REPUBLIC OF INDONESIA

BASIC SURVEY REPORT ON WATER SUPPLY FACILITIES OF HEALTH PROMOTION PROJECT IN NORTH SUMATRA

MARCH 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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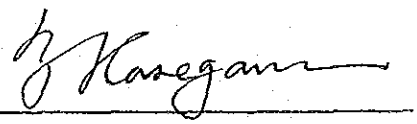
PREFACE

The North Sumatra Health Promotion Project was extended further for five years from April 1, 1984. At the same time, the project area was also expanded. In July, 1985, the Government of the Republic of Indonesia requested the Government of Japan to construct drinking water supply facilities mainly in the newly expanded part of the project area in order to improve hygienic conditions of the inhabitants there.

In response to the request, Japan International Cooperation Agency (JICA) dispatched a basic survey team on these facilities to the Republic of Indonesia from February 18 to March 19, 1986 in order to investigate a feasibility of the construction of such facilities.

The results of the investigation have been compiled in this report. We hope that this report will be fully utilized in establishing a plan for the construction of the these facilities in the future.

March, 1986



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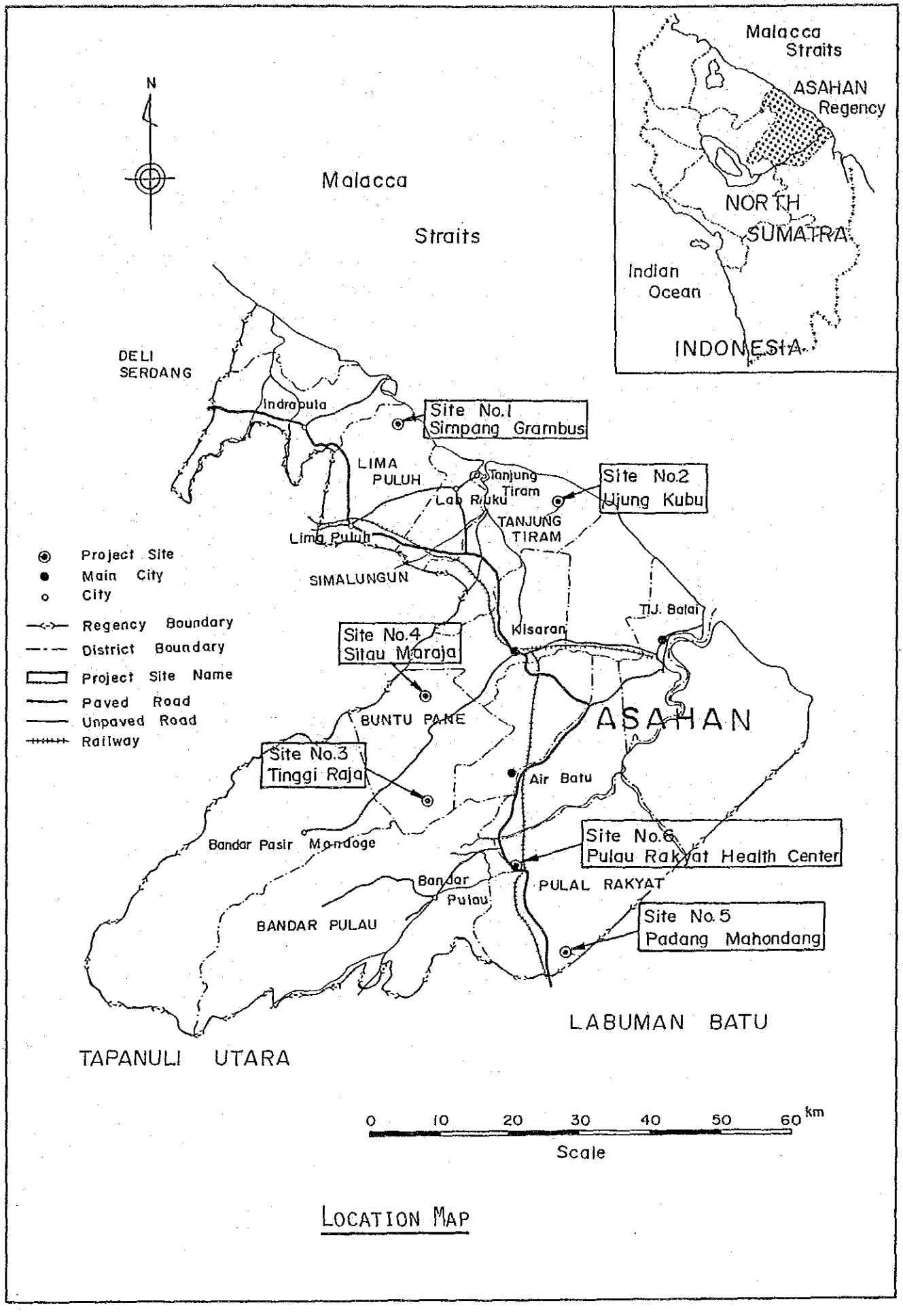

LOCATION MAP

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SUMMARY AND RECOMMENDATIONS

In accordance with the Agreement on the 9th Steering Committee Meeting held in August 1985 at Medan, JICA dispatched to Indonesia February - March 1986 "Basic Survey Team" on the water supply facilities which will be constructed in the extended project area in Asahan Regency.

The major purpose of the Team was to study availability and possibility of groundwater in the project sites proposed by the Indonesian Government as drinking water source, from engineering point of view.

As a result of the hydrogeological survey including geoelectric resistivity survey on the project sites for new water supply facilities, it has been confirmed that there exists possibility of the confined groundwater to be taken through deep wells, at the all of six sites proposed.

Followings are summary and recommendations for the present project:

(1) Project sites for water supply facilities which were nominated by the Indonesian Government by the letter dated on 10 October 1985 are:

- No.1: Sub Village No.16 of Simpang Gambus Village (in Lima Puluh District)
- No.2: Sub Village of Pematang Pao of Ujung Kubu Village (in Tanjung Tiram District)
- No.3: Tinggi Raja Village (in Buntu Pane District)
- No.4: Silau Maraja Village (in Buntu Pane District)
- No.5: Pandang Mahondang Village (in pulau Rakyat District)
- No.6: Pulau Rakyat Health Center.

By the field survey conducted during February - March 1986, it has been confirmed that these areas currently have no

suitable water avilable and new water supply facilities with safe and continuous water such as that from deep wells are badly and urgently required.

Among others, higher priority for new facilities will be preferably placed on sites No.6, No.1 and No.2.

The site of No.6 is the Pulau Rakyat Health Center which has a new hospital besides a clinic. However, its present water source is a shallow dug well and its quality is hygienically doubtful; and it has no water supply system other than the dug well. Accordingly the Health Center is not able to function much presently.

Sites of No.1 and No.2 are sub-villages formed by transmigration of Batak people from North Tapanuli about 20 - 30 years ago. They are isolated by plantation or swamp from others and considered the "closed and left behind" areas. Their daily-use water is in remarkably worse condition, specially in its quality.

(2) The common characteristics prevailing in the above villages of No.1 - No.5 are summarized as:

1) The areas are deeply surrounded by plantations.
2) Akmost of all people live on rice-field farming or plantation.
3) Public electricty (PLN) has not been yet supplied; however, electric supply by private generators is presently developing.

and,

4) As to water for domestic use, people depend on shallow dug wells; however, the wells are not protected and the water quality is not suitable hygienically. Further, taking water from the wells is rather difficult in dry seasons.

(3) Findings by the hydrogeological survey carried out on the project area, including geoelectric resistivity survey, are:

1) There would be possibility of groundwater development in the all project sites, and the promissing groundwater will be able to be taken by way of deep wells.

2) Groundwater aquifers containing confied water may exist firstly in the depth of 130-160 m, and secondly in 200-230 m.

3) The above aquifers may give self-flowing water to some extent through deep wells at sites of No.1 and No.2; however, its yield will not be enough for water supply to communities and it might decrease year by year.

4) Water quality of the above aquifers is anticipated to be suitable hygienically for domestic use of the people.

(4) For the water supply to communities, it will have an inevitable limitation in quantity, if solely depending on self-flowing of the groundwater and/or use of handpumps. In order to make the water supply stable, installation of the power-driven submersible pump is certainly required.

(5) Considering all of the aboves, it is recommendably proposed that water supply facilities in the project should be composed of the followings:

- One deep well (Depth: 180-220 m),
- One submersible pump together with a power generator,
- One elevated tank, and
- Public water taps under and/or near the elevated tank.

(6) It should be noted that existing water supply facilities which need mechanical maintenance and running power cost are not always well operated and maintained. It is considered mainly due to 1) lack of enough budget for repair and rehabilitation, and 2) unaffordability of the people to pay for running cost of the facilities. Therefore, it is recommended that the Ministry of Health gives the village people financial assistance together with technical aid upon completion of facilities until the people become to be able to maintain by themselves both technically and financially.

The financial assistance should include 1) repair and rehabilitation of facilities at regular intervals, and 2) daily running cost.

(7) Subsequent schedule of construction will be as follows:

1) Test well construction and detailed design (8 months)
: May 1986 - December 1986

2) Construction of facilities (5 months)
: November 1986 - March 1987

(8) The construction cost of test wells will be covered by JICA. The following items, however, shall be carried out under the responsibility of the Indonesian Government at its expense:

1) Aquisition of the pieces of land where test wells are to be constructed,

2) Ground-level formation of the above pieces of land, if required,

3) Preparation of access roads to these pieces of land, if required,

4) Protection of test wells from external damages after their completion; and,

5) Supply of counterpart personnel.

I. HYDROGEOLOGICAL ASPECT OF THE PROJECT AREA

1.1 Location and Topography

The groundwater potential study area is situated in the Asahan Regency, North Sumatra Province. Fig.1-1 illustrates the location and topographic condition of the area and locations of the six project sites for water supply facilities including deep wells.

In topographic features, the Asahan Regency is roughly divided into the three areas as shown below and Fig.1-1.

1) Coastal flat plain area
2) Hilly slope area, and
3) Mountaneous area

The topography of the project sites is coastal flat plains or hilly places, facing Malacca Straits. The sites of No.1 and No.2 are located on the coastal plain of low flat swampy area surrounded by paddy field with an elevation of several meters above sea level and the other 4 sites on the hilly places surrounded by plantations of oil palm, and rubber with elevation ranging from 25 m to 50 m above sea level.

The relationship between topography and land use is quite clear in the area. Plantations of oil palm and rubber are developed in the hilly places and paddy field in the flat and low land.

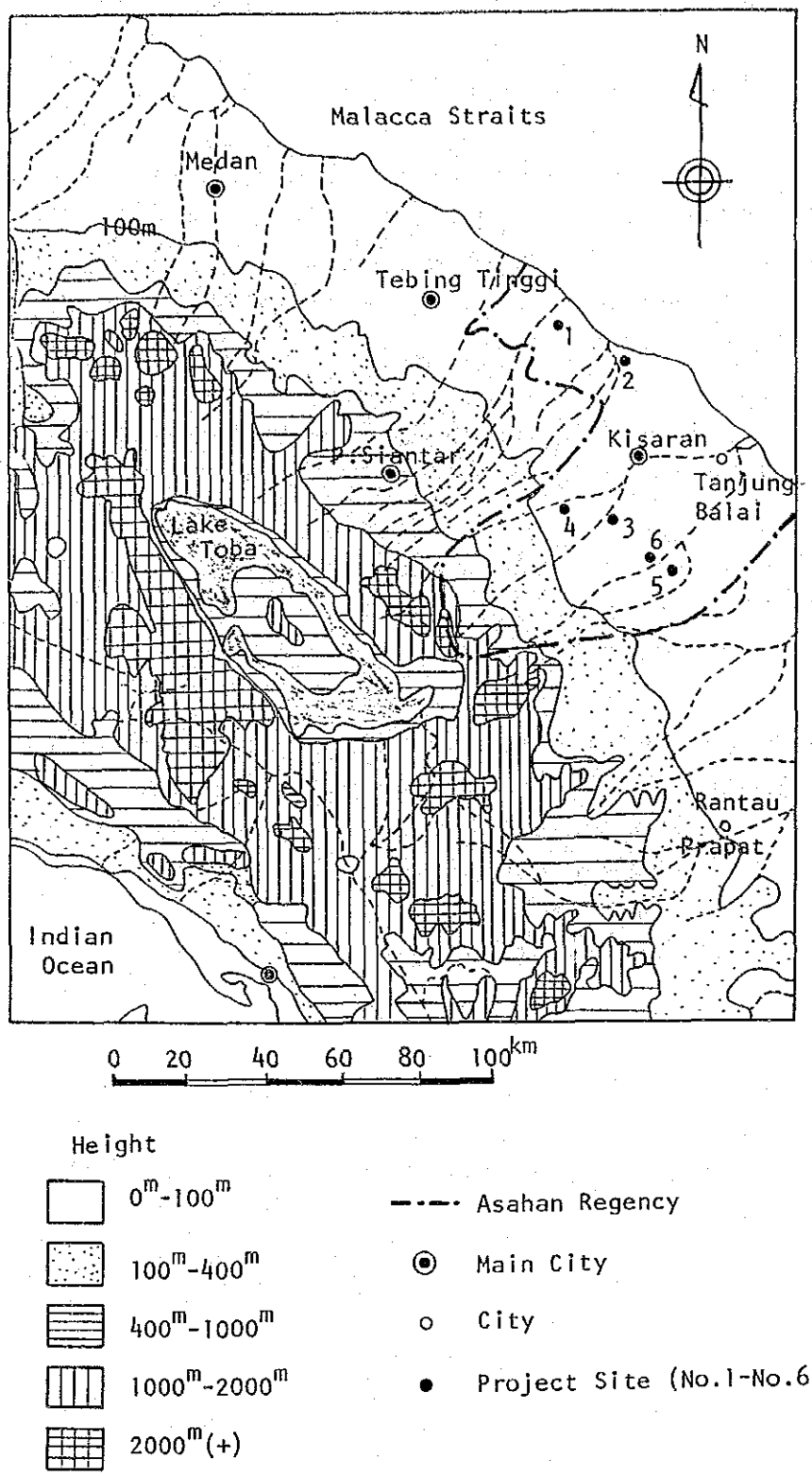


FIG. 1-1 LOCATION AND TOPOGRAPHY OF ASAHAN REGENCY, NORTH SUMATRA

1.2 Hydrometeorology

The survey area of the Asahan Regency is located in the tropical climate zone. Based on the hydrogeological map of DEG, 1983, the long range mean annual rainfall of North Sumatra area varies from 1,750 mm in the northeast coastal plain facing Malacca Straits to 3,000 mm in the southwest coastal plain facing Indian Ocean; and that of the project area is about 1,750 mm as shown in Fig. 1-2.

Fig. 1-3 illustrates the hydrometeorological condition of the project area, namely, rainfall, temperature and evaporation in 1983 at Sei Dadap Climatological Observation Station, Ashahan.

(1) Rainfall

The annual rainfall in 1983 was 1,416 mm. The dry season in the large part of Sumatra is not very pronounced. In the dry season, monthly rainfall during one or more months is less than 60 mm. On the other hand, the wet season is characterized by the monthly rainfall of more than 100 mm. The wet months are May to December when 86 % of the yearly rainfall occurs. According to the statistics, annual rainfall at Medan in 1983 was 2,054.2 mm; and from January to April it was varying monthly 38.5 mm to 85.1 mm. The wet season of Medan receives a considerable monthly rainfall varying from 128.6 mm to 335.2 mm.

(2) Temperature

The average monthly temperature as measured at Sei Dadap Station in 1983 ranged between 26.0°C and 26.8°C; that is, almost same temperature all year round. The daily average temperature at 7:00 hr., 13:00 hr. and 18:00 hr. varies considerably as 23.7°C, 31.5°C and 27.0°C, respectively.

(3) Evaporation

The monthly mean potential evaporation at Sei Dadap varied from 83.7 mm in December to 127.1 mm in October in 1983. The average annual potential evaporation of 1,341.2 mm and annual rainfall of 1,416 mm in 1983 were nearly equal (94.7 %) at Sei Dadap, however, the potential evaporation exceeded the rainfall during dry season through January to April.

(4) River Discharge

The rivers in the Asahan Regency originate in the southwestern part of volcanic mountain ranges and flow to the northeast into the Malacca Straits. The Asahan River is the biggest in the region and originates in the Lake Toba. The monthly river flow at Pulo Raja in 1983 ranged between 62.2 m3/sec in April and 158.1 m3/sec in December. Actual flow pattern based on 1983's data of PENGAIRAN is illustrated in Fig. 1-2, compared with monthly rainfall in the area. The relationship between the rainfall and the river discharge is well comparable.

