D. 3. 2 Agricultural Development Plan

a) Agricultural Development Plan related to Palawan Province

In the "The Medium-Term Agricultural Development Plan", 1993 to 1998, the national government introduced the Key Production Area approach. The Key Production Area is composed of four (4) sub-areas, namely, Key Grains Production Area (KGPA), Key Livestock Development Area (KLDA), Key Fisheries Development Area (KFDA) and Key Commercial Crop Area (KCCA). Two of the programs, the KLDA and KCCA, are applied in Palawan province. As for the KLDA in Palawan province, it aims to breed and increase cattle production in the very near future. As for the KCCA in Palawan province, it aims to expand mango and cashew orchard by 8,000 ha each.

In the provincial "Medium Term Development Plan 1994-2000", paddy and corn fields for grains production and cashew, mango, coconut, banana, coffee, cacao and pineapple orchards for commercial crops production will be expanded. For livestock, it plans to increase the heads of cattle, carabao, goat, swine and poultry population.

Based on the Puerto Princesa City Land Use Plan (Jan. 1994), the whole city area is divided into eight (8) clusters, and development potentials are set for each cluster. For Cluster-7, where the Study Area is included, the development potential strategies are enhanced rice production and intensified tree crop production (mango, cashew, jackfruit, guyabano, etc.). The Study Area is classified as a suitable area for agricultural development.

As for mango, there is now a ban to transport the fruit outside of Palawan province. This is to prevent the expansion of the harmful insects, the pulp weevil, although the area mainly infected is only on the southern part of Palawan province. In Puerto Princesa City, there is a plan to construct a mango processing plant for dried mango, juice, and puree. When the plant is established, mango will be very promising as a commercial and agro-industrial crop. The city already has a distribution program of mango seedling. The PAES produce a lot of mango seedlings and loan them out for 20 pesos per tree to the farmer. The repayment starts after the trees bear fruits and the farmer gains profit from these fruits.

Cashew is one of the special products of Palawan province. Climate is suitable and production is the highest among all provinces. One of the merits of fruit production in Palawan province is the rarity of typhoon attack. Production of fruits is, therefore, stable.

b) Proposed Crops

As for the determination of the proposed crops, climate conditions, land slope, availability of irrigation water, farmers technique level, population and consumption projection and production trend were examined.

1) Climate Limitation

Climate factors like temperature, radiation, typhoon and rainfall have to be considered. In tropical zone areas, temperature is high thus not conducive to crops that would require cool conditions. Rain decreases radiation, and crops that would require lots of radiation for growth can not survive during the rainy season. Strong wind induced by typhoons causes fruit falling. All these climatic factors will affect agricultural production. In the Study Area, the average monthly rainfall from January to April is less than 50 mm. As a consequence, river discharge decreases up to May. From April to May, crops that would need irrigation water, therefore, would be avoided. Only crops requiring limited water for growth would be introduced for this period.

2) Land Slope Limitation

Land slope conditions relate to reclamation and top soil erosion. The Bureau of Soils and Water Management classifies five (5) land slope categories, as follows: (1) level to very gently sloping: 0 to 3%, (2) very gently sloping to gently sloping: 3 to 8%, (3) gently sloping to sloping: 8 to 15%, (4) steep: 15 to 18%, (5) severely steep: more than 18 %. Each category has a basic conception for land use as follows:

(1) Level to very gently sloping (0 to 3%)
Suitable for paddy unless other limitations exist.

(2) Very gently sloping to gently sloping (3 to 8%)
Suitable for upland field. Upland field is better than paddy, because reclamation for paddy costs more.

(3) Gently sloping to sloping (8 to 15%)
Environmental disaster like soil erosion may occur. Avoid large scale land development. Use for orchard and inter-crop with some vegetables.

(4) Steep (15 to 18%)
Use for timber forest and for fire wood forest with reforestation.

(5) Severely steep (more than 18%)
Preserve for protected forest. Development may invite serious environmental disaster like soil erosion, land slide. Thus there is a need to preserve the forest, ban logging and reforestation of areas with no vegetative cover.

3) Availability of Irrigation Water

The availability of irrigation water will determine the crops to be introduced. In areas where water is not available during dry season like the Study Area, the availability of irrigation water becomes a vital factor in deciding the crops to be introduced. For areas with no irrigation water, the introduction of drought tolerant crops is suitable.

4) Farmer's Technique Level

Farmer's agricultural technical know-how and extension level in the area influence the type of crops to be introduced. Studies show that farmer's technique level on farming in the Study Area is not high. Introduction, therefore, of crops which require special farm techniques should be avoided at the present.

5) Population and Consumption Projection

The annual population growth rate of 3.58% of Palawan province from 1980 to 1990 is considered high due to in-migration from other

provinces. At the same period, the annual growth rates of the nation and the region are 2.35% and 3.04%, respectively. Annual growth rates, however, are less than the data of the previous ten (10) years (1970-1980) period, especially in Palawan province, the decrease is much bigger than that of the national and provincial data. This fact shows that in-migration from other provinces to Palawan started to slow down in recent years as compared with the 1970's. (refer to Table D.3.3).

The Provincial Planning and Development Office of Palawan province estimated the population projection from 1990 to 2000. They estimate that in-migration to Palawan province will continue for the next decade at 3.58% rate, which is the annual growth rate from 1980 to 1990. For projections from 1990 to 2000, it will be a little bit too high to apply the same rate (3.58%), because the annual growth rate though increasing, has decreased during the past decade. On the other hand, the annual growth rate of Region IV population projection gradually decreases year by year. So the population projection using the 3.58% is a safe projection. When the same annual growth rate is adopted, population of Palawan province will be 895,000. The food consumption is expected to increase in accordance with population increase. (refer to Table D.3.4)

In 1987, daily food consumption per capita is 869 grams, which consists of 659 grams originating from vegetables and 210 grams originating from animals. The consumption of rice which is the most important staple food is 303 grams per capita per day. It is equivalent to 110.6 kilograms of rice as annual consumption per capita. The whole rice consumption will be about 83,000 tons in 2005, converted to about 127,800 tons of palay. (refer to Table D.3.2)

6) Other Considerations

In the recent years, production of palay in Palawan province is relatively stable, so palay is transported from Palawan to other provinces. The annual production for these periods ranged from 70,000 to 100,000 tons. Hence, if palay production will stagnate, deficiency of palay will occur. For this situation, it is possible to meet

palay demand with only a paddy field area of 47,000 ha, if the present yield of palay in Palawan province (average in 1992: 1.94 ton/ha) lifts up to the national average yield (average in 1989: 2.7 ton/ha) through intensified extension and guidance. In 1992, there were 46,200 ha of paddy field including 15,790 ha of irrigated paddy in the province. If the yield would be improved, expansion of paddy field would no longer be necessary. (refer to Table D.3.5)

On the other hand, vegetables are imported from other provinces because of the limited supply. However, for the past years, the provincial production of tomato and eggplant increased every year by 10 to 20%, depending on consumption growth. Also, the growth of mungo bean production had increased during the same years.

