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# GROUNDWATER RESOURCES FOR AGRICULTURAL USE IN MALAYSIA

PROGRESS  
REPORTS  
August, 1982  
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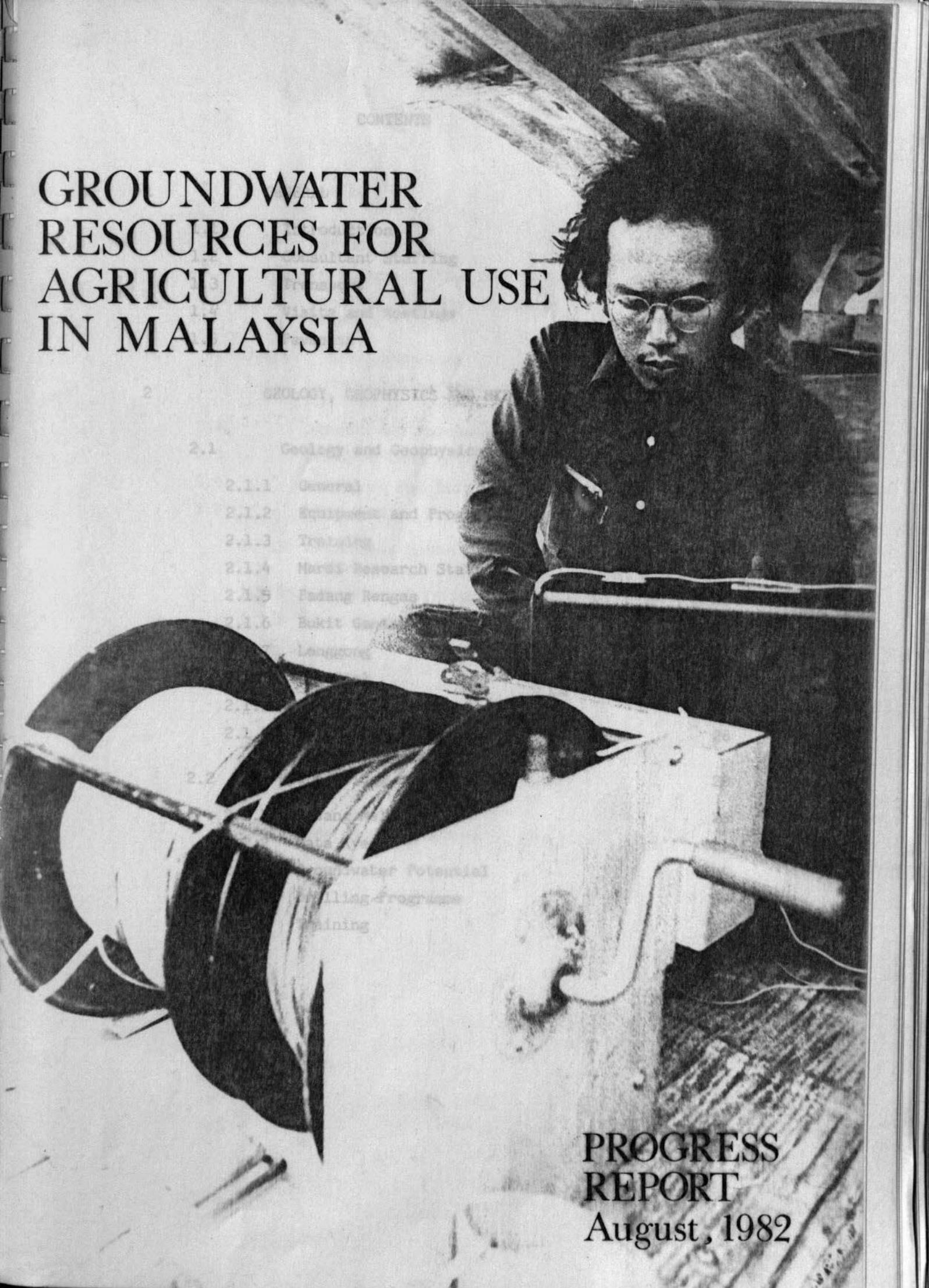
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## 1.2. Consultant Staffing

### 1. GENERAL

#### 1.1 Introduction

This is the fourth of a series of technical progress reports and deals with the period May 21 to August 20, 1982. It chiefly describes the results of drilling and testing operations and of geophysical resistivity surveys. Major drilling problems, connected with downhole conditions, are described in some detail as their eventual solution was considered a valuable rig crew training exercise.

Over 630 m of small diameter exploratory drilling was completed in limestones in Perlis, even though progress was impeded by difficult drilling conditions and by further rig mechanical problems.

Pump testing awaits the arrival of suitable turbine borehole pumps. The possible modes of operation of a pumping test team, either independently or rig based, are discussed in terms of required logistic support and their effects upon programme timing.

As a result of meetings between the JPT Planning Department and State JPT personnel, further programme revisions have been made or are under consideration; a revised but tentative programme of rig operation is given in this report.

Geophysical resistivity investigations have been carried out in proposed drilling areas in Bertam, Seberang Prai, Penang and in Perak (Taiping, Kuala Kangsar region and upper Sg. Perak). On the basis of some resistivity results which have indicated high groundwater salinities, drilling targets have been modified in the Balik Pulau area and cancelled in Juru.

## 1.2 Consultant Staffing

The project manager/hydrogeologist took annual leave from June 17 to July 18. The Consultant master driller II, Mr. W.M. Thomas completed his 11 month input on 23 August and left Malaysia on 26 August.

Supervision of both rigs will now be carried out by master driller I. The rig crews have acquired sufficient skills to operate at times without close supervision particularly in hard rock. It is still considered necessary that the master driller has easy access to both rigs on a day to day basis, particularly since the crews will now be drilling largely alluvial or soft rock materials.

A geographic split of the rigs, planned for January 1983, is considered desirable. It is hoped that crew skill and variety of experience (in hard rock and alluvium) at that time will be such that an adequate supervisory effort can be maintained by master driller I while the rigs work in geographically quite separate locations.

The project requirement for an experienced assistant hydrogeologist was first discussed by the JPT Planning Section and the Consultant in April 1982. The officer proposed for secondment to this post from the Geological Survey of Malaysia, is expected to arrive in early September. Evaluation of the officer's current experience and expertise in groundwater studies will facilitate the review of hydrogeological staff requirements planned for late September.

### 1.3 Transport Meetings

Transport was discussed at a meeting at JPT workshops, Ipoh on 21.6.82. The following points were made:

- the drilling section needs a long bodied lorry to carry drilling materials between drill sites and stores in Penang, Bantan, Seberang Prai and Perak to check on access and requirements for site works.
- the long wheel base station wagon landrover is considered ideal for geophysics crew transport and is preferred to the pick-up type currently available.

A long bodied lorry has recently arrived at JPT Ampang and, it is understood, this vehicle is assigned to groundwater work. However, the lorry has no hydraulic crane which make the loading of heavy drill equipment most difficult. If possible, a crane should be fitted.

It is hoped that the State JPT offices will be able to supply additional transport to the project. This is particularly necessary to allow hydrogeological staff to move rapidly between drill rigs and survey areas to carry out sampling, testing and logging.

Major moves, of drilling stores and rigs to new drilling areas, requires additional heavy transport.

On acquisition of borehole pumps, test pumping will need to take place at sites often remote from the drilling rigs. This will mean that the personnel carrying out these pump tests will require additional transport (Section 3.2).  
from the programme (Section 2.2.4).

#### 1.4 Visits and Meetings

The drilling works have been almost continuously supervised by consultant drilling staff whilst the Consultant geologist/geophysicist has spent prolonged periods in the field with the geophysics survey party. The hydrogeologist has visited projected drilling sites in Penang, Bertam, Seberang Prai and Perak to check on access and requirements for site works.

The master driller visited Kota Baru on August 2, to check on the suitability of a KSB borehole pump held by JPT Kelantan, as a test pump for the present investigations.

A meeting was also held at JPT Federal Workshops, Ipoh on 21.6.82, between staff from Federal Workshops, JPT Planning Section and the Consultant. The following were discussed:

- logistic support, spares and mechanical back up for the drilling rigs, trucks and ancillary equipment

#### 1.5

- Transport arrangements
- The possible purchase of a high capacity high pressure air compressor, and the purchase of turbine borehole test pumps
- requirement for a second welding set.

Personnel from JPT Planning Section and JPT State Offices held a meeting in July at which the present investigation programme was reviewed. Several areas, where water shortage is not now considered a limiting factor in the area development, were deleted from the programme (Section 2.2.4).

A site meeting was held in Perlis on 11 August between personnel from JPT Ampang, JPT Ipoh and the Consultant. The following topics were discussed:-

- provision by JPT Ipoh of chargemen/fitter to repair and maintain rigs
- lack of provision for transport during major moves of rigs + stores, to new drilling areas
- procurement of rig spares
- provision by JPT Ipoh of specifications of borehole test pumps ordered by them.

Various other informal meetings have been held between MMP and JPT on the subject of possible replacement of present geophysics resistivity equipment and on the requirements and logistics of a pump testing programme.

### 1.5 Payments

Scheduled payments for project months 13 and 14 were invoiced on 30 July and 2 August respectively (Table 1.1). Scheduled payments for months 11 and 12 were received on 7 June and 25 June respectively. Statements of Expenditure up to month 6 (asterisked in Table 1.1) will be finalised shortly.

Project Month	Invoice No.	Date Submitted
1	81/06/4034	15.5.81
2	81/06/4034	10.3.82
3	81/07/4034	10.3.82
4	81/08/4034	10.3.82
5	81/09/4034	10.3.82
6	81/10/4034	10.3.82
7	81/11/4034	10.3.82
8	81/12/4034	10.3.82
9	82/01/4034	8.4.82
10	82/02/4034	8.4.82
11	82/03/4034	3.4.82
12	82/04/4034	3.5.82
13	82/05/4034	3.5.82
14	82/06/4034	30.7.82
15	82/07/4034	2.8.82

TABLE 1.1

## PAYMENTS AND EXPENDITURE

## INVOICE

## STATEMENT OF EXPENDITURE

Project Month	Invoice No.	Date Submitted	Amount M\$	LStg.	Date Paid	S.O.E. No.	Date Submitted	Amount M\$	LStg.
Mobilisation	81/06/4034	15.6.81	36,604	28,461	6.11.81				
May	-	-	-	-		81/05/4035	14.8.81	138.41	842.86*
1 June	81/06/4034	10.3.82	8,280	7,763	7.4.82	81/06/4035A	14.8.81	5,333.91	6,914.74*
2 July	81/07/4034	10.3.82	11,500	15,225	"	81/07/4034	18.9.81	8,824.50	12,551.10*
3 Aug	81/08/4034	10.3.82	12,940	13,685	"	81/08/4034	12.11.81	11,731.78	13,630.44*
4 Sept	81/09/4034	10.3.82	9,480	11,237	"	81/09/4034	17.12.81	10,171.85	13,998.76*
5 Oct	81/10/4034	10.3.82	11,940	10,301	"	81/10/4034	19.12.81	10,599.44	14,133.00*
6 Nov	81/11/4034	10.3.82	10,200	9,842	"	81/11/4034	18.1.82	13,238.60	14,605.92*
7 Dec	81/12/4034	10.3.82	9,200	7,549	"	81/12/4034	11.3.82	9,748.88	10,670.00
8 Jan	82/01/4034	8.4.82	9,340	7,090	11.5.82	82/01/4034	12.4.82	9,207.20	10,964.50
9 Feb	82/02/4034	8.4.82	10,840	8,920	11.5.82	82/02/4034	13.4.82	7,236.62	11,214.78
10 Mar	82/03/4034	8.4.82	8,340	7,090	11.5.82	82/03/4034	30.4.82	10,174.34	10,755.93
11 April	82/04/4034	3.5.82	7,736	9,730	7.6.82	82/04/4034	7.6.82	10,969.90	10,905.68
12 May	82/05/4034	3.6.82	15,840	10,590	25.6.82	82/05/4034	15.6.82	10,135.80	11,134.23
13 June	82/06/4034	30.7.82	12,240	9,038	-	82/06/4034	30.7.82	10,234.40	9,763.37
14 July	82/07/4034	2.8.82	16,340	13,946	-	-	-	-	-

\* Subject to amendment/charge rate adjustment.



2. GEOLOGY, GEOPHYSICS AND HYDROGEOLOGY

2.1 Geology and Geophysics

2.1.1 General

The geophysics team has carried out surveys in Seberang Prai, in Pulau Pinang and in Perak (Figure 2.1) whilst the hydrogeology team has concentrated its work in Perlis. There has been less overlap between the teams because the geophysics crew has concentrated on reconnaissance studies in new areas, in advance of the drilling.

A geophysical study at the Mardi research station at Bertam also involved an inventory of private wells, well points and boreholes in the vicinity. Information was obtained on groundwater use in the area and on the areal and depth variations in groundwater salinity.

The geophysics crew is still using the original Scintrex equipment; the frustration and delays caused by the shortcomings of this equipment continue to affect progress.

Certain areas in Perak (Padang Rengas and Lenggong) were removed from the drilling investigation programme after the geophysics crew had completed their surveys. This is unfortunate since six survey days had been expended there.

The results from the reconnaissance surveys in all the areas indicate that exploitable groundwater may exist. However, in several areas, where either the aquifer is shallow and thin, or where access for large drilling rigs is difficult, alternative methods of groundwater exploitation (for example well points or dug wells) should be considered.

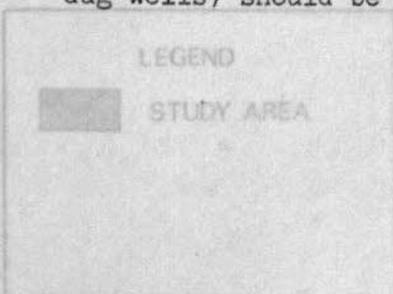
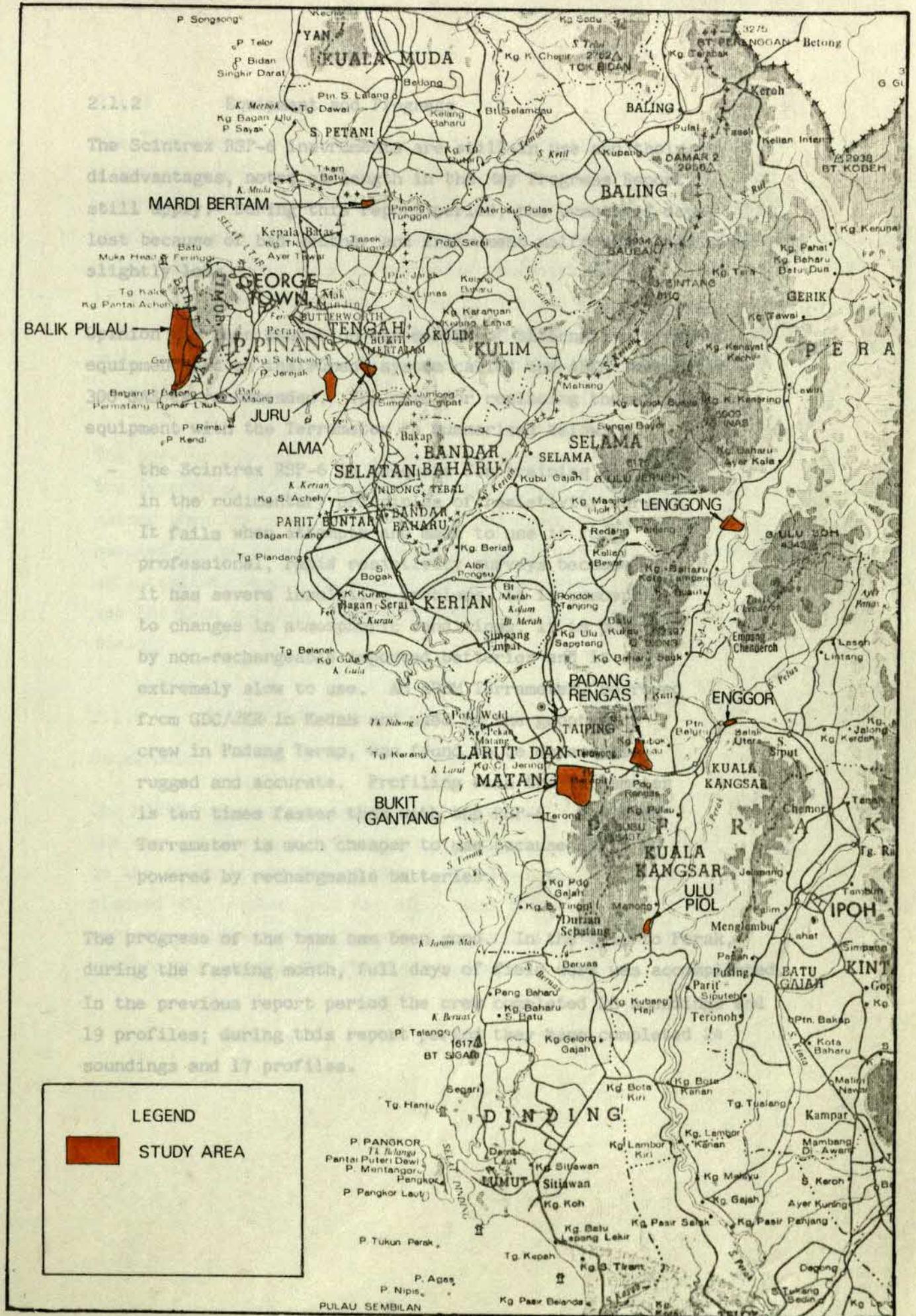


FIGURE 2.1 LOCATION OF STUDY AREAS



### 2.1.2 Equipment and Progress

The Scintrex RSP-6 instruments are still in use and their disadvantages, noted at length in the May Progress Report, still apply. During this report period, the number of days lost because of bad weather and instrument malfunction has been slightly less. Opinion has been sought on the merits of alternative types of equipment and an instrument system called the ABEM Terrameter 300 SAS is recommended. The case for replacing the existing equipment with the Terrameter is summarised below:

- the Scintrex RSP-6 is adequate for training new staff in the rudimentary principles of resistivity surveys. It fails when attempts are made to use it for professional, rapid resistivity surveys because it has severe insulation problems, it is susceptible to changes in atmospheric conditions, it is powered by non-rechargeable imported batteries and it is extremely slow to use. An ABEM Terrameter, borrowed from GDC/JKR in Kedah and used by the geophysics crew in Padang Terap, was found to be dependable, rugged and accurate. Profiling with the Terrameter is ten times faster than with the RSP-6. The ABEM Terrameter is much cheaper to use because it is powered by rechargeable batteries.

The progress of the team has been good. In the trip to Perak, during the fasting month, full days of field work was accomplished. In the previous report period the crew completed 28 soundings and 19 profiles; during this report period they have completed 24 soundings and 17 profiles.

### 2.1.3 Training

The move south to survey areas in Seberang Prai, Penang Island, and Perak has meant that the crew has become experienced in year working in areas of deep alluvium, and shallow alluvium overlying granite, marble, and other meta-sediments. The objective of the recent surveys has been to determine the thickness and stratigraphy of the alluvium rather than, as in Perlis and Kedah, determine the nature and structure of the bedrock. This change of emphasis has given the crew valuable experience in handling different hydro-geological concepts.

The work in Seberang Prai and Penang Island has demonstrated the importance of groundwater salinity. Good experience was gained when the combined geophysics and hydrogeology team carried out an inventory of wells in the Bertam area and constructed an isosalinity map. Members of both teams were also shown how to use the Hach portable chemistry laboratory for titrations in the field.

### 2.1.4 MARDI Research Station, Bertam

#### Background.

The MARDI covers approximately 300 acres and is located to the east of the main Butterworth to Sungei Patani road and to the south of the Sungei Muda. The land was originally planted with rubber, but has since been cleared. An irrigation canal network has been installed by DID in the western and central two third of the area.

FIGURE 2.2 MARDI, BERTAM RESISTIVITY SURVEY



The research station has been set up to undertake water management trials on a variety of crops, and therefore needs an assured year round water supply. The existing water supply comes from an off-take on a canal to the north, and is pumped into an unlined small reservoir (Figure 2.2). This supply is adequate except during the padi planting and growing seasons. The research station envisages a requirement for a 20-30 litre per second borehole which would be used to provide supplementary water to the irrigation canal or to the storage reservoir during times of shortage. There is an additional requirement for a rather smaller borehole supply in the east, to irrigate tree crops currently watered individually by bowser.

Existing groundwater supply is from two well points. The first (Well point A, Figure 2.2) was next to the storage reservoir. The 2 inch pipes were forced to 80 feet (24 metres) but the yield was insignificant. A second well point was sunk to 60 feet (18 m) half way between the reservoir and the workshop. The perforated pipe extends from 16 m to 18 m and a reliable yield of more than 1 litre per second is obtained.

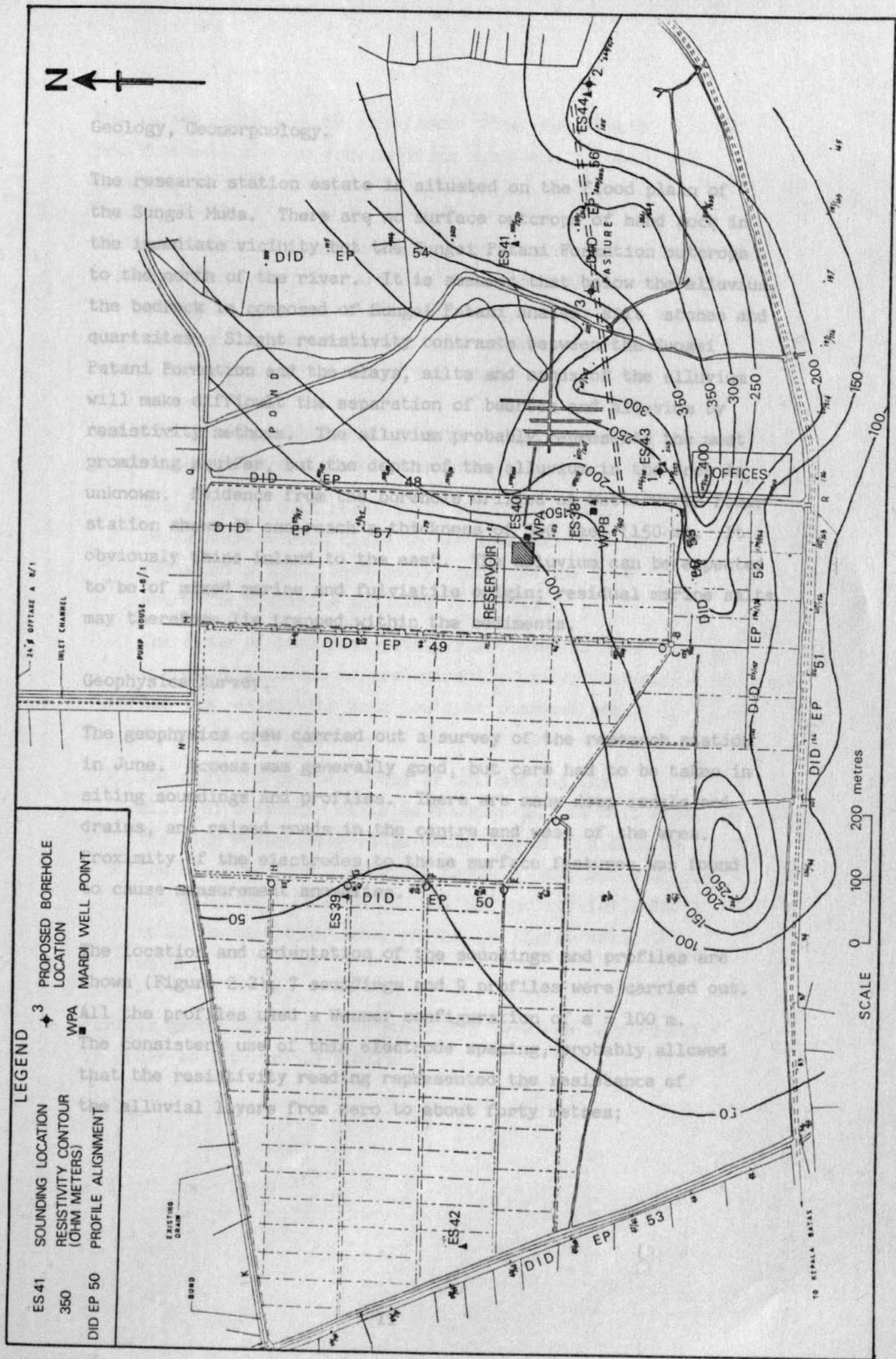
In mid July 1982 two unsuccessful well points were installed in the east of the estate. Reliable records of penetration rates are not available, but it appears that the installation crew abandoned each hole at 45 feet (14 m) because it became "too hard"; ferruginous quartzose layers within the alluvium, encountered in JPT drilling, could be responsible.

- LEGEND
- EG 41 - SOUNDING LOCATION
  - 350 - RESISTIVITY CONTOUR (OHM METERS)
  - DNO EP 50 - PROFILE ALIGNMENT
  - PROPOSED BOREHOLE LOCATION
  - WPA

SCALE 0 50 100 200 metres

FIGURE 2.2

MARDI, BERTAM : RESISTIVITY SURVEY



Geology, Geomorphology.

The research station estate is situated on the flood plain of the Sungei Muda. There are no surface outcrops of hard rock in the immediate vicinity but the Sungei Patani Formation outcrops to the north of the river. It is assumed that below the alluvium, the bedrock is composed of Sungei Patani shales, silt stones and quartzites. Slight resistivity contrasts between the Sungei Patani Formation and the clays, silts and sands of the alluvium will make difficult the separation of bedrock and alluvium by resistivity methods. The alluvium probably represents the most promising aquifer, but the depth of the alluvium in the area is unknown. Evidence from the borehole drilled at Butterworth Power station shows it can reach a thickness of 500 feet (150 m). It obviously thins inland to the east. The alluvium can be expected to be of mixed marine and fluvial origin; residual marine salts may therefore lie trapped within the sediments.

Geophysics Survey.

The geophysics crew carried out a survey of the research station in June. Access was generally good, but care had to be taken in siting soundings and profiles. There are many deep canals and drains, and raised roads in the centre and west of the area. Proximity of the electrodes to these surface features was found to cause measurement anomalies.

The location and orientation of the soundings and profiles are shown (Figure 2.2); 7 soundings and 9 profiles were carried out. All the profiles used a Wenner configuration of  $a = 100$  m. The consistent use of this electrode spacing, probably allowed that the resistivity reading represented the resistance of the alluvial layers from zero to about forty metres;

the values could then be contoured. Five north south profiles were run and four were run east west to check the results. The sounding curves are shown (Figure 2.3).

The iso-resistivity contours are shown (Figure 2.2). The values are consistent and there are very few irreconcilable anomalies. The pattern is of a relatively high resistivity ridge which extends from the east and north east and narrows as it runs across the south and centre of the area.

There is no unique interpretation for this resistivity contour pattern but there are three alternative interpretations:

- The ridge of high resistivity represents high resistance bedrock close to the surface. The low resistivity area, conversely, could be the area where the overlying alluvium is thicker.
- The ridge of high resistivity represents an area where the alluvium is predominantly sandy, whereas the low resistivity area could be composed predominantly of clays.
- The depth to bedrock could be uniform and the alluvial sediments could be homogenous. In this case, the high resistivity ridge could represent a zone of low salinity (low electrical conductivity) water within the alluvium. Conversely, the low resistivity areas could represent alluvium containing higher salinity water.

Further geophysical and hydrochemistry work was carried out in order to improve the analysis.

FIGURE 2.3 MARDI RESISTIVITY SOUNDING CURVES

Resistivity soundings were made in order to measure the resistance of the buried layers. The sites of the soundings were chosen in order to investigate both the high and the low resistivity zones on the contour map. The sounding curves are shown (Figure 2.3). Comparison between Figures 2.2 and 2.3 indicate that the soundings carried out in the east and centre of the area have generally high resistances whereas soundings ES 42, ES 39, and ES 40 in the west have low resistances. The interpretation has been refined by manual curve matching and curve simulation on a high powered calculator. The results (Figure 2.4) are given as a series interpretive sections showing layers of varying resistance. On or close to the high resistivity ridge, the soundings indicate high resistance layers in the upper and middle section with a thick layer of low resistance below. In the west, soundings ES 42 and ES 39, indicate that the section is almost wholly composed of low resistance layers. No soundings show evidence of a high resistance, hard, impervious bedrock within 100 metres of the surface. Experience in Kedah and Perlis, with soundings on sediments similar to the Sungai Patani Formation, suggests that the hard bedrock is likely to have a resistance of 1000 ohm metres or more. Resistances of this magnitude are only apparent below ES 43 at 200 metres depth.

The soundings indicate that the high resistivity ridge shown (Figure 2.2) represents a zone of sandy facies within the upper part of the alluvium. this interpretation concurs with the evidence of white sands encountered in well point B on the Mardi Station at 60 feet (18 m) and similar sands reported at 10-17 m, by the owners of well points in small holdings to the north east of the research station.

FIGURE 2.3 MARDI RESISTIVITY SOUNDING CURVES.

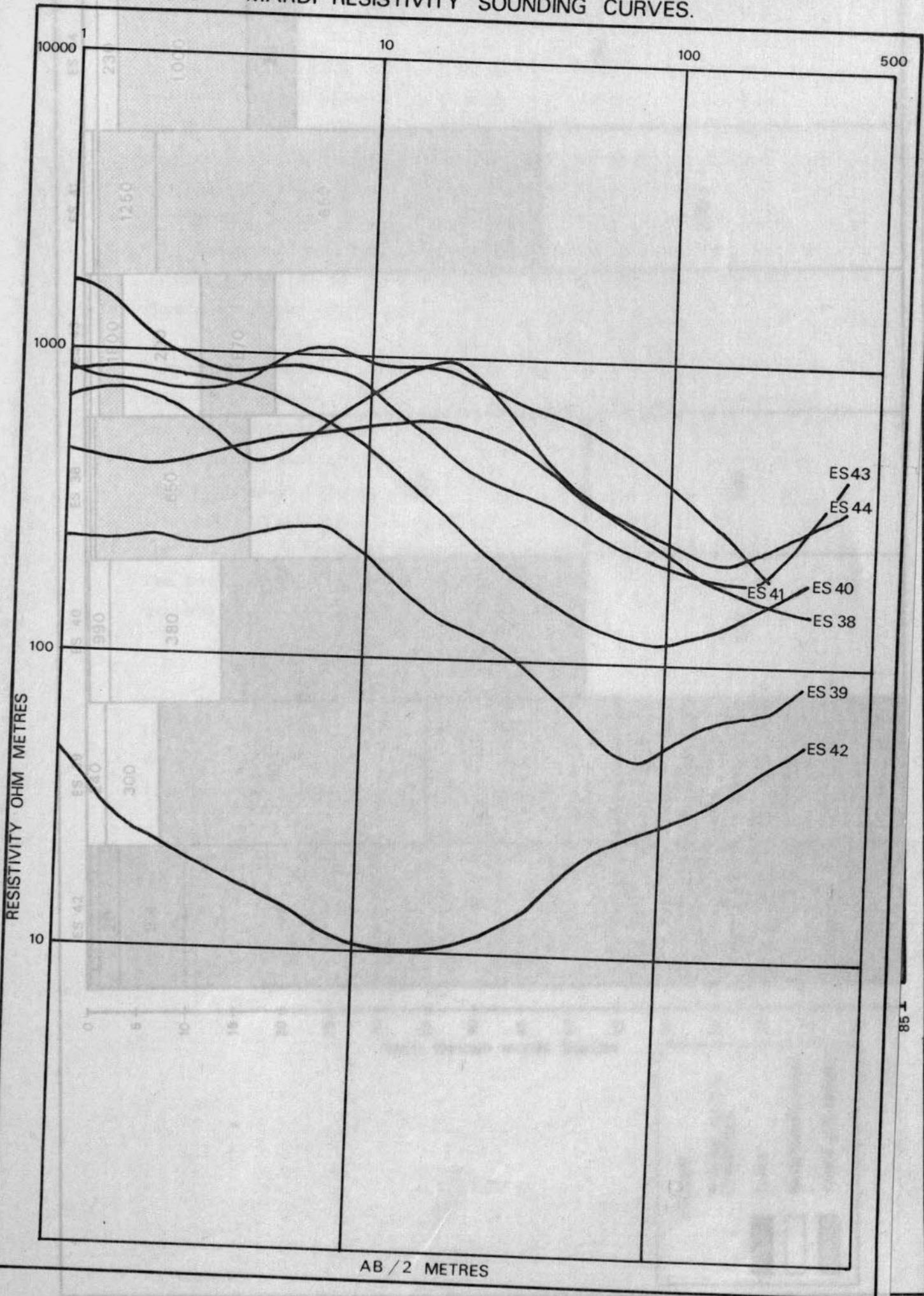


FIGURE 2.4 MARDI: HORIZONTAL LAYER INTERPRETATION OF SOUNDING CURVES.

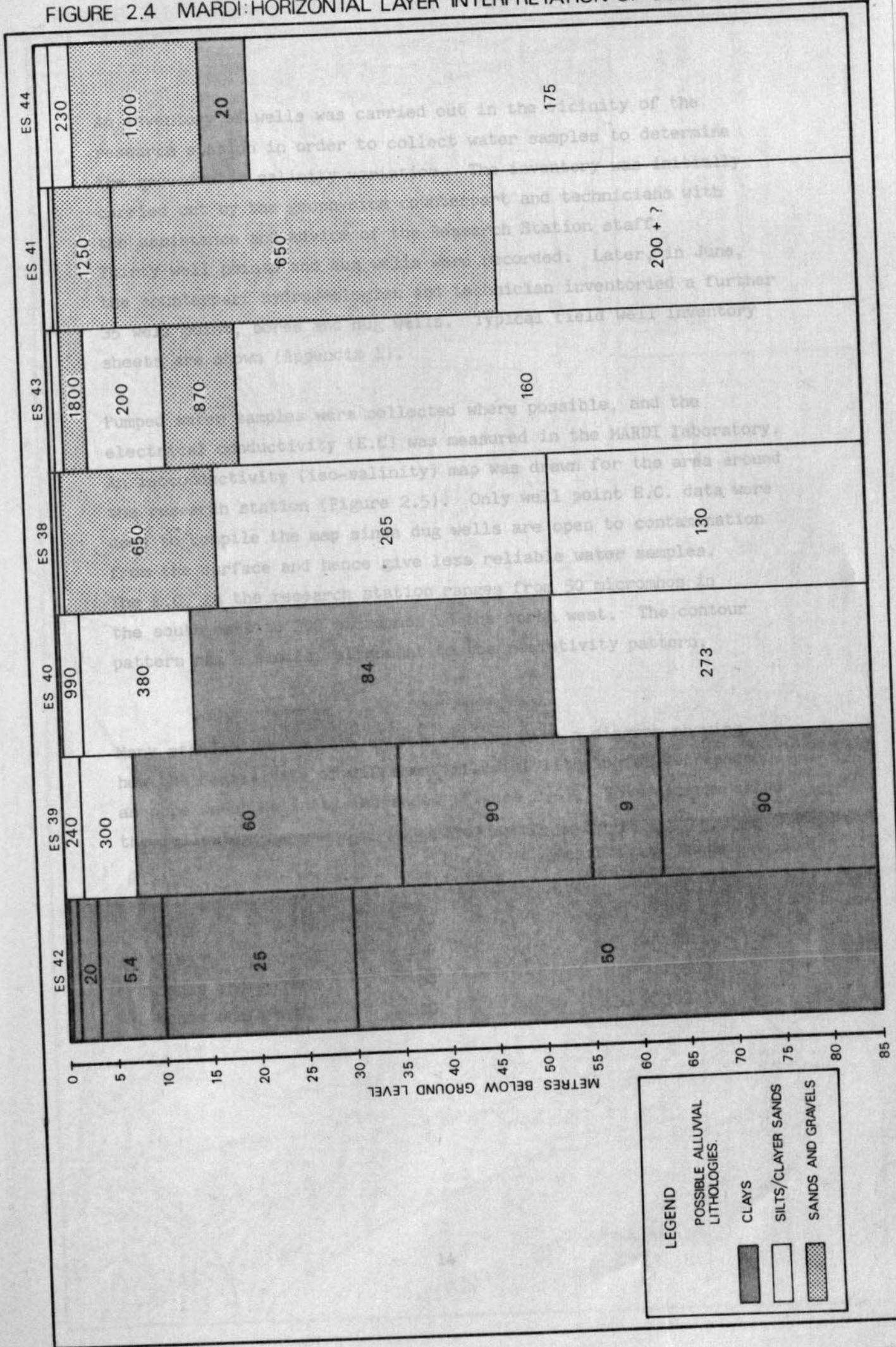


FIGURE 2.5 GROUNDWATER SALINITY NORTHERN SEBERANG PRAI

An inventory of wells was carried out in the vicinity of the research station in order to collect water samples to determine the groundwater salinity variation. The inventory was initially carried out by the geophysics counterpart and technicians with the assistance and advice of the Research Station staff. Thirty well points and dug wells were recorded. Later, in June, the counterpart hydrogeologist and technician inventoried a further 35 well point, bores and dug wells. Typical field well inventory sheets are shown (Appendix I).

Pumped water samples were collected where possible, and the electrical conductivity (E.C) was measured in the MARDI laboratory. An isoconductivity (iso-salinity) map was drawn for the area around the research station (Figure 2.5). Only well point E.C. data were used to compile the map since dug wells are open to contamination from the surface and hence give less reliable water samples. The E.C. in the research station ranges from 50 micromhos in the south east to 300 micromhos in the north west. The contour pattern has a similar alignment to the resistivity pattern.

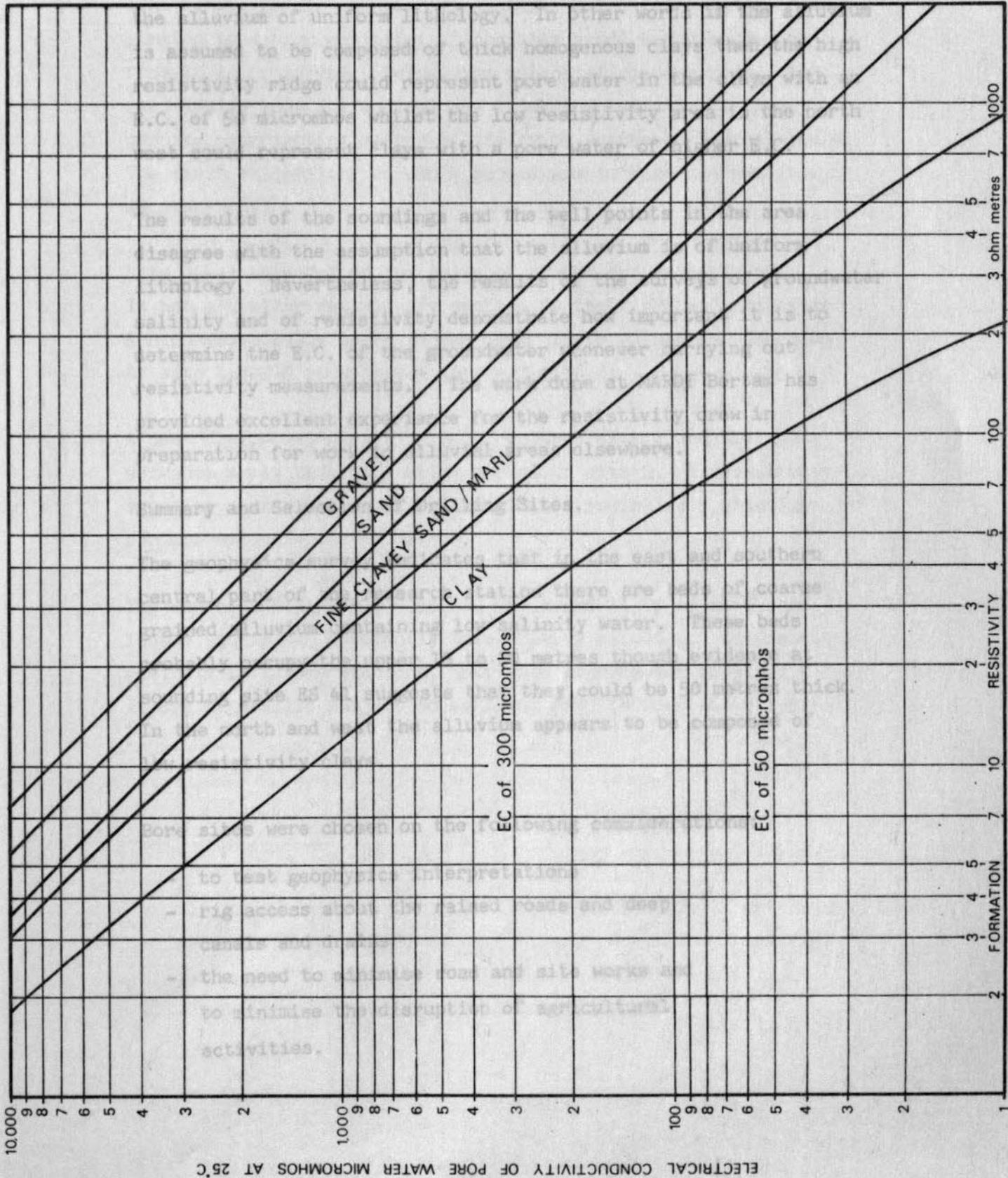
Many standard references on resistivity give a diagram showing, how the resistivity of different alluvial lithologies decreases as pore water salinity increases (Figure 2.6). This diagram shows the following:

Lithology	E.C. (micromhos)	Resistivity Range (Ohm metres)
Clay	50	100 - 300
Clay	300	30 - 70
Sands and gravel	50	700 - 1,500
Sands and gravel	300	130 - 300



**FIGURE 2.6 RELATIONSHIP BETWEEN PORE WATER CONDUCTIVITY AND FORMATION RESISTIVITY**

Considered alone, the groundwater E.C. range and the resistivity contours in Figure 2.2 may suggest that the change in resistivity over the area is caused by groundwater salinity variation within



the alluvium of uniform lithology. In other words, the alluvium is assumed to be composed of thick homogenous clay. The high resistivity ridge could represent pore water in the alluvium with an E.C. of 50 micromhos whilst the low resistivity area could represent the alluvium saturated with a pore water of 300 micromhos.

The results of the soundings and the well logs in this area disagree with the assumption that the alluvium is uniform lithology. Nevertheless, the assumption that the alluvium is uniform salinity and of resistivity dependent on salinity is important in determining the E.C. of the groundwater. However, by carrying out resistivity measurements in the alluvium at several points, as provided excellent examples of the resistivity curves in preparation for well logs elsewhere.

Summary and Conclusions

The geophysical investigation of the area east and south of the central part of the site has shown that there are beds of coarse grained alluvium containing low salinity water. These beds probably represent the alluvium which is 50 metres thick, according to the ES 42. It is suggested that they could be 50 metres thick in the north and west. The alluvium appears to be composed of clayey sand and marl.

Some sites were chosen on the following basis:

- to test geophysical interpretations
- rig access about the raised roads and deep
- canals and drainage
- the need to minimise road and site works and
- to minimise the disruption of agricultural

activities.

Considered alone, the groundwater E.C. range and the resistivity contours in Figure 2.2 may suggest that the change in resistivity over the area is caused by groundwater salinity variation within the alluvium of uniform lithology. In other words if the alluvium is assumed to be composed of thick homogenous clays then the high resistivity ridge could represent pore water in the clays with an E.C. of 50 micromhos whilst the low resistivity area in the north west could represent clays with a pore water of higher E.C.

The results of the soundings and the well points in the area disagree with the assumption that the alluvium is of uniform lithology. Nevertheless, the results of the surveys of groundwater salinity and of resistivity demonstrate how important it is to determine the E.C. of the groundwater whenever carrying out resistivity measurements. The work done at MARDI Bertam has provided excellent experience for the resistivity crew in preparation for work in alluvial areas elsewhere.

#### Summary and Selection of Drilling Sites.

The geophysics survey indicates that in the east and southern central part of the research station there are beds of coarse grained alluvium containing low salinity water. These beds probably occupy the upper 15 to 20 metres though evidence at sounding site ES 41 suggests that they could be 50 metres thick. In the north and west the alluvium appears to be composed of low resistivity clays.

Bore sites were chosen on the following considerations:

- to test geophysics interpretations
- rig access about the raised roads and deep canals and drains
- the need to minimise road and site works and to minimise the disruption of agricultural activities.

The first site (Figure 2.2) has been chosen next to the workshops just north of the offices. The ground needs no preparation and a successful borehole at this site could feed via a short pipeline into a canal. However the aquifer potential appears to be limited to a high resistivity (possibly sand) layer extending from 12 to 20 metres. Below, the potential appears poor; the resistivity sounding indicates a thick low resistivity layer perhaps representing either silt/clay or weathered bedrock shale. The first exploratory borehole should aim to find out what the sequence is.

Groundwater Section was asked to investigate the groundwater. Site 2 was selected on the basis of access and resistivity. It has a similar resistivity section to the first and indicates a high resistivity layer in the upper 15 to 20 metres. Success at site 1 would promote the worth of site 2. A new "field-road" is to be built between site 2 and the workshop area; this will allow access to site 3. A resistivity sounding nearby indicates thicker higher resistivity alluvium of perhaps extending to 50 metres.

The aim of site 4 was to explore the possibility of thin sand lenses within the apparently thick clayey alluvium. On present resistivity interpretations, this site appears unpromising. It may be drilled subject to drilling results from sites 1-3.

they contain an appreciable percentage of gravel size quartz crystals, the majority of the matrix is clayey. This material, on the basis of surface evidence, does not appear to be a potential aquifer.

The geophysics team carried out 2 profiles and three soundings in order to investigate the thickness of the alluvium and the lateral extent of the limestones. The location of the measurements is shown (Figure 2.7).

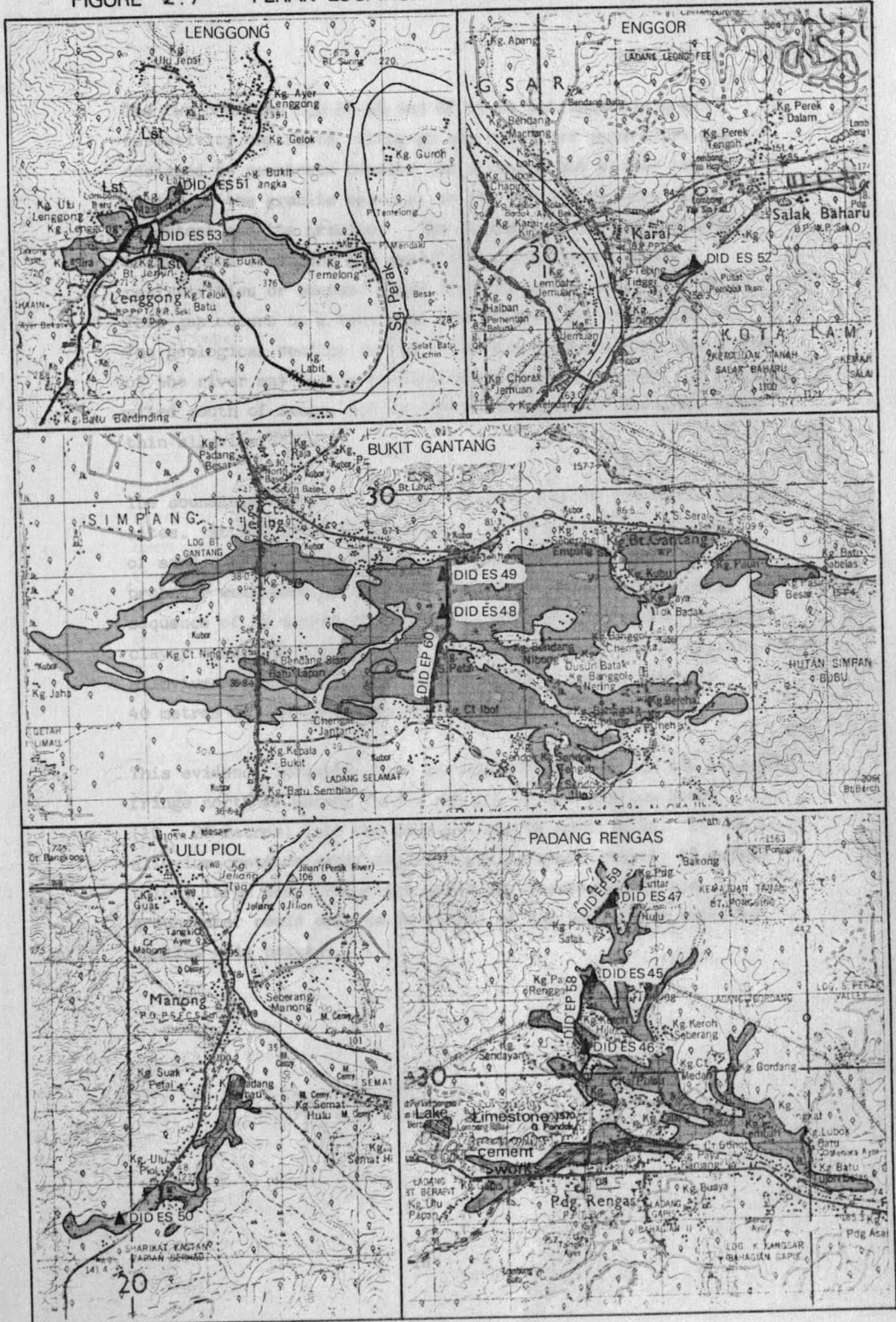
### 2.1.5 Padang Rengas

The Padang Rengas is composed of narrow strips of paid land on the tributaries of the Sungai Keroh. The area lies north of the main Butterworth-Kuala Lumpur railway line to the west of Kuala Kangsar (Figure 2.1). In 1981, the padi growing areas in the headwaters region to the north and north west were said by the JPT to be watershort. Groundwater was considered as a possible alternative to costly surface water diversion schemes. JPT Groundwater Section was asked to investigate the groundwater potential of these headwater areas.

The padi areas are probably underlain by granite or Permian metamorphosed limestone. The granite bedrock is unlikely to provide a potential aquifer. The limestone in the south of the area outcrops as a massive isolated hill called Gunong Pondok which is thought to rest on the granite and to extend below the alluvium only a short distance beyond the base of the cliffs of Gunong Pondok. If buried limestone does extend away from the hill it could form a potential aquifer worthy of exploratory drilling. Alluvial valley fill is likely to be thin in the narrow headwater valleys. The interfluvies between the headwater streams appear to be composed of colluvium, and deeply weathered granite. Surface samples of these materials show that, though they contain an appreciable percentage of gravel size quartz crystals, the majority of the matrix is clayey. This material, on the basis of surface evidence, does not appear to be a potential aquifer.

The geophysics team carried out 2 profiles and three soundings in order to investigate the thickness of the alluvium and the lateral extent of the limestone. The location of the measurements is shown (Figure 2.7).

FIGURE 2.7 PERAK LOCATION OF RESISTIVITY PROFILES AND SOUNDINGS



The two profiles DID EP 58 and EP 59 do not show any great resistivity contrasts, although the electrode separation was designed to penetrate beneath the alluvium and either locate faults in the granite bedrock, or the contact between the limestone and the granite. The contact may be undetectable because the limestone and granite bedrocks have similar resistivities or because there is a 176 m gap in profile EP 58. This gap occurs on a bend near the bridge over Sungei Ati. The geological section in the river bed suggests that the course of the river may follow the limestone-granite contact. A borehole sited south of Sungei Ati may strike karstified limestone below thin alluvium.

The soundings DID ES 45, 46 and 47 were done on potential drilling sites. At DID ES 46 there appears to be a 6 metre thick bed of sand overlying 70 metres of either sands and clays, or more probably weathered granite. At DID ES 45 there is a similar sequence of 10 metres of sandy silt overlying 25 metres of more clayey weathered granite. At the northern site DID ES 47, the alluvium appears to be about 1 metre thick, below which is 40 metres of clayey weathered granite.

This evidence indicates that an exploratory bore in the limestone fringe north of Gunong Pondok and one or two shallow bores (10 - 20 metres) into the alluvium may be worthwhile. If the alluvium contains sandy deposits and is approximately 10 metres thick, large deep production wells are inappropriate and groundwater could only be developed by the use of dug wells or shallow well points.

As their work was carried out along the feather edge of the alluvium abutting the granite hills, their results do not preclude the presence of deeper alluvium in the centre of the valley. The alluvium is possibly of fluvial and marine origin. It appears to infill two parallel, east-west orientated valleys and perhaps cover a low interfluvium.

#### 2.1.6 Bukit Gantang

The Bukit Gantang area occupies the floor of a wide valley to the south of Taiping. The padi growing area is nominally about 2,400 acres. JPT in Taiping say that the surface water resources have diminished and only 1,200 acres can be supplied with adequate water during the main season. The 1,200 acres for which JPT plan to provide a guaranteed surface water supply, are grouped near the offtake headworks.

The groundwater section has been asked to investigate two problems. The most urgent problem is to provide a groundwater supply for about 30 acres of land just south west of Kg. Jelutong on the Taiping-Kuala Kangsar road. This small enclave lies outside the area for which surface water can be guaranteed, but is cultivated each year by a resolute group of farmers. It is important for the future well being of the whole scheme that the farmer's perseverance is encouraged by the provision of a reliable water supply. The second is the more general question of whether potential aquifers underly the central and western section of the scheme.

The background information on the geology is scant. The underlying bedrock is probably granite. Certainly the hills to the north, east and west are composed of this rock. GSM have done some shallow augering along the northern edge of the area in order to assess the mineral composition of the alluvium.

The results indicate that along their survey line the thickness increases from less than 5 metres in the east to greater than 20 metres in the west. As their work was carried out along the feather edge of the alluvium abutting the granite hills, their results do not preclude the presence of deeper alluvium in the centre of the valley. The alluvium is possibly of fluviatile and marine origin. It appears to infill two parallel, east-west orientated valleys and perhaps cover a low interfluvium.

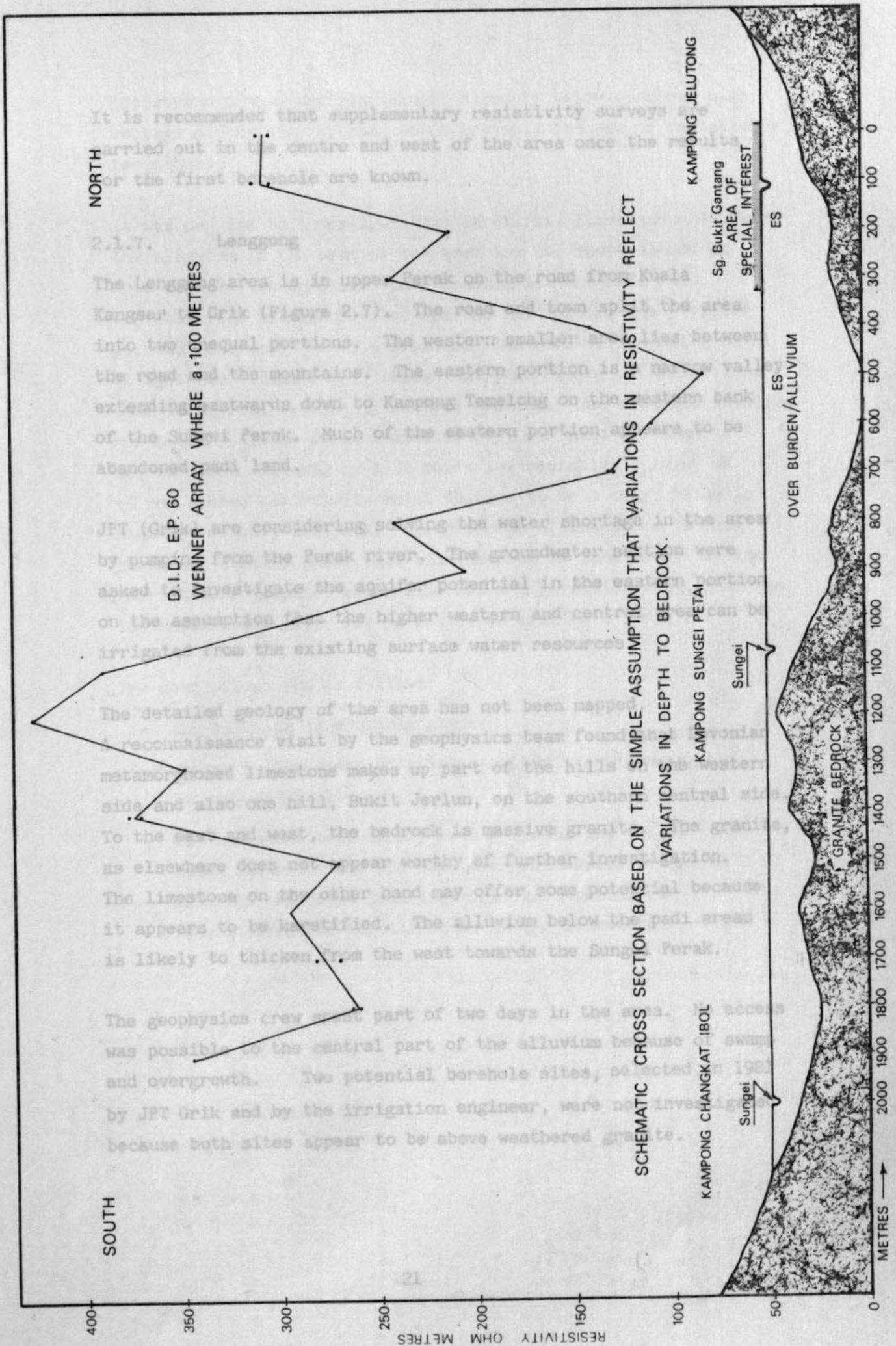
The geophysics team spent two days in the area and completed two soundings and one long profile (Figure 2.7). The profile DID EP 60 runs from north to south along the road from Kg. Jelutong to Kg. Changat Ibol (Figure 2.8). An interpretation of the results in terms of varying thickness of alluvium is given below the data plot. On this basis, it appears that beneath the padi area lie two buried valleys. The thickness of alluvium appears to be greater in the northern valley (Sungei Petai-Sungei Bukit Gantang). An alternative interpretation is that the thickness of alluvium does not vary but its composition does. In other words the alluvium in the south and north is predominantly low resistivity clays whereas in the centre near Kampong Sungei Petai it is composed of higher resistivity sands or gravels.

Two soundings were carried out. The first was done before the profile merely to assess the best electrode separation for the profile. The second sounding (DID ES 49) was done on the road on the eastern side of the 30 acre area of special interest. Both soundings have a similar curve shape. At DID ES 48 the curve matching interpretation indicates that the top 3 metres is clay. This is followed by 10 metres of sand, followed by a considerable depth (90 m?) of either clay or decomposed granite. The sequence at DID ES 49 is less promising with 6 metres of clay at the top followed by 5 metres of sand, above 18 metres of either clay or weathered granite.

Conclusions are that if an exploratory borehole should be drilled to investigate the potential productivity of the alluvium near the area of special interest, it should be sited on the southern or south eastern side of the area. At present it appears that there may only be 5-10 metres of high resistivity material (sand) in the alluvial-weathered bedrock section. Such a thin layer is likely to be inadequate.

FIGURE 2.8

RESISTIVITY PROFILE EP 60 BUKIT GANTANG



It is recommended that supplementary resistivity surveys are carried out in the centre and west of the area once the results for the first borehole are known.

#### 2.1.7. Lenggong

The Lenggong area is in upper Perak on the road from Kuala Kangsar to Grik (Figure 2.7). The road and town split the area into two unequal portions. The western smaller area lies between the road and the mountains. The eastern portion is a narrow valley extending eastwards down to Kampong Temelong on the western bank of the Sungei Perak. Much of the eastern portion appears to be abandoned padi land.

JPT (Grik) are considering solving the water shortage in the area by pumping from the Perak river. The groundwater section were asked to investigate the aquifer potential in the eastern portion on the assumption that the higher western and central area can be irrigated from the existing surface water resources.

The detailed geology of the area has not been mapped.

A reconnaissance visit by the geophysics team found that Devonian metamorphosed limestone makes up part of the hills on the western side and also one hill, Bukit Jerlun, on the southern central side. To the east and west, the bedrock is massive granite. The granite, as elsewhere does not appear worthy of further investigation. The limestone on the other hand may offer some potential because it appears to be karstified. The alluvium below the padi areas is likely to thicken from the west towards the Sungei Perak.

The geophysics crew spent part of two days in the area. No access was possible to the central part of the alluvium because of swamp and overgrowth. Two potential borehole sites, selected in 1981 by JPT Grik and by the irrigation engineer, were not investigated because both sites appear to be above weathered granite.

The southern site was also almost directly below overhead high voltage electricity pylons, which prevents the use of resistivity techniques.

It was decided to investigate the karstified limestone underlying the alluvium in the west of the area and two short soundings were carried out on minor roads leading off the main road. The main road was ignored because the fast moving heavy timber lorries made crew safety a problem. The northern sounding ES 51 at Kg. Lahar (Figure 2.7) shows that thin clayey alluvium (less than 10 metres) overlies limestone bedrock. The southern sounding north of Kg. Bukit Jelun indicates clay and sand alluvium to 3 metres depth followed by a 30 metre low resistivity layer of 45 ohm metres resistivity which appears to be a clay; below is high resistivity bed rock. The outcrops of limestone to the north and south suggest that this bedrock is limestone. If the bedrock were granite, which also has a high resistivity, then the low resistivity layer may be weathered granite.

The conclusions are as follows:

- the alluvium is probably clayey
- access to the areas of greatest alluvial thickness is very difficult
- the limestone bedrock may extend across the valley under the alluvium, and may have groundwater potential although extensive drilling might be necessary to locate permeable karstic zones in the limestone.

Access for the geophysics crew was very difficult; no suitable tracks cross the alluvium whilst the padi was planted and under water when visited in July 1982. The geophysics crew succeeded in doing a resistivity sounding on the top of a very narrow bund.

### 2.1.8 Ulu Piol

Ulu Piol is a narrow strip of paid land on the alluvial floor of a sharply defined valley south of Manong. The main Perak River lies to the east. The area is divided in two by the Bruas-Kuala Kangsar road (Figure 2.7). JPT, Kuala Kangsar say that whilst there is considerable interest in planting padi in the area, JPT can guarantee adequate water for the north eastern or downstream part but not for the upstream, south western part. The groundwater section has been asked to investigate the groundwater potential in the southwestern part.

The Geological Survey of Malaysia have recently completed mapping of the area which appears to lie on or close to the contact between granite to the west and Carboniferous sediments to the east. Unfortunately, neither of these hard rocks are likely to prove potential aquifers and the alluvium under the padi may provide the only hope of finding groundwater. Two drilling sites had been selected by the irrigation engineer. The first, adjacent to the irrigation headworks, appears to overlie clayey weathered granite. A second site, near the point where the main road crosses the valey, has the same underlying lithology as the first. Whilst both sites are suitable from the point of view of irrigation command, both are unlikely to give successful boreholes. A well point recently installed by the Ministry of Health 50 metres upstream from the second site struck hard rock at twenty feet; when pumped with a hand pump, the well point dries up in less than 5 minutes!

Access for the geophysics crew was very difficult; no suitable tracks cross the alluvium whilst the padi was planted and under water when visited in July 1982. The geophysics crew succeeded in doing a resistivity sounding on the top of a very narrow bund.

The site was selected because the instrument and operator could site in a hut on stilts above the flooded land. (Figure 2.9). The shape of the sounding curve indicates less than 5 metres of clay bound alluvium overlying a considerable thickness of high resistivity weathered bedrock.

The reconnaissance investigation indicates that the groundwater potential in the area is poor. The bedrock on either side of the valley is not considered promising as an aquifer bearing material whilst the alluvium in the valley floor appears thin and is certainly inaccessible for a large heavy rig. However, since there is apparently considerable interest in padi cultivation in the area, more work, both resistivity and drilling, may be worthwhile. Further resistivity work on the southern banks of the valley, might succeed in finding out if surface colluvium may here overly alluvium in a deep ancient valley cut by the Sungei Perak along the granite-sediment contact.

#### 2.1.9 Enggor

The fish breeding station at Enggor is sited in a valley next to the main road between Kuala Kangsar and Ipoh, about 1 kilometer from the eastern bank of the Sungei Perak (Figure 2.7). The present fish ponds occupy an area of 300 metres by 100 metres, and surface water is supplied from a diversion on a stream to the south east. The station wants to expand its facilities and excavate more ponds on abandoned sawah directly downstream of the existing ponds and an increased water supply is needed. Whilst JPT Kuala Kangsar have devised a surface water diversion scheme, the groundwater section has also been requested to investigate whether groundwater is a cheaper alternative.



b) The alluvial floor of the valley showing the flooded fields and the narrow bunds.

The valley is very  
at the western bow  
of the valley floor  
extension, gradient  
The valley sides  
colluvium and west  
Masif. The last  
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The geophysical  
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there was no  
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the only  
station  
the sounding  
sounding curve is  
of the inflections may be  
than horizontal layering.

a) Taking resistivity measurements from a hut on stilts above the flooded padi.

The curve may indicate the valley floor is underlain by less than 4 metres of either clayey alluvium or weathered bedrock. This interpretation seems reasonable in view of the geomorphology of the site.

The siting of a test aquifer is difficult as the evidence indicates that there is no obvious target aquifer, suitable for a deep drill



b) The alluvial floor of the valley showing the flooded fields and the narrow bunds.

The valley is very narrow and its floor is about 20 metres wide at the western boundary of the existing station. The gradient of the valley floor inside the station is steep but in the proposed extension, gradient diminishes and the valley is an overgrown swamp. The valley sides are steep and on the south appear to consist of colluvium and weathered granite derived from the Gunong Saiong Masif. The land to the north has lower relief and is reputed to consist of Silurian meta-sediments and a small outcrop of Tertiary beds.

The geophysics crew visited the site and found that there was no access to the area for the proposed extension. Since a resistivity survey could not be carried out on the steep valley sides, the only option was to try and do a sounding inside the existing station grounds. Despite obstacles and a restricted site, the sounding reached a maximum AB/2 of forty metres. The sounding curve is difficult to interpret because several of the inflections may be caused by lateral heterogeneity, rather than horizontal layering. The curve may indicate that the valley floor is underlain by less than 4 metres of sandy alluvium, followed by about 20 metres of either clayey alluvium or weathered bedrock. This interpretation seems reasonable in view of the geomorphology of the site.

The siting of a test borehole may be difficult as the evidence indicates that there is no obvious target aquifer, suitable for a deep drilling.

It is probable that alluvium either laid down under marine conditions, or alluvium close to the coast, will contain saline or brackish water. A second constraint on the development of groundwater from the alluvium is that the alluvium is probably thickest at the coast and thins rapidly inland. Therefore the zone with the least salinity problem is likely to also be the zone with the thinnest alluvial deposits. A cross section that illustrates the expected hydrogeological characteristics of the Balik Pulau area is given (Figure 2.11).

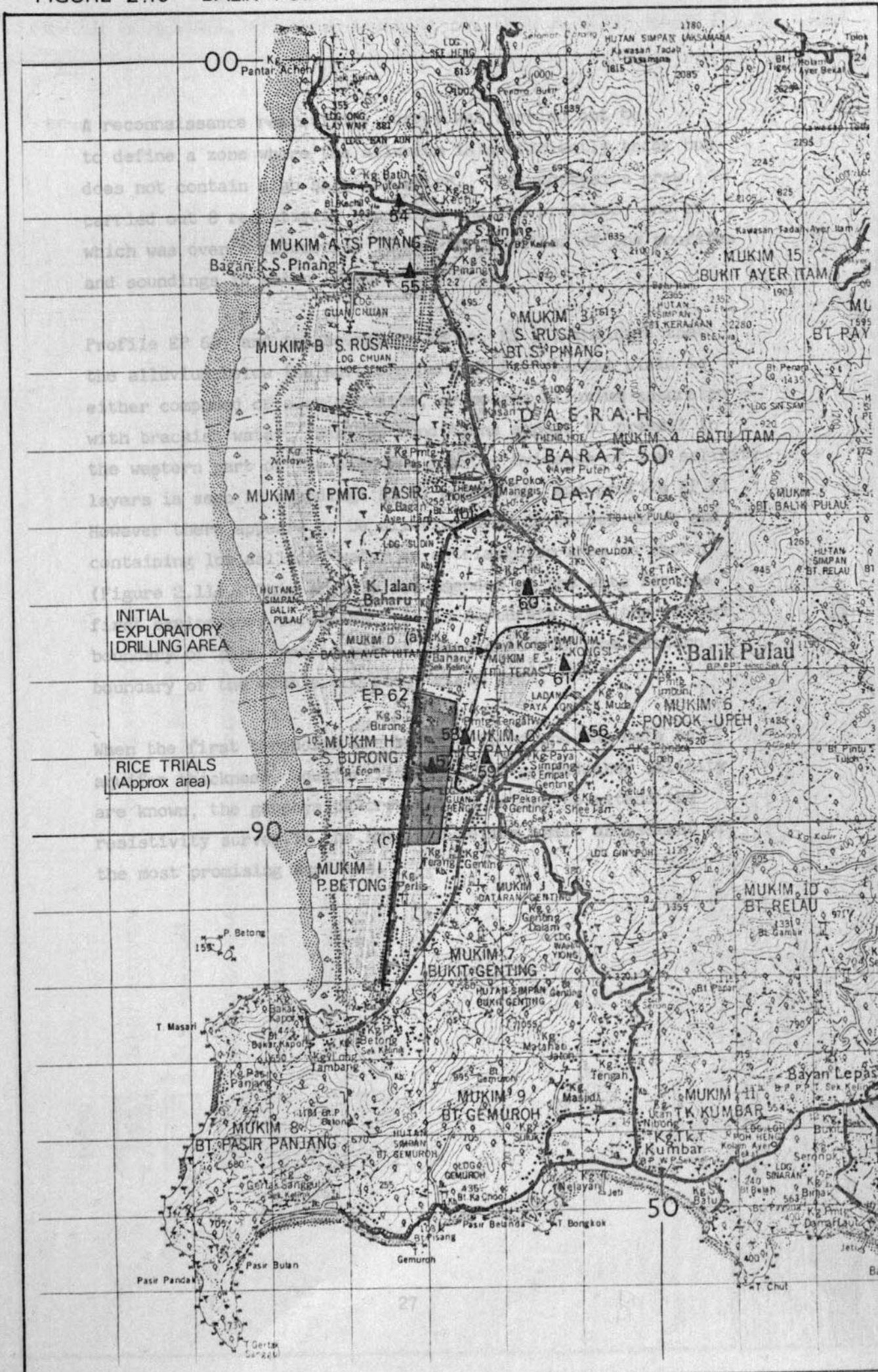
## 2.1.10 Balik Pulau, Penang.

The Balik Pulau area is a 10 kilometre long coastal plain on the west side of Penang Island; the plain is about 5 kilometres at its widest point (Figure 2.10). There is a continuous belt of mangrove swamp along the coast behind which is a narrow strip of recently reclaimed land. A two kilometre wide belt of padi land extends between the mountains and reclaimed land. Much of the padi land is abandoned for reasons which are complex and contentious and are not due solely to water shortage. Nevertheless, supplementary water supplies from groundwater may contribute to increased utilisation of the land, either by allowing the double cropping of padi or off season cropping of higher value cash crops. The groundwater section has been asked to investigate the groundwater potential of the area with a view, particularly, to providing supplementary water for current double cropping trials.

The geology of Penang Island is relatively straight forward. A central granite massif rises to over 2,200 feet in the centre of the island whilst a discontinuous fringe of beaches, and marine and fluvial alluvium lie around the base of the mountains. Beneath the narrow coastal plain, the bedrock is granite.

The groundwater potential of the hard granite for irrigation water supplies is low and likewise the often thick clayey zone of weathered granite. The best potential aquifer is the alluvium yet it is probable that alluvium either laid down under marine conditions, or alluvium close to the coast, will contain saline or brackish water. A second constraint on the development of groundwater from the alluvium is that the alluvium is probably thickest at the coast and thins rapidly inland. Therefore the zone with the least salinity problem is likely to also be the zone with the thinnest alluvial deposits. A cross section that illustrates the expected hydrogeological characteristics of the Balik Pulau area is given (Figure 2.11).

FIGURE 2.10 BALIK PULAU: LOCATION OF SOUNDINGS AND PROFILES



A reconnaissance resistivity survey was carried out to define a zone where the alluvium is sufficiently thick but does not contain high salinity water. The geophysics crew carried out 8 resistivity soundings and two profiles, one of which was over 6 kilometres long. The location of the profiles and soundings is shown (Figure 2.10).

Profile EP 60, and the soundings ES 54, ES 55, indicate that the alluvium below the northern part of the coastal plain is either composed of clay deposits, or coarse alluvium saturated with brackish water. Similar conditions appear to prevail in the western part of the southern area. Evidence of low salinity layers is seen in soundings ES 57 and ES 60, and profile EP 61. However there appears to be alluvium over 20 metres thick and containing low salinity water in a triangular area as shown (Figure 2.11). This area is recommended as the site for the first exploratory boreholes. It is fortunate that the western boundary of this area is almost coincident with the eastern boundary of the double cropping trials area.

When the first boreholes are being drilled and the data on aquifer thickness, aquifer lithology and groundwater salinity are known, the geophysics crew should return to extend the resistivity survey in the area and refine their assessment of the most promising aquifers.



