REPUBLIC OF INDONESIA

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

MARCH 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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P R E F A C E

The Japan International Cooperation Agency (JICA), entrusted with its work by the Government of Japan, has been extending cooperation to the Government of the Republic of Indonesia since 1977 on the Health Promotion Project in North Sumatra.

As part of the above Project, at the request of the Government of the Republic of Indonesia, JICA has decided to conduct a study on the rural water supply facilities, and despatched in November 1979 to the Republic of Indonesia a survey team headed by Dr. Michio Hashimoto, Professor of Graduate School of Environmental Science, Tsukuba University, to conduct a field survey.

After the field survey, the survey team analysed and evaluated the findings and data obtained, and has completed this report.

I hope that the project would contribute to the advancement of the welfare of the Indonesian people and to the strengthening of the friendly relations between our two countries.

I wish to express my sincere appreciation to the Authroities and officials concerned of Indonesia for their close cooperation and hospitality extended to the survey team.

March, 1980

Keisuke Arita
President
Japan International Cooperation Agency

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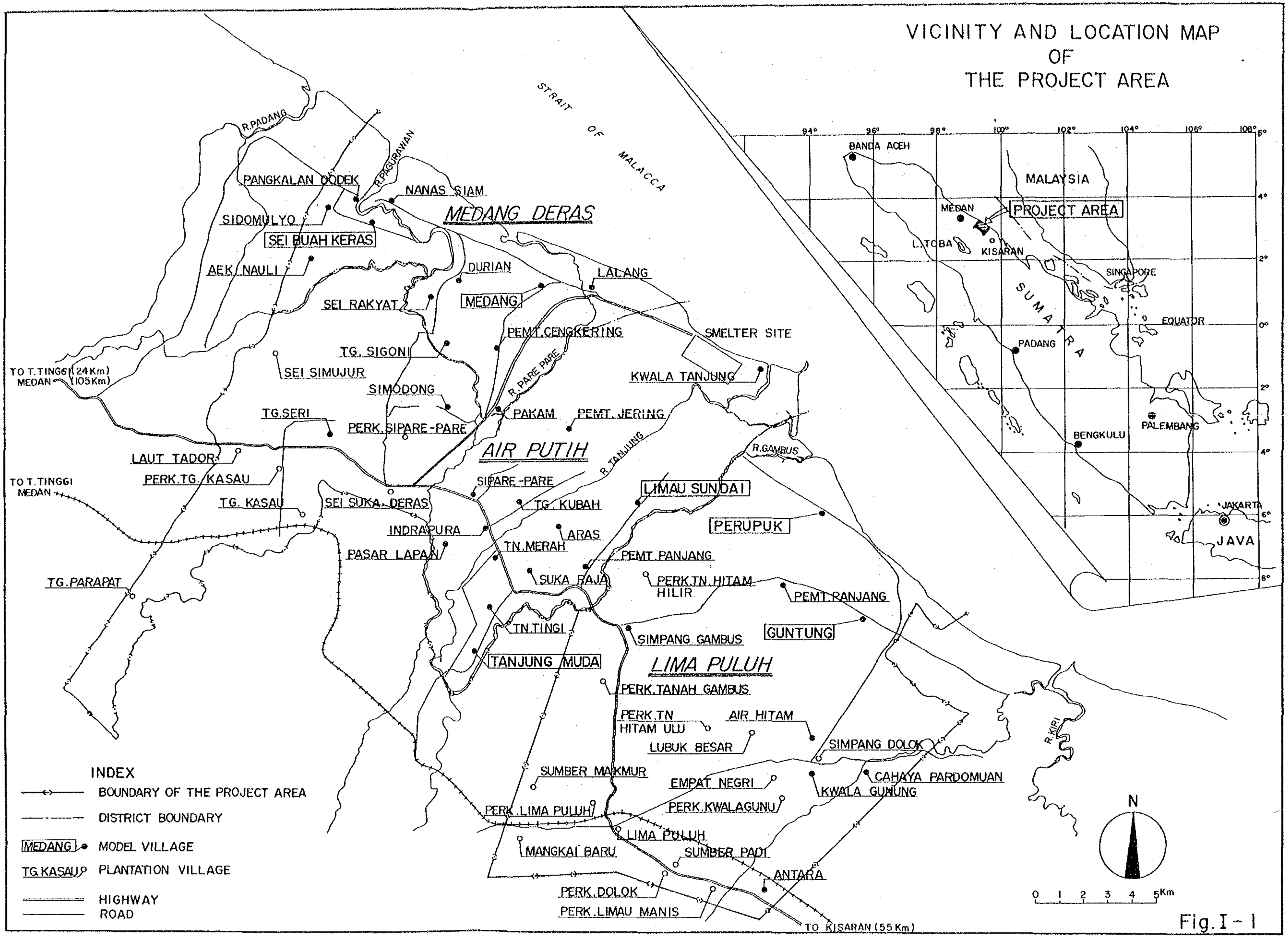
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INTRODUCTION

This report deals with water supply facilities to be provided in the project area of three districts, Lima Puluh, Air Putih and Medang Deras, in Asahan Regency, North Sumatra Province: presenting the results of the study carried out by the Japanese Survey Team. The study has been performed as a part of the Health Promotion Project in North Sumatra in accordance with OTA-43.

The Team visited the project site for one month, 21 Nobember - 20 December 1979, and performed technical investigation on the availability of drinking water and studied appropriate water supply facilities to be installed there; further exchanged views on the matters with officials concerned to make the study more complete. Member of the Team and officials met by the Team during its stay in Indonesia are listed in Appendices A-1 and A-3. The Team's daily activities are recorded and included in Appendix A-2.

The Team prepared the Progress Report which presented the Team's findings and preliminary planning on the water supply facilities during its stay in the survey sites, and submitted it to the officials concerned when the Team left Indonesia. Since its return to Japan, the Team has proceeded to complete the study, revising and supplementing the Progress Report; hence its results are compiled in this report.

The report involves:

- Outline of the project area,
- Present situation of water usage,
- Planning of water supply facilities to be provided in the project area, including cost estimates and implementation schedule, and
- Model study on the facilities for six selected villages.

Furthermore, following appendices are attached:

- Record of the field survey,
- Hydrogeological status of the project area,
- Data and papers concerned,
- Unit cost estimates,
- Record of disease cases,
- Supplementary planning, and
- Example of technical specification of construction works.

SUMMARY

Summary of the report is itemized as follows:

(1) Project Area

- Districts of the project:
  Three districts (Lima Puluh, Air Putih and Medang Deras in Asahan Regency, North Sumatra Province)
- Land area and ground height:
  700 square kilometers approximately; 0 - 25 meters above sea level
- Number of villages:
  56 villages being composed of 421 sub-villages
- Total population:
  Approximately 138,000
- Characteristics of the area:
  Very rural area
- Main industries:
  Agriculture and fishery
- Sickness rate:
  Very high at 94 per mil
- Water supply system:
  Not existing of public water supply system with pipeline, as of the end of 1979
- Current drinking water source:
  Mostly unprotected shallow wells
- Public electricity:
  Not existing of public electricity supply, as of the end of 1979

(2) Population to Be Served by the Project

About 104,000 people
(Out of the total population, inhabitants in the plantation area are excluded from the population to be served.)

(3) Basic Concept of Water Supply Planning and Design Criteria

- Purpose of the project:
  To find out reliable water source and to install facility for utilization on the spot.

- Water sources:
  Semi-deep wells with hand pumps (about 50 - 60 meters) and deep wells (about 150 - 200 meters).

- Number of water supply facilities:
  Several places in each village.

- Composition of the facility (per unit):
  - One deep well/semi-deep well,
  - One storage tank,
  - Several water taps,
  - One open place for water drawing and for washing,
  - Two walled sheds for bathing; each one for men and women,
  - One pit for drain, and
  - Technical tools for maintenance and spare parts required.

- Hand pump:
  Should be equipped on a well, when ground water has no positive pressure.

- Pipeline system and power driven pumps:
  Would not be employed.

- Operation and maintenance:
  Should be carried out by each villages organization.

- Water tariff:
  Would not be considered.

- Water quality:
  Would be most desirable quality being locally available.

- Per capita water demand:
  50 liters/day.

iv) Standardized Units of Water Supply Facilities

Type of Unit	A	B	C	D
Number of People to be Supplied	300 - 400 persons	300 - 400 persons	600 - 800 persons	1,200 - 1,800 persons
Water Demand	15 - 20 m^3/d	15 - 20 m^3/d	30 - 40 m^3/d	60 - 90 m^3/d
Well	Semi-deep well with a hand pump; 50 - 60 m	Deep well; 150 - 200 m	Deep well; 150 - 200 m	Deep well; 150 - 200 m
Production Expected	21 m^3/10hrs	21 m^3/10hrs	36 m^3/10hrs	72 m^3/10hrs
Construction Cost per unit	Rp.4,000,000 (US$6,500)	Rp.9,900,000 (US$16,000)	Rp.11,820,000 (US$19,100)	Rp.12,300,000 (US$19,900)
Construction Cost per Capita	Rp.11,400 (US$18.2)	Rp.28,300 (US$45.3)	Rp.16,900 (US$27.0)	Rp.8,200 (US$13.1)

Note: - Construction costs do not include applicable taxes.

- US$ 1.00 = Rp. 625

(5) Number of Facilities to be Constructed in the Project Area

District	Type "A"	Type "B"	Type "C"	Type "D"	Total
Lima Puluh	26	4	12	9	51
Air Putih	54	6	12	9	81
Medang Deras	12	4	11	7	34
Total	92	14	35	25	166

(6) Implementation Schedule

	First Stage (1980-1982)	Second Stage (1983-1987)	Total (1980-1987)
Construction Cost	Rp,447,500,000 = US$720,000	Rp.781,500,000 = US$1,250,000	Rp.1,229,000,000 = US$1,970,000
Number of Facilities to be Constructed	A = 36 B = - C = 10 D = 15 Total= 61	A = 56 B = 14 C = 25 D = 10 Total=105	A = 92 B = 14 C = 35 D = 25 Total=166
Population to be Served	44,000 (42%)	60,000 (58%)	104,000 (100%)

Note: The above years indicate fiscal years.

(7) Maintenance Program

- Operation and maintenance should be carried out by the beneficiary in principle.
- Each village should organize a committee or the like for the maintenance.
- The committee shall nominate certain villagers for the routine works of operation and maintenance of the facility.
- The local committees would be assisted by the governmental organization for the maintenance and procedures of operation.

RECOMMENDATION

In the course of the field survey including discussion with officials concerned, and planning of the water supply facilities, subjects to be recommended are summarized as in the followings:

(1) Implementation Organization:

To implement the project promptly and effectively, an implementation organization should be composed as soon as possible, prior to construction works, at Provincial or Regency level, with the assistance of Ministry of Health. Afterward, main body of the implementation organization could be transformed into the maintenance management organization.

(2) Maintenance Management Organization:

To keep the facilities satisfactory conditions and not to leave broken facilities as they are, a substantial body should be organized at Regency level prior to completion of construction works. It should include a sanitary engineer and/or a sanitarian and carry out overall management for the facilities including periodical inspection of the sites of facilities in the whole project area.

(3) Repair Shop:

To repair heavy damage of facilities, especially hand pumps, a public repair shop should be opened in the project area, and cover the all three districts. The shop shall store all kinds of spare parts and relating materials in addition to technical tools/machines; the shop shall be staffed with technicians. If it is not possible, a certain agent, private shop or contractor, should be hired with continuous contract for the repair work.

(4) Participation of Villagers:

In order to promote the project implementation, villagers concerned, that is, beneficiaries of the water supply facilities should participate in the very beginning stage of the project, in addition to the stages of construction and operation/maintenance, in such manners as participation in the meetings for selection of the location of the facilities and offering land required for the facilities; further supplying labor for construction and supervision.

It is advisable that a reasonable remuneration should be paid for villagers who offered labor or land.

(5) Maintenance Costs:

Water tariff would not be considered in this project; however, marginal substantial cost for facility maintenance, at least repair works should be encouraged to be borne by the people of community as beneficiary. This is essential for bringing up self-help philosophy among villagers.

(6) Improvement of Environmental Health:

Safe and adequate rural water supply project is indispensable service for control of waterborne communicable diseases. It is also essential for improvement of sanitation and hygiene to develop primary health care in the project area. Environmental health should be considered as a integral part of development planning in the Health Promotion Project.

(7) Drainage:

As well as water supply, drainage of contaminated water and surface water should be taken into consideration in this program. Though the drainage system covering whole project area will be planned at central government level in the future, for the time being the drainage should be considered by each village itself under the direction of the said operation management organization.

(8) Health Education:

Educational approach should be integrated from initial stage of implementation of rural water supply project. Community approach without educational efforts can not expect successful community preparation and participation. All community efforts should be carefully integrated into community development.

Health education should be performed periodically by sanitarians and/or public nurses, through firstly elementary schools and secondarily public institutions; for the education, audio-visual system is preferably utilized.

(9) Training of Sanitary Personnels:

Training of sanitary personnels in administration and voluntary villagers should be actively developed. It is highly desirable to initiate vocational training courses with effective training kits for well construction, maintenance and repair works.

(10) Disinfection:

Water supply facilities planned by the project are not equipped with disinfection apparatus; however, for emergency cases such as outbreak of communicable diseases, preparedness of the disinfection materials should be recommendably arranged by or under the direction of the operation management organization.

(11) Idea of Future Water Supply:

The proposed rural water supply project is a primary model to meet urgent need for prevention of epidemics of enteric infectious diseases at present. The philosophy of appropriate technology is taken into consideration. However, steady and continuous efforts should be done for uplift of practicable technology for safe and enough water supply for near future. The quantity of water is abundant, but quality is poor. If more advanced water supply technology can be applied, social and economic uplift of community living can be promised.

(12) Personnel Resources:

Strengthening of personnel resources of sanitarian and engineer in health administration and public works is basic potentials for environmental health development in the project area. The progress of environmental health in development planning can be achieved through those institutional efforts.

ABBREVIATIONS AND ACRONYMS

Unless the text states otherwise, the following terms and abbreviations have the following definitions:

WHO	- World Health Organization
UNICEF	- United Nations International Children Emergency Fund
UNDP	- United Nations Development Program
IBRD/IDA	- International Bank for Reconstruction and Development/International Development Association
ADB	- Asian Development Bank
BAPPENAS	- National Planning Board
CDC	- Directorate General of Communicable Diseases Control, Ministry of Health
DHS	- Directorate of Hygiene and Sanitation, Ministry of Health
PELITA I	- First Five-Year Development Plan, April 1969 - March 1974
PELITA II	- Second Five-Year Development Plan, April 1974 - March 1979
PELITA III	- Third Five-Year Development Plan, April 1979 - March 1984
INPRES	- Presidential Instructions
CIPTA KARYA	- Directorate General of Housing, Building, Planning and Urban Development of the Ministry of Public Works
ITB	- Institute Technology of Bandung
INALUM	- Indonesia Asahan Aluminium Company
cm	- centimeters
cm/sec	- centimeters per second
m^3	- cubic meters
m^3/h	- cubic meters per hour
EL	- Elevation, meters
Fig.	- Figure
kg/sq cm	- kilograms per square centimeter
kwh	- kilowatt-hour
kva	- kilovolt-ampere
lpd	- liters per day
l/sec	- liters per second

Max	-	maximum
Max day	-	maximum day
Min day	-	minimum day
mg/l	-	miligrams per liter
min	-	minutes
Min	-	minimum
mm	-	millimeters
mm/year	-	millimeters per year
m	-	meters
m/day	-	meters per day
MVA	-	mega volt-ampere
pH	-	potential of Hydrogen
ppm	-	parts per million
PVC	-	polyvinylchloride
rpm	-	revolutions per minute
cm^2	-	square centimeters
m^2	-	square meters
V	-	volts
m^3/sec	-	cubicmeters per second
m^3/min	-	cubicmeters per minute
m^3/day	-	cubicmeters per day

CURRENCY EQUIVALENTS

Currency Unit	=	Indonesian Rupiah (Rp.)
US$1	=	Rp. 625
US$1 million	=	Rp. 625 million
Rp.1	=	US$0.0016
Rp.1 million	=	US$1,600

FISCAL YEAR PERIOD, from APRIL 1 to MARCH 31

I. OUTLINE OF THE PROJECT AREA

1.1 Administrative Status

The project area consists of three districts (Kecamatan), Lima Puluh, Air Putih and Medang Deras, with 138,000 population and land area of about 700 square kilometers. These are three of fifteen districts in Asahan Regency which has 651,000 population and land area of 4,681 square kilometers.

These districts are under the rule of the governor of North Sumatra Province at provincial level and the head (Bupati) of Asahan Regency at regency level. The chief of district is named Camat, who has secretariat staff but has no executive organizations. Executive organizations such as health centers belong directly to the Bupati. See Fig. C - 6.

Each district is divided into villages (Desa); village is into sub-villages (Lorong). Number of villages in Lima Puluh, Air Putih and Medang Deras is respectively 22,22 and 12. Number of sub-villages of these districts is respectively 192, 146 and 83. The present population of each village is tabulated in Appendix C-5.

Administrative organization of a village is normally composed of the chief of village, LSD (Lembaga Social Desa), MBPD (Badan Musyawarah Pembangunan Desa), secretary and three staffs. The chief of village rules the chiefs of Lorongs. The chief of village is elected by the village people, and may usually be re-elected and continue to be in his position until his retirement. He manages the village in collaboration with LSD and BMPD. LSD, which consists of five members, discusses village matters and makes the direction of village activities. BMPD, which consists of religious people, is something like as a planning board to discuss social development matters. The three staffs are responsible for religious, economical and social activities. They are not full-time but part-time staffs. Organization chart of the village and the structure of Kecamatan are included in Appendix C-6.

Regarding the sanitary staff, only seven sanitarians are retained in Asahan Regency; only one sanitarian and no sanitary engineers in the project area.

1.2 Topographical Conditions

The project area is located at northern part of Sumatra Island streching from northwest to southeast, facing to Malacca Straits.

The area is in the alluvial plain, and a little hilly in the southwest and swampy in the northeast. Rivers in the area such as Indrapura River, Parepare River, etc., meander from southwest to northeast, and in the plain are diverted into many branches, and cause damages through floods once or twice every year. Therefore the soil in the area mainly consists of layers of clay and sand, occasionally with rotted trees inbedded in these layers.

Dividing this area into two zones, a main road from Medan to Kisaran runs as the boundary. The southwestern part of this highway is hilly with 10 m to 25 m in height above sea level, and the northeastern part is swampy with 10 m or less. In the hilly area, there are a number of plantations of rubber trees and palm trees. As a result of good management and drainage for the plantations, the area abounds in green and is hygienical. In the case of the swampy area , about 1/3 of it is paddy field, but almost all of the rest is swamps with shrubs and water is colored brown containing much organic matters and mud. As an exception, along the seacoast, there is a sandhill where can be observed some clusters of houses under hygienic condition.

Regarding ground water, while many springs are found at the foots of the mountains located in the western part of Asahan Regency, ground water with acceptable quality in the project area is confined deep in the ground and can be utilized only by drilling deep wells.

1.3 Social and Economical Conditions

Most of villages are located in the rice field area and along the coast line. From the view point of land-use, plantation is the core of the project area. Rubber plantations spread along the national highway, centering around the northwestern part of Air Putih. Palm oil plantations extend in the southwestern part of Lima Puluh. Swampy area is spreading in the center of Medang Deras and Air Putih. Rice fields surround plantations and swampy areas. In Air Putih, 30 percent of total area is covered by plantation, and 27 percent by rice fields. The rice field area is newly cultivated.

The ethnic structure is mainly composed of Malay, Javanese and Batak. The combination of the above tribes can be observed in almost villages.

Population age structure shows a pyramidal patern. Around 45 percent consist of children under fifteen years of age. The educational level of people seems to be not high enough.

In the rice field area, most of the inhabitants are farmers, and their productivity is reportedly not so high. In Indonesia, villages can be classified into three categories according to their crop situations. First one is Swasembada, where village people can get enough crops to sell the surplus. Second one is Swakarya, where they support their lives. Third one is Swadaya, where they can not harvest to support themselves. Most of villages in the project area are said to be in the second/third classes. People in villages of seaside are engaged in fishery but their productivity appears not high enough. Villages in the plantation supply labor forces for plantations.

Harvest of paddy rice is conducted by individual, or group works called Kelompok-Tani. In case of individual work the owner of rice field employ workers to harvest; they are paid within ten percent of the crop.

Coconut trees, domestic fowl, goats etc. are important properties of villages; pigs are reared by Batak people. Most of these properties belong to individuals. Such properties as coconut trees around the public places, mosque and public square are owned by the village. Harvest from the public properties seems to be used for public activities, for example, repairment of the mosque and the school etc.

In this area, commerce has not been matured. People of villages make trades through markets periodically opened in public squares.

Social infrastructure has not yet been developed. Especially primary ones such as wells, latrines, disposal facilities, markets and storage for crops are not sufficient. Workers and workshops for construction and maintaining public facilities seem to be insufficient.

A specific feature in the project area is that the Government of Indonesia is now operating the National Project of the Asahan Hydro-electric and Aluminium Project with the cooperation of the Japanese Government. Multiple and large scale of impact deriving from the National Project has been expected in the project area.

Budget of village is provided by both the central and local governments. Annual budget of each village from the central government is approximately 450,000 Rupiah. Other revenue supported by the provincial or regency governments are insufficient to the villagers.

The greatest concern of villages is to increase the productivity of the rice field. Villagers desire the betterment of their life environment, however, most of budget is expended for the agricultural activities such as small irrigations and small dams. The shortage of budget is supplemented by the village people with the contribution. Gotong-Royong (mutual cooperation system in Indonesia) also functions for community activity.

On the other hand, INPRES program, the central development policy, works to promote the living standard of village people. In the project area, elementary schools and two health centers have been established and wells with hand pump have also been constructed. This program supports capital cost. Operation and maintenance costs are borne by the people of villages. However, lack of these cost is prominent in almost all villages. In case of wells with hand pumps, it seems rather difficult to repair hand pumps when broken, these wells would become, occasionally, no longer use.

1.4 Public Health Conditions

In recent years, annual birth rate was 40 - 45 per 1,000 people and death rate was 20, and accordingly natural increase rate was 20 - 25 permill. Total population increase, the balance of natural increase and social increase, however, has been very slight. Population of both Medang Deras and and Lima Puluh have rather decreased slightly, though Air Putih has increased gradually since late 1977 when construction works of INALUM's smelter site began.

Disease record in the project area is presented in Appendix D-1. In the area, Medang Deras is in higher sickness rate of 94 permill. Through the observation of main diseases and causes of death, infection and contamination due to poor sanitary conditions, malnutrition and shortage of medical care are considered key factors for public health hazards in the project area.

