ANNEXURE-G

NATIONAL ENVIRONMENTAL QUALITY STANDARDS

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PART II

Statutory Notifications (S. R. O.)

GOVERNMENT OF PAKISTAN

MINISTRY OF ENVIRONMENT

NOTIFICATIONS

Islamabad, the 18th October, 2010

S. R. O. 1062(I)/2010.—In exercise of the powers conferred under clause (c) of sub-section (I) of section 6 of the Pakistan Environmental Protection Act, 1997 (XXXIV of 1997), the Pakistan Environmental Protection Agency, with the prior approval of the Pakistan Environmental Protection Council, is pleased to establish the following National Environmental Quality Standards for Ambient Air.

National Environmental Quality Standards for Ambient Air

Pollutants	Time-weighted average	Concentration in Ambient Air: Effective from 1st July, 2010	Concentration in Ambient Air: Effective from 1st January 2013	Method of measurement
Sulphur Dioxide (SO_2)	Annual Average*	80 $\mu g/m^3$	80 $\mu g/m^3$	-Ultraviolet Fluorescence method
	24 hours**	120 $\mu g/m^3$	120 $\mu g/m^3$	
Oxides of Nitrogen as (NO)	Annual Average*	40 $\mu g/m^3$	40 $\mu g/m^3$	- Gas Phase Chemiluminescence
	24 hours**	40 $\mu g/m^3$	40 $\mu g/m^3$	

Pollutants	Time-weighted average	Concentration in Ambient Air: Effective from 1st July, 2010	Concentration in Ambient Air: Effective from 1st January 2013	Method of measurement
Oxides of Nitrogen as (NO_x)	Annual Average*	40 µg/m³	40 µg/m³	- Gas Phase Chemiluminescence
	24 hours**	80 µg/m³	80 µg/m³	
O^3	1 hour	180 µg/m³	130 µg/m³	-Non dispersive UV absorption method
Suspended Particulate Matter (SPM)	Annual Average*	400 µg/m³	360 µg/m³	- High Volume Sampling, (Average flow rate not less than 1.1 m3/minute).
	24 hours**	550 µg/m³	500 µg/m³	
Respirable Particulate Matter, PM_{10}	Annual Average*	200 µg/m³	120 µg/m³	-β Ray absorption method
	24 hours**	250 µg/m³	150 µg/m³	
Respirable Particulate Matter, $PM_{2.5}$	Annual Average*	25 µg/m³	15 µg/m³	-β Ray absorption method
	24 hours**	40 µg/m³	35 µg/m³	
	1 hour	25 µg/m³	15 µg/m³	
Lead Pb	Annual Average*	1.5 µg/m³	1 µg/m³	- ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2 µg/m³	1.5 µg/m³	
Carbon Monoxide (CO)	8 hours**	5 mg/m³	5 mg/m³	- Non Dispersive Infra Red (NDIR) method
	1 hour	10 mg/m³	10 mg/m³	

*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly /8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.

S. R. O. 1063(I)/2010.— In exercise of the powers conferred under clause (c) of sub-section (1) of section 6 of the Pakistan Environmental Protection Act, 1997 (XXXIV of 1997), the Pakistan Environmental Protection Agency, with the prior approval of the Pakistan Environmental Protection Council, is pleased to establish the following National Standards for Drinking Water Quality.

National Standards for Drinking Water Quality

Properties/Parameters	Standard Values for Pakistan	Who Standards	Remarks
Bacterial			
All water intended for drinking (e.Coli or Thermotolerant Coliform bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Most Asian countries also follow WHO standards
Treated water entering the distribution system (E.Coli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Most Asian countries also follow WHO standards
Treated water in the distribution system (E. coli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12-month period.	Must not be detectable in any 100 ml sample In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12 month period.	Most Asian countries also follow WHO standards
Physical			
Colour	≤ 15 TCU	≤ 15 TCU	
Taste	Non objectionable/Acceptable	Non objectionable/Acceptable	
Odour	Non objectionable/Acceptable	Non objectionable/Acceptable	
Turbidity	⟨ 5 NTU	⟨ 5 NTU	
Total hardness as $CaCO_3$	< 500 mg/l	---	
TDS	⟨ 1000	⟨ 1000	
pH	6.5 – 8.5	6.5 – 8.5	
Chemical			
Essential Inorganic	***mg/Litre***	***mg/Litre***	
Aluminium (Al) mg/l	≤ 0.2	0.2	

Properties/Parameters	Standard Values for Pakistan	Who Standards	Remarks
Antimony (Sb)	≤ 0.005 (P)	0.02	
Arsenic (As)	≤ 0.05 (P)	0.01	Standard for Pakistan similar to most Asian developing countries
Barium (Ba)	0.7	0.7	
Boron (B)	0.3	0.3	
Cadmium (Cd)	0.01	0.003	Standard for Pakistan similar to most Asian developing countries
Chloride (Cl)	< 250	250	
Chromium (Cr)	≤ 0.05	0.05	
Copper (Cu)	2	2	
Toxic Inorganic	*mg/Litre*	*mg/Litre*	
Cyanide (CN)	≤ 0.05	0.07	Standard for Pakistan similar to Asian developing countries
Fluoride (F)*	≤ 1.5	1.5	
Lead (Pb)	≤ 0.05	0.01	Standard for Pakistan similar to most Asian developing countries
Manganese (Mn)	≤ 0.5	0.5	
Mercury (Hg)	≤ 0.001	0.001	
Nickel (Ni)	≤ 0.02	0.02	
Nitrate (NO_3)*	≤ 50	50	
Nitrite (NO_2)*	≤ 3 (P)	3	
Selenium (Se)	0.01(P)	0.01	
Residual chlorine	0.2-0.5 at consumer end 0.5-1.5 at source	—	
Zinc (Zn)	5.0	3	Standard for Pakistan similar to most Asian developing countries

* indicates priority health related inorganic constituents which need regular monitoring.

Properties/Parameters	Standard Values for Pakistan	Who Standards	Remarks
Organic			
Pesticides mg/L		PSQCA No. 4639-2004, Page No. 4 Table No. 3 Serial No. 20- 58 may be consulted.***	Annex II
Phenolic compounds (as Phenols) mg/L		≤ 0.002	
Polynuclear aromatic hydrocarbons (as PAH) g/L		0.01 (By GC/MS method)	
Radioactive			
Alpha Emitters bq/L or pCi	0.1	0.1	
Beta emitters	1	1	

*** PSQCA: Pakistan Standards Quality Control Authority.

Proviso:

The existing drinking water treatment infrastructure is not adequate to comply with WHO guidelines. The Arsenic concentrations in South Punjab and in some parts of Sindh have been found high then Revised WHO guidelines. It will take some time to control arsenic through treatment process. Lead concentration in the proposed standards is higher than WHO Guidelines. As the piping system for supply of drinking water in urban centres are generally old and will take significant resources and time to get them replaced. In the recent past, Lead was completely phased out from petroleum products to cut down Lead entering into environment. These steps will enable to achieve WHO guidelines for Arsenic, Lead, Cadmium and Zinc. However, for bottled water, WHO limits for Arsenic, Lead, Cadmium and Zinc will be applicable and PSQCA Standards for all the remaining parameters.

S. R. O. 1064(I)/2010.—In exercise of the powers conferred under clause (c) of sub-section (1) of section 6 of the Pakistan Environmental Protection Act, 1997 (XXXIV of 1997), the Pakistan Environmental Protection Agency, with the prior approval of the Pakistan Environmental Protection Council, is pleased to establish the following National Environmental Quality Standards for Noise.

National Environmental Quality Standards for Noise

S. No.	Category of Area / Zone	Effective from 1st July, 2010		Effective from 1st July, 2012	
		Limit in dB(A) Leq *			
		Day Time	Night Time	Day Time	Night Time
1.	Residential area (A)	65	50	55	45
2.	Commercial area (B)	70	60	65	55
3.	Industrial area (C)	80	75	75	65
4.	Silence Zone (D)	55	45	50	45

Note: 1. Day time hours: 6.00 a. m to 10.00 p. m.

2. Night time hours: 10.00 p. m. to 6.00 a.m.

3. Silence zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.

4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.

*dB(A) Leq: Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

[No. F. 1(12)/2010-11-General.]

MUHAMMAD KHALIL AWAN,
Section Officer (PEPC).

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ANNEXURE-H

CDA ZONING AND LAYOUT APPROVALS

ANNEXURE-I

HYDROLOGICAL ASSESSMENT

A REPORT

ON

ELECTRICAL RESISTIVITY SURVEY

CONDUCTED AT

GULBURG RESIDENCIA
ISLAMABAD

INVESTIGATORS

Dr. Zulfiqar Ahmed
Professor

Dr. M. Gulraiz Akhter
Professor

GEOELECTRIC RESISTIVITY MEASUREMENTS CONDUCTED AT GULBURG RESIDENCIA ISLAMABAD

INTRODUCTION

This report furnishes the results of geoelectric studies carried out at Gulburg Residencia, Islamabad.

The scope of the work includes the determination of the existence of suitable aquifer. If delineated successfully, a well field could be developed to fulfill the requirements of the proposed housing scheme. For delineating suitable aquifer in which tube wells have been installed.

In order to meet the desirable results, Electrical Resistivity Soundings (ERS) numbered as ERS-1, ERS-2, ERS-3 & so on are recorded on the already mentioned locations by the concern organization. Geographical data that gives the information/location (Northing and Easting) of these soundings are given in the Table 1. One hundred and two Electrical Resistivity Soundings (ERS) are recorded to configure the subsurface lithologies where tube well will be installed. In order to achieve the desire results, the most widely and reliable geophysical method for groundwater investigation i.e. the resistivity method using Schlumberger configuration was

employed extending the electrodes separation to a maximum distance of 120 to 140 meters on both-side of the resistivity point. The aim of the survey was to locate the promising sites for test boring later converted into tube wells to avoid the expensive method of random drilling.

Raw resistivity data collected from sites were interpreted by using computer-modeling Software. The interpretative results of the electrical resistivity measurements obtained from modeling are also attached as a computer outputs for ready reference. The lithologies with their respective thicknesses for the subsurface layers are shown as vertical resistivity columns in Fig.1 through Fig.50.

Table 1. Location of ERS		
ERS#	**Northing**	**Easting**
ERS-1	97187.250	33514.000
ERS-2	97382.417	33578.167
ERS-3	97770.250	33558.250
ERS-4	98384.167	33387.417
ERS-5	98621.833	33232.500
ERS-6	98002.750	33076.167
ERS-7	98506.269	34544.656
ERS-8	98075.602	34705.906
ERS-9	99377.750	35524.083
ERS-10	100021.000	35132.250
ERS-11	100909.167	37272.333
ERS-12	100696.000	37680.750
ERS-13	99167.750	35942.917
ERS-14	100659.500	38698.333
ERS-15	100657.503	38698.434
ERS-16	102055.323	38897.492
ERS-17	102350.826	39505.469

Table 1(continued)		
ERS-18	100876.833	38933.167
ERS-19	102205.000	37311.833
ERS-20	102823.083	37504.167
ERS-21	101623.750	34913.750
ERS-22	96470.667	33225.833
ERS-23	96758.500	33584.667
ERS-24	96215.333	33995.167
ERS-25	96952.417	34662.750
ERS-26	97249.000	35319.917
ERS-27	97648.083	35828.250
ERS-28	98596.417	36881.417
ERS-29	98878.000	37011.083
ERS-30	99102.083	37176.667
ERS-31	99335.500	37881.417
ERS-32	100041.417	38452.333
ERS-33	100993.417	39849.750
ERS-34	100970.000	40335.417
ERS-35	103077.667	38142.417

Table 1(continued)		
ERS-36	103188.000	40015.250
ERS-37	101602.500	39417.250
ERS-38	100877.667	40827.417
ERS-39	101455.333	40748.500
ERS-40	101806.167	41049.750
ERS-41	102400.000	40736.500
ERS-42	101517.917	40383.167
ERS-43	102326.083	41285.078
ERS-44	102377.085	41285.083
ERS-45	102695.750	41352.167
ERS-46	102790.250	41781.667
ERS-47	102966.250	41781.667
ERS-48	103453.917	41890.750
ERS-49	103158.750	41759.833
ERS-50	102949.992	41163.838
ERS-51	101458.833	41903.667
ERS-52	101961.250	42652.833
ERS-53	102387.167	41805.083

Table 1(continued)		
ERS-54	102919.583	43151.833
ERS-55	103613.583	41799.083
ERS-56	103676.333	42732.583
ERS-57	101914.667	41503.833
ERS-58	104527.500	40445.667
ERS-59	104428.083	40987.417
ERS-60	104174.000	41053.750
ERS-61	104273.417	41363.333
ERS-62	103663.250	40839.417
ERS-63	103953.000	41515.333
ERS-64	104273.417	41216.833
ERS-65	104801.000	40957.000
ERS-66	104894.917	40067.250
ERS-67	92382.417	51915.833
ERS-68	91870.750	51889.167
ERS-69	91779.333	52538.583
ERS-70	92582.500	52652.500
ERS-71	93037.417	52469.333

Table 1(continued)		
ERS-72	93197.167	52189.250
ERS-73	94107.917	51395.667
ERS-74	94081.917	51783.750
ERS-75	95159.000	52015.500
ERS-76	95646.000	51725.583
ERS-77	95750.167	52836.083
ERS-78	98709.000	51631.167
ERS-79	100075.91	52482.500
ERS-80	99743.833	53141.667
ERS-81	101136.000	52944.500
ERS-82	100316.250	48638.750
ERS-83	100787.833	48860.583
ERS-84	100735.917	49164.833
ERS-85	101621.833	50135.000
ERS-86	101094.000	48883.667
ERS-87	101955.167	49759.167
ERS-88	101581.917	49107.000
ERS-89	102062.750	49124.917

Table 1(continued)		
ERS-90	102340.083	47705.667
ERS-91	102844.000	47770.417
ERS-92	102569.250	48697.667
ERS-93	102603.500	48183.250
ERS-94	103207.000	47888.417
ERS-95	103175.167	47225.167
ERS-96	103558.167	47129.333
ERS-97	104282.000	46587.667
ERS-98	104539.917	45653.917
ERS-99	103513.667	46256.167
ERS-100	103437.750	46442.333
ERS-101	103193.750	44477.667

ELECTRICAL RESISTIVITY SURVEY

Electrical Resistivity Survey is a practical application of Ohm's law i.e. $R = K \times (\Delta V/I)$ to study the subsurface hydrological set up of the earth. The objective of electrical resistivity survey is to map the subsurface changes in earth resistivity and correlate them with the hidden geological formations.

Electrical Resistivity Survey can be used profitably to determine qualitatively the type of water bearing formation, e.g., sand, sandstone or boulder/gravel provided conditions are favorable and not complicated by abrupt lateral changes in lithology.

In making resistivity surveys a commuted direct current is introduced into the ground via two electrodes (A & B). The potential difference is measured between a second pair of electrodes (M & N). The four electrodes are arranged in any of several possible patterns. The current & potential measurements are then used to calculate apparent resistivity values. During the fieldwork Schlumberger electrode configuration is generally applied. This configuration is the most widely used in the world for conducting electrical resistivity survey. Four electrodes are placed along a straight line on the earth surface in the order of AM NB with 5 MN $\leq$ AB (as shown below).

1 $R \propto \Delta V/I$ OR $R = K \times \Delta V/I$

Where:

R = Resistivity; Ohm-meter

ΔV = Voltage (potential drop) milli-volt

I = Current; milli-ampere

K = Constant of proportionality

And

$$K = \frac{\pi/2\ (AB/2)^2 - (MN/2)^2}{MN}$$

Where: π = Constant i.e. 3.14159.

AB= Spacing between the current electrode; meter.

MN= Spacing between potential electrode; meter.

Field Procedure

ABEM TERRAMETER SAS 300C, a highly sensitive and wide measuring range instrument was used for the purpose of data acquisition. Although there are number of electrode configurations used to lay out the electrodes, Schlumberger configuration is the best when used for probing deeper into the ground. So this configuration is used during the fieldwork for conducting the electrical resistivity survey keeping 5 MN ≤ AB. The earth is energised using the battery pack at various electrode spacing at one Vertical

Electrical Sounding (VES also called ERS) station.

The instrument is capable to display calculated value of $\Delta V/I$ and by multiplying the Schlumberger electrode configuration constant 'K' factor, the apparent resistivity values for each electrode spacing were calculated. Apparent resistivities, being average resistivities of true resistivities of various subsurface layers do not represent the true electrical characteristics of individual subsurface layer.

To know the true resistivities of various subsurface layers field curves were plotted for further analysis. Apparent resistivities were plotted against current electrode spacing i.e. AB/2 on log-log graph paper (base 62.5 mm). These curves are matched with the curves made by the computer for that particular VES to finalise the interpretation. Resistivity survey has certain limitations that must be kept in mind as and when interpretation about the subsurface lithologies is made. As the resistivitiy values exhibit a large variety where some are overlapping; therefore number of subsurface layers revealed by resistivity survey often does not match with the results obtained by trial boring. Layers encountered by trial boring shall be greater in number than layers interpreted by resistivity survey.

INTERPRETATION OF FIELD DATA

Now-a-days field data have been interpreted by using the software packages that gives the model interpretation of individual curves stating/reflecting the number of layers, their true resistivity values, thickness and depth from the surface. These true resistivity values then interpreted/converted into lithologic units.

On the basis of resistivity values and subsequent subsurface lithology/thickness of aquifer, trial bore drilling site is recommended.

Apparent resistivity values are not true representation of the subsurface lithology until they are matched with the theoretical master curves manually or with the computer modeling. Resistivity data was interpreted manually and also by using a Computer Modeling Software on a microcomputer. Results were compared and adjusted, wherever needed, through an iterative procedure that finally provided a layer model based on true resistivity values. These subsurface layers have been assigned lithological units in terms of their true resistivity values and are shown in Fig.1 through Fig. 50.

RESULTS AND DISCUSSION

On-site inventory and reconnaissance supported by the resistivity results highlighted different hydrogeological features of the Gulburg Housing Scheme, Islamabad.

Interpretative resistivity results show that subsurface lithology is composed of variety of geological material. Subsurface geological material, as depicted from resistivity modeling, may be composed of clay, shale, sandstone, clays inter-bedded with gravel/sandstone and mixture of gravel/sandstone and clay.

Regionally, limited aquifer exists mostly under confined condition with sandstone/gravel (upper horizon) and impervious lithology (deeper horizon) as the predominating lithology in vertical and lateral extent thereby constituting moderate transmissive condition.

Impervious material seems to be the dominant subsurface lithology. Aquifer is mainly composed of sandstone exists in the upper horizon. Intercalation of sandstone/gravel and clay may exist alternatively also produce some quantity of water. At places where clayey content has increased concentrations, subsequent lesser chances of groundwater exist in that portion because this type of subsurface material retards the groundwater flow and recharge.

Results show that all the sites are underlain by almost similar subsurface lithological material with slightly variable thicknesses. At almost all sites except ERS-4, ERS-5, ERS-6, ERS-22, ERS-23, ERS-24, ERS-33, ERS-34, ERS-39, ERS-40, ERS-42, ERS-45 and ERS-46 seem to be devoid of groundwater.

In general, clay/shale is the dominant lithology where as in the upper shallow horizon consists of sandstone and beyond that impervious material is the dominant subsurface lithology. Due to insignificant recharging from the surrounding impervious material, a suitable aquifer has not been formed.

On the basis of ERS results, aquifer thickness and its yielding capability, the area is divided into two zones. The zone-1 consists of sites ERS-4, ERS-5, ERS-6, ERS-24, ERS-34, ERS-42 while sites ERS-22, ERS-23, ERS-33, ERS-39, ERS-40, ERS-45 and ERS-46 fall in Zone-2. Zone-1 seems to be the better where gravel/sandstone has been interpreted within the depth of 400 feet and beyond that again impervious material is a dominant subsurface lithology. The potential of ground water tends to improve in this zone and it also lies in the vicinity of River where large deposits of transported gravel and sand exist. Tube-well within 400 feet depth may be tested in this zone.

Aquifer is mainly composed of sandstone/gravel mixed with clay

exists in the shallow where as in the deeper horizon, the water bearing strata in the form of intercalation of sandstone and clay/shale has been interpreted in zone-1 and zone-2. Overall resistivity values at these sites indicated poor nature of aquifer where tube well of low yield may be installed.

From the interpretative results and on-site hydrogeological information it is concluded that subsurface areas contains low yield groundwater storage within the depth of 400 feet. Sandstone and gravel have been identified as water bearing strata that exists in the upper horizon, which form low yield aquifer under confining conditions.

Based on the interpretative resistivity results, sites ERS-4, ERS-5, ERS-6, ERS-24, ERS-34 and ERS-42 fall in first priority and sites ERS-22, ERS-23, ERS-33, ERS-39, ERS-40,ERS-45 and ERS-46 in second priority has been delineated where the further confirmation will have to be made by sinking trial bore.

CONCLUSIONS AND RECOMMENDATION

1. From the interpretative results, on-site hydrogeological information and grouping among resistivity points due to similarities and priority basis, Sites ERS-4, ERS-5, ERS-6, ERS-24, ERS-34, ERS-42 (First priority) and sites ERS-22, ERS-23, ERS-33, ERS-39, ERS-40, ERS-45 and ERS-46 (2nd priority) have been recommended, where low yield tube-wells of 400± 25 feet depth could be constructed.

2. Overall the impervious material is the dominant subsurface lithology, which is retard of ground water that's why aquifer is not formed.

3. A geophysical logging with sophisticated machine should be carried out after test boring to confirm the water-bearing zone for further development.

4. Under the existing geological environment percolation well with gallery is the better choice to install near the river bed. The discharge of this type of well is totally dependent on the flow of water in the river.