WEST

SEA  
MANGROVE SWAMPS  
PERMATANG OR OLD BEACH

OF WATER TABLE IN  
FRACTURES AND FAULTS

FIG. 2.11 SCHEMATIC HYDROGEOLOGICAL SECTION ACROSS BALIK PULAU AREA

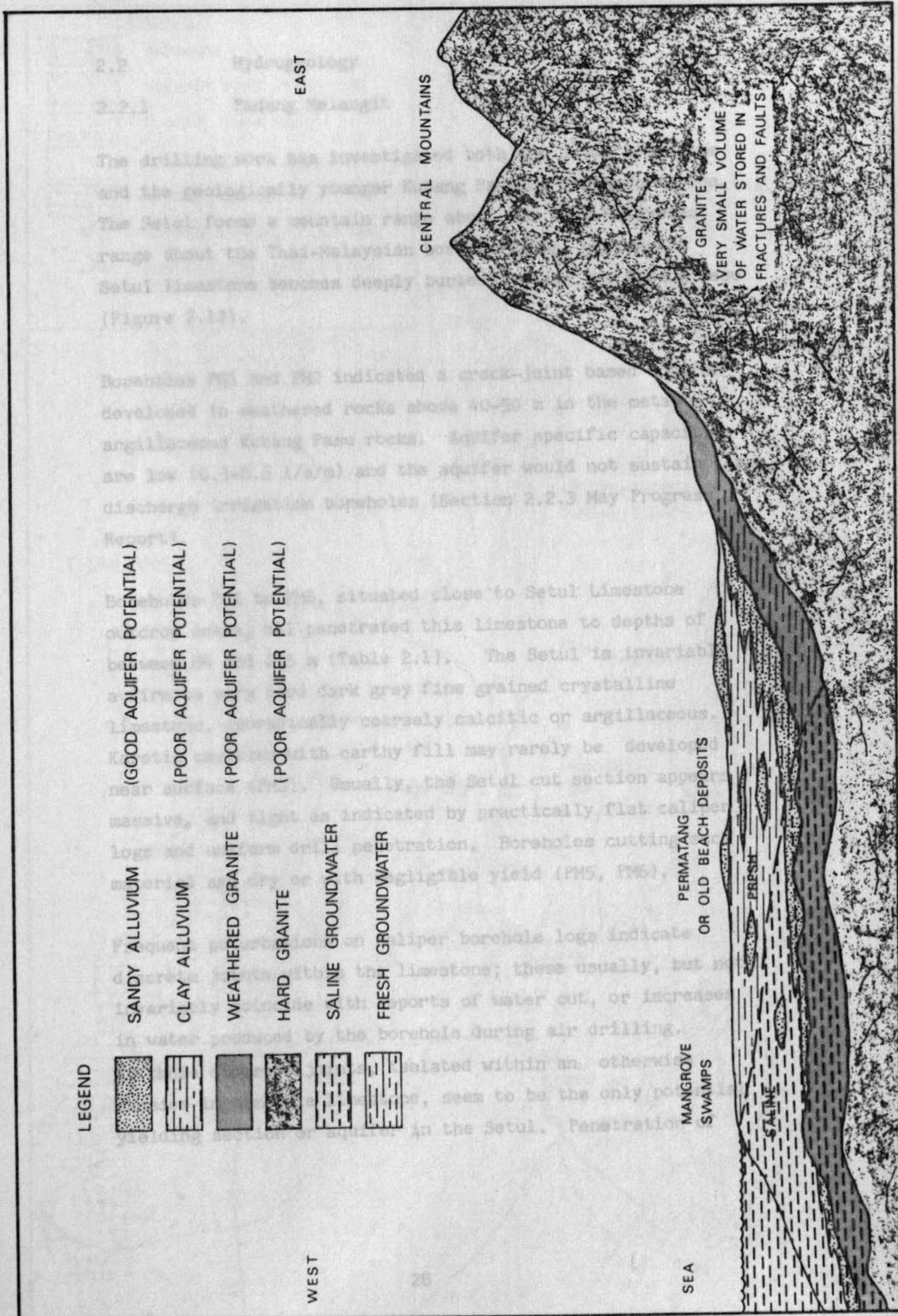


Figure 2.12 Perlis: Borehole Locations

LEGEND	
2.2	Hydrogeology
2.2.1	Padang Melangit

The drilling work has investigated both the Setul Limestone and the geologically younger Kubang Pasu or Singa Formation. The Setul forms a mountain range about the Thai-Malaysian range about the Thai-Malaysian border region; eastwards Setul limestone becomes deeply buried beneath the Kubang Pasu (Figure 2.12).

Boreholes PM1 and PM2 indicated a crack-joint based aquifer developed in weathered rocks above 40-50 m in the meta-argillaceous Kubang Pasu rocks. Aquifer specific capacities are low (0.5-0.6 l/s/m) and the aquifer would not sustain large discharge irrigation boreholes (Section 2.2.3 May Progress Report).

Boreholes PM3 to PM6, situated close to Setul Limestone outcrop areas, all penetrated this limestone to depths of between 84 and 115 m (Table 2.1). The Setul is invariably a firm to very hard dark grey fine grained crystalline limestone, sporadically coarsely calcitic or argillaceous. Karstic cavities with earthy fill may rarely be developed near surface (PM3). Usually, the Setul cut section appears massive, and tight as indicated by practically flat caliper logs and uniform drill penetration. Boreholes cutting such material are dry or with negligible yield (PM5, PM6).

Frequent perturbations on caliper borehole logs indicate discrete joints within the limestone; these usually, but not invariably coincide with reports of water cut, or increases in water produced by the borehole during air drilling.

If these discrete joints, isolated within an otherwise massive impermeable limestone, seem to be the only potential yielding section or aquifer in the Setul. Penetration of

Figure 2.12 Perlis: Borehole Locations

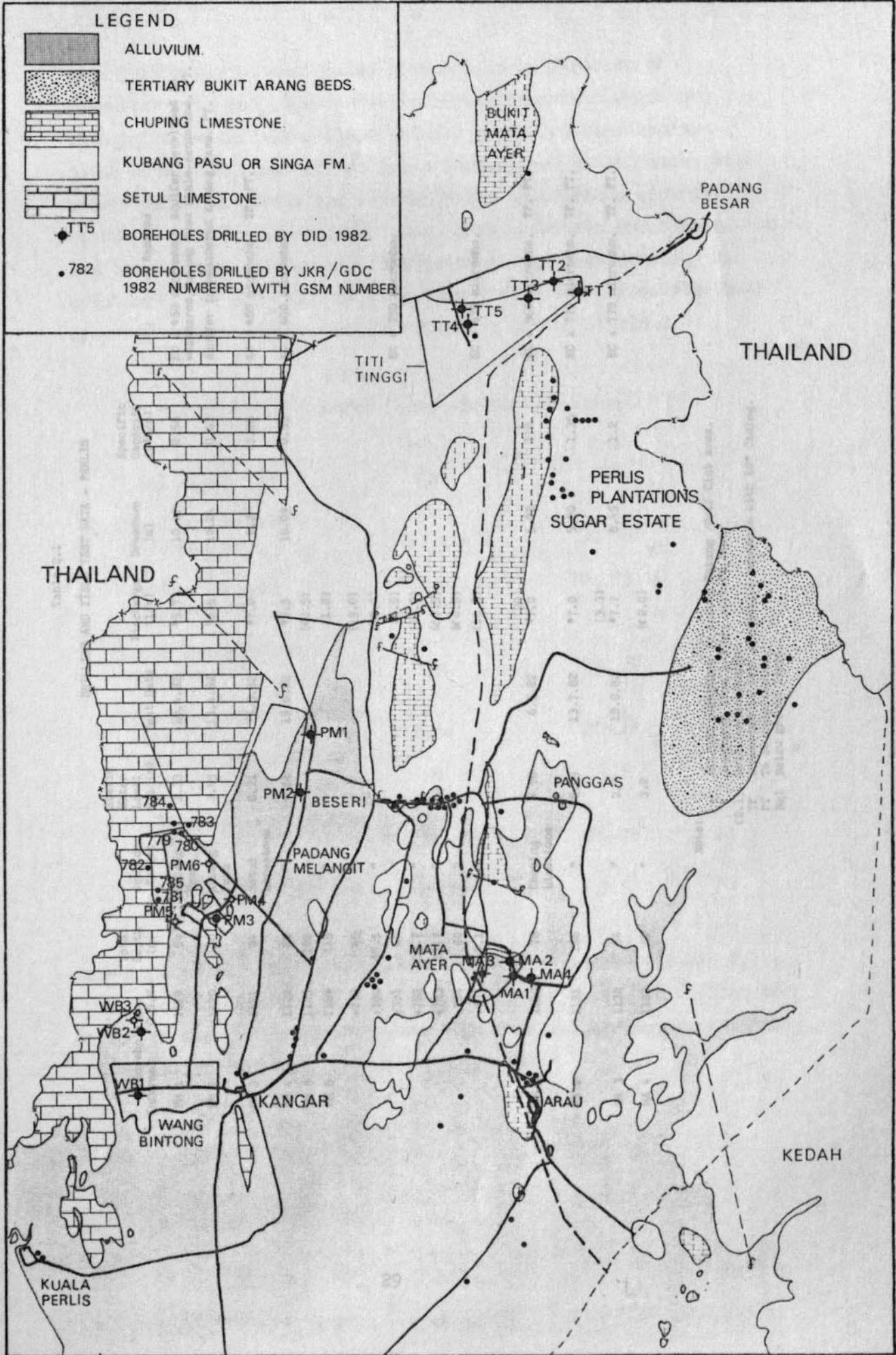


Table 2.1

## DRILLING AND YIELD TEST DATA - PERLIS

Borehole No. Informal	G.S.M.	Total Depth (m)	Aquifer: Target	Static Water Level Bgl (m)	Test Date	Discharge (l/s)	Drawdown (m)	Specific Capacity (l/s/m)	Remarks
PM 1	1119	54	Kubang Pasu	3.33	28.4.82	*5.7	10.17	0.56	EC = 450 micromho. Aquifer developed in weathered Kubang Pasu shale-sandstone. PT. Aquifer in weathered Kubang Pasu. PT.
PM 2	1120	130	Kubang Pasu	3.45	13.4.82	*6.5	10.24	0.63	
PM 3	1121	84	Setul Limestone	0.21	5.5.82	*7.0	2.2	3.18	EC = 480 micromho. TP. PT.
PM 4	1122	88	"	0.68	19.6.82	*5.5 (40.5)	10.09	0.55	EC = 600 micromho.
PM 5	1123	102	"			(1.8)			
PM 6	1124	115	"			(19.0)			
	+779	45	"			(19.0)			
	+780	55.5	"			(1.5)			EC = 350 micromho.
	+781	60	"			(15.0)			
	+782	30.7	"			(0.5)			
	+783	61.7	"			(0.5)			
	+784	60	"			(16.5)			EC = 610 micromho.
	+785	49.1	"						
MA 1	1130	78	Chuping Limestone	4.36	6.5.82	(20) *7.0	5.82	1.2	EC = 560 micromho. TP. PT.
MA 2	1131	186	"	5.09	13.7.82	*7.0	5.20	1.35	EC = 770 micromho. TP. PT.
MA 3	1132	84	"	2.9	18.8.82	(3.3) *7.7	6.45	1.2	EC = 770 micromho. TP. PT.
MA 4	1133	60	"	3.2		(2.0)			

## Note:

- \* JKR/GDC boreholes in Kurong Batang /Golf Club area.
- † Discharge from 2-3 hr. airlift test.
- (2.1) Drilling discharge.
- TP Converted to test production borehole with 10" casing.
- PT To be pump tested.
- Bgl Below ground level.

such joints may be associated with sudden colouration of borewater with red brown or yellow silty materials which are thought to be infilling these joints. Drill cuttings across joint zones may show reddish brown ferruginous joint faces, with brashy calcitic debris and reddish silt, in complete contrast to the normal dark grey limestone. Such materials and colouration indicate active groundwater flow paths along these joints. In both bores PM4 and PM3, moderate bore yields seem associated with discrete and extremely thin transmissive joints (Table 2.2).

Four borehole data Table 2.2  
 total of 84  
 specifically drilled  
 of the Chapter  
 Location of Aquifer Zones, Setul Limestone

	PM3	PM4
Total depth (m)	84	88
Cavities; driller evidence (m)	5.5, 26-27	30-35
Joints, caliper evidence (m)	40, 48.7, 54-55	70, 71.5
Water encountered; driller (m)	56	29, 72
Possible upper yielding zone (m)	none	30-33
Yield during drilling (l/s)	0	5.5
Possible lower yielding zone (m)	56-57	71-72
Yield during drilling (l/s)	7	3.8

10-20/40  
 Air lift yield tests were carried out on PM3 and PM4 (Table 2.1); the specific capacity of PM3 alone seems to justify conversion to a 10" TP bore and a variable and high rate discharge pump testing to establish borehole production potential.

Because the Setul is usually hard, massive and stable in cut section, production boreholes can be completed by drilling for and setting a permanent casing into competent rock through overburden and any superficial cavity bearing limestone; production would then be from transmissive joints intersected in the open bore below. Where overburden-cavity zone is very thin, production pumps could be set safely below casing depth, in the open bore.

### 2.2.2 Mata Ayer

Four boreholes have been completed in Chuping Limestone and a total of 408 m of drilling was completed. One bore, MA 4 was specifically drilled to test the possible eastwards extension of the Chuping as predicted by the resistivity survey work (Section 2.2.3(v), May Progress Report). A borehole summary is given (Table 2.1). Boreholes typically intersect unstable rubble materials above more competent Chuping (Table 2.3).

Table 2.3

Chuping Limestone Section Characteristics in P. Melangit.

Typical depth interval (m)	Typical Lithology	Comments
0-10	Soil, laterite, red-brown clays	Weathered mottled clay section 12-24m in MA 2 may be K. Pasu remnant or scree.
10-20/40	Karstic red-brown clay silt filled voids, cavities; fine running lime sands; poorly cemented and consolidated Chuping limestone rubble. (Rubble zone extends to 38 m in MA 3).	Circulation loss zone often forms a shallow aquifer. Karst voids could cause rig foundation/conductor subsidence.

The bore logging results (Table 2.1) indicate moderate typical depth interval (m) Typical Lithology Comments

Typical depth interval (m)	Typical Lithology	Comments
> 20/40	Pale yellow-cream, firm and fine grain, calcarenitic and friable or in deeper sections light olive grey, hard fine grain micro-crystalline limestone. Sporadic joints which may yield fine dolosands.	May contain joint-crack based aquifer. Usually free standing in open bores.

Nevertheless, it appears that in the Mata Ayer project area,

Aquifer zones are typically developed in the unstable rubble zone above 20 to 40 m and may be detected during bentonite mud drilling as loss circulation zones. This superficial aquifer is the only producing zone in MA 3. Beneath, aquifers are located in more competent Chuping limestone, in thin, discrete joint-crack zones and, probably less importantly, in porous calcarenite facies of the limestone. Frequent perturbations of caliper borehole logs will suggest the occurrence of joints which may contribute to the bore yield. Drilling and caliper logs suggest that yielding joints are unlikely to be encountered below 60-70 m in this area; this puts a tentative limit on useful penetration depths.

The Chuping Limestone poses some severe drilling and completion problems. The upper rubble aquifer material is unstable and must be cased or screened off. However, attempts to clean and develop this aquifer through screen result only in the prolonged ingress of red-brown water and loose silt; screen blockage may occur. In the lower aquifer zone, periodic fine flowing lime sands have been encountered which may necessitate the use of screen in production bores.

The bore testing results (Table 2.1) indicate moderate specific capacities at the low discharges (7 l/s) available during air lift testing. However, bores MA 1-3 require step and constant discharge tests with high capacity borehole pump in order to test their drawdown/discharge behaviour. Air lift results, particularly from bores which yield from thin, crack-joint transmissive zones, should be extrapolated to production conditions with extreme caution.

Nevertheless, it appears that in the Mata Ayer project area, the Chuping aquifer may sustain moderate yields to boreholes of depth not exceeding 70 m. If production drawdowns of 10 m and 15 m be assumed, then possible yields are given (Table 2.4).

Table 2.4  
Bore Yields : Mata Ayer

bore	Pump casing depth (m)	Static water level (m) bgl	Apparent specific capacity (l/s/m)	Possible yield for stated drawdowns (l/s)	
				10 m	15 m
MA 1	24	4.36	1.2	12	-n/a
MA 2	43	5.09	1.35	13	20
MA 3	35	2.9	1.2	12	18

Note: Specific capacities derived from crude air lift tests run at about 7 l/s.

Borehole waters from the Chuping aquifer under Mata Ayer are of moderate salinity (560-770 micromho/cm at 25°C or approximately 350-450 ppm salinity). Chemical characteristics will be fully checked during borehole pump testing.

### 2.2.3 Groundwater Potential

Recent drilling in the Setul limestone about Padang Melangit, by the JPT groundwater group and by JKR/GDC indicates, as follows:

- the Setul can provide moderate drilling discharges to boreholes, of up to 19 l/s (JKR/GDC GS 778, 780; Table 2.1).
- air lift testing (PM 3, PM 4) has indicated that moderately high specific capacities can occur, which would allow boreholes to be produced at 20 l/s or more with acceptable pumping heads.
- the characteristics of the Setul aquifer are highly variable. Apparent bore yields, and almost certainly specific capacities too, are highly variable between near zero and 20 l/s. Any development in the Setul will encounter a bore failure rate. For bores capable of production at 20 l/s with moderate drawdowns (not exceeding 10-15 m) a failure rate of over 50 per cent (or 6 in 11) might be expected.

All the comments made here are based on most imperfect evidence, from air lift yield tests and from water yields noted during air lift tests.

- no method is known whereby bores can be sited with confidence in productive zones in the Setul; a large scale drill and test operation, in or adjacent to irrigable areas, would have to be adopted. To make more specific recommendations, in particular about possible development in the Mata Ayer area,

Drilling work both in Mata Ayer and elsewhere in Perlis and in Kedah, indicates that the Chuping Limestone invariably contains an aquifer of moderate to high potential. At Arau, the aquifer has long been produced at over 20 l/s by JKR for water supply. Results from the present work indicate:

- air lift testing has indicated moderate specific capacities, around 1-1.3 l/s/m which could allow boreholes in Mata Ayer to produce 10-20 l/s with acceptable drawdowns and pumping heads (Table 2.4).
- the Chuping aquifer is much less variable than the Setul and unsuccessful or dry boreholes will be rare. A production drilling programme for irrigation bores of, say, greater than 10 l/s might anticipate a failure rate of only 10 per cent.
- the Chuping Limestone can be difficult to drill as it is unstable and subject to bore wall collapse. Some technical (borehole drilling) failure must be expected if production bores are drilled.

All the comments made here are based on most imperfect evidence, from air lift yield tests and from water yields noted during air drilling. At least five of the bores drilled must be fully pump tested in order to check on specific capacity over a large discharge range and to check on sustainable bore yields for an acceptable pumping head. This data will be used to make more specific recommendations, in particular about possible development in the Mata Ayer area.

## 2.2.4 Drilling Programme

## Programme Revisions.

A meeting was held on 16.7.82 at JPT Head office in Kuala Lumpur, by a committee composed representatives of State JPT offices and the Planning Department, to review the drilling investigation programme; the consultant was not present.

It was decided that several areas should be deleted from the programme whilst two areas were included. Accordingly the drilling programme given in the May 1982 Progress Report has been revised (Figure 2.13). Deleted/reinstated areas, with some

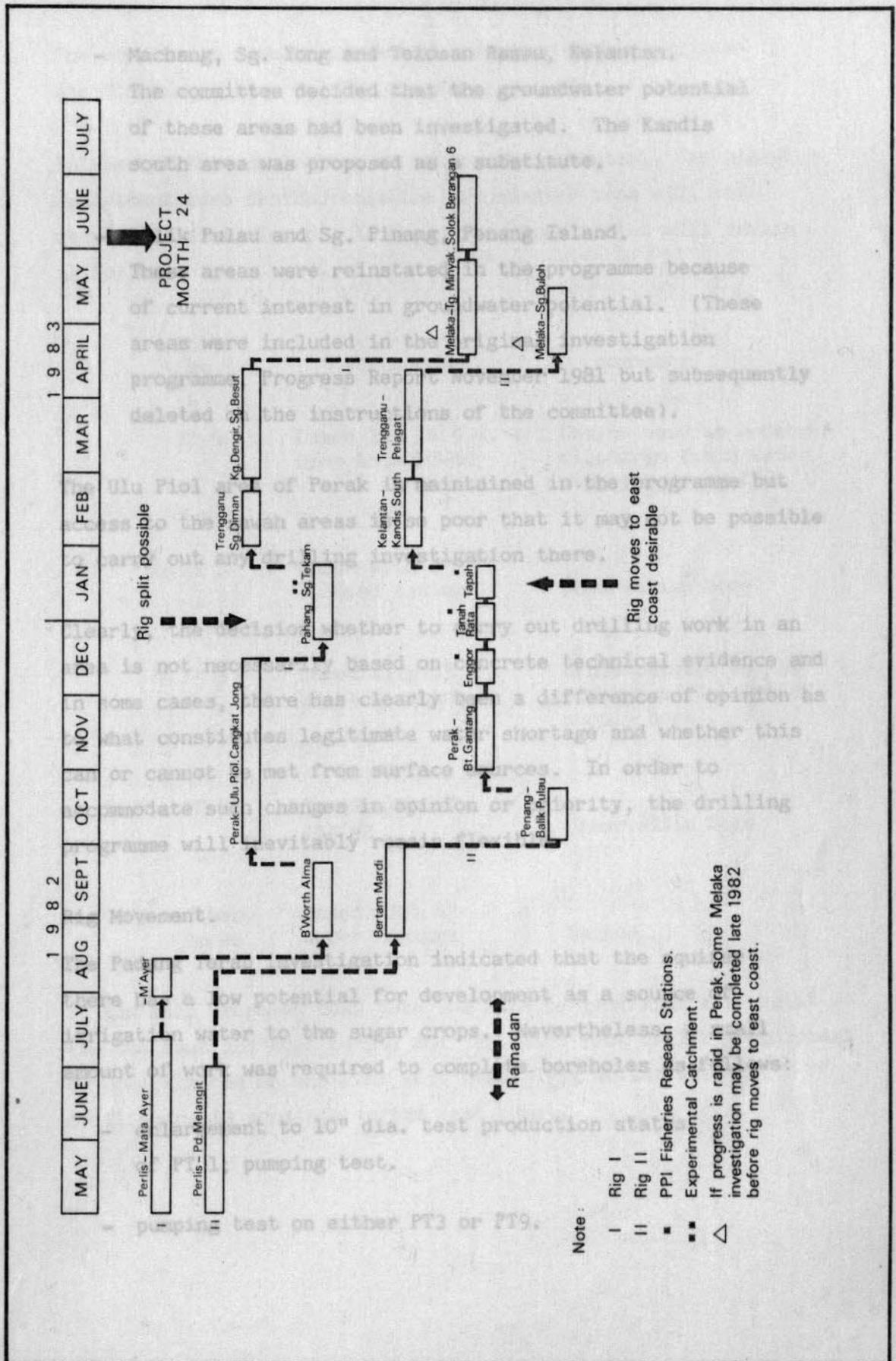
stated reasons, are given below:

deleted

- Kg. Juru, near Butterworth (Figure 2.1). Recent resistivity work and geological appraisal suggest this coastal area to be underlain by saline groundwater
- Padang Rengas, Perak. It was stated that a cement factory was to be built at the site
- Lenggong, Perak (relegated to low priority). It was stated that surface water from Sg. Perak could be used.
- Sirusa, N. Sembilan. It was thought that there is little prospect of agricultural activities in this largely residential area.
- Nyalas, Melaka (relegated to low priority). It was stated that constraints to agricultural development in the area are not caused by water shortage alone.

Figure 2.13

# TENTATIVE PROGRAMME OF RIG OPERATION



The - Machang, Sg. Yong and Telosan Rasau, Kelantan. and ancil The committee decided that the groundwater potential of these areas had been investigated. The Kandis In vis south area was proposed as a substitute. tial, the planning department have decided that the groundwater team will not ret - Balik Pulau and Sg. Pinang, Penang Island. us will remain as fol These areas were reinstated in the programme because of current interest in groundwater potential. (These areas were included in the original investigation programme, Progress Report November 1981 but subsequently deleted on the instructions of the committee).

The Ulu Piol area of Perak is maintained in the programme but access to the sawah areas is so poor that it may not be possible to carry out any drilling investigation there.

Clearly, the decision whether to carry out drilling work in an area is not necessarily based on concrete technical evidence and in some cases, there has clearly been a difference of opinion as to what constitutes legitimate water shortage and whether this can or cannot be met from surface sources. In order to accommodate such changes in opinion or priority, the drilling programme will inevitably remain flexible.

#### Rig Movement.

The Padang Terap investigation indicated that the aquifer there has a low potential for development as a source of irrigation water to the sugar crops. Nevertheless, a small amount of work was required to complete boreholes as follows:

- enlargement to 10" dia. test production status of PT 1; pumping test.
- pumping test on either PT3 or PT9.

The work would require the return of one drilling rig and ancillary equipment to the area for 2-3 weeks. In view of the conclusions as to aquifer potential, the planning department have decided that the groundwater team will not return to Padang Terap. In this case, bore status will remain as follows:

bore no.	status/use	comments
PT 1	Cased 10" to 9 m. Open hole 10-60	Can be used as moderate discharge field water supply bore by PTG.

Comments on these suggestions are as follows:

PT 3	Cased with 6" slotted casing	Observation bore
PT 9	Cased with 6" slotted casing	Could be used as low discharge field water supply bore
PT 12	Cased with 6" casing	Observation bore
Other bores	Cased with 6" upper casings	Capped.

It has been proposed that both the rigs be geographically split (to the east and west coast) and that hard rock drilling equipment be concentrated on one (the west coast) rig whilst alluvial drilling could continue on the east coast.

Discussions have been held between the Planning Department and the Consultant on the optimum time for such a split of the drilling rigs. It is envisaged that rigs would work at large distances apart and virtually independently. The advantages of this mode of operation are:

- to test ability of crews to function independently and hence to test the progress of the drilling training effort
- scarce equipment be concentrated on one rig and rock type i.e. hard or soft alluvial drilling.

Comments on these suggestions are as follows:

- both drill crews have had supervised, hard rock experience but little alluvial drilling experience. It is thought desirable that each crew has each type of experience. The Consultant therefore believes that both rigs should work the existing programme (Figure 2.13) which includes a good deal of alluvial investigations. By December, both crews would be expected to have balanced hard rock - soft rock experience.
- even if all hard rock equipment is attached to one rig, the rig will still not be capable of independent operation. This is because of an overall equipment shortage. The rigs still have to share on a day to day basis, a single truck, a single welding set and some spares.

- even now, when rigs work in close proximity,  
there are frequent long delays caused by logistics  
procurement and coordination.

Whatever, it is considered that a rig split is desirable, and that this might take place in December-January. At this time, it is envisaged that one rig could move to Pahang and then Trengganu while the other completes work in Perak. It should be emphasised that even when the rigs are split, transport and equipment will still have to be shared. It should be further emphasised that as distance between rig work locations increases, so do the problems of effective coordination, and supervision by the remaining consultant drilling engineer.

The revised programme timing is based on drilling operations alone and assumes that the rigs will not normally be involved in pump installation and testing. If they are, then there will be inevitable delays to the drilling programme. The possible mode of operation of a pump test group is discussed later (Section 3.2).

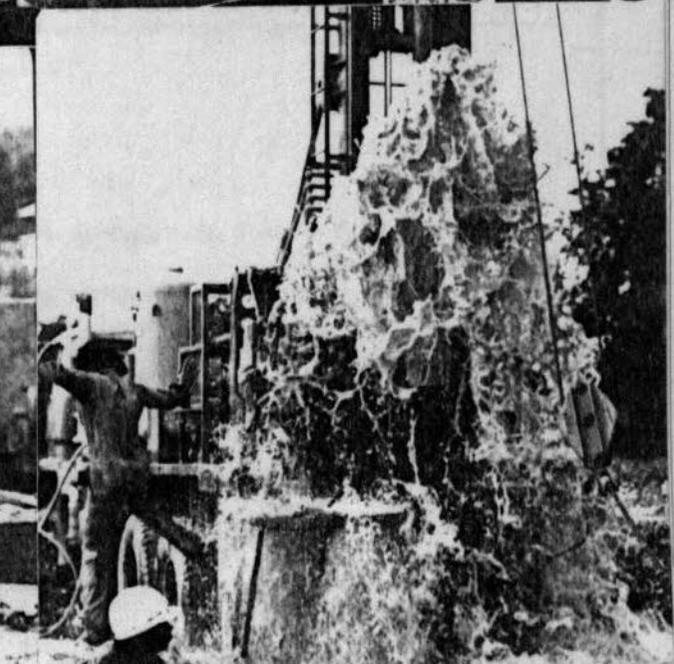
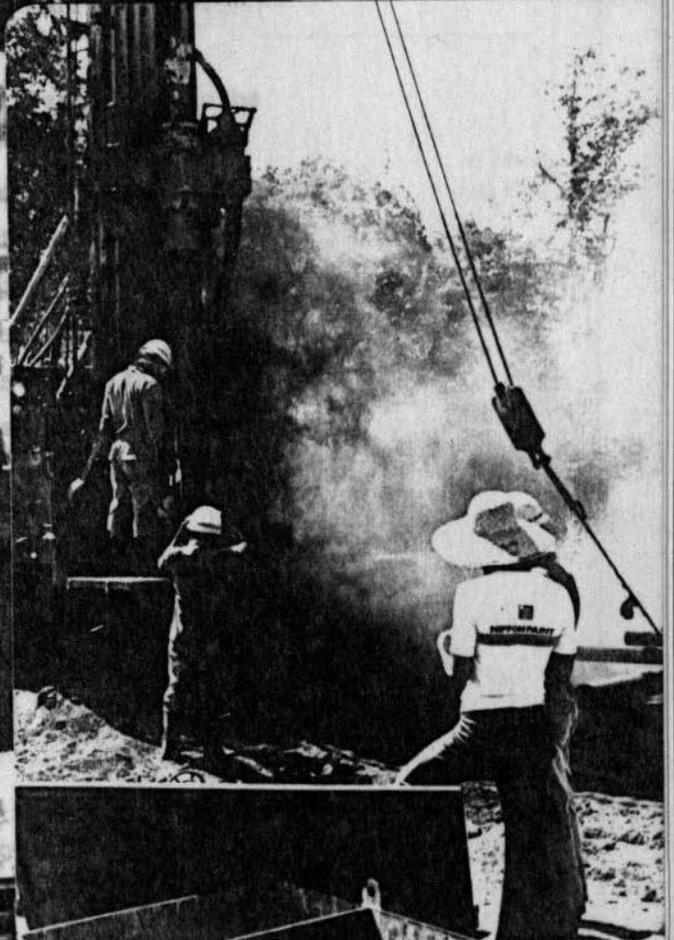
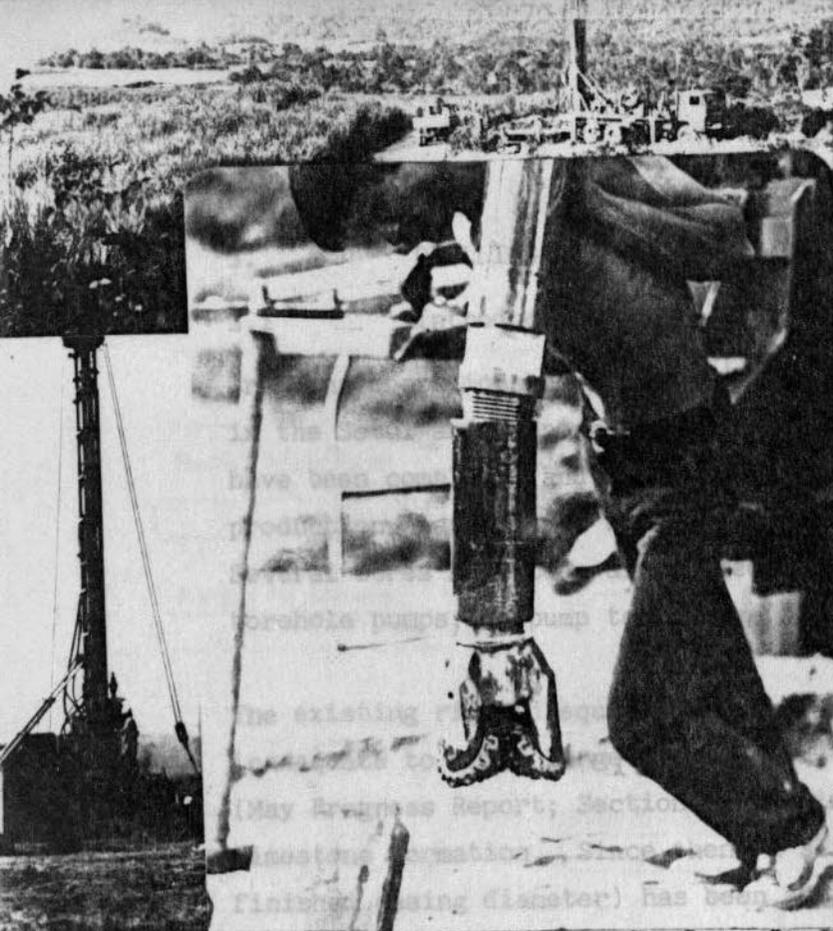
### 2.2.5 Training.

Field training has continued in aspects of sample and electric logging in limestones, and the use of this data, together with driller data, to detect productive zones.

Alluvial drilling, using bentonite mud circulation and naturally developed screened completions, is imminent and therefore some training has been given the following:

- alluvial sample logging
- sieve analysis technique
- plotting and interpretation of analyses
- well screen slot size choice
- use of electric and gamma logs in choosing optimum screen position.

It is hope shortly to run some demonstration films, on the subjects of well design, revert drilling mud and borehole logging.



# DRILLING PROGRESS

## 3. DRILLING

### 3.1 Introduction

1982

Drilling operations have continued in Perlis, principally in the Setul and Chuping Limestones. Seven exploratory bores have been completed and four have been converted to test-production status bores with 10" upper casings (Figure 3.1). Several bores have been air-lifted but in the absence of any borehole pumps, no pump tests have been carried out.

The existing rig and equipment were earlier shown to be inadequate to drill large diameter (10") TP boreholes (May Progress Report; Section 3.3.3) in the very hard Setul Limestone Formation. Since then, a slim hole design (6" finished casing diameter) has been adopted and Setul drilling has become routine and without problems. Difficulties have been experienced in drilling the less stable Chuping Limestone and whilst this has led to programme delays, the experience gained by the crews will remain invaluable (See Section 3.7).

A long break over the fasting month, a clutch failure on Rig II and recovery of a 'fishing' operation at MA2 reduced rig output considerably (Figure 3.1 and Table 3.1).

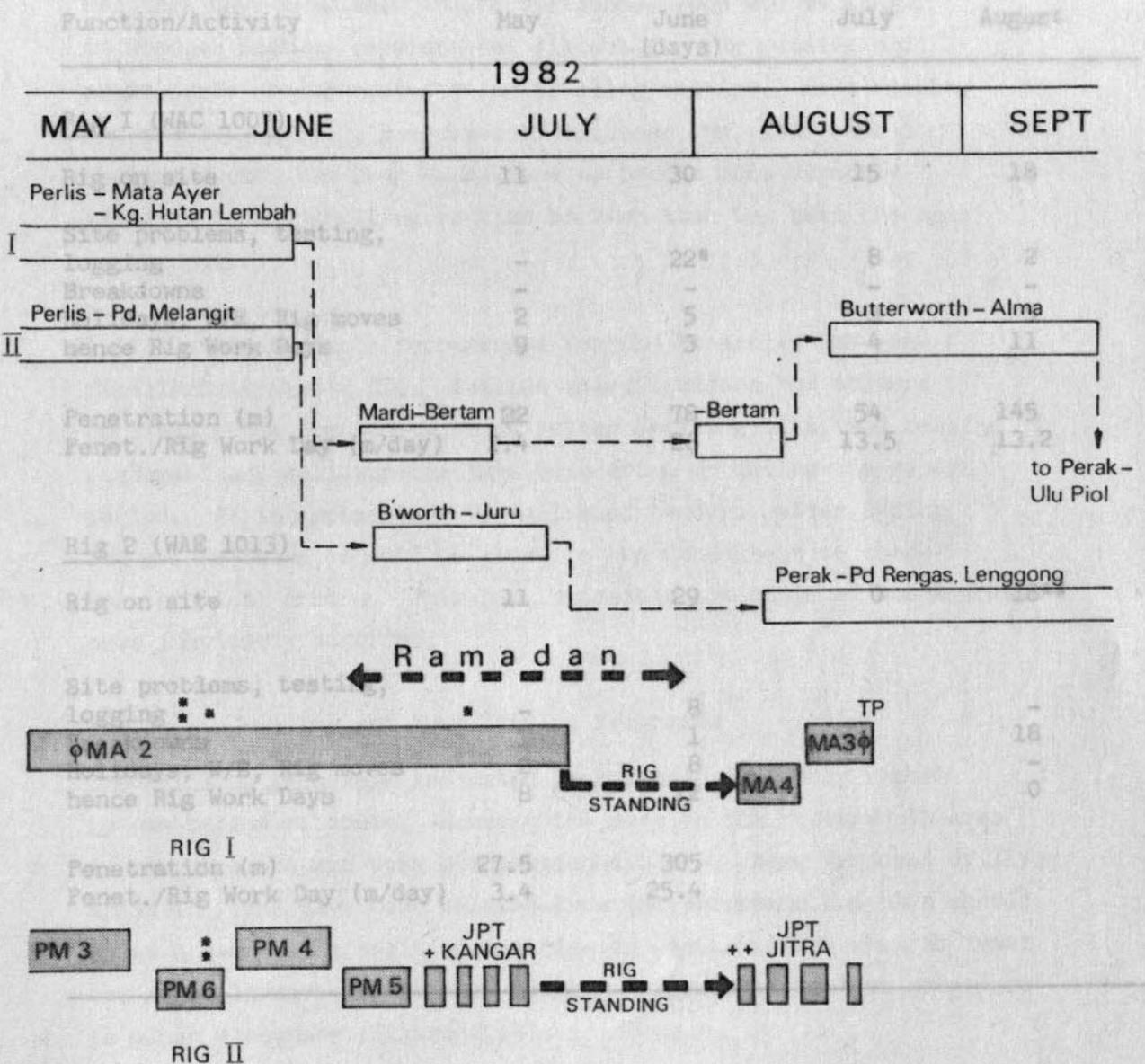
The defective Isuzu engine camshaft on Rig I has now been replaced by one of a more robust design. Rig II for the second time since commissioning, has suffered a clutch failure. However, on this occasion, the agent has been able to supply heavy duty clutch components.

Legend:

- Provisional programme (Progress Report May, 1982)
- MA 2 Progress to 20.8.1982
- TP Exploration bore, conversion to test production status
- \* Drill string stuck, free on 5.7.1982
- \*\* Rig winch oil seal failure
- Rig service - JPT Kangar
- Rig truck clutch - flywheel failure
- MA Mata Ayer (14 Kg Hutan Lembah)
- PM Padang Melangit

Table 3.1

# DRILLING PROGRESS



Note: data from May 21 to August 20.

Rig I in JPT Kangan store 15.7.82 - 1.8.82  
 Rig II in JPT Kangan store 30.8.82 - 1.9.82

\*drill string stuck around 120-130 m from 5.6.82 until 6.7.82.  
 \*\*Rig II clutch failure on 4.8.82 enroute to site.

Legend :

Provisional programme (Progress Report May, 1982)

MA 2 Progress, to 20.8.1982

MA 3  $\phi$  TP  
 Exploration bore, conversion to test production status

▪ Drill string stuck, free on 5.7.1982

▪▪ Rig winch oil seal failure

+ Rig service-JPT Kangan

++ Rig truck clutch-flywheel failure

MA Mata Ayer (& Kg. Hutan Lembah)

PM Padang Melangit

Table 3.1

## Rig Utilisation

Function/Activity	May	June (days)	July	August
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Rig I (WAC 1007)

Rig on site	11	30	15	18
Site problems, testing, logging	-	22*	8	2
Breakdowns	-	-	-	-
Holidays, W/E, Rig moves hence Rig Work Days	2	5	3	5
	9	3	4	11
Penetration (m)	22	78	54	145
Penet./Rig Work Day (m/day)	2.4	26	13.5	13.2

Rig 2 (WAE 1013)

Rig on site	11	29	0	18**
Site problems, testing, logging	-	8	-	-
Breakdowns	1	1	-	18
Holidays, W/E, Rig moves hence Rig Work Days	2	8	-	0
	8	12	-	-
Penetration (m)	27.5	305	-	-
Penet./Rig Work Day (m/day)	3.4	25.4	-	-

Note: data from May 21 to August 20.

Rig I in JPT Kangar store 15.7.82 - 3.8.82  
Rig II in JPT Kangar store 30.6.82 - 3.8.82

\*drill string stuck around 120-130 m from  
5.6.82 until 6.7.82.

\*\*Rig II clutch failure on 4.8.82 enroute to site.

Meetings have been held at JPT Workshops, Ipoh and at Kangar to discuss back-up services and liaison for rig repairs and spare parts procurement for the drilling section. As a result, two staff from Ipoh, a mechanical engineer (Mr. Khor) and a chargeman (Mr. Lee Seng Hong), are to become more directly involved in the drilling section back-up than has been the case in the past.

A list of spare parts recommended for the Tone rigs has been finalised (Appendix II). Outline specifications for tenders for test pumps, bentonite, rock roller drilling bits, mud testing equipment and well screens have been drawn up during the report period. It is emphasised that all such tenders, after typing but before issue, should be shown to the Consultant to check for technical errors. This has invariably not happened and errors have inevitably occurred.

### 3.2 Drilling and Pump Testing Programme

The drilling programme indicated in the last quarterly report is now behind schedule. However the move to the Butterworth area is now complete and work has commenced there. Some proposed drilling areas in Perak have been deleted from the programme and this should allow a geographic split of the rigs in January 1983, when at least one rig will move to the east coast. A revised tentative programme is given elsewhere (Figure 2.13).

The rapid procurement of spares for the Tone rig will certainly minimise programme delays in the future.

One or two test pumps should soon arrive and following commissioning by the pump agent, a small pump testing programme will be initiated. First tests will be carried out in Perlis, on previously drilled boreholes at Padang Melangit and Mata Ayer.

Testing will then be carried out progressively as drilling investigations are completed in each area. JPT have also been requested to carry out full pumping tests on previously completed 12" boreholes in the Tanah Merah and Pasir Mas districts of Kelantan.

Pumping tests should ideally be run in boreholes soon after these have been completed. For bores drilled with bentonite mud, long delays between drilling and pump testing may lead to partially plugged borehole screens.

The test pumping programme can be organised in two rather different ways, as follows:

- a separate pump test group be formed and be equipped to operate independently of the drilling rig crews. The group could consist of a technician/fitter and permanent helper, assisted by labourers supplied by State JPT offices. The group would ideally require their own transport, say a light truck with crane or block and tackle and a tripod, together with tools, pipe fittings, valves and air lines. The group would install the pump and headworks and then monitor and maintain the pump and engine during continuous pump tests of up to 3 days duration. Water level, discharge and water quality measurements during the test would be largely carried out by the hydrogeological technicians.

The chief advantage of this method of organisation is that it does allow operation independent of the rigs. Rig progress will be unaffected whilst pump testing could continue in areas distant from the rigs. Disadvantages include the burden of procurement and supply of extra transport, equipment and personnel for the group.

- the drilling crew, using the rig as a crane, would install the test pump, shaft, engine and ancillary headworks, would check mechanical operation during the test and then extract the pump. Pumps would usually be installed following bore drilling but in the case of Perlis and Pasir Mas, the rig would have to move to these previously drilled areas and function as a travelling crane.

Disadvantages are obvious. The current drilling programme would be markedly delayed while rigs were used not for drilling but as cranes; in addition, rigs would have to be diverted over large distances to previously drilled areas. The Tanah Merah and Pasir Mas pump testing work alone could extend over 35 days. (Step and constant discharge tests on 4 boreholes) and tie up one rig for most of this time. The advantages of a rig based pump testing capability is that existing personnel and equipment can be used, and the staff, control and logistics problems associated with an independent group will be avoided. The option should only be considered if the associated penalties, of rig underutilisation and drilling delays, are fully realised.

A choice must shortly be made by JPT between the two modes of operation.

### 3.3 Drilling Practice, Problems and Remedies.

#### 3.3.1 Setul Limestone

Since earlier drilling works, at Wang Bintong, had caused site collapse and sink hole exposure (WB1, WB2), operations have been carried out with caution. Thick hard-standing has been used and a raft of excavator mats placed under the rig to ensure safety. As an added precaution, the overburden was drilled by water flush, thus causing minimum disturbance to the formation.

There has been no evidence of the sink hole phenomena on the last four sites drilled in the Setul Limestone (PM 3-6) and it can therefore be presumed that it is confined to the Wang Bintong area. Elsewhere, less thorough and costly site preparation will be adequate. It should be sufficient only to stop the rig from becoming bogged down and an extra thickness of hard core and timbers is not required. The use of waterflush (which necessitated the use of a rock roller bit) is not required either. By using the Dresser T6 D.H.H. equipped with a 7½" bit, the shallow overburden and the rock to about 22 m below ground level may be drilled in one pass. Either welded line pipe or temporary casing may then be installed. Below, an exploration or slim bore is drilled. If sufficient water bearing zones are encountered, then the slim bore would be reamed out to accommodate 8" or 10" upper well casing. This reaming process is described in the May Progress Report, Section 3.3).

#### 3.3.2 Chuping Limestone.

Four bores have been drilled in the Chuping Limestone by the JPT. Three were converted to test/production (TP) well status, indicating the greater aquifer potential (and borehole success rate) of the Chuping as compared to the Setul Limestone.

The drilling of the Chuping Limestone formation to any depth is difficult. The formation may be unstable and require the hydrostatic support at a column of mud whilst the danger of circulation loss at any time requires an experienced and alert drilling crew. The JPT drilling staff are now fairly experienced in dealing with this kind of situation; they recently learned a hard lesson during the long recovery or fishing operation on MA 2. The preventative measures learned on this bore are appropriate to other areas, although it is doubtful if such severe conditions will be encountered again. (Section 3.7).

As a guide, the following general recommendations are given for future drilling of the Chuping Limestone:

- i) Drill a 7 5/8" pilot hole through overburden and continue into limestone. Use mud flush entirely. The loss of several pits of mud should be expected whilst drilling to the overburden - limestone contact and about 10 metres into the rock.
- ii) The average overburden thickness has been found to be 25 m, but free standing stable bore conditions (no casing formation) may not be found for another 10-15 metres. Therefore, if a deep exploration bore is required this formation is best cased off with temporary casing before resumption of drilling.
- vi) The diffuse contact zone between the overburden and limestone, and about two metres into the limestone, is likely to be the most productive part of the Chuping aquifer. However, this zone may comprise red-brown clay and silt filled karst voids; the borehole is susceptible to continuous

Further drilling at 6" diameter may continue using bentonite mud but experience shows that when grey limestone is encountered (as opposed to the white to cream limestone in which the aquifer zones are invariably developed) then air drilling will give more rapid penetration.

- iii) In order to convert the pilot/exploration bore into a TP status bore, a 12¼" rock roller bit should be used to open the hole out to accommodate a 10" pump chamber casing; this should be positioned about 1-2 m into the rock head.

The bore below the 10" casing should then be reamed to accommodate 6" or 8" dia. slotted casing or screen, if bore wall stability in the aquifer zones demands their use.

- iv) A reaming operation should definitely be conducted under bentonite. Therefore, a lower section of bore drilled previously by air, should be either sealed off (if non-productive) or be filled with mud to the surface before pulling back temporary casing; this prevents collapse of the upper bore.

v) The decision to convert to a TP bore will be made after consideration of many factors. The driller must especially consider loss of mud, penetration rates and logging (particularly the caliper log).

- vi) The diffuse contact zone between the overburden and limestone, and about two metres into the limestone, is likely to be the most productive part of the Chuping aquifer. However, this zone may comprise red-brown clay and silt filled karst voids; the borehole is susceptible to continuous

Miscellaneous ingress of silt and clay which may lead to eventual screen blockage. Production from clean fissures encountered lower in the Chuping limestone is to be preferred.

vii) Because of lack of screen, bores MA 1 and MA 2 were completed open hole. They need to be monitored for ingress of caving materials during heavy pumping. In MA 3, a slotted drop-set casing has been set opposite the main aquifer zone but, like MA 1 and MA 2, the bore needs a long period of 'over pumping' in order to become fully developed.

Mr. Khor, (Mechanical engineer, JPT Workshop, Ipoh) has now been appointed liaison officer for groundwater section

### 3.4 Repairs and Maintenance.

Routine repairs and maintenance have been carried out on both rigs. These include the following operations:

to co-ordinate maintenance under the direction of Mr. Khor.

Rig I  
Both are based at JPT Workshop, Ipoh.

Full service and oil changes (including changes of oil, fuel, air and hydraulic filters).

Adjustment to Isuzu engine tappet.

Replacement of " " camshaft.

Stripping and cleaning out Gardner Denver Compressor and locating water leak.

Replacement of oil seals on rig winch drum.

Procurement of drilling bits, screens, cementite etc, and those items requiring tendering procedure will continue to be carried

out by the staff at JPT Research Station, Jalan Ampang, under

Rig II  
Full service and oil changes (including changes of oil, fuel, air and hydraulic filters).

Adjustments to main clutch.

Repairs to dust deflector and hoist plug.

Replacement of oil seals on rig winch drum.

Replacement of clutch; Isuzu engine.

Replacement of transfer box oil seal.

### 3.6 Miscellaneous and Training.

Replacement of clutch;  
Repairs to Toyota land cruiser starter.

The replacement of a camshaft (Rig I) on a diesel engine after only 1000 hour of running is a rare occurrence. Since this Isuzu engine model is said to suffer from this defect, the supply agents should be encouraged to stock at least one spare, in case of camshaft failure on Rig II. Heavy duty replacement clutches have now been fitted to both rigs; the replacement was fitted to Rig I in November and it still appears to be in good order.

Crew I (and to some extent the crew from Rig II) have been Mr. Khor, (Mechanical engineer, JPT Workshop, Ipoh) has now been appointed liaison officer for groundwater section equipment, repair and maintenance. Mr. Lee Seng Hong (chargeman) will arrange or carry out major repairs and will co-ordinate maintenance under the direction of Mr. Khor. Both are based at JPT Workshop, Ipoh.

### Section 3.7.

### 3.5 Drilling Consumables and Procurement.

All the servicing and repairs have been carried out by the crew. Everyday requirements for running the drilling operation will continue to be provided through the State JPT office on the advice of the drilling supervisors and consultants.

Procurement of drilling bits, screens, bentonite etc. and those items requiring tendering procedure will continue to be carried out by the staff at JPT Research Station, Jalan Ampang, under guidance of the consultant.

Spares for the Isuzu trucks (rig carriers) and the Tone rigs will be handled by Ipoh through Mr. Khor. To that end, a list of Tone spares requirements has been drawn up (Appendix II) by the consultants and issued to those concerned.

### 3.6 Personnel and Training.

The drilling crews continue to receive the bulk of their training in the field in the form of active participation in the drilling operations.

Recently the emphasis of training has been on the use of bentonite for the mud circulation drilling technique. This has included the mixing and simple treatment of the mud to obtain correct viscosity. When lost circulation zones have been encountered, the mixing of padi husk to the mud has been demonstrated as an effective method in dealing with the situation.

Crew I (and to some extent the crew from Rig II) have come to realise the consequences of running out of drilling mud and not having reserve water on site. The consequence was a stuck drilling string in MA 2 which took a very long time to release. However the experience gained in recovery ('fishing') and later rehabilitation of the well, was most valuable and could never have been simulated. Details of the operation are given below in Section 3.7.

All the servicing and repairs have been carried out by the crew or with their assistance. Crew members able to weld and use the gas cutting equipment continue to improve and have produced some good work.

Mr. Thomas gave a lecture in Ampang on the use and effectiveness of cable tool drilling techniques.

3.7 Mata Ayer 2 A case history.

3.7.1 Operations prior to the drill pipe becoming stuck.

- i. A slim, pilot bore (5 7/8" dia.) was drilled to 30 m using air and foam flush through the overburden; rockhead was at approximately 29 m.
- ii. The bore was reamed to 30 m, with a 12 1/4" rock roller bit using foam flush.
- iii. Twenty seven metres of 10" I.D. casing were inserted. Since the bore had caved, the bore below casing was cleaned out using foam and a 7 5/8" rock roller bit. Three metres of 10" casing was then welded on and driven to the bottom of the bore.
- iv. The pilot bore was continued at 7 5/8" dia. using air and foam to 45 m where rock appeared to become harder.
- v. The bore was caving badly during stage (iv) so 10" casing was welded on in pieces and installed using the 'drill and drive' method. From 36 m onwards, the normal rig pull-down via the hydraulics (7 tonne) would not further move the casing and therefore the pull down was supplemented by the percussive effect of a Down-the-Hole Hammer. The casing was inserted to 45 m.

- ix. It appears that during the night of 4 June,
- vi. An attempt was made to drill on at 7 5/8" dia, using air flush and a rock roller bit but bore caving started again. Attempts were made to drive the 10" casing down but it was stuck.

x. The crew lowered the last few drill pipes to the formation from 29 m to 45 m appeared to be fractured limestone with lime sand filled fissures. The harder components of the limestone broke down when handled into angular particles. During the process of casing insertion, lime sand often flowed several metres up into the casing.

- vii. All drilling operations in Padang Terap and Perlis (hard rock areas) had up to this point, been conducted solely by air or foam flush methods. It was then decided that bentonite mud should be used to continue the drilling of bore MA 2, to give better control of bore wall condition and caving. Bentonite was mixed and circulated and drilling continued below 45 m. Because of heavy mud losses encountered within the first few meters, mud viscosity was increased by addition of padi husks until circulation was regained.
- viii. Drilling was continued at 7 5/8" dia. to 132 m; occasional mud loss was observed but this was presumed to be caused by leakage into the formation just below the casing.

In fact, the process happens each time drill pipes are pulled out of the bore unless their volume is continuously replaced by the addition of drilling mud.

- ix. It appears that during the night of 4 June, heavy rain flooded the mudpits (whose mud level was low). However, no attempt was made to add bentonite mud to the highly dilute low viscosity fluid when then occupied the mud pits.
- x. The crew lowered the last few drill pipes to near the bottom of the bore and flushed the last pipe down using the mud pump. The bit then reached 132 m with the kelly in the down position. The drillhead was then disconnected from the drill string ready to accept another drill pipe. It is then reported that the fluid inside the drill pipe flowed back out for two or three minutes. This indicates that the fluid in the annulus between drill pipe and borehole wall was full strength drilling mud, perhaps containing some cuttings and cavings. Its weight, perhaps 10-15% greater than water, was sufficient to force the lighter fluid out from inside the drill pipes.

the cause of the stuck pipe. They therefore

Experience shows us that the heavier fluid descending in the annulus will only stabilize when sufficient fluid has been expelled from the drill pipe. The stabilized fluid level in the annulus very often and certainly in this case, is much lower than the natural or static water level of the formation. In this case, groundwater flows into the annulus until its natural piezometric level is reached. In hard rocks this process does not matter too much apart from the dilution of the drilling mud. In fact, the process happens each time drill pipes are pulled out of the bore unless their volume is continuously replaced by the addition of drilling mud.

3.7.2 The Recovery ('Fishing') Operation  
The stability of alluvium or loose incompetent formation is guaranteed by a column of mud. The removal of this mud, the drill string or column or any severe reduction in its viscosity, allows groundwater ingress and the collapse of incompetent materials.

Water well drilling operations also suffer to a lesser degree from this problem. Borehole collapse often allows the formation to jam around the drillpipe in the vicinity of the incompetent formation whilst the viscous mud acts as a barrier in preventing the descent of caving material to fill the annulus to the bore bottom.

Water well rigs use pipe, subs and bit tools to maximum advantage. Similarly when pipe becomes stuck in the bore, the weight of the pipe is 10-12 tonnes cannot be lifted. In one case 100 tonnes. In one case near breaking strain to their maximum extent employed in freeing ('fishing') operations.

xi) The crew had no previous experience of this situation and did not know what had happened. When they coupled a new drill pipe, they found the drill pipe to be stuck. Following unsuccessful attempts to free the pipes, the crew decided that perhaps the mud was the cause of the stuck pipe. They therefore forced compressed air down the drill pipe. This action obviously made matters worse since it removed any remaining mud from the drill pipes and hole and allowed unstable angular limestone gravel to fill the annulus and enter the drill pipe via the bit. At this point, the jet nozzles within the bit became blocked making circulation impossible. Normal operations to regain movement are much better than attempts to pull them up directly. Neither movement was possible.

3.7.2 The Recovery ('Fishing') Operation.

A 'fishing' operation is often the result of the failure of the drill string or casing assembly failure, especially in deep oil wells.

Water well drilling operations also suffer to a lesser degree from this problem. Fishing may also be necessary when something is dropped down the bore or, in the case of bore MA 2, through a combination of severe drilling conditions and inexperience.

Water well rigs use oil field drilling equipment, i.e. drill pipe, subs and bits, but usually lack the power to utilize the tools to maximum advantage. Similarly when pipes become tight in the bore, the water well rig whose drawworks can only handle 10-12 tonnes cannot compete with a rig designed to pull over 100 tonnes. In other words the smaller rig cannot exert a near breaking strain pull on the drill pipe or rotate the pipes to their maximum extension. Instead, other means need to be employed in freeing drill pipes. The sequence of recovery ('fishing') operations adopted for MA 2 was as follows:

- i) When stuck, the first step should be to clean the bore by circulating (mud in this case) and at the same time attempt either (on both) rotational or vertical movement of the drill pipes. Neither proved possible.

Normally, if the drill pipes are above the bottom of the hole, attempts to push them down to regain movement are much better than attempts to pull them up directly. Neither movement was possible.

Because the bit was obviously blocked, circulation/cleaning could not be achieved and therefore 4" liners and pistons were substituted for the 6" set in the mud pump. This doubling of the mud pump output pressure was not effective in unblocking the bit.

- ii) Before the use of any 'fishing' technique, the rig was used to its maximum output, that is -

Torque	=	610 kg. m.
Winch	=	10 tonnes
Pulldown Hydraulics	=	7 tonnes
Pull up "	=	8 tonnes
Combination of pull-up by winch and hydraulics	=	18 tonnes approx.

Pulldown eventually lifts or tilts the rear end of the rig; 7 tonnes appears to be maximum limit for the Tone 750 A.

A little downward movement and rotation was achieved for a short period (without circulation) but cavings soon rendered the drill pipes immobile.

- iii) Part of the Tone rig package includes a drive hammer (or 'monkey') assembly. The hammer weighs about 68 kg. and can slide up and down a special pipe equipped with a drive ring at each end. Percussive effect is through the rigs winch rope, after removal of the travelling block, to give fast single line action.

The stroke length is 1.5 m. By coupling the hammer assembly between the stuck drill pipe and the power swivel, the hydraulic pulldown can be operated in either direction at the same time as the hammer is operated.

Afterwards, a similar exercise was carried out using a Mission A 6315 D.H.H. borrowed from JKR. With this assembly downward movement only is possible. It was hoped that the high frequency of blows (up to 900 per minute) with hydraulic pulldown would free the drill pipe or at least vibrate cuttings out of the bit to allow circulation to be restored. Neither effort had any effect.

Another similar percussive option would have been the use of a 'piling extractor' although none was available locally. This might be considered as a future recovery method.

Throughout the efforts mentioned, bentonite mud was maintained in the borehole to surface level, to prevent any further caving.

iv) Before initiation of long fishing operations, the following additional operations were carried out:

- an unsuccessful attempt was made to turn the pipes with the combined force of the power swivel and a large pipe wrench over which was placed a 6 m extension pipe; five men then pushed the pipe.

- a spider bowl and slips were placed around the top of the drill pipe and two jacks operated to exert approximately 30 tonnes thrust to the underside of the spider bowl. At the same time the winch and hydraulics were used to their maximum pull. The attempt was not successful.

- v) Following the failure of these efforts, the decision was made to recover the drill string by the 'wash over' method. This is essentially a process of cleaning the annulus between drill pipe and bore hole wall of all caving material. A string of casing, of a size smaller than the bore diameter and bigger than the drill pipe, is fitted with a shoe, is rotated downwards and at the same time, mud is flushed through. Temporary casing of 6 5/8" O.D. and 6" O.D. was the ideal size for use in the 7 5/8" bore containing 4 3/4" diameter stuck drill pipes.

The shorter the string of wash-over pipe used, the easier and safer would the cleaning operation be. As the top of the 'fish' was at 123 m, then ideally a similar length of wash-over pipe would be required to reach it. However, this amount of temporary casing was not immediately available and because the use of a shorter wash-over string was preferred, it was planned to unscrew the drill pipe within the borehole. To carry out this operation so that the greatest length of drill pipe may be recovered, it is normal practice to exert a heavy pull on the drill pipes and then back off (turn anti-

FIGURE 3.2 BORE M.A.2: FISHING OPERATION

clockwise). After several attempts, a drillpipe joint at 34 m b.g.l. backed off. The re-tightening of the drill pipes back into the stuck string (tighter than previously) eventually allowed 45 m of drill pipes to be recovered. The situation is shown (Figure 3.2).

Since it is often found that less drill pipe is recovered after each attempt, certain precautions should be observed each time the drill pipes are run back into the bore. Firstly, all grease is removed from both male and female threads and each joint is screwed together with a little fine sand sprinkled in the threads. The joint is then tightened under power so that it is tighter than joints within the string still down the bore hole.

- vi) The wash-over casing pipe was then washed and reamed down the bore from 45 m to approx. 99 m b.g.l. in 3 m joints. Troublesome circulation loss was experienced over the 45 m - 50 m zone where the wall case was disturbed by the casing. At 99 m, abrasion of the casing against the problematic 45-50 m zone allowed caving to take place and the wash-over casing became stuck.

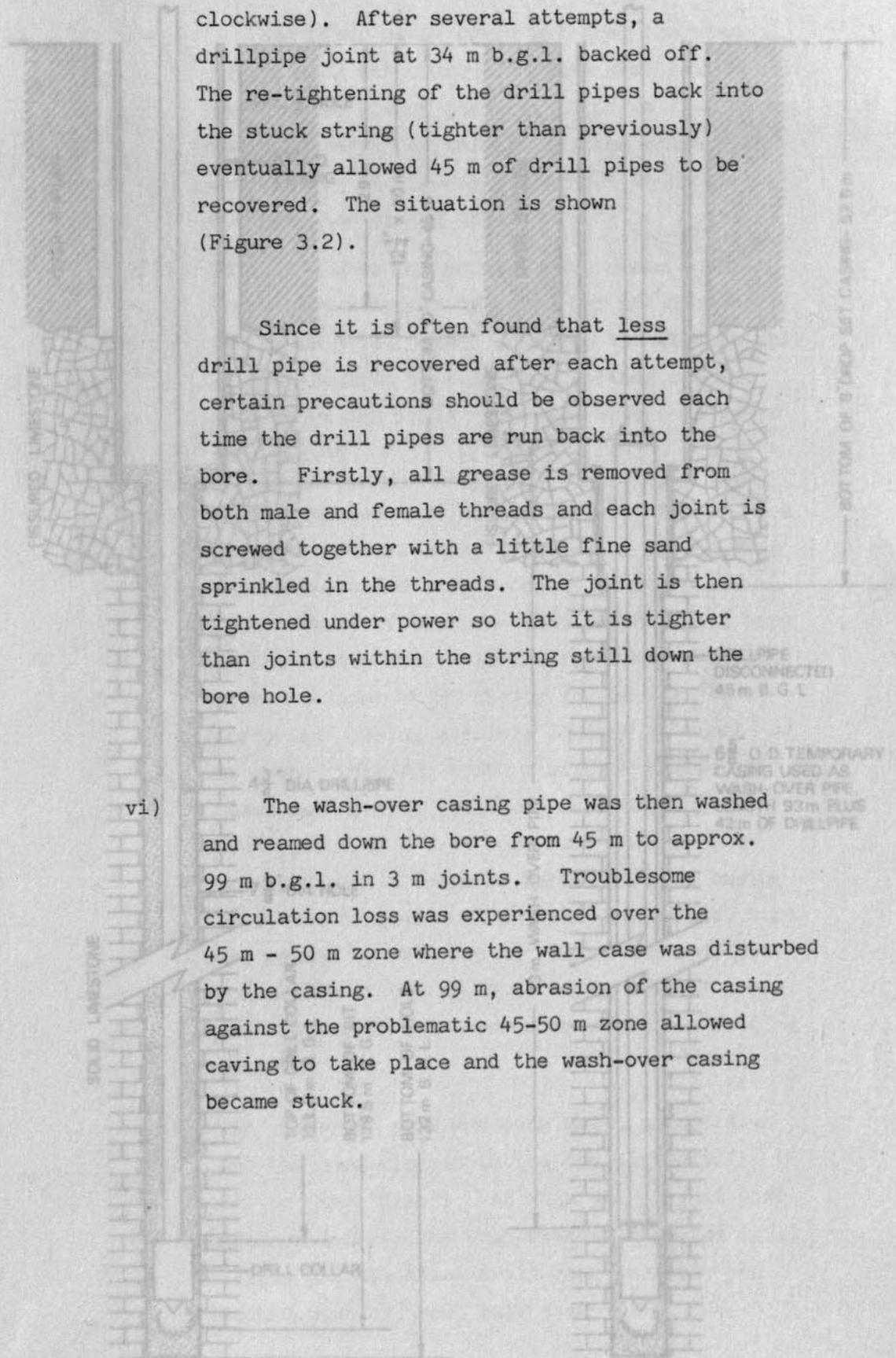
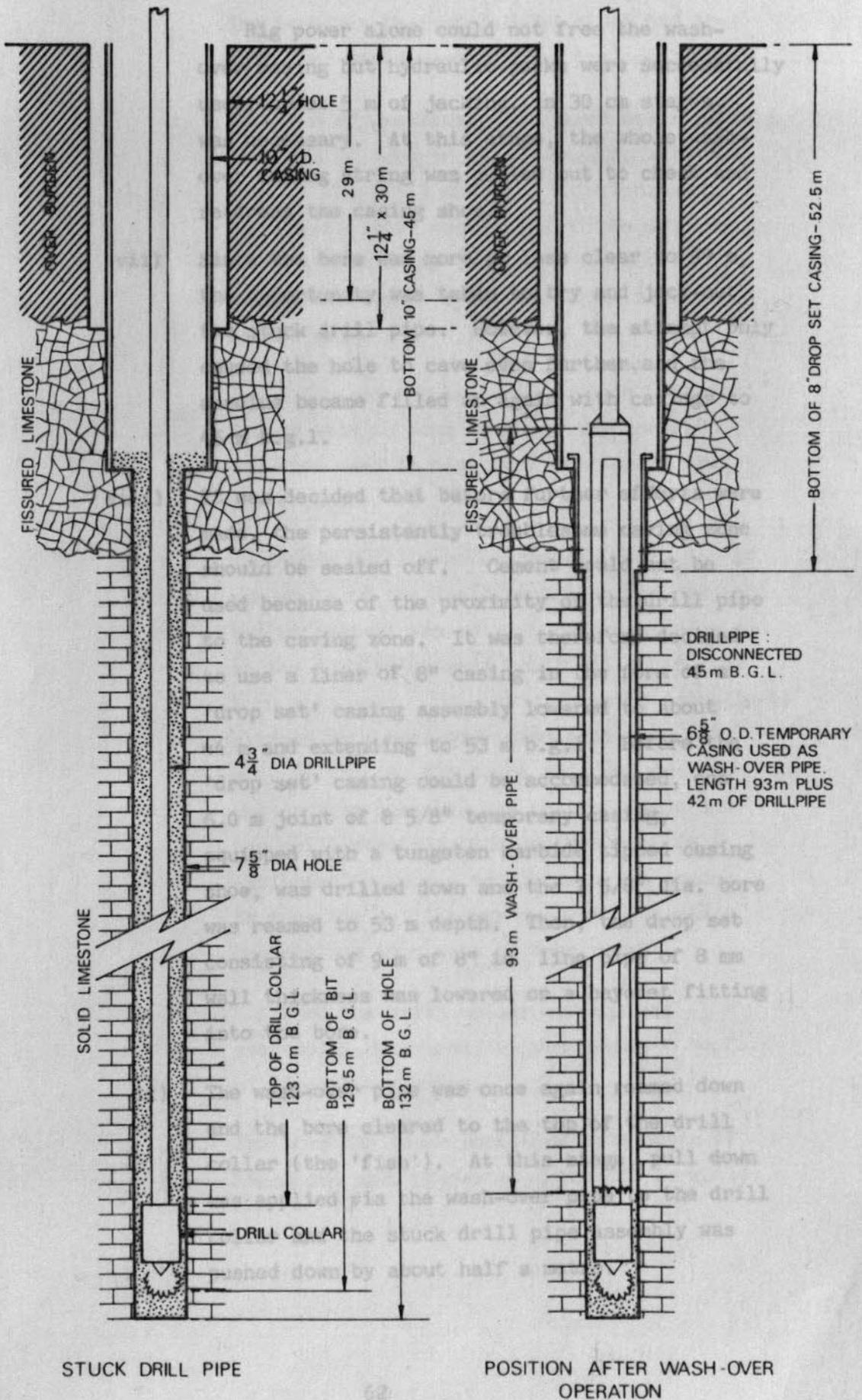


FIGURE 3.2 BORE M A 2: FISHING OPERATION



Rig power alone could not free the wash-over casing but hydraulic jacks were successfully used; about 5 m of jacking, in 30 cm stages, was necessary. At this stage, the whole wash-over casing string was pulled out to check and re-dress the casing shoe.

- vii) Since the bore was more or less clear to 99 m, the opportunity was taken to try and jack-out the stuck drill pipe. However, the attempt only caused the hole to cave even further, and the annulus became filled up again with cavings to 45 m b.g.l.
- viii) It was decided that before further efforts were made, the persistently troublesome caving zone should be sealed off. Cement could not be used because of the proximity of the drill pipe to the caving zone. It was therefore decided to use a liner of 8" casing in the form of a 'drop set' casing assembly lowered to about 44 m and extending to 53 m b.g.l. Before the 'drop set' casing could be accommodated, one 6.0 m joint of 8 5/8" temporary casing, equipped with a tungsten carbide tipped casing shoe, was drilled down and the 7 5/8" dia. bore was reamed to 53 m depth. Then, the drop set consisting of 9 m of 8" id line pipe of 8 mm wall thickness was lowered on a bayonet fitting into the bore.
- ix) The wash-over pipe was once again reamed down and the bore cleared to the top of the drill collar (the 'fish'). At this stage, pull down was applied via the wash-over pipe to the drill collar and the stuck drill pipe assembly was pushed down by about half a metre.

### 3.7.3

#### Conclusion

The bore was then circulated clean and the wash-over pipes removed from the bore.

During that time, the rig had several breakdowns. x) The 45 m of previously recovered drill pipes were run in bore to allow coupling with the rest of the drill string. Unfortunately, the female (box) connection of the drill pipe at 45 m within the bore, was blocked with limestone fragments and the connection could not be made.

A tapered fishing tap, dressed with hard facing weld to form teeth on the lower end, was then used to clean out the top of the drill pipe.

The time spent on the recovery operation was valuable.

Replacement xi) Following drill pipe connection, rotation of the whole of the drill string became possible but withdrawal was not, since gravel remained in the annulus between drill collar and the bore hole wall. This annulus would normally be cleaned by a wash-over pipe measuring  $7\frac{1}{2}$ " o.d. by 7" i.d. but since this was not available, the jacking assembly was re-positioned and the drill string jacked up by 4 m. An estimated 65 tonnes total force was needed to free the drill pipes even at that stage. The rig was then able to take over.

When the drill collar and bit was eventually recovered, it was found to be full of limestone cavings.

xii) The bore was later continued to a depth of 186 m and then converted into a TP borehole.

### 3.7.3 Conclusion

The fishing operation took one month to complete (Figure 3.1). During that time, the rig had several breakdowns, as follows:

- no winch for several days because of a burst oil seal; no spares readily available
- the rig air compressor had to be stripped down because it had accidentally been filled with drilling mud when a valve was operated wrongly.

The fishing month and its inevitable effects upon work effort, somewhat delayed progress.

The time spent on the recovery operation was valuable. Replacement cost of the equipment if abandoned would have been \$50,000 whilst no price can be put on the benefits of the exercise towards sound drilling training.

# APPENDIX



WELL INVENTORY DATA SHEET

Date: 22/10/82

Well No: 3 Location: 6. Jalar Man Mah

Well Owner: (Name) G. Kurniam Contractor: Ahmad Kurnia

Well Type: Well point/borehole/dug well Date of Construction: 1982

Construction Details: Depth: 50 m Diameter: 14 cm

Screened/Perforated casing: from 42 m to 55 m

Biological Comments from Owner/Contractor: water found in charge

Quality Comments: (e.g. iron content, saltness, crop response etc.)

Water Details: Static Water Level: 10 m below/above ground level.

Yield: 1/4 gallons/h. What equipment used to test: hand pump

Well Depth: Well? :

Annual Pumping Regime: hrs/day 7 Days/week

Season: throughout the year

Water Quality: 85 micrograms/cm<sup>2</sup> APPENDIX I

Sample Bottle Nos: Well Inventory of Kepala Batas,

Quality Comments: (iron content, saltness, crop response etc.) Kg. Padang Area -

Typical Field Sheets

Pump Details: Pump Type: handlift/surface centrifugal/electric submersible/

shaft driven deep turbine/hand pump bucket and rope).

Pump Manufacturer: HCB

Water Source: Type: Pore Manufacturer: Robyn CYSD

B.H.P. Rating:

Comments: e.g. changes in water level, quality, yield, e.g. well used no. of people using water, area irrigated, crop type, no. of crops p.a.).

Water consumed for domestic use

Water consumed by 2 households

WELL INVENTORY DATA SHEET

Date: 12/0/82

Well No. 3 Location: Kg. Jekar Kas Mati

Well Owner: Ismail b. Kassim Contractor: Ismail Urid

Well Type: Well point/borehole/dug well Date of Construction: Sept '81

Construction Details: Depth: 56 m/ft Diameter: 1 1/2 m/in.

Slotted/Perforated casing: from 43 m/ft to 55 m/ft.

Geological Comments from Owner/Contractor: water found in coarse sandy formations.

Water Details: Static Water Level 1.2 m/ft. below/above ground level.

Yield: 1/s/gallons/h. What equipment used to test: petrol pump

Test Duration: Well? :

Normal Pumping Regime: 7 hrs/day Days/week

Months: Throughout the year

Water Quality: EC micromhos/cm<sup>2</sup> @ 25°C.

Sample Bottle Nos: 3

Quality Comments: (Iron content, Taste, Turbidity, Saltness, Crop Response etc.).

Iron bearing water

Pump Details: Pump Type: Airlift/Surface centrifugal/Electric submersible/shaft driven deep Turbine/Hand Pump/Bucket and Rope).

Pump Manufacturer: Alcan

Power Source: Type: Petrol Manufacturer: Robin EY150

BH.P. Rating:

Comments: e.g. changes in water level, quality, yield, e.g. well use; no. of people using water, area irrigated, crop type, no. of crops p.a.).

1 wellpoint for domestic use

2 water consumed by 2 households

WELL INVENTORY DATA SHEET

Date: 12/6/82

Well No.: 9 Location: Kg. Paya Keladi Hujung

Well Owner: H. Yahya b. Mat Contractor: Moud Yusuf

Well Type: Well point/borehole/dug well Date of Construction: 15/3/82

Construction Details: Depth: 58 m/ft Diameter: 2 m/in.

Slotted/Perforated casing: from 45 m/ft to 58 m/ft.

Geological Comments from Owner/Contractor: white coarse sand encountered at 50 ft. between 45 ft to 50 ft grey clay/shale was encountered

Water Details: Static Water Level 0.22 m/ft. below/above ground level.

Yield: 1/s/gallons/h. What equipment used to test:

Test Duration: 3 hours Well? Not dried up.

Normal Pumping Regime: hrs/day Days/week

Months:

Water Quality: EC micromhos/cm<sup>2</sup> @ 25°C.

Sample Bottle Nos: samples obtained using tube 9

Quality Comments: (Iron content, Taste, Turbidity, Saltness, Crop Response etc.).

Pump Details: Pump Type: Airlift/Surface centrifugal/Electric submersible/shaft driven deep Turbine/Hand Pump/Bucket and Rope).

Pump Manufacturer:

Power Source: Type: Manufacturer:

BH.P. Rating:

Comments: e.g. changes in water level, quality, yield, e.g. well use: no. of people using water, area irrigated, crop type, no. of crops p.a.).

① Pump not yet installed

② well intended for paddy cultivation (4 acres)

WELL INVENTORY DATA SHEET

Date: 13/6/82

Well No: 14 Location: Kg. Pmtg. Tinggi B. (LP. JPK 18/4)

Well Owner: Hj. Hassan H. Awang Contractor: Ismail Oand

Well Type: Well point/borehole/dug well Date of Construction: April 82

Construction Details: Depth: 53 m/ft Diameter: 2 m/in.

Slotted/Perforated casing: from 43 m/ft to 53 m/ft.

Geological Comments from Owner/Contractor:

Water Details: Static Water Level ..... m/ft. below/above ground level.

