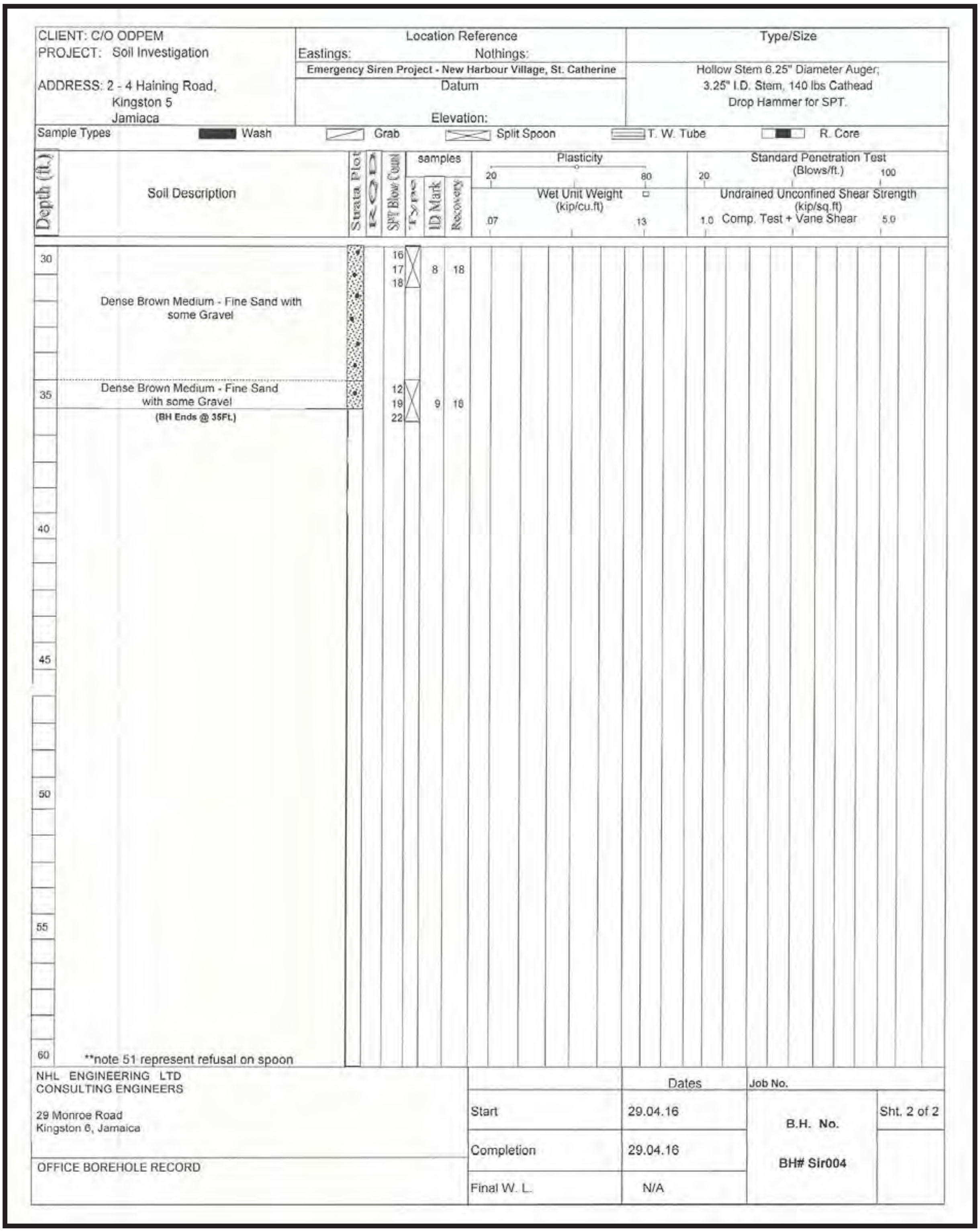
OFFICE BOREHOLE RECORD

	Dates
Start	29.04.16
Completion	29.04.16
Final W. L.	N/A

Job No.

B.H. No.
BH# Sir004

Sht. 1 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Nothings:
Emergency Siren Project - New Harbour Village, St. Catherine
Datum

Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ▱ Grab ⊠ Split Spoon ☰ T. W. Tube ◨ R. Core

Depth (ft.)	Soil Description	Strata Plot	R Q D	SPT Blow Count	samples Type	ID Mark	Recovery	Plasticity 20 – 80 Wet Unit Weight (kip/cu.ft) .07 – 13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
30	Dense Brown Medium - Fine Sand with some Gravel	▨		16 17 18	⊠	8	18		
35	Dense Brown Medium - Fine Sand with some Gravel **(BH Ends @ 35Ft.)**	▨		12 19 22	⊠	9	18		
40									
45									
50									
55									
60	**note 51 represent refusal on spoon								

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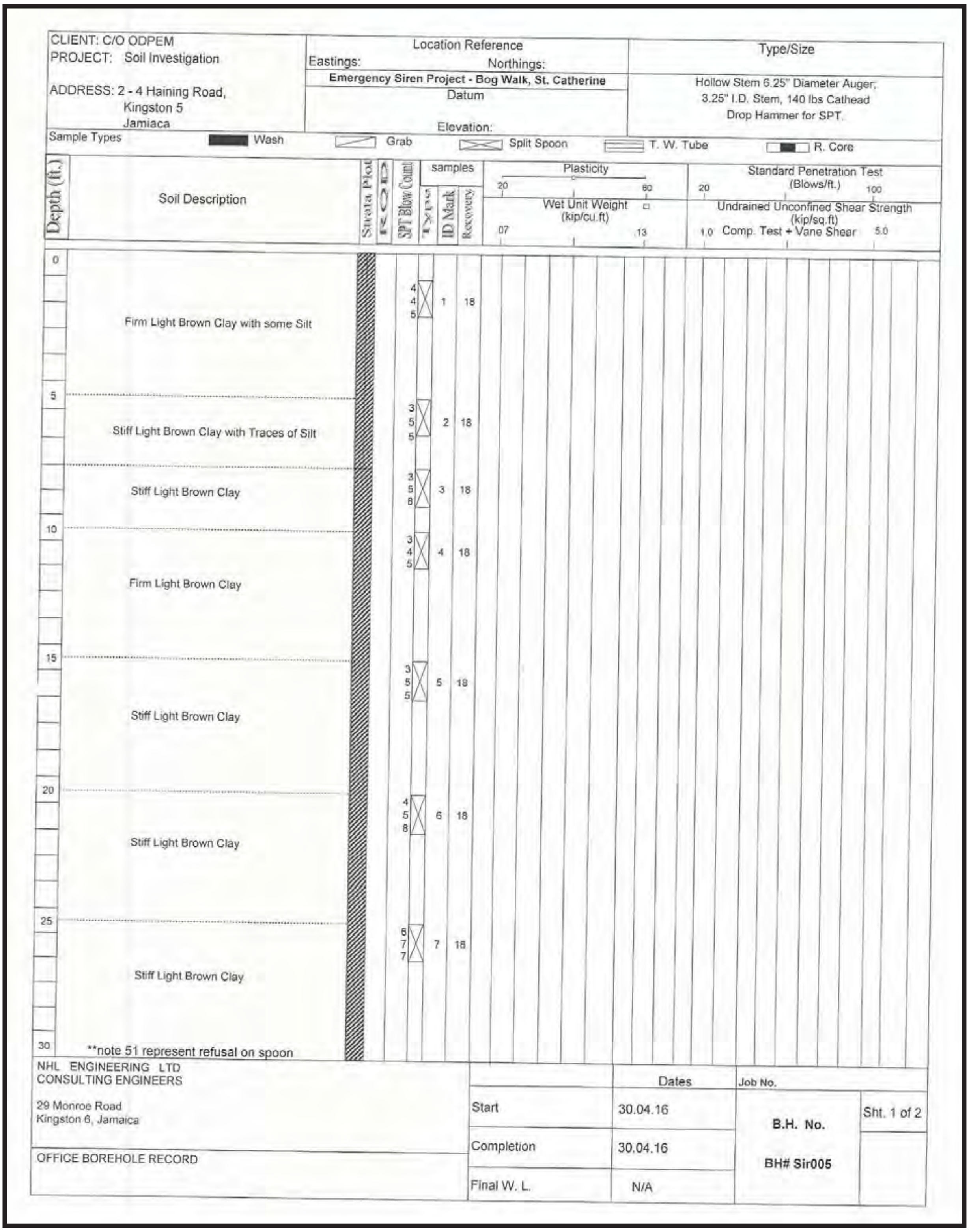
OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	29.04.16	B.H. No.	Sht. 2 of 2
Completion	29.04.16	BH# Sir004	
Final W. L.	N/A		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings:
Northings:
Emergency Siren Project - Bog Walk, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash; Grab; ☒ Split Spoon; T. W. Tube; R. Core

Plasticity: 20 — 60
Wet Unit Weight (kip/cu.ft): 07 — 13
Standard Penetration Test (Blows/ft.): 20 — 100
Undrained Unconfined Shear Strength (kip/sq.ft): 1.0 Comp. Test + Vane Shear 5.0

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	Type	ID Mark	Recovery
0	Firm Light Brown Clay with some Silt	▨		4 4 5	☒	1	18
5	Stiff Light Brown Clay with Traces of Silt	▨		3 5 5	☒	2	18
	Stiff Light Brown Clay	▨		3 5 8	☒	3	18
10	Firm Light Brown Clay	▨		3 4 5	☒	4	18
15	Stiff Light Brown Clay	▨		3 5 5	☒	5	18
20	Stiff Light Brown Clay	▨		4 5 8	☒	6	18
25	Stiff Light Brown Clay	▨		6 7 7	☒	7	18
30	**note 51 represent refusal on spoon						

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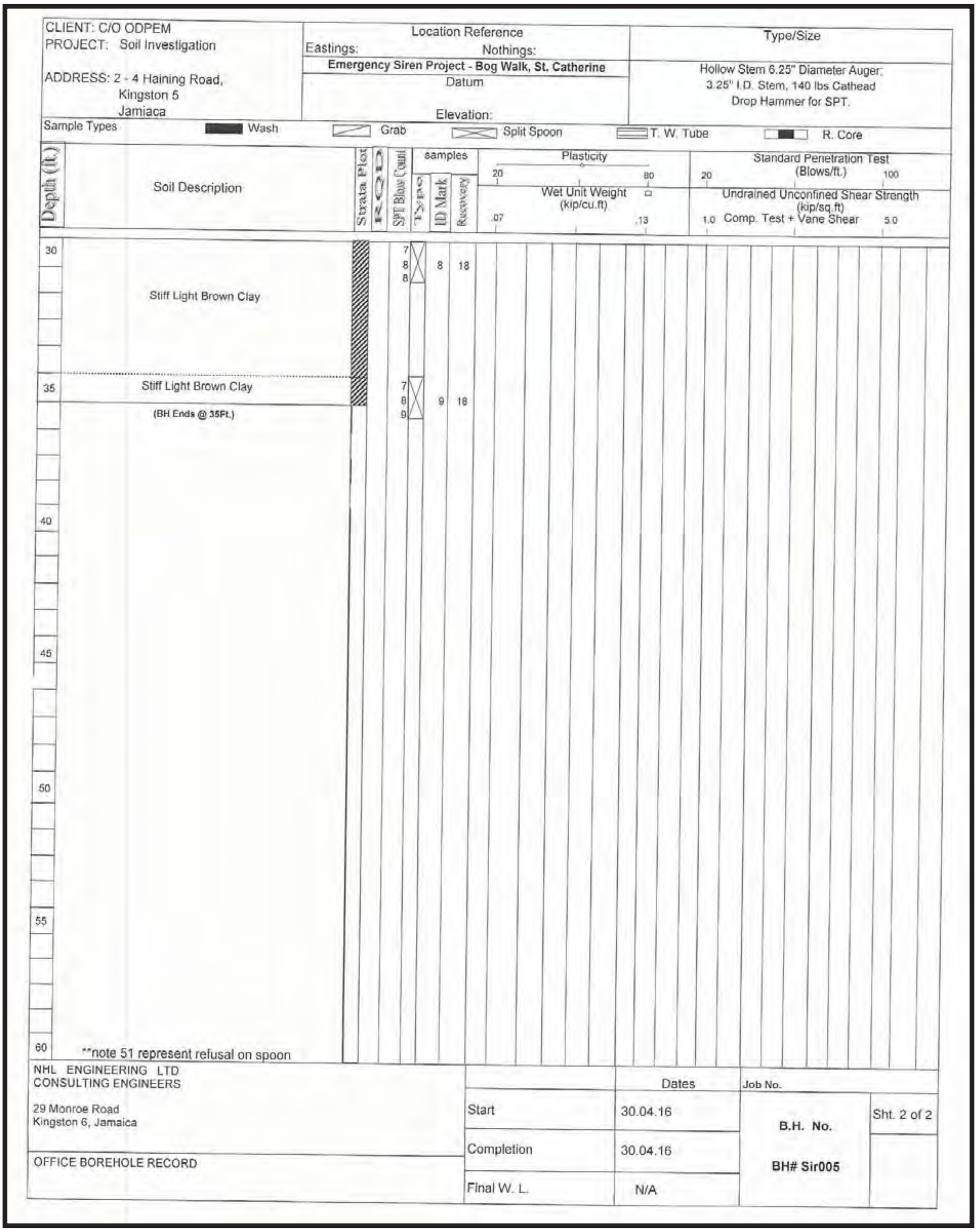
OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	30.04.16	B.H. No.	Sht. 1 of 2
Completion	30.04.16	BH# Sir005	
Final W. L.	N/A		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Nothings:
Emergency Siren Project - Bog Walk, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash; ▱ Grab; ⊠ Split Spoon; ☰ T. W. Tube; ▭ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples: Type	samples: ID Mark	samples: Recovery	Plasticity 20 – 80 / Wet Unit Weight (kip/cu.ft) .07 – .13	Standard Penetration Test (Blows/ft.) 20 – 100 / Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
30	Stiff Light Brown Clay	▨		7 8 8	⊠	8	18		
35	Stiff Light Brown Clay	▨		7 8 9	⊠	9	18		
	(BH Ends @ 35Ft.)								
40									
45									
50									
55									
60									

**note 51 represent refusal on spoon

NHL ENGINEERING LTD
CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

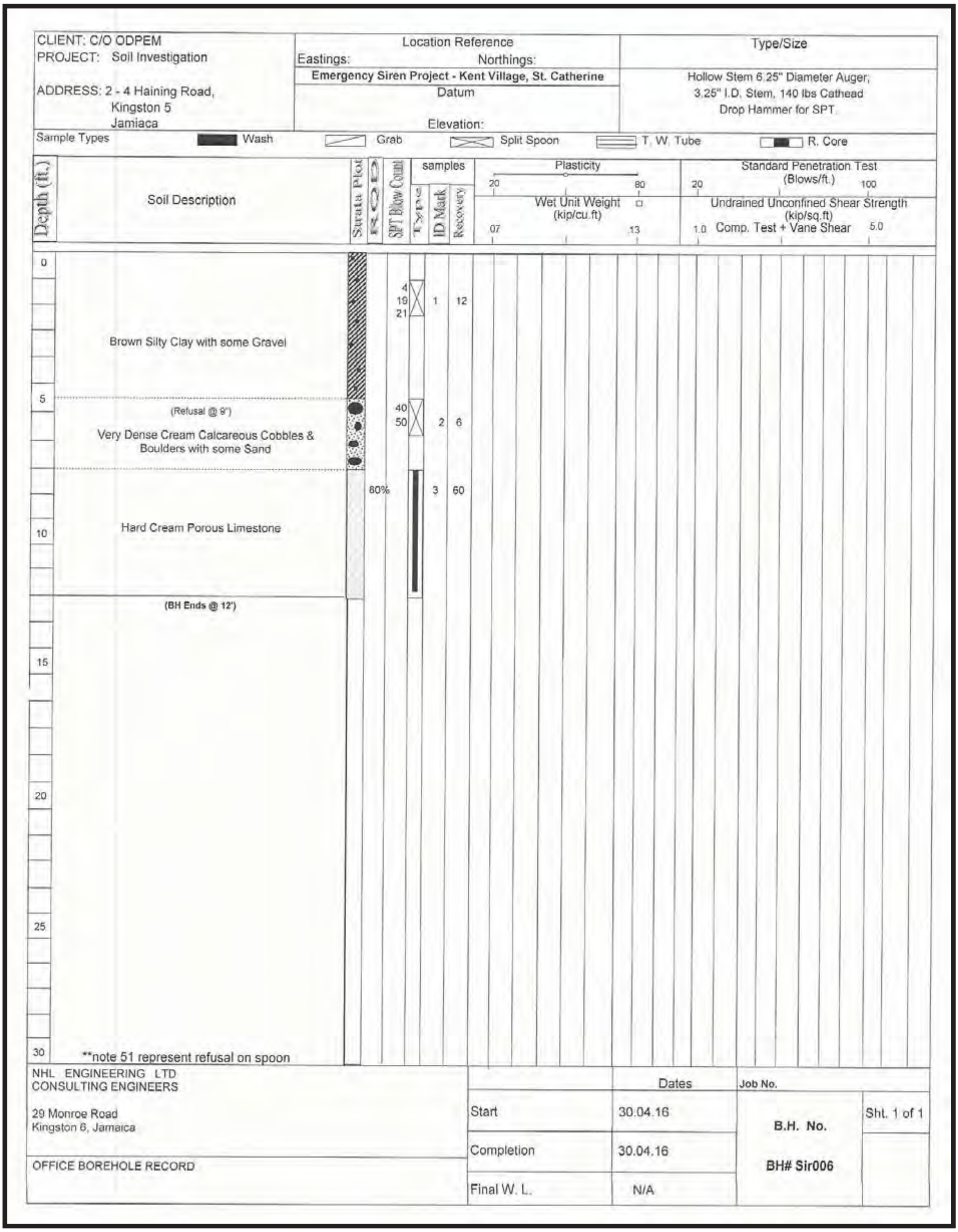
OFFICE BOREHOLE RECORD

	Dates
Start	30.04.16
Completion	30.04.16
Final W. L.	N/A

Job No.

