

**GEOTECHNICAL INVESTIGATION FOR PROPOSED
65 MW NLC SOLAR PV PROJECT AT CUDDALORE,
TAMIL NADU**

CLIENT

**BHARAT HEAVY ELECTRICALS LIMITED,
HYDERABAD**

TITLE

DRAFT REPORT

REPORT NO: SI/CHN/16/1334/25 MW/01

AUGUST 2016



GEO FOUNDATIONS & STRUCTURES PVT LTD

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SOIL INVESTIGATION REPORT

1.0 INTRODUCTION

- 1.1 The work of sub-soil Investigation for the for proposed 65 MW Solar Power Plant structures at NLC, Neyveli was entrusted to M/s. Geo Foundations and Structures (P) Ltd., Adyar, Chennai – 600 020, by M/s. BHEL PE & SD, Hyderabad. The entire project site is split in to two sites namely Site 1- 40 MW and Site 2 – 25 MW. **This report deals with details of ten bore holes of Site 2- 25 MW only.**
- 1.2 The soil Investigation and laboratory studies were carried out during **July** and **August 2016**. This report summarizes the results of the soil investigation, and presents recommendation for suitable type of foundations.

2.0 OBJECTIVE OF INVESTIGATION

- 2.1 The objective of soil investigation is to determine the nature and characteristics of sub-soil below the ground level for the proposed structures. The study includes identification of suitable type of foundations for the proposed structures and assessment of safe bearing capacity.

3.0 SCOPE OF WORK

The scope of work at this site comprises of the following:

- 3.1 Mobilization of boring rig with all necessary equipments and personnel.
- 3.2 Boring of **ten** bore holes of 150 mm diameter with Calyx drilling equipments through sand, silt, clay & rock etc up to hard strata.
- 3.3 Conducting Standard Penetration Tests in the bore holes and collecting the representative soil samples including packing and transportation to laboratory.
- 3.4 To conduct the following laboratory tests on soil samples:
 - (a) Sieve analysis
 - (b) Index properties:

- (i) Liquid limit
 - (ii) Plastic limit
 - (c) Dry & wet density
 - (d) Water content
 - (e) Specific gravity
 - (f) Direct shear test
 - (g) UCS
- 3.5 Recording ground water level.
- 3.6 Conducting Seventeen CBR Tests.
- 3.7 Conducting Fifteen Electrical Resistivity tests.
- 3.8 Preparation and sub submitting detailed report with field and laboratory results and recommendations for foundations.

4.0 FIELD INVESTIGATIONS-GEO-TECHNICAL STUDIES

- 4.1 Boring rig with all requisite equipments and accessories were mobilized at the worksite. A team of technical personnel with skilled labours was also deputed.
- 4.2 **Ten** bore holes of 150 mm diameter were bored to a maximum depth up to **5.5 m** below the existing ground level. The bore holes were made as per relevant Indian Standard IS: 1892.
- 4.3 Representative soil samples were collected at every change of strata of about 1 m depth interval from 0.5 m up to 5.5 m from the existing ground level. The samples so collected were sealed and numbered with full particulars for identification and sent to the laboratory for conducting the required tests.
- 4.4 Standard Penetration tests were conducted in the bore holes at 1 m depth intervals from 0.5 m up to 5.5 m from the existing ground level, as per the relevant Indian Standard, IS: 2131. In this test, a standard split spoon sampler is driven into

the ground at the required depth by means of standard hammer of 63.5 kgs weight, falling from a height of 75 cm. Number of blows for the first 15 cm is not taken into consideration because of possible disturbances or presence of settled, suspended matters at the bottom of the bore- holes. The total number of blows for the next 30 cm depth of penetration is considered as SPT 'N' value as shown in Figure nos. 1 to 10

5.0 LABORATORY INVESTIGATION

The following laboratory tests were conducted on the selected soil samples collected from the test bore holes:

- (a) Sieve analysis
- (b) Index properties:
 - (i) Liquid limit
 - (ii) Plastic limit
- (c) Dry & wet density
- (d) Water content
- (e) Specific gravity
- (f) Free swell index

All the above laboratory tests were carried out as per relevant Indian Standards.

All the soil samples were identified and classified as per relevant Indian Standard, IS: 1498. The results are shown in Tables Nos. 1 to 10.

6.0 SOIL PROFILE

Soil profile of the bore holes are as given below:

In bore hole BH 1, medium dense clayey sand occurs from ground level up to 2.5 m, followed by very dense clayey sand up to **5.5 m**, at which depth the borehole was terminated.

In bore hole BH 2, medium dense to dense clayey sand occurs from ground level up to 2.5 m, followed by very dense clayey sand up to 4.5 m, thereafter very dense silty sand occurs up to **5.5 m**, at which depth the borehole was terminated.

In bore hole BH 3, medium dense clayey sand occurs from ground level up to 2.5 m, followed by very dense clayey sand up to **5.5 m**, at which depth the borehole was terminated.

In bore hole BH 4, stiff to hard sandy clay of medium plasticity from ground level up to 3.5 m, followed by very dense clayey sand up to **5.5 m**, at which depth the borehole was terminated.

In bore hole BH 5, medium dense to dense clayey sand occurs from ground level up to 2.5 m, followed by very dense clayey sand up to **5.5 m**, thereafter hard sandy clay of low plasticity occurs at which depth the borehole was terminated.

In bore hole BH 6, medium dense clayey sand occurs from ground level up to 2.5 m, followed by very dense clayey sand up to **5.5 m**, at which depth the borehole was terminated.

In bore hole BH 7, stiff to hard to dense sandy clay of medium plasticity from ground level up to 2.5 m, followed by very dense clayey sand with gravel up to **5.5 m**, at which depth the borehole was terminated.

In bore hole BH 8, loose clayey sand occurs from ground level up to 1.5 m, followed by very dense clayey sand up to **5.5 m**, at which depth the borehole was terminated.

In bore hole BH 9, medium dense to dense clayey sand occurs from ground level up to 2.5 m, followed by very dense clayey sand up to **5.5 m**, at which depth the borehole was terminated.

In bore hole BH 10, medium dense to dense clayey sand occurs from ground level up to 2.5 m, followed by very dense clayey sand up to **5.5 m**, at which depth the borehole was terminated.

7.0 GROUND WATER LEVEL

Ground water level was met at a depth ranging from **2.5 m** to **3 m**, with in the bore holes during the continuous boring from **04.08.2016** to **05.08.2016**.

8.0 DESIGN PARAMETERS

Shear Parameters as presented in table-11 below were retrieved from UDS samples collected from Bore holes and CBR locations.

TABLE 11

Bore hole	Depth from EGL (m)	Type of sub Soil stratum	Test type	Shear Parameters	
				C (kg/cm ²)	φ in degree
BH – 1	1.0	Clayey SAND	DS	–	31
BH – 2	1.0	Clayey SAND	DS	–	33
BH – 3	1.0	Clayey SAND	DS	–	32
BH – 4	1.0	Sandy CLAY	TA	0.65	8
BH -5	1.0	Clayey SAND	DS	–	32
BH – 6	1.0	Clayey SAND	DS	–	32
BH – 7	1.0	Sandy CLAY	TA	0.60	10
BH – 8	1.0	Clayey SAND	DS	–	29
BH – 9	1.0	Clayey SAND	DS	–	33
BH – 10	1.0	Clayey SAND	DS	–	30

CBR	Depth from EGL	Type of sub Soil stratum	Test type	Shear Parameters	
				C (kg/cm ²)	φ in degree
	(m)				
CBR-1	0.5	Clayey SAND	DS	–	30
CBR-2	0.5	Clayey SAND	DS	–	34
CBR-3	0.5	Clayey SAND	DS	–	33
CBR-4	0.5	Clayey SAND	DS	–	30
CBR-5	0.5	Clayey SAND	DS	–	29
CBR-6	0.5	Clayey SAND	DS	–	30
CBR-7	0.5	Clayey SAND	DS	–	30
CBR-8	0.5	Clayey SAND	DS	–	29
CBR-9	0.5	Clayey SAND	DS	–	31
CBR-10	0.5	Clayey SAND	DS	–	32
CBR-11	0.5	Clayey SAND	DS	–	29
CBR-12	0.5	Clayey SAND	DS	–	32
CBR-13	0.5	Clayey SAND	DS	–	31
CBR-14	0.5	Clayey SAND	DS	–	32
CBR-15	0.5	Clayey SAND	DS	–	30
CBR-16	0.5	Sandy CLAY	TA	0.55	8
CBR-17	0.5	Clayey SAND	DS	–	29

9.0 DISCUSSION AND RECOMMENDATIONS ON RESULTS AND TYPE OF FOUNDATIONS:

On the basis of subsoil conditions discussed in Sl. No. 6, Pile foundations may be considered.

PILE FOUNDATIONS:

- Bored cast in situ concrete pile foundations of 1.8 m length from existing ground level are recommended.
- The recommended safe load carrying capacity of bored cast in situ concrete piles as per IS 2911 (Part 1/Sec2) for 30 cm pile diameter is presented in Table 12.

TABLE 12

Approximate Length of Pile from G.L (m)	Dia (cm)	Recommended Safe Vertical Capacity (T)	Lateral Capacity (T)	Up lift capacity (T)
1.8 m	30	3.5	1.0	1.5

10.0 CHEMICAL ANALYSIS OF SOIL SAMPLE:

The results of Chemical analysis of soil sample are shown in Appendix – III. Since the Chloride and sulphate values are within the limit, no specific type of cement is required.

- 10.0** The results and recommendations given in this report are based on the results of the soil investigation carried out. If, in actual execution, any variation is found, the consultants may also be referred to.

For GEO FOUNDATIONS & STRUCTURES PVT. LTD.


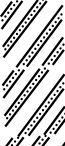
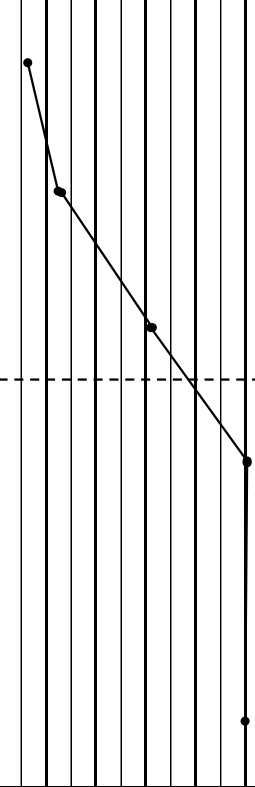
A. Suresh Kumar, M.Tech (Geo technical), **M.B.A** (T.M)



D.G.M. (Geo Technical)


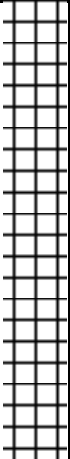
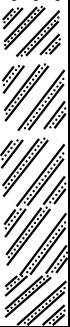
APPROVED BY,


Dr. K. Muthukrishnaiah BE (Hons), M.Tech., Ph.D.,
(Professor & Head, Ocean Engineering Dept. IIT Madras)(Rtd),
(Chief Consultant)


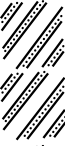
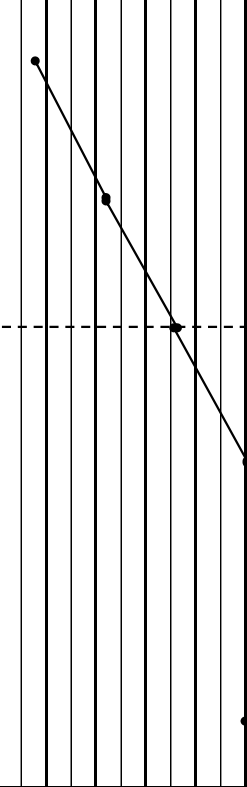
APPENDIX I
BORE LOGS


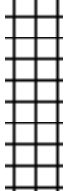



Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																				
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>				Bore Hole No : BH-01 Location : 25 MW NLC Co-ordinates : 330647 E 1281366 N Type of Boring : Calyx Ground Water Level : 2.90 m from G.L. on 06.08.2016 Termination Depth : 5.50 m					Drillhole Record -BH-01 Fig No. 1				Start Date : 05.08.2016 End Date : 05.08.2016							
				SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' PROFILE	C.R (%)	R.Q.D (%)	REMARKS	
									15cm	30cm	45cm	SPT 'N' Blows/300mm	20	40	60	80	100			
Clayey SAND (SC-CL)	Red	Medium Dense, Granular	2.50		SPT-1	SS	0.50	0.50-0.95	4	5	6	11								
		SPT-2			SS	1.50	1.50-1.95	6	11	16	27									
	SPT-3	SS	2.50		2.50-2.95	19	28	34	62	G.W.L										
	SPT-4	SS	3.50		3.50-3.93	29	41	>50	>100		50/13 cm penetration									
	SPT-5	SS	4.50		4.50-4.77	33	>50	-	>100		50/12 cm penetration									
	SPT-6	SS	5.50		5.50-5.62	>50	-	-	>100		50/12 cm penetration									
G.W.L: 2.90 m from G.L on 06.08.2016		No of SPT: 06 Nos		REMARKS																


Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																				
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>				Bore Hole No : BH-02 Location : 25 MW NLC Co-ordinates : 330449E 1281199N Type of Boring : Calyx Ground Water Level : 2.80 m from G.L on 06.08.2016 Termination Depth : 5.50 m					Drillhole Record -BH-02 Fig No. 2											
				Start Date : 05.08.2016 End Date : 05.08.2016																
SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE					C.R. (%)	R.Q.D.(%)	REMARKS
									15cm	30cm	45cm		20	40	60	80	100			
Clayey SAND (SC-CL)	Red	Medium Dense, Granular	1.50		SPT-1	SS	0.50	0.50-0.95	7	8	8	16	20							
		Dense, Granular	2.50		SPT-2	SS	1.50	1.50-1.95	11	18	26	44	40							
					SPT-3	SS	2.50	2.50-2.95	17	28	41	69	60							
	Very Dense, Granular		4.50		SPT-4	SS	3.50	3.50-3.89	22	41	>50	>100	80							
					SPT-5	SS	4.50	4.50-4.78	31	>50	-	>100	100							
Silty SAND (SM)	Red	Very Dense, Granular	5.50			SPT-6	SS	5.50	5.50-5.63	>50	-	>100								
G.W.L: 2.80 m from G.L on 06.08.2016			No of SPT: 06 Nos			REMARKS														



Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																								
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>				Bore Hole No : BH-04 Location : 25 MW NLC Co-ordinates : 330636E 1281071N Type of Boring : Calyx Ground Water Level : 2.80 m from G.L on 05.08.2016 Termination Depth : 5.50 m					Drillhole Record -BH-04 Fig No. 4				Start Date : 04.08.2016 End Date : 04.08.2016											
				SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' PROFILE	C.R (%)	R.Q.D (%)	REMARKS					
									15cm	30cm	45cm	SPT 'N' Blows/300mm	20	40	60	80	100							
Sandy CLAY (CI-SC)	Red	Stiff, Layered	1.50		SPT-1	SS	0.50	0.50-0.95	7	7	8	15	●											
					SPT-2	SS	1.50	1.50-1.95	14	19	25	44	●											
	Hard, Layered	3.50	SPT-3		SS	2.50	2.50-2.95	22	29	35	64	●												
Clayey SAND (SC-CL)	Red	Very Dense, Granular	5.50		SPT-4	SS	3.50	3.50-3.93	28	39	>50	>100	●									G.W.L		
					SPT-5	SS	4.50	4.50-4.77	35	>50	-	>100	●											50/13cm penetration
					SPT-6	SS	5.50	5.50-5.64	>50	-	-	>100	●											
G.W.L: 2.80 m from G.L on 05.08.2016				No of SPT: 06 Nos			REMARKS																	



Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																									
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>					Bore Hole No : BH-05 Location : 25 MW NLC Co-ordinates : 330836E 1281068N Type of Boring : Calyx Ground Water Level : 2.90 m from G.L on 07.08.2016 Termination Depth : 5.50 m					Drillhole Record - BH-05 Fig No. 5				Start Date : 06.08.2016 End Date : 06.08.2016											
					SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE					C.R (%)	R.Q.D(%)	REMARKS
									15cm	30cm	45cm		20	40	60	80	100								
Clayey SAND (SC-CL)	Medium Dense, Granular	1.50	[Diagonal Hatching]	SPT-1	SS	0.50	0.50-0.95	4	5	6	11														
				UDS-1	SS	1.00	1.00-1.45	-	-	-	-														
	Dense, Granular	2.50	[Diagonal Hatching]	SPT-2	SS	1.50	1.50-1.95	11	19	26	45														
				SPT-3	SS	2.50	2.50-2.95	18	27	35	62														
	Very Dense, Granular	5.50	[Diagonal Hatching]	SPT-4	SS	3.50	3.50-3.77	24	39	>50	>100														50/12cm penetration
				SPT-5	SS	4.50	4.50-4.76	44	>50	-	>100														
Reddish, Hard, Sandy CLAY (CL-SC)				[Grid Hatching]	SPT-6	SS	5.50	5.50-5.62	>50	-	-	>100												50/12 cm penetration	
G.W.L: 2.90 m from G.L on 07.08.2016			No of SPT: 06 Nos			No of UDS: 01 Nos			REMARKS																

Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																				
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>				Bore Hole No : BH-06 Location : 25 MW NLC Co-ordinates : 330439E 1280954N Type of Boring : Calyx Ground Water Level : 2.50 m from G.L on 05.08.2016 Termination Depth : 5.50 m						Drillhole Record -BH-06 Fig No. 6										
										Start Date : 04.08.2016 End Date : 04.08.2016										
SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE					C.R. (%)	R.Q.D.(%)	REMARKS
									15cm	30cm	45cm		20	40	60	80	100			
Clayey SAND (SC-CL)	Red	Medium Dense, Granular	1.50		SPT-1	SS	0.50	0.50-0.95	5	6	7	13								
		Dense, Granular	2.50		SPT-2	SS	1.50	1.50-1.95	12	19	26	45								
	Very Dense, Granular	SPT-3	SS		2.50	2.50-2.95	21	29	42	71	G.W.L									
		SPT-4	SS		3.50	3.50-3.94	28	41	>50	>100		50/14cm penetration								
		SPT-5	SS		4.50	4.50-4.78	38	>50	-	>100		50/13cm penetration								
		SPT-6	SS		5.50	5.50-5.63	>50	-	-	>100		50/13 cm penetration								
G.W.L: 2.50 m from G.L on 05.08.2016		No of SPT: 06 Nos		REMARKS																

Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																						
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>				Bore Hole No : BH-07 Location : 25 MW NLC Co-ordinates : 330637E 1280871N Type of Boring : Calyx Ground Water Level : 2.90 m from G.L on 04.08.2016 Termination Depth : 5.50 m					Drillhole Record -BH-07 Fig No. 7				Start Date : 03.08.2016 End Date : 03.08.2016									
				SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' PROFILE					C.R (%)	R.Q.D (%)
									15cm	30cm	45cm	SPT 'N' Blows/300mm	20	40	60	80	100					
Sandy CLAY (CI-SC)	Red	Stiff, Layered	1.50		SPT-1	SS	0.50	0.50-0.95	4	5	6	11	●									
		Hard, Layered	2.50		SPT-2	SS	1.50	1.50-1.95	11	15	21	36	●									
Clayey SAND (SC-CL)	Red	Very Dense, Granular	3.50		SPT-3	SS	2.50	2.50-2.95	22	29	41	70	●									
Clayey SAND with gravel (SC-CL-G)	Red	Very Dense, Granular	4.50		SPT-4	SS	3.50	3.50-3.94	28	40	>50	>100	●								50/14cm penetration	
Clayey SAND (SC-CL)	Red	Very Dense, Granular	5.50		SPT-5	SS	4.50	4.50-4.78	35	>50	-	>100	●									50/13cm penetration
					SPT-6	SS	5.50	5.50-5.64	>50	-	-	>100	●									
G.W.L: 2.90 m from G.L on 04.08.2016			No of SPT: 06 Nos			REMARKS																

Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																									
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>				Bore Hole No : BH-08 Location : 25 MW NLC Co-ordinates : 330522E 1280614N Type of Boring : Calyx Ground Water Level : 2.90 m from G.L on 03.08.2016 Termination Depth : 5.50 m						Drillhole Record - BH-08 Fig No. 8 Start Date : 02.08.2016 End Date : 02.08.2016															
				SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT "N" Blows/300mm	SPT 'N' PROFILE					C.R (%)	R.Q.D(%)	REMARKS	
									15cm	30cm	45cm		20	40	60	80	100								
Clayey SAND (SC-CL)	Loose, Granular	1.50	[Diagonal Hatching]	SPT-1	SS	0.50	0.50-0.95	4	4	5	9														
				SPT-2	SS	1.50	1.50-1.95	16	29	36	65														
	Very Dense, Granular	5.50	[Diagonal Hatching]	SPT-3	SS	2.50	2.50-2.95	22	38	49	87														
				SPT-4	SS	3.50	3.50-3.77	33	>50	-	>100													G.W.L	
				SPT-5	SS	4.50	4.50-4.78	35	>50	-	>100														50/12cm penetration
				SPT-6	SS	5.50	5.50-5.78	41	>50	-	>100														50/13cm penetration
G.W.L: 2.90 m from G.L on 03.08.2016		No of SPT: 06 Nos		REMARKS																					

Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																					
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>				Bore Hole No : BH-09 Location : 25 MW NLC Co-ordinates : 330771E 1280391N Type of Boring : Calyx Ground Water Level : 3.10 m from G.L on 07.08.2016 Termination Depth : 5.50 m					Drillhole Record -BH-09 Fig No. 9												
				Start Date : 06.08.2016 End Date : 06.08.2016																	
SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE					C.R. (%)	R.Q.D.(%)	REMARKS	
									15cm	30cm	45cm		20	40	60	80	100				
Clayey SAND (SC-CL)	Red	Medium Dense, Granular	1.50		SPT-1	SS	0.50	0.50-0.95	5	6	8	14	20								
		UDS-1			SS	1.00	1.00-1.45	-	-	-	-										
	Dense, Granular	2.50	SPT-2		SS	1.50	1.50-1.95	14	19	26	45										
	SPT-3		SS		2.50	2.50-2.95	21	29	36	65											
	Very Dense, Granular	SPT-4	SS		3.50	3.50-3.90	31	46	>50	>100											50/10cm penetration G.W.L
		SPT-5	SS		4.50	4.50-4.77	38	>50	-	>100											50/12cm penetration
			5.50	SPT-6	SS	5.50	5.50-5.61	>50	-	-	>100								50/11 cm penetration		
G.W.L: 3.10 m from G.L on 07.08.2016			No of SPT: 06 Nos			No of UDS: 01 Nos			REMARKS												

