

SETTLERS WAY INDUSTRIAL BUILDING DEVELOPMENT: EAST LONDON

GEOTECHNICAL DRILLING REPORT

October 2011

Prepared for:
East London IDZ (Pty) Ltd
Greenfields
East London
520

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EAST LONDON IDZ (PTY) LTD

SETTLERS WAY INDUSTRIAL BUILDING: EAST LONDON

GEOTECHNICAL DRILLING INVESTIGATION REPORT

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TERRECO QUALITY VERIFICATION			
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<i>DATE</i>	October 2011	October 2011	October 2011
<i>SIGNATURE</i>			

1 INTRODUCTION

1.1 GENERAL

Terreco Geotechnical cc was, on 18th July 2011, appointed by East London Industrial Development Zone (Pty) Ltd, to undertake a Detailed Geotechnical Drilling Investigation for the proposed Settlersway Industrial Building site immediately east of East London Airport. This after Dr GV Price of Terreco Geotechnical cc had on 28th June 2011 provided Ms Mgandela of the East London IDZ (Pty) Ltd with a proposal and cost for the investigation.

The drilling investigation follows on from previous investigations where the depth to rockhead was not intersected by trial hole excavations. Further geotechnical investigations would be concentrated on the northern flank of the Settlers Way road in Greenfields (See Figure 1.1): viz Northern Portion of Farm 913/1 and Erven 907 & 909.

This geotechnical investigation would also ascertain detailed geotechnical information to allow for foundation design of the proposed industrial building.

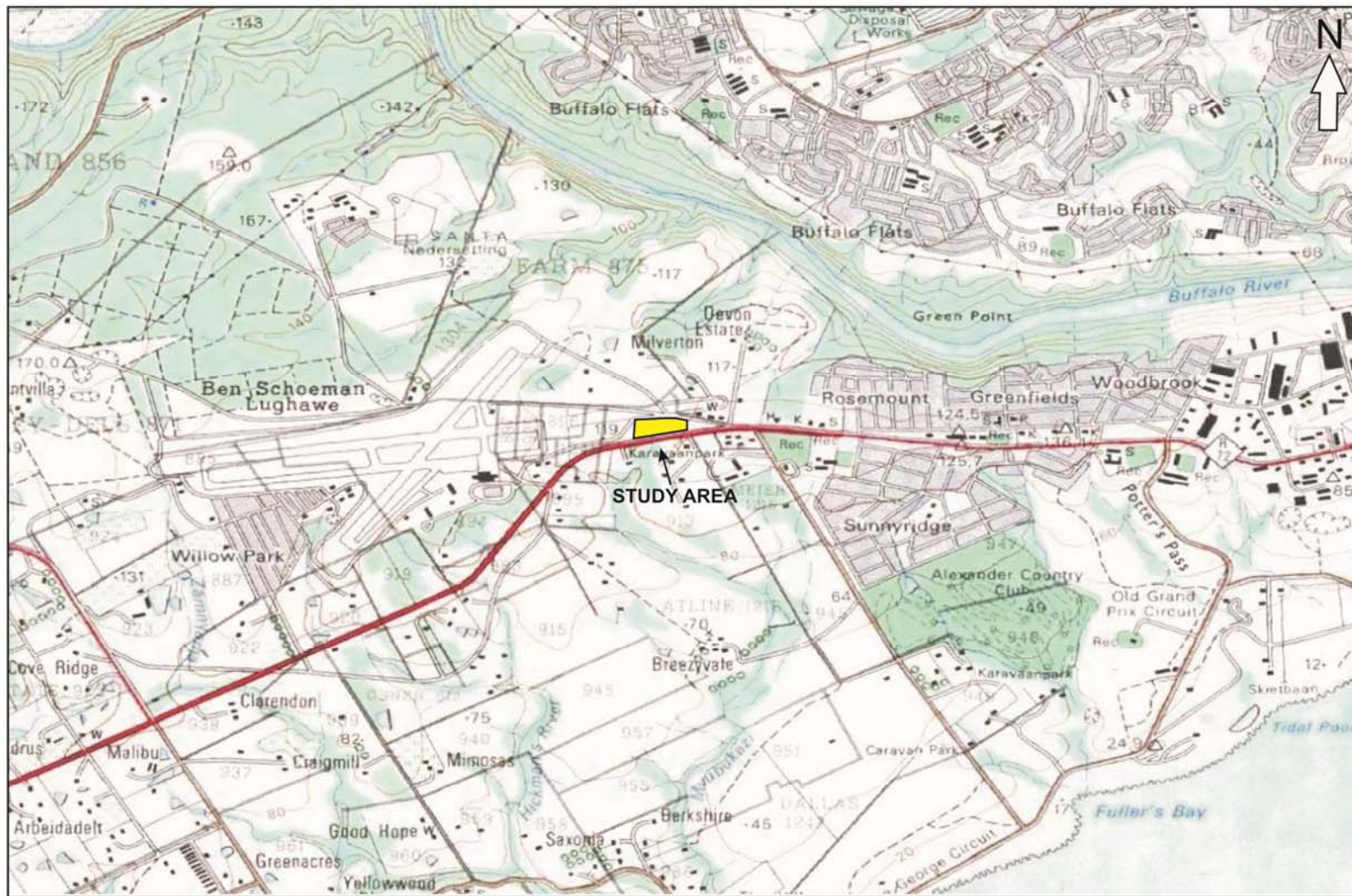
1.2 TERRECO PROPOSAL

Terreco Geotechnical cc provided a proposal, with costs, to undertake geotechnical investigations on the 28th June 2011. The proposals envisaged field investigations; drilling supervision; core logging; acquiring samples; analysis and compilation of a geotechnical report. The details of the proposal are as follows:

- Compilation of a drilling tender document according to COTO requirements including a Schedule of estimated Drilling Quantities and Drilling Specification. Boreholes, would consist of 5 rotary cored boreholes drilled to a depth of approximately 10m which would equate to an estimated minimum of 3m into the underlying rock
- A formal site inspection may of been undertaken by Terreco Geotechnical cc but due to the relatively small size of the drilling project this was found unnecessary. Prospective tenderers were though supplied with relevant site description and plans with recommendations to visit the site if deemed necessary
- The drilling tender document would be be distributed by email or facsimile to 6 known drilling companies in South Africa with instructions for return of completed tender at a specified date within 5 days of receipt
- Terreco Geotechnical cc would undertake a tender adjudication and provide a Tender Report with recommendations for appointment to East London IDZ
- Borehole positions would be indicated to the appointed geotechnical drilling contractor
- This proposal did not include costing for day to day driller supervision, however, the site would be visited when necessary during the drilling

operation to establish whether the work was progressing according to the required standards

- Boreholes would be logged on completion of the drilling according to SAIEG requirements
- Core samples would be removed for laboratory testing which would consist of 10X Point Load Strength Index (PLSI) tests from which an estimate would be made of Unconfined Compressive Strength (UCS) and Estimated Safe Allowable Bearing Pressure (ESABP)
- Geotechnical analyses would follow with recommendations for founding depth and foundation type
- This proposal **did not include** the actual drilling costs as these would be obtained from the drilling tenders returned by the drilling companies. It was indicated that current drilling rates would possibly vary between approximately R3000.00 and R4500.00 per meter. At 10m per each of the 5 boreholes this equates to an approximate total cost of the investigation of between R150 000.00 and R225 000.00
- The area south of Settlers Way, a portion of Farm 913 Portion 1, would not be investigated as the very steep nature of the terrain makes it unsuitable for development
- Portion 2 of Farm 905 would also be excluded from this investigation as rockhead was exposed in Trial Hole TH1 making drilling unnecessary
- The results of the investigation would be compiled into a detailed geotechnical report



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FIGURE 1.1:
SITE LOCALITY PLAN



Scale: Not to scale

Date: October 2011

1.3 AIM OF THIS REPORT

To provide details of the rock founding conditions for the Settlers Way Industrial Building and types of overburden to be expected.

1.4 STRUCTURE OF THIS REPORT

The structure and content of the report continues as follows:

Chapter 2	Method of Investigation
Chapter 3	Geology
Chapter 4	Drilling Investigation
Chapter 5	Laboratory Testing
Chapter 6	Geotechnical Appraisal
Chapter 7	Conclusion

2 METHOD OF INVESTIGATION

The investigations comprised of detailed geotechnical field and drilling investigations.

The detailed investigation consisted of:

- Compilation of a drilling tender
- Call for tenders
- Adjudication of tenders
- Compilation and submission of an Adjudication Report with recommendations for driller appointment
- Appointment of the drilling company
- Setting out boreholes in the field
- Supervision of the drilling contract
- Rotary core drilling of 3 boreholes with fewer boreholes than proposed due to the high degree of weathering of the underlying rock horizons. Deeper weathering meant fewer boreholes in order to accommodate the total meters of drilling allowed for in the project. This item was agreed with the engineer
- Logging and sampling of the borehole core
- Laboratory testing

All of the information gleaned from the detailed investigation follows as presented in this report.

3 GEOLOGY

The position of the study site was determined on a 1: 250 000 geological map of the region prior to the fieldwork investigation. This desktop exercise indicated that the general area is underlain by 2 main rock types, i.e. sedimentary mudstone of the Adelaide Subgroup, Beaufort Group, Karoo Sequence; and widespread intrusions of igneous dolerite within the mudstone country rock. The dolerite intrusions commonly form vertical dyke and horizontal sill structures within the sedimentary host rock (mudstone). Dolerite when unweathered is a grey, medium grained, closely to widely jointed, very hard rock.

Figure 3 (Geological Plan) indicates that the study area is situated directly south of the nearest dolerite intrusion, which exists as a large, horizontally-oriented sill structure. Within the confines of the study area, mudstone and completely weathered sandstone are the only rock types intersected. This confirms the geological plan information.

In addition to the mudstone and dolerite which occur in the general region, large deposits of quaternary sand, fixed dune and dune rock are also common along the coastline and are known to occur up to 5km inland.