The agricultural development plan of the nation and the province tend to emphasize the production of paddy and fruits. However, there is still no possibility that the province will meet the demand on vegetable. It is important that vegetable production be developed to meet the demand not only of the Study Area but also of the whole province due to high population growth rate.

7) Proposed Crops

In addition, production trend and other related data which include price trend and planting period, etc. are to be considered in determining the proposed crops. Among these crops, it is indispensable to intensify extension and guidance activities on vegetable production. Farming technologies for the proposed crop are show as the specific technology package. (refer to Table D.3.12)

Paddy:

To acquire and maintain self-sufficiency in rice , paddy will be planted during the wet season in irrigated areas. Price of paddy is stable and cultivation can easily be introduced to the farmers. The farming operation techniques are already established, and paddy has already been adopted in the plan by the city and provincial government.

Beans:

Beans like mungo bean and peanut can contribute to the maintenance of nitrogen in soil through the rhizobium action. In recent years, mungo bean production has increased. Duration of mungo bean cultivation is short and harvest is moderate even on poor soil, which is very suitable for double cropping. Mungo bean can be stored at longer duration after drying.

Corn:

Corn is the largest planted crop in Palawan province, most especially at the southern part of the island, at Brook's Point, Narra and Aborlan. The farm techniques for corn is already established, and it would be easy for the farmers to accept the technology. The extension worker is also familiar with corn technology. Furthermore, in the provincial and city development plans, corn production is encouraged. The demand for animal feeds is also increasing, and it is expected that feed demand shall be self sustaining.

Tomato:

The production of tomato in Palawan province increased from 10 to 20% annually in the recent years. Consumption of said product is also expected to increase in the future. Cultivation of tomato during the dry season is recommended because of lower disease probability.

Watermelon:

It is possible to grow watermelon throughout the year. Production increased in recent years and the demand is constant.

Taro (Gabi):

Cultivation is suitable during the wet season because it can grow under high humid condition and is shade tolerant. At Region IV level, the price has a tendency to rise.

Eggplant:

This crop is a perennial crop but economic plantation period is one (1) year. It can be cultivated throughout the year. Production increased in the recent years with also an increase in demand.

Squash:

Cultivation during the wet season is possible. The price in Region IV is increasing. In Aborlan and Narra, squash is planted, hence, there will be less problem to the extension of farming techniques.

Cashew:

It is one of the special products of Palawan province. In the national, provincial and city plans, cashew production is encouraged. If quality is improved, the fruit can become one of the most promising commercial crop and export of the province.

Mango:

Mango production is also included in the national, provincial and city plans. The price of mango has a tendency to increase. There are already seedling distribution programs of the city and the experimental station located in the city. It is therefore easy for the farmers to adopt the program and technology for mango production.

In the future, after the farmers have obtained the required farm and production management techniques, it will be possible to introduce other cash crops, such as the leafy vegetables, that need higher technology.

c) Proposed Cropping Pattern

1) Cropping Types

Generally, the cropping types are divided into following three types according to the main crops.

Type A: Cropping type based on paddy
Type B: Cropping type based on upland crops
Type C: Cropping type based on fruits trees

Type A is suitable for flat areas (0 to 3 %), Type B for gently sloping areas (3 to 8 %) and Type C for sloping area (8 to 15 %). Each type is further classified into two sub-types, based on the availability of irrigation water. (For example, even flat area where it is higher than the irrigation facilities belongs to non-irrigated area.)

Type A: Cropping type based on paddy (Irrigated)
Type A': Cropping type based on paddy (Non-irrigated)
Type B: Cropping type based on upland crops (Irrigated)
Type B': Cropping type based on upland crops (Non-irrigated)
Type C: Cropping type based on fruits trees (Irrigated)
Type C': Cropping type based on fruits trees (Non-irrigated)

Present vegetation of undulating area with more than 15 % slope should be maintained and preserved. If and when areas with more than 15% slope are already utilized for some purposes by farmers, land conservation technique such as contour farming techniques should be introduced to avoid devastation and soil erosion.

The largest area in the Study Area is 0 to 3%, which forms 35% of the total area. Second largest is more than 15%, which constitutes 24% of the total followed by 8 to 15% (forms 21%) slope. Judging only on the slope factor, 730 ha area is possible for Type A cropping pattern, 420 ha area is possible for Type B cropping pattern, 440 ha area is possible for Type C cropping pattern, and 490 ha area is basically for preservation area. (refer to Table D.3.6)

2) Proposed Cropping Pattern

Basically, irrigation facilities development for sloping area (8 to 15 %) is not introduced, because the system will become more complex and costly, hence, O/M labor and cost will increase. Therefore, the introduction of irrigation facilities is only for areas, where the slope is less than 8 %. To determine cropping period, the result of water balance study is considered.

Considering the site and elevation of water source and the canal alignment, about 430 ha flat area, which is 59 of the 0 to 3% slope area,

will be suitable for irrigated paddy. Of the 3 to 8% sloping area, 160 ha can be irrigated. The total irrigated area is 590 ha. Taking into account the distribution and hilly topography, the total upland crops area without irrigation is summed up to 265 ha, and the area for fruit trees is 271 ha.

Ideally, the ultimate cropping pattern for farmers is 200% cropping intensity. But for this pattern to be achieved, the facility condition for irrigation, post-harvest, etc. should be available. In the Study Area, the water resources available for development is hydrologically limited. Therefore, the actual cropping intensity is limited to 130%.

For areas with a slope of 0 to 3%, irrigated paddy is introduced during the wet season. Paddy is proposed to be cultivated only during the wet season, because supply of rice is already sufficient in Palawan province in the recent years. Hence, there is no urgent need to expand paddy field, specially if yield is improved through extension activities.

For upland areas with a slope of 3 to 8%, vegetables and beans are proposed to be introduced during the wet season. In the slope area ranging from 0 to 8 % without irrigation system, wet season crops like grains, beans, eggplant and root crops are proposed. At the end of wet season, from November to December, beans like mung bean and peanut can be planted.

