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GEOTECHNICAL INVESTIGATION REPORT

PROJECT: **RESIDENTIAL PROJECT**
VANDALUR-KELAMBAKKAM ROAD, KILKOTTAYUR VILLAGE, MAMBAKKAM

CLIENT: **SMART VALUE HOMES LIMITED**
PARAS PLAZA, 4TH FLOOR, NO: 30/1 CATHEDRAL GARDEN ROAD, NUNGAMBAKKAM, CHENNAI 600 0034

REPORT NO: **2Z/SVHL/KKTR/G-970**
DATE: **09 AUGUST 2012**

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44/17 'BHASKARA', 19 USHA STREET, DR. SEETHAPATHY NAGAR, VELACHERY, CHENNAI 600 042

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Geotechnical Investigation, Interpretation, Design and Quality Control Management

GEOTECHNICAL Solutions[A1]

SOIL INVESTIGATION FOR THE PROPOSED RESIDENTIAL PROJECT VANDALUR-KELAMBAKKAM ROAD, KILKOTTAYUR VILLAGE, MAMBAKKAM

SMART VALUE HOMES LIMITED
PARAS PLAZA, 4TH FLOOR
NO: 30/1 CATHEDRAL GARDEN ROAD
NUNGAMBAKKAM, CHENNAI 600 0034

2Z/SVHL/KKTR/G-970

09 AUGUST 2012

44/17 'BHASKARA'
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VELACHERY, CHENNAI 600 042

EXECUTIVE SUMMARY

Project	:	**Residential Project, Vandalur-Kelambakkam Road, Kilkottayur, Mambakkam**
Project Reference	:	**SVHL/KKTR/G-970**
Owner	:	Smart Value Homes Limited, Paras Plaza, 4th Floor, No: 30/1 Cathedral Garden Road, Nungambakkam, Chennai 600 0034
Architect	:	Venkataramanan Associates, 10/2, O'Shaughnessy Road, Langford Gardens, Bangalore
Consultants	:	H. G. Naikar, Pragathi Consultants, Bangalore
Type of Structure	:	Group housing scheme – Towers with one basement, 20 to 24 upper floors, club house
Scope	:	Additional Geotechnical Investigation for the area of construction
Area of Investigation	:	15.3 acres
Tests Conducted	:	Fourteen exploratory boreholes penetrated into weathered fractured rock and weathered jointed rock, conducting standard penetration tests, collecting soil samples, laboratory classifications tests, etc.
FINDINGS		
Soil at shallow depth	:	Dirty sand / sandy clay followed by dense clayey sand
Weak stratum	:	None
Hard stratum & type	:	Highly weathered fractured rock below varying depth of 3.10m and 4.50m from existing ground level.
Ground water table	:	At about 0.70m below existing GL during investigation in January 2012 and at 4.0m during investigation in July 2012. Likely to be at very shallow depth during rains and at about 5.00m during dry season.

FOUNDATION RECOMMENDATIONS				
Expected load		Light to moderate	Towers	
Type of foundation	:	Individual footings	Full Raft Foundation	Individual footings
Depth of foundation*	:	1.80m #	3.00m to 5.50m^	3.50m to 6.00m*
Type of soil at FL	:	Clayey fine to coarse sand	Sand to w.f.r.	Weathered fractured rock
Size of foundation	:	Any size	Building footprint	Any size
Net SBC t/m^2	:	21.0 t/m^2 **	>40 t/m^2	70 t/m^2
Expected settlement	:	<40mm total	3mm to 6mm and 28mm near BH/8^^	<12mm

Comments

The elevation of footings shall be decided based on the location of the structure and the natural ground level existing in the building footprint.

^ The elevations of raft foundation for different tower locations with respect to the site reference datum 10.00m are suggested as given in the table in section 5.7.4. The modulus of sub-grade reaction at different locations is also given in the table.

* The elevations of column footing for different tower locations with respect to the site reference datum 10.00m are suggested as given in the table in section 5.7.4. Each excavation for column footings shall be inspected thoroughly for confirming the presence of weathered fractured rock without any clay infill. Any clayey soil / matrix shall be replaced with rich PCC having strength more than 15Mpa.

The excavated soil except the sandy clay at some locations can be used for backfilling the foundation excavations and also in the general fill. Since the thickness of filling is relatively large, the compaction of entire filling shall be ensured for satisfactory performance of the ground floor flooring and the paving in the parking areas. Similar care shall be taken for filling below the roads.

The ground water table may be very shallow during rains and for couple of months after the rains. The water table is expected at 3.0m to 4.0m during dry season. The construction of foundation may be taken up during dry season with ground water table below the founding level.

The ground water contains only small amount of sulphate and chloride and are well within the permissible maximum limits. The pH value is very close to the neutral value.

The report 1Z/SVHL/KKTR/G-919 submitted on 3 February 2012 based on the preliminary investigation may be used for only record purposes. Complete data from this preliminary investigation are used for finalising the foundation recommendations presented in this report.

For **Geotechnical Solutions**

9 August 2012

14.11.2024

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Report on Soil Investigation for the Construction of
PROPOSED RESIDENTIAL PROJECT
KILKOTTAYUR VILLAGE, MAMBAKKAM

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Report on Soil Investigation (with Additional Data) for
THE PROPOSED RESIDENTIAL PROJECT
KILKOTTAYUR VILLAGE, MAMBAKKAM

1 INTRODUCTION

1.1 **Smart Value Homes Private Ltd** is developing a residential project in their land off Kelambakkam – Vandalur Road, Kilkottayur, South of Chennai. The total land area is roughly 15.3 acres (61850 sq m). High-rise apartment buildings and other township facilities are expected in the project.

1.2 Geotechnical investigation comprising five exploratory boreholes taken to a depth of 6.0m to 8.0m with 1.0m to 2.0m penetration into highly weathered jointed rock was carried out here as a preliminary study. Uniform sub-soil profile was found existing, but with variations in the elevations and thickness of different layers. The depth of highly weathered rock varied also because of general terrain of the land.

1.3 The project layout is subsequently finalised in which eight towers with twenty to twenty four levels above the ground level are planned. These blocks have one basement restricted to the tower footprints. The average load intensity at the basement floor level, depending on the floor heights, may be 35 t/m^2 to 38 t/m^2. Additional eight exploratory boreholes were suggested for providing a better picture of subsoil conditions and for finalising the type of foundation of these high-rise towers.

1.4 **Geotechnical Solutions**[A1]**, Chennai,** conducted the preliminary investigation comprising five boreholes during 16-21 January 2012. Nine additional exploratory boreholes extending into the highly weathered jointed rock found at varying depths were made during 16-27 July 2012.

1.5 The report describes the procedure of investigation adopted and then presents the complete investigation data. The data obtained from the investigation are reviewed and analysed to recommend the shear strength and compressibility parameters as described in Section 3.0. The bearing capacity of shallow foundation and the safe capacity of deep foundation are estimated in section 4.0, while the conclusions are drawn in section 5.0. The data from preliminary investigation are also included here for making this report complete. The report of January 2012 investigation, 1Z/ SVHL/KKTR/G-919 of 3 February 2012, may be referred only as a record, because the conclusions drawn in this report are based on the complete data gathered during the preliminary investigation as well as during the present one.

1.6 The site has a terrain sloping towards East. Ground level is about 11.50m RL at the North West corner and it dips down to 8.20m in the East far end of the project land. The elevation of very dense residual soil and weathered rock varied within the project area. Highly weathered and severely fractured rock occurs for a thickness of 1.50m to 3.00m and the rock formation found below is also highly weathered and severely jointed for the next 3.0m meters and more.

The core recovery is very poor and the RQD is zero for this 3.0m thick weathered and severeky jointed rock layer.

1.7 It is proposed to maintain three finished formation levels such as +11.0m towards South near the main road, +10.00m for the blocks in the West and + 9.00m for two blocks in the North East quarter. The basement floors are planned at 3.60m below these formation levels. Highly weathered and fractured rock occurs at about these depths. However, shallow column footings placed over this highly fractured zone is limited to about 70 t/m^2. The depth of foundation may also vary within same building for ensuring uniform type of founding stratum.

Since the net SBC requirement for individual footings is very large, full raft foundation placed over very dense residual soil or weathered disintegrated rock or over weathered fractured rock can be adopted depending on the elevation of basement floor finally decided. The full raft can act as the basement floor slab facilitating a good waterproofing system.

1.8 The ground water table was at about 0.50m below the lowest ground level during preliminary investigation in the month of January 2012. Water level dipped to about 4.00m during the present investigation in July 2012. Usually the ground water fluctuation is between the present ground level and 4.00m to 4.50m below the lowest ground level. Excavation for basement and foundation may call for some dewatering effort.

1.9 The reduced levels referred in this report are based on the survey map submitted by Apex Topomappers Pvt Ltd on 05-09-2011 and the Bench mark provided over the motor room.

2 INVESTIGATION PROGRAMME, PROCEDURE AND DATA

2.1 *Investigation Programme*

2.1.1 The complete investigation programme comprised sinking fourteen exploratory boreholes up to hard stratum and further into the weathered jointed rock. The borehole locations are shown in the key plan provided in **Figure 1** of this report. All the boreholes were advanced into weathered fractured rock using tungsten carbide core drill till the drilling advancement rate dropped significantly. The boreholes were further advanced using diamond core drill for varying depths of 1.00m to 3.00m. Weathered and severely jointed rock continued.

Borehole BH/8 during the detailed investigation recorded very dense soil and weathered disintegrated rock towards a large depth when compared with other boreholes. Weathered fractured rock occurred at 13.30m and then the jointed rock from 14.50m onwards. Borehole BH/10 made in the same tower footprint area recorded weathered fractured rock at 3.50m below GL. Hence one more borehole BH/14 was sunk at a distance of 20m from BH/8 and located towards the direction of BH/10. This borehole BH/14 recorded weathered fractured rock from 4.10m onwards.

2.1.2 The field-tests in the boreholes included Standard Penetration Tests, Disturbed Sampling, Identification of different soil layers, Ground water table observation, complete logging of the borehole, etc.

Laboratory investigation consisted of classification tests like grain size distribution analysis, determination of limit values, determination of differential free swell index, etc.

2.2 *Investigation Procedure*

2.2.1 Exploratory boreholes were advanced from the existing ground levels using rotary drilling technique supplemented by bentonite mud circulation. Mud circulation was used to stabilise the sides and the bottom of the boreholes, and then to bring the soil cuts to the surface. Use of drilling mud will also help in minimising the disturbance to the soil at the borehole bottom during drilling operations. Rotary drilling procedure with mud circulation is found most suitable for making exploratory boreholes.[1] Diameter of the borehole is in the range of 140 to 150mm for drilling through soil. NX size cutting tools were used for drilling through fractured rock and jointed rock.

Borehole was always kept full with the drilling mud so that a positive head is maintained in the borehole thus preventing any disturbance to the soil within the test zone.

2.2.2 Standard Penetration Tests were conducted at regular depth intervals in these boreholes and N values were recorded. These tests were carried out using winch and cathead device for which the expected energy level is roughly 65 to 70%. The N value resulting from this procedure may be considered equivalent to N_{70}. However, for all the practical purposes, the reported N values are used as N_{60} since actual energy measurements are possible for the SPTs. Disturbed samples collected through the split spoon sampler were preserved in two layers of polythene covers and transported to the laboratory for detailed identification tests.

2.2.3 Different soil layers collected from different levels were identified and classified. Weathered fractured rock with SPT refusal was found at varying depths of 3.10m to 4.40m below respective ground levels except in the case of BH/8. Boreholes were further advanced with rock drilling using NX size tungsten drill bits. Penetration using TC bit core drilling tool varied significantly at different boreholes between 1.20m to 3.40m. Further drilling required diamond drill bits even though the rock is significantly fractured. The boreholes were advanced into the jointed rock for a depth of 1.0m to 3.0m. The rock formation continued to be weathered and severely jointed for this 3.0m drilling.

2.2.4 Disturbed samples collected through the split spoon sampler were preserved in two layers of polythene covers and transported to the laboratory for detailed identification tests. Representative samples from clay layers were subjected to differential free swell index tests on air-dried samples. The Atterberg's limit values were determined directly on the natural soil adding necessary amount of distilled water to the soil specimens. Wherever the clay / sandy clay samples contain particles larger than 425 microns, such larger particles are removed while preparing the test specimens for limit tests and free swell index tests. Grain size analyses on selected samples were conducted on oven dried samples since accurate dry weights of test specimen is necessary in this case.

2.2.5 All the field and laboratory tests were conducted according to the procedures stipulated in relevant IS Codes[2].

2.3 *Investigation Data*

2.3.1 All the field test results from this investigation as well as from the preliminary investigation

[1] D.J. Douglas, "Standard Penetration Tests", Proceedings, In-situ Testing for Geotechnical Investigations, Sydney 1983, A.A. Balkema

[2] Compendium of Indian Standards on Soil Engineering SP 36 (Part 1 and Part 2)

are recorded in the bore logs illustrated in **Annexure 1** to **14**. Field N values along with the detailed blow count records are presented in these bore logs.

2.3.2 Laboratory test results on the soil samples from preliminary investigation (BH/1 to BH/5) are presented in **Table 1**. The laboratory test results on samples collected during this investigation are summarised in **Table 2** of the report. The grain size distribution curves are presented in **Annexure G-1** to **G-5**. Only the results from present investigation are given here. The results of chemical analysis on ground water samples are presented and discussed in the body of the report.

3 REVIEW OF FIELD AND LABORATORY TEST RESULTS

3.1 *Topography and Soil Profile*

3.1.1 The site is having a sloping terrain with highest ground level towards North West extreme corner. The ground level at this location is about 11.80m. It dips down to 8.20m RL in the North East end. The ground level variation between the South West corner (RL = 11.00m) and the North East corner of the bottom half of the project land (RL = 9.00m) is about 2meters. The reduced levels are with respect to the BM 10.00m fixed over the motor room for the open well outside the project land (in the East side, refer the survey plan).

3.1.2 The reduced level of Vandalur – Kelambakkam Road is 11.0m in the East and 12.0m in the West. The top level of village road in the North West of the project land is about 13.40m.

3.1.3 Two open wells in the site recorded water at very shallow depth during the initial survey. The water level stood at about 4.0m below the existing ground level during the detailed geotechnical investigation in July 2012. There is a pond beyond the South West boundary of the project land which collects water above the ground level of the project land. Accordingly the ground water table during rains is expected to be very shallow and also dipping towards East following the existing topography. Ground water table is expected to be 3.0m to 5.0m below the ground level during dry season.

3.1.4 The subsoil profile comprises a thin layer of clayey sand / sandy clay at surface followed by clayey silty sand with some cementation. Residual type clayey fine to coarse sand with high relative density is present from 2.00m to 2.50m depth from the existing ground levels. Very dense dirty sand with SPT more than 100 and has texture of the parent rock is classified as weathered disintegrated rock. The thickness of this layer varied from place to place. The samples collected through SPT sampler after penetration of 4cm to 5cm under 50 standard blows of 63.5 kg hammer are flakes of highly weathered rock. This layer is classified as weathered fractured rock. The tungsten core drilling and diamond core drilling produced no recovery or very poor recovery. The core recovery from diamond core drilling is only less than 15% and the samples have shown significant weathering and jointing. The main matrix of this weathered jointed rock comprises very small rock pieces that escape during drilling. The photographs of core samples recovered from rock drilling are presented in **Plate 1**.

3.1.5 The initial investigation with boreholes located at a spacing of 400 feet to 600 feet recorded significant variations in the thickness of different soil layers. These boreholes were located randomly since the tower locations were not finalised at the time of initial investigation. The additional boreholes carried out during this investigation were suggested based on the tower locations. The locations of present and old boreholes now represent the tower locations to

some extent. Typical sub-soil profiles are drawn comparing the stratification found in the boreholes located in the proximity of each tower and such profiles are presented in **Figures P1, P2, P3, P4, P5** and **P6**. The variations in the stratification and the elevation of different layers are considered gradual and smooth between two boreholes. However, abrupt changes in the thickness of different layers and in the degree of weathering shall be expected between these test locations. Typical soil stratification of this site is presented below. The depths are with respect to the respective ground levels with a general dip towards East.

GL	to	0.60m	Greyish brown clayey sand / sandy clay
0.60m	to	1.40m	Dark greyish brown / yellowish grey clayey cemented sand / sandy clay with coarse sand and gravel particles. SPT N varies between 6 and 41
1.40m	to	2.40m	Greyish brown / dark yellowish grey clayey silty fine to coarse sand with gravels; SPT N in the range of 50 to 70
2.40m	to	4.00m	Very dense clayey sand with weathered stones (weathered disintegrated rock), N >100
4.00m	to	5.50m	Yellowish grey and grey highly weathered fractured rock with SPT N equal to 50 blows for 4 to 5 cm penetration. This layer is absent in some boreholes in which weathered fractured rock with SPT rebound occurred directly below the weathered disintegrated rock.
			Next 1.50m to 3.50m formation is weathered fractured rock with SPT refusal. This is followed by highly weathered and severely jointed rock, identified as granitic gneiss.

3.1.6 The sandy clay and clayey cemented sand layers recorded good plasticity. The liquid limit is 32% to 56% with some values as large as 90%. The plasticity index is in the range of 20% to 58%. This sandy clay recoded high differential free swell index, of the order of 50% to 90% with some values much larger. The percentage of clay and silt is 20% to 30% while rest of the particles are of large size suggesting that the overall swelling potential may be moderate. The reworked sandy clay may have higher swelling potential.

3.1.7 The grain size distribution curves for clayey sand layers do not possess typical 'S' shape of sedimentary deposits. Presence of gravel size particles having angular edges and the gradation curves suggest that these layers are residual formations. The clayey sand layers below 2.0m from respective GLs are reasonably compact and the density improves towards depth. The residual soil with large amount of gravel size particles and SPT N more than 100 is classified as weathered disintegrated rock. Formation with lesser penetration of the sampler and that recovered samples with flakes of weathered rock is classified as weathered fractured rock.

3.1.8 The diamond core drilling for 1.0m to 3.0m in these boreholes did not produce good core recovery. The samples collected are of very small pieces of weathered rock with distinct joint faces. The rock is identified as granitic gneiss that recorded relatively good resistance to rock drilling. The recovery is very poor because of severe jointing and weathering. Sound rock with less jointing is expected only at relatively deeper levels.

3.2 *Groundwater Table*

3.2.1 The site has one open well that recorded water at bout 4.0m below respective GL. One open well outside the project land also recorded water at similar depth. These wells recorded water at very shallow depths during the initial investigation in the month of January 2012. The pond

present in the South West side of the land was having water, probably because of the rains prior to the earlier investigation. The pond was dry during July 2012 investigation.

