	BGR ENERGY SYSTEMS LIMITED **POWER PROJECTS DIVISION**	Sheet 1 of 1
	GEOTECHNICAL INVESTIGATION REPORT **VOLUME-II** **DOCUMENT NO: GID-208-CV-DOC-3958**	**Rev 2**

2x660MW IB THERMAL POWER STATION UNIT-3 & 4, OPGCL, BANHARPALLI, DIST. – JHARSUGUDA, ODISHA.

GEOTECHNICAL INVESTIGATION REPORT

VOLUME-II FOR BOP AREA

GID-208-CV-DOC-3958

BGR ENERGY SYSTEMS LIMITED

POWER PROJECTS DIVISION

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09-09-2015	Revised ERT test locations as executed in BH layout plan – R2	GM	HOD
03-05-2014	Revised as per OPGCL/DCPL comments dt:11-02-2014 – R1	GM/SPR	HOD
22-01-2014	For approval	GM/SPR	HOD

2x660MW IB THERMAL POWER STATION UNIT-3 & 4, OPGCL, BANHARPALLI, DIST. – JHARSUGUDA, ODISHA.

GEOTECHNICAL INVESTIGATION REPORT - VOLUME-II

OWNER: ORRISA POWER GENERATION CORPORATION LIMITED, ODISHA

CLIENT: BGR ENERGY SYSTEMS LTD, CHENNAI

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CONTENTS

1.0 INTRODUCTION

M/s BGR Energy Systems Limited has awarded the Soil Investigation works for the proposed 2X660 MW Unit # 3 & 4 – IB Thermal Power Project, Odisha to M/s Soil Engineering Consultants, New Delhi. This Volume II report presents the details of Geotechnical investigations carried out for BOP Area and data obtained from various field and laboratory tests, their presentation in graphical form, their computation, compilation, analysis and suitable recommendation made as regards to type of foundations to be adopted for the Plant structures.

2.0 SCOPE OF WORK

a) Drilling bore holes upto the maximum depth of 25.0 m by Shell and auger method or up to refusal. Beyond refusal strata drilling using Hydraulic Feed Drilling Machine with double tube core barrel and Nx size diamond drilling bits upto specified depth as per IS code of practice and as per the direction of the Engineer-in-Charge.

b) Conducting Standard Penetration tests in the bore holes at regular intervals of 1.50m or change of strata as per IS Code of Practice.

c) Collecting Disturbed / Undisturbed soil samples from the bore holes at regular intervals or change of strata as per IS Code of Practice.

d) Recording of water table level in the bore holes after completion of borehole.

e) Conducting Cyclic Plate Load Test at Five locations.

f) Conducting Electrical Resistivity Tests at Twenty Two Locations.

g) Conducting Cross Hole Shear Test at Two Locations.

h) Conducting Lab CBR Tests for Eight Locations.

i) Conducting all the necessary laboratory tests on the samples collected.

j) Preparation of report summarizing the details of soil classification, analysis of test data, type of foundation etc.

3.0 FIELD WORK

3.1 Boring

Bore holes of 150 mm dia. were drilled by Shell and auger method upto the refusal depth as per IS code of practice and the directions of the Engineer in charge. Refusal was obtained in all the boreholes at varying depths. In refusal strata rotary drilling was resorted by using Hydraulic feed drilling machine with double tube core barrel and Nx size diamond bits as per IS code of practice. The details about the depth of bore holes, co ordinates and RL's are given in Table 1 and also in borelogs.

3.2 Standard Penetration Test (SPT)

Standard Penetration tests were conducted at every 1.50m intervals and every change of strata or wherever possible. The tests were performed by driving into the soil (bore holes cleaned of any loose material) a standard split spoon sampler with the help of a standard hammer of 63.5 kg with a free fall of 75 cms on a driving head as described in IS: 2131. This head was attached to "A" drill rod to the other end of which the sampler was fitted. The number of blows needed to penetrate the first, second and third stages (each of 15 cms) depth of the sampler length, were noted. The number of blows (N- value) as given in the bore hole data sheets is the numerical sum of blows counted during the second & third stage only i.e. for a depth of 30 cms.

3.3 Collection of Samples

Both Disturbed and Undisturbed soil samples, Rock Core Samples were collected from the bore holes.

3.4 Recording of water table

Water table was met in all boreholes at varying depths during the Field investigation which was carried out during the months of Oct, 2103 to Jan 2014. The details are given in the respective bore logs and also at **Table I** Below.

Table I

Location	BH No.	Depth of BH (m)	RL (m)	Co-ordinates		water table (m)
				East	South	
ESP	13A	20.00	198.100	1441.30	1646.80	0.30
ID Fan	15	25.00	199.100	1342.00	1629.00	1.00
FO tank	17	25.00	199.500	1253.00	1857.00	1.40
Cooling Tower	18	25.00	199.100	928.00	790.00	4.10
	19	25.00	197.000	823.00	895.00	3.90
	20	25.00	196.300	741.00	779.00	1.05
	21	25.00	195.700	635.00	884.00	1.25
Stream Filter	22	20.00	194.850	820.00	1000.00	1.15
CWPH	23	25.00	194.950	920.00	1073.00	2.00
Effluent Treatment Plant	24A	20.00	193.500	836.00	1320.00	0.90
DM Plant	25	20.00	199.700	808.00	1484.50	1.10
Coal Settling Pond	26	20.00	198.650	1671.00	2044.00	0.50
Stock Pile	27	15.00	199.400	1371.00	2067.00	0.70
	28	15.00	199.400	1069.00	2067.00	0.50
	35	15.00	199.800	1189.00	2329.00	1.10
Crusher House	29	25.00	199.500	1678.500	2338.00	1.10
Ash Silo	30	25.00	194.200	1926.100	1993.40	0.80
DM Plant Neutralization Pit	31	20.00	199.500	855.00	1565.50	1.10
Main Gate	33	15.00	209.750	1812.00	839.00	1.90

3.5 Electrical Resistivity Test (ERT)

The method is based on the measurement and recording of changes in the apparent specific resistance of various soils. Each type of soil has its own resistivity depending upon water content, compaction and composition the objective of this test is to identify the type of strata. These tests were conducted by using four electrodes. Two electrodes for current and other two electrode for potential measurements. The instruments used for the resistivity survey consists of a) a power source b) Meter to measure current and potential c) Electrodes and cables. For D.C. measurements non polarising electrodes (copper rod in super saturated copper sulphate solutions) are used for potential measurements to eliminate contact potentials. Various electrode configurations are used as per field conveyance.

For the present case 'wenner" method has been used to eliminate the errors of surface in homogeneity. This arrangement consists of four equally spaced electrodes driven approx. 20cms in to the ground. In this method a DC or a very low frequency AC current of known magnitude is passed between, the two outer electrodes, thereby the resistivity of within soil an electric field, whose pattern is determined by the resistivity of the soils present within the field and boundary conditions. The potential drop E, for the surface current flow is measured by means of the inner electrodes. The apparent resistance is given by equation.

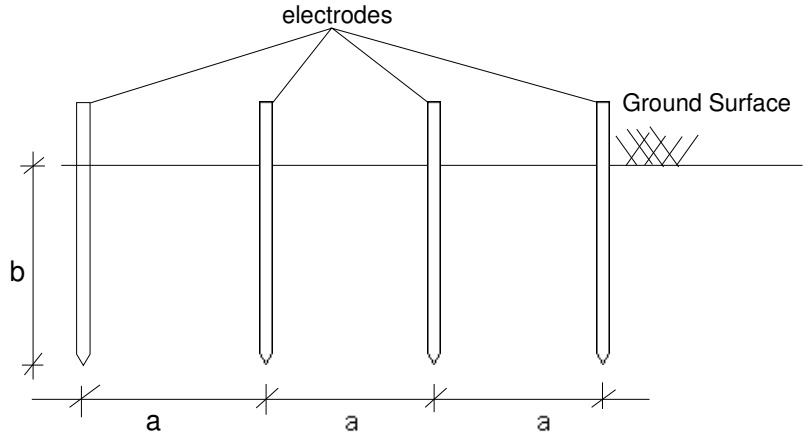
$$\rho = \frac{4\pi aR}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{2a}{\sqrt{4a^2 + 4b^2}}}$$

ρ= apparent Resistance

a= Distance between electrodes

b= Penetration depth of electrodes

R= Resistance



This test was carried out at Twenty Two locations in order to obtain apparent resistance. The apparent resistance calculated from the field observations for each electrodes spacing has been tabulated and given in **Annexure- III & IV.**

3.6 Cyclic Plate Load Test

The test essentially consists of loading the rigid plate, which is placed at founding level in a pit. The width of the pit is equal to five times the size of plate as per IS 1888. After the initial set up the initial readings of the dial gauges are noted and the first increment of the static load is applied. However, before applying next increments, the settlements observed on the plate is 0.02 mm per minutes in difference. The settlements under each load increment have been observed in different time intervals of 1,2.25,4,6.25,9,16,30 minutes and thereafter-hourly increments. In cyclic plate load test The entire load is then removed gradually and the plate allowed to rebound. When no further rebound occurs or the rate of rebound is negligible the settlements are observed again. The cycles of loading , unloading and reloading are continued till the ultimate load is reached. The test was conducted as per the latest code of IS 1888 and IS 5249.

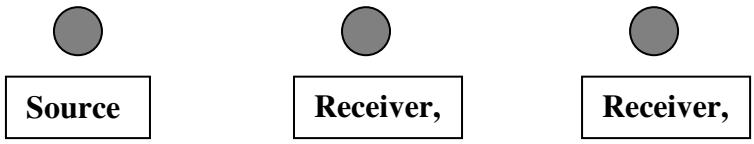
Co Ordinates of CPLT:

CPLT No.	Location	Co-ordinate	
		E	S
CPLT 1	Switch Yard	1440.00	973.50
CPLT 2	Clarified water Reservoir and Pump House	789.70	1463.80
CPLT 3	Boiler	1201.50	1423.50
CPLT 4	ESP	1421.50	1535.00
CPLT 5	Crushed Coal Stock Pile	1380.60	2077.70

3.7 Cross Hole Shear Test

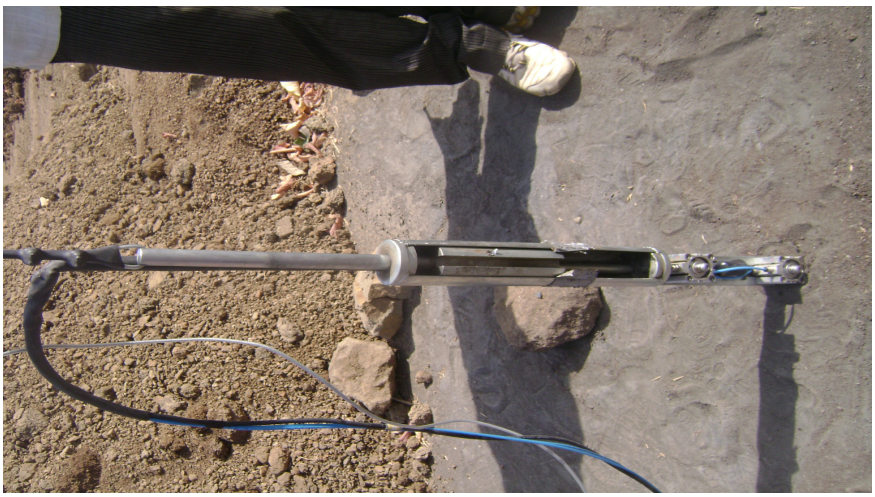
The Cross Hole Seismic test was conducted by generation of horizontally travelling P and S waves at a particular level in one borehole (Source Hole) and recording their arrivals at same level in one or two nearby boreholes (Receiver Holes).

Two Receiver holes were used in linear direction as under:



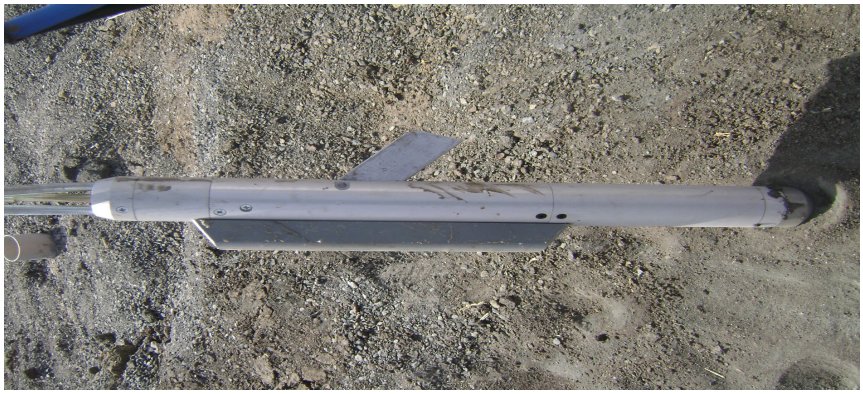
Energy Source:

Shear Wave Hammer was used for generating waves in the Source Borehole. The hammer generates waves in both the directions i.e. Up and Down, resulting in polarized energy.



Downhole Sensors:

Orthogonal Downhole Sensors were used to receive the waves in two Receiver Holes. The Sensors have two horizontal component and one vertical component geophones, encased in a steel tube and having water tight arrangement. The Sensors were lowered at the same depth as the Source, and clamp attached to them was inflated so as to make them in contact with the borehole wall.



SEISMOGRAPH:

Pasi Model 16S24P Engineering Seismograph was used to record field data. The Seismograph has the signal enhancement or stacking capability. The Seismograph records the arrival of Seismic waves through 24 channels. Only 6 channels were used for recording Cross

Hole data. Data was recorded with various sampling frequency rates. The Seismic waves detected by each Geophone are displayed simultaneously on the screen.

Co-ordinates of CHT

CHT No.	Location	Co-ordinate	
		E	S
CHST-1	Power House	1286	1379
CHST-2	Boiler Area	1455	1469

CALCULATION OF SOIL PARAMETERS:

The dynamic soil parameters are calculated from Seismic wave and the Bulk Density of the corresponding of the subsurface strata.

The calculations are based on IS Code 13372 (Part-2).

The Poisson's Ratio is determined directly from the Compressional (P) wave and Shear (S) wave data. It is expressed by the ratio of transverse strain to longitudinal strain. Its dynamic determination is expressed as:

$$\sigma = (m^2-2)/[2*(m^2-1)] \text{ where } m= V_P / V_s$$

Young's Modulus E is the uni-axial stress-strain ratio. Its dynamic value is expressed by the following equation:

$$E = \rho V_P^2 (1+\sigma)(1-2\sigma)/(1-\sigma)$$

The shear Modulus **G** is the stress-strain ratio for simple shear. Its dynamic value is obtained by the following:

$$G = E/2 (1+ \sigma) = \rho V_s^2$$

The Bulk Modulus is calculated using the following equation:

$$K = E / (3-6\sigma)$$

Where **ρ** bulk density in Kg/m^3 is, **σ** is Poisson's ratio and V_P is P-wave velocity in m/sec, **E** & **G** are in N/m^2.

The parameters as derived from Cross Hole data is given at **Annexure II.**

4.0 LABORATORY TESTS

A visual and discrete examination of all the soil / rock samples collected was carried out for deciding the number and type of tests to be tested from each bore hole. Based on the strata met at site the following tests were conducted on samples to classify them and to evaluate their index and Engineering properties.

SOIL SAMPLES

a) Grain size distribution as per IS: 2720(Part IV).
b) Hydrometer Analysis as per IS: 2720(Part IV).
c) Liquid and plastic limits as per IS: 2720(Part V).
d) Specific gravity as per IS : 2720(Part III).
e) Bulk density and dry density as per IS : 2720(Part II).
f) Moisture content as per IS : 2720(Part II).
g) Direct shear test as per IS : 2720(Part XIII)
h) Consolidated Undrained Shear Test as per IS : 2720(Part XII)
i) Consolidation as per IS : 2720(Part XV)
j) Modified compaction Tests as per IS: 2720 (part7) – 1980
k) Soaked CBR Tests based as per IS: 2720 (part16) – 1979
l) Chemical Analysis of soil
   - pH Values as per IS : 2720 (Part XXVI)
   - Sulphates as per IS : 2720 (Part XXVII)
   - Chlorides as per IS : 6925

m) Chemical Analysis of Water
   - pH Values as per IS : 3025 (Part XI)
   - Sulphates as per IS : 3025 (Part XXIV)
   - Chlorides as per IS : 3025 (Part XXXII)

ROCK SAMPLES

Though good core recovery and RQD greater than 20% was obtained the UCS tests could not be conducted as the rock samples on saturation were dissolved. Only Density tests were performed on the samples. The results are given at Annexure I.

5.0 General Geology of the Area

The Project area is situated at Banaharpalli, Jharsuguda district which is in the north western part of Orissa state. It is surrounded by Sundargarh district in the north, Sambalpur in the east, Bargarh in the south and Chhatisgarh state in the West. The Mahanadi reservoir formed by Hirakud Dam is adjacent to the site area block.

The district represents diverse geological sequence, from rocks of Eastern Ghats of Pre- Cambrian age, Iron-ore super group, Gondwana Super group, Laterites to alluvial deposits of Quaternary age.

The generalized Stratigraphic sequence of the formations present over the study area is given in table below:

Table 5.1: Stratigraphic Units/Sequence of Study Area, Orissa

Age	Formation	Thickness(m)	Lithology
Quaternary	Recent	Around 3-15	Alluvial fills, sand , silt deposits and clay of older alluvium, older and younger flood plain deposits, channel fills etc.,
Cenozoic	Laterite	Around 3-5	Laterites, laterised detrital pebble bed.
Upper Permian to Triassic	Undifferentiated Kamthi Formation	Up to 250	Fine to medium grained light to reddish sandstone and shale at the base and pale greenish sand stones with rare shale and pink clay bands, ferruginous coarse grained to pebble sandstone at top.
Lower Permian	Barren Measures Formation		Greenish grey to buff colored pebbly, coarse sandstone with variable proportions of fresh K-feldspar
Lower Permian	Karharbari Formation	Up to 300	Pale brownish yellow colored massive medium to coarse grained sandstone containing clasts of Talchir shale and coal seams
Upper carboniferous to Lower Permian	Talchir Formation	Up to 325	Diamicitie ,sandstone, needle shale, turbidite rhythmite and varves
……Unconformity…….			
Precambrian		-	Granites,gneisses and associated supracrustals

6.0 SOIL & ROCK CHARACTERISTICS

ID Fan

At this location One Borehole (BH 15) was drilled upto 25m depth. From the soil classification it revealed that the strata consists of Filled up soil upto 0.40m depth followed by Sandy Silt with gravel (SM-ML) upto 2.0m depth. Below 2.0m depth the strata consists of Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at 7.0m depth. The refusal strata is classified as highly weathered and fractured yellowish color Sand stone / siltstone upto 12.0m depth followed by highly weathered disintegrated rock upto 24.0m depth. Below 24.0m depth the strata is classified as Highly weathered and slightly fractured sand stone upto the depth drilled. From 7.0m to 12.0m depth the Core recovery is varying from 8% to 30%. From 12.0m and upto 24.0m depth the core recovery is Nil. Below 24.0m depth the core recovery is around 79%. RQD is Nil except from 7.0m to 7.5% (22%) , from 9.0m to 10.50m depth (12%) and from 24m to 25m depth (55%).

FO Tank Storage Area

At this location One Borehole (BH 17) was drilled upto 25m depth. From the soil classification it revealed that the strata consists of Filled up soil upto 2.50m depth followed by Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at 9.0m depth. The refusal strata is classified as highly weathered disintegrated rock upto 10.50m depth followed by Highly weathered and highly fractured yellowish color Sand stone / siltstone upto the depth drilled. The Core recovery is Nil upto 10.50m depth and below 10.50m depth the core recovery is varying from 8% to 44%. RQD is Nil upto 13.50m depth, from 21.0m to 22.50m depth and from 24.0m to 25.0m depth. At other depths RQD is varying from 7% to 24%.

Cooling Tower

At this location Four Boreholes (BH 18 to BH 21) were drilled upto 25m depth. From the soil classification it revealed that the strata consists of Silty clay of Medium Plasticity (CI) upto 5.50m depth followed by Sandy Sit with Gravel (SM-ML) upto the rocky strata . Rocky strata was obtained at varying depths of 2.50m to 7.50m depth.

The refusal strata is classified as highly weathered fractured rock / highly weathered disintegrated rock. The details of each bore hole are as given below:

BH 18

Rocky strata was obtained at a depth of 7.50m below ground surface. The overburden strata is classified as Silty clay of Medium Plasticity (CI) upto 5.50m depth followed by Sandy Sit with Gravel (SM-ML) upto the rocky strata. The refusal strata is classified as highly weathered and fractured yellowish color Sand stone / siltstone upto the depth drilled. The Core recovery is varying from 18% to 58%. RQD is varying from 7% to 35% except from 22.50m to 24.0m depth wherein RQD is Nil.

BH 19

Rocky strata was obtained at a depth of 4.50m below ground surface. The overburden strata is classified as Silty clay of Medium Plasticity (CI) upto 4.50m depth. The refusal strata is classified as highly weathered / moderately weathered and fractured yellowish color Sand stone / siltstone upto the depth drilled except from 18.0m to 24.0m depth wherein the strata is classified as Highly weathered disintegrated rock. The Core recovery is varying from 21% to 96% except from 18.0m to 24.0m depth wherein the core recovery is Nil. RQD is Nil except from 6.0m to 7.50m depth and from 9.0m to 15.0m depth wherein the RQD is varying from 7% to 76%.

BH 20

Rocky strata was obtained at a depth of 2.50m below ground surface. The overburden strata is classified as Silty clay of Medium Plasticity (CI) upto the rocky strata. The refusal strata is classified as highly weathered

and fractured yellowish color Sand stone / siltstone upto the depth drilled. The Core recovery is varying from 23% to 90%. RQD is varying from 8% to 72% except from 4.0m to 5.50m and from 17.50m to 19.0m depth wherein the RQD is Nil.

BH 21

Rocky strata was obtained at a depth of 3.50m below ground surface. The overburden strata is classified as Silty clay of Medium Plasticity (CI) upto the rocky strata. The refusal strata is classified as highly weathered and fractured yellowish color Sand stone / siltstone upto 18.0m depth. Below 18.0m depth the strata is classified as Highly weathered disintegrated rock upto the depth drilled. The Core recovery is varying from 25% to 65% upto 18.0m depth and below 18.0m depth the core recovery is Nil upto the depth drilled. RQD is varying from 7% to 49% except from 3.0m to 4.50m and below 18.0m depth wherein the RQD is Nil.

Stream Filter

At this location One Borehole (BH 22) was drilled upto 20m depth. From the soil classification it revealed that the strata consists of Filled up soil upto 1.0m depth followed by Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at 6.0m depth. The refusal strata is classified as highly weathered and highly fractured sand stone / Silt stone upto the depth drilled. The Core recovery is varying from 15% to 28%. RQD is Nil except from 9.0m to 10.50m depth (13%) , 15.0m to 16.50m depth (16%) and from 19.50m to 20.0m depth(38%).

CWPH

At this location One Borehole (BH 23) was drilled upto 20m depth. From the soil classification it revealed that the strata consists of Sandy Silt with Gravel (SM-ML) upto the rocky strata depth. Rocky strata was obtained at 2.0m depth. The refusal strata is classified as highly weathered and highly fractured / fractured sand stone / Silt stone upto the depth drilled. The Core recovery is varying from 20% to 80%. RQD is varying from 17%

to 56% except from 2.0m to 3.50m depth, from 8.0m to 9.50m depth , from 18.50m depth to 20.0m depth and below 23.0m depth wherein RQD is Nil.

Effluent Treatment Plant / Slush Basin

At this location One Borehole (BH 24A) was drilled upto 20m depth. From the soil classification it revealed that the strata consists of Filled up soil upto 1.5m depth followed by Silty clay of Medium Plasticity (CI) upto the rocky strata depth i.e)4.0m depth. The refusal strata is classified as Highly weathered and highly fractured / fractured sand stone / Silt stone. The Core recovery is varying from 19% to 65%. RQD is varying from 13% to 64% except from 4.50m to 6.0m depth and from 19.50m to 20.0m depth wherein the RQD is Nil.

DM Plant

At this location One Borehole (BH 25) was drilled upto 20m depth. From the soil classification it revealed that the strata consists of Filled up soil upto 1.0m depth followed by Silty clay of Medium Plasticity (CI) upto 4.0m depth. Below 4.0m depth the strata consists of Sandy Silt with Gravel (SM-ML) upto the rocky strata depth. Rocky strata was obtained at 9.0m depth. The refusal strata is classified as highly weathered disintegrated rock upto the depth drilled except from 12.0m to 13.50m depth and from 18.0m to 20.0m depth wherein the strata is classified as Highly weathered and highly fractured sand stone / Silt stone. The Core recovery is Nil upto the depth drilled except from 12.0m to 13.50m depth (14%) and from 18.0m to 20.0m depth (45% to 50%). RQD is Nil upto the depth drilled.

Coal Settling Pond & Over Flow Sump

At this location One Borehole (BH 26) was drilled upto 20m depth. From the soil classification it revealed that the strata consists of Moorum material upto 1.0m depth followed by Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at 5.50m depth.

The refusal strata is classified as Highly weathered and highly fractured yellowish color Sand stone / siltstone upto the depth drilled. The core recovery is varying from 20% to 49%. RQD is varying from 13% to 49% except from 5.50m to 6.0m depth, from 7.50m to 9.0m depth, from 16.50m to 20.0m depth wherein RQD is Nil.

Stock Pile

At this location three Boreholes (BH 27, BH 28 and BH 35) were drilled upto 15m depth. From the soil classification it revealed that the strata consists of non plastic Silty Sand with Gravel (SM) / Sandy Silt with gravel (SM-ML) followed by Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at varying depths of 3.50m to 10.0m depth. The refusal strata is classified as highly weathered disintegrated rock / Highly weathered and fractured rock. The details of classification, Core recovery and RQD are as given below:

BH 27

Rocky strata was observed from 8.50m depth. The overburden strata is classified as alternate layers of Silty Clay of High Plasticity (CH) and non-plastic Silty sand with gravel (SM) upto the rocky strata depth. The rocky strata is classified as Highly weathered disintegrated rock upto 11.50m depth followed by Highly weathered and highly fractured yellowish color Sandstone/siltstone upto the depth drilled. The Core recovery is varying from 8% to 66%. RQD is Nil upto the depth drilled.

BH 28

Rocky strata was observed from 10.0m depth. The overburden strata is classified as non-plastic Silty sand with gravel (SM)/ Silty clay of Medium Plasticity (CI). The rocky strata is classified as Highly weathered and highly fractured / fractured yellowish color Sandstone/siltstone upto the depth drilled with core recovery varying from 13% to 24%. RQD is varying from 7% to 20% upto 13.0m depth. Below 13.0m depth RQD is Nil upto the depth drilled.

BH 35

Rocky strata was observed from 3.50m depth. The overburden strata is classified as Filled up soil upto 0.50m depth followed by Silty clay of Medium Plasticity (CI). The rocky strata is classified as Highly to moderately weathered and slightly fractured yellowish color Sandstone/siltstone. The Core recovery is varying from 27% to 75%. RQD is varying from 17% to 61% upto the depth drilled.

Crusher House

At this location One Borehole (BH 29) was drilled upto 25m depth. From the soil classification it revealed that the strata consists of Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at 5.50m depth. The refusal strata is classified as Highly weathered and highly fractured yellowish color Sand stone / siltstone upto the depth drilled. The core recovery is varying from 21% to 79%. RQD is varying from 12% to 40% except from 7.50m to 9.0m depth wherein RQD is Nil.

Ash Silo

At this location One Borehole (BH 30) was drilled upto 25m depth. From the soil classification it revealed that the strata consists of Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at 1.5m depth. The refusal strata is classified as Highly weathered and fractured rock(Core recovery varying from 8% to 21%) upto the depth drilled except from 7.50m to 10.50m depth wherein the strata is classified as Highly weathered disintegrated rock(Core recovery Nil) . RQD is Nil upto the depth drilled.

DM Neutralisation Plant

At this location One Borehole (BH 31) was drilled upto 20m depth. From the soil classification it revealed that the strata consists of Filled up soil (Road Material) upto 0.50m depth followed by Silty Sand with gravel(SM) / Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at 6.0m depth. The refusal strata is

classified as alternate layers of Highly weathered disintegrated rock(Core recovery Nil) / Highly weathered and highly fractured rock(Core recovery varying from 13% to 30%) upto the depth drilled. RQD is Nil upto the depth drilled.

Main Gate

At this location One Borehole (BH 33) was drilled upto 15m depth. From the soil classification it revealed that the strata consists of Filled up soil upto 0.50m depth followed by Silty Sand with gravel(SM) / Silty clay of Medium Plasticity (CI) upto the rocky strata depth. Rocky strata was obtained at 6.5m depth. The refusal strata is classified as Highly weathered and fractured rock (Core recovery varying from 12% to 55%) upto the depth drilled except from 12.0m to 13.50m depth wherein the strata is classified as Highly weathered disintegrated rock(Core recovery Nil) . RQD is varying from 16% to 41% except from 12.0m to 13.50m depth wherein the RQD is Nil.

CBR TEST RESULTS

Eight Samples of approximately 50kg were collected at specified locations for conducting laboratory CBR tests. On the samples Grain size analysis, Atterberg limits, modified compaction tests were conducted. Plot was drawn between water content and dry density to know the optimum water content and maximum dry density of the soil and are shown in **Fig: OMC 1 to OMC 8**. California Bearing Ratio tests were conducted at optimum water content. Plot was drawn between load and penetration, and shown in **Fig: CBR 1 to CBR 8.** The test results are reported in **Annexure-V.**

7.0 DESIGN CRITERIA

As the refusal stratum has been encountered at shallow depths footing foundation has been analysed. The analysis is based on SPT & ϕ values as there is no core recovery or core recovery is less.

The water table was encountered at shallow depths. The water table was considered at ground level and accordingly correction factor has been considered as 0.50 for design purpose.

An allowable settlements of 25mm and 40mm has been considered for the analysis of footing foundation and raft foundation respectively.

6.1.1 Foundation resting on Non Plastic strata (Based on SPT & ϕ.)

a) Shear failure criteria

The safe bearing pressure from Shear failure criteria can be obtained, using the equation given below as per IS 6403- 1981.

$Qu = q (N_q - 1) S_q D_q I_q + 0.5 B \gamma N_\gamma S_\gamma D_\gamma I_\gamma W$

Where,

B = Width of the footing in m

D_q, D_γ = Depth factors

S_q, S_γ = Shape factors

I_q, I_γ = Inclination factors

N_q, N_γ = Bearing capacity factor

q = Effective overburden pressure at foundation, in t/m^2

W' = Water table correction factor

γ = Bulk unit wt. of foundation soil, in t/m^3

General Shear Failure:

When $\phi > 36$

Local Shear Failure: When $\phi < 28$

The values obtained are falling in between General Shear and Local Shear hence the values have interpolated between the above two as per IS 6403- 1981.

b) Settlements:

a) Soil profiles are given for each borehole. The soil profile, which is likely to cause greater settlements, is to be considered for calculations.

b) The imposed load at the foundation level is likely to compress the soil up to a depth of approximately equal to 1.5B below the foundations.

c) The settlements can be calculated using Fig No 9 of IS: 8009 Part 1 & 2, 1976.

6.1.2 Foundations resting on plastic soil

a) Shear failure criteria

The safe bearing pressure from Shear failure criteria can be obtained, using the equation given below

$Q_{ult} = cN_cs_cd_ci_c$

Where, c = Average cohesion below the foundation in t/m^2

$d_{c\gamma}$ = Depth factor

s_c = Shape factor

i_c = Inclination factor

N_c = Bearing capacity factor

b) Settlements:

When the strata consists of Plastic strata and Non Plastic

i) when the Foundation resting on plastic strata and its influence within the plastic strata the settlements can be obtained using the equation

$S_{t1} = H/(1+e_o)\ C_c \times \text{Log}((P+\delta P)/P)$

Where H =thickness under consideration

e_0=initial void ratio

Where H =thickness under consideration

e_0=initial void ratio

C_c= Co efficient of consolidation

P= Overburden pressure

δP = Increase in the effective stress due to external load

ii) when the foundation resting on plastic strata and its influence passing through plastic and non-plastic strata (Hough's Equation)

$$S_{t1} = H / C_r \times \text{Log} (P + \delta P / P)$$

Where H =thickness under consideration

Cr= Bearing Capacity Factor

P= Overburden pressure

δP = Increase in the effective stress due to external load

8.0 COMPUTATION

BH 13A (ESP)

Footing Foundation

Formation Level @ RL 199.500

Df @ RL 194.00

Shear Failure Criteria

Average cohesion, c = 16.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 16.0 X 5.14 X 1.3 = 106.912 t/m^2

Q_{safe} = 42.76t/m^2

Settlement Criteria

Df @ RL 194.00

Case I

Considering 25 t/m^2 for 25mm Settlement B= 3 m

C_r=110

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(450/110)xLog {((6.250+11.250)/6.25)} <25mm

Df @ RL 194.00

Considering 40 t/m² for 40mm Settlement B= 3 m

C_r=110

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(450/110)xLog {((6.250+18.00)/6.25)} <40mm

Df @ RL 194.00

Considering 25.0 t/m² for 25mm Settlement B= 5 m

C_r=120

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(750/120)xLog {((7.75+11.25)/7.75)} <25mm

Df @ RL 194.00

Considering 40 t/m² for 40mm Settlement B= 5 m

C_r=120

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(750/120)x Log {((7.75+18.00)/7.75)} <40mm

BH 15 (ID Fan)

Footing Foundation

Formation Level @ RL 199.500

Df @ RL 196.00

Shear Failure Criteria

Average cohesion, c = 15.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 15.0 X 5.14 X 1.3 = 100.23 t/m^2

Q_{safe} = 40.09 t/m^2

Settlement Criteria

Case I

Df @ RL 196.00

Considering 14.0t/m^2 for 40mm Settlement B= 3 m

e_0= 0.83 C_c=0.052

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(400/1.83)x0.052Log {((7.0+8.80)/7.00)} <40mm

Df @ RL 196.00

Considering 8.0t/m^2 for 25mm Settlement B= 3 m

e_0= 0.83 C_c=0.052

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(400/1.83)x0.052Log {((7.0+4.80)/7.00)} <25mm

Case II

Df @ RL 196.00

Considering 11.0t/m² for 40mm Settlement B= 5 m

e_0= 0.83 C_c=0.052

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o)\} x\ C_c\ x\ Log\ (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(400/1.83)x0.052Log {((7.0+8.80)/7.00)} <40mm

Df @ RL 196.00

Considering 6.0t/m² for 25mm Settlement B= 5 m

e_0= 0.83 C_c=0.052

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o)\} x\ C_c\ x\ Log\ (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(400/1.83)x0.052Log {((7.0+4.80)/7.0)} <25mm

Df @ RL 195.00

Shear Failure Criteria

Average cohesion, c = 20.0 t/m²

N_c = 5.14, s_c = 1.30; $d_c = i_c$ = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 20.0 X 5.14 X 1.3 = 133.64 t/m²

Q_{safe} = 53.40 t/m²

Settlement Criteria

Df @ RL 195.00

Case III

Considering 22.0t/m² for 40mm Settlement B= 3 m

e_0= 0.83 C_c=0.048

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o)\} x C_c x Log (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(300/1.83)x0.048Log {((8.0+16.0)/8.00)} <40mm

Considering 11.0t/m² for 25mm Settlement B= 3 m

e_0= 0.83 C_c=0.048

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o)\} x C_c x Log (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(300/1.83)x0.048Log {((8.0+8.80)/8.00)} <25mm

Case IV

Df @ RL 195.00

Considering 19.0t/m² for 40mm Settlement B= 5 m

e_0= 0.83 C_c=0.048

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o)\} x C_c x Log (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(300/1.83)x0.048Log {((8.0+15)/8.00)} <40mm

Df @ RL 195.00

Considering 11.0t/m² for 25mm Settlement B= 5 m

e_0= 0.83 C_c=0.048

Settlement below the foundation can be obtained using the following equation,

S_{f1} = {H /(1+e_o) }x C_c x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(300/1.83)x0.048Log {((8.0+8.80)/8.00)} <25mm

Df @ RL 193.00

Shear Failure Criteria

Average cohesion, c = 32.0 t/m²

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

Q_{ult} = c$N_c$$s_c$$d_c$$i_c$N

Substituting the data in the equation given, we get

Q_{ult} = 32 X 5.14 X 1.3 = 213.824 t/m²

Q_{safe} = 85.52 t/m²

Settlement Criteria

Case V

Df @ RL 193.00

Considering 40.0t/m² for 40mm Settlement B= 3 m

C_r= 160

Settlement below the foundation can be obtained using the following equation,

S_{f1} = {H /Cr x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(600/160) Log {((9+18.0)/9.00)} <40mm

Df @ RL 193.00

Considering 30.0t/m² for 25mm Settlement B= 3 m

C_r= 160

Settlement below the foundation can be obtained using the following equation,

S_{f1} = {H /Cr x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(600/160) Log {((9+13.50)/9.00)} <25mm

Case VI

Df @ RL 193.00

Considering 40.0t/m² for 40mm Settlement B= 5 m

C_r= 160

Settlement below the foundation can be obtained using the following equation,

S_{f1} = {H /Cr x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(900/160) Log {((10.50+18.0)/10.50)} <40mm

Df @ RL 193.00

Considering 30.0t/m² for 25mm Settlement B= 5 m

C_r= 160

Settlement below the foundation can be obtained using the following equation,

S_{f1} = {H /Cr x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(900/160) Log {((10.5+13.50)/10.50)} <25mm

BH 17 (FO Tank Storage Area)

PAD Foundation

Formation Level @ RL 199.500

Df @ RL 197.500 **D=8.00m**

Shear Failure Criteria

Average cohesion, c = 6.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 6.0 X 5.14 X 1.3 = 40 t/m^2

Q_{safe} = 16.0 t/m^2

Settlement Criteria

Settlement at the centre

Considering 15.0t/m^2

e_0= 0.83 C_{c1}=0.061 C_{c2}=0.054

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(200/1.83)x0.061Log {((4.0+15.0)/4.0)} = 45.11mm

S_{t2} = {(500/1.83)x0.054Log {((6.5+10.5)/6.5)} = 61.59mm

S_{t3} = {(800/200)Log {((11.0+3.75)/11)} = 5.08mm

Total = 111.78mm

Settlement at the edge

e_0= 0.83 C_{c1}=0.061 C_{c2}=0.054

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(200/1.83)x0.061Log {((4.0+7.5)/4.0)} = 18.30mm

S_{t2} = {(500/1.83)x0.054Log {((6.5+3.9)/6.50)}= 30.11mm

S_{t3} = {(800/200)Log {((11.0+2.75)/11)} = 3.78mm

Total = 52.28mm

BH 19 (Cooling Tower)

Footing Foundation

Formation Level @ RL 196.500

Df @ RL 194.00

Shear Failure Criteria

Average cohesion, c = 13.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 13.0 X 5.14 X 1.3 = 86.86 t/m^2

Q_{safe} = 34.74t/m^2

Settlement Criteria

Df @ RL 194.00

Case I

Considering 20.0 t/m^2 for 40mm Settlement **B= 2 m**

e_0= 0.82 C_c=0.056

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(150/1.82)x0.056Log {((3.0+16.0)/3.00)} <40mm

Df @ RL 194.00

Considering 9.0t/m² for 25mm Settlement **B=2 m**

e_0= 0.82 C_c=0.056

Settlement below the foundation can be obtained using the following equation,

S_{t1} = {H /(1+e_o) }x C_c x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(150/1.82)x0.056Log {((3.0+7.20)/3.00)} <25mm

Case II

Df @ RL 194.00

Considering 18.0t/m² for 40mm Settlement **B= 4 m**

e_0= 0.82 C_c=0.056

Settlement below the foundation can be obtained using the following equation,

S_{t1} = {H /(1+e_o) }x C_c x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(200/1.82)x0.056Log {((3.0+16.2)/3.00)} <40mm

Df @ RL 194.00

Considering 8.0t/m² for 25mm Settlement **B= 4 m**

e_0= 0.82 C_c=0.056

Settlement below the foundation can be obtained using the following equation,

S_{t1} = {H /(1+e_o) }x C_c x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(200/1.82)x0.056Log {((3.0+7.20)/3.00)} <25mm

Footing Foundation

Shear Failure Criteria

Case III

Since the founding strata is of Highly weathered disintegrated rock having Low Core Recovery, hence the strata consider as very dense Soil Strata

Df @ 192.50 **B = 3.00m**

ϕ = 34, ϕ' = 24, average ϕ = 29 F.O.S = 2.5

N_q= 16.44, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} =85.716t/m^2

Q_{safe} = 34.01 t/m^2

Case IV

Df @ 192.50 **B = 5.00m**

ϕ = 34, ϕ' = 24, average ϕ = 29 F.O.S = 2.5

N_q= 16.44, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 93.45 t/m^2 Q_{safe} = 37.38 t/m^2

Settlement Criteria

Df @ RL 192.50	B=3 to 5m
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	40

BH 18, & BH 21 (Cooling Tower)

Footing Foundation

Formation Level @ RL 196.500

Df @ RL 194.00

Shear Failure Criteria

Average cohesion, c = 15.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 15.0 X 5.14 X 1.3 = 100.23 t/m^2

Q_{safe} = 40.09 t/m^2

Settlement Criteria

Case I

Df @ RL 194.00

Considering 25.0 t/m^2 for 25mm Settlement **B= 2 m to 4m**

C_r=150

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = (H / C_r) \times \text{Log } (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(200/150)x Log {((3.0+21.25)/3.00)} <25mm

Df @ RL 194.00

Considering 35.0 t/m^2 for 40mm Settlement **B= 2 m to 4m**

C_r=150

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = (H / C_r) \times \text{Log } (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(200/150)x Log {((3.0+31.50)/3.00)} <40mm

BH 20 (Cooling Tower)

Footing Foundation

Shear Failure Criteria

Formation Level @ RL 196.500

Case I

Since the founding strata is of Highly weathered disintegrated rock having Low Core Recovery, hence the strata consider as very dense Soil Strata

Df @ RL 194.00 **B = 3.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40, S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} =61.16 t/m^2 Q_{safe} = 24.464 t/m^2

Case II

Df @ RL 194.00 **B = 5.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40, S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 70.12 t/m^2 Q_{safe} = 28.048 t/m^2

Settlement Criteria

Df @ RL 194.00	B=3 to 5m
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	40

BH 22 (Stream Filter)

Footing Foundation

Formation Level @ RL 196.50

Df @ RL 192.500

Shear Failure Criteria

Average cohesion, c = 17.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 17.0 X 5.14 X 1.3 = 113.59 t/m^2 Q_{safe} = 45.43 t/m^2

Settlement Criteria

Case I

Df @ RL 192.500

Considering 16.0 t/m^2 for 40mm Settlement B= 2 m

e_0= 0.83 C_c=0.054

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(300/1.83)x0.054x Log {((4.0+7.20)/4. 0)} <40mm

Case II

Df @ RL 192.500

Considering 8.0 t/m^2 for 40mm Settlement B= 4 m

e_0= 0.83 C_c=0.054

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(400/1.83)x0.054x Log {((4.50+5.60)/4.50)} ≈40mm

Footing Foundation

Formation Level @ RL 196.50

Df @ RL 191.50

Shear Failure Criteria

Average cohesion, c = 17.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 17.0 X 5.14 X 1.3 = 113.59 t/m^2

Q_{safe} = 45.43 t/m^2

Settlement Criteria

Case III

Df @ RL 191.50

Considering 22.0 t/m^2 for 40mm Settlement B= 2 m

e_0= 0.83 C_c=0.050

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(300/1.83)x0.050x Log {((4.85+9.90)/4.85)} <=40mm

Case IV

Df @ RL 191.50

Considering 12.0 t/m^2 for 40mm Settlement B= 4 m

e_0= 0.83 C_c=0.050 C_r=160

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

$S_{t2} = \{H /C_r$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(300/1.83)x0.050x Log {((4.85+9.60)/4.85)} = 38.86mm

S_{t2} = {(150/160) Log {((7.50+4.80)/7.50)} = 2.014

S_{t1+} S_{t2} = < 40mm

Footing Foundation

Shear Failure Criteria

Case V

Since the founding strata is of Highly weathered disintegrated rock having Low Core Recovery, hence the strata consider as very dense Soil Strata

Df @ 188.80 **B = 3.00 to 5.00m**

ϕ = 34, ϕ' = 24, average ϕ = 29 F.O.S = 2.5

N_q= 16.44, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q-1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} =85.716t/m^2

Q_{safe} = 34.01 t/m^2

Settlement Criteria

Df @ RL 188.80	B=3 to 5
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	40

BH 23 (CWPH)

Footing Foundation

Formation Level @ RL 196.500

Shear Failure Criteria

Since the founding strata is of Highly weathered disintegrated rock having Low Core Recovery, hence the strata consider as very dense Soil Strata

Case I

Df @ 192.00 **B = 2.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40 , S_q =1.30, S_r = 0.60, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} =70.00t/m^2

Q_{safe} = 28 t/m^2

Case II

Df @ 192.00 **B = 4.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40 , S_q =1.30, S_r = 0.60, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} =77.36 t/m^2

Q_{safe} = 30.94 t/m^2

Settlement Criteria

Df @ RL 192.00	B = 2 to 4
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	40

BH 24A (Effluent Treatment Plant)

Footing Foundation

Formation Level @ RL 195.500

Shear Failure Criteria

Case I

Df @ 189.00 **B = 3.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40 , S_q =1.30, S_r = 0.60, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 99.04 t/m^2

Q_{safe} = 39.61 t/m^2

Case II

Df @ 189.00 **B = 5.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40 , S_q =1.30, S_r = 0.60, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 108.00 t/m^2

Q_{safe} = 43.20 t/m^2

Case III

Df @ 189.00 **B = 8.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40 , S_q =1.30, S_r = 0.60, W' = 0.50

Using the equation

$Q_{ult} = q\,(N_q-1)\,s_q\,d_q\,i_q + 0.5\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$

Substituting the data in the equation given, we get

Q_{ult} = 121.44 t/m^2 Q_{safe} = 48.57 t/m^2

Settlement Criteria

Df @ RL 189.00	
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table correction	10mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	7mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	35.71
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	57.14

BH 25 (DM Plant)

Footing Foundation

Formation Level @ RL 199.500 RL of BH 199.700

Shear Failure Criteria

Case I

Df @ 195.50 **B = 2.00m**

ϕ = 33, ϕ' = 23, average ϕ = 28 F.O.S = 2.5

N_q= 14.72, N_r = 16.72 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\,(N_q-1)\,s_q\,d_q\,i_q + 0.5\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$

Substituting the data in the equation given, we get

Q_{ult} = 72.544 t/m^2 Q_{safe} = 29.05 t/m^2

Case II

Df @ 195.50 **B = 4.00m**

ϕ = 33, ϕ' = 23, average ϕ = 28 F.O.S = 2.5

N_q= 14.72, N_r = 16.72 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 79.23 t/m^2 Q_{safe} = 31.69 t/m^2

Settlement Criteria

DF @ RL 195.50	B=2 to 4
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	40

BH 26 (Coal Settling Pond & Overflow Sump)

Footing Foundation

Formation Level @ RL 199.500

Df @ RL 196.500

Shear Failure Criteria

Average cohesion, c = 3.90 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 3.90 X 5.14 X 1.3 = 26.06 t/m^2

Q_{safe} = 10.42 t/m^2

Settlement Criteria

Case I

Df @ RL 196.500

Considering 9.00t/m² B=2.00 m

e_0= 0.86 C_c=0.062

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c\ x\ Log\ (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(400/1.86)x0.062Log {((4.0+4.05)/4.0)} ≈ 40mm

Case II

Df @ RL 196.500

Considering 8.50t/m² B=4.00 m

e_0= 0.86 C_c=0.062

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = \{H /(1+e_o) \}x\ C_c\ x\ Log\ (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(400/1.86)x0.062Log {((4.0+3.825)/4.0)} = <40mm

Footing Foundation

Df @ RL 194.500

Shear Failure Criteria

Average cohesion, c = 12 t/m²

N_c = 5.14, s_c = 1.30; $d_c = i_c$ = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} =12 X 5.14 X 1.3 = 80.184 t/m^2

Q_{safe} = 32.073 t/m^2

Settlement Criteria

Df @ RL 194.500

Case III

Considering 25.00t/m^2 for 40 mm Settlement B=2.00 m

Cr=50

Settlement below the foundation can be obtained using the following equation,

S_{f1} = {H /C_r x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(300/50)xLog {((5.50+11.25)/5.50)} < 40mm

Case IV

Df @ RL 194.500

Considering 20.00t/m^2 for 25 mm Settlement B=2.00 m

Cr=50

Settlement below the foundation can be obtained using the following equation,

S_{f1} = {H /C_r x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(300/50)xLog {((5.50+9.0)/5.50)} ≈ 25mm

Case V

Df @ RL 194.500

Considering 20.00t/m^2 for 40 mm Settlement B=4.00 m

Cr=50

Settlement below the foundation can be obtained using the following equation,

S_{f1} = {H /C_r x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(150/50)xLog {((4.75+20.0)/4.75)} =24.88 mm

S_{t2} = {(450/120)xLog {((7.75+9.0)/7.75)} =12.55 mm

$S_t = S_{t1} + S_{t2}$ = <40mm

Case VI

Df @ RL 194.500

Considering 12.00t/m² for 25 mm Settlement B=4.00 m

Cr=50

Settlement below the foundation can be obtained using the following equation,

S_{t1} = {H /C_r x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{t1} = {(150/50) x Log {((4.75+12.0)/4.75)} =16.418 mm

S_{t2} = {(450/120) x Log {((7.75+5.40)/7.75)} =8.65 mm

$S_t = S_{t1} + S_{t2} \approx 25$mm

Footing Foundation

Shear Failure Criteria

Case VII

Since the founding strata is of highly weathered disintegrated rock having Low Core Recovery, hence the strata consider as very dense Soil Strata

Df @ RL 193.00 B = 2.00m

ϕ = 34, ϕ' = 24, average ϕ = 29 F.O.S = 2.5

N_q= 16.44, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 81.848 t/m²

Q_{safe} = 32.74 t/m²

Case VIII

Df @ RL 193.00 **B = 4.00m**

ϕ = 34, ϕ' = 24, average ϕ = 29 F.O.S = 2.5

N_q= 16.44, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 89.584 t/m^2 Q_{safe} = 35.836 t/m^2

Settlement Criteria

Df @ RL 193.00	B=2 to 4
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	40

BH 27 (Stock Pile)

Footing Foundation

Formation Level @ RL 199.500

Df @ RL 197.500

Shear Failure Criteria

Average cohesion, c = 8.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 8.0 X 5.14 X 1.3 = 53.456 t/m^2

Q_{safe} = 21.38 t/m^2

Settlement Criteria

Case I

Df @ RL 197.500

Considering 10.0 t/m² for 40mm Settlement **B= 3 m to 5m**

e_0= 0.84 C_c=0.061 C_r=50

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o)\} x\ C_c\ x\ Log\ (P+ \delta P / P)$

$S_{f1} = H /C_r\ x\ Log\ (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(100/1.84)x0.061x Log {((2.50+9.45)/2.50)} =22.52 mm

S_{f2} = {150/50x Log {((3.75+6.00)/3.75)} =12.45mm

S_{f3} = {150/50x Log {((5.50+3.50)/5.50)} =4.27mm

$S_f = S_{f1} + S_{f2} + S_{f3} \approx$ 40mm

Case II

Df @ RL 197.500

Considering 5.0 t/m² for 25mm Settlement **B= 3 m**

e_0= 0.84 C_c=0.061 C_r=50

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o)\} x\ C_c\ x\ Log\ (P+ \delta P / P)$

$S_{f1} = H /C_r\ x\ Log\ (P+ \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(100/1.84)x0.061x Log {((2.50+4.75)/2.50)} = 15.33 mm

S_{f2} = {150/50x Log {((3.75+3.00)/3.75)} =7.66mm

S_{f3} = {150/50x Log {((5.50+3.50)/5.50)} =2.40mm

$S_f = S_{f1} + S_{f2} + S_{f3} \approx$ 25mm

Footing Foundation

Shear Failure Criteria

Case III

Df @ 196.00 **B = 3.00m**

ϕ = 31, ϕ' = 21, average ϕ = 26 F.O.S = 2.5

N_q= 11.85, N_r = 12.54 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 51.792 t/m^2

Q_{safe} = 20.71 t/m^2

Case IV

Df @ RL 196.00 **B = 5.00m**

ϕ = 31, ϕ' = 21, average ϕ = 26 F.O.S = 2.5

N_q= 11.85, N_r = 12.54, S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 56.808 t/m^2 Q_{safe} = 22.7232 t/m^2

Settlement Criteria

Df @ RL 196.00

Considering 20.0 t/m^2 for 40mm Settlement **B= 3 m**

C_r=50

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times \text{Log}\ (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(100/50 Log {((3.50+20)/3.50)} =16.54 mm

S_{t2} = {100/50x Log {((4.50+14.0)/4.50)} =12.28mm

S_{t3} = {150/80x Log {((5.75+7.0)/5.75)} =6.483mm

$S_t = S_{t1} + S_{t2} + S_{t3} < 40mm$

Df @ RL 196.00

Considering 12.0 t/m² for 25mm Settlement **B= 3 m**

C_r=50

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(100/50x Log {((3.50+12)/3.50)} = 12.92 mm

S_{t2} = {100/50x Log {((4.50+7.2)/4.50)} =8.30mm

S_{t3} = {100/50x Log {((5.75+4.20)/5.75)} =4.46mm

$S_t = S_{t1} + S_{t2} + S_{t3} \approx 25$mm

Df @ RL 196.00

Considering 16.0 t/m² for 40mm Settlement **B= 5 m**

C_r=50

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(100/50 Log {((3.50+16)/3.50)} =14.91 mm

S_{t2} = {100/50x Log {((4.50+12.80)/4.50)} =11.69mm

S_{t3} = {150/80x Log {((5.75+10.40)/5.75)} =8.41mm

S_{t4} = {200/100x Log {((7.50+4.50)/7.50)} =4.08mm

$S_t = S_{t1} + S_{t2} + S_{t3} + S_{t4} < 40$mm

Df @ RL 196.00

Considering 8.0 t/m² for 25mm Settlement **B= 5 m**

C_r=50

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(100/50 Log {((3.50+8.0)/3.50)} =10.330 mm

S_{t2} = {100/50x Log {((4.50+6.40)/4.50)} =7.683mm

S_{t3} = {150/80x Log {((5.75+5.20)/5.75)} = 5.24mm

S_{t4} = {200/100x Log {((7.50+2.0)/7.50)} =1.584mm

$S_t = S_{t1} + S_{t2} + S_{t3} + S_{t4} < 25mm$

Footing Foundation

Shear Failure Criteria

Case V

Df @ RL 193.00 **B = 3.00m**

ϕ = 32, ϕ' = 22, average ϕ = 27 F.O.S = 2.5

N_q= 13.20, N_r = 14.47 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q-1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 81.88 t/m^2

Q_{safe} = 32.75 t/m^2

Case VI

Df @ RL 193.00 **B = 5.00m**

ϕ = 32, ϕ' = 22, average ϕ = 27 F.O.S = 2.5

N_q= 13.20, N_r = 14.47 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q-1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 87.66 t/m^2 Q_{safe} = 35.066 t/m^2

Settlement Criteria

Df @ RL 193.00

Considering 30.0 t/m^2 for 40mm Settlement **B= 3 m**

C_r=70

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times \text{Log}\ (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(300/70 Log {((7.50+21)/7.50)} = 24.80 mm

S_{t2} = {150/120x Log {((9.75+7.50)/9.75)} =3.09mm

$S_t = S_{t1} + S_{t2} < 40mm$

Df @ RL 193.00

Considering 25.0 t/m² for 25mm Settlement **B= 3 m**

C_r=70

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times Log (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(300/70x Log {((7.50+17.50)/7.50)} = 22.40 mm

S_{t2} = {150/120x Log {((9.75+6.25)/9.75)} =2.685 mm

$S_t = S_{t1} + S_{t2} < 25mm$

Df @ RL 193.00

Considering 25.0 t/m² for 40mm Settlement **B= 5 m**

C_r=70

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times Log (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(300/70 Log {((7.50+20)/7.50)} =24.23 mm

S_{t2} = {450/130x Log {((11.25+6.25)/11.25)} =6.663mm

$S_t = S_{t1} + S_{t2} < 40mm$

Df @ RL 193.00

Considering 20 t/m² for 25mm Settlement **B= 5 m**

C_r=70

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times \text{Log}\ (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(300/70 Log {((7.50+16.0)/7.50)} =21.05mm

S_{t2} = {450/130x Log {((11.25+5.00)/11.25)} = 4.98mm

$S_t = S_{t1} + S_{t2} < 25mm$

BH 28 (Stock Pile)

Footing Foundation

Formation Level @ RL 199.500

Shear Failure Criteria

Case I

Df @ RL 197.500 **B = 3.00m**

ϕ = 33, ϕ' = 23, average ϕ = 28 F.O.S = 2.5

N_q= 14.72, N_r = 16.72 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q-1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 42.96 t/m² Q_{safe} = 17.18 t/m²

Case II

Df @ RL 197.500 **B = 5.00m**

ϕ = 33, ϕ' = 23, average ϕ = 28 F.O.S = 2.5

N_q= 14.72, N_r = 16.72 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q-1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 49.64 t/m² Q_{safe} = 19.85 t/m²

Settlement Criteria

Df @ RL 197.500	B= 3 to 5
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	9mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	18mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	13.89
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	22.22

Footing Foundation

Formation Level @ RL 199.500

Shear Failure Criteria

Case III

Df @ RL 195.000 **B = 3.00m**

ϕ = 33, ϕ' = 23, average ϕ = 29 F.O.S = 2.5

N_q= 16.44, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 85.716 t/m^2 Q_{safe} = 34.28 t/m^2

Case IV

Df @ RL 195.000 **B = 5.00m**

ϕ = 33, ϕ' = 23, average ϕ = 29 F.O.S = 2.5

N_q= 16.44, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 93.452 t/m^2 Q_{safe} = 37.38 t/m^2

Settlement Criteria

Df @ RL 195.000

Considering 30 t/m² for 40mm Settlement B= 3 m

C_r=80

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(450/80 Log {((6.25+13.50)/6.25)} <40 mm

Df @ RL 195.000

Considering 25.0 t/m² for 25mm Settlement B= 3 m

C_r=80

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(450/80x Log {((6.25+11.25)/6.25)} ≈ 25mm

S_{f2} = {150/120x Log {((9.75+6.25)/9.75)} =2.685 mm

$S_f = S_{f1} + S_{f2} < 25$mm

Df @ RL 195.000

Considering 25.0 t/m² for 40mm Settlement B= 5 m

C_r=80

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = H / C_r \times \text{Log} (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {(450/80 Log {((6.25+18.75)/6.25)} =33.86mm

S_{f2} = {300/120x Log {((10.0+6.25)/10.00)} =5.27mm

$S_f = S_{f1} + S_{f2} <$40mm

Df @ RL 195.000

Considering 14 t/m² for 25mm Settlement **B= 5 m**

C_r=80

Settlement below the foundation can be obtained using the following equation,

$S_{t1} = H / C_r \times \text{Log}\ (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{t1} = {(450/80 Log {((6.25+10.50)/6.25)} =24.08mm

S_{t2} = {300/120x Log {((10.0+3.50)/10.00)} =3.45mm

$S_t = S_{t1} + S_{t2}$ <25mm

BH 35 (Stock Pile)

Footing Foundation

Formation Level @ RL 199.500

Shear Failure Criteria

Case I

Df @ RL 197.500 **B = 3.00m**

ϕ = 33, ϕ' = 23, average ϕ = 28 F.O.S = 2.5

N_q= 14.72, N_r = 16.72 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q-1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 42.96 t/m² Q_{safe} = 17.18 t/m²

Case II

Df @ RL 197.500 **B = 5.00m**

ϕ = 33, ϕ' = 23, average ϕ = 28 F.O.S = 2.5

N_q= 14.72, N_r = 16.72 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q-1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 49.64 t/m² Q_{safe} = 19.85 t/m²

Settlement Criteria

Df @ RL 197.500	B=3 to 5
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	9mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	18mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	13.89
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	22.22

Footing Foundation

Formation Level @ RL 199.500

Shear Failure Criteria

Case I

Since the founding strata is of Highly weathered disintegrated rock having Low Core Recovery, hence the strata consider as very dense Soil Strata

Df @ RL 196.00 **B = 3.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\,(N_q-1)\,s_q\,d_q\,i_q + 0.5\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$

Substituting the data in the equation given, we get

Q_{ult} = 86.52 t/m^2 Q_{safe} = 34.608 t/m^2

Case II

Df @ RL 196.00 **B = 5.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\,(N_q-1)\,s_q\,d_q\,i_q + 0.5\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$

Substituting the data in the equation given, we get

Q_{ult} = 95.46 t/m^2 Q_{safe} = 38.19 t/m^2

Settlement Criteria

Df @ RL 196.00	B=3 to 5
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	40

BH 29 (Crusher House)

Footing Foundation

Formation Level @ RL 199.500

Df= RL 197.500

Shear Failure Criteria

Average cohesion, c = 30.00 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 30.0 X 5.14 X 1.3 = 200.46 t/m^2

Q_{safe} = 80.18 t/m^2

Settlement Criteria

Case I

Df= RL 197.500

Considering 25 t/m^2 for 40mm Settlement B= 3 m to 5m

C_r=100

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = H / C_r$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {750/100x Log {((5.75+11.25)/5.75)} <40mm

Case II

Df= RL 197.500

Considering 20.0 t/m² for 25mm Settlement **B= 3 to 5 m**

C_r=100

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = H / C_r \times \text{Log}\ (P + \delta P / P)$

Using equation

Substituting the data we get.

S_{f1} = {700/100x Log {((5.75+9.00)/5.75)} <25mm

BH 30 (Ash Silo)

Raft Foundation

Formation Level @ RL 199.500

Shear Failure Criteria

Case I

Since the founding strata is of Highly weathered disintegrated rock having Low Core Recovery, hence the strata consider as very dense Soil Strata

Df @ RL 192.50 **B = 6.00m**

ϕ = 35, ϕ' = 25, average ϕ = 30 F.O.S = 2.5

N_q= 18.40, N_r = 22.40 , S_q =1.30, S_r = 0.60, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 65.40t/m²

Q_{safe} = 26.16 t/m²

Settlement Criteria

DF @ RL 192.500	B=6m
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Settlement under footing with a load intensity of 10 t/m^2 with water table, depth and rigidity correction	8mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	31.25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	50

BH 31 (DM Plant Neutralization Pit)

Footing Foundation

Formation Level @ RL 195.500

Shear Failure Criteria

Case I

Df @ RL 193.00 **B = 3.00m**

ϕ = 34, ϕ' = 24, average ϕ = 29 F.O.S = 2.5

N_q= 18.40, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 63.804t/m^2 Q_{safe} = 25.52 t/m^2

Case II

Df @ RL 193.00 **B = 5.00m**

ϕ = 34, ϕ' = 24, average ϕ = 29 F.O.S = 2.5

N_q= 18.40, N_r = 19.34 , S_q =1.20, S_r = 0.80, W' = 0.50

Using the equation

$Q_{ult} = q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + 0.5\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Substituting the data in the equation given, we get

Q_{ult} = 71.54t/m^2 Q_{safe} = 28.616 t/m^2

Settlement Criteria

DF @ RL 193.00	B=3 to 5
Settlement under footing with a load intensity of 10 t/m^2 in dry condition	5mm
Settlement under footing with a load intensity of 10 t/m^2 with water table and depth correction	10mm
Net safe bearing pressure for allowable settlement of 25 mm (t/m^2)	25
Net safe bearing pressure for allowable settlement of 40 mm (t/m^2)	40

BH 33 (Main Gate)

Footing Foundation

Df = 1.50m Natural Ground Level

Shear Failure Criteria

Average cohesion, c = 15.0 t/m^2

N_c = 5.14, s_c = 1.30; d_c = i_c = 1

Using the equation

$Q_{ult} = cN_cs_cd_ci_cN$

Substituting the data in the equation given, we get

Q_{ult} = 15.0 X 5.14 X 1.3 = 100.23 t/m^2

Q_{safe} = 40.09 t/m^2

Settlement Criteria

Case I

Considering 20.0t/m^2 for 40mm Settlement B= 1 m

e_0= 0.83 C_c=0.056

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o) \}x\ C_c$ x Log (P+ δP / P)

Using equation

Substituting the data we get.

S_{f1} = {(150/1.83)x0.056Log {((2.25+11.05)/2.25)} <40mm

Considering 12.0t/m² for 40mm Settlement B= 2 m

e_0= 0.83 C_c=0.056

Settlement below the foundation can be obtained using the following equation,

$S_{f1} = \{H /(1+e_o)\} x C_c x Log (P+ \delta P / P)$

Using equation

Substituting the data we get.

$S_{f1} = \{(300/1.83)x0.056Log \{((3.00+5.40)/3.00)\}$ <40mm

From the Cyclic Plate Load Tests

Modulus of subgrade reaction:

The values of ksf and ksp have been evaluated using the each following equation.

$k_{sf} = k_{sp} (b_p / b_f)$ Where $k_{sp} = q/ s$

q= load intensity

s = settlement

b_f = width of foundation

b_p = width of plate

ksp = modulus of sub grade reaction of plate (kg/cm³)

ksf =modulus of sub grade reaction of foundation (kg/cm³) for maximum foundation area of 10 m² .

The modulus of sub grade reaction has been calculated at different load intensity. The results are as given below.

CPLT No	Load intensity (t/m²)	Ksp (kg/cm³)	Ksf (kg/cm³) (For 10m²)
CPLT 1	10	0.833	0.158
	15	1.00	0.189
CPLT 2	10	1.33	0.252
	15	1.25	0.237
CPLT 3	10	1.66	0.315
	15	1.50	0.284
CPLT 4	10	1.33	0.252
	15	1.25	0.237

DYNAMIC PROPOERTIES OF SOIL

The shape of the foundation has been assumed to be same as that of the plate and the depth of the foundation has been assumed at the test depth and hence no corrections have been applied for Shape and depth

Corrections due to effect of Size:

$C_{u1} / C_{u2} = \sqrt{A_2/A_1}$

C_{u1} = Co-efficient of Elastic Uniform Compression C_u for foundation area of $10m^2$

C_{u2} = Co-efficient of Elastic Uniform Compression C_u for 60cm x 60cm size plate, obtained from CPLT

A_2 = Size of the plate = $0.36m^2$

A_1 = Foundation area of $10m^2$

C_u = Co-efficient of Elastic Uniform Compression

$C\tau$ = Co-efficient of Elastic Uniform Shear

$C\phi$ = Co-efficient of Elastic Non Uniform Compression

$C\psi$ = Co-efficient of Elastic Non Uniform shear

Substituting the values we get

	CPLT 1	CPLT 2	CPLT 3	CPLT 4
C_u for foundation area of $10m^2$ (Kg/cm^3)	1.875	5.71	2.50	3.75
$C\tau$ for foundation area of 10m(Kg/cm^3) = $C_u/1.50$	1.250	3.80	1.66	2.50
$C\phi$ for foundation area of $10m^2$ (Kg/cm^3) = 3.46 $C\tau$	4.325	13.17	5.766	8.85
$C\psi$ for foundation area of $10m^2$ (Kg/cm^3) = 1.50 $C\tau$	1.875	5.71	2.50	3.75

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9.0 RECOMMENDATIONS

Footing Foundation is recommended. The depth of foundation, width of foundation and the safe bearing pressure are as given below:

Structures	BH	Df @ RL	Width of Fdn (m)	Safe Bearing pressure (t/m^2) for allowable settlements of	
				25mm	40mm
ESP	13A	194.00	3 to 5	25	40
ID FAN	15	196.00	3	8	14
			5	6	11
		195.00	3	11	22
			5	11	19
		193.00	3	30	40
			5	30	40
Cooling Tower	18 & 21	194.00	2 to 4	25	35
	19	194.00	2	9	20
			4	8	18
		192.50	3	24	24
			5	24	24
	20	194.00	2	24	24
			4	24	24
STREAM FILTER	22	192.50	2	-	16
			4	-	8
		191.50	2		22
			4		12
		188.80	3 to 5	25	30
CWPH	23	192.00	2	25	28
			4	25	30

Structures	BH	Df @ RL	Width of Fdn (m)	Safe Bearing pressure (t/m^2) for allowable settlements of	
				25mm	40mm
Effluent Treatment Plant	24 A	189.00	3	35	39
			5 to 8	40	43
DM Plant	25	195.50	2	25	28
			4	25	30
Coal Settling Pond	26	196.50	2	-	9
			4	-	8.5
		194.50	2	20	25
			4	12	20
		193.00	2 to 4	25	30
Stock Pile	27	197.50	3 to 5	5.0	10
		196.00	3	12	20
			5	8	16
		193.00	3	25	30
			5	20	25
	28	197.50	3	13	18
			5	13	18
		195.00	3	25	30
			5	14	25
	35	197.50	3	13	18
			5	13	18
		196.00	3 to 5	25	30
Crusher House	29	197.50	3 to 5	20	25
DM Plant Neutralization pit	31	193.00	3 to 5	25	25
Main Gate	33	1.50m ground Level	1	-	20
			2	-	12

FO Tank (BH 17)

Pad foundation is recommended @ RL 197.50. A Net safe bearing pressure of 15 t/m^2 can be taken for the design of 8.0m dia pad Foundation with settlements of 112mm and 53mm at Center and Edge respectively. While hydro testing the tanks, loading can be done at eight stages. At each stage of load increment, the settlements shall be stabilised.

Ash Silo (BH 30)

Raft Foundation is recommended at RL 192.50.A net Safe bearing pressure of 26 t/m^2 can be taken for the design of Raft foundation for an allowable settlement of 40mm.

DYNAMIC PROPERTIES OF SOIL BASED ON CROSS HOLE SHEAR TEST

CHST 1		BH 4	Power House Area			E = 1286 S= 1379		
Depth (m) BGL	Vp (m/s)	Vs (m/s)	Density (kg/m3)	m=Vp/Vs	Poisson Ratio	Young's Modulus (MPa)	Shear Modulus (MPa)	Bulk Modulus (MPa)
2	320	158	1800	2.025	0.339	120.32	44.94	124.41
3	375	186	1800	2.016	0.337	166.50	62.27	170.09
4	512	254	1800	2.016	0.337	310.48	116.13	317.02
5	710	350	1800	2.029	0.339	590.72	220.50	613.38
6	758	375	2000	2.021	0.338	752.61	281.25	774.13
7	975	482	2000	2.023	0.338	1243.66	464.65	1281.72
8	1025	512	2000	2.002	0.334	1398.56	524.29	1402.20
9	1125	560	2000	2.009	0.335	1675.00	627.20	1694.98
10	1230	615	2000	2.000	0.333	2017.20	756.45	2017.20
11	1275	639	2000	1.995	0.332	2176.00	816.64	2162.39
12	1350	685	2000	1.971	0.327	2489.96	938.45	2393.73
13	1550	854	2000	1.815	0.282	3740.10	1458.63	2860.16
14	1768	986	2000	1.793	0.274	4955.43	1944.39	3659.13
15	1985	1125	2000	1.764	0.263	6395.96	2531.25	4505.45

CHST 2 (BH 8)				Boiler Area		E = 1455 S= 1469		
Depth (m) BGL	Vp (m/s)	Vs (m/s)	Density (kg/m3)	m=Vp/ Vs	Poisson Ratio	Young's Modulus (MPa)	Shear Modulus (MPa)	Bulk Modulus (MPa)
2	245	115	1500	2.130	0.359	53.91	19.84	63.59
3	351	165	1500	2.127	0.358	110.93	40.84	130.35
4	439	220	2090	1.995	0.332	269.54	101.16	267.91
5	816	412	2000	1.981	0.329	902.31	339.49	879.06
6	972	496	2000	1.960	0.324	1302.87	492.03	1233.53
7	994	512	2000	1.941	0.319	1383.53	524.29	1277.02
8	1043	524	2150	1.990	0.331	1571.71	590.34	1551.76
9	1120	564	2150	1.986	0.330	1819.37	683.91	1785.08
10	1238	625	2150	1.981	0.329	2232.26	839.84	2175.39
11	1426	726	2080	1.964	0.325	2905.36	1096.32	2767.87
12	1832	934	2080	1.961	0.324	4806.23	1814.50	4561.61
13	1942	1065	2080	1.823	0.285	6062.88	2359.19	4698.85
14	2105	1156	2080	1.821	0.284	7138.47	2779.58	5510.43
15	2354	1350	2080	1.744	0.255	9514.62	3790.80	6471.54

Roads and Pavements

For the design of Raods the CBR value as given in Annexure V may be considered as per the locations.