Project : Soil Investigation for 65 MW NLC Solar PV Project at Cuddalore, Tamil Nadu																			
 <p>GEO FOUNDATIONS & STRUCTURES PVT. LTD</p>				Bore Hole No : BH-10 Location : 25 MW NLC Co-ordinates : 330407 E 1280333 N Type of Boring : Calyx Ground Water Level : 3.0m from G.L on 04.08.2016 Termination Depth : 5.50 m					Drillhole Record -BH-10 Fig No. 10				Start Date : 03.08.2016 End Date : 03.08.2016						
				SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' PROFILE	C.R. (%)	R.Q.D.(%)	REMARKS
Clayey SAND (SC-CL)	Red	Medium Dense, Granular	1.50		SPT-1	SS	0.50	0.50-0.95	15cm	30cm	45cm	SPT 'N' Blows/300mm	20	40	60	80	100		
		Dense, Granular	2.50		SPT-2	SS	1.50	1.50-1.95	4	5	5	10							
	Very Dense, Granular	SPT-3	SS		2.50	2.50-2.95	11	19	24	43									
		SPT-4	SS		3.50	3.50-3.94	16	27	41	68									
		SPT-5	SS		4.50	4.50-4.87	22	40	>50	>100									
		SPT-6	SS		5.50	5.50-5.55	29	47	>50	>100									
G.W.L: 3.00 m from G.L on 04.08.2016			No of SPT: 06 Nos			REMARKS													

APPENDIX II

LAB RESULTS

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu				Boring Start: 05.08.16		Termination Depth		Table No.	1						
							Boring End : 05.08.16		5.50 m		Bore-Hole No.		1					
							Location: 25 MW		CO-ORDINATES									
							G.W.T	2.90 m	3306352 E		1281367 N							
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				SHEAR PARAMETERS						
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	SHINKAGE LIMIT (%)	DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	TEST METHOD	C in Kg/cm ²
11	0.50	SPT-1	Clayey SAND	SC-CL	0	66	34											
27	1.50	SPT-2		SC-CL	0	62	38	28	11	17	11			9				
62	2.50	SPT-3		SC-CL	4	56	40	28	12	16				17	2.55			
>100	3.50	SPT-4		SC-CL	4	60	36				14			13				
>100	4.50	SPT-5		SC-CL	6	56	38							10				
>100	5.50	SPT-6		SC-CL														

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu						Boring Start: 05.08.16		Termination Depth		Table No.							
									Boring End : 05.08.16		5.5 m		2							
									Location: 25 MW				CO-ORDINATES							
									G.W.T		2.80 m		330577 E		128120 N					
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				SHEAR PARAMETERS								
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT,%	PLASTIC LIMIT,%	PLASTICITY INDEX	SHINKAGE LIMIT (%)	DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	TEST METHOD	C in Kg/cm ²	φ in degrees	
16	0.50	SPT-1	Clayey SAND	SC-CL	2	67	31													
44	1.50	SPT-2		SC-CL	3	67	30													
69	2.50	SPT-3		SC-CL	0	65	35	25	12	13			5							
>100	3.50	SPT-4		SC-CL	7	59	34						10							
>100	4.50	SPT-5	Silty SAND	SM	5	66	29						14	2.55						
>100	5.5	SPT-6		SM	4	69	27						10							

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu						Boring Start: 04.08.16		Termination Depth		Table No.							
									Boring End : 04.08.16		5.50 m		Bore-Hole No.		3					
									Location: 25 MW				CO-ORDINATES							
									G.W.T		2.90 m		330673 E		1281297 N					
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS			
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT,%	PLASTIC LIMIT,%	PLASTICITY INDEX	SHINKAGE LIMIT (%)						TEST METHOD	C in Kg/cm ²	φ in degrees	
13	0.50	SPT-1	Clayey SAND	SC-CI	2	74	34													
32	1.50	SPT-2		SC-CI									10							
55	2.50	SPT-3		SC-CI	9	54	37	35	16	19	12			9						
>100	3.50	SPT-4		SC-CI	1	58	41							10						
>100	4.50	SPT-5		SC-CL	0	55	45	29	11	18	13			10	2.62					
>100	5.5	SPT-6		SC-CL	4	55	41							10						

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu						Boring Start: 04.08.16		Termination Depth		Table No.						
									Boring End : 04.08.16		5.50 m		4		Bore-Hole No.		4		
									Location: 25 MW				CO-ORDINATES						
									G.W.T		2.80 m		330621 E		1281079 N				
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT,%	PLASTIC LIMIT,%	PLASTICITY INDEX	SHINKAGE LIMIT (%)						TEST METHOD	C in Kg/cm ²	φ in degrees
15	0.50	SPT-1	Sandy CLAY	CI-SC	7	25	68	34	20	14									
44	1.50	SPT-2		CI-SC	9	31	60	36	13	23	16			8					
64	2.50	SPT-3		CI-SC	8	39	53	35	16	19	13			12					
>100	3.50	SPT-4	Clayey SAND	SC- CL	1	59	40	25	13	12				11	2.55				
>100	4.50	SPT-5		SC- CL	1	64	35							11					
>100	5.50	SPT-6		SC- CL	3	61	36							11					

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu										Boring Start: 06.08.16		Termination Depth		Table No.	5			
													Boring End : 06.08.16		5.5 m		Bore-Hole No.	5			
													Location: 25 MW			CO-ORDINATES					
													G.W.T		2.90 m		330673 E		1281297 N		
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS				
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT,%	PLASTIC LIMIT,%	PLASTICITY INDEX	SHINKAGE LIMIT (%)						TEST METHOD	C in Kg/cm ²	Φ in degrees		
11	0.50	SPT-1	Clayey SAND	SC-CL	0	53	47	27	14	13											
-	1.00	UDS-1		SC-CL	0	64	36							2.65							
45	1.50	SPT-2		SC-CL	0	59	41						6								
62	2.50	SPT-3		SC-CL	0	57	43						8								
>100	3.50	SPT-4		SC-CL	0	58	42	26	11	15	13		12								
>100	4.50	SPT-5		SC-CL	1	59	40						8								
>100	5.50	SPT-6	Sandy CLAY	CL-SC	0	49	51	32	13	19	16			8							

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu					Boring Start: 04.08.16		Termination Depth		Table No.		6							
								Boring End : 04.08.16		5.5 m		Bore-Hole No.		6							
								Location: 25 MW				CO-ORDINATES									
								G.W.T		2.5 m		330452 E		1280932 N							
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				SHEAR PARAMETERS									
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT,%	PLASTIC LIMIT,%	PLASTICITY INDEX	SHINKAGE LIMIT (%)	DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	TEST METHOD	C in Kg/cm ²	Φ in degrees		
13	0.50	SPT-1	Clayey SAND	SC-CL	0	60	40	28	11	17											
45	1.50	SPT-2		SC-CL	0	51	49	27	12	15				10							
71	2.50	SPT-3		SC-CL	0	67	33	21	11	10	10			8							
>100	3.50	SPT-4		SC-CL										7							
>100	4.50	SPT-5		SC-CL	1	52	47	29	13	16	11			1							
>100	5.50	SPT-6		SC-CL	0	69	31							10							

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu				Boring Start: 03.08.2016		Termination Depth		Table No.								
							Boring End : 03.08.2016		5.5 m		Bore-Hole No.								
							Location: 25 MW		CO-ORDINATES										
							G.W.T		2.90 m		330634 E		1280832 N						
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				SHEAR PARAMETERS							
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT,%	PLASTIC LIMIT,%	PLASTICITY INDEX	SHINKAGE LIMIT (%)	DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	TEST METHOD	C in Kg/cm ²	φ in degrees
11	0.50	SPT-1	Sandy CLAY	CL - SC	2	39	59	36	16	20									
36	1.50	SPT-2		CL - SC	1	47	52	33	15	18	15			11	2.68				
70	2.50	SPT-3	Clayey SAND	SC-CL	1	53	46	26	11	15				14					
>100	3.50	SPT-4	Clayey SAND with Gravel	SC-CL -G	22	45	33							12					
>100	4.50	SPT-5	Clayey SAND	SC - CL	1	66	33				11			10	2.55				
>100	5.5	SPT-6		SC - CL	1	64	35							13					

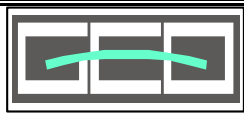
TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu						Boring Start: 02.08.16		Termination Depth		Table No.						
									Boring End : 02.08.16		5.5 m		8		Bore-Hole No.		8		
									Location: 25 MW				CO-ORDINATES						
									G.W.T		2.90 m		330522 E		1280614 N				
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT,%	PLASTIC LIMIT,%	PLASTICITY INDEX	SHINKAGE LIMIT (%)						TEST METHOD	C in Kg/cm ²	φ in degrees
9	0.50	SPT-1	Clayey SAND	SC-CL	0	57	43	25	13	12									
65	1.50	SPT-2		SC-CL	0	60	40	23	12	11			9	2.50					
87	2.50	SPT-3		SC-CL	0	56	44						9						
>100	3.50	SPT-4		SC-CL	0	54	46	27	13	14			7	2.62					
>100	4.50	SPT-5		SC-CL	1	58	41						8						
>100	5.50	SPT-6		SC-CL	1	66	33	25	11	14			8						

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu							Boring Start: 06.08.16		Termination Depth		Table No.						
										Boring End : 06.08.16		5.5 m		Bore-Hole No.		9				
										Location: 25 MW			CO-ORDINATES							
										G.W.T		3.10 m		330540 E		1280050 N				
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				SHEAR PARAMETERS								
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT:%	PLASTIC LIMIT:%	PLASTICITY INDEX	SHINKAGE LIMIT (%)	DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	TEST METHOD	C in Kg/cm ²	Φ in degrees	
14	0.50	SPT-1	Clayey SAND	SC-CL	0	61	39													
-	1.00	UDS-1		SC-CL																
45	1.50	SPT-2		SC-CL	1	56	43	25	12	13				11						
65	2.50	SPT-3		SC-CL										12						
>100	3.50	SPT-4		SC-CL	6	55	39	29	13	16				10						
>100	4.50	SPT-5		SC-CL																
>100	5.50	SPT-6		SC-CL	7	62	31								12					

TEST RESULTS			Project :Soil Investigation works for the proposed 65 MW NLC Solar Power Project at Cuddalore, Tamil Nadu						Boring Start: 03.08.16		Termination Depth		Table No.						
									Boring End : 03.08.16		5.5 m		10						
									Location: 25 MW				CO-ORDINATES						
									G.W.T		3.0 m		330491 E		1280261 N				
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS				SHEAR PARAMETERS							
					GRAVEL, %	SAND, %	SILT & CLAY, %	LIQUID LIMIT,%	PLASTIC LIMIT,%	PLASTICITY INDEX	SHINKAGE LIMIT (%)	DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	TEST METHOD	C in Kg/cm ²	φ in degrees
10	0.50	SPT-1	Clayey SAND	SC-CL	0	72	28	23	13	10	12			7	2.61				
43	1.50	SPT-2		SC-CL	4	76	20								6				
68	2.50	SPT-3		SC-CL	0	64	36	29	13	16	11				12	2.55			
>100	3.50	SPT-4		SC-CL											11				
>100	4.50	SPT-5		SC-CL	1	66	33								12				
>100	5.50	SPT-6		SC-CL	0	65	35												

APPENDIX III

**CHEMICAL ANALYSIS
OF SOIL**



Client : BHARAT HEAVY ELECTRICALS LIMITED, HYDERABAD
Project : SGEOTECHNICAL INVESTIGATION FOR PROPOSED 65 MW NLC SOLAR PV PROJECT
AT CUDDALORE, TAMIL NADU
Report No. : SI/CHN/16/1334/25 MW/01
Bore Hole No : 9

Chemical Analysis of Soil Sample

TESTS	BH 9
	1.5 m
p ^H	6.08
Chloride as Cl (ppm)	100
Sulphate as SO ₄ (%)	0

APPENDIX IV

CBR TEST RESULTS

2.0 CALIFORNIA BEARING RATIO TEST RESULTS- 25 MW

2.1.0 OBJECTIVE

- The objectives of the CBR test results are to evaluate the California Bearing ratio values of soil sample collected from Seventeen locations pertaining to 25 MW plant at a depth of 0.5 m from the existing ground level.

2.2.0 SCOPE OF WORK

The scope of work at this site comprised the following:

- Mobilization of all necessary equipments and personnel.
- Collecting soil samples from the specified locations, packing and transporting to laboratory.
- Conducting California Bearing Ratio Tests.
- Preparation and submission of the laboratory results.

2.3.0 FIELD INVESTIGATION

- The soil samples were collected from Seventeen locations at a depth of 0.5 m from the existing ground level.

2.4.0 LABORATORY INVESTIGATION

- California bearing ratio tests were conducted on the soil samples at maximum dry density, as per the relevant Indian Standard, IS 2720: Part 16 : 1987, The results of CBR tests are presented in Table No 2.1

2.5.0 CONCLUSIONS

The field and laboratory tests were carried out as per the relevant Indian Standard and the results show that the soaked CBR value varies from 3.07 to 3.62 at the maximum dry density and optimum moisture content.

TABLE-2.1

CBR	Depth from EGL	Type of sub Soil stratum	4 days soaked CBR %
	(m)		
CBR-1	0.5	Clayey SAND	3.62
CBR-2	0.5	Clayey SAND	3.43
CBR-3	0.5	Clayey SAND	3.07
CBR-4	0.5	Clayey SAND	3.43
CBR-5	0.5	Clayey SAND	3.07
CBR-6	0.5	Clayey SAND	3.62
CBR-7	0.5	Clayey SAND	3.15
CBR-8	0.5	Clayey SAND	3.43
CBR-9	0.5	Clayey SAND	3.07
CBR-10	0.5	Clayey SAND	3.15
CBR-11	0.5	Clayey SAND	3.72
CBR-12	0.5	Clayey SAND	3.07
CBR-13	0.5	Clayey SAND	3.12
CBR-14	0.5	Clayey SAND	3.62
CBR-15	0.5	Clayey SAND	3.43
CBR-16	0.5	Sandy CLAY	3.07
CBR-17	0.5	Clayey SAND	3.43

APPENDIX V

**ELECTRICAL
RESISTIVITY TEST**

3.0 ELECTRICAL RESISTIVITY TEST

3.1.0 INTRODUCTION

3.1.1 The field studies were carried out in **August 2016**. This report summarizes Earth Resistivity values for 15 different locations at 25 MW site, Neyveli.

3.2.0 OBJECT OF INVESTIGATION

3.2.1 The object of investigation is to ascertain the variation in apparent resistivity of sub-soil below the ground level and to obtain an idea about the variation in soil profile at the proposed site. Electrical Resistivity values are required for designing safety grounding system in the area.

3.3.0 FIELD INVESTIGATIONS

3.3.1 The method depends on the difference in the electrical resistance of different soil strata. These are several methods by which the field resistivity measurements are made. The most popular method is by Wenner's four-electrode configuration. The test is carried out as per IS 3043-1987.

3.3.2 Four electrodes were driven into the ground at equal spacing and designed depth. The four electrodes are connected to the terminals of the earth resistivity meter. The resistivity meter is pressed "ON" to allow the current to flow through the electrodes. On pressing the "TEST" switch available in the meter for 10 ohms and 1000 ohms, the resistance value is displayed in the meter, which is noted down.

3.3.3 Readings of resistance for different electrode spacing in different directions are noted as per the said procedure.

3.4.0 METHOD OF COMPUTING OF RESISTIVITY VALUE

Earth resistivity is calculated by according to the formula.

$$= 2 \pi d R$$

Where

R = resistance in Ohms (megger reading for 10 ohm)

d = is the distance between spikes if spikes are placed at equal distances (m).



3.5.0 RESULTS

The values of resistivity, calculated as per formula given in section 4.0 above are as enclosed. After finding out the resistivity, average resistivity value at very test locations were also calculated and given in Table No: 3.1. The polar resistivity curves were drawn as per IS: 3043-1987 under Clause: 36.6. and corresponding other graphs are also drawn show in figure no. 2.1.1 to 2.15.3.

Table No.3.1

MARKIN GS	Co - ordinates	Average Resistivity in each direction (Ω m)							
		1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m
ERT 1	1281362 N 330732 E	123.01	212.96	305.17	395.39	453.48	512.98	764.48	1091.83
ERT 2	1281230 N 330455 E	118.07	227.44	324.96	340.85	375.33	262.38	106.65	30.16
ERT 3	1281229 N 330684 E	61.76	58.81	48.06	32.11	22.85	20.07	18.22	21.44
ERT 4	1281229 N 330761 E	4.37	2.32	2.26	2.20	2.20	2.45	2.83	3.53
ERT 5	1281129 N 330860 E	52.81	33.52	37.46	36.13	22.54	17.72	11.62	16.02
ERT 6	1281073 N 330608 E	63.55	43.48	34.73	32.61	35.11	24.60	23.56	15.31
ERT 7	1281043 N 330829 E	110.08	96.00	49.20	28.65	22.15	17.25	18.38	20.03
ERT 8	1280988 N 330442 E	46.18	27.02	14.09	16.71	16.49	10.93	13.82	11.55
ERT 9	1280873 N 330608 E	49.32	26.51	30.63	29.53	14.45	12.06	9.74	7.07
ERT 10	1280795 N 330824 E	25.71	16.30	17.25	13.13	12.57	12.53	17.28	24.27
ERT 11	1280665 N 330441 E	5.29	7.85	9.05	10.30	11.23	10.84	14.29	14.37
ERT 12	1280669 N 330608 E	52.89	35.40	28.46	9.86	11.00	8.95	9.11	12.49
ERT 13	1280531 N 330441 E	49.49	28.43	26.01	28.02	18.61	16.49	19.01	18.69
ERT 14	1280425 N 330660 E	53.89	32.51	27.76	26.89	23.40	20.64	23.09	21.91
ERT 15	1280360 N 330523 E	52.20	33.11	30.54	27.39	25.37	17.44	19.16	17.67



GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 1

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	124.40	242.52	360.77	475.25	568.93	663.86	955.64	1382.57	596.74
E	125.09	240.51	360.39	480.02	572.07	683.84	1125.29	1615.36	650.32
S	122.20	240.14	357.94	462.68	572.07	646.14	955.02	1340.16	587.04
W	120.32	128.68	141.56	163.61	100.84	58.05	21.99	29.22	95.53

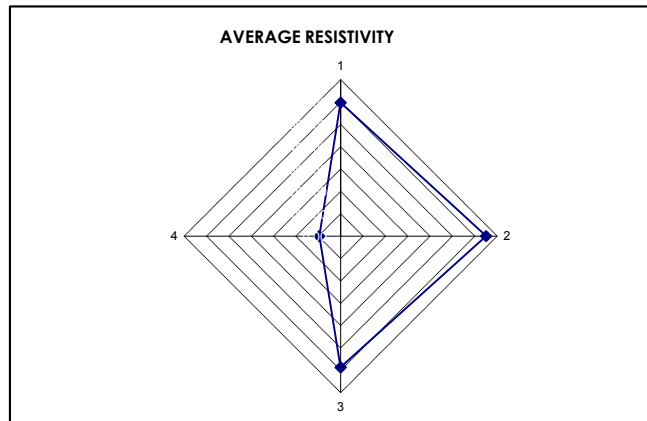
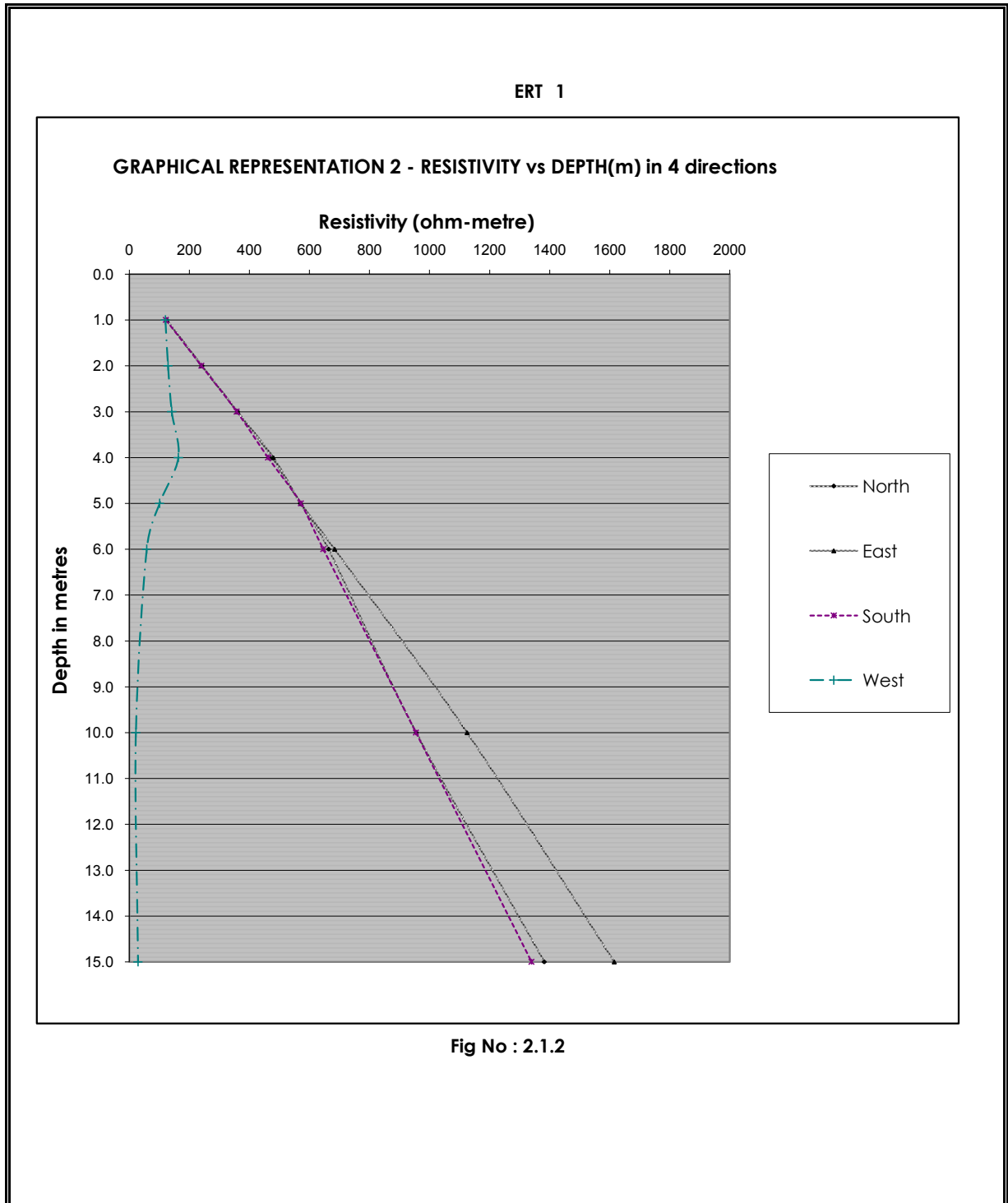