Regarding diseases caused death, followings were listed up in 1974: bronchopneumonia, tobicasis, tetanus neonatorum, putrefication, tetanus, fistel rectal, malnutrition, stomach perforation, sepsis and enteritis.

Disease of parasites shows high rate of 95% in the area which might depend on a causative factor. Ulcer and perforation of stomatch are also highly observed, but the reasons are not identified. Prevalence rate of tuberculosis, which clinical diagnosis of tuberculosis is largely depending on bacteriological examination currently, was 0.6% and incidence rate was 0.15%; these figures are comparatively high. In the case of malaria, parasite prevalence rate presented extremely high rate of 8.26%. As for filariasis, no systematic survey has yet been done and available information at present is very limited. According to the data provided by Asahan Regency, there were 12 cases of filariasis in 1977/1978 and 18 cases in 1978/1979 in the project area, and survey data in 1974 shows 4.9% of positive rate in 885 examiness in two villages, Asahan Regency.

In relation to rural water supply project, problems of enteric disease and its infection are considered very important. Cases of enteric disease in 1972 and 1973 are shown in Appendix D-2; and clinically-suspected cholera in Appendices D-3 and D-4. It is cleared that epidemic of clinically-suspected cholera is getting worse in 1979. High morbidity of 1.48% in Medang Deras should be noted, meanwhile Lima Puluh is highest in fatailty. Morbidity in villages with plantation, including partly plantation, is 0.07%, comparatively low; however, that of other villages being without plantation is higher at 0.62%. Appendix D-5 shows its comparison among three districts in the project area.

A result of field bacteriological study in Sungai Buah Keras is presented in Appendix D-6. Quantity of surface water in the project area is rich, but quality of the water is poor. Water supply conditions at health centers and clinics are also not necessary satisfactory. Positive rate of enteropathogenic bacteria (Shigella flexineri and sonnei) is highest among people using shallow wells. Positive rate among people using deep wells is the lowest. Low positive rate among people using river water may attributed by dilution effect of river stream and practice of boiling water. Fortunately, boiling habit for drinking water is practiced among 95.6% of people.

The result of 6 villages' study in March 1979 indicates that 71.9% of people use river water, and 24.1% well water. Meanwhile, local habit of excretion of feces in river is not seldom. It is reported that 6.2% of people in Lima Puluh and 28.9% in Air Putih have such habit.

Taking morbidity of clinically-suspected cholera and positive rate of pathogenic bacteria into consideration, urgent development of safe water supply as well as latrines should be stressed in the project area.

Water resources control including water management is still underdeveloped. It is a reason of flood disasters in rainy seasons and water shortage in shallow wells in dry seasons. Both problems of flood and dried-up adversely affect to the quality of water.

Provision of safe and sufficient drinking water, together with adequate latrines, is considered basic and essential need for community health in the project area.

II. PRESENT SITUATION OF WATER USE IN THE PROJECT AREA

2.1 General

There are three kinds of water sources which are used in the project area, i.e., shallow ground water, deep ground water and surface water.

Shallow ground water is taken by means of dug wells usually 3 to 5 m deep. The water quality is not necessarily acceptable, because the well water is often directly influenced by contaminated surface water and the wells are almost not protected. It should be noted that the people habitually excrete on the surface water. Shallow ground water is most widely used for private domestic use, but there are some cases where it is used for public use.

Deep ground water is not in wide use in the area. There are several old deep wells which were constructed in the Dutch age and even today have plentiful production with good quality. Some deep wells have been constructed by inhabitants in the recent years; their production is poor because of their too small sizes. Deep wells in the low area are mostly of artesian type.

Surface water is abundant in the project area, as there are many swamps and rivers. Numerous inhabitants are obliged to use such surface water, although the water quality is not good. The swamp water has deep brown color containing fine mud and is contaminated by human activities and with various organic matters. The river water is less colored, but contaminated to the degree similar to the swamp water. Inhabitants seem not to use the water directly for drinking, but use for other domestic purposes. This practice may have some adverse effect on their health. Surface water, poor in quality but abundant in quantity in the project area, shall be studied in the future for further utilization.

2.2 Shallow Wells

Shallow wells are most popular water source in the project area. The standard one is a dug well with 3 to 5 m depth, and about 1 m diameter, from which water is drawn using a bucket with rope; usually without protection.

In the Lima Puluh health center, a closed type shallow well is observed, using a hand pump and 1-1/4 inch pipe with the depth about 13 m. In the case of the Indrapura health center, an infiltration gallery having water collecting pipes is observed.

From the view point of usage, these wells are divided into two uses, public and private. In the case of public use well, it covers 200 to 400 people. And a private one covers 1 to 2 families (5 to 10 people) or one institutional building. The well in Indrapura health center was constructed only for private use, but is being used by about 250 neighboring people, because no other wells with proper quality can be found at hand.

The existence of a public use well does not always mean the absence of private domestic wells in the area. Because of the poor quality of the private well and/or the poor quantity in the dry season, public wells are sometimes used in addition to the private wells. Furthermore, it can be said that the public wells are used mainly for the purpose of drinking and cooking, and private wells for bathing and washing.

Generally water quality is not good enough. Color as well as total bacteria, coliform groups which are considered indexes of contamination are detected in almost all shallow wells. The example of worse water quality was observed at a house in Limau Sundai. It shows, even after filtration by home-made sand filter, existence of 5 degrees of turbidity, 30 ppm of COD, 190 Nos./cc of coliform groups. Also, the infiltration gallery constructed in the court of Indrapura health center has problems of contamination.

Many facilities such as wards, a kitchen, toilets, etc. are located near the infiltration well, and ground water table is as high as ground level itself since the health center is located in the lower land, and this well with infiltration gallery is not free from contamination.

On the contrary, the shallow well set up in the Lima Puluh health center is an unusually good example; no contaminants, both physicochemically and biologically was detected in the water.

2.3 Deep Wells

Deep wells are a most important method to supply in the project area. As mentioned before, these are divided into two types.

(1) Deep wells Constructed in Dutch Age

These wells were dug by Dutch about 40 to 60 years ago. Three wells located at Guntung, Indrapura and Simpang Dolok were investigated in the present survey; the depth of these wells in reprotedly 200 - 240 m, but not certain. The diameter of all the pipes is 4 inches, and it is a little bigger than that of one newly constructed by people. Almost all of wells are of artesian type, and the one which springs out the largest quantity is at Guntung. At Guntung, water is delivered to several places near by through pipelines, where quantity for drawing and washing was measured at 1.34 l/sec. These deep wells always have facilities for washing and bathing in addition to drawing. All of them are for public use and each covers 300 to 1,000 people. Regarding water quality, no problem was found in both chemical and hygienic items; no coliform groups were detected at any well. Other water quality items are shown in Appendix C-1 and Appendix C-2.

A little ammonium nitrogen was detected, but probably it was caused through reducing process from nitric nitrogen in deep wells; accordingly the concentration of ammonium nitrogen is not a problem. The temperature is high as about 40 degrees centigrade, but it does not cause any problem for any purpose.

(2) Deep wells Constructed by People in Recent Years

There are some deep wells newly constructed by people in recent years, and the water source development of this type is expected to be promoted in the future, too.

The well has a depth up to about 100 m, and has a simple style of inserting the pipe into the ground. Ordinarily, the well is an artesian type with an yield of 0.1 l/sec to 0.15/sec.

Sometimes a pump is used to increase the yield, but then it takes 4 ~ 5 days for the well to return to an artesian condition. About the quality of the water, while it is used directly, there is no problem, but where water is reserved in the tank coliform groups and other items showing contamination are detected.

The number of people covered by one public use well, is estimated 300 ~ 1,000, and the number seems to depend on the scale of the village and the alternative water source near by, rather than on the amount of well production,

Because of the insufficiency of the production, the water is not used for bathing but principally for cooking and drinking. However, where the covered people are not so many, it is used for washing, too.

2.4 Water Consumption Per Capita

As it was impossible to measure the actual consumption per capita in the present survey, the following figures prepared by the survey team were presented to CDC of Ministry of Health, Indonesia, for discussion and confirmation.

Table II-1 Per Capita Consumption

Drinking and Cooking	5 to 8 l/day
Bathing	20 to 25 "
Washing	10 to 15 "
Cleaning	1 to 3 "
Toilet	4 to 9 "
Total	40 to 60 l/day
Average	50 l/day

It was informed during the discussion that a study is now under way to revise the design figure of consumption per capita to 80 l/day. For the present plan, however, the figures shown in the above table were agreed as adequate.

III. PLANNING OF WATER SUPPLY FACILITIES

3.1 Villages and Population to be Served

3.1.1 Districts of the Project

Districts to be covered by the project are three Districts (Kecamatan), located at northern part of Asahan Regency (Kabupaten), facing to Strait of Malacca, in North Sumatra Province (Propinsi).

They are Districts of Lima Puluh, Air Putih and Medang Deras, consisting of 56 villages (Desa) and 421 sub-villages (Lorong), being in scale of about 1/5 of whole Asahan Regency formed of 15 Districts, 220 villages and 2,073 sub-villages.

The three districts are summarized in the following table.

Table III-1 Three Districts of the Project

Districts (Kecamatan)	Number of Villages (Desa)	Number of Sub-villages (Lorong)	Number of Household	Population
Lima Puluh	22	192	11,024	60,042
Air Putih	22	146	9,758	52,474
Medang Deras	12	83	4,802	25,326
Total	56	421	25,584	137,842

Note: Lima Puluh: Statistics of 1979 (AHP-JICA 790 223), except Perupuk (Data from Village Office, 1979)
Air Putih and Medang Deras: Statistics of 1979 (offices of Camat in Air Putih and Medang Deras)

3.1.2 Population Projection

Population to be served in the area is regarded as one of the most important factors for water supply planning; magnitude of the project is generally in proportion to the population to be served.

For purposes of this study, the population increase in the past six years, 1973 through 1979, were examined using the data obtained, and the population increase ratio of the three districts of Lima Puluh, Air Putih and Medang Deras are 1.0 percent, 8.8 percent and 4.4 percent in six years, respectively.

In this project, the current population in each village, included in Appendix C-5, would be employed for water supply planning, on the basis of following:

a. Recent population increase in the project area is not remarkable, due to the characteristics of the very rural area. Annual population increase of the three districts are estimated as 0.2 percent for Lima Puluh, 1.3 percent for Air Putih, and 0.7 percent for Medang Deras: these figures would not affect the scale of water supply facilities of the project, as far as within the near future.

b. Water supply facilities planned are expected to be rather of simple system and would be constructed within a short period, if provided that project costs and responsible organizations for maintenance are prepared; for the time being, population increase would not be a major component for water supply planning.

3.1.3 Areas to be Excluded from Water Supply Planning

Out of the three districts mentioned in 3.1.1, plantation areas prevailing in higher land would be excluded from the areas to be covered by the project for water supply planning, since water supply conditions for inhabitants in the plantation area are rather in good condition, for they have been supplied with water by the plantation firm's water sources with satisfactory quality/quantity: deep wells, semi-deep wells or shallow wells in places, and for water being available by way of shallow wells in the area, higher land, is rather acceptable to the inhabitants.

Villages of plantation area are referred to Fig. I-1 and Appendix C-5.

3.1.4 Population to be Covered by the Project

Based on the concept described in the preceding sections of 3.1.2 and 3.1.3, population to be planned for water supply is calculated in each village and tabulated in Table III-3 through Table III-5. Table III-2 shows the summary of the population served in the project area.

Table III-2 Population to be Covered by the Project

Districts	(A) Total Population	(B) Population In Plantation Area	(C) Population to be Served (A) - (B)
Lima Puluh	60,042 (100%)	24,248 (40.4%)	35,794 (59.6%)
Air Putih	52,474 (100%)	9,923 (18.9%)	42,551 (81.1%)
Medang Deras	25,326 (100%)	0	25,326 (100%)
Total	137,842 (100%)	34,171 (24.8%)	103,671 (75.2%)

Table III-3 Population to be Served in Lima Puluh

Villages	A Present Population	B Population in the Plantation	C Served Population (A - B)	Reference B/A
Lima Puluh				
1) Perk. Tanah Gambus	4,474	4,474	-	1.0
2) Perk. Lima Puluh	2,702	2,702	-	1.0
3) Perk. Tanah Hitam Ulu	2,500	2,500	-	1.0
4) Perk. Tanah Itam Iilir	1,408	1,408	-	1.0
5) Perk. Dolok	1,757	1,757	-	1.0
6) Perk. Limau Manis	780	780	-	1.0
7) Perk. Kwara Gunung	719	719	-	1.0
8) Lima Puluh	2,698	2,698	-	1.0
9) Antara	1,389	-	1,389	0
10) Cahaya Pardomuan	1,320	-	1,320	0
11) Kwala Gunung	912	-	912	0
12) Air Hitam	2,960	-	2,960	0
13) Simpang Dolok	1,598	799	799	0.5
14) Empat Negri	2,631	1,316	1,315	0.5
15) Lubuk Besar	3,433	1,717	1,716	0.5
16) Sumber Makmur	1,295	648	647	0.5
17) Sumber Padi	1,883	942	941	0.5
18) Mangkai Baru	3,575	1,788	1,787	0.5
19) Simpang Gambus	6,759	-	6,759	0
20) Pematang Panjang	6,222	-	6,222	0
21) Guntung	2,800	-	2,800	0
22) Perupuk	6,227	-	6,227	0
Total (Lima Puluh)	60,042	24,248	35,794	

Table III-4 Population to be Served in Air Putih

Villages	A Present Population	B Population in the Plantation	C Served Population (A - B)	Reference B/A
<u>Air Putih</u>				
1) Indrapura	3,809	-	3,809	0
2) Limau Sundai	3,067	-	3,067	0
3) Pem. Panjang	3,375	-	3,375	0
4) Suka Raja	1,673	-	1,673	0
5) Tanah Tinggi	2,785	-	2,785	0
6) Tanjung Muda	1,310	-	1,310	0
7) Tanah Merah	1,026	-	1,026	0
8) Aras	2,277	-	2,277	0
9) Tanjung Kubah	2,677	-	2,677	0
10) Pasar Lapan	1,829	-	1,829	0
11) Sipare-pare	2,696	-	2,696	0
12) Pematang Jering	2,496	-	2,496	0
13) Simodong	2,781	-	2,781	0
14) Perk. Sipare-pare	1,405	1,405	-	1.0
15) Sei Suka Deras	2,454	1,227	1,227	0.5
16) Tanjung Seri	2,866	-	2,866	0
17) Sei Simujur	2,171	1,086	1,085	0.5
18) Perk. Tanjung Kesau	2,810	2,810	-	1.0
19) Tanjung Kasau	1,383	692	691	0.5
20) Laut Tador	3,673	1,837	1,836	0.5
21) Tanjung Parapat	1,731	866	865	0.5
22) Kwala Tanjung	2,190	-	2,190	0
Total (Air Putih)	52,474	9,923	42,551	

Table III-5 Population to be Served in Medang Deras

Villages	A Present Population	B Population in the Plantation	C Served Population (A - B)	Reference B/A
Medang Deras				
1) Pangkalan Dodek	4,814	-	4,814	0
2) Sidomulyo	1,644	-	1,644	0
3) Sei Buah Keras	2,056	-	2,056	0
4) Aek Nauli	1,089	-	1,089	0
5) Nenas Siam	1,241	-	1,241	0
6) Durian	1,824	-	1,824	0
7) Medang	3,039	-	3,039	0
8) Pakam	2,362	-	2,362	0
9) Lalang	2,294	-	2,294	0
10) Pemt. Cengkering	2,305	-	2,305	0
11) Sei Rakyat	1,694	-	1,694	0
12) Tanjung Sigoni	964	-	964	0
Total (Medang Deras)	25,326	0	25,326	

3.2 Basic Concept of Water Supply Planning

As results of the study on the general local conditions (refer to I.) and present situation of water usage (refer to II.), and from viewpoints of technical/hydrogeological conditions including water quality (refer to Appendix B and C.), basic concept of water supply system to be planned in the project area is worked out and presented as follows:

(1) The project aims at present to find out reliable water sources for public use which have acceptable quality for drinking as well as enough quantity, and to construct water intake facilities together with public facilities for water use.

(2) The water sources shall be ground water to be taken by way of deep wells (± 150 to 200 meters in depth) or semi-deep wells (± 50 to 60 meters in depth).

(3) The water sources including public facilities for water use would be constructed at several places in each village (Desa); one water source will cover several sub-villages (Lorong).

(4) The water supply facilities would be composed of a deep well (or a semi-deep well), a storage tank with public taps, an open place for water-drawing and washing, two walled sheds for bathing: each one for men and women, and a pit for drain.

(5) In case the groundwater therein has no positive pressure (i.e., static water level remains underground, in the well casing), a hand pump shall be equiped for the well; no power-driven pump would be employed.

(6) Pipeline system for either transmission or house connection will not be considered, in this study, since it requires power-driven pump facilities together with elevated tanks resulting to cause high costs and difficulties in operation and maintenance.

(7) As regards the structure and method of the facilities, special emphasis should be placed on economy in construction and maintenance (Maintenance-free or almost free), and simplicity of the facilities.

(8) Operation and maintenance of the facilities installed should be carried out by each village's organization or by responsibility of the village.

(9) In principle water tariff will not be considered on routine basis, however, minimal substantial cost for maintenance or repair should be borne by the beneficiary.

Technical backgrounds for the above concepts are described below:

Water which is naturally available in the project area is from river, from underground and from rainfall. In case of river water, it must be treated for drinking use through treatment plant/facilities which need a certain technology and higher costs in operation and maintenance being a substantial burden to villages under the present situation. Rain water is not reliable in quantity throughout the year and the water stored in the water tank is not always in good condition. The present project, therefore, is to rely on ground water for the water source.

Hydrogeological conditions in the project area are found rather complicated by the field investigation including geoelectric resistivity survey. Generally, however, first aquifer exists in depth of around 40 ~ 50 meters underground. The aquifer is comparatively continuous and the groundwater table is not confined; i.e., water pressure is negative and water level remains underground.

A deeper aquifer seems to exist below the first aquifer. It is in the layer between the first aquifer and 200 m depth. The layer is generally composed of silt or mixture of sand, silt and clay. At places within this layer a sandy and permeable layer develops as an aquifer, which is termed second aquifer in this report. The depth and the thickness of the second aquifer varies place by place, and it is not found in hill-side area of the project area. The second aquifer seems to be confined; i.e., water pressure is positive and water level appears on the ground surface.

The existence of the third aquifer is estimated in the layer of deeper than 200 m from the ground surface. Confined and a large quantity of water from the third aquifer is also estimated but the detail features are not examined in this study because of insufficient data.

According to the hydrogeological analysis, the amount of ground water recharged into the first aquifer and the second aquifer in the project area are roughly calculated as 200,000 cub. meter per day and 5,000 cub. meter per day respectively. See in detail Appendix B.

The project area has not been supplied with public electricity till the end of 1979. Only Indrapura area is scheduled to be supplied shortely; the electricity is to be transferred from Tebing Tinggi City located to north-west of the project area, along the national highway.

3.3 Design Criteria

Based on results of the detailed feild investigation and views of officials concerned and Japanese survey team, design criteria for water supply facilities of the project are prepared as follows:

(1) Per Capita Water Demand: 50 liters/day (Refer to II Present Situation of Water Use in the Project Area)

- For drinking and cooking	5 ~ 8	liters/day
- For bathing	20 ~ 25	"
- For washing	10 ~ 15	"
- For cleaning	1 ~ 3	"
Total	36 ~ 51	"
say,	50 liters/day	

(2) Facilities:

Facilities to be provided by the project for each water supply facility shall compose of:

- One deep well/semi-deep well
- One storage tank
- Water taps
- One open place for water-drawing and for washing
- Two walled sheds for bathing; each one for men and women
- One pit for drain
- Tools for maintenance and spare parts required

(3) Water Source:

Ground water shall be taken by a deep well (around 150 ~ 200 meters in depth) or a semi-deep well (around 50 meters in depth).

Confined ground water with positive pressure is preferable. However, in case the ground water has no positive pressure, hand pump shall be equipped on the well; a power-driven pump will not be used.

(4) Water quality:

Quality of water to be supplied by the project shall be most desirable one that is locally available, and treatment process will not be applied. People in this area have a habit of boiling water for drinking and cooking.

(5) Standardization of Water Supply Facilities:

Facilities to be provided by the project would be standardized with a few types for the advantages of planning, construction and maintenance, taking account of sort of wells (deep well or semi-deep well), either use of hand pump or not, population to be served, water demand and production capacity of the well.

3.4 Proposed Water Supply Facilities

According to the preceding section, proposed water supply facilities are standardized in the four kinds of types as shown in Table III-6 and Fig. III-1 through Fig. III-9. Each village is to be provided with combination of the standardized facilities in necessary numbers.

Proposed type of facilities and its numbers for each village are studied and tabulated in Table III-7 through Table III-9.

3.4.1 Standardized Facilities

Type-A well shall be a semi-deep well and aim to draw water from the first aquifer (free surface ground water) using a hand pump. Wells of Type B, C and D shall be deep wells. Artesian flowing water from the second aquifer is expected to these deep wells.

Hand pumps installation for the deep wells will also be planned in such cases of; (a) water flowing is not artesian from the very beginning of the service of the facility, (b) when the artesian flowing come to a stop, such a case anticipated empirically, after a few years of service.

These deep wells are planned to be constructed according to the following criteria based on the prospected water quality of the water source in the project area.

(1) Type-A: Applied for hilly area and dry lands.
(2) Type-B, C and D: Applied for wet lowlands and coastal area.