ERT Result Interpretation

The Electrical Resistivity test are tabulated and given in **Annexure-IV.**

The apparent resistivity in general are in the range of 11 to 75 ohm-m. These data may be used to design electrical grounding systems for various facilities.

The electrical resistivity data may also be used as an indicator for potential for corrosion of buried metallic pipes and other utility lines. We are of the opinion that the potential for corrosion of buried pipes and utility lines is Severe to Moderate.

Backfilling and Compaction

The soil available at site is suitable for back filling. The soil shall be compacted in layers of 150mm to 95% of maximum dry density determined in accordance with IS 2720 Part VII (Standard Proctor).

Excavations

Temporary open cut excavations through soil to about 2 to 3 m may be cut nearly vertically (side slope of 1 vertical on 0.1 to 0.2 horizontal). The excavation should be monitored for stability. In case excessive sloughing or caving occurs, the slopes may be flattened further to ensure stability.

In case of deep excavations due to the presence of high water table proper dewatering shall be resorted to. The dewatering shall be done by pumping from sumps placed outside the excavation area and shall be discharged well clear of the excavated area. The effectiveness of the system and the effects on the behavior of nearby structures shall be checked by monitoring the ground water level and the ground movements.

Aggressiveness of Soil and Ground Water to foundation Concrete

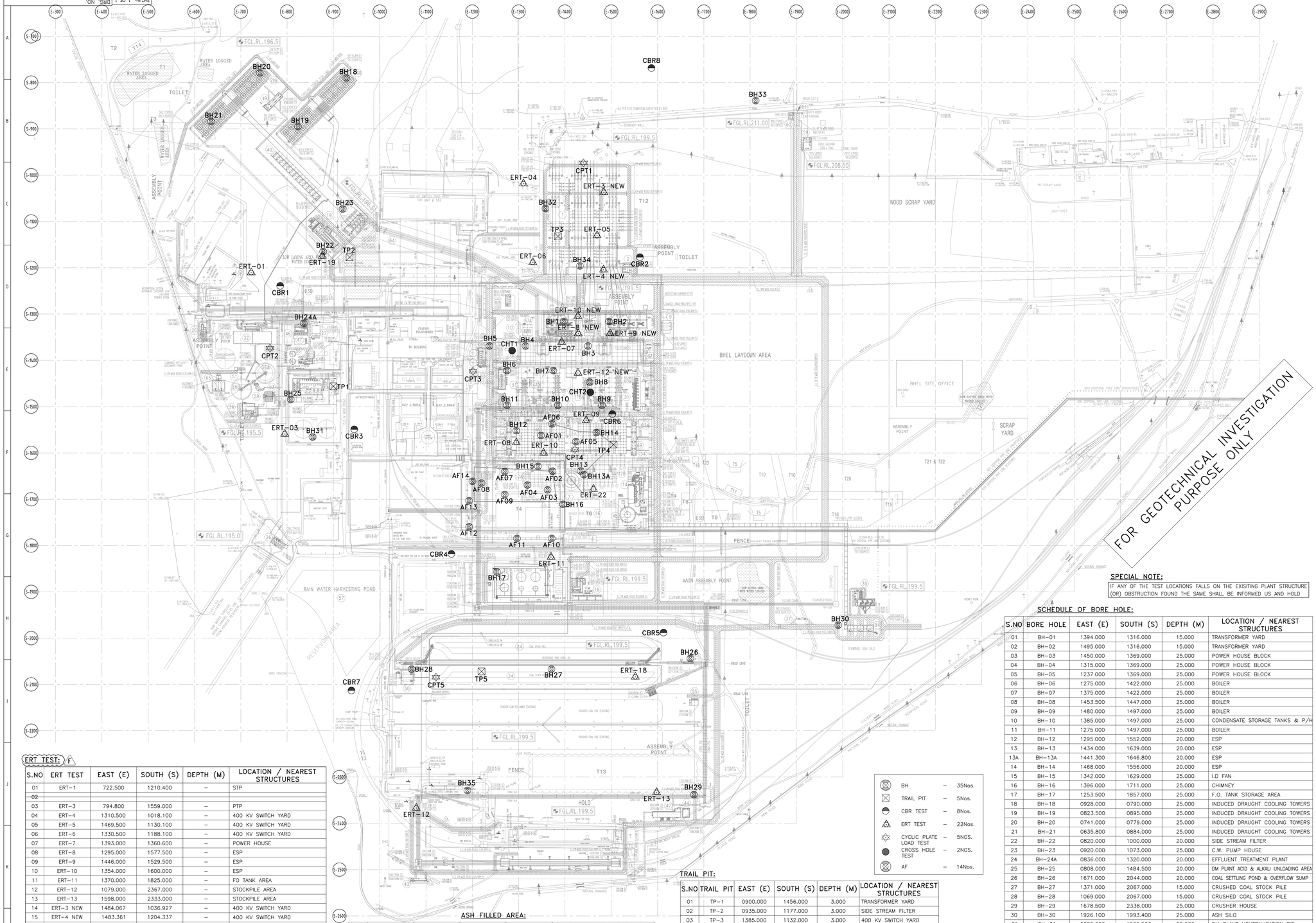
The test results of Chemical Analysis of Soil and Water are given in Annexure VI. From the results it can be seen that the maximum chloride and Sulphate contents are within the permissible limits. Therefore no special precautions are required to be taken for concreting of substructures against chlorides and sulphates.

For Soil Engineering Consultants

(AVS Ranga Rao)
Consultant

FIRST ANGLE PROJECTION

SHT No. 1 OF 1 DRG. NO. GID-208-CV-DWG-3002



S.NO	DESCRIPTION
55	SEPTIC TANK
54	STP COMMON COLLECTION SUMP
53	DM PLANT NEUTRALIZATION PIT
52	AHP VACUUM PUMP HOUSE
51	PTP COMMON SLUDGE SUMP
50	COAL SETTLING POND & OVERFLOW SUMP
49	IDCT MCC ROOM
48	DM PLANT ACID & ALKALI UNLOADING AREA
47	ETP RO-CONCENTRATE TANK
46	ETP RO-PERMEATE TANK
45	AHP CLARIFIER
44	CHP OFFICE BUILDING
43	TRACK HOPPER CONTROL ROOM
42	MAIN CHP CONTROL ROOM
41	CRUSHER HOUSE
40	SIDE STREAM FILTER
39	CHEMICAL HOUSE
38	CPU NUTRALISATION PIT
37	WEIGH BRIDGE
36	WAGON LOADING CONTROL & REMOTE SILO UTILITY BUILDING
35	HCSD PUMP & ART TANK
34	ASH SILO
33	EFFLUENT TREATMENT PLANT
32	CLARIFIED WATER RESERVOIR & PUMP HOUSE
31	NOT USED
30	C.W. PUMP HOUSE
29	INDUCED DRAUGHT COOLING TOWERS
28	PRE-TREATMENT AREA
27	CENTRAL MONITORING BASIN
26	RAW WATER PUMP HOUSE (EXISTING)
25	UNIDIRECTIONAL STACKER CUM RECLAIMER
24	CRUSHED COAL STOCK PILE
23	CPU REGENERATION BUILDING
22	ASH WATER PUMP HOUSE
21	COMPRESSOR HOUSE
20	HYDROGEN GEN. PLANT & STORAGE AREA
19	C.W. TREATMENT CUM CHLORINATION BUILDING
18	F.O. PRESSURISING PUMP HOUSE
17	F.O. TANK FIRM AREA
16	SPACE FOR FGD
15	FIRE WATER TANKS AND PUMPS
14	ASH SLURRY PUMP HOUSE
13	AHP/MILL REJECT SYS. COMPRESSOR HOUSE
12	I.D FAN
11	MILL BAY
10	CONDENSATE STORAGE TANKS & P/H
09	DIESEL GENERATOR BUILDING
08	TRANSFORMER YARD
07	CHIMNEY
06	ESP CONTROL ROOM
05	ESP
04	BOILER
03	POWER HOUSE BLOCK
02	SWITCH YARD CONTROL ROOM
01	400 KV SWITCH YARD

NOTES:

1. ALL DIMENSIONS, LEVELS AND CO-ORDINATES ARE IN METRES.
2. THE ENTIRE PLOT IS ON SAME GRADE LEVEL WHICH IS AROUND 199.5 M ABOVE MEAN SEA LEVEL (MSL).
3. TOP OF FINISHED GROUND FLOOR LEVEL OF POWER HOUSE BUILDING IS AT EL.(±)0.00 WHICH CORRESPONDS TO RL. 200 M.
4. ALL DIMENSIONS AND LOCATION FOR THE NEW BUILDING/PREMISES ARE INDICATIVE ONLY.

SPECIAL NOTE:

IF ANY OF THE TEST LOCATIONS FALLS ON THE EXISITING PLANT STRUCTURE (OR) OBSTRUCTION FOUND THE SAME SHALL BE INFORMED US AND HOLD

LEGENDS:

- ▨ – DENOTES ROADS TO BE CONSTRUCTED FOR THE PROPOSED UNITS.
- ▭ – DENOTES EXISTING ROADS FOR UNITS #1 & #2.
- ▭ – DENOTES PIPE RACK TO BE CONSTRUCTED FOR THE PROPOSED UNITS.
- —— – BURIED PIPE.
- Ⓑ – BORE HOLE

SCHEDULE OF BORE HOLE:

S.NO	BORE HOLE	EAST (E)	SOUTH (S)	DEPTH (M)	LOCATION / NEAREST STRUCTURES
01	BH-01	1394.000	1316.000	15.000	TRANSFORMER YARD
02	BH-02	1495.000	1316.000	15.000	TRANSFORMER YARD
03	BH-03	1450.000	1369.000	25.000	POWER HOUSE BLOCK
04	BH-04	1315.000	1369.000	25.000	POWER HOUSE BLOCK
05	BH-05	1237.000	1369.000	25.000	POWER HOUSE BLOCK
06	BH-06	1275.000	1422.000	25.000	BOILER
07	BH-07	1375.000	1422.000	25.000	BOILER
08	BH-08	1453.500	1447.000	25.000	BOILER
09	BH-09	1480.000	1497.000	25.000	BOILER
10	BH-10	1385.000	1497.000	25.000	CONDENSATE STORAGE TANKS & P/H
11	BH-11	1275.000	1497.000	25.000	BOILER
12	BH-12	1295.000	1552.000	20.000	ESP
13	BH-13	1434.000	1639.000	20.000	ESP
13A	BH-13A	1441.300	1646.800	20.000	ESP
14	BH-14	1468.000	1556.000	20.000	ESP
15	BH-15	1342.000	1629.000	25.000	I.D FAN
16	BH-16	1396.000	1711.000	25.000	CHIMNEY
17	BH-17	1253.500	1857.000	25.000	F.O. TANK STORAGE AREA
18	BH-18	0928.000	0790.000	25.000	INDUCED DRAUGHT COOLING TOWERS
19	BH-19	0823.500	0895.000	25.000	INDUCED DRAUGHT COOLING TOWERS
20	BH-20	0741.000	0779.000	25.000	INDUCED DRAUGHT COOLING TOWERS
21	BH-21	0635.800	0884.000	25.000	INDUCED DRAUGHT COOLING TOWERS
22	BH-22	0820.000	1000.000	20.000	SIDE STREAM FILTER
23	BH-23	0920.000	1073.000	25.000	C.W. PUMP HOUSE
24	BH-24A	0836.000	1320.000	20.000	EFFLUENT TREATMENT PLANT
25	BH-25	0808.000	1484.500	20.000	DM PLANT ACID & ALKALI UNLOADING AREA
26	BH-26	1671.000	2044.000	20.000	COAL SETTLING POND & OVERFLOW SUMP
27	BH-27	1371.000	2067.000	15.000	CRUSHED COAL STOCK PILE
28	BH-28	1069.000	2067.000	15.000	CRUSHED COAL STOCK PILE
29	BH-29	1678.500	2338.000	25.000	CRUSHER HOUSE
30	BH-30	1926.100	1993.400	25.000	ASH SILO
31	BH-31	0855.000	1565.500	20.000	DM PLANT NEUTRALIZATION PIT
32	BH-32	1358.000	1072.000	15.000	400 KV SWITCH YARD
33	BH-33	1812.000	0839.000	15.000	–
34	BH-34	1432.500	1196.000	15.000	TRANSFORMER YARD
35	BH-35	1189.500	2329.000	15.000	CRUSHED COAL STOCK PILE

CBR TEST:

S.NO	CBR TEST	EAST (E)	SOUTH (S)	DEPTH (M)	LOCATION / NEAREST STRUCTURES
01	CBR-1	0785.000	1239.000	0.500	CPU REGENERATION BUILDING
02	CBR-2	1562.000	1177.000	0.500	400 KV SWITCH YARD
03	CBR-3	0945.000	1549.000	0.500	–
04	CBR-4	1155.000	1818.000	0.500	–
05	CBR-5	1613.000	1988.000	0.500	–
06	CBR-6	1502.500	1516.000	0.500	ESP
07	CBR-7	0939.000	2113.000	0.500	–
08	CBR-8	1587.000	0768.500	0.500	–

DO NOT SCALE THE DRAWING — POWER PROJECTS DIVISION

OWNER: ORISSA POWER GENERATION CORPORATION LIMITED

PROJECT: IB THERMAL POWER STATION, BANHARPALI
2 X 660 MW UNITS 3 & 4

OWNER'S CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA . MUMBAI . CHENNAI . NEW DELHI

BOP CONTRACTOR: BGR ENERGY SYSTEMS LIMITED
CHENNAI - INDIA

ERT TEST:

S.NO	ERT TEST	EAST (E)	SOUTH (S)	DEPTH (M)	LOCATION / NEAREST STRUCTURES
01	ERT-1	722.500	1210.400	–	STP
02					
03	ERT-3	794.800	1559.000	–	PTP
04	ERT-4	1310.500	1018.100	–	400 KV SWITCH YARD
05	ERT-5	1469.500	1130.100	–	400 KV SWITCH YARD
06	ERT-6	1330.500	1188.100	–	400 KV SWITCH YARD
07	ERT-7	1393.000	1360.600	–	POWER HOUSE
08	ERT-8	1295.000	1577.500	–	ESP
09	ERT-9	1446.000	1529.500	–	ESP
10	ERT-10	1354.000	1600.000	–	ESP
11	ERT-11	1370.000	1825.000	–	FO TANK AREA
12	ERT-12	1079.000	2367.000	–	STOCKPILE AREA
13	ERT-13	1598.000	2333.000	–	STOCKPILE AREA
14	ERT-3 NEW	1484.067	1036.927	–	400 KV SWITCH YARD
15	ERT-4 NEW	1483.361	1204.337	–	400 KV SWITCH YARD
16	ERT-8 NEW	1428.944	1342.160	–	TRANSFORMER YARD
17	ERT-9 NEW	1497.703	1341.898	–	TRANSFORMER YARD
18	ERT-10 NEW	1427.909	1304.756	–	TRANSFORMER YARD
19	ERT-12 NEW	1428.305	1427.353	–	BOILER
20	ERT-18	1552.055	2083.572	–	CHP
21	ERT-19	876.000	1174.600	–	CWPH
22	ERT-22	1461.716	1678.005	–	AHP

CYCLIC PLATE LOAD TEST:

S.NO	CPL TEST	EAST (E)	SOUTH (S)	DEPTH (M)	LOCATION / NEAREST STRUCTURES
01	CPT-1	1440.000	0973.500	1.000/2.000	400 KV SWITCH YARD
02	CPT-2	0763.000	1373.500	1.000/2.000	CLARIFIED WATER RESERVOIR & PUMP HOUSE
03	CPT-3	1201.500	1423.500	1.000/2.000	BOILER
04	CPT-4	1421.500	1592.500	1.000/2.000	ESP
05	CPT-5	1121.500	2084.500	1.000/2.000	CRUSHED COAL STOCK PILE

ASH FILLED AREA:

S.NO	ASH FILL	EAST (E)	SOUTH (S)	DEPTH (M)	LOCATION / NEAREST STRUCTURES
1	AF-01	1348.376	1562.168	0.500	ESP AREA
2	AF-02	1373.222	1639.393	4.500	ID FAN
3	AF-03	1362.656	1679.783	5.000	ID FAN
4	AF-04	1319.085	1669.333	4.500	ID FAN
5	AF-05	1423.640	1575.600	2.500	ESP AREA
6	AF-06	1372.100	1536.500	0.500	ESP AREA
7	AF-07	1270.000	1640.000	1.500	AUXILIARY BUILDING
8	AF-08	1220.000	1665.000	2.500	NEAR AUXILIARY BUILDING
9	AF-09	1270.000	1690.000	3.000	NEAR AUXILIARY BUILDING
10	AF-10	1371.700	1784.700	2.800	RE-ROUTED PIPE RACK
11	AF-11	1296.400	1784.700	3.000	RE-ROUTED PIPE RACK
12	AF-12	1193.200	1759.500	4.500	RE-ROUTED PIPE RACK
13	AF-13	1193.000	1703.200	2.500	RE-ROUTED PIPE RACK
14	AF-14	1200.200	1661.300	1.500	RE-ROUTED PIPE RACK

BH	–	35Nos.
TRAIL PIT	–	5Nos.
CBR TEST	–	8Nos.
ERT TEST	–	22Nos.
CYCLIC PLATE LOAD TEST	–	5NOS.
CROSS HOLE TEST	–	2NOS.
AF	–	14Nos.

TRAIL PIT:

S.NO	TRAIL PIT	EAST (E)	SOUTH (S)	DEPTH (M)	LOCATION / NEAREST STRUCTURES
01	TP-1	0900.000	1456.000	3.000	TRANSFORMER YARD
02	TP-2	0935.000	1177.000	3.000	SIDE STREAM FILTER
03	TP-3	1385.000	1132.000	3.000	400 KV SWITCH YARD
04	TP-4	1505.000	1582.000	3.000	ESP
05	TP-5	1220.000	2072.000	3.000	CRUSHED COAL STOCK PILE

CROSS HOLE TEST:

S.NO	TRAIL PIT	EAST (E)	SOUTH (S)	DEPTH (M)	LOCATION / NEAREST STRUCTURES
01	CHT-1	1286.000	1379.000	15.000	POWER HOUSE BLOCK
02	CHT-2	1455.000	1469.000	15.000	POWER HOUSE BLOCK

LEGEND (NOISE MAPPING)

LOCATION	NEARBY VILLAGE	LATITUDE	LONGITUDE	REMARKS
A	BANAHARPALI	21°41'8.6778" N	83°52'19.5486" E	
B	PLANT ENTRY GATE	21°41'43.8498" N	83°51'45.4818" E	
C	BARGARH	21°41'31.902" N	83°51'18.0318" E	
D	BINKA	21°40'51.50" N	83°51'41.25" E	

ZONE	REV	DESCRIPTION	DATE	CIVIL	MECH.	ELEC.	HPCE
	F	REVISED AS MARKED AS EXECUTED	08.09.15				
	E	REVISED BASED ON OPGCL/DCPL COMMENTS ISSUED VIDE LETTER NO. OPGC/BOP/0321 DATED. 13.02.14	02.05.14	-Sd-	-Sd-	-Sd-	-Sd-
	D	REVISED BASED ON DCPL COMMENTS VIDE EMAIL DATED: 11.02.14	21.02.14	-Sd-	-Sd-	-Sd-	-Sd-
	C	REVISED AS PER LATEST PLOT PLAN DATED: 21.12.13	22.01.14	-Sd-	-Sd-	-Sd-	-Sd-
	B	REVISED FOR NEW ERT LOCATIONS AS PER 2013.09.05 BGRE-S-MOM.	07.09.13	-Sd-	-Sd-	-Sd-	-Sd-
	A	ISSUED FOR APPROVAL	22.07.13	-Sd-	-Sd-	-Sd-	-Sd-

REVISIONS — APPROVED

	NAME	SIGN	DATE
DRN.	NK/MMR	-Sd-	22.07.13
PRP.	GM	-Sd-	22.07.13
CHD.	SPR	-Sd-	22.07.13
APPD.	JV/TVBSSM	-Sd-	22.07.13

SHEET: A0 — NO.OF VAR.: N.A.

DEPT. / CODE. — UNTOL. DIMS: ±X, ±M/C — SCALE: 1:3000 — WEIGHT (KG): N.A. — REF. TO ASSY. DRG.: N.A. — ITEM NO.: N.A. — NO.OF ITEMS: N.A.

TITLE: LAYOUT PLAN FOR BORE HOLES & OTHER FIELD TESTS LOCATION.

CARD CODE: -NA- — DRAWING NO.: GID-208-CV-DWG-3002 — REV.: F

SHT. No. 1 OF 1

FILE NAME:- GID-208-CV-DWG-3002

Annexure I

ROCK TEST RESULT

S.No	Location	BH No	Depth (m)		Density (t/m^3)
			From	To	
1	Cooling Tower	18	7.50	9.00	2.37
2			9.00	10.50	2.85
3			12.00	13.50	2.59
4			13.50	15.00	2.31
5			15.00	16.50	2.29
6			16.50	18.00	2.22
7			18.00	19.50	2.23
8			21.00	22.50	2.32
9			22.50	24.00	2.37
10		19	6.00	7.50	2.22
11			7.50	9.00	2.23
12			9.00	10.50	2.23
13			10.50	12.00	2.31
14			12.00	13.50	2.25
15			13.50	15.00	2.23
16		20	2.50	4.00	2.27
17			4.00	5.50	2.43
18			7.00	8.50	2.30
19			8.50	10.00	2.70
20		21	3.00	4.50	1.87
21			4.50	6.00	1.94
22			6.00	7.50	2.00
23			7.50	9.00	1.97
24			9.00	10.50	2.33
25			10.50	12.00	1.97
26			12.00	13.50	2.07
27			13.50	15.00	2.20
28	Stream Filter	22	9.00	10.50	2.31
29			10.50	12.00	2.35
30			12.00	13.50	2.36
31			13.50	15.00	2.21
32			15.00	16.50	2.26
33	CWPH	23	3.50	5.00	2.06
34			5.00	6.50	2.24
35			6.50	8.00	2.24
36			8.00	9.50	2.39
37			9.50	12.50	2.26
38			12.50	14.00	2.29
39			14.00	15.50	2.40
40			15.50	17.00	2.31
41			17.00	18.50	2.41
42			18.50	20.00	2.21
43			20.00	23.00	2.25
44			23.00	25.00	2.33

S.No	Location	BH No	Depth (m)		Density (t/m^3)
			From	To	
45	Coal Settling Pond	26	6.00	7.50	1.83
46			7.50	9.00	2.00
47			9.00	10.50	2.09
48			10.50	12.00	2.21
49			12.00	13.50	2.07
50			13.50	15.00	2.03
51			15.00	16.50	2.09
52			16.50	18.00	2.00
53	Crusher House	29	6.00	7.50	2.07
54			7.50	9.00	2.11
55			9.00	10.50	2.14
56			10.50	12.00	2.13
57			12.00	13.50	2.14
58			13.50	15.00	2.25
59			15.00	16.50	2.17
60			16.50	18.00	2.17
61			18.00	19.50	2.30
62			19.50	21.00	2.29
63			21.00	22.50	2.18
64			22.50	25.00	2.20
65	DM Plant	31	7.50	9.00	2.11
66			9.00	10.50	2.11
67			10.50	12.00	2.14
68	Main Gate	33	6.00	7.50	1.92
69			7.50	9.00	1.91
70			9.00	10.50	1.94
71			10.50	12.00	1.88
72			13.50	15.00	2.03
73	Stock Pile	35	3.00	4.50	1.86
74			4.50	6.00	1.80
75			6.00	7.50	2.07
76			7.50	9.00	2.30
77			9.00	10.50	2.15

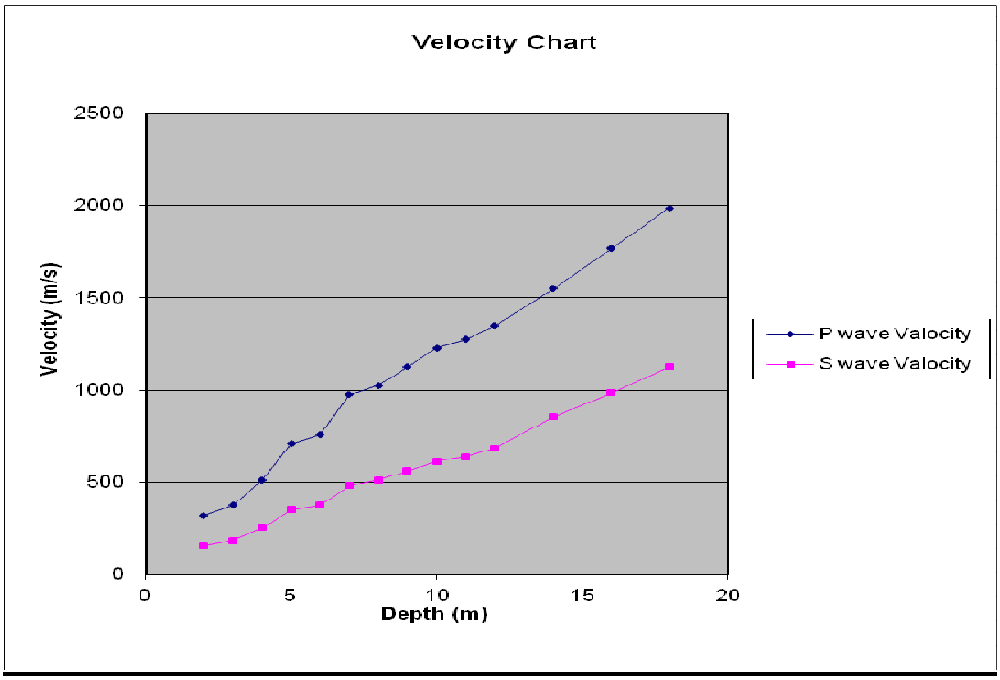
Annexure II

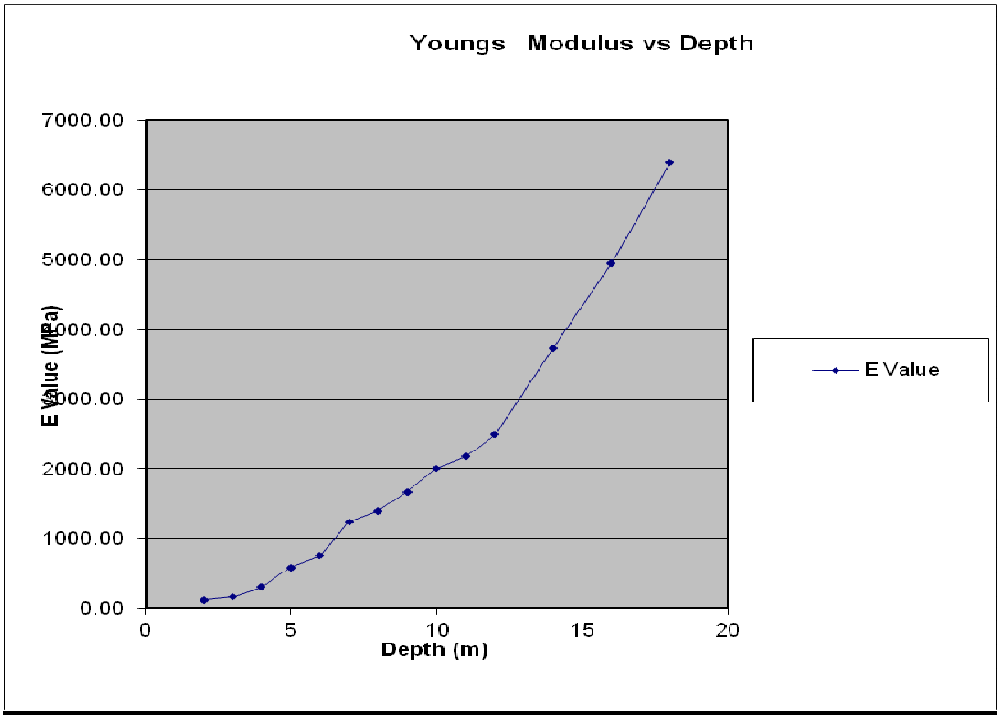
CHST TEST RESULTS

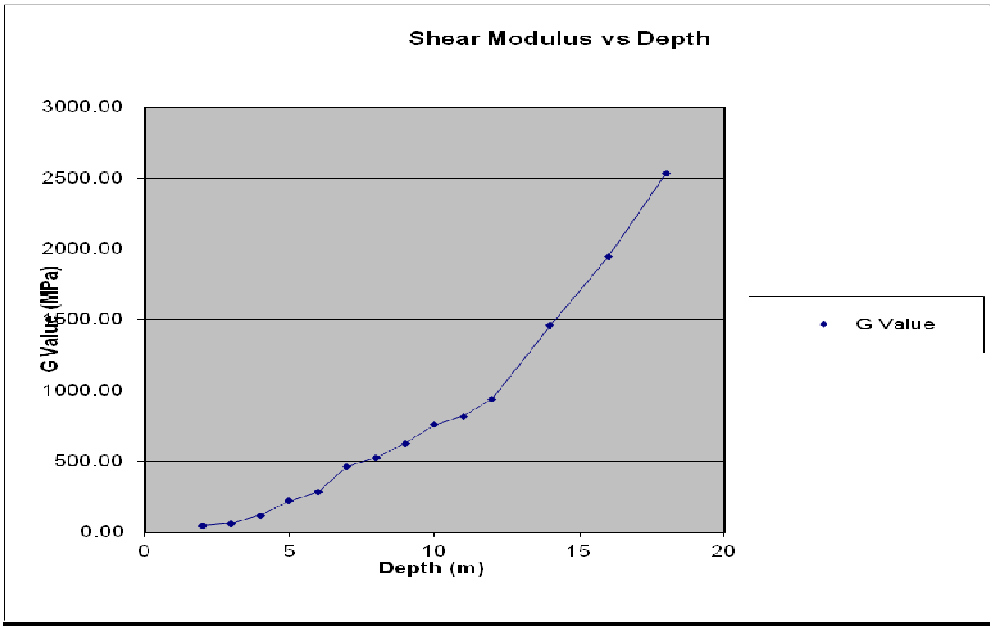
CHST 1		BH 4	Power House Area			E = 1286 S= 1379		
Depth (m) BGL	Vp (m/s)	Vs (m/s)	Density (kg/m3)	m=Vp/Vs	Poisson Ratio	Young's Modulus (MPa)	Shear Modulus (MPa)	Bulk Modulus (MPa)
2	320	158	1800	2.025	0.339	120.32	44.94	124.41
3	375	186	1800	2.016	0.337	166.50	62.27	170.09
4	512	254	1800	2.016	0.337	310.48	116.13	317.02
5	710	350	1800	2.029	0.339	590.72	220.50	613.38
6	758	375	2000	2.021	0.338	752.61	281.25	774.13
7	975	482	2000	2.023	0.338	1243.66	464.65	1281.72
8	1025	512	2000	2.002	0.334	1398.56	524.29	1402.20
9	1125	560	2000	2.009	0.335	1675.00	627.20	1694.98
10	1230	615	2000	2.000	0.333	2017.20	756.45	2017.20
11	1275	639	2000	1.995	0.332	2176.00	816.64	2162.39
12	1350	685	2000	1.971	0.327	2489.96	938.45	2393.73
13	1550	854	2000	1.815	0.282	3740.10	1458.63	2860.16
14	1768	986	2000	1.793	0.274	4955.43	1944.39	3659.13
15	1985	1125	2000	1.764	0.263	6395.96	2531.25	4505.45

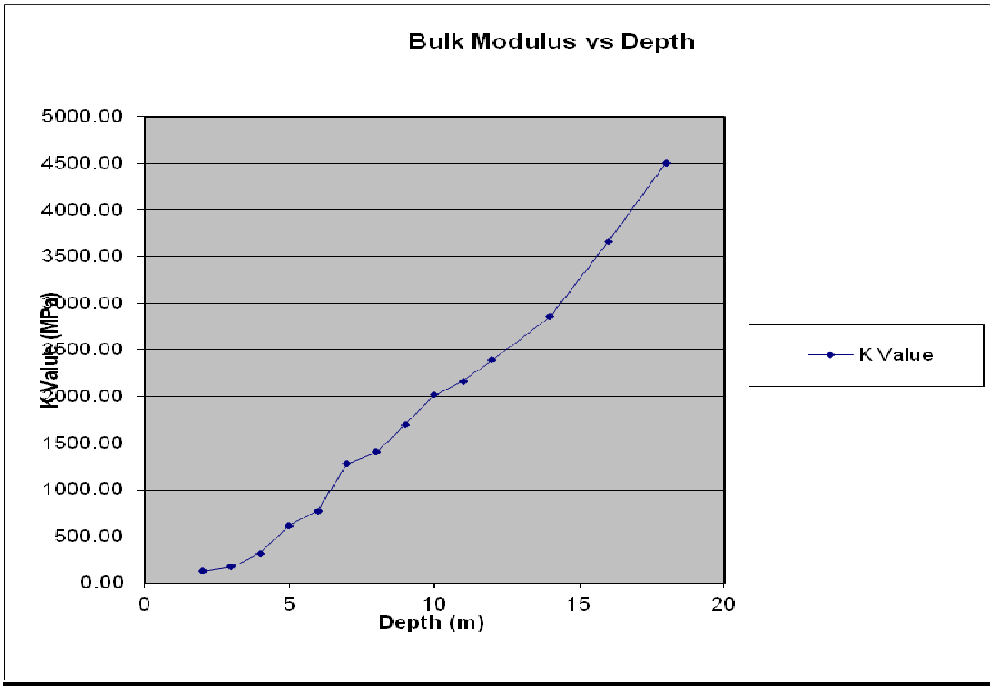
CROSS HOLE SHEAR TEST GRAPHS

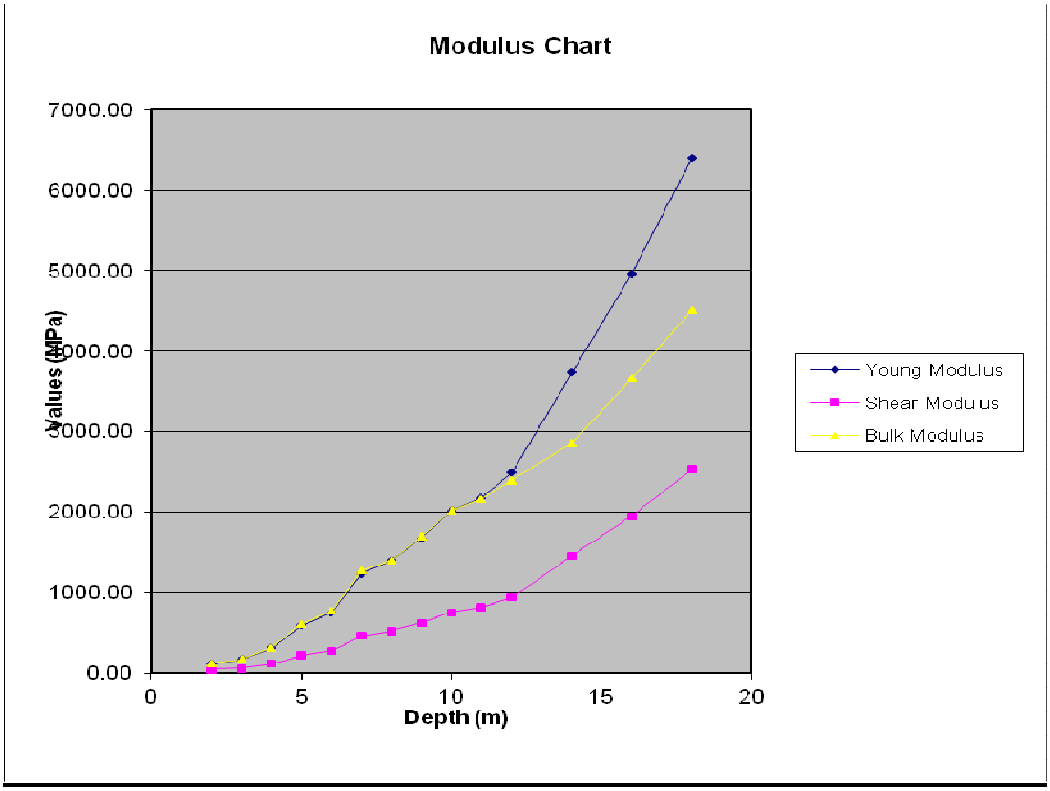
CHST 1 (BH 4)






Shear Modulus vs Depth
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
G Value (MPa)
0
5
10
15
20
Depth (m)
G Value

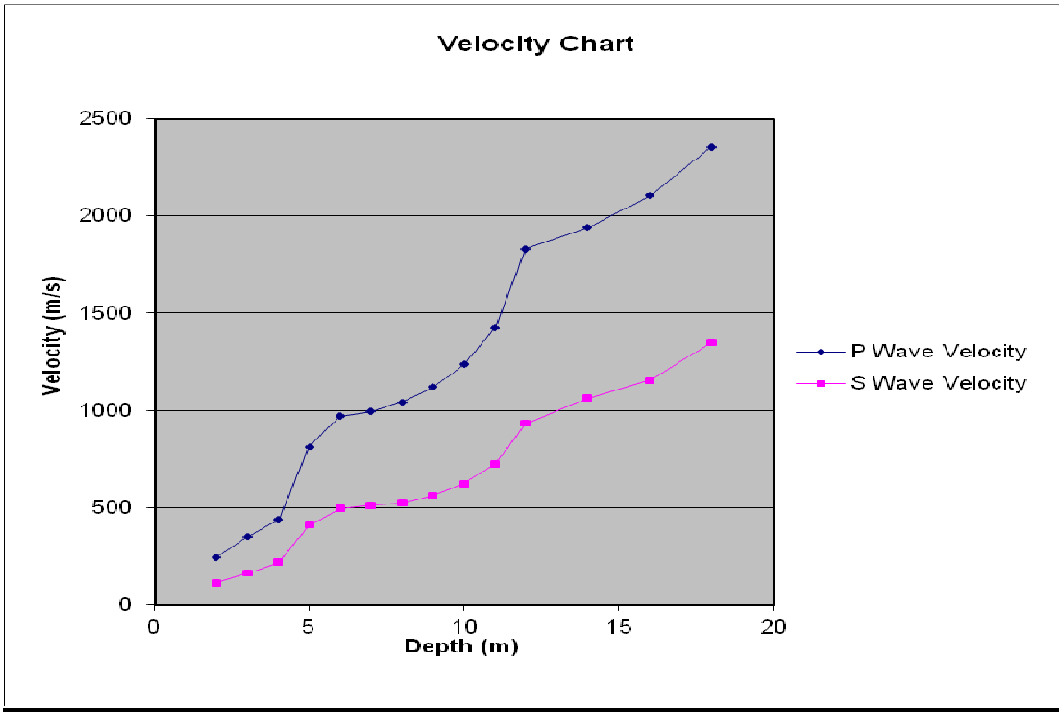

Bulk Modulus vs Depth
5000.00
4500.00
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
K Value (MPa)
0
5
10
15
20
Depth (m)
K Value

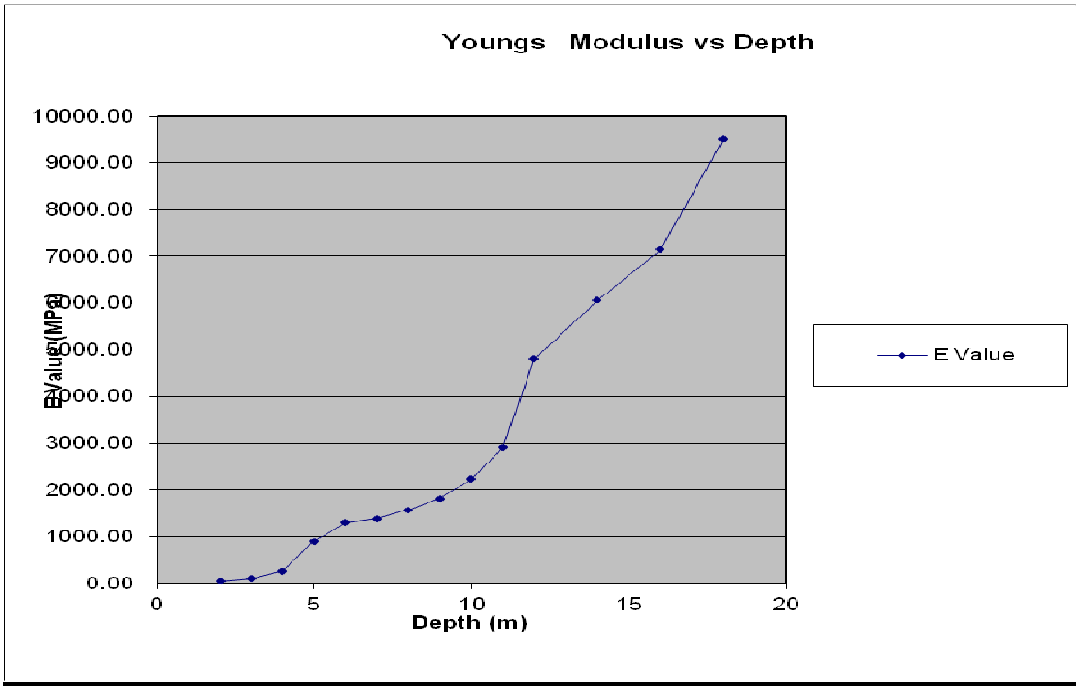

Modulus Chart
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
Values (MPa)
0
5
10
15
20
Depth (m)
Young Modulus
Shear Modulus
Bulk Modulus

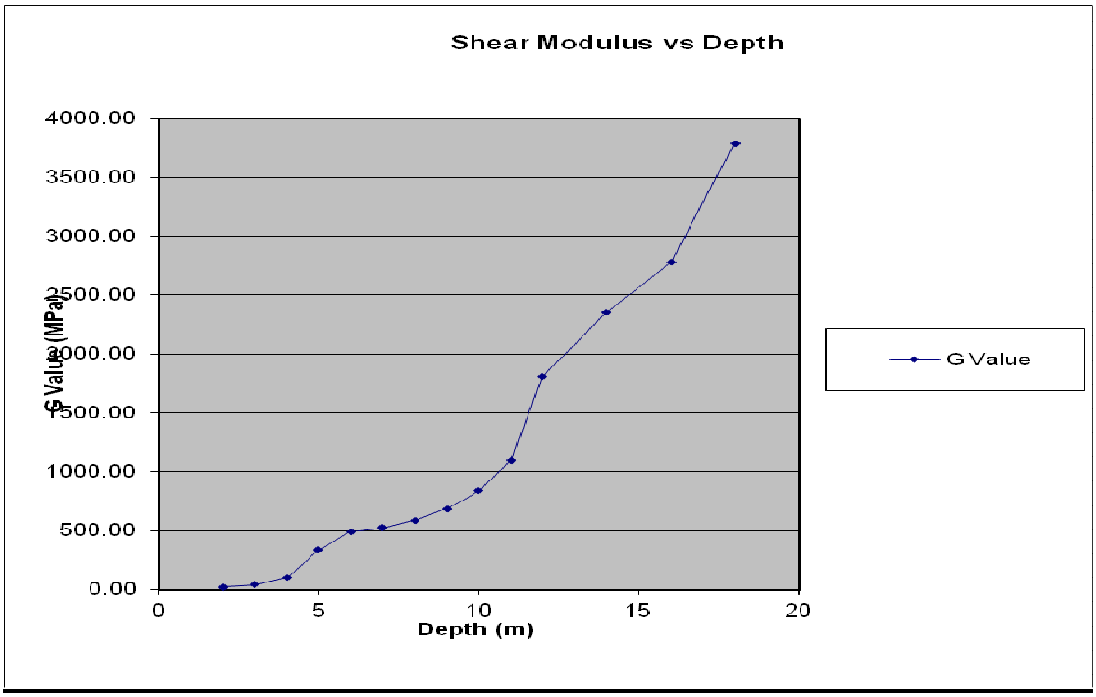
CHST 2 (BH 8)				Boiler Area		E = 1455 S= 1469		
Depth (m) BGL	Vp (m/s)	Vs (m/s)	Density (kg/m3)	m=Vp/ Vs	Poisson Ratio	Young's Modulus (MPa)	Shear Modulus (MPa)	Bulk Modulus (MPa)
2	245	115	1500	2.130	0.359	53.91	19.84	63.59
3	351	165	1500	2.127	0.358	110.93	40.84	130.35
4	439	220	2090	1.995	0.332	269.54	101.16	267.91
5	816	412	2000	1.981	0.329	902.31	339.49	879.06
6	972	496	2000	1.960	0.324	1302.87	492.03	1233.53
7	994	512	2000	1.941	0.319	1383.53	524.29	1277.02
8	1043	524	2150	1.990	0.331	1571.71	590.34	1551.76
9	1120	564	2150	1.986	0.330	1819.37	683.91	1785.08
10	1238	625	2150	1.981	0.329	2232.26	839.84	2175.39
11	1426	726	2080	1.964	0.325	2905.36	1096.32	2767.87
12	1832	934	2080	1.961	0.324	4806.23	1814.50	4561.61
13	1942	1065	2080	1.823	0.285	6062.88	2359.19	4698.85
14	2105	1156	2080	1.821	0.284	7138.47	2779.58	5510.43
15	2354	1350	2080	1.744	0.255	9514.62	3790.80	6471.54

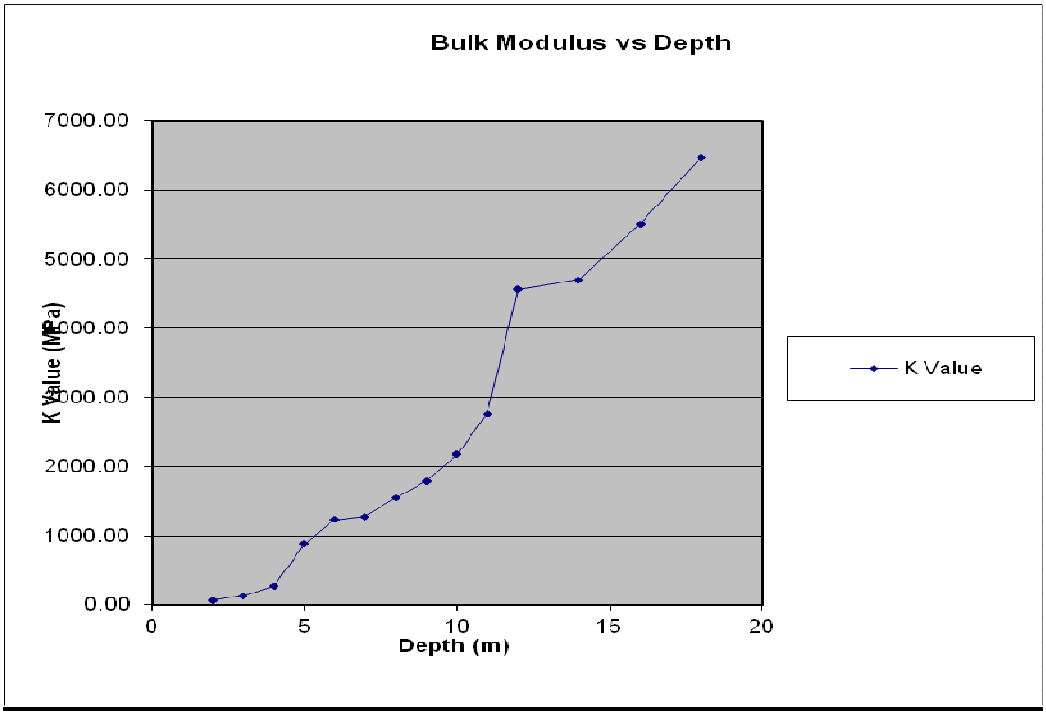
CROSS HOLE SHEAR TEST GRAPHS

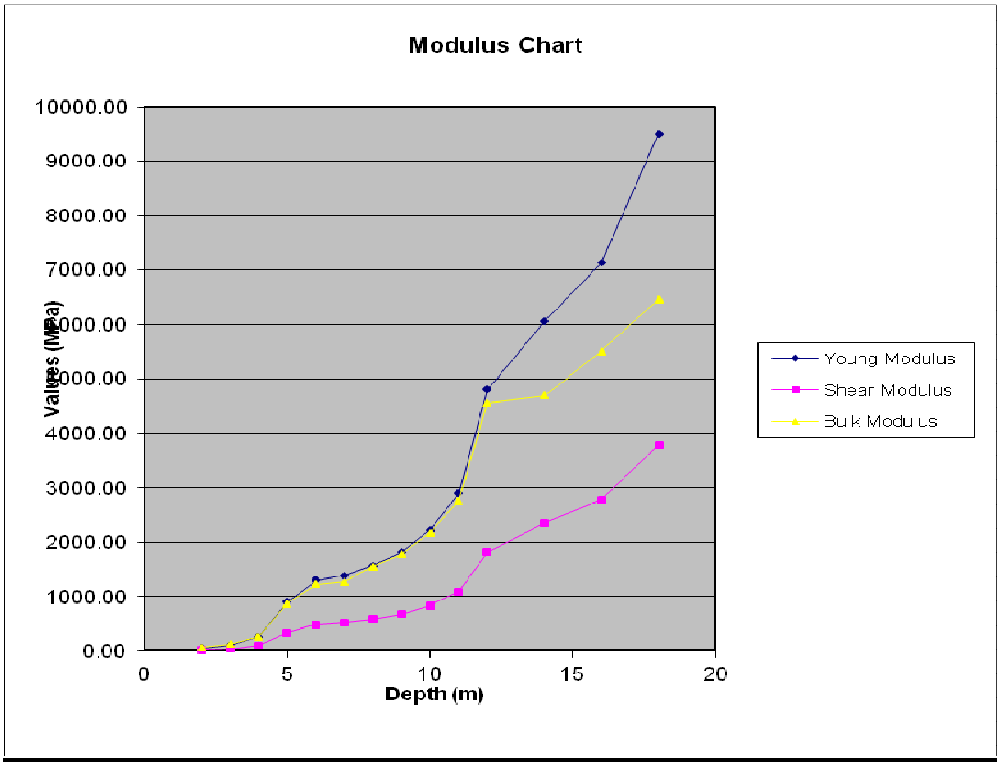
CHST 2 (BH 8)






Shear Modulus vs Depth
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
G Value (MPa)
0
5
10
15
20
Depth (m)
G Value


Bulk Modulus vs Depth
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
K Value (MPa)
0
5
10
15
20
Depth (m)
K Value


Modulus Chart
10000.00
9000.00
8000.00
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
Values (MPa)
0
5
10
15
20
Depth (m)
Young Modulus
Shear Modulus
Bulk Modulus

Electrical Resistivity Test Results

Annexure III

ERT - 1	Location: STP		E 772.50, S 1210.400	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	1059.50	221.50	32.02
	200	432.50	307.00	18.00
	400	38.50	81.50	11.92
	600	86.50	258.00	12.66
	800	60.50	242.50	12.55
N-S	100	1138.00	224.00	34.01
	200	279.00	264.00	13.50
	400	191.00	295.50	16.31
	600	143.50	315.00	17.20
	800	79.50	243.50	16.42
NE-SW	100	1256.00	274.00	30.68
	200	426.50	295.00	18.47
	400	145.00	306.50	11.94
	600	100.00	300.00	12.58
	800	76.00	253.50	15.08
NW-SE	100	901.00	203.00	29.71
	200	305.00	234.50	16.62
	400	121.50	256.50	11.95
	600	94.00	227.50	15.60
	800	72.00	218.00	16.61
NEE-SWW	100	1165.00	322.50	24.18
	200	286.50	232.50	15.74
	400	131.50	338.50	9.80
	600	62.50	215.00	10.97
	800	26.50	93.00	14.33
NWW-SEE	100	1029.00	304.00	22.66
	200	431.00	234.00	23.53
	400	173.00	232.00	18.81
	600	91.00	303.50	11.32
	800	71.00	223.00	16.01

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	1455.00	345.00	28.23
	200	625.00	290.50	27.49
	400	167.50	313.50	13.48
	600	97.50	285.50	12.89
	800	68.50	259.50	13.28
NNW-SSE	100	891.00	200.00	29.82
	200	531.00	341.50	19.87
	400	171.00	293.00	14.72
	600	65.50	184.50	13.40
	800	43.00	192.00	11.26

ERT - 3	Pre Treatment Plant		E 794.800, S 1559.000	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	297.50	22.00	90.52
	200	55.50	13.50	52.53
	400	97.50	53.50	45.98
	600	12.00	7.00	64.72
	800	10.50	7.00	75.44
N-S	100	566.00	31.50	120.28
	200	181.50	27.50	84.32
	400	54.00	30.00	45.41
	600	21.50	21.50	37.75
	800	32.50	54.50	29.99
NE-SW	100	652.00	33.00	132.25
	200	151.00	22.00	87.69
	400	123.00	46.50	66.74
	600	36.50	30.50	45.18
	800	49.00	30.50	80.80
NW-SE	100	219.00	22.50	65.15
	200	141.50	27.00	66.96
	400	62.00	28.00	55.87
	600	37.00	21.50	64.97
	800	55.00	59.50	46.49
NEE-SWW	100	365.50	22.00	111.21
	200	126.00	17.00	94.70
	400	123.50	41.50	75.08
	600	8.50	4.00	80.23
	800	8.00	3.50	114.96
NWW-SEE	100	385.50	19.00	135.81
	200	133.00	21.50	79.04
	400	119.50	46.50	64.84
	600	51.50	33.50	58.04
	800	7.50	8.00	47.15

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	322.50	19.00	113.62
	200	181.50	23.00	100.82
	400	87.00	35.50	61.83
	600	35.00	38.50	34.32
	800	8.50	25.00	17.10
NNW-SSE	100	364.00	30.00	81.22
	200	202.00	35.50	72.70
	400	99.50	64.00	39.22
	600	18.50	30.50	22.90
	800	16.00	36.00	22.35

ERT - 4	Switch Yard		E 1310.500 , S 1018.100	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	14.00	5.00	18.74
	200	5.00	2.00	31.94
	400	5.50	8.00	17.35
	600	41.00	14.50	106.75
	800	13.50	29.50	23.02
N-S	100	27.50	8.00	23.01
	200	112.00	57.00	25.10
	400	89.50	126.00	17.92
	600	81.50	190.00	16.19
	800	69.00	240.00	14.46
NE-SW	100	7.50	4.50	11.16
	200	47.50	5.50	110.34
	400	43.00	123.50	8.78
	600	41.00	218.50	7.08
	800	23.50	245.00	4.82
NW-SE	100	33.00	12.00	18.41
	200	19.00	12.50	19.42
	400	11.50	33.00	8.79
	600	11.50	56.50	7.68
	800	9.50	58.50	8.17
NEE-SWW	100	14.00	5.00	18.74
	200	8.00	7.00	14.60
	400	5.00	12.00	10.51
	600	6.50	18.00	13.63
	800	9.50	34.00	14.05
NWW-SEE	100	24.00	5.00	32.13
	200	10.50	3.00	44.72
	400	8.00	4.50	44.85
	600	7.50	43.50	6.51
	800	12.00	72.50	8.32

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	9.50	4.00	15.90
	200	40.00	13.50	37.86
	400	69.50	160.50	10.92
	600	46.00	202.00	8.60
	800	33.50	226.00	7.46
NNW-SSE	100	25.50	8.00	21.34
	200	7.00	8.00	11.18
	400	51.00	91.50	14.06
	600	18.00	82.00	8.29
	800	20.50	75.50	13.66

ERT - 5	Switch Yard		E 1469.500 , S 1130.100	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	1094.50	173.50	42.23
	200	612.00	152.50	51.27
	400	320.00	172.50	46.80
	600	154.00	202.50	28.71
	800	25.50	73.50	17.45
N-S	100	708.50	112.50	42.16
	200	257.50	133.50	24.64
	400	29.00	185.00	3.95
	600	37.50	294.50	4.81
	800	20.50	197.50	5.22
NE-SW	100	1315.00	282.50	31.16
	200	692.50	156.50	56.53
	400	436.50	236.50	46.57
	600	234.00	240.50	36.73
	800	153.50	308.50	25.03
NW-SE	100	800.00	184.00	29.10
	200	196.50	88.00	28.53
	400	214.00	186.00	29.03
	600	97.00	175.50	20.87
	800	27.00	75.00	18.11
NEE-SWW	100	989.50	178.00	37.21
	200	539.00	171.50	40.15
	400	79.00	60.00	33.22
	600	141.50	170.00	31.42
	800	171.50	265.50	32.49
NWW-SEE	100	633.50	148.00	28.65
	200	78.50	33.00	30.39
	400	89.00	162.50	13.82
	600	66.50	180.50	13.91
	800	96.50	254.00	19.11

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	1455.50	238.00	40.94
	200	430.50	114.50	48.04
	400	268.50	217.50	31.15
	600	217.50	265.00	30.99
	800	120.00	243.00	24.84
NNW-SSE	100	1365.00	234.00	39.05
	200	492.50	164.50	38.25
	400	256.50	224.50	28.83
	600	101.50	142.00	26.99
	800	128.50	270.00	23.94

ERT - 6	Switch Yard		E 1330.500, S 1188.100	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	1836.00	248.00	49.56
	200	918.00	159.00	73.77
	400	363.50	107.00	85.71
	600	108.50	119.00	34.42
	800	26.00	27.50	47.55
N-S	100	1255.00	181.00	46.41
	200	1169.00	204.50	73.03
	400	663.50	181.00	92.48
	600	247.00	129.00	72.29
	800	101.50	146.50	34.85
NE-SW	100	1315.00	190.00	46.33
	200	1424.00	196.00	92.82
	400	805.00	151.50	134.06
	600	650.50	141.50	173.56
	800	507.50	162.50	157.07
NW-SE	100	1241.00	170.00	48.86
	200	911.00	153.00	76.07
	400	677.00	196.00	87.14
	600	523.50	126.00	156.86
	800	299.50	124.50	120.99
NEE-SWW	100	890.50	138.50	43.04
	200	327.00	84.50	49.44
	400	266.50	83.00	81.01
	600	418.50	143.00	110.49
	800	346.50	159.50	109.26
NWW-SEE	100	1266.00	149.50	56.68
	200	556.00	121.00	58.71
	400	429.00	140.00	77.31
	600	292.00	140.50	78.46
	800	212.50	168.50	63.43

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	1717.50	226.00	50.87
	200	904.00	166.50	69.37
	400	725.50	174.50	104.89
	600	671.00	189.00	134.03
	800	351.00	135.50	130.28
NNW-SSE	100	711.50	98.50	48.35
	200	652.50	114.50	72.81
	400	520.00	136.50	96.11
	600	341.00	149.50	86.11
	800	259.50	156.50	83.40

ERT - 7	Power House		E 1393.00, S 1360.600	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	561.00	196.00	19.16
	200	147.00	106.00	17.72
	400	15.00	29.00	13.05
	600	45.00	96.00	17.70
	800	45.50	127.50	17.95
N-S	100	257.50	132.00	13.06
	200	302.00	214.50	17.99
	400	271.50	396.00	17.30
	600	128.50	350.50	13.84
	800	44.50	162.00	13.82
NE-SW	100	239.00	114.00	14.03
	200	507.50	237.50	27.30
	400	215.50	354.00	15.36
	600	33.50	85.00	14.88
	800	46.50	149.50	15.64
NW-SE	100	431.00	133.50	21.61
	200	9.50	6.50	18.67
	400	73.50	119.00	15.58
	600	64.00	148.50	16.27
	800	29.00	96.00	15.19
NEE-SWW	100	300.00	138.00	14.55
	200	83.50	58.50	18.24
	400	78.50	157.50	12.57
	600	48.50	118.00	15.52
	800	23.50	69.00	17.13
NWW-SEE	100	360.50	144.50	16.70
	200	241.50	185.00	16.68
	400	45.50	146.50	7.84
	600	11.00	26.00	15.97
	800	22.50	72.00	15.72

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	71.50	37.50	12.76
	200	60.00	49.50	15.49
	400	185.00	315.50	14.79
	600	157.00	390.50	15.18
	800	27.00	84.00	16.17
NNW-SSE	100	98.00	26.00	25.23
	200	105.00	75.50	17.77
	400	21.00	36.00	14.72
	600	67.50	171.00	14.90
	800	26.50	105.00	12.69

ERT - 8	ESP		E 1295.00, S 1577.500	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	471.50	499.50	6.32
	200	239.00	429.50	7.11
	400	134.00	394.00	8.58
	600	63.50	245.00	9.78
	800	83.00	362.00	11.53
N-S	100	453.50	247.50	12.27
	200	346.50	383.50	11.54
	400	221.50	358.50	15.59
	600	96.50	283.50	12.85
	800	94.00	347.50	13.60
NE-SW	100	640.00	266.50	16.08
	200	288.00	292.50	12.58
	400	181.50	304.00	15.06
	600	93.50	270.50	13.05
	800	17.50	69.50	12.66
NW-SE	100	529.50	324.00	10.94
	200	288.00	331.50	11.10
	400	165.00	359.50	11.58
	600	91.00	317.50	10.82
	800	133.50	86.50	77.62
NEE-SWW	100	830.00	280.00	19.84
	200	293.00	255.50	14.65
	400	283.50	400.00	17.88
	600	92.00	256.50	13.54
	800	86.50	271.00	16.05
NWW-SEE	100	578.50	430.50	8.99
	200	275.50	317.00	11.10
	400	109.50	293.00	9.43
	600	87.50	301.00	10.97
	800	69.50	264.50	13.22

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	522.50	243.00	14.39
	200	296.00	269.50	14.03
	400	151.50	249.00	15.35
	600	35.00	97.50	13.55
	800	67.50	199.00	17.06
NNW-SSE	100	512.50	287.00	11.95
	200	170.50	195.50	11.14
	400	147.50	337.50	11.03
	600	87.00	255.00	12.88
	800	57.00	309.00	9.28

ERT - 9	ESP		E 1446.00, S 1529.500	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	29.50	7.50	26.33
	200	59.00	37.00	20.37
	400	7.50	17.00	11.13
	600	12.00	12.50	36.24
	800	11.50	32.00	18.07
N-S	100	204.00	29.50	46.29
	200	46.50	22.50	26.40
	400	8.00	14.50	13.92
	600	17.50	41.50	15.92
	800	26.00	51.50	25.39
NE-SW	100	228.00	30.00	50.87
	200	56.00	40.50	17.67
	400	22.00	35.50	15.64
	600	38.50	89.00	16.33
	800	23.50	68.50	17.25
NW-SE	100	140.50	34.00	27.66
	200	26.00	12.50	26.57
	400	11.00	16.50	16.82
	600	7.50	11.50	24.62
	800	13.50	30.00	22.63
NEE-SWW	100	92.50	15.00	41.28
	200	11.50	10.00	14.69
	400	16.00	23.50	17.18
	600	14.50	34.50	15.87
	800	13.50	25.50	26.63
NWW-SEE	100	235.50	38.00	41.48
	200	12.50	10.50	15.21
	400	11.50	10.50	27.63
	600	15.50	34.00	17.21
	800	14.00	25.00	28.17

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	281.50	43.00	43.82
	200	48.00	36.00	17.04
	400	11.00	18.50	15.00
	600	8.50	14.00	22.92
	800	30.00	92.50	16.31
NNW-SSE	100	185.00	39.00	31.75
	200	28.00	26.50	13.50
	400	9.00	6.00	37.84
	600	7.50	12.50	22.65
	800	18.00	52.50	17.24

ERT - 10	ESP		E 1354.00, S 1600.00	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	834.50	309.00	18.08
	200	447.50	337.00	16.97
	400	170.00	344.50	12.45
	600	106.00	414.00	9.67
	800	82.50	391.00	10.61
N-S	100	683.50	362.50	12.62
	200	327.50	365.50	11.45
	400	178.50	339.50	13.26
	600	153.00	425.00	13.59
	800	110.50	450.00	12.35
NE-SW	100	905.00	341.00	17.76
	200	387.50	347.50	14.25
	400	167.00	384.50	10.96
	600	61.50	211.50	10.98
	800	46.50	245.00	9.55
NW-SE	100	770.50	305.00	16.91
	200	396.50	272.50	18.59
	400	268.50	387.00	17.50
	600	93.00	267.00	13.15
	800	86.00	449.00	9.63
NEE-SWW	100	967.50	380.00	17.04
	200	507.50	310.00	20.92
	400	237.50	396.50	15.11
	600	147.50	433.00	12.86
	800	80.00	366.50	10.98
NWW-SEE	100	727.00	307.00	15.85
	200	510.00	425.50	15.31
	400	220.00	416.00	13.34
	600	114.50	377.50	11.45
	800	50.50	251.50	10.10

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	945.00	411.50	15.37
	200	407.00	379.00	13.72
	400	299.50	418.50	18.06
	600	152.50	405.00	14.22
	800	76.50	277.50	13.87
NNW-SSE	100	653.50	297.50	14.70
	200	500.50	374.50	17.08
	400	275.00	427.50	16.23
	600	81.50	216.50	14.21
	800	19.00	83.50	11.44

ERT - 11	FO Tank Fire Area		E 1370.00, S 1825.00	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	551.50	35.50	103.99
	200	201.00	43.00	59.72
	400	139.50	42.50	82.81
	600	53.50	46.00	43.91
	800	54.50	46.00	59.59
N-S	100	730.00	38.00	128.59
	200	512.50	33.50	195.46
	400	34.50	9.00	96.71
NEE-SWW	100	977.50	40.00	163.58
	200	111.50	19.00	74.98
	400	123.50	56.50	55.15
	600	11.50	13.00	33.40
	800	39.00	64.00	30.65
NWW-SEE	100	704.50	42.00	112.28
	200	209.00	27.00	98.90
	400	111.50	41.00	68.61
	600	47.50	39.00	45.98
	800	29.50	40.50	36.63

ERT - 12	Stock Pile		E 1079.00, S 2367.00	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	626.00	229.50	18.26
	200	466.50	281.00	21.21
	400	279.00	354.00	19.88
	600	149.00	299.00	18.81
	800	123.00	291.00	21.26
N-S	100	1529.00	291.00	35.17
	200	604.00	255.00	30.26
	400	301.50	297.00	25.61
	600	203.00	344.00	22.28
	800	178.00	368.50	24.29
NE-SW	100	1167.00	258.50	30.22
	200	502.50	319.50	20.09
	400	177.50	310.50	14.42
	600	116.50	341.00	12.90
	800	54.00	318.00	8.54
NW-SE	100	1069.50	236.50	30.27
	200	627.50	242.50	33.06
	400	404.50	216.00	47.25
	600	207.50	317.50	24.67
	800	151.00	299.00	25.40
NEE-SWW	100	854.00	218.00	26.22
	200	432.00	217.00	25.44
	400	145.00	297.50	12.30
	600	73.50	230.50	12.04
	800	62.50	237.00	13.26
NWW-SEE	100	1031.50	243.50	28.36
	200	299.50	249.00	15.37
	400	182.00	297.00	15.46
	600	113.50	251.50	17.04
	800	24.00	67.50	17.88

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	778.00	228.50	22.79
	200	498.00	230.50	27.60
	400	233.00	256.50	22.92
	600	192.00	267.50	27.10
	800	176.50	316.50	28.05
NNW-SSE	100	968.50	209.50	30.94
	200	387.00	239.50	20.64
	400	166.00	275.00	15.23
	600	91.50	255.50	13.52
	800	108.00	330.00	16.46

ERT - 13	Stock Pile		E 1598.00, S 2333.00	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	295.50	180.00	10.99
	200	162.00	190.50	10.86
	400	126.00	225.50	14.10
	600	80.50	179.00	16.98
	800	61.50	154.50	20.02
N-S	100	781.00	278.00	18.81
	200	187.50	165.50	14.47
	400	112.50	225.00	12.61
	600	41.50	99.00	15.83
	800	33.50	66.50	25.34
NE-SW	100	704.00	280.50	16.80
	200	341.50	246.00	17.74
	400	151.00	227.00	16.78
	600	134.50	263.00	19.31
	800	64.50	193.00	16.81
NW-SE	100	659.50	299.00	14.76
	200	269.00	262.50	13.09
	400	100.00	173.00	14.58
	600	121.50	275.00	16.68
	800	90.50	292.50	15.56
NEE-SWW	100	622.00	235.00	17.72
	200	255.00	254.00	12.83
	400	108.50	178.50	15.34
	600	83.00	231.50	13.54
	800	60.00	230.50	13.09
NWW-SEE	100	571.00	271.00	14.10
	200	307.00	249.00	15.75
	400	161.00	323.00	12.58
	600	94.00	295.00	12.03
	800	78.50	304.50	12.97

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	643.00	219.00	19.65
	200	572.00	234.00	31.23
	400	143.50	230.50	15.71
	600	99.50	271.00	13.86
	800	71.00	259.50	13.76
NNW-SSE	100	556.50	306.50	12.15
	200	236.50	198.50	15.22
	400	89.00	153.50	14.63
	600	77.00	128.50	22.62
	800	115.50	249.50	23.28

ERT - 3 New	Switch Yard		E 1484.067, S 1036.927	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	200	363.00	47.00	98.68
	400	38.00	60.50	15.85
	600	15.50	53.00	11.04
	800	19.00	80.00	11.95
N-S	200	686.50	63.00	139.22
	400	39.00	98.50	9.99
	600	16.50	52.50	11.87
	800	8.00	31.50	12.77
NE-SW	200	174.00	29.00	76.66
	400	21.00	71.50	7.41
	600	17.50	86.00	7.68
	800	11.50	78.00	7.42
NW-SE	200	226.00	47.50	60.79
	400	17.50	36.50	12.10
	600	12.50	45.00	10.49
	800	9.50	43.00	11.11
NEE-SWW	200	255.50	59.00	55.33
	400	62.50	68.50	23.02
	600	39.00	107.50	13.70
	800	34.50	157.00	11.05
NWW-SEE	200	157.50	39.00	51.60
	400	13.50	39.00	8.73
	600	11.00	53.50	7.76
	800	5.50	34.00	8.14

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	200	13.50	4.00	43.12
	400	21.50	56.00	9.69
	600	24.00	87.50	10.36
	800	5.50	46.50	5.95
NNW-SSE	200	133.00	46.50	36.54
	400	16.50	44.50	9.35
	600	11.50	47.00	9.24
	800	21.50	119.00	9.09

ERT - 4 New	Switch Yard		E 1483.361, S 1204.337	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	1046.00	143.00	48.96
	200	351.00	98.50	45.53
	400	134.50	134.50	25.23
	600	47.00	86.50	20.51
	800	21.00	67.00	15.76
N-S	100	1027.50	141.00	48.78
	200	310.00	78.00	50.78
	400	206.50	142.00	36.69
	600	124.50	173.50	27.09
	800	36.00	115.50	15.68
NE-SW	100	1116.50	145.50	51.36
	200	451.00	142.50	40.44
	400	117.00	107.50	27.46
	600	85.00	167.50	19.16
	800	39.00	138.00	14.21
NW-SE	100	1110.00	136.00	54.63
	200	189.50	72.00	33.63
	400	112.00	94.00	30.06
	600	20.00	43.50	17.36
	800	19.50	80.50	12.18
NEE-SWW	100	766.50	134.50	38.15
	200	548.00	145.00	48.29
	400	186.00	168.50	27.85
	600	55.50	99.50	21.06
	800	20.50	55.00	18.75
NWW-SEE	100	707.50	93.50	50.65
	200	507.00	148.00	43.77
	400	108.50	88.50	30.93
	600	61.50	86.00	27.00
	800	10.00	29.00	17.34

