SCG INTERNATIONAL TRINIDAD AND TOBAGO LIMITED

COUVA CHILDREN'S HOSPITAL

COUVA, TRINIDAD

GEOTECHNICAL INVESTIGATION REPORT

CONSULTANT

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1. INTRODUCTION

1.1. *Project Description and Location*

Shanghai Construction Group (SCG) International Trinidad and Tobago Limited in conjunction with their Design Consultant HKS Engineering (HKS Reference Project No.: 15117.000) has commissioned a detailed Geotechnical Investigation at the site of the proposed Couva Children's Hospital located in Couva, Trinidad. Figure 1.1-1.3.

1.2. *Project Development and Infrastructure*

The site which is presently used for agricultural purposes (Figure 1.3) is divided into three (3) phases as presented in Figure 1.4. The site investigation is focussed on Phase I (Figure 1.4) which includes the Main Hospital with accompanying parking facilities, CEP Building and Training Centre. Phases II-III which are to be completed at a later date will see the construction of a Hotel and Residential Area respectively.

The general project description for Phase I as provided by HKS is outlined as follows:

Hospital: Overall size approximately 25,500 sq. m, consisting of 2 bed towers and a D&T building.

- **Bed Towers**: 4-story structures (includes Lower Level). A Lower Level will occur below each Tower footprint which is currently planned for parking. The Lower Level elevation has been preliminarily established at EL. 48.50m.
- **D&T Building**: 2-story structure predominantly beginning at Level 1 with some areas of the building having a Lower Level, thereby 3 story. Preliminarily, the Lower Level and Level 1 floor elevations are anticipated as EL. 48.50m and 53.00m respectively.

Supplemental Structures:

- **Training Facility** – 2-story structure beginning at Level 1. Overall size approximately 8,800 sq. m. Preliminary Level 1 elevation has been established at EL. 54.00m. A full crawl space is anticipated below Level 1.
- **Central Plant** – 1-story structure beginning at Level 1 to house major mechanical/electrical equipment, approximately 1,000 sq. m, with Level 1 elevation preliminarily established at EL. 54.00m. A full crawl space is anticipated below Level 1.

1.3. *Structural Framing and Preliminary Loading*

The structural framing system for the various structures is anticipated to be cast-in-place concrete. The exterior façade is not finalized; however, we anticipate a combination of precast concrete, stucco over block wall back-up, and glass/glazing.

Based on the preliminary geotechnical assessment, we anticipate having crawl spaces below each of the buildings ground level floors.

Maximum column service loads are estimated as follows:

- Bed Towers: 3560 – 3783 kN range (800 -850 kips)
- D&T: 2225 – 2893 kN range (500 – 650 kips)
- Training Facility: 2003 – 2225 kN range (450 - 500 kips)
- Central Plant: 1780 - 2003 kN range (400 – 450 kips)

1.4. *Geotechnical Scope of Services (HKS)*

The number of borings proposed by HKS makes the assumption that sufficient information can be obtained about subsurface conditions at the site for geotechnical recommendations to be developed. The geotechnical investigation and subsequent report should address the following information and recommendations. Additionally, the geotechnical engineer should include any other recommendations or information applicable to this project based upon his experience and knowledge of subsurface conditions in the area:

1. **Test Boring Results**

- Plan showing the location of test borings
- Logs of test borings
- Information regarding ground water conditions
- Estimate of seasonal high ground water conditions

2. **Building Foundation Design**

  - Recommendations for foundation type(s), including the expected bearing stratum and allowable design values for bearing and skin friction, if applicable. Include uplift resistance values.
  - Estimated total and differential settlement of foundations designed in accordance with the recommendations. Recommendations for slab-on-grade construction (if

considered applicable), including any sub-grade preparation required to limit slab movements to ½" (max) and also to 1 inch (max). Please specifically address the potential for utilizing slab-on-grade construction below the Bed Towers if utilized solely for parking. Is this a viable alternative?

- Recommendations for drainage below Level 1 and/or Lower Level slabs-on-grade, if required, and if the use of slab-on-grade construction is feasible
- Recommendations for drainage within crawl space areas
- Minimum depth of foundations
- Requirements for corrosion protection of underground metal and structures. Indicate if sulphate-resistant cement will be required for below-grade concrete work.
- Recommendations for coefficient of friction and passive earth pressure to be used in resisting horizontal loads

3. **Basement and Retaining Wall Design**

- Horizontal earth pressure values to be used in the design of below grade building walls and/or cantilevered retaining walls (active and passive)
- Backfill and drainage requirements, if any, related to given horizontal earth pressures
- Determination of the seismic increment for active pressure on building walls and retaining walls

4. **Seismic Design Information**

- Information about the site and discussion with respect to seismic activity
- Site classification per section 11.4.2 and chapter 20 of ASCE 7-05. (If improvement to the Site Class is deemed possible by specialized supplemental testing, eg..pressuremeter, or other, include a discussion on this aspect and a corresponding additional line item fee.)
- Geologic hazards required to be addressed by ASCE 7-05 in Section 11.8 for Seismic Design Categories C through F and/or D through F as applicable, including, but not limited to, slope instability, liquefaction, seismic total/differential settlement, and surface displacement due to faulting or seismically induced lateral spreading/flow. Based on the preliminary geotechnical information previously provided, we anticipate Seismic Design Category D
- If any geologic hazards are found provide recommendations for ground modification or foundation type mediation for the building foundations and floor slabs.

5. Other Recommendations

- Required sub-grade preparation below parking and drive areas
- Discussion of conditions that will be encountered during foundation excavations and building pad preparation, such as ability to excavate with conventional equipment, dewatering, allowable embankment slopes, temporary bracing requirements, etc.

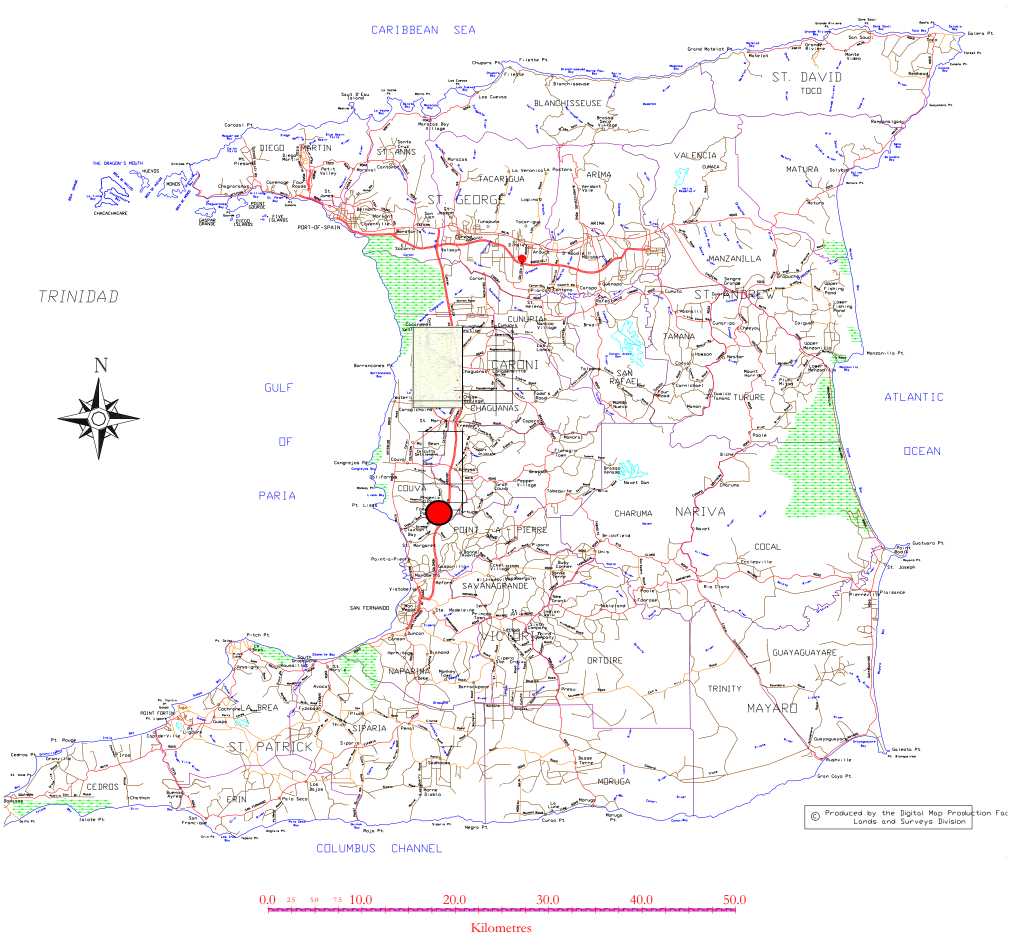


FIGURE. 1.1 - COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – SITE LOCATION TRINIDAD ROAD MAP (LAND & SURVEYS DIVISION).

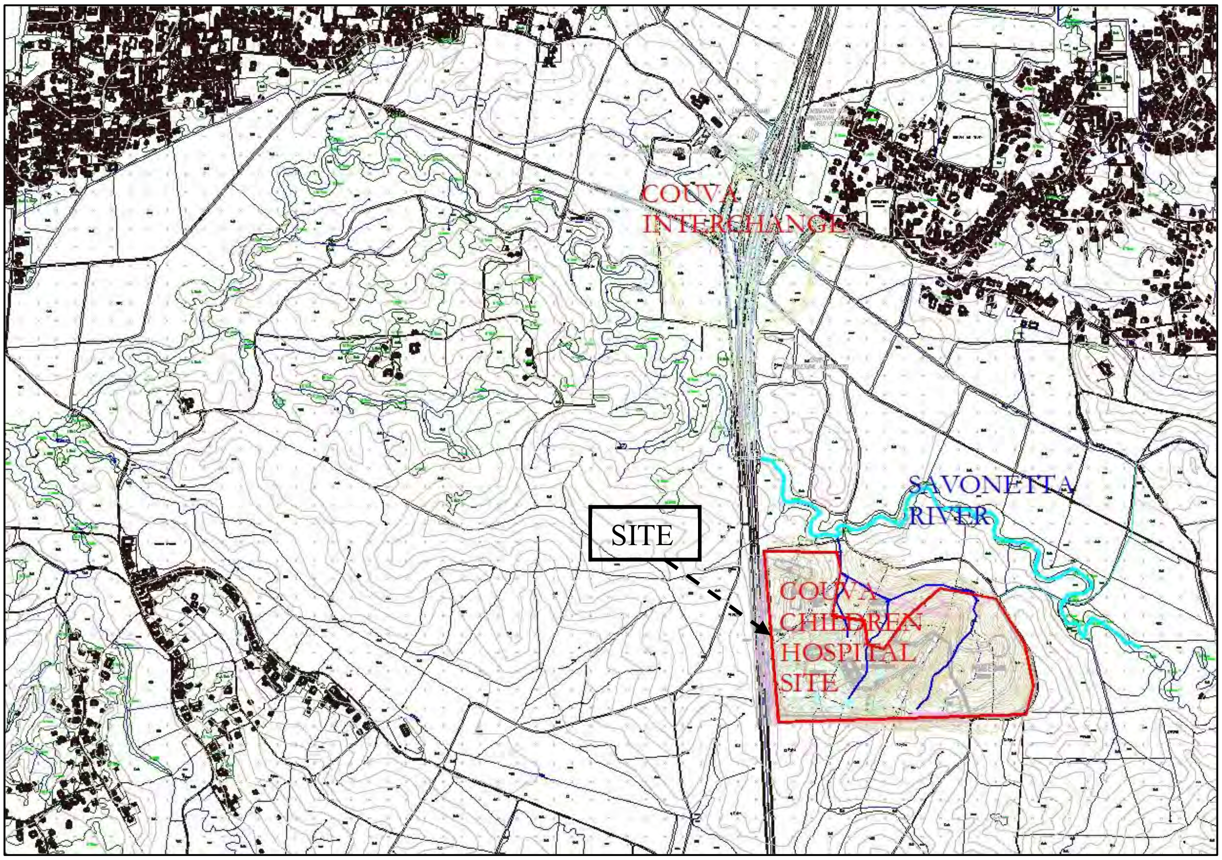


FIGURE. 1.2 - COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD –SITE LOCATION, TRINIDAD TOPOGRAPHIC MAP. ((LAND & SURVEYS DIVISION).

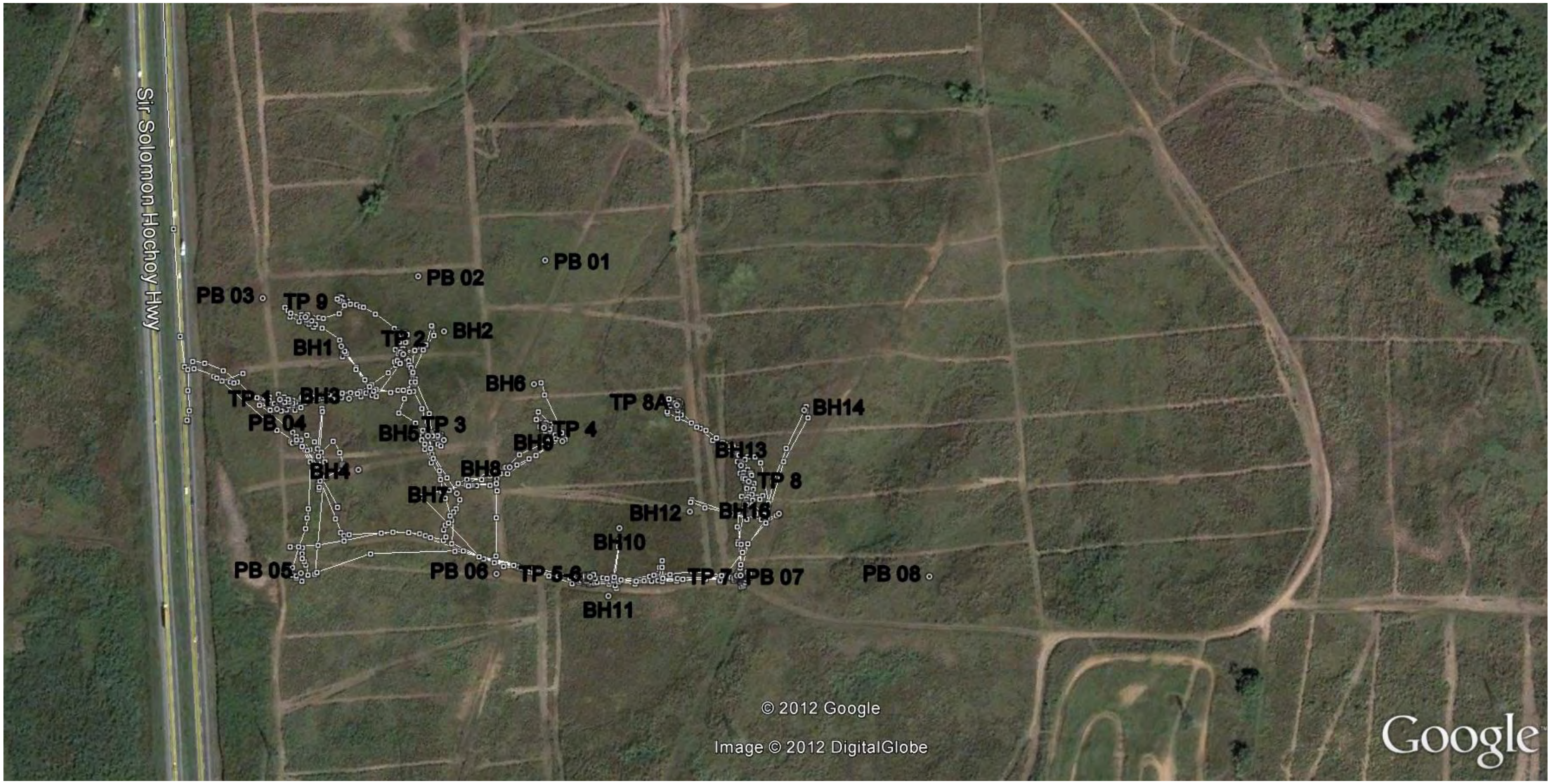


FIGURE. 1.3 - COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD –SITE LOCATION, GOOGLE AERIAL 2005

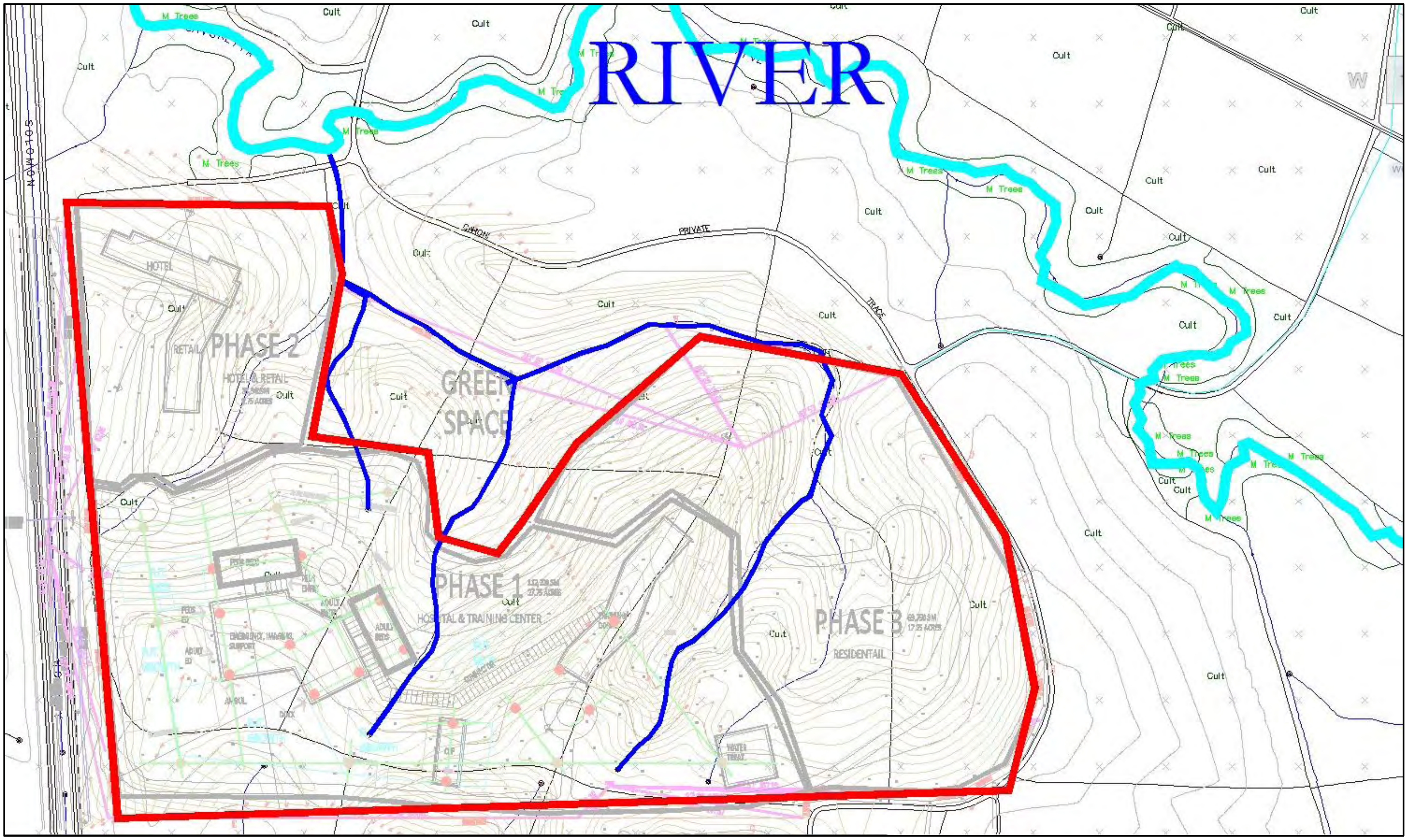


FIGURE. 1.4 - COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – PROPOSED LAYOUT OF ALL THREE PHASES – **HKS 20120627**

2. GEOTECHNICAL SERVICES AND USE OF REPORT

2.1. *Report Structure and Scope of Geotechnical Services*

After careful review of the design requirements outlined by HKS coupled with our initial walk over survey and site reconnaissance, it is the purpose of this investigation to determine the soil and ground water conditions at the site based on the proposed site development plan provided.

As presented in Figure 2.1 a total of fifteen (15) borings, nine (9) test-pits and numerous Dynamic Cone Penetrometer (DCPs) tests were carried out at the site. The objective of this report therefore is to present the findings of the investigation and the geotechnical design parameters and recommendations for the proposed development.

The structure of the report will be discussed as follows;

- Desktop studies using existing information i.e. maps, photographs, reports etc.
- Site Reconnaissance and Walk Over Surveys
- Detailed Topographical Survey
- Detailed Field Investigation which includes fifteen (15) boreholes and approximately nine (9) test pits
- Laboratory Testing Programme
- Preliminary Geotechnical Engineering Analyses

2.2. *Use of Report*

This report has been prepared for the exclusive use of SCG International Trinidad and Tobago Limited and their sub-consultants. This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of Earth Investigation Systems Limited (EISL) being obtained.

EISL accepts no responsibility or liability for the consequences of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify EISL for all loss or damage resulting therefrom. EISL accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

3. SITE CHARACTERISATION AND FIELD OBSERVATIONS

3.1. *Geology*

3.1.1. Structural Geology

Unlike most islands of the Lesser Antilles, Trinidad is of sedimentary origin, rather than volcanic composition. The island lies within a 200 km wide tectonic plate boundary zone, between the Caribbean Plate and the South American Plate (Burke, 1988). This tectonic zone has a predominantly right lateral strike slip character, as the Caribbean Plate pushes to the east, past the South American continent. The area has been tectonically active for the last 30 million years (Oligocene to present) and has a complex geologic history.

Trinidad consists of three up-thrust ranges of mountains and hills, separated by two deep sedimentary basins. Metamorphic rocks of the Northern Range transition abruptly southwards across the El Pilar – Arima Fault Zone (PAFZ) to undeformed, essentially flat lying, Holocene and Pleistocene alluvial and marginal marine sediments of the Northern Basin.

The Northern Basin is a late Miocene – Pleistocene extensional feature with 7000 – 9000 ft of sedimentary fill resting on highly indurated Lower Cretaceous basement. The Guatapajaro – Guico Anticline forms an east-west drainage divide, upon either side of which runoff derived from the south and north, drains into east-west trending transverse river systems along the basin axis (Figure 3.1).

The Couva Hospital Site is located within the south western foothills of the Central Range.

South of the Central Range highlands lies the Naparima Fault Belt and the Central Trinidad Fault Zone (CTFZ). The latter is a dominantly right lateral wrench fault system with both transpressional and transtensional components. The Naparima Fault Belt is tectonically active but remains topographically low because of the soft nature of the sediments presently being uplifted.

To the south is the Southern Basin, a deep Cretaceous – Tertiary sedimentary basin and prolific hydrocarbon province. The Southern Basin is bounded along the south coast by the South Trinidad Fault Zone (STFZ), an active right lateral wrench system. Bedding along the eastern south coast is vertical and the Southern Range is really a series of low sand-prone ridges, erosionally delineated from up-thrust sands and clays. The pervasive compressional deformation between the CTFZ and the STFZ has resulted in uneven hilly terrain with a series of northeast trending thrust anticlines, adjacent to similarly trending, large synclines. The former structures, such as the Rock Dome Anticline (Figure 3.1), are composed of clay rich, deep marine, lower and middle Tertiary sediments that were deposited in a foreland basin trough.

3.1.2. Structure/Seismicity

Structure in the context of Geology (Structural Geology) refers to the crustal formations of the earth on a scale of tens to hundreds of kilometres. Here we include the study of the location and activity of geological faults, as they are likely to influence and define the seismology and stability of slopes in the area (Figure 3.1-3.2).

Seismological phenomena shall be studied in the context of developing appropriate earthquake loading parameters. In the early 1980's the Ministry of Works adopted the then Earthquake Zone system where Trinidad and Tobago was placed in Zone 3 as defined in the SEAOC code at that time. Practitioners in Trinidad and Tobago typically followed this methodology up to about 2000 through the Uniform Building Code. This method was to be replaced by the International Building Code (latest version IBC 2009), in which the ground accelerations are defined at a 2% probability of exceedance in 50 years (2500 year return period). This methodology represents a significant deviation from previous practice, as it demands a different set of frequency dependent ground parameters to be developed. In the design of the proposed building infrastructure and slopes the methods outlined in the IBC 2009 should be adopted.

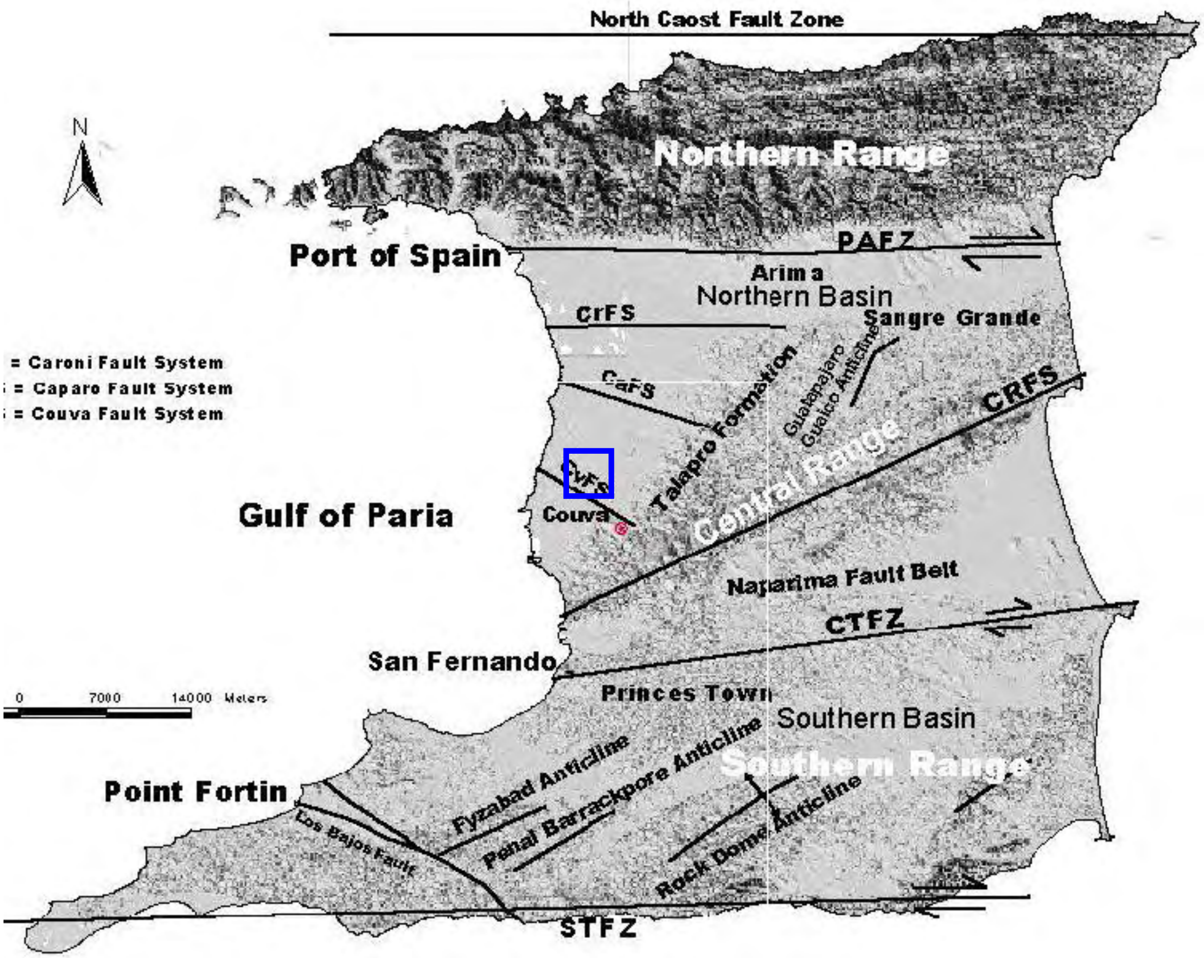


Figure 3.1 COUVA CHILDREN'S HOSPITAL, COUVA, located over Geomorphology Map of Trinidad (de Verteuil et al. 2001).

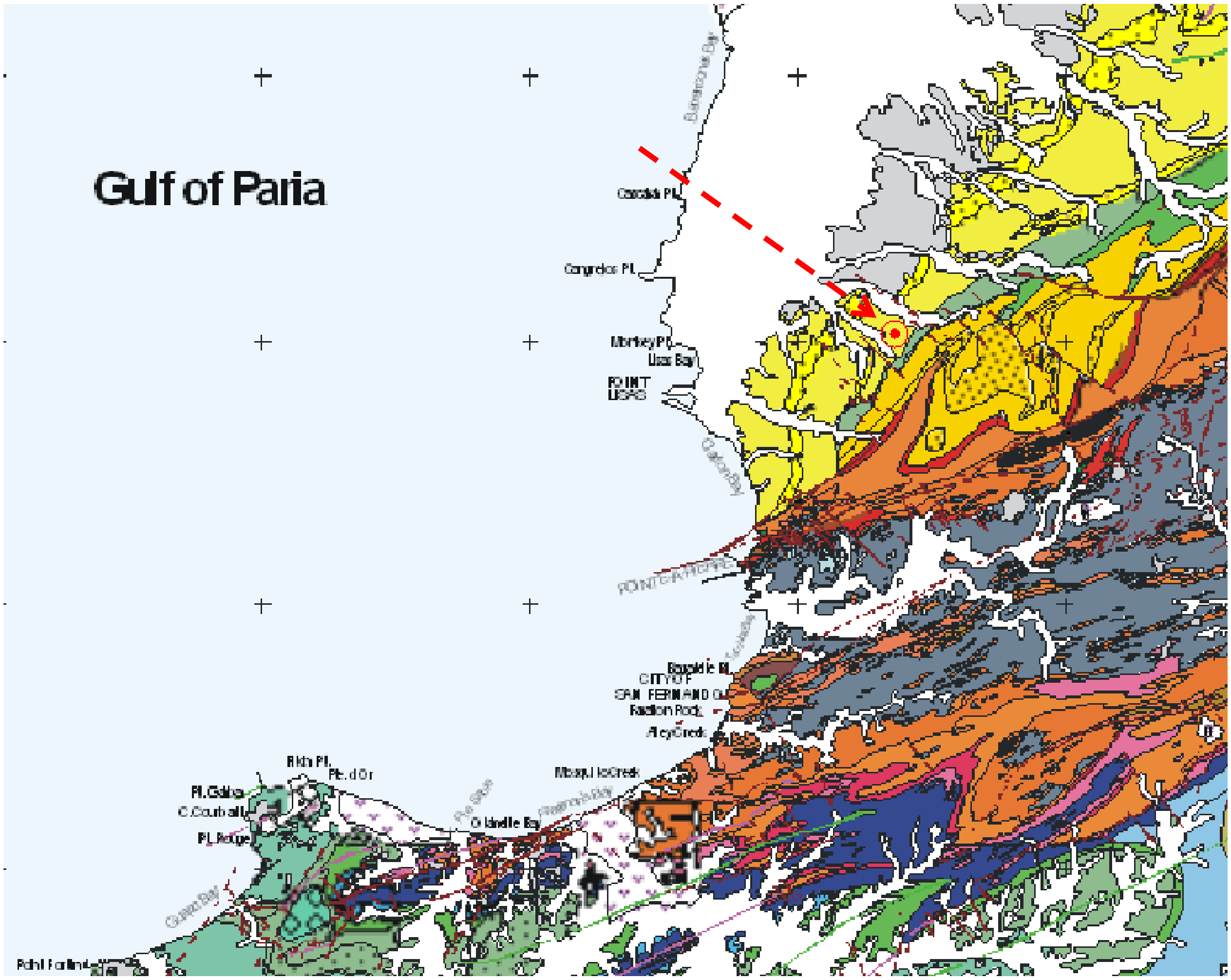


Figure 3.2 COUVA CHILDREN'S HOSPITAL, COUVA, Site located over Structural Geology Map of Trinidad (de Verteuil et al. 2001)

3.2. *Hydrogeology*

The hydrogeological map of Trinidad (Water Resources Agency, 1989) indicates that the Naparima Peneplains region comprise "strata with local and limited groundwater resources or strata with essentially no groundwater resources". This is significant insofar as fully developed deep artesian systems are not likely in this area. However, shallow bedded alluvial sands, recharged by surface and perched water table systems can give rise to unusual pore water pressure development with the near surface (5-6 m depths).

3.3. *Topography and Drainage*

The site is located within the North West foothills of the Central Range where topography is primarily described as rolling hills which are predominated by over-consolidated clays. Significant variations in elevation can be expected, as much as 20.0 m where elevations range between +56.0 MSL to +36.0 MSL, Figure 3.3.

Several natural water courses originate from the site which flow to the north basin into the Savonetta River system which meanders and outfalls in the Gulf of Paria along the west coast of Trinidad.

Surface flows are also considered significant given the observed erosion channels as presented in Figure 3.4. Generally the drainage at the site tends to follow the existing topography.

As previously discussed the site is present used for agricultural purposes and as such several ponds were observed over the site. These ponds were excavated by Farmers for crop irrigation however this could lead to saturation of the surface given the proximity of the slopes.

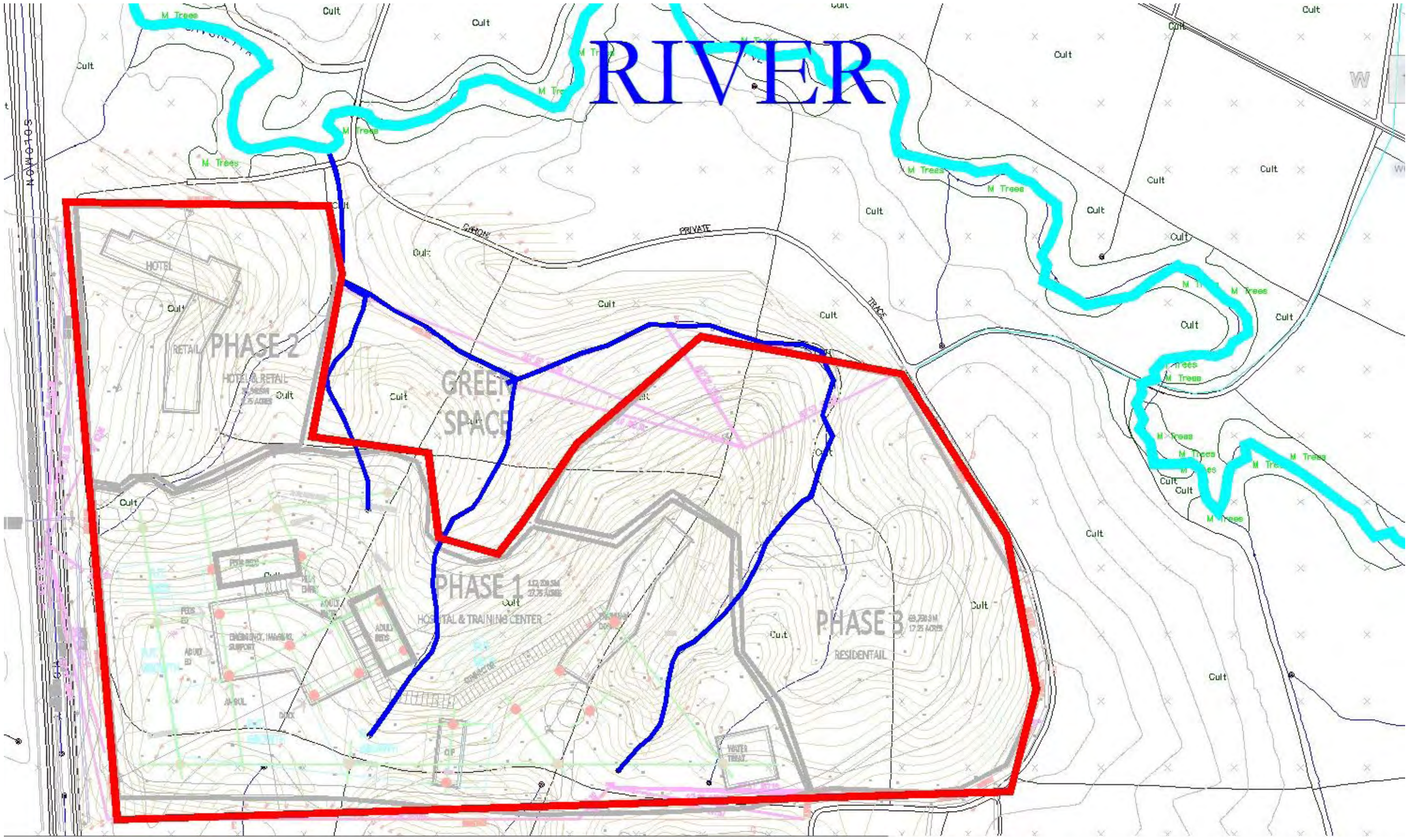


FIGURE 3.3 COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – EXISTING TOPOGRAPHY AND DRAINAGE

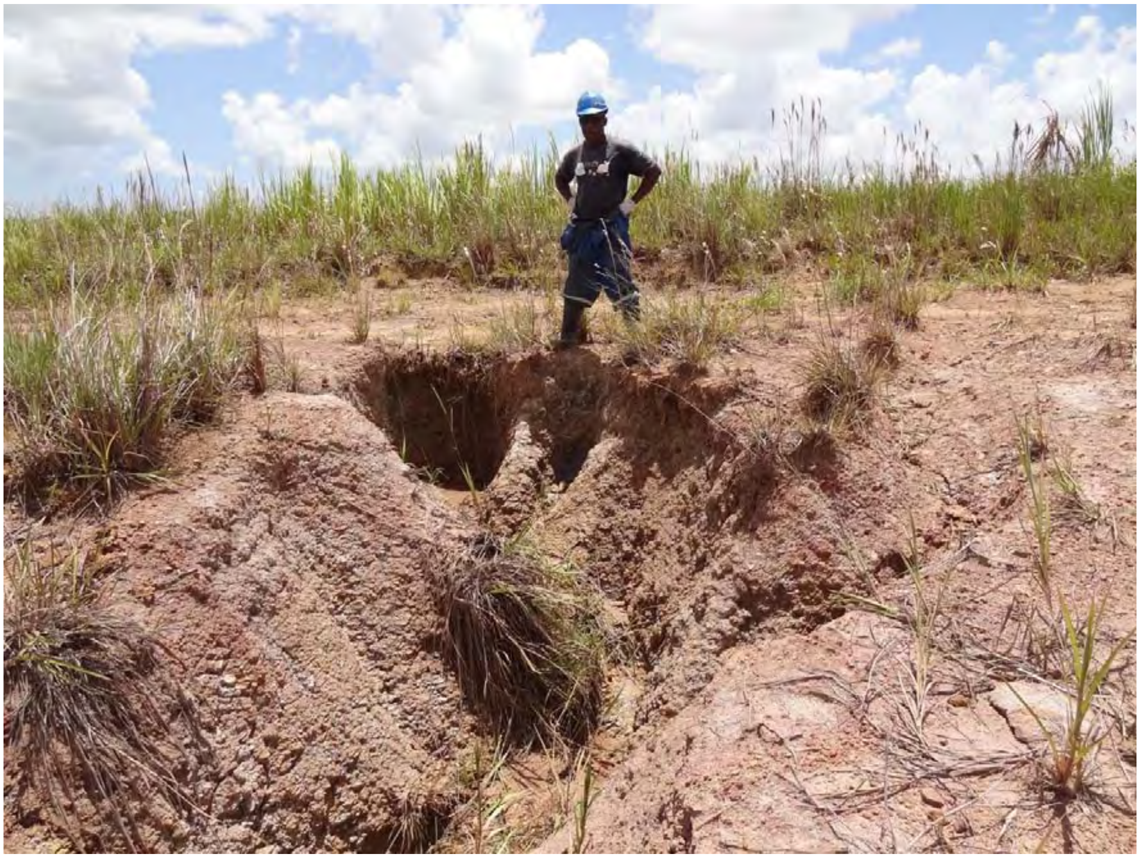


FIGURE 3.4 COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – EROSION CHANNEL CAUSED BY SURFACE FLOWS.

FIGURE 3.5 COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – TYPICAL PONDS DUG BY FARMERS FOR IRRIGATION OF CROPS

3.4. *Climate*

Climate plays an important role in the context of soil behaviour in highly over-consolidated clay soils. Both volume change potential and slope stability are directly influenced by rainfall and evapotranspiration. Many researchers have demonstrated the influence of these parameters on stability in these soil environments (ASCE 1989, Nelson and Miller 1992, Ramana 1993, Gay 1994). The mean annual rainfall expected at the site is 1700 mm with a mark dry season of 2-3 months.

The Thornthwaite Moisture Index (TMI) is perhaps the simplest moisture balance parameter that can be used in the study of volume change potential. In conjunction with soil plasticity and classification parameters we shall use this parameter in the determination of the expansive potential of soils. The climatic data to determine the TMI is available through the Water Resources Agency.

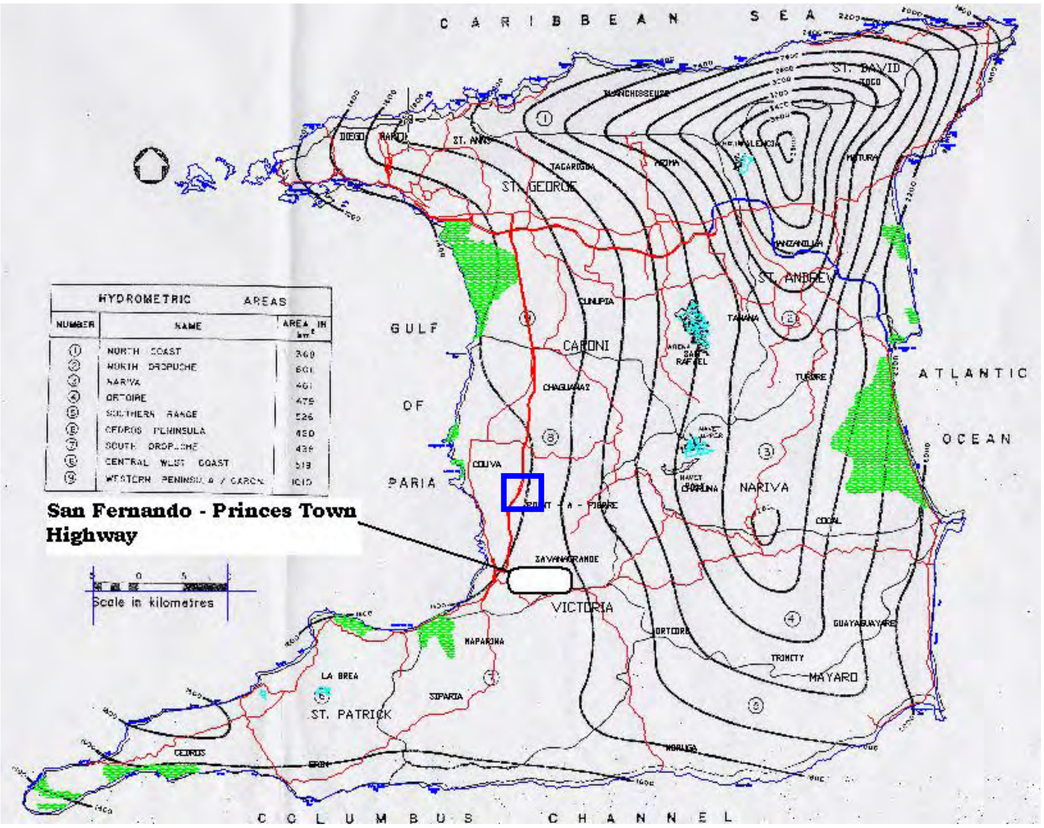
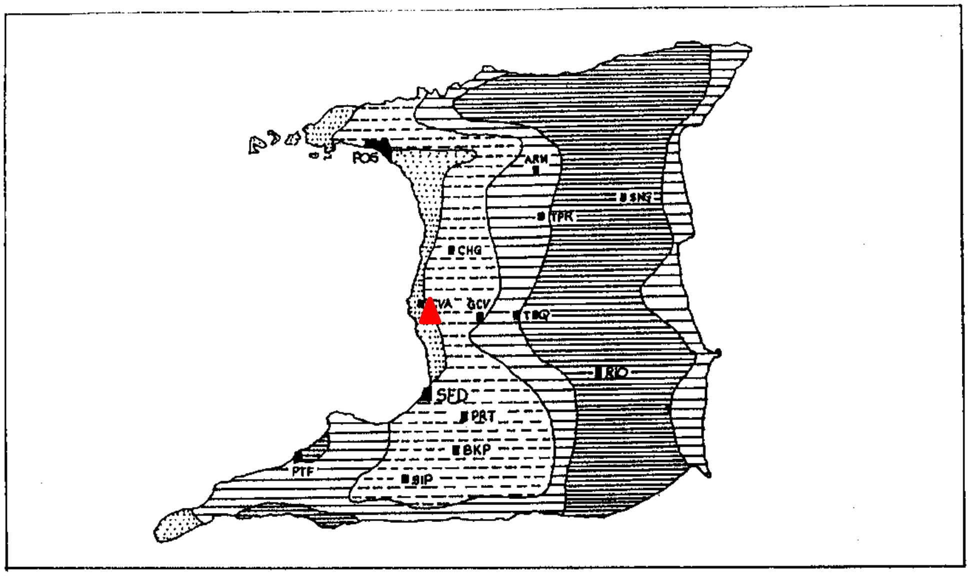


Figure 3.6 Mean Annual Rainfall distribution over Trinidad (Water Resources Agency).



Legend	Climate Soil humidity	Moisture Index	Equilibrium Suction (pF)	Active Depth (m)	Moisture regime Heave condition
▤	Humid Continuously moist (no dry months)	40	2	1-2	1*mostly unaffected 2*significant 3*edge lift dominant
☰	Humid Weak dry season (1 month)	20-40	2-2.5	1-2	1.small 2.present 3.edge lift
┅	Moist subhumid Marked dry season (2-3 months)	10-20	2.5-3.0	2-3	1.small 2.present 3.edge lift
⁙	Moist subhumid Intense dry season (4-6 months)	0-10	3.0-3.5	3-4	1.central moisture accumulation 2.small 3.centre lift if water table is deep.

1* soil moisture variation between the edge and centre of covered areas
2* effect of cyclic moisture change around the edge
3* possible heave pattern

NOTE: Moisture index values are approximate and can vary 10-20 units from year to year

Dry period : Monthly rainfall 50-100mm or less. Evaporation exceeds rainfall.

Wet period : Monthly rainfall 100mm or more. Rainfall exceeds evaporation.

Figure 3.7 Distribution of Thornthwaithe Moisture Index (TMI) over Trinidad (Ramana 1993).

3.5. *Vegetation*

Much of the natural vegetation of the site comprises grass and shrubs varying between 3-5 feet in height. These grasses are significant in that they can develop significant suction pressures in these expansive clays invoking shrink-swell behaviour.

Figure 3.8 Vegetation within the proposed Site (Looking north from PB 4 towards PB 3)

Figure 3.9 Vegetation within the proposed Site (Looking south and upslope from BB10)

3.6. *Soils*

The site has been located on the Agricultural Soils and Land Capability Survey maps of Trinidad and Tobago Figure 3.10 (The Ministry of Agriculture and UWI, 1972), which provide an excellent basis for the identification, and classification of soils for engineering purposes. In these, soils are categorised in respect of their lithological and geomorphological characteristics that can typically be related to soil properties (plasticity, activity, and expansive potential) and expected field characteristics (slope instability and erosion potential).

These maps can be typically used in the classification of at grade soil types, particularly when their agricultural soil classifications are converted to their equivalent engineering basis through the methodology of the FAO (Olson, 1973). Venkataramana (1993) also provides a useful starting point for the engineering classification of Trinidad soils.

The soil types are summarized in Table 3.1.

- The **C2 – 177D2 Talparo Clay**, which make up the majority of the area can be classified as soils of high plasticity, which are well known for their instability on slopes and relatively high activity and expansive potential. These soils are then expected to pose problems associated with low CBR (bearing capacity) values and our finds suggest significant saturation to approximately 2.0 m in some areas.

- The soils map indicates an outcrop of soil type **C1-261 D2 Arena Sand** within the boundary of the site. This data observed from the mapping is consistent with our findings from the test pit investigation as observed in Test pit number TP06-05.

Table 3.1 SOILS: COUVA CHILDREN'S HOSPITAL, COUVA

Soil Group	Geological Formation		Classification		Lithology	(%) clay	Plasticity Index (%)	Residual Friction Angle	Volume Change Potential
			Textural - Slope & Erosion Category	**Unified**					
C1	Cedros	Soils of the intermediate uplands with free internal drainage	261 D2 Arena sand	SC-SM	Sand	~ 0.0 – 30.0			
C2	Cedros	Soils of the intermediate uplands with restricted internal drainage	**177 D2 Talparo clay**	CH	Clay shale	~60.0	~50.0	7.0	High

Slope Categories: A 0-2^{O}
B 2-5^{O}
C 5-10
D 10-20
E 20-30, F > 30

Erosion Categories: 0 - No apparent Erosion
1 - Slight < 10% of topsoil lost
2 - Moderate > 10% of topsoil lost
3 - Severe all topsoil lost

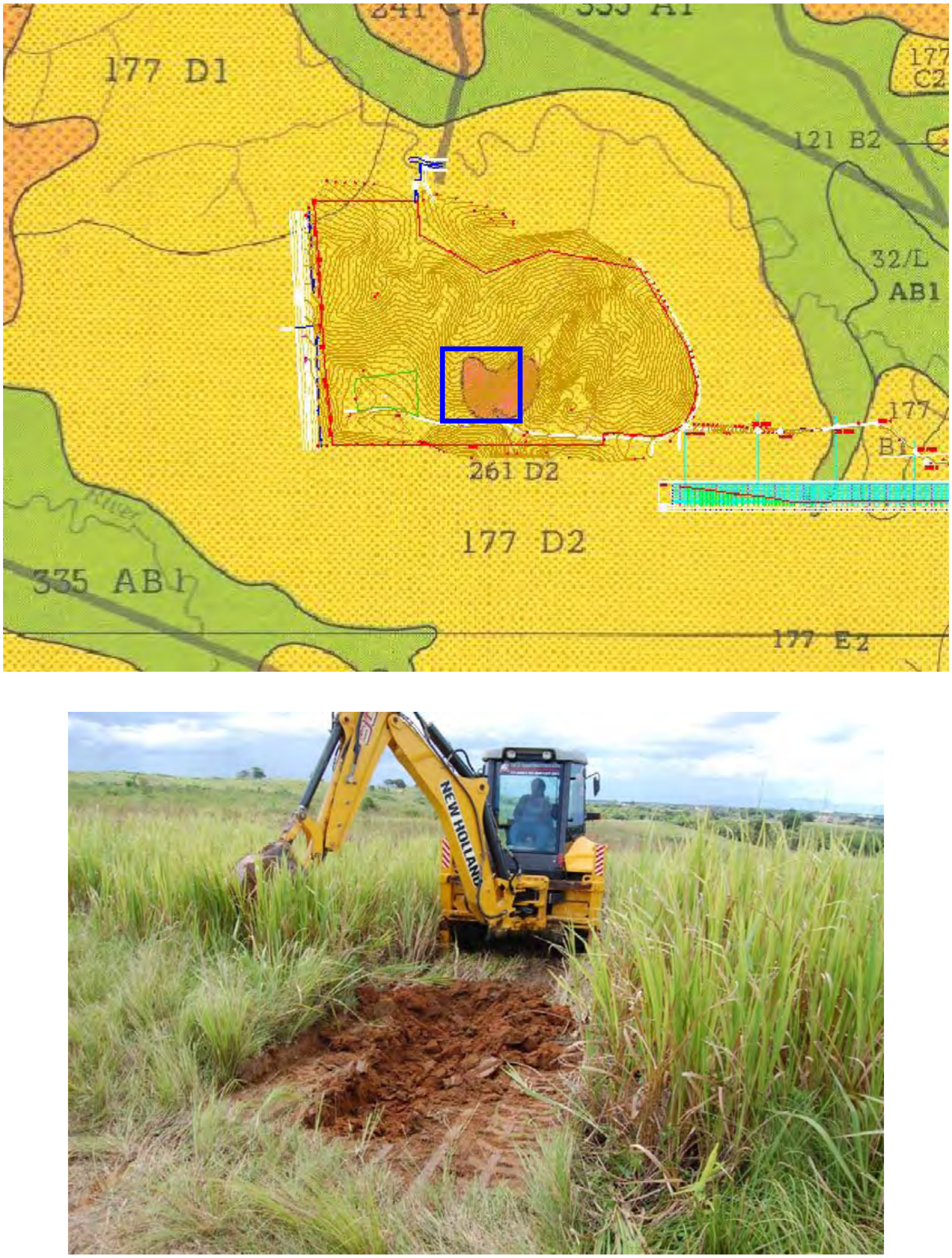


Figure 3.10 COUVA CHILDREN'S HOSPITAL, Couva. Site Location on Trinidad soil Map, Lands and Surveys Division, Note localized outcrop of Soil Type 261 Arena Sand.

3.7. *Geomorphology Features of Peneplians and Landslide Occurance*

This project is located in a geomorphologic region known as the Naparima Peneplain (Beaven, 1964), where the elevation of the ridges is remarkably constant, falling from 60 m in the east to 30 m in the west where the ridge top is narrow, or the slopes over-steep, this can result in landslips toward the water courses.

Water courses have cut into the old over-consolidated uplifted (tectonic uplift) surfaces and the valleys have been widened by the slipping of the clay into the valley bottoms. At the beginning of the wet season, water can penetrate the soil along cracks, which develop in the dry season. If the slope is long, and especially if it is a dip slope, the wet clay - dry clay shale contact will be lubricated to such an extent that the wet mass would slide over a large concave area. Landslip adjustment in this area produces a mature slope of about 14º. Slopes from adjacent valleys now intersect in narrow ridges, which are often used in the location of roads.

During a detailed survey of part of the Central Range, Havord was able to distinguish a "landslip phase" of two soil series developed in clay soils where the slope was greater than 10º. In considering the stability of natural slopes in London clay, Skempton has calculated that the critical slope is 9 3/4º when the ground water level is at the surface, although, where the depth to the water table is a quarter of the depth to the slip plane, then the critical angle is increased to 12 ½º. In an assessment of grass covered slopes the maximum stable slope was 10 ½º.
Beaven (1964) suggests that saturated soils in this region on slopes greater than 10º are liable to erosion, landslip and soil creep.

This is consistent with the observations of this site and is consistent based on experiences from previous projects in these terrains as illustrated in Figure 3.11.

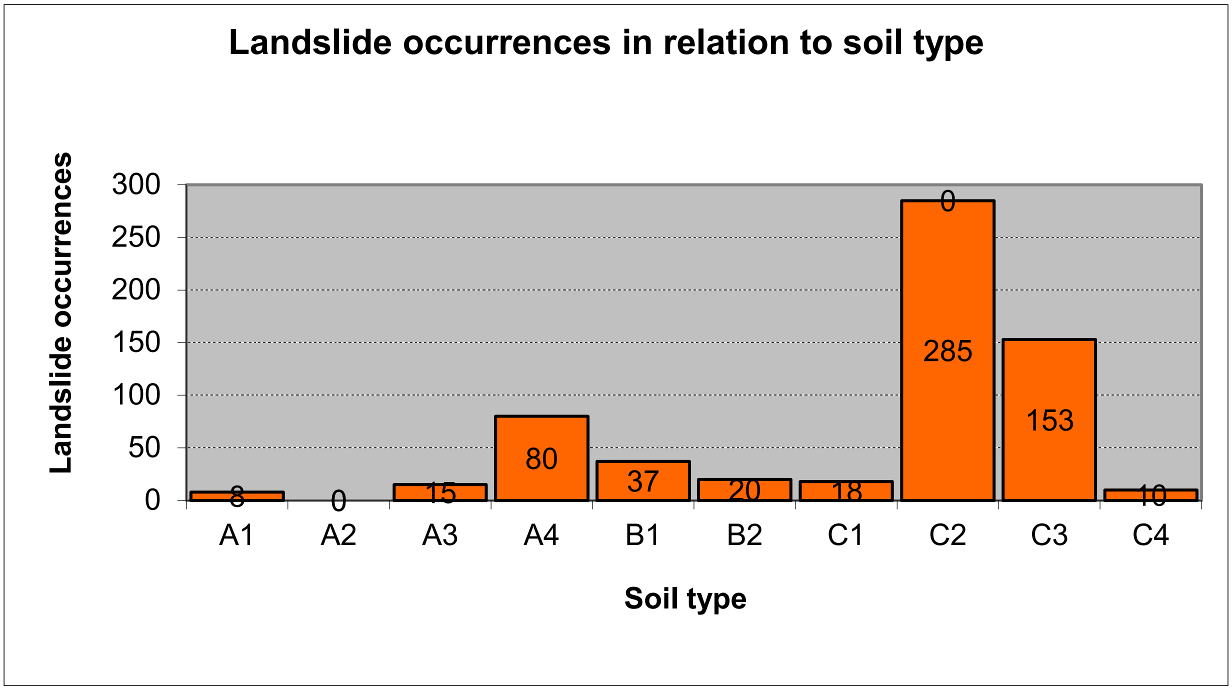


Figure 3.11 Landslide occurrence in relation to Soil Series Type, Central & Southern Range Trinidad (Gay 2004)

4. GEOTECHNICAL FIELD INVESTIGATION SUMMARY

4.1. *Borehole Investigation*

In general, the complementary site investigation included:

- Mechanical Boreholes
- Standard Penetration Tests
- Trial Pits
- Sieve analyses
- Atterberg Limits
- Dynamic Cone Penetrometer tests –PB1-7
- Direct shear tests
- Proctor compaction and CBR tests

The soil borings were drilled using conventional percussion boring drilling procedures with sampling as outlined in ASTM D1586 Standard Penetration Tests (SPT) and Split Barrel sampling.

