FINAL REPORT ON:

APPRAISAL OF GROUND WATER POTENTIAL AT NIMLI VILLAGE, TIJARA ALWAR, RAJASTHAN

Submitted to:

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1.0 INTRODUCTION

1.1 Project Description

The Centre for Science & Environment (CSE) is planning to construct an Environmental Training Institute. The site is located in Nimli Village, Tijara Block, District Alwar, Rajasthan.

To decide regarding the suitability of the site, the client requires a detailed study of the ground water conditions. For this purpose M/s. Cengrs Geotechnica Pvt. Ltd. has conducted a geo-physical and geo-hydrological survey at the site.

This report presents the results of the survey conducted together with our observations at site.

1.2 Scope of Work

The main purpose of the study was to assess the groundwater conditions to meet the water requirement of the project. The geophysical survey was carried out on 4.06.2012 after a review of the literature available on the area and earlier work done.

1.3 Technical Background

Hydro-geology is a scientific discipline that requires the appreciation of physiography, meteorological parameters, hydrology, geology and structure of the region in which the particular site is situated along with local details, for a quantitative evaluation of the ground water potential and for a continued development of the water resources.

This report presents the relevant technical background together with our recommendations on expected yield and water quality.

2.0 GENERAL SITE CONDITIONS

2.1 Location

The site surveyed is located at Nimli Village, Tijara Block, Alwar District, Rajasthan. The site under study is situated about 120 km

southwest of Delhi. It lies between coordinates latitudes 27°50' 17.32" and longitudes E 76°55' 47.21".

2.2 Physiography & Climate

The site surveyed is a plain land and undulating land, sloping downwards towards north. It comes under Aravali hill range. Locally the ridges have a Northeast - Southwest trends. The area is at about 296 to 308 m above mean sea level the area is covered by thick alluvium bed, the area having extremes of climate in summer and winter.

The area falls in a semi-arid zone, with extremes of climate in summer and winter. Dust storms are common during the summer months in the area and it experiences severe heat during May and June, with the highest temperatures hovering around 45±3°C and minimum temperatures touch lows of the order of 3°C in winters.

The Southwest monsoon period between June and September is the main rainy season of the area when about 85% of the annual precipitation occurs. The mean annual rainfall is about 724 mm. The coefficient of variation is fairly low at 15 mm and the corresponding dispersion of mean rainfall is 20% with a 90 mm standard deviation. The air over this area is generally dry for most part of the year. The soils are sandy clays and fairly well drained.

2.3 Geology

Inliers of Delhi Super Group formations surrounded by Alluvium occupy the region. The site is covered by thick alluvium bed, made up of clay, fine to medium sand, silt, clay and kankar (calcareous nodules). The surface beds are admixed with wind-blown sediments of Recent Age.

These deposits have high porosity and permeability and readily absorb water. These alluvial sediments are underlain by harder formations of the Delhi System of rocks. The quartzites of Delhi System encountered in the area are massive, compact and hard. These quartzites are intruded by Pegmatites. These pegmatites, on weathering, yield mica zones encountered in the area. The thickness of the alluvial cover varies across the area.

The stratigraphic sequence of the area is as under:

Recent to Sub-Recent	Alluvium comprising of clay, medium to fine sand, silt, kankar and Aeolian deposits.
~~Unconformity~~~~~~~~	
Post Delhi Intrusives	Pegmatitic and basic intrusives
Algonkian (Delhi System)	Alwar quartzites

2.4 Hydrogeology

The area is near the northeast extension of Aravali range of hills comprising of quartzites, schists and phyllites. It is covered by thick layer of alluvium bed.

The aquifer system in the unit has been formed by a different types of sand zones and kankar zones (calcareous nodules).

The hydro-geological setting of the site is relatively favourable. The water level in the area is presently reported to be at about 4 to 10 m. As per Central Groundwater Board, the area comes under good ground water belt. The quality of water is good.

There are number of shallow and deep tubewells in the vicinity. There is no surface water body in the area.

2.5 Basic Data

As per CGWB broad survey the project site comes under good potential zone. The groundwater is potable and fit for domestic, agriculture and Industrial use.