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	1074.00	136.00	52.86
	200	408.50	127.50	40.93
	400	148.00	130.50	28.61
	600	92.50	165.00	21.16
	800	36.00	133.50	13.56
NNW-SSE	100	873.00	123.00	47.51
	200	425.00	105.00	51.71
	400	235.00	130.50	45.43
	600	45.00	61.00	27.85
	800	26.50	62.50	21.33

ERT - 8 New	Transformer Yard		E 1428.944, S 1342.160	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	753.50	242.50	20.80
	200	372.50	272.50	17.46
	400	162.50	224.50	18.26
	600	26.50	48.50	20.63
	800	66.00	139.00	23.88
N-S	100	683.00	291.00	15.71
	200	133.50	79.00	21.59
	400	170.50	196.50	21.89
	600	119.50	120.00	37.60
	800	74.00	136.50	27.27
NE-SW	100	727.50	370.50	13.14
	200	265.50	212.50	15.96
	400	62.00	92.50	16.91
	600	27.00	59.00	17.28
	800	15.00	35.50	21.25
NW-SE	100	975.00	409.00	15.96
	200	160.50	132.50	15.48
	400	134.00	198.00	17.07
	600	81.00	150.50	20.32
	800	51.50	126.50	20.48
NEE-SWW	100	713.00	243.00	19.64
	200	396.00	303.00	16.70
	400	147.00	193.50	19.17
	600	83.00	163.00	19.22
	800	30.00	91.50	16.49
NWW-SEE	100	864.00	282.00	20.51
	200	493.00	312.00	20.19
	400	77.50	112.50	17.38
	600	114.00	211.00	20.40
	800	19.50	51.50	19.04

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	302.00	166.50	12.14
	200	170.00	151.50	14.34
	400	162.00	199.00	20.54
	600	7.50	11.50	24.62
	800	42.50	69.50	30.76
NNW-SSE	100	1285.00	362.50	23.73
	200	600.00	365.00	21.00
	400	276.50	337.50	20.67
	600	53.00	104.50	19.15
	800	12.50	39.50	15.92

ERT - 9 New	Transformer Yard		E 1497.703, S 1341.898	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	200	157.50	17.00	118.37
	400	121.00	14.00	218.05
	600	61.00	19.00	121.21
	800	48.50	42.50	57.40
N-S	200	308.00	57.50	68.44
	400	390.00	142.50	69.05
	600	114.50	67.50	64.04
	800	20.50	23.00	44.83
NE-SW	200	80.50	12.00	85.71
	400	42.00	12.00	88.30
	600	59.50	28.50	78.82
	800	12.00	22.00	27.43
NW-SE	200	257.00	39.00	84.19
	400	70.00	26.00	67.93
	600	190.00	126.50	56.70
	800	41.50	35.00	59.64
NEE-SWW	200	228.00	28.50	102.21
	400	170.50	40.00	107.54
	600	70.00	26.00	101.64
	800	90.00	60.00	75.44
NWW-SEE	200	533.00	71.50	95.24
	400	59.00	25.00	59.54
	600	93.00	76.50	45.90
	800	54.00	73.00	37.20

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	200	260.50	31.50	105.66
	400	185.00	64.00	72.93
	600	123.50	80.50	57.92
	800	69.50	81.50	42.89
NNW-SSE	200	270.50	44.00	78.55
	400	94.00	39.00	60.81
	600	21.50	13.00	62.44
	800	15.00	15.50	48.67

ERT - 10 New	Transformer Yard		E 1427.909, S 1304.756	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	200	519.50	47.50	139.73
	400	282.50	109.00	65.39
	600	27.00	39.50	25.81
	800	16.50	37.50	22.13
N-S	200	299.00	27.00	141.49
	400	170.50	58.50	73.53
	600	53.50	75.00	26.93
	800	13.50	57.50	11.81
NE-SW	200	527.00	43.50	154.79
	400	139.50	51.00	69.01
	600	49.50	93.00	20.09
	800	11.00	43.00	12.87
NW-SE	200	233.50	26.00	114.74
	400	98.00	47.50	52.05
	600	28.00	47.50	22.25
	800	11.50	28.50	20.29
NEE-SWW	200	552.50	51.00	138.41
	400	137.50	63.50	54.63
	600	24.00	39.50	22.94
	800	6.50	32.50	10.06
NWW-SEE	200	316.50	32.50	124.42
	400	108.00	81.00	33.64
	600	31.50	41.00	29.01
	800	15.50	25.50	30.57

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	200	752.00	57.00	168.56
	400	293.50	78.50	94.33
	600	201.50	122.00	62.35
	800	30.00	87.50	17.24
NNW-SSE	200	248.00	28.50	111.18
	400	169.50	81.00	52.80
	600	47.50	69.50	25.80
	800	17.50	36.00	24.45

ERT - 12 New	Boiler		E 1428.305, S 1427.353	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	1206.50	276.50	29.21
	200	564.00	261.50	27.56
	400	200.00	224.00	22.53
	600	117.50	236.50	18.76
	800	52.00	139.00	18.82
N-S	100	1089.00	273.50	26.65
	200	680.50	286.00	30.40
	400	135.50	147.50	23.18
	600	72.00	127.00	21.40
	800	51.50	113.50	22.82
NE-SW	100	1026.50	272.50	25.22
	200	430.00	246.50	22.29
	400	216.50	198.50	27.52
	600	118.00	207.00	21.52
	800	84.00	150.00	28.17
NW-SE	100	1101.00	253.00	29.13
	200	585.00	231.00	32.36
	400	156.50	197.50	19.99
	600	106.50	226.50	17.75
	800	83.50	147.50	28.47
NEE-SWW	100	913.50	216.00	28.31
	200	642.50	253.50	32.38
	400	146.00	171.00	21.54
	600	100.50	197.50	19.21
	800	55.50	107.50	25.97
NWW-SEE	100	1592.50	266.50	40.00
	200	787.00	233.00	43.15
	400	552.50	240.00	58.08
	600	244.50	174.00	53.05
	800	124.50	156.00	40.14

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	1410.50	267.00	35.36
	200	589.00	252.00	29.86
	400	170.00	171.50	25.01
	600	91.00	156.50	21.95
	800	95.50	164.50	29.20
NNW-SSE	100	969.50	224.50	28.91
	200	710.00	272.50	33.29
	400	161.00	203.00	20.01
	600	88.50	190.50	17.54
	800	103.00	188.00	27.56

ERT - 18	CHP		E 1552.055, S 2083.572	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	1526.50	129.00	79.21
	200	733.50	98.00	95.63
	400	145.00	91.00	40.20
	600	112.50	121.00	35.10
	800	99.50	149.50	33.47
N-S	100	1810.50	158.50	76.46
	200	1240.50	149.00	106.37
	400	194.00	131.50	37.22
	600	96.00	137.00	26.45
	800	41.50	92.50	22.56
NE-SW	100	1439.00	141.00	68.31
	200	724.50	121.00	76.50
	400	122.50	83.50	37.01
	600	89.00	125.50	26.77
	800	38.50	87.50	22.13
NW-SE	100	1071.00	90.00	79.66
	200	500.00	65.50	97.53
	400	119.00	59.50	50.46
	600	51.00	73.00	26.38
	800	35.00	77.50	22.71
NEE-SWW	100	1241.00	126.00	65.93
	200	938.50	146.50	81.85
	400	571.50	136.00	106.02
	600	228.00	138.50	62.15
	800	45.50	56.50	40.50
NWW-SEE	100	1916.00	152.50	84.10
	200	878.00	134.50	83.40
	400	213.00	144.50	37.19
	600	143.50	197.50	27.43
	800	94.00	207.50	22.78

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	1902.50	156.00	81.63
	200	1091.00	122.00	114.25
	400	271.50	160.00	42.81
	600	101.00	133.50	28.56
	800	78.50	114.00	34.63
NNW-SSE	100	978.00	90.50	72.34
	200	501.00	68.00	94.13
	400	258.00	61.00	106.71
	600	75.00	65.00	43.56
	800	45.00	68.50	33.04

ERT - 19	CWPH		E 876.00, S 1174.600	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	100	279.50	36.50	51.26
	200	226.00	36.50	79.11
	400	41.00	41.00	25.23
	600	18.50	37.50	18.62
	800	8.50	16.50	25.91
N-S	100	355.00	50.00	47.53
	200	76.50	28.50	34.29
	400	22.50	39.00	14.56
	600	10.50	25.50	15.55
	800	8.50	20.00	21.38
NE-SW	100	445.50	46.00	64.83
	200	121.00	45.00	34.35
	400	22.50	47.50	11.95
	600	14.50	37.50	14.60
	800	23.00	45.00	25.71
NW-SE	100	421.50	49.00	57.58
	200	209.50	49.50	54.07
	400	41.50	52.00	20.14
	600	17.00	30.50	21.04
	800	15.50	57.00	13.68
NEE-SWW	100	251.50	37.00	45.50
	200	113.50	36.00	40.28
	400	31.50	47.00	16.91
	600	10.00	22.50	16.78
	800	11.50	25.50	22.68
NWW-SEE	100	278.00	39.00	47.71
	200	223.50	49.50	57.69
	400	40.00	52.50	19.22
	600	10.50	26.00	15.25
	800	8.50	21.50	19.88

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	100	309.50	41.50	49.92
	200	99.50	27.50	46.23
	400	65.50	56.00	29.51
	600	20.00	40.50	18.64
	800	9.00	25.50	17.75
NNW-SSE	100	413.00	45.00	61.43
	200	116.00	29.50	50.24
	400	24.50	32.00	19.32
	600	17.50	42.00	15.73
	800	13.50	33.00	20.58

ERT - 22	Ash Handling Pump		E 1461.716, S 1678.005	
Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
E-W	200	116.50	19.50	76.33
	400	7.50	11.00	17.20
	600	5.50	12.50	16.61
	800	16.50	36.00	23.05
N-S	200	25.50	11.50	28.33
	400	34.00	55.50	15.46
	600	8.50	16.00	20.06
	800	7.50	14.00	26.94
NE-SW	200	190.50	26.00	93.61
	400	7.00	8.00	22.08
	600	5.50	9.50	21.86
	800	10.50	18.00	29.34
NW-SE	200	175.00	23.50	95.14
	400	54.00	60.00	22.71
	600	11.50	5.00	86.83
	800	11.00	21.00	26.34
NEE-SWW	200	106.50	17.50	77.75
	400	22.50	15.00	37.84
	600	6.00	17.00	13.32
	800	7.50	13.00	29.02
NWW-SEE	200	269.50	25.00	137.73
	400	65.00	64.50	25.43
	600	11.50	19.50	22.26
	800	16.00	24.50	32.85

Direction	Spacing (Cm)	voltage (Volts)	Current (Amperes)	Apparent Resistivity ohm- m
NNE-SSW	200	22.00	5.50	51.11
	400	18.50	27.00	17.29
	600	4.50	10.00	16.99
	800	13.50	24.50	27.71
NNW-SSE	200	121.00	32.50	47.57
	400	14.00	22.50	15.70
	600	9.50	24.00	14.94
	800	9.50	27.00	17.70

Annexure IV

ERT -1 (STP)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	32.02	34.01	30.68	29.71	24.18	22.66	28.23	29.82	28.91
200	18.00	13.50	18.47	16.62	15.74	23.53	27.49	19.87	19.15
400	11.92	16.31	11.94	11.95	9.80	18.81	13.48	14.72	13.62
600	12.66	17.20	12.58	15.60	10.97	11.32	12.89	13.40	13.33
800	12.55	16.42	15.08	16.61	14.33	16.01	13.28	11.26	14.44

ERT -3 (Pre Treatment Plant)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	90.52	120.28	132.25	65.15	111.21	135.81	113.62	81.22	106.26
200	52.53	84.32	87.69	66.96	94.70	79.04	100.82	72.70	79.84
400	45.98	45.41	66.74	55.87	75.08	64.84	61.83	39.22	56.87
600	64.72	37.75	45.18	64.97	80.23	58.04	34.32	22.90	51.01
800	75.44	29.99	80.80	46.49	114.96	47.15	17.10	22.35	54.29

ERT -4 (Switch Yard)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	18.74	23.01	11.16	18.41	18.74	32.13	15.90	21.34	19.93
200	31.94	25.10	110.34	19.42	14.60	44.72	37.86	11.18	36.90
400	17.35	17.92	8.78	8.79	10.51	44.85	10.92	14.06	16.65
600	106.75	16.19	7.08	7.68	13.63	6.51	8.60	8.29	21.84
800	23.02	14.46	4.82	8.17	14.05	8.32	7.46	13.66	11.74

ERT -5 (Switch Yard)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	42.23	42.16	31.16	29.10	37.21	28.65	40.94	39.05	36.31
200	51.27	24.64	56.53	28.53	40.15	30.39	48.04	38.25	39.73
400	46.80	3.95	46.57	29.03	33.22	13.82	31.15	28.83	29.17
600	28.71	4.81	36.73	20.87	31.42	13.91	30.99	26.99	24.30
800	17.45	5.22	25.03	18.11	32.49	19.11	24.84	23.94	20.77

ERT -6 (Switch Yard)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	49.56	46.41	46.33	48.86	43.04	56.68	50.87	48.35	48.76
200	73.77	73.03	92.82	76.07	49.44	58.71	69.37	72.81	70.75
400	85.71	92.48	134.06	87.14	81.01	77.31	104.89	96.11	94.84
600	34.42	72.29	173.56	156.86	110.49	78.46	134.03	86.11	105.78
800	47.55	34.85	157.07	120.99	109.26	63.43	130.28	83.40	93.35

ERT -7 (Power House)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	19.16	13.06	14.03	21.61	14.55	16.70	12.76	25.23	17.14
200	17.72	17.99	27.30	18.67	18.24	16.68	15.49	17.77	18.73
400	13.05	17.30	15.36	15.58	12.57	7.84	14.79	14.72	13.90
600	17.70	13.84	14.88	16.27	15.52	15.97	15.18	14.90	15.53
800	17.95	13.82	15.64	15.19	17.13	15.72	16.17	12.69	15.54

ERT -8 (ESP)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	6.32	12.27	16.08	10.94	19.84	8.99	14.39	11.95	12.60
200	7.11	11.54	12.58	11.10	14.65	11.10	14.03	11.14	11.66
400	8.58	15.59	15.06	11.58	17.88	9.43	15.35	11.03	13.06
600	9.78	12.85	13.05	10.82	13.54	10.97	13.55	12.88	12.18
800	11.53	13.60	12.66	77.62	16.05	13.22	17.06	9.28	21.38

ERT -9 (ESP)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	26.33	46.29	50.87	27.66	41.28	41.48	43.82	31.75	38.69
200	20.37	26.40	17.67	26.57	14.69	15.21	17.04	13.50	18.93
400	11.13	13.92	15.64	16.82	17.18	27.63	15.00	37.84	19.40
600	36.24	15.92	16.33	24.62	15.87	17.21	22.92	22.65	21.47
800	18.07	25.39	17.25	22.63	26.63	28.17	16.31	17.24	21.46

ERT -10 (ESP)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	18.08	12.62	17.76	16.91	17.04	15.85	15.37	14.70	16.04
200	16.97	11.45	14.25	18.59	20.92	15.31	13.72	17.08	16.03
400	12.45	13.26	10.96	17.50	15.11	13.34	18.06	16.23	14.61
600	9.67	13.59	10.98	13.15	12.86	11.45	14.22	14.21	12.52
800	10.61	12.35	9.55	9.63	10.98	10.10	13.87	11.44	11.07

ERT -11 (FO Tank Fire Area)					
Direction	Average Resistivity Ohm-m				
	E-W	N-S	NEE-WWS	NWW-SEE	Avg
100	103.99	128.59	163.58	112.28	127.11
200	59.72	195.46	74.98	98.90	107.26
400	82.81	96.71	55.15	68.61	75.82
600	43.91		33.40	45.98	41.10
800	59.59		30.65	36.63	42.29

ERT -12 (Stock Pile)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	18.26	35.17	30.22	30.27	26.22	28.36	22.79	30.94	27.78
200	21.21	30.26	20.09	33.06	25.44	15.37	27.60	20.64	24.21
400	19.88	25.61	14.42	47.25	12.30	15.46	22.92	15.23	21.63
600	18.81	22.28	12.90	24.67	12.04	17.04	27.10	13.52	18.54
800	21.26	24.29	8.54	25.40	13.26	17.88	28.05	16.46	19.39

ERT -13 (Stock Pile)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	10.99	18.81	16.80	14.76	17.72	14.10	19.65	12.15	15.62
200	10.86	14.47	17.74	13.09	12.83	15.75	31.23	15.22	16.40
400	14.10	12.61	16.78	14.58	15.34	12.58	15.71	14.63	14.54
600	16.98	15.83	19.31	16.68	13.54	12.03	13.86	22.62	16.36
800	20.02	25.34	16.81	15.56	13.09	12.97	13.76	23.28	17.60

ERT -3 New (Switch Yard)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
200	98.68	139.22	76.66	60.79	55.33	51.60	43.12	36.54	70.24
400	15.85	9.99	7.41	12.10	23.02	8.73	9.69	9.35	12.02
600	11.04	11.87	7.68	10.49	13.70	7.76	10.36	9.24	10.27
800	11.95	12.77	7.42	11.11	11.05	8.14	5.95	9.09	9.68

ERT -4 New (Switch Yard)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	48.96	48.78	51.36	54.63	38.15	50.65	52.86	47.51	49.11
200	45.53	50.78	40.44	33.63	48.29	43.77	40.93	51.71	44.38
400	25.23	36.69	27.46	30.06	27.85	30.93	28.61	45.43	31.53
600	20.51	27.09	19.16	17.36	21.06	27.00	21.16	27.85	22.65
800	15.76	15.68	14.21	12.18	18.75	17.34	13.56	21.33	16.10

ERT -8 New (Transformer Yard)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	20.80	15.71	13.14	15.96	19.64	20.51	12.14	23.73	17.70
200	17.46	21.59	15.96	15.48	16.70	20.19	14.34	21.00	17.84
400	18.26	21.89	16.91	17.07	19.17	17.38	20.54	20.67	18.99
600	20.63	37.60	17.28	20.32	19.22	20.40	24.62	19.15	22.40
800	23.88	27.27	21.25	20.48	16.49	19.04	30.76	15.92	21.89

ERT -9 New (Transformer Yard)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
200	118.37	68.44	85.71	84.19	102.21	95.24	105.66	78.55	92.30
400	218.05	69.05	88.30	67.93	107.54	59.54	72.93	60.81	93.02
600	121.21	64.04	78.82	56.70	101.64	45.90	57.92	62.44	73.58
800	57.40	44.83	27.43	59.64	75.44	37.20	42.89	48.67	49.19

ERT -10 New (Transformer Yard)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
200	139.73	141.49	154.79	114.74	138.41	124.42	168.56	111.18	136.66
400	65.39	73.53	69.01	52.05	54.63	33.64	94.33	52.80	61.92
600	25.81	26.93	20.09	22.25	22.94	29.01	62.35	25.80	29.40
800	22.13	11.81	12.87	20.29	10.06	30.57	17.24	24.45	18.68

ERT -12 New (Boiler)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	29.21	26.65	25.22	29.13	28.31	40.00	35.36	28.91	30.35
200	27.56	30.40	22.29	32.36	32.38	43.15	29.86	33.29	31.41
400	22.53	23.18	27.52	19.99	21.54	58.08	25.01	20.01	27.23
600	18.76	21.40	21.52	17.75	19.21	53.05	21.95	17.54	23.90
800	18.82	22.82	28.17	28.47	25.97	40.14	29.20	27.56	27.64

ERT -18 (CHP)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	79.21	76.46	68.31	79.66	65.93	84.10	81.63	72.34	75.96
200	95.63	106.37	76.50	97.53	81.85	83.40	114.25	94.13	93.71
400	40.20	37.22	37.01	50.46	106.02	37.19	42.81	106.71	57.20
600	35.10	26.45	26.77	26.38	62.15	27.43	28.56	43.56	34.55
800	33.47	22.56	22.13	22.71	40.50	22.78	34.63	33.04	28.98

ERT -19 (CWHP)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
100	51.26	47.53	64.83	57.58	45.50	47.71	49.92	61.43	53.22
200	79.11	34.29	34.35	54.07	40.28	57.69	46.23	50.24	49.53
400	25.23	14.56	11.95	20.14	16.91	19.22	29.51	19.32	19.60
600	18.62	15.55	14.60	21.04	16.78	15.25	18.64	15.73	17.03
800	25.91	21.38	25.71	13.68	22.68	19.88	17.75	20.58	20.95

ERT -22 (Ash Handling Pump)									
Direction	Average Resistivity Ohm-m								
	E-W	N-S	NE-SW	NW-SE	NEE-WWS	NWW-SEE	NNE-SSW	NNW-SSE	Avg
200	76.33	28.33	93.61	95.14	77.75	137.73	51.11	47.57	75.95
400	17.20	15.46	22.08	22.71	37.84	25.43	17.29	15.70	21.71
600	16.61	20.06	21.86	86.83	13.32	22.26	16.99	14.94	26.61
800	23.05	26.94	29.34	26.34	29.02	32.85	27.71	17.70	26.62

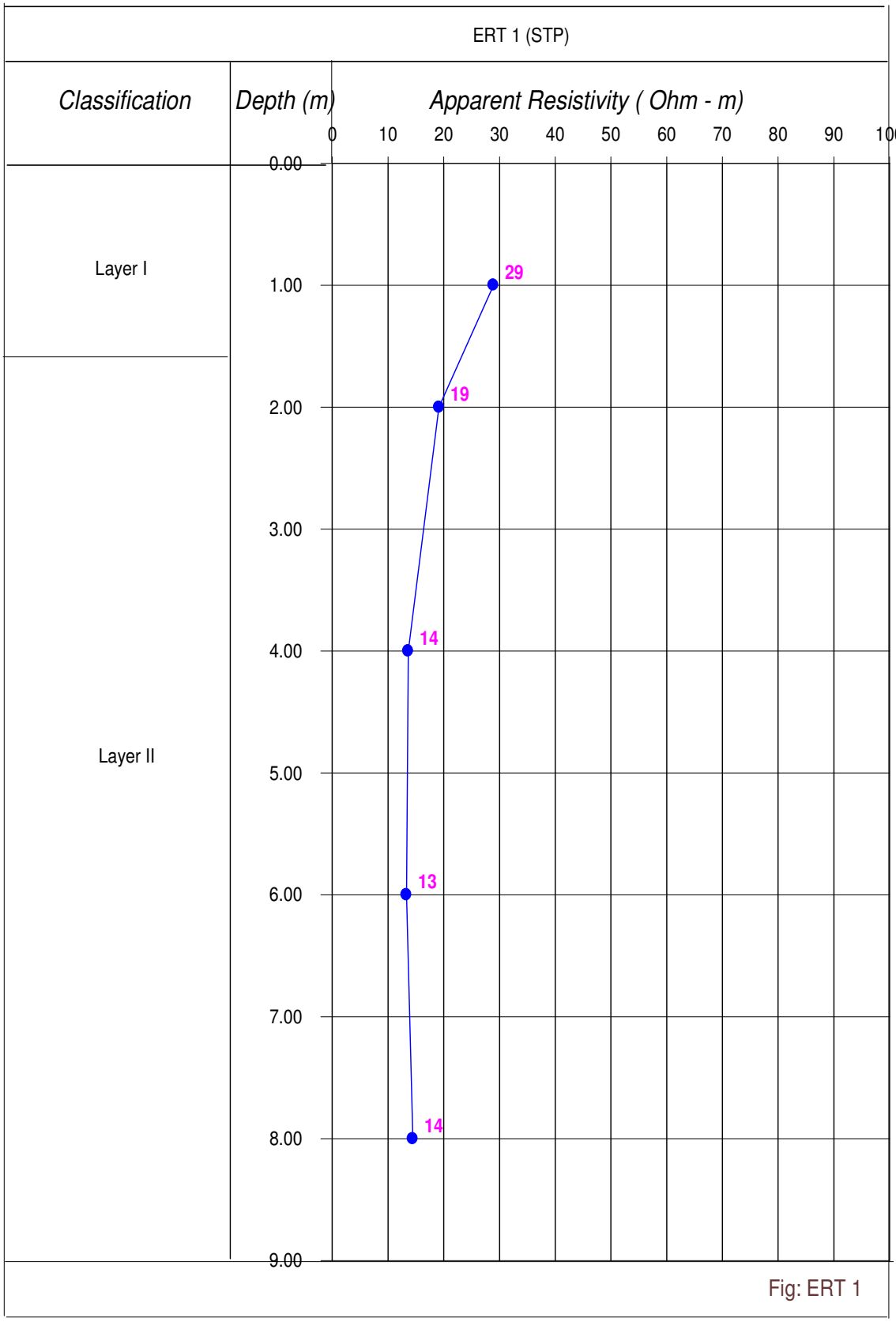

ERT 1 (STP)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
29
19
14
13
14

Fig: ERT 1

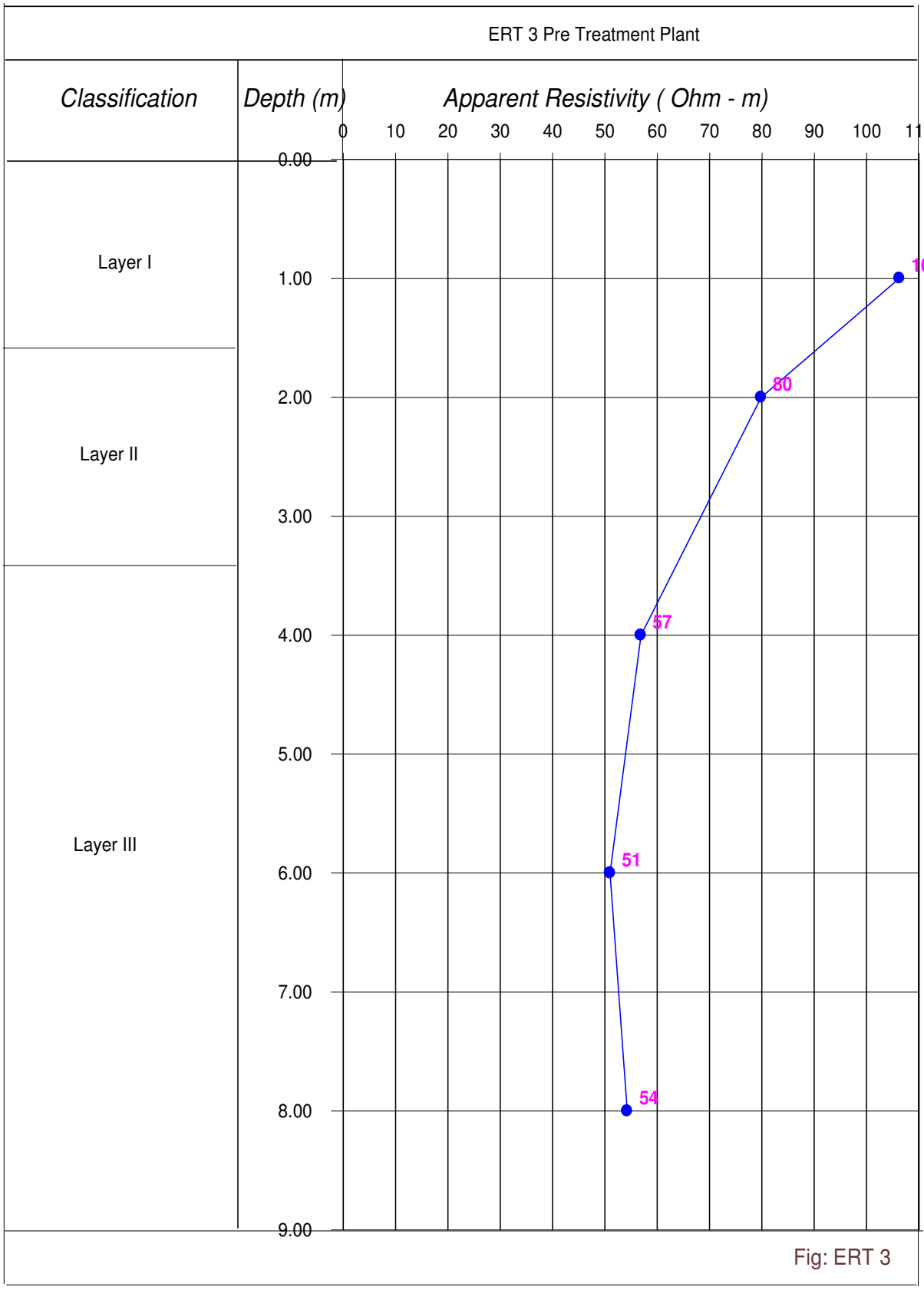

ERT 3 Pre Treatment Plant
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
Layer III
106
80
57
51
54

Fig: ERT 3

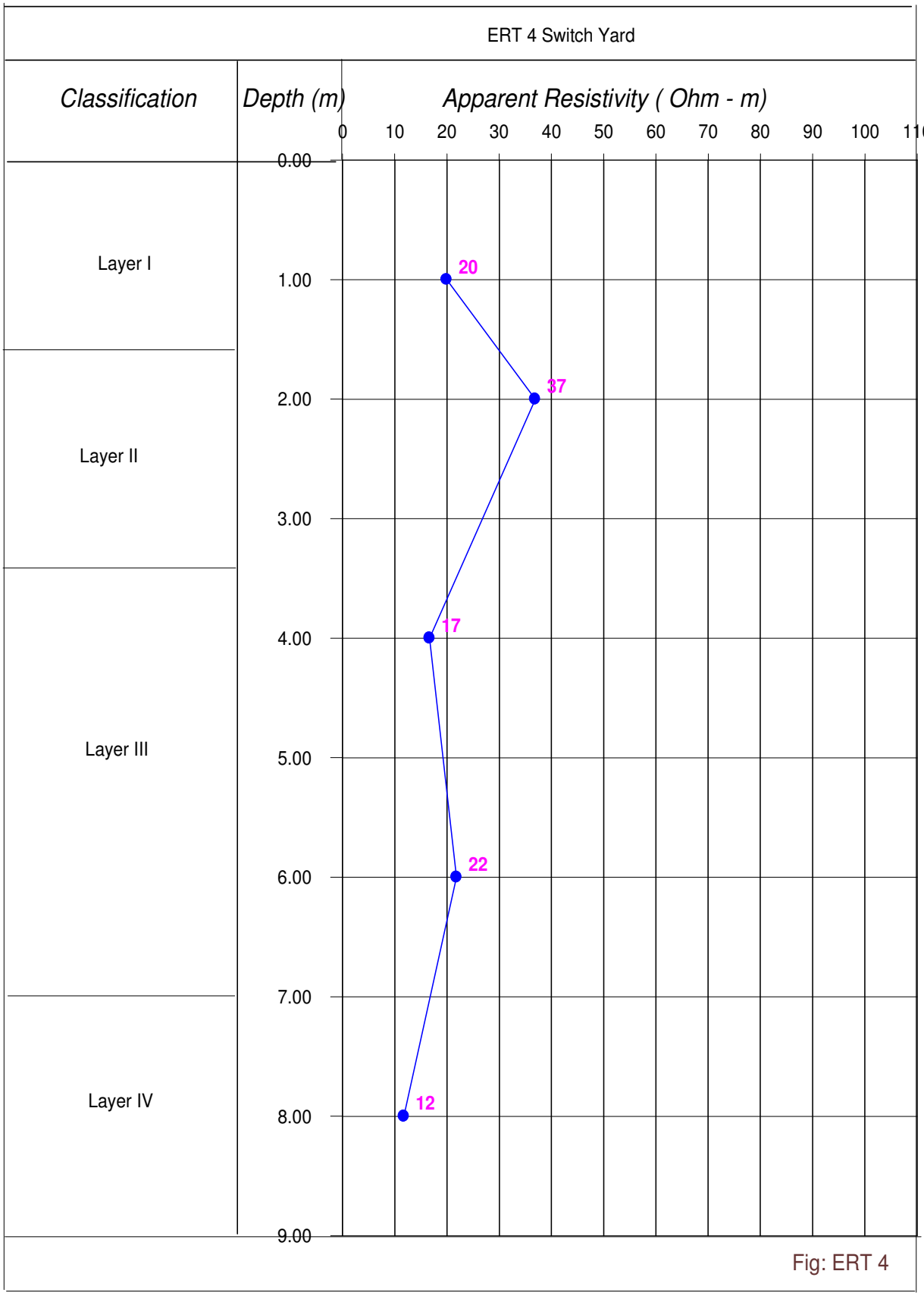

ERT 4 Switch Yard
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
Layer III
Layer IV
20
37
17
22
12

Fig: ERT 4

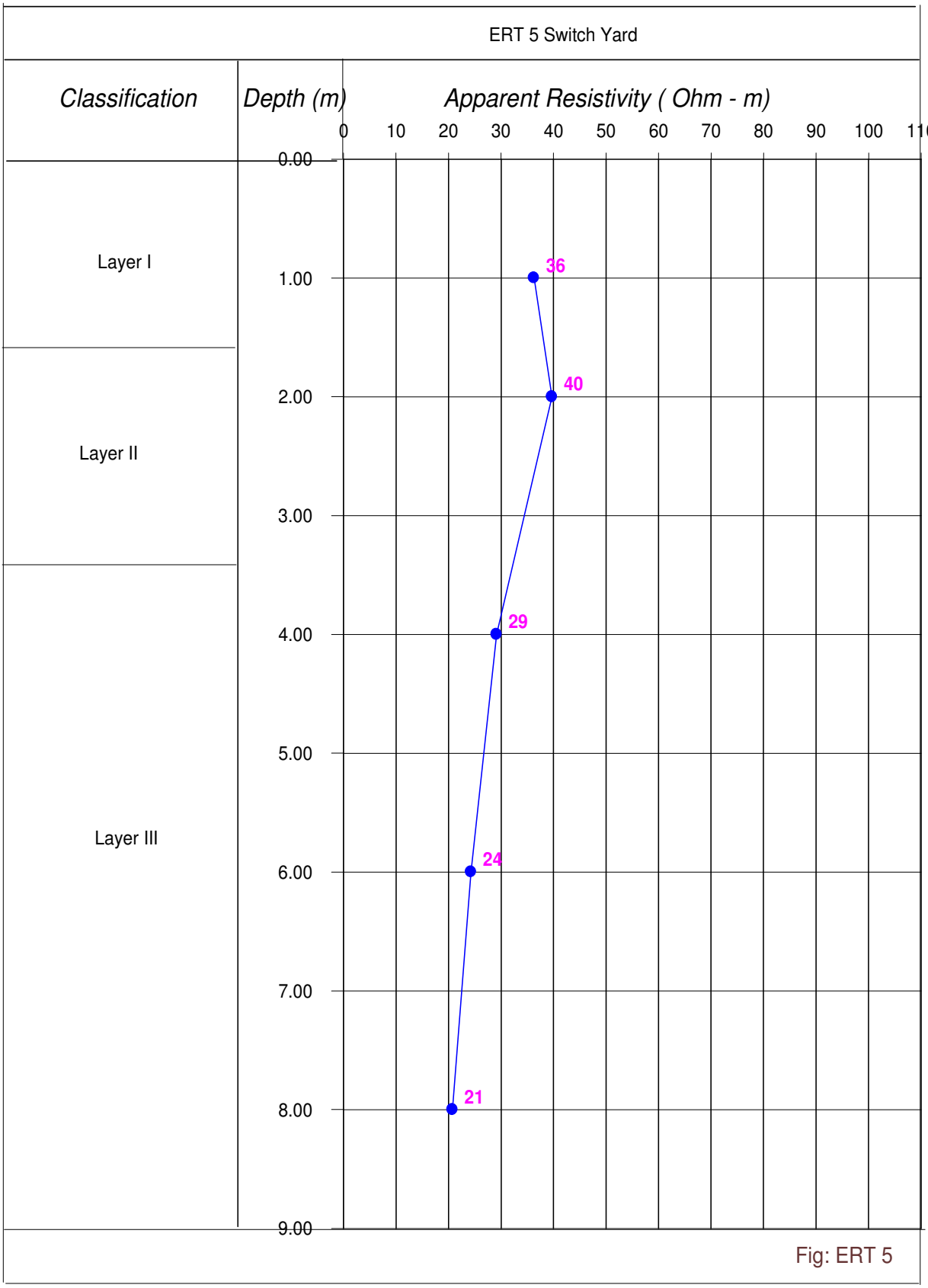

ERT 5 Switch Yard
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
Layer III
36
40
29
24
21

Fig: ERT 5

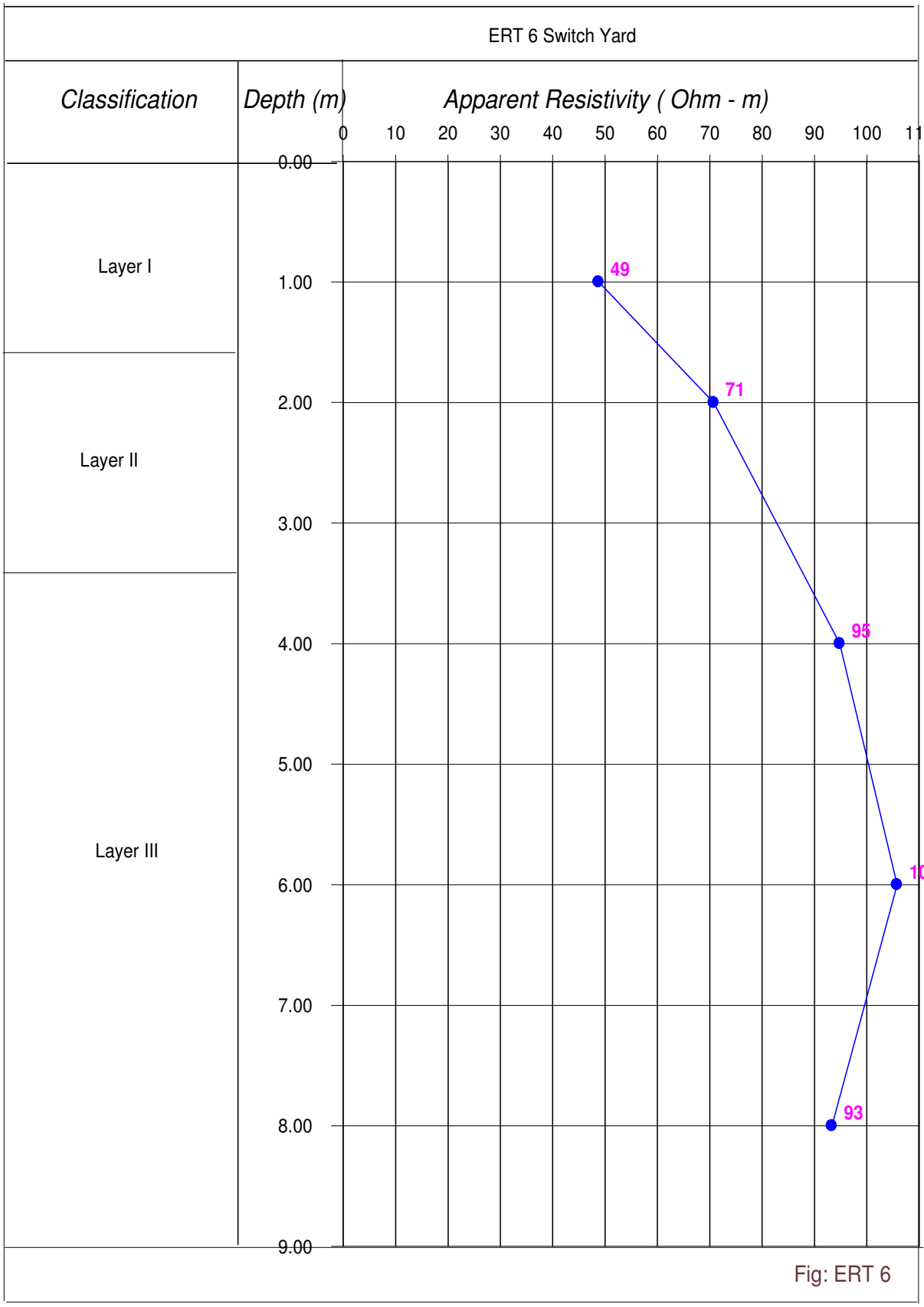

ERT 6 Switch Yard
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
Layer III
49
71
95
106
93

Fig: ERT 6

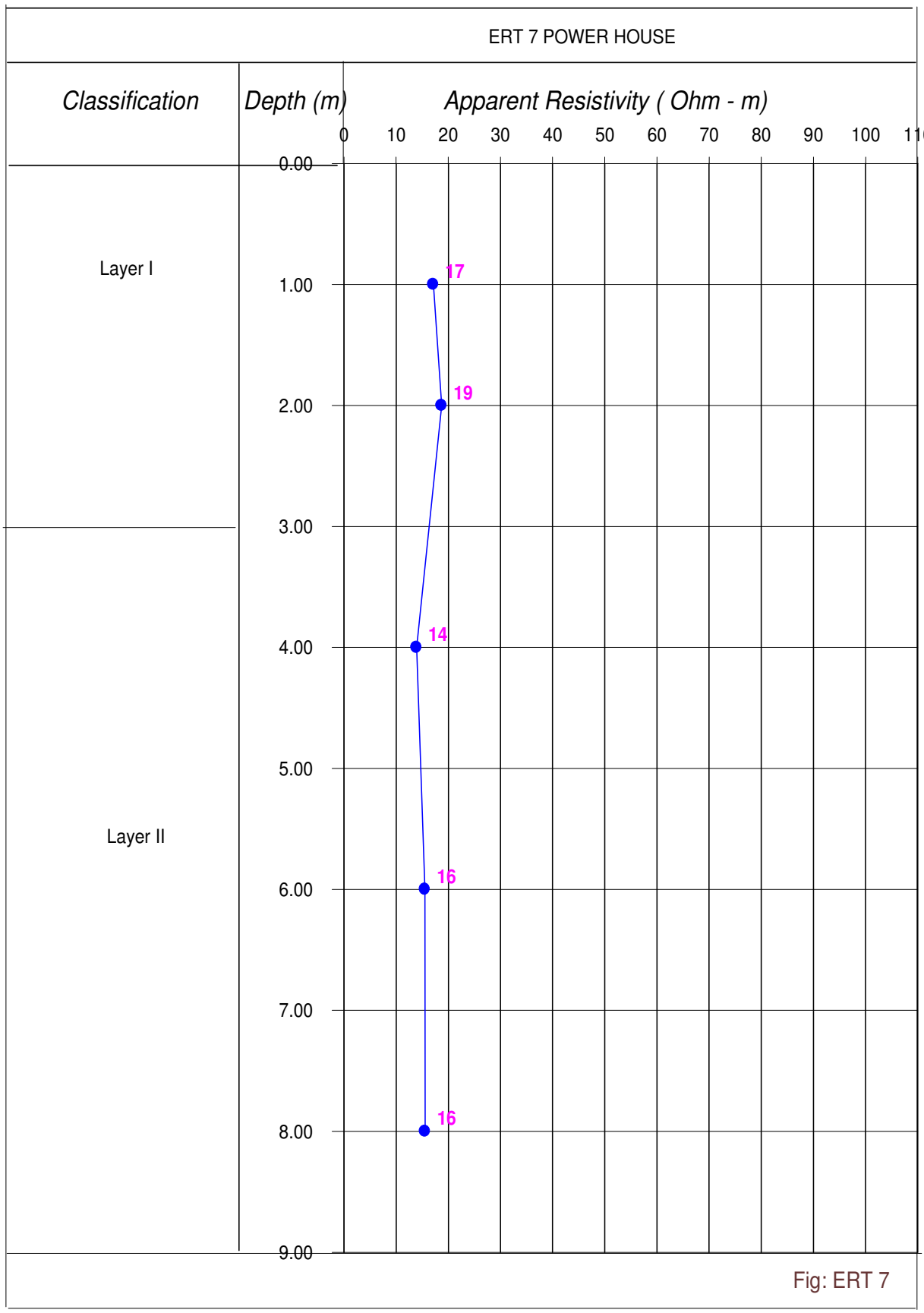

ERT 7 POWER HOUSE
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
17
19
14
16
16

Fig: ERT 7

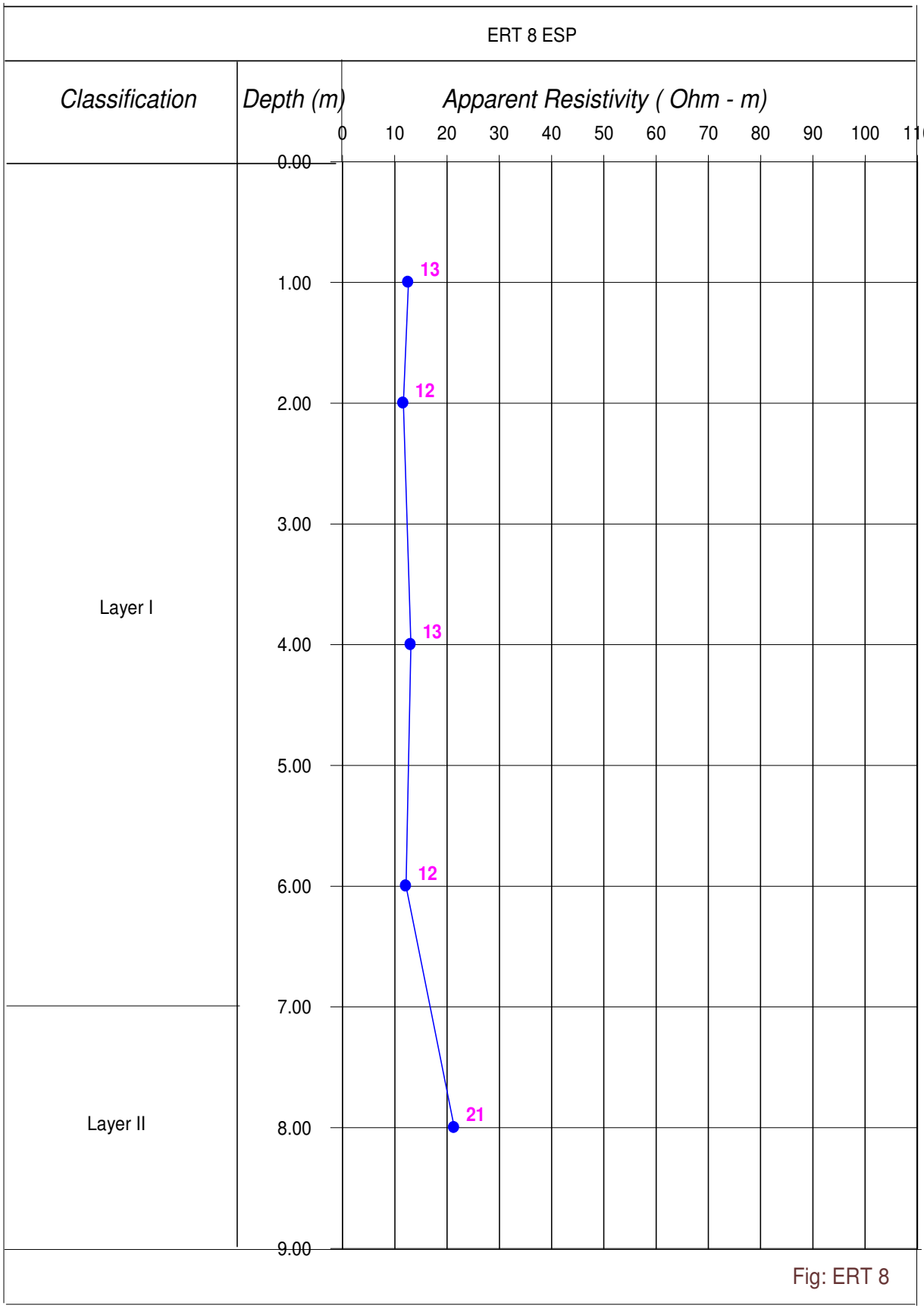

ERT 8 ESP
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
13
12
13
12
21
Layer I
Layer II

Fig: ERT 8

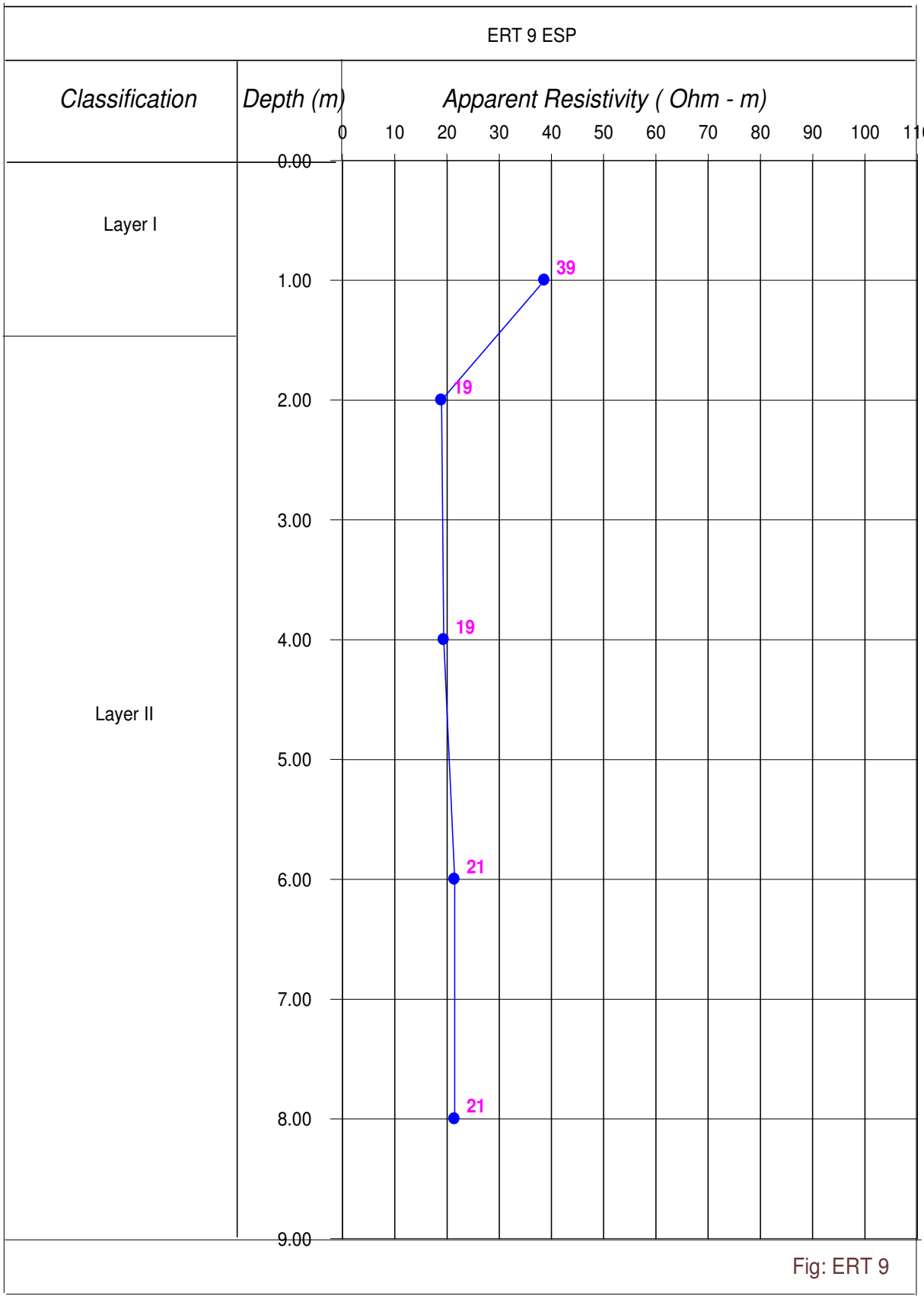

ERT 9 ESP
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
39
19
19
21
21

Fig: ERT 9

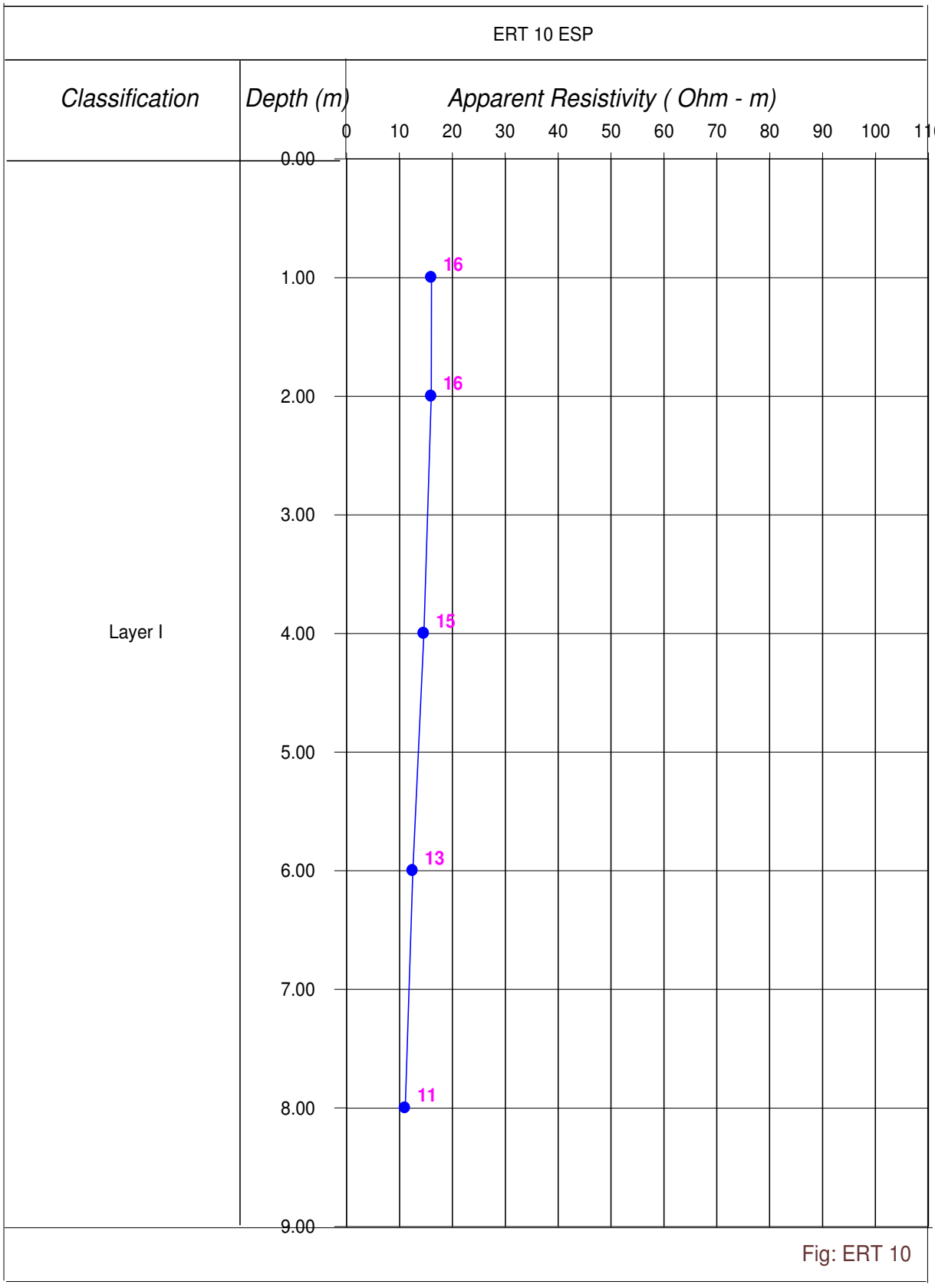

ERT 10 ESP
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
16
16
15
13
11
Layer I

Fig: ERT 10

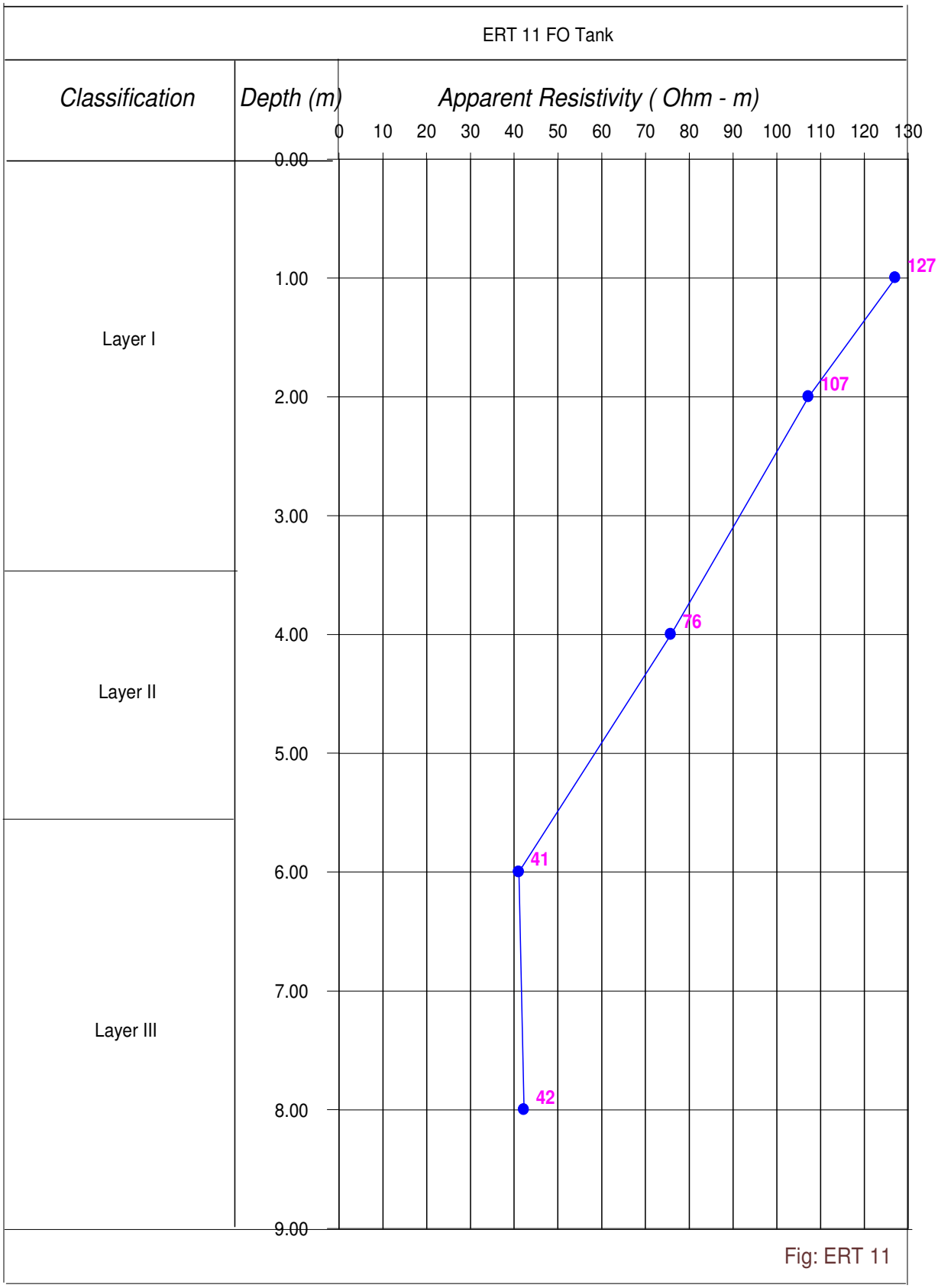

ERT 11 FO Tank
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
Layer III
127
107
76
41
42

Fig: ERT 11

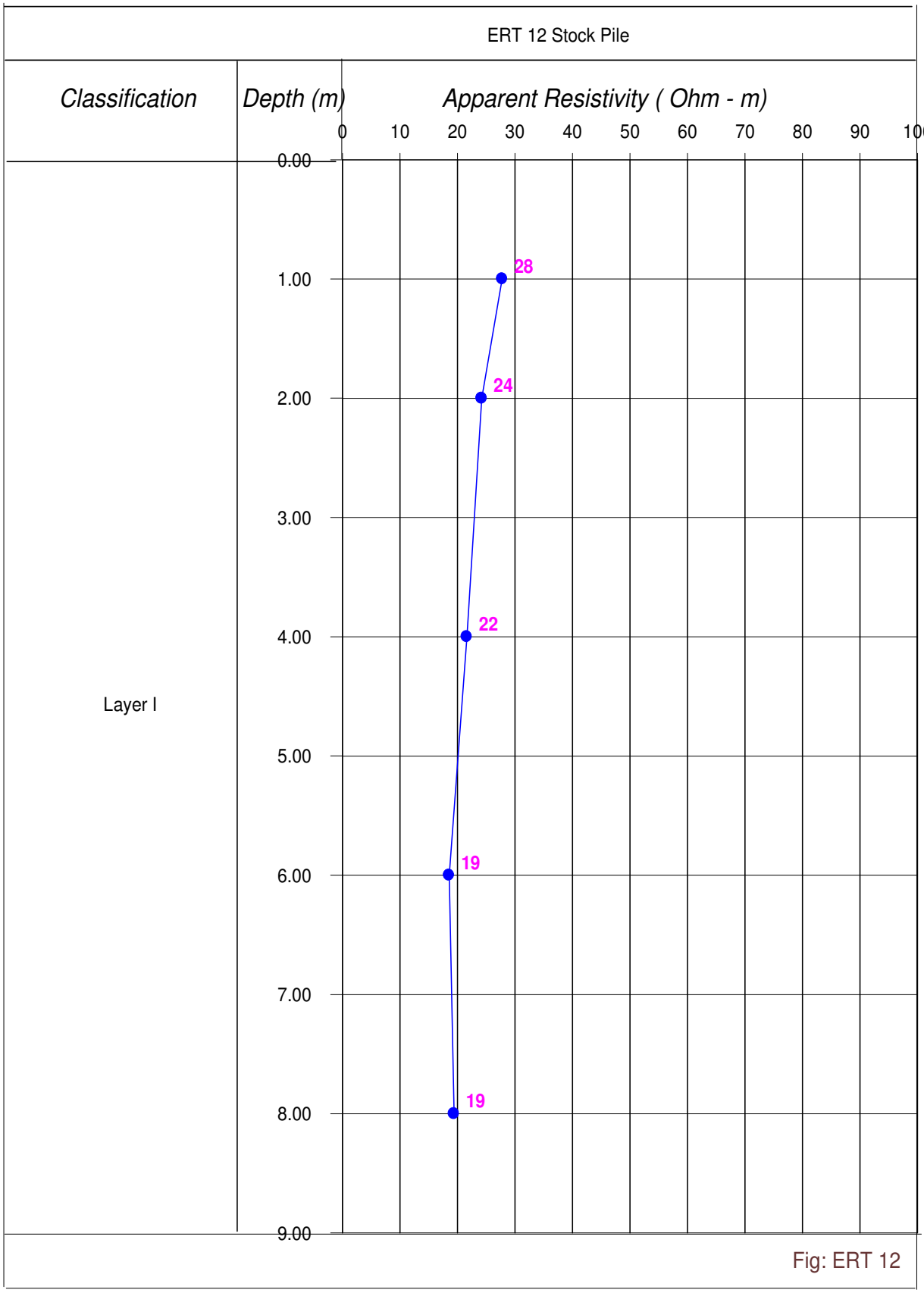

ERT 12 Stock Pile
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
28
24
22
19
19
Layer I

Fig: ERT 12

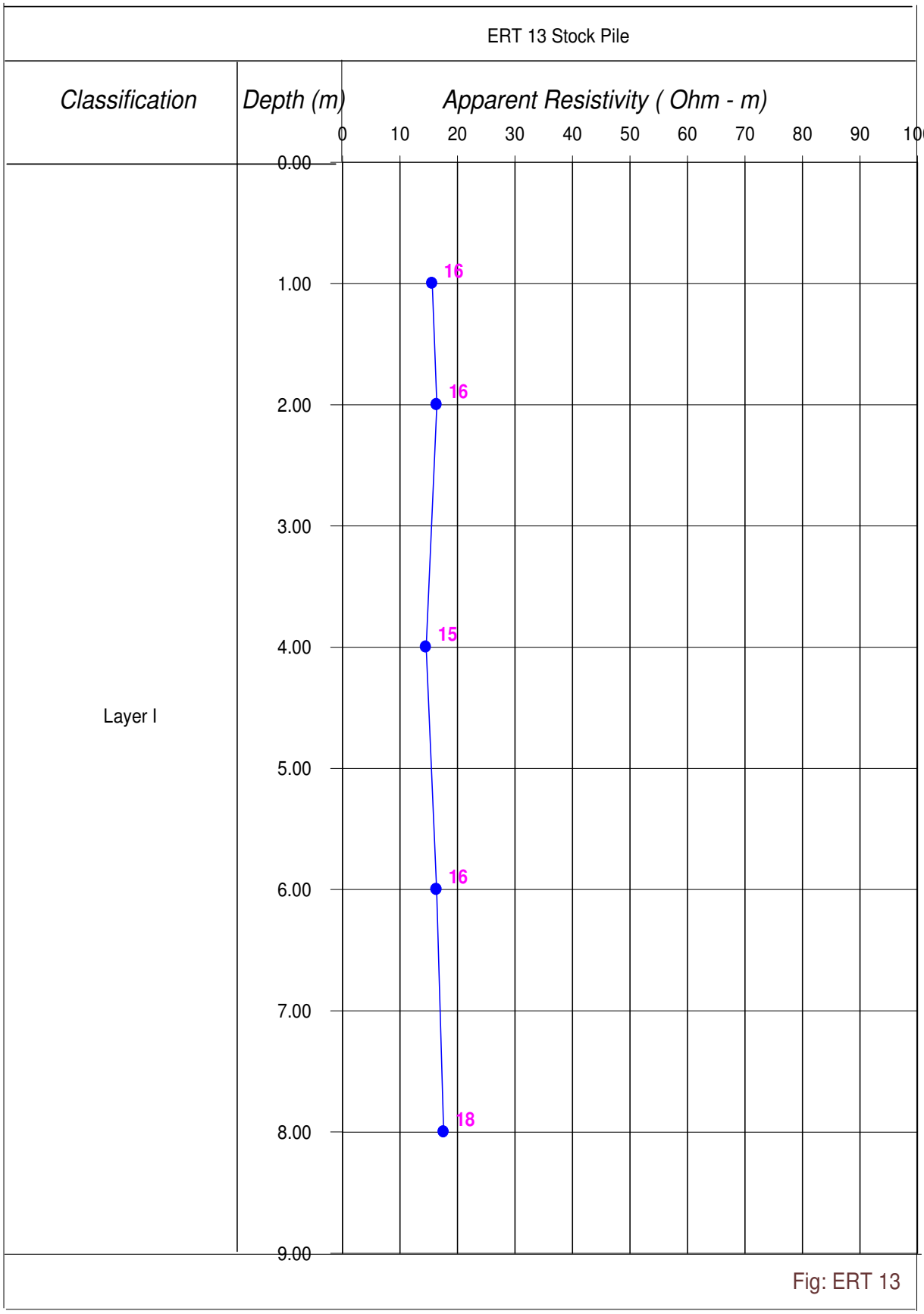

ERT 13 Stock Pile
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
16
16
15
16
18
Layer I

Fig: ERT 13

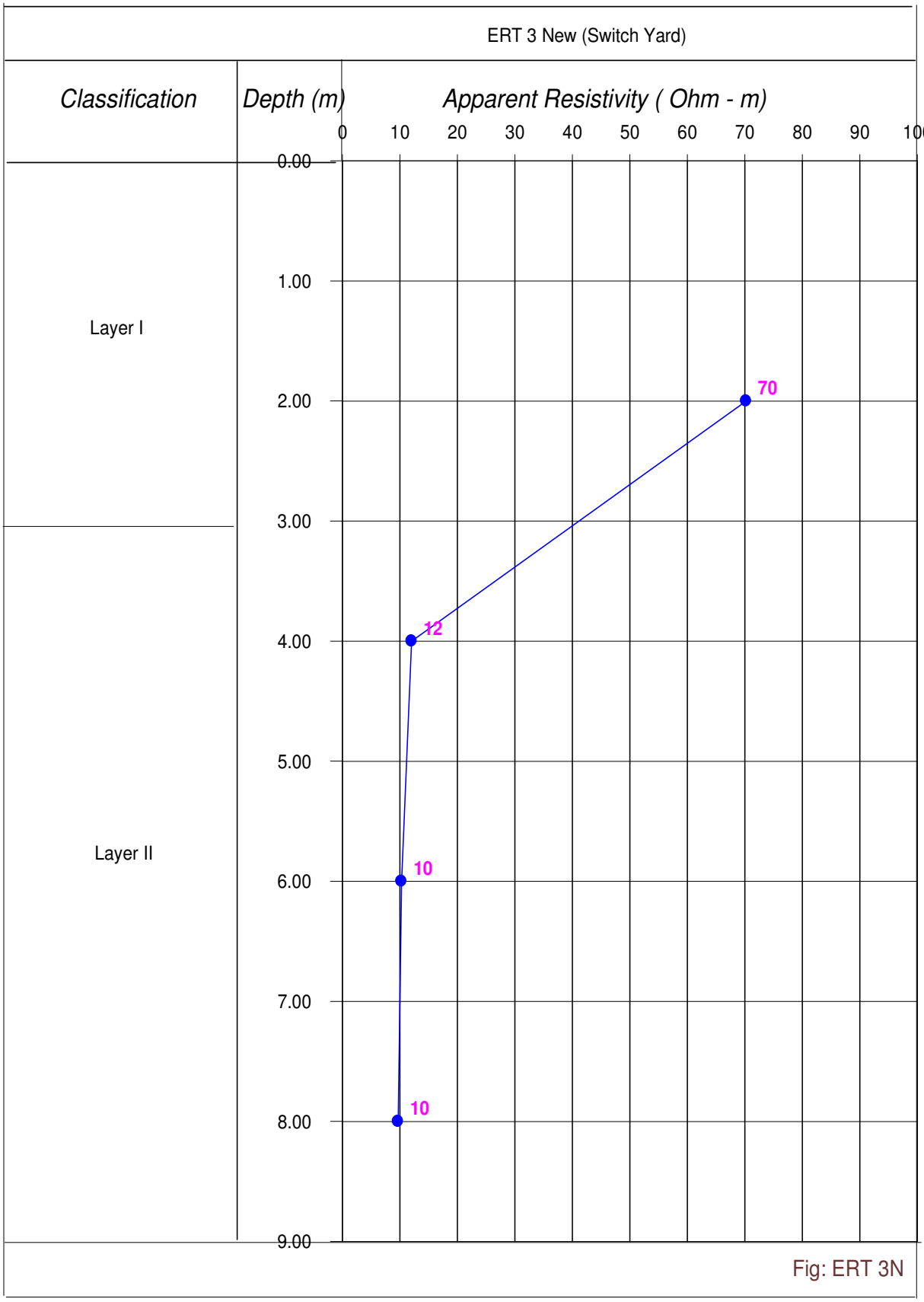

ERT 3 New (Switch Yard)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
70
12
10
10