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FIGURE 3:
GEOLOGICAL PLAN SHOWING
LOCATION OF STUDY SITE



Scale: Not to scale

Date: OCTOBER 2011

4 DRILLING INVESTIGATION

4.1 GENERAL

After obtaining tender quotations from three competent drilling companies the adjudication of tenders was completed in August 2011. The company recommended by Terreco Geotechnical cc was, Fairbrother Geotechnical Engineering, who were then appointed by Lukhozi Consulting Engineers (Pty) Ltd on behalf of the EL IDZ (Pty) Ltd on the 2nd September 2011 to undertake the work.

4.2 SUB-SURFACE INVESTIGATION

Drilling was completed by Fairbrother Geotechnical Engineering on the 26th September 2011 with core logging and sampling completed on the same day. Core logging provided information regarding the nature and quality of the underlying alluvium and sedimentary rock, as well as information regarding any variations of depth to rockhead, and presence or absence of underlying sedimentary rockhead contact at depth.

Drilling results from each of the boreholes are summarized in Table 4.2:

Table 4.2: Summary of lithology and depths of all boreholes

Borehole	Material	Depth (m)	Thickness (m)
BH1	Sandy Clay : Alluvium	0.95	0.95
	Completely weathered mudstone	9.80	8.85
	Completely weathered sandstone	15.00	6.15
BH2	Clay: Alluvial	1.45	1.45
	Sand Clay: Alluvial	3.40	1.95
	Sand: Alluvial	5.10	1.70
	Highly weathered mudstone	5.20	0.10
	Completely weathered sandstone	10.00	4.80
BH3	Clay : Alluvium	1.45	1.45
	Sandy clay: Alluvium	2.45	1.00
	Clayey sand: Alluvium	4.00	1.55
	Sandy clay: Alluvium	6.40	2.40
	Completely weathered claystone	8.50	2.10
	Completely weathered mudstone	14.40	5.90
	Highly weathered mudstone	16.50	2.10
	Moderately to slightly weathered mudstone	25.00	8.50

The rotary cored drilling positions are indicated in Figure 4.2. Boreholes were positioned across the site to provide details of the subsurface materials and an indication of founding depths. Depths to rock head contact vary with BH1 at 9.8m; BH2 at 5.2m and BH3 at 8.5m. Of concern is the degree of weathering of the rock horizons where completely weathered rock extends to a depth of 14.4m in BH3. Moderately to slightly weathered rock was only intersected in BH3 at 16.5m and even though weathered to a lesser degree still has occasional highly fractured horizons with clay infill along joints. All boreholes were not drilled into moderately to slightly weathered rock due to a drilling limit of 50m.