B.H. No.
BH# Sir005

Sht. 2 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Northings:
Emergency Siren Project - Kent Village, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger,
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT

Sample Types ■ Wash ▭ Grab ⊠ Split Spoon ☰ T. W. Tube ▣ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	Type	ID Mark	Recovery
0	Brown Silty Clay with some Gravel	▨		4 19 21	⊠	1	12
5	(Refusal @ 9') Very Dense Cream Calcareous Cobbles & Boulders with some Sand	●		40 50	⊠	2	6
	Hard Cream Porous Limestone		60%		▣	3	60
10							
	(BH Ends @ 12')						
15							
20							
25							
30							

Plasticity: 20 – 80
Wet Unit Weight (kip/cu.ft): 07 – 13
Standard Penetration Test (Blows/ft.): 20 – 100
Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear: 1.0 – 5.0

**note 51 represent refusal on spoon

NHL ENGINEERING LTD
CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

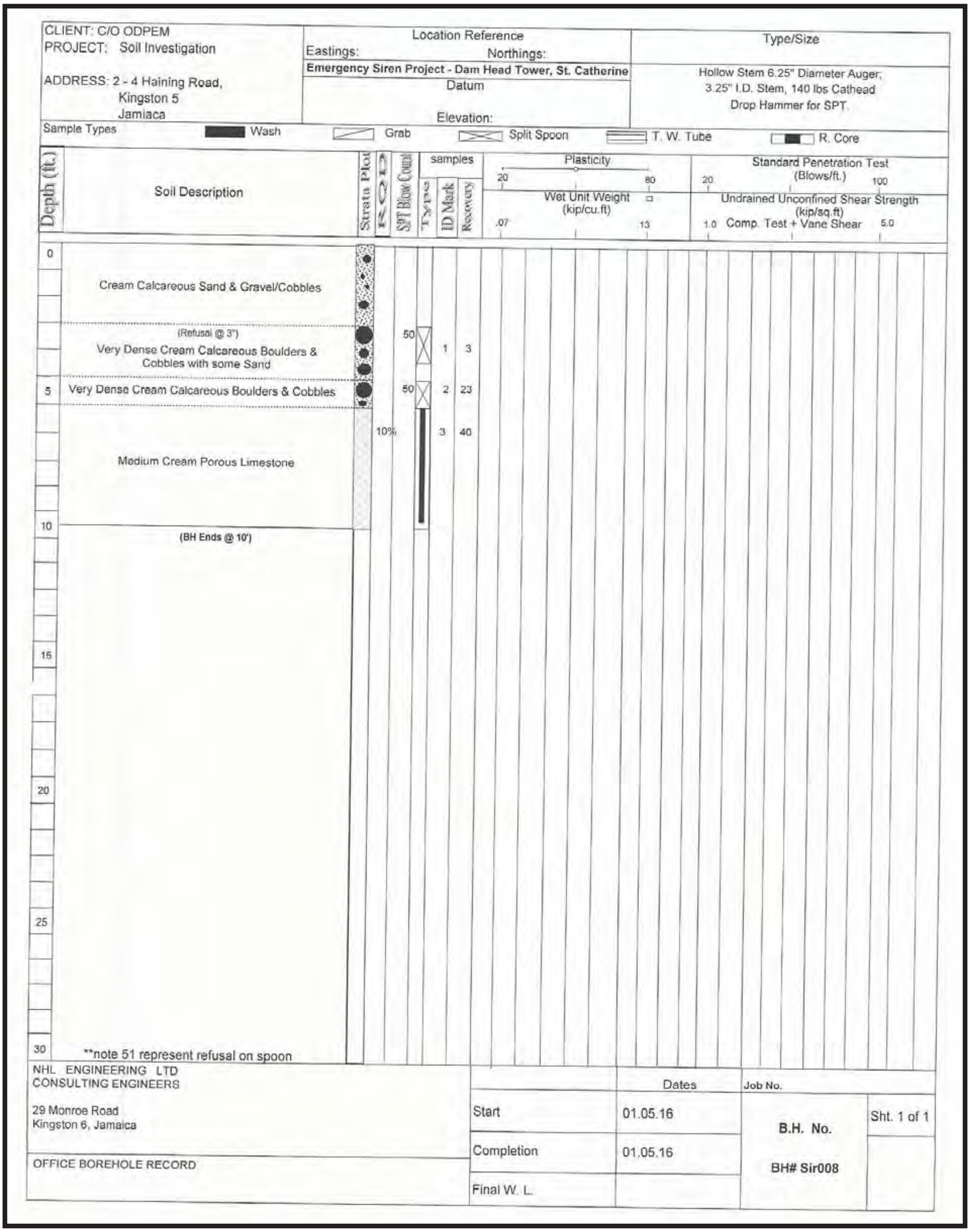
	Dates
Start	30.04.16
Completion	30.04.16
Final W. L.	N/A

Job No.

B.H. No.

BH# Sir006

Sht. 1 of 1



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference	Type/Size
Eastings: Northings:	
Emergency Siren Project - Dam Head Tower, St. Catherine	Hollow Stem 6.25" Diameter Auger; 3.25" I.D. Stem, 140 lbs Cathead Drop Hammer for SPT.
Datum Elevation:	

Sample Types: ■ Wash ▱ Grab ⊠ Split Spoon ☰ T. W. Tube ▣ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples Type	ID Mark	Recovery	Plasticity 20 – 80 Wet Unit Weight (kip/cu.ft) .07 – 13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
0	Cream Calcareous Sand & Gravel/Cobbles								
	(Refusal @ 3") Very Dense Cream Calcareous Boulders & Cobbles with some Sand			50	⊠	1	3		
5	Very Dense Cream Calcareous Boulders & Cobbles			50	⊠	2	23		
	Medium Cream Porous Limestone		10%			3	40		
10	**(BH Ends @ 10')**								
15									
20									
25									
30	**note 51 represent refusal on spoon								

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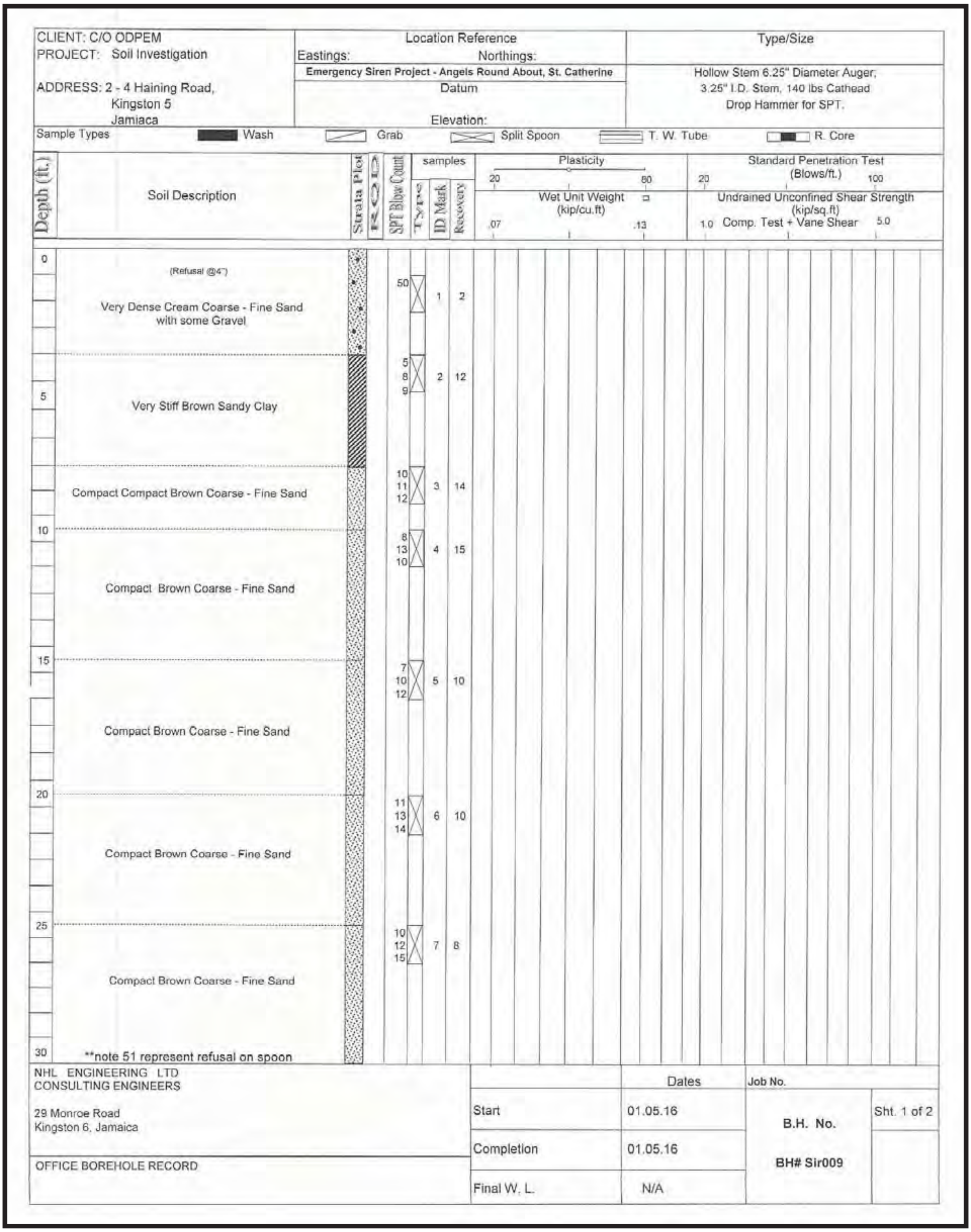
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	01.05.16	B.H. No.	Sht. 1 of 1
Completion	01.05.16	**BH# Sir008**	
Final W. L.			



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Northings:
Emergency Siren Project - Angels Round About, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger,
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ▬ Wash ▱ Grab ☒ Split Spoon ▤ T. W. Tube ▭ R. Core

Plasticity: 20 — 80
Wet Unit Weight (kip/cu.ft): .07 — .13
Standard Penetration Test (Blows/ft.): 20 — 100
Undrained Unconfined Shear Strength (kip/sq.ft): 1.0 Comp. Test + Vane Shear 5.0

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	Type	ID Mark	Recovery
0	(Refusal @4") Very Dense Cream Coarse - Fine Sand with some Gravel			50	☒	1	2
5	Very Stiff Brown Sandy Clay			5 8 9	☒	2	12
	Compact Compact Brown Coarse - Fine Sand			10 11 12	☒	3	14
10	Compact Brown Coarse - Fine Sand			8 13 10	☒	4	15
15	Compact Brown Coarse - Fine Sand			7 10 12	☒	5	10
20	Compact Brown Coarse - Fine Sand			11 13 14	☒	6	10
25	Compact Brown Coarse - Fine Sand			10 12 15	☒	7	8
30	**note 51 represent refusal on spoon						

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29 Monroe Road
Kingston 6, Jamaica

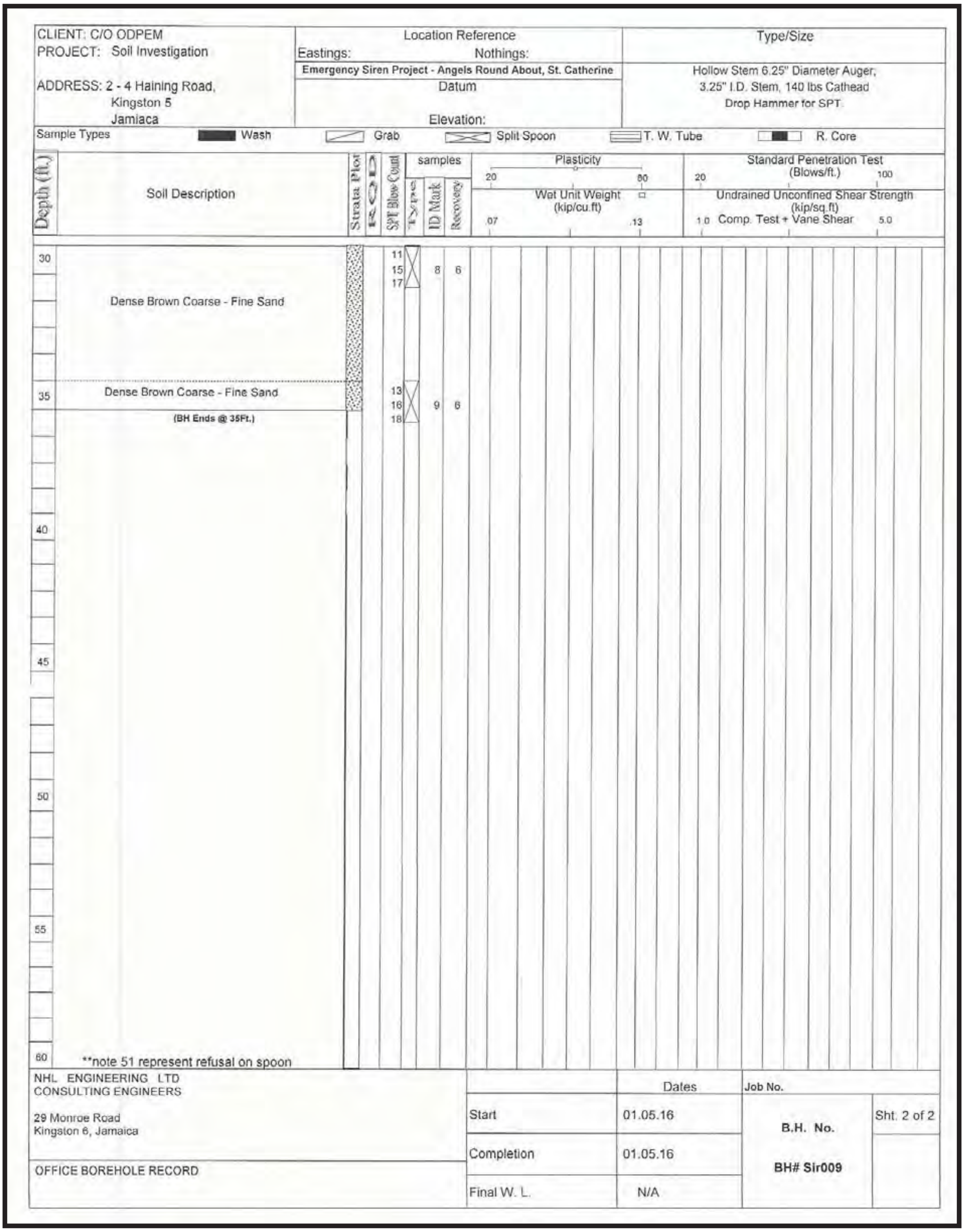
OFFICE BOREHOLE RECORD

	Dates
Start	01.05.16
Completion	01.05.16
Final W. L.	N/A

Job No.