Fig: ERT 3N

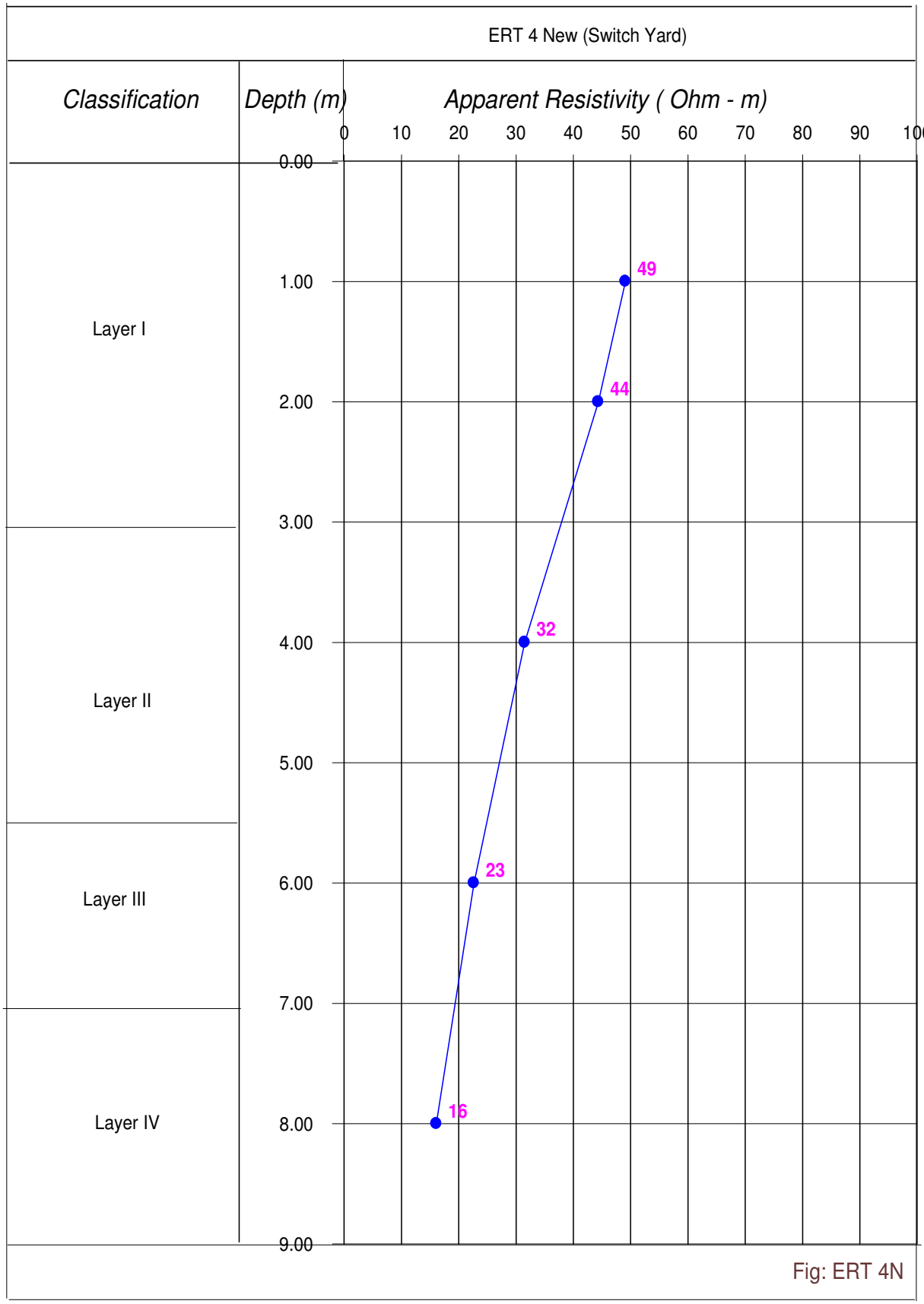

ERT 4 New (Switch Yard)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
Layer III
Layer IV
49
44
32
23
16

Fig: ERT 4N

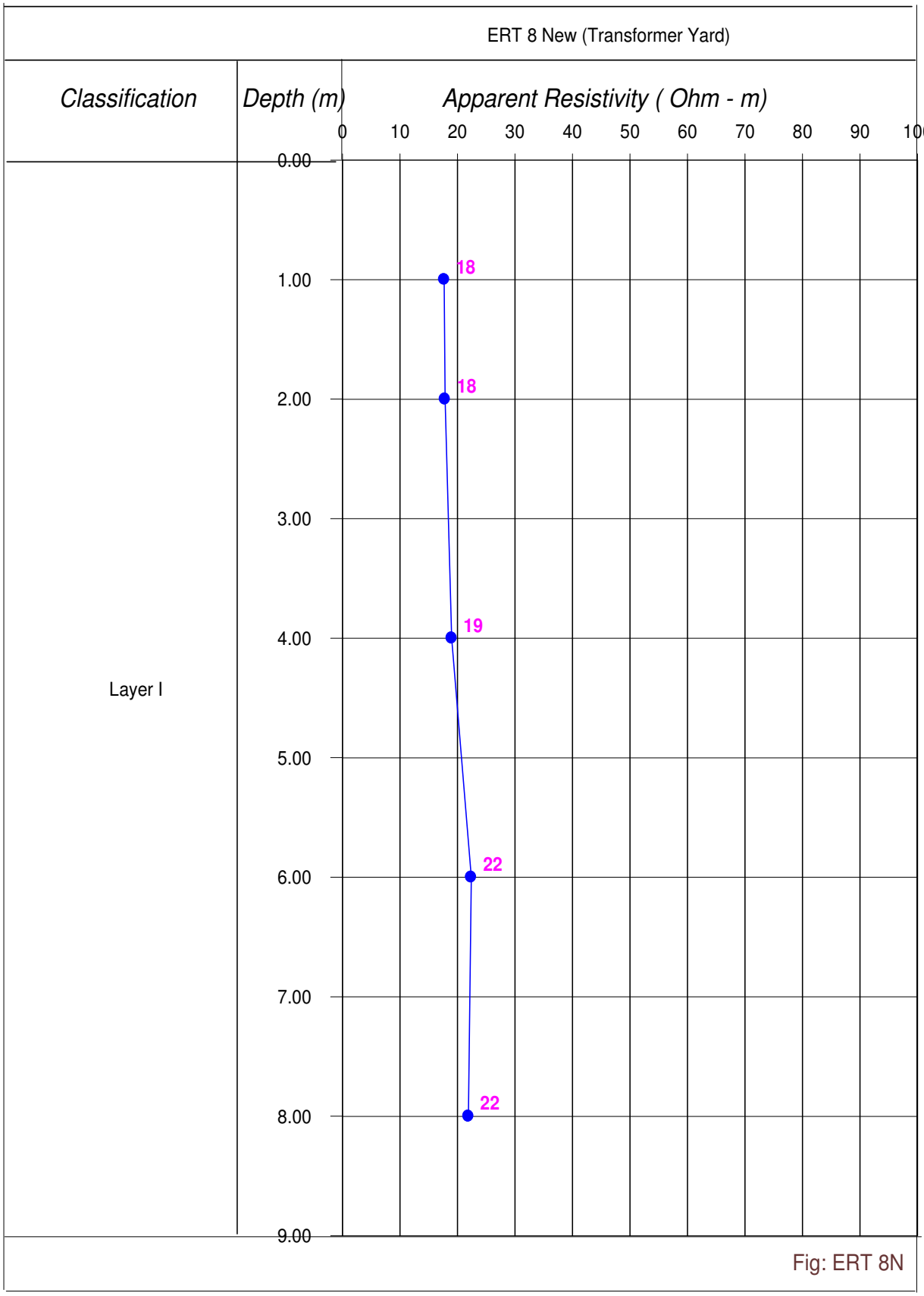

ERT 8 New (Transformer Yard)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
18
18
19
22
22
Layer I

Fig: ERT 8N

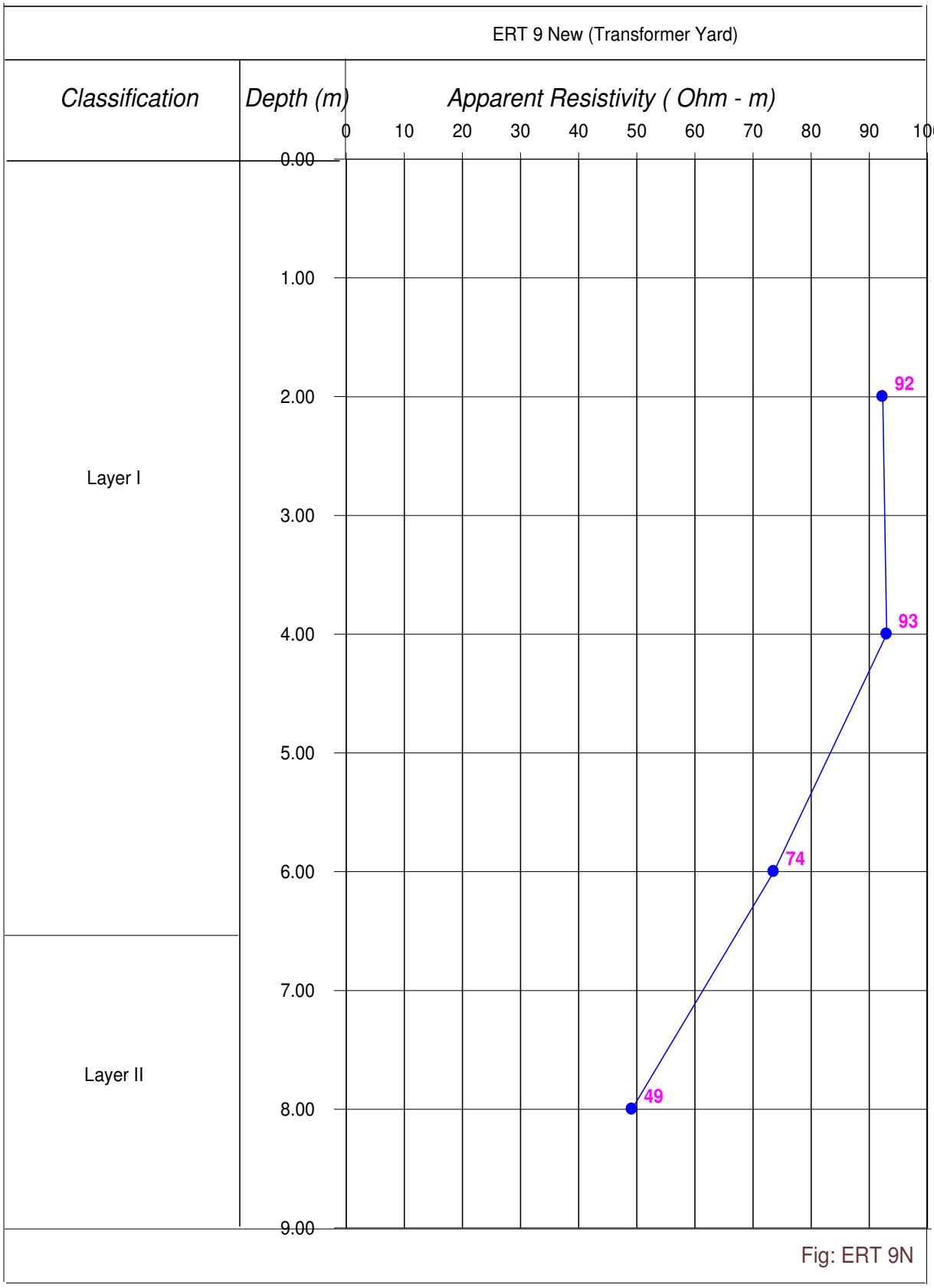

ERT 9 New (Transformer Yard)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0
10
20
30
40
50
60
70
80
90
100
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
92
93
74
49

Fig: ERT 9N

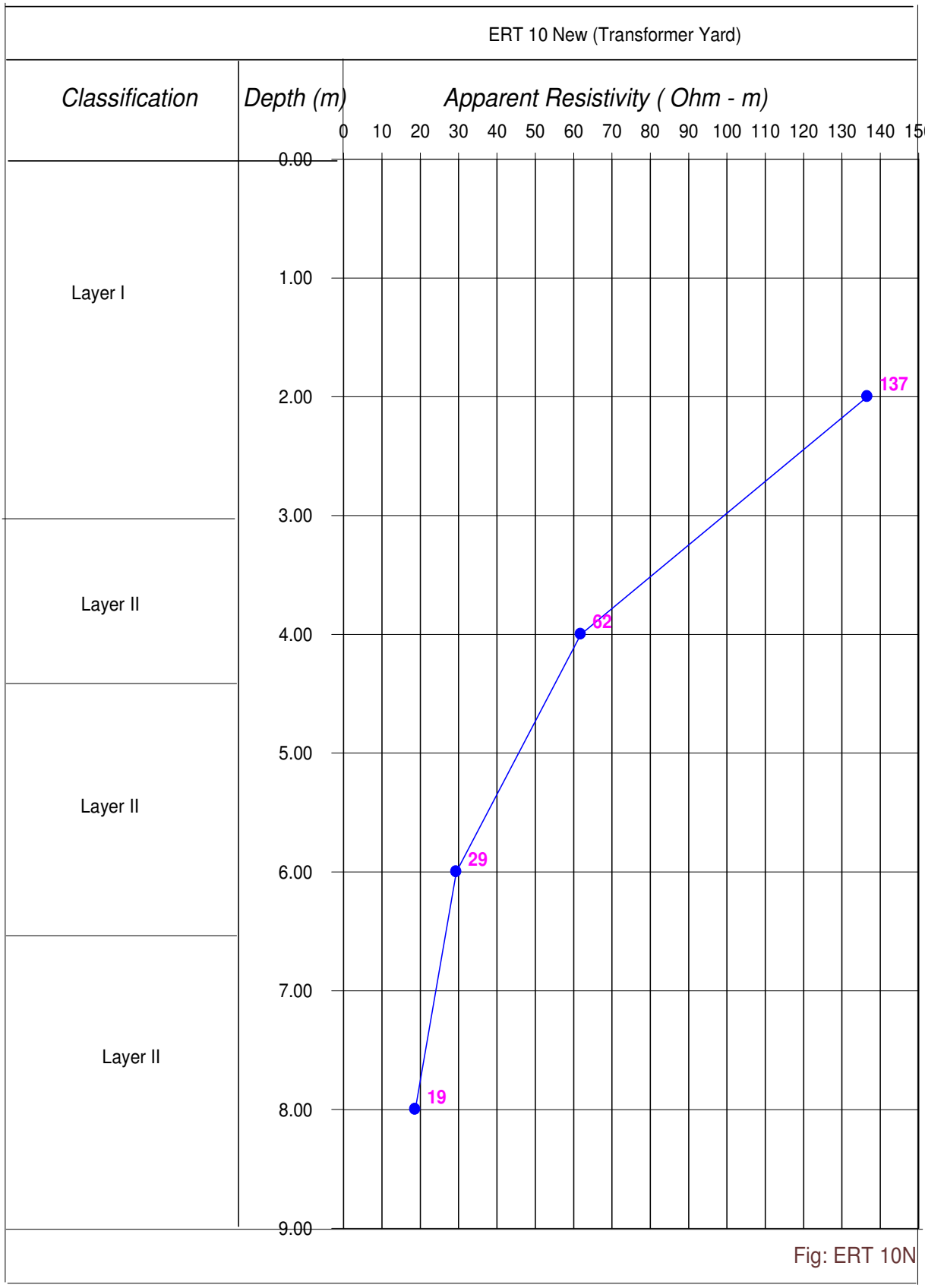

ERT 10 New (Transformer Yard)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
Layer II
Layer II
137
62
29
19

Fig: ERT 10N

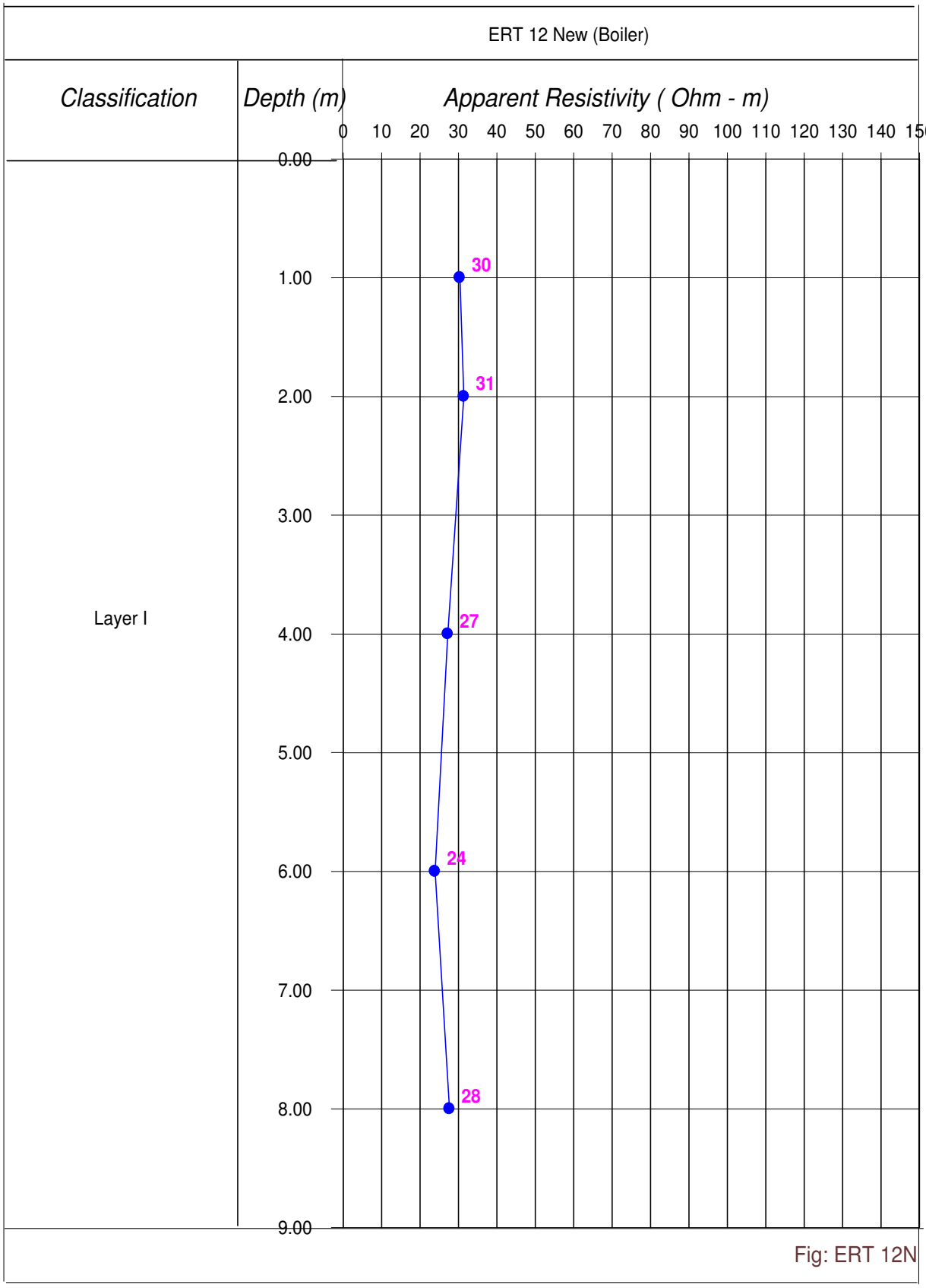

ERT 12 New (Boiler)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
30
31
27
24
28
Layer I

Fig: ERT 12N

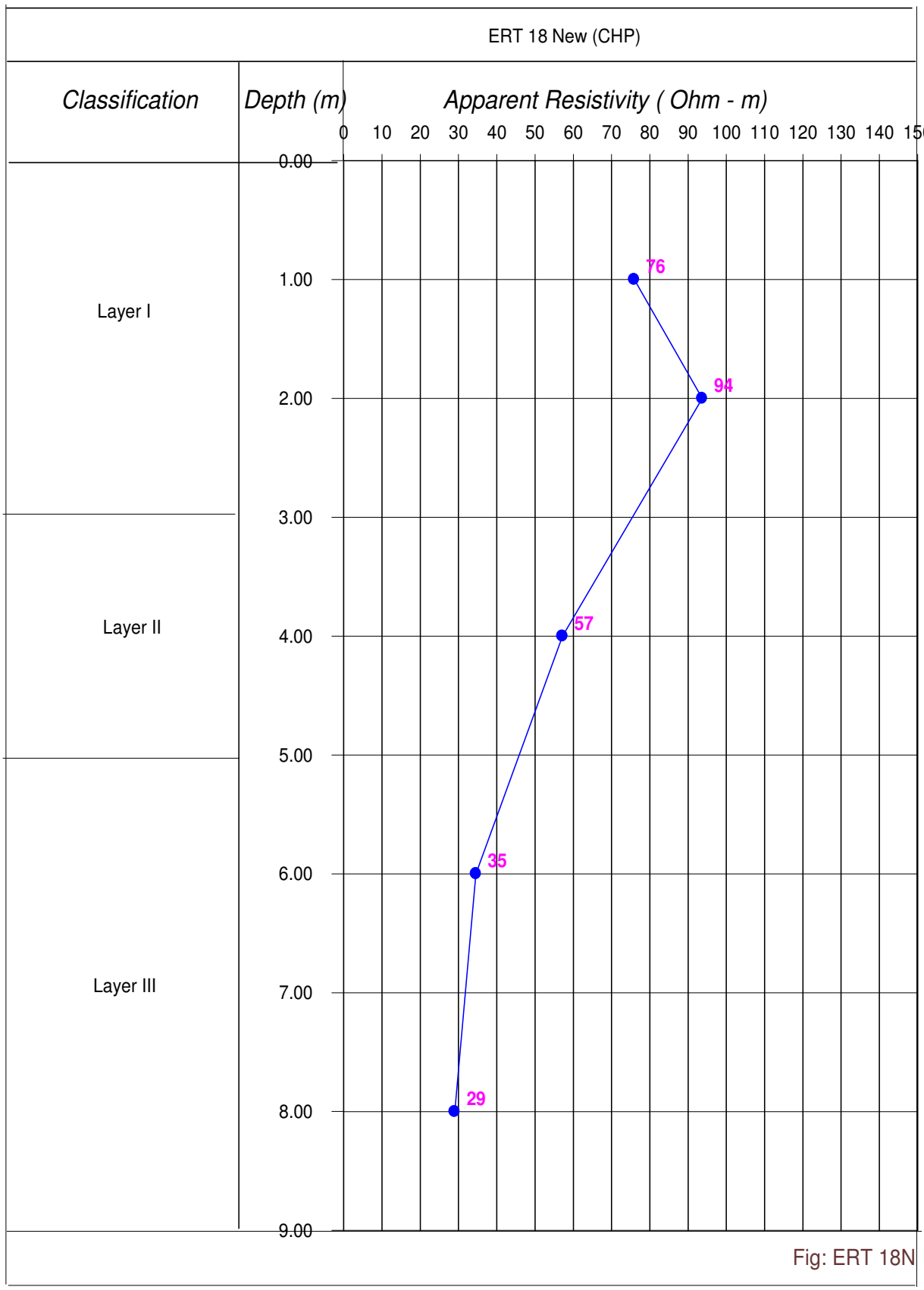

ERT 18 New (CHP)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
Layer III
76
94
57
35
29

Fig: ERT 18N

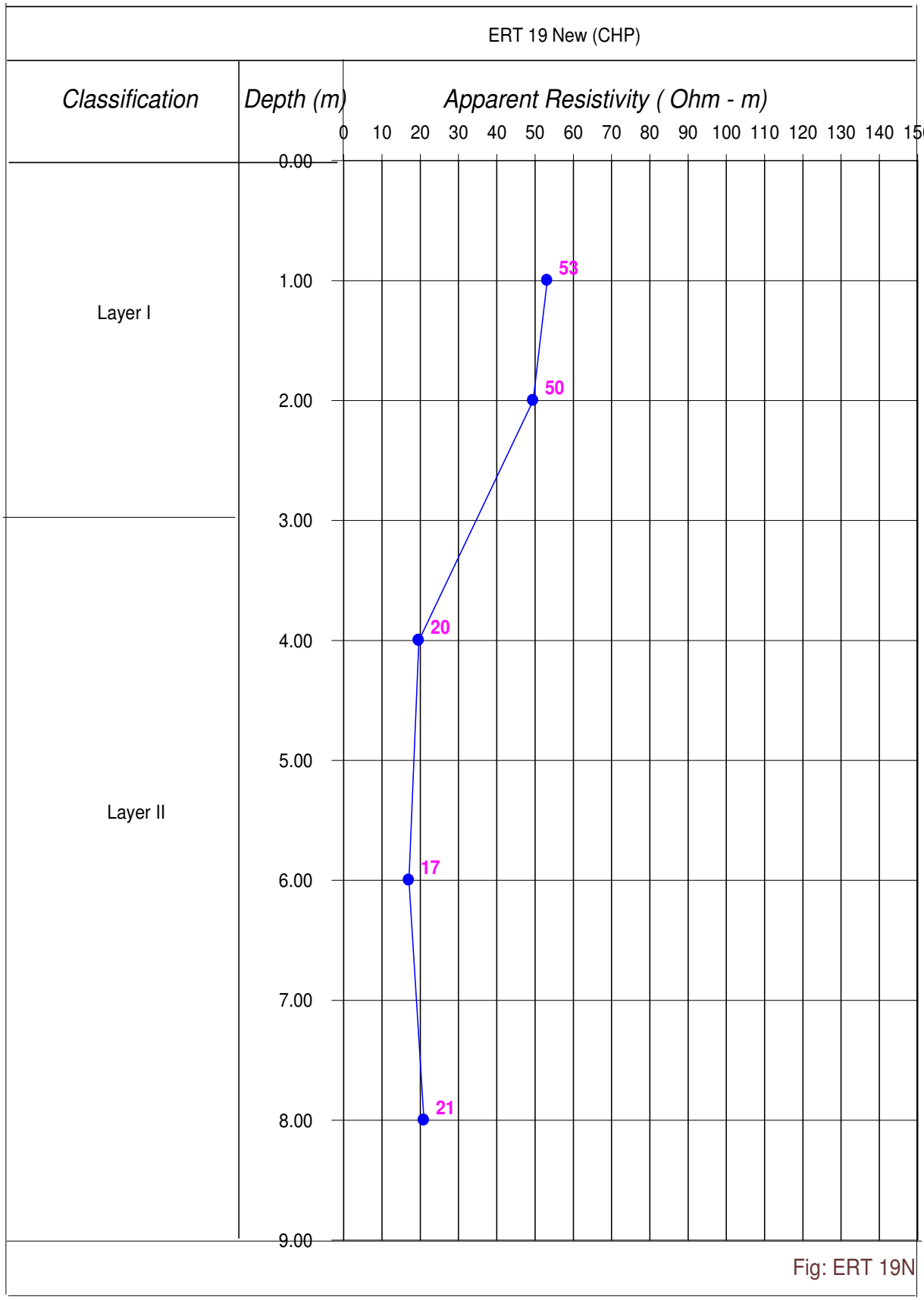

ERT 19 New (CHP)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
53
50
20
17
21

Fig: ERT 19N

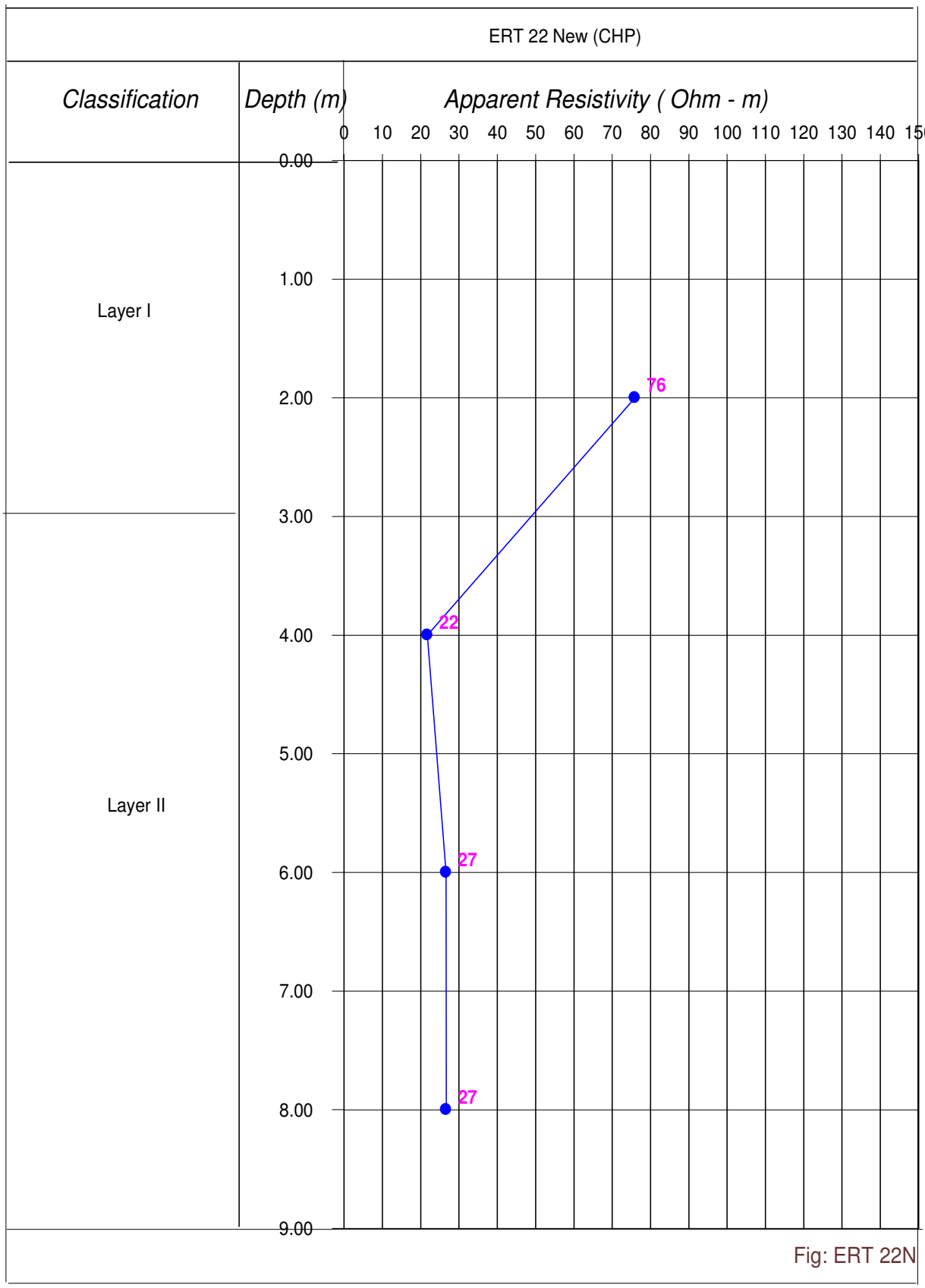

ERT 22 New (CHP)
Classification
Depth (m)
Apparent Resistivity (Ohm - m)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Layer I
Layer II
76
22
27
27

Fig: ERT 22N

CBR TEST RESULTS

Annexure V

CBR	Sieve Analysis			Atterbergs'Limit		Description	Classification	O.M.C.	MDD	C.B.R Soaked	
	Gravel (%)	Sand (%)	Silt/Clay (%)	L.L	P.L					at 2.5 mm.	at 5.0 mm.
1	1	22	77	Non Plastic		Sandy Silt with Gravel	SM-ML	15.40	1.796	6.07	6.62
2	1	4	95	Non Plastic		Ash	-	26.75	1.286	6.77	6.14
3	26	30	44	40	20	Sandy Clay mixed with Gravel	SC-SG	11.00	2.040	6.31	6.22
4	42	27	31	48	23			11.50	2.069	12.26	12.61
5	34	39	27	51	25			12.83	2.040	11.21	11.14
6	1	11	88	47	22	Silty Clay with Sand and Gravel	CI	15.75	1.825	5.37	5.85
7	4	10	86	Non Plastic		Sandy Silt with Gravel	SM-ML	18.29	1.797	9.42	9.21
8	49	33	18	41	20	Sandy Clay mixed with Gravel	SC-SG	11.20	2.110	12.61	12.28

DETERMINATION OF MOISTURE DENSITY RELATION OF SOIL (MODIFIED PROCTOR TEST)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4
Banharpalli, Dist-Jharsugura, Odisha.
Discription of sample: Sandy Silt with Gravel

CBR 1
Date of Testing 3/1/2014
Coordinate: 808.200 E,1203.650 S

COMPACTION TEST (MDD)							
Sno.	Trail No.	1	2	3	4	5	6
1	Wt. of cylinder + compacted soil	7750	7920	8150	8310	8270	8150
2	Wt. of cylinder	3620	3620	3620	3620	3620	3620
3	Volume of cylinder(cc)	2263	2263	2263	2263	2263	2263
4	Wet Density gm/cc	1.825	1.900	2.002	2.072	2.055	2.002
5	Wt. of wet soil + cont.	81.75	75.20	72.52	66.29	76.06	81.55
6	Wt. of dry soil + cont.	78.35	70.60	66.34	60.27	67.44	70.90
7	Wt. of container	21.10	19.39	21.20	21.24	20.33	20.72
8	Moistures content %	5.94	8.98	13.69	15.42	18.30	21.22
9	Dry density gm/cc	1.723	1.744	1.761	1.796	1.737	1.651

Maximum Dry Density 1.796 gm/cc
From Graph (gm/ cc)
O M C in % 15.40 %

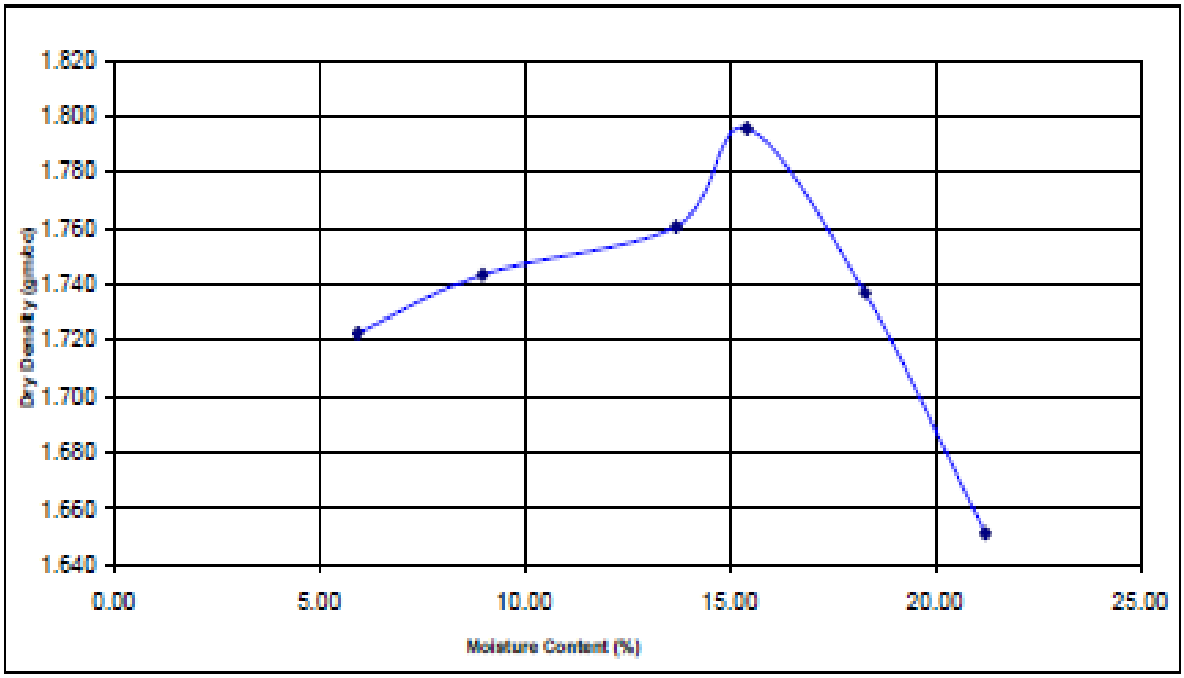


Fig: OMC-1

DETERMINATION OF MOISTURE DENSITY RELATION OF SOIL (MODIFIED PROCTOR TEST)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4
Banharpalli, Dist-Jharsugura, Odisha.
Discription of sample: Ash

CBR 2
Date of Testing 6/1/2014
Coordinate: 1512 E,1230 S

COMPACTION TEST (MDD)								
Sno.	Trail No.	1	2	3	4	5	6	7
1	Wt. of cylinder + compacted soil	6720	6890	7000	7100	7210	7310	7290
2	Wt. of cylinder	3620	3620	3620	3620	3620	3620	3620
3	Volume of cylinder(cc)	2263	2263	2263	2263	2263	2263	2263
4	Wet Density gm/cc	1.370	1.445	1.494	1.538	1.586	1.631	1.622
5	Wt. of wet soil + cont.	61.88	57.95	57.11	63.45	65.13	63.88	61.65
6	Wt. of dry soil + cont.	56.78	52.49	51.08	55.87	56.38	54.80	52.87
7	Wt. of container	20.89	21.34	21.30	22.31	21.26	20.86	21.36
8	Moistures content %	14.21	17.53	20.25	22.59	24.91	26.75	27.86
9	Dry density gm/cc	1.199	1.229	1.242	1.254	1.270	1.286	1.268

Maximum Dry Density From Graph (gm/ cc) 1.286 gm/cc
O M C in % 26.75 %

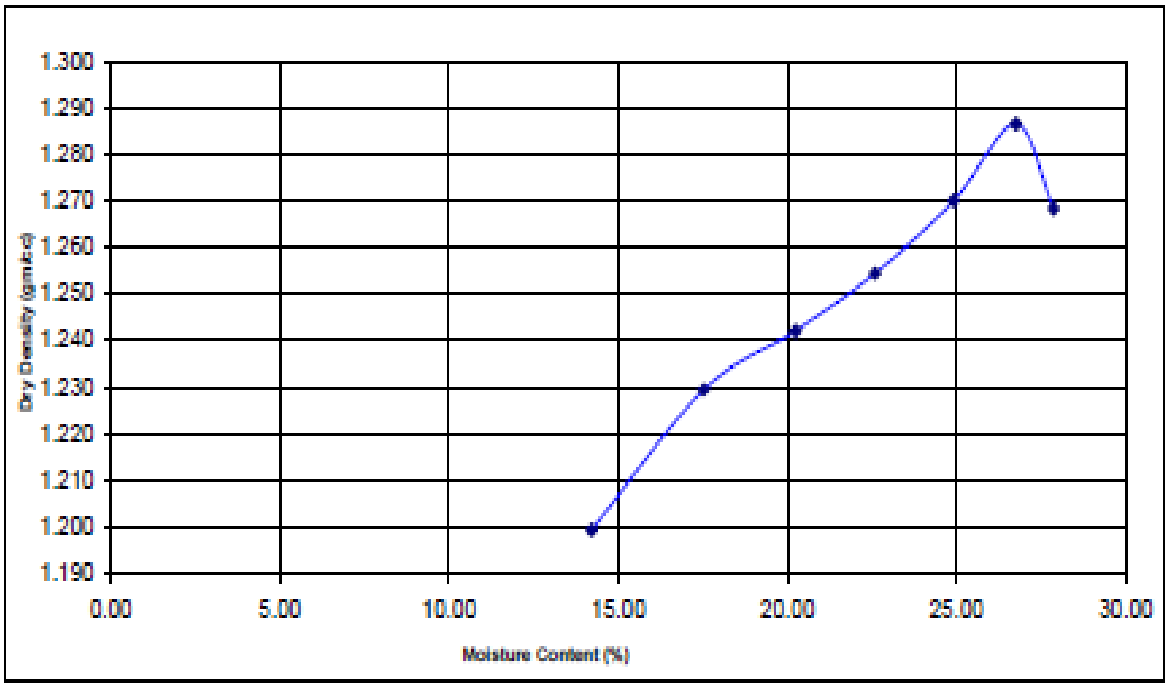


Fig: OMC-2

DETERMINATION OF MOISTURE DENSITY RELATION OF SOIL (MODIFIED PROCTOR TEST)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4
Banharpalli, Dist-Jharsugura, Odisha.
Discription of sample:-Sandy Clay mixed with Gravel

CBR 3
Date of Testing 6/1/2014
Coordinate: 945 E,1549 S

COMPACTION TEST (MDD)							
Sno.	Trail No.	1	2	3	4	5	6
1	Wt. of cylinder + compacted soil	8150	8280	8590	8750	8500	8460
2	Wt. of cylinder	3620	3620	3620	3620	3620	3620
3	Volume of cylinder(cc)	2263	2263	2263	2263	2263	2263
4	Wet Density gm/cc	2.002	2.059	2.196	2.267	2.156	2.139
5	Wt. of wet soil + cont.	81.99	81.75	72.96	73.89	78.50	78.70
6	Wt. of dry soil + cont.	78.56	77.35	68.53	68.52	71.95	71.24
7	Wt. of container	20.85	21.26	22.20	21.20	20.28	20.69
8	Moistures content %	5.94	7.84	9.56	11.35	12.68	14.76
9	Dry density gm/cc	1.889	1.909	2.005	2.036	1.914	1.864

Maximum Dry Density From Graph (gm/ cc) 2.04 gm/cc
O M C in % 11.00 %

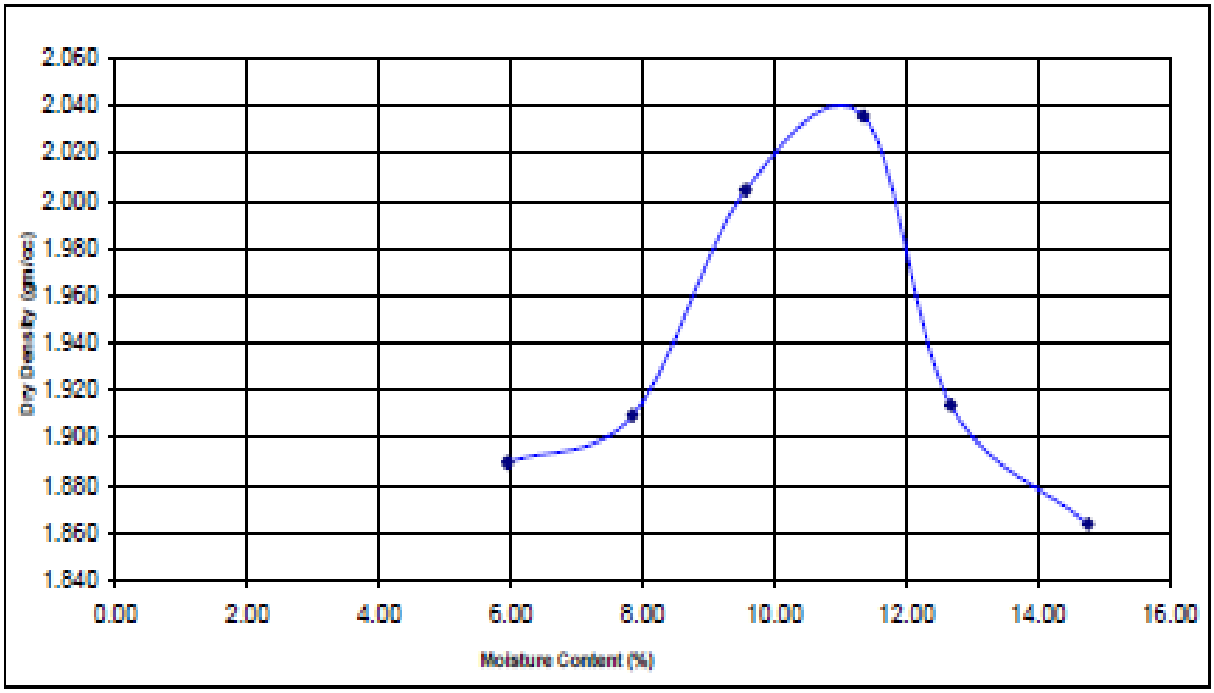


Fig: OMC-3

DETERMINATION OF MOISTURE DENSITY RELATION OF SOIL (MODIFIED PROCTOR TEST)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsugura, Odisha.
Discription of sample:-Sandy Clay mixed with Gravel

CBR 4
Date of Testing 2/1/2014
Coordinate: 1155 E,1818 S

COMPACTION TEST (MDD)							
Sno.	Trail No.	1	2	3	4	5	6
1	Wt. of cylinder + compacted soil	7550	7760	7920	8170	8100	7930
2	Wt. of cylinder	2950	2950	2950	2950	2950	2950
3	Volume of cylinder(cc)	2263	2263	2263	2263	2263	2263
4	Wet Density gm/cc	2.033	2.125	2.196	2.307	2.276	2.201
5	Wt. of wet soil + cont.	77.35	83.69	79.22	78.91	79.16	75.65
6	Wt. of dry soil + cont.	75.05	79.78	74.42	73.06	72.86	68.51
7	Wt. of container	20.80	22.25	20.98	22.18	21.32	20.39
8	Moistures content %	4.24	6.80	8.98	11.50	12.22	14.84
9	Dry density gm/cc	1.950	1.990	2.015	2.069	2.028	1.916

Maximum Dry Density From Graph (gm/ cc) 2.069 gm/cc
O M C in % 11.50 %

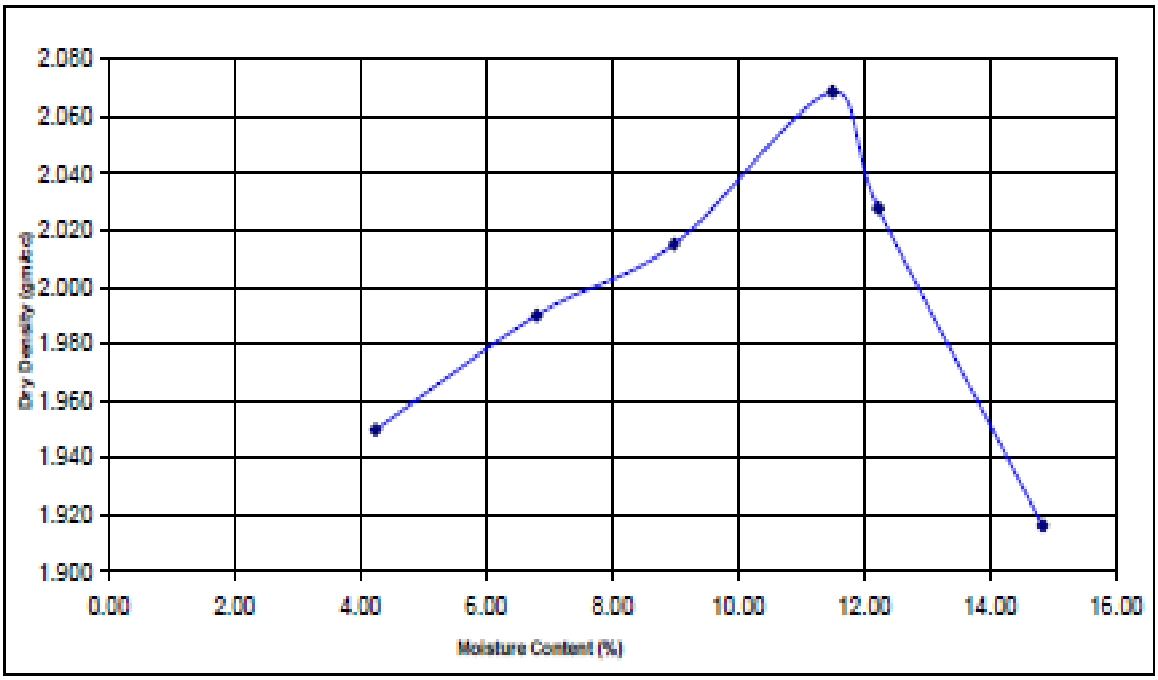


Fig: OMC-4

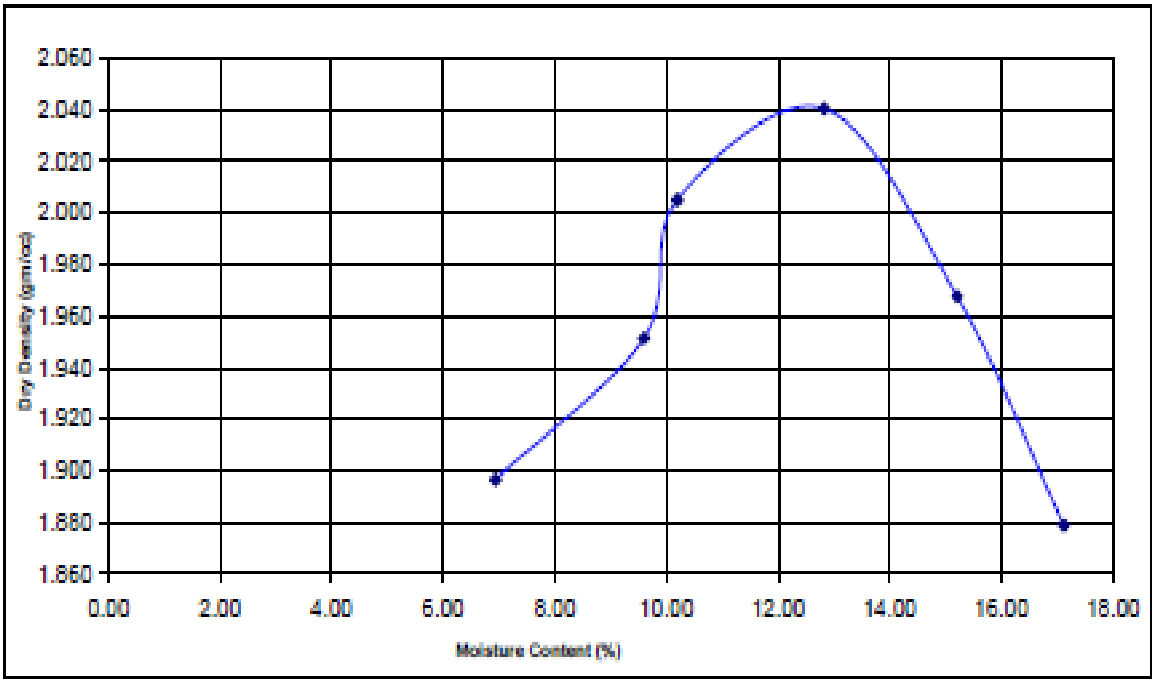
DETERMINATION OF MOISTURE DENSITY RELATION OF SOIL (MODIFIED PROCTOR TEST)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4
Banharpalli, Dist-Jharsugura, Odisha.
Discription of sample:-Sandy Clay mixed with Gravel

CBR 5
Date of Testing 2/1/2014
Coordinate:1613 E,1988 S

COMPACTION TEST (MDD)							
Sno.	Trail No.	1	2	3	4	5	6
1	Wt. of cylinder + compacted soil	8210	8460	8620	8830	8750	8600
2	Wt. of cylinder	3620	3620	3620	3620	3620	3620
3	Volume of cylinder(cc)	2263	2263	2263	2263	2263	2263
4	Wet Density gm/cc	2.028	2.139	2.209	2.302	2.267	2.201
5	Wt. of wet soil + cont.	86.12	79.01	77.94	73.84	84.03	88.23
6	Wt. of dry soil + cont.	81.87	73.90	72.70	67.77	75.74	78.43
7	Wt. of container	20.64	20.66	21.29	20.45	21.24	21.18
8	Moistures content %	6.94	9.60	10.19	12.83	15.21	17.12
9	Dry density gm/cc	1.897	1.951	2.005	2.041	1.968	1.879

Maximum Dry Density 2.04 gm/cc
From Graph (gm/ cc)
O M C in % 12.83 %



Fig; OMC-5

DETERMINATION OF MOISTURE DENSITY RELATION OF SOIL (MODIFIED PROCTOR TEST)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4
Banharpalli, Dist-Jharsugura, Odisha.
Discription of sample:-Silty Clay of Medium Plasticity

CBR 6
Date of Testing 2/1/2014
Coordinate:1502.50 E,1516 S

COMPACTION TEST (MDD)								
Sno.	Trail No.		1	2	3	4	5	6
1	Wt. of cylinder + compacted soil	7750	7900	8060	8200	8400	8250	8100
2	Wt. of cylinder	3620	3620	3620	3620	3620	3620	3620
3	Volume of cylinder(cc)	2263	2263	2263	2263	2263	2263	2263
4	Wet Density gm/cc	1.825	1.891	1.962	2.024	2.112	2.046	1.980
5	Wt. of wet soil + cont.	75.46	86.14	70.50	74.30	70.16	73.25	73.20
6	Wt. of dry soil + cont.	71.57	80.70	65.78	68.40	63.50	65.60	65.15
7	Wt. of container	21.34	21.60	21.27	20.35	21.21	21.30	20.89
8	Moistures content %	7.74	9.20	10.60	12.28	15.75	17.27	18.19
9	Dry density gm/cc	1.694	1.732	1.774	1.803	1.825	1.745	1.675

Maximum Dry Density From Graph (gm/ cc) 1.825 gm/cc
O M C in % 15.75 %

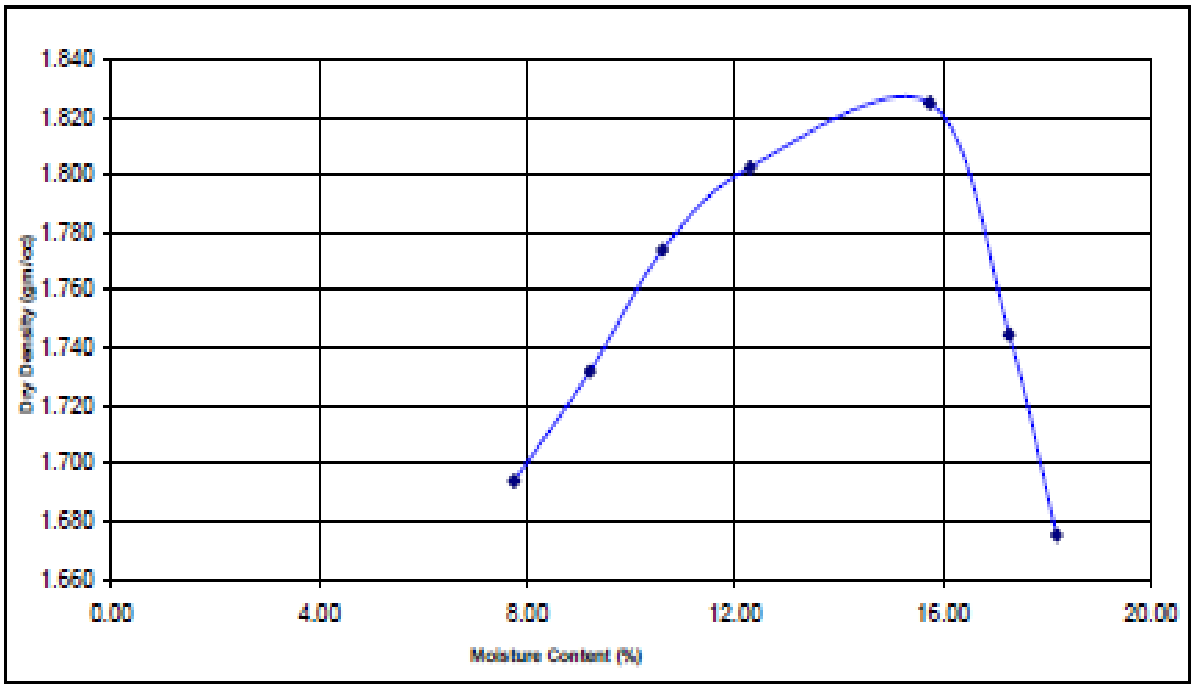


Fig: OMC-6

SOIL ENGINEERING CONSULTANTS

DETERMINATION OF MOISTURE DENSITY RELATION OF SOIL
(MODIFIED PROCTOR TEST)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4
Banharpalli, Dist-Jharsugura, Odisha.
Discription of sample:Sandy Silt with Gravel

CBR 7
Date of Testing 6/1/2014
Coordinate:947.600 E,2135.600 S

COMPACTION TEST (MDD)							
Sno.	Trail No.	1	2	3	4	5	6
1	Wt. of cylinder + compacted soil	7310	7470	7620	7760	7680	7590
2	Wt. of cylinder	2950	2950	2950	2950	2950	2950
3	Volume of cylinder(cc)	2263	2263	2263	2263	2263	2263
4	Wet Density gm/cc	1.927	1.997	2.064	2.125	2.090	2.050
5	Wt. of wet soil + cont.	64.67	65.98	72.22	71.37	73.42	70.34
6	Wt. of dry soil + cont.	60.11	60.31	64.99	63.55	64.70	61.38
7	Wt. of container	21.22	21.22	20.28	20.80	22.26	21.26
8	Moistures content %	11.73	14.50	16.17	18.29	20.55	22.33
9	Dry density gm/cc	1.724	1.744	1.776	1.797	1.734	1.676

Maximum Dry Density 1.797 gm/cc
From Graph (gm/ cc)
O M C in % 18.29 %

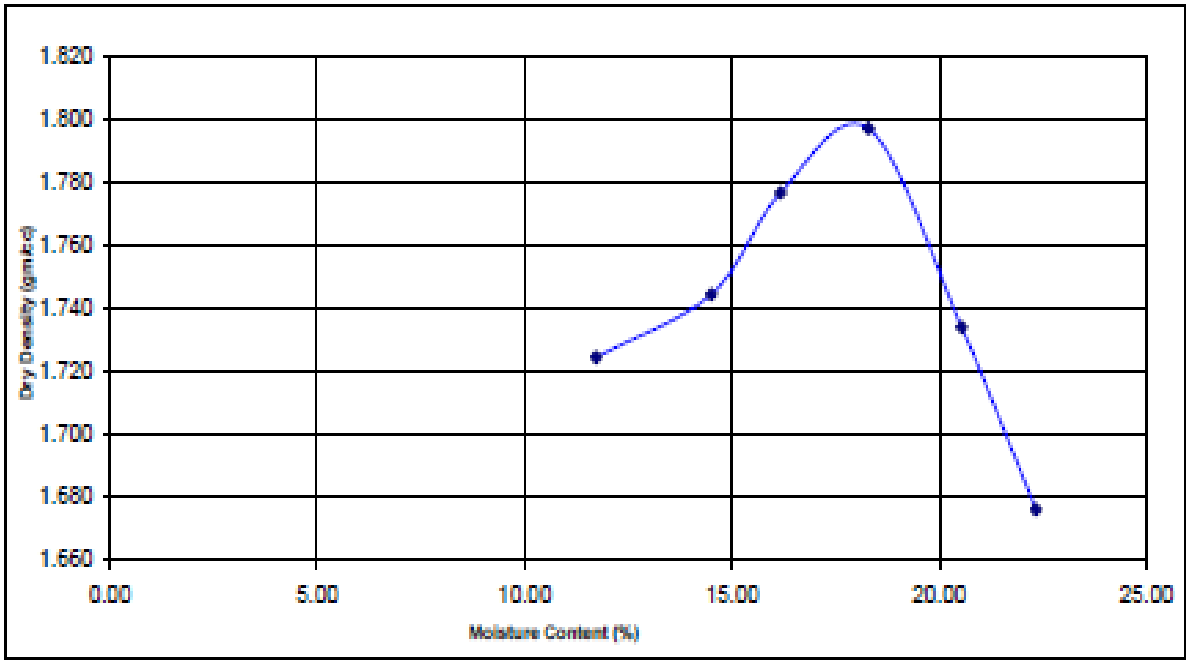


Fig: OMC-7

DETERMINATION OF MOISTURE DENSITY RELATION OF SOIL (MODIFIED PROCTOR TEST)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4
Banharpalli, Dist-Jharsugura, Odisha.
Discription of sample: Sandy Clay mixed with Gravel

CBR 8
Date of Testing 3/1/2014
Coordinate: 1892.450 E, 856.250 S

COMPACTION TEST (MDD)								
Sno.	Trail No.	1	2	3	4	5	6	7
1	Wt. of cylinder + compacted soil	7750	7900	8030	8170	8280	8160	8000
2	Wt. of cylinder	2950	2950	2950	2950	2950	2950	2950
3	Volume of cylinder(cc)	2263	2263	2263	2263	2263	2263	2263
4	Wet Density gm/cc	2.121	2.187	2.245	2.307	2.355	2.302	2.232
5	Wt. of wet soil + cont.	83.14	77.30	71.06	73.61	76.72	77.33	86.94
6	Wt. of dry soil + cont.	79.98	73.62	67.35	68.63	71.03	70.34	78.25
7	Wt. of container	21.3	20.47	21.85	20.57	21.55	19.96	21.63
8	Moistures content %	5.39	6.92	8.15	10.36	11.50	13.87	15.35
9	Dry density gm/cc	2.013	2.046	2.076	2.090	2.112	2.022	1.935

Maximum Dry Density From Graph (gm/ cc) 2.11 gm/cc
O M C in % 11.20 %

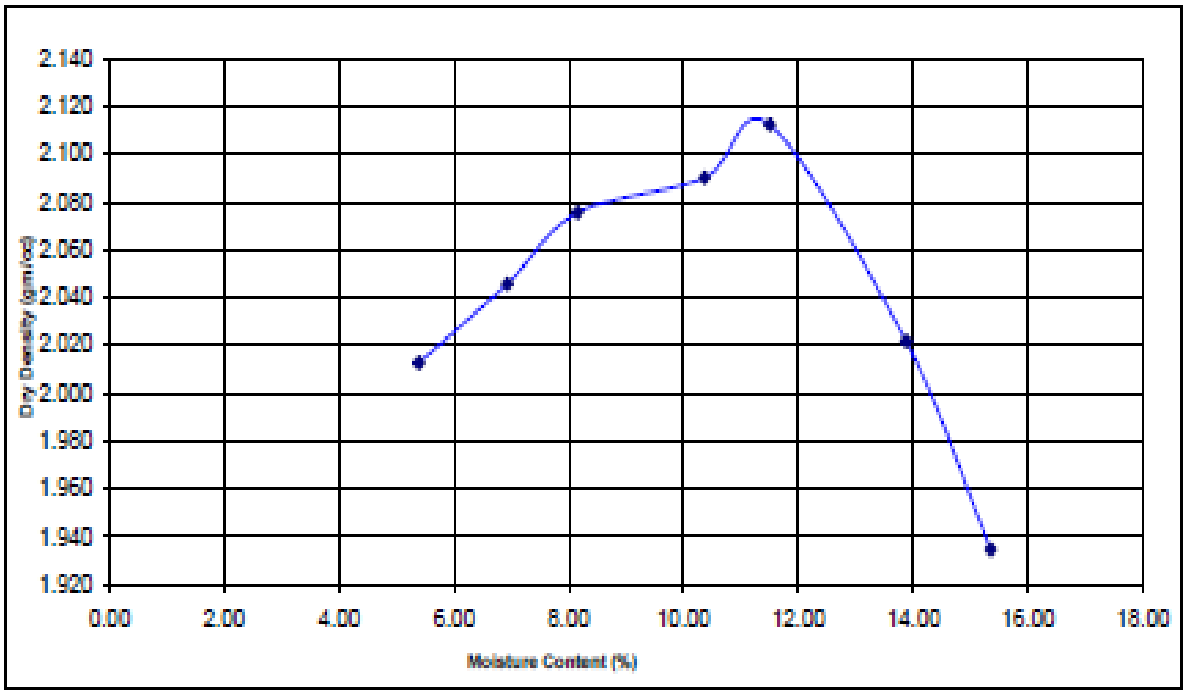


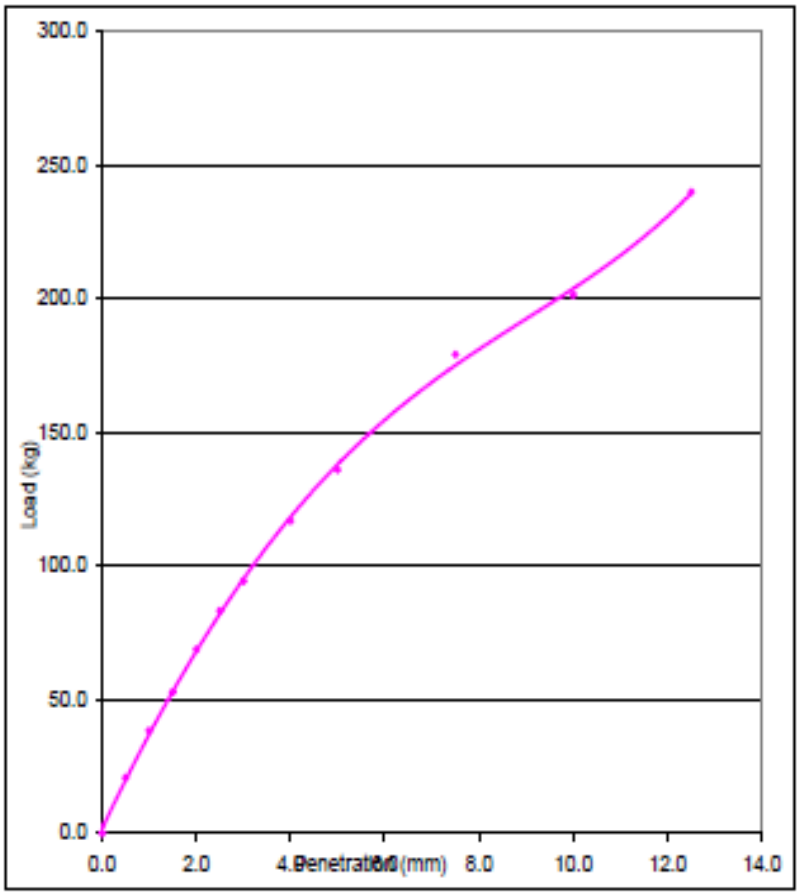
Fig: OMC-8

California Bearing Ratio Test (IS 2720 P-16)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsugura, Odisha.

Location : CBR 1
Description of Sample : Sandy Silt with Gravel
Surcharge Weight Used : 5.00Kg

Condition of Test : Soaked (96 Hours)
Guage Least Count : 0.01-25 mm
Coordinate: 808.200 E,1203.650 S



STD CBR at 2.5pnt. 1370 kg STD CBR at 5.0pnt. 2055 kg
% of CBR at pnt. Load/std CBRx100

	CBR @	
	2.5mm pnt	5.0mm pnt.
Soaked CBR	6.07	6.62

Fig: CBR-1

California Bearing Ratio Test (IS 2720 P-16)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsuguda, Odisha.

Location : CBR 2

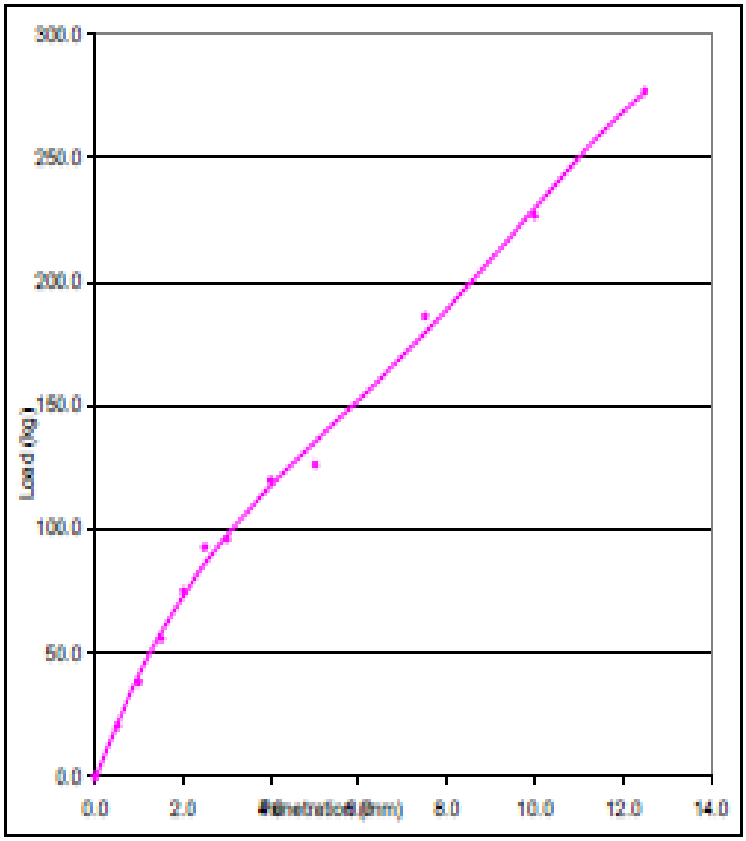
Description of Sample : Ash

Surcharge Weight Used : 5.00Kg

Condition of Test : Soaked (96 Hours)

Guage Least Count : 0.01-25 mm

Coordinate: 1512 E,1230 S



STD CBR at 2.5pnt. 1370 kg STD CBR at 5.0pnt. 2055 kg
% of CBR at pnt. Load/std CBRx100

	CBR @	
	2.5mm pnt	5.0mm pnt.
Soaked CBR	6.77	6.14

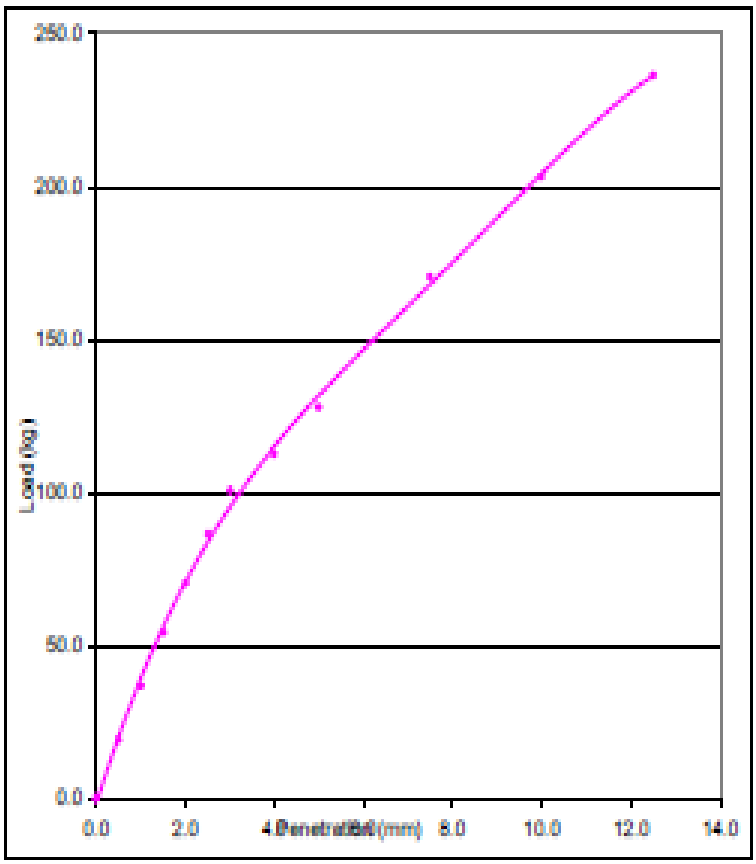
Fig: CBR-2

California Bearing Ratio Test (IS 2720 P-16)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsuguda, Odisha.

Location : CBR 3
Description of Sample : Sandy Clay mixed with Gravel
Surcharge Weight Used : 5.00Kg

Condition of Test : Soaked (96 Hours)
Gauge Least Count : 0.01-25 mm
Coordinate: 945 E,1549 S



STD CBR at 2.5pnt. 1370 kg STD CBR at 5.0pnt. 2055 kg
% of CBR at pnt. Load/std CBRx100

	CBR @	
	2.5mm pnt	5.0mm pnt.
Soaked CBR	6.31	6.22

Fig: CBR-3

California Bearing Ratio Test (IS 2720 P-16)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsuguda, Odisha.