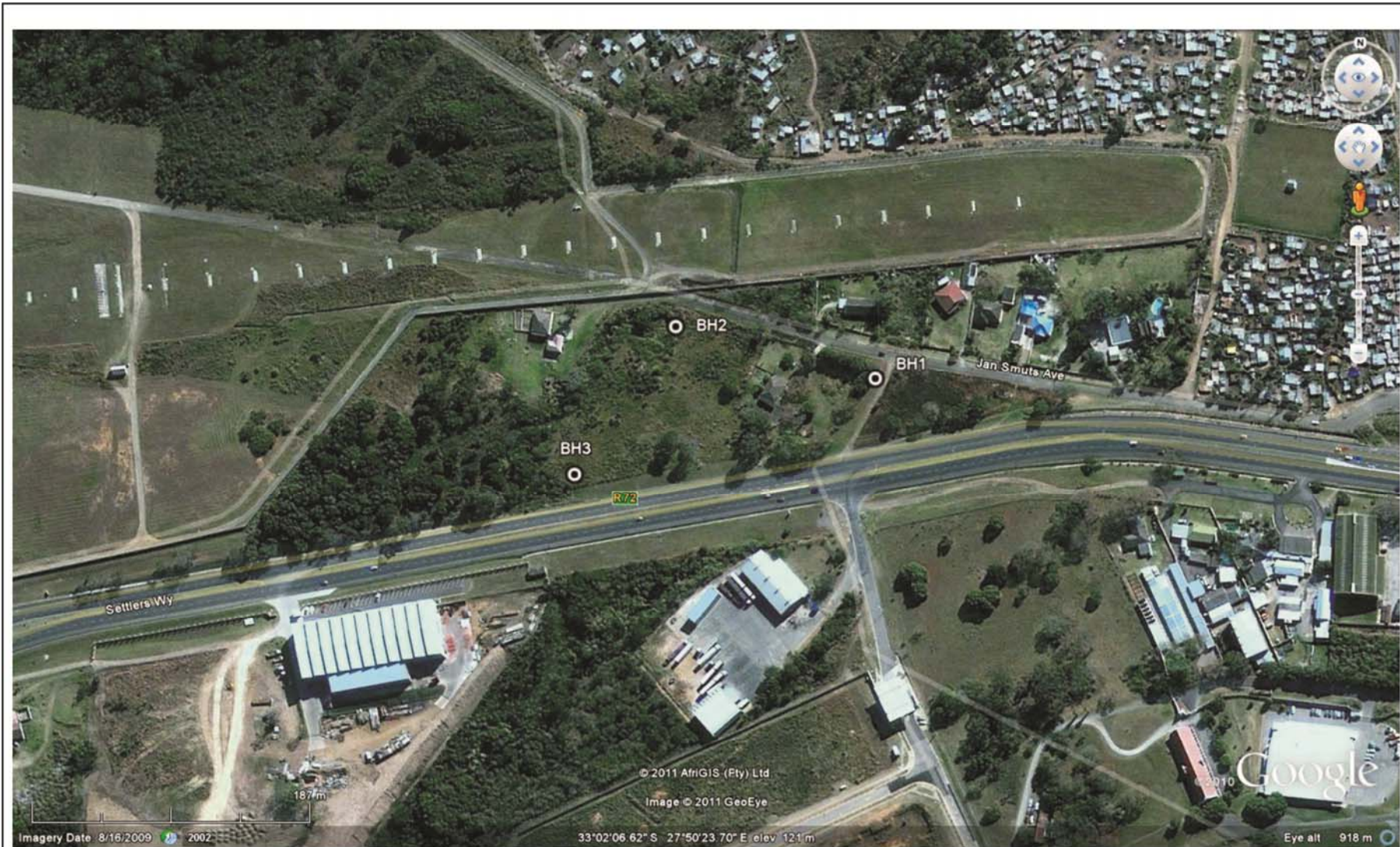
4.3 SPT TESTING

SPT testing was undertaken to determine the density of the underlying soil horizons. These are classified in Table 4.3.1.

Table 4.3.1: Soil densities using SPT values

Borehole	Depth (m)	Soil / Rock	N Value	Density Classification
BH1	1.0 – 1.4	Completely weathered mudstone	11	Medium Dense
	2.5 – 2.9	Completely weathered mudstone	25	Medium Dense
	4.0 – 4.4	Completely weathered mudstone	26	Medium Dense
	8.5 – 8.8	Completely weathered mudstone	Refusal	Very Dense
BH2	1.0 – 1.4	Alluvial clay	13	Medium Dense
	2.5 – 2.9	Alluvial sand clay	15	Medium Dense
	4.0 -4.4	Alluvial Sand	19	Medium Dense
BH3	1.0 – 1.4	Alluvial clay	11	Medium Dense
	2.5 – 4.0	Alluvial clayey sand	14	Medium Dense
	4.0 – 4.4	Alluvial sandy clay	30	Dense
	5.5 – 6.6	Completely weathered claystone	Refusal	Very Dense

SPT testing and using the *N* value allows for classification of the soil / rock densities. All of which are classified as at least 'medium dense'. The completely weathered rock and alluvium generally classifies as 'medium dense' with the exception of completely weathered rock at 8.5m in BH1 and completely weathered claystone at 5.5m where refusal occurs, permitting classification as 'very dense' material.



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EAST LONDON

FIGURE 4.2:
BOREHOLE POSITIONS



Scale: Not to scale

Date: October 2011

5 LABORATORY TESTING

5.1 GENERAL

Point Load Strength Index (PLSI) tests were undertaken to determine the strength of the underlying rock. The PLSI results have been converted to a UCS equivalent value and from this a calculated assessment of estimated allowable safe bearing capacity (EASBP) made.

5.2 LABORATORY TEST RESULTS

Samples were taken from the borehole cores and tested in the laboratory. The results are shown in Table 5.2.1.

Results enable the slightly weathered Mudstone to be classified according to COLTO as R3 'Medium Hard Rock' which is in range of what is expected for Karoo Super-group sedimentary rocks. The completely weathered rock classifies as R1 'Very Soft Rock' and the highly weathered rock as R2 'Soft Rock'.

Table 5.2.1 Rock Core Strength (PLSI)

Sample No.	Borehole No.	Depth (m)	Material	PLSI (MPa)	Equiv UCS (MPa)	EASBP (kPa)
PL1	BH1	7.5	Completely weathered sandstone	0.03	0	36
PL2	BH2	14.4	Completely weathered sandstone	0.06	1	76
PL3	BH3	8.3	Completely weathered claystone	0.14	2	163
PL4	BH3	10.0	Completely weathered mudstone	0.21	2	247
PL5	BH3	14.8	Highly weathered fractured mudstone	0.05	1	63
PL6	BH3	18.2	Slightly weathered mudstone	1.73	21	1656
PL7	BH3	2.6	Moderately weathered mudstone	1.19	14	1425
PL8	BH3	22.0	Slightly weathered mudstone	1.49	18	1788
PL9	BH3	22.6	Moderately weathered mudstone	1.08	13	1297
PL10	BH3	24.7	Moderately weathered mudstone	0.74	9	888

Results from Table 5.2.1 shows very low strength values for all completely to highly weathered horizons while the moderately weathered mudstone intersected at depth has an Estimated Allowable Safe Bearing Pressure of 888kPa.

