Environmental and Social Impact Assessment Report (ESIA) – Lombok (Annex D)

Project No.: 51209-002
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INO: Eastern Indonesia Renewable Energy Project (Phase 2)

Prepared by ERM for PT Infrastruktur Terbarukan Lestari

ANNEX D GEOELECTRIC EXPLORATION REPORT

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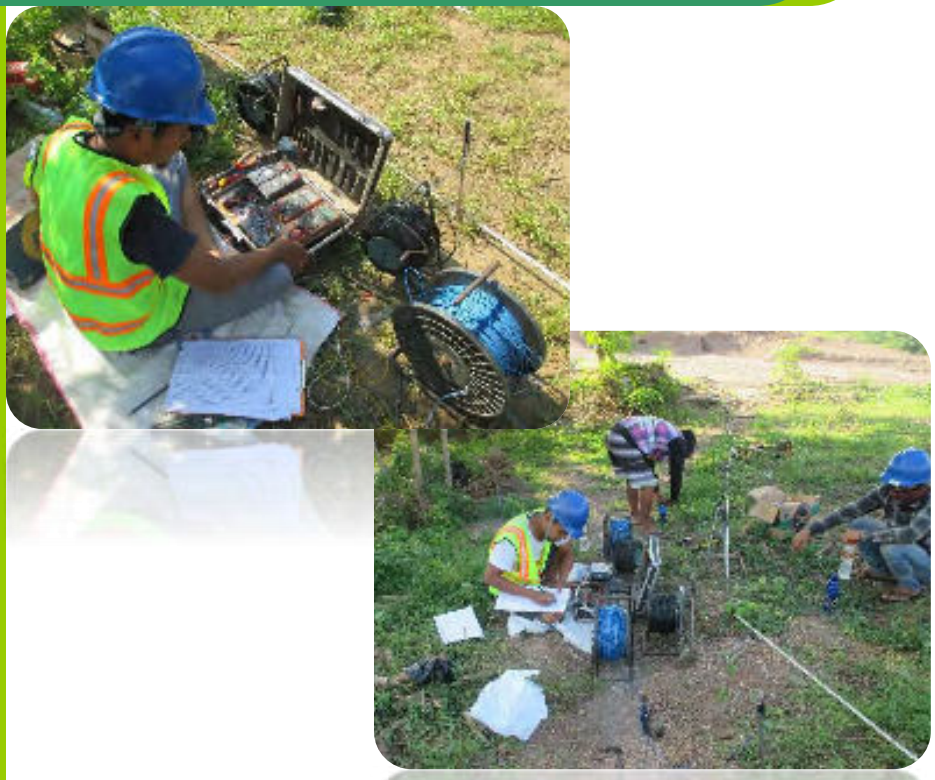
5 MW SOLAR POWER PLANT PROJECT

Site : Pringgabaya, East Lombok,
West Nusa Tenggara.

GEOELECTRICAL INVESTIGATION REPORT



DECEMBER
2017

PREFACE

No : 90/*Geoelectrical-Report*/XII/2017
Attachment : 1 Set
Subject : Geoelectrical Report

To

PT. PP (Persero) Tbk

In order to fulfill the requested from PT. PP (Persero) Tbk for Geoelectrical Test at Pringgabaya Solar Power Plant Site, East Lombok, West Nusa Tenggara, CV. Rekayasa Bumi Karya has finished the test for 4 point location at the site. Geoelectrical test has been conducted on 13th December 2017. The result of the test can be figured in this report.

We hope this report can help the construction of the project as well. Thank you for your faith and cooperation to us.

Mataram, 27th December 2017
Director,

Sukandi, ST., M.Eng

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CHAPTER I
INTRODUCTION

1.1 Background

Geoelectrical investigation used to have information of the water ground conditions to fulfill the needs of raw water. Water ground locations are variative and spreading unequally, it depends on the geological conditions below the surface or the aquifer layer and the topograpchic site condition.

1.2 Aim and Purpose

The aim of this work to determined the aquifer layers which is contain the ground water. The Purpose of this work to find the characteristics of aquifer layers so we can figure the depth and positions of aquifer layers.

1.3 Scope of Work

1. Geoelectrical investigation has been done on 4 point locations at Pringgabaya's Site.
2. Makes data interpretation from the 4 point location.

1.4 Project Location

Geoelectrical site located at Pringgabaya, East Lombok, West Nusa Tenggara.

1.5 Date of Test

The test was held on 13th – 14th December 2017.

CHAPTER 2
METHODOLOGY

2.1 Geoelectrical Investigation

Geoelectrical investigation is one of the geophysics method who studied electrical current flow inside the earth and how to detect it from the surface. The method that we used in this investigation is geoelectrical resistivity method. This geoelectrical resistivity investigation has been conducted to know the deployment and the differences of Soil layers below the surface vertically or horizontally. The characteristics of rocks resistivity depends on several factors such as rocks material, mineral content, rock electrolyte content. To interpret the rock classification we can combined the resistivity result and geological site condition. So we can determined which one of the rock layer as a aquifer.

2.1.1 Theory

Principal of resistivity geoelectrical survey is injected the electrical current into the earth through two electrodes. This electrical current caused the voltage for the both point. Due to the differences between the rock layers which is through by the electricity current, caused the difference of voltages between the both points. This difference can be measured from the surface by receiver (V) through two potential electrodes.

There are some electrode configurations for this resistivity test, such as *Wenner*, *Schlumberger*, *dipole-pole*, etc. The difference of configuration usage will be affected to geophysics parameter. Schlumberger configuration is used in this resistivity test at Pringgabaya Site. The span of cables were adjusted with site condition.

According to aim of the resistivity geoelectrical investigation, we have two ways to collected the data.

1. Mapping/traversing

   Electrodes span are determined how depth we know the variations of rock resistivity under the ground surface horizontally.

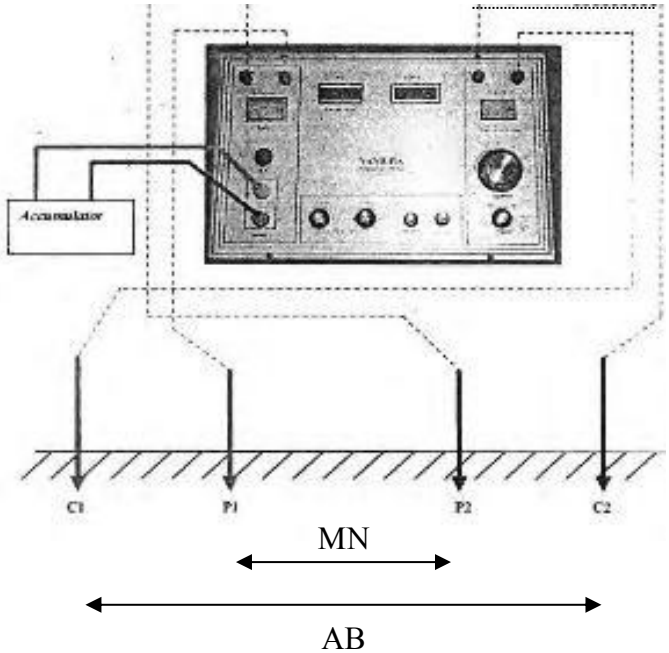
2. Vertical Electrical Sounding (VES)

To know the variations of rock resistivity under the ground surface vertically.

2.1.2 Equipment

1. Geoelectrical appliance type G-Sound Twin Probe
2. ACCU
3. Current electrode which is made from steel peg
4. Voltage electrode which is made from copper peg
5. Cable around 300 meters to connect voltage electrode to geoelectrical appliance
6. Cable around 300 meters to connect current electrode to geoelectrical appliance
7. Connecting battery cable to geoelectric appliance
8. Hammer
9. Meter
10. Data form
11. Stationery
12. Compass

2.1.3 Steps of Geoelectrical Measurement



Picture 2.1 Array of electrodes in Resistivity meter using Schlumberger Configuration

1. After all the appliance are completed, and then set it up with accumulator. The voltage on indicator transmitter will be 24 Volt and around the middle for incoming voltage is 12 volt.
2. Determined the measurement track for one sounding point. Gradually added electrode spacing for one sounding point. The space of electrode based on schlumberger configuration.
3. After set up the electrode at certain space, based on used configuration, connect the current electrode with current terminal. Current loop indicator will be deviated to right side at red area. Connect the potential electrode to potential terminal.
4. Calibrate the geoelectrical appliance to neutralize natural potential effect to measurement. On digital meter will be showed a certain number, arranged the compensator to zero using smooth potentiometer.
5. Injected the electrical current, turn the switch volt to position 1, the current can be increased by raising the voltage to higher position. When current reading is still good enough, there is no need to raise the voltage to avoid the broken fuse. After pushing start button, current value will be showed on display. Write down the current value and then push hold button and potential value will be showed at potential display. The current value used to be small at AB/2 position. If current value does not show up when the start button is injected, then check the battery. Recessive surface or over spacing electrode caused current value undetected.
6. Detected Current and potential value are written on measurement form.

2.2 Data Analysis

The data obtained from field investigation are potential current and potential difference on electrode composition with AB/2 and MN/2. Formula to analysis the value of pseudo-resistivity according Schlumberger electrode configuration rules are:

$$\rho\alpha = K\left(\frac{\Delta V}{I}\right)$$

$$K = \pi(AB^2 - MN^2)/4MN$$

In geoelectrical resistivity method, the earth is assumed having isotrophic homogeny characteristic, therefore the measurable resistivity is the real value of resistivity. It is not depending on electrode spacing. The earth consist from many of rock layers with different resistivity, therefore the measurable potential affected by those layers. The measurable resistivity value is not the resistivity for all rock layers. Especially for wide electrode space, the measurable pseudo-resistivity value called pseudo-resistivity value. Pseudo-resistivity value is resistivity value from equivalent fictive homogeny medium with reviewed plated medium.

For example, a reviewed plated medium consist of two rock layers with different resistivity value (ρ1 dan ρ2) consider as a layered homogeny medium which is having one pseudo-resistivity (ρα). ρα value plotted to AB/2 on transparent bilogaritma paper to be interpreted.

2.3 Interpretation

There are some methods to interpreted resistivity value data, one of the simplest way is curve matching, matching the field curve with standard curve, and then the result analysis with IP2WIN and Progres program software.

The resistivity value of each material as the subsurface lithological interpretation can be interpreted as the table below :

Table 2.1 Resistivity value of each materials

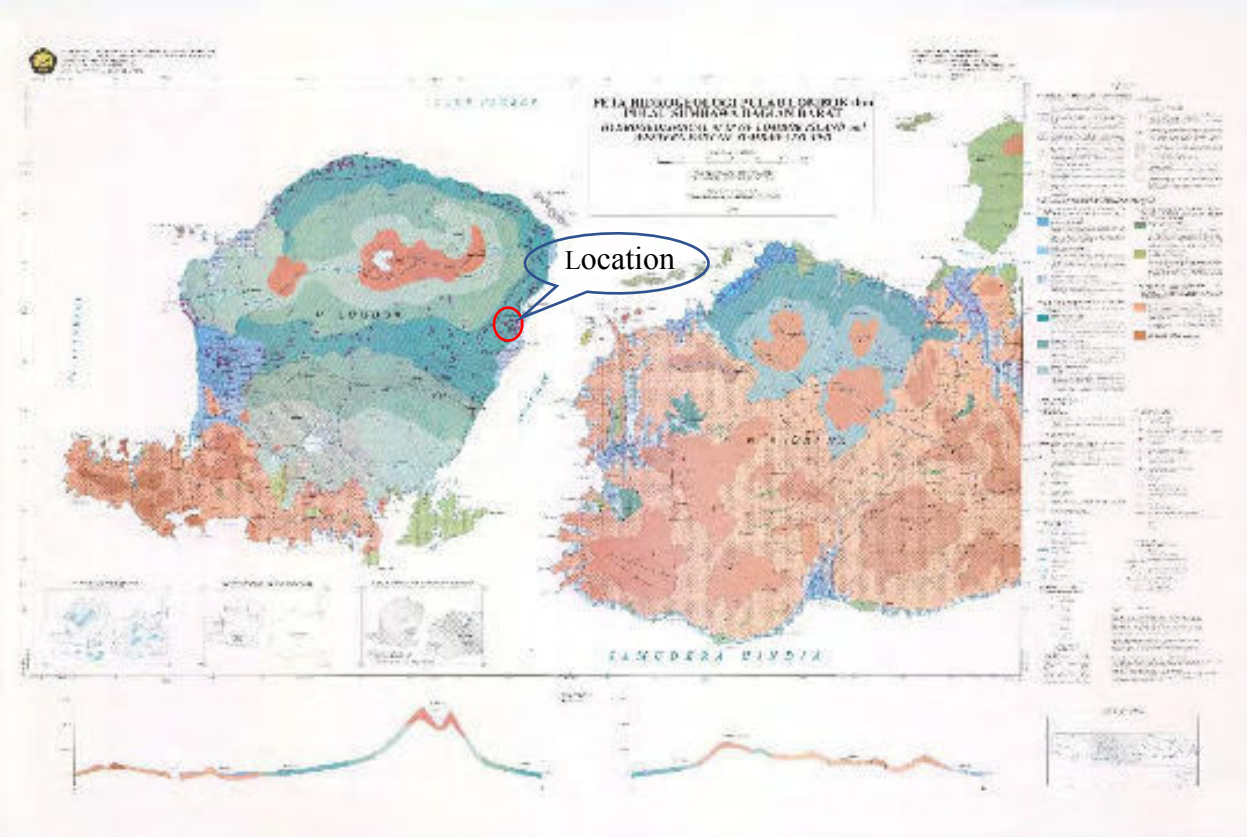
Material	Resistivity (Ohm-m)
Basalt	1000 - 10^8
Marble	100 – 2.5x10^8
Quartzite	100 – 2x10^8
Sandstone	8 – 4000
Shale	20 – 2000
Limestone	50 – 400
Clay	1 – 100
Alluvium	10 – 800
Ground Water	0.1 – 100
Salt Water	0.2
Conglomerate	100 – 500
Tuff	20 – 200
Andesite	100 – 2000
Granit	1000 – 10000
Chert, slate	200 – 2000

Source: Loke. M.H., 1997-2001

CHAPTER III
RESULTS

3.1 Hydrogeological Condition

The period of Rainfall in Lombok island is about 4 – 5 months (November – April) with rainfall intensity 900 – 2600 mm/year. The biggest intensity located at West Lombok and around Rinjani Mountain. The available amount of surface water at River Basin Unit around 2.50 – 3.50 Billion m^3 . Whereas for ground water potency in Lombok island around 0.9 billion m^3.



Picture 3.1 Hydrogeological Map of Lombok Island and Western Part of Sumbawa Island

Geoelectrical investigation located at Pringgabaya, East Lombok, West Nusa Tenggara Barat. This investigation aim for Power Solar Plant construction at Pringgabaya's Site. Hydrogeologically, this investigation site is an area with highly productive aquifer. The depth to

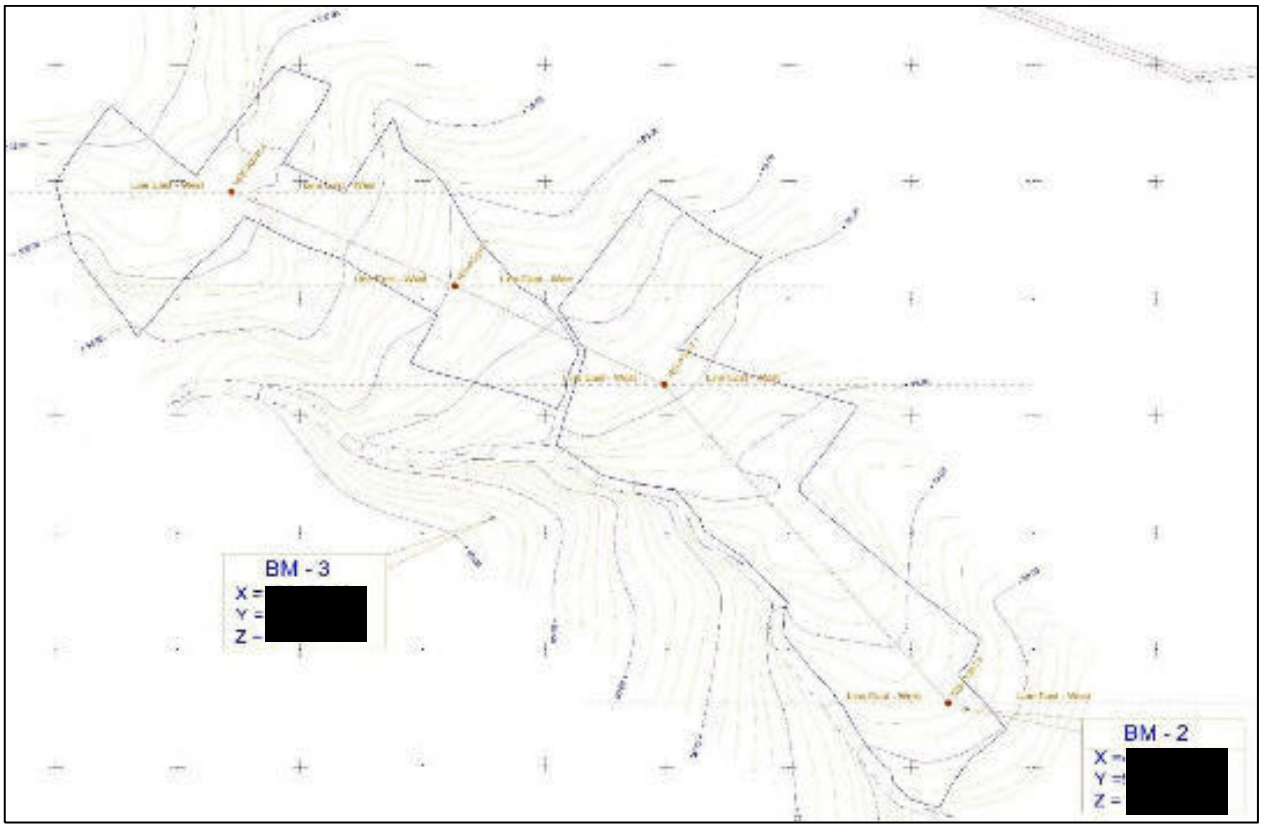
free ground water level more than 16 m below subsurface. Ground water in aquifer layer flows from rock intrusion. Geomorfologically this site is an hilly area with slope range from 20° - 50°. Meanwhile geologically this site is one of volcanic area with base rock which is consist of breccia, tuff, and lava.

3.2 Geoelectrical Interpretation Result

According to the field investigation result using schlumberger configuration, we use IP2WIN and Progress software to get the true resistivity value and subsurface depth.

Table 3.1 Location of Geoelectrical Investigations.

No.	Sounding Point	Coordinates	Elevation (m)
1	VES – 01	[redacted]	81
2	VES – 02	[redacted]	67
3	VES – 03	[redacted]	89
4	VES – 04	[redacted]	101



Picture 3.2 Geoelectrical Line Direction

1. Vertical Electrical Sounding (VES) 01

Line Direction of VES – 01 from east to west. With elevation 81 m above the sea level. Subsurface of lithological cross section on the **table 3.2** and Hydrogeology cross section at **table 3.3.**

Table 3.2 Rock Layers Interpretation for VES – 01

Resistivity Model	Interpretation
	
	Top Soil : **Sandy silt, boulder (lava),** resistivity 4.13 – 215.07 Ohm.m, depth 0.0 – 1.82 m
	Tuff Breccia : resistivity 377.03 Ohm.m, depth 1.82 – 2.79 m
	Breccia : Resistivity 1408.85 Ohm.m, depth 12.59 – 21.30 m
	Tuff Breccia : Resistivity 37.55 Ohm.m, depth 21.30 – 48.27 m
	Breccia : Resistivity 531.25 – 1047.63 Ohm.m, depth 48.27 – 88.17 m
	Tuff Breccia : Resistivity 31.46 Ohm.m, depth 88.17 – 117.70 m
	Tuff Breccia : Resistivity 80.06 Ohm.m, depth 88.17 – ~ m

Table 3.3 Hydrogeological Cross Section

Resistivity Model	Interpretation
VES - 01 	From rock layers interpretation we assumed that confined aquifer layer (natural water) at depth 21.30 – 48.27 m and phreatic aquifer layer (natural water) at depth 88.17 – 117.70 m. Phreatic Aquifer layer located at Tuff Breccia with resistivity value 31.46 – 80.06 Ohm.m.

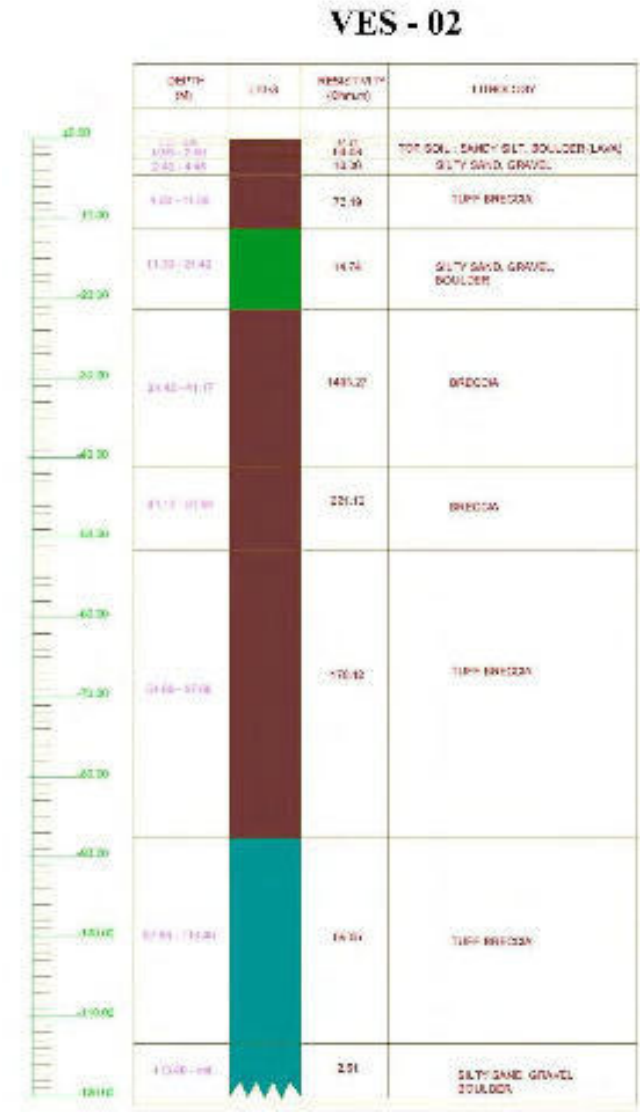
2. Vertical Electrical Sounding (VES) 02

Line Direction of VES – 02 from east to west. With elevation 67 m above the sea level. Subsurface of lithological cross section on the **table 3.4** and Hydrogeology cross section at **table 3.5.**

Table 3.4 Rock Layers Interpretation

Resistivity Model	Interpretation
	
	Top Soil : **Sandy silt, boulder (lava),** resistivity 54.08 – 54.72 Ohm.m, depth 0.0 – 2.40 m
	Silty sand, gravel : resistivity 10.00 Ohm.m, depth 2.40 – 4.48 m
	Tuff Breccia : Resistivity 73.19 Ohm.m, depth 4.80 – 11.30 m
	Silty Sand, gravel, boulder : Resistivity 14.74 Ohm.m, depth 11.30 – 21.42 m
	Breccia : Resistivity 221.10 – 1493.27 Ohm.m, depth 21.42 – 51.66 m
	Tuff Breccia : Resistivity 178.42 – 59.05 Ohm.m, depth 51.66 – 113.40 m
	Silty sand, gravel, boulder : Resistivity 2.51 Ohm.m, depth 113.40 – ~ m

Table 3.5 Hydrogeological Cross Section

Resistivity Model	Interpretation
	From rock layers interpretation we assumed that confined aquifer layer (natural water) at depth 11.30 – 21.42 m and phreatic aquifer layer (natural water) at depth 87.66 – 113.40 m. Phreatic Aquifer layer located at Tuff Breccia and Silty sand, gravel, and boulder with resistivity value 2.51 – 59.05 Ohm.m.

3. Vertical Electrical Sounding (VES) 03

Line Direction of VES – 03 from east to west. With elevation 89 m above the sea level. Subsurface of lithological cross section on the **table 3.6** and Hydrogeology cross section at **table 3.7.**

Table 3.6 Rock Layers Interpretation

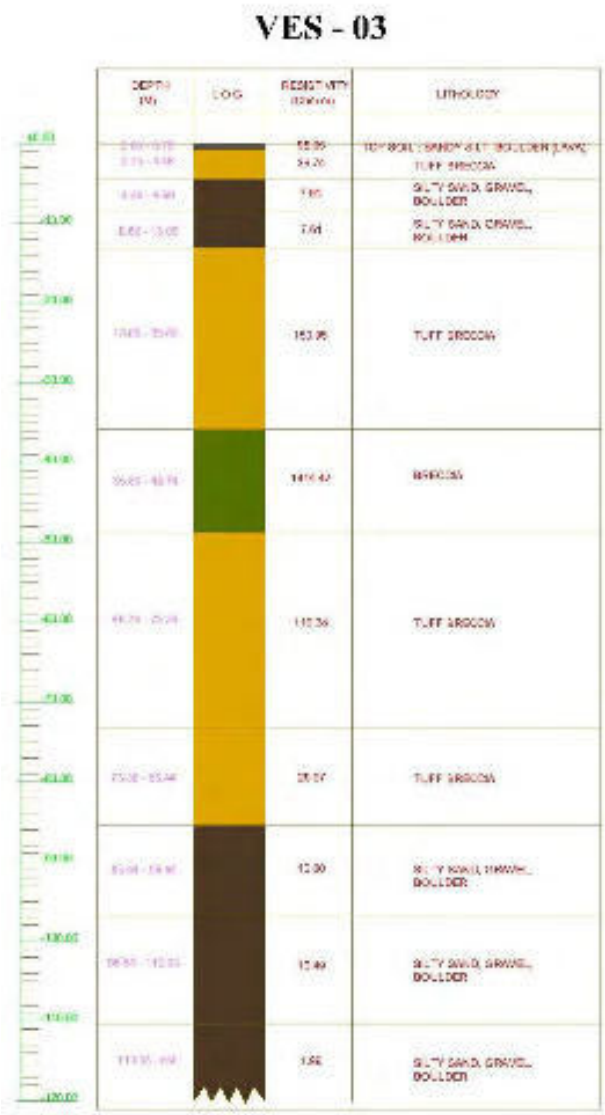
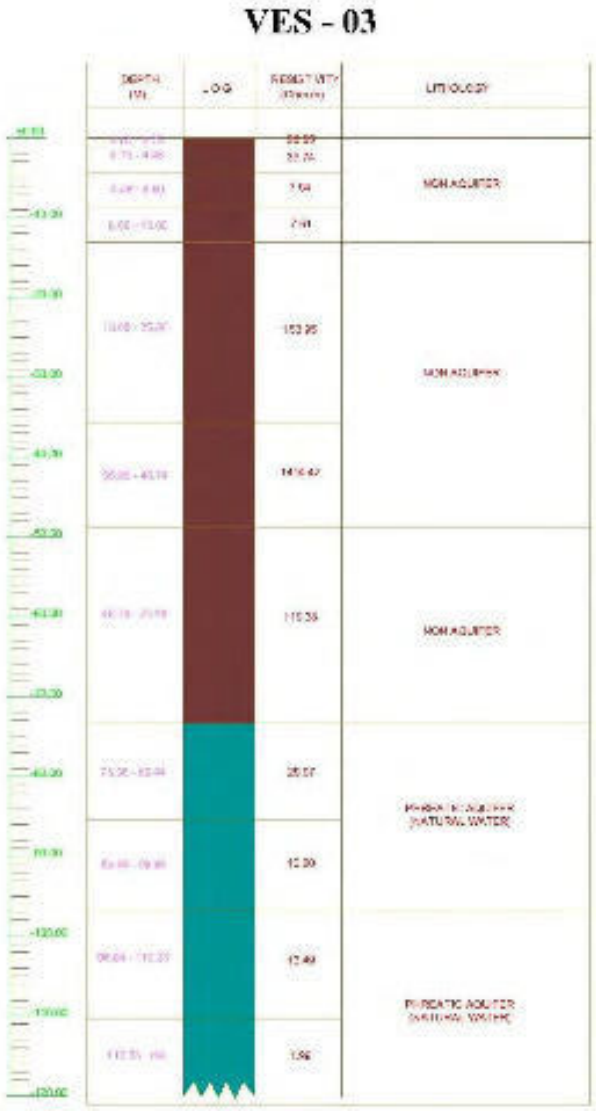
Resistivity Model	Interpretation
	
	Top Soil : **Sandy silt, boulder (lava),** resistivity 98.05 Ohm.m, depth 0.0 – 0.75 m
	Tuff breccia : resistivity 39.74 Ohm.m, depth 0.75 – 4.46 m
	Silty sand, gravel, boulder : Resistivity 7.61 – 7.94 Ohm.m, depth 4.46 – 13.05 m
	Tuff breccia : Resistivity 153.95 Ohm.m, depth 13.05 – 35.80 m
	Breccia : Resistivity 1414.42 Ohm.m, depth 35.80 – 48.74 m
	Tuff Breccia : Resistivity 29.97 – 119.38 Ohm.m, depth 48.74 – 85.44 m
	Silty sand, gravel, boulder : Resistivity 10.00 – 13.49 Ohm.m, depth 85.44 – 110.33 m
	Silty sand, gravel, boulder : Resistivity 1.99 Ohm.m, depth 110.33 – ~ m

Table 3.7 Hydrogeological Cross Section

Resistivity Model	Interpretation
	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 73.36 – 110.33 m. Phreatic aquifer layer located at Tuff Breccia and Silty sand, gravel, and boulder with resistivity 1.99 – 29.97 Ohm.m.

4. Vertical Electrical Sounding (VES) 04

Line Direction of VES – 04 from east to west. With elevation 101 m above the sea level. Subsurface of lithological cross section on the **table 3.8** and Hydrogeology cross section at **table 3.9.**

Table 3.8 Rock Layers Interpretation

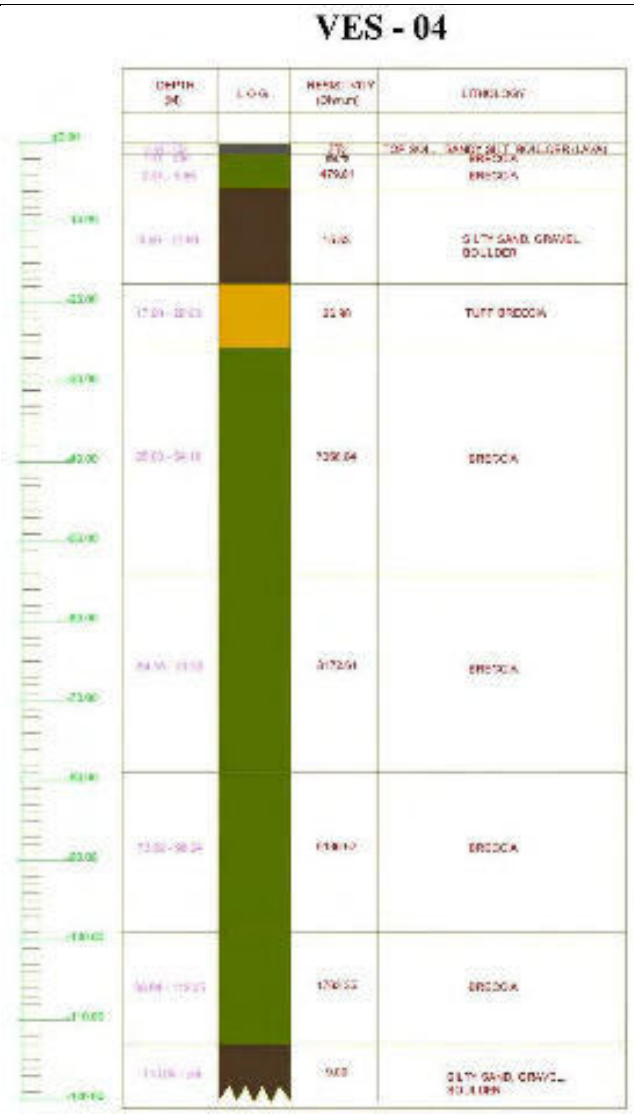
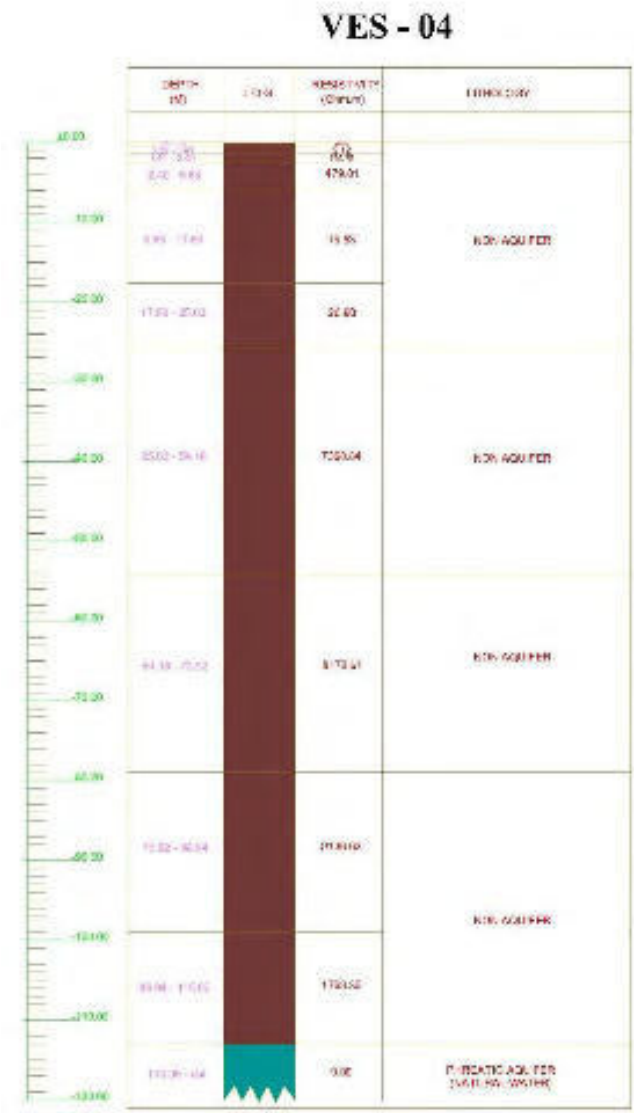
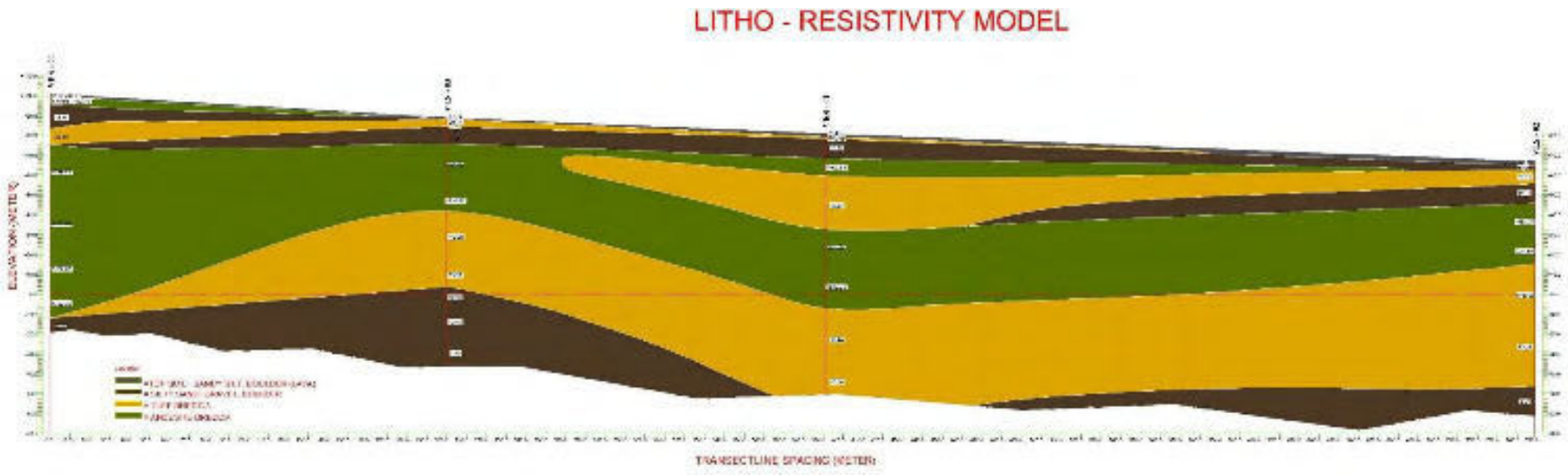
Resistivity Model	Interpretation
	
	Top Soil : **Sandy silt, boulder (lava),** resistivity 2.12 – 49.01 Ohm.m, depth 0.0 – 1.41 m
	Breccia : resistivity 156.75 – 479.81 Ohm.m, depth 1.41 – 5.65 m
	Silty sand, gravel, boulder : Resistivity 15.83 Ohm.m, depth 5.65 – 17.69 m
	Tuff breccia : Resistivity 26.90 Ohm.m, depth 17.69 – 25.63 m
	Breccia : Resistivity 1763.35 – 9136.62 Ohm.m, depth 25.63 – 113.05 m
	Silty sand, gravel, boulder : Resistivity 9.00 Ohm.m, depth 113.05 – ~ m

Table 3.9 Hydrogeological Cross Section

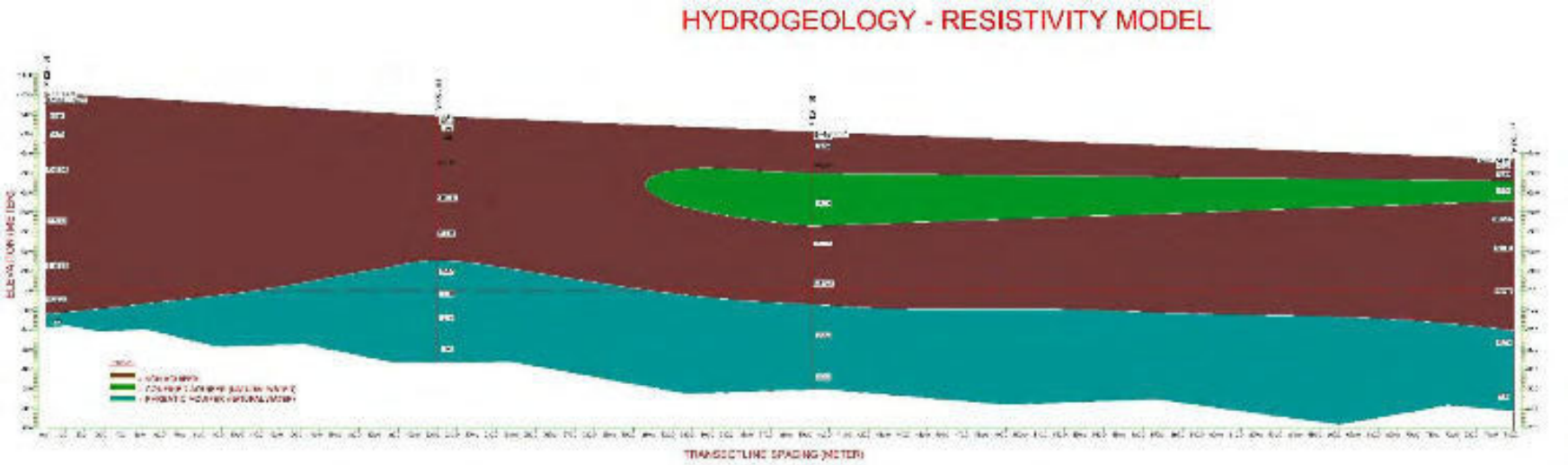
Resistivity Model	Interpretation
	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 113.05 m. Phreatic aquifer layer located at Silty sand, gravel, and boulder layer with resistivity value 9.00 Ohm.m.