Location : CBR 4

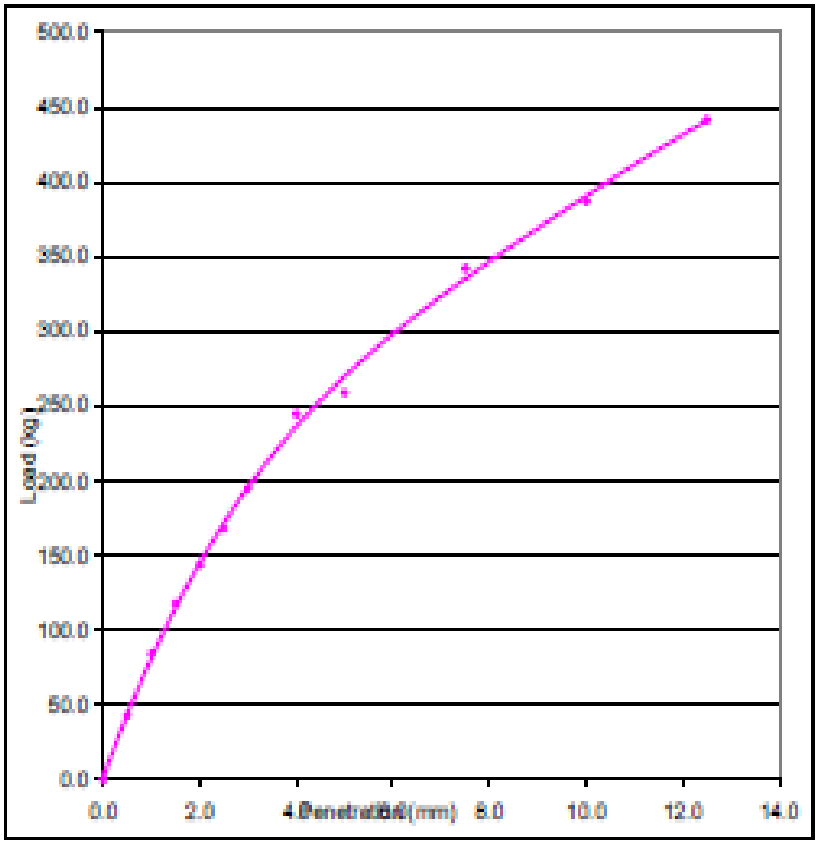
Description of Sample : Sandy Clay mixed with Gravel

Surcharge Weight Used : 5.00Kg

Condition of Test : Soaked (96 Hours)

Gauge Least Count : 0.01-25 mm

Coordinate: 1155 E,1818 S



STD CBR at 2.5pnt. 1370 kg STD CBR at 5.0pnt. 2055 kg
% of CBR at pnt. Load/std CBRx100

	CBR @	
	2.5mm pnt	5.0mm pnt.
Soaked CBR	12.26	12.61

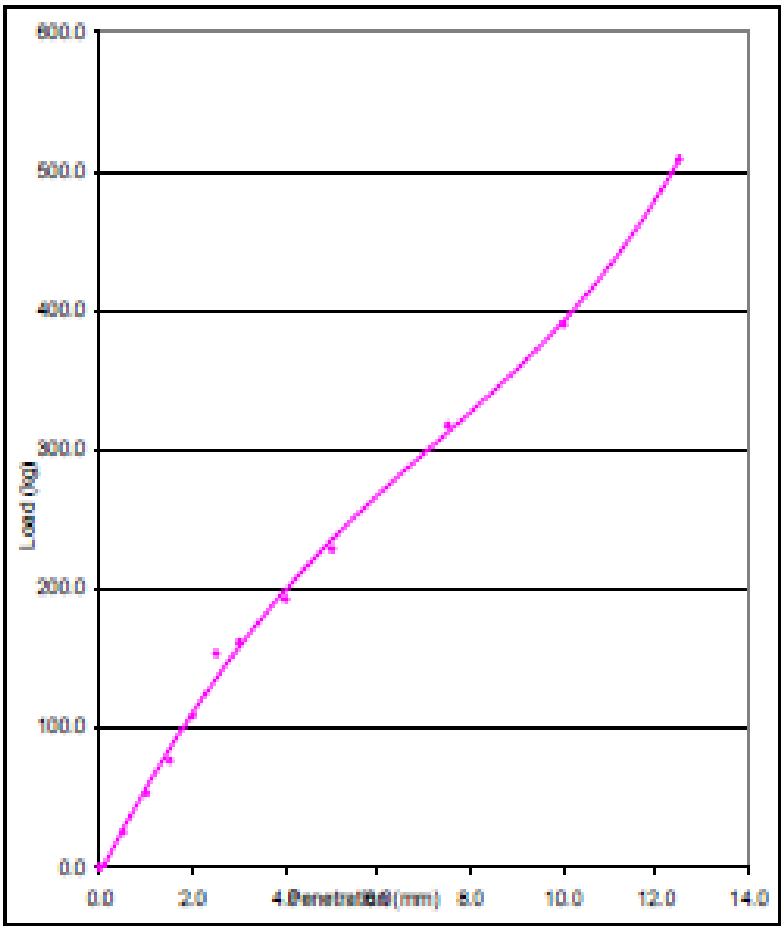
Fig: CBR-4

California Bearing Ratio Test (IS 2720 P-16)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsuguda, Odisha.

Location : CBR 5
Description of Sample : Sandy Clay mixed with Gravel
Surcharge Weight Used : 5.00Kg

Condition of Test : Soaked (96 Hours)
Guage Least Count : 0.01-25 mm
Coordinate:1613 E,1988 S



STD CBR at 2.5pnt. 1370 kg
STD CBR at 5.0pnt. 2055 kg
% of CBR at pnt. Load/std CBRx100

	CBR @	
	2.5mm pnt	5.0mm pnt.
Soaked CBR	11.21	11.14

Fig: CBR-5

California Bearing Ratio Test (IS 2720 P-16)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsuguda, Odisha.

Location : CBR 6

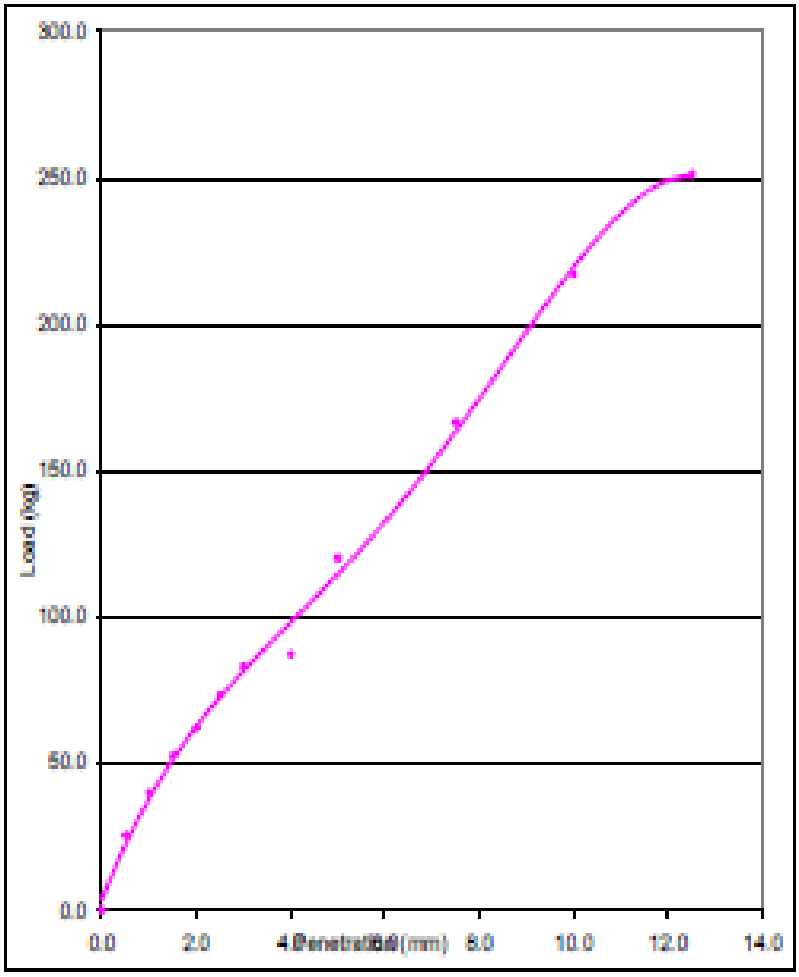
Description of Sample : Silty Clay of Medium Plasticity

Surcharge Weight Used : 5.00Kg

Condition of Test : Soaked (96 Hours)

Guage Least Count : 0.01-25 mm

Coordinate:1502.50 E,1516 S



STD CBR at 2.5prt. 1370 kg
STD CBR at 5.0prt. 2055 kg
% of CBR at prt. Load/std CBRx100

	CBR @	
	2.5mm prt	5.0mm prt.
Soaked CBR	5.37	5.85

Fig: CBR-6

California Bearing Ratio Test (IS 2720 P-16)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsuguda, Odisha.

Location : CBR 7

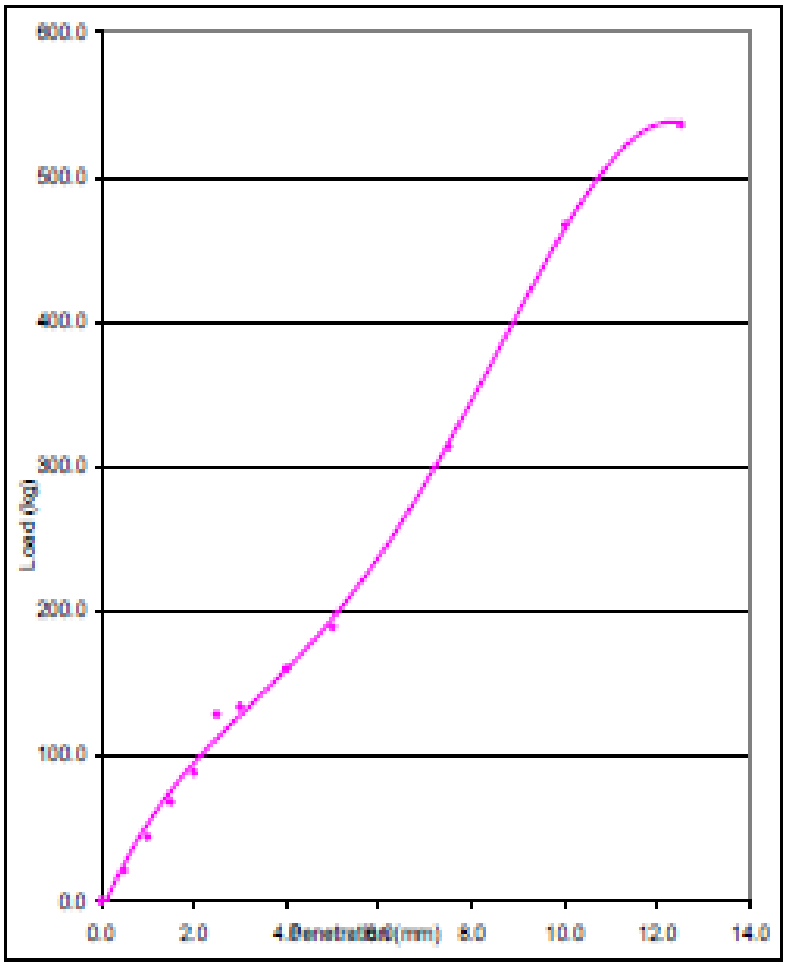
Description of Sample : Sandy Silt with Gravel

Surcharge Weight Used : 5.00Kg

Condition of Test : Soaked (96 Hours)

Guage Least Count : 0.01-25 mm

Coordinate:947.600 E,2135.600 S



STD CBR at 2.5pnt. 1370 kg STD CBR at 5.0pnt. 2055 kg
% of CBR at pnt. Load/std CBRx100

	CBR @	
	2.5mm pnt	5.0mm pnt.
Soaked CBR	9.42	9.21

Fig: CBR-7

California Bearing Ratio Test (IS 2720 P-16)

Project : 2x660MW IB Thermal Power Station,Unit-3 & 4 Banharpalli, Dist-Jharsuguda, Odisha.

Location : CBR 8

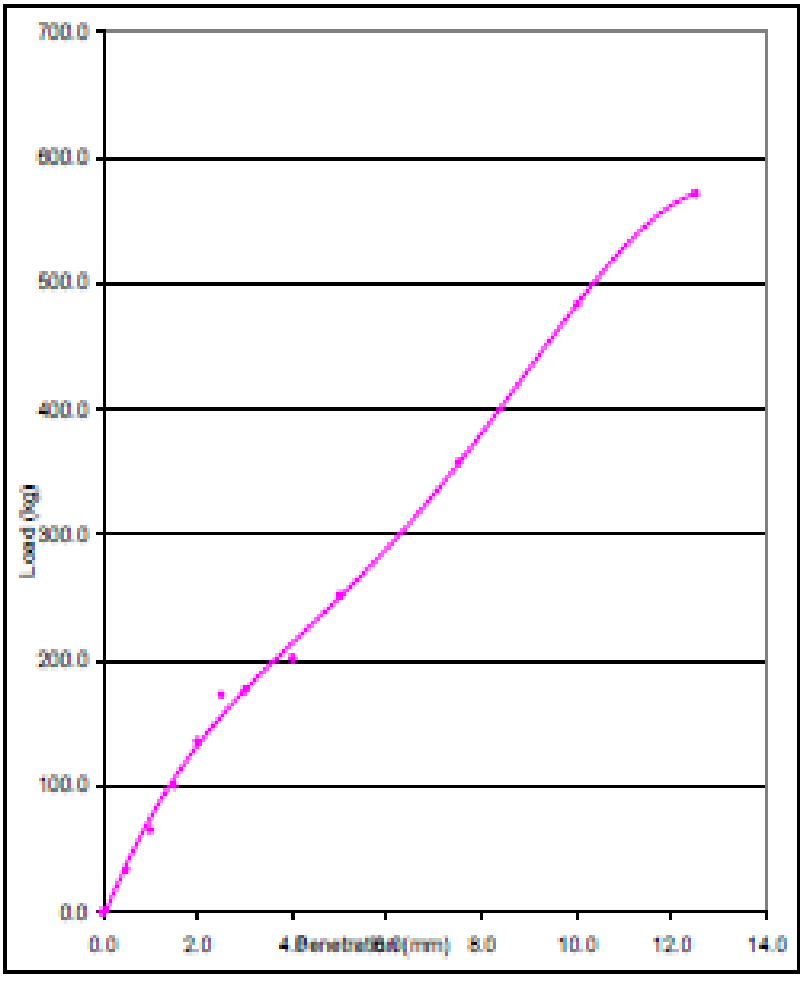
Description of Sample : Sandy Clay mixed with Gravel

Surcharge Weight Used : 5.00Kg

Condition of Test : Soaked (96 Hours)

Guage Least Count : 0.01-25 mm

Coordinate: 1892.450 E, 856.250 S



STD CBR at 2.5pnt. 1370 kg
STD CBR at 5.0pnt. 2055 kg
% of CBR at pnt. Load/std CBRx100

	CBR @	
	2.5mm pnt	5.0mm pnt.
Soaked CBR	12.61	12.28

Fig: CBR-8

Annexure VI

Chemical Analysis of Soil															
S. No	Tests	BH 1	BH 3	BH 5	BH 7	BH 9	BH 11	BH 12	BH 15	BH 16	BH 18	BH 20	BH 22	BH 23	BH 25	BH 26
1	pH	6.94	6.96	7.1	7.2	6.96	6.97	6.98	6.98	6.96	6.98	6.95	6.97	6.98	6.99	7.1
2	Chloride(As Cl) % By Mass	0.016	0.017	0.016	0.017	0.017	0.016	0.015	0.015	0.016	0.017	0.0156	0.0159	0.016	0.017	0.015
3	Sulphate (As So4) % By Mass	0.01	0.012	0.01	0.011	0.012	0.01	0.01	0.012	0.012	0.012	0.1	0.01	0.011	0.01	0.01

Chemical Analysis of Soil							
S.No	Tests	BH 27	BH 29	BH 30	BH 32	BH 34	BH 35
1	pH	6.94	6.95	6.94	6.96	6.94	7.1
2	Chloride(As Cl) % By Mass	0.016	0.017	0.016	0.017	0.0154	0.016
3	Sulphate (As So4) % By Mass	0.01	0.01	0.011	0.012	0.0122	0.011

Chemical Analysis of Water															
S. No	Tests	BH 1	BH 3	BH 5	BH 7	BH 9	BH 11	BH 12	BH 15	BH 16	BH 18	BH 20	BH 22	BH 23	BH 25	BH 26
1	pH	7.39	7.38	7.36	7.4	7.4	7.39	7.38	7.36	7.39	7.4	7.41	7.39	7.36	7.38	7.35
2	Chloride(As Cl), Mg/L	8.10	7.96	7.99	8.12	8.13	8.10	8.12	8.10	8.11	8.10	7.99	8.12	8.10	8.11	8.10
3	Sulphate (As So4), Mg/L	1.0	1.0	1.01	1.05	1.0	1.01	1.01	1.0	1.06	1.0	1.06	1.02	1.0	1.03	1.02

Chemical Analysis of Water							
S.No	Tests	BH 27	BH 29	BH 30	BH 32	BH 34	BH 35
1	pH	7.39	7.38	7.39	7.38	7.38	7.39
2	Chloride(As Cl), Mg/L	8.09	8.10	8.12	8.10	8.10	8.09
3	Sulphate (As So4), Mg/L	1.01	1.0	1.02	1.0	1.02	1.0

Annexure VII

Trial Pits

TP	Seive Analysis			Atterbergs'Limit		Description	Classification
	Gravel (%)	Sand (%)	Silt/Clay (%)	LL	PL		
1	18	25	57	Non Plastic		Moorum Soil	
2	2	25	73	40	23	Silty Clay of Medium Plasticity	CI
3	1	18	81	39	21	Silty Clay of Medium Plasticity	CI
4	1	22	77	Non Plastic		Sandy Silt with Gravel	SM-ML
5	3	11	86	41	22	Silty Clay of Medium Plasticity	CI

PIT-1
785.400 E, 1480.800 S

PIT 2
935.000 E, 1177.000 S

PIT 3
1385.00 E, 1132 S

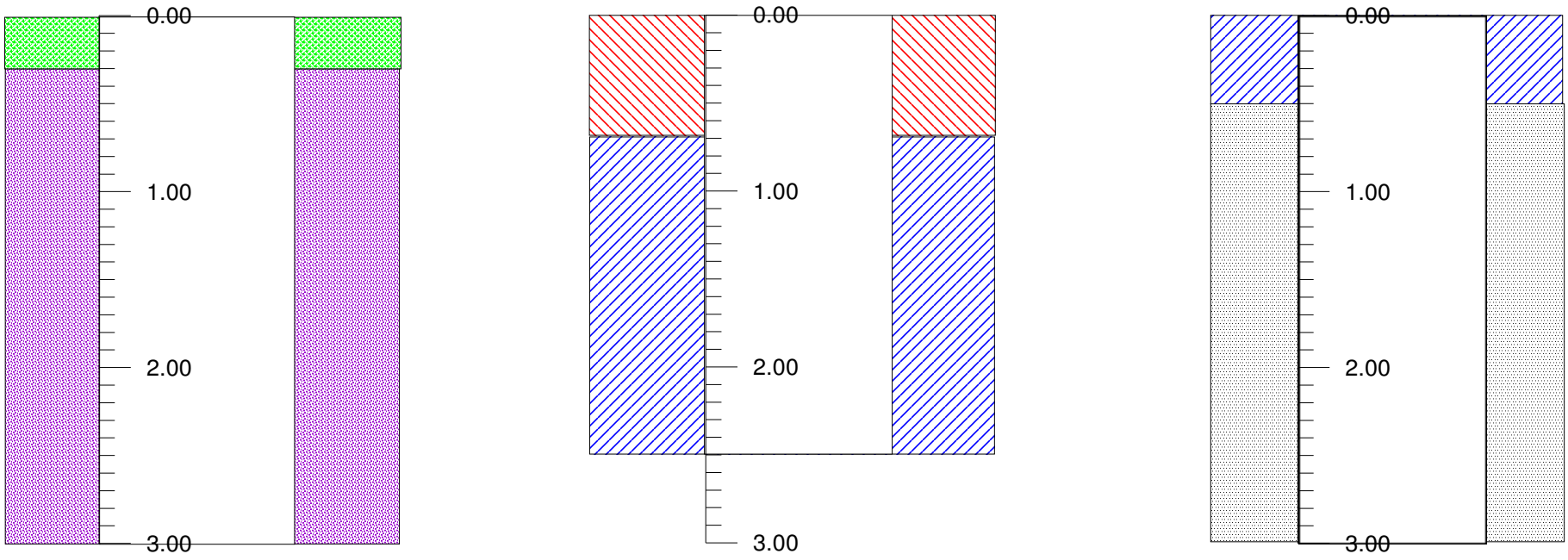


Figure : TP -1

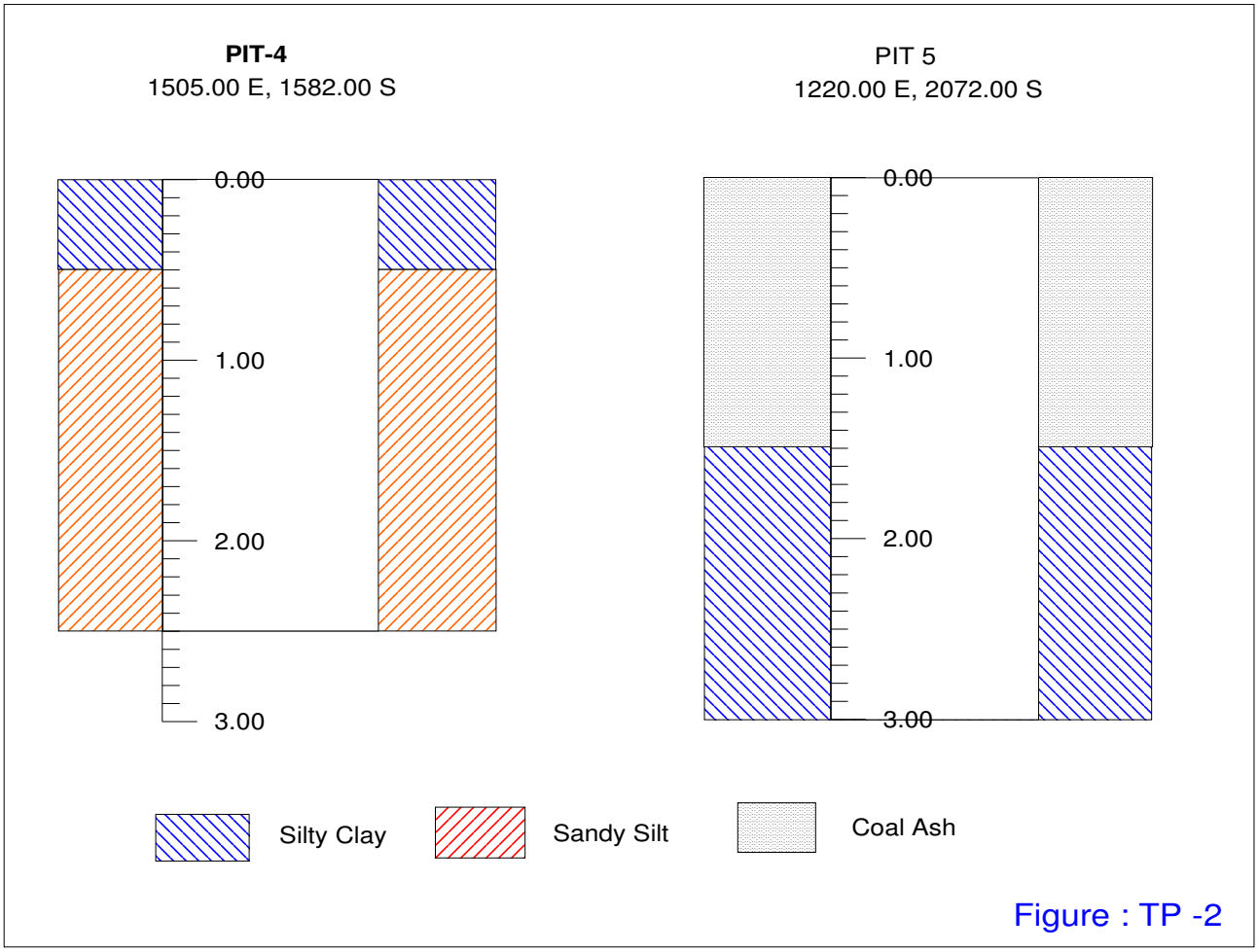

PIT-4
1505.00 E, 1582.00 S
0.00
1.00
2.00
3.00
PIT 5
1220.00 E, 2072.00 S
0.00
1.00
2.00
3.00
Silty Clay
Sandy Silt
Coal Ash

Figure : TP -2

Borelogs and Figures

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

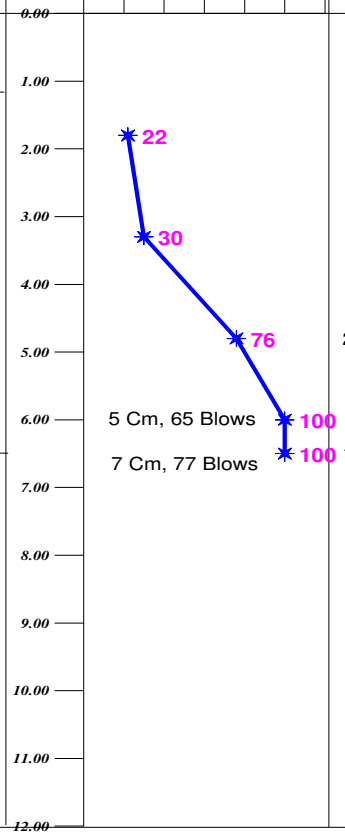
Coordinate: 1441.300 E, 1646.800 S RL: 198.100 Project No: 1988

BH No. : 13 A DEPTH : 20.00 m Depth of Water Table- 0.30m

Date of Start : 28/11/2013 Date of Finish : 01/12/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P. L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
198.100	0.00		Filledup Soil & Ash													
196.300	1.80	SPT	Silty Clay of medium Plasticity (Cl)	1	30	43/26				39	20					
195.600	2.50	UDS					1.85	1.49	24.30			2.76	1.23	3	0.059	
194.800	3.30	SPT		2	39	37/22										
193.300	4.80	SPT		20	33	24/23				42	22					
192.100	6.00	SPT		2	46	52										
191.600	6.50	SPT	Refusal Strata	18	41	41				Non Plastic						

S.P.T Plot



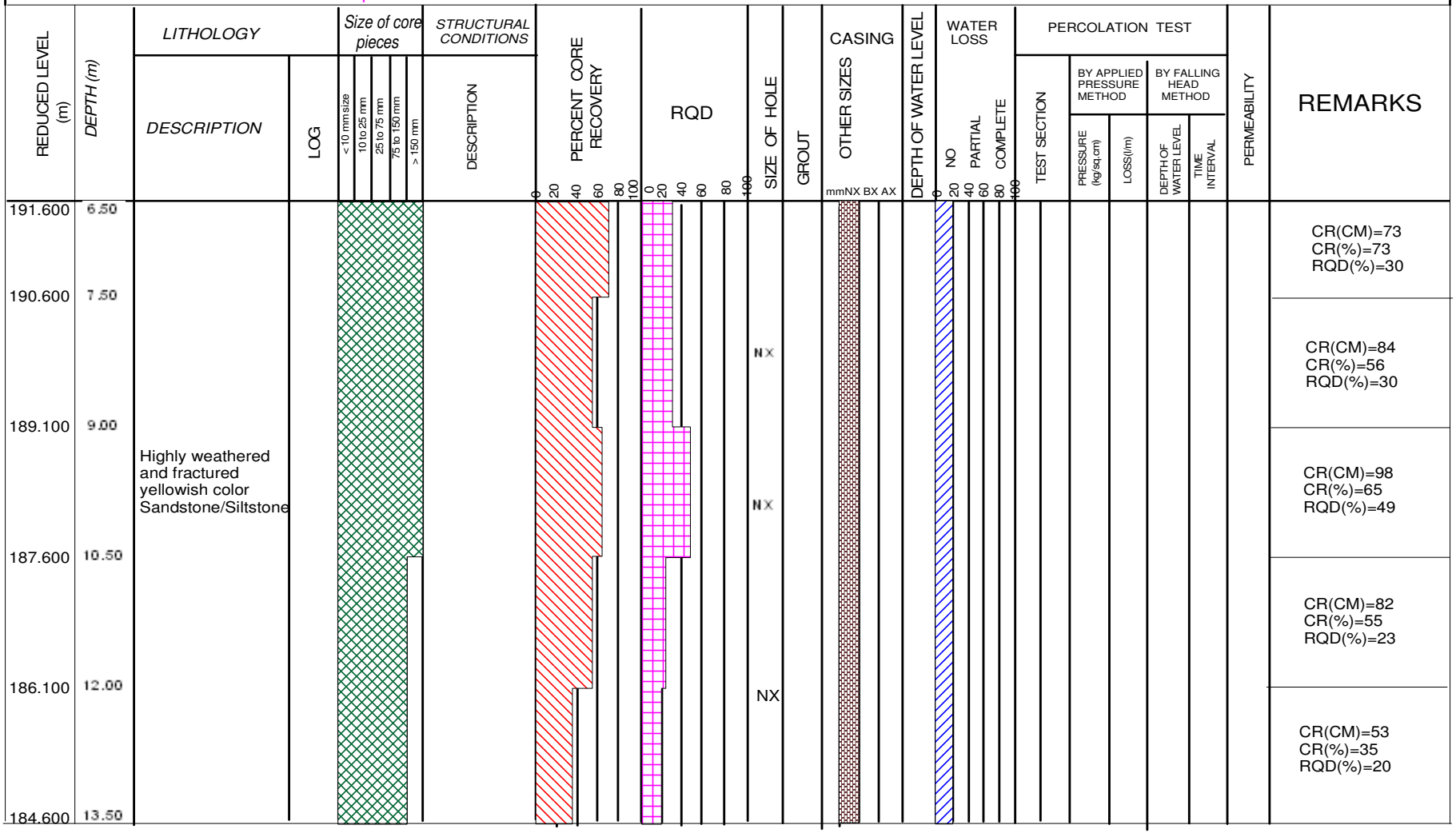
BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1441.300 E, 1646.800 S RL: 198.100 Project No: 1988

BH No. : 13 A DEPTH : 20.00m Depth of Water Table 0.30m

Date of Start : 28/11/2013 Date of Finish : 01/12/2013



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1441.300 E, 1646.800 S RL: 198.100 Project No: 1988

BH No. : 13A DEPTH : 20.00m Depth of Water Table 0.30m

Date of Start : 28/11/2013 Date of Finish : 01/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LITHOLOGY: LOG	Size of core pieces: < 10 mm size	Size of core pieces: 10 to 25 mm	Size of core pieces: 25 to 75 mm	Size of core pieces: 75 to 150 mm	Size of core pieces: > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: LOSS(l/m)	PERCOLATION TEST: BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	PERCOLATION TEST: BY FALLING HEAD METHOD: TIME INTERVAL	PERMEABILITY	REMARKS
184.600	13.50	Highly weathered and fractured yellowish color Sandstone/Siltstone										NX											CR(CM)=60 CR(%)=40 RQD(%)=40
183.100	15.00																						CR(CM)=46 CR(%)=31 RQD(%)=28
181.600	16.50											NX											CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 8cm, 72 Blows
180.100	18.00	Highly weathered disintegrated Rock										NX											CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 6cm, 78 Blows
178.600	19.50																						CR(CM)=Nil,CR(%)=Nil RQD(%)=Nil N>100 5cm, 70 Blows
178.100	20.00																						

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

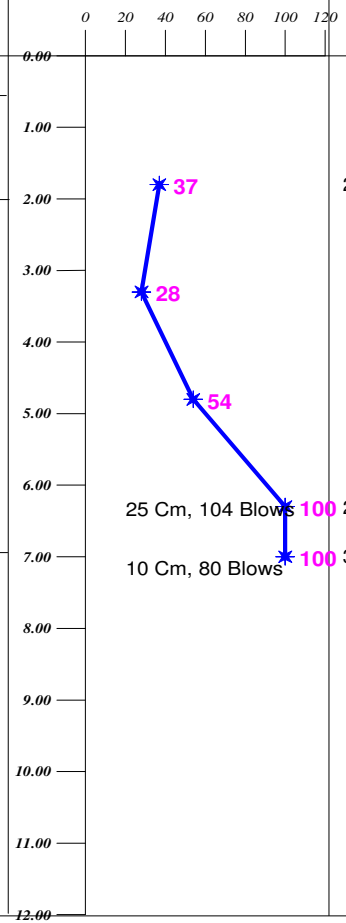
Coordinate: 1342.0 E, 1629.0 S RL:199.100 — Project No: 1988

Location: ID Fan — BH No. : 15 — DEPTH : 25.00 m — Depth of Water Table- 1.00 m

Date of Start : 09/10/2013 — Date of Finish : 12/10/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P.L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
199.100	0.00		Filledup Soil													
			Sandy Silt with Gravel (SM-ML)													
197.300	1.80	SPT		25	32	43				Non	Plastic					
196.600	2.50	UDS					1.85	1.48	24.89			2.76	UU	1.48	3	0.058
195.800	3.30	SPT		0	30	46/24				38	19					
			Silty Clay of medium Plasticity (Cl)													
194.300	4.80	SPT		1	8	70/21				38	20					
193.600	5.50	UDS					2.03	1.66	22.45				UU	3.28	3	0.041
192.800	6.30	SPT		26	34	40				Non	Plastic					
192.100	7.00	SPT		31	49	20				Non	Plastic					
			Refusal Strata													

S.P.T Plot



BORE LOG

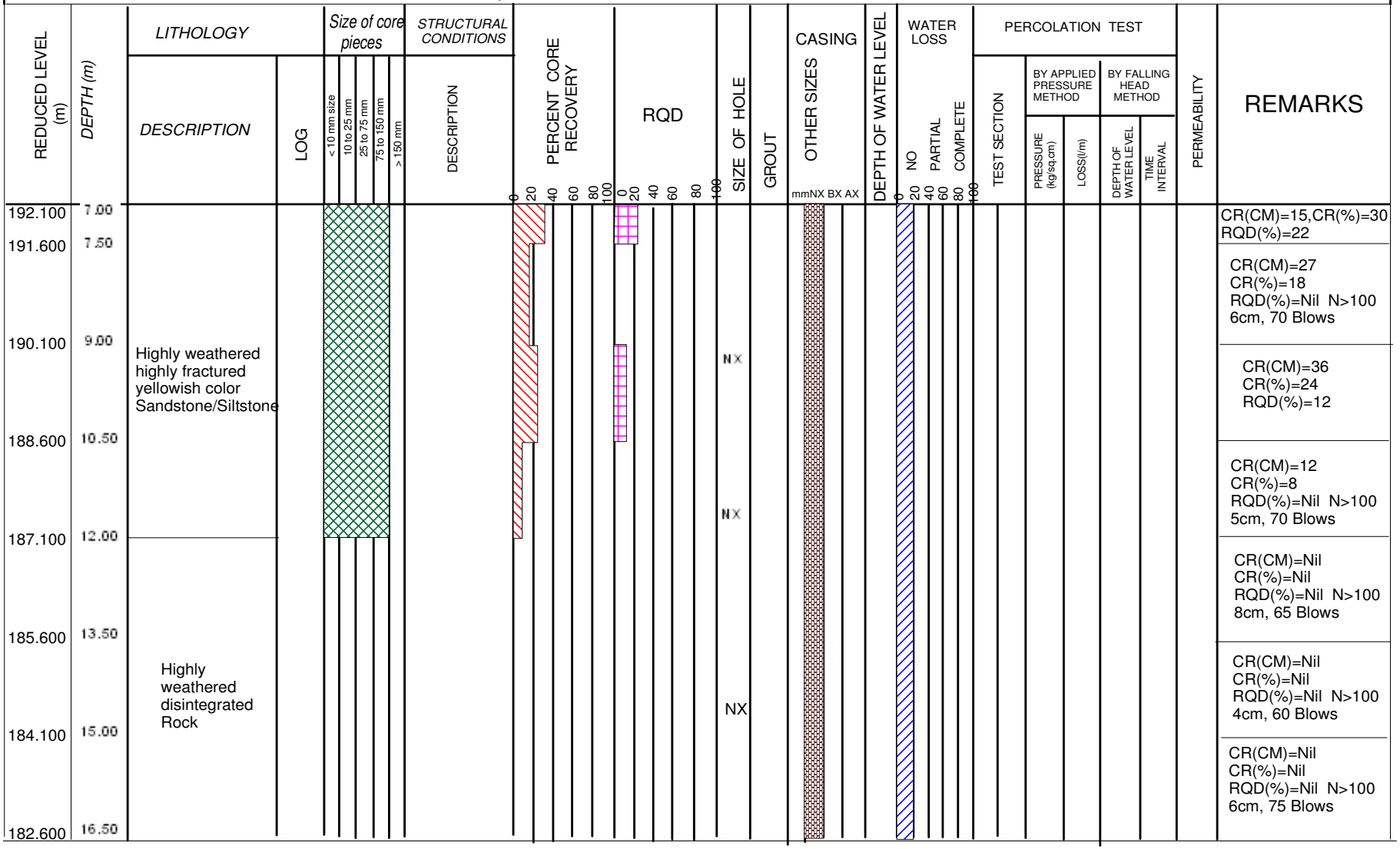
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1342.0 E, 1629.0 S RL:199.100

Project No: 1988

Location: ID Fan BH No. : 15 DEPTH : 25.00m Depth of Water Table:1.00m

Date of Start : 09/10/2013 Date of Finish : 12/10/2013



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1342.0 E, 1629.0 S RL:199.100

Project No: 1988

Location: ID Fan BH No. : 15 DEPTH : 25.00m Depth of Water Table:1.00m

Date of Start : 09/10/2013 Date of Finish : 12/10/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LITHOLOGY: LOG	Size of core pieces: < 10 mm size	Size of core pieces: 10 to 25 mm	Size of core pieces: 25 to 75 mm	Size of core pieces: 75 to 150 mm	Size of core pieces: > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS: NO	WATER LOSS: PARTIAL	WATER LOSS: COMPLETE	PERCOLATION TEST: TEST SECTION	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: LOSS(l/m)	PERCOLATION TEST: BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	PERCOLATION TEST: BY FALLING HEAD METHOD: TIME INTERVAL	PERMEABILITY	REMARKS
182.600	16.50	Highly weathered disintegrated Rock																							CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 3cm, 55 Blows
181.100	18.00											NX													CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 5cm, 70 Blows
179.600	19.50																								CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 6cm, 65 Blows
178.100	21.00											NX													
176.600	22.50																								CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 8cm, 75 Blows
175.100	24.00	Highly weathered highly fractured yellowish color Sandstone/Siltstone										NX													CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 4cm, 80 Blows
174.100	25.00																								CR(CM)=79 CR(%)=79 RQD(%)=55

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

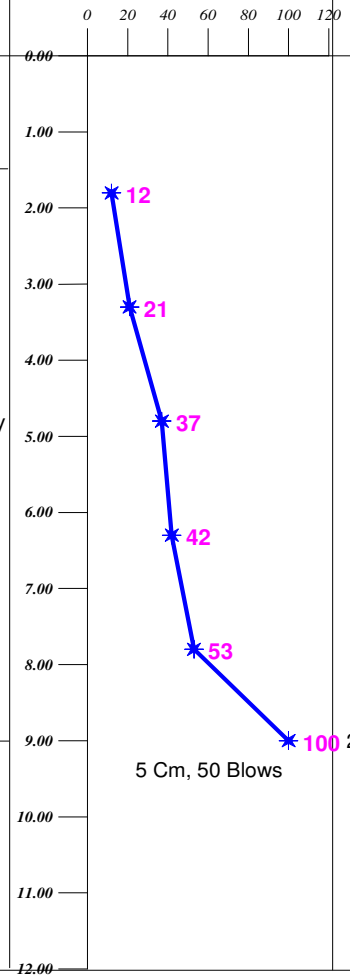
Coordinate: 1253.00 E, 1857.00 S RL:199.500 — Project No: 1988

Location: FO Tank Storage Area — BH No. : 17 — DEPTH : 25.00 m — Depth of Water Table:1.40m

Date of Start : 17/10/2013 — Date of Finish : 19/10/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
199.500	0.00		Filledup Soil Road Material													
197.700	1.80	SPT	Silty Clay of medium Plasticity (Cl)	3	35	53/19				46	23					
197.000	2.50	UDS					1.81	1.44	25.26			2.76	UU	0.62	2	0.061
196.200	3.30	SPT		1	24	75										
194.700	4.80	SPT		4	28	46/22				41	20					
194.000	5.50	UDS					1.94	1.58	22.43			2.76	UU	1.94	2	0.054
193.200	6.30	SPT		7	24	69										
191.700	7.80	SPT		6	32	40/22				46	22					
190.500	9.00	SPT	Refusal Strata	29	30	41										

S.P.T Plot — Observed



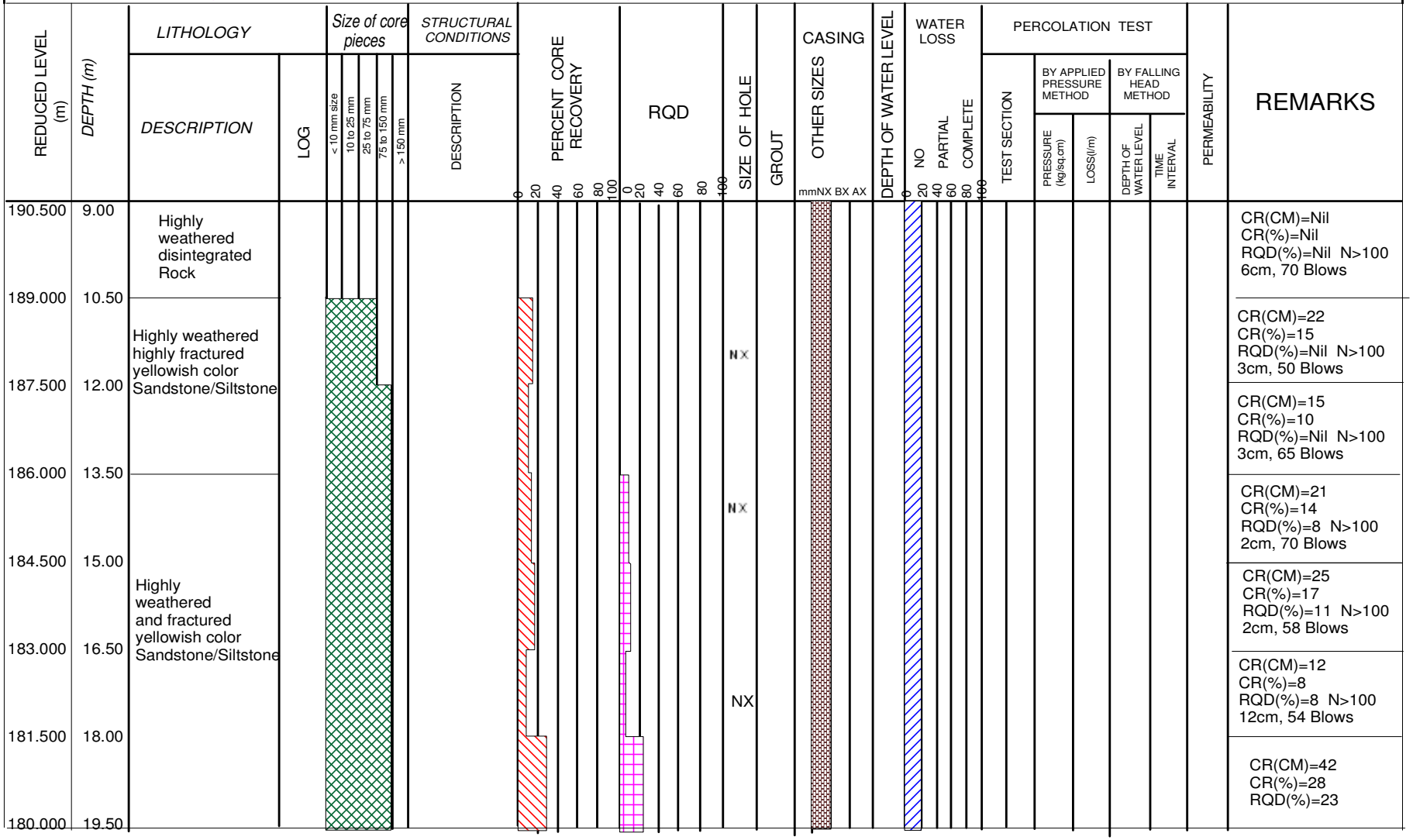
BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1253.00 E, 1857.00 S RL:199.500 Project No: 1988

Location: FO Tank Storage Area BH No. : 17 DEPTH : 25.00 m Depth of Water Table:1.40m

Date of Start : 17/10/2013 Date of Finish : 19/10/2013



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1253.00 E, 1857.00 S RL:199.500

Project No: 1988

Location: FO Tank Storage Area BH No. : 17 DEPTH : 25.00 m Depth of Water Table:1.40m

Date of Start : 17/10/2013 Date of Finish : 19/10/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces	STRUCTURAL CONDITIONS: DESCRIPTION	REMARKS
180.000	19.50	Highly weathered and fractured yellowish color Sandstone/Siltstone				CR(CM)=66 CR(%)=44 RQD(%)=24
178.500	21.00	Highly weathered highly fractured yellowish color Sandstone/Siltstone				CR(CM)=15 CR(%)=10 RQD(%)=Nil N>100 2cm, 58 Blows
177.000	22.50	Highly weathered and fractured yellowish color Sandstone/Siltstone				CR(CM)=16 CR(%)=11 RQD(%)=7 N>100 2cm, 60 Blows
175.500	24.00	Highly weathered highly fractured yellowish color Sandstone/Siltstone				CR(CM)=22 CR(%)=22 RQD(%)=Nil
174.500	25.00					

PERCENT CORE RECOVERY: 0 20 40 60 80 100

RQD: 0 20 40 60 80 100

SIZE OF HOLE: NX NX NX

CASING: OTHER SIZES mmNX BX AX

DEPTH OF WATER LEVEL

WATER LOSS: NO PARTIAL COMPLETE; 0 20 40 60 80 100

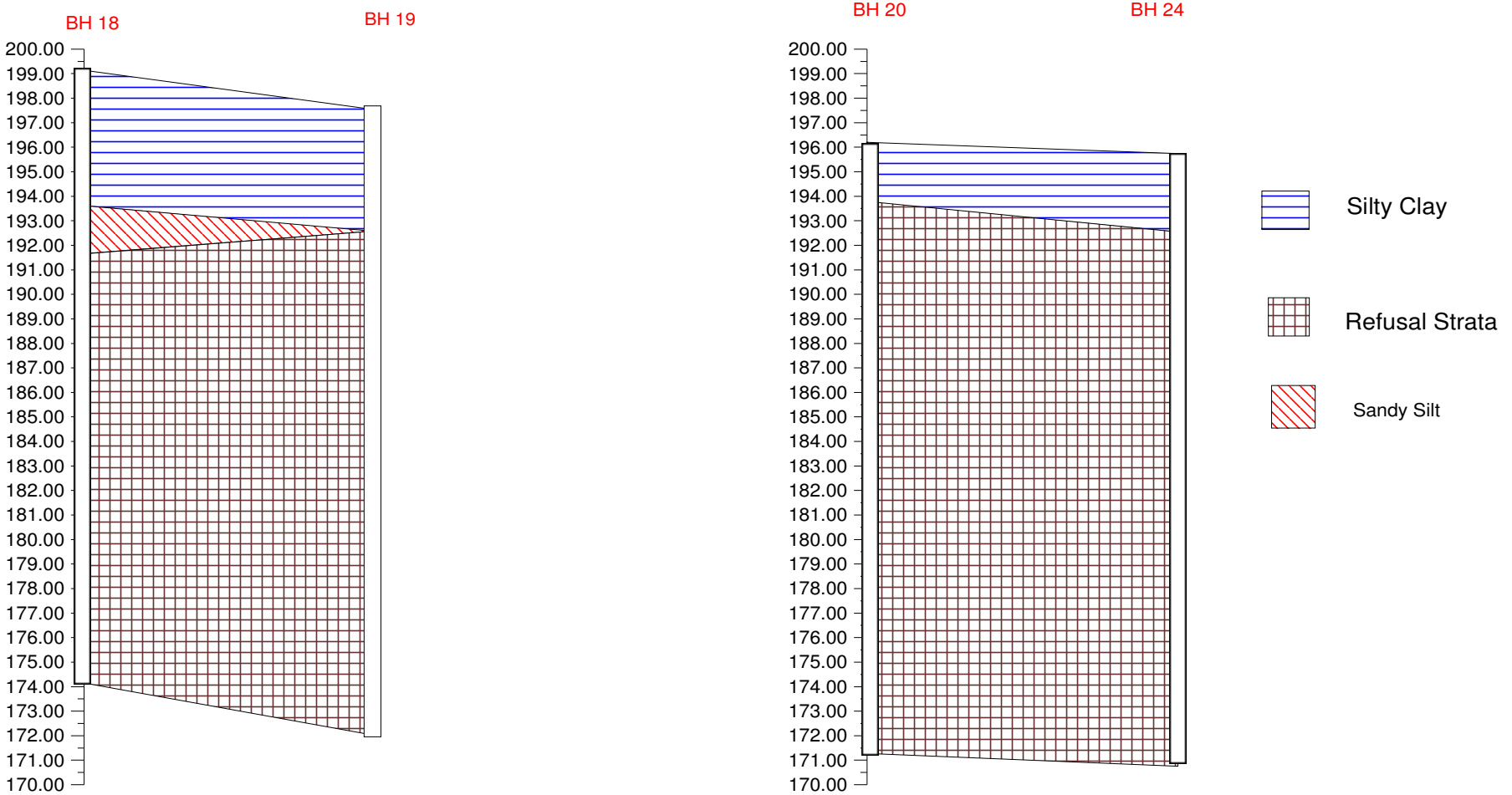
PERCOLATION TEST: TEST SECTION; BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm), LOSS(l/m); BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL, TIME INTERVAL

PERMEABILITY

GROUT

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Project No. 1988



EXPECTED SOIL PROFILE

Figure : Soilpro A

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

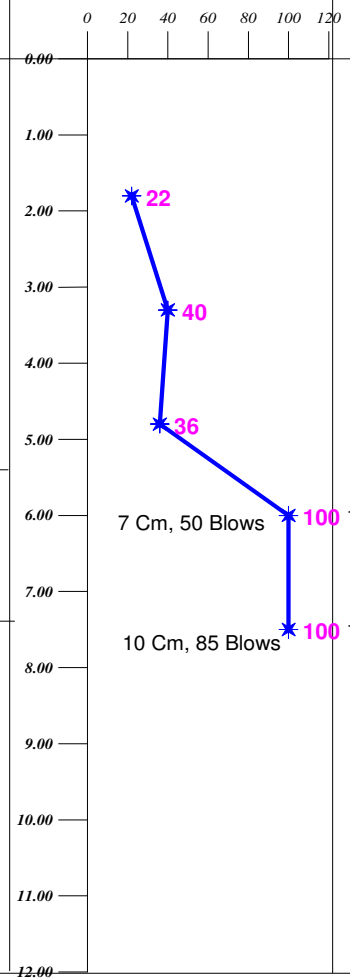
Coordinate: 928.00 E, 790.00 S RL: 199.100 — Project No: 1988

Location: Cooling Tower — BH No. : 18 — DEPTH : 25.00 m — Depth of Water Table: 4.10 m

Date of Start : 02/12/2013 — Date of Finish : 07/12/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
199.100	0.00															
197.300	1.80	SPT		0	5	72/23				46	29					
196.600	2.50	UDS	Silty Clay of medium Plasticity (CI)				1.86	1.52	22.48			2.76	UU	1.36	2	0.057
195.800	3.30	SPT		0	2	98				41	24					
194.300	4.80	SPT		1	5	76/18										
193.100	6.00	SPT	Sandy Silt with Gravel (SM-ML)	15	31	54				Non Plastic						
191.600	7.50	SPT	Refusal Strata	12	74	14				Non Plastic						

S.P.T Plot — Observed



BORE LOG

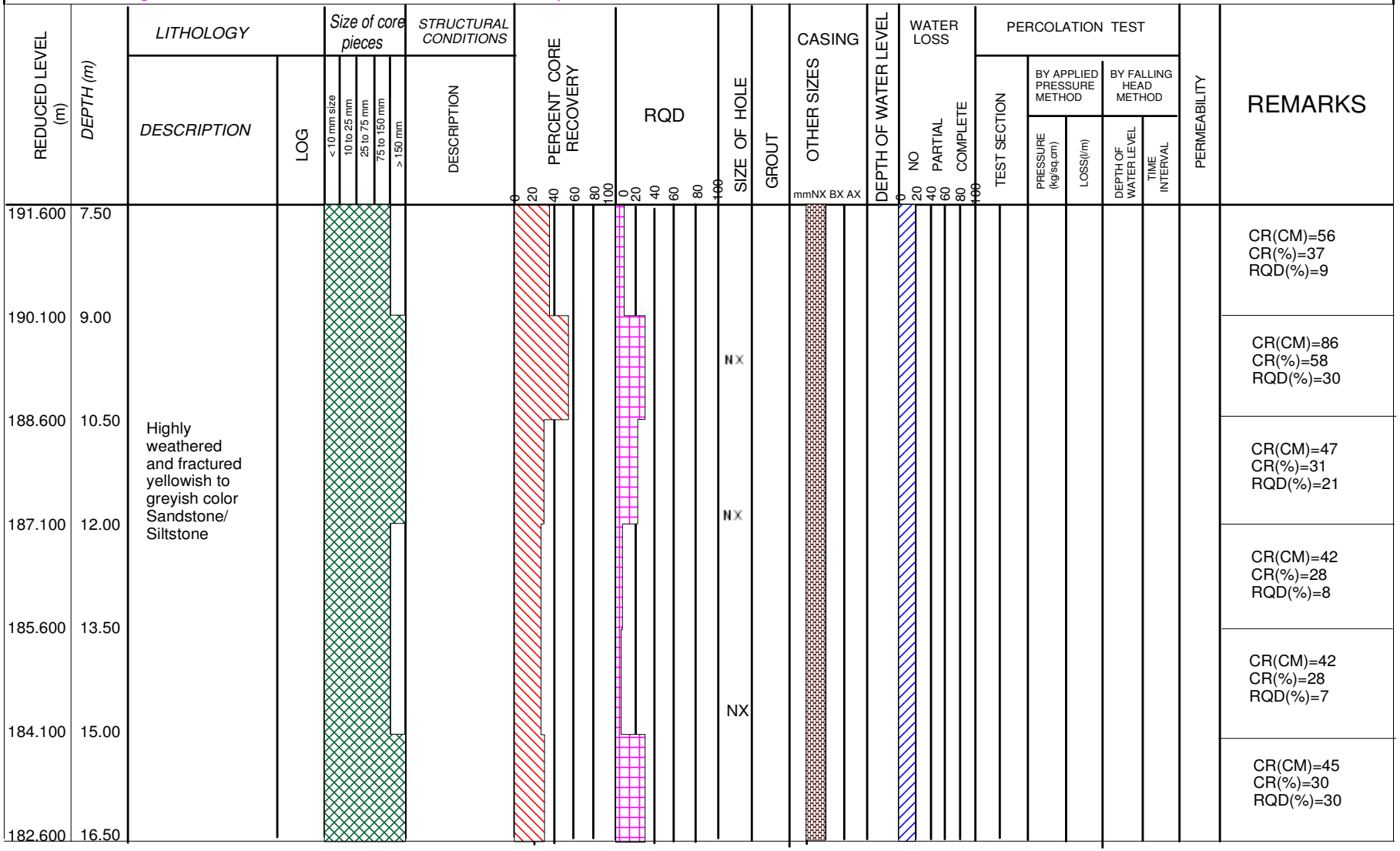
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 928.00 E, 790.00 S RL: 199.100

Project No: 1988

Location: Cooling Tower BH No. : 18 DEPTH : 25.00 m Depth of Water Table: 4.10 m

Date of Start : 02/12/2013 Date of Finish : 07/12/2013



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 928.00 E, 790.00 S RL: 199.100

Project No: 1988

Location: Cooling Tower BH No. : 18 DEPTH : 25.00 m Depth of Water Table: 4.10 m

Date of Start : 02/12/2013 Date of Finish : 07/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS	PERCOLATION TEST: TEST SECTION	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: LOSS(l/m)	PERCOLATION TEST: BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	PERCOLATION TEST: BY FALLING HEAD METHOD: TIME INTERVAL	PERMEABILITY	REMARKS
182.600	16.50	Highly weathered and fractured yellowish to greyish color Sandstone/ Siltstone		< 10 mm size; 10 to 25 mm; 25 to 75 mm; 75 to 150 mm; > 150 mm		0 20 40 60 80 100	0 20 40 60 80 100			mmNX BX AX		NO; PARTIAL; COMPLETE 0 20 40 60 80 100							CR(CM)=26 CR(%)=18 RQD(%)=7
181.100	18.00							NX											CR(CM)=42 CR(%)=28 RQD(%)=14
179.600	19.50																		CR(CM)=49 CR(%)=32 RQD(%)=20
178.100	21.00							NX											
176.600	22.50	Highly weathered highly fractured greyish color Sandstone/Siltstone																	CR(CM)=46 CR(%)=31 RQD(%)=30
175.100	24.00	Highly weathered and fractured greyish color Sandstone/Siltstone						NX											CR(CM)=43 CR(%)=29 RQD(%)=Nil
174.100	25.00																		CR(CM)=40 CR(%)=40 RQD(%)=35

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 823.00 E, 895.00 S RL: 197.000 Project No: 1988

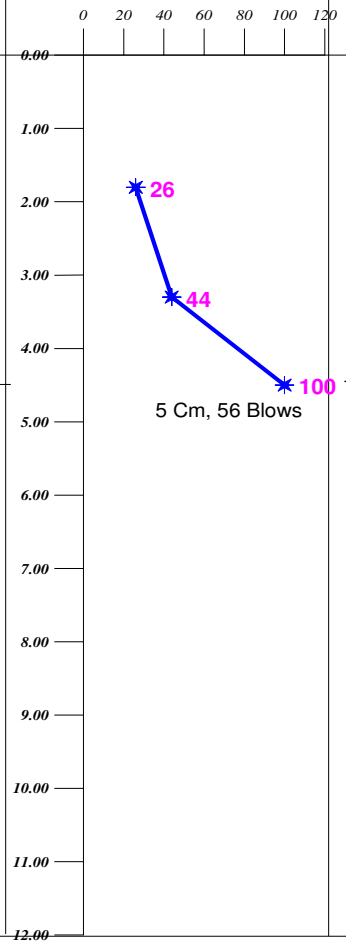
Location: Cooling Tower BH No. : 19 DEPTH : 25.00 m Depth of Water Table: 3.90 m

Date of Start : 02/12/2013 Date of Finish : 07/12/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
197.000	0.00															
195.200	1.80	SPT	Silty Clay of High Plasticity (CH)	0	5	70/25				57	26					
194.500	2.50	UDS					1.87	1.61	15.83			2.76	UU	1.38	5	0.056
193.700	3.30	SPT		1	6	70/23										
192.500	4.50	SPT	Refusal Strata	14	18	68										

S.P.T Plot

Observed



BORE LOG

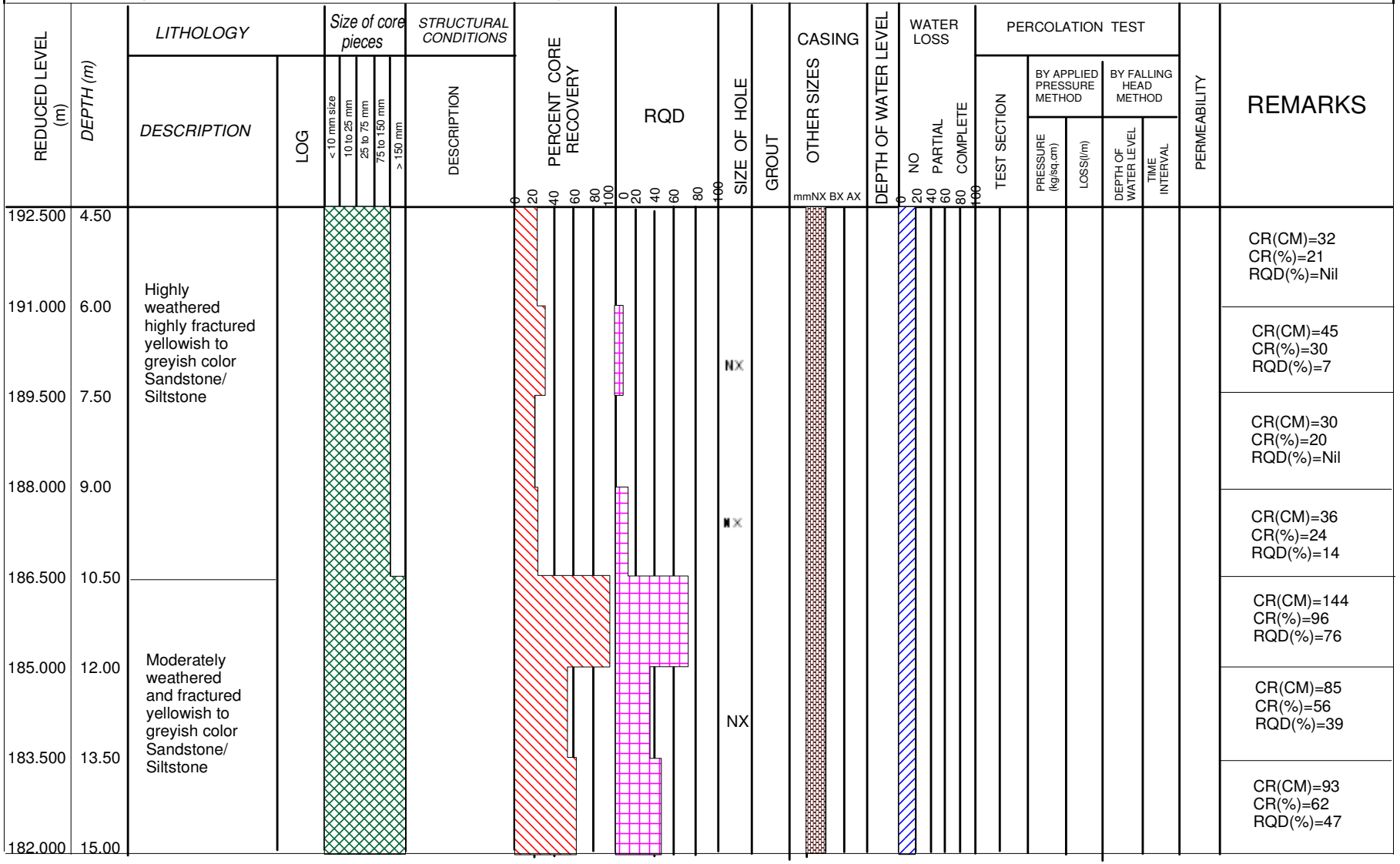
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 823.00 E, 895.00 S RL: 197.000

Project No: 1988

Location: Cooling Tower BH No. : 19 DEPTH : 25.00 m Depth of Water Table: 3.90 m

Date of Start : 07/12/2013 Date of Finish : 10/12/2013



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 823.00 E, 895.00 S RL: 197.000

Project No: 1988

Location: Cooling Tower BH No. : 19 DEPTH : 25.00 m Depth of Water Table: 3.90 m

Date of Start : 07/12/2013 Date of Finish : 10/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
182.000	15.00	Highly weathered highly fractured yellowish to greyish color Sandstone/ Siltstone															CR(CM)=36 CR(%)=24 RQD(%)=Nil
180.500	16.50							NX									CR(CM)=42 CR(%)=28 RQD(%)=Nil
179.000	18.00																CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 4cm, 61 Blows
177.500	19.50	Highly weathered disintegrated Rock						NX									CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 3cm, 69 Blows
176.000	21.00																CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 2cm, 55 Blows
174.500	22.50							NX									CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 4cm, 72 Blows
173.000	24.00	Highly weathered highly fractured Sandstone/Siltstone															CR(CM)=33 CR(%)=33 RQD(%)=Nil
172.000	25.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 741.00 E, 779.00 S RL: 196.300

Project No: 1988

Location: Cooling Tower BH No. : 20 DEPTH : 25.00 m Depth of Water Table: 1.05m

Date of Start : 13/12/2013 Date of Finish : 19/12/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	S.P.T Plot (Observed)	Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	Density (gm/cc) r(dry)	W/C W(%)	Limits (%) LL	Limits (%) P . L	Sp.Gr	Shear Parameters Type of test	Shear Parameters C(kg/sq.cm)	Shear Parameters phi(degrees)	Cc
196.300	0.00																
			Silty Clay of medium Plasticity (CI)														
194.500	1.80	SPT		32	0	13	67/20				46	21					
193.800	2.50	SPT		100 12 Cm, 88 Blows	12	4	84										
			Refusal Strata														

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 741.00 E, 779.00 S RL: 196.300

Project No: 1988

Location: Cooling Tower BH No. : 20 DEPTH : 25.00 m Depth of Water Table: 1.05 m

Date of Start : 13/12/2013 Date of Finish : 19/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
193.800	2.50	Highly weathered and fractured Sandstone/ Siltstone															CR(CM)=42 CR(%)=28 RQD(%)=28
192.300	4.00	Highly weathered highly fractured Sandstone/ Siltstone						NX									CR(CM)=34 CR(%)=23 RQD(%)=Nil
190.800	5.50																CR(CM)=38 CR(%)=26 RQD(%)=7
189.300	7.00							NX									CR(CM)=84 CR(%)=56 RQD(%)=34
187.800	8.50	Highly weathered and fractured yellowish to greyish color Sandstone/ Siltstone															CR(CM)=107 CR(%)=72 RQD(%)=34
186.300	10.00							NX									CR(CM)=53 CR(%)=36 RQD(%)=16
184.800	11.50																CR(CM)=81 CR(%)=54 RQD(%)=37
183.300	13.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 741.00 E, 779.00 S RL: 196.300

Project No: 1988

Location: Cooling Tower BH No. : 20 DEPTH : 25.00 m Depth of Water Table: 1.05 m

Date of Start : 13/12/2013 Date of Finish : 19/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS	PERCOLATION TEST: TEST SECTION	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: LOSS(l/m)	PERCOLATION TEST: BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	PERCOLATION TEST: BY FALLING HEAD METHOD: TIME INTERVAL	PERMEABILITY	REMARKS
183.300	13.00																		CR(CM)=33 CR(%)=22 RQD(%)=10
181.800	14.50	Highly weathered and fractured Sandstone/ Siltstone																	CR(CM)=41 CR(%)=27 RQD(%)=22
180.300	16.00							NX											CR(CM)=39 CR(%)=26 RQD(%)=15
178.800	17.50	Highly weathered highly fractured Sandstone/ Siltstone																	CR(CM)=32 CR(%)=22 RQD(%)=Nil
177.300	19.00							NX											CR(CM)=57 CR(%)=38 RQD(%)=38
175.800	20.50	Highly weathered and fractured yellowish to greyish color Sandstone/ Siltstone																	CR(CM)=72 CR(%)=48 RQD(%)=30
174.300	22.00							NX											CR(CM)=135 CR(%)=90 RQD(%)=72
172.800	23.50																		CR(CM)=80 CR(%)=53 RQD(%)=31
171.300	25.00																		

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

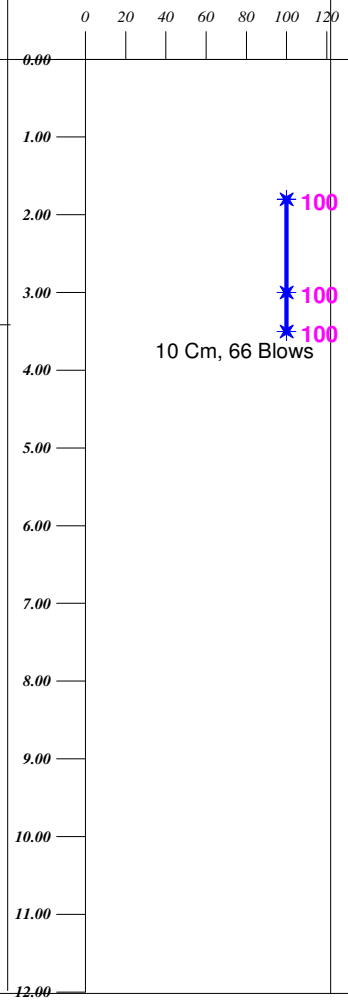
Coordinate: 635.000 , 884.000 S RL: 195.700

Project No: 1988

Location: Cooling Tower BH No. : 21 DEPTH : 25.00 m Depth of Water Table: 1.25 m

Date of Start : 21/11/2013 Date of Finish : 26/11/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	S.P.T Plot (Observed)	Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	Density (gm/cc) r(dry)	W/C W(%)	Limits (%) L.L	Limits (%) P . L	Sp.Gr	Shear Parameters Type of test	Shear Parameters C(kg/sq.cm)	Shear Parameters phi(degrees)	Cc
195.700	0.00																
194.500	1.80	SPT	Silty Clay of medium Plasticity (CI)	100	2	9	64/25				41	23					
193.800	3.00	SPT		100	1	25	54/20										
192.500	3.50	SPT		100	5	41	54										
			Refusal Strata														



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 635.000 , 884.000 S RL: 195.700 — Project No: 1988

Location: Cooling Tower — BH No. : 21 — DEPTH : 25.00 m — Depth of Water Table: 1.25 m

Date of Start : 21/11/2013 — Date of Finish : 26/11/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
192.200	3.50	Highly weathered highly fractured Sandstone/ Siltstone															CR(CM)=40 CR(%)=40 RQD(%)=Nil
191.200	4.50																CR(CM)=98 CR(%)=65 RQD(%)=49
189.700	6.00							NX									CR(CM)=87 CR(%)=58 RQD(%)=21
188.200	7.50																CR(CM)=50 CR(%)=33 RQD(%)=9
186.700	9.00							NX									CR(CM)=69 CR(%)=46 RQD(%)=19
185.200	10.50	Highly weathered and fractured yellowish to greyish color Sandstone/ Siltstone															CR(CM)=73 CR(%)=49 RQD(%)=41
183.700	12.00							NX									CR(CM)=50 CR(%)=33 RQD(%)=7
182.200	13.50																CR(CM)=66 CR(%)=44 RQD(%)=28
180.700	15.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 635.000 , 884.000 S RL: 195.700

Project No: 1988

Location: Cooling Tower BH No. : 21 DEPTH : 25.00 m Depth of Water Table: 1.25 m

Date of Start : 21/11/2013 Date of Finish : 26/11/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
180.700	15.00	Highly weathered and fractured yellowish to greyish color Sandstone/ Siltstone															CR(CM)=91 CR(%)=61 RQD(%)=48
179.200	16.50							NX									CR(CM)=38 CR(%)=25 RQD(%)=17
177.700	18.00																CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 10cm, 74 Blows
176.200	19.50							NX									CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 7cm, 71 Blows
174.700	21.00	Highly weathered disintegrated Rock															CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 8cm, 75 Blows
173.200	22.50							NX									CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 6cm, 67 Blows
171.700	24.00																CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 5cm, 65 Blows
170.700	25.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

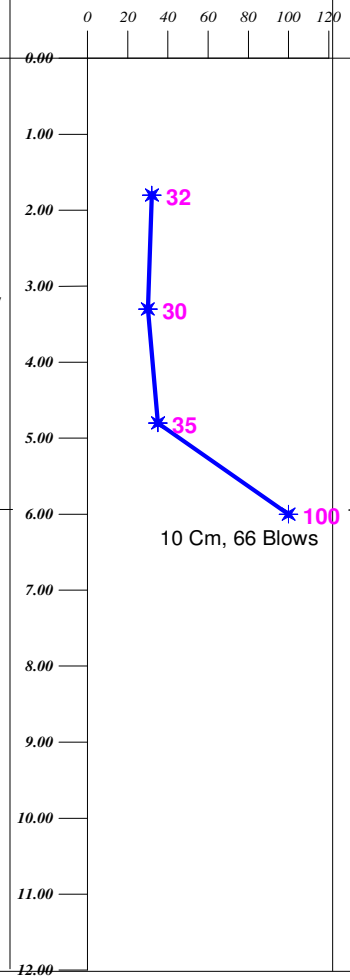
Coordinate: 820.00 E , 1000.00 S RL: 194.850 Project No: 1988

