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Selection of Groundwater Potential Zones Using Geophysical Exploration Studies in Muguru Addahalla Watershed, Mysuru and Chamarajanagar Distcricts, Karnataka, India.

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ABSTRACT: *Rapid expansion of urban and industrial sectors expanding agricultural domains has put great stress on groundwater, consequently the stress on ground water exploration. The necessity of evaluating the extent of subsurface water bearing horizons and the quantum of water available has considerably enhanced the role of geophysical prospecting. Geophysical study, which works on the physical properties of bedrocks and weathered zone can provide useful information on significant features of subsurface stratigraphy and structure. This in turn helps in locating sites for groundwater exploitation, with greater precision. Geophysical study also helps in measuring aquifer characteristics. Geophysical study is also vital to determine the lateral extent, thickness and the volume of a formation which in turn helps in estimating the depth of an aquifer and of the hydrostatic level. Evaluation of the total porosity, water stored in an aquifer system is also studies carried by geophysical investigations. Electrical resistivity methods are the most popular among them. Also the connection between resistivity and ground water hydraulic conductivity in hard rock terrains is highly significant.*

Keywards: *Bedrocks, Thickness, Hydrostatic level, hydroelectric conductivity, Hardrock Terrains.*

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I. INTRODUCTION

The presure on both surface and subsurface resources is increasing mainfold globally. In the recent years due to several water demanding factors like population explosion, spreading urbanization, rapid industrialization, extensive irrigation the demand has also increased in an unexpected manner. Geeophysical study has been carried out with knowledge of geology and geomorphology of the area. Electrical method, which is the best suited method, is used in the present study to understand the aquifer characteristics and their potential for groundwater storage. This study is conducted to study the vertical or the lateral variation of the resistivity of the subsurface geologic formations. The lateral electrical variation can be clearly detected by electrical profiling method. In this method, the electrode array, along a line is moved from place to place on the horizontal surface along a chosen path. The apparent resistivity values at a particular depth at different points reflect the lateral variations of resistivity in the sub-surface geological formation. The resistivity sounding curves are interpreted by using well known technique of curve matching with the theoretical master curves (Orellana and Mooney, 1966) for horizontally stratified formation in conjunction with auxiliary point chart. The knowledge of geology and structural features provides a good background for geophysical study. Satellite imageries provide a great deal of precision in the location of points for geophysical study. As an example a fault line in the field may not be able to be recognized, because of the masking effect of weathering. But an imagery, which provides a synoptic view of any terrain, can show the fault line clearly and overlaying of such features with toposheets helps to locate the structure with greater precision. Satellite imageries also provide valuable clues on the nature of bedrocks, their susceptibility of erosion, lithological contacts topographic expression, drainage pattern, joints and their pattern, vegetation and soil cover large scale lineaments which are all very helpful delineating correct areas for geophysical study.

II. STUDY AREA:

The Muguru Addahalla watershed spreads in two districts viz. Mysore and Chamarajanagar in southern part of Karnataka (**Fig 1**). The spatial extent of the study area is 248.827 sq km. The area is covered in Survey of India toposheet numbers 57D/16, 58A/13 and 57H/4. It is bound by North Latitude of 11˚ 58’ 20.78’’ N to 12˚ 12’33.67” N and East longitude of 76˚ 52’ 50.34” E to 76˚ 59’ 25.68” E. The topomap and image of the area is shown in (**Fig 2 and Fig 3**). The area is well connected with all-weather roads (**Fig 4**).

III. PHYSIOGRAPHY:

Physiographically, Muguru Addahalla watershed forms the 'Southern Maidan' region of Karnataka. It is bound by the Doddasampige Reserve Forest area in the east and Suttur village in the west. The River Cauvery drains in the North and city Chamarajanagar is located at the south. The Muguru Addahalla stream originates at Ummathur Gudda ("Gudda" means mound, in the regional language) in the south and it joins the Cauvery River near the village Ayyanurhundi. The maximum elevation of the area is 900 m (AMSL) at Ummathuru Gudda and minimum is 540m (AMSL) seen at Muguru Addahalla, where it joins the Cauvery River. The rest of the area constitutes very gently dipping plains, dissected by shallow rivulets. Much of the area is under cultivation.

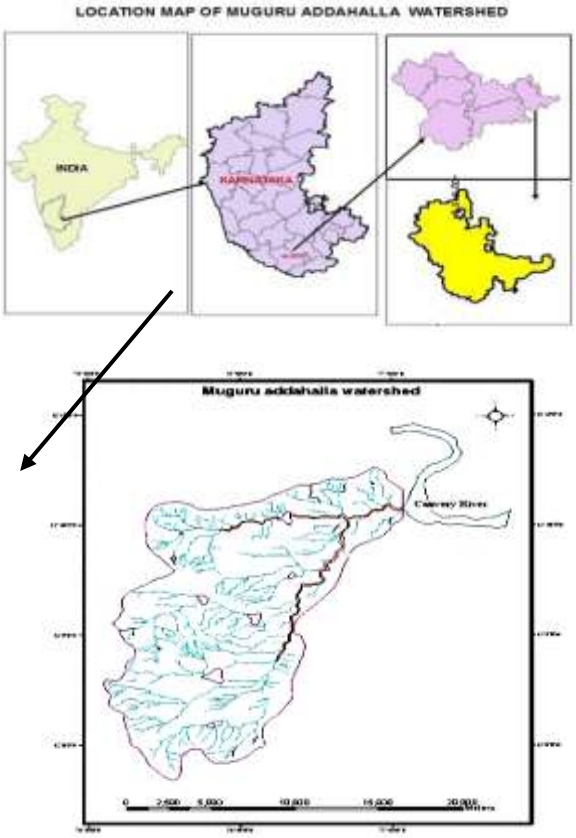


Fig 1: Location map of the Muguru Addahalla watershed

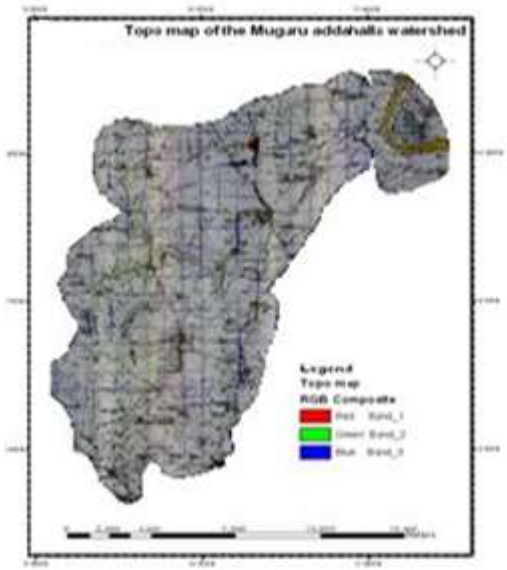


Fig 2: Topo map of the Muguru Addahalla watershed (Merged toposheets of 57D/16, 58A/13 and 57H/4)