For areas with slope of 8 to 15%, cashew and mango are proposed considering land condition. In fruit garden, inter-cropping shall be introduced to use farm land efficiently and to increase farm incomes. (refer to Table D.3.7 and Figure D.3.9 and D.3.10)

3) Farm Labor Requirement

Initially, the farm labor balance in the Study Area was roughly investigated. Based on the cropping pattern, the farm labor requirement for each month was calculated. The month of June requires the most labor demand with 23,808 man-day. (refer to Table D.3.8)

On the other hand, the farm labor was calculated based on the settlement plan for Tagumpay Settlement. According to the plan, the total beneficiary family is 332 families for Tagumpay Settlement (1,066 ha). The total beneficial families of the Study Area (2,069 ha) is estimated to be about 472 families. (The remaining area will be distributed to only about 140 farmers, because some areas shall be preserved / conserved.) The average farm labor is 2.1 persons, so the total farm labor in the Study Area is estimated to be 991 man-day ($472 \times 2.1 = 991.2$). The most demand month for farm labor (June) requires 23,808 man-day. Thus the farm labor in the Study Area can meet the total labor requirement, since the calculated required period (24.0 days) is less than 30 days. ($23,808 \div 991.2 = 24.0$ days)

In terms of private farm labor management, land preparation and harvesting of paddy, which require the most number of labor for farm operations, was analyzed. The result shows, that even with 30 days working period, these two operations will limit the areas the farmer can manage to only less than 2.5 or 2.6 ha due to labor shortage. Therefore, hired labor will be necessary to manage a paddy field of more than 2.5 ha or to cultivate other crops with different cropping calendar aside from paddy. (refer to Table D.3.9)

The distributed area to the farmer beneficiaries ranges from 3 to 6 ha. Based on this figure, a family finds difficulty in managing his land, especially if the distributed farmland is almost flat and suitable for paddy. For the management of these lands, cooperative farming and/or joint operations will solve the labor shortage. However, when the system of joint operation is not established, it is desirable to employ hired labor. In Tagumpay Area, the farmers, who were given non-arable land such as hilly topography, waterways, high elevation, could serve as hired labor. To utilize land resource at the maximum level, an effective land use system through the assistance of the official agencies who can guide and advise the farmers must be established.

d) Agricultural Production

1) Cultivated Area

Based on the topo-map prepared by JICA, the potential arable land in the Study Area is estimated to be 1,125 ha with slope ranging from 0 to 15% excluding the northern and western hilly areas. Of these area, about 525 ha has slope ranging from 0 to 3%. Taking into account the irrigation facility plan, land condition, etc., 430 ha area with elevation below 40 m are suitable for irrigated paddy during the wet season (Type A). For dry season crops, beans of 215 ha, corn of 129 ha, tomato of 43 ha and watermelon of 43 ha are recommended with the aim to increase farm income through higher land productivity. For the area of 160 ha which is below 40 m elevation and with slope ranging from 3 to 8% and where irrigation water is available, double cropping of vegetables and beans is planned (Type B). (refer to Figure D.3.9 and D.3.10)

For the area of 265 ha with elevation above 40 m, with slope ranging from 0 to 8 % and without irrigation facility, upland farming is proposed even during the wet season (Type A', B'). This area (265 ha) consists of 95 ha of grains, 50 ha of beans, 80 ha of vegetables represented by eggplant, etc. and 40 ha of root crops.

The area with slope ranging from 8 to 15 % is about 270 ha. Even if some of the areas are below 40 m elevation, they are excluded from the irrigation service areas (Type C,C'). From the viewpoint of land conservation, cashew and mango orchard with some inter-cropping is planned for this area.

2) Target Yield and Production

For the above-mentioned crops, target yield will be determined based on the national and provincial plans, the yield trend of Region IV and Palawan province. Production is also calculated based on the yield and the area. (refer to Table D.3.10 and D.3.11)

e) Marketing and Credit

Most grains, which are harvested from the Study Area and relying on rainfall, are consumed within the area. Only a few are sold. After completion of agricultural facilities and institutional development through intensive extension and training, agricultural production will considerably increase. Consequently, the products, except for home consumption, which can be sold will increase.

To sell the agricultural products remuneratively in the market, good quality products and establishing the cooperative is important. For good quality products not only before harvesting, cultivation management, but also after harvesting, post harvest process are important. For example, the farmgate price of paddy depends on the moisture content and it differs from three to six pesos per kilogram. Therefore it is important for farmers to maintain the moisture content around 14%, because it induces more income.

In terms of selling products in the market, transportation is necessary. For the Study Area, the main market is Puerto Princesa City. At present, some farmers bring their agricultural products by jeepney at a fairly high charge, i. e., 20 to 25 pesos per 50 kg/bag. So to save from such high cost, transportation of products can be done by farmers themselves or can manage their own transportation vehicle, through the cooperative.

Most of the farmers in the Study Area do not have enough capital to buy agricultural inputs. However in order to obtain credit from local or public banks, some kind of bank deposit or cooperative guarantee is required. So the farmers who could not obtain credit from banks are forced to borrow money from traders, relatives, neighbors and wholesalers at higher interest rates. For the agricultural growth in the Study Area, a new institution or composite institutional groups, that can extend credit under more lenient condition, are necessary.

D. 3. 3 Agricultural Facilities Development Plan

a) Post-Harvest Facility

In the future, the harvest from the Study Area will increase. Specifically, paddy which has the largest area of all proposed crops is expected to expand immediately. The facilities for paddy development are therefore proposed initially.

At present, there is only one solar dryer in the Study Area, which is merely 70 sq.m. The insufficient drying paddy induces lower quality and lower selling price. As a result of the studies for drying method and quantity of facilities, solar dryer is suitable and economical for the Study Area. The number of other facilities, required in the Study Area, such as rice thresher, rice mill unit, etc. is determined based on the expected production. (refer to Table D.3.10 and Figure D.3.11)

Proposed Post-Harvest Facilities

Description	Unit	Total	With*1 Priority	Remark
1 Warehouse	house	3	1	350 m^2
2 Motor Pool	house	1	1	350 m^2
3 Solar Dryer	yard	3	1	600 m^2
4 Rice Thresher	unit	6	2	1 ton/hr
5 Rice Mill Unit	unit	2	1	0.5 ton/hr
6 Mechanical Dryer	unit	1	1	2.4 ton capacity
7 Transportation Vehicle	unit	10	3	4 ton diesel
8 Potable Conveyer	unit	3	1	8.5 m length
9 Hand Tractor	unit	10	3	diesel engine tiller
10 Trailer	unit	10	3	0.5 ton loading
11 Others	L. S.	1	1	moisture meter calculator etc.

Note: *1 The figures are included in total.