2.6 Groundwater Conditions

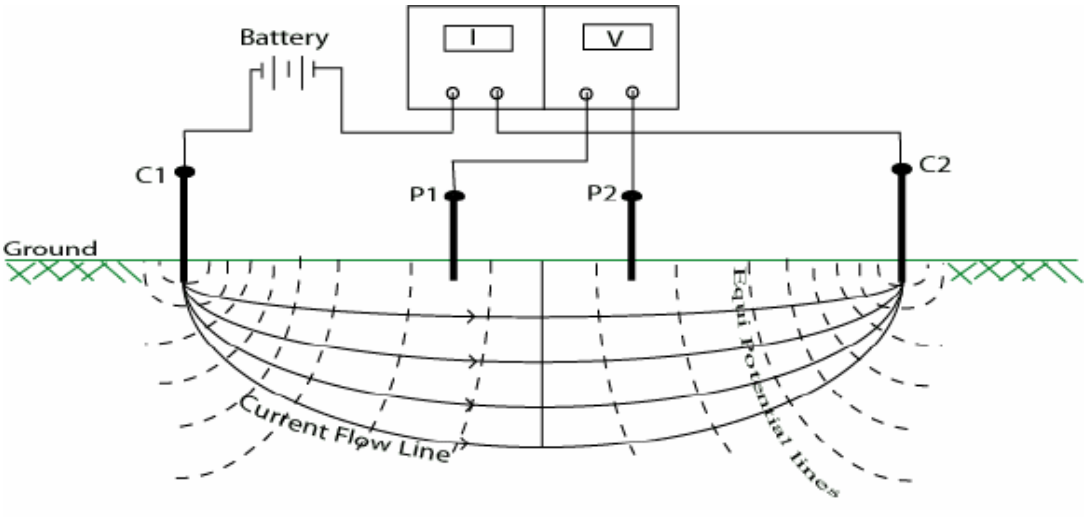
The area, in general, is composed of alluvium formations with good yield of water. The study indicated that the site has good ground water potential and the water quality is potable. The details of the study and the results there of are presented in this report.

3.0 RESISTIVITY SURVEY

3.1 General Principles

When electricity passes through the earth, it encounters resistance to the flow from the soil / rock-materials. The impedance is dependent on the elemental constitution, granular arrangement and fluid content of the underlying earth layers. A four electrode Schlumberger array, as illustrated below, with a maximum current electrode separation of 150 m was used to obtain the vertical sequence of materials at several specific locations.

The apparent resistivity offered by these layers is calculated using the relationship between the distances of potential and current electrodes and the amperage used to generate the measured voltage difference after nullifying, if any, the natural potential of such materials. Based on parametric soundings at locations where the subsurface lithology is known and by curve matching techniques the thickness and nature of formations in a given area are obtained by interpretation.



Typical Schematic of Schlumberger electrode array.

3.2 Vertical Electric Soundings

To obtain a total coverage of the area and to probe the conditions at greater depths, electrical soundings have been carried out. Electrical soundings were made to probe the subsurface conditions prevailing, to the depths of 150 m using extrapolation

techniques. The data obtained were analyzed by curve matching methods as well as empirical methods.

A total of four Vertical Electric Soundings (VES) were conducted at site. The VES locations are illustrated on Fig. 1 and marked on the master plan.

The data was plotted as measured resistivity values versus the current electrode spacing (AB/2). The measured apparent resistivity values are tabulated on Table 1. Graphical plots of the results are presented on Figs. 2 to 9.

4.0 GROUNDWATER ASSESSMENT AND RECOMMENDATIONS

4.1 Site Assessment

The data obtained has been evaluated to assess the general trend of groundwater conditions across the site. Keeping in view various hydro-geological and geophysical aspects of the study area, our assessment of site conditions is as follows:

a) The area surveyed is part of north sloping Aravali hill range with sand, gravel kankar and weathered rock forming the potential aquifers.

b) Groundwater occurs under phreatic conditions at shallow depths and under semi-confined conditions at greater depths.

c) Resistivity data indicates that the surveyed area has uniform underground conditions with minor changes at specific locations. In general, the trend of groundwater conditions is uniform and no substantial variations are expected.

d) The survey indicated hard rock formations comes at depth of 40 m below ground level.

4.2 Groundwater Potential and Quality

There are no exact methods of calculating yields from tube-wells using VES data. However, a good and reliable estimate can be made on the basis of resistivity values, interpreted stratigraphy, hydrological

information and local site conditions. Broadly the assessment of yield is made after careful review of the following:

a) Thickness of sand zones,
b) Presence of fractured / jointed rock,
c) Groundwater conditions in the area,
d) Geology of the area,
e) Actual yield from the existing wells in vicinity,
f) Presence of water bodies in the surrounding areas.
g) Rainfall in the project area and expected recharge of the groundwater sources,
h) Assessment of hydraulic gradient and ground water flow.

Based on review of various parameters as explained above, the interpreted stratigraphy and expected water quality at each of the 5 VES locations is presented on Tables 2 to 6. Our assessment of groundwater potential is as follows:

a) Resistivity data indicates that the surveyed area has uniform underground conditions with minor changes at specific locations.

b) The quality of groundwater is potable and fit for any use. There may be minor variations in the actual quantity that can be drawn depending upon various seasonal and hydrological factors.

c) Overall study indicated that the site has good ground water potential.

d) Whereas yields will be higher in coarse sand, the yield will be lesser in fine sand and strata containing silts and clays.