6 GEOTECHNICAL APPRAISAL

6.1 BUILDING FOUNDATIONS

The drilling investigation indicates a high degree of weathering of the rock horizons plus clay infill along joints, with competent rock only intersected in BH3 at 25m. The rock intersected has been tested using Point Load Strength Index (PLSI) tests and from these it is shown that the Estimated Allowable Safe Bearing Pressures (ESABP) are a minimum of 888kPa for the moderately weathered mudstone at deep depths below 20m.

Two possible options are recommended for the foundations of structures on this site:

Option 1

If Auger excavation is seen as viable then Augered Cast In-situ Piles could be used and would require socketing of 300mm into the underlying slightly weathered rock at depths of approximately 25m. Strength tests of the mudstone shows Point Load values of 0.74MPa, equivalent UCS values of 9MPa and EASBP of 888kPa at these depths.

Option 2

As the structure envisaged is an industrial building, most likely with a steel frame, piling down to 25m may be uneconomical. The other option is to use robust Stiffened or Cellular rafts with articulation joints and reinforced masonry. This foundation solution should accommodate the differential settlements that would be expected in unconsolidated horizons and completely weathered rock horizons.

6.2 EXCAVATABILITY

The relatively soft unconsolidated horizons will be easily excavated with TLB's or Excavators depending on the required machine reach limit and hence depth of excavation.

6.3 FLOORS

Two options are recommended if the piling option is pursued:

Option 1

- It is recommended suspended floors be used in conjunction with piles
- The reason for this is once floors are constructed they provide an impermeable capping preventing evaporation within the soil and thus causing a moisture buildup beneath the floors. This moisture can cause

heave within the underlying soil horizon and differential cracking of floor slabs and adjacent structures

- Suspending the floors will greatly minimize the possibility of cracking associated with differential settlement of alluvial horizons

Option 2

- To minimize the influence of heaving/collapsible soils the area below the floor slab should be excavated 1.5m into existing subsoil material
- Install a subsoil drain along the upper slope of the excavation
- The subsoil material must be scarified and compacted to 90 % MOD AASHTO at OMC
- Place a geofabric geogrid separation layer over the base and connect to subsoil drains. The geogrid should comprise of a product such as Maccaferri's FlexMesh or Rockgrid PC (Biaxial 100 kN/m) from Kaytech
- Introduce imported G7 material (preferably highly weathered dolerite); compact in maximum of 200mm layers each to 93% MOD AASHTO at OMC
- Include a second grid layer midway to strengthen the engineered fill. The fill should extend 2m to 3m beyond the building footprint to ensure adequate coverage
- Construct reinforced concrete floor slabs as a series of separate panels

Seepage can be expected at the base of excavations in alluvium with collapse making shoring or trimming of excavations to a stable slope mandatory.

6.4 DEVELOPMENT OPPORTUNITY

This site, if the EL IDZ intend considering its development, is unfortunately fraught with geotechnical problems.

- Sound foundations are deep in excess of 20m requiring expensive piling or raft foundations
- Unconsolidated materials may be highly compressible suggesting problems with collapse and/or differential settlement
- Clays within the soil profile are possibly active meaning that post-construction heave on wetting and shrinkage on drying could occur and would have to be accommodated by structural design

These geotechnical items will require due consideration should the EL IDZ consider purchase/development of these sites.

7 CONCLUSION

Drilling investigations intersected rock in all boreholes but due to the high degree of weathering indicates founding depths of 25m into slightly to moderately weathered rock will be required. This due to laboratory test results which show strength and bearing pressures that are particularly low up until a depth of 18.2m after which they begin to increase.

Two foundation recommendations have been described with the preferred method being 'Option 2' stiffened or cellular rafts with articulation and reinforced masonry to support the envisaged structure. 'Option 1' describes the less preferred Augered Cast In-situ Piled solution.

The relatively soft unconsolidated horizons will be easily excavated with TLB's or Excavators depending on the required machine reach limit and hence depth of excavation. Excavatability for services is therefore easy.

Two floor options have also been recommended to coincide with the foundation recommendations for the piling foundation option. The first option suggests suspended floors while the second an engineered fill below reinforced concrete floor slabs.

During construction seepage can be expected at the base of excavations in alluvium with collapse making shoring or trimming of excavations to a stable slope mandatory.

It is concluded that the site has relatively difficult geotechnical problems that need to be overcome should development of the sites be considered. These include compressible unconsolidated materials; potentially active clays; and very deep founding to below 20m or, alternatively costly reinforced raft foundations.