5. Correlation VES 01 – 04 of Lithological and Hydrological Cross Section

Based on Correlation VES 01 – 04, and then lithological and hydrological cross section has been made. From lithological cross section the rock and soil layers can be figured as the **picture 3.3** below. Meanwhile, hydrological cross section can be figured at **Picture 3.4.**

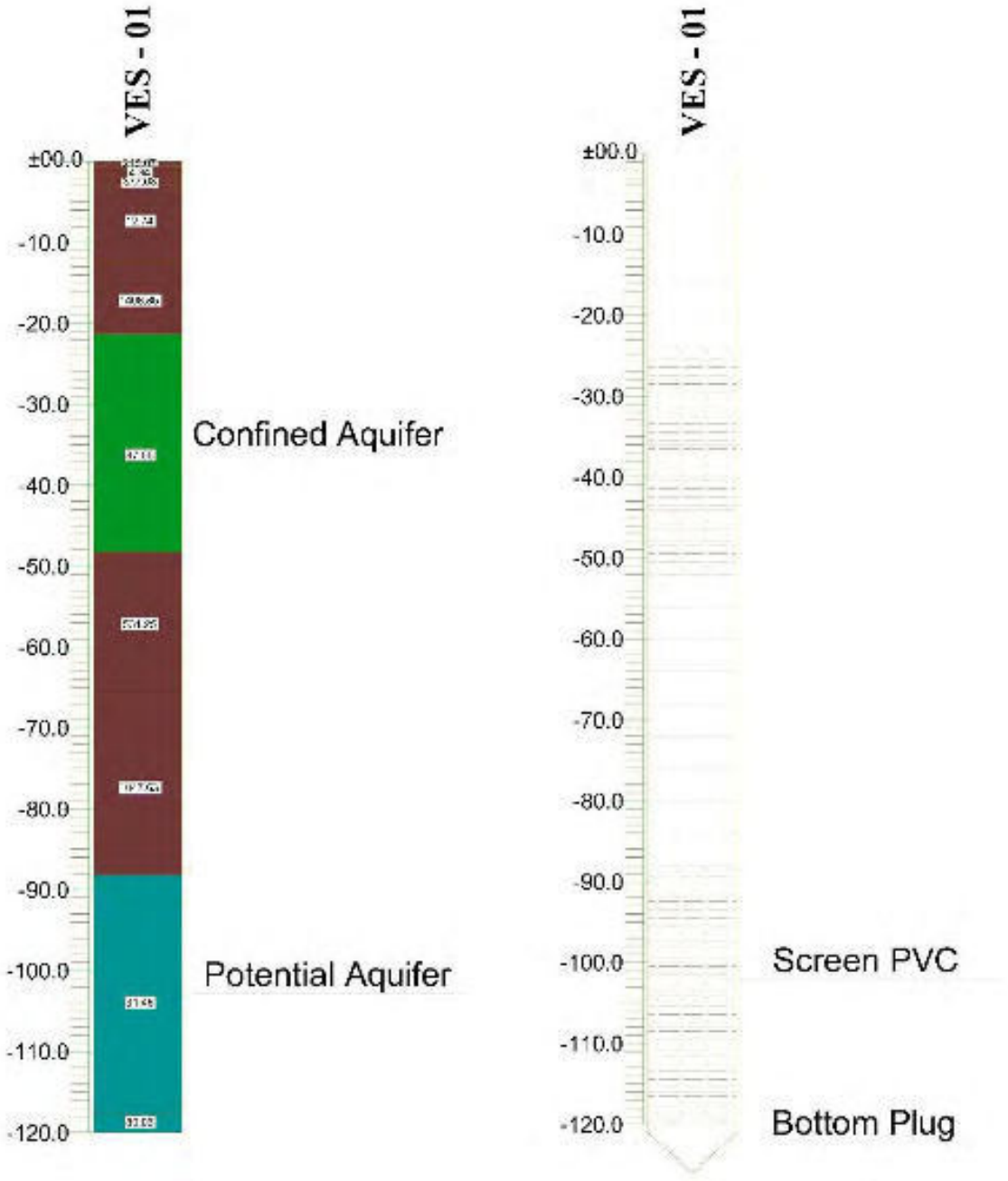


Picture 3.3 Correlation VES 01 – 04 of Lithological Cross Section



Picture 3.4 Correlation VES 01 – 04 of Hydrogeological Cross Section

If the drilling exploration will be done, the most potential water ground source on VES – 01. Bore design can be figured as picture below.



Picture 3.5 Bore Design

CHAPTER IV
CONCLUSION AND RECOMMENDATION

1. Conclusion

a. Geoelectric Investigation has been conducted on 13th – 14th December 2017. Total track of investigation is 4 points. Geoelectrical used Schlumberger method, and for data analysis used IP2WIN and Progress software.

b. The depth of ground water level at VES – 01 is 21.30 m – 48.27 m for confined aquifer, and for phreatic aquifer at depth 88.0 – 117.0 m from surface. Both of aquifer layer located on Tuff breccia layer.

c. The depth of ground water level at VES – 02 is 11.30– 21.42 m for confined aquifer (silty sand, gravel, and boulder layer), and for phreatic aquifer (tuff breccia layer) at depth 87.00 – 113.00 m from surface.

d. The depth of ground water level at VES – 03 is for phreatic aquifer at depth 73.00 – 110.00 m from surface. Located at silty sand, gravel and boulder layer.

e. The depth of ground water level at VES – 04 is 113.00 m below the surface. Located at silty sand, gravel and boulder layer.

2. Recommendation

To get more complete information about the ground water level, drilling exploration can be done at VES-01, VES-02, and VES-03. The depth of drilling exploration should be done to 120 meters below subsurface. Based on resistivity value we found that potential aquifer (natural water) at depth up to 120 meters below the surface.

ATACHMENTS

Geoelectrical Data measurement at VES - 01

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	67.34	0.5	6.28	1185	1183	110.4	110.5
2	2	33.78	0.5	11.78	320	315	110.7	110.7
3	2.5	18.19	0.5	18.84	106	105	109.3	109.4
4	3	11.22	0.5	27.48	45.3	45.6	111.2	111.3
5	4	11.06	0.5	49.46	24.5	25.1	110.9	110.9
6	5	14.62	0.5	77.72	21.5	20.4	111.4	111.4
7	6	16.21	0.5	112.26	16.4	15.4	110.1	110.1
8	8	22.77	0.5	200.18	13.3	11.9	110.8	110.8
9	10	23.95	0.5	313.22	8.7	8.1	109.9	109.9
10	12	24.05	0.5	451.38	5.8	6	110.8	110.8
11	15	29.55	0.5	705.72	4.7	4.5	109.9	109.9
12	15	29.55	5	62.80	52	51.4	109	109
13	20	31.65	5	117.75	29	29.5	109	109
14	25	31.27	5	188.40	17.9	18.9	111	111.1
15	30	35.70	5	274.75	14.3	14.5	111	111
16	30	35.70	10	125.60	31.1	30.6	111	111
17	40	39.68	10	235.50	19	18.5	111.6	111.6
18	50	41.95	10	376.80	12.6	12.2	111.7	111.7
19	60	49.00	10	549.50	10	9.9	111.9	111.9
20	75	65.83	10	867.43	8.1	8.8	111.6	111.7
21	75	65.83	25	314.00	24.2	23.2	111.7	111.7
22	100	88.79	25	588.75	16.7	16.5	110.3	110.3
23	125	80.70	25	942.00	7.5	7.6	88.9	87.7
24	150	82.90	25	1373.75	6.8	6.4	109.6	109.6
25	150	82.90	45	714.35	10.8	11.3	109.6	109.7
26	175	87.96	45	997.82	10	9.7	112	112
27	200	100.28	45	1324.91	8.6	8.2	111.1	111.4
28	225	110.26	45	1695.60	7.7	7.3	111.3	111.2
29	225	110.26	65	1120.74	11.1	10.8	111.5	111.1
30	250	118.68	65	1407.57	9.2	9.4	110.2	110.4
31	275	132.01	65	1724.58	8.5	8.6	111.7	111.7
32	300	124.23	65	2071.80	6.7	6.6	110.9	110.9

Geoelectrical Data measurement at VES - 02

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	27.40	0.5	6.28	470	471	106.9	106.9
2	2	22.58	0.5	11.78	204	210	107	107.1
3	2.5	21.07	0.5	18.84	123	122	108.6	108.6
4	3	20.69	0.5	27.48	84	81	108.1	109.1
5	4	23.30	0.5	49.46	51.9	51.5	108.8	108.8
6	5	24.57	0.5	77.72	33.7	31.5	102.3	102.2
7	6	25.98	0.5	112.26	24.5	25.7	107.5	107.6
8	8	25.75	0.5	200.18	13.9	12.5	108.9	108.9
9	10	26.03	0.5	313.22	9	9	107.4	107.4
10	12	26.66	0.5	451.38	6.5	6.5	109.1	109.1
11	15	28.41	0.5	705.72	2.4	2.1	65.6	65.4
12	15	28.41	5	62.80	29.1	30	65.6	65.6
13	20	34.30	5	117.75	31.6	32.3	110.1	110.2
14	25	36.51	5	188.40	20.7	20.4	106.5	106.5
15	30	38.11	5	274.75	12.3	12.4	105.5	105.5
16	30	38.11	10	125.60	31.8	32	105.6	105.6
17	40	44.27	10	235.50	20.3	20.5	109	109
18	50	45.26	10	376.80	12.2	11.5	104	104
19	60	46.62	10	549.50	7.3	7.5	95.4	95.4
20	75	54.95	10	867.43	6.8	7	109.4	109.4
21	75	54.95	25	314.00	21.8	22	109.4	109.4
22	100	77.00	25	588.75	15.6	14.7	101.9	101.9
23	125	93.75	25	942.00	11.8	11.1	107.9	107.9
24	150	105.50	25	1373.75	5.6	6	97.5	97
25	150	105.50	45	714.35	14.3	14.5	97.5	97.5
26	175	118.02	45	997.82	12.4	12.9	106.9	107
27	200	136.06	45	1324.91	8.9	9	87.9	86.4
28	225	137.01	45	1695.60	7.2	7.9	110.6	110.6
29	225	137.01	65	1120.74	14.3	14.3	110.6	110.6
30	250	129.41	65	1407.57	9.9	10.4	110.4	110.4
31	275	116.99	65	1724.58	7.5	7.6	111.3	111.3
32	300	101.72	65	2071.80	3.9	3.7	77.4	77.4

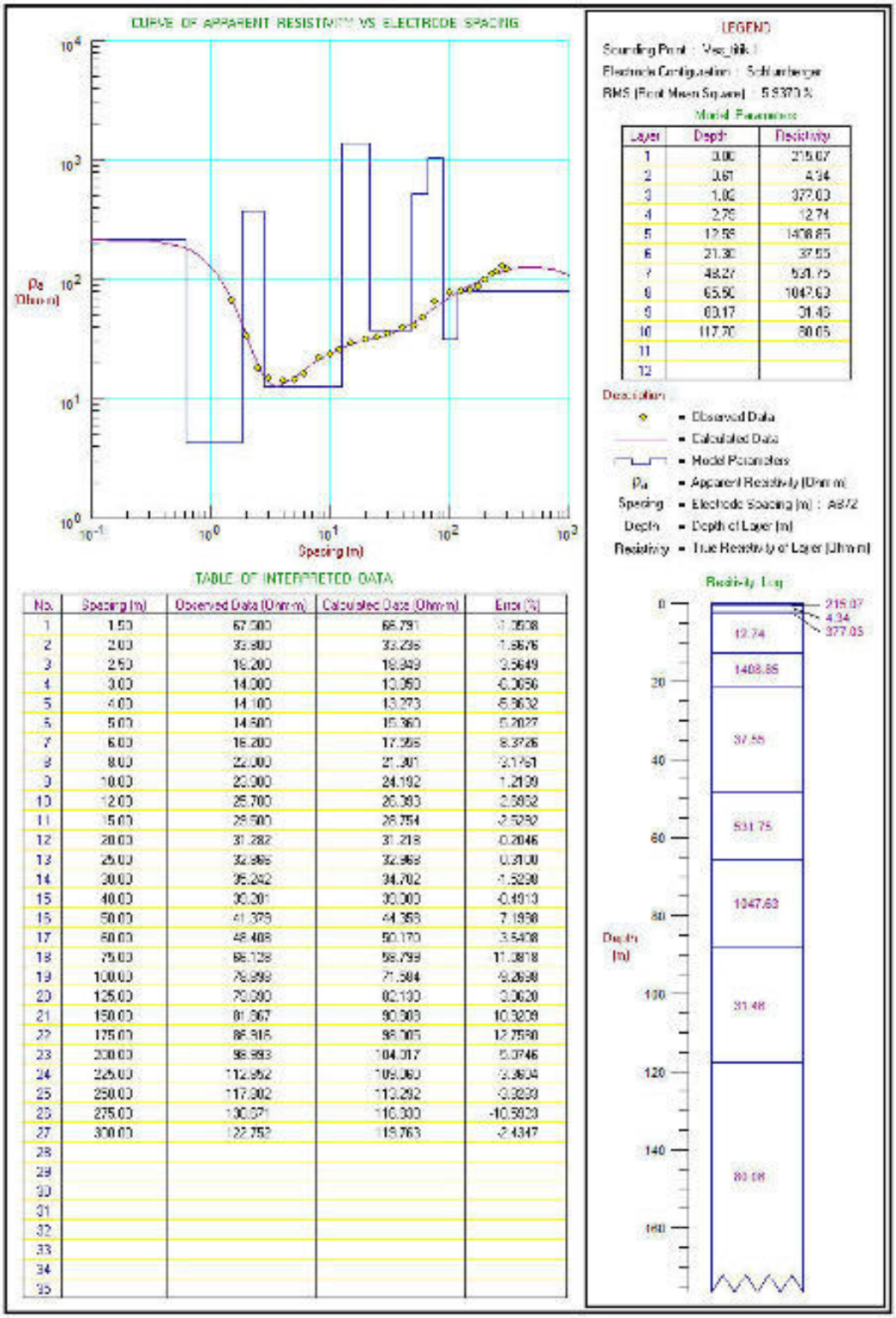
Geoelectrical Data measurement at VES - 03

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	6.68	0.5	6.28	114	115	110.8	110.9
2	2	5.22	0.5	11.78	37.7	39.1	110.9	111
3	2.5	4.89	0.5	18.84	27.5	28.5	111	111
4	3	5.72	0.5	27.48	21.8	23.1	111	111
5	4	7.57	0.5	49.46	17.2	15.8	111	111
6	5	10.16	0.5	77.72	14.3	13.9	111	111
7	6	12.23	0.5	112.26	11.7	11.8	111	111
8	8	15.79	0.5	200.18	9	9	111.1	111.1
9	10	17.51	0.5	313.22	4.1	5	111.1	111.1
10	12	19.43	0.5	451.38	4.4	4.9	111.2	111.1
11	15	27.27	0.5	705.72	4.3	4.4	111.1	111.1
12	15	27.27	5	62.80	46.2	47	111.1	111.1
13	20	39.41	5	117.75	36.1	35.7	111	111.1
14	25	44.31	5	188.40	25.1	25.4	111.2	111.1
15	30	48.63	5	274.75	18.9	19.1	111.1	111.2
16	30	48.63	10	125.60	43.4	41.9	111	111
17	40	47.19	10	235.50	21.2	21.9	111	111
18	50	47.91	10	376.80	12.9	12.7	110.7	110.7
19	60	53.11	10	549.50	10.5	10.1	110	110
20	75	59.83	10	867.43	7.4	7.3	110	110
21	75	59.83	25	314.00	19.7	21	111	111
22	100	64.80	25	588.75	11.3	12	110	110
23	125	78.32	25	942.00	8.7	8.9	110	110
24	150	99.42	25	1373.75	8.2	8.4	110	110.4
25	150	99.42	45	714.35	19.6	19.1	110.4	110.4
26	175	117.74	45	997.82	12.5	13	110.4	110.9
27	200	140.07	45	1324.91	11.4	11.5	110.9	110.9
28	225	144.63	45	1695.60	8.9	9.6	110.9	111.2
29	225	144.63	65	1120.74	17.8	18.2	111.3	111.2
30	250	160.12	65	1407.57	12.8	12.5	111.2	111.2
31	275	165.18	65	1724.58	13.1	13.5	111.2	111.2
32	300	162.09	65	2071.80	8.8	8.6	111.2	111.2

Geoelectrical Data measurement at VES - 04

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	72.93	0.5	6.28	1263	1265	110.5	110.5
2	2	59.71	0.5	11.78	554	552	110.7	110.7
3	2.5	52.84	0.5	18.84	300	310	110.4	110.4
4	3	49.43	0.5	27.48	196	196	110.6	110.6
5	4	40.24	0.5	49.46	89	89.6	110.9	111.9
6	5	37.31	0.5	77.72	52.3	52.5	110.8	110.8
7	6	32.19	0.5	112.26	31.3	31.3	110.8	110.8
8	8	26.46	0.5	200.18	14.5	14.3	110.6	110.6
9	10	20.79	0.5	313.22	7.2	7.3	110.9	110.9
10	12	18.43	0.5	451.38	1.3	1.6	111	110.9
11	15	17.79	0.5	705.72	1.3	1.5	110.4	110.4
12	15	17.79	5	62.80	30.6	31.4	110.5	110.5
13	20	17.70	5	117.75	13.5	15	109.6	109.6
14	25	19.85	5	188.40	11	12	110.2	110.2
15	30	22.15	5	274.75	8.7	9.9	111.1	105.5
16	30	22.15	10	125.60	18.2	19.2	111.1	111.1
17	40	31.77	10	235.50	14.9	14.7	110.5	111.1
18	50	37.10	10	376.80	10.6	11	111.1	110.4
19	60	48.65	10	549.50	9.9	9.4	109	111.1
20	75	61.73	10	867.43	7.8	7.7	110.9	109
21	75	61.73	25	314.00	17.3	17.9	111	111
22	100	75.17	25	588.75	14	14.1	110.8	111
23	125	87.35	25	942.00	10.2	10.2	110.9	110.8
24	150	93.24	25	1373.75	8.4	8.4	111.2	111
25	150	93.24	45	714.35	13.2	14	111.2	111.2
26	175	101.10	45	997.82	11	11.5	111.2	112.6
27	200	106.98	45	1324.91	8.7	9	110.4	110.5
28	225	114.14	45	1695.60	7.7	7.9	111	111
29	225	114.14	65	1120.74	11.1	11.5	110.9	111
30	250	115.03	65	1407.57	7.9	7.7	111.2	111.2
31	275	111.16	65	1724.58	4.7	9.5	110.1	110.2
32	300	103.16	65	2071.80	3.9	4	111.1	111

VES – 01 Data Analysis by Progress software



Layer	Depth	Resistivity
1	3.00	215.07
2	3.61	4.34
3	1.00	377.03
4	2.75	12.74
5	12.59	1408.85
6	21.38	37.55
7	48.27	531.75
8	65.50	1047.63
9	63.17	31.48
10	117.70	80.05
11		
12		

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	67.500	68.791	-1.9508
2	2.00	33.600	33.236	1.0876
3	2.50	19.200	18.949	2.5649
4	3.00	14.000	13.950	0.3656
5	4.00	14.100	13.273	5.8632
6	5.00	14.500	15.360	-5.9027
7	6.00	16.200	17.556	-8.3726
8	8.00	22.000	21.401	2.7451
9	10.00	23.000	24.192	-1.2139
10	12.00	25.700	26.393	-2.5952
11	15.00	29.500	28.754	2.5092
12	20.00	31.282	31.218	0.2046
13	25.00	32.986	32.968	0.0700
14	30.00	35.242	34.702	1.5239
15	40.00	30.201	30.000	0.4913
16	50.00	41.375	44.359	-7.1938
17	60.00	48.408	50.170	-3.5408
18	75.00	66.128	58.799	11.0818
19	100.00	78.599	71.584	8.8698
20	125.00	70.090	62.100	0.3620
21	150.00	81.367	90.303	10.3209
22	175.00	86.916	98.905	12.7590
23	200.00	98.993	104.317	5.3746
24	225.00	112.952	109.060	3.3634
25	250.00	117.902	113.292	3.9239
26	275.00	130.071	116.300	-10.5923
27	300.00	122.752	115.763	-2.4347
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VES – 02 Data Analysis by Progress software

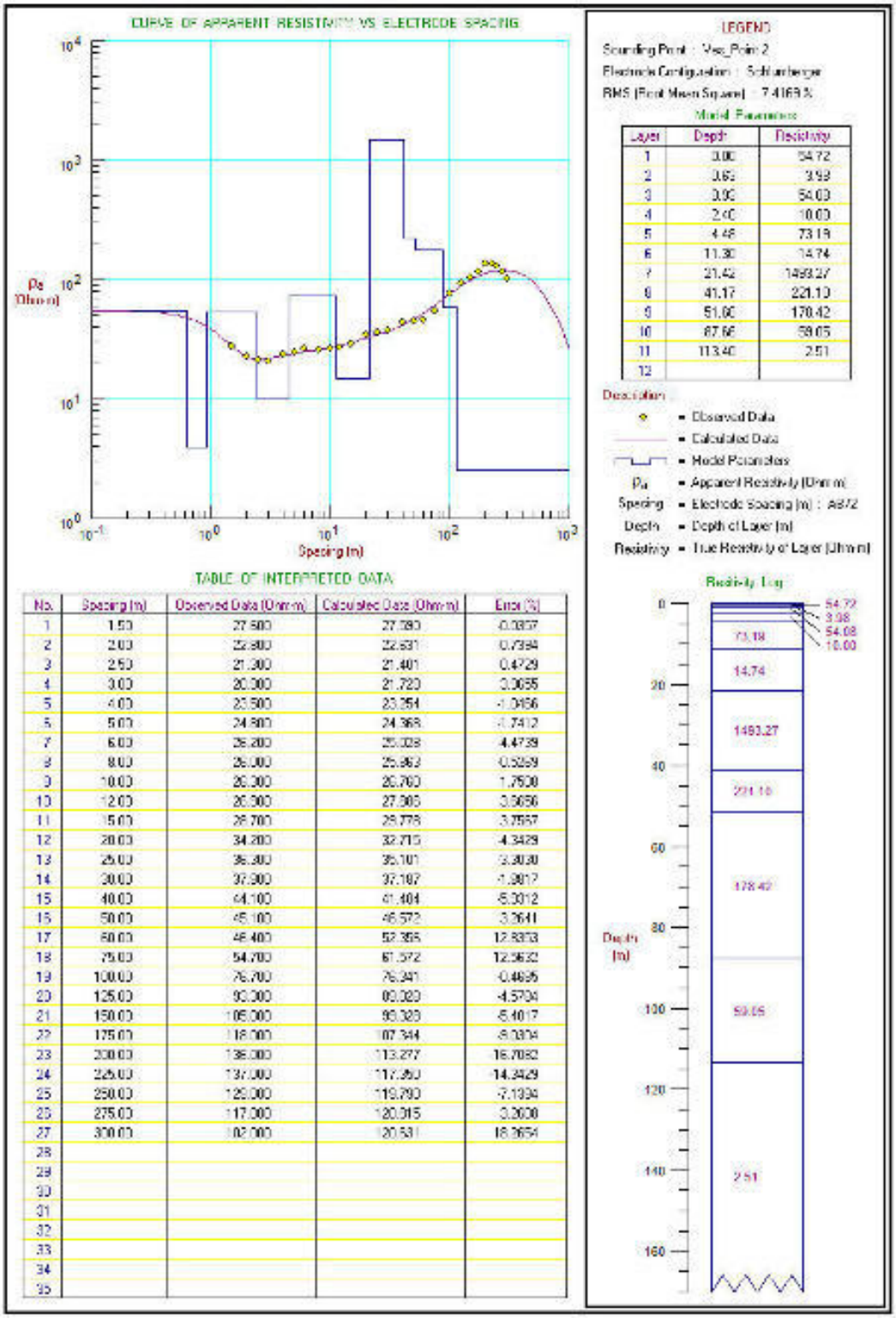

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	27.500	27.280	0.8007
2	2.00	22.800	22.631	0.7394
3	2.50	21.300	21.401	0.4729
4	3.00	20.300	21.720	6.9655
5	4.00	23.500	23.254	1.0456
6	5.00	24.800	24.368	1.7412
7	6.00	26.200	25.028	4.4739
8	8.00	26.000	25.862	0.5269
9	10.00	20.300	20.760	1.7500
10	12.00	20.300	27.305	0.3656
11	15.00	28.700	28.778	3.7557
12	20.00	34.200	32.715	4.3429
13	25.00	36.800	35.101	3.8030
14	30.00	37.900	37.187	1.3017
15	40.00	64.100	61.404	5.3012
16	50.00	45.100	46.572	3.2641
17	60.00	46.400	52.355	12.8373
18	75.00	54.700	61.572	12.5632
19	100.00	76.700	76.341	0.4695
20	125.00	90.300	93.329	4.5704
21	150.00	105.000	99.329	5.4017
22	175.00	118.000	107.344	9.0374
23	200.00	138.000	113.277	16.7082
24	225.00	137.000	117.350	14.3429
25	250.00	125.000	119.790	4.1936
26	275.00	117.000	120.315	2.8038
27	300.00	102.000	120.531	18.2654
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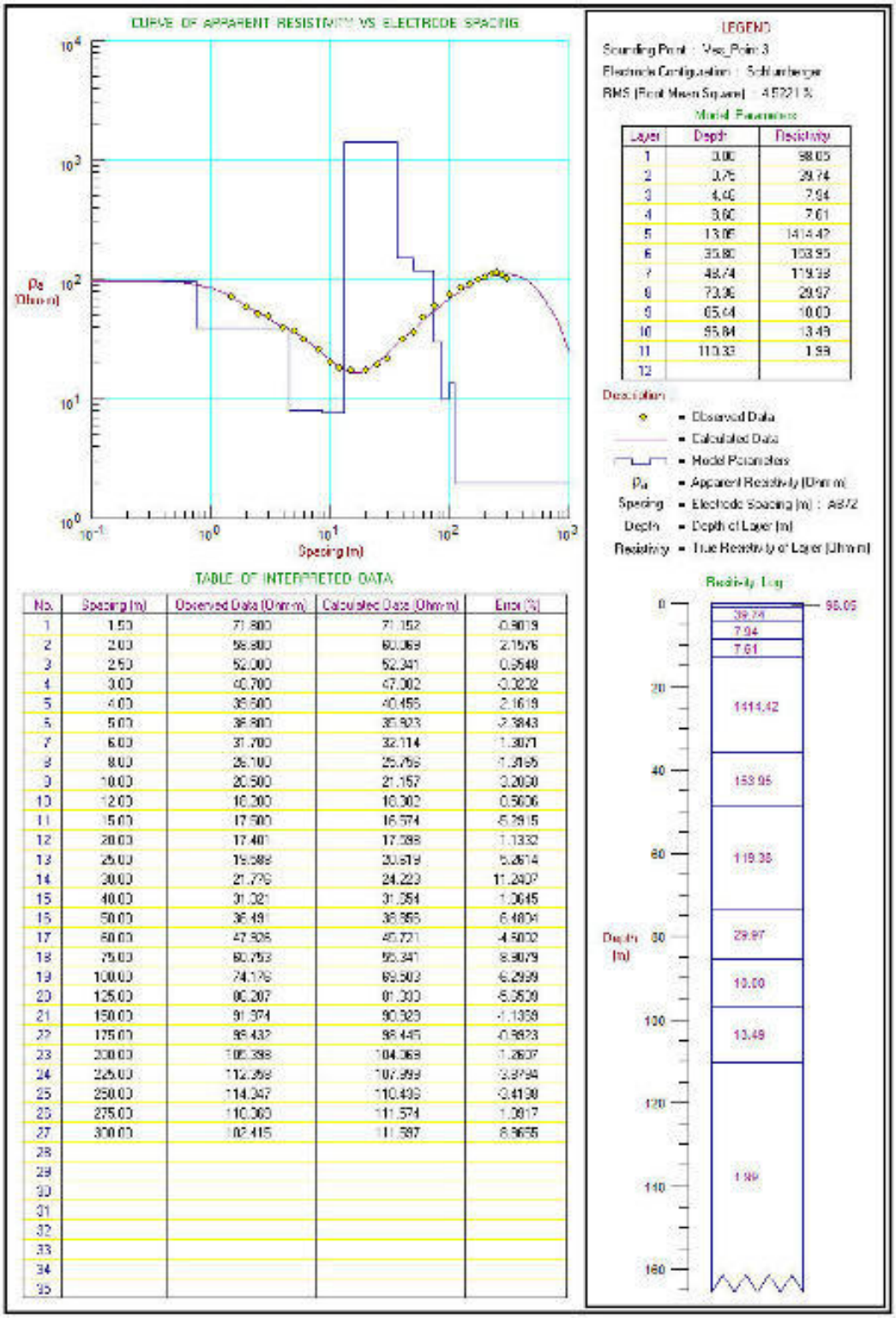
VES – 03 Data Analysis by Progress software



Layer	Depth	Resistivity
1	3.00	98.05
2	3.75	29.74
3	4.49	7.94
4	9.60	7.61
5	13.09	1414.42
6	35.80	153.95
7	48.74	119.38
8	73.06	29.97
9	85.64	10.00
10	95.84	13.49
11	113.33	1.99
12		

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	71.800	71.152	-0.9019
2	2.00	58.800	60.069	2.1576
3	2.50	52.000	52.341	0.6549
4	3.00	46.700	47.302	1.2892
5	4.00	39.500	40.455	2.4169
6	5.00	36.800	35.923	-2.3843
7	6.00	31.700	32.114	1.3071
8	8.00	26.100	25.756	-1.3165
9	10.00	20.500	21.157	3.2098
10	12.00	18.300	18.302	0.0106
11	15.00	17.500	16.574	-5.2915
12	20.00	17.401	17.288	-0.6332
13	25.00	19.589	20.619	5.2614
14	30.00	21.776	24.223	11.2407
15	40.00	31.021	31.354	1.0645
16	50.00	36.49	38.955	6.4804
17	60.00	47.926	45.721	-4.5002
18	75.00	60.753	55.341	-8.9079
19	100.00	74.176	69.503	-6.2959
20	125.00	90.207	81.303	-5.3529
21	150.00	91.374	90.323	-1.1358
22	175.00	98.432	98.445	0.0823
23	200.00	105.398	104.369	-1.2607
24	225.00	112.359	107.999	-3.8794
25	250.00	114.047	110.499	-3.4139
26	275.00	110.360	111.574	1.0917
27	300.00	102.415	111.597	8.9695
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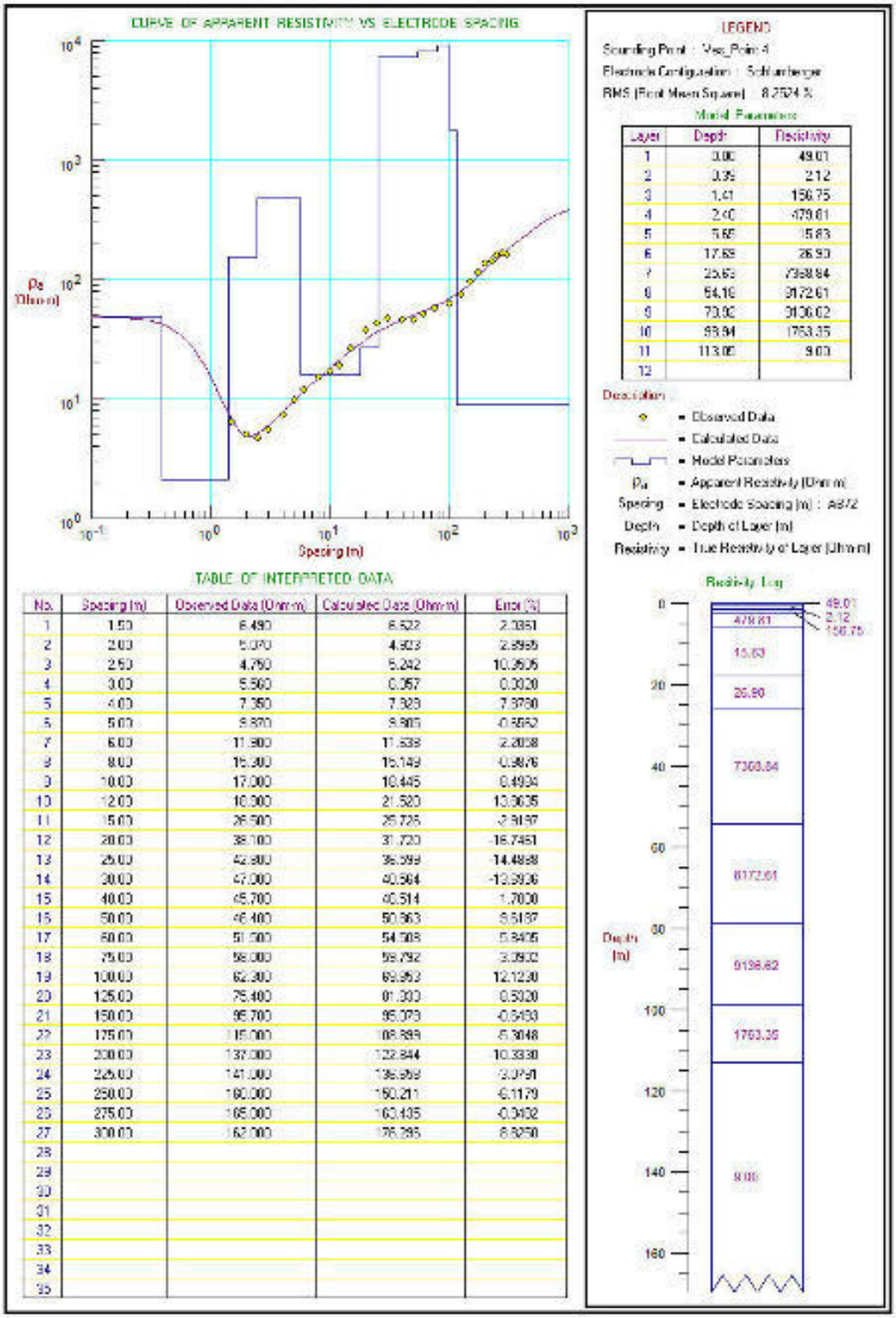
VES – 04 Data Analysis by Progress software



Layer	Depth	Resistivity
1	3.00	49.01
2	3.35	2.12
3	1.41	156.75
4	2.40	479.61
5	5.65	15.63
6	17.69	26.90
7	25.62	7368.84
8	54.16	8172.61
9	73.92	9136.62
10	93.94	1763.35
11	113.06	9.00
12		

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	6.490	6.522	2.3851
2	2.00	5.070	4.923	2.8995
3	2.50	4.750	5.242	10.3505
4	3.00	5.560	0.057	0.3020
5	4.00	7.350	7.329	7.3730
6	5.00	9.870	9.805	-0.6552
7	6.00	11.900	11.638	2.2038
8	8.00	15.900	15.149	-0.9576
9	10.00	17.000	10.445	0.4904
10	12.00	10.000	21.520	10.3635
11	15.00	26.500	25.725	-2.9197
12	20.00	38.100	31.720	-16.7451
13	25.00	42.800	36.599	14.4868
14	30.00	47.000	40.564	-13.3936
15	40.00	45.700	40.514	1.7030
16	50.00	46.400	50.963	9.5187
17	60.00	51.500	54.708	5.8495
18	75.00	58.000	59.792	3.0902
19	100.00	62.300	69.852	12.1230
20	125.00	75.400	01.300	0.5020
21	150.00	95.700	95.379	-0.5493
22	175.00	115.000	08.889	-5.3048
23	200.00	137.000	122.844	10.3330
24	225.00	147.000	136.569	-3.0791
25	250.00	160.000	160.211	-0.1179
26	275.00	165.000	160.435	-0.3402
27	300.00	162.000	76.295	6.9259
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Pringgabaya Solar Power Plant site for Geoelectrical investigation