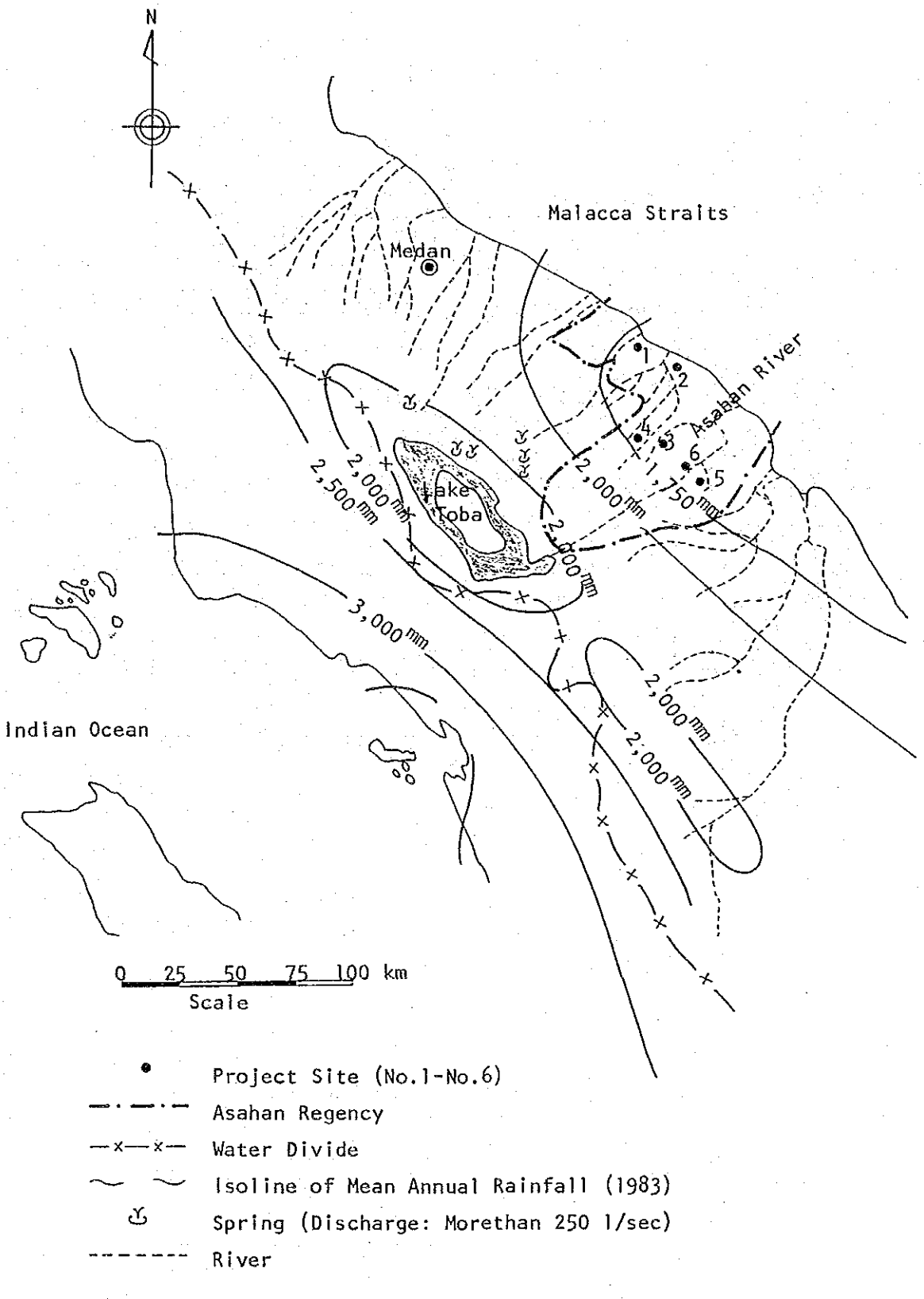


FIG. 1-2 ANNUAL RAINFALL IN NORTH SUMATRA AREA

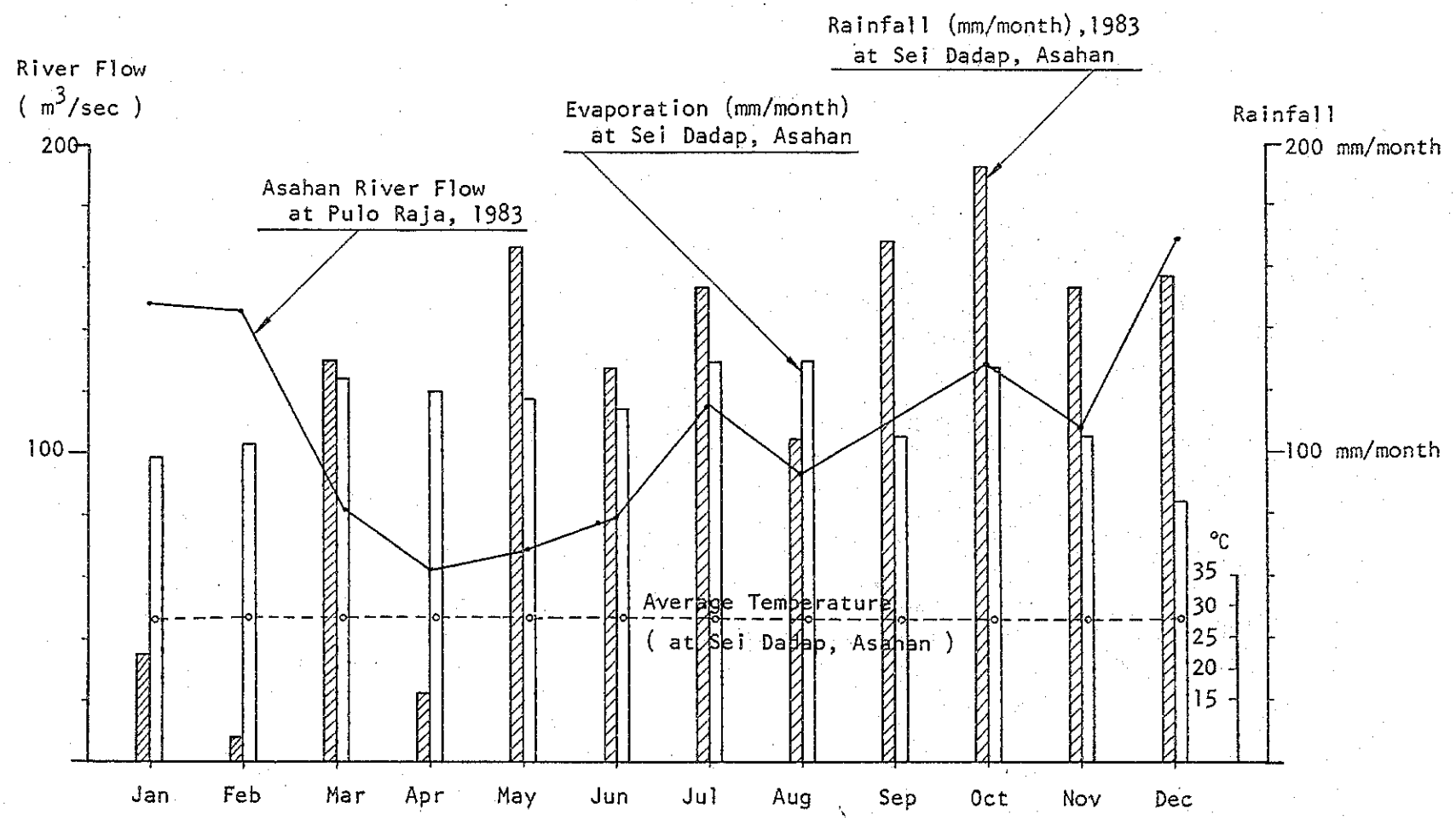


FIG. 1-3 HYDROMETEOROLOGICAL CONDITION IN THE PROJECT AREA

1.3 Hydrogeology

Based on the topographical and geological conditions affecting the occurance of groundwater, four types of groundwater potential may be distinguished in the Asahan Regency, namely the ignious and metamorophic rocks in mountain ranges, the consolidated Tertiary and Pre-Tertiary sediments, the Quarternary volcanic products on the hills, and the alluvial deposits in the coastal plain. Fig.1-4 summarizes the hydrogeological conditions indicating groundwater potential in the survey area.

The six project sites are situated on the alluvial coastal plain and Quarternary volcanic hilly area. The both areas are expected to have comparatively high groundwater potential. There exists groundwater artesian basin along the coastal plain. The two project sites are located in the edge of the basin where self-flow condition could be expected. However, it is reported the poor quality of groundwater at shallow aquifer in the southern part of the artesian basin.

Based on the existing data, Fig. 1-5 shows the hydrogeological cross section in the area. The five aquifers system is defined in the area consisting of unconfined, semi-confined and confined aquifers as given below:

I : Unconfined Aquifer (1 - 10 m zone)
II : Semi-confined Aquifer (30 - 50 m zone)
III : Confined Aquifer (60 - 100 m zone)
IV : Confined Aquifer (130 m - 160 m zone)
V : Confined Aquifer (200 m - 230 m zone)

The lower three confined aquifers are important for the current project due to the high possibility of enough groundwater with suitable quality.

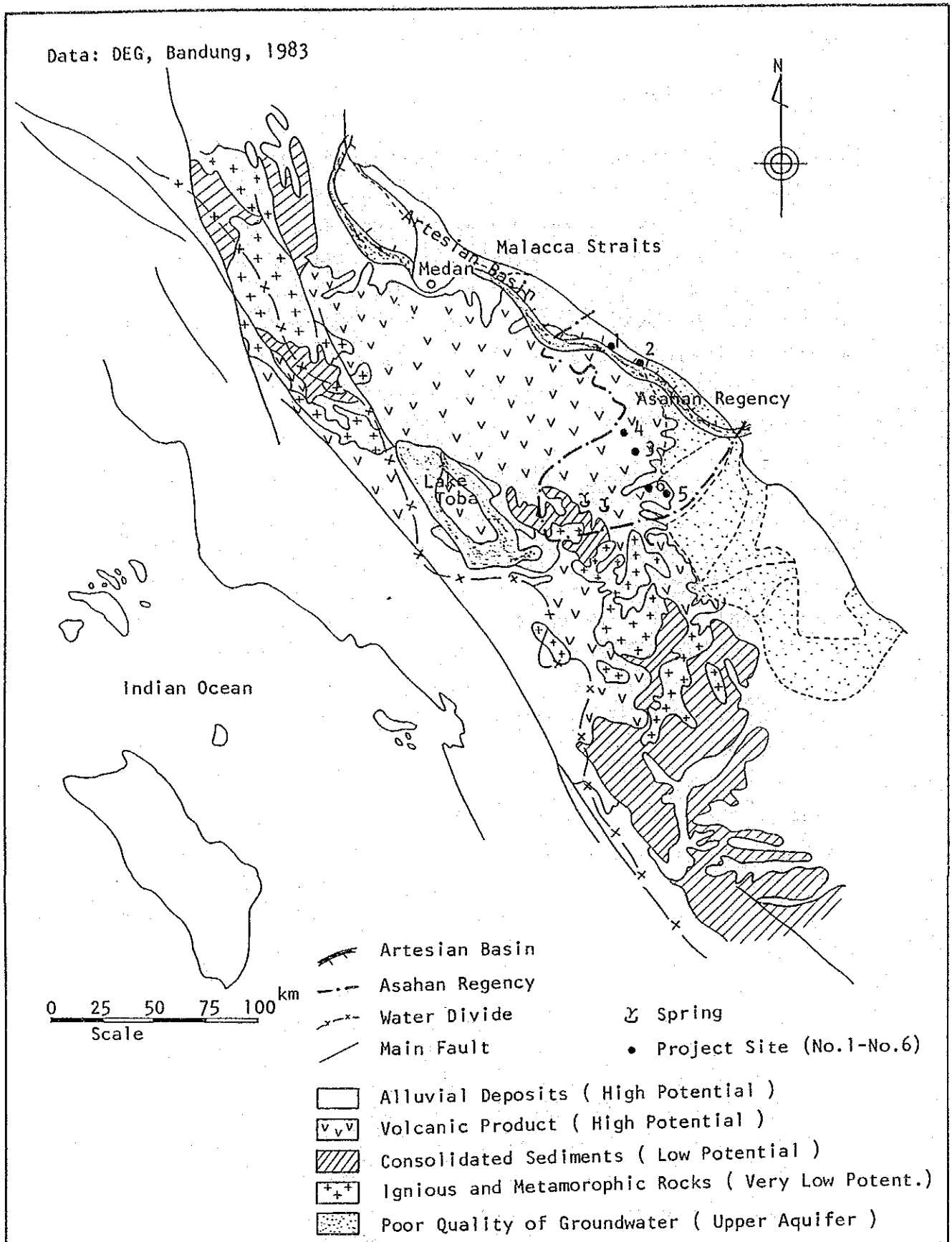


FIG. 1-4 HYDROGEOLOGICAL MAP OF ASAHAN REGENCY, NORTH SUMATRA

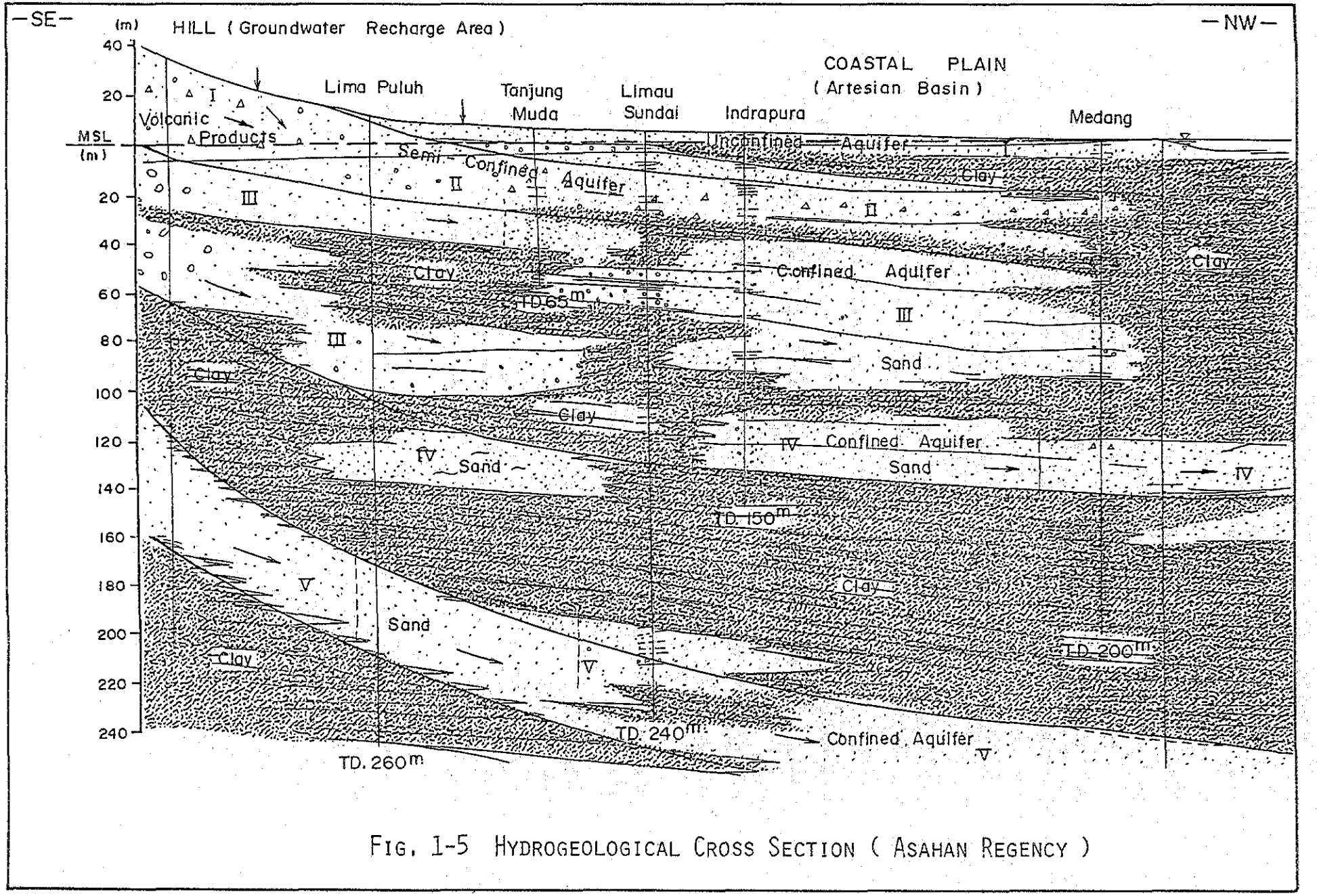


FIG. 1-5 HYDROGEOLOGICAL CROSS SECTION (ASAHAN REGENCY)

1.4 Groundwater Evaluation

The evaluation of confiend aquifer was carried out based on the pumping test data. Fig. 1-6 illustrates the Drawdown-Discharge curves of the existing JICA production wells constructed in 1981. The critical discharge points were observed in the No.IV confined aquifer at Indrapura and Medang wells at the rate of 190 m3/day and 210 m3/day; and drawdown of 16.5 m and 5.4 m, respectively. Therefore, these discharges are considered saturated production capacity.