B.H. No.
BH# Sir009

Sht. 1 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Nothings:
Emergency Siren Project - Angels Round About, St. Catherine
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger,
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT

Sample Types ■ Wash ▱ Grab ☒ Split Spoon ☰ T. W. Tube ▣ R. Core

Plasticity 20 80
Wet Unit Weight (kip/cu.ft) .07 .13
Standard Penetration Test (Blows/ft.) 20 100
Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples Type	samples ID Mark	samples Recovery
30	Dense Brown Coarse - Fine Sand	▨		11 15 17	☒	8	6
35	Dense Brown Coarse - Fine Sand **(BH Ends @ 35Ft.)**	▨		13 16 18	☒	9	6
40							
45							
50							
55							
60							

**note 51 represent refusal on spoon

NHL ENGINEERING LTD
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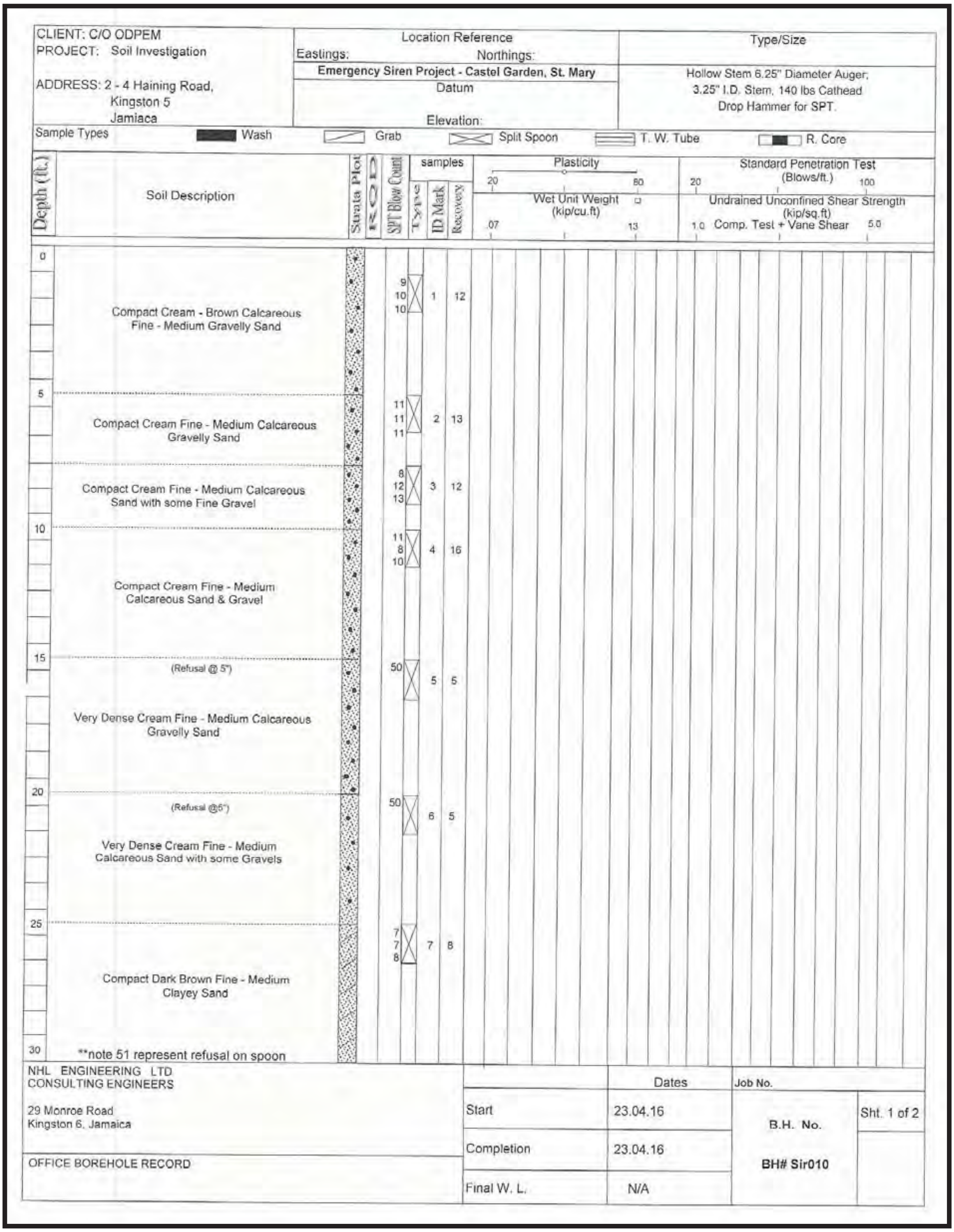
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	01.05.16	**B.H. No.**	Sht: 2 of 2
Completion	01.05.16	**BH# Sir009**	
Final W. L.	N/A		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Northings:
Emergency Siren Project - Castel Garden, St. Mary
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ▱ Grab ⊠ Split Spoon ☰ T. W. Tube ▣ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	Type	ID Mark	Recovery
0	Compact Cream - Brown Calcareous Fine - Medium Gravelly Sand			9 10 10	⊠	1	12
5	Compact Cream Fine - Medium Calcareous Gravelly Sand			11 11 11	⊠	2	13
	Compact Cream Fine - Medium Calcareous Sand with some Fine Gravel			8 12 13	⊠	3	12
10	Compact Cream Fine - Medium Calcareous Sand & Gravel			11 8 10	⊠	4	16
15	(Refusal @ 5") Very Dense Cream Fine - Medium Calcareous Gravelly Sand			50	⊠	5	5
20	(Refusal @5") Very Dense Cream Fine - Medium Calcareous Sand with some Gravels			50	⊠	6	5
25	Compact Dark Brown Fine - Medium Clayey Sand			7 7 8	⊠	7	8
30	**note 51 represent refusal on spoon						

Plasticity: 20 — 80
Wet Unit Weight (kip/cu.ft): .07 — 13
Standard Penetration Test (Blows/ft.): 20 — 100
Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear: 1.0 — 5.0

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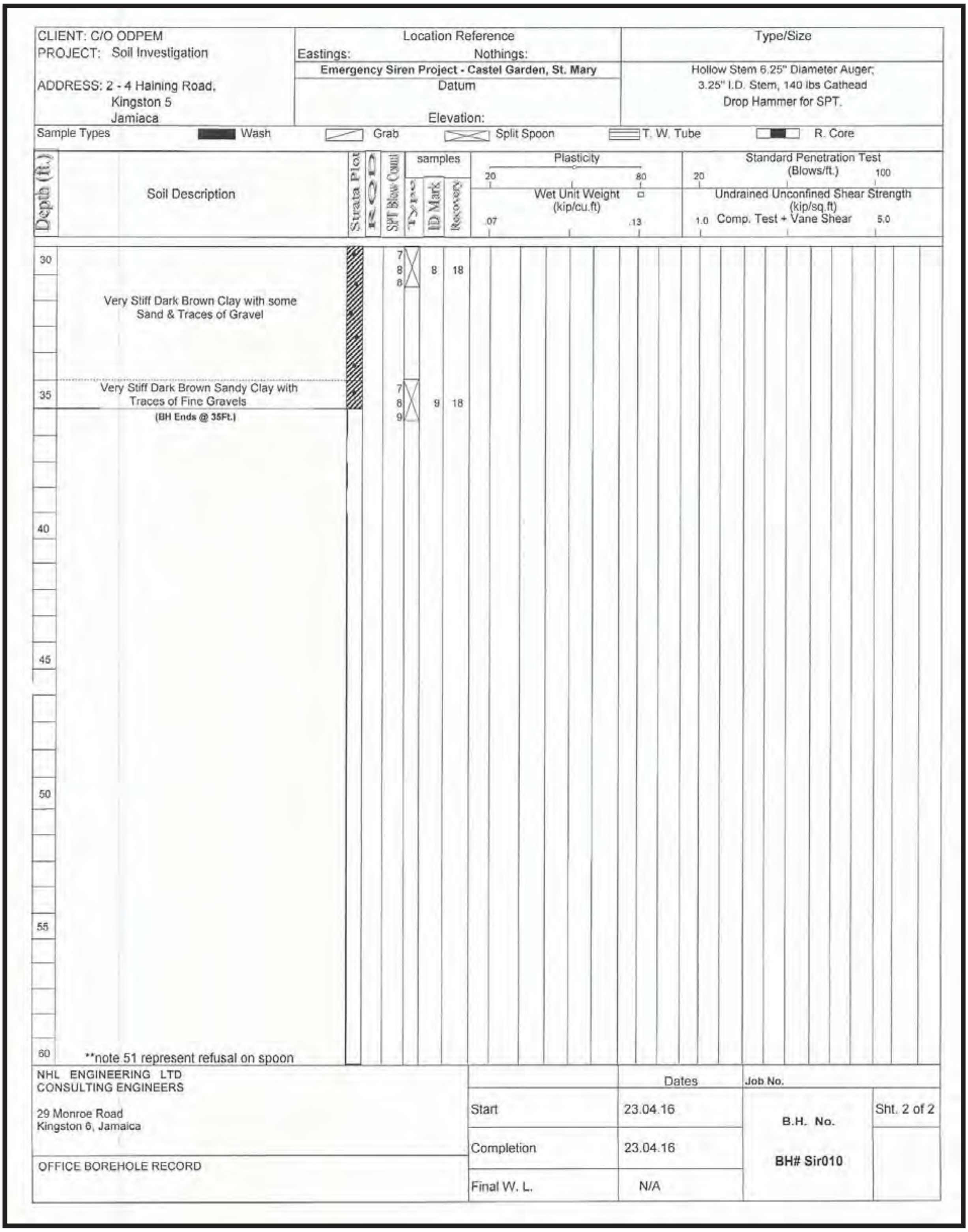
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	23.04.16	B.H. No.	Sht. 1 of 2
Completion	23.04.16	BH# Sir010	
Final W. L.	N/A		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Nothings:
Emergency Siren Project - Castel Garden, St. Mary
Datum

Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types ■ Wash ▭ Grab ☒ Split Spoon ☰ T. W. Tube ◧ R. Core

Plasticity 20 80
Wet Unit Weight (kip/cu.ft) .07 .13

Standard Penetration Test (Blows/ft.) 20 100
Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples Type	samples ID Mark	samples Recovery	Plasticity / Wet Unit Weight	Standard Penetration Test / Undrained Unconfined Shear Strength
30	Very Stiff Dark Brown Clay with some Sand & Traces of Gravel	▨		7 8 8	☒	8	18		
35	Very Stiff Dark Brown Sandy Clay with Traces of Fine Gravels **(BH Ends @ 35Ft.)**	▨		7 8 9	☒	9	18		
40									
45									
50									
55									
60									

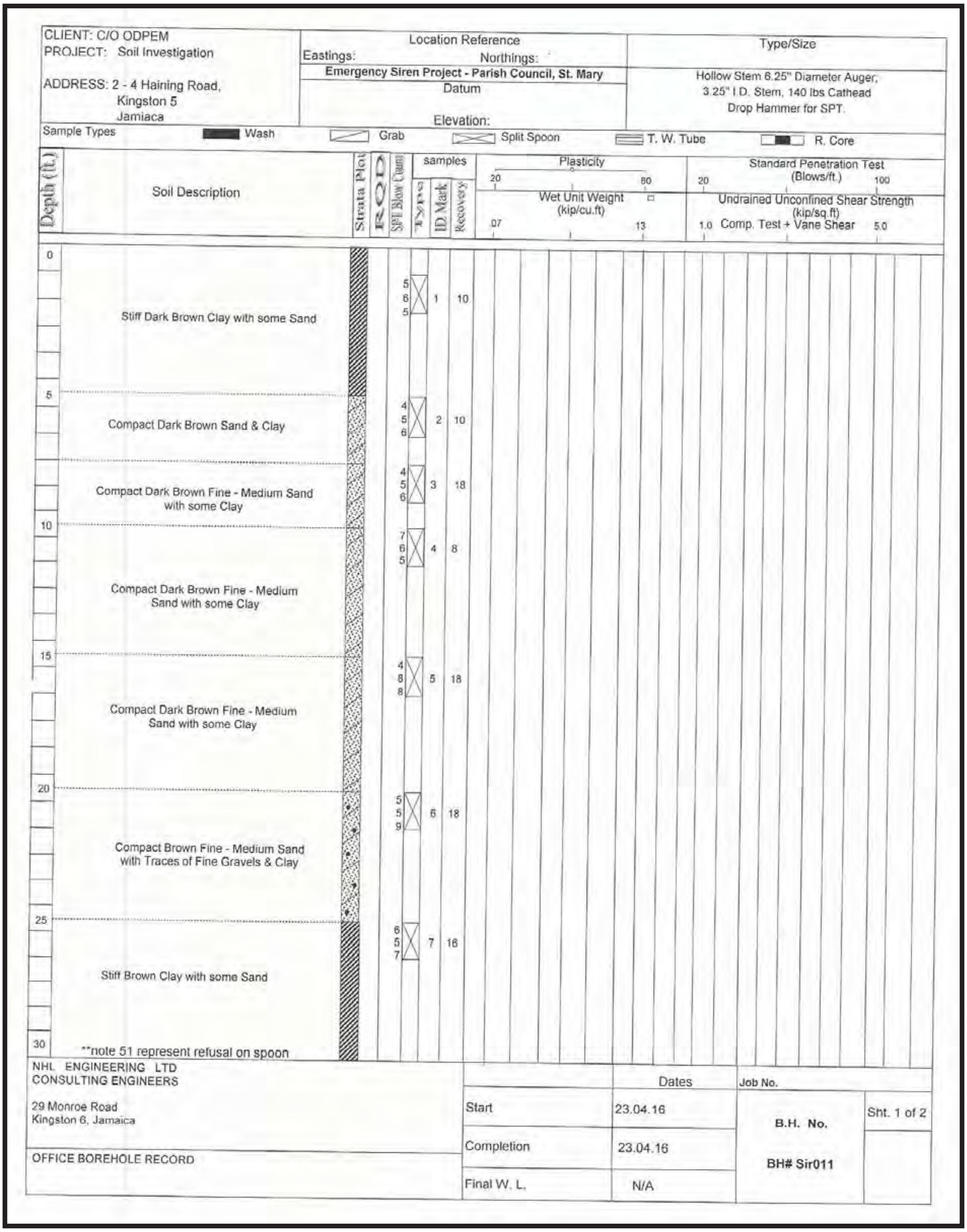
**note 51 represent refusal on spoon

NHL ENGINEERING LTD
CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	23.04.16	B.H. No.	Sht. 2 of 2
Completion	23.04.16	**BH# Sir010**	
Final W. L.	N/A		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings:
Northings:
Emergency Siren Project - Parish Council, St. Mary
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger,
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: Wash, Grab, Split Spoon, T. W. Tube, R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	Type	ID Mark	Recovery
0	Stiff Dark Brown Clay with some Sand			5 6 5	☒	1	10
5	Compact Dark Brown Sand & Clay			4 5 6	☒	2	10
	Compact Dark Brown Fine - Medium Sand with some Clay			4 5 6	☒	3	18
10	Compact Dark Brown Fine - Medium Sand with some Clay			7 6 5	☒	4	8
15	Compact Dark Brown Fine - Medium Sand with some Clay			4 8 8	☒	5	18
20	Compact Brown Fine - Medium Sand with Traces of Fine Gravels & Clay			5 5 9	☒	6	18
25	Stiff Brown Clay with some Sand			6 5 7	☒	7	16
30	**note 51 represent refusal on spoon						