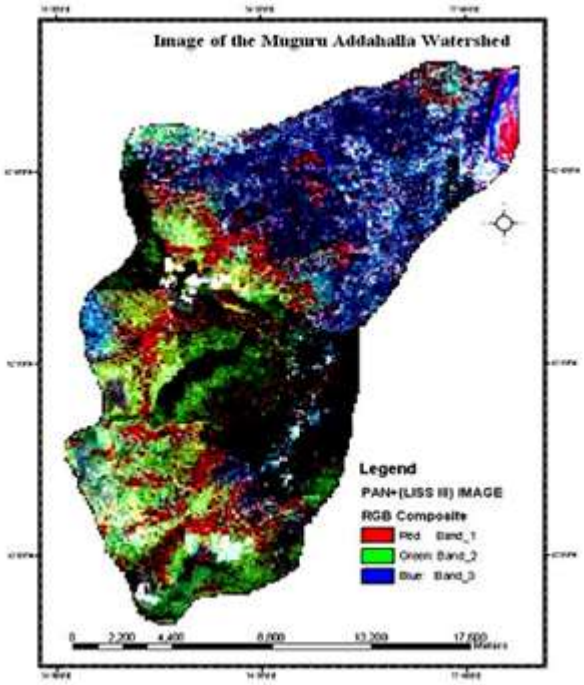


Fig 3: Image of the Muguru Addahalla Watershed

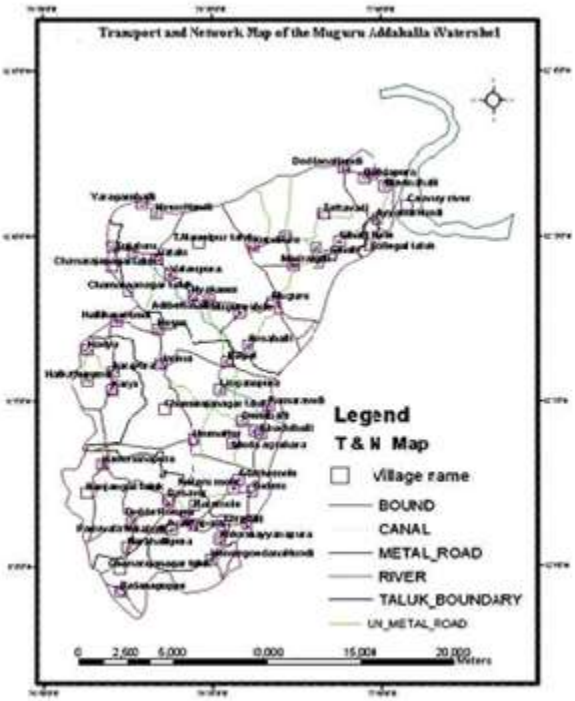


Fig 4: Transport and Network Map of the Muguru Addahalla Watershed

IV. MATERIAL AND METHODS:

In the recent decades, extensive studies have been made for ground water exploration in hard rock terrains using Geophysical Exploration. A series of measurements of resistivity are made by increasing the electrode spacing in successive steps. This method of vertical exploration is known as the expanding electrode method. It is used to study the variation of resistivity with depth. The depth of penetration is controlled by the separation of the current electrodes C1 and C2 which carry the current. An electrical sounding consists of a succession of Apparent resistivity measurements made with an increasing electrode distance. The arrangement of the four electrodes on the ground surface is referred to as the array or configuration. Geophysical

characteristics of this method are elaborated by which provide a comprehensive review of Wenner and Schlumgerger configurations, and are generally used in groundwater studies.

4.1 Wenner configuration:
In the case of 'Wenner arrangement' the 4 electrodes are arranged in straight line with constant distance of separation. By successively increasing the electrodes separation the resistivity is measured.

4.2 Schlumberger configuration:

In depth probing by the Schlumberger arrangement, the electrodes M and N are kept fixed but the electrodes A and B are moved further away on either side i.e increasing the interval 'a' (AB/2) in successive steps and the resistivity values for one setting of MN are obtained. With these arrangements deep probing can be made in two or more settings by increasing the spacing of the potential electrodes and then moving out the current electrodes. These configurations (Wenner's and Schlumberger's) are shown in **Image.1 and 2** respectively.

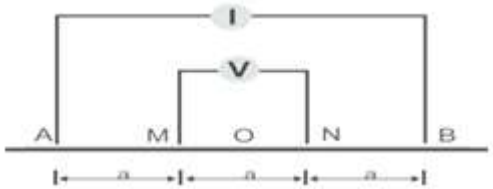


Image.1: Wenner configuration

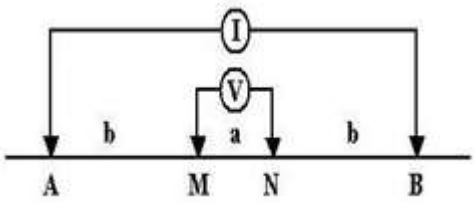


Image.2: Schlumberger configuration

VES data interpretation:

Interpretations of vertical electrical sounding were carried out by curve matching method. Apparent resistivity values (ρa) are calculated from field data and are plotted against half current electrode separation (AB/2), on double log graph paper, and smooth curve is drawn for each of the curves which are matched with the master curves.

Software Techniques:

The software developed numerical computer automated fit of resistivity data making the data interpretation fast and more accurate. Modern computer software's are readily available which can be run to find out AB/2 value against Apparent resistivity. In the present study area Resist 87 software has been used to plot 5 layer thickness of AB/2 against resistance of the earth.

Data interpretation of the study area

The Vertical electrical sounding values (VES) of the study area Survey have been carriedout 19 locations. In 19 VES soundings were collected and interpreted using soft wares RESIST 87 of five layer method. Using software excel, resistance (Ohm mt) V/s AB/2 in (mt) have been plotted. The vertical electrical soundings were carried out using Schlumberger method. The locations of the geophysical survey were Karya (1sounding), Marahallipura (2 sounding), Demahalli (1sounding), Badanaguppe (3 sounding), Muguru (1sounding), Thoravalli (1sounding), Bagali (3sounding), Hyakanuru (2sounding), Doddapura (1sounding), Ummathuru (1sounding), Jennuru Hosuru (1sounding), Kuderu (1sounding), and Adibettahalli (1sounding). The resistivity curves and data of the AB/2 /ρa values are shown in Fig.1.2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18 and 19. Correspondingly the Tables 1 to 10 show the resistivity data and related bore hole location points are shown in the **Fig 5**. Based on the VES soundings and other parameters like lithology, geomorphology, soil condition, slope, structures, depth of weathering vegetation, condition of existing bore wells and water bodies, suitable areas of potential groundwater have been identified.

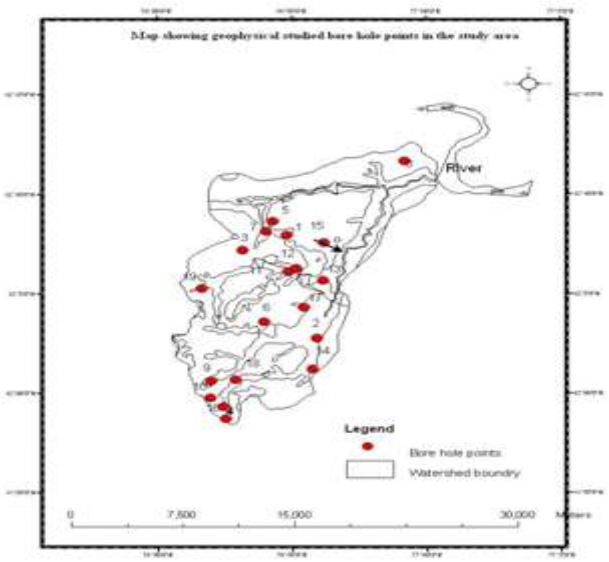


Fig 5: Map Showing Geophysical studied bore hole pointspoints in the study area

Table 1. Geophysical resistivity data of Adibettahalli and Kuderu area

Serial.no	AB/2	MN/2	Constant	Fig. 6/Ves	Resistance	Fig. 7/Ves	Resistance
1	2	0.5	12	-	-	-	-
2	3	0.5	27.5	-	-	-	-
3	4	0.5	49.5	-	-	-	-
4	4	1	23.5	-	-	-	-
5	6	1	55	-	-	-	-
6	8	1	99	-	-	-	-
7	10	1	155.5	-	-	-	-
8	10	2	75.5	0.074	5.587	0.146	11.023
9	15	2	173.5	0.042	7.287	0.092	15.962
10	20	2	311	0.036	11.196	0.064	19.904
11	20	5	118	0.094	11.092	0.168	19.824
12	25	5	188.5	0.076	14.326	0.128	24.128
13	30	5	275	0.064	17.6	0.106	29.15
14	35	5	377	0.057	21.489	0.09	33.93
15	40	5	495	0.047	23.265	0.075	37.125
16	45	5	628.5	0.037	23.25	0.066	41.481
17	50	5	777.5	0.032	24.88	0.116	90.16
18	50	10	377	0.077	29.029	0.093	35.061
19	60	10	550	0.07	38.5	0.079	43.45
20	70	10	754	0.051	38.454	0.07	52.78
21	80	10	989.5	0.045	44.53	0.061	60.36
22	90	10	1257	0.041	51.532	0.05	62.85
23	100	10	1555	0.038	59.09	-	-
24	100	20	754	-	-	-	-