Table III-6 Standardized Facilities

Type		A	B	C	D
Number of People to be Supplied		300 - 400 persons	300 - 400 persons	600 - 800 persons	1,200 - 1,800 persons
Water Demand		15 - 20 m^3/d	15 - 20 m^3/d	30 - 40 m^3/d	60 - 90 m^3/d
Well	Well	Semi-deep well	Deep well	Deep well	Deep well
	Depth	50 - 60 m	150 - 200 m	150 - 200 m	150 - 200 m
	Hand pump	With a hand pump	-	-	-
	Production Expected	35 l/min = 21 m^3/10hrs	35 l/min = 21 m^3/10hrs	60 l/min = 36 m^3/10hrs	120 l/min = 72 m^3/10hrs
	Diameter of Bore-hole	200 mm	200 mm	250 mm	250 mm
	Diameter of Casing Pipe	100 mm	100 mm	150 mm	150 mm
	Diameter of Screen	100 mm	100 mm	150 mm	150 mm
	Length of Screen	20 m	30 m	30 m	30 m
Number of Water Taps		1 for general use, and 1 for bathing	3 for general use, and 2 for bathing	3 for general use, and 2 for bathing	4 for general use, and 2 for bathing
Bathing Sheds	Number of Bathing Sheds	2 (1 each for men/women)	2 (1 each for men/women)	2 (1 each for men/women)	2 (1 each for men/women)
	Number of person to use/one time	2 men + 2 women = 4 persons	2 men + 2 women = 4 persons	4 men + 4 women = 8 persons	6 men + 6 women = 12 persons
	Space of Shed	4.7 m^2 x 2 = 9.4 m^2	4.7 m^2 x 2 = 9,4 m^2	7.5 m^2 x 2 = 15.0 m^2	10.5 m^2 x 2 = 21.0 m^2
Washing Space		4.2 m^2	7.2 m^2	11.3 m^2	14.4 m^2
Water Reservoir		-	1.7 m^3	3.3 m^3	5.0 m^3
Water tank for bathing		0.43 m^3	0.45 m^3	0.74 m^3	1.16 m^3
Construction Period Anticipated		45 days	60 days	75 days	75 days

3.4.2 Facilities to be Provided by Each Village

Table III-7 Facilities to be Provided in Lima Puluh

Villages	Present Population	Population to be Served	Number of Facilities to be Provided					Remarks
			Type "A"	Type "B"	Type "C"	Type "D"	Total	
1) Perk. Tanah Gambus	4,474	-	-	-	-	-	-	
2) Perk. Lima Puluh	2,702	-	-	-	-	-	-	
3) Perk. Tanah Hitam Ulu	2,500	-	-	-	-	-	-	
4) Perk. Tanah Itam Iilir	1,408	-	-	-	-	-	-	
5) Perk. Dolok	1,757	-	-	-	-	-	-	
6) Perk. Limau Manis	780	-	-	-	-	-	-	
7) Perk. Kwara Gunung	719	-	-	-	-	-	-	
8) Lima Puluh	2,698	-	-	-	-	-	-	
9) Antara	1,389	1,389	2	-	-	-	2	
10) Cahaya Pardomuan	1,320	1,320	2	-	1	-	3	
11) Kwala Gunung	912	912	1	-	1	-	2	
12) Air Hitam	2,960	2,960	2	-	3	-	5	
13) Simpang Dolok	1,598	799	1	-	-	-	1	Ex. D. W.
14) Empat Negri	2,631	1,315	2	-	1	-	3	
15) Lubuk Besar	3,433	1,716	3	1	1	-	5	
16) Sumber Makmur	1,295	647	2	-	-	-	2	
17) Sumber Padi	1,883	941	3	-	-	-	3	
18) Mangkai Baru	3,575	1,787	4	-	-	-	4	
19) Simpang Gambus	6,759	6,759	4	2	2	2	10	
20) Pematang Panjang	6,222	6,222	-	-	2	3	5	
21) Guntung	2,800	2,800	-	1	-	-	1	Ex. D. W.
22) Perpuk	6,227	6,227	-	-	1	4	5	
Total (Lima Puluh)	60,042	35,794	26	4	12	9	51	

Note: Ex. D. W. = Excluding existing Deep Well

Table III-8 Facilities to be Provided in Air Putih

Villages	Present Population	Population to be Served	Number of Facilities to be Provided					Remarks
			Type "A"	Type "B"	Type "C"	Type "D"	Total	
1) Indrapura	3,809	3,809	-	-	-	2	2	Ex. D. W.
2) Limau Sundai	3,067	3,067	2	1	1	1	5	
3) Pem. Panjang	3,375	3,375	2	1	1	1	5	
4) Suka Raja	1,673	1,673	2	-	-	1	3	
5) Tanah Tinggi	2,785	2,785	8	-	-	-	8	
6) Tanjung Muda	1,310	1,310	4	-	-	-	4	
7) Tanah Merah	1,026	1,026	2	-	1	-	3	
8) Aras	2,277	2,277	2	-	2	-	4	
9) Tanjung Kubah	2,667	2,667	2	-	1	1	4	
10) Pasar Lapan	1,829	1,829	6	-	-	-	6	
11) Sipare-pare	2,696	2,696	2	-	-	1	3	
12) Pematang Jering	2,496	2,496	3	-	2	-	5	
13) Simodong	2,781	2,781	-	1	1	1	3	
14) Perk. Sipare-pare	1,405	-	-	-	-	-	-	
15) Sei Suka Deras	2,454	1,227	4	-	-	-	4	
16) Tanjung Seri	2,866	2,866	4	1	2	-	7	
17) Sei Simujur	2,171	1,085	1	2	-	-	3	
18) Perk. Tanjung Kasau	2,810	-	-	-	-	-	-	
19) Tanjung Kasau	1,383	691	2	-	-	-	2	
20) Laut Tador	3,673	1,836	5	-	-	-	5	
21) Tanjung Parapat	1,731	865	3	-	-	-	3	
22) Kwala Tanjung	2,190	2,190	-	-	1	1	2	
Total (Air Putih)	52,474	42,551	54	6	12	9	81	

Note: Ex. D. W. = Excluding existing Deep Well

Table III-9 Facilities to be Provided in Medang Deras

Villages	Present Population	Population to be Served	Number of Facilities to be Provided					Remarks
			Type "A"	Type "B"	Type "C"	Type "D"	Total	
1) Pangkalan Dodek	4,814	4,814	-	-	-	2	2	
2) Sidomulyo	1,644	1,644	-	1	-	1	2	
3) Sei Buah Keras	2,056	2,056	-	1	1	-	2	Ex. D. W.
4) Aek Nauli	1,089	1,089	2	-	1	-	3	
5) Nenas Siam	1,241	1,241	-	-	2	-	2	
6) Durian	1,824	1,824	-	1	-	1	2	
7) Medang	3,039	3,039	-	-	2	1	3	Ex. D. W.
8) Pakam	2,362	2,362	3	-	-	1	4	
9) Lalang	2,294	2,294	-	-	1	1	2	
10) Pemt. Cengkering	2,305	2,305	4	-	2	-	6	
11) Sei Rakyat	1,694	1,694	2	1	1	-	4	
12) Tanjung Sigoni	964	964	1	-	1	-	2	
Total	25,326	25,326	12	4	11	7	34	

Note: Ex. D. W. = Excluding existing Deep Well

Summary of Facilities to be Provided in the Project Area

Districts	Present Population	Population to be Served	Number of Facilities to be Provided				
			Type "A"	Type "B"	Type "C"	Type "D"	Total
Lima Puluh	60,042	35,794	26	4	12	9	51
Air Putih	52,474	42,551	54	6	12	9	81
Medang Deras	25,326	25,326	12	4	11	7	34
Total	137,842	103,671	92	14	35	25	166

