Original Article

Locating Collector Well Sites in Coastal Part of Andhrapradesh

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Abstract

Coastal part of Guntur district spread over an area of around 380 sq Km along the coast of the Bay of Bengal. Groundwater from the sands of this area is being extracted through shallow pits. This region contains potable groundwater free move along the surface of brackish water in the lower clay formations. Hence, collector wells need to be constructed in this type of regions for extracting potable groundwater. Superficial sand aquifer's thickness is very limited and its occurrence is non- uniform in the region. Subsequently, these sandy aquifers need better management and control methods to extract groundwater without pollution and recharging to maintain groundwater balance in this region. Electrical resistivity survey using traversing method, and vertical electrical sounding methods are conducted in these areas to locate suitable places contain sufficient permeable coarse sand which yields good amounts of fresh water. It helps for similar studies in coastal zones throughout the world.

Keywords: Andhra Pradesh, Coastal Part, Groundwater, Resistivity Traversing Method, Vertical Electrical Sounding Method.

INTRODUCTION

This region is situated west side of the Bay of Bengal as shown in map enclosed (Figure 1). It is occurred in S.E. part of the district in Nagaram, Khazipalem mandals etc. Coarse, permeable sands occur as superficial formations, which contains potable groundwater. These sandy formations are underlained by clay formations contain brackish water which occurs in less quantity due to impermeable nature of clay material. Hence, fresh water occurs at shallow depths in these areas underlained by saline water. The fresh water is being tapped manually through traditionally excavated conical pits. This groundwater is used for irrigation and domestic purpose. The use of traditional pits leads to pollution of groundwater, not proper use of good fertile agricultural lands due to unavailability of sufficient water [1], [3], [6], [7], [10]. Evaporation losses and lack of use of recent agricultural methods [4], [9], [12], [13], [14], [15].

To prevent this pollution, resistivity surveys using profiling method are conducted in the study area for construction of collector wells [8], [11] in coastal areas for extracting the floating fresh water in saline water region. Site selection of collector wells depends on adequate thickness of sand aquifer formations for sufficient discharge of groundwater. Clayey sands are not suitable for construction of collector wells because of impermeability nature of the clayey formation. To locate suitable places contain sufficient permeable coarse sand, resistivity surveys using traversing method are conducted in these areas.

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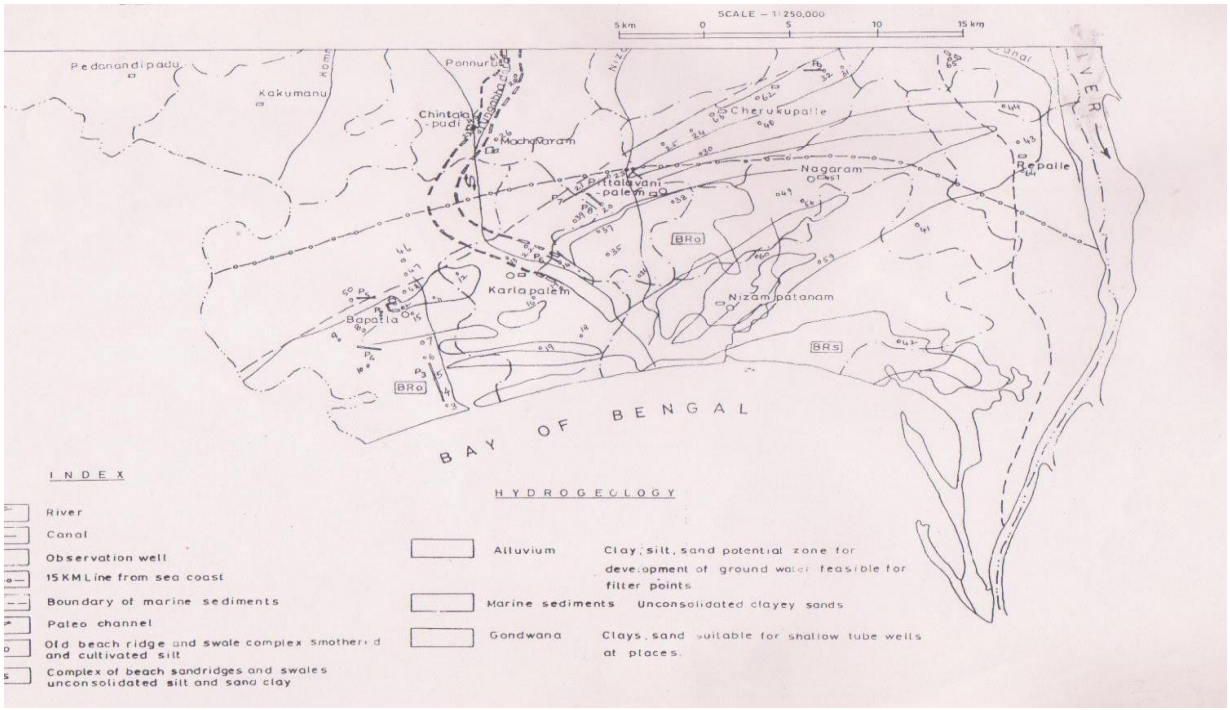