FIG NO 2.1.1

Average Resistivity at 15 m (ohm-meter) : 482.41

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 100 Ohm - m



ERT 1

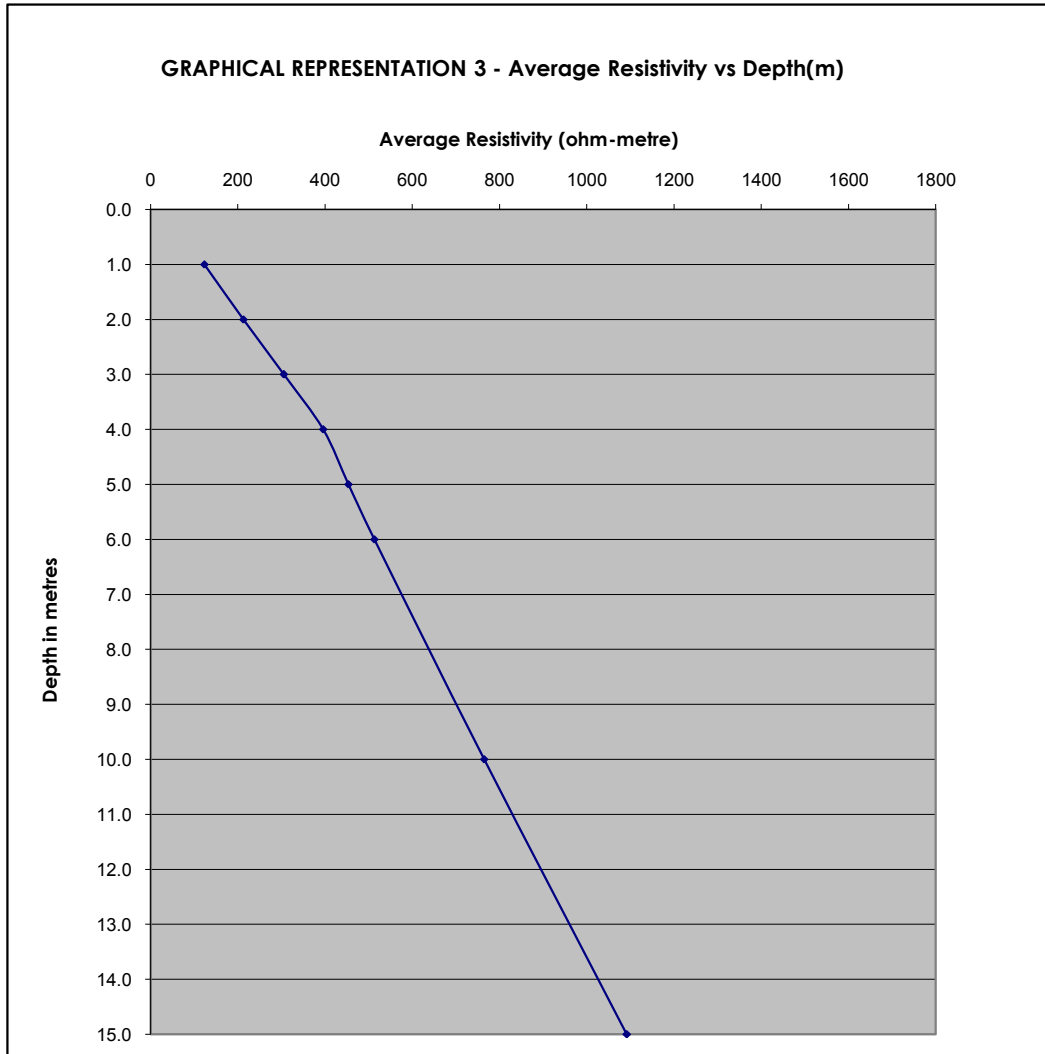


Fig No : 2.1.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 2

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	119.19	228.95	322.51	419.96	477.82	396.21	270.80	50.89	285.79
E	113.97	216.26	314.59	382.26	448.29	301.96	40.84	29.22	230.92
S	119.50	231.84	323.07	306.86	317.29	196.41	50.89	17.91	195.47
W	119.63	232.72	339.66	254.34	257.92	154.94	64.09	22.62	180.74

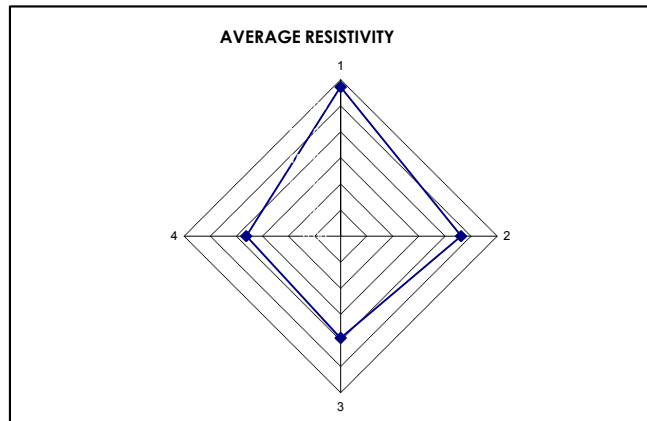
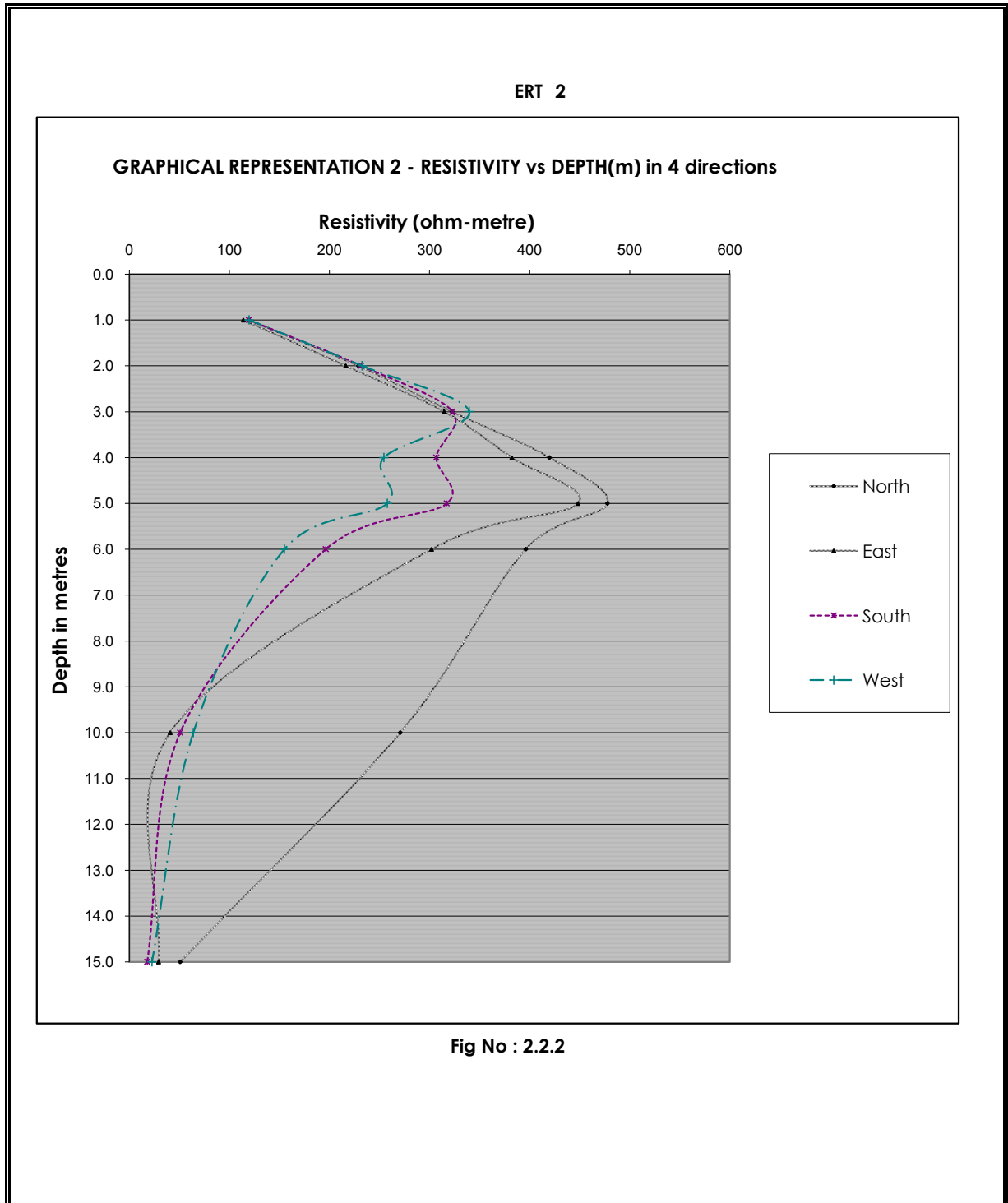


FIG NO 2.2.1

Average Resistivity at 15 m (ohm-meter) : 223.23

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 50 Ohm - m



ERT 2

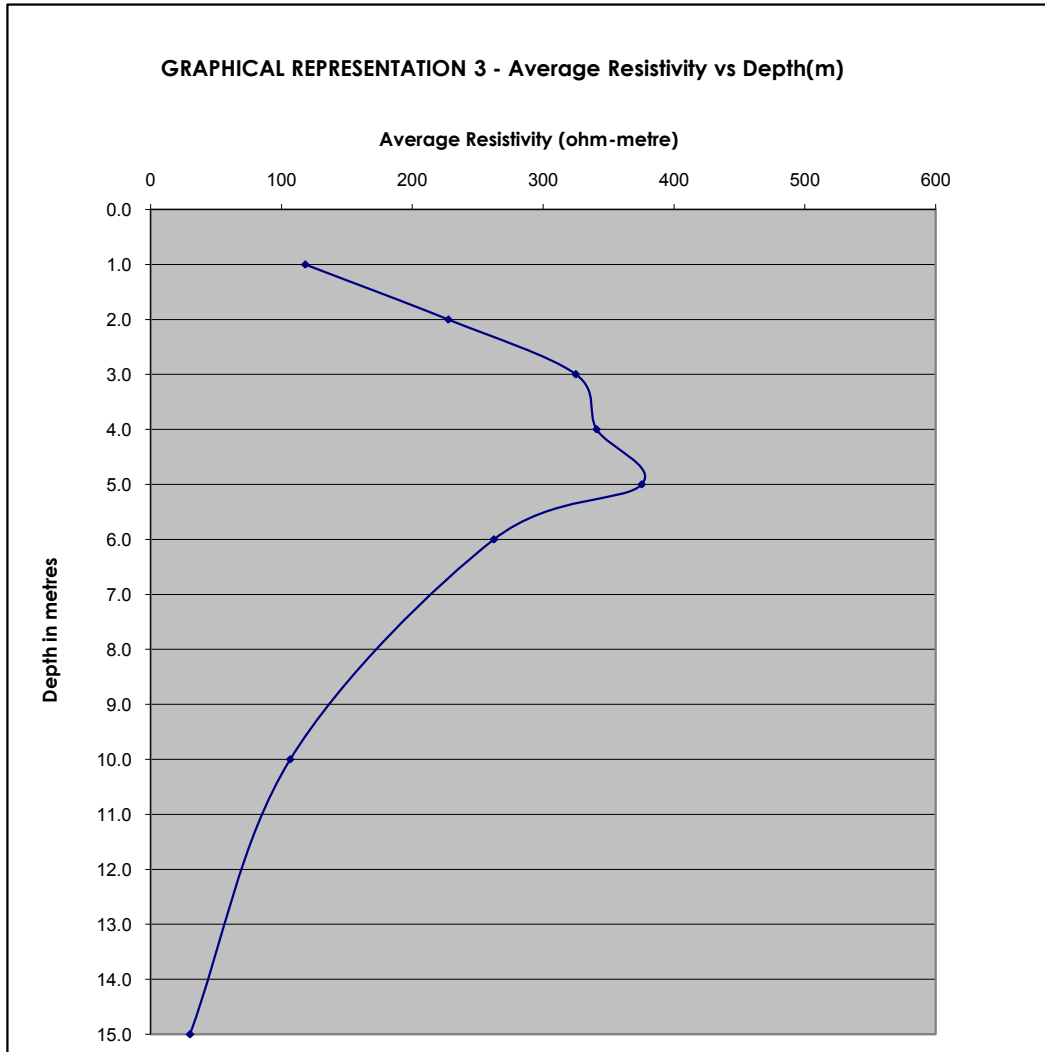


Fig No : 2.2.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 3

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	61.64	61.57	56.36	35.44	30.79	26.77	20.11	25.45	39.76
E	55.98	40.34	37.51	21.86	16.02	11.31	15.71	17.91	27.08
S	63.52	65.47	39.77	24.88	16.34	11.69	10.68	14.14	30.81
W	65.91	67.86	58.62	46.24	28.27	30.54	26.39	28.27	44.01

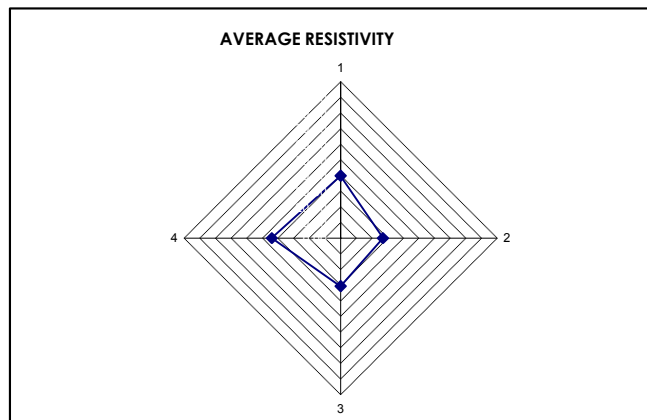
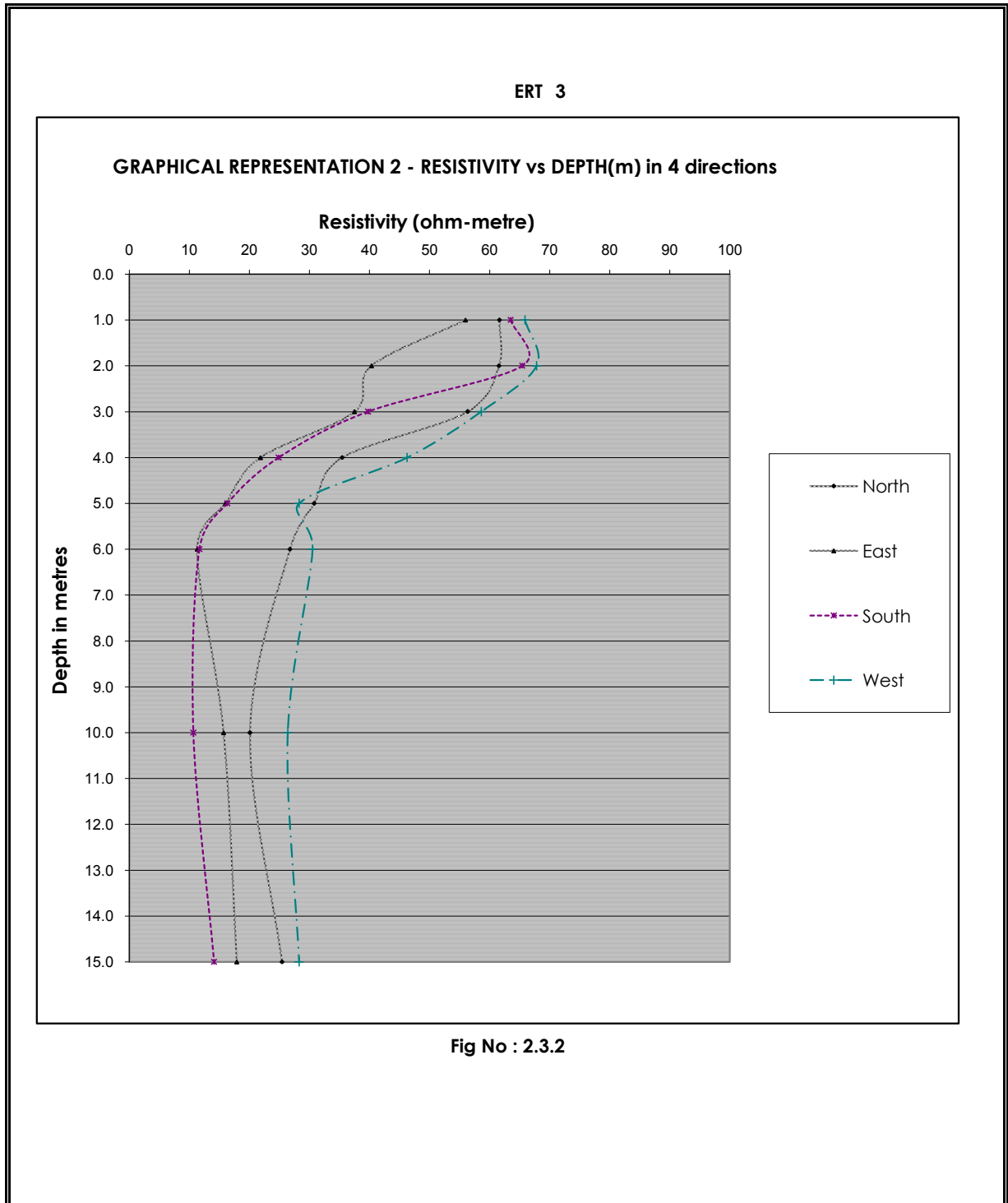


FIG NO 2.3.1

Average Resistivity at 15 m (ohm-meter) : 35.42

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 10 Ohm - m



ERT 3

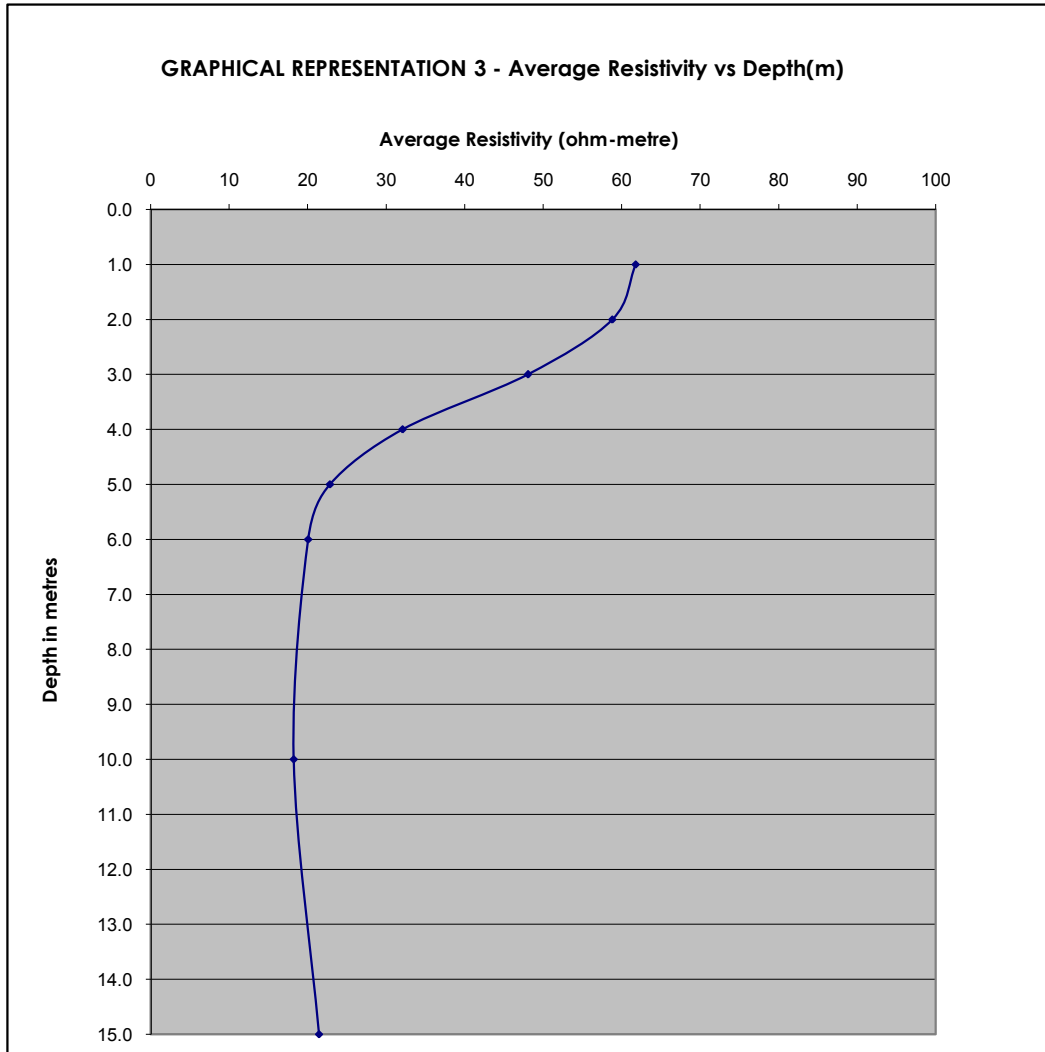


Fig No : 2.3.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 4

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	4.21	2.26	1.70	2.01	2.51	2.64	3.77	4.71	2.98
E	4.34	2.39	2.83	2.26	2.20	3.02	1.88	2.83	2.72
S	4.40	2.14	1.88	1.76	1.88	1.88	2.51	2.83	2.41
W	4.52	2.51	2.64	2.76	2.20	2.26	3.14	3.77	2.98