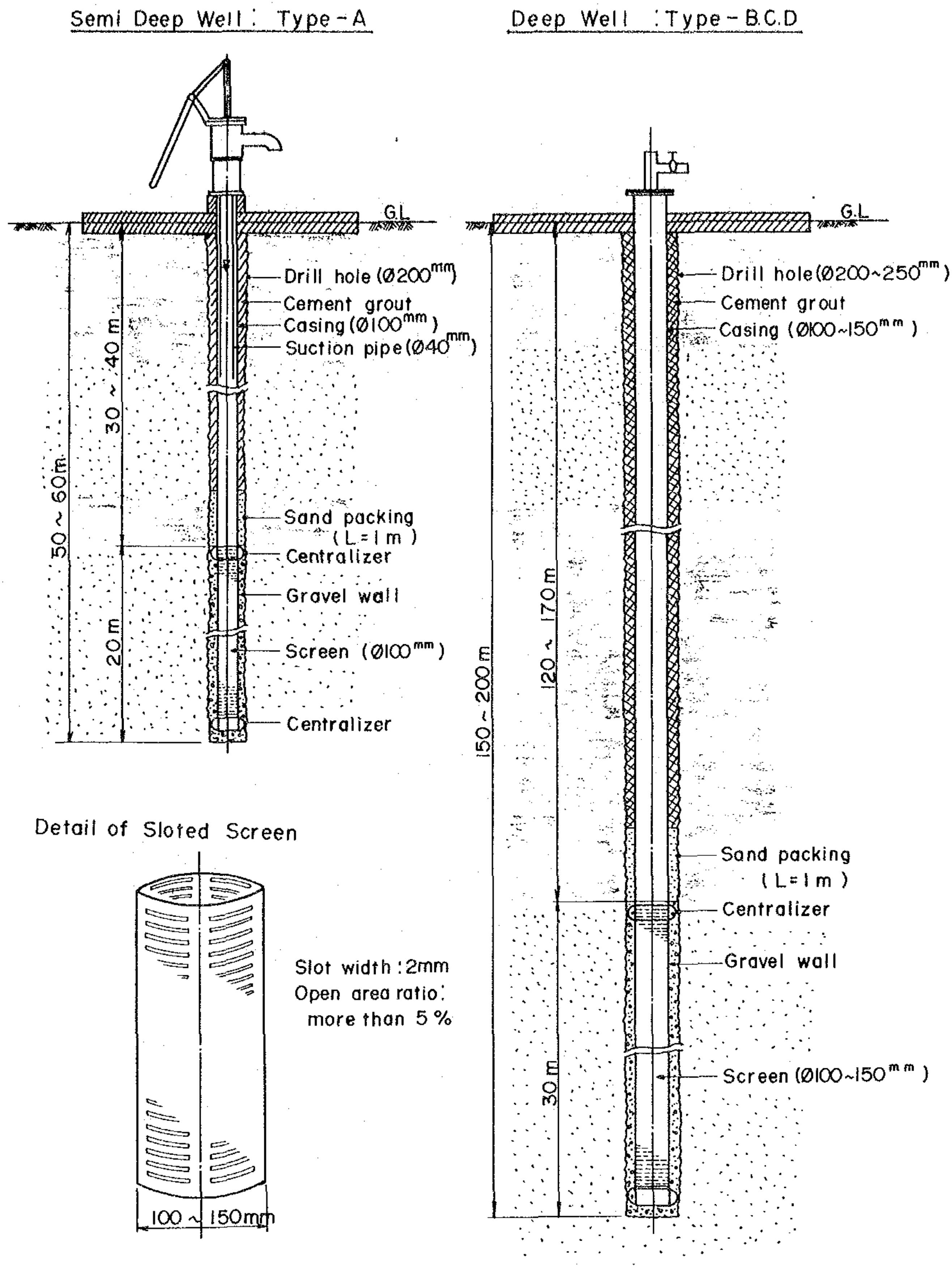


Fig. III-1 Structure of Well NONE SCALE

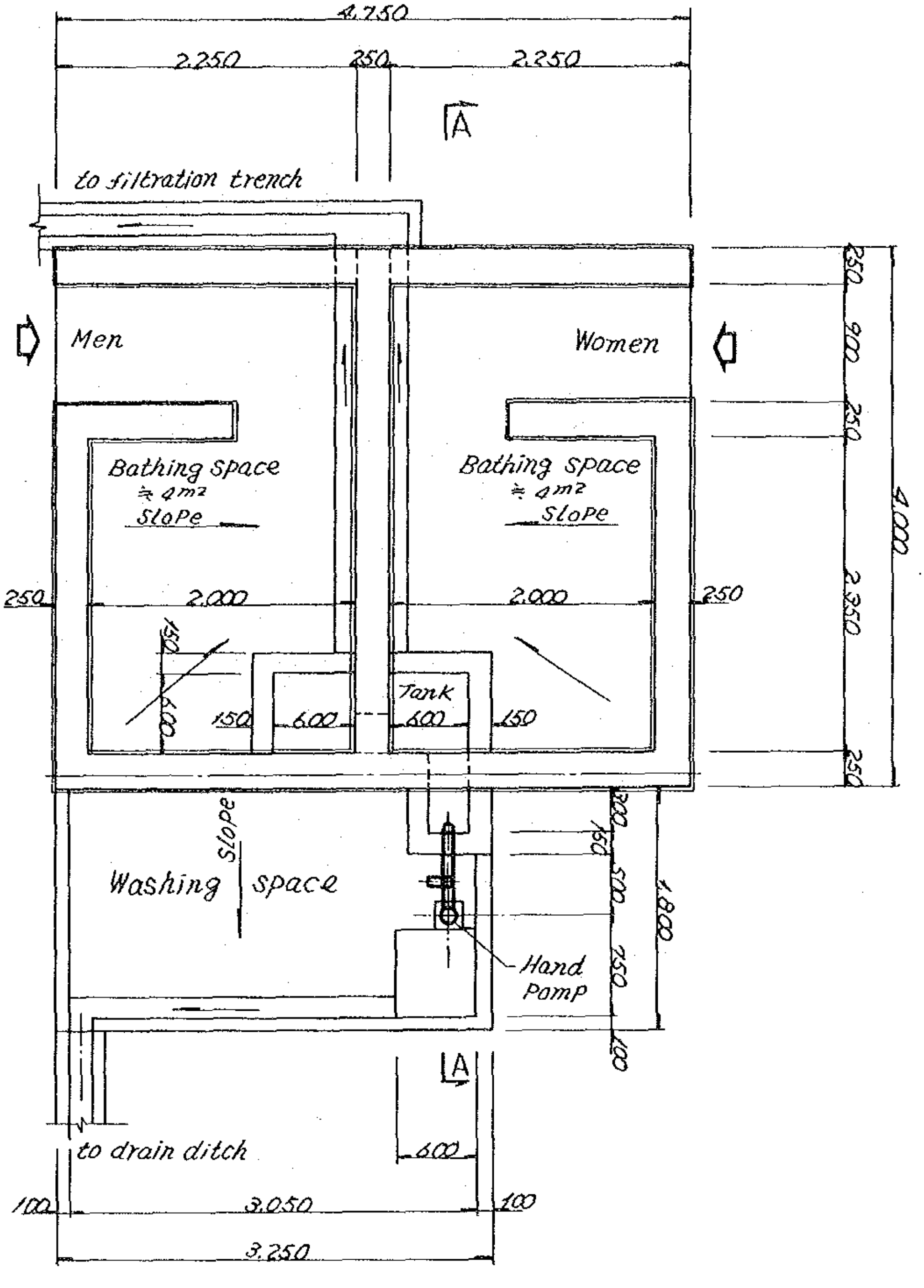


Fig.Ⅲ-2 TYPE-A FACILITY-PLAN S=1/50

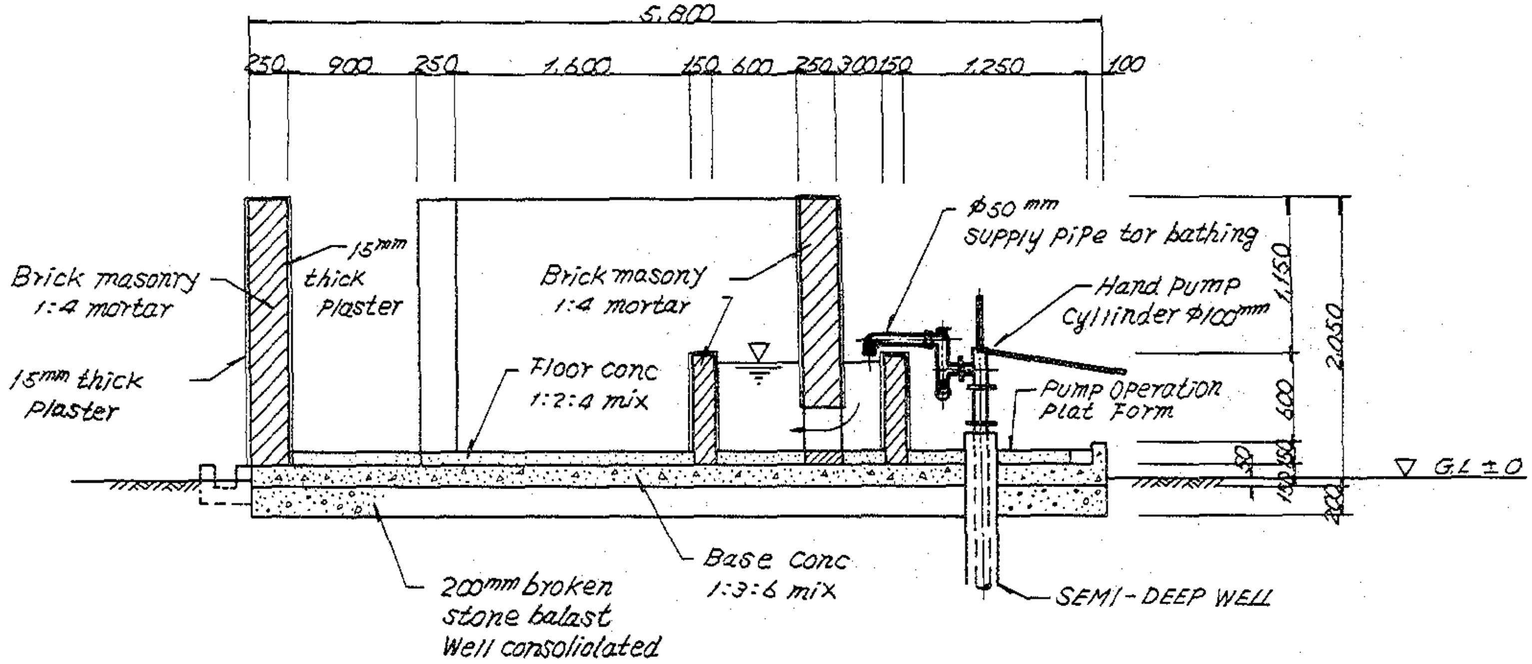


Fig.III-3 A-A SECTION OF TYPE-A FACILITY S=1/50

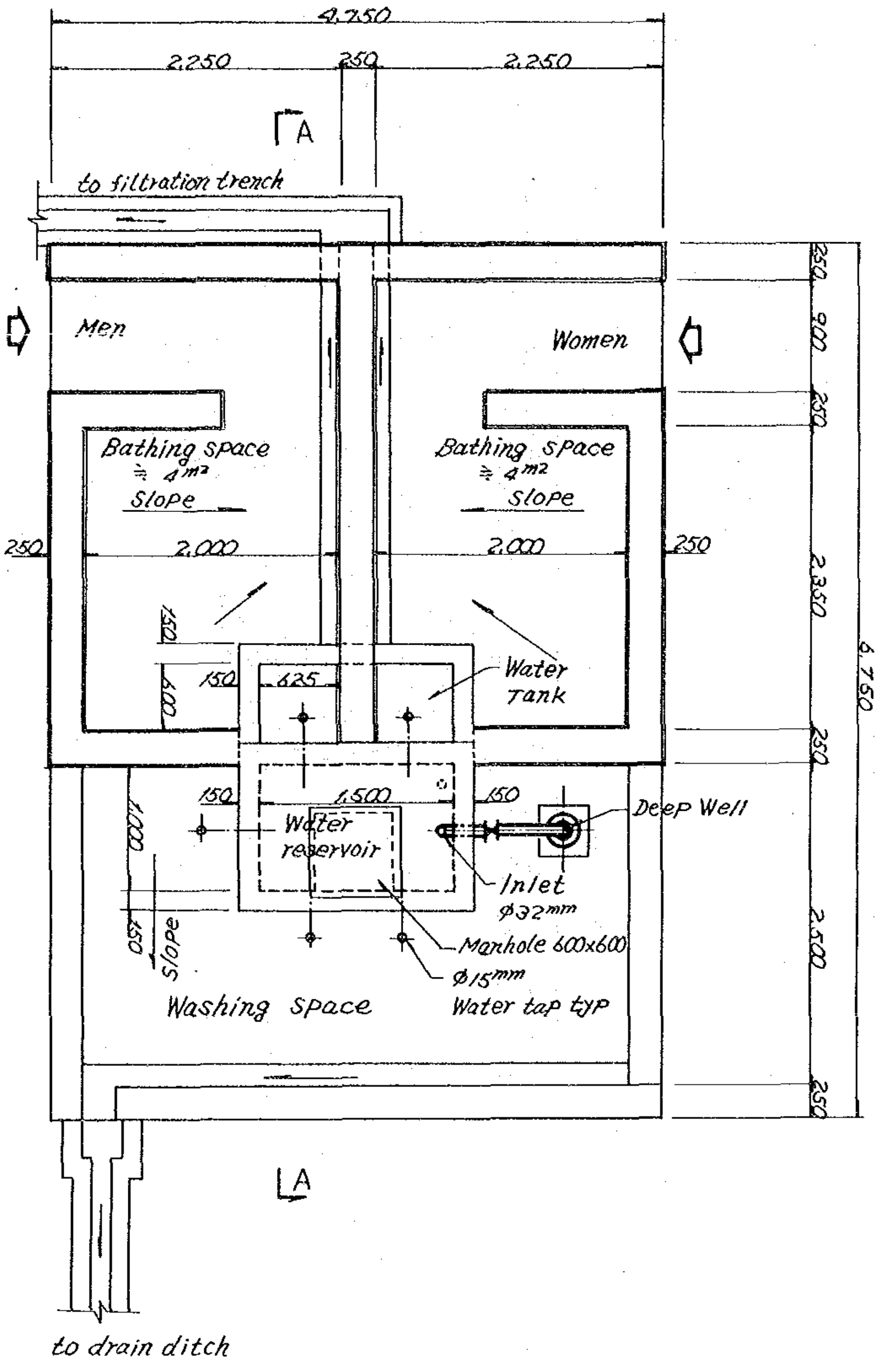


Fig.Ⅲ-4 TYPE-B FACILITY-PLAN S=1/50

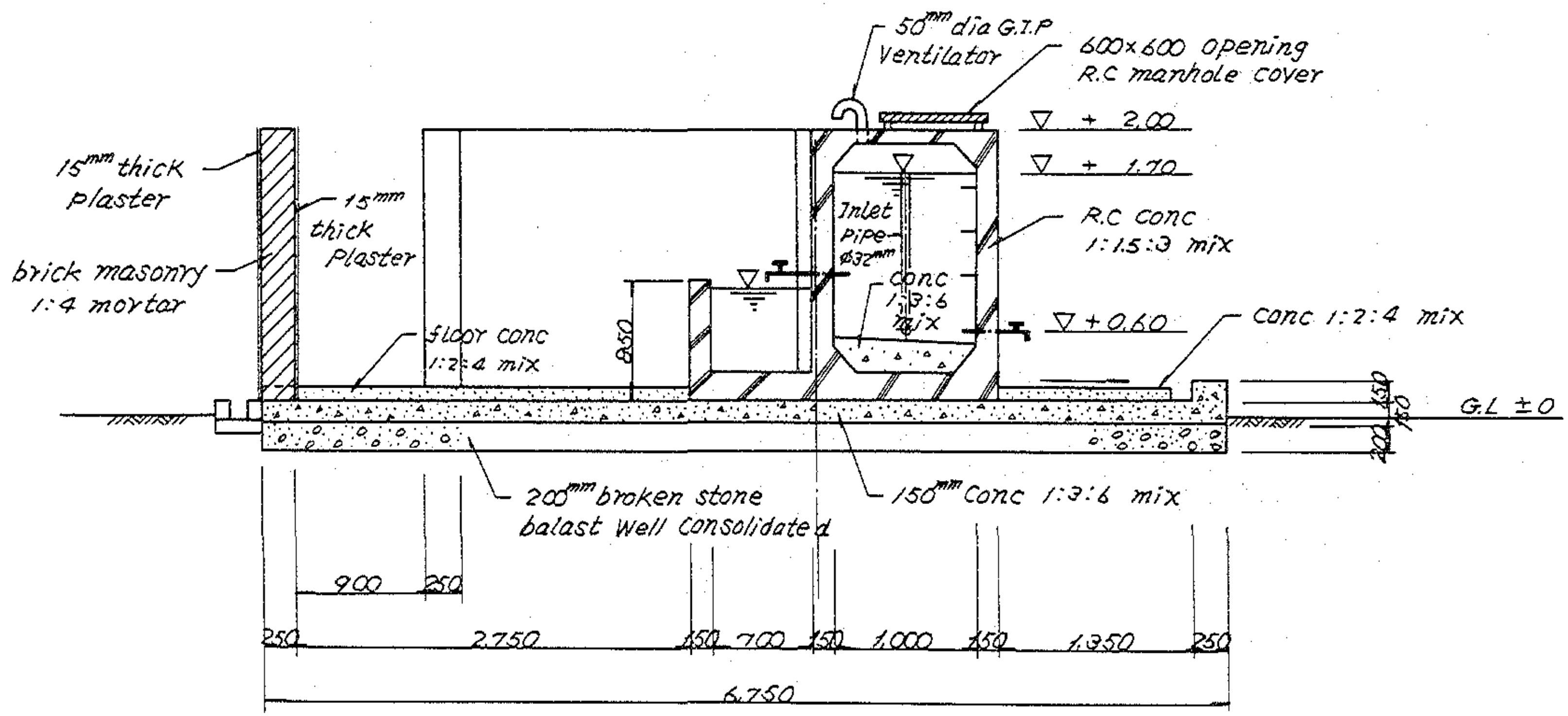


Fig.III-5 A-A SECTION OF TYPE-B FACILITY S=1/50

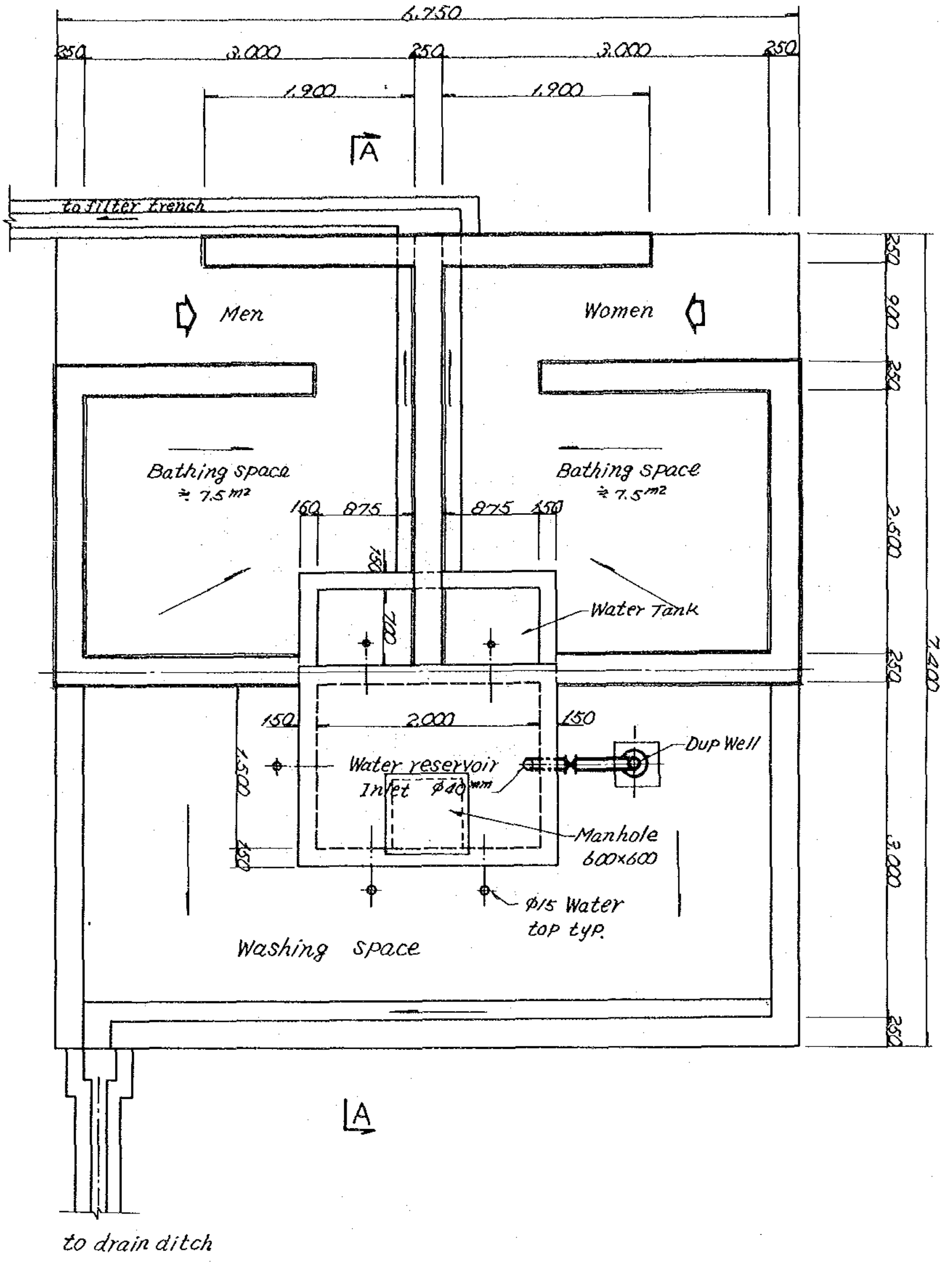


Fig. III-6 TYPE-C FACILITY-PLAN S=1/50

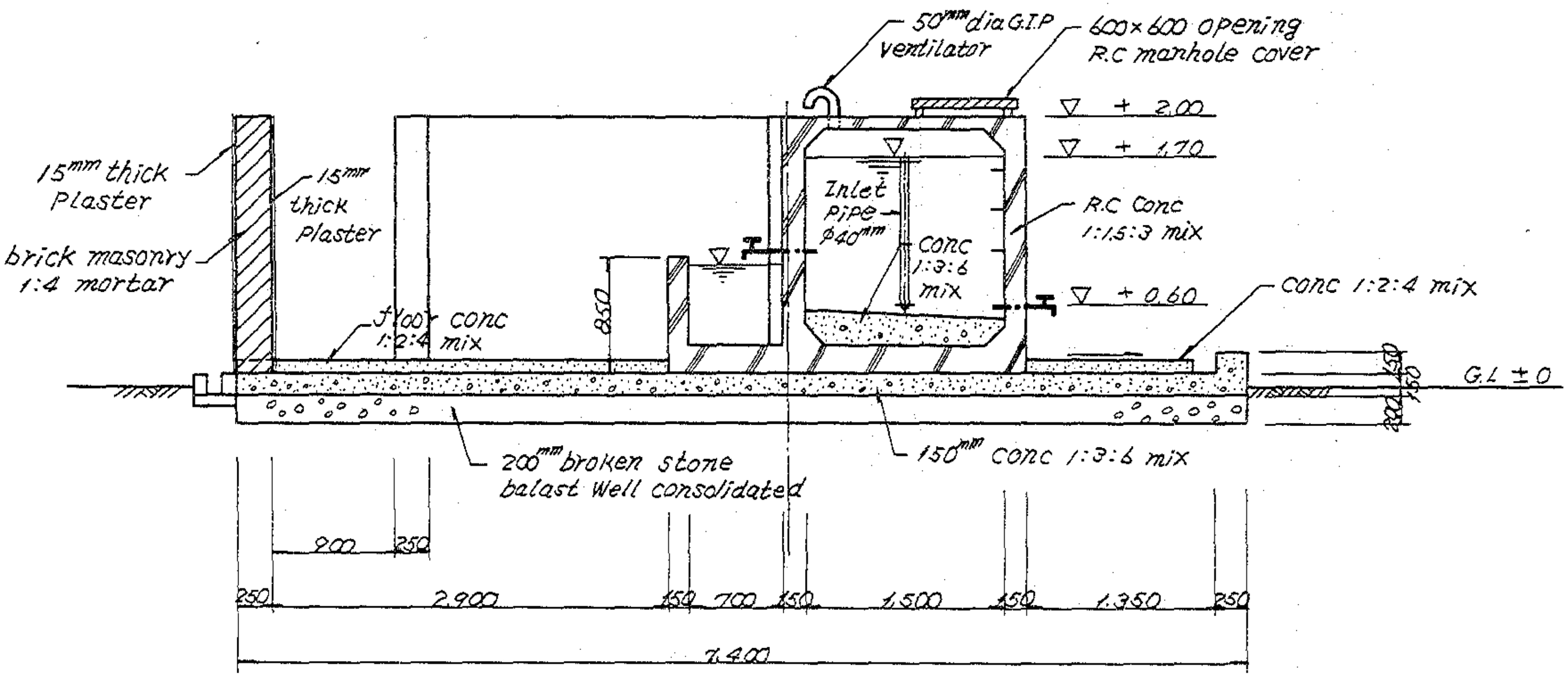


Fig.Ⅲ-7 A-A SECTION OF TYPE-C FACILITY s=1/50

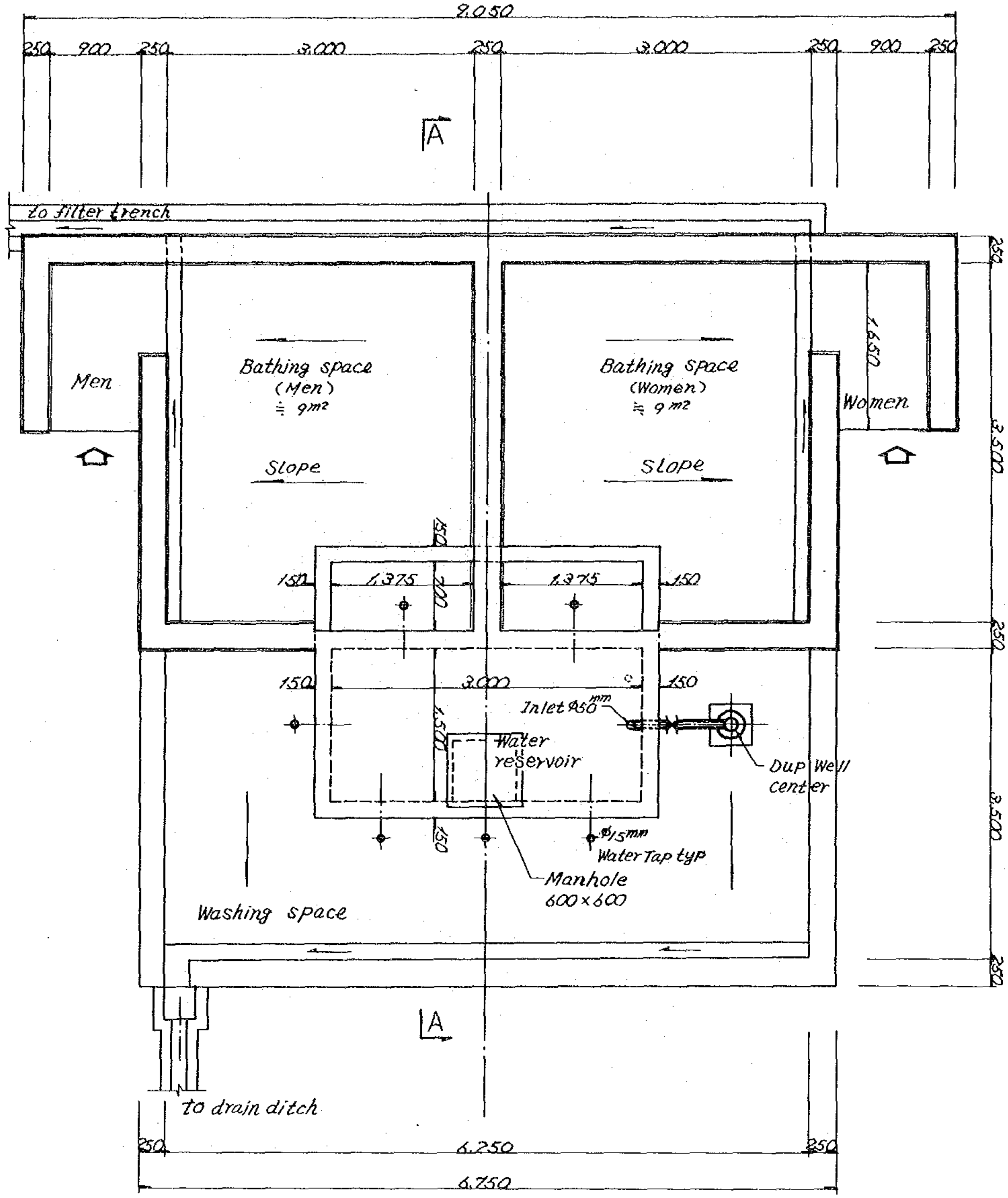


Fig.Ⅲ-8 TYPE-D FACILITY-PLAN S=1/50

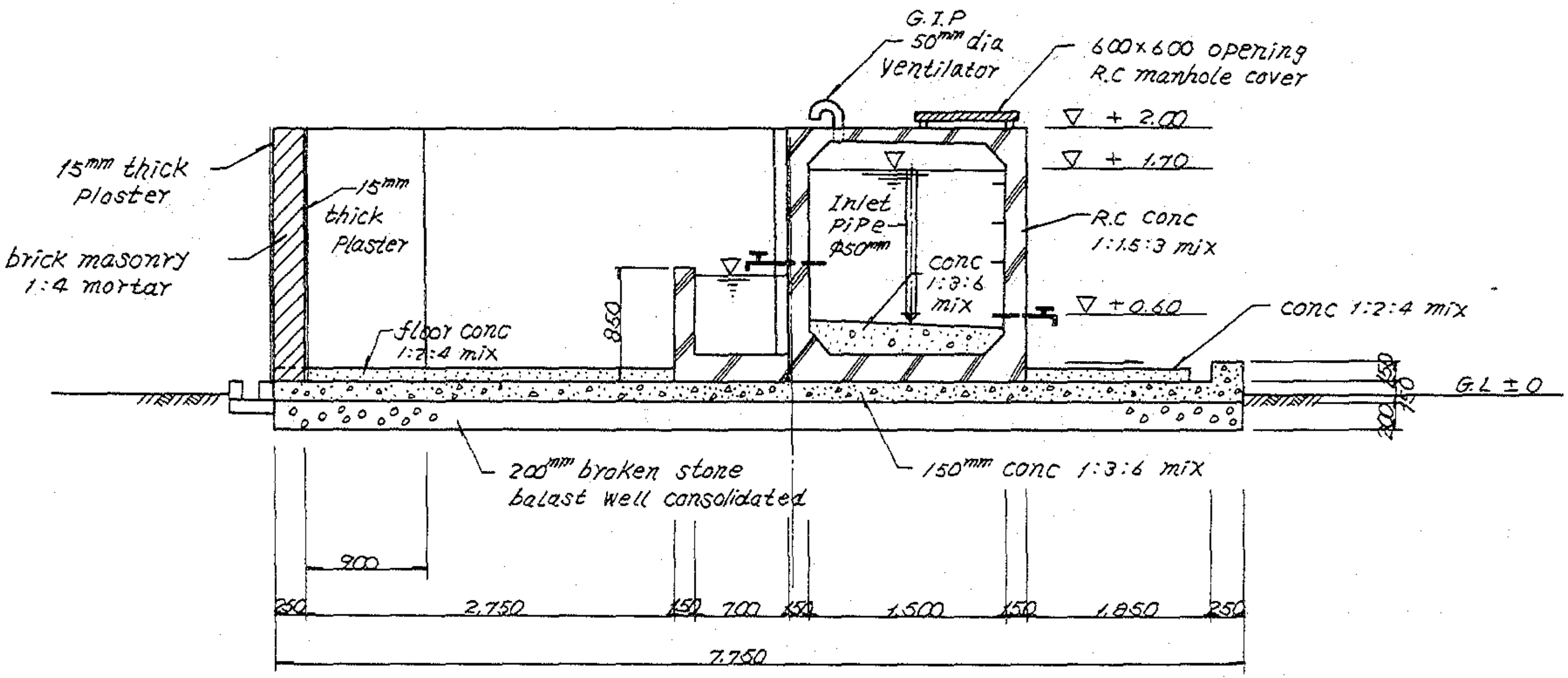
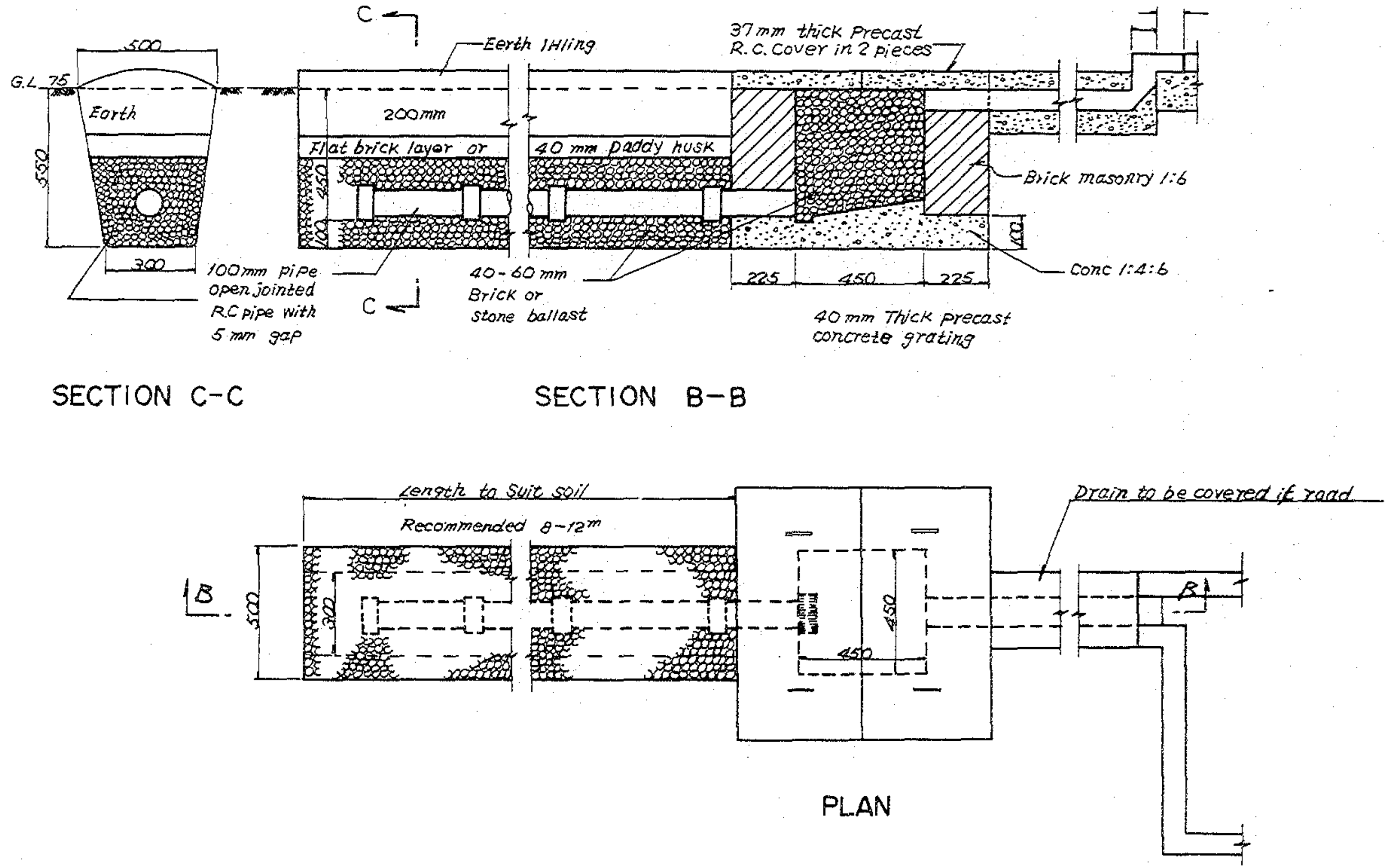


Fig. III-9 A-A SECTION OF TYPE-D FACILITY S=1/50

Fig.Ⅲ-10 SUB-SURFACE TILE FILTER TRENCH (S=1/20)



3.5 Maintenance Program

As already described in the basic concept in Section 3.2 operation and maintenance of the facilities provided in this project should be carried out by the beneficiary of the facilities, i.e., by each villagers organization or by responsibility of the concerned village. Furthermore, it should be strongly recommended that people in the village shall participate in the program from the beginning stage of construction works of the proposed facilities, including preparatory period.

3.5.1 Maintenance Organization and Management

a) Local level

In addition the regency and district level agency, organizations should be developed at a village level in the form of committee or some other entity that is usual in the community. The importance of a local committee is that it represents the village, directly involves the leader or village head and responsible people for day-to-day operation and administration of the system, and hopefully, educates and motivates the users of the facilities. The committee is required to nominate certain villagers who may be given a through training in facility maintenance, particulary of hand pumps, and virtually all responsibility left in their hand; may be paid by a reasonable amount for their works. The nominated villagers, called village craftsmen tentatively, will then be responsible for the facilities once it is constructed, and will carry a small stock of leather components and other spare parts in their store. If a major breakdown occurs they will go to the health center (district office) and either obtain the parts needed to do the repairs by themselves, or else get the district water engineer fillers to do the job. A recommended maintenance organization chart is shown in Fig. III-11.

b) Central and Regency level

The great number of water supply facilities, including small hand pump systems, requires central and regency organizations for planning, funding, engineering, purchasing, construction, training, supervision and control. Such organizations can obtain the benefits of economics of scale, bulk purchasing, standadization, and qualified staff.

The central and regency organizations are also responsible for administering the national program and policy; sets the technical standards and controls the execution of the program; is responsible for obtaining community participation; and insuring health education of the committees and the village, emphasizing the benefits of safe water and correct operation and maintenance. The central and regency organizations also assist the local committees in establishing systems of maintenance and procedures for operation. It should have central and regional stores of spare parts, and materials, tools, and heavy equipment for common use in special repairs.