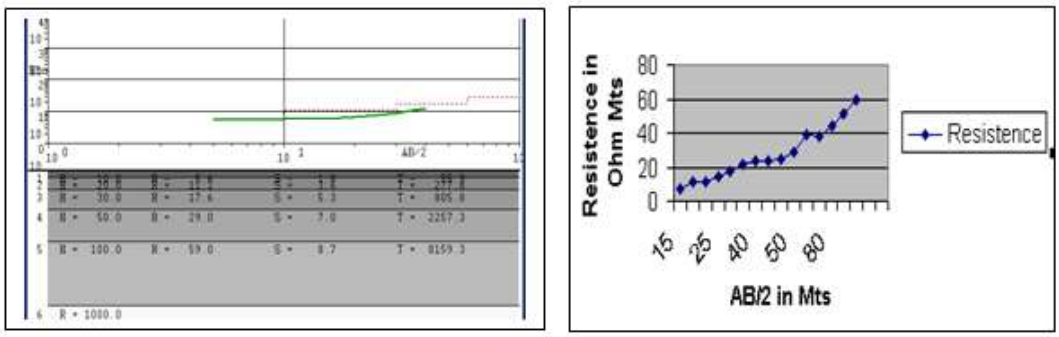


Fig.6 Geophysical resistivity curve map for Adibettahalli area

Interpretation of VES data for the village Adibettahalli

Here a single sounding has been carried out and its data is given in **Table 1** and graphically shown in **Fig.6**.The depth of the sounding is 240-300 ft, weathered zone is estimated to be 15-20 ft. It has a moderately weathered zone of 8-30 ft and a soil cover of 8 ft. moderately hard rock with minor joints is estimated at a depth of 30-75 ft. Above 75 ft hard and compact rock can be encountered. It is in pediplain shallow region. The estimated yield in this site is 800-900 ft. Close to this site a canal course passes through which could have influenced the ground water recharge, as can be seen from the VES data.

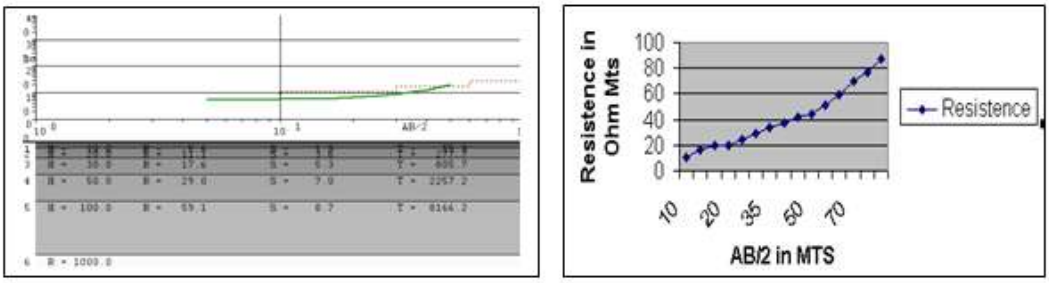


Fig .7 Geophysical resistivity curve map for Kuderu area

Interpretation of VES data for the village Kuderu

This site is in pediplain moderate region and is under rain fed area. Here one sounding has been carried out and the depth of sounding is 240-294 ft, in which weathered zone is 10-50 ft. Soil cover is deciphered to be 10 ft; jointed weathered zone 50-120; gradually hardened jointed bed rock at above 120 ft. Here the estimated yield is 600 ga. The VES data is given in **Table 1** and the data is graphically shown in **Fig.7**.

Table 2. Geophysical resistivity data of Jennuru Hosuru and Badanaguppe area

Serial.no	AB/2	MN/2	Constant	Fig. 8/Ves	Resistance	Fig. 9/Ves	Resistance
1	2	0.5	12	-	-	-	-
2	3	0.5	27.5	-	-	-	-
3	4	0.5	49.5	-	-	-	-
4	4	1	23.5	-	-	-	-
5	6	1	55	-	-	-	-
6	8	1	99	-	-	-	-
7	10	1	155.5	--	-	-	-
8	10	2	75.5	0.066	12.533	0.832	62.816
9	15	2	173.5	0.108	18.738	0.306	53.09
10	20	2	311	0.035	26.435	0.478	148.658
11	20	5	118	0.136	16.048	0.391	46.138
12	25	5	188.5	0.148	27.398	0.248	46.748
13	30	5	275	0.098	26.95	0.184	50.6
14	35	5	377	0.081	30.537	0.158	59.566
15	40	5	495	0.062	30.69	0.126	62.37
16	45	5	628.5	0.053	33.31	0.113	71.0205
17	50	5	777.5	0.043	33.43	0.102	79.305
18	50	10	377	0.089	33.553	0.217	81.809
19	60	10	550	0.068	37.4	0.184	101.2
20	70	10	754	0.049	36.946	0.175	116.87
21	80	10	989.5	0.044	43.538	0.155	116.87
22	90	10	1257	0.045	56.505	0.137	135.05
23	100	10	1555	0.054	83.92	0.12	150.09
24	100	20	754	-	--	-	-

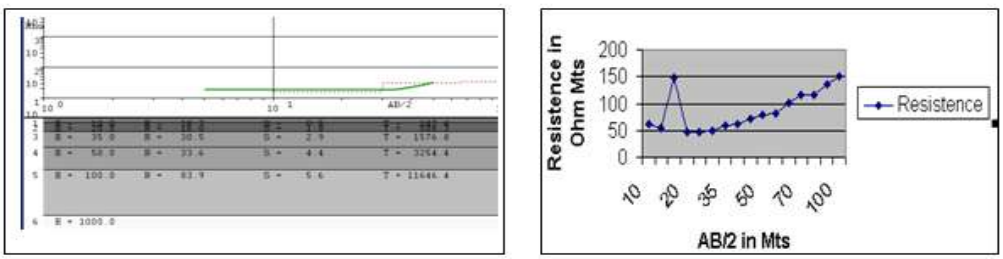


Fig.8 Geophysical resistivity curve map for Jennuru Hosuru area

Interpretation of VES data for the village Jennuru Hosuru

Here one sounding has been carried out and the data is presented in **Table.2**, and graphically shown in **Fig.8**. The total depth of the sounding is 270-300, and the weathered zone is 30-60 ft. moderately weathered zone is deciphered to be at 60-120 ft. Hard rock with minor joints is at 120-150 ft. Soil cover has a thickness of 30 ft. Hard and compact rock is above 150 ft. It falls under pediplain shallow region and the approximate yield estimated is 500-550 gallon.

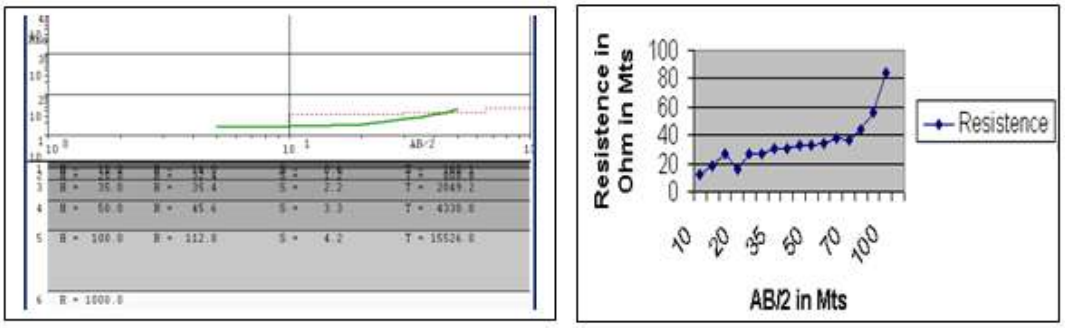


Fig.9: Geophysical resistivity curve map for Badanaguppe area

Interpretation of VES data for the village Badanaguppe

Here 3 soundings have been carried in different locations surrounding the village. The data is shown in **Tables 2, 6** and **9** and graphically presented in **Figs.9, 15, and 21**. In the first sounding total depth of sounding is 255 ft; weathered zone 20 ft; weathered foliated zone 20-30 ft; jointed rock 30-50 ft; jointed column rock 50-108 ft hard and compact rock is above 108 ft. This site is in pediplain moderate. Approximate yield calculated for this well is 600-800 ga. The second sounding has a total penetration of 250-288 ft with an approximate weathered zone of 18-24 ft. Soil cover is inferred to be 6 ft in thickness. Highly fractured zone has a depth of 20-185 ft, whereas hard and compact rock occurs at over 185 ft. It falls in pediplain shallow region of rain fed area. The yield is estimated to be 450-500 ga which is in moderate yield category. The thired sounding was for a depth of 255-300 ft with a weathered zone of 24-30 ft. The soil overburden is inferred for a depth of 15 ft. highly fractured zone has a depth of 25-180 ft. Hard and compact rock is encountered above 180 ft. Estimated yield from this site is 400-450 ga. This site is in pediplain shallow.