Figure 1. Location map of study area

Study area

The region extends for nearly 20 km from north to south and nearly 15 km from east to west. It has a gentle slope from west to east. It has dendritic drainage pattern. Irrigation is being provided by Nizampatnam canal and kommamur canal under Krishna western delta system [2],[3]. It contains two main drains which drain north to southwards and finally drain into the Bay of Bengal. Small beach ridges and sand dunes from 2 to 3.5 m in height spread along the coast. It has an average annual rainfall of 864 mm. It belongs to subtropical to tropical temperate monsoon climate.

HYDROGEOLOGY

This region consists of clay and sand of recent period. The sand is permeable in nature and medium to coarse in grain size. This superficial sand formation lies above clay formations[3]. Potable groundwater occurs in this sand formation. The sandy aquifer width extends from 4.5 m to 5.5 m only. Because of this small extent of aquifer zone, groundwater has been extracted through doruvus, which are in conical shape. Groundwater is extracted manually with small pots and used for domestic and irrigation purpose. Each doruvu can irrigate 0.38 to 0.49 Acres of agricultural field. Field investigations conducted in this region show that the superficial sandy aquifer contains groundwater under unconfined conditions and quality is within the prescribed limits for drinking and agricultural use [5]. 24 wells used for drinking and agricultural use in this region are observed and the data is as shown in the Table 1. The groundwater is also being extracted through collector wells at some places in this region. These collector wells discharges continuous supply of water for 5 to 6 hours and yields around 200 to 250 liters per minute. National Agricultural Technology Project constructed collector wells experimentally at Perali, Maruproluvaripalem, and Thimmareddypalem area to extract fresh groundwater floating above the saline water. The water level data from Table 2 of observation wells in Perali, Buddam, Rambotlavaripalem, khajipalem, and Cherukupalli villages indicate that the depth of water levels varies from 1.68 m to 3.28 m and water level variations are small. The water level variation from 2021 year to 2022 year in five observation wells varies from 0.37 m to1.48 m. This small variation indicates the stable aquifer conditions.

Table 1. Well inventory data

Place of well	Depth of well (m)	Water level depth (m)	well diameter (m)	Discharge (lpm)
1. Perali	9.20	2.80	1.50	150
2. Basvireddypalem	6.00	4.50	1.50	100
3.Maruproluvari palem	6.50	1.65	Collector well	250
4. Ganapavaram	6.50	3.20	1.00	150
5. Mandevari malapaiiy	6.00	4.00	1.50	domestic
6. Pittuvaripalem	8.00	5.00	2.50	domestic
7. Basvireddypalem	6.50	3.40	2.00	domestic
8.Pothanakattavari palem	4.00	2.50	1.50	domestic
9.Kolaganivari palem	6.50	3.60	2.00	domestic
10.Padapuluguvari palem	6.50	4.20	2.00	domestic
11. Vullipalem	6.50	3.50	2.00	domestic
12. Nadimpalli	6.00	3.60	2.00	domestic
13. Pallekona	12.00	4.90	Filter well	250
14. Pallapatla	7.00	3.60	2.00	domestic
15. Avalavaripalem	6.50	3.75	2.50	domestic
16. Chandolu	6.00	3.50	2.00	domestic
17. Rajavolu	7.50	4.50	2.50	domestic
18. Machavaram	6.00	3.30	2.50	domestic
19. Sajjavaripalem	15.00	6.60	Filter well	250
20. Thotapalli	12.00	6.00	Filter well	250
21.Govada	14.00	6.40	Filter well	200
22.Cherukupalli	14.00	5.30	Filter well	250
23. Bharthipudi	6.50	4.20	2.00	domestic
24.Addankivari palem	11.00	5.10	Filter well	250