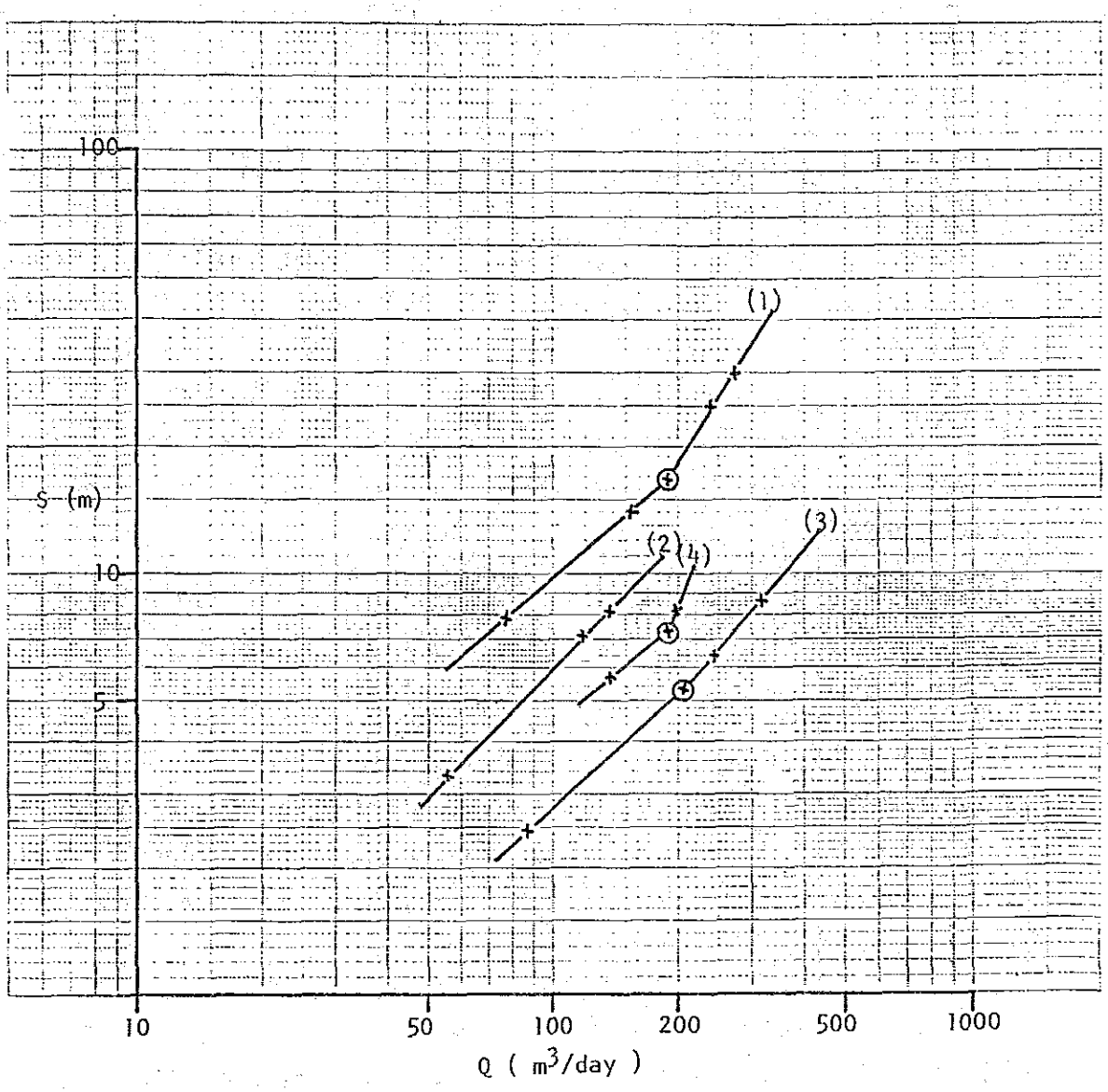
On the other hand, the No.V confined aquifer at Limau Sundai has higher potential than the above discharges of 200 m3/day due to no indication of such discharge critical point.

Table 1-1 shows summary of prospective aquifer system in the survey area and conclusions are as follows:

i) The most promising prospective aquifers in the project sites are those of No.IV and No.V; and self-flow from the aquifers is expected in the project sites No.1 and No.2. However, its quantity is not always big enough to satisfy domestic water demand of the villages, and the long term self-flow condition could not be promised in future due to pressure down owing to the increase of groundwater utilization in the area. Therefore, a system which has a submersible motor pump with generator will be recommended for the adequate public water supply.

ii) Water of the confined aquifers contains high anmonium ranging between 0.5 and 7.0 ppm, high pH from 8.0 to 9.0 and high water temperature, that is, original characteristics of the confined aquifer.

FIG. 1-6 EVALUATION OF CONFINED AQUIFER



Note: (1) Indrapura's Deep Well (JICA,1981)
Aquifer IV (108-134 m)
Q=190m3/d ΔS=16.5m SC=11.5m3/d/m

(2) Limau Suindai's Deep Well (JICA,1981)
Aquifer V (200-228 m)
Q=200m3/d ΔS=12.0m SC=16.7m3/d/m

(3) Medang's Deep Well (JICA,1981)
Aquifer IV (100-112 m, 118-148 m)
Q=210m3/d ΔS= 5.4m SC=38.9m3/d/m

(4) Sei Buah Keras's Deep Well (JICA,1981)
Aquifer III & IV (88-100 m, 124-136 m)
Q=190m3/d ΔS= 7.3m SC=26.0m3/d/m

Table 1-1 Summary of Prospective Aquifer System

Aquifer	Potential Area	Existing Wells	Self-flow Condition	Groundwater Potential	Water Quality
[I] Unconfined Depth: 1-10 m	Coastal and hilly area	Most in the project area	-	-	Unsuitable for public supply
[II] Semi-confined Depth: 30-50m	Hilly places	Tanjung Muda 60 m	-	Q=10-20 m3/d ΔS=14 m SC= 0.85m3/d/m	WT=27.4°C EC=210 μS/cm pH=6.8
[III] Confined Depth: 60-100m	Coastal plain	Medang Deras 60 - 100 m	Flowing Height= 0.5-0.6m Q=8.6-13m3/d	Q=40 m3/d (Estimated)	WT=32-35°C EC=580-710 pH=7-8 NH4 0.5-7 Fe 0.1-1 Cl=20-200
[IV] Confined Depth:130-160m	Coastal and Hilly Area	Medang 165m Indrapura 140m Sei Buahkeras 160m	Flowing Height= 1.5-3.2m Q=29-86m3/d (1981) decreasing	Q=210 m3/d ΔS=5.4m SC=38.9m3/d/m	WT 35-37°C EC 900-2,200 pH=8-9 NH4 1-1.9 Fe 0-0.3 Cl 3.4-41
[V] Confined Depth:200-230m	Coastal and Hilly Area	Limau Sundai 240m Lima Puluh 260 m	Flowing Height= 2.4-2.7m Q=15.6m3/d (1981)	Q=200 m3/d ΔS=12.0m SC=16.7m3/d/m	WT 35-37°C EC 420 pH=8.0-8.5 NH4 1.5-2.0 Fe 0-0.060 Cl 6-12

Note ΔS : Dropdown of Groundwater
Q : Discharge by pump
SC : Specific Capacity
WT : Water Temperature
EC : Electric Conductivity(μS/cm)
NH4 : Ammonium (ppm)
Fe : Iron (ppm)
Cl : Chlorine ion (ppm)

1.5 Geoelectric Prospecting

(1) Survey Method

Geoelectric prospecting is the most common method of geophysical survey for groundwater exploration. The field operation measures a series of values of earth resistivities at respective measurement stations through two pairs of electrodes set in the ground. The survey method of using electrodes is referred to as Wenner's 4-electrode system and it forms the basis for specific resistivity prospecting, as shown in Fig. 1-7.

The apparent resistivity is given by the ratio of voltage to current times a spacing factor.

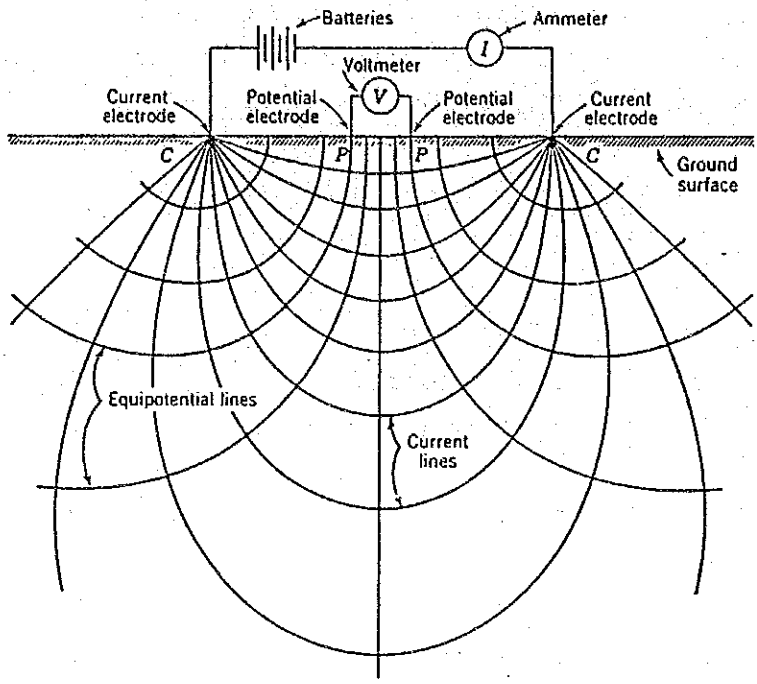
For the Wenner arrangement, the apparent resistivity is:

$$\sigma = 2\pi a \times V/I$$

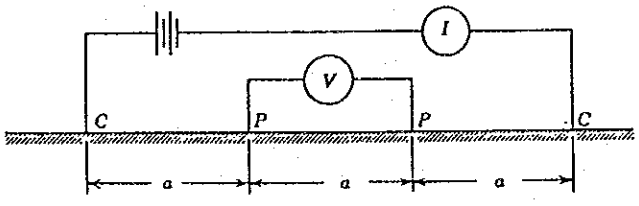
where, σ = Earth resistivity
a = Distance between adjacent electrodes
V = Voltage difference between the potantial electrodes
I = Applied current

The results of measurements are used to obtain information on the subsurface geological structures and groundwater potentiality. For the survey, the electric resistivity instrument Model ES-G1/G2 manufactured by Oyo Corporation, Japan, was employed, effectively applied for the groundwater exploration.

FIG. 1-7 GEOELECTRIC PROSPECTING AND WENNER METHOD



Electrical circuit for resistivity determination and electrical field for a homogeneous subsurface stratum.



Common electrode arrangements for resistivity determination.

(2) Interpretation

Actual earth resistivities of rock formations vary over a wide range depending on material density, porsity and water content. For example, clay and silt with high water content has low resistivity of 1 to 15 ohm-m, whereas a good aquifer of sand and gravel indicates a resistivity of 50 to 150 ohm-m. Consolidated rock of basalt has a very high resistivity of over 1,000 ohm-m. However, a partly fractured water containing zone of this rock shows relatively low resistivities.

The survey was performed to investigate the existence and depth of confined aquifers, and the characteristics of groundwater potentiality. For this purpose, two survey stations were laid out in the each project site at the prospective depth of 260 m and the most promissing water well drilling depth was decided based on the interpretation of the geoelectric prospecting curve. Fig. 1-8 shows the example of geoelectric prospecting curve obtained in the village of Silau Maraja and its analysis of earth resistivity.

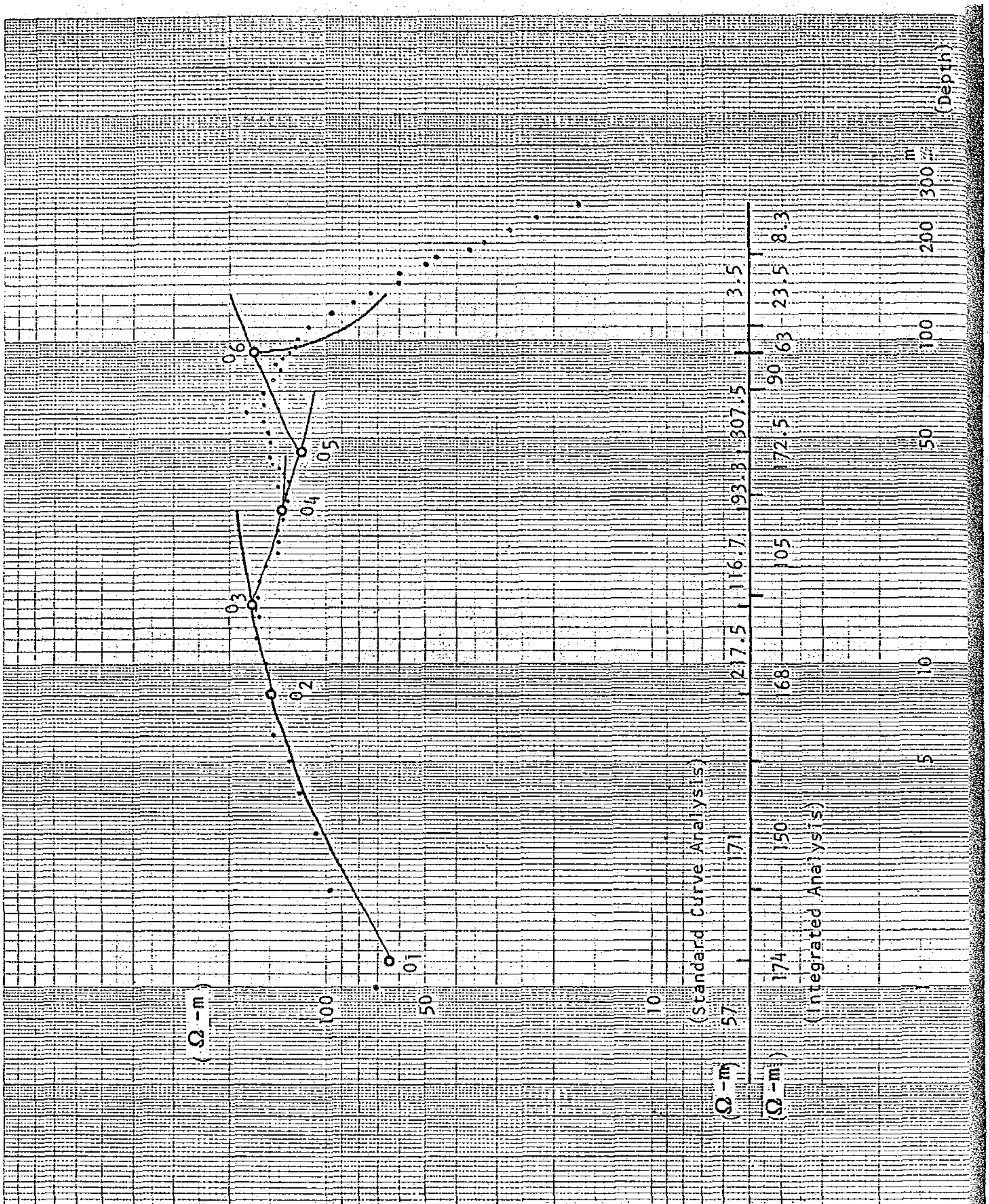


FIG. 1-8 EXAMPLE OF GEOELECTRIC PROSPECTIVE CURVE
(SILAU MARAJA VILLAGE)

II. OUTLINE OF THE PROJECT SITES

2.1 Sub Village No.16 of Simpang Gambus (in Lima Puluh District)

(1) Outline of the Village

The village of Simpang Gambus, located 7 km southeast of Indrapura, faces to the Provincial road at the entrance of the village and is extended to east about 12 km.

The village being composed of 16 sub-villages has a total poulation of 7,802 with 1,566 households. Its area is 882 ha in which rice fields occupy 491 ha (56%). The village land is rather flat, though it is lowered towards east, coastal line. The village is divided by plantation at the center into two parts. The proposed site of a new deep well is located in the eastern part of the village: sub-village No.16.

Main buildings in the village are 8 schools, 2 big mosques, 7 small mosques, 7 churches and 1 village office. The village has not been yet supplied by public electricity (PLN).

As to water supply, there exist no deep wells and all people depend on shallow dug wells. Water of wells nearby the provincial road is comparatively good, however, water quality gets worse in the eastern area as groundwater level gets shallow. In the plantation, a water supply ystem with an elevated tank and pipelines was constructed one year ago, using deep well water depth of which is about 135 m.

(2) Outline of the Sub Village No.16

This sub village was developed in 1955 together with the adjacent sub-village No.12 by transmigration of Batak people from North Tapanuli; this condition is almost same as Limau Sundai Village where JICA's deep well was sunk in 1981.

The sub-village has 60 households and 350 in population and their job is almost farming. Being the so-called developed sub-village, their houses are placed compactly and orderly, and the housing area is clearly separated from rice fields. This status is considered a suitable condition for construction of an effective water supply system.

Among 60 households, 8 houses keep their-own private shallow wells and others take water from the two public shallow wells constructed in 1966 and 1967. Water quality of these wells is unsatisfactory: rather turbid and it seems hard to take water in dry seasons due to decrease of water level.

In January 1986, cholera, one of typical water-borne diseases broke out and two persons (one 18 years boy and one 3 years girl) died among 8 patients. The outbreak of cholera was since 1969.

This sub-village is directly connected to the adjacent sub-village No.12, therefore, in case water supply system is constructed in the sub-village No.16, people of sub-village No.12 will utilize it frequently.