Tube-wells for the project should be installed to about 130 - 140 m depth. As per our assessment, each well in the area can yield about 15,000 litres per hour (1,50,000 litres per day for maximum 10 hours of pumping). The recharge of groundwater is good; however it is likely that the yield could decrease over a period of time.

We anticipate that the estimated yield is likely to be available for a period of at least 10-15 years.

The yield and quality of groundwater will be influenced by the urbanization and industrialization in the area and the number of tube-

wells that may be installed within the site area and in the surrounding area in the future and quantum of water extracted from the aquifer.

4.3 Recommended Tube-wells

Tube-well drilled to a depth of 120 m to 140 m using DTH technique with an efficient pumping system may be installed under an expert guidance. The study confirms that the underground formations are fairly uniform.

Hence tube-well may be drilled at any five locations (Refer Fig. 1). Our suggested order of preference is as follows:

1. VES- 1 2. VES-3 3. VES-2
4. VES-5 and 5. VES-4

Our recommended tubewell design is given in Fig.13. It shows the depths of the blank and slotted casings. The actual location of the well screen should be decided during drilling. The gap between the hole and casing should be filled with pea gravel.

To avoid interference, we suggest that a minimum distance of not less than 100 m be kept between adjacent tube-wells.

The quality of underground water is potable. Testing of water to ascertain quality is essential.

5.0 RAINWATER HARVESTING

To conserve water as a runoff from the surface of open areas and building roof, rainwater harvesting is recommended to recharge the shallow aquifer through a recharge structure.

Rainwater harvesting is likely to be beneficial in the long run for sustained yield from the wells and also to limit further increase in salinity. At least two structures may be provided at the project site. For successful rainwater harvesting, all water from storm-water drains should flow into the recharge structure. Also, the ground slopes should be such that all water from open areas flow into the water-harvesting structure.

There is a nallah passing through the site. We understand that it runs full during the monsoons. The water in this nallah may be intercepted in the higher reaches and fed into a recharge well installed specifically for this purpose. It should be ensured that the recharge well can absorb the peak-monsoon discharge of the nallah. This will enhance the groundwater scenario in the area and ensure long life of the wells.

6.0 LIMITATIONS

All projections and recommendations are subject to the inherent limitations of the technique employed. There could be variations as the underground conditions are not always amenable to physical interpretations. In case any major variations are observed, we request to be informed so that our hydro-geologists may review the site conditions in light of these variations.

7.0 SUMMARY OF PRINCIPAL FINDINGS AND RECOMMEMDATIONS

Cengrs Geotechnica Pvt. Ltd assessed the ground water potential at the proposed Environmental Training Institute at Nimli Village Tijara, Rajasthan. He purpose is to establish the reliability and adequacy of source to meet its water requirement. The results from the hydro-geological and geophysical investigations reveal good groundwater potential and good quality.

A general assessment of the site indicates that the current groundwater potential can be about 12,000 to 15,000 litres per hour from one tube-well. In case two or more tube-wells are installed they should be spaced 100 m apart. For long term performance of the wells, rainwater harvesting is suggested.

8.0 CLOSURE

We appreciate the opportunity to perform this investigation for you and have pleasure in submitting this report. Please contact us when we can be of further service to you.

for CENGRS GEOTECHNICA PRIVATE LIMITED

(RAVI SUNDARAM)
DIRECTOR

(SANJAY GUPTA)
MANAGING DIRECTOR

	CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-B	Table No. 1

ESP in m (AB/2)	Apparent Resistivity in ohm metres				
	VES-1	VES-2	VES-3	VES-4	VES-5
1	35	32	30	36	38
3	36	34	42	35	36
5	32	36	33	50	33
7	36	35	32	34	33
10	35	32	36	35	35
15	34	31	34	36	36
20	30	22	33	32	34
25	21	25	22	22	25
30	25	24	21	105	23
35	26	23	23	22	21
40	28	32	25	105	28
45	24	35	120	112	125
50	23	34	45	22	35
55	145	105	124	125	110
60	52	42	52	143	34
70	140	125	105	146	135
80	124	145	106	120	210
90	135	122	110	244	225
100	124	156	205	245	314
110	245	254	210	316	355
120	312	312	312	445	125
130	210	445	120	456	143
140	110	115	104	124	120
150	412	434	385	325	184

VES: Vertical Electrical Sounding (Schlumberger Array)
ESP: Electrode Separation in m
Values in table are measured apparent resistivity values (ohm-m) for corresponding electrode separation

APPARENT RESISTIVITY VERSUS ELECTRODE SPACING

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

Expected Formation and Water Quality at VES - 1:

Depth, m	App. Resistivity, ohm-m	Expected litho-log	Expected Quality
0 – 3	35 – 36	Surface Soil	--
3 – 20*	30 –40	Sandy clay	Potable
20 – 50	20 –30	Clay with kankar	---
50 – 80*	40 – 145	Rock boulders with sand	Potable
80 – 100*	100 – 200	Weathered rock	Potable
100 – 120	200<	Hard rock	----
120– 140*	110- 312	Fractured rock	Potable
140 - 150	> 200	Hard rock	

* Aquifer zone

Specifications of the tube well construction at **VES -1** (See Fig. 5):

a)	Depth	130 m
b)	Hole Diameter	10” /8”(250 mm/200 mm)
c)	Pipe Diameter	8” (200 mm)
d)	Expected Yield	15,000 Liters per hour
e)	Drilling Technique	DTH

Notes:

The yield is estimated based on thickness of Sand, fractures & weathered zones (Aquifer) and well inventory.

EXPECTED STRATIGRAPHY AND TUBE-WELL SPECIFICATIONS

VES-1

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

Expected Formation and Water Quality at VES - 2:

Depth, m	App. Resistivity, ohm-m	Expected litho-log	Expected Quality
0 – 4	32 – 34	Surface Soil	--
4 – 15*	30-40	Sandy clay	Potable
15 - 35	20-30	Clay with kankar	---
35– 50*	30-40	Sandy clay	Potable
50 – 65*	53 – 56	Rock boulders with sand	Potable
65 – 95*	100 – 200	Weathered rock	Potable
95 – 130	200<	Hard rock	----
130– 140*	110– 210	Fractured rock	Potable
140 - 150	> 200	Hard rock	

* Aquifer zone

Specifications of the tube well construction at **VES -2** (See Fig. 5):

a)	Depth	140 m
b)	Hole Diameter	10” /8”(250 mm/200 mm)
c)	Pipe Diameter	8” (200 mm)
d)	Expected Yield	14,000 Liters per hour
e)	Drilling Technique	DTH

Notes:

The yield is estimated based on thickness of Sand, fractures & weathered zones (Aquifer) and well inventory.

EXPECTED STRATIGRAPHY AND TUBE-WELL SPECIFICATIONS
VES-2
Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

Expected Formation and Water Quality at VES - 3:

Depth, m	App. Resistivity, ohm-m	Expected litho-log	Expected Quality
0 – 3	30 – 42	Surface Soil	--
3 – 20*	30-40	Sandy clay	Potable
20 - 40	20-30	Clay with kankar	---
40 – 60*	45-124	Rock boulders with sand	Potable
60 – 90*	110-200	Weathered rock	Potable
90 – 120	200<	Hard rock	----
120– 140*	104-312	Fractured rock	Potable
140 - 150	> 200	Hard rock	

* Aquifer zone

Specifications of the tube well construction at **VES -3** (See Fig. 5):

a)	Depth	130 m
b)	Hole Diameter	10” /8”(250 mm/200 mm)
c)	Pipe Diameter	8” (200 mm)
d)	Expected Yield	15,000 Liters per hour
e)	Drilling Technique	DTH

Notes:

The yield is estimated based on thickness of Sand, fractures & weathered zones (Aquifer) and well inventory.

EXPECTED STRATIGRAPHY AND TUBE-WELL SPECIFICATIONS
VES-3
Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

Expected Formation and Water Quality at VES - 4:

Depth, m	App. Resistivity, ohm-m	Expected litho-log	Expected Quality
0 – 4	36-50	Surface Soil	--
4 – 25	30-40	Sandy clay with kankar	---
25 –45*	22-112	Boulderts with clay	Potable
45 – 60*	22-143	Clay with weathered rock	Potable
60 – 80*	100-200	Weathered rock	Potable
80 – 130	200<	Hard rock	---
130 – 140*	100-200	Weathered rock	Potable
140 - 150*	124 – 325	Hard rock	

* Aquifer zone

Specifications of the tube well construction at **VES -4** (See Fig. 5):

a)	Depth	130 m
b)	Hole Diameter	10” /8”(250 mm/200 mm)
c)	Pipe Diameter	8” (200 mm)
d)	Expected Yield	12,000 Liters per hour
e)	Drilling Technique	DTH

Notes:

The yield is estimated based on thickness of Sand,fractures & weathered zones (Aquifer) and well inventory.