Table 2. Variation of water level depth in the region

Sl. No.	Place of observation well	Water level depth in 2021 (m)	Water level depth in 2022 (m)	Water level variation (m)
1.	Perali	2.16	3.28	-1.12
2.	Buddam	1.96	2.79	-0.83
3.	Rambotlavari palem	2.03	2.57	-0.54
4.	Khajipalem	1.68	3.16	-1.48
5.	Cherukupalli	2.60	2.97	-0.37

Well inventory data of Table 1 shows that in some regions such as Thotapalli, Sajjavaripalem, Govada, Pallekona, Addankivaripalem thickness of sandy aquifer zone is more. The recharge conditions to this sandy aquifer are limited and are affected by canals, drains and precipitation. Hydrogeological conditions in this region indicates that the old beach bridges occurs all along Perali, Kavuru road which runs parallel to the coast. Detailed investigations are carried out in this region to determine the thickness of superficial sandy aquifer zone, subsurface formation characteristics, locate sites for collector wells in large scale in this region.

Electrical Resistivity Traverses Methods

All geological formations have a property called electrical resistivity (ρ) and this resistivity is expressed in the units of Ohm-meter. The electrical resistivity of subsurface formations varies from one another and are studied with the help of the electrical resistivity methods. Resistivity

methods are classified into traversing Method and sounding method. Electrical resistivity traversing is done to detect lateral changes in resistivity which reflects the subsurface lithology in a large area whereas electrical resistivity sounding, which is popularily known as Vertical Electrical Sounding (VES) is done to determine vertical changes in resistivity which reveals the changes in lithology at a particular place with increasing depth.

Electrical resistivity traverses are carried out in this region with location interval of 100m and distance of current electrodes at 4m, 8m, and 15m intervals and potential electrodes at 1m interval. 3 electrical resistivity traverses are conducted to cover an extent of 6 line kilometers. Resistivity traverses are carried out in Perali, Basvireddypalem, west of P.K. palem, along Murukondapadu road, north of Khajipalem village, along Kavuru road, and Cherukupalli village areas. Resistivity traverse curves (Figure 2) showed that the apparent resistivity values ranging from 380 to 870 ohm-m for 4m depth from Table 3 indicates dry sands. And the resistivity values from Table 3 varying from 10 to 250 ohm-m for 8m depth indicates saturated coarse sands which are suitable for construction of collector wells. The clayey sands and silts at 15m from Table 3 are indicated with resistivity values less than 10 ohm-m. Saturated sands identified with resistivity values varying from 50 to 280 ohm-m in electrical resistivity traverses conducted in Perali, and Basvireddypalem from Table 3 a) are suitable for extraction of groundwater by construction of collector wells up to 6m to 9m depth below ground level. Electrical resistivity traverse curve near P.K. palem and Cherukupalli villages from Table 3 b) shows that the resistivity values varying from 50 to 400 ohm-m represents saturated sandy regions are suitable for construction of collector wells. Electrical resistivity traverse along Kavuru road represents the suitability of collector wells construction

Traverse curves along Murukondapadu, and Yazali villages from Table 3 c) represent clayey sands, which are not suitable for construction of collector wells. The suitable locations are marked in map as shown in Figure 3. Electrical resistivity sounding data carried out in Perali, Khajipalem and Nagaram areas showed that the sandy aquifer extend to a depth of 8m to 9m underlained by clay formations, which contains brackish groundwater. Fresh water is not occurred in deeper zones in these areas.

Table 3. Apparent Resistivity values at various depths

a) Apparent Resistivity values at various depths along Perali and Basvireddypalem villages