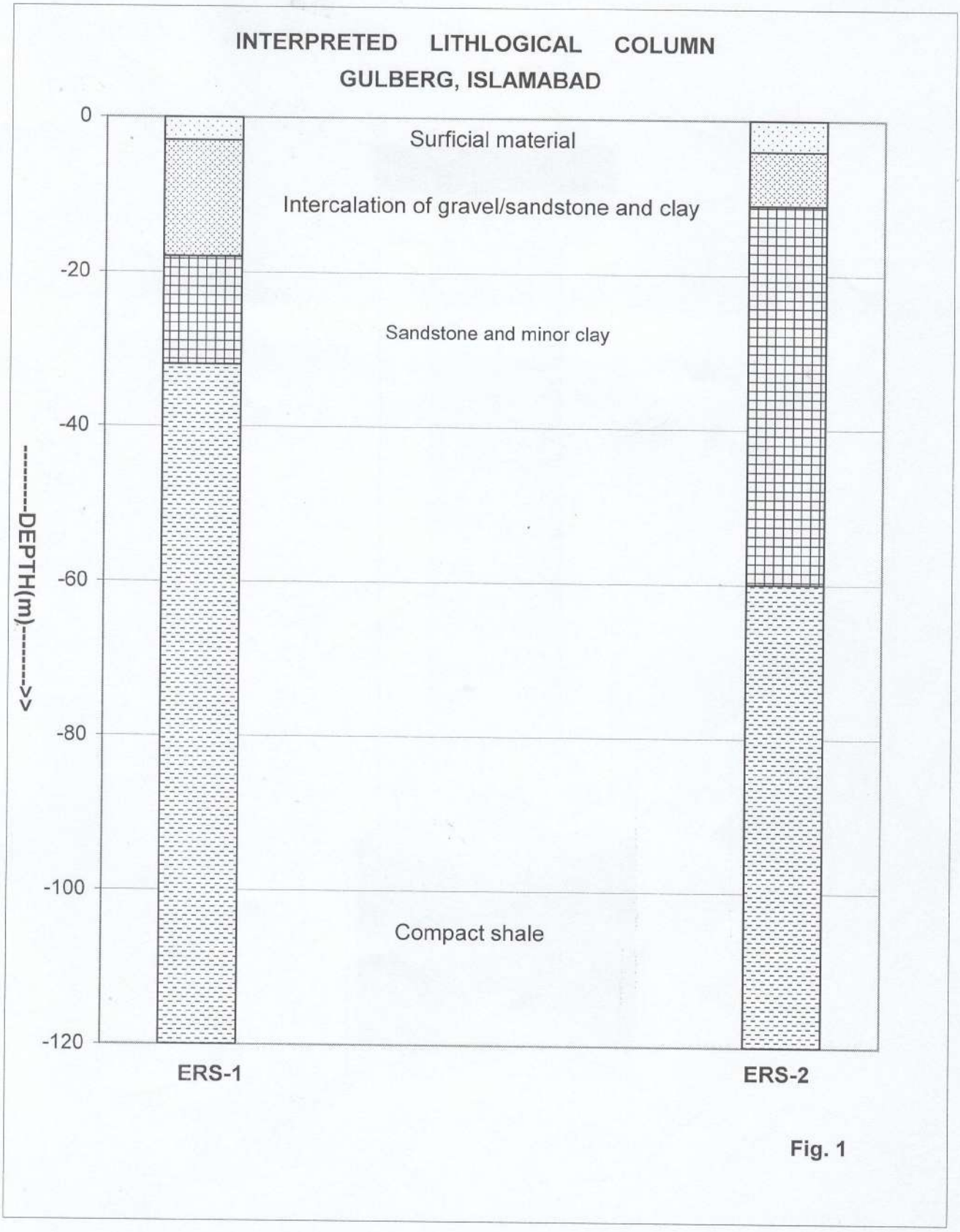

INTERPRETED LITHLOGICAL COLUMN
GULBERG, ISLAMABAD
0
-20
-40
-60
-80
-100
-120
Surficial material
Intercalation of gravel/sandstone and clay
Sandstone and minor clay
Compact shale
----------DEPTH(m)---------->>
ERS-1
ERS-2

Fig. 1

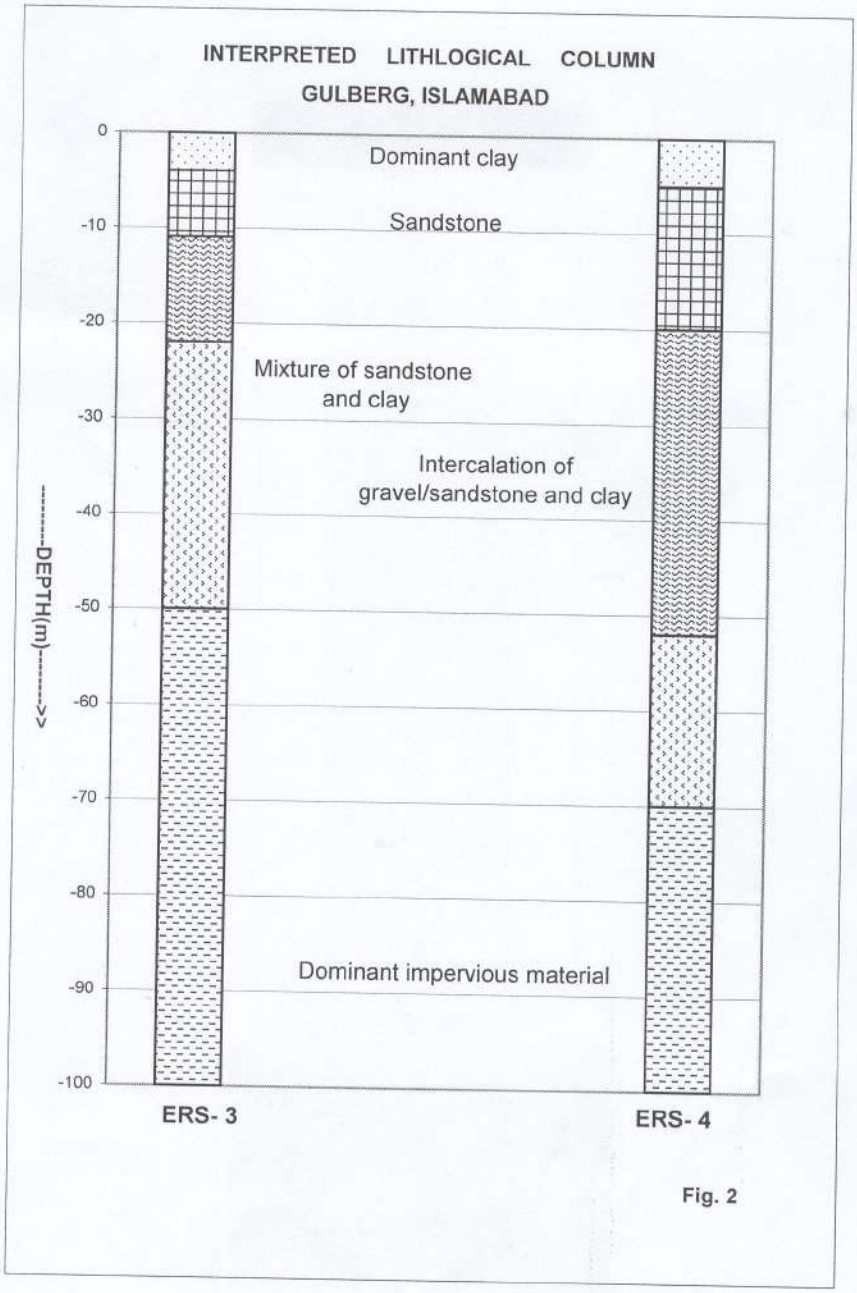

INTERPRETED LITHLOGICAL COLUMN
GULBERG, ISLAMABAD
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
<<-------DEPTH(m)------>>
Dominant clay
Sandstone
Mixture of sandstone and clay
Intercalation of gravel/sandstone and clay
Dominant impervious material
ERS- 3
ERS- 4

Fig. 2

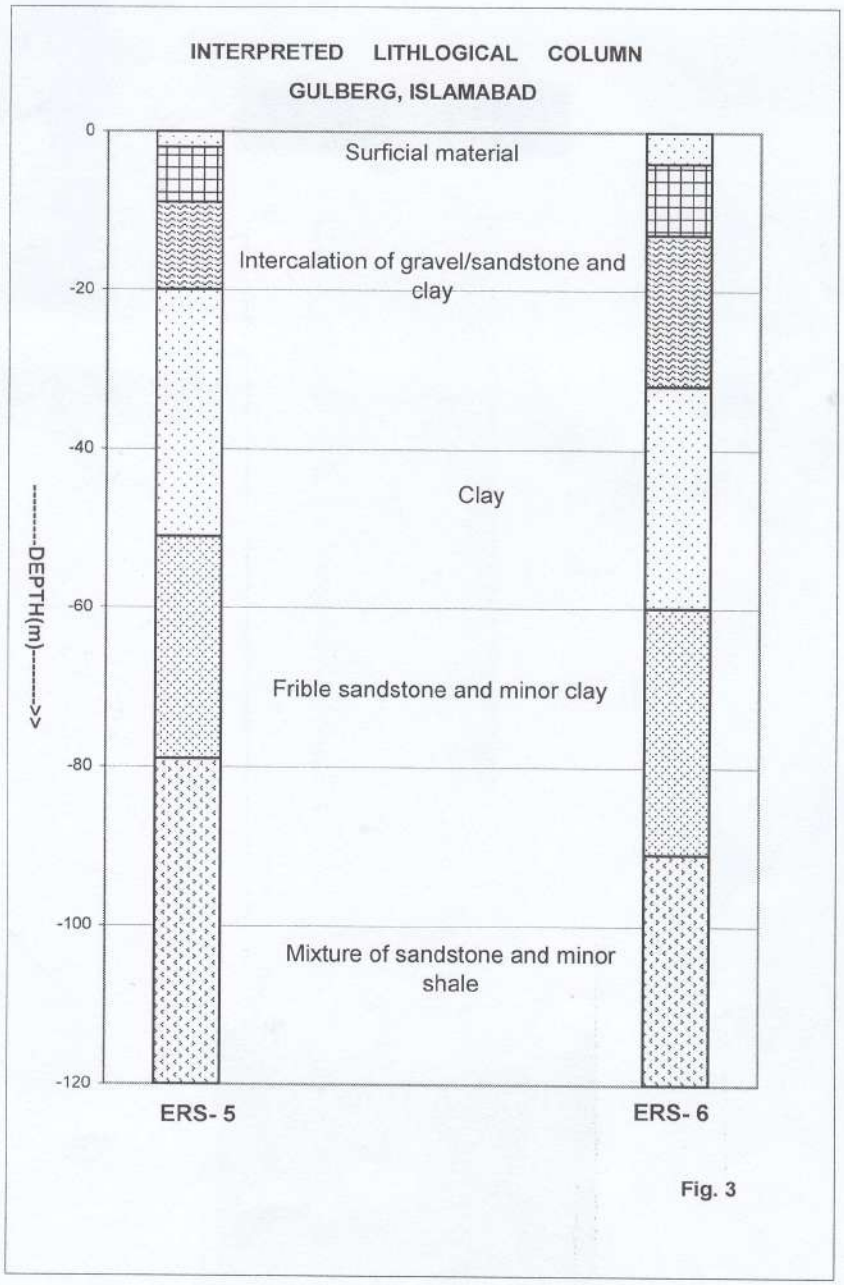

INTERPRETED LITHLOGICAL COLUMN
GULBERG, ISLAMABAD
0
-20
-40
-60
-80
-100
-120
----------DEPTH(m)---------->>
Surficial material
Intercalation of gravel/sandstone and clay
Clay
Frible sandstone and minor clay
Mixture of sandstone and minor shale
ERS- 5
ERS- 6

Fig. 3

INTELLIGENCE BUREAU EMPLOYEES COOPERATIVE HOUSING SOCIETY, ISLAMABAD

A REPORT ON GEOELECTRIC RESISTIVITY MEASUREMENTS CONDUCTED AT IBECHS

INTRODUCTION

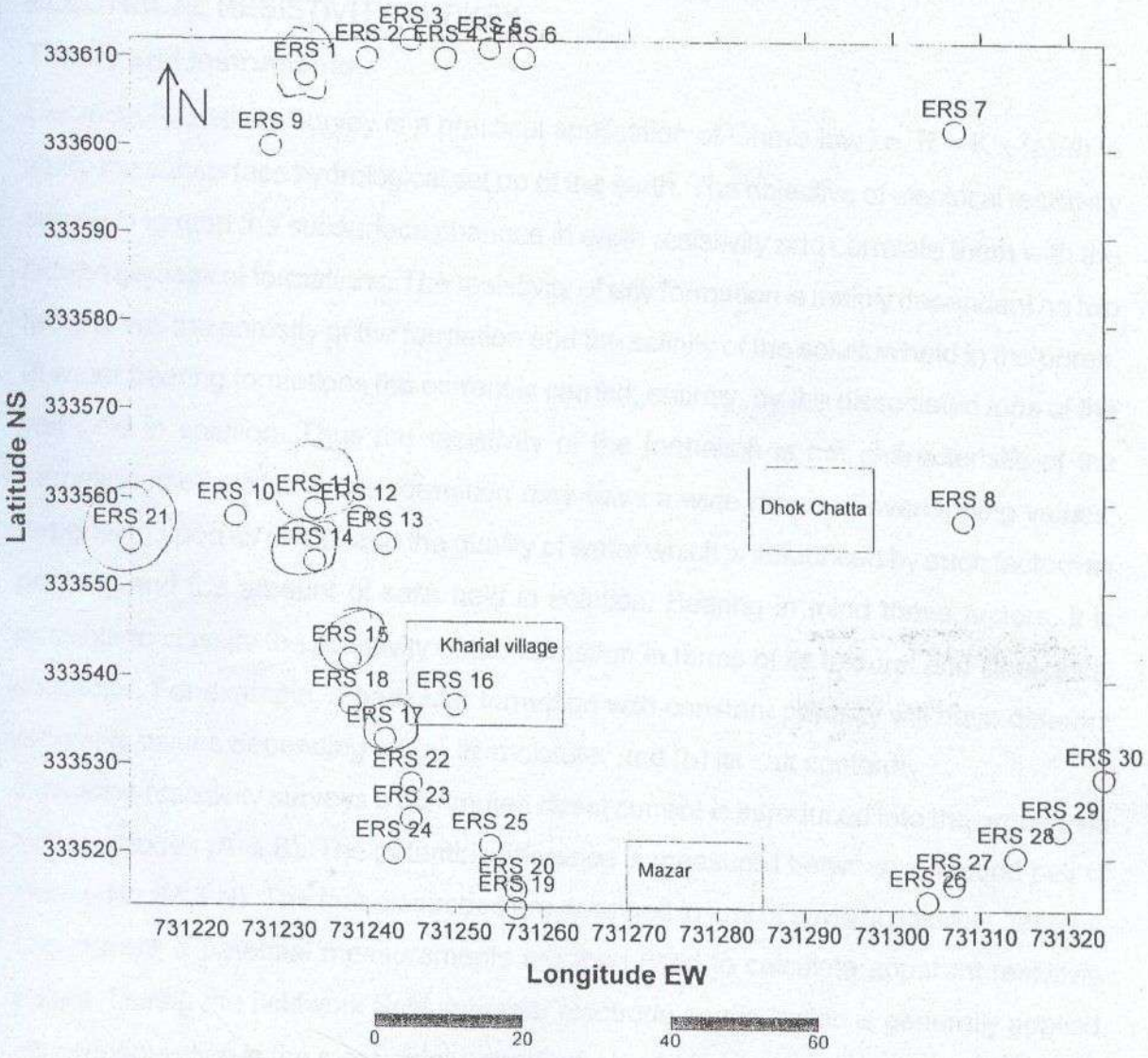
This report furnishes hydrogeological information about the subsoil groundwater aquifers for which geoelectric studies have been carried out at thirty (30) different sites located in Intelligence Bureau Employees Cooperative Housing Society, Islamabad (study started with the courtesy of Mr. Abdul Sattar). Resistivity sites are spread over the entire area of investigation and subsurface information about the lithology, water quality, and discharging capability of the aquifers has been evaluated.

The main objective of this study was to examine the possibility of groundwater, thickness and potential of aquifers, lithological logs of the subsurface material, and to locate appropriate sites for suitable test boring sites. The electrical resistivity sounding (ERS) is numbered as ERS-1, ERS-2, ERS-3, and so on. A table is provided that gives information of the location of sites with corresponding latitude and longitude. These geographical locations are evaluated using global positioning system with reference to the Geodetic System and Datum Indian 1960, Allai Khwar and converted into Lambert System with India Zone 1. A location Map showing the distribution of electrical resistivity sounding stations (ERSS) is also provided.

LOCATIONS OF ERSS SITES AND THEIR LATITUDE/ LONGITUDE, IBECHS			
Resistivity sites	Latitude (North) in degree-min-sec	Longitude (East) in degree-min-sec	Location (elevation above mean sea level)
ERS-1	33-36-08	73-12-33	Near main office 554 m
ERS-2	33-36-08	73-12-33	In east side 553 m
ERS-3	33-36-12	73-12-45	542 m
ERS-4	33-36-10	73-12-49	542 m
ERS-5	33-36-11	73-12-54	548 m
ERS-6	33-36-10	73-12-58	545 m
ERS-7	33-36-02	73-13-07	522 m
ERS-8	33-35-58	73-13-08	521 m
ERS-9	33-36-00	73-12-29	535 m
ERS-10	33-35-58	73-12-25	541 m
ERS-11	33-35-59	73-12-34	532 m
ERS-12	33-35-58	73-12-39	532 m
ERS-13	33-35-55	73-12-42	535 m
ERS-14	33-35-53	73-12-34	530 m
ERS-15	33-35-42	73-12-38	519 m
ERS-16	33-35-37	73-12-50	511 m
ERS-17	33-35-33	73-12-42	514 m
ERS-18	33-35-37	73-12-38	527 m
ERS-19	33-35-14	73-12-57	502 m
ERS-20	33-35-16	73-12-57	502 m
ERS-21	33-35-55	73-12-13	539 m
ERS-22	33-35-28	73-12-45	508 m
ERS-23	33-35-24	73-12-37	507 m
ERS-24	33-35-20	73-12-43	510 m
ERS-25	33-35-21	73-12-54	496 m
ERS-26	33-35-15	73-13-04	497 m
ERS-27	33-35-17	73-13-07	496 m
ERS-28	33-35-20	73-13-14	491 m
ERS-29	33-35-20	73-13-14	499 m
ERS-30	33-35-29	73-13-24	Village Ratyal east of Mazar, 516 m

The Schlumberger electrode configuration was employed extending the electrodes separation to a maximum distance of 200 meters for all the electrical resistivity survey. This has enabled to obtain subsurface soil and water condition in terms of permeable

LOCATION MAP OF INTELLIGENCE BUREAU EMPLOYEES COOPERATIVE HOUSING SOCIETY



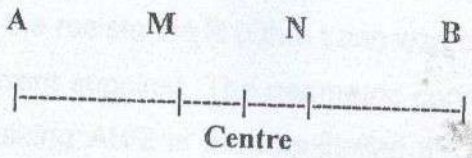
lithology. Raw resistivity data collected from sites were entered in the computer and interpretation done by computer modeling using 1D1X Computer Software and results are also rechecked manually. The interpretative results of the electrical resistivity measurements obtained from modeling are shown as vertical resistivity columns along with modeling results in Appendix.

ELECTRICAL RESISTIVITY SURVEY

Theory and Instruments

Electrical Resistivity Survey is a practical application of Ohm's law i.e. $R = K \times (\Delta V/I)$ to study the subsurface hydrological set up of the earth. The objective of electrical resistivity survey is to map the subsurface changes in earth resistivity and correlate them with the hidden geological formations. The resistivity of any formation is mainly dependent on two factors, viz. the porosity of the formation and the salinity of the solution held in the pores. In water bearing formations the current is carried, entirely, by the dissociated ions of the salt held in solution. Thus the resistivity of the formation is not characteristic of the formation itself and any one formation may have a wide range of overlapping values, depending upon its nature and the quality of water which is influenced by such factors as porosity and the amount of salts held in solution. Bearing in mind these factors, it is possible to classify the resistivity of the formation in terms of its textural and lithological character. For example, a particular formation with constant porosity will have different resistivity values depending on (a) its moisture, and (b) its salt content.

In making resistivity surveys a commuted direct current is introduced into the ground via two electrodes (A & B). The potential difference is measured between a second pair of electrodes (M & N). The four electrodes are arranged in any of several possible patterns. The current & potential measurements are then used to calculate apparent resistivity values. During the fieldwork Schlumberger electrode configuration is generally applied. This configuration is the most widely used in the world for conducting electrical resistivity survey. Four electrodes are placed along a straight line on the earth surface in the order of AM NB with $AB \leq 5\ MN$ (as shown below).



$$R \propto \Delta V/I$$

Or

$$R = K \times \Delta V/I$$

Where:
R = Resistivity; Ohm-meter
ΔV = Voltage (potential drop) milli-volt
I = Current; milli-ampere
K = Constant of proportionality
And

$$K = \pi/2 \frac{(AB/2)^2 - (MN/2)^2}{MN}$$

Where:
π = Constant i.e. 3.14159.
AB= Spacing between the current electrode; meter.
MN= Spacing between potential electrode; meter.

DATA ACQUISITION

ABEM TERRAMETER SAS 300 C, (diagram attached) a highly sensitive and wide measuring range instrument was used for the purpose of data acquisition. Although there are number of electrode configurations used to lay out the electrodes, Schlumberger configuration is the best when used for probing deeper into the ground. Four electrodes were used in the Schlumberger configuration. The current was passed to the ground through two outer electrodes A & B while two inner electrodes M & N were used to measure the potential drop at different points.

The distance between the current electrodes was always kept greater than equal to 5 times the distance between the potential electrodes. The distance of current electrodes was gradually increased to the maximum of 200 meters from the center point while the position of MN was only changed when required.

At each position of A & B the resistance R (Ohm Law) was calculated by dividing the potential drop with the current supplied. The geometric constant K that is evaluated from current electrode spacing AB/2 is then multiplied it. At each position a new geometric constant is calculated to get the apparent resistivity of the subsurface material.

INTERPRETATION OF FIELD DATA

Now-a-days field data have been interpreted by using the software packages, that gives the model interpretation of individual curves stating/reflecting the number of layers, their true resistivity values, thickness and depth from the surface.

These true resistivity values are interpreted/converted into lithologic units by adjusting these values in different resistivity zones indicating the presence of fresh and brackish water and their approximate depths of interface from the ground surface.

Apparent resistivity values are not true representation of the subsurface lithology until they are matched with the theoretical master curves manually or with the computer modeling. Resistivity data was interpreted manually and also by using the Computer Softwares on a microcomputer. Results were compared and adjusted, wherever needed, through an iterative procedure that finally provided a layer model based on true resistivity values. These subsurface layers have been assigned lithological units in terms of their true resistivity values. The vertical columns and computer outputs are also given in the Appendix.

RESULTS & DISCUSSION

From the interpretative results, on-site hydrogeological information and grouping among resistivity points due to similarities and priority basis, the following conclusions and recommendations are made:

The subsurface material in IBECHS is composed of almost similar type of geological material that is composed of sandstone, gravel/sandstone, clay/shale & compact clay. Aquifer appears to contain sandstone & gravel with intercalation of

clayey lenses at places.

Resistivity soundings ERS-1, ERS-11, ERS-14, ERS-15, ERS-17 and ERS-21 are underlain by permeable material in the deeper horizons and appear to have some quantity of groundwater where tube-wells could be sunk. Other ERS sites contain more clayey material in the deeper horizon; hence these sites are not suitable.

RECOMMENDATIONS

IBECHS		
Location	**Proposed Source**	**Recommendation**
33° –36' –08" N 73° -12' –33" E	*Near Main Office (tubewell)*	Tubewell 400-450 feet depth at ERSS-1
33° –35' –59" N 73° -12' –34" E 33° –35' –53" N 73° -12' –34" E 33° –35' –42" N 73° -12' –38" E	*Tubewell Fresh Water*	Tubewell 450 feet depth at ERSS-11, 14, 15
33° –35' –33" N 73° -12' –42" E 33° –35' –55" N 73° -12' –13" E	*Tubewell Fresh Water*	Tubewell 450 feet depth at ERSS-17, 21

INTERPRETED LITHLOGICAL COLUMN

Intilligence Bureau Employees Cooperative Housing Society (IBECHS)

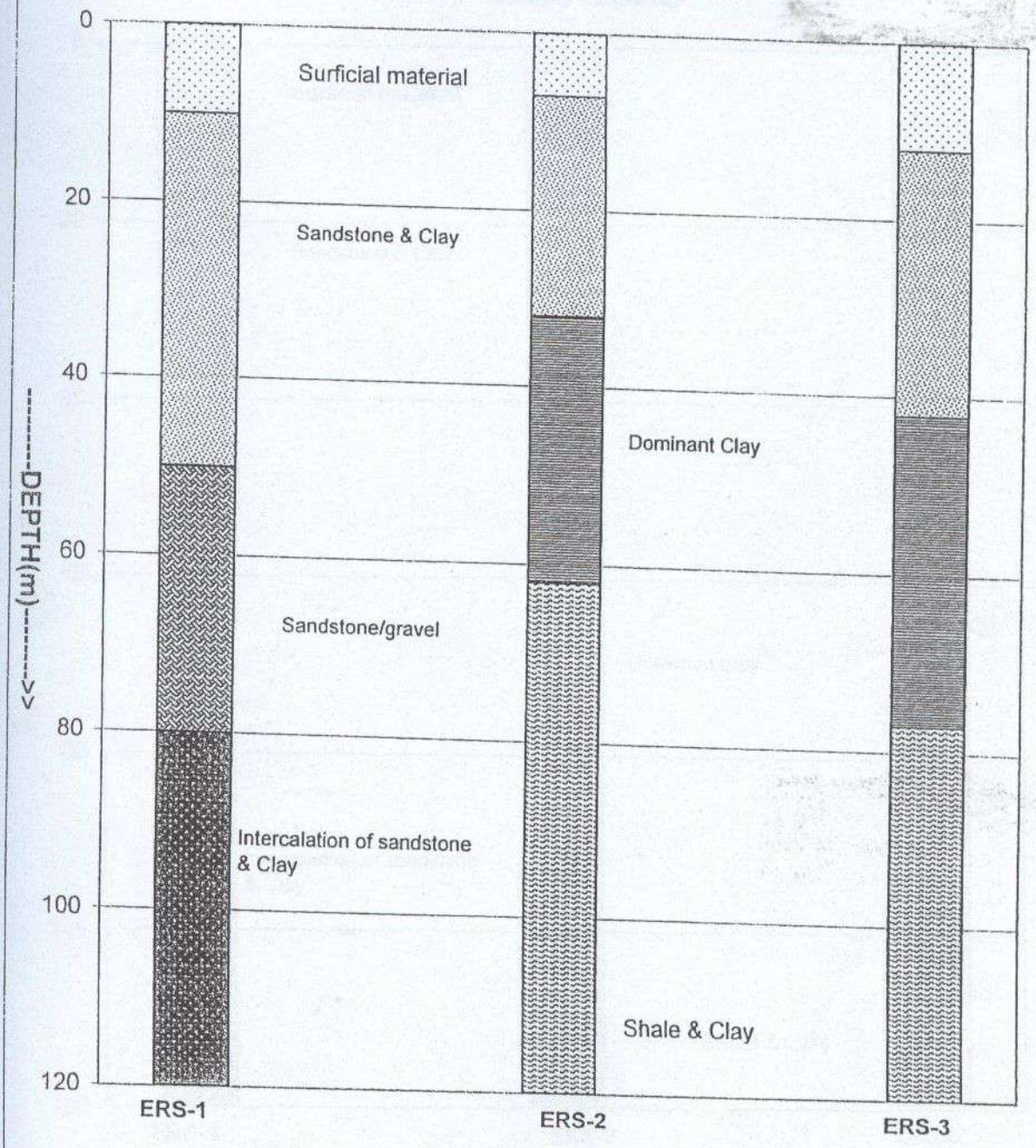


Fig. 1

INTERPRETED LITHLOGICAL COLUMN

Intilligence Bureau Employees Cooperative Housing Society (IBECHS)