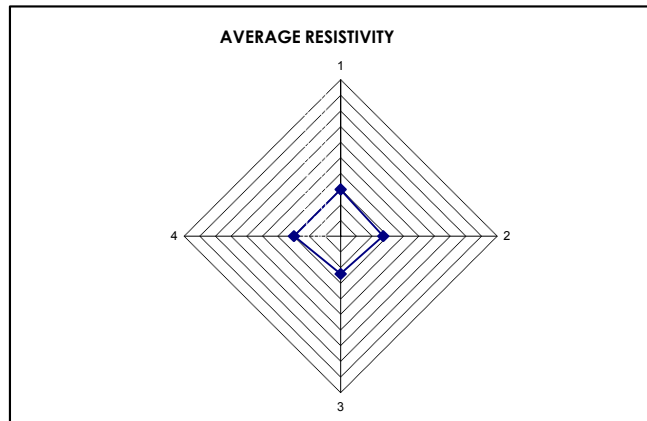
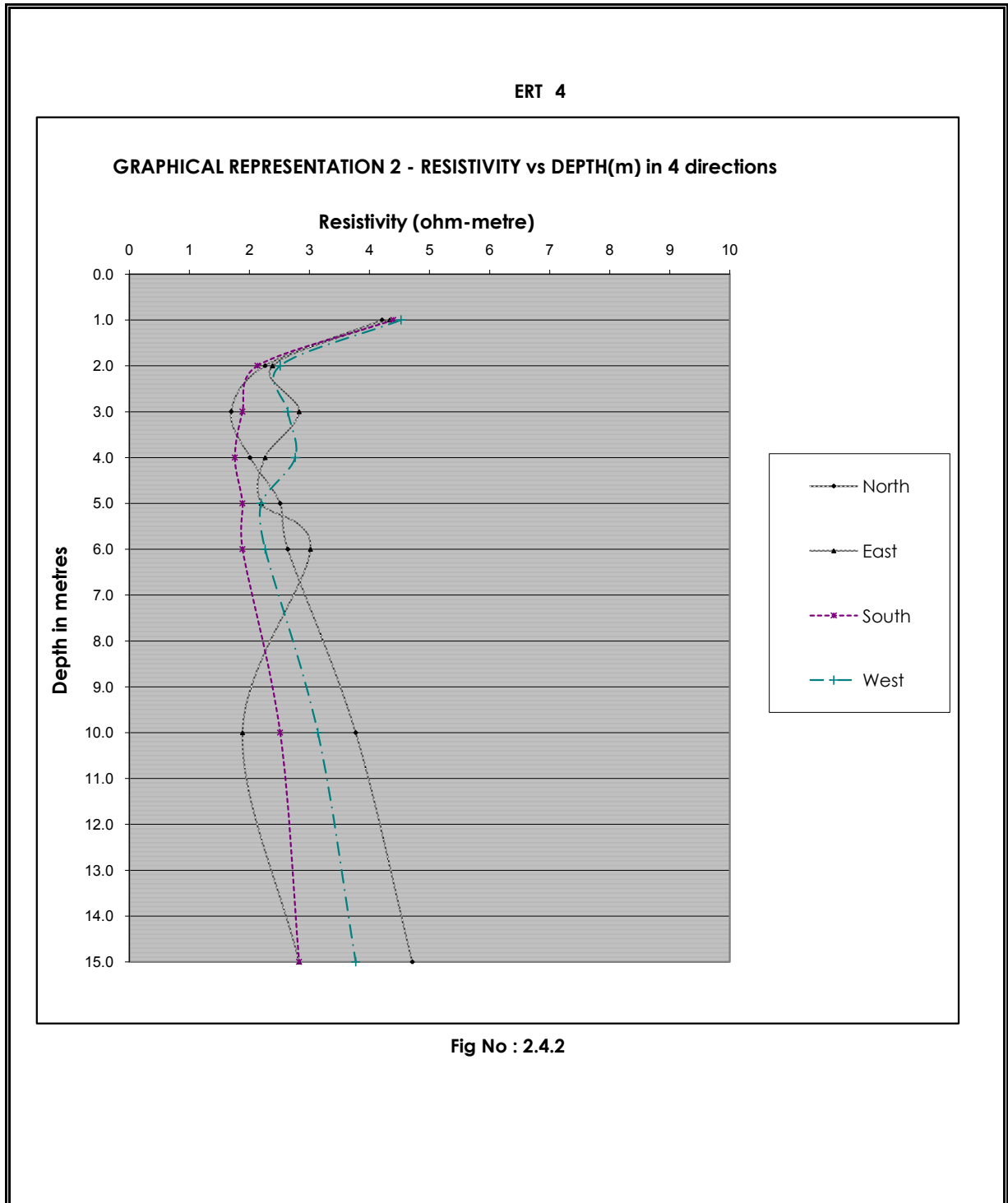


FIG NO 2.4.1

Average Resistivity at 15 m (ohm-meter) : 2.77

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 1 Ohm - m



ERT 4

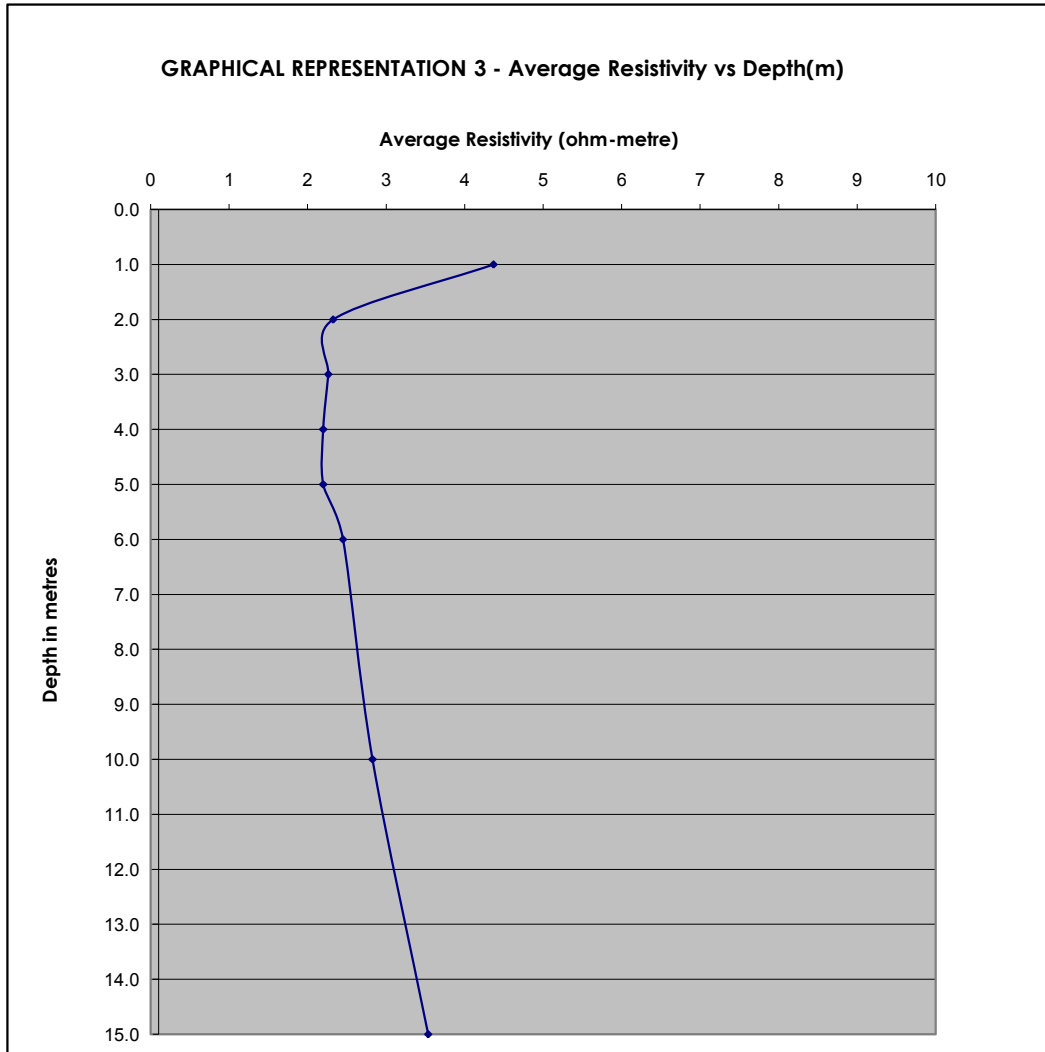


Fig No : 2.4.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 5

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	51.58	32.17	37.89	38.70	28.59	20.36	5.65	7.54	27.81
E	49.70	25.63	29.59	24.88	14.14	11.69	11.94	16.02	22.95
S	51.14	36.44	38.64	38.70	16.96	10.56	8.80	12.25	26.69
W	58.81	39.83	43.73	42.22	30.47	28.27	20.11	28.27	36.46

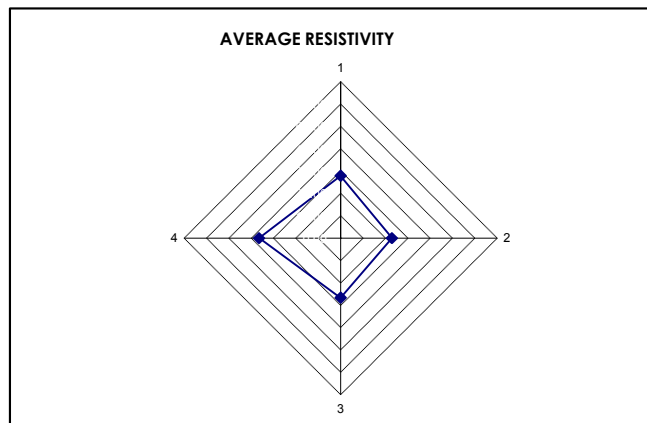
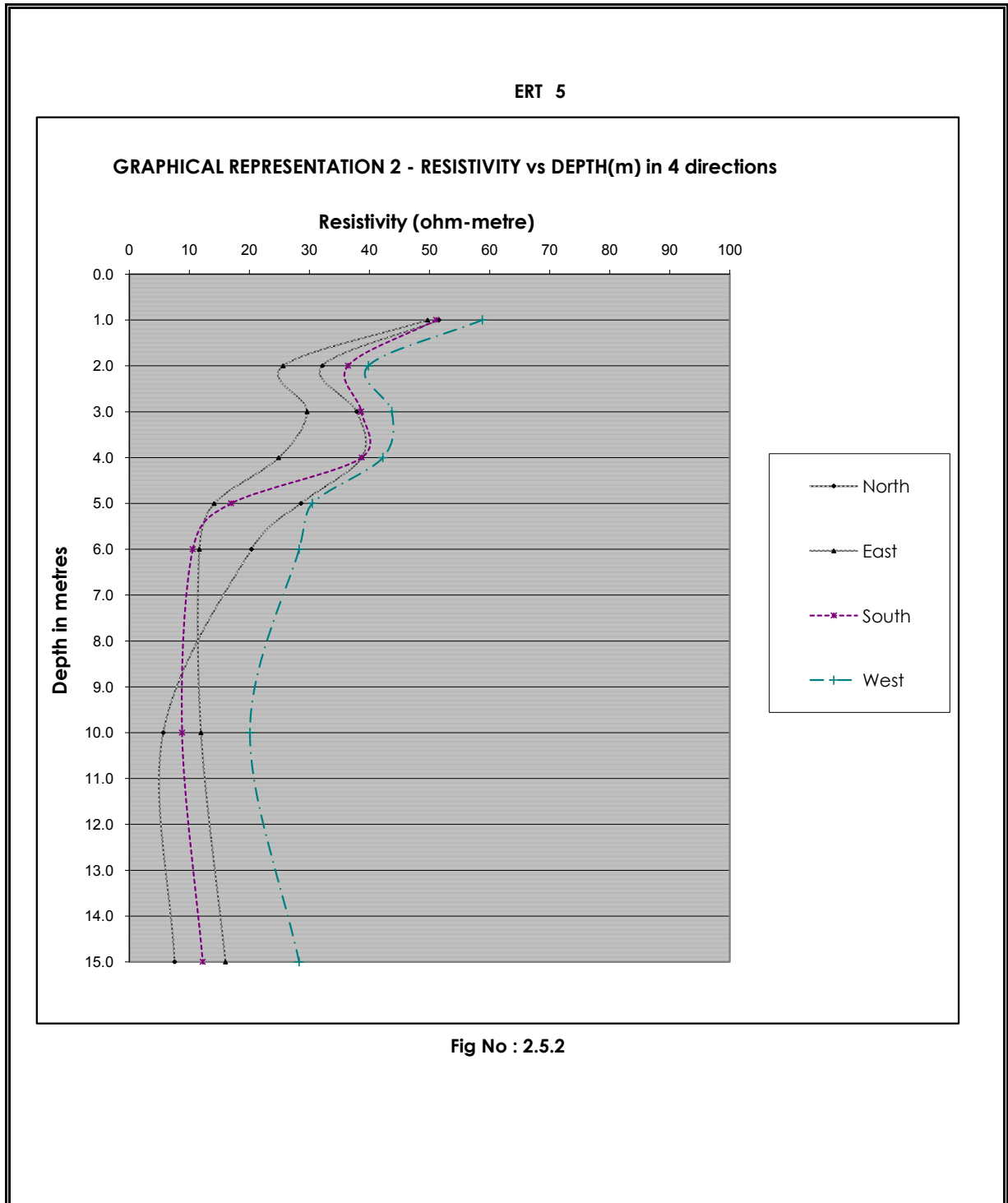


FIG NO 2.5.1

Average Resistivity at 15 m (ohm-meter) : 28.48

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 10 Ohm - m



ERT 5

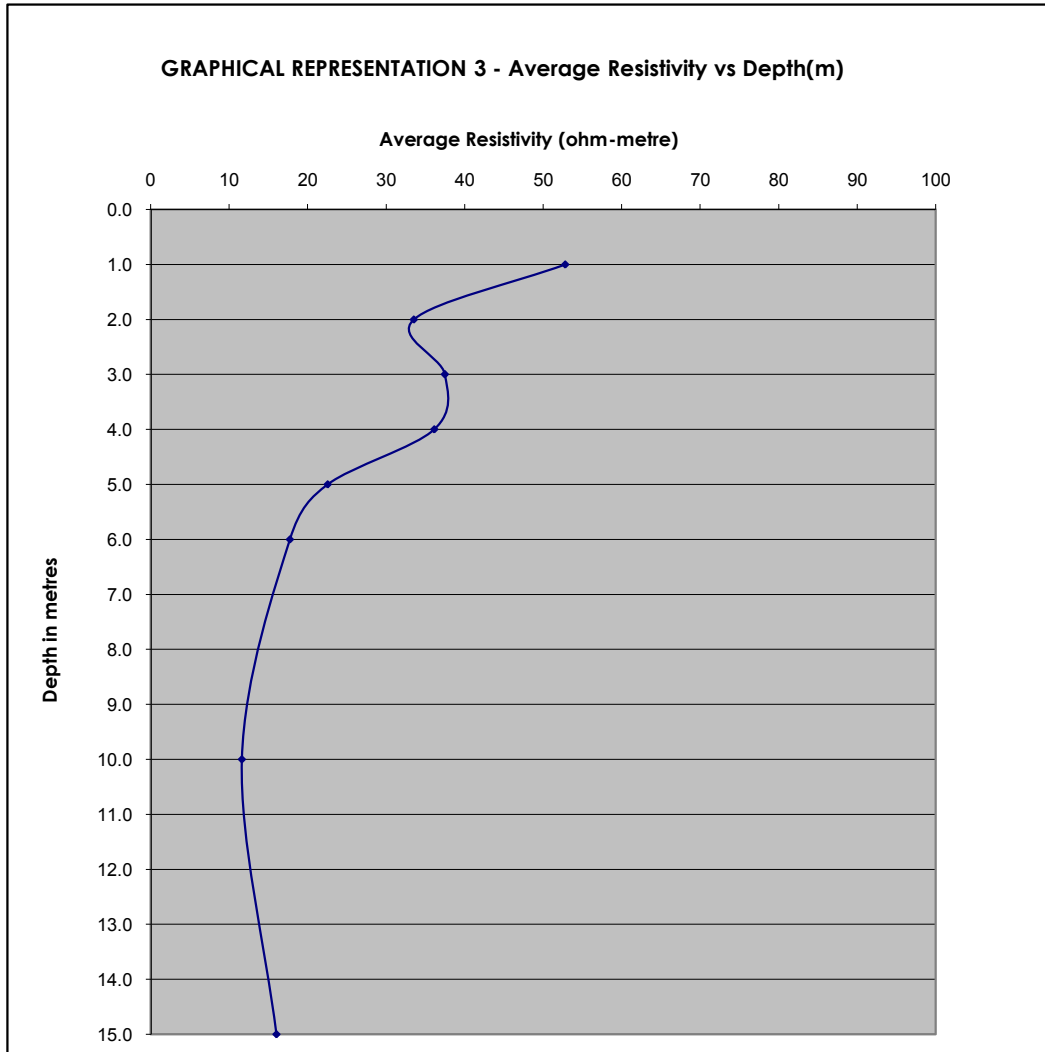


Fig No : 2.5.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 6

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	63.58	40.34	23.56	27.90	31.73	34.31	48.38	10.37	35.02
E	57.24	46.49	42.98	32.67	36.76	18.47	16.34	17.91	33.61
S	69.87	47.63	31.10	32.42	37.07	19.60	16.96	16.02	33.83
W	63.52	39.46	41.28	37.45	34.87	26.01	12.57	16.96	34.01

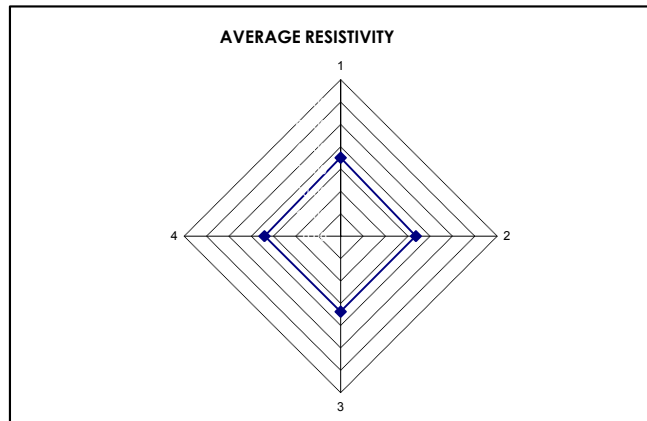
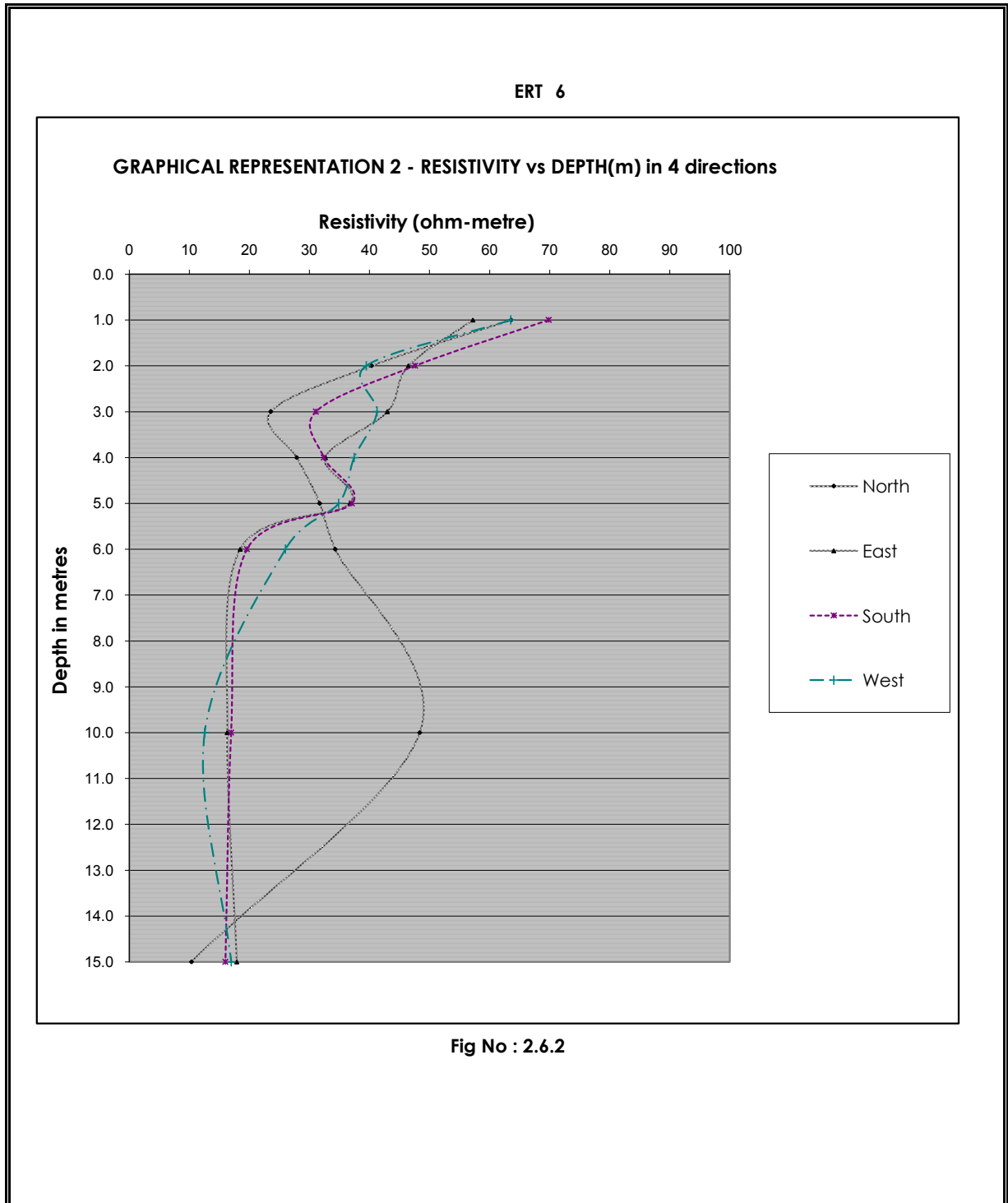