The objective of this ground investigation was to characterize the subsurface soils to provide geotechnical information for the proposed site development.

The boring and sampling program conducted by EISL to date consisted of a total of twelve (12) borings with depths ranging between 6.5 and 20.0 m. However refusal was achieved in most of the soil borings. The summary of the boreholes and test pits is presented in Table 4.1-4.2 and Figure 4.1-4.2 with complete boring logs presented in Appendix A.

Laboratory classification, strength tests were performed on recovered samples while ground water measurements were monitored to observe the fluctuations in the water table.

TABLE 4.1 Summary of Soil Borings, Phase I Couva Childrens Hospital September 2012.

DATE	BOREHOLE ID	EASTING	NORTHING	ELEV.	WL(24 hrs)	DEPTH(m)
2012				(m)	(m)	(m)
August 2nd	BH 1	673279	1150550	47.5	0.914	18.90
August 29th	BH 2	673346	1150560	48	1.829	8.84
August 1st	BH 3	673285	1150516	52.5	1.219	15.85
August 27th	BH 4	673292	1150470	55.25	Hole Caved	7.31
August 3rd	BH 5	673337	1150492	53	0.914	12.80
August 9th	BH 7	673356	1150455	54	0.610	18.90
August 17th	BH 8	673390	1150472	50.25	1.524	12.80
August 27th	BH 9	673424	1150489	44.25	0.914	18.90
August 21st	BH 10	673462	1150433	52	Hole Caved	6.71
August 14th	BH 11	673455	1150389	55	Hole Caved	14.32
August 25th	BH 14	673582	1150510	54	3.962	17.37
August 22nd	BH 15	673566	1150443	56.5	0.914	15.85

TABLE 4.2 Summary of Test Pits, Couva August 2012

DATE	TEST PIT ID	EASTING	NORTHING	ELEV.	WL	DEPTH
2012				(m)	(m)	(m)
July 31st	TP 1	673240	1150515	54	None	2.39
July 31st	TP 2	673320	1150545	52	None	2.87
July 31st	TP 3	673347	1150489	52	None	3.00
July 31st	TP 4	673412	1150498	46	None	3.35
July 31st	TP 6-5	673443	1150401	55	None	3.00
July 31st	TP 7	673541	1150403	57	None	3.00
July 31st	TP 8	673546	1150464	53	None	2.87
July 31st	TP 8A	673499	1150513	40	None	2.74
July 31st	TP 9	673255	1150569	41	None	2.59

Note: Dynamic Cone Penetrometer tests –PB1-7

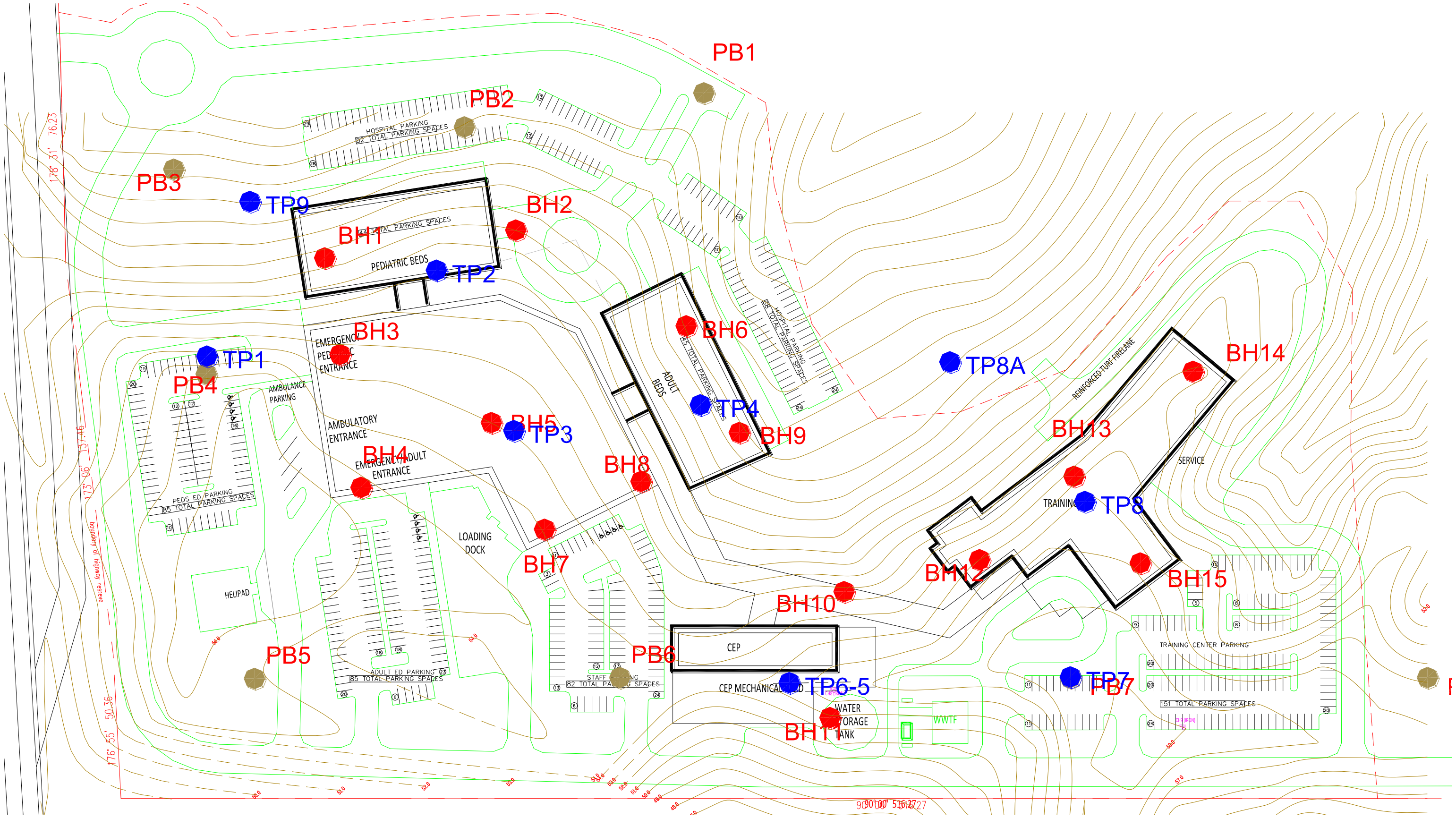


Figure 4.1 COUVA CHILDREN'S HOSPITAL, COUVA, Borehole and Testpit Layout on revised site plan received 4th September, 2012

4.2. *ASTM D1586 Standard Penetration Tests (SPT) and Split Barrel Sampling of Soil*

The results obtained from SPT as outlined in ASTM D1586 conducted during the borehole investigations were plotted to give an indication of the stiffness/strength profile over depth for the completed boreholes.

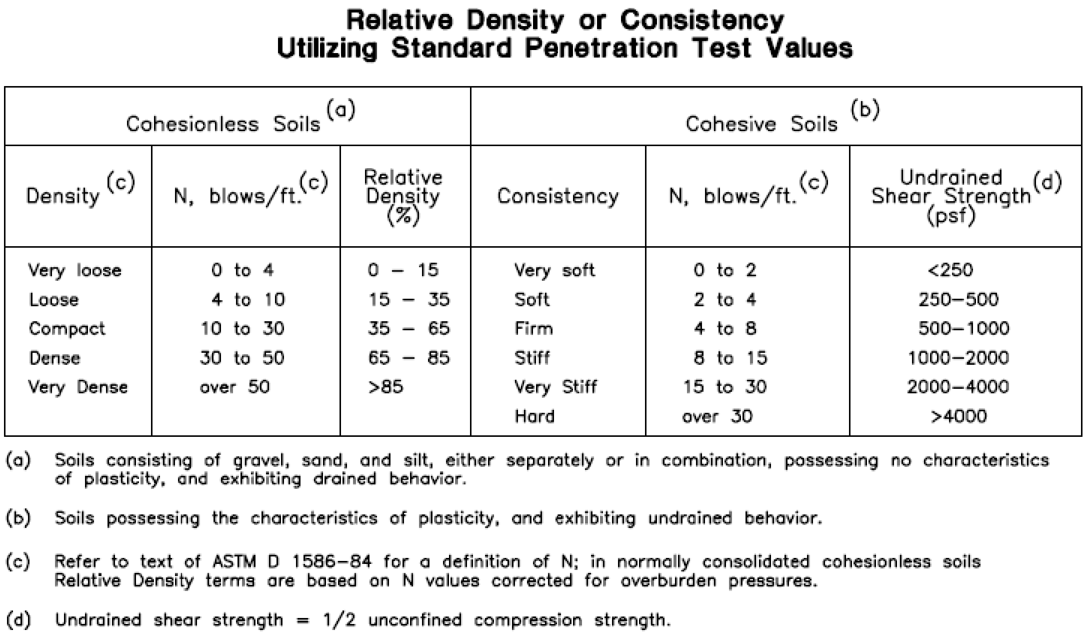
For the purposes of this report the soil profile at the site can be summarized based on the mean distribution (± standard deviation) of SPT with an idealised stiffness/strength profile over depth. This distribution of SPT with depth is illustrated in Figures 4.2 includes all borings.

For the purpose of illustration however, the SPT profile for all structures will also be included so as to gain an appreciation for variation or non-variation of stiffness over smaller areas.

4.3. *Water Table*

The water levels from the borings were monitored and the data suggest a water table observed at 1.0 m below existing ground level. However, observations made by the 7th of September indicated that all borings had caved between 0.30 and 1.0 m of the surface. No water was observed during the execution of the test pits.

During the wet season, the presence of surface fissures (macro-pores) facilitates substantial ingress of water into otherwise relatively impermeable (in their homogeneous/intact state) clay. This rapid infiltration of surface water is also primarily responsible for the formation of a perched water table within this horizon I, a major contributing factor to slope instability. For design purposes we recommend the use of a water table at 1.0 m below existing ground surface.



Relative Density or Consistency
Utilizing Standard Penetration Test Values

Cohesionless Soils (a)			Cohesive Soils (b)		
Density (c)	N, blows/ft. (c)	Relative Density (%)	Consistency	N, blows/ft. (c)	Undrained Shear Strength (psf) (d)
Very loose	0 to 4	0 – 15	Very soft	0 to 2	<250
Loose	4 to 10	15 – 35	Soft	2 to 4	250–500
Compact	10 to 30	35 – 65	Firm	4 to 8	500–1000
Dense	30 to 50	65 – 85	Stiff	8 to 15	1000–2000
Very Dense	over 50	>85	Very Stiff	15 to 30	2000–4000
			Hard	over 30	>4000

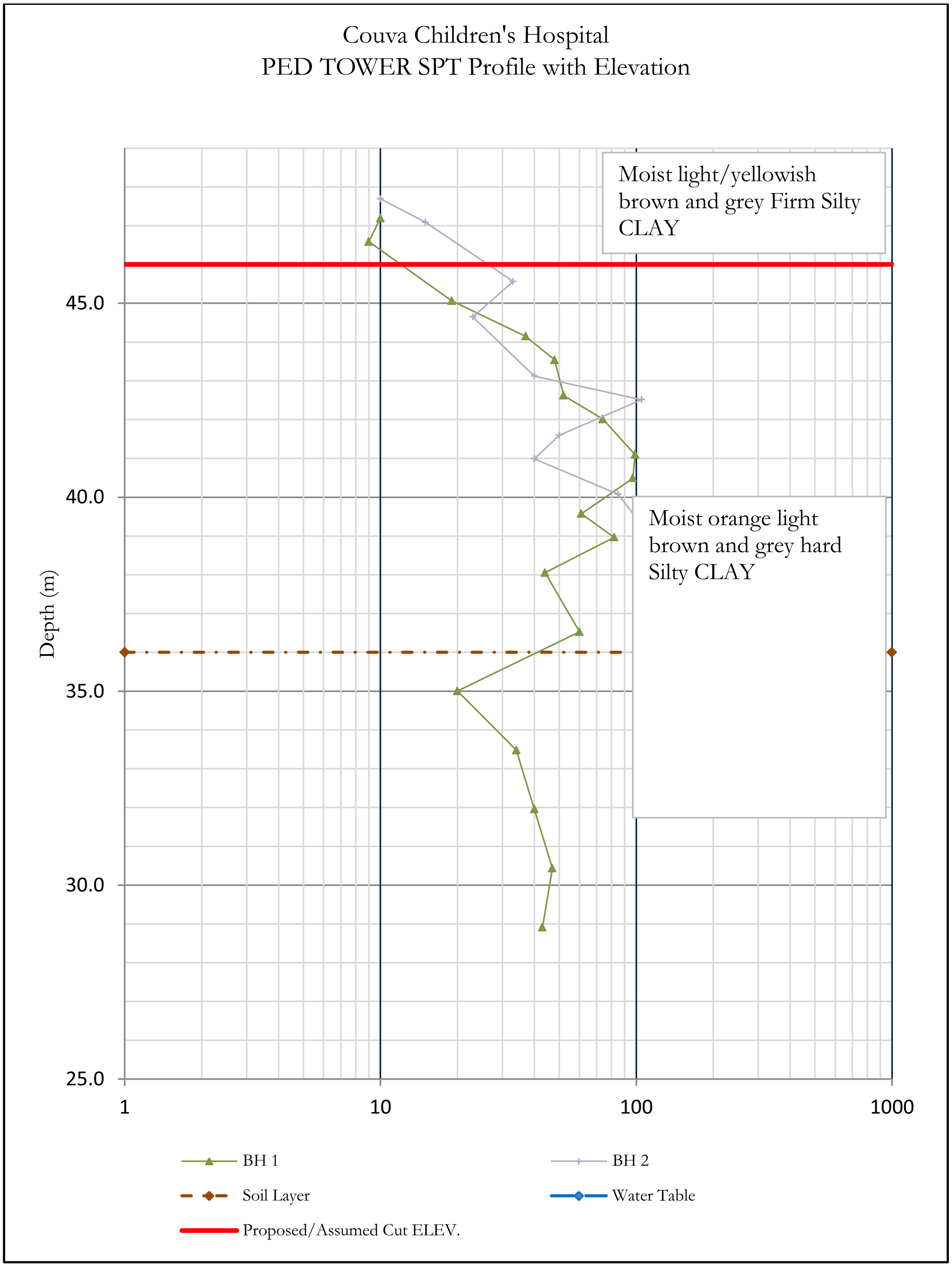
(a) Soils consisting of gravel, sand, and silt, either separately or in combination, possessing no characteristics of plasticity, and exhibiting drained behavior.

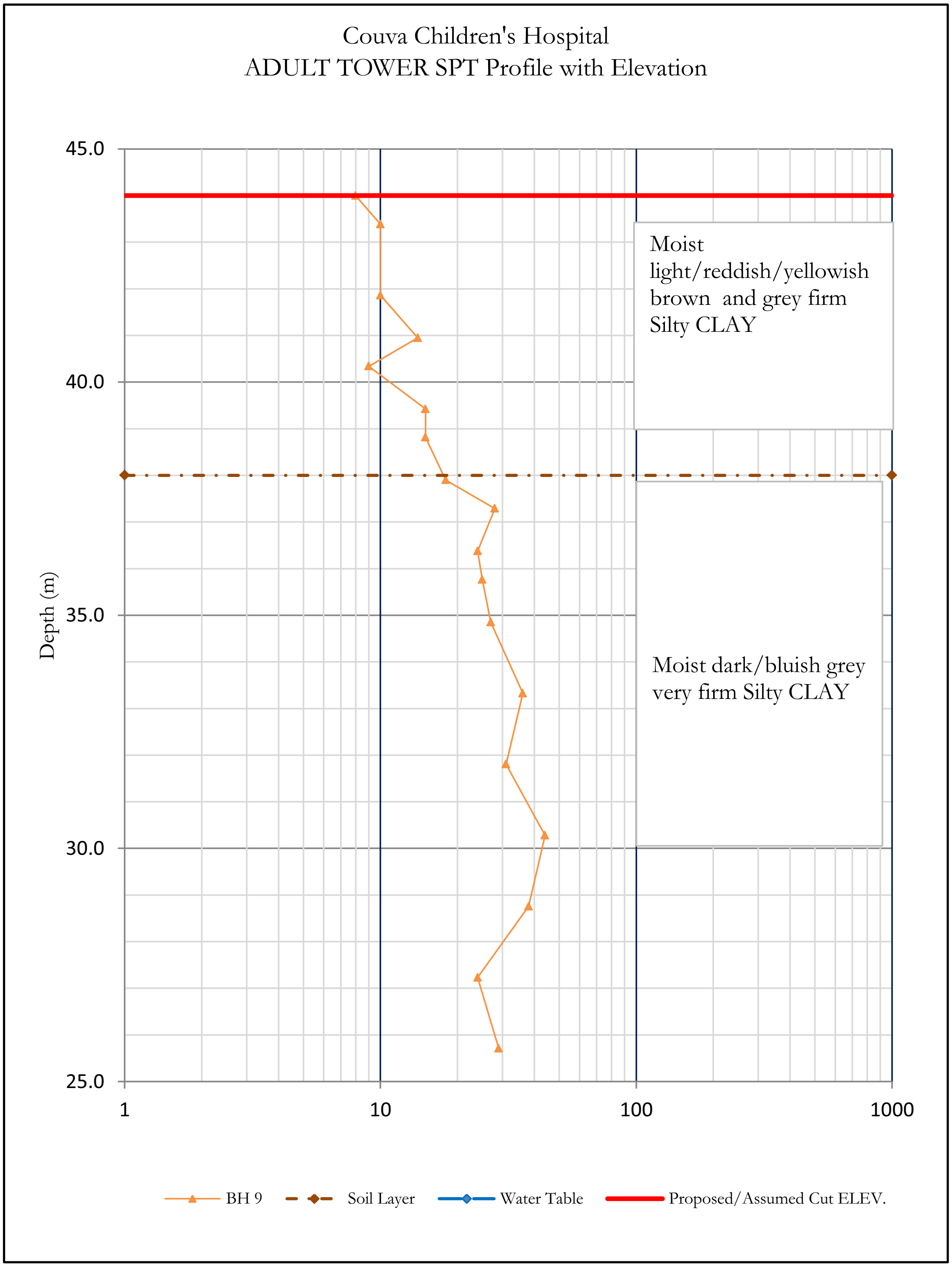
(b) Soils possessing the characteristics of plasticity, and exhibiting undrained behavior.

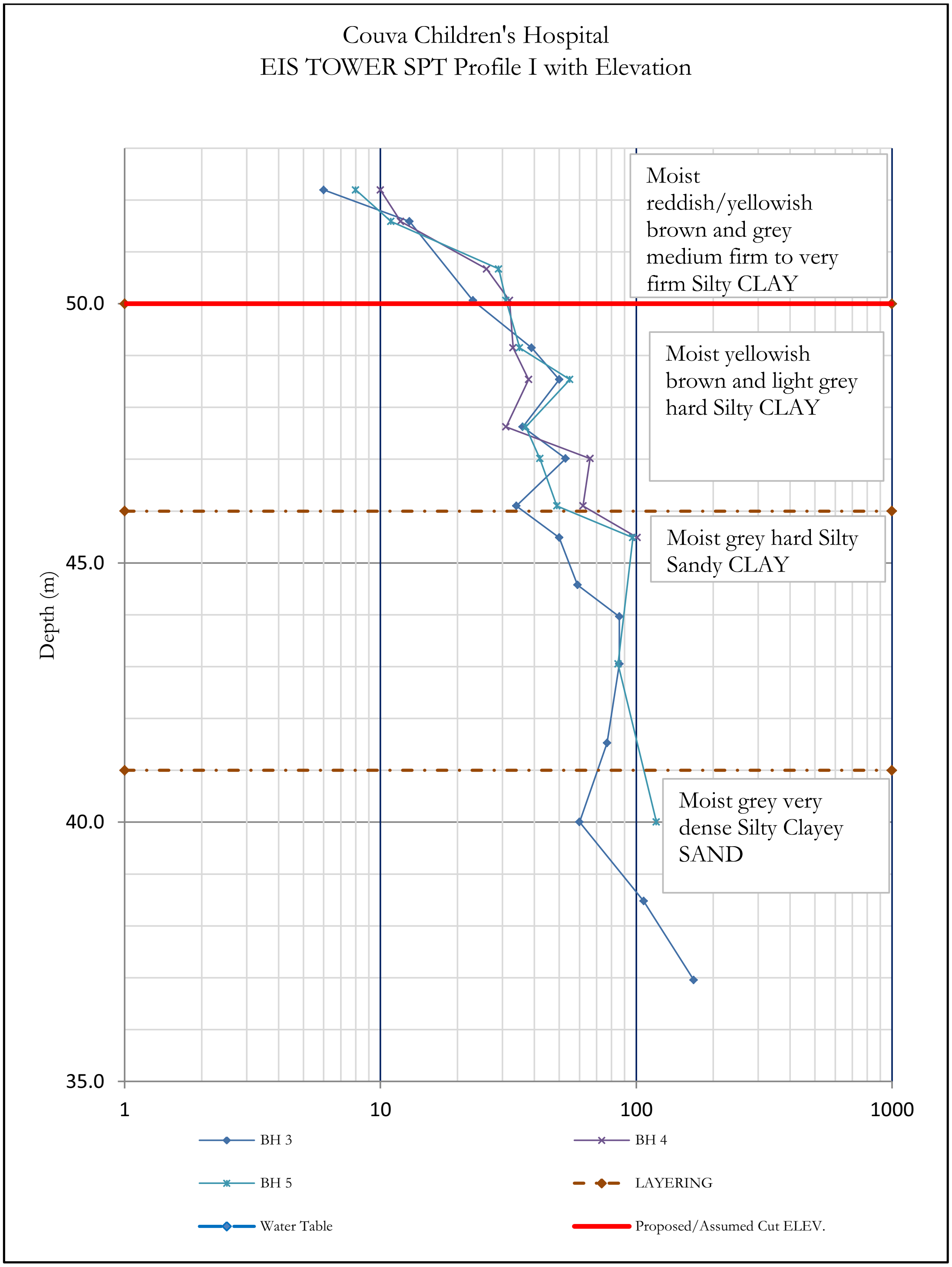
(c) Refer to text of ASTM D 1586–84 for a definition of N; in normally consolidated cohesionless soils Relative Density terms are based on N values corrected for overburden pressures.

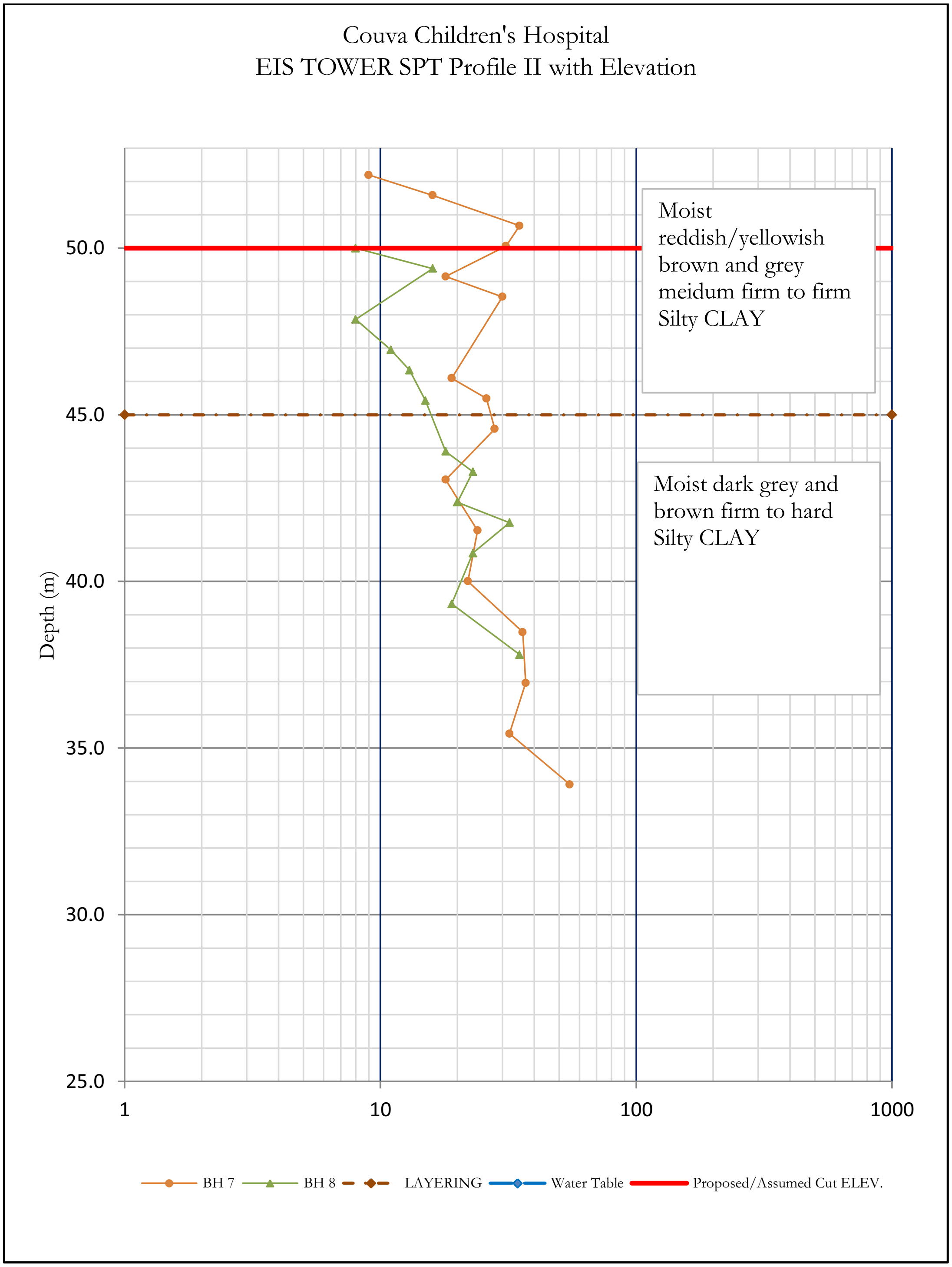
(d) Undrained shear strength = 1/2 unconfined compression strength.

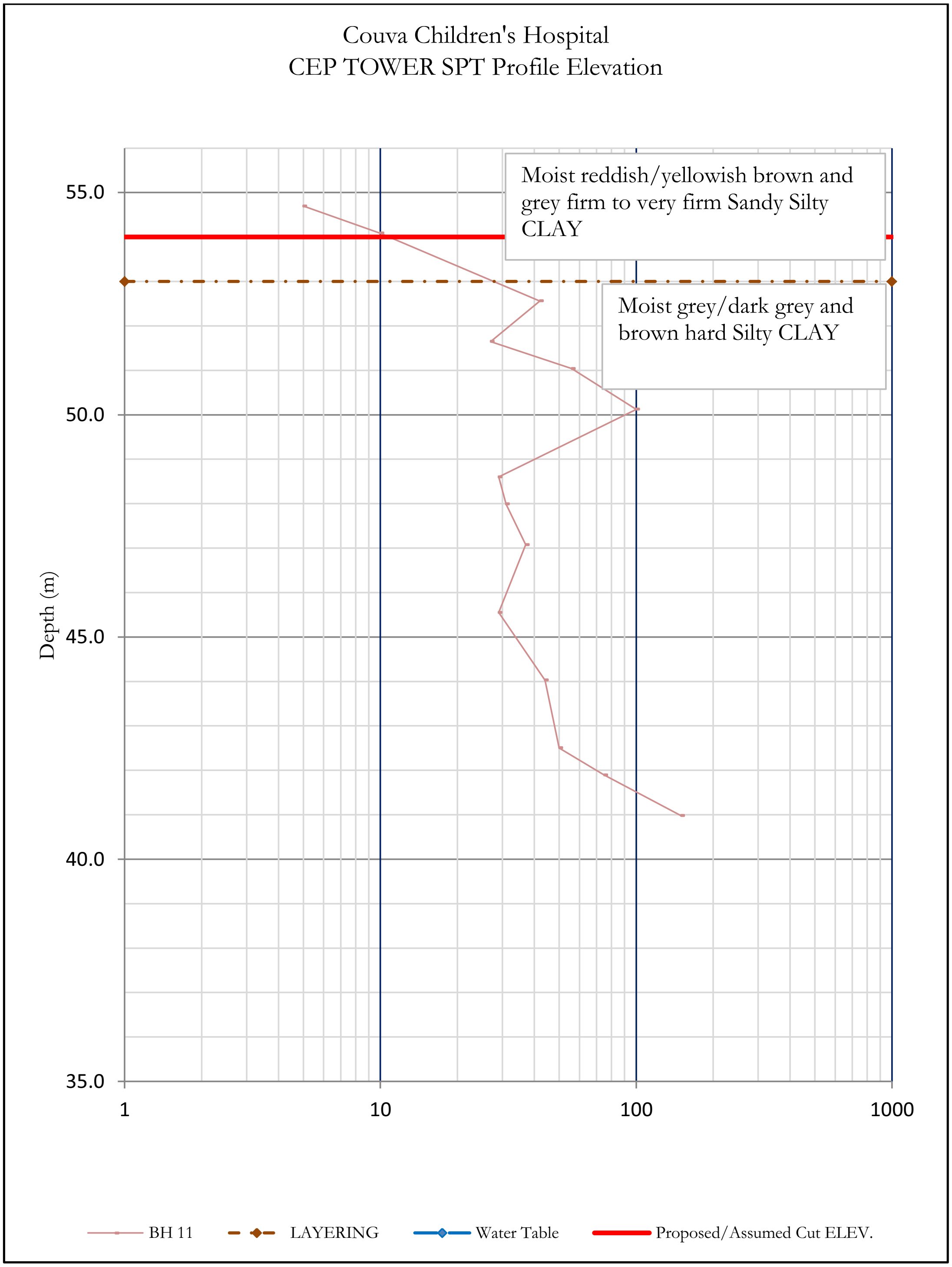
Figure 4.1 - Relative Density or Consistency Table based on Standard Penetration Tests.


Couva Children's Hospital
PED TOWER SPT Profile with Elevation
Moist light/yellowish brown and grey Firm Silty CLAY
Moist orange light brown and grey hard Silty CLAY
Depth (m)
45.0
40.0
35.0
30.0
25.0
1
10
100
1000
BH 1
BH 2
Soil Layer
Water Table
Proposed/Assumed Cut ELEV.


Couva Children's Hospital
ADULT TOWER SPT Profile with Elevation
45.0
40.0
35.0
30.0
25.0
Depth (m)
1
10
100
1000
Moist light/reddish/yellowish brown and grey firm Silty CLAY
Moist dark/bluish grey very firm Silty CLAY
BH 9
Soil Layer
Water Table
Proposed/Assumed Cut ELEV.


Couva Children's Hospital
EIS TOWER SPT Profile I with Elevation
Moist reddish/yellowish brown and grey medium firm to very firm Silty CLAY
Moist yellowish brown and light grey hard Silty CLAY
Moist grey hard Silty Sandy CLAY
Moist grey very dense Silty Clayey SAND
Depth (m)
50.0
45.0
40.0
35.0
1
10
100
1000
BH 3
BH 4
BH 5
LAYERING
Water Table
Proposed/Assumed Cut ELEV.


Couva Children's Hospital
EIS TOWER SPT Profile II with Elevation
Moist reddish/yellowish brown and grey meidum firm to firm Silty CLAY
Moist dark grey and brown firm to hard Silty CLAY
Depth (m)
50.0
45.0
40.0
35.0
30.0
25.0
1
10
100
1000
BH 7
BH 8
LAYERING
Water Table
Proposed/Assumed Cut ELEV.


Couva Children's Hospital
CEP TOWER SPT Profile Elevation
Moist reddish/yellowish brown and grey firm to very firm Sandy Silty CLAY
Moist grey/dark grey and brown hard Silty CLAY
Depth (m)
55.0
50.0
45.0
40.0
35.0
1
10
100
1000
BH 11
LAYERING
Water Table
Proposed/Assumed Cut ELEV.

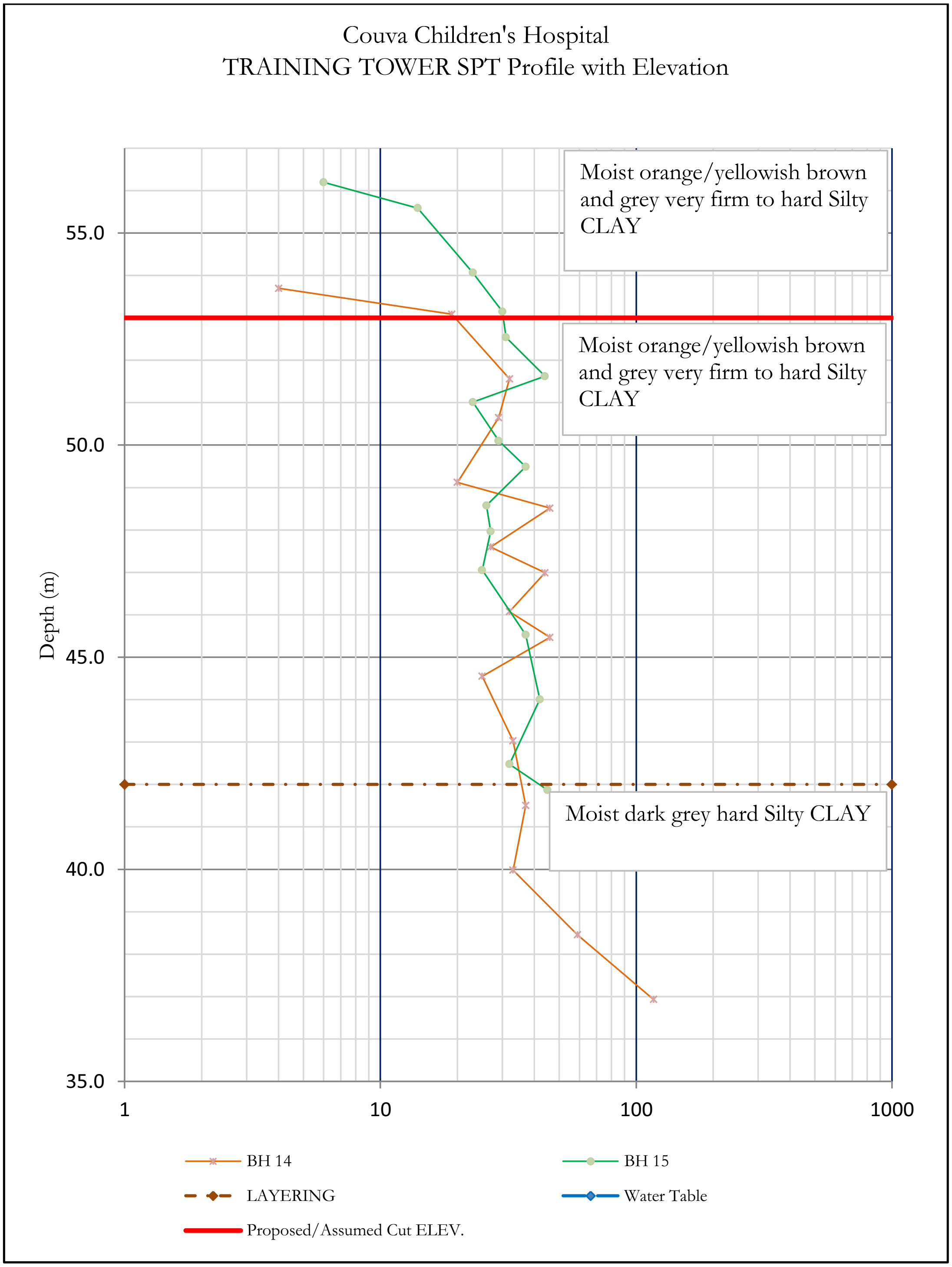


FIGURE 4.2 - COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – SPT VARIATION PROFILE WITH ELEVATION FOR EACH STRUCTURE.

5. GEOTECHNICAL LABORATORY TESTING PROGRAM

5.1. *Laboratory Tests*

The following table presents the tests conducted on the soil samples retrieved and the relevant standards to which each are performed.

Table 5.1: Respective laboratory tests and testing standards conducted on retrieved samples

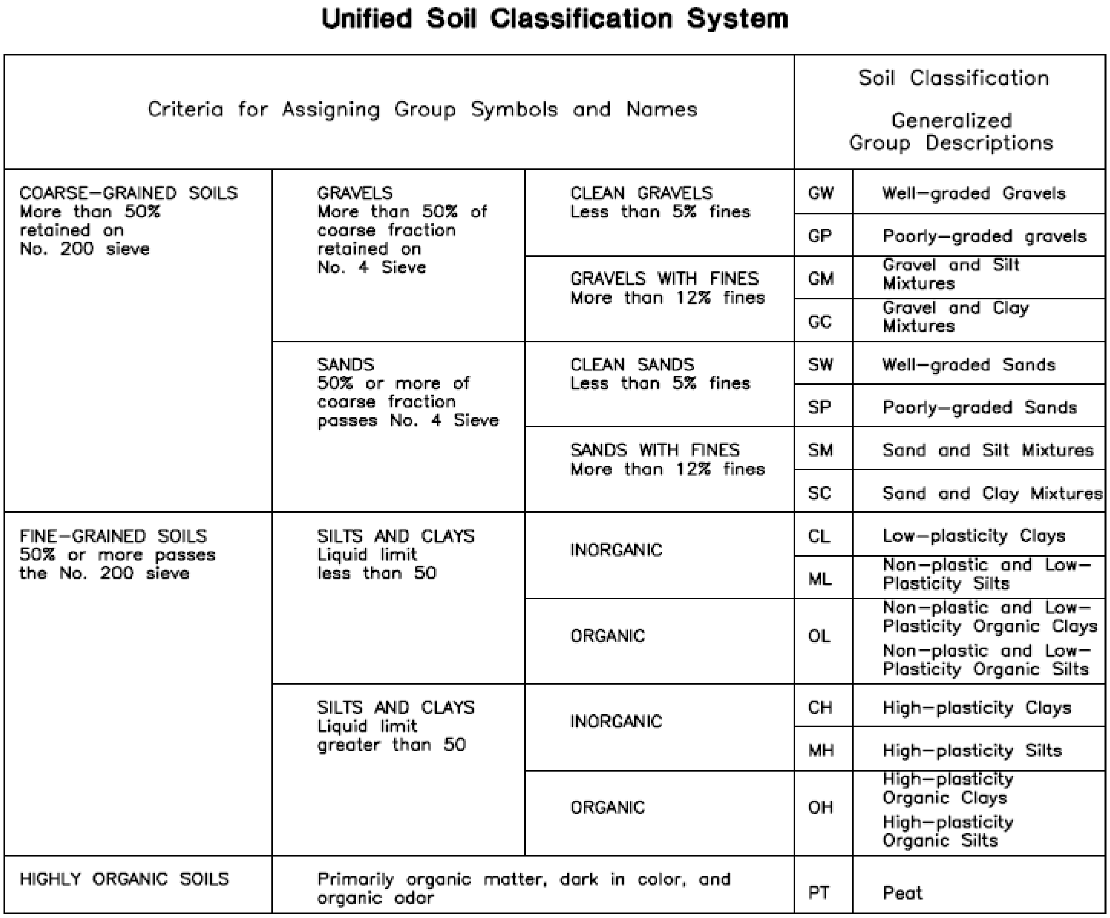
Laboratory Test	Testing Standard
Visual Identification	ASTM D2488
Textural Identification	ASTM D2248
Water Content	ASTM D2216
Atterberg Limits	ASTM D4318
Grain Size Analysis	ASTM D421, D422
Materials in Soil Finer than No. 200 Sieve-Hydrometer Analysis	ASTM D1140
Unconfined Compressive Test	ASTM D2166

The geological materials at the site include predominantly over-consolidated Silty Clays with interbedded layers of Sand.

5.2. *Visual & Textural Identification*

Visual and textural identification of the samples retrieved from the boreholes indicates the presence of only fine grain soils. According to the Unified Soil Classification system these soils can be described as loams with varying percentages of Silty Clays (CL-CH) in varying shades of brown and grey (Mottled brown, reddish, orange, light/dark).

FIGURE. 5.1 - COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – TEST PIT 2 - TOP SOIL OVER MOIST MOTTLED BROWN PLASTIC SILTY CLAYS



Unified Soil Classification System

Criteria for Assigning Group Symbols and Names			Soil Classification Generalized Group Descriptions	
COARSE–GRAINED SOILS More than 50% retained on No. 200 sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 Sieve	CLEAN GRAVELS Less than 5% fines	GW	Well–graded Gravels
			GP	Poorly–graded gravels
		GRAVELS WITH FINES More than 12% fines	GM	Gravel and Silt Mixtures
			GC	Gravel and Clay Mixtures
	SANDS 50% or more of coarse fraction passes No. 4 Sieve	CLEAN SANDS Less than 5% fines	SW	Well–graded Sands
			SP	Poorly–graded Sands
		SANDS WITH FINES More than 12% fines	SM	Sand and Silt Mixtures
			SC	Sand and Clay Mixtures
FINE–GRAINED SOILS 50% or more passes the No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50	INORGANIC	CL	Low–plasticity Clays
			ML	Non–plastic and Low–Plasticity Silts
		ORGANIC	OL	Non–plastic and Low–Plasticity Organic Clays Non–plastic and Low–Plasticity Organic Silts
	SILTS AND CLAYS Liquid limit greater than 50	INORGANIC	CH	High–plasticity Clays
			MH	High–plasticity Silts
		ORGANIC	OH	High–plasticity Organic Clays High–plasticity Organic Silts
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat

FIGURE. 5.2 - COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – UNIFIED CLASSIFICATION SYSTEM.

5.3. *Particle Size Analysis*

The results obtained from sieve analyses suggest the site soils to be predominantly plastic Silty clays. In some locations we observed higher percentages of sands 20.0 – 25.0 % as in boreholes BH1, 10 and 11 and lower portion of BH 3. A layer approximately 2.0 m thick of Sand was excavated from test pit 6-5 as previously discussed.

5.4. *Moisture Content Profile*

The moisture content profiles generated for each borehole is presented in Figure 5.3. Given the large data set it can be observed that moisture contents vary between 28.0 and 40.0 % across the site within the upper 12.0 m. Below 12.0 m, the variation reduces to between 30.0 and 35.0 % approximately. Lower moisture contents as expected can be observed in soils which have slightly higher percentages of sand as in BH1, 3, 10 and 11.

5.5. *Atterberg Limits*

The Atterberg limit tests were carried out on representative samples. The sample data is sorted irrespective of depth which suggests a plasticity index (PI) ranging from 28.0 to 61.0 % indicating a significant variation of PI over the site and with depth. In addition, this range of PI also indicates clay soils in the category of high volume change potential (expansive clay potential).

Though moisture contents tend to be closer to the plastic limits of the soils which possess large volume change potential, the fact that these moisture contents tend to be equal to or greater than equilibrium moistures, swell potential is reduced.

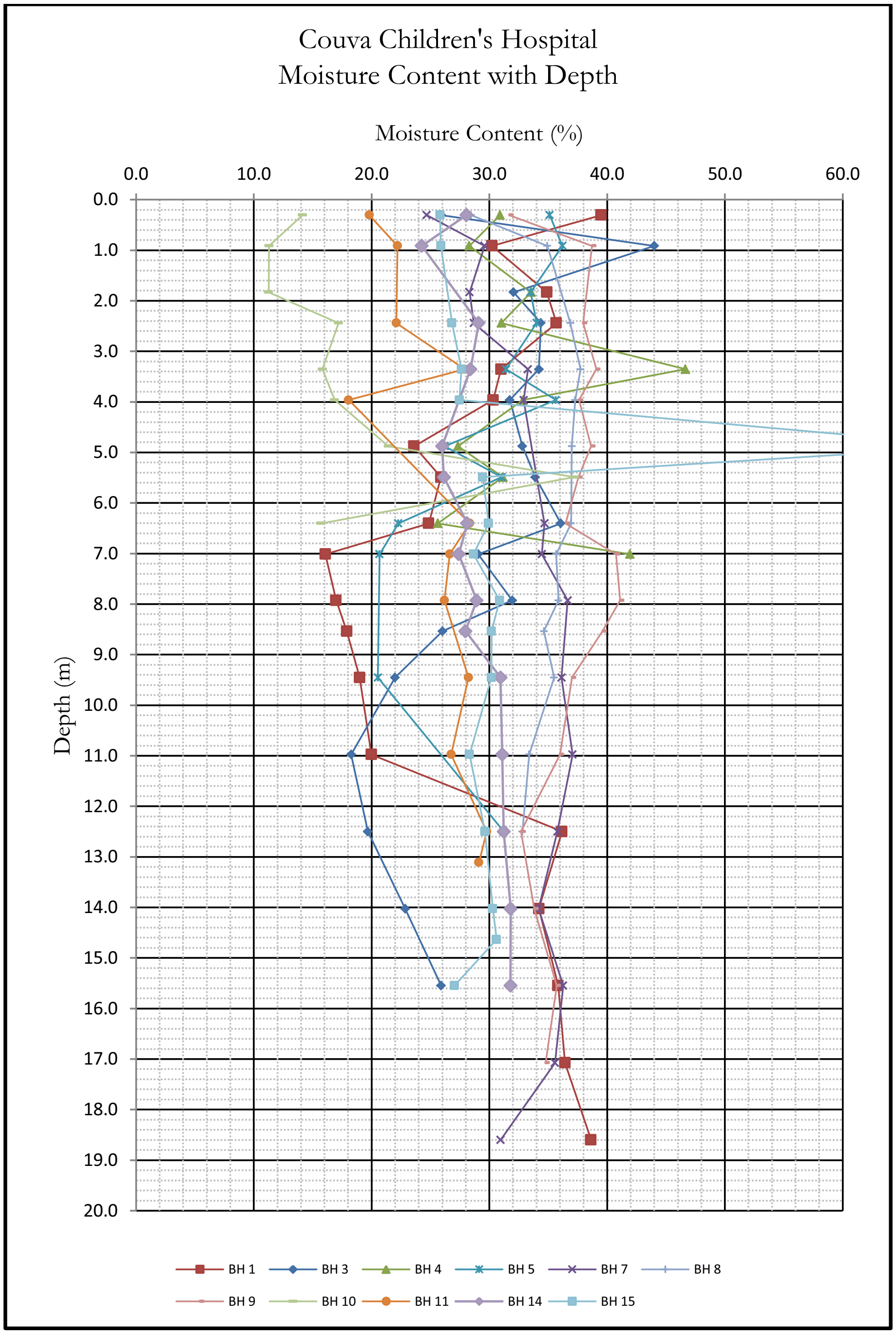


FIGURE. 5.3 - COUVA CHILDREN'S HOSPITAL, COUVA, TRINIDAD – MOISTURE VARIATION WITH DEPTH FOR ALL BORINGS.

5.6. *Unconfined Compressive Strength Tests*

Several tests were conducted on select undisturbed samples to gain an appreciation of their stress-strain behaviour under undrained loading scenarios. The results of these tests are tabulated in the following table along with the corresponding correlations which relate SPT to the undrained shear strength of cohesive soils.

Sample ID	**SPT N-Value above/below (Blows/ft)**	**Unconfined Compressive Strength, q (kPa)**	**Undrained Shear Strength, S_u (kPa)**	**Strain at Failure (%)**	**Corr. Undrained Shear Strength, S_u cor. (kPa)**
BH3-S3	13/23	170.0	85.0	4.6	100 – 175
BH11-S3	10/42	205.0	102.5	9.6	50 – 200
BH14-S3	19/32	98.0	49.0	7.2	100 – 200
BH15-S3	14/23	37.0	18.5	5.2	90 – 150

The stress-strain profiles typically indicate failures which tend to be brittle. This coincides with the present state of the soils which has been determined to be over-consolidated. Also the soils of BHs 14 and 15 returned undrained strengths lower than the correlated values. This may indicate failure along an existing macro fissure given the fissured nature of the soils.

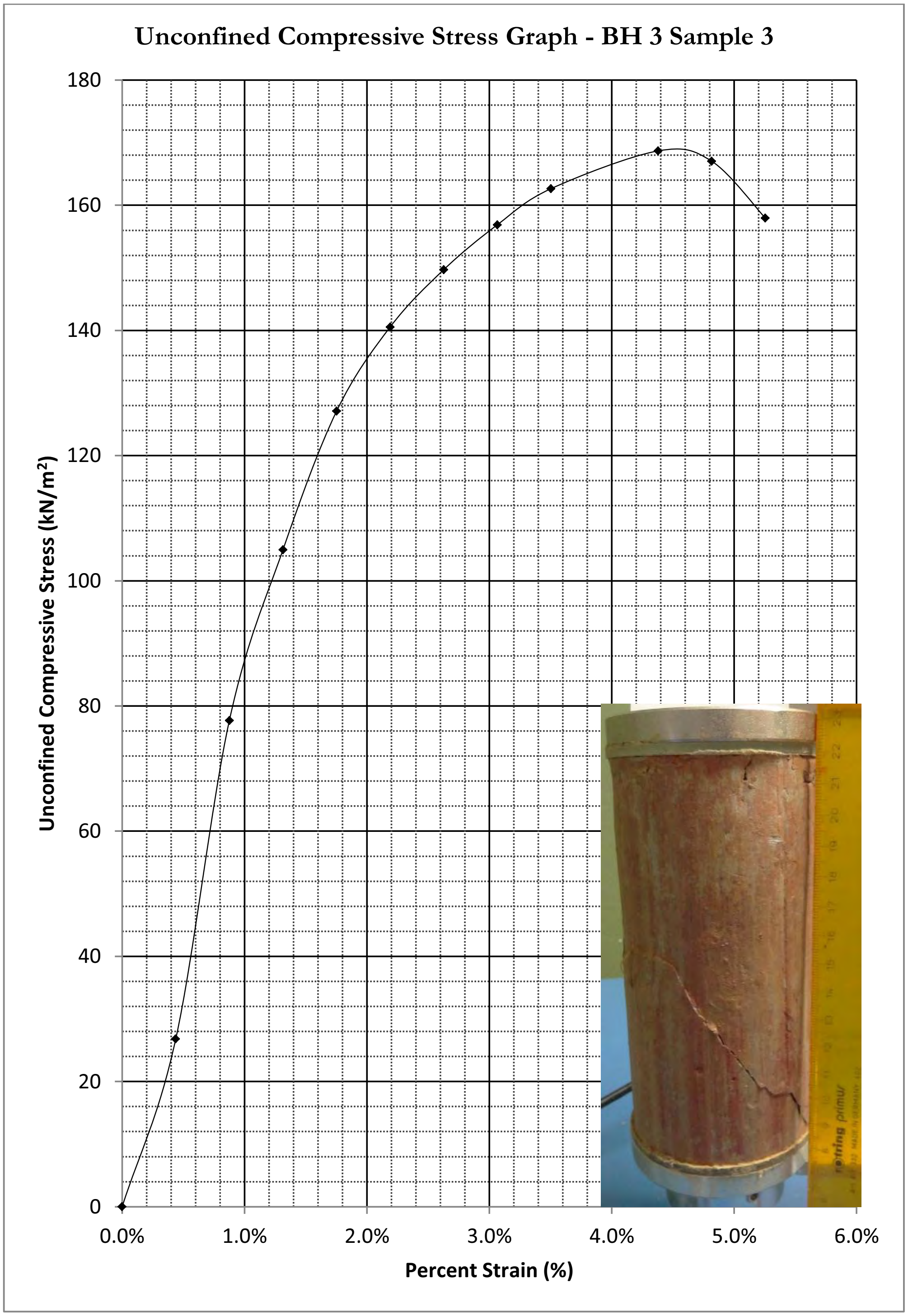


FIGURE. 5.4 - UNCONFINED COMPRESSIVE STRENGTH CURVE – BH 3 S3

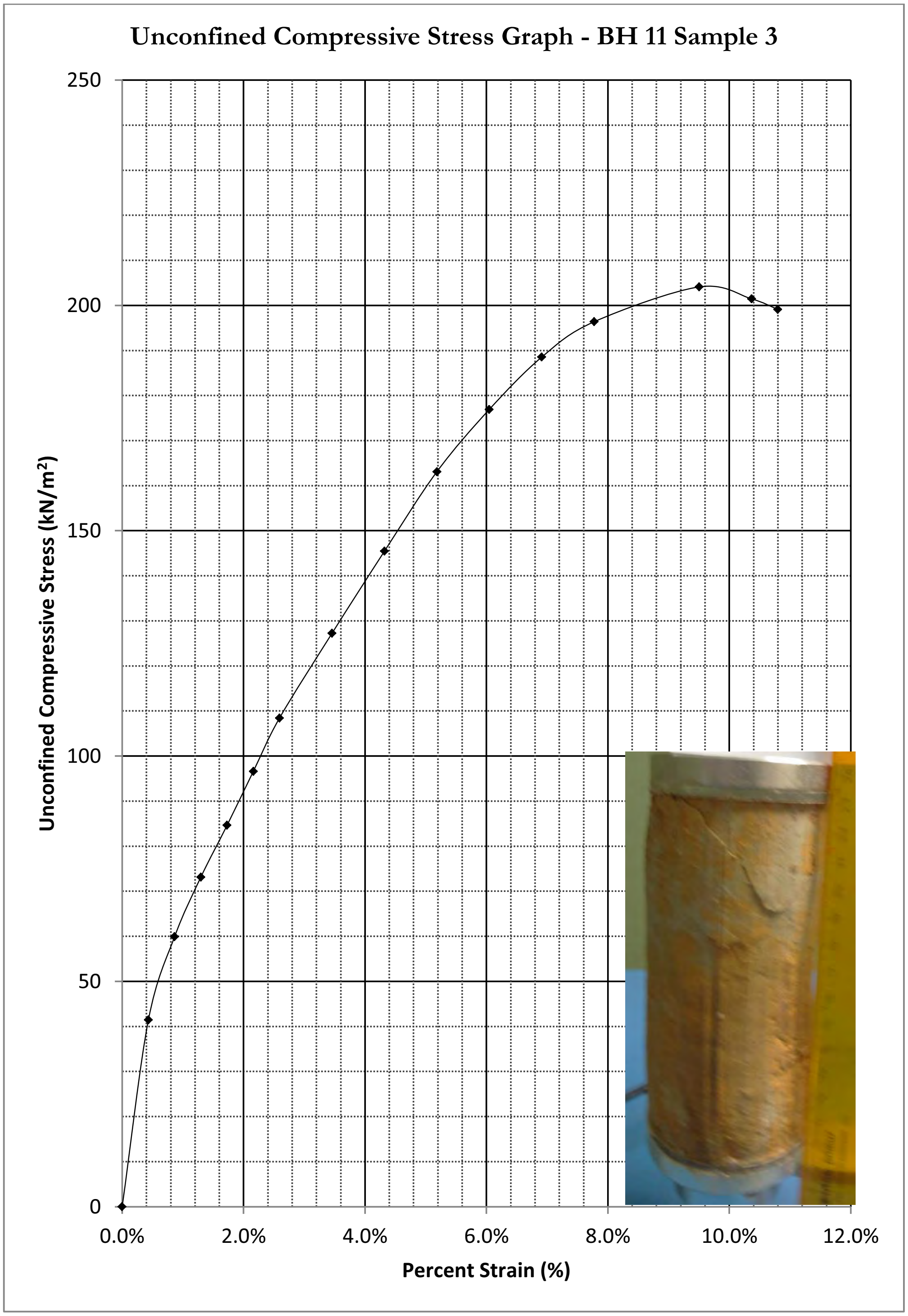


FIGURE. 5.5 - UNCONFINED COMPRESSIVE STRENGTH CURVE – BH 11 S3

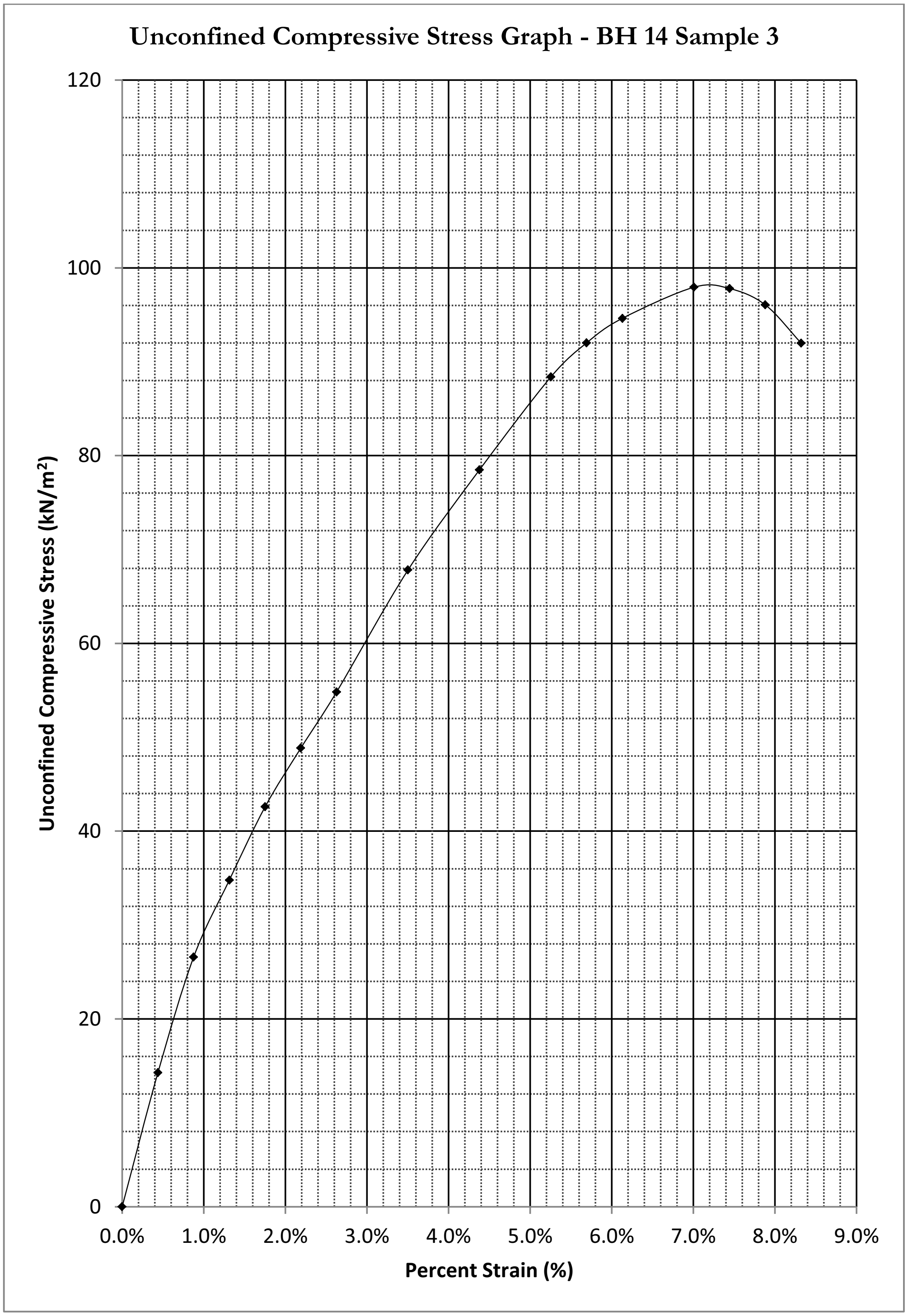


FIGURE. 5.6 - UNCONFINED COMPRESSIVE STRENGTH CURVE – BH 14 S3

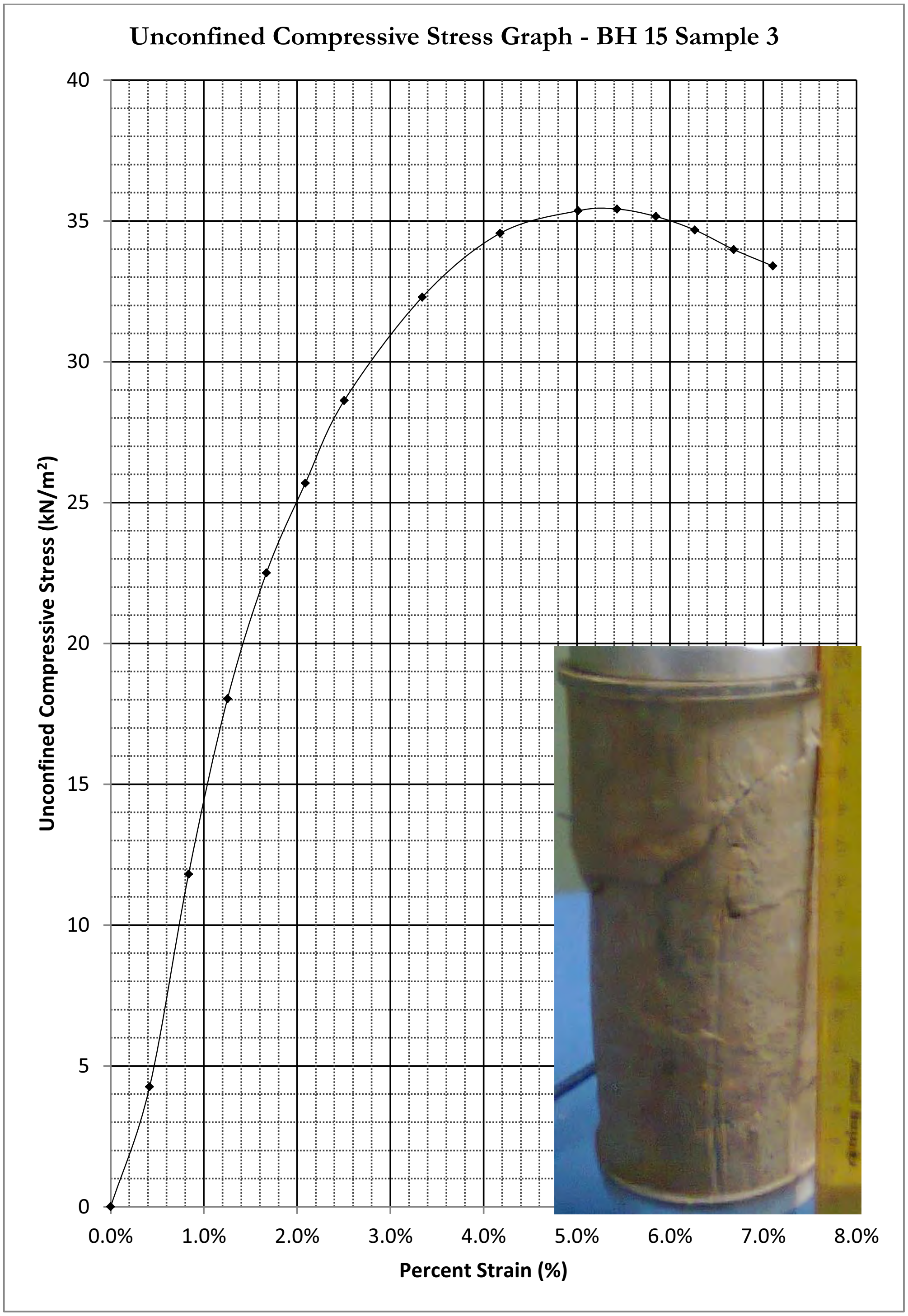


FIGURE. 5.7 - UNCONFINED COMPRESSIVE STRENGTH CURVE – BH 15 S3

5.7. *One-Dimensional Consolidation*

The following graphs of Void Ratio Vs Effective Stress for the undisturbed samples retrieved from BHs 1 and 3 indicate and confirm a degree of over-consolidation within the soils across the site. Effective Past Overburden Pressures were determined to be 210 kPa and 280 kPa respectively with corresponding Over Consolidation Ratios of 5.7 and 7.7.