Technical support could include assistance to solve problems and training at a community level. Local level financial support could include provision of funds, spare parts, tools, transport, and initiation of a community water supply fund.

3.5.2 Regular Maintenance Works

a) Common failure

Among the facilities to be provided by the project hand pump facilities will be the most troublesome one in the regular maintenance. In this section, therefore, only hand pumps maintenance works are dealt with common operating problems and their causes and repair of hand pumps summarized in Table III-10 and Table III-11.

b) Manufacturer's instruction

The manufacturer's instruction for assembly, installation, and lubrication and maintenance should be followed closely. The pump should be examined thoroughly and all adjustment made prior to installation.

c) Training

Training programs related to pump maintenance should emphasize installation, operation, and maintenance. The latter is of vital importance. Manufactueres' and agency booklets on installation, operation, and maintenance of the particular pumps in use should be supported by actual on-site training.

Trainees should be instructed in how hand pumps work, the more common cause of failure, and their correction. Training should not be confined to lectures; trainees should be physically involved. On the job training during original pump installation is an excellent means of training.

Training kits including samples of hand pump(s) used locally, with tools to dismantle and reassembly them, should be available for training. A collection of broken or worn parts is also useful for demonstration purposes.

Fig. III-11 Water Supply Facilities Operation and Maintenance Functional Chart

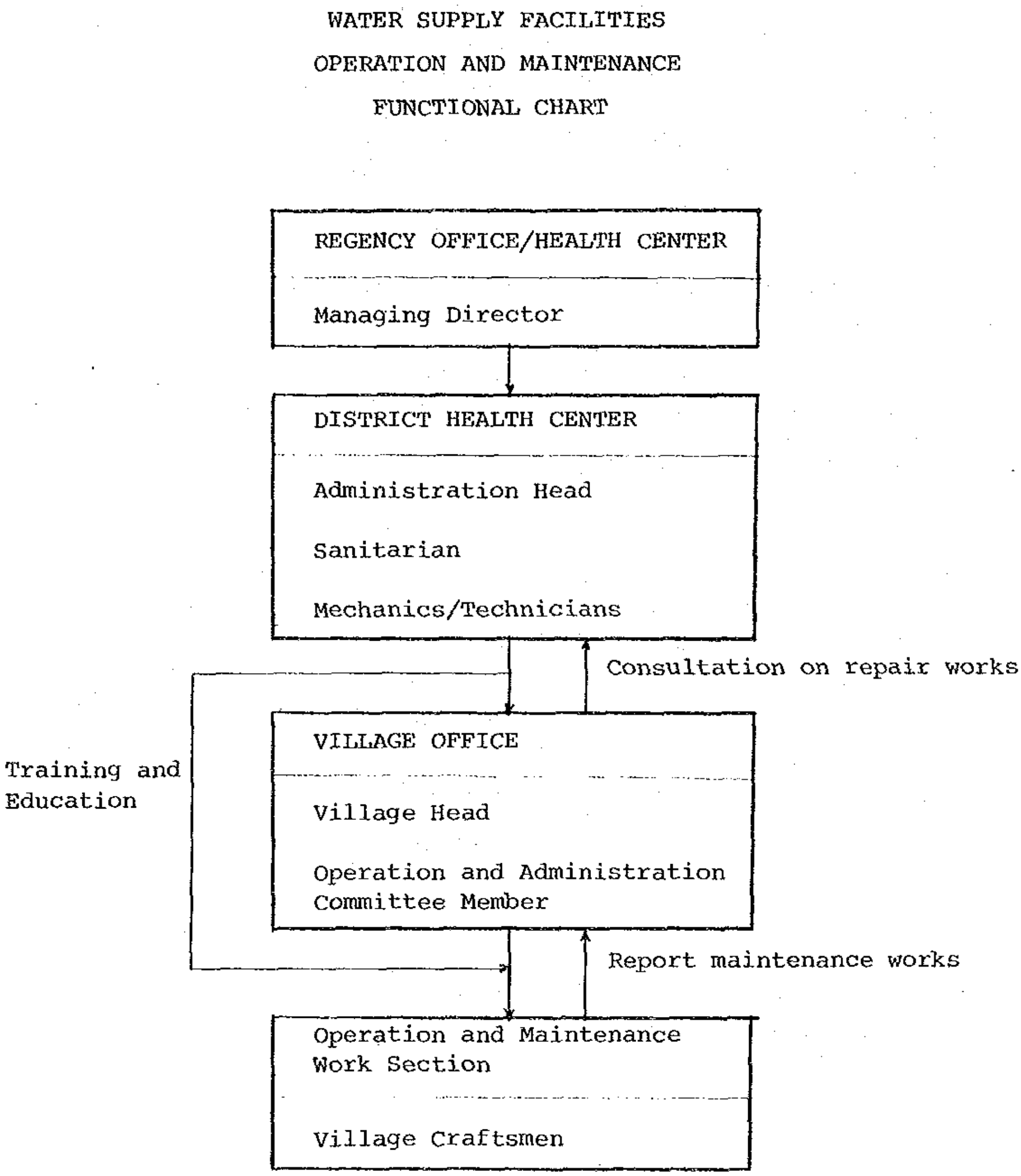


TABLE III-10

COMMON HAND PUMP TROUBLES AND REMEDIES

TROUBLE	LIKELY CAUSE	REMEDY
1. Pump handle works easily but no water delivered.	A. No Water at the source. Well dry.	Rehabilitate well, or develop a new source or sources of water.
	or	
	B. Level of water has dropped below suction distance of pump.	Can be checked with vacuum gauge or with weighted string. Reduce pumping rate or lower pump cylinder.
	or	
	C. Pump has lost its priming.	Prime the pump. If the pump repeatedly loses its priming it may be periodically pumping the well dry, the suction line may be leaking, or the suction valve or discharge check valve may be leaking. Repair line or valve.
	or	
	D. The cylinder cup seals ("leathers") may be worn out	Renew the cylinder cup seals ("leathers").
	or	
	E. The valves or valve seats may be worn or corroded.	Renew valves and repair or renew seates.
	or	
	F. With a deep-well plunger pump the plunger rod may be broken.	This trouble would be indicated by the pump running freer and and probably quieter. Turn the pump over by hand and note if there is resistance on the upstroke. Broken rods must be renewed and this usually means pulling the drop pipe and cylinder out of the well.
	or	
	G. Shutoff valve may be closed (force pump).	Open valve
	or	

Continued

TROUBLE	LIKELY CAUSE	REMEDY
1. Pump handle works easily but no water delivered (continued)	H. Hole in suction pipe.	Renew suction pipe. Cylinder may be lowered below water level in well.
	or	
	I. The suction pipe may be plugged with scale or iron bacterial growth or sediment.	Can be checked with vacuum gauge. Remove suction pipe and clean or renew.
	or	
	J. The pump cylinder may be cracked.	Renew the cylinder.
	or	
	K. Leak at base of cylinder.	Renew cylinder gasket.
	or	
	L. One or more check valves held open by trash or scale.	Remove valves and inspect for trouble. With deep-well plunger pumps this may mean pulling the pump cylinder or plunger and valves out of the well.
2. Pump runs but delivers only	A. Plunger leathers badly worn (plunger and piston pumps).	Renew leathers.
	or	
	B. Well not yielding enough water.	Decrease demands or establish new sources of water.
	or	
	C. Cracked cylinder (plunger or piston pump).	Renew cylinder.
	or	
	D. Check valve(s) liaking.	Repair valve(s).
	or	

Continued

TROUBLE	LIKELY CAUSE	REMEDY
2. Pump runs but delivers only a small amount of water. (continued)	E. Screen or suction valve may be obstructed.	Removed and clean
	or	
	F. Suction pipes are too small.	Can be checked with vacuum Gauge. Install pipe with larger diameter, or for deep well pump, lower pump cylinder below water level in well.
	or	
	G. Suction valve(s) may be out of order.	Repair valve(s).
	or	
	H. Cracked drop pipe or coupling.	Renew drop pipe or coupling.
3. Pump needs too many strokes to start	A. Pump has lost its priming.	Prime the pump. If the pump repeatedly loses its priming, it may be periodically pumping the well dry, or the suction line or the suction valve may be leaking. Repair or renew line or valve.
	or	
	B. The cylinder cup seals ("leathers") may be worn out.	Renew the cylinder cup seals.
4. Handle springs up after down stroke.	A. Suction pipe plugged up below pump cylinder.	Remove pump and clean out suction pipe. If well has filled with dirt up to suction pipe, the well should be cleaned out or the pipe cut off.
	or	
	B. Plunger check valve fails to open or to close.	Repair check valve.
	or	

Continued

TROUBLE	LIKELY CAUSE	REMEDY
4. Handle springs up after down stroke (continued)	C. Suction pipe too small.	Replace with larger suction pipe.
	or	
	D. Water too far below pump (suction pipe too long).	Place cylinder nearer water.
5. Leaks at suffing box	A. Packing worn out or loose.	Renew or tighten packing. Leave packing nut loose enough to allow a slow drip of water. The water serves as a lubricant.
	or	
	B. Plunger rod badly scored.	Renew plunger rod.
6. Pump is noisy	A. Bearings or other working parts of the pump are loose.	Tighten or renew parts.
	or	
	B. Pump is loose on mountings.	Righten mountings.
	or	
	C. With deep-well plunger pumps having a steel plunger rod the rod may be slapping against the drop line.	Use a wooden rod or install guides for rod or straigten drop pipe if crooked.

TABLE III-11 SCHEDULE FOR MAINTENANCE OF SIMPLE HAND PUMPS

daily	1.	Clean the well-head and space for water-drawing.
Weekly	1.	thorough clean-up of pump, well-head and surroundings.
	2.	oil or grease all thing pins, bearings, and sliding parts, after checking that no rust has developed on them.
	3.	inspect and take care of the drain ditch and the infiltration trench.
	4.	record any comments from users about irregularities in working (tightness of parts, leaks from stuffing box, fall-off in water raised). Correct these when possible.
monthly	1.	if necessary, adjust the stuffing box or gland. Usually this is done by tightening the packing nut. This should not be too tight-there should be a slight leak when the adjustment is correct.
	2.	check that all nuts and bolts are tight, and check that there is no evidence of loose connections on the pump rods.
	3.	check for symptoms of wear at the leathers, noting any comments from users about any falling off in the water raised. If the pump fails to raise water when worked slowly (e.g., at 10 strokes per minute), replace the leathers.
	4.	carry out all weekly maintenance tasks.
annualy	1.	paint all exposed parts to prevent development of rust.
	2.	repair any cracked concrete in the well-head and surrounds.
	3.	check wear at handle bearings and replace parts as necessary. On the Craelius pump, worn bushes can be replaced by short sections of pipe of suitable diameter.
	4.	check plunger valve and foot valve; replace if found leaking.
	5.	check the pump rod and replace any defective lengths or connectors.
	6.	replace packing at the stuffing box or gland.
	7.	carry out all monthly maintenance tasks.

3.6 Cost Estimates for Construction

The cost estimate of the facilities for whole project area is computed using developed unit costs for major construction items. All unit costs are based on the cost of materials and labor as of December 1979, and do not include any amount of contingencies and escalation. Unit cost figures are prepared on the bases of present cost data collected during the field survey. The unit cost figures for major items and estimated construction costs of each facility are included in Appendix D. The cost estimates summary for the whole project area is shown in Table III-12, and the cost estimates for the model villages are discussed in more detail in Section 4.4.

Table III-12 The Estimated Capital Costs

Type of Facilities	Proposed of Facilities	Unit Cost (Thousand Rp.)	Total Cost (Thousand Rp.)
Type-A	92	4,000	368,000
Type-B	14	9,900	138,600
Type-C	35	11,820	413,700
Type-D	25	12,300	307,500
Training kits and Tools for Repair Shop*			1,200
	116		Rp. 1,229,000

* Note: The above repair shop means a central level repair shop.

3.7 Implementation Schedule

As already stated in the preceding section this program is a part of the Health Promotion Project in North Sumatra. In this section, therefore, a general implementation schedule has been developed considering a close connection to the Project. It should be noted here that the planning including design and its implementation schedule is only a general guideline to cover primary urgent needs, and is subject to changes and modifications as conditions warrant.

To envisage the implementation of the program following conditions shall be taken into account:

(1) Priority of the selection of villages for implementation shall be based on the National Rural Water Supply Program which is presented in Appendix C-5.

(2) As regards construction of facilities in villages the followings orders of priority is recommended based on the Cost-Effect iveness concepts and taking into account that an alternate usage of wells with motor pumps installation in the future. First for Type-D, second for Type-A, third for Type-C and the last for Type-B.

(3) On the bases of the Planning of the Health Promotion Project, and the capability of the local well drilling contractor, the implementation of the program is proposed into following two stages:

a) First Stage: The fiscal years of 1980 through 1982.
b) Second Stage: The fiscal years of 1983 through 1987.

(4) The term of construction required for all Type-A facilities, which include semi-deep wells, is estimated approximately eight years by two constructing parties (by two simaltanious construction works executed.) While, the term of construction for the other all facilities, which include deep wells, is estimated as approximately seven years by three constracting parties.

(5) As for the local well drilling contractors, there are two contractors, which are officialy registered to the list of well drilling contractor, which is field in the office of Public Works in North Sumatra Province, in Medan. Besides that, there are two more contractors in the region of the project area, which have enough experiences of well drilling works. All those contractors are considered to be capable for well drilling works of the proposed project.

The implementation schedule for the program is shown in Table III-13. Cost estimates of separated stages are shown in Table III-14 and Table III-15.

Approximate population to be covered by the first stage and the second stage will be 44,000 and 60,000, or 42 percent and 58 percent of the proposed population to be served, respectively.

Table III-13 Implementation Schedule

Item of Works	Proposed Numbers in First Stage (1980-1982)	Proposed Numbers in Second Stage (1983-1987)	Total of the Program Plan
1. Construction of Facilities			
(1) Type-A	36	56	92
(2) Type-B	-	14	14
(3) Type-C	10	25	35
(4) Type-D	15	10	25
Total of 1	61	105	166
2. Furnishing of Tools	2/3	1/3	1

Note: The above years are of Fiscal Years.

Table III-14 Cost Estimates of the First Stage, 1980-1982

Item of Works	Proposed Numbers	Unit Cost (Thousand Rp.)	Total Cost (Thousand Rp.)
Construction of Facilities			
1. Type-A	36	4,000	144,000
2. Type-C	10	11,820	118,200
3. Type-D	15	12,300	184,500
Furnishing of Tools	1 L.S.		800
Total Cost of First Stage			Rp. 447,500

Table III-15 Cost Estimates of the Second Stage, 1983-1987

Item of Works	Proposed Numbers	Unit Cost (Thousand Rp.)	Total Cost (Thousand Rp.)
1. Construction of Facilities			
(1) Type-A	56	4,000	224,000
(2) Type-B	14	9,900	138,600
(3) Type-C	25	11,820	295,500
(4) Type-D	10	12,300	123,000
2. Furnishing of Tools	1 L.S.		400
Total Cost of Second Stage			Rp. 781,500

IV. MODEL STUDY FOR SELECTED VILLAGES

4.1 Selection of Villages

Out of 56 villages in the three districts of the project area, six villages are selected for model design in this study; they are Sei Buah Keras and Medang in Medang Deras District, Limau Sundai and Tanjung Muda in Air Putih District, and Perupuk and Guntung (Kedai Sianam) in Lima Puluh District.

The six villages were selected by the Japanese Expert Team, being taking part in the Health Promotion Project in the project area. The Team's efforts are mainly concentrated on the above villages, which were selected according to the consideration of such factors of endemic diseases, social conditions, medical and health conditions and geographic features; which may represent the whole project area.

As a general reference, statistics of the six villages and the study results made by the Health Promotion Project, which is now on-going, are quoted and tabulated in Tables IV-1 and IV-2.

4.2 Outline of the Selected Villages

(1) Sei Buah Keras

This village is located in the flat and wet lowlands covered by rice fields and the primeval forest in the western part of the project area. This is one of the typical villages of poor medical and social situations and of high incidence of communicable diseases. At present people in the village use three deep wells which were recently constructed and conventional shallow wells which produce unadequate water in both quantity and quality.

(2) Medang

This village is located along the access road to the Smelter Site of INALUM (Indomesian Asahan Aluminium Co.). Almost all the villagers are Moslem. Houses in this village are scattered here and there in the rice fields and under coconut trees and not clustered. Most people use shallow wells which are not sufficient in numbers and poor in water quality. There exists one newly constructed deep well which quality is acceptable but yields small amount of water. With regard to social characteristics it should be noted that many people of this village work at the construction site of the Smelter Plant and its substructural works.

(3) Limau Sundai

This village is isolated in the flat and wet low lands which lie between the big rivers. Only one narrow access road connects the village with the main road of the national highway. Most of the inhabitants, being Batak, dwell in the three clusters of sub-villages (Lorong) along the village road. The villagers are earning rather high income by virture of widely spread rice fields and live-stocks, especially pigs. There is not deep well at present and people in this village are relying on the domestic shallow wells with a depth of less than three meters and of colored low quality water. Most of the wells are equipped with home made sand filters. Not only cholera cases but also worm diseases and enteritis cases are chronically observed.

(4) Tanjung Muda

This village is in a hilly area which is far from the seacoast and rises between the big rivers. Most houses are found along the village road in small scale of clusters. This village includes samll size rice fields and deep forest. Rather deep (10 - 12 meters in depth) shallow wells supply village people with water of acceptable quality.

(5) Perupuk

This village is one of the biggest village, which has over 6,000 of population, in the project area. The village is located along the seacoast and has only one approach road through Guntung. Most people of the village live on fishery. Most wells in the village are shallow within three meters in depth and sometimes dry up in the dry season. Clinically suspected cholera cases in 1979 are rather few but this village has more seriuos problems of malaria, worm diseases, respiratory diseases and skin diseases.

(6) Guntung (Kedai Sianam)

This village is located at the east end of the project area facing to the sea. The village receives adequate quantity and quality of water from an old deep well constructed in the Dutch age. One remarkable thing of the village is that no cholera cases was observed in 1979.

Table IV-1 Major Item Statistics of Six Villages

December 1979

ITEM / VILLAGE	Population			Total Area (ha)	Rice-field (ha)	Religions (percent)			Races (percent)			
	Male	Female	Total			Moslem	Christian	Others	Malay	Batak	Java	Others
1. S. Buah Keras	1,048	1,008	2,056	450	less than 200	36.6	63.0	3.4	33.9	65.0	3.0	8.1
2. Medang	1,485	1,554	3,039	650	400	99.0	0	1.0	86.3	0	13.7	0
3. Limau Sundai	1,543	1,524	3,067	1,558	1,000	11.4	85.2	3.4	7.2	87.3	0	5.5
4. Tanjung Muda	659	651	1,310	188	126	52.2	47.8	0	28.4	28.4	0	43.1
5. Perpuk	3,052	3,175	6,227	2,020	175	98	2.0		91.8	1.6	6.7	0
6. Guntung	1,430	1,370	2,800	1,145	200	(99.0)	(1.0)		(90.0)	–	–	–

4.3 Planning of Water Supply Facilities

In this section detailed planning of water supply facilities for the six selected villages are studied and presented in the Table IV-4 and Figures IV-1 through IV-6 Types and numbers of facilities for the six villages are identical as those studied and shown in the Section 3.4.

Following conditions are introduced to the designing of applications and selection of the facilities:

(1) Population scale of the village and Lorongs.

(2) Hydrogeological situations investigated in the survey and included in Appendices B and C.

(3) Exact location of the facilities shall be decided upon previous consultation with the villagers concerned. Here, in this model study, the location of the proposed facilities is tentatively set up on the map.

General data of the six villages required for designing works are tabulated in Table IV-3.

The design process and its results are shown in the following pages.

STARTING OF DESIGN WORKS

PRIOR INSTRUCTION OF THE PROJECT ADMINISTRATION OFFICE

↓

Collection and arrangement of data:

(1) Population breakdown in each Lorong,

(2) General map of the village showing land-use, location of each Lorong and housing distribution,

(3) Location of existing wells, and

(4) Location of main public facilities,

↓

Classification and analysis of the collected data,

↓

Preparation of the general map of the village,

↓

Preliminary designing of the facilities:

(1) Grouping the Lorong population to be served into three classes as of following magnitude: (a) 300-400 capita, (b) 600-800 capita and (c) 1,200-1,800 capita,

(2) Setting the tentative location of each facility, and

(3) Setting the covering population of each facility.

↓

REVIEW AND INSTRUCTION OF THE PROJECT ADMINISTRATION OFFICE, COORDINATION WITH THE AGENCIES CONCERNED

↓

Consultation of the location of the planned facility with the villagers.

↓

Field survey;

(1) Location confirmation and determination of the planned facilities, and

(2) Detailed environmental investigation of the planned facilities.

↓

Final designing with due modifications of the standard facility, if required.

↓

Cost estimation of the all facilities to be constructed using the updated unit costs.

↓

REVIEW AND INSTRUCTION OF THE PROJECT ADMINISTRATION OFFICE

↓

Preparation of the required documents for tendering of the facility construction.