Table 3. Geophysical resistivity data of Hyakanuru and Ummaturu area

Serial.no	AB/2	MN/2	Constant	Fig.10/Ves	Resistence	Fig.11/Ves	Resistance
1	2	0.5	12	-	-	-	-
2	3	0.5	27.5	-	-	-	-
3	4	0.5	49.5	-	-	-	-
4	4	1	23.5	-	-	-	-
5	6	1	55	-	-	-	-
6	8	1	99	-	-	-	-
7	10	1	155.5	-	-	-	-
8	10	2	75.5	0.212	16.006	0.222	16.761
9	15	2	173.5	0.127	20.345	0.124	21.514
10	20	2	311	0.097	30.167	0.086	24.368
11	20	5	118	0.19	32.42	0.227	26.786
12	25	5	188.5	0.138	26.013	0.17	22.045
13	30	5	275	0.116	31.9	0.134	36.85
14	35	5	377	0.094	35.438	0.23	86.31
15	40	5	495	0.08	39.6	0.174	96.03
16	45	5	628.5	0.066	46.481	0.166	104.33
17	50	5	777.5	0.06	46.65	0.149	115.84
18	50	10	377	0.121	45.617	0.304	114.608
19	60	10	550	0.104	52.2	0.234	128.7
20	70	10	754	0.086	64.844	0.202	144.768
21	80	10	989.5	0.098	77.187	0.189	187.015
22	90	10	1257	0.076	95.532	0.119	149.583
23	100	10	1555	0.072	111.96	0.101	157.055
24	100	20	754	-	-	-	-

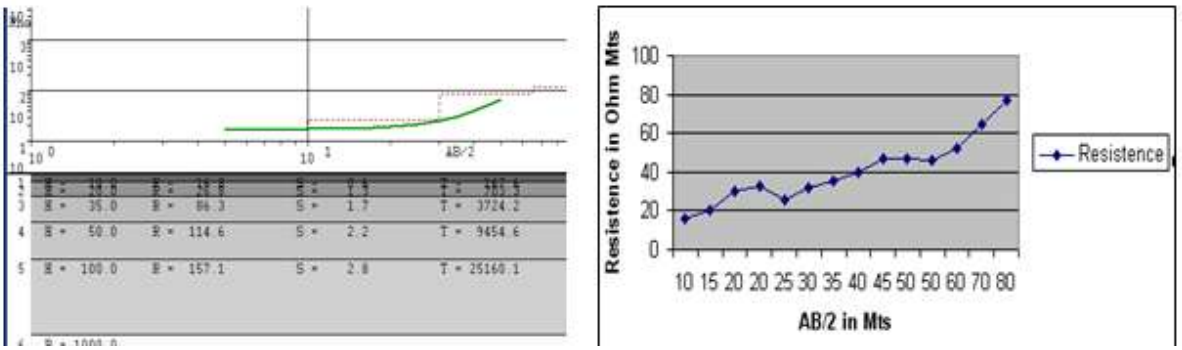


Fig.10 Geophysical resistivity curve map for Hyakanuru area

Interpretation of VES data for the village Hyakanur

Two soundings have been carried out in this location. In the 1st sounding the depth is up to 170 ft. Weathered zone is interpreted to be around 30 to 40 ft out of which intensely weathered zone is up to 30 ft. Moderately hard rock with minor joints is 45 to 80 feet whereas hard and compact rock is above 80 feet. This site is in moderate region and the approximate yield range is 900 gal. Its data is shown in **Table.3** and graphically represented in **Fig.10**. It is in pediplain shallow command region. The second sounding has a depth of 150-165, and the weathered zone is interpreted to be around 25-40, out of which intensely weathered over burden is 25 ft. Moderately hard rock with minor joints is estimated to be 40-75 ft, and hard and compact rock is above 75 ft. It comes under pediplain shallow moderate area, and the estimated yield is 800 gal. The command area appears to have some influence over ground water storage. The data of this sounding is given in **Table 4** and the **Fig.12** represents graphical depiction.

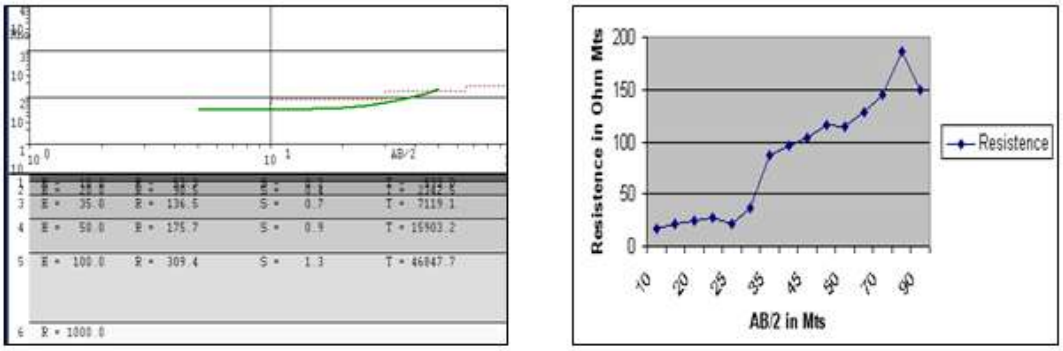


Fig.11 Geophysical resistivity curve map for Ummathuru area

Interpretation of VES data for the village Ummatturu

Here one well has been studied geophysically by VES method for a depth of 240-270 ft. Here weathered zone is at 40-60 ft with a soil cover of 40 ft. jointed weathered zone is interpreted to be at 60-130 ft and hard rock with minor joints at 130-150 ft. hard and compact rock is above 150 ft. This site is in pediplain shallow region in rain fed area. Obviously the yield is expected to be low, but due to a tank close to this site could influence ground water recharge. However the yield estimated in the present case is 500-600 gal. The VES for the above site is provided in **Table.3** and graphically shown in **Fig.11**.

Table 4. Geophysical resistivity data of Hyakanuru and Doddapura area

Serial.no	AB/2	MN/2	Constant	Fig.12/Ves	Resistance	Fig.13/Ves	Resistance
1	2	0.5	12	2.21	26.57	2.44	29.28
2	3	0.5	27.5	1.072	29.48	0.9	24.75
3	4	0.5	49.5	0.665	32.917	0.478	23.661
4	4	1	23.5	1.38	32.43	1.01	23.735
5	6	1	55	0.74	40.7	0.421	23.155
6	8	1	99	0.482	47.717	0.242	23.958
7	10	1	155.5	0.355	54.25	0.175	27.2125
8	10	2	75.5	0.706	53.303	0.38	28.69
9	15	2	173.5	0.414	71.829	0.206	35.741
10	20	2	311	0.288	90.155	0.135	41.985
11	20	5	118	0.769	90.742	0.349	41.182
12	25	5	188.5	0.562	105.937	0.255	44.3

13	30	5	275	0.45	123.75	0.185	50.875
14	35	5	377	0.362	136.479	0.153	57.681
15	40	5	495	0.301	148.995	0.129	63.855
16	45	5	628.5	0.259	162.78	0.113	71.02
17	50	5	777.5	0.229	176.86	0.098	76.195
18	50	10	377	0.466	175.682	0.233	87.841
19	60	10	550	0.361	198.55	0.158	86.9
20	70	10	754	0.295	222.43	0.131	98.774
21	80	10	989.5	0.249	246.385	0.112	110.824
22	90	10	1257	0.215	270.255	0.098	123.186
23	100	10	1555	0.199	309.445	0.088	136.84
24	100	20	754	-	-	-	-