Soils at deeper levels are therefore expected to have increasingly larger O.C.R.s and it is suggested that published documents within public domain may be used to correlate their values.

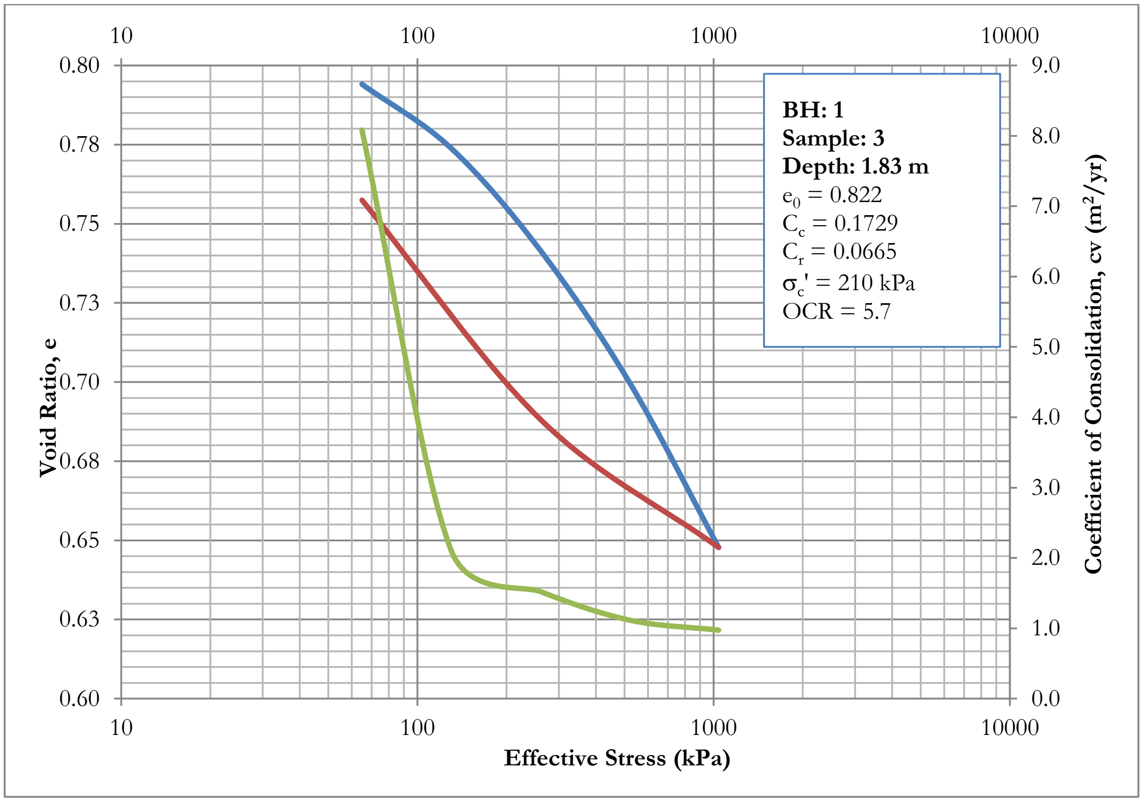


FIGURE. 5.8 - VOID RATIO VS EFFECTIVE STRESS – BH 1 S3

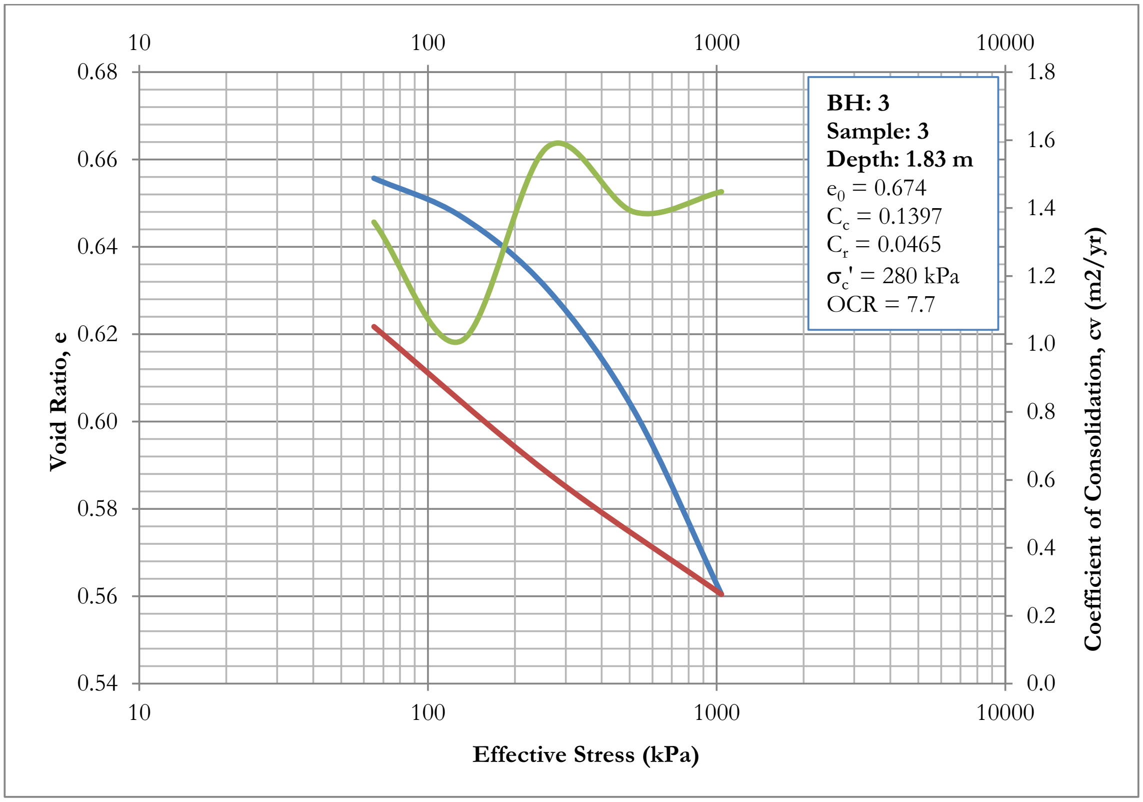


FIGURE. 5.9 - VOID RATIO VS EFFECTIVE STRESS – BH 3 S3

6. IDEALIZED SOIL PROFILE AND SOIL PARAMETERS

6.1. *Idealized Soil Profiles*

Due to the number of structures proposed, variation of SPTs observed, and changes in elevation, several profiles will be provided. This is significant considering the choice of foundations for the site.

Typically, the following features can be expected within each profile varying only with thickness and stiffness. Some locations may at times of only two horizons. As indicated in the particle size analysis section, some locations are expected to have an higher percentage of sand.

Horizon I:(1-3 m) a highly weathered surface layer usually covered with grasses and/or other shrub vegetation. Over the dry season, the process of evapo transpiration from exposed and vegetated surfaces induces substantial drying and fissuring, typically due to the rooting depths of the vegetation. Depending on the plasticity of the soils and vegetation type, these cracks can develop to 25-75 mm wide at the surface. From the onset of the wet season, the presence of these surface fissures (macro-pores) developed during the preceding dry season facilitates substantial ingress of water into an otherwise relatively impermeable (in their homogeneous/intact state) clay fabric.

This rapid infiltration of surface water is also primarily responsible for the formation of a perched water table within this horizon and is a major contributing factor to slope instability. This cycle of wetting/drying swelling/shrinkage gives rise to a highly brecciated soil structure. As a consequence the soil is highly non-homogenous and fragmented with large variations in water content occurring between fissured surfaces and intact blocks. The basic structure consists of blocky fragments of drier clay surrounded by wetter fissure surfaces (brecciated structure). Substantial deposits of gypsum can also be found at the base of this horizon where the crack density and widths decrease significantly.

The colour of this horizon can be described as typically mottled dark brown, orange/yellow and grey clays, where the dark brown and orange/yellow colours are associated with ferric and ferrous iron oxides respectively. The dark grey colour is indicative of un-weathered blocks in which the Alumina and Sodium oxides and hydroxides predominate.

Horizon II: (3-6 m) the transition between the Brecciated Zone and the underlying dark grey silty clay (intact un-weathered parent material). This layer is felt to consist of the upper surface of the dark grey clay shale that has been subject to weathering. Oxidation products and leachates of the Brecciated Zone are often deposited in the fissures of Horizon II. There can also be a high degree of fissuring in this layer that sometimes brecciated. It is difficult to distinguish the beginning and end of this transition horizon. The soil is similarly non-homogenous as the overlying Brecciated Zone.

Horizon III:(>6m) consists of dark grey silty clay shale. This layer is free from brown staining but can have gypsum crystals. It is highly fissured and slickensided but gives the appearance of homogeneity although its water content can vary over short distances.

6.2. *Building Specific Soil Profiles*

PED TOWER – BHs 1, 2

46.0 – 36.0 m.s.l.: materials under HORIZON I/II which become increasingly hard mid-layer (30 – 100 blows/ft.) reducing to approximately 50 blows/ft. at the bottom of the layer.

Below 36.0 m.s.l.: hard materials indicative of the HORIZON III with an SPT of 40 blows/ft.

ADULT TOWER – BH 9

44.0 – 38.0 m.s.l.: firm material of HORIZON I/II with 10 blows/ft.

Below 38.0 m.s.l.: very firm to hard soils of HORIZON III having SPTs of 30 blows/ft.

EIS TOWER I – BHs 3, 4, 5

53.0 – 50.0 m.s.l.: firm to very firm HORIZON I material with approximately 20 blows/ft.

50.0 – 46.0 m.s.l.: HORIZON II having an SPT of 40 blows/ft.

46.0 – 41.0 m.s.l.: HORIZON III with SPTs of 90 blows/ft.

Below 41.0 m.s.l.: Sandy Clayey SAND with an SPT in excess of 100 blows/ft.

EIS TOWER II – BHs 7, 8

BHs 7 and 8 indicate relatively softer consistencies throughout their depth and hence are idealised as follows:

52.0 – 45.0 m.s.l.: medium firm to firm HORIZON I with SPTs between 10 and 20 blows/ft.

45.0 – 30.0 m.s.l.: very firm to hard soils of HORIZON II/III with SPTs between 20 and 30 blows/ft.

CEP TOWER – BHs 11

56.0 – 53.0 m.s.l.: soft to medium firm material of HORIZON I with 10 blows/ft.

Below 53.0 m.s.l.: HORIZON II/III material considered as hard with SPTs varying between 30 and 100 blows/ft.

TRAINING CENTRE – BHs 14, 15

57.0 – 42.0 m.s.l.: HORIZON I/ II material with SPTs between 20 and 40 blows/ft. indicating very firm to hard consistencies.

Below 42.0 m.s.l.: Material of HORIZON III of hard consistency with SPTs increasing from 30 to 100 blows/ft.

6.3. *Design Soil Parameters*

Based on SPT correlations and laboratory investigations, we have estimated the undrained and drained strength parameters for the idealized soil profiles as shown in Table 6.2. The drained strength parameters (effective strength) are based on correlations with Plasticity Index in the foundation bearing layer.

Table 6.2: - Strength Parameters from SPT Correlation and Laboratory Testing

Horizon	**Elevation**	**SPT**	**γ**	**w**	**Undrained Shear Strength, S_u**	**Effective Strength**			
						Correlation with PI			**PI**
						$Ø'_{Peak}$	$Ø'_{Rem}$	$Ø'_{Res}$	
	m.s.l.	(blows/ft)	(kN/m^3)	(%)	(kN/m^2)	$(^0)$	$(^0)$	$(^0)$	(%)
PED TOWER – BHs 1, 2									
I/II	49.0 – 36.0	30 – 100	19.5	36	50-125	24	14	7	50
III	below 36.0	60	20.0	36	>200	23	13	6	60
ADULT TOWER – BH 9									
I/II	44.0 – 38.0	10	18.0	30 – 38	50	24	14	7	50
III	below 38.0	30	20.0	35	200	24	14	7	50
EIS TOWER I – BHs 3, 4, 5									
I	53.0 – 50.0	20	19.0	26 – 40	125-150	24	14	7	50
II	50.0 – 46.0	40	20.0	35	>150	24	14	7	50
III	46.0 – 41.0	90	21.0	20 – 30	>200	24	14	7	50
Clayey SAND	below 41.0	100	21.0	18	-	31	23	12	20
EIS TOWER II – BHs 7, 8									
I	52.0 – 45.0	10 – 20	19.0	30 – 35	50 – 150	24	13	7	55
II/III	below 45.0	20 – 30	19.5	35	150 – 200	24	13	7	55
CEP TOWER – BH 11									
I	56.0 – 53.0	10	18.0	22	50	23	13	6	60
II/III	below 53.0	30 – 100	21.0	28	>200	23	13	6	60
TRAINING CENTER – BH 14, 15									
I/II	57.0 – 42.0	20 – 40	19.5	28	150 – 200	23	13	6	60
III	below 42.0	30 – 100	21.0	30	>200	23	13	6	60

[1] Undrained Shear Strength as interpreted from SPT results (Bowles 1996)

[2] Drained residual friction angle as interpreted from Plasticity Index (Bowles 1996)

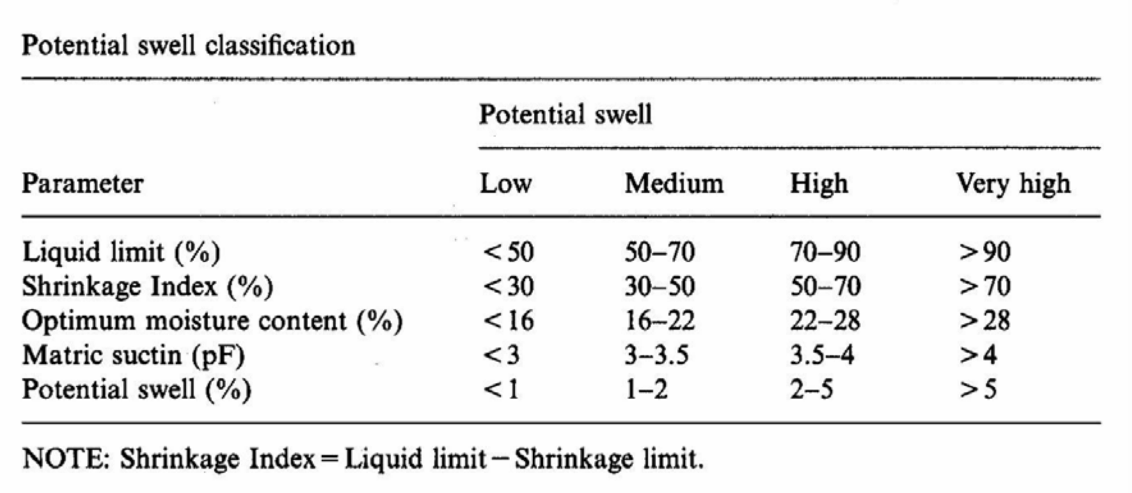
7. GEOTECHNICAL DESIGN RECOMMENDATIONS

7.1. *Site Soil Classification: Volume Change Potential - Expansive Clays*

The predominant soil type encountered at this site was C2 177 Talparo Clay (95 %) with the remaining 5 % comprising Sand. This clay soil type is typically well known to be over consolidated, highly plastic, and potentially expansive. Based on seventy-eight (78) Atterberg Limits carried out on clay samples obtained from this site, these limits can be summarised as follows:

- Plastic Limit (PL): 19.64 ± 3.68 % (mean ± stdev)
- Liquid Limit (LL): 76.73 ± 11.33 %
- Plasticity Index (PI): 57.09 1 ± 1.33 %

Using one of the standard classifications as quoted by Ramana (1993), these soils would fall in the category of Medium - High Expansive potential based on values of LL (as indicated in the figure below).



Potential swell classification

	Potential swell			
Parameter	**Low**	**Medium**	**High**	**Very high**
Liquid limit (%)	< 50	50–70	70–90	> 90
Shrinkage Index (%)	< 30	30–50	50–70	> 70
Optimum moisture content (%)	< 16	16–22	22–28	> 28
Matric suctin (pF)	< 3	3–3.5	3.5–4	> 4
Potential swell (%)	< 1	1–2	2–5	> 5

NOTE: Shrinkage Index = Liquid limit − Shrinkage limit.

Classifications such as these are typically used in conjunction with a climatic parameter such as the Thornthwaite Moisture Index (TMI), which typically attempts to quantify/represent the expected range of moisture change that can be expected at a particular geographical location/site over a typical climatic cycle (normally one year). The PI is also used to describe expansive potential with similar effect. The PI describes the range of % moisture content change possible within a particular soil type and the TMI represents the capacity of the prevailing climate to drive this change.

The Post Tensioning Institute (PTI) of the USA provides a methodology for the design of slabs on grade based on soil properties (PI, Cation Exchange Capacity, % Clay, etc..) and the possible extremes of moisture exchange possible as described by the TMI. This PTI methodology would therefore provide the maximum expected value of volume change at the site in question.

The principal vehicle/mechanism of moisture loss included in the TMI is the Potential Evapo-Transpiration (PET); a combination of surface Evaporation and plant/root Transpiration. Surface evaporation from a wet/moist clay soil surface is typically confined to within 100-200 mm of the surface over a typical dry season associated with a TMI of 10-15, however, moisture loss associated with root transpiration can penetrate much deeper to 2-3 m depth, depending on the type and maturity of the grass/vegetation cover. Hence, one method of removing the potential for volume change is to limit the potential for evapotranspiration, particularly for soils that are typically wet of their Plastic Limit, as the significant volume changes and associated high swell pressures are associated with moisture content changes/wetting from values significantly **dry** of the Plastic Limit.

7.1. ***Shallow Foundations in Expansive Soils: General Approaches***

Foundations placed on potentially expansive soils fall in a very special category of foundation design as such soils can experience significant volume changes (shrink/swell) and swelling pressures with changes moisture content. Such volume change potential is typically characterised by soil plasticity parameters and the expected values of moisture change (climatic or manmade). Although Bearing Capacity and Settlement can be computed based on typical strength and compressibility parameters, the effects of swelling pressures and unsaturated volume change are difficult if not impossible to compute based on linear elastic and/or limit state plastic analyses.

As a consequence we typically recommend the following guidelines in respect of foundation design on expansive clays:

1. Apply sufficient Dead Load pressure is exerted on the foundation, so as to balance/counteract the expected swell pressures that could develop as a result of wetting from a relatively desiccated state.
2. The structure is rigid enough such that differential settlement/heave-induced cracking is minimised/eliminated by designing appropriately for the expected moments and shear forces

that are likely to develop as a result of soil moisture change and/or load related movements (PTI method).

3. The swelling potential of the foundation soils are reduced or eliminated, through pre-construction treatment; (i) stabilisation with lime or cement, (ii) removal and re-compaction of foundation soils or (iii) pre-wetting.
4. Placing foundations below the zone of potential surface evaporation, for soils at the end of the rainy season (wet of their PLs).
5. Using 1.5-2.0 m wide aprons around building areas to limit moisture loss by evaporation.
6. Controlling moisture exchange by trees/vegetation transpiration; using rooting trees that do not spread laterally below building areas (tap rooted trees). The site is currently clear, hence appropriate landscaping can be effected to maintain a suitable subsurface moisture regime.
7. Keeping water bearing utilities (water supply, sewer), away from lightly loaded foundation areas and retaining walls.

7.2. ***Slabs on Grade***

At this site the clays tested typically indicate well defined/constrained Plastic Limit values, PL = 19.64 ± 3.68%, in addition, moisture content results of all clay samples tested indicate that in-situ moisture contents are on average +10-20 % wetter than their Plastic Limit values, with the higher values occurring predominantly within 2-3 m of the ground surface. This is not unusual as it is indicative of a typical wet season moisture profile where the upper bound values describe the depth of seasonal moisture variation. This depth of seasonal moisture variation is typical for the sugarcane (grasses) plantations of the type that this site once supported. This "wet of the PL" moisture condition can be exploited to advantage; if we were to cover this soil with slabs at grade at depths that would preclude edge moisture loss from surface evaporation and remove the potential for root transpiration by the removal of sugarcane and other deep rooting/aggressive grasses, then the potential for shrinkage volume change would be typically reduced significantly if not removed altogether, as these soils have already **expended > 80 % of their volume change capacity**. **The potential for swelling by ingress of surface and subsurface waters can also be eliminated by the use of surface drains and apron slabs.**

For these reasons we can typically recommend the use of slabs on grade for non-critical structures such as car parks, storage and warehouse type construction. This recommendation is predicated on the observation/analysis that the in-situ moisture contents are sufficiently higher than their Plastic Limits so as to limit the potential for volume change/swell due to water absorption. Shrinkage due to moisture loss can be mitigated through the placement of the slab/foundation below the expected depth of evaporation moisture loss (~ 200 mm). Further precautions in respect of moisture absorption can be managed by ensuring that water bearing utilities (potable water, sewer, underground drains) are not founded below or in the immediate vicinity of such construction.

Under the current site/soil conditions we can recommend that these slabs be founded on a minimum of 200 mm of cohesionless granular material, upon removal of this equivalent depth of clay topsoil. Alternatively, a conservative approach can be adopted by using the Post Tensioning Institute's (PTI) method for design of slabs on grade. In this method soils and climatic data are used to design stiffened raft type foundations at grade. At this site a TMI of 10-15 is appropriate.

7.2.1. Soil Stiffness Modulus K_s

The soil stiffness modulus is used in the soil-structure interaction analysis of the strip/raft type foundations. For lightly loaded slabs/strips and under relatively uniform soil conditions single-valued soil stiffness can be generally recommended. For this type of loaded slab design we can recommend that the clay soils can develop a stiffness modulus of 35,000 kN/m^3 under the cohesionless granular fill. However, given the difference in effective soils stiffness suggested by the variation in SPT at the near surface (mean ± standard deviation) a nonlinear distribution of soil stiffness can be recommended using a "step function" type stiffness transition from 35,000 kN/m^3 to 18,000 kN/m^3 anywhere along the loaded length.

7.3. *Shallow Foundation Design*

7.3.1. Bearing Capacity

In highly over consolidated soils such as those encountered at the site, we can recommend that the drained effective strength parameters be used in bearing capacity analyses as opposed to the undrained values, as undrained strengths in these over-consolidated clays are sometimes uncharacteristically high due to their negative suction pressure states associated with their unsaturated soil matrix. The drained or effective strength bearing capacity can be determined using the Terzaghi type bearing capacity expressions, where the effective strength parameters are obtained via correlation with the Plasticity Index (PI) or through drained direct shear tests. In this procedure, the permissible stress method1 is instituted where the Allowable Bearing Capacity is based on a F.S. = 3.0 on the calculated Ultimate Bearing Capacity.

Based on the lower bound mean undrained shear strength of 50 kN/m^2 (Un-confined Compression Tests) at a **minimum depth of 1.5 m** below the existing ground a lower bound allowable bearing capacity of 128 kN/m^2 (FS = 3.0) can therefore be recommended for **strip** foundations in this clay profile. Strip foundations should be utilized to reduce the any effects of differential settlement that might occur with the implementation of pad foundations.

Isolated Pad footings are best recommended in combination, designed as a pile cap connected by structurally integrated ground beams.

Table 7.1 Recommended Allowable Bearing Capacities and Total Expected Settlements

Found. Type	Foundation Width, B (m)	Depth of Embedment (m)	Allowable Bearing Capacity, q_{all} (kN/m^2)	Total Expected Settlement, S_e (mm)
Strip				
	1.0	1.5	128	<18
	1.5	1.5	128	<25
	2.0	1.5	128	<25
	2.5	1.5	128	<25

---

[1] **Permissible Stress Method**
This method is adopted from the BS 8004:1986 [7], which incorporates a lumped factor of safety to ensure that the pressure applied to a foundation element is significantly less than the value which would cause shear failure in the supporting soil.

7.3.2. Settlement

Based on the results obtained from our oedometer tests confirmed that soils at the site are typically over-consolidated, with OCRs in the range 5.5 – 7.0 with maximum past consolidation pressures typically >200 kN/m^2. Under such conditions foundation induced stresses would lead to tolerable total and differential settlements. However, for lightly loaded pavements/slabs in cut sections, differential heave can induce significant differential movements which must be addressed in design.

7.4. ***Shallow Foundation on Granular Fill - Effect on Edge Lift***

7.4.1. Foundation Model and Design Parameters

The parameters presented in Table 7.3 were used to develope a typical raft foundation on 200 mm of granular FILL. A finite element analysis was used to determine the foundation deflections/settlement based on a uniform and edge loading condition. This preliminary model is based on the writers assumption of a relatively light uniform distributed load of 75 kPa over the footing width. The output from the analysis is presented in Figure 7.1 where a maximum displacement of 6 mm is expected at the foundation edges.

Table 7-2 Soil and Material Parameters used in the Finite Element Analysis

Parameter	**Symbol**		**Dense Sand and Gravel**	**Granular Fill**	**Unit**
Material Model	Model		Mohr-Coulomb	Mohr-Coulomb	
Type of Behaviour	**Type**		**Drained**	**Drained**	
Unsaturated weight	γ_{unsat}		18	18	kN/m^3
Saturated Weight	γ_{sat}		18	18	kN/m^3
Youngs modulus	E		35000	25000	kN/m^2
Poissons ratio	ν		0.30	0.30	-
Cohesion	c		15	20	kN/m^2
Friction Angle	φ		35	30	°
Dilatancy Angle	ψ		2	2	°
Permeability x dir	k_x		1.2	1.0	m/day
Permeability y dir	k_y		1.2	1.0	m/day

Ko			Automatic	Automatic	-
Parameter	**Symbol**	**Concrete Footing**			**Unit**
Material Behaviour	Model	Elastic			
Axial Stiffness	EA	$6.9.10^6$			kN/m
Flexural Stiffness	EI	$5.18.10^4$			kNm^2/m
Weight	γ	3.0			kN/m/m
Poissons ratio	ν	0.2			-

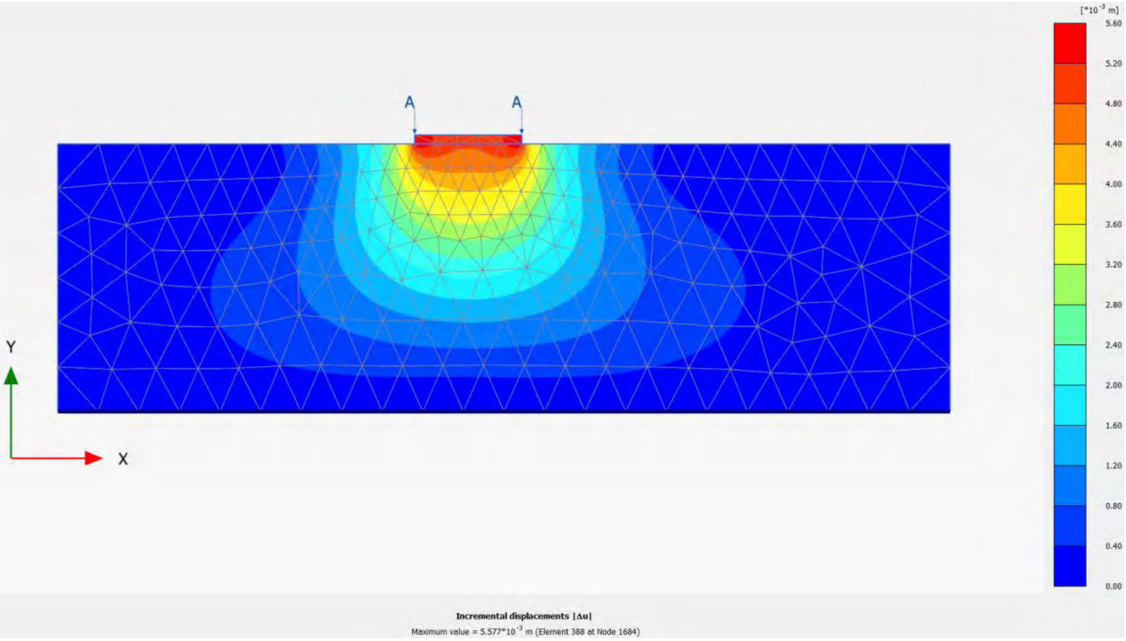


Figure 7.1 Raft Foundation Model, Incremental Displacement output. Maximum Displacement at Foundation Edges = 6 mm

7.5. *Deep (Pile) Foundation Design*

7.5.1. Ultimate Axial Pile Capacity and Factory of Safety

The **ultimate** drained axial pile capacities for 450 mm and 600 mm augered piles for each building are presented in Figure 7.2-7.4. The analysis was determined from the Beta-Method for these over-consolidated plastic clays. The recommended Factor of Safety on the Ultimate Axial Pile Capacity is 2.5.

The following assumptions were made:

1. Axial Pile Capacities were assumed for reduced/cut profiles corresponding to the lowest elevations for any given structure. Figure 7.5.
2. The observed variability in pile capacities is due to the general soil variability across the site and with depth.
3. The larger pile capacities determined for building EIS I are as a result of the Sand Horizon within the lower soil horizon. This sand content reduces the PI of the material with a direct result on the drained strength parameters of the soils as previously presented in Table 6.2.

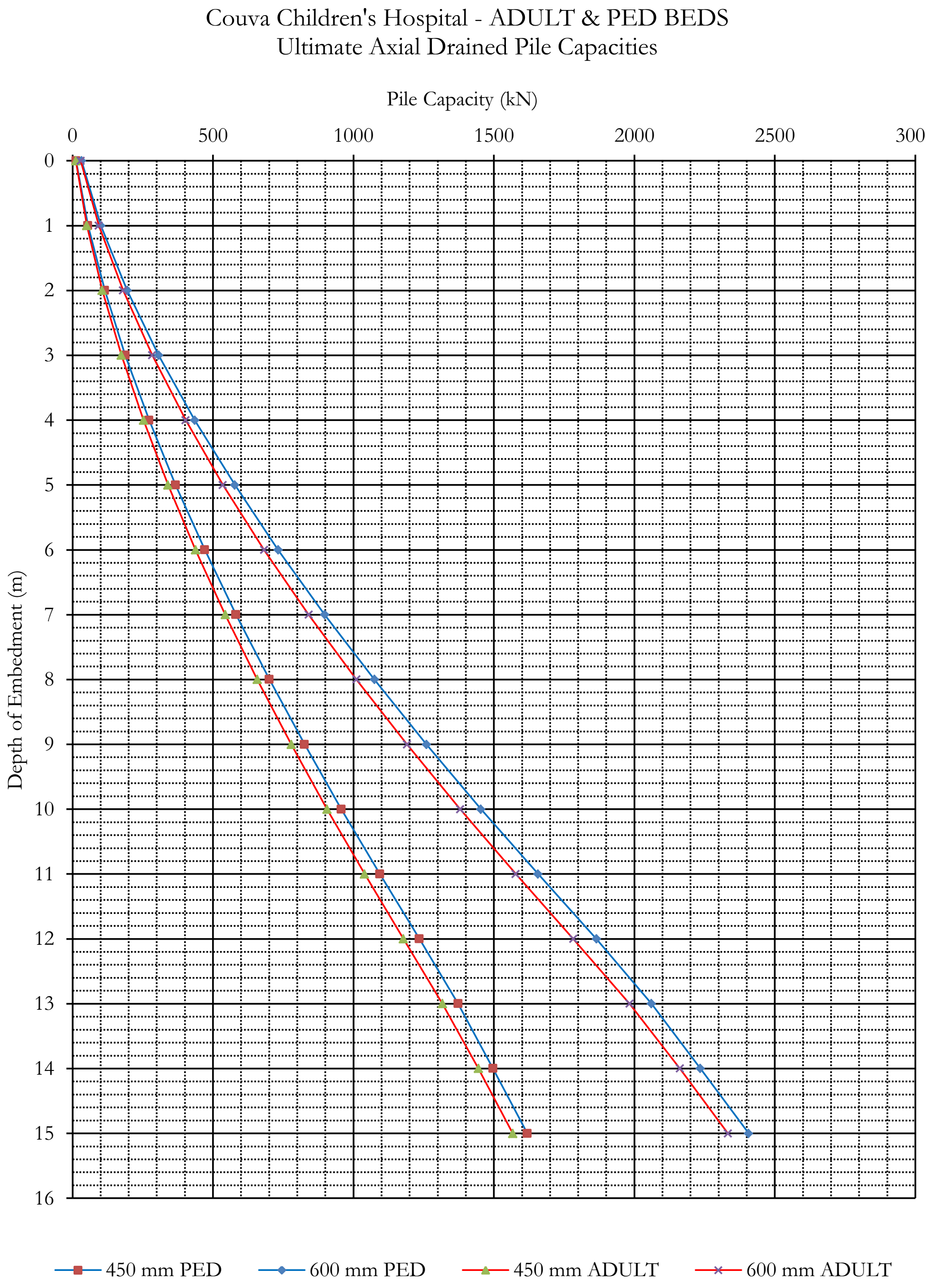


Figure 7.2 - Ultimate Axial Pile Capacity for 450 and 600 mm Piles, Adult and Ped Beds.

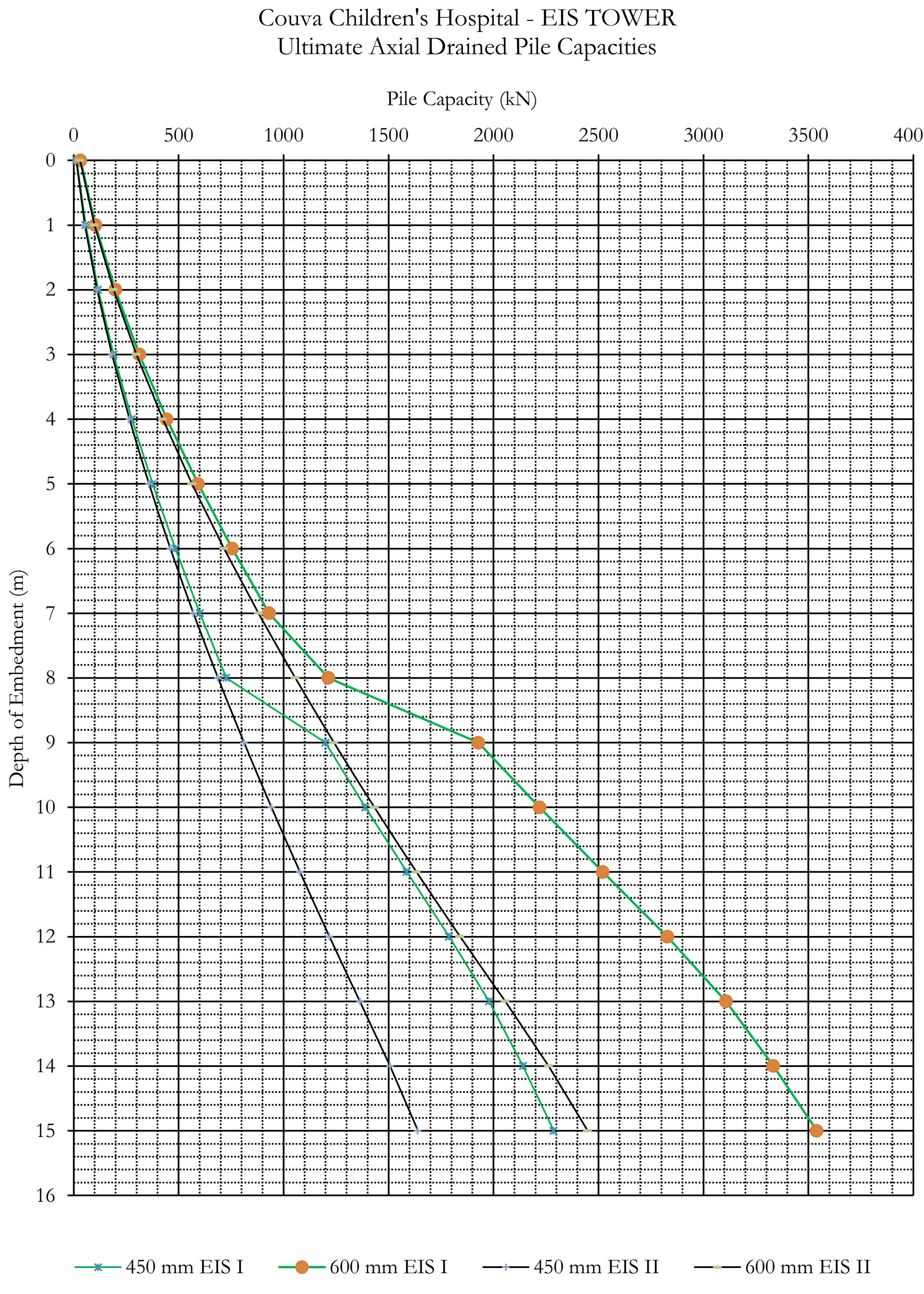


FIGURE 7.3 - ULTIMATE AXIAL PILE CAPACITY FOR 450 AND 600 MM PILES, EIS TOWER

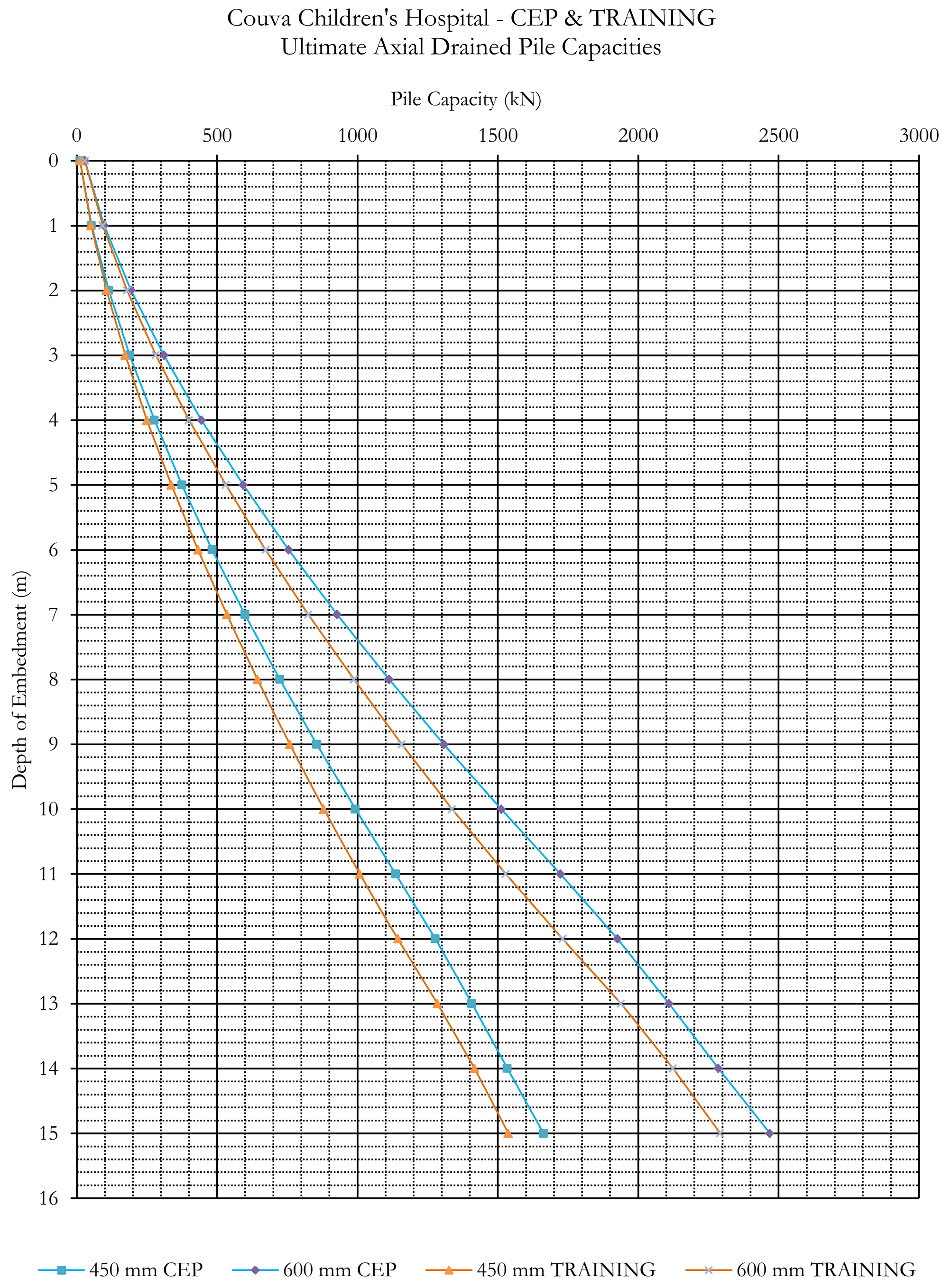
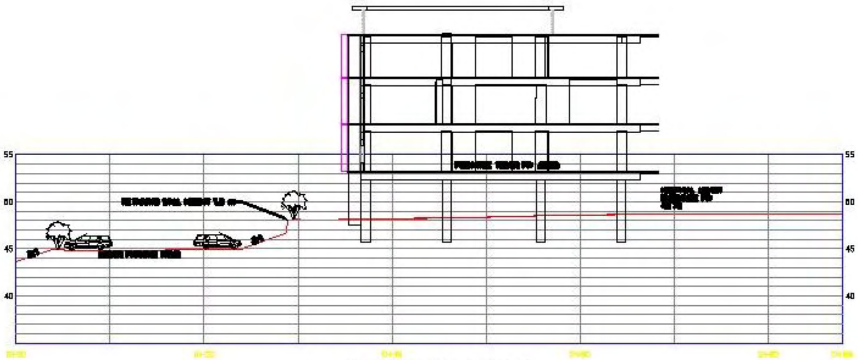
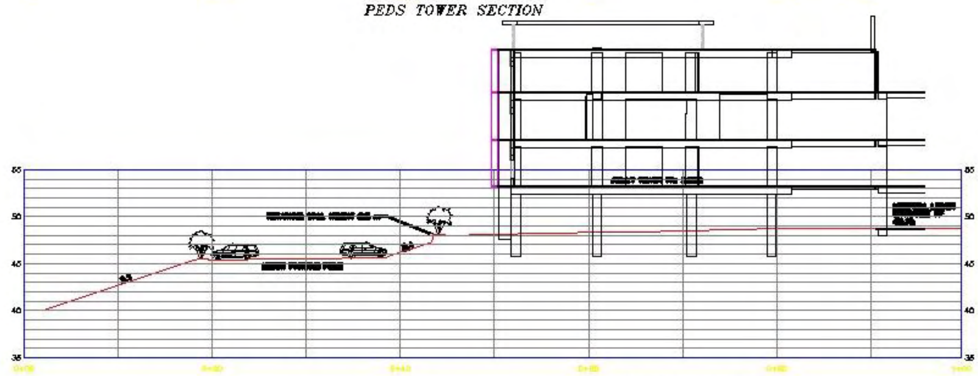


FIGURE 7.4 - ULTIMATE AXIAL PILE CAPACITY FOR 450 AND 600 MM PILES, CEP 7 TRAINING



PEDS TOWER SECTION



ADULT TOWER SECTION

TRAINING CENTER SECTION

Figure 7.5 - Proposed Reduce CUT Profiles for Pile Capacity Analysis for 450 and 600 mm Piles, HKS September 2012.

7.5.2. Pile Groups and Efficiency

Several pile group configurations were analysed considering the structural loads provided by HKS in Section 1.3 from which the following recommendations have been inferred:

1. It has been calculated that a minimum center-to-center spacing of 2.5 pile diameters will be sufficient in providing a group efficiency of approximately 100% (∑ individual pile capacities). This applies to pile configurations of 2 x 2, 2 x 3, and 2 x 4.

2. For 15.0 m length piles, it has been determined that the following configurations can be utilized below the individual structures.

BUILDING	**450 mm**	**600 mm**
Adult/PED Beds	2 x 3 (6)	2 x 2 (4)
EIS	2 x 2 (4)	Triangular (3)
Training Centre	2 x 2 (4)	Triangular (3)
CEP	Triangular (3)	Triangular (3)

3. Structurally, a minimum distance between the outer extent of the piles and the edge of the pile cap should be one (1) pile diameter.

4. For triangular layouts, it is assumed that the pile cap will also be in the shape of a triangle. This will ensure that the axial load is distributed equally between all piles.

7.5.3. Uplift/Tension Capacity of Piles

Uplift capacities were determined for all profiles and are shown in Figures 7.6 – 7.8. A minimum F.S. of 2.0 is recommended on the ultimate uplift/tension capacity of the piles.