3.2.2 The ground water table is expected to be at very shallow depth during investigation as the boreholes during initial investigation also recorded water at shallow depths. Generally the ground water table is shallow during rains. Since the performance of foundation depends on the ground water table, the design ground water table is taken as the present ground level.

3.2.3 Water table is expected to deplete during summer and may be deeper than 4.00m below GL. The top sandy clay layers may experience significant loss of moisture during dry season.

3.3 ***Shear Strength***

3.3.1 Standard Penetration Test blow counts N is measured at different levels in the boreholes. Mainly these N values are used to assess the shear strength of different soil layers.

3.3.2 The classification of N values in moderate to high plasticity sedimentary clay deposits developed by Terzaghi[3] is used to estimate the shear strength of sandy clay. Cole & Stroud[4] extended the classification by Terzaghi to low plasticity deposits formed by weathering and decomposition of rock and can be effectively used to estimate the shear strength of highly weathered fractured rock with SPT sampler penetration in the range of 4 to 5cm for 50 blows of SPT hammer fall. The maximum SPT N extrapolated from SPT blow counts in weathered fractured rock is taken as 200.

3.3.3 The dense to very dense clayey sand / dirty sand layers found up to weathered rock are residual type. Even though standard correlations are not available for SPT N values in such deposits, the angle of friction ϕ is estimated based on the standard correlations developed for sedimentary sand deposits taking into the effect of the presence of plastic fines if any.

3.3.4 Shear strength parameters in terms of angle of friction ϕ and undrained shear strength c_u for different layers are presented in **Appendix A.**

3.4 ***Compressibility Different Layers***

3.4.1 There are no very weak soil layers at any depth in these boreholes. The minimum depth of shallow foundation such as individual column footings or full raft shall be 1.50m to 2.00m below natural ground levels as the soil above this depth is having erratic shear strength profile. The sandy clay layers within this depth range have moderate to high swelling potential also that might adversely influence the performance of shallow foundations. Soil layers below the top sandy clay are having high relative density and the stiffness increases very rapidly towards depth.

3.4.2 Dense to very dense clayey sand / dirty sand present below 2.00m to 2.50m from respective ground levels have very good shear strength and very low compressibility. Since the foundations are to be placed in very dense soil and as the stiffness increases rapidly towards depth, detailed settlement estimations are not necessary.

3.4.3 However, the variations in the thickness of very dense residual sand and the variations in the

[3] K. Terzaghi & R.B. Peck, 'Soil Mechanics in Engineering Practice' Table 45.2 Art 45.
[4] A.W. Cole & M.A. Stroud, in Symposium on "Piles in Weak Rock", ICE London -1977

elevation of weathered fractured rock may result relatively large 'differential' settlements in spite of total settlements well within the allowable limits. It is necessary to restrict the net allowable bearing pressures of shallow individual footings so as to limit the differential settlements. The compressibility of clayey sand and dirty sand layers is represented by C that is equal to 1.5 times the ratio of cone resistance and the effective overburden pressure at the respective depths. The present investigation comprises exploratory boreholes in which SPT N values are determined at regular depth intervals. These N values are used to estimate the cone resistance of sand layers and thereby the compressibility parameter C.

3.5 *Chemical Analysis of Groundwater*

3.5.1 Two water samples from the open wells were analysed for sulphate and chloride contents. The sulphate (SO_4) is in the range of 21ppm to 32ppm, while the chloride cl is 88ppm to 93ppm. The pH value is 7.08 to 7.14.

3.5.2 The pH value, sulphate and chloride are very limited and well within the allowable maximum limits enabling the use of normal concrete mixes in the foundation construction.

4 BEARING CAPACITY OF SOIL AND FOUNDATION

4.1 Multi-storey apartment buildings and some structures for related facilities are expected in the project. Seven blocks having one basement, ground floor and twenty upper floors are proposed now. Few more floors may be considered in the final design. The average load intensity from a 26 level residential tower may be in the range of 35 t/m^2 to 38 t/m^2. Heavy additional transitional loads from wind and seismic actions are also expected over the founding soil.

4.2 The finished formation levels recommended for the project is based on the present terrain. The site grading to the proposed formation levels may require 0.50m to 1.50m filling in most of the area and some cutting in the North West side is also required. The formation levels are fixed as +11.0m, +10.0m and +9.0m and the basement floor level is roughly 3.60m below the formation levels. Since the present average ground level is about 2.0m below the average road level, site grading with significant amount of filling is expected. Thus the depth of basement floor with respect to the natural ground level may be 0.50m to 3.00m depending on the location of the tower.

4.3 The net SBC required for individual column footings for supporting such load may be of the order of 80 t/m^2 to 100 t/m^2.

4.4 *Shallow Foundation – Individual Column Footings*

4.4.1 *Bearing Stratum:* The net SBC requirement is very large here because of heavy column loads. Footings resting in very dense sand or weathered and disintegrated rock cannot offer such large net safe bearing capacity without allowing relatively large settlements. IS 12070 for shallow foundations on rocks allows 12m settlement so as to take care of heterogeneity in the rock formation.

The weathered and fractured rock layer available at varying depths of 3.10m to 4.40m below the natural ground level can offer relatively large net SBC. The rock mass rating, RMR, is usually used for estimating the net SBC of footings resting in weathered rock with limiting

settlement of 12mm. Even though relatively intact rock is not available for a large depth, same procedure is used for arriving at the net SBC of shallow foundation resting in weathered fractured rock. The most favouring component in the case of weathered fractured rock here is the absence of soft gouge fill within the joints. The wash samples contained only coarse particles and there was no indication of cohesive infill material. The weathered disintegrated rock samples collected through the SPT sampler also contained only sand and gravel size particles. The compressive strength of weathered granitic gneiss is more than 150 kg/cm^2 and based on these parameters, the RMR of weathered fractured rock can be 25 to 35.

4.4.2 *Net SBC:* Based on the classification given in Table 3 of IS 12070-1987, this formation can be classified as poor rock and the net SBC may be in the range of 58 t/m^2 to 145 t/m^2. Since the thickness of highly weathered fractured rock is of the order of 1.20m to 2.50m, the average RMR within a depth equal to one width of the footing is not likely to improve significantly. Accordingly, the net safe bearing capacity for individual footings resting over highly weathered fractured rock is limited to 70 t/m^2. Since the net SBC using RMR is suggested for limiting settlements, this can be taken as the allowable bearing pressure.

4.4.3 *Foundation depths:* Minimum depth of foundation at different tower locations in the case of column footings is given in the table 4.1 give below. The elevation of footings may vary at some locations as the weathered fractured rock can be varying. Each foundation excavation shall be thoroughly inspected for confirming that the founding stratum is weathered fractured crock without any clay infill. Any clayey soil / matrix shall be replaced with rich PCC having strength more than 15Mpa.

Table 4.1 Elevation of Column Footings with 70 t/m^2 net SBC

Tower	Boreholes	Profile	Basement FL	Founding level	Remarks
Tower 1	BH/5, 12	Figure P-5	+7.40m	+5.50m to +5.00m	
Tower 2	BH/11, 13	Figure P-6	+7.40m	+6.00m	
Tower 3	BH/2, 11	Figure P-4	+7.40m	+5.20m	
Tower 4	BH/8, 10,14	Figure P-3	+6.40m	+5.50m to +5.00m	Full raft preferred
Tower 5	BH/3, 7	Figure P-1	+6.40m	+5.50m	
Tower 6	BH/4, 6	Figure P-2	+5.40m	+4.50m	
Tower 7	BH/4		+5.40m	+4.50m	
Tower 8	BH/9		+5.40m	+4.20m	

4.5 ***Shallow Foundation – Full Raft Foundation***

4.5.1 The proposed towers are for housing residential apartments and accordingly the column spacing will be relatively small. The individual footings with high safe bearing capacity will also be closer leaving not much space between. Full raft foundation with marginal extension beyond the building footprint can offer adequate bearing capacity and stability for supporting these towers. The base width of these towers is about 16.5m while the height of tower above formation level is 60 metres to 72 metres. Since the columns are not usually located at large spacing in the case of residential apartment constructions, the thickness of raft foundation may be relatively small making it economical.

4.5.2 The depth of full raft foundation (and also the individual column footings, if adopted) shall be decided based on the stability against overturning as well as the required net safe bearing pressure.

4.5.3 The basement floor levels are suggested as +7.4m, +6.4m and +5.4m, all 3.60m below the respective formation levels. Considering 600mm to 800mm thick full raft foundations, the soil immediately below the full raft is very dense sand to highly weathered fractured rock. Studying the profiles given in figures P-1 to P-6, the founding soil for different blocks will be as illustrated in the table 4.2 below.

Table 4.2 Elevation of Full Raft Foundation with net SBC >40 t/m²

Tower	Boreholes	Profile	Basement FL	Founding level	Soil
Tower 1	BH/5, 12	Figure P-5	+7.40m	+6.60m	w.f.r.
Tower 2	BH/11, 13	Figure P-6	+7.40m	+6.60m	Fine to coarse sand
Tower 3	BH/2, 11	Figure P-4	+7.40m	+6.60m	Fine to coarse sand
Tower 4	BH/8, 10,14	Figure P-3	+6.40m	+5.60m	w.d.r, w.f.r, sand
Tower 5	BH/3, 7	Figure P-1	+6.40m	+5.60m	w.f.r & w.j.r
Tower 6	BH/4, 6	Figure P-2	+5.40m	+4.60m	w.f.r
Tower 7	BH/4		+5.40m	+4.60m	w.f.r & w.d.r.
Tower 8	BH/9		+5.40m	+4.60m	w.f.r

w.d.r. is weathered disintegrated rock, w.f.r. is weathered fractured rock and w.j.r. is weathered jointed rock. Founding level is assuming 800mm thick raft

4.5.4 In all the above cases, except in the case of tower 4, the foundation conditions are more or less uniform within the footprint. The net safe bearing capacity of full raft foundation placed over very dense sand is about 40 t/m², while the net SBC of foundation placed over weathered disintegrated and jointed rock at different depths is more than 40 t/m². The modulus of sub-grade reaction will vary can be taken as those values suggested for individual footings at respective levels.

4.5.5 The full raft foundation is expected to settle less than 10mm in most of the cases, while the settlement may be more near BH/8. Detailed settlement estimations are made and found that the settlement is in the range of 2mm to 32mm for different soil conditions. This will result varying modulus of sub-grade reaction below each raft.

In all the cases a range of modulus sub-grade reaction between 6,500 t/m²/m to 15,000 t/m²/m may be considered over a distance of 20m. It may be appropriate to consider such variations randomly to take care of the variations in modulus.

However, in the case of tower 4 where borehole BH/8 recorded relatively poor soil conditions, there is an abrupt drop of sub-grade modulus in the vicinity of this borehole. The estimated settlement of full raft is 26mm and the modulus of sub-grade reaction is as small as 1400 t/m²/m. Replacement of dense sand immediately below the founding level may not improve the modulus significantly as there are weaker layers towards depth also. It is necessary to stiffen the raft locally for taking care of additional moments.

4.6 *Shallow Foundation – Individual Column Footings for Small Constructions*

4.6.1 The net SBC requirement for facilities like club house, etc. is relatively small and shallow footings placed over dense clayey sand or dirty sand below the gravelly clay layer shall be considered for supporting such structures. The depth of foundation is 1.80m below existing natural ground levels. Accordingly the elevation of foundation bottom can be decided based on the location of the structure and the average ground level within the plan area of the unit.

4.6.2 The net safe bearing capacity of these footings is estimated considering average angle of friction ϕ equal to 34°. Typical estimations for 1.50m to 3.50m wide square footings are presented in **Appendix B**. The estimated net SBC is in the range of 21.0 t/m² to 24.5 t/m² for footing sizes 1.50m to 3.50m. The net SBC is uniformly recommended as 21.0 t/m² for design.

The thickness of overburden soil is limited and the compression of these layers will be much smaller than the limiting settlement of 40mm to 50mm allowed for individual footings supporting RCC framed constructions.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 About 15 acres of land at Kilakottayur is being developed as residential colony. Initial sub-soil investigation comprising five exploratory boreholes was carried out before finalising the layout of different blocks. Very dense clayey / dirty sand overlain with gravelly sandy clay is found present at shallow depth. Highly weathered and disintegrated rock in the form of fine to coarse sand with gravel size weathered rock pieces is present for another 0.50m to 1.50m to be followed by highly weathered and fractured rock. Weathered jointed rock followed.

5.2 Subsequently the layout of the project was finalised with eight towers having one basement, ground floor and twenty floors and other facilities like club house, etc. Even though the general sub-soil conditions were established from the preliminary investigation, more exploratory boreholes were necessary to study the uniformity in sub-soil conditions near these blocks. Eight exploratory boreholes with rock drilling were suggested. One more was made near BH/8 since this borehole alone recorded very thick overburden soil.

5.3 The complete investigation comprising fourteen exploratory boreholes has fairly established the sub-soil profile and its variations across the construction areas. Highly weathered fractured rock with SPT rebound is found present from varying depths of 3.10m to 4.40m from natural ground level, except in the case of BH/8. Thickness of this very weak rock formation that could be drilling using tungsten carbide drill bit is 1.20m to 2.50m. Further drilling using diamond core drilling produced poor core recovery and pieces of highly weathered jointed granitic gneiss. Weathered rock for the next three meters is found to have severe jointing that produced fine to coarse gravel size particles and some large pieces. The wash sample did not provide any indication of cohesive particles within the joints.

5.4 The elevation of weathered fractured rock is also dipping as the general ground profile dip towards East side. The ground level is found varying between +11.50m to +8.50m with respect to the site reference bench mark 10.00m marked over the pump room near the well outside the project land. The main Vandalur road is also dipping towards East with levels +12.0m RL near the South West corner of the project land and +11.00m near South East

corner. Considering the ground terrain, three different formation levels such as +11.0m, +10.00m and +9.00m RL are finalised for the projects. The basement is proposed below the footprint of each tower and the basement floor level is 3.60m below the formation level in each location.

5.5 The sandy clay at very shallow depth has moderate to high swelling characteristics. However, the swelling potential may be limited as the percentage of sand and gravel is very large in this layer. The excavated and reworked soil can offer large volume changes under moisture variations.

5.6 Presently the ground water table is at about 4.00m below the lower ground. Water table was very shallow during the preliminary investigation conducted in January 2012. The local sources reported water table at very shallow depth during rains and the design ground water table is assumed at the existing ground level. The water table is below 3.0m during most of the dry period. Large pond available in the South West of the project land collects water during rains creating very shallow ground water table conditions in the nearby areas.

5.7 ***Foundation Recommendations***

5.7.1 The proposed constructions are high-rise towers with one basement and twenty to twenty four floors above. The average load intensity at the basement floor level may be 36 t/m^2 to 38 t/m^2. The individual column footings shall have very high net SBC for supporting such heavy loads.

5.7.2 The basement floor level is 2.50m to 3.50m below the natural ground level. Mostly, weathered fractured rock and weathered disintegrated rock occur at this level. In certain cases such as tower 2 and 3, very dense residuals and occurs at this level. The tower numbers are designated as 1 to 8 as presented in Figure 2 for easy understanding and identification. It is found that the subsoil conditions are good for adopting full raft foundation at the proposed basement floor levels.

5.7.3 However, if column footings are to be adopted in the design, the depth of column footings may be deeper in some cases so that the footings are placed over weathered fractured rock. The available net SBC for column footings placed over weathered fractured rock is 70 t/m^2. Since the thickness of weathered fractured rock is varying from 1.20m to 2.50m, better SBC can be achieved only when the footings are placed over weathered jointed rock. There will be difficulties in proper identification (visually) of a competent layer for offering better SBC that may result adverse performance.

5.7.4 Based on these findings, the following foundation recommendations are made for supporting the proposed constructions.

<u>For Light to Moderate Column Loads</u>

Type of foundation	- Individual footings
Depth of foundation	- 1.80m below existing GL*
Recommended net SBC	- 21 t/m^2
Type of soil present at FL	- Dense clayey fine to coarse sand

* The elevation of footings shall be decided based on the location of the structure and the natural ground level existing in the building footprint.

For Towers

Option 1 (Preferred)

Type of foundation - Full Raft Foundation

Depth of foundation - 3.00m to 5.50m below natural ground level^

Recommended net SBC - >40 t/m²

Type of soil present at FL - varying between very dense sand and weathered fractured rock.

Modulus of sub-grade reaction - Varying modulus of sub-grade reaction^

^ The elevations of raft foundation for different tower locations with respect to the site reference datum 10.00m are suggested as given in the table below. The modulus of sub-grade reaction at different locations is also given in the table.

Tower	Boreholes	Profile	Basement Floor level	Founding level	Soil	Modulus of sub-grade reaction (t/m²/m)
Tower 1	BH/5, 12	Figure P-5	+7.40m	+6.60m	w.f.r.	10000
Tower 2	BH/11, 13	Figure P-6	+7.40m	+6.60m	Sand	6000 to 12000
Tower 3	BH/2, 11	Figure P-4	+7.40m	+6.60m	Sand	6000 to 12000
Tower 4	BH/8, 10,14	Figure P-3	+6.40m	+5.60m	w.d.r, w.f.r, sand	1400 to 10000
Tower 5	BH/3, 7	Figure P-1	+6.40m	+5.60m	w.f.r & w.j.r	10000 to 18000
Tower 6	BH/4, 6	Figure P-2	+5.40m	+4.60m	w.f.r	10000
Tower 7	BH/4		+5.40m	+4.60m	w.f.r & w.d.r.	6000 to 12000
Tower 8	BH/9		+5.40m	+4.60m	w.f.r	10000

w.d.r. is weathered disintegrated rock, w.f.r. is weathered fractured rock and w.j.r. is weathered jointed rock. Founding level is assuming 800mm thick raft. In the case of tower 4, abrupt change in modulus shall be considered, say over a distance of 10m.

Option2

Type of foundation - Individual column footings

Founding stratum - Weathered fractured rock with SPT rebound

Depth of foundation - 3.50m to 6.00m below natural ground level*

Recommended net SBC - 70 t/m²

* The elevations of column footing for different tower locations with respect to the site reference datum 10.00m are suggested as given in the table below.