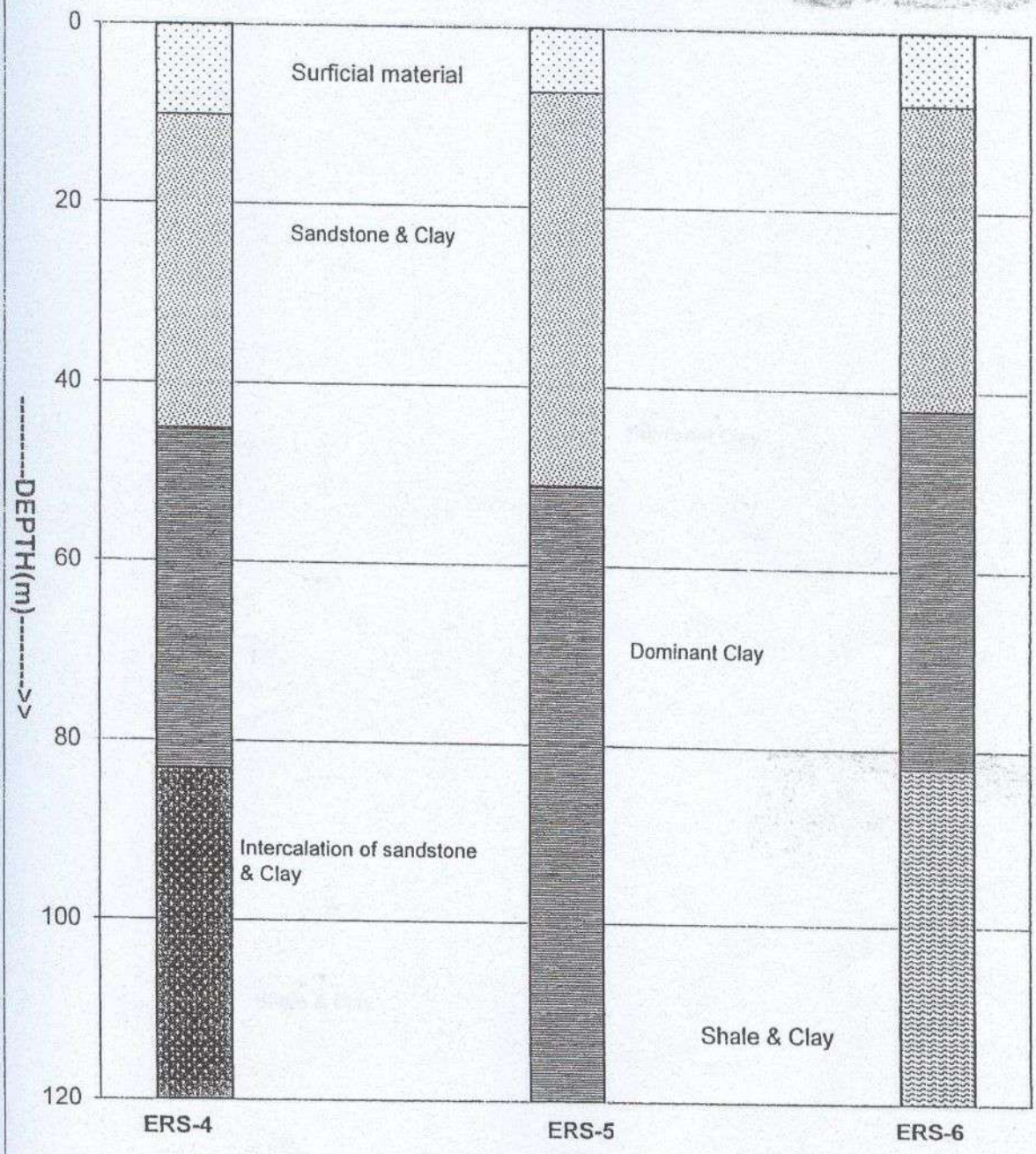


Fig. 2

INTERPRETED LITHLOGICAL COLUMN

Intilligence Bureau Employees Cooperative Housing Society (IBECHS)

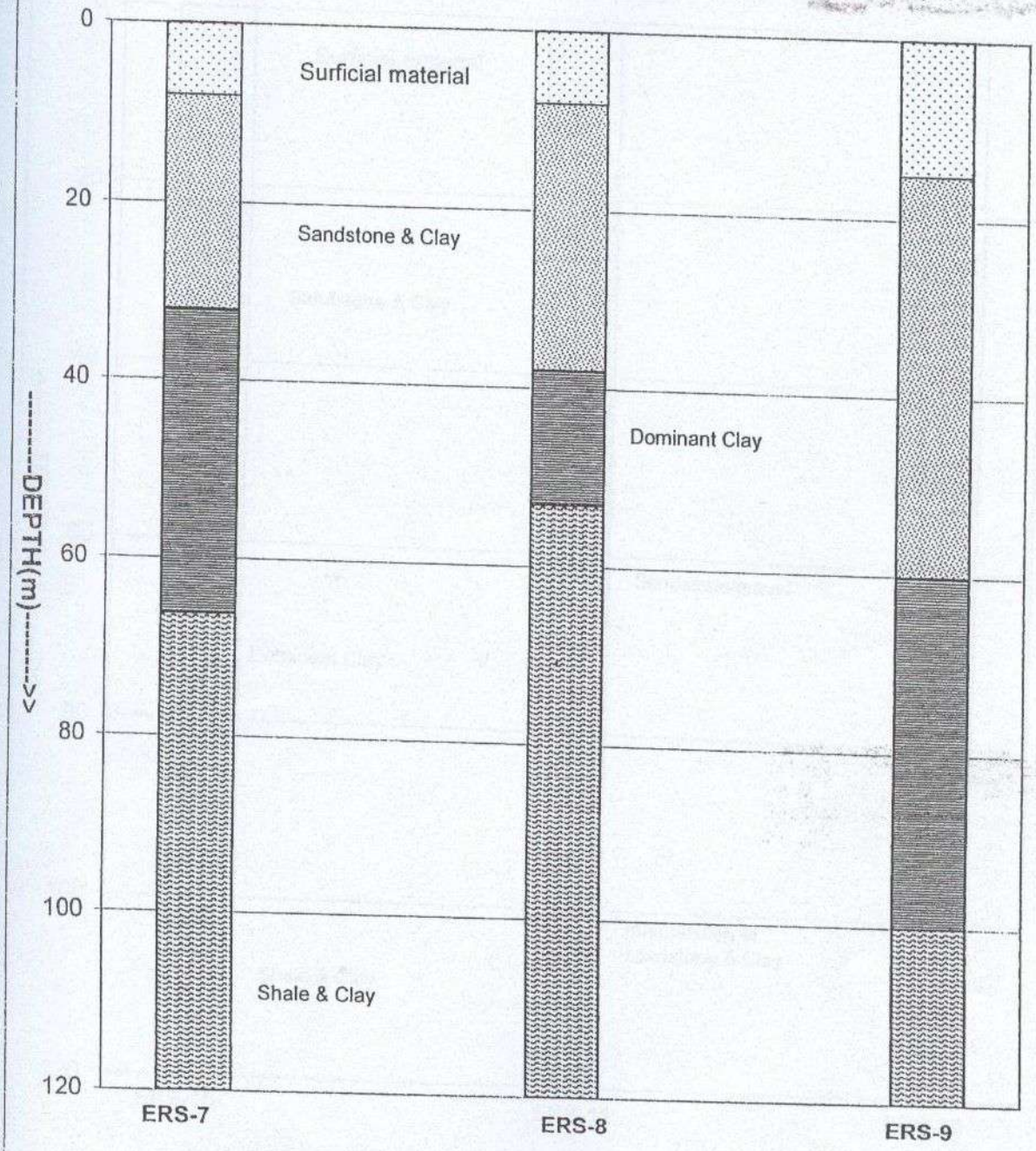


Fig. 3

INTERPRETED LITHLOGICAL COLUMN

Intilligence Bureau Employees Cooperative Housing Society (IBECHS)

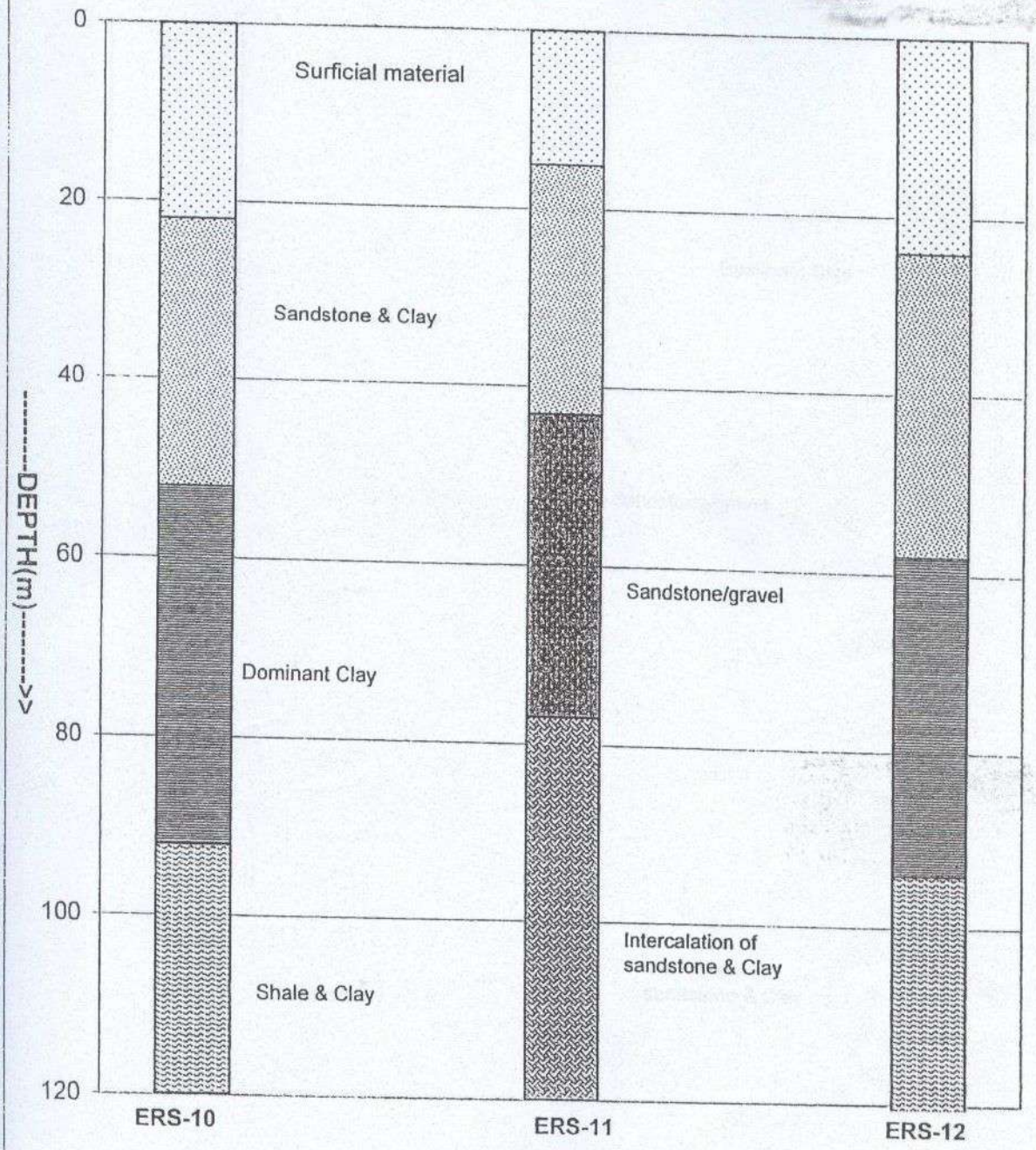


Fig. 4

INTERPRETED LITHLOGICAL COLUMN

Intilligence Bureau Employees Cooperative Housing Society (IBECHS)

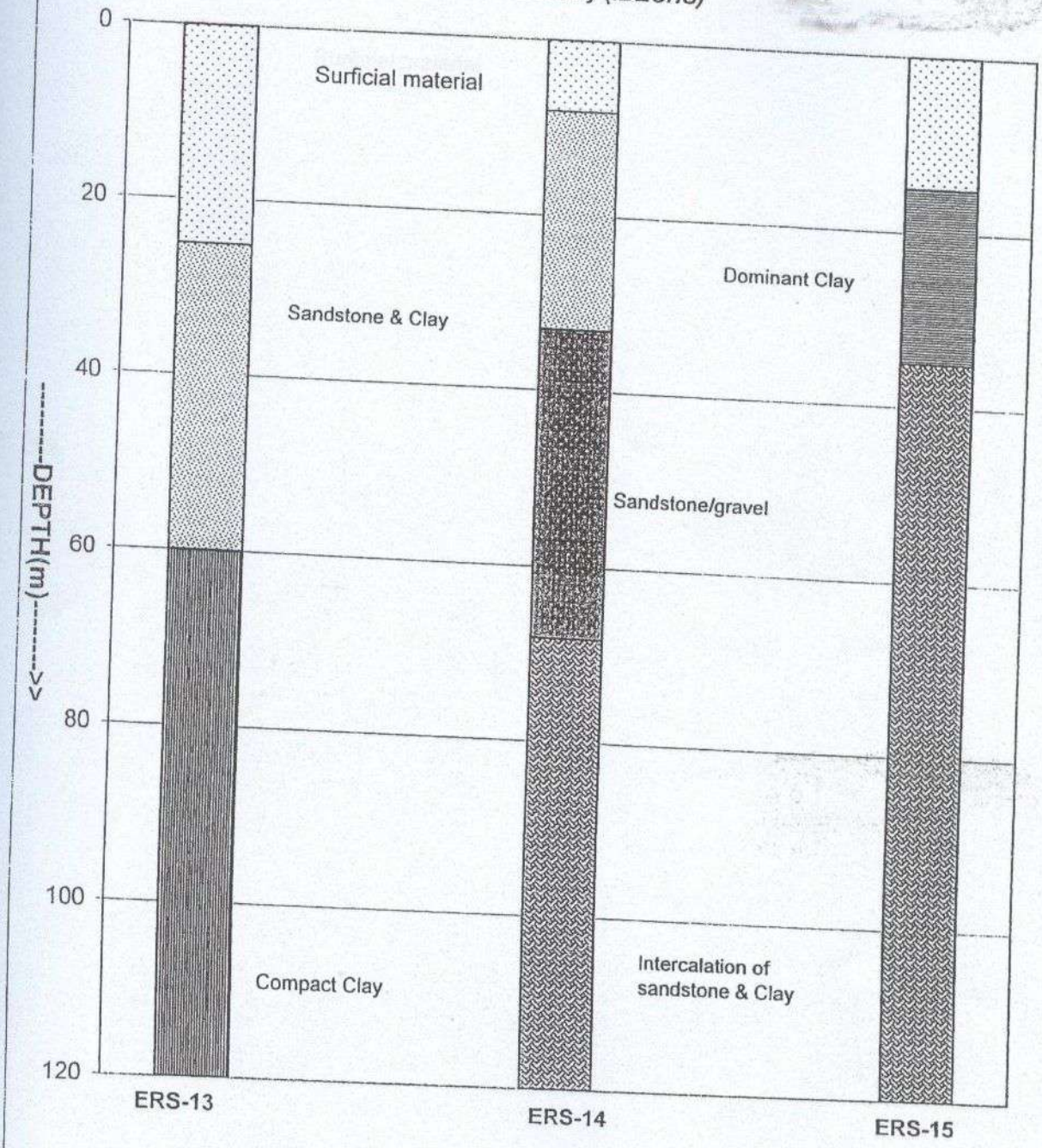


Fig. 5

INTERPRETED LITHLOGICAL COLUMN

Intilligence Bureau Employees Cooperative Housing Society (IBECHS)

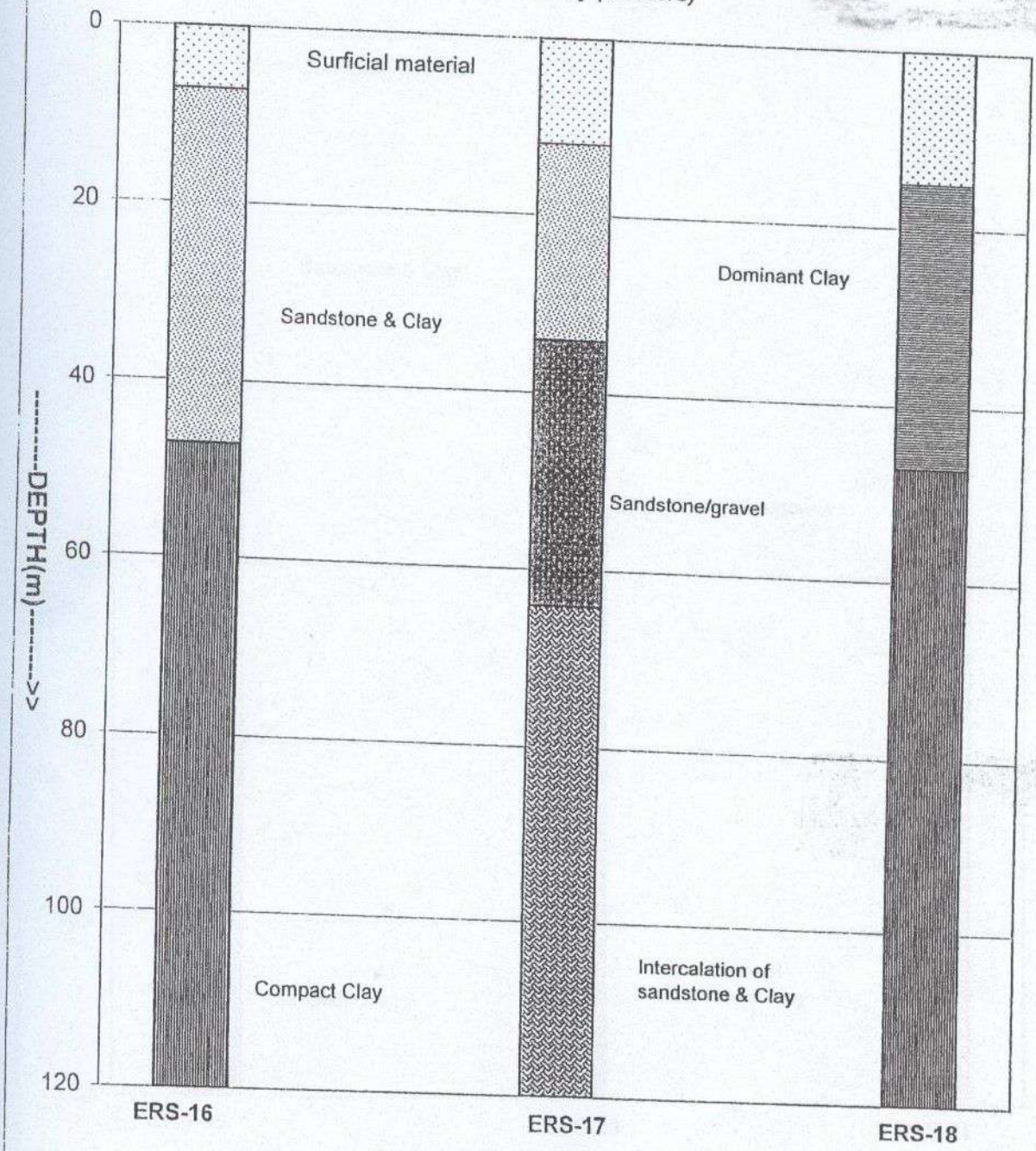


Fig. 6

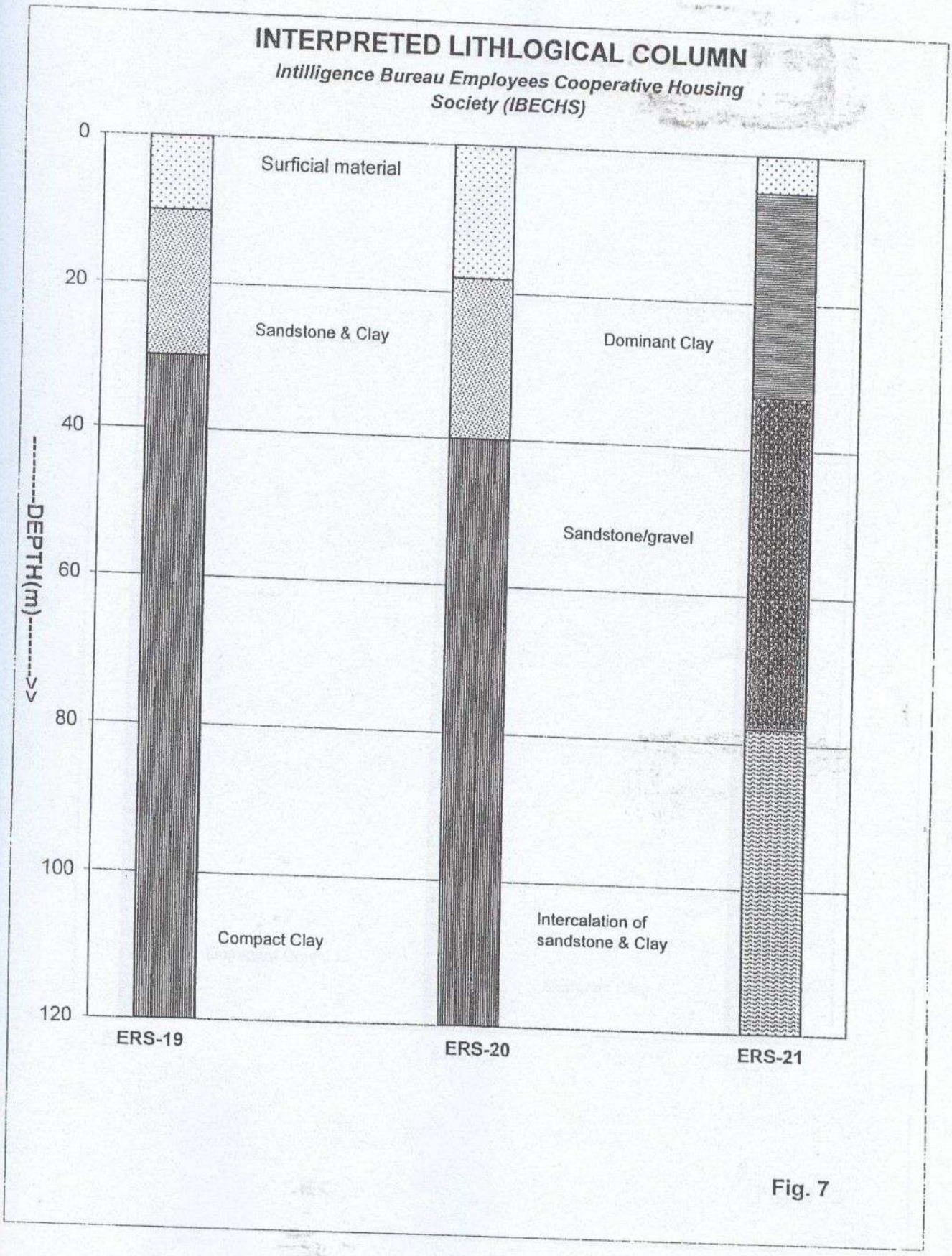

INTERPRETED LITHLOGICAL COLUMN
Intilligence Bureau Employees Cooperative Housing Society (IBECHS)
0
20
40
60
80
100
120
DEPTH(m)
Surficial material
Sandstone & Clay
Compact Clay
Dominant Clay
Sandstone/gravel
Intercalation of sandstone & Clay
ERS-19
ERS-20
ERS-21