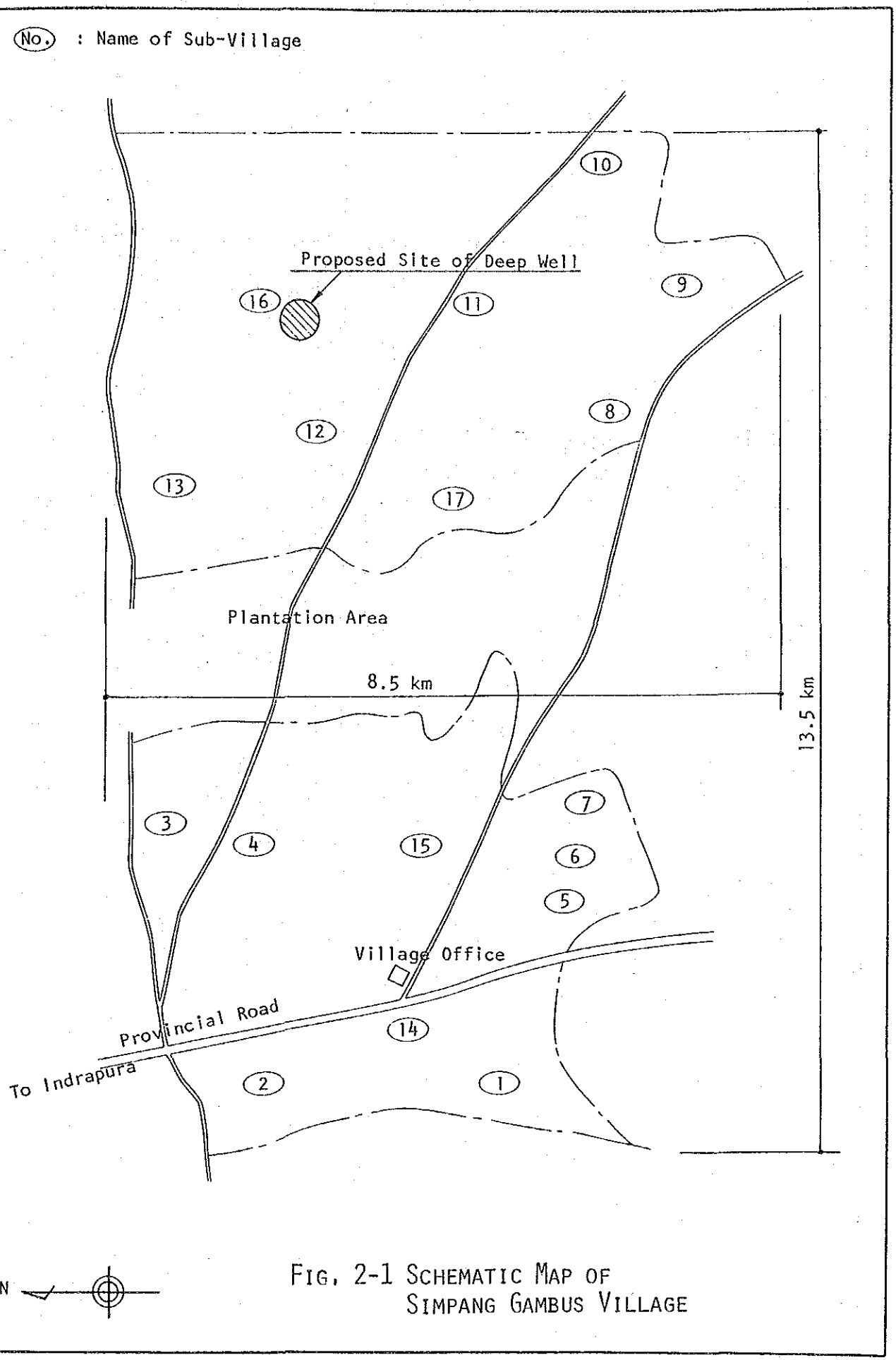


FIG. 2-1 SCHEMATIC MAP OF SIMPANG GAMBUS VILLAGE

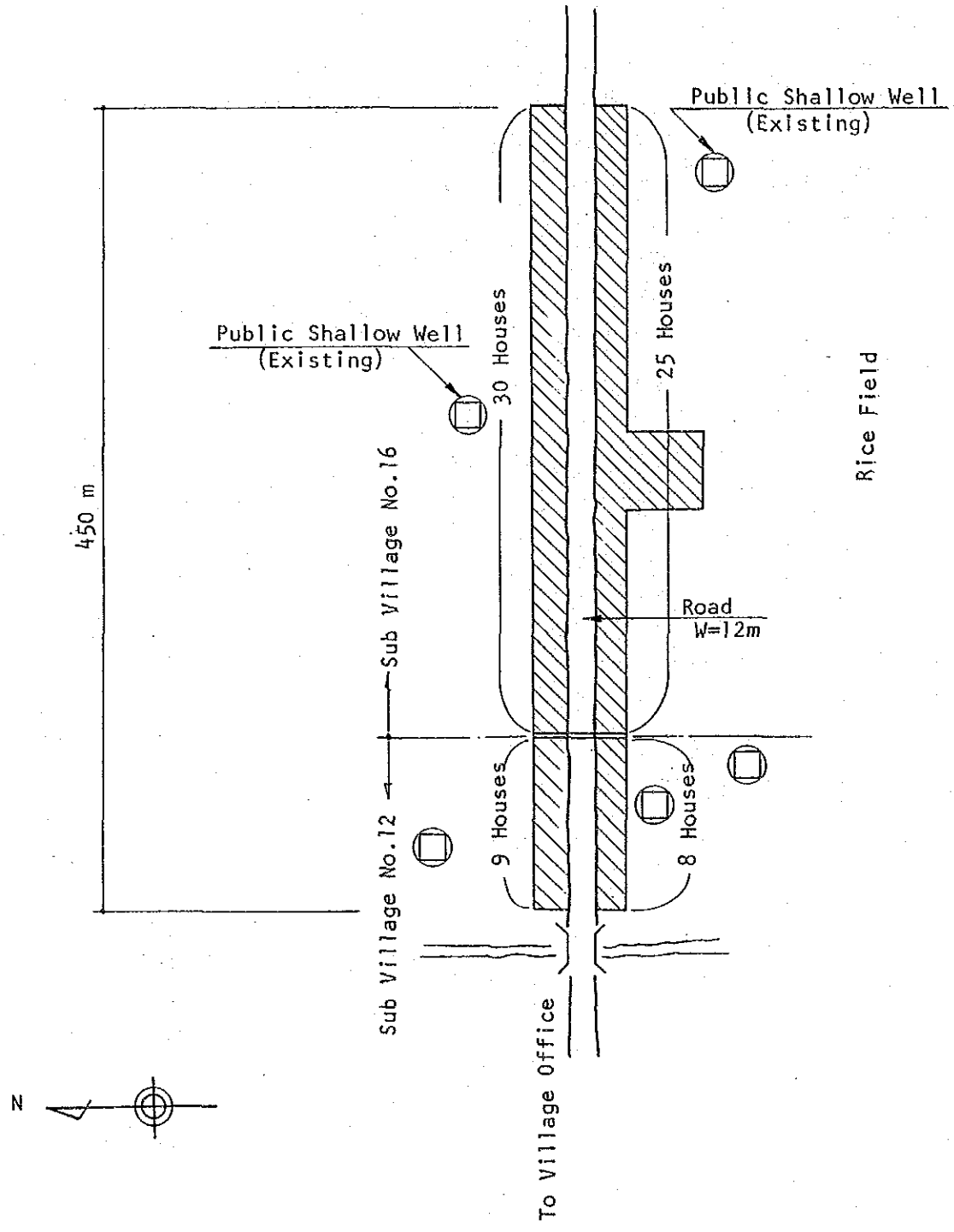


FIG. 2-2 SCHEMATIC MAP OF
SUB VILLAGE NO.16 IN SIMPANG GAMBUS

2.2 Sub Village of Pematang Pao of Ujung Kubu Village (in Tanjung Tiram District)

(1) Outline of the Village

The village of Ujung Kubu, the biggest village among 19 villages in Tanjung Tiram District, is located east of Tanjung Tiram and it faces to Malacca Straits northern side.

The village is composed of 20 sub-villages and have population of 12,229 consisting of 6,634 males and 5,595 females, with 2,495 households. Its area extends to about 10,000 ha including 2,200 ha of plantation and 1,500 ha of forest. Main public buildings are 2 big mosques, 22 small mosques, 7 churches and 1 village office.

Peoples live on agriculture (73 %), fishery (5 %) and house-industries (16 %); and their religions are Islam (81 %) and Protestantism (19 %).

The village people take daily-use water partly from deep wells (1 public well and 8 private wells with depth of about 80 m) and others from shallow dug wells.

(2) Outline of the Sub Village of Pematang Pao

Pematang Pao where a new deep well is to be constructed, is situated at the most eastern part of the village and is the second biggest sub-village in population among 20 sub-villages.

This sub village with present population of 1,300 and 250 households was formed in 1963 by transmigration of Batak people from North Tapanuli as well as the case of the Sub Village No.16 of Simpang Gambus Village. Almost all of the prople works on agriculture of rice fields. Their religions are Islam (16 %) and Christianity (84 %).

Regarding communicable diseases, cholera happens and leads death of patients.

Although public electricty has not been supplied yet, all houses take electricity from two private generators recently installed. A household pays Rp.1,000/month in average for 10 watt's electric equipment.

The people take water from shallow dug wells held by about 2/3 households. Water level of the wells is very shallow as 0.5 - 1.0 meters from the ground, and its quality is considered poorest among others in the present survey as drinking water. It is dark-yellow colored and turbid, and hygienically contaminated due to lack of protection.

Affordability to pay for drinkable water will be about Rp.200/month judging from their income and current payment to electricity.

Sampled water from two shallow wells were analyzed and shown below:

Table 2-1 Water Analysis

(Pematang Pao)

Sample No.	Well Type	Well Depth (m)	Well Water (m)	Water Temp. (C)	Turbidity (ppm)	Color (ppm)	pH	Elec. Cond. μS/cm	NH3-N (ppm)	NO2-N (ppm)	Fe (ppm)	Bacteria /ml	Coliform /ml
No.1	Shal	1.5	0.8	29	-	200	6.9	910	1.2	0.05	0.8	300	150
No.2	Shal	1.5	0.8	29	-	200	6.7	360	1.2	0.05	0.8	250	100

Note:
- Both are similar each other in quality, but No.1 is much contaminated.
- Containing high color, much iron, NH3-N, both are not suitable for drinking purpose.
- High color is considered due to much iron contained and dissolved organic matters in the soil.
- Considering existence of NH3-N, NO2-N, and much bacteria and coliform groups, the wells contain human disposals.

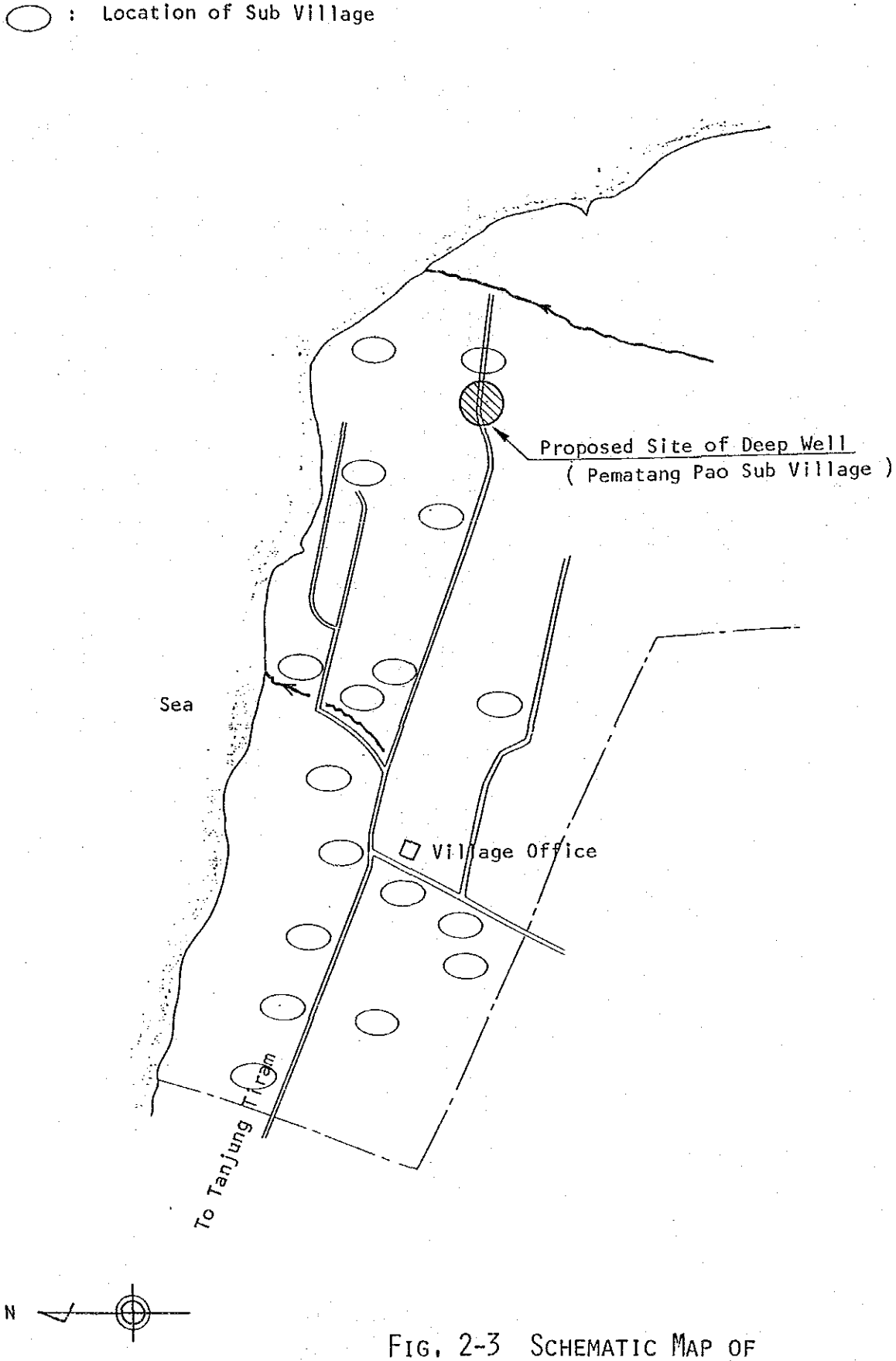


FIG. 2-3 SCHEMATIC MAP OF UJUNG KUBU VILLAGE

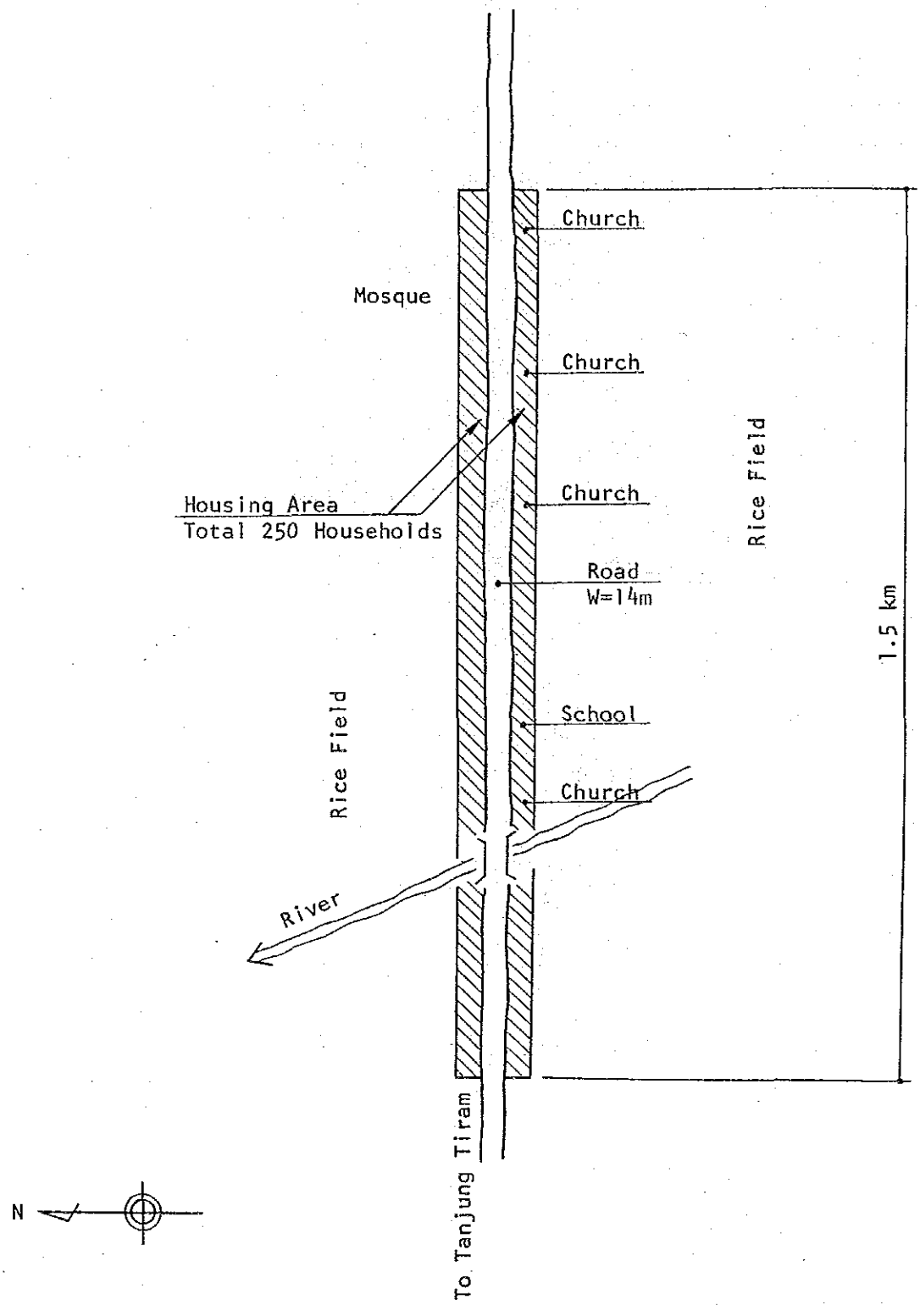


FIG. 2-4 SCHEMATIC MAP OF PEMATANG PAO SUB VILLAGE

2.3 Tinggi Raja Village (in Buntu Pane District)

(1) Outline of the Village

The village of Tinggi Raja was settled in 1929 and had been developing with plantation industry.

Present total population of the village composed of 13 sub-villages is 6,246 with 1,071 households.

The total land area is 2,141 ha including rice field of 250 ha (12 %); while plantation area of rubber, coconut, cacao etc. occupies 1,845 ha (86 %), great majority of the land of the village.

The people is composed of Jawanese (73 %) and Batak people (24 %), and most of them are farmers (36 %) or plantation workers (26 %). Almost all of them (99 %) is Moslem.

As to electricity, public electricity (PLN) is scheduled to be supplied within 1986. Currently about 250 households (23 %) use electricity by private generators.

(2) Present Water Use

Present water use is classified into three categories, and they are:

- Category 1: Vicinity of the village office.
  People use both shallow dug well water and river water. The shalalow well with depth of 3 m has no good water and people use this for washing and bathing only, and for drinking/ cooking purpose they obtain surface river water which is clearer than the shallow well water.

- Category 2: Rather hilly place.
  Water source is rather-deep dug well water, with depth of 8 - 13 m. Its quality is better than that of Category 1. However, its construction cost is high as about Rp.200,000: accordingly number of the wells already constructed is not much. During the period of dry season continuing several months the wells are almost dried up, and people there is forced to go to a remote river to take water.

- Category 3: Places surrounded by plantation.
  Peoples depend on shallw wells' water; quality of which is placed between those of Categories 1 and 2.

Among the aboves, high priority for development of new water source is placed on the area of Category 2, where well water is scarecely available in dry seasons. In fact, INPRES wells of 5 units with approximate 20 m depth were placed in this area. These wells are now out of use because of damage of handpumps installed.