Tower	Boreholes	Profile	Basement FL	Founding level	Remarks
Tower 1	BH/5, 12	Figure P-5	+7.40m	+5.50m to +5.00m	
Tower 2	BH/11, 13	Figure P-6	+7.40m	+6.00m	
Tower 3	BH/2, 11	Figure P-4	+7.40m	+5.20m	
Tower 4	BH/8, 10,14	Figure P-3	+6.40m	+5.50m to +5.00m	Full raft preferred
Tower 5	BH/3, 7	Figure P-1	+6.40m	+5.50m	
Tower 6	BH/4, 6	Figure P-2	+5.40m	+4.50m	
Tower 7	BH/4		+5.40m	+4.50m	
Tower 8	BH/9		+5.40m	+4.20m	

Each excavation for column footings shall be inspected thoroughly for confirming the presence of weathered fractured rock without any clay infill. Any clayey soil / matrix shall be replaced with rich PCC having strength more than 15Mpa.

5.7.5 The excavated soil except the sandy clay at some locations can be used for backfilling the foundation excavations and also in the general fill. Since the thickness of filling is relatively large, the compaction of entire filling shall be ensured for satisfactory performance of the ground floor flooring and the paving in the parking areas. Similar care shall be taken for filling below the roads.

5.7.6 The ground water table may be very shallow during rains and for couple of months after the rains. The water table is expected at 3.0m to 4.0m during dry season. The construction of foundation may be taken up during dry season with ground water table below the founding level.

5.7.7 The ground water contains only small amount of sulphate and chloride and are well within the permissible maximum limits. The pH value is very close to the neutral value.

5.7.8 The report 1Z/SVHL/KKTR/G-919 submitted on 3 February 2012 based on the preliminary investigation may be used for only record purposes. Complete data from this preliminary investigation are used for finalising the foundation recommendations presented in this report.

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SHEAR STRENGTH PARAMETERS FOR DIFFERENT LAYERS
HOUSING PROJECT- SMART VALUE HOMES PVT LTD, KILKOTTAYUR VILLAGE, MAMBAKKAM

Ground water table = 0.70m (well) (January 2012)
4.00m (well) (July 2012)

Borehole BH/1 (GL = 9.900m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Greyish brown clayey sand			
0.60m to 1.40m	Brownish grey and light grey sandy clay	14	14	c_u = 7.0 t/m²
1.40m to 2.20m	Yell grey clayey silty fine to coarse sand with gravel (cemented)	51	50	ϕ = 38.5°
2.20m to 3.70m	Yell grey clayey silty fine to coarse sand with gravel & stones (weathered disintegrated rock)	76,>100	>70	ϕ = 44°
3.70m to 5.30m	Yellowish grey and grey fine to coarse sand with weathered stones (weathered fractured rock)	>100	180	c_u = 100 t/m²
5.30m to 7.10m	Yellowish grey weathered fractured rock	RB	200	c_u =120 t/m²
7.10m to 8.10m	Yellowish grey and grey weathered and severely jointed rock	RB		c_u =200 t/m²

Borehole BH/2 (GL = 9.500m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Dark brownish grey clayey sand with roots			
0.60m to 1.40m	Dark greyish brown clayey fine to coarse sand with gravel (cemented)	24	25	ϕ = 32.5°
1.40m to 2.20m	Dark brownish grey dirty fine to coarse sand	71	>70	ϕ = 44°
2.20m to 3.80m	Dark yell grey dirty fine to coarse sand with weathered stones (weathered disintegrated rock)	>100	120	c_u = 70 t/m²
3.80m to 6.20m	Dark yellowish grey weathered fractured rock	RB	200	c_u = 120 t/m²
6.20m to 8.20m	Yellowish and grey highly weathered and severely jointed rock	RB		c_u =200 t/m²

Borehole BH/3 (GL = 9.300m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Dark brownish silty sand with roots			
0.60m to 1.40m	Greyish brown clayey sand with gravel and stones (cemented)	41	40	ϕ = 34.5°
1.40m to 2.30m	Greyish brown clayey fine to coarse sand & weathered stones	58	55	ϕ = 38.5°
2.30m to 3.70m	Yellowish grey fine to coarse sand with gravel (weathered disintegrated rock)	>100	120	c_u = 70 t/m²
3.70m to 5.50m	Dark yellowish grey weathered fractured rock	RB	200	c_u = 120 t/m²
5.50m to 6.50m	Yellowish brown and grey highly weathered and severely jointed rock	RB		c_u =200 t/m²

Borehole BH/4 (GL = 8.400m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Greyish brown clayey sand with gravel			
0.60m to 1.70m	Greyish brown clayey fine to coarse sand with gravel (cemented)	9	12	ϕ = 30.5°
1.70m to 2.30m	Greyish brown clayey fine to coarse sand with gravel (cemented)	45	45	ϕ = 34.5°
2.30m to 3.80m	Greyish brown fine to coarse sand with weathered stones (weathered disintegrated rock)	>100	120	c_u = 70 t/m²
3.80m to 5.30m	Dark yellowish grey weathered fractured rock	RB	200	c_u = 120 t/m²
5.30m to 6.30m	Yellowish brown and grey highly weathered jointed rock	RB		c_u =200 t/m²

Borehole BH/5 (GL = 10.200m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Yellowish grey sandy clay with gravel			
0.60m to 1.60m	Yellowish grey and light yellow clayey sand with stones (cemented)	6	8	$\phi = 27.5°$
1.60m to 2.20m	Lt grey & dark grey dirty fine to coarse sand & stones	62	60	$\phi = 38.5°$
2.20m to 3.00m	Dark yell grey dirty fine to coarse sand with weathered stones (weathered disintegrated rock)	>100	120	$c_u = 70$ t/m²
3.00m to 4.40m	Dark grey dirty fine to coarse sand with weathered stones (highly weathered fractured rock)	>100	180	$c_u = 100$ t/m²
4.40m to 5.70m	Dark yellowish grey weathered fractured rock	RB	200	$c_u = 120$ t/m²
5.70m to 6.70m	Greyish highly weathered and severely jointed rock	RB		$c_u = 200$ t/m²

Borehole BH/6 (GL = 8.40m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.40m	Greyish brown dirty fine to medium sand			
0.40m to 1.40m	Brownish grey sandy clay with white stones	38	20	$c_u = 10$ t/m²
1.40m to 2.20m	Yellowish grey clayey fine to coarse sand with weathered stones	75	50	$\phi = 38°$
2.20m to 3.10m	Yellowish grey dirty fine to coarse sand with weathered stones	>100	>70	$\phi = 44°$
3.10m to 5.30m	Dark yellowish grey highly weathered fractured rock	RB	200	$c_u = 120$ t/m²
5.30m to 8.30m	Greyish and brownish highly weathered jointed rock	RB		$c_u = 200$ t/m²

Borehole BH/7 (GL = 10.550m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Greyish brown clayey sand with gravel			
0.60m to 1.50m	Greyish brown sandy clay with stones and gravel	13	10	$c_u = 5$ t/m²
1.50m to 2.30m	Yell grey & black clayey silty fine to coarse sand with weathered stones	>100	>70	$\phi = 44°$
2.30m to 4.70m	Yellowish grey highly / severely weathered fractured rock	RB	200	$c_u = 120$ t/m²
4.70m to 7.70m	Greyish and brownish highly weathered jointed rock	RB		$c_u = 200$ t/m²

Borehole BH/8 (GL = 9.370m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Brownish grey sandy silty clay			
0.60m to 1.50m	Brownish grey sandy clay with gravel	26	20	$c_u = 10$ t/m²
1.50m to 2.30m	Greyish yellow clayey fine to coarse sand with weathered stones	71	50	$\phi = 38°$
2.30m to 3.00m	Yell clayey dirty fine to coarse sand with weath stones	>100	50	$\phi = 38°$
3.00m to 4.40m	Yellowish grey dirty fine to coarse sand	24,25	29	$\phi = 34°$
4.40m to 8.30m	Yellowish grey severely weathered disintegrated rock	>100	120	$c_u = 70$ t/m²
8.30m to 11.20m	Greenish grey dirty fine to coarse sand with weathered stones	66,56	52	$\phi = 38°$
11.20m to 13.30m	Yellowish grey severely weathered disintegrated rock	>100	120	$c_u = 70$ t/m²
13.30m to 14.50m	Dark yellowish grey highly weathered fractured rock	RB	200	$c_u = 120$ t/m²
14.50m to 15.50m	Greyish and brown highly weathered jointed rock	RB		$c_u = 200$ t/m²

Borehole BH/9 (GL = 8.620m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Greyish brown clayey silty sand			
0.60m to 2.20m	Yellowish grey sandy clay with gravel	42,61	30	c_u = 15 t/m²
2.20m to 3.00m	Yell grey dirty fine to coarse sand with weathd stones & gravel	>100	70	ϕ = 44°
3.00m to 3.70m	Yellowish grey weathered disintegrated rock	>100	120	c_u = 70 t/m²
3.70m to 5.20m	Yellowish grey highly weathered fractured rock	RB	200	c_u = 120 t/m²
5.20m to 8.20m	Greyish and brownish highly weathered jointed rock	RB		c_u =200 t/m²

Borehole BH/10 (GL = 9.760m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.60m	Greyish brown sandy clay			
0.60m to 1.40m	Dark brown sandy clay with gravel	26	15	c_u = 7.5 t/m²
1.40m to 1.90m	Yell grey clayey fine to coarse sand with sandy clay lumps and gravel	76	50	ϕ = 38°
1.90m to 2.60m	Yell grey clayey silty fine to coarse sand with gravel and weathered stones	>100	>70	ϕ = 44°
2.60m to 4.00m	Dark yellowish grey severely weathered fractured rock	RB	200	c_u = 120 t/m²
4.00m to 4.90m	Greyish and brownish highly weathered jointed rock	RB		c_u =200 t/m²

Borehole BH/11 (GL = 9.050m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Brownish grey clayey silty sand			
0.60m to 1.50m	Yellowish grey sandy clay with black patches and white stones	16	10	c_u = 5 t/m²
1.50m to 2.40m	Yellowish grey clayey fine to coarse sand with weathered stones	78,>100	>70	ϕ = 42°
2.40m to 3.80m	Yellowish grey dirty fine to coarse sand with weathered stones	73,>100	>70	ϕ = 44°
3.80m to 6.30m	Dark yellowish grey severely weathered fractured rock	RB	200	c_u = 120 t/m²
6.30m to 8.30m	Greyish and brownish highly weathered jointed rock	RB		c_u =200 t/m²

Borehole BH/12 (GL = 9.730m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.60m	Brownish grey clayey silty sand with gravel			
0.60m to 1.40m	Yellowish grey sandy clay with gravel	33	25	c_u = 12.5 t/m²
1.40m to 2.20m	Yell grey clayey fine to medium sand with weathered stones	71	50	ϕ = 38°
2.20m to 2.90m	Yell grey dirty fine to coarse sand with weath stones	>100	70	ϕ = 44°
.90m to 5.40m	Yellowish grey severely weathered fractured rock	RB	200	c_u = 120 t/m²
5.40m to 8.40m	Light grey and brown highly weathered jointed rock	RB		c_u =200 t/m²

Borehole BH/13 (GL = 9.500m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to 0.70m	Yellowish grey sandy clay with gravel (top sand)			
0.70m to 1.50m	Yell grey and brown sandy clay with gravel and black patches	21	15	c_u = 7.5 t/m²
1.50m to 2.30m	Light yell grey clayey silty fine to coarse sand	56	50	ϕ = 38°
2.30m to 3.80m	Lt yell grey dirty fine to coarse sand with weathered stones	>100	70	ϕ = 44°
3.80m to 4.90m	Greyish and brownish severely weathered fractured rock	RB	200	c_u = 120 t/m²
4.90m to 7.85m	Light grey and brown highly weathered jointed rock	RB		c_u =200 t/m²

Borehole BH/14 (GL = 9.430m RL)

Depth Below GL	Soil	N	Design N	Shear Strength c_u or ϕ
0.00m to0.60m	Greyish brown sandy clay			
0.60m to 1.70m	Greyish brown and yellowish brown sandy clay with gravel & black patches	26	15	c_u = 7.5 t/m²
1.70m to 2.90m	Yellowish grey clayey silty / dirty fine to coarse sand with weathered stones	59,77	50	ϕ = 38°
2.90m to 4.10m	Dark yellowish grey severely weathered disintegrated rock	>100	120	c_u = 70 t/m²
4.10m to 5.80m	Dark yellowish grey severely weathered fractured rock	RB	200	c_u = 120 t/m²
5.80m to 8.80m	Greyish highly weathered jointed rock	RB		c_u =200 t/m²

BEARING CAPACITY **INDIVIDUAL FOOTINGS AT 1.80M BELOW NGL**

Project:	**Residential Project, Smart Value Homes, Kilkottayur**		
Structure	**Club house, etc**		

Ultimate Bearing Capacity $= cN_c s_c d_c i_c g_c + 1/2 B \gamma N_\gamma s_\gamma d_\gamma i_\gamma g_\gamma + \gamma D(N_q - 1) s_q d_q i_q g_q$

Bearing Capacity Estimation using **IS Code 6403 -1981**

Soil Data			
Reference Bore Hole	**BH/10**		
Type of Soil	Sand		
Corrected SPT N	>30		*Failure Case*
Cohesion c	0.0	t/m^2	*Local Shear failure when angle of friction is 28deg or less*
Bulk density above FL	1.80	gm/cc	*Angle of frcition is adjusted to 0.67 tan(phi)*
Bulk density below FL	1.90	gm/cc	*General shear failure when angle of friction is 36deg or more*
Ground water table	0.00	m	*Angle of frcition is equal to original value*
			Intermediate case when 28deg < PHI <36deg
Factor of safety	3.00		*Angle of frcition is interpolated*

ESTIMATION 1

Depth of Foundation	**1.80 m**	Angle of Friction ϕ				34.0 deg		
Shape of Footing	**Square**	Failure Case				Intermediate		
Width of Foundation	**1.50 m**	Design Angle of Friction				31.6 deg.		
			N_i	s_i	d_i	i_i	N	Ultimate
		N_c	34.35	1.30	1.40	1.00	62.5	0.0
		N_q	22.13	1.20	1.21	1.00	30.8	49.9
		N_r	28.46	0.60	1.21	1.00	20.7	14.0
		Total Ultimate Bearing capacity					63.9 t/m^2	
		Net Safe Bearing Capacity					**21.0 t/m^2**	

ESTIMATION 2

Depth of Foundation	**1.80 m**	Angle of Friction ϕ				34.0 deg		
Shape of Footing	**Square**	Failure Case				Intermediate		
Width of Foundation	**2.50 m**	Design Angle of Friction				31.6 deg		
			N_i	s_i	d_i	i_i	N	Ultimate
		N_c	34.35	1.30	1.26	1.00	56.2	0.0
		N_q	22.13	1.20	1.13	1.00	28.6	46.4
		N_r	28.46	0.60	1.13	1.00	19.3	21.7
		Total Ultimate Bearing capacity					68.1 t/m^2	
		Net Safe Bearing Capacity					**22.5 t/m^2**	

ESTIMATION 3

Depth of Foundation	**1.80 m**	Angle of Friction ϕ				34.0 deg		
Shape of Footing	**Square**	Failure Case				Intermediate		
Width of Foundation	**3.50 m**	Design Angle of Friction				31.6 deg		
			N_i	s_i	d_i	i_i	N	Ultimate
		N_c	34.35	1.30	1.18	1.00	52.9	0.0
		N_q	22.13	1.20	1.09	1.00	27.7	44.9
		N_r	28.46	0.60	1.09	1.00	18.7	29.4
		Total Ultimate Bearing capacity					74.2 t/m^2	
		Net Safe Bearing Capacity					**24.5 t/m^2**	

Note: If loading is eccentric, total load shall be estimated for corrected area = L' x B' where L'=L-2e_l and B'= B-2e_b