Yield: ..... l/s/gallons/h. What equipment used to test:.....

Test Duration: ..... Well? :.....

Normal Pumping Regime: ..... hrs/day ..... Days/week

Months: Throughout the year.

Water Quality: EC micromhos/cm<sup>2</sup> @ 25°C. ....

Sample Bottle Nos: samples obtained from tank

Quality Comments: (Iron content, Taste, Turbidity, Saltness, Crop Response etc.).

Iron bearing water. Taste O.K.

Pump Details: Pump Type: Airlift/Surface centrifugal/Electric submersible/shaft driven deep Turbine/Hand Pump/Bucket and Rope).

Pump Manufacturer: Alcan

Power Source: Type: Petrol Manufacturer: Robin EX 13-20

BH.P. Rating: 3.3 and 4,000 rpm

Comments: e.g. changes in water level, quality, yield, e.g. well use: no. of people using water, area irrigated, crop type, no. of crops p.a.).

1) Water for both domestic and cultivation usage 2) \$500 construction cost and \$50 - \$150 operating cost since pump usually fail

3) Owner was not satisfied - happier if govt pipeline installed.

## WELL INVENTORY DATA SHEET

Date: 1/7/82

Well No: 37 Location: Kg. Bakar Kapar

Well Owner: Ang Peng Kiam Contractor: own made

Well Type: Well point/~~borehole~~/dug well Date of Construction: 7/2/82

Construction Details: Depth: 105 m/ft Diameter: 3 in.

~~Slotted~~/Perforated casing: from 95 m/ft to 105 m/ft.

Geological Comments from Owner/Contractor: alternate layer of peat (black soil) and sand at 90'

Water Details: Static Water Level 2 m/ft. below/above ground level.

Yield: 1/s/gallons/h. What equipment used to test: -

Test Duration: - Well? -

Normal Pumping Regime: 24 hrs/day 7 Days/week

Months: Jan, Feb only during dry season and when required.

Water Quality: EC micromhos/cm<sup>2</sup> @ 25°C.

Sample Bottle Nos: Not available to be taken

Quality Comments: (Iron content, Taste, Turbidity, Saltness, Crop Response etc.).

Slight salty taste down to 60', below this no taste.

Pump Details: Pump Type: Airlift/Surface centrifugal/Electric submersible/shaft driven deep Turbine/Hand Pump/Bucket and Rope).

Pump Manufacturer: Fuji

Power Source: Type: Diesel type Manufacturer: Kubota

B.H.P. Rating: -

Comments: e.g. changes in water level, quality, yield, e.g. well use: no. of people using water, area irrigated, crop type, no. of crops p.a.).

Only for irrigation use of 3 acres of padi. Water is pump only during growing season 24 hours a day, whenever the pump and fuel is available.

## WELL INVENTORY DATA SHEET

Date: 2/7/82

Well No. 54 Location: Jalan Datuk Ahmad Badawi

Well Owner: Lee Yew Loon Contractor: Own make

Well Type: ~~Well point/borehole/dug well~~ Date of Construction: 30 yr.

Construction Details: Depth: 3.6 m/ft Diameter: 0.6 m/in.

Slotted/Perforated casing: concrete lining from ..... m/ft to ..... m/ft.

Geological Comments from Owner/Contractor: .....

Red clay soil, silty sand at bottom of well.

Water Details: Static Water Level 0.65 m/ft. below/above ground level.

Yield: 1.4 1/s/gallons/h. What equipment used to test: .....

Test Duration: 2/7/82 Well? .....

Normal Pumping Regime: 2 hrs/day 7 Days/week

Months: Good yield throughout year, all month used anytime needed.

Water Quality: EC micromhos/cm<sup>2</sup> @ 25°C. ....

Sample Bottle Nos: 54.

Quality Comments: (Iron content, Taste, Turbidity, Saltiness, Crop Response etc.).

Red cloudy colour but clear when it rains. severe staining of pump and surrounding area.

Pump Details: Pump Type: Airlift/Surface centrifugal/Electric submersible/shaft driven deep Turbine/Hand Pump/Bucket and Rope).

Pump Manufacturer: EL PROM made in Bulgaria

Power Source: Type: Electrical source Manufacturer: .....

B.H.P. Rating: 2890 v.p.m. 11.00 BHP.

Comments: e.g. changes in water level, quality, yield, e.g. well use: no. of people using water, area irrigated, crop type, no. of crops p.a.).

Only use for poultry farm (chicken, ducks for cal market) and washing and making rubber sheet. Pipe system present for domestic use of 8 person.

## WELL INVENTORY DATA SHEET

Date: 2/7/82

Well No. 61 Location: Kg. Lahar Kepar

Well Owner: Ismail Ahmad Contractor: own make

Well Type: Well point/borehole/dug well Date of Construction: 1 year

Construction Details: Depth: 50 m/ft Diameter: 2 m/in.

Slotted/Perforated casing: from 40 m/ft to 50 m/ft.

Geological Comments from Owner/Contractor:

Black soil (clay + peat) down to 30 feet,  
white, fine sand formation below 30 feet

Water Details: Static Water Level 7 m/ft. below/above ground level.

Yield: 0.83 gal/sec. 1/s/gallons/h. What equipment used to test: -

Test Duration: - Well? -

Normal Pumping Regime: 24 hrs/day 4 Days/week

Months: All month used except rainy season, and  
harvesting may, June.Water Quality: EC micromhos/cm<sup>2</sup> @ 25°C.

Sample Bottle Nos: -

Quality Comments: (Iron content, Taste, Turbidity, Saltness,  
Crop Response etc.).

slightly bad smell

Pump Details: Pump Type: Airlift/Surface centrifugal/Electric submersible/  
shaft driven deep Turbine/Hand Pump/Bucket and  
Rope).

Pump Manufacturer: Same pump is use

Power Source: Type: Manufacturer:

B.H.P. Rating:

Comments: e.g. changes in water level, quality, yield, e.g. well use:  
no. of people using water, area irrigated, crop type,  
no. of crops p.a.).Use for rice irrigation; about 3 acres,  
for 1 year has never dried up.



LIST OF RECOMMENDED RIG SPARES FOR TONE TOP 750A

Page No.	Ass'y Drg. No.	Parts Drg. No.	Parts Name	Parts No.	Quantity Required	Name of Assembly
6	B5405 - 080	SKY-100	Packing	14	8	Jack Ass'y
"	"	SKY-112-1	"	15	8 "	" "
"	"	SKY-100	Back Up Ring	16	4 "	" "
"	"	SKY-112-1	"	17	8 "	" "
"	"	Dust Seal	B2401	19	4 "	" "
"	"	DKI 100.114.8.11	Eslight Wear Ring	18	8	" "
"	"	SW 125-20-3				
"	"	G-140	O-Ring	20	4	" "
"	"	P-18	"	21	8 "	" "
7	B5226 - 334	E0267-055	Bushing	5	8 "	Frame Ass'y
"	"	D0325-217	Bolt Eye	11	4 "	" "
"	"	M36-3	Nut Hex	27	4 "	" "
"	"					" "
8	B5323 - 065	SL04-5018NR	Bearing	14	3 "	Head Sheave Ass'y
9	B5725 - 268	E0251-414	Bushing	1	2 "	Cylinder Ass'y
"	"	E0251-415	"	2	2 "	" "
"	"	DKI 60.74.8.11	Dust Seal	17	10	" "
"	"	110.126.9.12	Dust Seal	18	10	" "
"	"	BR 125 Snap Ring	JTS B 2401	29	2 "	" "
"	"	G60	O-Ring	19	6	" "
"	"	G90	"	20	6	" "
"	"	G105	"	21	6	" "
"	"	G110	"	22	6	" "
"	"	G135	"	23	6	" "
"	"					" "
"	"					" "
"	"					" "
"	"					" "

(i)

(11)

Page No.	Ass'y Drg. No.	Parts Drg. No.	Parts Name	Parts No.	Quantity Required	Name of Assembly
9	B5725 - 268	JIS B 2401	O-Ring			
"	"	P 60	"	24	6	Cylinder Ass'y
"	"	P 85	"	25	6	"
"	"	P 115	"	26	6	"
"	"	P 85	Back Up Ring	27	2	"
"	"	P 115	"	28	2	"
10	B5725 - 283	E0251-985	Bushing	1	4	Gearing Ass'y
"	"	S10 4-5016 NR Bearing	"			
"	"	JIS B 2401 P 8	"	15	4	"
"	"	G 45	O-Ring	16	12	"
"	"	G 125	"	17	16	"
"	"	OCS-70	Ring	21	16	"
"	"	UPI 60,80,12 Packing	"	18	20	"
"	"	UPI 90, 110, 12 Packing	"	19	20	"
"	"	SW-112 Eslight Wear Ring	"	20	20	"
"	"	60, 74, 8, 11 Dust Seal	"	22	24	"
"	"	BR 74	Snap Ring	31	8	"
"	"	I-125	"	23	4	"
11	B5272 - 151	23ASI	Oil Motor	37	1	Gearing Ass'y
"	"	22309	Bearing	38	1	"
"	"	22213	"	39	2	"
"	"	62152	"	40	1	"
"	"	6038 Z	"	41	2	"
"	"	ARX 200 26548 Bearing	"	42	2	"
"	"	6015 ZZ	"	47	1	"
"	"	SB 200,240,20 Oil Seal	"	43	10	"
"	"	JIS B2401 G 180 O-Ring	"	44	4	"
"	"	I-115	Snap Ring	48	1	"
"	"	I-125	"	49	1	"

Page No.	Ass'y Drg. No.	Parts Drg. No.	Parts Name	Parts No.	Quantity Required	Name of Assembly
12	B5275 - 239	D-2705-337	Liner	8	4	Guide Ass'y
"	"	D-2705-338	"	9	4	"
"	"	Mach Screw M6-12	ASS	16	72	"
13	C5630 - 717	JIS 2401 P 29	O-Ring	7	8	Piping Ass'y
"	"	90° Elbow 1"	"	8	2	"
"	"	BS 3021J-16	"	9	1	"
"	"	90° Elbow 3/8"	"	9	1	"
"	"	BS 30215-06	"	9	1	"
15	C5722 - 132	D2560-105	Piece, Chuck	9	3	Screw Chuck Ass'y
"	"	E2741-035	Ring, Snap	11	4	"
"	"	JIS B 2401 G 165	O-Ring	15	1	"
"	"	"	"	"	"	"
16	B5046 - 122	C4049 - 090	Brake Band Ass'y	14	2 sets	Brake Ass'y
"	"	C4049 - 091	"	15	2	"
"	"	SC1 D70-05	Spring	16	4	"
"	"	"	"	"	"	"
17	B5136 - 139	6217 LLB	Bearing	32	3	Drum Ass'y
"	"	6219 LLB	"	34	3	"
"	"	6311 LB	"	35	12	"
"	"	22216 B	"	36	4	"
"	"	SB95, R5, 14,	Oil Seal	37	6	"
"	"	SB 100, R5, 13	"	38	4	"
"	"	I-1ZO Snap Ring	"	39	8	"

(iii)

(v)

(vi)



Page No.	Ass'y Drg. No.	Parts Drg. No.	Parts Name	Parts No.	Quantity Required	Name of Assembly
22	B5185 - 042		PRESSURE GAUGE ASS D4047-004	5	2 Sets	DELIVERY LINE ASS
"	"		VALVE ASS DIAPHRAGM	5-2	2 "	"
"	"		E0540-002 "	5-2-1	2 "	"
"	"		PACKING	5-2-8	2 Nos.	"
"	"		PRESSURE DAMPER TPT 0375	5-3	2 "	"
"	"		E2521 - 541		"	"
"	"		DAMPER TPT 0375-2	5-3-2	2 "	"
"	"		PRESSURE GAUGE AT 3/8-100 x 80	5-6	2 "	"
"	"		JIS B 2401 G95 O-RING	13	4 "	"
"	"		O-Ring	14	4 "	"
"	"			15	"	"
"	"			16	"	"
"	"			17	"	"
"	"			39	"	"
"	"			40	"	"
"	"			41	"	"
"	"			42	"	"
"	"			43	"	"
"	"			44	"	"
"	"			45	"	"
"	"			46	"	"
"	"			47	"	"
"	"			48	"	"
"	"			49	10	"
"	"			50	10	"
"	"			51	10	"
"	"			52	10	"
"	"			53	4	"
"	"			54	4	"
"	"			55	4	"
"	"			56	4	"
"	"			57	4	"
"	"			58	4	"
"	"			59	2	"
"	"			60	10	"

(v)

(lv)

Page No.	Ass'y Drg. No.	Parts Drg. No.	Parts Name	Parts No.	Quantity Required	Name of Assembly
23/24	B5450 - 080	E0251-336	BUSHING	2	4	Crank Disc Ass.
"	"	E1801 - 847	COLLAR	13	2	"
"	"	E1801 - 848	COLLAR	14	2	"
"	"	E2521 - 493	PACKING	17	4	"
"	"	E2521 - 494	PACKING	18	4	"
"	"	E2521 - 496	PACKING	19	2	"
"	"	D2705 - 119	LINER			"
"	"	T-LG 0035		25	4	"
"	"		GAUGE ASS	31	2	"
"	"	T-PW 2000	PACKING	35	4	"
"	"	22313-0	BEARING ROLLER	38	2	"
"	"	22314	BEARING ROLLER	39	2	"
"	"	6313	BEARING BALL	40	4	"
"	"	SB-80-105- 13	OIL SEAL	43	4	"
"	"	5/16/800	GRAPHITE PACKING	55	2	"
"	"	F2521-495	PACKING	63	4	"
"	"	E0251-335				
"	"	INA NTN	BUSHING	64-1	4	"
"	"	SL01 4844	BEARING ROLLER	64-5	2	"
"	"	JIS B 2401 G65	O RING	65	4	"

(v)

Page No.	Ass'y Drg. No.	Parts Drg. No.	Parts Name	Parts No.	Quantity Required	Name of Assembly
26	C5738-006	E2521-211	PACKING	4	4	SAFETY VALVE ASS'Y
"	"	E251-337	PACKING	5	4	"
"	"	E2702-889	RUBBER PACKING	15	2	"
"	"	E2555-552	PIN	6	4	"
27	ASS DWG. No. B5630-954	JIS B2401 P 135	O RING	57	4	PIPING ASS'Y
29/30	B5272-153	E1828-279	COLLAR	12	2	GEARING ASS'Y
"	"	E1828-280	COLLAR	13	2	"
"	"	E1828-287	COLLAR	14	2	"
"	"	E1828-288	COLLAR	15	2	"
"	"	E1828-289	COLLAR	16	2	"
"	"	D1874-076 Clutch, Claw		17	4	"
"	"	6209 Bearing		39	4	"
"	"	6212 "		40	4	"
"	"	6213LB "		41	4	"
"	"	6309 "		42	4	"
"	"	6310 "		43	4	"
"	"	2214B "		44	4	"
"	"	NJ 2209 "		45	4	"
"	"	SB 55-72-9 Oil Seal Bearing		46	4	"
"	"	SB 65-90-13" Bearing		47	4	"
"	"	SB 85-110-13 "		48	4	"
"	"	JIS B 2401-G40 O-Ring		49	10	"
"	"	JIS B 2401-G45 O-Ring		50	10	"
"	"	JIS B 2401-G50 O-Ring		51	10	"
"	"	JIS B 2401-G65 O-Ring		52	10	"
"	"	0-45 Snap Ring		53	4	"
"	"	0-48 "		54	4	"
"	"	0-60 "		55	4	"
"	"	0-65 "		56	4	"
"	"	I-85 "		57	4	"
"	"	I-120 "		58	4	"
"	"	Top-10A Trochoid Pump		59	2	"
"	"	SV-850 Belt, V		60	14	"



Page No.	Ass'y Drg. No.	Parts Drg. No.	Parts Name	Parts No.	Quantity Required	Name of Assembly
34	C5054 - 053	D1185-091	Torque Gauge	3	2	Hydraulic Control Ass'y
"	"	D2596-048	Bit Loadgauge	7	2	"
"	"	DKI-3/8 PT x 3/8 PF	Damper	10	5	"
"	"	DU3/8 x 100 x 350 <sup>k</sup>	Pressure Gauge	11	2	"
"	"	HG-9210-10-22	Manual Control	12	2	"
"	"	DMG-06-3D3-40	Valve	14	2	"
"	"	DMG-03-3D60-40	"	16	1	"
"	"	BG-03-32	Relief Valve	19	1	"
"	"	DU3/8 x 100 x 35k	Hirose Pressure Gauge	28	2	"
35	B5643 - 041	E1874 - 075	Clutch Claw	3	4	Pump Ass'y
"	"	E2559-180	Pin	4	2	"
"	"	E2743-346	Ring	5	2	"
"	"	E0267-129	Bushing	11-1	4	"
"	"	E4647-009	Pump ASS	12	2	"
"	"	E2072	Bearing Ball	14	4	"
"	"	6206 ZZ	Bearing Ball	15	4	"
"	"		1-72 Snap Ring	16	4	"
"	"		1-62 Snap Ring	17	4	"
"	"		0-50 Snap Ring	18	4	"
"	"		0-35 Snap Ring	19	4	"
"	"		Spring Roll Pin	20	6	"
"	"	E4473-097	Coupling Ass	28	2 Sets	"
"	"	3V-355	V Belt	32	4	"



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# GROUNDWATER RESOURCES FOR AGRICULTURAL USE IN MALAYSIA



PROGRESS  
REPORT  
November, 1982

SIR M. MACDONALD & PARTNERS LIMITED  
Consulting Engineers  
Cambridge, England.



GROUNDWATER  
RESOURCES FOR  
AGRICULTURAL USE  
IN MALAYSIA

PROGRESS  
REPORT  
November, 1982

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## GENERAL APPENDIX

## Mardi, Bertam Composite Bore Logs.

This is the fifth of a series of technical progress reports.

It is mainly concerned with the period from August 21 to end November,

1962 and describes the results of resistivity geophysical surveys

and drilling operations conducted during that time.

Over 3000 metres of boreholes were completed in the area.

of 2.4 metres diameter with associated air lift

systems. Balik Pulau - Borehole Capacities were completed.

Within the area, both rigs were recalled because of constraints

on operating the rigs. Subsequently, a one rig operation is planned.

Budget uncertainties have caused several revisions of programme.

the one rig drilling programme given in this report is at a tentative stage.

Projected work.

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21-26 November, to review consultant staffing arrangements and pump

procurement.

1. W. B. GENERAL leave according to the Consultants normal practice

### 1.1 Introduction

This is the fifth in a series of technical progress reports.

It is mainly concerned with the period from August 21 to end November, 1982 and describes the results of resistivity geophysical surveys and drilling and testing operations conducted during that time.

Over 550 m of exploratory drilling was completed in the areas of Seberang Prai and Penang Island, together with associated air lift yield testing and borehole logging; 10 boreholes were completed.

Within the report period, both rigs were recalled because of constraints on operating budget; subsequently, a one rig operation is planned. Budget uncertainties have caused several revisions of programme; the one rig drilling programme given in this report is at best a tentative statement of projected work.

In the same period, geophysical resistivity work was somewhat curtailed. Nevertheless surveys were completed in Perak, at Cangkat Jong and Tapah, in Tanah Rata and in Kelantan in the South Kandis area and at the Sg. Selehong river closure.

### 1.3 Visits and Meetings

#### 1.2 Staffing

Visits were made as follows:

Mr. W.M. Thomas, master driller II, completed his 11 month input on August 23 and left Malaysia on 26 August 1982. The geologist-geophysicist Mr. D.M. Ball, completed an agreed 2½ month extension input (14½ month total) on October 1 and left Malaysia on October 2. Consultant staff has been maintained at two since that time. Supervising hydrogeologist D.M. Milne visited the project between 21-26 November, to review consultant staffing arrangements and pump procurement.

F.M. Bonnell took leave according to the Consultants normal practice between October 11 and 16 to visit a NWWA-ADA conference and seminar on drilling techniques held in Perth, Western Australia.

The Consultant has suggested that JPT approve the input in 1983 of an additional hydrogeologist from the consultants staff. Input tasks would be to assist in the preparation of drilling manuals, investigation area reports and in the pump testing which has been long delayed.

A Geological Survey of Malaysia (GSM) geologist, Encik Mohd. Azmer Ashari joined the project on 7 September 1982 to fill the assistant hydrogeologist post; Encik Azmer is on quasi-secondment to JPT Groundwater Section (cadre status) and is expected eventually to rejoin GSM.

The cut back of the programme to a 1 rig operation will necessitate some redeployment of JPT drilling and technical staff. It is anticipated that some redeployed drilling staff will assist with the pump testing programme, specifically with pump installation. It is planned that staff from the geophysics team will run pump tests and handle routine water level/discharge measurements in addition to geophysical resistivity surveys.

Visits were held as follows:

### 1.3 Visits and Meetings

Visits were made as follows:

- 15.9.82; to a seminar on groundwater, well design and well screen by UOP-Johnson; various JPT staff attended.
- 17.9.82; a groundwater, drilling and well hydraulics seminar given by JKR, GSM and by Australian Groundwater Consultants; various Senior JPT staff attended.
- 22-23.9.82; JPT drilling staff and the Consultant, visited a new GSM drilling rig (Ingersoll-Rand) drilling at Kg. Maur near Kuala Lumpur.

- 23.9.82; Geophysical staff (Azuhan + DMB) visited Alor Setar to familiarise themselves with operation of an ABEM Terrameter resistivity instrument currently operated in Kedah by GDC/JKR.
  - 28.9.82; The Consultant visited pump supplier Gadelius to examine the Grundfos BF 45-4 lineshaft turbine pump ordered by JPT. It was ascertained that pump dimensions and drive (flat belt) render the pump somewhat unsuitable for a test pump.
  - 7.10.82 and 13/14.10.82; The Consultant visited projected investigation areas in Perak (Enggor, Bt. Gantang, Ulu Piol and Cangkat Jong) to select drilling sites and to liaise with local JPT offices on logistics and site preparation.
  - 14.10.82; Azuhan b. Mohamad, Ferdaos b. Hj. Mohamad and RAF visited project investigation areas in Malacca, to identify targets for geophysics and drilling.
  - 4.11.82; JPT Ampang Staff and the Consultant (FMB) visited JPT workshop, Ipoh to review arrangements for conversion of Tone rig hydraulic cooling systems.
- Meetings were held as follows:

- 25.8.82; between a representative of Gadelius and the Consultant, MMP, to discuss specification and characteristics of a small Gadelius borehole pump ordered by JPT.
- 10.9.82; between drilling mud suppliers (Magcobar Dresser/Mutiara Indah) and the Consultant. It is anticipated that Magcobar can later supply a field mud engineer to give a 1 day on-site lecture and practical demonstration in drilling mud techniques.
- 21.9.82; at Mardi, Bertam (RAF, FMB and Mardi Staff) to discuss water demand and bore siting.

- 28.9.82; between representatives of JPT Workshop Ipoh, MMP and Kawansetia, the Tone rig agent. To discuss rig maintenance, spares and rig cooling system modification. The fitting of a redundant crane to a new truck was also discussed with JPT, Ipoh.
- 22.10.82; Staff of JPT Headquarters, JPT Ampang and the Consultant, to discuss budget constraints and drilling programme.
- 18.11.82; between JPT Planning Dept., staff of JPT Ampang, JPT Perak and MMP. The meeting discussed the report submitted on the Padang Terap groundwater investigation and the August Progress report. The rather low project bore success rate was discussed in terms of budget cuts, staffing and future programmes. It was decided to continue with a 1 rig drilling programme. Procurement of borehole pumps was also discussed.

A mud test kit was borrowed from JKR/GDC in Kedah in August and returned in early November. A quantity of drillpipe (102 m of 3½" I.F. Tone T9) was loaned to JKR/GDC in Kedah on 17 October. This will enable JKR to continue their drilling programme which had been delayed by drillpipe failure.

#### 1.4 Expenditure and Payments

Month 13 and 14 scheduled payments were received on 22.11.82 (Figure 1.1).

Statements of Expenditure have been submitted up to and including Month 16 (September 1982).

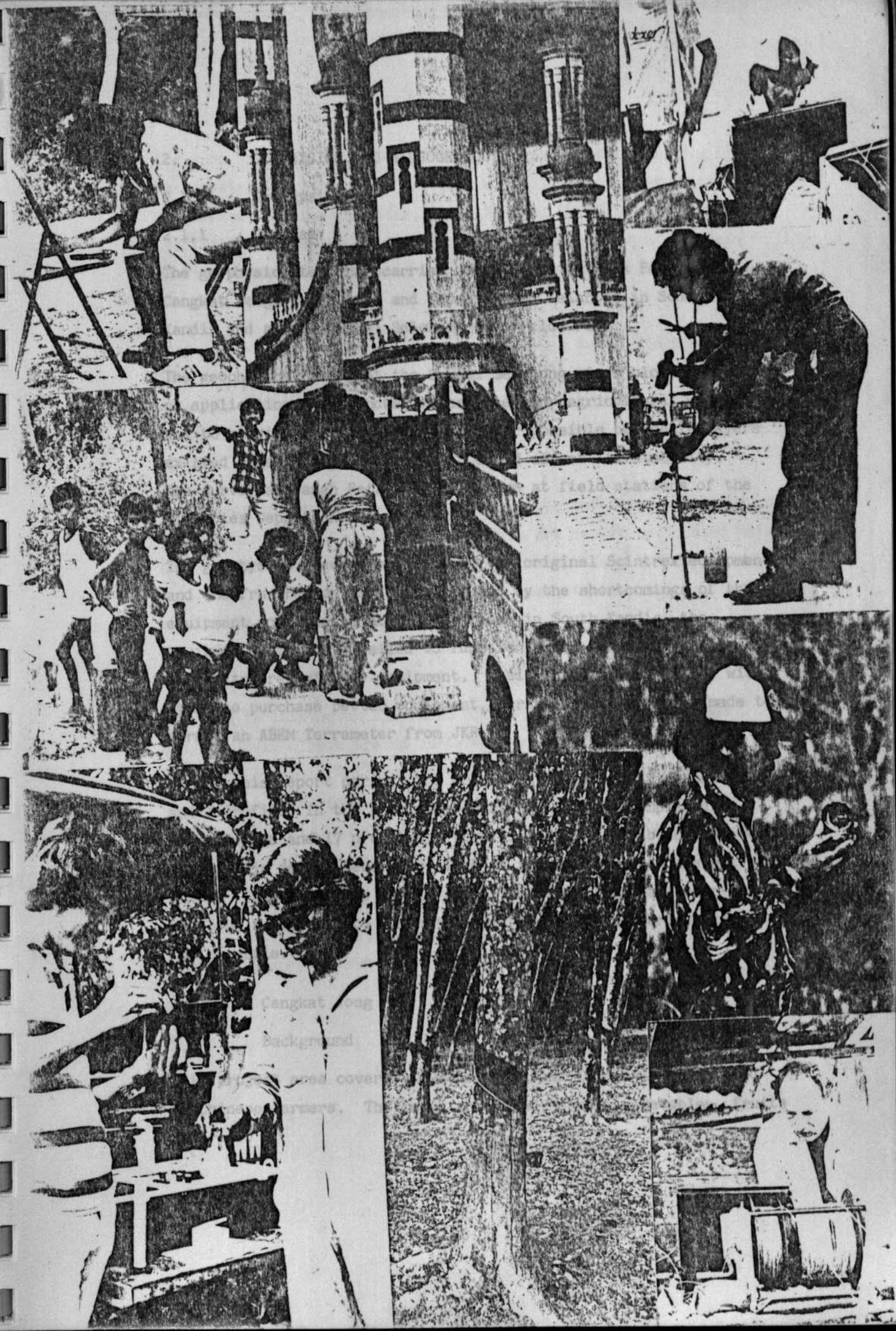
TABLE 1.1

## PAYMENTS AND EXPENDITURE

## INVOICE

## STATEMENT OF EXPENDITURE

Project Month	Invoice No.	Date Submitted	Amount M\$	£Stg.	Date Paid	S.O.E. No.	Date Submitted	Amount M\$	£Stg.
Mobilisation	81/06/4034	15.6.81	36,604	28,461	6.11.81				
May	-	-	-	-		81/05/5035	14.8.81	138.41	918.93
1 June	81 81/06/4034	10.3.82	8,280	7,763	7.4.82	81/06/4035A	14.8.81	5,333.91	6,300.11
2 July	81/07/4034	10.3.82	11,500	15,225	"	81/07/4034	18.9.81	8,824.50	12,104.20
3 Aug	81/08/4034	10.3.82	12,940	13,685	"	81/08/4034	12.11.81	11,731.78	13,146.40
4 Sept	81/09/4034	10.3.82	9,480	11,237	"	81/09/4034	17.12.81	10,171.85	13,368.60
5 Oct	81/10/4034	10.3.82	11,940	10,301	"	81/10/4034	19.12.81	10,599.44	13,342.00
6 Nov	81/11/4034	10.3.82	10,200	9,842	"	81/11/4034	18.1.82	13,238.60	14,063.92
7 Dec	81/12/4034	10.3.82	9,200	7,549	"	81/12/4034	11.3.82	9,748.88	10,914.50
8 Jan	82 82/01/4034	8.4.82	9,340	7,090	11.5.82	82/01/4034	12.4.82	9,207.20	10,964.50
9 Feb	82/02/4034	8.4.82	10,840	8,920	11.5.82	82/02/4034	13.4.82	7,236.62	11,214.78
10 Mar	82/03/4034	8.4.82	8,340	7,090	11.5.82	82/03/4034	30.4.82	10,174.34	10,755.93
11 April	82/04/4034	3.5.82	7,736	9,730	7.6.82	82/04/4034	7.6.82	10,969.90	10,905.68
12 May	82/05/4034	3.6.82	15,840	10,590	25.6.82	82/05/4034	15.6.82	10,135.80	11,134.23
13 June	82/06/4034	30.7.82	12,240	9,038	1.9.82	82/06/4034	30.7.82	10,234.40	9,763.37
14 July	82/07/4034	2.8.82	16,340	13,946	22.11.82	82/07/4034	20.9.82	7,391.81	9,553.93
15 August	82/08/4034	1.9.82	13,740	8,106	22.11.82	82/08/4034	29.9.82	10,946.03	12,156.53
16 Sept	82/09/4034	1.10.82	11,140	8,106			26.10.82	21,484.47	8,836.50
17 Oct	82/10/4034	5.11.82	11,740	8,106					



## 2. area 1 GEOPHYSICS AND HYDROGEOLOGY

### 2.1 Geophysics

#### 2.1.1 General

The geophysics team has carried out surveys both in Perak, at Cangkat Jong, Tanah Rata and Tapah and in Kelantan in South Kandis and at the Sungei Selehong river closure.

Most of the area in the south-west suffers a water shortage which

The geophysical study at the Sungei Selehong river closure had no application to groundwater resources for agricultural use but was to provide a quick check on whether possible permeable layers existed beneath the closure which could affect its stability.

The survey at Tanah Rata and Tapah were at field stations of the Fisheries Department.

the poor irrigation system. These areas are centrally located between

The geophysics crew is still using the original Scintrex equipment and the frustration and delays caused by the shortcomings of this equipment continue to hinder progress; in South Kandis, the equipment completely failed to function which reinforces the need for better resistivity equipment. Until funds are available with which to purchase better equipment, arrangements are being made to borrow an ABEM Terrameter from JKR.

During this report period, the crew have completed 15 soundings and 1 profile; in the previous report period they completed 24 soundings and 17 profiles. Very little work has been achieved during this period because of lack of funds. The crew has not been in the field since the middle of September. They have been doing odd jobs in the office since then with consequent decrease in their morale.

#### 2.1.2 Cangkat Jong

##### Background

This project area covers 2,000 hectares and is mainly cultivated by Chinese farmers. The crops are mixed, namely vegetables, fruits and rice.

The area is being irrigated by an irrigation canal network which was constructed during the British colonial period. Water is abstracted from Sungei Bidor, above Kampong Bekas Mata-Mata Khas Ayer Hitam. From the headworks, water is channelled in the main canal and then redistributed into the 8 secondary canals serving the area (Figure 2.1).

Most of the area in the south-west suffers a water shortage which is not surprising since it is situated at the end of the irrigation network. With the limited amount of water in the main canal, most of it is consumed by the area in the north-east i.e. at the beginning of the irrigation network.

Some areas in the north-east also lack water but this may be due to the poor irrigation system. These areas are centrally located between the 2 secondary canals. Water from the canals take quite sometime to irrigate these areas. Furthermore, most of the water has been used up by the area bordering the canals.

#### Geology/Geomorphology

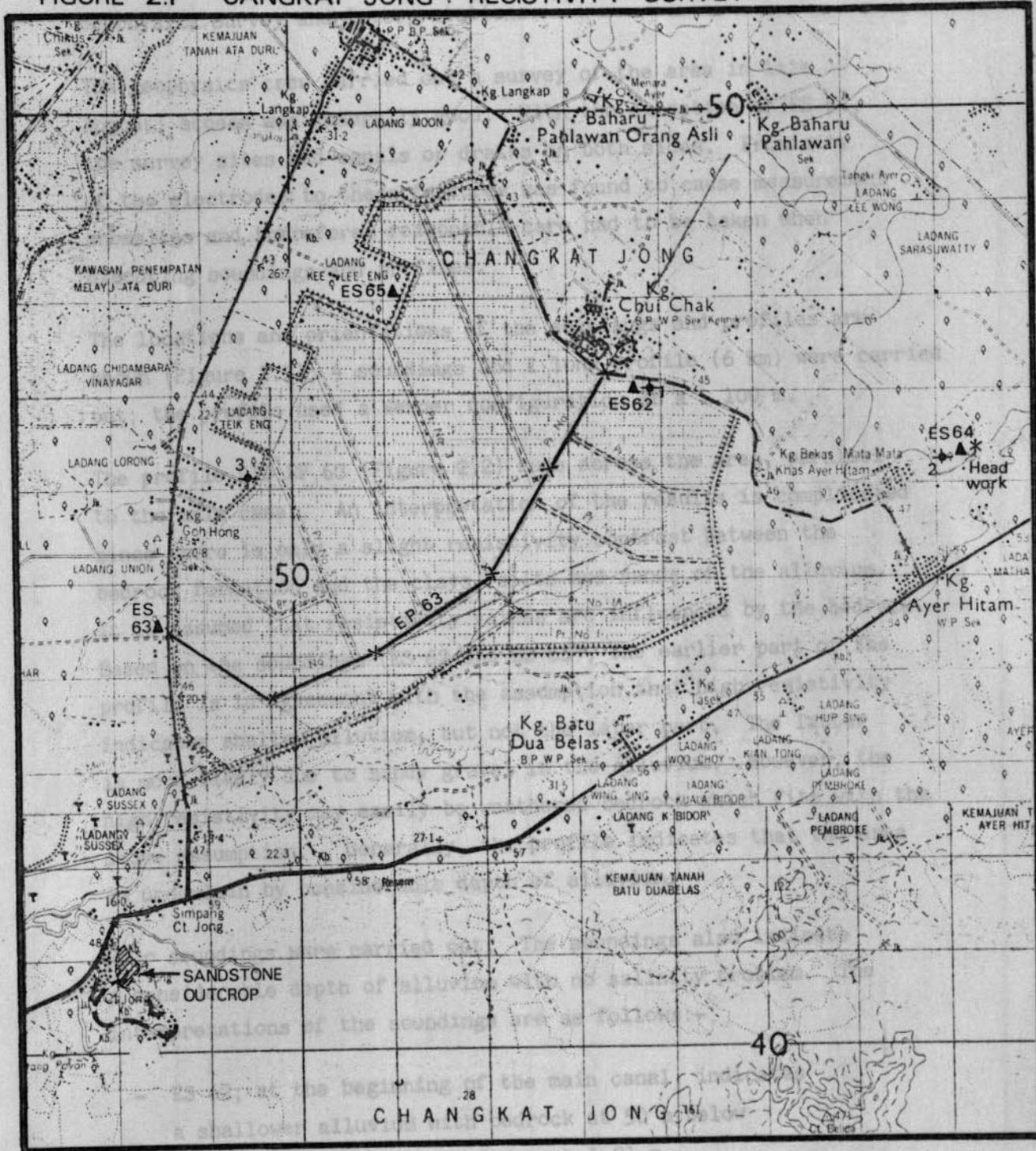
The area is located on the flood plains of Sungei Pahlawan and Sungei Bidor. There are no surface outcrops of hard rock in the immediate vicinity but there are sandstone outcrops to the south of the area at Kampong Cangkat Jong (Figure 2.1). It is assumed that below the alluvium, the bedrock is composed of sandstone, siltstone, shale and quartzites.

Most promising aquifers would be expected within the alluvium. However, an aquifer could also be expected from the sandstone where this has retained primary intergranular porosity.

#### Legend

- ▲ ES 84 Electrical Sounding Location
- ⊕ Possible Borehole Site

FIGURE 2.1 CANGKAT JONG : RESISTIVITY SURVEY



**Legend**

- ▲ ES 64 Electrical Sounding Location.
- ✦ 3 Possible Borehole Site.

### Geophysics Survey and Interpretations

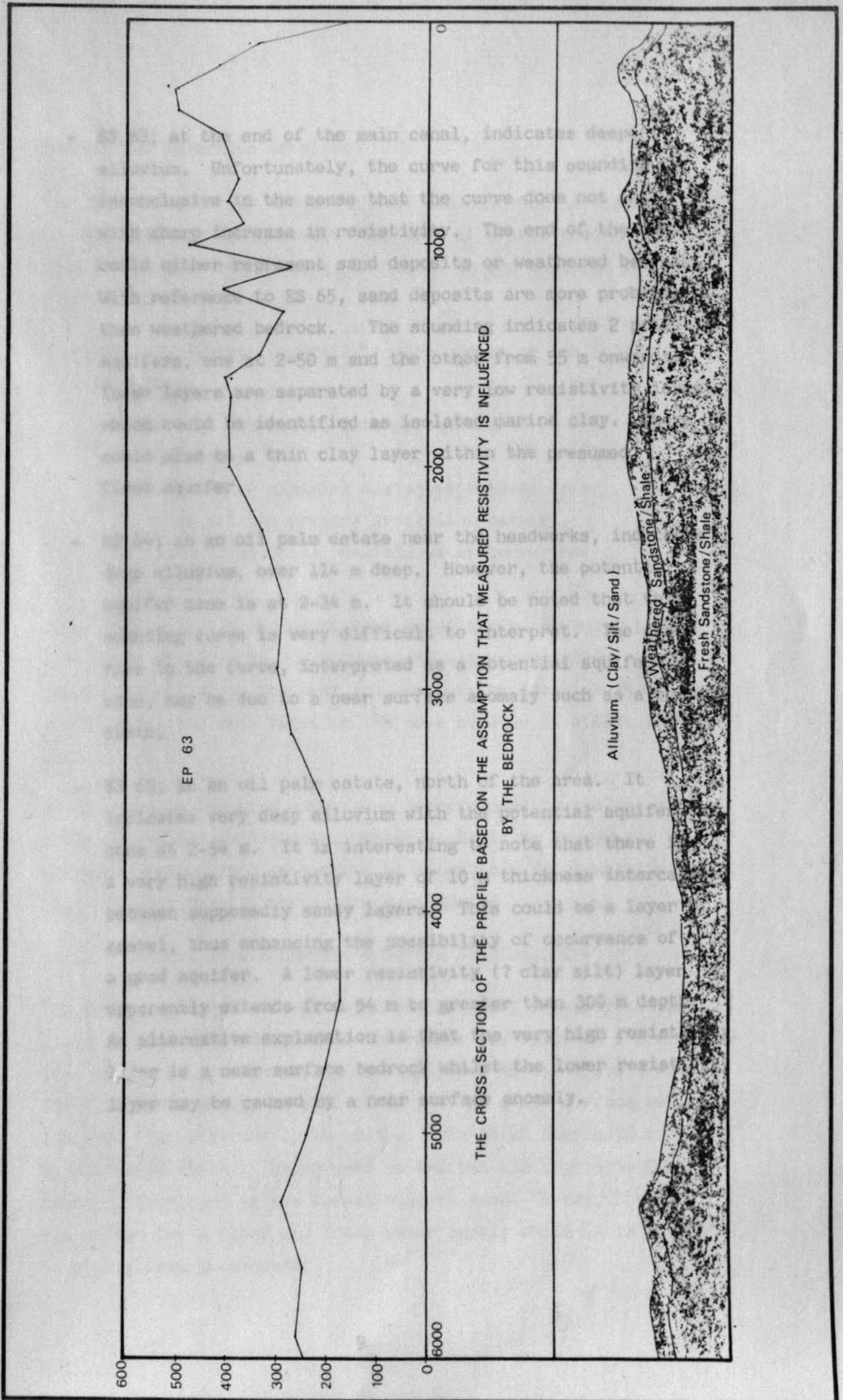
The geophysics crew carried out a survey of the area in late August; access was generally good. With the exception of ES 64, the survey sites had canals or drains on both sides. Proximity of the electrodes to these features was found to cause measurement anomalies and therefore, reasonable care had to be taken when executing soundings and profiles.

The locations and orientations of the soundings and profiles are shown (Figure 2.1); 4 soundings and 1 long profile (6 km) were carried out; the profile used a Wenner configuration of  $a = 100$  m.

The profile DID EP 63 (Figure 2.2) runs across the area, parallel to the main canal. An interpretation of the results is complicated since there is only a slight resistivity contrast between the bedrock formation and the clays, silts and sands of the alluvium. It is assumed that resistivity values are influenced by the bedrock. Based on the soundings (ES 62 and ES 63), the earlier part of the profile is in agreement with the assumption that high resistivity indicates shallow alluvium, but not the later part. The latter is more likely due to sandy gravel in the alluvium. However, the high resistivity may easily be weathered bedrock which fits with the above assumption. Generally, the profile indicates that the area is underlain by considerable depth of alluvium.

Four soundings were carried out. The soundings also indicate a considerable depth of alluvium with no salinity problem. The interpretations of the soundings are as follows:-

- ES 62; at the beginning of the main canal, indicates a shallower alluvium with bedrock at 50 m below ground level and a sandy layer at 1-21 m.



EP 63

THE CROSS-SECTION OF THE PROFILE BASED ON THE ASSUMPTION THAT MEASURED RESISTIVITY IS INFLUENCED BY THE BEDROCK

Alluvium (Clay/Silt/Sand)

Weathered Sandstone/Shale

Fresh Sandstone/Shale

- ES 63; at the end of the main canal, indicates deeper alluvium. Unfortunately, the curve for this sounding is inconclusive in the sense that the curve does not end with sharp increase in resistivity. The end of the curve could either represent sand deposits or weathered bedrock. With reference to ES 65, sand deposits are more probable than weathered bedrock. The sounding indicates 2 potential aquifers, one at 2-50 m and the other from 55 m onwards. These layers are separated by a very low resistivity layer which could be identified as isolated marine clay. There could also be a thin clay layer within the presumed first aquifer.
  - ES 64; in an oil palm estate near the headworks, indicates deep alluvium, over 114 m deep. However, the potential aquifer zone is at 2-34 m. It should be noted that this sounding curve is very difficult to interpret. The sharp rise in the curve, interpreted as a potential aquifer zone, may be due to a near surface anomaly such as a buried drain.
  - ES 65; in an oil palm estate, north of the area. It indicates very deep alluvium with the potential aquifer zone at 2-54 m. It is interesting to note that there is a very high resistivity layer of 10 m thickness intercalated between supposedly sandy layers. This could be a layer of gravel, thus enhancing the possibility of occurrence of a good aquifer. A lower resistivity (? clay silt) layer apparently extends from 54 m to greater than 300 m depth. An alternative explanation is that the very high resistivity layer is a near surface bedrock whilst the lower resistivity layer may be caused by a near surface anomaly.
- face water is supplied from a stream in the hill. This water source is polluted by pesticide which is being used in the tea and vegetable fields recently developed in the forest reserve area. Hence, the need has arisen for a clear and fresh water supply which it is hoped to supply from groundwater.

## Summary and Selection of Sites

The geophysics survey indicates that the alluvium is deep; deeper in the west than in the east. The beds of coarse grained alluvium also follow that trend being 50 m thick in the west and 20-30 m thick in the east.

Possible bore sites (Figure 2.1) were chosen on the following considerations:

- to test geophysics interpretations
- rig access
- the need to minimise distances between bore sites and the present irrigation network (i.e. to minimise possible water conveyance costs).

Site 1 and site 2 were chosen because of their proximity to the main canal whilst site 3 was chosen to allow comparison between the aquifer potential in the west and east of the area. No sites were chosen along the main canal in the area because of difficult rig access.

Groundwater in the area might also be developed by the use of dug wells or shallow well-points. Farmers should be encouraged to construct well-points in their plot since this is a cheap, easy and efficient mean of harvesting groundwater.

### 2.1.3 Tanah Rata Fisheries Research Station (PFI)

The fisheries station is situated in the MARDI research station. It is located near one side of the valley and is about 5 m from the foot of the hill. The valley at this point is about 150 m wide. The fish ponds occupy an area of 60 m by 80 m and surface water is supplied from a stream in the hill. This water source is polluted by pesticide which is being used in the tea and vegetable fields recently developed in the forest reserve area. Hence, the need has arisen for a clear and fresh water supply which it is hoped to supply from groundwater.

Since a resistivity survey could not be carried out inside the fishery station, a sounding was conducted in front of the station. The sounding reached a maximum AB/2 of fifty metres. The curve may indicate that the valley floor is underlain by less than 5 metres of sandy alluvium, followed by about 15 metres of either clayey alluvium or weathered bedrock. The siting of a test borehole is difficult due to the fact that there is no obvious target aquifer.

#### 2.1.4 Tapah Fisheries Research Station (PPI)

The fisheries station at Tapah is sited in a valley next to the main road between Tapah and Cameron Highlands i.e. at the 6th mile. The fish ponds occupy an area of 50 m by 100 m and surface water is supplied from a stream; the latter is facing domestic pollution from aborigine villages upstream and is also infested by pathogens. The need for high quality water to ensure successful breeding and hatching initiated the investigation of a possible groundwater source. A total of 2 soundings were carried out, with AB/2 spacings of 40 m and 50 m. The sounding curves are difficult to interpret because of anomalies such as buried drains and proximity to the ponds. The curves may indicate that the valley floor is underlain by 6-10 metres of sandy alluvium, followed by about 10 metres of either clayey alluvium or weathered bedrock.

The siting of a test borehole may be difficult as the evidence indicates that there is no obvious target aquifer.

#### 2.1.5 South Kandis

The groundwater section has been requested to investigate the aquifer succession in the area in order to formulate criteria for the design, construction and operation of production boreholes for irrigation and domestic supply for the proposed South Kandis resettlement project; the project area is of about 5½ sq. km.

The geophysical team have spent 4 survey days in the area and have managed with perseverance to complete 5 soundings (Figure 2.3). All soundings are suspect and only very rough conclusions could be derived from them. Generally, when  $AB/2 = 30$  m or greater, it was not possible to obtain reliable readings. SP values with current switched off are different from those with the switch on, even though no current is flowing into the ground. This difference is probably caused by poor internal insulation. The problems is not very noticeable when  $AB/2$  is small and the resistivities are high. However, the presence of a saline second layer at 10-20 m below a high resistivity first layer exacerbates the problem. Use of the booster worsens the insulation problem. The very low resistivity saline second layer give values that are either beyond or at the limit of the measurement range of the present RSP-6 instrument. The geophysical team intends to return to the area once better equipment has been acquired.

The sounding curves merely show the existence of a top aquifer and a saline layer below. However, previous studies in and around the area indicate that there are three aquifers separated by thin semi-permeable argillaceous layers. The aquifer layers are as follows:-

- Upper aquifer-thin and may contain water with unacceptably high chloride levels
- Middle aquifer-saline
- Lower aquifer-relatively thick, contains high dissolved iron concentrations, but otherwise of good quality.

#### 2.1.6 Sungei Selehong River Closure

The Geophysics team of the JPT Ampang Groundwater Section was asked to investigate the subsurface formation beneath the completed river closure on Sungai Selehong. This closure is located at Kg. Lubok

### FIGURE 2.3 SOUTH KANDIS RESISTIVITY SURVEY

Jong (Figure 2.4). Geophysics was used to attempt the detection of permeable formations underneath the closure which could lead to the leakage of the closure; leakage could ultimately cause the collapse of the closure.

A total of 3 soundings were carried out, one on each river bank and one on the closure (Figure 2.4). The soundings on the river banks were carried out at a distance from the closure; space was not available on the abutments of the closure to extend the electrodes of the resistivity survey. The sounding on the closure is suspect.

Geophysical investigations are frequently inexact or difficult to interpret, and they are most useful when supplemented by subsurface investigations. Therefore, before interpretation of the actual resistivities in terms of subsurface geologic and groundwater conditions, a study of the existing hydrogeological reports of the area was conducted. The Geological Survey Department of Malaysia (GSM) has carried out hydrogeological investigations of the Tumpat area (GSM Report No. GPH 4/1976). Several exploratory boreholes were sunk to the south and to the west of the river closure (Figure 2.4). The geologic logs of these boreholes are shown (Figure 2.5). A cross-section line E-F of the area from the north-west to the south-east is given (Figure 2.6).

#### Sounding Interpretations.

The soundings indicate a considerable thickness of alluvium saturated with brackish/saline water. It should be noted that Sg. Selehong is tidal. The interpretations of the soundings are as follows:-

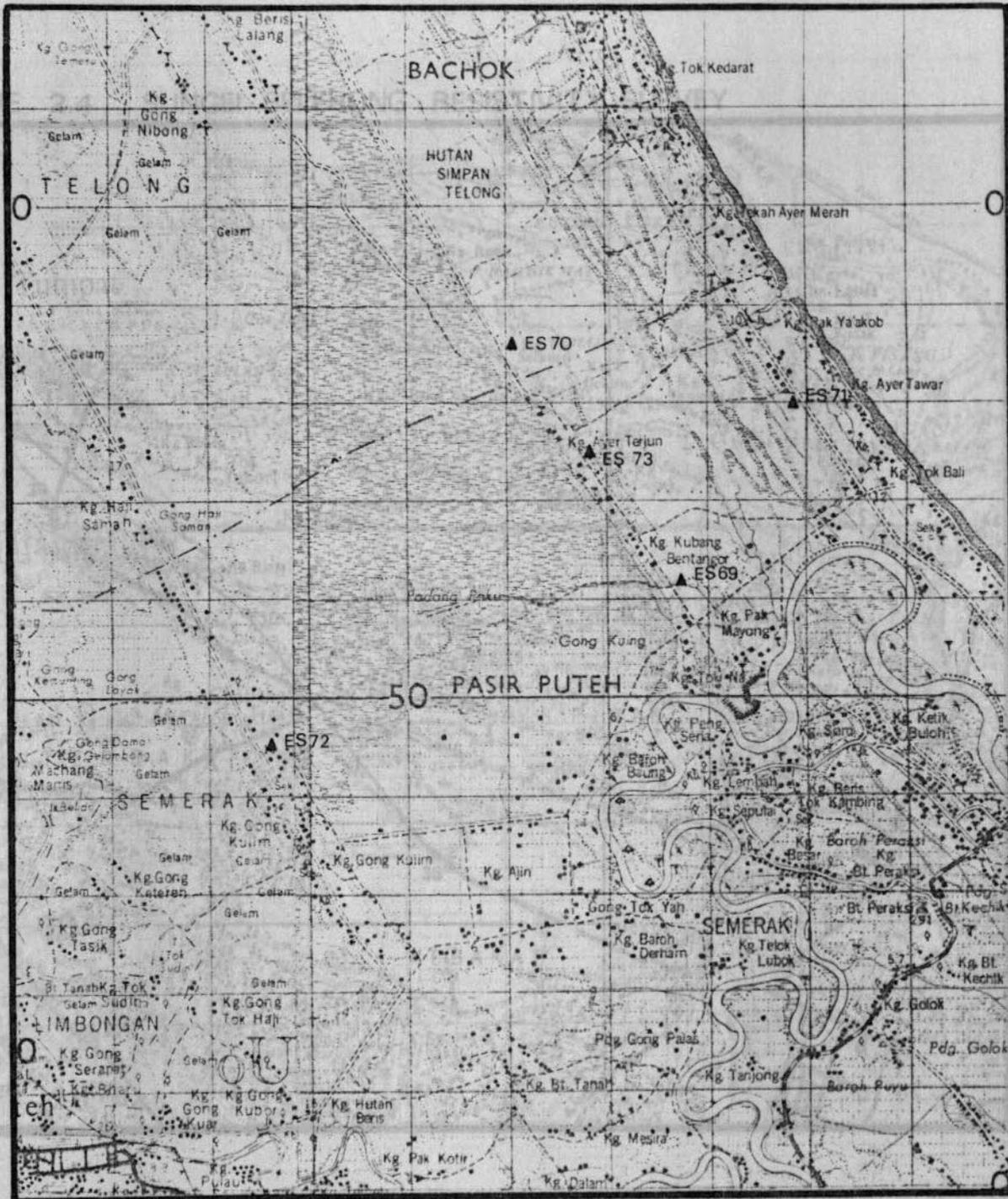
- ES 74 : on the West bank of the river. This sounding was done on cleared land; the upper formation has been excavated.

Legend

ES 74

Electrical Sounding Location

FIGURE 2.3 SOUTH KANDIS : RESISTIVITY SURVEY

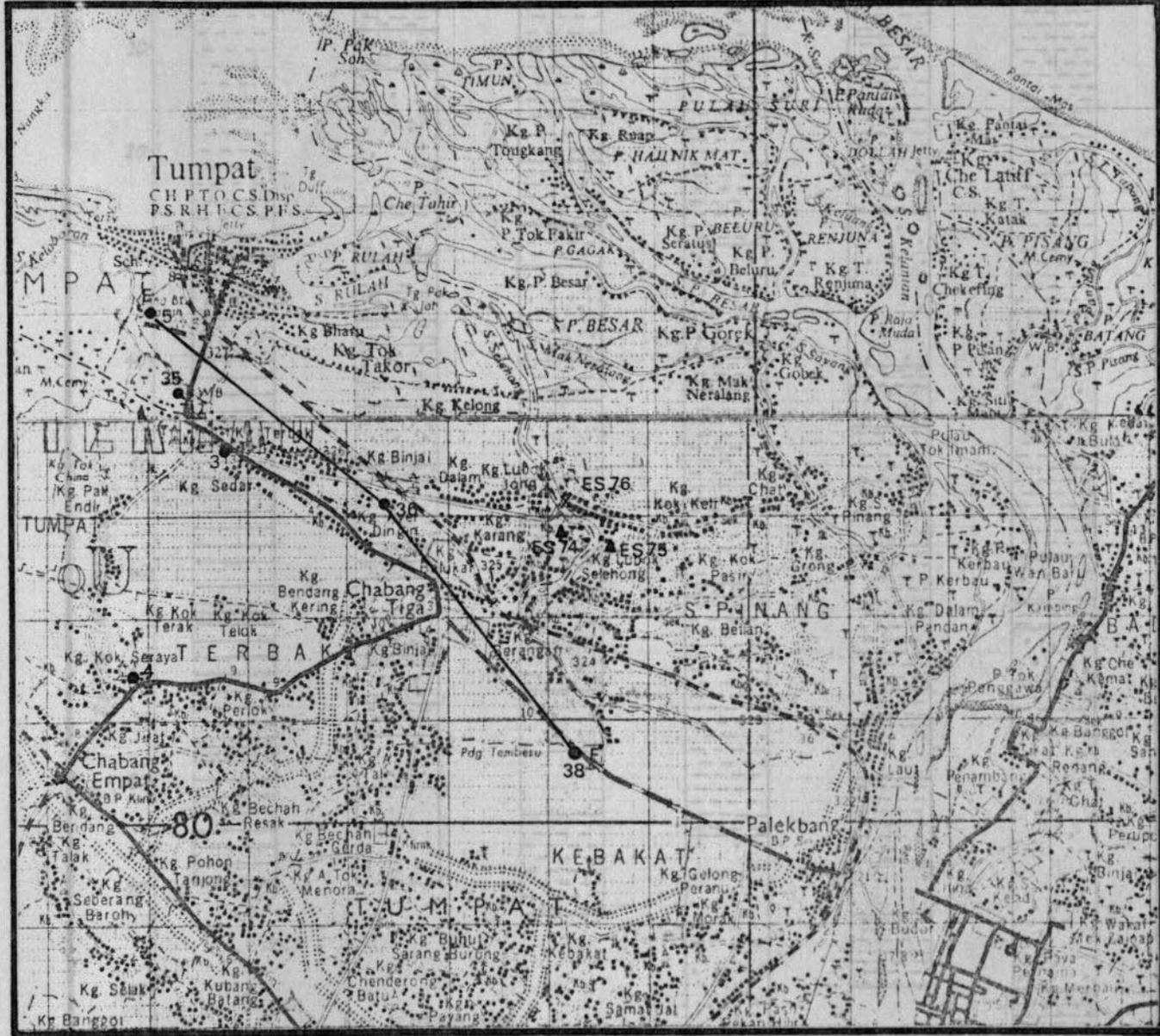


**Legend**

- ▲ ES 70 Electrical Sounding Location
- ▲ ES 69 Electrical Sounding Location
- Cross Section Line With

FIGURE 2.5 GEOLOGIC LOGS OF GSM EXPLORATION BOREHOLES  
TUMPAT, KELANTAN

FIGURE 2.4 SUNGEI SELEHONG RESISTIVITY SURVEY



- Legend**
- ▲ ES 75 Electrical Sounding Location
  - ES 38 Geological Cross Section Line, With GSM Borehole No.

FIGURE 2.5 GEOLOGIC LOGS OF GSM EXPLORATION BOREHOLES, TUMPAT, KELANTAN.

FIGURE 2.6 GEOLOGIC CROSS SECTION : TUMPAT, KELANTAN

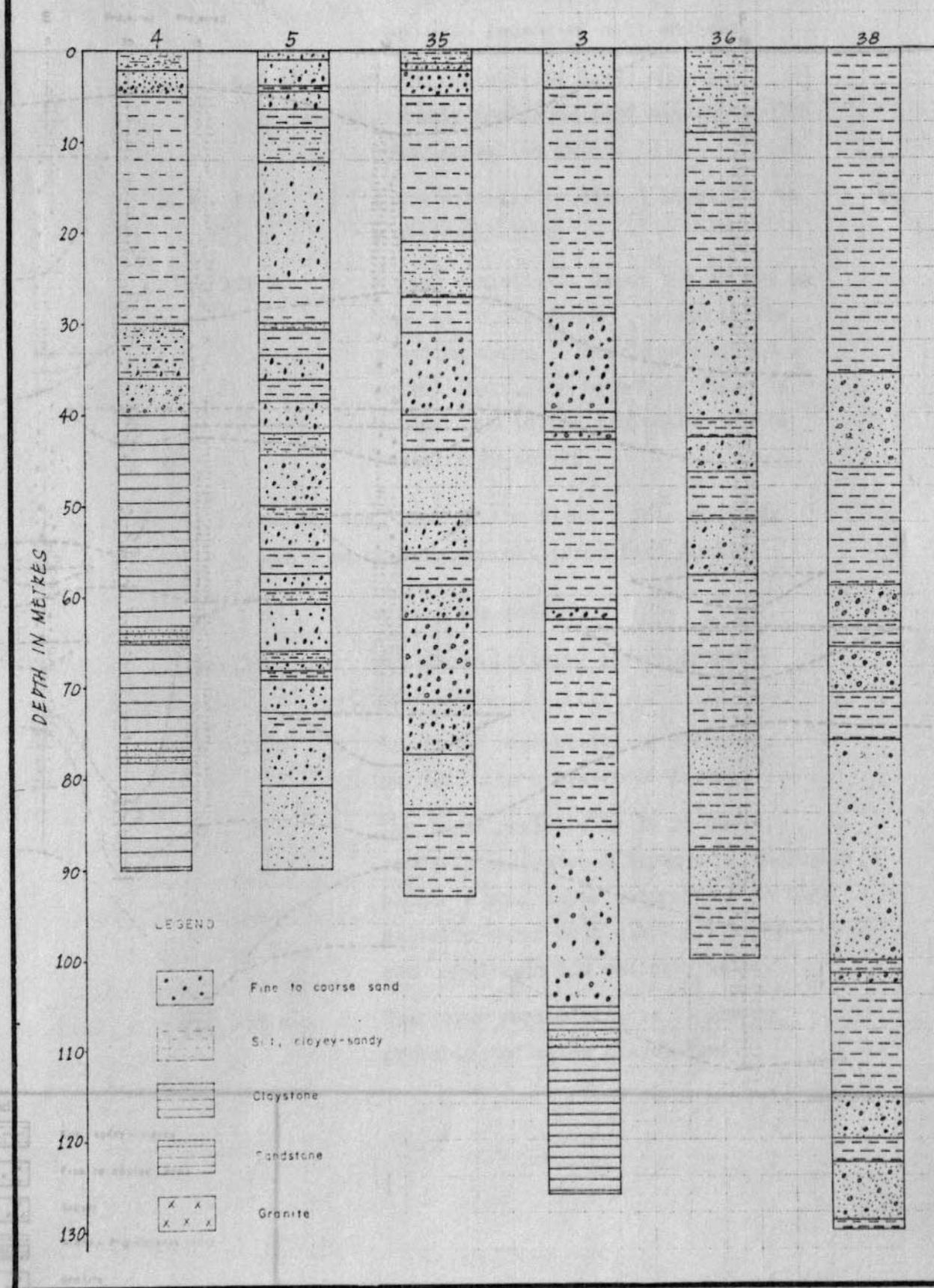
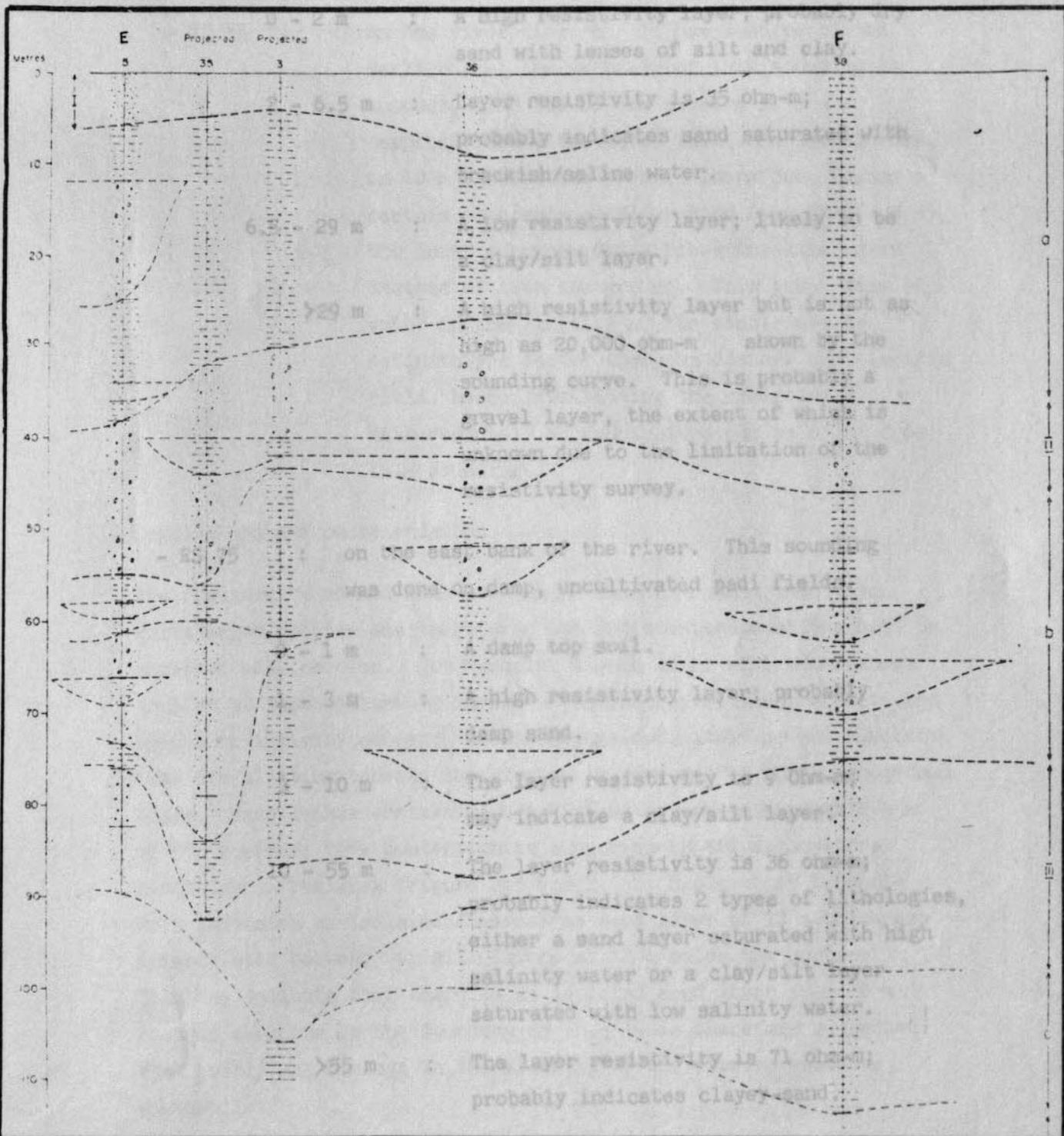


FIGURE 2.6 GEOLOGIC CROSS SECTION : TUMPAT, KELANTAN.



Legend

-  Silt, sandy - clayey
-  Fine to coarse sand
-  Gravel
-  Arenaceous - Argillaceous rocks
-  Granite

- ES 76
- 0 - 2 m : A high resistivity layer, probably dry sand with lenses of silt and clay.
  - 2 - 6.5 m : Layer resistivity is 35 ohm-m; probably indicates sand saturated with brackish/saline water.
  - 6.5 - 29 m : A low resistivity layer; likely to be a clay/silt layer.
  - >29 m : A high resistivity layer but is not as high as 20,000 ohm-m shown by the sounding curve. This is probably a gravel layer, the extent of which is unknown due to the limitation of the resistivity survey.

Conclusions and recommendation

- ES 75 : on the east bank of the river. This sounding was done on damp, uncultivated padi fields. The resistivity was done on damp, uncultivated padi fields. an earth layer problem and therefore, the above interpretations must be accepted with caution. For example, a sand layer of 1 m thickness located at 0 - 1 m between 2 A high resistivity layer; probably detected by the resistivity survey. damp sand. definitely do not indicate that the alluvium beneath the closure is composed of thick homogeneous clays. Sand lenses containing brackish water within 5 m of the surface; this contention is supported by the exploratory boreholes in the area (Figure No.5 indicates an isolated intercalated between two silt This may indicate that there onwards as shown by the sounding that trial/test >55 m : The layer resistivity is 71 ohm-m; probably indicates clayey-sand.

- ES 76 Hydro: on the river closure. It has been mentioned earlier that the accuracy of this sounding is suspect. The top of the closure is 3 m (approx.) above the water level and the closure is 10 m wide at the crest. Therefore, beyond a certain electrode configuration (say  $AB/2 = 5$  m), the input current mostly flows into the water instead of into the ground. This great mass of water in the vicinity of the electrodes is definitely a factor that can disturb the electric field, hence invalidating the resistivity measurements. No conclusions can be drawn from this sounding.

#### Conclusions and recommendation

The resistivity method does not yield definite solutions to an earth layer problem and therefore, the above interpretations must be accepted with caution. For example, a sand layer of 1 m thickness located at depth between 2 layers of thick clay will not be detected by the resistivity survey. The soundings definitely do not indicate that the alluvium beneath the closure is composed of thick homogenous clays. Sand lenses containing brackish water may exist within 5 m of the surface; this contention is supported by the exploratory boreholes in the area (Figure 2.5 and 2.6). Exploratory borehole No.5 indicates an isolated fine/coarse sand layer of 13 m thickness intercalated between two silt layers at 12 m below the surface. This may indicate that there is an isolated sand layer from 10 m onwards as shown by the sounding ES 75. It is therefore suggested that trial/test borings in the vicinity of the closure would be worthwhile.

On the basis of this pattern and known regional changes in shallow aquifer salinity (August Progress Report; Figure 2.5) the following conclusions were made:

Table 2.1

Bore Yields - Setul Limestone, Perlis

## 2.2 Hydrogeology

## 2.2.1 Setul and Chuping Limestones

Drilling work was completed at Mata Ayer early in the report period; MA 3 was completed in the Chuping Limestone aquifer. Pump testing has yet to begin in any area because of the delays in obtaining suitable test pumps but when pumps are available, already completed boreholes in both Setul Limestone (PM 3 and 4) and Chuping Limestone (MA 1, 2 and 3) will be fully pump tested.

A preliminary discussion of the groundwater potential of these limestones in Perlis was given earlier (August Progress Report; Section 2.2.3). Further drilling has been completed by JKR/GDC in both the Setul and Chuping. JKR/GDC apparent bore yield data and similar data from the JPT investigation is tabulated here (Table 2.1 and 2.2) and shown in histogram form (Figure 2.7).

From this quite large sample, it is possible to appreciate the extreme yield variability found in both aquifers. Whilst dry or almost dry bores are quite common, large drilling discharges (>25 l/s) are possible, particularly from the Chuping aquifer. These data will be reviewed when pumping tests have been completed since accurate drawdown discharge data (or the derived specific capacity index) are a much more concrete indicator of bore performance and potential for production.

## 2.2.2 Mardi Bertam

Resistivity survey data indicate large resistivity changes (Figure 2.8) associated with a high resistivity ridge region in the east and south; resistivities progressively decrease to the northwest. On the basis of this pattern and known regional changes in shallow aquifer salinity (August Progress Report; Figure 2.5) the following conclusions were made:

Table 2.1

Bore Yields - Setul Limestone, Perlis

Location	GSM No.	Total depth (m)	Total depth (m)	Apparent* Yield (l/s)	Remarks
Bl. Yempin/Kodiang			755	97.9	0.38
Taman Ular/Kurong Batang	779	45.0	759	39.7	18.92
Taman Ular/Kurong Batang	780	55.5	760	43.4	18.92
Padang Linching/Kurong Batang	781	60.0	762	38.1	1.51
Padang Linching/Kurong Batang	782	30.7	763	49.2	15.13
Taman Ular/Kurong Batang	783	61.7	764	42.0	0.38
Taman Ular/Kurong Batang	784	60.0	767	33.6	0.08
Padang Linching/Kurong Batang	785	49.1	769	36.1	16.65
Kelian/Titti Tinggi	793	49.3	770	30.1	18.92
" " "	794	45.1	771	36.9	7.57
Govt. Forest Reserve/ Kg. Kurong Batang	PM3 1121	84	772	61.3	6.9
" " " "	PM4 1122	88	773	49.3	4.3
Kg. Sentol/Kurong Batang	PM5 1123	102	775	98.0	<0.5
Kg. Bungkas/Kurong Batang	PM6 1124	115	777	55.4	1.8
" " /Baseri			778	43	0.1
Bawah Bukit/Chuping			790	43.7	6.05
" " /Chuping			791	49.0	0.1
Mata Ayer 1			1130	78	20
" " 2			1131	186	-
" " 3			1132	84	3.1
" " 4			1133	60	<2.0

Notes:

\* during drilling/dev.

700 Series bores drilled 1981/82 by GDC/JKR in Kedah-Perlis.

1100 Series bores drilled 1992 by MWP/JPT in Perlis.

Apparent yields are a measure of water blown from the bore during air flush drilling and are not a reliable indicator of production bore yield.

Table 2.2

## DISTRIBUTION OF BOREHOLE YIELDS IN CHUPING

Bore Yields - Chuping Limestone

Location	GSM No.	Total Depth (m)	Apparent Yield* (l/s)	Remarks
Bt. Kepelu/Kodiang	756	97.9	0.38	
Tambun Tulang/Arau	759	39.7	7.56	
Kg. Behor/Arau	760	43.4	18.92	
Arau-Pumping Station	761	38.1	37.83	
" " "	762	49.2	7.56	Pump test max. discharge 5.15 l/s.
" " "	763	42.0	10.22	Pump test max. discharge 10.67 l/s.
Arau	764	33.6	11.35	
Paya Kerchut/Chuping	767	36.1	22.7	
" " /Paya	768	21.9	? 11	
" " /Paya	769	49.9	6.05	
" " /Paya	770	30.1	0	Limestone/Shale
" " /Chuping	771	36.9	22.7	Pump test max. discharge 26.86 l/s.
Govt. Forest Reserve/Chuping	772	61.3	4.01	
" " "	773	49.3	1.36	
" " "	774	98.0	0.07	
Titi Tampang/Chuping	775	55.4	0.76	
Panggas/Chuping	777	40.0	3.78	
" /Chuping	778	49.2	4.54	
Bukit Temiang/Beseri	788	55	3.03	Limestone/Sandstone; ?basal Chuping
" " /Beseri	789	43	0.1	Sandstone; ?basal Chuping
Bawah Bukit/Chuping	790	43.7	6.05	
" " /Chuping	791	49.0	0	
Mata Ayer 1	1130	78	20	
" " 2	1131	186	-	Airlift discharge 7.0 l/s.
" " 3	1132	84	3.3	
" " 4	1133	60	<2.0	

Notes:

\* during drilling/dev.

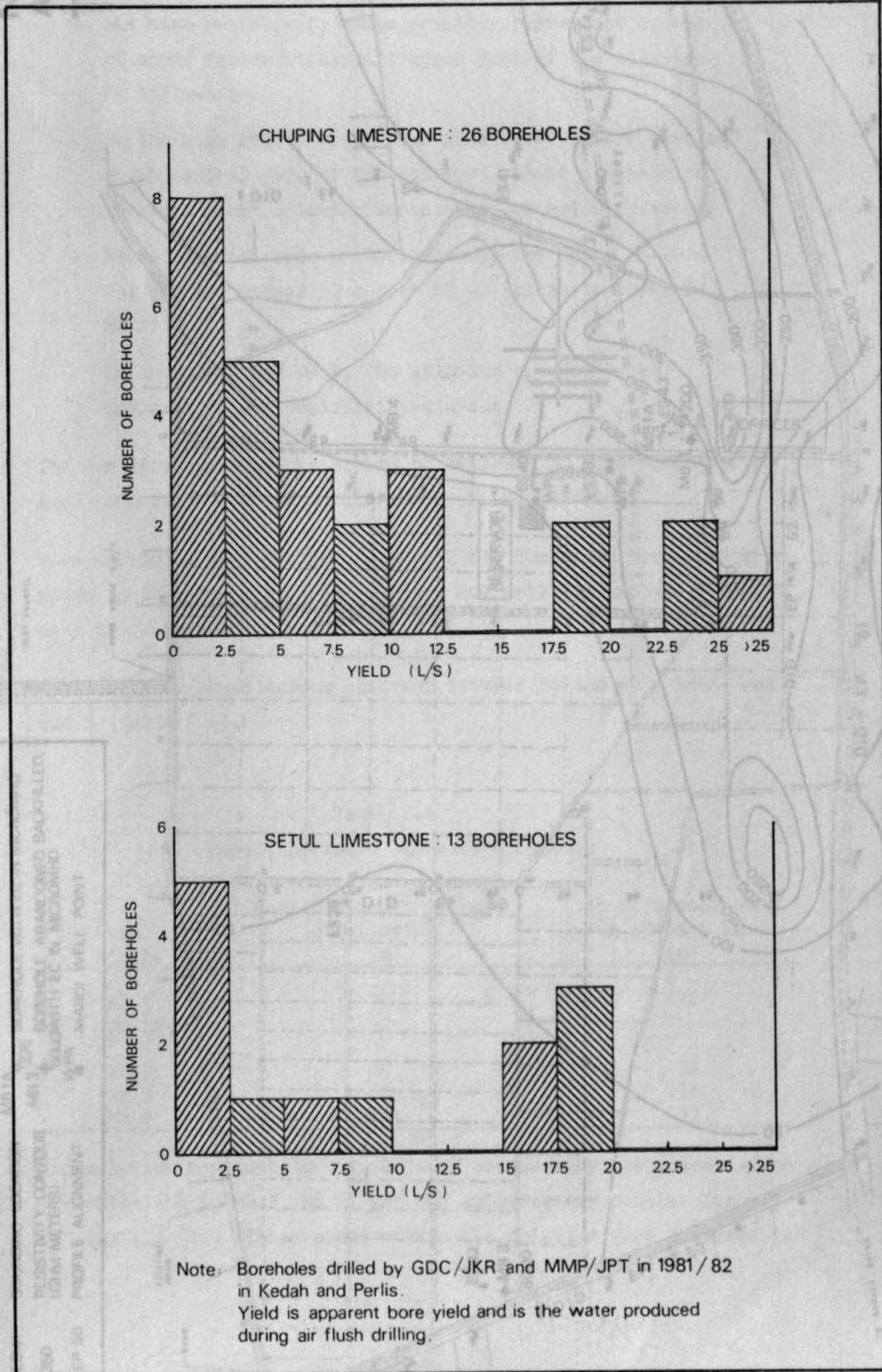
700 Series bores drilled 1981/82 by GDC/JKR in Kedah-Perlis.

