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Aquifer Types at Groundwater Drilling Locations in the Munggur Area and Its Surroundings, Gunungkidul Regency, Yogyakarta Special Region

Purwanto, Siti Hamidah , Intan Paramita Haty

Universitas Pembangunan Nasional Veteran Yogyakarta,
Email address purwantogeotek@yahoo.co.id ,Email address shamidah81@yahoo.co.id ,Email address intanparamitahaty@yahoo.co.id

Abstract

Gunungkidul Regency is an area that is actively developing natural tourism. This development certainly cannot be separated from various problems. One of the existing problems is clean water, one of which is to overcome this problem is by developing groundwater sources. This research aims to detect various potential locations in the northern part of Gunungkidul to develop groundwater. The research method used is geological study, hydrogeological, climatological conditions, and geoelectric method. It is hoped that potential points will be obtained with the information on the depth of the aquifer. Based on the results of the study in the form of potential points, aquifer depths, technical data on plans for deep wells and piping networks, then the data can be used to develop groundwater to meet the needs of clean water which is increasing from year to year.

Keywords: aquifer, hydrogeology, water, geoelectric, Gunungkidul Regency

I. INTRODUCTION

Water as a natural resource is very important and necessary for all living things, whether humans, animals, or plants. Water is used by humans for various household purposes, agriculture, fisheries, industry, energy sources, means of transportation, and others. The amount of water on earth is 1,385,984,610 km3 and from this amount, freshwater is only 35,029,210 km3 or only 25% of the total water. Most of the human need for water is met by freshwater and groundwater because the nature of groundwater is clean, pollution-free, and relatively low temperature. Linsley et. AI. 1982, apart from its direct use, groundwater is also an important phase of the hydrological cycle (hydrological cycle).

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Most of the water that is used for daily life for the people in the Special Region of Yogyakarta is shallow well water. Based on monitoring carried out by the Regional Environmental Impact Management Agency of the Yogyakarta Special Region since 2002, it has shown a decrease in the quality and quantity of groundwater. The results showed that the groundwater in the area was contaminated with bacterial cold, nitrite, ammonia, and iron as well as a decrease in the discharge of deep boreholes and an increase in the depth of dug wells.

The development of physical development occurred in the Province of Yogyakarta Special Region, makes a decrease in the quantity of groundwater because of the catchment area for the Special Region of Yogyakarta Province in the northern region (Sleman Regency). The natural existence in Sleman Regency is more profitable than other areas, both weather, soil fertility, and water quality. It is very interesting for the immigrants to build a house as a place for old age because quite comfortable. Meanwhile, the catchment area for Gunungkidul district is scattered locally and in a small area. This condition causes the groundwater system in Gunungkidul Regency different and not as good as in Sleman Regency. Some areas of the groundwater basin in the Gunungkidul region have a specific hydrological system, a small groundwater potential due to the characteristics of rocks that cannot properly store and transmit water. In the rainy season, generally, the depth of groundwater in the area is more than 15 m with fluctuations in the groundwater level ranging from 4 - 15 meters. In the dry season, most of the groundwater is found in deep aquifer layers (> 40 meters) and some are in the form of underground river channels that are difficult to detect so this makes it difficult for people in the area and has difficulty utilizing/utilizing water to meet raw water needs. Therefore, to meet the water needs in water-scarce areas, additional deep groundwater drilling well facilities and equipment for groundwater production are required.

Determination of drilling locations, well depths, and a study of potential aquifer conditions in water-scarce areas are needed before drilling for groundwater to be successful as expected based on geological, geomorphological, hydrogeological, and climatological data.

It is very necessary to conduct a research entitled Intensification of Groundwater Development in Baturagung Hills area, Gunungkidul Regency, Yogyakarta Special Region.

II. LITERATURE REVIEW

Referring to the regional physiography of Van Bemmelen (1949), the study area is included in the Java Central Depression Zone. This zone is a low area that later became the place for the emergence of Quaternary volcanoes. In the west, it is bordered by the Menoreh Mountains, while in the east it is bordered by the Southern Mountains.cavity.