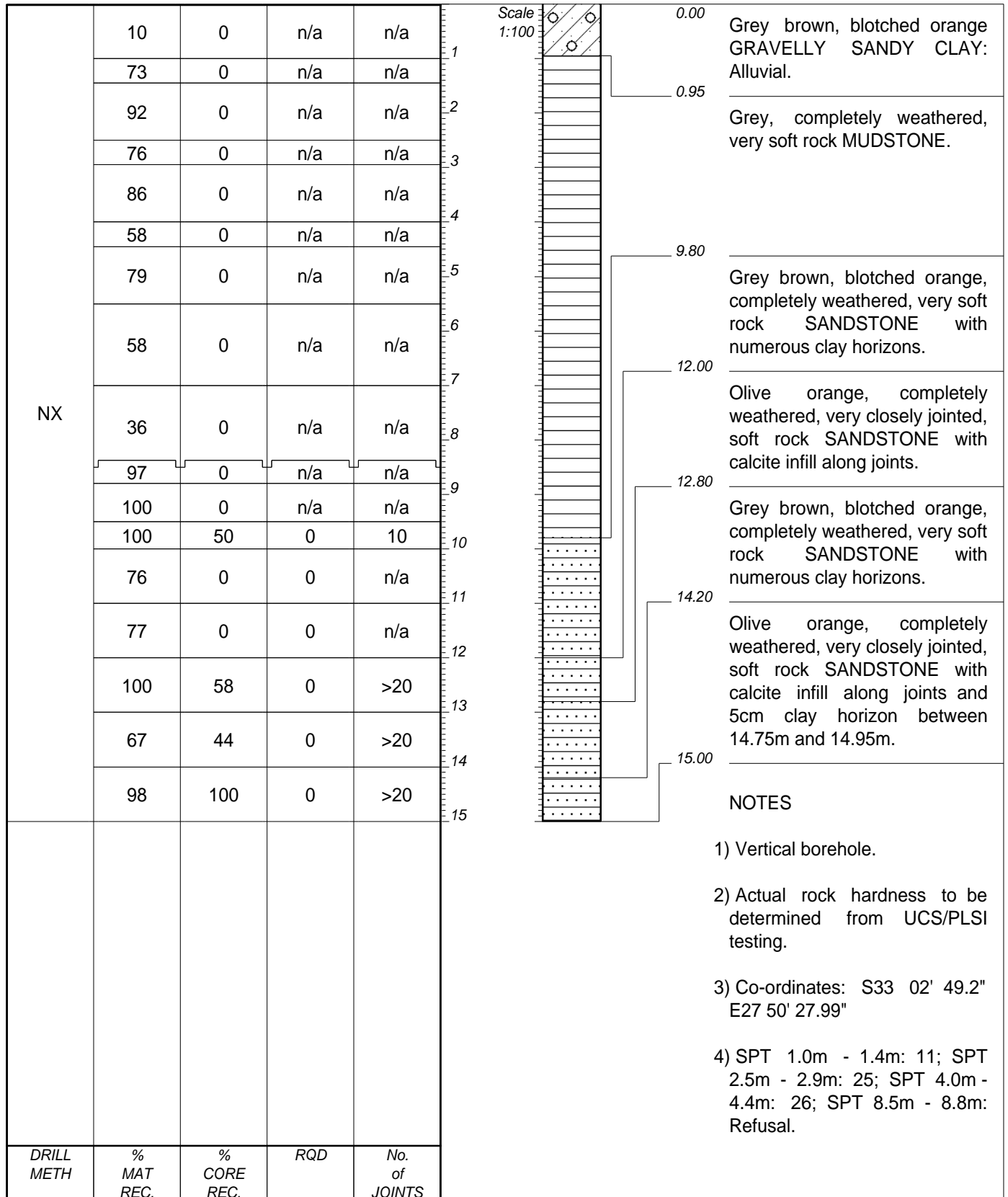
APPENDIX 1: BOREHOLE LOGS

APPENDIX 2: LABORATORY RESULTS

EL IDZ
SETTLERSWAY INDUSTRIAL BUILDING

HOLE No: BH1
Sheet 1 of 1

JOB NUMBER: GT343



CONTRACTOR :
MACHINE :
DRILLED BY : FAIRBROTHER GEOTECH
PROFILED BY : M JONES
TYPE SET BY :