Fig. 7

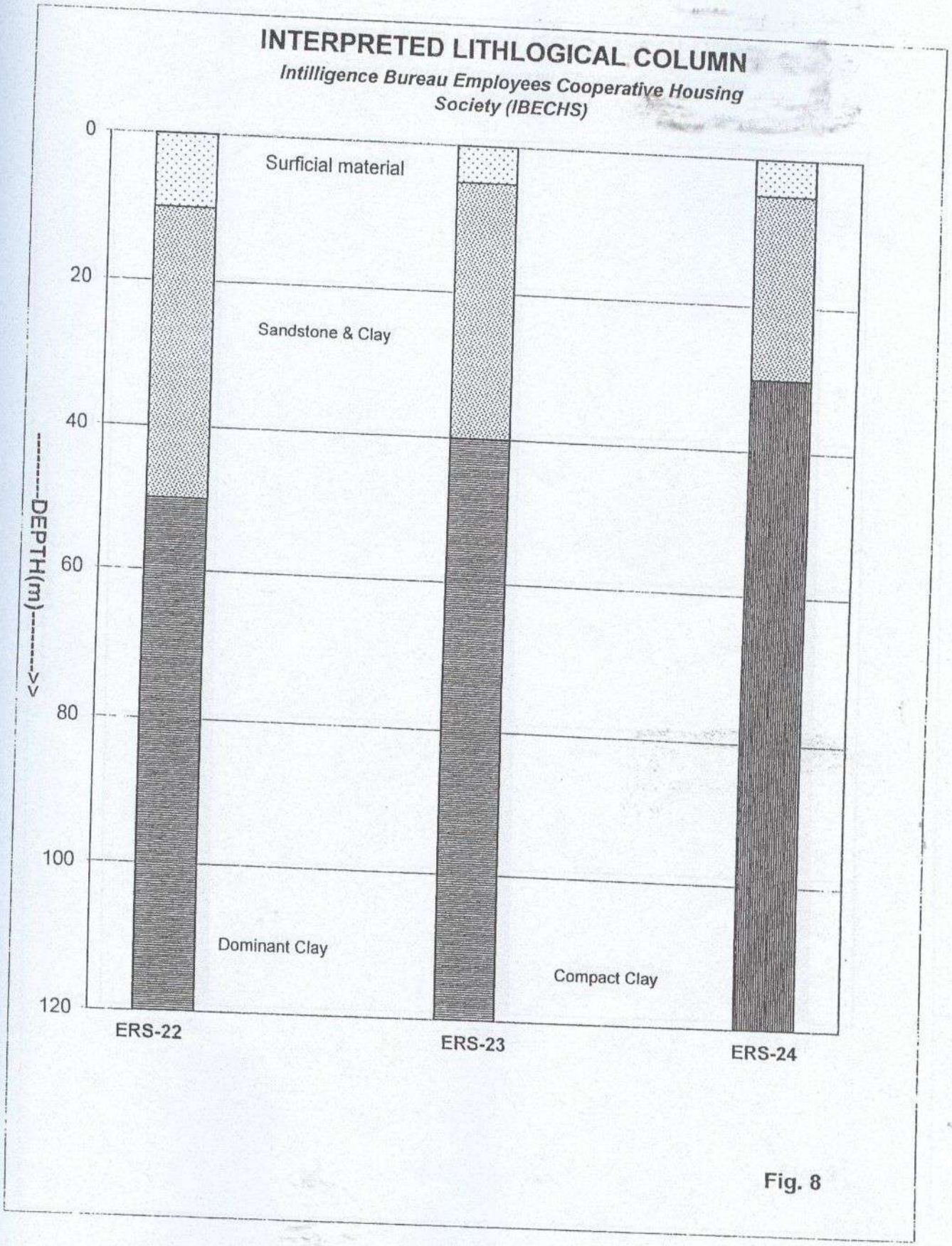

INTERPRETED LITHLOGICAL COLUMN
Intilligence Bureau Employees Cooperative Housing Society (IBECHS)
0
20
40
60
80
100
120
DEPTH(m)
Surficial material
Sandstone & Clay
Dominant Clay
Compact Clay
ERS-22
ERS-23
ERS-24

Fig. 8

INTERPRETED LITHLOGICAL COLUMN

Intilligence Bureau Employees Cooperative Housing Society (IBECHS)

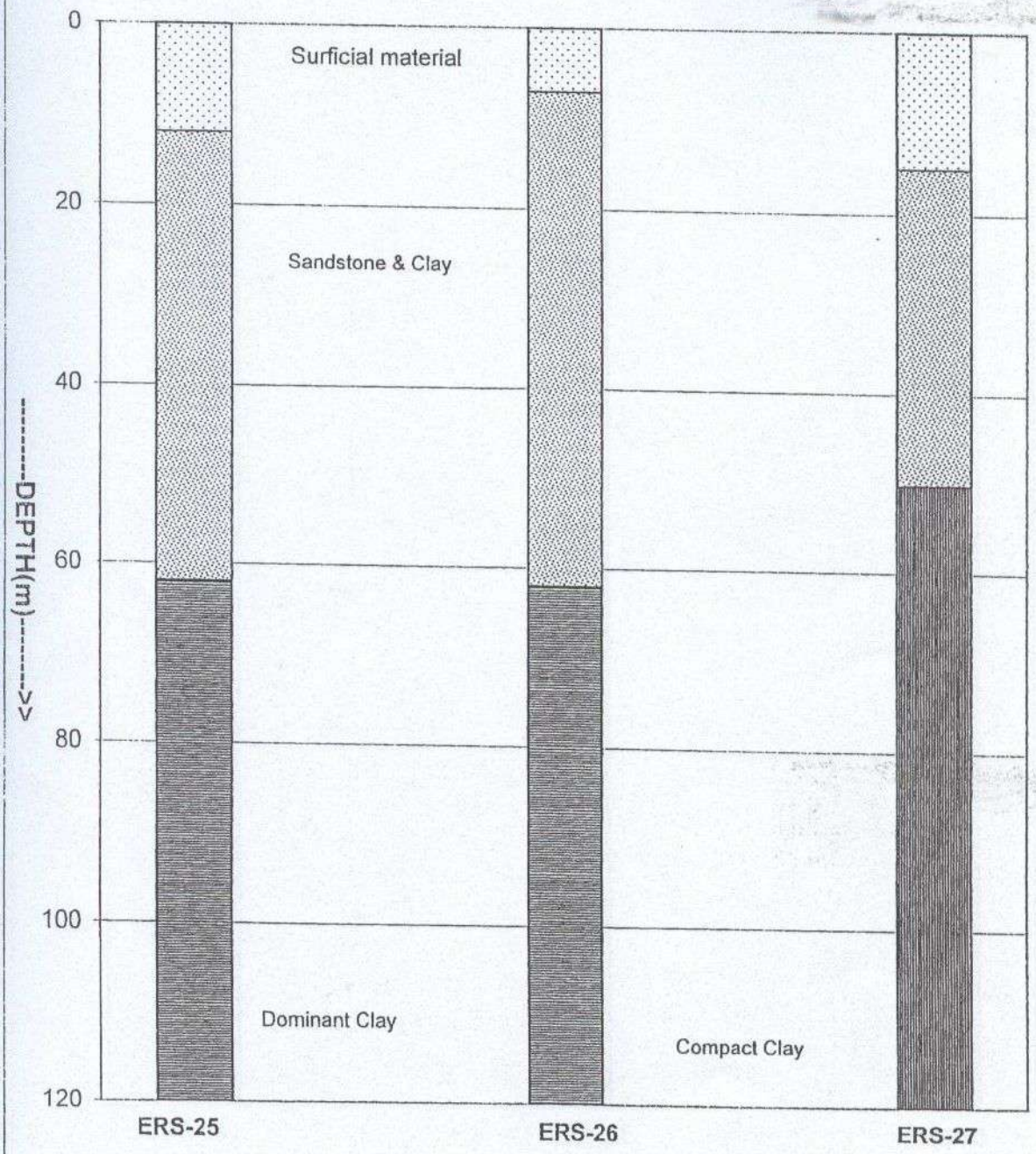


Fig. 9

INTERPRETED LITHLOGICAL COLUMN

Intilligence Bureau Employees Cooperative Housing Society (IBECHS)

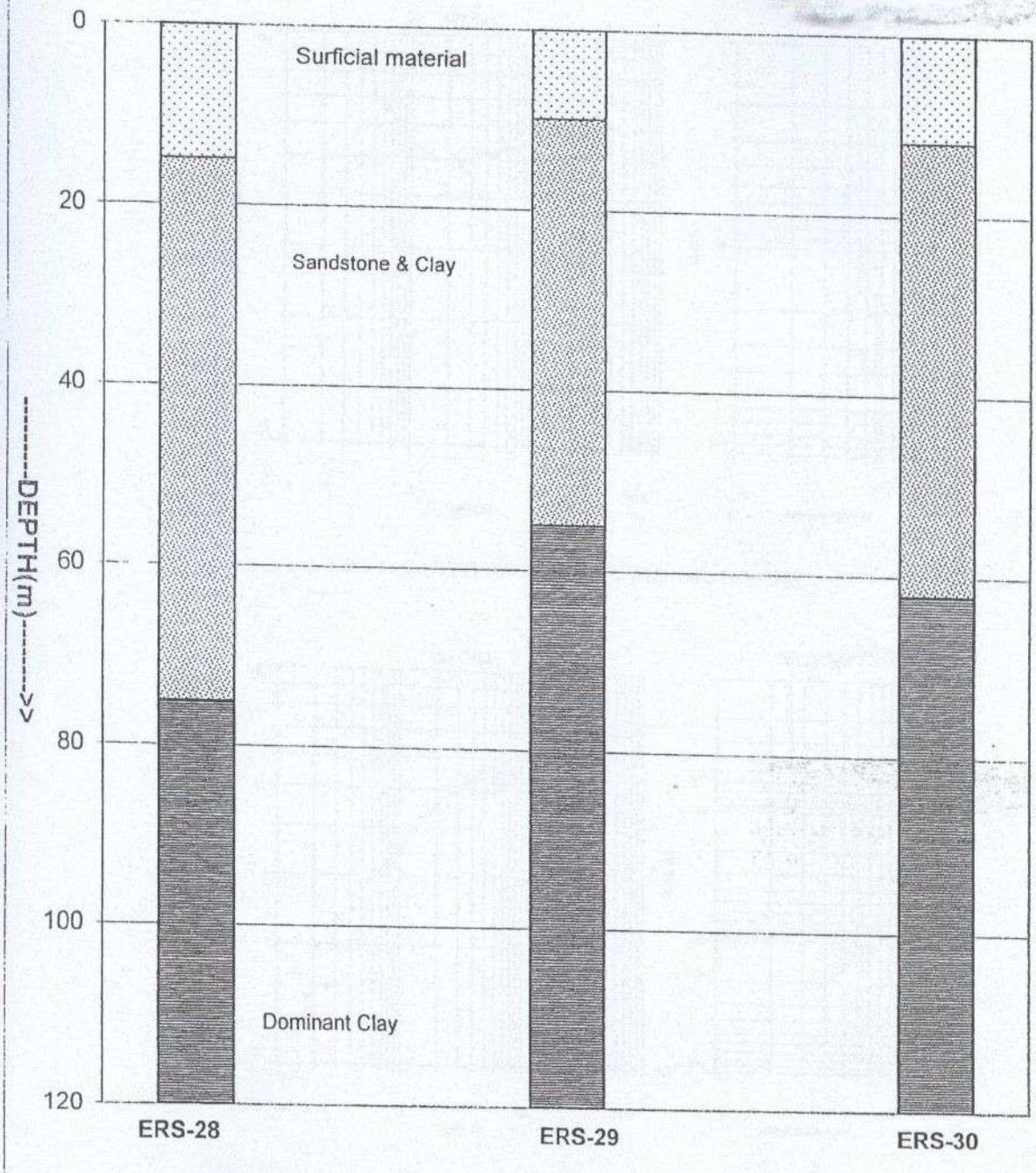
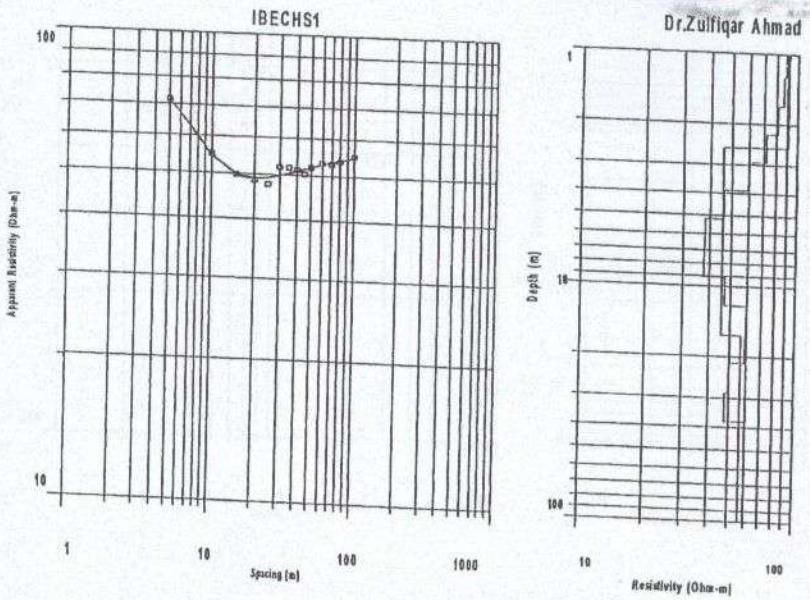
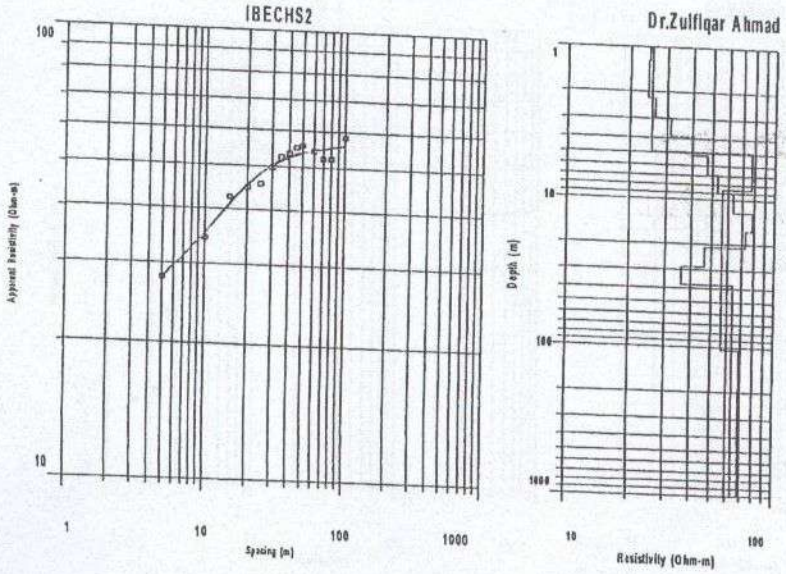


Fig. 10

INTELLIGENCE BUREAU EMPLOYEES COOPERATIVE HOUSING SOCIETY

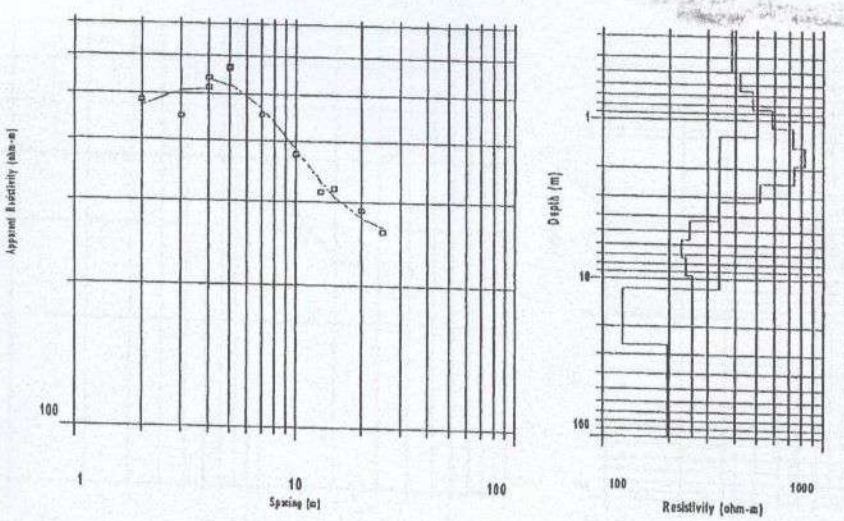


ERS-1: EARTH RESISTIVITY MODEL IBECHS

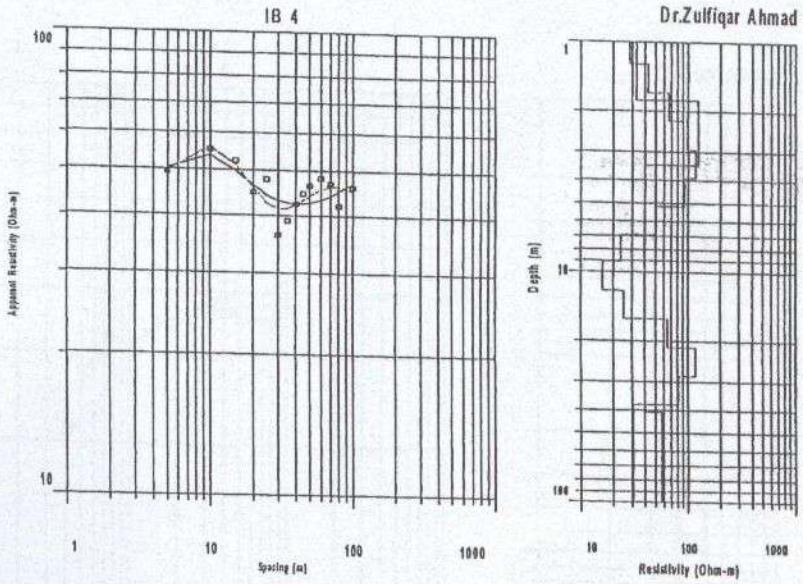


ERS-2 EARTH RESISTIVITY MODEL IBECHS

INTELLIGENCE BUREAU EMPLOYEES COOPERATIVE HOUSING SOCIETY



ERS-3: EARTH RESISTIVITY MODEL IBECHS



ERS-4: EARTH RESISTIVITY MODEL IBECHS

ANNEXURE-J

AQUIFER RECHARGE AND SUSTAINABILITY ANALYSIS

C O N T E N T S

Page / Plan No.

- ❖ INTRODUCTION 1
- ❖ SCOPE OF WORK 1
- ❖ LOCATIONS OF BOREHOLES 2
- ❖ FIELD WORK 2
- ❖ IN-SITU TESTING
  - ➢ STANDARD PENETRATION TEST 3
- ❖ LABORATORY TEST 5
- ❖ NATURE OF SUB-SURFACE 6
- ❖ SUMMARY & RECOMMENDATIONS 10

APPENDICES

- ❖ LOCATIONS OF BOREHOLES ..... Plan No. 4646–01
- ❖ BORE LOGS ..... Plan No. 4646–02/05
- ❖ ABSTRACT DATA ON LABORATORY TESTS RESULT. Plan No. 4646–06/09
- ❖ GRAIN SIZE DISTRIBUTION CURVES ..... Plan No. 4646–10/24
- ❖ UNCONFINED COMPRESSION TEST ..... Plan No. 4646–25/29

REPORT ON SUB-SOIL INVESTIGATION OF THE PROPOSED OVERHEAD & UNDERGROUND WATER TANK AT BLOCK-V, GULBERG-III ISLAMABAD

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Ref. ST/4646/13

Date. 13-03-2013

REPORT ON SUB-SOIL INVESTIGATION OF THE PROPOSED OVERHEAD & UNDERGROUND WATER TANK AT BLOCK-V, GULBERG-III ISLAMABAD

INTRODUCTION:

The IB Employee's Cooperative Housing Society, IBECHS, the Client, is developing a landmark housing project named Gulberg Islamabad located at Islamabad Expressway. Messrs Urban Planning and Design (Pvt) Ltd, Islamabad, is rendering the planning and designing services whereas Messrs Al-Kamal International has been rendering the development services on the said project. As a part of the project, various residential blocks are being developed and to fulfill the Water requirement of these blocks, Overhead and Underground Water Tanks of One Lac Gallons capacity are proposed to be constructed in each block. One such facility is proposed in Block-V. Prior to the structural design and construction of the proposed structures, it is required to carry-out detailed sub-soil investigation of the proposed site. The object of this investigation is to ascertain the allowable bearing capacity of the soil and other geological features to design a safe, sound and an economical foundation for the proposed structures.

For the purpose, the work of sub-soil investigation was entrusted to Messrs SWIS-TECH, Engineers & Contractors, Rawalpindi, by the Developers.

On the basis of field and laboratory work of the proposed site, this detailed report is being submitted respectfully which gives full account of field and laboratory testing activities, describes subsurface conditions and incorporates engineering recommendation regarding the design of foundation of the proposed structures.

SCOPE OF WORK:

The foreseen work was comprised of the following:

1. Drilling of two (2) boreholes of 50-ft depth at the location of Overhead Water Tank and two (2) boreholes of 35-ft depth at the location of Underground Water Tank.
2. Execution of Standard Penetration Test (S.P.T.) at 5-ft interval or as selected by the Geo-technical Engineer.
3. Collection of disturbed and undisturbed soil samples.
4. Execution of necessary laboratory tests.
5. Elaboration and submission of FINAL REPORT stating type of foundation and bearing capacity of soils.

LOCATIONS OF BOREHOLES:

Location of site and boreholes were provided by the Project Manager of Al-Kamal International. Locations of these boreholes can be seen from the appended Plan No. 4646 – 01.

FIELD WORK:

Progress of fieldwork, bore by bore, can be seen from the following table:

Progress of Work

BH. No.	Location	Date of Starting	Date of Completion	Depth
1.	O/H Water Tank	23-01-2013	24-01-2013	50-ft
2.	O/H Water Tank	26-01-2013	27-01-2013	50-ft
3.	U/G Water Tank	28-01-2013	28-01-2013	35-ft
4.	U/G Water Tank	23-01-2013	29-01-2013	35-ft

Standard Penetration Tests were performed at an interval of 5-ft. S.P.T. / disturbed soil samples were collected and preserved for visual inspection and conducting the laboratory testing. All collected samples were properly preserved, labeled and transported to SWIS-TECH laboratory. The entire fieldwork was carried out under the direct supervision of Project Manager and an experienced Geo-technical Engineer on the behalf of the firm.

IN-SITU TESTING:
STANDARD PENETRATION TEST:

The standard penetration test (ASTM D – 1586) is a sounding method of sub-surface exploration with the general purpose of evaluating the characteristics, firmness and density of soils. Besides the empirical application of foundation investigation another important advantage of this test is that a sample is retained for visual inspection, classification or laboratory testing. The sampler is also called a split spoon, consists of a thick walled steel tube, split lengthwise. To the lower end is attached a cutting shoe, to the upper end, a check valve and connector to the drill rods. The standard size $1^{3}/_{8}$ in. ID and 2 in. OD, is generally used. The hole is drilled upto the desired depth or until a change in the soil is detected. The drill tool is removed and the sampler lowered to the bottom of the hole. It is first driven 6 in. into the soil to ensure that the cutting edge is seated in virgin material. It is then driven 12 in. in 6 in. increments with a 63.5 kg (140 lbs) hammer of falling 30 in. The number of blows for each 6 in. of penetration is recorded. The standard penetration resistance, N, is the sum of the second and third increments.

S.P.T. blows and N-values as encountered at site in four (4) boreholes are given on appended Bore Logs and also on the following page for a quick reference and comparison:

COMPARISON OF S.P.T. BLOWS & N-VALUES ENCOUNTERED AT SITE IN '4' BOREHOLES

Depth	BH – 1		BH – 2		BH – 3		BH – 4	
	SPT Blows	N-Value	SPT Blows	N-Value	SPT Blows	N-Value	SPT Blows	N-Value
5'-0"	6 + 6 + 9	15	4 + 11 + 24	35	7 + 7 + 7	14	3 + 3 + 3	6
10'-0"	50/4"	Refusal	50/2"	Refusal	6 + 10 + 15	25	4 + 6 + 8	14
15'-0"	50/3"	Refusal	50/2"	Refusal	26 + 50/5"	Refusal	15 + 22 + 40	62
20'-0"	20/0	Refusal	50/3"	Refusal	50/5"	Refusal	18 + 35 + 50/3"	Refusal
25'-0"	50/4"	Refusal	Not conducted	-	50/5"	Refusal	50/4"	Refusal
30'-0'	50/2"	Refusal	50/3"	Refusal	50/5"	Refusal	50/2"	Refusal
35'-0"	50/4"	Refusal	Not conducted	-	50/2"	Refusal	50/2"	Refusal
40'-0"	50/2"	Refusal	50/2"	Refusal	-	-	-	-
45'-0"	50/2"	Refusal	20/1"	Refusal	-	-	-	-
50'-0"	50/2"	Refusal	50/3"	Refusal	-	-	-	-

LABORATORY TEST:

The laboratory tests on the selected soil samples were performed on the basis of sub-soil encountered at the site to classify sub-soil properly and to obtain the design parameters for the determination of soil bearing capacity. Following laboratory tests were conducted in the laboratory:

1. Natural Moisture Content.
2. Grain Size Distribution by Sieve Analysis.
3. Grain Size Distribution by Hydrometer Analysis.
4. Atterberg's Limits.
5. Bulk Density.
6. Unconfined Compression Test.

The above tests were performed in the SWIS-TECH laboratory under the supervision of Mr. Rais Agha, B.E. (Civil), as per ASTM and AASHTO standard procedures of testing. Results of the same are appended in the report as Abstract Data On Laboratory Test Results Plan No: 4646 – 06/09.