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Velachery, Chennai 600 042

FIGURE 1
LOCATION OF BORE HOLES

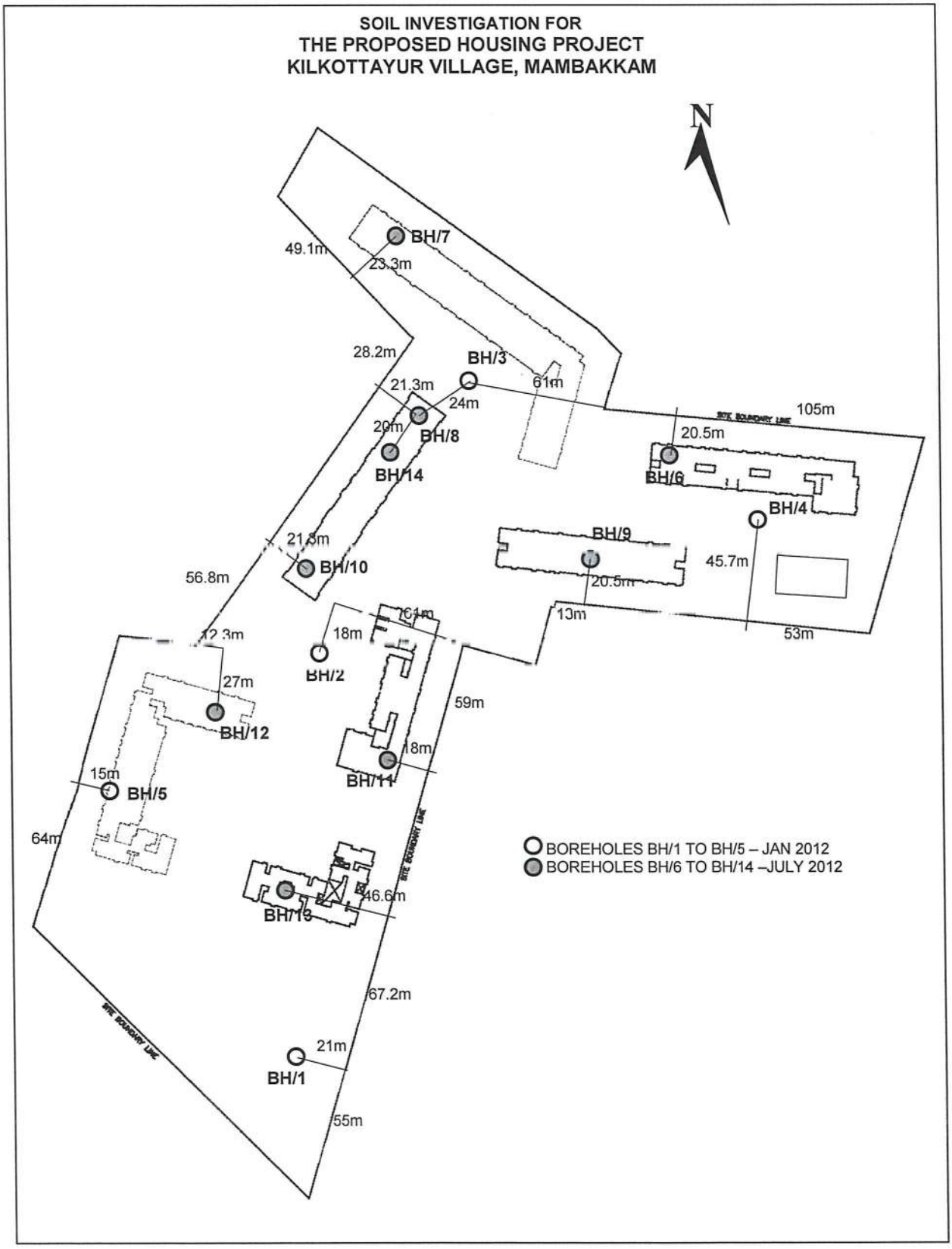
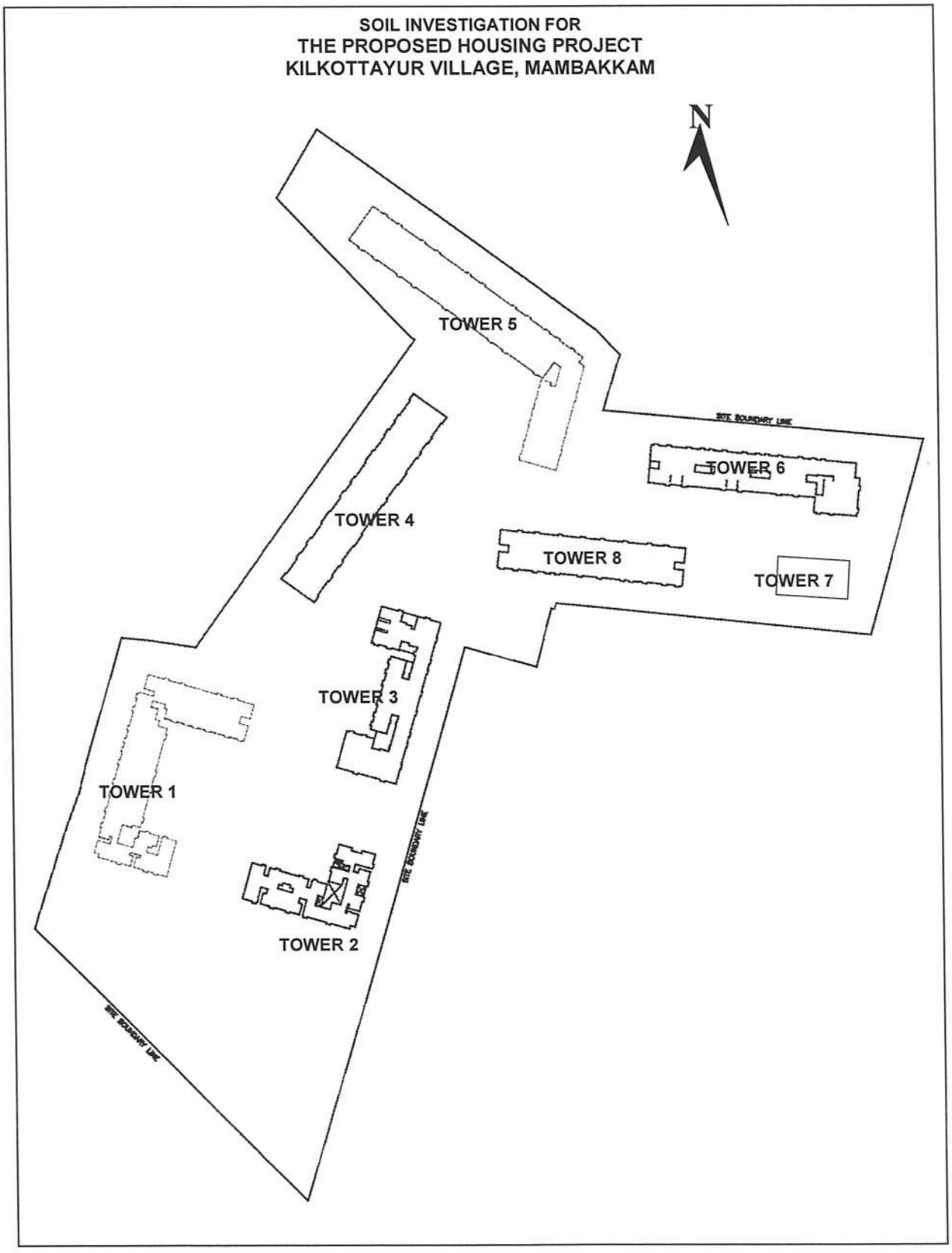
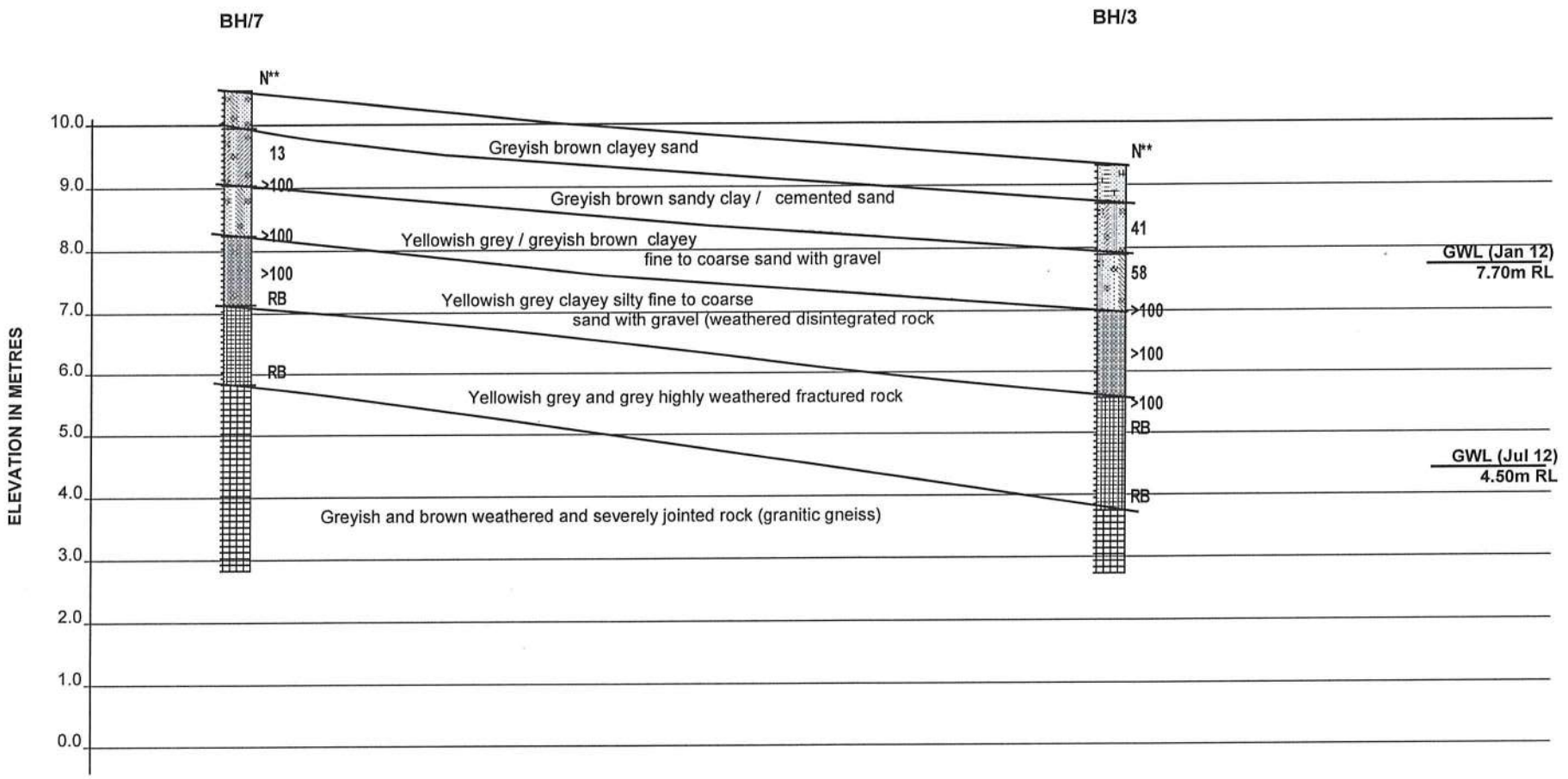


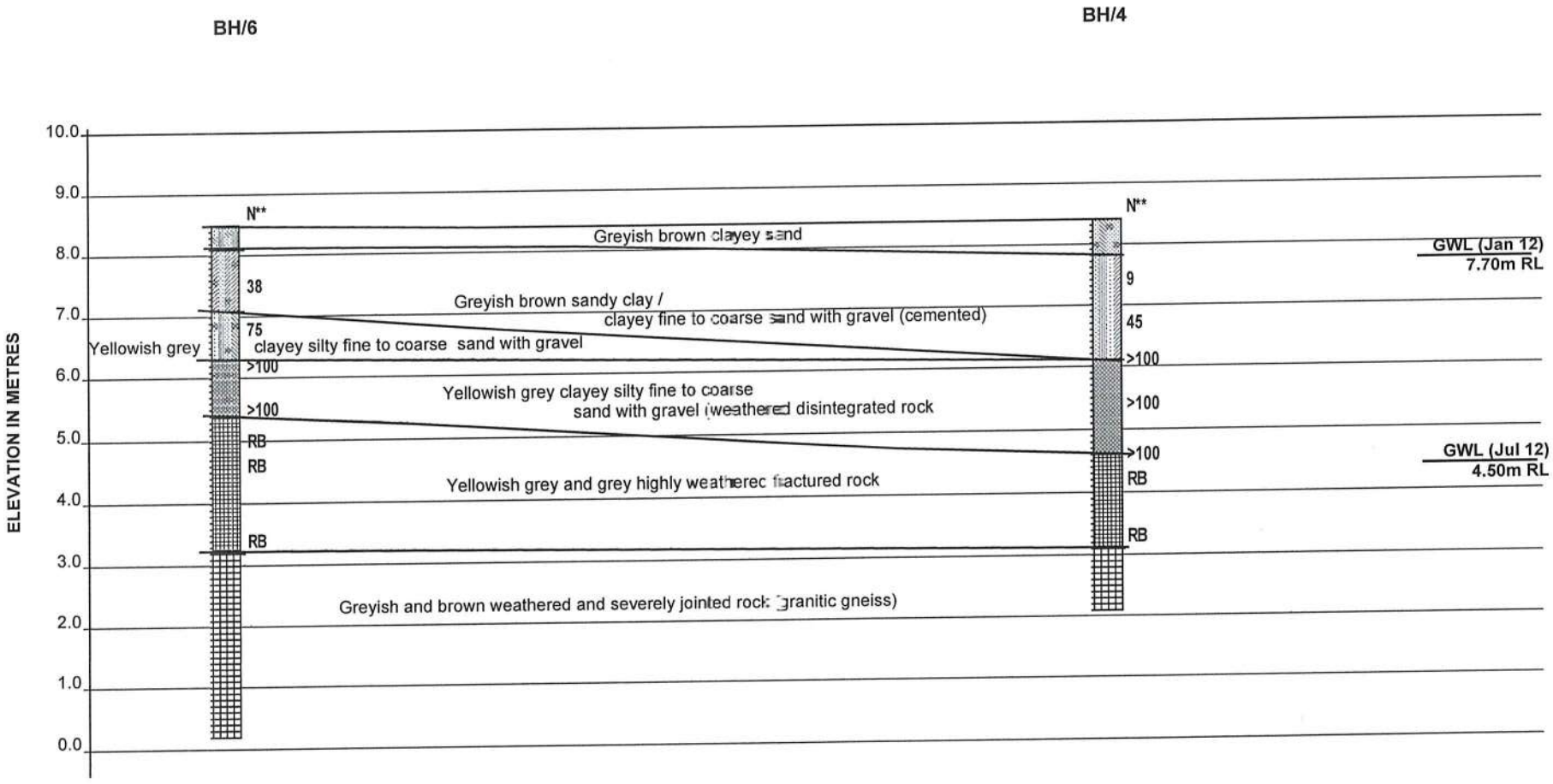
FIGURE 2
TOWER NUMBERS





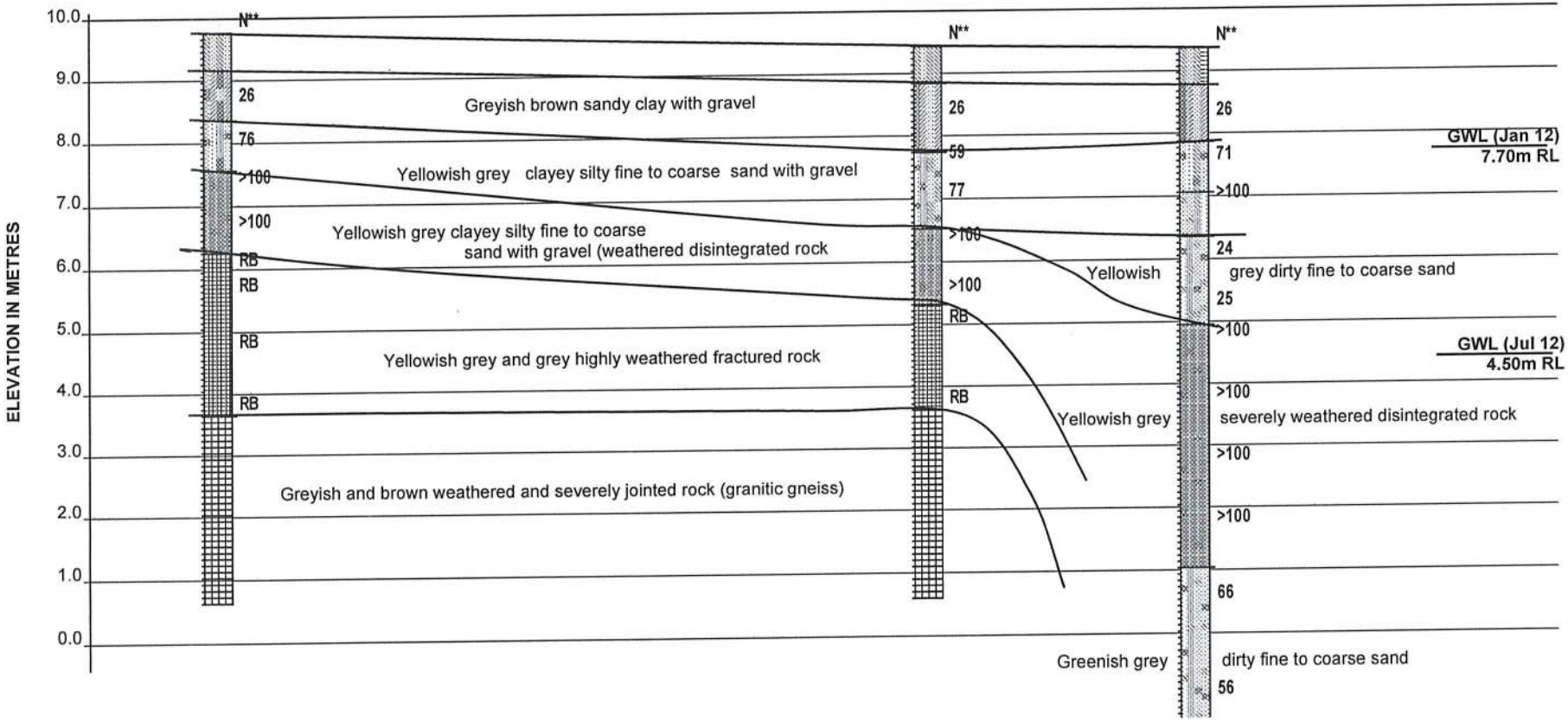
NOTE: The elevation is with respect to site BM 10.00m located over the pump house near the well outside the project land (in the East)
Ground water table from two open wells

FIGURE P-1
SUB-SOIL PROFILE BH/7 – BH/3
RESIDENTIAL PROJECT, SMART VALUE HOMES, KILKOTTAYUR



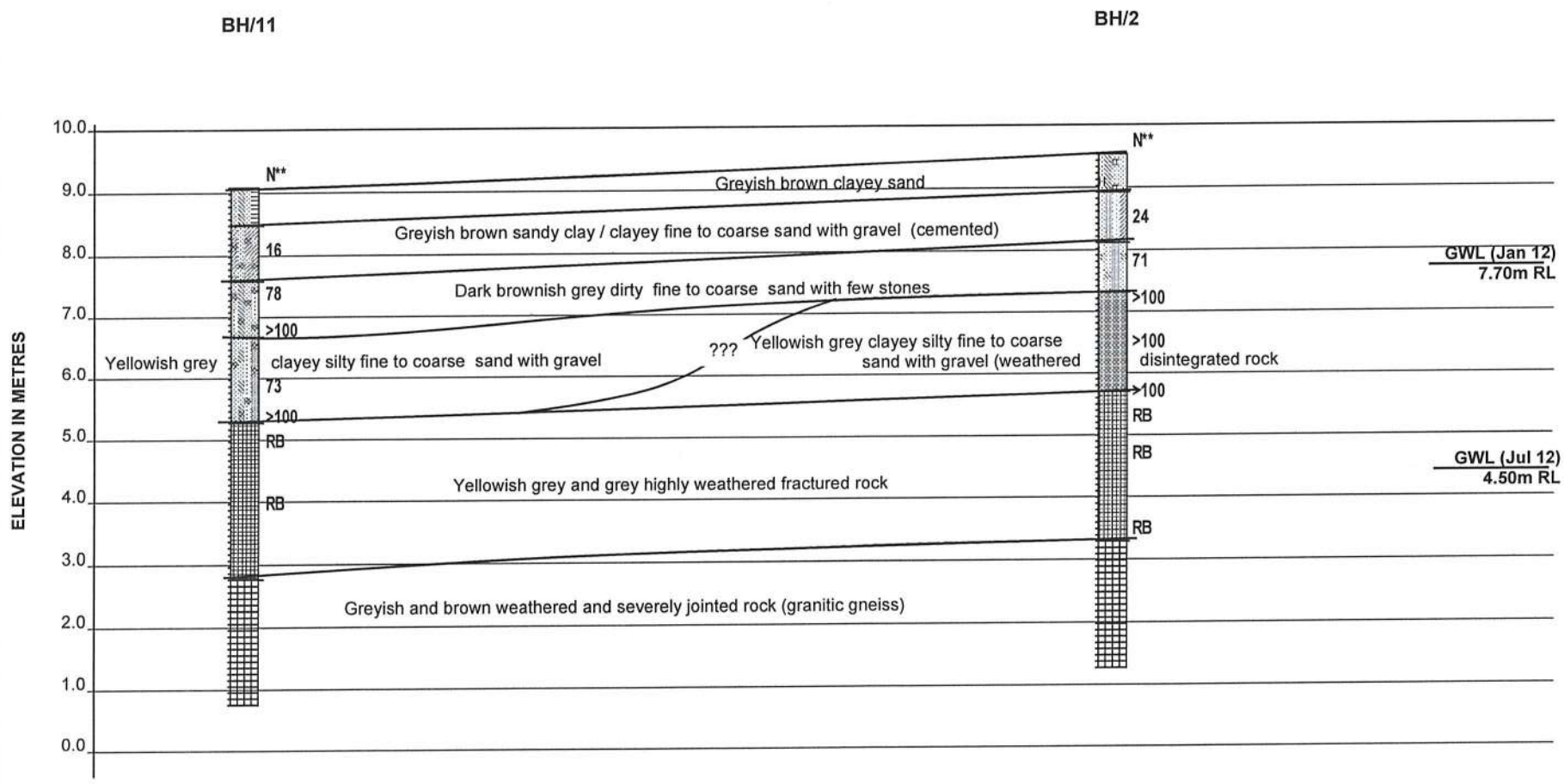
NOTE: The elevation is with respect to site BM 10.00m located over the pump house near the well outside the project land (in the East)
Ground water table from two open wells