The lithology of the research area consists of volcanic breccias, agglomerates, tuffs, and andesite-basal lava flows, and andesite lava. The volcanic breccias and agglomerates that dominate these formations are generally not layered. The pieces consist of andesite and a little basalt, measuring 2 - 50 cm. In the middle part of this formation, namely in volcanic breccias, reef limestones were found that form lenses or in the form of pieces. Locally, this formation is inserted by well-layered epiclastic and tuff volcanic sandstones (Rahardjo and Surono with changes, 1994)

Gunung kidul included in the karst area has a productive aquifer system, indicated by groundwater drilled wells that are used for irrigation or domestic purposes. Based on the value of aquifer transmissivity, the quantity of groundwater in the study area varies spatially, from the medium potential for domestic and very poor for irrigation to excellent potential for domestic uses and irrigation (Taat Setiawan, Nofi M.Alfan Asgaf, 2016)

III. RESEARCH METHODOLOGY

The methods and stages of work in this study are as follows: compilation of regional geological data, including population data, geomorphology, hydrogeology, climatology, and general land use in the research area. Retrieval and analysis of geoelectric data in the research area are carried out to assess aquifers and potential groundwater points for development plans. Then evaluate and analyze the data that has been obtained, namely various field data, as an effort to determine the factors that trigger groundwater level changes in changes in the hydrological system, and the results of the geo-electric analysis to determine the hydrogeological system and the direction of groundwater flow and aquifer variations for planning considerations. development area in the research area. The last makes recommendations for groundwater development and provides technical documents for its development. Geoelectric is a geophysical method that studies the nature of electricity flow in the earth and how to detect it on the earth's surface, includes the measurement of potential, currents, and electromagnetic fields that occur, either naturally or as a result of current injection into the earth. There are many kinds of geoelectric methods, including the resistivity method. In the resistivity method, an electric current is injected into the earth through the current electrode, then the potential difference that arises is measured through two potential electrodes.

Geoelectric (resistivity method) is a geophysical method based on the electrical properties of rocks. Rocks with high resistivity will have smaller conductivity. Rock resistivity is influenced by metal content, rock texture, and porosity, rock temperature, rock permeability, salt content.

IV. FINDING AND DISCUSSION

In general, the measurement area is located in a hilly area with a fairly high relief with a slope angle of 0 - 12^{o}. It is a wavy hill with breccia rock with clay inserts called the Semilir Formation, Nglanggran Formation, and Sambipitu Formation. Lots of perennials are overgrown with soil that is quite fertile with a soil thickness of 1 - 1.5 meters, generally used as agricultural crops. At this location, groundwater is very difficult to find (Figure 1).

The lithology of rocks forming this area is pumice and tuff sandstones of the Similar Formation, breccias with clay inserts, and sandstones of the Nglanggran Formation. Generally, a lot of rotten breccias are found in relatively high hilly areas. Breccia color brown-gray, Andesite fragments 5 - 10 cm in size, angular, sand matrix, and silica cement. Clay inserts often found in low areas, dark gray color, plastic with a layer of 2 - 100 cm, sandstones 1 - 50 cm thick, gray color, large porosity. The Sambipitu Formation consists of sandstones with clay and marl inserts and at the top is the limestone

of the Wonosari Formation. The lithology of the Munggur Region, Watusigar Village, Ngawen District, Gunungkidul Regency consists of Volcanic Breccias, Tuffs, and Alluvial Deposits

Based on the results of the final sounding analysis (Schlumberger method) was carried out with a computer program, and also with curve matching and supported by local and regional geological data of the study area, the final results of the depth correlated with the true resistivity of the rock divided into Several rock units are as follows: Soil with resistivity values ranging from 50 to more than 1000 Ohm meters, consisting of loose sand, loam, silt, gravel, and gravel. Clay or Tuff units with a resistivity value of less than 10 ohm-meter, consist of clay or tuff. Generally very impermeable. The siltstone unit has a resistivity value between 10 - 20 ohm-meters, the dominant rock is marled sand or clay with a mixture of tuff or inserts of both, which are somewhat permeable, generally watery but the discharge is not that large. Tuffan Sandstone and Sandstone Units with a resistivity price of 20-200 ohm-m, consisting of sandstones which are generally sandstone deposits It is a good aquifer, very permeable and contains water with quite a lot of discharge, as well as a Volcanic Breccia unit which has a resistivity price of 200-1000 ohms-meter. Very compact, generally with lump fragments of 20-40 cm, sand matrix andesite fragments with sand matrices.