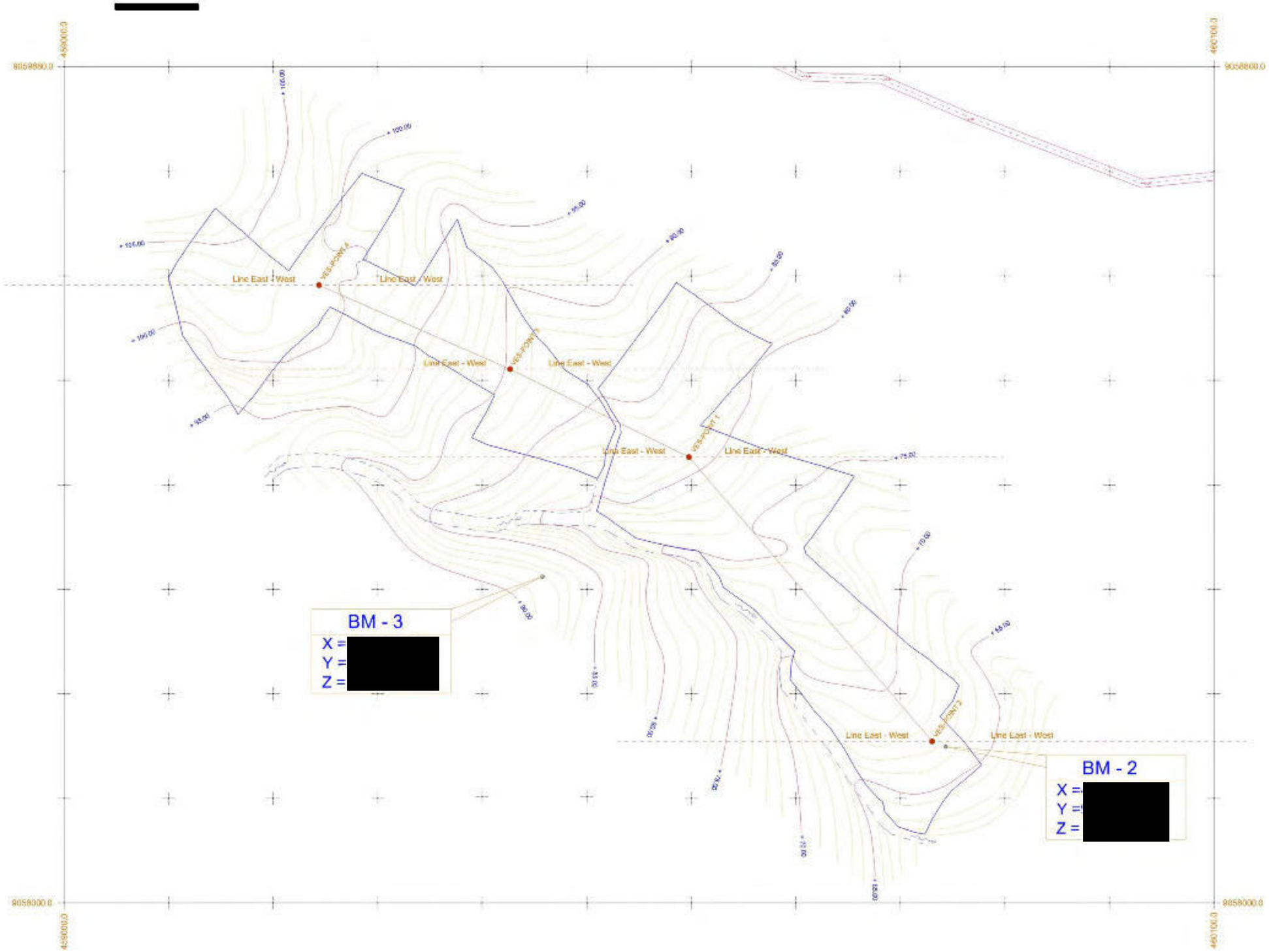
Geoelectrical investigation process

Geoelectrical investigation process

Geoelectrical investigation process

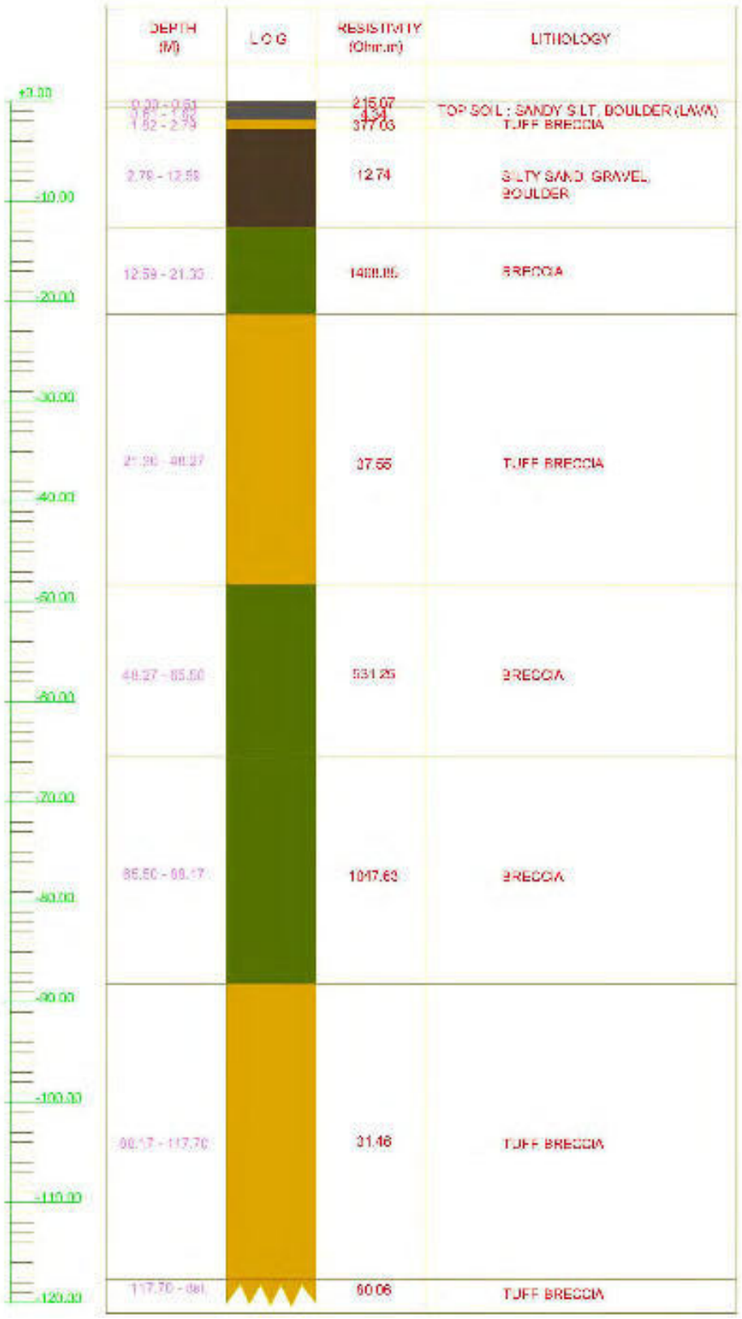
Geoelectrical point track at pringgabaya's site

Stacking current electrode and potential electrode pegs

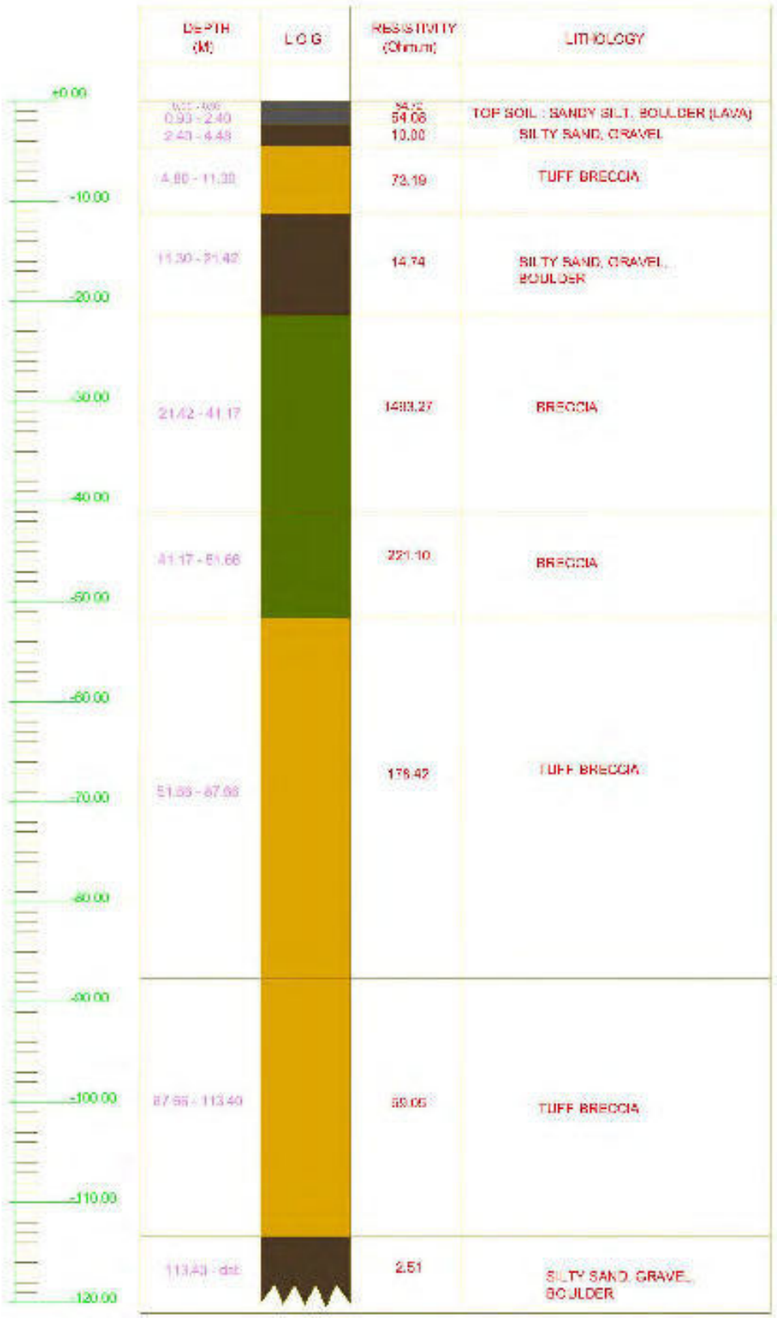


Track Direction of Geoelectrical Investigation

VES - 01



VES - 02



LEGEND :

- = TOP SOIL : SANDY SILT, BOULDER (LAVA)
- = SILTY SAND, GRAVEL, BOULDER
- = TUFF BRECCIA
- = ANDESITE BRECCIA

LITHOLOGY

SKALA 1: 100

Lithological Cross Section Model VES - 01 and VES – 02

VES - 03

DEPTH (M)	L O G	RESISTIVITY (Ohm.m)	LITHOLOGY
0.00 - 0.75		96.05	TOP SOIL : SANDY SILT, BOULDER (LAVA)
0.75 - 4.45		39.74	TUFF BRECCIA
4.45 - 9.60		7.84	SILTY SAND, GRAVEL, BOULDER
9.60 - 13.05		7.61	SILTY SAND, GRAVEL, BOULDER
13.05 - 35.80		153.85	TUFF BRECCIA
35.80 - 46.74		1414.42	BRECCIA
46.74 - 73.38		119.36	TUFF BRECCIA
73.38 - 85.44		29.37	TUFF BRECCIA
85.44 - 88.64		10.00	SILTY SAND, GRAVEL, BOULDER
88.64 - 113.33		13.49	SILTY SAND, GRAVEL, BOULDER
113.33 - dst		1.69	SILTY SAND, GRAVEL, BOULDER

VES - 04

DEPTH (M)	L O G	RESISTIVITY (Ohm.m)	LITHOLOGY
0.00 - 0.41		27.5	TOP SOIL : SANDY SILT, BOULDER (LAVA)
0.41 - 2.40		133.6	BRECCIA
2.40 - 5.65		473.61	BRECCIA
5.65 - 17.69		15.83	SILTY SAND, GRAVEL, BOULDER
17.69 - 25.63		26.90	TUFF BRECCIA
25.63 - 54.15		7366.84	BRECCIA
54.18 - 73.82		8172.61	BRECCIA
73.82 - 98.94		9136.62	BRECCIA
98.94 - 113.05		1763.35	BRECCIA
113.05 - dst		5.00	SILTY SAND, GRAVEL, BOULDER

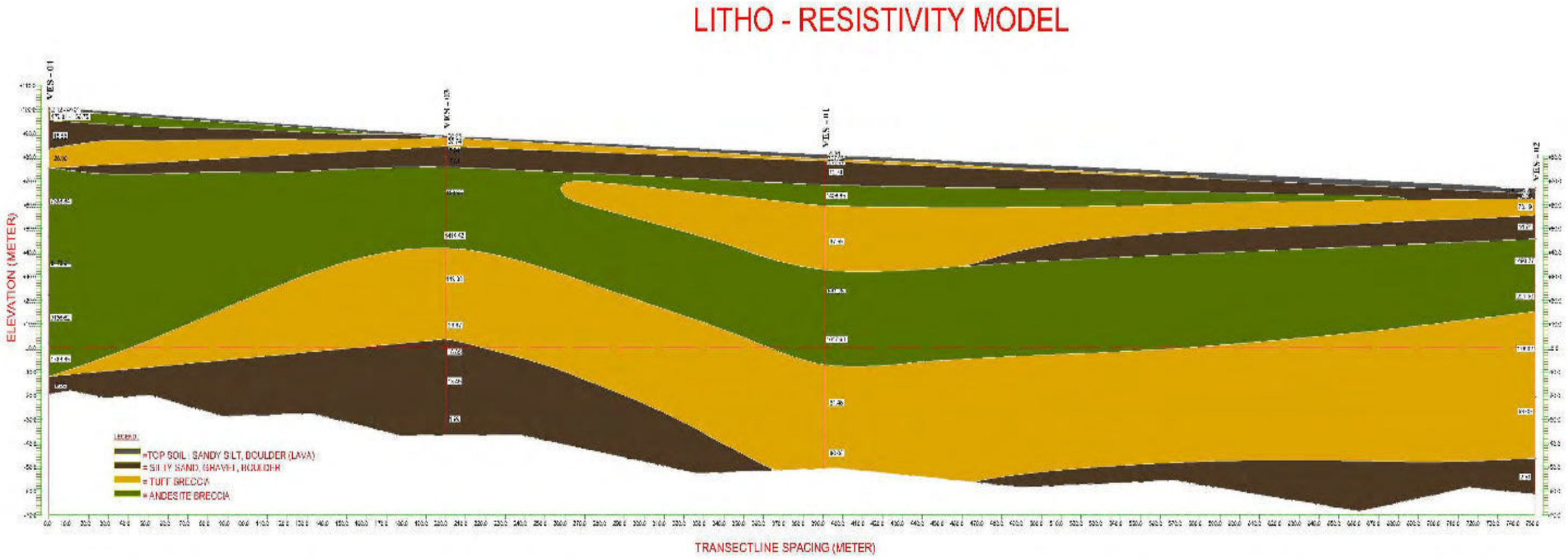
LEGEND :

- = TOP SOIL : SANDY SILT, BOULDER (LAVA)
- = SILTY SAND, GRAVEL, BOULDER
- = TUFF BRECCIA
- = ANDESITE BRECCIA

LITOLOGY

SKALA 1: 100

Lithological Cross Section Model VES - 03 and VES - 04



Lithology Resistivity Model VES 01 – VES 04

VES - 01

DEPTH (M)	LOG	RESISTIVITY (Ohm-m)	LITHOLOGY
0.00 - 0.63		215.07	TOP SOIL : SANDY SILT, BOULDER (LAVA)
0.63 - 1.82		4.32	TUFF BRECCIA
1.82 - 2.79		377.03	
2.79 - 12.59		12.74	SILTY SAND, GRAVEL, BOULDER
12.59 - 21.30		1466.85	BRECCIA
21.30 - 46.27		37.53	TUFF BRECCIA
46.27 - 65.50		531.25	BRECCIA
65.50 - 88.17		1047.83	BRECCIA
88.17 - 117.73		31.43	TUFF BRECCIA
117.73 - dst		80.06	TUFF BRECCIA

VES - 02

DEPTH (M)	LOG	RESISTIVITY (Ohm-m)	LITHOLOGY
0.00 - 0.55		84.22	TOP SOIL : SANDY SILT, BOULDER (LAVA)
0.55 - 2.40		64.09	SILTY SAND, GRAVEL
2.40 - 4.48		10.00	
4.48 - 11.30		73.19	TUFF BRECCIA
11.30 - 21.42		14.74	SILTY SAND, GRAVEL, BOULDER
21.42 - 41.17		1493.27	BRECCIA
41.17 - 51.66		221.10	BRECCIA
51.66 - 87.66		176.42	TUFF BRECCIA
87.66 - 113.40		59.33	TUFF BRECCIA
113.40 - dst		2.51	SILTY SAND, GRAVEL, BOULDER

LEGEND :

- = NON AQUIFER
- = CONFINED AQUIFER (NATURAL WATER)
- = PHREATIC AQUIFER (NATURAL WATER)

HYDROGEOLOGY

SKALA 1: 100

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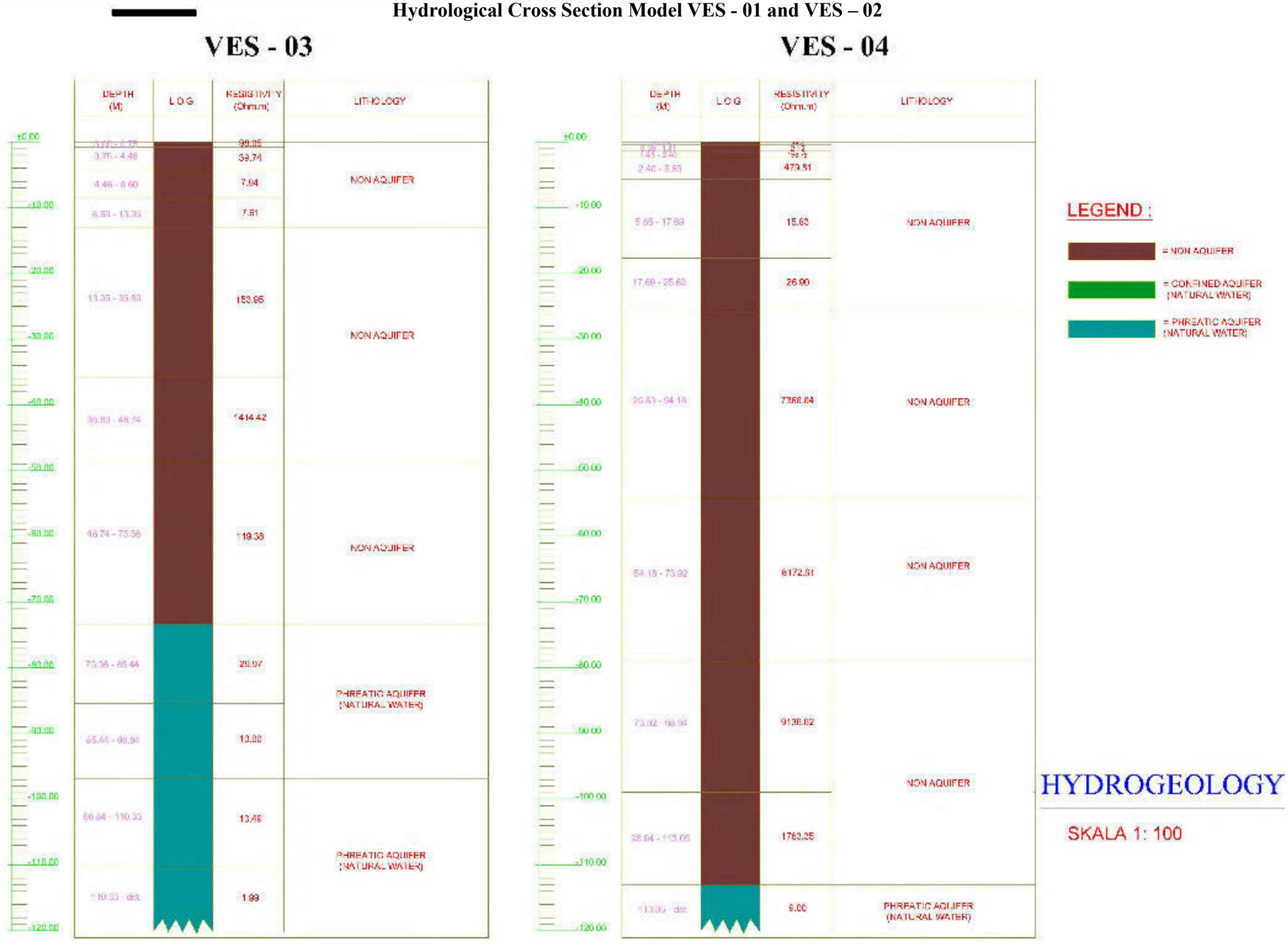
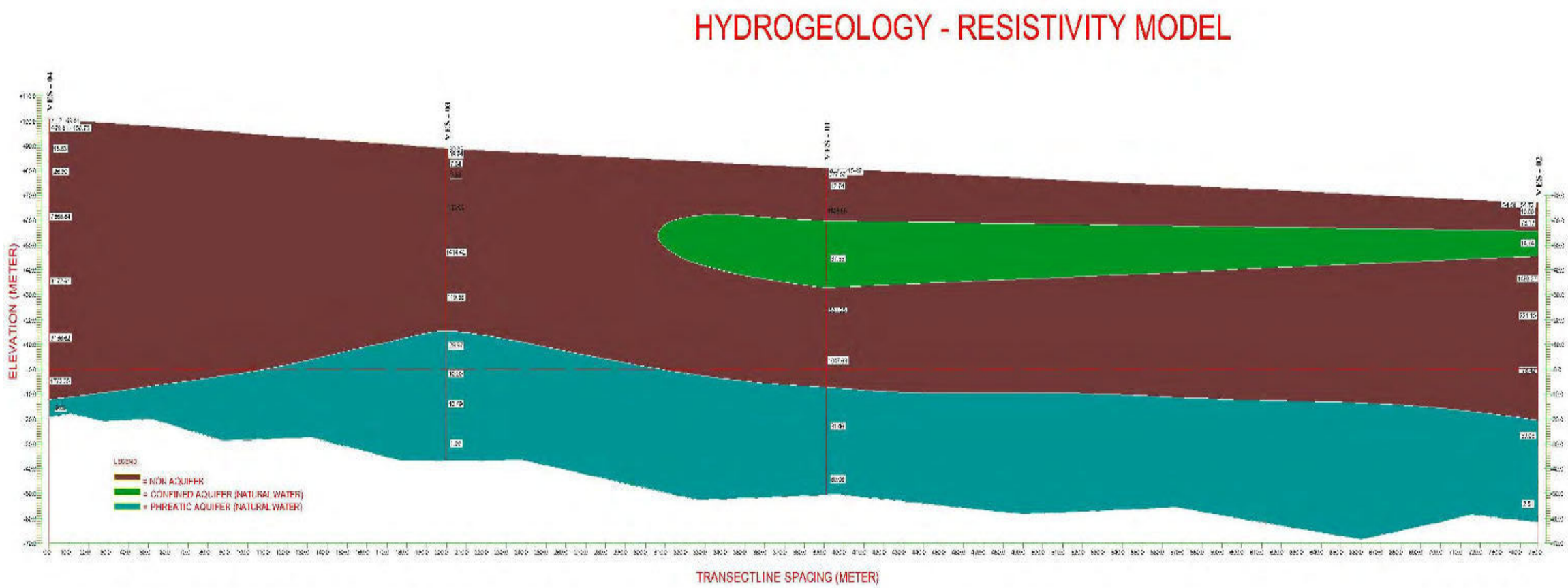
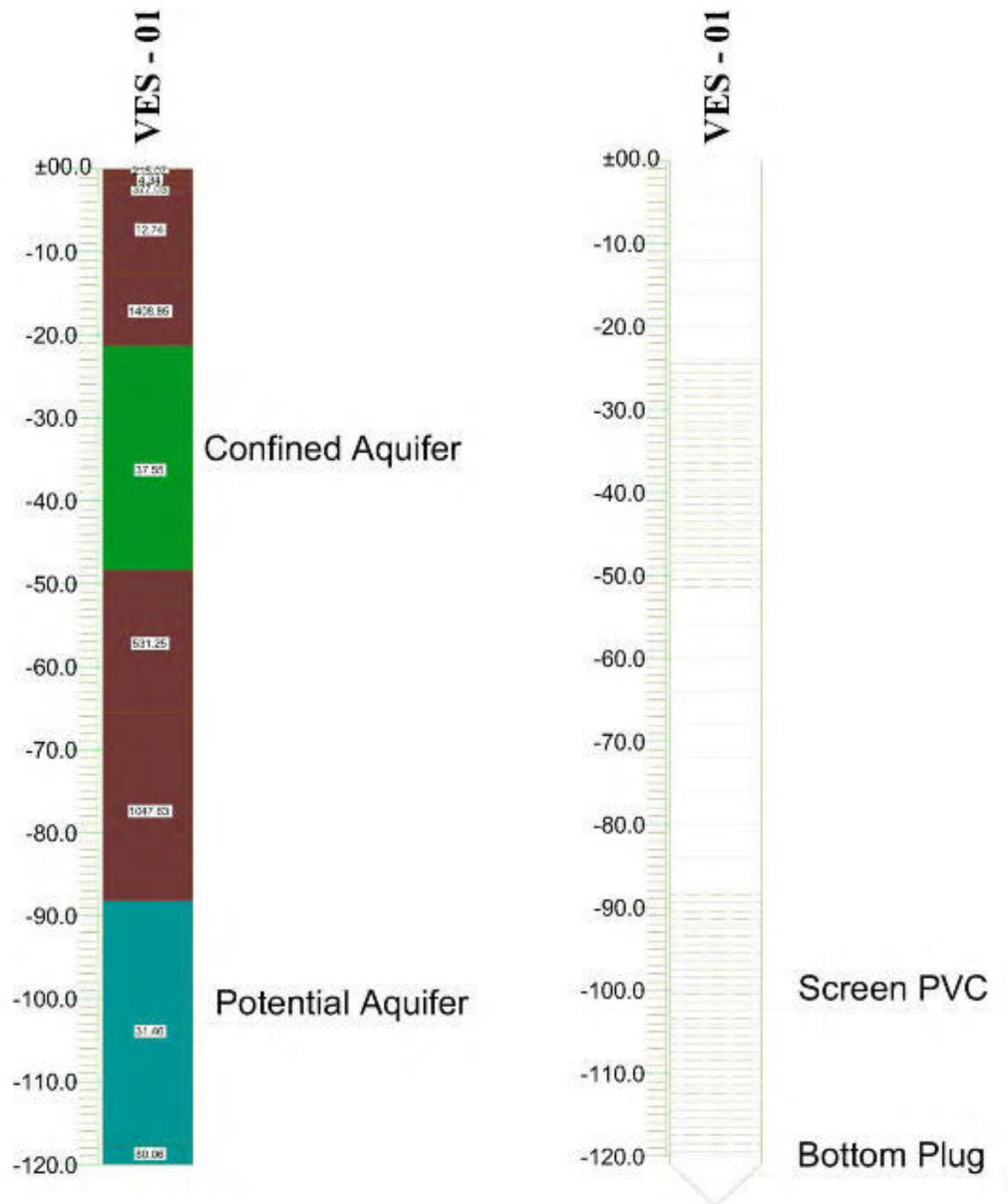
Hydrological Cross Section Model VES - 01 and VES – 02



Hydrological Cross Section Model VES - 03 and VES – 04



Hydrogeology Resistivity Model VES 01 – VES 04



Bore Design for VES - 01

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SOIL INVESTIGATION - GEOTECHNICAL ENGINEERING - GEOPHYSICS - MAPING
GIS - WATER RESOURCES DEVELOPMENT - HIDRO OCEANOGRAPHY - DESIGN
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5 MW SOLAR POWER PLANT PROJECT

Site : Selong, East Lombok, West Nusa Tenggara.

GEOELECTRICAL INVESTIGATION REPORT

DECEMBER 2017

PREFACE

No : 91/*Geoelectrical-Report*/XII/2017
Attachment : 1 Set
Subject : Geoelectrical Investigation Report

To

PT. PP (Persero) Tbk

In order to fulfill the requested from PT. PP (Persero) Tbk for Geoelectrical Test at Selong Solar Power Plant Site, East Lombok, West Nusa Tenggara, CV. Rekayasa Bumi Karya has finished the test for 4 point location at the site. Geoelectrical test has been conducted on 14th – 15th December 2017. The result of the test can be figured in this report.

We hope this report can help the construction of the project as well. Thank you for your faith and cooperation to us.

Mataram, 27th December 2017
Director,

Sukandi, ST., M.Eng

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CHAPTER I
INTRODUCTION

1.1 Background

Geoelectrical investigation used to have information of the water ground conditions to fulfill the needs of raw water. Water ground locations are variative and spreading unequally, it depends on the subsurface geological conditions or the aquifer layer and the topographic site condition.

1.2 Aim and Purpose

The aim of this work to determine the aquifer layers which is contain the ground water.

The Purpose of this work to find the characteristics of aquifer layers so we can figure the depth and positions of aquifer layers.

1.3 Scope of Work

1. Geoelectrical investigation has been done on 4 points locations at Selong's Site.
2. Makes data interpretation from the 4 points locations.

1.4 Project Location

Geoelectrical site located at Selong, East Lombok, West Nusa Tenggara.

1.5 Date of Test

The test was held on 14th – 15th December 2017.

CHAPTER 2
METHODOLOGY

2.1 Geoelectrical Investigation

Geoelectrical investigation is one of the geophysics method who studied electrical current flow inside the earth and how to detect it from the surface. The method that we used in this investigation is geoelectrical resistivity method. This geoelectrical resistivity investigation has been conducted to know the deployment and the differences of Soil layers below the surface vertically or horizontally. The characteristics of rocks resistivity depends on several factors such as rocks material, mineral content, rock electrolyte content. To interpret the rock classification we can combined the resistivity result and geological site condition. So we can determine which one of the rock layer as a aquifer.

2.1.1 Theory

Principal of resistivity geoelectrical survey is injected the electrical current into the earth through two electrodes. This electrical current caused the voltage for the both point. Due to the differences between the rock layers which is through by the electricity current, caused the difference of voltages between the both points. This difference can be measured from the surface by receiver (V) through two potential electrodes.

There are some electrode configurations for this resistivity test, such as *Wenner*, *Schlumberger*, *dipole-pole*, etc. The difference of configuration usage will be affected to geophysics parameter. Schlumberger configuration is used in this resistivity test at Pringgabaya Site. The span of cables were adjusted with site condition.

According to aim of the resistivity geoelectrical investigation, we have two ways to collected the data.

1. Mapping/traversing

   Electrodes span are determined how depth we know the variations of rock resistivity under the ground surface horizontally.

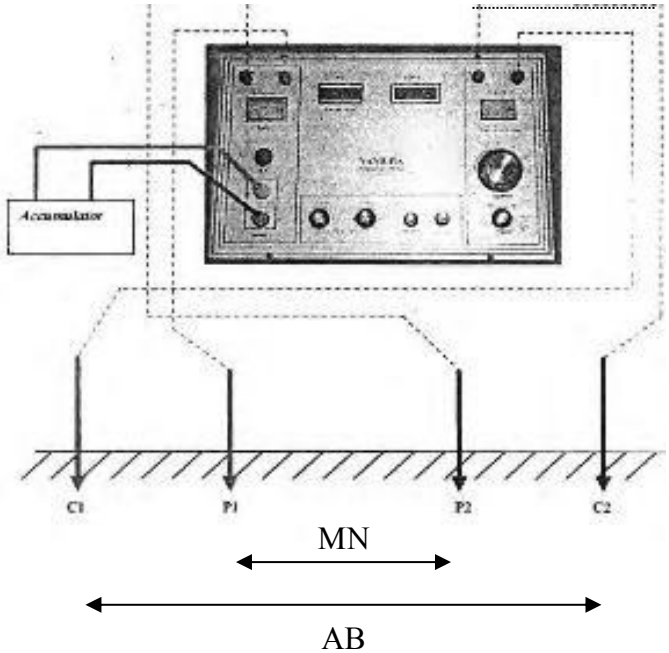
2. Vertical Electrical Sounding (VES)

To know the variations of rock resistivity under the ground surface vertically.

2.1.2 Equipment

1. Geoelectrical appliance type G-Sound Twin Probe
2. ACCU
3. Current electrode which is made from steel peg
4. Voltage electrode which is made from copper peg
5. Cable around 300 meters to connect voltage electrode to geoelectrical appliance
6. Cable around 300 meters to connect current electrode to geoelectrical appliance
7. Connecting battery cable to geoelectric appliance
8. Hammer
9. Meter
10. Data form
11. Stationery
12. Compass

2.1.3 Steps of Geoelectrical Measurement



Picture 2.1 Array of electrodes in Resistivity meter using Schlumberger Configuration

1. After all the appliance are completed, and then set it up with accumulator. The voltage on indicator transmitter will be 24 Volt and around the middle for incoming voltage is 12 volt.
2. Determined the measurement track for one sounding point. Gradually added electrode spacing for one sounding point. The space of electrode based on schlumberger configuration.
3. After set up the electrode at certain space, based on used configuration, connect the current electrode with current terminal. Current loop indicator will be deviated to right side at red area. Connect the potential electrode to potential terminal.
4. Calibrate the geoelectrical appliance to neutralize natural potential effect to measurement. On digital meter will be showed a certain number, arranged the compensator to zero using smooth potentiometer.
5. Injected the electrical current, turn the switch volt to position 1, the current can be increased by raising the voltage to higher position. When current reading is still good enough, there is no need to raise the voltage to avoid the broken fuse. After pushing start button, current value will be showed on display. Write down the current value and then push hold button and potential value will be showed at potential display. The current value used to be small at AB/2 position. If current value does not show up when the start button is injected, then check the battery. Recessive surface or over spacing electrode caused current value undetected.
6. Detected Current and potential value are written on measurement form.

2.2 Data Analysis

The data obtained from field investigation are potential current and potential difference on electrode composition with AB/2 and MN/2. Formula to analysis the value of pseudo-resistivity according Schlumberger electrode configuration rules are:

$$\rho\alpha = K\left(\frac{\Delta V}{I}\right)$$

$$K = \pi(AB^2 - MN^2)/4MN$$

In geoelectrical resistivity method, the earth is assumed having isotrophic homogeny characteristic, therefore the measurable resistivity is the real value of resistivity. It is not depending on electrode spacing. The earth consist from many of rock layers with different resistivity, therefore the measurable potential affected by those layers. The measurable resistivity value is not the resistivity for all rock layers. Especially for wide electrode space, the measurable pseudo-resistivity value called pseudo-resistivity value. Pseudo-resistivity value is resistivity value from equivalent fictive homogeny medium with reviewed plated medium.

For example, a reviewed plated medium consist of two rock layers with different resistivity value (ρ1 dan ρ2) consider as a layered homogeny medium which is having one pseudo-resistivity (ρα). ρα value plotted to AB/2 on transparent bilogaritma paper to be interpreted.

2.3 Interpretation

There are some methods to interpreted resistivity value data, one of the simplest way is curve matching, matching the field curve with standard curve, and then the result analysis with I*P2WIN* and *Progress* program software.

The resistivity value of each material as the subsurface lithological interpretation can be interpreted as the table below :

Table 2.1 Resistivity value of each materials

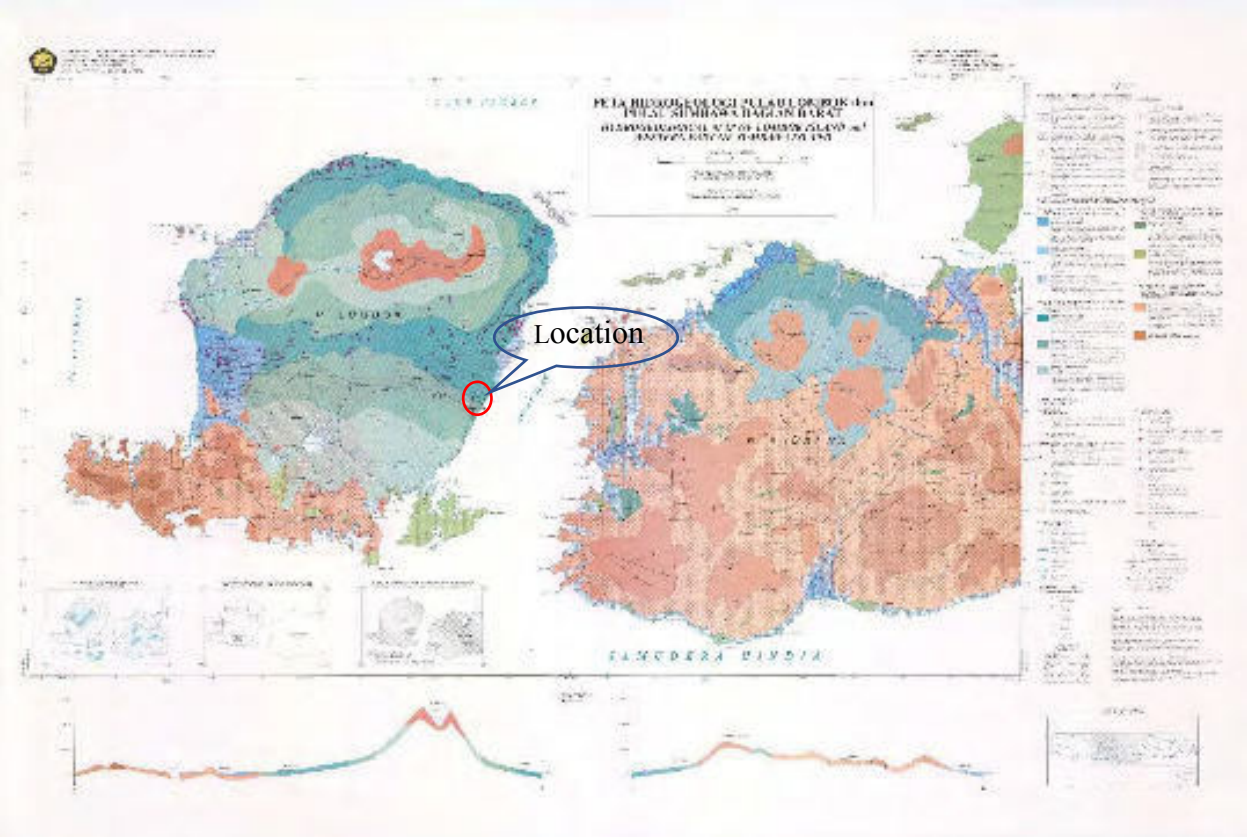
Material	Resistivity (Ohm-m)
Basalt	1000 - 10^8
Marble	100 – 2.5x10^8
Quartzite	100 – 2x10^8
Sandstone	8 – 4000
Shale	20 – 2000
Limestone	50 – 400
Clay	1 – 100
Alluvium	10 – 800
Ground Water	0.1 – 100
Salt Water	0.2
Conglomerate	100 – 500
Tuff	20 – 200
Andesite	100 – 2000
Granit	1000 – 10000
Chert, slate	200 – 2000

Source: Loke. M.H., 1997-2001

CHAPTER III
RESULTS

3.1 Hydrogeological Condition

The period of Rainfall in Lombok island is about 4 – 5 months (November – April) with rainfall intensity 900 – 2600 mm/year. The biggest intensity located at West Lombok and around Rinjani Mountain. The available amount of surface water at River Basin Unit around 2.50 – 3.50 Billion m^3 . Whereas for ground water potency in Lombok island around 0.9 billion m^3.