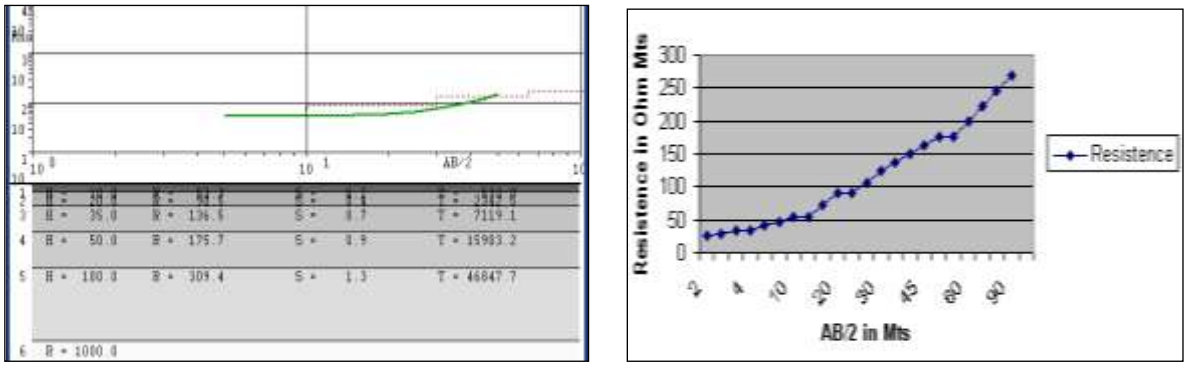


Fig.12: Geophysical resistivity curve map for Hyakanuru area

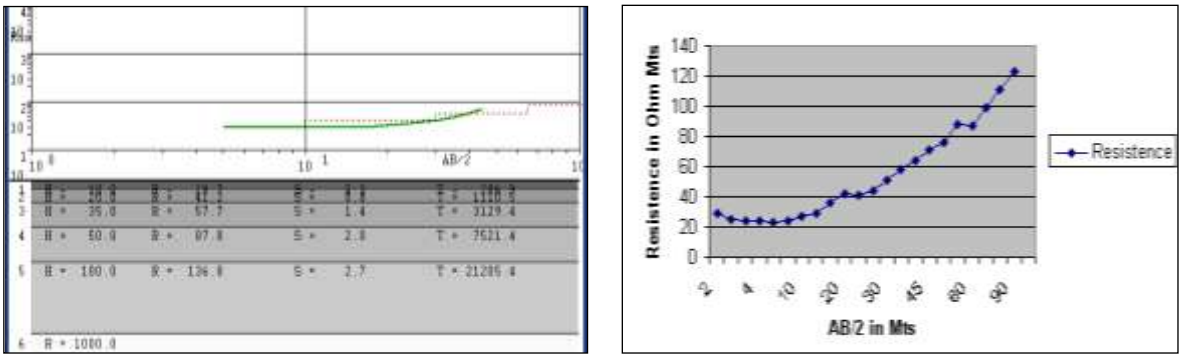


Fig.13 Geophysical resistivity curve map for Doddapura area

Interpretation of VES data for the village Doddapura

Here only one sounding has been carried out and its data is shown in **Table 4** and graphically represented in **Fig.13**. The total depth of the sounding was 180-195 with a weathered zone thickness of 30-40 ft with intensely weathered zone thickness of 30 ft. Bed rock with minor joints inferred to have a depth of 40-70 ft, and hard and compact rocks above 70 ft. It is in pediplain shallow command area which appears to have considerable influence on ground water yield which is estimated to be around 1000 gal.

Table 5 Geophysical resistivity data of Marahallipura area

Serial.no	AB/2	MN/2	Constant	Fig. 14/Ves	Resistance
1	2	0.5	12	9	108
2	3	0.5	27.5	4.31	118.525
3	4	0.5	49.5	2.19	108.405
4	4	1	23.5	4.76	111.86
5	6	1	55	1.28	70.4
6	8	1	99	0.98	97.02
7	10	1	155.5	0.91	141.869
8	10	2	75.5	1.9	143.45
9	15	2	173.5	0.9	156.15
10	20	2	311	0.58	180.38
11	20	5	118	1.3	153.4
12	25	5	188.5	0.91	171.535
13	30	5	275	0.68	187
14	35	5	377	0.41	154.57

15	40	5	495	0.46	227.7
16	45	5	628.5	0.39	245.115
17	50	5	777.5	0.33	256.575
18	50	10	377	0.31	116.87
19	60	10	550	0.44	242
20	70	10	754	0.39	294.06
21	80	10	989.5	0.36	356.22
22	90	10	1257	0.31	389.67
23	100	10	1555	0.29	450.95
24	100	20	754	-	-

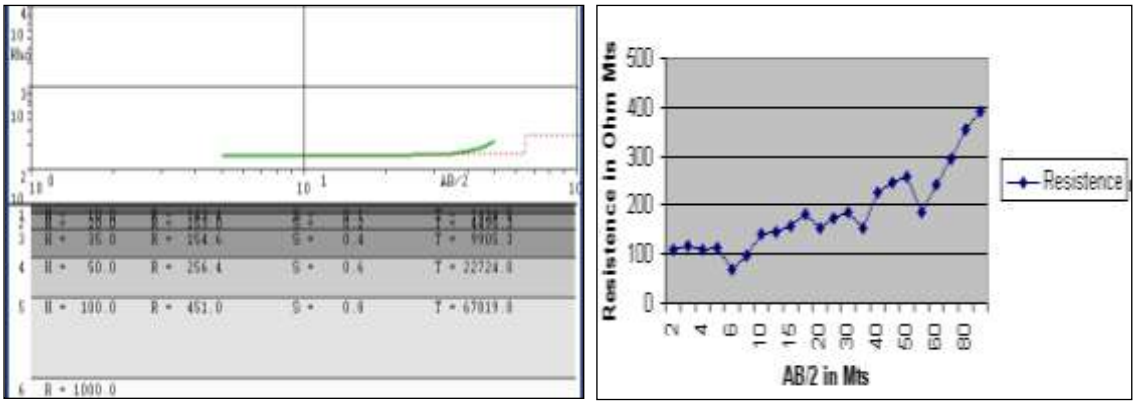


Fig.14 Geophysical resistivity curve map for Marahallipura area

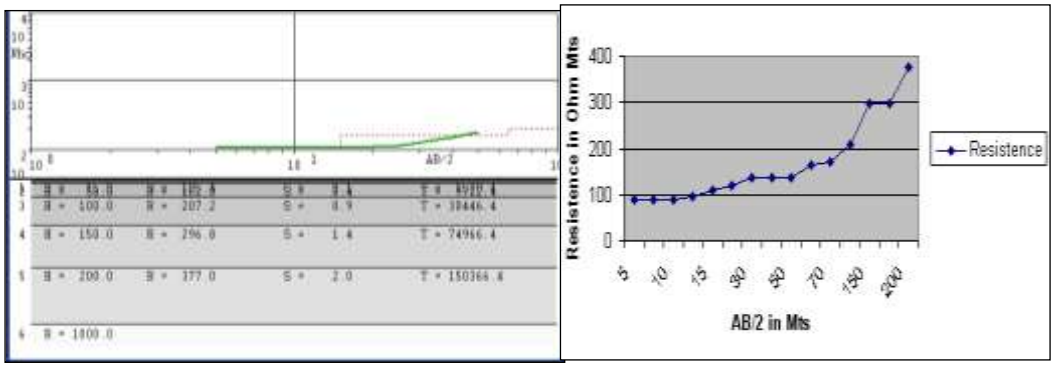
Interpretation of VES data for the village Marahallipura

Marahallipura is situated close to Badanaguppe railway station. In this village two soundings were carried out and their data is given in **Tables 5, and 10**. They are represented in **Fig.14 and 23** respectively. In the case of first sounding the depth of sounding is 240-270 ft. approximate weathered zone is 30 to 50 feet, out of which intensely weathered zone is 20-30 ft (upto which casing is required). Jointed weathered zone is inferred to be 50-120 ft, whereas hard rock with minor joints is at 120-140 ft. Hard and compact rock is inferred to be above 140 ft. It falls in the pediplain moderate region. Aprroximate yield calculated to be 500-600 gal where it is in the moderate category. The other sounding has a depth of 250-280 ft with a weathered zone of 60-66 ft with intensely weathered zone (casing length) more or less to the full extent. A soil cover of 20 is inferred and jointed rock is at 50-75 ft. Hard rock expected with minor joints at a depth of 75-110 ft. Hard and compact rock is above 110 ft. Geomorphologically, this site is in pediplain moderate region. The yield of the well is 500-550 gal, which is in moderate category.