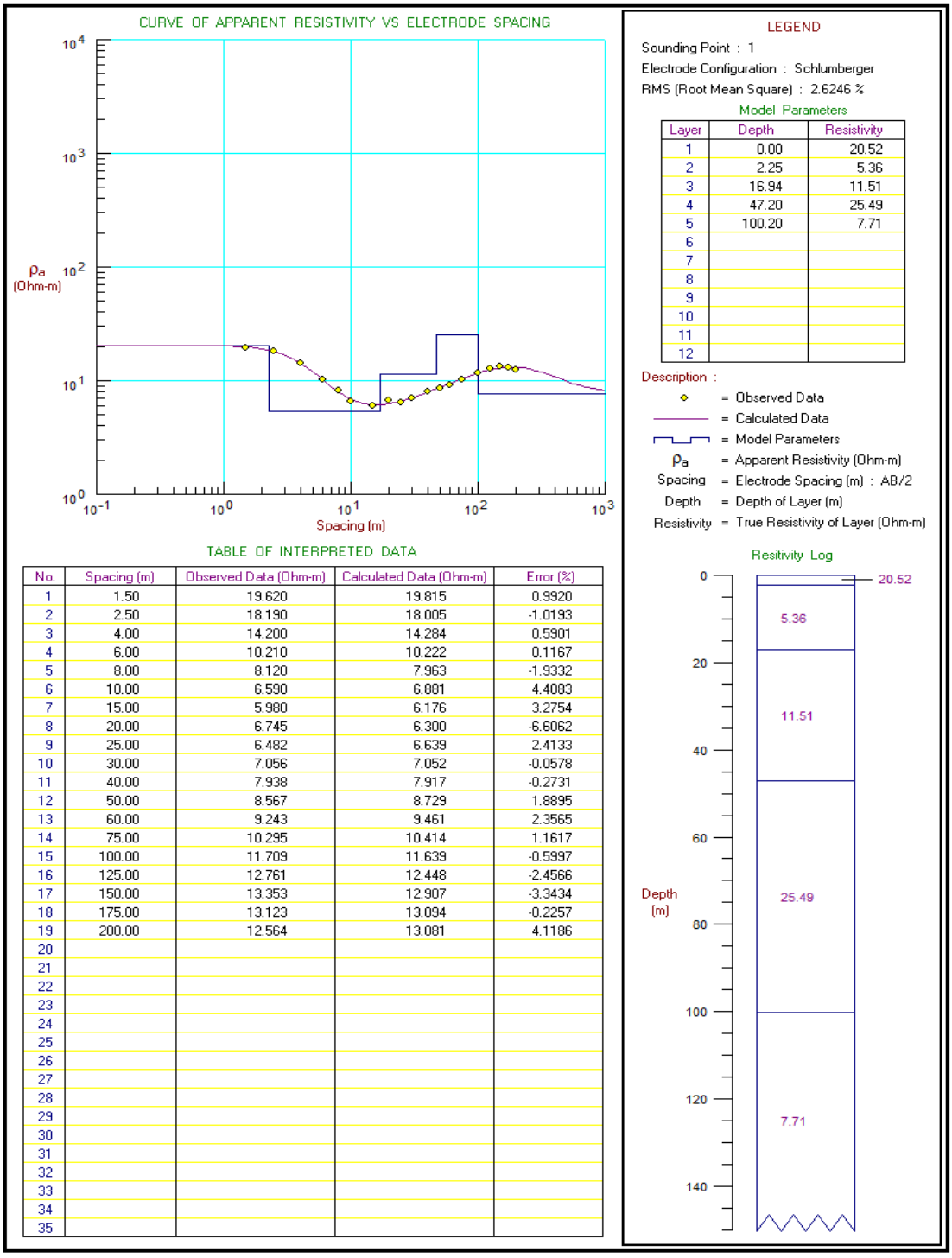
Interpretation is carried out based on manual comparisons and the results of three computer programs, the final result that best represents each area will be analyzed geologically (qualitatively) and quantitatively, the final results are as follows.