Picture 3.1 Hydrogeological Map of Lombok Island and Western Part of Sumbawa Island

Geoelectrical investigation located at Selong, East Lombok, West Nusa Tenggara Barat. This investigation aim for Power Solar Plant construction at Selong's Site. Hydrogeologically, this investigation site is an area with highly productive aquifer. The depth to free ground water level

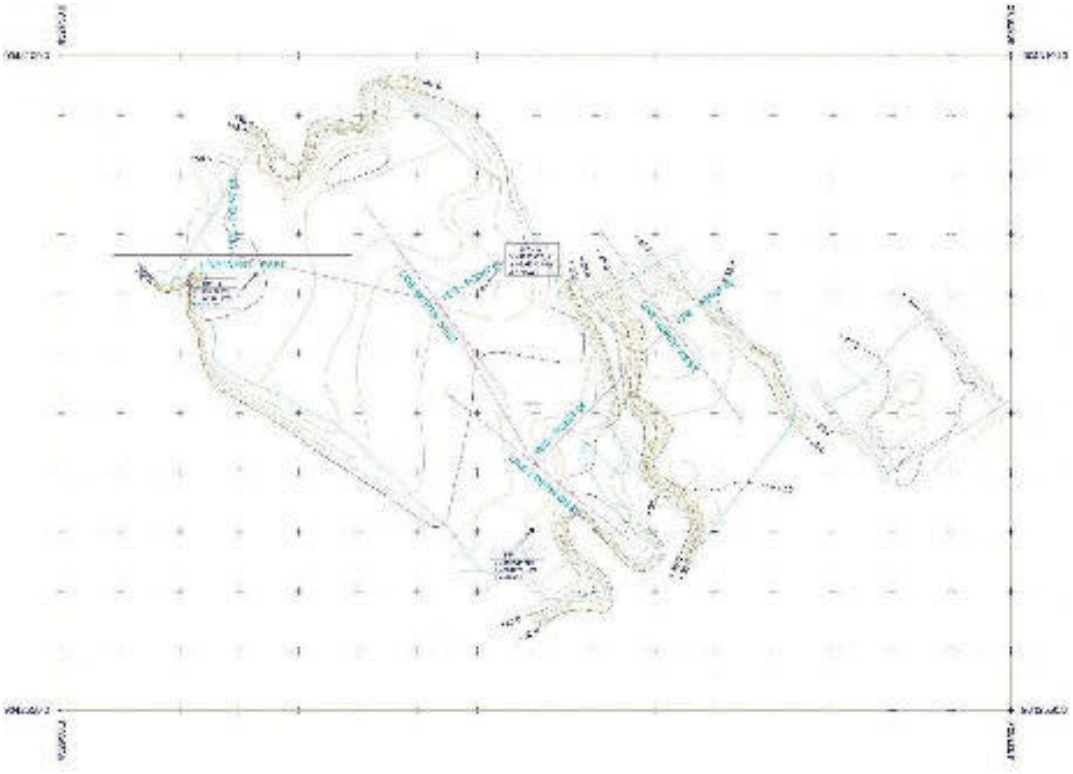
more than 15 m below subsurface. Ground water in aquifer layer flows from rock intrusion. Geomorfologically this site is an hilly area with slope range from 5° - 30°. Meanwhile geologically this site is one of volcanic area with base rock which is consist of pumice tuff, locally breccia, lahar and lava are found.

3.2 Geoelectrical Interpretation Result

According to the field investigation result using schlumberger configuration, we use IP2WIN and Progress software to get the true resistivity value and subsurface depth.

Table 3.1 Location of Geoelectrical Investigations.

No.	Sounding Point	Coordinates	Elevation (m)
1	VES – 01	[redacted]	46
2	VES – 02	[redacted]	50.5
3	VES – 03	[redacted]	42
4	VES – 04	[redacted]	43.5



Picture 3.2 Geoelectrical Line Direction

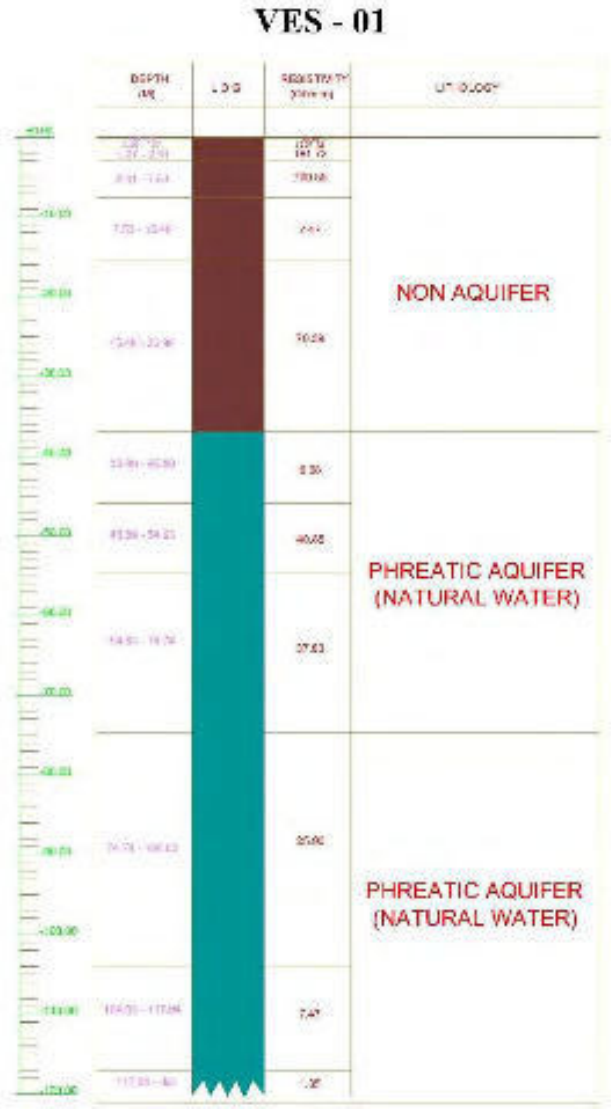
1. Vertical Electrical Sounding (VES) 01

Line Direction of VES – 01 from east to west. With elevation 81 m above the sea level. Subsurface of lithological cross section on the **table 3.2** and Hydrogeology cross section at **table 3.3.**

Table 3.2 Rock Layers Interpretation for VES – 01

Resistivity Model	Interpretation
	
	Top Soil : **Silty sand, gravel (pumice)** resistivity 180.69 – 7391.42 Ohm.m, depth 0.0 – 1.27 m
	Pumice Tuff : resistivity 181.72 – 700.59 Ohm.m, depth 1.27 – 7.53 m
	Gravely Sand : Resistivity 7.47 Ohm.m, depth 7.53 – 15.49 m
	Pumice Tuff : Resistivity 70.39 Ohm.m, depth 15.49 – 36.99 m
	Gravely Sand : Resistivity 6.68 Ohm.m, depth 36.99 – 45.89 m
	Pumice Tuff : Resistivity 25.96 – 40.85 Ohm.m, depth 845.89 – 104.03 m
	Gravely Sand : Resistivity 1.35 – 7.47 Ohm.m, depth 104.03 – ~ m

Table 3.3 Hydrogeological Cross Section

Resistivity Model	Interpretation
	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 36.99 – 117.04 m. Phreatic Aquifer layer located at Gravely sand and pumice tuff layer with resistivity value 1.35 – 40.85 Ohm.m.

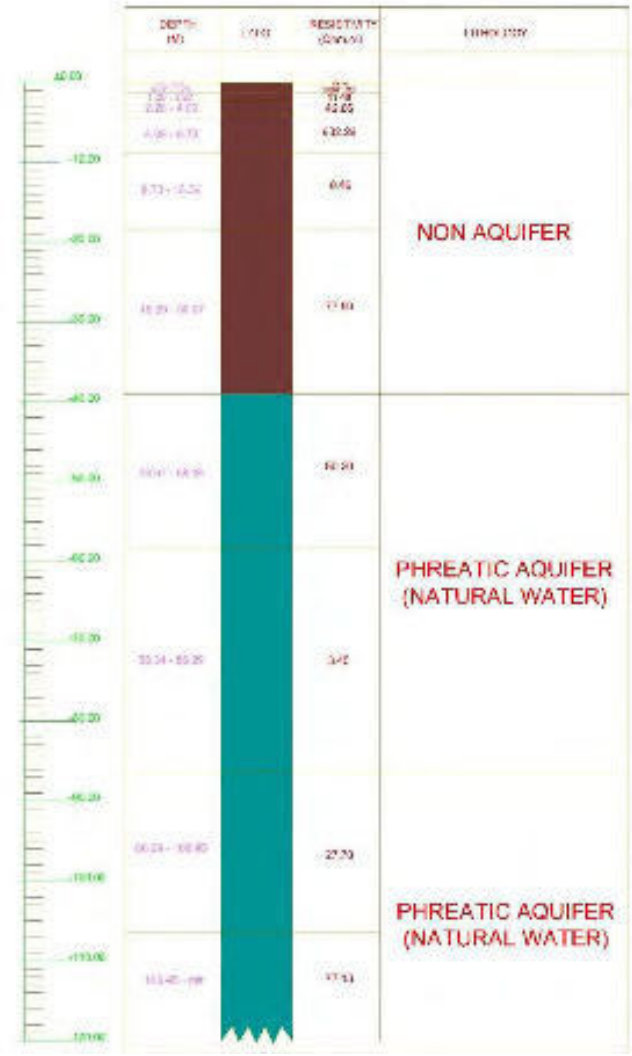
2. Vertical Electrical Sounding (VES) 02

Line Direction of VES – 02 from east to west. With elevation 67 m above the sea level. Subsurface of lithological cross section on the **table 3.4** and Hydrogeology cross section at **table 3.5.**

Table 3.4 Rock Layers Interpretation

Resistivity Model	Interpretation
	
	Top Soil : **Silty sand, gravel (pumice)** resistivity 398.70 – 19941.80 Ohm.m, depth 0.0 – 1.26 m
	Pumice Tuff : Resistivity 41.48 – 42.66 Ohm.m, depth 1.26 – 4.09 m
	Gravely Sand : Resistivity 8.46Ohm.m, depth 8.73 – 18.39 m
	Pumice Tuff: Resistivity 60.20 – 77.90 Ohm.m, depth 18.39 – 58.34 m
	Gravely Sand : Resistivity 3.45 Ohm.m, depth 58.34 – 86.29 m
	Pumice Tuff : Resistivity 27.70 Ohm.m, depth 86.29 – 106.45 m
	Pumice Tuff : Resistivity 77.13 Ohm.m, depth 106.45 – ~ m

Table 3.5 Hydrogeological Cross Section

Resistivity Model	Interpretation
VES - 02 	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 39.97 – 106.45 m. Phreatic Aquifer layer located at Pumice Tuff and Gravely sand layer with resistivity value 3.45 – 77.13 Ohm.m.

3. Vertical Electrical Sounding (VES) 03

Line Direction of VES – 03 from east to west. With elevation 89 m above the sea level. Subsurface of lithological cross section on the **table 3.6** and Hydrogeology cross section at **table 3.7.**

Table 3.6 Rock Layers Interpretation

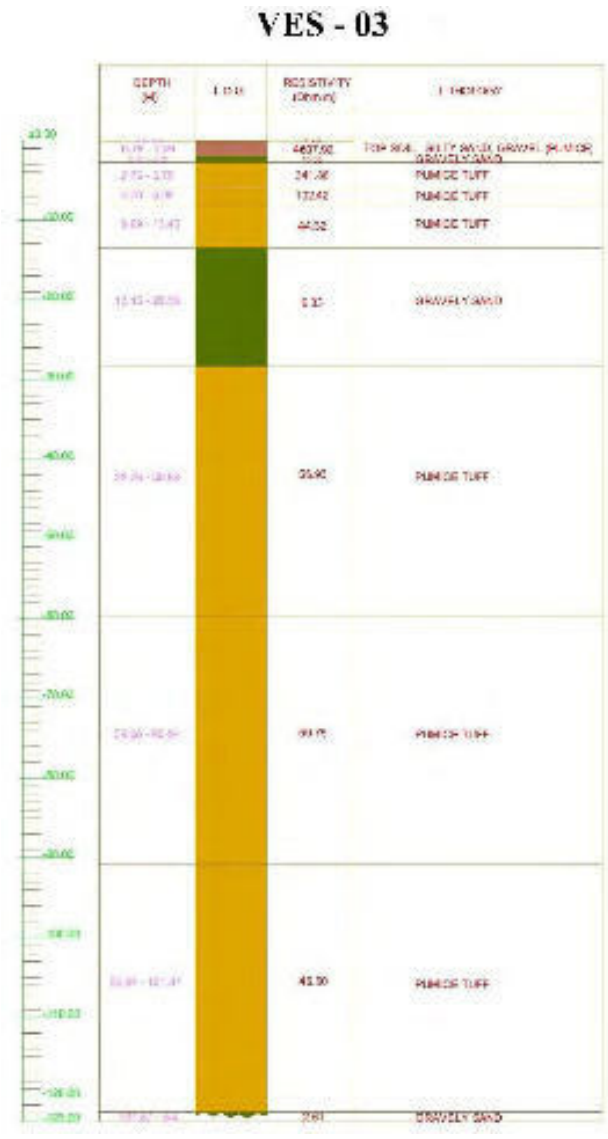
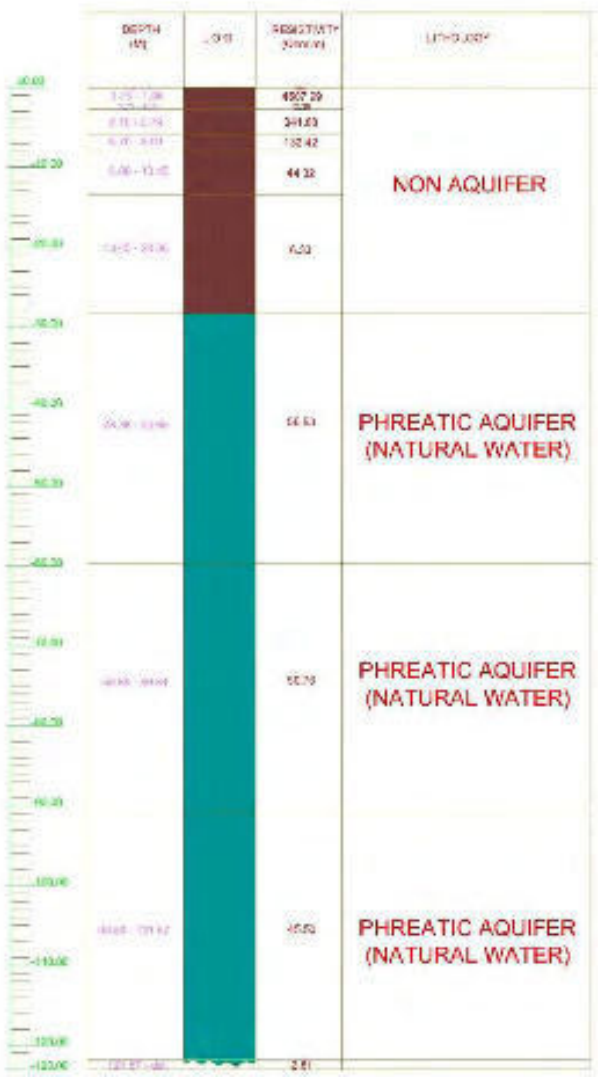
Resistivity Model	Interpretation
Gravely san 	
	Top Soil : **Silty sand, gravel (pumice),** resistivity 179.21 – 4607.99 Ohm.m, depth 0.0 – 1.96 m
	Gravely Sand : resistivity 10.38 Ohm.m, depth 1.96 – 2.75 m
	Pumice Tuff : resistivity 44.32 – 341.88 Ohm.m, depth 2.75 – 13.45 m
	Gravely Sand : Resistivity 6.33 Ohm.m, depth 13.45 – 28.36 m
	Pumice Tuff : Resistivity 45.50 - 56.93 Ohm.m, depth 28.36 – 121.87 m
	Gravely Sand : Resistivity 2.61 Ohm.m, depth 121.87 - ~ m

Table 3.7 Hydrogeological Cross Section

Resistivity Model	Interpretation
VES - 03 	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 28.36 – 121.87 m. Phreatic aquifer layer located at Pumice tuff and gravely sand layer with resistivity 2.61 – 56.93 Ohm.m.

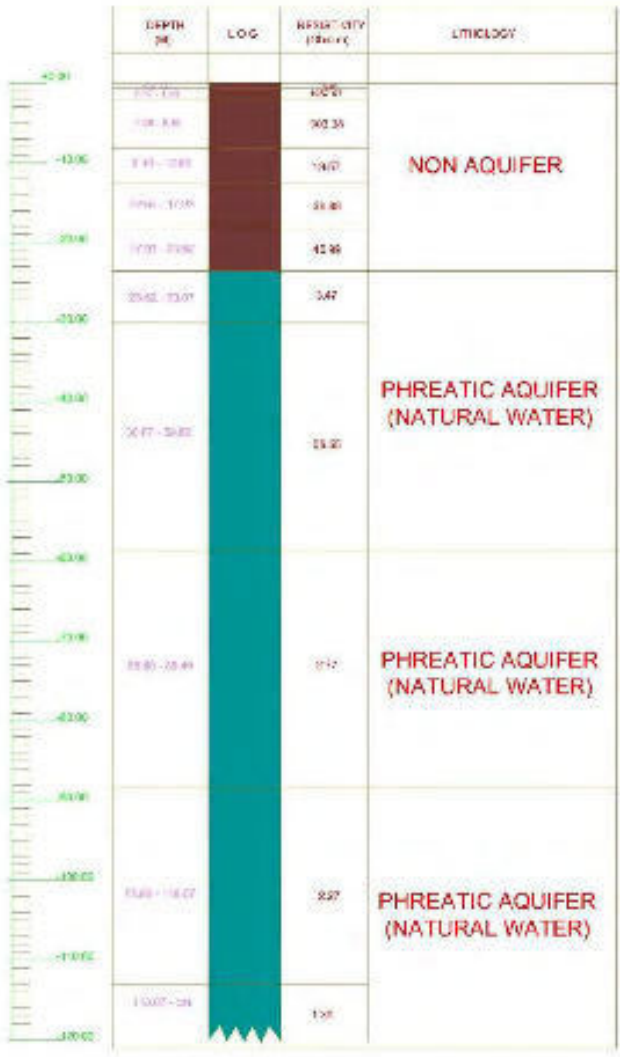
4. Vertical Electrical Sounding (VES) 04

Line Direction of VES – 04 from east to west. With elevation 101 m above the sea level. Subsurface of lithological cross section on the **table 3.8** and Hydrogeology cross section at **table 3.9.**

Table 3.8 Rock Layers Interpretation

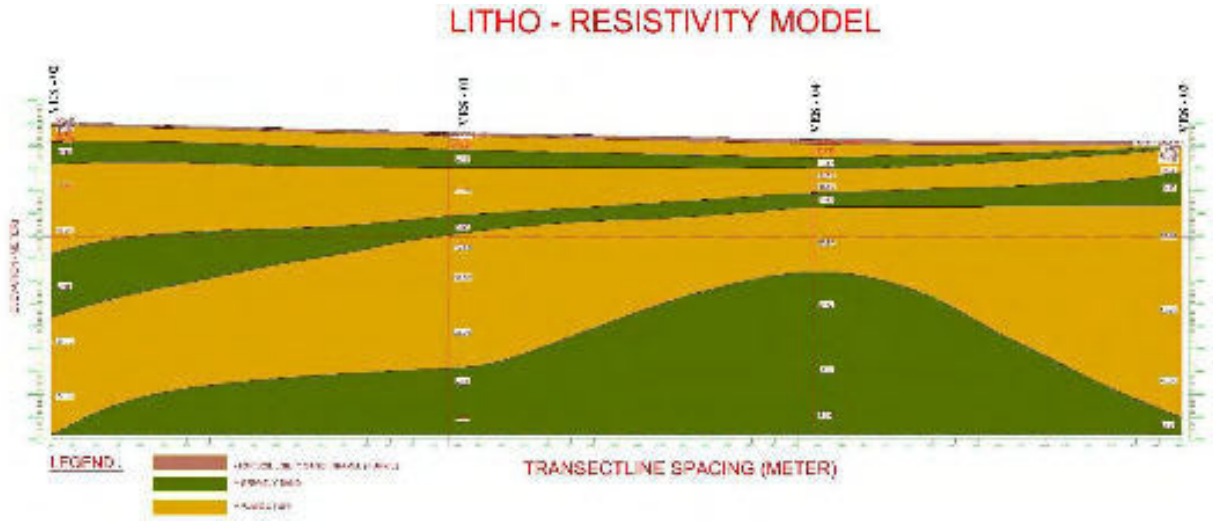
Resistivity Model	Interpretation
VES - 04 	
	Top Soil : **Silty sand and gravel (pumice)** resistivity 775.86 – 1957.47 Ohm.m, depth 0.0 – 1.98 m
	Pumice Tuff : resistivity 303.38 Ohm.m, depth 1.98 – 8.16 m
	Gravely sand : Resistivity 19.57 Ohm.m, depth 8.16 – 12.65 m
	Pumice Tuff : Resistivity 36.88 – 45.99 Ohm.m, depth 12.65 – 23.62 m
	Gravely sand : Resistivity 3.47 Ohm.m, depth 23.62 – 30.07 m
	Pumice Tuff : Resistivity 58.55 Ohm.m, depth 30.07 – 58.60 m
	Gravely Sand : Resistivity 2.27 – 2.77 Ohm.m, depth 58.60 – 118.07 m
	Gravely sand : Resistivity 1.39 Ohm.m, depth 118.07 – ~ m

Table 3.9 Hydrogeological Cross Section

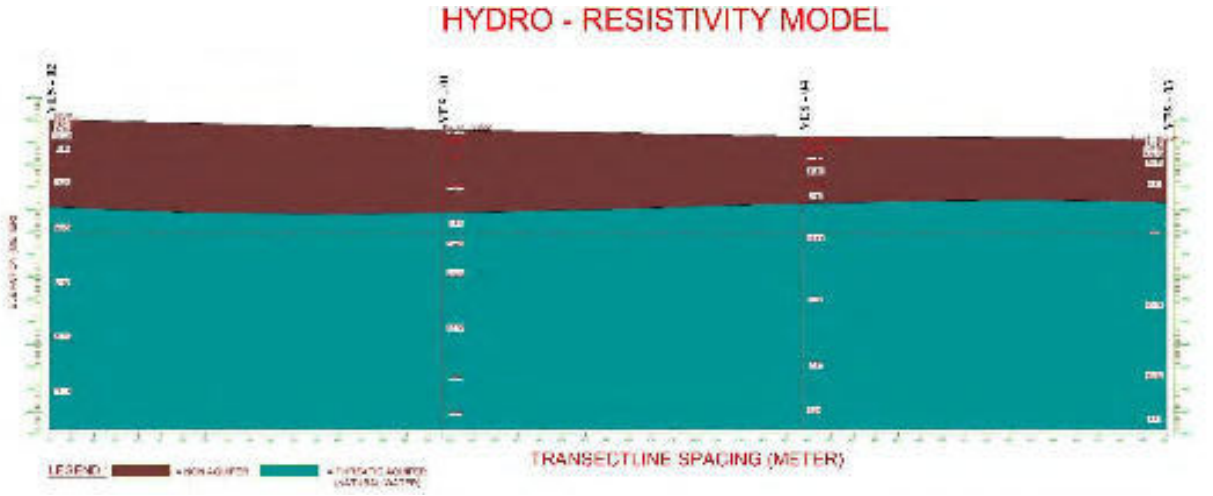
Resistivity Model	Interpretation
VES - 04 	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 23.62 – 118.07 m. Phreatic aquifer layer located at Gravely Sand and Pumice Tuff layer with resistivity value 1.39 – 58.55 Ohm.m.

5. Correlation VES 01 – 04 of Lithological and Hydrological Cross Section

Based on Correlation VES 01 – 04, and then lithological and hydrological cross section has been made. From lithological cross section the rock and soil layers can be figured as the **picture 3.3** below. Meanwhile, hydrological cross section can be figured at **Picture 3.4.**

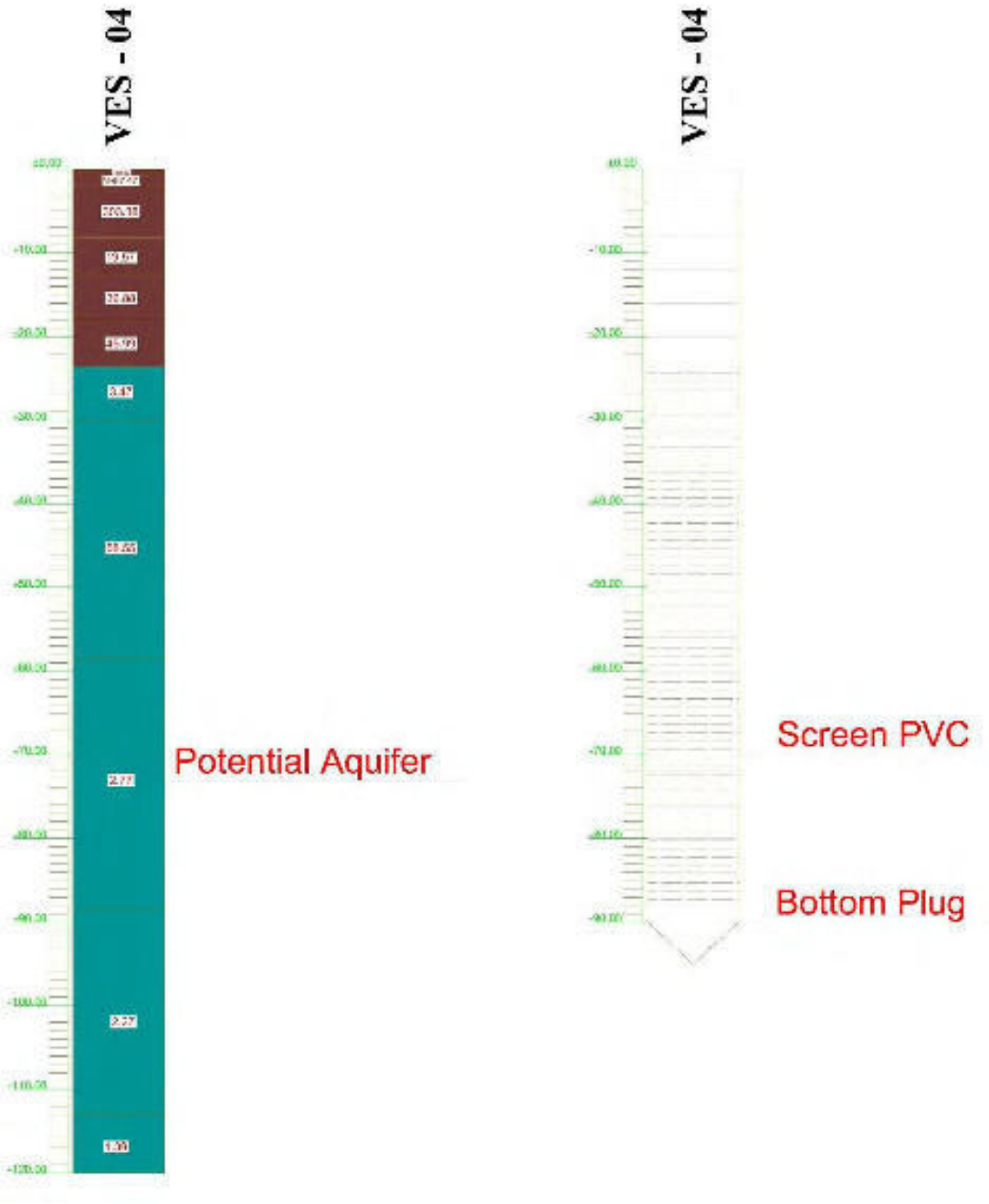


Picture 3.3 Correlation VES 01 – 04 of Lithological Cross Section



Picture 3.4 Correlation VES 01 – 04 of Hydrogeological Cross Section

If the drilling exploration will be done, the most potential water ground source on VES – 04. Bore design can be figured as picture below.



Picture 3.5 Bore Design

CHAPTER IV
CONCLUSION AND RECOMMENDATION

1. Conclusion

a. Geoelectric Investigation has been conducted on 15th – 16th December 2017. Total track of investigation is 4 points. Geoelectrical used Schlumberger method, and for data analysis used *IP2WIN* and *Progress* software.

b. The depth of ground water level at VES – 01 is 36.99 m – 117.04 m for phreatic aquifer. The phreatic aquifer layer located on Gravely Sand and Pumice Tuff layer.

c. The depth of ground water level at VES – 02 is 39.97 – 106.45 m. Phreatic Aquifer layer located at Pumice Tuff and Gravely sand layer.

d. The depth of ground water level at VES – 03 is for phreatic aquifer at depth 28.36 – 121.87 m. Phreatic aquifer layer located at Pumice tuff and gravely sand layer.

e. The depth of ground water level at VES – 04 is 23.62 – 118.07 m. Phreatic aquifer layer located at Gravely Sand and Pumice Tuff layer.

2. Recommendation

To get more complete information about the ground water level, drilling exploration can be done at VES-01, VES-02, VES-03, and VES-04. The depth of drilling exploration should be done to 90 meters below subsurface. Based on resistivity value we found that potential aquifer (natural water) at depth up to 90 meters below the subsurface.

ATACHMENTS

Geoelectrical Data measurement at VES - 01

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	785.00	0.5	6.28	8270	8230	65.2	66.1
2	2	923.00	0.5	11.78	4150	4170	52.9	52.7
3	2.5	1160.00	0.5	18.84	2980	2960	47.6	48.4
4	3	1325.00	0.5	27.48	3070	3050	63.5	62.8
5	4	1479.00	0.5	49.46	1680	1680	56.1	55.7
6	5	1523.00	0.5	77.72	1190	1180	60.4	60
7	6	1523.00	0.5	112.26	850	860	62.8	62.7
8	8	1337.00	0.5	200.18	390	390	58.2	58.1
9	10	1063.00	0.5	313.22	187.8	189.9	55.4	55.4
10	12	832.00	0.5	451.38	139.8	138.9	75.2	75.2
11	15	552.00	0.5	705.72	57	58.8	72.2	75.2
12	15	552.00	5	62.80	396.6	336.5	73	73.8
13	20	482.00	5	117.75	215	214	66.9	66.7
14	25	431.00	5	188.40	219	218.3	76.3	76.3
15	30	141.00	5	274.75	27.9	28	61.5	62
16	30	141.00	10	125.60	68.6	71.1	62	62.3
17	40	67.60	10	235.50	15.4	15.2	53.3	53.3
18	50	43.10	10	376.80	9	9.4	80	80.7
19	60	30.60	10	549.50	3.3	3.4	60.1	60
20	75	28.60	10	867.43	1.1	1	42.3	42.3
21	75	28.60	25	314.00	3.5	3.5	43	42.7
22	100	29.60	25	588.75	2	1.7	37.02	36.52
23	125	29.30	25	942.00	1.2	1.2	38.7	38.5
24	150	22.90	25	1373.75	0.6	0.5	44.8	44.9
25	150	22.90	45	714.35	1.6	1.7	51.3	51.6
26	175	21.00	45	997.82	1.2	1.1	55.8	55.6
27	200	21.50	45	1324.91	0.8	0.6	42.6	43.6
28	225	21.50	45	1695.60	0.9	0.9	53.8	53.1
29	225	21.50	65	1120.74	1.5	1.3	75	75.4
30	250	21.50	65	1407.57	1	1	64.7	65
31	275	18.50	65	1724.58	0.8	0.7	69.9	70
32	300	10.30	65	2071.80	0.3	0.4	70.1	70.1

Geoelectrical Data measurement at VES - 02

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	1531.00	0.5	6.28	380.4	383.4	51.8	51
2	2	1939.00	0.5	11.78	387	385.4	52.3	52.2
3	2.5	2529.00	0.5	18.84	403.8	401	48.6	48.5
4	3	3064.00	0.5	27.48	375.8	399.9	53.8	55.5
5	4	3604.00	0.5	49.46	403.8	401	45	45.3
6	5	3938.00	0.5	77.72	2240	2271	42.7	42.9
7	6	3823.00	0.5	112.26	1364	1394	39.7	40
8	8	3176.00	0.5	200.18	727	720	44.4	46.6
9	10	2438.00	0.5	313.22	340	336.9	43.5	43.3
10	12	1894.00	0.5	451.38	211.6	214	50.6	50.6
11	15	1227.00	0.5	705.72	81.6	81.9	50	50.1
12	15	1227.00	5	62.80	977	970	49.5	50.1
13	20	470.00	5	117.75	156	156	39	39.1
14	25	332.00	5	188.40	73.2	71.6	41.2	41
15	30	215.00	5	274.75	67.6	69.1	52	50.2
16	30	215.00	10	125.60	90.8	91.3	53.5	53.4
17	40	161.00	10	235.50	27.5	26	39.3	39.4
18	50	142.00	10	376.80	18.5	18.5	49.3	49.3
19	60	123.00	10	549.50	5.9	6.1	26.83	27.21
20	75	61.10	10	867.43	4.5	4.6	64.4	65.5
21	75	61.10	25	314.00	9	8	65.5	66.2
22	100	52.80	25	588.75	9	9.4	47.6	47.4
23	125	42.30	25	942.00	1.6	1.4	67.1	67.5
24	150	34.90	25	1373.75	0.8	0.9	48.4	48.4
25	150	34.90	45	714.35	3.7	4	81.1	80.5
26	175	31.50	45	997.82	5.7	6.8	80.5	80.5
27	200	29.20	45	1324.91	8.4	8.5	77.4	74.5
28	225	27.60	45	1695.60	0.9	0.9	69.5	70
29	225	27.60	65	1120.74	1.5	1.3	72.5	72.5
30	250	27.30	65	1407.57	1	1.2	54.9	55.2
31	275	27.30	65	1724.58	1	1.6	70	70.2
32	300	26.90	65	2071.80	1.1	1	66.5	67.9

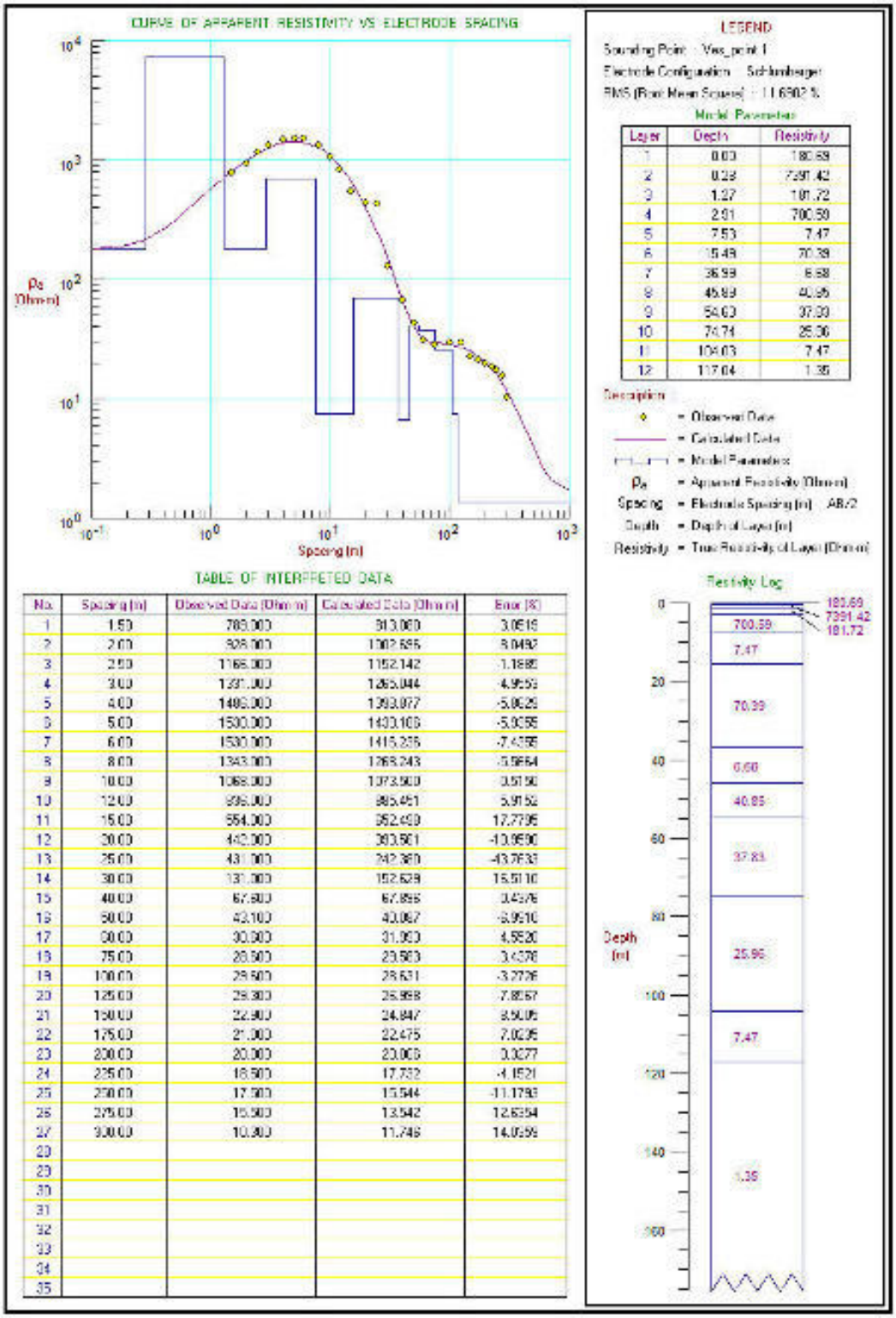
Geoelectrical Data measurement at VES - 03