Table 6: Geophysical resistivity data of Badanaguppe and Bagali area

Serial.no	AB/2	MN/2	Constant	Fig.15/Ves	Resistance	Fig.16/Ves	Resistance
1	5	0.5	24	3.65	87.6	0.57	13.68
2	7	0.5	47	1.89	88.83	0.25	11.75
3	10	0.5	95	0.95	90.25	0.107	10.165
4	15	0.5	215	0.45	96.75	0.042	9.03
5	15	2.5	43	2.52	108.36	0.214	9.203
6	20	2.5	76	1.58	120.08	0.113	8.585
7	30	2.5	170	0.8	136	0.044	7.48
8	40	2.5	301	0.45	135.45	0.026	7.826
9	50	2.5	472	0.29	136.88	0.019	8.968
10	50	10	118	1.38	162.84	0.076	8.968
11	70	10	231	0.74	170.94	0.054	12.474
12	100	10	471	0.44	207.24	0.036	16.956
13	150	10	1060	0.28	296.8	0.024	25.44
14	150	25	424	0.7	296.8	0.06	25.44
15	200	25	754	0.5	377	0.047	35.438
16	300	25	-	-	-	-	-
17	300	50	-	-	-	-	-

Fig.15 Geophysical resistivity curve map for Badanaguppe area



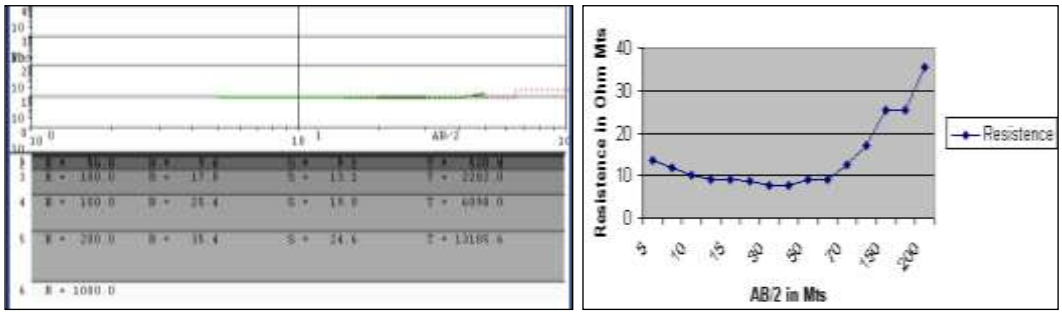


Fig.16 Geophysical resistivity curve map for Bagali area

Interpretation of VES data for the village Bagali

Here 3 soundings have been carried out. The first sounding is for a depth of 180 ft with a weathered zone of 20 ft. Soil covers 8 ft thickness. Moderately weathered rock is at 8-25 ft. moderately hard rock with minor jointing is expected at 25-70 ft. Hard and compact rock is expected to be above 70 ft. It is pediplain moderate region. The estimated yield is 700-800 ga. The 2nd sounding is for a depth of 180 ft, and weathered zone has 20 ft thickness. Soil cover is deciphered to be 8 ft thick, whereas moderately weathered rock has a thickness of 8-30 ft. Moderately hard rock with minor joints is 30-70 ft thick. Hard and compact rock is above 70 ft. It is in pediplain moderate region. The estimated yield for this sounding is 700-900 gal. The soundings around the above village clearly indicate the influence of a tank and also a main canal which passes near the vicinity. Considerable seepage appears to have taken place from these two sources which has enabled poddible high yield in all the 3 soundings mentioned above. The data of the above 3 soundings are provided in **Tables 6 and 7** and graphically represented in **Figs. 16, 17 and 18**, respectively.

Table 7: Geophysical resistivity data of Bagali area

Serial.no	AB/2	MN/2	Constant	Fig.17/Ves	Resistance	Fig.18/Ves	Resistance
1	5	0.5	24	5	120	4.29	102.96
2	7	0.5	47	2.04	95.88	1.86	87.42
3	10	0.5	95	0.83	78.85	1	95
4	15	0.5	215	0.34	72.1	0.43	92.45
5	15	2.5	43	1.81	77.83	1.78	76.54
6	20	2.5	76	0.9	68.4	0.98	74.48
7	30	2.5	170	0.41	69.7	0.43	73.1
8	40	2.5	301	0.24	72.24	0.28	84.28
9	50	2.5	472	0.166	78.352	0.2	94.4
10	50	10	118	0.7	82.6	0.8	94.4
11	70	10	231	0.38	87.78	0.52	120.12
12	100	10	471	0.19	89.49	0.37	174.27
13	150	10	1060	0.094	99.64	0.22	233.2
14	150	25	424	0.24	101.76	0.55	233.2
15	200	25	754	0.17	128.18	0.44	331.56
16	300	25	-	-	-	-	-
17	300	50	-	-	-	-	-