↓

STARTING OF CONSTRUCTION WORKS

Table IV-2 Survey Record of Sanitary Environment in the Six Villages in March 1979

Village	District	(1) Total Populat-ion	(2) Total House-hold	(3) Surveied Populat-ion	(4) Surveied House-hold	(5) Rerigion (capita)			(6) Relying Water Sources (Household)					(7) Domestic Waste Discharged to: (Household)				(8) Garbage Disposal (Household)			(9) Distance between W.C. and Well (Household)		(10) Distance between Waste Water and Well (Household)	
						Moslem	Christian	Others	Shallow Well with Hand pump	Artesian Type Deep Well	Shallow Well	River	Others	Ditch	River	Pond	Ground	Burn	Bury	Indifinite	>10m	<10m	>10m	<10m
1. Sei Buah Keras	Medang Deras	2,031	406	169	34	39	130	-	-	12	18	4	-	4	7	-	23	13	-	21	17	17	4	30
2. Medang	- ditto -	2,953	600	233	54	233	-	-	1	3	50	-	-	41	6	-	7	27	-	27	41	13	10	44
3. Limau Sundai	Air Putih	2,593	518	121	26	-	106	15	-	-	25	-	1	-	1	-	25	20	-	6	2	24	8	18
4. Tanjung Muda	- ditto -	1,263	250	117	22	52	65	-	-	-	20	1	1	6	6	-	10	7	1	14	13	9	2	20
5. Perpuk	Lima Puluh	5,896	1,180	316	59	312	-	4	-	1	49	3	-	19	7	-	33	38	-	21	40	19	27	32
6. Guntung	- ditto -	2,800	560	188	33	-	-	-	-	7	32	-	-	20	-	1	12	16	-	17	25	8	15	18
Total:		17,536	3,514	1,144	228	824	301	19	1	23	194	8	2	90	27	1	110	121	1	106	138	90	66	162
(Persentage)				(100%)	(100%)	(72.0%)	(26.3%)	(1.7%)	(0.4%)	(10.1%)	(85.1%)	(3.5%)	(0.9%)	(39.5%)	(11.8%)	(0.4%)	(48.2%)	(53.1%)	(0.4%)	(46.5%)	(60.5%)	(39.5%)	(28.9%)	(71.1%)

July 25, 1979
Directorate of Hygiene and Sanitation, Medan

TABLE IV-3 Design Data and Conditions of the Six Villages

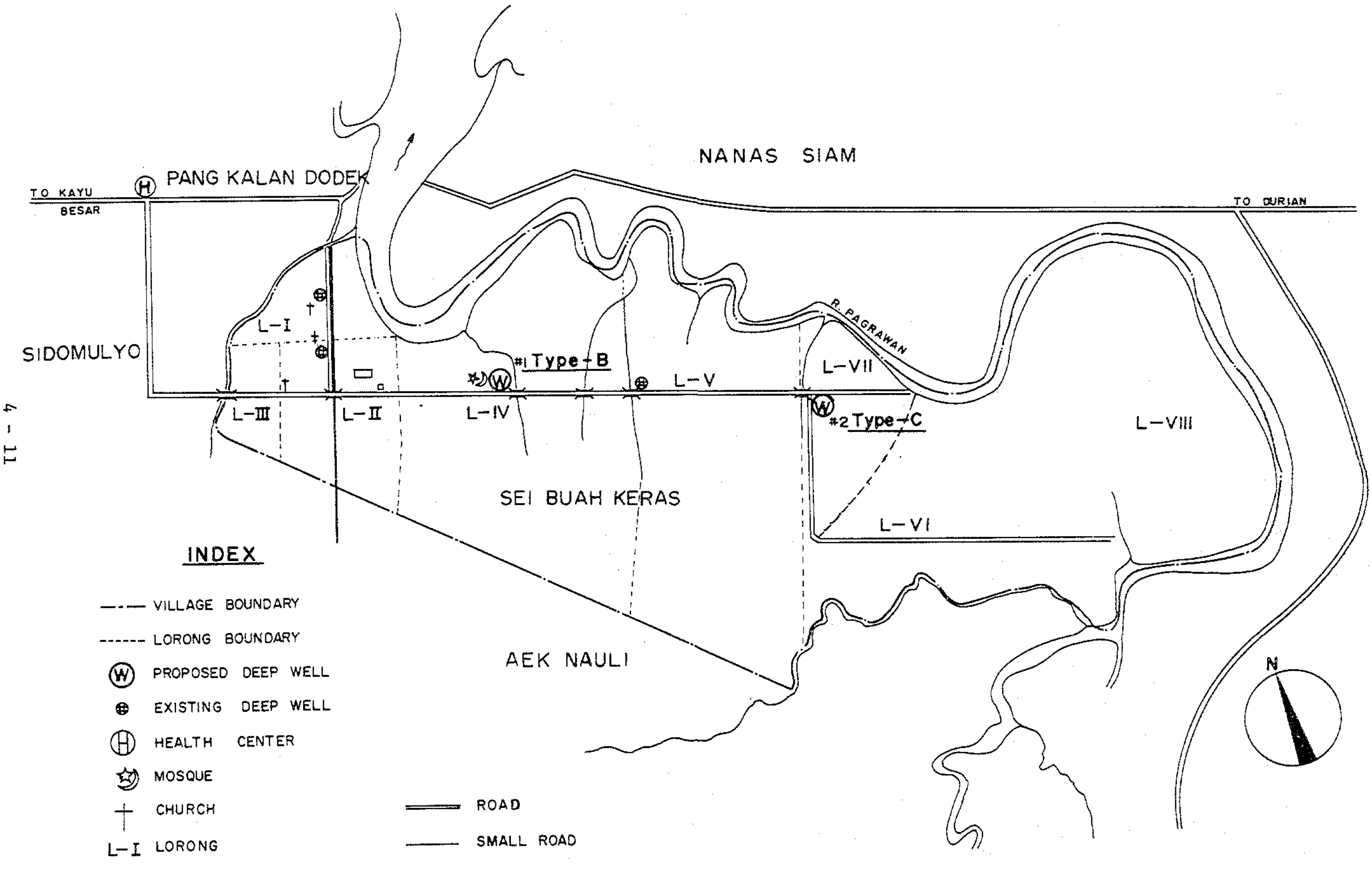
December 1979

Village	Total Population	Population to be Served	Total Area (ha)	Number of Lorong	Geological Situation	Existing Deep Well Numbers	Existing Deep Well Covering Population
(1) Sei Buah Keras	2,056	2,056	450	8	Lowland	3	300 and over
(2) Medang	3,039	3,039	650	11	Lowland & facing to the sea	1	300
(3) Limau Sundai	3,067	3,067	1,558	14	Wet lowland	-	-
(4) Tanjung Muda	1,310	1,310	188	7	Hilly & dry land	-	-
(5) Perupuk	6,227	6,227	2,020	13	Lowland & facing to the sea	2	200 and over
(6) Guntung	2,800	2,800	1,145	5	- ditto -	1	more than 1,000

Table IV-4 Number of Facilities to be Constructed in the Six Villages

Villages		Proposed Number of Facilities				
		Type-A	Type-B	Type-C	Type-D	Total
(1)	Sei Buah Keras	-	1	1	-	2
(2)	Medang	-	-	2	1	3
(3)	Limau Sundai	2	1	1	1	4
(4)	Tanjung Muda	4	-	-	-	4
(5)	Perupuk	-	-	1	4	5
(6)	Guntung	-	1	-	-	1
	Total:	6	3	5	6	20

Fig.IV-1 GENERAL MAP OF SEI BUAH KERAS



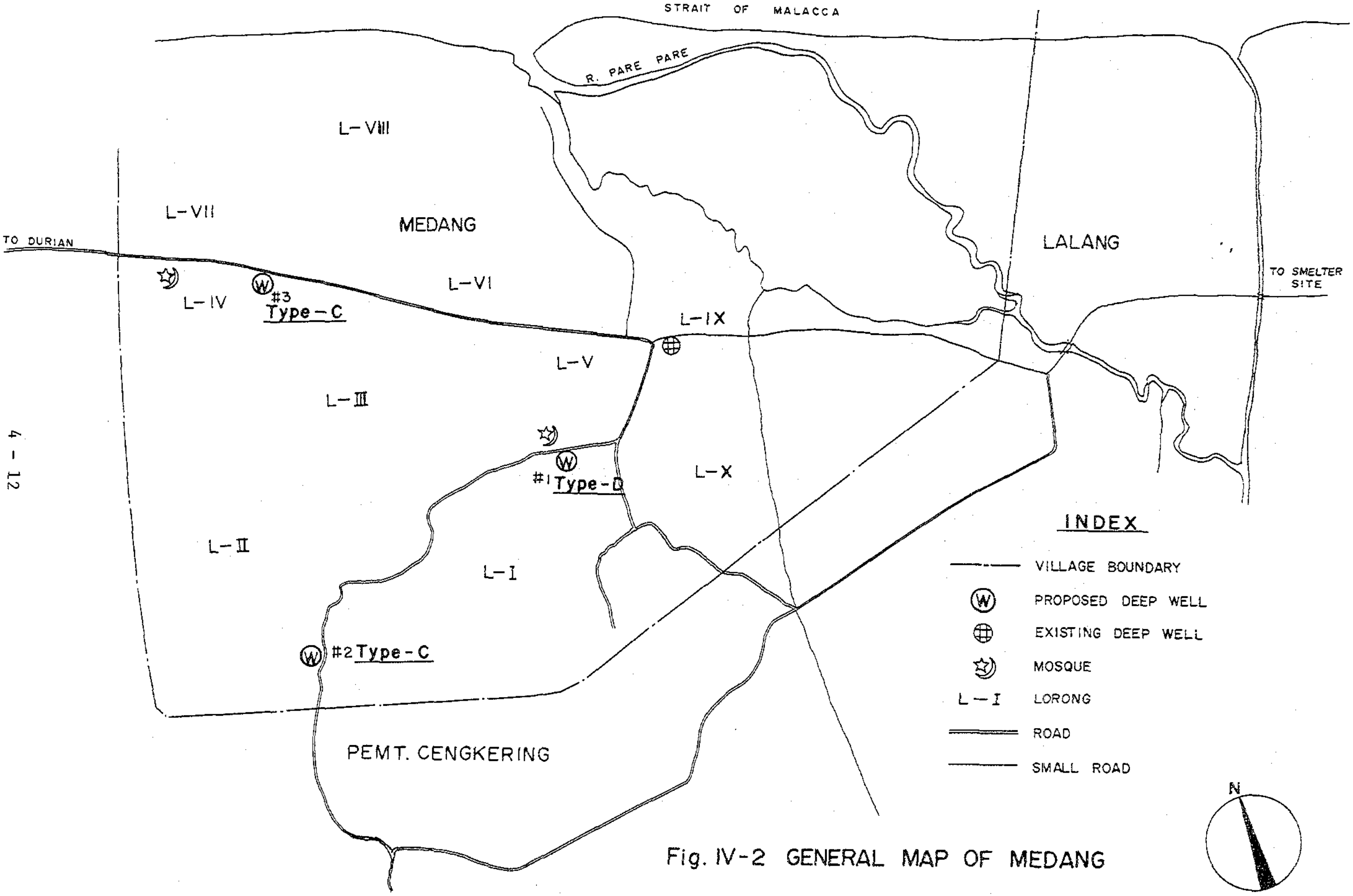


Fig. IV-2 GENERAL MAP OF MEDANG

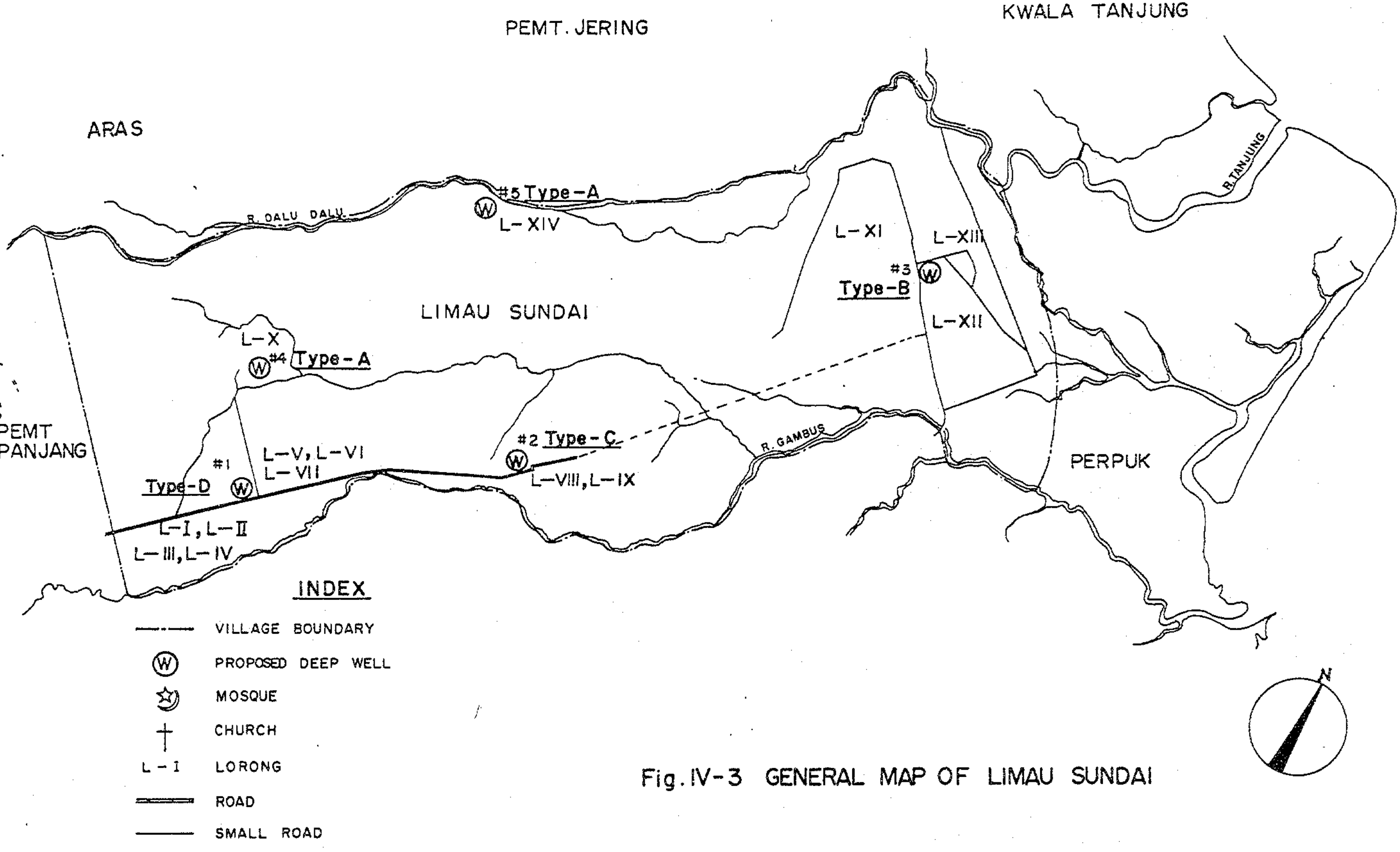
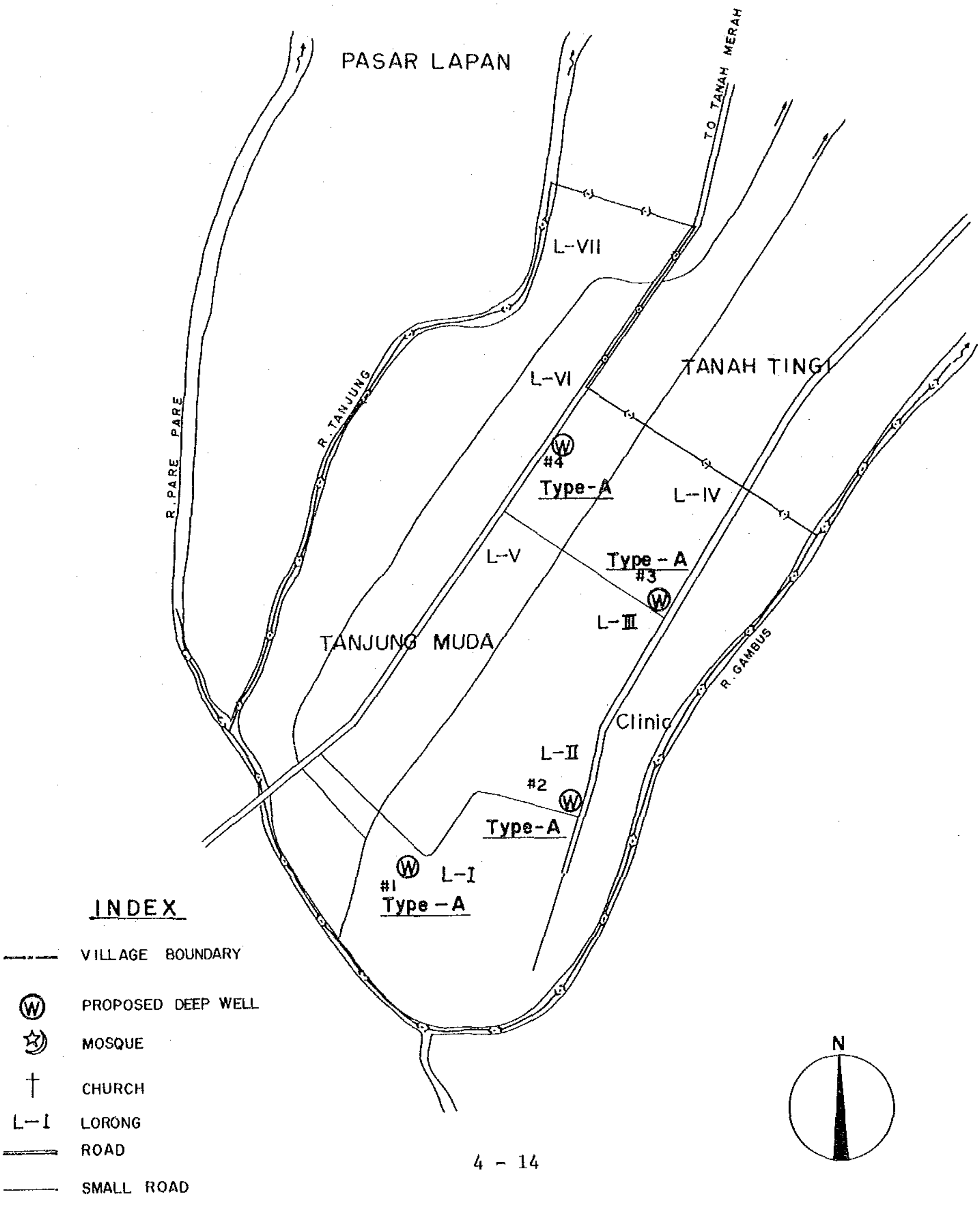


Fig. IV-3 GENERAL MAP OF LIMAU SUNDAI

Fig. IV-4 GENERAL MAP OF TANJUNG MUDA



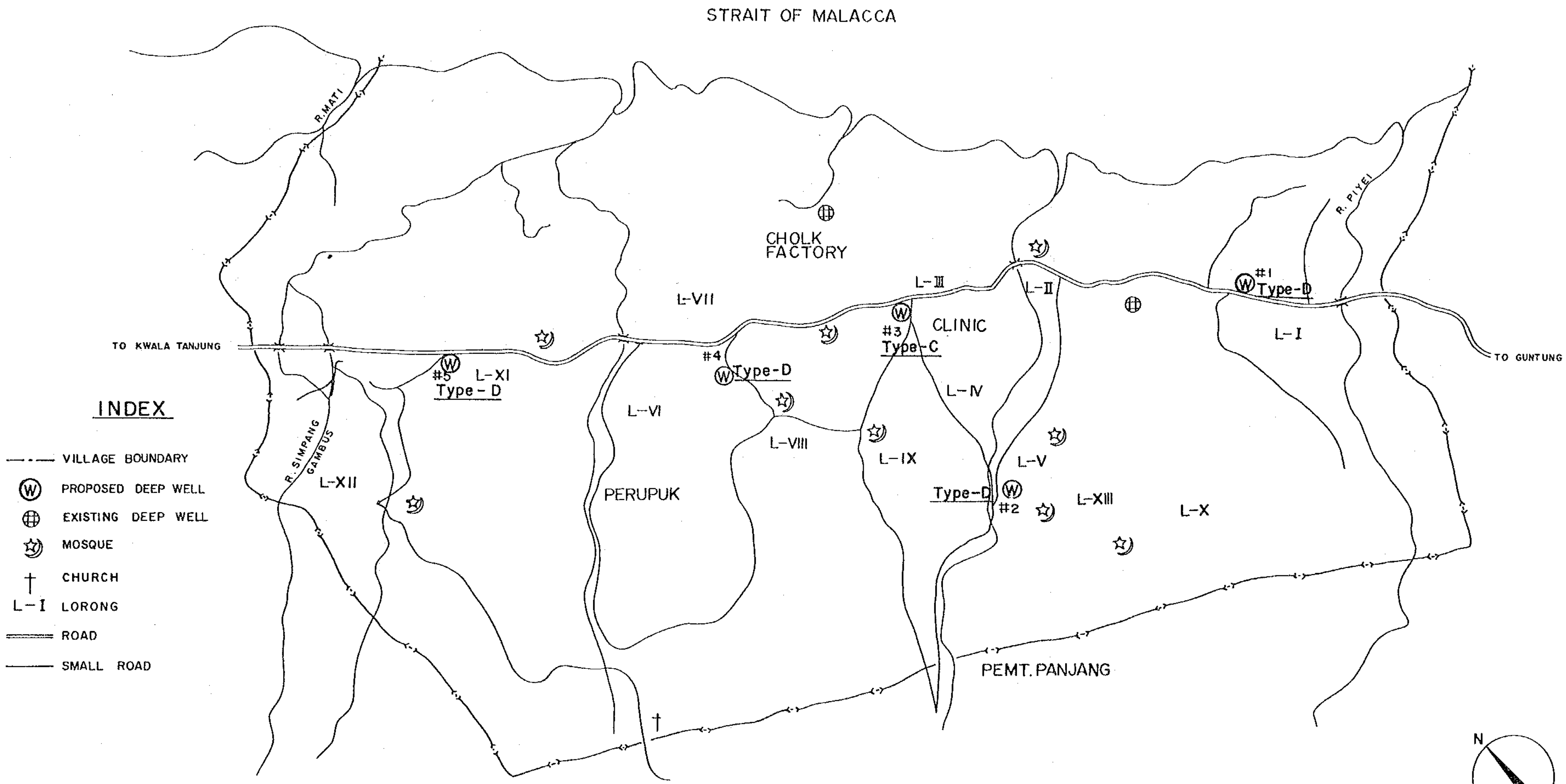


Fig. IV-5 GENERAL MAP OF PERUPUK

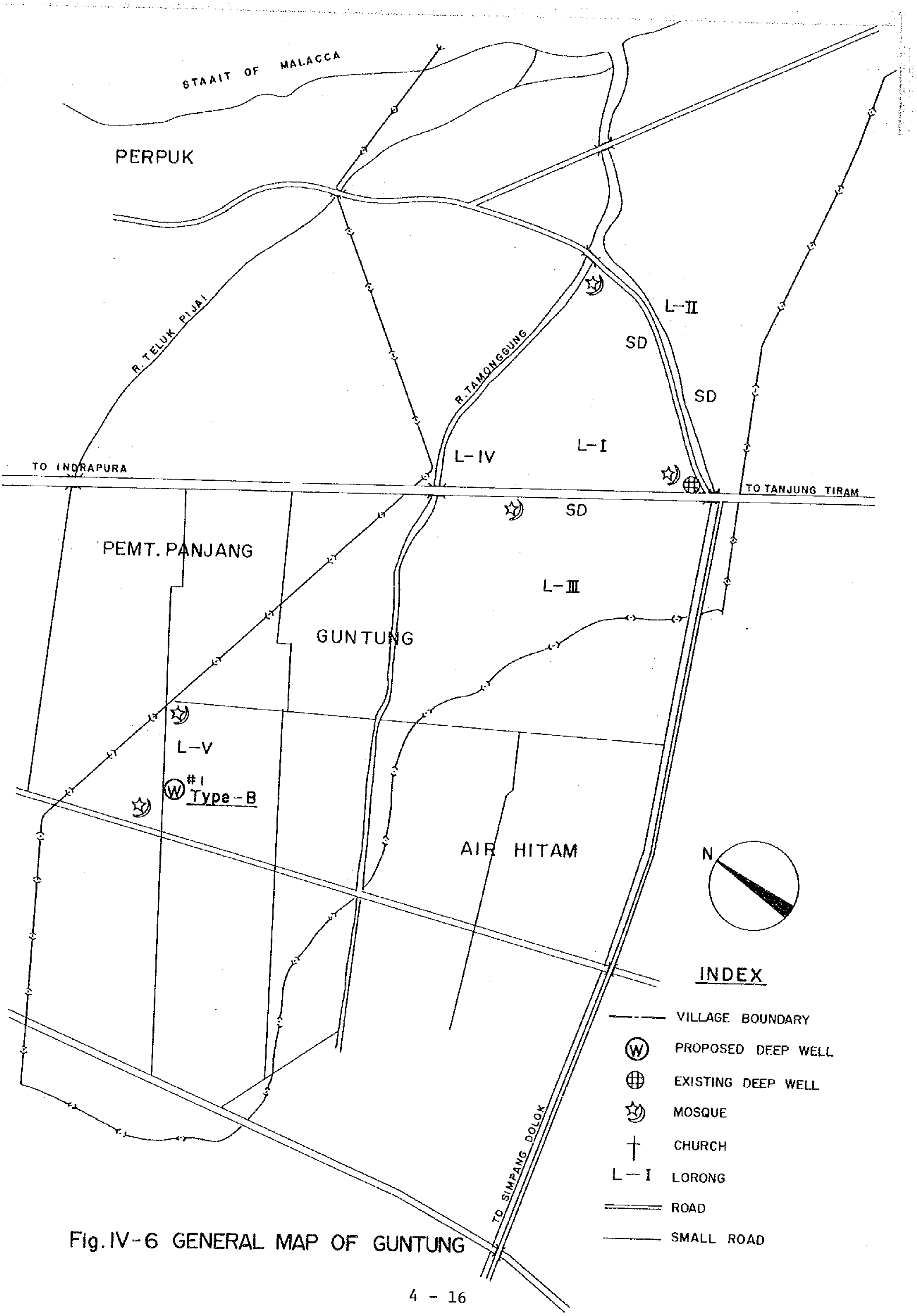


Fig. IV-6 GENERAL MAP OF GUNTUNG

4.4 Cost Estimates

Cost estimates for the six villages are computed using the unit facility costs included in Appendix D-3. Total construction costs for the six villages are shown in Table IV-5. Construction schedule by stages and costs for each stage are studied and shown in Table IV-6.