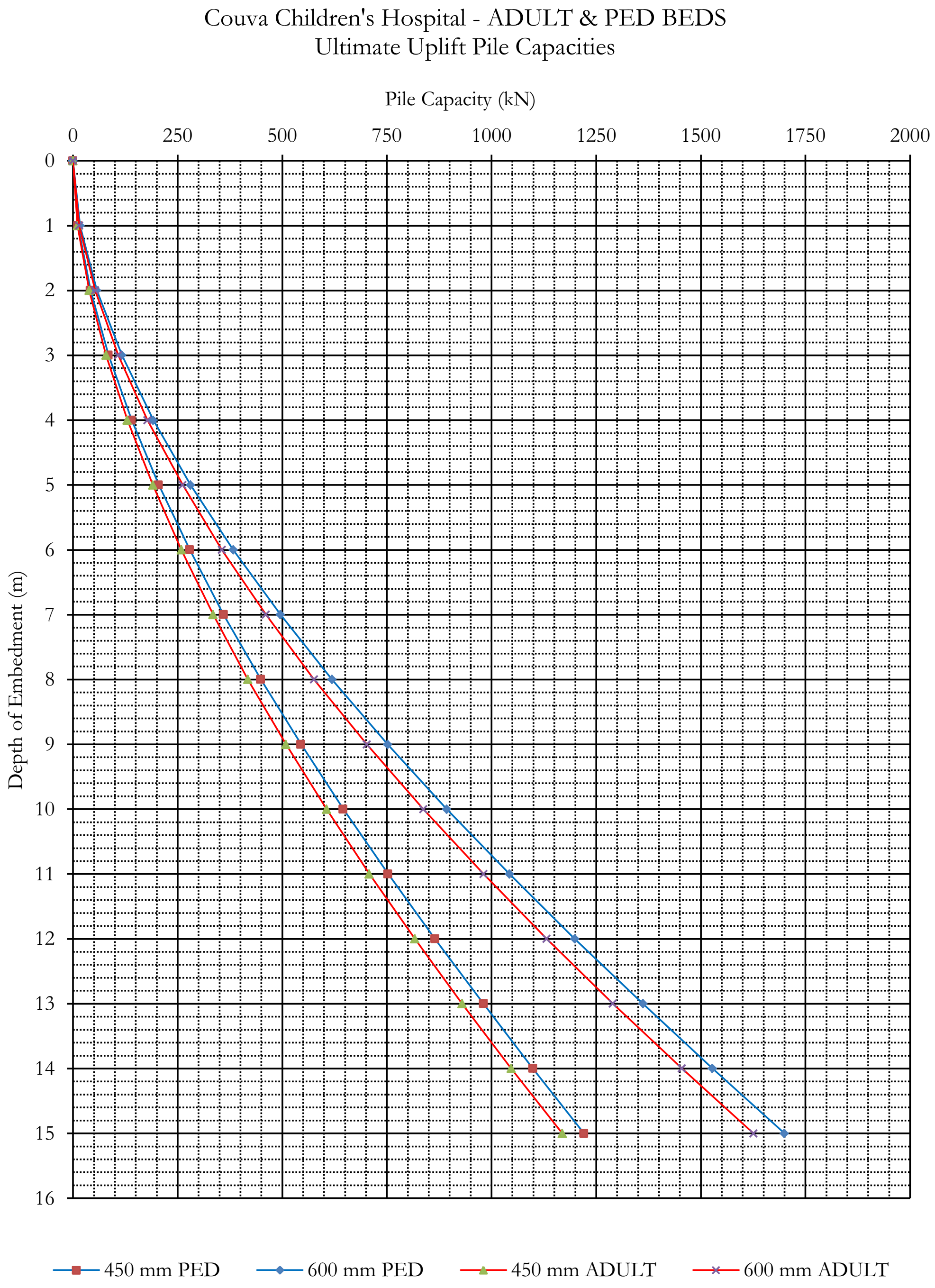


FIGURE 7.6 - ULTIMATE UPLIFT/TENSION PILE CAPACITY FOR 450 AND 600 MM PILES

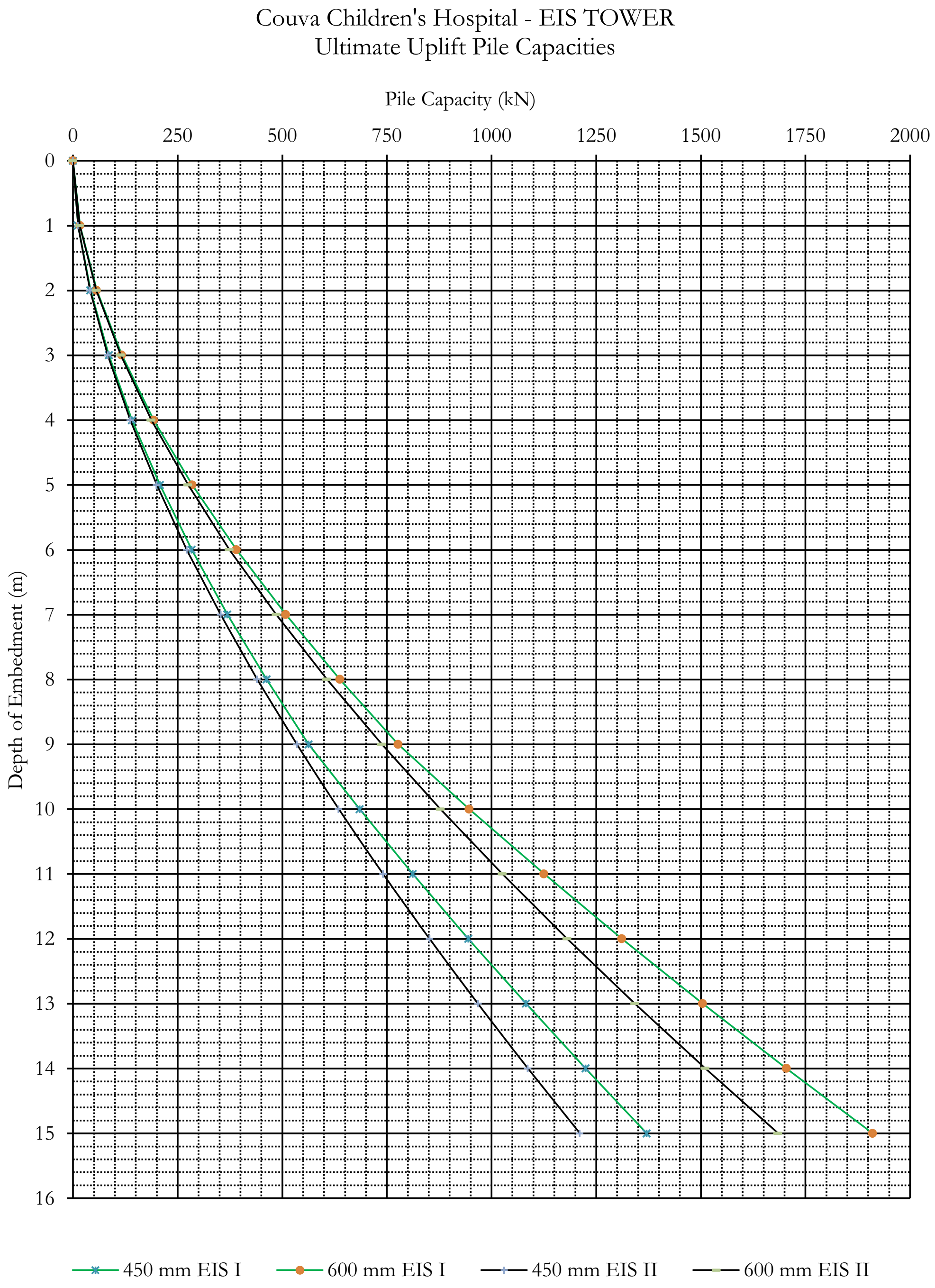


FIGURE 7.7 - ULTIMATE UPLIFT/TENSION PILE CAPACITY FOR 450 AND 600 MM PILES

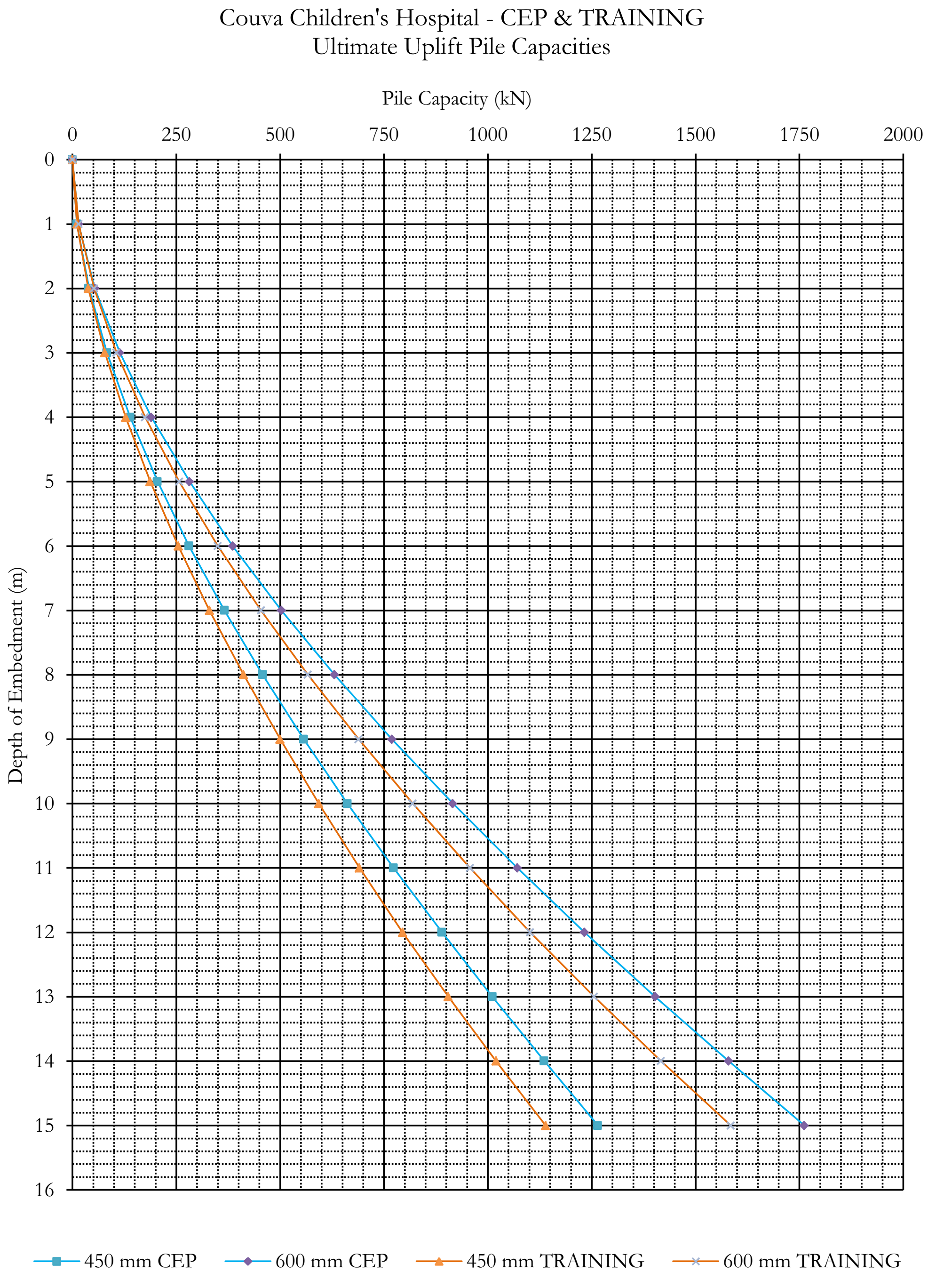


FIGURE 7.8 - ULTIMATE UPLIFT/TENSION PILE CAPACITY FOR 450 AND 600 MM PILES

7.5.4. Lateral Capacity of Piles

Lateral analyses were determined for the PED Tower, EIS Tower I, CEP Tower, and TRAINING CENTRE assuming the following Moduli of Subgrade Reaction:

Horizon I/II: **75,000 kN/m^2/m**

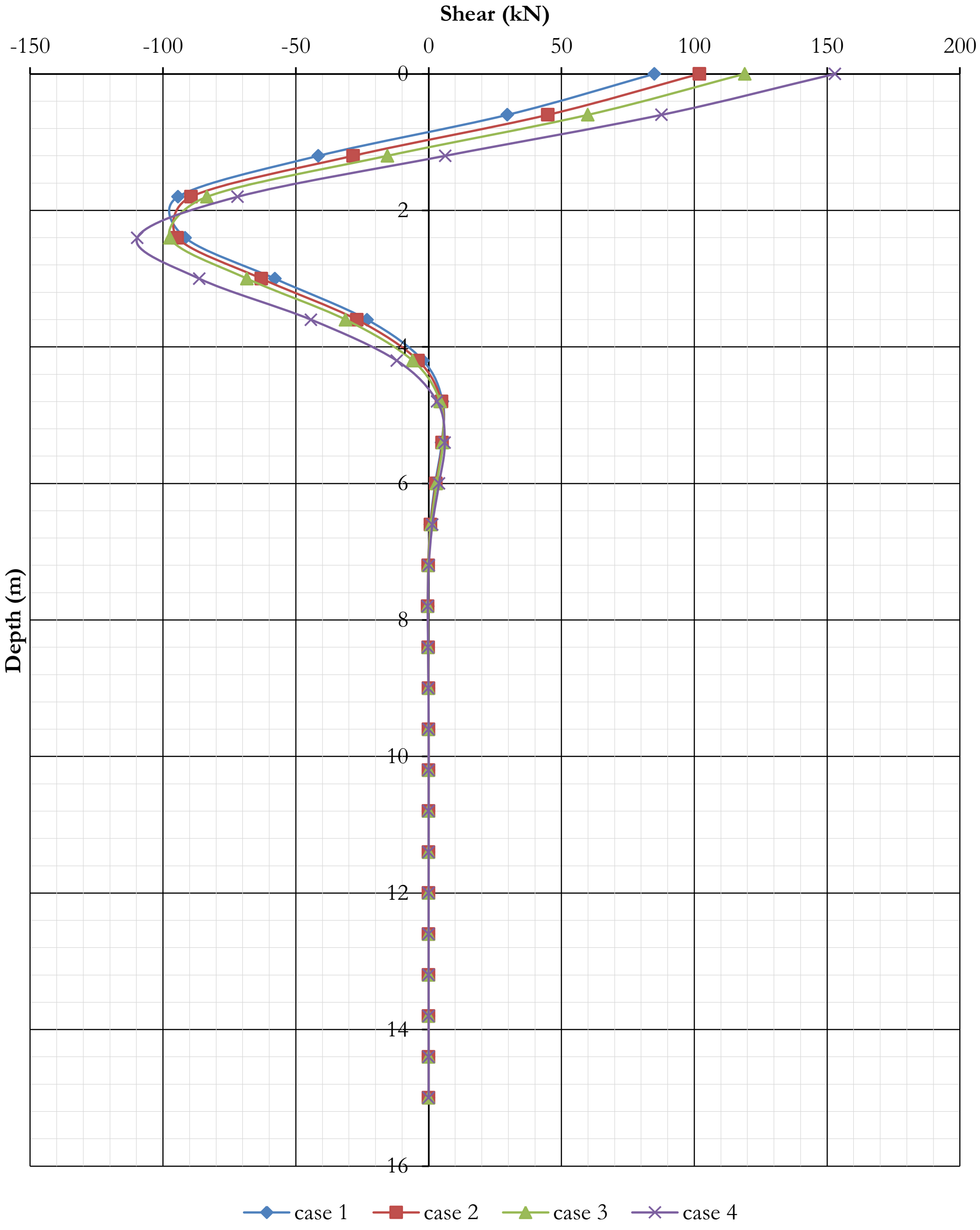
Horizon III: **100,000 kN/m^2/m**

A range of lateral loads and moment combinations (without load factors) were assumed in the analyses. Loads were so chosen that the maximum resultant nominal moments were lesser than the moment capacities of the piles.

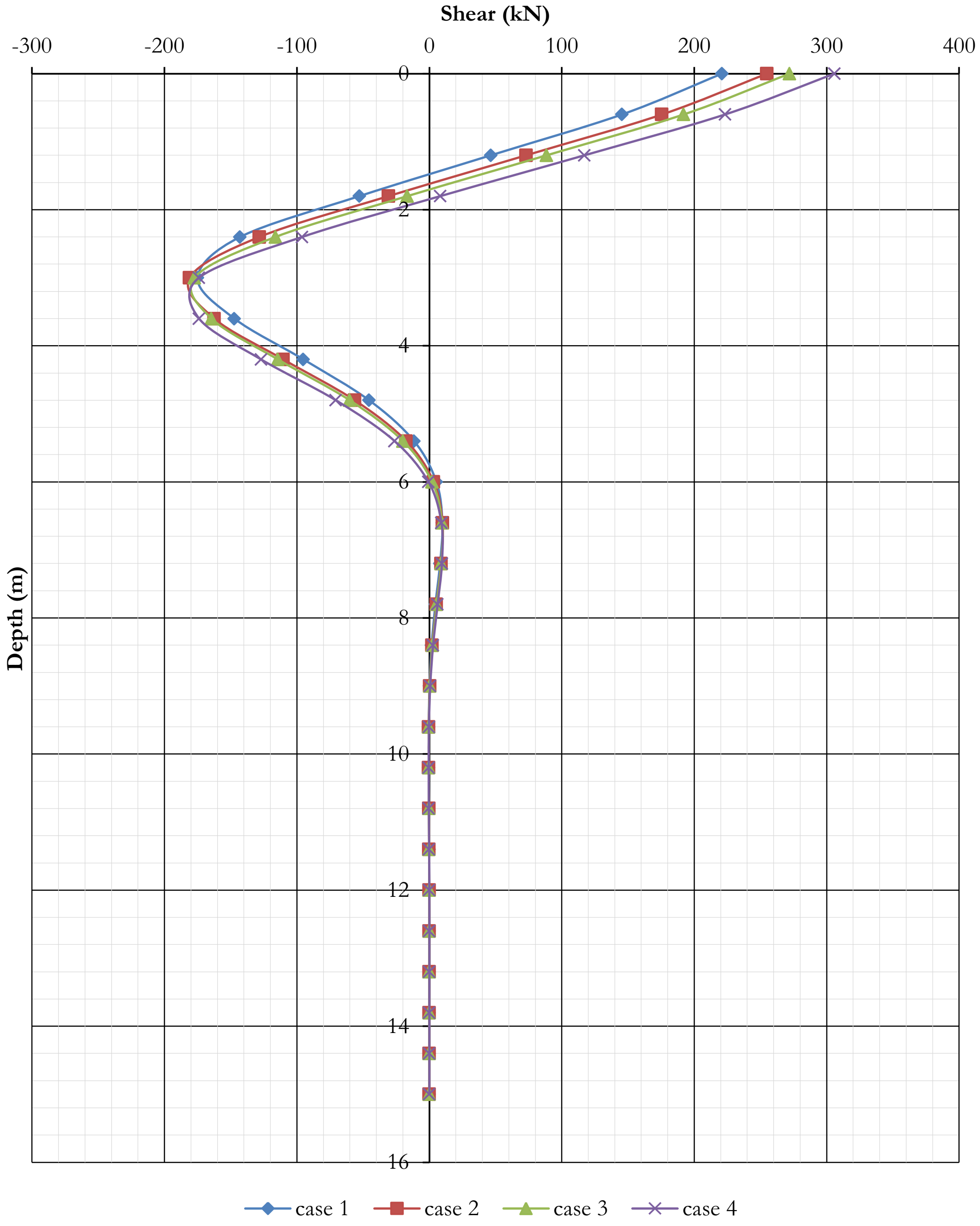
The following table indicates service loads which may be applied to the pile caps. The corresponding pile head deflections are also presented.

Scenario	**Pile Diameter (mm)**	**Unfactored Lateral Load (kN)**	**Unfactored Moment (kN-m)**	**Pile Head Deflection**
1	**450**	50	80	Approximately 4.5 – 5.0 mm
2		60	70	
3		70	60	
4		90	50	
1	**600**	130	120	Approximately 5.0 mm
2		150	100	
3		160	80	
4		180	50	

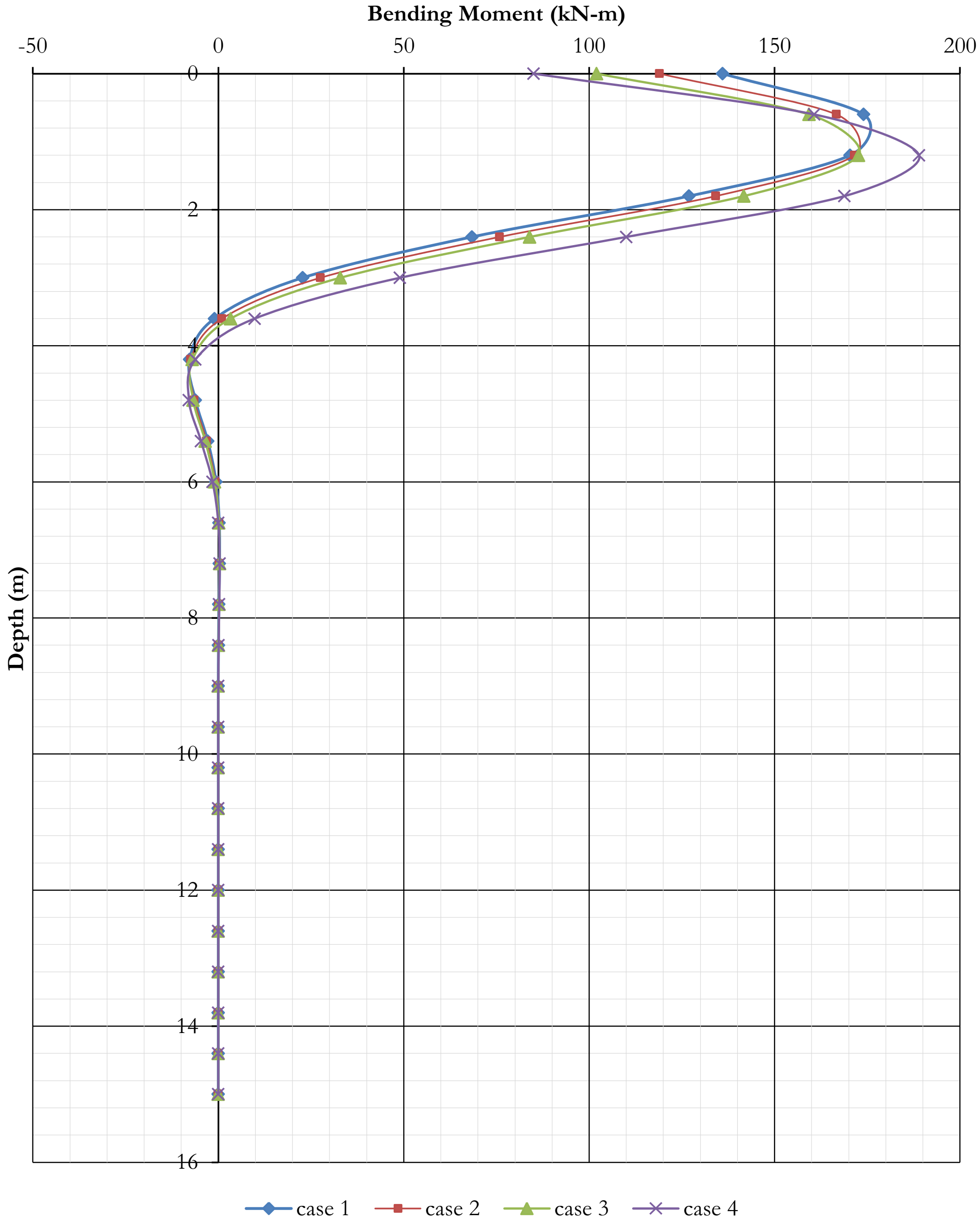
Shear Forces for 450 mm Piles within EIS I, PED, CEP, and Training Centre Tower Profiles



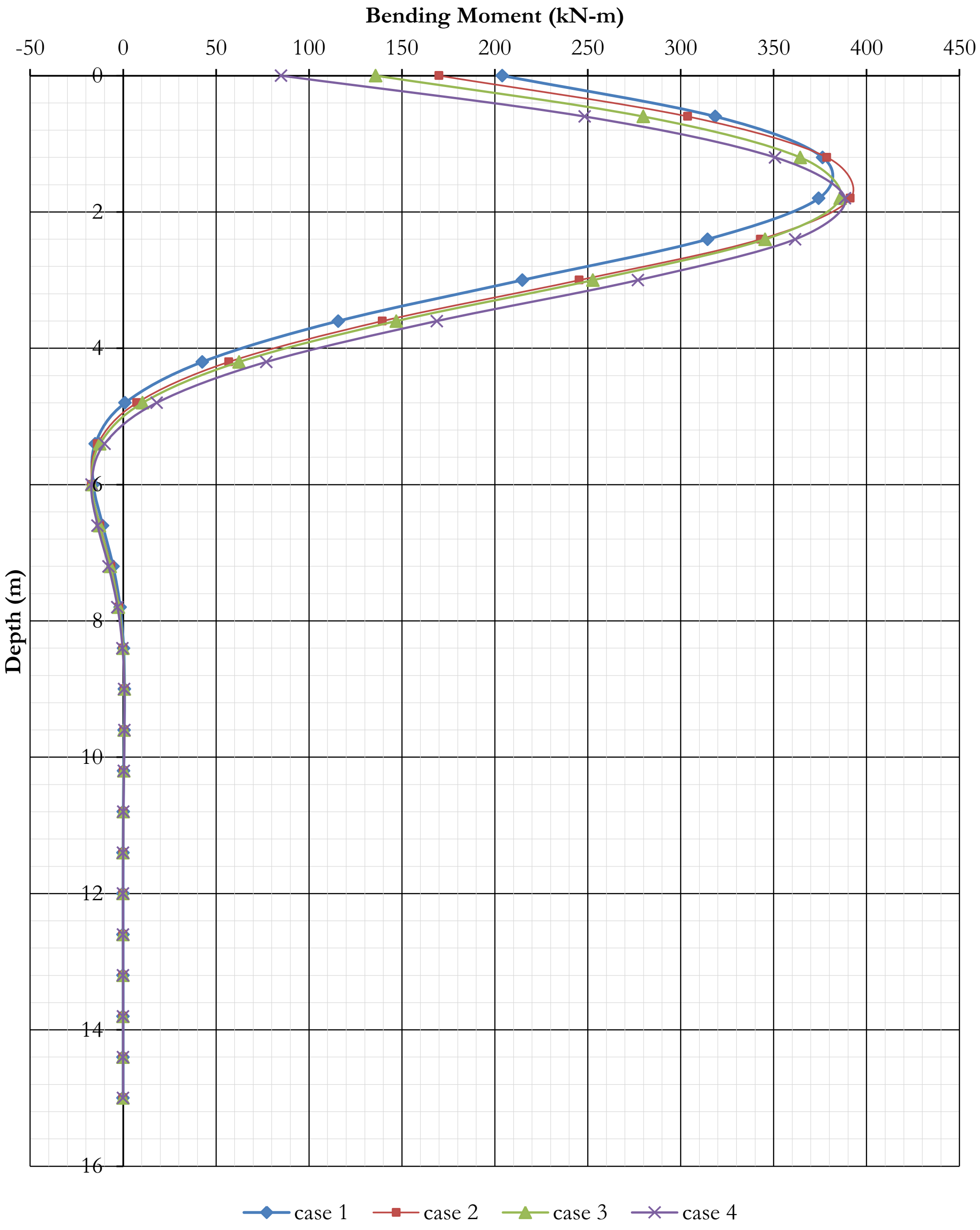
Shear Forces for 600 mm Piles within EIS I, PED, CEP, and Training Centre Tower Profiles



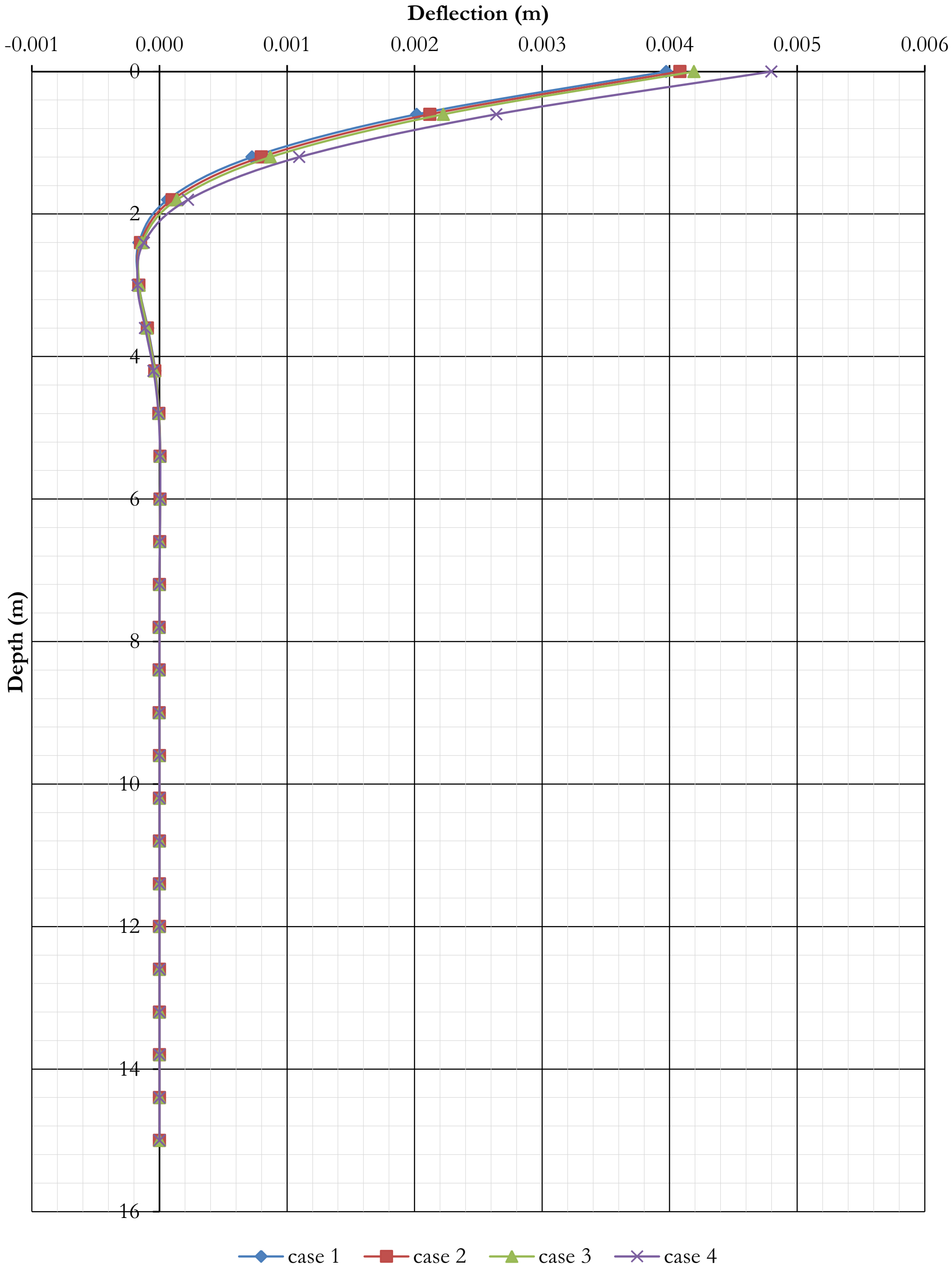
Bending Moments for 450 mm Piles within EIS I, PED, CEP, and Training Centre Tower Profiles



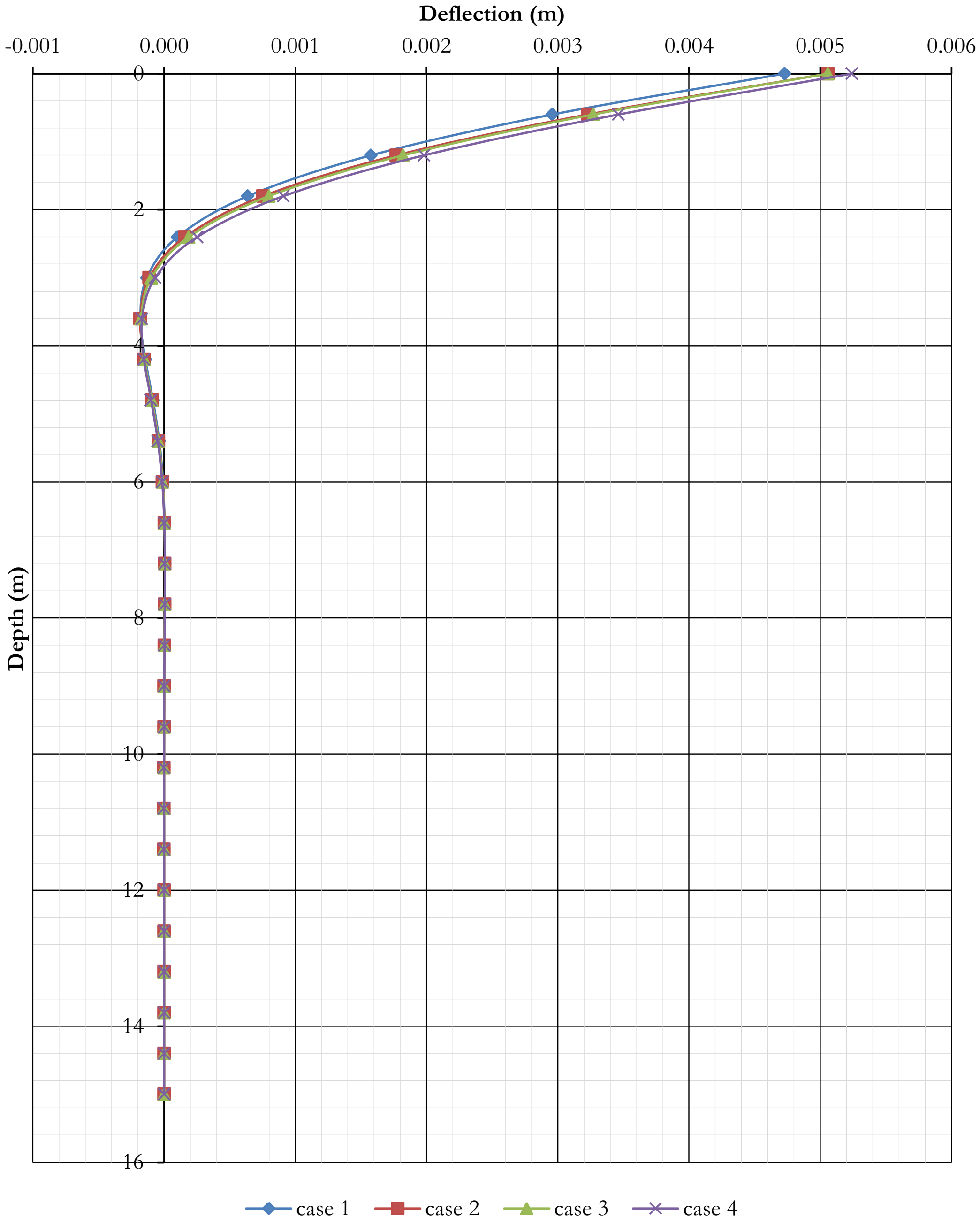
Bending Moments for 600 mm Piles within EIS I, PED, CEP, and Training Centre Tower Profiles



Lateral Deflections for 450 mm Piles within EIS I, PED, CEP, and Training Centre Tower Profiles



Lateral Deflections for 600 mm Piles within EIS I, PED, CEP, and Training Centre Tower Profiles



Due to the lower strengths determined within the vicinity of the ADULT Tower and EIS Tower II profiles, reduced Moduli of Subgrade Reaction have been provided.

The following table indicates capacities for these profiles.

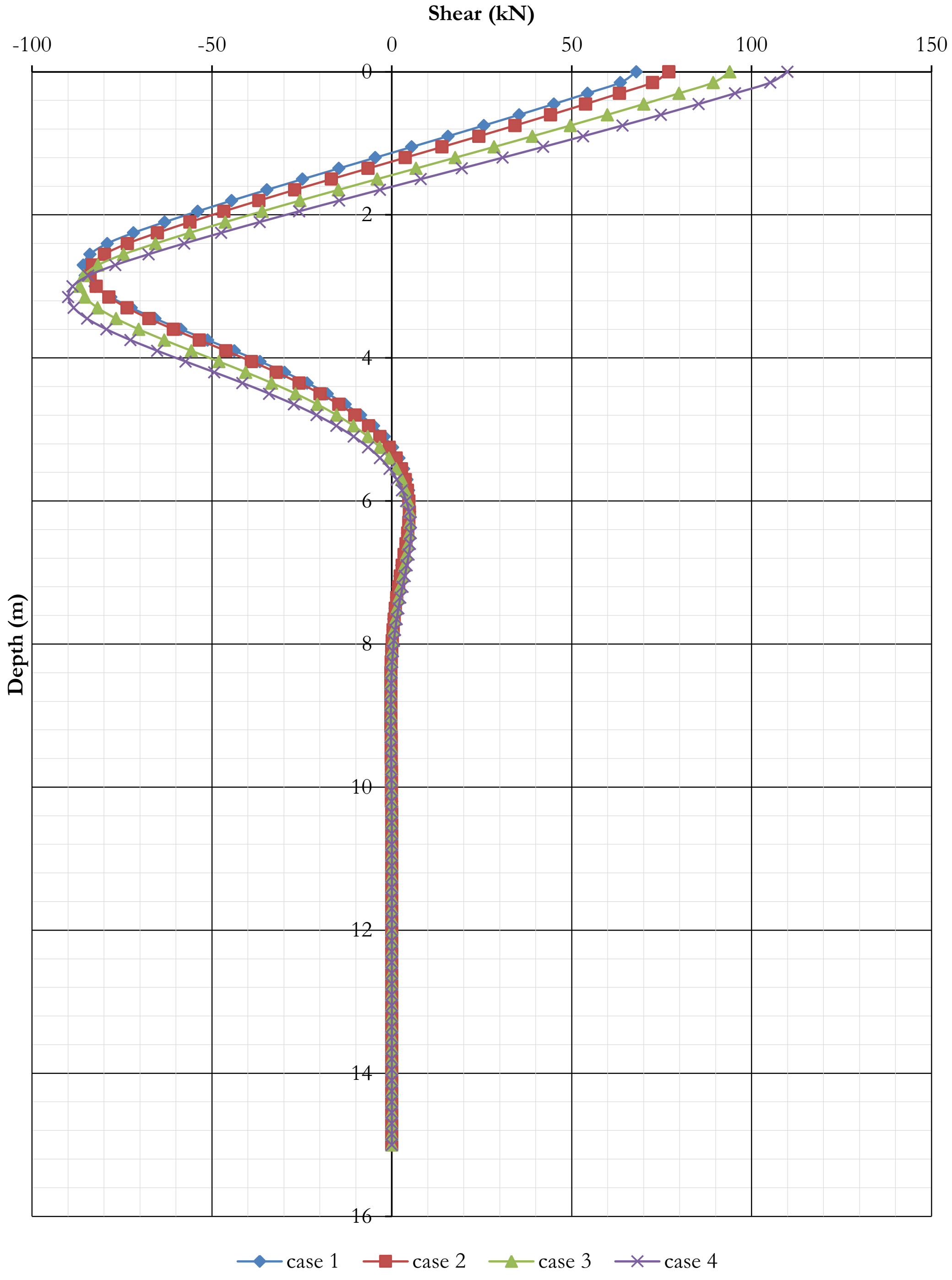
Horizon I/II: **40,000 kN/m^2/m**

Horizon III: **80,000 kN/m^2/m**

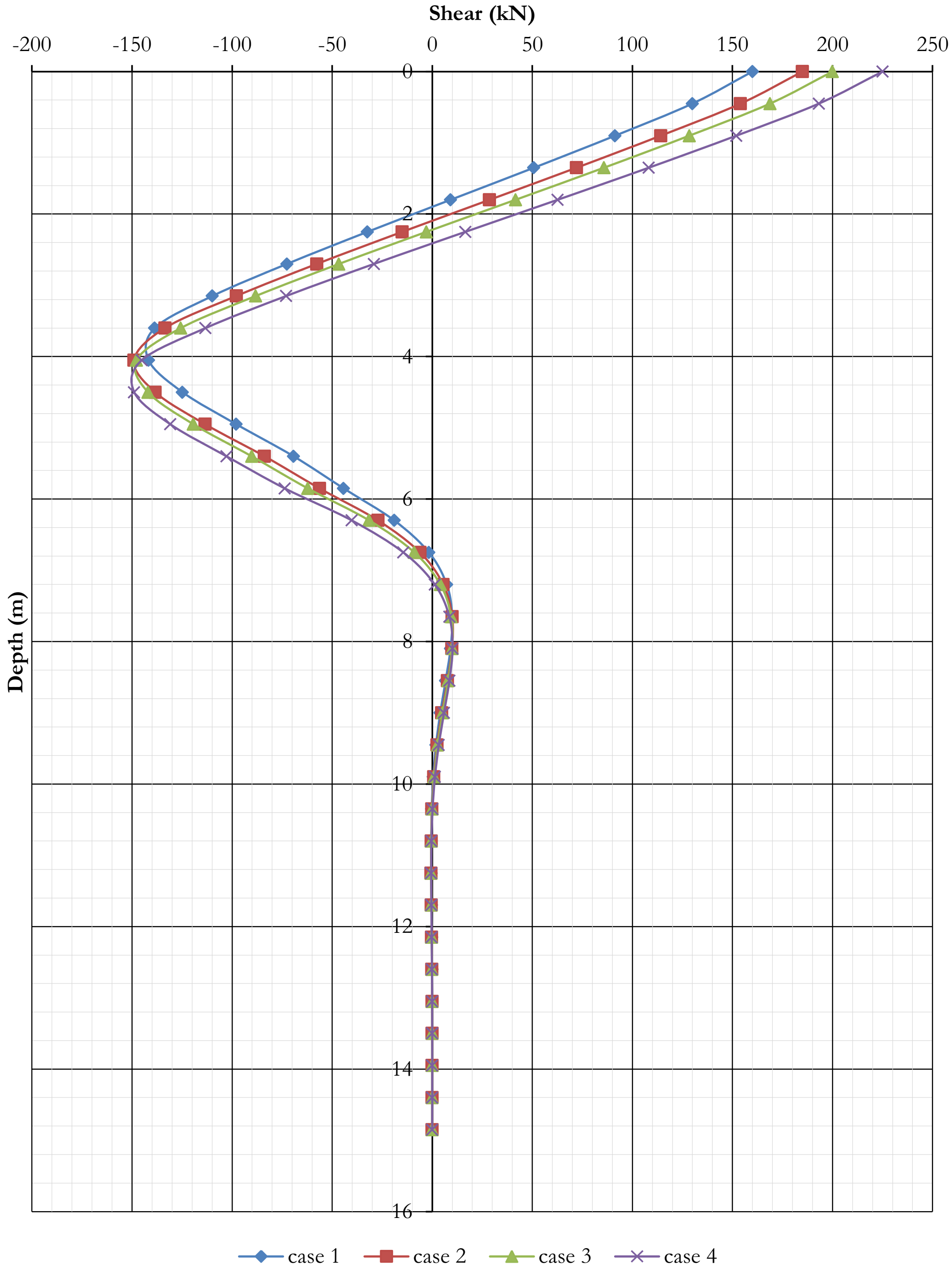
The following table indicates service loads which may be applied to the pile caps with their corresponding estimated deflections.

Scenario	**Pile Diameter (mm)**	**Unfactored Lateral Load (kN)**	**Unfactored Moment (kN-m)**	**Pile Head Deflection**
1	**450**	40	80	Approximately 6.0 mm
2		45	70	
3		55	60	
4		65	50	
1	**600**	95	120	Approximately 7.0 mm
2		110	100	
3		120	80	
4		130	50	

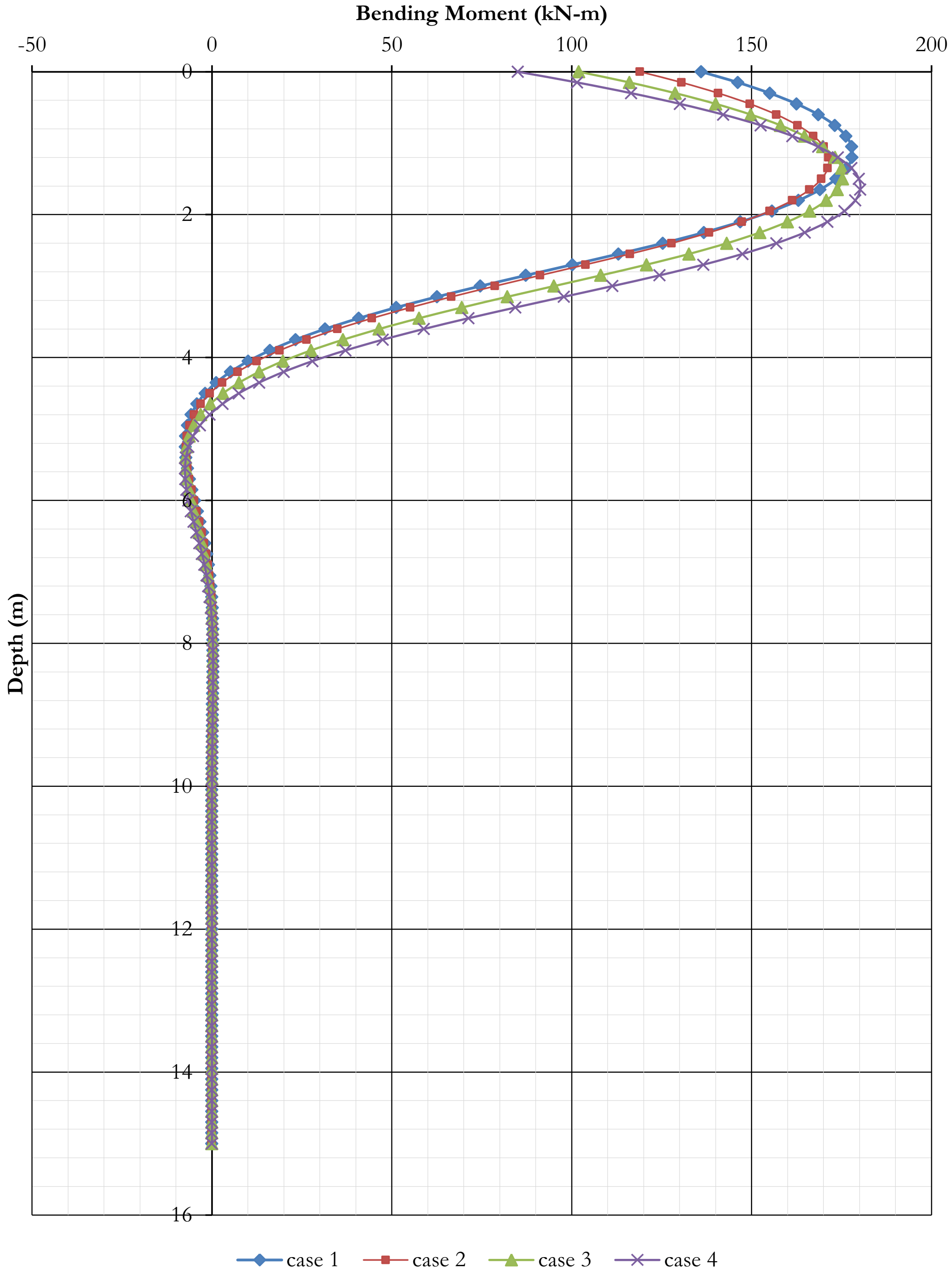
Shear Forces for 450 mm Piles within EIS II and ADULT Tower Profiles



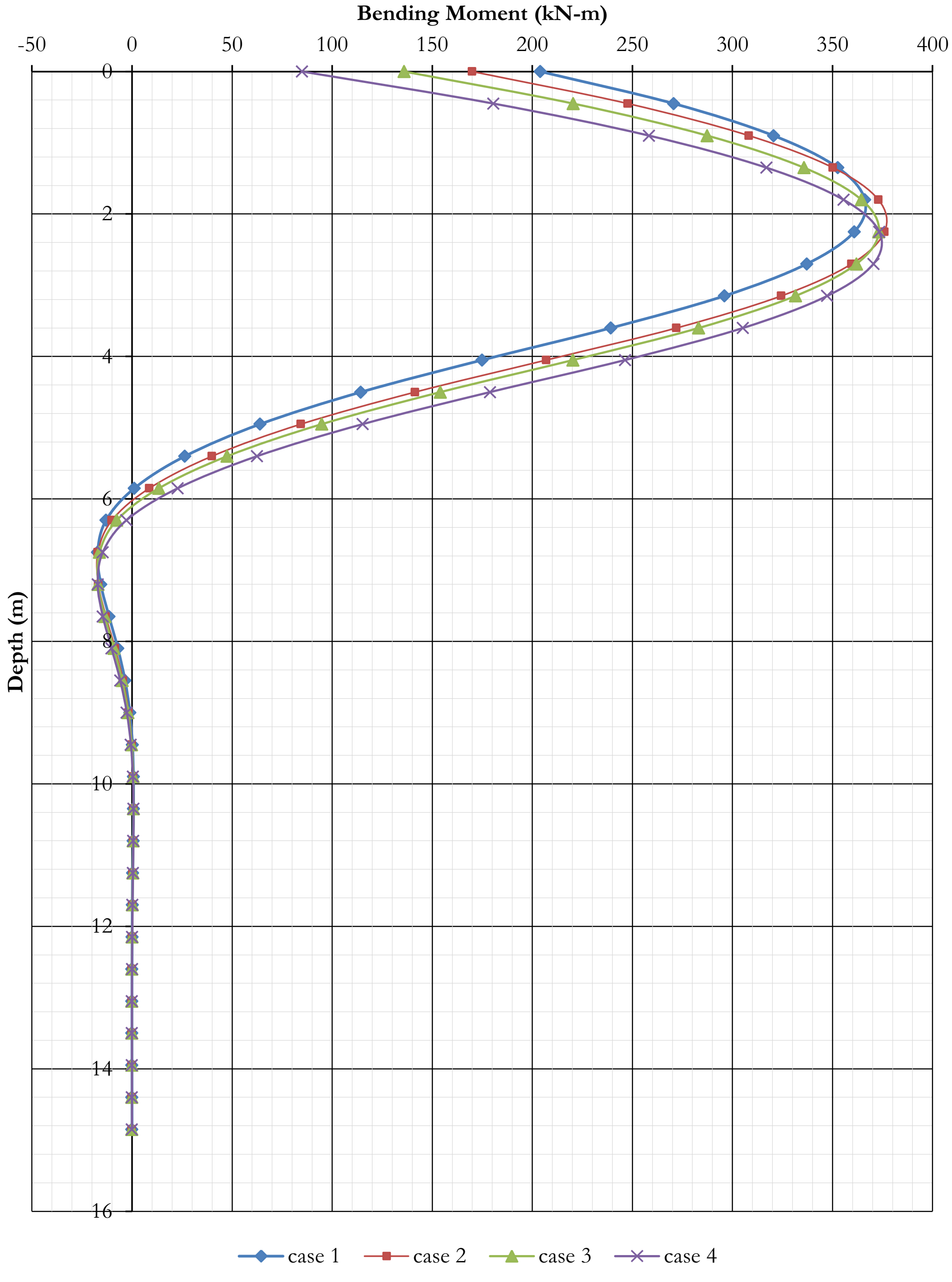
Shear Forces for 600 mm Piles within EIS II and ADULT Tower Profiles



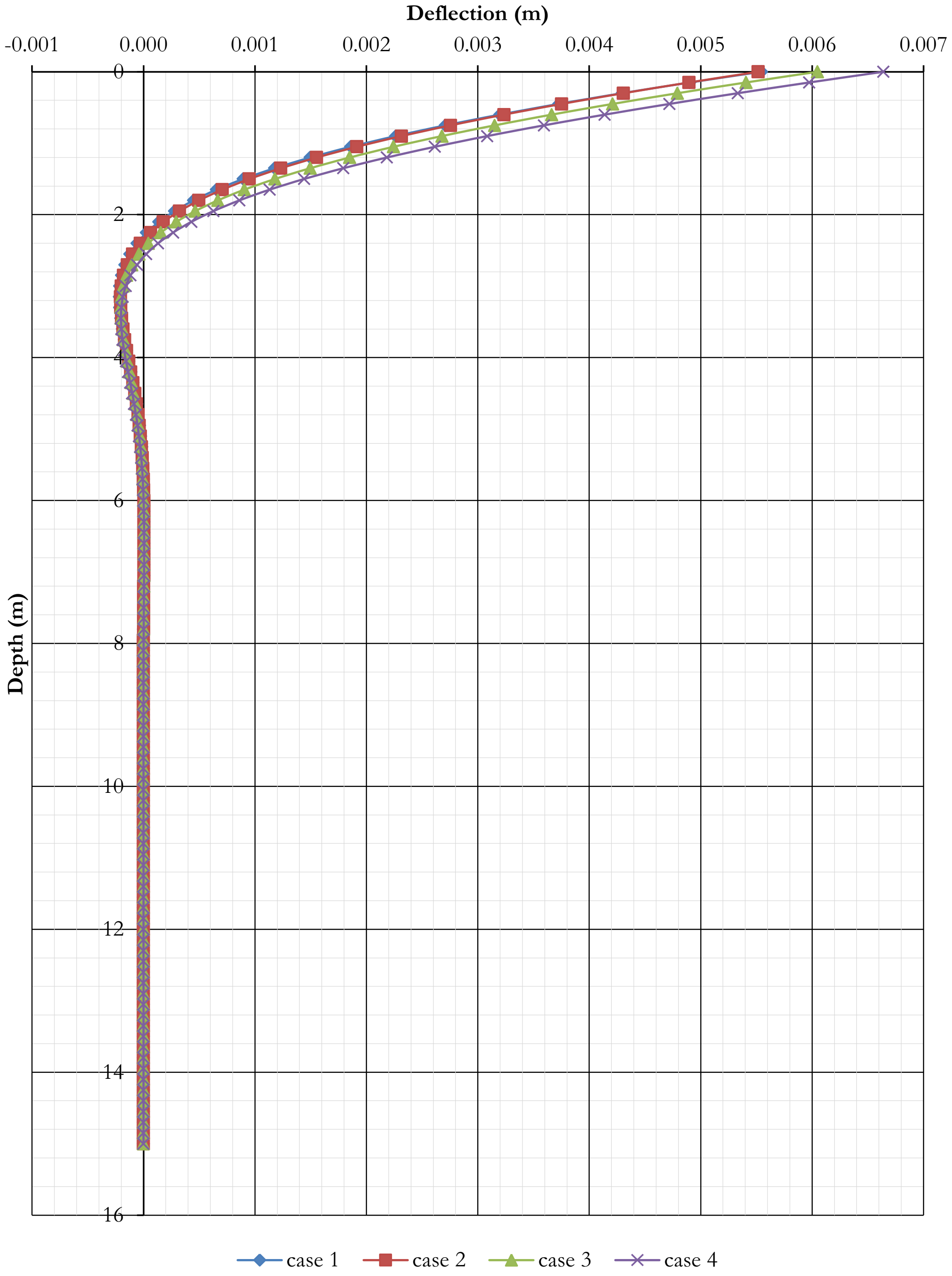
Bending Moments for 450 mm Piles within EIS II and ADULT Tower Profiles



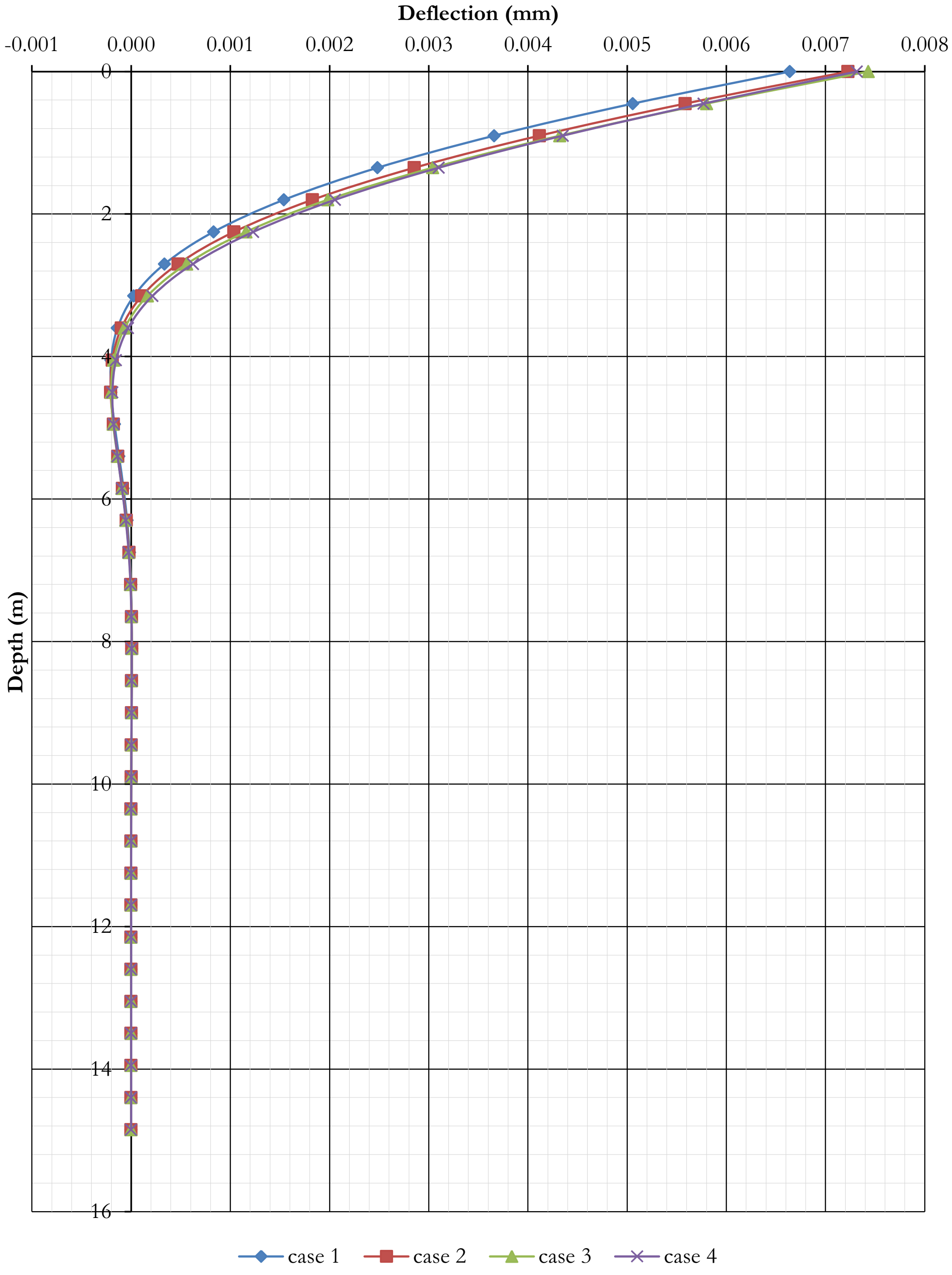
Bending Moments for 600 mm Piles within EIS II and ADULT Tower Profiles



Lateral Deflections for 450 mm Piles within EIS II and ADULT Tower Profiles



Lateral Deflections for 600 mm Piles within EIS II and ADULT Tower Profiles



7.5.5. Pile Load Testing

Pile testing is a fundamental part of the pile foundation design and is the most effective means of dealing with uncertainties that inevitably arise during design and construction of piles. We therefore recommend that a minimum of one (1) Maintained Load (ML) test be carried out under each structure in accordance with ASTM D1143-81 to a maximum Factor of Safety of 3.0

Figure 7.9 - Axial Pile Load test being carried out on a 600 mm CFA Pile (EISL 2010).

7.6. *Retaining Wall Design*

7.6.1. Stability Analysis

Stability calculations for a 3.5 - 4.0 m high cantilever retaining wall would thus be performed for the soil conditions at the site.

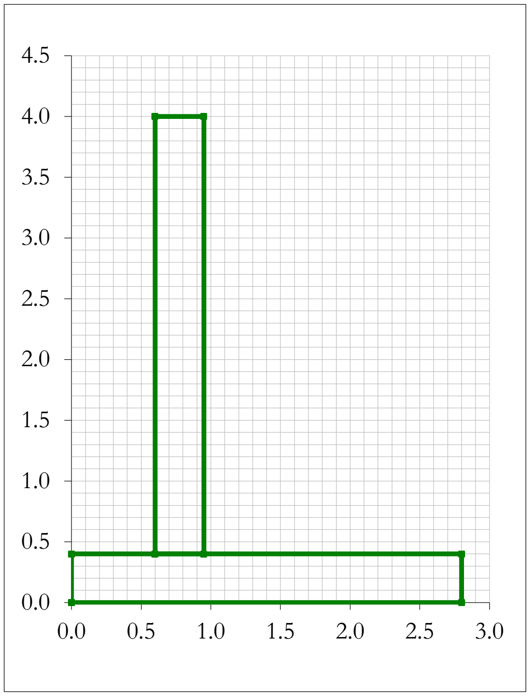


Figure 7.10 Trial wall section

7.6.2. Lateral Earth Pressure

The lateral earth pressure variation used in this analysis is based on the angle of friction of sand backfill material, where the worst case friction angle for a fine to medium grained sand is **30°**. Using the friction angle of the **backfill** to design retaining walls is typically predicated on the premise that the active failure wedge can develop within the backfill zone. However, in cases where the backfill is contained in a narrow silo/chimney zone behind the wall such that the active wedge cannot fully develop and is trucncated ($45-\varphi/2$ wedge), the friction angle of the retained original earth-material must be used; in this case the highly plastic clays of residual friction angle **~12°.** In cases such as these the earth pressure coefficients Ka and K_0 can be over 100 % greater for the clay dominated back-fill condition. This condition/configuration is illustrated in Figure 7.11.

Given the highly fissured nature of the near surface clay soils, we can recommend that the active earth pressure coefficient Ka for long-term drained analysis be based on the effective/softened friction angle of the retained clays. However, under earthquake conditions we can recommend that the Mononobe-Okabe modification of the Ka be used based on the backfill material φ^o and a Zone 3 horizontal seismic coefficient. In cases where a wall might be considered restrained at the top or propped, the K_0 earth pressure coefficient applies.

For this site the upper 4.0 m of the soil profile a K_A factor of 0.66 should be utilized for the determination of the active earth pressure against the proposed retaining wall. The lateral earth pressure coefficient under the effect of seismic loading is determined using the Mononobe – Okabe theory and gives a K_{AE} factor of 0.74. (δ, β, $i = 0$, $k_v = 0$, $k_h = 0.3$)

The following other parameters are recommended for use in designing retaining structures:

- Coefficient of Passive Earth Pressure, K_P : 1.52
- Friction at concrete/insitu soil interface : $0.67\phi' = 8.04°$
- Friction at concrete/structural fill interface, δ : 20°
- Effective cohesion, c' : 0 kPa
- Sand Backfill Unit weight, γ_F : 18 kN/m^3

7.6.3. Hydrostatic Pressure

The retaining walls appear to be part of the structure and thus drainage through the wall may not be allowed, a full height of water should be assumed to contribute to lateral pressure behind the wall. For sections that are allowed to drain through the wall, the height of water that would contribute to the lateral forces of the wall should be taken as the height to the first level of weep holes.

If drainage is required to relieve hydrostatic pressure behind the retaining wall which is critical to the stability of the structure. The specification requires backfilling with granular material, with the interface between the granular material and natural material separated by a geotextile membrane or blockwork wrapped with geotextile. The selected material should meet the following requirements:

- All material should pass the 75mm sieve
- Not more than 40% of the material should pass the No. 40 sieve
- Not more than 10% of the material should pass the No. 200 sieve
- Liquid limit < 27
- Plasticity Index < 5

7.6.4. Surcharge Pressure

The surcharge load chosen should take into account both dead load and live load surcharges. A minimum surcharge load of 10 kN/m2 is recommended to contribute to lateral forces against the wall.