NATURE OF SUB-SURFACE:

Total Four (4) boreholes are located at the proposed site, two each at the locations of Underground and Overhead Water Tank. BH-1 and BH-2 are located at the proposed site for Overhead Tank and drilled upto 50-ft depth and BH-3 and BH-4 are located at the site of Underground Tank and drilled upto 35-ft. These both sites are located at the junction of V-6 (40-ft) and V-9 (40-ft) roads in Block-V of Gulberg-III. Locations of these boreholes can be seen from the appended location plan No. 4646 - 01. This site has an almost plain topography and Reduced Level for these boreholes has been taken as 883.00 as provided by the Project manager. The study of Bore Logs, field and laboratory test results reveals variable sub-soil conditions at such small distances and clearly suggests a need of thorough and proper investigations all around in this area. However, mostly sub-soils are highly suitable for the direct placement of foundation, which are explained as follows:

BH - 1:

0'-0" / 7'-0":	Light brown to brown, dry to slightly moist, SILTY CLAY followed by light brown to brown, dry to slightly moist, low plastic, SANDY SILTY CLAY (CL-ML) trace clay nodules.
7'-0" / 20'-0":	Slightly brownish grey to grey, slightly moist, poorly-cemented, fine-grained, SILTY SAND (SM) near to soft SANDSTONE. High fine content (40 – 44%). High slaking stratum; dissolved in water easily.
20'-0" / 24'-0":	Brownish grey, dry, soft, SANDSTONE.
24'-0" / 30'-0":	Slightly brownish grey to grey, poorly-cemented, fine to medium grained, SILTY SAND (SM) near to soft SANDSTONE. High slaking stratum.
30'-0" / 31'-0":	Greyish brown, fine-grained, soft, SANDSTONE. High slaking.
31'-0" / 40'-0":	Slightly brownish grey to grey, poorly-cemented, fine grained, SILTY SAND (SM) near to soft SANDSTONE. High slaking stratum.
40'-0" / 41'-0":	Greyish brown, slightly moist, fine-grained, SANDSTONE.
41'-0" / 44'-0":	Greyish brown to slightly reddish brown, slightly moist, fine-grained, SANDSTONE.
44'-0" / 50'-0":	Grey, slightly moist, fine-grained, soft, SANDSTONE upto 47'-0" and thereafter, brown, slightly moist, soft, fine-grained, silty SANDSTONE; becomes, greenish grey, soft, CLAYSTONE at 50-ft.

BH - 2:

0'-0" / 6'-0": Light brown to slightly yellowish brown, dry to slightly moist, soft, SILTY CLAY.

6'-0" / 10'-0": Light brown to slightly yellowish brown, dry to slightly moist, very hard and compacted, low plastic, SANDY SILTY CLAY (CL-ML) near to SILTSTONE.

10'-0" / 15'-0": Brown, soft to medium hard, SANDY SILTSTONE. High slaking rock; easily dissolvable in water.

15'-0" / 17'-0": Brown to slightly greyish brown, medium hard, fine-grained, SANDSTONE. Non-slaking rock.

17'-0" / 25'-0": Greyish brown, dry, very hard and compacted, low to low-medium plastic, SANDY SILT (ML) near to SILTSTONE. High slaking.

25'-0" / 27'-0": Brown to slightly greyish brown, soft, fine-grained, silty SANDSTONE. High fine content (40%). High slaking rock.

27'-0" / 35'-0": Almost same rock as above, but relatively softer: Brown to slightly greyish brown, slightly moist, soft, fine-grained, silty SANDSTONE. High slaking.

35'-0" / 39'-0": Same stratum as above, but relatively much harder i.e. Brown to slightly greyish brown, medium hard, fine-grained, silty SANDSTONE. Partial slaking rock.

39'-0" / 45'-0": Greyish brown, soft to medium hard, SANDY SILTSTONE. High slaking.

45'-0" / 50'-0": Greyish brown, soft to medium hard, fine-grained, SANDSTONE. High slaking rock.

BH - 3:

0'-0" / 10'-0": Brown to slightly reddish brown, slightly moist, stiff, low plastic, SILTY CLAY with sand (CL-ML) trace clay nodules.

10'-0" / 15'-0": Brown to slightly yellowish brown, dry to slightly moist, very stiff to medium hard, low plastic, SANDY SILTY CLAY (CL-ML) trace to little gravel & clay nodules.

15'-0" / 20'-0": Brown to slightly yellowish brown, dry, very hard, low plastic, LEAN CLAY with sand (CL) trace clay nodules. Vertical thin beds of grey sand. Horizontally weak joints.

20'-0" / 25'-0": Brown to slightly yellowish brown, dry, very hard, low plastic, SANDY SITLY CLAY (CL-ML) near to claystone. Tiny wormholes are present.

25'-0" / 30'-0": Brown to yellowish brown, dry, very hard, low plastic, SILTY CLAY with sand (CL-ML). Thin beds of Sandstone are also found.

30'-0" / 35'-0": Greyish brown, slightly moist, very dense near to poorly-cemented, fine-grained, SILTY CLAYEY SAND (SC-SM).

BH - 4:

0'-0" / 9'-0": Brown to slightly yellowish brown, slightly moist, soft to firm, low plastic, LEAN CLAY (CL) trace sand.

9'-0" /15'-0": Reddish brown, slightly moist, stiff, medium plastic, SITL (ML) trace sand & fine clay nodules.

15'-0" / 20'-0": Reddish brown, dry to slightly moist, very hard, medium plastic, SANDY SILT (ML) trace clay nodules.

20'-0" / 23'-0": Reddish brown, dry, very hard, low to low-medium plastic, LEAN CLAY with sand (CL). Thin beds of grey colour sand are also found.

23'-0" / 30'-0": Brown to slightly yellowish brown, dry, very hard, low plastic, LEAN CLAY with sand (CL) near to CLAYSTONE. High slaking.

30'-0" / 35'-0": Brown, dry to slightly moist, soft, Sandy CLAYSTONE. Colour of rock changes at 35'-0" becomes reddish brown. High slaking rocks; easily dissolvable.

GROUND WATER TABLE:

Ground Water Table is not encountered in any of four boreholes upto the drilled depth.

SUMMARY & RECOMMENDATIONS:

- Total Four (4) boreholes were selected at the proposed site, two each at the locations of Underground and Overhead Water Tank. BH-1 and BH-2 were located at the proposed site for Overhead Tank and drilled upto 50-ft depth each, whereas BH-3 and BH-4 were located at the site of Underground Tank and drilled upto 35-ft. These both sites are located at the junction of V-6 (40-ft) and V-9 (40-ft) roads in Block-V of Gulberg-III. Locations of these boreholes can be seen from the appended location plan No. 4646 - 01. This site has an almost plain topography and Reduced Level for these boreholes has been taken as 883.00 ft as provided by the Project manager.

- The study of Bore Logs, field and laboratory test results reveals variable sub-soil conditions at such small distances and clearly suggests a need of thorough and proper investigations all around whenever required in this area. However, at this particular site, mostly sub-soils are highly suitable for the direct placement of foundation.

- Generally RAFT foundation is adopted for Overhead and Underground Water Tank with its certain advantages over other types of foundations. There is no substitute of RAFT for underground tank and it must be provided at the proposed site as well. Recommendations about safe allowable bearing capacities will be given later. However, for Overhead Tanks, other types of foundations may also be adopted depending on design requirements and of course soil conditions. Compression of soil is a primary requirement of all foundations, but legs of elevated water tanks are subjected to uplift or tension forces. Uplift may be the principal mode of resistance or may be among several possible load combinations. Drilled shafts with or without enlarged base are most commonly used to resist uplift because they are the safest foundations in compression as well as in uplift or tension. In special cases, they may be most economical also. In case of shallow foundations, most Tension Foundations are either round or square. Whatever be the selected foundation, it must be checked against uplift or tension. In the worst case i.e. for loose soils, a satisfactory design can be achieved by using only the weight of footing plus the weight of the soil that will be uplifted when the base is pulled up.

- On the basis of the worst soil conditions present at site and in the light of the above discussion, it is recommended to adopt following as the safe net allowable bearing capacity:

OVERHEAD & UNDERGROUND WATER TANK

Depth of RAFT from Existing Ground Level	Reduced Level	Net Allowable Bearing Capacity
10'-0"	873.00 ft	1.00 Tonne/ft^2
12'-6"	870.50 ft	1.50 Tonne/ft^2
15'-0"	868.00 ft	2.00 Tonne/ft^2

- As mentioned previously, uplift resistance heavily depends upon weight of foundation plus the weight of the soil that will be uplifted when the base is pulled up, thus, all re-fill material must be compacted under the controlled engineering practices. For guidance, this can be said that all Re-fill material must be placed in loose 8" layers with proper compaction i.e. at least upto 95% of the maximum dry density obtained in a soil laboratory from Proctor Test at optimum moisture content. Re-fill soils around and above the footings upto floor level with the proper compaction wherever required. This is essential.

- Sub-soil conditions at this site are such that vertical stability of cuts will not be any problem, but still some care will be required in foundation excavation, particularly during rains.

- Concrete floor at the Ground surface and also a concrete apron, at least 5-ft wide, must be provided along the outside perimeter of the proposed underground tank and at least 10-ft along the outside perimeter of the proposed Overhead tank to avoid any ingress of surface or rain water. For the same reason, proper arrangement for overflowing water is must.

- ❖ Proper lean concrete must be placed under the proposed foundations and before laying it all loose excavated material must be removed.
- ❖ Depth and Size of the proposed foundation must be checked against seismic loads, uplift forces or overturning moments.

Engr. Rais Agha
B.E. Civil; P.E. (Pak.)
Civil / 12099

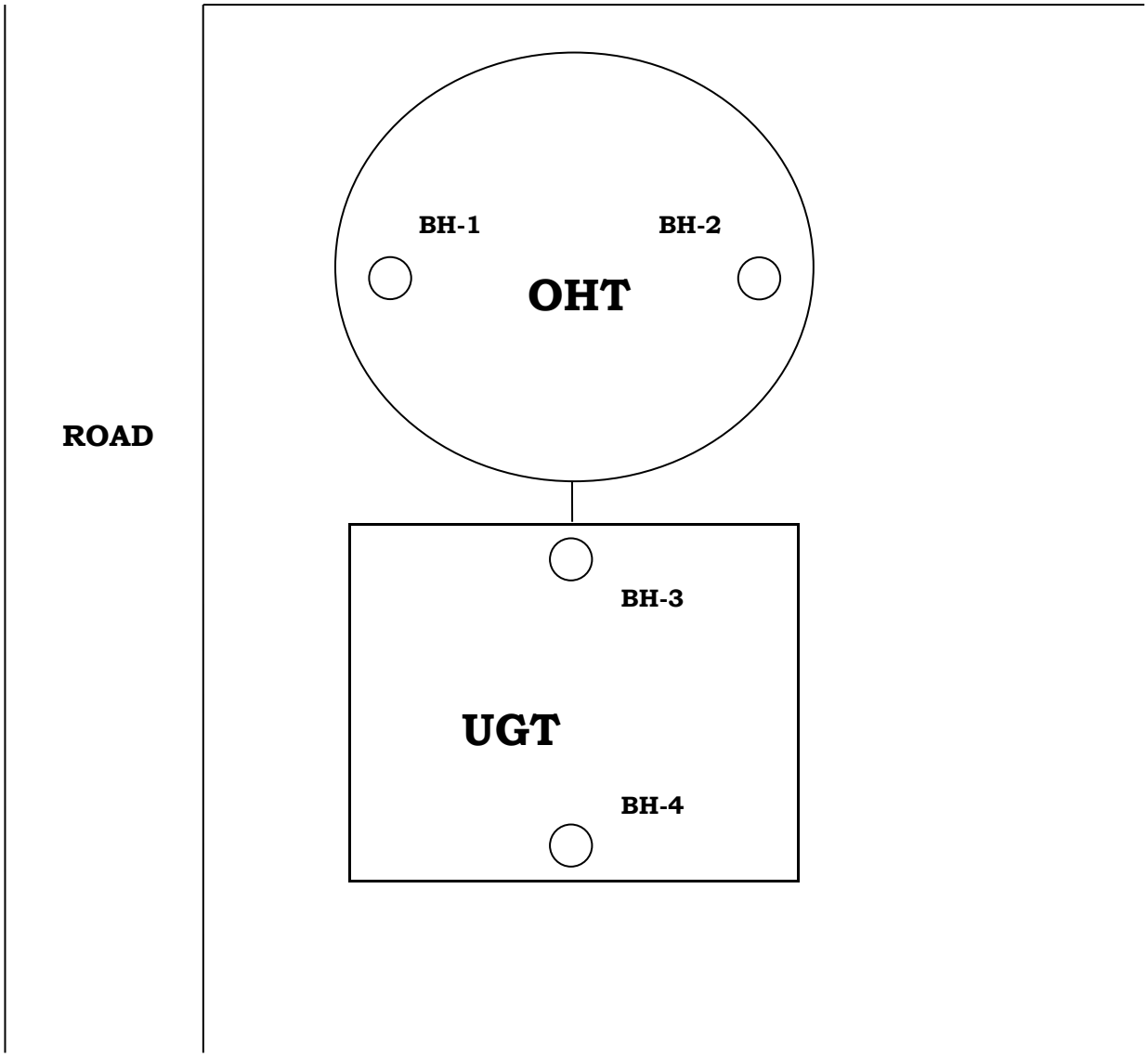
SWIS-TECH
Engineers & Contractors
Rawalpindi.

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

PROPOSED OVERHEAD & UNDERGROUND WATER TANK AT BLOCK-V, GULBERG-III ISLAMABAD



Locations of Boreholes

SWIS-TECH
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PLAN NO. 4646 - 01

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

Location: Overhead Tank **BH. No: 1 (1/2)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 883.00 ft										
23-01-2013	879.0	4'-0"	4'-0"	Light brown to brown, dry to slightly moist, SILTY CLAY.		6" DIA PERCUSSION DRILLING	6 + 6 + 9	5			
	876.0	7'-0"	3'-0"	Light brown to brown, dry to slightly moist, low plastic, SANDY SILTY CLAY (CL-ML) trace clay nodules.			N = 15				
	863.0	20'-0"	13'-0"	Slightly brownish grey to grey, slightly moist, poorly-cemented, fine-grained, SILTY SAND (SM) near to soft SANDSTONE. High fine content (40 – 44%). High slaking stratum; dissolved in water easily.			50/4"	10			
							Refusal				
							50/3"	15			
							Refusal				
							20/0	20			
24-01-2013	859.0	24'-0"	4'-0"	Brownish grey, dry, soft, SANDSTONE.			Refusal				
	853.0	30'-0"	6'-0"	Slightly brownish grey to grey, poorly-cemented, fine to medium grained, SILTY SAND (SM) near to soft SANDSTONE. High slaking stratum.			50/4"	25			
							Refusal				
							50/2"	30			
	852.0	31'-0"	1'-0"	Greyish brown, fine-grained, soft, SANDSTONE. High slaking.			Refusal				
	848.0	35'-0"	4'-0"	Slightly brownish grey to grey, poorly-cemented, fine grained, SILTY SAND (SM) near to soft SANDSTONE. High slaking stratum.			50/4"	35			
							Refusal				

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ENGINEERS & CONTRACTORS
Rawalpindi

G.W.T. is not encountered upto the drilled depth.

PLAN NO. 4646 – 02 (1/2)

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

Location: Overhead Tank **BH. No: 1 (2/2)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 848.0 ft										
24-01-2013	843.0	40'-0"	5'-0"	Same stratum as above i.e. slightly brownish grey to grey, poorly-cemented, fine grained, SILTY SAND (SM) near to soft SANDSTONE. High slaking stratum.		6" DIA PERCUSSION DRILLING	50/2"	40			
	842.0	41'-0"	1'-0"	Greyish brown, slightly moist, fine-grained, SANDSTONE.			Refusal				
	839.0	44'-0"	3'-0"	Greyish brown to slightly reddish brown, slightly moist, fine-grained, SANDSTONE.			50/2"	45			
	836.0	47'-0"	3'-0"	Grey, slightly moist, fine-grained, soft, SANDSTONE.			Refusal				
	833.0	50'-0"	3'-0"	Brown, slightly moist, soft, fine-grained, silty SANDSTONE, which becomes, greenish grey, soft, CLAYSTONE at 50-ft.			50/4"	50			
				END OF BOREHOLE			Refusal	55 60 65 70			

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G.W.T. is not encountered upto the drilled depth.

PLAN NO. 4646 – 02 (2/2)

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

DEVELOPMENT OF IBECHS GULBERG-III, ISLAMABAD
PROPOSED OVERHEAD & UNDERGROUND WATER TANK
BLOCK-V, GULBERG, ISLAMABAD

Location: Overhead Tank **BH. No: 2 (1/2)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 883.00 ft										
26-01-2013	877.0	6'-0'	6'-0"	Light brown to slightly yellowish brown, dry to slightly moist, soft, SILTY CLAY.		6" DIA PERCUSSION DRILLING	4 + 11 + 24 N = 35	5			
	873.0	10'-0"	4'-0"	Light brown to slightly yellowish brown, dry to slightly moist, very hard and compacted, low plastic, SANDY SILTY CLAY (CL-ML) near to SILTSTONE.			50/2"	10			
	868.0	15'-0"	5'-0"	Brown, soft to medium hard, SANDY SILTSTONE. High slaking rock; easily dissolvable in water.			Refusal 50/2"	15			
	866.0	17'-0"	2'-0"	Brown to slightly greyish brown, medium hard, fine-grained, SANDSTONE. Non-slaking rock.			Refusal				
	858.0	25'-0"	8'-0"	Greyish brown, dry, very hard and compacted, low to low-medium plastic, SANDY SILT (ML) near to SILTSTONE. High slaking.			50/3" Refusal SPT was not conducted	20 25			
	856.0	27'-0"	2'-0"	Brown to slightly greyish brown, soft, fine-grained, silty SANDSTONE. High fine content (40%). High slaking rock.							
27-01-13	848.0	35'-0"	8'-0"	Almost same rock as above, but relatively softer: Brown to slightly greyish brown, slightly moist, soft, fine-grained, silty SANDSTONE. High slaking.			50/3" Refusal SPT was not conducted	30 35			

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Rawalpindi

G.W.T. is not encountered upto the drilled depth.

PLAN NO. 4646 – 03 (1/2)

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

Location: Overhead Tank **BH. No: 2 (2/2)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 848.00 ft										
27-01-2013	844.0	39'-0"	4'-0"	Same stratum as above, but relatively much harder i.e. Brown to slightly greyish brown, medium hard, fine-grained, silty SANDSTONE. Partial slaking rock.		6" DIA PERCUSSION DRILLING	50/2"	40			
	838.0	45'-0"	6'-0"	Greyish brown, soft to medium hard, SANDY SILTSTONE. High slaking.			Refusal 20/1"	45			
	833.0	50'-0"	5'-0"	Greyish brown, soft to medium hard, fine-grained, SANDSTONE. High slaking rock.			Refusal 50/3"	50			
				END OF BOREHOLE			Refusal	55 60 65 70			

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Rawalpindi

G.W.T. is not encountered upto the drilled depth.

PLAN NO. 4646 – 03 (2/2)

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

Location: Underground Tank **BH. No: 3**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	UN-DISTB	WATER
	∇ 883.00 ft										
28-01-2013			10'-0"	Brown to slightly reddish brown, slightly moist, stiff, low plastic, SILTY CLAY with sand (CL-ML) trace clay nodules.		6" DIA PERCUSSION DRILLING	7 + 7 + 7 N = 14	5			
	873.0	10'-0"					6 + 10 + 15	10			
	868.0	15'-0"	5'-0"	Brown to slightly yellowish brown, dry to slightly moist, very stiff to medium hard, low plastic, SANDY SILTY CLAY (CL-ML) trace to little gravel & clay nodules.			N = 25 26 + 50/5"	15			
	863.0	20'-0"	5'-0"	Brown to slightly yellowish brown, dry, very hard, low plastic, LEAN CLAY with sand (CL) trace clay nodules. Vertical thin beds of grey sand. Horizontally weak joints.			Refusal 50/5"	20			
	858.0	25'-0"	5'-0"	Brown to slightly yellowish brown, dry, very hard, low plastic, SANDY SITLY CLAY (CL-ML) near to claystone. Tiny wormholes are present.			Refusal 50/5"	25			
	853.0	30'-0"	5'-0"	Brown to yellowish brown, dry, very hard, low plastic, SILTY CLAY with sand (CL-ML). Thin beds of Sandstone are also found.			Refusal 50/5"	30			
	848.0	35'-0"	5'-0"	Greyish brown, slightly moist, very dense near to poorly-cemented, fine-grained, SILTY CLAYEY SAND (SC-SM).			Refusal 50/5"	35			
							Refusal				

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Rawalpindi

G.W.T. is not encountered upto the drilled depth.

PLAN NO. 4646 – 04

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

Location: Underground Tank **BH. No: 4**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value (10 30 50 70 90)	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 883.00 ft										
23-01-2013			9'-0"	Brown to slightly yellowish brown, slightly moist, soft to firm, low plastic, LEAN CLAY (CL) trace sand.		6" DIA PERCUSSION DRILLING	3 + 3 + 3 N = 6	5			
	874.0	9'-0"									
			6'-0"	Reddish brown, slightly moist, stiff, medium plastic, SITL (ML) trace sand & fine clay nodules.			4 + 6 + 8 N = 14	10			
	868.0	15'-0"									
			5'-0"	Reddish brown, dry to slightly moist, very hard, medium plastic, SANDY SILT (ML) trace clay nodules.			15 + 22 + 40 N = 62	15			
	863.0	20'-0'									
29-01-2013			3'-0"	Reddish brown, dry, very hard, low to low-medium plastic, LEAN CLAY with sand (CL). Thin beds of grey colour sand are also found.			18 + 35 + 50/3" Refusal	20			
	860.0	23'-0"									
			7'-0"	Brown to slightly yellowish brown, dry, very hard, low plastic, LEAN CLAY with sand (CL) near to CLAYSTONE. High slaking.			50/4" Refusal	25			
	853.0	30'-0"									
			5'-0"	Brown, dry to slightly moist, soft, Sandy CLAYSTONE. Colour of rock changes at 35'-0" becomes reddish brown. High slaking rocks; easily dissolvable.			50/2" Refusal	30			
	848.0	35'-0"					50/2" Refusal	35			

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G.W.T. is not encountered upto the drilled depth.

PLAN NO. 4646 – 05

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

ABSTRACT DATA ON LABORATORY TEST RESULTS

BOREHOLE NO.		BH – 1									
DEPTH (ft)		5'-0" 6'-6"	10'-0" 11'-0"	15'-0" 16'-0"	20'-0" 21'-0"	25'-0" 26'-0"	30'-0" 31'-0"	35'-0" 36'-0"	40'-0" 41'-0"	45'-0" 46'-0"	50'-0" 50'-4"
TYPE OF SAMPLE		SPT	Dist	Dist	Dist	Dist	Dist	Dist	SPT	Dist	SPT
MOISTURE CONTENT %		11.6	7.9	9.3	3.0	9.2	5.1	9.6	7.0	5.8	5.7
BULK DENSITY gm/cm³		-	-	-	-	-	-	-	-	-	-
GRAIN SIZE ANALYSIS	GRAVEL %	-	-	-	-	-	[a]06	01	-	[a]04	[a]22
	SAND %	33	60	56	-	62	71	63	80	71	49
	FINES -200 %	67	40	44	-	38	23	36	20	25	29
ATTERBERG'S LIMITS	LIQUID LIMIT	22.6	-	-	-	-	-	-	-	-	-
	PLASTIC LIMIT	17.5	-	-	-	-	-	-	-	-	-
	PLASTIC INDEX	5.1	-	-	-	-	-	-	-	-	-
UNCONFINED COMPRESSION TEST	STRESS kg/cm²	-	-	-	-	-	-	-	-	-	-
	STRAIN %	-	-	-	-	-	-	-	-	-	-

a. Undissolved rock fragments.

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Engineers & Contractors
Rawalpindi

PLAN NO. 4646 – 06

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

ABSTRACT DATA ON LABORATORY TEST RESULTS

BOREHOLE NO.		BH – 2									
DEPTH (ft)		5'-0" 6'-6"	10'-0" 11'-0"	15'-0" 16'-0"	20'-0" 21'-0"	25'-0" 26'-0"	30'-0" 31'-0"	35'-0" 36'-0"	40'-0" 41'-0"	45'-0" 46'-0"	50'-0" 50'-3"
TYPE OF SAMPLE		SPT	Dist	Dist	Dist	Dist	SPT	Dist	Dist	Dist	SPT
MOISTURE CONTENT %		9.3	8.3	4.5	9.3	6.1	10.5	6.6	7.4	8.2	9.5
BULK DENSITY gm/cm³		-	-	-	-	-	-	-	-	-	-
GRAIN SIZE ANALYSIS	GRAVEL %	02	-	-	-	-	[a]06	[a]45	-	-	-
	SAND %	33	43	-	38	60	47	39	45	61	67
	FINES -200 %	65	57	-	62	40	47	16	55	39	33
ATTERBERG'S LIMITS	LIQUID LIMIT	22.4	-	-	29.7	-	-	-	-	-	-
	PLASTIC LIMIT	17.2	-	-	23.0	-	-	-	-	-	-
	PLASTIC INDEX	5.2	-	-	6.7	-	-	-	-	-	-
UNCONFINED COMPRESSION TEST	STRESS kg/cm²	-	-	-	-	-	-	-	-	-	-
	STRAIN %	-	-	-	-	-	-	-	-	-	-

a. Undissolved rock fragments.