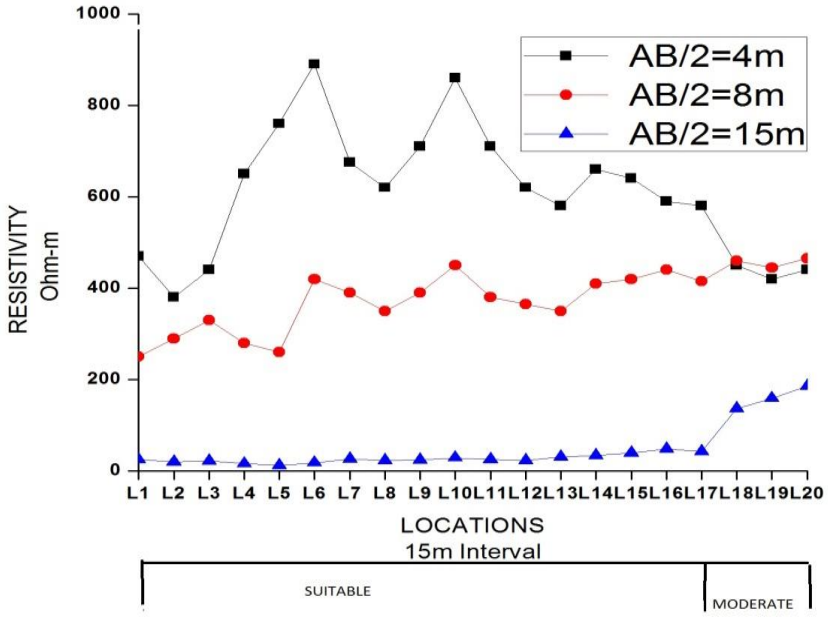
Location number	Apparent Resistivity (ρ_a) value at the depth below ground level		
	4m	8m	15m
L1	470	250	25
L2	380	290	20
L3	440	330	22
L4	650	280	16
L5	760	260	12
L6	890	420	18
L7	675	390	26
L8	620	350	23
L9	710	390	24
L10	860	450	29
L11	710	380	25
L12	620	365	23
L13	580	350	31
L14	660	410	34
L15	640	420	39
L16	590	440	48
L17	580	415	43
L18	450	460	137
L19	420	445	159
L20	440	465	186

b) Apparent Resistivity values at various depths along P.K.Palem and Cherukupalli villages

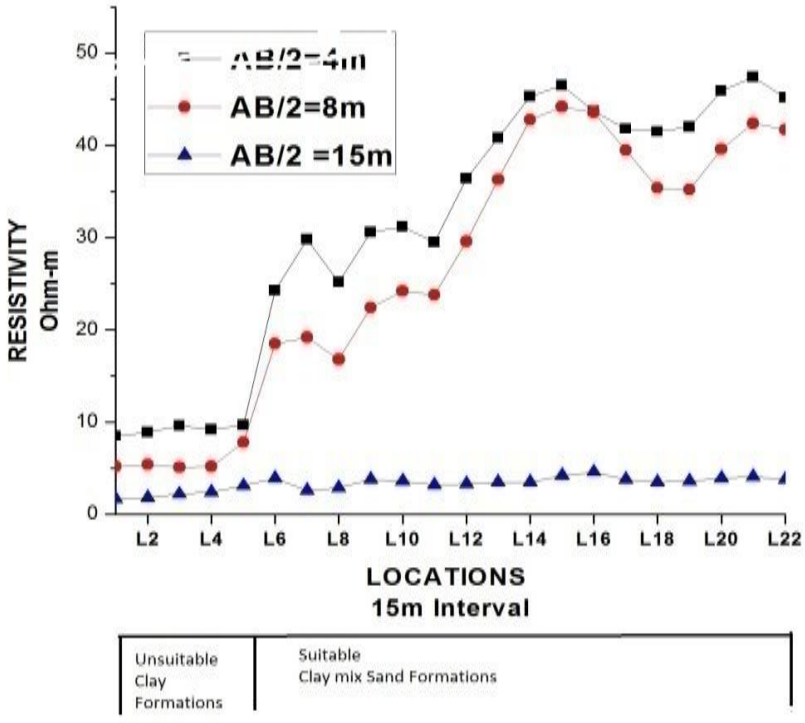
Location number	Apparent Resistivity (ρ_a) value at the depth below ground level		
	4m	8m	15m
L1	8.5	5.2	1.7
L2	8.9	5.4	1.8
L3	9.6	5.1	2.2
L4	9.2	5.2	2.4
L5	9.7	7.8	3.1
L6	24.3	18.5	3.9
L7	29.8	19.2	2.6
L8	25.2	16.8	2.9
L9	30.6	22.4	3.8
L10	31.2	24.2	3.6
L11	29.5	23.8	3.2
L12	36.4	29.6	3.3
L13	40.8	36.3	3.5
L14	45.3	42.8	3.5
L15	46.5	44.2	4.2
L16	43.7	43.6	4.6
L17	41.8	39.5	3.8
L18	41.5	35.4	3.5
L19	42	35.2	3.6
L20	45.9	39.6	3.9
L21	47.4	42.4	4.1
L22	45.2	41.7	3.8

c) Apparent Resistivity values at various depths along Murukondapadu road, and Yazali village