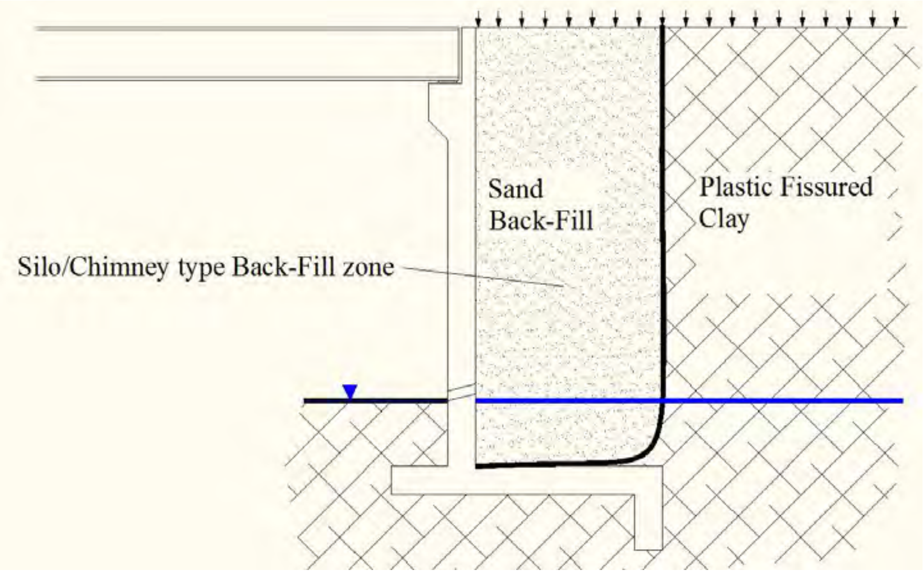


Figure 7.11 Lateral earth pressure; Silo/Chimney back-fill condition.

7.6.6. Retaining Wall Piled Foundation

Stability checks performed without piled foundations on the section shown in Figure 7.10 revealed that the wall fails to attain sufficient factors of safey in sliding and bearing. Table 7.4 provides the Factor of Safety for each failure mode.

Unless the retaining wall is designed as part of the building Structure where the top and base are propped, a piled foundation would thus be required for retaining soil of heights from 2.0 to 4.0 m.

Table 7.3 Stability analysis of 4.0 m high retaining wall

Stability Check	Factor of Safety (FOS)
Sliding	0.4
Overturning	3.0
Bearing	0.8

The length of the base of the wall is selected such that the piles in the foundation are only subjected to compressive forces rather than both compressive & tensile (uplift) forces.

7.7. *Seismic Site Classification- ASCE-05*

The site classes in the IBC ASCE7-02 and ASCE7-05 directly impacts the seismic design force for all buildings weather low-rise or high rise building. In regions of low to moderate seismicity a difference is site class may change the seismic design category (SDC) resulting in a difference in design and detailing requirements.

Any soil profile with more than 10 ft of soil having the following characteristics

- Plasticity Index >20
- Moisture Contents >40%
- Undrained Shear Strength <1000 psf is classified as Site Class E.

Based on the results of our field investigation and laboratory testing the Couva Children's Hospital Site is classified as **Site Class E**.

The earthquake maps provided by the University of the West Indies Seismic Research Centre http://www.uwiseismic.com should be reviewed carefully when developing the Design Response Spectrum for the site.

8. STABILITY OF SLOPES: RECOMMENDATIONS FOR CUTS AND LOCATION OF UTILITIES

8.1. *Existing Slope Angles and CUT Slopes*

The existing slope angles at the site measure in the rainy season between 9° - 12° which suggest the slopes to be at the residual slope angle (Figure 8.1). Because of the rolling nature of the topography, cuts of significant depth (>3.0 m) will be required. Extensively fissured stiff to hard clays of the type found in this area are prone to swelling and softening on removal of overburden and therefore careful consideration must be given to the selection of design CUT slopes.

Removal of overburden in a cutting causes a reduction in total stress in the surrounding soil, with consequent immediate reduction in pore pressure. Since the pore pressures thus established are less than the steady state condition for the ground, there will be the tendency for the soil to suck in water increasing pore pressure and reducing its shear strength.

The long term stability of stiff fissured clays is therefore controlled in part by their softened/remoulded strength, and the rate at which this softening takes place depends on the availability and access of water. When a slip occurs there is a further reduction in shear strength (to residual strength) along the slip plane, due to particle orientation.

A slope in clay which has swollen to its softened strength will be most susceptible when the pore pressure reaches its maximum value. Temporary high pore pressures can be induced near to the surface by intensive rainfall and the degree and depth of infiltration achieved will significantly influence the long-term stability of the cuts.

As recorded by EISL over time, serious instabilities have occurred in cuttings in these soil types in the relatively short time (approx. 5 years). Slopes steeper than 1:3 and the clay revealed by the slips exhibits very extensive fissuring.

Large cracks greater than 25 mm in width and 3m in depth occur in a direction perpendicular to the line of the cut. These show weathering along their faces and organic matter has been washed into them. They no doubt act as water channels during periods of heavy rainfall when it is likely that a perched water table with associated high pore pressures is established near to the surface.

The cracks would appear to explain why the life of the cuts is relatively' short. Their direction indicates that they have not been induced by the excavation but they are likely to have been the result of severe desiccation.

We therefore recommend that all CUT slopes be constructed to a maximum of 1V:3H and immediately vegetated, keeping all surface drainage away from these slopes.

8.2. *Effect on Slope Movement by Leaking Utilities*

New construction close to or near a slope undoubtedly allows the land to become irrigated. Careful planning is therefore required to direct drainage away from the slopes. Slope vegetation with deep root systems helps to anchor the soil and reduce the likely movement which may develop due to over-wetting.

Leaking water mains are the main cause of failures along roadways in Trinidad. A typical Failure is presented in Figure 8.2. We recommend that utilities (water lines, sewer lines) be design such that access to likely leaking connects are easily accessible and are kept away from foundations.

8.3. *Use of CUT Material and Imported FILL on Slopes*

These plastic clays are **not** recommended for use as structural FILL, possibly only for landscaping. Specifications for structural backfill and sand backfill been provided.

Structural Backfill

- Free draining, granular material, free of excess moisture, muck, roots, sod or other deleterious materials (i.e natural gravel or crushed stone).
- Maximum particle size of 75 mm with ≤ 15% passing the 75 µm sieve
- Liquid Limit ≤ 30%.
- Lifts should be no greater than 200 mm compacted to 95% the material's Modified Proctor value.

Sand

- Gradation:

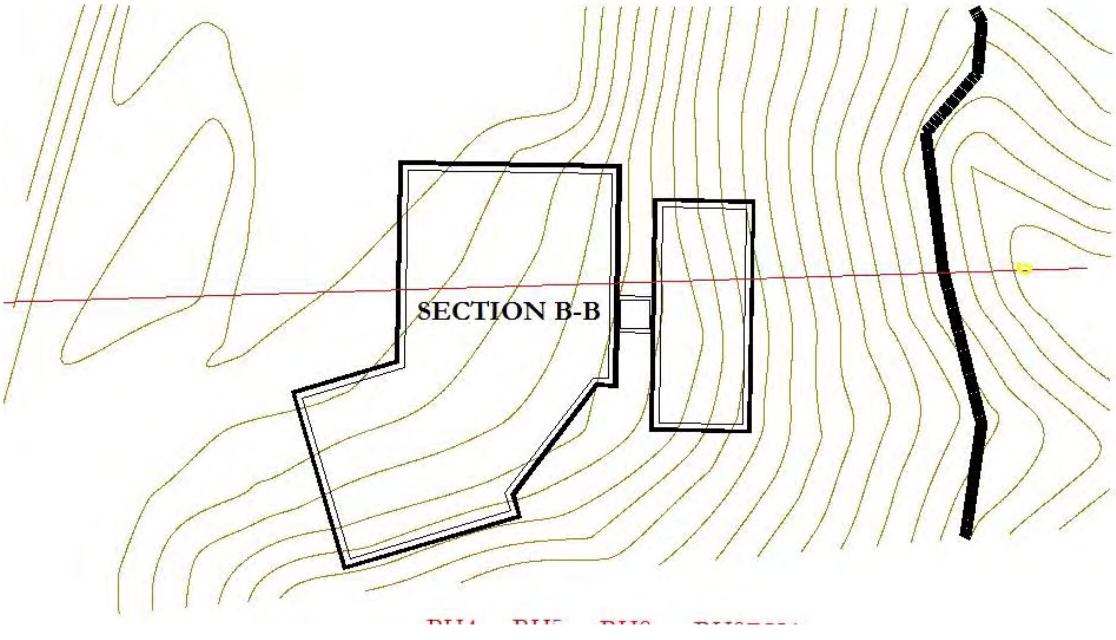
Sieve Size	Alternate Sieve Size	% Passing
9.5 mm	3/8"	**100**
4.75 mm	No. 4	**95-100**
0.600 mm	No. 30	**90-100**
0.300 mm	No. 50	**40-95**
0.150 mm	No. 100	**10-30**
0.075 mm	No. 200	**5-15**

- Plasticity Index < 5
- Lifts should be no greater than 150 mm compacted to 95% the material's Modified Proctor value

A minimum depth of excavation of 1.0 m is required on slopes prior to the placement of any imported FILL. It is recommended that these excavations be assessed and supervised by a competent Geotechnical Engineer. The existing subgrade must be prepared and compacted to 95% Standard Proctor

The stockpiling of material at the top of slopes is not recommended unless the area is prepared or strengthens, eg. Use of Geogrids.

.


SECTION B-B

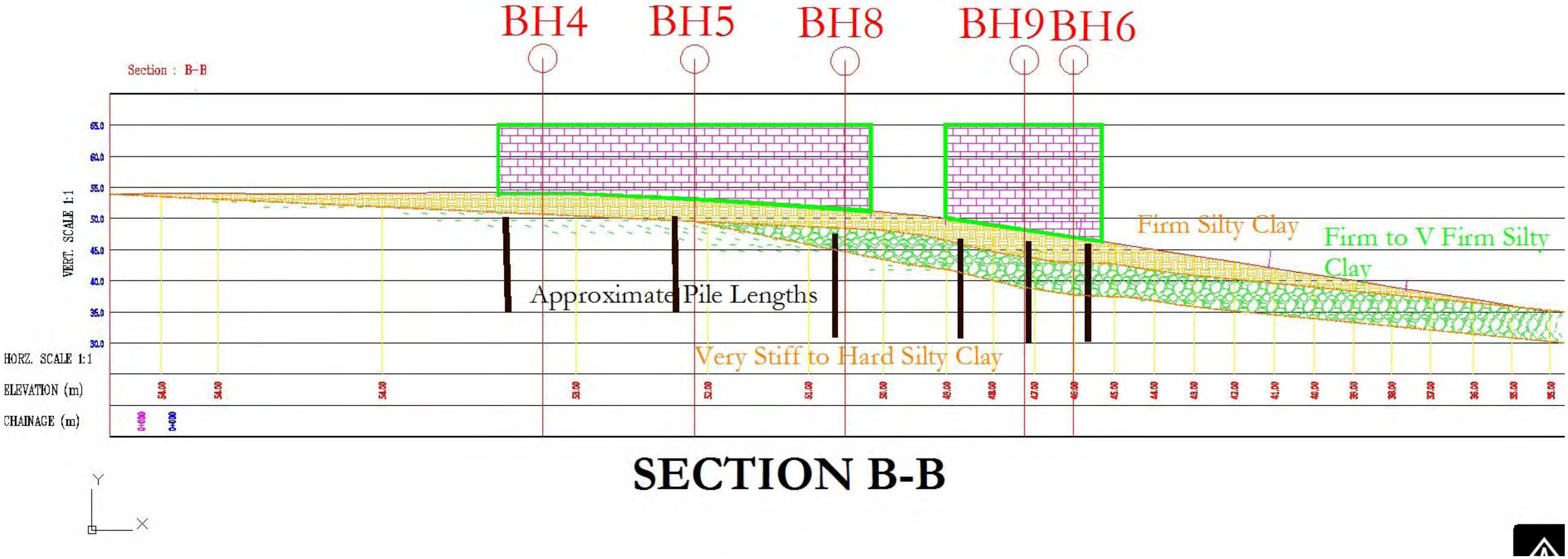


Figure 8.1 Cross-Section developed from Topographical Survey with residual slope angle at 9°.

Figure 8.2 Typical Landslide Failure along Secondary Roads in Trinidad caused by leaking water mains.

9. DESIGN OF FLEXIBLE PAVEMENT (AASTHO)

9.1. ***CBR & Resilient Modulus***

The AASHTO Guide for the design of Pavement Structures (1986) of the American Association of State Highway Officials, Washington DC, amongst other guides across the world, uses the Structural Number (SN) approach for pavement design.

This approach has a number of advantages, namely simplicity of use, suitability to obtain a quick design and ability to incorporate local knowledge into designs regarding climate, material behaviour and performance. In addition, new materials can be readily incorporated in the SN approach.

The SN is an empirical design approach and thus has several limitations that must be recognised. It does not necessarily provide the correct combinations of layer types to obtain optimal pavement performance and can lead to unbalanced pavement structures. For this reason, it should not be used by inexperienced designers and its application is limited to lighter pavement structures.

The SN design procedure requires material type and quality to be known for inclusion in a pavement structure. Provided the quality of the material and thickness of each individual layer can be estimated, the Structural Number (SN) for the overall pavement structure can be calculated using "Structural Layer Coefficients" assigned to each material type. The overall pavement structure's capacity is calculated as the sums of the products of structural layer coefficients and thicknesses of the individual layers.

All material exhibits some deformation (strain) when subjected to loads per unit area (stress). As long as the stress is less than the strength, no failure is likely to occur. The relationship between the stress and strain can be expressed as resilient modulus (MR). It is well known that most paving materials experience some permanent deformation after each load application. This might lead to rutting of asphalt pavements. Therefore the value of resilient modulus of each materials and supporting sub-grade soils is desired.

The results of Dynamic Cone Penetration and CBR tests are presented in Appendix C and summarized below

Layer	**CBR (%)**	**Resilient Modulus, Mr (psi)**
Clay Subgrade	2-3%	-

For road construction on these plastic clays (subgrade) we recommend the use of a capping layer. Sand is the most suitable material to be used as a capping layer.

9.2. *Factors Influencing Subgrade Compaction*

Effective compaction of these medium to high plastic clays is a function of both plant type and fill type. Plants achieving specification and productivity targets for one fill may not do so for another. The depth of spread of compactive effort is related to the mass per meter roll of the compaction plant. The heavier the plant the deeper the spread of compactive effort into the fill. Likewise the slower the speed at which the equipment operates the greater the compactive effort imparted. Thinner layers promote the uniform penetration of compactive effort and should be carried out between 100- 300 mm with 4-8 passes depending on the variability and distribution observed.

9.3. *Subgrade Preparation*

ASTM 698 Standard Method of Laboratory Compaction for soils was used for testing bulk samples retrieve from the test pits, some of which are presently on-going. These results are presented in Appendix B and summarised below which suggest significant variation.

SampleID	**Maximum Dry Density (kg/m^3)**	**Optimum Moisture Content (%)**
Testpit 1(1.37 m)	1800	17.2
Testpit 3 (2.37m)	1580	26.0

After all required stripping and excavation has been carried out, all areas beneath any proposed road way and foundation slabs shall be moistened or dried to near optimum moisture, scarified a depth of at least 125 mm and compacted to at least 95% maximum dry density as determined by ASTM D 1557.

9.4. *Geogrids or Geotextiles for added Subgrade Strength*

To strengthen the subgrade a geotextile or geosynthetic fabric can be added. A fabric and/or grid is placed over the subgrade soil before the select sub-base material is brought in. A woven or nonwoven fabric (geotextile) placed on the subgrade becomes a separator between the weak soil and the new material placed above it.

The pumping action occurs when traffic passes over the surface and the road deflects under the load. Pressure from the load will cause water in the subgrade to rise to the surface and carry fine soil particles with it. This will contaminate and weaken the new material very quickly and make it weak, undrainable, and unstable. A fabric prevents this by filtering out the fine soils while allowing water to pass through it and drain out of the clean, granular material above.

10. CONCLUSIONS AND RECOMMENDATIONS

1. The soil types are summarized in Table 3.1. The C2 soil types, which make up the majority of the area can be classified as soils of high plasticity, which are well known for their instability on slopes and relatively high activity and expansive potential. These soils are then expected to pose problems associated with low CBR (bearing capacity) values within saturated subgrades.

2. Foundations placed on potentially expansive soils fall in a very special category of foundation design as such soils can experience significant volume changes (shrink/swell) and swelling pressures with changes moisture content. Such volume change potential is typically characterised by soil plasticity parameters and the expected values of moisture change (climatic or manmade). Although Bearing Capacity and Settlement can be computed based on typical strength and compressibility parameters (as described in the preceding sections), the effects of swelling pressures and unsaturated volume change are difficult if not impossible to compute based on linear elastic and/or limit state plastic analyses

3. The soils encountered over the project area were consistent with that suggested by desktop studies of the geology, soils, vegetation and climate of the area. The geomorphological form is that of dissected peneplains, where interconnected ridges are flanked by shallow slopes (12° - 18°), low valleys and seasonal streams. The soil type was predominantly silty clays of medium stiff to stiff consistency at the near surface, becoming hard silty clay shale with sands at depth.

4. The observed uniformity of the soil stratification over the project area suggests that the adopted statistical approach to soil parameter estimation and design to be an appropriate methodology.

5. Interpretation of the field SPT and consolidation testing indicate the predominantly clay formations to be highly over consolidated with Over Consolidation Ratios (OCR) in the range 3.5-7.0. Such high OCRs suggest that settlements under lightly loaded foundations and embankments are likely to be within tolerable values. However, roadway formations within cuts in excess of 6m are likely to undergo swelling, the majority of which is expected

to occur during construction.

6. Consolidation/Swell pressure testing indicates that swell pressures in the range 60-90 KPa are characteristic of the soils over the project area. However, the expected field values would be dependent on the initial and final soil moisture states.

7. Field SPT testing results of the soils within the project area suggests soils of high undrained strength and low compressibility. This typically suggests that shallow foundations might be appropriate for structural foundations. However, the highly overconsolidated fissured soil fabric and commensurate low drained strength of these soils make them particularly vulnerable to sliding instability even at relatively low lateral stress states. As a consequence we can recommend that all structures that are expected to support lateral earth pressures (retaining walls and abutments) be founded on piles.

8. In the absence of a well-defined site development plan and the proposed selected FILL type and type of retaining walls proposed, recommendations will only be provided for reinforced concrete cantilever retaining walls with a maximum height of 3.0 – 4.0 m as presented in Table 7.1.

9. The lateral earth pressure theory to be used in this analysis is based on the **angle of friction** of the proposed backfill material,. Using the friction angle of the **backfill** to design retaining walls is typically predicated on the premise that the active failure wedge can develop within the backfill zone.

10. However, in cases where the backfill is contained in a narrow silo/chimney zone behind the wall such that the active wedge cannot fully develop and is trucncated (45-φ/2 wedge), the friction angle of the retained original earth-material must be used; in this case the highly plastic clays of residual friction angle ~12°. In cases such as these the earth pressure coefficients Ka and K_0 can be over 100 % greater for the clay dominated back-fill condition.

11. We can typically recommend the use of slabs on grade for non-critical structures such as car parks and storage warehouse type construction, where these slabs should be founded on 200-300 mm of cohesionless granular material, upon removal of this equivalent depth of clay topsoil (lower thickness in cut sections).

12. In cases where these slabs on grade are used, water bearing infrastructure (potable water pipes, sewer mains, underground drains) must not be located directly under these or in the immediate vicinity of such construction; leakage can cause strength reduction and/or associated volume change/heave. If such cases are unavoidable, we can recommended that that subsurface sand drains be implemented to direct water away from covered areas.

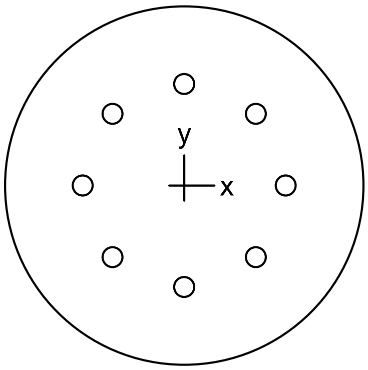
13. For the design of loaded slabs/strips on grade, we can recommend that the clay soils be modelled with a stiffness uniform stiffness modulus of 35,000 kN/m^3 under the cohesionless granular fill. In the cases where softening is likely, we can recommend a worst case scenario of a "step function" type stiffness transition from 35,000 kN/m^3 to 18,000 kN/m^3 anywhere along the loaded length.

14. Given the highly fissured nature of the near surface clay soils, we can recommend that the active earth pressure coefficient Ka for long-term drained analysis be based on the effective/softened friction angle of the retained clays. However, under earthquake conditions we can recommend that the Mononobe-Okabe modification of the Ka be used based on the backfill material φ^o and a Zone 3 horizontal seismic coefficient. In cases where a wall might be considered restrained at the top or propped, the K_0 earth pressure coefficient applies.

15. A minimum depth of excavation of 1.0 m is required on slopes prior to the placement of any imported FILL. It is recommended that these excavations be assessed and supervised by a competent Geotechnical Engineer. The existing subgrade must be prepared and compacted to 95% Standard Proctor

16. We recommend that all CUT slopes be constructed to a maximum of 1V:3H and immediately vegetated, keeping all surface drainage away from these slopes.

11. APPENDIX A: MOMENT DISTRIBUTION DIAGRAMS FOR PILE DESIGN.



450 mm diam.

Code: ACI 318-11

Units: Metric

Run axis: About X-axis

Run option: Investigation

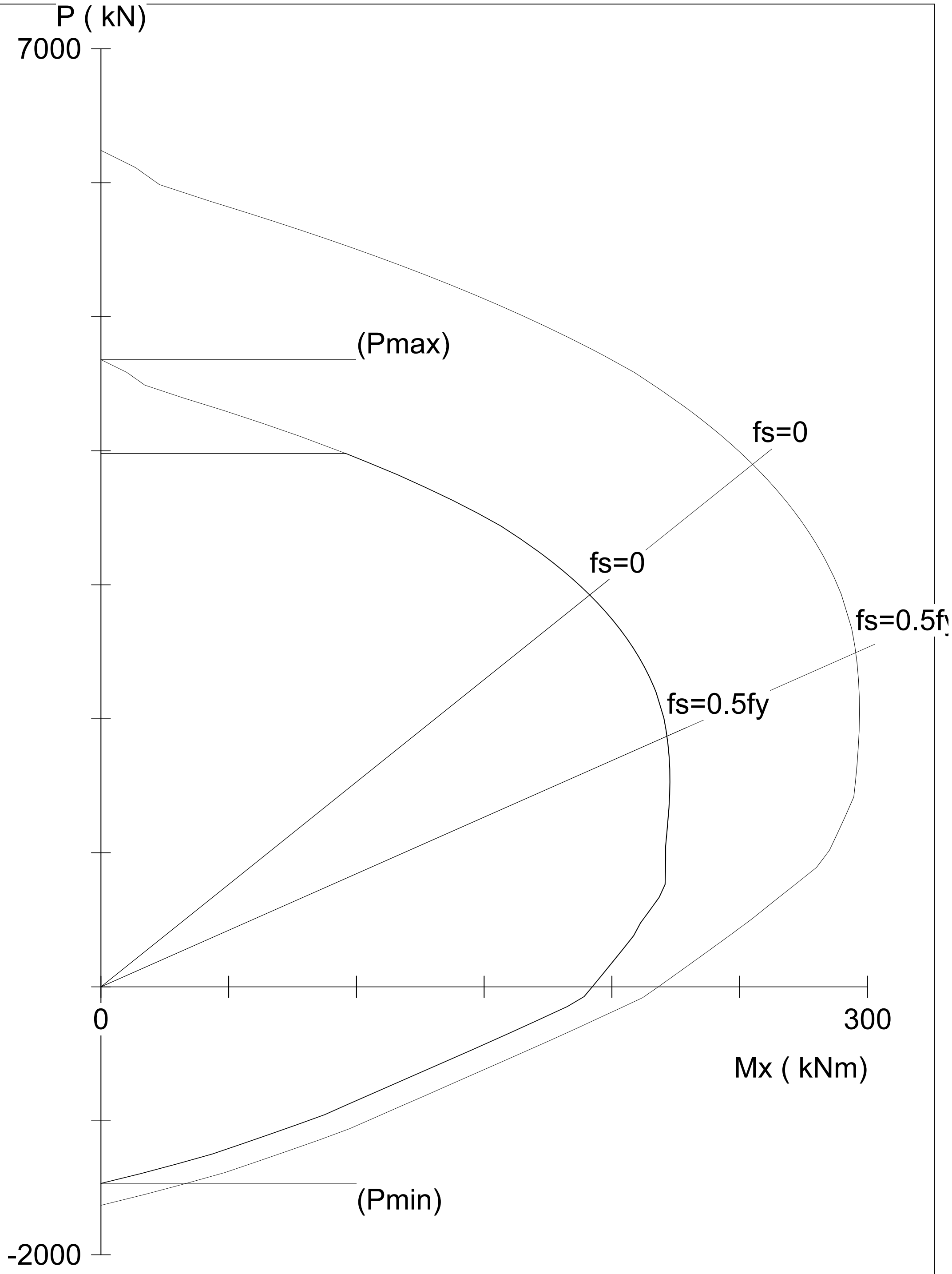
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 05/13/12

Time: 21:09:26



spColumn v4.80. 15 day trial license. Locking Code: 4-214C8. User: Rommel, Microsoft

File: untitled.col

Project:

Column:

f'c = 35 MPa

Ec = 27806 MPa

fc = 29.75 MPa

e_u = 0.003 mm/mm

Beta1 = 0.796192

Confinement: Spiral

phi(a) = 0.85, phi(b) = 0.9, phi(c) = 0.75

fy = 400 MPa

Es = 200000 MPa

Engineer:

Ag = 159043 mm^2

As = 4077 mm^2

Xo = 0 mm

Yo = 0 mm

Min clear spacing = 72 mm

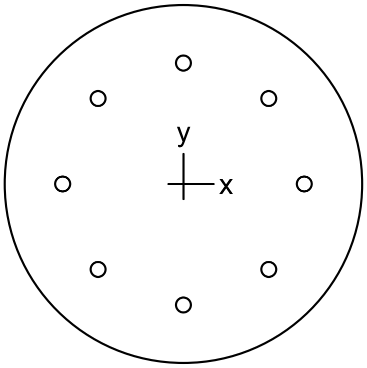
8 #8 bars

rho = 2.56%

Ix = 2.01e+009 mm^4

Iy = 2.01e+009 mm^4

Clear cover = 85 mm



600 mm diam.

Code: ACI 318-11

Units: Metric

Run axis: About X-axis

Run option: Investigation

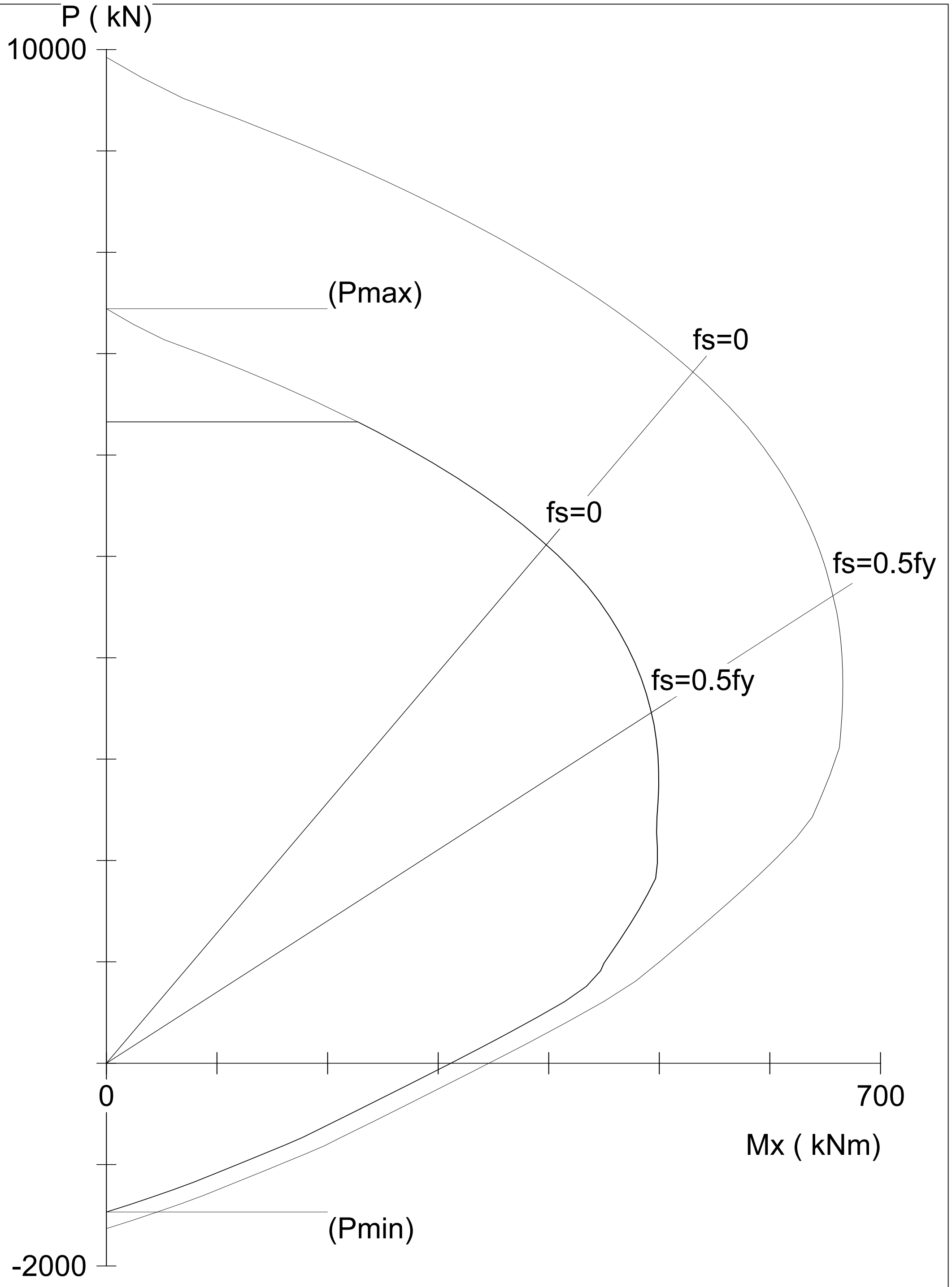
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 05/17/12

Time: 14:32:39



spColumn v4.80. 15 day trial license. Locking Code: 4-214C8. User: Rommel, Microsoft

File: untitled.col

Project:

Column:

Engineer:

f'c = 35 MPa
fy = 400 MPa
Ag = 282743 mm^2
8 #8 bars

Ec = 27806 MPa
Es = 200000 MPa
As = 4077 mm^2
rho = 1.44%

fc = 29.75 MPa
Xo = 0 mm
Ix = 6.36e+009 mm^4

e_u = 0.003 mm/mm
Yo = 0 mm
Iy = 6.36e+009 mm^4

Beta1 = 0.796192
Min clear spacing = 130 mm
Clear cover = 85 mm

Confinement: Spiral

phi(a) = 0.85, phi(b) = 0.9, phi(c) = 0.75

12. APPENDIX B: BOREHOLE LOGS

ENCLOSURE No. 1

EISL
Earth Investigation Systems Ltd

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673279, Northing: 1150550

LOG OF BOREHOLE BH 01

Date Started: 2 August 2012
Date Completed: 2 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring): 1.83 m
WL (24 hr):

Sample Condition
■ Shelby Tube
☒ Split Spoon
▦ Augured
▩ Wash Out
◧ Rock Core
☐ Sample Lost

Water Levels
▼ Immediate Water Level
▽ After Boring
▼ 24hr Water Level

ELEV. (m)	DEPTH (m)
47.5	0.0
46.5	1.0
45.5	2.0
44.5	3.0
43.5	4.0
42.5	5.0
41.5	6.0
40.5	7.0
39.5	8.0
38.5	9.0
37.5	10.0
36.5	11.0
35.5	12.0
34.5	13.0
33.5	14.0
32.5	15.0
31.5	16.0
30.5	17.0
29.5	18.0
28.5	19.0
27.5	20.0

DESCRIPTION

Moist, dark and light brown with grey, firm, Sandy Silty CLAY.

Moist, yellow brown and grey, very firm, Silty CLAY.

Moist, light yellow with reddish brown and grey, very firm, Sandy Silty CLAY.

Moist, light yellow with brown and grey, hard, Silty CLAY with iron oxides.

Moist, brown and light grey, very dense, Clayey Silty SAND.

Moist, light brown and grey, hard, Sandy Silty CLAY with iron oxides.

Moist, orange brown and grey, hard, Silty CLAY.

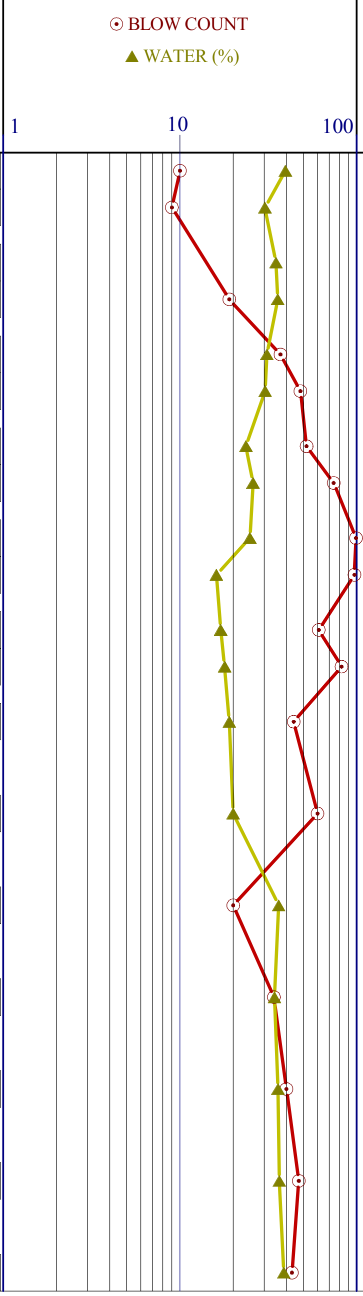
Moist, light brown and light grey, hard, Sandy Silty CLAY.

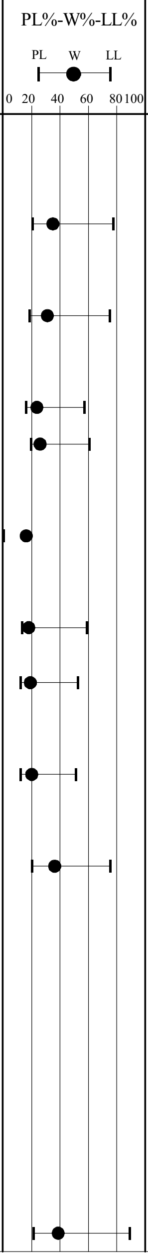
Moist, dark grey, firm, Silty CLAY with iron oxides.

Moist, olive grey and dark grey, hard, Silty CLAY.

END OF BOREHOLE AT 18.90m

WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)	PL%-LL%
	☒	1	10	40	
	☒	2	9	30	
▽	■	3		35	20,78
	☒	4	19	36	
	☒	5	37	31	18,75
	☒	6	48	30	
	☒	7	52	24	16,57
	☒	8	74	26	19,61
	☒	9	99	25	
	☒	10	97	16	0,0
	☒	11	61	17	
	☒	12	82	18	13,59
	☒	13	44	19	12,52
	☒	14	60	20	12,51
	☒	15	20	36	20,75
	☒	16	34	34	
	☒	17	40	36	
	☒	18	47	36	
	☒	19	43	39	21,89





REMARKS:

EISL
Earth Investigation Systems Ltd

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673285, Northing: 1150516

LOG OF BOREHOLE BH 03

Date Started: 1 August 2012
Date Completed: 1 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring): 1.24 m
WL (24 hr): 0.71 m

Sample Condition	
■	Shelby Tube
☒	Split Spoon
▦	Augured
▩	Wash Out
◧	Rock Core
☐	Sample Lost

Water Levels	
▼	Immediate Water Level
▽	After Boring
▼	24hr Water Level

ELEV. (m) DEPTH (m) 53.0

ELEV. (m)	DEPTH (m)
53.0	0.0
52.0	1.0
51.0	2.0
50.0	3.0
49.0	4.0
48.0	5.0
47.0	6.0
46.0	7.0
45.0	8.0
44.0	9.0
43.0	10.0
42.0	11.0
41.0	12.0
40.0	13.0
39.0	14.0
38.0	15.0
37.0	16.0
36.0	17.0
35.0	18.0
34.0	19.0
33.0	20.0

DESCRIPTION

Moist, light brown and dark brown, loose, lensed Clayey Silty SAND with gravel.

Moist, reddish yellowish brown, firm, Silty CLAY with iron oxide.

Moist, reddish light grey, very firm, Silty CLAY with iron oxide.

Moist, yellowish light grey, hard, slickensided Silty CLAY with iron oxide.

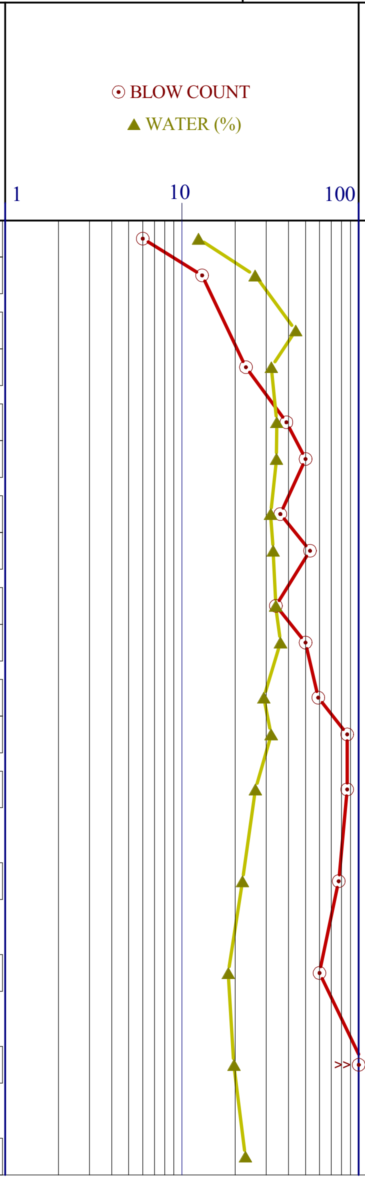
Moist, yellowish dark grey, hard, slickensided Silty CLAY with iron oxide.

Moist, reddish yellowish rust brown and grey, hard, slickensided Silty CLAY with iron oxide.

Moist, yellowish light grey, very dense, Silty Clayey SAND.

END OF BOREHOLE AT 15.85m

WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)	PL%-W%-LL%	PL%-LL%
▼	☒	1	6	12		
▽	☒	2	13	26		
	■	3		44	├─●─┤	19,70
	☒	4	23	32		
	☒	5	39	34		
	☒	6	50	34		
	☒	7	36	32		
	☒	8	53	33		
	☒	9	34	34		
	☒	10	50	36		
	☒	11	59	29		
	☒	12	86	32		
	☒	13	86	26		
	☒	14	77	22		
	☒	15	60	18		
	☒	16	107	20		
	☒	17	56/4"	23		



PL%-W%-LL%
PL W LL
0 20 40 60 80 100

REMARKS:

ENCLOSURE No. 3

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673292, Northing: 1150470

LOG OF BOREHOLE BH 04

Date Started: 27 July 2012
Date Completed: 27 July 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring):
WL (24 hr):

Sample Condition
- ■ Shelby Tube
- ☒ Split Spoon
- ▦ Augured
- ▩ Wash Out
- ◨ Rock Core
- ☐ Sample Lost

Water Levels
- ▼ Immediate Water Level
- ▽ After Boring
- ▼ 24hr Water Level

ELEV. (m)	DEPTH (m)
53.0	0.0
52.0	1.0
51.0	2.0
50.0	3.0
49.0	4.0
48.0	5.0
47.0	6.0
46.0	7.0
45.0	8.0
44.0	9.0
43.0	10.0
42.0	11.0
41.0	12.0
40.0	13.0
39.0	14.0
38.0	15.0
37.0	16.0
36.0	17.0
35.0	18.0
34.0	19.0
33.0	20.0

DESCRIPTION

Moist, dark brown, firm, Silty CLAY with roots and organics; organic odour.

Moist, grey and brown, firm, Silty CLAY with Sand, organics and oxides.

Moist, grey and rusty, yellowish brown, very firm, Silty CLAY with Sand and organics.

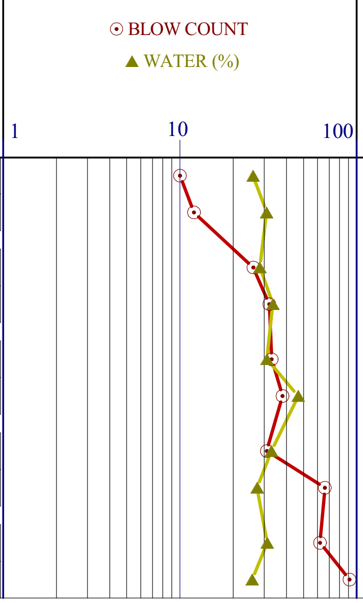
Moist, grey and yellowish brown, very firm, Silty CLAY with iron oxides.

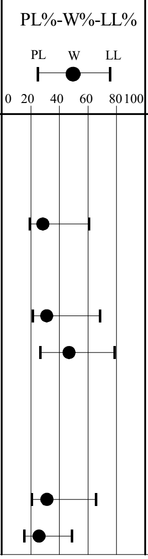
Moist, grey and yellowish, reddish brown, hard, Sandy Silty CLAY.

Moist, grey and mottled reddish brown, hard, Silty CLAY with iron oxides.

Moist, grey and light yellow, hard, Silty CLAY.

END OF BOREHOLE AT 7.32m





SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)	PL%-LL%
☒	1	10	26	
☒	2	12	31	
☒	3	26	28	19,60
☒	4	32	34	
☒	5	33	31	21,69
☒	6	38	47	26,79
☒	7	31	33	
☒	8	66	27	
☒	9	62	31	20,66
☒	10	50/5"	26	15,49

REMARKS:

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673337, Northing: 1150492

LOG OF BOREHOLE BH 05

Date Started: 3 August 2012
Date Completed: 3 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring): 2.18 m
WL (24 hr): 0.66 m

Sample Condition
- ■ Shelby Tube
- ☒ Split Spoon
- ▦ Augured
- ▩ Wash Out
- ◧ Rock Core
- ☐ Sample Lost

Water Levels
- ▼ Immediate Water Level
- ▽ After Boring
- ▼ 24hr Water Level

DESCRIPTION

Moist, reddish dark brown, medium, laminated Silty CLAY with roots & iron oxide.

Moist, reddish yellowish grey, firm to very firm, laminated Silty CLAY with iron oxide.

Moist, reddish yellowish grey, hard, stratified Silty CLAY with iron oxide.

Moist, reddish yellowish grey, hard, laminated Silty CLAY with iron oxide.

WASH OUT.

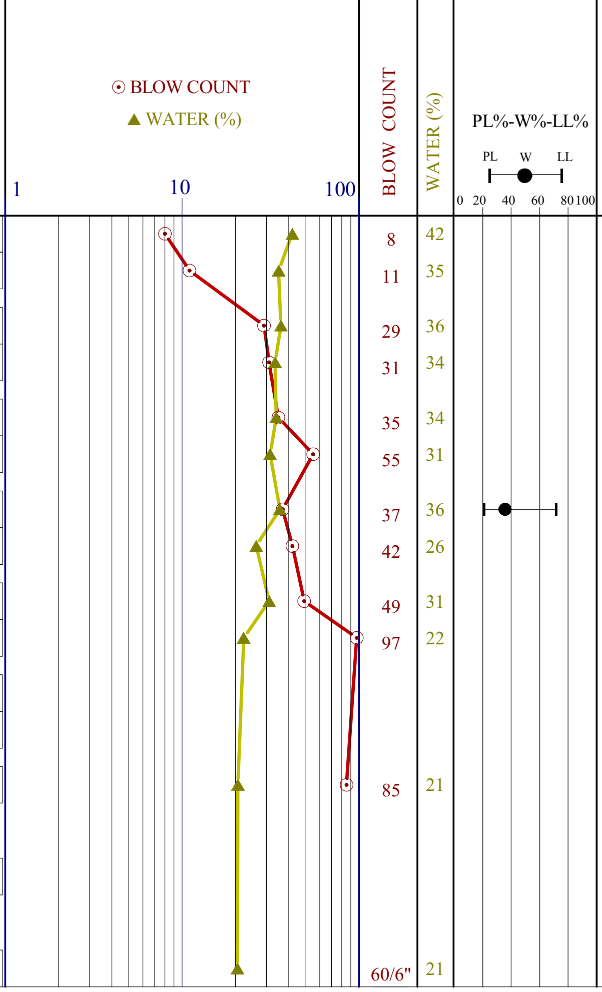
Moist, grey, hard, homogeneous Silty Sandy CLAY.

WASH OUT.

Moist, grey, hard, lensed Silty Sandy CLAY.

END OF BOREHOLE AT 12.80m

SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	WATER (%)	PL%-LL%
1	☒	8	42	
2	☒	11	35	
3	☒	29	36	
4	☒	31	34	
5	☒	35	34	
6	☒	55	31	
7	☒	37	36	21,71
8	☒	42	26	
9	☒	49	31	
10	☒	97	22	
11	▩			
12	▩			
13	☒	85	21	
14	▩			
15	☒	60/6"	21	



ELEV. (m)	DEPTH (m)
53.0	0.0
52.0	1.0
51.0	2.0
50.0	3.0
49.0	4.0
48.0	5.0
47.0	6.0
46.0	7.0
45.0	8.0
44.0	9.0
43.0	10.0
42.0	11.0
41.0	12.0
40.0	13.0
39.0	14.0
38.0	15.0
37.0	16.0
36.0	17.0
35.0	18.0
34.0	19.0
33.0	20.0

REMARKS:

ENCLOSURE No. 5

EISL
Earth Investigation Systems Ltd

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: , Northing:

LOG OF BOREHOLE BH 06

Date Started: 28 August 2012
Date Completed: 28 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring):
WL (24 hr):

Sample Condition
■ Shelby Tube
☒ Split Spoon
▦ Augured
▩ Wash Out
◧ Rock Core
☐ Sample Lost

Water Levels
▼ Immediate Water Level
▽ After Boring
▼ 24hr Water Level

ELEV. (m) DEPTH (m) | LAYER GRAPHIC | DESCRIPTION | WATER LEVEL | SAMPLE TYPE | SAMPLE NUMBER | BLOW COUNT | WATER (%) | PL%-W%-LL% | PL%-LL%

DESCRIPTION:

Moist, light brown and dark grey, firm to very firm, Silty CLAY with organics & roots.

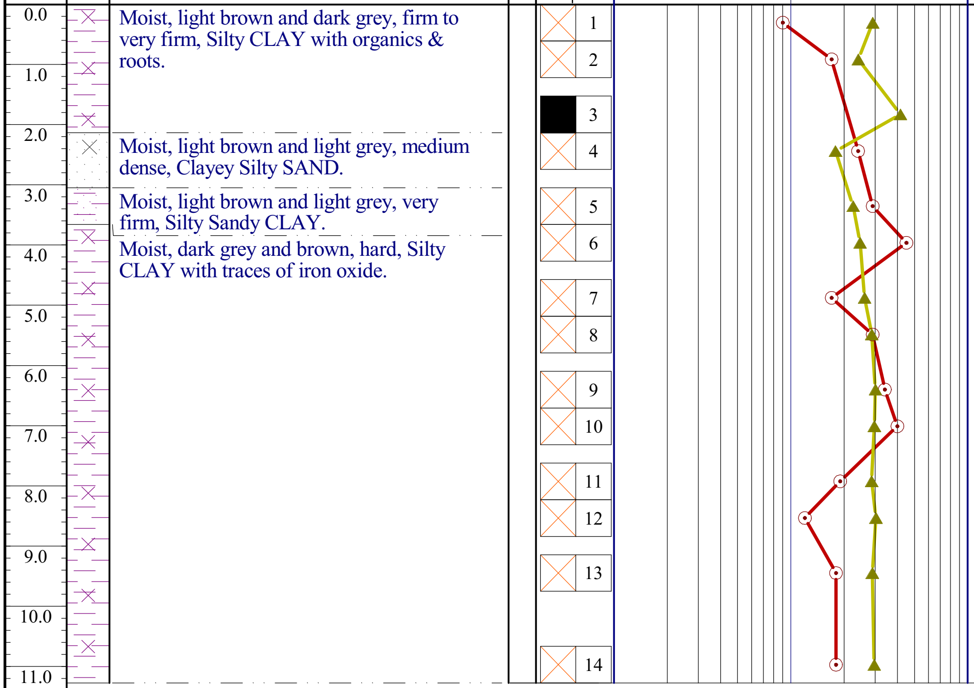
Moist, light brown and light grey, medium dense, Clayey Silty SAND.

Moist, light brown and light grey, very firm, Silty Sandy CLAY.

Moist, dark grey and brown, hard, Silty CLAY with traces of iron oxide.

END OF BOREHOLE AT 11.28m

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)
☒	1	9	29
☒	2	17	24
■	3		42
☒	4	24	18
☒	5	29	23
☒	6	45	25
☒	7	17	26
☒	8	29	29
☒	9	34	30
☒	10	40	30
☒	11	19	29
☒	12	12	30
☒	13	18	29
☒	14	18	30



PL W LL
0 20 40 60 80 100

REMARKS:

ENCLOSURE No. 6

0412_01_2012
Couva Children's Hospital

Couva
SITE INVESTIGATION
Easting: 673356, Northing: 1150455

LOG OF BOREHOLE BH 07

Date Started: 9 August 2012
Date Completed: 10 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring):
WL (24 hr): 0.74 m

Sample Condition
- ■ Shelby Tube
- ☒ Split Spoon
- ▦ Augured
- ▩ Wash Out
- ◧ Rock Core
- ☐ Sample Lost

Water Levels
- ▼ Immediate Water Level
- ▽ After Boring
- ▼ 24hr Water Level

DESCRIPTION

Moist, reddish brown and grey, firm to hard, slickensided Silty CLAY with iron oxide.

Moist, brown and dark brown, very firm, slickensided Silty CLAY with cemented particles & iron oxide.

WASH OUT.

Moist, grey and brown, very firm, slickensided Silty CLAY with iron oxide.

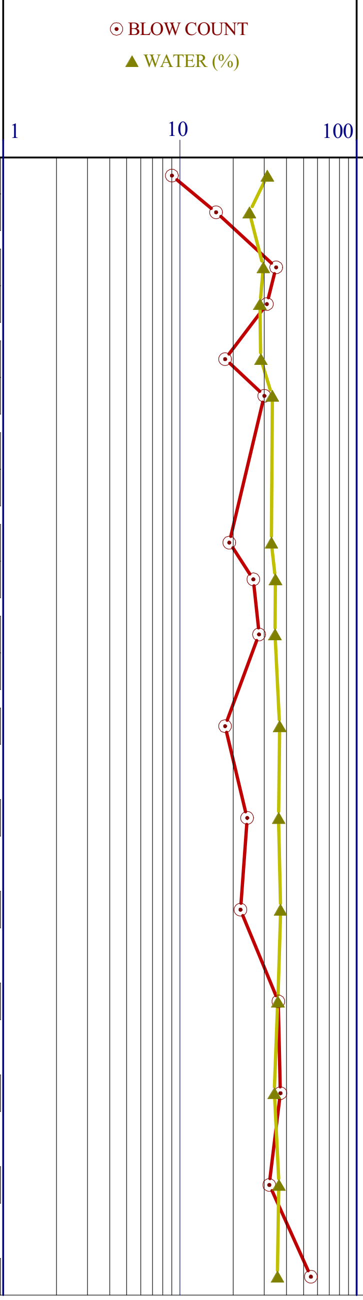
WASH OUT.

Moist, dark grey and brown, very firm, slickensided Silty CLAY with iron oxide.

END OF BOREHOLE AT 18.90m

ELEV. (m)	DEPTH (m)
52.5	0.0
51.5	1.0
50.5	2.0
49.5	3.0
48.5	4.0
47.5	5.0
46.5	6.0
45.5	7.0
44.5	8.0
43.5	9.0
42.5	10.0
41.5	11.0
40.5	12.0
39.5	13.0
38.5	14.0
37.5	15.0
36.5	16.0
35.5	17.0
34.5	18.0
33.5	19.0
32.5	20.0

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)
☒	1	9	31
☒	2	16	25
☒	3	35	30
☒	4	31	28
☒	5	18	29
☒	6	30	33
▩	7		
▩	8		
☒	9	19	33
☒	10	26	35
☒	11	28	34
▩	12		
☒	13	18	37
☒	14	24	36
☒	15	22	37
☒	16	36	36
☒	17	37	34
☒	18	32	36
☒	19	55	36



PL%-W%-LL%
PL W LL
0 20 40 60 80 100

PL%-LL%

REMARKS:

ENCLOSURE No. 7

EISL
Earth Investigation Systems Ltd

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673390, Northing: 1150472

LOG OF BOREHOLE BH 08

Date Started: 17 August 2012
Date Completed: 17 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring):
WL (24 hr):

Sample Condition
- ■ Shelby Tube
- ☒ Split Spoon
- ▦ Augured
- ▩ Wash Out
- ◧ Rock Core
- ☐ Sample Lost

Water Levels
- ▼ Immediate Water Level
- ▽ After Boring
- ▼ 24hr Water Level

ELEV. (m) DEPTH (m) | LAYER GRAPHIC | DESCRIPTION | WATER LEVEL | SAMPLE TYPE | SAMPLE NUMBER | BLOW COUNT | WATER (%) | PL%-W%-LL% | PL%-LL%

50.3	0.0
49.3	1.0
48.3	2.0
47.3	3.0
46.3	4.0
45.3	5.0
44.3	6.0
43.3	7.0
42.3	8.0
41.3	9.0
40.3	10.0
39.3	11.0
38.3	12.0
37.3	13.0
36.3	14.0
35.3	15.0
34.3	16.0
33.3	17.0
32.3	18.0
31.3	19.0
30.3	20.0

Moist, reddish light brown and grey, medium to firm, slickensided Silty CLAY with roots.

Moist, bluish grey and light brown, firm, slickensided Silty CLAY with iron oxide.

WASH OUT.

Moist, bluish grey and yellowish brown, very firm, slickensided Silty CLAY with iron oxide.

Moist, grey and yellow, hard, fissured Silty CLAY with iron oxide.

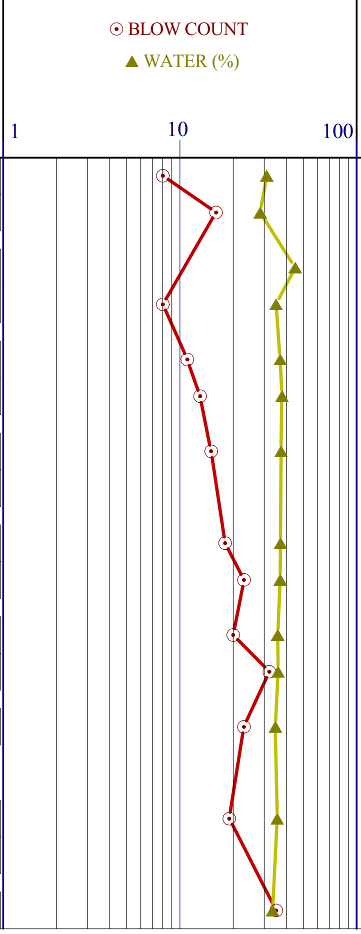
Moist, dark grey and yellowish reddish brown, very firm, slickensided Silty CLAY with iron oxide.

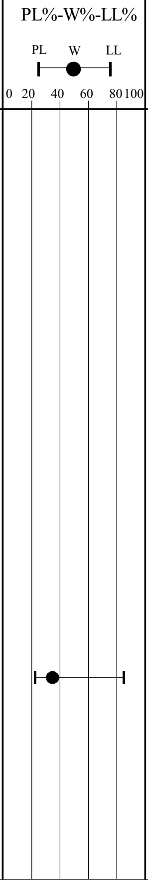
WASH OUT.

Moist, dark grey and yellowish reddish brown, hard, slickensided Silty CLAY with iron oxide.