FIG NO 2.6.1

Average Resistivity at 15 m (ohm-meter) : 34.12

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 10 Ohm - m



ERT 6

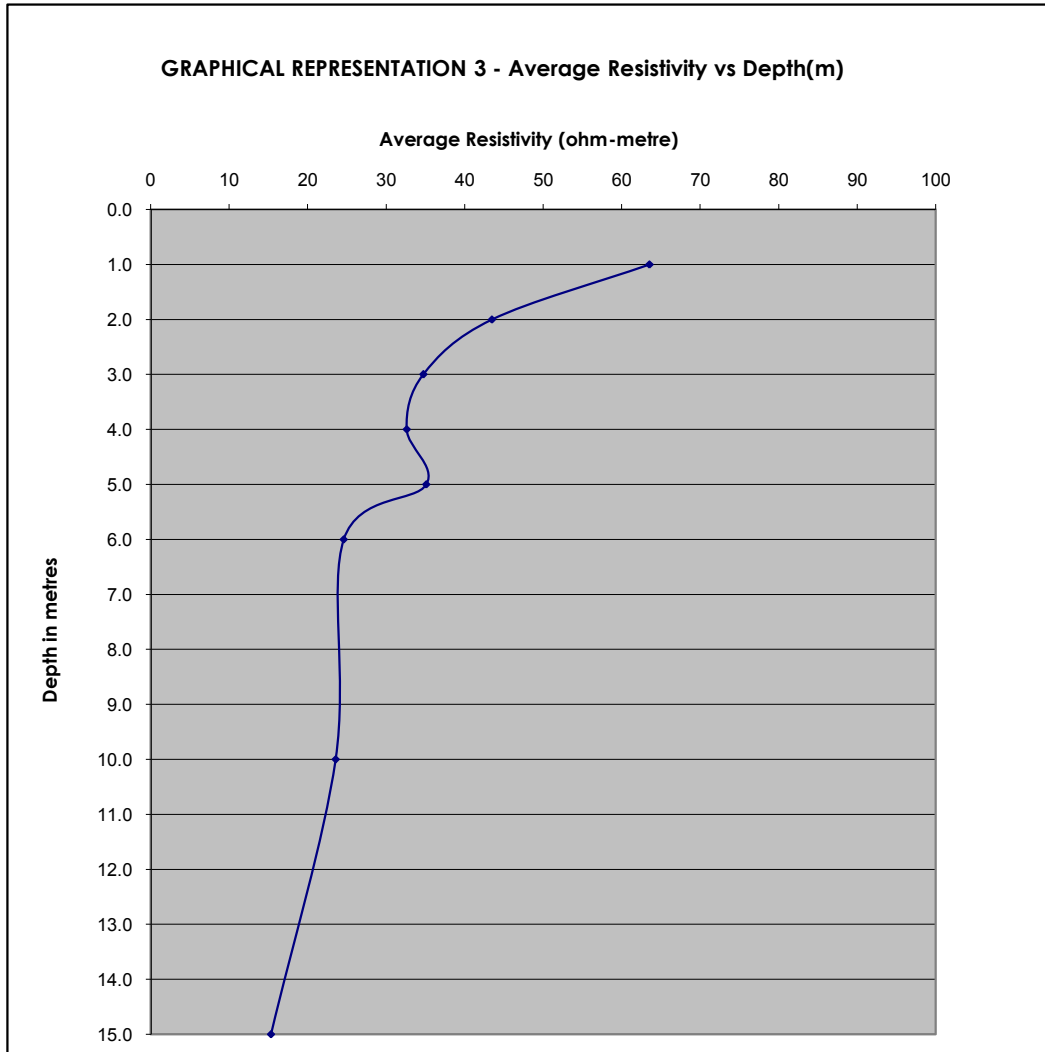


Fig No : 2.6.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 7

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	101.41	89.47	60.51	24.63	27.33	19.23	19.48	16.96	44.88
E	114.04	89.72	47.31	37.95	28.59	20.36	17.59	17.91	46.68
S	107.50	102.41	41.66	25.63	25.76	17.72	18.22	19.79	44.84
W	117.37	102.41	47.31	26.39	6.91	11.69	18.22	25.45	44.47

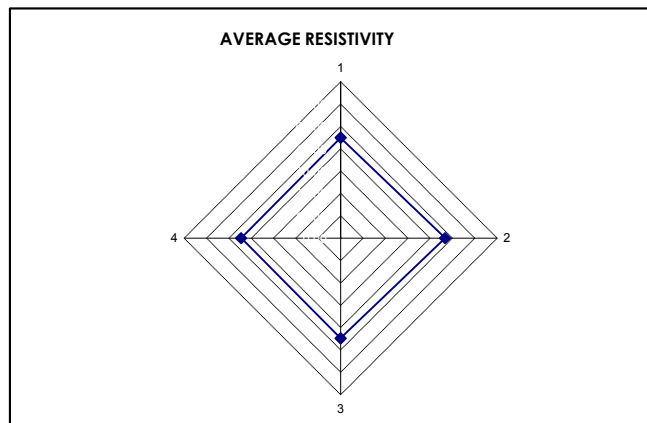
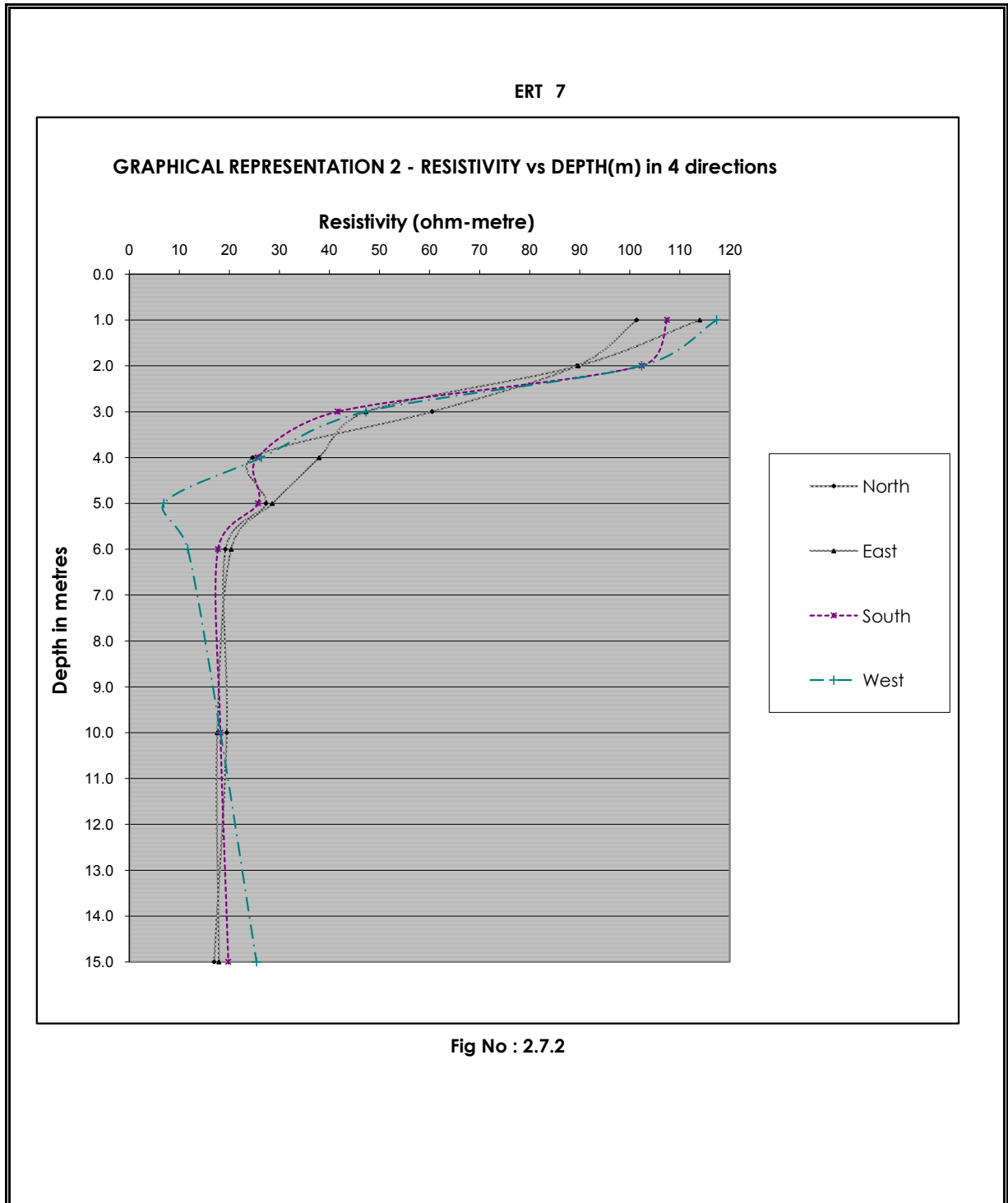


FIG NO 2.7.1

Average Resistivity at 15 m (ohm-meter) : 45.22

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 10 Ohm - m



ERT 7

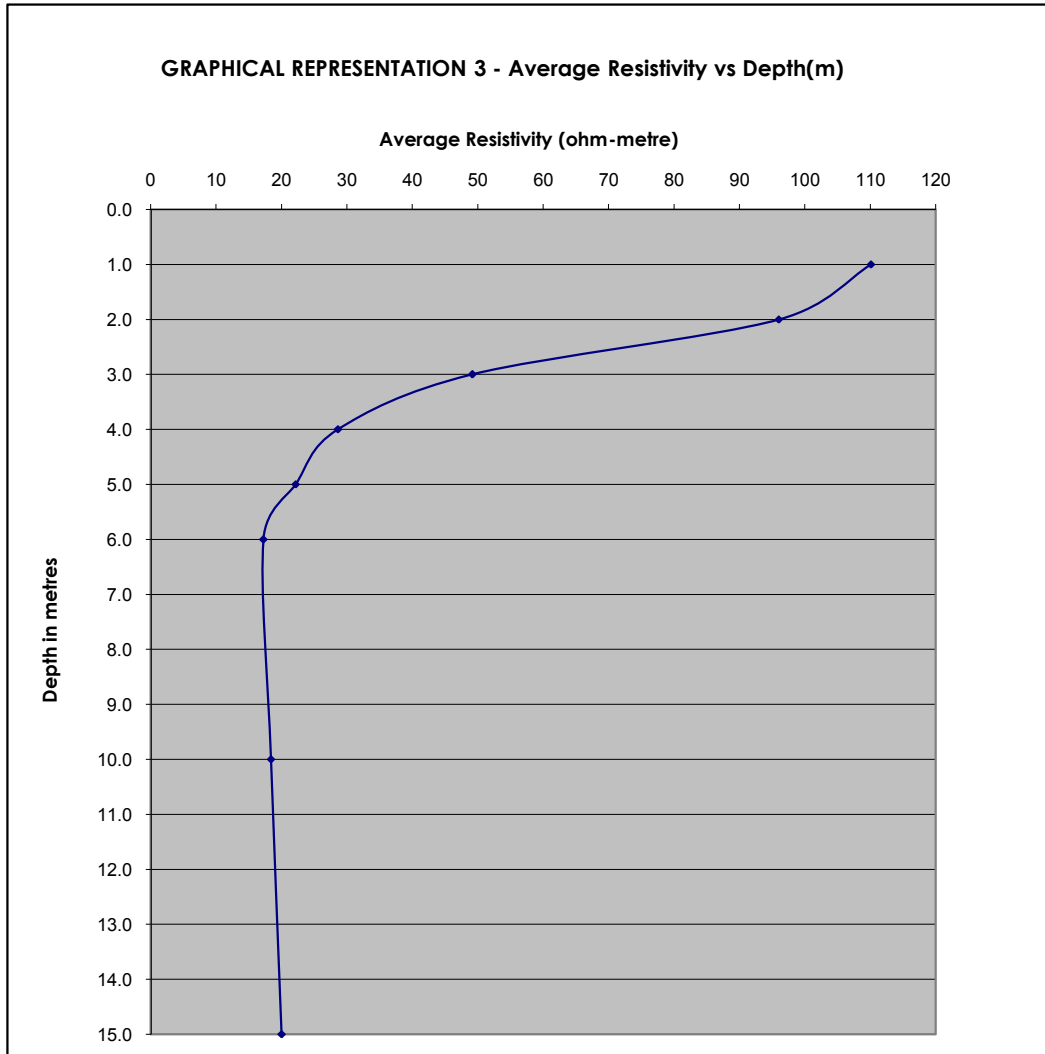


Fig No : 2.7.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 8

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	51.02	27.14	13.38	17.34	15.08	11.69	16.96	15.08	20.96
E	49.57	32.42	14.89	13.57	22.62	9.42	13.82	16.02	21.54
S	50.96	29.03	13.95	13.57	15.39	15.83	14.45	8.48	20.21
W	33.17	19.48	14.14	22.37	12.88	6.79	10.05	6.60	15.68

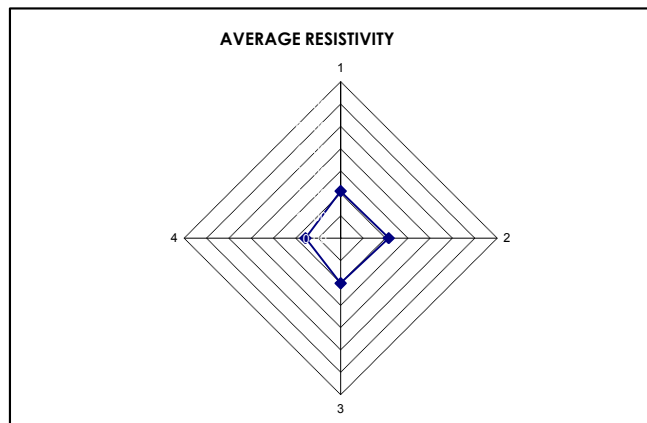
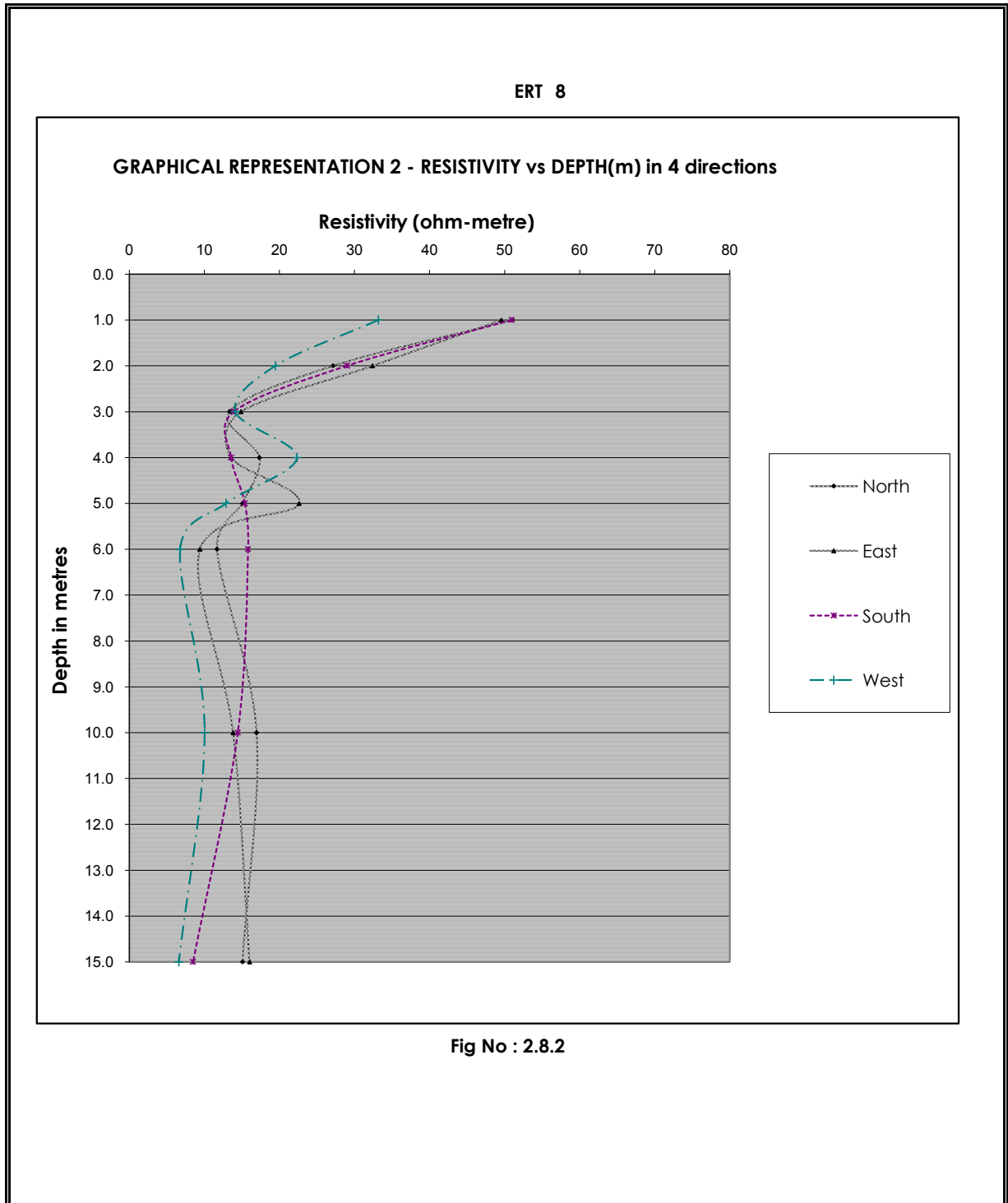


FIG NO 2.8.1

Average Resistivity at 15 m (ohm-meter) : 19.60

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 10 Ohm - m



ERT 8

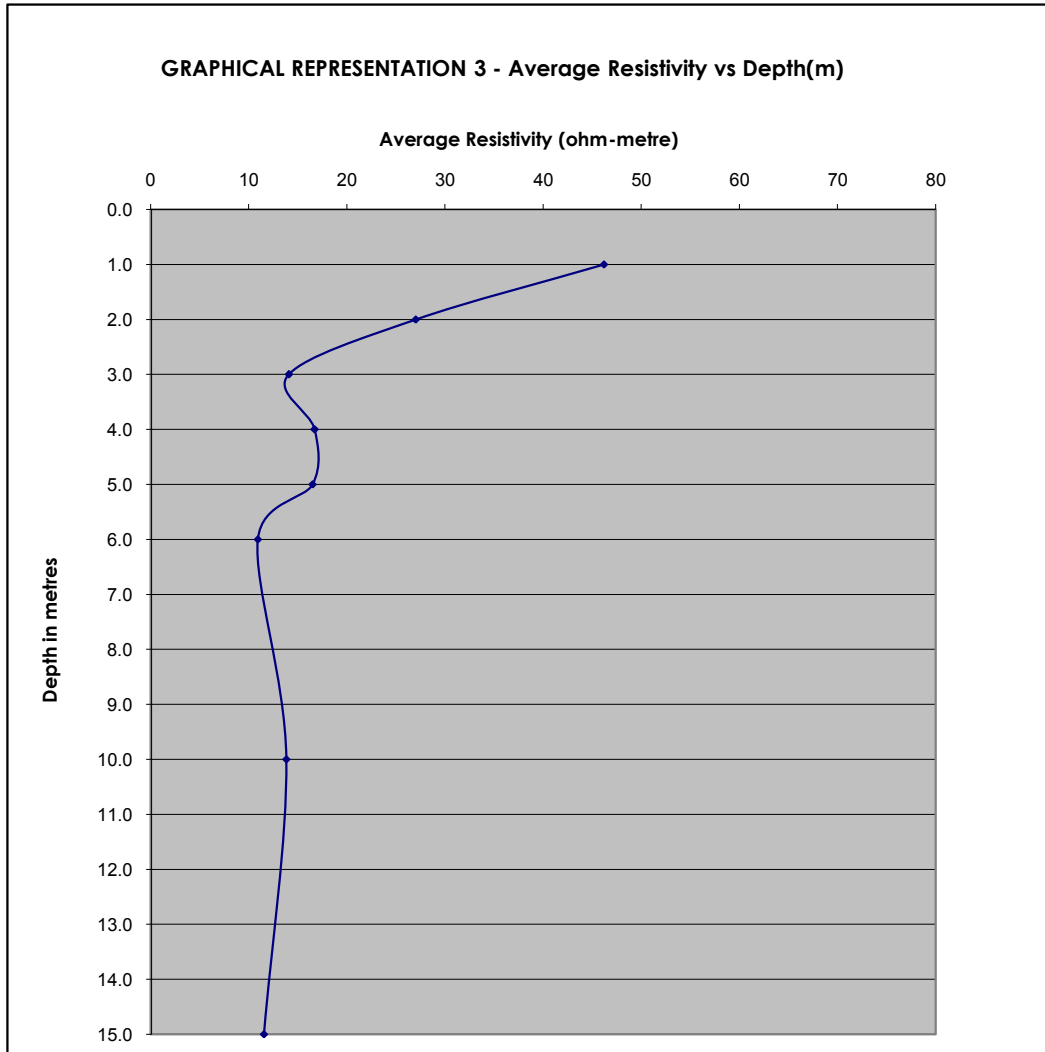


Fig No : 2.8.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 9

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	48.25	27.52	32.04	26.64	11.94	10.93	8.80	3.77	21.24
E	50.39	35.31	29.03	25.63	17.28	11.69	11.31	7.54	23.52
S	53.78	36.44	30.54	40.21	11.62	12.82	8.17	5.65	24.90
W	44.86	6.79	30.91	25.63	16.96	12.82	10.68	11.31	20.00