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	1065.00	0.5	6.28	16040	15910	92.3	91.6
2	2	1179.00	0.5	11.78	11650	11800	89.2	90.1
3	2.5	1308.00	0.5	18.84	5780	5800	81.1	81.7
4	3	1390.00	0.5	27.48	4470	4450	86.1	86
5	4	1644.00	0.5	49.46	2840	2830	83.2	83.3
6	5	1770.00	0.5	77.72	1700	1748	73.5	74.3
7	6	1750.00	0.5	112.26	1403	1413	88.1	88.2
8	8	1330.00	0.5	200.18	519	526	76.7	76.9
9	10	999.00	0.5	313.22	276	276	84	85
10	12	557.00	0.5	451.38	101	107	81.5	83
11	15	391.00	0.5	705.72	35.7	36.7	100.8	101.2
12	15	391.00	5	62.80	660	620	101.7	102
13	20	170.00	5	117.75	151	147	102.1	102
14	25	112.00	5	188.40	60	61.6	100.8	100.9
15	30	86.80	5	274.75	25.7	25.7	91.4	90.9
16	30	86.80	10	125.60	76.3	77.6	93.2	93.4
17	40	57.20	10	235.50	24.4	25.1	100.4	101.2
18	50	36.50	10	376.80	8.8	9	90.6	91.3
19	60	29.70	10	549.50	4.9	4.7	88	88.1
20	75	26.90	10	867.43	2.4	3	97.2	97.5
21	75	26.90	25	314.00	8.4	8.6	99.3	99.1
22	100	23.80	25	588.75	3.7	3.3	93.2	93.6
23	125	24.30	25	942.00	2.1	2.3	84.5	86.3
24	150	24.30	25	1373.75	1.7	1.5	94.2	95
25	150	24.30	45	714.35	5.8	4.8	97.5	97
26	175	25.40	45	997.82	2.6	2.7	103.9	104.2
27	200	26.60	45	1324.91	2.1	2.3	105.9	105.9
28	225	26.40	45	1695.60	1.1	1.3	95.9	96.5
29	225	26.40	65	1120.74	3	3	98.9	99.2
30	250	25.80	65	1407.57	1.8	2	98.8	99.9
31	275	23.70	65	1724.58	1.4	1.5	105.5	105.3
32	300	19.00	65	2071.80	0.8	0.7	82.6	81

Geoelectrical Data measurement at VES - 04

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	1038.00	0.5	6.28	12540	12540	75.4	75.5
2	2	1083.00	0.5	11.78	6780	6930	73.2	75
3	2.5	1082.00	0.5	18.84	4570	4570	79.1	79.1
4	3	1142.00	0.5	27.48	2920	2913	70.1	69.4
5	4	990.00	0.5	49.46	1484	1474	73.5	73.5
6	5	869.00	0.5	77.72	370	559	67.6	66.7
7	6	716.00	0.5	112.26	422	438	66.7	67.4
8	8	523.00	0.5	200.18	190	188	72.2	71.7
9	10	333.00	0.5	313.22	87.6	89.5	82.2	83.5
10	12	256.00	0.5	451.38	47.8	47.2	83.4	83.4
11	15	192.00	0.5	705.72	18.6	18	80.3	79.6
12	15	192.00	5	62.80	276.9	279.5	82.8	82.4
13	20	104.00	5	117.75	81.4	83.7	92.2	92.9
14	25	59.10	5	188.40	33.4	30.5	101.2	101.5
15	30	40.80	5	274.75	10.6	10.4	80.8	80.7
16	30	40.80	10	125.60	27.6	27.4	82.7	82.5
17	40	28.00	10	235.50	11.5	12.9	100.2	100.4
18	50	24.50	10	376.80	6.8	6.6	100.6	100.8
19	60	20.20	10	549.50	3.8	3.9	101.9	102.1
20	75	17.90	10	867.43	2.3	2.1	103.7	104.1
21	75	17.90	25	314.00	11.6	10.1	104.5	104.7
22	100	18.20	25	588.75	4.4	4.6	91	91.5
23	125	19.20	25	942.00	1.3	1.3	63.5	63.2
24	150	18.10	25	1373.75	0.2	0.3	98.8	95
25	150	18.10	45	714.35	2.9	2.2	100.3	100.4
26	175	12.90	45	997.82	1.2	1.3	97	96.7
27	200	10.90	45	1324.91	0.9	0.9	108.9	109.1
28	225	10.60	45	1695.60	0.7	0.7	96.1	96.7
29	225	10.60	65	1120.74	3.7	3.7	98.6	98.1
30	250	10.10	65	1407.57	1.5	1.3	104.6	104.4
31	275	8.63	65	1724.58	0.5	0.4	89.2	90.6
32	300	3.27	65	2071.80	0.2	0.1	95.3	95

VES – 01 Data Analysis by Progress software



No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	788.000	813.060	3.0515
2	2.00	908.000	1002.595	9.0492
3	2.50	1165.000	1152.142	-1.1885
4	3.00	1231.000	1285.044	4.3953
5	4.00	1486.000	1393.977	-5.0629
6	5.00	1530.000	1403.105	-5.0555
7	6.00	1530.000	1415.235	-7.4395
8	8.00	1343.000	1268.243	-5.5664
9	10.00	1088.000	1373.560	3.5758
10	12.00	936.000	885.451	5.9152
11	15.00	554.000	362.459	17.7795
12	20.00	442.000	393.561	-10.9590
13	25.00	431.000	242.360	-43.7833
14	30.00	131.000	152.629	15.5110
15	40.00	67.600	67.896	3.4376
16	50.00	43.100	43.067	-5.9510
17	60.00	30.000	31.993	4.5520
18	75.00	26.500	23.563	3.4376
19	100.00	29.500	28.631	-3.2726
20	125.00	29.300	26.958	-7.8867
21	150.00	22.900	24.847	8.5005
22	175.00	21.300	22.475	7.0095
23	200.00	20.000	23.003	3.0077
24	225.00	18.500	17.732	-4.1521
25	250.00	17.500	15.544	-11.1793
26	275.00	15.500	13.542	12.6954
27	300.00	10.800	11.746	14.0659
28				
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VES – 02 Data Analysis by Progress software

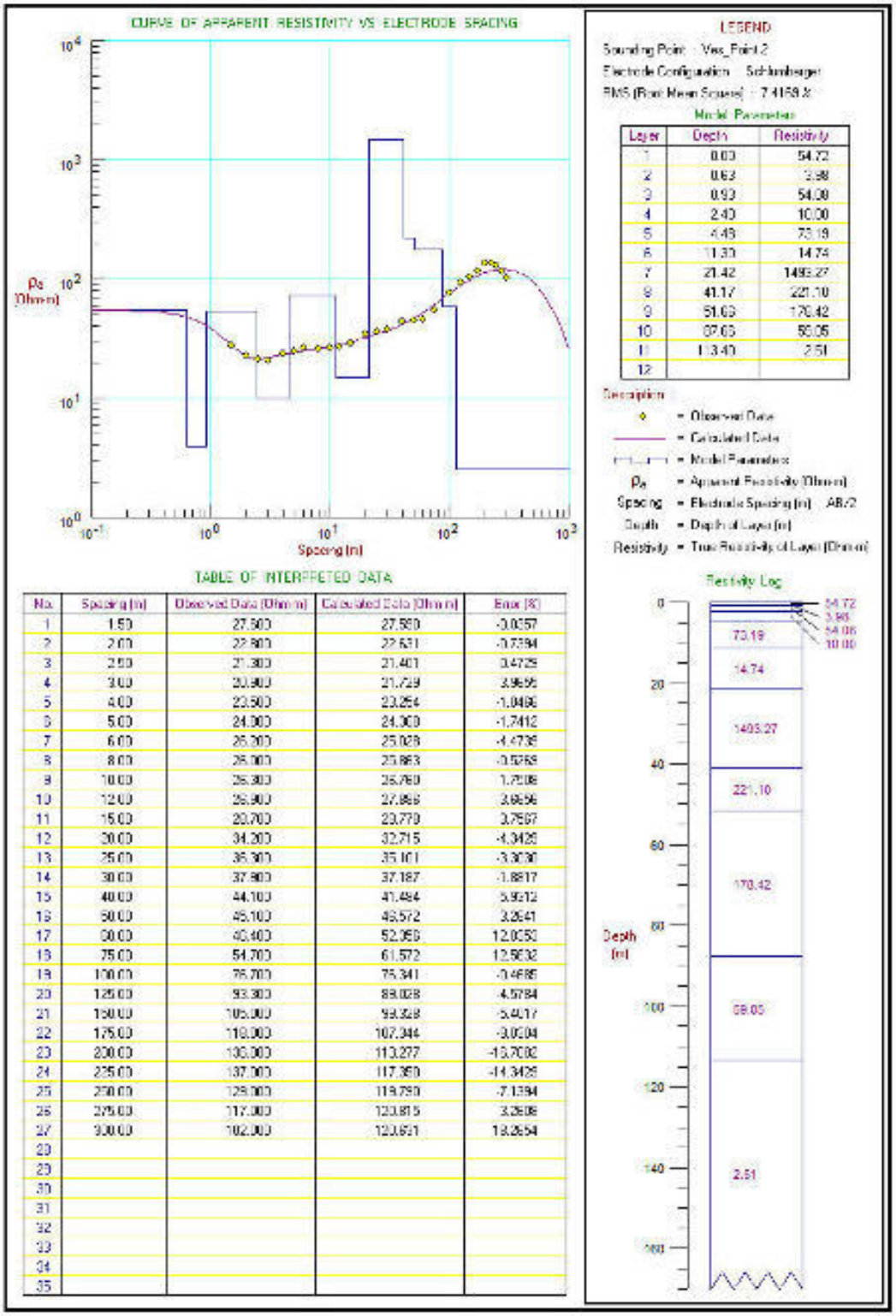

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	27.500	27.509	-0.0357
2	2.00	22.800	22.631	0.7394
3	2.50	21.300	21.401	-0.4729
4	3.00	20.900	21.729	-3.9695
5	4.00	23.500	23.254	1.0486
6	5.00	24.000	24.009	-0.0412
7	6.00	25.200	25.028	0.6746
8	8.00	25.000	25.063	-0.2519
9	10.00	25.300	25.780	-1.9008
10	12.00	26.900	27.856	-3.5596
11	15.00	20.700	23.779	-3.7697
12	20.00	34.200	32.715	4.3426
13	25.00	35.300	35.101	0.5666
14	30.00	37.900	37.187	1.8817
15	40.00	44.100	41.484	5.9512
16	50.00	45.100	46.572	-3.2641
17	60.00	40.400	52.060	-12.0050
18	75.00	54.700	61.572	-12.5032
19	100.00	75.700	75.341	0.4685
20	125.00	93.300	88.028	4.5784
21	150.00	105.000	99.328	5.4117
22	175.00	110.000	107.344	-3.0004
23	200.00	100.000	113.277	-13.7002
24	225.00	137.000	117.950	-14.3428
25	250.00	129.000	119.790	-7.1394
26	275.00	117.000	120.815	-3.2609
27	300.00	102.000	120.651	-18.2654
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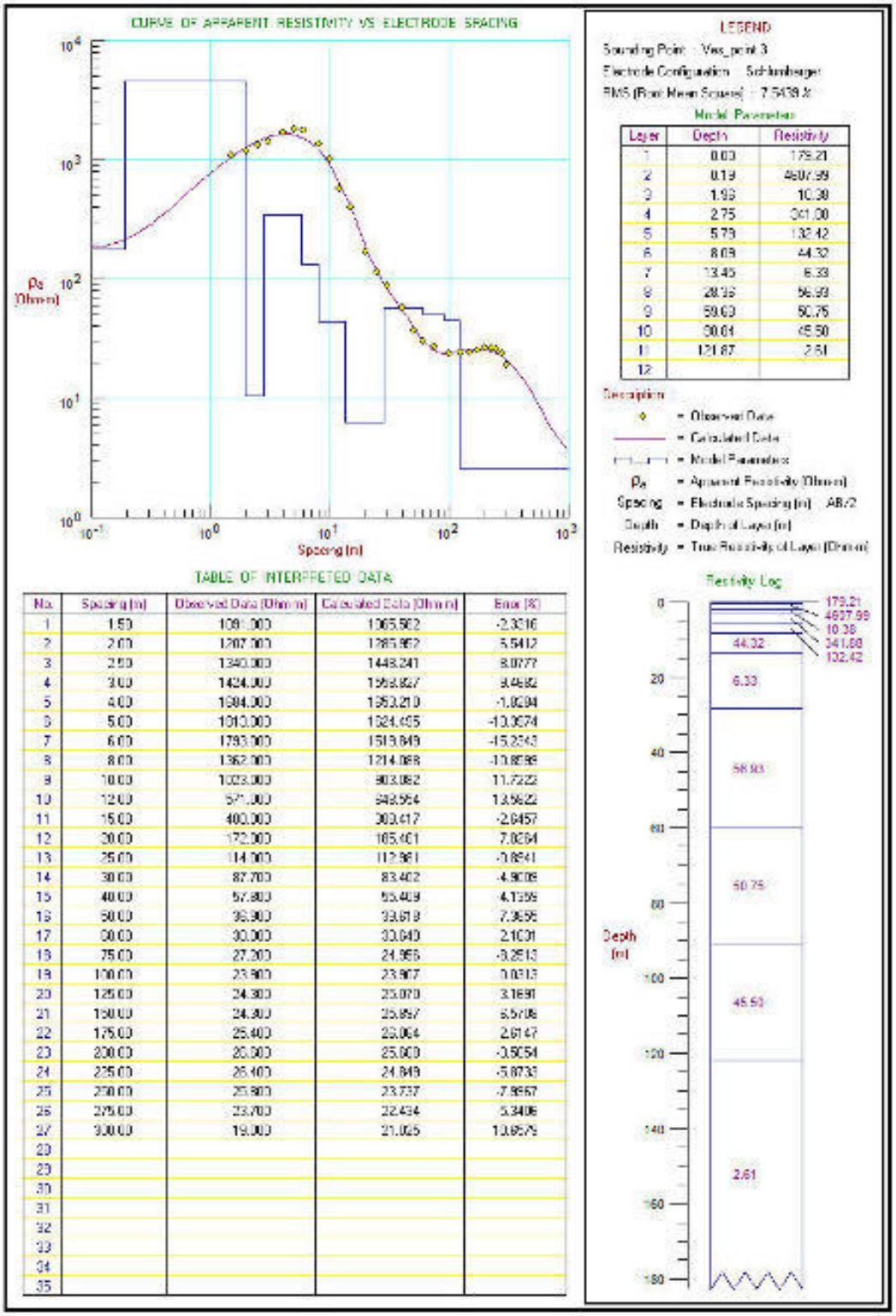
VES – 03 Data Analysis by Progress software



VES – 04 Data Analysis by Progress software

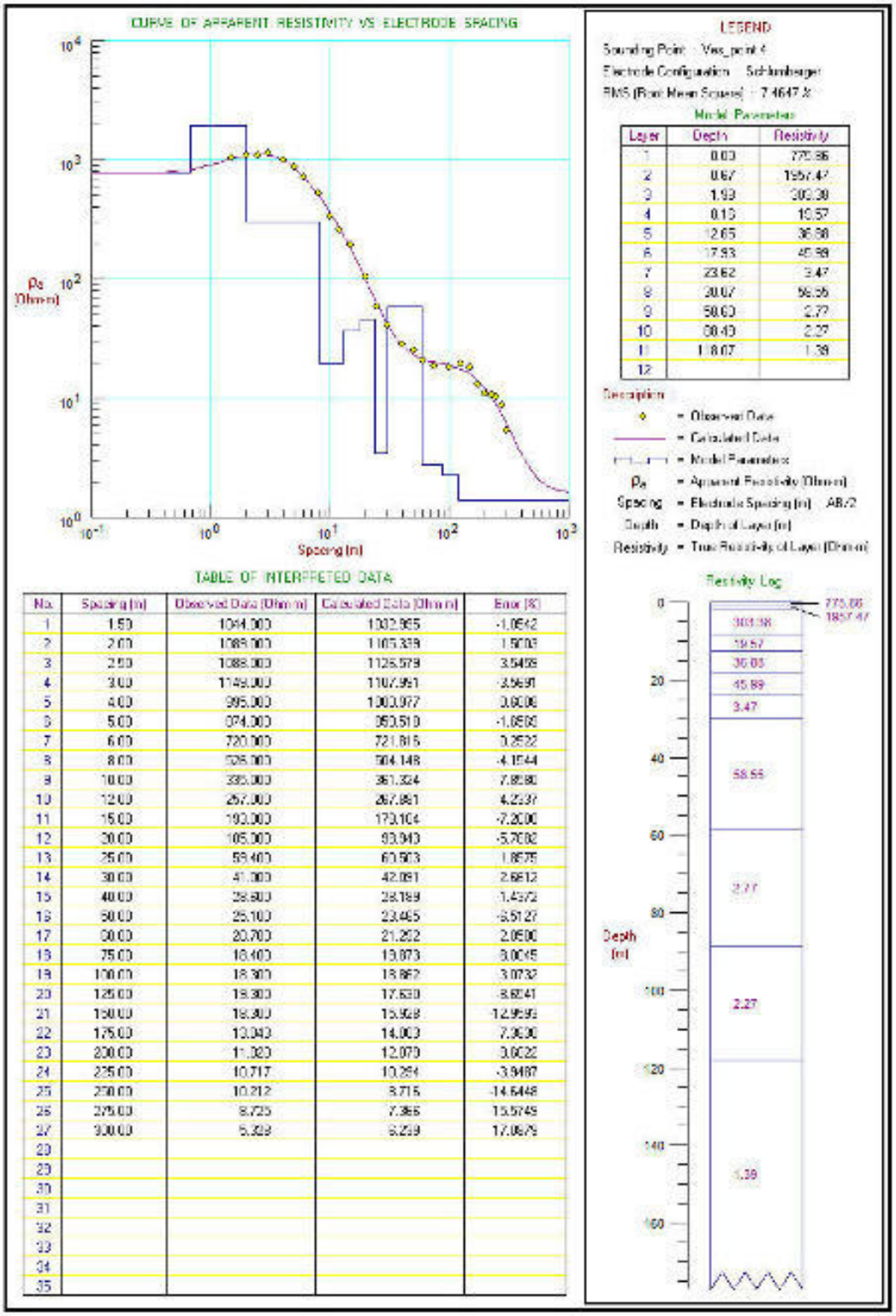


TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	1094.000	1032.965	-1.0542
2	2.00	1089.000	1105.339	1.5003
3	2.50	1088.000	1125.579	3.5499
4	3.00	1149.000	1107.951	-3.5691
5	4.00	995.000	1003.977	0.8908
6	5.00	974.000	963.519	-1.0680
7	6.00	720.000	721.815	0.2522
8	8.00	526.000	504.148	-4.1544
9	10.00	335.000	361.324	7.8580
10	12.00	257.000	267.861	4.2237
11	15.00	193.000	179.104	-7.2000
12	20.00	105.000	99.040	-5.7000
13	25.00	59.400	60.503	1.8575
14	30.00	41.000	42.091	2.6612
15	40.00	28.600	28.189	-1.4372
16	50.00	25.100	23.465	-6.5127
17	60.00	20.700	21.232	2.0500
18	75.00	18.400	19.073	3.0045
19	100.00	18.300	18.862	3.0732
20	125.00	19.300	17.639	-8.6041
21	150.00	19.300	16.958	-12.9599
22	175.00	13.040	14.003	7.3630
23	200.00	11.320	12.079	3.0022
24	225.00	10.717	10.264	-3.9487
25	250.00	10.212	8.715	-14.6448
26	275.00	8.725	7.366	15.5749
27	300.00	5.329	6.239	17.0679
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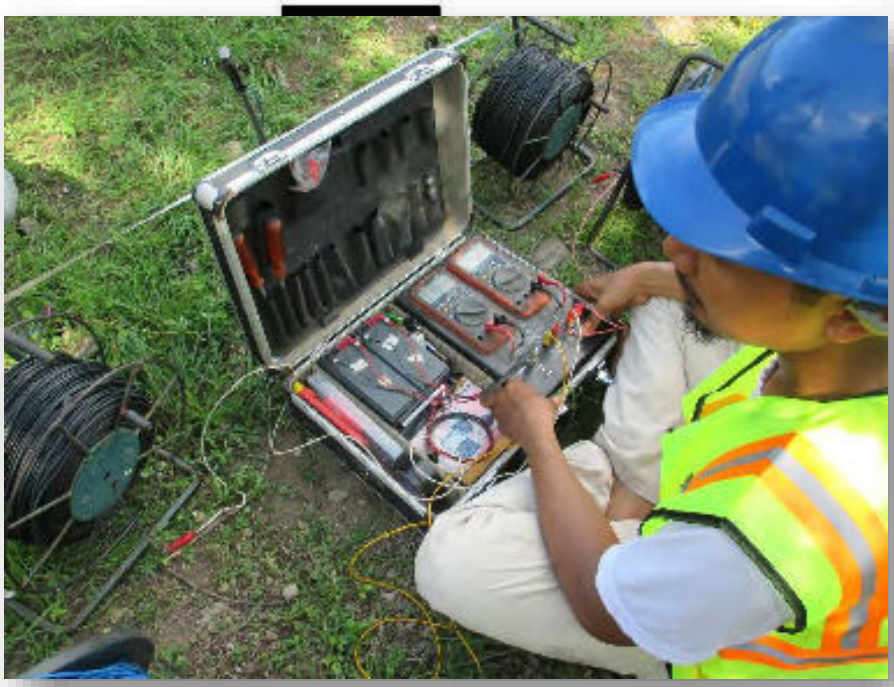
Selong Solar Power Plant site for Geoelectrical investigation

Geoelectrical investigation process

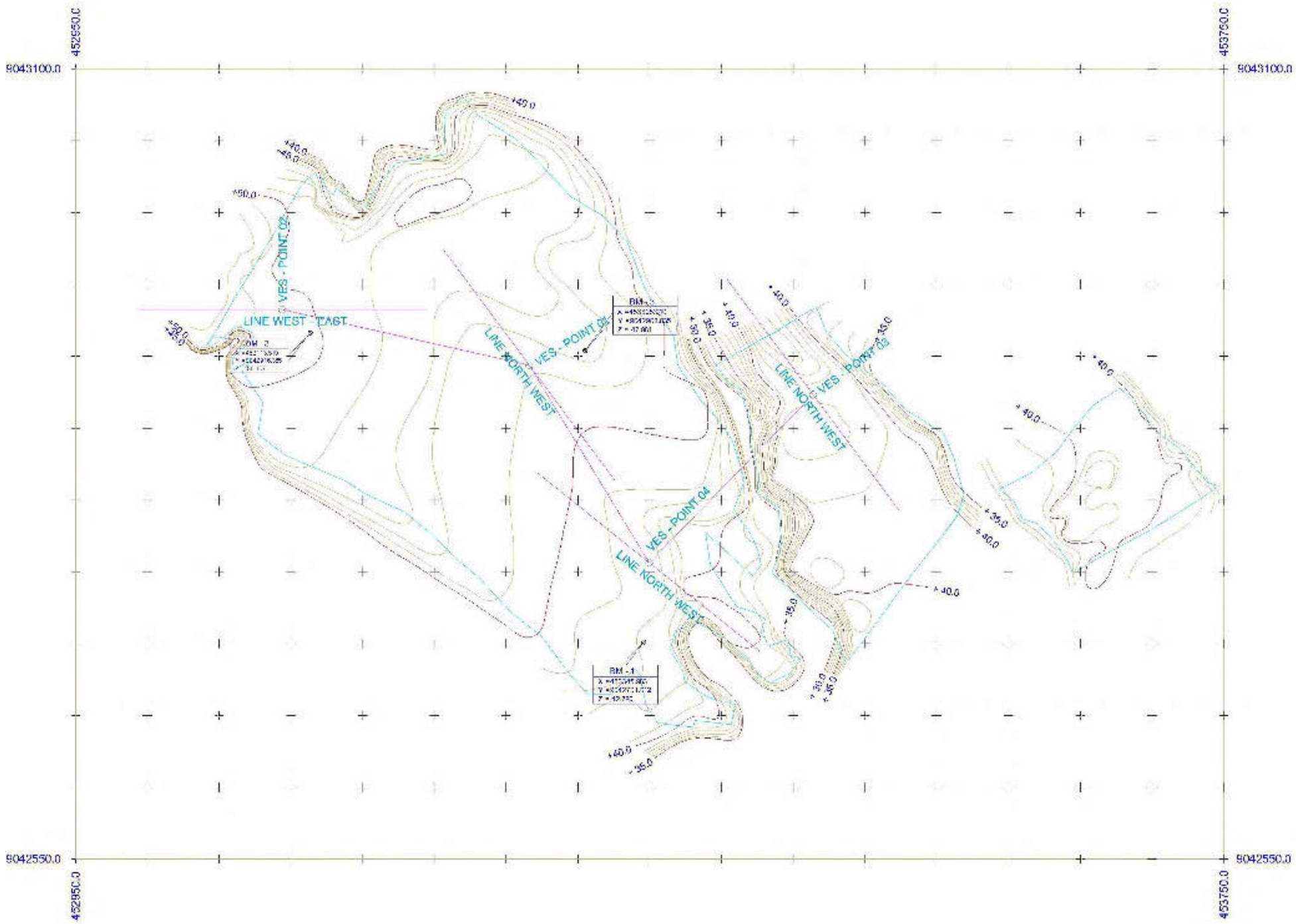


Geoelectrical investigation process

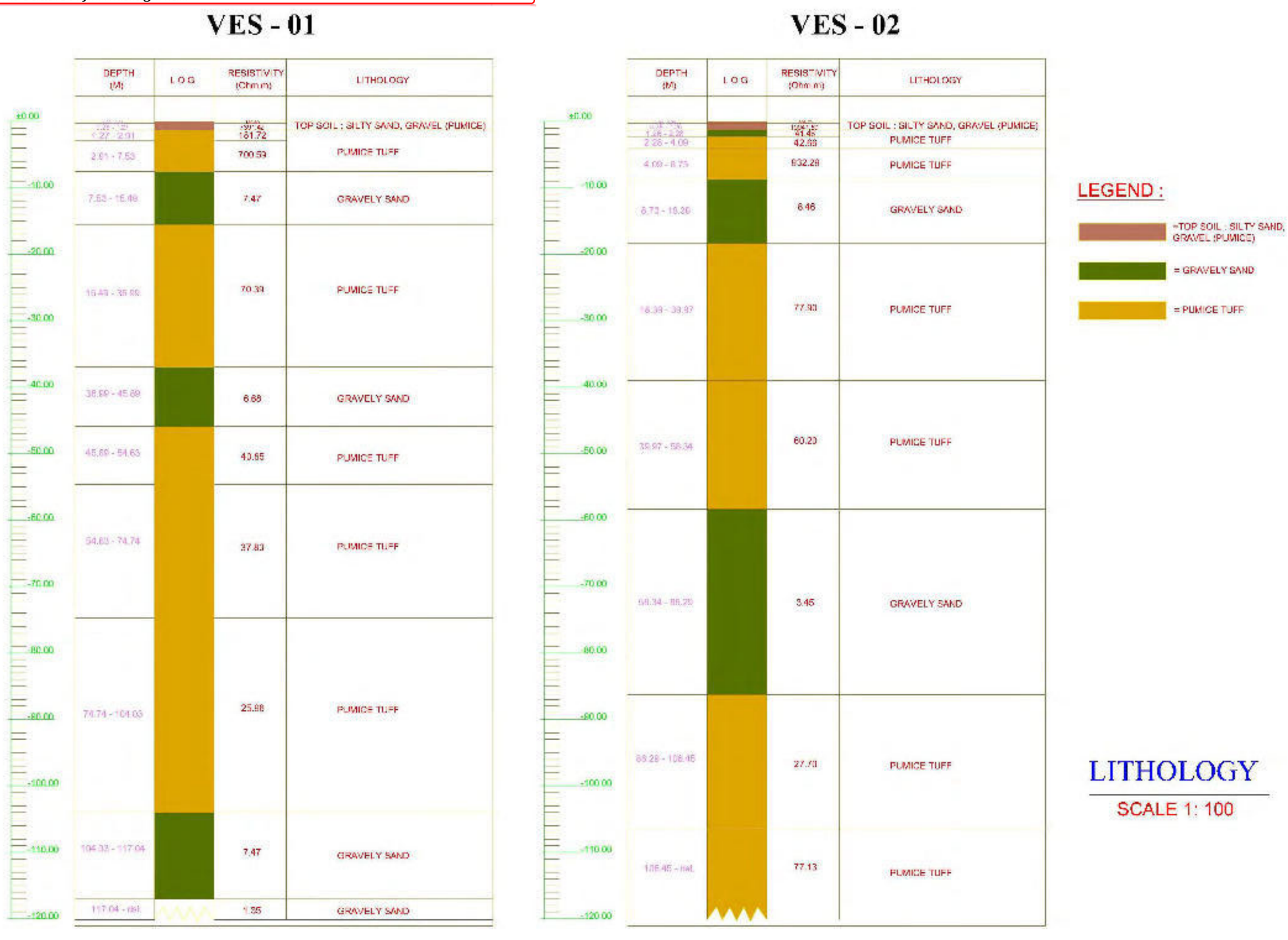
Geoelectrical investigation process

Geoelectrical point track at selong's site

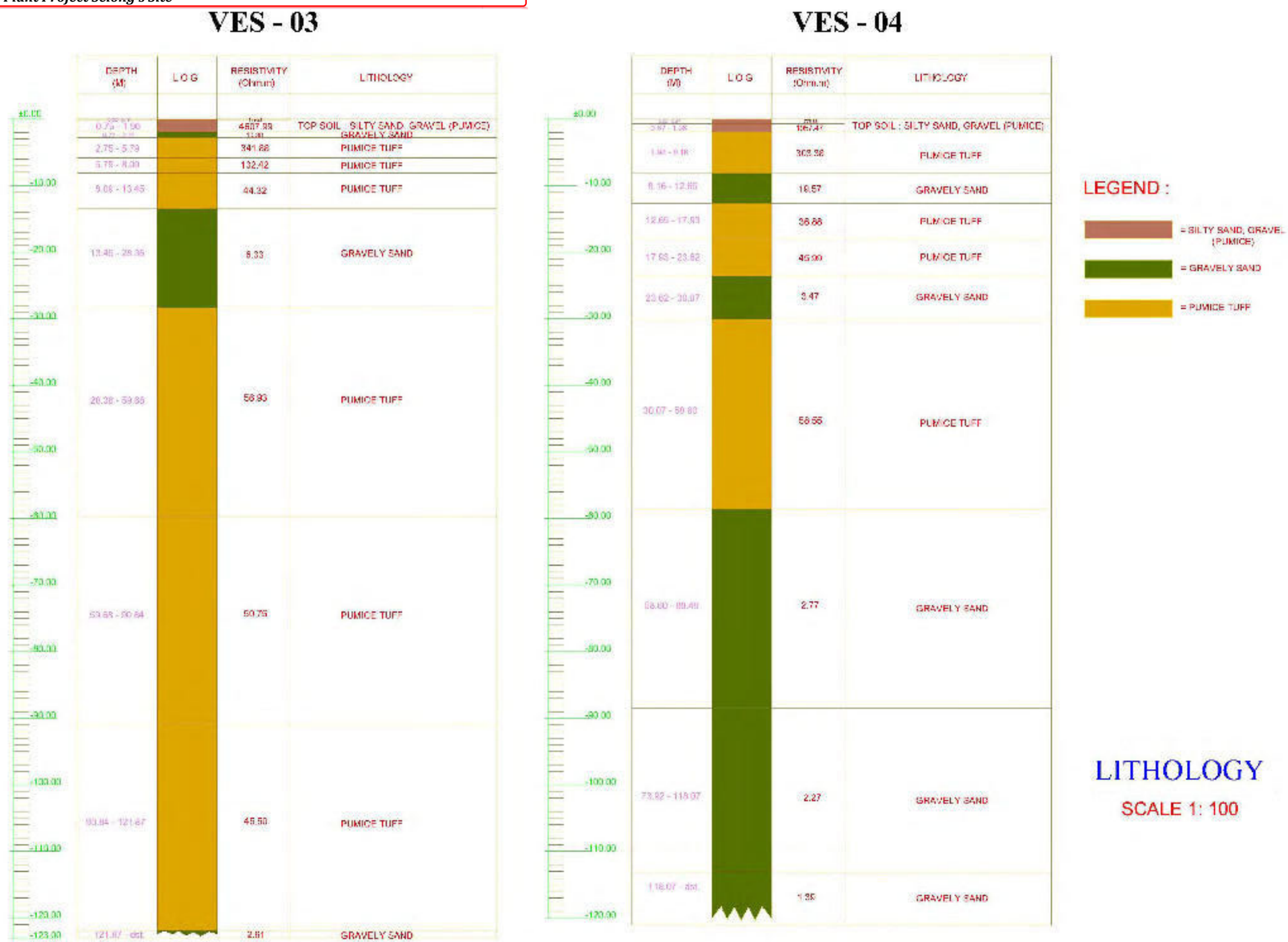
Stacking current electrode and potential electrode pegs



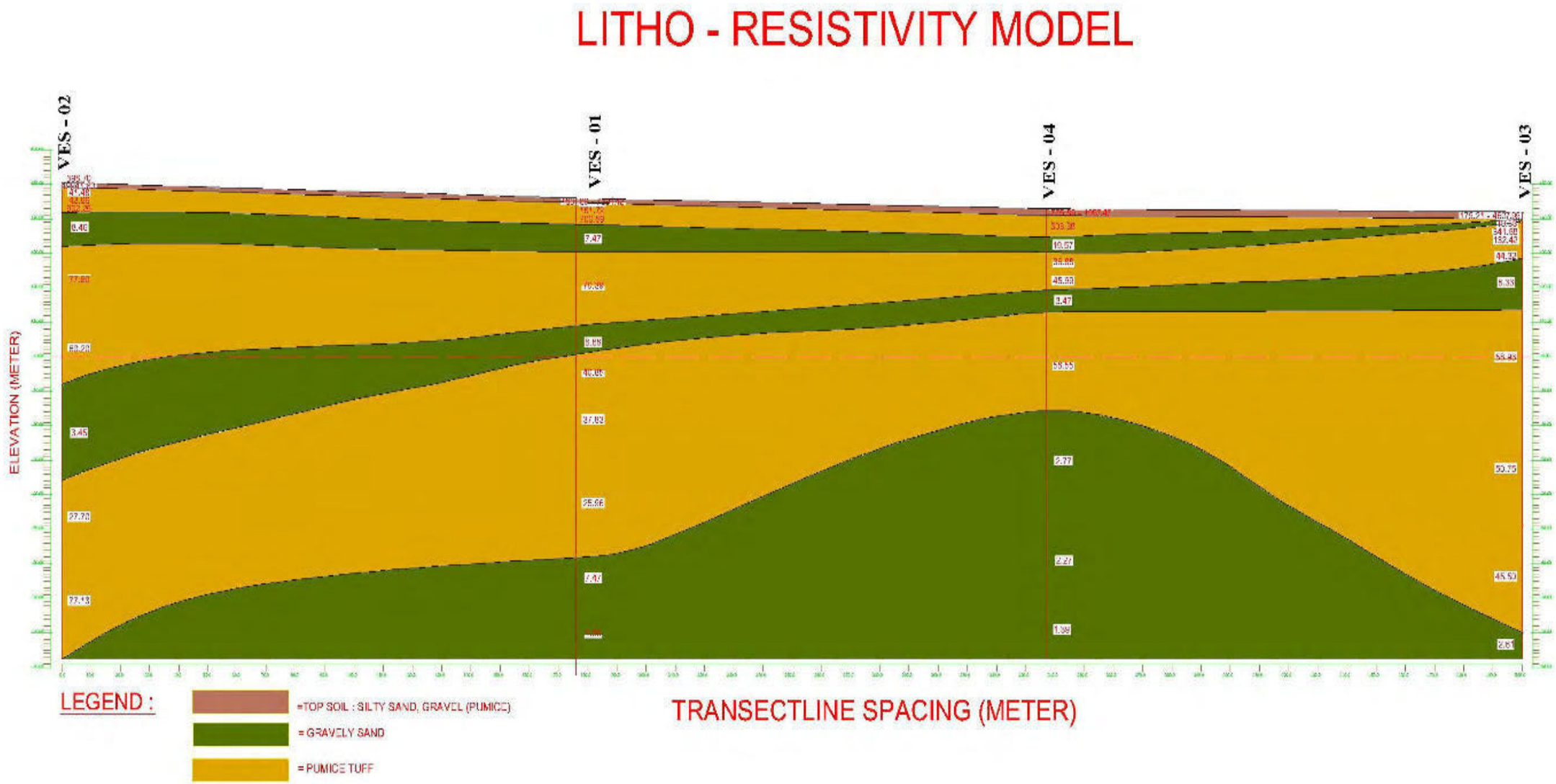
Track Direction of Geoelectrical Investigation