FIGURE P-2
SUB-SOIL PROFILE BH/6 – BH/4
RESIDENTIAL PROJECT, SMART VALUE HOMES, KILKOTTAYUR



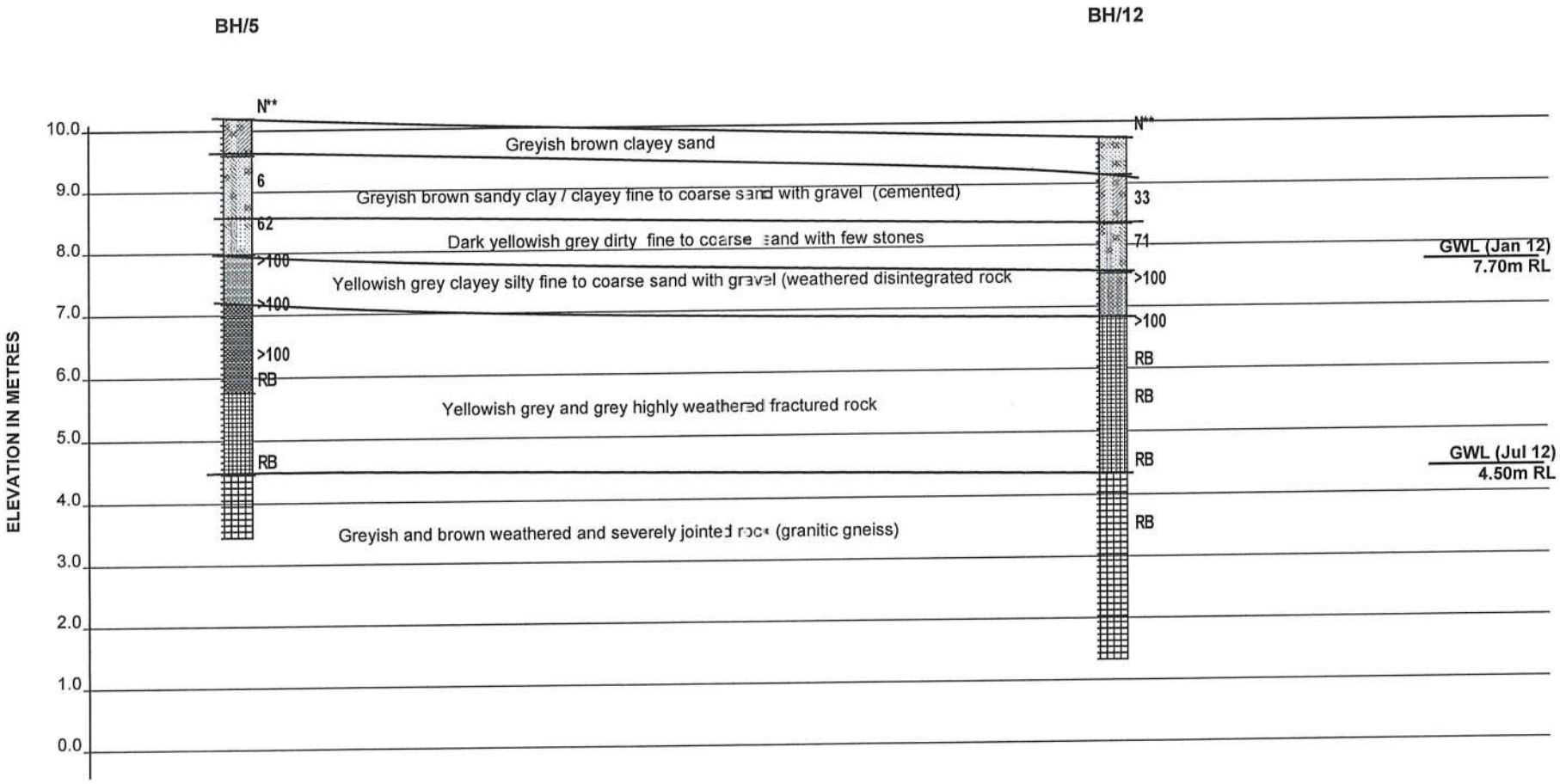
NOTE: The elevation is with respect to site BM 10.00m located over the pump house near the well outside the project land (in the East)
Ground water table from two open wells

FIGURE P-3
SUB-SOIL PROFILE BH/10 – BH/14 - BH/8
RESIDENTIAL PROJECT, SMART VALUE HOMES, KILKOTTAYUR



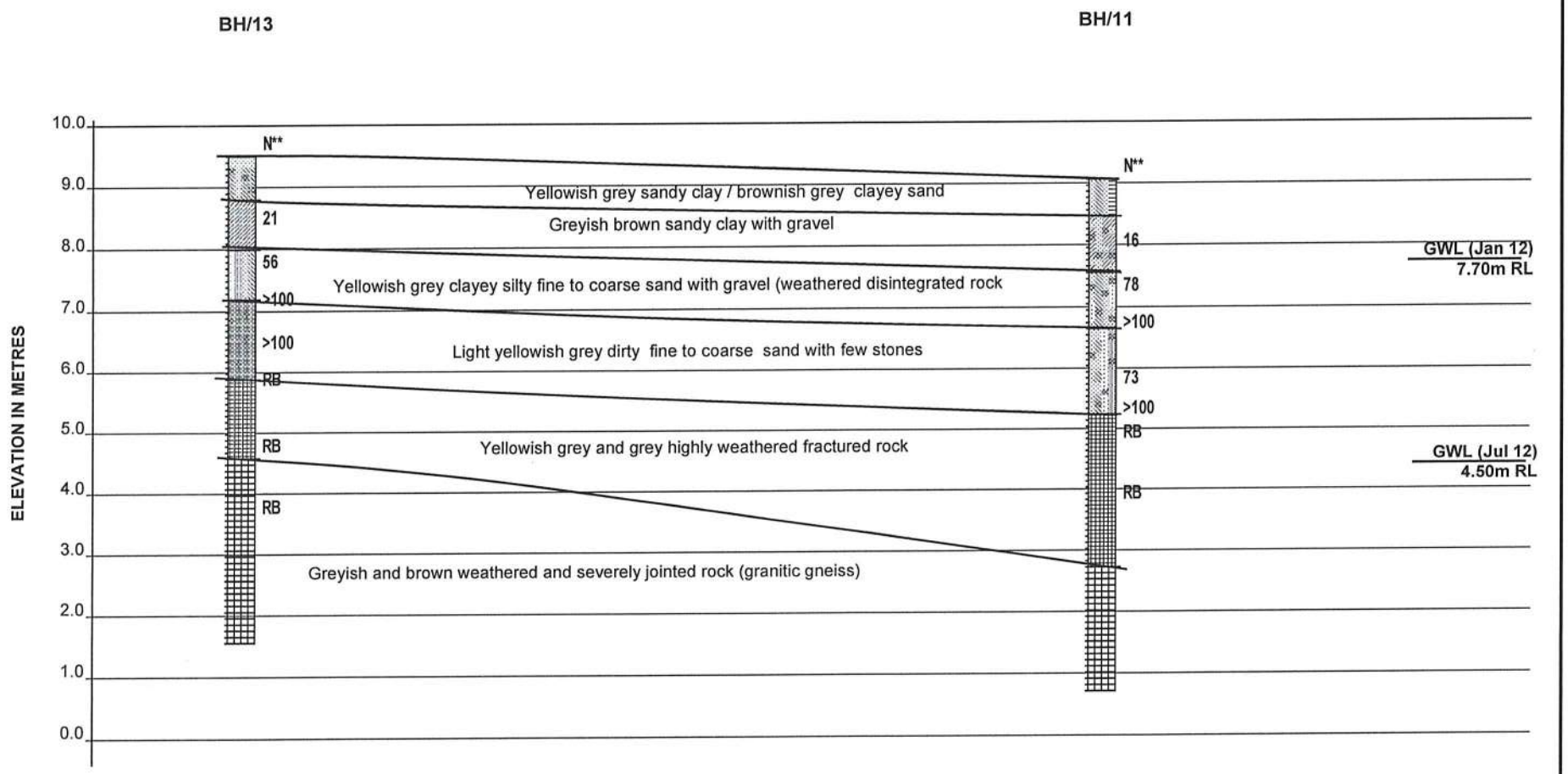
NOTE: The elevation is with respect to site BM 10.00m located over the pump house near the well outside the project land (in the East)
Ground water table from two open wells

FIGURE P-4
SUB-SOIL PROFILE BH/11 – BH/2
RESIDENTIAL PROJECT, SMART VALUE HOMES, KILKOTTAYUR



NOTE: The elevation is with respect to site BM 10.00m located over the pump house near the well outside the project land (in the East)
Ground water table from two open wells

FIGURE P-5
SUB-SOIL PROFILE BH/5 – BH/12
RESIDENTIAL PROJECT, SMART VALUE HOMES, KILKOTTAYUR

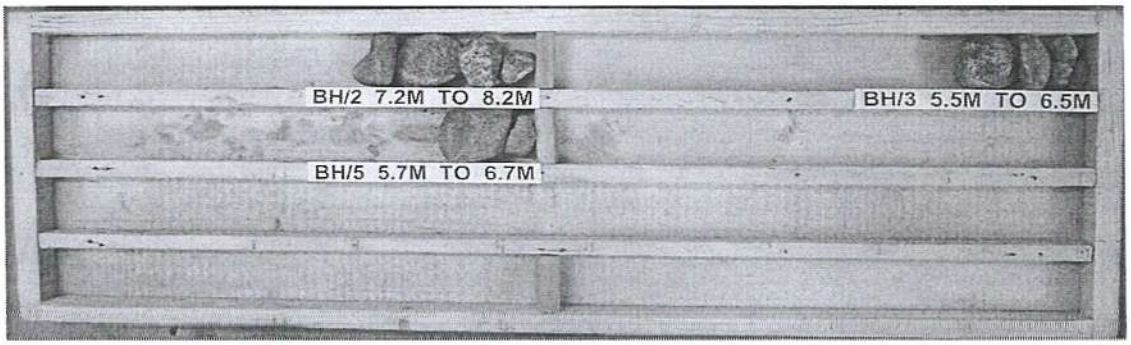


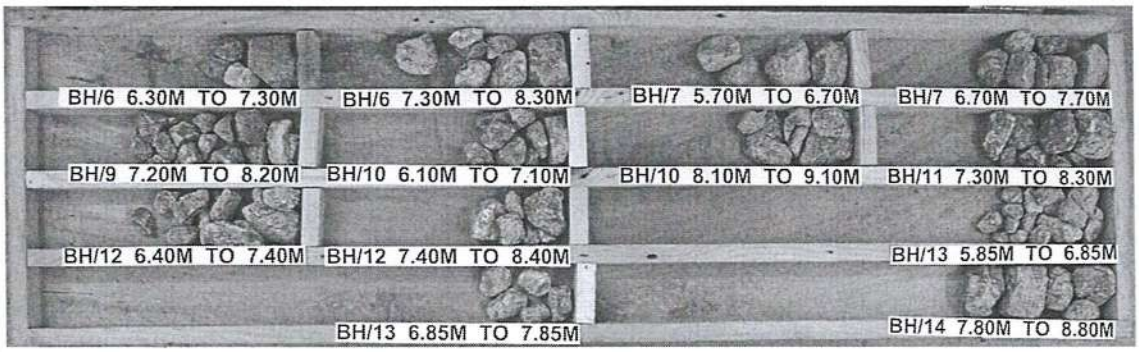
NOTE: The elevation is with respect to site BM 10.00m located over the pump house near the well outside the project land (in the East)
Ground water table from two open wells

FIGURE P-6
SUB-SOIL PROFILE BH/13 – BH/11
RESIDENTIAL PROJECT, SMART VALUE HOMES, KILKOTTAYUR

PLATE 1

CORE SAMPLES FROM BH/1 TO BH/14
RESIDENTIAL PROJECT
KILKOTTAYUR VILLAGE, MAMBAKKAM





GEOTECHNICAL SOLUTIONS[A1]

SUMMARY OF LABORATORY TEST RESULTS

TABLE 1

Project: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam, Kancheepuram**

Borehole Nos: **BH/1, BH/2, BH/3, BH/4 and BH/5**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 0.70m (well) Januray 2012

Sample Depth m	Sample Type	Visual Identification of Soil	SPT "N"	Classification	Natural Moisture content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Free Swell Index %	Specific Gravity	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt %	Clay %
Depth (1)	Type (2)	Description (3)	(4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/1															
GL	DS	Greyish brown clayey sand			9.7												
0.50	DS	Greyish brown clayey sand															
0.75	SPT	Brownish grey and light grey sandy clay	14	SC-CI	18.0	55.0	16.7	38.3	0.034	60.0							
1.50	SPT	Yell grey clayey silty fine to coarse sand with gravel (cemented)	51	SGC	17.5		LSL-9.28%					22.6	19.8	17.5	15.6	24.5	
2.25	SPT	Yell grey clayey silty fine to coarse sand with gravel & stones	76		15.3												
3.00	SPT	Yell grey clayey silty fine to coarse sand with gravel & stones(w.d.r)	>100	SG	13.4							31.9	33.5	14.1	9.4	11.1	
3.75	SPT	Yellowish grey and grey weathered fractured rock	>100		2.1												
4.50	SPT	Yellowish grey and grey weathered fractured rock	>100		2.1												
		BOREHOLE BH/2															
GL	DS	Dark brownish grey clayey sand with roots			11.8												
0.50	DS	Dark brownish grey clayey sand with roots															
0.75	SPT	Dark greyish brown clayey fine to coarse sand with gravel (cemented)	24	SGC	22.0		LSL-9.28%			32.0		28.8	28.5	12.7	9.0	21.0	
1.50	SPT	Dark brownish grey dirty fine to coarse sand	51	SC	20.5							5.4	23.3	40.6	15.1	15.6	

TABLE 1

Project: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam, Kancheepuram** SHEET 2 OF 3

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
2.25	SPT	Dark yell grey dirty fine to coarse sand with weathered stones (w.d.r)	>100	SG	4.7							12.2	32.5	36.3	16.4	2.6	
3.00	SPT	Dark yell grey dirty fine to coarse sand with weathered stones (w.d.r)	>100		4.5												
3.75	SPT	Dark yell grey dirty fine to coarse sand with weathered stones (w.f.r)	>100	SG	4.2							24.6	30.4	29.6	13.1	2.3	
7.20-8.20		Yellowish brown and grey weathered jointed rock															
		BOREHOLE BH/3															
GL	DS	Dark brownish silty sand with roots															
0.50	SPT	Dark brownish silty sand with roots			13.2												
0.75	SPT	Greyish brown clayey sand with gravel and stones (cemented)	41	SCG	16.4		LSL-16.42%			50.0		14.8	20.7	26.6	14.8	23.1	
1.50	SPT	Greyish brown clayey fine to coarse sand & weathered stones	58	SGC	17.2							29.0	23.3	18.4	12.4	16.9	
2.25	SPT	Yellowish grey fine to coarse sand with gravel (w.d.r.)	>100	SG	4.6							30.3	27.8	22.0	13.0	6.9	
3.00	SPT	Dark yell grey dirty fine to coarse sand with stones (w.d.r.)	>100	SG	6.8							19.9	26.2	34.7	14.8	4.4	
3.75	SPT	Dark yellowish grey weathered fractured rock	>100		5.7												
5.50-6.50		Yellowish brown and grey weathered jointed rock															
		BOREHOLE BH/4															
GL	DS	Greyish brown clayey sand with gravel															
0.50	DS	Greyish brown clayey sand with gravel			8.2												
0.75	SPT	Greyish brown clayey fine to coarse sand with gravel (cemented)	9	SCG	27.5		LSL-11.42%			42.0		11.3	35.8	20.3	10.0	22.6	
1.50	SPT	Greyish brown clayey fine to coarse sand with gravel (cemented)	45	SCG	16.4		LSL-11.42%					21.8	25.8	17.6	14.6	20.2	
2.25	SPT	Greyish brown fine to coarse sand with weathered stones (w.d.r)	>100	SG	5.5							13.6	10.1	35.4	37.1	3.8	
3.00	SPT	Dark yell grey dirty fine to coarse sand with weathered stones (w.d.r)	>100	SG	7.3							24.5	21.8	34.4	17.3	2.0	
3.75	SPT	Dark yellowish grey weathered fractured rock	>100		5.6												

TABLE 1

Project: **Housing Project, Smart Value Homes, Kilkottayur Village, Manbakkam, Kancheepuram** SHEET 3 OF 3

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/5															
GL	DS	Yellowish grey sandy clay with gravel															
0.50	DS	Yellowish grey sandy clay with gravel			11.8												
0.75	SPT	Yellowish grey and light yellow clayey sand with stones (cemented)	3	SCG	17.7		LSL-13.57%			41.0		14.6	23.9	22.1	12.5	26.9	
1.50	SPT	Light grey and dark grey dirty fine to coarse sand with stones	52	SCG	18.7							11.7	16.0	25.8	24.0	22.5	
2.25	SPT	Dark yell grey dirty fine to coarse sand with weathered stones (w.d.r)	>100	SGC	12.4							17.2	9.6	27.1	29.5	16.6	
3.00	SPT	Dark grey dirty fine to coarse sand with weathered stones(h.w.f.r.)	>100	SG	3.1							23.6	27.0	30.6	16.0	2.8	
3.75	SPT	Dark grey dirty fine to coarse sand with weathered stones(h.w.f.r.)	>100		3.7												
5.70-6.70		Greyish weathered jointed rock															
		NOTE:															
		w.d.r. - weathered disintegrated rock															
		w.f.r. - weathered fractured rock															
		h.w.f.r. highly weathered fractured rock															