EXPECTED STRATIGRAPHY AND TUBE-WELL SPECIFICATIONS VES-4

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

Expected Formation and Water Quality at VES - 5:

Depth, m	App. Resistivity, ohm-m	Expected litho-log	Expected Quality
0 – 4	36 – 38	Surface Soil	--
4 – 20	30-40	Sandy clay with kankar	----
20 –40	20-30	Clay with kankar	---
40 – 60*	34-125	Boulders with Sandy clay	Potable
60 – 70*	100-200	Weathered rock	Potable
70 – 110	200<	Hard rock	---
110 – 140*	100-200	Weathered rock	Potable
140 - 150*	120-212	Hard rock with fractures	Potable

* Aquifer zone

Specifications of the tube well construction at **VES -5** (See Fig. 5):

a)	Depth	130 m
b)	Hole Diameter	10” /8”(250 mm/200 mm)
c)	Pipe Diameter	8” (200 mm)
d)	Expected Yield	13,000 Liters per hour
e)	Drilling Technique	DTH

Notes:

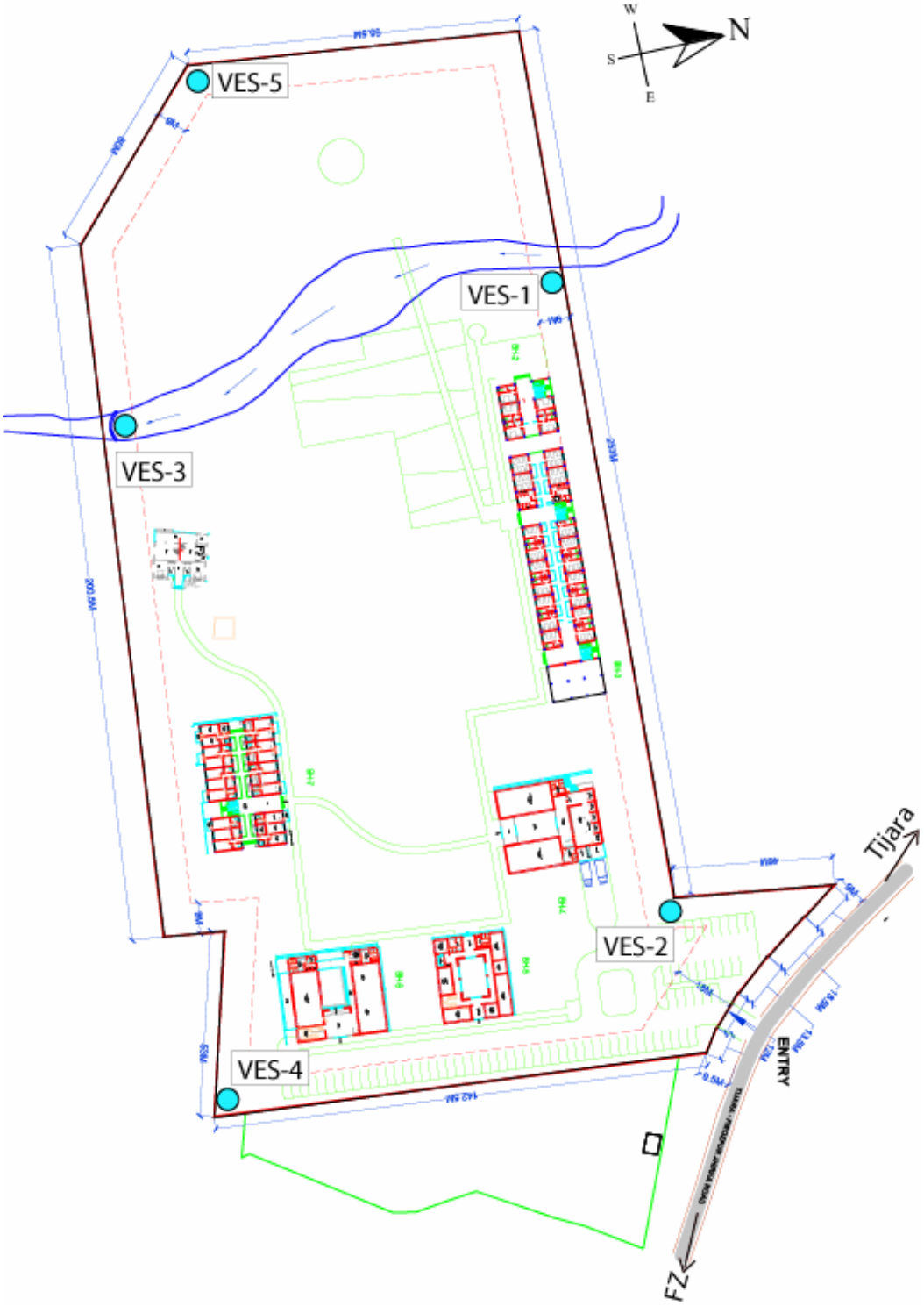
The yield is estimated based on thickness of Sand, fractures & weathered zones (Aquifer) and well inventory.