SWIS-TECH
Engineers & Contractors
Rawalpindi

PLAN NO. 4646 – 07

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

ABSTRACT DATA ON LABORATORY TEST RESULTS

BOREHOLE NO.		BH - 3						
DEPTH (ft)		5'-0" 6'-6"	10'-0" 11'-6"	15'-0" 15'-11"	20'-0" 20'-5"	25'-0" 25'-5"	30'-0" 30'-5"	35'-0" 35'-5"
TYPE OF SAMPLE		SPT	SPT	SPT	SPT	SPT	SPT	SPT
MOISTURE CONTENT %		14.0	9.4	8.7	8.6	8.5	9.1	6.5
BULK DENSITY gm/cm³		115.9	120.7	-	-	-	-	-
GRAIN SIZE ANALYSIS	GRAVEL %	01	[a]11	01	-	[a]04	-	-
	SAND %	18	21	17	30	23	63	69
	FINES -200 %	81	68	82	70	73	37	31
ATTERBERG'S LIMITS	LIQUID LIMIT	22.7	27.0	29.8	24.4	27.5	25.9	25.5
	PLASTIC LIMIT	17.5	20.8	20.9	18.7	20.7	19.4	20.0
	PLASTIC INDEX	5.2	6.2	8.9	5.7	6.8	6.5	5.5
UNCONFINED COMPRESSION TEST	STRESS kg/cm²	1.247	2.720	-	-	-	-	-
	STRAIN %	4.264	3.929	-	-	-	-	-

a. Undissolved rock fragments.

SWIS-TECH
Engineers & Contractors
Rawalpindi

PLAN NO. 4646 – 08

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-V, GULBERG-III
ISLAMABAD

ABSTRACT DATA ON LABORATORY TEST RESULTS

BOREHOLE NO.		BH - 4						
DEPTH (ft)		5'-0" 6'-6"	10'-0" 11'-6"	15'-0" 16'-6"	20'-0" 21'-3"	25'-0" 26'-0"	30'-0" 31'-0"	35'-0" 35'-6"
TYPE OF SAMPLE		SPT	SPT	SPT	SPT	Dist	Dist	Dist
MOISTURE CONTENT %		17.1	15.5	12.9	9.9	7.3	5.5	6.1
BULK DENSITY gm/cm³		-	120.5	124.7	125.2	-	-	-
GRAIN SIZE ANALYSIS	GRAVEL %	-	-	02	-	-	[a]15	[a]15
	SAND %	04	11	33	18	21	23	34
	FINES -200 %	96	89	65	82	79	62	51
ATTERBERG'S LIMITS	LIQUID LIMIT	27.8	34.0	34.5	31.4	30.4	29.4	30.4
	PLASTIC LIMIT	20.2	24.0	24.7	22.1	21.2	21.6	21.6
	PLASTIC INDEX	7.6	10.0	9.8	9.3	9.2	7.8	8.8
UNCONFINED COMPRESSION TEST	STRESS kg/cm²	-	1.736	3.919	4.362	-	-	-
	STRAIN %	-	5.372	5.751	5.580	-	-	-

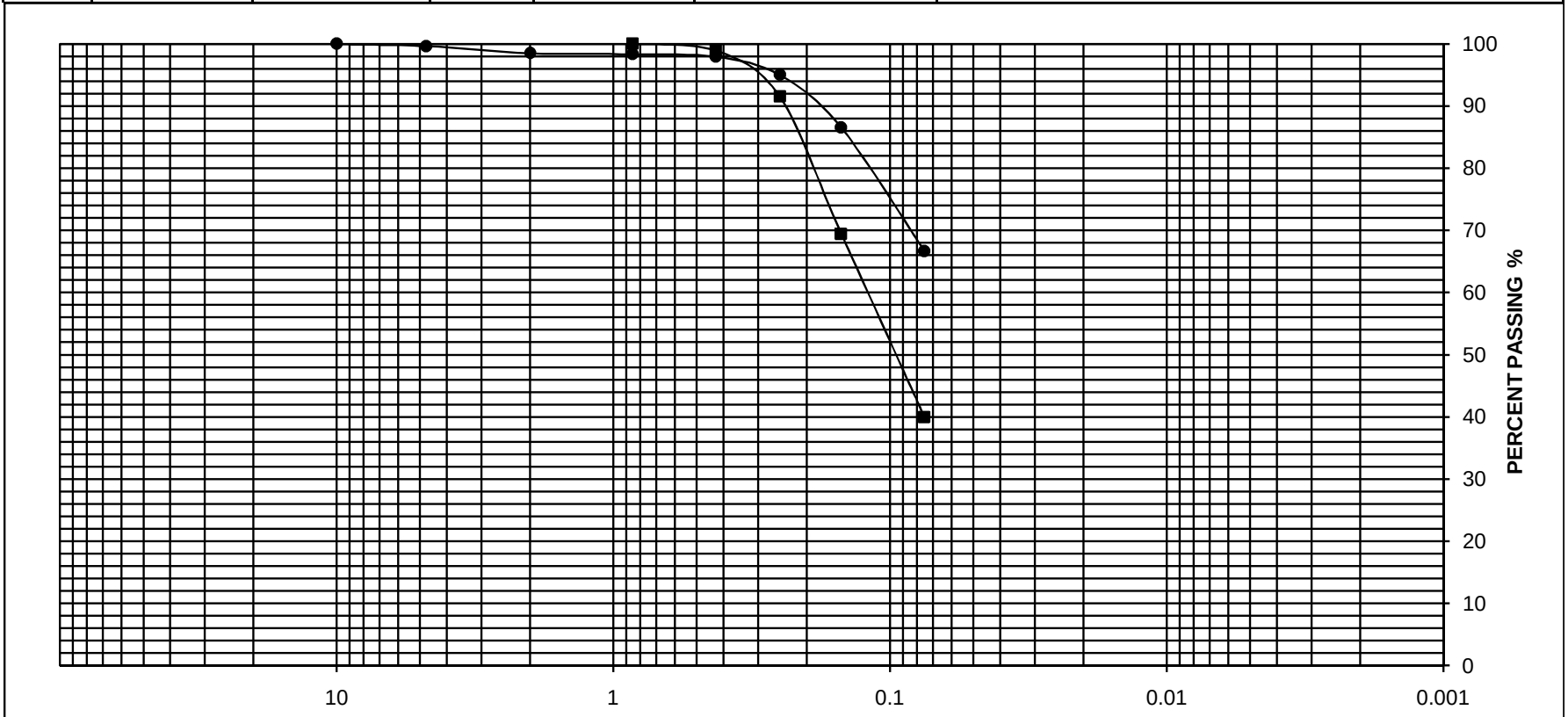
a. Undissolved rock fragments.

SWIS-TECH
Engineers & Contractors
Rawalpindi

PLAN NO. 4646 – 09

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



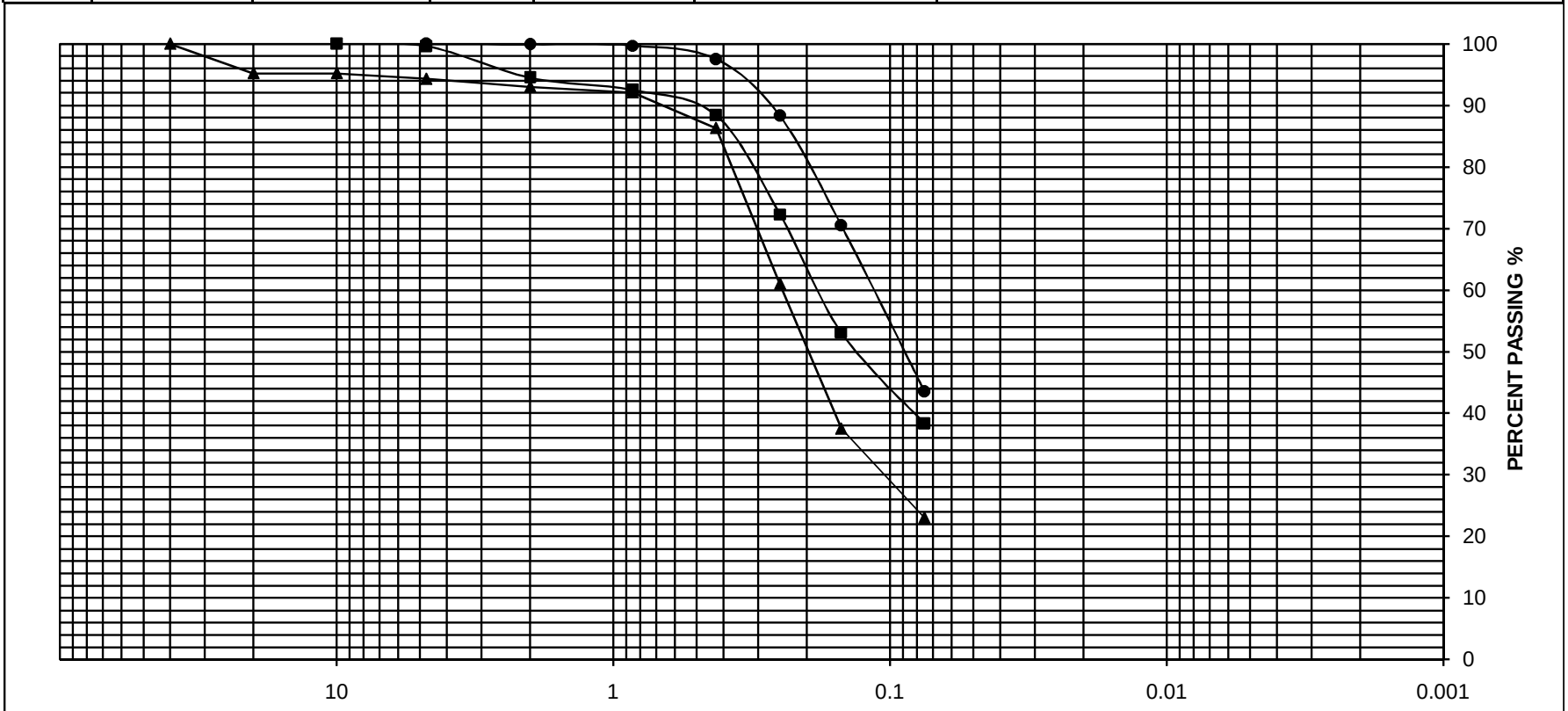
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	1	SPT	5'-0" / 6'-6"	SANDY SITLY CLAY	-	33	*67			22.6	17.5	5.1	CL-ML
■	1	Dist	10'-0" / 11'-0"	SILTY SAND	-	60	*40			-	-	-	SM

*Hydrometer analysis was not performed.

PLAN NO: 4646 -10

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



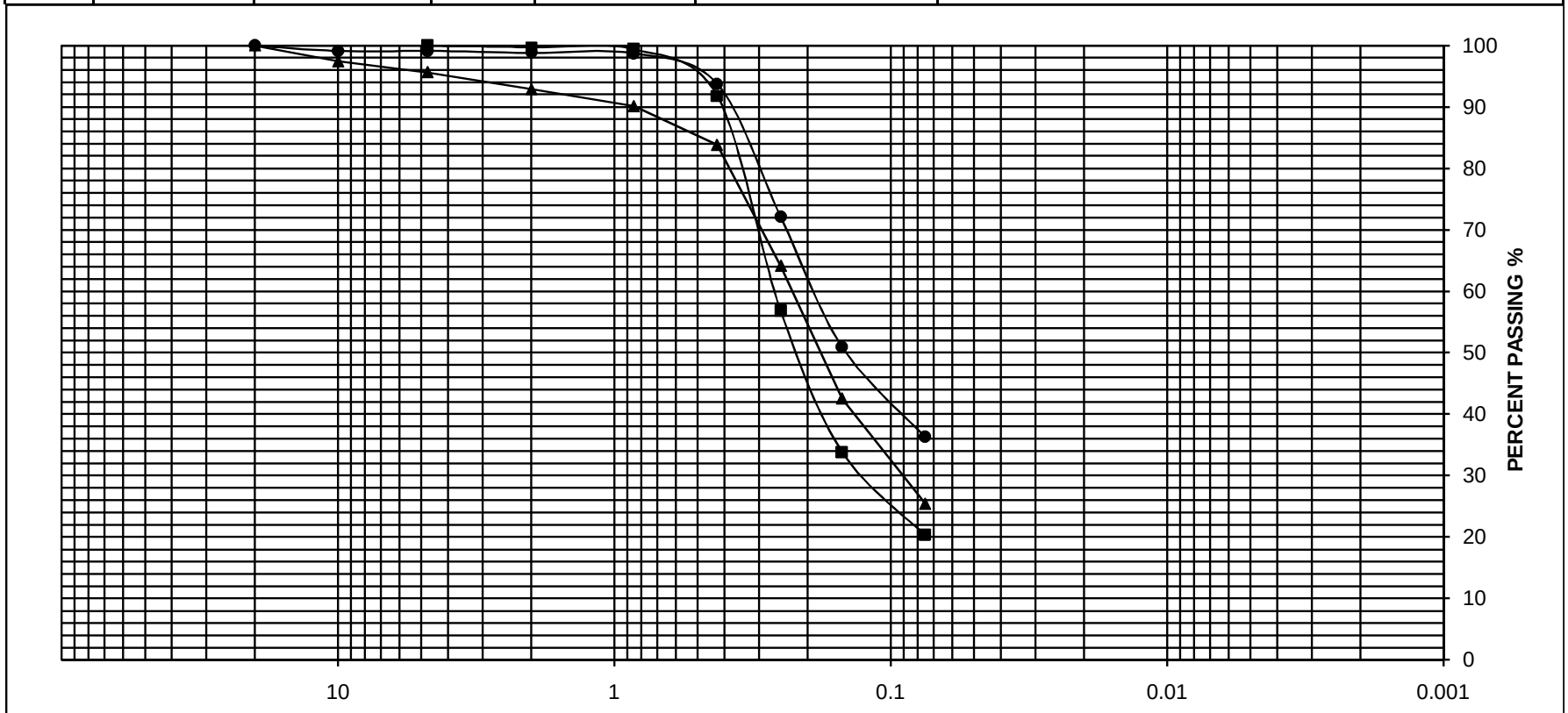
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	1	Dist	15'-0" / 16'-0"	SILTY SAND	-	56	*44			-	-	-	SM
■	1	Dist	25'-0" / 26'-0"	SILTY SAND	-	62	*38			-	-	-	SM
▲	1	Dist	30'-0" / 31'-0"	SILTY SAND	[a]6	71	*23			-	-	-	SM

*Hydrometer analysis was not performed. [a]Pieces of undissolved rock. [b]Slightly erratic and gap-graded curve.

PLAN NO: 4646 - 11

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



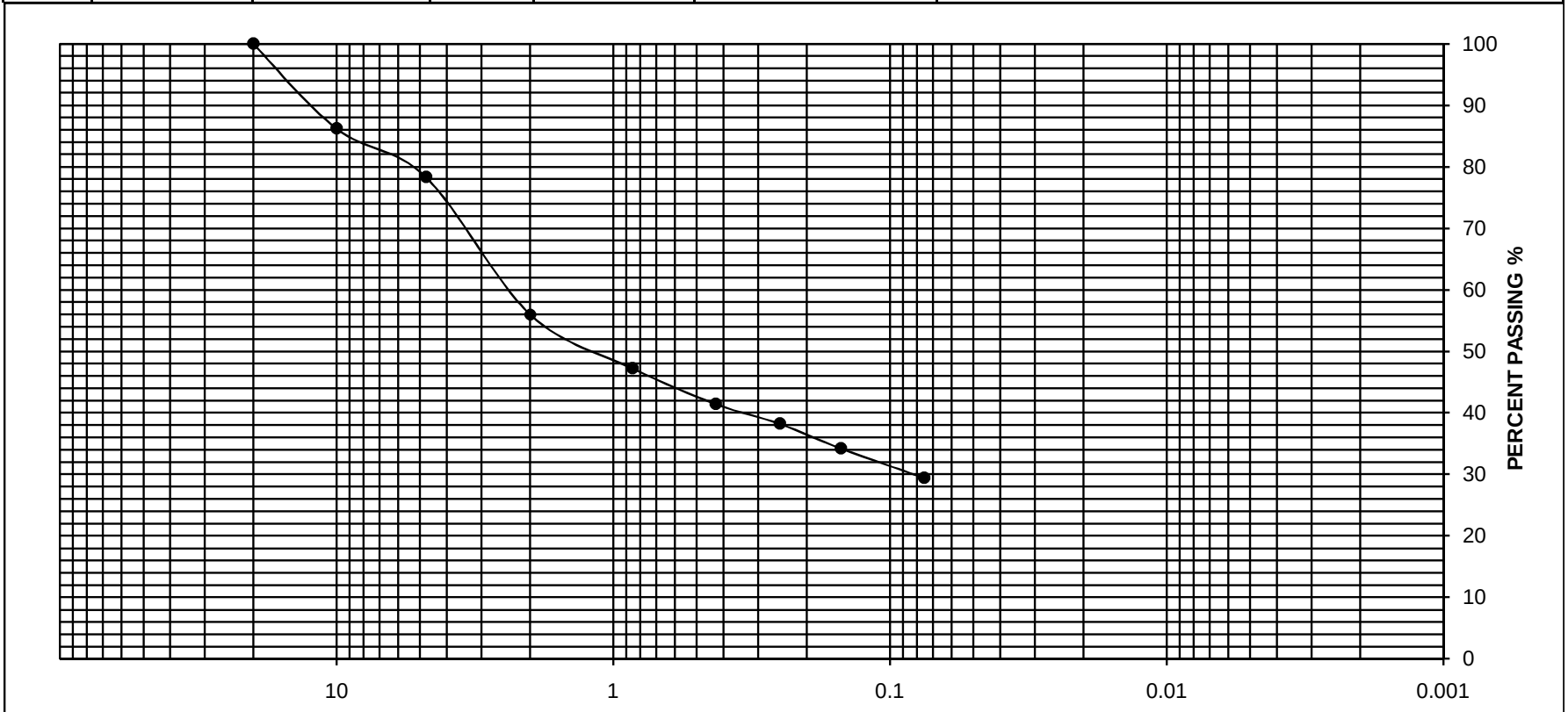
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	1	Dist	35'-0" / 30'-0"	SILTY SAND	[a]1	63	*36			-	-	-	SM
■	1	Dist	40'-0" / 41'-0"	SILTY SAND	-	80	*20			-	-	-	SM
▲	1	Dist	45'-0" / 46'-0"	SILTY SAND	[a]4	71	*25			-	-	-	SM

*Hydrometer analysis was not performed. [a]Pieces of undissolved rock.

PLAN NO: 4646 - 12

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



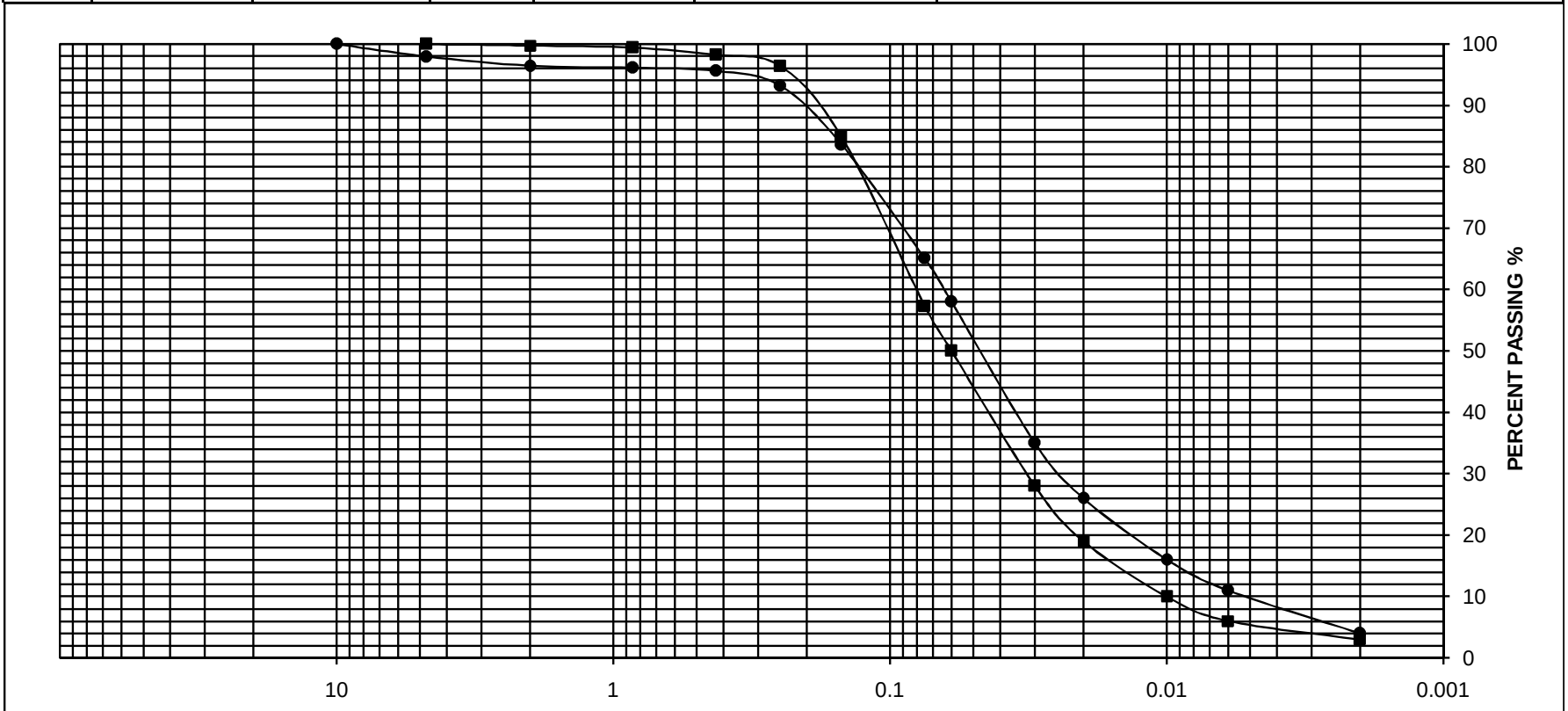
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	*Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	1	SPT	50'-0" / 50'-4"	SILTY SAND	[a]22	49	*29			-	-	-	SM

* Hydrometer analysis was not performed. [a]Pieces of undissolved rock. [b]Slightly erratic and gap-graded curve.

PLAN NO: 4646 - 13

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



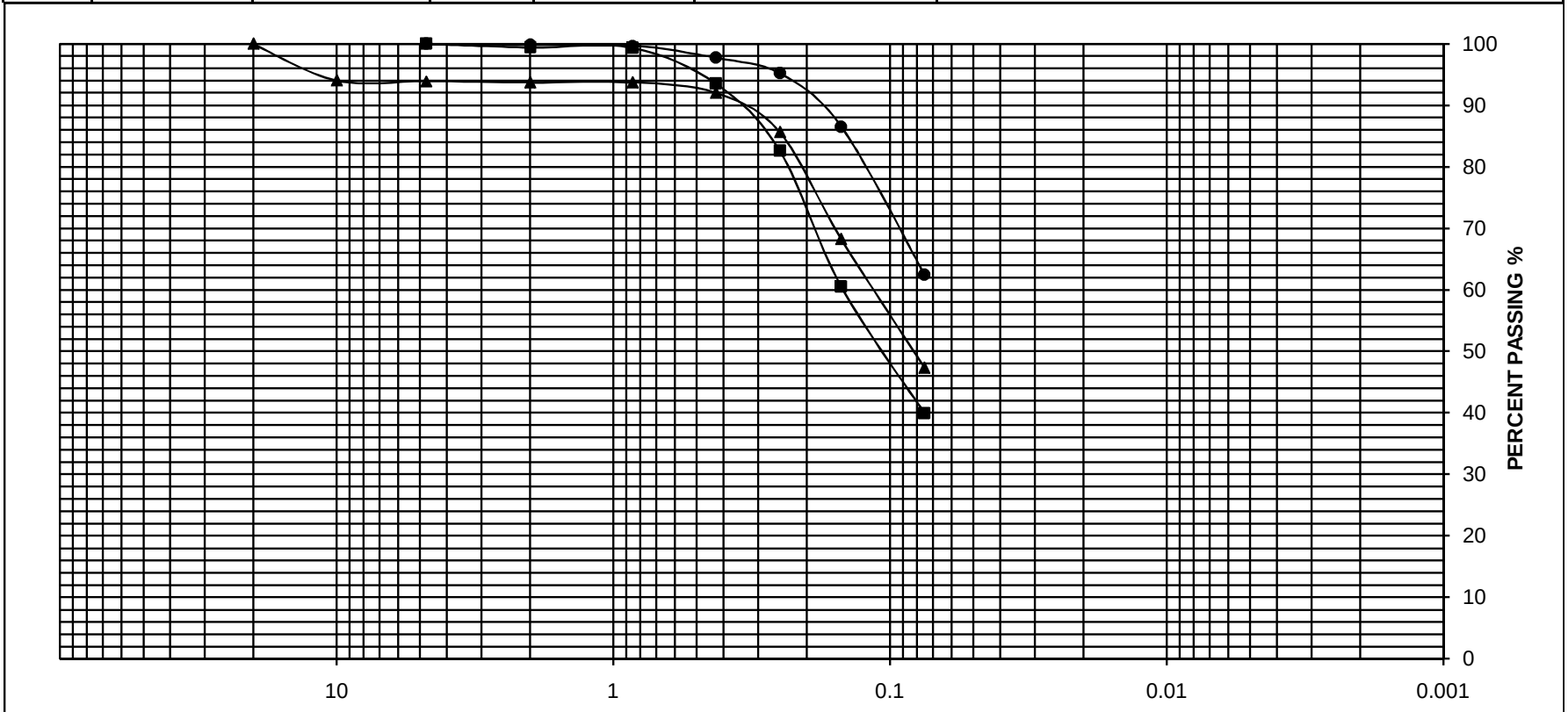
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	2	SPT	5'-0" / 6'-6"	SANDY SILTY CLAY	[a]2	33	65			22.4	17.2	5.2	CL-ML
■	2	Dist	10'-0" / 11'-0"	SANDY SILT	-	43	57			-	-	-	ML

[a]Pieces of undissolved rock.