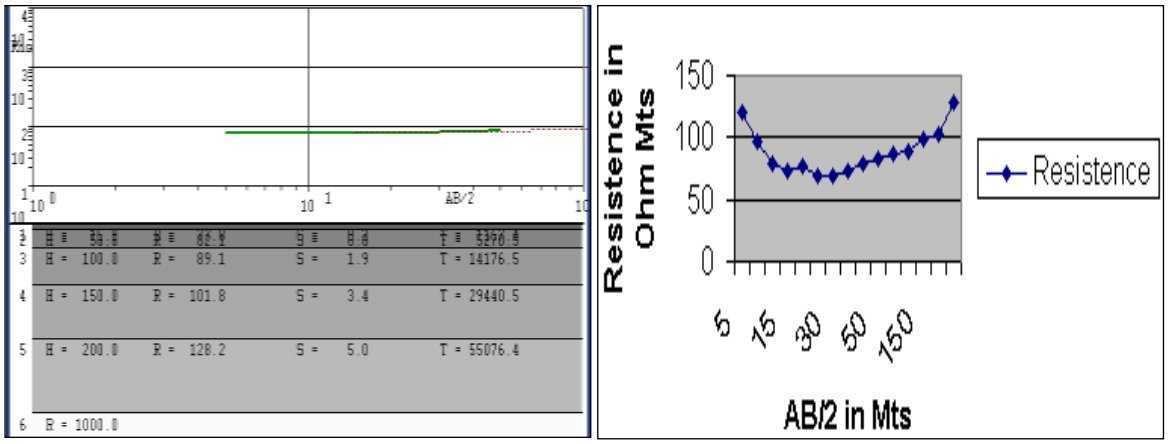


Fig.17 Geophysical resistivity curve map for Bagali area

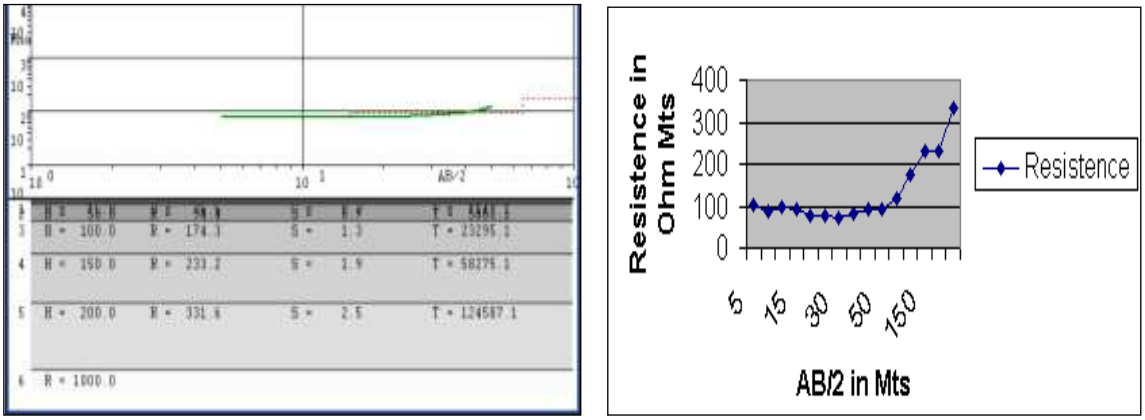


Fig.18 Geophysical resistivity curve map for Bagali area

Table 8 Geophysical resistivity data of Thoravalli and Muguru area

Serial.no	AB/2	MN/2	Constant	Fig.19/Ves	Resistance	Fig.20/Ves	Resistance
1	5	0.5	24	0.19	4	1.236	5.664
2	7	0.5	47	0.101	4.7	0.166	5.452
3	10	0.5	95	0.05	4.7	0.056	5.32
4	15	0.5	215	0.025	5.4	0.029	6.235
5	15	2.5	43	0.138	5.9	0.132	5.676
6	20	2.5	76	0.019	6	0.083	6.308
7	30	2.5	170	0.036	6.1	0.044	7.48
8	40	2.5	301	0.04	6.3	0.027	8.127
9	50	2.5	472	0.015	7	0.019	8.968
10	50	10	118	0.057	6.7	0.076	8.968
11	70	10	231	0.034	7.8	0.05	11.55
12	100	10	471	0.022	10	0.031	14.601
13	150	10	1060	0.015	16	0.019	20.14
14	150	25	424	0.037	15	0.046	90.504
15	200	25	754	0.027	20	0.032	24.128
16	300	25	1700	-	-	0.017	28.9
17	300	50	-	-	-	-	-

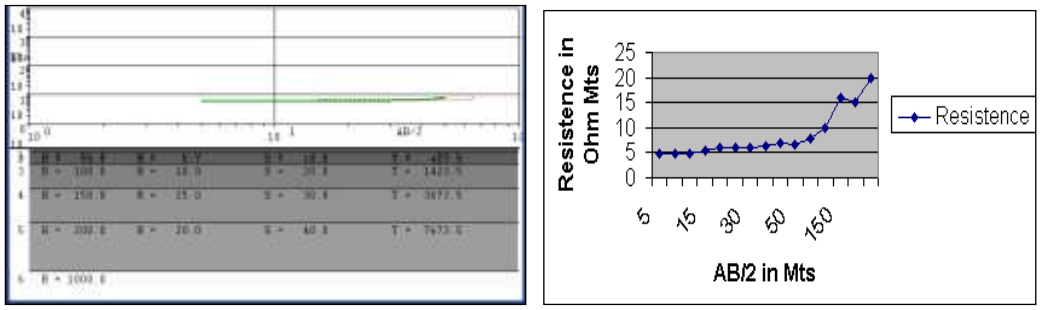


Fig.19 Geophysical resistivity curve map for Thoravalli area

Interpretation of VES data for the village Thoravalli

The VES data near this village is presented in **Table 8** and graphically shown in **Fig.19**. The total depth of penetration is 270-300 ft with a weathered zone of 10-50 ft. Soil cover is deciphered to be 10 ft. Jointed and weathered zone is 50-120 ft. Gradually hardened jointed bed rock is above 120 ft. It is in pediplain moderate region. The estimated yield is 500-600 ga. As it is a rain fed area the yield appears to be controlled by it.

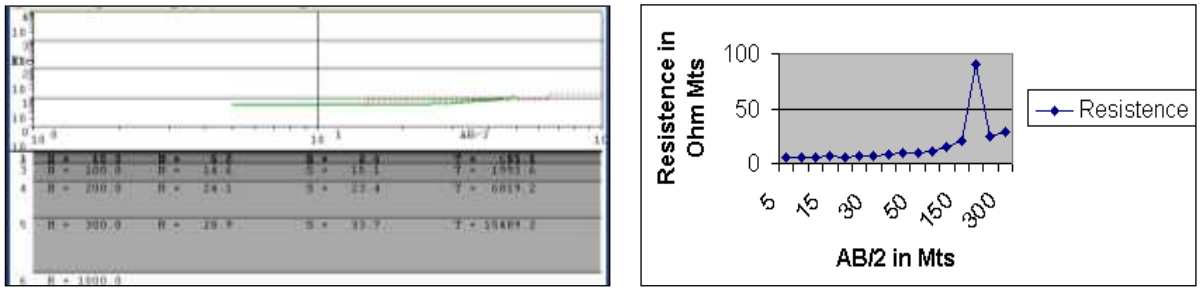


Fig.20 Geophysical resistivity curve map for Muguru area

Interpretation of VES data for the village Muguru

Only one sounding has been carried out at this place. The depth of penetration is 165-180 ft. It has a soil cover of 10 ft. Weathered zone has a thickness of 12-15 ft. Moderately weathered rock is deciphered for a thickness of 10-30 ft. Moderately hard rock with minor joints is expected at 30-70 ft. Hard and compact rock is above 70 ft. The data is presented in **Table 8**. and graphically shown in **Fig.20**. It falls in pediplain moderately command region. The yield is expected to 2500 gal. The VES data here clearly indicate considerable seepage to ground water, thus enhancing its potential.

Table 9 Geophysical resistivity data of Badanaguppe and Demahalli area

Serial.no	AB/2	MN/2	Constant	Fig.21/Ves	Resistance	Fig.22/Ves	Resistance
1	5	0.5	24	4.45	107	1.91	46
2	7	0.5	47	2.29	108	0.85	40
3	10	0.5	95	1.02	97	0.37	35
4	15	0.5	215	0.47	88	0.15	32
5	15	2.5	43	1.88	81	0.74	32
6	20	2.5	76	1	76	0.38	29
7	30	2.5	170	0.42	71	0.2	34
8	40	2.5	301	0.23	69	0.14	42
9	50	2.5	472	0.16	76	0.11	52
10	50	10	118	0.6	71	0.44	52
11	70	10	231	0.34	79	0.28	65
12	100	10	471	0.19	89	0.16	75
13	150	10	1060	0.1	106	0.08	85
14	150	25	424	0.27	114	0.22	93
15	200	25	754	0.17	128	0.16	121
16	300	25	-	-	-	-	-
17	300	50	-	-	-	-	-