END OF BOREHOLE AT 12.80m

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)	PL%-LL%
☒	1	8	31	
☒	2	16	28	
■	3		45	
☒	4	8	35	
☒	5	11	37	
☒	6	13	38	
☒	7	15	37	
▩	8			
☒	9	18	37	
☒	10	23	37	
☒	11	20	36	
☒	12	32	36	
☒	13	23	35	22,85
☒	14	19	35	
▩	15			
☒	16	35	33	





REMARKS:

EISL
Earth Investigation Systems Ltd

0412_01_2012
Couva Children's Hospital

Couva
SITE INVESTIGATION
Easting: 673424, Northing: 1150489

LOG OF BOREHOLE BH 09

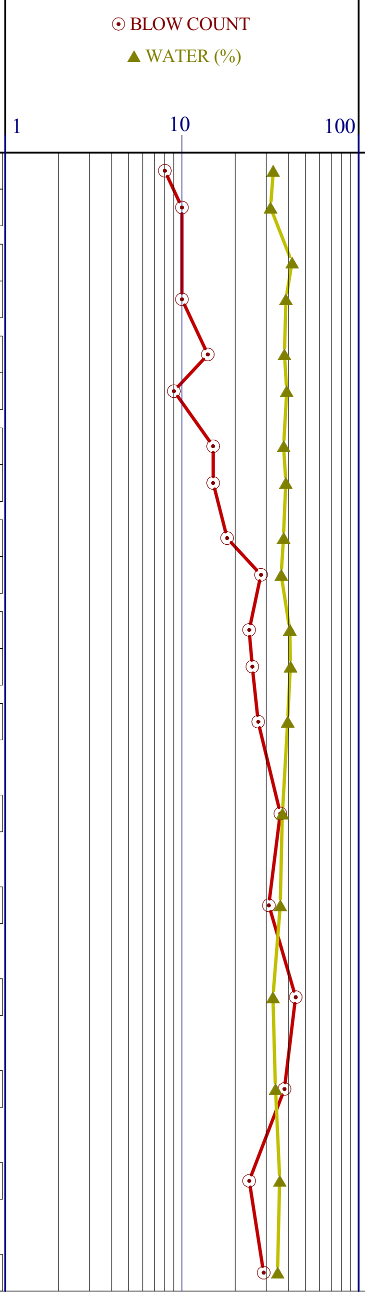
Date Started: 27 August 2012
Date Completed: 27 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring): 0.91 m
WL (24 hr):

Sample Condition
■ Shelby Tube
☒ Split Spoon
▦ Augured
▩ Wash Out
◧ Rock Core
☐ Sample Lost

Water Levels
▼ Immediate Water Level
▽ After Boring
▼ 24hr Water Level

ELEV. (m) DEPTH (m)	DESCRIPTION
44.3 0.0	Moist, light brown and brown, medium, Silty CLAY with organics, roots & grass.
	▽ Moist, reddish yellowish brown and grey, firm, Silty CLAY with iron oxide.
43.3 1.0	
42.3 2.0	
41.3 3.0	
40.3 4.0	
	Moist, yellowish dark brown and dark grey, firm, Silty CLAY with iron oxide.
39.3 5.0	
38.3 6.0	Moist, dark grey, very firm, Silty CLAY.
37.3 7.0	
36.3 8.0	
35.3 9.0	Moist, bluish grey, very firm, Silty CLAY.
34.3 10.0	
33.3 11.0	
32.3 12.0	
31.3 13.0	
30.3 14.0	
29.3 15.0	
28.3 16.0	
27.3 17.0	
26.3 18.0	
25.3 19.0	END OF BOREHOLE AT 18.90m
24.3 20.0	

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)
☒	1	8	33
☒	2	10	32
■	3		42
☒	4	10	39
☒	5	14	38
☒	6	9	39
☒	7	15	38
☒	8	15	39
☒	9	18	38
☒	10	28	36
☒	11	24	41
☒	12	25	41
☒	13	27	40
☒	14	36	37
☒	15	31	36
☒	16	44	33
☒	17	38	34
☒	18	24	36
☒	19	29	35



PL%-W%-LL%
PL W LL
0 20 40 60 80 100

PL%-LL%

REMARKS:

ENCLOSURE No. 9

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673462, Northing: 1150433

LOG OF BOREHOLE BH 10

Date Started: 21 August 2012
Date Completed: 21 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring):
WL (24 hr):

Sample Condition
- ■ Shelby Tube
- ☒ Split Spoon
- ▦ Augured
- ▩ Wash Out
- ◧ Rock Core
- ☐ Sample Lost

Water Levels
- ▼ Immediate Water Level
- ▽ After Boring
- ▼ 24hr Water Level

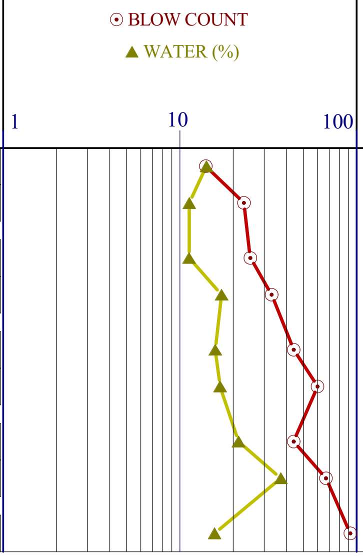
ELEV. (m) DEPTH (m) | LAYER GRAPHIC | DESCRIPTION | WATER LEVEL | SAMPLE TYPE | SAMPLE NUMBER | BLOW COUNT | WATER (%) | PL%-W%-LL% | PL%-LL%

52.0

DESCRIPTION
Moist, reddish brown and grey, loose to medium dense, Clayey Silty SAND.
Moist, yellowish reddish brown, medium dense, Silty Clayey SAND with layers of fine sand.
Moist, yellowish reddish brown and light grey, hard, Silty Sandy CLAY with cemented particles.
Moist, light brown and light grey, hard, Sandy Silty CLAY with iron oxide.
Moist, dark grey and dark brown, hard, Sandy Silty CLAY.

END OF BOREHOLE AT 6.71m

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)
☒	1	14	14
☒	2	23	11
☒	3	25	11
☒	4	33	17
☒	5	44	16
☒	6	60	17
☒	7	44	21
☒	8	67	37
☒	9	50/3"	16



PL%-W%-LL%
PL W LL
0 20 40 60 80 100

PL%-LL%

ELEV. (m)	DEPTH (m)
52.0	0.0
51.0	1.0
50.0	2.0
49.0	3.0
48.0	4.0
47.0	5.0
46.0	6.0
45.0	7.0
44.0	8.0
43.0	9.0
42.0	10.0
41.0	11.0
40.0	12.0
39.0	13.0
38.0	14.0
37.0	15.0
36.0	16.0
35.0	17.0
34.0	18.0
33.0	19.0
32.0	20.0

REMARKS:

ENCLOSURE No. 10

EISL
Earth Investigation Systems Ltd

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673455, Northing: 1150389

LOG OF BOREHOLE BH 11

Date Started: 14 August 2012
Date Completed: 14 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring):
WL (24 hr):

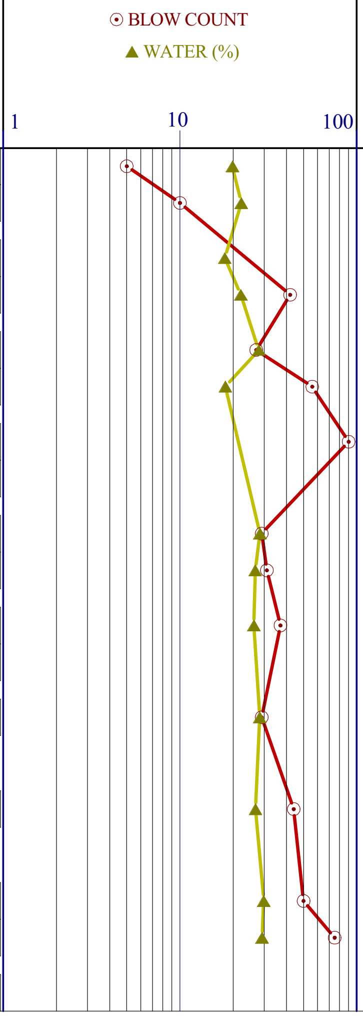
Sample Condition
- ■ Shelby Tube
- ☒ Split Spoon
- ▦ Augured
- ▩ Wash Out
- ◧ Rock Core
- ☐ Sample Lost

Water Levels
- ▼ Immediate Water Level
- ▽ After Boring
- ▼ 24hr Water Level

ELEV. (m)	DEPTH (m)
55.0	0.0
54.0	1.0
53.0	2.0
52.0	3.0
51.0	4.0
50.0	5.0
49.0	6.0
48.0	7.0
47.0	8.0
46.0	9.0
45.0	10.0
44.0	11.0
43.0	12.0
42.0	13.0
41.0	14.0
40.0	15.0
39.0	16.0
38.0	17.0
37.0	18.0
36.0	19.0
35.0	20.0

DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)
Moist, reddish orangish grey and brown, medium to firm, stratified Sandy Silty CLAY with roots.	☒	1	5	20
	☒	2	10	22
	■	3		18
Moist, reddish brown and grey, hard, laminated Silty CLAY with traces of sand & iron oxide.	☒	4	42	22
	☒	5	27	28
	☒	6	56	18
NO RECOVERY.	○	7	50/5"	
WASH OUT.	▩	8		
Moist, reddish grey and brown, very firm to hard, laminated Silty CLAY with traces of sand & iron oxide.	☒	9	29	28
	☒	10	31	27
Moist, grey, hard, homogeneous Silty CLAY with Sand.	☒	11	37	26
WASH OUT.	▩	12		
Moist, grey and brown, very firm to hard, laminated Silty CLAY with iron oxide & sands.	☒	13	29	28
	☒	14	44	27
Moist, dark grey, hard, Silty CLAY with iron oxide.	☒	15	50	30
	☒	16	75	29
NO RECOVERY.	○	17	50/4"	

END OF BOREHOLE AT 14.33m



PL%-W%-LL%
PL W LL
0 20 40 60 80 100

PL%-LL%

REMARKS:

ENCLOSURE No. 11

EISL
Earth Investigation Systems Ltd

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673582, Northing: 1150510

LOG OF BOREHOLE BH 14

Date Started: 25 August 2012
Date Completed: 25 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring): 3.05 m
WL (24 hr):

Sample Condition

■	Shelby Tube
☒	Split Spoon
▦	Augured
▩	Wash Out
◧	Rock Core
☐	Sample Lost

Water Levels

▼	Immediate Water Level
▽	After Boring
▼	24hr Water Level

ELEV. (m)	DEPTH (m)
54.0	0.0
53.0	1.0
52.0	2.0
51.0	3.0
50.0	4.0
49.0	5.0
48.0	6.0
47.0	7.0
46.0	8.0
45.0	9.0
44.0	10.0
43.0	11.0
42.0	12.0
41.0	13.0
40.0	14.0
39.0	15.0
38.0	16.0
37.0	17.0
36.0	18.0
35.0	19.0
34.0	20.0

DESCRIPTION

Moist, reddish yellowish brown and grey, soft to very firm, Silty CLAY with traces of sand, organics & iron oxide.

WASH OUT.

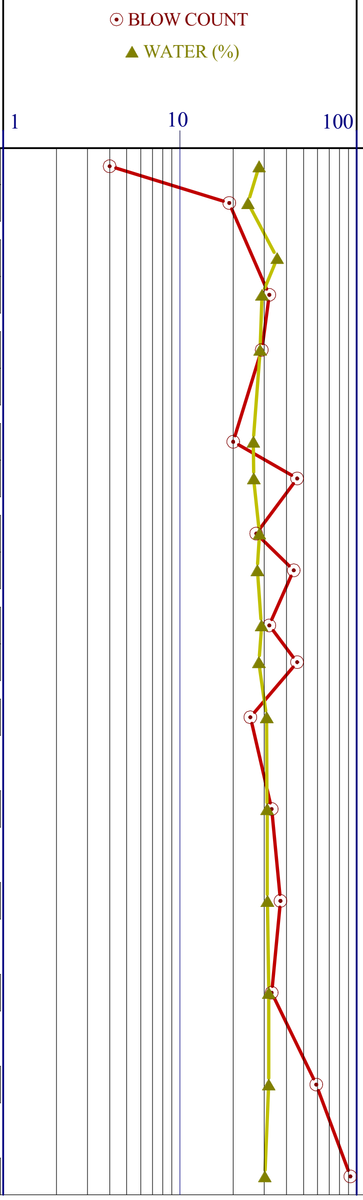
Moist, orangish yellowish brown and grey, very firm to hard, Silty CLAY with iron oxide.

Moist, dark grey, hard, slickensided CLAY with iron oxide.

END OF BOREHOLE AT 17.38m

WATER LEVEL: ▽

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)
☒	1	4	28
☒	2	19	24
■	3		35
☒	4	32	29
☒	5	29	28
▩	6		
☒	7	20	26
☒	8	46	26
☒	9	27	28
☒	10	44	27
☒	11	32	29
☒	12	46	28
☒	13	25	31
☒	14	33	31
☒	15	37	31
☒	16	33	32
☒	17	59	32
☒	18	50/4"	30



PL%-W%-LL%

PL W LL

0 20 40 60 80 100

PL%-LL%

REMARKS:

0412_01_2012
Couva Children's Hospital

Couva

SITE INVESTIGATION

Easting: 673566, Northing: 1150443

LOG OF BOREHOLE BH 15

Date Started: 22 August 2012
Date Completed: 22 August 2012
Drilling Method: Wash Boring
Sampling Method: Split Spoon
WATER LEVEL INFORMATION
WL (Immediate):
WL (With Casing):
WL (Casing Removed):
WL (After Boring):
WL (24 hr):

Sample Condition
- ■ Shelby Tube
- ☒ Split Spoon
- ▦ Augured
- ▩ Wash Out
- ◧ Rock Core
- ☐ Sample Lost

Water Levels
- ▼ Immediate Water Level
- ▽ After Boring
- ▼ 24hr Water Level

ELEV. (m)	DEPTH (m)
56.5	0.0
55.5	1.0
54.5	2.0
53.5	3.0
52.5	4.0
51.5	5.0
50.5	6.0
49.5	7.0
48.5	8.0
47.5	9.0
46.5	10.0
45.5	11.0
44.5	12.0
43.5	13.0
42.5	14.0
41.5	15.0
40.5	16.0
39.5	17.0
38.5	18.0
37.5	19.0
36.5	20.0

DESCRIPTION

Moist, brown and reddish brown, medium, Silty CLAY with roots.

Moist, reddish grey, firm, Silty CLAY.

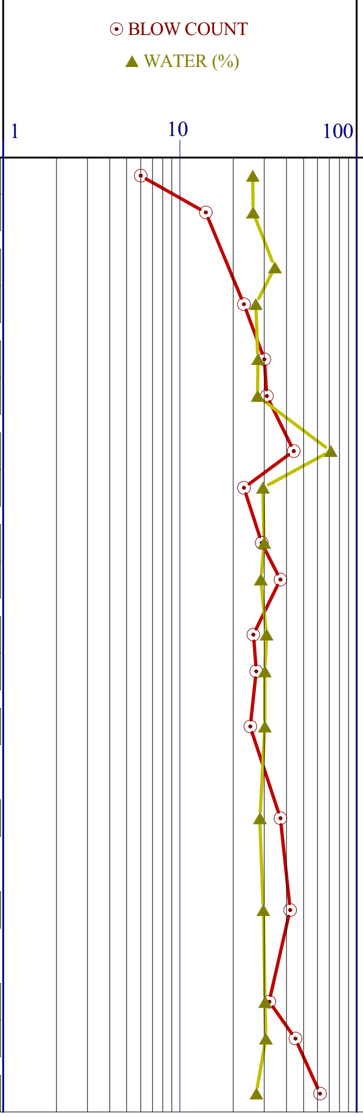
Moist, grey and brown, very firm to hard, Silty CLAY with iron oxide.

Moist, brown and grey, hard to very firm, Silty CLAY with iron oxide.

Moist, grey, hard, Silty CLAY with iron oxide.

END OF BOREHOLE AT 15.85m

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	WATER (%)
☒	1	6	26
☒	2	14	26
■	3		34
☒	4	23	27
☒	5	30	28
☒	6	31	27
☒	7	44	71
☒	8	23	29
☒	9	29	30
☒	10	37	29
☒	11	26	31
☒	12	27	30
☒	13	25	30
☒	14	37	28
☒	15	42	30
☒	16	32	30
☒	17	45	31
☒	18	62	27



PL%-W%-LL%

PL W LL

0 20 40 60 80 100

PL%-LL%

REMARKS:
Continuous Sampling from 45'
BH was stopped due to the high plasticity of the soil making it difficult to retrieve sampler

Earth Investigation Systems Ltd.
#2 Perseverance Street
Petit Bourg, San Juan
Telephone: 1-868-638-3978
Fax: 1-868-675-4960

ENCLOSURE No. 1

TEST PIT PROFILE

Project No.: 0412_01_2012

Project: Couva Children's Hospital

Location: Couva

Type: SITE INVESTIGATION

○	No Recovery
◧	Hand Auger
◫	Vane Shear
B	Bulk Sample
☒	Disturbed Sample
■	Shelby Tube

Water Symbols

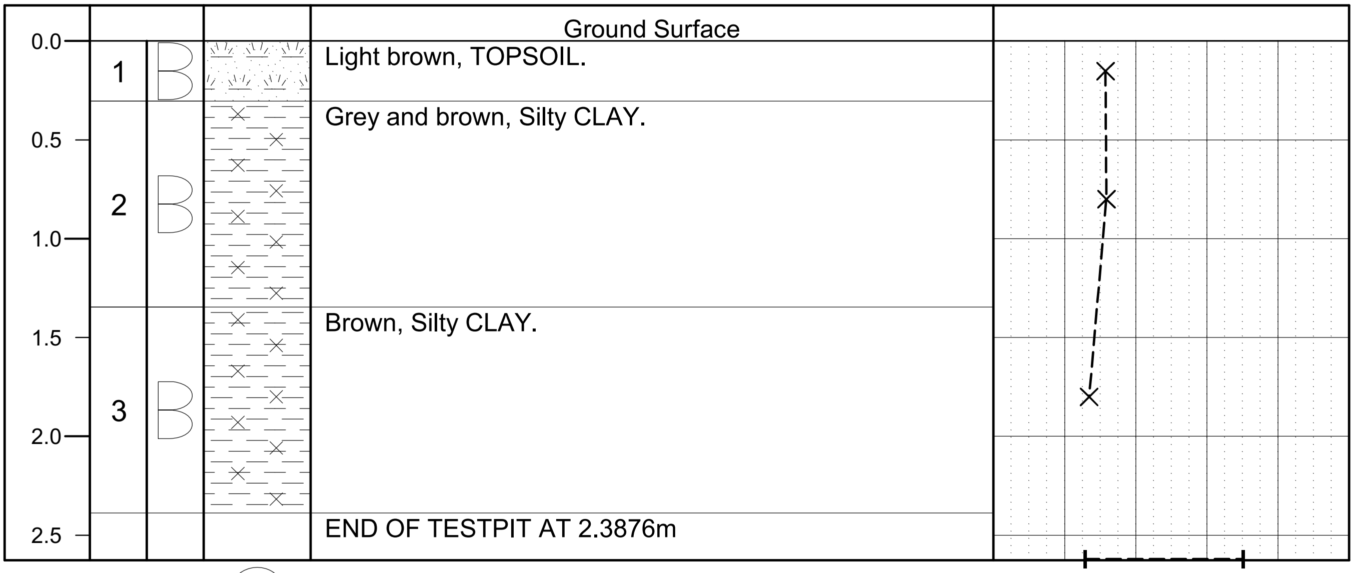
Groundwater Seepage	≈
Groundwater Level	▼
Natural Moisture Content	–×–
Plastic and Liquid Limit	├–┤

Shear Strength (Cu)

Pilcon Vane Test	✚

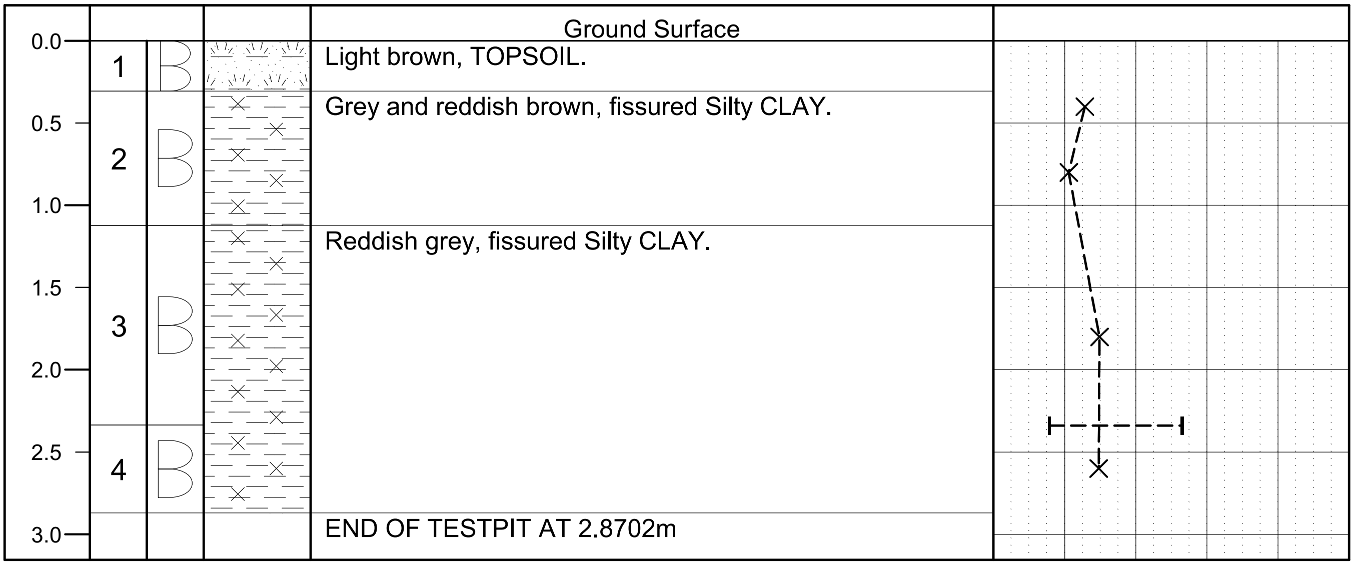
Depth (m)	Sample No.	Sample Type	Symbol	Soil Description	Cu 40 80 120 160 (kPa) / w% 20 40 60 80

TEST PIT No. TP 01



Sample No.	Type	Soil Description
		Ground Surface
1	B	Light brown, TOPSOIL.
2	B	Grey and brown, Silty CLAY.
3	B	Brown, Silty CLAY.
		END OF TESTPIT AT 2.3876m

TEST PIT No. TP 02



Sample No.	Type	Soil Description
		Ground Surface
1	B	Light brown, TOPSOIL.
2	B	Grey and reddish brown, fissured Silty CLAY.
3	B	Reddish grey, fissured Silty CLAY.
4	B	
		END OF TESTPIT AT 2.8702m

Earth Investigation Systems Ltd.
#2 Perseverance Street
Petit Bourg, San Juan
Telephone: 1-868-638-3978
Fax: 1-868-675-4960

ENCLOSURE No. 3

TEST PIT PROFILE

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Location: Couva
Type: SITE INVESTIGATION

○	No Recovery
◧	Hand Auger
▯	Vane Shear
B	Bulk Sample
☒	Disturbed Sample
■	Shelby Tube

Water Symbols

Groundwater Seepage	≈
Groundwater Level	▼
Natural Moisture Content	–×–
Plastic and Liquid Limit	├– – –┤

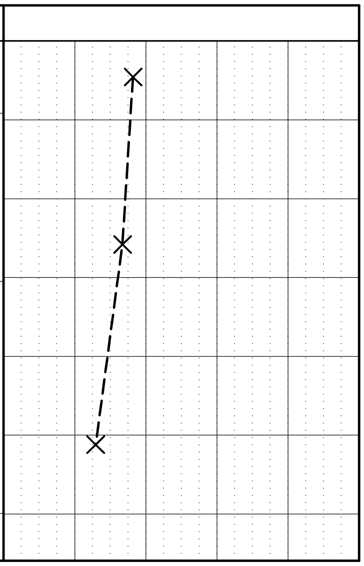
Shear Strength (Cu)

Pilcon Vane Test	✚

Depth (m)	Sample No.	Sample Type	Symbol	Soil Description	Cu 40 80 120 160 (kPa) w% 20 40 60 80

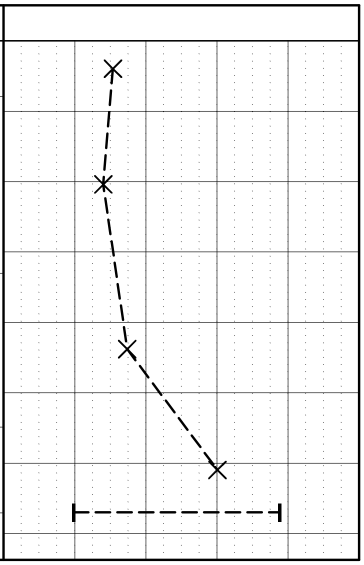
TEST PIT No. TP 03

Depth (m)	No.	Type	Soil Description
0.0			Ground Surface
	1	B	Light brown, TOP SOIL.
0.5	2	B	Reddish grey and brown, Silty CLAY.
1.5	3	B	Reddish grey and brown, Silty CLAY.
3.0			END OF TESTPIT AT 2.996m



TEST PIT No. TP 04

Depth (m)	No.	Type	Soil Description
0.0			Ground Surface
	1	B	Light brown and reddish brown, TOPSOIL-silty clay.
	2	B	Greyish brown to red, Silty CLAY.
	3	B	Bluish grey and yellow brown, Silty CLAY.
	4	B	Bluish grey and brown, Silty CLAY.
3.5			END OF TESTPIT AT 3.3528m



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ENCLOSURE No. 5

TEST PIT PROFILE

Project No.: 0412_01_2012

Project: Couva Children's Hospital

Location: Couva

Type: SITE INVESTIGATION

○	No Recovery
◧	Hand Auger
◫	Vane Shear
B	Bulk Sample
☒	Disturbed Sample
■	Shelby Tube

Water Symbols

Groundwater Seepage	≈
Groundwater Level	▼
Natural Moisture Content	-×-
Plastic and Liquid Limit	├--┤

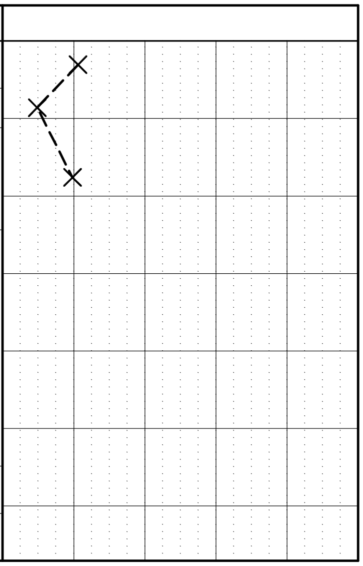
Shear Strength (Cu)

Pilcon Vane Test	✚

Depth (m)	Sample No.	Sample Type	Symbol	Soil Description	Cu 40 / 80 / 120 / 160 (kPa) w% 20 / 40 / 60 / 80

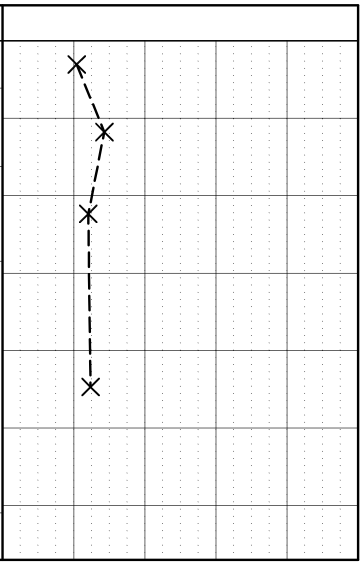
TEST PIT No. TP 06-05

Depth (m)	No.	Type	Soil Description
			Ground Surface
0.0	1	B	Olive brown, TOPSOIL- SANDY CLAY.
0.5	2	B	Reddish brown, Clayey Silty SAND.
1.0	3	B	Brown to black, Clayey Silty SAND.
1.5 2.0 2.5	4	B	Yellow brown, Silty SAND with traces of clay.
3.0	5	B	Whitish grey and light brown, Silty SAND.
			END OF TESTPIT AT 3.048m



TEST PIT No. TP 07

Depth (m)	No.	Type	Soil Description
			Ground Surface
0.0	1	B	Light brown, TOPSOIL.
0.5	2	B	Olive brown, Silty CLAY.
1.0	3	B	Light grey and reddish brown, Silty CLAY.
1.5 2.0 2.5 3.0	4	B	Greyish brown, Silty CLAY.
			END OF TESTPIT AT 3.048m



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ENCLOSURE No. 7

TEST PIT PROFILE

Project No.: 0412_01_2012

Project: Couva Children's Hospital

Location: Couva

Type: SITE INVESTIGATION

- ○ No Recovery
- ◧ Hand Auger
- ◫ Vane Shear
- B Bulk Sample
- ☒ Disturbed Sample
- ■ Shelby Tube

Water Symbols

Groundwater Seepage	≈
Groundwater Level	▼
Natural Moisture Content	—×—
Plastic and Liquid Limit	├──┤

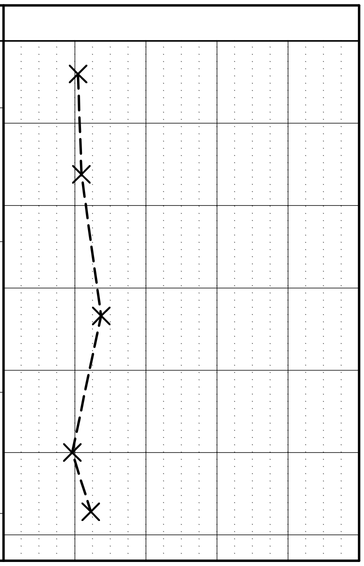
Shear Strength (Cu)

Pilcon Vane Test	✚

Depth (m)	Sample No.	Sample Type	Symbol	Soil Description	Cu 40 80 120 160 (kPa) w% 20 40 60 80

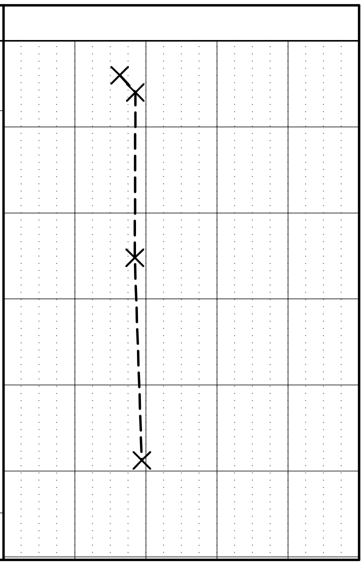
TEST PIT No. TP 08

Depth (m)	No.	Type	Soil Description
0.0			Ground Surface
	1	B	Light brown, TOPSOIL.
0.5	2	B	Greyish brown, slightly fissured Silty CLAY.
1.0	3	B	Greyish brown and bluish grey, fissured Silty CLAY.
1.5			
2.0	4	B	Bluish grey and reddish brown, fissured Silty CLAY.
2.5			
3.0			END OF TESTPIT AT 2.8702m



TEST PIT No. TP 08A

Depth (m)	No.	Type	Soil Description
0.0			Ground Surface
	1	B	Light brown, TOPSOIL.
0.5	2	B	Reddish brown and grey, Silty CLAY.
1.0			
1.5			
2.0			
2.5			
3.0			END OF TESTPIT AT 2.7432m



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ENCLOSURE No. 9

TEST PIT PROFILE

Project No.: 0412_01_2012

Project: Couva Children's Hospital

Location: Couva

Type: SITE INVESTIGATION

○	No Recovery
◧	Hand Auger
◫	Vane Shear
B	Bulk Sample
☒	Disturbed Sample
■	Shelby Tube

Water Symbols

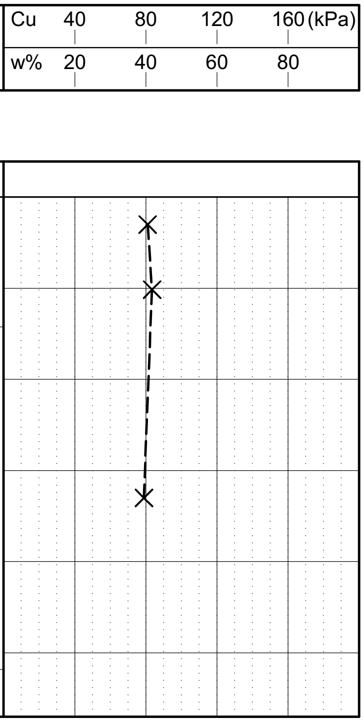
Groundwater Seepage	≈
Groundwater Level	▼
Natural Moisture Content	–×–
Plastic and Liquid Limit	├– – –┤

Shear Strength (Cu)

Pilcon Vane Test	✚

TEST PIT No. TP 09

Depth (m)	Sample No.	Sample Type	Symbol	Soil Description
0.0				Ground Surface
0.0 – 0.5	1	B		Brown, Silty CLAY.
1.0 – 2.5	2	B		Grey and brown, Silty CLAY.
				END OF TESTPIT AT 2.591m



13. APPENDIX C: LABORATORY TESTING RESULTS

ENCLOSURE No. 1

Sheet 1 of 3

Sample ID	Classification	% Gravel	% Sand	% Silt	% Clay	LL	PL	PI	% Moisture Content
BH 01 SA 3 *1.83 m*	FAT CLAY with SAND(CH)	7.7	11.4	13.3	67.5	78	20	58	34.9
BH 01 SA 5 *3.35 m*	FAT CLAY(CH)	0.0	1.1	23.7	75.2	75	18	57	31.0
BH 01 SA 7 *4.88 m*	FAT CLAY with SAND(CH)	4.2	18.1	30.7	47.0	57	16	41	23.6
BH 01 SA 8 *5.49 m*	FAT CLAY(CH)	0.3	9.2	30.9	59.6	61	19	42	25.9
BH 01 SA 10 *7.01 m*	SANDY SILT(ML)	0.0	40.0	36.1	23.9	NP	NP	NP	16.1
BH 01 SA 12 *8.53 m*	FAT CLAY(CH)	0.0	5.2	39.0	55.8	59	13	46	17.9
BH 01 SA 13 *9.45 m*	FAT CLAY(CH)	0.0	7.5	41.5	50.9	52	12	40	19.0
BH 01 SA 14 *10.97 m*	FAT CLAY(CH)	0.9	10.1	43.5	45.4	51	12	39	20.0
BH 01 SA 15 *12.50 m*	FAT CLAY(CH)	0.8	7.1	15.7	76.5	75	20	55	36.2
BH 01 SA 19 *18.59 m*	FAT CLAY(CH)	0.0	0.1	11.3	88.6	89	21	68	38.6
BH 03 SA 3 *1.83 m*					51.0	70	19	51	44.0
BH 03 SA 5 *3.35 m*		0.0	2.7	16.8	80.5				34.4
BH 03 SA 7 *4.88 m*		0.2	3.2	27.6	69.0				31.7
BH 03 SA 10 *7.01 m*		0.0	1.3	13.9	84.8				36.1
BH 03 SA 13 *9.45 m*		0.0	1.6	38.4	60.0				26.0
BH 03 SA 15 *12.50 m*		0.0	23.3	32.1	44.6				18.3
BH 03 SA 17 *15.54 m*		0.0	50.8	20.6	28.6				22.9
BH 04 SA 3 *1.83 m*	FAT CLAY(CH)	1.0	5.1	19.5	74.4	60	19	41	28.3
BH 04 SA 5 *3.35 m*	FAT CLAY with SAND(CH)	4.8	12.8	10.3	72.1	69	21	48	31.0
BH 04 SA 6 *3.96 m*	FAT CLAY(CH)	0.0	3.2	13.4	83.3	79	26	53	46.7
BH 04 SA 9 *6.40 m*	FAT CLAY(CH)	0.0	0.1	24.4	75.4	66	20	46	31.2
BH 04 SA 10 *7.01 m*	LEAN CLAY(CI)	0.0	5.1	34.2	60.7	49	15	34	25.6
BH 05 SA 3 *1.83 m*		0.0	5.0	11.5	83.5				36.2
BH 05 SA 5 *3.35 m*		0.1	14.1	11.7	74.0				34.0
BH 05 SA 7 *4.88 m*	FAT CLAY(CH)	1.0	11.4	26.7	60.9	71	21	50	35.6
BH 05 SA 9 *6.40 m*		0.1	2.8	31.5	65.6				31.1
BH 05 SA 13 *9.45 m*		0.0	7.2	35.8	57.0				20.7
BH 06 SA 3 *1.83 m*		1.0	5.5	93.6					41.7
BH 06 SA 4 *2.44 m*		0.0	77.5	22.5					17.9
BH 06 SA 6 *3.96 m*		0.0	14.1	85.9					24.6

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Classification Summary

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

CLASSIFICATION SUMMARY 0412_01_2012 COUVA HOSPITAL.GPJ EISL.GDT 11/9/12

Sample ID	Classification	% Gravel	% Sand	% Silt	% Clay	LL	PL	PI	% Moisture Content
BH 06 SA 7 *4.88 m*		1.6	2.9	95.5					26.1
BH 06 SA 8 *5.49 m*		0.4	1.9	97.7					28.7
BH 06 SA 11 *7.92 m*		0.5	5.3	94.2					28.6
BH 06 SA 14 *10.97 m*		0.0	2.7	97.3					29.6
BH 06 SA *13.11 m*		0.0	0.7	99.3					
BH 07 SA 3 *1.83 m*		0.1	3.1	21.5	75.4				29.6
BH 07 SA 5 *3.35 m*		0.0	3.0	26.0	71.0				28.7
BH 07 SA 6 *3.96 m*		1.5	1.3	15.5	81.7				33.3
BH 07 SA 10 *7.01 m*		0.0	0.9	12.8	86.3				34.7
BH 07 SA 14 *10.97 m*		0.0	1.7	6.5	91.8				36.1
BH 07 SA 17 *15.54 m*		0.0	0.2	19.1	80.7				34.2
BH 07 SA 19 *18.59 m*		1.4	1.3	9.6	87.7				35.6
BH 08 SA 3 *1.83 m*		0.5	3.9	95.6					44.8
BH 08 SA 5 *3.35 m*		0.0	1.9	98.0					36.9
BH 08 SA 7 *4.88 m*		0.0	4.9	95.1					37.3
BH 08 SA 10 *7.01 m*		0.0	2.7	97.3					36.9
BH 08 SA 13 *9.45 m*	FAT CLAY(CH)	0.6	7.8	91.6		85	22	63	34.6
BH 08 SA 16 *12.50 m*		0.0	0.3	99.7					33.4
BH 09 SA 3 *1.83 m*		0.8	3.4	95.8					42.0
BH 11 SA 3 *1.83 m*		2.6	36.6	60.8					17.9
BH 11 SA 9 *6.40 m*		0.0	2.2	28.4	69.4				28.3
BH 11 SA 14 *10.97 m*					41.3				26.8
BH 14 SA 3 *1.83 m*		0.0	5.0	95.0					35.4
BH 14 SA 5 *3.35 m*		0.2	5.4	94.4					28.4
BH 14 SA 8 *5.49 m*		1.3	10.2	88.5					26.1
BH 14 SA 11 *7.92 m*		0.2	2.5	97.3					28.9
BH 14 SA 15 *12.50 m*		0.1	0.6	99.3					31.2
BH 14 SA 17 *15.54 m*		0.0	1.9	98.1					31.8
BH 14 SA 18 *17.07 m*		0.1	2.4	97.5					30.2
BH 15 SA 3 *1.83 m*		0.0	1.8	98.2					34.4

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Classification Summary

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 3

Sheet 3 of 3

Sample ID	Classification	% Gravel	% Sand	% Silt	% Clay	LL	PL	PI	% Moisture Content
BH 15 SA 6 *3.96 m*		0.2	5.1	94.7					27.5
BH 15 SA 9 *6.40 m*		0.0	1.3	98.7					29.9
BH 15 SA 12 *8.53 m*		0.0	1.0	99.0					30.2
BH 15 SA 14 *10.97 m*		0.0	1.0	99.0					28.3
BH 15 SA 18 *15.54 m*		0.0	2.2	97.8					27.0

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Classification Summary

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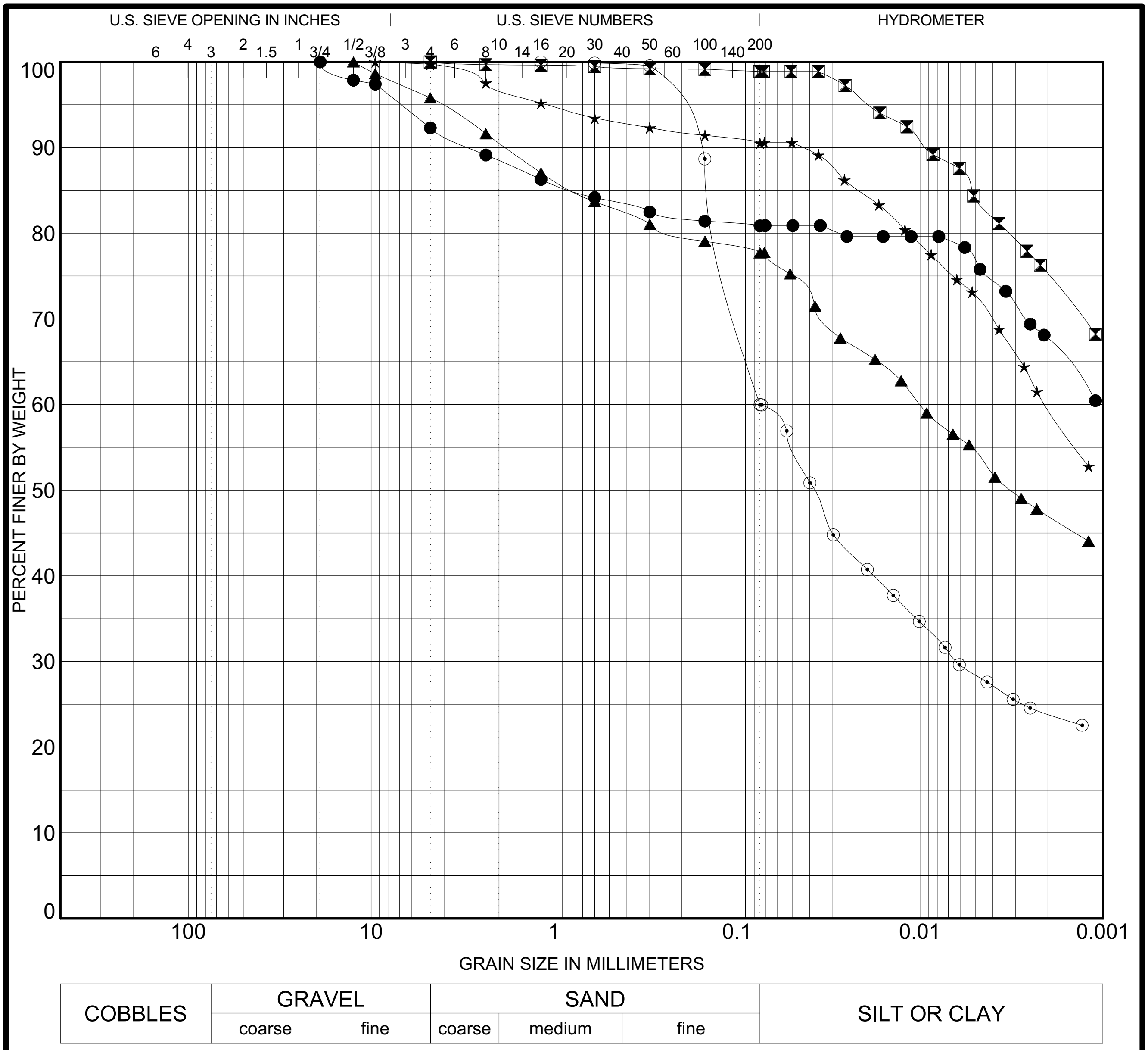
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 1



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**BH 01/SA 3**	**1.83m**	**FAT CLAY with SAND(CH)**	**78**	**20**	**58**		
⧗	**BH 01/SA 5**	**3.35m**	**FAT CLAY(CH)**	**75**	**18**	**57**		
▲	**BH 01/SA 7**	**4.88m**	**FAT CLAY with SAND(CH)**	**57**	**16**	**41**		
★	**BH 01/SA 8**	**5.49m**	**FAT CLAY(CH)**	**61**	**19**	**42**		
⊙	**BH 01/SA 10**	**7.01m**	**SANDY SILT(ML)**	**NP**	**NP**	**NP**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 01/SA 3**	**1.83m**	**19**				**7.7**	**11.4**	**13.3**	**67.5**
⧗	**BH 01/SA 5**	**3.35m**	**4.75**				**0.0**	**1.1**	**23.7**	**75.2**
▲	**BH 01/SA 7**	**4.88m**	**12.5**	**0.01**			**4.2**	**18.1**	**30.7**	**47.0**
★	**BH 01/SA 8**	**5.49m**	**9.5**	**0**			**0.3**	**9.2**	**30.9**	**59.6**
⊙	**BH 01/SA 10**	**7.01m**	**1.18**	**0.08**	**0.01**		**0.0**	**40.0**	**36.1**	**23.9**

EISL SIEVE 0412_01_2012 COUVA HOSPITAL.GPJ EISL.GDT 11/9/12

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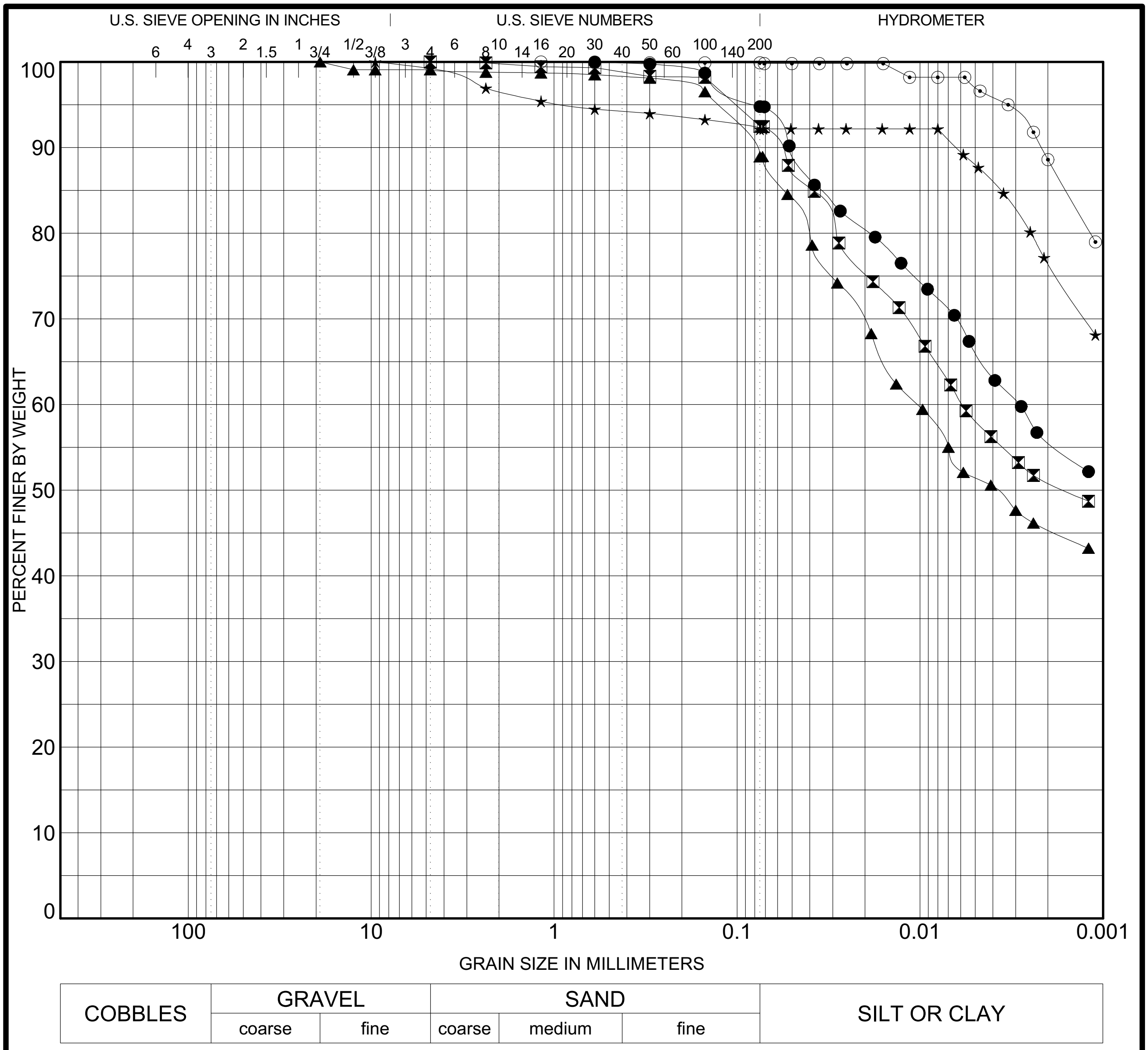
GRAIN SIZE DISTRIBUTION

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 2



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BH 01/SA 12 8.53m**	**FAT CLAY(CH)**	**59**	**13**	**46**		
⧗	**BH 01/SA 13 9.45m**	**FAT CLAY(CH)**	**52**	**12**	**40**		
▲	**BH 01/SA 14 10.97m**	**FAT CLAY(CH)**	**51**	**12**	**39**		
★	**BH 01/SA 15 12.50m**	**FAT CLAY(CH)**	**75**	**20**	**55**		
⊙	**BH 01/SA 19 18.59m**	**FAT CLAY(CH)**	**89**	**21**	**68**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 01/SA 12 8.53m**	**0.6**	**0**			**0.0**	**5.2**	**39.0**	**55.8**
⧗	**BH 01/SA 13 9.45m**	**4.75**	**0.01**			**0.0**	**7.5**	**41.5**	**50.9**
▲	**BH 01/SA 14 10.97m**	**19**	**0.01**			**0.9**	**10.1**	**43.5**	**45.4**
★	**BH 01/SA 15 12.50m**	**9.5**				**0.8**	**7.1**	**15.7**	**76.5**
⊙	**BH 01/SA 19 18.59m**	**1.18**				**0.0**	**0.1**	**11.3**	**88.6**

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GRAIN SIZE DISTRIBUTION

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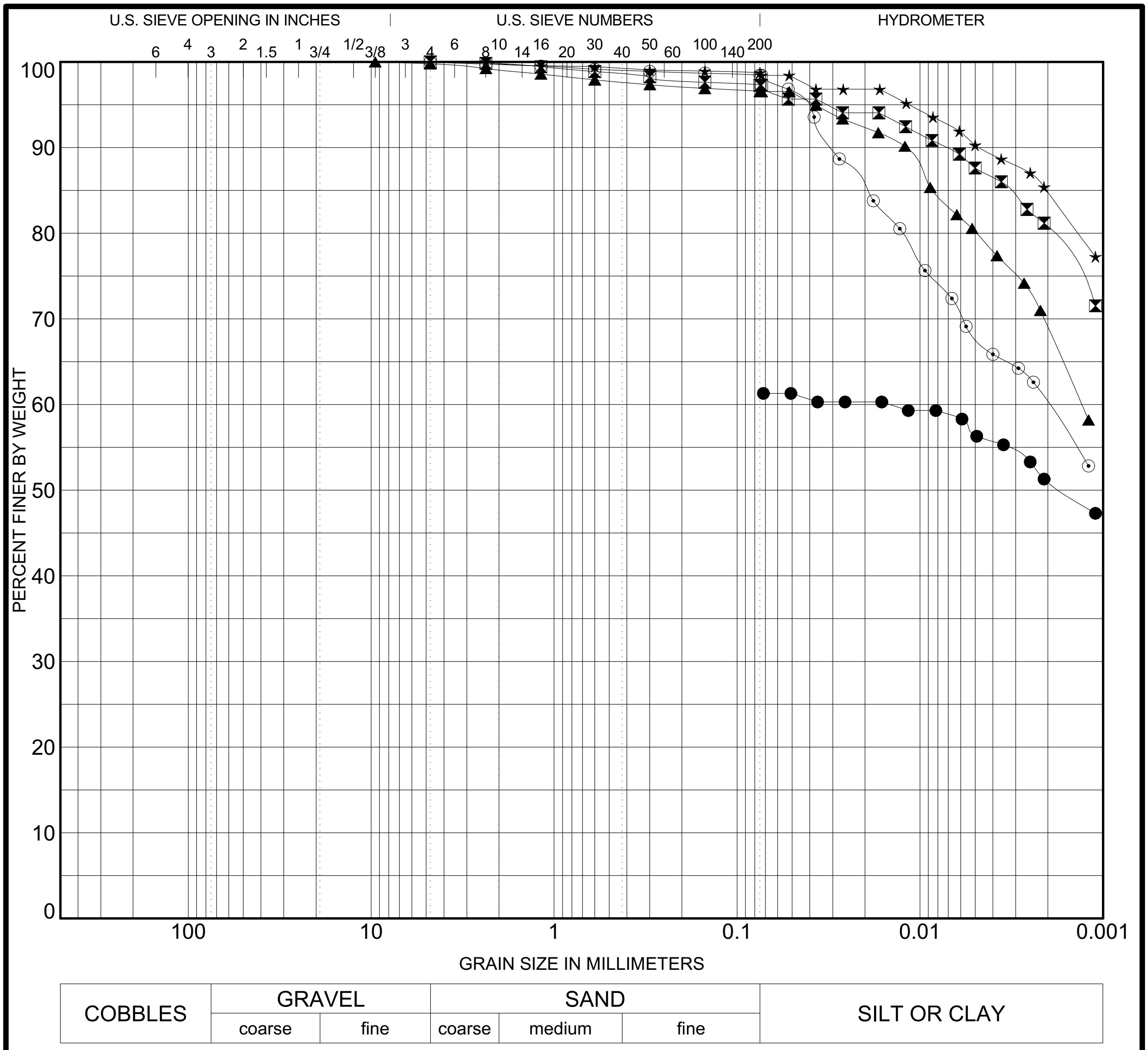
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 3



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**BH 03/SA 3**	**1.83m**		**70**	**19**	**51**		
⧗	**BH 03/SA 5**	**3.35m**						
▲	**BH 03/SA 7**	**4.88m**						
★	**BH 03/SA 10**	**7.01m**						
☉	**BH 03/SA 13**	**9.45m**						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 03/SA 3**	**1.83m**		**0.01**						**51.0**
⧗	**BH 03/SA 5**	**3.35m**	**4.75**				**0.0**	**2.7**	**16.8**	**80.5**
▲	**BH 03/SA 7**	**4.88m**	**9.5**	**0**			**0.2**	**3.2**	**27.6**	**69.0**
★	**BH 03/SA 10**	**7.01m**	**2.36**				**0.0**	**1.3**	**13.9**	**84.8**
☉	**BH 03/SA 13**	**9.45m**	**4.75**	**0**			**0.0**	**1.6**	**38.4**	**60.0**

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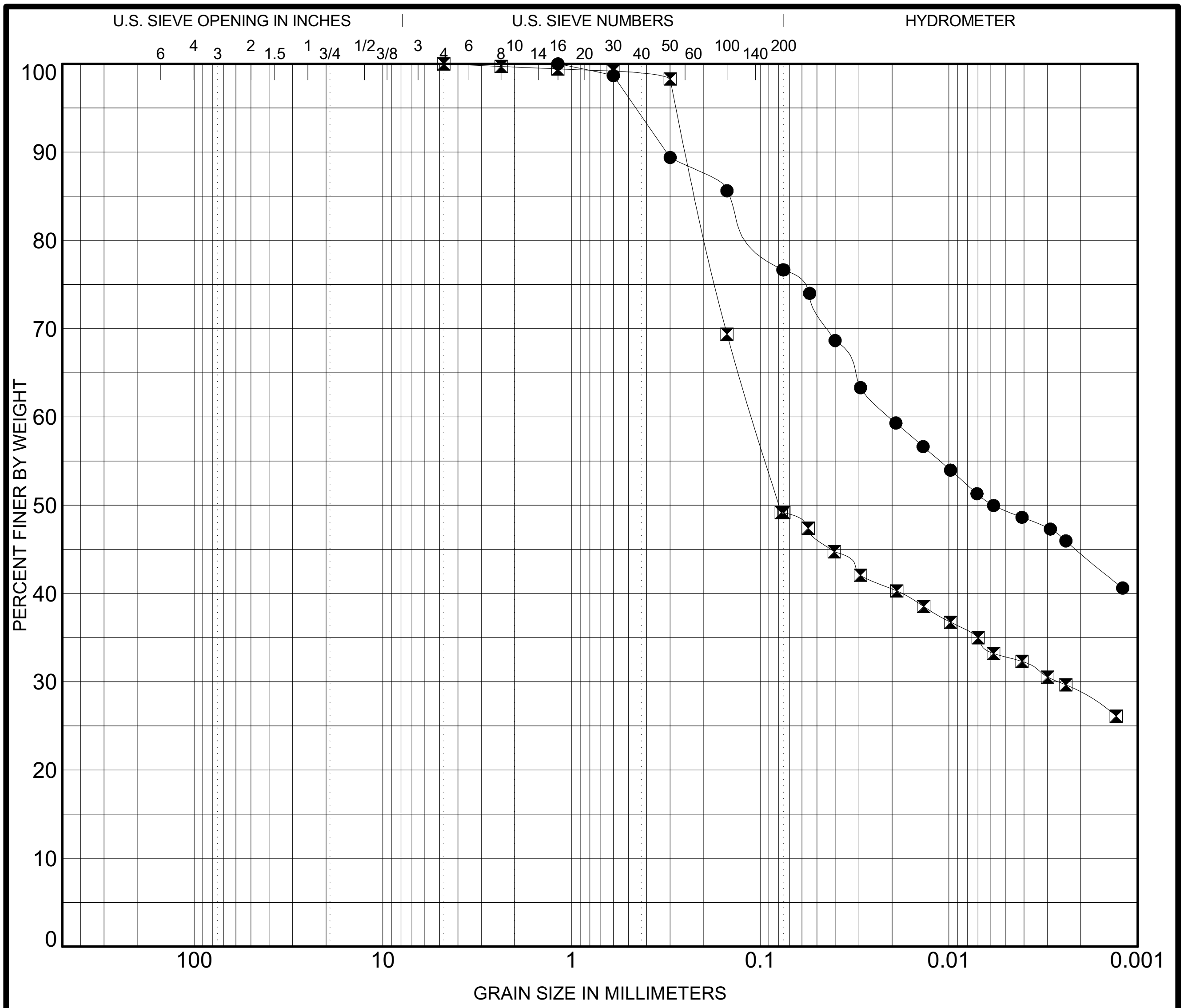
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 4