1100 Series bores drilled 1982 by MMP/JPT in Perlis.

Apparent yields are a measure of water blown from the bore during air flush drilling and are not a reliable indicator of production bore yield.

Figure 2.7

DISTRIBUTION OF BOREHOLE YIELDS IN CHUPING AND SETUL LIMESTONE





- the high resistivity ridge probably represents a zone of sandy facies within the upper part of the alluvium. It follows that :
- in the high resistivity ridge area (i.e. in the east and south central part of the station), there are beds of coarse grained alluvium containing low salinity water.
- these alluvial beds probably occupy the upper 15-20 m but perhaps exceed 50 m near ES 41 (close to borehole MB 2).
- in the north and west, the alluvium appears to be composed of low resistivity clays.

The resistivity soundings showed no evidence of high resistivity, hard impervious bedrock within 100 m of the surface.

Five boreholes were drilled (Figure 2.8); composite bore logs are given in the Appendix to this report and drilling and yield test data is given below (Table 2.3).

Typically, an argillaceous alluvium between 20 and 40 m thick was cut. (Table 2.4).

Table 2.4  
Mardi, Bertam : Formation Depths

Bore Number	Possible depth to base of alluvium (m)	Top of unweathered Sg. Petani Fm (m)
MB 1 MB 1A	36	42
MB 2	39	56
MB 3	20	78
MB 4	17	37

The alluvium may contain thin beds of coarse sand and gravel up to 3 m thick (MB 1, MB 3, MB 2) yet the alluvium may consist largely of clay (MB 4). These sands within the alluvium were screened in

Table 2.3  
DRILLING AND YIELD TEST DATA

Borehole No. Informal	Total Depth (m)	Aquifer: Target	Static Water Level bgl (m)	Test Date	Discharge (L/s)	Drawdown (m)	Specific Capacity (L/s/m)	Remarks
A 1	55	Alluvium; weathered bedrock	-	3.9.82	*1.5	large	-	EC 2000 Mmhos from 20-25 m aquifer interval. EC 15000 Mmhos from weathered granite below 29 m. Bore backfilled, abandoned.
A 2	41	Alluvium; weathered bedrock	-	8.9.82	*1.8	-	-	Airlift test at 124 m; EC approx. 20000 Mmhos and at 35 m in weathered bedrock; EC approx. 21000 casing withdrawn; bore abandoned. Adjacent drain water EC = 3800 Mmhos.
MB 1	54	Alluvium	-	-	(1.3)	-	-	Low discharge after development. Screens (21-24 m) and 6" casing withdrawn; MB 1A drilled adjacent.
MB 1A	88	Sg. Petani Fm.	1.6	26.10.82	*3.0	14.4	0.21	Production from joint-cracks in Sg. Petani Fm. EC = 200 Mmhos. 6" Ø casing 0-38 m.
MB 2	84	Alluvium and Sg. Petani Fm.	1.76	15.9.82	*3.25	17.2	0.18	0-39 m? alluvium. Crack-joint aquifer in Sg. Petani meta shale and sandstone. EC = 275 Mmho. PT. 6" Ø casing 0-60.5 m.
MB 3	79	Alluvium and Sg. Petani Fm.	-	-	(5.5)	-	-	0-20 m? Alluvium. Crack-joint aquifer in Sg. Petani Fm (meta shales and sandstones); EC = 8000 Mmhos. Casing withdrawn; bore abandoned.
MB 4	100	Sg. Petani Fm.	-	-	(0.7)	-	-	0-17 m alluvium; low permeability. Very low drilling discharge during drilling of Sg. Petani Fm. Casing withdrawn; bore withdrawn.
BP 1	97	Eluvium- coastal alluvium	1.0	4.10.82	*3.8	18.31	0.21	Screened 40-49 m (2 mm slot WwRb). EC = 85 Mmhos. PT.
BP 2	101	Eluvium- coastal alluvium	1.9	15.10.82	*5.5	14.5	0.38	Screened 42.5-45.5 m (1.1 mm slot WwRb) and 51-54 m (2 mm slot WwRb). EC = 100 Mmhos. PT.

\* Air lift test data.  
(5.5) drilling discharge  
PT to be pump tested

MB 1, and the screened zone developed and air lift tested with a very low yield (Table 2.3). Screen and casing was withdrawn from MB 1 and the bore abandoned. It is concluded that the permeability of these sands, themselves within an argillaceous alluvium, is much reduced by interstitial clay content. Comparison of lithologic logs between MB 1 and MB 4 further indicate these alluvial sands and gravels to be laterally impersistent.

Because of these low yield characteristics, the alluvium, and the soft, weathered Sg. Petani rocks below it, were cased off and bores drilled deep to investigate the aquifer characteristics of the Sg. Petani Formation. This formation is a folded, slightly metamorphosed sequence of shales and fine tough grey sandstones, often soft and weathered (Table 2.4). Intergranular porosity within the sandstones is low yet the formation yields water to boreholes through open cracks and joints in both sandstone and shale sections. The potential of this hard rock aquifer is thought to be somewhat greater than the alluvial aquifer in the area. Bore yields, whilst rather low (Table 2.3), may be sufficient to irrigate nursery and vegetable operations at the Mardi Station (MB 1A, MB 2) but yields are quite inadequate for the padi irrigation planned in the north west area.

Salinity in the bedrock aquifer is low except in the west (MB 3) where an extremely high salinity was detected (EC = 8,000 micromho). Salinity distribution in the Sg. Petani aquifer appears to show concordance with the resistivity contour map discussed earlier. (Figure 2.8). Low salinities are associated with apparent resistivities exceeding 150 ohm.m whilst at MB 3, an electrical conductivity of 8,000 micromho seems clearly to be reflected in the very low resistivities recorded in the western area.

It must be concluded that the high resistivity ridge, detected by resistivity methods, is a reflection principally of groundwater salinities in the Sg. Petani bedrock. It appears unrelated to the lithology of the bedrock and cannot confidently be related to sandy lithologies in the alluvium. The ambiguities in the resistivity results can be explained by the difficulty in separation of fluid salinity and lithology in determining apparent resistivities. Now that some borehole control is available, some further geophysics work seems warranted.

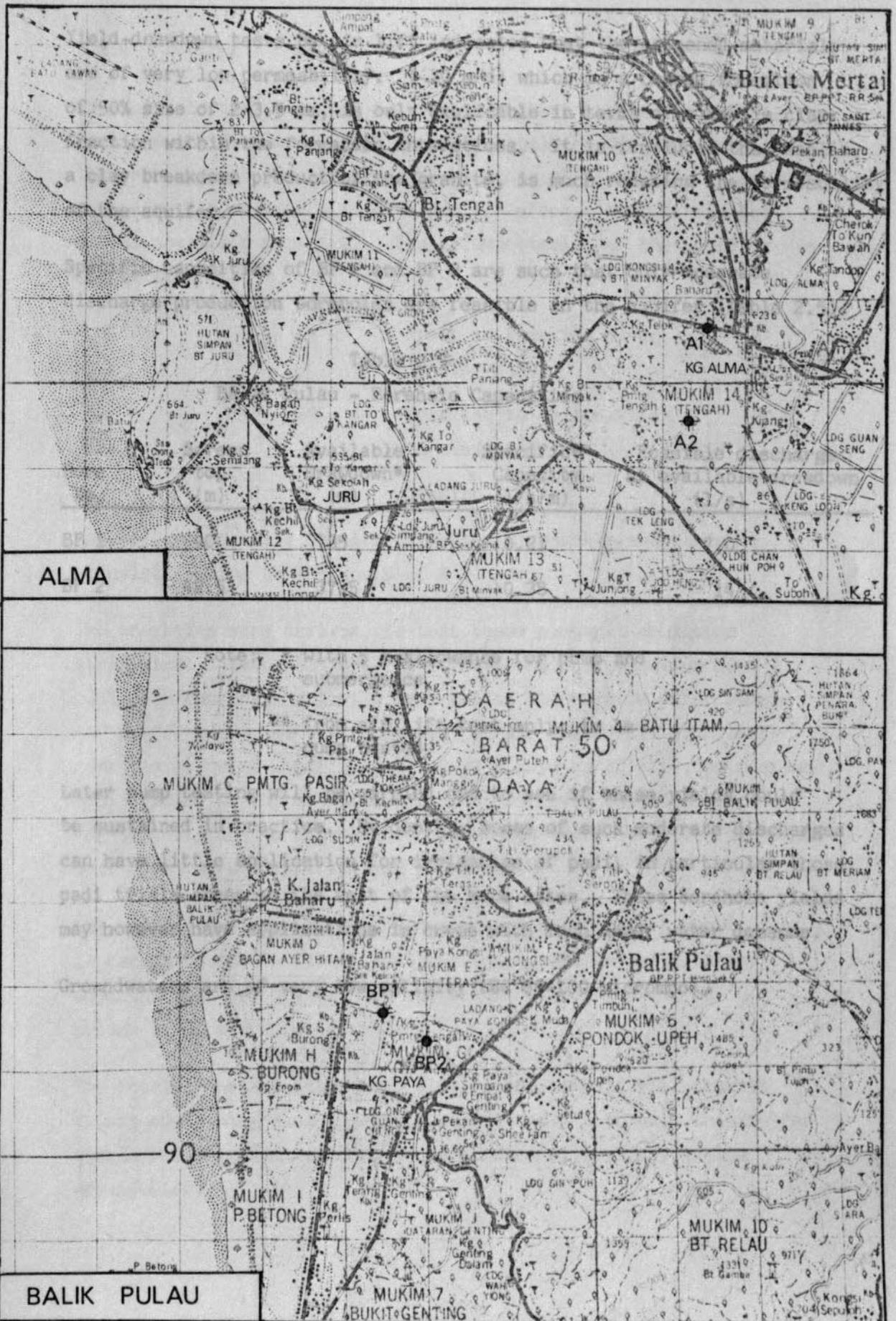
It is planned to pump test MB 1A and MB 2, to determine draw-down-discharge characteristics and hence to advise Mardi on a possible production pump. Groundwater salinity will be checked during the pump test, in view of the high groundwater salinities in the region of MB 3.

### 2.2.3 Balik Pulau

Resistivity surveys in the Balik Pulau region of Penang Island had delineated those areas of eluvium/alluvium more likely to contain fresh groundwaters and to be of sufficient thickness for exploitation by boreholes. Likewise, areas probably underlain by saline groundwaters, on the coast and in the north, were eliminated from further investigation. Specific alluvial targets were indicated in the Mukim Sg. Paya area, to the southwest of Balik Pulau town (Figure 2.9) and two boreholes were drilled there. Drilling and yield test data are given (Table 2.3); the bores were yield tested by air lift but await pumping tests.

Boreholes BP 1 and BP 2 cut some 76 m and 67 m respectively at alluvial/eluvial material before entering highly weathered granitic bedrock. On evidence from gamma logs and lithologic cutting samples, wire wound rod based screens were chosen to allow natural development of the well graded coarse sand-fine gravel formations. Prolonged development of the screen-formation zone with air lift water jetting and surging, was carried out to avoid any screen blockage and hence to allow a permeable natural filter zone to develop.

Figure 2.9 BOREHOLE LOCATIONS: ALMA AND BALIK PULAU



Yield-drawdown tests by air lift indicated that the screened materials are of very low permeability. (<10 m/d) which in a coarse formation of 50% size of 2-3.5 mm, is only explicable in terms of a kaolin clay fraction within the formation interstices. It is concluded that kaolin, a clay breakdown product of the granite, is much reducing the permeability of the aquifer.

Specific capacities of BP 1 and BP 2 are such that only moderate discharge production boreholes are feasible in the aquifer (Table 2.5).

Table 2.5  
Balik Pulau - Borehole Capacities

Bore No.	Screen top (m)	Available Drawdown* (m)	Specific** Capacity (l/s/m)	Possible discharge at available drawdown (l/s)
BP 1	40	35	0.21	7.0
BP 2	42.5	37.5	0.38	14

Note: \* with 5 m allowance for pump and submergence  
\*\* from air lift test only; to be pump tested.

Later pump testing will be carried out to see if these yields could be sustained in practice. Evidently, bores of such moderate discharges can have little application for irrigation of padi, in particular those padi trials areas to the west of the bore sites. These borehole yields may however have applications in crops with much lower water demands.

It cannot be due to direct infiltration of saline water since Groundwaters are of very low salinity (EC 85-100 micromho).

around 3,000 micromho.

The conclusions are that about 4ms, a shallow alluvial deposit exists containing sand layers between 2 and 7 m thick. The aquifer within the alluvium is, however, saturated with highly saline groundwater.

#### 2.2.4 Alma Programme

This largely derelict area is to the southwest of Kg. Alma and contains polluted drains and a supply canal (Figure 2.9).

The area was briefly investigated by means of a resistivity sounding adjacent to bore site A 1 and a profile along a bund stretching to the southeast from A 1. The interpretation of the sounding was as follows:

0 - 15 m	Fresh to brackish water in clay-sand
15 - 20 + m	Brackish to saline water in clay-sand
20 + m	Granite

However, the profile results suggested a possible much thicker alluvial section to the south of A 1.

Two boreholes were drilled, to test these somewhat ambiguous geophysical interpretations. A 1 proved 26 m of alluvium over a weathered bedrock; whilst a very saline bottom hole water sample (EC 20,000 micromho) was recovered, an air lift drill stem test over the alluvial sand interval 20-25 m gave an EC of 2,000 micromho. A 2, drilled to the south, cut 31 m of alluvium over bedrock; the salinity of the alluvial aquifer sands exceeded 21,000 micromho. Both bores were backfilled and abandoned.

The reasons for such high groundwater salinity are not known. It cannot be due to direct infiltration of saline water since adjacent polluted drains have electrical conductivities of around 3,000 micromho.

The conclusions are that about Alma, a shallow alluvial deposit exists containing sand layers between 2 and 7 m thick. The aquifer within the alluvium is, however, saturated with highly saline groundwater.

### 2.3 Drilling Programme

A comparative lack of success of the programme in proving high yielding aquifers was recently considered in the context of budgetary constraints. Accordingly the drilling programme was reviewed and it was decided to continue but as a 1 drill rig operation. At the same time, certain areas were reduced in priority or indefinitely postponed (e.g. the Melaka areas) whilst during negotiations between JPT and the Fisheries Department, it had been concluded that only one drilling investigation at a PP 1 station would be carried out; planned work at Tapah and Tanah Rata has been cancelled.

Previously scheduled work in Kelantan and Trengganu is expected to proceed. However, JPT anticipate that the Groundwater Section may carry out the groundwater investigation component of the Kemasin-Semerak (KS) project in Kelantan. If this is approved, then KS project work will perhaps continue concurrently with area investigations already planned.

The latest tentative programme is given (Figure 2.10).

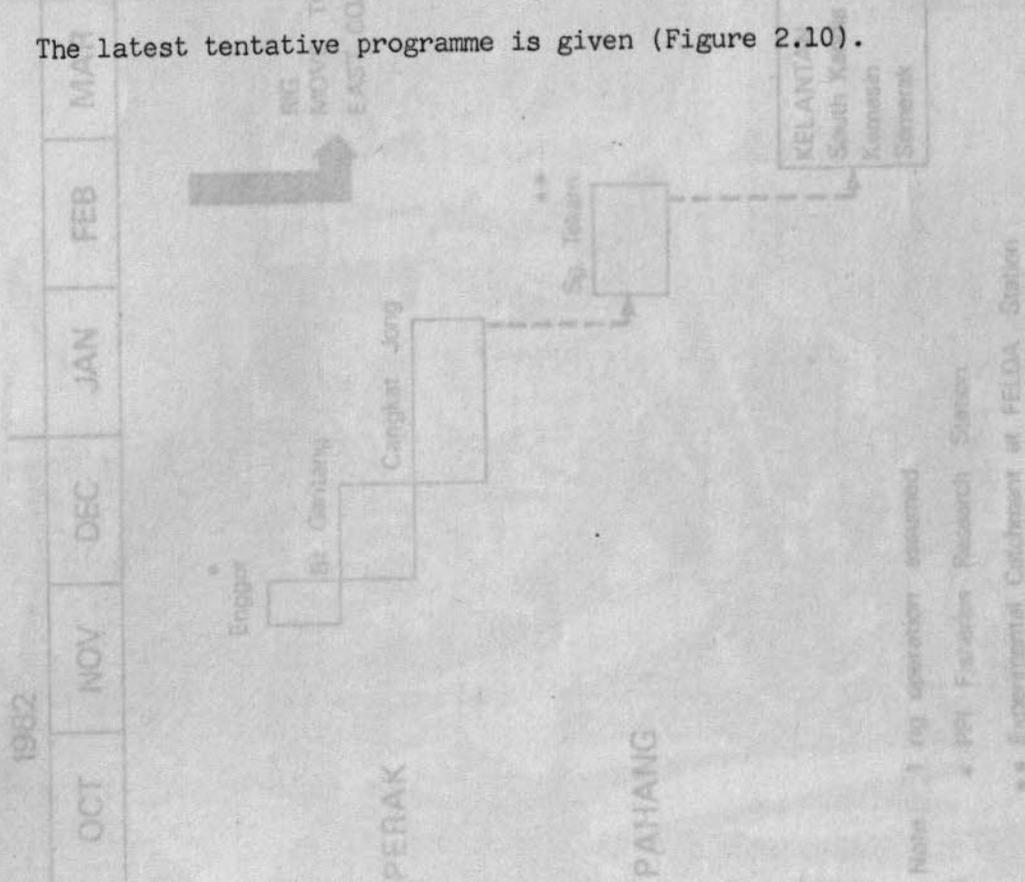
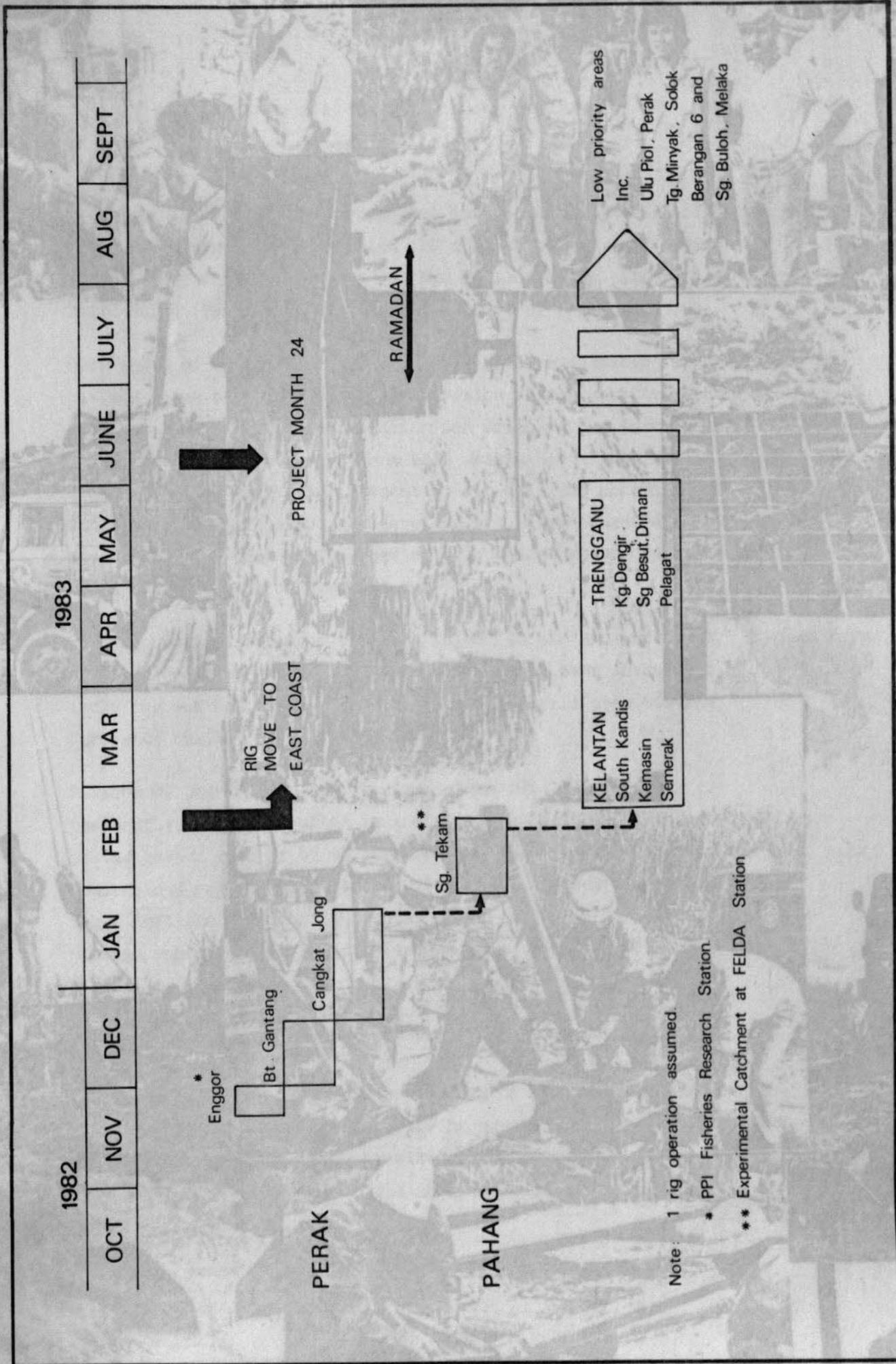
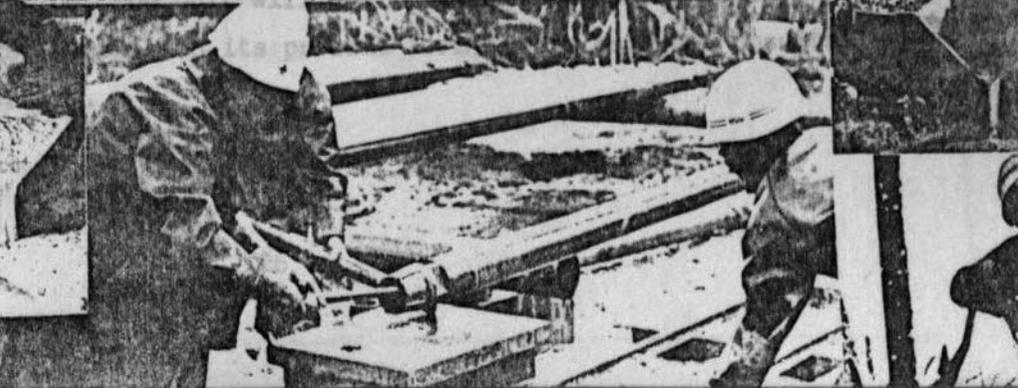
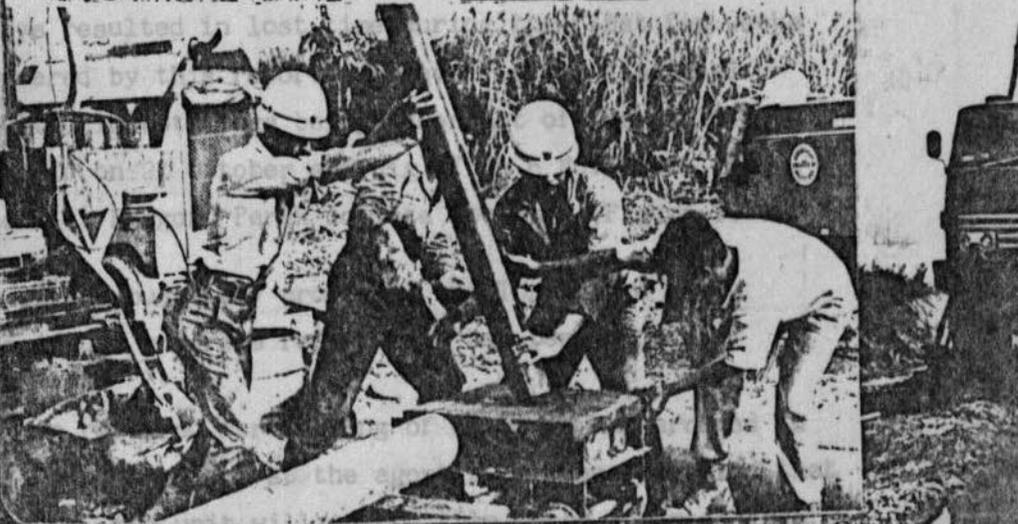
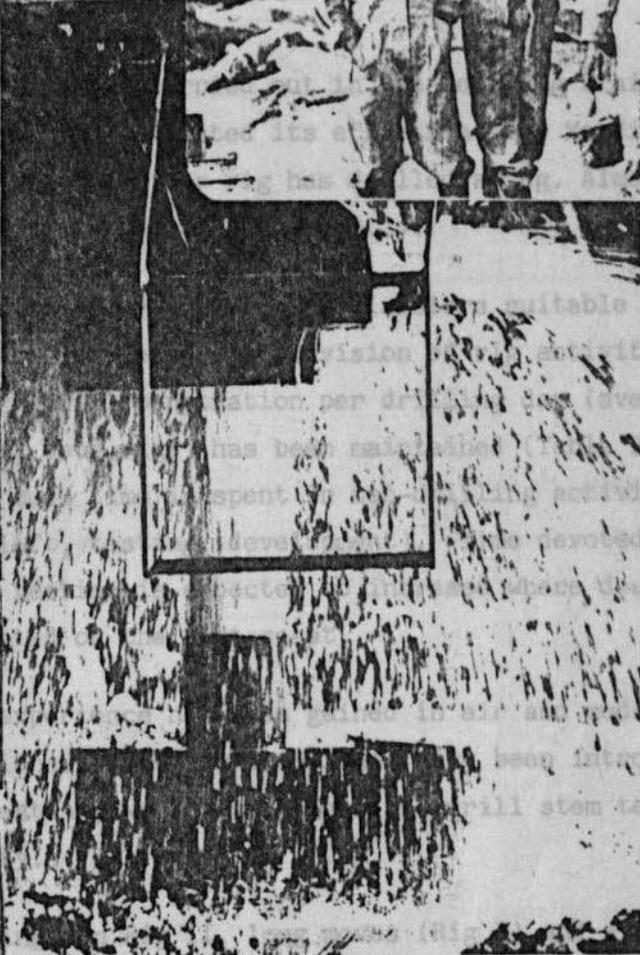
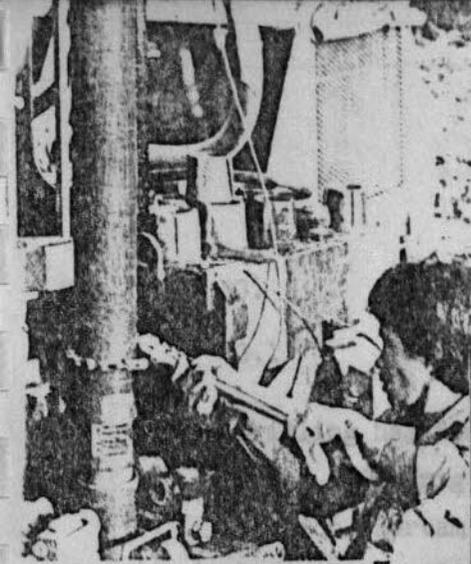


FIGURE 2.10 TENTATIVE PROGRAMME OF RIG OPERATION.





# DRILLING PROGRESS

## 3. DRILLING

### 3.1 Introduction

1 9 8 2

AUG	SEPT	OCT	NOV	DEC
-----	------	-----	-----	-----

Drilling has been mainly carried out in the Seberang Prai and Penang areas. One rig has concentrated its efforts at the Mardi research station, Bertam and the other rig has drilled at Kg. Alma and at Balik Pulau (Penang Island). (Figure 3.1).

Over 550 m of exploratory drilling at diameters suitable for 6" casings, have been completed. Subdivision of rig activities indicates that satisfactory drill penetration per drilling day (average 17.3 m per drilling day, both rigs) has been maintained (Table 3.1). The data do indicate how much time is spent in non-drilling activities (i.e. rig moves, air lift, testing, development). Time devoted to bore development and testing is expected to increase where deep alluvial bores are completed on the east coast.

Further useful experience has been gained in air and mud flush drilling operations. Some new techniques have been introduced including mud testing, well development and drill stem testing for water quality.

Failure of bearings on Rig II, long moves (Rig I) and site preparation delays resulted in lost time during the first few weeks of the period covered by this report. However later, financial constraints resulted in both rigs being taken out of the field. Rig I left the field on 21 October and Rig II on 6 November. Rig I resumed operations at Enggor, Perak in late November (Figure 3.1).

Because perhaps of the budgetary problems, the Tone spare parts mentioned in the August progress report have not been ordered.

The small test pump required for testing of 6" bores has arrived in K.L. An inspection of the pump at the agent's premises revealed that without modification, the unit will not be able to be inserted in 6" diameter casings and that in its present form, it is somewhat unsuitable for borehole testing.

△ At JPT Workshops Ipoh, cooling system modification

# DRILLING PROGRESS

Rig Utilisation

Function/Activity

August

September

October

November

RIG I (WAC 1007)

1 9 8 2

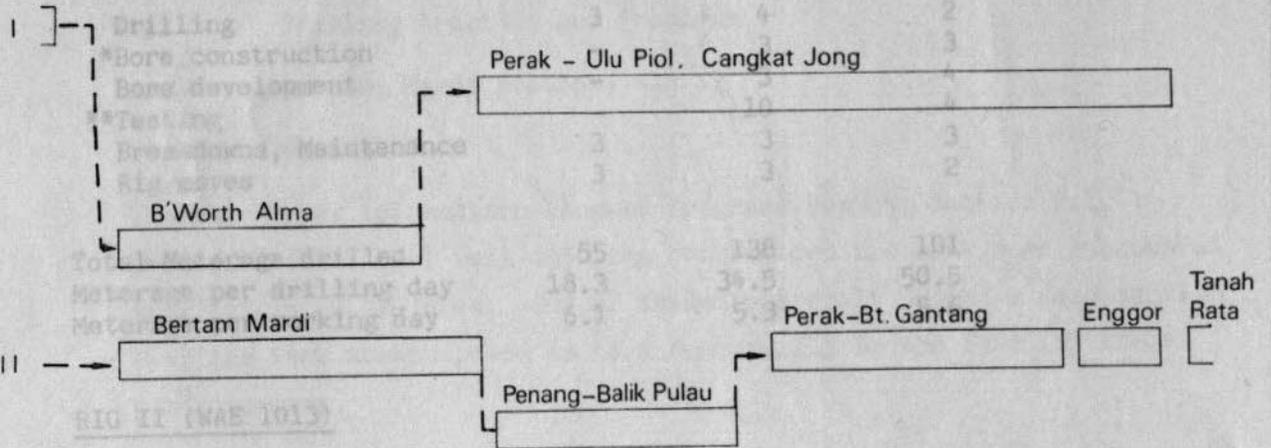
AUG	SEPT	OCT	NOV	DEC
-----	------	-----	-----	-----

Working days

9

26

18



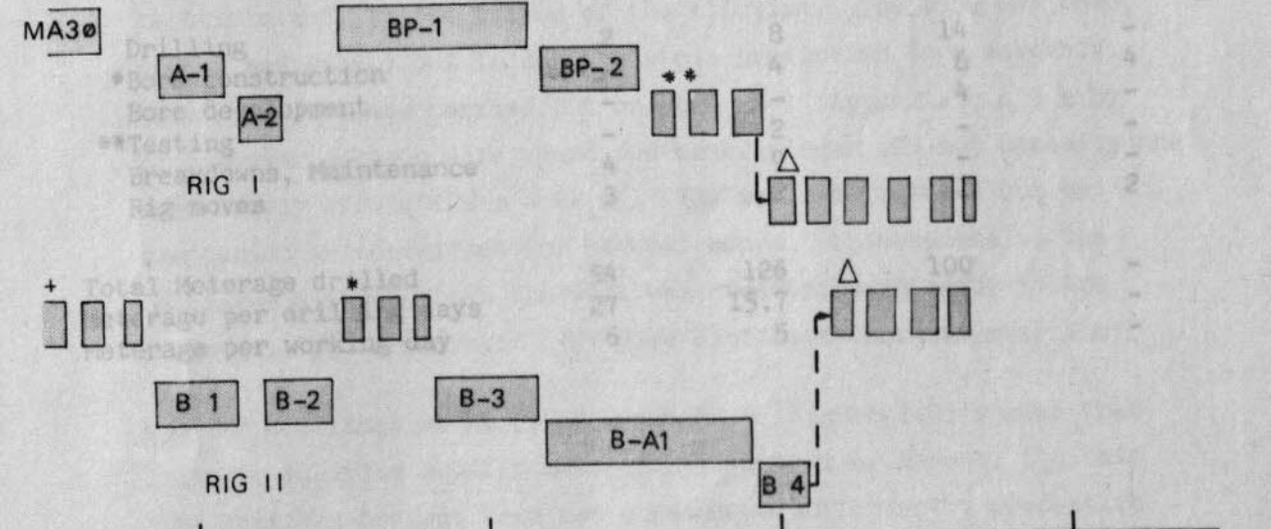
RIG II (WAC 1013)

Rig on site  
Holidays, w/e  
Working days

11

30

31



Legend:

- Tentative Programme, (Aug. Progress Report, Fig 2.13)
- Progress, to 20.11.82
- \* Transfer - gear box failure, repair
- + JPT Jitra-clutch flywheel failure, repair
- \*\* Standing at Cangkat Jong
- △ At JPT Workshops, Ipoh, cooling, system modification
- MA Mata Ayer, Perlis
- A Alma
- B Mardi Bertam
- BP Balik Pulau

Table 3.1  
Rig Utilisation

Function/Activity	August	September	October	November
<u>RIG I (WAC 1007)</u>				
Rig on site	11	30	21	
Holidays, w/e	2	4	3	
Working days	9	26	18	
Drilling	3	4	2	
*Bore construction	-	3	3	
Bore development	-	3	4	
**Testing	-	10	4	
Breakdowns, Maintenance	3	3	3	
Rig moves	3	3	2	
Total Meterage drilled	55	138	101	
Meterage per drilling day	18.3	34.5	50.5	
Meterage per working day	6.1	5.3	5.6	
<u>RIG II (WAE 1013)</u>				
Rig on site	11	30	31	6
Holidays, w/e	2	5	6	-
Working days	9	25	25	6
Drilling	2	8	14	-
*Bore construction	-	4	6	4
Bore development	-	-	-	-
**Testing	-	2	-	-
Breakdowns, Maintenance	4	9	-	-
Rig moves	3	2	1	2
Total Meterage drilled	54	126	100	-
Meterage per drilling days	27	15.7	7.1	-
Meterage per working day	6	5	4	-

Note: Data for August 21 to November 20. Rig I finished sitework 21 October, Rig II finished site work 6 November.

- \* Includes welding casing and gravel packing.
- \*\* Includes air lift testing and logging.

Parts arrived from Tone (Japan) for the conversion of the rig hydraulic cooling system. The work is being carried out in JPT workshops, Ipoh. One rig has been completed and field tests show that whilst superior cooling efficiency has been achieved, there is a rise in plunger pump (gear end) hydraulic pressure.

### 3.2 Drilling Practice and Problems

#### 3.2.1 Bertam; Mardi Station: Rig II

General Initial survey information (August Progress Report; Section 2.1.4) indicated that local well drilling contractors had sunk some successful well points in the area. One of these apparently tapped a sand section near the farm workshop and is used continually by the farm for their plant nursery.

On the basis of this information and the resistivity results, our drilling methods were designed to first drill a pilot hole, with bentonite mud, to the bottom of the alluvium. The bore was then, logged and reamed out to accommodate a production bore assembly. This procedure was carried out on bore MB 1 (Appendix); a 3 m by 6" diameter Johnson wire wound rod based screen was set opposite the most likely strata (21 m - 24 m). The well was cleaned out on completion and developed for several hours. Unfortunately, the discharge was such that the well was considered inferior to the crude well point nearby! (2" pipe slotted by hacksaw over 2 m).

Further drillings at MB 2, MB 3 and MB 4 (Figure 2.8) showed that suitable alluvium aquifer materials were thin or absent; the thin sand sections present were not considered sufficiently productive to justify bore conversion to a production bores.

Bores MB 2, MB 3 and MB 4 were therefore drilled below the alluvial section (which was cased off) into the hard rock Sungei Petani Formation which proved to contain an impersistent crack based aquifer. Later, MB 1 was abandoned and the adjacent MB 1A completed in the Sg. Petani rocks.

#### Problems - Alluvium.

The drilling of the alluvium presented no problems in itself.

All holes were drilled using the mud flush technique and care was taken to ensure the bore was filled at all times with mud.

This procedure prevented any caving due to insufficient hydrostatic support. However, the first 30 meters of the first bore, MB 1 was drilled with a mud which was too viscous with the result that samples were contaminated with sand which was being re-circulated around the system. Fortunately, the problem was recognised and a 'mud test kit' was borrowed from J.K.R. Measurement of mud weight, viscosity and sand content allows the make up of a mud having suitable properties, without guess work. In this case, the mud viscosity was changed from 53 seconds to 37 seconds and the sand was then able to drop out of the mud into the channels before reaching the pump suction pit.

into rockhead and the bore was continued a further 30 m in granite.

#### Problems - Hard rock.

drilling, the bore did fill up over a weekend. The water was later  
The lower, hard rock Sungei Formation was drilled mainly by using

air flush with either rock roller bit or Down-the-Hole Hammer (DTH).

The formation generally consists of alternating bands of sandstone and shale, possibly steeply inclined.

The formation was rather more difficult to handle than the stratified sedimentary rocks encountered previously in Kedah and Perlis possibly because the shales were softer than those found in the northern states and because the sandstone interbeds contributed a slight amount of water; these characteristics probably caused stickiness within the bore. Since neither a large volume of air was available to continuously flush the bore clean, nor water injection available during drilling, narrowing of the bore (necking or collaring) occurred which created back-pressure on the DTH exhaust. The result was very slow penetration rates. Only a larger compressor and water injection pump can avoid this type of problem.

Bore MB 1A was cased into what was thought to be competent rock. However wetting and erosion caused the shale section below the base of the casing to cave. The bore eventually had to be lined with a perforated drop-set made from 4" galvanised pipe (Appendix).

In a hard rock bore completion, the casing used to seal off the upper alluvium must be firmly set into competent hard rock. However, where such a casing is set too deeply into hard rock, there is the danger that it may seal off good aquifer material in the weathered hard rock zone.

### 3.2.2 Alma : Rig I

At Alma bore A 1, 29 m of alluvium was cut; the alluvium contained a reasonable thickness of sand. Six inch temporary casing was inserted into rockhead and the bore was continued a further 30 m in granite. Although the hard rock section of the bore did not yield water during drilling, the bore did fill up over a weekend. The water was later discharged and sampled; electrical conductivity (EC) was 20,000 micromhos.

A procedure termed drill stem testing was then carried out in the bore. This can be used where aquifer salinity is suspected and where some confirmatory test can perhaps avoid the need to construct and pump a screened bore. A 5.5 m length of slotted 6 5/8" o.d. casing, complete with bottom plug, was positioned opposite the aquifer sand. The slotted pipe is usually lowered down on drillpipe, but in this case, temporary casing was used instead. Any water entering the screen, after the drilling mud is removed, is then airlifted out for sampling. Initially, EC was about 3,500 micromho; it then stabilised at about 2,000 micromho. The bore was then abandoned because of the rather brackish water present. A second bore (A 2) was drilled but this penetrated less deeply into the granite. Drill stem testing was used to sample two separate aquifers; both showed high salinities and the bore was abandoned.

With care, the drill stem test can be performed at any depth but different methods of sealing the upper hole from the test zone may have to be adopted to avoid 'mixing' of water from different aquifers. The method adopted, whereby a 6 5/8" O.D. slotted pipe is run into a 7 3/8" O.D. hole, depends on the collapse of the aquifer sand against the pipe. A different approach may be needed on more consolidated aquifers (Figure 3.2).

### 3.2.3 Balik Pulau; Penang Island : Rig I

The two exploration bores at Balik Pulau (BP 1, BP 2) encountered about 90 m of poorly consolidated alluvial and granite residual material; each bore was converted to a test production well of 6" diameter.

A drill stem test was performed on MB 1. After sampling, the drill stem assembly was found to be stuck but was released fairly quickly by jacking out.

Both bores were equipped with rod based wire wound screen and were designed for natural gravel pack. However, a fine gravel was introduced into the annulus above the screen zone (formation stabiliser) so that clay from upper formations could not fall down the bore annulus and block the screen.

A high velocity jetting tool, fitted with four 4.7 mm diameter nozzles, was used in conjunction with the rig compressor to develop each screen. A system of rotary jetting of high pressure air against the screen not only cleans each slot but will allow debris to pass through the screen and blast off formation wall cake (deposited as a result of using bentonite), and vigorously agitate the surrounding formation. At the same time, finer elements within the surrounding formation are removed by the airlift system. Occasionally during the process, and for a longer period afterwards, the jetting tool was withdrawn in the blank upper casing and the bore pumped by airlift; this assists in creating a stable natural gravel pack.

### 3.2.4 Miscellaneous drilling problems

#### Drilling mud to Records

An awareness of the functions and properties of drilling mud is necessary if down-hole trouble is to be avoided. When electric logging of bore Balik Pulau No.1 was attempted, it was found that bore caving had taken place and the logging could not be performed. Simple cleaning of the bore was not possible due to hole enlargement and therefore, 20 m of 8" diameter casing had to be reamed down and the drilling mud re-conditioned; the logging could then be carried out.

Doubtless, the initial caving was caused by the pulling out of the drill pipe from the pilot hole without the bore being filled with mud to the surface at the same time. The loss of the excess hydrostatic pressure on the formation is particularly serious when unconsolidated sediments are associated with a high water table.

#### Drilling Site Records

The keeping of accurate records of all site operations is most important. The construction of a borehole is expensive and it is imperative that a good permanent record of the bore remain. Where records are incomplete, not taken or lost, it is difficult to assemble any worthwhile bore log. Furthermore, decisions regarding bore conversion to test-production status can only be made on the basis of accurate site records. All site staff concerned should therefore keep a diary record. General responsibilities are shown (Table 3.2).

### 3.3 Training

Practical field training has recently included drill stem testing, drilling mud measurement and control, well construction using wire wound rod based screens and well development. Talks have also been given on these subjects at the Ampang office.

Table 3.2

Site Records

Staff designation	Records to be kept.
Chief driller, driller	Driller log, penetration rate, bit record, casing record, water cut, mud loss, mud viscosity, weight.
Technician, hydrogeological staff (assisted by drilling staff)	EC measurements with depth, time during drill stem tests. EC and drawdown measurements with times during airlift or pumping tests. EC measurements of discharge during drilling. V-notch weir discharges during air drilling. Down-hole geophysical logs (with log settings, scales, depths, fluid levels, casing, etc).
Lithologic sample descriptions.	
Sieve analysis of sand and gravel aquifer materials.	

The table shows the primary responsibilities in record keeping between technical hydrogeological and drilling staff. Inevitably, there is overlap and mutual assistance. Generally, records (or at least a copy) should be available on site until the bore is complete.

3.3 Training

Practical field training has recently included drill stem testing, drilling mud measurement and control, well construction using wire wound rod based screens and well development. Talks have also been given on these subjects at the Ampang office.

Some project staff were able to attend a one day seminar given by UOP Johnson screen on 15 September, 1982. The Seminar, although given by a commercial concern, was a useful treatment of basic drilling, hydrogeology and well design. In late September, some senior JPT staff attended a seminar on drilling and well hydraulics given by Geological Survey of Malaysia in conjunction with JKR. Subsequently a visit was paid by JPT groundwater staff to GSM drilling sites close to K.L. Discussions were held on GSM drilling and cementing techniques and equipment.

### 3.4 Equipment

#### 3.4.1 General

Normal servicing has been carried out, including rig and chassis oil changes. Hydraulic filters (line) have been changed but stocks of spare filters are now very low. Two bearings on Rig II transfer box (compound case) failed and have been replaced. The booster (mini pack) on the Isuzu rig truck clutch has been changed on the same rig. Both rigs were taken to the Ipon workshops at the beginning of November where conversion of the rigs' hydraulic cooling systems is being carried out. A radiator and fan arrangement will be substituted for the water cooled system originally supplied. A list of minor defects and repair requirements has been drawn up. Minor defects and repairs on the rigs were identified. These have been remedied by the rig crews whilst the rigs have been standing at Ipoh.

By mid-September, the rigs were geographically separated by a substantial distance, between Penang Island and Bertam (Figure 3.1). This separation showed clearly the considerable problems inherent in sharing a supply truck and a welding set between two sites.

Subsequently, JPT workshop Ipoh agreed to loan an extra truck and welding set; these arrived on 8.10.82. This extra equipment would have particularly suited the programme projected for October and November during which the concurrent operations were proposed both near Telok Intan and in Taiping (August Progress Report; Figure 2.13).

The continuing depletion of the small stock of Tone hydraulic spares is a serious problem. Whilst all parties agree that such spares are required, recent financial constraints may further delay the purchase of such spares. Isuzu agents have still been unable to supply the air ducting pipe required to join the air filter assembly to the Isuzu truck engine. The engine has been running for some weeks without the assembly and some reduction in engine life is anticipated. It is now proposed that JPT workshop, Ipoh will fabricate the required air filter ducting.

### 3.4.2 Pumps

There is a requirement for 2 test pumps, one capable of insertion within 6 inch i.d. casing, the other and bigger pump capable of insertion within 10 inch i.d. casing. Discharge-head ranges envisaged are approximately as follows:

6" pump	2-12 l/s over total heads of 30 to 5 m respectively
10" pump	10-60 l/s over total heads of 30 to 5 m respectively

A test pump should ideally allow the following:

- ready adjustment over wide discharge range (by engine speed or valve)
- capable of rough treatment during frequent installation and use for bore development with consequent sand pumping
- easy ingress of electric water level sonde into the annulus between pump column and casing (minimum 1" annulus).

A small pump, a Grundfos BP 45-4 belt-drive lineshaft has been purchased and whilst the pump largely meets the discharge-head requirements, it's suitability as a test pump is problematic for the following reasons:

- pump head drive is by flat belt which is not an ideal system where engine speed (and hence belt tension) is to be varied
- pump diameter over its suction inlet/strainer is about 6.5 inch and will therefore have to be replaced before the pump will fit a 6 inch casing
- the diesel engine is without a clutch
- outside diameter of pump column pipe is about 5.1 inch (129 mm) and the resultant annulus of 12.5 mm is quite inadequate to allow passage of an electric measuring sonde. During testing the water levels will therefore need to be measured with a somewhat inaccurate airline system.

The BP 45-4 is next month to be commissioned by the supplier in a 6" JPT borehole.

Specifications for a larger test pump, suitable for installation into 10 inch diameter casing, are now being prepared. It is initially intended to operate such a pump on the 10 inch boreholes at Mata Ayer (MA 1-3).

Orifice discharge measurement systems for both pumps are being fabricated by JPT workshops, Ipoh, where a pump installation tripod has already been fabricated.

# APPENDIX

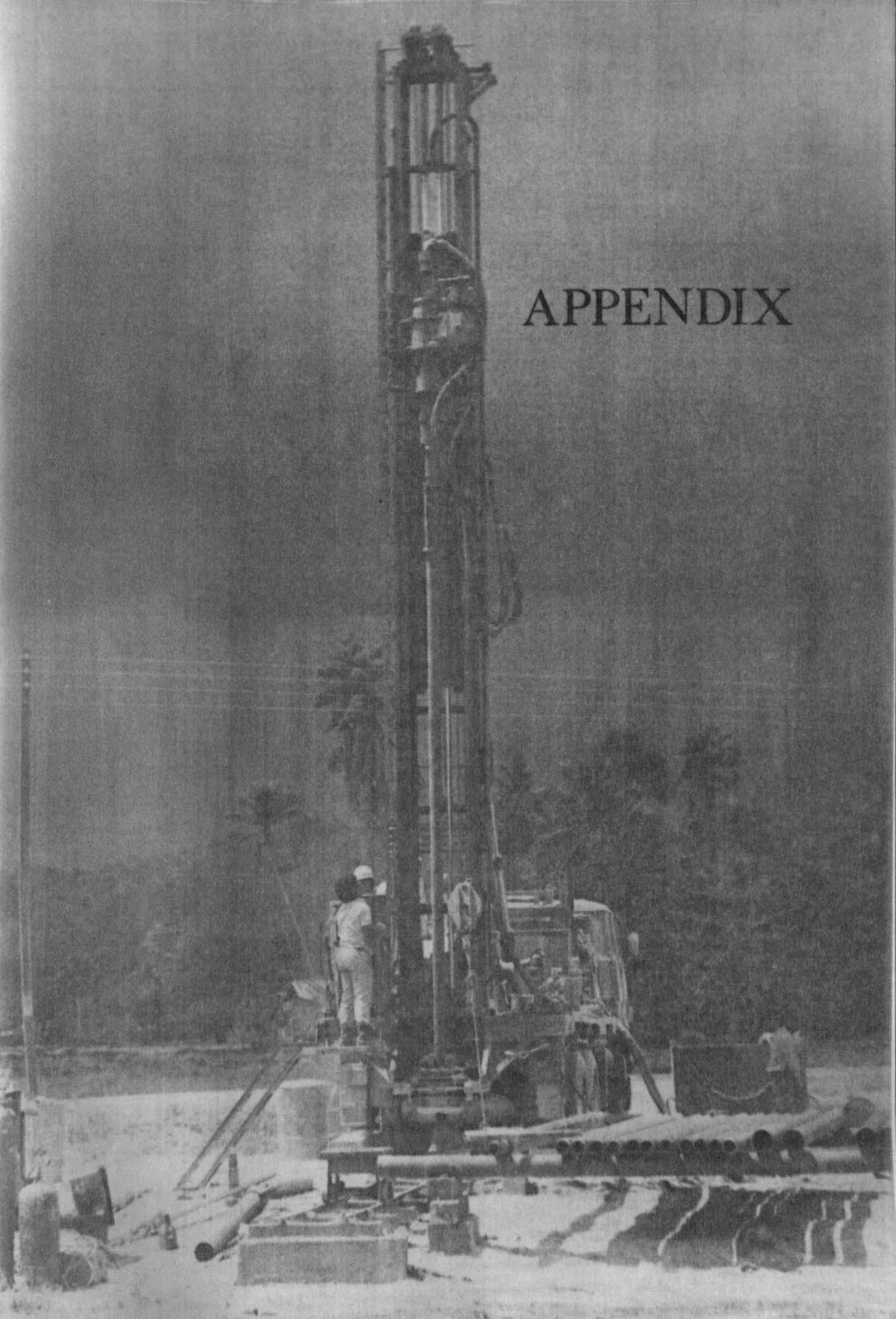


FIGURE 3 2 DRILLSTEM TEST APPARATUS AND METHODS

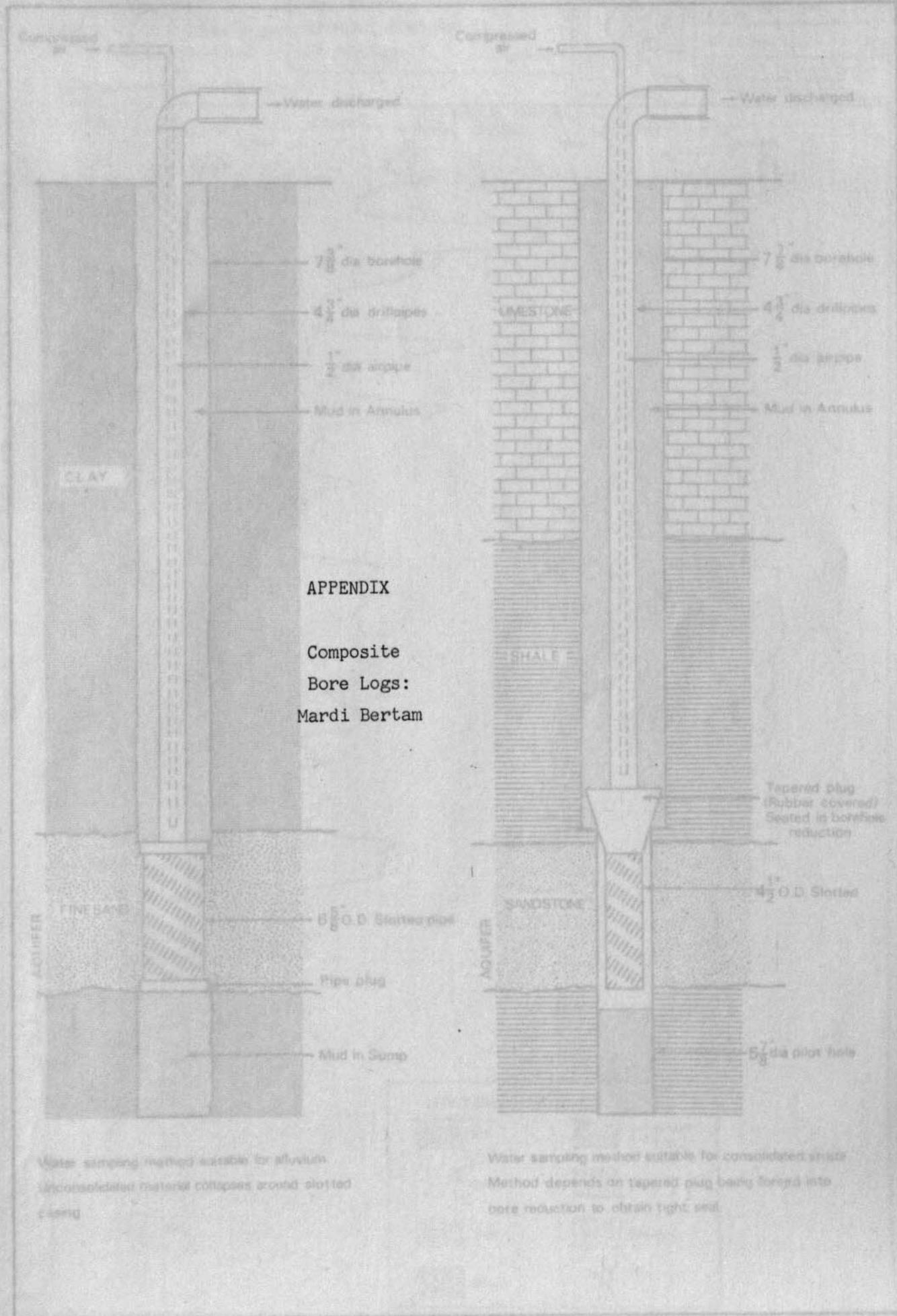
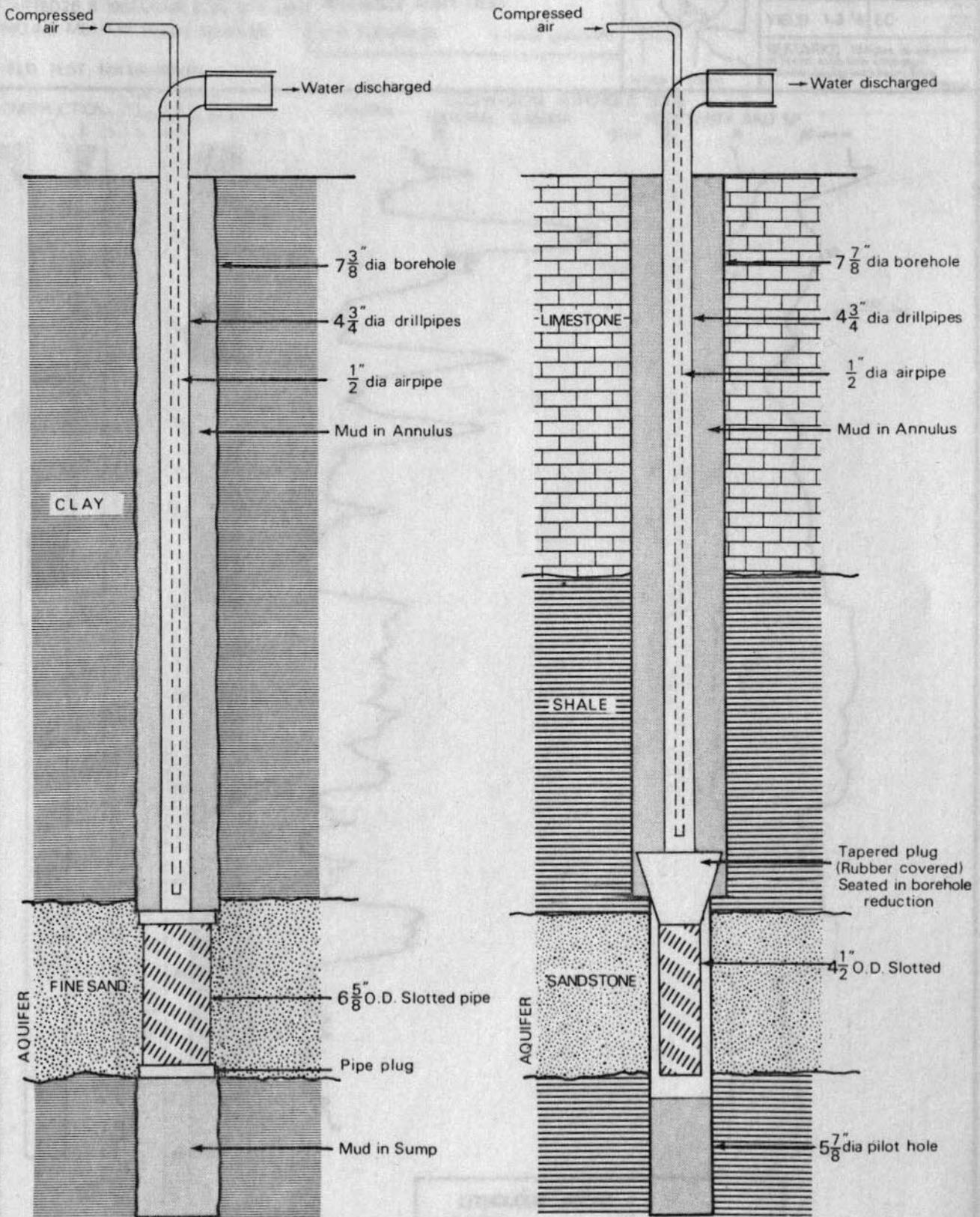


FIGURE 3.2 DRILLSTEM TEST APPARATUS AND METHODS



Water sampling method suitable for alluvium.  
 Unconsolidated material collapses around slotted casing.

Water sampling method suitable for consolidated strata.  
 Method depends on tapered plug being forced into bore reduction to obtain tight seal.

# COMPOSITE BORE LOG

TOPO SHEET 16 Sungai Petani



## MB 1 GS 1136

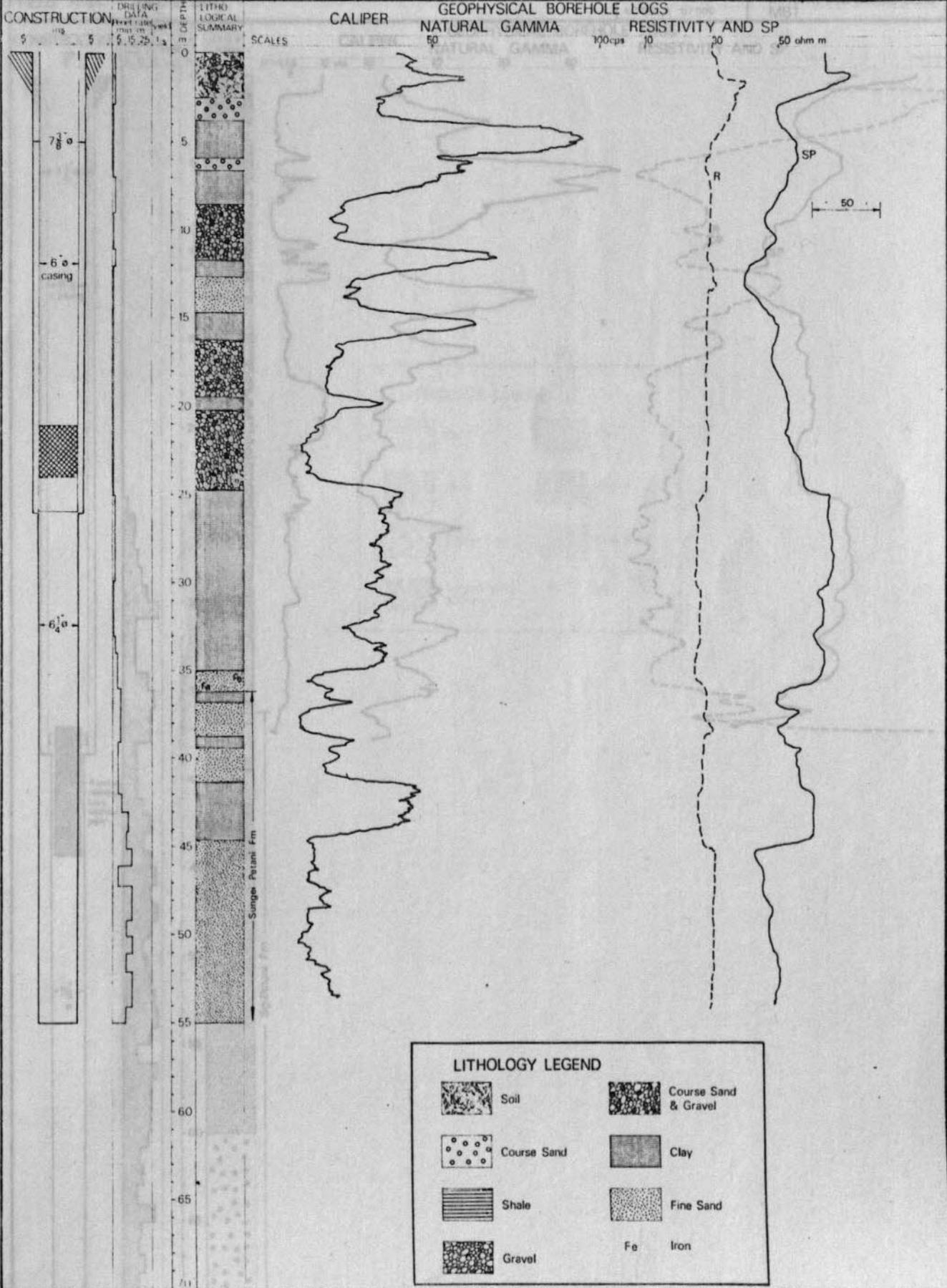
LOCATION Mardi Station, Bertam Seberang Prai  
 STARTED 26 8 1982 COMPLETED 3 9 1982  
 DRILLING METHOD Rotary mud flush

GRID REFERENCE 762136  
 REFERENCE POINT (R P)  
 R P ELEVATION m (above ground level)

TOTAL DEPTH 55 m SWL m  
 YIELD 1.3 1/8 EC

YIELD TEST Not carried out.

REMARKS 10 hours development of screen zone Low discharge 6' screen/casing withdrawn bore abandoned



LITHOLOGY LEGEND	
	Soil
	Course Sand & Gravel
	Course Sand
	Clay
	Shale
	Fine Sand
	Gravel
	Fe Iron

# COMPOSITE BORE LOG

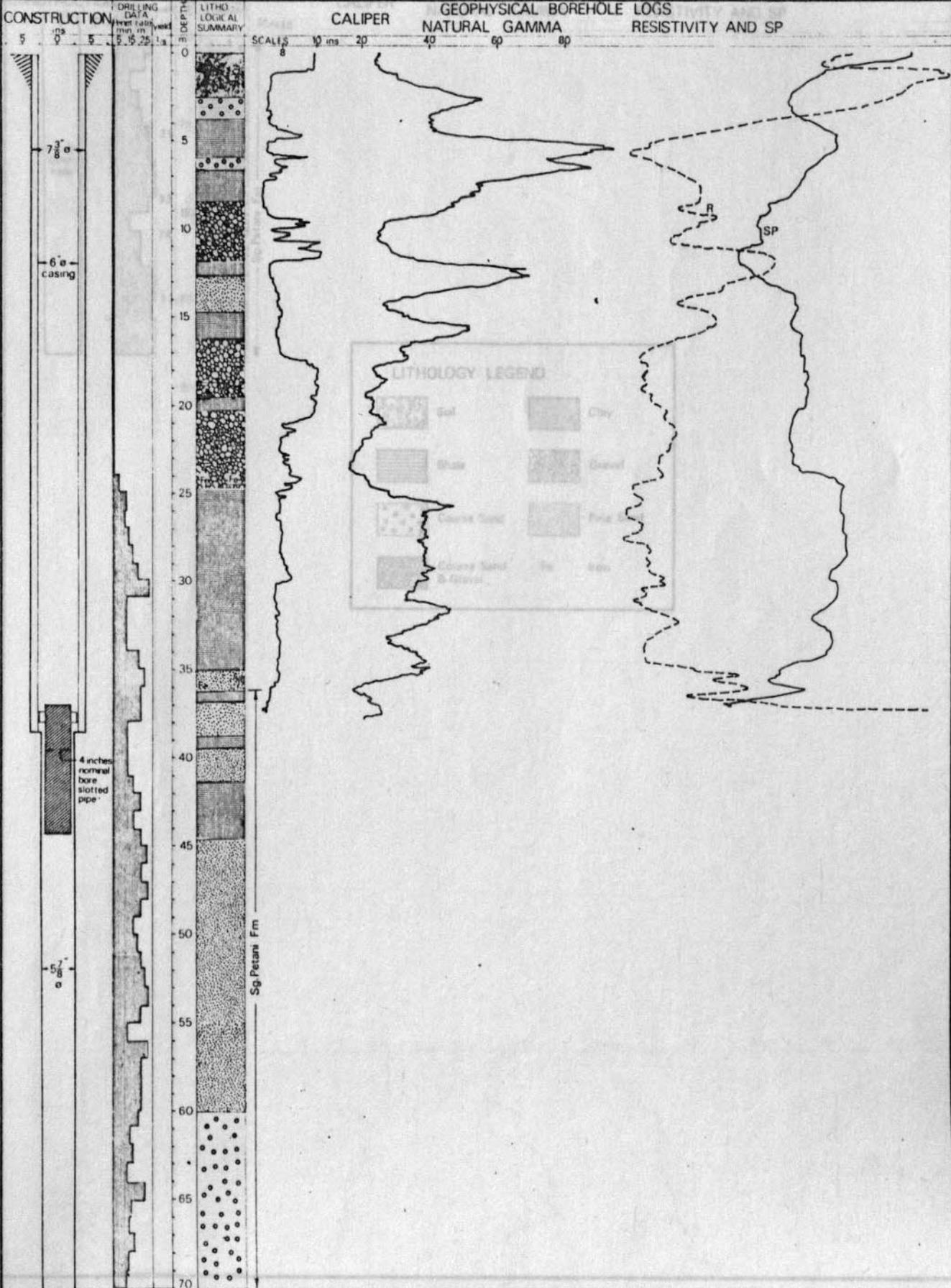
**LOCATION** Mardi Bertam 1A, north of office building  
**STARTED** 7 10 1982 **COMPLETED** 26 10 1982  
**DRILLING METHOD** Rotary mud flush  
 0 - 38m, Rotary air flush 38 - 85m  
**YIELD TEST** 150 mn. airlift

**TOPO SHEET** 16-Sungai Petani  
**GRID REFERENCE** 762136  
**REFERENCE POINT (R.P.)** Top of casing  
**R.P. ELEVATION** \_\_\_\_\_ m (above ground level)



## MB1AGS 1136

**TOTAL DEPTH** 88 m **SWL** 1.60 m  
**YIELD** 3.0 1/5 **EC** 200 (micro mhos/cm at 25°C)  
**REMARKS** Sheet 1/2  
 m form abandoned bone MB1



# COMPOSITE BORE LOG

TOPO SHEET: *Sungai Petani*  
 GRID REFERENCE: *1133*  
 REFERENCE POINT (R.P.): *(R.P.)*  
 R.P. ELEVATION: *m (above ground level)*

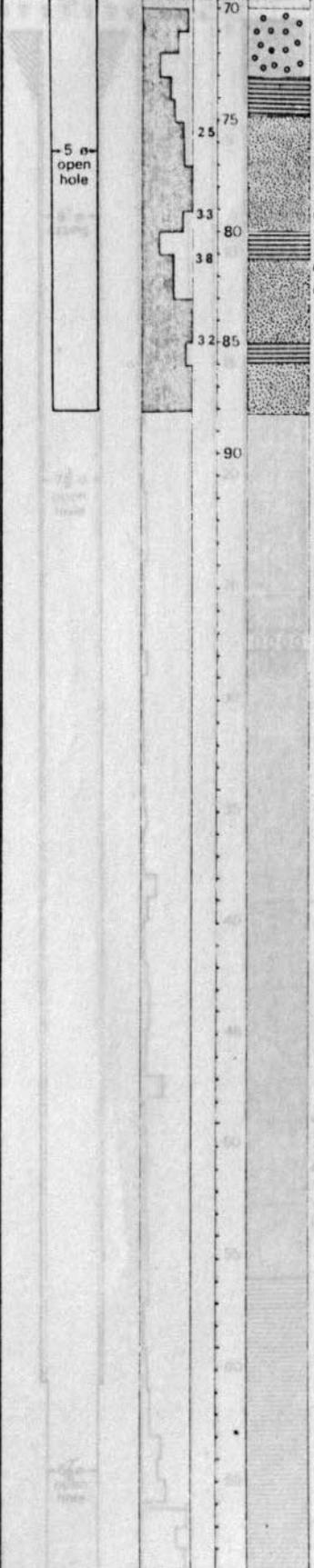
LOCATION MAP

Cont'd MB IA	GS 1136	
TOTAL DEPTH	m	SWL m
YIELD	1/s	EC <small>micro mhos at 25°C</small>
REMARKS	Sheet 2/2	

LOCATION  
 STARTED 1982 COMPLETED 1982  
 DRILLING METHOD  
 YIELD TEST

APPROX 1

## CONSTRUCTION DRILLING DATA LITHO LOGICAL SUMMARY CALIPER GEOPHYSICAL BOREHOLE LOGS NATURAL GAMMA RESISTIVITY AND SP



### LITHOLOGY LEGEND

	Soil		Clay
	Shale		Gravel
	Course Sand		Fine Sand
	Course Sand & Gravel		Fe Iron

# COMPOSITE BORE LOG

LOCATION Mardi Bertam 2

STARTED 7 9 1982 COMPLETED 15 9 1982

DRILLING METHOD Rotary mud flush  
0-66m, Rotary Air flush 66-84.5m

YIELD TEST:

TOPO SHEET 16 Sungai Petani

GRID REFERENCE : 767139

REFERENCE POINT (R.P.) Top of casing

R.P. ELEVATION 0.64 m (above ground level)

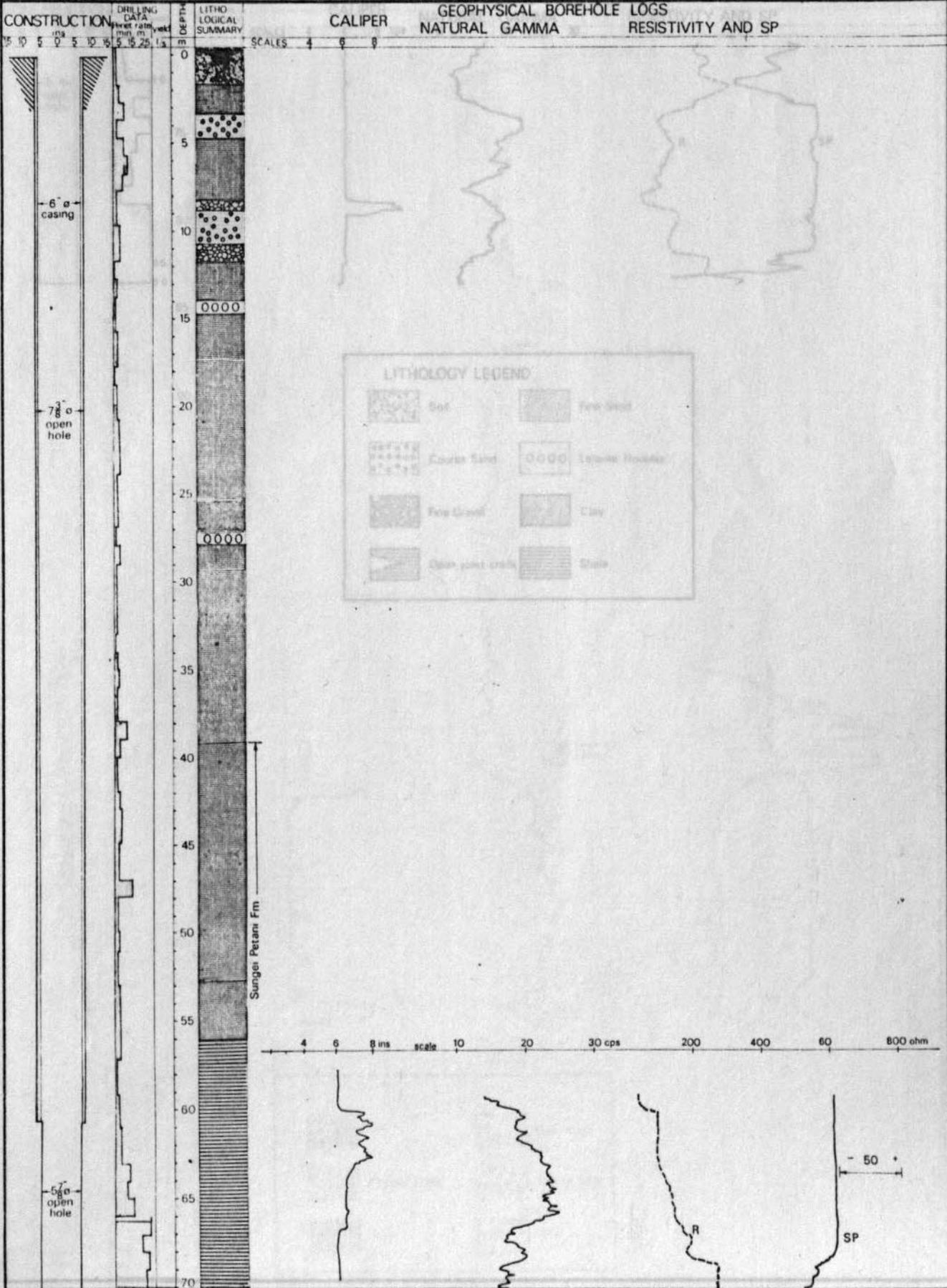


## MB2 GS 1137

TOTAL DEPTH 84 m SWL 2.40 m

YIELD 1/8 EC 275 (11.20 m³/m³ at 25°C)

REMARKS Sheet 1/2



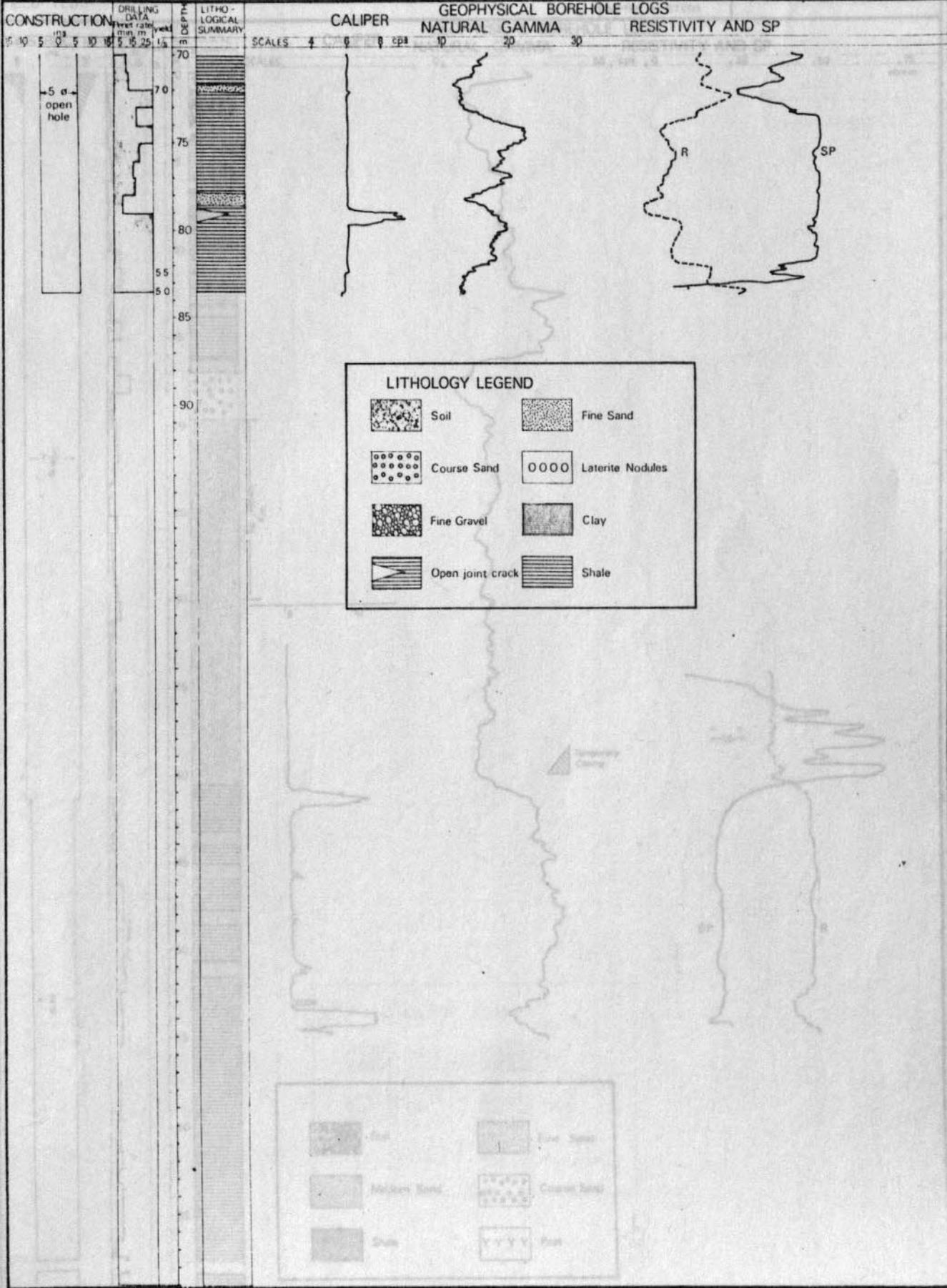
# COMPOSITE BORE LOG

TOPO SHEET: 16 Sargol Petrol  
 GRID REFERENCE: 16 Sargol Petrol  
 REFERENCE POINT (R.P.):  
 R.P. ELEVATION: m (above ground level)

LOCATION MAP  
 APPROX 1

Cont'd MB 2 GS1137  
 TOTAL DEPTH m SWL m  
 YIELD 1/3 EC  
 REMARKS Sheet 2/2

LOCATION:  
 STARTED: 1982 COMPLETED: 1982  
 DRILLING METHOD:  
 YIELD TEST:



### LITHOLOGY LEGEND

	Soil		Fine Sand
	Course Sand		Laterite Nodules
	Fine Gravel		Clay
	Open joint crack		Shale

	Silt		Low Sand
	Medium Sand		Course Sand
	Shale		Silt



# COMPOSITE BORE LOG

LOCATION Mardi Bertam 4  
 STARTED 27 10 1982 COMPLETED 4 11 1982  
 DRILLING METHOD 0-53m Rotary mud  
 Flush 53-100m DTH  
 YIELD TEST: Not tested

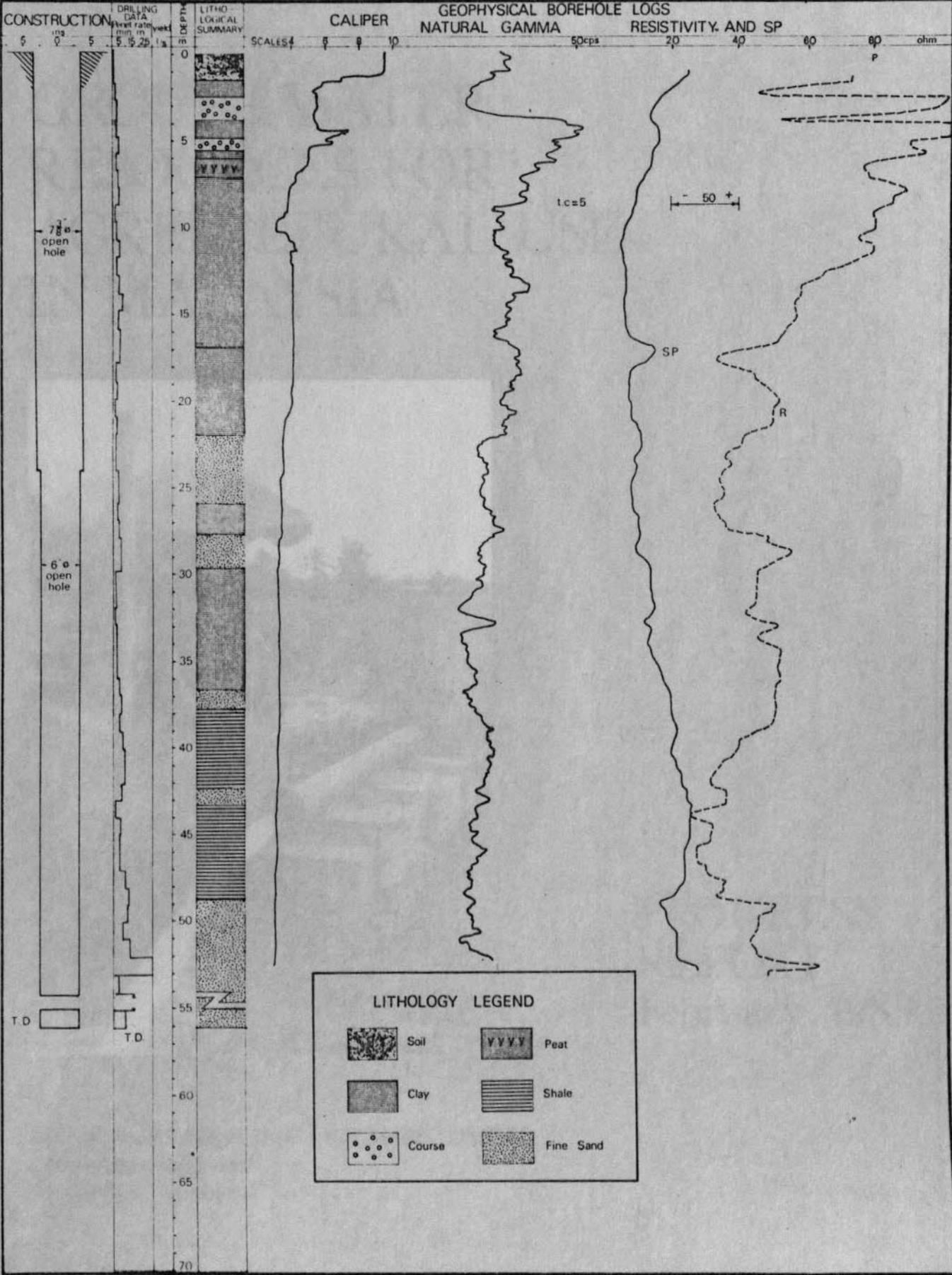
TOPO SHEET: 16 Sg. Petani  
 GRID REFERENCE: 765140  
 REFERENCE POINT (R.P)  
 R.P ELEVATION: m (above ground level)



**MB4 GS 1139**

TOTAL DEPTH	100 m	SWL	m
YIELD	< 0.1 1/8	EC	150 micro mhos at 25°C

REMARKS: Bore abandoned



DRAINAGE AND IRRIGATION DEPARTMENT  
MINISTRY OF AGRICULTURE  
GOVERNMENT OF MALAYSIA

JABATAN PARIT DAN TALIAIR  
KEMENTERIAN PERTANIAN  
KERAJAAN MALAYSIA

# GROUNDWATER RESOURCES FOR AGRICULTURAL USE IN MALAYSIA



PROGRESS  
REPORT  
February, 1983

SIR M. MACDONALD & PARTNERS LIMITED  
Consulting Engineers  
Cambridge, England.