GEOTECHNICAL SOLUTIONS[A1]

SUMMARY OF LABORATORY TEST RESULTS

TABLE 2

Project: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam**

Borehole Nos: **BH/6 to BH14**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table:

Sample Depth m	Sample Type	Visual Identification of Soil	SPT "N"	Classification	Natural Moisture content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Free Swell Index %	Specific Gravity	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt %	Clay %
Depth (1)	Type (2)	Description (3)	(4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/6															
GL	DS	Greyish brown dirty fine to medium sand			4.7												
0.50	SPT	Brownish grey sandy clay			13.1					50.0							
0.75	SPT	Brownish grey sandy clay with white stones	38	SC-CH	10.3	52.5	18.3	34.2	<0.00	90.0							
1.50	SPT	Yellowish grey clayey fine to coarse sand with weathered stones	75	SCG-SP	6.3							19.4	15.7	21.7	21.2	22.0	
2.25	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	>100	SG-SW	4.5							27.9	28.1	22.0	13.4	8.6	
3.00	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	>100	SG-SW	6.3							14.6	25.0	29.0	19.8	11.6	
6.30-7.30		Greyish and brownish highly weathered jointed rock															
7.30-8.30		Greyish and brownish highly weathered jointed rock															
		BOREHOLE BH/7															
GL-0.5	DS	Greyish brown clayey sand with gravel			7.2												
0.75	SPT	Greyish brown sandy clay with stones and gravel	13	SC-CH	31.0	56.1	32.7	23.4	<0.00								
1.50	SPT	Yell grey & black clayey silty fine to coarse sand with weathered stones	>100	SC-SW	25.4							2.7	25.4	43.0	15.1	13.8	
2.25	SPT	Yellowish grey highly weathered fractured rock	>100	SG-SW	4.3							34.3	35.5	17.5	9.8	2.9	
3.00	SPT	Yellowish grey highly weathered fractured rock	>100		4.4												
5.70-6.70		Greyish and brownish highly weathered jointed rock															
6.70-7.70		Greyish and brownish highly weathered jointed rock															

TABLE 2

Project: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam**

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/8															
					16.0					50.0							
GL-0.5	DS	Brownish grey sandy silty clay															
0.75	SPT	Brownish grey sandy clay with gravel	26	SC-CH	16.4	93.8	26.8	67.0	<0.00	263.0							
1.50	SPT	Greyish yellow clayey fine to coarse sand with weathered stones	71	SC-SP	15.1							4.7	10.8	30.9	29.6	24.0	
2.25	SPT	Yellowish clayey dirty fine to coarse sand with weathered stones	>100	SC-SP	20.3							2.6	14.3	39.1	25.6	18.4	
3.00	SPT	Yellowish grey dirty fine to coarse sand	24		18.7												
3.75	SPT	Yellowish grey dirty fine to coarse sand	25	SC-SP	17.2							5.6	15.1	33.0	26.2	20.1	
4.50	SPT	Yellowish grey weathered disintegrated rock	>100	SG-SW	3.9							19.3	42.7	25.4	9.5	3.1	
5.50	SPT	Yellowish grey weathered disintegrated rock	>100		3.1												
6.50	SPT	Yellowish grey weathered disintegrated rock	>100	SG-SW	5.9							20.0	38.4	23.6	13.0	5.0	
7.50	SPT	Yellowish grey weathered disintegrated rock	>100	SG-SW	6.0							18.2	31.4	28.0	16.3	6.1	
8.50	SPT	Greenish grey dirty fine to coarse sand with weathered stones	66		6.2												
10.00	SPT	Greenish grey dirty fine to coarse sand with weathered stones	56	SG-SW	5.9							8.0	32.6	34.4	20.1	4.9	
11.50	SPT	Yellowish grey severely weathered disintegrated rock	>100	SG-SW	5.9							16.5	37.4	26.6	13.8	5.7	
13.00	SPT	Yellowish grey severely weathered disintegrated rock	>100		4.8												
		BOREHOLE BH/9															
					6.3												
GL-0.5	DS	Greyish brown clayey silty sand															
0.75	SPT	Yellowish grey sandy clay with gravel	42	SC-CH	11.1	52.1	18.6	33.5	<0.00	60.0							
1.50	SPT	Yellowish grey sandy clay with gravel	61	SC-SW	7.8							10.8	20.1	22.1	19.1	27.9	
2.25	SPT	Yellowish grey dirty fine to coarse sand with weathered stones & gravel	>100	SCG-SW	8.2							13.3	28.4	18.9	17.0	22.4	
3.00	SPT	Yellowish grey severely weathered disintegrated rock	>100		4.0												
3.75	SPT	Yellowish grey highly weathered fractured rock	>100														
7.20-8.20		Greyish highly weathered jointed rock															

TABLE 2

Project: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam** SHEET 3 OF 4

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/10															
GL-0.5	DS	Greyish brown sandy clay			17.2												
0.75	SPT	Dark brown sandy clay with gravel	26	SC-CH	12.0	88.8	29.4	59.4	<0.00	50.0		24.4	32.9	15.4	5.8	21.5	
1.50	SPT	Yell grey clayey fine to coarse sand with sandy clay lumps and gravel	76	SC-SW	18.1							5.6	22.5	34.5	15.6	21.8	
2.25	SPT	Yell grey clayey silty fine to coarse sand with gravel and weathered stones	>100	SGC-SW	9.9							22.6	23.6	24.3	12.1	17.4	
3.00	SPT	Yell grey clayey silty fine to coarse sand with gravel and weathered stones	>100	SG-SW	10.3							35.2	22.7	20.4	11.1	10.6	
6.10-7.10		Greyish and brownish highly weathered jointed rock															
8.10-9.10		Greyish and brownish highly weathered jointed rock															
		BOREHOLE BH/11															
GL-0.5	DS	Brownish grey clayey silty sand			9.6												
0.75	SPT	Yellowish grey sandy clay with black patches and white stones	16	SC-CH	15.9		LSL-14.28%			70.0		8.5	17.3	20.9	22.5	30.8	
1.50	SPT	Yellowish grey clayey fine to coarse sand with weathered stones	78	SC-CL	9.4		LSL-8.5%					14.0	22.7	19.2	18.8	25.3	
2.25	SPT	Yellowish grey clayey fine to coarse sand with weathered stones	>100		9.4												
3.00	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	73	SCG-SW	7.1							21.4	23.8	22.0	17.7	15.1	
3.75	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	>100		4.8												
7.30-8.30		Light grey and brown highly weathered jointed rock															
		BOREHOLE BH/12															
GL-0.5	DS	Brownish grey clayey silty sand with gravel			5.5												
0.75	SPT	Yellowish grey sandy clay with gravel	33	SC-CH	21.2	56.4	22.1	34.3	<0.00	90.0							
1.50	SPT	Yellowish grey clayey fine to medium sand with weathered stones	71	SC	12.8							8.2	7.5	33.3	24.6	26.4	
2.25	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	>100	SC-SW	14.2							2.7	25.4	43.0	15.1	13.8	
3.00	SPT	Yellowish grey severely weathered fractured rock	>100														

TABLE 2

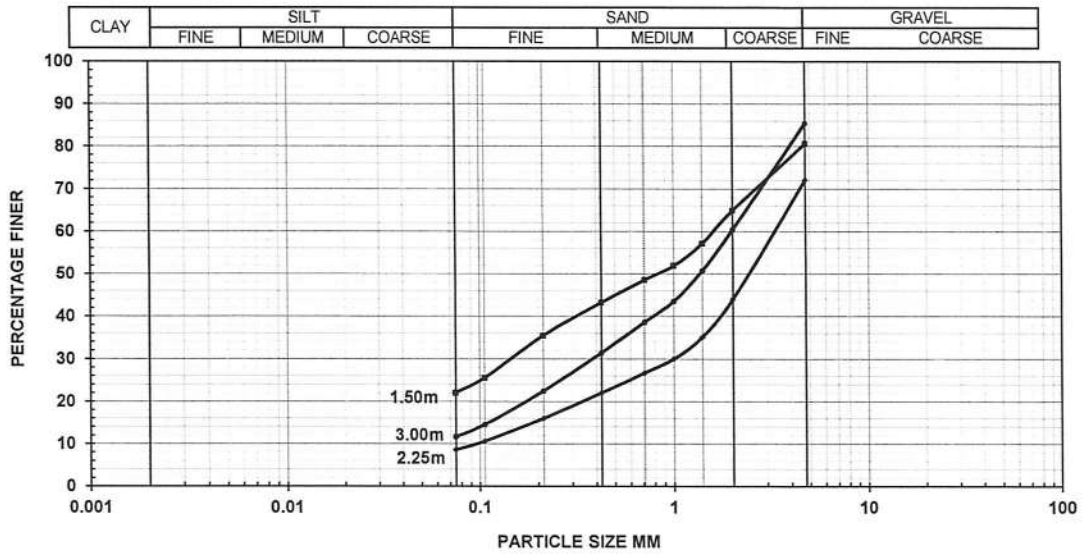
Project: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam** SHEET 4 OF 4

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
6.40-7.40		Light grey and brown highly weathered jointed rock															
7.40-8.40		Light grey and brown highly weathered jointed rock															
		BOREHOLE BH/13															
GL	DS	Brownish grey dirty fine to medium sand			5.7												
0.50	SPT	Yellowish grey sandy clay with gravel			5.1												
0.75	SPT	Yellowish grey and brown sandy clay with gravel and black patches	21	SC-CI	12.4	39.8	LSL-6.42%			150.0							
1.50	SPT	Light yellowish grey clayey silty fine to coarse sand	56	SC-CI	7.3		LSL-8.5%					3.3	10.9	22.9	35.0	27.9	
2.25	SPT	Light yellowish grey dirty fine to coarse sand with weathered stones	>100	SCG-SP	9.1							17.0	16.4	19.8	28.1	18.7	
3.00	SPT	Light yellowish grey dirty fine to coarse sand with weathered stones	>100	SCG-SW	4.0							15.9	19.3	28.4	20.3	16.1	
3.75	SPT	Greyish and brownish severely weathered fractured rock	RB														
5.85-6.85		Light grey and brown highly weathered jointed rock															
6.85-7.85		Light grey and brown highly weathered jointed rock															
		BOREHOLE BH/14															
GL-0.5	DS	Greyish brown sandy clay			12.1												
0.75	SPT	Greyish brown and yellowish brown sandy clay with gravel & black patches	26	SC-CH	21.2	67.8	32.7	35.1	<0.00								
1.50	SPT	TOP: Yellowish grey sandy clay with few stones	59	SC-CI	25.0		LSL-8.5%					2.6	12.8	18.7	21.4	44.5	
		BOT: Yellowish grey clayey silty fine to coarse sand with weathered stones			13.9												
2.25	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	77	SCG-SW	9.9							22.6	21.3	23.7	15.4	17.0	
3.00	SPT	Dark yellowish grey severely weathered disintegrated rock	>100		5.7												
3.75	SPT	Dark yellowish grey severely weathered disintegrated rock	>100	SG-SP	4.7							42.2	29.3	15.6	7.2	5.7	
7.80-8.80		Greyish highly weathered jointed rock															

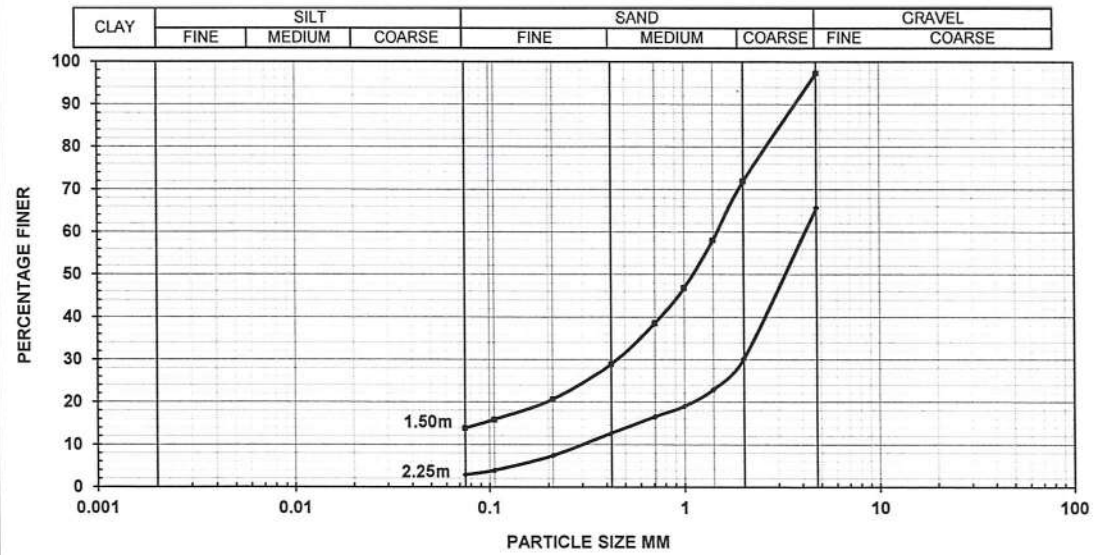
ANNEXURE G-1

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam**



BH NO	DEPTH	PERCENTAGE FINER							Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425m	75m	2m	A	B	C	E	D	E	F	G	H	I
BH/6	1.50m		100.0	80.6	64.9	43.2	22.0		19.4	15.7	21.7	21.2	22.0		SCG-SP	0.826	15.376	0.877
BH/6	2.25m		100.0	72.1	44.0	22.0	8.6		27.9	28.1	22.0	13.4	8.6		SG-SW	2.406	10.411	3.012
BH/6	3.00m		100.0	85.4	60.4	31.4	11.6		14.6	25.0	29.0	19.8	11.6		SG-SW	1.355	12.292	1.202

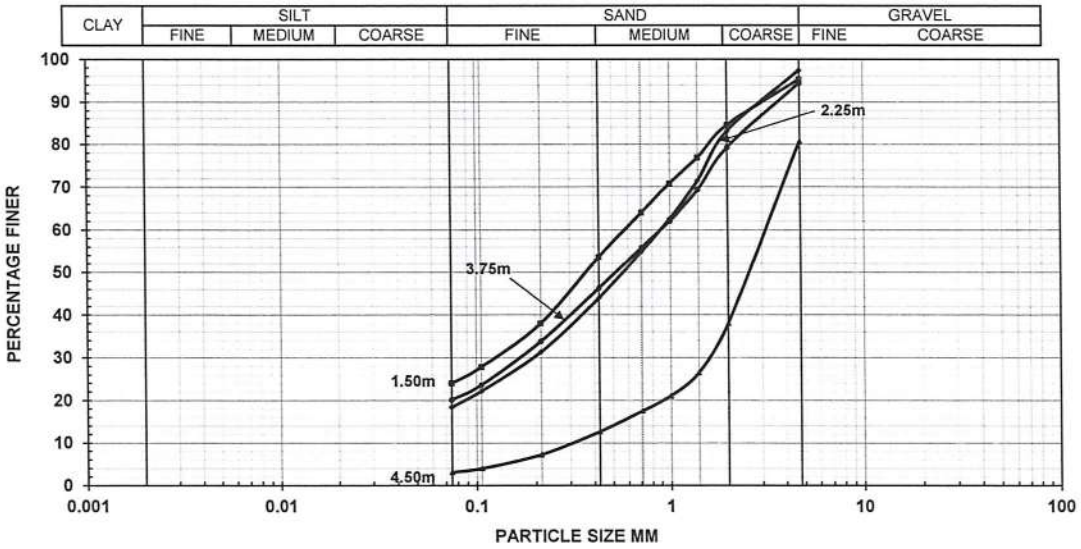


BH NO	DEPTH	PERCENTAGE FINER							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425m	75m	2m	A	B	C	E	D	E	F	G	H	I
BH/7	1.50m		100.0	97.3	71.9	28.9	13.8		2.7	25.4	43.0	15.1	13.8		SC-SW	1.101	6.877	1.323
BH/7	2.25m		100.0	65.7	30.2	12.7	2.9		34.3	35.5	17.5	9.8	2.9		SG-SW	3.240	6.989	3.395

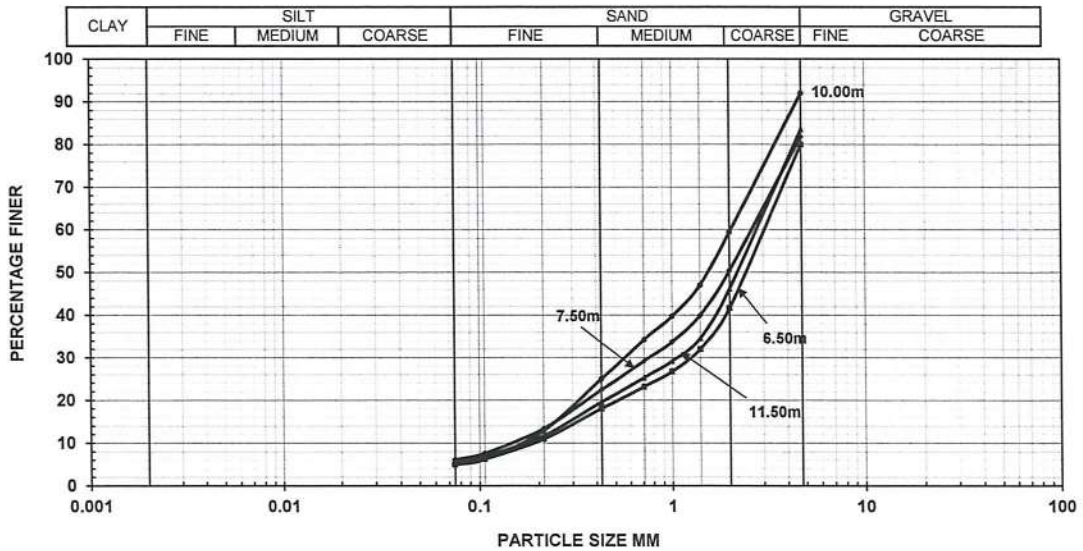
ANNEXURE G-2

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam**



BH NO	DEPTH	PERCENTAGE FINER							Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425m	75m	2m	A	B	C	E	D	E	F	G	H	I
BH/8	1.50m		100.0	95.3	84.5	53.6	24.0		4.7	10.8	30.9	29.6	24.0		SC-SP	0.362	6.862	0.763
BH/8	2.25m		100.0	97.4	83.1	44.0	18.4		2.6	14.3	39.1	25.6	18.4		SC-SP	0.564	8.114	0.901
BH/8	3.75m		100.0	94.4	79.3	46.3	20.1		5.6	15.1	33.0	26.2	20.1		SC-SP	0.519	9.152	0.745
BH/8	4.50m		100.0	80.7	38.0	12.6	3.1		19.3	42.7	25.4	9.5	3.1		SG-SW	2.550	6.380	2.324