Table IV-5 Construction Costs (Unit: Thousand Rp.)

Cost by Each Type of Facility
(Proposed Number of Facilities)

Villages	Type-A	Type-B	Type-C	Type-D	Total
1) Sei Buah Keras	-	9,900 (1)	11,820 (1)	-	21,720 (2)
2) Medang	-	-	23,640 (2)	12,300 (1)	35,940 (3)
3) Limau Sundai	8,000 (2)	9,900 (1)	11,820 (1)	12,300 (1)	42,020 (5)
4) Tanjung Muda	16,000 (4)	-	-	-	16,000 (4)
5) Perupuk	—	-	11,820 (1)	49,200 (4)	61,020 (5)
6) Guntung	-	9,900 (1)	-	-	9,900 (1)
Total	Rp.24,000 (6)	Rp.29,700 (3)	Rp.59,100 (5)	Rp.73,800 (6)	Rp.186,600 (20)

Table IV-6 Construction Schedule and Costs by Stage

(Unit: Thousand Rp.)

Village	First Stage: 1980 - 1982 Cost for Each Type of Facility (Proposed Number of Facility)					Second Stage: 1983 - 1987 Cost for Each Type of Facility (Proposed Number of Facility)				
	Type-A	Type-B	Type-C	Type-D	Total:	Type-A	Type-B	Type-C	Type-D	Total:
1) Sei Buah Keras	-	-	11,820 (1)	-	11,820 (1)	-	9,900 (1)	-	-	9,900 (1)
2) Medang	-	-	-	12,300 (1)	12,300 (1)	-	-	23,640 (2)	-	23,640 (2)
3) Limau Sundai	8,000 (2)	-	-	12,300 (1)	20,300 (3)	-	9,900 (1)	11,820 (1)	-	21,720 (2)
4) Tanjung Muda	8,000 (2)	-	-	-	8,000 (2)	8,000 (2)	-	-	-	8,000 (2)
5) Perupuk	-	-	-	24,600 (2)	24,600 (2)	-	-	11,820 (1)	24,600 (2)	36,420 (3)
6) Guntung	-	-	-	-	-	-	9,900 (1)	-	-	9,900 (1)
Total:	Rp. 16,000 (4)	-	Rp. 11,820 (1)	Rp. 49,200 (4)	Rp. 77,020 (9)	Rp. 8,000 (2)	Rp. 29,700 (3)	Rp. 47,280 (4)	Rp. 24,600 (2)	Rp. 109,580 (11)

APPENDIX

APPENDIX A: RECORD OF THE FIELD SURVEY

A-1. Members of the Japanese Survey Team

A-2. Activities in the Field

A-3. List of Authorities and Officials Concerned

A-4. List of Date Collected

A-1 Members of the Japanese Survey Team

Name and Profession	Speciality	Assignment for the Project
1) Team leader: Dr. Michio HASHIMOTO (Professor, Graduate School of Environmental Science, Tsukuba University)	Public health	Public health and overall management
2) Member: Mr. Kazunobu ONOGAWA (Chief, Second Planning Section, Planning Division, Water Supply and Environmental Sanitation Department, Ministry of Health and Welfare)	Environmental sanitation engineering and administration	Engineering for environmental sanitation
3) Member: Mr. Koichi MIYOSHI (Staff, Medical Cooperation Department, Japan International Cooperation Agency)	Social economy and general administration	Socio-economic study and logistics for the team
4) Member: Mr. Hideki YAMAZAKI (Chief, Second Engineering Section, Water Supply Department, Nihon Suido Consultants Co., Ltd.)	Water supply engineering	Planning of drinking water supply systems
5) Member: Mr. Shoji SASAKI (Sub Chief, First Engineering Section, Water Supply Department, Nihon Suido Consultants Co., Ltd.)	Water supply engineering	Designing of drinking water supply facilities
6) Member: Mr. Michio SEKINE (Sub Chief, Engineering Section, Water Resources Department, Nihon Suido Consultants Co., Ltd.)	Hydrogeology	Investigation of groundwater resources

A-2. Record of Activities in the Field

(1) Team's Activity

Date, 1979		Particulars
21 Nov.	(Wed)	- Trip from Tokyo to Jakarta
22	(Thu)	- Courtesy call to Director General of Communicable Desease Control (CDC), Ministry of Health
		- Meeting with officials of Ministry of Health
		- Courtesy call to Embassy of Japan
		- Meeting with officials of Embassy of Japan and Japan International Cooperation Agency (JICA), Jakarta
		- Meeting with Director General of Community Health, Ministry of Health
23	(Fri)	- Trip from Jakarta to Medan by air
		- Meeting with Japanese Experts Team in Medan
24	(Sat)	- Courtesy call to Chief of Provincial Health Office of North Sumatra Province, Medan
		- Meeting with officials of the above office
		- Meeting with Japanese team for pre-fabricated building of laboratory at Indrapura Health Center
25	(Sun)	- Trip from Medan to survey base of the Team, Pematang Siantar, by jeep
26	(Mon)	- Visit to Indrapura Health Center
		- Preliminary field reconnaissance around areas of Limau Sundai, Guntung and Perupuk
27	(Tue)	- Detailed investigation of existing wells (1 deep well at Medang, 1 shallow well at Medang, 2 deep wells at Pagurawan)
28	(Wed)	- Detailed investigation of existing wells (1 shallow well at Limau Sundai and 1 shallow well at Lima Puluh)
29	(Thu)	- Detailed investigation of existing wells (1 deep well at Tanjung Kasau and 1 shallow well at Simodong)
		- Hydrogeological pumping test using the above existing deep well

- To be continued -

Date, 1979		Particulars
30 Nov.	(Fri)	- Detailed investigation of existing wells (1 deep well at Guntung, 1 deep well at Perupuk and 1 shallow well at Indrapura Health Center) - Preliminary planning of new water supply system for Indrapura Health Center - Check of conditions of geoelectric resistivity survey equipment and demonstration of the survey
1 Dec.	(Sat)	- Transportation of ten sampled well water to Provincial Laboratory in Medan for detailed water quality analysis - Detailed investigation of existing wells (1 deep well at Simpang Dolok, 1 shallow well at Tanjung Muda and 1 deep well at Indrapura)
2	(Sun)	- Desk work - Preparation of geoelectric resistivity survey
3	(Mon)	- Execution of geoelectric resistity survey (3 points, each 240 meters in depth, at Tanjung Muda) - Desk work
4	(Tue)	- Execution of geoelectric resistivity survey (3 points, 240 meters at two points and 160 meters at 1 point, at Medang) - Visit to Inalum's smelter site - Desk work
6	(Thu)	- Execution of geoelectric resistivity survey (3 points, 240 meters each, along the access road to Inalum's smelter site) - Desk work - Dr. Hashimoto's leaving for Japan
7	(Fri)	- Execution of geoelectric resistivity survey (2 points, 240 meters each, nearby Indrapura Health Center) - Visit to Tanjung Muda for detailed data collection - Desk work

- To be continued -

Date, 1979		Particulars
8 Dec.	(Sat)	- Visit to Sei Buah Keras for detailed data collection
		- Desk work
10	(Mon)	- Visit to Medang for detailed data collection
		- Contact with a well driller in Tebing Tinggi
		- Desk work
11	(Tue)	- Desk work, preparation of the Report
12	(Wed)	- Desk work, preparation of the Report
13	(Thu)	- Trip from survey base to Medan
		- Interview to a well driller in Tebing Tinggi
14	(Fri)	- Meeting with officials of Provincial Health Office of North Sumatra Province, Medan
		- Desk work, preparation of the Report
		- Interview to a well drilling company in Medan
15	(Sat)	- Visit to Provincial Health Laboratory, Medan
		- Visit to Public Works of North Sumarta
16	(Sun)	- Preparation of the Progress Report
17	(Mon)	- Presentation of the Progress Report to Provincial Public Health Office of North Sumatra Province
		- Mobilization from Medan to Jakarta
18	(Tue)	- Visit to Community Health, Ministry of Health (Presentation of Progress Report and discussion)
		- Visit to Communicable Desease Control, Ministry of Health
		- Visit to Embassy of Japan
19	(Wed)	- Visit to Communicable Desease Control, Ministry of Health (Presentation of Progress Report and discussion)
20	(Thu)	- Trip from Jakarta to Tokyo

(2) Team Leader's Activities

Upon arrival at the survey field, Medan, the Team Leader, Dr. Michio Hashimoto, took different activities from that of other team members, in order to discuss with officials concerned on the matters and to promote the project administratively.

His activities are recorded hereinafter.

Date 1979			Particular
21 Nov.	(Wed)	-	Same activities as other team members (See [1])
22	(Thu)	-	- ditto -
23	(Fri)	-	- ditto -
24	(Sat)	-	- ditto -
25	(Sun)	-	Arrangement of the schedule, in Medan
26	(Mon)	-	Visit to Provincial Health Office of North Sumatra Province, Medan
		-	Meeting with the Japanese Experts Team, Medan
		-	Courtesy call to Consulate of Japan, Medan
		-	Visit to Inalum Company, Medan
27	(Tue)	-	Meeting with the Japanese Experts Team
		-	Visit to Provincial Health Laboratory, Medan
28	(Wed)	-	Visit to BAPPENDASU, Medan and meeting with officials
		-	Field reconnaissance at places remarkable of cholera cases in Medan
		-	Meeting with Japanese team for pre-fabricated building of laboratory
29	(Thu)	-	Trip from Medan to Kisaran by jeep
		-	Visit to Regency Health Office of Asahan Regency, Kisaran
		-	Trip from Kisaran to Siantar and joining to the Team

- To be continued -

Date 1979	Particular
30 Nov. (Fri)	- Field investigation at Guntung, Perupuk and Indrapura Health Center, together with the Team
	- meeting with First Secretary of Embassy of Japan
1 Dec. (Sat)	- Trip from Siantar to Medan by jeep
	- Visit to Provincial Health Office, Medan
	- Meeting with Japanese team for pre-fabricated building of laboratory
	- Visit to Consulate of Japan, Medan
2 (Sun)	- Meeting with Japanese Experts Team
3 (Mon)	- Meeting with officials of Provincial Health Office
	- Trip from Medan to Jakarta by air
4 (Tue)	- Courtesy call to Embassy of Japan, Jakarta
	- Meeting with Asahan Authority, Jakarta
5 (Wed)	- Visit to Ministry of Public Works
	- Meeting with Directors of Directorate of City Planning and Directorate of Sanitary Engineering
	- Visit to Japan International Cooperation Agency (JICA), Jakarta
	- Leaving Jakarta for Japan by air
6 (Thu)	- Arrival at Tokyo

A-3. List of Authorities and Officials Concerned

(1) Directorate of Community Health, Ministry of Health

Jl. Prapatan No. 10, Jakarta

Telephone No. = 343788

- Dr. R. Soebekti MPH (Director General of Community Health)
- Mr. Priyono (Staff of Community Health)

(2) Directorate of Communicable Desease Control, Ministry of Health

Jl. Percetakan Negara I, Jakarta Pusat

Telephone No. = 881817, P. O. Box = 223

- Dr. Adhyatma MPH (Director General of CDC)
- Mr. Wahyu Widodo DPH (Director of Hygiene and Sanitation)
- Mr. R. Soetyono (Chief of Pesticide Division)
- Mr. Soemali (Head of Water Supply Division)
- Mr. D. Luthfi (Staff of Directorate of Hygiene and Sanitation)

(3) Provincial Health Office of North Sumatra

41 AA Jl. Prof. HM Yamin SH, Medan

Telephone No. = 23301, 23510

- Dr. Mangasa Siregar MCH (Chief of Provincial Health Office)
- Dr. A. Hasan Siregar SKM (Director of Community Health and Medical Care)
- Dr. R. Tampubolon MPH (Assistant Manager of Asahan Health Promotion Project)
- Mr. Purba (Chief, Subdirectorate of Hygiene and Sanitation)
- Mr. S. Adhi Nugroho (Staff of Asahan Health Promotion Project)
- Mr. M. B. Manik (Sanitation Staff)

(4) Provincial Health Laboratory of Medan

- Dr. Sudiranto (Director of Provincial Health Laboratory)

(5) Regency Health Office of Asahan Regency

Jl. Singamangaraja 310, Kisaran

Telephone No. = 113

- Dr. Panjaitan SKM (Chief of Regency Health Office)
- Dr. Adil Syukri (Chief of Health Center, Lima Puluh District)
- Dr. Imran Nasution (Chief of Health Center, Air Putih District)
- Dr. Rustam Efendi (Chief of Health Center, Medang Deras District)

(6) Public Works of North Sumatra

Jl. Jati 39, Medan

Telephone No. = 23549

- Mr. Mulyono BAE (Project Manager of Environmental Sanitation in North Sumatra)

(7) Embassy of Japan

24, Jl. Thamrin, Jakarta

Telephone No. = 350742

- Mr. Kunikazu Teshima (First Secretary)

(8) Consulate of Japan, Medan

Jl. Suryo No. 12, Medan, North Sumatra

- Mr. Tadashi Masui (Consul)

(9) Japan International Cooperation Agency (JICA), Jakarta Office

c/o Embassy of Japan, 24 Jl. Thamrin, Jakarta

Telephone No. = 350061

- Mr. Moriya Miyamoto (Chief of Office)
- Mr. Akira Kojima (Assistant Resident Representative)

(10) Japanese Experts Team for Health Promotion Project

41 AA, Jl. Prof. HM Yamin SH, Medan, North Sumatra

Telephone No. = 23301, 23510

- Dr. Tsuguo Yanagibashi (Team Leader)
- Dr. Kazuo Tanaka (Entemologist)
- Dr. Norichika Kumazawa (Epidemiologist)
- Mr. Hiroshi Hashiura (Coordinator)

A-4. List of data collected

Following data have been collected by the team :

(1) General

- Report on Health Promotion Project in North Sumatra (Japanese Edition), JICA, August 1978
- Report of the Japanese Implementation Survey Team on Health Promotion Project in North Sumatra (Japanese Edition), JICA, Dec. 1977
- Clinically Suspected Cholera Cases in Kec. Lima Puluh, Kec. Air Putih and Kec. Medang Deras, 1979, by Dr. N.H. Kumazawa

(2) Topography, Geology and Hydrogeology

- Topographical maps, 1971, Scale= 1/50,000
- Topographical maps, 1975, Scale= 1/50,000, Directorat Geologi
- Topographical maps, 1976, Scale= 1/20,000, INALUM
- Geological map, Scale= 1/1,000,000, Directorat Geologi
- Rainfall Record: Jan. 1978 - Dec. 1978, Rubber factory in Tanjung Kasau village
- Weather Record: Dec. 1975 - May 1976, Tebing Tinggi, INALUM
- Boring logs: INALUM's Town site, Feb 1976
- Boring logs of deep wells: Belawan, 1950 - 1971
- Water quality test records: Well water at Tanjung Gading, INALUM, Aug. 1979
- Water quality test records: Groundwater at Smelter site, INALUM, 1976
- Water quality test records: Toba Lake, 1976
- Water quality test records: River water, Asahan Porsea and others, 1975 and 1976

(3) Population and Area

- Villages population in Kecamatan Medang Deras, 1979, Pangkalan Dodek Health Center
- Villages population in Kecamatan Air Putih, 1979, Camet Indorapura

- Villages population in Kecamatan Lima Puluh, 1976/1977, Lima Puluh Health Center
- Population and area of Desa Sei Buah Keras, 1979
- Population and area of Desa Medang, 1979
- Population and area of Desa Limau Sundai, 1979
- Population and area of Desa Tanjung Muda, 1979
- Population and area of Desa Purpuk, 1979
- Household survey, 1972, L. Ratna Pundarika and J. Sulianti Suroso

(4) Rural Water Supply

- The Rural Health Servicea and the Community Development in Indonesia, Ministry of Health, 1976
- National Survey on Community Water Supply and Excreta Disposal in 19,000 Villages in Indonesia, October 1976
- Draft Report on the Pre-Survey of Water Supply Facilities in North Sumatra, JICA Survey Team, August 1979
- Rural Water Supply in Indonesia since Pelita I.

(5) Well Drilling Contractor

- List of well drilling contractor in North Sumatra, DPU Provinsi Dati I, Sumatera Utara
- Well drilling contractors capability (Interview), Medang

(6) Costing

- Daftar Analisa: Untuk Pekerjaan Perlindungan Mata Air, Dinas Kesehatan Medan, October 1978
- Analisis BOW
- Quotation of Laboratory Construction in Indrapura Health Center
- Recent example of well drilling project, DPU Provinsi Dati I, Sumatera Utara

(7) Socio-Ecomomics

- Statistics of Kecamatan Air Putih, 1978/1979. Camat Indrapura

APPENDIX B : HYDROGEOLOGICAL STATUS OF THE PROJECT AREA

APPENDIX B : HYDROGEOLOGICAL STATUS OF THE PROJECT AREA

B-1. Summary of Hydrogeology

The Team carried out hydrogeological survey during the period of stay in the field, including field reconnaissance, detailed investigation of the existing wells, execution of geoelectric resistivity survey, water quality analysis, pumping test and collection/analysis of data and maps concerned.

The summary of findings on the hydrogeology in the project area is as follows:

(1) Most parts of the project area are of flat land below around 20 meters in ground height, and swamp spreads prevailingly on the lands of 10 meters or less in ground height, lying along rivers.

(2) Strata composing the project area are of the Quarternary clay/silt/sand and of their mixtures.

(3) Sand stratum which is expected to be a desirable aquifer, is widely distributed in the area with about 50 meters in thickness from the ground surface. This is considered first aquifer. At the coastal area, however, this aquifer is thinner or missing.

(4) In the depth of 50 - 200 meters, a stratum mainly composed of clay lies thickly. It gradually changes from clayey stratum to silty one or the mixtures of silt/sand/clay, from higher land toward coastal area.

(5) Within the above clayey stratum, there seems to exist silty stratum or the mixtures of clay/silt/sand. Being distinguished from the first aquifer, it might be considered second aquifer,

B-2 Geographical and Geological Characteristics of the Project Area

The project area is located at longitude 99°40' east and 3°20' north of Equator and in the low flat land facing Malacca Straits. The area belongs to Asahan Regency, North Sumatra Province.

According to the climatic classification by Köppen, this area is included in the climate area of tropical rain forest which is not clear in distinction of the dry season and the rainy season.

Most of the area is flat with an elevation less than 20 m and the average ground gradient is about 1/500. In the area there are many swamps along the rivers and in the land with an elevation less than 10 m, and they extend as far as the sea coast. Southern part of the project area is hilly rising gradually in elevation up to the mountain range of Sumatra.

There are a few rivers in the project area which originate in the hills and flow into the sea. As the land is extremely gently sloped, the rivers meander very widely and some of them have "raised bed river."

Regarding the land use in the project area, plantations of oil palm and rubber are developed in the hills, and paddy fields in the lowland with wide swampy areas left unused.

Land formation in the project area consists mostly of clay, silt or sand layers or its alternate layers. The geological map 1/1,000,000 tells that Alluvium in the project area extends from the sea coast to about 30 km inland. It is estimated that volcanic product (Rhyolite) from Volcanic Mount Toba underlies the Alluvium. The volcano was most active during the latter period of the Diluvial Age.

General topographical map of the Project area is shown in Fig. B-1.

although good permeability would not be much expected in the stratum according to the analysis of geoelectric resistivity survey. The second aquifer becomes thinner gradually at higher land.

(Note): - In the case of Indrapura area, the stratum is combined with the first aquifer and is not distinguishable.
- Continuity of the stratum toward coastal area is unknown.

(6) Further strata deeper than 200 meters are not well known because of the shortage of available technical data. However, according to the geoelectric resistivity survey, of high electrical resisitivity is presumed at depth of around 220 meters in Tanjung Muda, higher land. Moreover, at INALUM's Smelter Site, water is taken from depth of about 250 meters by a deep well.

The aboves seem to show the possibility of existence of the third aquifer.