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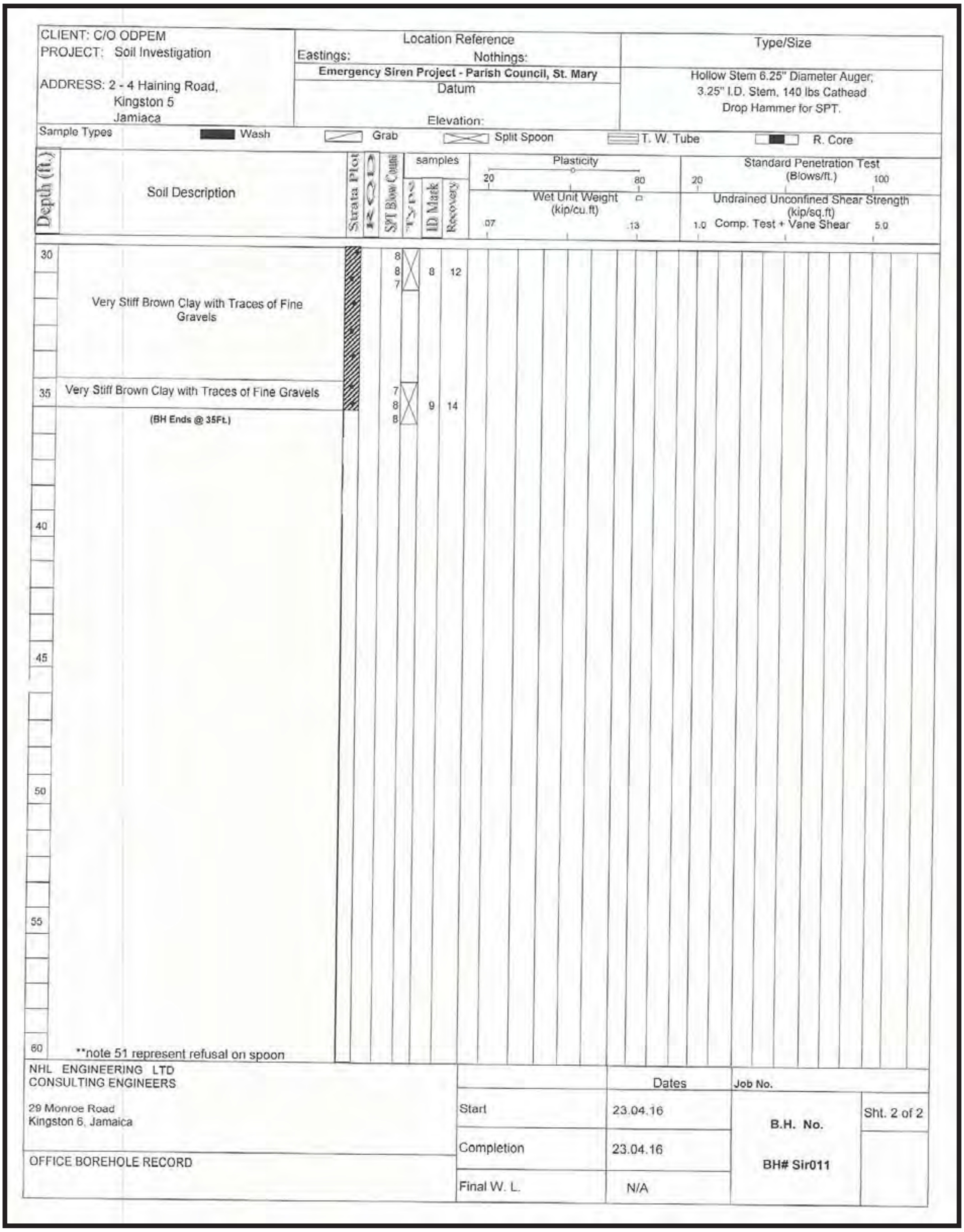
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	23.04.16	B.H. No.	Sht. 1 of 2
Completion	23.04.16	BH# Sir011	
Final W. L.	N/A		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Nothings:
Emergency Siren Project - Parish Council, St. Mary
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ▱ Grab ☒ Split Spoon ☰ T. W. Tube ▭ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples: Type	samples: ID Mark	samples: Recovery	Plasticity 20 – 80 Wet Unit Weight (kip/cu.ft) .07 – .13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
30	Very Stiff Brown Clay with Traces of Fine Gravels	▨		8 8 7	☒	8	12		
35	Very Stiff Brown Clay with Traces of Fine Gravels	▨		7 8 8	☒	9	14		
	(BH Ends @ 35Ft.)								
40									
45									
50									
55									
60	**note 51 represent refusal on spoon								

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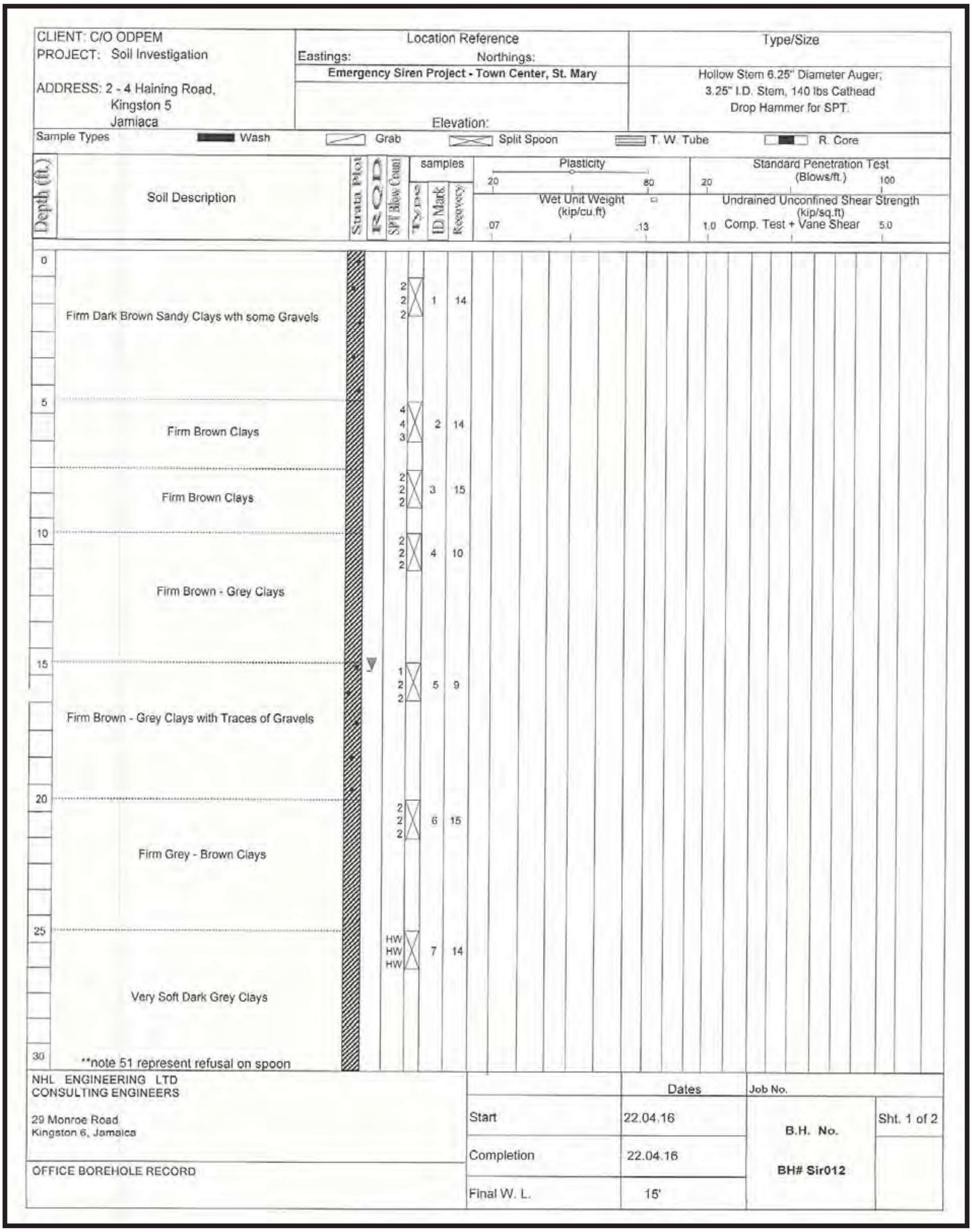
CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	23.04.16	B.H. No.	Sht. 2 of 2
Completion	23.04.16	**BH# Sir011**	
Final W. L.	N/A		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Northings:
Emergency Siren Project - Town Center, St. Mary
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ▬ Wash ▱ Grab ☒ Split Spoon ▤ T. W. Tube ▭ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples Type	ID Mark	Recovery	Plasticity 20 – 80 Wet Unit Weight (kip/cu.ft) .07 – .13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
0	Firm Dark Brown Sandy Clays wth some Gravels			2 2 2	☒	1	14		
5	Firm Brown Clays			4 4 3	☒	2	14		
	Firm Brown Clays			2 2 2	☒	3	15		
10	Firm Brown - Grey Clays			2 2 2	☒	4	10		
15	Firm Brown - Grey Clays with Traces of Gravels		▼	1 2 2	☒	5	9		
20	Firm Grey - Brown Clays			2 2 2	☒	6	15		
25	Very Soft Dark Grey Clays			HW HW HW	☒	7	14		
30	**note 51 represent refusal on spoon								

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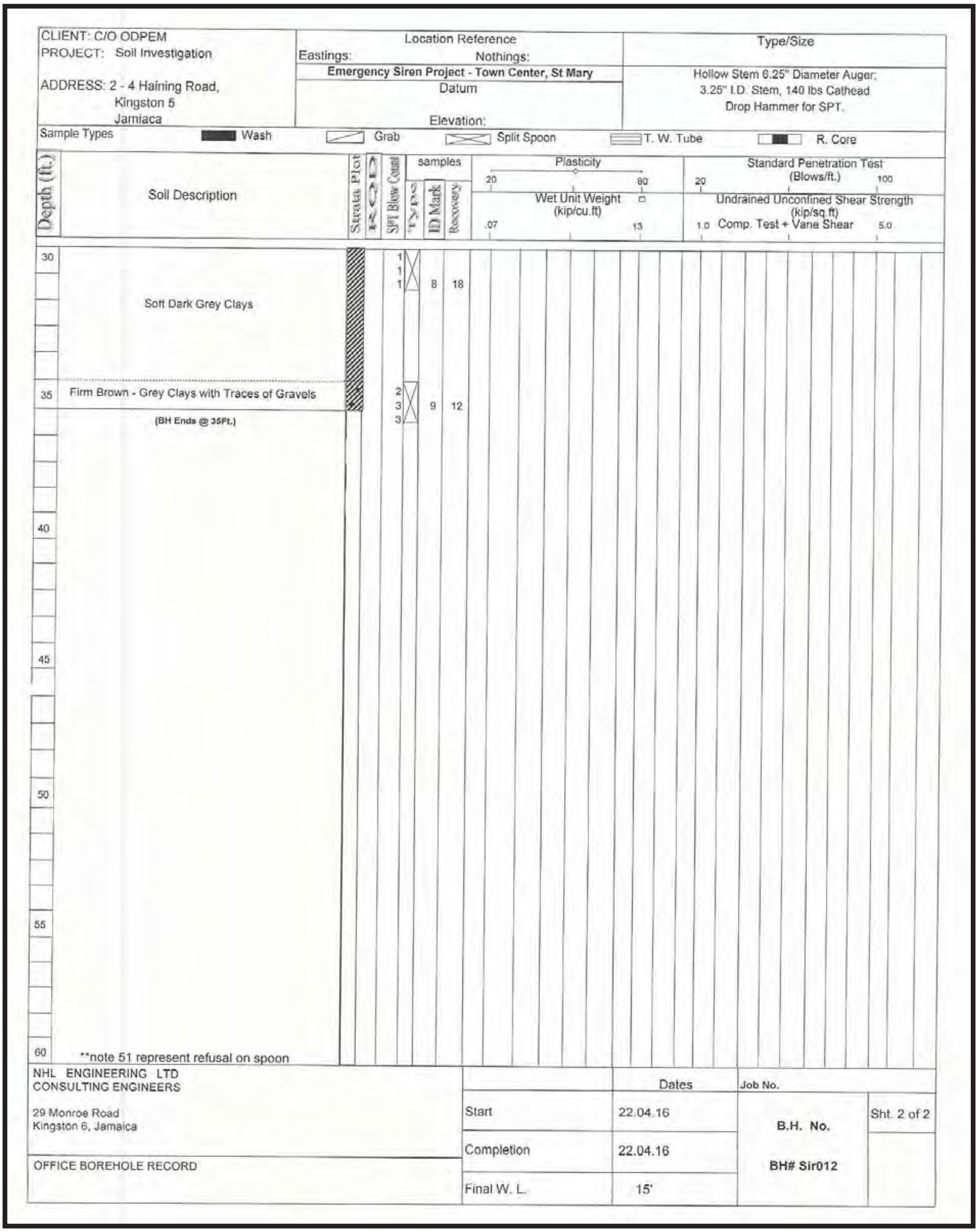
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	22.04.16	B.H. No.	Sht. 1 of 2
Completion	22.04.16	**BH# Sir012**	
Final W. L.	15'		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Nothings:
Emergency Siren Project - Town Center, St Mary
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash; Grab; Split Spoon; T. W. Tube; R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	Type	ID Mark	Recovery	Plasticity 20 – 80 / Wet Unit Weight (kip/cu.ft) .07 – 13	Standard Penetration Test (Blows/ft.) 20 – 100 / Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
30	Soft Dark Grey Clays	▨		1 1 1	☒	8	18		
35	Firm Brown - Grey Clays with Traces of Gravels	▨		2 3 3	☒	9	12		
	(BH Ends @ 35Ft.)								
40									
45									
50									
55									
60	**note 51 represent refusal on spoon								

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29 Monroe Road
Kingston 6, Jamaica

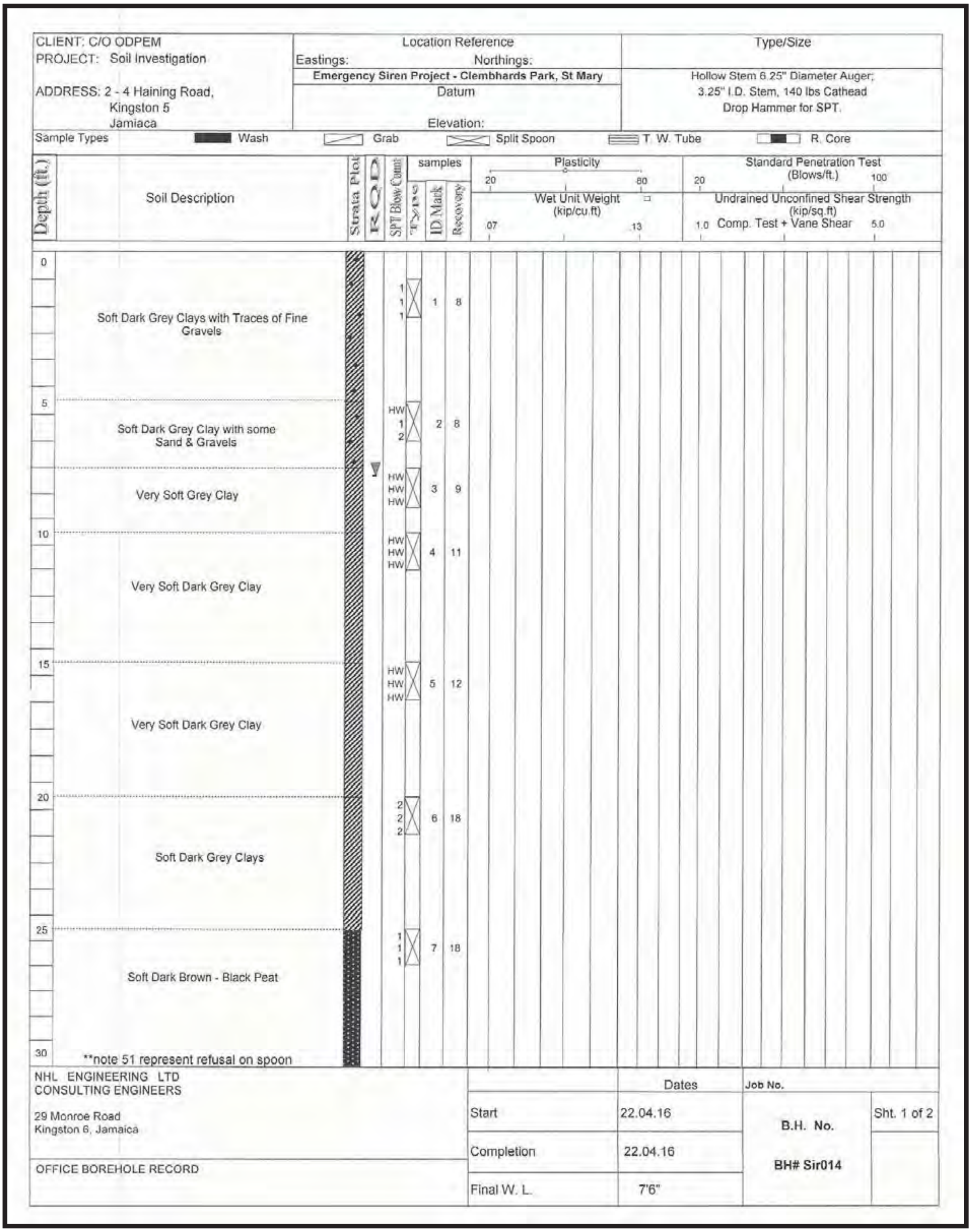
OFFICE BOREHOLE RECORD

	Dates
Start	22.04.16
Completion	22.04.16
Final W. L.	15'

Job No.