MGW1, the constituent rocks are alternating sandstones with breccias and alternating between siltstone and tuff. The depth of the groundwater aquifer is at a depth of 17 - 100 m, with a thickness of 83 m and a resistivity of 11.51 - 25.49 ohm-m (Figure 2).

MGW2: The constituent rocks are alternating sandstones with breccias and alternating between siltstone and tuff. The depth of the groundwater aquifer is at a depth of 51 - 108 m, with a thickness of 57 m and a resistivity of 19.85 ohm-m (Figure 3).

MGW3: The constituent rocks are alternating sandstones with breccias and alternating between siltstone and tuff. The depth of the groundwater aquifer is 21 - 108 m deep, with a thickness of 87 m and a resistivity of 12.83 ohm-m (Figure 4).

Figure 1. Geoelectric Measurement Points of Munggur Hamlet, Watusigar Village



Layer	Depth	Resistivity
1	0.00	20.52
2	2.25	5.36
3	16.94	11.51
4	47.20	25.49
5	100.20	7.71
6		
7		
8		
9		
10		
11		
12		

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	19.620	19.815	0.9920
2	2.50	18.190	18.005	-1.0193
3	4.00	14.200	14.284	0.5901
4	6.00	10.210	10.222	0.1167
5	8.00	8.120	7.963	-1.9332
6	10.00	6.590	6.881	4.4083
7	15.00	5.980	6.176	3.2754
8	20.00	6.745	6.300	-6.6062
9	25.00	6.482	6.639	2.4133
10	30.00	7.056	7.052	-0.0578
11	40.00	7.938	7.917	-0.2731
12	50.00	8.567	8.729	1.8895
13	60.00	9.243	9.461	2.3565
14	75.00	10.295	10.414	1.1617
15	100.00	11.709	11.639	-0.5997
16	125.00	12.761	12.448	-2.4566
17	150.00	13.353	12.907	-3.3434
18	175.00	13.123	13.094	-0.2257
19	200.00	12.564	13.081	4.1186
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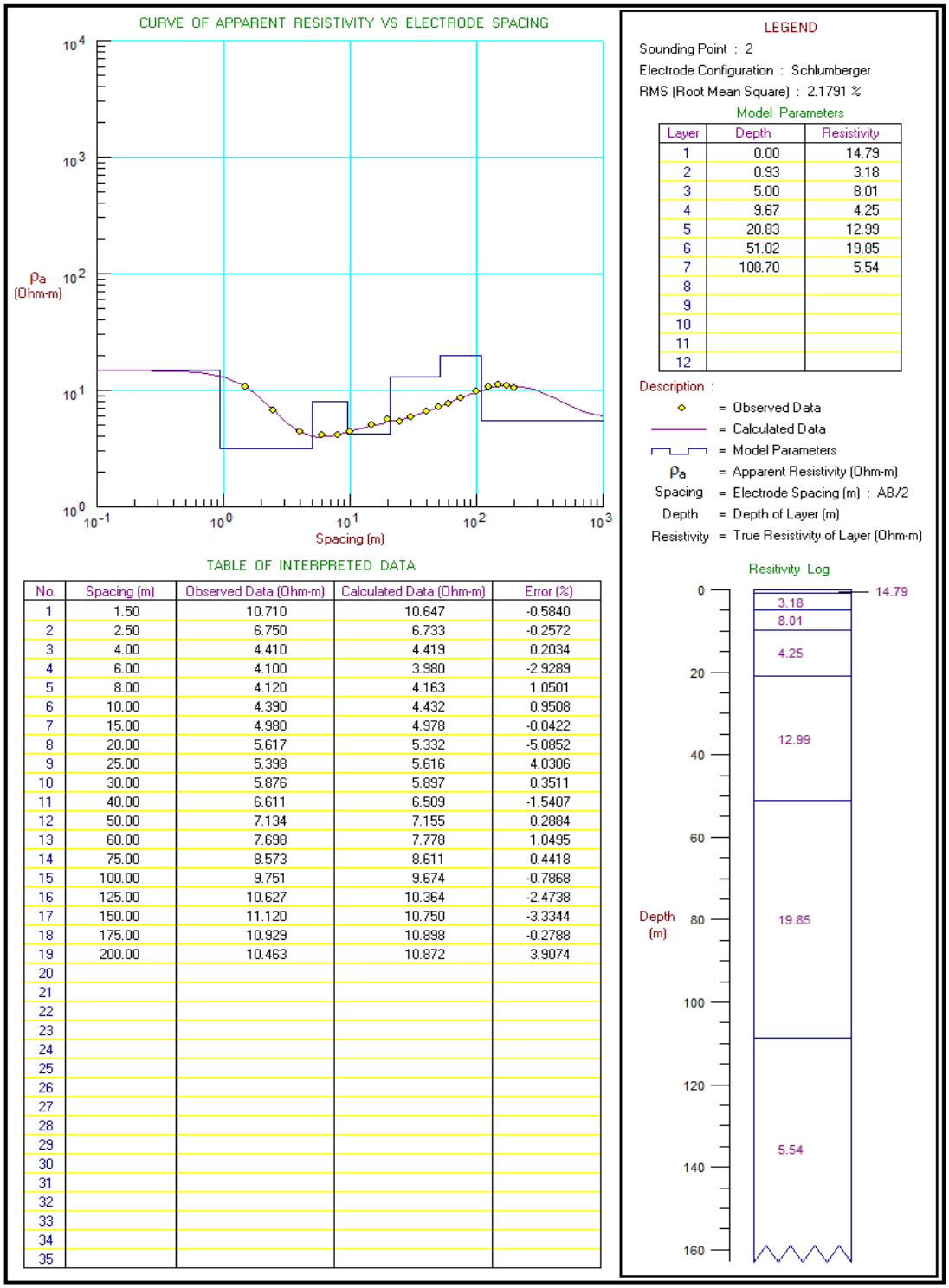
Figure 2. MGW1 Geoelectric Data Processing