(7) Existing wells scattered in the project area are classified as follows:

Type-1: Shallow wells with around 5 meters in depth

- Wells are shallower (2 - 3 meters) at lower land and deeper (5 - 6 meters) at higher land.
- Wells in higher land, dug in sand layer, have rather good quality.

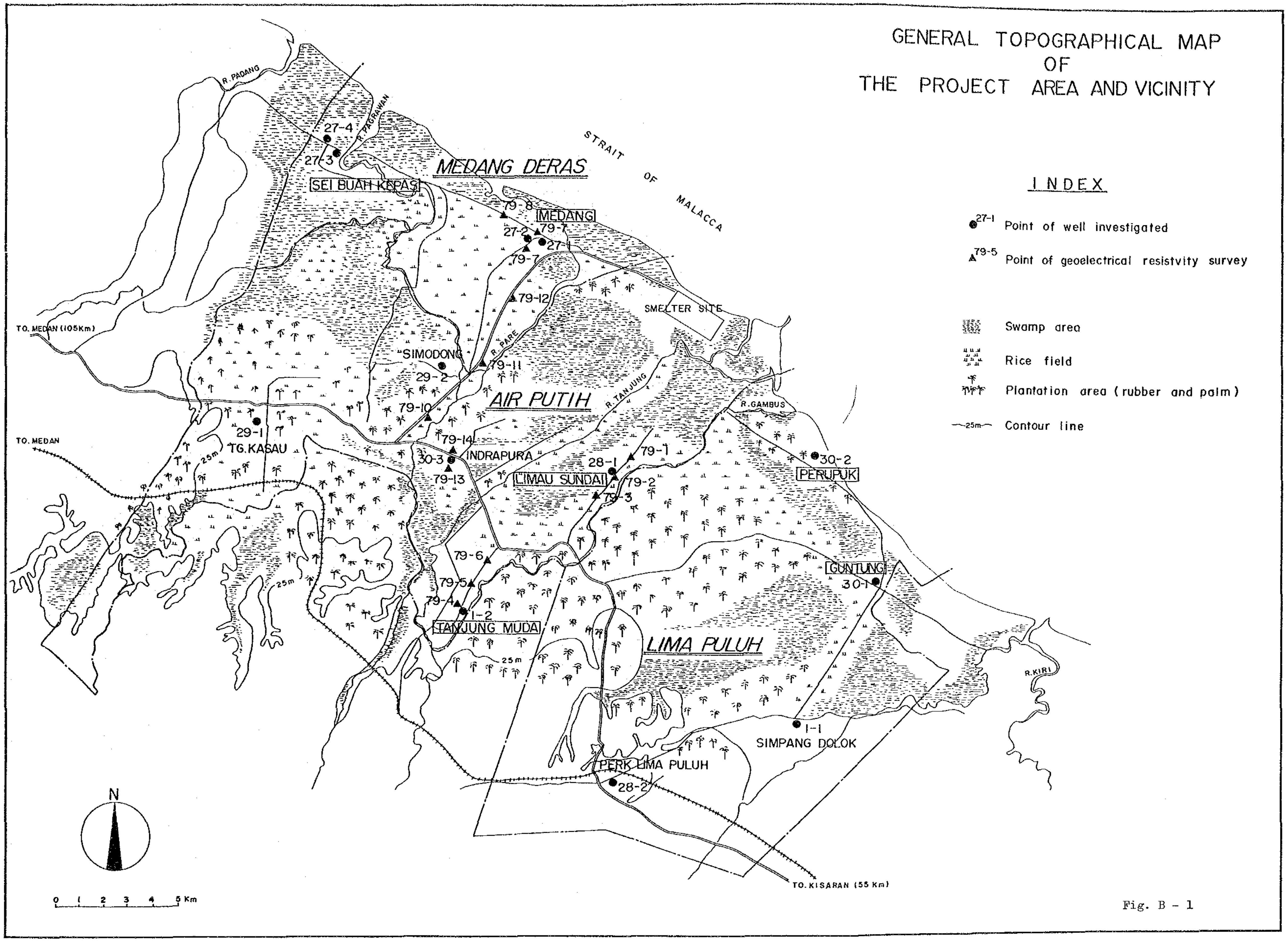

GENERAL TOPOGRAPHICAL MAP
OF
THE PROJECT AREA AND VICINITY
INDEX
27-1 Point of well investigated
79-5 Point of geoelectrical resistvity survey
Swamp area
Rice field
Plantation area (rubber and palm)
25m Contour line
STRAIT OF MALACCA
MEDANG DERAS
SEI BUAH KEPAS
MEDANG
SMELTER SITE
SIMODONG
AIR PUTIH
INDRAPURA
LIMAU SUNDAI
TG. KASAU
PERUPUK
GUNTUNG
TANJUNG MUDA
LIMA PULUH
SIMPANG DOLOK
PERK LIMA PULUH
TO. MEDAN (105Km)
TO. MEDAN
TO. KISARAN (55 Km)
N
0 1 2 3 4 5 Km

Fig. B - 1

Type-2: Deep Wells with depth of around 80 - 120 meters

- Wells in the coastal area, lowland, have positive pressure and water comes out of itself on the ground. Shallower wells present faint salty taste.
- Wells in higher land have not enough pressure of artesian flow and may require pumps for water drawing.

Type-3: Deep wells with depth of more than 200 meters

- Actual depth of the existing wells constructed in the Dutch age and depth of the aquifer are unknown , except a new well owned by INALUM Company.
- Wells have higher positive pressure showing 2 - 3 meters over the ground surface and have comparatively large production.
- Water has acceptable quality.
- Water temperature is fairly high: more than 40°C and 46°C at maximum.

(8) According to the study on the hydrogeology in the project area, ground water development would be planned in the following manner.

- For higher land (Southern part of the national highway): Semi-deep well with depth about 50 meters, drawing water from the first aquifer.
- For lower land (from coast up to about 4 km inland): Deep wells with depth about 200 meters, drawing water from the second aquifer. Some areas seem to require wells deeper than 200 meters.
- For the middle land (Between the national highway and the lower land): Combination of deep wells and semi-deep wells.

B-3 Existing Wells

a. Depth and Location

In the project area three types of well are currently used, namely, dug wells 2 to 6 m deep; driven wells, 1-1/4 inches (32 mm) in diameter and 80 to 120 m deep; and bored well, 4 inches (100 mm) in diameter and about 200 m deep. In the recent years some deep wells, about 250 m deep, have been developed for the use of factories.

Dug wells for the domestic use are found throughout the project area with a depth 5 to 6 m in the hilly area and 2 to 3 m in the lowland. To draw water from the well, a bucket or a well bucket is usually employed except some instances where hand pumps are installed.

Driven wells with a depth of 80 to 120 m have been developed in the coastal area, for the quality of the shallow well water is not suited for drinking and other domestic uses. Most of them are of artesian type. The yield has generally been declining as the time proceeds and some of the wells are equipped with a pump. Yield of each well is about 0.1 to 0.2 l/sec and the positive pressure is 0.5 to 0.6 m over the ground level.

There are three examples of deep wells, about 200 m deep and 4 inches (100 mm) in diameter, at Guntung, Simpan Dolok and Indrapura, all of which were constructed in the Dutch age. Although there is no reliable record of well depth, it may possibly be deeper than 200 m considering the high temperature of well water (46.3°C at Guntung). The positive pressure at the ground level is 1.7 to 2.7 m, fairly high, and the well at Guntung has an yield of 1.34 l/sec.

Deep wells at the Smelter Site for INALUM and Lima Puluh have a depth 247 m and 237 m respectively. There is a hard consolidated layer, according to the statement of the driller concerned, at 200 m depth, under which exists abundant groundwater. These wells have positive pressure. To increase the yield, submerged pumps are equipped to both wells.

Relationship between the well depth and well's physical chracteristics are shown in Fig. B-2.

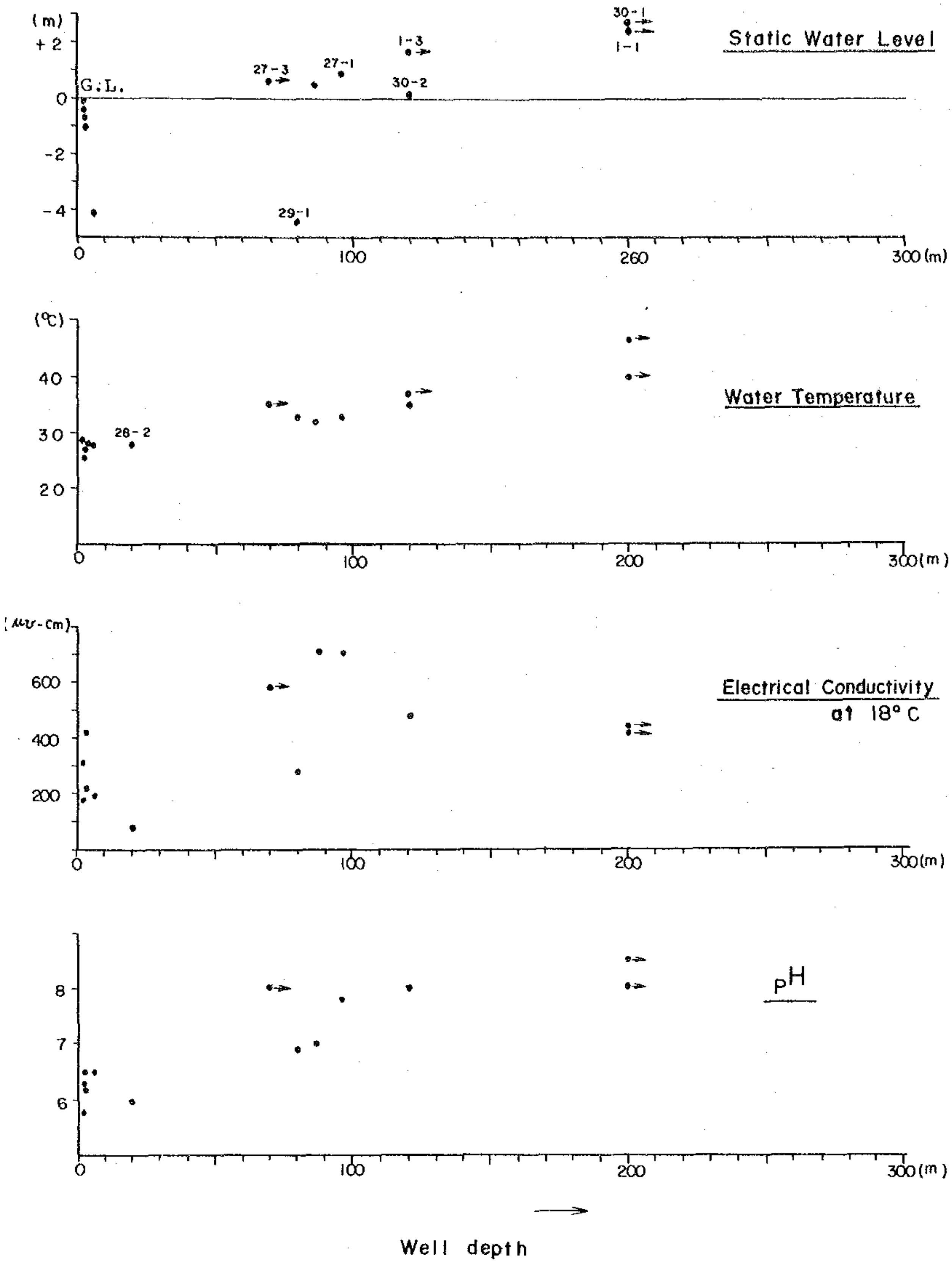


Fig. B-2 Relationship Between Well Depth and Characterislics

b. Water Quality

There is general belief among the inhabitants in the project area, that water of shallow wells contains turbidity, salt and iron, unsuitable for drinking, in the lowland, but that in the hilly area is generally good. Deep well water is potable even if containes little salt or iron concentrations. In order to ascertain whether or not it is correct and reliable, investigations have been carried out in the field. The findings are described in the following paragraphs and results of water analyses made by the Team and by the Laboratory at Medan are shown in Table C-1 and Table C-2.

As regards shallow well water, iron was not found except only one well at Limau Sundai, and chlorine ion concentration was all less than 100 mg/l. Further, $KMnO_4$ consumption, an index of organic contamination, was not singnificant. Bacteriological examination, however, revealed that shallow well water undergoes heavy contamination, and it is not suited for domestic use including drinking.

As to deep well water, all items of analysis are within values of acceptable range. Results of bacteriological test were also favorable except for stored water in the tank.

B-4 Storage Capacity of Ground Water

There are two types of aquifer in the project area, that is, 1) aquifer of free ground water and 2) confined aquifer. Shallow wells take water from the former type aquifer and deep wells from the latter type. These two acquifers can be distinguished by water pressure and quality.

There seems to be a hydrogeological boundary at the depth of about 200 m separating the confined aquifer into two aquifers. In this report, the free ground water aquifer will be termed as first aquifer, the confined aquifer down to 200 m depth as second aquifer and the aquifer deeper than 200 m as third aquifer.

The first aquifer was known to cover a very wide area and have a depth of about 50 m as a result of the present geoelectrical investigation. The boring data, which was made during the construction works of INALUM, say the first aquifer extends from the hilly area toward the sea coast, but according to the geoelectrical investigation the aquifer is not distinct in the coastal area. The geological formation changes from sand-rich gradually to silt-rich in the direction from the hills to the coast. The permeability of the soil decreases in the same manner. The lowland is covered at places with a clayey layer several meters deep.

Free ground water in the first aquifer in the lowland usually contains Cl-ion, Fe-ion and bacteria and is not suitable for drinking, but in the hilly area the quality of ground water is good. The reason for the above is presumed that in the lowland contaminated waste water is mixed with the ground water as the water table is almost flat with the ground surface, and in the hilly area the surface water infiltrates into the ground undergoing some filtration actions.

The second aquifer exists between 50 m and 200 m depth. In the project area this aquifer is not recognized in the hilly area and it is observed from Indrapura to the sea coast. However around Indrapura there is no distinct boundary between the first and second aquifers. Along the access road to INALUM and around Limau Sundai a clayey layer separate the two aquifers. It is estimated that the second aquifer sinks gradually toward the coast. In addition to this aquifer another aquifer is considered to exist between the first and second aquifers, because there are some artesian wells with a depth of 80 to 120 m. The second aquifer seems to be recharged at places not far away or the aquifer joins the first aquifer in the hilly area.

Ground water from the second aquifer has a good quality for drinking.

The third aquifer is estimated to exist at the depth of 200 m or more. As described previously, the aquifer is confined and has a rich yield. The aquifer appears to be recharged in the mountain slope in the hinterland.

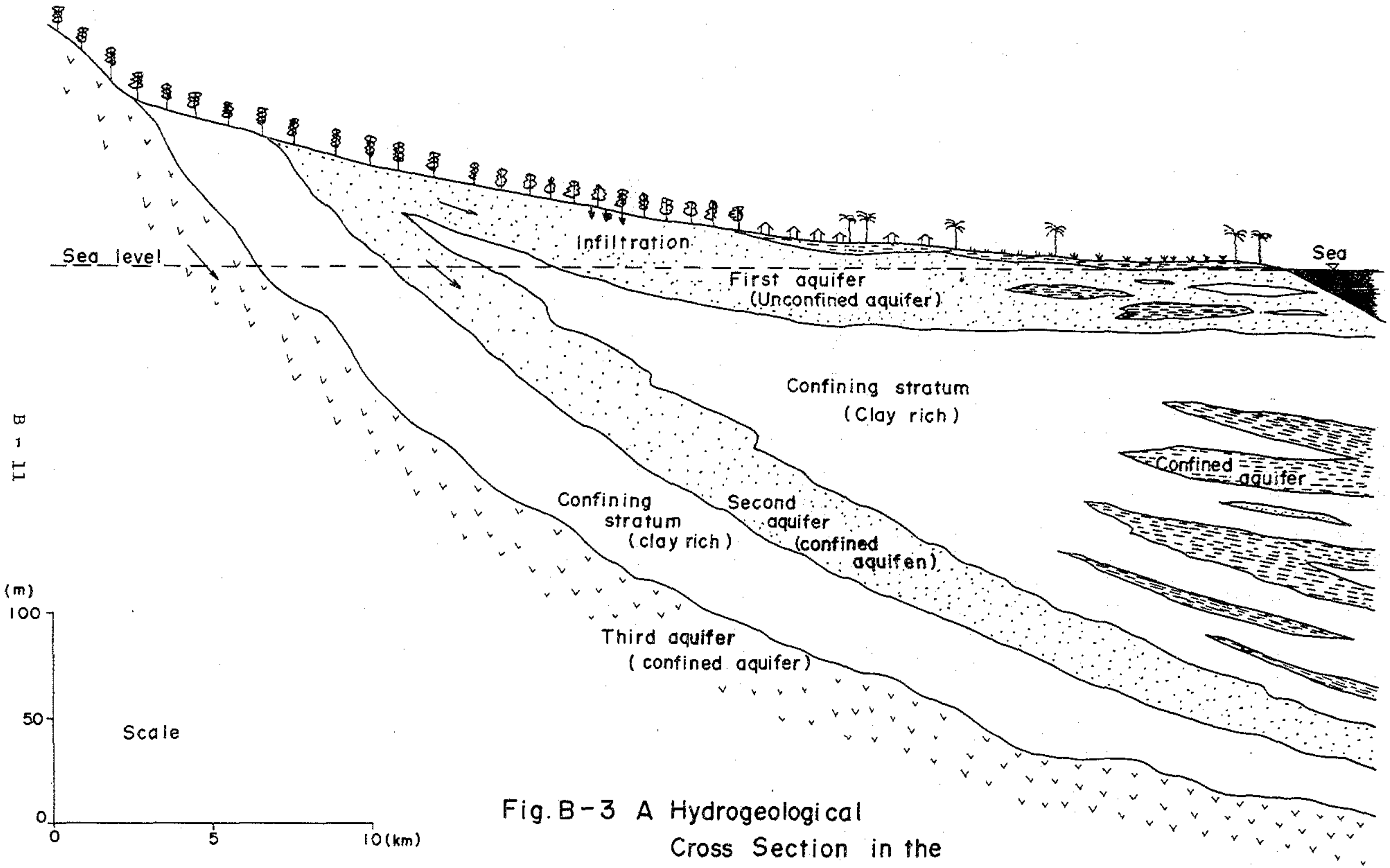


Fig. B-3 A Hydrogeological Cross Section in the Project Area

Fig. B-3 represents the presumed hydrogeological cross section in the project ares.

B-5 Quantity Study of Ground Water

When development of ground water is put into practice a quantity analysis of ground water shall be studied previously. To draw the ground water more than the recharged quantity in the concerning project area induces a over-consumption of the ground water, which results in such situations of drawdownning of the ground water table and salination of the ground water, and furthermore, a nuisance of ground sinking.

Sufficient data of hydrometeorology such as precipitations, flow records of the river, evapotranspirations, and further hydraulic factors of coefficient of permiability and storage coefficient of aquifer are required to analyze the availability of the ground water. Unfortunately, however, in this project area those data are almost nil then in this study the generally applied factors are adopted.

It is assumed that there are three independent aquifers in this area, therefore, the availability of ground water from those aquifers is tried to calculate for respective aquifers except for the third aquifer.

The first aquifer will be recharged of the almost of its quantity by the rainfall in the region concerned. Generally speaking, the quantity of recharge made by the rainfall is assumed as 1/3 - 1/5 of the presipitations, therefore, here in this study it is calculated as follows:

$$Q_1' = (1,688 \text{ mm } (1) + 1,820 \text{ mm } (2))/2 \times 1/5 = 351 \text{ mm/year}$$

where : [1] shows an average rainfall record of Tebing Tinggi from 1950 through 1973

[2] shows that of Kisaran from 1971 through 1973

The total amount of recharge in this region (Q_1) is obtained by multiplying Q_1' by the area as follows:

$$Q_1 = 351 \text{ mm/year} \times 30 \text{ km} \times 15 \text{ km}$$
$$= 157,950,000 \text{ m}^3\text{/year}$$
$$= 432,740 \text{ m}^3\text{/day}$$

From the above calculation the rechargeable rainfall into the first aquifer is assumed approximately as 430,000 m^3 per day. However, infiltration capacity in the wet land and the area of which surface is covered by clay is low, and the amount of recharge is lessened. It can be concluded, therefore, that the half of the recharge of the above figure is taken as the amount of recharge for the first aquifer.

The second aquifer is a confined aquifer and not directly influenced by the rainfall in the area. Darcy's law is adopted to assume the amount (Q_2) to be recharged into the second aquifer.

$$Q_2 = k \cdot I \cdot L \cdot D$$

Where k is the coefficient factor of water permiability, I is the hydraulic gradient, L is the width of the aquifer and D is the thickness of the aquifer. These factors are estimated as follows;

$$k = 2 \times 10^{-3} \text{ cm/sec}$$
$$I = 1/500$$
$$L = 30 \text{ km}$$
$$D = 50 \text{ m}$$

Using the above factors, the amount to be recharged in to the second aquifer is calculated as follows:

$$Q_2 = 2 \times 10^{-2} \text{ cm/sec} \times 10^{-2} \times 1/500 \times 30 \times 10^3 \text{ m} \times 50 \text{ m}$$
$$= 0.06 \text{ m}^3\text{/sec}$$
$$= 5,184 \text{ m}^3\text{/day}$$

The ground water possibly passing through the second aquifer is estimated about 5,000 m^3/day in the area.

Those factors used in the above calculation are based on the assumption, therefore, at this moment, the reliability is not high and these factors due modification according to the detailed informations/data in the future.

B-6 Ground Water Development

In the preceding section the rechargeable amount of ground water into the first aquifer and the second aquifer are estimated as approximately 20,000 m^3 per day and 5,000 m^3 per day respectively. The proposed amount of water to be developed is about 7,500 m^3 per day for this project and is possible to be drawn from the first and the second aquifer. For the time being, the development of ground water will be focused to the first and the second aquifer only.

Wells to draw water from the first aquifer with a depth of 50 meters will be equipped with a hand pump since the water from the first aquifer has no artesian flow but the free water. The distance between the neighboring wells can be put 50 meters to 100 meters since the water in the aquifer has free water and the drawing quantity is not much. Deep wells to draw water from the second aquifer will require the depth from 150 meters to 200 meters.

The second aquifer is the pressured (confined) aquifer, then, the distance between the neighboring wells shall be set more than 2 kilometers preferably to avoid the mutual interference. In most cases of the artesian wells the artesian flow is becoming to decrease its flow rate gradualy and finally stop it. To cope with such a circumstance, a hand pump will be applied later on to draw water from the non pressured aquifer.