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : NX
DATE : 26 SEPTEMBER 2011
DATE : 30 SEPTEMBER 2011
DATE : 03/11/11 13:45
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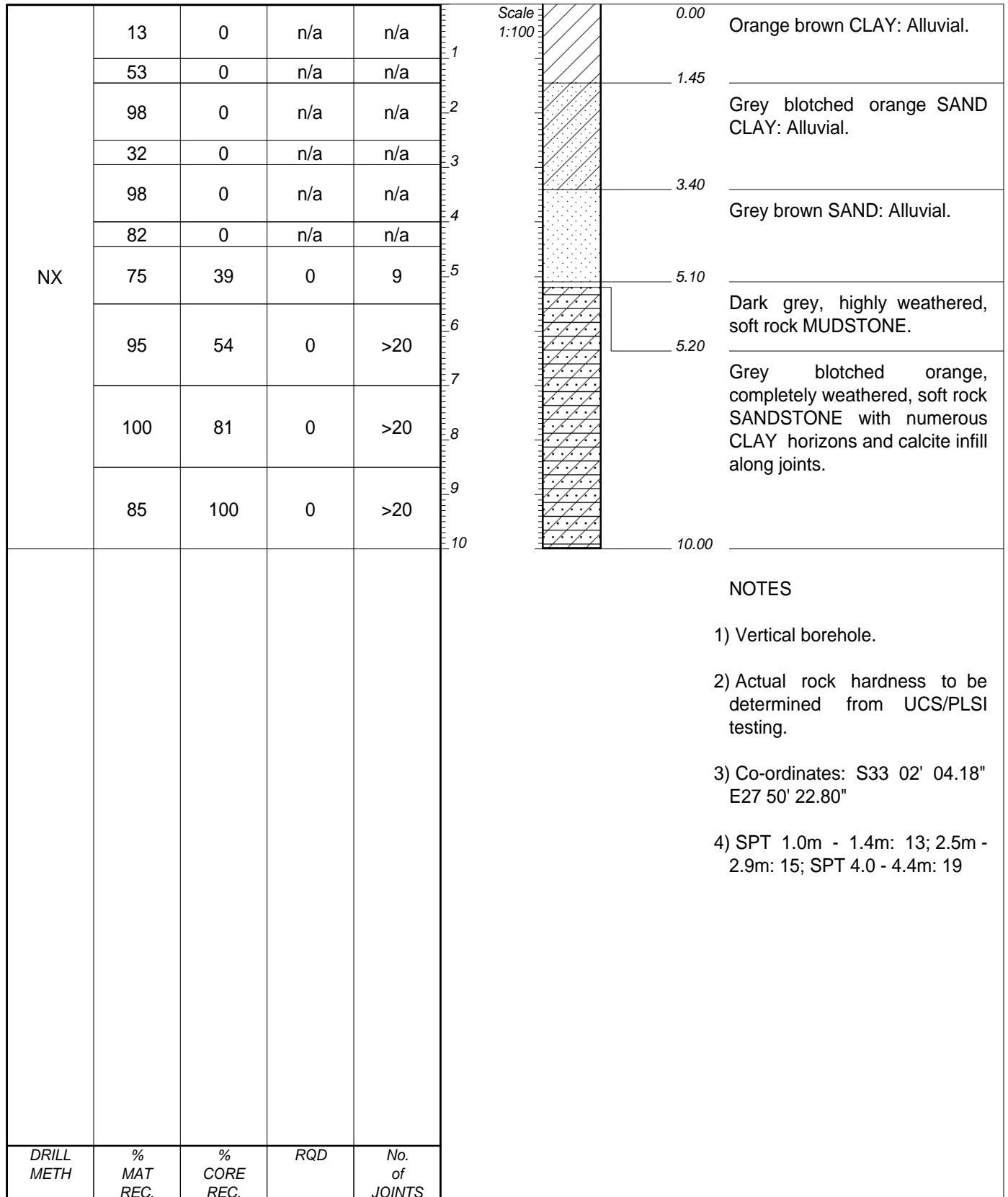
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: BH1