B.H. No.
BH# Sir012

Sht. 2 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Northings:
Emergency Siren Project - Clembhards Park, St Mary
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ▆ Wash; ▱ Grab; ⊠ Split Spoon; ☰ T. W. Tube; ▭ R. Core

Depth (ft.)	Soil Description	Strata Plot	R Q D	SPT Blow Count	samples Type	samples ID Mark	samples Recovery	Plasticity 20 – 80 Wet Unit Weight (kip/cu.ft) .07 – .13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
0	Soft Dark Grey Clays with Traces of Fine Gravels	▨		1 1 1	⊠	1	8		
5	Soft Dark Grey Clay with some Sand & Gravels	▨		HW 1 2	⊠	2	8		
	Very Soft Grey Clay	▨	▼	HW HW HW	⊠	3	9		
10	Very Soft Dark Grey Clay	▨		HW HW HW	⊠	4	11		
15	Very Soft Dark Grey Clay	▨		HW HW HW	⊠	5	12		
20	Soft Dark Grey Clays	▨		2 2 2	⊠	6	18		
25	Soft Dark Brown - Black Peat	▩		1 1 1	⊠	7	18		
30									

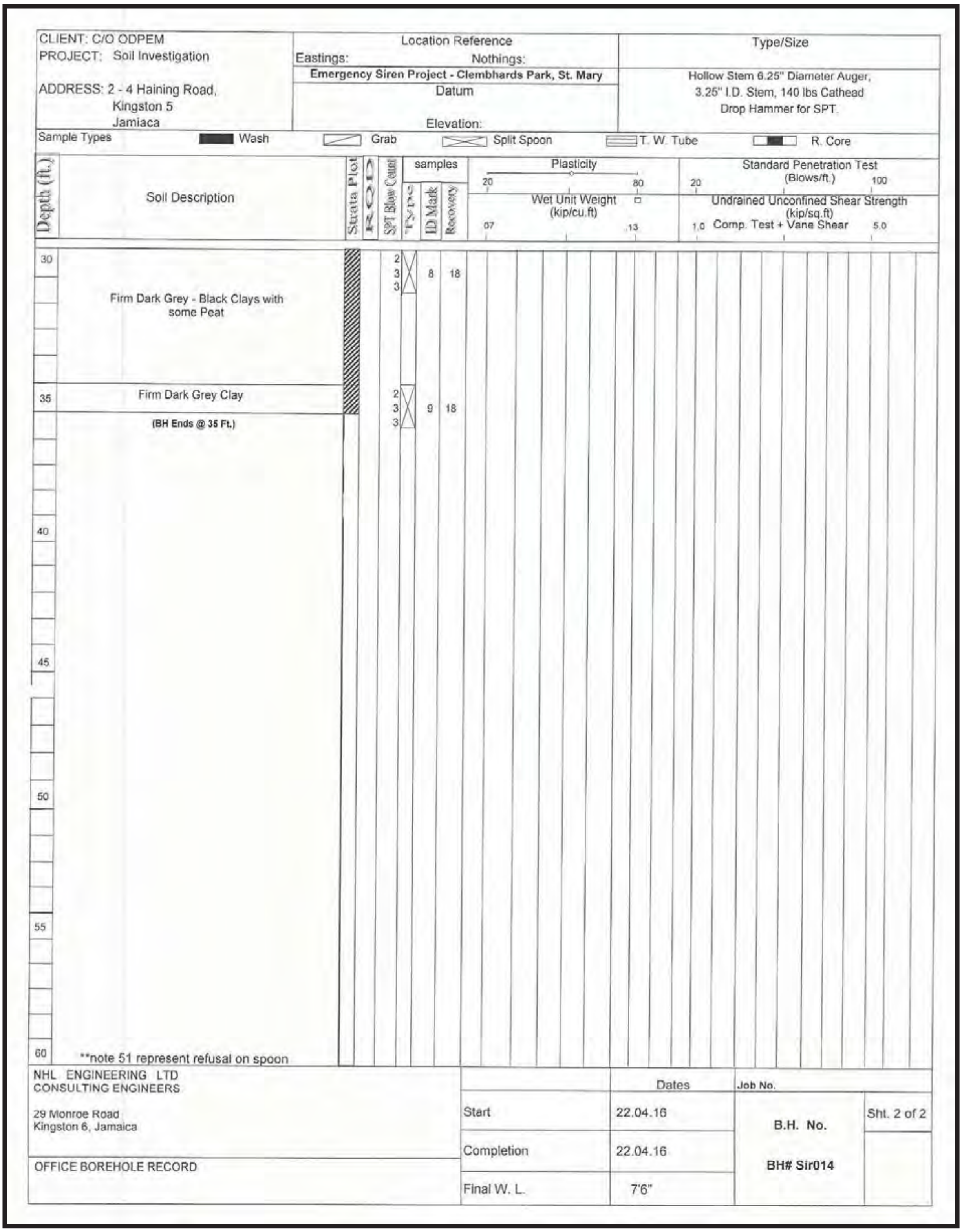
**note 51 represent refusal on spoon

NHL ENGINEERING LTD
CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	22.04.16	B.H. No.	Sht. 1 of 2
Completion	22.04.16	BH# Sir014	
Final W. L.	7'6"		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Nothings:
Emergency Siren Project - Clembhards Park, St. Mary
Datum

Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger,
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types ■ Wash ▱ Grab ☒ Split Spoon ☰ T. W. Tube ◨ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples: Type	samples: ID Mark	samples: Recovery	Plasticity 20 – 80 Wet Unit Weight (kip/cu.ft) 07 – .13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
30	Firm Dark Grey - Black Clays with some Peat	▨		2 3 3	☒	8	18		
35	Firm Dark Grey Clay	▨		2 3 3	☒	9	18		
	(BH Ends @ 35 Ft.)								
40									
45									
50									
55									
60	**note 51 represent refusal on spoon								

NHL ENGINEERING LTD
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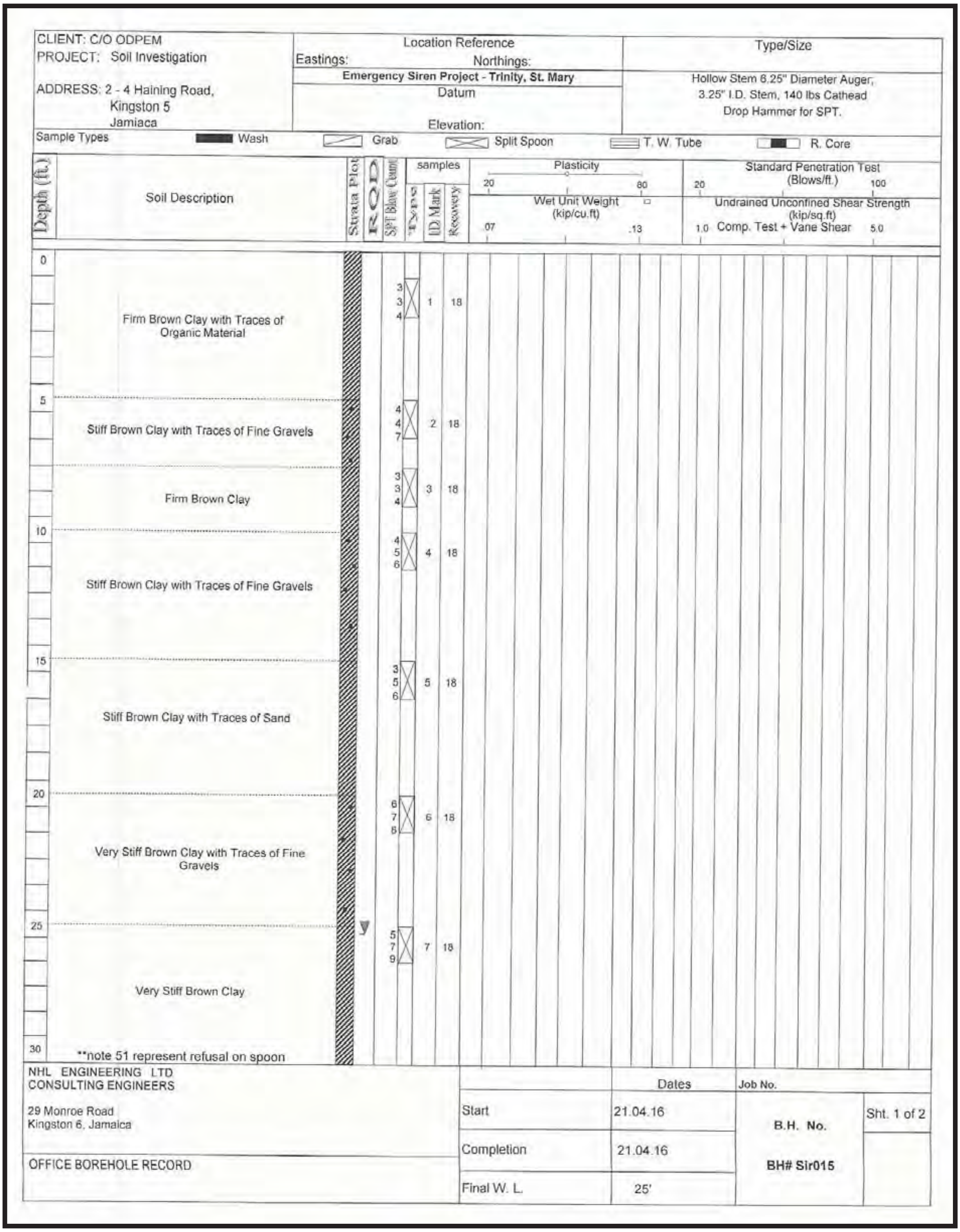
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	22.04.16	B.H. No.	Sht. 2 of 2
Completion	22.04.16	**BH# Sir014**	
Final W. L.	7'6"		



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamiaca

Location Reference
Eastings: Northings:
Emergency Siren Project - Trinity, St. Mary
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger,
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ▬ Wash ▭ Grab ▭ Split Spoon ▤ T. W. Tube ▭ R. Core

Depth (ft.)	Soil Description	SPT Blow Count	ID Mark	Recovery
0	Firm Brown Clay with Traces of Organic Material	3 3 4	1	18
5	Stiff Brown Clay with Traces of Fine Gravels	4 4 7	2	18
	Firm Brown Clay	3 3 4	3	18
10	Stiff Brown Clay with Traces of Fine Gravels	4 5 6	4	18
15	Stiff Brown Clay with Traces of Sand	3 5 6	5	18
20	Very Stiff Brown Clay with Traces of Fine Gravels	6 7 8	6	18
25	Very Stiff Brown Clay	5 7 9	7	18
30	**note 51 represent refusal on spoon			

Plasticity 20 — 80; Wet Unit Weight (kip/cu.ft) .07 — .13; Standard Penetration Test (Blows/ft.) 20 — 100; Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0

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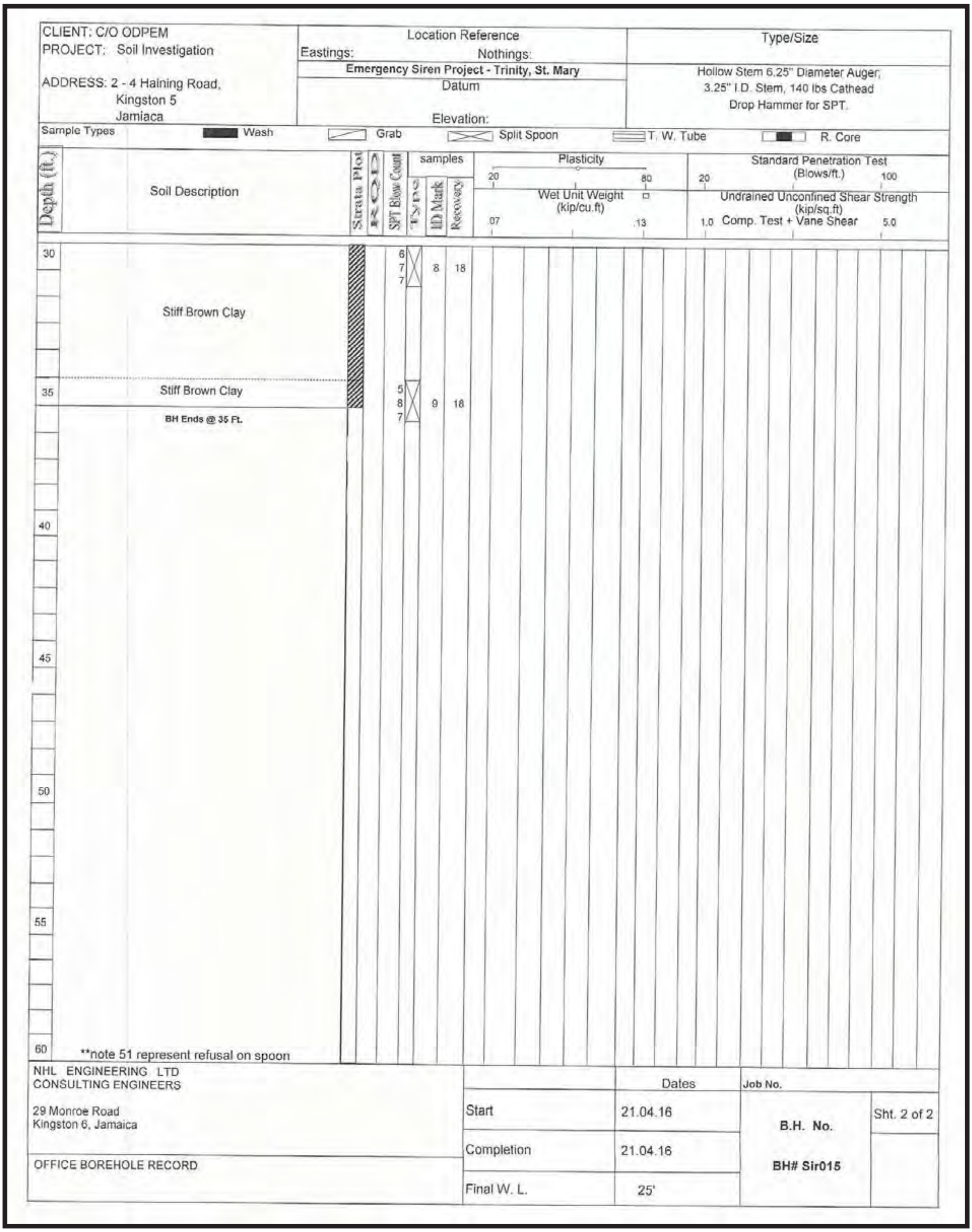
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates
Start	21.04.16
Completion	21.04.16
Final W. L.	25'

Job No.
B.H. No. BH# Sir015
Sht. 1 of 2



CLIENT: C/O ODPEM
PROJECT: Soil Investigation

ADDRESS: 2 - 4 Haining Road,
Kingston 5
Jamaica

Location Reference
Eastings: Nothings:
Emergency Siren Project - Trinity, St. Mary
Datum
Elevation:

Type/Size
Hollow Stem 6.25" Diameter Auger,
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types: ■ Wash ▱ Grab ☒ Split Spoon ☰ T. W. Tube ■ R. Core

Depth (ft.)	Soil Description	Strata Plot	RQD	SPT Blow Count	samples			Plasticity 20 – 80 Wet Unit Weight (kip/cu.ft) .07 – .13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) 1.0 Comp. Test + Vane Shear 5.0
					Type	ID Mark	Recovery		
30	Stiff Brown Clay	▨		6 7 7	☒	8	18		
35	Stiff Brown Clay	▨		5 8 7	☒	9	18		
	BH Ends @ 35 Ft.								
40									
45									
50									
55									
60									