GROUNDWATER  
RESOURCES FOR  
AGRICULTURAL USE  
IN MALAYSIA

PROGRESS  
REPORT  
February, 1983

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M. J. J.  
1974

Page No.

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GENERAL APPENDIX

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- This is the sixth of the series of technical progress reports and is concerned mainly with the period from and November 1982 to February 1983.

TABLES

Because of budgetary constraints, field investigations have been somewhat limited. However, the following drilling operation throughout the period has been achieved.

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FIGURES

Basic field surveys have been carried out in the Sg. Tekam (Paiala) area as part of the Kemasin-Semerak project area.

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## 1. GENERAL

### 1.1 Introduction

This is the sixth of the series of technical progress reports and is concerned mainly with the period from end November 1982 to February 1983.

Because of budgetary constraints, field investigations have been somewhat reduced with a one rig drilling operation throughout the period. Over 500 m of exploratory drilling has been achieved, in Perak and in Sg. Tekam, Pahang and 8 boreholes have been completed, together with several attempts at undisturbed sampling (coring) at adjacent sites.

Resistivity surveys have been carried out in the Sg. Tekam (Felda) area and in a part of the Kemasin-Semerak project area, northwest of Pasir Puteh.

Two line shaft borehole turbine pumps have been purchased.

The smaller unit, a Grundfos BP 45-4 has been commissioned and is currently being used in the pump test programme in Perlis.

### 1.2 Staffing

In November 1982, the Consultant proposed to JPT an additional 4 man-month input (from about project Month 21) of a hydrogeologist from the Consultant's staff to assist with long delayed pump testing and analysis, field supervision of geophysics and drilling and preparation of manuals and reports. It has been decided however not to proceed with this input. Mr. D.M. Milne, Supervising Hydrogeologist visited the project in late November. He returned on February 23, 1983 and it is anticipated that he will stay for up to 1 month, to assist on pump test analysis and preparation of manuals.

The geophysics team now combines geophysical (resistivity) survey work with the pump testing of boreholes. Team members have already run 2 pump tests in Perlis with consultant supervision and mechanical assistance from JPT Ipoh. The pump test team members are responsible for pump, engine and orifice weir installation, measurements of discharge and drawdown in the boreholes and piezometers and routine measurements of salinity and chemical characteristics of the water pumped.

The counterpart hydrogeologist/planning engineer, Encik Ferdaoz b. Hj. Mohamed has been transferred to JPT Headquarters to assist on irrigation planning and water balance studies. Technician Ong Seng Sim has been transferred from the geophysics team to other duties at JPT Headquarters.

As a result of the decision to operate only 1 drilling rig for the foreseeable future, drill team 2 has been disbanded and staff reassigned to other duties.

### 1.3 Visits and Meetings

The consultant has continued to make routine field supervisory visits to the drilling and pump testing operations. Other visits were made as follows:

- 3.12.82; The JPT counterpart geophysicist together with the consultant, visited Felda, Sungei Tekam to review the proposed drilling investigation in the Tekam experimental catchments.
- 30.12.82 and 3.1.83; Staff and Consultants from the JPT Groundwater group visited Lake Gardens, K.L. to see the commissioning by the supplier of a small Gadelius BP 45-4 lineshaft pump in an artesian borehole.

- 1.2.83; the consultant visited Kota Baru for a meeting with the Kemasin Semerak (K-S) project manager. He then made a field trip to identify possible bore sites in the hilly non-sawah areas to the west of Pasir Puteh.

Meetings have been held as follows:

- 22.11.82; between Transwater Engineering (suppliers of Worthington pumps), the consultant MMP and representatives of JPT Ampang to discuss pump duty and procurement.
- 30.11.82; between staff of JPT Ampang, JPT Workshops, Ipoh and the Consultant to discuss pump modification and procurement, drilling spares, reductions in field work and a one rig operation and redeployment of surplus drill team II staff. In addition, detailed specifications for a large capacity (60 l/s) lineshaft pump were drawn up.
- 9.12.82; a preliminary meeting was held between the consultants to the K-S project, SCET-Agri and the consultants MMP to discuss a possible groundwater investigation to be made in the area northwest of Pasir Puteh by the JPT Groundwater group on behalf of the K-S project.
- 13.12.82; between the consultant and JPT staff from Ampang and JPT workshops, Ipoh to discuss the suitability of the small lineshaft pump (BP 45-4) for test pumping. Purchase of ancillary pump test equipment and the composition of a pump testing team was also discussed.
- 12.1.83; between JPT Planning Dept. and the consultant to discuss possible contribution to the Kemasin-Semerak study by the JPT Groundwater Section. The justification for the proposed drilling in Sg. Tekam was also discussed; it was felt that the work would allow some quantification of the groundwater contribution to the Sg. Tekam catchment water balance.

- 18.1.83 and 26.1.83; between the K-S project manager, MMP, SCET-Agri, JPT Planning Department and JPT Ampang. The meeting discussed groundwater requirements and need for groundwater investigations in the K-S project area. The scope and timing of an investigation programme by the JPT Groundwater group was discussed.
- 9.2.83; between staff of JPT Planning Dept. and the consultant, to discuss the Progress Report dated November 1982. Other matters discussed were the 1983 drilling programme in Kelantan and Trengganu.
- 11.2.83; between MMP and SCET Agri. Sites for a reconnaissance drilling and testing programme west of Pasir Puteh were agreed.
- 18.2.83; a meeting was held between a representative of Risda and staff of JPT Ampang; the consultant attended. The meeting discussed the possible drilling of a water supply borehole by JPT, at a rubber factory on the Kuala Kangsar-Grik road.

#### 1.4 Expenditure and Payments

As a result of discrepancies between scheduled payments made up to the end of project Month 15 (August 31, 1982) and actual expenditures made to that date, the Government, according to Clause 3.04(c) of the Agreement, requested the consultant to submit a revised Schedule of Payments beginning September 1982 (Month 16) to correct for overpayments made to August 31, 1982. A revised Schedule D was submitted to the Government on 23 December 1982 and accepted on 12.1.83 ((4) dlm. PPT. 461/21.4 Jld. 3). Payments are now being made according to this revised schedule.

Scheduled payments for Months 16-20 are due whilst statements of expenditure up to Month 20 (January 1983) have been submitted by the consultant (Table 1.1).

Table 1.1

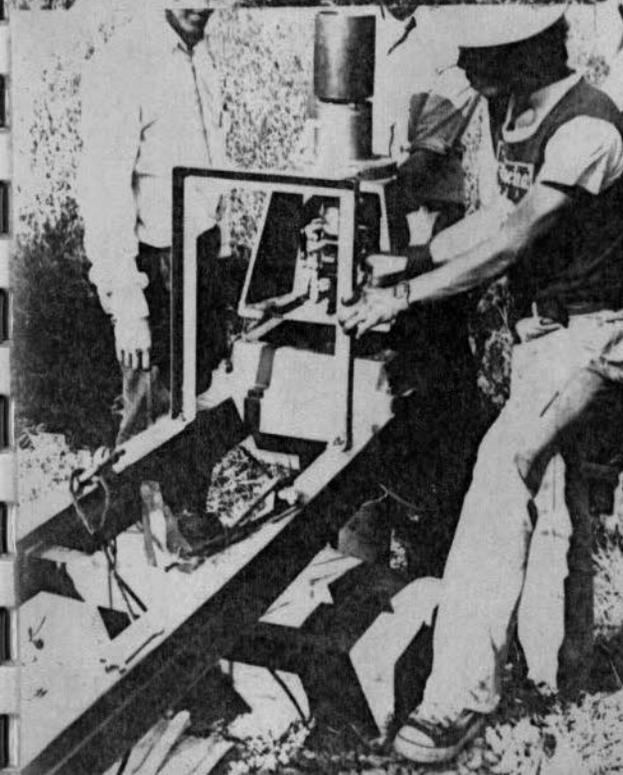
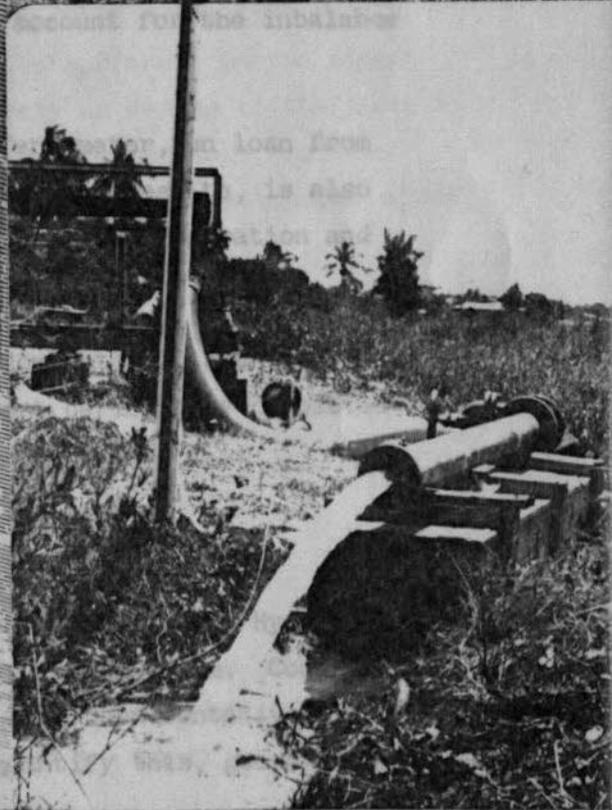
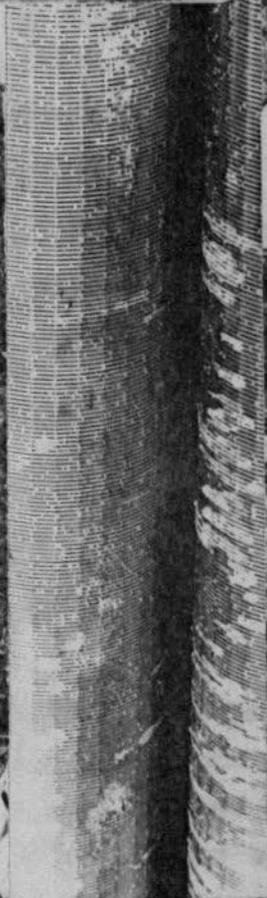
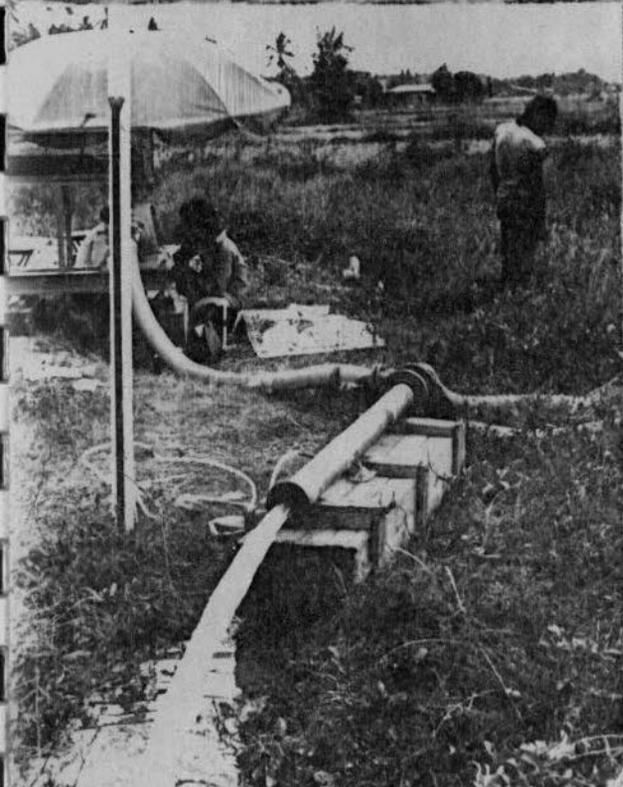
## PAYMENTS AND EXPENDITURE

## STATEMENT OF EXPENDITURE

## INVOICE

Project Month	Invoice No.	Date Submitted	INVOICE		Date paid	S.O.E. No.	STATEMENT OF EXPENDITURE	
			Amount M\$	£Stg.			Amount M\$	£Stg.
Scheduled payments invoiced and paid to 31.8.82 according to Agreement Schedule D; Mobilisation + M1-M15.								
			204,560	178,573		Actual expenditure submitted to 31.8.82	146,083.47	170,607.61
16	Sept. 82 82/09/4034	17.1.83	0*	4,000*		82/09/4034	21,484.47	8,836.50
17	Oct. 82 82/10/4034	17.1.83	0	2,634.39		82/10/4034	6,948.04	5,763.28
18	Nov. 82 82/11/4034	20.1.83	0	7,463.11		82/11/4034	5,790.71	7,338.00
19	Dec. 82 82/12/4034	20.1.83	0	6,130.50		82/12/4034	4,858.49	6,255.50
20	Jan. 83 83/01/4034	4.2.83	0	7,155.00		83/01/4034	4,465.11	6,666.50

\* Schedule of payments from M16 onwards revised to correct for overpayments of £Stg. 7,965.39 and M\$58,476.53 to August 31, 1982.



## 2. GEOPHYSICS AND HYDROGEOLOGY: in the area; 9 soundings

were executed (Figure 2.1). The hilly terrain is

### 2.1 Geophysics resistivity survey as it is impossible to get suitable

#### 2.1.1 General which to extend the electrode spread. The Hydrogeology

has indicated 3 borehole positions; T 1 near Weir B, T 2 near

The geophysics team has carried out surveys both in Pahang, (2.12).

at Sg. Tekam and in Kelantan in the Pasir Puteh area, for the

Kemasin-Semerak project. The difficulty in maintaining the electrodes

on a flat stretch of land.

The geophysical study at Sg. Tekam is a contribution to investigations of the aquifer formations in the area, beneath the experimental basin catchment, which could account for the inbalance of the water balance. It is very close to the surface. On the other

hand, the sounding curves indicate a variety of depths to the bedrock.

The geophysics crew is now using an ABEM Terrameter, on loan from JKR. An ABEM Terrameter, besides producing good results, is also quicker to work with than the Scintrex equipment; frustration and delays are thereby avoided.

The conclusions are that the bedrock is close to the surface and During this report period, the crew have completed 20 soundings

and 1 profile whereas in the previous report period they completed 15 soundings and 1 profile. Area (Kemasin-Semerak Project)

#### 2.1.2 Sungei Tekam

The groundwater section has been requested to assist the Hydrology Section in a catchment water balance study at Sg. Tekam. Considerable unexplained imbalances, of about 500 mm, have been tentatively ascribed to groundwater outflow. To confirm and quantify this, geophysical and drilling work has been carried out. Livium and thereby assist in

groundwater potential evaluation.

The experimental basins (i.e. in Pusat Penyelidikan Pertanian Tun Razak, Sg. Tekam) are covered by 3 main types of soil, Munchong series, Katong series and Segamat series. It was thought that the Segamat soil is based on an andesite parent rock whilst the Munchong and Katong soils are developed upon shale/sandstone. It is therefore assumed that both volcanic and sedimentary rocks occur although no outcrop has been found.

The resistivity team spent 7 survey days in the area; 9 soundings and 1 profile were executed (Figure 2.1). The hilly terrain is unsuitable for resistivity survey as it is impossible to get suitable flat areas upon which to extend the electrode spread. The Hydrogeology Section has located 3 borehole positions; T 1 near Weir B, T 2 near Weir A and T 3 to the north-west of Weir A (Figures 2.1 and 2.12). Unfortunately, no soundings could be executed exactly on the proposed site due to the difficulty in maintaining the electrodes on a flat stretch of land.

The profile EP 64 (Figure 2.2) may indicate the presence of 2 bedrock types, andesite and shale/sandstone. It seems that at one point the andesite is very close to the surface. On the other hand, the sounding curves indicate a variety of depths to the bedrock, ranging from 7 m to 39 m deep. The curves also indicate that the rock is overlain by lateritic clay. Unfortunately no potential water bearing formations are detected on the sounding curves.

The conclusions are that the bedrock is close to the surface and that a promising aquifer is unlikely to exist in the area.

### 2.1.3 Pasir Puteh Area (Kemasin-Semerak Project)

#### General

The Geophysics team of the JPT Ampang Groundwater section was asked to conduct a resistivity survey for the Kemasin-Semerak Project, in the area west and north west of Pasir Puteh. The aims of the resistivity survey were to determine the depth to bedrock, the type of bedrock and the type of alluvium and thereby assist in groundwater potential evaluation.

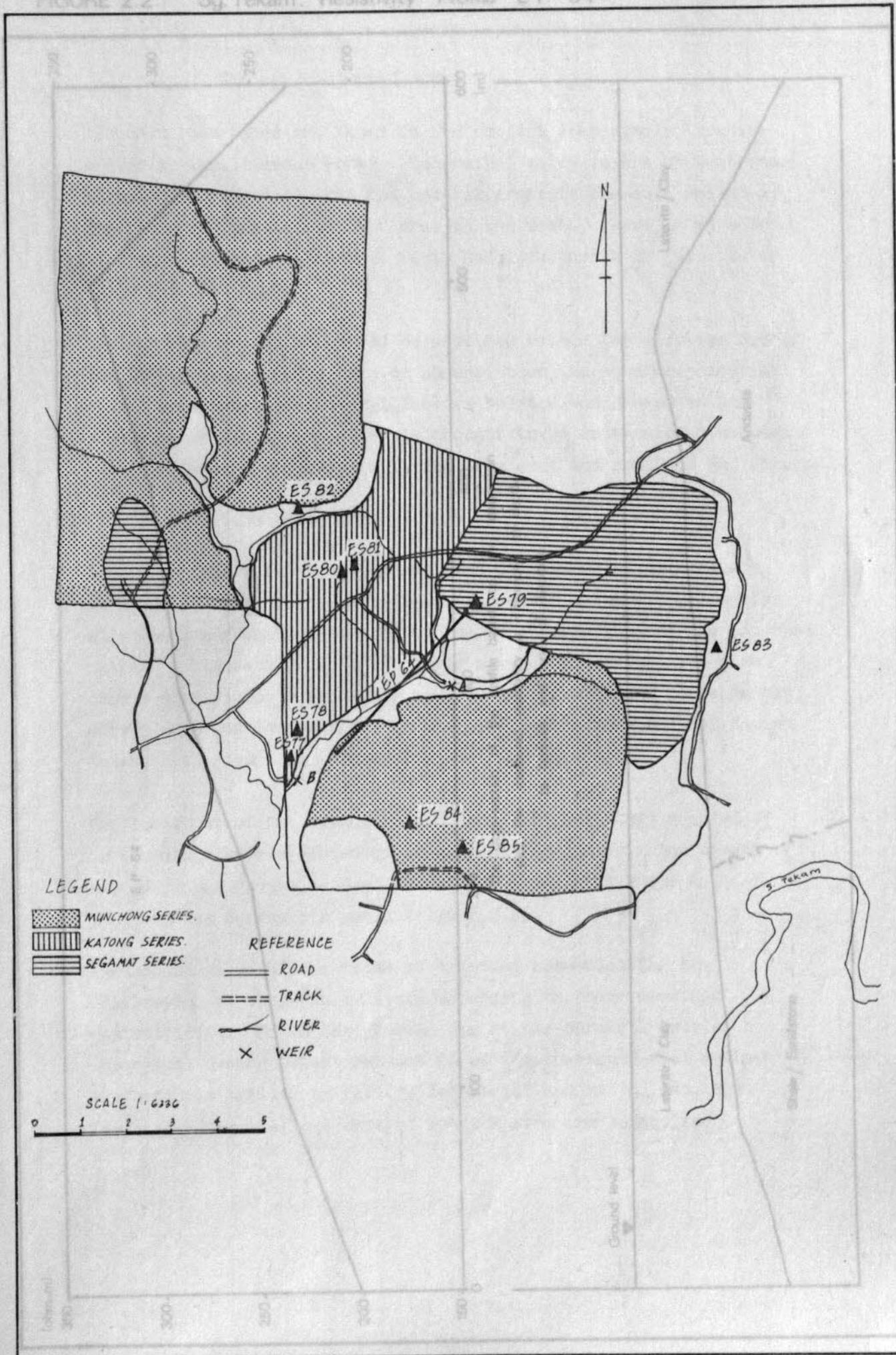


--- TRACK  
— RIVER  
X WEIR

SCALE 1:1000



Figure 2.1 Resistivity Survey Sungei Tekam Experimental Basin



LEGEND

-  MUNCHONG SERIES.
-  KATONG SERIES.
-  SEGAMAT SERIES.

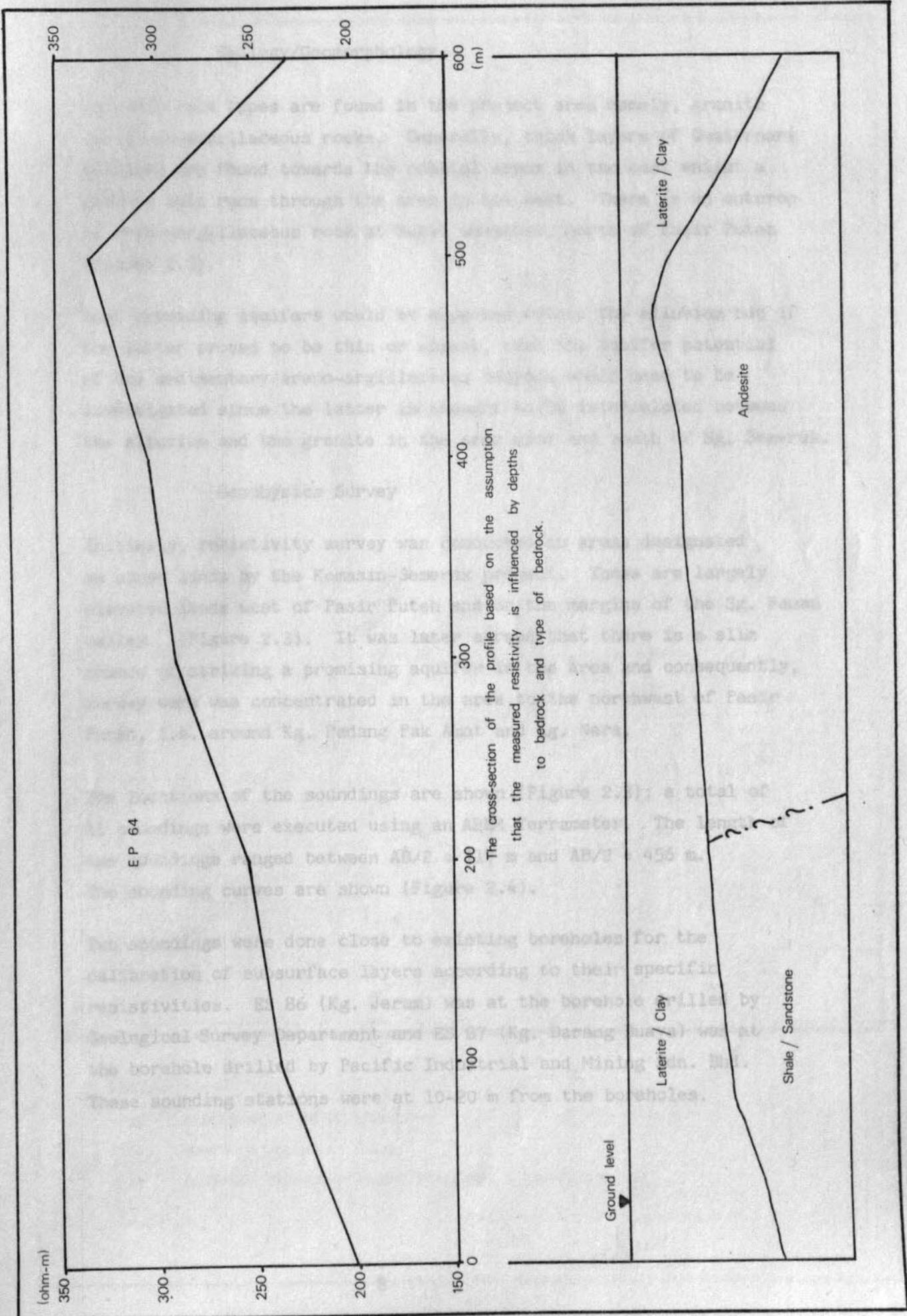
REFERENCE

-  ROAD
-  TRACK
-  RIVER
-  WEIR

SCALE 1:6250



FIGURE 2.2 Sg. Tekam: Resistivity Profile E P 64



### Geology/Geomorphology

Two main rock types are found in the project area namely, granite and areno-argillaceous rocks. Generally, thick layers of Quaternary alluvium are found towards the coastal areas in the east whilst a granite belt runs through the area in the west. There is an outcrop of areno-argillaceous rock at Bukit Gedombak, north of Pasir Puteh (Figure 2.3).

Most promising aquifers would be expected within the alluvium but if the latter proved to be thin or absent, then the aquifer potential of the sedimentary areno-argillaceous bedrock would need to be investigated since the latter is thought to be intercalated between the alluvium and the granite in the area east and south of Sg. Semerak.

### Geophysics Survey

Initially, resistivity survey was conducted in areas designated as upper lands by the Kemasin-Semerak project. These are largely elevated lands west of Pasir Puteh and on the margins of the Sg. Rasau valley. (Figure 2.3). It was later agreed that there is a slim chance of striking a promising aquifer in the area and consequently, survey work was concentrated in the area to the northwest of Pasir Puteh, i.e. around Kg. Padang Pak Amat and Kg. Nara.

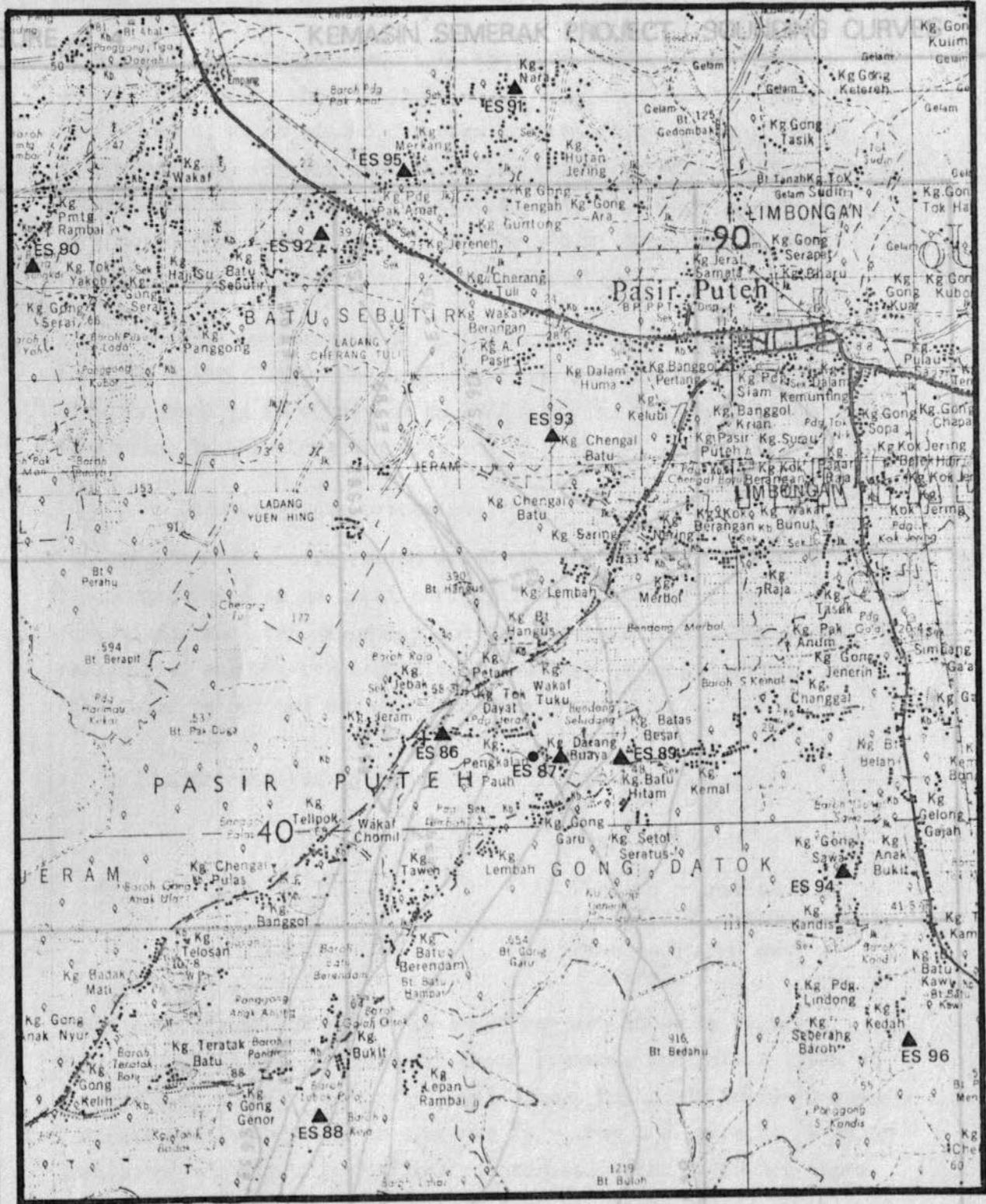
The locations of the soundings are shown (Figure 2.3); a total of 11 soundings were executed using an ABEM Terrameter. The length of the soundings ranged between  $AB/2 = 117$  m and  $AB/2 = 456$  m. The sounding curves are shown (Figure 2.4).

Two soundings were done close to existing boreholes for the calibration of subsurface layers according to their specific resistivities. ES 86 (Kg. Jeram) was at the borehole drilled by Geological Survey Department and ES 87 (Kg. Darang Buaya) was at the borehole drilled by Pacific Industrial and Mining Sdn. Bhd. These sounding stations were at 10-20 m from the boreholes.

- ▲ ELECTRICAL SOUNDING LOCATION
- + BOREHOLE DRILLED BY G.S.D
- ★ BOREHOLE DRILLED BY PACIFIC INDUSTRIAL & MINING SDN BHD

FIGURE 2.3

KEMASIN SEMERAK : RESISTIVITY SURVEY.

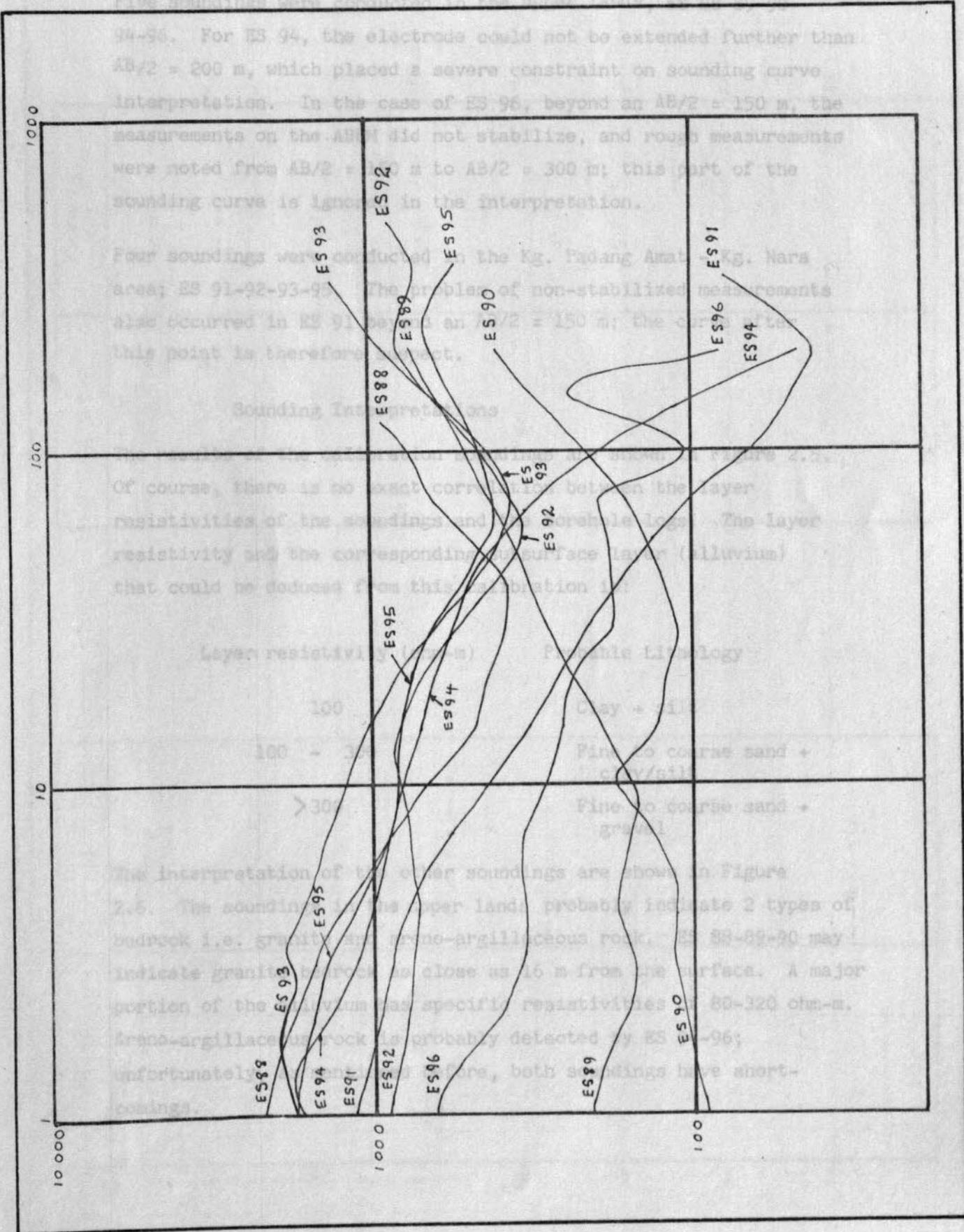


**LEGEND**

- ▲ ES 86 ELECTRICAL SOUNDING LOCATION.
- + BOREHOLE DRILLED BY G.S.D.
- BOREHOLE DRILLED BY PACIFIC INDUSTRIAL & MINING SDN. BHD.

FIGURE 2.4

KEMASIN SEMERAK PROJECT : SOUNDING CURVES



34-36. For ES 94, the electrodes could not be extended further than  $AB/2 = 200$  m, which placed a severe constraint on sounding curve interpretation. In the case of ES 96, beyond an  $AB/2 = 150$  m, the measurements on the  $AB/2$  did not stabilize, and rough measurements were noted from  $AB/2 = 150$  m to  $AB/2 = 300$  m; this part of the sounding curve is ignored in the interpretation.

Four soundings were conducted in the Kg. Padang Amat - Kg. Nara area; ES 91-92-93-94. The problem of non-stabilized measurements also occurred in ES 91 at an  $AB/2 = 150$  m; the curve after this point is therefore not used.

Of course, there is no exact correlation between the layer resistivities of the soundings and the resistivity logs. The layer resistivity and the corresponding surface layer (alluvium) that could be deduced from this combination of data are:

- Layer resistivity (ohm-m)      Facies Lithology
- 100      Clay + silt
- 100 - 300      Fine to coarse sand + silt/clay
- >300      Fine to coarse sand + gravel

The interpretation of the other soundings are shown in Figure 2.5. The sounding in the upper lands probably indicate 2 types of bedrock i.e. granitic and meta-argillaceous rock. ES 88-89-90 may indicate granitic rock as close as 15 m from the surface. A major portion of the alluvium has specific resistivities of 80-320 ohm-m. Meta-argillaceous rock is probably detected by ES 91-96; unfortunately, these are, both soundings have short-soundings.

FIGURE 2.5 KEMASIN SEMERAK PROJECT: CALIBRATION SOUNDINGS

Five soundings were conducted in the upper lands, ES 88-89-90-94-96. For ES 94, the electrode could not be extended further than  $AB/2 = 200$  m, which placed a severe constraint on sounding curve interpretation. In the case of ES 96, beyond an  $AB/2 = 150$  m, the measurements on the ABEM did not stabilize, and rough measurements were noted from  $AB/2 = 150$  m to  $AB/2 = 300$  m; this part of the sounding curve is ignored in the interpretation.

Four soundings were conducted in the Kg. Padang Amat - Kg. Nara area; ES 91-92-93-95. The problem of non-stabilized measurements also occurred in ES 91 beyond an  $AB/2 = 150$  m; the curve after this point is therefore suspect.

#### Sounding Interpretations

The results of the calibration soundings are shown in Figure 2.5. Of course, there is no exact correlation between the layer resistivities of the soundings and the borehole logs. The layer resistivity and the corresponding subsurface layer (alluvium) that could be deduced from this calibration is:

Layer resistivity (ohm-m)	Probable Lithology
---------------------------	--------------------

100

Clay + silt

100 - 300

Fine to coarse sand + clay/silt

$>300$

Fine to coarse sand + gravel

The interpretation of the other soundings are shown in Figure 2.6. The soundings in the upper lands probably indicate 2 types of bedrock i.e. granite and areno-argillaceous rock. ES 88-89-90 may indicate granite bedrock as close as 16 m from the surface. A major portion of the alluvium has specific resistivities of 80-320 ohm-m. Areno-argillaceous rock is probably detected by ES 94-96; unfortunately, as mentioned before, both soundings have shortcomings.

FIGURE 2.5 KEMASIN SEMERAK PROJECT: CALIBRATION SOUNDINGS

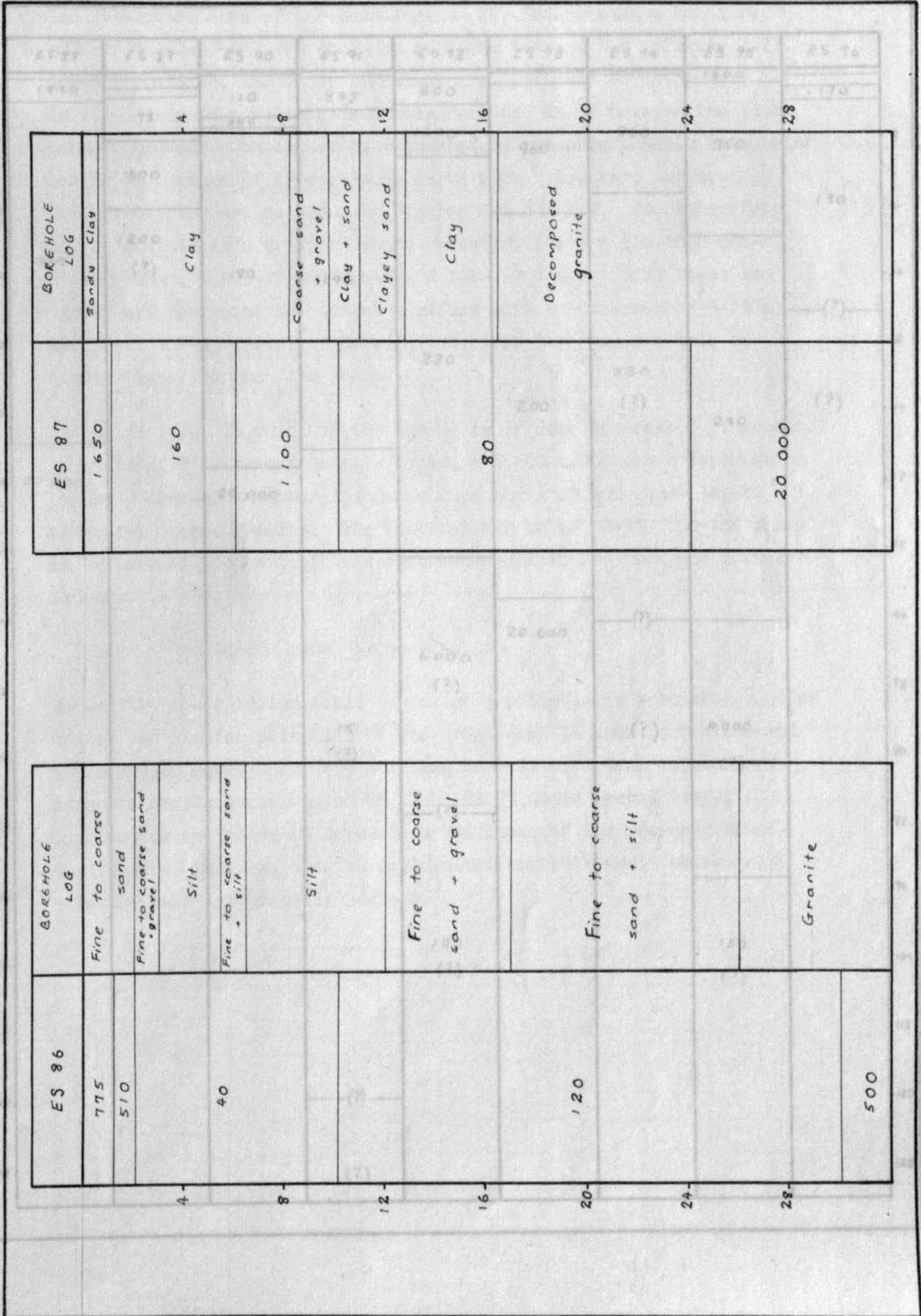
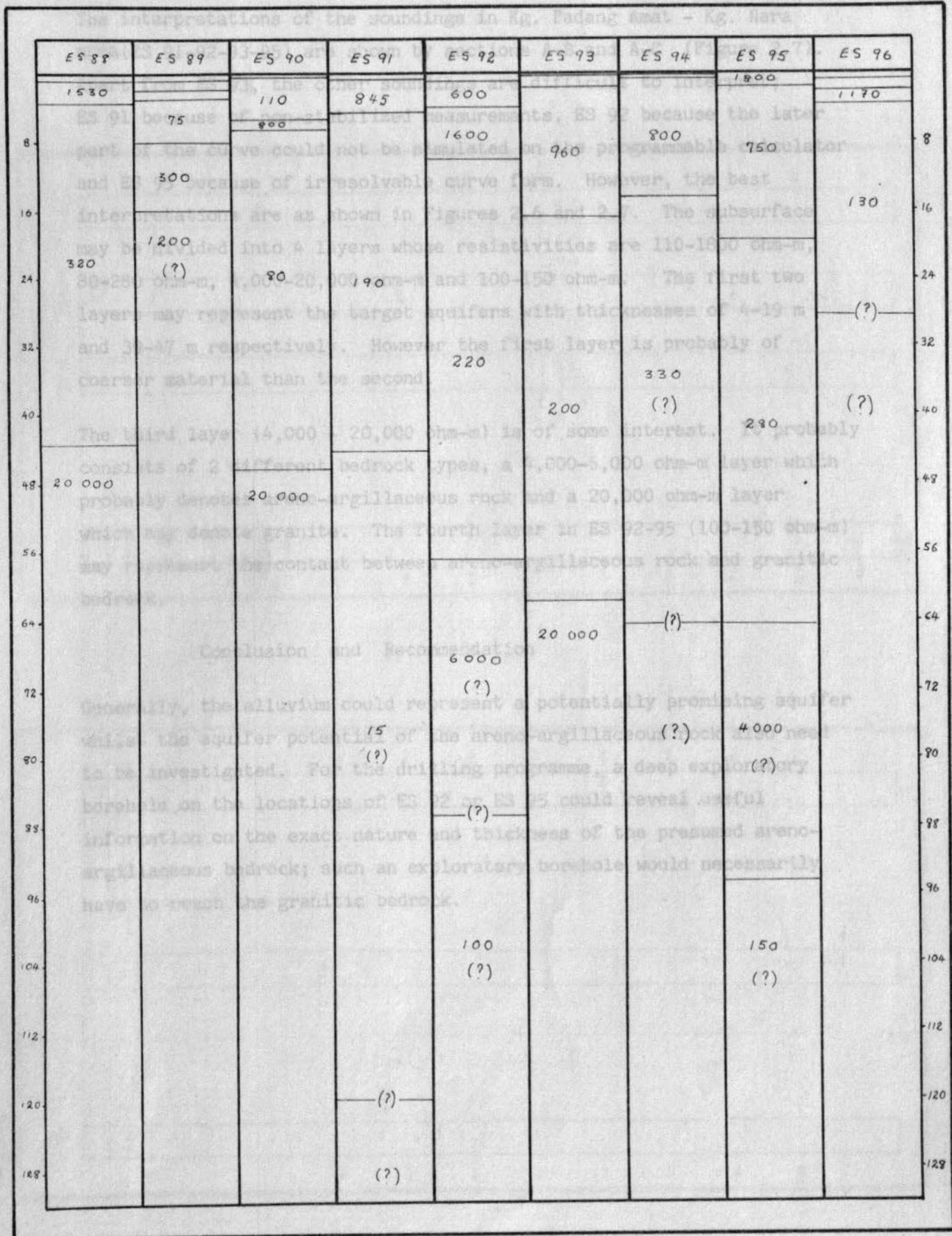


FIGURE 2.6

KEMASIN SEMERAK PROJECT : HORIZONTAL LAYER INTERPRETATION



The interpretations of the soundings in Kg. Padang Amat - Kg. Nara area (ES 91-92-93-95) are shown by sections A-B and A-C (Figure 2.7). Apart from ES 93, the other soundings are difficult to interpret; ES 91 because of non-stabilized measurements, ES 92 because the later part of the curve could not be simulated on the programmable calculator and ES 95 because of irresolvable curve form. However, the best interpretations are as shown in Figures 2.6 and 2.7. The subsurface may be divided into 4 layers whose resistivities are 110-1800 ohm-m, 80-280 ohm-m, 4,000-20,000 ohm-m and 100-150 ohm-m. The first two layers may represent the target aquifers with thicknesses of 4-19 m and 39-47 m respectively. However the first layer is probably of coarser material than the second.

The third layer (4,000 - 20,000 ohm-m) is of some interest. It probably consists of 2 different bedrock types, a 4,000-6,000 ohm-m layer which probably denotes arenaceous argillaceous rock and a 20,000 ohm-m layer which may denote granite. The fourth layer in ES 92-95 (100-150 ohm-m) may represent the contact between arenaceous argillaceous rock and granitic bedrock.

#### Conclusion and Recommendation

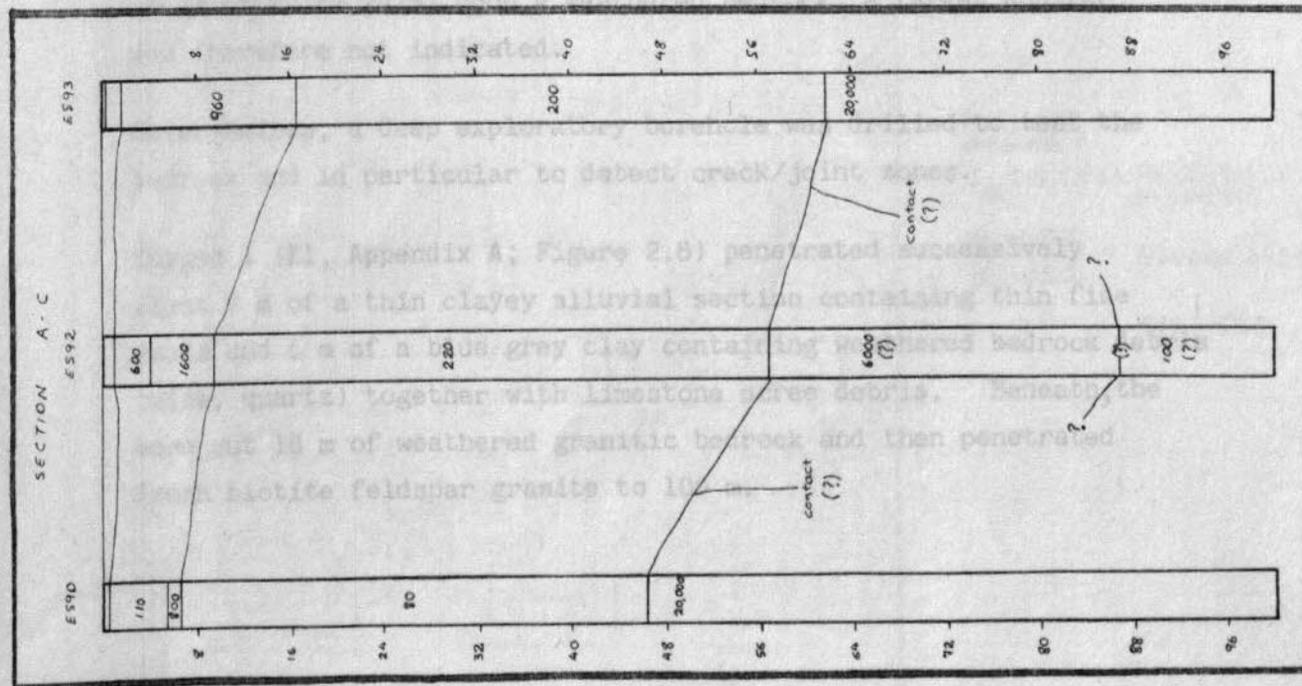
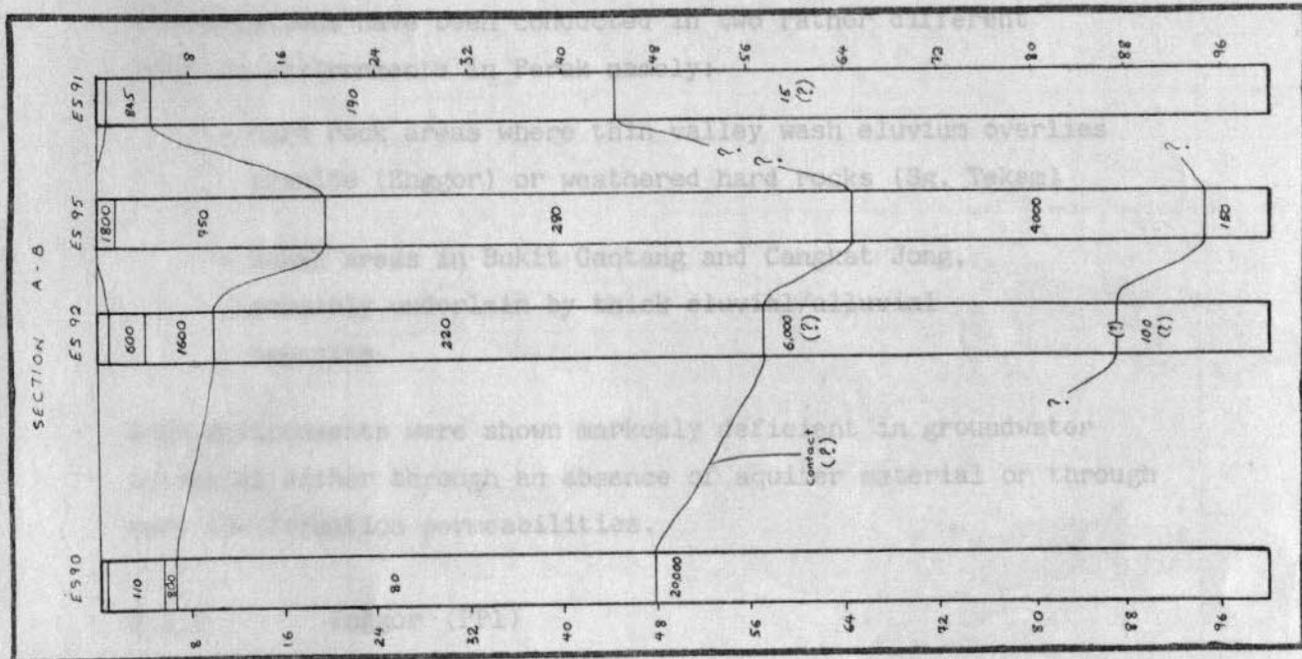
Generally, the alluvium could represent a potentially promising aquifer whilst the aquifer potential of the arenaceous argillaceous rock also need to be investigated. For the drilling programme, a deep exploratory borehole on the locations of ES 92 or ES 95 could reveal useful information on the exact nature and thickness of the presumed arenaceous argillaceous bedrock; such an exploratory borehole would necessarily have to reach the granitic bedrock.



FIGURE 2.7

KEMASIN SEMERAK PROJECT : RESISTIVITY SECTION

Hydrogeology  
General



## 2.2 Hydrogeology

### 2.2.1 General

Investigations have been conducted in two rather different geologic environments in Perak namely:

- hard rock areas where thin valley wash eluvium overlies granite (Enggor) or weathered hard rocks (Sg. Tekam)
- sawah areas in Bukit Gantang and Cangkat Jong, possibly underlain by thick eluvial/alluvial deposits

Both environments were shown markedly deficient in groundwater potential either through an absence of aquifer material or through very low formation permeabilities.

### 2.2.2 Enggor (PPI)

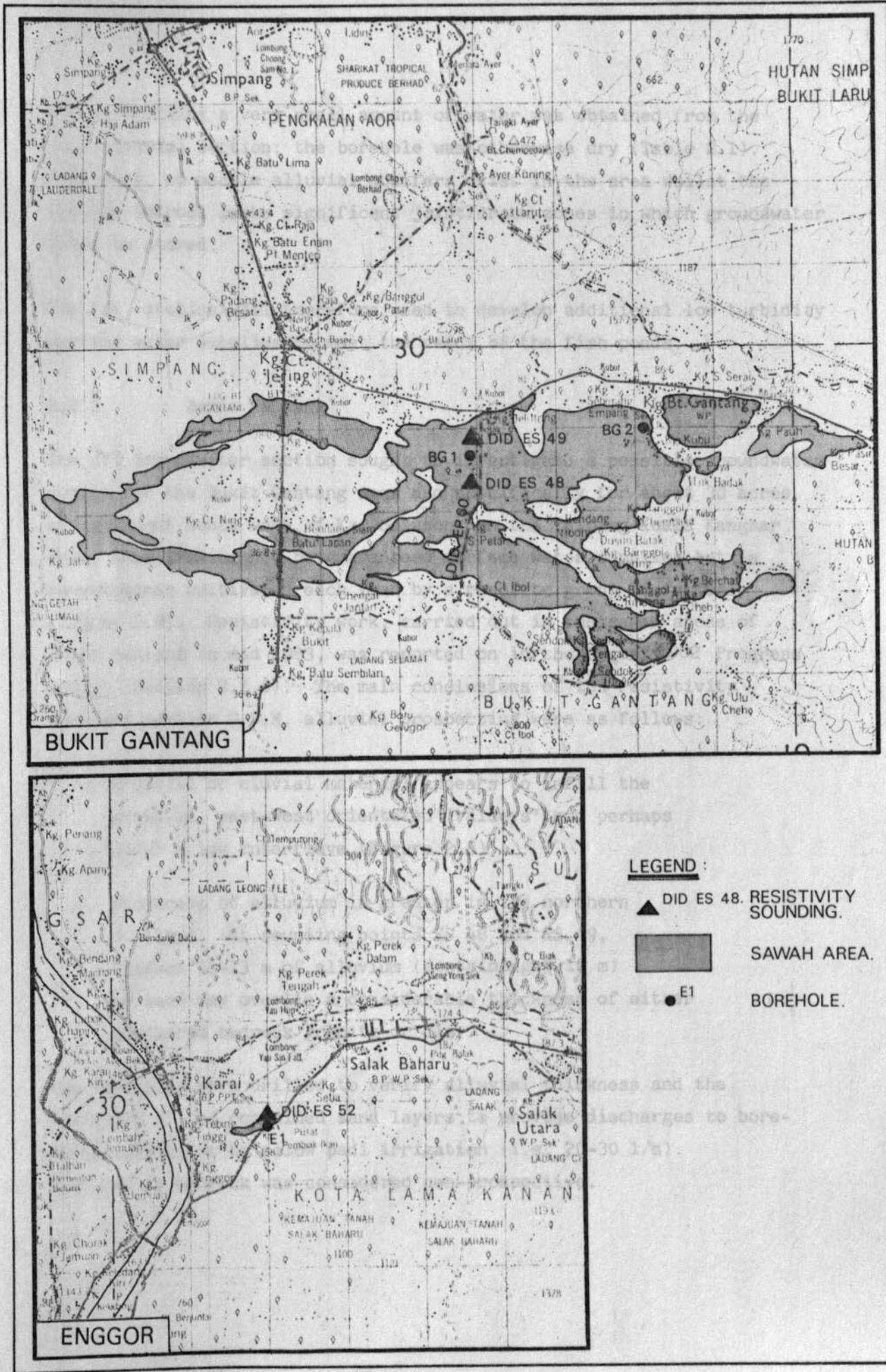
Resistivity survey was earlier carried out in the general area of the Enggor fisheries station (August 1982 Progress Report; Section 2.1.9). Results had suggested thin argillaceous alluvium (4 to 24?m) upon a weathered bedrock; a target aquifer was therefore not indicated.

Nevertheless, a deep exploratory borehole was drilled to test the bedrock and in particular to detect crack/joint zones.

Enggor 1 (E1, Appendix A; Figure 2.8) penetrated successively about 7 m of a thin clayey alluvial section containing thin fine sands and 6 m of a blue grey clay containing weathered bedrock debris (mica, quartz) together with limestone scree debris. Beneath, the bore cut 18 m of weathered granitic bedrock and then penetrated fresh biotite feldspar granite to 100 m.

FIGURE 2.8

ENGGOR AND BUKIT GANTANG : BOREHOLE LOCATIONS.



During drilling a very small amount of water was obtained from the thin alluvial section; the borehole was otherwise dry (Table 2.1). Evidently, no usable alluvial aquifers exist in the area whilst the granite bedrock lacks significant joint/crack zones in which groundwater could be stored.

The PP1 station will therefore need to develop additional low turbidity surface water supplies to meet the needs of the fish ponds.

### 2.2.3 Bukit Gantang

The JPT Groundwater section sought to investigate a possible groundwater supply for the Bukit Gantang area and specifically for about 30 acres of land just south west of Kg. Jelutong on the Taiping-Kuala Kangsar road; this area cannot be guaranteed surface water supplies but is nevertheless cultivated each year by a resolute group of farmers (Figure 2.8). Resistivity work, carried out in the sawah areas of Bukit Gantang in mid 1983, was reported on in the August 1982 Progress report (Section 2.1.6). The main conclusions of the resistivity work and earlier G.S.M. alluvial prospecting were as follows:

- alluvial or eluvial material appears to infill the parallel, east-west orientated 'valleys' and perhaps cover a low interfluvium (Figure 2.8).
- thickness of alluvium is greater in the northern 'valley'. At sounding points ES 48 and ES 49, between 11-13 m of alluvium (containing 5-10 m) of sand may overlie a considerable thickness of either weathered bedrock granite or clay.

Two boreholes were drilled to verify alluvial thickness and the potential of the contained sand layers to provide discharges to boreholes sufficient to allow padi irrigation (i.e. 20-30 l/s). The granite bedrock was considered non-prospective.

Table 2.1  
DRILLING AND YIELD TEST DATA

Borehole No. Informal GSM	Total Depth m	Aquifer Target	Static Water Level bgl (m)	Test Date	Discharge (l/s)	Drawdown (m)	Specific Capacity (l/s/m)	Remarks
E 1	100	Eluvium; weathered granite quartz residual	-	-	(<0.1)	-	-	Thin (12 m) argillaceous over granite. Bore abandoned.
BG 1	40	Eluvium-Alluvium	0.45	11.12.82	* 1.0	5.07	0.2	Capped, for observation. EC = 50 micromho/cm.
BG 2	21	Eluvium-Alluvium	-	-	-	-	-	Thin (12 m) argillaceous alluvium over weathered granite. Bore abandoned.
CJ 1	42	Alluvium	-	22.1.83	<0.1*	-	-	1 m screen set opposite intervals 9-12 m and 15-18 m and airlifted; discharge <0.1 l/s. Argillaceous 'alluvium'. Bore abandoned, backfilled.
CJ 2	86	Alluvium	-	Not tested	-	-	-	Abandoned, backfilled; Argillaceous 'alluvium' over bedrock shale.
CJ 3	66	Alluvium	1.69	8.1.82	2.3*	19.21	0.12	Screen with 15 m of Johnson WRB 55 screen. Capped for observation EC = 170 micromho/cm. Argillaceous 'alluvium'.
T 1	51	Weathered rock	-	Not tested	(<1.0)	-	-	Observation piezometer with 6" casing. For water balance study.
T 2	60	Weathered rock	-	Not tested	(<1.0)	-	-	- ditto -

Notes:  
E Enggor PPI Station  
BG Bukit Gantang  
CJ Cangkat Jong

(<0.1) Drilling discharge  
2.3\* Discharge from 2-3 hr. airlift test  
bgl below ground level

BG 1 was drilled to 40 m depth between the positions of electrical soundings ES 48 and ES 49. The bore penetrated 19 m of white, rather clayey alluvium lying above weathered granite. The mud drilled bore was logged with gamma and SP-R tools. Grain size sieve analysis was carried out on drill cuttings, indicating slightly kaolinitic coarse sands and fine gravel materials (50% size 1.7 - 2.0 mm) over the interval 12-19 m. Wire wound rod based screen of 1.5 mm opening was then installed over the interval 12-18 m and the bore cleaned and developed by jetting and airlift pumping to surge and agitate opposite the screen zone and so produce a stable natural gravel pack; detergent was used to assist in mud cake breakdown. Further pumping with a centrifugal pump indicated a low bore yield whilst an airlift test indicated low specific capacity and a very low formation permeability of less than 4 m/d (Table 2.1). Evidently, the low permeability and thickness of the formation is quite insufficient to sustain the large yields required of boreholes for padi irrigation.

The low formation permeability was investigated further. A 3" Ø corehole (BG 1A) was drilled close to BG 1 and 4 cores attempted over the screened zone at depth intervals 12-13 m, 13.4-14.4 m, 15-16 m and 16.5-17.5 m. Lithologic descriptions of the cores are given (Appendix B1). The undisturbed core material is composed of white coarse sand and fine gravel bound with a considerable clay-silt component probably of kaolin clay composition; grain supported clean sand-gravel is rare. The granular materials are usually rather angular, badly sorted and consist of quartz with degraded or rotten feldspar fragments. Lab analysis of bulk core material in the sand-gravel rich core sections confirms a considerable clay silt fraction (Table 2.2). Grain size curves of the same samples are given (Figure 2.9) to show the considerable fines loss between in situ samples and drill wash cuttings.