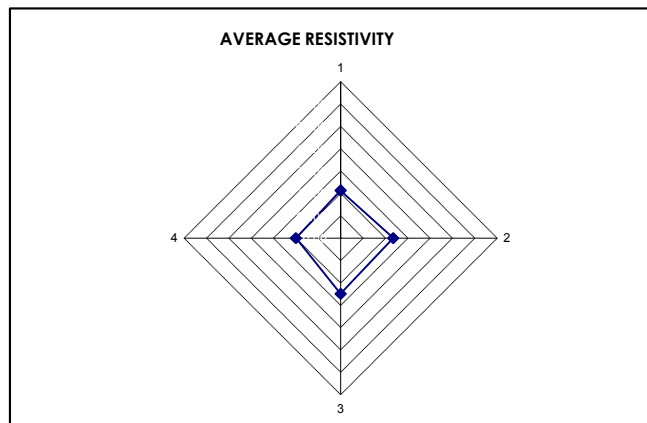
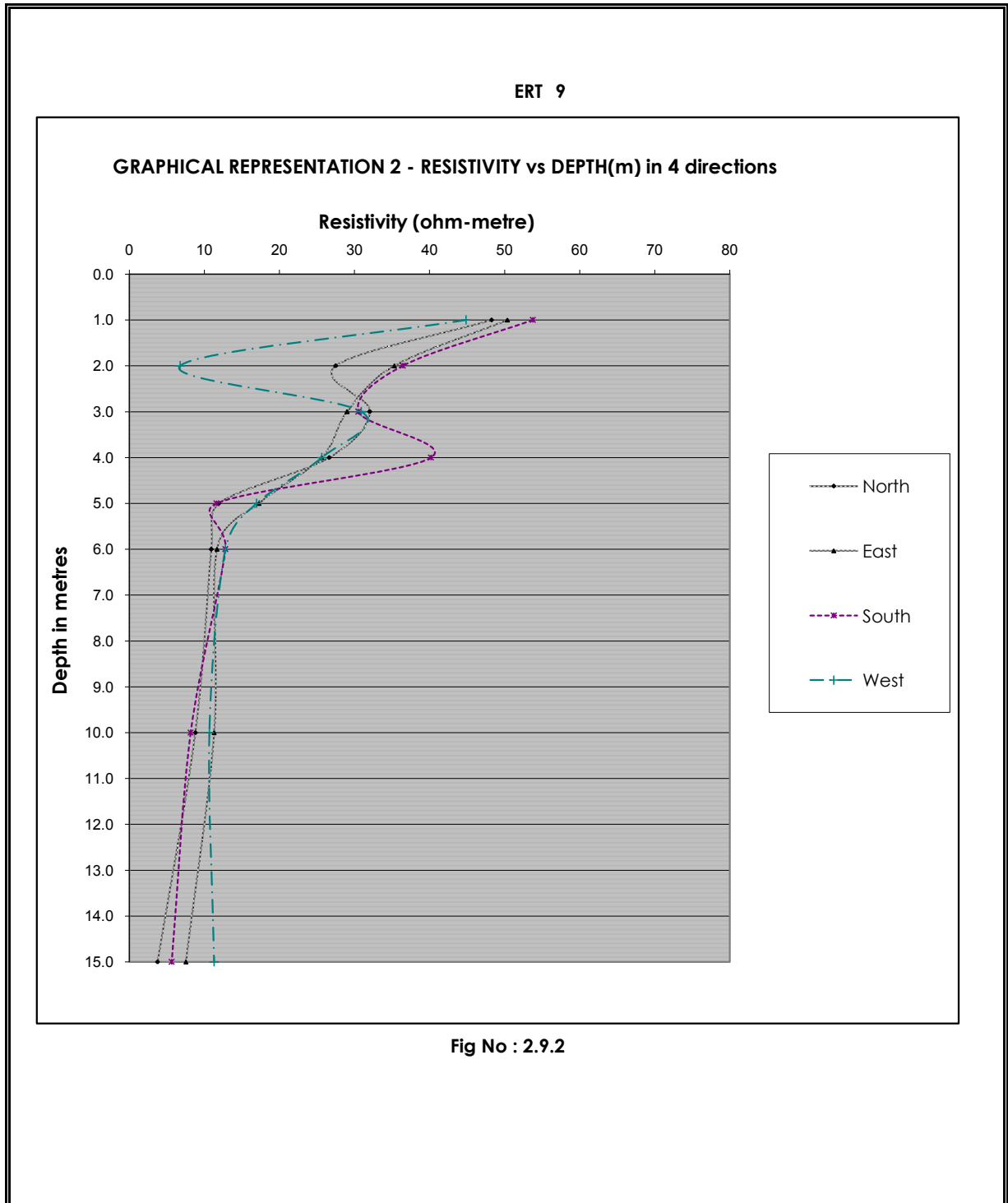


FIG NO 2.9.1

Average Resistivity at 15 m (ohm-meter) : 22.41

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 10 Ohm - m



ERT 9

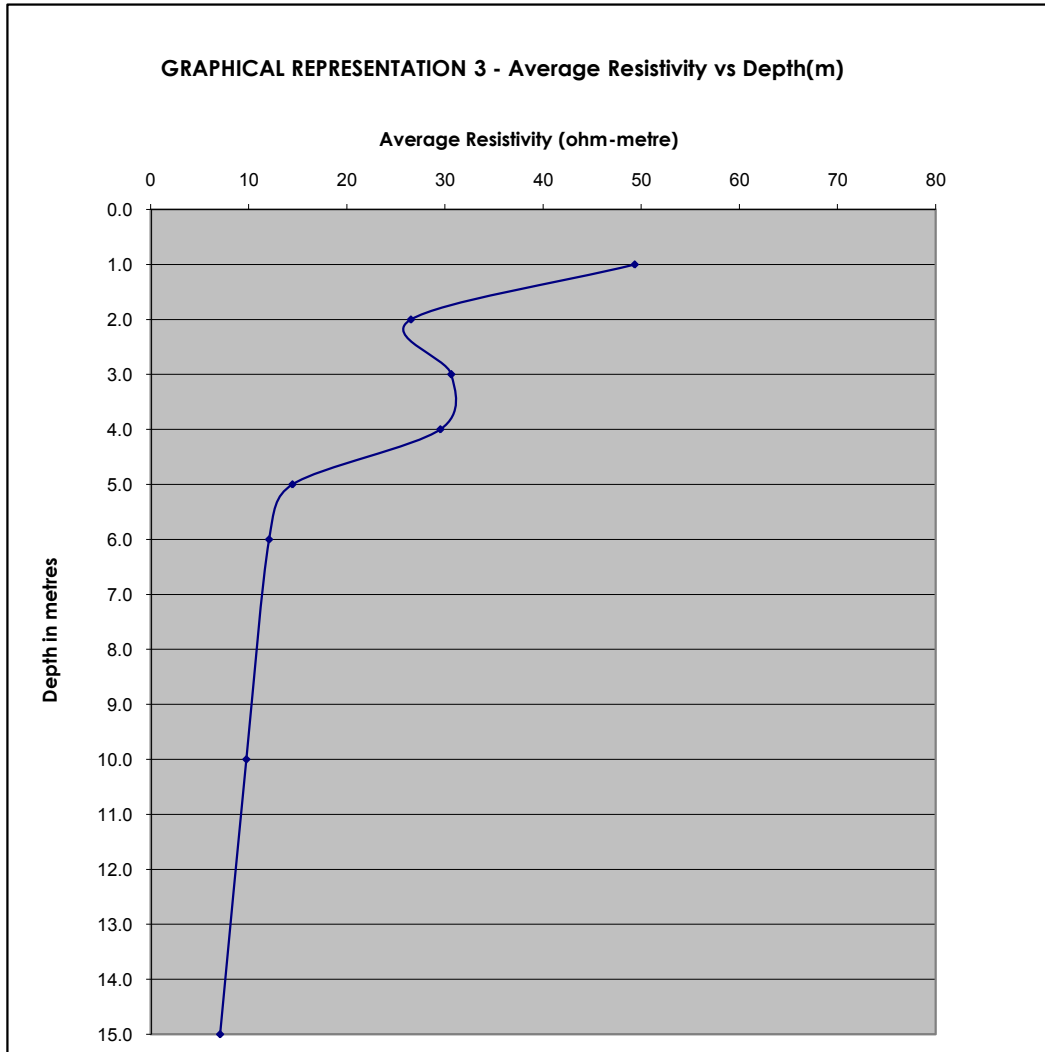


Fig No : 2.9.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 10

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	21.68	14.33	18.47	20.36	19.16	15.46	20.11	27.33	19.61
E	25.89	16.08	17.15	6.53	8.48	9.80	13.82	17.91	14.46
S	26.07	14.45	16.78	7.79	8.48	9.42	15.08	22.62	15.09
W	29.22	20.36	16.59	17.84	14.14	15.46	20.11	29.22	20.36

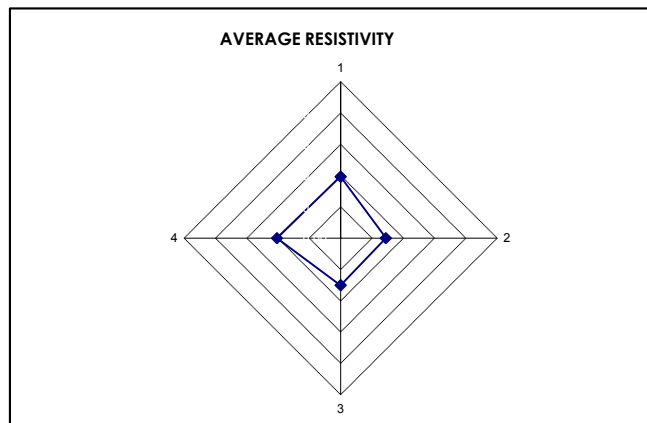
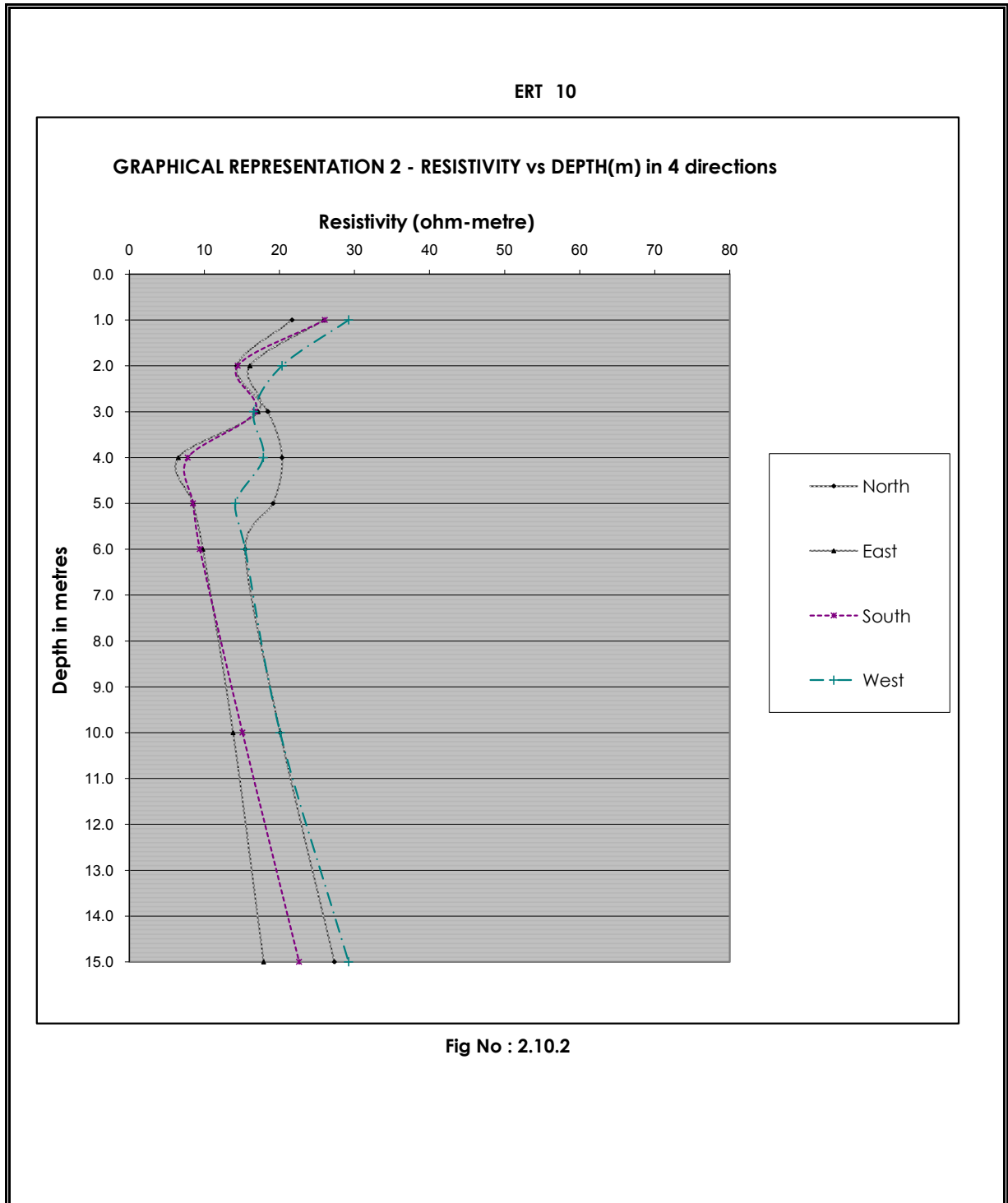


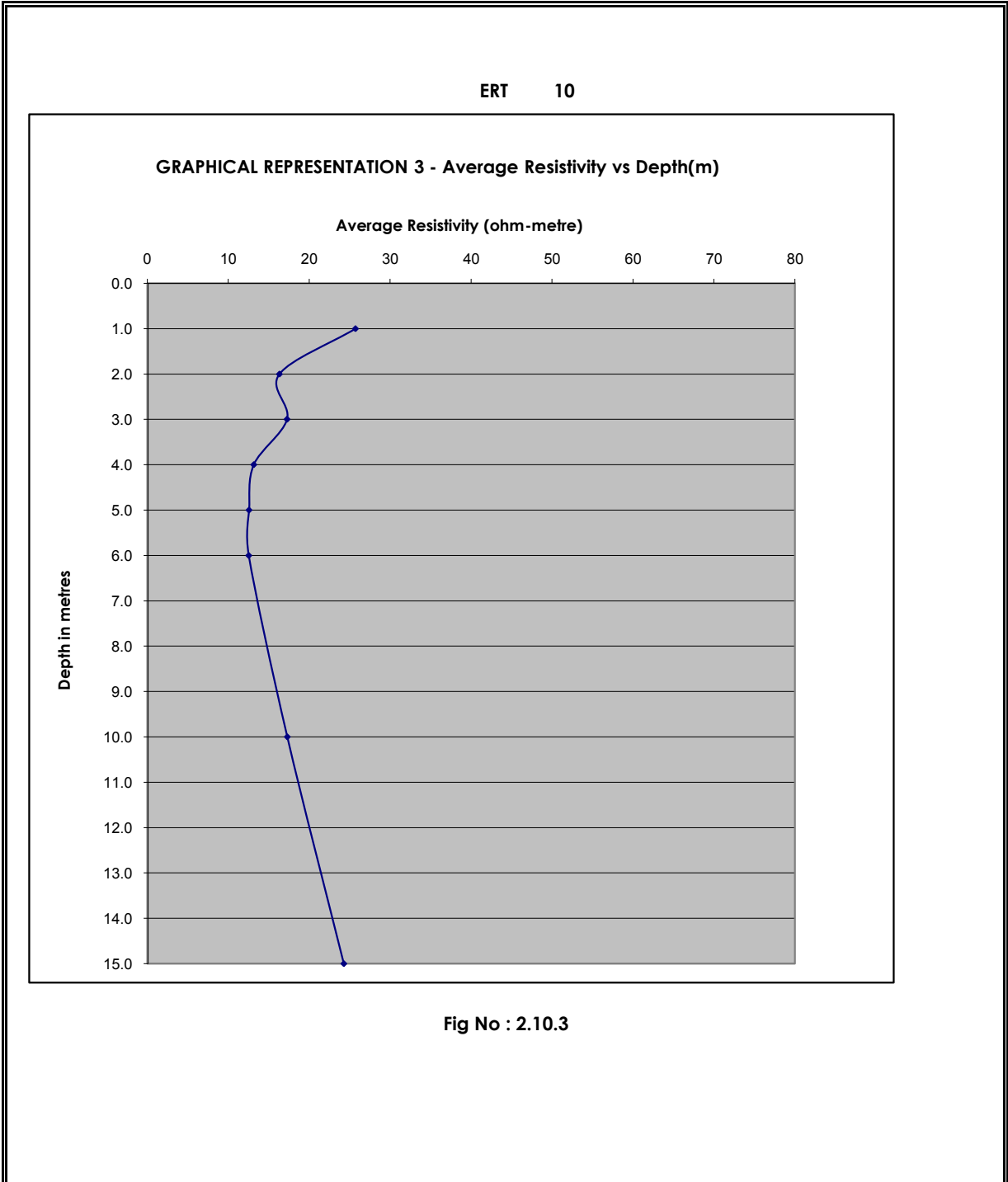
FIG NO 2.10.1

Average Resistivity at 15 m (ohm-meter) : 17.38

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 10 Ohm - m





GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 11

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	5.15	5.28	6.97	7.79	9.11	8.29	12.57	14.14	8.66
E	3.52	4.52	1.51	1.76	2.20	2.26	2.51	2.83	2.64
S	6.41	10.18	13.01	15.33	17.28	15.83	21.99	22.62	15.33
W	6.09	11.44	14.70	16.34	16.34	16.96	20.11	17.91	14.98

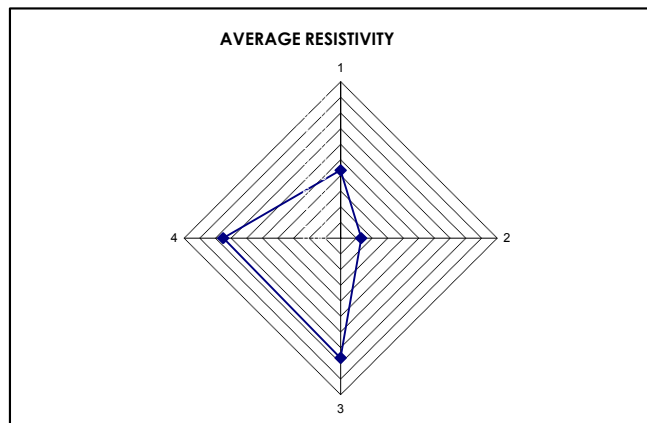
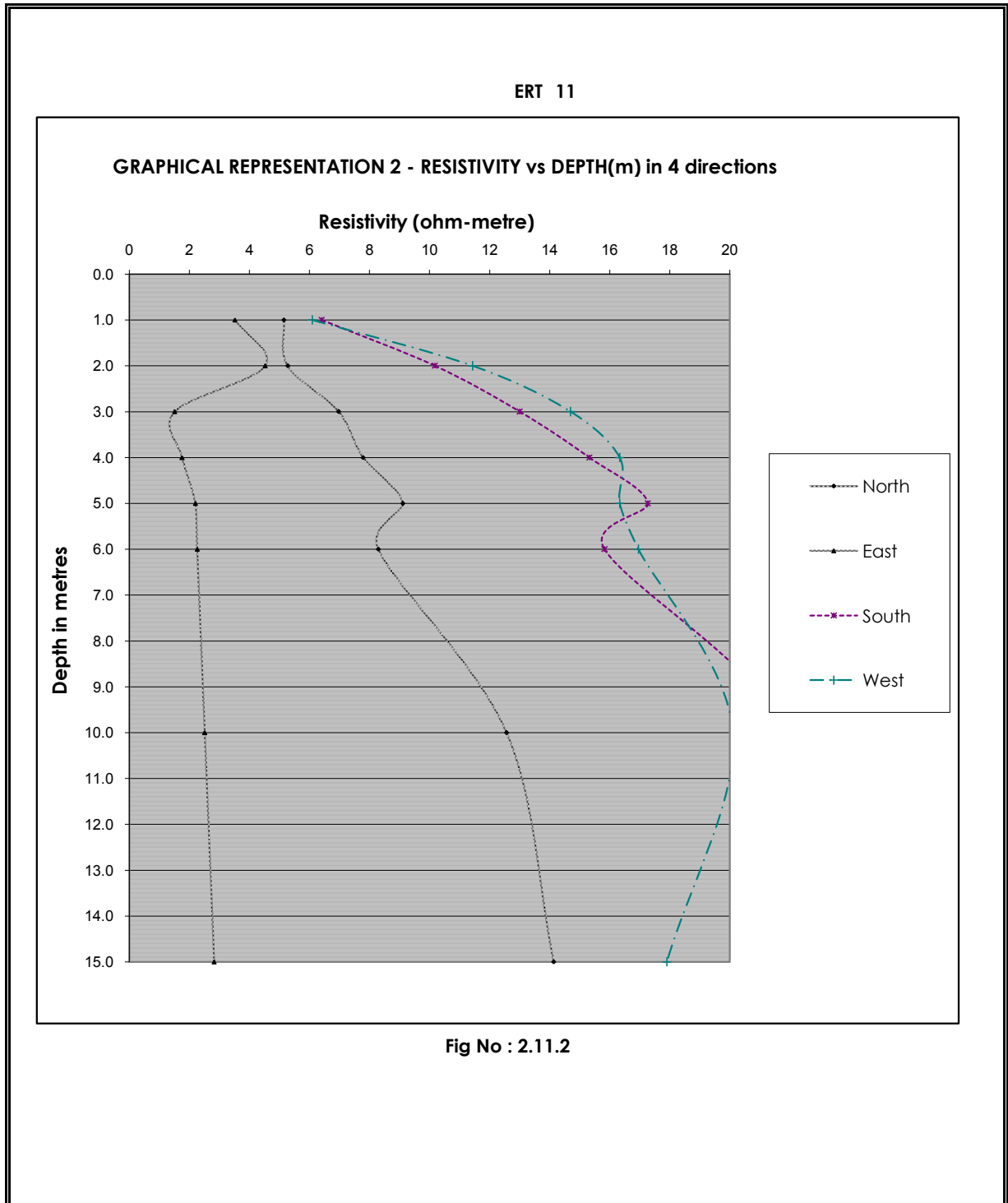