EXPECTED STRATIGRAPHY AND TUBE-WELL SPECIFICATIONS

VES-5

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

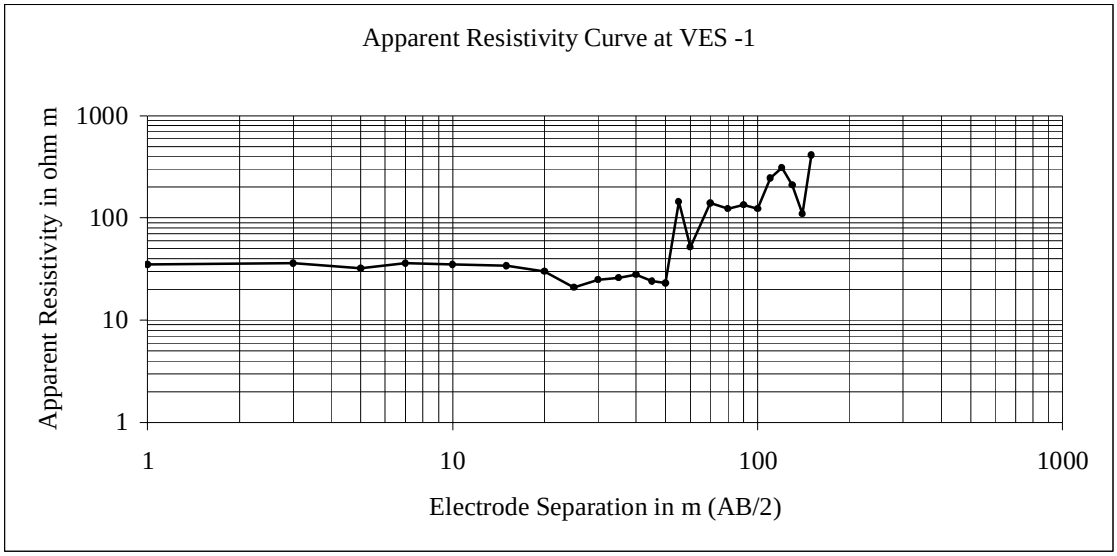
	CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-B	Fig. No. 1