PLAN NO: 4646 - 14

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	2	Dist	20'-0" / 21'-0"	SANDY SILT	-	38	*62			29.7	23.0	6.7	ML
■	2	Dist	25'-0" / 26'-0"	SANDY SILT	-	60	*40			-	-	-	ML
▲	2	Dist	30'-0" / 31'-0"	SANDY SILT	[a]6	47	*47			-	-	-	ML

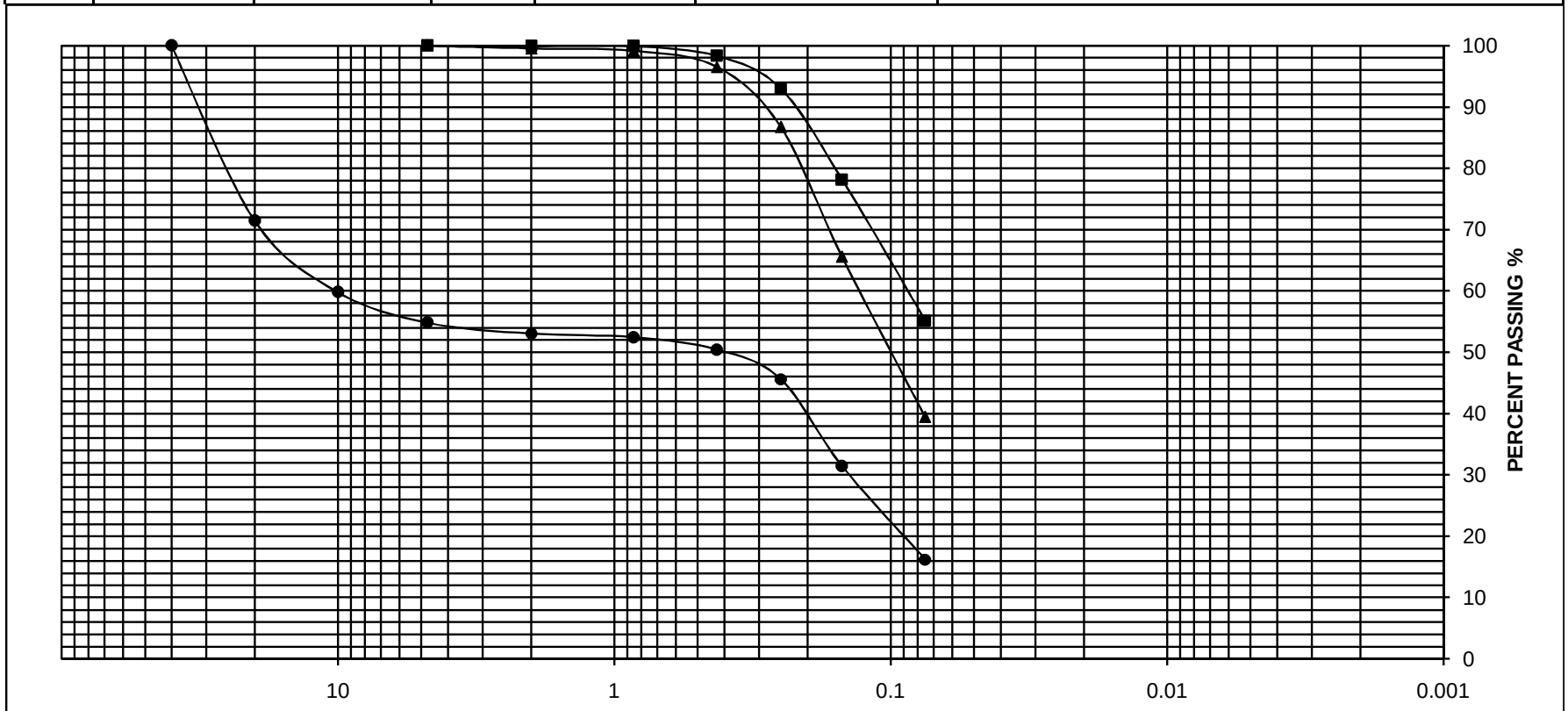
* Hydrometer analysis was not performed.

[a]Pieces of undissolved rock.

PLAN NO: 4646 - 15

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	2	Dist	35'-0" / 36'-0"	SANDY SILT	[a]45	39	*16			-	-	-	ML
■	2	Dist	40'-0" / 41'-0"	SANDY SILT	-	45	*55			-	-	-	ML
▲	2	Dist	45'-0"/ 46'-0"	SILTY SAND	-	61	*39			-	-	-	SM

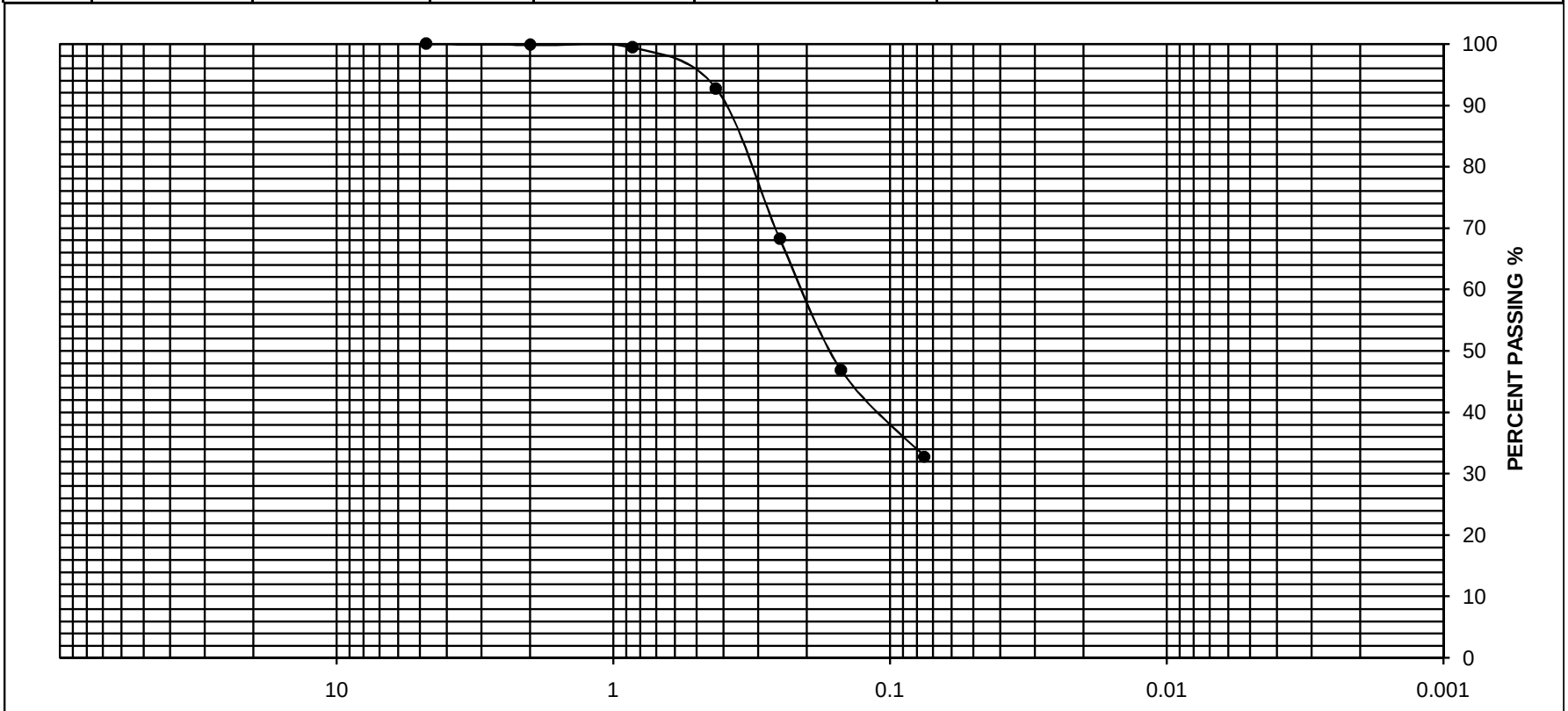
* Hydrometer analysis was not performed.

[a]Pieces of undissolved rock.

PLAN NO: 4646 - 16

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



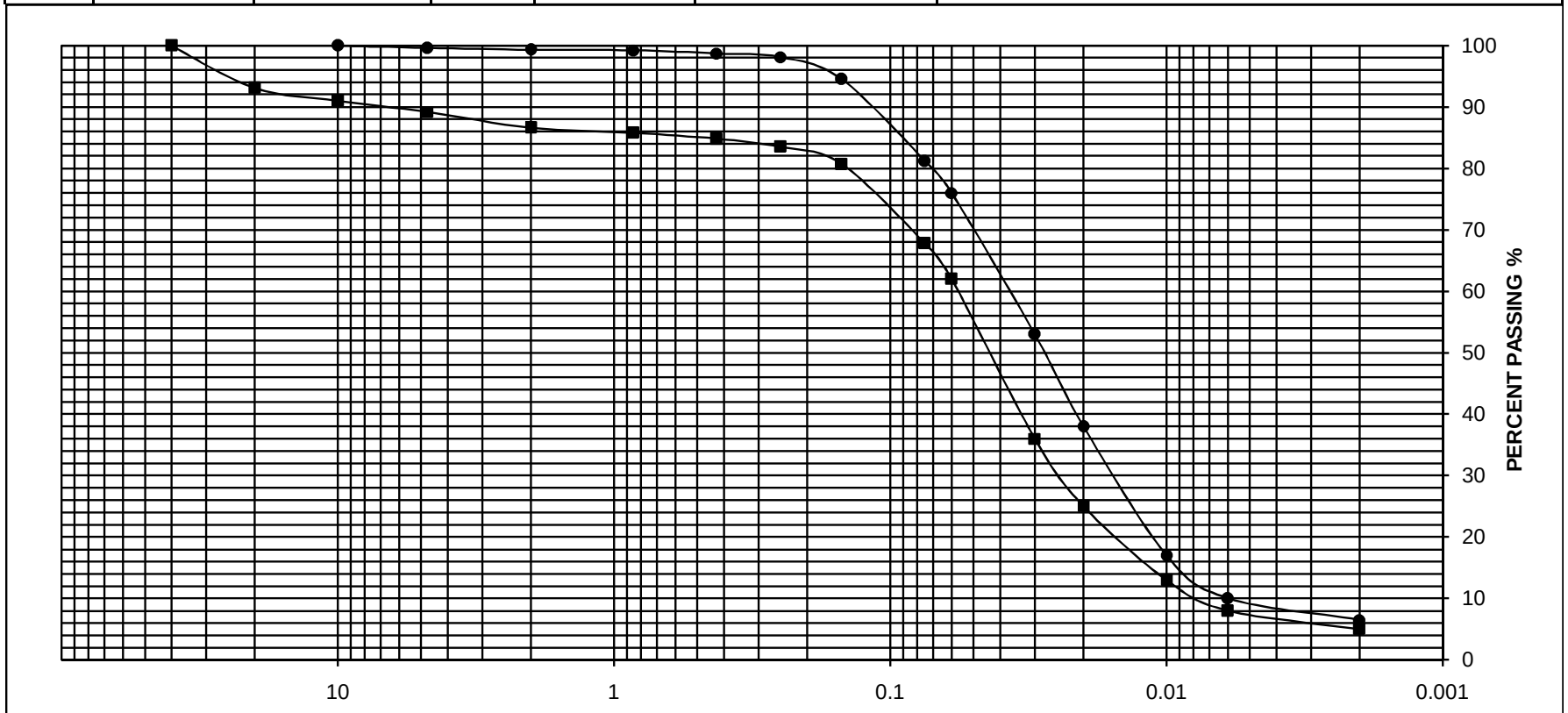
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	2	SPT	50'-0" / 50'-3"	SILTY SAND	-	67	*33			-	-	-	SM

* Hydrometer analysis was not performed.

PLAN NO: 4646 - 17

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	3	SPT	5'-0" / 6'-6"	SILTY CLAY with sand	[a]1	18	81			22.7	17.5	5.2	CL-ML
■	3	SPT	10'-0" / 11'-6"	SANDY SILTY CLAY	[a]11	21	68			27.0	20.8	6.2	CL-ML

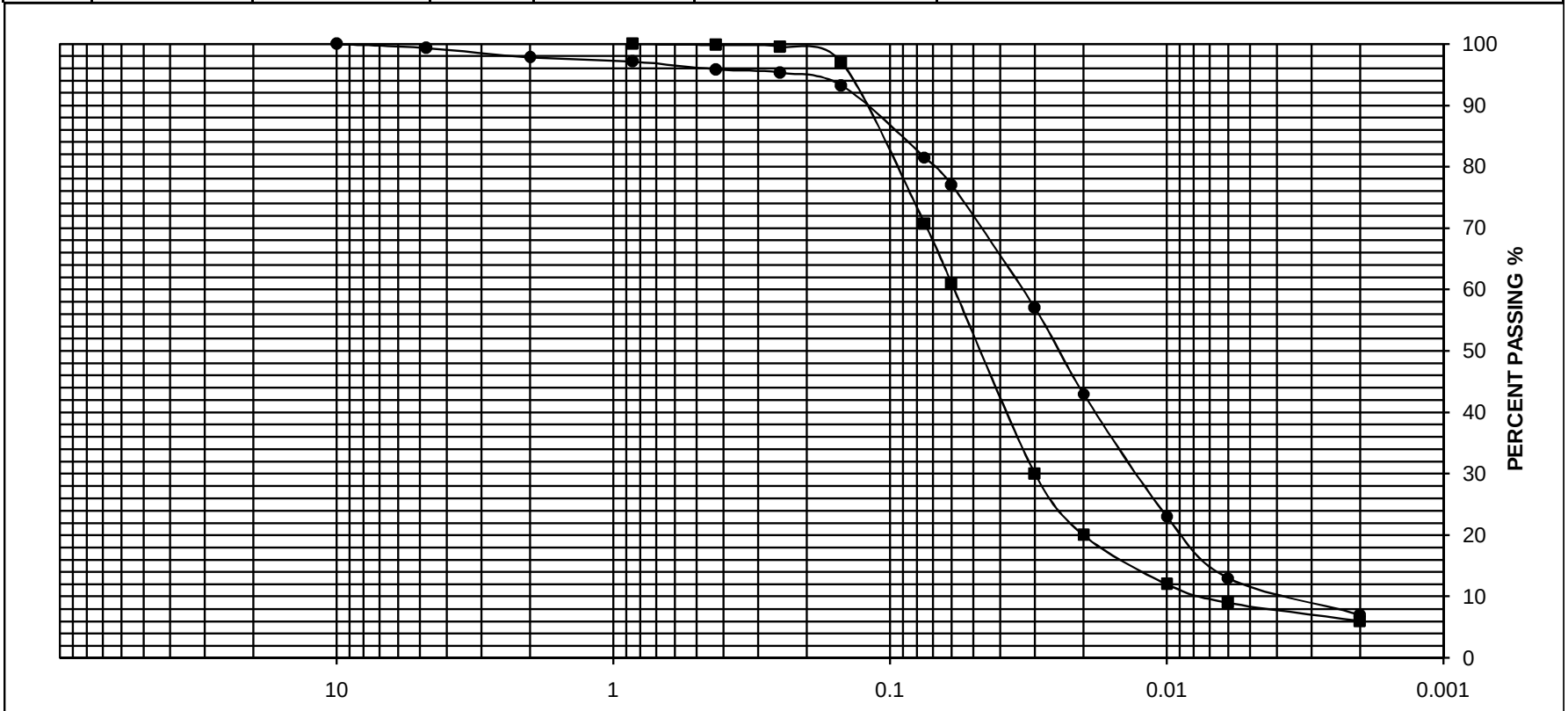
* Hydrometer analysis was not performed.

[a]Pieces of undissolved rock.

PLAN NO: 4646 - 18

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



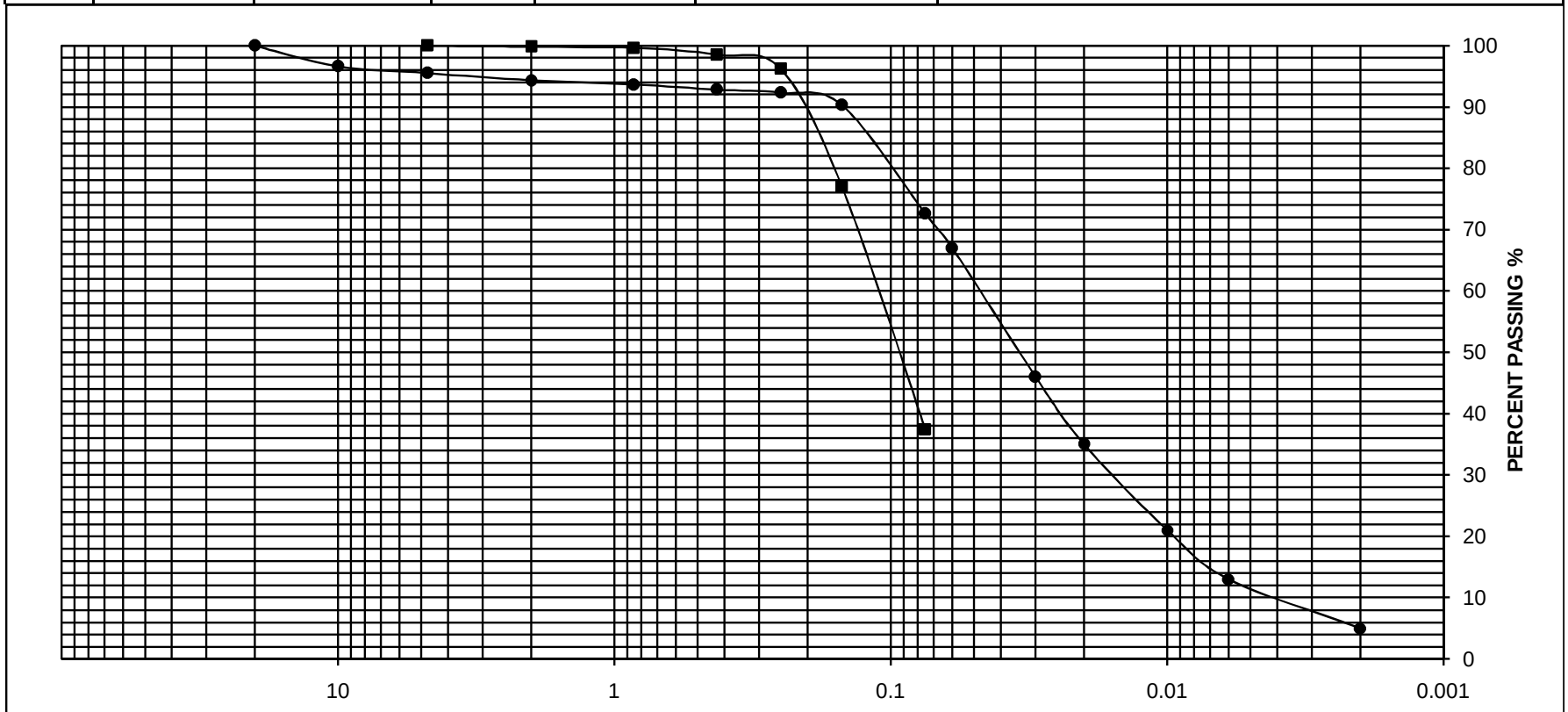
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	3	SPT	15'-0" / 15'-11"	LEAN CLAY with sand	[a]1	17	82			29.8	20.9	8.9	CL
■	3	SPT	20'-0" / 20'-5"	SANDY SILTY CLAY	-	30	70			24.4	18.7	5.7	CL-ML

[a]Pieces of undissolved rock.

PLAN NO: 4646 - 19

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



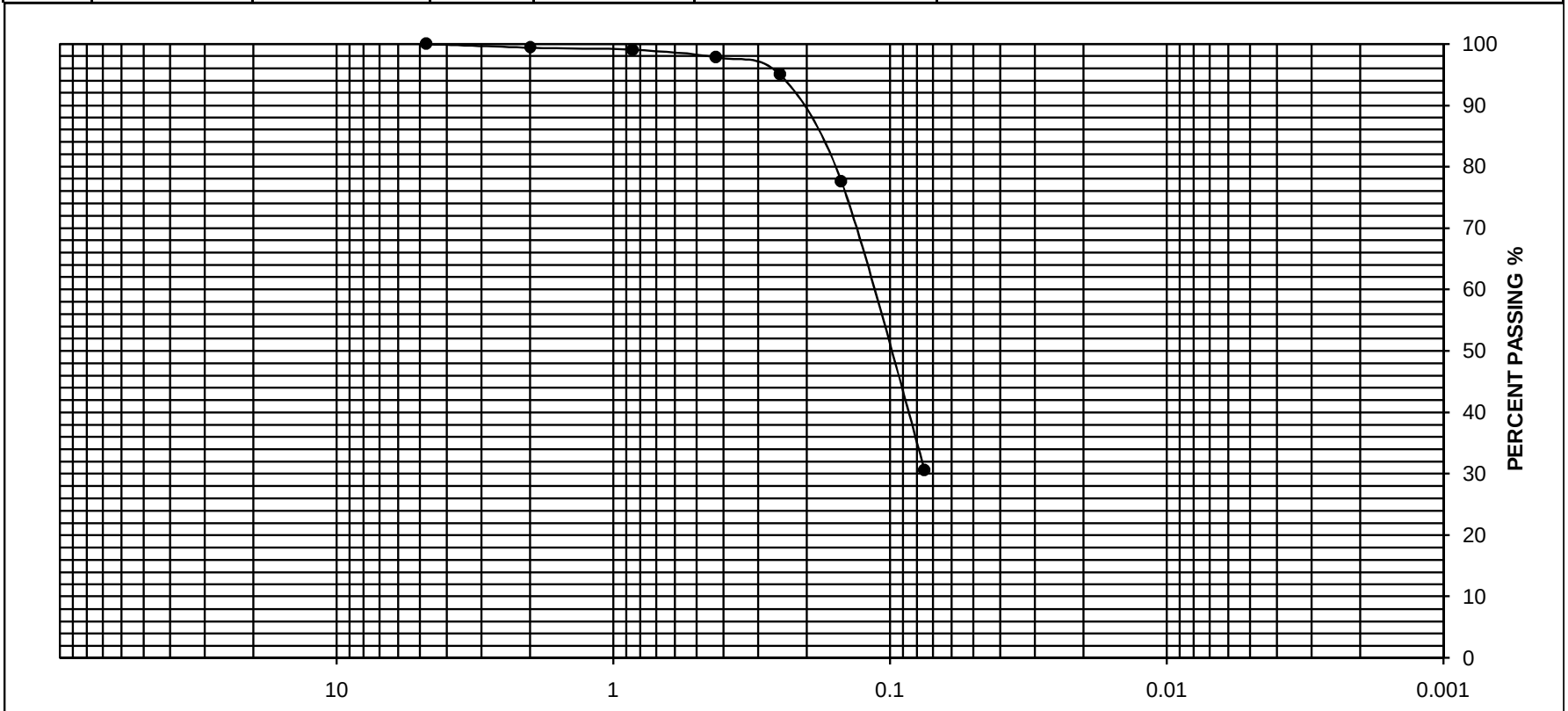
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	3	SPT	25'-0" / 25'-5"	SILTY CLAY with sand	[a]4	23	73			27.5	20.7	6.8	CL-ML
■	3	SPT	30'-0" / 30'-5"	SILTY CLAYEY SAND	-	63	*37			25.9	19.4	6.5	SC-SM

* Hydrometer analysis was not performed. [a]Pieces of undissolved rock.