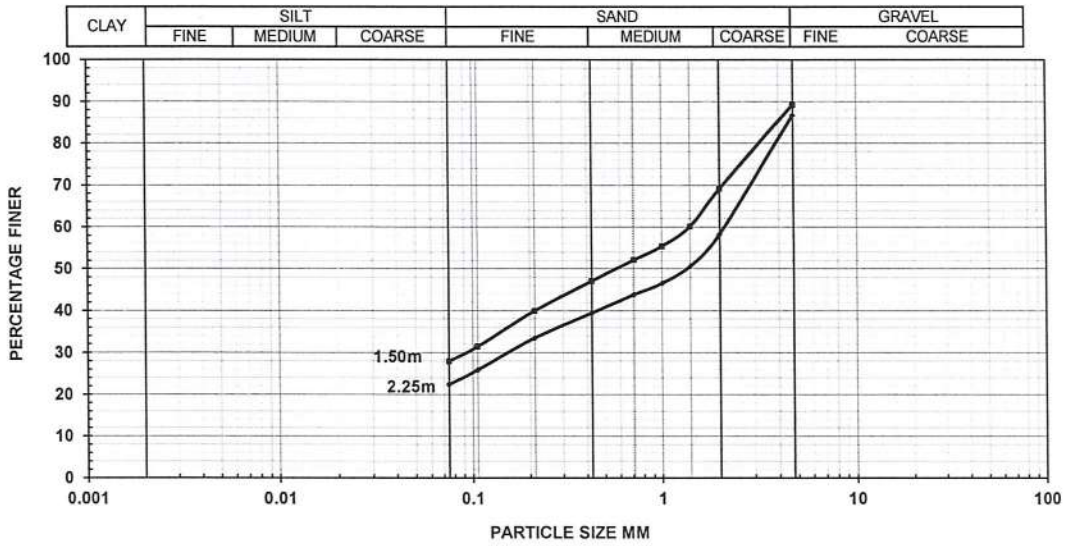


BH NO	DEPTH	PERCENTAGE FINER							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425μ	75μ	2μ	A	B	C	E	D	E	F	G	H	I
BH/8	6.50m		100.0	80.0	41.6	18.0	5.0		20.0	38.4	23.6	13.0	5.0		SG-SW	2.417	8.970	2.685
BH/8	7.50m		100.0	81.8	50.4	22.4	6.1		18.2	31.4	28.0	16.3	6.1		SG-SW	1.973	9.901	1.730
BH/8	10.00m		100.0	92.0	59.4	25.0	4.9		8.0	32.6	34.4	20.1	4.9		SG-SW	1.526	9.135	0.947
BH/8	11.50m		100.0	83.5	46.1	19.5	5.7		16.5	37.4	26.6	13.8	5.7		SG-SW	2.189	9.010	2.465

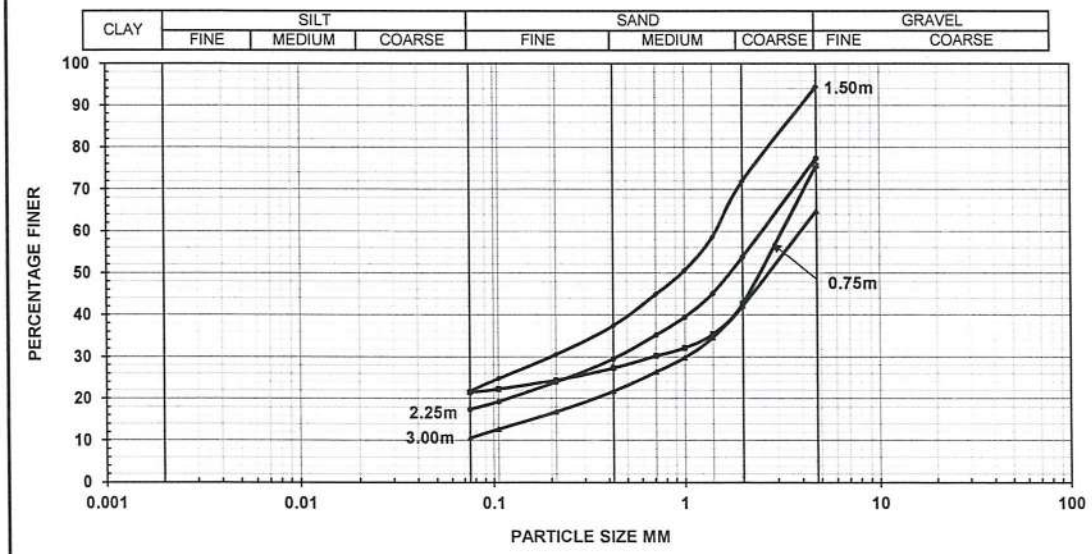
ANNEXURE G-3

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam**



BH NO	DEPTH	PERCENTAGE FINER							Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425m	75m	2m	A	B	C	E	D	E	F	G	H	I
BH/9	1.50m		100.0	89.2	69.1	47.0	27.9		10.8	20.1	22.1	19.1	27.9		SC-SW	0.575	14.775	0.989
BH/9	2.25m		100.0	86.7	58.3	39.4	22.4		13.3	28.4	18.9	17.0	22.4		SCG-SW	1.333	15.811	2.063

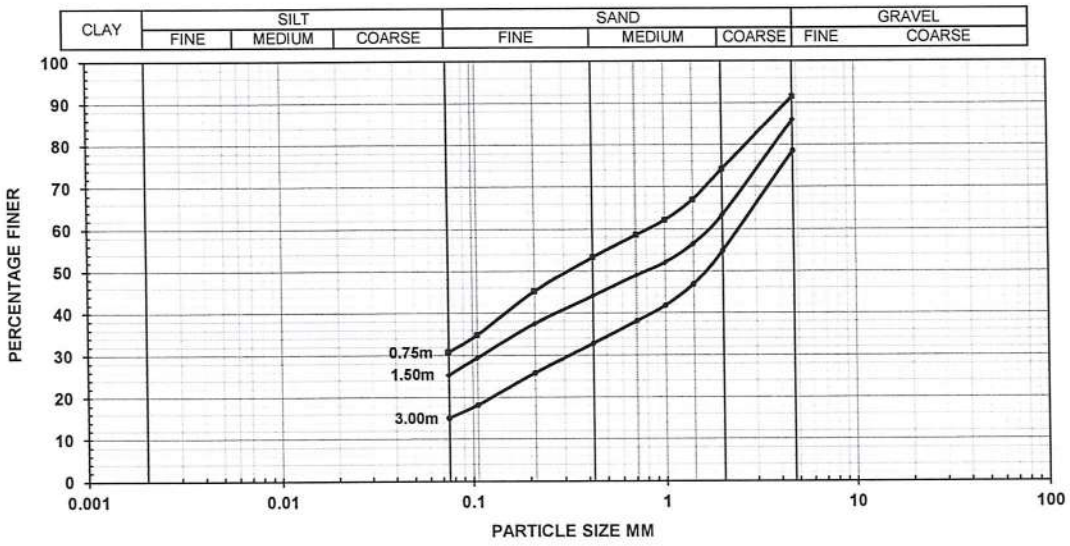


BH NO	DEPTH	PERCENTAGE FINER							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425m	75m	2m	A	B	C	E	D	E	F	G	H	I
BH/10	0.75m		100.0	75.6	42.7	27.3	21.5		24.4	32.9	15.4	5.8	21.5		SC-SW	2.423	4.841	2.378
BH/10	1.50m		100.0	94.4	71.9	37.4	21.8		5.6	22.5	34.5	15.6	21.8		SC-SW	0.970	9.640	1.506
BH/10	2.25m		100.0	77.4	53.8	29.5	17.4		22.6	23.6	24.3	12.1	17.4		SGC-SW	1.712	9.700	2.057
BH/10	3.00m		100.0	64.8	42.1	21.7	10.6		35.2	22.7	20.4	11.1	10.6		SG-SW	2.703	8.901	2.943

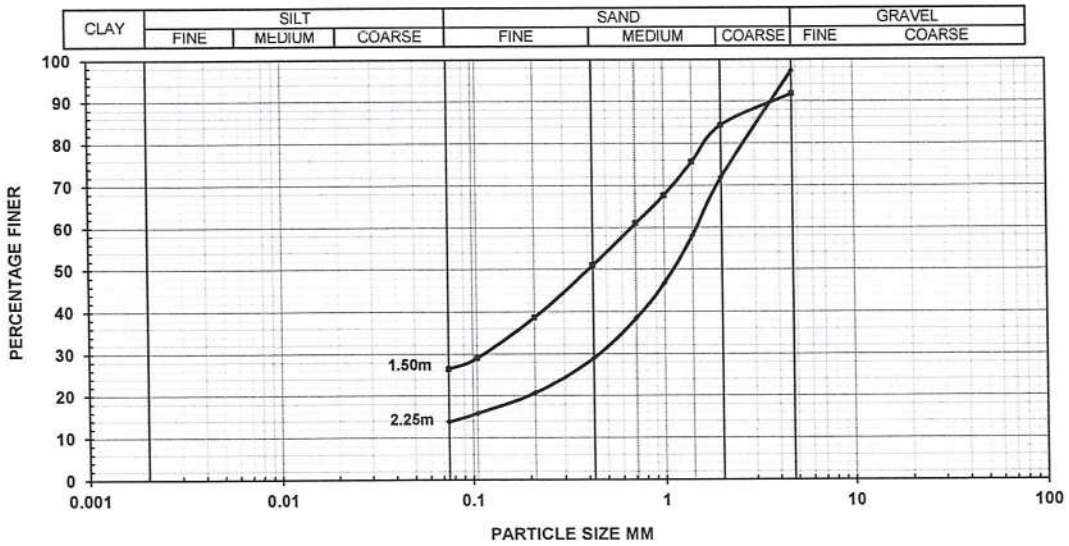
ANNEXURE G-4

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam**



BH NO	DEPTH	PERCENTAGE FINER							Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425m	75m	2m	A	B	C	E	D	E	F	G	H	I
BH/11	0.75m		100.0	91.5	74.2	53.3	30.8		8.5	17.3	20.9	22.5	30.8		SC	0.320	14.165	0.570
BH/11	1.50m		100.0	88.6	68.8	44.1	20.0		14.0	20.7	19.2	18.0	20.0		SC	0.706	19.911	1.160
BH/11	3.00m		100.0	78.6	54.8	32.8	15.1		21.4	23.8	22.0	17.7	15.1		SGC-SW	1.615	14.310	1.853

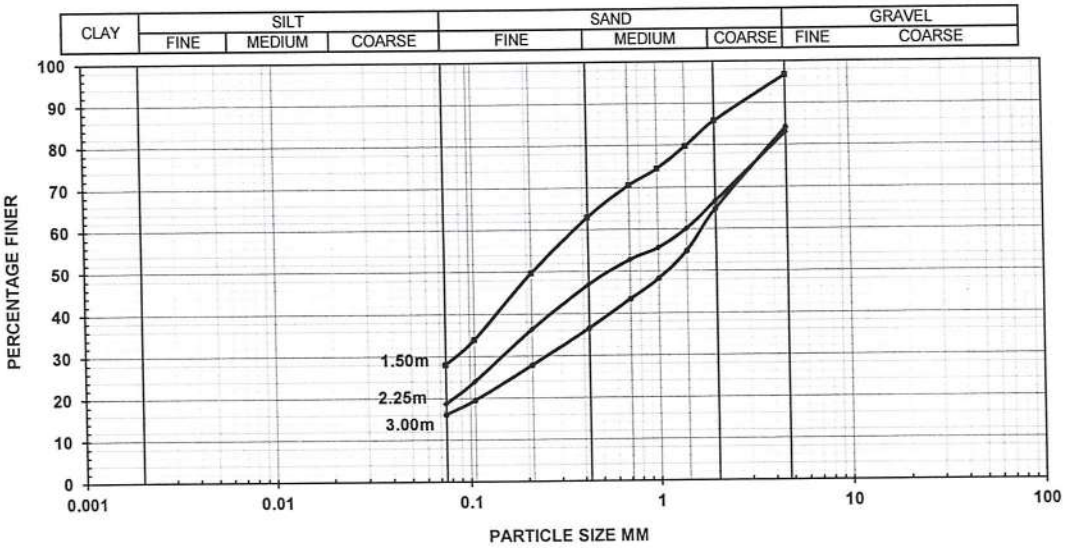


BH NO	DEPTH	PERCENTAGE FINER							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425μ	75μ	2μ	A	B	C	E	D	E	F	G	H	I
BH/12	1.50m		100.0	91.8	84.3	51.0	26.4		8.2	7.5	33.3	24.6	26.4		SC	0.402	7.576	0.804
BH/12	2.25m		100.0	97.3	71.9	28.9	13.8		2.7	25.4	43.0	15.1	13.8		SC-SW	1.101	6.877	1.323

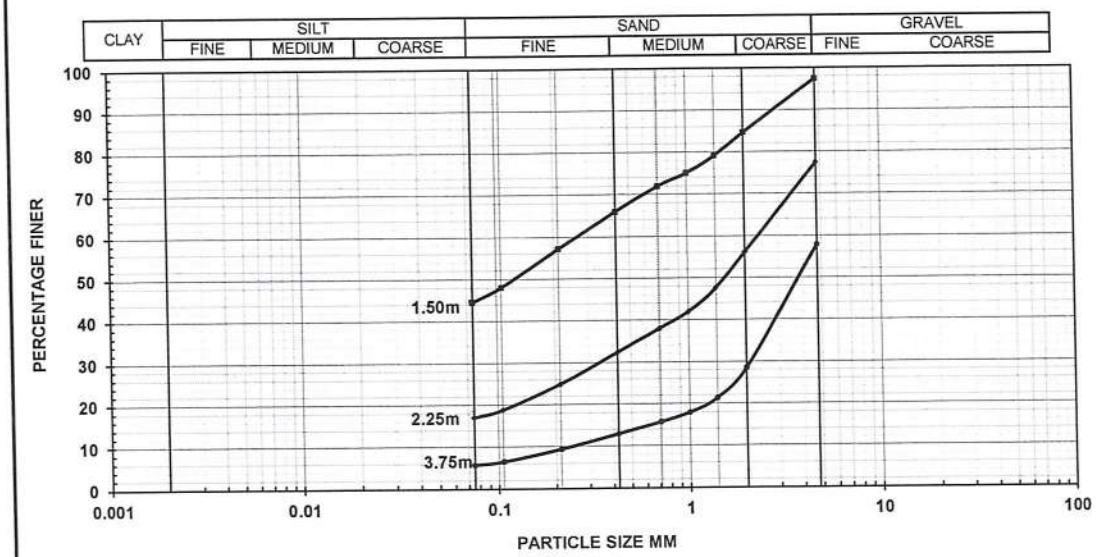
ANNEXURE G-5

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Housing Project, Smart Value Homes, Kilkottayur Village, Mambakkam**



BH NO	DEPTH	PERCENTAGE FINER							Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425m	75m	2m	A	B	C	E	D	E	F	G	H	I
BH/13	1.50m		100.0	96.7	85.8	62.9	27.9		3.3	10.9	22.9	35.0	27.9		SC	0.215	6.730	0.526
BH/13	2.25m		100.0	83.0	66.6	46.8	18.7		17.0	16.4	19.8	28.1	18.7		SCG-SP	0.559	16.461	0.434
BH/13	3.00m		100.0	84.1	64.8	36.4	16.1		15.9	19.3	28.4	20.3	16.1		SCG-SW	1.096	12.949	1.102



BH NO	DEPTH	PERCENTAGE FINER							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80m	20m	4.75	2.0m	425m	75m	2m	A	B	C	E	D	E	F	G	H	I
BH/14	1.50m		100.0	97.4	84.6	65.9	44.5		2.6	12.8	18.7	21.4	44.5		SC	0.123	10.156	0.547
BH/14	2.25m		100.0	77.4	56.1	32.4	17.0		22.6	21.3	23.7	15.4	17.0		SCG-SW	1.548	11.225	1.611
BH/14	3.75m		100.0	57.8	28.5	12.9	5.7		42.2	29.3	15.6	7.2	5.7		SG-SP	3.773		

FIELD BORE LOG

ANNEXURE 1

GEOTECHNICAL Solutions[A1]

PROJECT NO:	**SVHL/KKTR/G-919**
BORE HOLE NO:	**BH/1**

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 16-Jan-2012
Date of finish : 16-Jan-2012
GWL from GL : 0.70m (well)
Ground level RL : 9.900m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Greyish brown clayey sand		0.50							
1.0		Brownish grey and light grey sandy clay		0.75	0.75	5	7	7	9	14	Stiff
1.4		Yell grey clayey silty fine to coarse sand with gravel (cemented)		1.50	1.50	11	20	31		51	Dense
2.0				2.25	2.25	19	34	42		76	
2.2		Yell grey clayey silty fine to coarse sand with gravel & stones (weathered disintegrated rock)		3.00	3.00	50/10cm				>100	Very dense
3.0											
3.7				3.75	3.75	50/4cm				>100	
4.0		Yellowish grey and grey fine to coarse sand with weathered stones (weathered fractured rock)		4.50	4.50	50/3cm				>100	Very dense
5.0					5.30	Rebound				RB	
5.3		Yellowish grey weathered fractured rock	5.30-6.30		TC Core drilling 6.30	Rebound				RB	Very weak
6.0											
7.0			6.30-7.10		TC Core drilling						
7.1		Yellowish grey and grey weathered and severely jointed rock	7.10-8.10		Diamond core drilling NX size, recovery nil, RQD nil						Weak to moderate
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 5.30m to 7.10m DC core drlling from 7.10m to 8.10m									

Borehole terminated at 8.10m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 2

GEOTECHNICAL Solutions[A1]