To operate and maintain the above-mentioned facilities, a farmers organization should be established and organized to manage post harvest facilities. The farmer's organization shall be organized prior to implementation

and will be assisted by DAR and other agencies concerned. (refer to Appendix J.2)

b) Inland Fishery Development

After the construction of water resource facility, the water surface of 29 ha will be developed. (At stage I, the water surface of 8 ha will be developed.) Utilizing this storage water, fish farming of tilapia, mud fish and fresh water crab is possible, so the farmers can get supplement income by selling fish/crab. And operation and maintenance of water resource facility will be done by the fishery involved farmers at regular intervals.

The cooperative shall purchase the necessary inputs such as farming nets and fingerling. ATI has a fisherman's training center, hence the farmers will be able to get technical support and guidance from the center.

c) Possibility of Agro-Industry

Based on the agricultural development plan, following utilization and processing are possible.

Tomato	:	canning (whole tomato, tomato juice, tomato puree, tomato paste, tomato catchup), dehydrating
Corn	:	canning (whole corn, cream style corn)
Eggplant	:	canning
Mung bean	:	bean paste, bean noodle, bean sprouts
Cashew (shell)	:	oil extraction
Cashew (apple)	:	livestock feed, juice, candy, wine, syrup, jam, preserve
Mango	:	mango juice, mango puree, mango preserve, dried mango

Of the above , mango and cashew processing has most possibility of being implemented, because both are adopted in the national and provincial agricultural plan. Moreover, the provincial government has already a plan to establish a mango processing plant.

Table D.3.1 Present Farm Land of the Study Area

as of Sept., 1994

Land Categories	Land Use	Study Area (ha)		Ratio to Total (%)		Remarks
		Wet Season	Dry Season	Wet Season	Dry Season	
Farm	Paddy F.	48.2	48.2	2.5	2.5	
Land	Upland P.F.	74.8	0.0	3.9	0.0	
	Upland F.	296.0	9.6	15.3	0.5	
	Coconut	14.3	14.3	0.8	0.8	
	Cashewnut	8.4	8.4	0.4	0.4	
Total		441.7	80.5	22.9	4.2	

Source: Measuring of 1/4,000 topo-map.
The air photographs were taken in February, 1994.

Table D.3.2 Per Capita Daily Food Consumption by Food Group (1987)

Food Group	Food consumption (AP,grams)_/1
Grand Total	869
I.Vegetable Origin	659
1.Cereals	345
a.Rice and products	303
b.Corn and products	24
c.Cereal products	18
2.Roots and tubers	22
3.Sugar and Syrups	24
4.Pulses and nuts	10
5.Vegetables	111
6.Fruits	107
7.Fats and Oils	14
8.Miscellaneous	26
II.Animal Origin	210
1.Meat and Poultry prods.	46
2.Fish and products	111
3.Milk and products	43
4.Eggs	10

1_/Intake of edible portion converted to A.P.(As Purchased) obtained from the table of mean one-day Capita Food Intake in the Philippines, 1987 released by the Food and Nutrition Research Institute as of May 1989.

Source:1987-1989 Food Balance Sheet of the Philippines, NSCB

Table D.3.3 Population Enumerated in Various Censuses
(1970 to 1990)

Region/Province	1970	1975	1980	(1988)	1990
Philippines	36,684,486	-	42,070,660	-	60,684,887
(Ratio)	-	-	114.7%	-	144.2%
(Annual Growth Rate)	-	-	2.71%	-	2.35%
Region IV	4,458,008	5,214,143	6,118,620	-	8,259,794
(Ratio)	-	117.0%	117.3%	-	135.0%
(Annual Growth Rate)	-	3.18%	3.25%	-	3.04%
Palawan	236,635	300,065	371,782	471,058	528,287
(Ratio)	-	126.8%	123.9%	-	142.1%
(Annual Growth Rate)	-	4.86%	4.38%	-	3.58%
Puerto Princesa City	37,774	45,709	60,234	82,058	92,147
(Ratio)	-	121.0%	131.8%	-	153.0%
(Annual Growth Rate)	-	3.89%	5.67%	-	4.34%

Source: Statistical Yearbook 1992, NSCB
1990 Census of Population and Housing, NCSO

Table D.3.4 Population Projection of Region IV and Palawan
(1991 - 2000)

Year	Population Projection		Annual Growth Rate (%)	
	Region IV	Palawan	Region IV	Palawan
1991	-	547,200	-	-
1992	-	566,789	-	3.58
1993	8,990,000	587,080	-	3.58
1994	9,240,000	608,098	2.79	3.58
1995	9,490,000	629,868	2.71	3.58
1996	9,740,000	652,417	2.63	3.58
1997	9,990,000	675,774	2.56	3.58
1998	10,240,000	699,966	2.48	3.58
1999	-	725,025	-	3.58
2000	-	750,981	-	3.58

Source: Southern Tagalog Regional Development Plan,
1993-1998, Regional Development Council
Palawan Facts and Figures, PPDO

Table D.3.5 Estimated Yield and Production of Paddy and Corn
(Paddy 1984 to 1992, Corn 1981 to 1989)

Item	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Palay										
Area Harvested(ha)	31,460	32,880	33,050	34,530	34,780	39,190	33,530	44,820	46,200	-
Irrigated	13,120	15,290	13,300	11,290	10,740	9,370	10,120	15,540	15,790	-
Rainfed	18,340	17,590	19,750	23,240	24,040	29,820	23,410	29,280	30,410	-
Production(M.T.)	51,468	58,324	68,808	66,338	69,957	73,333	71,696	102,232	89,640	-
Irrigated	25,059	34,402	34,048	28,225	26,205	28,389	26,514	38,695	30,948	-
Rainfed	26,409	23,922	34,760	38,113	43,752	44,944	45,181	63,538	58,691	-
Yield(M.T./ha)	1.64	1.77	2.08	1.92	2.01	1.87	2.14	2.28	1.94	1.97
Irrigated	1.91	2.25	2.56	2.50	2.44	2.70	2.62	2.49	1.96	2.38
Rainfed	1.44	1.36	1.76	1.64	1.82	1.80	1.93	2.17	1.93	1.76
Item	1981	1982	1983	1984	1985	1986	1987	1988	1989	Average
Corn										
Area Harvested(ha)	8,170	9,330	12,890	12,080	12,480	13,320	13,720	12,680	12,700	-
White	5,670	660	0	450	10	0	20	0	0	-
Yellow	2,500	8,670	12,890	11,630	12,470	13,320	13,700	12,680	12,700	-
Production(M.T.)	10,846	11,960	19,463	16,493	22,825	23,176	22,204	21,302	21,336	-
White	7,371	950	0	328	5	0	10	0	0	-
Yellow	3,475	11,010	19,463	16,165	22,820	23,176	22,194	21,302	21,336	-
Yield(M.T./ha)	1.33	1.28	1.51	1.37	1.83	1.74	1.62	1.68	1.68	1.58
White	1.30	1.44	0.00	0.73	0.50	0.00	0.50	0.00	0.00	1.27
Yellow	1.39	1.27	1.51	1.39	1.83	1.74	1.62	1.68	1.68	1.60

Source: BAS, Palawan

Table D.3.6 Land Slope Classification
(in the Study Area)

Slope(%)	Area(ha)	Distribution(%)	Remark
0-3	733	35.1	Class-I
3-8	419	20.1	Class-II
8-15	439	21.0	Class-III
15-	495	23.7	
Total	2,086	100.0	

Source: Measuring of 1/4,000 topo-map.