FIGURE 2.9

PARTICLE SIZE DISTRIBUTION GRAPH

Borehole location: Bukit Gantang, Perak

Borehole number: BG1.1A

Sample 1 - 3 Cored, sieved dry, lab

Sample 4 - 5 Drill cuttings, sieved in field

Table 2.2

Bukit Gantang 1A  
Clay-silt Content

Sample no	Depth interval (m)	$D_{40} / D_{90}$ Uniformity coefficient	$D_{60}$
1	13.90 - 14.05	0.7	1.4
2	14.15 - 14.25	6.7	1.25
3	17.14 - 17.32	9.4	1.51
4	12 - 20	2.9	2.1
5	14 - 18	2.8	1.6

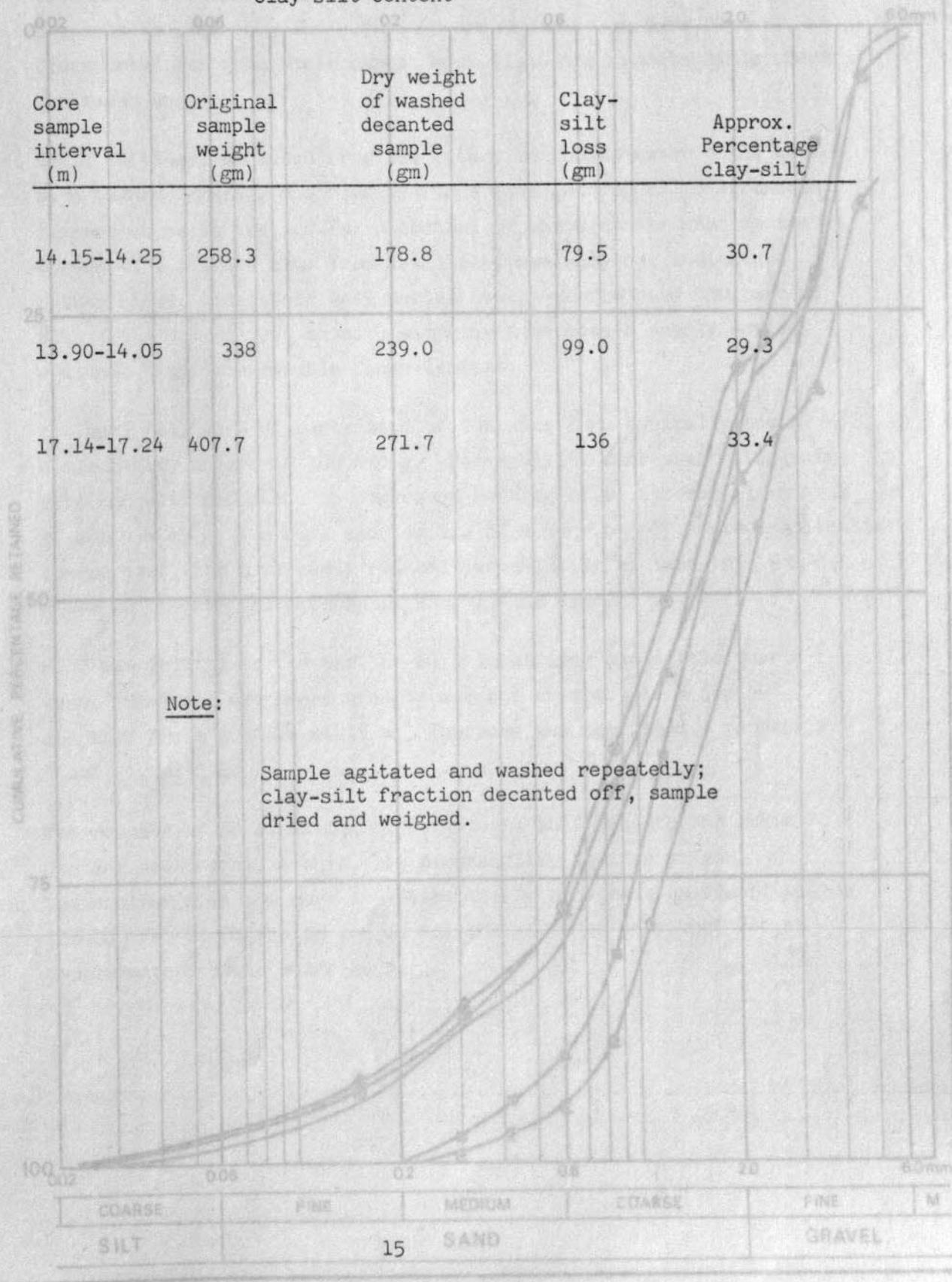


FIGURE 2.9

PARTICLE SIZE DISTRIBUTION GRAPH

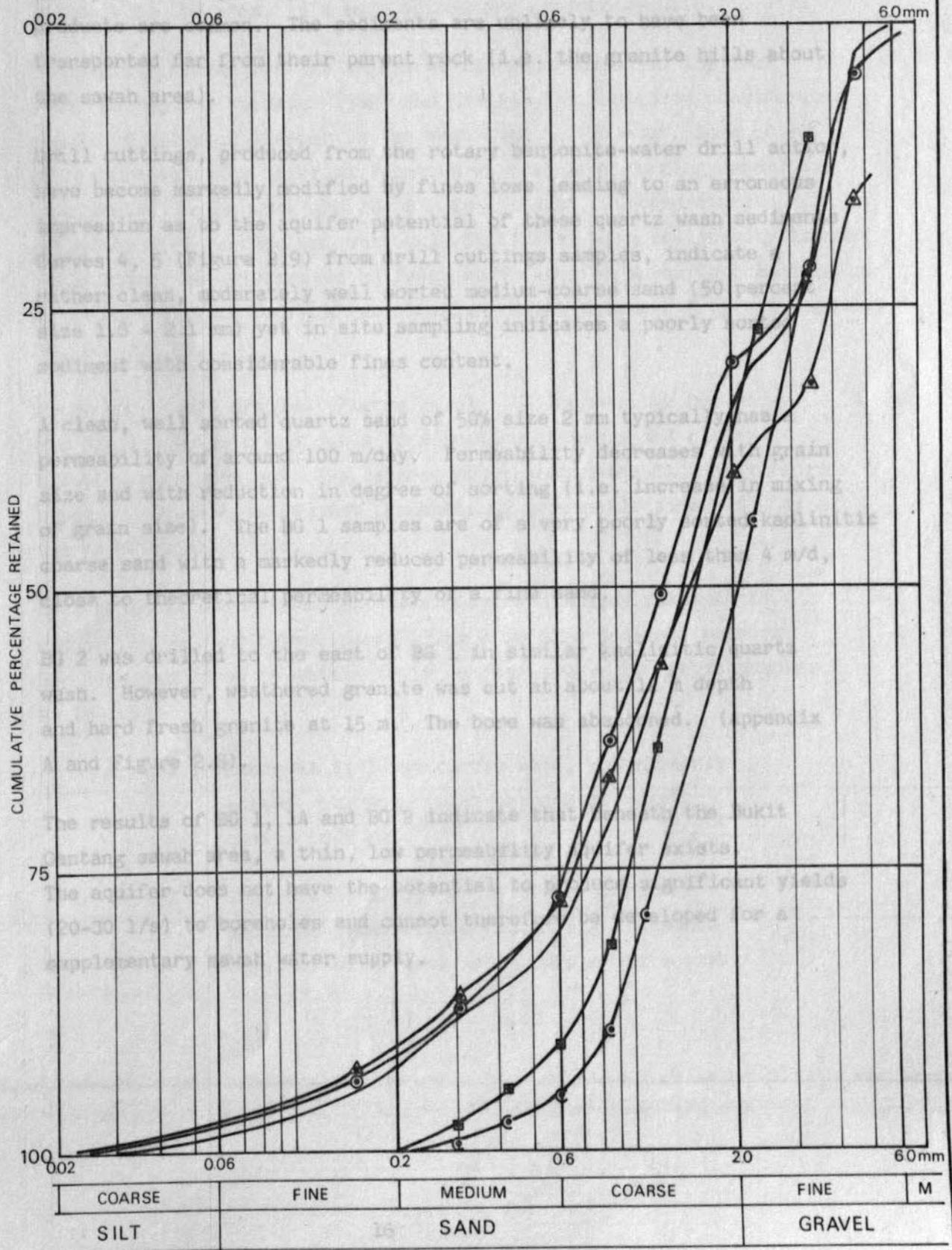
Borehole location: Bukit Gantang, Perak.

Borehole number: BG1,1 A

Sample 1 - 3 Cored, sieved dry, lab

Sample 4 - 5 Drill cuttings, sieved in field  
BG1

Sample no.	Depth interval (m)	$D_{40} / D_{90}$ Uniformity coefficient	$D_{50}$
• 1	13.90 - 14.05	6.7	1.4
⊙ 2	14.15 - 14.25	6.7	1.25
△ 3	17.14 - 17.32	9.4	1.51
⊕ 4	12 - 20	2.9	2.1
⊞ 5	14 - 18	2.9	1.6



Several conclusions can be drawn from the work on BG 1 and BG 1A. The 'alluvial' deposits in the area are best described as an eluvial quartz wash, the product of weathering of granites. The sediment is immature, poorly sorted and clasts are little rounded; partially decomposed feldspar crystals and their kaolin clay end decomposition products are common. The sediments are unlikely to have been transported far from their parent rock (i.e. the granite hills about the sawah area).

Drill cuttings, produced from the rotary bentonite-water drill action, have become markedly modified by fines loss leading to an erroneous impression as to the aquifer potential of these quartz wash sediments. Curves 4, 5 (Figure 2.9) from drill cuttings samples, indicate a rather clean, moderately well sorted medium-coarse sand (50 percent size 1.6 - 2.1 mm) yet in situ sampling indicates a poorly sorted sediment with considerable fines content.

A clean, well sorted quartz sand of 50% size 2 mm typically has a permeability of around 100 m/day. Permeability decreases with grain size and with reduction in degree of sorting (i.e. increase in mixing of grain size). The BG 1 samples are of a very poorly sorted kaolinitic coarse sand with a markedly reduced permeability of less than 4 m/d, close to theoretical permeability of a fine sand.

BG 2 was drilled to the east of BG 1 in similar kaolinitic quartz wash. However, weathered granite was cut at about 12 m depth and hard fresh granite at 15 m. The bore was abandoned. (Appendix A and Figure 2.8).

The results of BG 1, 1A and BG 2 indicate that beneath the Bukit Gantang sawah area, a thin, low permeability aquifer exists. The aquifer does not have the potential to produce significant yields (20-30 l/s) to boreholes and cannot therefore be developed for a supplementary sawah water supply.

## FIGURE 2.10 CANGKAT JONG BOREHOLE LOCATIONS

### 2.2.4 Cangkat Jong

Cangkat Jong is a sawah area on the flood plains of the Sg. Pehlawan and Sg. Bidor; alluvial material underlies the sawah and was expected to contain exploitable aquifers. Bedrock, from evidence of outcrops adjacent to the area, is a metasedimentary sandstone-shale.

Resistivity survey work in this area was reported on in the last progress report (November 1982) and the results indicated considerable depths of alluvium, deeper in the west than in the east. Some 50 m of high resistivity material (equated with aquifer forming sands) was interpreted in the west and 20-30 m in the east. Interpretation of geophysical results was evidently difficult; high resistivity layers could either be interpreted as fresh water aquifer sands in the alluvium or as near surface bedrock (see Sounding ES 65 November Progress Report, Section 2.1.2).

Three bores were drilled (Figure 2.10). CJ 2, near the headworks was drilled to 86 m and cut a 20 m section of sandy and clayey alluvium with peat and clay layers, above monotonous dark grey bedrock shales. Since a sufficient thickness of screenable sands was not cut, the bore was abandoned.

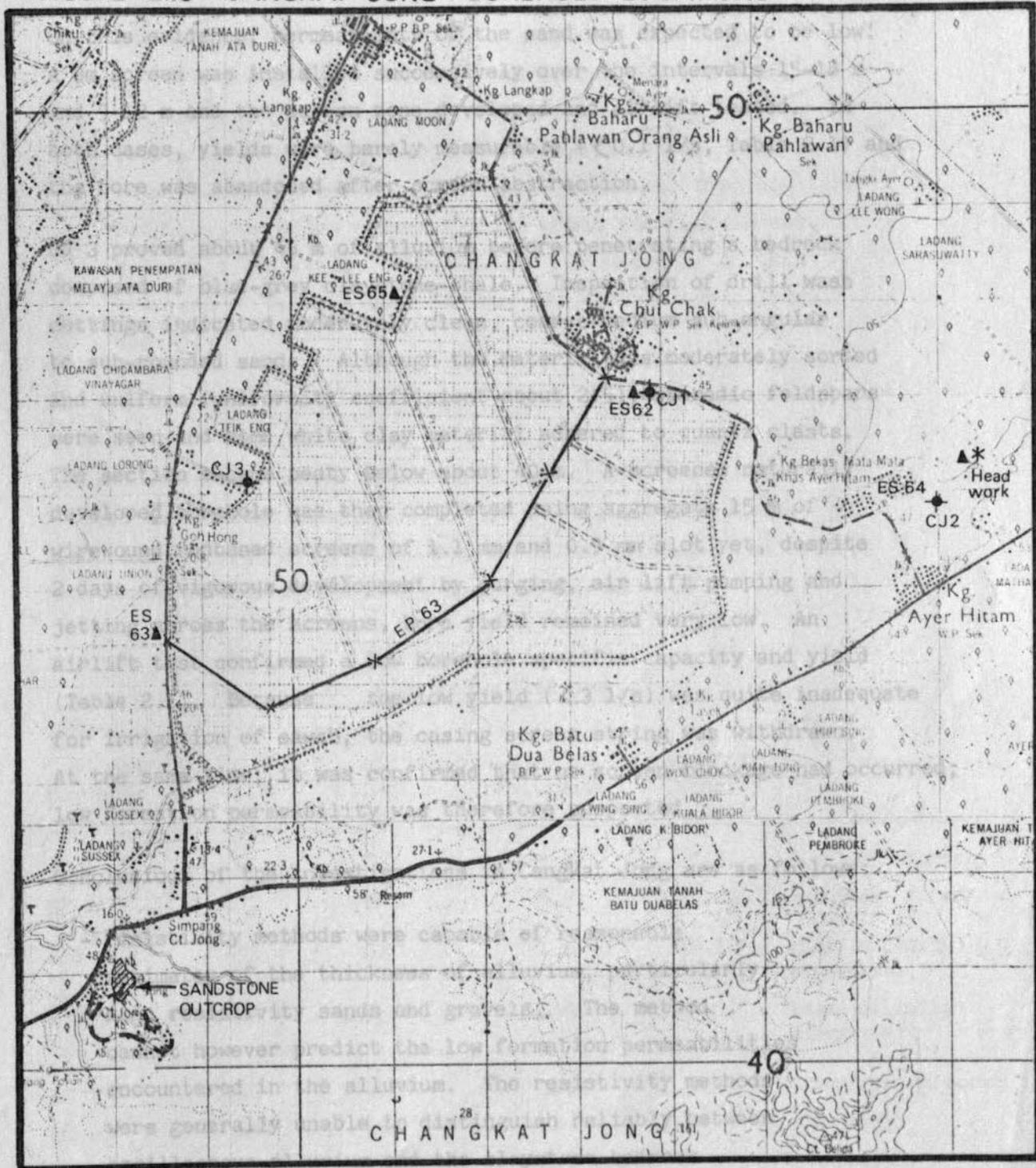
CJ 1 of total depth 42 m, cut 14 m only of a clayey feldspathic medium coarse sand before penetrating a reddish mudstone bedrock. The bore was cored to obtain truly representative formation samples, as follows:

- Core # 1 interval 11-12 m: coarse sand, white poorly sorted, claybound with subangular quartz clasts to 2 cm.
- Core # 2 interval 16-17 m: purple brown quartzose mudstone (?bedrock) contain rock fragments together with (? ex situ) purple-white clay.

#### Legend

- ES 64 Electrical Sounding Location
- CJ 3 Borehole Location

FIGURE 2.10 CANGKAT JONG : BOREHOLE LOCATIONS



**Legend**

- ▲ ES 64 Electrical Sounding Location.
- ◆ CJ 3 Borehole Location.

On this evidence, permeability of the sand was expected to be low! A 3m screen was installed successively over the intervals 15-18 m and 9-12 m and the screen zone developed and airlift tested. In both cases, yields were barely measurable ( $<0.1$  l/s, Table 2.1) and the bore was abandoned after screen abstraction.

CJ 3 proved about 45 m of alluvium before penetrating a bedrock composed of blue-grey claystone-shale. Inspection of drill wash cuttings indicated moderately clean, coarse-medium sub-angular to sub-rounded sands. Although the material was moderately sorted and uniform (uniformity coefficient about 2.5), sporadic feldspars were seen and some white clay material adhered to quartz clasts. The section became peaty below about 40 m. A screened naturally developed borehole was then completed using aggregate 15 m of wirewound rodbased screens of 1.1 mm and 0.9 mm slot yet, despite 2 days of vigorous development by surging, air lift pumping and jetting across the screens, bore yield remained very low. An airlift test confirmed a low borehole specific capacity and yield (Table 2.1). Because the low yield ( $<3$  l/s) was quite inadequate for irrigation of sawah, the casing screen string was withdrawn. At the same time, it was confirmed that no screen blockage had occurred; low formation permeability was therefore suspected.

Conclusions of the investigations in Cangkat Jong are as follows:

- resistivity methods were capable of reasonable estimates of the thickness of alluvium, particularly high resistivity sands and gravels. The method cannot however predict the low formation permeabilities encountered in the alluvium. The resistivity methods were generally unable to distinguish reliably between argillaceous alluvium and the claystone bedrock (e.g. ES 63, ES 65 November 1982 Progress Report, and CJ 3 this report).

- the alluvium of Cangkat Jong is misnamed. It is an eluvial quartz wash sediment, poorly sorted with sub-angular quartz and feldspar clasts and kaolin clay rich matrix derived from feldspar decomposition. As noted in Bukit Gantang (Section 2.2.3), such sediments form aquifers with low formation permeabilities which can sustain only extremely low yields to boreholes. Groundwater in this area cannot be developed for any large scale agricultural use.

### 2.2.5 Alluvial Aquifer Potential

Unconsolidated sediments have been tested by JPT Groundwater Section in the coastal enclave of Balik Pulau, Penang Island, at Alma, and in Perak at Cangkat Jong and Bukit Gantang. The results from these nine boreholes are summarised (Table 2.3).

Table 2.3  
Data Summary : Bores in Alluvium

Borehole No.	Depth (m)	Thickness of alluvium (m)	Airlift Discharge (l/s)	Specific Capacity (l/s/m)	Remarks
BP 1	97	76	3.8	0.21	9 m WwRb screen
BP 2	101	67	5.5	0.38	6 m WwRb screen
A 1-5	55	26	1.5	<0.1	High salinity; abandoned
A 2	41	31.5	1.8	-	High salinity; abandoned
BG 1	40	19	1.0	0.2	Observation bore
BG 2	21	12	0	-	abandoned
CJ 1	42	14	<0.1	-	abandoned
CJ 2	86	20	0	-	abandoned
CJ 3	66	45	2.3	0.12	15 m WwRb screen; screen withdrawn; abandoned.

Generally, small alluvial thicknesses have been proved. Even in the extensive low level plain about Cangkat Jong, bedrock is frequently found at shallow depths. Groundwater potential is however reduced not so much by thickness of alluvial material as by generally very low formation permeabilities. The 'alluvium' is better termed granite wash because it shows few signs of passage through a fluvial cycle and is an ill-sorted argillaceous sediment derived from granite decomposition. Exceptionally, these materials have been reworked by river systems to produce well sorted, clean granular materials; in such cases (e.g. Kg. Gajah on Sg. Perak) high permeabilities are recorded from what is accurately termed alluvium.

Airlift yield tests (Table 2.3) indicate very low specific capacities and hence low permeabilities. Theoretical permeabilities of clean granular well sorted materials are shown (Figure 2.11) together with permeability estimates from project boreholes. The coarse sand-fine gravel materials obtained from BG 1A wash samples (evidently unrepresentative) have a 50% size of 2 mm and a theoretical permeability of around 100 m/day. In situ samples are argillaceous and ill sorted and show a large permeability decrease, to 1-10 m/day. Small alluvial thicknesses of low permeability will not give large yields appropriate to irrigation boreholes. The groundwater potential for irrigation of these quartz wash 'alluvial' materials is therefore low.

2.2.6 Sg. Tekam (Felda)

A water balance has been attempted for the Sg. Tekam experimental catchment in Pahang. All catchment water balances, on present data, show between 441 and 509 mm/y of water unaccounted for.

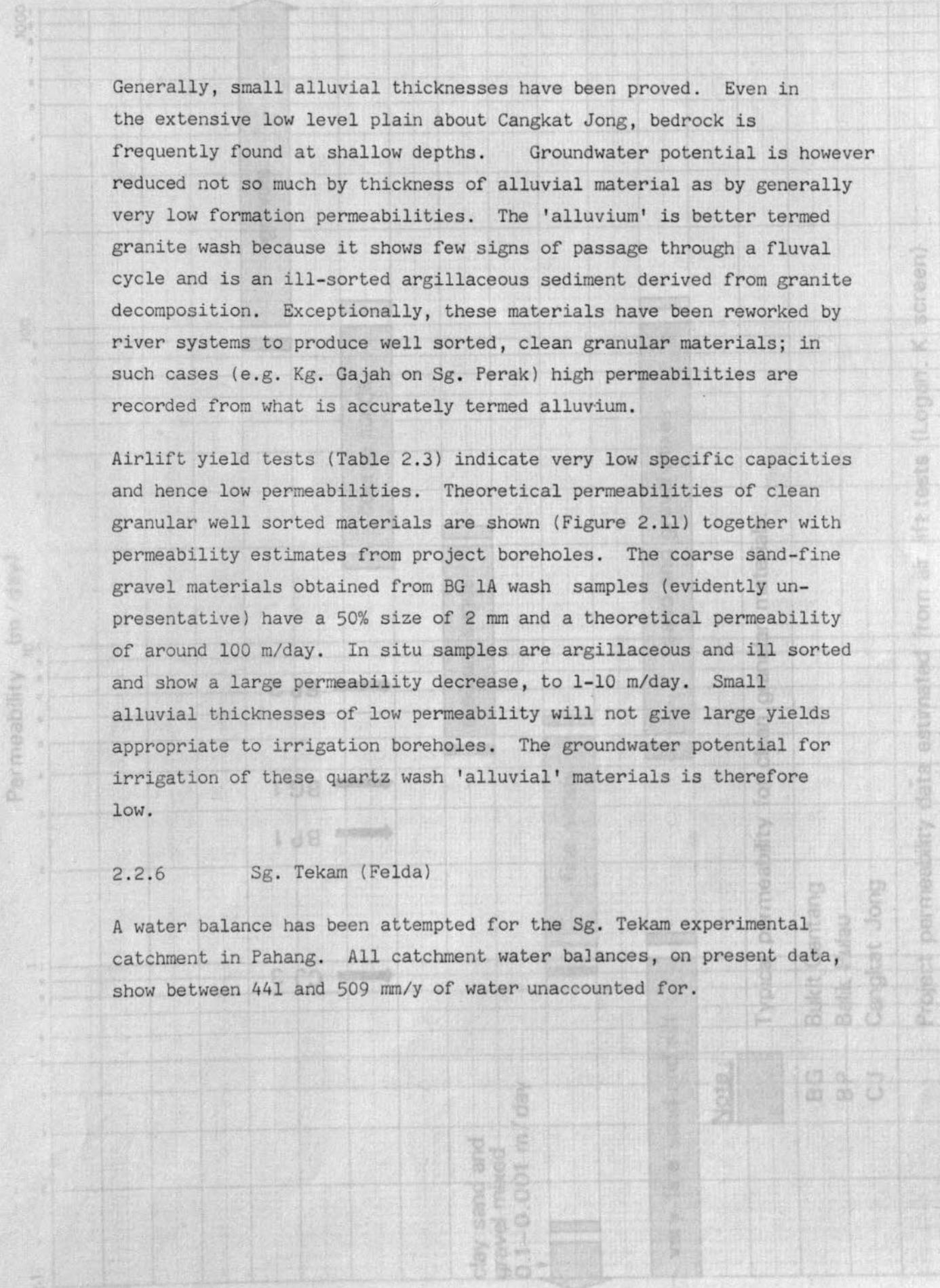
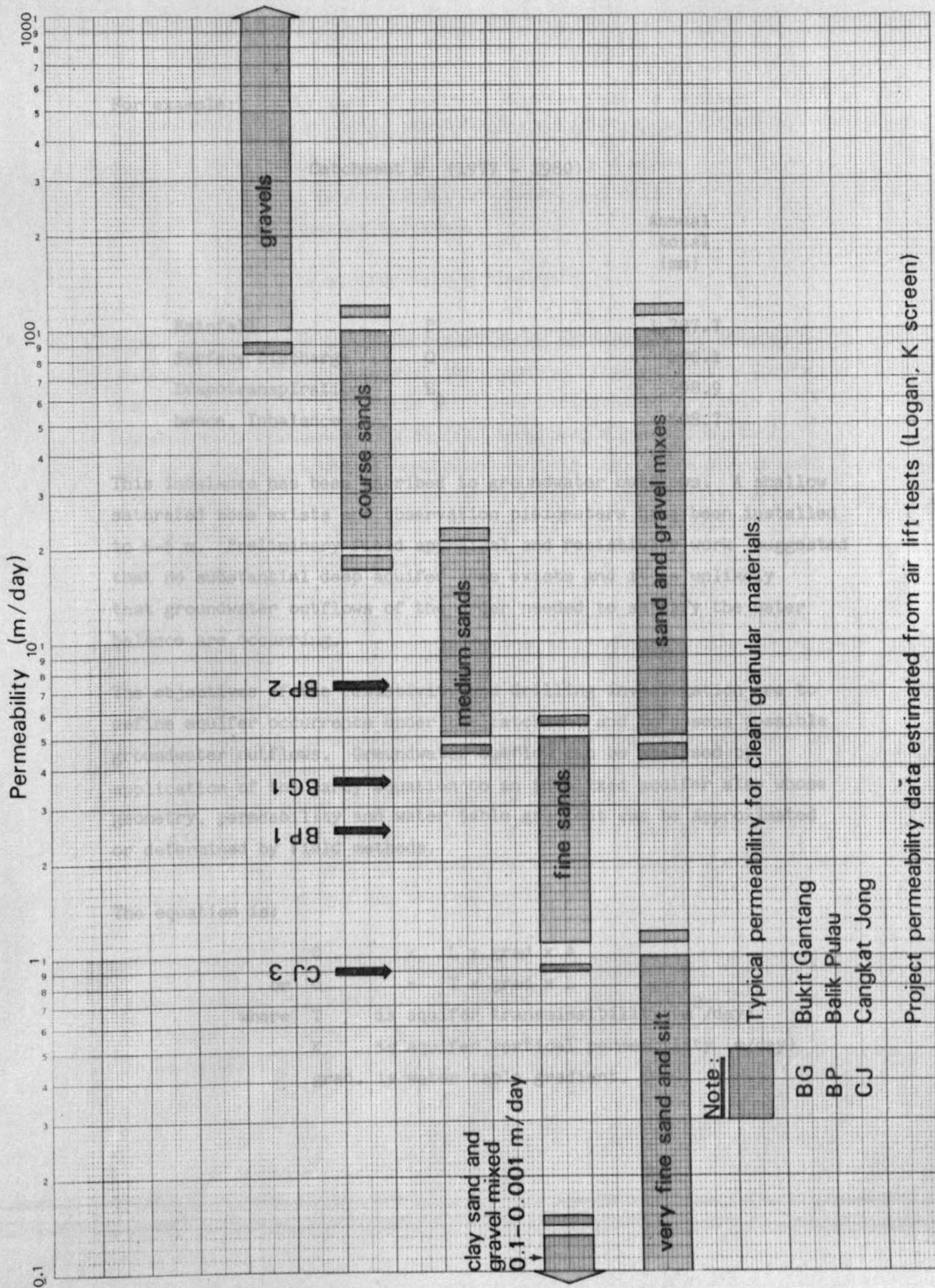


FIGURE 2.11 THEORETICAL PERMEABILITIES AND PROJECT RESULTS



For example:

A is area of vertical outflow face of aquifer  
 at the margin of the catchment element  
 Catchment B (1977 - 1980) x d where  
 L is the length of element and d is  
 aquifer thickness  
 Q is aquifer throughflow ( $m^3/d$ )

Annual  
 total  
 (mm)

Rainfall	P	1,797.7
Surface Discharge	Q	290.1
Evapotranspiration	E	998.9
hence, Inbalance	P	508.7

This inbalance has been ascribed to groundwater outflows. A shallow saturated zone exists and observation piezometers have been installed to 5-6 m. Preliminary field appraisal and resistivity work suggested that no substantial deep aquifer zone exists and it is unlikely that groundwater outflows of the order needed to satisfy the water balance are occurring.

The objectives of the resistivity and drilling investigation are to define aquifer occurrence under the catchment and to assess possible groundwater outflows. Groundwater outflow can be analysed by application of the Darcy equation to an idealized aquifer slab whose geometry, permeability and water table gradient can be approximated or determined by field methods.

The equation is:

$$Q = L \times \text{grad} \times A$$

$$\text{or } Q = T \times \text{grad} \times L$$

where T is aquifer transmissibility ( $m^2/\text{day}$ )

K is aquifer vertical permeability (m/day)

grad. is water table gradient.

A is area of vertical outflow face of aquifer at the margin of the catchment element considered; A is given by  $L \times d$  where L is the length of element and d is aquifer thickness

Q is aquifer throughflow ( $m^3/d$ )

Three boreholes are under construction in catchment B to attempt estimates of the parameters in the equation (Figure 2.12). The two bores completed T1, T2 (Table 2.1) have indicated a very thin impersistent weathered rock aquifer developed in andesite, tuff and meta shale; yields to boreholes are less than 1 l/s and at such low yields, air lift pumping tests to estimate permeability are impractical. Bores are being completed as cased 6" diameter observation piezometers whose casing heads have been extended up to 2 m above ground level to avoid ingress of flood waters. Casing heads will be levelled to allow calculation of groundwater table gradient.

The preliminary conclusion of the work is that the very thin, impersistent low permeability aquifer will be unable to transmit sufficient groundwater to account for the 508 mm imbalance mentioned earlier. An example of an appropriate Darcy calculation, given in Appendix C, suggests that the aquifer might transmit of the order of  $0.0091 \times 10^6 m^3/year$  of groundwater whereas some  $0.49 \times 10^6 m^3/year$  is required to satisfy the balance equation.

### 2.2.7 Drilling Programme

A one drilling rig operation is planned until further notice. On completion of work at Sg. Tekam, the rig will move to Kelantan in early March.

FIGURE 2.12

SG. TEKAM EXPERIMENTAL BASIN: BOREHOLE LOCATION.



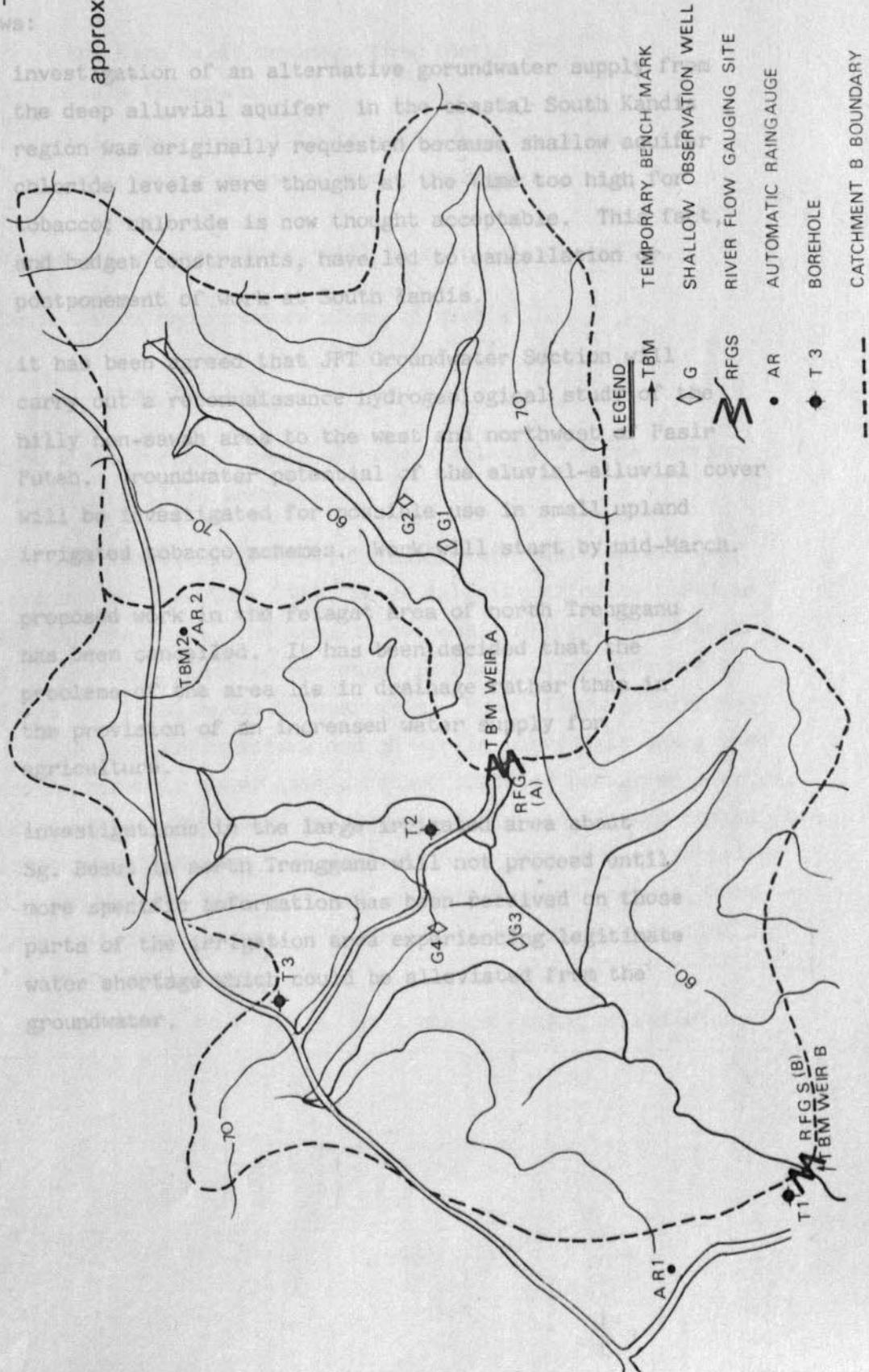
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As a result of meetings between the consultant and JFT, Planning Department, FEL Agri (the consultants to Kemasin-Jemarak project) and JFT, Terengganu, some programme revisions have been made, as follows:

- investigation of an alternative groundwater supply from the deep alluvial aquifer in the coastal South Kinta region was originally requested because shallow aquifer levels were thought to be too high for irrigation. It is now thought acceptable. This is subject to budget constraints, having to translocate on a post-ponement of the South Kinta irrigation project. It has been proposed that JFT undertake detailed hydro-geological studies to the west and north-west of the main alluvial-aluvial cover will be investigated for possible small-land irrigated tobacco schemes.

- proposed investigation of the large area north of Terengganu has been cancelled. It has been decided that the area is in danger of being lost to the problem of increased salt water intrusion from the sea.

- investigation of the large area north of Terengganu more specifically in the area of the proposed investigation parts of the area is in danger of being lost to the water shortage problem. It is proposed that the groundwater



As a result of meetings between the consultant and JPT, Planning Department, SCET Agri (the consultants to Kemasin-Semerak project) and JPT, Trengganu, some programme revisions have been made, as follows:

- investigation of an alternative groundwater supply from the deep alluvial aquifer in the coastal South Kandis region was originally requested because shallow aquifer chloride levels were thought at the time too high for tobacco; chloride is now thought acceptable. This fact, and budget constraints, have led to cancellation or postponement of work at South Kandis.
- it has been agreed that JPT Groundwater Section will carry out a reconnaissance hydrogeological study of the hilly non-sawah area to the west and northwest of Pasir Puteh. Groundwater potential of the eluvial-alluvial cover will be investigated for possible use in small upland irrigated tobacco schemes. Work will start by mid-March.
- proposed work in the Pelagat area of north Trengganu has been cancelled. It has been decided that the problems of the area lie in drainage rather than in the provision of an increased water supply for agriculture.
- investigations in the large irrigated area about Sg. Besut in north Trengganu will not proceed until more specific information has been received on those parts of the irrigation area experiencing legitimate water shortage which could be alleviated from the groundwater.

- JPT Trengganu has recently indicated, in a general way, two areas where groundwater investigation could be required. These are:

- the Batu Rakit drainage area (north of Kuala Trengganu)
- bris soil coastal lands near Kuala Besut and near Marang (south of Kuala Trengganu).

Reconnaissance of these areas will be carried out shortly.

The current work programme is given (Figure 2.13).

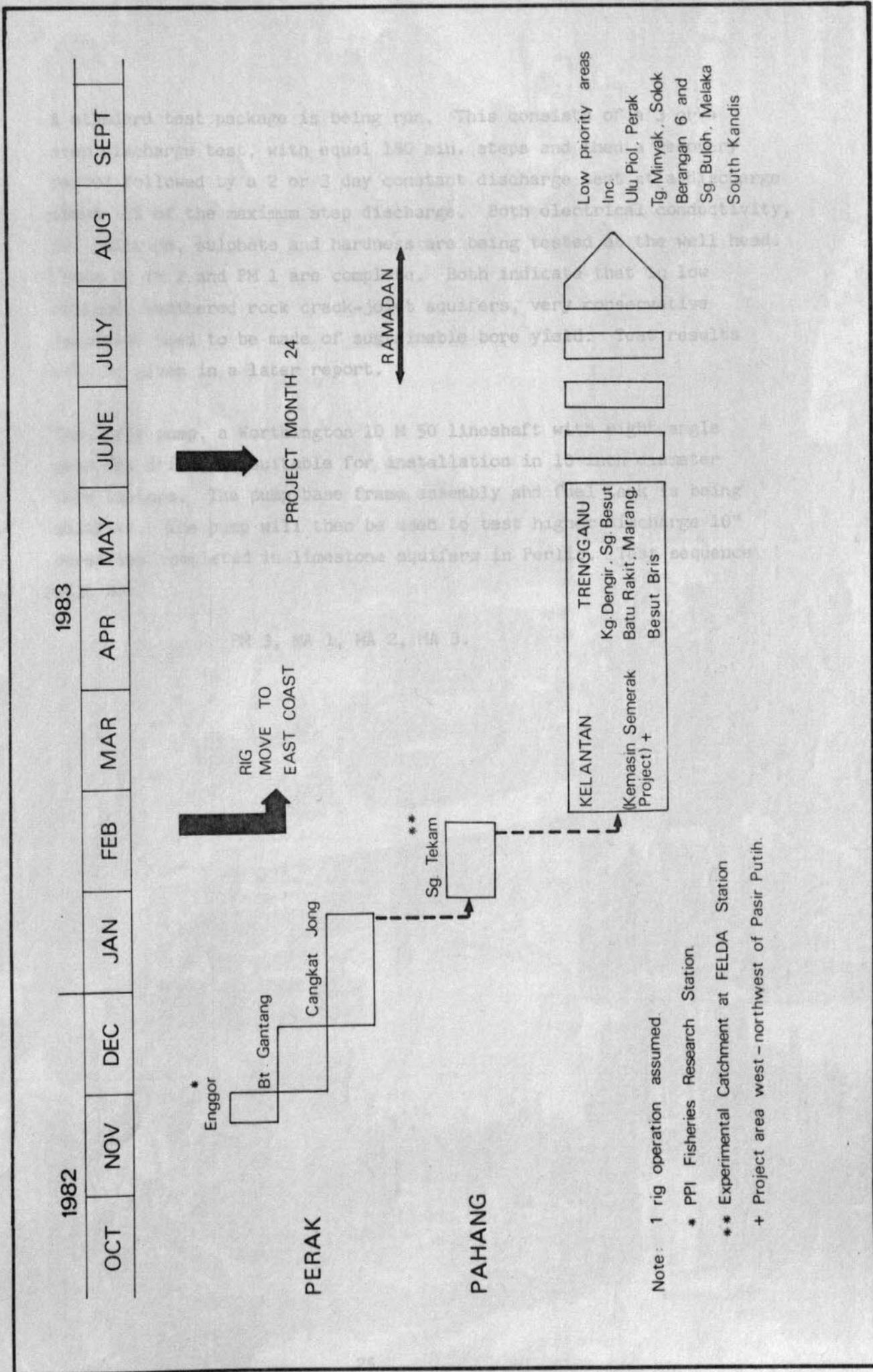
#### 2.2.8 Pump Testing

Two line shaft borehole pumps are now available for the testing of previously drilled boreholes.

A small pump (Gadelius BP 45-4, lineshaft with belt drive) was commissioned on 3 January 1983, in an existing artesian borehole in Lake Gardens, K.L. The pump is currently being used to test cased 6" internal diameter boreholes in Perlis at discharges up to 12 l/s and total heads of over 25 m. Pump clearance within 6" i.d. casing is unsatisfactory and an airline device is being used to measure borehole water levels rather than the preferred electric measuring sonde. The small annular clearance has already contributed to airline damage during pump installation. The BP 45-4 is being used in conjunction with a 4" i.d. orifice tube with 2", 2½" and 3" diameter orifice plates. Tests are being run on boreholes in the following sequence:

PM 2 PM 1 PM 4 MB 1A MB 2 thence Penang or Kelantan.

FIGURE: 2.13 TENTATIVE PROGRAMME OF RIG OPERATION.



A standard test package is being run. This consists of a 3 or 4 step discharge test, with equal 180 min. steps and then a recovery period followed by a 2 or 3 day constant discharge test at a discharge about 75% of the maximum step discharge. Both electrical conductivity, pH, chloride, sulphate and hardness are being tested at the well head. Tests on PM 2 and PM 1 are complete. Both indicate that in low storage, weathered rock crack-joint aquifers, very conservative estimates need to be made of sustainable bore yield. Test results will be given in a later report.

The large pump, a Worthington 10 M 50 lineshaft with right angle gear box drive, is suitable for installation in 10 inch diameter bore casings. The pump base frame assembly and fuel tank is being modified. The pump will then be used to test higher discharge 10" boreholes completed in limestone aquifers in Perlis. Test sequence will be:

PM 3, MA 1, MA 2, MA 3.



FIGURE 3.1

## DRILLING PROGRESS

### 3. DRILLING

#### 3.1 Introduction

Investigations and testing has been performed in three separate areas (Figure 3.1) whilst JPT Taiping, JPT Telok Intan and currently, Felda, Sg. Tekam in Pahang have been used as storage bases for the drilling group. Although the transfer of equipment and stores between bases has taken up much time, ten boreholes have been completed (Table 3.1). Besides the normal exploration and test bore programme, extra coreholes drilled solely for undisturbed sampling have been necessary.

Drilling operations during the period covered by this report have been carried out by one rig only; the spare unit has been placed in the Ampang store. During the move between Telok Intan and Pahang, Rig I was replaced by Rig II, although the same crew was retained. During its stay in Ampang it is hoped that the maintenance and repairs required on Rig I will be carried out by the reserve crew.

Equipment from the redundant rig, temporarily placed in the JPT workshop Ipoh, is now being transferred to Ampang. An accumulation of other excess stores deposited in Taiping and Telok Intan are also being returned to Ampang when transport can be arranged. Unused 10" and 6" well casing now stored at Taiping should be transferred directly to Kota Baru via the east-west highway.

#### 3.2 Drilling Investigations

Up-grading of the rig hydraulic cooling systems was completed by the end of November. Rig I, the first to be completed, commenced drilling E1 at the Enggor PPI fisheries station on the 26th of November. The bore cut 13 m of clayey alluvium containing weathered products and 18 m of weathered granite before cutting fresh granite. The bore was continued to 100 m by down-hole-hammer (D.H.H.) but groundwater was not present and the site was abandoned.

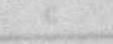
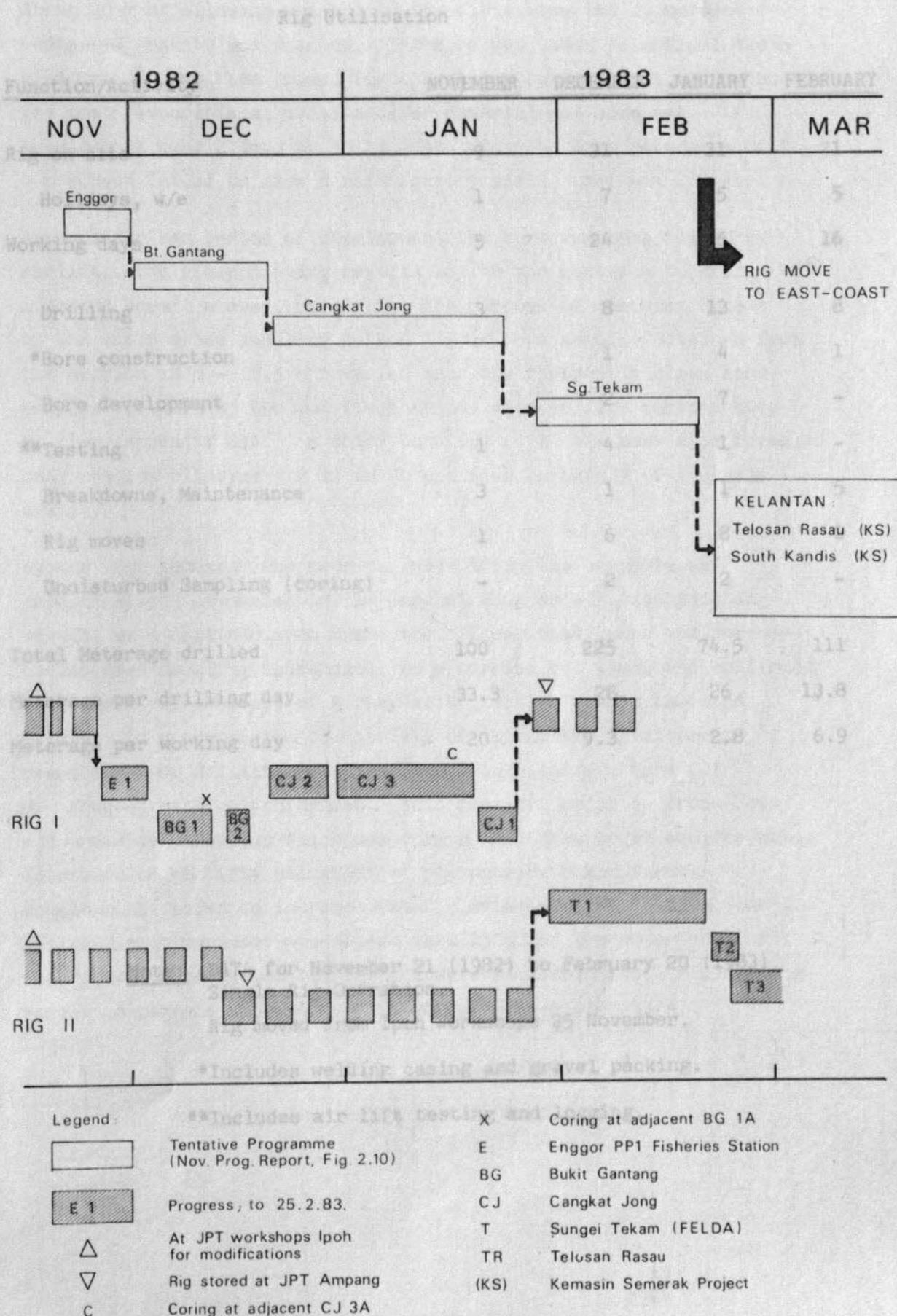
	Tentative Programme (New Prog Report, Fig 2.30)	E	Enggor PPI Fisheries Station
	Progress to 26/11/83	BG	Batu Gantang
	At JPT workshop Ipoh for modifications	CJ	Cangkar Jeng
	Rig stored at JPT Ampang	T	Sungai Tekam (FELDA)
	Coring at site	TR	Terosan Resau
		(KS)	Kemasah Dendak Project

FIGURE 3.1

# DRILLING PROGRESS.



Work at Bukit Gantang near Table 3.1 commenced on the 4th December.

About 20 m of alluvium Rig Utilisation first site (BU 1) before weathered granite was reached. The bore was taken to a final depth

<u>Function/Activity</u>	<u>NOVEMBER</u>	<u>DECEMBER</u>	<u>JANUARY</u>	<u>FEBRUARY</u>
Rig on site	9	31	31	21
Holidays, w/e	1	7	5	5
Working days	5	24	26	16
Drilling	3	8	13	8
*Bore construction		1	4	1
Bore development		2	7	-
**Testing	1	4	1	-
Breakdowns, Maintenance	3	1	1	5
Rig moves	1	6	8	2
Undisturbed Sampling (coring)	-	2	2	-
Total Meterage drilled	100	225	74.5	111
Meterage per drilling day	33.3	28	26	13.8
Meterage per working day	20	9.3	2.8	6.9

Note: DATA for November 21 (1982) to February 20 (1983)  
Single Rig Operation.  
Rig moved from Ipoh Workshops 25 November.

\*Includes welding casing and gravel packing.

\*\*Includes air lift testing and logging.

Work at Bukit Gantang near Taiping commenced on the 4th December. About 20 m of alluvium was cut at the first site (BG 1) before weathered granite was reached. The bore was taken to a final depth of 40 m. It was then reamed for conversion to test well status and the most favourable alluvial aquifer material was screened. Development over 2 days by jetting and cleaning with detergent of the 6 m screen failed to give a satisfactory yield (section 2.2.3).

After a further period of development the bore was pump tested by airlift. The disappointing results led to the decision to drill a second bore 3 m away, purely for the purpose of checking strata by the undisturbed sampling method. Four core samples obtained from the section 12 m - 17.5 m revealed that the apparently clean sand samples obtained by the mud flush system were in fact contaminated by clay (Appendix B1). A third bore (BG 2) in the same area revealed only shallow alluvium (12 m) which was most certainly of the same quality.

By the 20th December the move to Telok Intan was complete and investigations commenced in the Cangkat Jong area. Disappointing results were obtained from there too. Three test bores and further undisturbed sampling (coreholes) were carried out there and confirmed once again the presence of a clay-silt fraction within the sand. However, to discount the possibility of incomplete development resulting from drilling mud invasion of the aquifer, bore CJ2 was treated with polyphosphate. This chemical helps to break down mud and clay particles which can form a wall cake to be aquifer zone. Introduction of fifty kilograms of polyphosphate and further development failed to increase yield. After airlift testing, the casing-screen assembly was pulled back 15 m and the upper aquifer material developed, but the results were similarly poor. All casing-screen components were later recovered for use elsewhere.

The move from Telok Intan to the Felda scheme at Sungai Tekamery (Pahang) took place during the last week of January. To allow time for minor rig repairs it was thought advantageous to exchange rigs at JPT, Ampang. This process is exaggerated under drilling conditions where cuttings are returned to the surface after being removed from the bottom of the hole by a stream of high pressure/volume drilling fluid. The contribution by the JPT Groundwater Section to the water balance study at Sungai Tekam involves drilling two or three bores to establish if highly permeable strata is present under the area (Section 2.2.6). Later, the bores will be continuously monitored for water levels.

The first bore encountered hard shattered sandstone from 8 m. Trouble occurred with overbreak of the rock whilst using the D.H.H. This led to overlarge rock fragments being produced and evacuation of these fragments through the borehole drillpipe annulus proved difficult. Because of this, the powerful Dresser D.H.H. then being used was pulled from the bore and the Tone hammer substituted. The lighter blow imparted from this hammer to the bit then produced much small cuttings which did not damage the surrounding rock. Penetration rate was, of course, reduced. The 1 l/s discharge from this bore was produced entirely from the zone 8-12 m.

### 3.3 Drilling Problems and Recommendations

#### 3.3.1 General

Unexpected, extremely low yields from test bores causes alarm to the most experienced. Mistakes can be made in sampling, depth estimation, description of strata, analysis of electric and gamma logs and by the use of inappropriate bore development techniques. All these matters were checked many times at Bukit Gantang and Cangkat Jong, but not until adjacent coreholes (specifically for undisturbed sampling) were drilled and cores obtained and extracted in the Ampang laboratories, could considerable percentages of kaolinitic clay silt be demonstrated; this fine fraction provided a reason for the poor permeability (Table 2.2).

Simple tests on the undisturbed core samples showed that the very light clay found in the samples could be floated off the quartz-feldspar grains within seconds when agitated in water under a running tap. This process is exaggerated under drilling conditions where cuttings are returned to the surface after being removed from the bottom of the hole by a stream of high pressure/volume drilling mud.

As discussed in section 2.2, the so-called quartz wash or mining sands (mainly derived from weathered granites) found on the western side of the peninsular appear to make very poor aquifers. Poor aquifer permeability is indicated by the many alluvial tin mines which are worked well below the water table in open pits where minimal drainage is necessary.

The following notes are written with a view to illustrating the problems associated in obtaining representative samples by the mud flush system of drilling. However, under the most favourable conditions it would be extremely difficult to recognise the presence of a clay/silt fraction in normal mud drilled sand cuttings samples when the particles of interest may be as small and similar in appearance to those in adjacent clay layers, or perhaps to the ingredients of the drilling mud (bentonite) itself. In this case undisturbed core samples or samples obtained by bailers could give a more accurate picture of insitu lithology.

### 3.3.2 Mud Flush Sampling and Mud Control.

#### Sampling Error

Drilling by mud flush accounts for about 90% of all drilling done worldwide. In unconsolidated formations under the right conditions, only reverse circulation by water flush gives better results. For successful drilling, mud at the correct viscosity, volume and density must be circulated down the drill pipes, through the bit and back up the hole. If these conditions are not met, sampling may become haphazard.

Examples below show some of the consequences of poor drilling mud control:

Fault	Result
iv. Mud volume excessive (U.H.V. too high)	a) Collapse at the bore wall with a possibility of collapse
i. Mud viscosity too low (thin)	a) Insufficient buoyancy (carrying ability) to support heavy cuttings. Cuttings which cannot reach the surface are allowed to descend when mud-pump is stopped.  b) Leads to lost circulation problems.
ii. Mud viscosity too high (thick)	a) Leads to difficulty in dropping cuttings at the surface and allows them to be recirculated back down the bore.  b) Leads to high sand content in the drilling mud which causes premature wear to pump components, etc.
iii. Insufficient volume (Low U.H.V.)	c) Causes later bore development problems because of increase of weight in the mud column (due to recirculation of drill cuttings).
(Low U.H.V.) Mud Viscosity	a) Poor hole cleaning  b) Causes larger cuttings to separate from host material
A drilling mud viscosity of between 36 and 48 seconds, measured on the Marsh Funnel, is normally ideal. However, higher viscosity may be necessary in some cases. The following are pertinent to mud viscosity control:	c) Creates wall cake due to build up of clay and cuttings.  d) Bit is not cleared properly, cuttings remain on hole bottom and then are reground.

UP HOLE VELOCITY - MUDFLUSH.

Fault	Result
iv. Mud volume excessive (U.H.V. too high)	a) Erosion at the bore wall with a possibility of collapse
v. High density (S.G. high)	a) Can lead to lost circulation problems, thick wall cake. Mainly caused by solids build up in drilling mud.

Up Hole Velocity

Research as shown that an up hole velocity (U.H.V.) between borehole wall and drill pipe in alluvial materials is ideally between 60-75 cm per second. It can be seen (Fig. 3.2) that, while using 4 3/4" drill pipe to drill a 6 1/4" dia. exploration bore, U.H.V. is excessively high when the maximum output of the Tone mud pump is used. There is some evidence from caliper logs that hole enlargement (or belling) of some sections of recent bores (e.g. CJ 3) has taken place.

Whilst erosion can, as discussed previously, cause caving of the bore through erosion and undermining of strata, the resultant large diameter hole also creates a drop in the mud U.H.V. in that region, with the result that cuttings from lower down do not appear at the surface in proper order. Moreover, while erosion is taking place this material mixes with the drill cuttings and misleading samples are recovered.

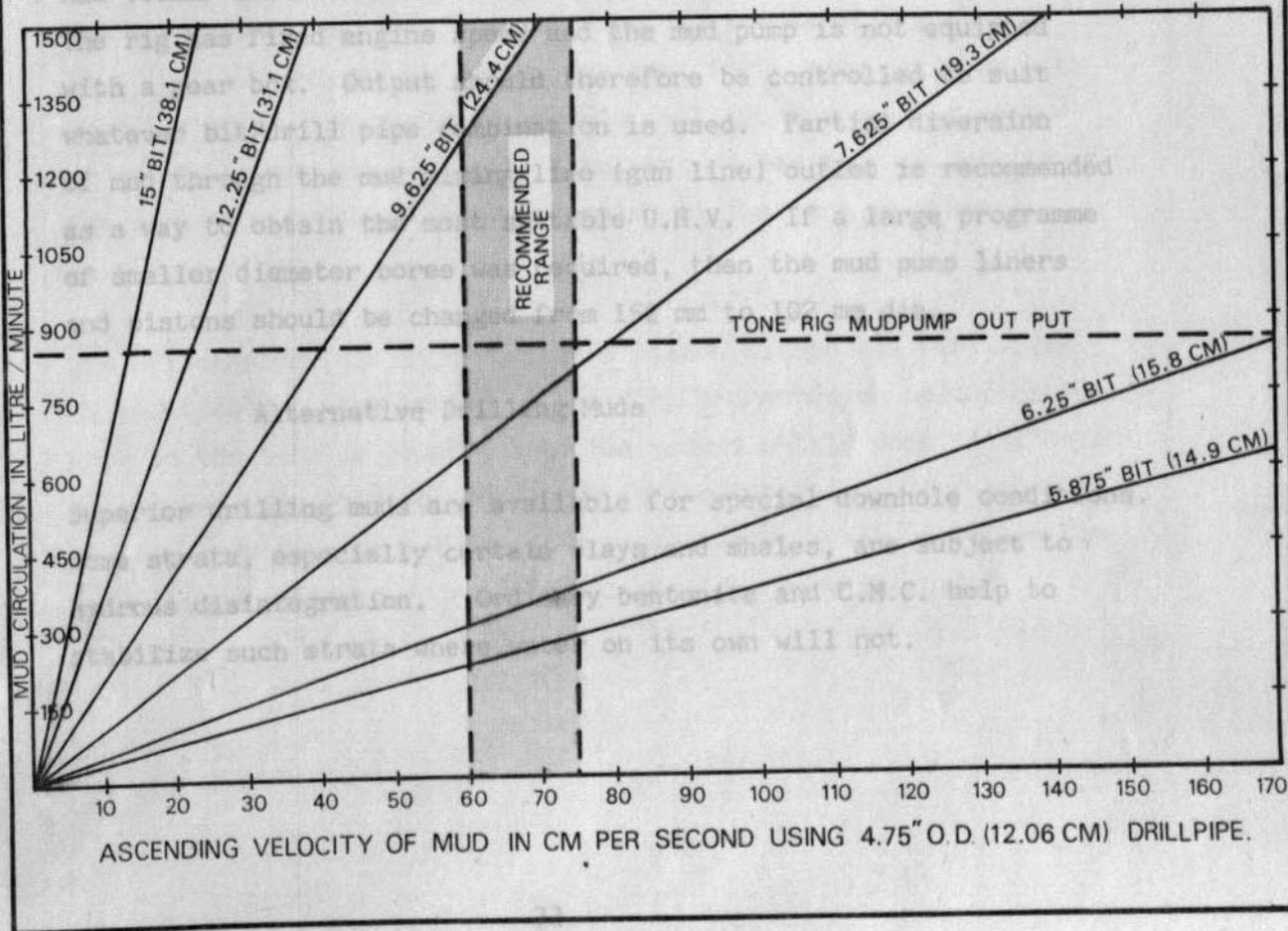
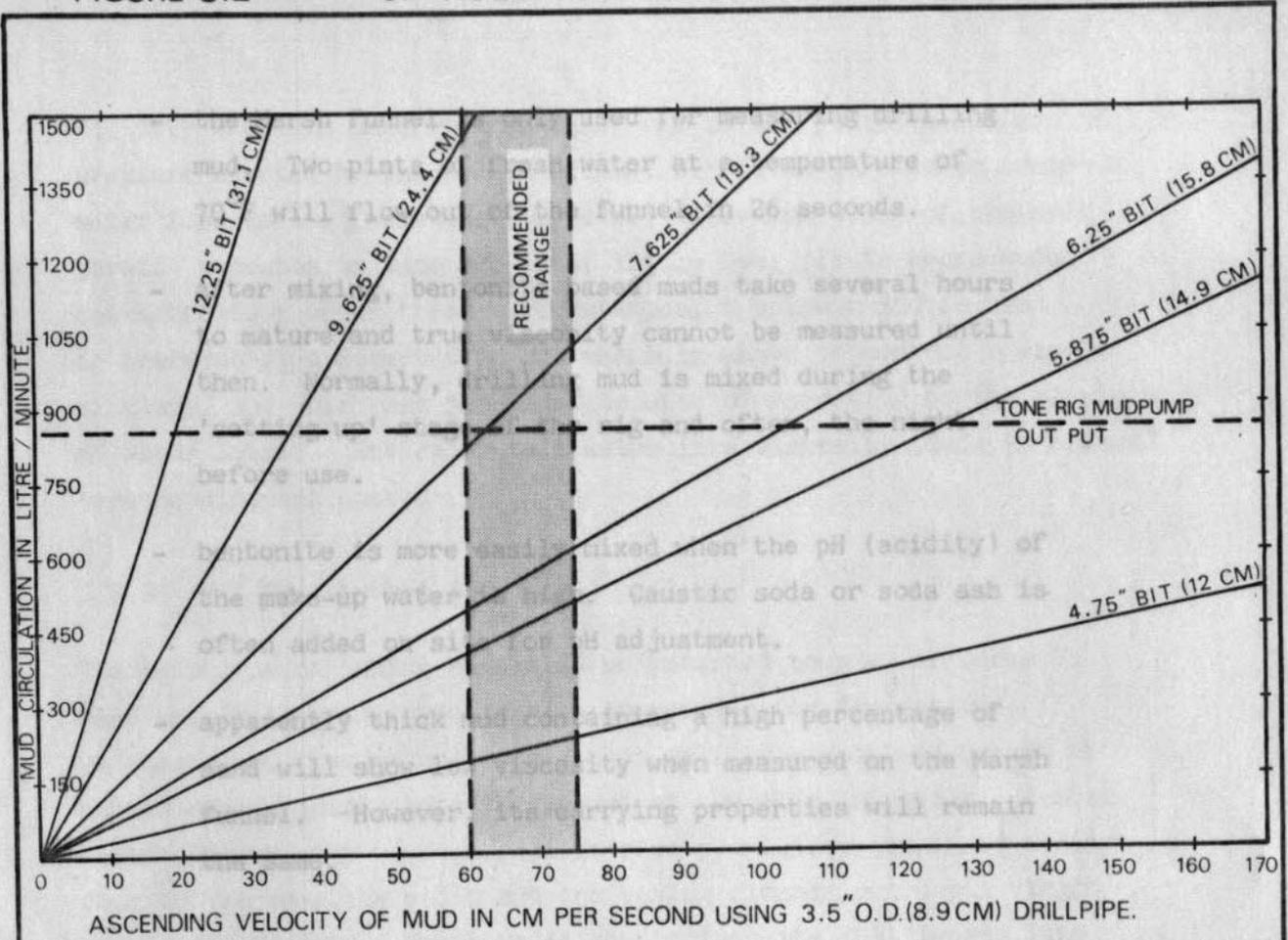
Mud Viscosity

A drilling mud viscosity of between 36 and 40 seconds, measured on the Marsh Funnel, is normally ideal for waterwell drilling. However, higher viscosity may be necessary, especially when U.H.V. requirements cannot be met. The following are pertinent to mud viscosity control:

ASCENDING VELOCITY OF MUD IN CM PER SECOND USING 4.75" O.D. (12.06 CM) DRILLPIPE

FIGURE 3.2

UP HOLE VELOCITY - MUDFLUSH.



- the Marsh funnel is only used for measuring drilling mud. Two pints of fresh water at a temperature of 70°F will flow out of the funnel in 26 seconds.

- after mixing, bentonite based muds take several hours to mature and true viscosity cannot be measured until then. Normally, drilling mud is mixed during the 'setting up' stage of the rig and often, the night before use.

- bentonite is more easily mixed when the pH (acidity) of the make-up water is high. Caustic soda or soda ash is often added on site for pH adjustment.

- apparently thick mud containing a high percentage of sand will show low viscosity when measured on the Marsh funnel. However, its carrying properties will remain the same.

#### Mud Volume Control

Mud volume control is not easy to achieve with the Tone rig. The rig has fixed engine speed and the mud pump is not equipped with a gear box. Output should therefore be controlled to suit whatever bit/drill pipe combination is used. Partial diversion of mud through the mud mixing line (gun line) outlet is recommended as a way to obtain the most suitable U.H.V. If a large programme of smaller diameter bores was required, then the mud pump liners and pistons should be changed from 152 mm to 102 mm dia.

#### Alternative Drilling Muds

Superior drilling muds are available for special downhole conditions. Some strata, especially certain clays and shales, are subject to hydrous disintegration. Ordinary bentonite and C.M.C. help to stabilize such strata where water on its own will not.

Possibly the main benefit from their use is the positive differential pressure exerted by the column of mud; C.M.C. in particular controls water loss to the formation. However, in severe cases of unstable strata, a bentonite base mud is of little use. It is recommended therefore that under these circumstances, a polymer mud is used or preferably, a Revert type mud which is known to control breakdown of clays, and which has the added benefit of reverting to the consistency of water later. Reversion to a water like viscosity leads to reduced bore development costs.

### 3.3.3 Undisturbed Sampling

The technique of taking so-called undisturbed samples or cores is used mainly in soil investigation programmes for foundation calculations. The method uses a thin wall tube which is driven or pushed hydraulically into the ground at specific intervals. A soil investigation unit would normally drive protective temporary casing down to the sampling point and the casing cleaned out until virgin strata was exposed. The tube is then driven its full length into the strata (usually 0.5 to 1.0 m penetration).

The undisturbed sampling tube is rated in inches of diameter (i.e. U2, U3, U4) and is really designed for clayey soils or very cohesive sands. Such simple tubes do not incorporate any method of retaining the sample in the tube, but rather rely on packing of the formation to the tube or expansion at the core as occurs with some clays.

The JPT sampler (U3) incorporates a piston within the tube which is positioned at the bottom of the tube and moves up on top of the core as the tube is pressed into the ground until, when final depth is reached, the 'piston rod' locks in the tube head. Any tendency for the core to slip out on withdrawal creates a vacuum within the tube thus creating favourable conditions for core retention.

In the Consultants experience, the sampling tubes mentioned above are incapable of retention of the non-cohesive, unconsolidated sands and gravels which form good aquifers; rather such sands and gravels can only be sampled by the bailer method. The fact that the sampling conducted in possible aquifer zones at BG 1A and CJ 3A with sampling tubes was mainly successful in core recovery (Appendix B1) indicates (even before core extrusion and examination) that the material sampled can be of little potential as an aquifer. Good core recovery indicates a cohesive clay rich material.

It is recommended, however, that when such tube sampling is attempted, the bore is properly cleaned of cuttings andavings. After it has been circulated clean, the bore must be kept full of mud whilst the drill pipes are removed. It is not envisaged that casing the bore to each sampling interval would be practical. In fact sampling under mud has been proved to be feasible in an uncased bore.

### 3.3.4 Maintenance and Repairs

#### General

The newly fitted hydraulic oil cooling systems are working well. A slight rise in oil pressure has been noticed and therefore the hydraulic pump relief valves have been re-set accordingly. The rise in pressure is probably due to the hydraulic oil retaining its viscosity now that superior cooling has been effected.

#### Rig I

This rig, now in Ampang, developed clutch trouble on its journey from Telok Intan to K.L. and had to be towed the last few kilometres. An inspection reveals that a replacement is required. The present clutch was installed in December 1981. Although heavy duty plates were installed, the clutch unit suffers greatly when the rig becomes stuck in soft ground. This is because the gearing is too high, as mentioned in past reports.

Whilst Rig I is in Ampang, rig fault rectification requires the following work:

- replace Isuzu clutch and check flywheel
  - replace/repair exhaust components
  - replace hydraulic control valve spindle
  - repair compressor coupling
  - repack mud swivel
  - repair damper sub (obtain seal from Japan)
  - re-set Tone remote clutch control mini-pack
  - replace yokes on air compressor and mud pump dog-clutches
  - replace drill head shims
  - fabricate new Tone table and Kelly guide bushings.\*
  - repair mast locking clamp
- 3.3.5 Pump Testing and Equipment
- free drill head hinge shaft

\* Note :

Rig II was driven from Ipoh to K.L. after its November overhaul and on the way both table and bushings were 'lost'. Total weight of the assembly is 200 Kg! In the event that the second rig is urgently needed for fieldwork, it would not be able to operate without these components. The consultant will supply suitable drawings so that a new table assembly can be fabricated.

During the Rig II toning, the supplier experienced little or no pump installation and adjustments to it. A fault in the remote clutch control unit on rig II proved difficult to identify due to the complicated tie-up between the truck Isuzu system and that built on by the Tone factory. Apart from the cab clutch control pedal and the rig clutch remote control, a third clutch control, on the front winch, is able to operate the main clutch. Incorporated into these systems are four hydraulic master cylinders (one of which is air assisted) and one transfer pack. Apart from these complications the clutch itself is rather delicate and requires constant checking for clearance between the master cylinder and the push rod.

It is hoped that the recent exercise and previous repairs and adjustments carried out in the field have been observed and noted by JPT drilling staff.

The column pipes supplied with the two pump packages are fitted with valves which are of little further use.

### 3.3.5 Pump Testing and Equipment

#### BP 45-4 Test Pump for 6 inch Bores

The small test pump became available to the groundwater section by the end of December 1982. As part of the supply contract the pump was to have been installed in a 6" diameter JPT bore for commissioning purposes. Instead the supplier was allowed to install it at their convenience in a large diameter bore in the Lake Gardens, K.L.

The pump was only installed to 14 m and artificial head equal to 30 m setting induced by operation of a gate valve fixed to the pump discharge. The pump was accepted by the JPT mechanical engineer when tests showed it complied with JPT specifications. Later, the whole pump/engine framework was reduced in height by 30 cm in order to cut out some vibration and allow easier starting. The oversize foot valve originally supplied was replaced by a smaller unit and the intake strainer altered accordingly.

During the commissioning, the supplier explained little of pump installation and adjustments to JPT personnel. Consequently, the pump had to be recommissioned with the help of the consultant and the chargeman from the JPT workshops, Ipoh. This work was carried out in Perlis on the Padang Melangit test bore, PM 2.

#### Worthington 10 M 50 Test Pump for 10 inch Bores

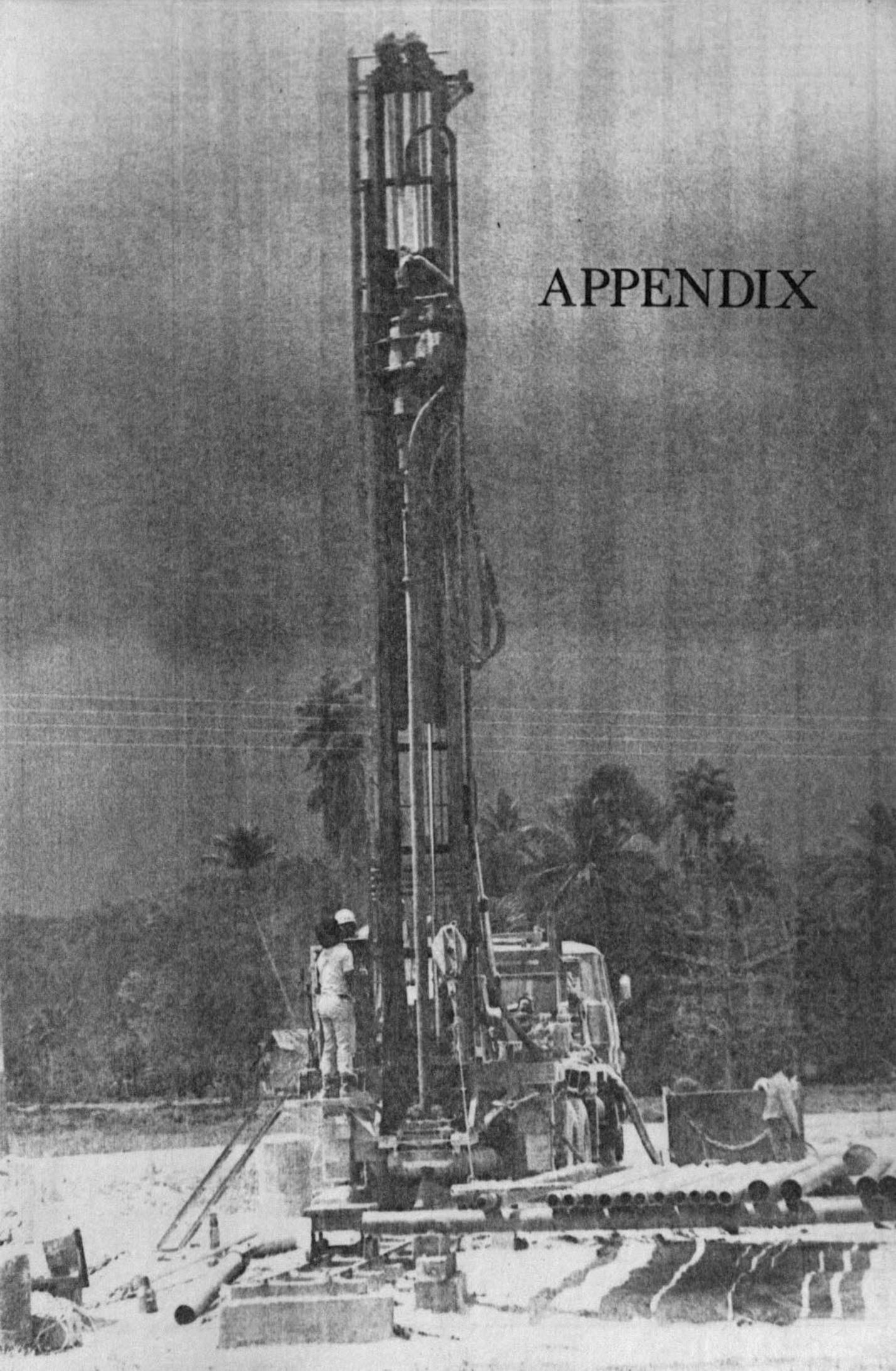
A 10" vertical turbine test pump, procured using specifications drawn up by the consultant, was delivered to Ampang at the end of December. Presently, it is being fitted to a base frame (skid) and is expected to be ready for operation by the end of February.

#### Recommendations

The column pipes supplied with the two pump packages are fitted with thin plastic thread protectors which, once removed from the pipes, are of little further use.

It is essential that the column pipe threads are kept in good condition at all times. The very nature of the pump test work means that numerous installations are required with subsequent loading/unloading at various sites all of which will lead to damage, even with the best care. It is recommended that sufficient steel thread protectors to suit both column pipe sizes, should be procured as soon as possible.

# APPENDIX



COMPOSITE BORE LOG

TOPO SHEET 78 Pulau Pinang and  
 Butterworth



AT	CS 1128
TOTAL	1000
DEPTH	1000
YIELD	1000
REMARKS	1000

Appendix A

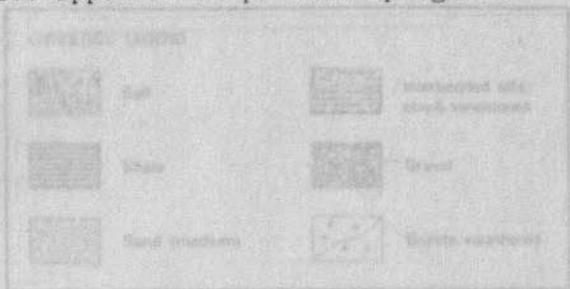
Composite Bore Logs:

State	Borehole Name	Log ID
Pulau Pinang	Alma	A 1
		A 2
Perak	Bukit Gantang	BG 1
		BG 2
Pulau Pinang	Balik Pulau	BP 1*
		BP 2*
Perak	Enggor	E 1
Perlis	Mata Ayer	MA 1*
		MA 2*
		MA 3*
		MA 4
Perlis	Padang Melangit	PM 1*
		PM 2*
		PM 3*
		PM 4*
		PM 5
		PM 6
Perlis	Wang Bintong	WB 1
		WB 2
Perlis	Titti Tinggi	TT 1
		TT 2
		TT 3
		TT 4
		TT 5

Note:

Composite bore logs, where asterisked, are provisional and will be modified when pump testing has been completed.

Composite bore logs for Sg. Tekam and Cangkat Jong are incomplete whilst logs for the Padang Terap and Mardi Bertam boreholes appeared in previous progress reports.