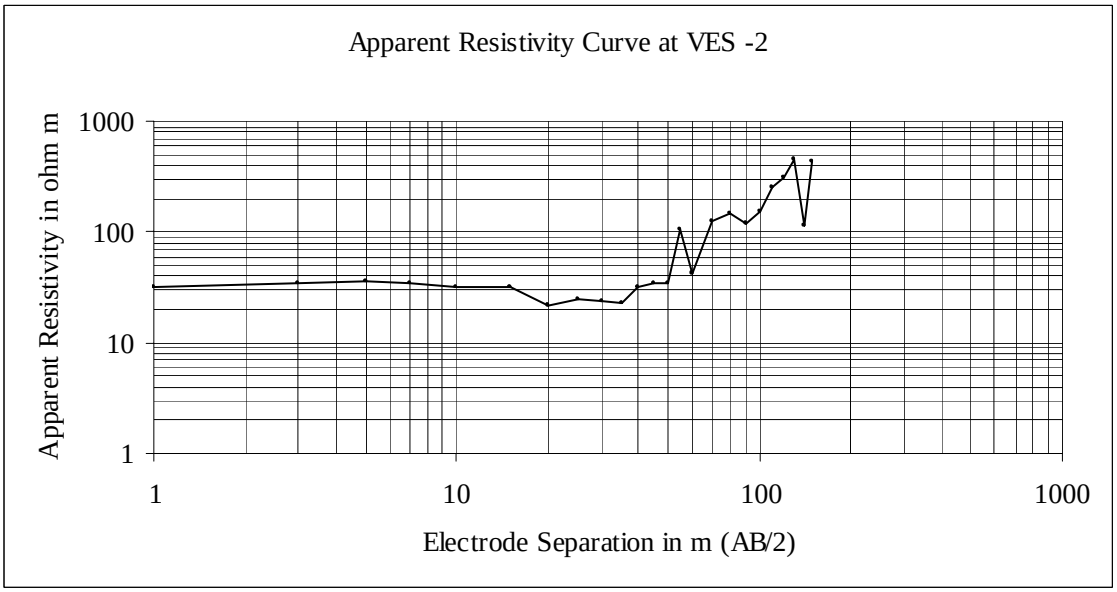


Layout Plan Showing VES(Point) Locations

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

	CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-B	Fig. No. 2



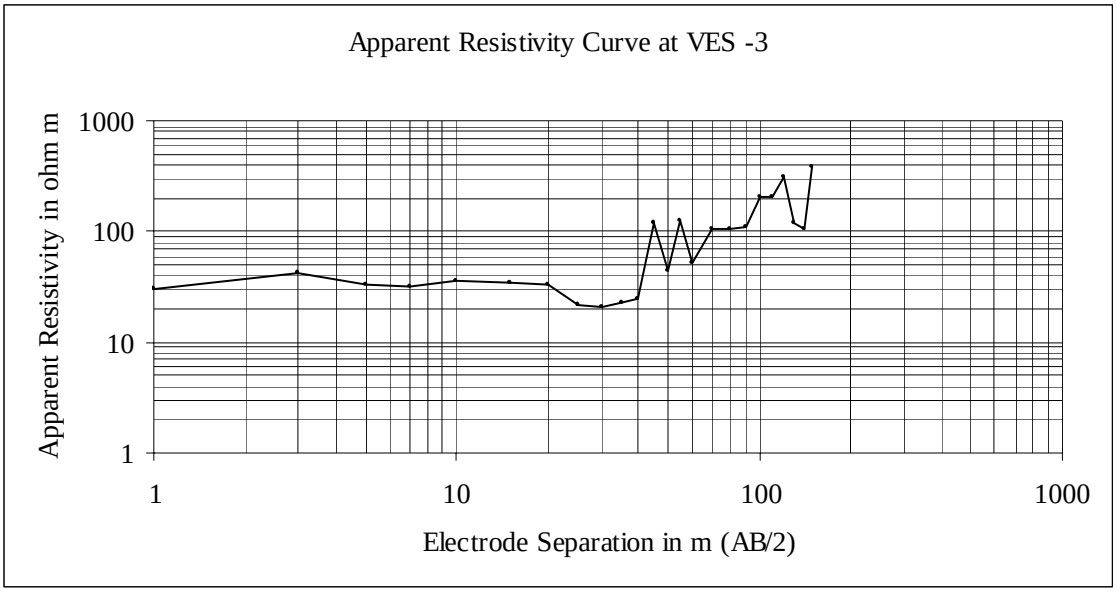


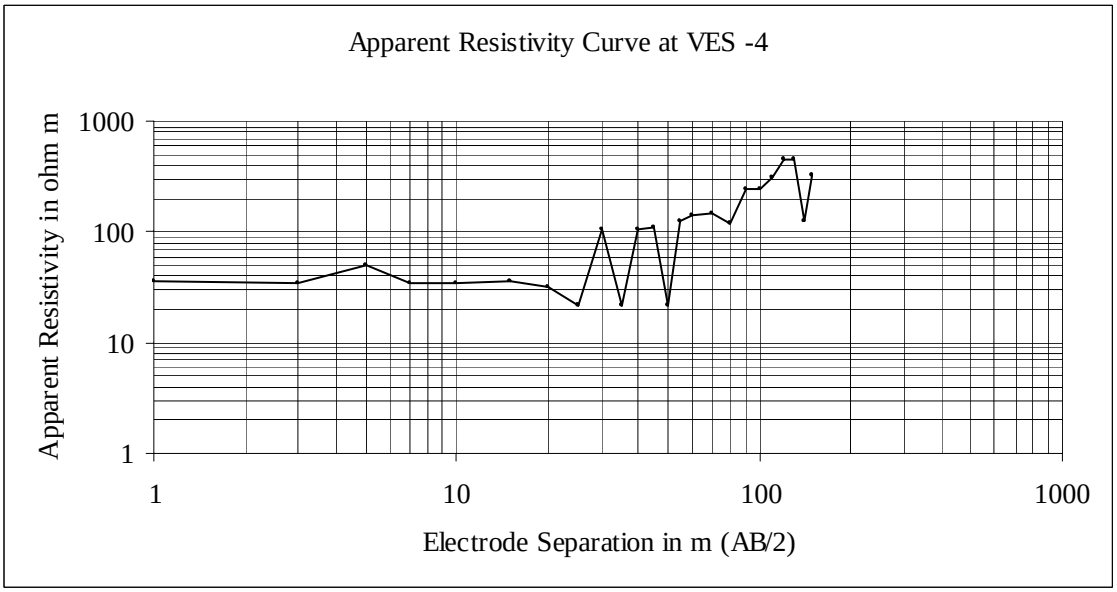
APPARENT RESISTIVITY VERSUS ELECTRODE SPACING