Table D.3.7 Proposed Cropping Pattern

Condition	Slope	Wet Season	Dry Season
With Irrigation Facilities	Class-I	Irrigated Paddy	Corn
	Class-II	Beans(Mungo,Peanut etc.) Squash(Ampalaya etc.)	Beans(Mungo,Peanut etc.) Tomato(Okra etc.) Watermelon(Cucumber etc.) Eggplant(Bell Pepper etc.)
Without Irrigation Facilities	Class-I	Grains(Corn,Rainfed and Upland Paddy etc.)	Beans(Mungo,Peanut etc.)
	Class-II	Beans(Mungo,Peanut etc.) Eggplant(Cucumber, Ampalaya,Upo etc.) Root Crops(Taro,Camote Ubi etc.)	
	Class-III	Cashew+Intercropping Mango+Intercropping	Cashew Mango

Note:Class-I:0-3%, Class-II:3-8%, Class-III:8-15%

Table D.3.9 Private Labor Requirement
(on Paddy Cultivation)

Family Labor : 2.1 person/family

Working Period : 30 days

(1)Land Preparation

Labor Requirement per One Hectare

Farm Operation	MD	MAD
Seedbed Preparation	0.0	0.4
Land Preparation	2.0	23.2
Plowing	0.0	7.6
Harrowing	0.0	13.6
Repair of Dike/Buds	0.0	2.0
Subtotal	2.0	23.6

Available Area (ha)

2.1 x 30 / (2.0+23.6) = 2.5

(2)Harvesting

Labor Requirement per One Hectare

Farm Operation	MD	MAD
Harvesting etc.	23.8	0.3
Harvesting/Threshing	22.2	0.0
Drying	1.3	0.0
Hauling	0.3	0.0
Subtotal	23.8	0.3

Available Area (ha)

2.1 x 30 / (23.8+0.3) = 2.6

Source:Farming Systems Research Project in Palawan, PIADPO

Table D.3.8 Total Farm Labor Requirement

CROP INTENSITY : 200%

LABOR REQUIREMENT PER HECTARE(man-day)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Gross Area(ha)
Wet Season Cropping						22.0	13.5	2.5	2.0	10.0	11.0		61.0	430.0
Paddy						27.0	6.0	6.0	22.0				61.0	130.0
Beans(mungo)						85.0	44.0	208.0	44.0	17.5	17.5		416.0	80.0
Vegetable(eggplant)					9.0	20.6	15.0	4.0	10.6	13.2	7.3		79.7	95.0
Grains(corn)						22.5	37.5	29.0	29.0	7.0			125.0	80.0
Vegetable(squash)						34.0	5.0	3.0	10.5	10.5			63.0	40.0
Vegetable(taro)														
Dry Season Cropping												24.0	102.3	43.0
Vegetable(tomato)	29.3	15.0	18.0	16.0								23.6	79.7	129.0
Grains(corn)	24.0	5.0	13.2	13.9							13.5	16.5	61.0	215.0
Beans I (mungo)	6.0	13.0	7.0	5.0							45.0	42.0	157.0	43.0
Vegetable(watermelon)	14.0	13.0	21.5	21.5							85.0	44.0	208.0	80.0
Vegetable(eggplant)	44.0	17.5	17.5								13.5	19.5	61.0	345.0
Beans II (mungo)	6.0	11.0	11.0											
Fruit trees														
Cashew	4.0	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	52.0	188.9
Mango	9.0	9.0	9.0	9.0	10.0	10.0	12.0	12.0	12.0	9.0	9.0	9.0	119.0	82.1

TOTAL LABOR REQUIREMENT IN THE STUDY AREA(man-day)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Net Area*(ha)
Wet Season Cropping						8,514.0	5,224.5	967.5	774.0	3,870.0	4,257.0		23,607.0	387.0
Paddy						3,159.0	702.0	702.0	2,574.0				7,137.0	117.0
Beans(mungo)						6,120.0	3,168.0	14,976.0	3,168.0	1,260.0	1,260.0		29,952.0	72.0
Vegetable(eggplant)					769.5	1,761.3	1,282.5	342.0	906.3	1,128.6	624.2		6,814.4	85.5
Grains(corn)						1,620.0	2,700.0	2,088.0	2,088.0	504.0			9,000.0	72.0
Vegetable(squash)						1,224.0	180.0	108.0	378.0	378.0			2,268.0	36.0
Vegetable(taro)														
Dry Season Cropping												928.8	3,959.0	38.7
Vegetable(tomato)	1,133.9	580.5	696.6	619.2								2,740.0	9,253.2	116.1
Grains(corn)	2,786.4	580.5	1,532.5	1,613.8							2,612.3	3,192.8	11,803.5	193.5
Beans I (mungo)	1,161.0	2,515.5	1,354.5	967.5							1,741.5	1,625.4	6,075.9	38.7
Vegetable(watermelon)	541.8	503.1	832.1	832.1							6,120.0	3,168.0	14,976.0	72.0
Vegetable(eggplant)	3,168.0	1,260.0	1,260.0								4,191.8	6,054.8	18,940.5	310.5
Beans II (mungo)	1,863.0	3,415.5	3,415.5											
Fruit trees														
Cashew	680.0	850.1	850.1	850.1	850.1	680.0	680.0	680.0	680.0	680.0	680.0	680.0	8,840.5	170.0
Mango	665.0	665.0	665.0	665.0	738.9	738.9	886.7	886.7	886.7	665.0	665.0	665.0	8,792.9	73.9
Total(A)	11,990.6	10,361.7	10,597.8	5,539.1	2,349.0	23,807.7	14,812.2	20,738.7	11,443.5	8,477.1	22,143.2	19,046.2	161,419.9	1,782.9
FARM LABOR IN THE STUDY AREA(B)	991.2	991.2	991.2	991.2	991.2	991.2	991.2	991.2	991.2	991.2	991.2	991.2	-	-
REQUIRED DAYS(C=A/B)	12.1	10.5	10.7	5.6	2.4	24.0	14.9	20.9	11.5	8.6	22.3	19.2	-	-

Note:*10% is used for unusable land percentage.