Water taken from shallow wells in the village is analysed as below:

Table 2-2 Water Analysis
(Tinggi Raja)

Sample No.	Well			Water Temp. (C)	Turbidity (ppm)	Color (ppm)	pH	Elec. Cond. μS/cm	NH3-N (ppm)	NO2-N (ppm)	Fe (ppm)	Bacteria /ml	Coliform /ml
	Type	Depth (m)	Water (m)										
No.1	Shal			25.9	20	50	7.0	130	0.4	0.0	0.5	500	50
No.2	Shal	2.5	1.0	26.7-	15	100	7.1	210	0.6	0.0	0.3	500	30
No.3	Shal	13	3	27.5	0	1	6.5	510	3.5	0.15	0.2	30	15

Note:

- No.1 (Shallow well in the Health Center) shows high turbidity and high color, much iron, NH3-N, general bacteria and coliform groups; apparently polluted.
- No.2 is similar to No.1, and further has higher color being not suitable for drinking.
- No.3 is in good appearance, however it might be polluted because of existence of coliform groups. Its higher NH3-N would not necessarily show contamination but it probably due to water aquifer itself, because of little bacteria.

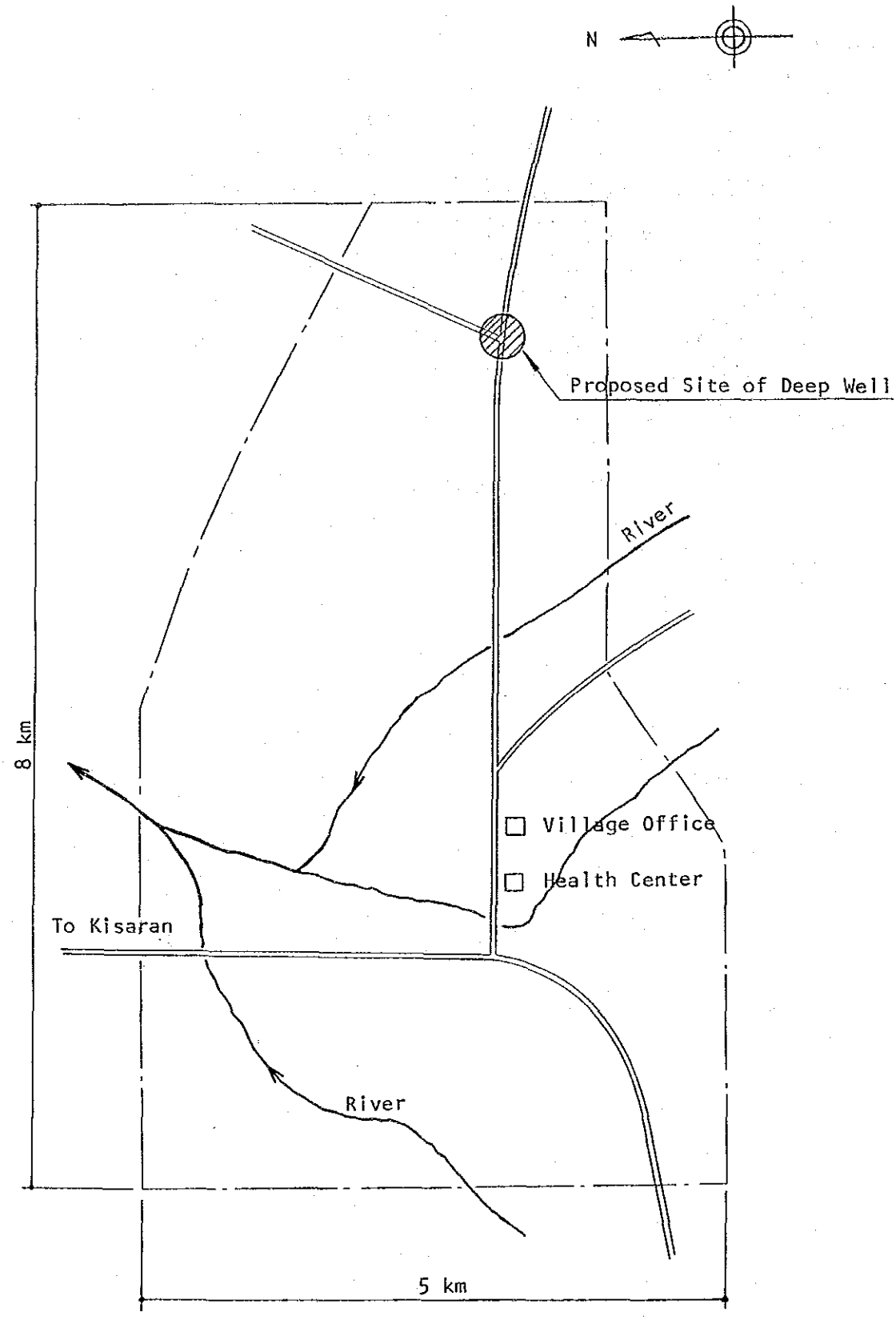


FIG. 2-5 SCHEMATIC MAP OF TINGGI RAJA VILLAGE

2.4 Silau Maraja Village (in Buntu Pane District)

(1) Outline of the Village

The village of Silau Maraja originated in 1935 by Batak peoples' transmigration from North Tapanuli, while surrounding plantation was already started before that age. It is located about 20 km southwest of Kisaran, the capital of Asahan Regency.

Population of the village in 1984 was 1,900 consisting of 966 males and 934 females. Annual population increase showed rather high rate at 5 %, because of scarcity of family planning.

Total area of the village is 1,332 ha, composed of plantation (63 %), rice field (17 %), housing area (8 %) and others.

Most people of village (80 %) are farmers including plantation workers. The people is composed of Batak (87 %) and Jawanese (13 %) in human tribes; and Islam (32 %), Protestant (66 %) and Catholic (2 %) in their religions.

Main public buildings in the village are 1 big mosque, 2 small mosques, 8 churches and 1 village office.

As to disease, malaria, cholera and skin disease and in 1983 four persons were died of cholera.

Public electricity (PLN) has not been supplied yet; however the village holds a cooperation which operates generators and supplies electricity to houses. Presently about 200 households (58 %) are supplied among total households of 345; and each house pays in average Rp.5,000/month for the electricity (Rp. 125/Watts x 40 Watts).

(2) Present Water Use

Currently all houses in the village take water from dug wells for daily use. The wells are rather-deeply-dug shallow wells with depth of 10 - 12 m. Water depth in the wells ranges about 2 m in rainy seasons and 1.0 - 0.3 m in dry seasons; and water quality is not always suitable higienically.

The deeper depth of these wells gives much difficulty to peoples. It requires high construction cost and is dangerous to children. Construction cost is rather high at Rp.70,000 for one well, and households which keep wells are about 50 % only. As to danger, in the past 15 years period, 5 children died by accidents of falling-down into wells.

In the past years, totally 14 INPRES wells with depth of 12 - 15 m were constructed, however, none of them are working at present due to damage of handpumps installed, as well as those of many other villages.

Affordability of the people in this village to potable water is estimated at Rp.500/month, judging from present expense of Rp.5,000/month to electricity.

Water analysis of a shallow well in the village and of a deep well of IKK located 4 km from the village are shown below:

Table 2-3 Water Analysis

(Silau Maraja)

Sam-ple No.	Well			Water Temp. (C)	Turbi-dity (ppm)	Color (ppm)	pH	Elec. Cond. μS/cm	NH3-N (ppm)	NO2-N (ppm)	Fe (ppm)	Bac-teria /ml	Coli form /ml
	Type	Depth (m)	Water (m)										
No.1	Deep	260		30.7	1	2	6.9	202	0.0	0.0	0.0	0	0
No.2	Shal	10		27.0	0.5	1	6.2	205	0.4	0.0	0.0	120	240

Note: - No.1 water of a deep well is potable enough, being free from contamination.
- No.2 water is polluted by human disposals because of existence of NH3-N and coliform groups, and not suitable as drinking water.

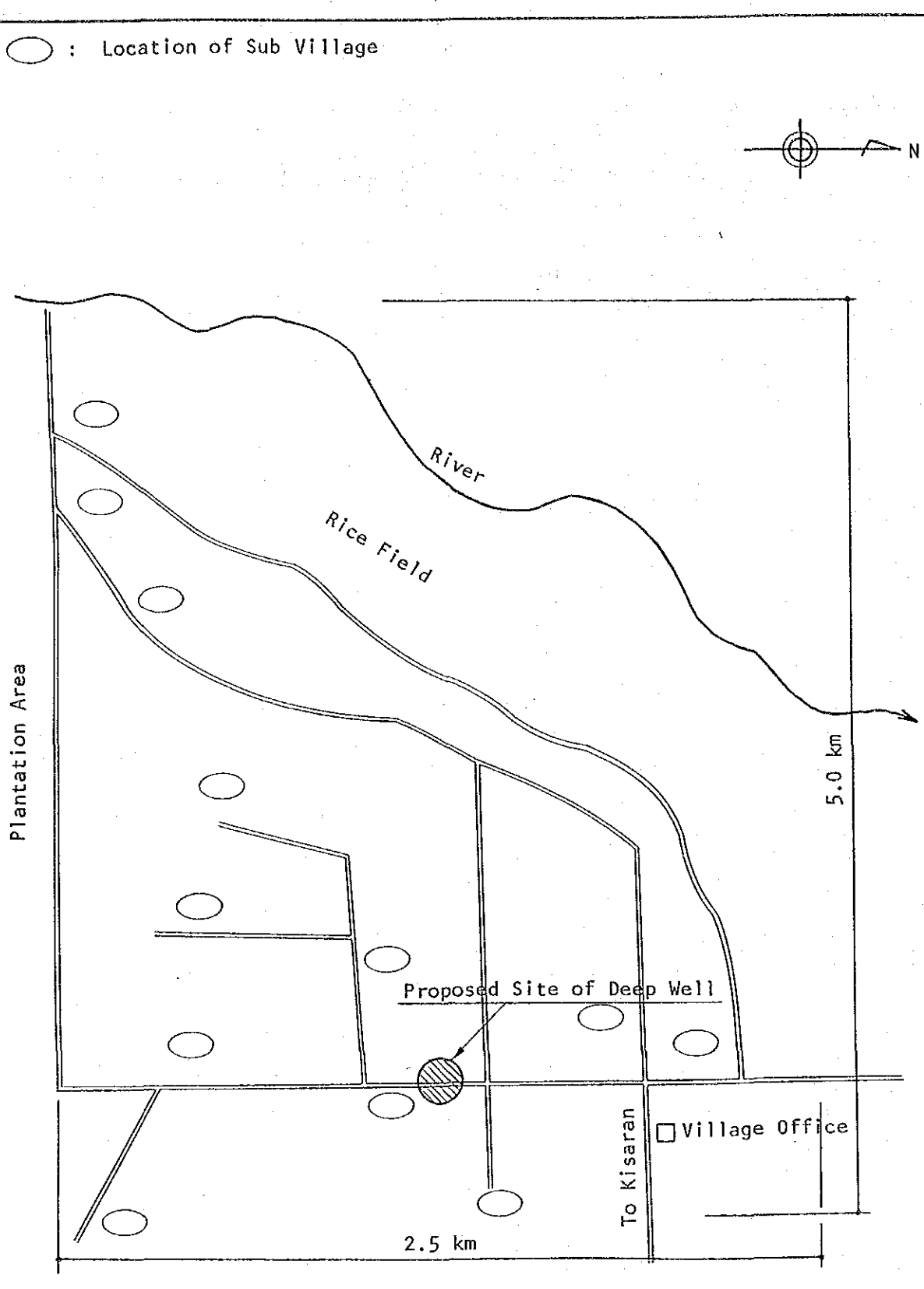


FIG. 2-6 SCHEMATIC MAP OF SILAU MARAJA VILLAGE

2.5 Padang Mahondang Village (in Pulau Rakyat District)

(1) Outline of the Village

Vicinity of the village was originally developed in 1920 by a Belgian palm oil company with plantation which needed plantation workers and then Jawaneses transmigrated to the village. In 1962, Batak people commenced transmigration to the village with 100 households for farming, and they are presently majority of inhabitants.

Total population of the village in 1984 was 7,454 (male: 3,766 and female: 3,688) with households of 1,414; and annual population increase was 101 persons (1.4 % per annum).

The village land appears comparatively flat and its total land area is 9,133 ha; its majority is forest/wild land (64 %), followed by farming land (rice field).

Majority of the people live on agriculture (77 %) and river fishery (4 %).

The people is composed of Batak (71 %) and Jawanese (25 %), and their religions are Islam (34 %), Protestantism (47 %) and Catholicism (18 %).

Regarding public buildings in the village, there exist 3 big mosques, 3 small mosques, 19 churches, 8 schools, 1 clinic and 1 village office.

As to disease, skin disease and influenza are very common, and no case of cholera happened in 1985, while 3 cases in 1984.

Public electricity is not yet supplied in the village; however, 840 households or 59 % among whole households is supplied with electricity by private generators of the village cooperation. They pay Rp.2,800/month in average at the unit cost of Rp.1,400/10 w/month.

(2) Present Water Use

People in the village fully depend on shallow well water for all purposes, including drinking and cooking.
Almost all of households has their own wells with depth of 3 - 4 m anywhere in the village. Water level of the wells fluctuates by seasons but water has not been dried up. However, the wells are not walled but just dug; and almost no lavatories exist, therefore, their water quality is judged extremely doubtful hygienically.

In 1976, 10 units of INPRES' well were constructed, but among them only one unit is currently working, which is maintained by the clinic and others have been abandoned due to breakage of handpumps installed.

Water analysis for two shallow wells in the village are given below:

Table 2-4 Water Analysis
(Padang Mahondang)

Sam-ple No.	Well Type	Depth (m)	Water (m)	Water Temp. (C)	Turbi-dity (ppm)	Color (ppm)	pH	Elec. Cond. μS/cm	NH3-N (ppm)	NO2-N (ppm)	Fe (ppm)	Bac-teria /ml	Coli form /ml
No.1	Shal	4		27.8	1	2	7.5	230	0.0	0.0	0.0	500	1000
No.2	Shal	4		32.6	0.5	2	5.7	180	0.0	0.0	0.0	-	-

Note: - No.1 water is contaminated bacteriologically.
- No. 2 water is considered chemically acceptable, except the lower value of pH which is probably due to extricated carbonate.

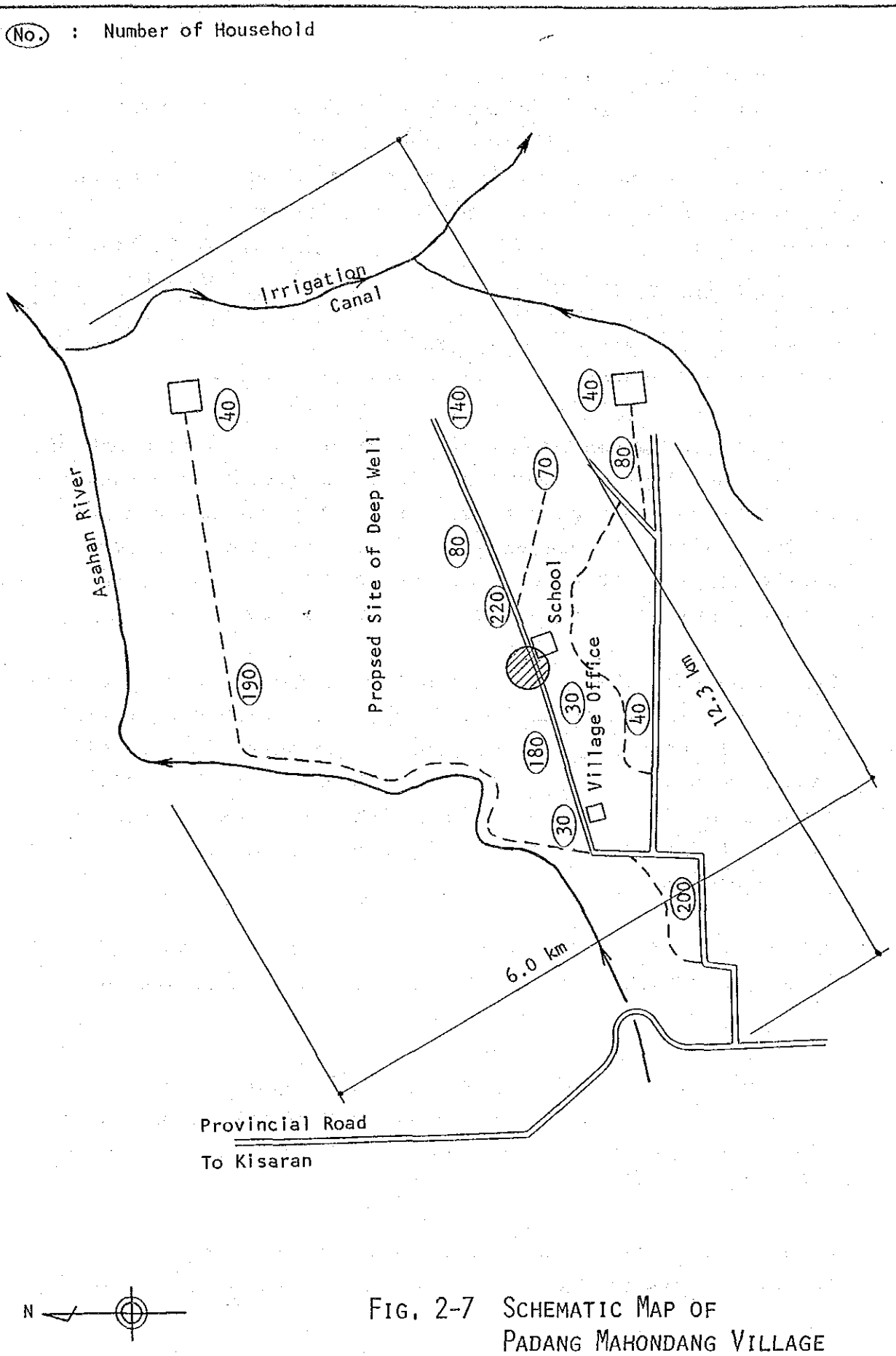


FIG. 2-7 SCHEMATIC MAP OF PADANG MAHONDANG VILLAGE

2.6 Pulau Rakyat Health Center
(at Pulau Rakyat Tua Village in Pulau Rakyat District)

This Center is one of two health centers located in Pulau Rakyat District, and its complex is composed of the followings:

- One clinic building,
- One hospital with 10 beds, and
- Four staff houses.