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**BH 03/SA 15 12.50m**						
⧗	**BH 03/SA 17 15.54m**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 03/SA 15 12.50m**	**1.18**	**0.02**			**0.0**	**23.3**	**32.1**	**44.6**
⧗	**BH 03/SA 17 15.54m**	**4.75**	**0.11**	**0**		**0.0**	**50.8**	**20.6**	**28.6**

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GRAIN SIZE DISTRIBUTION

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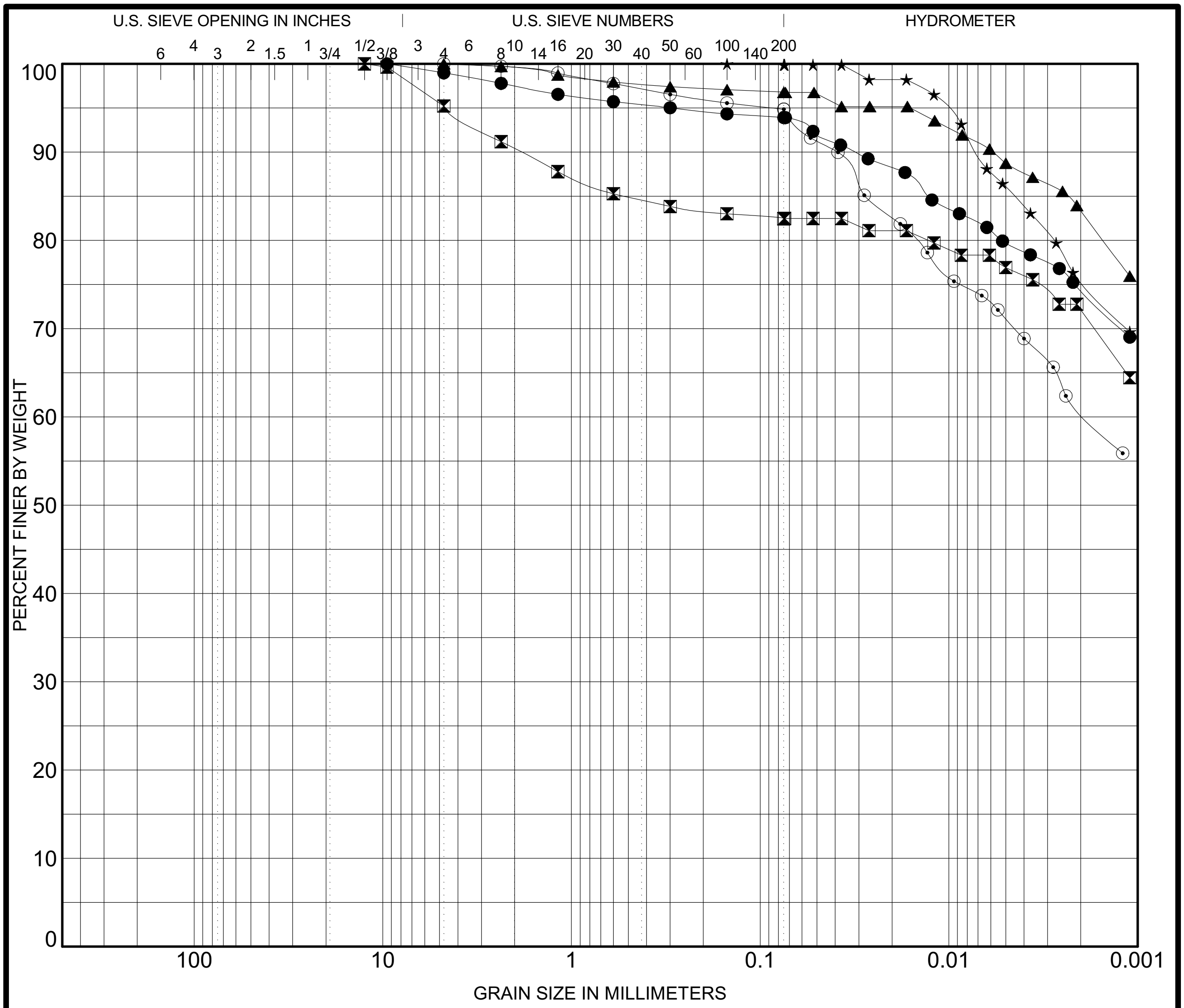
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 5



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**BH 04/SA 3**	**1.83m**	**FAT CLAY(CH)**	**60**	**19**	**41**		
⧗	**BH 04/SA 5**	**3.35m**	**FAT CLAY with SAND(CH)**	**69**	**21**	**48**		
▲	**BH 04/SA 6**	**3.96m**	**FAT CLAY(CH)**	**79**	**26**	**53**		
★	**BH 04/SA 9**	**6.40m**	**FAT CLAY(CH)**	**66**	**20**	**46**		
⊙	**BH 04/SA 10**	**7.01m**	**LEAN CLAY(CI)**	**49**	**15**	**34**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 04/SA 3**	**1.83m**	**9.5**				**1.0**	**5.1**	**19.5**	**74.4**
⧗	**BH 04/SA 5**	**3.35m**	**12.5**				**4.8**	**12.8**	**10.3**	**72.1**
▲	**BH 04/SA 6**	**3.96m**	**4.75**				**0.0**	**3.2**	**13.4**	**83.3**
★	**BH 04/SA 9**	**6.40m**	**0.15**				**0.0**	**0.1**	**24.4**	**75.4**
⊙	**BH 04/SA 10**	**7.01m**	**4.75**	**0**			**0.0**	**5.1**	**34.2**	**60.7**

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GRAIN SIZE DISTRIBUTION

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

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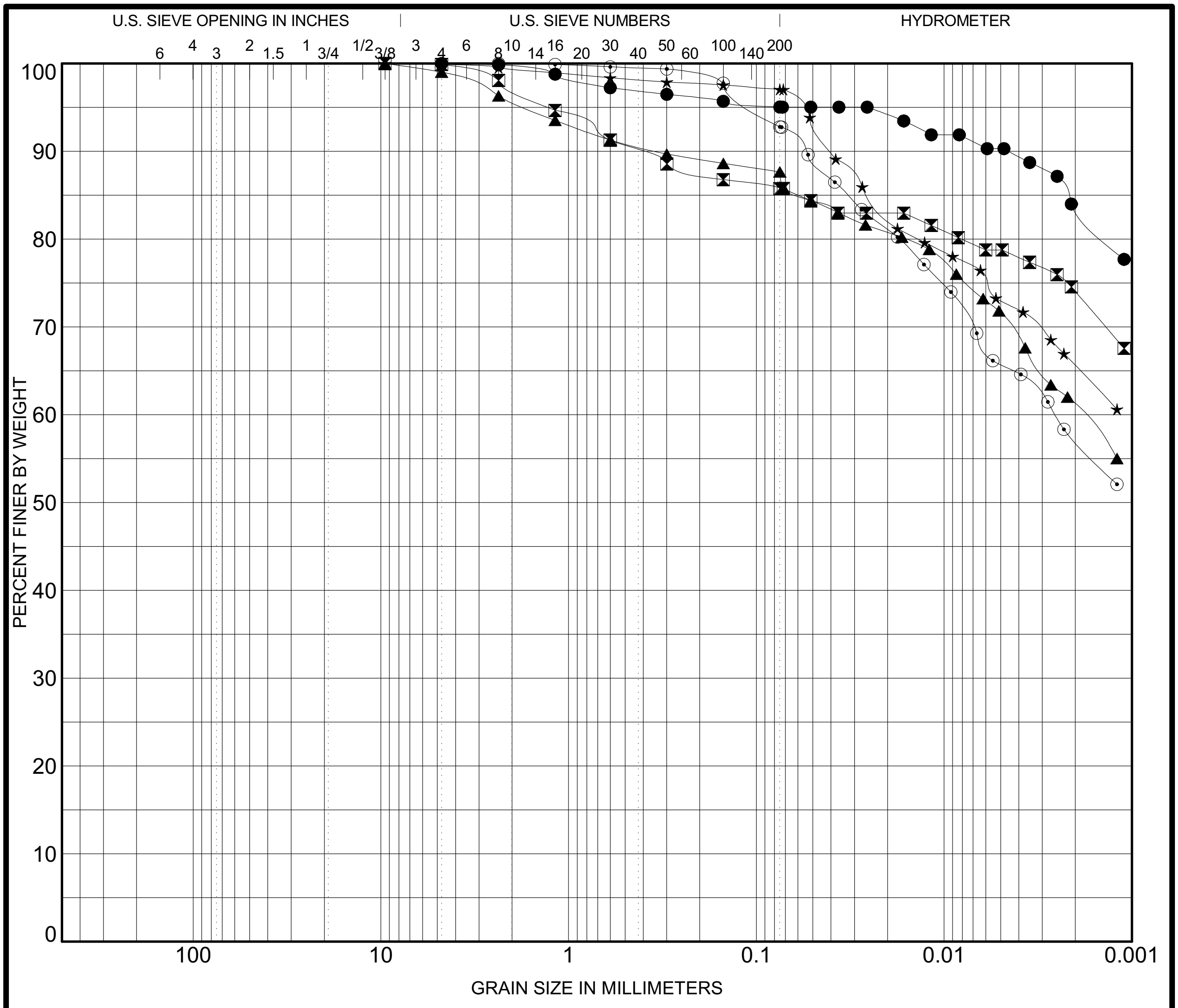
ENCLOSURE No. 6



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	BH 05/SA 3	1.83m						
⧗	BH 05/SA 5	3.35m						
▲	BH 05/SA 7	4.88m	FAT CLAY(CH)	71	21	50		
★	BH 05/SA 9	6.40m						
☉	BH 05/SA 13	9.45m						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH 05/SA 3	1.83m	4.75				0.0	5.0	11.5	83.5
⧗	BH 05/SA 5	3.35m	9.5				0.1	14.1	11.7	74.0
▲	BH 05/SA 7	4.88m	9.5	0			1.0	11.4	26.7	60.9
★	BH 05/SA 9	6.40m	9.5				0.1	2.8	31.5	65.6
☉	BH 05/SA 13	9.45m	2.36	0			0.0	7.2	35.8	57.0

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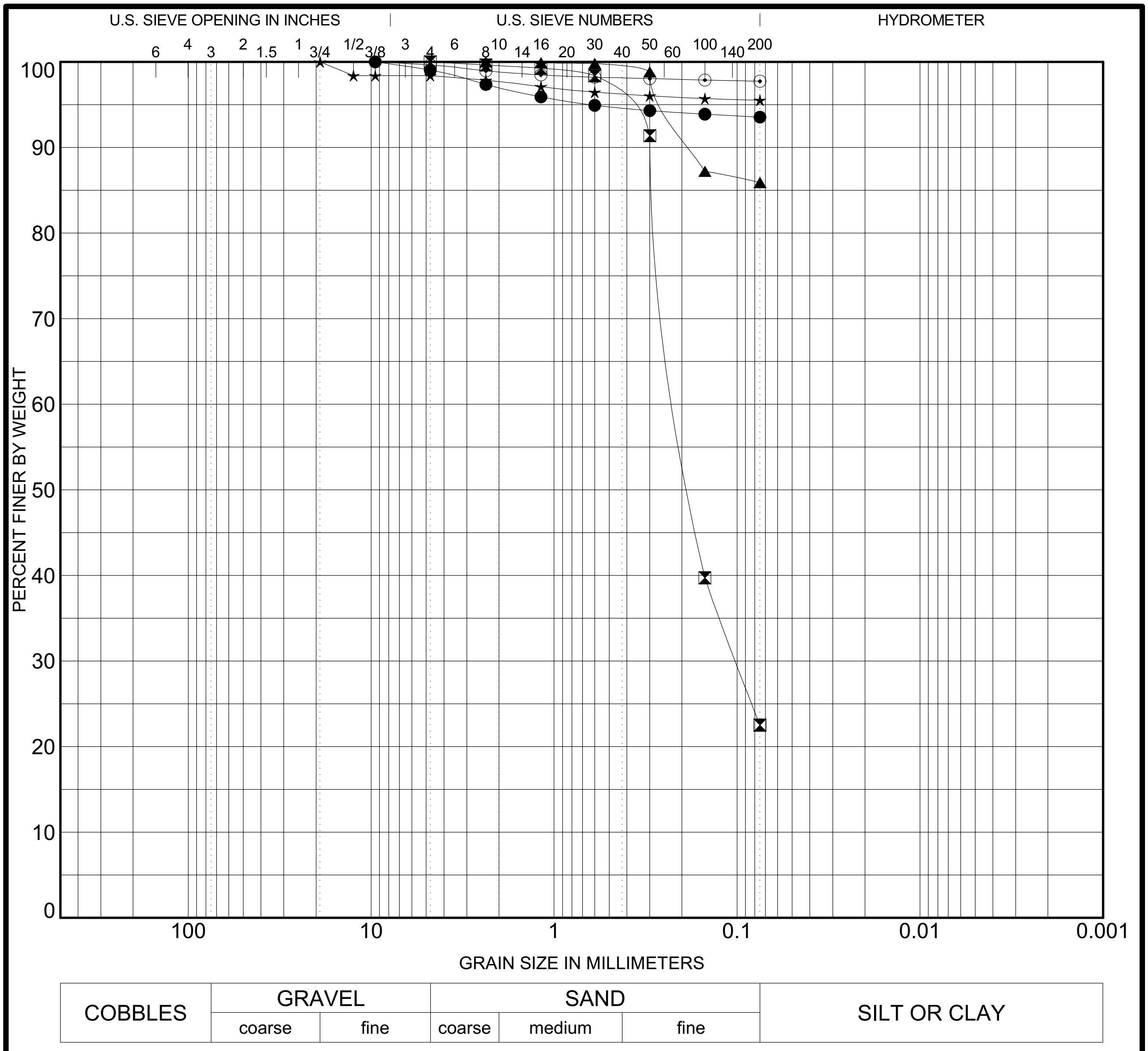
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION



Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● **BH 06/SA 3 1.83m**						
⧗ **BH 06/SA 4 2.44m**						
▲ **BH 06/SA 6 3.96m**						
★ **BH 06/SA 7 4.88m**						
☉ **BH 06/SA 8 5.49m**						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **BH 06/SA 3 1.83m**	**9.5**				**1.0**	**5.5**	**93.6**	
⧗ **BH 06/SA 4 2.44m**	**4.75**	**0.2**	**0.1**		**0.0**	**77.5**	**22.5**	
▲ **BH 06/SA 6 3.96m**	**2.36**				**0.0**	**14.1**	**85.9**	
★ **BH 06/SA 7 4.88m**	**19**				**1.6**	**2.9**	**95.5**	
☉ **BH 06/SA 8 5.49m**	**9.5**				**0.4**	**1.9**	**97.7**	

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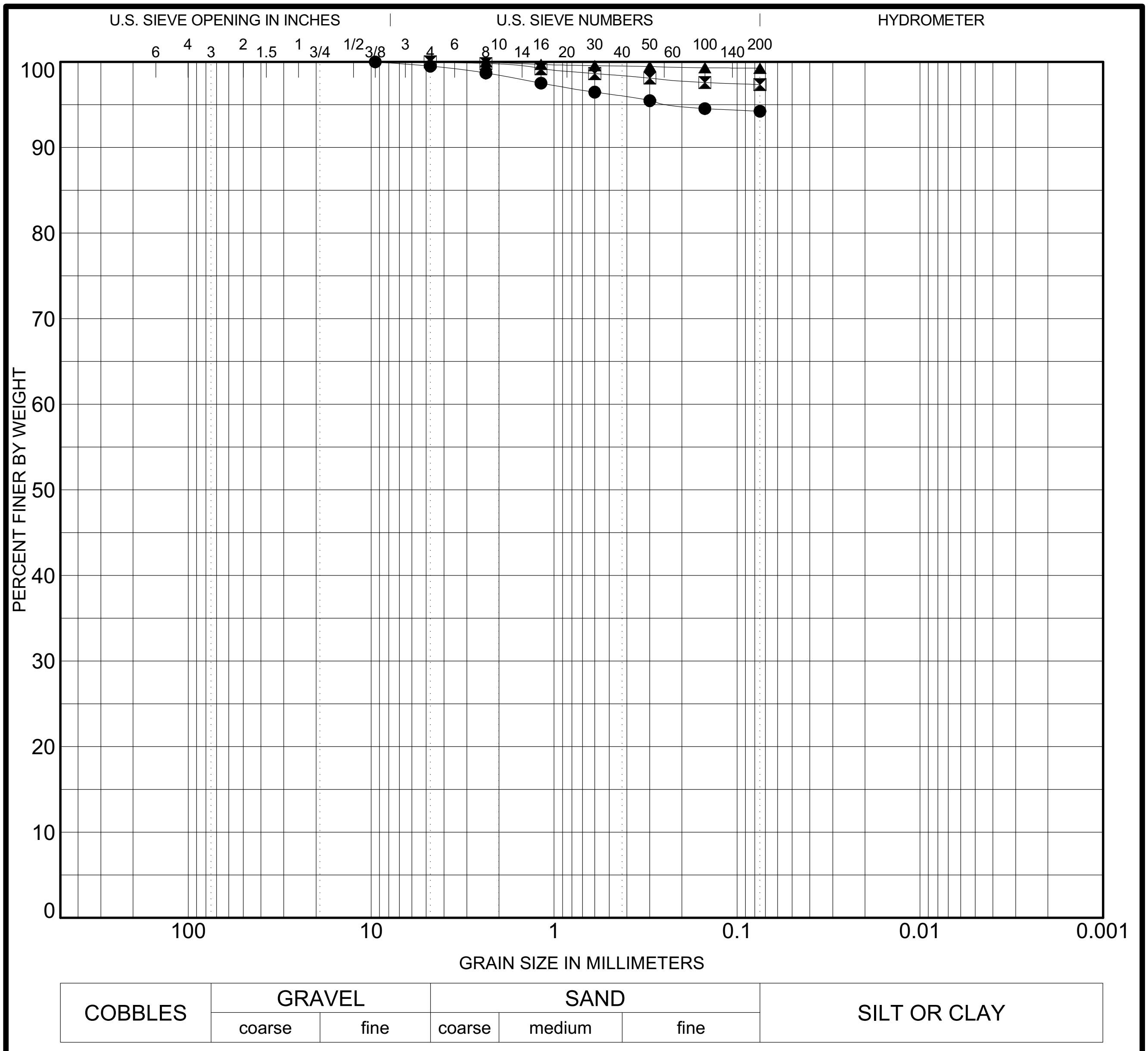
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 8



Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● **BH 06/SA 11 7.92m**						
⧗ **BH 06/SA 14 10.97m**						
▲ **BH 06/SA 13.11m**						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **BH 06/SA 11 7.92m**	**9.5**				**0.5**	**5.3**	**94.2**	
⧗ **BH 06/SA 14 10.97m**	**4.75**				**0.0**	**2.7**	**97.3**	
▲ **BH 06/SA 13.11m**	**2.36**				**0.0**	**0.7**	**99.3**	

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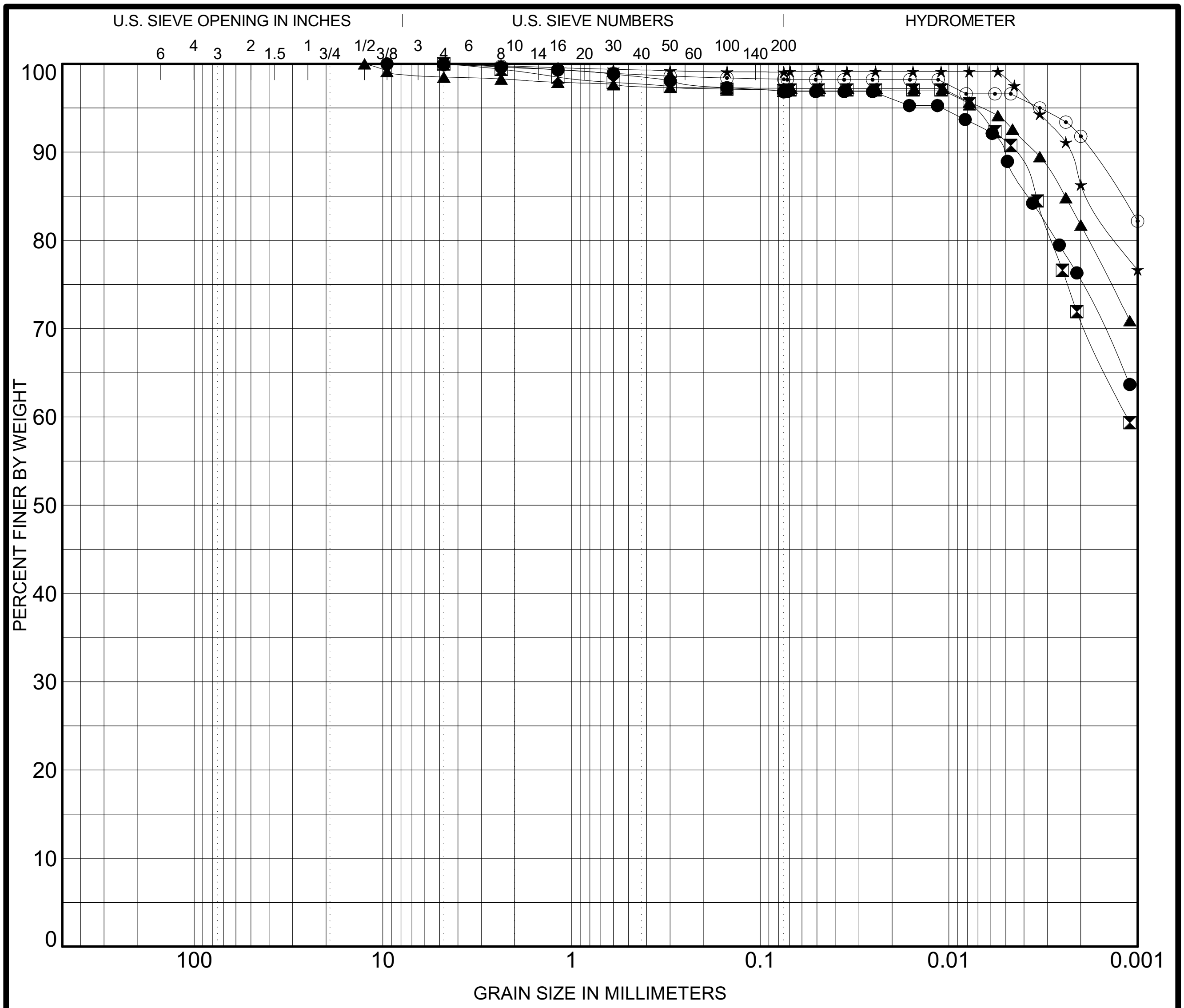
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 9



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BH 07/SA 3**	**1.83m**						
⧗	**BH 07/SA 5**	**3.35m**						
▲	**BH 07/SA 6**	**3.96m**						
★	**BH 07/SA 10**	**7.01m**						
☉	**BH 07/SA 14**	**10.97m**						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 07/SA 3**	**1.83m**	**9.5**				**0.1**	**3.1**	**21.5**	**75.4**
⧗	**BH 07/SA 5**	**3.35m**	**4.75**	**0**			**0.0**	**3.0**	**26.0**	**71.0**
▲	**BH 07/SA 6**	**3.96m**	**12.5**				**1.5**	**1.3**	**15.5**	**81.7**
★	**BH 07/SA 10**	**7.01m**	**4.75**				**0.0**	**0.9**	**12.8**	**86.3**
☉	**BH 07/SA 14**	**10.97m**	**4.75**				**0.0**	**1.7**	**6.5**	**91.8**

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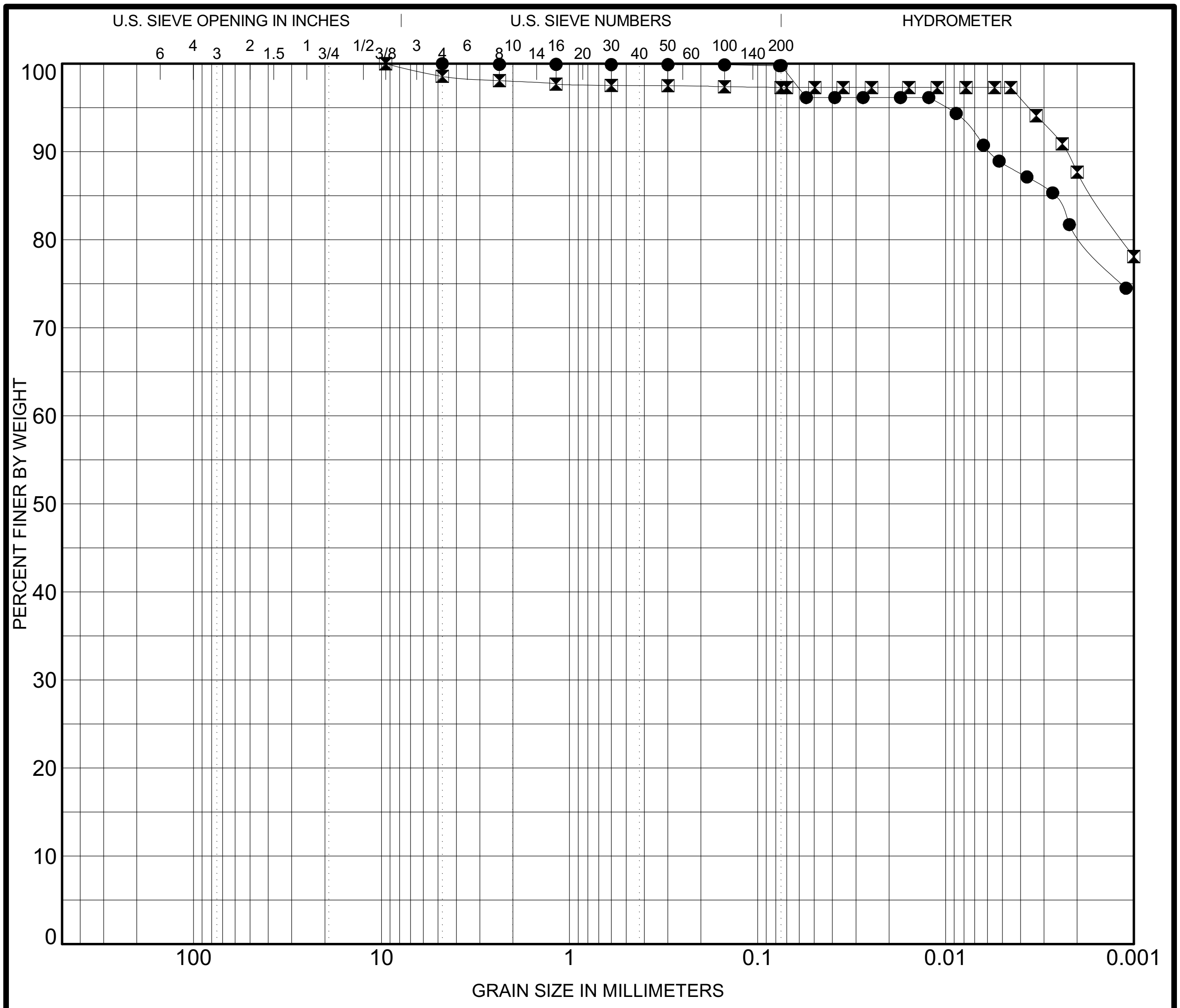
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**BH 07/SA 17 15.54m**						
⧗	**BH 07/SA 19 18.59m**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 07/SA 17 15.54m**	**4.75**				**0.0**	**0.2**	**19.1**	**80.7**
⧗	**BH 07/SA 19 18.59m**	**9.5**				**1.4**	**1.3**	**9.6**	**87.7**

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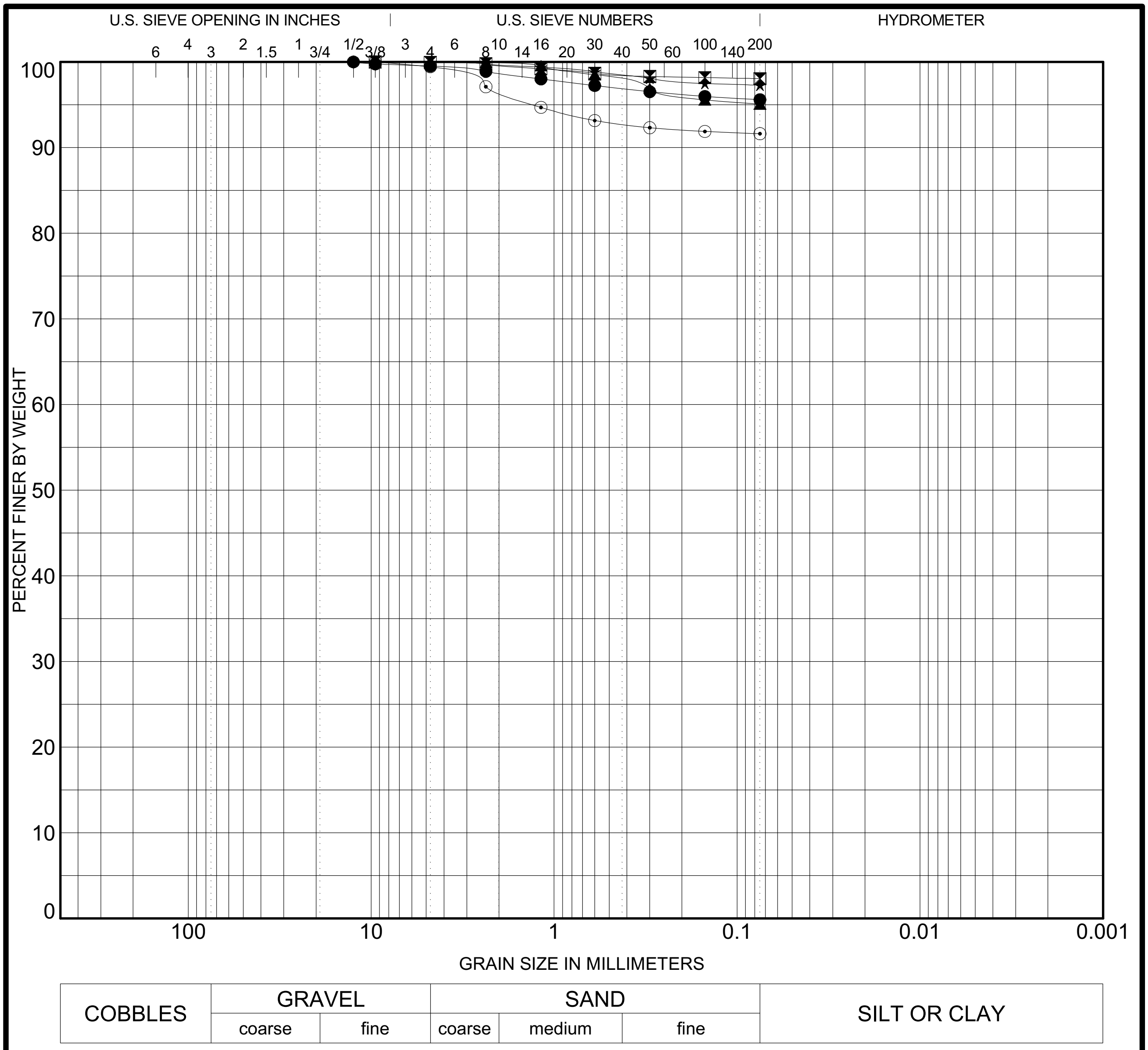
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 11



Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● **BH 08/SA 3 1.83m**						
⧗ **BH 08/SA 5 3.35m**						
▲ **BH 08/SA 7 4.88m**						
★ **BH 08/SA 10 7.01m**						
☉ **BH 08/SA 13 9.45m**	**FAT CLAY(CH)**	**85**	**22**	**63**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **BH 08/SA 3 1.83m**	**12.5**				**0.5**	**3.9**	**95.6**	
⧗ **BH 08/SA 5 3.35m**	**9.5**				**0.0**	**1.9**	**98.0**	
▲ **BH 08/SA 7 4.88m**	**4.75**				**0.0**	**4.9**	**95.1**	
★ **BH 08/SA 10 7.01m**	**9.5**				**0.0**	**2.7**	**97.3**	
☉ **BH 08/SA 13 9.45m**	**9.5**				**0.6**	**7.8**	**91.6**	

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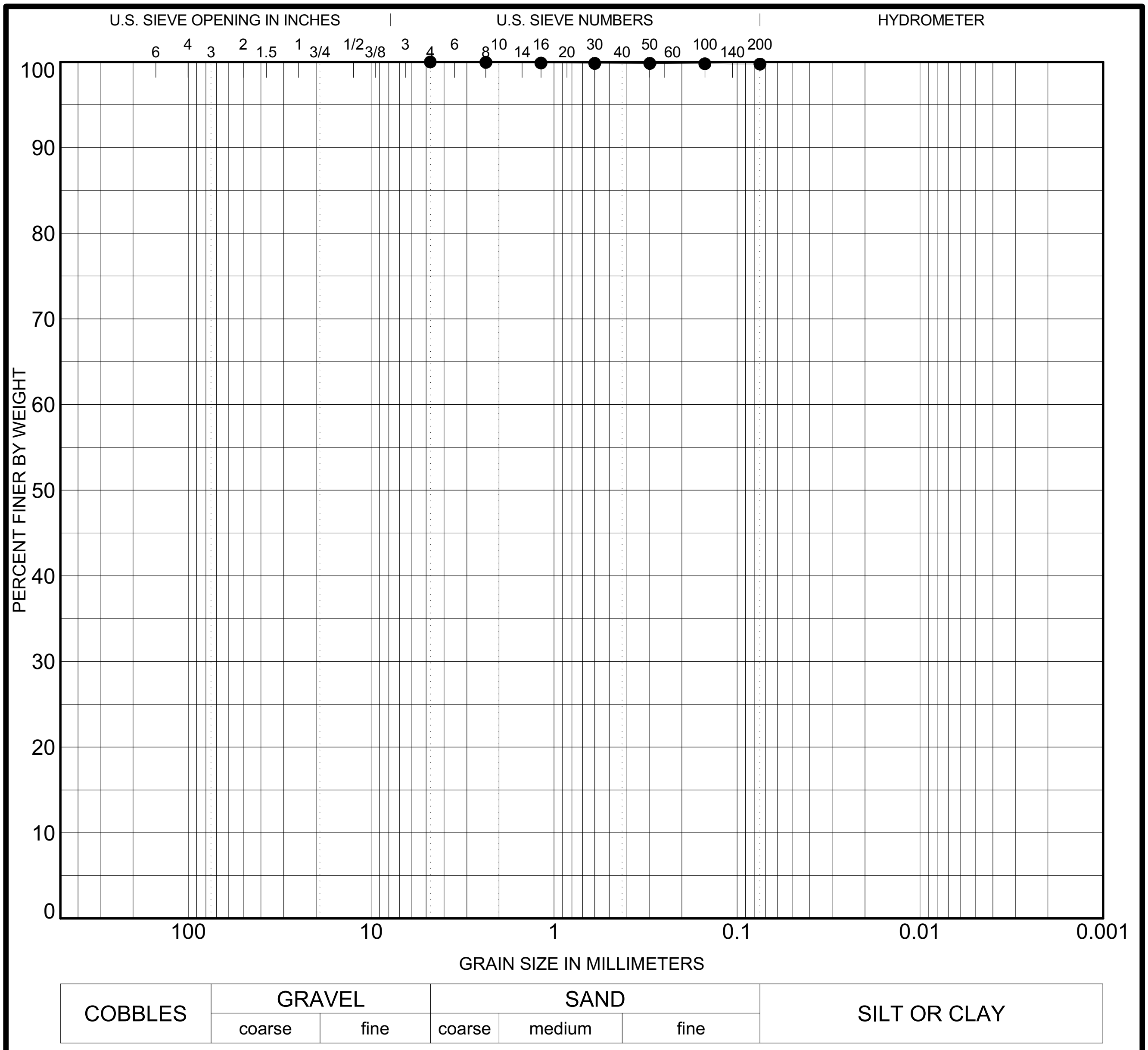
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 12



	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**BH 08/SA 16 12.50m**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 08/SA 16 12.50m**	**4.75**				**0.0**	**0.3**	**99.7**	

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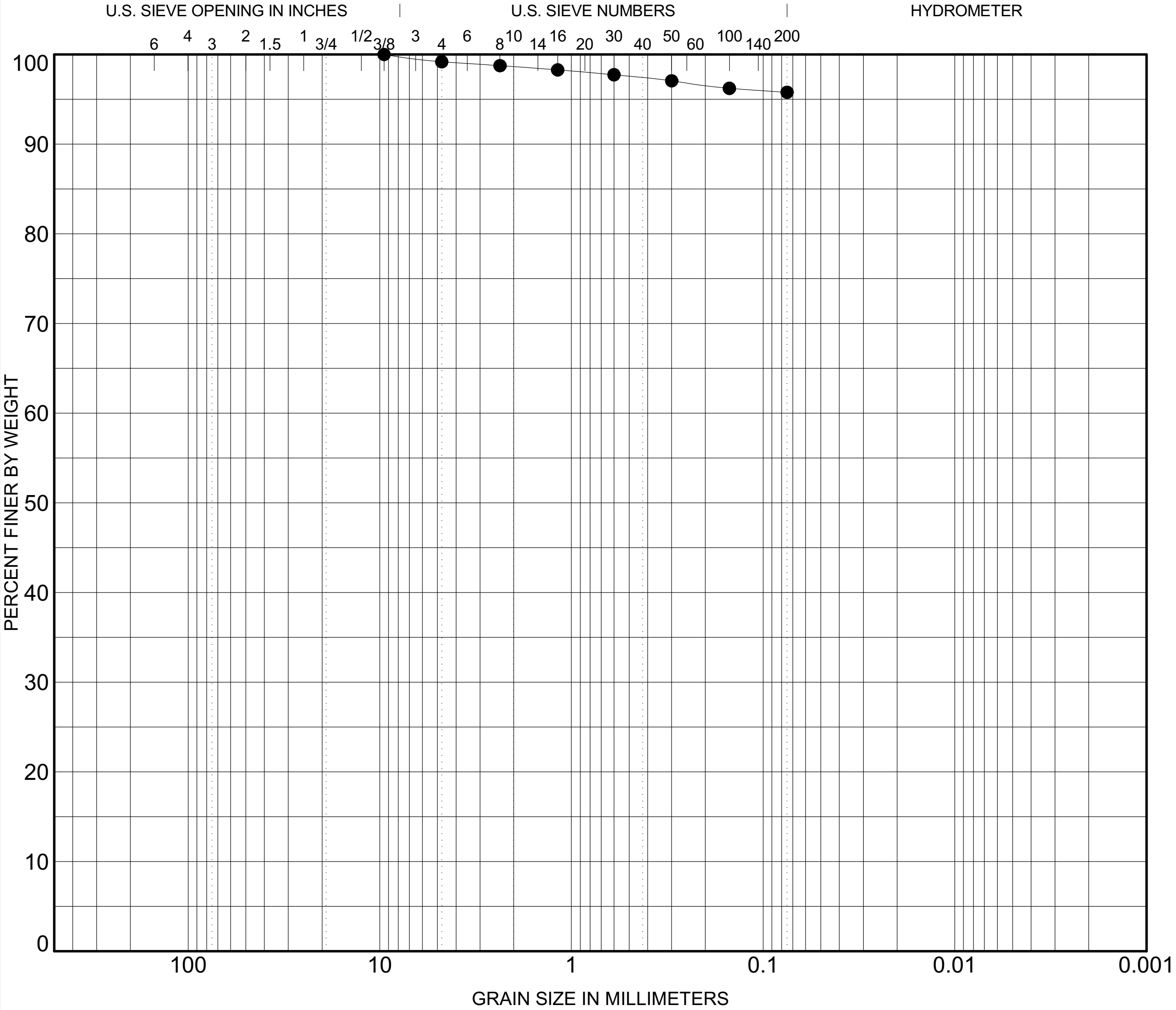
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 13



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**BH 09/SA 3 1.83m**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 09/SA 3 1.83m**	**9.5**				**0.8**	**3.4**	**95.8**	

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Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

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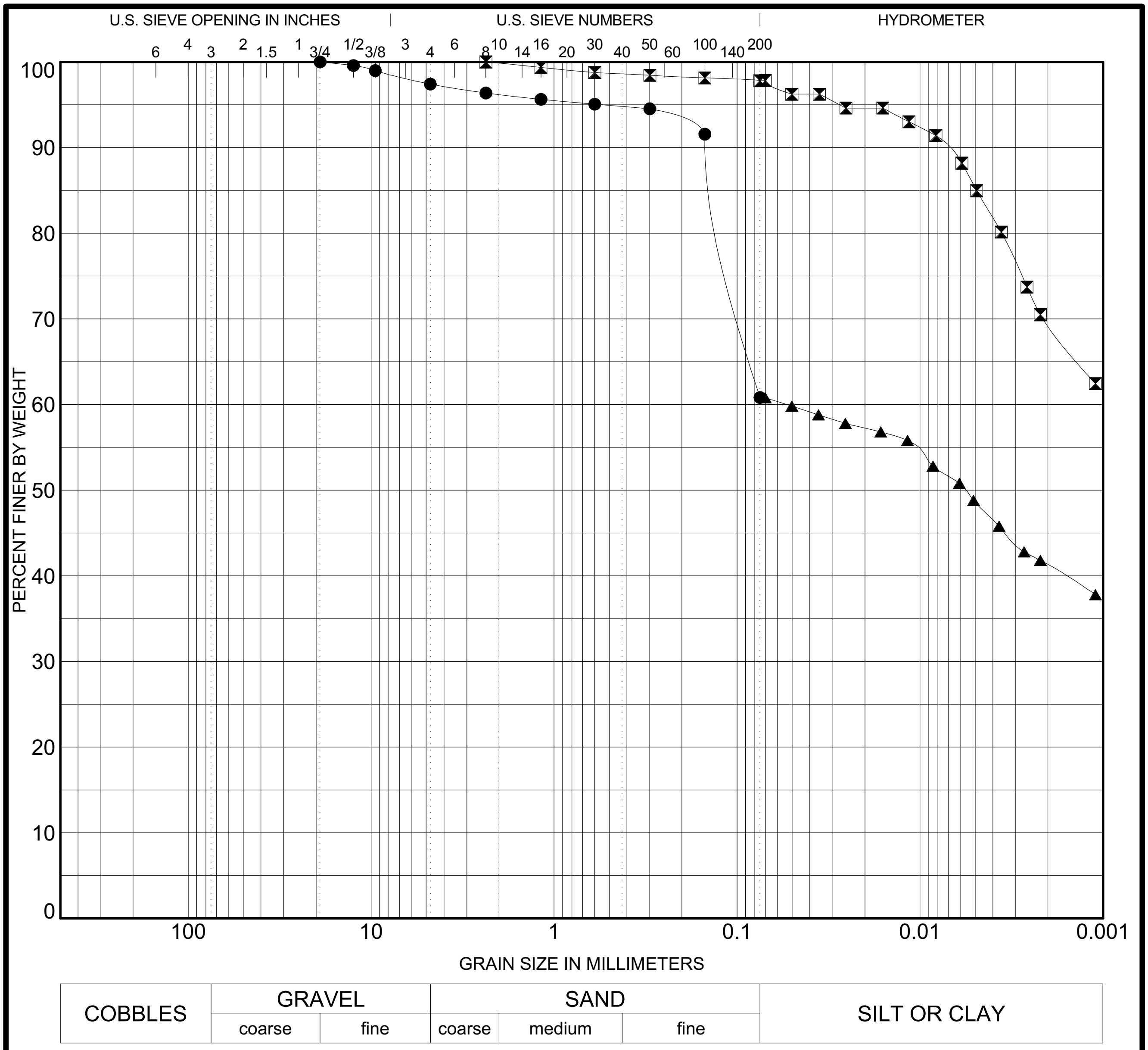
ENCLOSURE No. 14



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BH 11/SA 3 1.83m**						
⧗	**BH 11/SA 9 6.40m**						
▲	**BH 11/SA 14 10.97m**						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 11/SA 3 1.83m**	**19**				**2.6**	**36.6**	**60.8**	
⧗	**BH 11/SA 9 6.40m**	**2.36**				**0.0**	**2.2**	**28.4**	**69.4**
▲	**BH 11/SA 14 10.97m**		**0.05**						**41.3**

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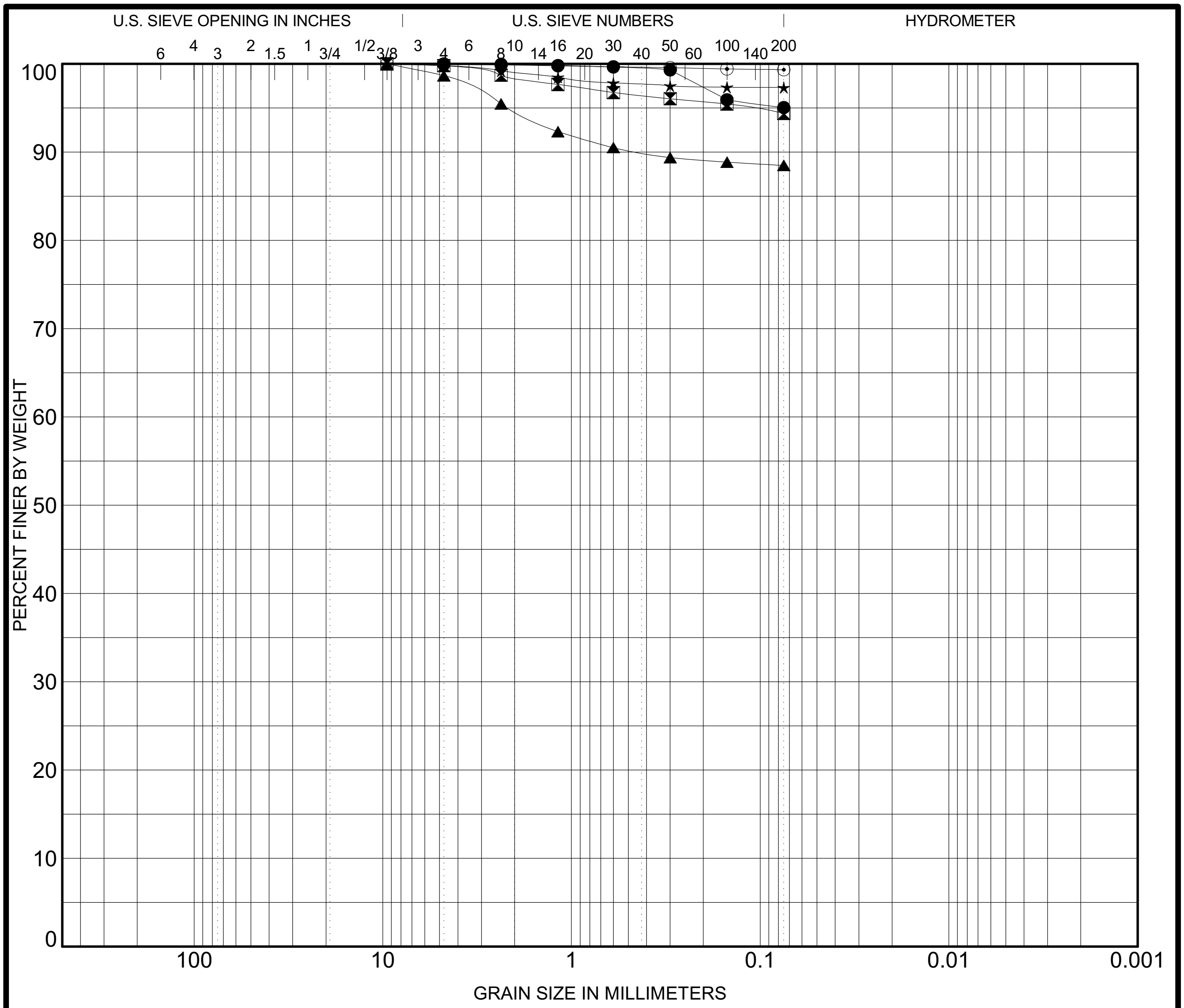
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 15



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BH 14/SA 3 1.83m**						
⧗	**BH 14/SA 5 3.35m**						
▲	**BH 14/SA 8 5.49m**						
★	**BH 14/SA 11 7.92m**						
☉	**BH 14/SA 15 12.50m**						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 14/SA 3 1.83m**	**4.75**				**0.0**	**5.0**	**95.0**	
⧗	**BH 14/SA 5 3.35m**	**9.5**				**0.2**	**5.4**	**94.4**	
▲	**BH 14/SA 8 5.49m**	**9.5**				**1.3**	**10.2**	**88.5**	
★	**BH 14/SA 11 7.92m**	**9.5**				**0.2**	**2.5**	**97.3**	
☉	**BH 14/SA 15 12.50m**	**9.5**				**0.1**	**0.6**	**99.3**	

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Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

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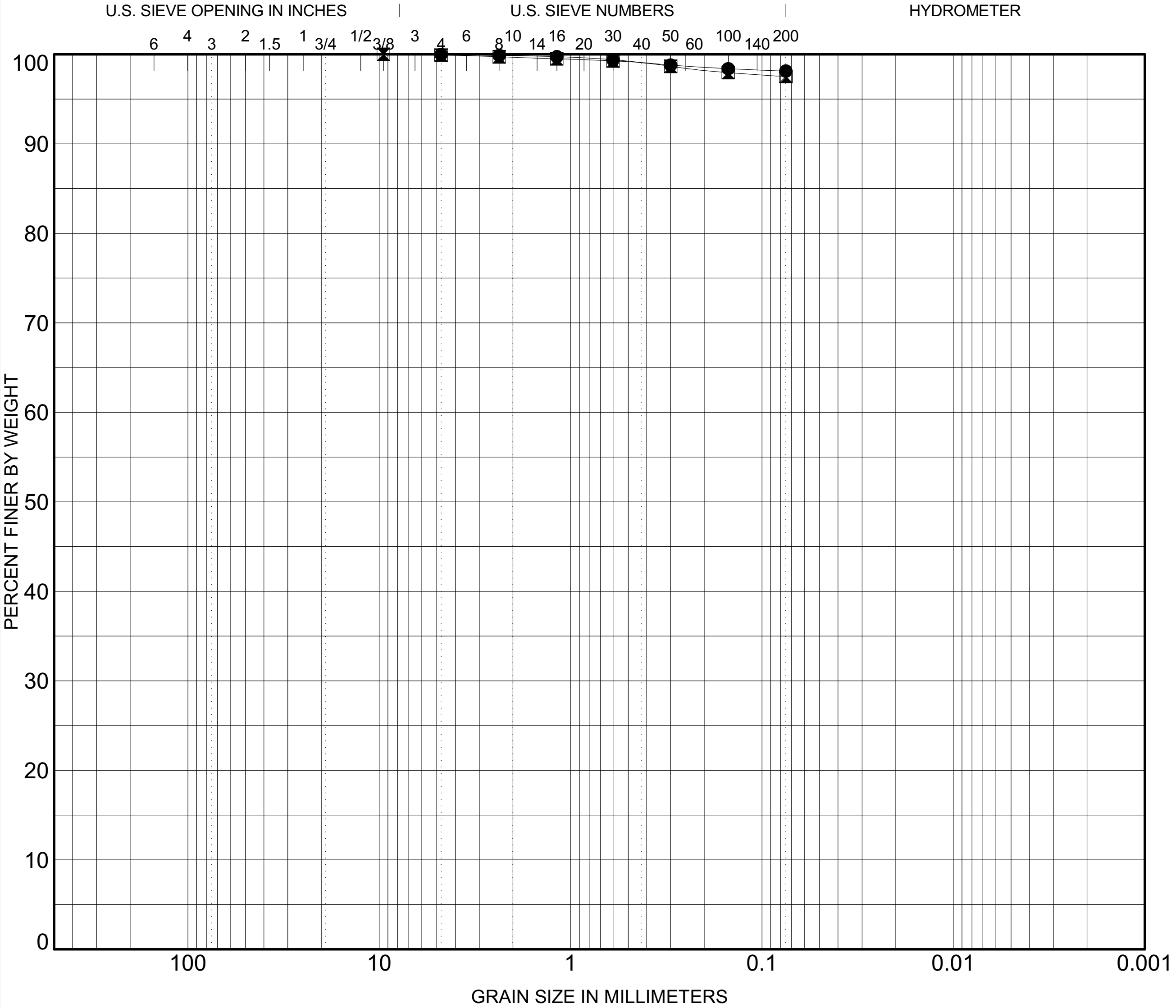
ENCLOSURE No. 16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● **BH 14/SA 17 15.54m**						
⧗ **BH 14/SA 18 17.07m**						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **BH 14/SA 17 15.54m**	**4.75**				**0.0**	**1.9**	**98.1**	
⧗ **BH 14/SA 18 17.07m**	**9.5**				**0.1**	**2.4**	**97.5**	

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Type: SITE INVESTIGATION

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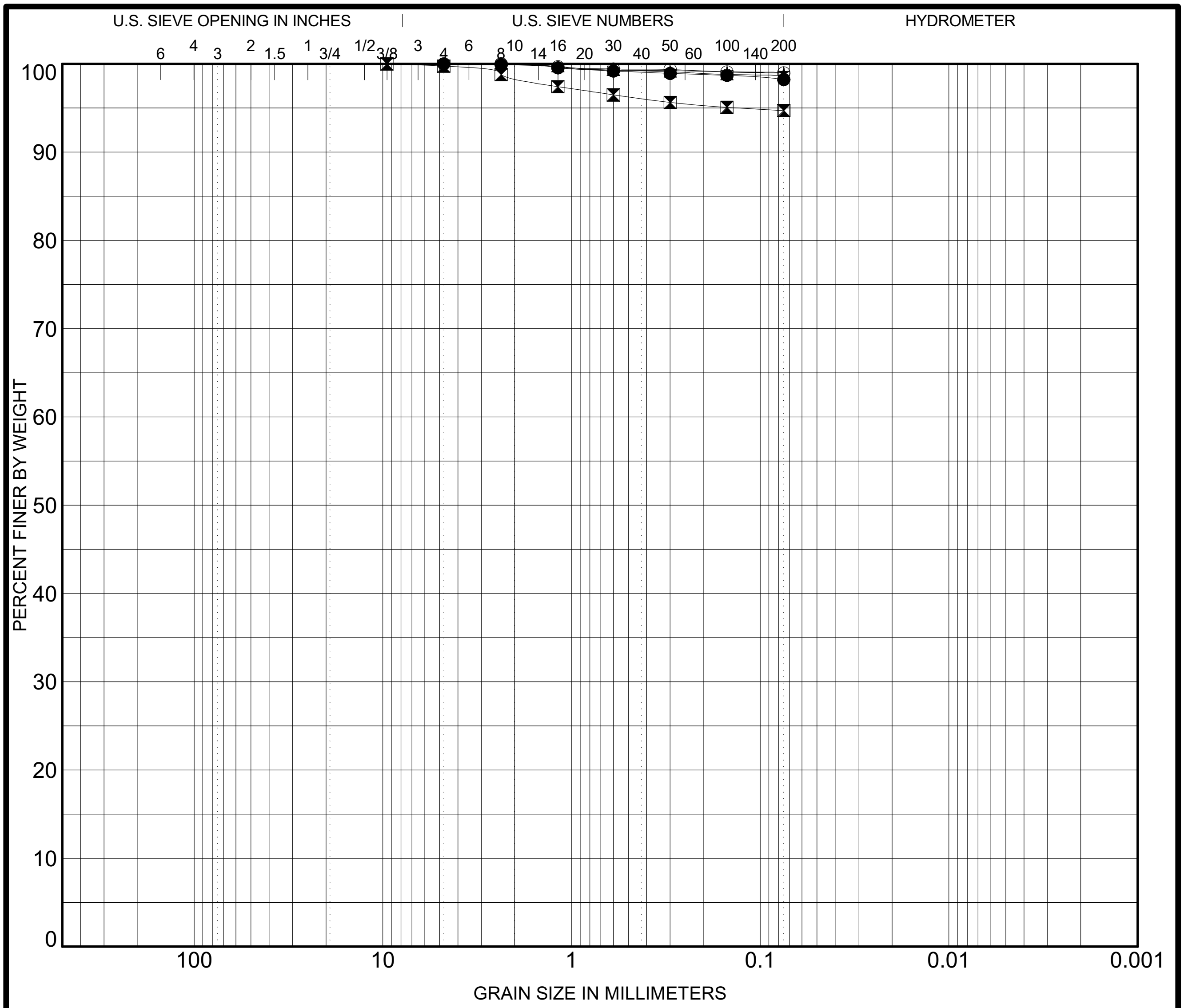
ENCLOSURE No. 17



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● **BH 15/SA 3 1.83m**						
⧗ **BH 15/SA 6 3.96m**						
▲ **BH 15/SA 9 6.40m**						
★ **BH 15/SA 12 8.53m**						
☉ **BH 15/SA 14 10.97m**						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **BH 15/SA 3 1.83m**	**4.75**				**0.0**	**1.8**	**98.2**	
⧗ **BH 15/SA 6 3.96m**	**9.5**				**0.2**	**5.1**	**94.7**	
▲ **BH 15/SA 9 6.40m**	**2.36**				**0.0**	**1.3**	**98.7**	
★ **BH 15/SA 12 8.53m**	**2.36**				**0.0**	**1.0**	**99.0**	
☉ **BH 15/SA 14 10.97m**	**2.36**				**0.0**	**1.0**	**99.0**	

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Project: Couva Children's Hospital
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Type: SITE INVESTIGATION