Table D.3.10 Proposed Yield and Production
(Cropping Intensity 200 %)

Crop	Basic Data (ton/ha)	Target Yield (ton/ha)	Area (ha)	Production (ton)
Paddy Irrigated	National Target 5.0			
	-Grains Production Enhancement Program			
	Provincial Target 6.0			
	-Medium Term Development Plan 1994-2000			
	Average Yield of Southern Tagalog Region			
	1982 1983 1984 1985 1986 1987 1988 1989 1990			
	2.86 2.74 2.90 3.24 2.90 2.64 2.79 2.87 3.12			
	Average Yield of Palawan Province			
	1984 1985 1986 1987 1988 1989 1990 1991 1992			
	1.91 2.25 2.56 2.50 2.44 2.70 2.62 2.49 1.96	4.0	387.0	1,548
Beans (mungo)	Provincial Target 1.0 (dry)			
	-Palawan Technoguide	1.0	265.5	266
	Average Yield of Southern Tagalog Region	0.9	238.5	215
	1984 1985 1986 1987 1988 1989 (wet)			
	Jan.-Jun. 0.74 0.75 0.76 0.75 0.76 0.76	1.0	72.0	72
	Jul.-Dec. 0.42 0.42 0.43 0.43 0.45 0.46	0.75	45.0	34
Squash	Average Yield of Southern Tagalog Region			
	1982 1983 1984 1985 1986 1987			
	16.9 17.9 18.1 19.2 18.9 20.2	19.0	72.0	1,368
Grains (Corn)	National Target 5.0			
	-Grain Production Enhancement Program			
	Provincial Target 4.0			
	-Medium Term Development Plan 1994-2000			
	Average Yield of Southern Tagalog Region			
	1983 1984 1985 1986 1987 1988 1989 1990 1991			
	Jan.-Jun. 0.81 0.66 0.81 0.80 0.80 0.82 0.80 0.74 0.79			
	Jul.-Dec. 1.27 1.34 1.41 1.50 1.39 1.30 1.31 1.36 1.28 (dry)			
	Average Yield of Palawan Province	2.1	116.1	244
	1983 1984 1985 1986 1987 1988 1989 1990 1991 (wet)			
	1.51 1.37 1.83 1.74 1.62 1.68 1.77 2.67 2.24	2.0	85.5	171
Eggplant	Average Yield of Southern Tagalog Region (dry)			
	1984 1985 1986 1987 1988 1989	14.0	72.0	1,008
	Jan.-Jun. 15.7 12.1 11.7 12.2 11.8 11.9 (wet)			
	Jul.-Dec. 10.7 9.5 8.6 8.4 8.8 8.8	10.0	72.0	720
Taro(Gabi)	Average Yield of Southern Tagalog Region			
	1982 1983 1984 1985 1986 1987			
	2.76 2.91 2.67 3.10 3.24 3.23			
	Average Yield of Palawan Province			
	1985 1986 1987 1988 1989 1990			
	2.00 2.00 2.00 1.90 1.80 1.80	3.5	36.0	126

Source: Grains Production Enhancement Program, DA
Medium Term Development Plan 1994-2000, PPDO
Southern Tagalog Statistical Yearbook 1991, NEDA
Selected Crops Statistics 1980-1989 (National and Regional Level), DA, BAS
BAS,Palawan

Crop	Basic Data (ton/ha)	Target Yield (ton/ha)	Area (ha)	Production (ton)
Tomato	Average Yield of Southern Tagalog Region			
	1984 1985 1986 1987 1988 1989			
	Jan.-Jun. 6.85 7.69 10.4 10.4 9.04 9.43	10.0	38.7	387
Water-melon	Average Yield of Southern Tagalog Region			
	1982 1983 1984 1985 1986 1987			
	27.4 16.9 10.2 7.54 5.80 10.4			
	Average Yield of Palawan Province			
	1985 1986 1987 1988 1989 1990			
	25.0 25.0 22.0 20.0 20.0 20.0	25.0	38.7	968
Cashew	Average Yield of Southern Tagalog Region			
	1982 1983 1984 1985 1986 1987 (ton/1000			
	5.12 4.76 4.69 - 2.17 5.46 bearing trees)			
	Average Yield of Palawan Province			
	1989 1990 1991 1992 1993			
	1.8 1.8 1.8 1.8 1.8 (ton /ha)	6.9	170.0	1,173
Mango	Average Yield of Southern Tagalog Region			
	1982 1983 1984 1985 1986 1987 (ton/1000			
	179 171 165 - 146 197 bearing trees)			
	Average Yield of Palawan Province			
	1989 1990 1991 1992 1993			
	3.75 3.75 3.75 3.75 3.75 (ton /ha)	0.9	73.9	67

Source: Grains Production Enhancement Program, DA
Medium Term Development Plan 1994-2000, PPDO
Southern Tagalog Statistical Yearbook 1991, NEDA
Selected Crops Statistics 1980-1989 (National and Regional Level), DA, BAS
BAS,Palawan

Table D.3.11 Proposed Yield and Production
(Cropping Intensity 130 %)

Crop	Basic Data (ton/ha)	Target Yield (ton/ha)	Area (ha)	Production (ton)
Paddy Irrigated	National Target 5.0 -Grains Production Enhancement Program Provincial Target 6.0 -Medium Term Development Plan 1994-2000 Average Yield of Southern Tagalog Region 1982 1983 1984 1985 1986 1987 1988 1989 1990 2.86 2.74 2.90 3.24 2.90 2.64 2.79 2.87 3.12 Average Yield of Palawan Province 1984 1985 1986 1987 1988 1989 1990 1991 1992 1.91 2.25 2.56 2.50 2.44 2.70 2.62 2.49 1.96	4.0	387.0	1,548
Beans (mungo)	Provincial Target 1.0 (dry) -Palawan Technoguide	1.0	101.3	101
	Average Yield of Southern Tagalog Region	0.9	238.5	215
	1984 1985 1986 1987 1988 1989 (wet)			
	Jan.-Jun. 0.74 0.75 0.76 0.75 0.76 0.76	1.0	72.0	72
	Jul.-Dec. 0.42 0.42 0.43 0.43 0.45 0.46	0.75	45.0	34
Squash	Average Yield of Southern Tagalog Region 1982 1983 1984 1985 1986 1987 16.9 17.9 18.1 19.2 18.9 20.2	19.0	72.0	1,368
Grains (Corn)	National Target 5.0 -Grain Production Enhancement Program Provincial Target 4.0 -Medium Term Development Plan 1994-2000 Average Yield of Southern Tagalog Region 1983 1984 1985 1986 1987 1988 1989 1990 1991 Jan.-Jun. 0.81 0.66 0.81 0.80 0.80 0.82 0.80 0.74 0.79 Jul.-Dec. 1.27 1.34 1.41 1.50 1.39 1.30 1.31 1.36 1.28 (dry)	2.1	34.8	73
	Average Yield of Palawan Province 1983 1984 1985 1986 1987 1988 1989 1990 1991 (wet) 1.51 1.37 1.83 1.74 1.62 1.68 1.77 2.67 2.24	2.0	85.5	171
Eggplant	Average Yield of Southern Tagalog Region 1984 1985 1986 1987 1988 1989 Jan.-Jun. 15.7 12.1 11.7 12.2 11.8 11.9 (wet) Jul.-Dec. 10.7 9.5 8.6 8.4 8.8 8.8	10.0	72.0	720
Taro(Gabi)	Average Yield of Southern Tagalog Region 1982 1983 1984 1985 1986 1987 2.76 2.91 2.67 3.10 3.24 3.23 Average Yield of Palawan Province 1985 1986 1987 1988 1989 1990 2.00 2.00 2.00 1.90 1.80 1.80	3.5	36.0	126