EL IDZ
SETTLERSWAY INDUSTRIAL BUILDING

HOLE No: BH2
Sheet 1 of 1

JOB NUMBER: GT343



CONTRACTOR :
MACHINE :
DRILLED BY : FAIRBROTHER GEOTECH
PROFIED BY : M JONES
TYPE SET BY :
SETUP FILE : STANDARD.SET

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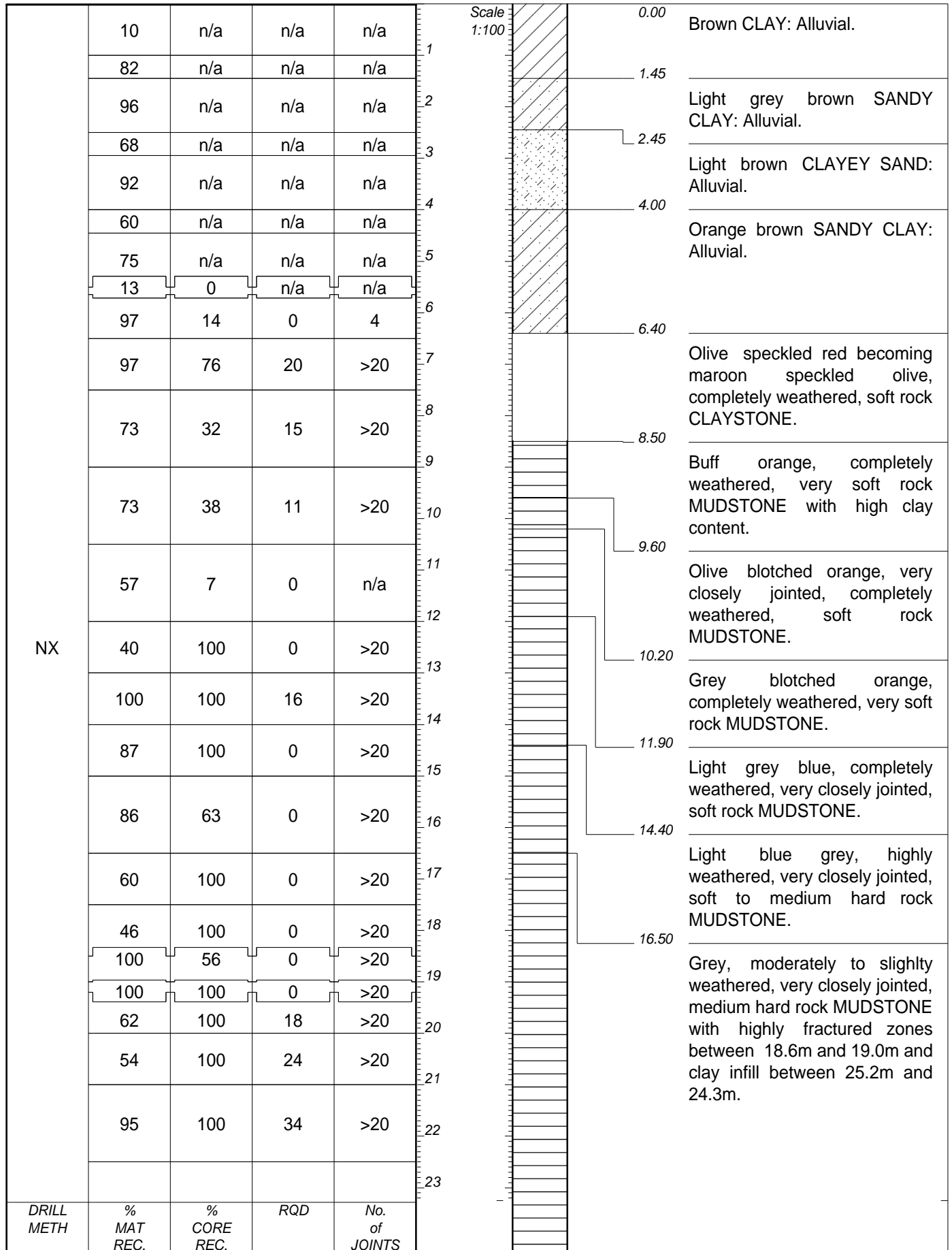
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: BH2

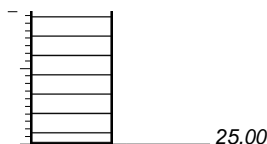
EL IDZ
SETTLERSWAY INDUSTRIAL BUILDING

HOLE No: BH3
Sheet 1 of 2

JOB NUMBER: GT343



HOLE No: BH3
Sheet 2 of 2

[illegible]

- 1) Vertical borehole.
- 2) Actual rock hardness to be determined from UCS/PLSI testing.
- 3) Co-ordinates: S33 02' 07.63" E27 50' 19.88"
- 4) SPT 1.0m - 1.4m: 11; SPT 2.5m - 4.0m: 14; SPT 4.0m - 4.4m: 30; SPT 5.5m - 6.6m: Refusal.

INCLINATION : Vertical
DIAM : NX
DATE : 26 SEPTEMBER 2011
DATE : 30 SEPTEMBER 2011
DATE : 03/11/11 13:46
TEXT : ..\BHLOGS~1\BH3.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: BH3



TERRECO
GEOTECHNICAL CC

**TERRECO GEOTECHNICAL
POINT LOAD STRENGTH TESTING**

PROJECT:	Settlersway Industrial Building	DATE: 12/10/2011
CLIENT:	East London IDZ	NO: 1

Borehole/ Trial Hole No.	Sample Number	Material	Pressure Orientation	Diameter (mm)	Pressure (kN)	PLSI (Mpa)	Mean PLSI (MPa)	Equiv UCS (MPa)	EASBP (kPa)
BH2	PL1	Completely Weathered	=	51	0.1	0.04	0.03	0	36
		Sandstone	↓	67	0.1	0.02			
BH1	PL2	Completely Weathered	=	48	0.2	0.09	0.06	1	76
		Sandstone	↓	50	0.1	0.04			
BH3	PL3	Completely Weathered	=	48	0.3	0.13	0.14	2	163
		Claystone	↓	46	0.3	0.14			
BH3	PL4	Completely Weathered	=	48	0.7	0.30	0.21	2	247
		Mudstone	↓	43	0.2	0.11			
BH3	PL5	Highly Weathered	=	53	0.1	0.04	0.05	1	63
		Fractured Mudstone	↓	38	0.1	0.07			
BH3	PL6	Slightly weathered	=	41	4.9	2.91	1.73	21	1656
		Mudstone	↓	41	0.9	0.54			
BH3	PL7	Moderately weathered	=	46	3.4	1.61	1.19	14	1425
		Mudstone	↓	51	2.0	0.77			
BH3	PL8	Slightly weathered	=	53	2.9	1.03	1.49	18	1788
		Mudstone	↓	43	3.6	1.95			
BH3	PL9	Moderately weathered	=	51	3.9	1.50	1.08	13	1297
		Mudstone	↓	65	2.8	0.66			
BH3	PL10	Moderately weathered	=	52	2.4	0.89	0.74	9	888
		Mudstone	↓	65	2.5	0.59			
			=						
			↓						
			=						
			↓						

SIGNED: _____