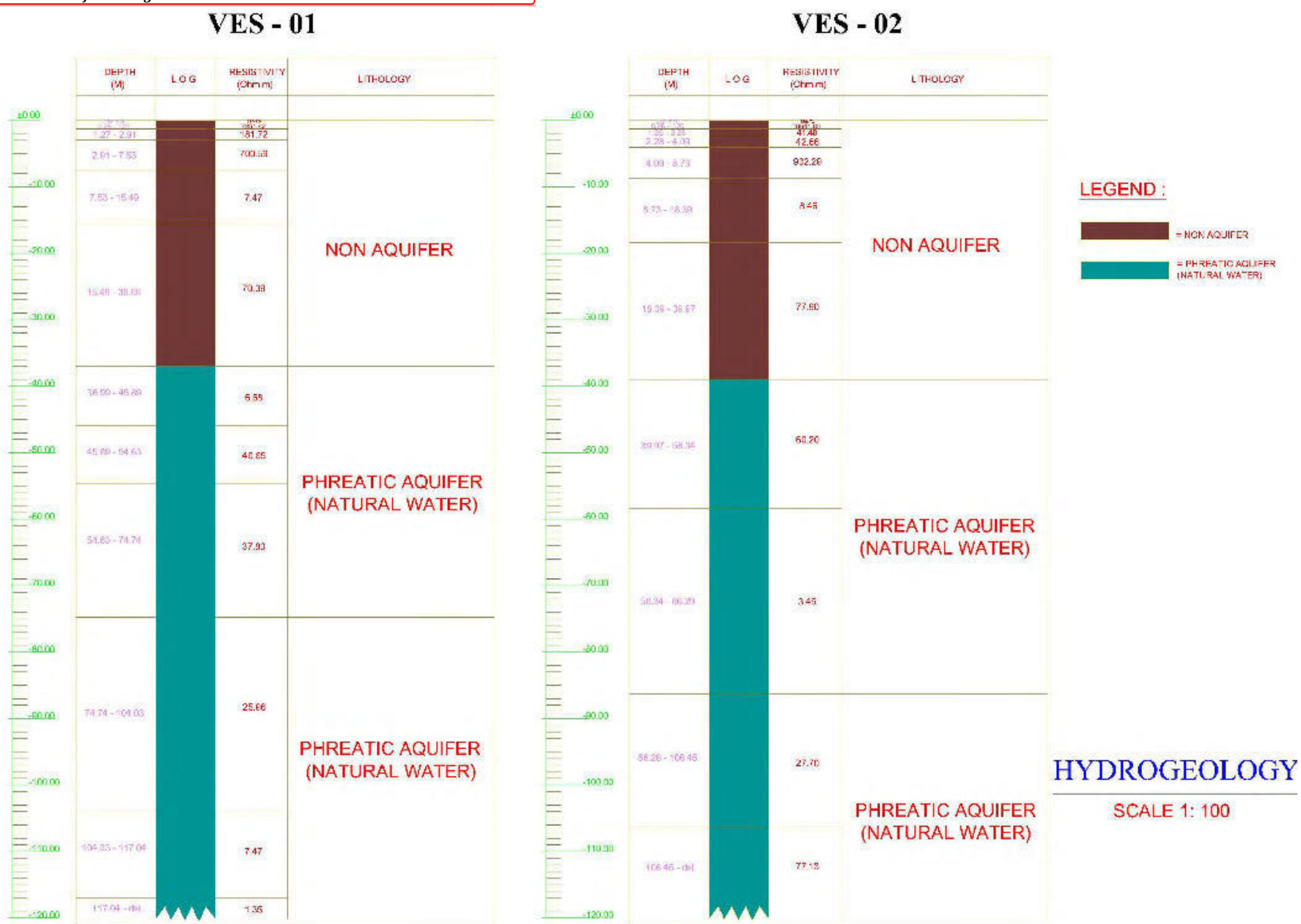
Lithological Cross Section Model VES - 01 and VES – 02



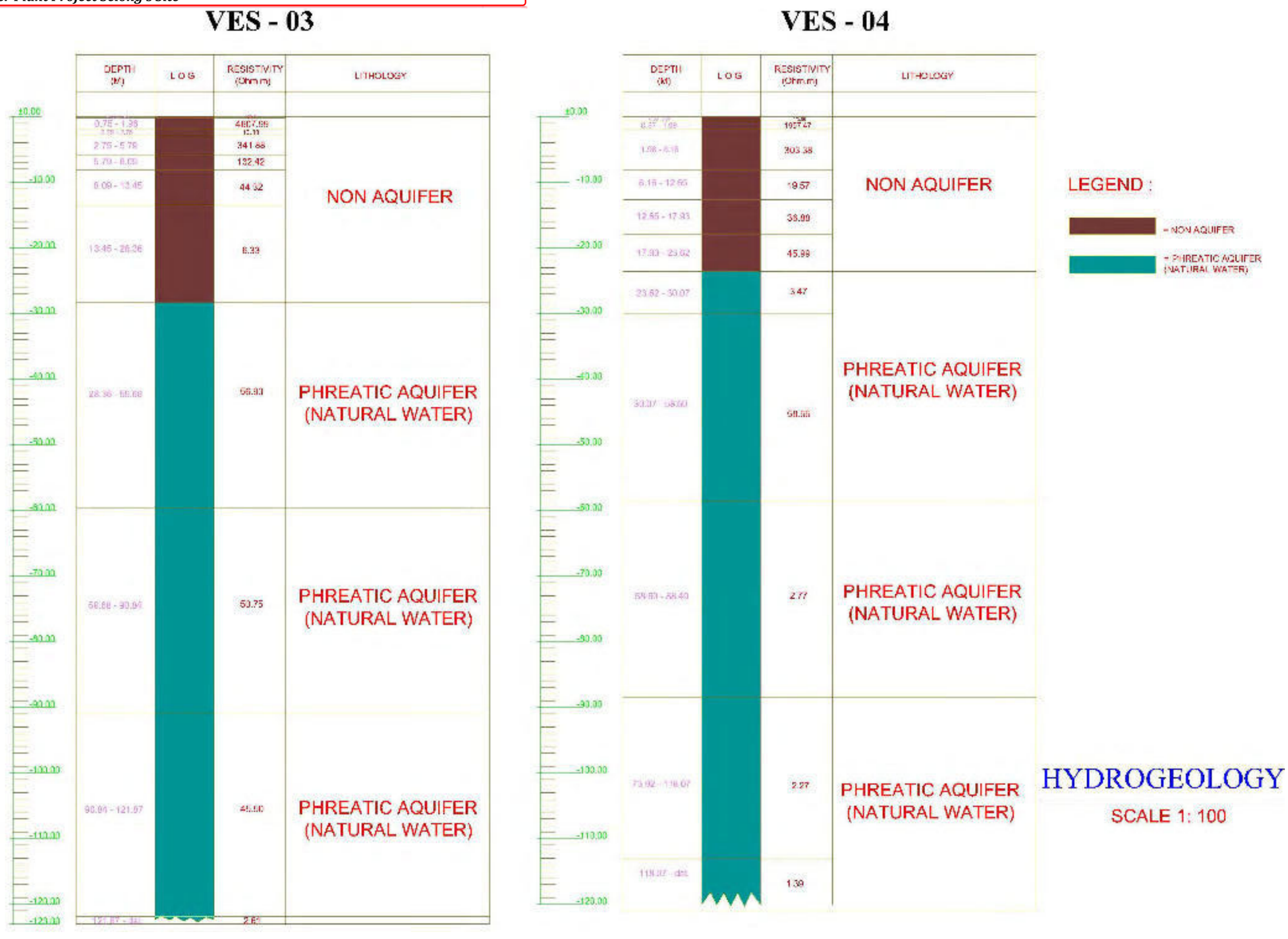
Lithological Cross Section Model VES - 03 and VES - 04



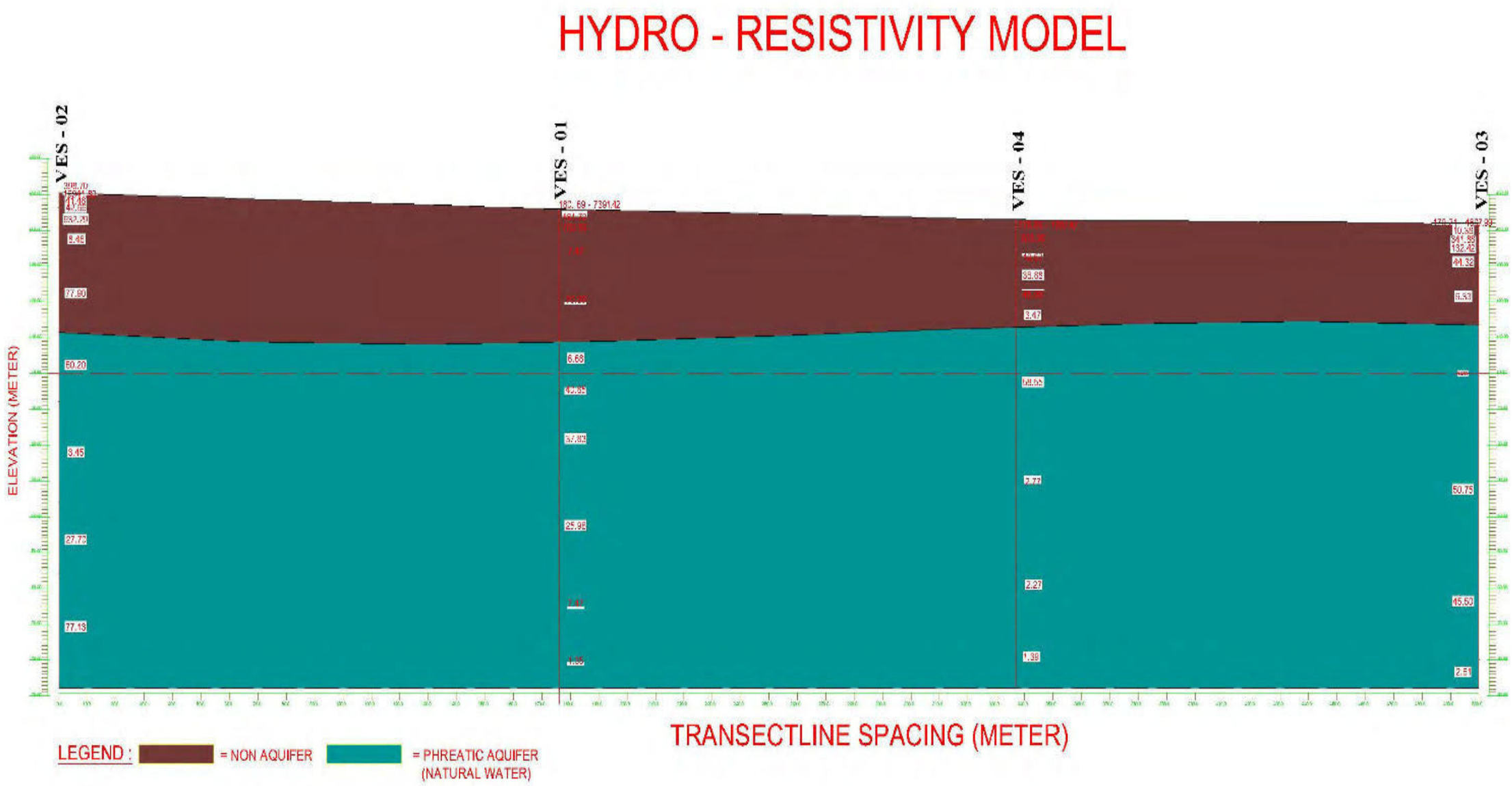
Lithology Resistivity Model VES 01 – VES 04



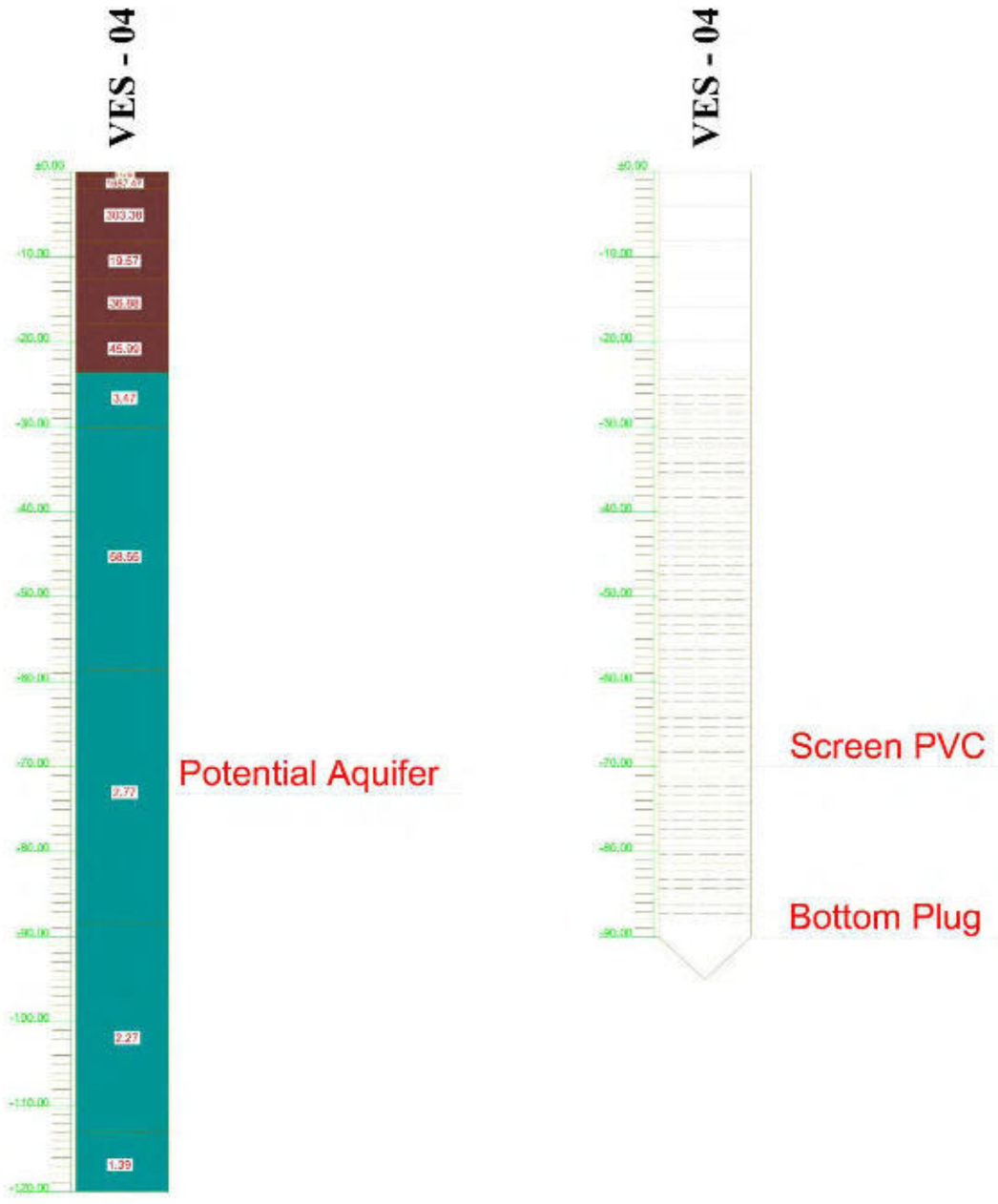
Hydrological Cross Section Model VES - 01 and VES – 02



Hydrological Cross Section Model VES - 03 and VES – 04



Hydrogeology Resistivity Model VES 01 – VES 04



Bore Design for VES - 04

REKAYASA BUMI KARYA
SOIL INVESTIGATION - GEOTECHNICAL ENGINEERING - GEOPHYSICS - MAPING
GIS - WATER RESOURCES DEVELOPMENT - HIDRO OCEANOGRAPHY - DESIGN
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5 MW SOLAR POWER PLANT PROJECT

Site : Sengkol, Central Lombok,
West Nusa Tenggara.

GEOELECTRICAL INVESTIGATION REPORT

DECEMBER
2017

PREFACE

No : 92/*Geoelectrical-Report*/XII/2017
Attachment : 1 Set
Subject : Geoelectrical Investigation Report

To

PT. PP (Persero) Tbk

In order to fulfill the requested from PT. PP (Persero) Tbk for Geoelectrical Test at Sengkol Solar Power Plant Site, Central Lombok, West Nusa Tenggara, CV. Rekayasa Bumi Karya has finished the test for 4 point location at the site. Geoelectrical test has been conducted on 16th – 17th December 2017. The result of the test can be figured in this report.

We hope this report can help the construction of the project as well. Thank you for your faith and cooperation to us.

Mataram, 31th December 2017
Director,

Sukandi, ST., M.Eng

Table of Contents

CHAPTER I
INTRODUCTION

1.1 Background

Geoelectrical investigation used to have information of the water ground conditions to fulfill the needs of raw water. Water ground locations are variative and spreading unequally, it depends on the subsurface geological conditions or the aquifer layer and the topographic site condition.

1.2 Aim and Purpose

The aim of this work to determine the aquifer layers which is contain the ground water.

The Purpose of this work to find the characteristics of aquifer layers so we can figure the depth and positions of aquifer layers.

1.3 Scope of Work

1. Geoelectrical investigation has been done on 4 points locations at Sengkol's Site.
2. Makes data interpretation from the 4 points locations.

1.4 Project Location

Geoelectrical site located at Sengkol, Central Lombok, West Nusa Tenggara.

1.5 Date of Test

The test was held on 16th – 17th December 2017.

CHAPTER 2
METHODOLOGY

2.1 Geoelectrical Investigation

Geoelectrical investigation is one of the geophysics method who studied electrical current flow inside the earth and how to detect it from the surface. The method that we used in this investigation is geoelectrical resistivity method. This geoelectrical resistivity investigation has been conducted to know the deployment and the differences of Soil layers below the surface vertically or horizontally. The characteristics of rocks resistivity depends on several factors such as rocks material, mineral content, rock electrolyte content. To interpret the rock classification we can combined the resistivity result and geological site condition. So we can determine which one of the rock layer as a aquifer.

2.1.1 Theory

Principal of resistivity geoelectrical survey is injected the electrical current into the earth through two electrodes. This electrical current caused the voltage for the both point. Due to the differences between the rock layers which is through by the electricity current, caused the difference of voltages between the both points. This difference can be measured from the surface by receiver (V) through two potential electrodes.

There are some electrode configurations for this resistivity test, such as *Wenner*, *Schlumberger*, *dipole-pole*, etc. The difference of configuration usage will be affected to geophysics parameter. Schlumberger configuration is used in this resistivity test at Pringgabaya Site. The span of cables were adjusted with site condition.

According to aim of the resistivity geoelectrical investigation, we have two ways to collected the data.

1. Mapping/traversing

   Electrodes span are determined how depth we know the variations of rock resistivity under the ground surface horizontally.

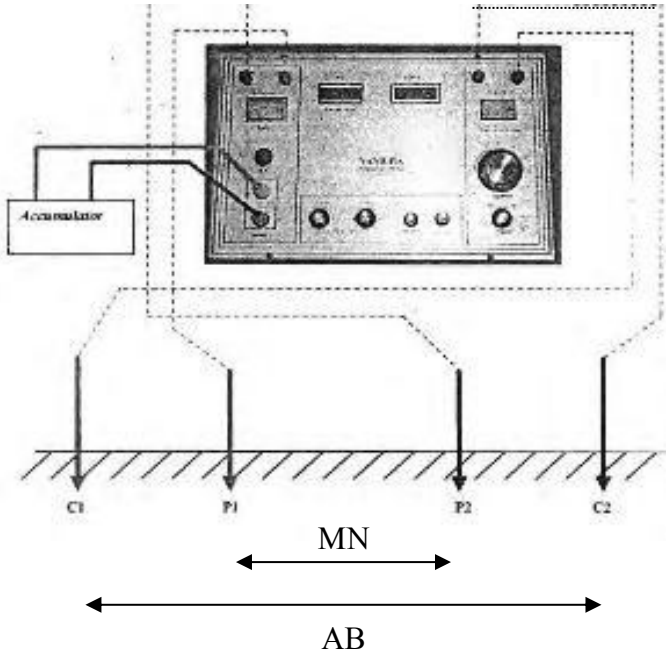
2. Vertical Electrical Sounding (VES)

To know the variations of rock resistivity under the ground surface vertically.

2.1.2 Equipment

1. Geoelectrical appliance type G-Sound Twin Probe
2. ACCU
3. Current electrode which is made from steel peg
4. Voltage electrode which is made from copper peg
5. Cable around 300 meters to connect voltage electrode to geoelectrical appliance
6. Cable around 300 meters to connect current electrode to geoelectrical appliance
7. Connecting battery cable to geoelectric appliance
8. Hammer
9. Meter
10. Data form
11. Stationery
12. Compass

2.1.3 Steps of Geoelectrical Measurement



Picture 2.1 Array of electrodes in Resistivity meter using Schlumberger Configuration

1. After all the appliance are completed, and then set it up with accumulator. The voltage on indicator transmitter will be 24 Volt and around the middle for incoming voltage is 12 volt.
2. Determined the measurement track for one sounding point. Gradually added electrode spacing for one sounding point. The space of electrode based on schlumberger configuration.
3. After set up the electrode at certain space, based on used configuration, connect the current electrode with current terminal. Current loop indicator will be deviated to right side at red area. Connect the potential electrode to potential terminal.
4. Calibrate the geoelectrical appliance to neutralize natural potential effect to measurement. On digital meter will be showed a certain number, arranged the compensator to zero using smooth potentiometer.
5. Injected the electrical current, turn the switch volt to position 1, the current can be increased by raising the voltage to higher position. When current reading is still good enough, there is no need to raise the voltage to avoid the broken fuse. After pushing start button, current value will be showed on display. Write down the current value and then push hold button and potential value will be showed at potential display. The current value used to be small at AB/2 position. If current value does not show up when the start button is injected, then check the battery. Recessive surface or over spacing electrode caused current value undetected.
6. Detected Current and potential value are written on measurement form.

2.2 Data Analysis

The data obtained from field investigation are potential current and potential difference on electrode composition with AB/2 and MN/2. Formula to analysis the value of pseudo-resistivity according Schlumberger electrode configuration rules are:

$$\rho\alpha = K\left(\frac{\Delta V}{I}\right)$$

$$K = \pi(AB^2 - MN^2)/4MN$$

In geoelectrical resistivity method, the earth is assumed having isotrophic homogeny characteristic, therefore the measurable resistivity is the real value of resistivity. It is not depending on electrode spacing. The earth consist from many of rock layers with different resistivity, therefore the measurable potential affected by those layers. The measurable resistivity value is not the resistivity for all rock layers. Especially for wide electrode space, the measurable pseudo-resistivity value called pseudo-resistivity value. Pseudo-resistivity value is resistivity value from equivalent fictive homogeny medium with reviewed plated medium.

For example, a reviewed plated medium consist of two rock layers with different resistivity value (ρ1 dan ρ2) consider as a layered homogeny medium which is having one pseudo-resistivity (ρα). ρα value plotted to AB/2 on transparent bilogaritma paper to be interpreted.

2.3 Interpretation

There are some methods to interpreted resistivity value data, one of the simplest way is curve matching, matching the field curve with standard curve, and then the result analysis with I*P2WIN* and *Progress* program software.

The resistivity value of each material as the subsurface lithological interpretation can be interpreted as the table below :

Table 2.1 Resistivity value of each materials

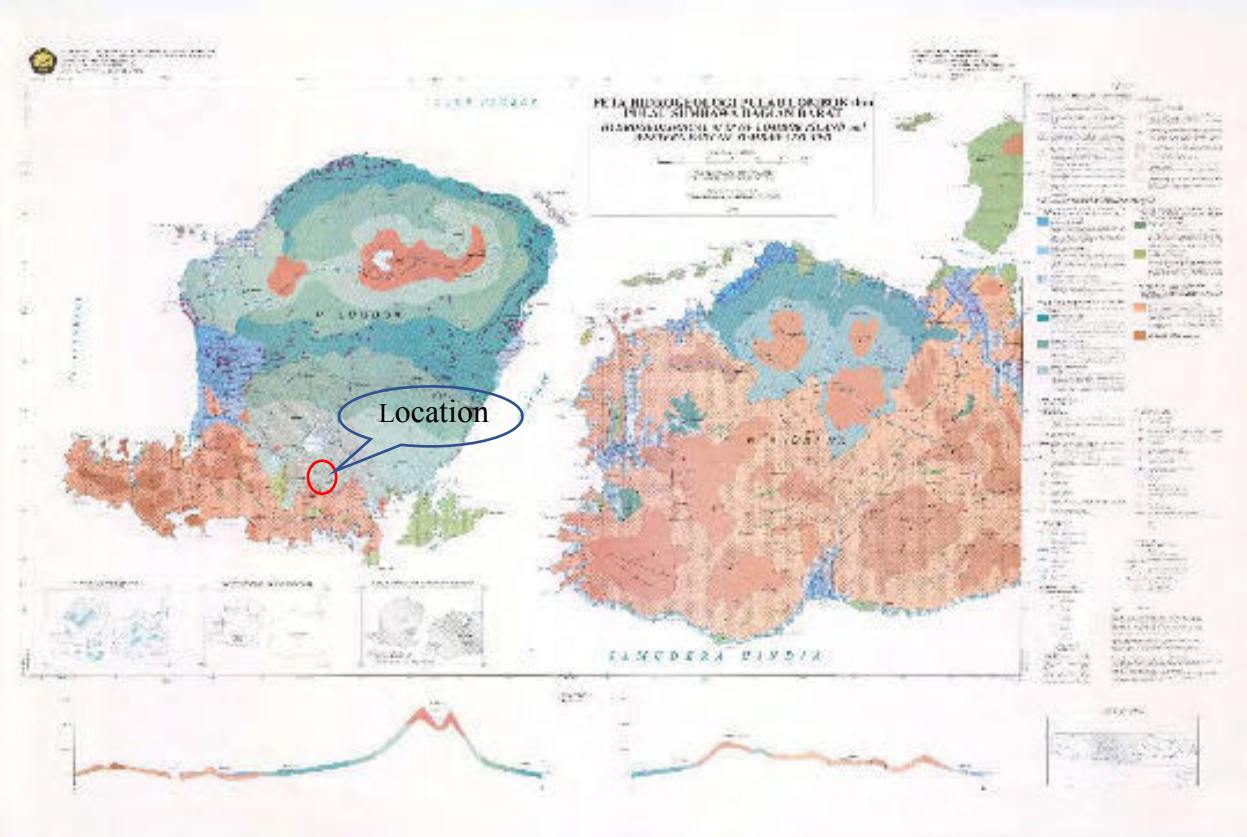
Material	Resistivity (Ohm-m)
Basalt	$1000 - 10^8$
Marble	$100 – 2.5x10^8$
Quartzite	$100 – 2x10^8$
Sandstone	8 – 4000
Shale	20 – 2000
Limestone	50 – 400
Clay	1 – 100
Alluvium	10 – 800
Ground Water	0.1 – 100
Salt Water	0.2
Conglomerate	100 – 500
Tuff	20 – 200
Andesite	100 – 2000
Granit	1000 – 10000
Chert, slate	200 – 2000

Source: Loke. M.H., 1997-2001

CHAPTER III
RESULTS

3.1 Hydrogeological Condition

The period of Rainfall in Lombok island is about 4 – 5 months (November – April) with rainfall intensity 900 – 2600 mm/year. The biggest intensity located at West Lombok and around Rinjani Mountain. The available amount of surface water at River Basin Unit around 2.50 – 3.50 Billion m^3 . Whereas for ground water potency in Lombok island around 0.9 billion m^3.



Picture 3.1 Hydrogeological Map of Lombok Island and Western Part of Sumbawa Island

Geoelectrical investigation located at Sengkol, Central Lombok, West Nusa Tenggara. This investigation aim for Power Solar Plant construction at Sengkol's Site. Based on Hydrogeological map , this investigation site is an area with Locally productive aquifer . Aquifer

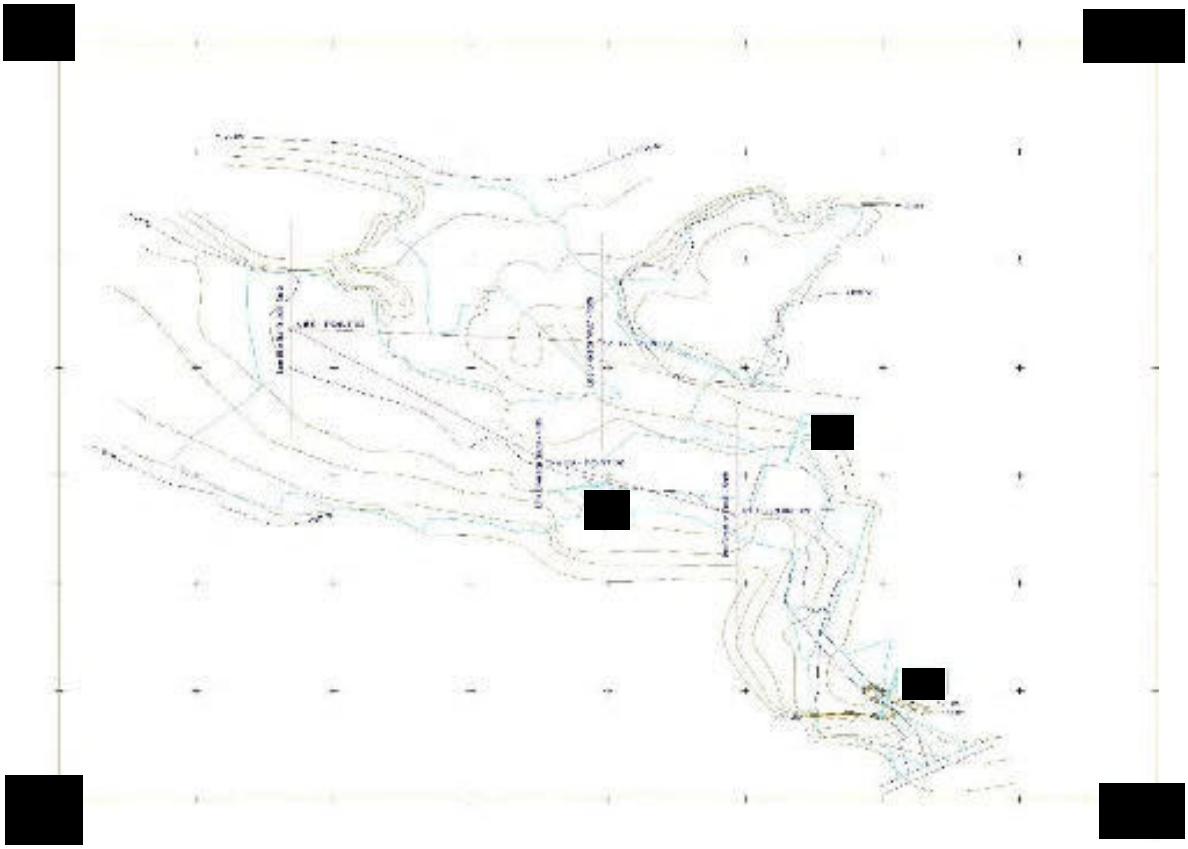
of largely varying transmissivity, generally no ground water exploitation by drilling due great to the ground water table, locally small spring can be captured. Geomorfologically this site is an hilly area with smooth relief, slope range from 5° - 15°. Meanwhile geologically this site is one of volcanic area with base rock which is consist of breccia, lava, and calcareous breccia.

3.2 Geoelectrical Interpretation Result

According to the field investigation result using schlumberger configuration, we use IP2WIN and Progress software to get the true resistivity value and subsurface depth.

Table 3.1 Location of Geoelectrical Investigations.

No.	Sounding Point	Coordinates	Elevation (m)
1	VES – 01	[redacted]	125
2	VES – 02	[redacted]	124
3	VES – 03	[redacted]	124.5
4	VES – 04	[redacted]	121.5



Picture 3.2 Geoelectrical Line Direction

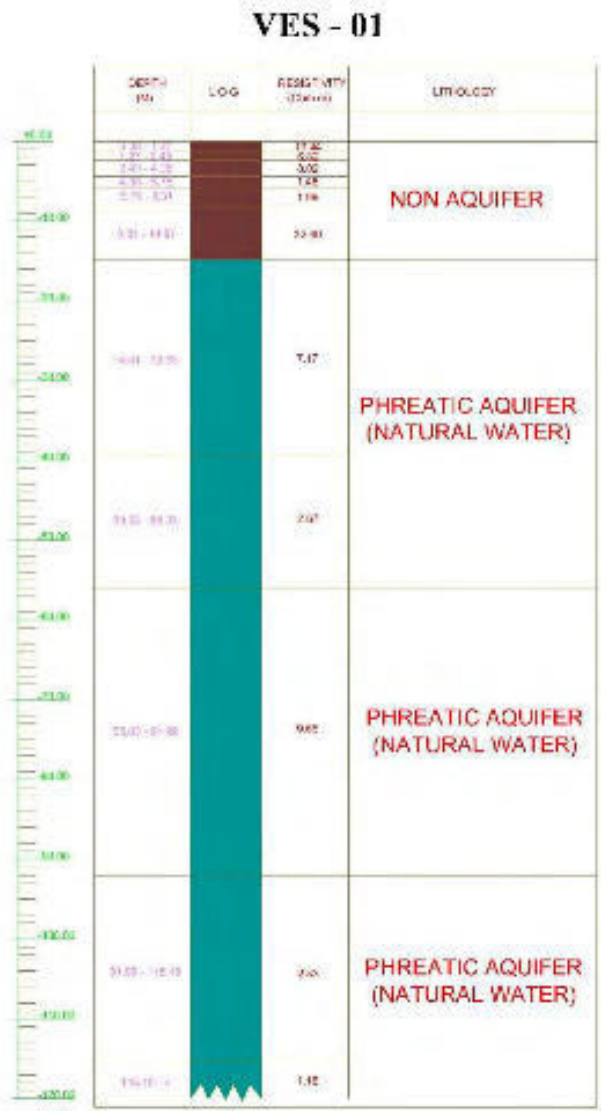
1. Vertical Electrical Sounding (VES) 01

Line Direction of VES – 01 from south to north. With elevation 125 m above the sea level. Subsurface of lithological cross section on the **table 3.2** and Hydrogeology cross section at **table 3.3.**

Table 3.2 Rock Layers Interpretation for VES – 01

Resistivity Model	Interpretation
	
	Top Soil : **(clay)** resistivity 19.44 Ohm.m, depth 0.0 – 1.27 m
	Sandy Clay : resistivity 6.82 – 8.02 Ohm.m, depth 1.27 – 4.38 m
	Clay : Resistivity 1.48 – 1.96 Ohm.m, depth 4.38 – 8.31 m
	Clayty Sand : Resistivity 32.9 Ohm.m, depth 8.31 – 14.81 m
	Sandy Clay : Resistivity 7.17 Ohm.m, depth 14.81 – 39.33 m
	Clay : Resistivity 2.67 Ohm.m, depth 39.33 – 56.03 m
	Sandy Clay : Resistivity 9.65 Ohm.m, depth 56.03 – 91.99 m
	Clay : Resistivity 2.83 Ohm.m, depth 91.99 – 115.19 m
	Clay : Resistivity 1.16 Ohm.m, depth 115.19 - ~ m

Table 3.3 Hydrogeological Cross Section

Resistivity Model	Interpretation
	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 14.81 – 115.19 m. Phreatic Aquifer layer located at Sandy Clay and Clay layer with resistivity value 1.16 – 32.9 Ohm.m.

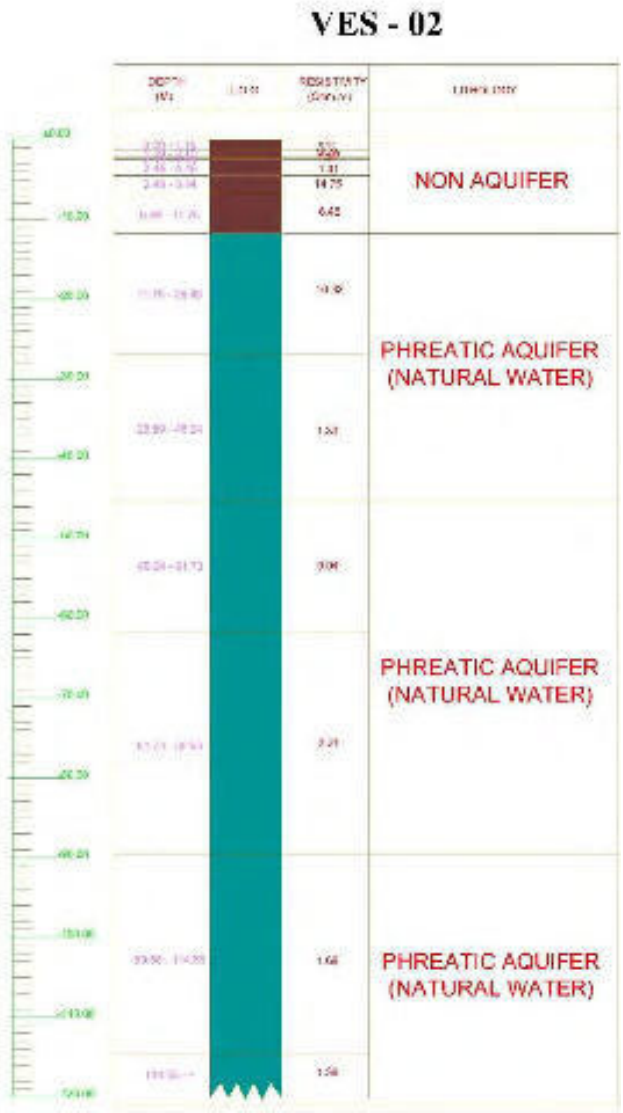
2. Vertical Electrical Sounding (VES) 02

Line Direction of VES – 02 from south to north. With elevation 124.5 m above the sea level. Subsurface of lithological cross section on the **table 3.4** and Hydrogeology cross section at **table 3.5.**

Table 3.4 Rock Layers Interpretation

Resistivity Model	Interpretation
	
	Top Soil : **Clay** resistivity 8.5 Ohm.m, depth 0.0 – 1.19 m
	Clayty Sand : Resistivity 30.98 Ohm.m, depth 1.19 – 2.10m
	Clay : Resistivity 1.41 Ohm.m, depth 2.10 – 4.48 m
	Sandy Clay : Resistivity 8.46 – 14.75 Ohm.m, depth 2.48 – 11.75 m
	Clayty Sand : Resistivity 16.32 Ohm.m, depth 11.75 – 26.89 m
	Clay : Resistivity 1.33 Ohm.m, depth 26.89 – 45.24 m
	Sandy Clay : Resistivity 9.04 Ohm.m, depth 45.24 – 61.73 m
	Clay : Resistivity 1.69 – 2.21 Ohm.m, depth 61.73 – 114.55 m
	Clay : Resistivity 1.39 Ohm.m, depth 114.55 - ~ m

Table 3.5 Hydrogeological Cross Section

Resistivity Model	Interpretation
	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 11.75 – 114.55 m. Phreatic Aquifer layer located at Clayty Sand, Sandy Clay, and Clay layer with resistivity value 1.33 – 16.32 Ohm.m.