PROJECT NO:	**SVHL/KKTR/G-919**
BORE HOLE NO:	**BH/2**

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 17-Jan-2012
Date of finish : 18-Jan-2012
GWL from GL : 0.70m (well)
Ground level RL : 9.50m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Dark brownish grey clayey sand with roots		0.50							
1.0		Dark greyish brown clayey fine to coarse sand with gravel (cemented)		0.75	0.75	9	11	13	14	24	Stif / dense
1.4				1.50	1.50	20	31	40		71	Very dense
2.0		Dark brownish grey dirty fine to coarse sand		2.25	2.25	50/14cm				>100	
2.2											
3.0		Dark yell grey dirty fine to coarse sand with weathered stones (weathered disintegrated rock)		3.00	3.00	50/10cm				>100	Very dense
3.8											
4.0				3.75	3.75	50/7cm				>100	
					4.00	Rebound				RB	
5.0		Dark yellowish grey weathered fractured rock	4.00-5.00		5.00	Rebound				RB	Very weak
6.0			5.00-6.20		TC core drilling 6.20	Rebound				RB	
6.2											
7.0		Yellowish and grey weathered and severely jointed rock	6.20-7.20		Diamond core drilling NX size, recovery nil, RQD nil						Weak to moderate
8.0			7.20-8.20		Diamond core drilling NX size, recovery 12%, RQD nil						
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.00m to 6.20m DC core drlling from 6.20m to 8.20m									

Borehole terminated at 8.20m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 3

GEOTECHNICAL Solutions[A1]

PROJECT NO:	**SVHL/KKTR/G-919**
BORE HOLE NO:	**BH/3**

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 18-Jan-2012
Date of finish : 18-Jan-2012
GWL from GL : 0.70m (well)
Ground level RL : 9.300m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Dark brownish silty sand with roots		0.50							
1.0		Greyish brown clayey sand with gravel and stones (cemented)		0.75	0.75	10	16	25		41	Stiff / dense
1.4				1.50	1.50	12	23	35		58	Dense
2.0		Greyish brown clayey fine to coarse sand & weathered stones		2.25	2.25	50/10cm				>100	
2.3				3.00	3.00	50/10cm				>100	Very dense
3.0		Yellowish grey fine to coarse sand with gravel (weathered disintegrated rock)		3.75	3.75	50/4cm				>100	
3.7					4.00	Rebound				RB	
4.0		Dark yellowish grey weathered fractured rock	4.00-5.50		TC core drilling 5.50	Rebound				RB	Very weak
5.0											
5.5											
6.0		Yellowish brown and grey weathered and severely jointed rock	5.50-6.50		Diamond core drilling NX size, recovery 10%, RQD nil						Weak to moderate
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.00m to 5.00m DC core drlling from 5.00m to 6.50m									

Borehole terminated at 6.50m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 4

GEOTECHNICAL Solutions[A1]

PROJECT NO:	**SVHL/KKTR/G-919**
BORE HOLE NO:	**BH/4**

Project Housing Project, Smart Value Homes Pvt Ltd.
Site Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 19-Jan-2012
Date of finish : 20-Jan-2012
GWL from GL : 0.70m (well)
Ground level RL : 8.400m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	SPT blow counts 15	30	45	60	N**	
0.6		Greyish brown clayey sand with gravel		0.50							
1.0		Greyish brown clayey fine to coarse sand with gravel (cemented)		0.75	0.75	3	4	5	7	9	Loose to medium
2.0				1.50	1.50	9	20	25		45	
2.3		Greyish brown fine to coarse sand with weathered stones (weathered disintegrated rock)		2.25	2.25	21	50/10cm			>100	Very dense
3.0				3.00	3.00	50/12cm				>100	
3.8											
4.0				3.75	3.75	50/5cm				>100	
5.0		Dark yellowish grey weathered fractured rock	4.20-5.30		4.20	Rebound				RB	Very weak
5.3					TC core drilling 5.30	Rebound				RB	
6.0		Yellowish brown and grey weathered jointed rock	5.30-6.30		Diamond core drilling NX size, recovery nil, RQD nil						Weak to moderate
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.20m to 5.30m DC core drlling from 5.30m to 6.30m									

Borehole terminated at 6.30m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 5

GEOTECHNICAL Solutions[A1]

PROJECT NO:	**SVHL/KKTR/G-919**
BORE HOLE NO:	**BH/5**

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 21-Jan-2012
Date of finish : 21-Jan-2012
GWL from GL : 0.70m (well)
Ground level RL : 10.200m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Yellowish grey sandy clay with gravel		0.50							
1.0		Yellowish grey and light yellow clayey sand with stones (cemented)		0.75	0.75	2	3	3	5	6	Loose
1.6				1.50	1.50	10	24	38		62	Dense
2.0		Lt grey & dark grey dirty fine to coarse sand & stones		2.25	2.25	50/14cm				>100	Very dense
2.2		Dark yell grey dirty fine to coarse sand with weathered stones (weathered disintegrated rock)		3.00	3.00	50/6cm				>100	
3.0				3.75	3.75	50/6cm				>100	Very dense
4.0		Dark grey dirty fine to coarse sand with weathered stones (highly weathered fractured rock)			4.30	Rebound				RB	
4.4			4.30-5.70		TC core drilling						Very weak
5.0		Dark yellowish grey weathered fractured rock			5.70	Rebound				RB	
5.7			5.70-6.70		Diamond core drilling NX size, recovery 7%, RQD nil						Weak to moderate
6.0		Greyish weathered and severely jointed rock									
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.30m to 5.70m DC core drlling from 5.70m to 6.70m									

Borehole terminated at 6.70m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 6

GEOTECHNICAL Solutions[A1]

PROJECT NO:	SVHL/KKTR/G-970
BORE HOLE NO:	BH/6

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 23-Jul-2012
Date of finish : 24-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 8.460m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.4		Greyish brown dirty fine to medium sand		0.50							
1.0		Brownish grey sandy clay with white stones		0.75	0.75	10	17	21	25	38	Stiff (dry)
1.4		Yellowish grey clayey fine to coarse sand with weathered stones		1.50	1.50	21	30	45		75	Very dense
2.0				2.25	2.25	50/10cm				>100	Very dense
2.2		Yellowish grey dirty fine to coarse sand with weathered stones		3.00	3.00	50/7cm				>100	
3.0					3.75	Rebound				RB	
3.1		Dark yellowish grey highly weathered fractured rock			4.00	Rebound				RB	Very weak
4.0			4.00-5.30		TC core drilling						
5.0					5.30	Rebound				RB	
5.3		Greyish and brownish highly weathered jointed rock	5.30-6.30		Diamond core drilling NX size, recovery nill						Weak to moderate
6.0			6.30-7.30		Diamond core drilling NX size, recovery 06%, RQD nil						
7.0			7.30-8.30		Diamond core drilling NX size, recovery 10%, RQD nil						
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.00m to 5.30m DC core drilling from 5.30m to 8.30m									

Borehole terminated at 8.30m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 7

GEOTECHNICAL Solutions[A1]

PROJECT NO:	SVHL/KKTR/G-970
BORE HOLE NO:	BH/7

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 26-Jul-2012
Date of finish : 26-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 10.550m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Greyish brown clayey sand with gravel		0.50							
1.0		Greyish brown sandy clay with stones and gravel		0.75	0.75	3	5	8	10	**13**	Stiff
1.5				1.50	1.50	30	50/10cm			**>100**	
2.0		Yell grey & black clayey silty fine to coarse sand with weathered stones									Very dense
2.3				2.25	2.25	50/8cm				**>100**	
3.0		Dark yellowish gery highly weathered disintegrated rock		3.00	3.00	50/8cm				**>100**	Very dense
3.4					3.50	Rebound				**RB**	
4.0		Yellowish grey highly / severely weathered fractured rock	3.50-4.70		TC core drilling						Very weak
4.7					4.70	Rebound				**RB**	
5.0		Greyish and brownish highly weathered jointed rock	4.70-5.70		Diamond core drilling NX size, recovery nill						Weak to moderate
6.0			5.70-6.70		Diamond core drilling NX size, recovery 8%, RQD nil						
7.0			6.70-7.70		Diamond core drilling NX size, recovery 10, RQD nil						
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 3.50m to 4.70m DC core drilling from 4.70m to 7.70m									

Borehole terminated at 7.70m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 8

GEOTECHNICAL Solutions[A1]

PROJECT NO:	**SVHL/KKTR/G-970**
BORE HOLE NO:	**BH/8**

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 24-Jul-2012
Date of finish : 25-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 9.370m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Brownish grey sandy silty clay		0.50							
1.0		Brownish grey sandy clay with gravel		0.75	0.75	11	12	14	15	**26**	Very stiff
1.5				1.50	1.50	18	31	40		**71**	Dense
2.0		Greyish yellow clayey fine to coarse sand with weathered stones		2.25	2.25	31	50/10cm			**>100**	Very dense
2.3		Yell clayey dirty fine to coarse sand with weath stones									
3.0				3.00	3.00	10	12	12	13	**24**	Medium to dense
4.0		Yellowish grey dirty fine to coarse sand		3.75	3.75	11	13	12	12	**25**	
4.4				4.50	4.50	30	50/10cm			**>100**	Very dense
5.0											
6.0		Yellowish grey severely weathered disintegrated rock		5.50	5.50	35	50/7cm			**>100**	
7.0				6.50	6.50	37	50/10cm			**>100**	
8.0				7.50	7.50	35	50/10cm			**>100**	
8.3											
0.0				8.50	8.50	20	30	36		**66**	Very dense
10.0		Greenish grey dirty fine to coarse sand with weathered stones									
11.0				10.00	10.00	21	25	31		**56**	
11.2				11.50	11.50	40	50/10cm			**>100**	Very dense
12.0		Yellowish grey severely weathered disintegrated rock									
13.0				13.00	13.00	50/11cm				**>100**	
13.3					13.60	Rebound				**RB**	
14.0		Dark yellowish grey highly weathered fractured rock	13.60-14.50		TC core drilling 14.50	Rebound				**RB**	Very weak
14.5											
15.0		Greyish and brown highly weathered jointed rock	14.50-15.50		Diamond core drilling NX size, recovery nill						Weak to moderate
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 13.60m to 14.50m DC core drilling from 14.50m to 15.50m									

Borehole terminated at 15.50m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 9

GEOTECHNICAL Solutions[A1]

PROJECT NO:	SVHL/KKTR/G-970
BORE HOLE NO:	BH/9

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 21-Jul-2012
Date of finish : 23-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 8.620m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Greyish brown clayey silty sand		0.50							
1.0		Yellowish grey sandy clay with gravel		0.75	0.75	19	20	22		42	Very stoff tio hard (dry)
2.0				1.50	1.50	21	29	32		61	
2.2		Yellowish grey dirty fine to coarse sand with weathered stones & gravel		2.25	2.25	35	50/8cm			>100	Very dense
3.0				3.00	3.00	50/9cm				>100	Very dense
3.7		Yellowish grey weathered disintegrated rock									
4.0				3.75	3.00	50/5cm				>100	Very weak
5.0		Yellowish grey highly weathered fractured rock	4.30-5.20		4.30	Rebound				RB	
5.2					TC core drilling 5.20	Rebound				RB	
6.0		Greyish and brownish highly weathered jointed rock	5.20-6.20		Diamond core drilling NX size, recovery nill						Weak to moderate
7.0			6.20-7.20		Diamond core drilling NX size, recovery nill						
8.0			7.20-8.20		Diamond core drilling NX size, recovery 10%, RQD nil						
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0		TC core drilling from 4.30m to 5.20m DC core drilling from 5.20m to 8.20m									
20.0											

Borehole terminated at 8.20m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 10

GEOTECHNICAL Solutions[A1]

PROJECT NO:	SVHL/KKTR/G-970
BORE HOLE NO:	BH/10

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 20-Jul-2012
Date of finish : 21-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 9.760m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Greyish brown sandy clay		0.50							
1.0		Dark brown sandy clay with gravel		0.75	0.75	18	13	13	15	26	Very stiff (dry)
1.4		Yell grey clayey fine to coarse sand with sandy clay lumps and gravel		1.50	1.50	20	31	45		76	Very dense
2.0				2.25	2.25	33	50/14cm			>100	
2.2		Yell grey clayey silty fine to coarse sand with gravel and weathered stones		3.00	3.00	50/10cm				>100	Very dense
3.0				3.75	3.75	Rebound				RB	
3.5					4.10	Rebound				RB	
4.0		Dark yellowish grey severely weathered fractured rock	4.10-5.10		TC core drilling 5.10	Rebound				RB	Very weak
5.0			5.10-6.10		TC core drilling 6.10	Rebound				RB	
6.0											
6.1		Greyish and brownish highly weathered jointed rock	6.10-7.10		Diamond core drilling NX size, recovery 8%, RQD nil						Moderately weak
7.0			7.10-8.10		Diamond core drilling NX size, recovery nil						
8.0			8.10-9.10		Diamond core drilling NX size, recovery 10%, RQD nil						
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.10m to 6.10m DC core drilling from 6.10m to 9.10m									

Borehole terminated at 9.10m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 11

GEOTECHNICAL Solutions[A1]

PROJECT NO:	SVHL/KKTR/G-970
BORE HOLE NO:	BH/11

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 18-Jul-2012
Date of finish : 18-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 9.050m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Brownish grey clayey silty sand		0.50							
1.0		Yellowish grey sandy clay with black patches and white stones		0.75	0.75	6	7	9	11	16	Stiff (dry)
1.5				1.50	1.50	23	38	40		78	Very dense
2.0		Yellowish grey clayey fine to coarse sand with weathered stones		2.25	2.25	30	50/7cm			>100	
2.4											
3.0		Yellowish grey dirty fine to coarse sand with weathered stones		3.00	3.00	20	31	42		73	Very dense
3.8				3.75	3.75	50/8cm				>100	
4.0					4.30	Rebound				RB	
5.0		Dark yellowish grey severely weathered fractured rock	4.30-5.30		TC core drilling						Very weak
6.0			5.30-6.30		5.30	Rebound				RB	
6.3					TC core drilling						
7.0		Greyish and brownish highly weathered jointed rock	6.30-7.30		Diamond core drilling NX size, recovery nill						Weak to moderate
8.0			7.30-8.30		Diamond core drilling NX size recovery 10%, RQD nil						
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.30m to 6.30m DC core drilling from 6.30m to 8.30m									

Borehole terminated at 8.30m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 12

GEOTECHNICAL Solutions[A1]

PROJECT NO:	**SVHL/KKTR/G-970**
BORE HOLE NO:	**BH/12**

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 19-Jul-2012
Date of finish : 19-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 9.730m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Brownish grey clayey silty sand with gravel		0.50							
1.0		Yellowish grey sandy clay with gravel		0.75	0.75	7	13	20	17	33	Very stiff (dry)
1.4		Yellowish grey clayey fine to medium sand with weathered stones		1.50	1.50	20	31	40		71	Very dense
2.0				2.25	2.25	50/14cm				>100	Very dense
2.2		Yell grey dirty fine to coarse sand with weath stones									
2.9				3.00	3.00	50/4cm				>100	
3.0					3.75	Rebound				RB	
4.0		Yellowish grey severely weathered fractured rock			4.40	Rebound				RB	Very weak
5.0			4.40- 5.40		TC core drilling 5.40	Rebound				RB	
5.4											
6.0		Light grey and brown highly weathered jointed rock	5.40-6.40		DC core drilling 6.40	Rebound				RB	Weak to moderate
7.0			6.40-7.40		Diamond core drilling NX size, recovery 10%, RQD nil						
8.0			7.40-8.40		Diamond core drilling NX size, recovery 7%, RQD nil						
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.40m to 5.40m DC core drilling from 5.40m to 8.40m									

Borehole terminated at 8.40m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 13

GEOTECHNICAL Solutions[A1]

PROJECT NO:	SVHL/KKTR/G-970
BORE HOLE NO:	BH/13

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 17-Jul-2012
Date of finish : 17-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 9.500m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.7		Yellowish grey sandy clay with gravel (top sand)		0.50							
1.0		Yellowish grey and brown sandy clay with gravel and black patches		0.75	0.75	7	11	10	10	21	Stiff (dry)
1.5				1.50	1.50	10	21	35		56	Dense
2.0		Light yell grey clayey silty fine to coarse sand		2.25	2.25	25	50/8cm			>100	
2.3											
3.0		Light yellowish grey dirty fine to coarse sand with weathered stones		3.00	3.00	30	50/11cm			>100	Very dense
3.6					3.75	Rebound				RB	
4.0		Greyish and brownish severely weathered fractured rock	3.75-4.85		TC core drilling 4.85	Rebound				RB	Very weak
4.9											
5.0			4.85-5.85		DC Core drilling 5.85	Rebound				RB	
6.0		Light grey and brown highly weathered jointed rock	5.85-6.82		Diamond core drilling NX size, recovery 10%, RQD nil						Weak to moderate
7.0			6.85-7.85		Diamond core drilling NX size, recovery 5%, RQD nil						
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 3.75m to 4.85m DC core drilling from 4.85m to 9.10m									

Borehole terminated at 7.85m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIELD BORE LOG

ANNEXURE 14

GEOTECHNICAL Solutions[A1]

PROJECT NO:	SVHL/KKTR/G-970
BORE HOLE NO:	BH/14

Project : Housing Project, Smart Value Homes Pvt Ltd.
Site : Kilkottayur Village, Mambakkam, Kancheepuram
Co-ordinates : As shown in Figure 1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 26-Jul-2012
Date of finish : 26-Jul-2012
GWL from GL : 4.00m (well)
Ground level RL : 9.430m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Greyish brown sandy clay		0.50							
1.0		Greyish brown and yellowish brown sandy clay with gravel & black patches		0.75	0.75	6	11	15	20	26	Stiff
1.7				1.50	1.50	10	25	34		59	
2.0		Yellowish grey clayey silty / dirty fine to coarse sand with weathered stones		2.25	2.25	27	36	41		77	Dense
2.9											
3.0				3.00	3.00	50/11cm				>100	
4.0		Dark yellowish grey severely weathered disintegrated rock		3.75	3.00	50/10cm				>100	Very dense
4.1					4.50	Rebound				RB	
5.0		Dark yellowish grey severely weathered fractured rock	4.50-5.80		TC core drilling						Very weak
5.8					5.80	Rebound				RB	
6.0		Greyish highly weathered jointed rock	5.80-6.80		Diamond core drilling NX size, recovery nill						Weak to moderate
7.0			6.80-7.80		Diamond core drilling NX size, recovery nill						
8.0			7.80-8.80		Diamond core drilling NX size, recovery 12%, RQD nil						
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Ground level RLs at the borehole locations with respect to the site reference TBM marked over the pump room of well outside the projet land.									
19.0											
20.0		TC core drilling from 4.50m to 5.80m DC core drilling from 5.80m to 8.80m									

Borehole terminated at 8.80m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}



our services doesn't just end there

Buying & Selling Services

Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.



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Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

Ownership, Compliance & Legal Verification

Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

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