FIG NO 2.11.1

Average Resistivity at 15 m (ohm-meter) : 10.40

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 2 Ohm - m



ERT 11

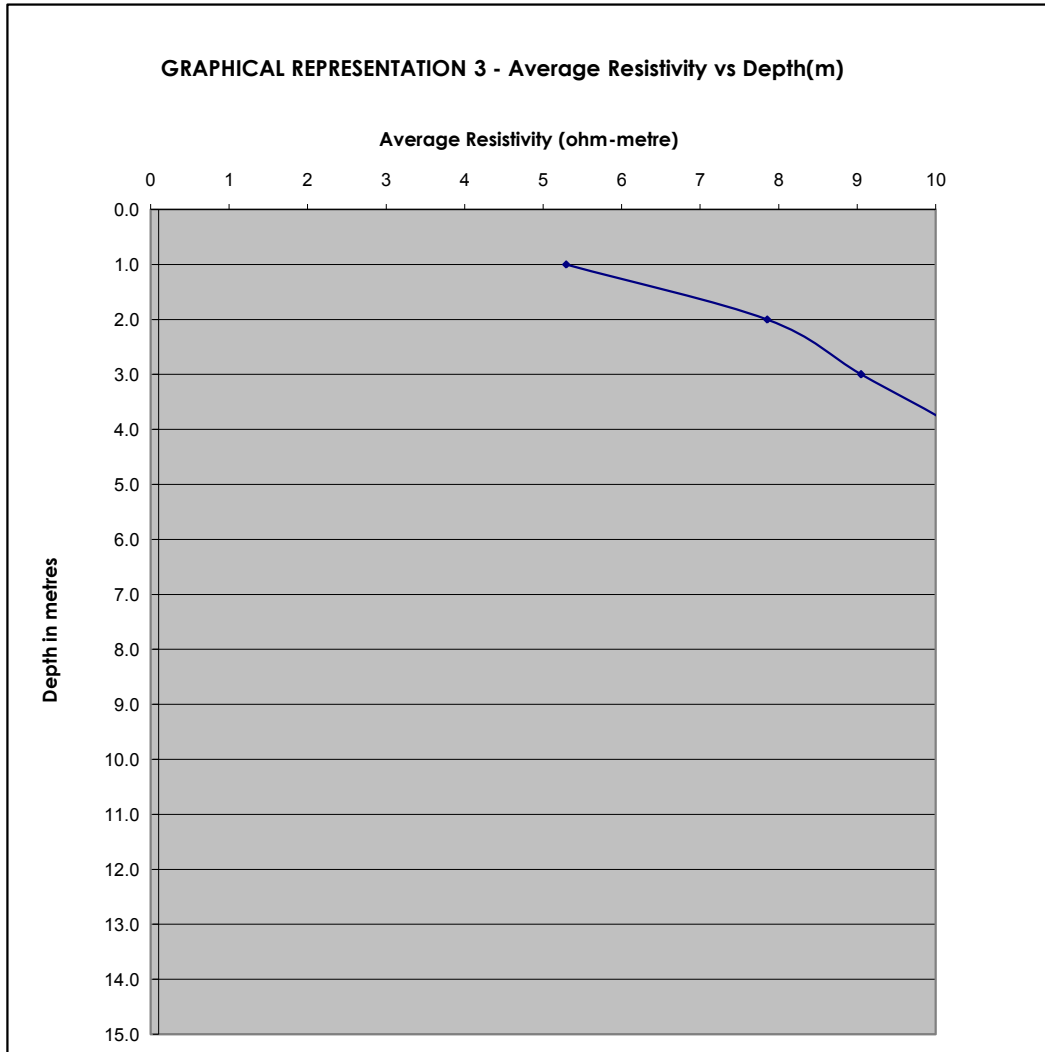


Fig No : 2.11.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 12

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	53.78	36.44	29.03	10.30	11.62	7.16	9.42	13.19	21.37
E	51.14	36.69	23.56	10.30	11.94	15.46	11.94	16.96	22.25
S	50.01	36.57	30.54	9.30	11.31	4.90	3.14	3.77	18.69
W	56.61	31.92	30.72	9.55	9.11	8.29	11.94	16.02	21.77

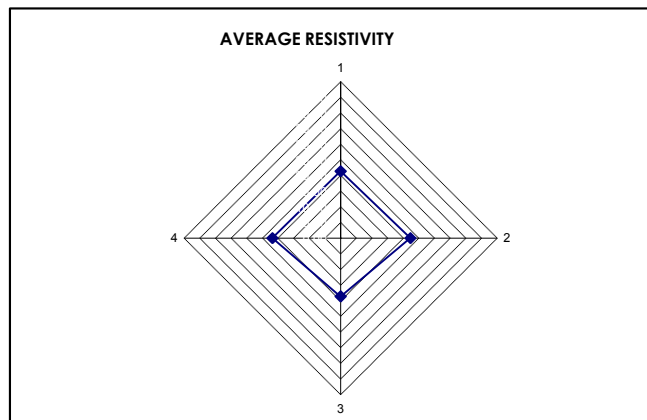
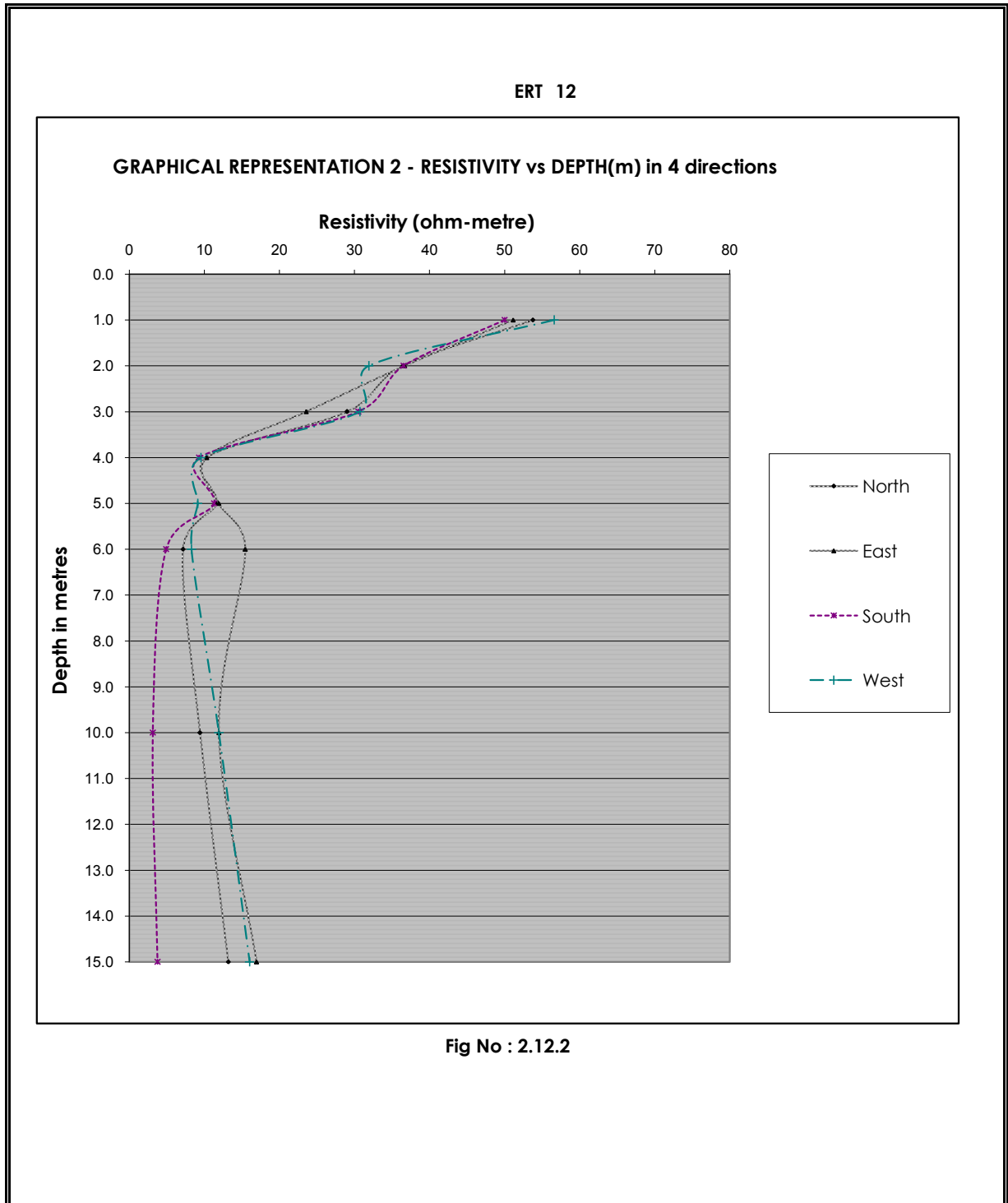


FIG NO 2.12.1

Average Resistivity at 15 m (ohm-meter) : 21.02

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 5 Ohm - m



ERT 12

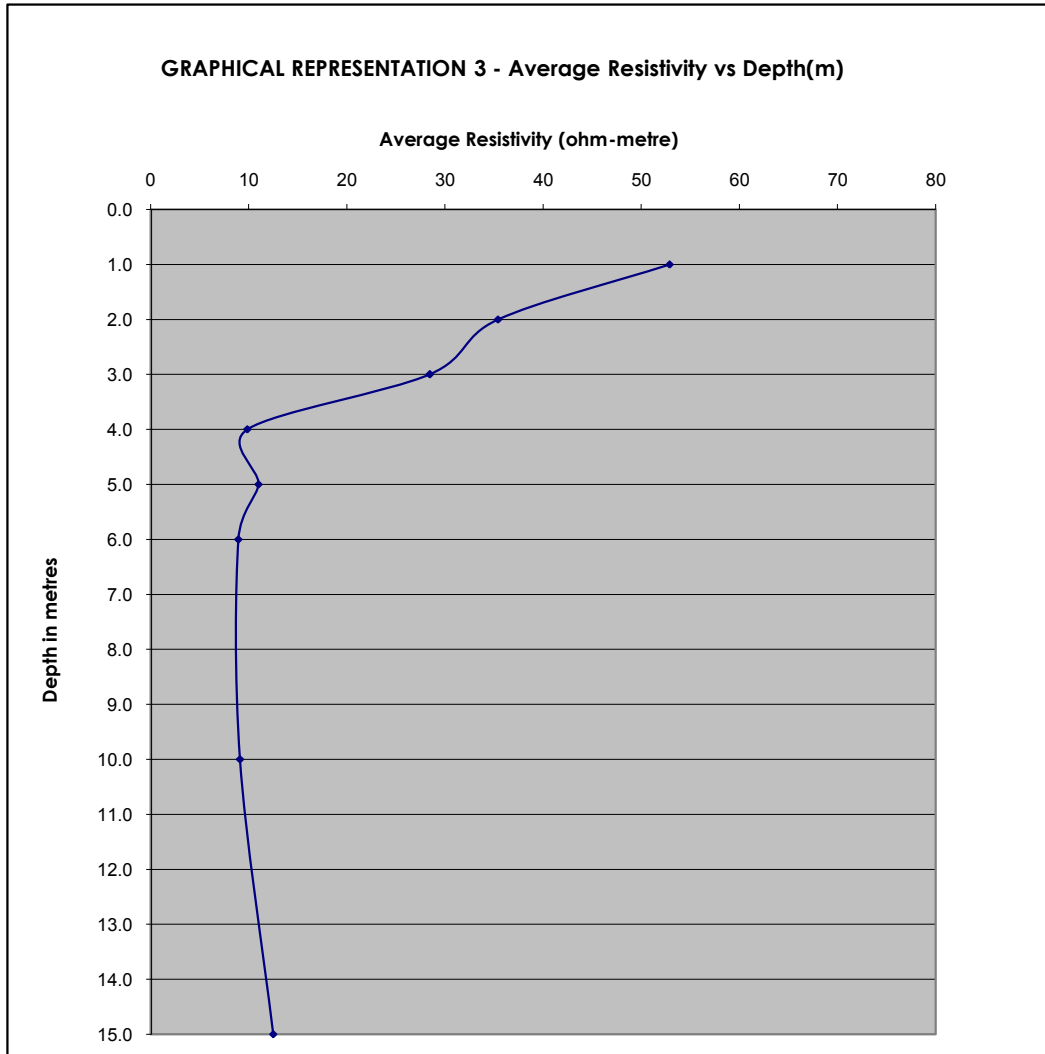


Fig No : 2.12.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 13

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	49.07	25.26	28.65	29.40	16.96	17.34	18.22	17.91	25.35
E	50.39	25.01	28.65	28.65	20.11	15.83	20.11	19.79	26.07
S	47.37	31.92	21.49	27.14	18.22	14.70	18.22	17.91	24.62
W	51.14	31.54	25.26	26.89	19.16	18.10	19.48	18.85	26.30

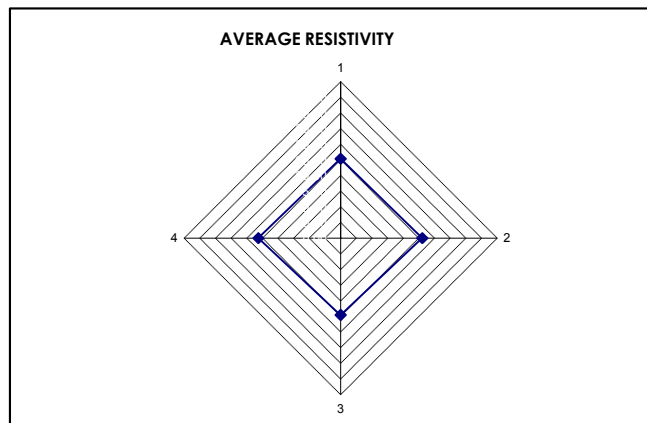
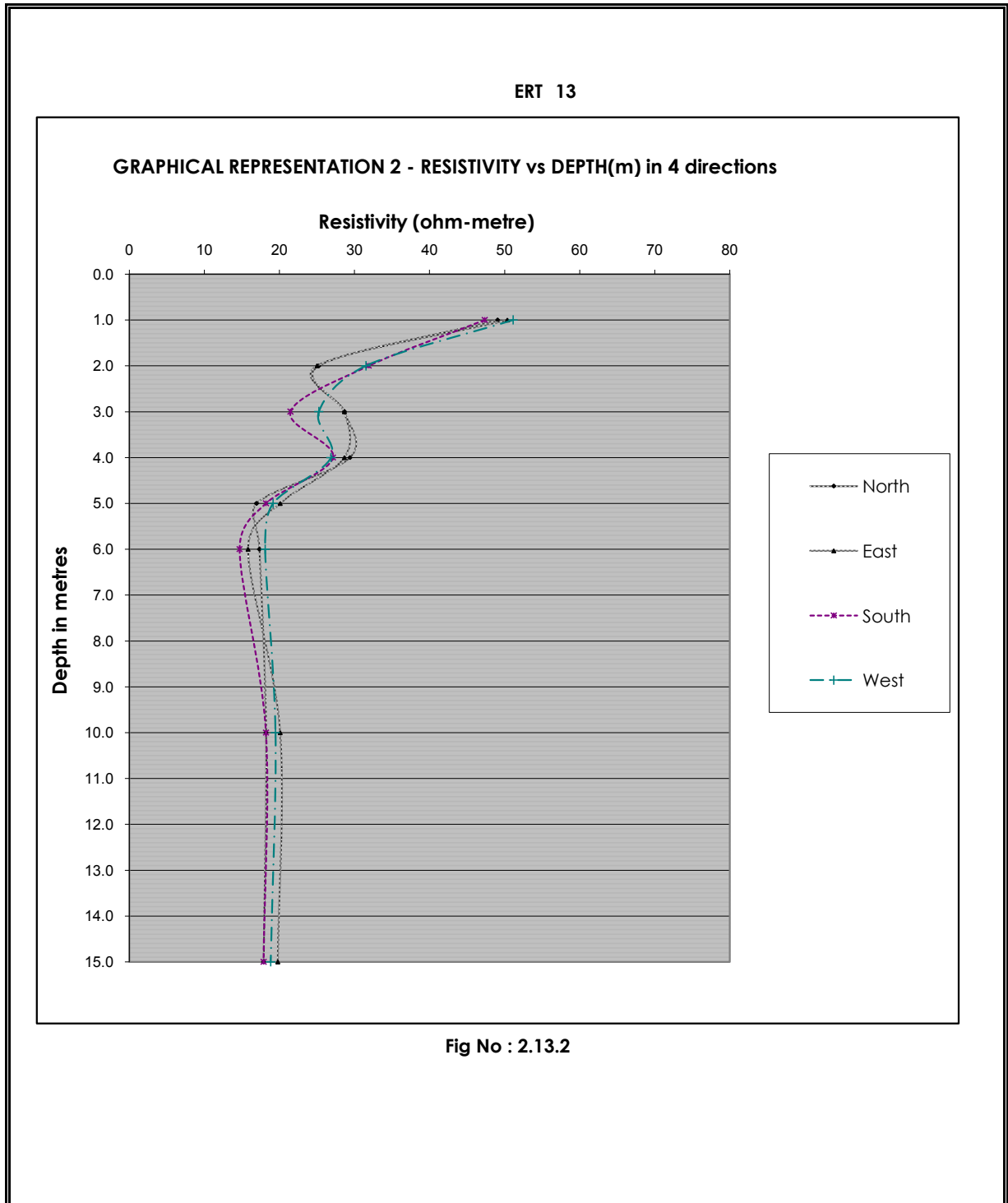


FIG NO 2.13.1

Average Resistivity at 15 m (ohm-meter) : 25.59

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 5 Ohm - m



ERT 13

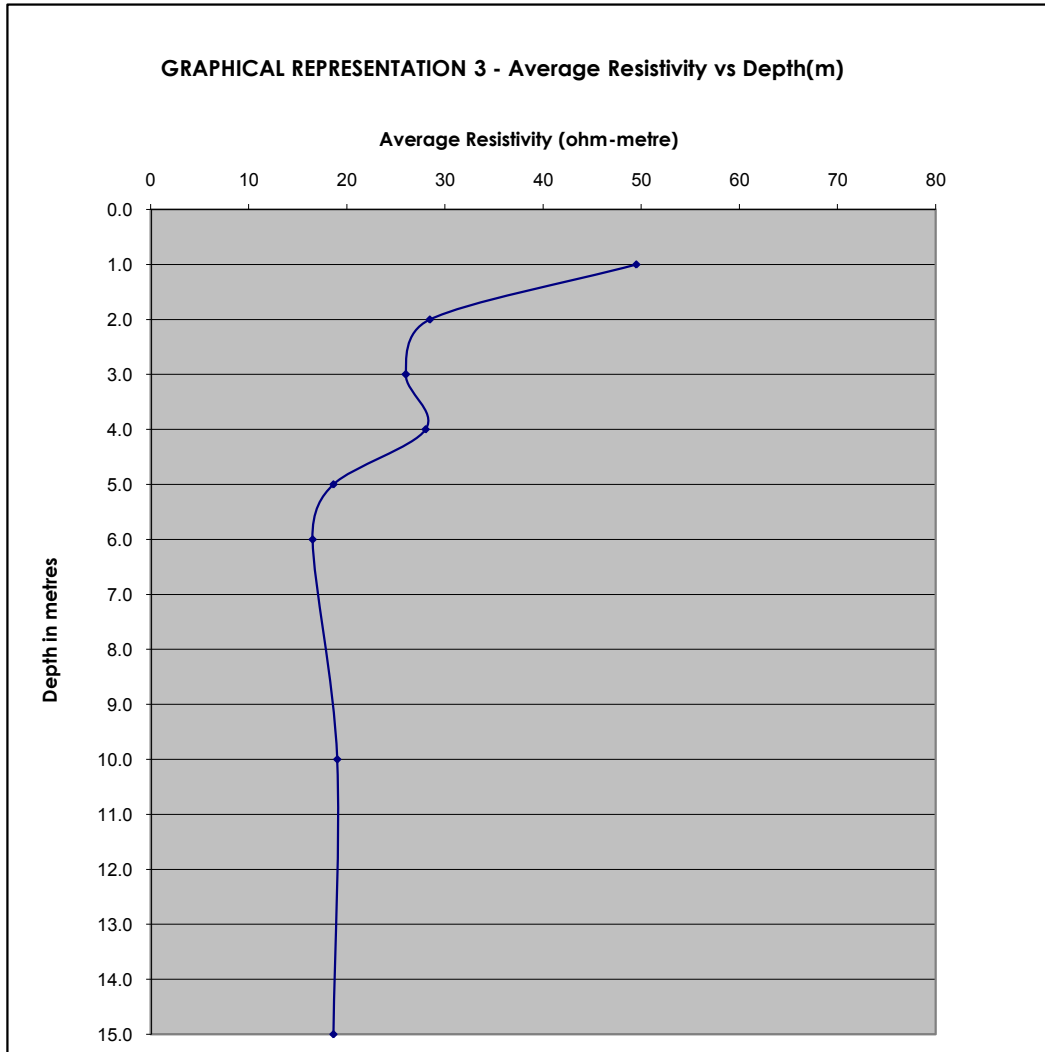


Fig No : 2.13.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 14

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	61.64	35.44	32.23	27.90	25.45	26.01	33.93	17.91	32.56
E	51.58	32.04	29.40	27.39	19.16	20.36	18.85	22.62	27.68
S	44.86	35.31	24.13	26.64	25.76	23.37	20.11	24.50	28.09
W	57.49	27.27	25.26	25.63	23.25	12.82	19.48	22.62	26.73