Source: Grains Production Enhancement Program, DA
Medium Term Development Plan 1994-2000, PPDO
Southern Tagalog Statistical Yearbook 1991, NEDA
Selected Crops Statistics 1980-1989 (National and Regional Level), DA, BAS
BAS,Palawan

Crop	Basic Data (ton/ha)	Target Yield (ton/ha)	Area (ha)	Production (ton)
Tomato	Average Yield of Southern Tagalog Region 1984 1985 1986 1987 1988 1989 Jan.-Jun. 6.85 7.69 10.4 10.4 9.04 9.43	10.0	11.6	116
Water-melon	Average Yield of Southern Tagalog Region 1982 1983 1984 1985 1986 1987 27.4 16.9 10.2 7.54 5.80 10.4 Average Yield of Palawan Province 1985 1986 1987 1988 1989 1990 25.0 25.0 22.0 20.0 20.0 20.0	25.0	11.6	290
Cashew	Average Yield of Southern Tagalog Region 1982 1983 1984 1985 1986 1987 (ton/1000 5.12 4.76 4.69 - 2.17 5.46 bearing trees) Average Yield of Palawan Province 1989 1990 1991 1992 1993 1.8 1.8 1.8 1.8 1.8 (ton /ha)	6.9	170.0	1,173
Mango	Average Yield of Southern Tagalog Region 1982 1983 1984 1985 1986 1987 (ton/1000 179 171 165 - 146 197 bearing trees) Average Yield of Palawan Province 1989 1990 1991 1992 1993 3.75 3.75 3.75 3.75 3.75 (ton /ha)	0.9	73.9	67

Source: Grains Production Enhancement Program, DA
Medium Term Development Plan 1994-2000, PPDO
Southern Tagalog Statistical Yearbook 1991, NEDA
Selected Crops Statistics 1980-1989 (National and Regional Level), DA, BAS
BAS,Palawan

Table D.3.12 Specific Technology Package

Irrigated Paddy

(1) Varieties	IR Series (IR36,IR54,IR64,etc.),BPI Ri-12, BPI Ri-10
(2) Growth Period	110 - 120 days
(3) Planting	
-Planting Method	Transplanting
-Amount of Seed	45kg per hectare
-Area of Nursery Bed	4 - 5% of planting area
-Nursery Period	2 - 3 weeks
-Planting Density	20 x 20 cm (25 x 20 cm)
-Planting Depth	2 - 3 cm
(4) Land Preparation	Plowing : once Harrowing: twice Puddling: twice
(5) Fertilization	
-Application Amount	Manure - 2 ton/ha N : 60kg- 4.3bags of complete fertilizer(14-14-14) 3.0bags of ammonium sulfate(20-0-0) P : 30kg- 4.3bags of complete fertilizer(14-14-14) K : 30kg- 4.3bags of complete fertilizer(14-14-14)
-Time of Application	
Basal Dressing	Before 2nd puddling N-2/3 of total amount P and K-all
Top Dressing	5 days before panicle formation stage(38-42days after transplanting) N-1/3 of total amount
(6) Weeding	Manual: 2 times at 20-30 and 35-45 days after transplanting Herbicides: 2-4-D,MCPA,Zelan,Agroxone
(7) Control of pests and diseases	Insecticide: Fudan 3G,Azodrin (against whorl maggot) Thiodan,Sevin, Gusathion, Brodan, Dursban, Lannate (against caseworm) Lindane, Diazinon, Thiodan, Dimecron, Gustathion, Basudin, Azordin, Hostathion, Dursban, Lannate (against stem borer) Sevin, Thiodan, Gustathion, Basudin, Komet, Azordin, Brodan, Dursban, Lannate (against army worm) Malathion, Sevin, Hopcin, Etrofolan, Thiodan, Basudin, Komet (against rice bug) Pesticide: Benlate (against rice blast and rotten neck) Arasan D-chemical seed treatment (against brown spot)
(8) Harvesting	Manual harvesting by sickle
(9) Water Management	Irrgate the fields for 14 days and drain it for 7 days. Water reuirements: 1.Decomposition period:10-15 cm of water two to three weeks after planting 2.Saturation point:1-2 cm of water 10-15 days after seeding and transplanting 3.Tillering stage:2-3cm 4.Panicle initiation to booting stage:3-4cm 5.Booting stage to soft dough stage:5-10cm 6.Hard dough stage:4-2cm. Drain the field 15 days before harvesting to avoid delayed maturity