3. Vertical Electrical Sounding (VES) 03

Line Direction of VES – 03 from south to north. With elevation 124.5 m above the sea level. Subsurface of lithological cross section on the **table 3.6** and Hydrogeology cross section at **table 3.7.**

Table 3.6 Rock Layers Interpretation

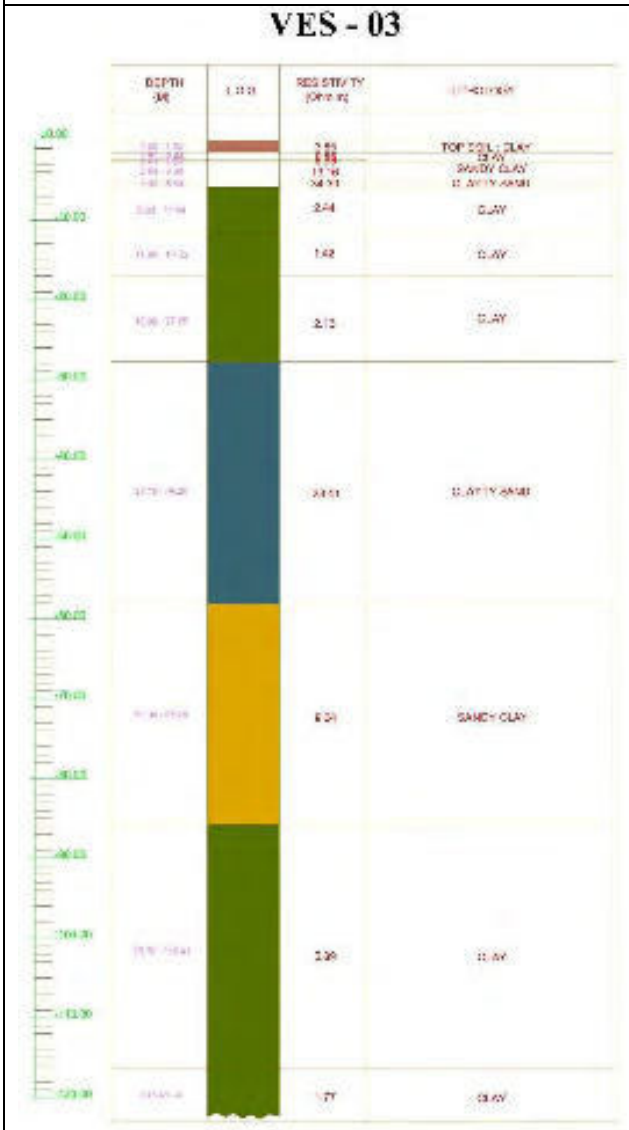
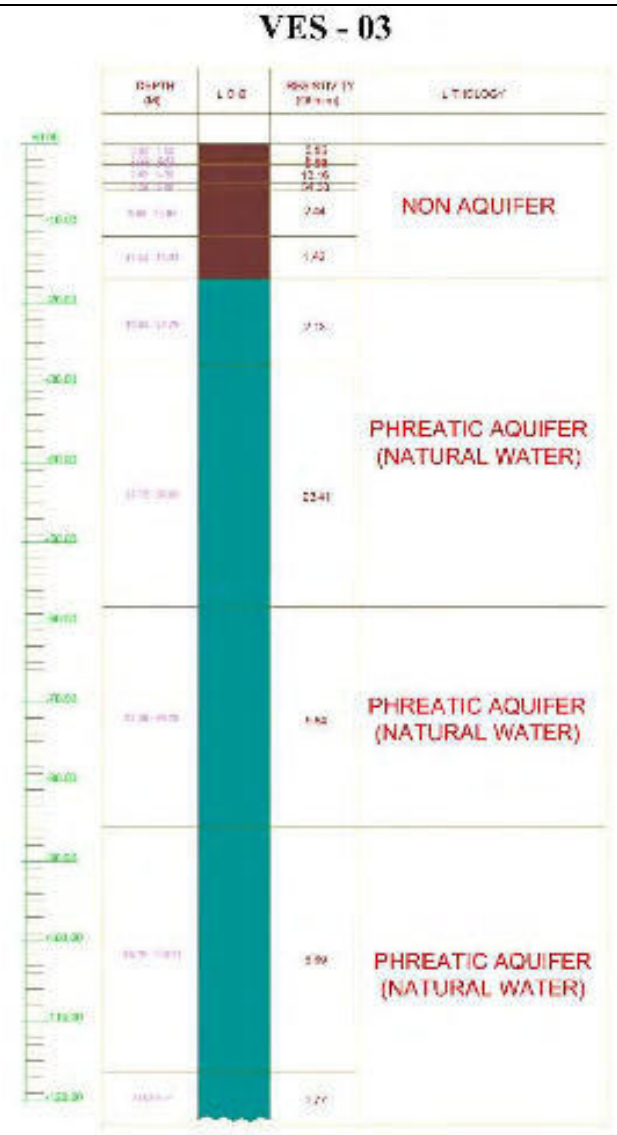
Resistivity Model	Interpretation
	
	Top Soil : **Clay** resistivity 0.55 – 3.85 Ohm.m, depth 0.0 – 2.63 m
	Sandy Clay : resistivity 13.16 Ohm.m, depth 2.63 – 3.39 m
	Clayty Sand : resistivity 34.30 Ohm.m, depth 3.39 – 5.89 m
	Clay : Resistivity 1.42 – 2.44 Ohm.m, depth 5.89 – 27.75 m
	Clayty Sand : Resistivity 23.41 Ohm.m, depth 27.75 – 58.06 m
	Sandy Clay : Resistivity 9.64 Ohm.m, depth 58.06 – 85.76 m
	Clay : Resistivity 5.89 Ohm.m, depth 85.76 – 116.41 m
	Clay : Resistivity 1.77 Ohm.m, depth 116.41- ~ m

Table 3.7 Hydrogeological Cross Section

Resistivity Model	Interpretation
	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 16.93 – 116.41 m. Phreatic aquifer layer located at Clay, Clayty Sand, and Sandy Clay layer with resistivity 1.77 – 23.41 Ohm.m.

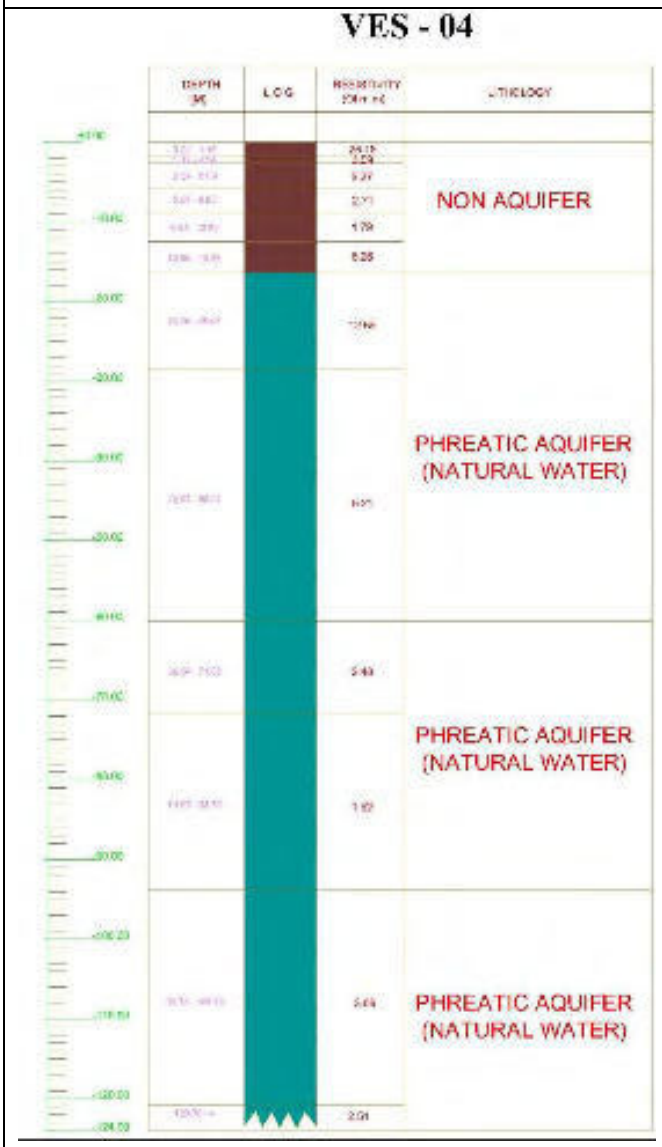
4. Vertical Electrical Sounding (VES) 04

Line Direction of VES – 04 from south to north. With elevation 121.5 m above the sea level. Subsurface of lithological cross section on the **table 3.8** and Hydrogeology cross section at **table 3.9.**

Table 3.8 Rock Layers Interpretation

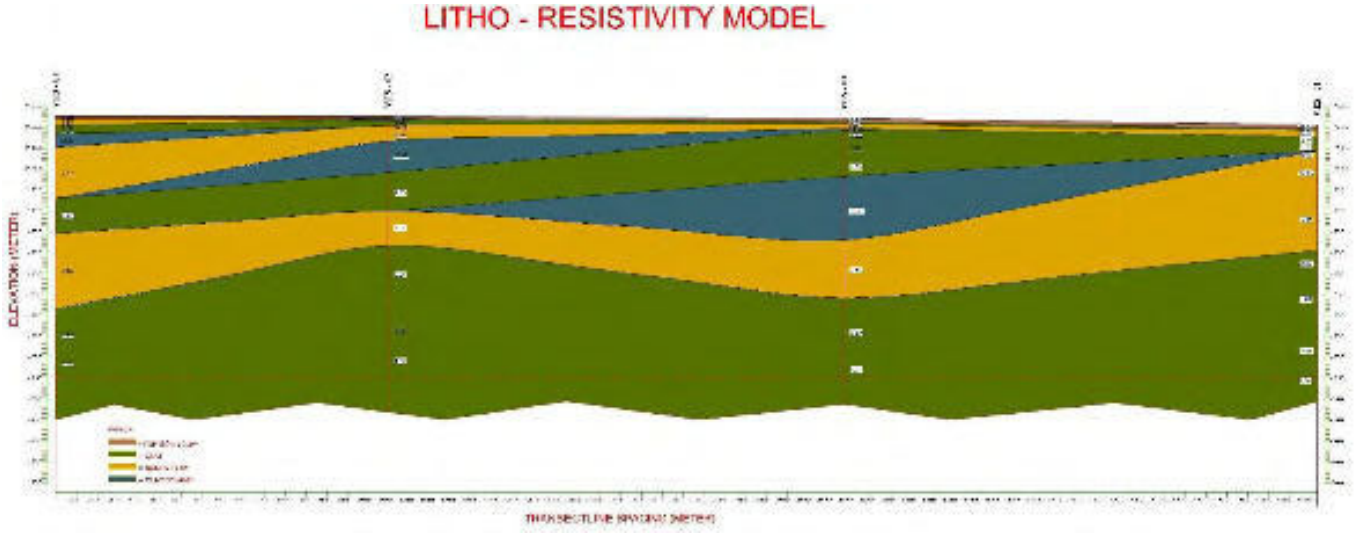
Resistivity Model	Interpretation
	
	Top Soil : **Clay** resistivity 3.59 – 26.18 Ohm.m, depth 0.0 – 2.54 m
	Sandy Clay : resistivity 5.27 Ohm.m, depth 2.54 – 5.69 m
	Clay : Resistivity 2.71 – 1.79 Ohm.m, depth 5.69 – 12.50 m
	Sandy Clay : Resistivity 6.21 – 12.65 Ohm.m, depth 12.50 – 60.04 m
	Clay : Resistivity 1.52 – 3.06 Ohm.m, depth 60.04 – 120.76 m
	Clay : Resistivity 2.51 Ohm.m, depth 120.76 - ~ m

Table 3.9 Hydrogeological Cross Section

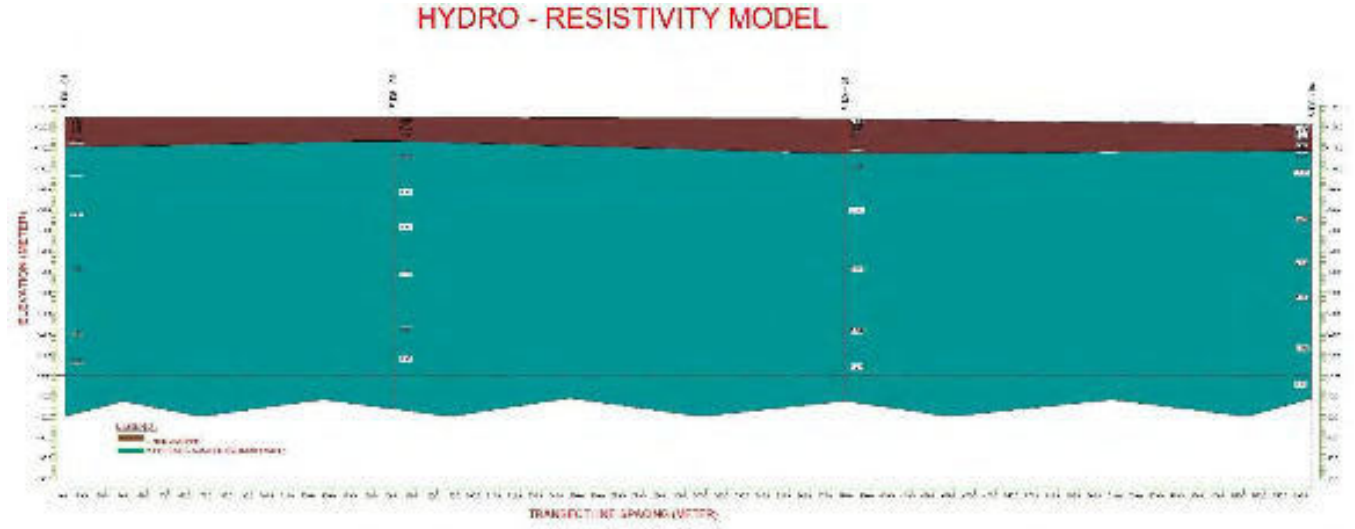
Resistivity Model	Interpretation
	From rock layers interpretation we assumed that phreatic aquifer layer (natural water) at depth 18.36 – 120.76 m. Phreatic aquifer layer located at Sandy Clay and Clay layer with resistivity value 1.52 – 12.65 Ohm.m.

5. Correlation VES 01 – 04 of Lithological and Hydrological Cross Section

Based on Correlation VES 01 – 04, and then lithological and hydrological cross section has been made. From lithological cross section the rock and soil layers can be figured as the **picture 3.3** below. Meanwhile, hydrological cross section can be figured at **Picture 3.4**

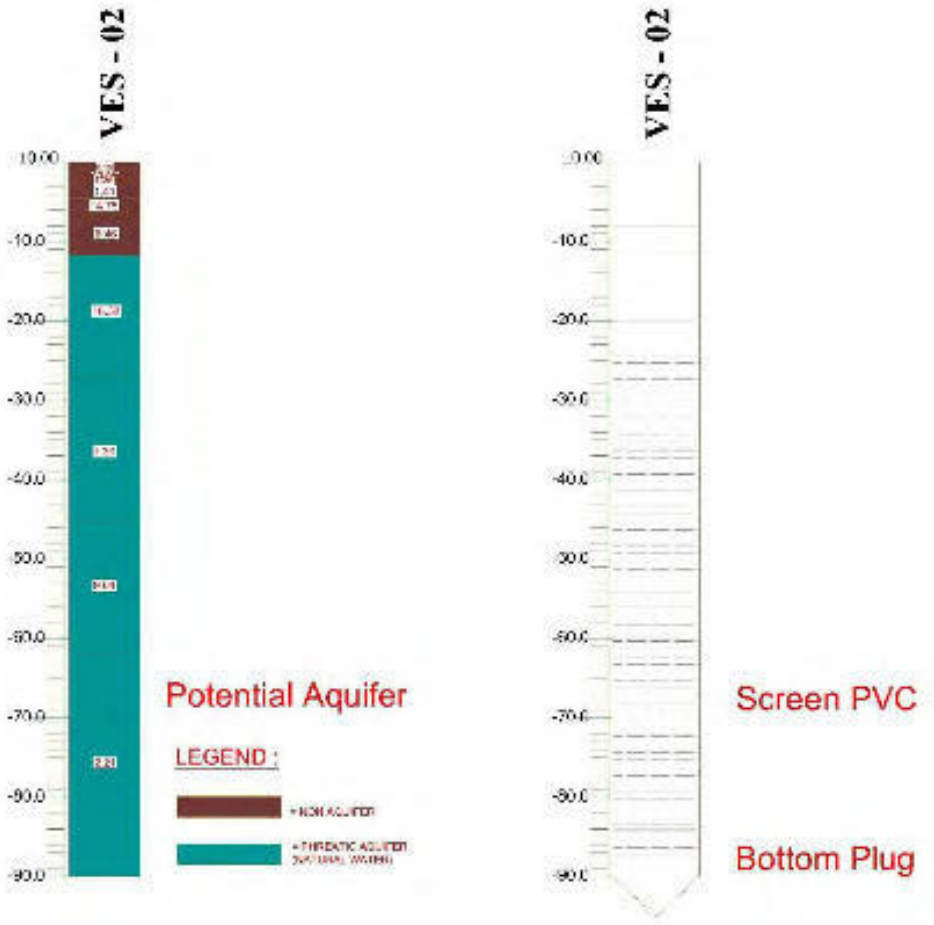


Picture 3.3 Correlation VES 01 – 04 of Lithological Cross Section



Picture 3.4 Correlation VES 01 – 04 of Hydrogeological Cross Section

If the drilling exploration will be done, the most potential water ground source on VES – 02. Bore design can be figured as picture below.



Picture 3.5 Bore Design

CHAPTER IV
CONCLUSION AND RECOMMENDATION

1. Conclusion

a. Geoelectric Investigation has been conducted on 16th – 17th December 2017. Total track of investigation is 4 points. Geoelectrical used Schlumberger method, and for data analysis used *IP2WIN* and *Progress* software.

b. The depth of ground water level at VES – 01 is 14.81 – 115.19 m. Phreatic Aquifer layer located at Sandy Clay and Clay layer.

c. The depth of ground water level at VES – 02 is 11.75 – 114.55 m. Phreatic Aquifer layer located at Clayty Sand, Sandy Clay, and Clay layer.

d. The depth of ground water level at VES – 03 is 16.93 – 116.41 m. Phreatic aquifer layer located at Clay, Clayty Sand, and Sandy Clay layer.

e. The depth of ground water level at VES – 04 is 18.36 – 120.76 m. Phreatic aquifer layer located at Sandy Clay and Clay layer.

2. Recommendation

To get more complete information about the ground water level, drilling exploration can be done at VES-01, VES-02, VES-03, and VES-04. The depth of drilling exploration should be done to 90 meters below subsurface. Based on resistivity value we found that potential aquifer (natural water) at depth up to 90 meters below the subsurface.

ATACHMENTS

Geoelectrical Data measurement at VES - 01

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	17.40	0.5	6.28	305.1	308.2	111	111
2	2	14.80	0.5	11.78	139.1	141	111.1	111.1
3	2.5	13.90	0.5	18.84	82.4	82.1	111	111.1
4	3	12.90	0.5	27.48	58.7	58.7	111.2	111.2
5	4	9.85	0.5	49.46	22	22.3	111.2	111.2
6	5	7.69	0.5	77.72	11.1	10.9	111.1	111.1
7	6	6.57	0.5	112.26	6	7	111.1	111
8	8	5.82	0.5	200.18	1.5	1.6	111	111
9	10	5.36	0.5	313.22	1.9	1.9	111	111
10	12	4.83	0.5	451.38	0.5	0.6	111	111
11	15	4.45	0.5	705.72	0.7	0.7	111.1	111.1
12	15	4.45	5	62.80	10.2	10.5	111	111
13	20	5.25	5	117.75	4.7	5.2	111	111
14	25	6.70	5	188.40	4	3.9	111	111
15	30	7.30	5	274.75	2.9	3	111	111
16	30	7.30	10	125.60	5.2	5.5	110.9	111
17	40	7.49	10	235.50	3.6	3.4	110	110
18	50	8.66	10	376.80	2.5	2.6	111	111
19	60	7.93	10	549.50	1.5	1.7	110.9	110.9
20	75	7.02	10	867.43	0.8	0.7	111	111
21	75	7.02	25	314.00	2	2.3	110.9	110.9
22	100	6.90	25	588.75	1.3	1.3	110.9	110.9
23	125	6.37	25	942.00	0.8	0.7	110.9	110.9
24	150	6.21	25	1373.75	0.5	0.5	110.6	110.6
25	150	6.21	45	714.35	0.7	0.6	110.5	110.4
26	175	5.12	45	997.82	0.3	0.3	110.9	110.9
27	200	4.38	45	1324.91	0.2	0.1	110.8	110.8
28	225	4.05	45	1695.60	0.4	0.4	110.9	110.9
29	225	4.05	65	1120.74	0.4	0.4	110.8	110.8
30	250	3.18	65	1407.57	0.2	0.3	110.8	110.8
31	275	3.11	65	1724.58	0.2	0.2	110.8	110.8
32	300	2.80	65	2071.80	0.2	0.1	110.9	110.9

Geoelectrical Data measurement at VES - 02

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	10.10	0.5	6.28	175.4	179.1	110.1	110.1
2	2	9.59	0.5	11.78	83.4	80.1	110.4	110.4
3	2.5	9.87	0.5	18.84	57.7	58	110.4	110.4
4	3	10.90	0.5	27.48	48	44.3	110.4	110.4
5	4	11.10	0.5	49.46	23.1	24.1	110.4	110.4
6	5	10.30	0.5	77.72	14.2	15.1	110.3	110.4
7	6	8.98	0.5	112.26	8.9	8.8	110.6	110.6
8	8	6.69	0.5	200.18	3.8	3.6	110.6	110.7
9	10	5.23	0.5	313.22	1.8	1.9	110.7	110.8
10	12	5.06	0.5	451.38	1.6	1.7	110.7	110.7
11	15	5.10	0.5	705.72	0.9	0.7	110.7	110.7
12	15	5.10	5	62.80	15.2	16.8	110.7	110.7
13	20	5.84	5	117.75	5.6	5.4	110.8	110.8
14	25	6.11	5	188.40	7.9	7.4	110.7	110.7
15	30	5.79	5	274.75	1.2	1.4	111.6	110.7
16	30	5.79	10	125.60	5.2	5	110.7	110.7
17	40	5.53	10	235.50	2.6	2.6	110.8	110.8
18	50	5.12	10	376.80	1.8	1.5	110.7	110.7
19	60	4.60	10	549.50	1.1	0.6	110.8	110.8
20	75	4.40	10	867.43	0.4	0.5	110.7	110.7
21	75	4.40	25	314.00	2.2	2.4	110.7	110.7
22	100	4.56	25	588.75	0.7	0.8	110.7	110.7
23	125	5.56	25	942.00	1	1	110.8	110.8
24	150	5.99	25	1373.75	0.7	0.7	110.7	110.7
25	150	5.99	45	714.35	1.3	1.4	111.6	111.6
26	175	5.93	45	997.82	0.9	0.7	110.7	110.7
27	200	5.80	45	1324.91	0.5	0.6	110.7	110.7
28	225	5.28	45	1695.60	0.2	0.3	110.7	110.7
29	225	5.28	65	1120.74	0.8	0.7	110.8	110.5
30	250	4.66	65	1407.57	0.3	0.4	110.7	110.7
31	275	4.40	65	1724.58	0.2	0.1	110.8	110.8
32	300	4.10	65	2071.80	0.1	0.2	110.8	110.8

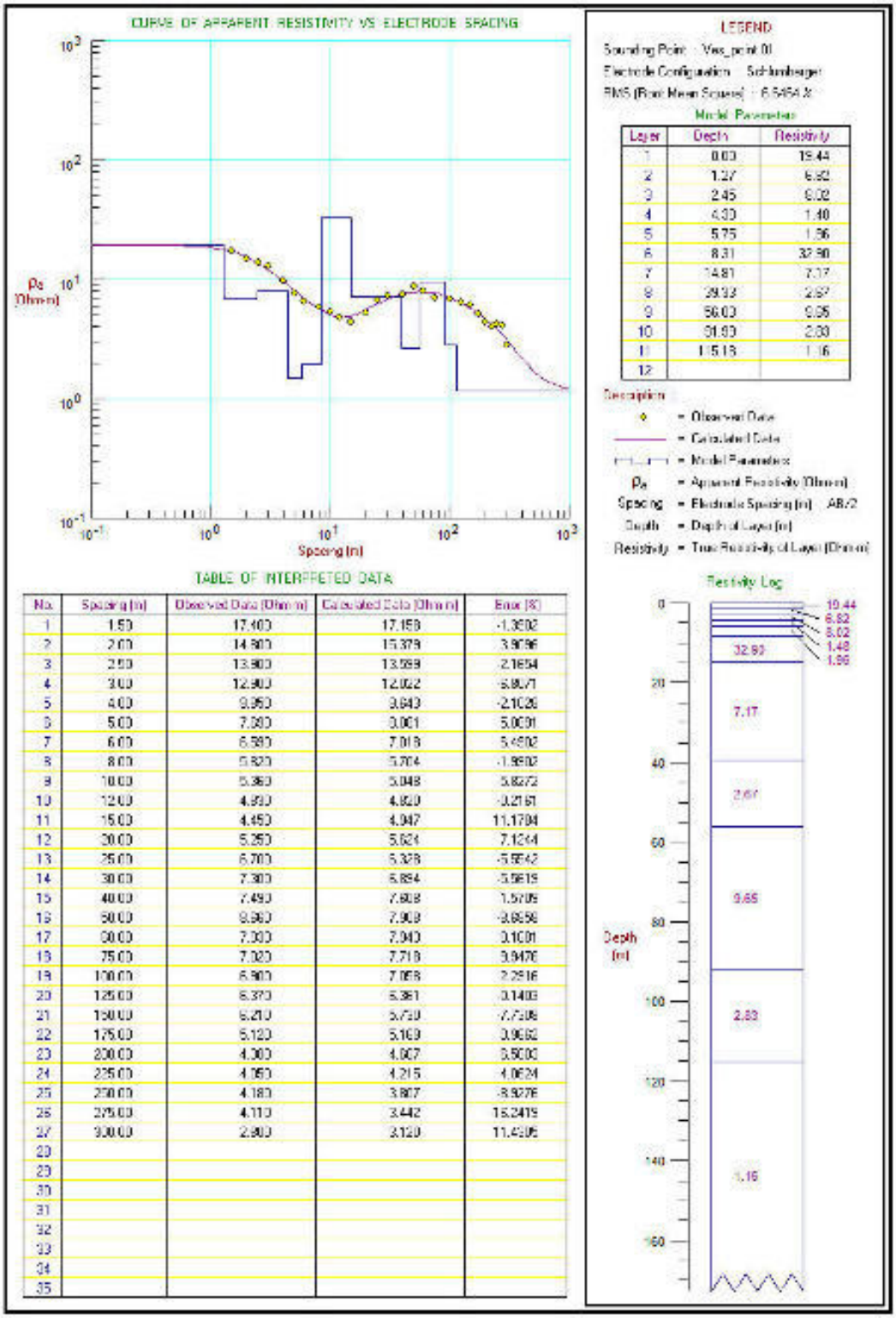
Geoelectrical Data measurement at VES - 03

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	3.25	0.5	6.28	55.9	57	109	109
2	2	3.31	0.5	11.78	30.9	30.5	109.1	109.1
3	2.5	2.96	0.5	18.84	17.3	17	109.1	109.1
4	3	2.62	0.5	27.48	8.3	8.4	109.2	109.2
5	4	2.42	0.5	49.46	5.5	5.2	109.3	109.3
6	5	2.33	0.5	77.72	3.1	3.1	109.2	109.2
7	6	2.47	0.5	112.26	2.5	2.3	109.2	109.2
8	8	3.03	0.5	200.18	1.7	1.6	109.1	109.1
9	10	3.45	0.5	313.22	1.3	1.1	109.1	109.1
10	12	3.92	0.5	451.38	1	0.9	109.2	109.2
11	15	4.60	0.5	705.72	0.5	0.7	109.3	109.3
12	15	4.60	5	62.80	7.7	7.4	109.2	109.2
13	20	5.65	5	117.75	5.3	5.2	109.2	109.2
14	25	5.86	5	188.40	3.2	3.3	109.2	109.2
15	30	5.73	5	274.75	2.1	2	109.5	109.5
16	30	5.73	10	125.60	5.6	5.4	108	108
17	40	5.28	10	235.50	2.9	2.1	108.5	108.5
18	50	4.36	10	376.80	1.3	1.2	108.1	108.1
19	60	4.19	10	549.50	0.3	0.4	108.5	108.5
20	75	4.42	10	867.43	0.5	0.5	108.3	108.3
21	75	4.42	25	314.00	2.5	2.4	108.5	108.5
22	100	5.39	25	588.75	1.5	1.3	108.3	108.3
23	125	6.37	25	942.00	0.3	0.5	108.5	108.5
24	150	6.78	25	1373.75	0.7	0.5	108.4	108.4
25	150	6.78	45	714.35	2	1.8	108.8	108.8
26	175	6.85	45	997.82	0.9	0.9	108.9	108.9
27	200	6.50	45	1324.91	0.5	0.5	108.6	108.6
28	225	6.24	45	1695.60	0.4	0.4	108.6	108.6
29	225	6.24	65	1120.74	1.2	1.3	108.7	108.7
30	250	6.18	65	1407.57	0.8	0.7	108.7	108.7
31	275	5.68	65	1724.58	0.4	0.4	108.7	108.7
32	300	5.23	65	2071.80	0.1	0.2	108.7	108.7

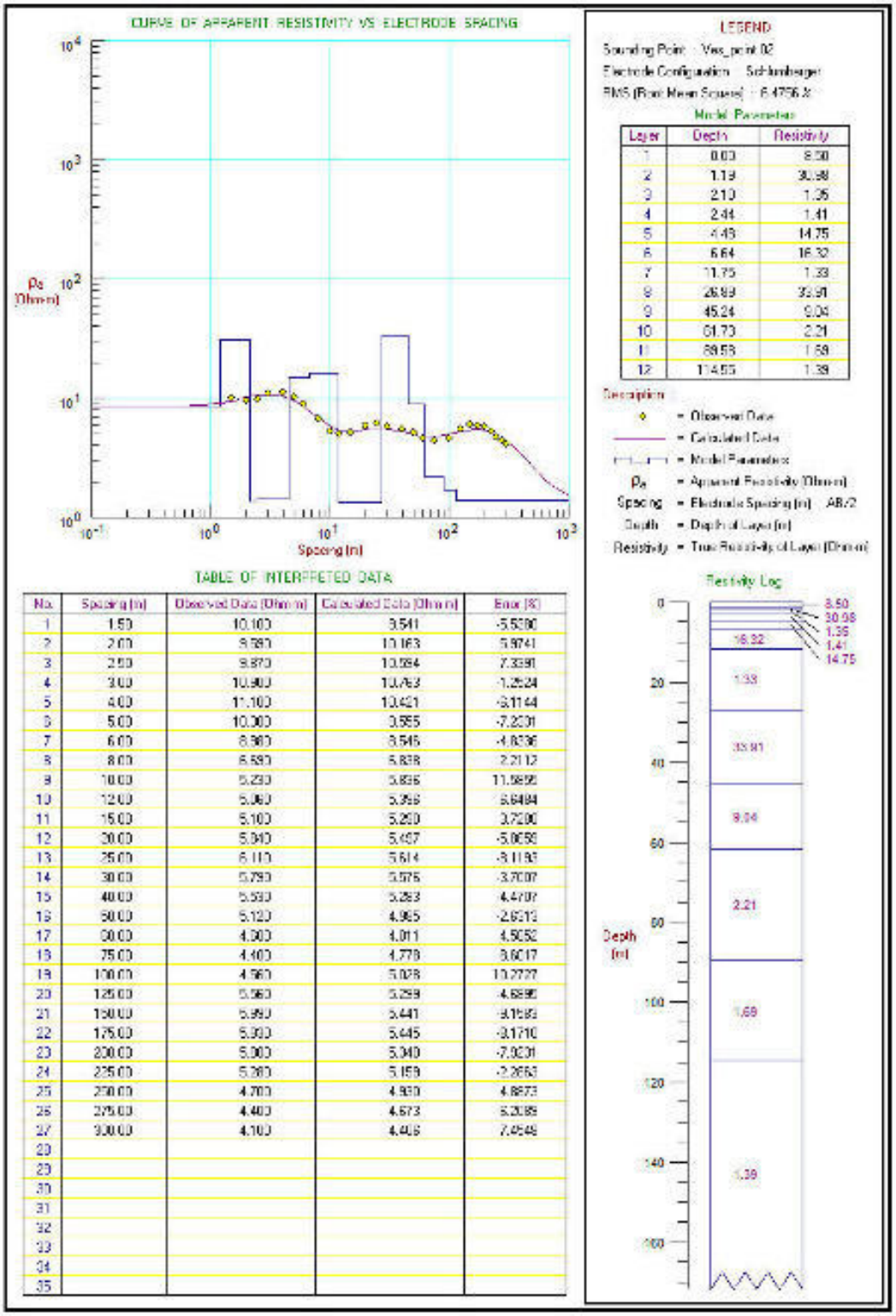
Geoelectrical Data measurement at VES - 04

No.	AB/2	Rho(Ohm-m)	MN/2	K	V1(mV)	V2(mV)	I1(mA)	I2(mA)
1	1.5	22.50	0.5	6.28	383.4	389.8	109.4	109.4
2	2	24.30	0.5	11.78	229.6	230.3	109.4	109.4
3	2.5	22.40	0.5	18.84	128	128.4	109.5	109.5
4	3	17.80	0.5	27.48	53.1	55.5	109.4	109.4
5	4	12.70	0.5	49.46	26.8	25.9	104.4	104.3
6	5	10.40	0.5	77.72	14.1	14.5	108	108
7	6	7.83	0.5	112.26	7.7	7.4	109.6	109.6
8	8	6.00	0.5	200.18	1.4	1.3	107.4	107.5
9	10	4.81	0.5	313.22	1.5	1.5	99	99
10	12	4.23	0.5	451.38	0.7	0.8	107.2	107.5
11	15	3.90	0.5	705.72	0.3	0.2	107.6	107.6
12	15	3.90	5	62.80	7.8	7.6	107.7	107.7
13	20	3.81	5	117.75	3.4	3.6	109.6	109.6
14	25	4.44	5	188.40	2.7	2.4	109.8	109.8
15	30	4.62	5	274.75	2.1	2.1	109.7	109.7
16	30	4.62	10	125.60	3.9	4	108.9	108.9
17	40	5.09	10	235.50	2.3	2.4	110.3	110.3
18	50	5.37	10	376.80	1.3	1.4	109.9	109.9
19	60	5.44	10	549.50	0.5	0.6	110.1	110.1
20	75	5.51	10	867.43	0.5	0.3	110.2	110.2
21	75	5.51	25	314.00	1.3	1.3	110.2	110.2
22	100	5.34	25	588.75	1	1	110.2	110.2
23	125	5.16	25	942.00	0.8	0.6	110.1	110.1
24	150	4.58	25	1373.75	0.3	0.4	110.1	110.1
25	150	4.58	45	714.35	3.2	3.1	110.1	110.1
26	175	4.01	45	997.82	0.7	0.8	110	110
27	200	3.62	45	1324.91	0.3	0.2	110.2	110.2
28	225	3.30	45	1695.60	0.1	0.1	110.2	110.2
29	225	3.30	65	1120.74	0.5	0.4	110.2	110.2
30	250	3.19	65	1407.57	0.3	0.2	110.2	110.2
31	275	3.13	65	1724.58	0.3	0.1	110.2	110.2
32	300	3.03	65	2071.80	0.1	0.1	110.2	110.2