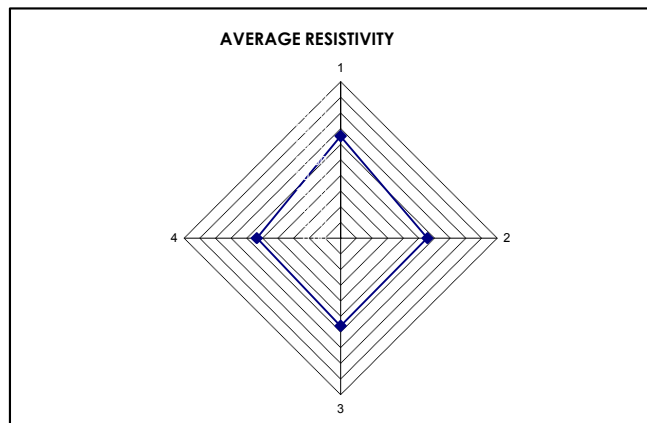
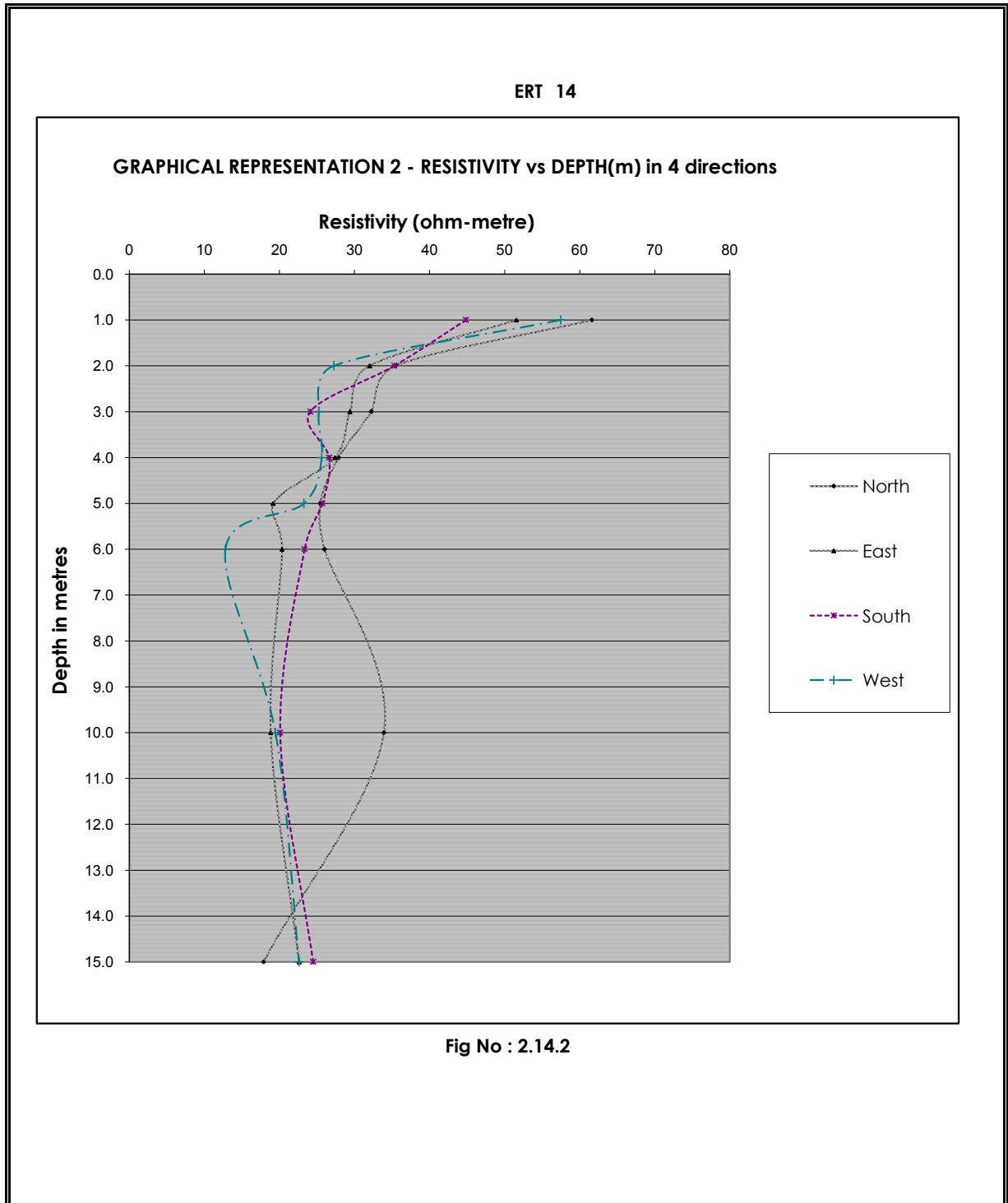


FIG NO 2.14.1

Average Resistivity at 15 m (ohm-meter) : 28.76

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 5 Ohm - m



ERT 14

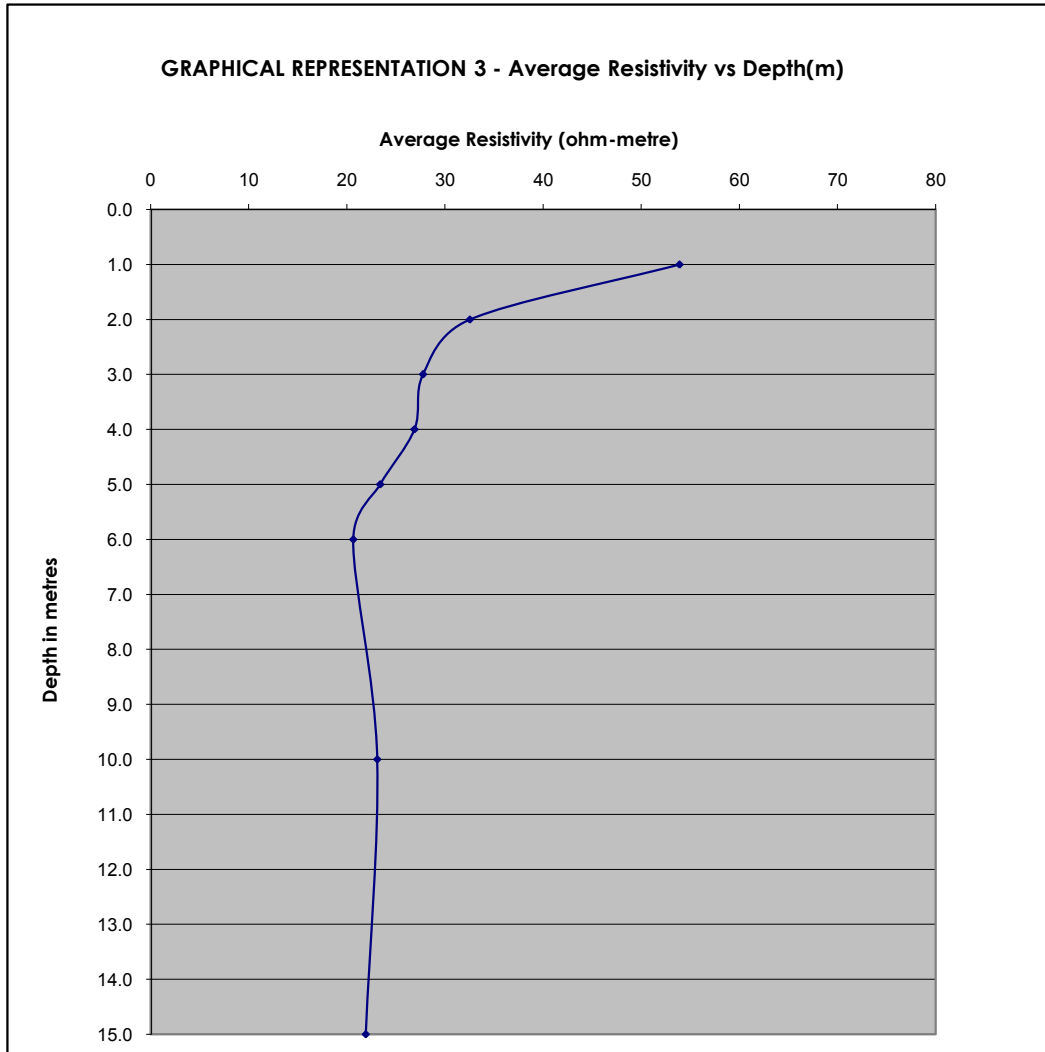


Fig No : 2.14.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT - 15

Direction	Average Resistivity in each direction								
	1 m	2 m	3 m	4 m	5 m	6 m	10 m	15 m	Avg.
N	50.39	36.06	32.42	26.89	30.79	16.96	21.99	17.91	29.18
E	51.27	31.92	30.72	25.89	23.88	21.86	21.36	20.73	28.45
S	49.70	35.31	29.03	26.39	21.68	20.36	19.48	16.96	27.36
W	57.43	29.15	29.97	30.41	25.13	10.56	13.82	15.08	26.44

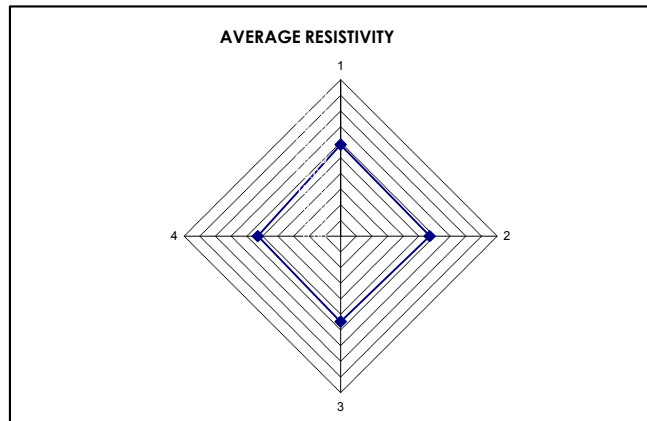
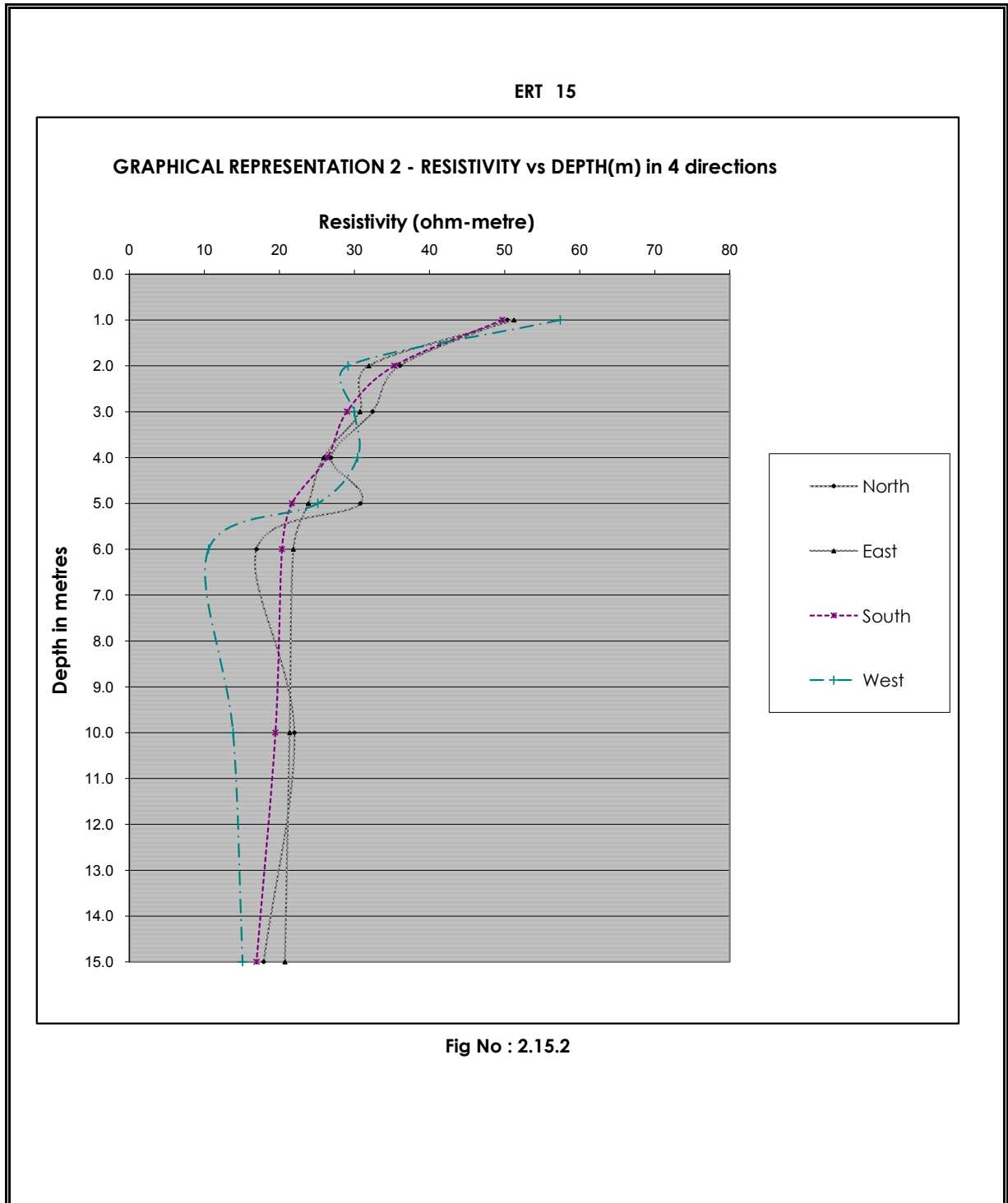


FIG NO 2.15.1

Average Resistivity at 15 m (ohm-meter) : 27.86

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 5 Ohm - m



ERT 15

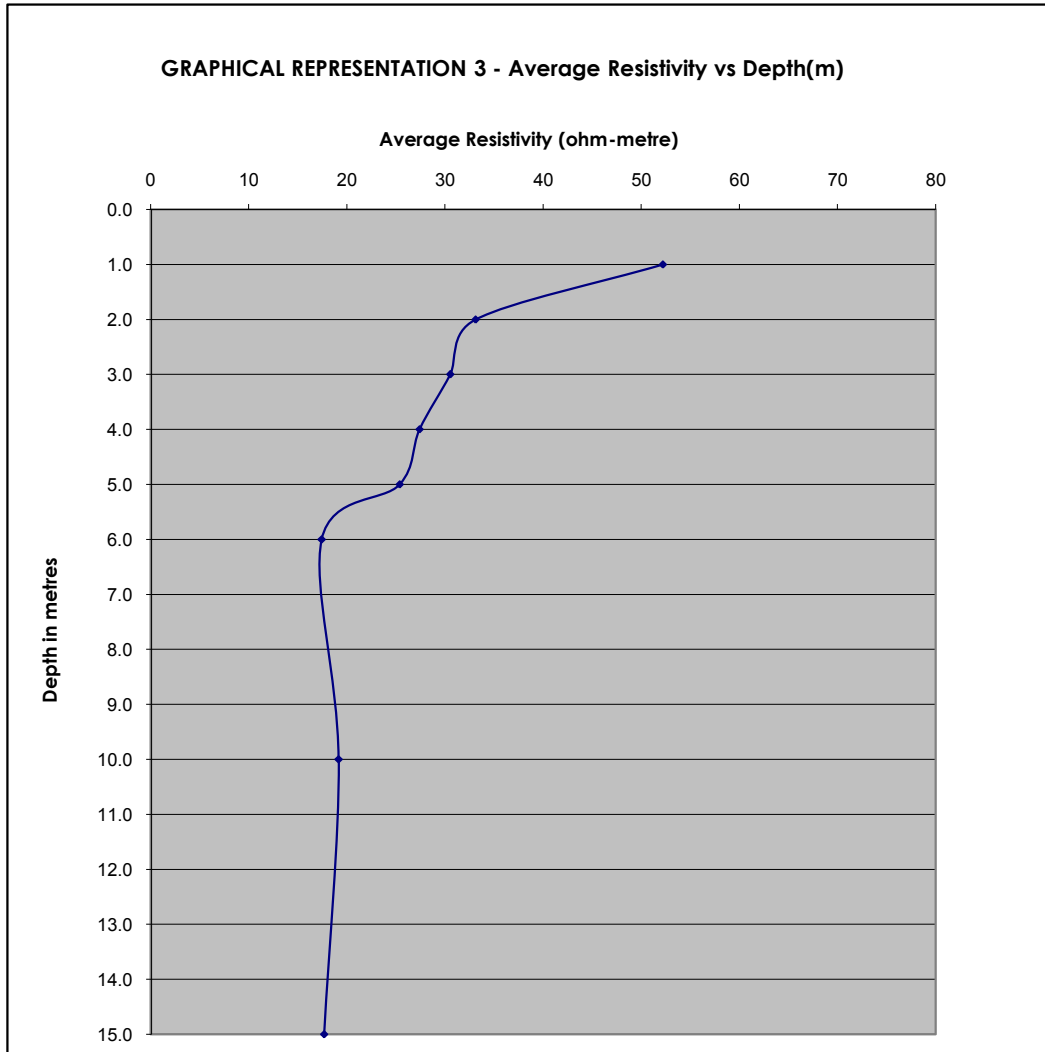
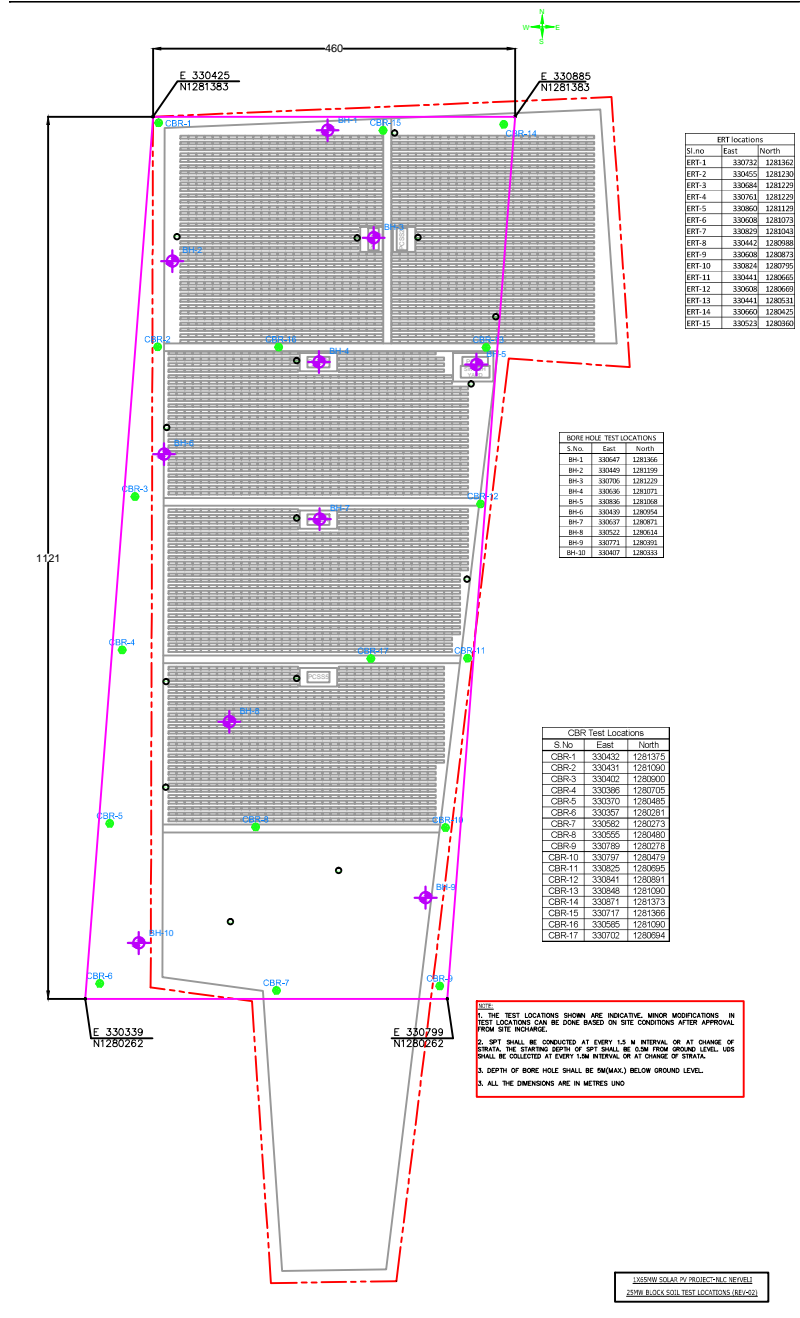


Fig No : 2.15.3

APPENDIX VI

**BORE HOLES LOCATION
DRAWING**



Sr. no.	East	North
ERT-1	330732	1281362
ERT-2	330455	1281230
ERT-3	330681	1281229
ERT-4	330761	1281229
ERT-5	330860	1281123
ERT-6	330608	1281073
ERT-7	330829	1281043
ERT-8	330442	1280988
ERT-9	330608	1280873
ERT-10	330624	1280795
ERT-11	330441	1280665
ERT-12	330608	1280660
ERT-13	330441	1280531
ERT-14	330660	1280425
ERT-15	330625	1280360

S.No.	East	North
BH-1	330427	1281366
BH-2	330489	1281199
BH-3	330796	1281229
BH-4	330306	1281073
BH-5	330386	1281068
BH-6	330439	1280954
BH-7	330617	1280873
BH-8	330521	1280854
BH-9	330771	1280839
BH-10	330427	1280333

S.No.	East	North
CBR-1	330432	1281375
CBR-2	330421	1281042
CBR-3	330402	1280900
CBR-4	330396	1280705
CBR-5	330370	1280465
CBR-6	330357	1280281
CBR-7	330362	1280273
CBR-8	330355	1280463
CBR-9	330389	1280278
CBR-10	330797	1280479
CBR-11	330625	1280895
CBR-12	330441	1280891
CBR-13	330848	1281090
CBR-14	330871	1281373
CBR-15	330717	1281595
CBR-16	330585	1281090
CBR-17	330702	1280984

NOTE:
 1. THE TEST LOCATIONS SHOWN ARE INDICATIVE. MINOR MODIFICATIONS IN TEST LOCATIONS CAN BE DONE BASED ON SITE CONDITIONS AFTER APPROVAL FROM SITE INCHARGE.
 2. BPT SHALL BE CONDUCTED AT EVERY 1.0 M INTERVAL OR AT CHANGE OF STRATA. THE STARTING DEPTH OF BPT SHALL BE 0.3M FROM GROUND LEVEL. LOGS SHALL BE COLLECTED AT EVERY 1.0M INTERVAL OR AT CHANGE OF STRATA.
 3. DEPTH OF BORE HOLE SHALL BE (0)MAX. BELOW GROUND LEVEL.
 4. ALL THE DIMENSIONS ARE IN METRES UNDO

ISSUED SOLELY FOR REFERENCE ONLY
 2016 BLACK SOIL TEST LOCATIONS (REV.02)