Layer	Depth	Resistivity
1	0.00	14.79
2	0.93	3.18
3	5.00	8.01
4	9.67	4.25
5	20.83	12.99
6	51.02	19.85
7	108.70	5.54
8		
9		
10		
11		
12		

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	10.710	10.647	-0.5840
2	2.50	6.750	6.733	-0.2572
3	4.00	4.410	4.419	0.2034
4	6.00	4.100	3.980	-2.9289
5	8.00	4.120	4.163	1.0501
6	10.00	4.390	4.432	0.9508
7	15.00	4.980	4.978	-0.0422
8	20.00	5.617	5.332	-5.0852
9	25.00	5.398	5.616	4.0306
10	30.00	5.876	5.897	0.3511
11	40.00	6.611	6.509	-1.5407
12	50.00	7.134	7.155	0.2884
13	60.00	7.698	7.778	1.0495
14	75.00	8.573	8.611	0.4418
15	100.00	9.751	9.674	-0.7868
16	125.00	10.627	10.364	-2.4738
17	150.00	11.120	10.750	-3.3344
18	175.00	10.929	10.898	-0.2788
19	200.00	10.463	10.872	3.9074
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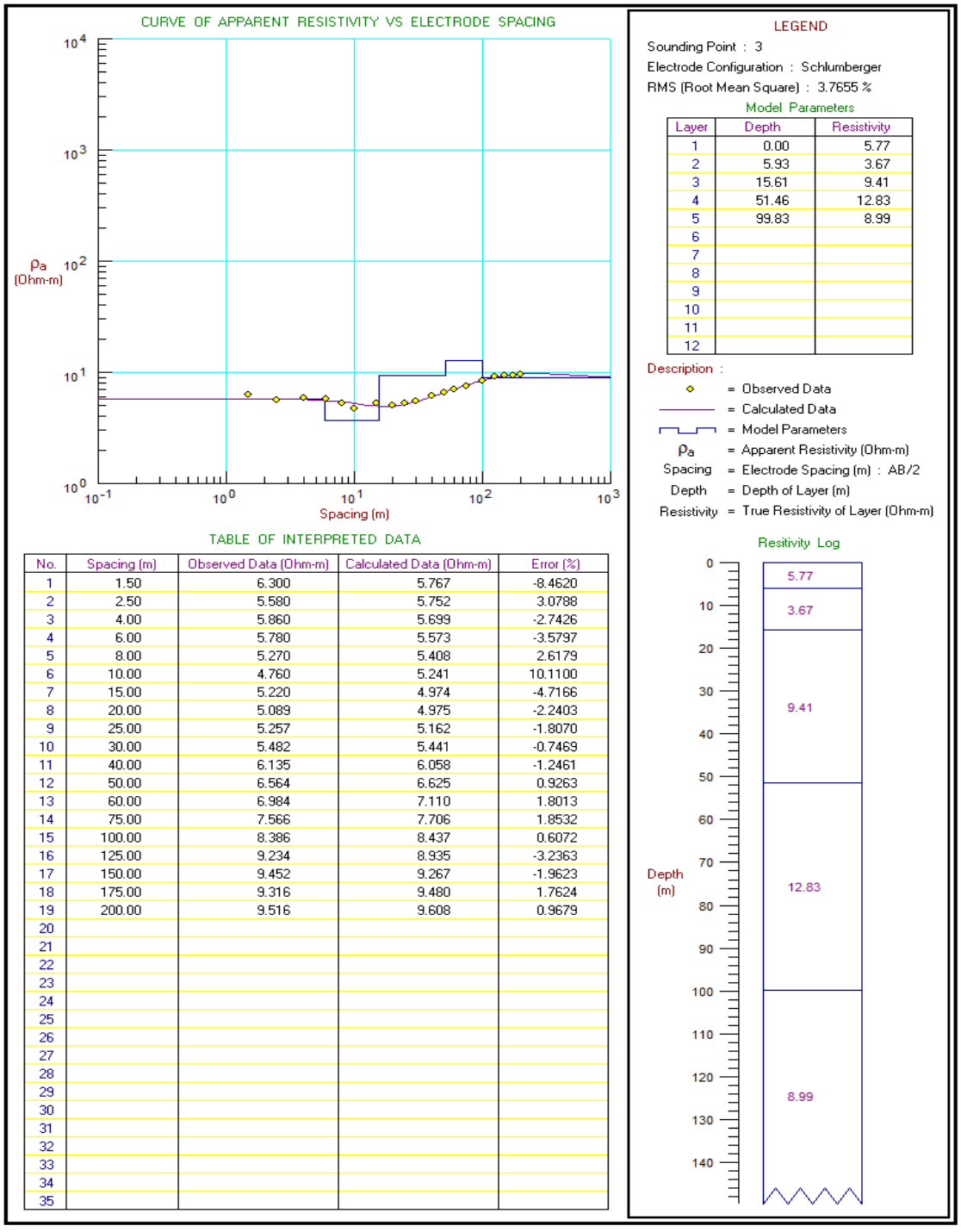
Figure 3. MGW2 Geoelectric Data Processing



Layer	Depth	Resistivity
1	0.00	5.77
2	5.93	3.67
3	15.61	9.41
4	51.46	12.83
5	99.83	8.99
6		
7		
8		
9		
10		
11		
12		

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	6.300	5.767	-8.4620
2	2.50	5.580	5.752	3.0788
3	4.00	5.860	5.699	-2.7426
4	6.00	5.780	5.573	-3.5797
5	8.00	5.270	5.408	2.6179
6	10.00	4.760	5.241	10.1100
7	15.00	5.220	4.974	-4.7166
8	20.00	5.089	4.975	-2.2403
9	25.00	5.257	5.162	-1.8070
10	30.00	5.482	5.441	-0.7469
11	40.00	6.135	6.058	-1.2461
12	50.00	6.564	6.625	0.9263
13	60.00	6.984	7.110	1.8013
14	75.00	7.566	7.706	1.8532
15	100.00	8.386	8.437	0.6072
16	125.00	9.234	8.935	-3.2363
17	150.00	9.452	9.267	-1.9623
18	175.00	9.316	9.480	1.7624
19	200.00	9.516	9.608	0.9679
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Figure 4. MGW3 Geoelectric Data Processing

Based on 3 geoelectric measurement points, found that the most potential result for groundwater drilling was MGW1 with an aquifer resistivity value of 11.51 - 25.49 ohm-m at a depth of 17 - 100 meters. The aquifer is composed of alternating sandstones with breccias (Figure 5).