Water source currently used is a shallow well with depth of 6 m. Water level is about 2 m from the ground in March, but the water has been almost dried up in dry seasons and both of its quality and quantity is not satisfactory for such health centers. Partly due to the problem of water, the hospital has not been effectively functioned.

Supposing that the hospital and the clinic are supplied with enough water with suitable quality, the health center will remarkably contribute to peoples in the district, as well as Indrapura Health Center in Air Putih District where JICA constructed in 1980 a deep well with a submersible pump and an elevated tank and it has helped proper activities of the Health Center.

Water requirement of the Pulau Rakyat Health Center Complex is estimated around 10 m3/day of the above whole facilities including 24 working staff's use.

As to electricity, the Center currently operates a private-own generator; however, supply of public electricity (PLN) is scheduled to start in this village within the year 1986.

Water sampled from the existing shallow well in the Health Center was analyzed and is shown in the following table.

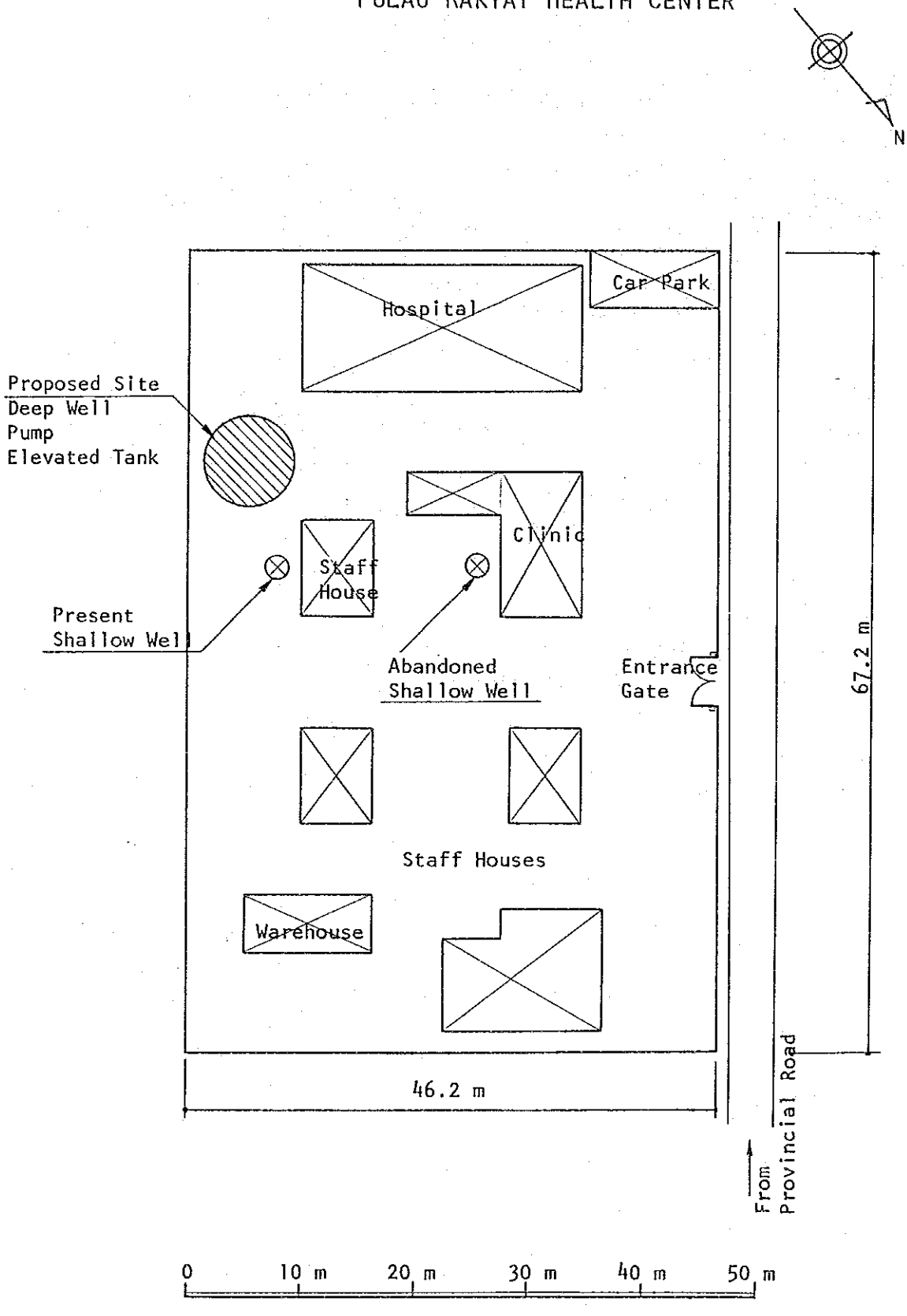
Table 2-5 Water Analysis

(Pulau Rakyat Health Center)

Sample No.	Well			Water Temp. (C)	Turbidity (ppm)	Color (ppm)	pH	Elec. Cond. μS/cm	NH3-N (ppm)	NO2-N (ppm)	Fe (ppm)	Bacteria /ml	Coliform /ml
	Type	Depth (m)	Water (m)										
No.1	Shal	6.0	4.0	31	0	0	6.8	110	0.0	0.0	0.0	90	80

Note: - The water is chemically acceptable but bacteriologically doubtful.

FIG. 2-8 SITE MAP OF
PULAU RAKYAT HEALTH CENTER



III. GEOELECTRIC PROSPECTING IN THE PROJECT SITES

3.1 Sub Village No.16 of Simpang Gambus Village

The project site No.1 of Sub Village No.16 Simpang Gambus Village is located on the coastal plain: flat area surrounded by paddy fields with elevation around few meters above sea level, and the hinterland of hilly places is a developed plantation of oil palm. The existing sole water source in the area is shallow dug wells with depth of 2 m to 8 m and they are contaminated by waste water. Though no deepwells exist in the project site, a deepwell for plantation employees was constructed in 1985 in the plantation of the hilly place with a depth of 135 m.

Concerning groundwater potential survey, geoelectric prospecting was carried out at two stations: in the center of the sub-village No.16 of Simpang Gambus Village and near a deepwell in the plantation on the hill. Each prospecting depth was 260 m. The integrated hydrogeological interpretation including analysis of geoelectric prospecting is concludeed in Fig.3-1.

In the project site where groundwater potential is comparatively high, the prospective confined aquifer is expected at depth ranging from 160 m to 180 m, indicating earth resistivities ranging from 105 Ω-m to 145 Ω-m. Concerning the analysis of earth resistivities, the actual earth resistivities are higher than those in other alluvial areas. Sands and volcanic products are abundant, and clay and silt layers are limited in the area. The project site No.1 is situated at the edge of the artesian groundwater basin, and self-flow of groundwater is expected.

A groundwater development program has been planned as follows:

- Well Drilling Point: Sub-village No.16 of Simpang Gambus Village (Fig.2-1)
- Expected Aquifer Depth: 135 m - 170 m
- Well Drilling Depth: 180 m
- Well Diameter: ϕ 6"

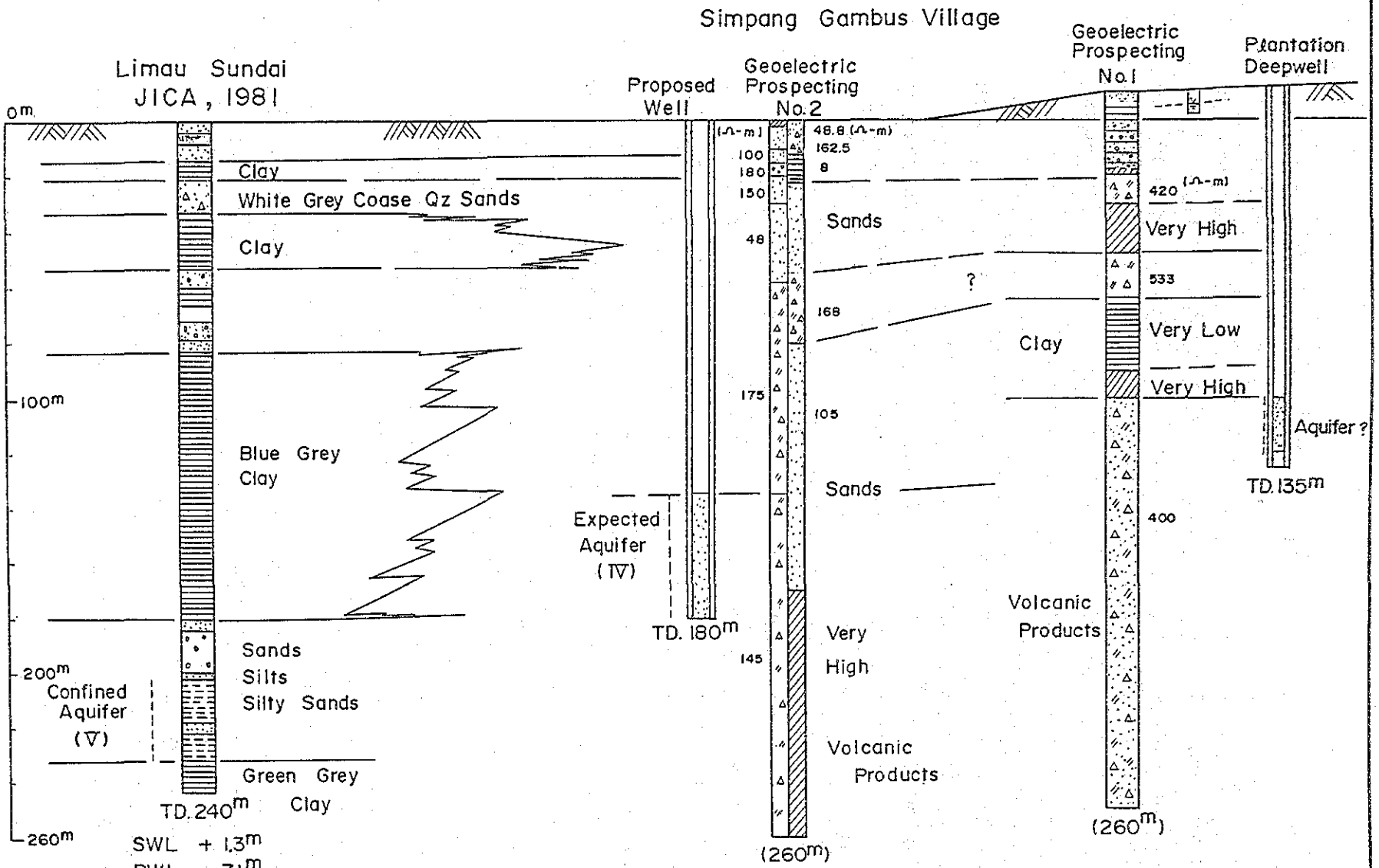


FIG. 3-1 HYDROGEOLOGICAL INTERPRETATION
(SIMPANG GAMBUS)

3.2 Sub Village of Pematang Pao of Ujung Kubu Village

The project site No.2 of Sub Village of Pematang Pao of Ujung Kubu Village is located on the coastal plain: flat area surrounded by paddy fields with elevation around few meters. The existing water sources in the project site are shallow dug wells with depth of 1.5 m to 2.0 m and these wells are contaminated by human disposals. The water is colored with yellow to brown and is not suitable for drinking purpose. Though no deepwells are in the project site, there exist a public deepwell and eight private deepwells in Ujung Kubu Village, far from 3 - 4 km from the site. Water quality of those deepwells is suitable for public water supply.

Concerning groundwater potential survey, geoelectric prospecting was carried out at two stations: in the center of the sub-village of Pematang Pao and near the public deepwell in Ujung Kubu with depth of 100 m. Each prospecting depth was 260 m. The integrated hydrogeological interpretation including analysis of geoelectric prospecting is concluded in Fig.3-2.

The project site No.2 is located in the artesian groundwater basin and based on the analysis of geoeolectric prospecting there are alternating thick sand/gravel layers and clay layers. In the project site where groundwater potential is comparatively high, the prospecting confined aquifer is expected at depth ranging from 130 m - 170 m, indicating earth resistivities ranging from 22 Ω-m to 4 Ω-m. On the other hand, the alternating thick clay layers with sands and gravel exist indicating earth resistivities ranging from 2.6 Ω-m to 6.0 Ω-m; therefore, self-flow of groundwater is expected in this area. The quantity of groundwater flow, however, is not big enough for the public water supply in

the area, and it will require a submersible pump. According to the existing 9 deepwells in Ujung Kubu Village quality of deep well water in the project site is expected to be suitable for a public water supply.

A groundwater development program has been planned as follows:

- Well Drilling Point: In the center of the sub-village of Pematang Pao Sub Village (Fig.2-3).
- Expected Aquifer Depth: 130 m - 170 m
- Well Drilling Depth: 180 m
- Well Diameter: ϕ 6"

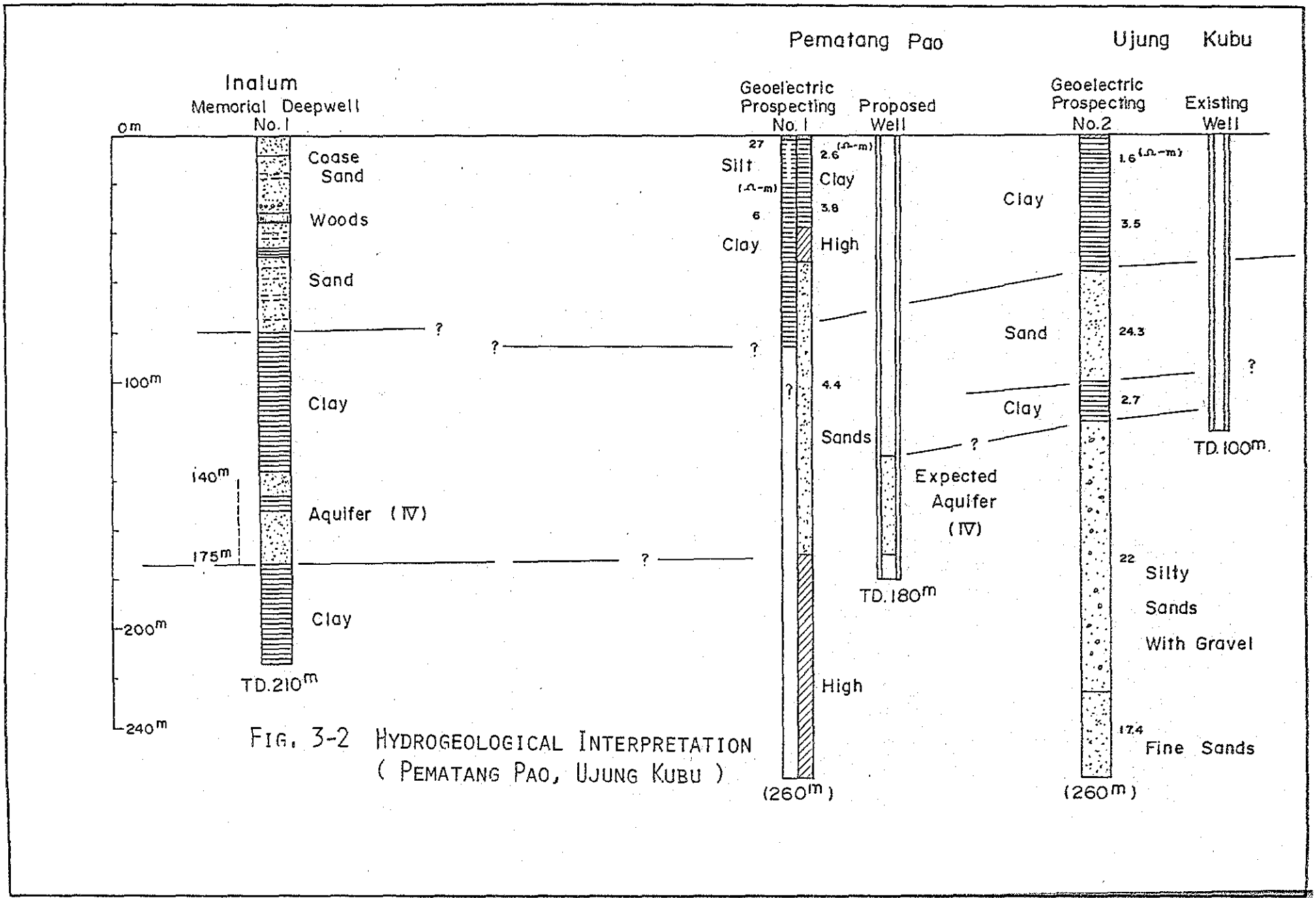


FIG. 3-2 HYDROGEOLOGICAL INTERPRETATION
(PEMATANG PAO, UJUNG KUBU)

3.3 Tinggi Raja Village

The project site No.3 of Tinggi Raja Village consists topographically of two parts, the low river terrace and hilly places, and the proposed water supply area is situated on the hilly part. The existing water sources are mainly shallow dug wells and river water occationally used for domestic purpose. Deepwells do not exist in the project site, and shallow dug wells on the hilly place with a depth of 8 m - 10 m are often dried up during dry seasons.