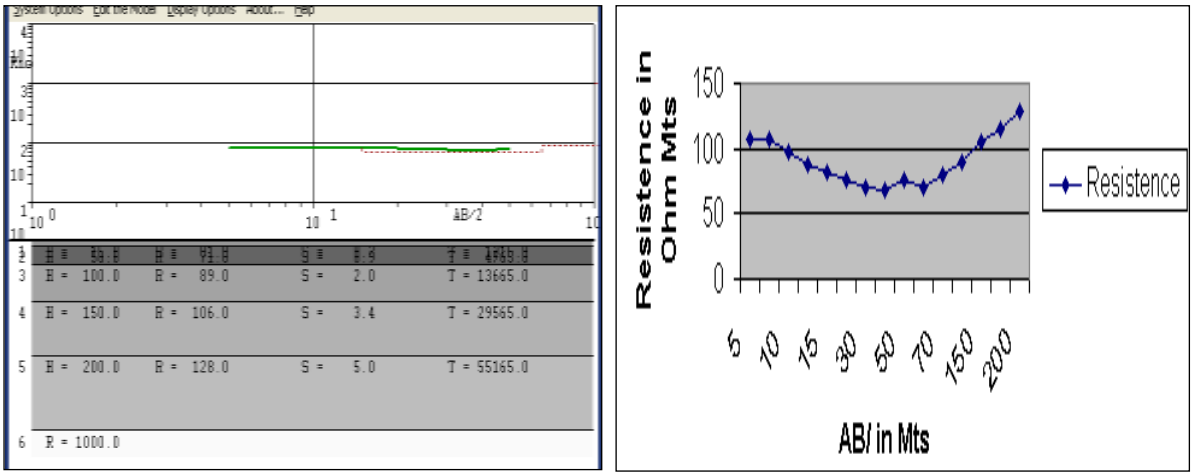


Fig.21 Geophysical resistivity curve map for Badanaguppe area

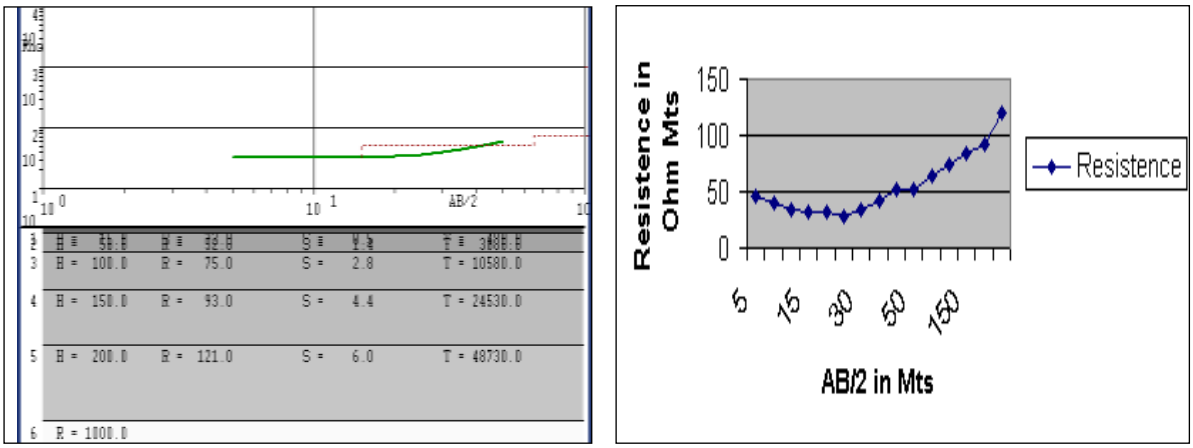


Fig.22 Geophysical resistivity curve map for Demahalli area

Interpretation of VES for the village Demahalli

This site is located in pediplain moderate region near Demahalli. The VES data recorded for this site is shown in **Table 9** and represented on graph in **Fig.22**. The depth of sounding was up to 100 m. The soil cover is interpreted to be up to 20 feet deep; fractured zone 20-70 ft; jointed rocks 70-150 ft and bed rock is encountered after 150 ft. The yield estimated in this well is 450 to 500 gallons.

Table 10 Geophysical resistivity data of Marahallipura and Karya area

Serial.no	AB/2	MN/2	Constant	Fig.23/Ves	Resistance	Fig.24/Ves	Resistance
1	5	0.5	24	2.85	68.4	1.7	40.8
2	7	0.5	47	1.37	64.39	0.67	31.49
3	10	0.5	95	0.11	67.45	0.2	19
4	15	0.5	215	0.35	77.35	0.06	12.9
5	15	2.5	43	1.43	58.65	0.32	13.76
6	20	2.5	76	0.84	63.84	0.15	11.4
7	30	2.5	170	0.46	78.2	0.06	10.2
8	40	2.5	301	0.27	81.27	0.035	10.535
9	50	2.5	472	0.2	94.4	0.02	9.45
10	50	10	118	0.8	94.4	0.08	9.44
11	70	10	231	0.48	110.88	0.05	11.55
12	100	10	471	0.29	136.59	0.03	14.13
13	150	10	1060	0.17	180.2	0.018	19.18
14	150	25	424	0.38	161.12	0.047	19.928
15	200	25	754	0.28	211.12	0.035	26.39
16	300	25	-	-	-	-	-
17	300	50	-	-	-	-	-

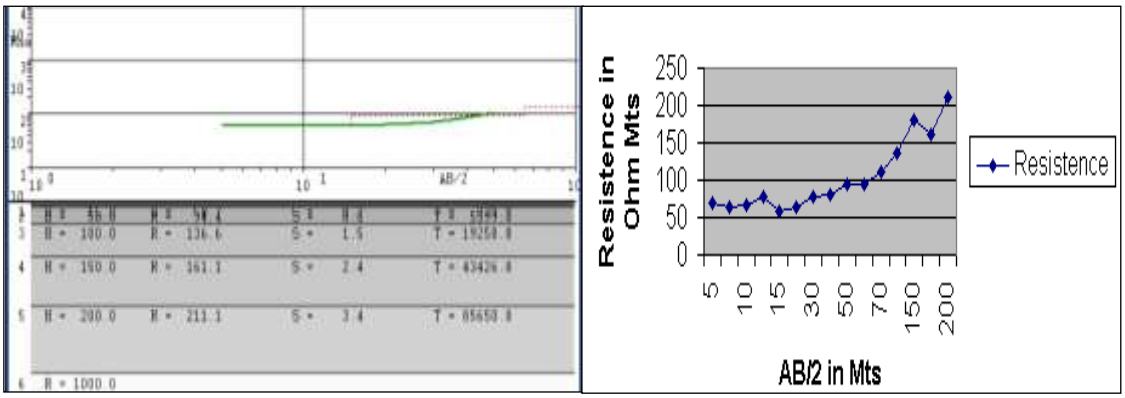


Fig.23 Geophysical resistivity curve map for Marahallipura area

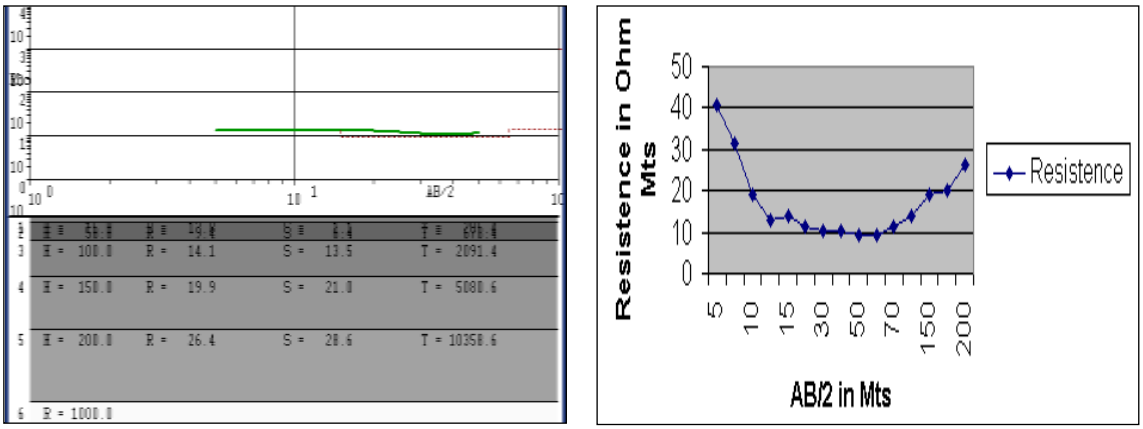


Fig.24 Geophysical resistivity curve map for Karya area

Interpretation of VES data for the village Karya

Karya village situated near Siddeswara hill and falls under pediplain moderate region. The data obtained for this village is represented **Fig 24** and the data is given in **Table 10**. Based on VES pattern and the field studies the following interpretations have been made. Soil cover is estimated up to 40 feet, moderately weathered zone is between 40 and 60 feet; jointed weathered zone is 60 to 130 feet; hard rock with minor joint is 130 to 150 feet; and hard and compact rock is above 150 feet. The approximate yield is estimated to be 1.5 to 2 inches. The minimum casing required here is 15 m.

General Acquifer conditions in the study area

The general depth of VES 135 ft to 250 ft By the overall geophysical data it can be inferred that the study area has a weathered zone of 18 to 60 ft. However depending on the intensity of weathering and soil cover the casing length required (in event of bore well drilling) is 15 to 90ft. Normally the soil cover thickness is 5 to 40 ft. Weathered rock is ranging from 30 to 130 ft and jointed and weathered rock is between 40 and 150 ft. Highly fractured zone is encountered at 20 to 185 ft; moderately weathered rock is between 8 and 120ft. moderately hard rock with minor joints is expected at 25 to 75ft. hard jointed bedrock is above 120 ft and hard and compact rock is above 80 to 185ft.

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