Location: Stream Filter BH No. : 22 DEPTH : 20.00 m Depth of Water Table: 1.15 m

Date of Start : 15/12/2013 Date of Finish : 18/12/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Gravel	Sand	Silt/Clay	r(wet)	r(dry)	W(%)	LL	P . L	Sp.Gr	Type of test	C(kg/sq.cm)	phi(degrees)	Cc
194.850	0.00															
193.050	1.80	SPT		2	21	56/21				37	19					
192.350	2.50	UDS	Silty Clay of medium Plasticity (Cl)				1.89	1.53	23.89			2.78	UU	1.76	3	
191.550	3.30	SPT		0	12	88										
190.050	4.80	SPT		0	20	61/19				40	21					
188.850	6.00	SPT	Refusal Strata	12	34	54										

S.P.T Plot — Observed



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 820.00 E , 1000.00 S RL: 194.850 — Project No: 1988

Location: Stream Filter BH No. : 22 DEPTH : 20.00 m Depth of Water Table: 1.15m

Date of Start : 15/12/2013 Date of Finish : 18/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
188.850	6.00	Highly weathered Highly fractured yellowish to greyish color Sandstone/ Siltstone						NX									CR(CM)=23 CR(%)=15 RQD(%)=Nil N> 100 4cm, 72 Blows
187.350	7.50																CR(CM)=25 CR(%)=17 RQD(%)=Nil N> 100 3cm, 72 Blows
185.850	9.00	Highly weathered and fractured yellowish to greyish color Sandstone/ Siltstone						NX									CR(CM)=24 CR(%)=16 RQD(%)=16 N> 100 2cm, 66 Blows
184.350	10.50	Highly weathered highly fractured yellowish to greyish color Sandstone/ Siltstone						NX									CR(CM)=27 CR(%)=18 RQD(%)=Nil N> 100 5cm, 69 Blows
182.850	12.00																CR(CM)=27 CR(%)=18 RQD(%)=Nil N> 100 4cm, 80 Blows
181.350	13.50																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 820.00 E , 1000.00 S RL: 194.850

Project No: 1988

Location: Stream Filter BH No. : 22 DEPTH : 20.00 m Depth of Water Table: 1.15m

Date of Start : 15/12/2013 Date of Finish : 18/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LITHOLOGY: LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mm NX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
181.350	13.50	Highly weathered Highly fractured yellowish to greyish color Sandstone/ Siltstone															CR(CM)=40 CR(%)=27 RQD(%)=Nil
179.850	15.00	Highly weathered and fractured yellowish to greyish color Sandstone/ Siltstone						NX									CR(CM)=53 CR(%)=35 RQD(%)=13
178.350	16.50	Highly weathered highly fractured yellowish to greyish color Sandstone/ Siltstone						NX									CR(CM)=30 CR(%)=20 RQD(%)=Nil
176.850	18.00							NX									CR(CM)=42 CR(%)=28 RQD(%)=Nil
175.350	19.50																CR(CM)=36 CR(%)=72 RQD(%)=38
174.850	20.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 920.00 E, 1073.00 S RL: 194.950

Project No: 1988

Location: CWPH BH No.: 23 DEPTH: 25.00m Depth of Water Table: 2.00 m

Date of Start : 21/12/2013 Date of Finish : 24/12/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	S.P.T Plot (Observed)	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) L.L	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
194.950	0.00		Sandy Silt with Gravel (SM-ML)														
193.150	1.80	SPT		35	0	22	78				Non Plastic						
192.950	2.00	SPT	Refusal Strata	100 / 9 Cm, 100. Blows	25	30	45				Non Plastic						

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 920.00 E, 1073.00 S RL: 194.950

Project No: 1988

Location: CWPH BH No.: 23 DEPTH: 25.00m Depth of Water Table: 2.00 m

Date of Start : 24/12/2013 Date of Finish : 24/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size	10 to 25 mm	25 to 75 mm	75 to 150 mm	> 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	TIME INTERVAL	PERMEABILITY	REMARKS
192.950	2.00	Highly weathered Highly fractured Sandstone/Siltstone																					CR(CM)=40 CR(%)=27 RQD(%)=Nil
191.450	3.50																						CR(CM)=91 CR(%)=61 RQD(%)=39
189.950	5.00	Highly weathered and fractured Sandstone /Siltstone										NX											CR(CM)=109 CR(%)=73 RQD(%)=46
188.450	6.50																						CR(CM)=46 CR(%)=31 RQD(%)=17
186.950	8.00	Highly weathered Highly fractured Sandstone/Siltstone										NX											CR(CM)=33 CR(%)=22 RQD(%)=Nil
185.450	9.50																						CR(CM)=63 CR(%)=42 RQD(%)=15
183.950	11.00	Highly weathered and fractured Sandstone /Siltstone										NX											CR(CM)=72 CR(%)=48 RQD(%)=31
182.450	12.50																						CR(CM)=124 CR(%)=83 RQD(%)=56
180.950	14.00																						

BORE LOG

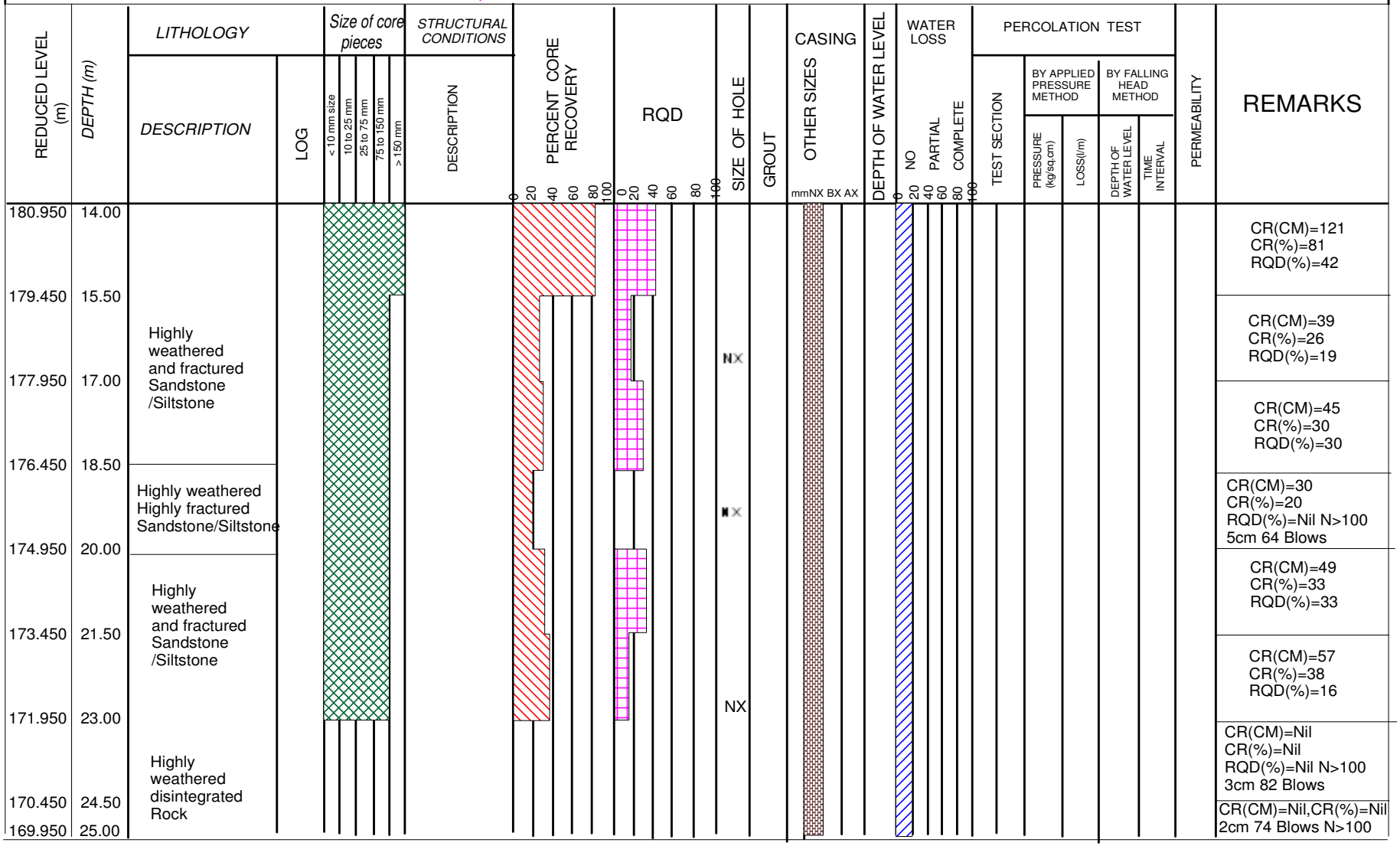
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 920.00 E, 1073.00 S RL: 194.950

Project No: 1988

Location: CWPH BH No.: 23 DEPTH: 25.00m Depth of Water Table: 2.00 m

Date of Start : 24/12/2013 Date of Finish : 24/12/2013



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 836.00 E, 1320 S RL: 193.500

Project No: 1988

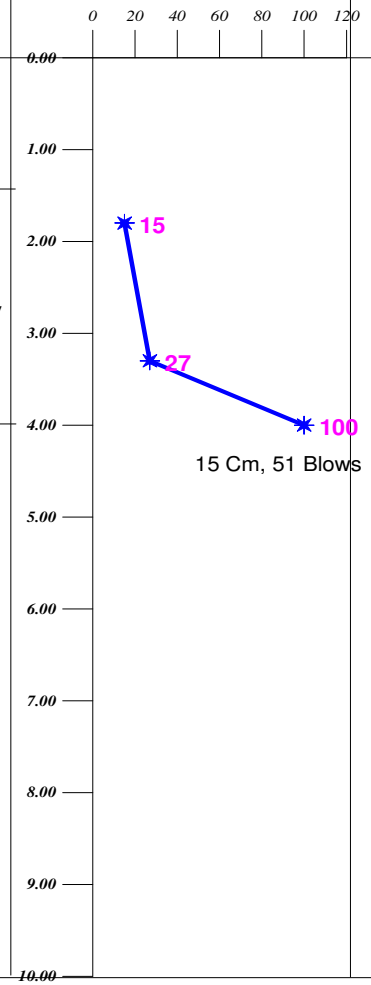
Location: Effluent Treatment Plant BH No.: 24 A DEPTH: 20.00m Depth of Water Table: 0.90m

Date of Start : 07/01/2014 Date of Finish : 09/01/2014

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) L.L	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
193.500	0.00		Filledup Material													
191.700	1.80	SPT		2	31	67				41	20					
191.000	2.50	UDS	Silty Clay of medium Plasticity (CI)				1.86	0.00	23.86			2.76	UU	0.86	4	
190.200	3.30	SPT		2	27	71										
189.500	4.00	SPT	Refusal Strata	1	58	41										

S.P.T Plot

Observed



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 836.00 E, 1320 S RL: 193.500 — Project No: 1988

Location: Effluent Treatment Plant — BH No.: 24A — DEPTH: 20.00m — Depth of Water Table: 0.90m — Date of Start : 07/01/2014 — Date of Finish : 09/01/2014

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY (0 20 40 60 80 100)	RQD (0 20 40 60 80 100)	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mm NX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS (NO / PARTIAL / COMPLETE; 0 20 40 60 80 100)	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS l/m	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
189.500	4.00	Highly weathered and fractured Sandstone/Siltstone															CR(CM)=25,CR(%)=50 RQD(%)=40
189.000	4.50	Highly weathered Highly fractured Sandstone /Siltstone															CR(CM)=28 CR(%)=19 RQD(%)=Nil
187.500	6.00							NX									CR(CM)=36 CR(%)=24 RQD(%)=13
186.000	7.50							NX									CR(CM)=39 CR(%)=26 RQD(%)=11
184.500	9.00	Highly weathered and fractured Sandstone /Siltstone															CR(CM)=55 CR(%)=37 RQD(%)=33
183.000	10.50							NX									CR(CM)=61 CR(%)=41 RQD(%)=31
181.500	12.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 836.00 E, 1320 S RL: 193.500

Project No: 1988

Location: Effluent Treatment Plant BH No.: 24A DEPTH: 20.00m Depth of Water Table: 0.90m

Date of Start : 07/01/2014 Date of Finish : 09/01/2014

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY (0 20 40 60 80 100)	RQD (0 20 40 60 80 100)	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE (0 20 40 60 80 100)	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
181.500	12.00	Highly weathered and fractured Sandstone /Siltstone															CR(CM)=61 CR(%)=41 RQD(%)=23
180.000	13.50							NX									CR(CM)=60 CR(%)=40 RQD(%)=21
178.500	15.00							NX									CR(CM)=97 CR(%)=65 RQD(%)=54
177.000	16.50																CR(CM)=73 CR(%)=49 RQD(%)=7
175.500	18.00							NX									CR(CM)=72 CR(%)=48 RQD(%)=18
174.000	19.50	Highly weathered Highly fractured Sandstone/Siltstone															CR(CM)=28,CR(%)=56 RQD(%)=Nil
173.500	20.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

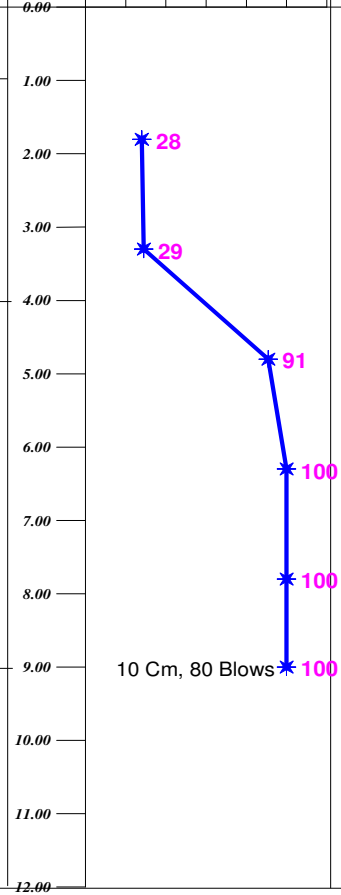
Coordinate: 808.00 E, 1484.00 S RL: 199.700 — Project No: 1988

Location: DM Plant — BH No. : 25 — DEPTH : 20.00 m — Depth of Water Table: 1.10 m

Date of Start : 15/10/2013 — Date of Finish : 18/10/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
199.700	0.00		Filledup Road Material													
197.900	1.80	SPT	Silty Clay of medium Plasticity (CI)	26	32	42				42	24					
197.200	2.50	UDS					1.89	1.53	23.86			2.76	UU	1.74	2	0.058
196.400	3.30	SPT		2	10	63/25				45	24					
194.900	4.80	SPT	Sandy Silt with Gravel (SM-ML)	13	30	57				Non Plastic						
193.400	6.30	SPT		1	19	80				Non Plastic						
191.900	7.80	SPT		2	37	61				Non Plastic						
190.700	9.00	SPT	Refusal Strata	12	37	51				Non Plastic						

S.P.T Plot



BORE LOG

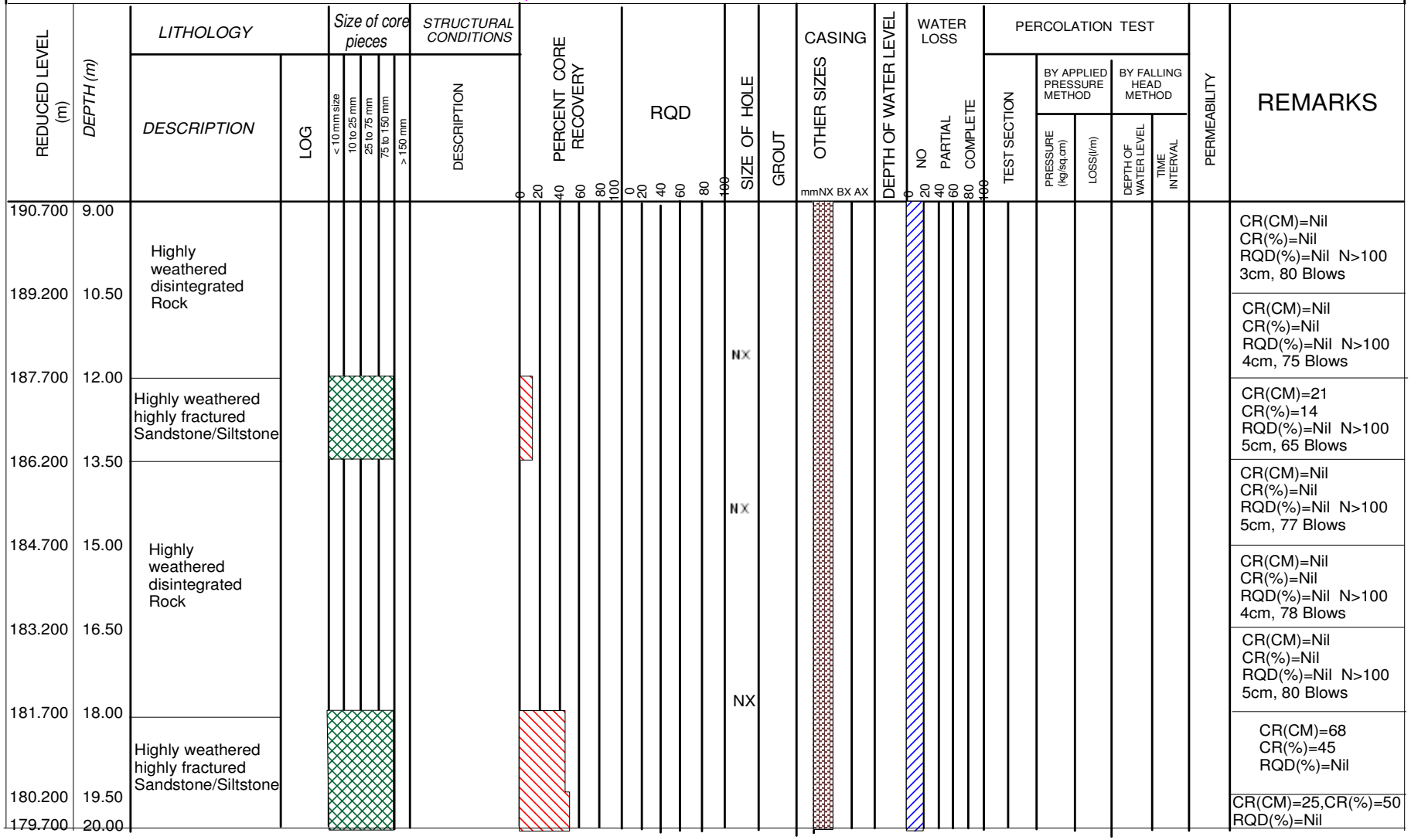
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 808.00 E, 1484.00 S RL: 199.700

Project No: 1988

Location: DM Plant BH No. : 25 DEPTH : 20.00 m Depth of Water Table: 1.10 m

Date of Start : 15/10/2013 Date of Finish : 18/10/2013



BORE LOG

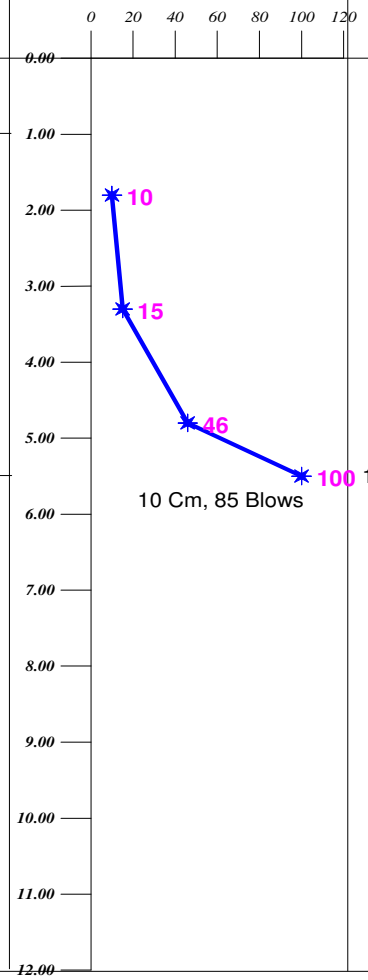
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1671.00 E, 2044.00 S RL: 198.650 — Project No: 1988

Location:Coal Settling Pond & Overflow Sump BH No.: 26 DEPTH:20.00m Depth of Water Table:0.50 m — Date of Start : 27/10/2013 — Date of Finish : 29/10/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P.L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
198.650	0.00		Morrum													
196.850	1.80	SPT	Silty Clay of medium Plasticity (CI)	1	34	43/22				41	22					
196.150	2.50	UDS					1.78	1.41	26.11			2.76	UU	0.39	2	0.062
195.350	3.30	SPT		2	42	56				43	23					
193.850	4.80	SPT		1	41	41/17				45	22					
193.150	5.50	SPT		15	64	21				Non Plastic						
			Refusal Strata													

S.P.T Plot



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1671.00 E, 2044.00 S RL: 198.650 Project No: 1988

Location:Coal Settling Pond & Overflow Sump BH No.: 26 DEPTH:20.00m Depth of Water Table:0.50 m Date of Start : 27/10/2013 Date of Finish : 29/10/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
193.150	5.50	Highly weathered highly fractured Sandstone/Siltstone															CR(CM)=21 CR(%)=42 RQD(%)=Nil
192.650	6.00	Highly weathered and fractured Sandstone /Siltstone						NX									CR(CM)=60 CR(%)=40 RQD(%)=13
191.150	7.50	Highly weathered highly fractured Sandstone/Siltstone						NX									CR(CM)=43 CR(%)=29 RQD(%)=Nil
189.650	9.00	Highly weathered and fractured Sandstone /Siltstone						NX									CR(CM)=39 CR(%)=26 RQD(%)=13
188.150	10.50																CR(CM)=67 CR(%)=45 RQD(%)=17
186.650	12.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1671.00 E, 2044.00 S RL: 198.650

Project No: 1988

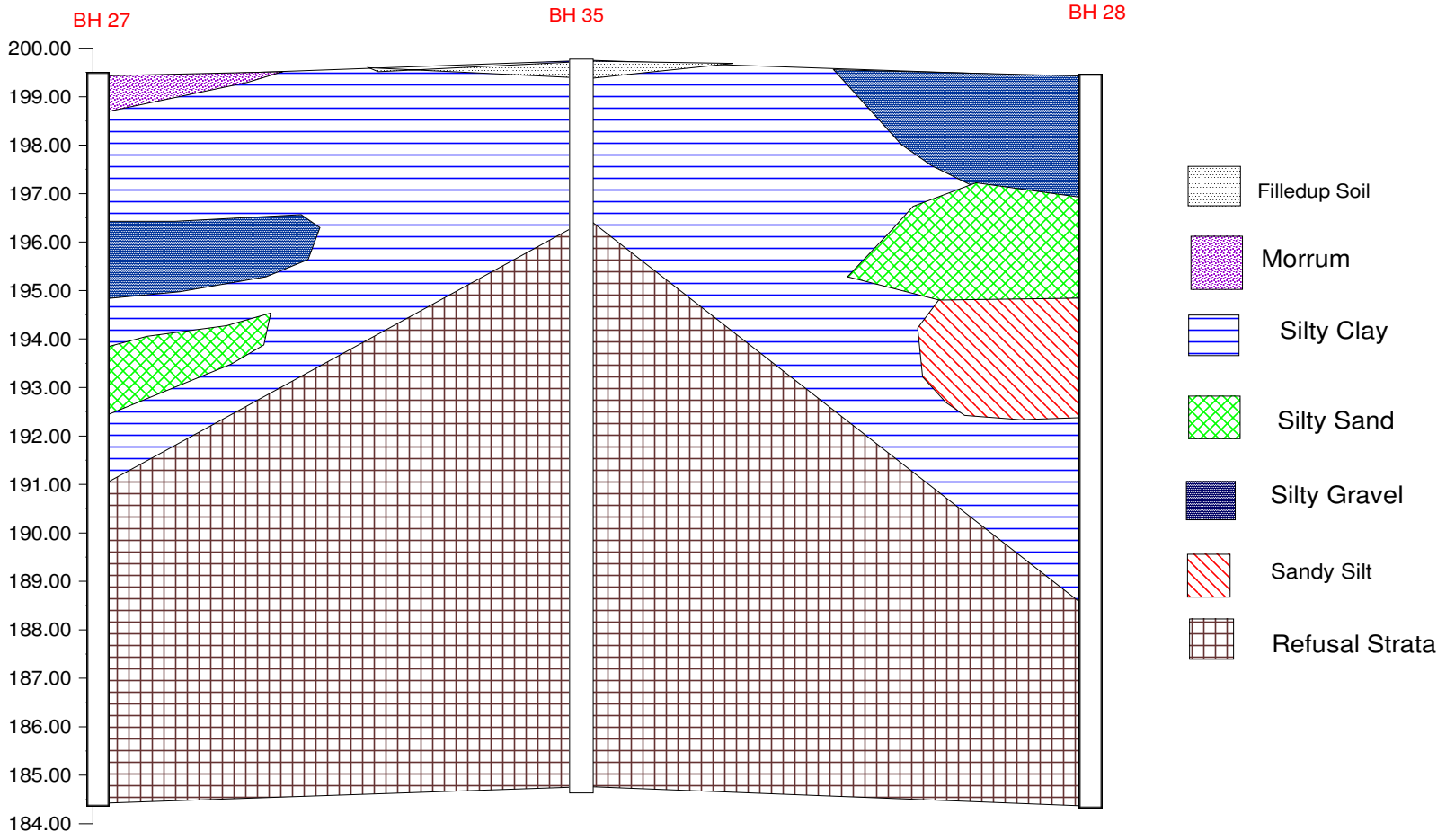
Location:Coal Settling Pond & Overflow Sump BH No.: 26 DEPTH:20.00m Depth of Water Table:0.50 m

Date of Start : 27/10/2013 Date of Finish : 29/10/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: <10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / >150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY (0 20 40 60 80 100)	RQD (0 20 40 60 80 100)	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE (0 20 40 60 80 100)	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
186.650	12.00	Highly weathered and fractured Sandstone /Siltstone						NX									CR(CM)=74 CR(%)=49 RQD(%)=37
185.150	13.50																CR(CM)=51 CR(%)=34 RQD(%)=21
183.650	15.00							NX									CR(CM)=71 CR(%)=47 RQD(%)=42
182.150	16.50	Highly weathered highly fractured Sandstone/ Siltstone															CR(CM)=34 CR(%)=23 RQD(%)=Nil
180.650	18.00							NX									CR(CM)=30 CR(%)=20 RQD(%)=Nil
179.150	19.50	Highly weathered disintegrated Rock															CR(CM)=Nil,CR(%)=Nil N>100, 2cm 84 Blows
178.650	20.00																

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Project No. 1988



EXPECTED SOIL PROFILE

Figure : Soilpro B

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

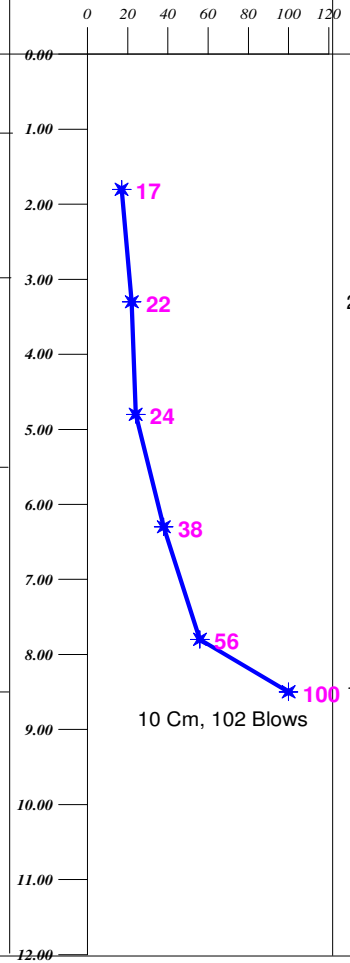
Coordinate: 1371.00 E, 2067.00 S RL: 199.400 Project No: 1988

Location: Stock Pile BH No.: 27 DEPTH:15.00m Depth of Water Table: 0.70 m

Date of Start : 11/12/2013 Date of Finish : 13/12/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) L.L	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
199.400	0.00		Morrum													
197.600	1.80	SPT	Silty Clay of High Plasticity (CH)	1	30	50/19				56	25					
196.900	2.50	UDS					1.84	1.47	25.16			2.78	UU	0.83	3	0.061
196.100	3.30	SPT	Gravely Silt with Sand (GM)	29	23	48				Non Plastic						
194.600	4.80	SPT	Silty Clay of High Plasticity (CH)	2	28	48/22				41	23					
193.100	6.30	SPT	Silty Sand with Gravel (SM)	1	64	35				Non Plastic						
191.600	7.80	SPT	Silty Clay of High Plasticity (CH)	1	7	65/27				49	26					
190.900	8.50	SPT	Refusal Strata	12	33	55										

S.P.T Plot — Observed



BORE LOG

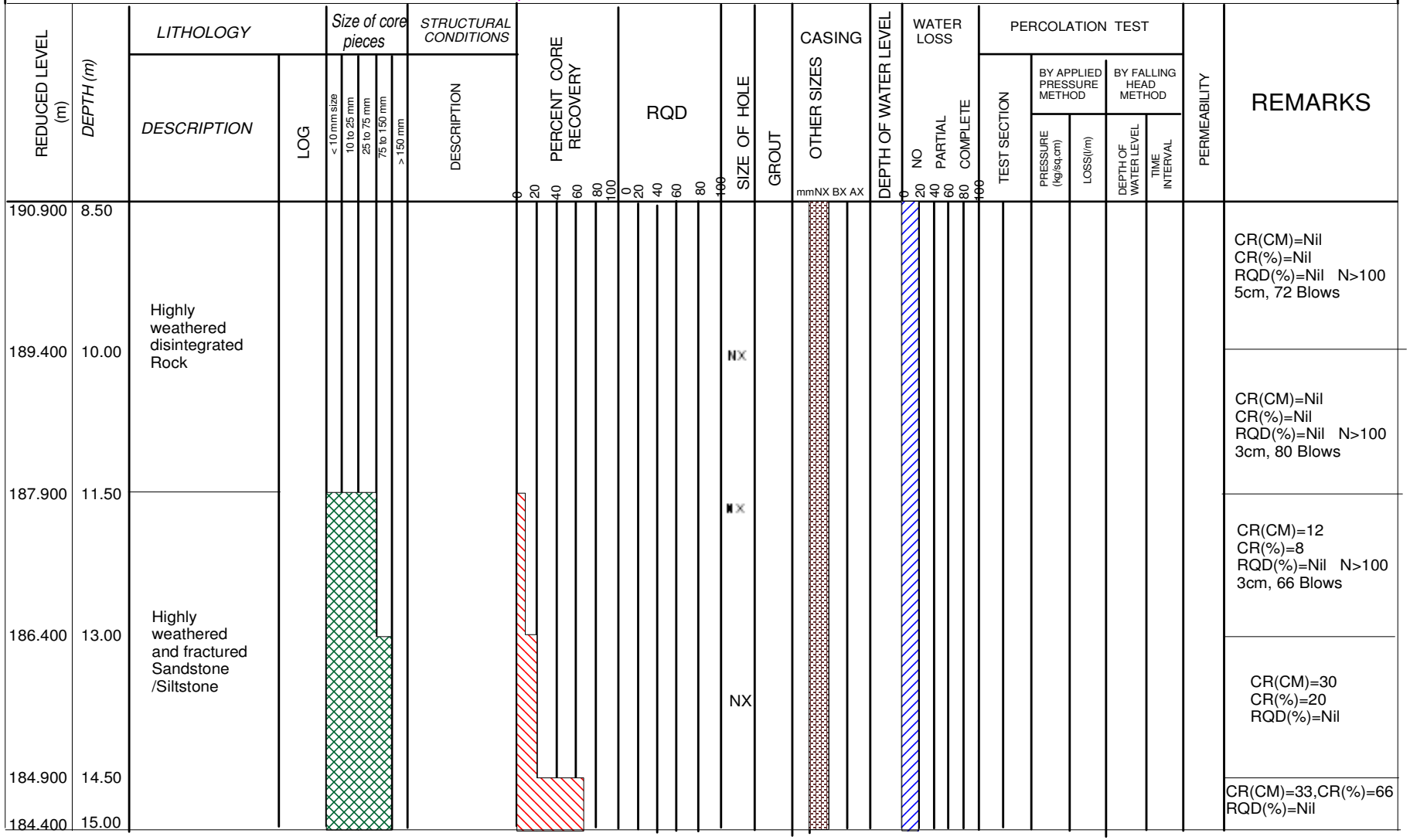
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1371.00 E, 2067.00 S RL: 199.400

Project No: 1988

Location: Stock Pile BH No.: 27 DEPTH: 15.00m Depth of Water Table: 0.70 m

Date of Start : 11/12/2013 Date of Finish : 13/12/2013



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

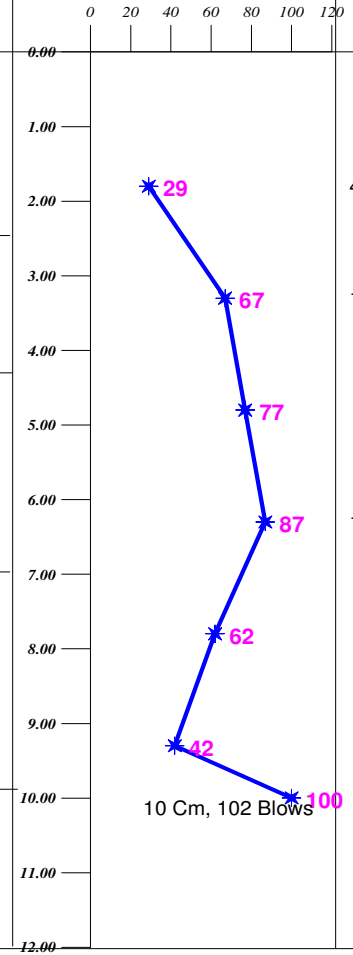
Coordinate: 1069.00 E, 2067.00 S RL: 199.400 Project No: 1988

Location: Stock Pile BH No.: 28 DEPTH:15.00m Depth of Water Table: 0.50 m

Date of Start : 12/10/2013 Date of Finish : 14/10/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) L.L	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
199.400	0.00		Silty Gravel with Sand (GM)													
197.600	1.80	SPT		44	5	51				Non	Plastic					
196.100	3.30	SPT	Silty Sand with Gravel (SM)	10	53	37				Non	Plastic					
194.600	4.80	SPT	Sandy Silt with Gravel (SM-ML)	7	44	49				Non	Plastic					
193.100	6.30	SPT		18	31	51				Non	Plastic					
191.600	7.80	SPT	Silty Clay of medium Plasticity (CI)	0	24	50/26				42	21					
190.100	9.30	SPT		1	27	72										
189.400	10.00	SPT	Refusal Strata	1	45	54				Non	Plastic					

S.P.T Plot — Observed



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1069.00 E, 2067.00 S RL: 199.400

Project No: 1988

Location: Stock Pile BH No.: 28 DEPTH: 15.00m Depth of Water Table: 0.50 m

Date of Start : 12/12/2013 Date of Finish : 14/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: <10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / >150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
189.400	10.00	Highly weathered and fractured Sandstone /Siltstone						NX									CR(CM)=25 CR(%)=17 RQD(%)=7 N>100 5cm, 70 Blows
187.900	11.50							NX									CR(CM)=35 CR(%)=24 RQD(%)=20
186.400	13.00	Highly weathered highly fractured Sandstone /Siltstone						NX									CR(CM)=20 CR(%)=13 RQD(%)=Nil N>100 4cm, 60 Blows
184.900	14.50																CR(CM)=6,CR(%)=12 RQD(%)=Nil N>100 7cm, 72Blows
184.400	15.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1189.00 E, 2329.00 S RL: 199.800 Project No: 1988

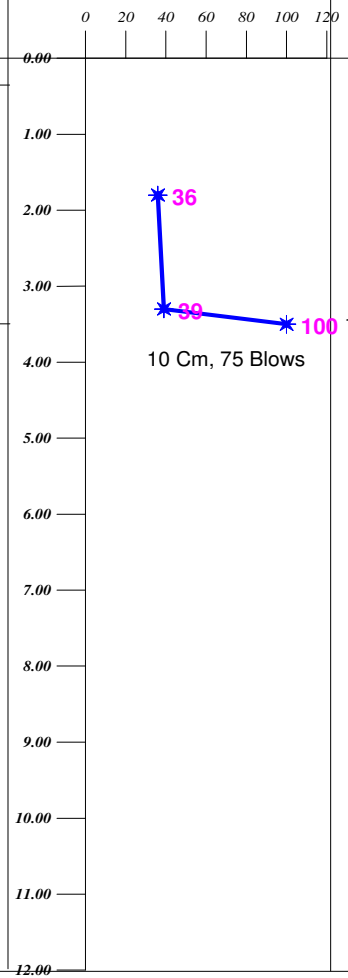
Location: Stock Pile BH No.: 35 DEPTH: 15.00m Depth of Water Table: 1.00 m

Date of Start : 21/10/2013 Date of Finish : 23/10/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
199.800	0.00		Filledup Soil													
198.000	1.80	SPT	Silty Clay of medium Plasticity (Cl)	0	12	66/22				50	26					
197.300	2.50	UDS					1.95	1.59	22.76			2.76	UU	1.82	3	0.054
196.500	3.30	SPT		0	15	85										
196.300	3.50	SPT	Refusal Strata	18	41	41				Non Plastic						

S.P.T Plot

Observed



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1189.00 E, 2329.00 S RL: 199.800 Project No: 1988

Location: Stock Pile BH No.: 35 DEPTH: 15.00m Depth of Water Table: 1.00 m

Date of Start : 26/11/2013 Date of Finish : 28/11/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LITHOLOGY: LOG	Size of core pieces: < 10 mm size	Size of core pieces: 10 to 25 mm	Size of core pieces: 25 to 75 mm	Size of core pieces: 75 to 150 mm	Size of core pieces: > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS: NO	WATER LOSS: PARTIAL	WATER LOSS: COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	BY APPLIED PRESSURE METHOD: LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	BY FALLING HEAD METHOD: TIME INTERVAL	PERMEABILITY	REMARKS
196.300	3.50	Highly to moderately weathered and fractured brownish to yellowish color Sandstone /Siltstone										NX													CR(CM)=68 CR(%)=68 RQD(%)=35
195.300	4.50																								CR(CM)=66 CR(%)=44 RQD(%)=17
193.800	6.00																								CR(CM)=112 CR(%)=74 RQD(%)=43
192.300	7.50																								CR(CM)=115 CR(%)=76 RQD(%)=61
190.800	9.00											NX													CR(CM)=113 CR(%)=75 RQD(%)=42
189.300	10.50																								CR(CM)=76 CR(%)=51 RQD(%)=33
187.800	12.00											NX													CR(CM)=79 CR(%)=53 RQD(%)=34
186.300	13.50																								CR(CM)=40 CR(%)=27 RQD(%)=17
184.800	15.00																								

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1678.50 E, 2338.00 S RL: 199.500 Project No: 1988

Location: Crusher House BH No.: 29 DEPTH: 25.00m Depth of Water Table: 1.10m

Date of Start : 21/10/2013 Date of Finish : 25/10/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	S.P.T Plot (Observed)	Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	Density (gm/cc) r(dry)	W/C W(%)	Limits (%) L.L	Limits (%) P.L	Sp.Gr	Shear Parameters Type of test	Shear Parameters C(kg/sq.cm)	Shear Parameters phi(degrees)	Cc
199.500	0.00																
197.700	1.80	SPT	Silty Clay of medium Plasticity (CI)	100	1	30	47/22										
196.200	3.30	SPT		100	1	56	43										
194.700	4.80	SPT		100	1	40	42/17				40	19					
194.000	5.50	SPT		100	2	57	41				Non Plastic						
			Refusal Strata	10 Cm, 80 Blows													

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1678.50 E, 2338.00 S RL: 199.500 Project No: 1988

Location: Crusher House BH No.: 29 DEPTH: 25.00m Depth of Water Table: 1.10 m

Date of Start : 21/10/2013 Date of Finish : 25/10/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size	10 to 25 mm	25 to 75 mm	75 to 150 mm	> 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES mmNX BX AX	DEPTH OF WATER LEVEL	WATER LOSS: NO	PARTIAL	COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	TIME INTERVAL	PERMEABILITY	REMARKS
194.000	5.50	Highly weathered and fractured Sandstone /Siltstone																							CR(CM)=20,CR(%)=40 RQD(%)=40
193.500	6.00																								CR(CM)=36 CR(%)=24 RQD(%)=12
192.000	7.50	Highly weathered highly fractured Sandstone /Siltstone										NX													CR(CM)=32 CR(%)=21 RQD(%)=Nil
190.500	9.00																								CR(CM)=119 CR(%)=79 RQD(%)=15
189.000	10.50	Highly weathered and fractured Sandstone /Siltstone										NX													CR(CM)=89 CR(%)=59 RQD(%)=25
187.500	12.00																								CR(CM)=52 CR(%)=35 RQD(%)=23
186.000	13.50											NX													CR(CM)=69 CR(%)=46 RQD(%)=30
184.500	15.00																								

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1678.50 E, 2338.00 S RL: 199.500 Project No: 1988

Location: Crusher House BH No.: 29 DEPTH: 25.00m Depth of Water Table: 1.10 m

Date of Start : 21/10/2013 Date of Finish : 25/10/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
184.500	15.00	Highly weathered and fractured Sandstone /Siltstone															CR(CM)=78 CR(%)=52 RQD(%)=38
183.000	16.50							NX									CR(CM)=45 CR(%)=30 RQD(%)=17
181.500	18.00																CR(CM)=50 CR(%)=33 RQD(%)=33
180.000	19.50							NX									CR(CM)=40 CR(%)=26 RQD(%)=9
178.500	21.00																CR(CM)=46 CR(%)=31 RQD(%)=28
177.000	22.50	Highly weathered highly fractured Sandstone /Siltstone						NX									CR(CM)=35 CR(%)=23 RQD(%)=Nil
175.500	24.00	Highly weathered and fractured Sandstone /Siltstone															CR(CM)=30 CR(%)=30 RQD(%)=30
174.500	25.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1926.100 E, 1993.400 S RL:194.200 Project No: 1988

Location: Ash Silo BH No.: 30 DEPTH: 25.00m Depth of Water Table: 0.80 m

Date of Start : 26/12/2013 Date of Finish : 30/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size	10 to 25 mm	25 to 75 mm	75 to 150 mm	> 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES mmNX BX AX	DEPTH OF WATER LEVEL	WATER LOSS: NO	PARTIAL	COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	TIME INTERVAL	PERMEABILITY	REMARKS
194.200	0.00	Silty Clay																							Silty Clay 8cm,100 Blows
192.700	1.50	Highly weathered highly fractured Sandstone /Siltstone										NX													CR(CM)=31 CR(%)=21 RQD(%)=Nil N>100 4cm, 60 Blows
191.200	3.00																								CR(CM)=24 CR(%)=16 RQD(%)=Nil N>100 4cm, 78 Blows
189.700	4.50																								CR(CM)=30 CR(%)=20 RQD(%)=Nil N>100 6cm, 80 Blows
188.200	6.00											NX													CR(CM)=27 CR(%)=18 RQD(%)=Nil N>100 5cm, 81 Blows
186.700	7.50	Highly weathered disintegrated Rock																							CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 11cm, 83 Blows
185.200	9.00											NX													CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 10cm, 76 Blows
183.700	10.50	Highly weathered highly fractured Sandstone /Siltstone																							CR(CM)=12 CR(%)=8 RQD(%)=Nil N>100 7cm, 70 Blows
182.200	12.00																								

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1926.100 E, 1993.400 S RL:194.200 Project No: 1988

Location: Ash Silo BH No.: 30 DEPTH: 25.00m Depth of Water Table: 0.80 m

Date of Start : 26/12/2013 Date of Finish : 30/12/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LITHOLOGY: LOG	Size of core pieces: < 10 mm size	Size of core pieces: 10 to 25 mm	Size of core pieces: 25 to 75 mm	Size of core pieces: 75 to 150 mm	Size of core pieces: > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY (0 20 40 60 80 100)	RQD (0 20 40 60 80 100)	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO	WATER LOSS: PARTIAL	WATER LOSS: COMPLETE (0 20 40 60 80 100)	PERCOLATION TEST: TEST SECTION	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm)	PERCOLATION TEST: BY APPLIED PRESSURE METHOD: LOSS(l/m)	PERCOLATION TEST: BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL	PERCOLATION TEST: BY FALLING HEAD METHOD: TIME INTERVAL	PERMEABILITY	REMARKS
182.200	12.00	Highly weathered disintegrated Rock																							CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 9cm, 77 Blows
180.700	13.50																								CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 6cm, 71 Blows
179.200	15.00											NX													CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 6cm, 69 Blows
177.700	16.50																								CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 7cm, 65 Blows
176.200	18.00											NX													CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 5cm, 63 Blows
174.700	19.50																								CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 5cm, 66 Blows
173.200	21.00																								CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 4cm, 68 Blows
171.700	22.50											NX													CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 4cm, 60 Blows
170.200	24.00																								CR(CM)=Nil, CR(%)=Nil RQD(%)=Nil N>100 3cm, 65 Blows
169.200	25.00																								

BORE LOG

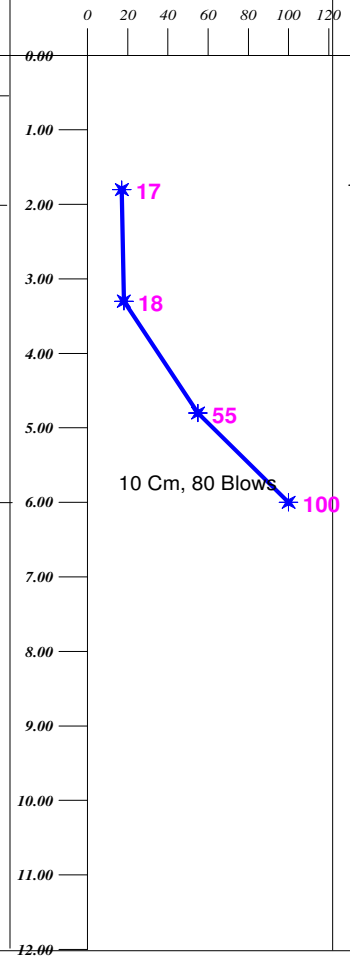
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 855.00 E, 1565.00 S RL: 199.500 — Project No: 1988

Location: DM Plant Neutralization Pit BH No.: 31 DEPTH: 20.00m Depth of Water Table: 1.00 m — Date of Start : 11/10/2013 Date of Finish : 14/10/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
199.500	0.00		Road Material													
			Silty Sand with Gravel (SM)													
197.700	1.80	SPT		10	55	35				Non Plastic						
197.000	2.50	UDS					1.83	1.48	23.64			2.76	UU	0.84	2	0.057
196.200	3.30	SPT	Silty Clay of medium Plasticity (CI)	0	15	85				48	22					
194.700	4.80	SPT		8	26	42/24				43	21					
193.500	6.00	SPT		3	31	66				Non Plastic						
			Refusal Strata													

S.P.T Plot



BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 855.00 E, 1565.00 S RL: 199.500

Project No: 1988

Location: DM Plant Neutralization Pit BH No.: 31 DEPTH: 20.00m Depth of Water Table: 1.00 m

Date of Start : 21/10/2013 Date of Finish : 25/10/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY	RQD	SIZE OF HOLE	GROUT	CASING: OTHER SIZES	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
193.500	6.00	Highly weathered disintegrated Rock															CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 5cm, 60 Blows
192.000	7.50	Highly weathered highly fractured Sandstone /Siltstone						NX									CR(CM)=46 CR(%)=30 RQD(%)=Nil
190.500	9.00																CR(CM)=19 CR(%)=13 RQD(%)=Nil N>100 1cm, 60 Blows
189.000	10.50																CR(CM)=29 CR(%)=20 RQD(%)=Nil N>100 3cm, 50 Blows
187.500	12.00	Highly weathered disintegrated Rock						NX									CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 5cm, 50 Blows
186.000	13.50																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 855.00 E, 1565.00 S RL: 199.500

Project No: 1988

Location: DM Plant Neutralization Pit BH No.: 31 DEPTH: 20.00m Depth of Water Table: 1.00 m

Date of Start : 21/10/2013 Date of Finish : 25/10/2013

REDUCED LEVEL (m)	DEPTH (m)	LITHOLOGY: DESCRIPTION	LOG	Size of core pieces: < 10 mm size / 10 to 25 mm / 25 to 75 mm / 75 to 150 mm / > 150 mm	STRUCTURAL CONDITIONS: DESCRIPTION	PERCENT CORE RECOVERY (0 20 40 60 80 100)	RQD (0 20 40 60 80 100)	SIZE OF HOLE	GROUT	CASING: OTHER SIZES (mmNX BX AX)	DEPTH OF WATER LEVEL	WATER LOSS: NO / PARTIAL / COMPLETE (0 20 40 60 80 100)	PERCOLATION TEST: TEST SECTION	BY APPLIED PRESSURE METHOD: PRESSURE (kg/sq.cm) / LOSS(l/m)	BY FALLING HEAD METHOD: DEPTH OF WATER LEVEL / TIME INTERVAL	PERMEABILITY	REMARKS
186.000	13.50	Highly weathered disintegrated Rock															CR(CM)=Nil CR(%)=Nil RQD(%)=Nil N>100 3cm, 55 Blows
184.500	15.00	Highly weathered highly fractured Sandstone /Siltstone						NX									CR(CM)=21 CR(%)=15 RQD(%)=Nil N>100 5cm, 55 Blows
183.000	16.50							NX									CR(CM)=9 CR(%)=6 RQD(%)=Nil N>100 4cm, 70 Blows
181.500	18.00							NX									CR(CM)=11 CR(%)=8 RQD(%)=Nil N>100 3cm, 60 Blows
180.000	19.50																CR(CM)=15,CR(%)=30 RQD(%)= Nil
179.500	20.00																

BORE LOG

PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

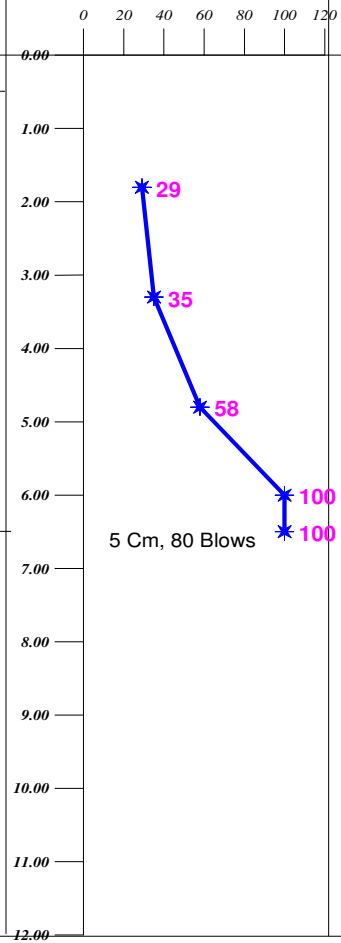
Coordinate: 1812.00 E, 839.00 S RL: 209.750 — Project No: 1988

Location:Main Gate BH No.: 33 DEPTH: 15.00m Depth of Water Table: 1.90m

Date of Start : 26/11/2013 Date of Finish : 28/11/2013

Reduced Level (m)	Depth (m)	Type of sample	Soil Classification	Grain size (%) Gravel	Sand	Silt/Clay	Density (gm/cc) r(wet)	r(dry)	W/C W(%)	Limits (%) LL	P . L	Sp.Gr	Shear Parameters Type of test	C(kg/sq.cm)	phi(degrees)	Cc
209.750	0.00		Filledup Soil													
207.950	1.80	SPT		10	13	60/17				42	20					
207.250	2.50	UDS					1.91	1.54	23.81			2.76	UU	1.73	3	0.056
206.450	3.30	SPT	Silty Clay of medium Plasticity (CI)	1	7	92										
204.950	4.80	SPT		0	13	64/23				47	27					
203.750	6.00	SPT		1	10	89										
203.250	6.50	SPT		0	11	89				53	26					
			Refusal Strata													

S.P.T Plot



BORE LOG

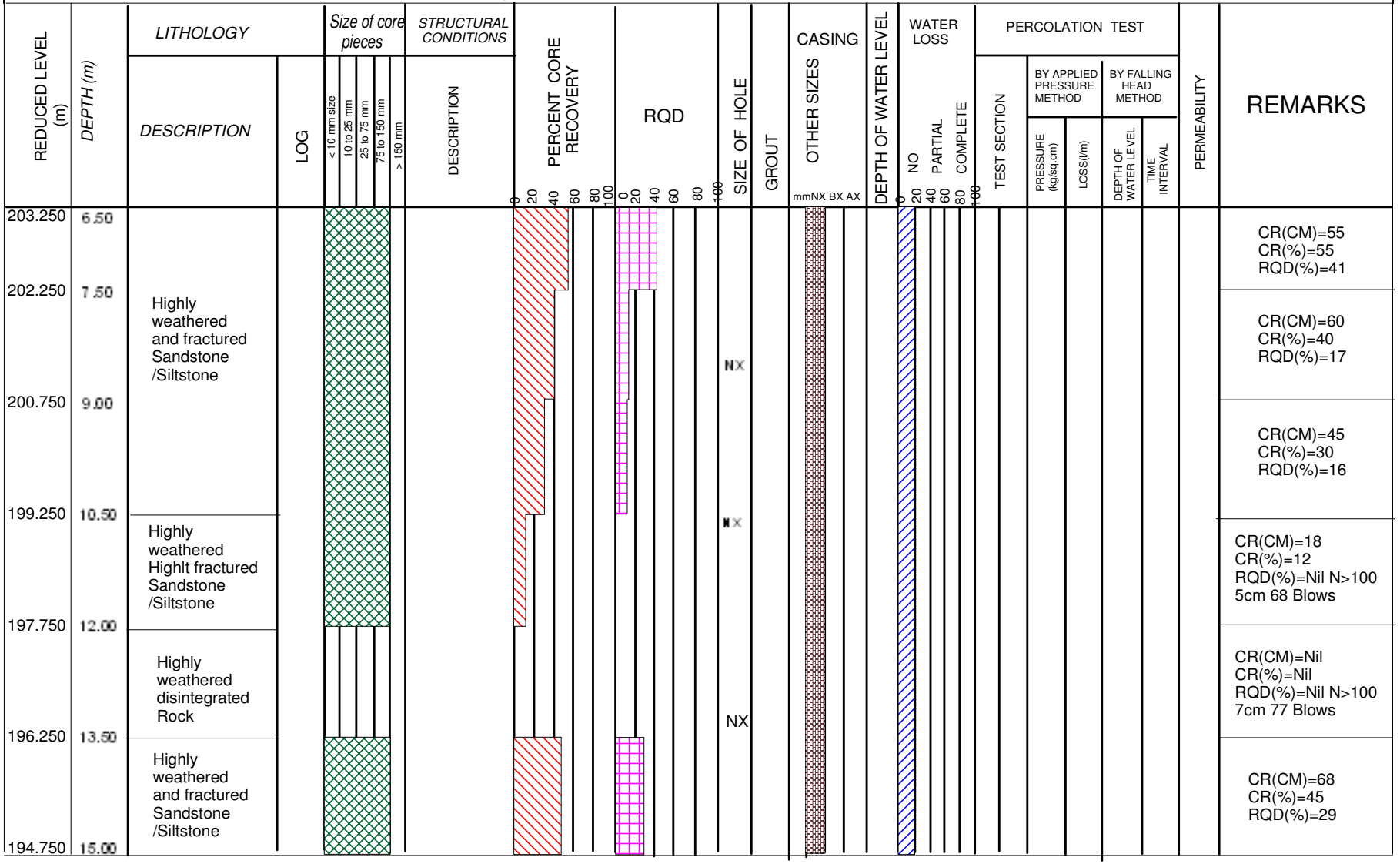
PROJECT: Geotechnical Investigation work for 2x660MW IB Thermal Power Station, Unit-3 & 4, Banharpalli, Dist-Jharsugura, Odisha.

Coordinate: 1812.00 E, 839.00 S RL: 209.750

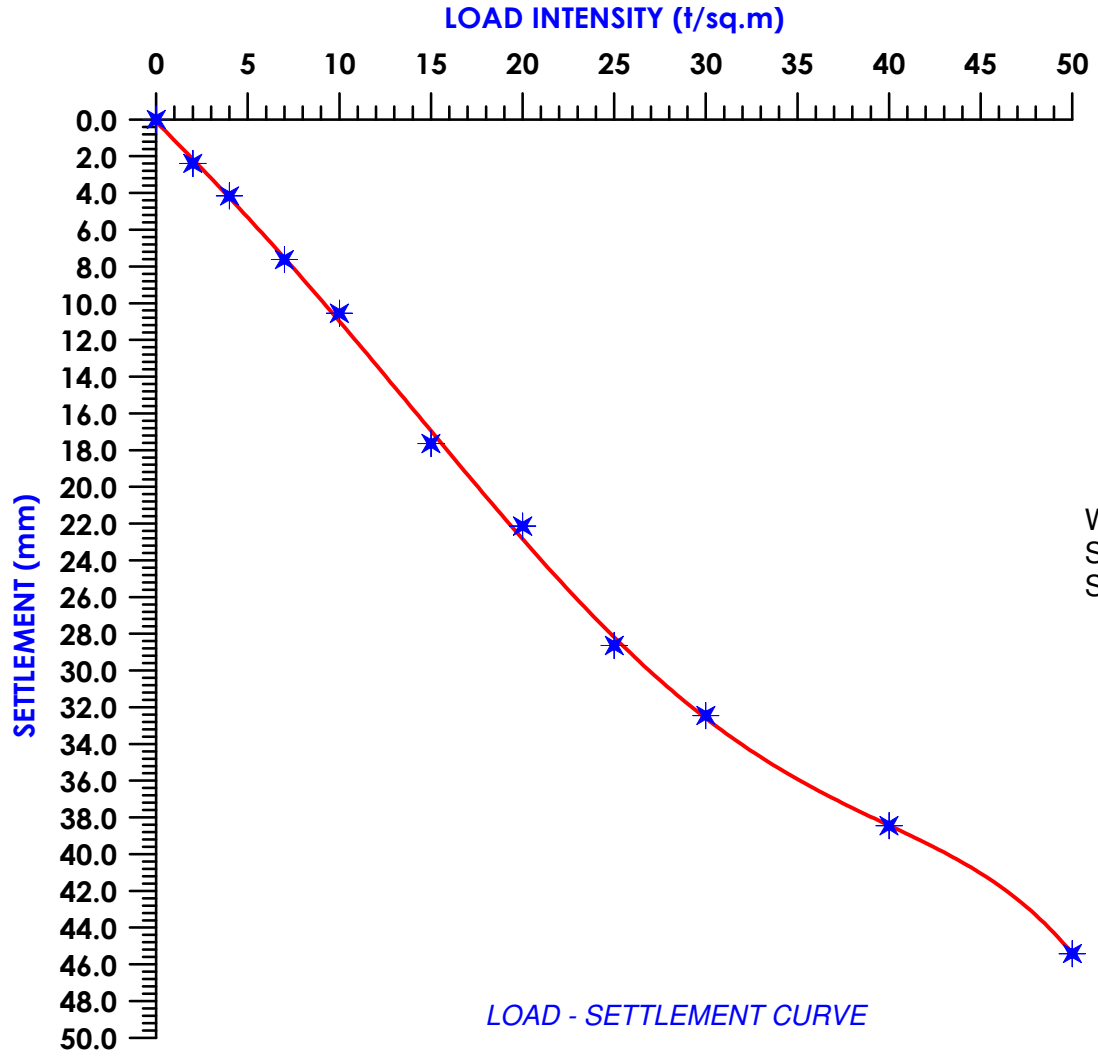
Project No: 1988

Location: Main Gate BH No.: 33 DEPTH: 15.00m Depth of Water Table: 1.90 m

Date of Start : 26/11/2013 Date of Finish : 28/11/2013



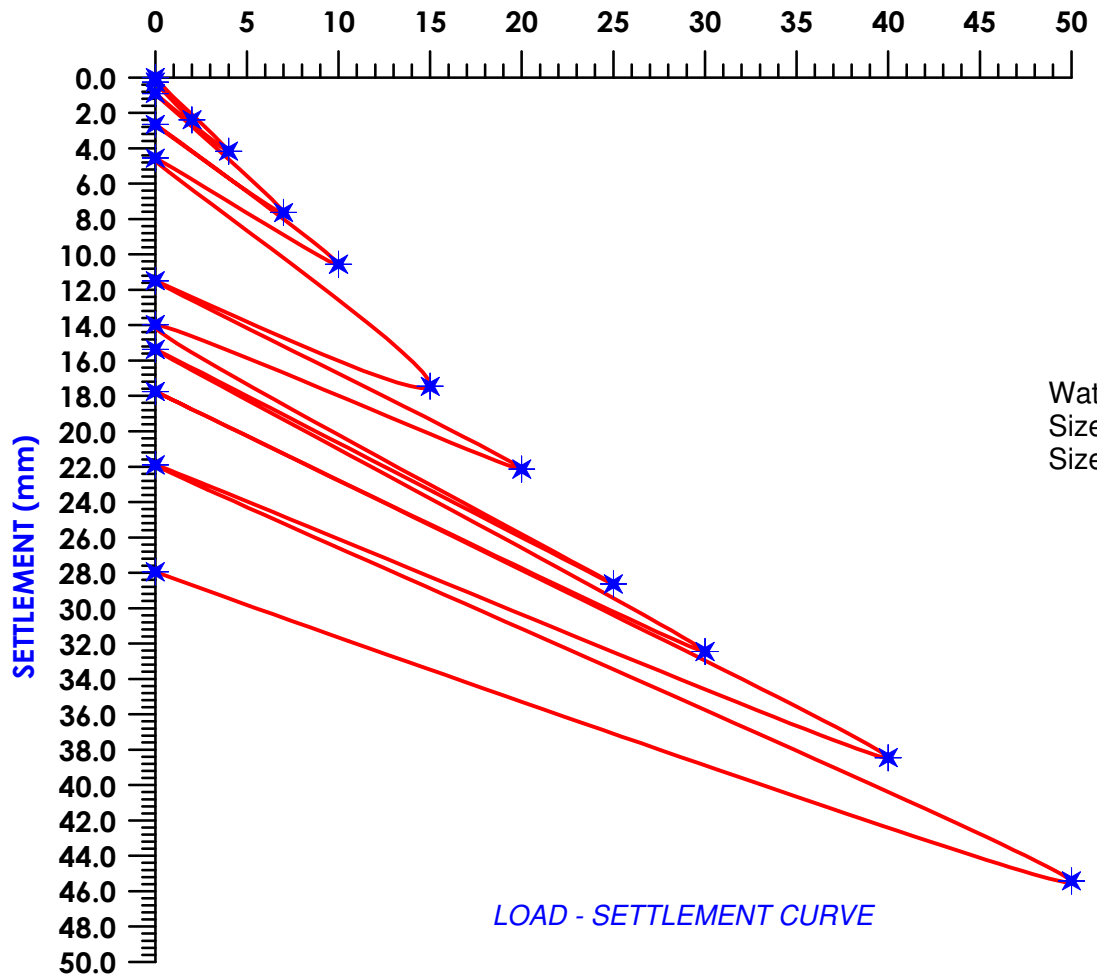
CPLT 1 Switch Yard (E 1440.00 S 973.500)



Water Table: Not Met
Size of Pit: 3m x3m x 1.5m
Size of plate : 0.60m x 0.60m

LOAD - SETTLEMENT CURVE

Fig: CPLT- 1a



Water Table : Not Met
Size of Pit: 3m x3m x1.5m
Size of plate : 0.60m x 0.60m

Fig: CPLT-1b

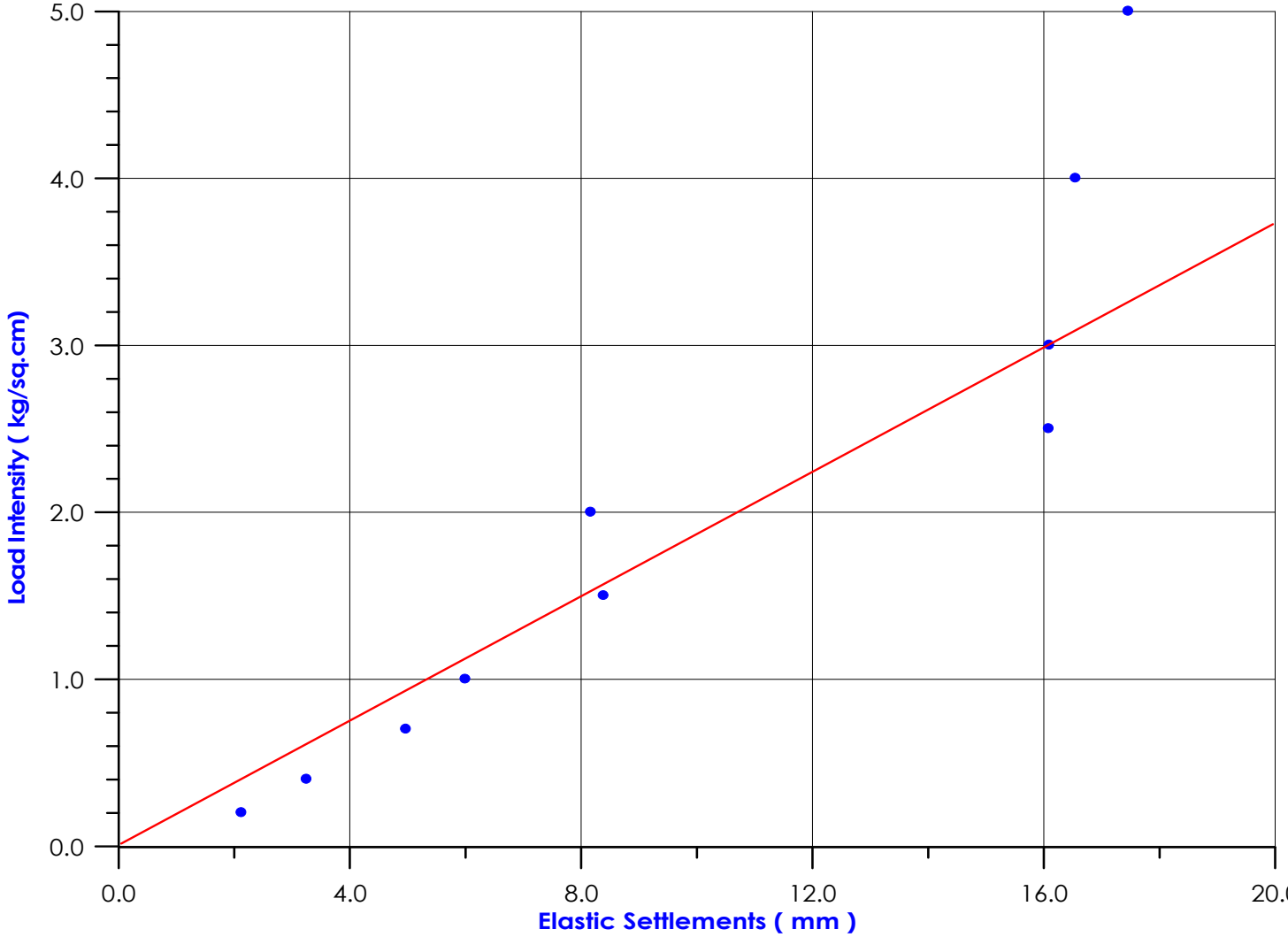
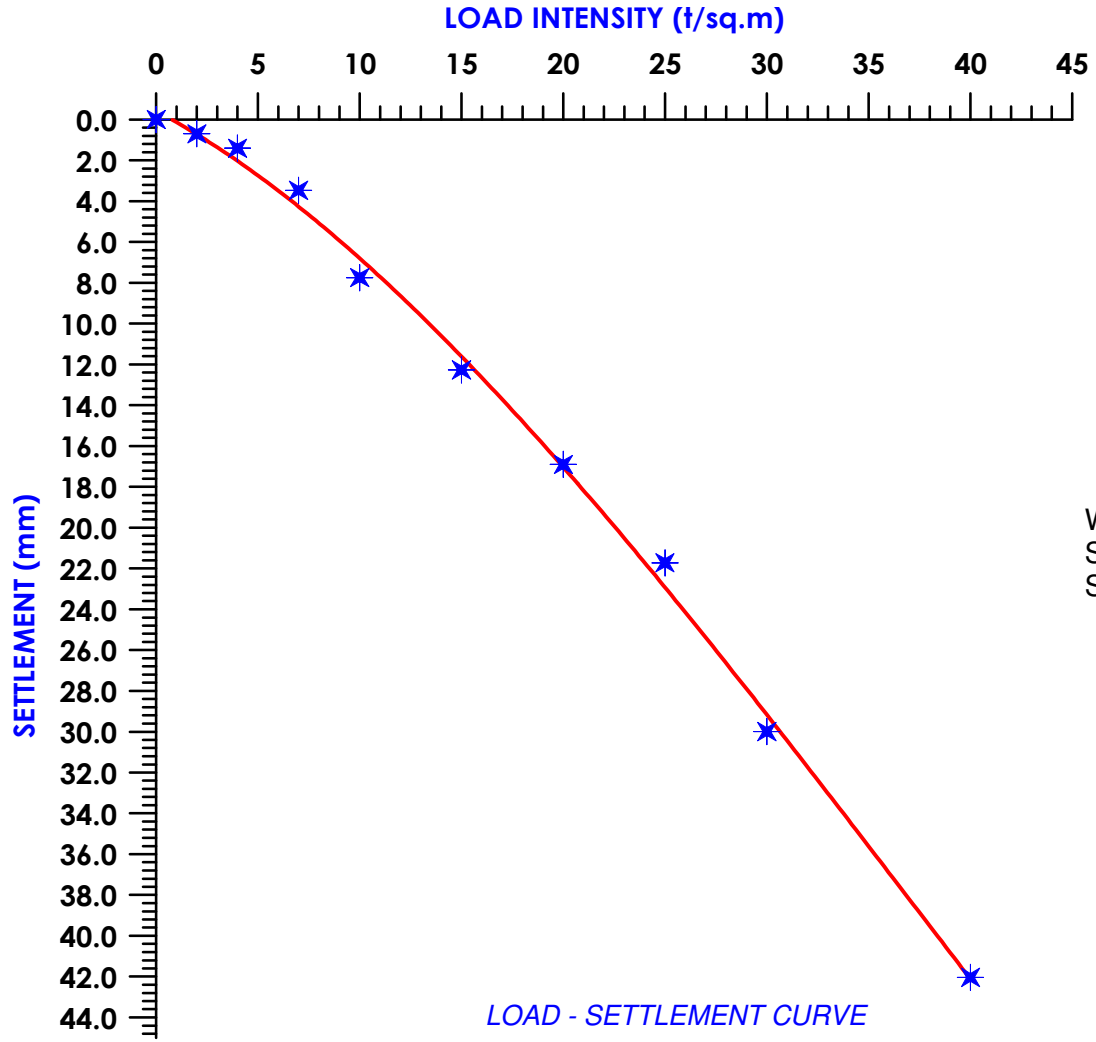

5.0
4.0
3.0
2.0
1.0
0.0
Load Intensity (kg/sq.cm)
0.0
4.0
8.0
12.0
16.0
20.0
Elastic Settlements (mm)