Concerning groundwater potential survey, geoelectric prospecting was carried out at two stations; on the low flat area of river terrace and in the sub village of the hilly place. Each prospecting depth was 260 m. The integrated hydrogeological interpretation including analysis of geoelectric prospecting is concluded in Fig.3-3.

The project site No.3 is hydrogeologically located on Quaternary volcanic products area, therefore groundwater potential is expected comparatively high. The surface of the area is covered by Quaternary volcanic products indicating earth resitivities ranging from 236 Ω-m to 90 Ω-m. There also exist very thick clay and silt layers indicating earth resistivities ranging from 1.7 Ω-m to 17.3 Ω-m and the expecting confined aquifer indicating earth resistivities ranging from 57.5 Ω-m to 58.5 Ω-m. The confined aquifer (V) is expected at the depth more than 230 m in the lower river terrace and the depth ranging from 190 m - 210 m in the other hilly places. During the test well drilling, the confined aquifer (IV) shall be also examined in the depth ranging from 130 m - 160 m. In the project site, self-flow of groundwater is not expected, and water quality will be good for the water supply.

A groundwater development program has been planned as follow:

- Well Drilling Point: On the hilly part of the village of Tinggi Raja (Fig.2-5)
- Expected Aquifer Depth: 130 m - 160 m & 190 m - 210 m
- Well Drilling Depth: 220 m
- Well Diameter: ϕ 6"

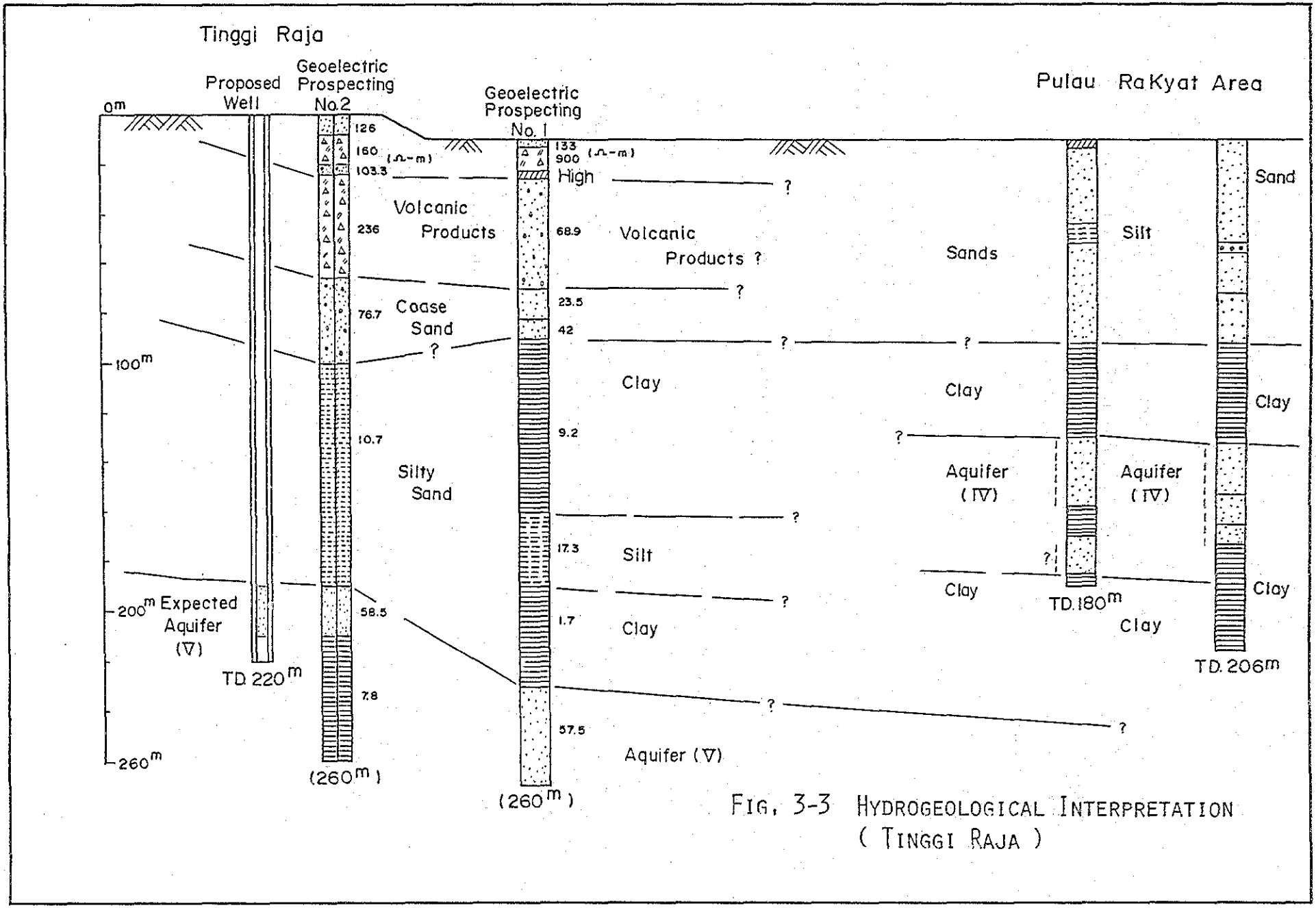


FIG. 3-3 HYDROGEOLOGICAL INTERPRETATION (TINGGI RAJA)

3.4 Silau Maraja Village

The project site No.4 of Silau Maraja Village is located on the hilly place surrounded by rubber plantation. The sole existing water source in the area is shallow dug wells with depth of 10 m to 12 m and the water level descreases in dry seasons and is almost dried. Neither quantity nor quality of water in the village is enough for domestic use.

Concerning groundwater potential survey, geoelectric prospecting was carried out at two stations in the central part of the village. Each prospecting depth was 260 m. The integrated hydrogeological interpretation including analysis of geoelectric prospecting is concluded in Fig.3-4.

The project site No.4 is hydrogeologically is located on Quarternary volcanic products area, and groundwater potential is comparatively high. The prospective confined aquifer indicating earth resistivities ranging from 23.5 Ω-m to 74 Ω-m are expected in the depths ranging from 170 m to 180 m, however the thickness of the aquifer is not so thick in these area comparing with coastal area. Concerning test well drilling, the confined aquifer indicating earth resistivities 22.5 Ω-m to 90 Ω-m and depth ranging from 90 m to 130 m also shall be examined for its potentiality. Although no deepwells exist in the project site, about 5 - 6 km east of the project site the IKK project deepwell was constructed in the hilly place with a depth of 260 m. The piezometric level of the deepwell is in almost self-flow condition and water quality is remarkably good. In the IKK project, groundwater is supplied by the submersible moter pump.

A groundwater development program has been planned in this site as follows:

- Well Drilling Point: In the center of the village of Silau Maraja (Fig. 2-6)
- Expected Aquifer Depth: 90 m - 130 m & 170 m - 180 m
- Well Drilling Depth: 190 m
- Well Diameter: ϕ 6"

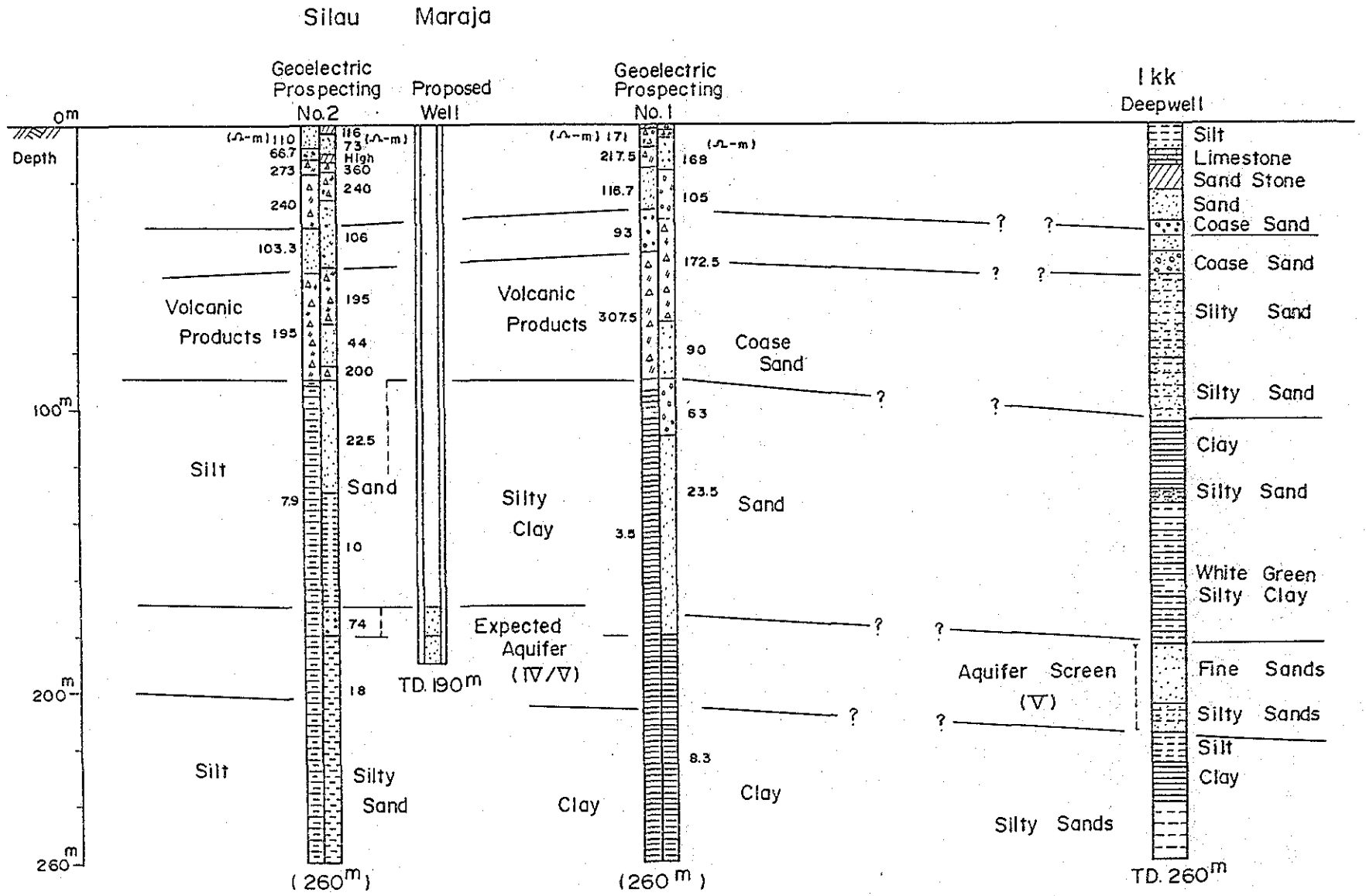


FIG. 3-4 HYDROGEOLOGICAL INTERPRETATION
(SILAU MARAJA)

3.5 Padang Mahondang Village

The project site No.5 of Padang Mahondang is located on the hilly place surrounded by oil palm plantation. The existing water source in the area is only shallow dug wells with depth of about 4 m. Though no deepwells exist in the project site, a deepwell with depth of 208 m was sunk in the oil palm plantation.

Concerning groundwater potential survey, geoelectric prospecting was carried out at two stations along the main road in the center of the village. Each prospecting depth was 260 m. The integrated hydrogeological interpretation including analysis of geoelectric prospecting is concluded in Fig.3-5.

The project site No.5 is hydrogeologically located on Quarternary volcanic products area; therefore groundwater potential is expected comparatively high. The most promising aquifer in this area is the confined aquifer (IV) indicating earth resistivities ranging from 15 Ω-m to 105 Ω-m at the depth ranging from 145 m to 170 m. There also exist thick clay and silt layers indicating earth resitivities ranging from 1.5 Ω-m to 2.7 Ω-m and 5.8 Ω-m to 9.0 Ω-m, respectively. Although self-flow of groundwater would not be expected, the piezometric level is comparatively shallow in depth. The water quality is expected to be good based on the analysis of the existing deepwell in the plantation.

A groundwater development program has been planned in this site as follows:

- Well Drilling Point: Near a public school in the center of the village of Padang Mahondang (Fig. 2-7).
- Expected Aquifer Depth: 145 m - 170 m
- Well Drilling Depth: 180 m
- Well Diameter: ϕ 6"

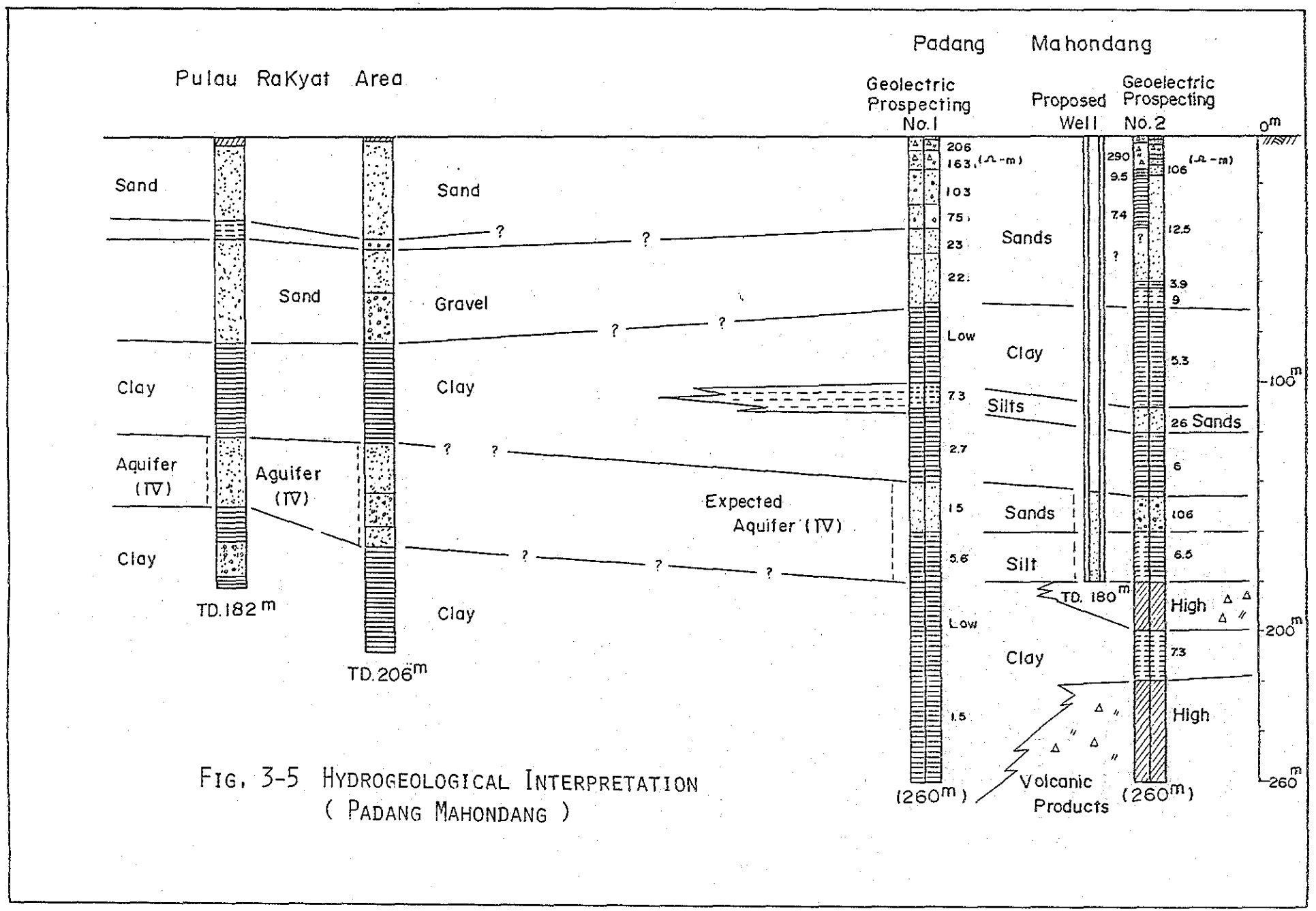


FIG. 3-5 HYDROGEOLOGICAL INTERPRETATION
(PADANG MAHONDANG)

3.6 Pulau Rakyat Health Center

The project site No.6 of Pulau Rakyat Health Center is located on the hilly flat area along the main road. The present water source is a shallow dug well with depth of about 6 m. Deepwells with depth ranging from 176 m to 202 m in the area have been constructed in the oil palm plantation and their water quality is comparatively good.

Concerning groundwater potential survey, geoelectric prospecting was carried out on the access road of the Health Center. The prospecting depth was 260 m. The integrated hydrogeological interpretation including analysis of geoelectric prospecting is concluded in Fig.3-6.

The project site No.6 is hydrogeologically located on Quaternary volcanic products area and the volcanic products indicating earth resistivities ranging from 175 Ω-m to 350 Ω-m cover the area with thickness about 80 m. The most promising aquifers in this area are expected in the confined aquifers IV and V indicating earth resitivities ranging from 44 Ω-m to 66 Ω-m at the depth ranging from 130 m to 190 m and 225 m to 260 m, respectively (Fig.3-6). The aquifers consisting of sand and gravel are clearly divided by the thick clay (9 Ω-m) and silt (16.7 Ω-m). Comparing with the deepwells in the oil palm plantations in Pulau Rakyat District, groundwater potential is comparatively high in the area and the well confined aquifer is expected in the depth of 120 m 160 m in the site. Water quality and quantity is also expected suitable for water supply.