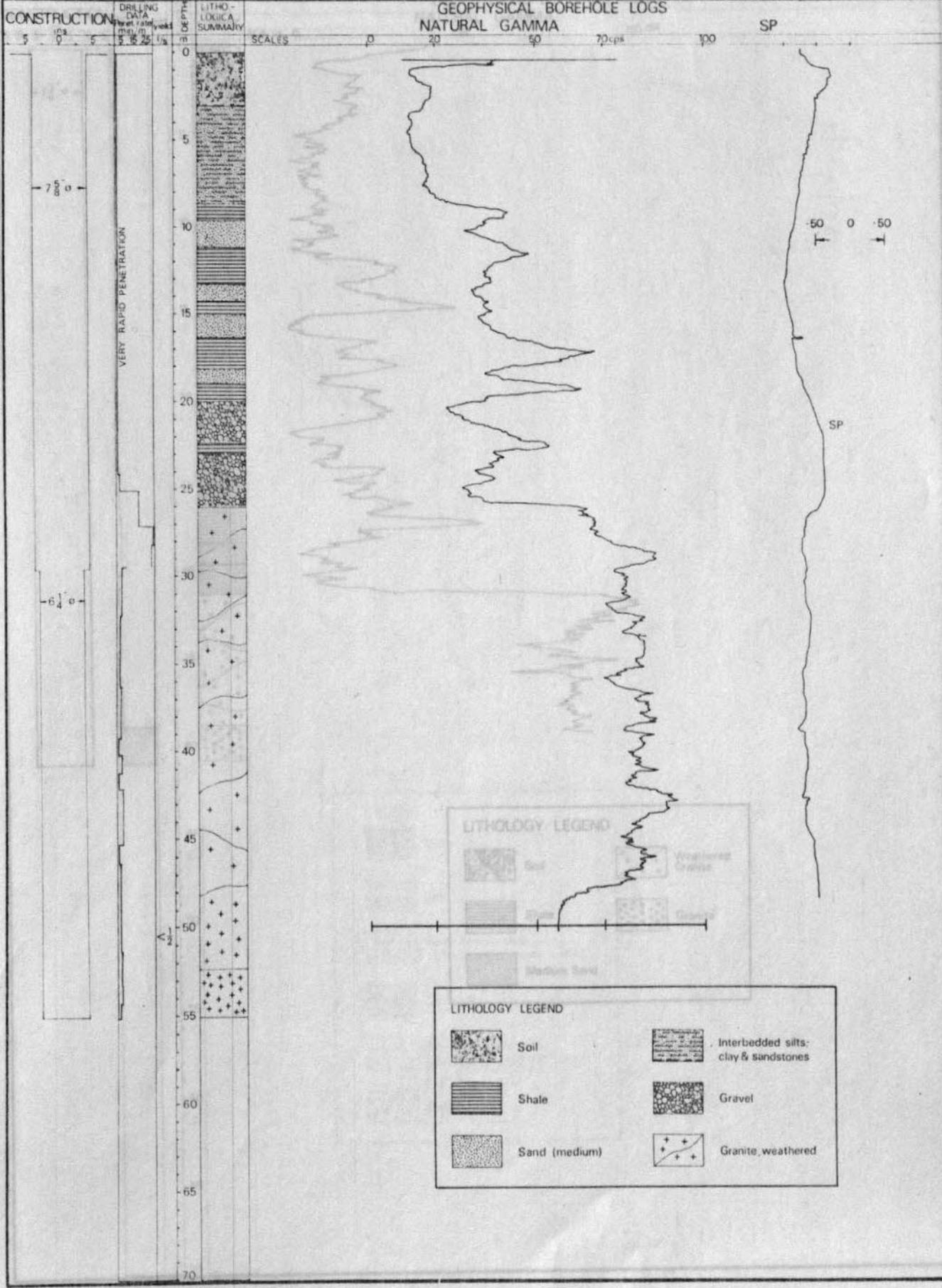
# COMPOSITE BORE LOG

LOCATION Kg Alma, Seberang Prai  
 STARTED 7/8/1982 COMPLETED 3/9/1982  
 DRILLING METHOD Rotary mud flush  
 0-29 m, air hammer 29-TD.  
 YIELD TEST 3/9/82 134 min duration

TOPO SHEET: 28 Pulau Pinang and Butterworth  
 GRID REFERENCE 756906  
 REFERENCE POINT (R.P.)  
 R.P. ELEVATION \_\_\_\_\_ m (above ground level)



**A1 GS 1128**  
 TOTAL DEPTH 55 m SWL \_\_\_\_\_ m  
 YIELD 1.5 l/s EC 2000 micro mhos/cm (20-25m) at 25°C  
 REMARKS Casing withdrawn bore backfilled.  
 EC ≤ 15000 below 30 m



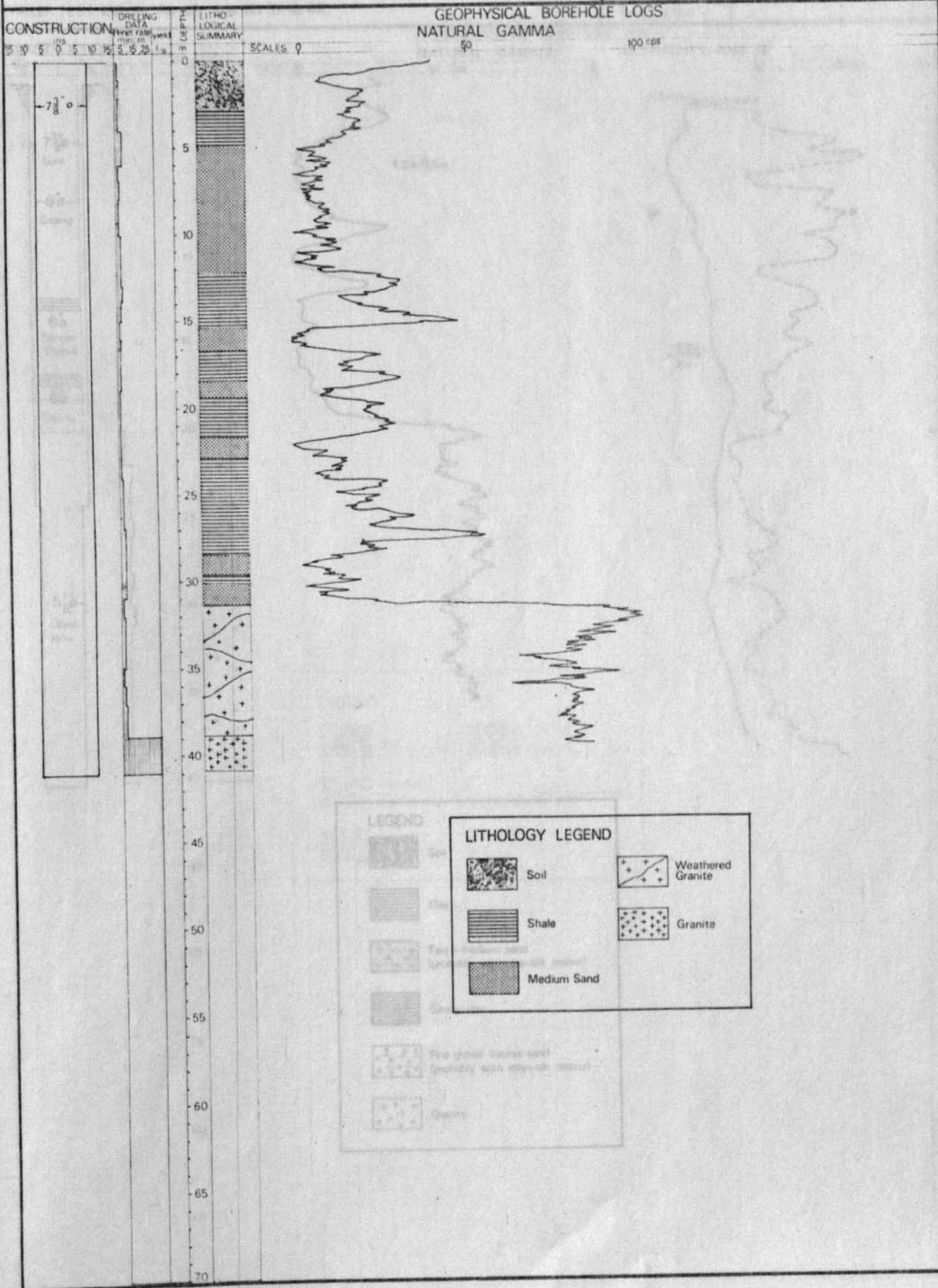
# COMPOSITE BORE LOG

LOCATION Kg. Alma, Seberang Prai  
 STARTED 4 9 1982 COMPLETED 8 9 1982  
 DRILLING METHOD Rotary mud flush  
 YIELD TEST 8 9 82

TOPO SHEET Pulau Pinang and Butterworth  
 GRID REFERENCE 754895  
 REFERENCE POINT (R P)  
 R P ELEVATION m (above ground level)



**A2 GS 1129**  
 TOTAL DEPTH 41 m SWL m  
 YIELD 1.8 l/s EC 20000 micro mhos/cm (31.36 mg/l at 25°C)  
 REMARKS Bore abandoned, backfilled EC 21500 at 18-24m.



# COMPOSITE BORE LOG

TOPO SHEET 40 Taiping

LOCATION Bukit Gantang PERAK

GRID REFERENCE 060289

STARTED 3 12 1982 COMPLETED 11 12 1982

REFERENCE POINT (R.P.) Top of casing

DRILLING METHOD Rotary mud Flush

R.P. ELEVATION 0.5

YIELD TEST 150min Air lift test on 11 12 82



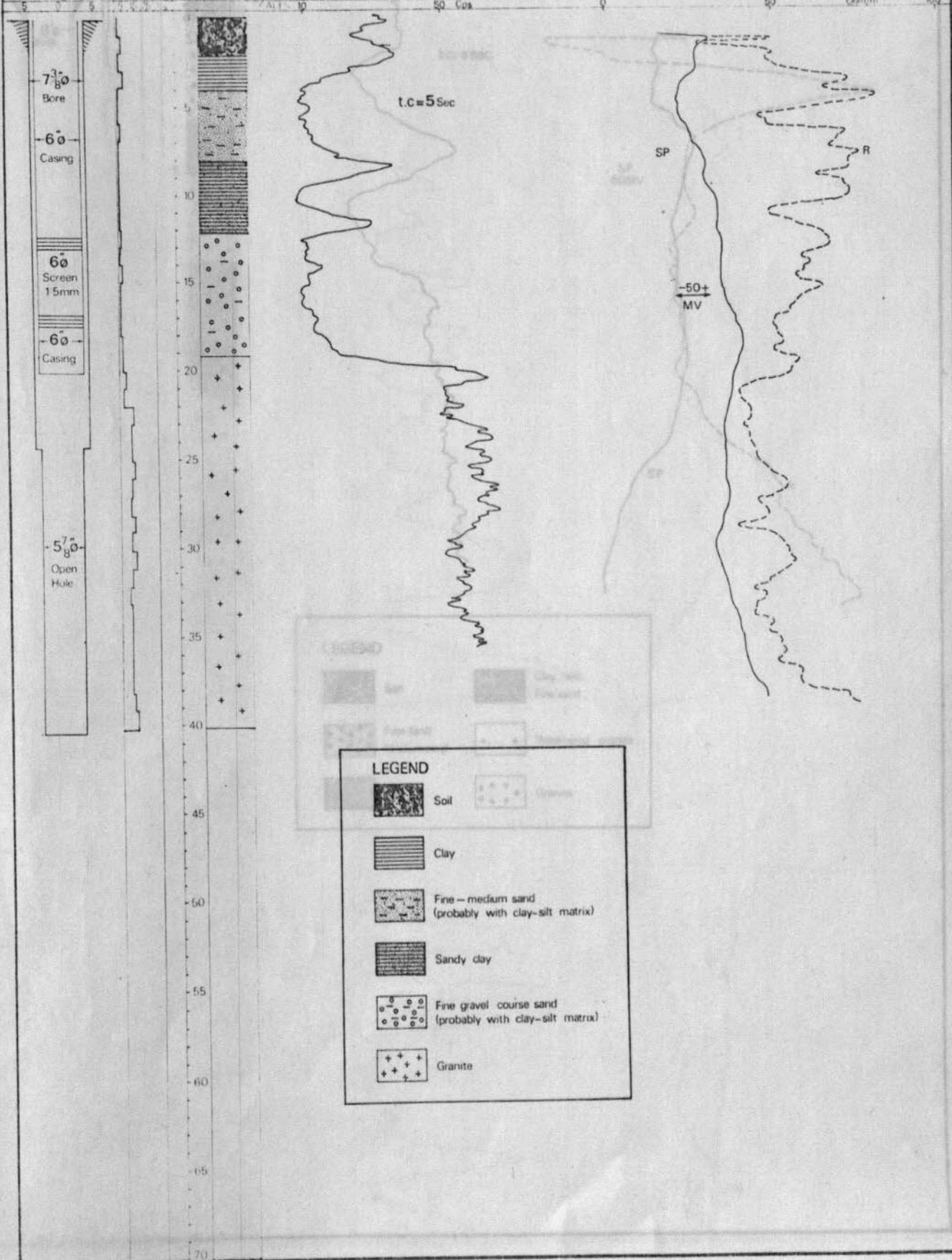
BG-1 GS1140

TOTAL DEPTH 40 m SWL 0.95 m

YIELD 10 L/s EC 50

REMARKS

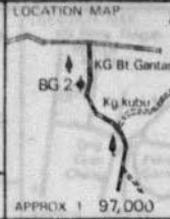
## CONSTRUCTION NATURAL GAMMA RESISTIVITY AND SP



# COMPOSITE BORE LOG

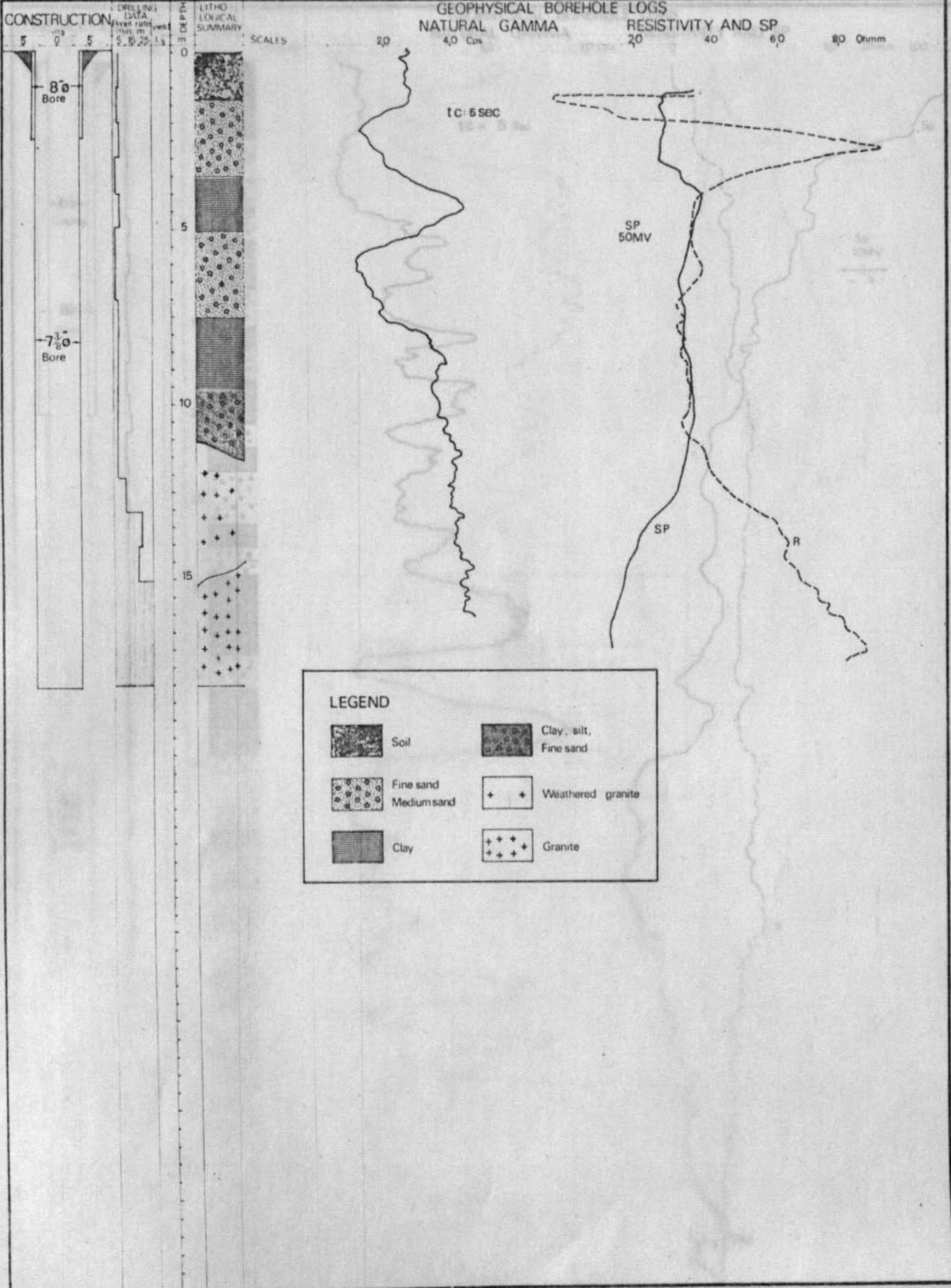
LOCATION Bukit Gantang, Taiping  
 STARTED 15 12 1982 COMPLETED 16 12 1982  
 DRILLING METHOD: Rotary mud flush  
 YIELD TEST: Not conducted

TOPO SHEET 40 TAIPING  
 GRID REFERENCE 082290  
 REFERENCE POINT (R.P.) Ground level  
 R.P. ELEVATION 343



## BG2 GS 1141

TOTAL DEPTH 18 m SWL m  
 YIELD 0 1/3 EC at 25 C  
 REMARKS  
 Bore Abandoned





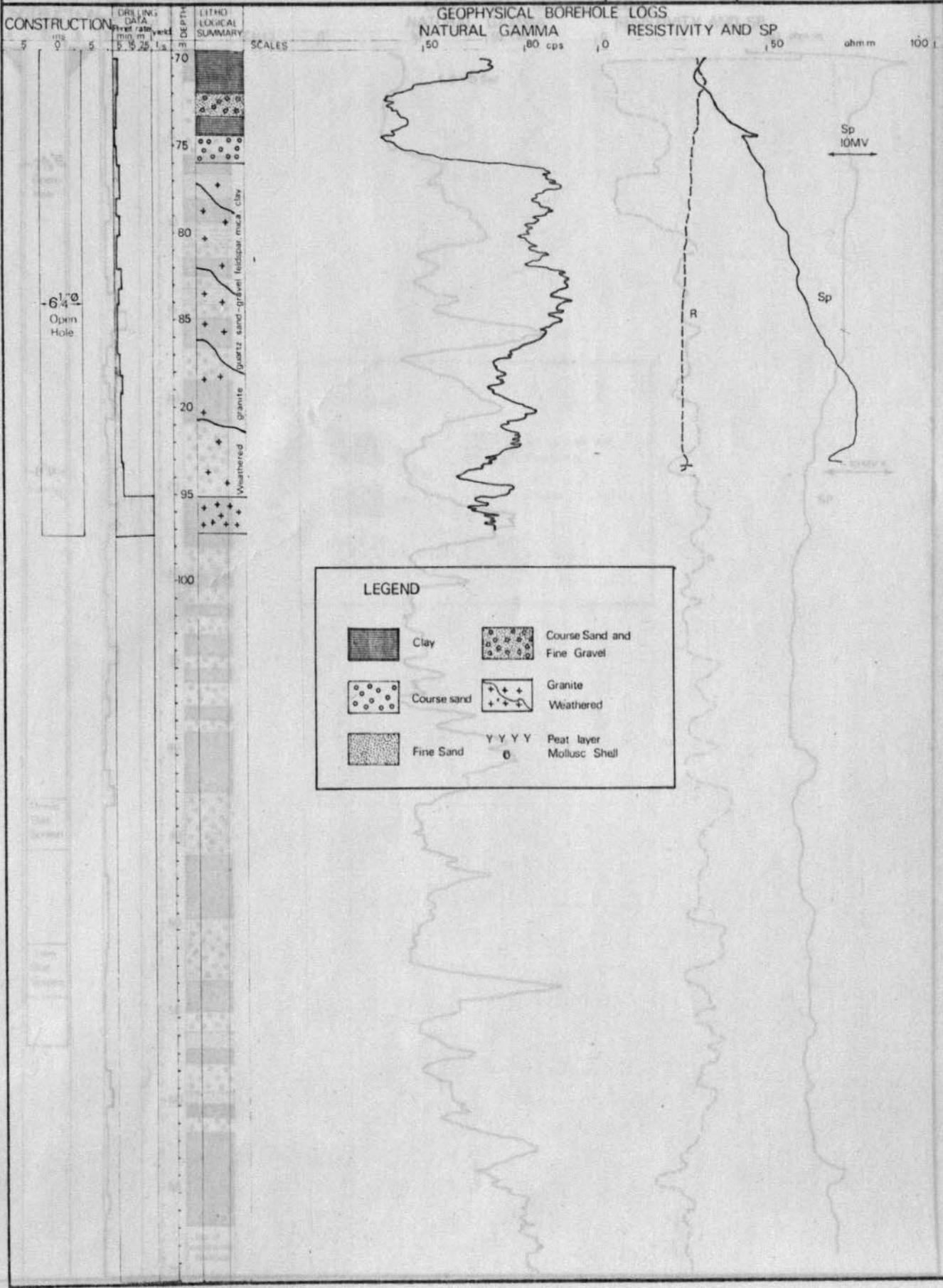
# COMPOSITE BORE LOG

TOPO SHEET  
 GRID REFERENCE  
 REFERENCE POINT (R.P.)  
 R.P. ELEVATION



Cont'd BPI GS 1134	
TOTAL DEPTH	m SWL m
YIELD	1/5 EC
REMARKS Sheet 2/2	

LOCATION  
 STARTED 1982 COMPLETED 1982  
 DRILLING METHOD  
 YIELD TEST



# COMPOSITE BORE LOG

LOCATION Balik Pulau Penang

STARTED 7 10 1982 COMPLETED 15 10 1982

DRILLING METHOD Rotary mud Flush

YIELD TEST 180min Air Lift Test: 15 10.82

TOPO SHEET PPinang & Butterworth

GRID REFERENCE 478912

REFERENCE POINT (R.P) Top of Casing

R.P. ELEVATION 4.265m

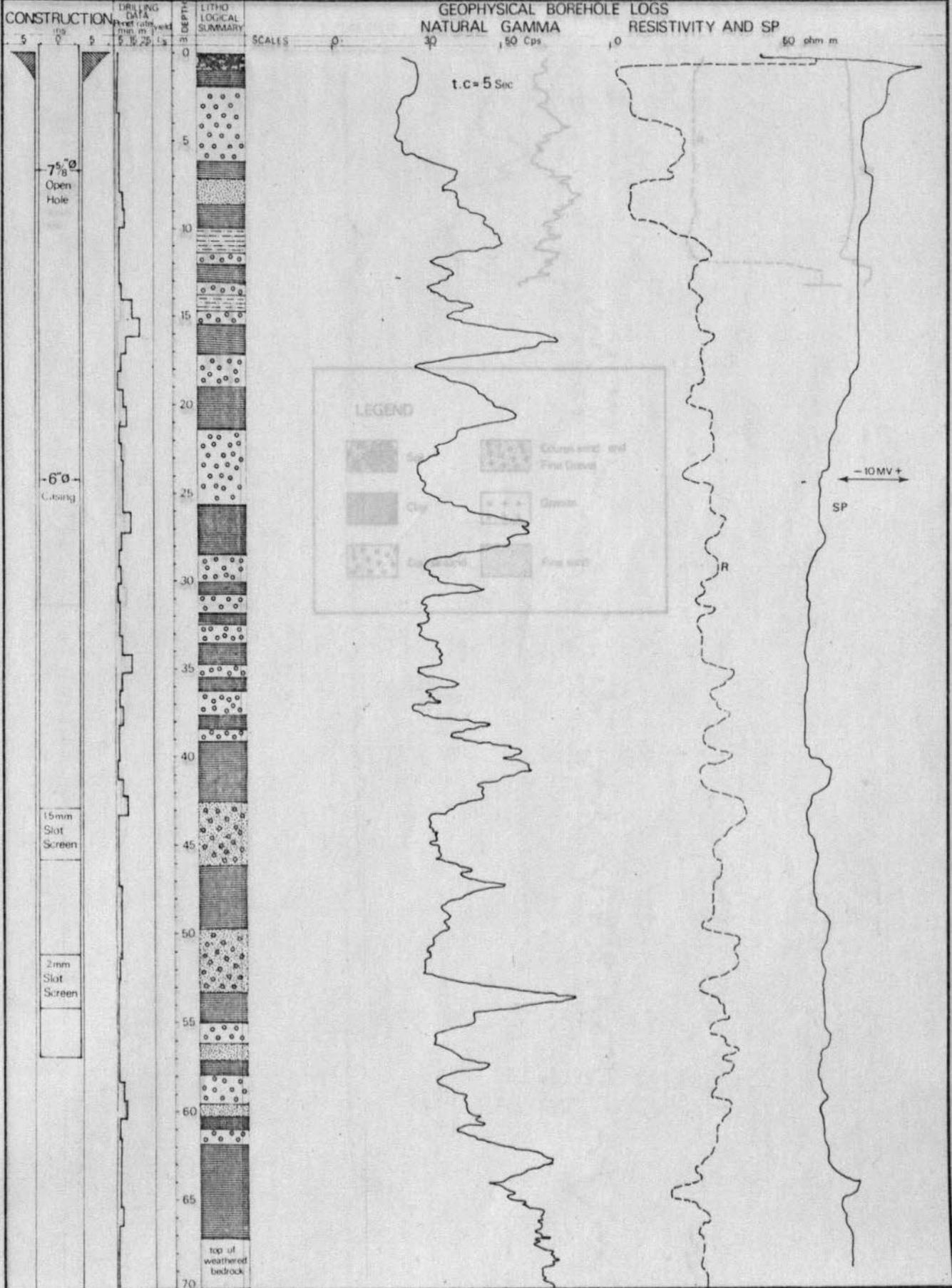


## BP2 GS 1135

TOTAL DEPTH 101 m SWL 190 m

YIELD 5.5 1/8 EC 100

REMARKS Sheet 1/2



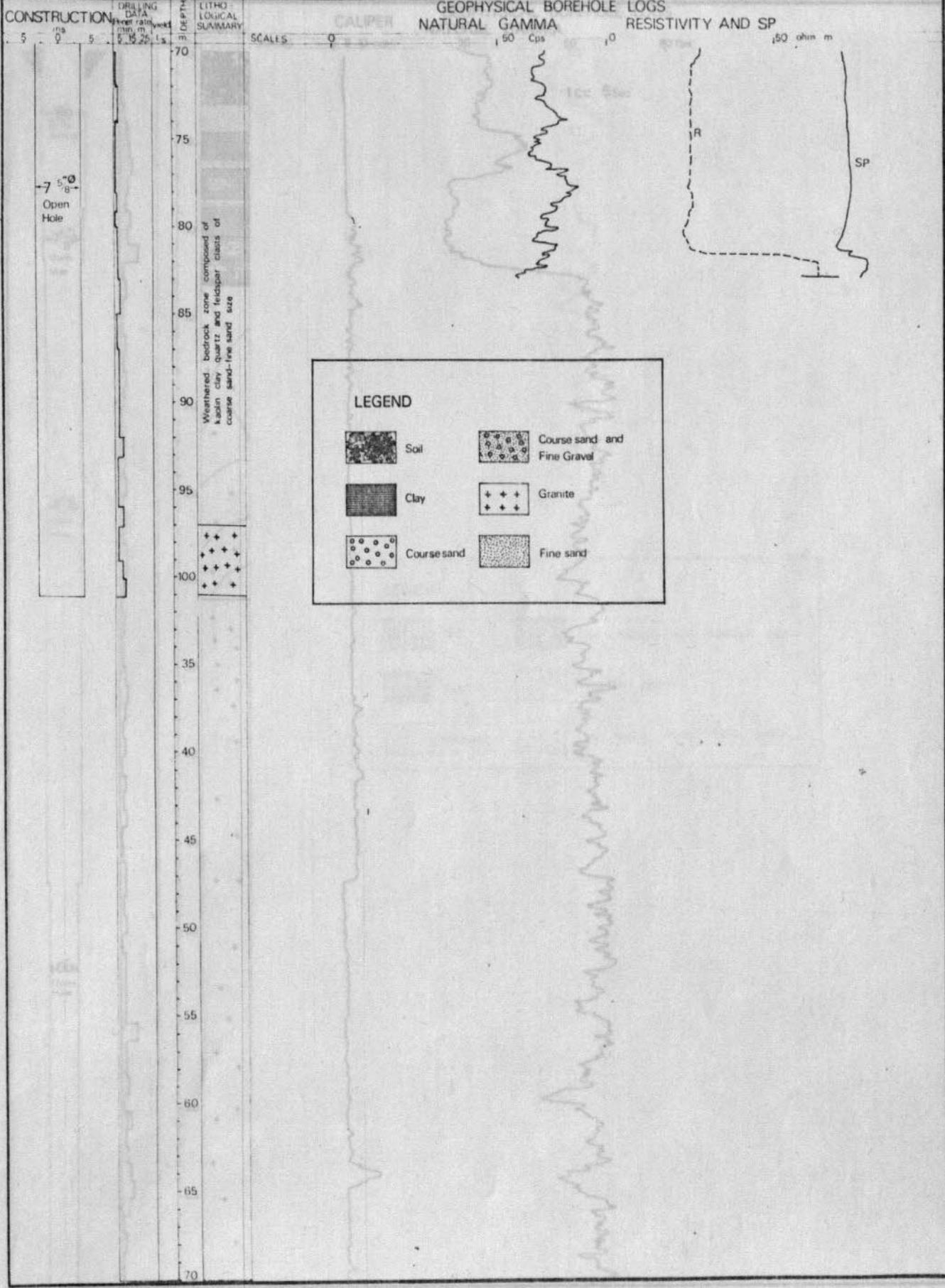
# COMPOSITE BORE LOG

LOCATION: *PERAK*  
 STARTED 1982 COMPLETED 1982  
 DRILLING METHOD: *10-12m DTH*  
 YIELD TEST: *Sand*

TOPO SHEET: *41 (K. Kangar)*  
 GRID REFERENCE: *322348*  
 REFERENCE POINT (R.P.): *Ground level*  
 R.P. ELEVATION: *m (above ground level)*



Cont'd BP 2		GS 1135	
TOTAL DEPTH	101 m	SWL	190 m
YIELD	55 1/8	EC	100
REMARKS		Sheet 2/2	



# COMPOSITE BORE LOG

LOCATION Enggor, Kuala Kangsar (PERAK)

STARTED 26 11 1982 COMPLETED 30 11 1982

DRILLING METHOD RAF (0-12m) DTH  
(12m-100m)

YIELD TEST Not Tested

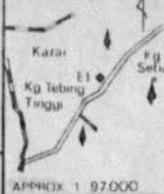
TOPO SHEET 41 (K. Kangsar)

GRID REFERENCE 322348

REFERENCE POINT (R.P.) Ground level

R.P. ELEVATION m (above ground level)

LOCATION MAP



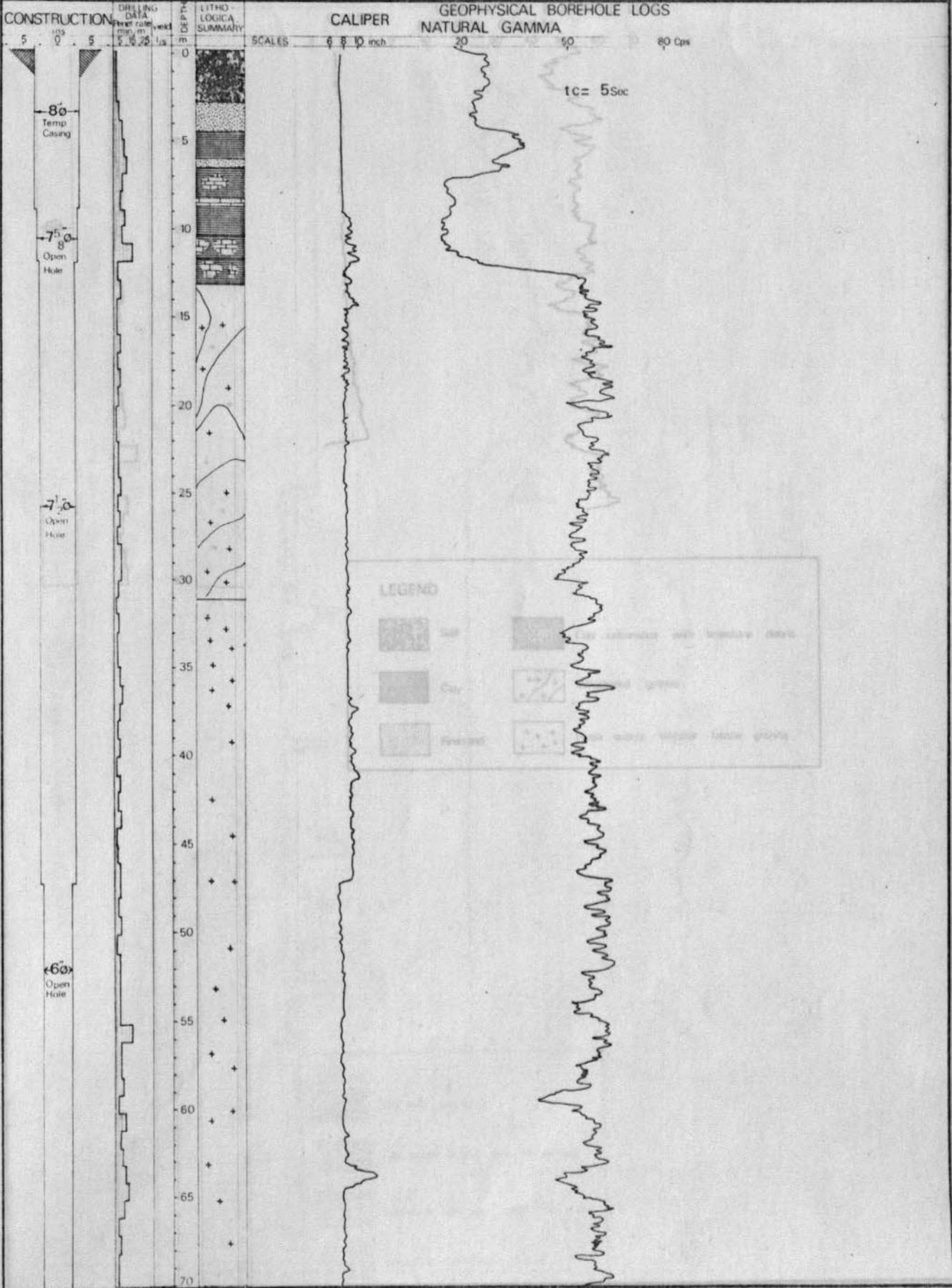
## E1 GS 1113

TOTAL DEPTH 100 m SWL 1.5 m

YIELD < 0.1 l/s EC

REMARKS Bore abandoned casing withdrawn

Sheet 1/2

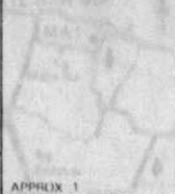


# COMPOSITE BORE LOG

LOCATION  
 STARTED 1982 COMPLETED 1982  
 DRILLING METHOD

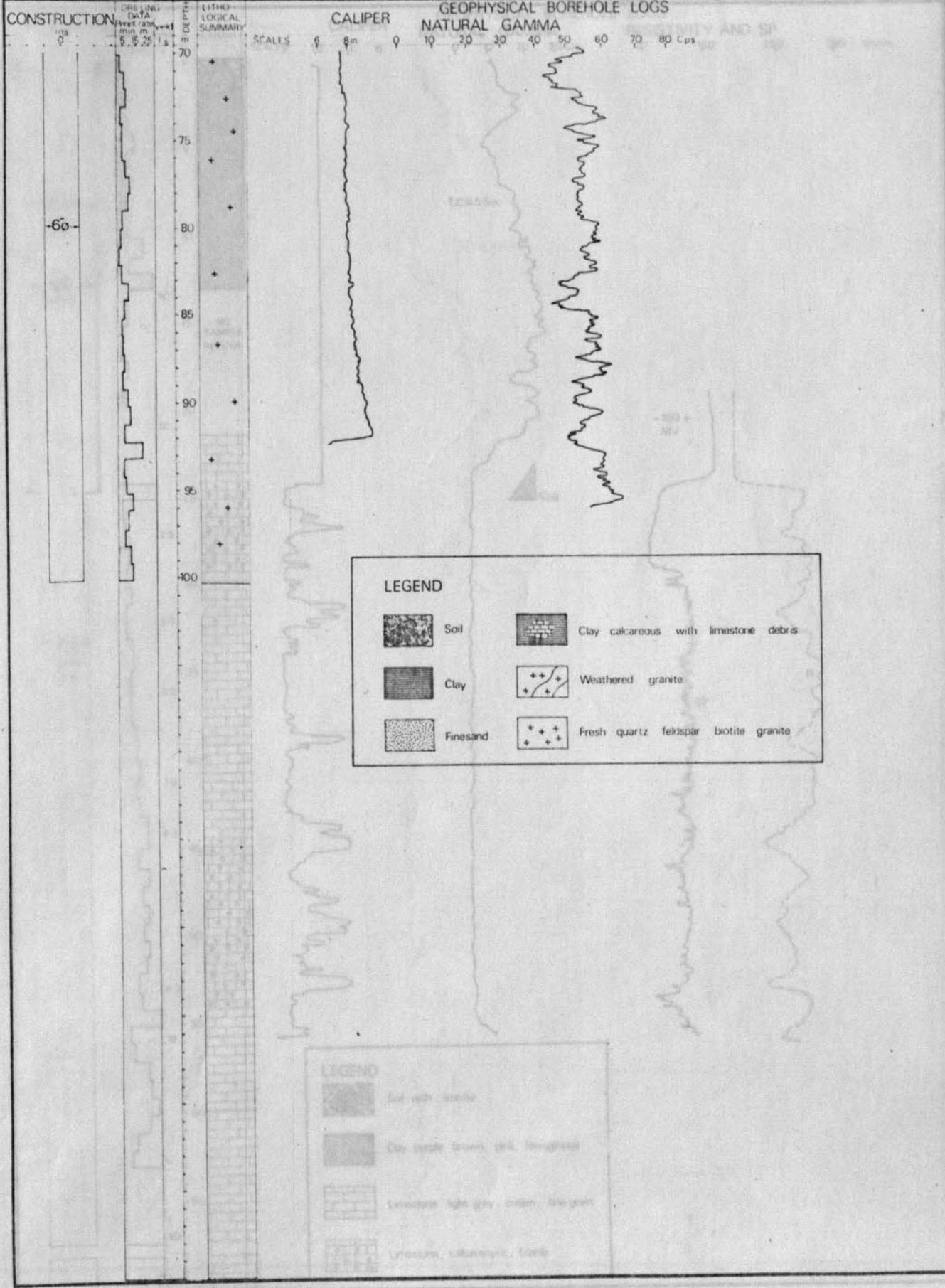
TOPO SHEET  
 GRID REFERENCE  
 REFERENCE POINT (R.P.)  
 R.P. ELEVATION m (above ground level)

LOCATION MAP



Contd  
 E1 GS 1113  
 TOTAL DEPTH 100m SWL 1.5 m  
 YIELD 1/5 EC  
 REMARKS Sheet 2/2

YIELD TEST



# COMPOSITE BORE LOG

LOCATION Mata. Air PERLIS

STARTED 29 4 1982 COMPLETED 13 5 1982

DRILLING METHOD Rotary Air Flush

TOPO SHEET 152 (JITRA)

GRID REFERENCE 543170

REFERENCE POINT (R.P) Top of Casing

R.P. ELEVATION 0.6m.

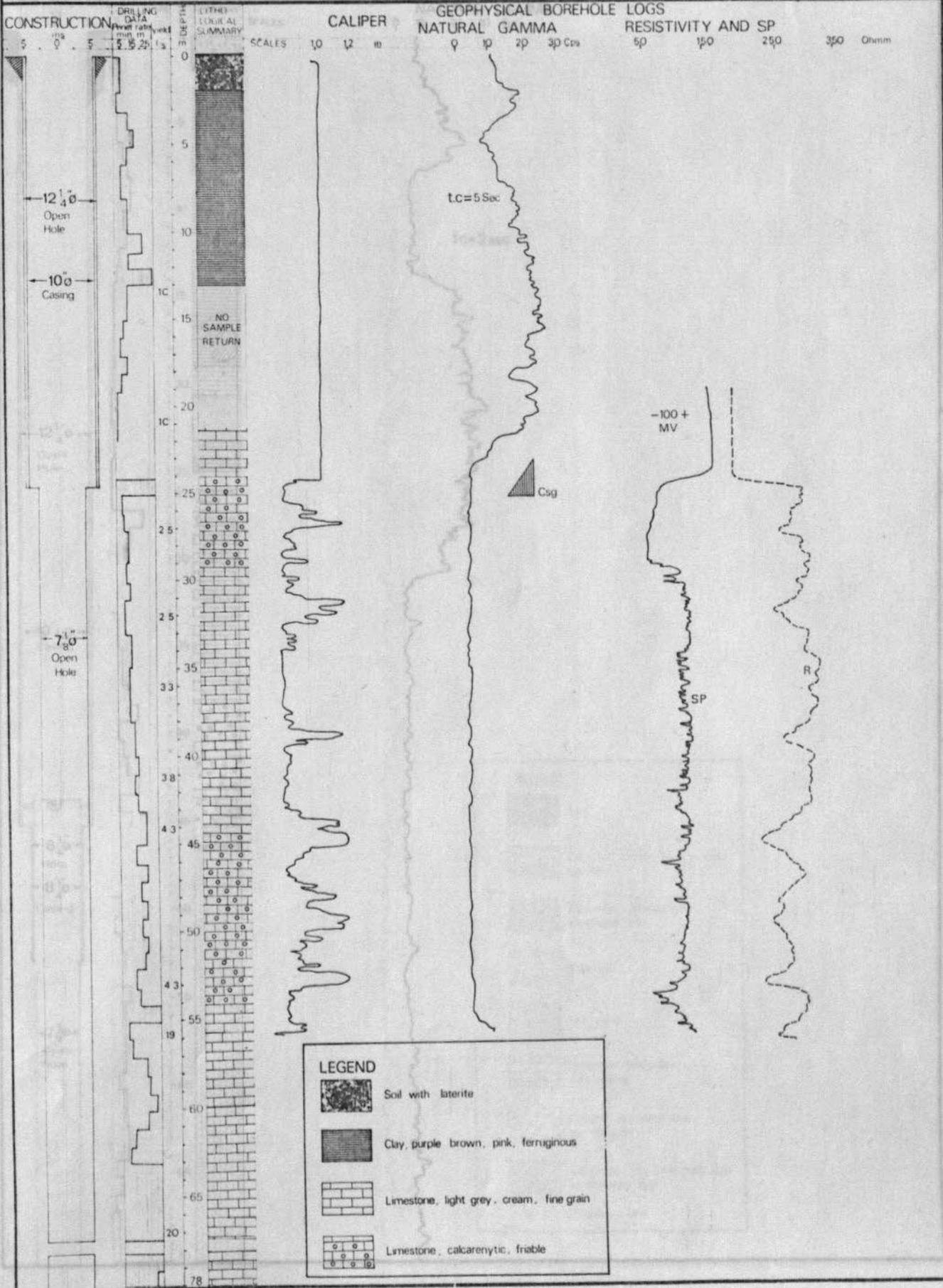


## MA1GS 1130

TOTAL DEPTH	78 m	SWL	4.36 m
YIELD	7.0 l/s	EC	560

REMARKS

YIELD TEST 180 min Airlift. through drill pipe



# COMPOSITE BORE LOG

LOCATION Mata Air PERLIS

STARTED 16 5 1982 COMPLETED 13 7 1982

DRILLING METHOD Rotary Air flush 0-45m  
Rotary bentonite mud flush 45-TD.

YIELD TEST Air lift test 13-7-82

TOPO SHEET 152 JITRA

GRID REFERENCE 537173

REFERENCE POINT (R.P) Top of casing

R.P ELEVATION m (above ground level)

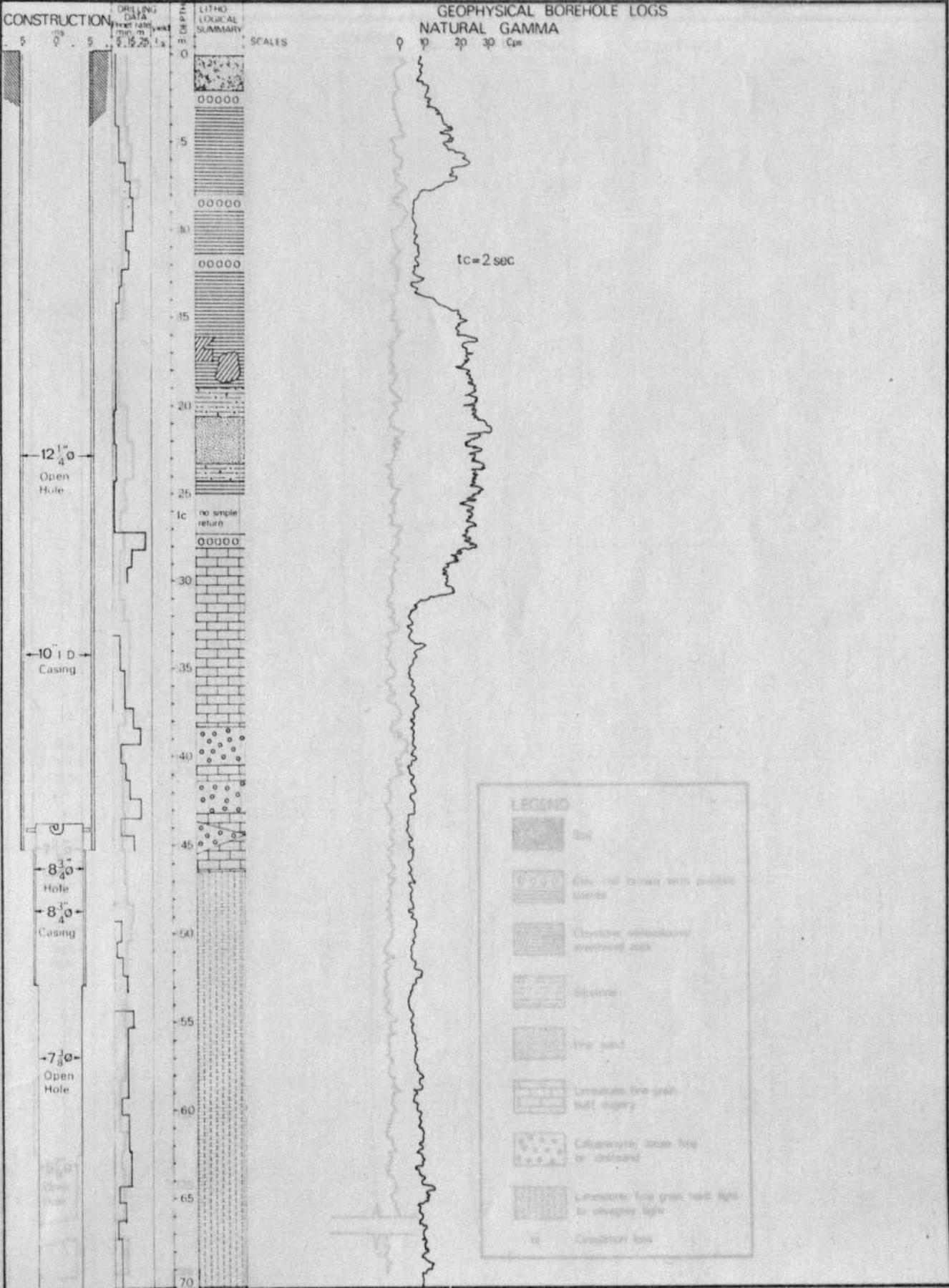


## MA2 GS1131

TOTAL DEPTH 186 m SWL 5.09 m

YIELD 7.0 1/5 EC 705 at 25°C

REMARKS Sheet 1/2.



# COMPOSITE BORE LOG

TOPO SHEET

LOCATION MAP

Cont'd  
MA2

GS1131

LOCATION Mata Air PERLIS

GRID REFERENCE



TOTAL DEPTH 186 m SWL 5.09 m

STARTED 16 5 1982 COMPLETED 13 7 1982

REFERENCE POINT (R.P.)

YIELD 7.0 1/5 EC 705

DRILLING METHOD

R.P. ELEVATION m (above ground level)

REMARKS sheet 2/2

YIELD TEST Air lift test 13.7.82

APPENDIX 1

## CONSTRUCTION

DRILLING DATA  
Rate of penetration  
min m / h

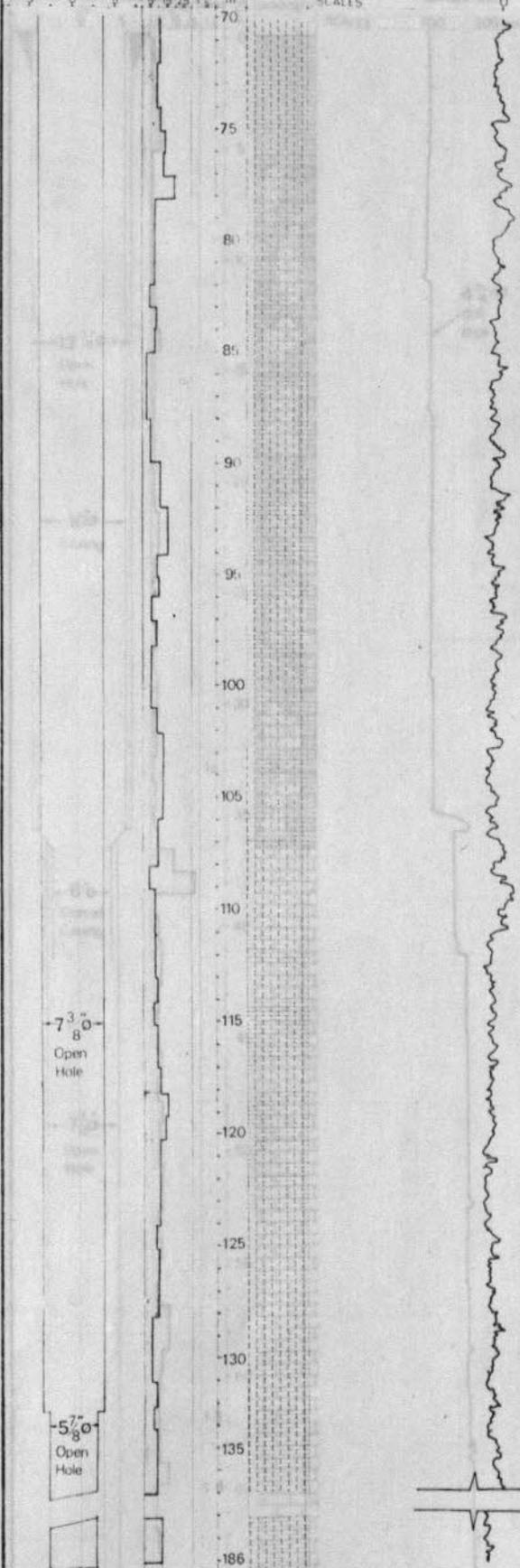
LITHO LOGICAL SUMMARY

## GEOPHYSICAL BOREHOLE LOGS

### NATURAL GAMMA

10 20 30 Cps

SCALES



**LEGEND**

- Soil
- Clay, red brown with pisolitic laterite
- Claystone, varicoloured, weathered rock
- Siltstone
- Fine sand
- Limestone, fine grain, buff, sugary
- Calcarenyte, loose lime or dolosand
- Limestone, fine grain, hard, light to olivegrey tight
- Ic Circulation loss

# COMPOSITE BORE LOG

LOCATION Mata Air (PERLIS)

STARTED 12 8 1982 COMPLETED 19 8 1982

DRILLING METHOD Rotary mud circulation  
0-36 DTH 38-84.5m

YIELD TEST 150min AIR LIFT on 18-8-82

TOPO SHEET 150 JITRA

GRID REFERENCE 532160

REFERENCE POINT (R.P.) Top of Casing

R.P. ELEVATION 0.78 m

LOCATION MAP

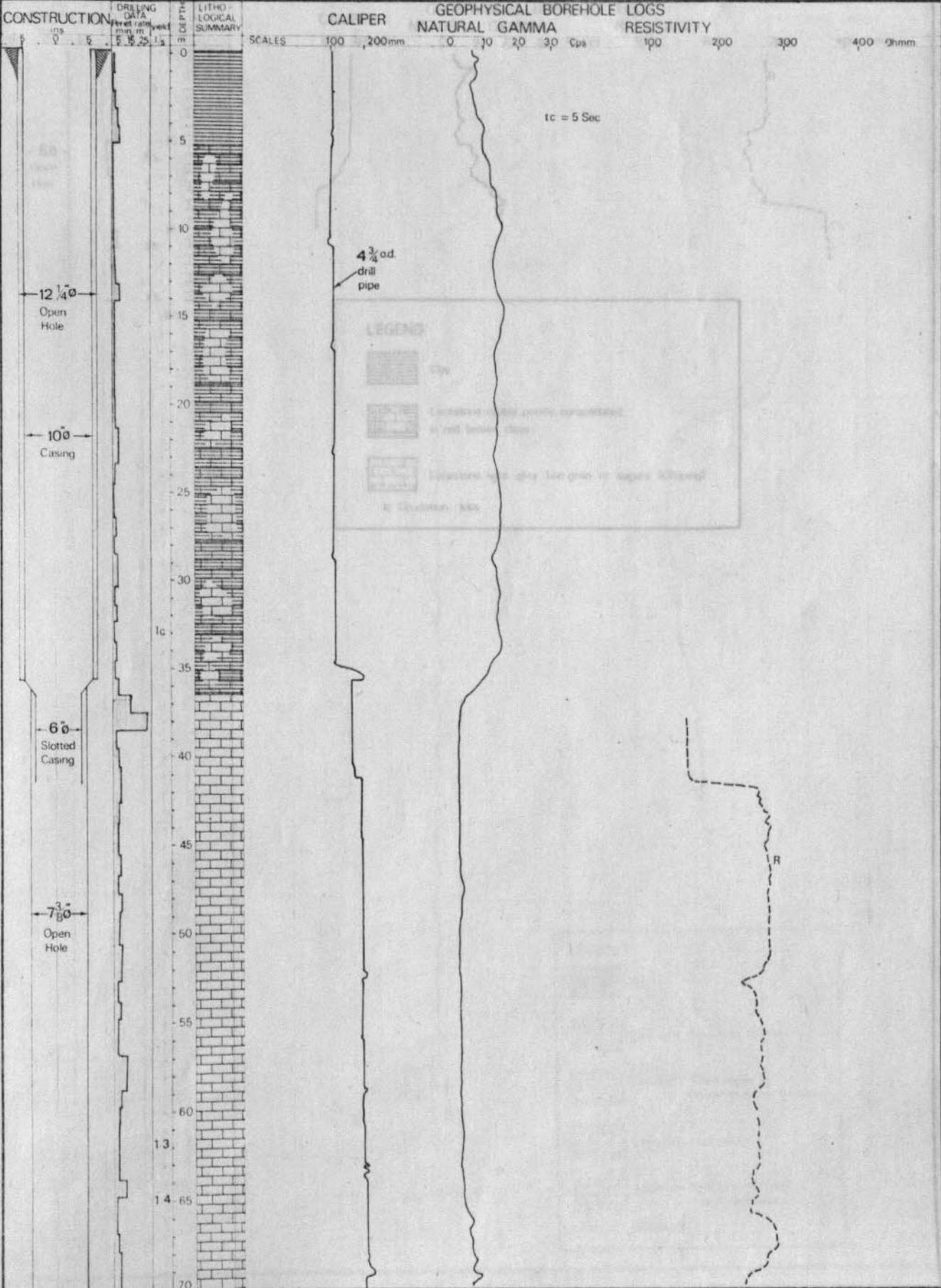


## MA3 GS 1132

TOTAL DEPTH 84 m SWL 2.90 m

YIELD 7.7 l/s EC 770

REMARKS sheet 1/2 Gamma  
Logs run inside drillpipe



# COMPOSITE BORE LOG

LOCATION

STARTED 1982 COMPLETED 1982

DRILLING METHOD

YIELD TEST

TOPO SHEET

GRID REFERENCE

REFERENCE POINT (R.P.)

R.P. ELEVATION

LOCATION MAP

Cont'd  
MA3

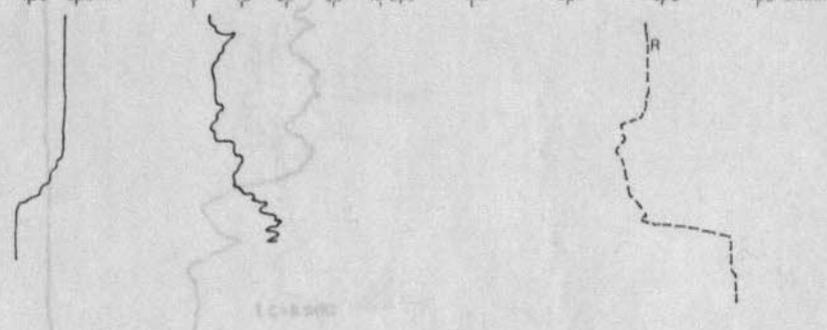
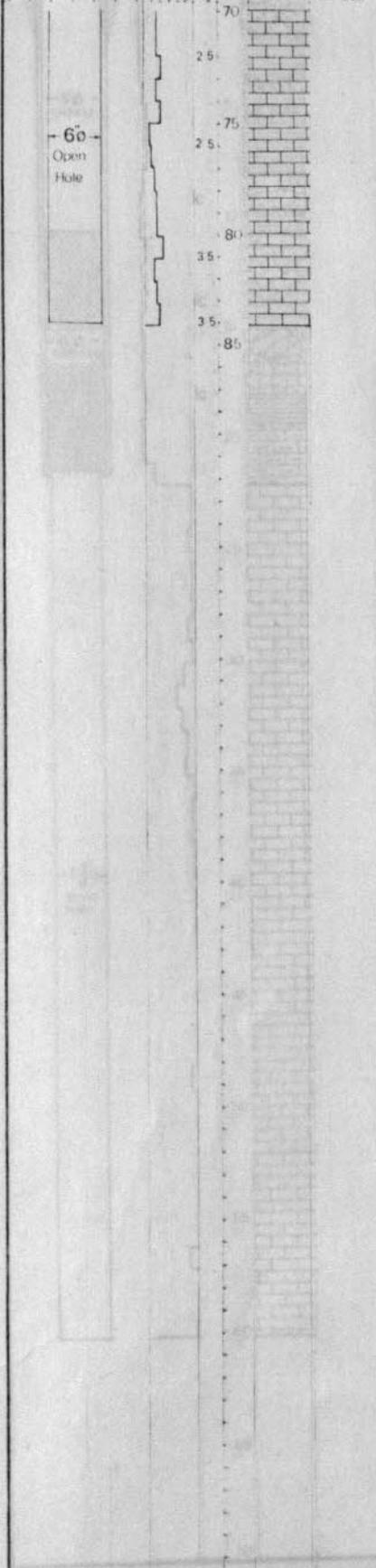
GS 1132

TOTAL DEPTH m SWL m

YIELD l/s EC

REMARKS sheet 2/2

CONSTRUCTION GEOPHYSICAL BOREHOLE LOGS  
 CALIPER NATURAL GAMMA RESISTIVITY  
 SCALES 100 200mm 0 30 20 30 40 Cps 100 200 300 400 Ohm-m



**LEGEND**

- Clay
- Limestone rubble, poorly consolidated in red brown clays
- Limestone light grey fine grain or sugary (Chuping)
- lc Circulation loss

**LEGEND**

- Sand
- Clay with ferruginous stains
- Limestone rubble, poorly consolidated in red brown clays
- Limestone, light grey
- Limestone light grey fine grain, sugary, crystalline
- lc Circulation loss

# COMPOSITE BORE LOG

LOCATION Kg. Gial, Mata Air, PERLIS

STARTED 4 8 1982 COMPLETED 10 8 1982

DRILLING METHOD Rotary mud flush

YIELD TEST Not tested

TOPO SHEET 152 JITRA

GRID REFERENCE 548158

REFERENCE POINT (R.P.) Top of casing

R.P. ELEVATION 0.8m (above ground level)

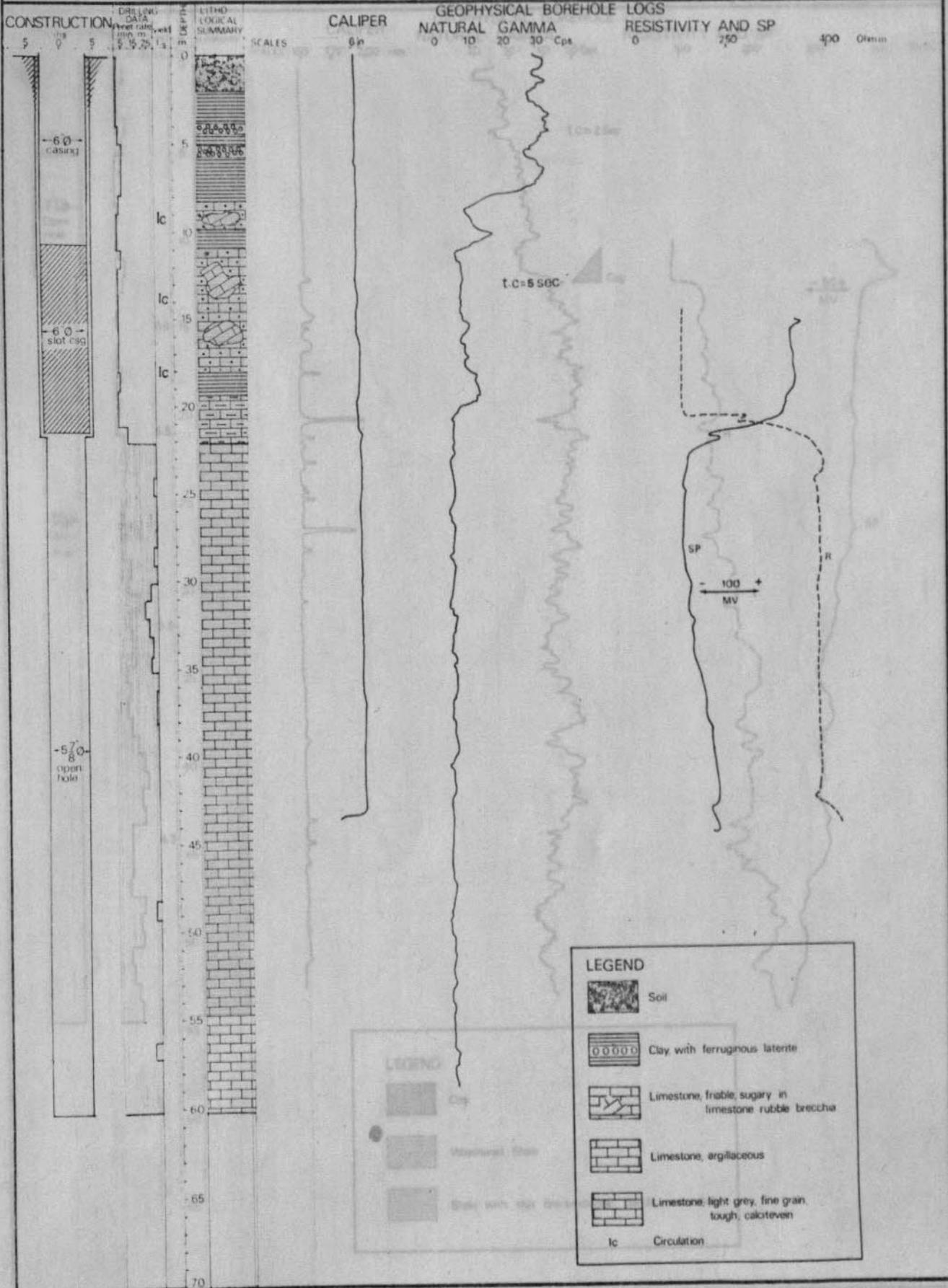


## MA 4 GS 1133

TOTAL DEPTH 60 m SWL m

YIELD 1.0 l/s EC

REMARKS



**LEGEND**

- Soil
- Clay with ferruginous laterite
- Limestone, friable, sugary in limestone rubble breccia
- Limestone, argillaceous
- Limestone, light grey, fine grain, tough, calciteven
- Circulation

# COMPOSITE BORE LOG

LOCATION Padang Melangit PERLIS

STARTED 25.4.1982. COMPLETED 27.4.1982

DRILLING METHOD Rotary Air Flush

YIELD TEST Air Lift, 300 min on 28.4.82

TOPO SHEET 151 (KANGAR)

GRID REFERENCE 483232

REFERENCE POINT (R.P.) Top of casing

R.P. ELEVATION 0.6m

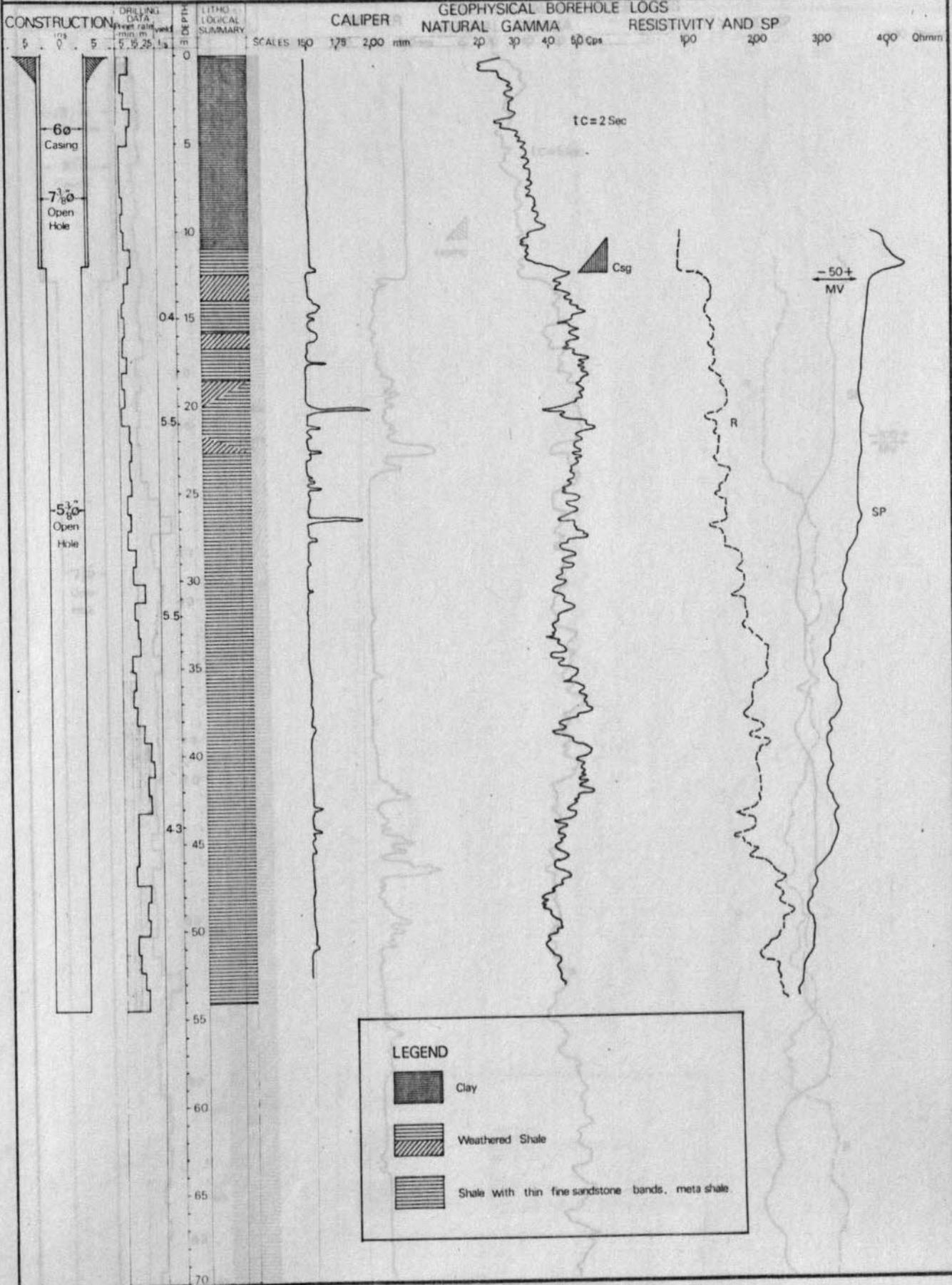


## PM 1 GS 1119

TOTAL DEPTH 54 m SWL 3.93 m

YIELD 5.7 1/5 EC 450

REMARKS



# COMPOSITE BORE LOG

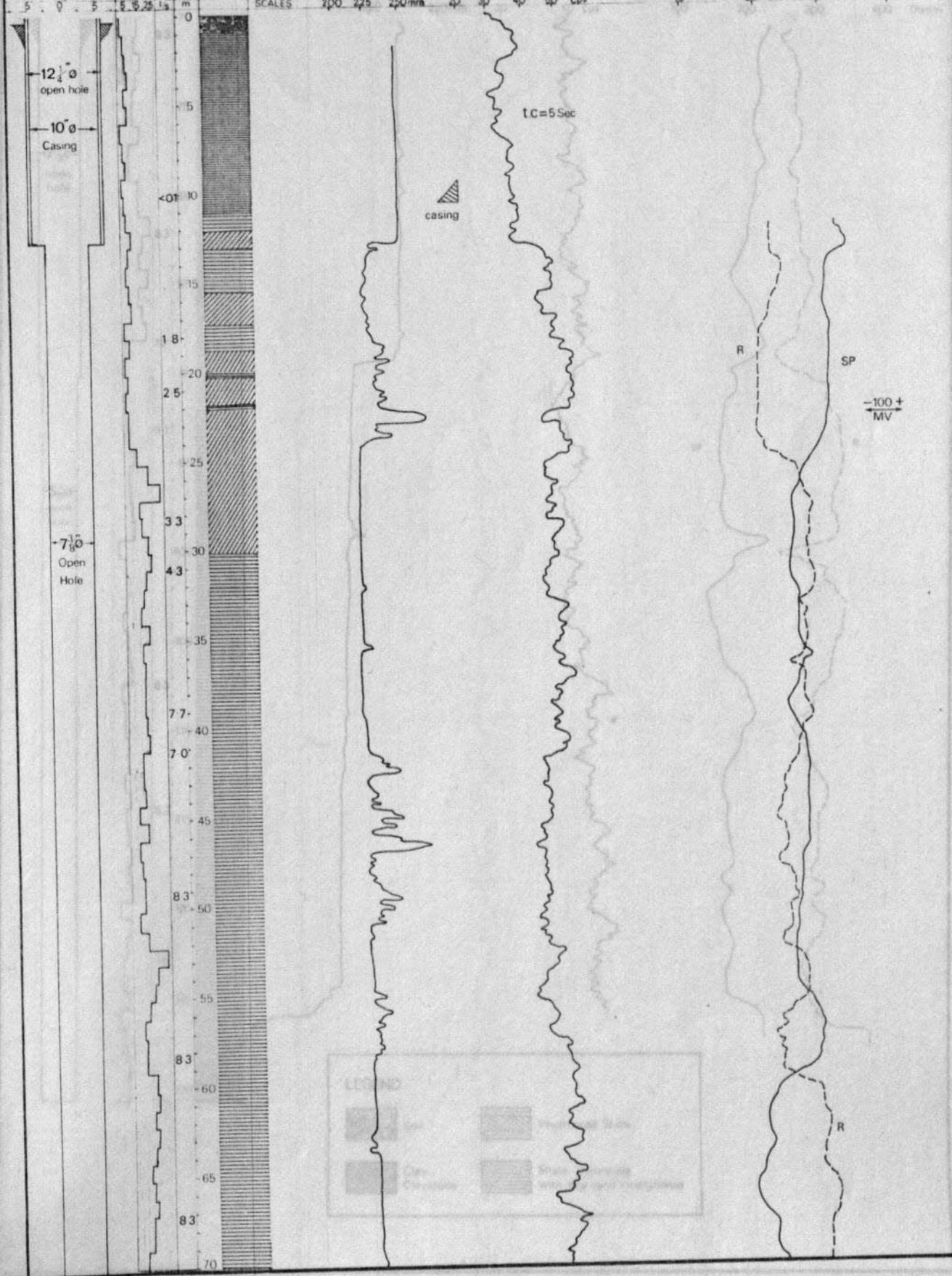
LOCATION Padang Melangit, Perlis.  
 STARTED 8 4 1982.COMPLETED 20 4 1982  
 DRILLING METHOD Rotary Air Flush  
 YIELD TEST Air Lift through Drill Pipe. 13.4.82

TOPO SHEET 151 (KANGAR)  
 GRID REFERENCE 479212  
 REFERENCE POINT (R.P) Csg. top  
 R.P. ELEVATION 0.42 m (above ground level)



<b>PM2GS 1120</b>	
TOTAL DEPTH 130 m	SWL 3 87 m
YIELD 65 1/5	EC 330 <small>micro mhos at 25 C</small>
REMARKS Sheet 1/2 Discharge declining through air lift test	

## GEOPHYSICAL BOREHOLE LOGS



# COMPOSITE BORE LOG

TOPO SHEET: 181 KANGAR  
 GRID REFERENCE: 480182  
 REFERENCE POINT (R.P.):  
 R.P. ELEVATION: m (above ground level)

LOCATION MAP

Cont'd  
PM2 GS 1120

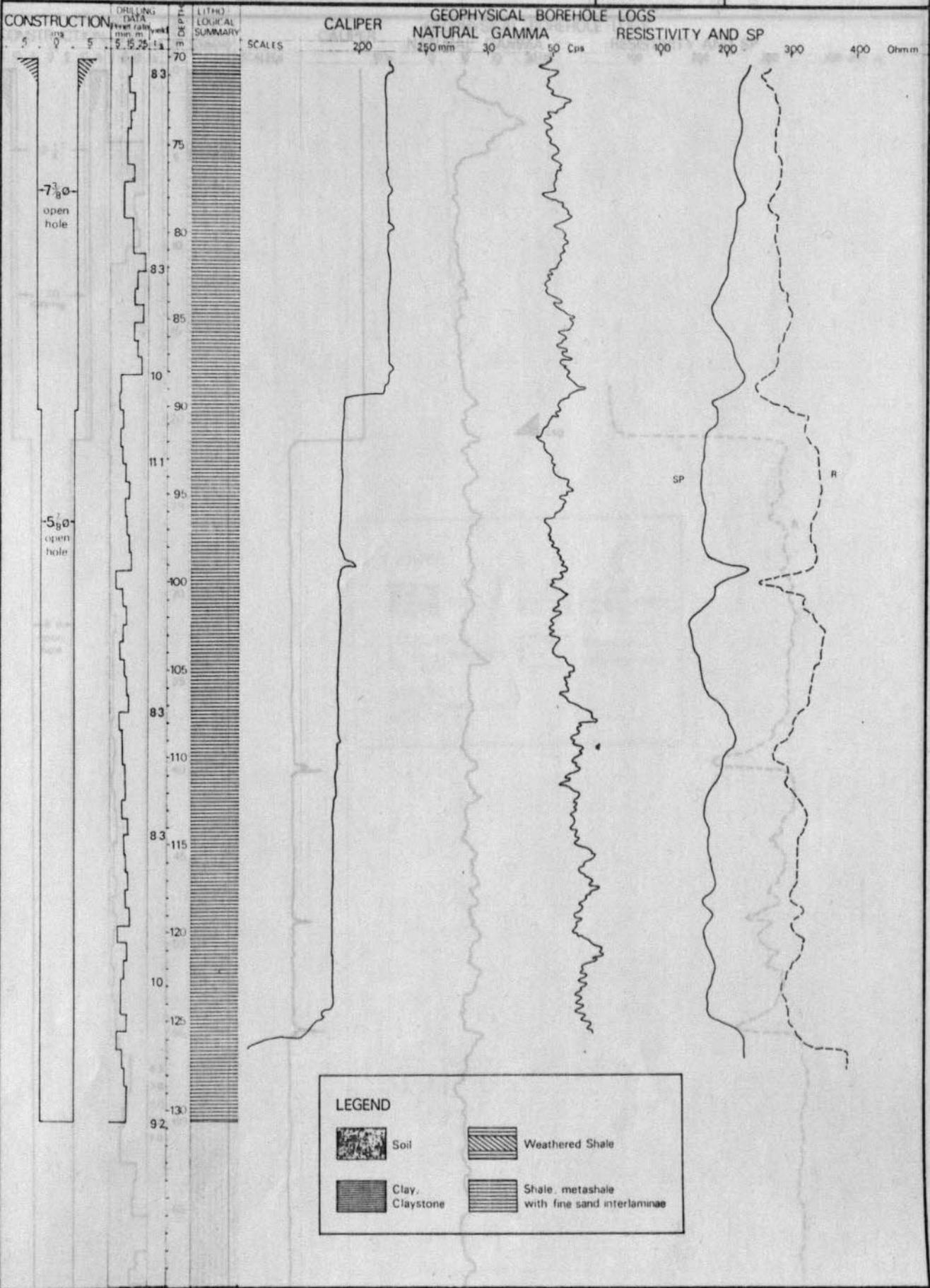
LOCATION

STARTED: 1982 COMPLETED: 1982  
 DRILLING METHOD:

YIELD TEST

TOTAL DEPTH	m	SWL	m
YIELD	l/s	EC	cm/sec at 25°C

REMARKS  
Sheet 2/2



# COMPOSITE BORE LOG

LOCATION Padang Melangit, Perlis.