PLAN NO: 4646 - 20

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



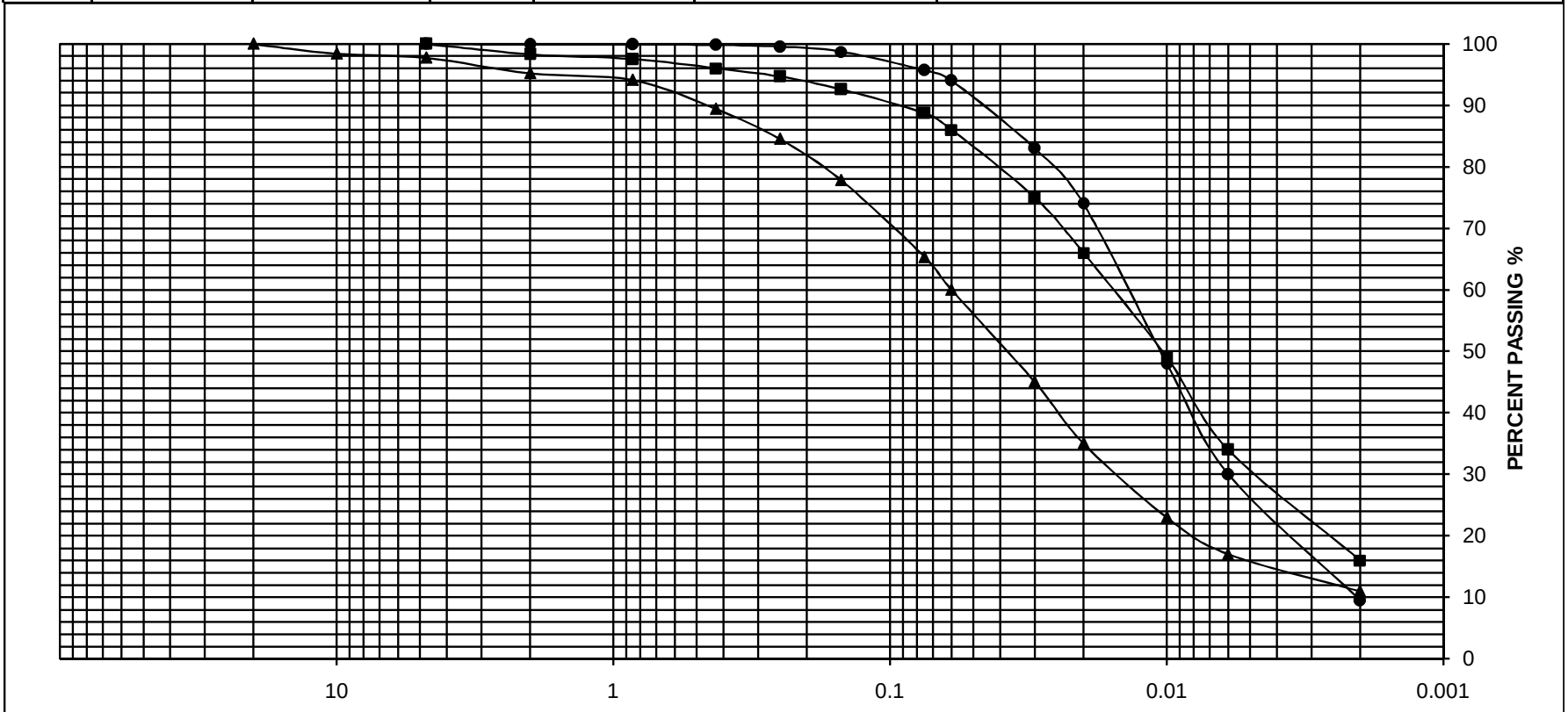
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	3	SPT	35'-0" / 35'-5"	SILTY CLAYEY SAND	-	69	*31			25.5	20.0	5.5	SC-SM

* Hydrometer analysis was not performed.

PLAN NO: 4646 - 21

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



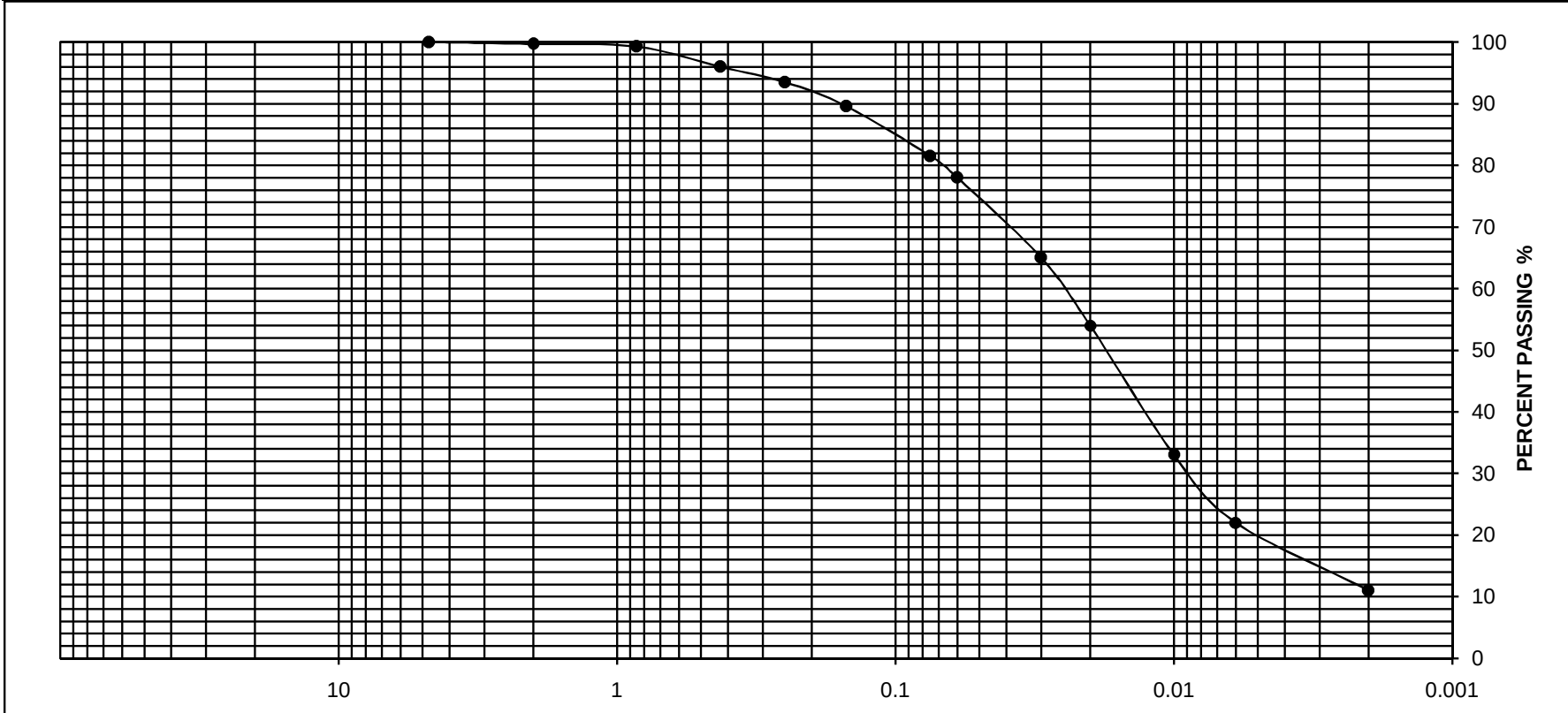
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	4	SPT	5'-0" / 6'-6"	LEAN CLAY	-	4	96			27.8	20.2	7.6	CL
■	4	SPT	10'-0" / 11'-6"	SILT	-	11	89			34.0	24.0	10.0	ML
▲	4	SPT	15'-0" / 16'-6"	SANDY SILT	[a]2	33	65			34.5	24.7	9.8	ML

[a]Pieces of undissolved rock.

PLAN NO: 4646 - 22

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	

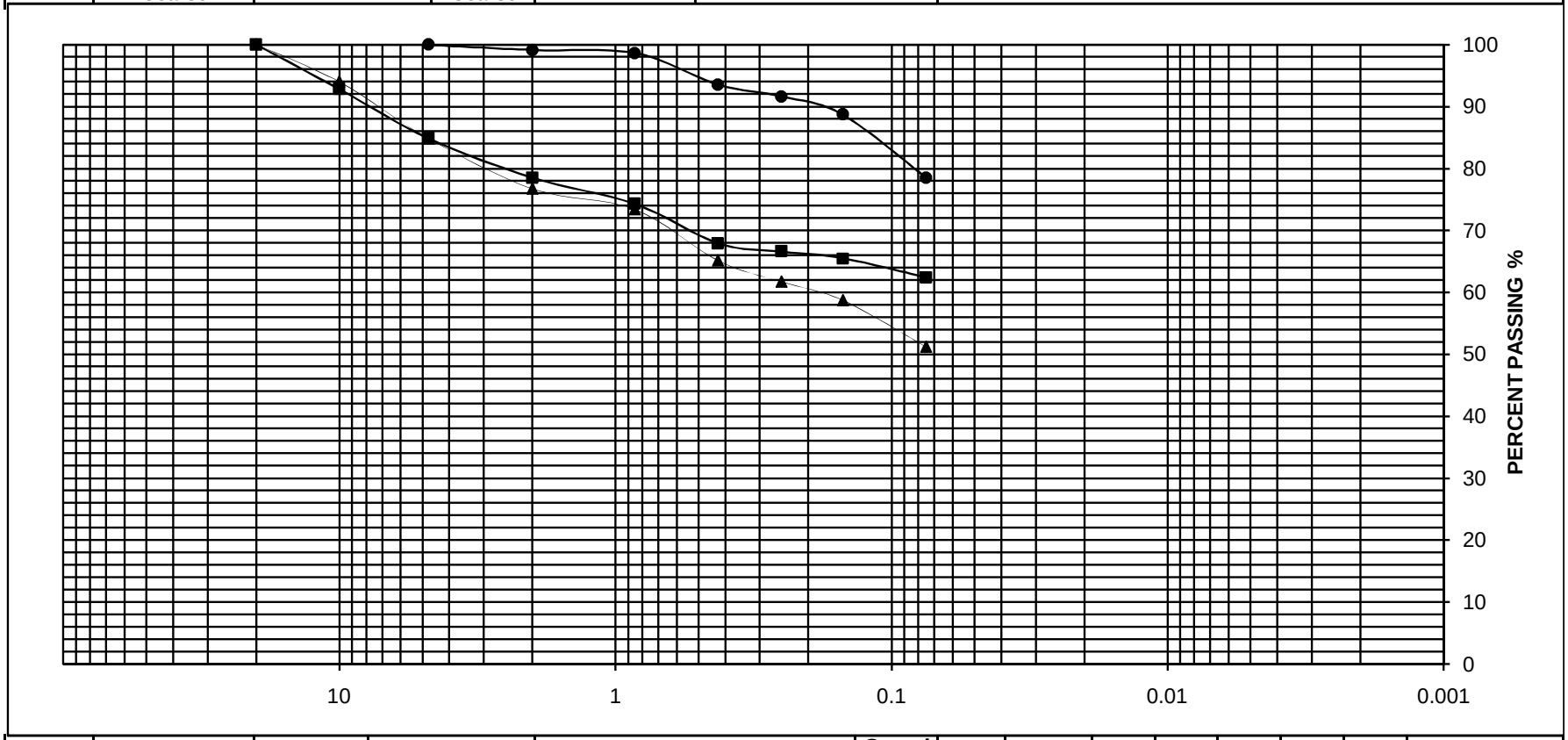


Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	4	SPT	20'-0" / 21'-3"	LEAN CLAY with sand	-	18	82			31.4	22.1	9.3	CL

PLAN NO: 4646 - 23

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-V, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
•	4	Dist	25'-0" / 26'-0"	LEAN CLAY with sand	-	21	*79			30.4	21.2	9.2	CL
■	4	Dist	30'-0" / 31'-0"	SANDY LEAN CLAY	[a]15	23	*62			29.4	21.6	7.8	CL
▲	4	Dist	35'-0" / 35'-6"	SANDY LEAN CLAY	[a]15	34	*51			30.4	21.6	8.8	CL

* Hydrometer analysis was not performed. [a]Pieces of undissolved rock. [b]Slightly erratic and gap-graded curve.

PLAN NO: 4646 - 24

SWIS-TECH

ENGINEERS & CONTRACTORS

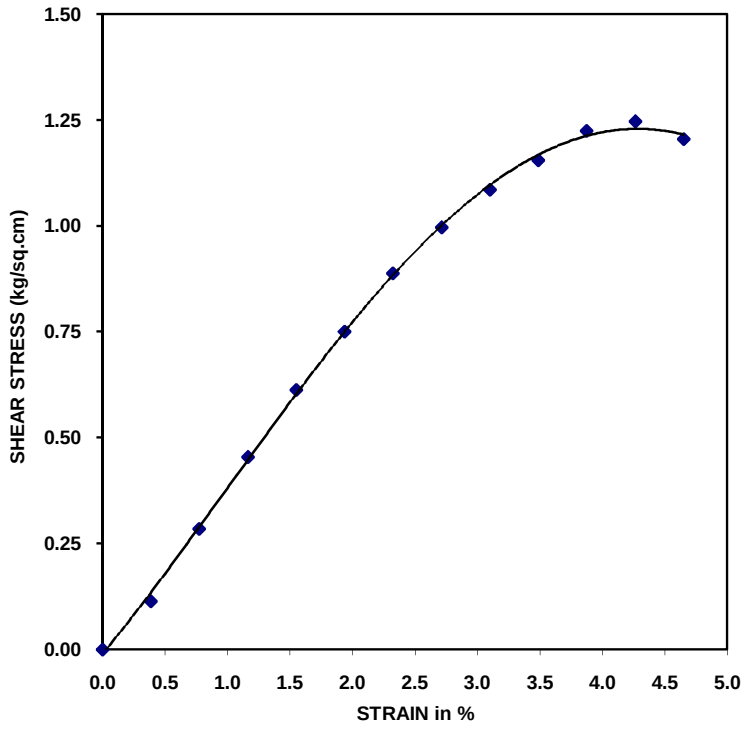
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Consultant:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-V, Gulberg-III, Islamabad.				
Bore No:	3	Depth:	5'-0" / 6'-6"	Type of Sample:	SPT
Soil Material:	Brown to slightly reddish brown, SILTY CLAY with sand (CL-ML).				

Diameter :	3.495 cm	Wet Weight :	114.9 gm
Height :	6.450 cm	Moisture Content :	14.000 %
Area :	9.594 sq.cm	Wet Density :	1.857 g/cc
Volume :	61.879 cu.cm	Dry Density :	1.629 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.388	0.114
0.775	0.285
1.163	0.454
1.550	0.612
1.938	0.751
2.326	0.888
2.713	0.996
3.101	1.085
3.488	1.154
3.876	1.223
4.264	**1.246**
4.651	1.204



Remarks:

1) H/D = 1.845

SWIS-TECH

ENGINEERS & CONTRACTORS

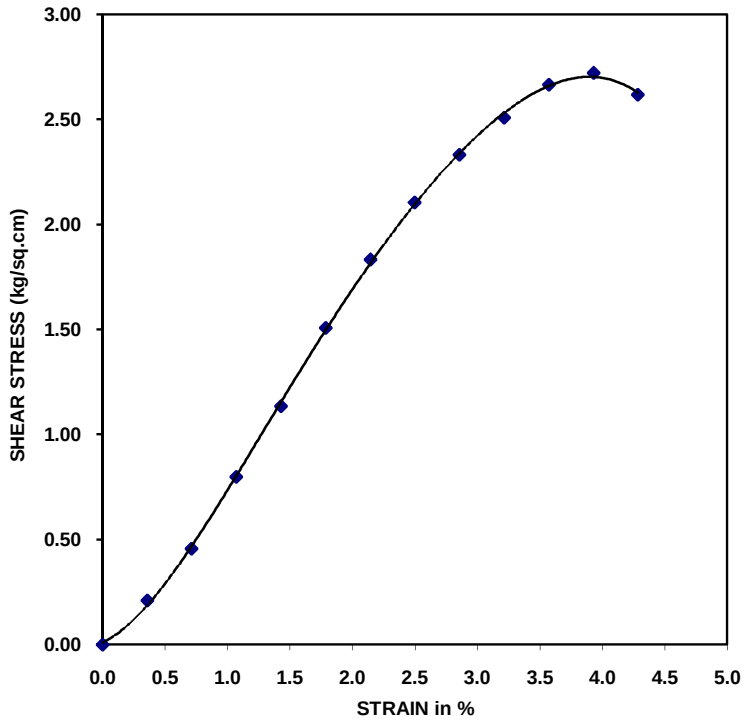
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Consultant:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-V, Gulberg-III, Islamabad.				
Bore No:	3	Depth:	10'-0" / 11'-6"	Type of Sample:	SPT
Soil Material:	Brown to slighlty yellowish brown, SANDY SILTY CLAY (CL-ML).				

Diameter :	3.490 cm	Wet Weight :	129.5 gm
Height :	7.000 cm	Moisture Content :	9.400 %
Area :	9.566 sq.cm	Wet Density :	1.934 g/cc
Volume :	66.964 cu.cm	Dry Density :	1.768 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.357	0.210
0.714	0.457
1.071	0.797
1.429	1.135
1.786	1.508
2.143	1.831
2.500	2.105
2.857	2.331
3.214	2.508
3.571	2.665
3.929	**2.720**
4.286	2.618



Remarks:

1) H/D = 2.006

SWIS-TECH

ENGINEERS & CONTRACTORS

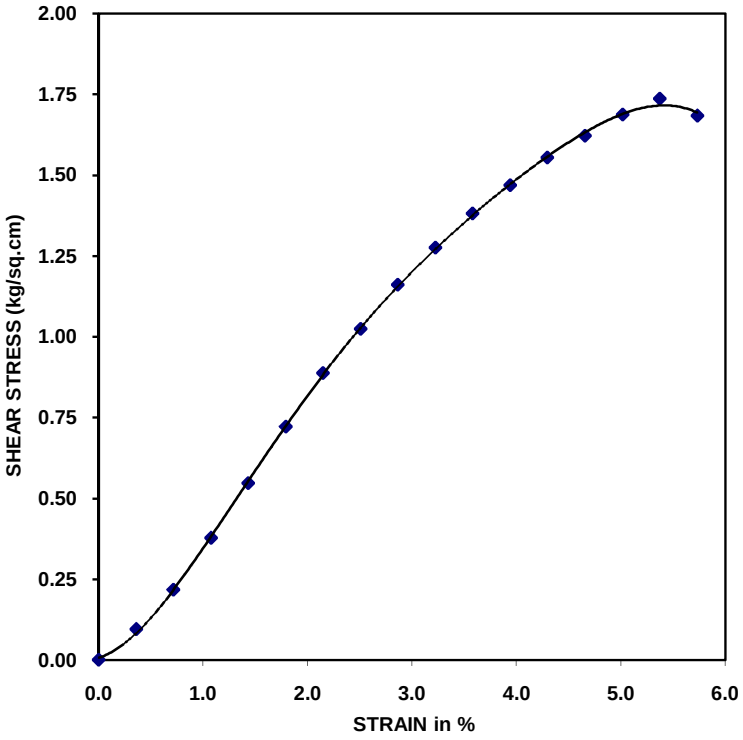
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Consultant:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-V, Gulberg-III, Islamabad.				
Bore No:	4	Depth:	10'-0" / 11'-6"	Type of Sample:	SPT
Soil Material:	Reddish brown, SILT (ML).				

Diameter :	3.498 cm	Wet Weight :	129.5 gm
Height :	6.980 cm	Moisture Content :	15.500 %
Area :	9.610 sq.cm	Wet Density :	1.931 g/cc
Volume :	67.079 cu.cm	Dry Density :	1.672 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.358	0.095
0.716	0.218
1.074	0.378
1.433	0.546
1.791	0.722
2.149	0.888
2.507	1.024
2.865	1.160
3.223	1.276
3.582	1.382
3.940	1.468
4.298	1.554
4.656	1.621
5.014	1.688
5.372	**1.736**
5.731	1.684



Remarks:

1) H/D = 1.995

SWIS-TECH

ENGINEERS & CONTRACTORS

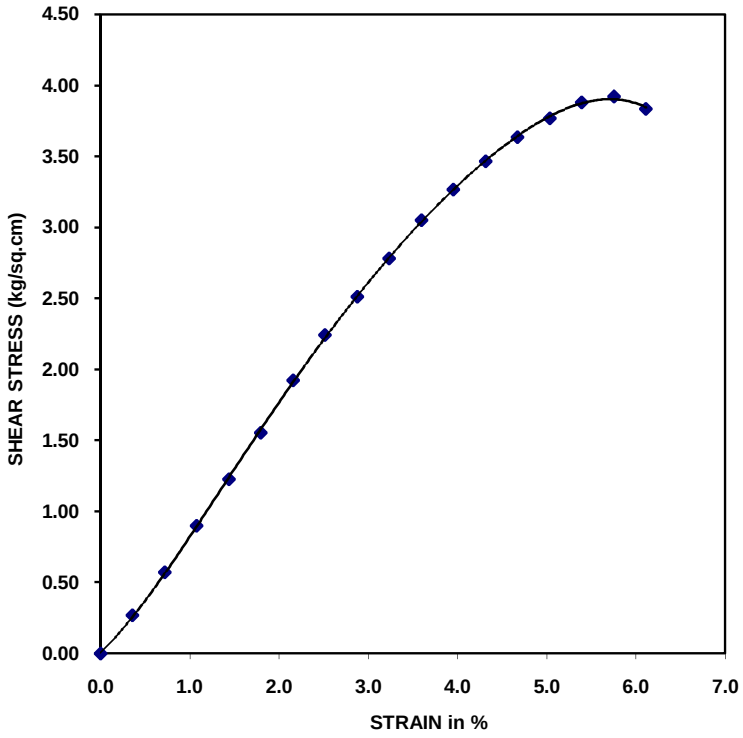
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Consultant:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-V, Gulberg-III, Islamabad.				
Bore No:	4	Depth:	15'-0" / 16'-6"	Type of Sample:	SPT
Soil Material:	Reddish brown, SANDY SILT (ML).				

Diameter :	3.493 cm	Wet Weight :	133.2 gm
Height :	6.955 cm	Moisture Content :	12.900 %
Area :	9.583 sq.cm	Wet Density :	1.998 g/cc
Volume :	66.648 cu.cm	Dry Density :	1.770 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:	0.0918 Kg/div				

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.359	0.267
0.719	0.571
1.078	0.900
1.438	1.227
1.797	1.552
2.157	1.921
2.516	2.241
2.876	2.512
3.235	2.781
3.595	3.048
3.954	3.266
4.313	3.465
4.673	3.635
5.032	3.766
5.392	3.879
5.751	**3.919**
6.111	3.832



Remarks:

1) H/D = 1.991

SWIS-TECH

ENGINEERS & CONTRACTORS

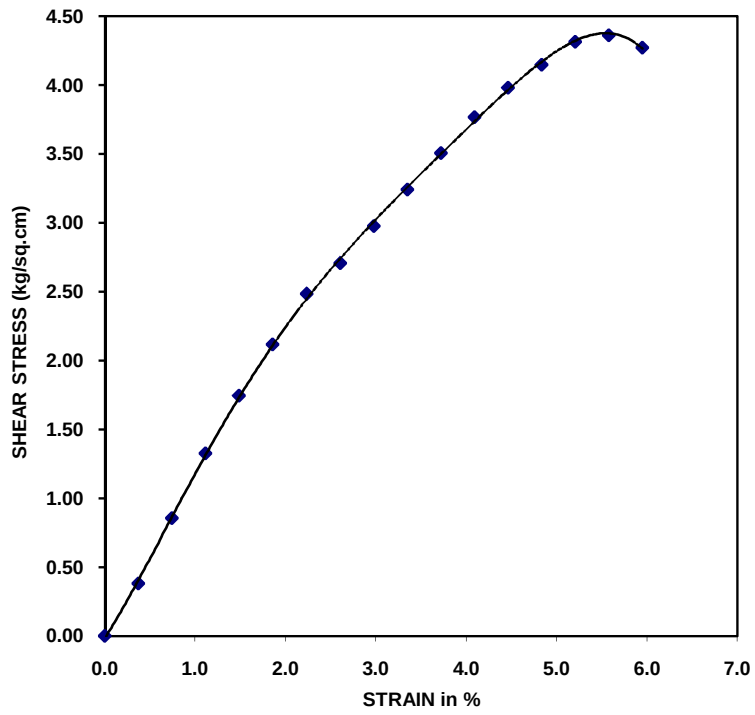
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Contractor:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-V, Gulberg-III, Islamabad.				
Bore No:	4	Depth:	20'-0" / 21'-3"	Type of Sample:	SPT
Soil Material:	Reddish brown, LEAN CLAY with sand (CL).				

Diameter :	3.492 cm	Wet Weight :	129.1 gm
Height :	6.720 cm	Moisture Content :	9.900 %
Area :	9.577 sq.cm	Wet Density :	2.006 g/cc
Volume :	64.359 cu.cm	Dry Density :	1.826 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:	0.0918 Kg/div				

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.372	0.382
0.744	0.856
1.116	1.327
1.488	1.747
1.860	2.117
2.232	2.483
2.604	2.707
2.976	2.976
3.348	3.243
3.720	3.507
4.092	3.769
4.464	3.983
4.836	4.150
5.208	4.316
5.580	**4.362**
5.952	4.273



Remarks:

1) H/D = 1.924

Plan No. 4646 - 29