**note 51 represent refusal on spoon

NHL ENGINEERING LTD
CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

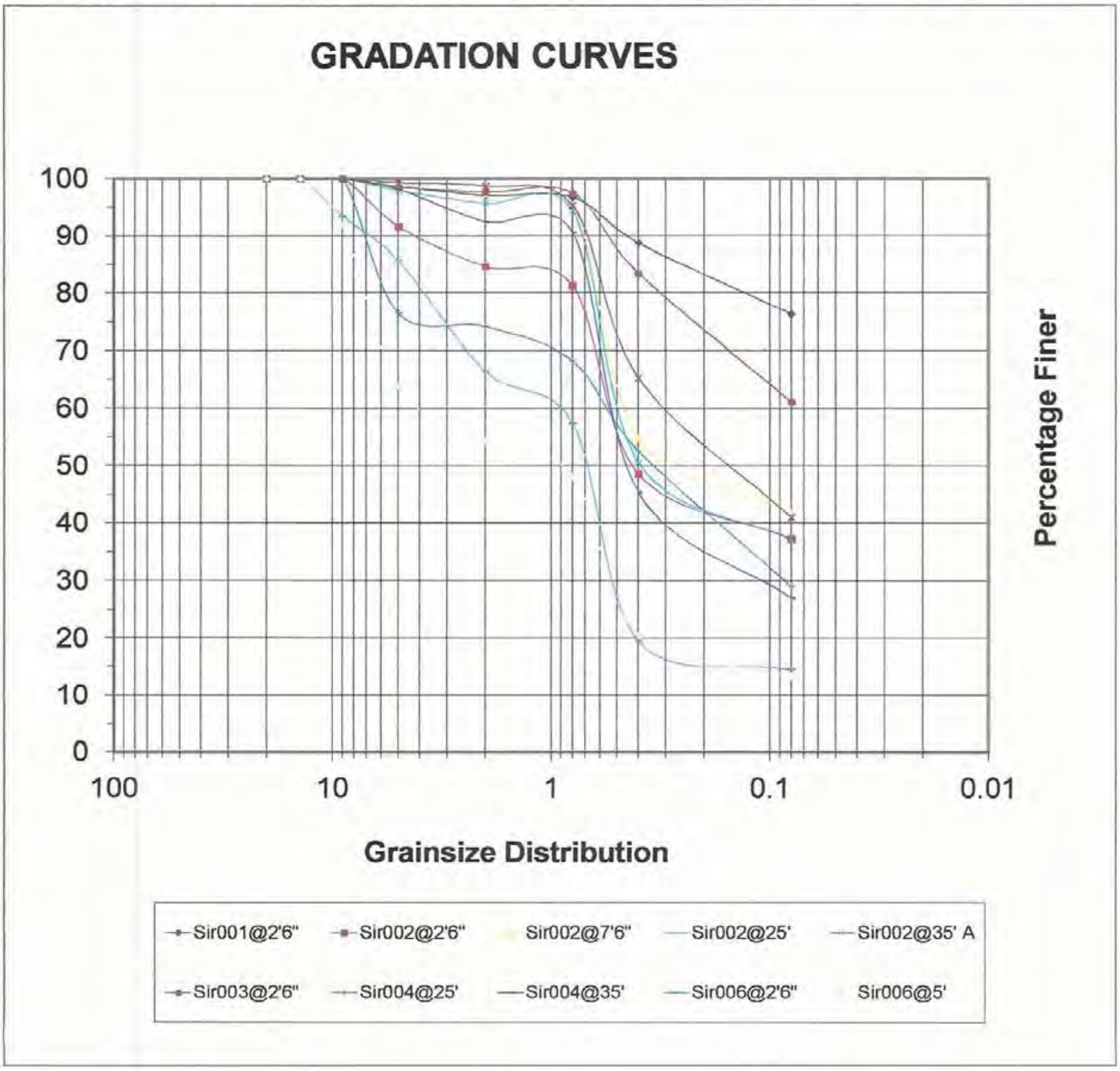
OFFICE BOREHOLE RECORD

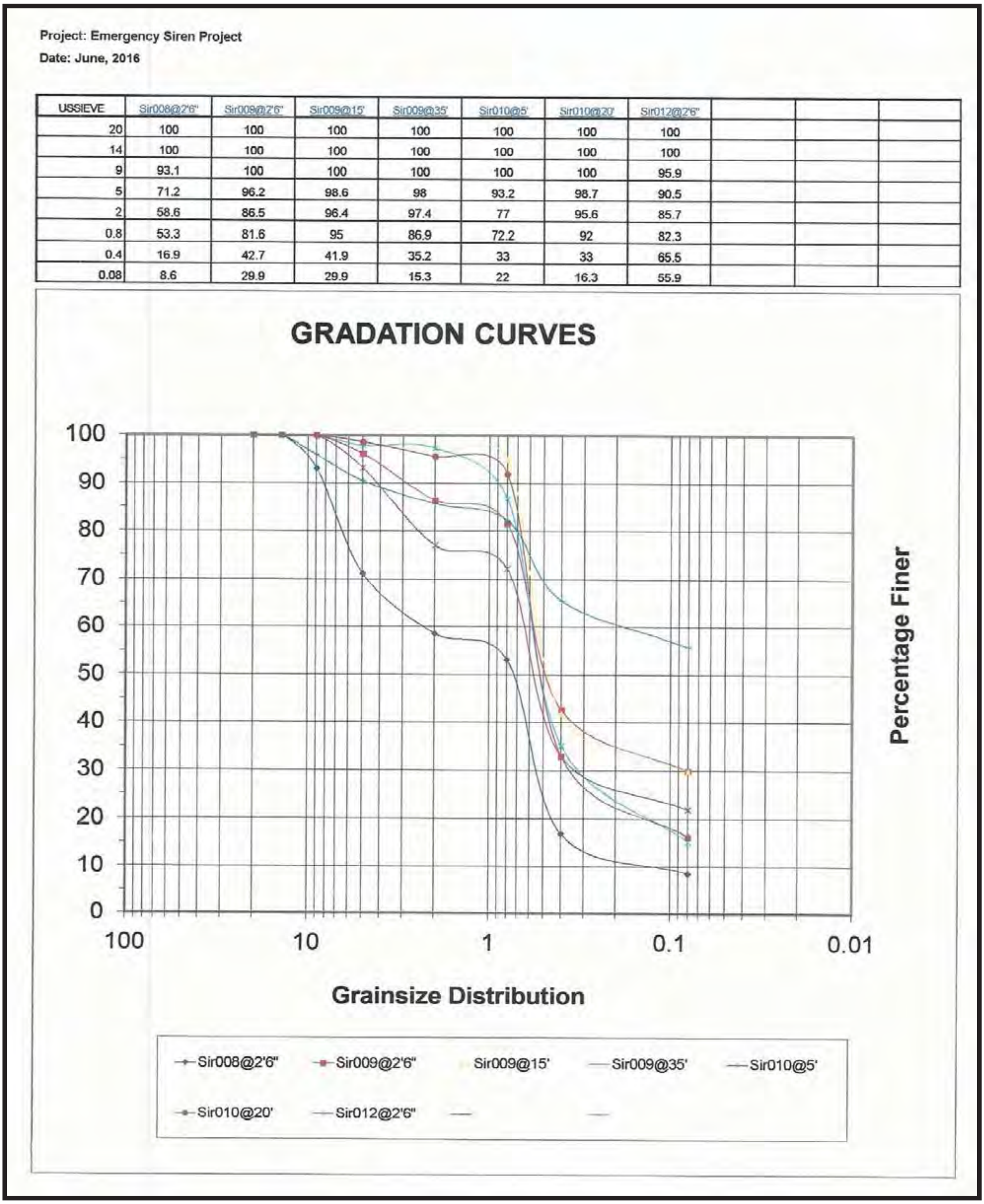
	Dates	Job No.	
Start	21.04.16	B.H. No.	Sht. 2 of 2
Completion	21.04.16	**BH# Sir015**	
Final W. L.	25'		

Appendix III **Laboratory Physical Soil Test Results**

Project: Emergency Siren Project
Date: June, 2016

USSIEVE	Sir001@2'6"	Sir002@2'6"	Sir002@7'6"	Sir002@25'	Sir002@35' A	Sir003@2'6"	Sir004@25'	Sir004@35'	Sir006@2'6"	Sir006@5'
20	100	100	100	100	100	100	100	100	100	100
14	100	100	100	100	100	100	100	100	100	100
9	100	100	100	100	100	100	100	100	93.5	91.9
5	98.7	91.7	98.7	98	99.3	98.6	76.5	98.2	85.7	63.9
2	97.1	84.7	97.3	95.7	98.7	97.7	74.2	92.5	66.4	54.3
0.8	96.8	81.3	95.1	94.4	95.3	97.5	68.2	90.6	57.4	48.2
0.4	88.8	48.6	54.9	50.6	65.3	83.5	52.6	45.4	19.6	20.5
0.08	76.3	37.3	42	37	41	61.1	29	27.1	14.5	13.3



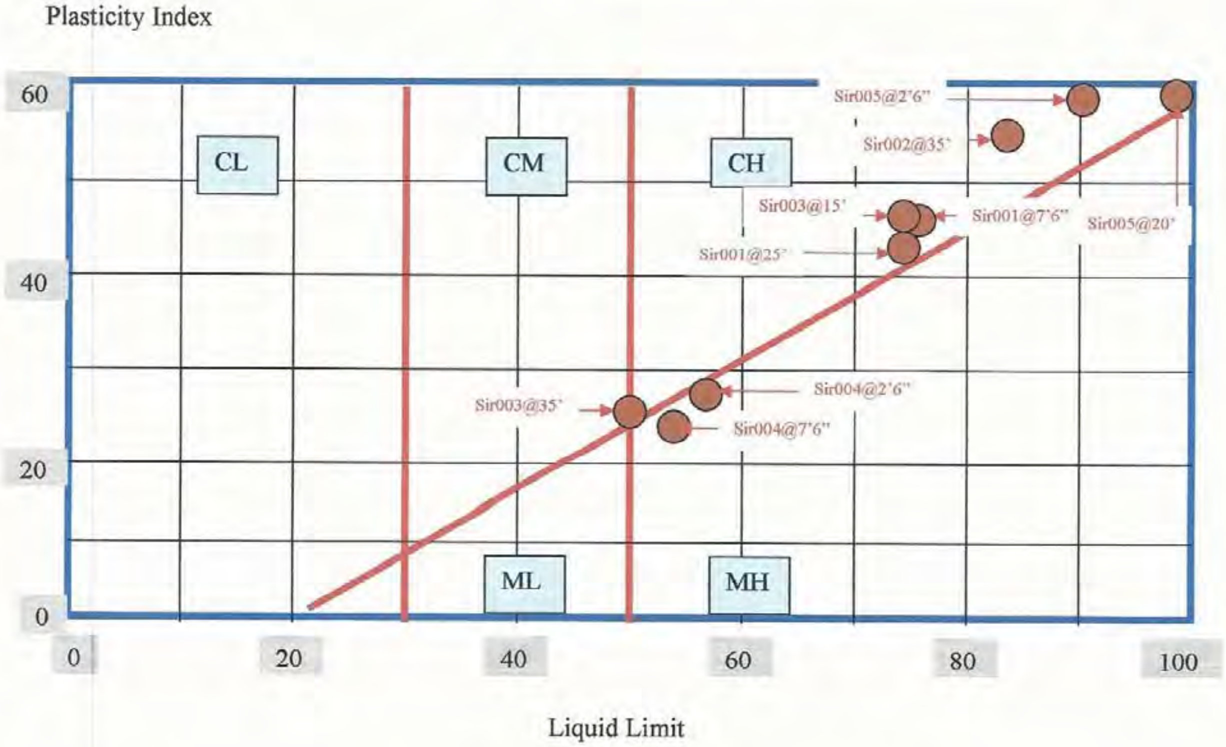


Project: Emergency Siren Project

Date: June, 2016

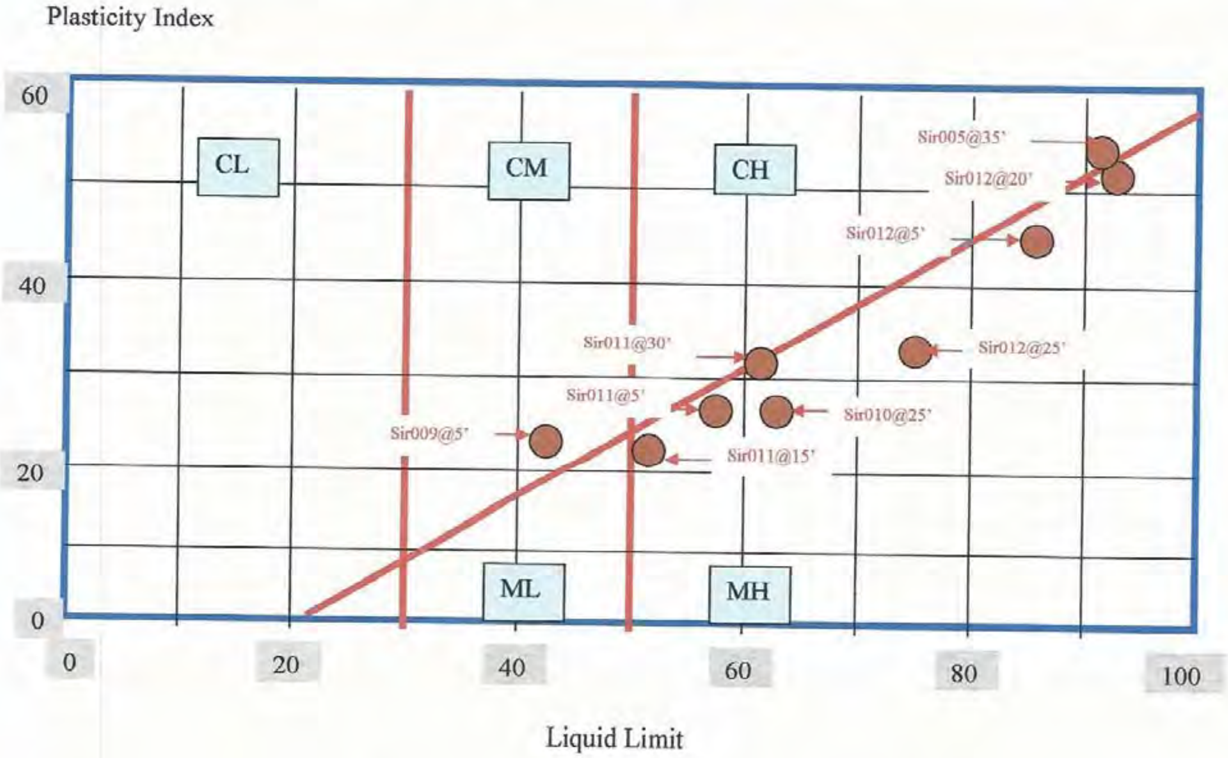
USSIEVE	Sir008@2'6"	Sir009@2'6"	Sir009@15'	Sir009@35'	Sir010@5'	Sir010@20'	Sir012@2'6"			
20	100	100	100	100	100	100	100			
14	100	100	100	100	100	100	100			
9	93.1	100	100	100	100	100	95.9			
5	71.2	96.2	98.6	98	93.2	98.7	90.5			
2	58.6	86.5	96.4	97.4	77	95.6	85.7			
0.8	53.3	81.6	95	86.9	72.2	92	82.3			
0.4	16.9	42.7	41.9	35.2	33	33	65.5			
0.08	8.6	29.9	29.9	15.3	22	16.3	55.9			

BH #	Sample Dept	Liquid Limit	Plastic Limit	Moisture Content	% Passing #40
Sir001	7’6”	75.0	27.3	24.02	85.5
Sir001	25’	73.0	29.4	23.02	85.1
Sir002	35’	84.8	28.6	18.08	83.6
Sir003	15’	73.7	25.6	16.07	84.3
Sir003	35’	50.0	23.6	19.04	85.3
Sir004	2’6”	57.4	30.0	09.01	85.1
Sir004	7’6”	54.4	30.5	22.07	87.0
Sir005	2’6”	90.7	30.1	26.04	84.7
Sir005	20’	101.6	38.1	30.02	84.9