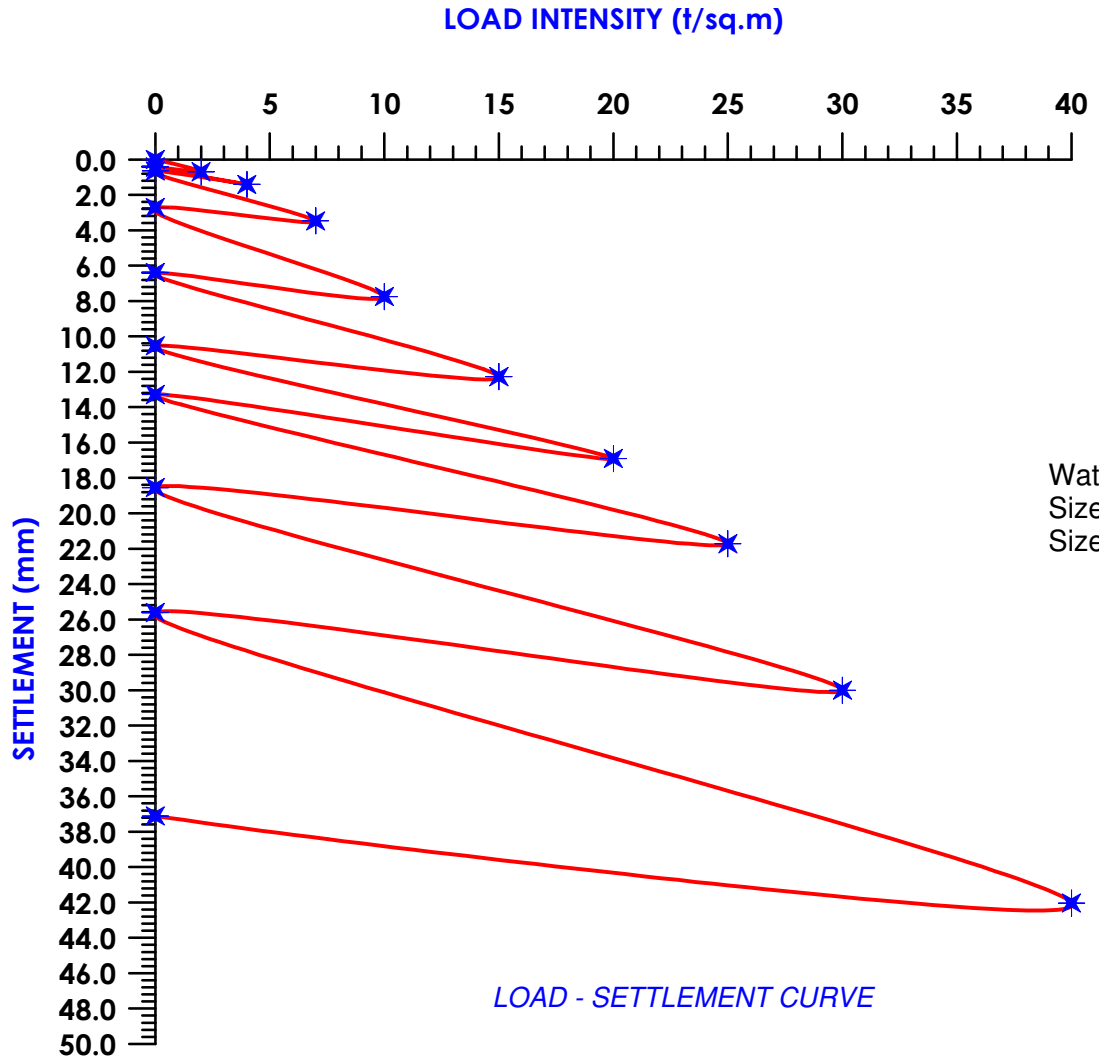
FIG: CPLT-1C

CPLT 2 Clarified Water Resrvoir PH (E 789.700 S 1463.800)



Water Table: Not Met
Size of Pit: 3m x3m x 1.5m
Size of plate : 0.60m x 0.60m

Fig: CPLT- 2a



Water Table : Not Met
Size of Pit: 3m x3m x1.5m
Size of plate : 0.60m x 0.60m

LOAD - SETTLEMENT CURVE

Fig: CPLT-2b

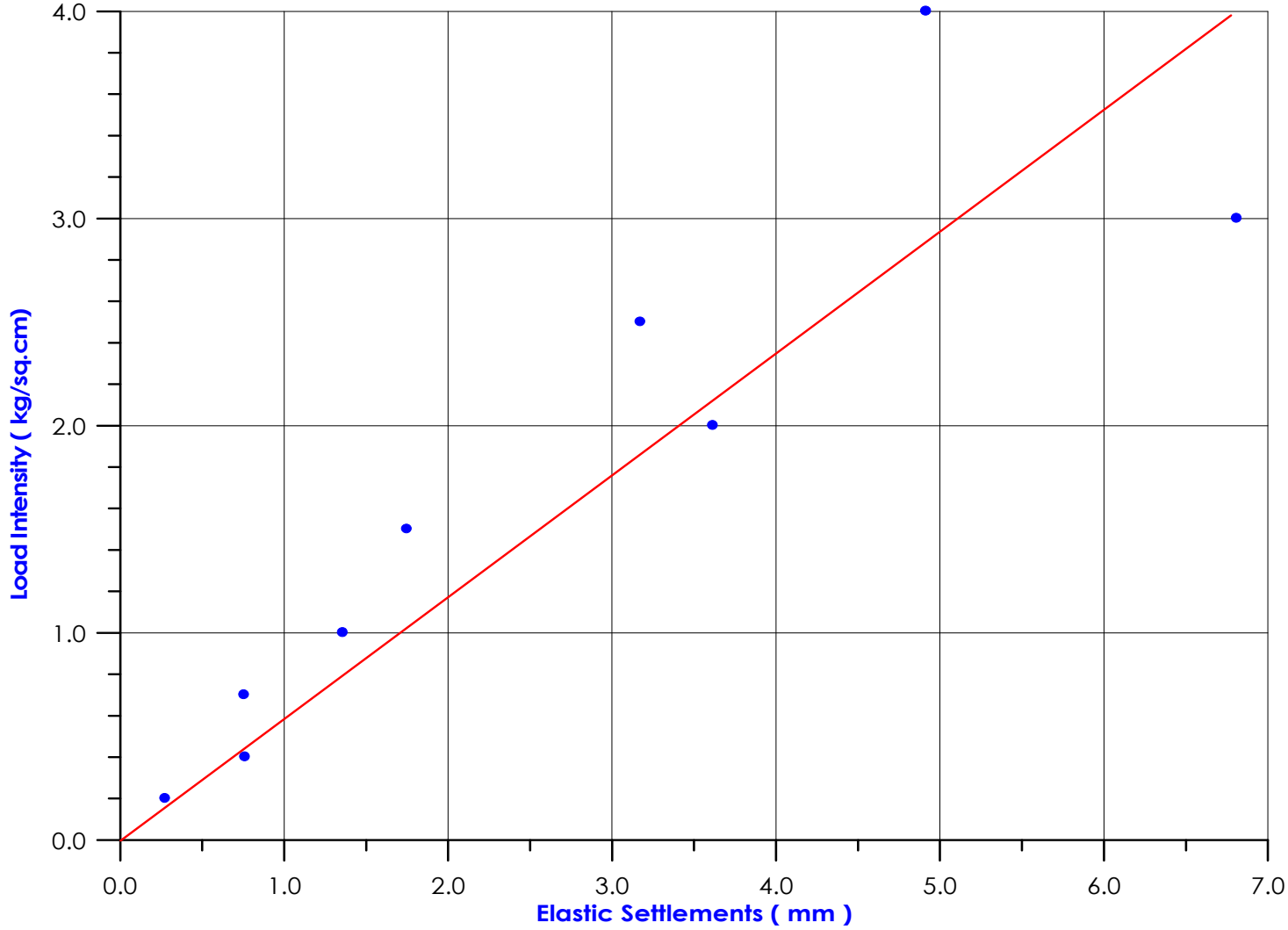
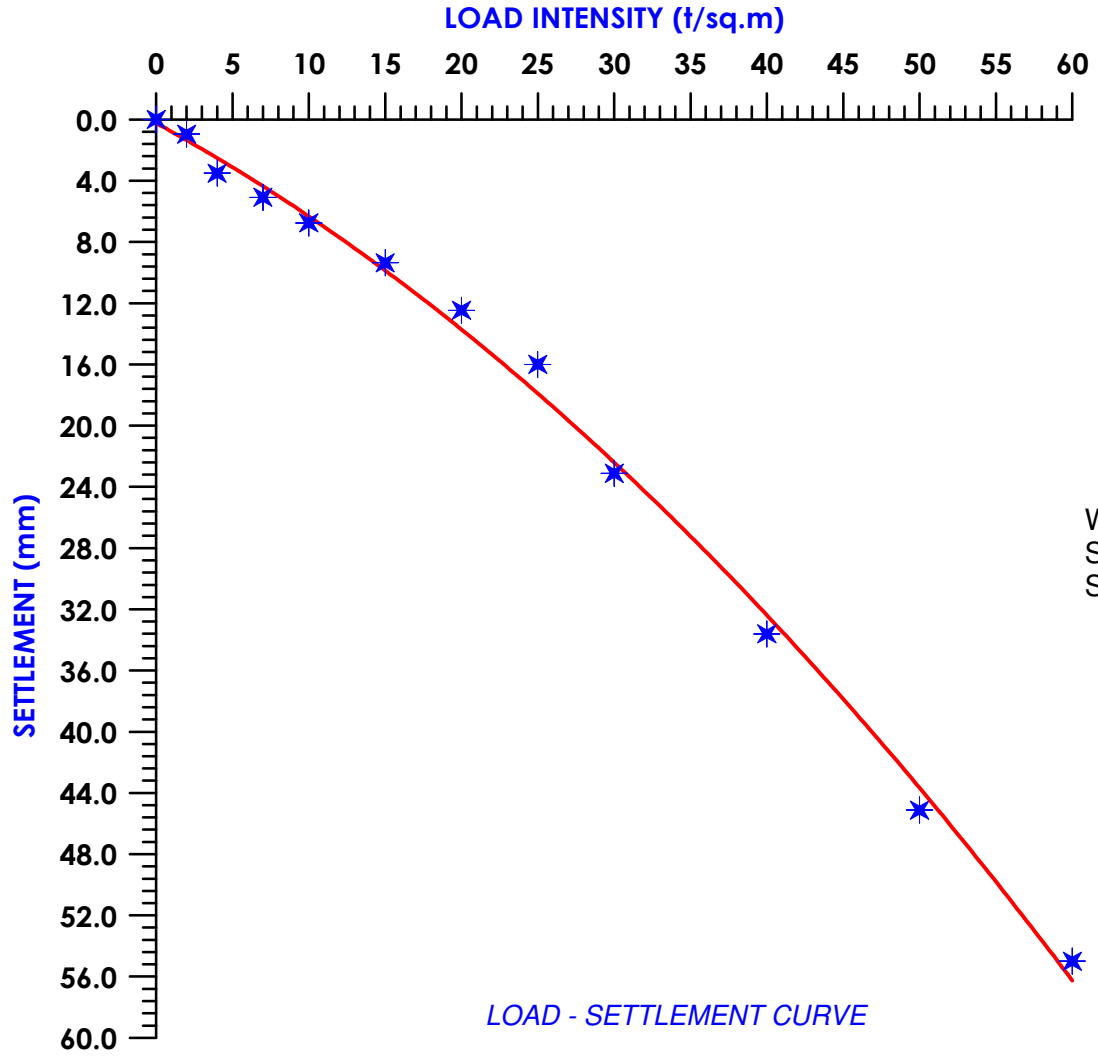

4.0
3.0
2.0
1.0
0.0
Load Intensity (kg/sq.cm)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Elastic Settlements (mm)

FIG: CPLT-2C

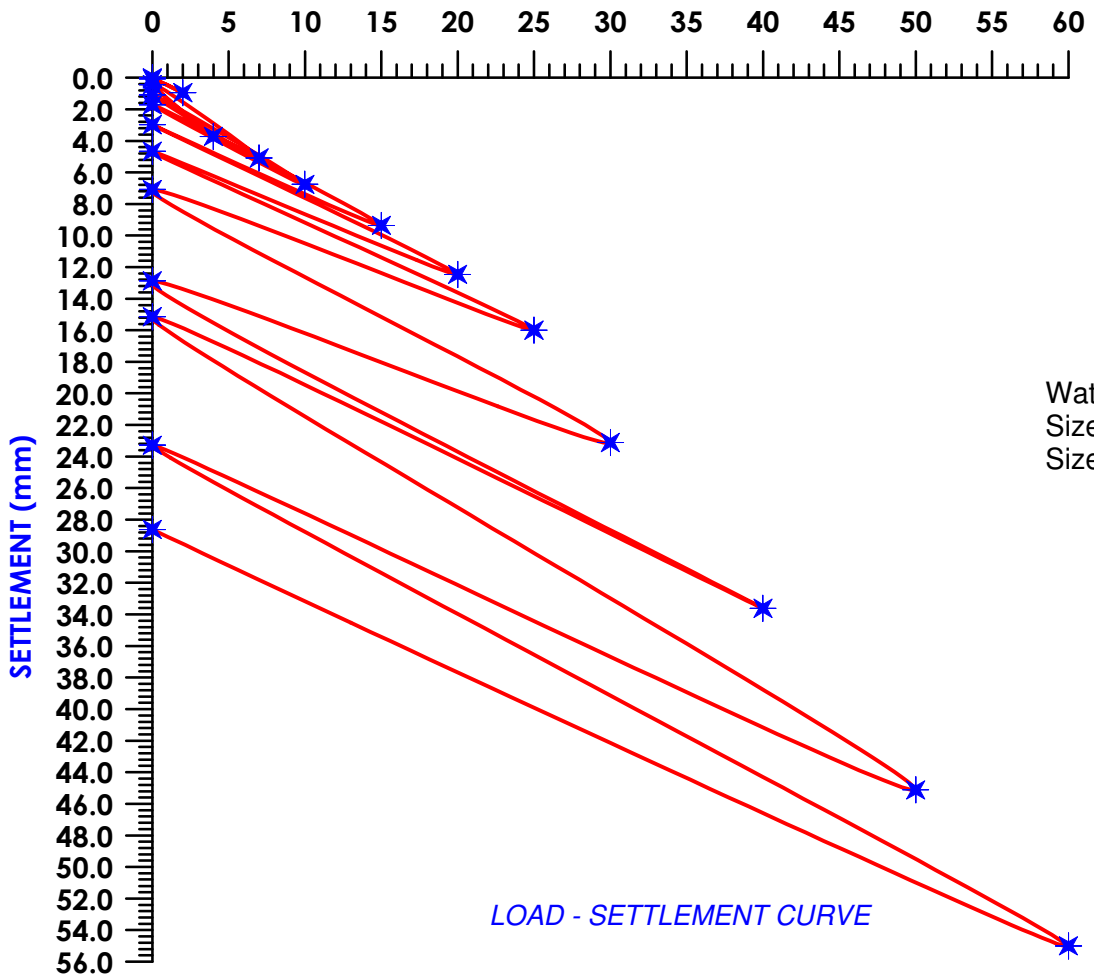
CPLT 3 Boiler (E 1201.500 S 1423.500)



Water Table: 0.90 m
Size of Pit: 3m x3m x 1.7m
Size of plate : 0.60m x 0.60m

LOAD - SETTLEMENT CURVE

Fig: CPLT- 3a



Water Table : 0.90 m
Size of Pit: 3m x3m x1.7m
Size of plate : 0.60m x 0.60m

Fig: CPLT-3b

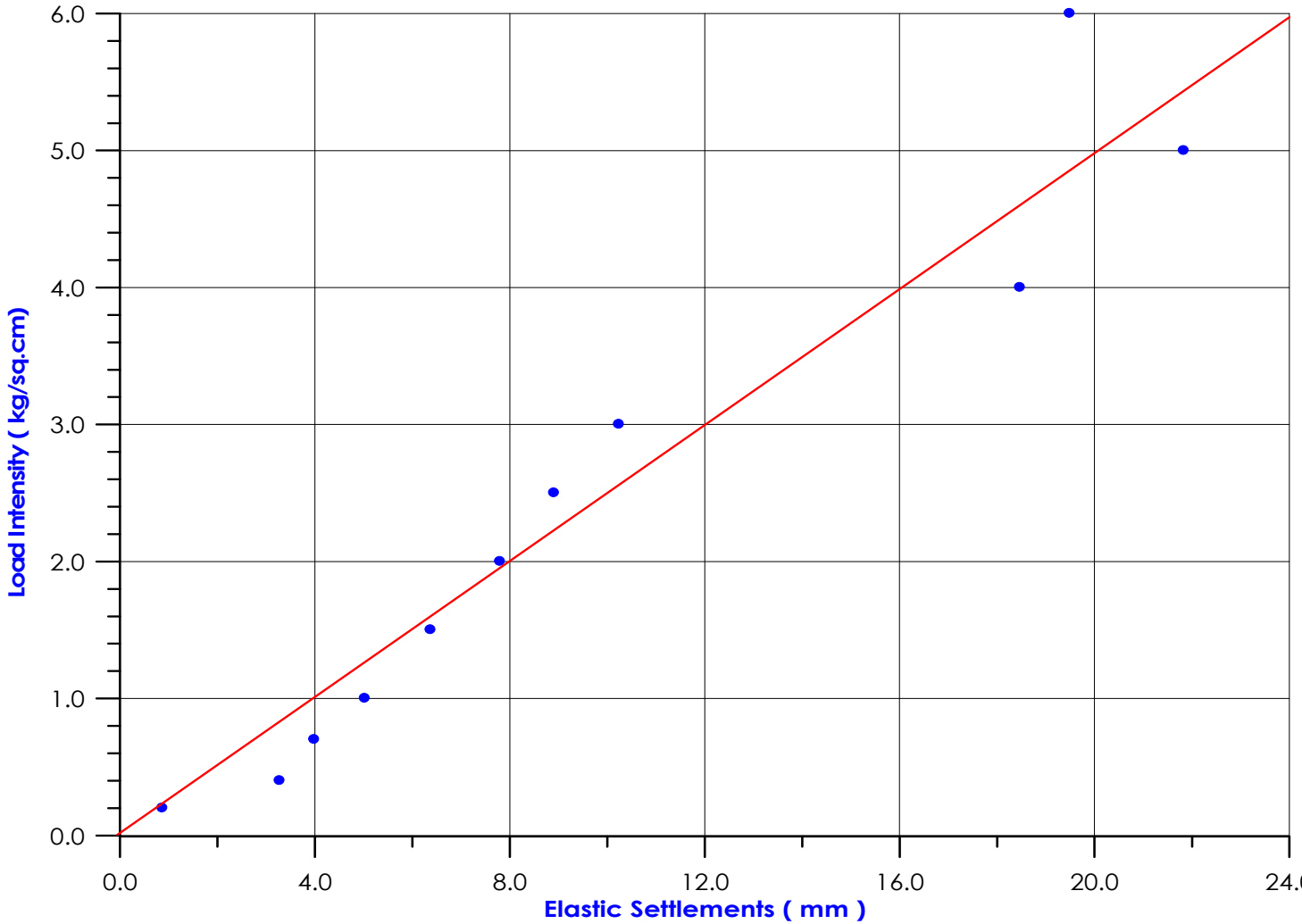

6.0
5.0
4.0
3.0
2.0
1.0
0.0
Load Intensity (kg/sq.cm)
0.0
4.0
8.0
12.0
16.0
20.0
24.0
Elastic Settlements (mm)

FIG: CPLT-3C

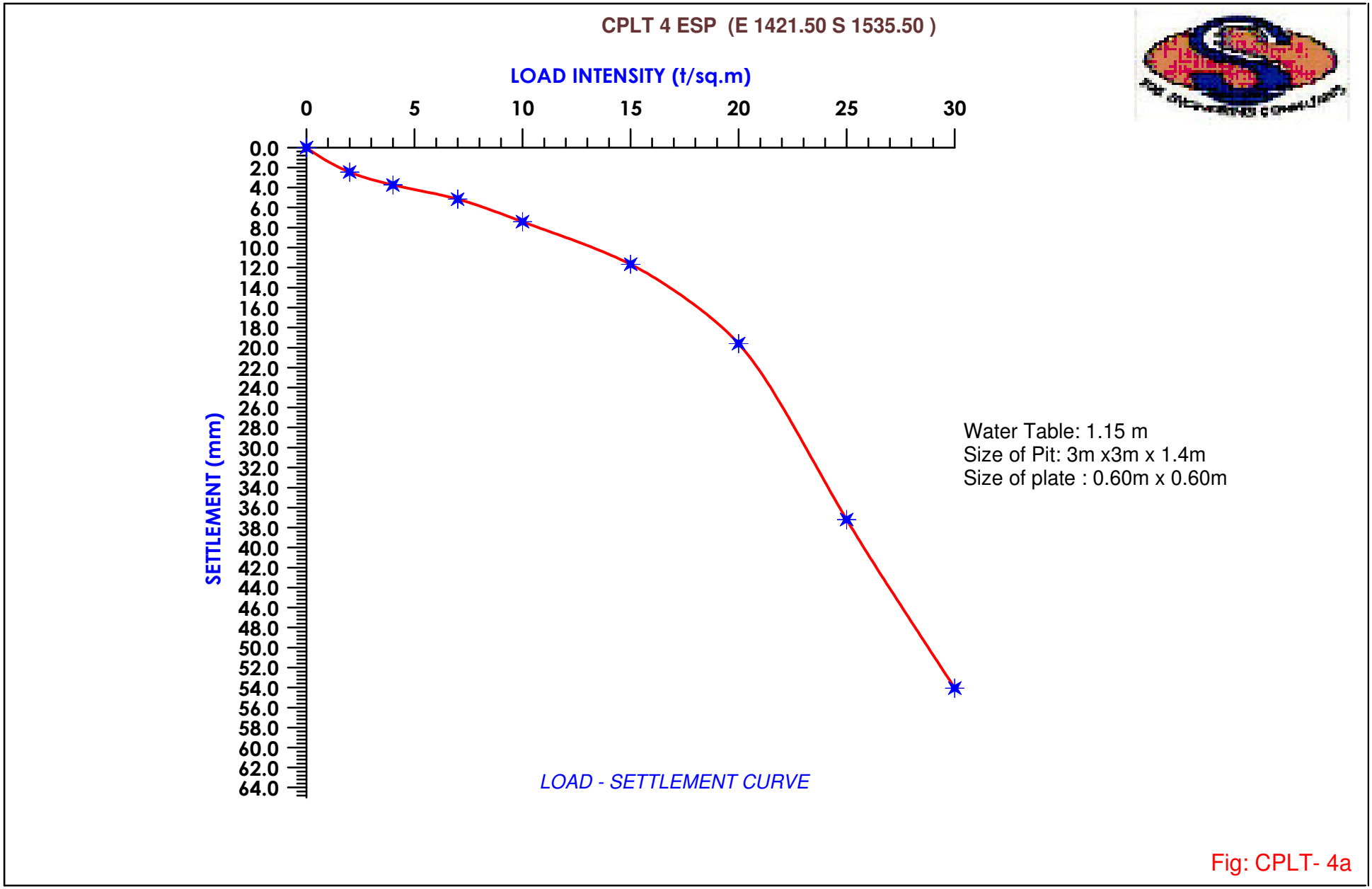
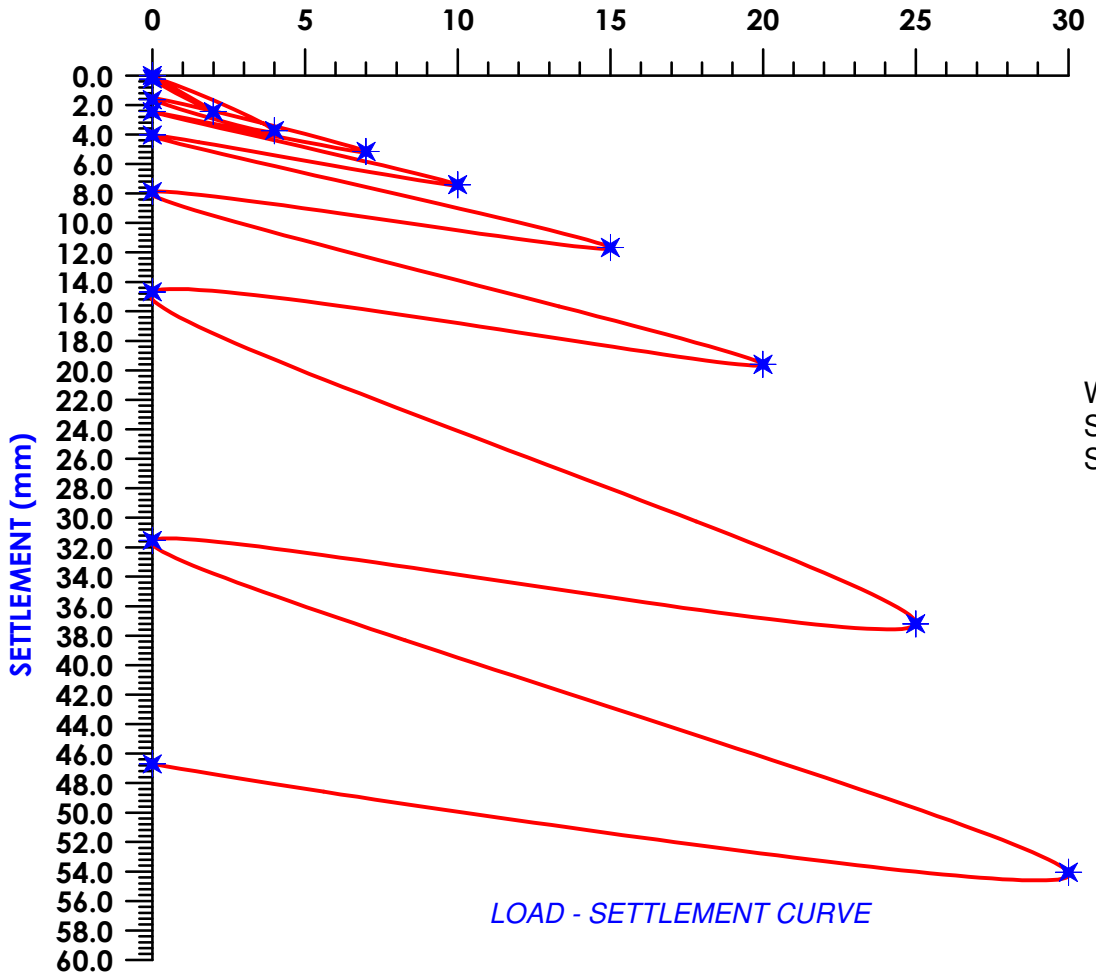

CPLT 4 ESP (E 1421.50 S 1535.50)
LOAD INTENSITY (t/sq.m)
0
5
10
15
20
25
30
SETTLEMENT (mm)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
22.0
24.0
26.0
28.0
30.0
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
50.0
52.0
54.0
56.0
58.0
60.0
62.0
64.0
Water Table: 1.15 m
Size of Pit: 3m x3m x 1.4m
Size of plate : 0.60m x 0.60m
LOAD - SETTLEMENT CURVE

Fig: CPLT- 4a



Water Table: 1.15 m
Size of Pit: 3m x3m x 1.4m
Size of plate : 0.60m x 0.60m

Fig: CPLT-4b

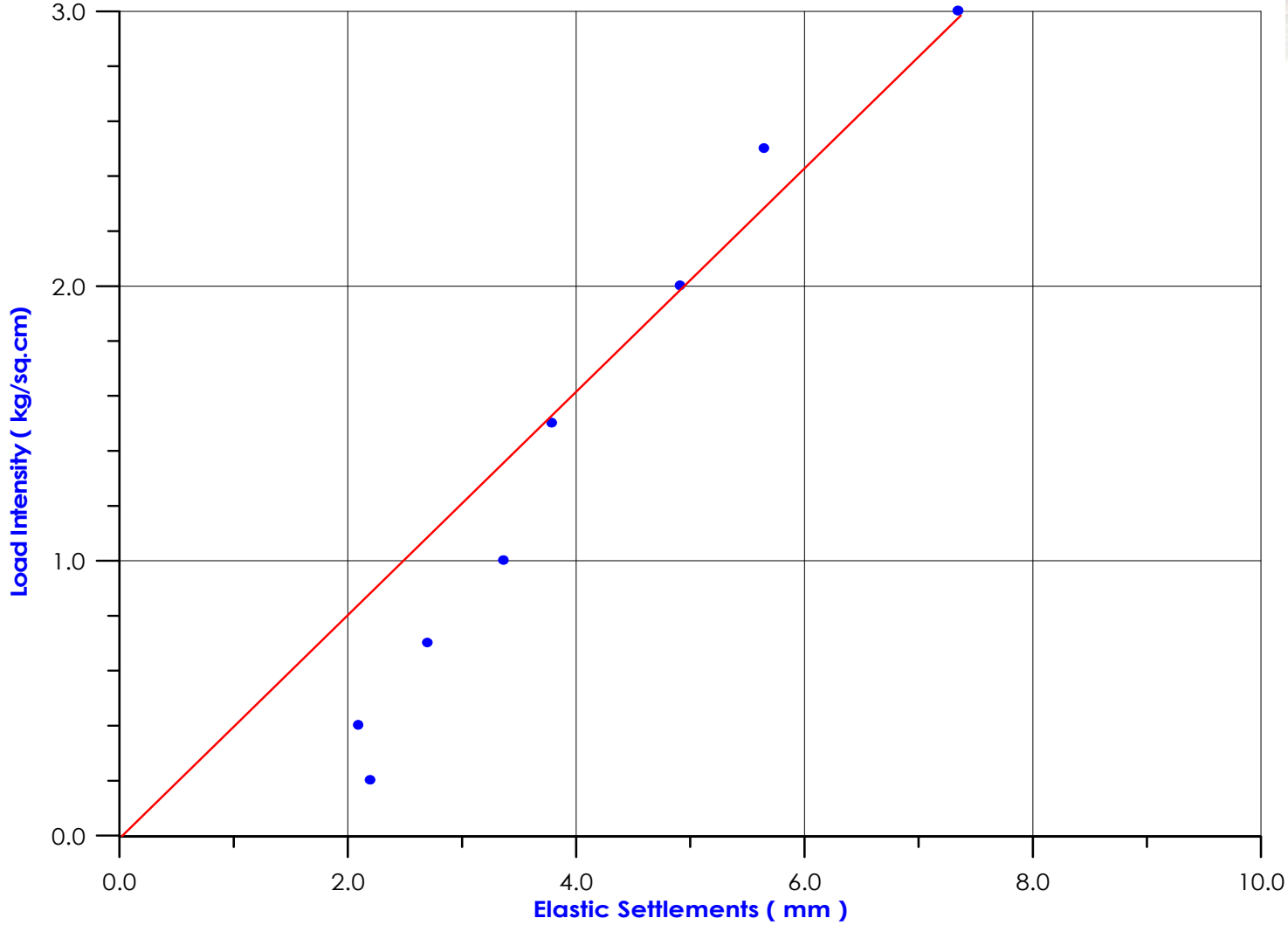
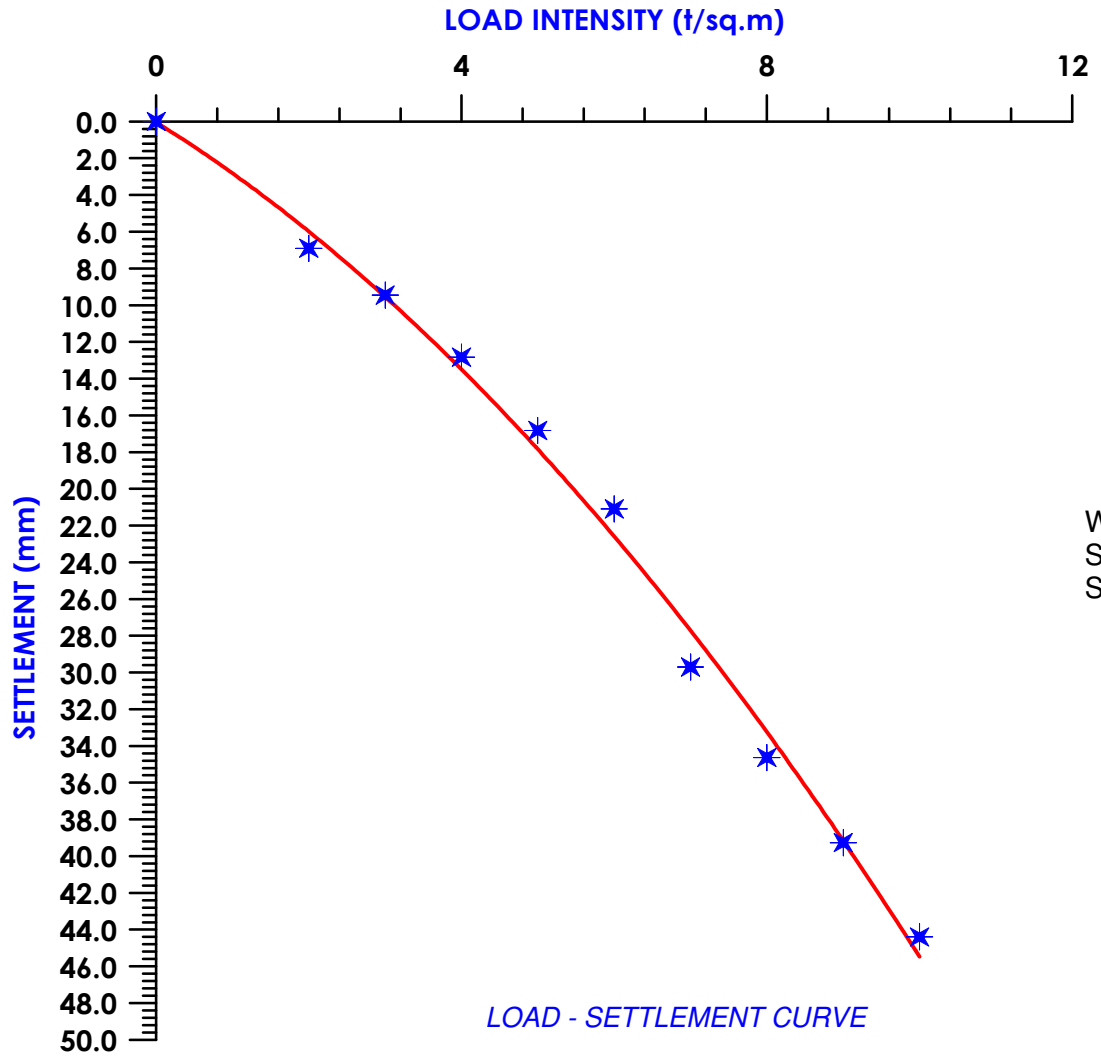

3.0
2.0
1.0
0.0
Load Intensity (kg/sq.cm)
0.0
2.0
4.0
6.0
8.0
10.0
Elastic Settlements (mm)

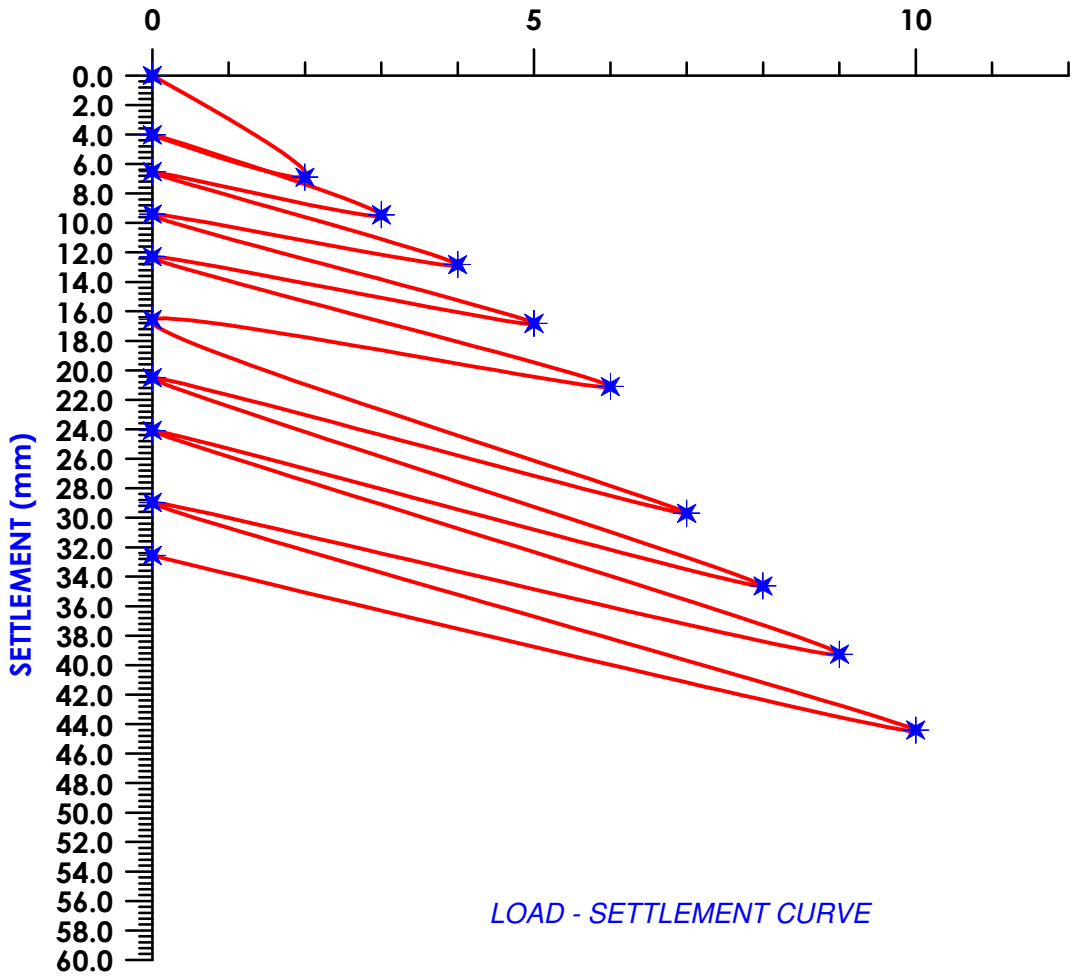
FIG: CPLT-4C

CPLT 5 (E 1380.600 S 2077.700)



Water Table: 1.20 m
Size of Pit: 3m x3m x 1.25m
Size of plate : 0.60m x 0.60m

Fig: CPLT- 5a



LOAD - SETTLEMENT CURVE

Water Table : 1.20 m
Size of Pit: 3m x3m x1.25m
Size of plate : 0.60m x 0.60m

Fig: CPLT-5b

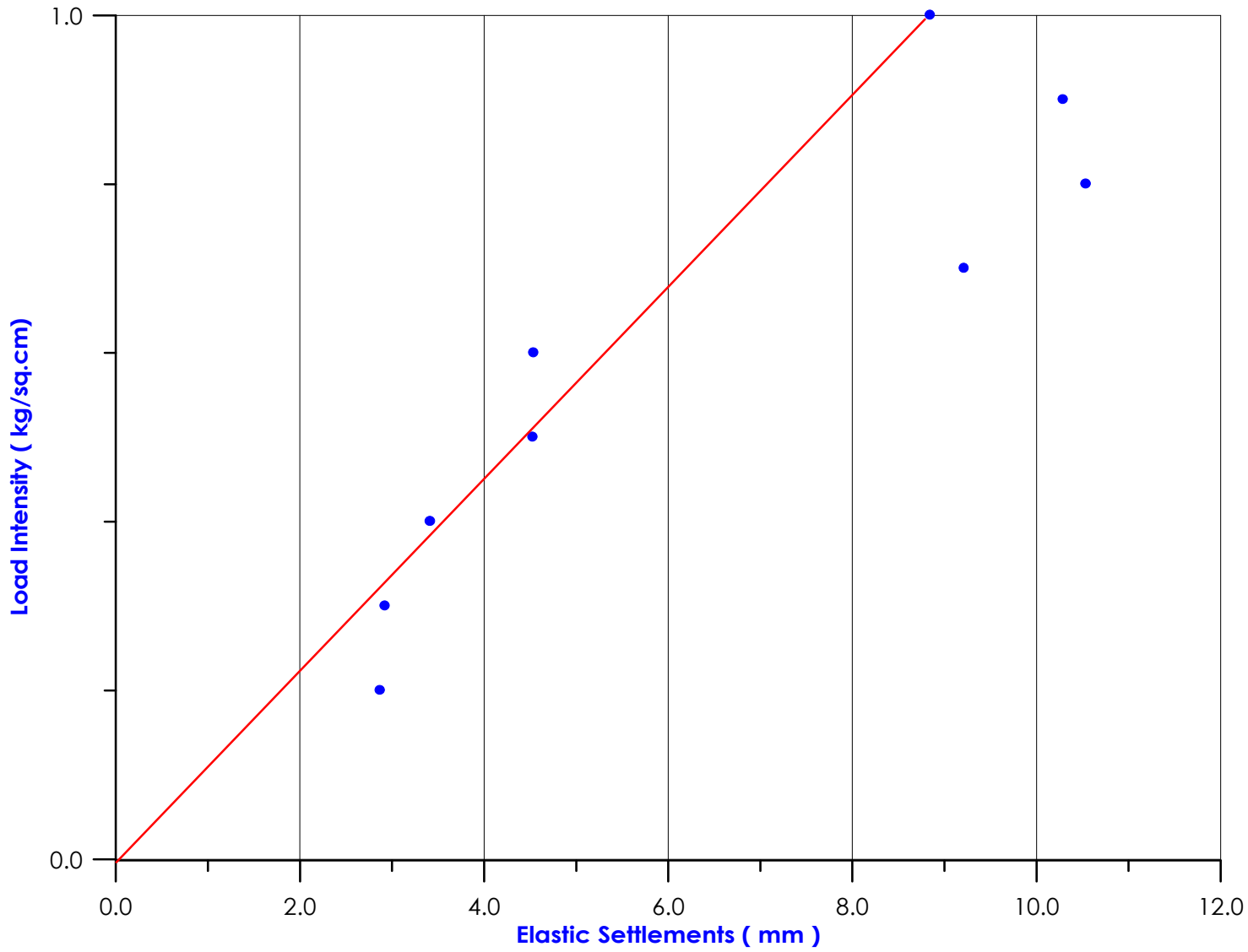

1.0
0.0
Load Intensity (kg/sq.cm)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Elastic Settlements (mm)

FIG: CPLT-5C

GSD Curves, Tri axial curves and consolidation curves

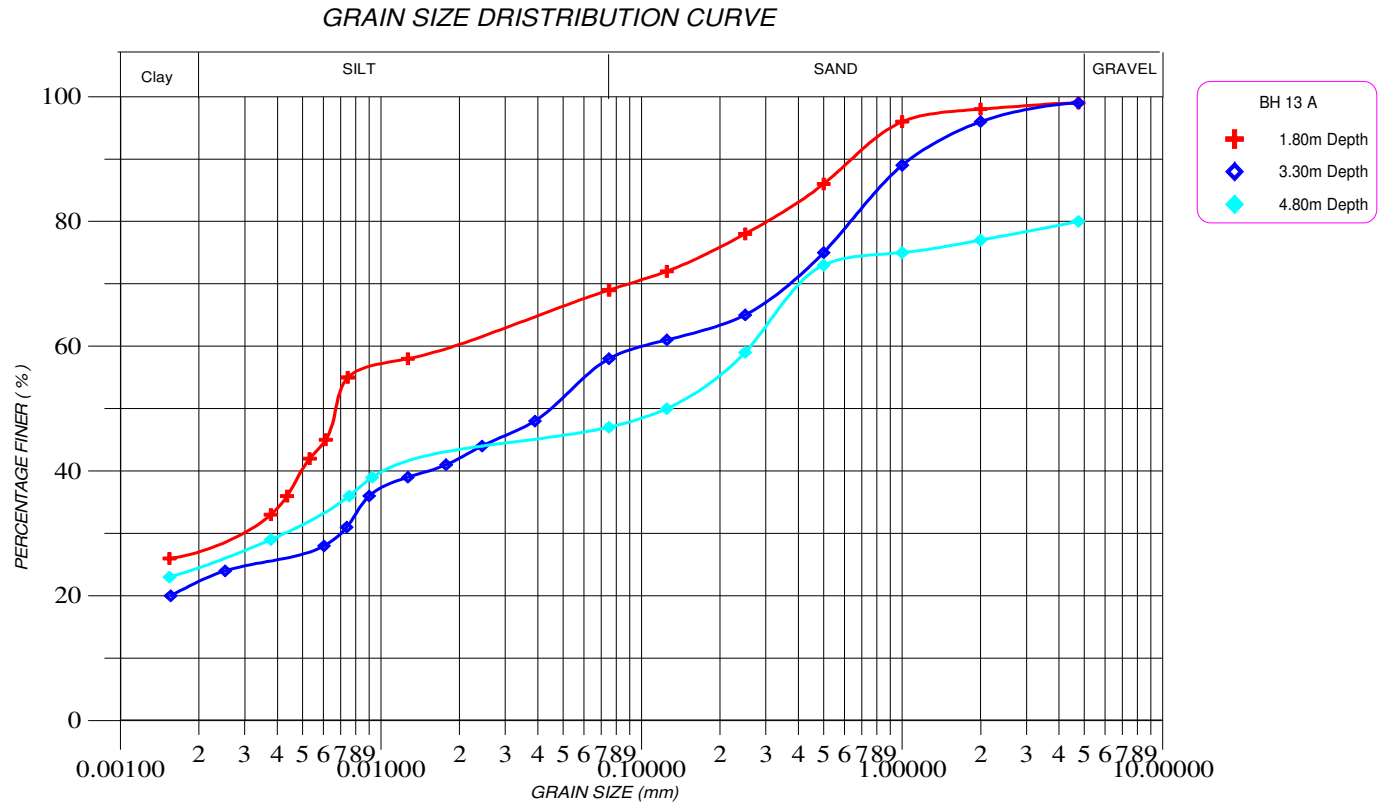

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 13 A
1.80m Depth
3.30m Depth
4.80m Depth

Fig : GSD-13A

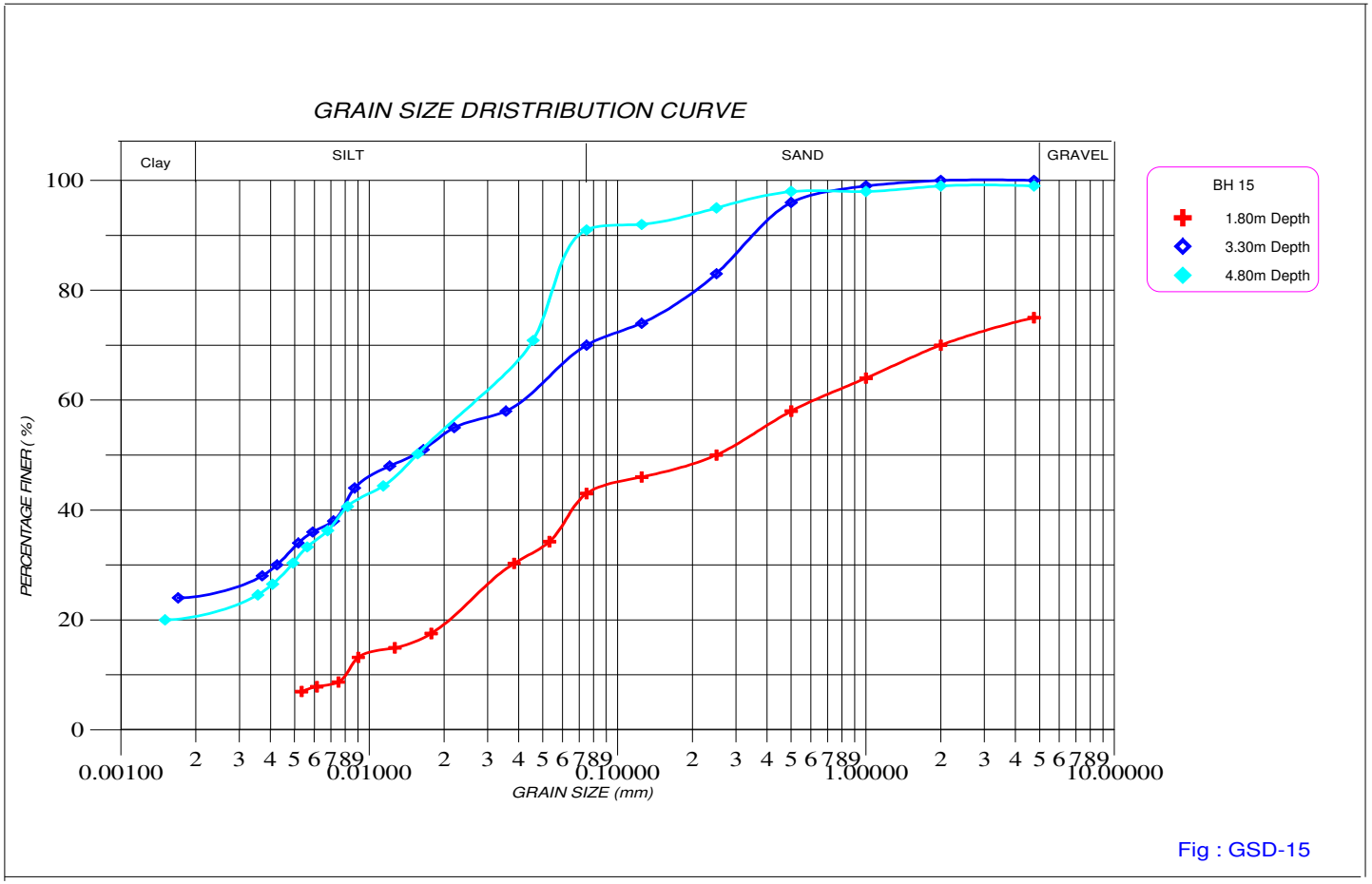

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 15
1.80m Depth
3.30m Depth
4.80m Depth

Fig : GSD-15

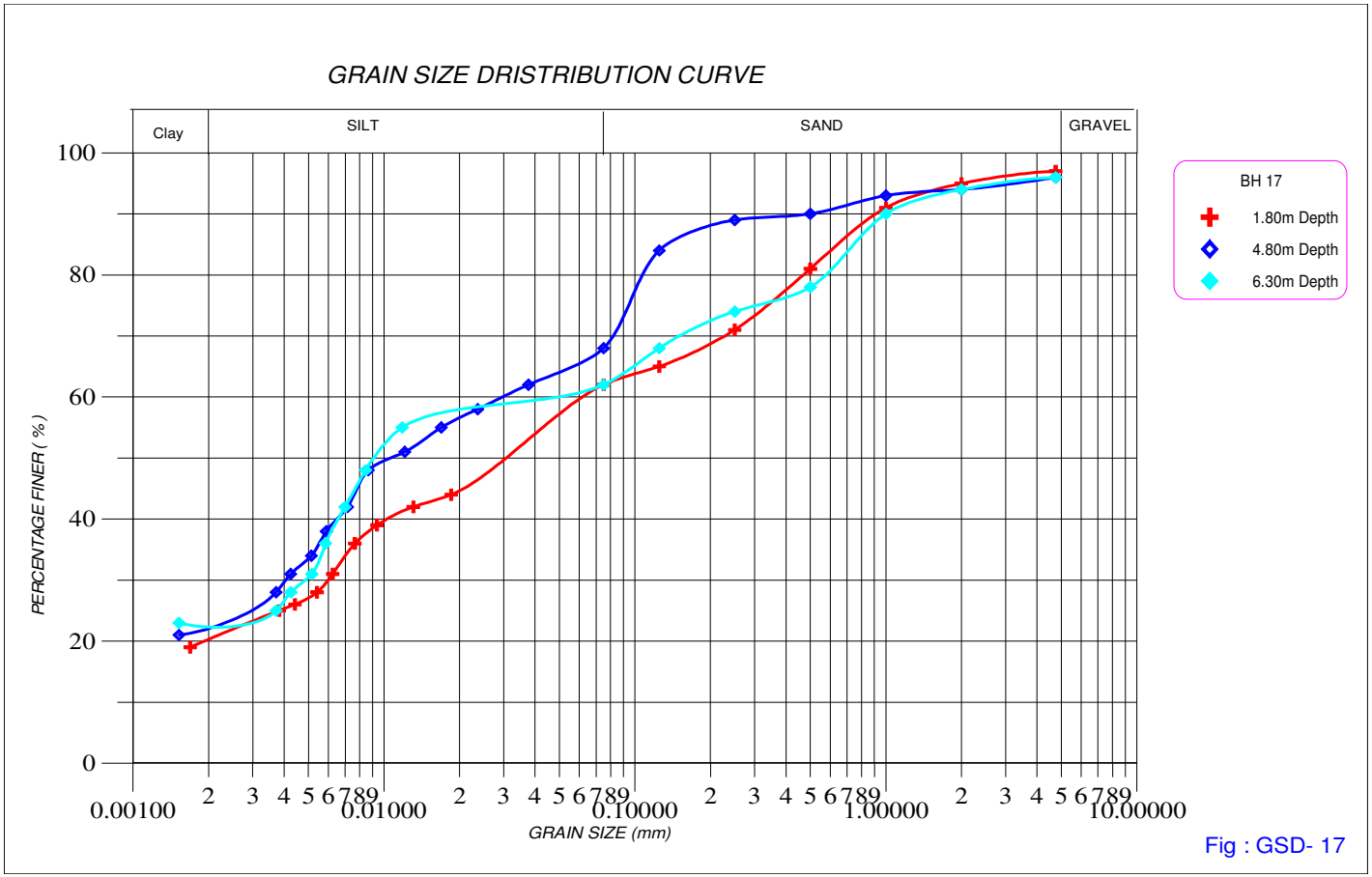

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 17
1.80m Depth
4.80m Depth
6.30m Depth

Fig : GSD- 17

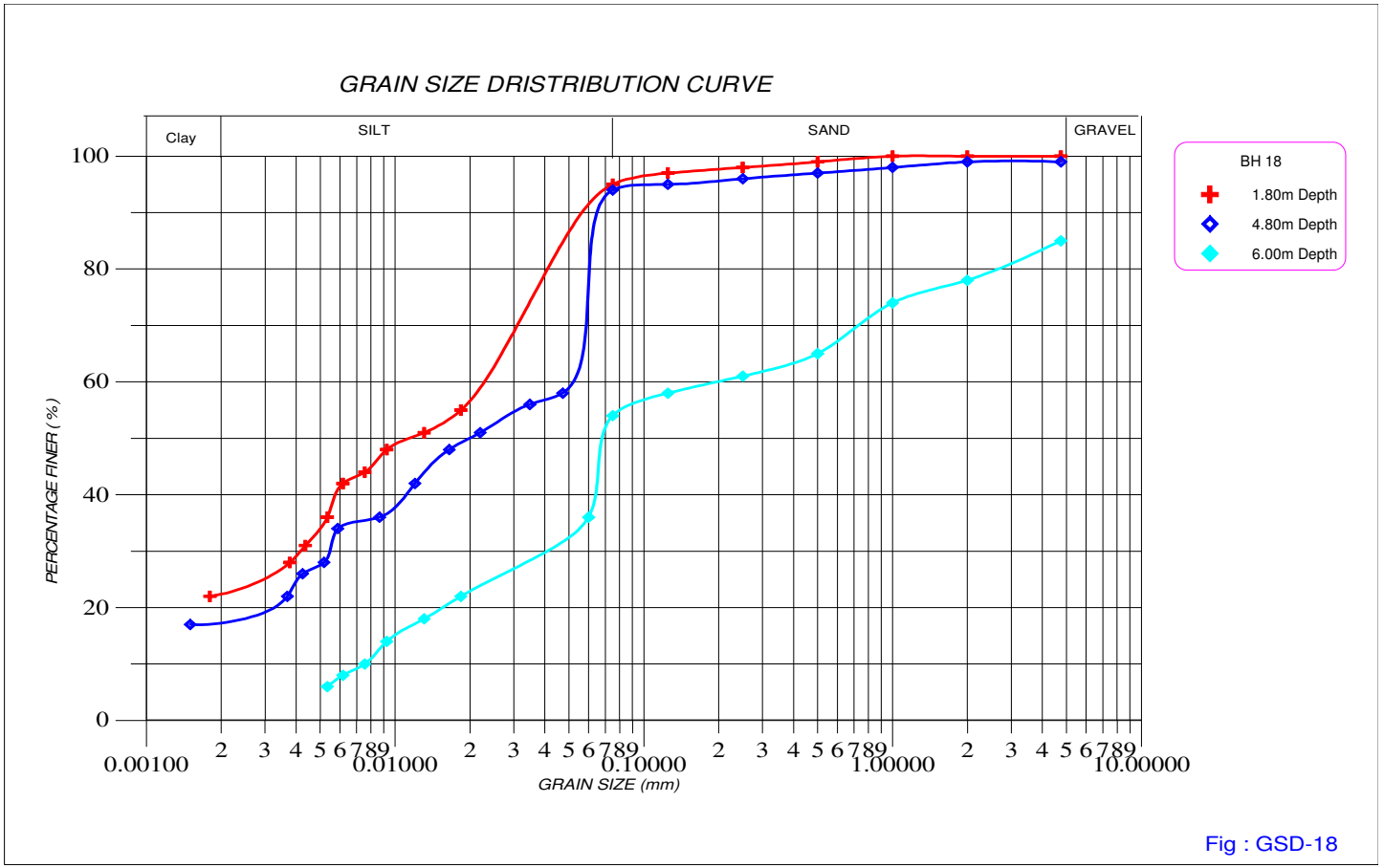

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 18
1.80m Depth
4.80m Depth
6.00m Depth

Fig : GSD-18

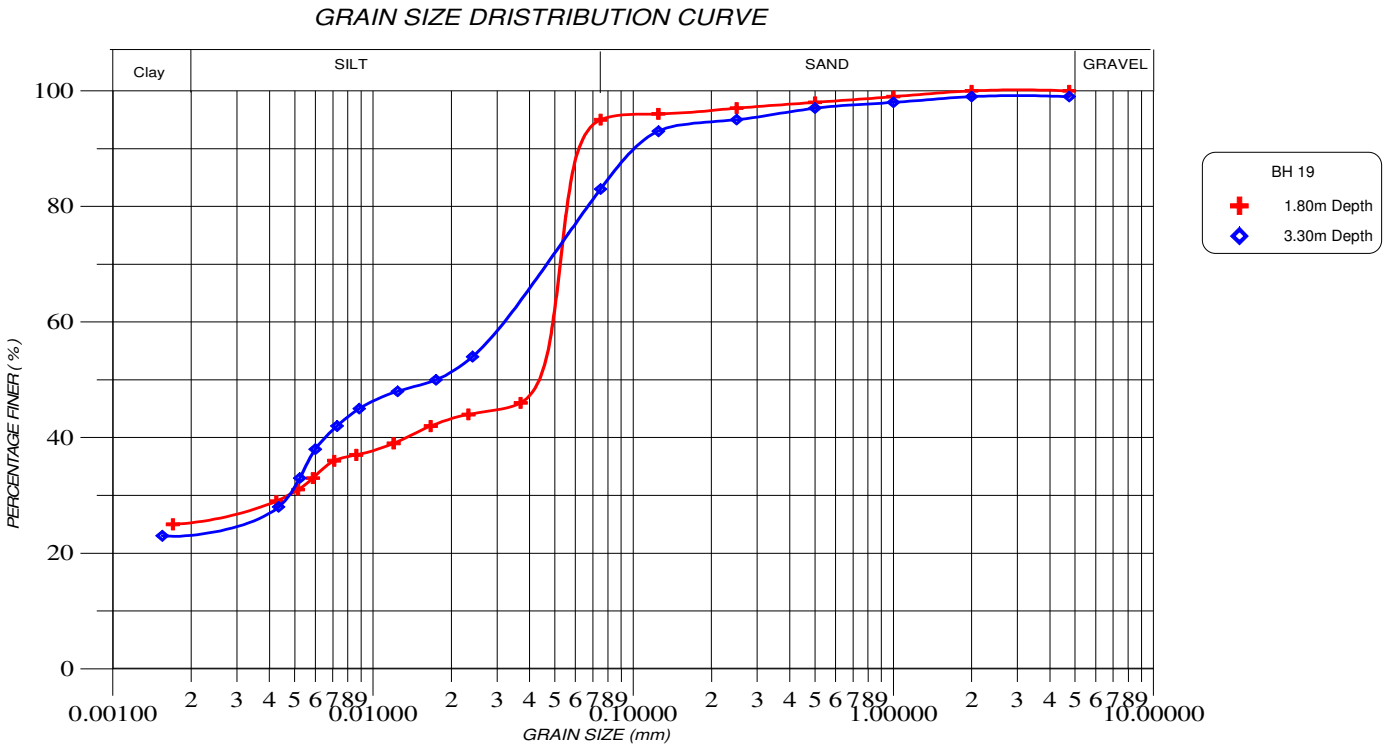

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 19
1.80m Depth
3.30m Depth

Fig : GSD-19

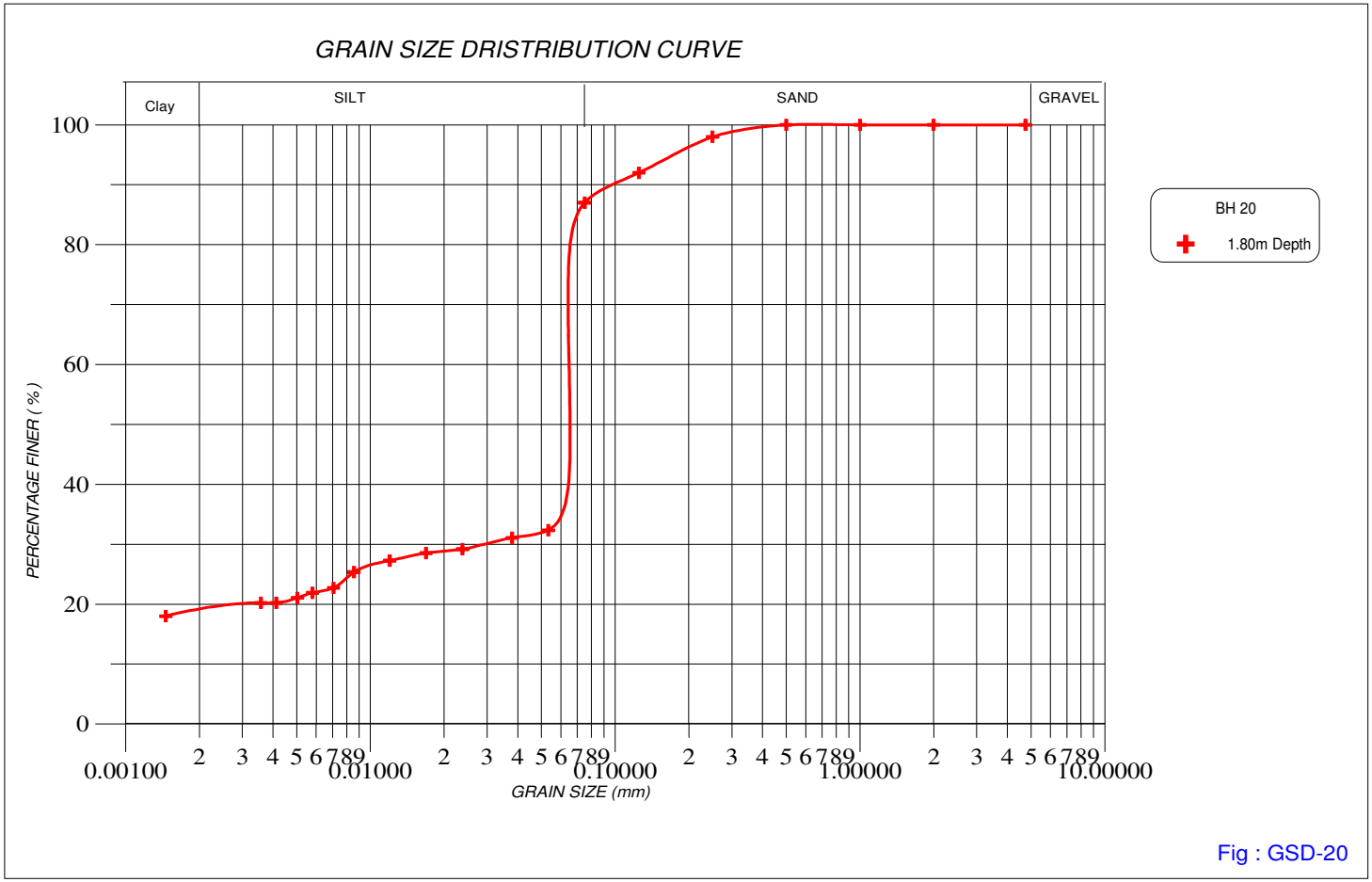

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 20
1.80m Depth

Fig : GSD-20

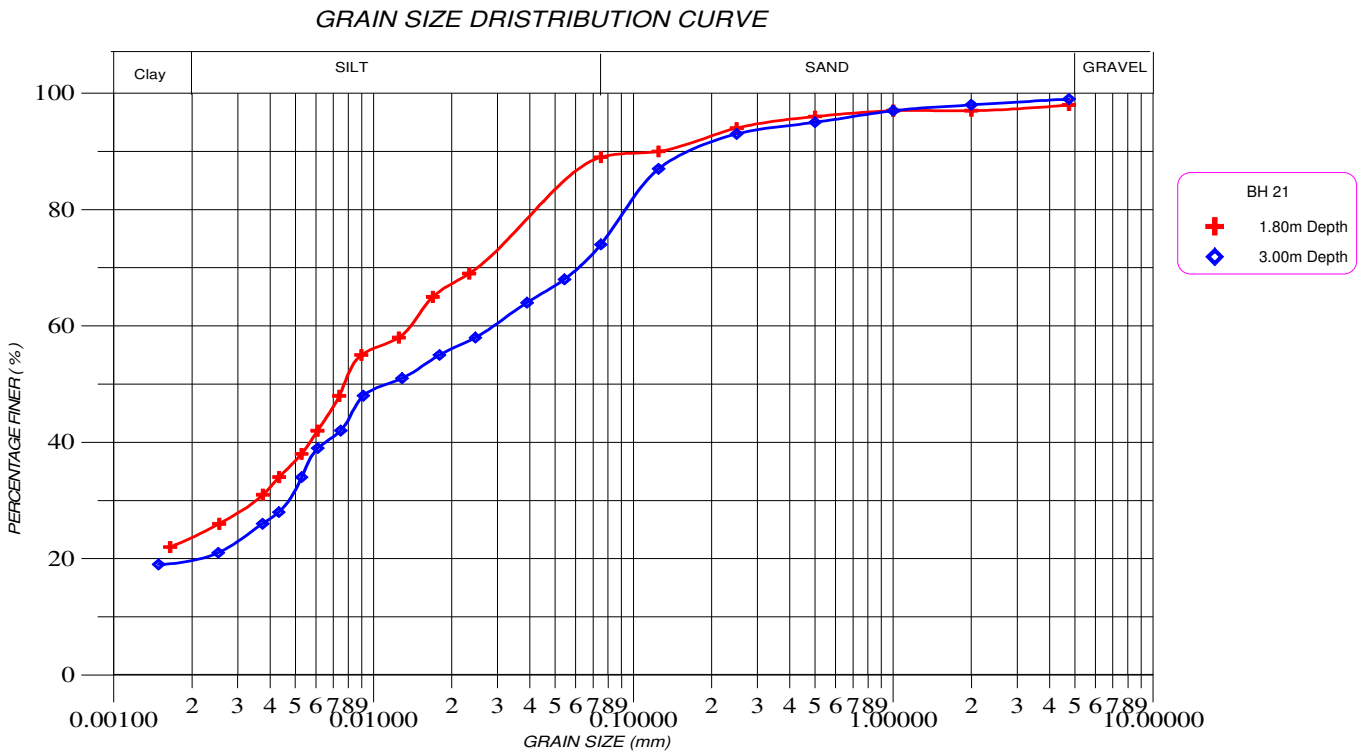

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 21
1.80m Depth
3.00m Depth

Fig : GSD-21

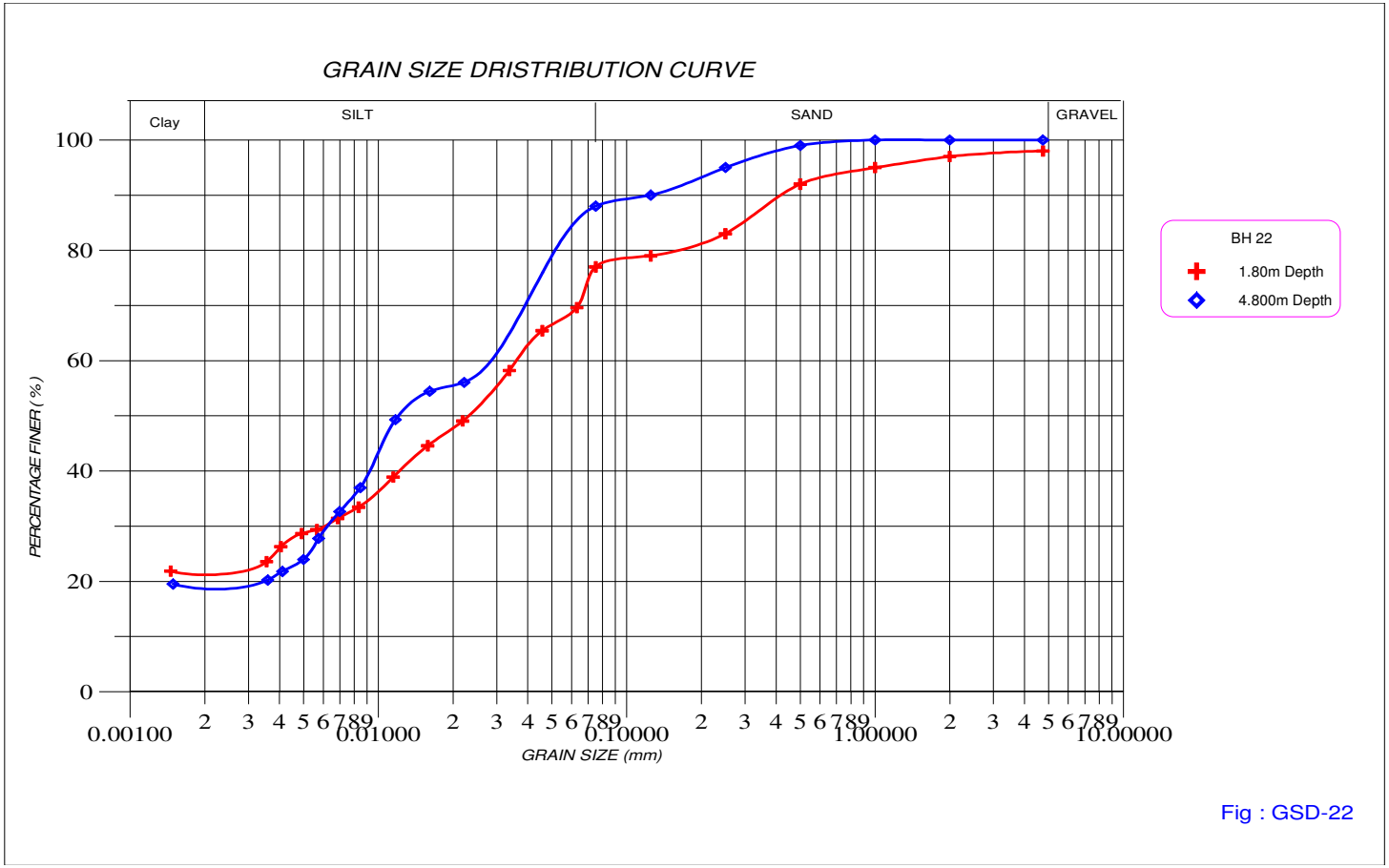

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 22
1.80m Depth
4.800m Depth