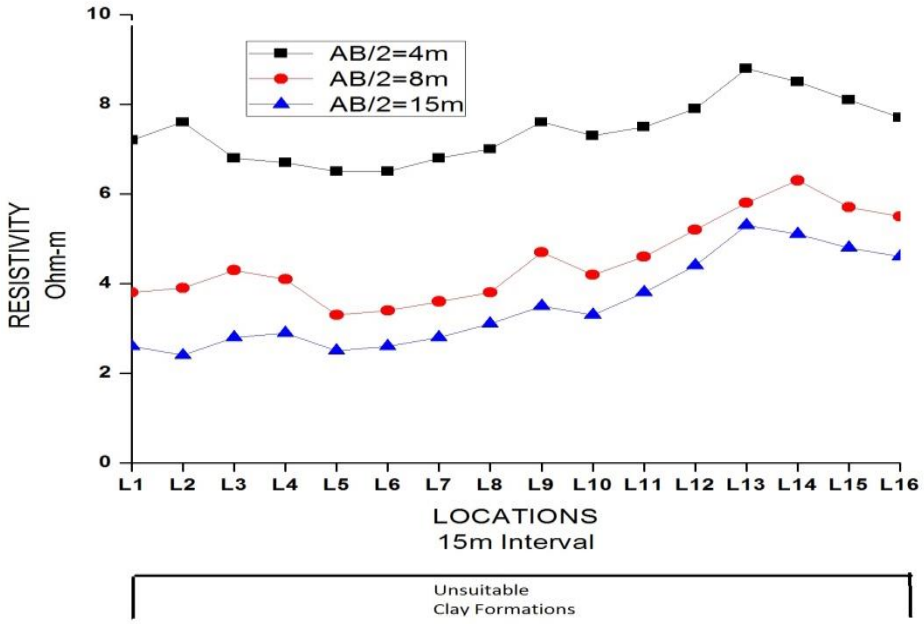
Location number	Apparent Resistivity (ρ_a) value at the depth below ground level		
	4m	8m	15m
L1	7.2	3.8	2.6
L2	7.6	3.9	2.4
L3	6.8	4.3	2.8
L4	6.7	4.1	2.9
L5	6.5	3.3	2.5
L6	6.5	3.4	2.6
L7	6.8	3.6	2.8
L8	7	3.8	3.1
L9	7.6	4.7	3.5
L10	7.3	4.2	3.3
L11	7.5	4.6	3.8
L12	7.9	5.2	4.4
L13	8.8	5.8	5.3
L14	8.5	6.3	5.1
L15	8.1	5.7	4.8
L16	7.7	5.5	4.6