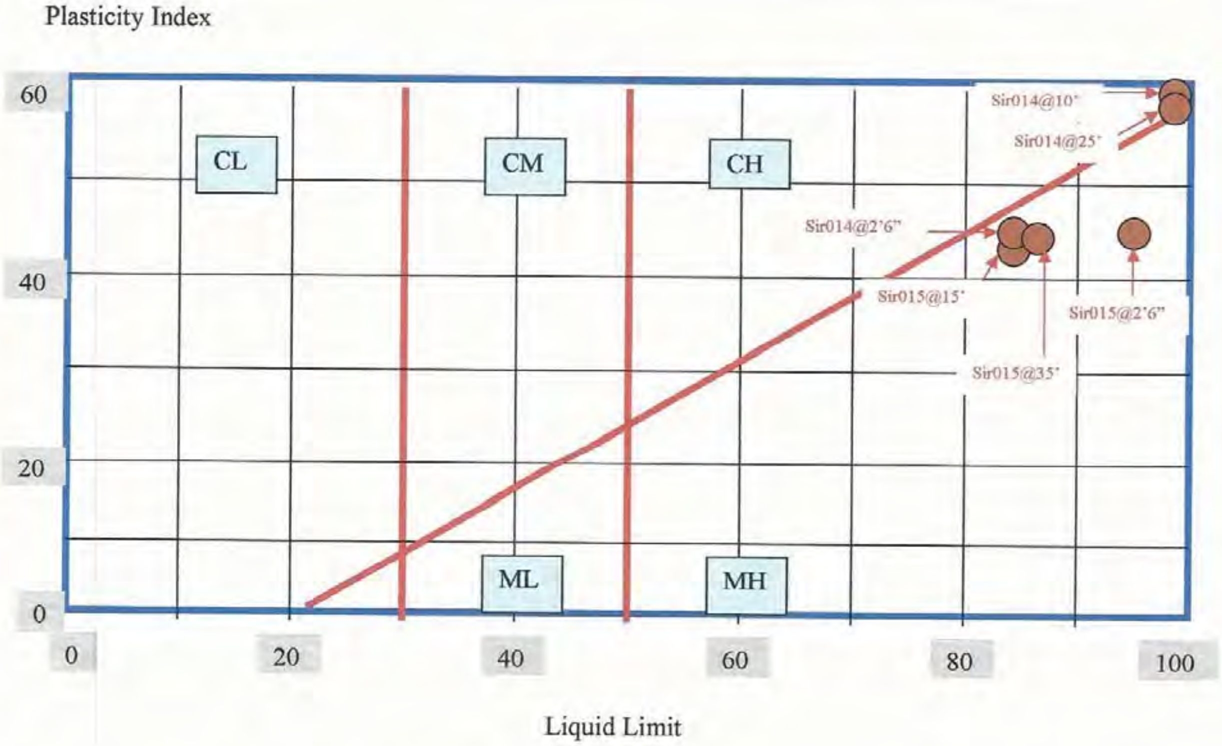
ATTERBERG LIMIT – EMERGENCY SIREN PROJECT

BH #	Sample Dept	Liquid Limit	Plastic Limit	Moisture Content	% Passing #40
Sir005	35’	91.4	91.4	25.06	85.9
Sir009	5’	42.3	19.8	13.01	84.4
Sir010	25’	62.8	35.4	19.09	85.6
Sir011	5’	58.2	30.3	15.03	87.0
Sir011	15’	51.2	29.1	21.05	85.3
Sir011	30’	61.6	30.4	21.03	84.2
Sir012	5’	85.4	40.9	27.03	86.0
Sir012	20’	92.1	40.6	37.05	85.6
Sir012	25’	76.2	42.7	47.01	87.3



ATTERBERG LIMIT – EMERGENCY SIREN PROJECT

BH #	Sample Dept	Liquid Limit	Plastic Limit	Moisture Content	% Passing #40
Sir014	2’6”	85.4	39.0	35.09	86.7
Sir014	10’	137.6	47.4	50.00	95.7
Sir014	25’	161.0	87.7	116.01	94.7
Sir015	2’6”	96.0	49.6	28.04	87.0
Sir015	15’	83.1	41.1	29.06	85.6
Sir015	35’	86.3	41.6	33.03	88.4



ATTERBERG LIMIT – EMERGENCY SIREN PROJECT

A report on concrete testing at the Telecommunication Tower site at Shotover, Portland (Project for Improvement of Emergency Communication System in Jamaica

Table of Contents

LIST OF FIGURES

1.0 INTRODUCTION

1.1 OBJECTIVES

The aim of this geotechnical report is to:

- Conduct materials testing on concrete base (slab) of control room at selected telecommunications site
- Present findings on analysis of concrete study
- Present recommendations based on findings

1.2 BACKGROUND

In recent years the Japan International Cooperation Agency; JICA, and the Jamaican Government have strengthened bilateral arrangements with the aim of promoting the islands social and economic development.

A crucial component of JICA's operation is aimed at strengthening the goals and strategic objectives of the islands Comprehensive Disaster Management Framework, which partly involves the improvement of Jamaica's emergency communication infrastructure.

Hence, the objective of the project is to improve the existing emergency communication infrastructure in Jamaica. This will be accomplished by upgrading the existing communication infrastructure which will inevitably result in more efficient and effective communication island wide, and by extension a stronger emergency response mechanism in the event of natural disasters

1.3 PROJECT SCOPE

The scope of works provided and commissioned by Yachiyo Engineering Company Limited (YEC) and guided by an addendum to contract dated April 14th 2016 included all activities necessary to produce findings of geotechnical investigations at target sites and recommendations for construction and design. The addendum covered concrete testing of concrete base below an existing control room at the location. Testing locations were guided by YEC. Results from the material testing should then form the basis of recommendations for the use of the existing base for new or replacement Control Room

This report was prepared for the exclusive use of our client and their consultants for design of this project. In the event that any changes are made in the character, design or layout of the improvements, we must be contacted to review the conclusions and recommendations contained in this report to determine whether modifications are necessary. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without our express written consent.

1.4 PROJECT DESCRIPTION

The purpose of this project is to improve the existing emergency telecommunication infrastructure in Jamaica. This involves installing the requisite wireless communication systems and relevant infrastructure.

The assessment of the structural integrity of the Control Room base serves as a component of the study, as it assesses the existing structure and its capability of supporting a new structure.

The report hereby presents the findings of this concrete test.

No.	Name	Parish	Longitude	Latitude
??	Shotover	Portland	18°10'18.39"N	76°28'51.02"W

Figure 1 Table showing geographic coordinate locations of Shotover, Portland tower site

1.5 PROJECT LOCATION

This project involves concrete testing at the Telecommunication Tower located at Shotover, in the north-central section of the parish of Portland. (See fig.2).

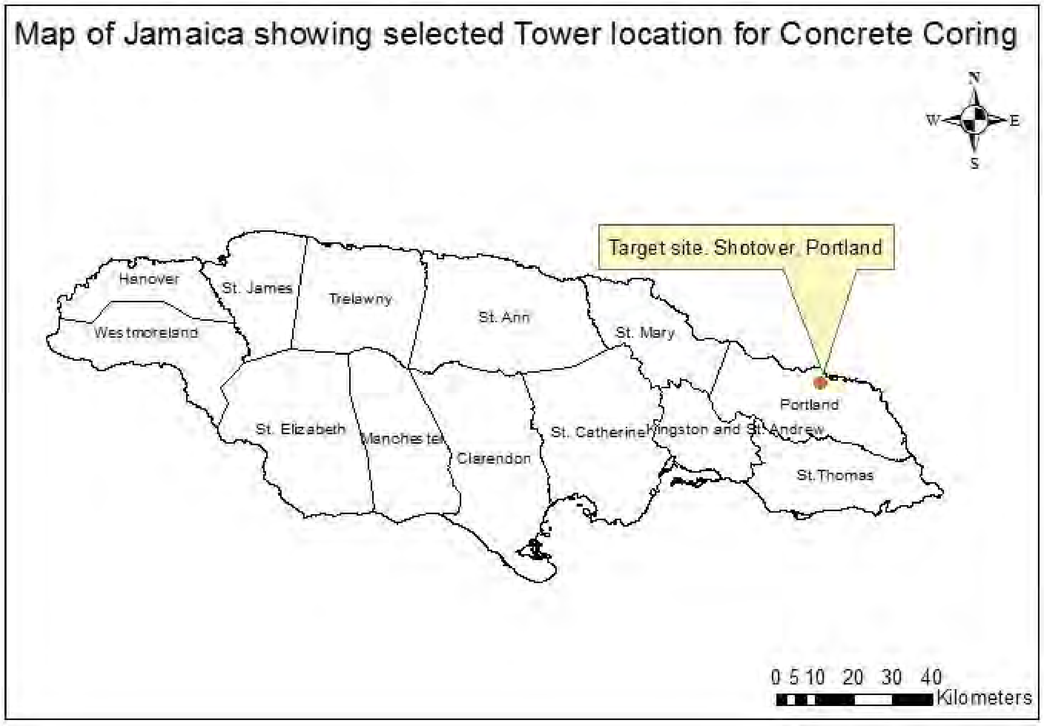


Figure 2. Map showing location of selected tower sites where soil investigations were conducted

The targeted Telecommunication Tower site is found in the rural community of Shotover, about four kilometers west southwest of the parish capital of Port Antonio. It is accessed via a parochial road that serves the District of Boundbrook leading to the rural community of Spring Bank. The site is located in highlands which rise in excess of three hundred feet above sea level, overlooking Unity Valley and Burlington which is separated by the Rio Grande, which empties at the coast, near the seaside town of St. Margret Bay. (See fig. 3)

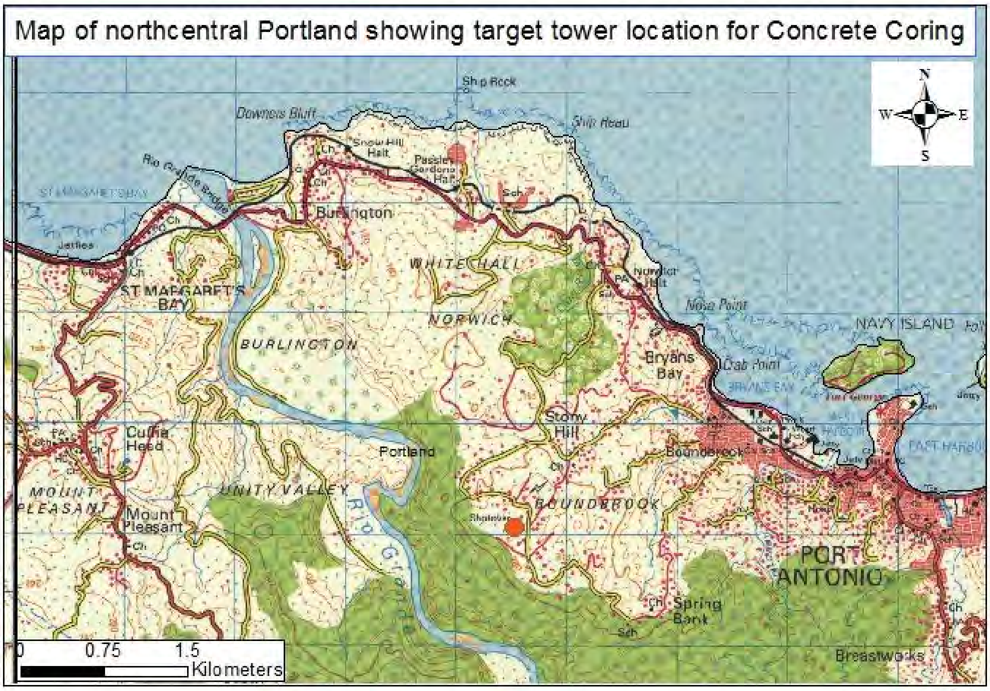


Figure 3 Map showing location of tower site in Mount Airy, Westmoreland

2.0 METHODOLOGY

2.1 TESTING LOCATIONS

Site selection for concrete testing was guided by representative of YEC. Three locations were identified on and along existing concrete slab. Two (2) holes on western side and one (1) on eastern side of concrete. (See fig. 4)

MIDDLE OF WESTERN SIDE

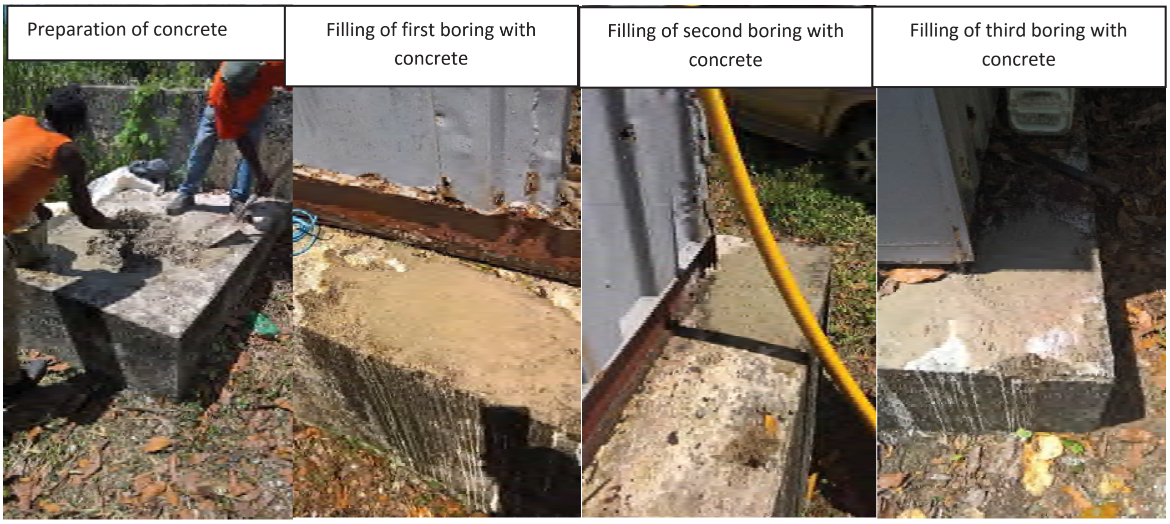
SOUTHWESTERN CORNER

SOUTHEASTERN CORNER

Figure 4. Pictures showing locations of coring sites on concrete base, Shotover, Portland

2.2 ACQUISITION OF SAMPLES

Sites for coring were initially identified and marked out on slab. Safety checks were conducted to ensure there were no services infront and behind the location to be cored. Wall anchor was then drilled and installed. Coring machine was then mounted, 4”diamond core bit was then affixed and centred on marked position. Water was then fed to core bit and coring occurred to a depth of eight inches (8”). At achievement of desired depth (8”) machine was stopped and core removed for measurements, observations and packaging for transport to lab. Concrete mixture was then prepared and used to replace and fill cylindrical void created by coring exercise. This mixture had a ratio of 3:2:1 (cement:sand:fine gravel)



Preparation of concrete

Filling of first boring with concrete

Filling of second boring with concrete

Filling of third boring with concrete

Figure 5. Pictures showing concrete preparation and infilled boring with prepared concrete mix

3.0 FINDINGS

Findings and results of the coring exercise at Shotover, Portland are presented below. This will be presented with respect to each coring site. All cores were drilled to a depth of eight inches (8”). Location of each target drilling position was also measured with respect to dimensions of concrete slab and its proximity to existing control room structure (metal container) siting on base. Presence of reinforcement steel bars was also noted if encountered.