Fig : GSD-22

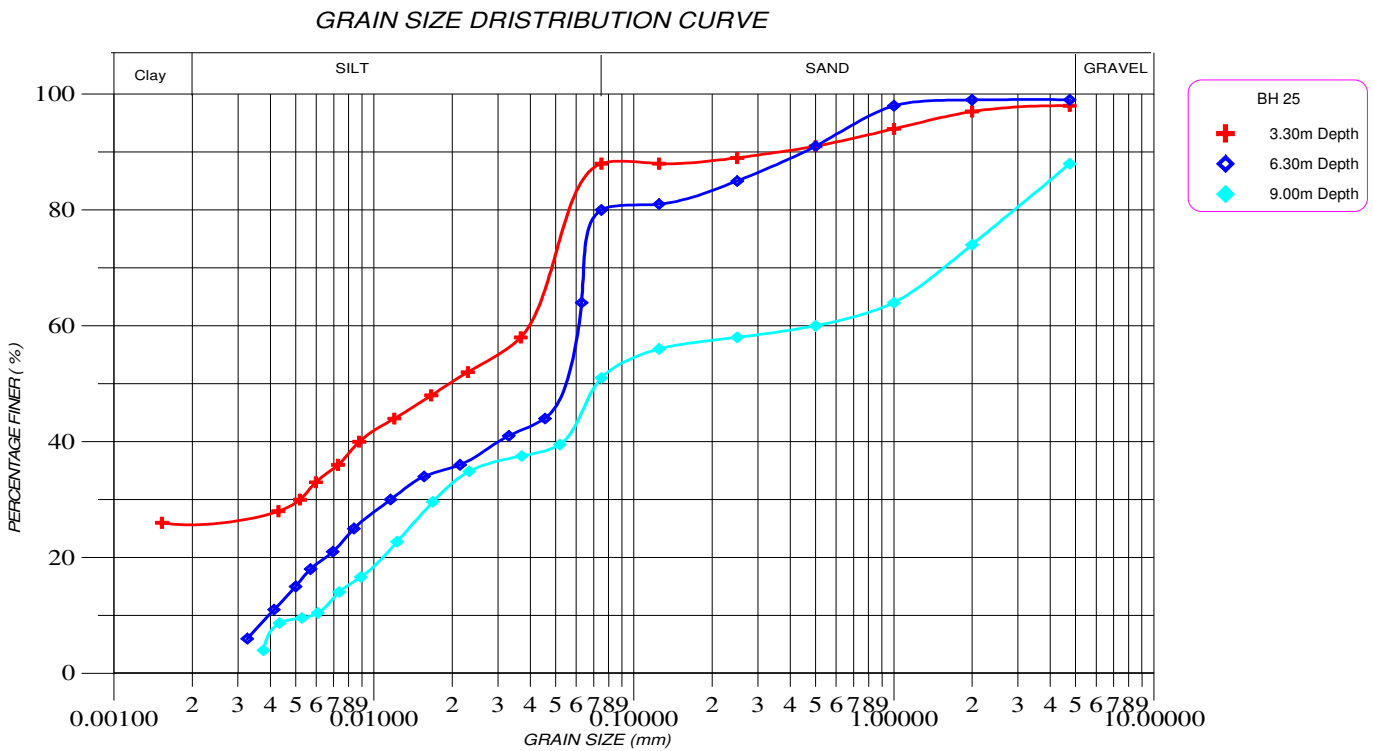

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 25
3.30m Depth
6.30m Depth
9.00m Depth

Fig : GSD 25

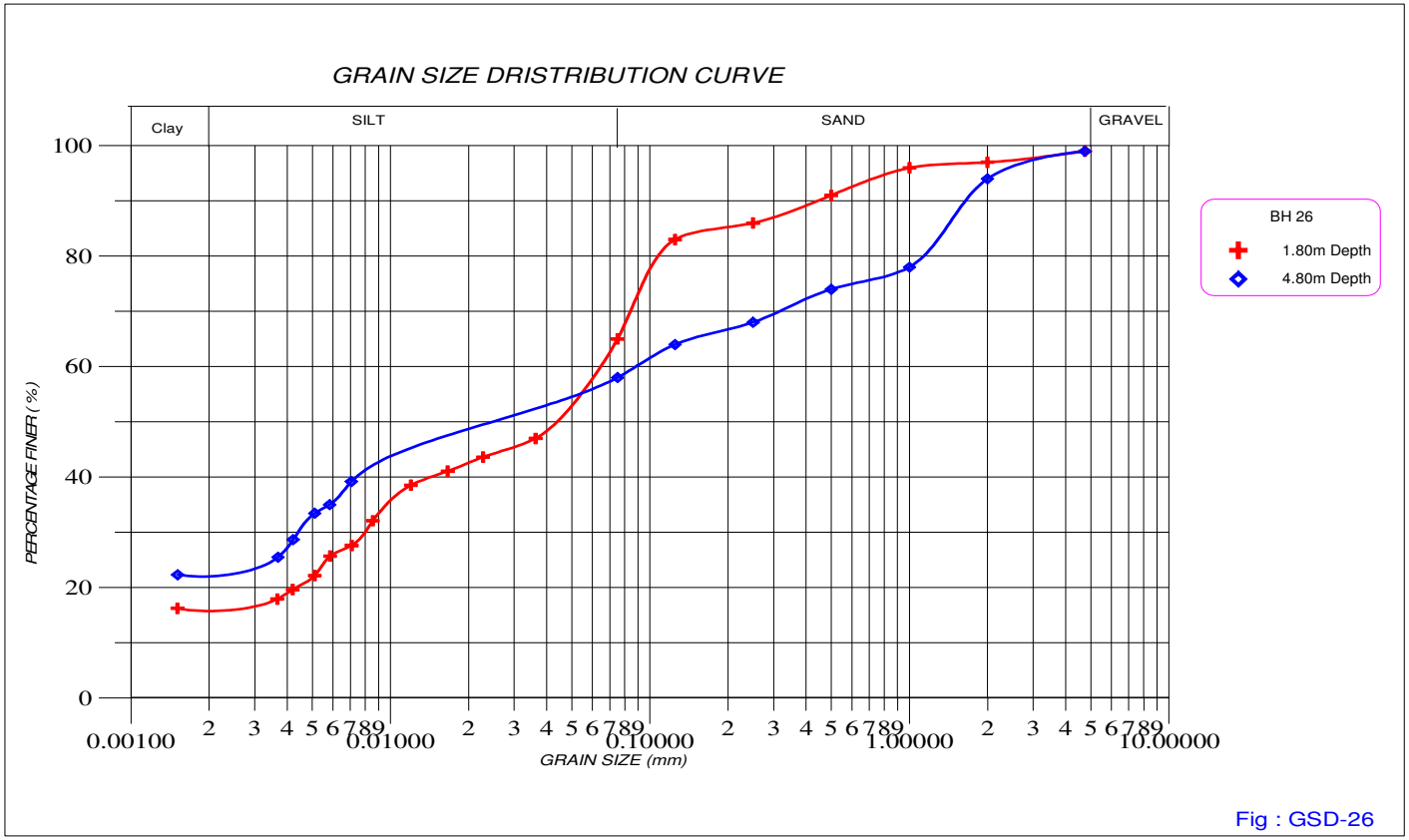

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 26
1.80m Depth
4.80m Depth

Fig : GSD-26

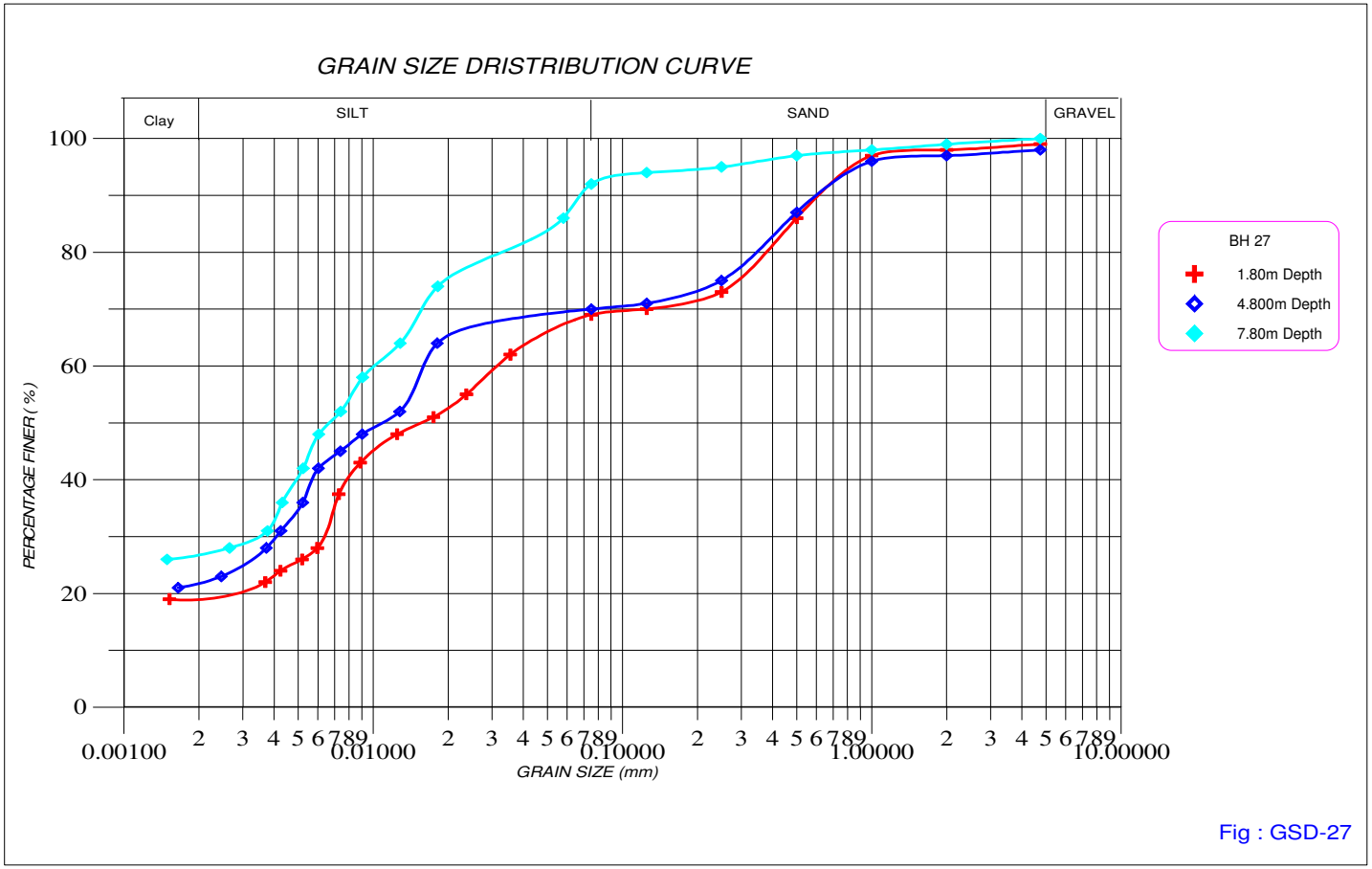

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 27
1.80m Depth
4.800m Depth
7.80m Depth

Fig : GSD-27

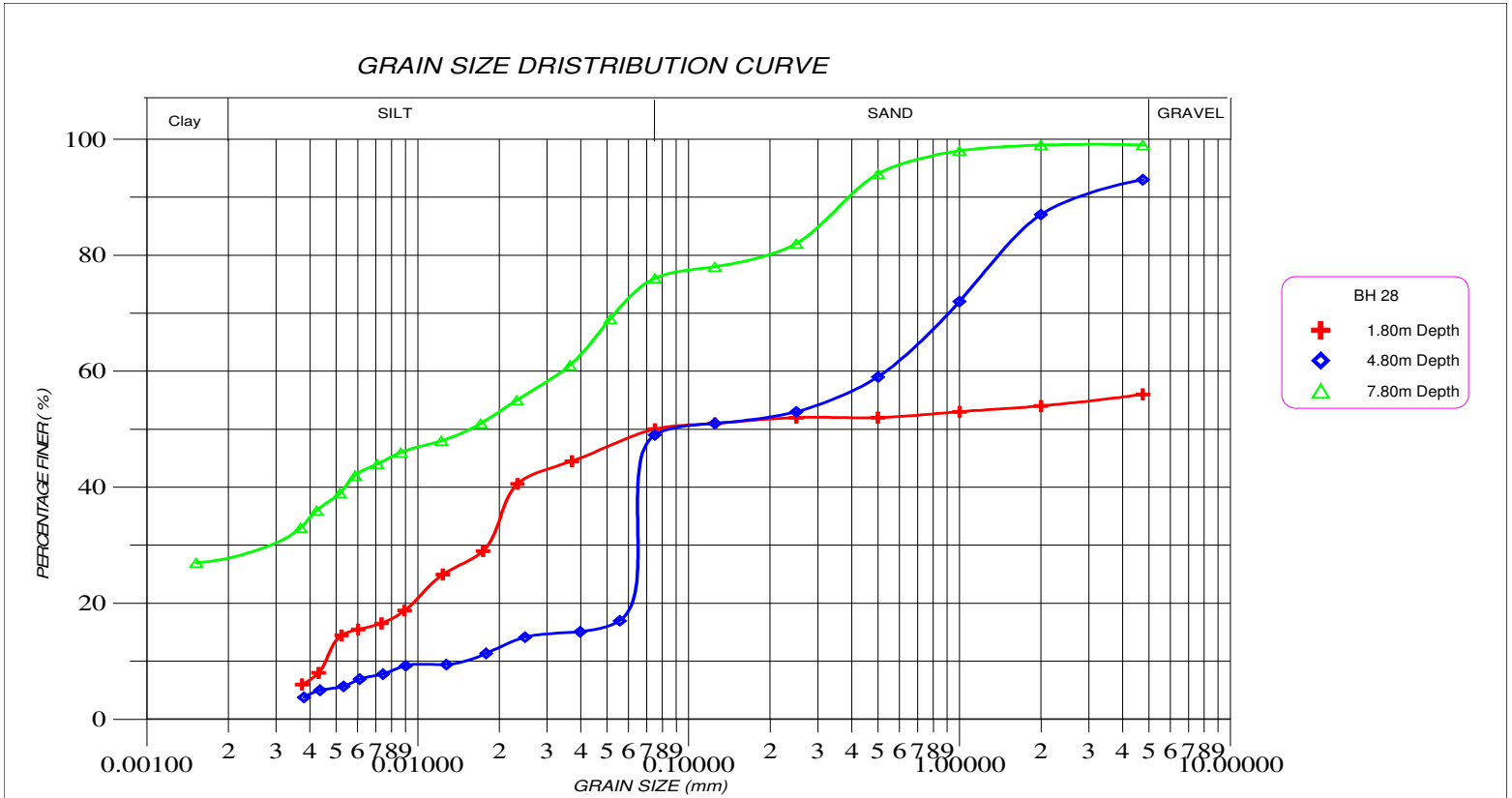

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 28
1.80m Depth
4.80m Depth
7.80m Depth

Fig : GSD- 28

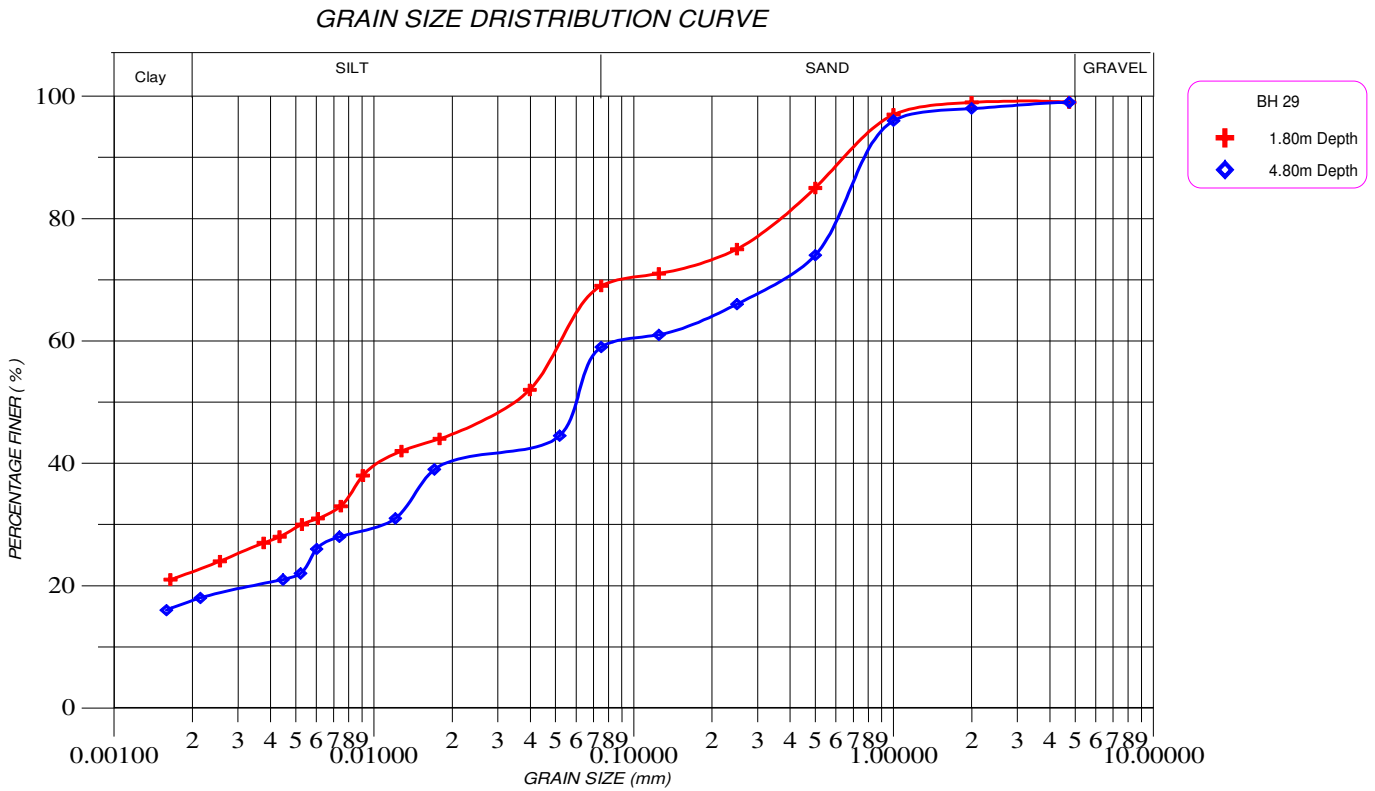

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 29
1.80m Depth
4.80m Depth

Fig : GSD-29

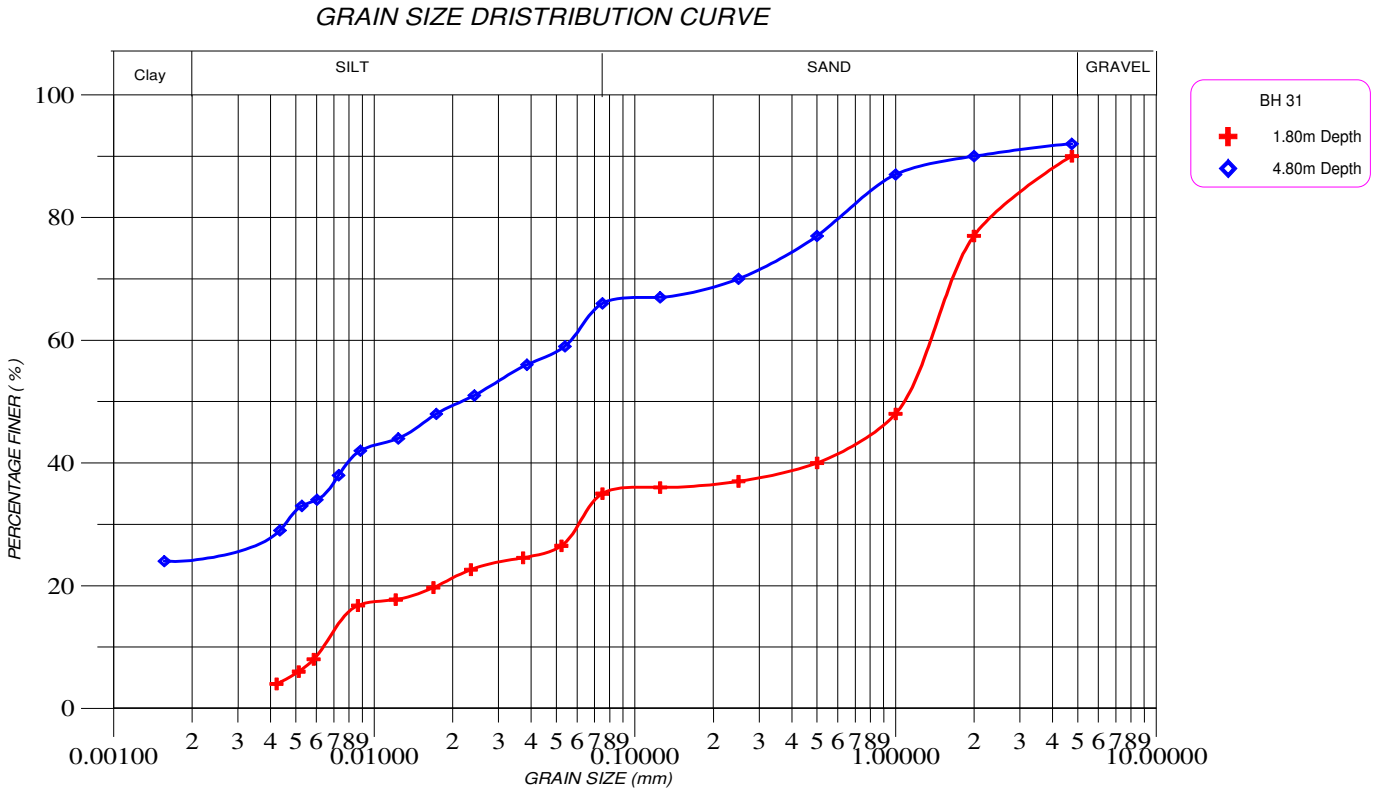

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 31
1.80m Depth
4.80m Depth

Fig : GSD-31

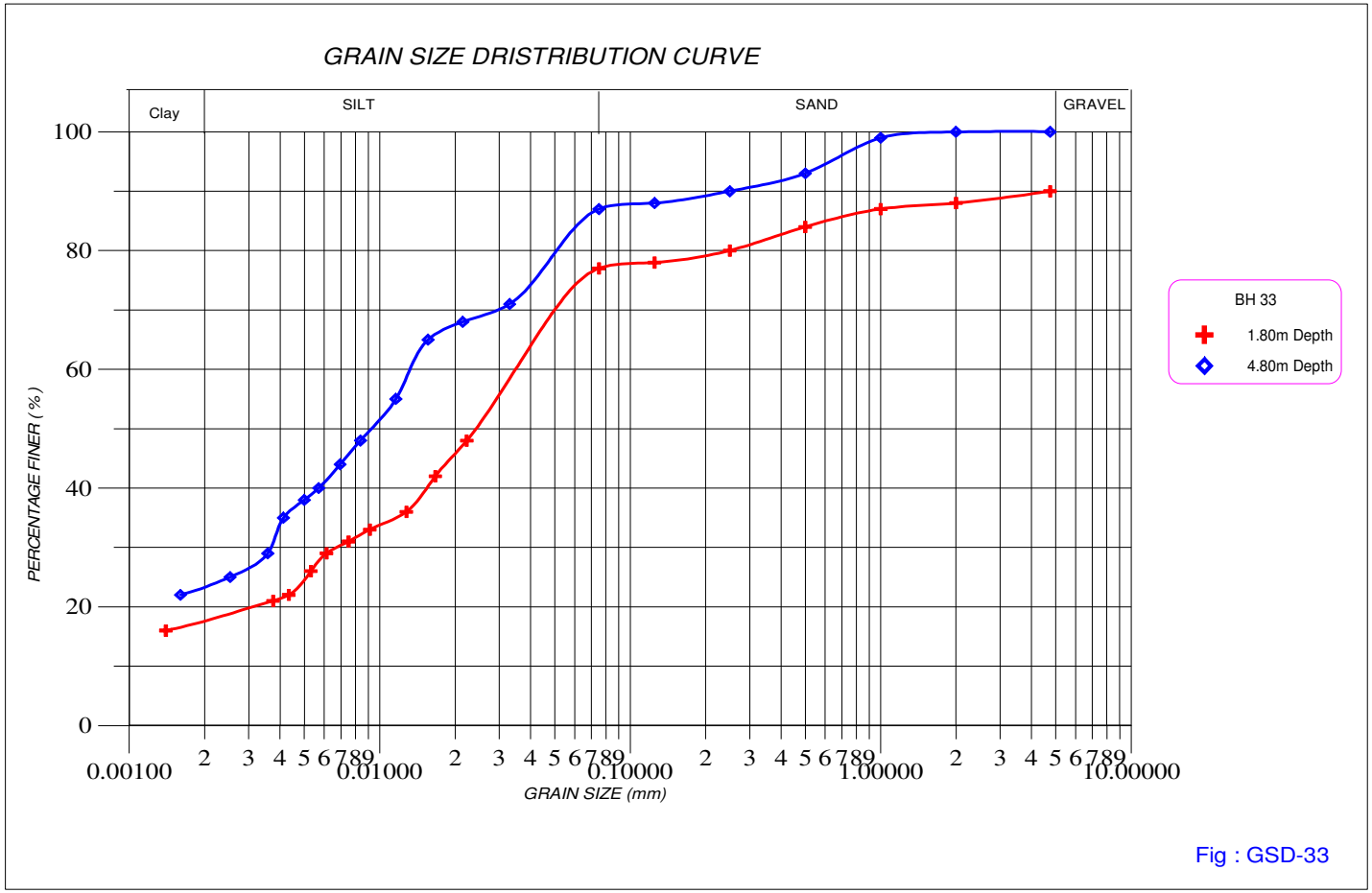

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
100
80
60
40
20
0
PERCENTAGE FINER (%)
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)
BH 33
1.80m Depth
4.80m Depth

Fig : GSD-33

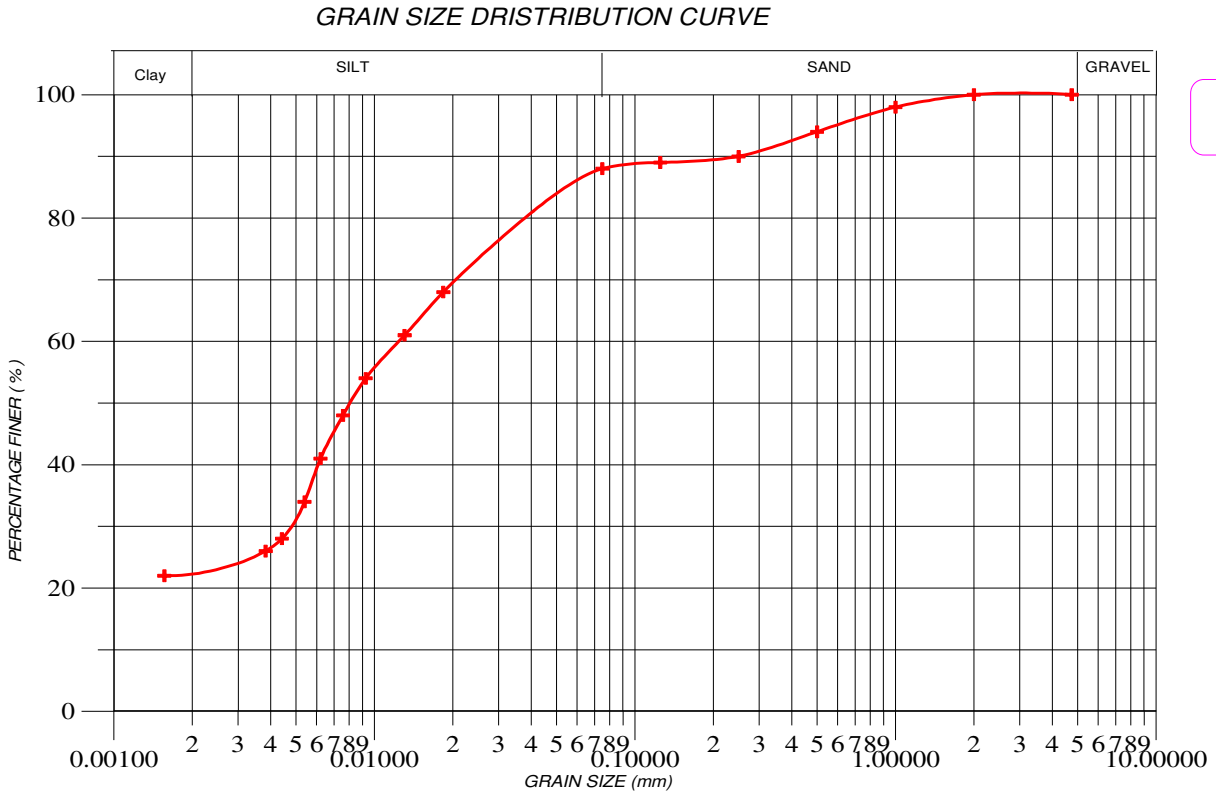

GRAIN SIZE DRISTRIBUTION CURVE
Clay
SILT
SAND
GRAVEL
BH 35
1.80m Depth
PERCENTAGE FINER (%)
100
80
60
40
20
0
0.00100
0.01000
0.10000
1.00000
10.00000
GRAIN SIZE (mm)

Fig : GSD-35

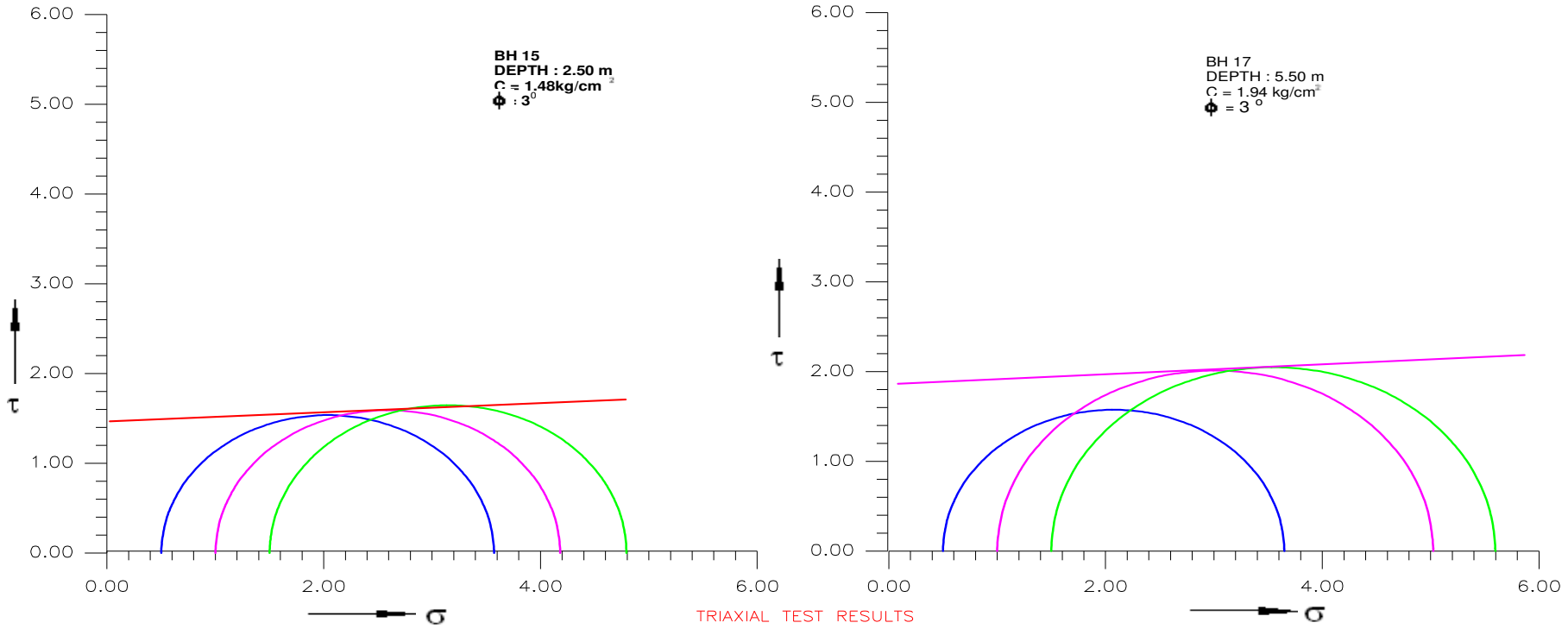

BH 15
DEPTH : 2.50 m
C = 1.48kg/cm²
ϕ : 3°
BH 17
DEPTH : 5.50 m
C = 1.94 kg/cm²
ϕ = 3 °
τ
σ
0.00
1.00
2.00
3.00
4.00
5.00
6.00
TRIAXIAL TEST RESULTS

Figure : T16

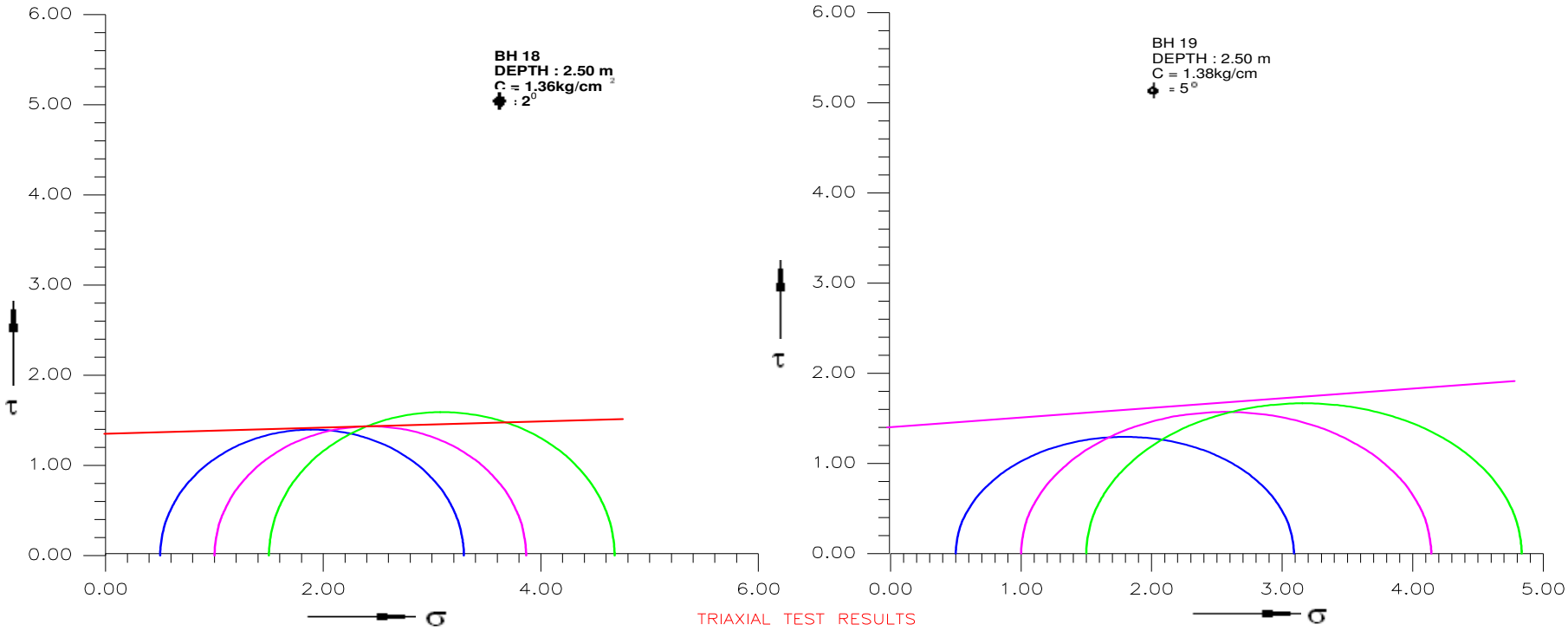

BH 18
DEPTH : 2.50 m
C = 1.36kg/cm²
φ : 2°
BH 19
DEPTH : 2.50 m
C = 1.38kg/cm
φ = 5°
τ
σ
0.00
1.00
2.00
3.00
4.00
5.00
6.00
TRIAXIAL TEST RESULTS

Figure : T18

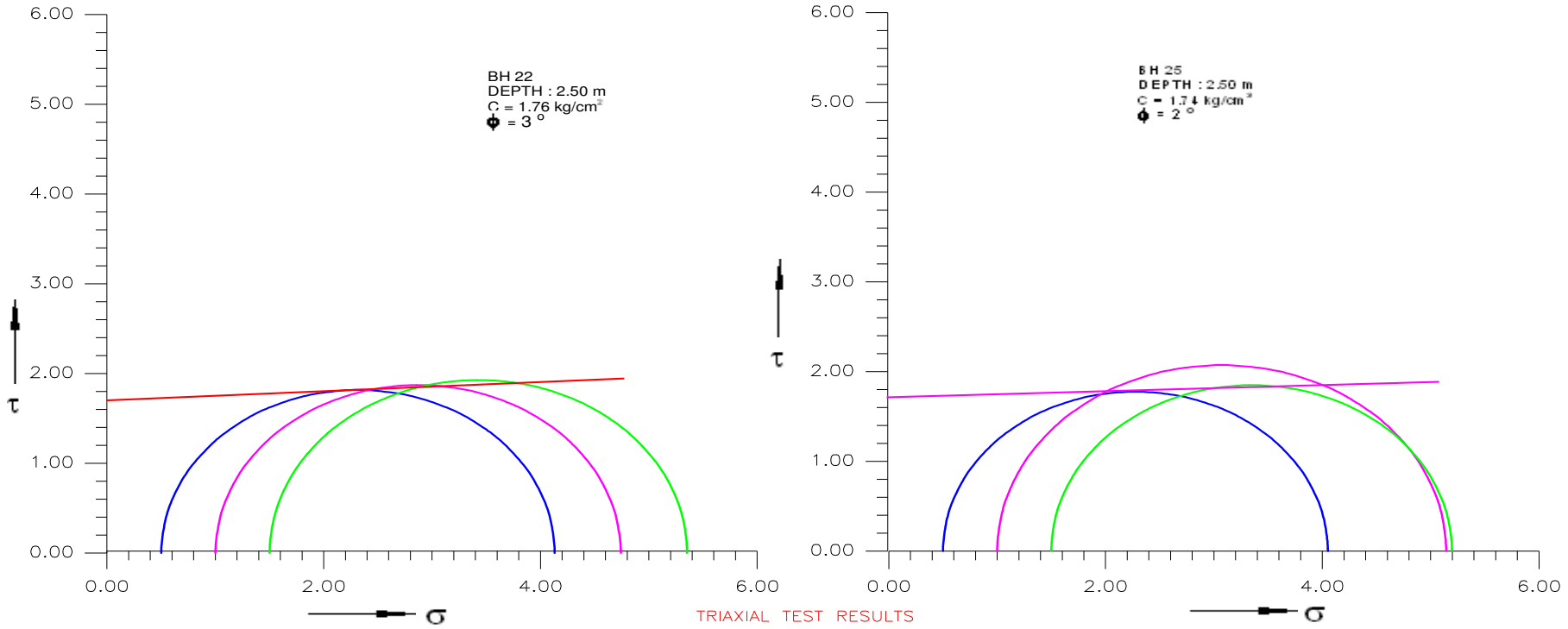

BH 22
DEPTH : 2.50 m
C = 1.76 kg/cm²
Φ = 3 °
BH 25
DEPTH : 2.50 m
C = 1.74 kg/cm²
Φ = 2 °
τ
σ
0.00
1.00
2.00
3.00
4.00
5.00
6.00
TRIAXIAL TEST RESULTS

Figure : T22

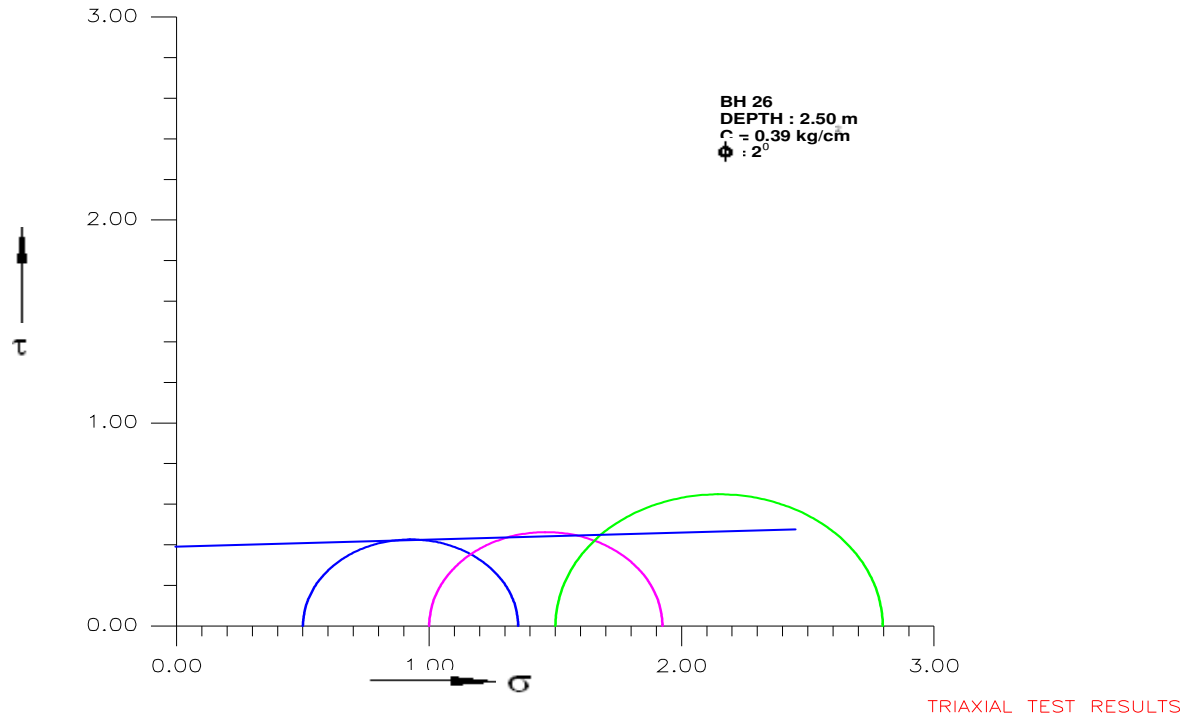
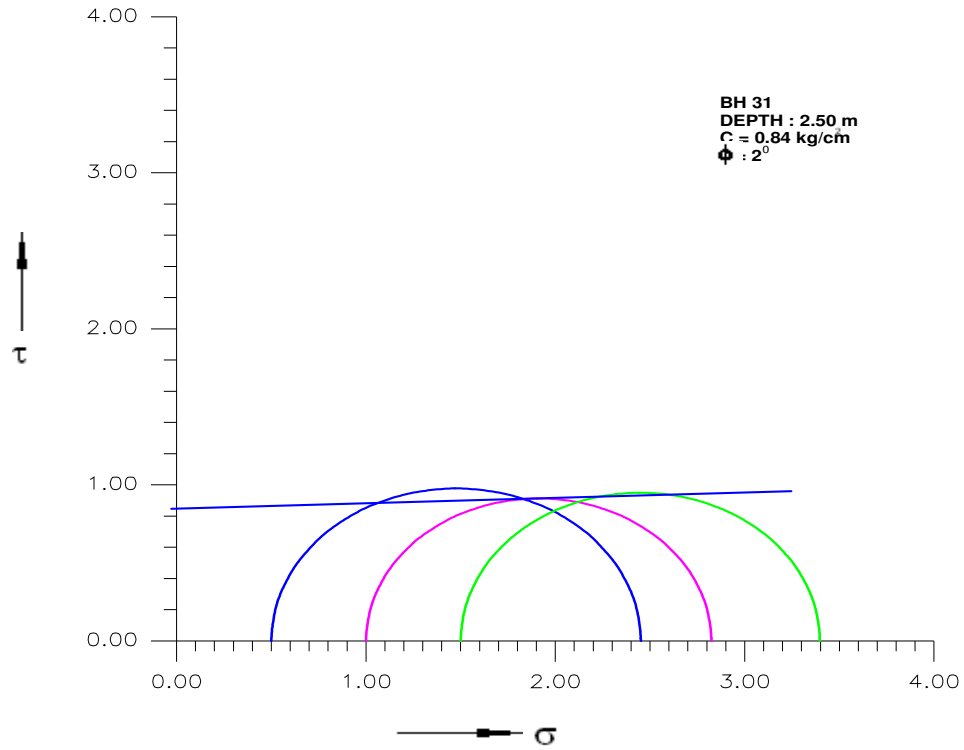

3.00
2.00
1.00
0.00
τ
BH 26
DEPTH : 2.50 m
C = 0.39 kg/cm
ϕ : 2°
0.00
1.00
2.00
3.00
σ
TRIAXIAL TEST RESULTS

Figure : T26



TRIAXIAL TEST RESULTS

Figure : T31

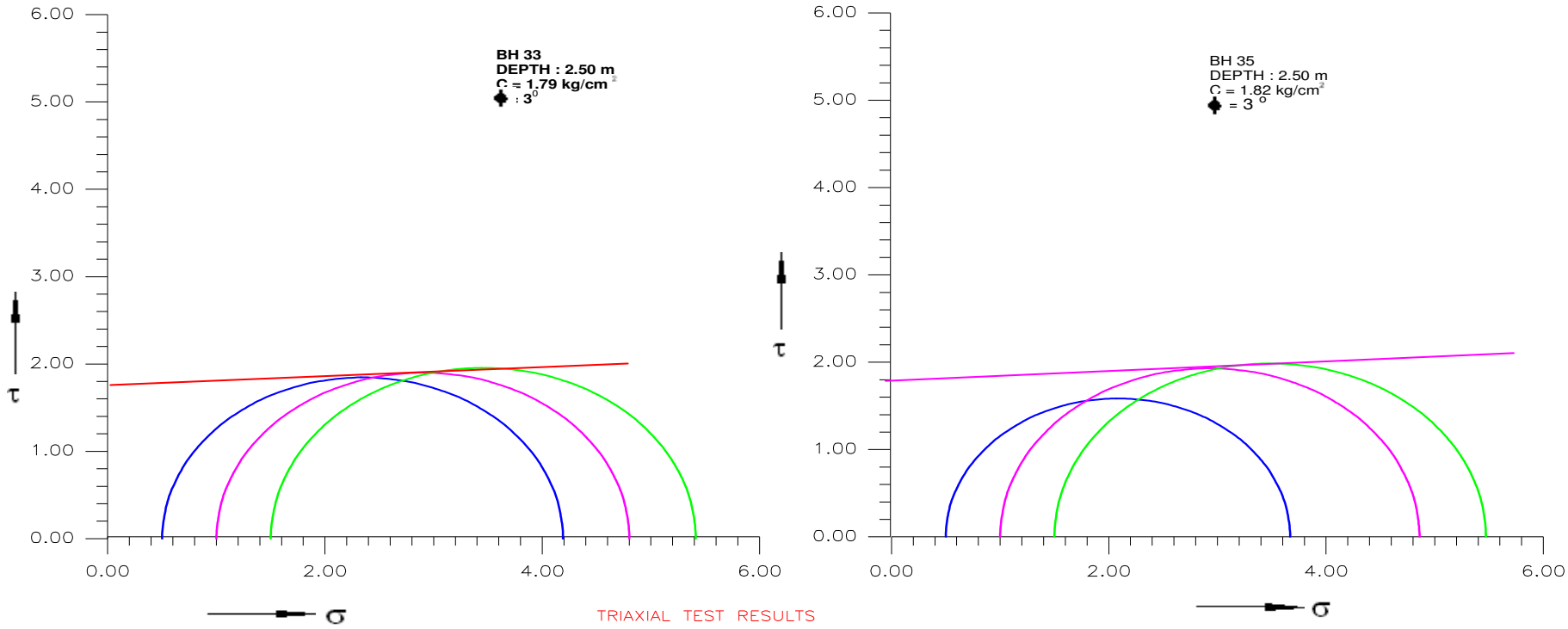

BH 33
DEPTH : 2.50 m
C = 1.79 kg/cm²
φ : 3°
BH 35
DEPTH : 2.50 m
C = 1.82 kg/cm²
φ = 3 °
τ
σ
0.00
1.00
2.00
3.00
4.00
5.00
6.00
TRIAXIAL TEST RESULTS

Figure : T35

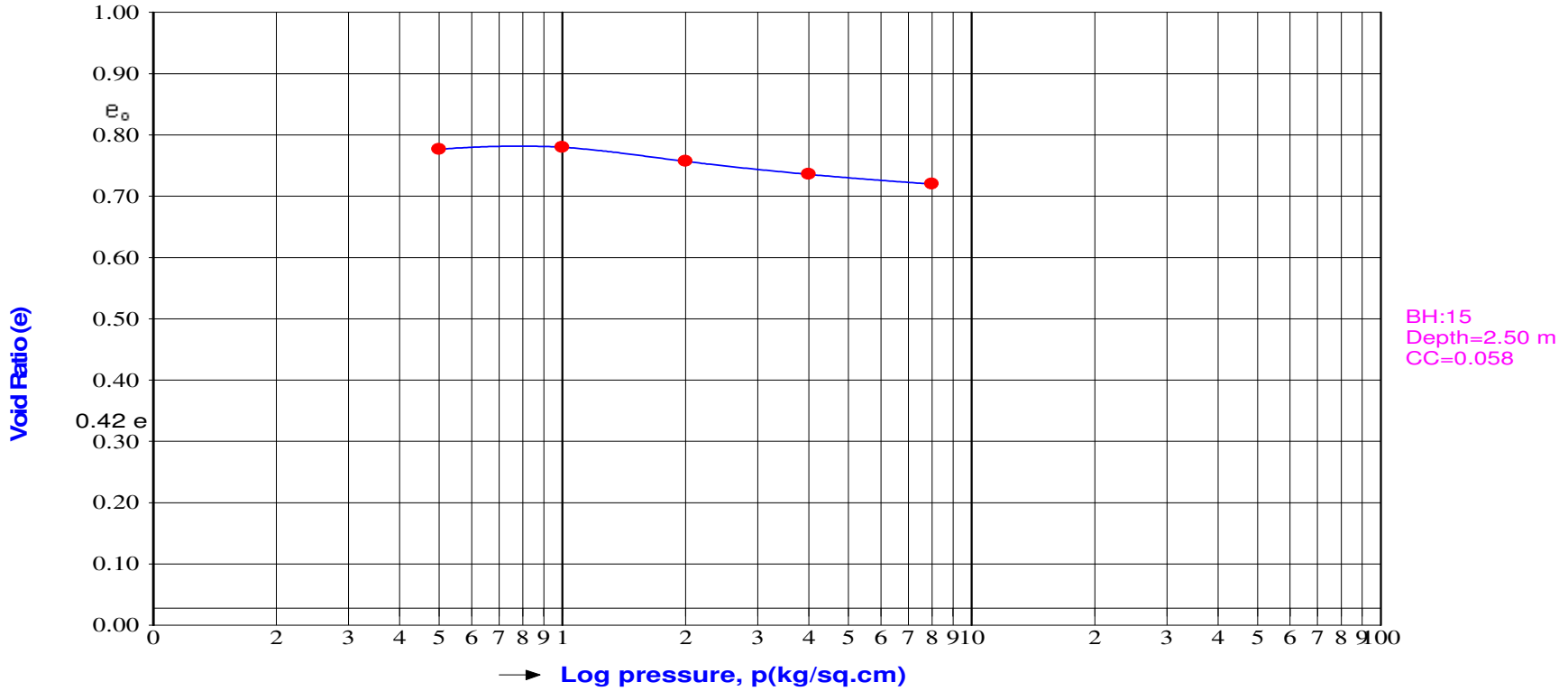

1.00
0.90
e₀
0.80
0.70
0.60
0.50
0.40
0.42 e
0.30
0.20
0.10
0.00
Void Ratio (e)
0 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 100
Log pressure, p(kg/sq.cm)
BH:15
Depth=2.50 m
CC=0.058

Fig:C- 15

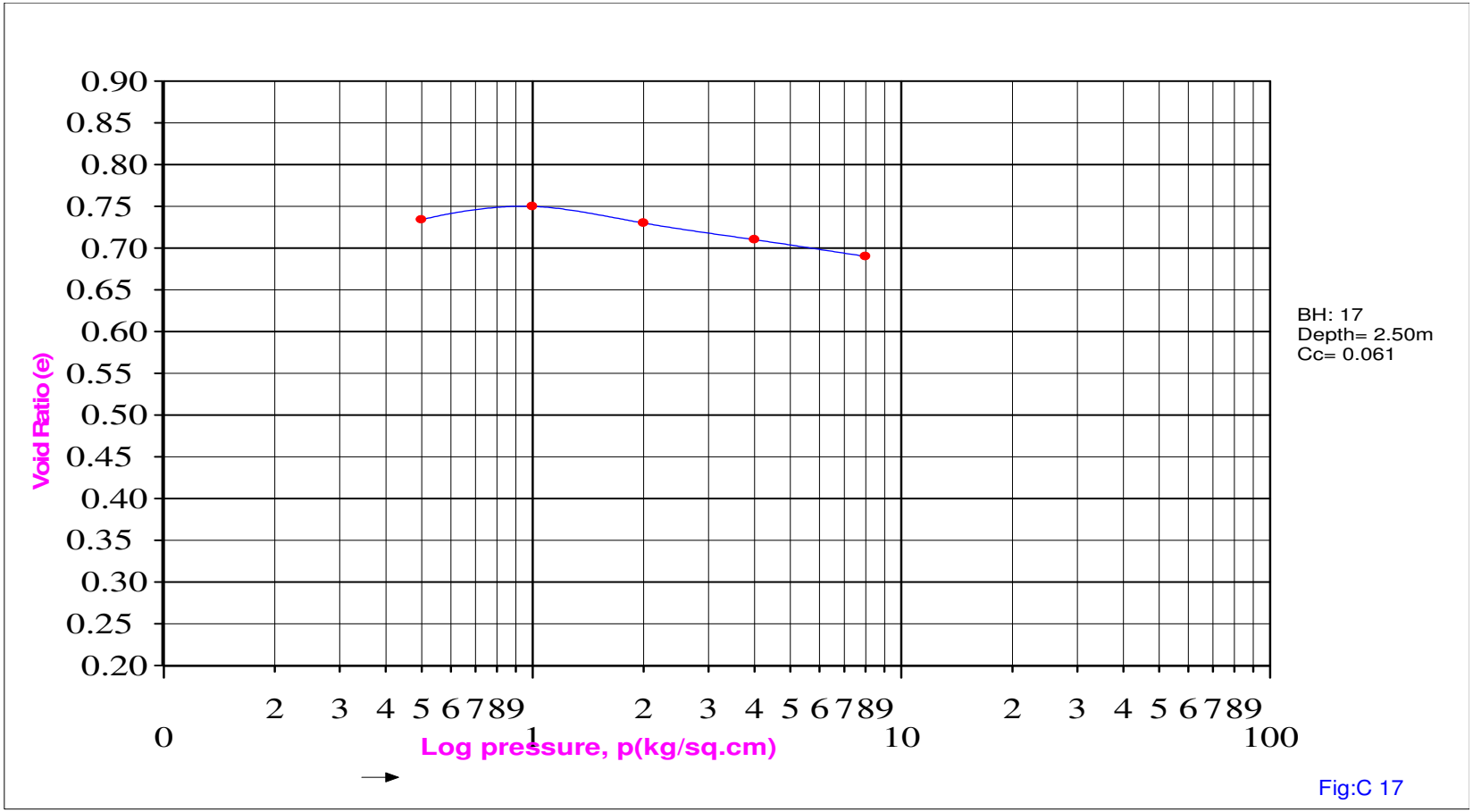

0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
Void Ratio (e)
0
2 3 4 5 6 7 8 9
1
2 3 4 5 6 7 8 9
10
2 3 4 5 6 7 8 9
100
Log pressure, p(kg/sq.cm)
BH: 17
Depth= 2.50m
Cc= 0.061

Fig:C 17

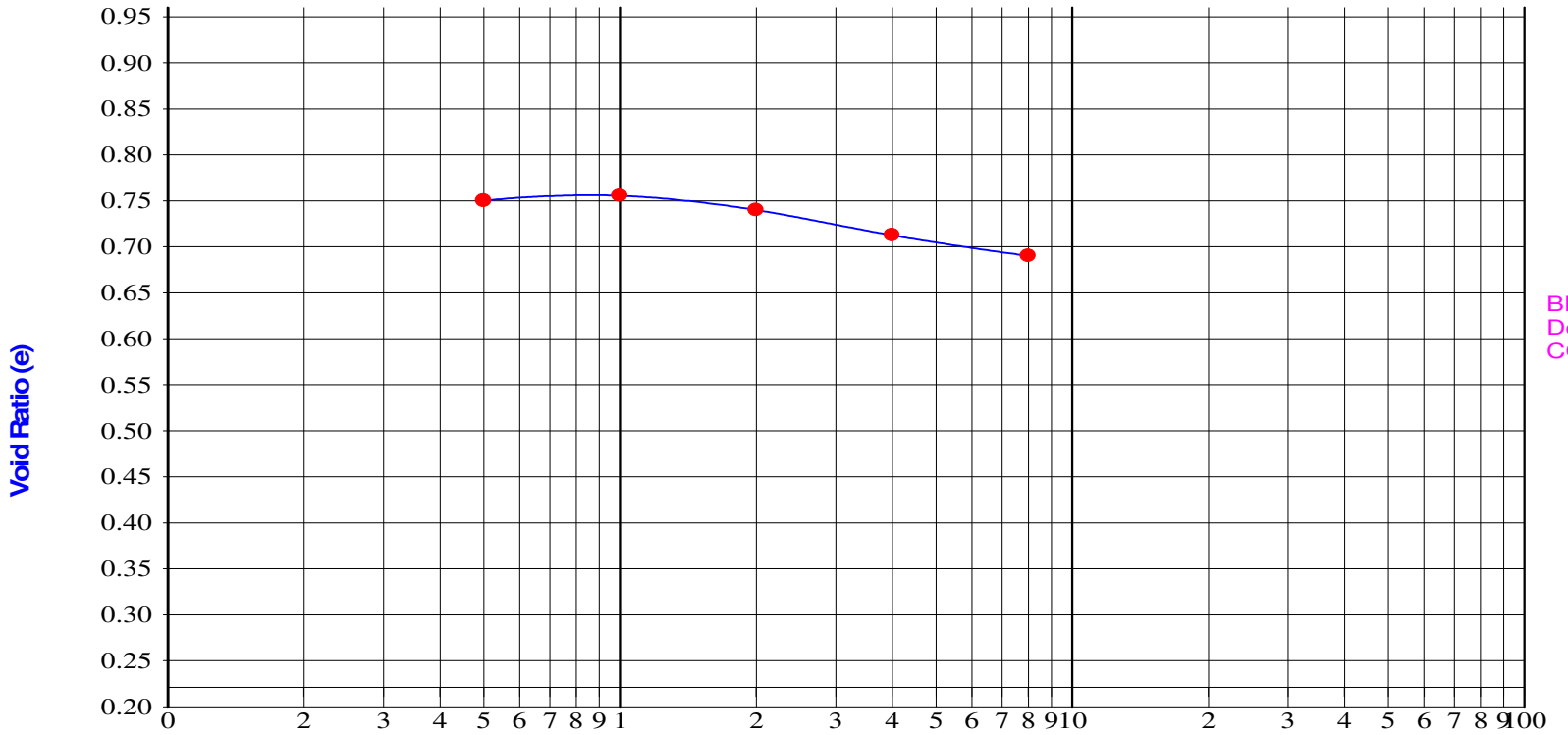

Void Ratio (e)
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 100
Log pressure, p(kg/sq.cm)
BH: 18
Depth=2.50 m
CC=0.057

Fig:C-18

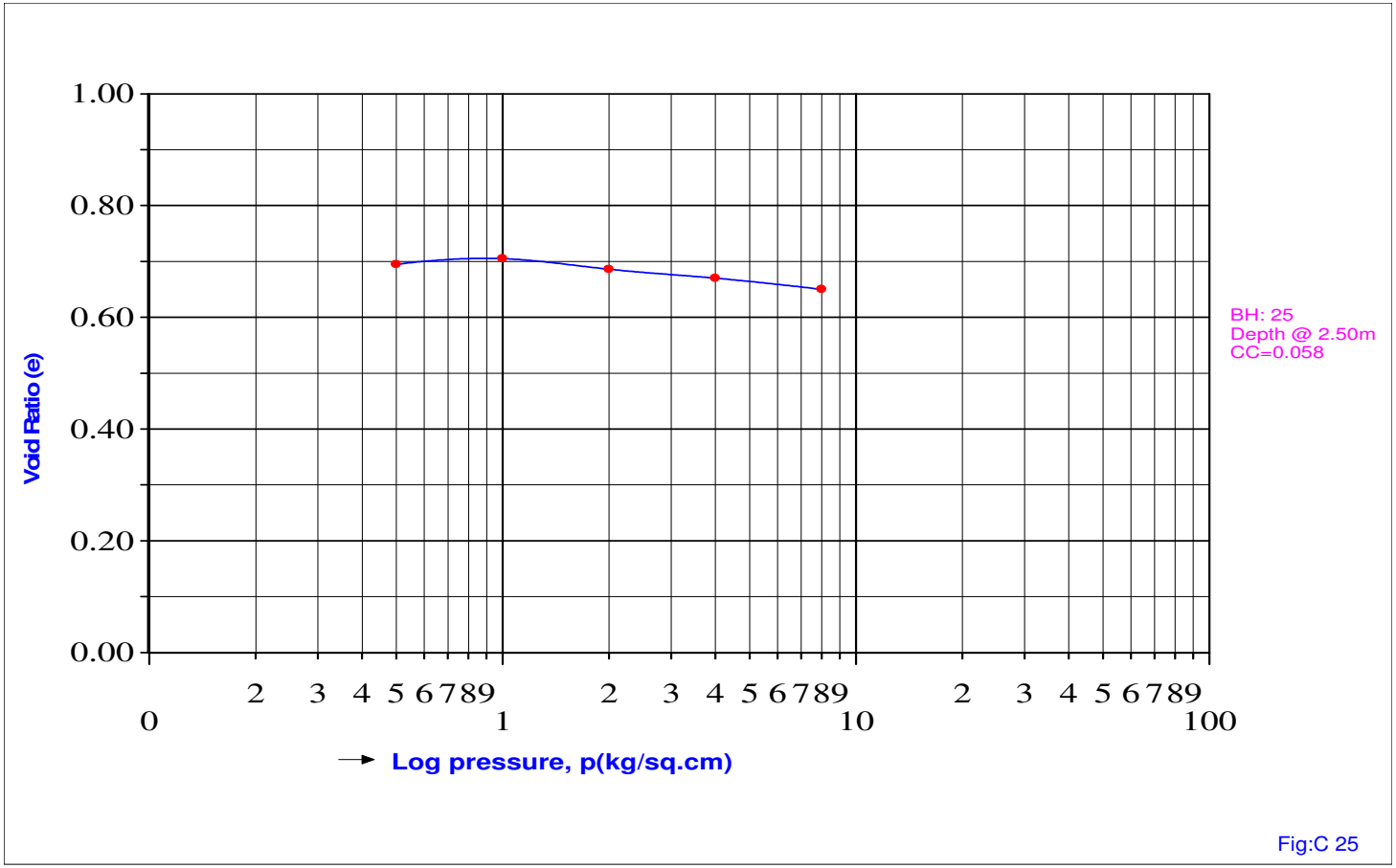

1.00
0.80
0.60
0.40
0.20
0.00
Void Ratio (e)
0
2 3 4 5 6 7 8 9
1
2 3 4 5 6 7 8 9
10
2 3 4 5 6 7 8 9
100
Log pressure, p(kg/sq.cm)
BH: 25
Depth @ 2.50m
CC=0.058

Fig:C 25

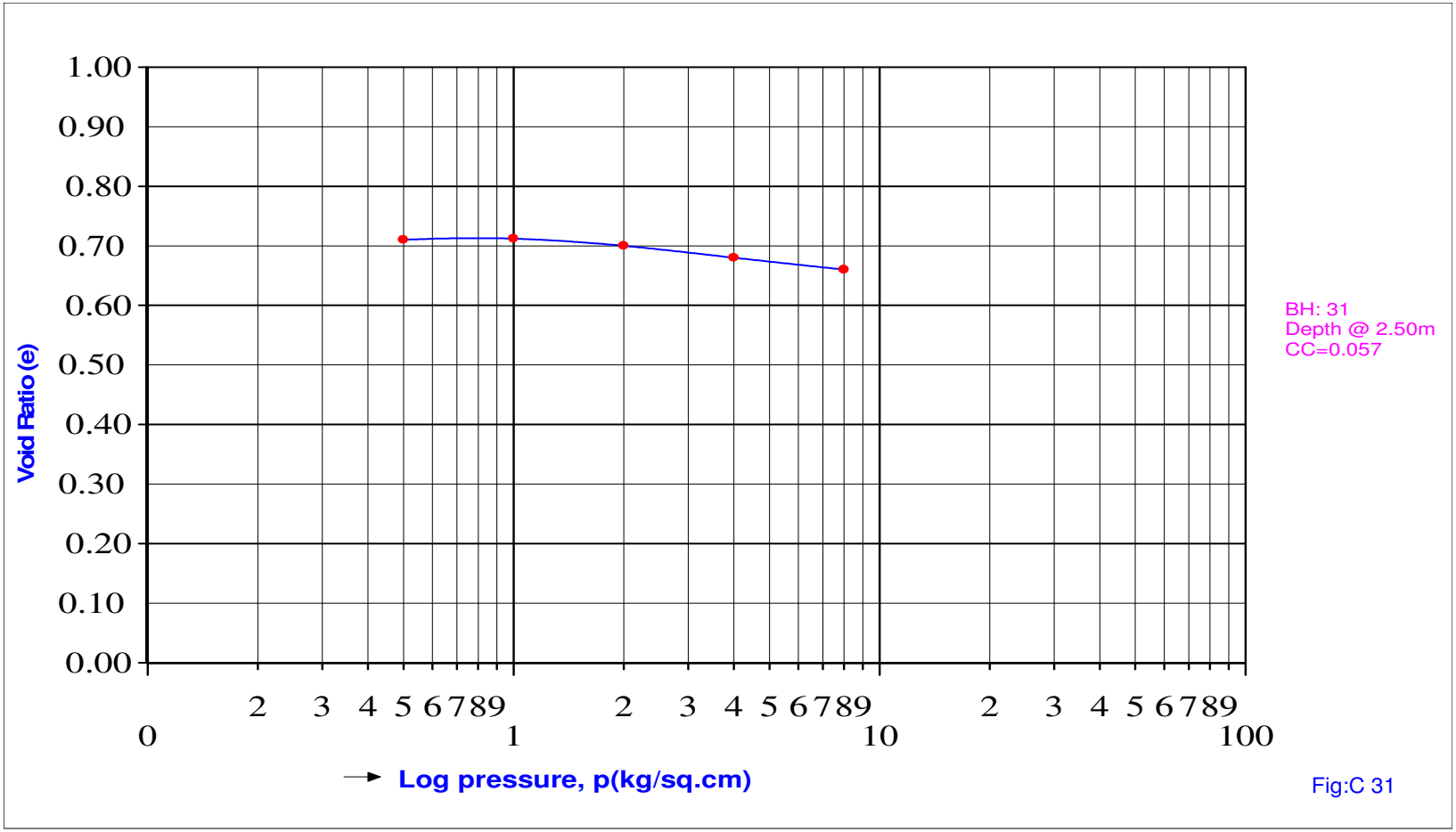

1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Void Ratio (e)
0
2 3 4 5 6 7 8 9
1
2 3 4 5 6 7 8 9
10
2 3 4 5 6 7 8 9
100
Log pressure, p(kg/sq.cm)
BH: 31
Depth @ 2.50m
CC=0.057

Fig:C 31

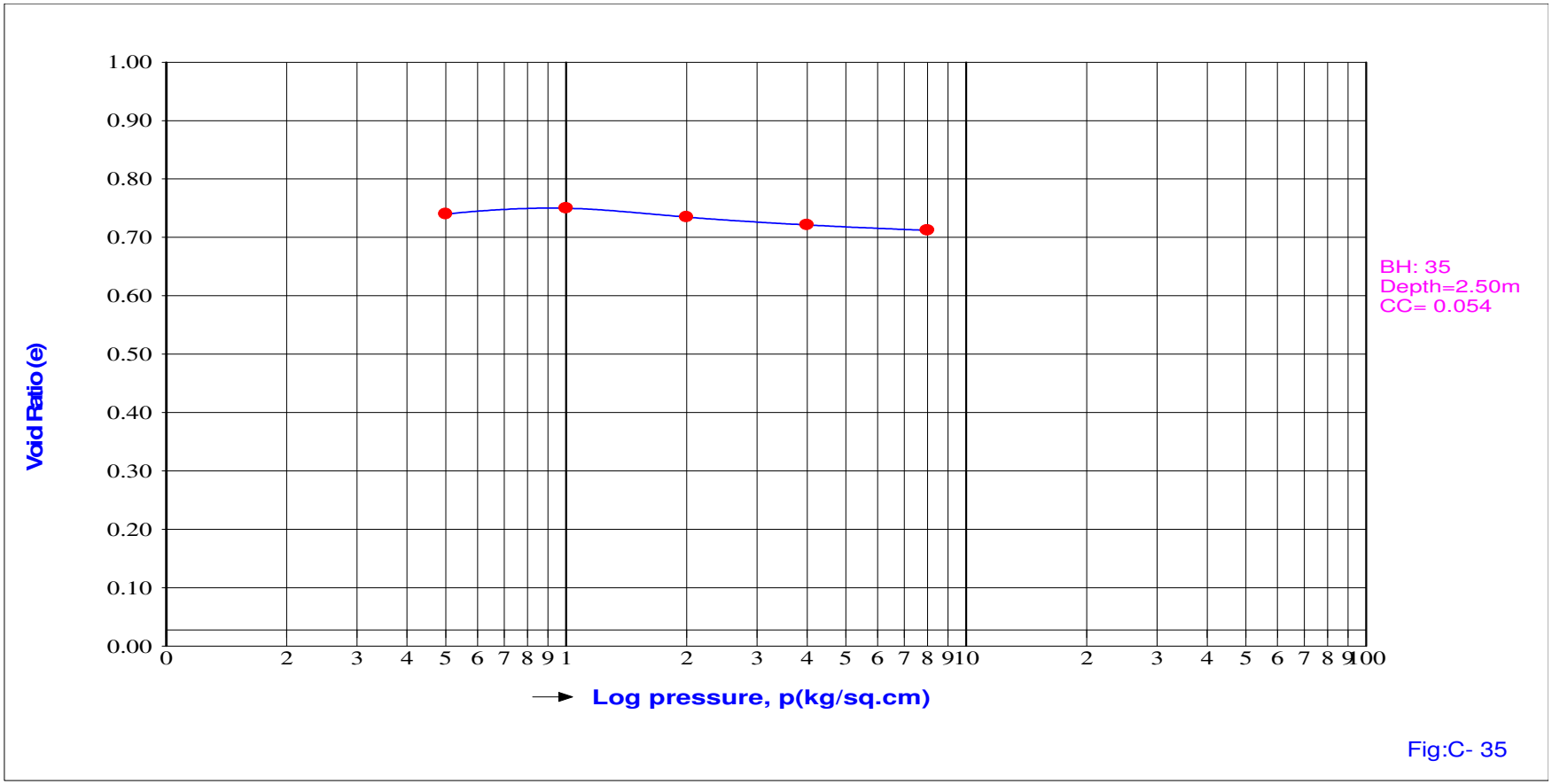

1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Void Ratio (e)
0 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 100
Log pressure, p(kg/sq.cm)
BH: 35
Depth=2.50m
CC= 0.054

Fig:C- 35