a) Along Perali and Basvireddypalem villages



b) Along P.K.Palem and Cherukupalli villages



c) Along Murukondapadu road, and Yazali village

Figure 2. Resistivity traverse curves

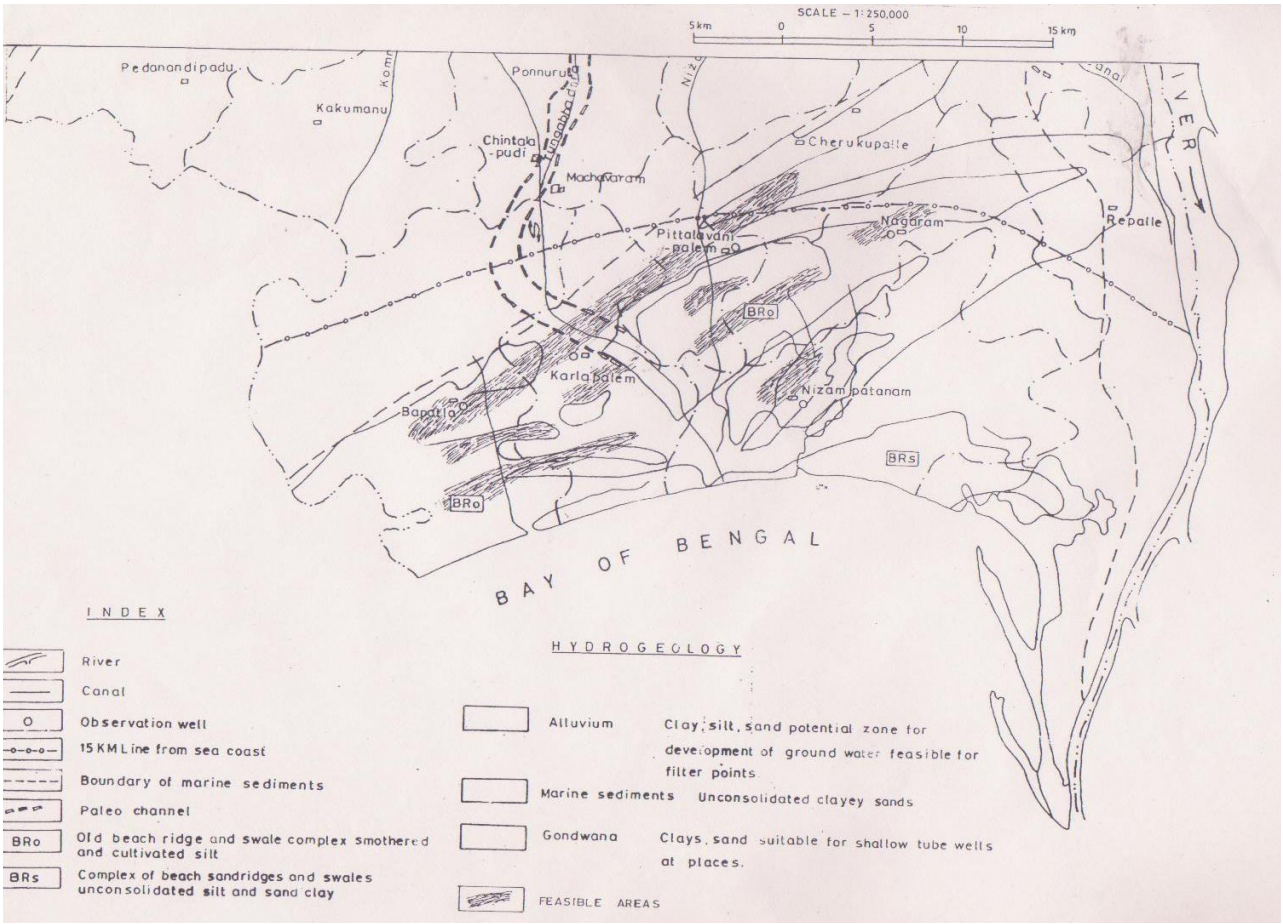


Figure 3. Map showing suitable locations for collector wells

CONCLUSIONS

The investigations carried out in this region infer that the region contains superficial coastal sands overlain by clay formations. The sandy aquifer zone varies from 4.5m to 6.5m in thickness and continues up to a depth of 9 m to 10 m below ground level and it is more in some places. This sandy zone lies above clay formation, which contains brackish water in small amounts due to the impermeable nature of clay. Water level depth ranges from 1.68m to 3.28m below ground level and change in seasonal variation of water levels is small and ranges from 0.37m to 1.48m as from Table 2. Electrical resistivity data infers that resistivity values of the superficial sandy aquifer zone varies from 50 to 280 ohm.m, which indicates medium sand grains to coarse sand grains as from Table 3 This sandy aquifer is more in thickness in some places such as Thotapalli, Sajjavaripalem, Pallekona, Addankivaripalem, Govada etc. The details of recommendations for construction of collector wells are marked in map as shown in Figure 3. Collector wells should be constructed in huge number in these regions upto a depth of 10 m. Groundwater in this region is potable and its quality lies in the prescribed limits of safe drinking water and agriculture purpose.

43 locations for construction of collector wells are selected in 30 villages in this region as per electrical resistivity sounding data. Potential regions also identified for construction of collector wells in this region as per electrical resistivity traversing data. These potential areas in this region are as marked in the Figure 3. The limited extension of superficial sandy aquifer zone in depth, and limited recharge by percolation of rain water, canal water and agriculture fields, and to encourage construction of more number of collector wells in this region, suggest that it is necessary to recharge this superficial sandy aquifer zone by artificial methods. Recharge wells should be constructed in this region and these should be recharged through canal water.

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