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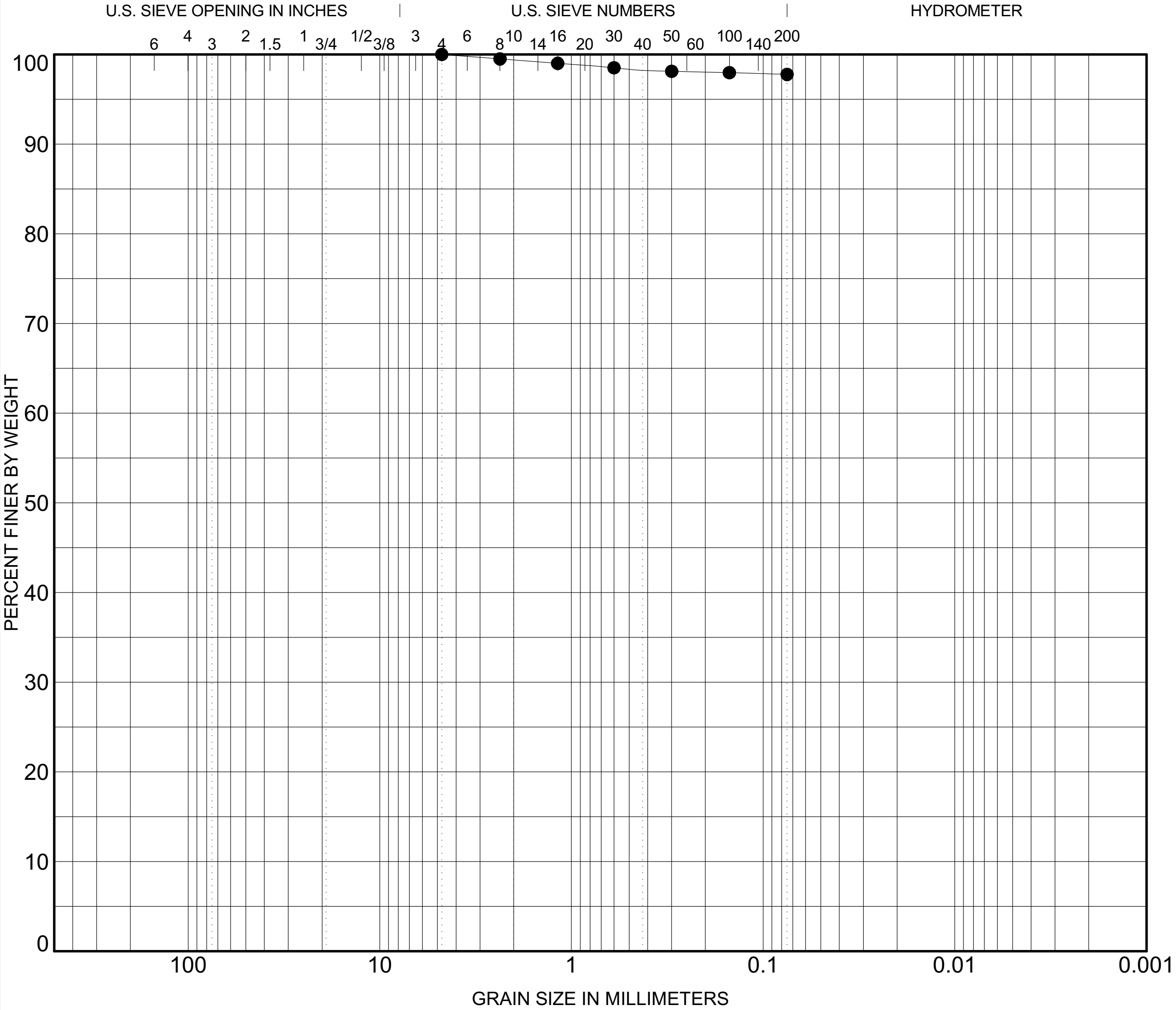

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**BH 15/SA 18 15.54m**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 15/SA 18 15.54m**	**4.75**				**0.0**	**2.2**	**97.8**	

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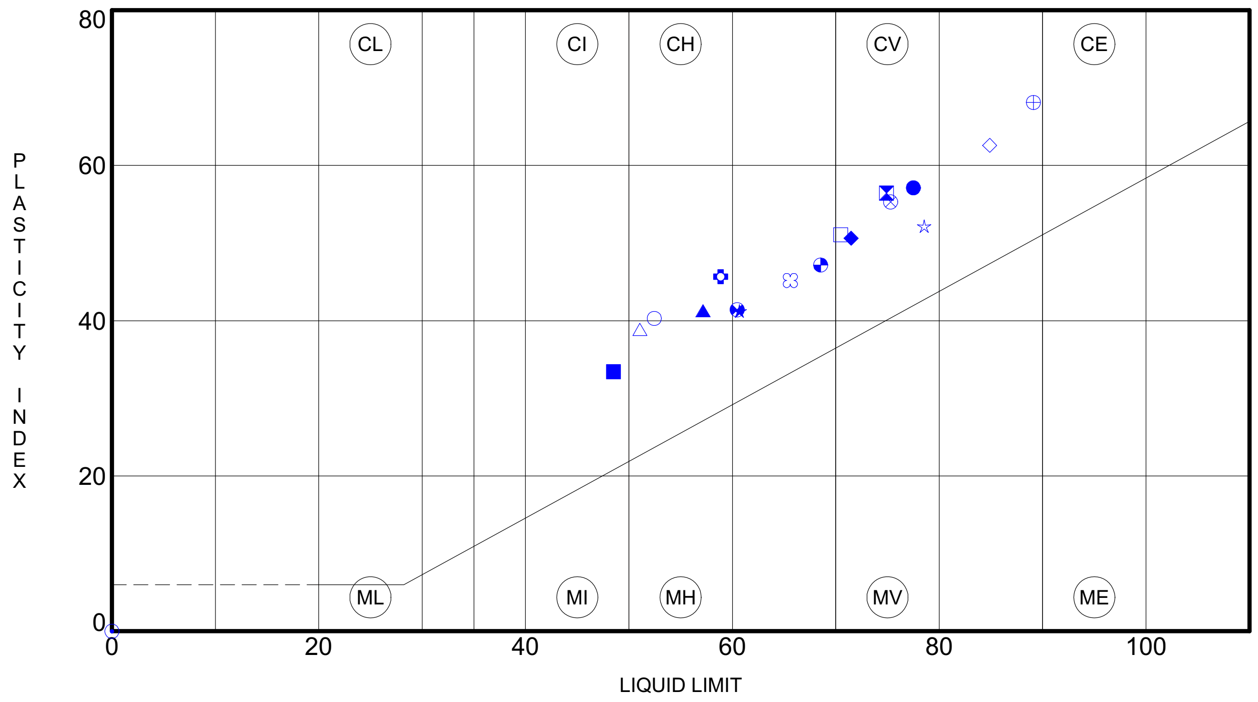
Location: Couva
Type: SITE INVESTIGATION



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 01/SA 3**	**1.83m**	**78**	**20**	**58**	**80.9**	**FAT CLAY with SAND(CH)**
⧗	**BH 01/SA 5**	**3.35m**	**75**	**18**	**57**	**98.9**	**FAT CLAY(CH)**
▲	**BH 01/SA 7**	**4.88m**	**57**	**16**	**41**	**77.7**	**FAT CLAY with SAND(CH)**
★	**BH 01/SA 8**	**5.49m**	**61**	**19**	**42**	**90.5**	**FAT CLAY(CH)**
⊙	**BH 01/SA 10**	**7.01m**	**NP**	**NP**	**NP**	**60.0**	**SANDY SILT(ML)**
✿	**BH 01/SA 12**	**8.53m**	**59**	**13**	**46**	**94.8**	**FAT CLAY(CH)**
○	**BH 01/SA 13**	**9.45m**	**52**	**12**	**40**	**92.5**	**FAT CLAY(CH)**
△	**BH 01/SA 14**	**10.97m**	**51**	**12**	**39**	**88.9**	**FAT CLAY(CH)**
⊗	**BH 01/SA 15**	**12.50m**	**75**	**20**	**55**	**92.1**	**FAT CLAY(CH)**
⊕	**BH 01/SA 19**	**18.59m**	**89**	**21**	**68**	**99.9**	**FAT CLAY(CH)**
□	**BH 03/SA 3**	**1.83m**	**70**	**19**	**51**		
⊛	**BH 04/SA 3**	**1.83m**	**60**	**19**	**41**	**93.9**	**FAT CLAY(CH)**
◕	**BH 04/SA 5**	**3.35m**	**69**	**21**	**48**	**82.5**	**FAT CLAY with SAND(CH)**
☆	**BH 04/SA 6**	**3.96m**	**79**	**26**	**53**	**96.8**	**FAT CLAY(CH)**
❀	**BH 04/SA 9**	**6.40m**	**66**	**20**	**46**	**99.9**	**FAT CLAY(CH)**
■	**BH 04/SA 10**	**7.01m**	**49**	**15**	**34**	**94.9**	**LEAN CLAY(CI)**
◆	**BH 05/SA 7**	**4.88m**	**71**	**21**	**50**	**87.7**	**FAT CLAY(CH)**
◇	**BH 08/SA 13**	**9.45m**	**85**	**22**	**63**	**91.6**	**FAT CLAY(CH)**

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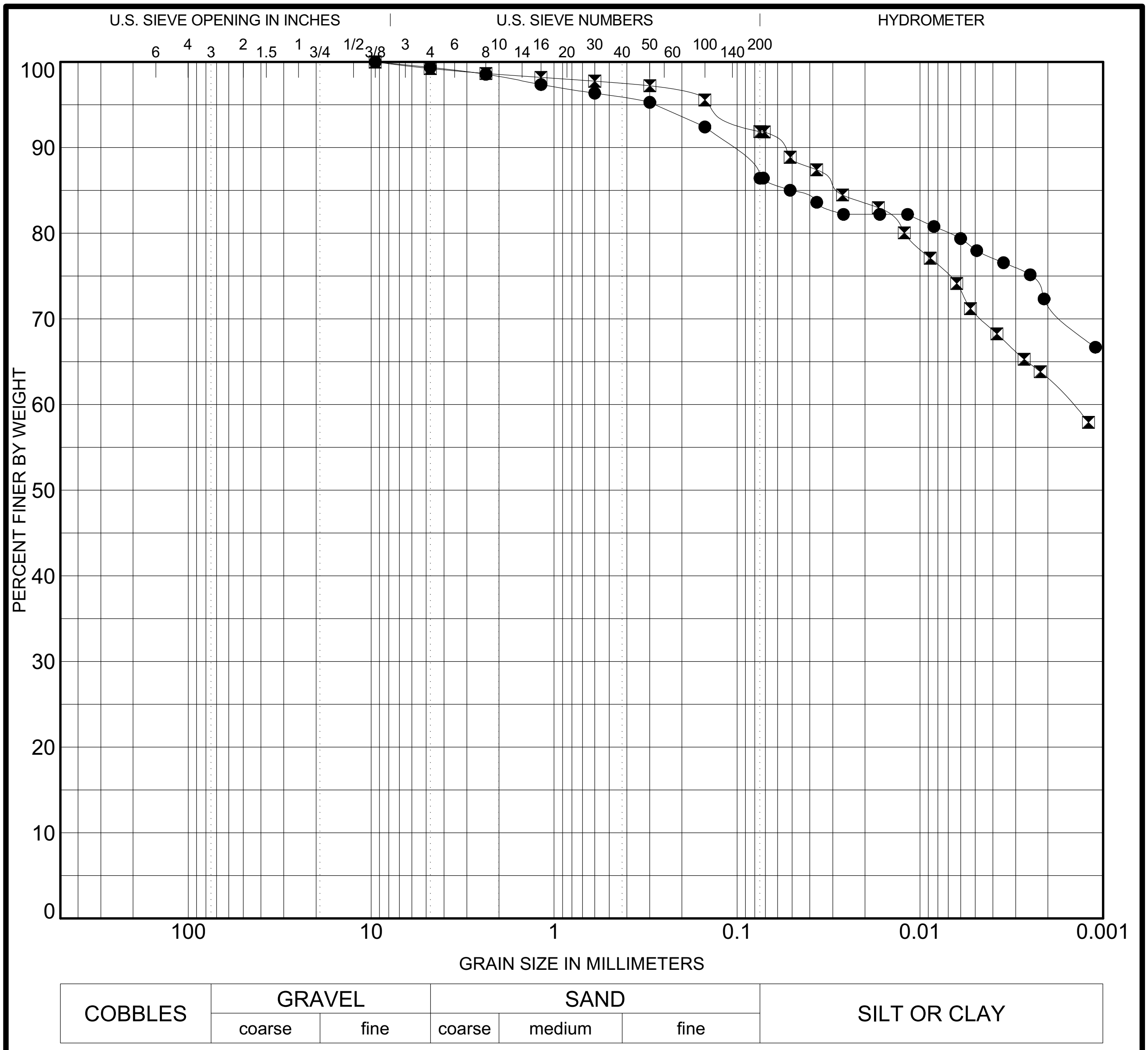
Telephone: 1-868-638-3978
Fax: 1-868-675-4960

ATTERBERG LIMITS' RESULTS

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Location: Couva
Client: Shanghai Construction Group International Ltd.
Type: SITE INVESTIGATION

ENCLOSURE No. 1



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**TP 01/SA 2**	**0.80m**	**FAT CLAY(CH)**	**70**	**26**	**44**		
⧗	**TP 01/SA 3**	**1.80m**	**FAT CLAY(CH)**	**65**	**15**	**50**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 01/SA 2**	**0.80m**	**9.5**				**0.6**	**12.9**	**14.5**	**71.9**
⧗	**TP 01/SA 3**	**1.80m**	**9.5**	**0**			**0.8**	**7.4**	**29.0**	**62.9**

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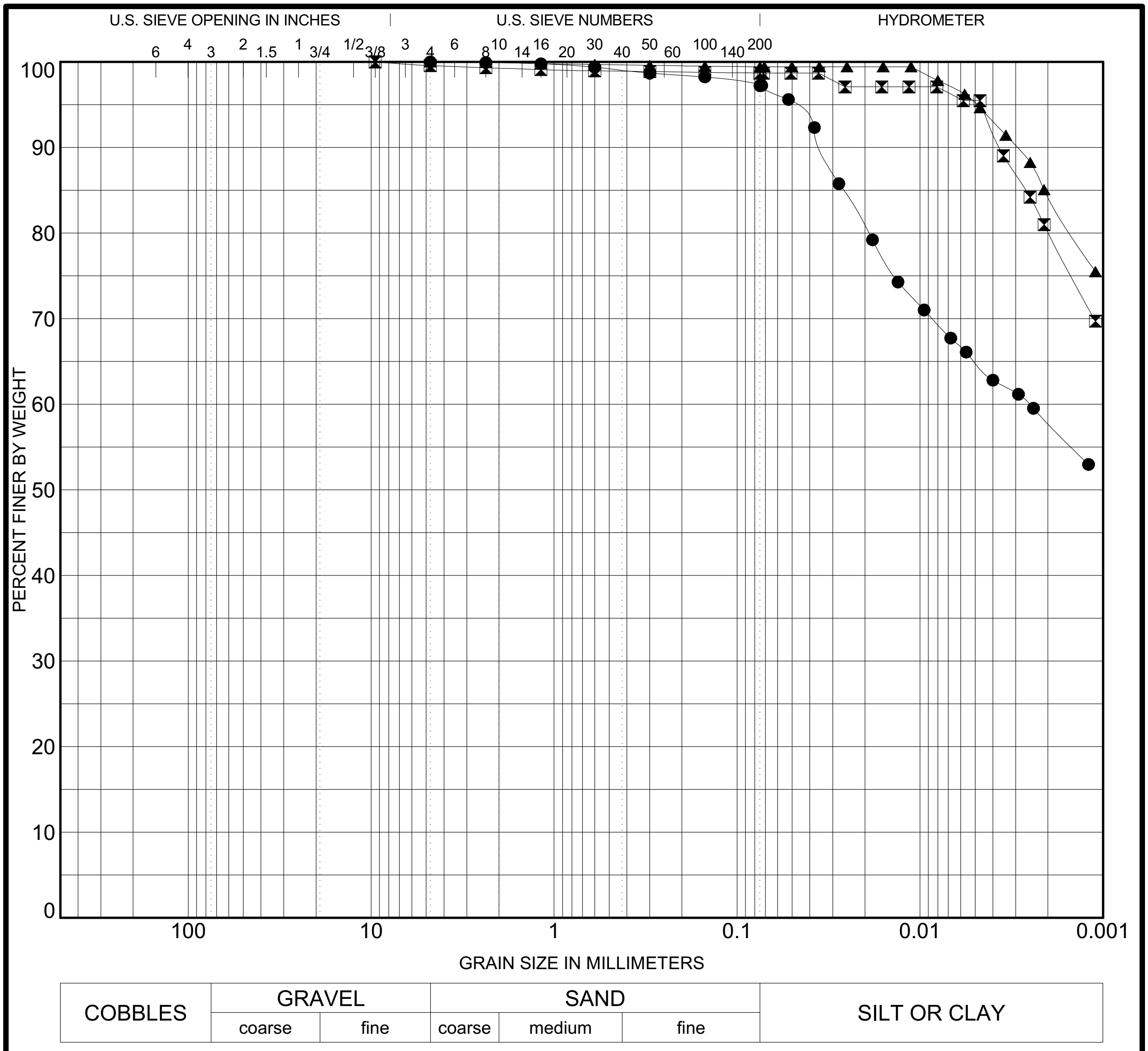
GRAIN SIZE DISTRIBUTION

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

EISL SIEVE 0412 01 2012 COUVA HOSPITAL.GPJ EISL.GDT 11/9/12

ENCLOSURE No. 2



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● **TP 02/SA**	**0.71m**	**FAT CLAY(CH)**	**53**	**16**	**37**		
⧗ **TP 02/SA**	**1.73m**	**FAT CLAY(CH)**	**78**	**21**	**57**		
▲ **TP 02/SA**	**2.60m**	**FAT CLAY(CH)**	**86**	**23**	**63**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **TP 02/SA**	**0.71m**	**4.75**	**0**			**0.0**	**2.8**	**39.4**	**57.8**
⧗ **TP 02/SA**	**1.73m**	**9.5**				**0.4**	**0.9**	**18.6**	**80.1**
▲ **TP 02/SA**	**2.60m**	**4.75**				**0.0**	**0.6**	**15.1**	**84.3**

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GRAIN SIZE DISTRIBUTION

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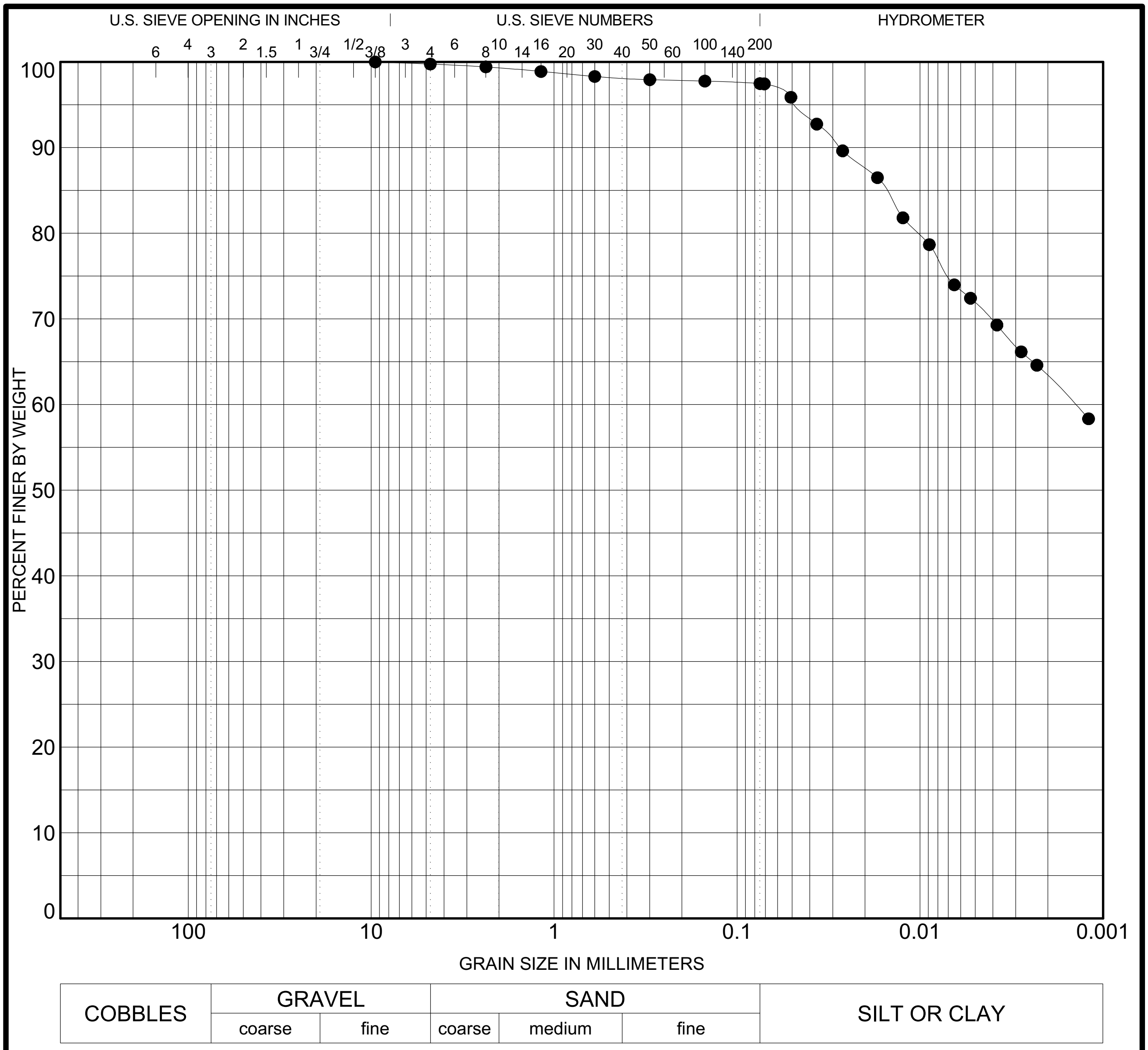
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

EISL SIEVE 0412_01_2012 COUVA HOSPITAL.GPJ EISL.GDT 11/9/12

ENCLOSURE No. 3



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**TP 03/SA**	**2.56m**	**FAT CLAY(CH)**	**66**	**17**	**49**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 03/SA**	**2.56m**	**9.5**	**0**			**0.2**	**2.3**	**34.2**	**63.2**

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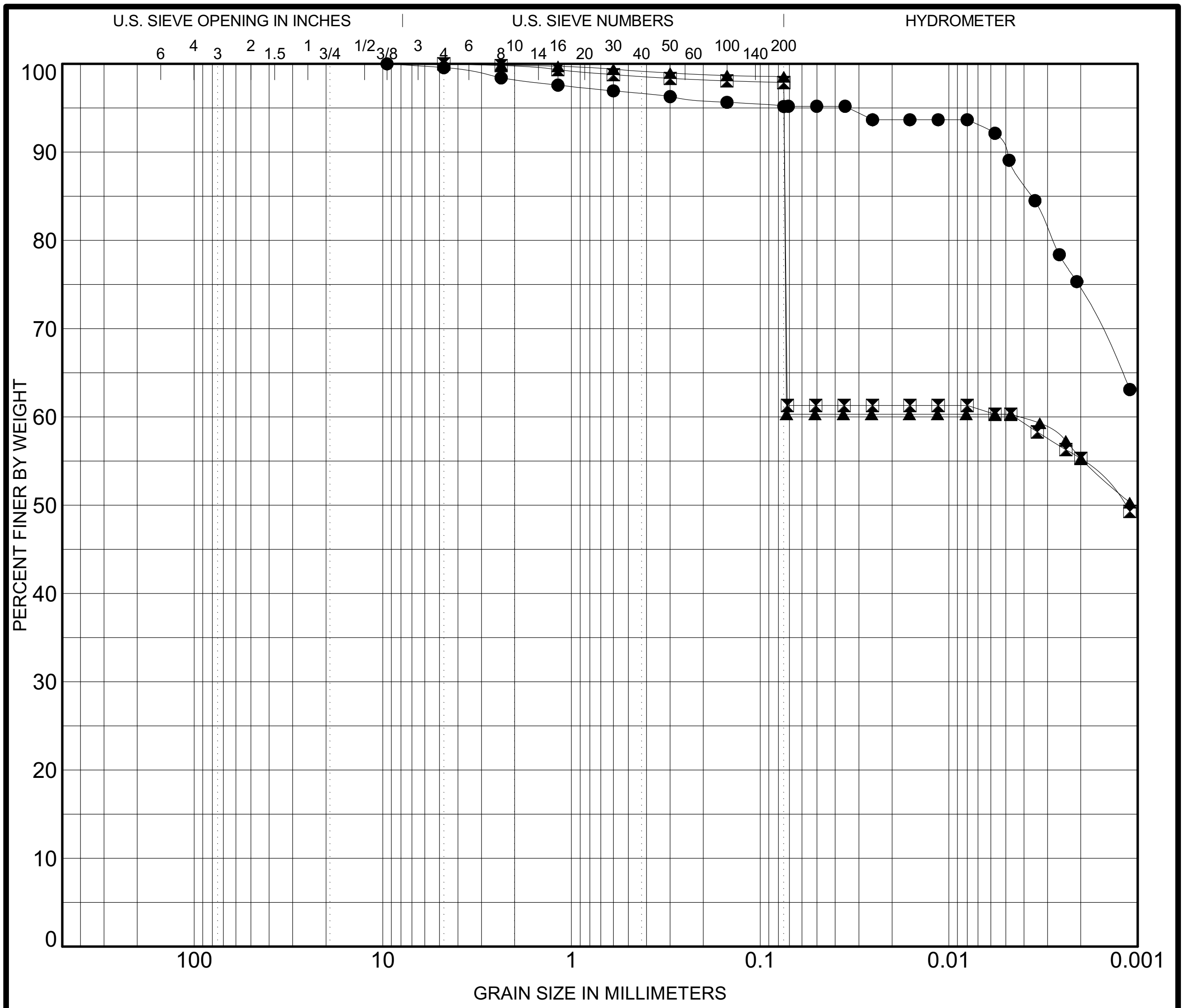
GRAIN SIZE DISTRIBUTION

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 4



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**TP 04/SA**	**1.02m**	**FAT CLAY(CH)**	**78**	**20**	**58**		
⧗	**TP 04/SA**	**2.19m**	**FAT CLAY(CH)**	**97**	**21**	**76**		
▲	**TP 04/SA**	**3.05m**	**FAT CLAY(CH)**	**102**	**21**	**81**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 04/SA**	**1.02m**	**9.5**				**0.4**	**4.4**	**20.8**	**74.4**
⧗	**TP 04/SA**	**2.19m**	**4.75**	**0**			**0.0**	**2.1**	**42.6**	**55.3**
▲	**TP 04/SA**	**3.05m**	**4.75**	**0**			**0.0**	**1.5**	**43.2**	**55.3**

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GRAIN SIZE DISTRIBUTION

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Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

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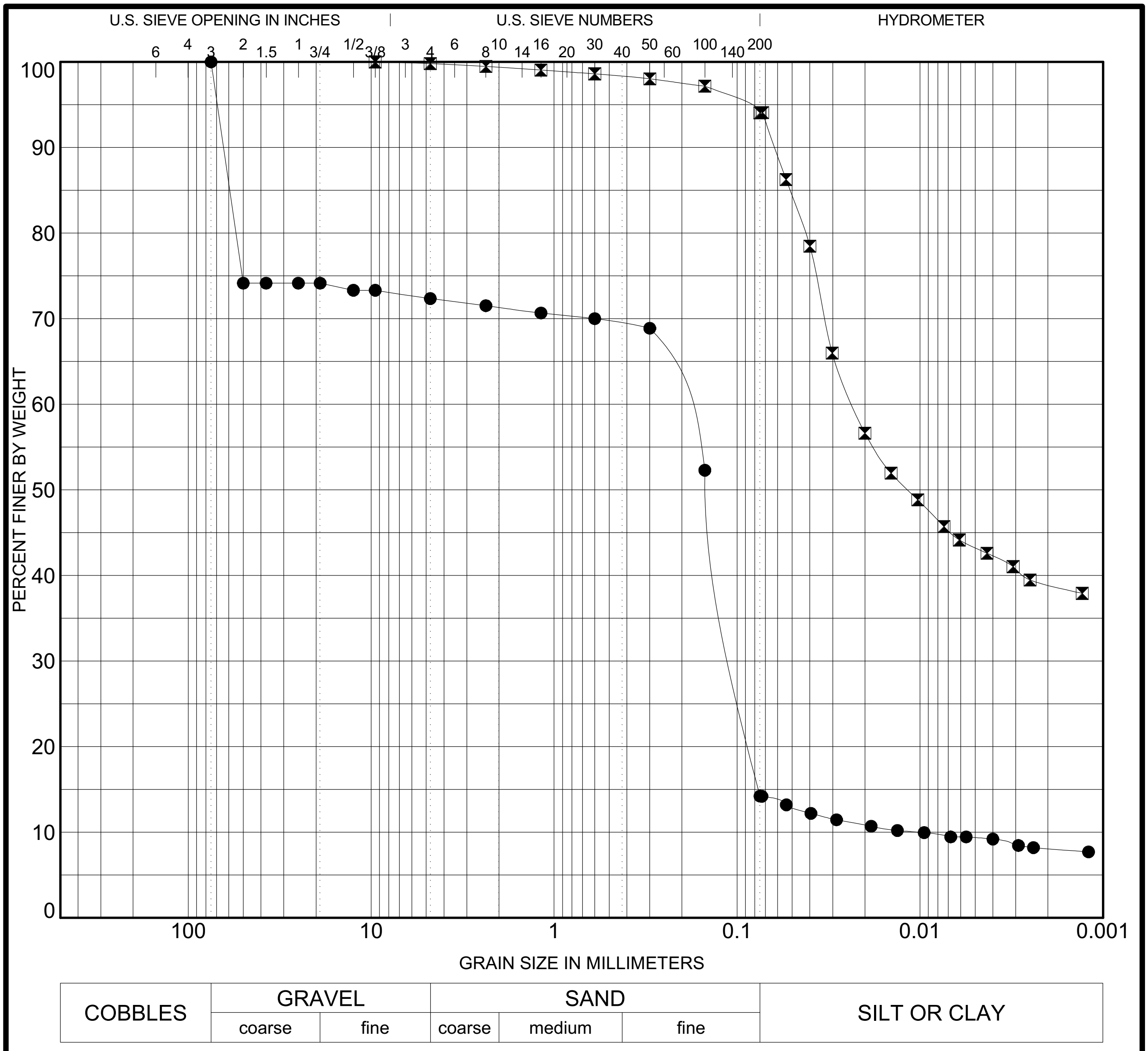
ENCLOSURE No. 5



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**TP 06-05/SA 0.35m**					**4.76**	**20.42**
⧗	**TP 06-05/SA 0.89m**						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 06-05/SA 0.35m**	**75**	**0.21**	**0.1**	**0.01**	**27.6**	**58.1**	**6.1**	**8.1**
⧗	**TP 06-05/SA 0.89m**	**9.5**	**0.02**			**0.2**	**5.7**	**55.1**	**38.9**

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GRAIN SIZE DISTRIBUTION

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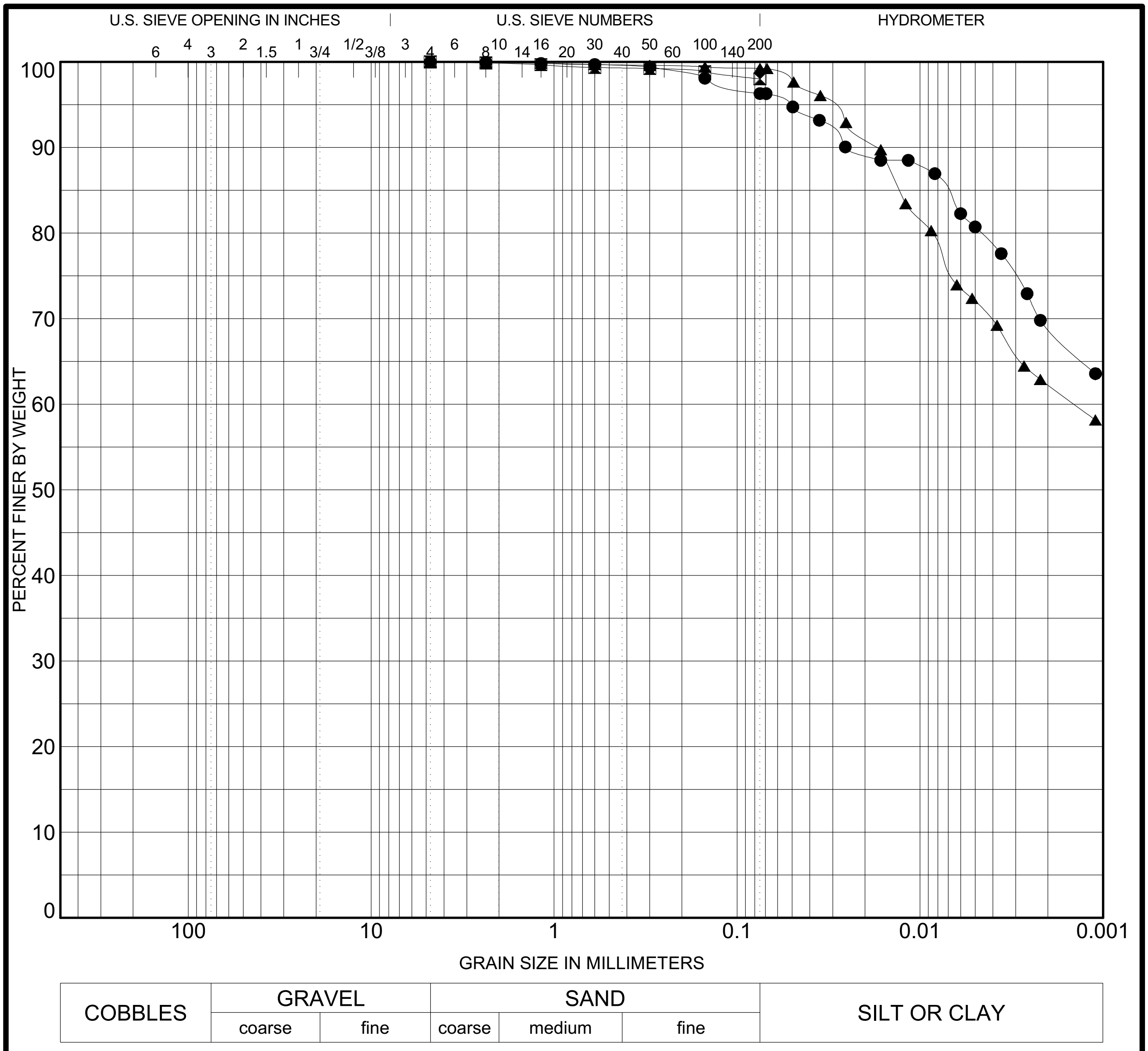
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

EISL SIEVE 0412_01_2012 COUVA HOSPITAL.GPJ EISL.GDT 11/9/12



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● **TP 07/SA 2**	**0.59m**						
⧗ **TP 07/SA 3**	**1.10m**						
▲ **TP 07/SA 4**	**2.23m**	**FAT CLAY(CH)**	**74**	**15**	**59**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **TP 07/SA 2**	**0.59m**	**4.75**				**0.0**	**3.7**	**27.3**	**69.0**
⧗ **TP 07/SA 3**	**1.10m**	**4.75**				**0.0**	**2.0**	**98.0**	
▲ **TP 07/SA 4**	**2.23m**	**4.75**	**0**			**0.0**	**0.8**	**37.0**	**62.2**

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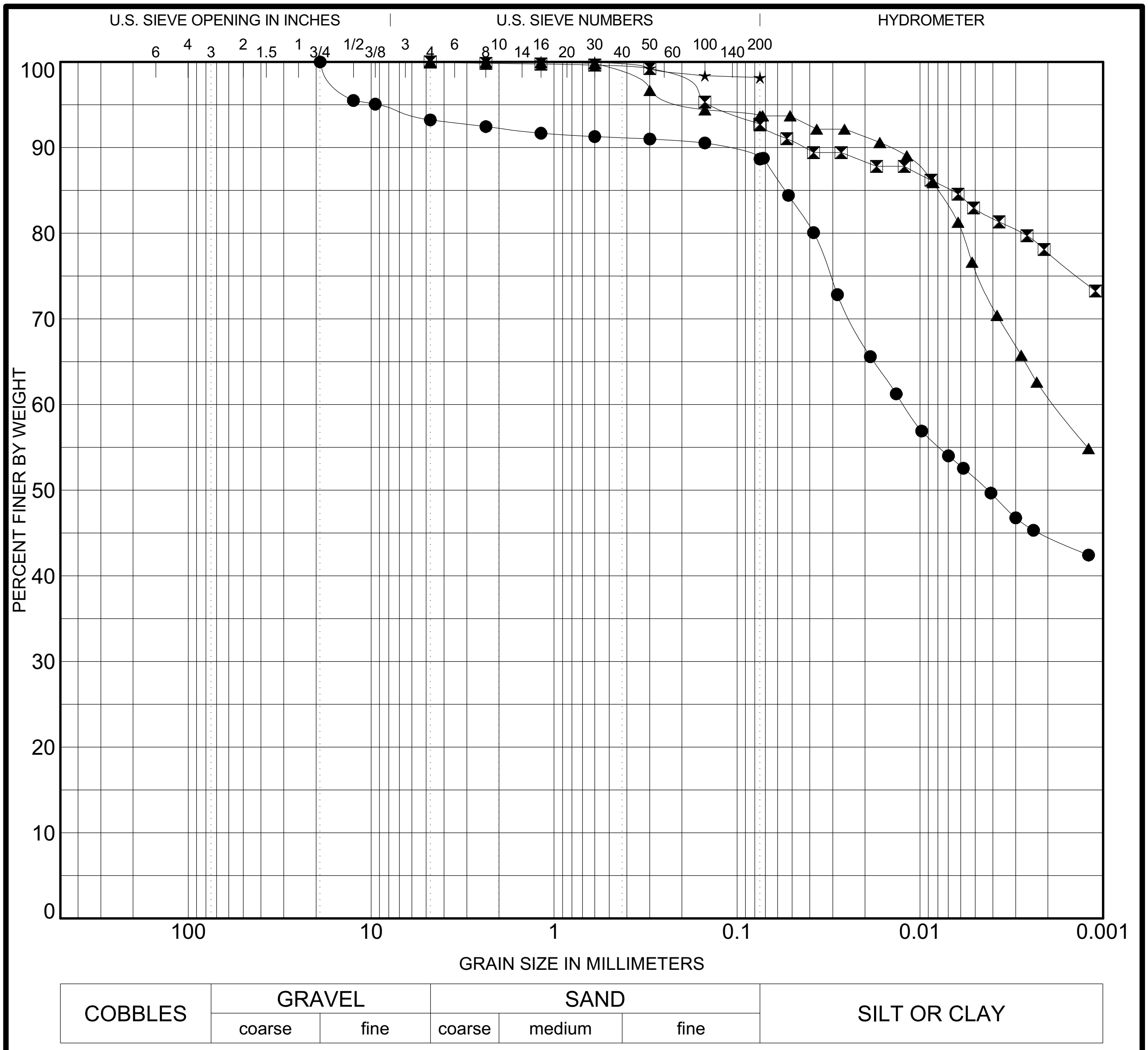
GRAIN SIZE DISTRIBUTION

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

ENCLOSURE No. 7



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**TP 08/SA**	**0.81m**						
⧗	**TP 08/SA**	**1.68m**						
▲	**TP 08/SA**	**2.50m**						
★	**TP 08/SA**	**2.87m**						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 08/SA**	**0.81m**	**19**	**0.01**			**6.8**	**4.6**	**44.1**	**44.6**
⧗	**TP 08/SA**	**1.68m**	**4.75**				**0.0**	**7.3**	**15.0**	**77.7**
▲	**TP 08/SA**	**2.50m**	**4.75**	**0**			**0.0**	**6.3**	**32.7**	**61.0**
★	**TP 08/SA**	**2.87m**	**1.18**				**0.0**	**1.8**	**98.2**	

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GRAIN SIZE DISTRIBUTION

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Project: Couva Children's Hospital
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Location: Couva
Type: SITE INVESTIGATION

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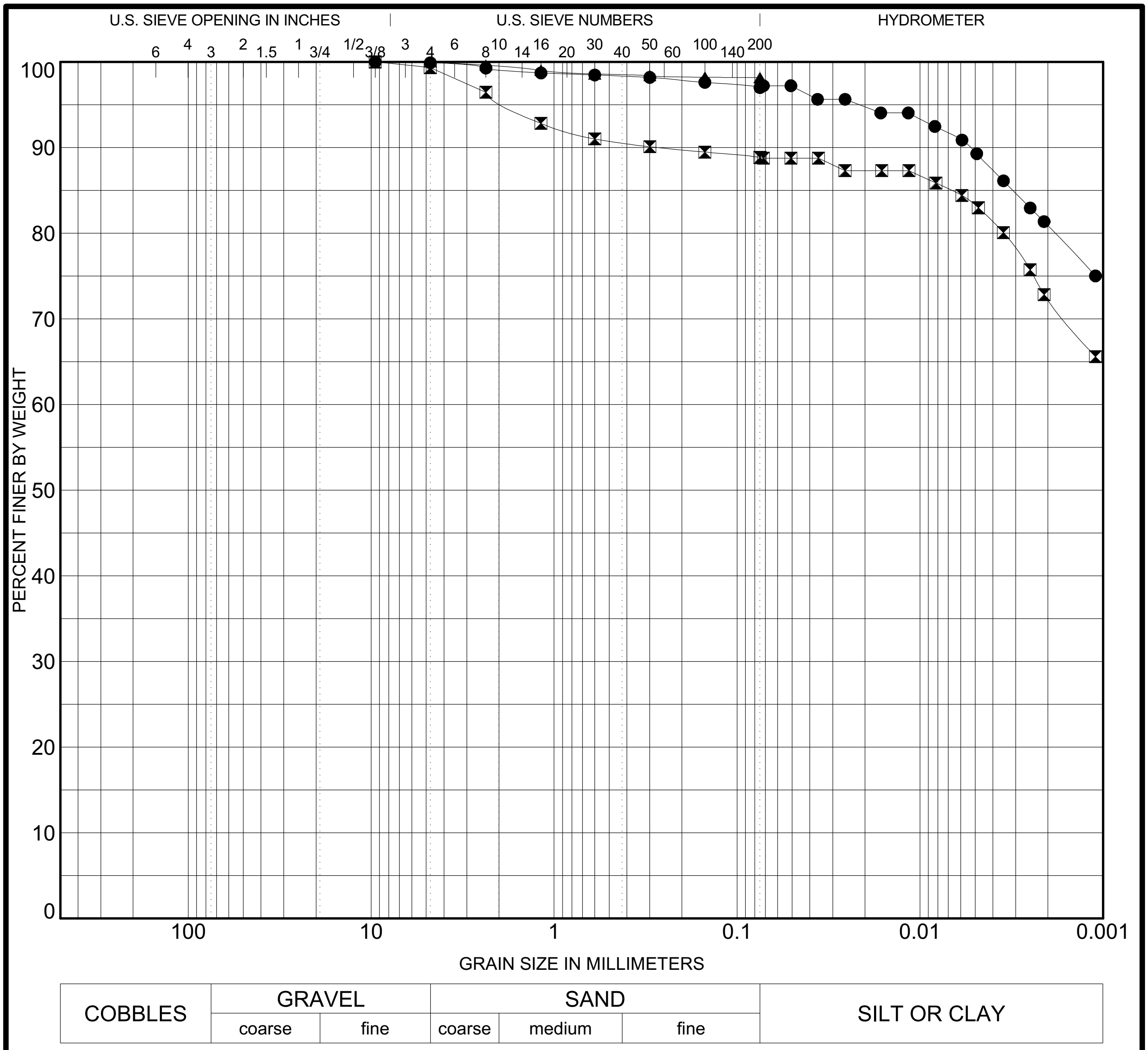
ENCLOSURE No. 8



Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● **TP 08A/SA 0.30m**						
⧗ **TP 08A/SA 1.27m**						
▲ **TP 08A/SA 2.44m**						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **TP 08A/SA 0.30m**	**9.5**				**0.1**	**2.9**	**16.1**	**80.9**
⧗ **TP 08A/SA 1.27m**	**9.5**				**0.7**	**10.5**	**16.6**	**72.3**
▲ **TP 08A/SA 2.44m**	**4.75**				**0.0**	**1.8**	**98.2**	

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GRAIN SIZE DISTRIBUTION

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Location: Couva
Type: SITE INVESTIGATION

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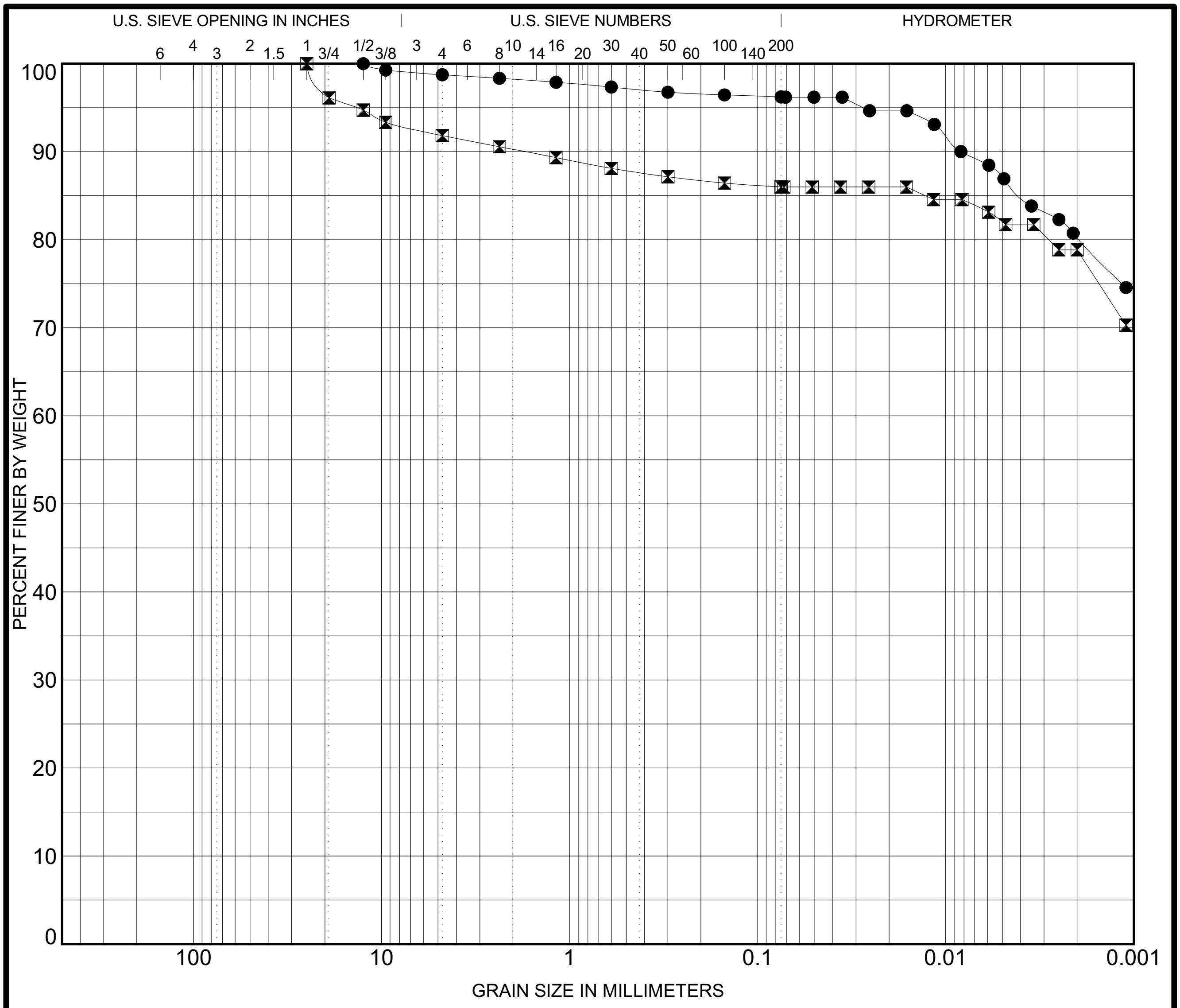
ENCLOSURE No. 9



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**TP 09/SA 3**	**0.51m**						
⧗	**TP 09/SA**	**1.65m**						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 09/SA 3**	**0.51m**	**12.5**				**1.3**	**2.5**	**15.9**	**80.3**
⧗	**TP 09/SA**	**1.65m**	**25**				**8.2**	**5.8**	**7.1**	**78.9**

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GRAIN SIZE DISTRIBUTION

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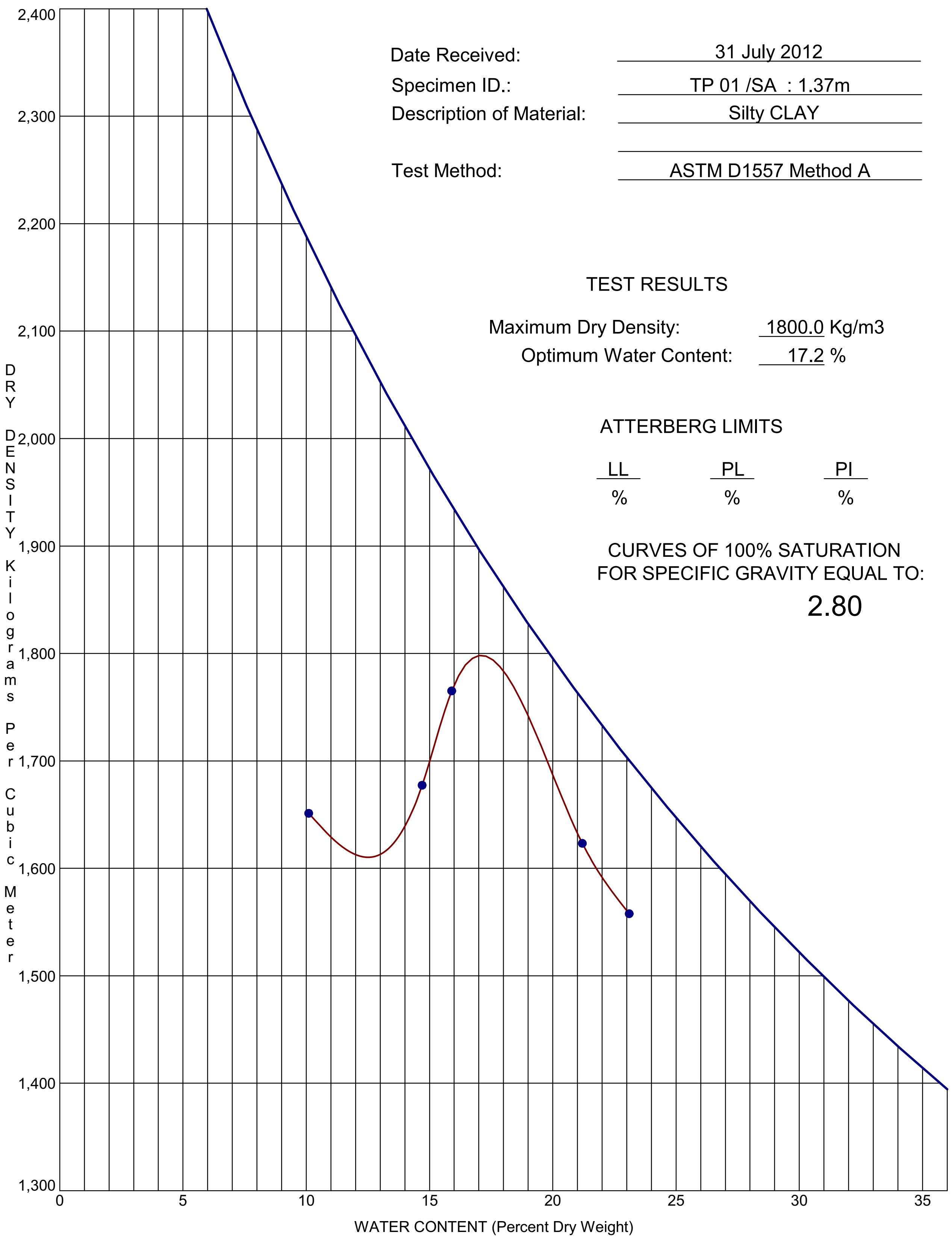
Client: Shanghai Construction Group International Ltd.
Location: Couva
Type: SITE INVESTIGATION

EISL SIEVE 0412 01 2012 COUVA HOSPITAL.GPJ EISL.GDT 11/9/12

ENCLOSURE No. 1



Date Received: 31 July 2012

Specimen ID.: TP 01 /SA : 1.37m

Description of Material: Silty CLAY

Test Method: ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density: 1800.0 Kg/m3

Optimum Water Content: 17.2 %

ATTERBERG LIMITS

LL	PL	PI
%	%	%

CURVES OF 100% SATURATION
FOR SPECIFIC GRAVITY EQUAL TO:
2.80

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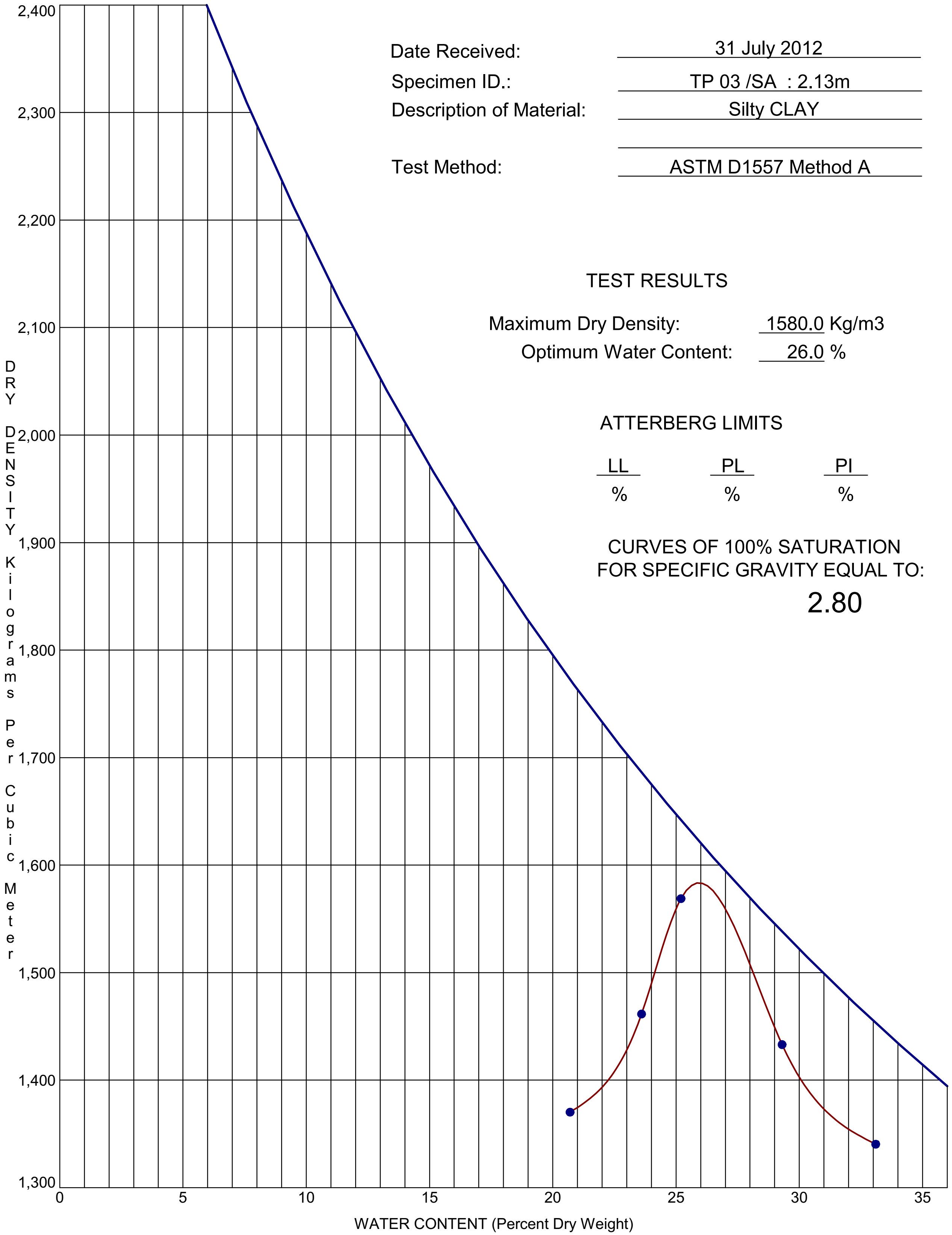
MOISTURE-DENSITY RELATIONSHIP

Project No.: 0412_01_2012
Project: Couva Children's Hospital
Location: Couva
Client: Shangai Construction Group International Ltd.
Type: SITE INVESTIGATION

ENCLOSURE No. 2



Date Received: 31 July 2012

Specimen ID.: TP 03 /SA : 2.13m

Description of Material: Silty CLAY

Test Method: ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density: 1580.0 Kg/m3

Optimum Water Content: 26.0 %

ATTERBERG LIMITS

LL	PL	PI
%	%	%

CURVES OF 100% SATURATION
FOR SPECIFIC GRAVITY EQUAL TO:
2.80

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MOISTURE-DENSITY RELATIONSHIP

Project No.: 0412_01_2012
Project: Couva Children's Hospital
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Type: SITE INVESTIGATION