STARTED 29 4 1982 COMPLETED 13 5 1982

DRILLING METHOD Rotary air flush 0-10  
Dth 10.5 to 72m, R.A.F. 72m to 84m

YIELD TEST 5.5.1982 Method: Airlift.

TOPO SHEET: 151 KANGAR

GRID REFERENCE: 480182

REFERENCE POINT (R.P)

R.P. ELEVATION \_\_\_\_\_ m (above ground level)

LOCATION MAP



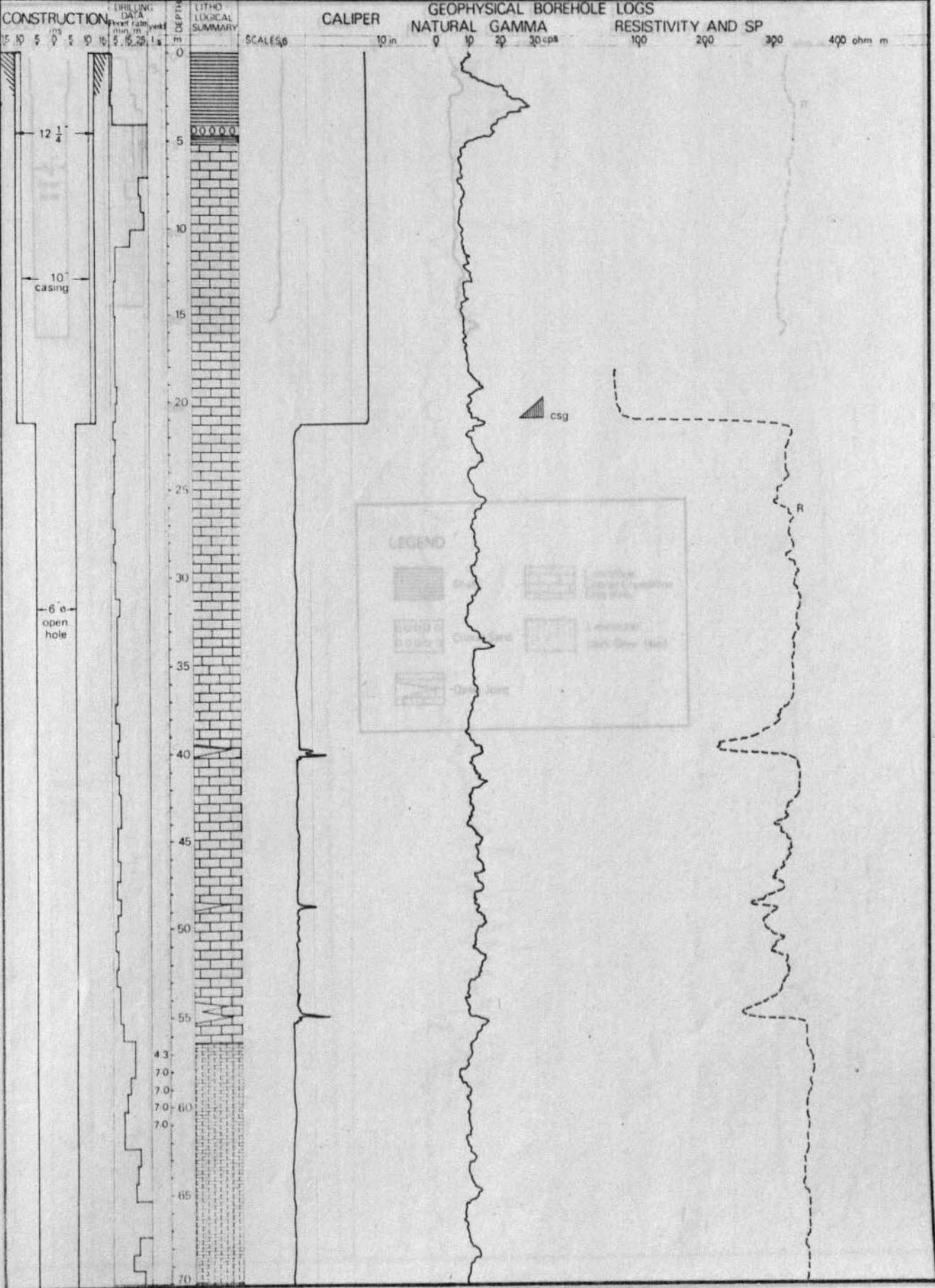
## PM3 GS1121

TOTAL DEPTH 86 m SWL 0 21 m

YIELD 7.2 1/5 EC 480

REMARKS Sheet 1/2

APPROX 1 97000



# COMPOSITE BORE LOG

TOPO SHEET

LOCATION MAP

Cont'd  
PM 3 GS 1121

LOCATION

GRID REFERENCE

TOTAL DEPTH 86 m SWL 0.21 m

STARTED 1982 COMPLETED 1982

REFERENCE POINT (R.P.)

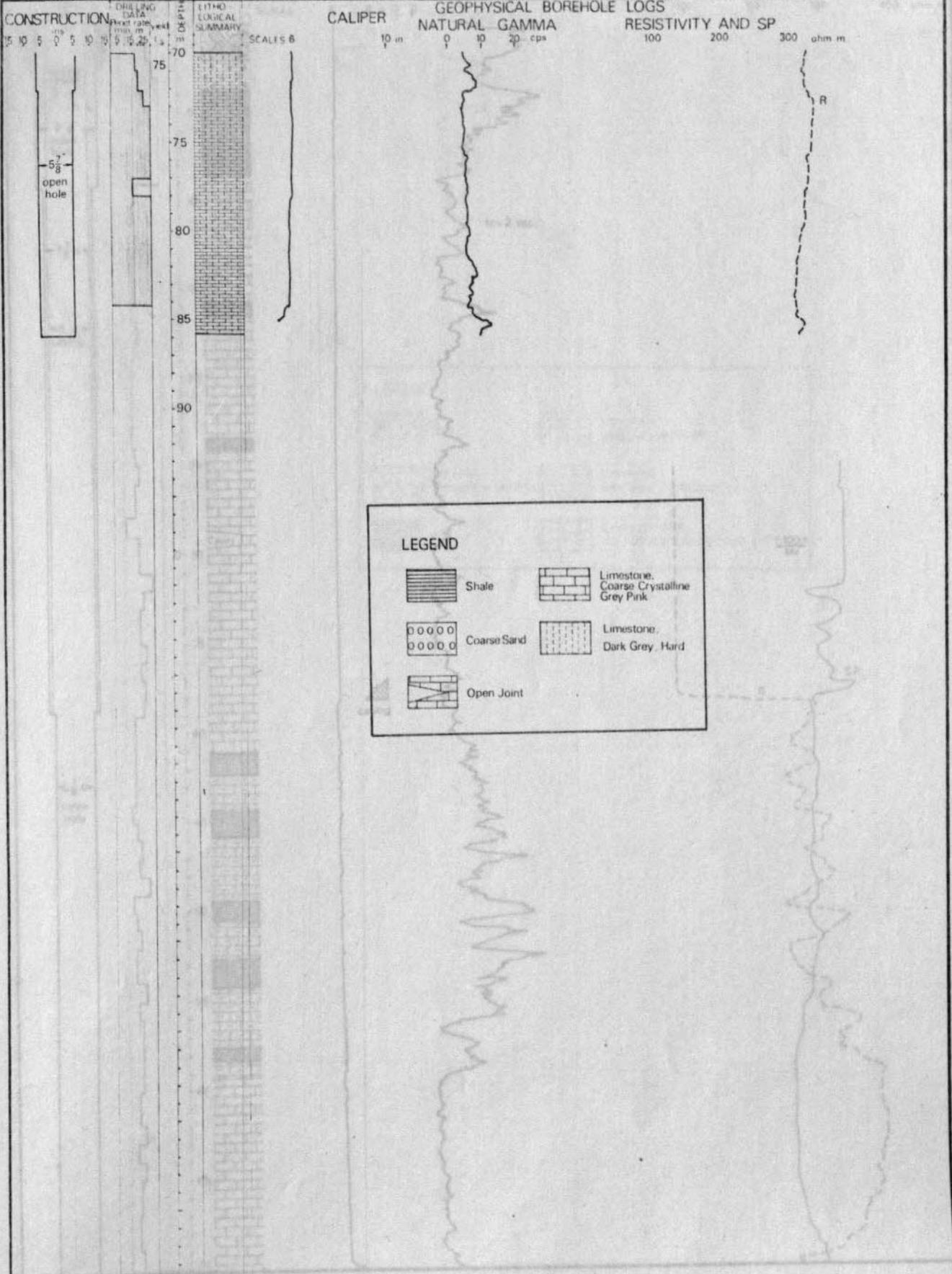
YIELD 7.2 l/s EC 480

DRILLING METHOD

R.P. ELEVATION (m below ground level)

REMARKS Sheet 2/2

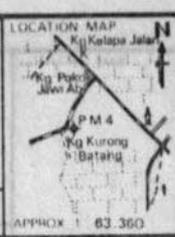
YIELD TEST



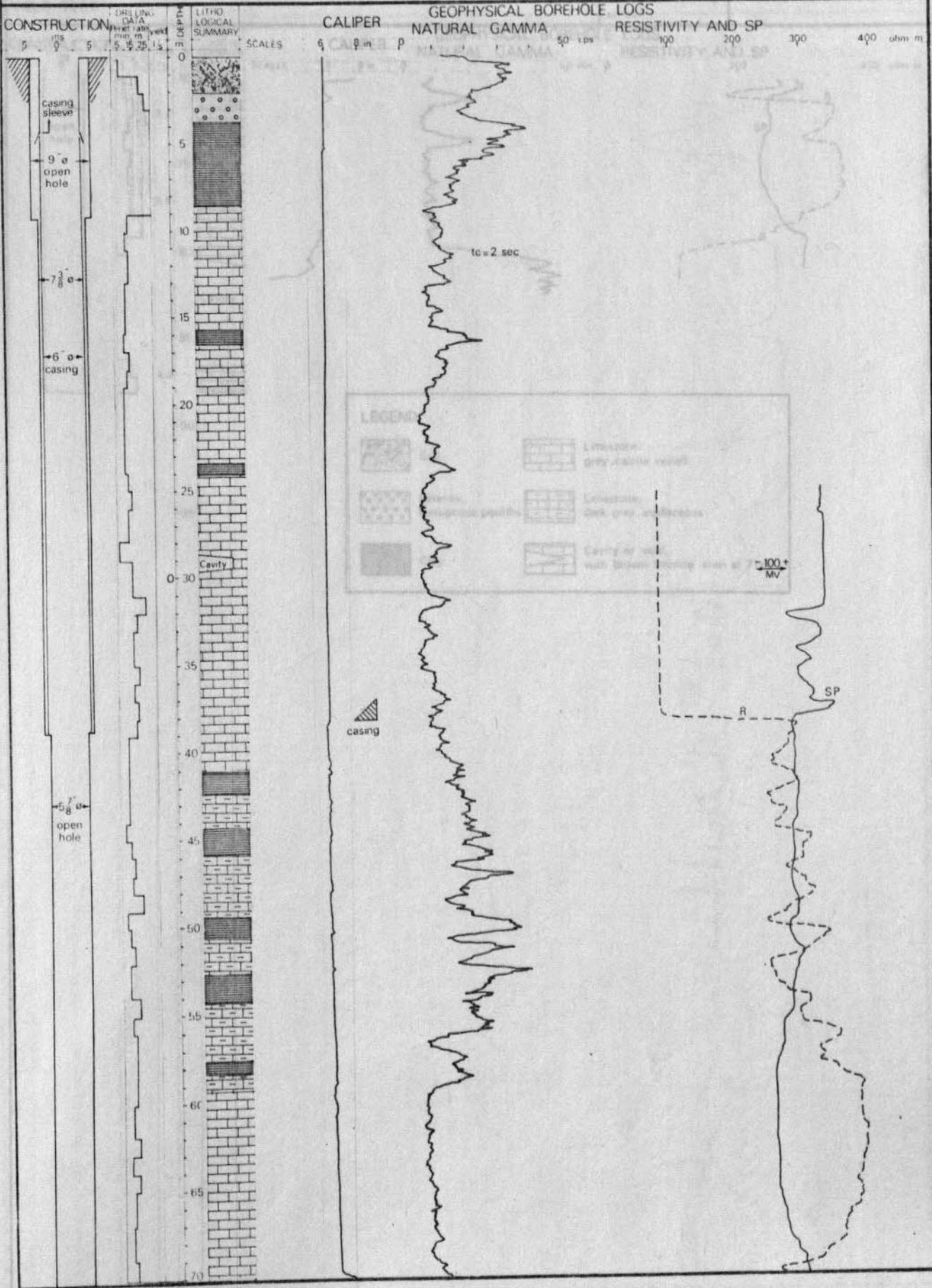
# COMPOSITE BORE LOG

LOCATION Padang Melangit, Perlis  
 STARTED 8 6 1982, COMPLETED 19 6 1982  
 DRILLING METHOD Rotary air flush : DHH  
 YIELD TEST 150min. air lift : 19 6 82

TOPO SHEET 151 KANGAR  
 GRID REFERENCE 456184  
 REFERENCE POINT (R P) Csg. top.  
 R P ELEVATION 0.5 m (above ground level)



**P.M.4GS II22**  
 TOTAL DEPTH 88 m SWL 1.18 m  
 YIELD 5.5 l/s EC 595  
 REMARKS Sheet 1/2



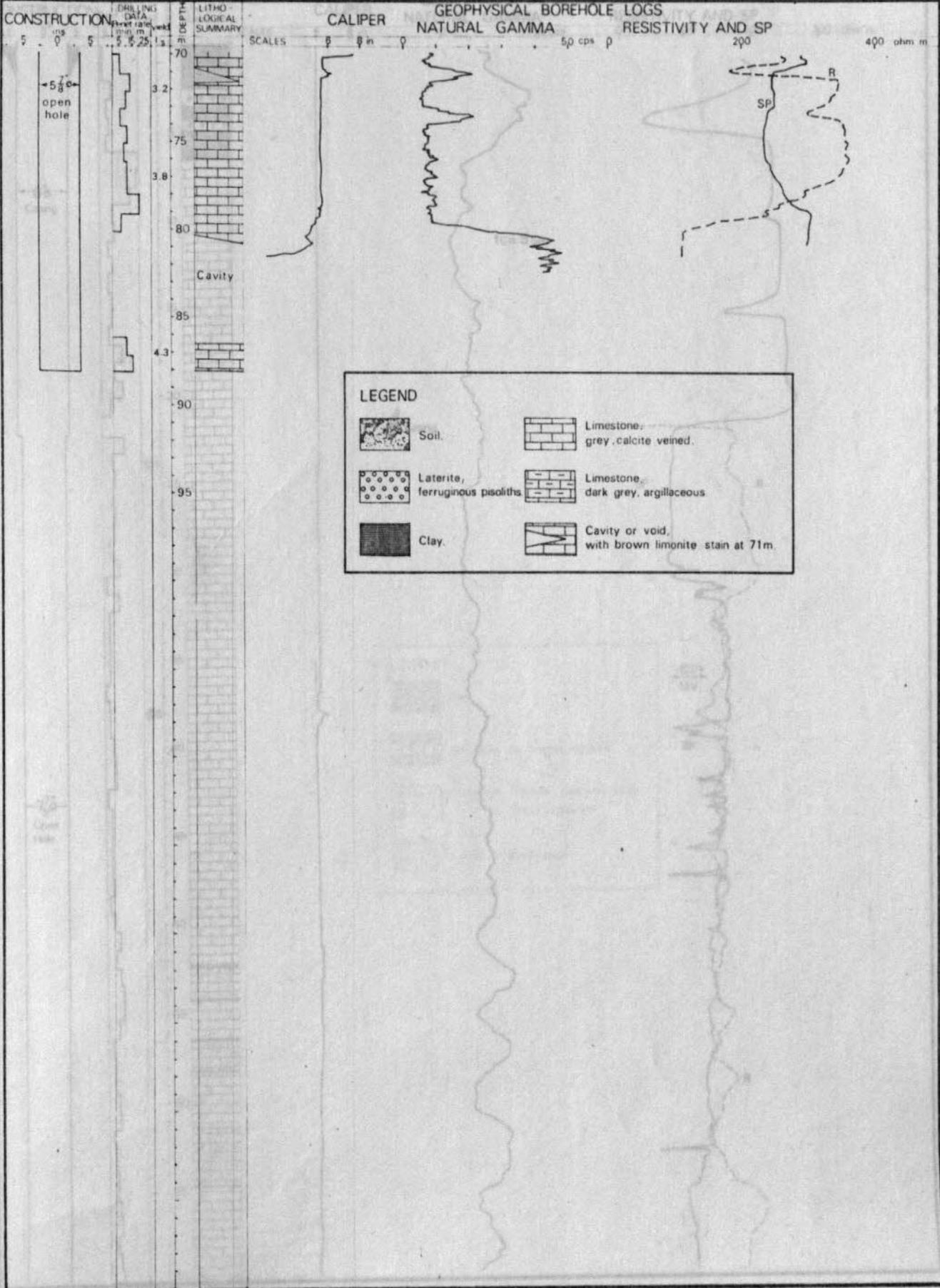
# COMPOSITE BORE LOG

LOCATION  
 STARTED 1982 COMPLETED 1982  
 DRILLING METHOD  
 YIELD TEST

TOPO SHEET  
 GRID REFERENCE  
 REFERENCE POINT (R.P.)  
 R.P. ELEVATION m (above ground level)

LOCATION MAP  
 APPROX 1

Cont'd P.M. 4 GS 1122  
 TOTAL DEPTH m SWL m  
 YIELD 1/3 EC  
 REMARKS Sheet 2/2



# COMPOSITE BORE LOG

TOPO SHEET 151 (Kangar)

LOCATION MAP

PM 5GS 1123

LOCATION Padang Melangit (PERLIS)

GRID REFERENCE 440177



TOTAL DEPTH 102 m SWL m

STARTED 21 6 1982 COMPLETED 29 6 1982

REFERENCE POINT (R.P.) Top of casing

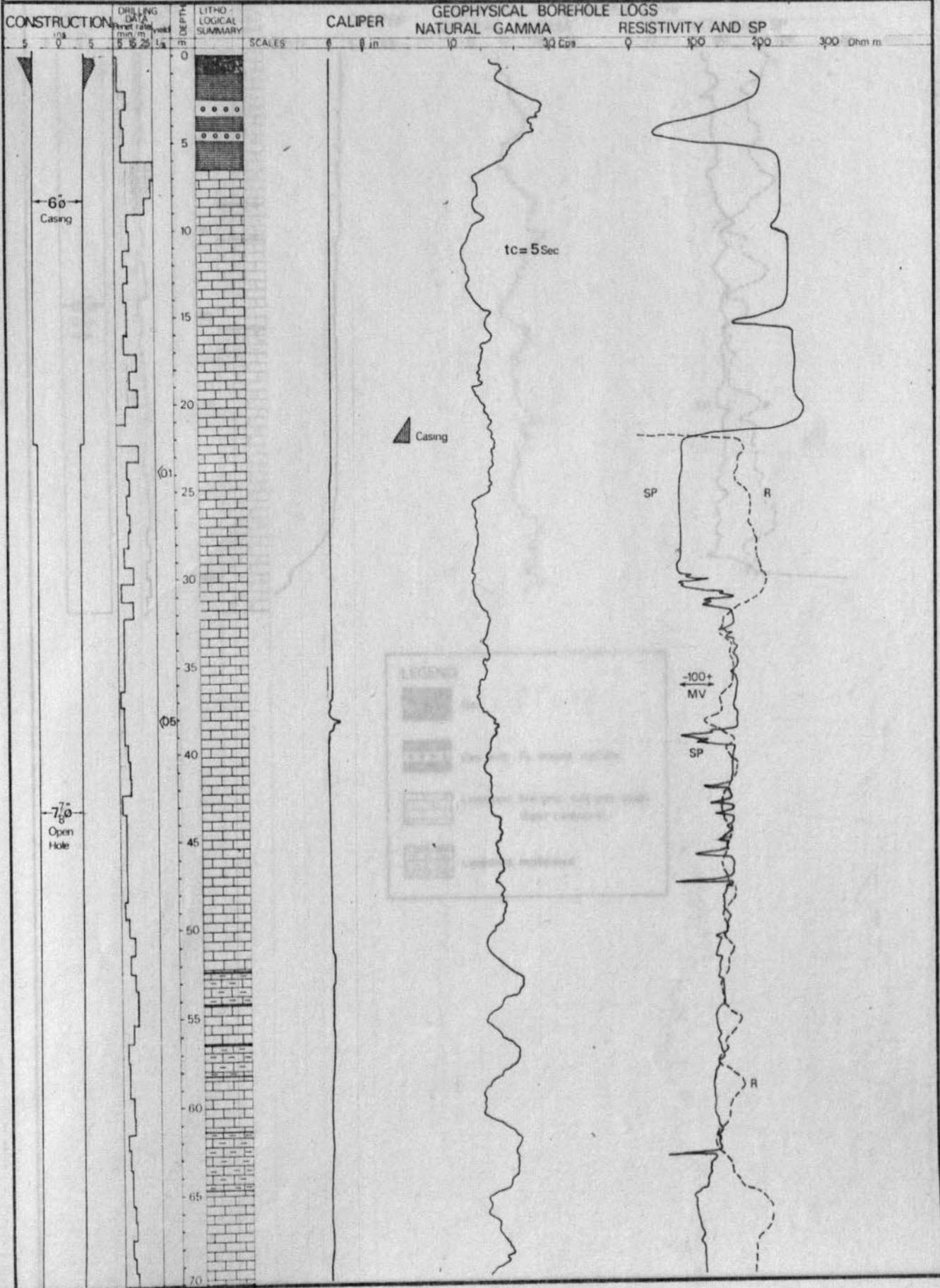
YIELD < 0.5 1/5 EC

DRILLING METHOD Rotary water flush  
0-10m Down hole hammer (DHH) 10-120m

R.P. ELEVATION m (above ground level)

REMARKS sheet 1/2

YIELD TEST: Not Conducted



# COMPOSITE BORE LOG

LOCATION

STARTED 1982 COMPLETED 1982

YIELD TEST

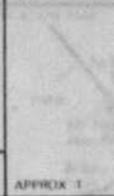
TOPO SHEET

GRID REFERENCE

REFERENCE POINT (R.P.)

R.P. ELEVATION m (above sea level)

LOCATION MAP

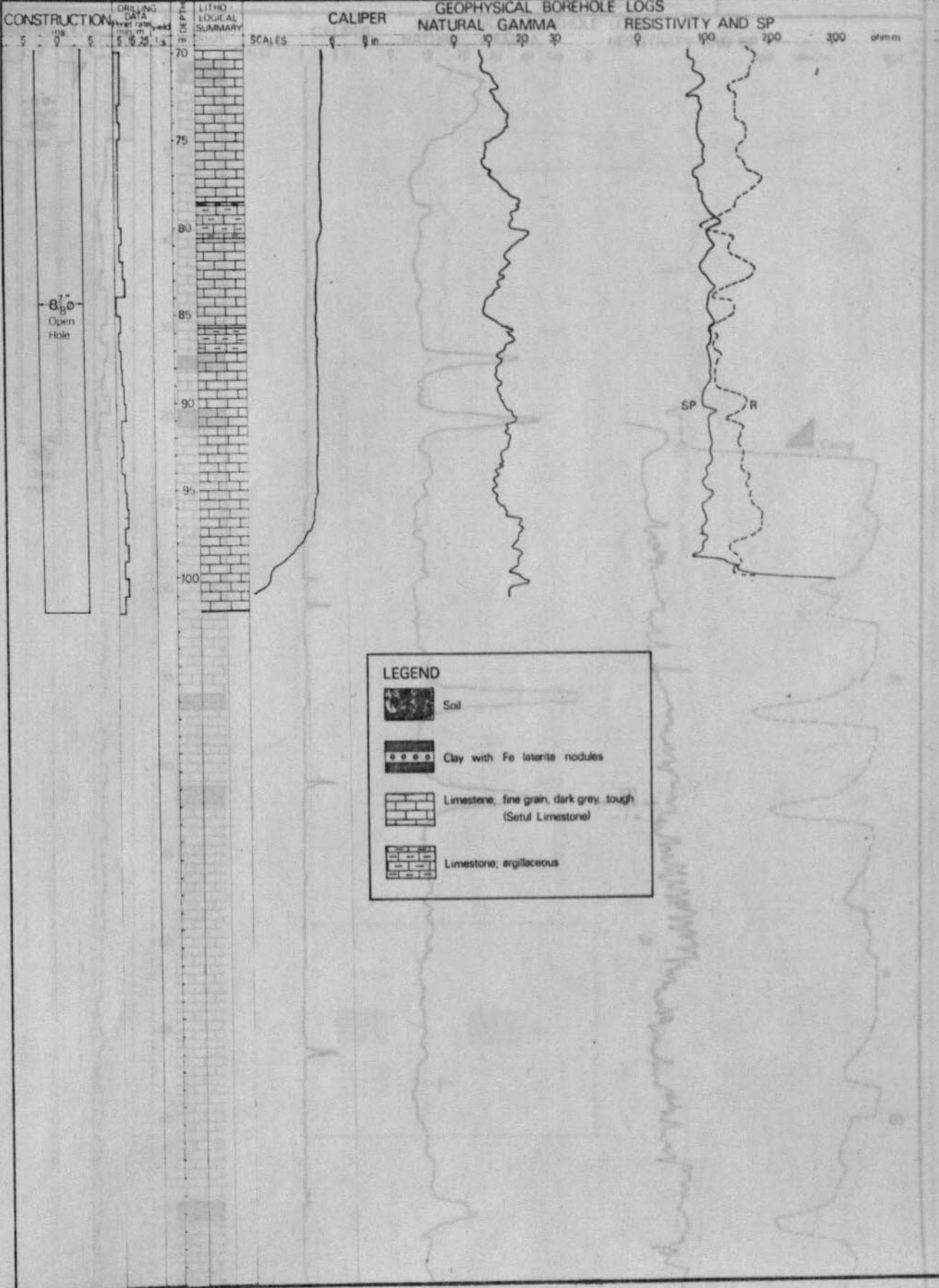


Cont'd  
PM5 GS 1123

TOTAL DEPTH m SWL m

YIELD 1/2 EC

REMARKS sheet 2/2



# COMPOSITE BORE LOG

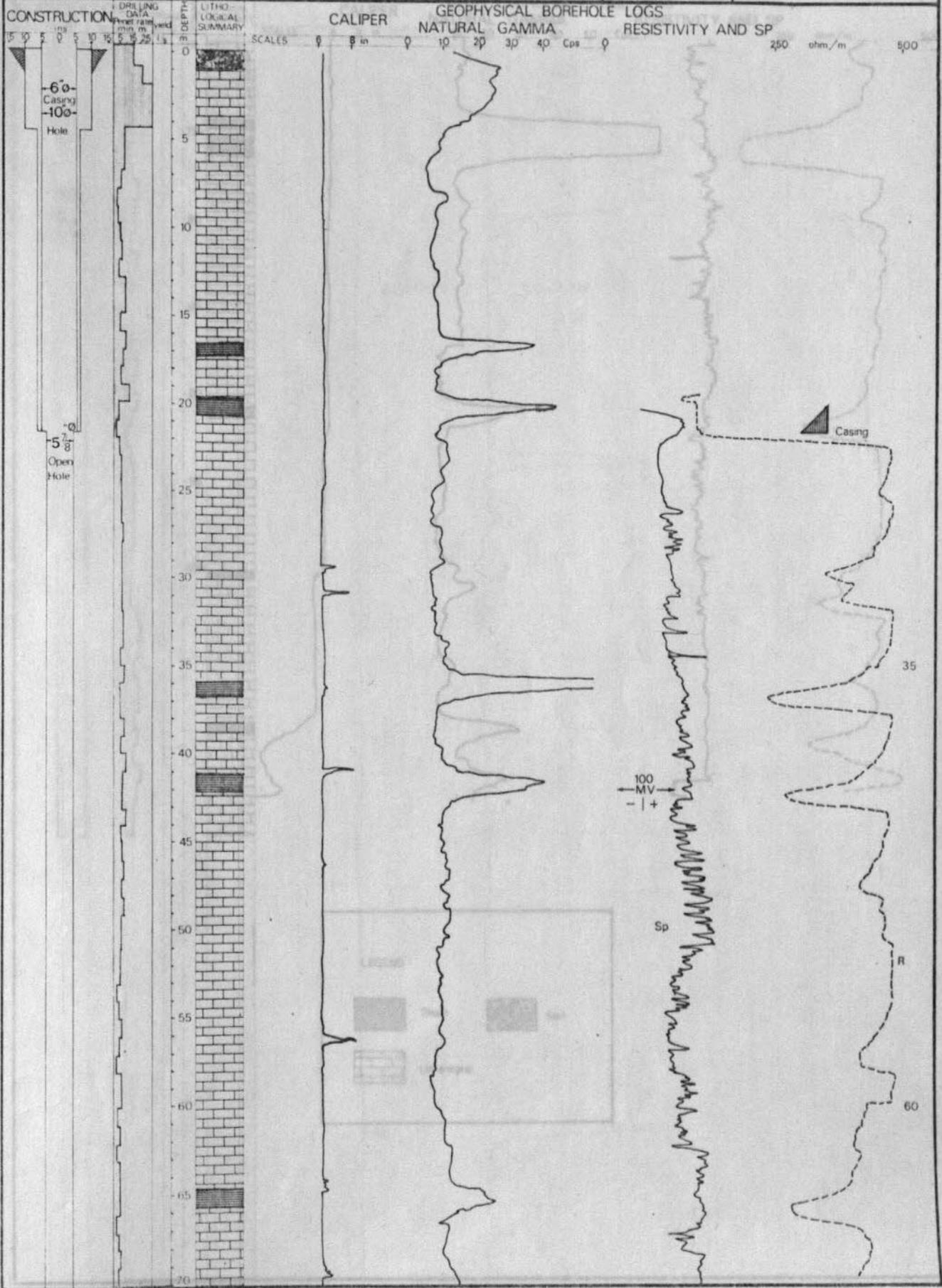
LOCATION PADANG MELANGIT (PERLIS)  
 Jalan Batu Pahat, Kangar Perlis  
 STARTED 30 5 1982 COMPLETED 3 6 1982  
 DRILLING METHOD 0-4.5 Rotary Air  
 Flush, 4.5-114m Down Hole Hammer.  
 YIELD TEST Not Tested

TOPO SHEET 151 Kangar  
 GRID REFERENCE 453195  
 REFERENCE POINT (R.P.)  
 R.P. ELEVATION m (above ground level)



## PM6GS1124

TOTAL DEPTH	115 m	SWL	0.5 m
YIELD	< 2 1/2 EC		
REMARKS	Sheet 1/2		





# COMPOSITE BORE LOG

LOCATION Wang Bintong 1

STARTED 8 4 1982 COMPLETED 28 4 1982

DRILLING METHOD Rotary water flush  
0-14m. Down Hole Hammer 14-92m

YIELD TEST No test carried out

TOPO SHEET 151 KANGAR

GRID REFERENCE 427131

REFERENCE POINT (R.P.) Top of casing

R.P. ELEVATION \_\_\_\_\_ m (above ground level)

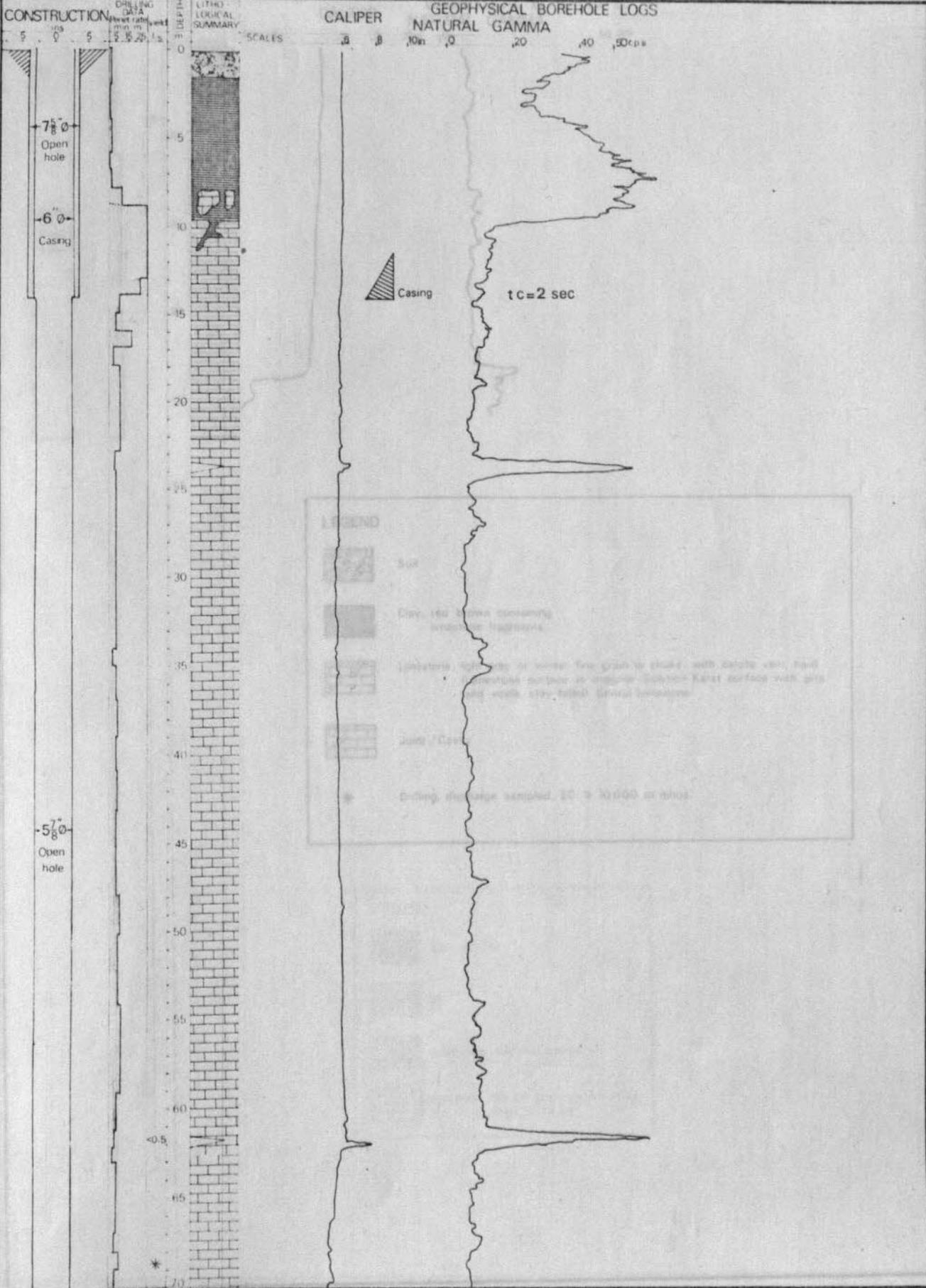


WB.1 GS 1126

TOTAL DEPTH 92 m SWL \_\_\_\_\_ m

YIELD < 0.1 l/s EC > 10000

REMARKS Sheet 1/2 WB (1 of 2)  
drilled close by collapsed at near surface and abandoned at 40m





# COMPOSITE BORE LOG

LOCATION Wang Bintong PERLIS

STARTED 28 3 1982 COMPLETED 7 4 1982  
 DRILLING METHOD Rotary Air flush 0-30m  
 Down hole hammer with airflush 30-53m  
 YIELD TEST

TOPO SHEET 151 Kangar

GRID REFERENCE 42914 2

REFERENCE POINT (R.P.) Top of casing

R.P. ELEVATION m (above ground level)

LOCATION MAP

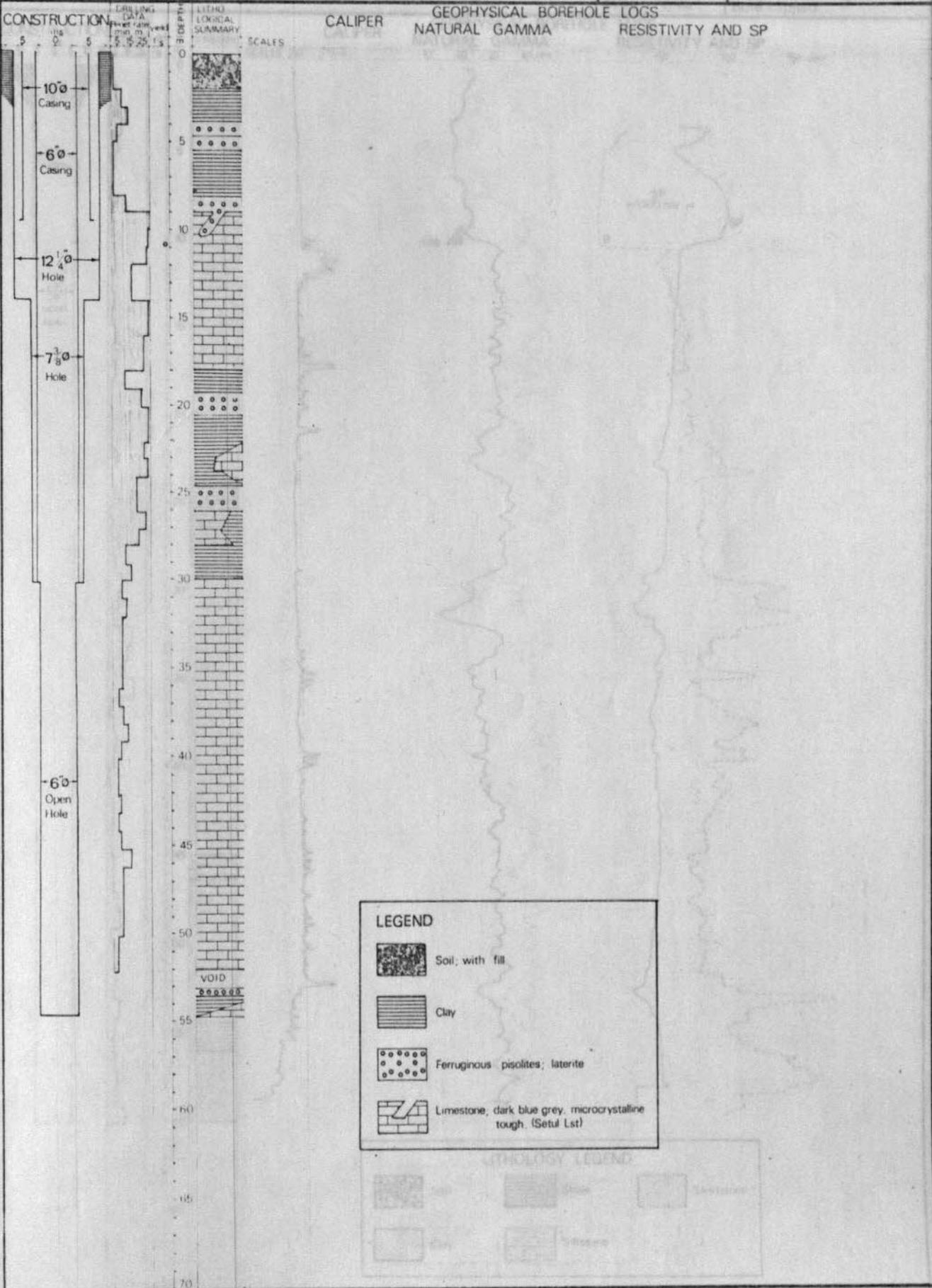


## WB2GS1127

TOTAL DEPTH 54m SWL m

YIELD 1.5 EC

REMARKS  
 no geophysical logs run  
 Bore abandoned, foundation problems



# COMPOSITE BORE LOG

TOPO SHEET 145 (PADANG BESAR)

(T.T.1)GS1114

LOCATION PERLIS, TITI TINGGI 1  
KG. KOK MAK

GRID REFERENCE 567 358

STARTED 17/3/1982, COMPLETED 23/3/1982

REFERENCE POINT (R.P.) TOP OF CASING

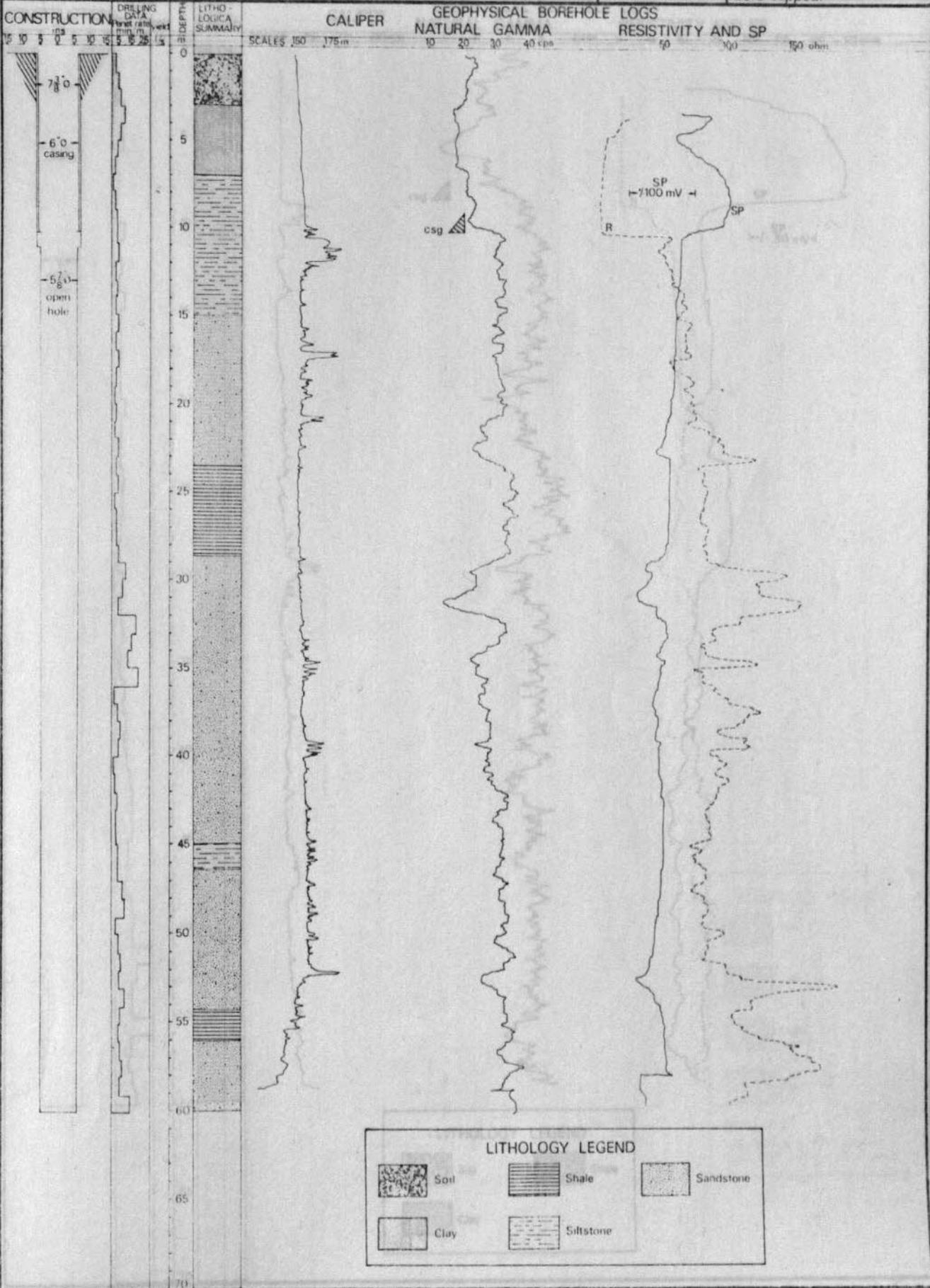
DRILLING METHOD ROTARY AIR FLASH  
1-11m. AND AIR HAMMER 11-60m.

R.P. ELEVATION \_\_\_\_\_ m (above ground level)

YIELD TEST: NOT TESTED



TOTAL DEPTH	60 m	SWL	4.28 m
YIELD	0 l/s	EC	
REMARKS negligible water yield during drilling. Bore capped.			



# COMPOSITE BORE LOG

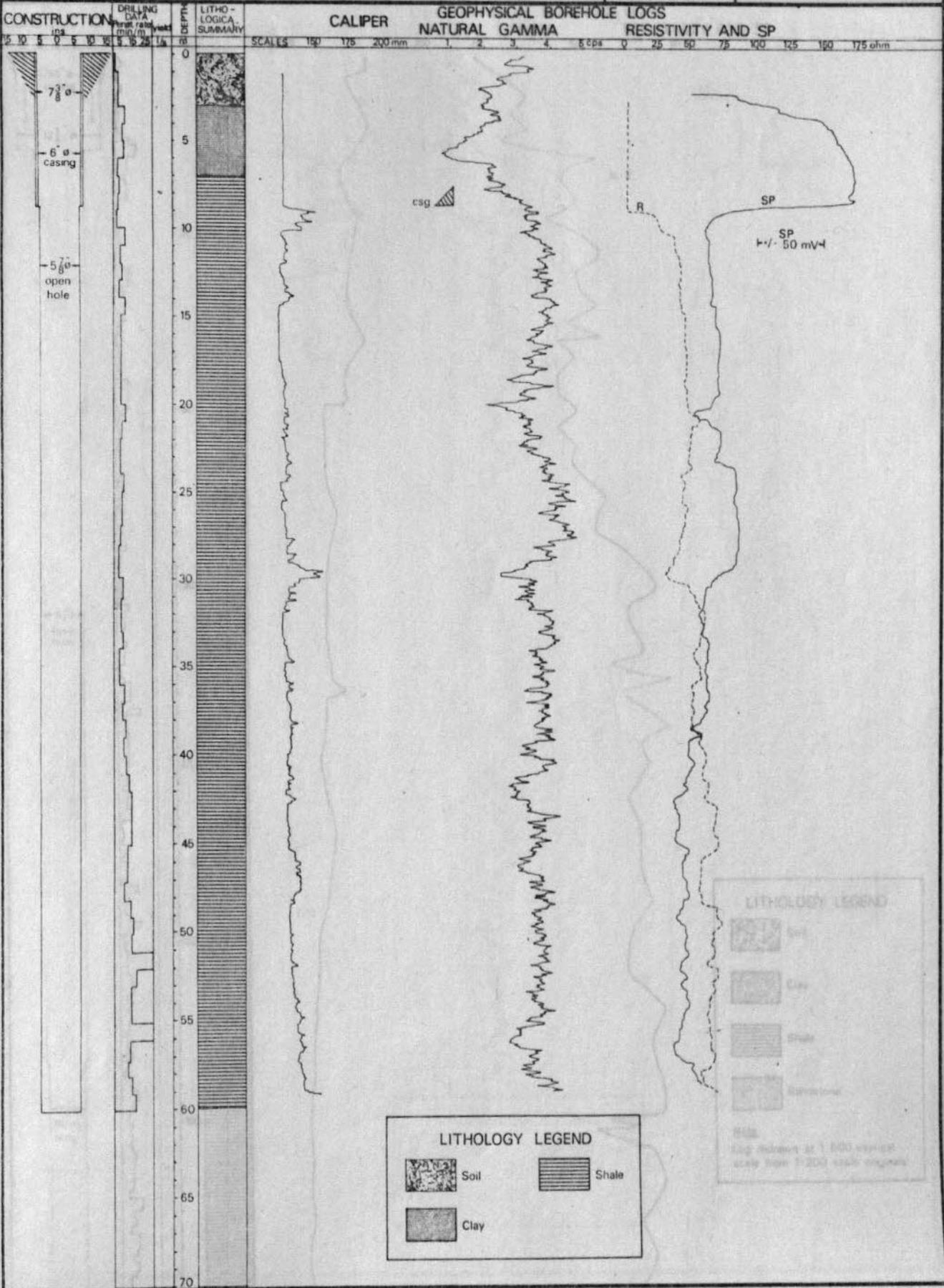
LOCATION: TITI TINGGI, PERLIS  
 STARTED 15.3.1982 COMPLETED 16.3.1982  
 DRILLING METHOD: ROTARY AIR FLUSH.  
 0-60 METRES.  
 YIELD TEST: NOT TESTED.

TOPO SHEET: 145 (PADANG BESAR)  
 GRID REFERENCE: 559 363  
 REFERENCE POINT (R.P.) TOP OF CASING.  
 R.P. ELEVATION: m (above ground level)



(T.T.2) GS1115

TOTAL DEPTH 60 m SWL 2.2 m  
 YIELD 0 1/8 EC.  
 REMARKS: dry borehole  
 Dry Test



# COMPOSITE BORE LOG

TOPO SHEET: 145 PADANG BESAR.



(T.T.3) GS1116

LOCATION: KG. SENA, TITI TINGGI, PERLIS.

GRID REFERENCE: 552357

TOTAL DEPTH 216 m SWL m

STARTED 6: 3: 1982, COMPLETED 11: 3: 1982

REFERENCE POINT (R.P.) TOP OF CASING.

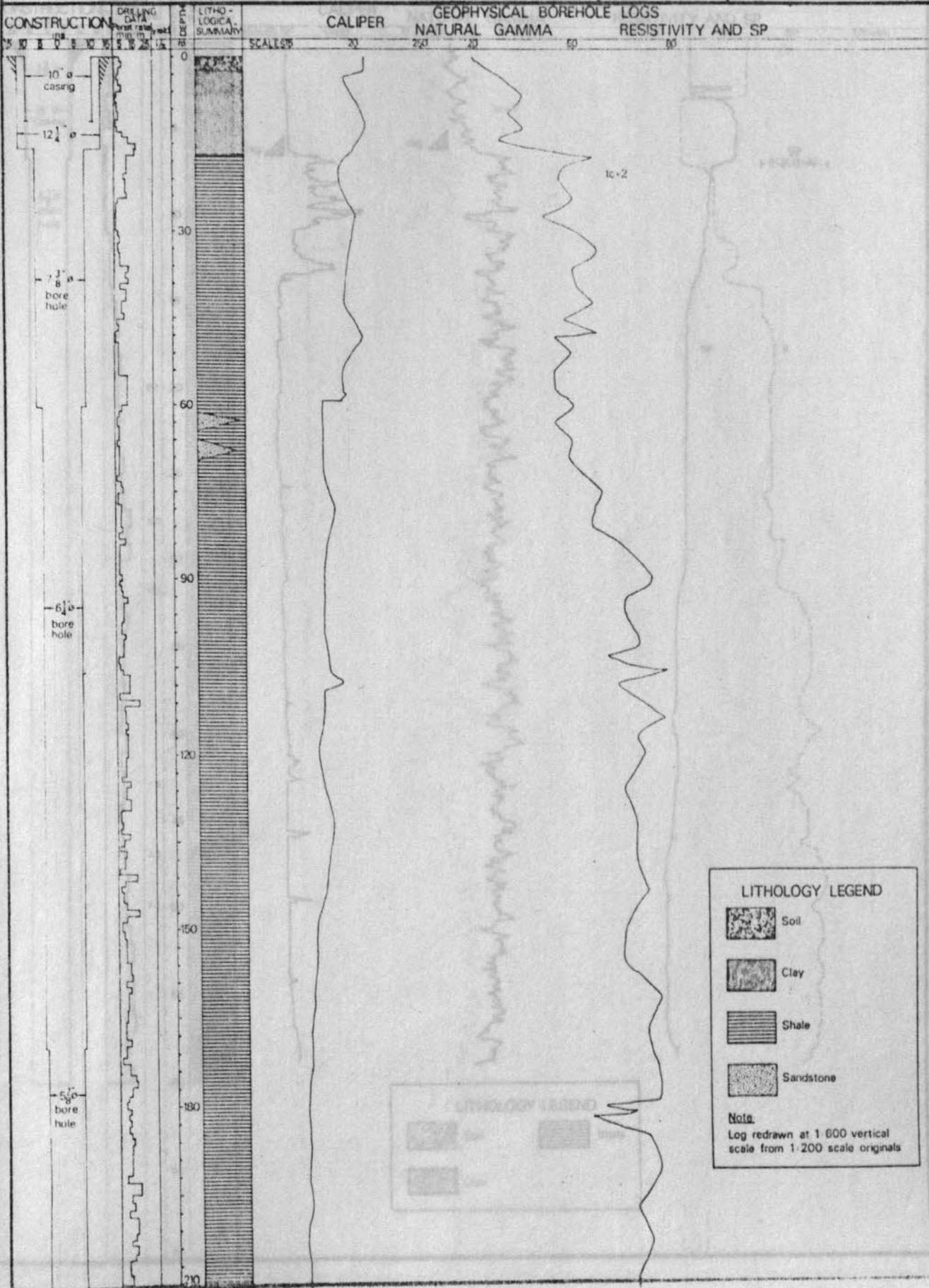
YIELD 1/8 EC

DRILLING METHOD: ROTARY AIR FLASH.

R.P. ELEVATION: m (above ground level)

REMARKS: Logged to 210m dry bore.

YIELD TEST: NOT CONDUCTED.



# COMPOSITE BORE LOG

LOCATION: KG. TITI TINGGI, PERLIS.

STARTED 24. 3. 1982, COMPLETED 28. 3. 1982

DRILLING METHOD: ROTARY AIR FLUSH  
DRILLING METHOD  
 1-60 METRES.

YIELD TEST: NOT CONDUCTED.

TOPO SHEET: 145 (PADANG BESAR)

GRID REFERENCE: 534349

REFERENCE POINT (R.P.) TOP OF CASING

R.P. ELEVATION: \_\_\_\_\_ m (above ground level)

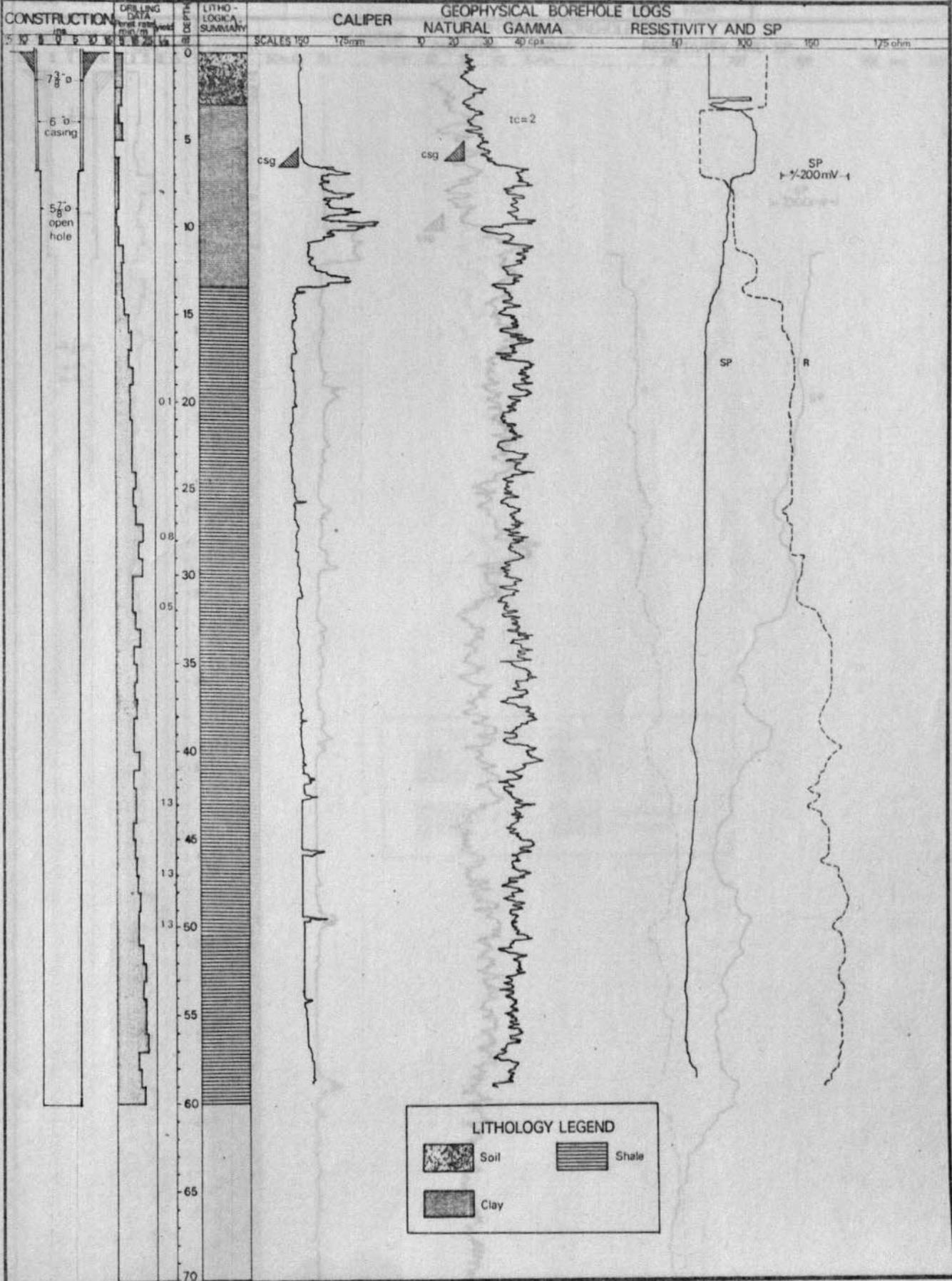


## (T.T.4)GS 1117

TOTAL DEPTH 60m SWL 3.57m

YIELD 1/5 EC nickel  
mangan  
at 25°C

REMARKS



# COMPOSITE BORE LOG

LOCATION KG TITI TINGGI, PERLIS

STARTED 30 3 1982, COMPLETED 7 4 1982

DRILLING METHOD: ROTARY AIR FLUSH  
(0-36m AND 54-66m, AIR HAMMER 37-54m AND 67-100m)

YIELD TEST NOT TESTED

TOPO SHEET 145 (PADANG BESAR)

GRID REFERENCE 532 355

REFERENCE POINT (R.P.) TOP OF CASING

R.P. ELEVATION \_\_\_\_\_ m (above ground level)

LOCATION MAP



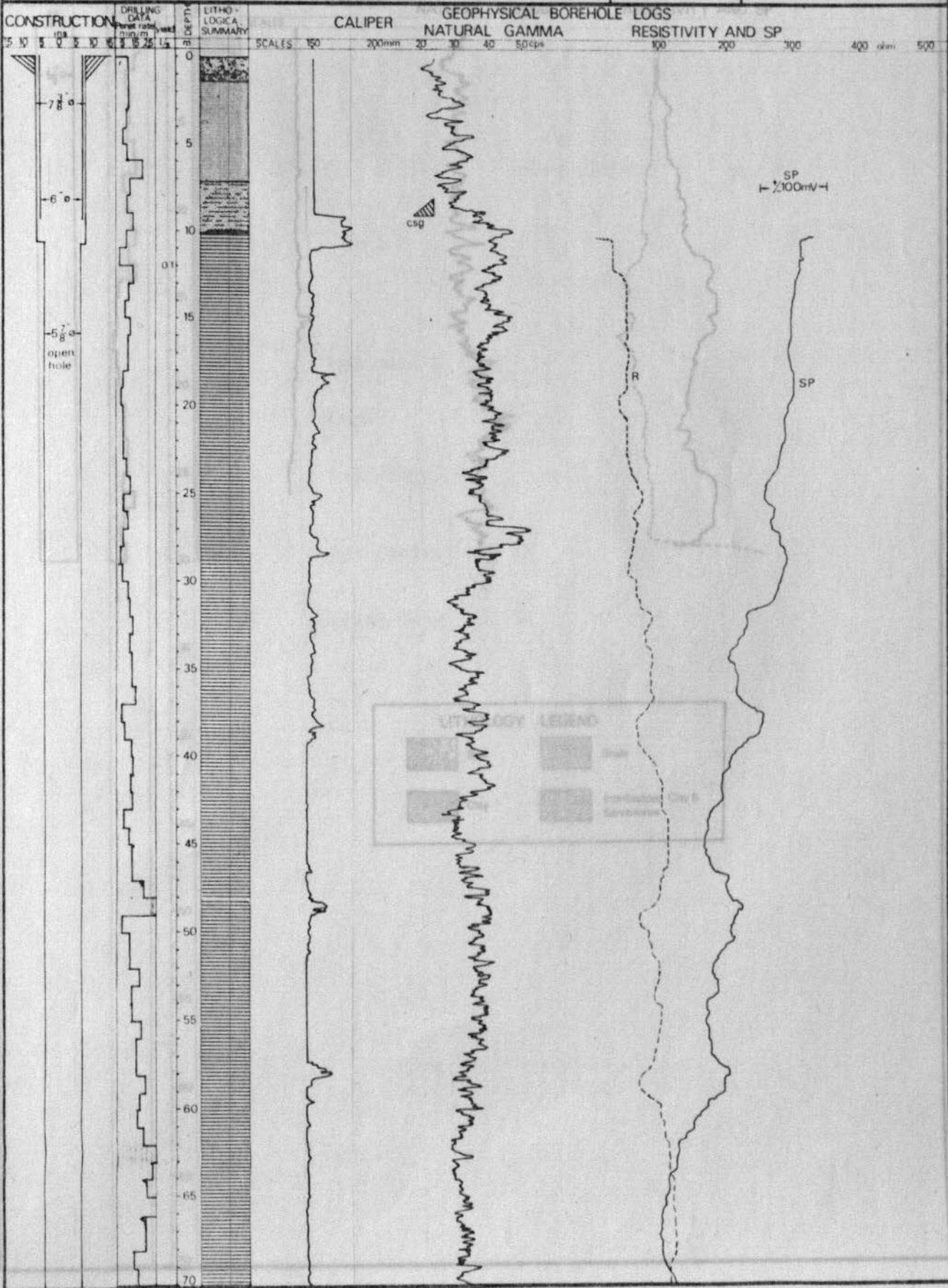
APPROX 1 97000

(T.T.5)GS 1118

TOTAL DEPTH 100m SWL \_\_\_\_\_ m

YIELD <math>0.1^{1/2}</math> EC \_\_\_\_\_ m<sup>3</sup>/hour at 25°C

REMARKS



# COMPOSITE BORE LOG

TOPO SHEET :

LOCATION MAP

## T.T.5 GS 1118

LOCATION

GRID REFERENCE :

TOTAL DEPTH	m	SWL	m
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STARTED : 1982 COMPLETED : 1982

REFERENCE POINT (R.P.)

YIELD	1/8	EC	11000 11500 at 25°C
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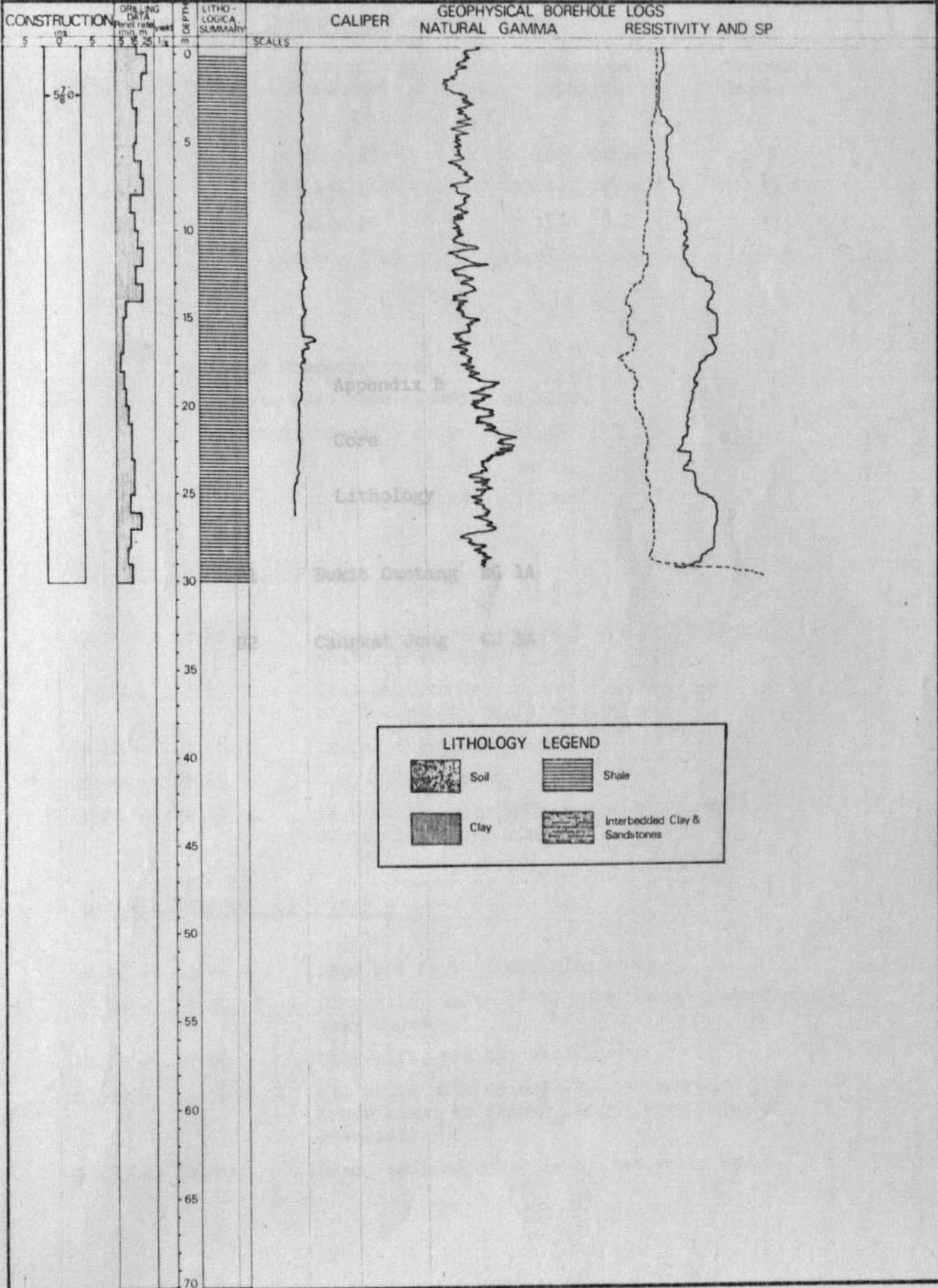
DRILLING METHOD :

R.P. ELEVATION : m (above ground level)

REMARKS :

YIELD TEST :

APPROX 1



Corehole  
Bukit Gantang 1A (adjacent to BG 1)

Core No.	Interval attempted	% Recovered Interval	Percent Recovery
1	12 - 13	12 - 12.88	88
2	13.4 - 14.4	13.4 - 14.28	86
3	15 - 16	15 - 15.7	70
4	16.9 - 17.5	16.77 - 17.32	55

Notes:

5 inch diameter core

## Appendix B

D disturbed; core material *in situ*.

Intervals Studied: 13.9 - 14.85

## Core

14.15 - 14.25

Lithology 14 - 17.32

Core # 1 Interval B1 12-13 m Bukit Gantang BG 1A

12.9 - 12.95	B2	Cangkat Jong CJ 3A fine sand (cs-fg), clay bound, white, disturbed.
12.95 - 12.65		Clay-silt, white, minor 1 cm laminae of fine medium argillaceous sand.
12.65 - 12.66		Cs-fg, clay-silt bound.
12.66 - 12.95		Clay-silt, white.
12.85 - 12.88		Cs with fg, subangular-subround (sa-or), bound with white clay-silt.

Core # 2 Interval 13.4-14.4 m

13.40 - 13.44	D	Sand and fg to 1 cm; clay bound
13.44 - 13.64		Clay-silt, white (70%) with medium sand laminae; clay bound.
13.64 - 13.70		Clay-silt, gritty, white.
13.70 - 13.75	D	Cs, white with ms and fg, subround (sr), trace clay; collapsed core. (Best aquifer material?)
13.95 - 14.28		Sand, medium-course (m-c), sr, clay bound.

Core # 1 Interval 12-13 m

Corehole  
Bukit Gantang 1A (adjacent to BG 1) clean.

Core No.	Interval attempted	? Recovered Interval	Percent Recovery
1	12 - 13	12 - 12.88	88
2	13.4 - 14.4	13.4 - 14.26	86
3	15 - 16	15 - 15.7	70
4	16.5 - 17.5	16.77 - 17.32	55

15.76 - 15.85 D Sand m-c, sr, moderately clean, trace clay.

Note:

3 inch diameter core

D disturbed; core material ex situ.

Intervals Sieved : 13.9 - 14.05

14.15 - 14.25

17.14 - 17.32

Core # 1 Interval 12-13 m

12.0 - 12.06 D	Coarse sand-fine gravel (cs-fg), clay bound, white, disturbed.
12.06 - 12.65	Clay-silt, white, minor 1 cm laminae of fine medium argillaceous sand.
12.65 - 12.66	Cs-fg, clay-silt bound.
12.66 - 12.85	Clay-silt, white.
12.85 - 12.88	Cs with fg, subangular-subround (sa-sr), bound with white clay-silt.

Core # 2 Interval 13.4-14.4 m

13.40 - 13.44 D	Sand and fg to 1 cm; clay bound
13.44 - 13.64	Clay-silt, white (70%) with medium sand laminae; clay bound.
13.64 - 13.70	Clay-silt, gritty, white.
13.70 - 13.95 D	Cs, white with ms and fg, subround (sr), trace clay; collapsed core. (Best aquifer material?)
13.95 - 14.26	Sand, medium-coarse (m-c), sr, clay bound.

Core # 3 Interval 15-16 m

15.0 - 15.10 D	Caving? Cs with fg, clean.
15.10 - 15.19 D	Cs-fg, gravel to 2 cm, sr clasts of feldspar, quartz; feldspar rotten 70% clay silt 30%
15.19 - 15.25	Cs-fg, white, clay bound. low.
15.25 - 15.39	Sand, m-c, clay bound. buff, subangular,
15.39 - 15.76	Clay-silt, white to pale yellow, with sporadic m-c sand laminae. Minor 5 cm sugary limestone and feldspar clasts.
15.76 - 15.86 D	Sand m-c, sr, moderately clean, trace clay.

Core # 4 Interval 16.5-17.5 m

16.50 - 16.77 D	(Caving) m or mc clean sand. (Possible loss between 16.77 and 16.60)
16.77 - 16.82 D	Cs-gravel, poorly sorted, minor grey clay; collapsed core.
16.82 - 16.93	Sand, medium, clay bound.
16.93 - 17.03	Clay-silt, buff white with 10% grey silt-clay flakes ex situ?
17.03 - 17.32	Sand, m-c with sporadic gravel to 3 cm; sr, clasts of quartz, feldspar. Poorly sorted, clay bound. Core contains black sub-horizontal peaty lenses. (Core cohesive 15.3-15.6 m and free standing).

Core # 5 Interval 29.5-30.5 m

Sample probably ex situ,avings.  
Lithologies include:

- medium sand, argillaceous, silty, buff.
- med-coarse, poorly sorted sand (grading silt to gravel); peaty.
- light grey-buff clay with 10% m sand.

Corehole  
Cangkat Jong CJ 3A (adjacent to CJ 3)

Core # 1 Interval 12-13 m (recovery  $\approx$  40%)

12 - 12.25 m	Clean, cs-fg (cavings ex situ).
12.25 - 12.47 m	Clay, sandy, buff to pale yellow.
12.47 - 12.53 m	Sand, m-c, argillaceous, buff, subangular, poorly sorted.
12.53 - 12.63	Sand, cs-fg, poorly sorted, subangular, argillaceous.
12.63 - 12.68	Clay, buff-light brown with entrained medium sand.

Core # 2 Interval 13.5-14.5 m

13.5 - 14.5 m	Coarse sand-fine gravel, very poorly sorted, subangular; quartz clasts to 1.5 cm. White kaolinitic clay-silt matrix.
---------------	--

Core # 3 Interval 15-16 m

12 - 15.30 m	Coarse sand-fine gravel (cavings ex situ).
15.3 - 16.0 m	Clay-sand, white-light grey, poorly sorted with subangular clasts of quartz, feldspar ilmenite/magnetite in kaolin silt-clay. Sand is medium-coarse. Core contains black sub-horizontal peaty laminae. (Core cohesive 15.3-15.6 m and free standing).

Core # 4 Interval 29.5-30.5 m

Sample probably ex situ, cavings.  
 Lithologies include:

- medium sand, argillaceous, silty, buff.
- med-coarse, poorly sorted sand (grading silt to gravel); peaty.
- light grey-buff clay with 10% m sand.

Appendix C

Sg. Tekam - Groundwater Throughflow Calculation for Catchment B.

Throughflow  $Q = T \cdot \text{grad} \cdot D$

where a value for transmissibility  $T = 25 \text{ m}^2/\text{d}$  is assumed; this value is derived from tests on similar weathered rocks at Mardā which are having  $T_{eq}$ . A typical natural groundwater gradient of 0.002 is assumed. Catchment element considered is approximately 508 m wide whilst the area of catchment B is 96.9 ha.

$$Q = 25 \times 0.002 \times 508 = 25 \text{ m}^3/\text{day}$$

$$\text{Appendix C} = 0.0091 \times 10^6 \text{ m}^3/\text{year}$$

Sg. Tekam : Groundwater Throughflow Calculation

for a 508 m wide aquifer, the flow is as follows:

Required Outflow  $= 508 \text{ m} \times 96.9 \text{ ha}$

$$= 0.508 \text{ m} \times 96.9 \times 100^2 \text{ m}^3/\text{year}$$

$$= 0.49 \times 10^6 \text{ m}^3/\text{year}$$

In present drilling evidence, it is unlikely that the thin aquifer existing under catchment B can annually transmit this amount of flow.

## Appendix C

### Sg. Tekam - Groundwater Throughflow Calculation for Catchment B.

Darcy equation  $Q = T \text{ grad } L$

Where a value for transmissibility  $T = 25 \text{ m}^2/\text{d}$  is assumed; this value is derived from tests on similar weathered rocks at Mardi Bertam and Padang Terap. A typical natural groundwater gradient (0.002) is assumed. Catchment element considered is approximately 500 m in width whilst the area of catchment B is 96.9 ha.

Substituting:

$$\begin{aligned} Q &= 25 \times 0.002 \times 500 &= 25 \text{ m}^3/\text{day} \\ & &= 0.0091 \times 10^6 \text{ m}^3/\text{year} \end{aligned}$$

For a 508 mm imbalance, the required outflow is as follows:

$$\begin{aligned} \text{Required Outflow} &= 508 \text{ mm} \times 96.6 \text{ ha.} \\ &= 0.508 \text{ m} \times 96.6 \times 100^2 && \text{m}^3/\text{year} \\ &= 0.49 \times 10^6 && \text{m}^3/\text{year} \end{aligned}$$

On present drilling evidence, it is unlikely that the thin aquifer existing under catchment B can annually transmit this amount of flow.