VES – 01 Data Analysis by Progress software



VES – 02 Data Analysis by Progress software

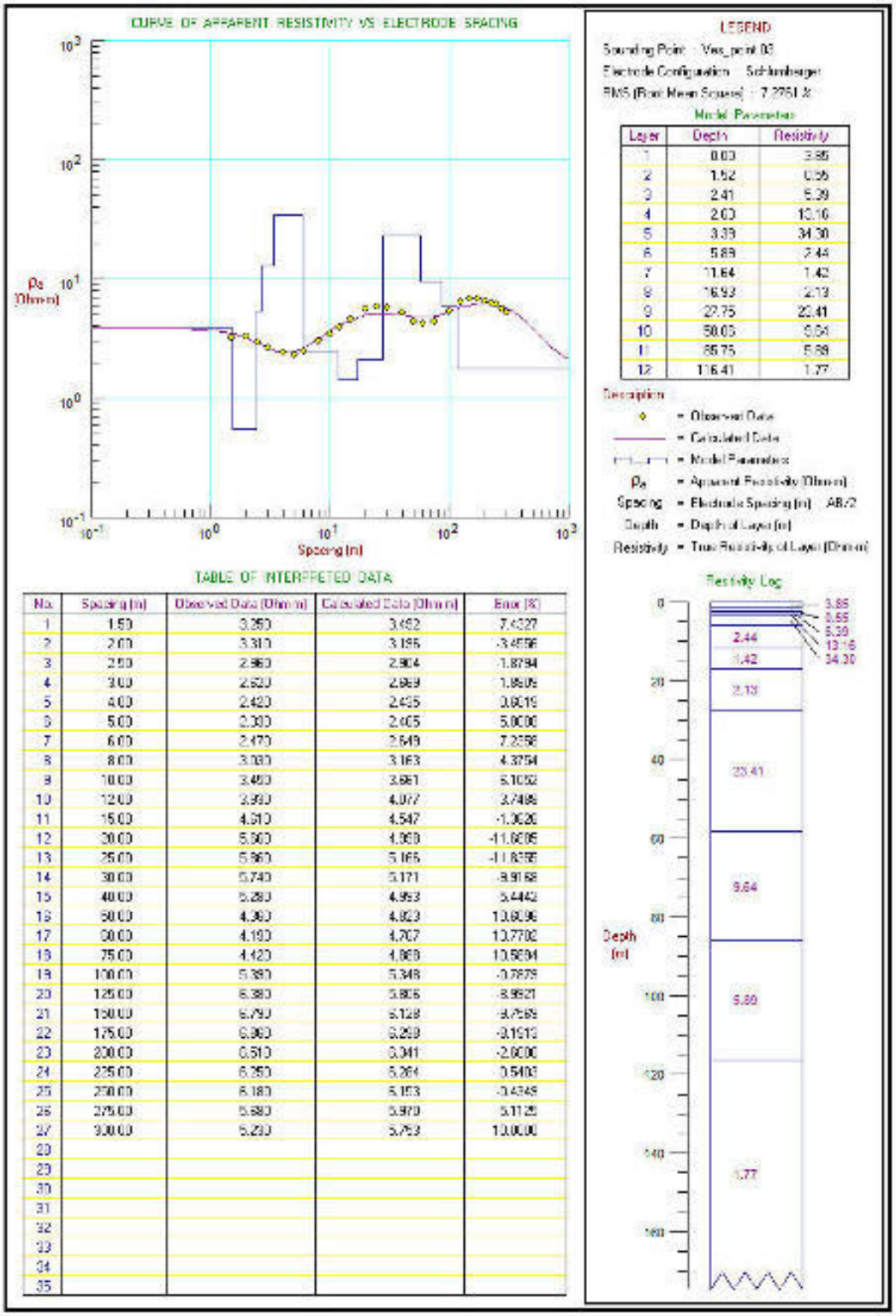


Layer	Depth	Resistivity
1	0.00	8.50
2	1.19	30.98
3	2.10	1.39
4	2.44	1.41
5	4.48	14.75
6	6.64	16.32
7	11.75	1.33
8	26.89	35.91
9	45.24	9.04
10	61.73	2.21
11	89.58	1.69
12	114.55	1.39

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	10.100	9.541	-5.5390
2	2.00	9.580	10.163	6.0741
3	2.50	9.870	10.594	7.3391
4	3.00	10.900	10.763	-1.2524
5	4.00	11.100	10.421	-6.1144
6	5.00	10.000	9.565	-7.2201
7	6.00	8.980	8.546	-4.8396
8	8.00	8.690	8.828	2.2112
9	10.00	8.230	8.836	11.5892
10	12.00	8.060	8.956	8.6484
11	15.00	8.100	8.269	3.7200
12	20.00	8.040	8.457	-5.0656
13	25.00	8.110	8.614	-8.1193
14	30.00	8.790	8.575	-3.7007
15	40.00	8.590	8.263	4.4707
16	50.00	8.120	8.965	-2.6213
17	60.00	8.300	8.011	4.5052
18	75.00	8.400	8.778	8.6017
19	100.00	8.960	8.028	10.2727
20	125.00	8.560	8.299	4.6895
21	150.00	8.990	8.441	-6.1583
22	175.00	8.900	8.445	-5.1710
23	200.00	8.900	8.340	-7.0031
24	225.00	8.280	8.159	-2.3663
25	250.00	8.700	8.930	4.8873
26	275.00	8.400	8.673	5.2089
27	300.00	8.100	8.446	7.0549
28				
29				
30				
31				
32				
33				
34				
35				

VES – 03 Data Analysis by Progress software

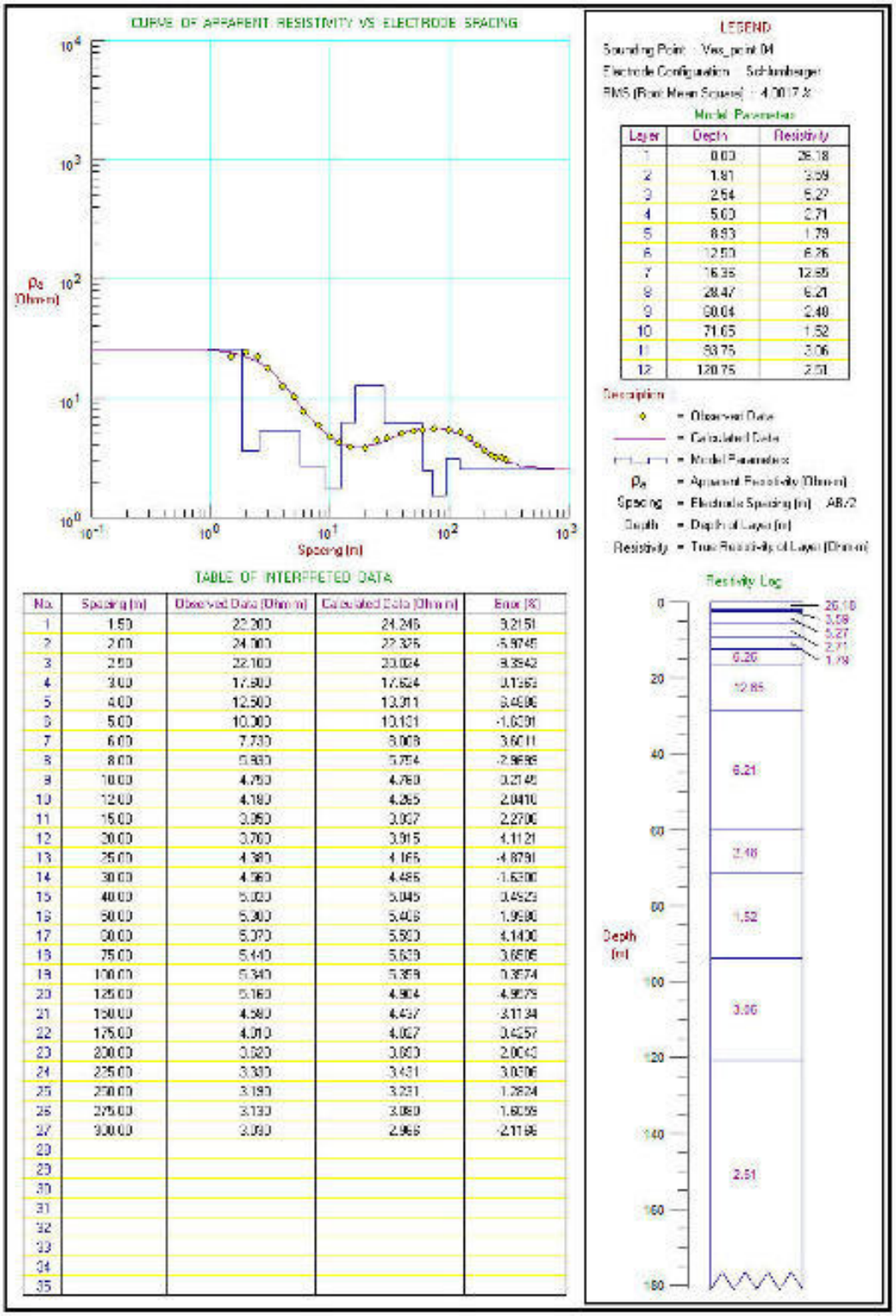


Layer	Depth	Resistivity
1	0.00	3.85
2	1.52	0.55
3	2.41	5.39
4	2.60	13.16
5	3.39	34.30
6	5.89	2.44
7	11.64	1.42
8	16.93	2.13
9	22.75	22.41
10	58.05	9.64
11	85.75	5.89
12	116.41	1.77

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	3.250	3.462	7.4027
2	2.00	3.310	3.195	-3.4556
3	2.50	2.960	2.904	-1.8784
4	3.00	2.620	2.669	1.8609
5	4.00	2.420	2.425	0.0019
6	5.00	2.300	2.405	5.0000
7	6.00	2.470	2.649	7.2256
8	8.00	3.030	3.163	4.3754
9	10.00	3.450	3.661	6.1052
10	12.00	3.990	4.077	3.7489
11	15.00	4.510	4.547	-1.3020
12	20.00	5.560	4.969	-11.6006
13	25.00	5.860	5.165	-11.8395
14	30.00	5.740	5.171	-9.9168
15	40.00	5.280	4.953	-6.4442
16	50.00	4.360	4.823	10.6096
17	60.00	4.190	4.707	12.7702
18	75.00	4.420	4.869	10.5894
19	100.00	5.380	5.348	-0.7979
20	125.00	6.380	5.805	-8.9921
21	150.00	6.790	6.128	-9.7569
22	175.00	6.960	6.259	-9.9193
23	200.00	6.510	6.341	-2.6000
24	225.00	6.250	6.284	0.5403
25	250.00	6.180	6.153	-0.4349
26	275.00	5.980	5.970	0.1125
27	300.00	5.290	5.753	10.0000
28				
29				
30				
31				
32				
33				
34				
35				

VES – 04 Data Analysis by Progress software



Sengkol Solar Power Plant site for Geoelectrical investigation

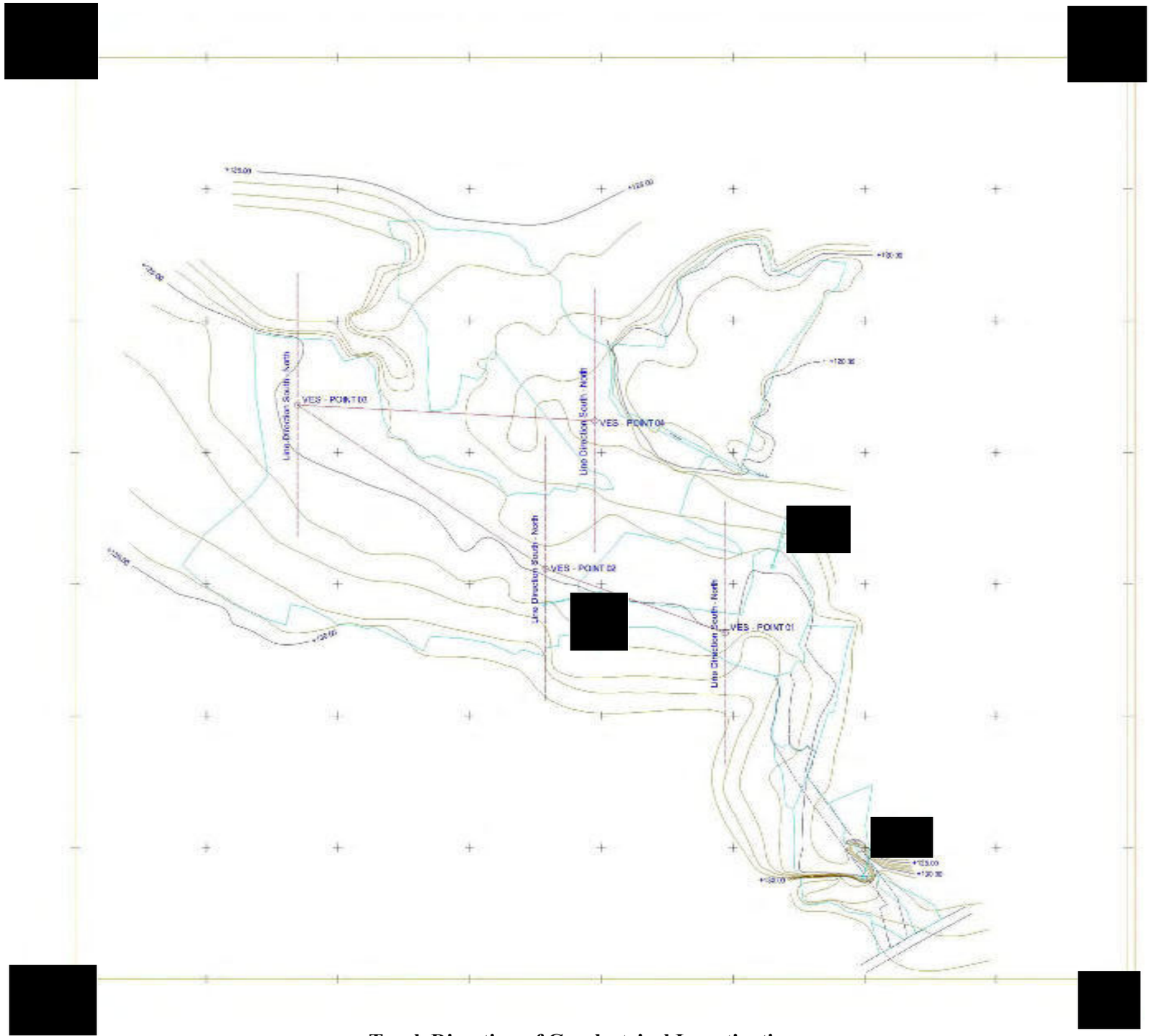
Geoelectrical investigation process

Geoelectrical investigation process

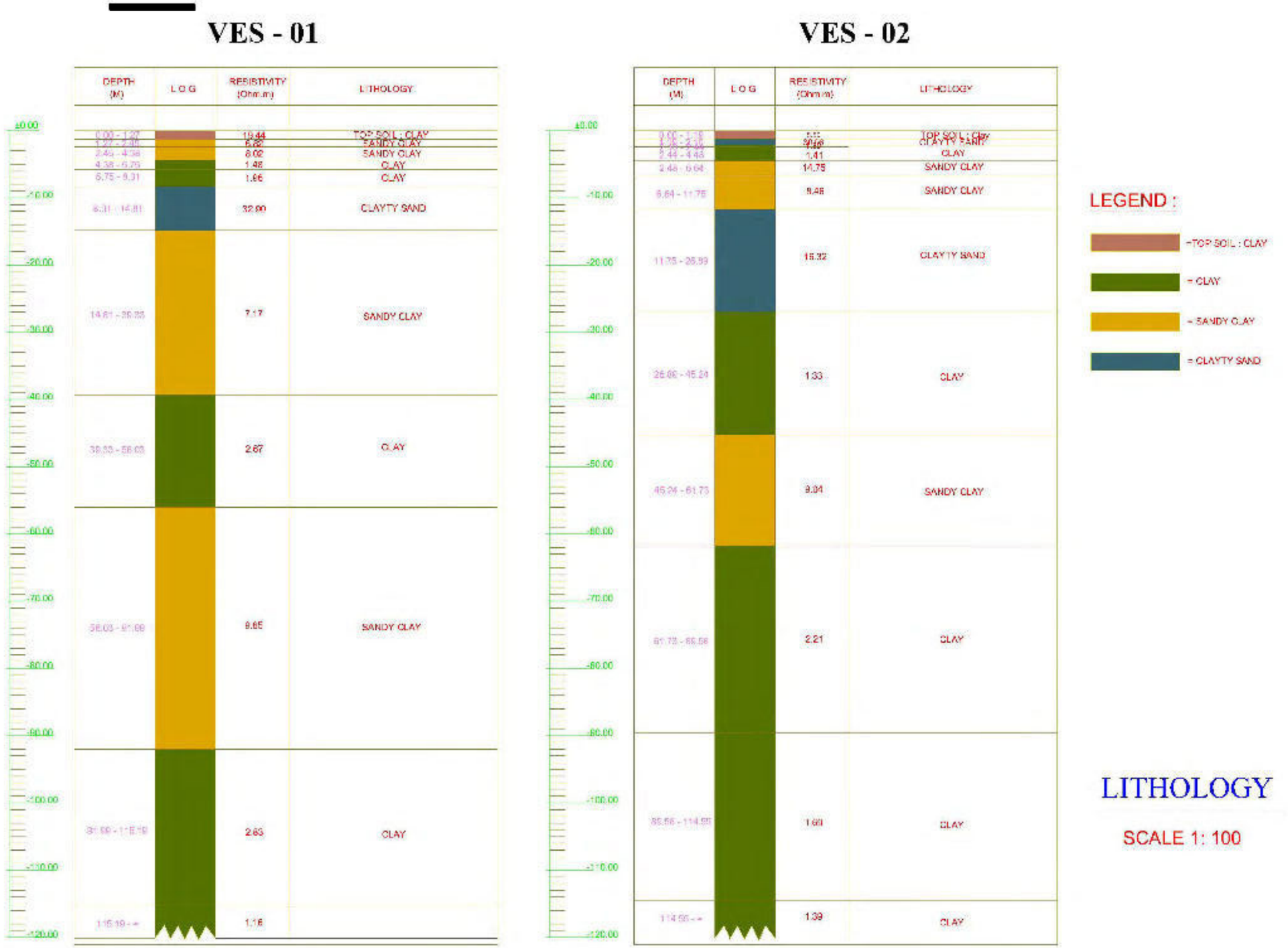
Geoelectrical investigation process

Geoelectrical investigation process

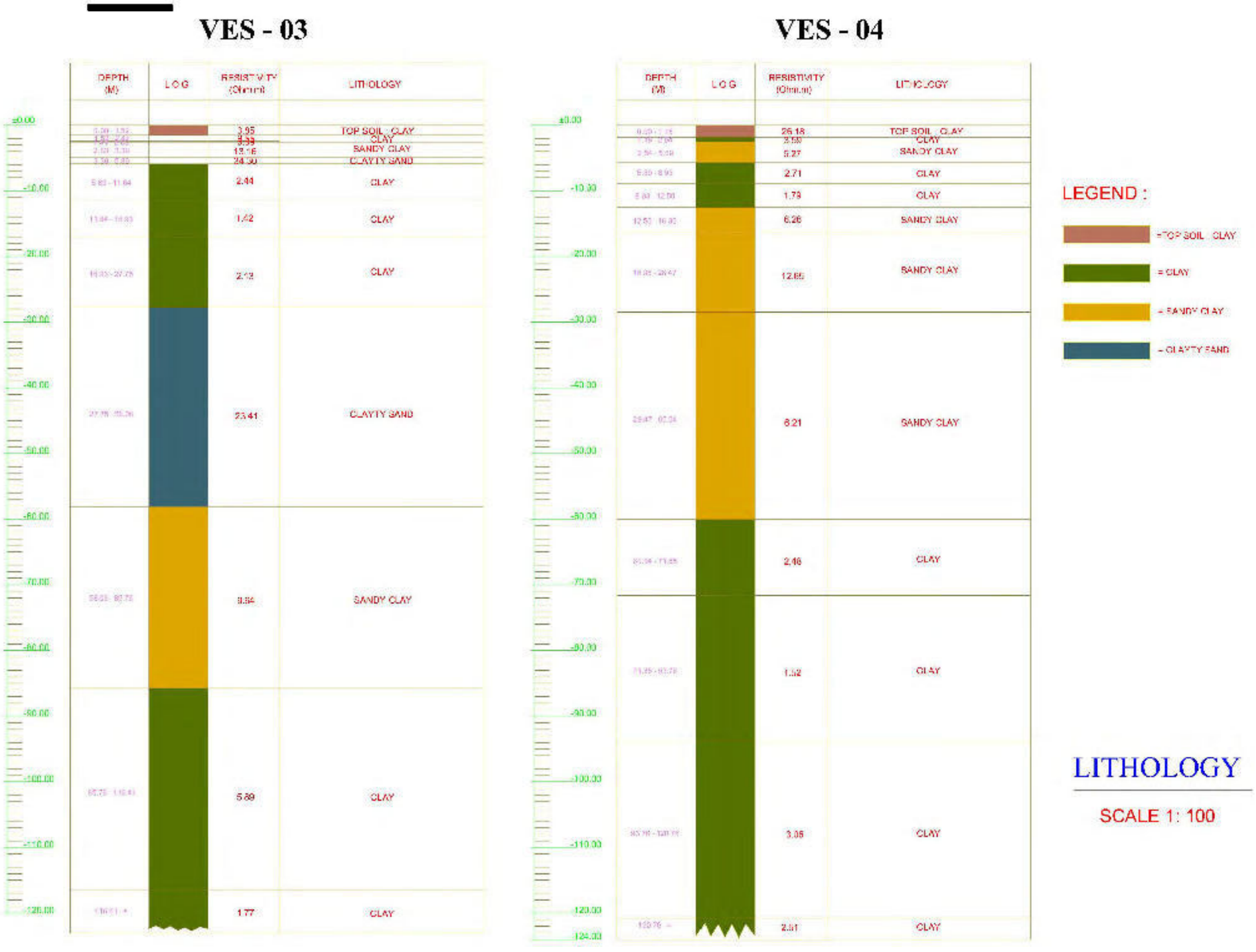
Stacking current electrode and potential electrode pegs



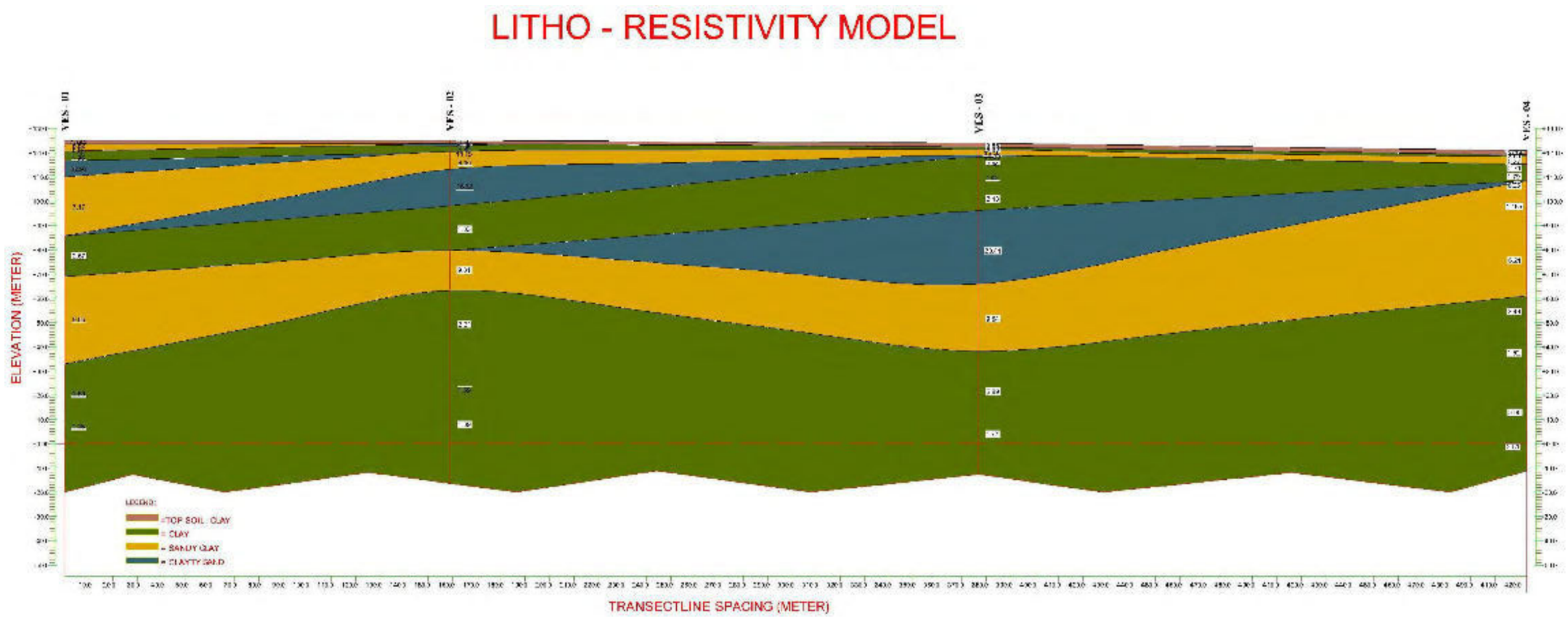
Track Direction of Geoelectrical Investigation



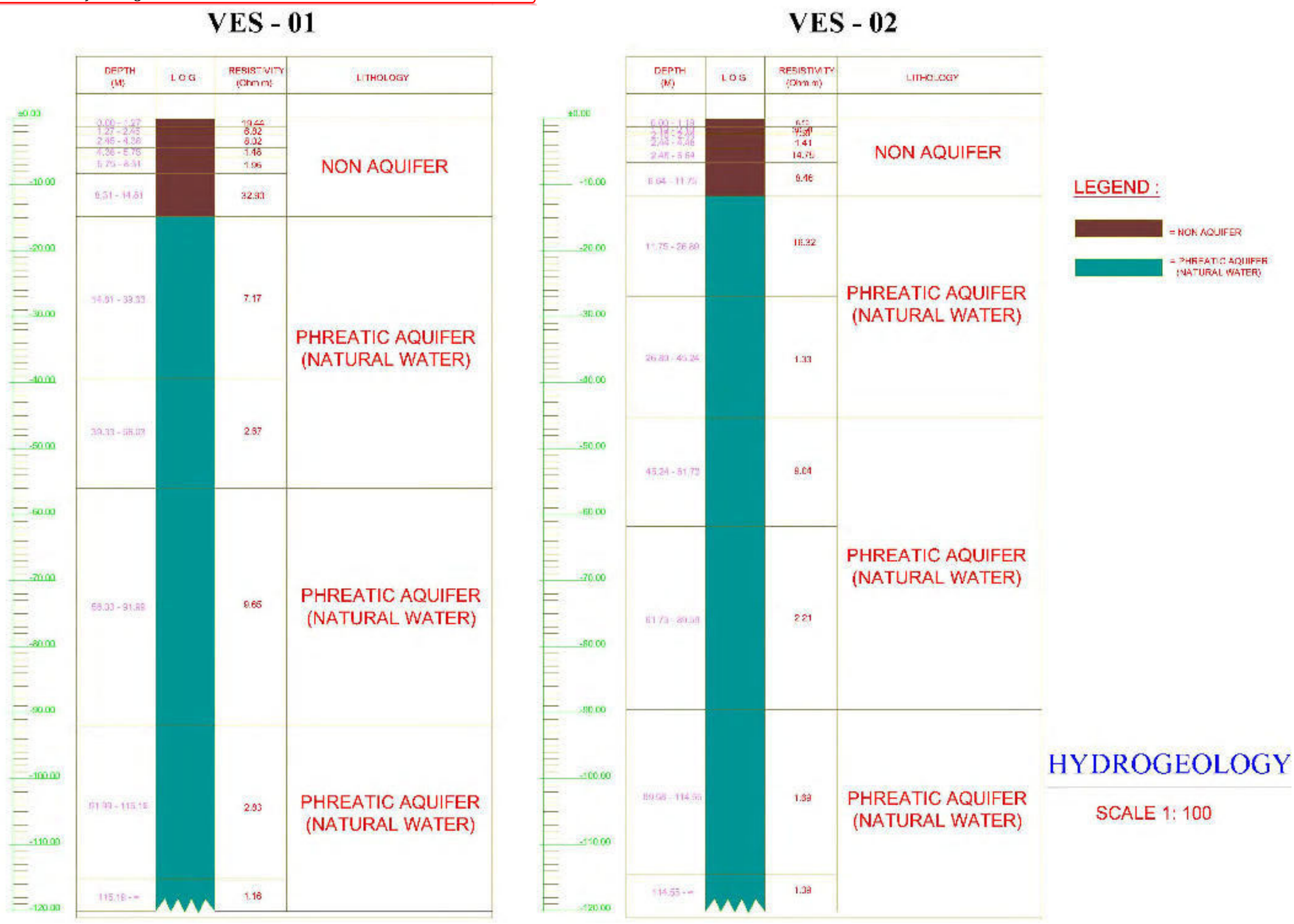
Lithological Cross Section Model VES - 01 and VES – 02



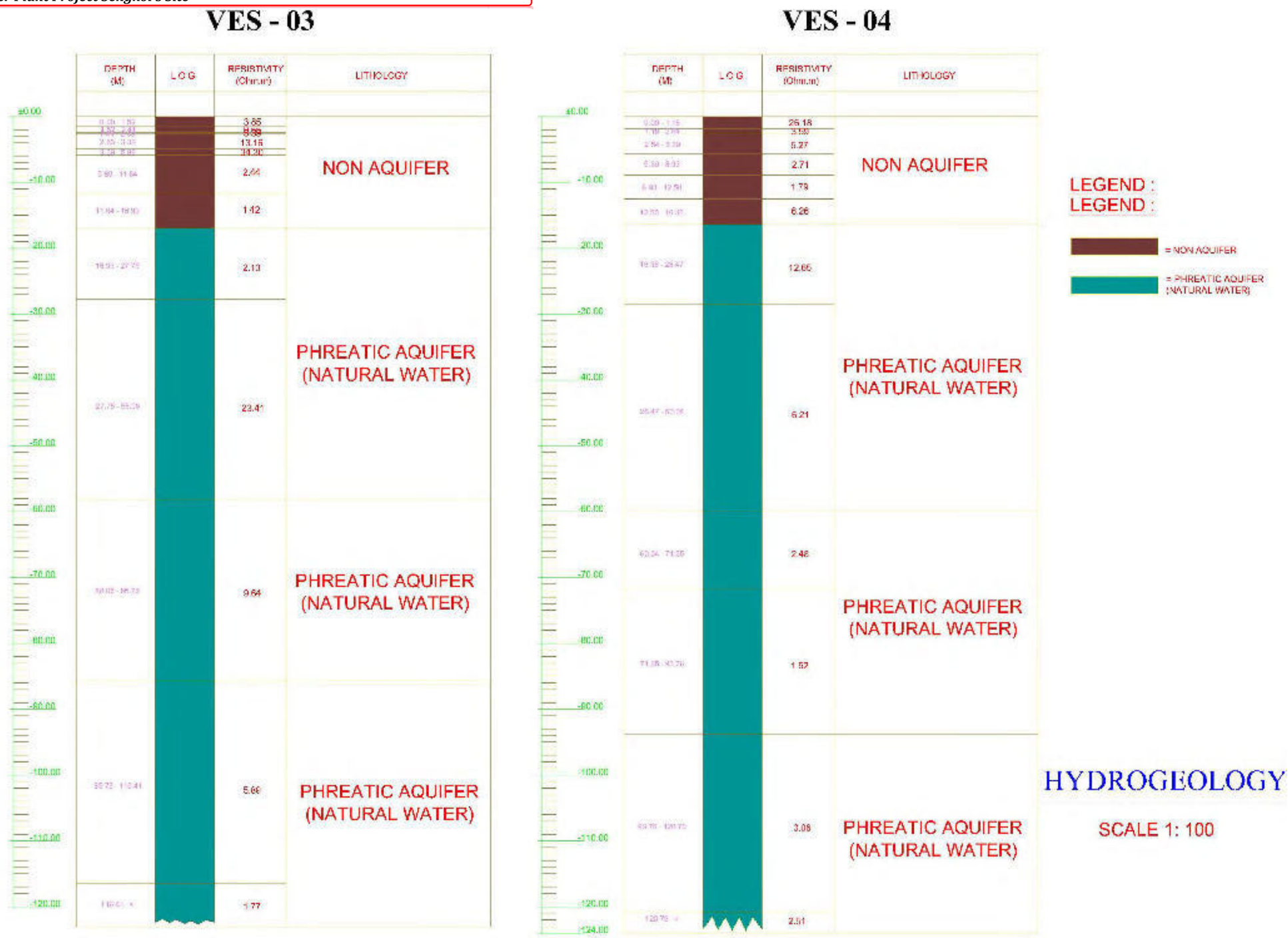
Lithological Cross Section Model VES - 03 and VES - 04



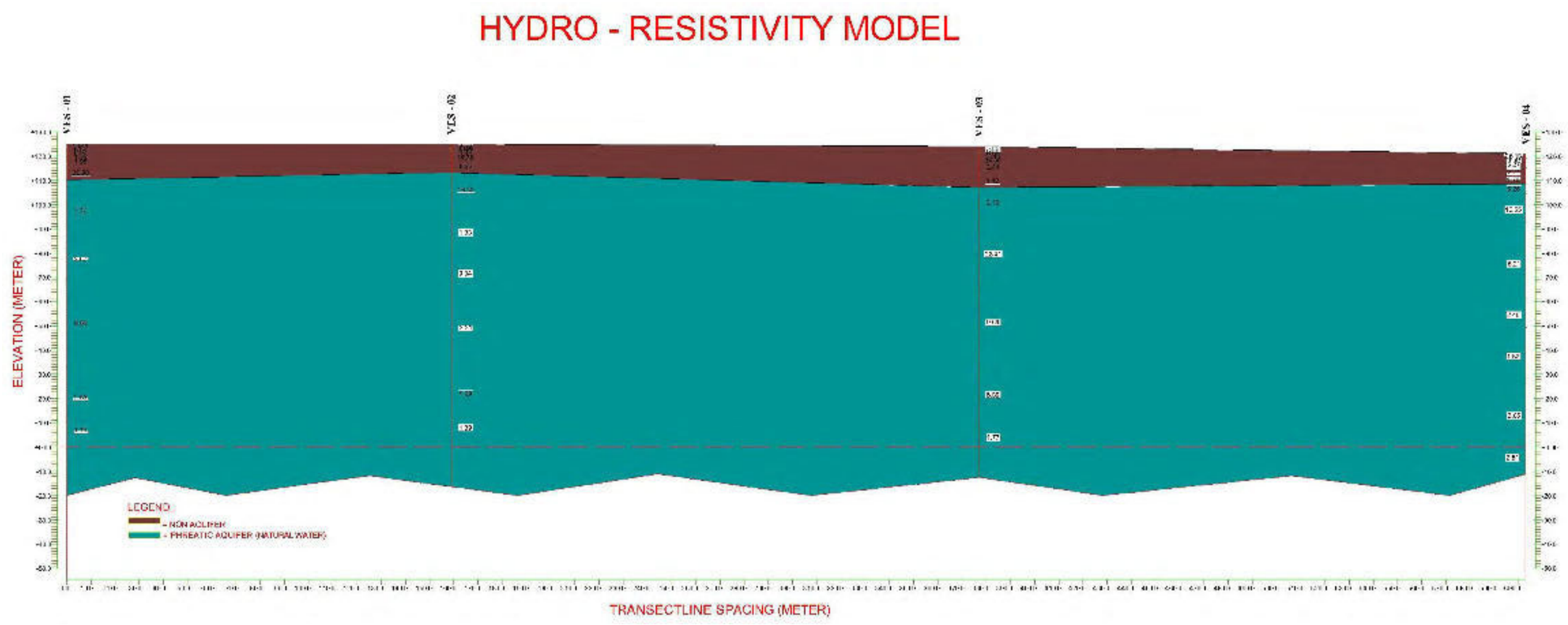
Lithology Resistivity Model VES 01 – VES 04



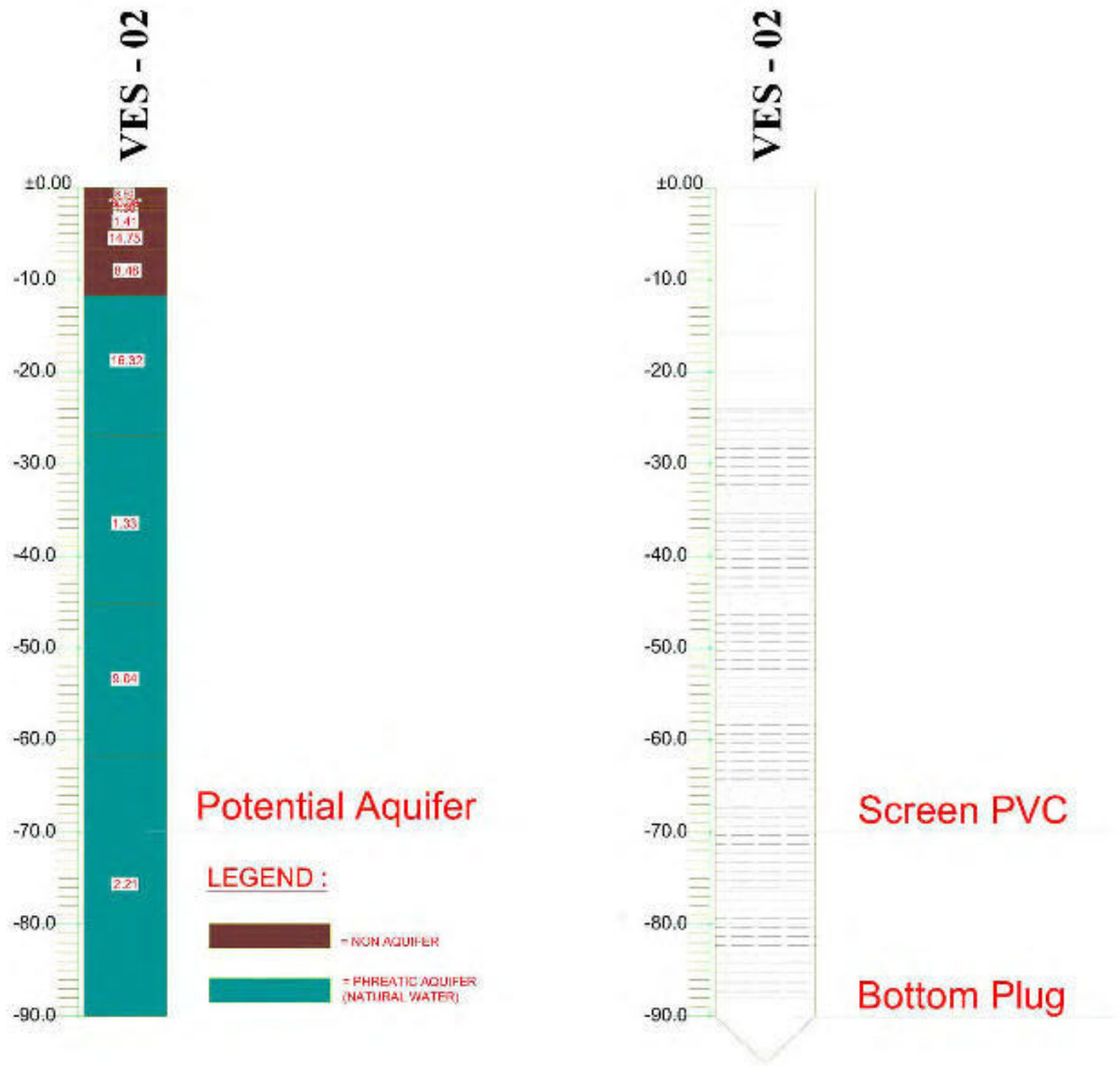
Hydrological Cross Section Model VES - 01 and VES – 02



Hydrological Cross Section Model VES - 03 and VES – 04



Hydrogeology Resistivity Model VES 01 – VES 04



Bore Design for VES - 02