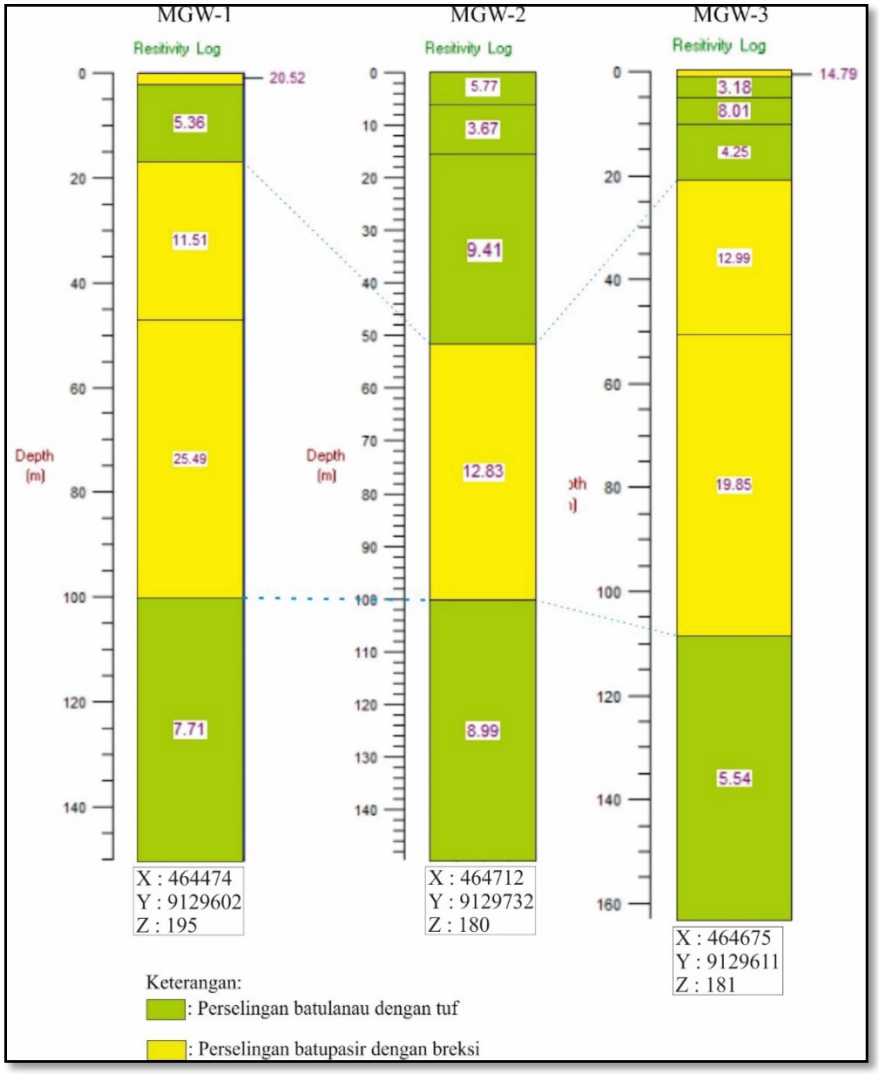

Figure 5. Geoelectric Correlation of Munggur Hamlet, Watusigar Village (Without Scale)

V. CONCLUSION AND FURTHER RESEARCH

Some of the things that can conclude from this activity are as follows: the provision of raw water for several locations scattered in Gunungkidul Regency is the object of this research is very much needed, considering that in the dry season these hamlets are very short of water. From the results of

groundwater investigations using the Schlumberger Method, it is concluded that the research area has sufficient raw water potential. Location MGW1 found groundwater aquifers with a depth of 17 - 100 meters, with a thickness of 83 m. At MGW2 point, groundwater aquifers are found at a depth of 51 - 108 meters, the thickness of the aquifer is 57 m, while in MGW3 the groundwater aquifer is located at a depth of 21 - 108 meters, and the aquifer is 87 m thick. The estimated average discharge for this area = 2 - 3 liters per second. Planning for drilling wells in a number of these locations is highly recommended, and planning is adjusted to the amount of demand and availability of raw water as well as the location of the highest housing in all service areas.

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