3.1 FIRST CORE

CORE LOCATION

At the site of the first core the container sits twelve inches (12”) away from the edge of concrete base. This is located on the western side of the concrete slab. Boring was done approximately four and half inches (4 ½”) away from base of metal container. The boring had a diameter of four inches(4”)

Figure 6. Location of first coring

CORE DESCRIPTION

NO	ITEM DESCRIPTION	OBSERVATIONS
1	LENGTH	8”
2	DIAMETER	4”
3	PRESENCE OF REBARS	None observed
4	CORE DESCRIPTION	Core composed of a section of 6” limestone block. Limestone block space infilled with concrete mixture of alluvial aggregate. Voids seen within infilled concrete. Limestone block is composed of limestone chips and limestone dust (crusher run)

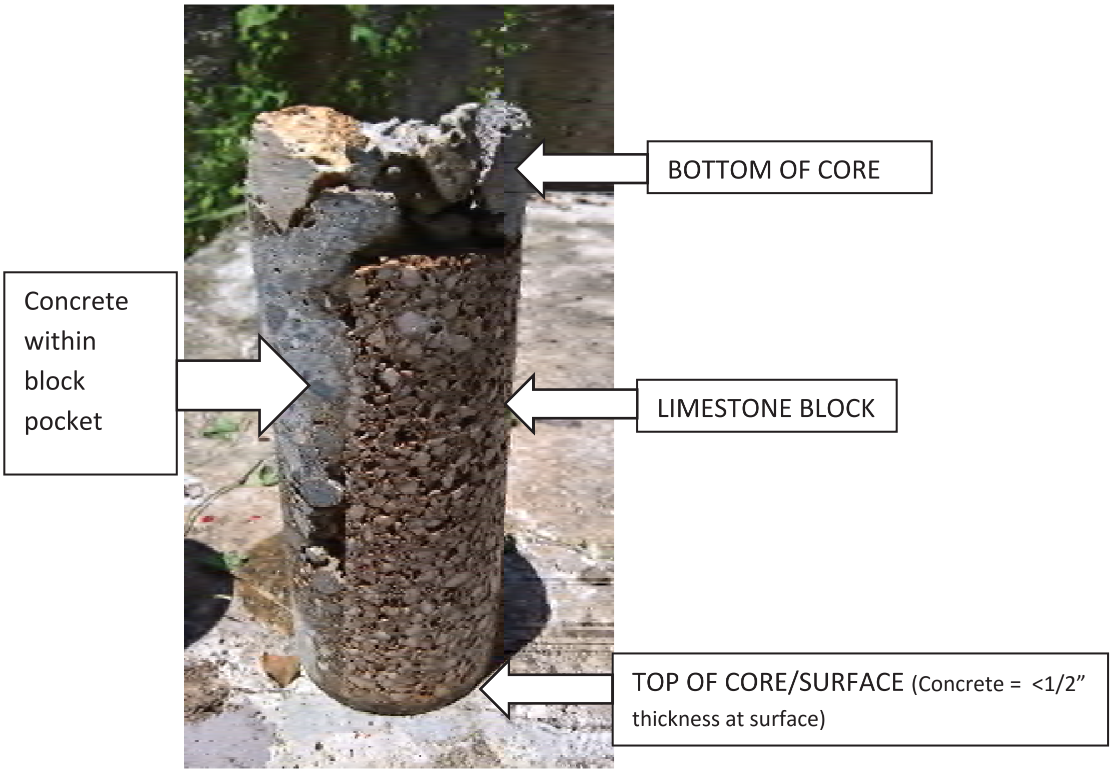


Figure 7. Picture of first core

3.2 SECOND CORE

CORE LOCATION

At the site of the second core the container sits twelve inches (12") away from the edge of concrete base and is located in the southwestern corner of the concrete base. Boring was done approximately two and half inches (2 ½") away from base of metal container. The boring had a diameter of four inches(4")

Figure 8. Picture showing location of second boring in southwestern corner of concrete base

CORE DESCRIPTION

NO	ITEM DESCRIPTION	OBSERVATIONS
1	LENGTH	8”
2	DIAMETER	4”
3	PRESENCE OF REBARS	None observed
4	CORE DESCRIPTION	Core composed of a section of 6” limestone block. Limestone block space is partially infilled with concrete mixture of alluvial aggregate. Concrete observed to a thickness of less than three inches (3”) within block pocket. Broken pieces of limestone blocks and limestone pebbles seen in block pocket. Limestone block is composed of limestone chips and limestone dust (crusher run)

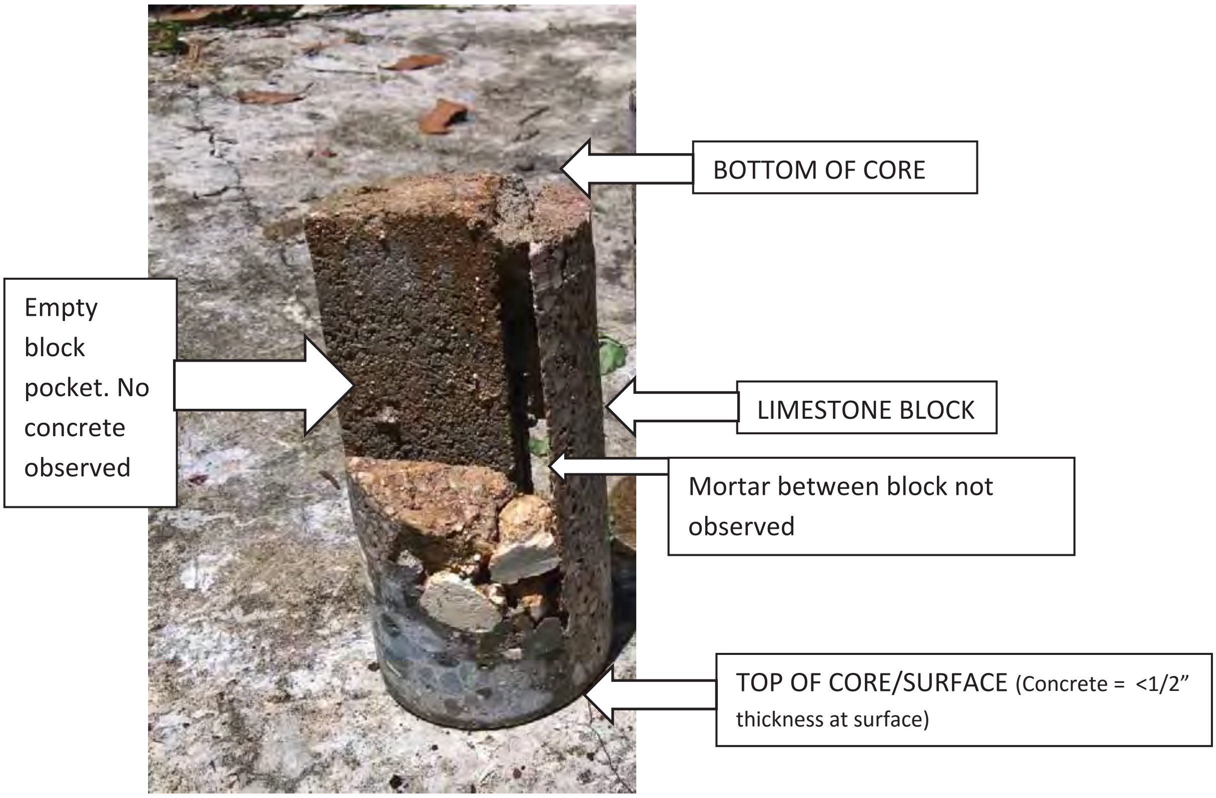


Figure 9. Picture of second core

Figure 10. Picture showing thickness of partial infilling of block pocket at location of second boring

MAJOR FINDING

At the second boring site, located in the southwestern corner of the concrete base we observed a cavity within the concrete structure. This became evident three inches (3") below the surface

Figure 11. Picture showing entrance to cavity found at second boring site

3.3 THIRD CORE

CORE LOCATION

At the site of the first core the container sits fifteen and a quarter inches (15 ¼ ”) away from the edge of concrete base. This is located on the southeastern corner of the concrete slab. Boring was done approximately five and quarter inches (5 ¼ ”) away from base of metal container. The boring had a diameter of four inches(4”)

Figure 12. Picture location of third boring in southeastern corner of concrete base

CORE DESCRIPTION

NO	ITEM DESCRIPTION	OBSERVATIONS
1	LENGTH	8”
2	DIAMETER	4”
3	PRESENCE OF REBARS	None observed
4	CORE DESCRIPTION	Core composed of a section of 6” limestone block. Limestone block space is partially infilled with concrete mixture of alluvial aggregate. Concrete observed to a thickness of less than three inches (3”) within block pocket. Broken pieces of limestone blocks and limestone pebbles seen in block pocket. Limestone block is composed of limestone chips and limestone dust (crusher run

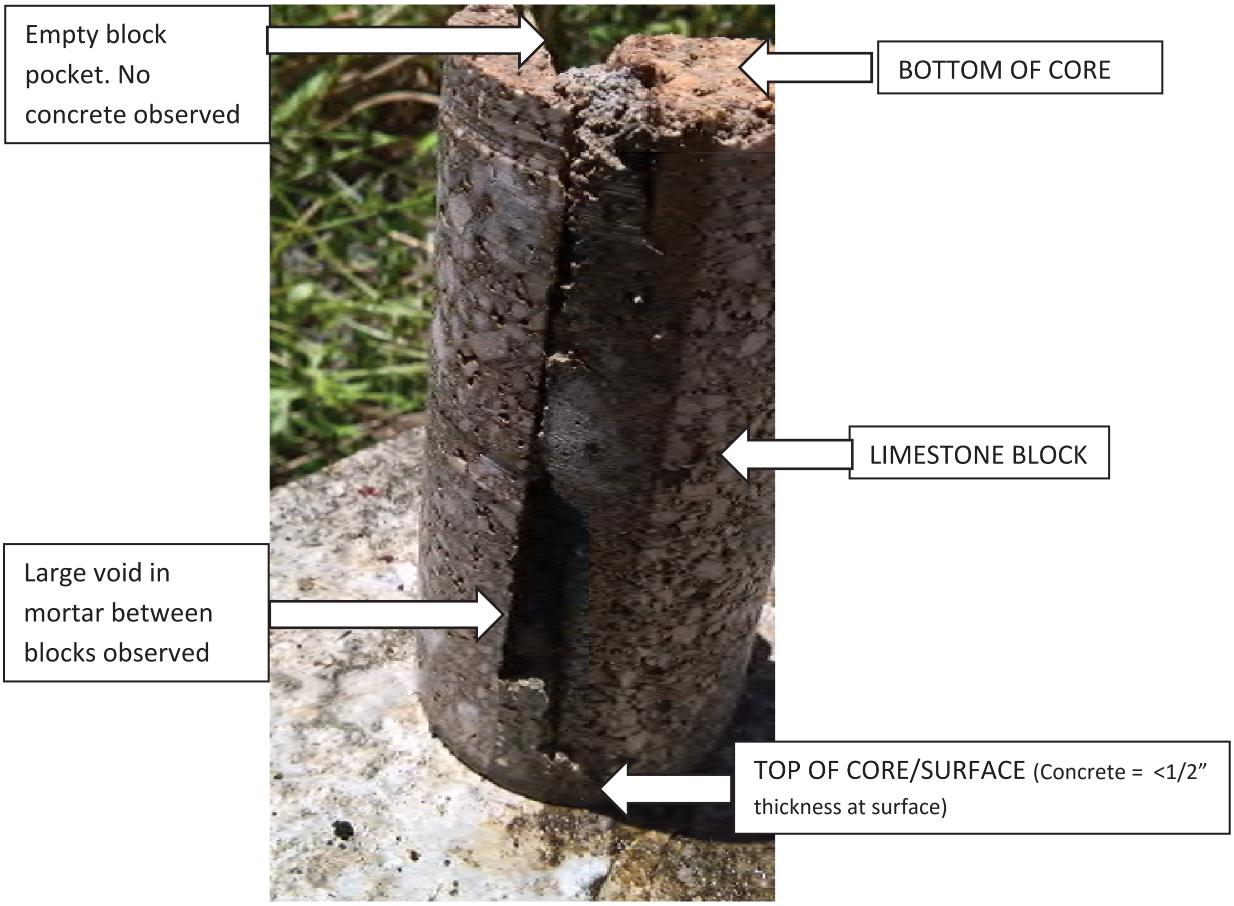


Figure 13. Picture of third core

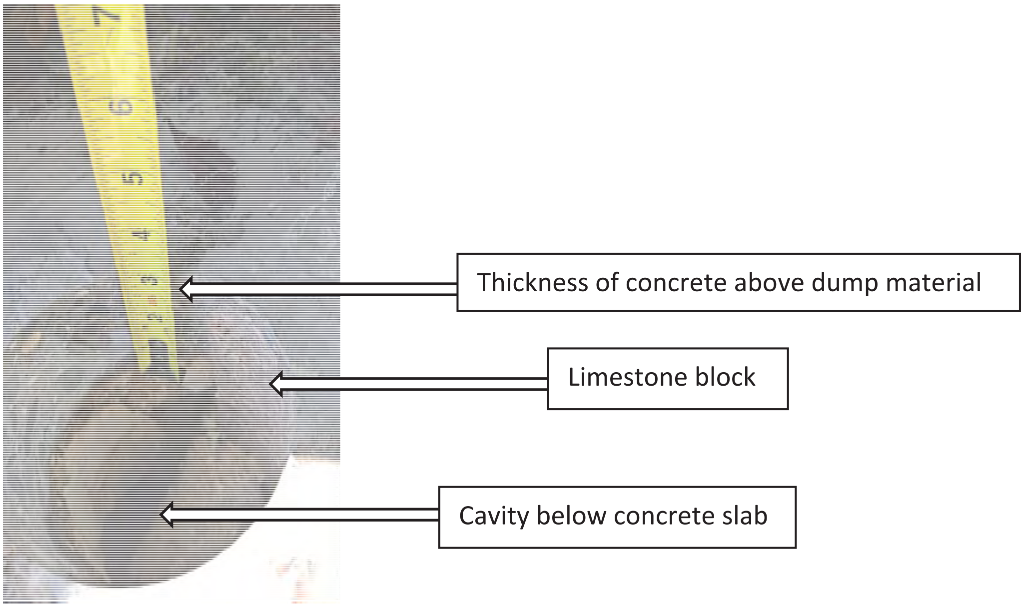


Figure 14. Picture showing thickness of partial infilling of block pocket at location of third boring

MAJOR FINDING

At the third boring site, located in the southeastern corner of the concrete base we again observed a cavity within the concrete structure. This became evident six inches (6") below the surface. (See fig. 14)

4.0 LABORATORY RESULTS OF CORE TESTING

Concrete core samples won from the coring exercise at the Telecommunication tower found at Shotover, Portland were not suitable for laboratory testing. None of the cores produced a complete cylindrical shape or core. Core recovery ranged from 35-80% due mainly to the material used in the construction of this concrete structure.

5.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

CONCLUSIONS

The existing concrete base at the Shotover (Portland) Telecommunication Tower site is ten feet two inches wide (10'2"), twelve feet two inches (12'2") in length and two and a half feet high (2'6").

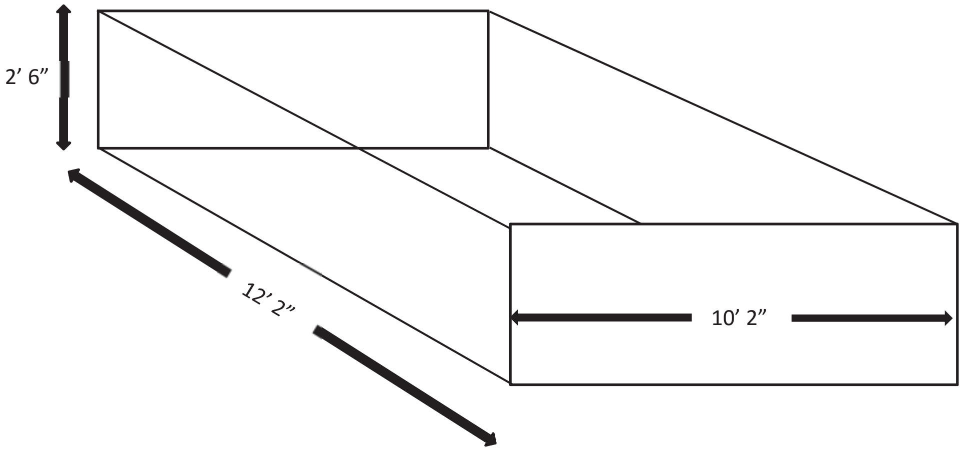


Figure 15. Schematic diagram of concrete slab

Cavities were observed in both the second and third borings which occurred on the southern side (front/entrance to container) of the concrete slab. We are unable to determine the size of the cavity but it is important to note that during the infilling of the boring it took three-four times the volume of concrete to fill space. We however stopped this seepage and siphoning of concrete by the use of limestone rocks found lying around site that was used to pack base of borings. From observation and also using stick to probe cavity, we believe that it extends beyond two feet from affected borings. This cavity was probably due to poor compaction of material used to fill this structure before the pouring of the concrete. These cavities could have also been formed post construction due to the weathering and breakdown of the inferior limestone fill used.

We did not encounter any rebars (reinforcement steel) in any of the won concrete cores. Coring done in the southwestern and southeastern corners are near the corners of the concrete structure where a stiffener (small structural column), supported by rebars, would have normally been placed in the construction of the slab to support the anticipated weight. The cores however revealed that the construction (limestone) blocks were just tied (lapped) during the block laying process.

Coring has revealed in two instances where the block pockets were not filled with concrete. We are unable to determine how pervasive this condition is throughout the structure. These instances indicate the construction of the concrete base suffered from poor workmanship and inappropriate and insufficient use of materials.

RECOMMENDATIONS

Based on the findings from this study we will highly recommend that the existing concrete structure be demolished and rebuilt, engineered for the anticipated purpose. This recommendation is based on the fact the structural integrity of the concrete base is questionable and compromised. Yachiyo Engineering Company has not shared the technical specification of use for concrete base, therefore this recommendation is solely based on findings and conditions at site. This recommendation is guided by the following:

- Absence of reinforcement steel in concrete slab
- Presence of large cavity observed on southern side of concrete slab
- Presence of unfilled block pockets in more than one testing location
- Poor compaction of fill within concrete structure
- Our inability to determine how pervasive are these instances of poor workmanship, insufficient use of building materials and poor structural design.