A groundwater development program has been planned in ths site as follows:

- Well Drilling Point: The back-yard of Pulau Rakyat Health Center (Fig.2-8)
- Expected Aquifer Depth: 130 m - 190 m
- Well Drilling Depth: 200 m
- Well Diameter: ϕ 6"

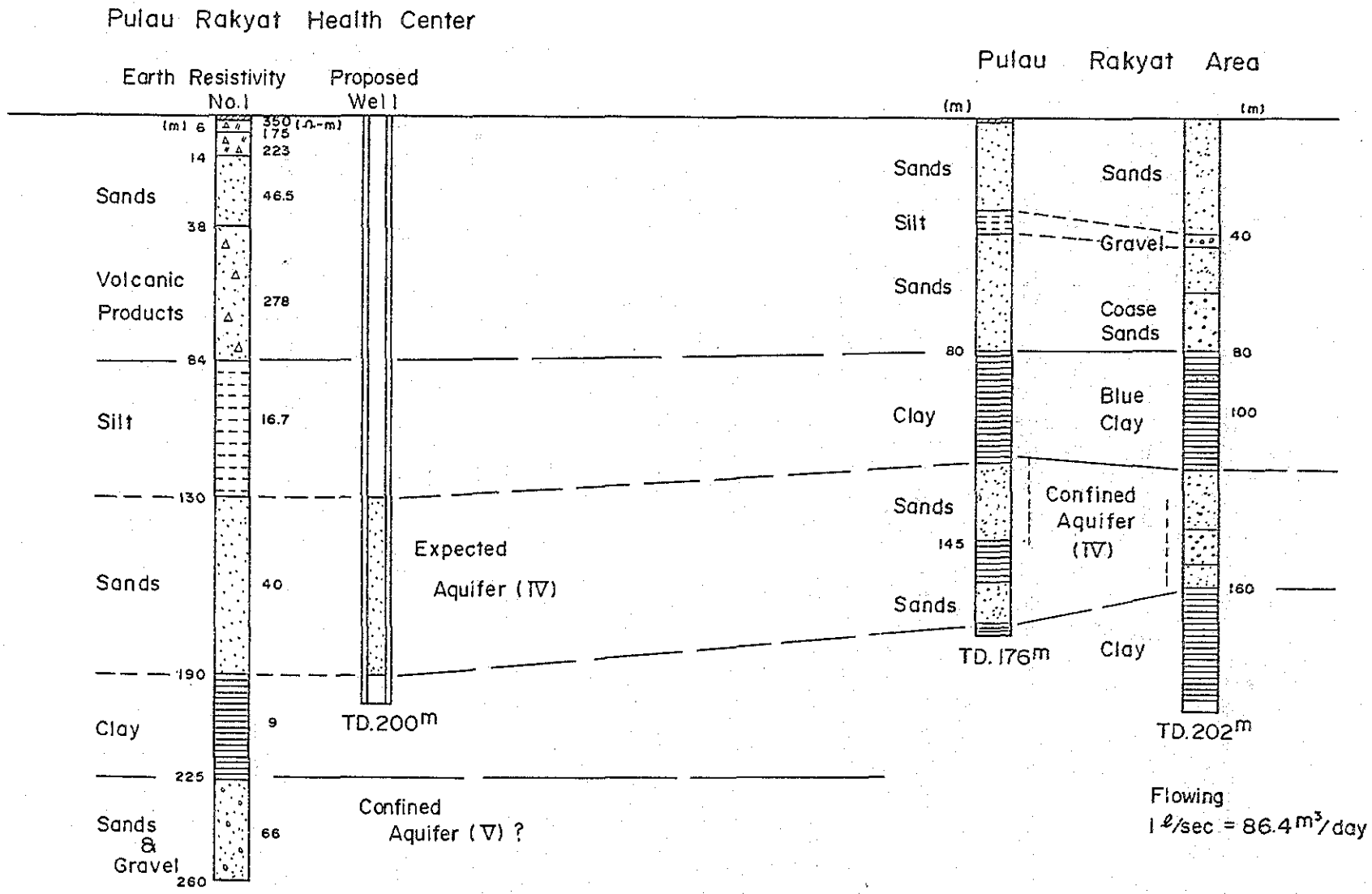


FIG. 3-6 HYDROGEOLOGICAL INTERPRETATION
(PULAU RAKYAT)

IV. PRELIMINARY PLANNING OF WATER SUPPLY FACILITIES

4.1 Design Criteria

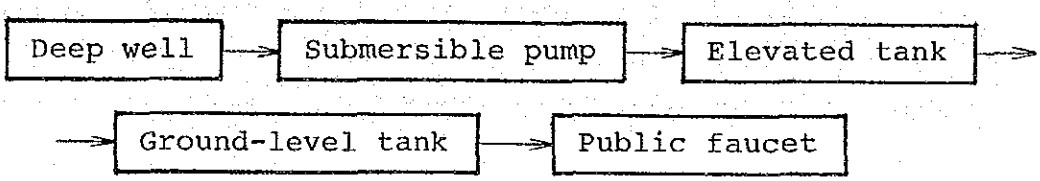
Design criteria for this project are proposed hereunder.

1) People to be Supplied: One community or several hundred persons

2) Water Source: Groundwater deeply confined

3) Per Capita Consumption: 60 l/day/person

4) Water Supply System:



5) Deep well: Depth = 180 m - 220 m
Casing pipe = GSP 150 mm

6) Submersible Pump: Total head = 30 m - 50 m
Operation hours = 3 hours - 8 hours
Capacity = 4 m3/h - 12 m3/h
Power = 1.5 kW - 3.7 kW

7) Power Source: Diesel generator

8) Elevated Tank: Height = 10 m - 15 m
(8 m for Health Center)
Material = Steel made
Capacity = One hour's equivalent of pump capacity

9) Ground-level Tank: Material = Reinforced concrete
Capacity = 2 m3 - 3 m3
Accessories: 3 - 4 public faucets

10) Distribution Pipelines: To be installed in the future by the village people with assistance of Indonesian Government

11) Operation and Maintenance: To be carried out by village people.

4.2 Facility Planning

Based on the above design criteria, water supply facilities to be constructed for the current project are planned as shown in the Fig. 4-1, 4-2 and Table 4-1.

4.3 Running Cost Estimate

Water supply facilities for sites No.1 through No.5 are for village peoples, and their operation and maintenance will be done by the village peoples.

For reference, power running costs are estimated and shown in Table 4-2. In the calculation of the running cost, the following assumptions were employed:

1) Personnel cost is not considered.

2) Repair/rehabilitation cost of equipment is not considered.

3) Power cost only is required.

4) The power will be given by diesel generators, since all the villages have not yet supplied with public electricity (PLN).

5) However, Tinggi Raja Village is scheduled to be supplied by the public electricity (PLN) shortly; therefore, this case further was calculated.

As a result, water costs were estimated at:

- Simpang Ganbus : 64 Rp./m3 or 772 Rp./month/Household
- Ujung Kubu : 60 " 563 " "
- Tinggi Raja : 64 " 662 " "
  (In case of public electricity, 26 Rp./m3 or 267 Rp./month/Household)
- Silau Maraja : 108 Rp./m3 or 1,106 Rp./month/Household
- Padang Mahondang: 64 " 617 " "

FIG. 4-1 SCHEMATIC PLAN OF WATER SUPPLY SYSTEM IN THE VILLAGES

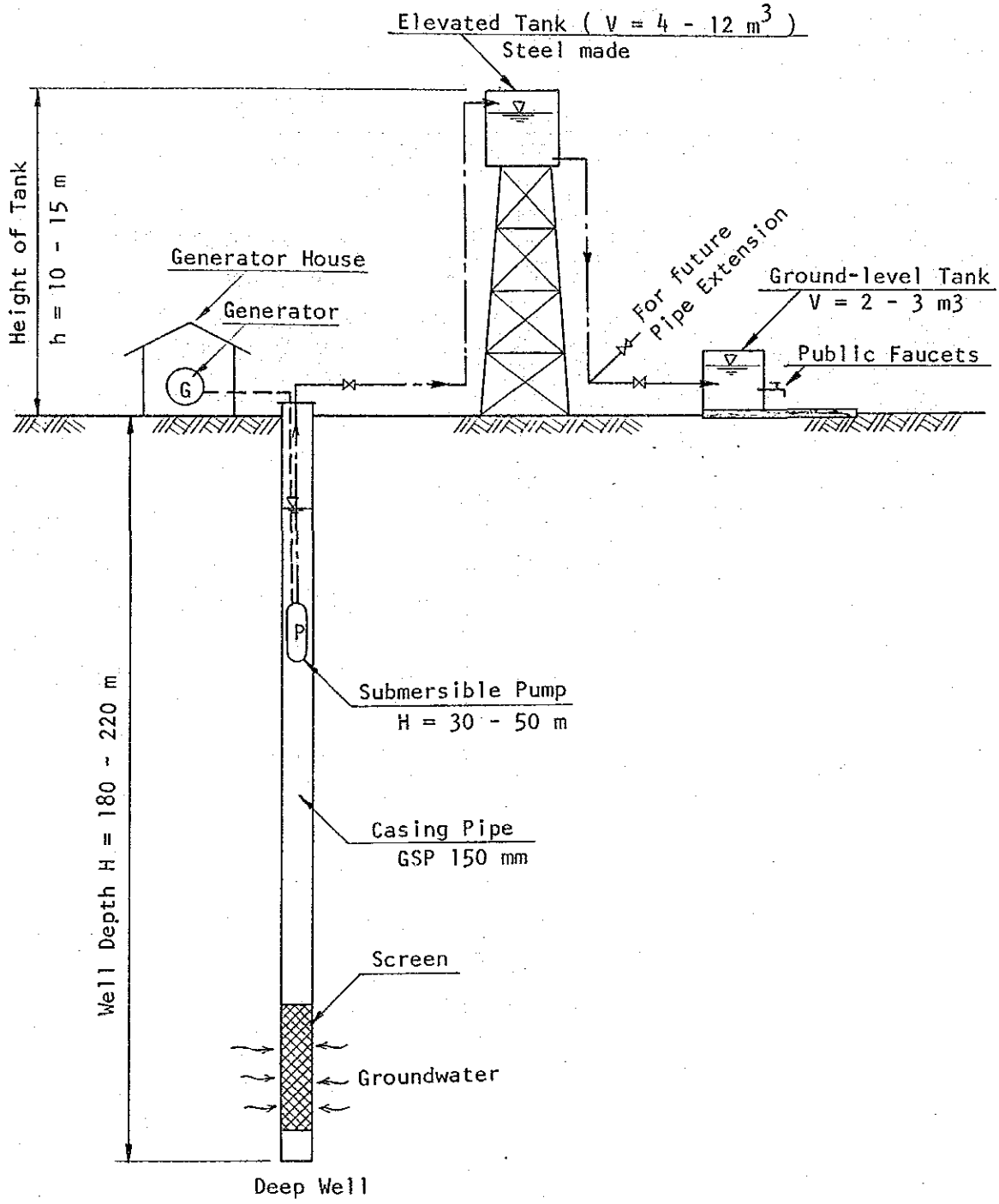


FIG. 4-2 WELL DESIGN

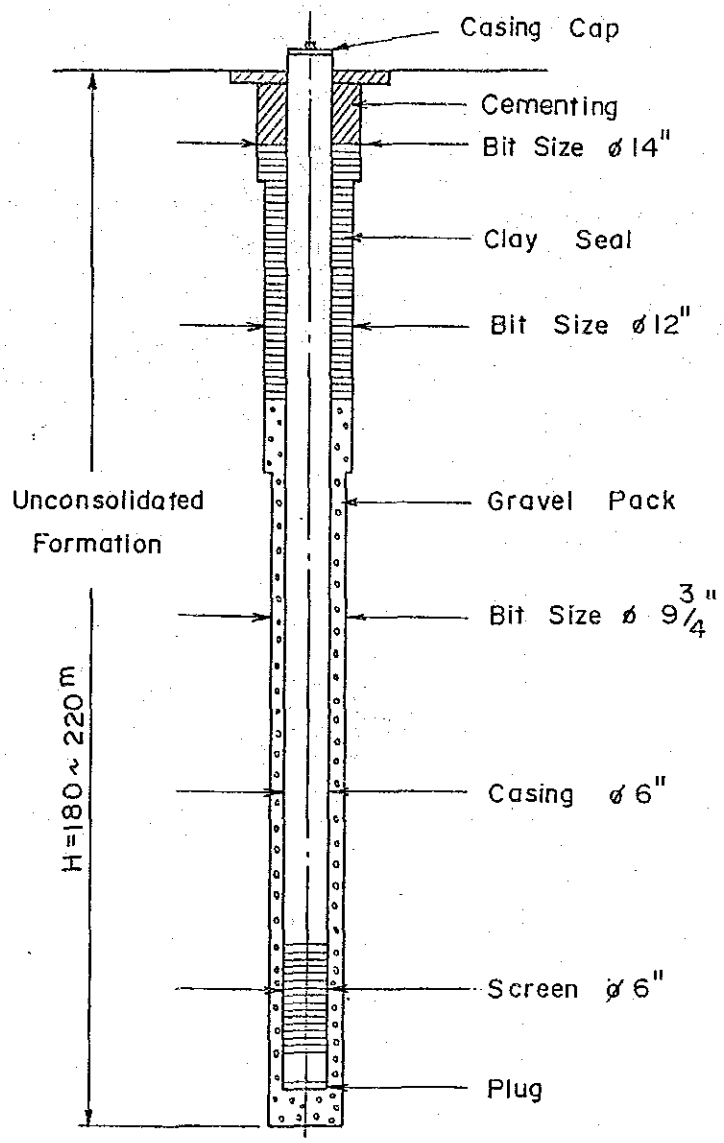


Table 4-1 Planning of Water Supply Facilities

Items \ Site		No.1 Sub-Vil. No.16 of Simpang Gambus Village	No.2 Sub-Vil. Pem. Pao of Ujung Kubu Village	No.3 Tinggi Raja Village	No.4 Silau Maraja Village	No.5 Padang Mahon-dang Village	No.6 Pulau Rakyat Health Center
Population to be Supplied		400	1,300	400	200	400	Hospital Clinic Staff houses
Per Capita Consumption		60 ℓ/d	60 ℓ/d	60 ℓ/d	60 ℓ/d	60 ℓ/d	
Total Water Demand		24 m³/d	78 m³/d	24 m³/d	12 m³/d	24 m³/d	10 m³/d
Depth of Deep Well		180 m	180 m	180 m	180 m	180 m	180 m
Pump	Capacity	8 m³/h	12 m³/h	8 m³/h	4 m³/h	8 m³/h	4 m³/h
	Operation	3 hrs	6.5 hrs	3 hrs	3 hrs	3 hrs	2.5 hrs
	Power	2.2 kw	3.7 kw	2.2 kw	1.5 kw	2.2 kw	1.5 kw
Generator		10 kVA	12.5 kVA	10 kVA	10 kVA	10 kVA	10 kVA
Elevated Tank	Capacity	8 m³	12 m³	8 m³	4 m³	8 m³	4 m³
	Height	12 m	15 m	12 m	10 m	12 m	8 m
Ground-level Tank		2 m³	3 m³	2 m³	2 m³	2 m³	2 m³

Table 4-2 Power Cost Estimates

Item		No.1	No.2	No.3		No.4	No.5
	Village	Simpang Ganbus	Ujung Kubu	Tinggi Raja		Silau Maraja	Padang Mahond.
Population Served		400	1,300	400		200	400
Number of Household		60	250	70		35	75
Supply Capacity	per Day	24 m³	78 m³	24 m³		12 m³	24 m³
	per Month	720 m³	2,340 m³	720 m³		360 m³	720 m³
Power	Source	Generator	Generator	Generator	PublicPLN	Generator	Generator
	Capacity	10 kVA	12.5kVA	10 kVA	2.2 KW (3 kvA)	10 kVA	10 kVA
	Operation	3 hours	6.5hours	3 hours	3 hours	3 hours	3 hours
Fuel or Power	Kind	Dies. Oil	Dies. Oil	Dies. Oil	Electri.	Dies. Oil	Dies. Oil
	Consumption	3.5 ℓ/h	4.2 ℓ/h	3.5 ℓ/h	2.2 KWh	3.5 ℓ/h	3.5 ℓ/h
	Effectivity	60 %	70 %	60 %	100 %	50 %	60 %
	Actual Consumption	3.5 x60% =2.1 ℓ/h	4.2 x70% =2.94 ℓ/h	3.5 x60% =2.1 ℓ/h	2.2 x100% =2.2 KWh	3.5 x50% =1.75 ℓ/h	3.5 x60% =2.1 ℓ/h
	Consumption per Day	2.1 x 3 = 6.3 ℓ	2.94x6.5 =19.11 ℓ	2.1 x 3 = 6.3 ℓ	2.2 x 3 = 6.6KWh	1.75 x 3 =5.25 ℓ	2.1 x 3 = 6.3 ℓ
	Consumption per Month	6.3 x 30 = 189 ℓ	19.11x30 = 574 ℓ	6.3 x 30 = 189 ℓ	6.6 x 30 = 198KWh	5.25 x30 = 158 ℓ	6.3 x 30 = 189 ℓ
	Unit Price (Rp.)	Diesel Oil 245 Rp/ℓ	Diesel Oil 245 Rp/ℓ	Diesel Oil 245 Rp/ℓ	Basic Ch. 3,680/kvA Consum. 38.5Rp/KW	Diesel Oil 245 Rp/ℓ	Diesel Oil 245 Rp/ℓ
	Power Cost per Month (Rp.)	189 x245 =46,305	574 x245 =140,630	189 x245 =46,305	3 x3,680 +198x38.5 = 18,663	158 x245 =38,710	189 x245 =46,305
Power Cost per Month per Household (Rp.)		Rp 46,305 ÷ 60 = Rp 772	Rp140,630 ÷ 250 = Rp 563	Rp 46,305 ÷ 70 = Rp 662	Rp 18,663 ÷ 70 = Rp 267	Rp 38,710 ÷ 35 =Rp1,106	Rp 46,305 ÷ 75 = Rp 617
Unit Price of Water per 1 m³		Rp 46,305 ÷ 720m³ = Rp 64	Rp140,630 ÷2,340m³ = Rp 60	Rp 46,305 ÷ 720m³ = Rp 64	Rp 18,663 ÷ 720m³ = Rp 26	Rp 38,710 ÷ 360m³ = Rp 108	Rp 46,305 ÷ 720m³ = Rp 64