Schlumberger Array

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

	CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-B	Fig. No. 3



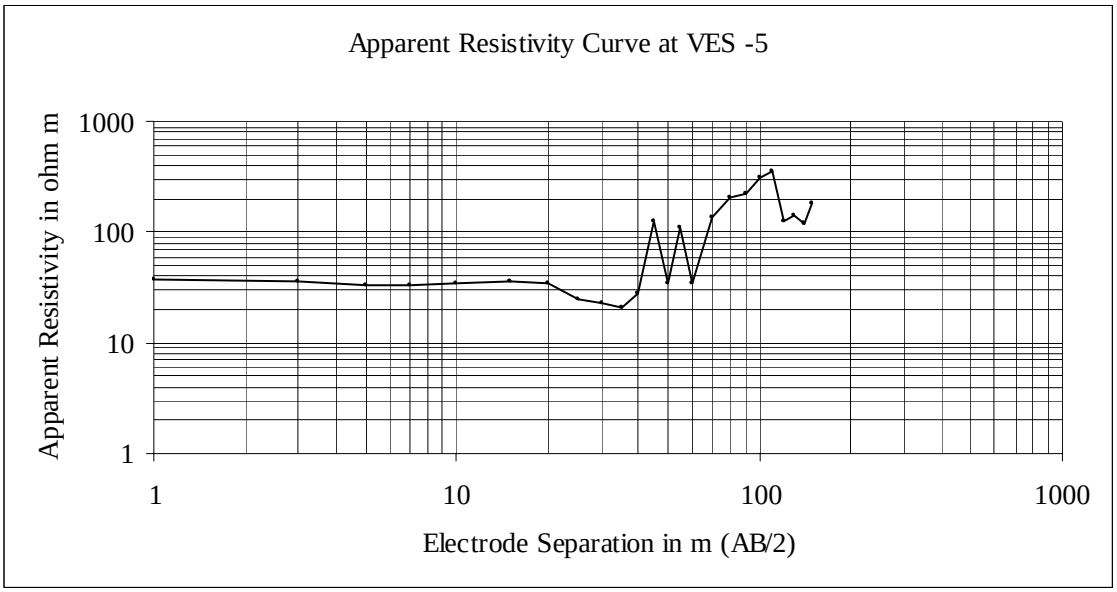


APPARENT RESISTIVITY VERSUS ELECTRODE SPACING

Schlumberger Array

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

	CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-B	Fig. No. 4

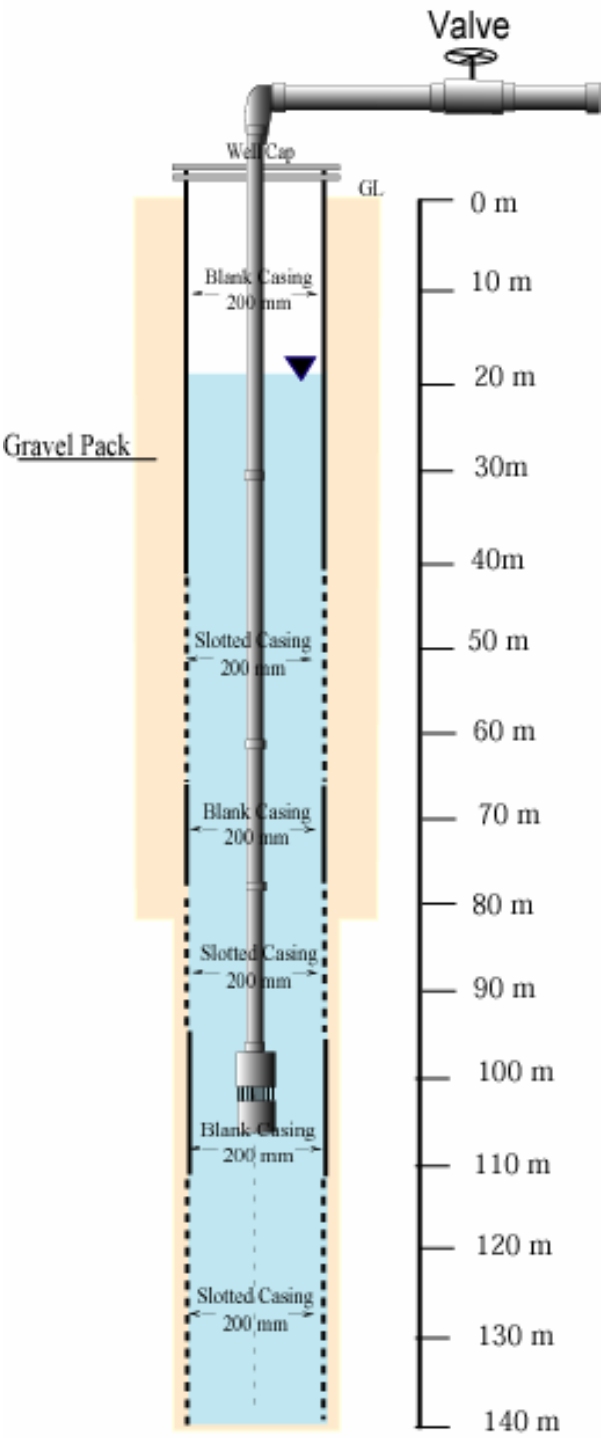


APPARENT RESISTIVITY VERSUS ELECTRODE SPACING

Schlumberger Array

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

	CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-B	Fig. No. 5



Recommended Tubewell Design

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan

	CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-B	Fig. No. 6

Site Photographs

Groundwater Survey at Environmental Regulatory Training Institute at Nimli Village, Tijara, Alwar, Rajasthan