Corn

(1) Varieties	UPCA VAR.1,UPCA VAR.5,BPI Var.1 Super Sweet
(2) Growth Period	105 -110days(UPCA VAR.1,UPCA VAR.5,BPI Var.1) 70 - 75days(Super Sweet)
(3) Planting	
-Planting Method	Drilling,Listed Planting
-Amount of Seed	20kg per hectare
-Planting Density	Between rows : 75 cm Between hills : 50 cm (2plants/hill) (Between hills : 25 cm (1plants/hill))
-Planting Depth	Dry season : 5 - 8 cm Wet season : 2 - 5 cm
(4) Land Preparation	Plowing : twice Harrowing: twice Furrowing: once
(5) Fertilization	
-Application Amount	Manure - 0.5 ton/ha N : 20kg- 4.3bags of complete fertilizer(14-14-14) 3.0bags of ammonium sulfate(20-0-0) P : 10kg- 4.3bags of complete fertilizer(14-14-14)
-Time of Application	
Basal Dressing	Dry season : N and P - all Wet season : N - 1/2 of total amount, P - all
Top Dressing	Wet season : N - 1/2 of total amount (just before 4 - 5 weeks after germination; the height is knee high)
(6) Weeding	Manual: Hand weeding by hoe to make weed-free(4-5 weeks after germination) Herbicides: MCPA, 2 4-D, Amine, Esters
(7) Control of pests and diseases	Insecticide: Furadan, Heptachlor (against white grubs) Thiodan , Endox , Endosulfan , Furadan ,Malathion (against corn seedling maggots and thrips) Basudin, Thiodan, Endox, Endosulfan, Lannate, Furadan (against armyworms and cutworms) Furadan, Hytox, Mipcin, Sevin, Carbin, Vetox, Thiodan, Endox, Endosulfan, Basudin, Lannate (against corn borer0 Sevin, Carbin, Vetox, Mipcin, Hytox, Thiodan, Endox, Endosulfan, Azinos, Furadan,Eradex(agaisnt corn earworm) Pesticide: Arasan 75WP, Delsan AD-seed treatment (agaisnt corn rust)
(8) Harvesting	Manual harvesting by removing the complete cobs
(9) Water Management	The corn plant has an average daily water consumption of 4-5 mm, except during the silking and dough stages when water requirement is as high as 6-8 mm.

Table D.3.12

Mung bean

(1) Varieties	MG 50-10A (wet and dry season) MD 15-2 (dry season) CES 1D-21 (wet and dry season)
(2) Growth Period	60-65 days (MG 50-10A,MD 15-2) 65-68 days (CES 1D-21)
(3) Planting	
-Planting Method	Hill method (Row-drill (less laborious than hill method)) (Broadcast method (after harvest of rice under low management))
-Amount of Seed	25kg per hectare
-Planting Density	Between rows : 50-75 cm Between hills : 25-30 cm
(4) Land Preparation	Plowing : twice Harrowing: twice Furrowing: once
(5) Fertilization	
-Application Amount	Manure - 1 ton/ha N : 15kg- 0.7bags of urea(45-0-0) P : 40kg- 4.0bags of solophos(0-20-0) K : 45kg- 1.5bags of muriate of potash(0-0-60)
-Time of Application	
Basal Dressing	Dry season : N ,P and K - all Wet season : N - 1/2 of total amount, P and K - all
Top Dressing	Wet season : N - 1/2 of total amount (3-4 weeks after sowing)
(6) Weeding	Manual: Hilling up by hand-hoe (3-5 weeks after germination) Herbicide: Amex 820, Dachtal, Basagran
(7) Control of pests and diseases	Insecticide: Azordin (against flea beetle and bean podborer) Basudin (against green soldier bug) Malathion (against aphids) Thiodan (against spotted lady beetle) Pesticide: Benlate, Fungitox (against powdery mildew) Dithane, Daconil, Derosol(against Cercospora leaf spot) Orthocide, Arasan SF, Vitavax, Demosan -seed treatment(against damping-off)
(8) Harvesting	Manual harvesting (hand picking of matured pods)
(9) Water Management	In general, mungo needs only little rain and is not affected much by drought. But critical periods when water is needed are during germination, just before and after flowering and during pod-filling stages. Needs about 4-5 mm water per day especially during the months of Jan.-Mar.

Tomato

(1) Varieties	BPI TmP-1 UPL Tm-6 UPL Tm-2
(2) Growth Period	60-65 days (BPI Tm-1) 75-80 days (UPI Tm-6,UPI Tm-2)
(3) Planting	
-Planting Method	Transplanting
-Amount of Seed	150 grams per hectare
-Nursery Period	3 -4 weeks
-Planting Density	Between rows : 1.0 m Between hills : 30 cm
(4) Land Preparation	Plowing : twice Harrowing: twice Furrowing: once
(5) Fertilization	
-Application Amount	Manure - 3 ton/ha N : 60kg- 5.7bags of ammonium sulfate(21-0-0) P : 130kg- 12.9bags of solophos(0-20-0) K : 96kg- 3.2bags of muriate of potash(0-0-60)
-Time of Application	
Basal Dressing	N and K: 1/3 of total amount P : all
1st Top Dressing	N and K : 1/3 of total amount (2 weeks after transplanting)
2nd Top Dressing	N and K : 1/3 of total amount (4 weeks after transplanting)
(6) Weeding	Manual: Hand weeding by hoe (twice) (from transplanting to the early fruiting stage)
(7) Control of pests and diseases	Insecticide: Malathion, Azodrin, Lannete (against fruit worms) Diazinon, Malathion, Azodrin (against aphids) Pesticide: Dithane M-45, Manzate D, Daconil (against early blight) Benlate, Fungitox (against powdery mildow)
(8) Harvesting	Manual harvesting (about 8 times)
(9) Water Management	Need about 25 mm. of water per week throughout the growing period. Sporadic watering especially at reproductive phase is the most frequent cause of physiological disorders on fruits, so 8-10 times furrow irrigation at regular interval will promote maximum yield.

Table D.3.12

Watermelon

(1) Varieties	Sugar Baby, Charlston Gray Klondyke, Striped Klondyke
(2) Growth Period	80-90 days
(3) Planting	
-Planting Method	Direct sowing
-Amount of Seed	2.5kg per hectare (3-4 seeds per hill) (thin 1-2 plants per hill at 3-4 leaves)
-Planting Density	1.5-2.5 m x 1.5-2.5 m
-Planting Depth	2.5 cm
(4) Land Preparation	Plowing : twice Harrowing: twice Furrowing: once
(5) Fertilization	
-Application Amount	Manure - 3 ton/ha N : 60kg- 10.0bags of mixtured fertilizer(12-24-12) P : 120kg- 10.0bags of mixtured fertilizer(12-24-12) K : 60kg- 10.0bags of mixtured fertilizer(12-24-12)
-Time of Application	
Basal Dressing	N : 1/2 of total amount P and K : all
Top Dressing	N : 1/2 of total amount (about 1 month after planting)
(6) Weeding	Manual: Pulling by hands (up to the vines obtain considerable length)
(7) Control of pests and diseases	Insecticide: Carboryl, Malathion (against cucurbit beetle) Kelthane, Tedion V18 (against mites) Pesticide: Fernate, Manzate, Zerlate (against powdery mildow)
(8) Harvesting	Manual harvesting (generally 35-40 days after pollination) (One signs of maturity is a change in background color of the rind from white to light yellow.)
(9) Water Management	Sudden rain after drought sometimes induces crack of fruits, so occasional irrigation is required during dry season.

Eggplant

(1) Varieties	CA Cluster "Tagumpay" UPL Egll
(2) Growth Period	Wet season 75 days (CA Cluster "Tagumpay") 79 days (UPL Egll) Dry season 55 days (CA Cluster "Tagumpay") 86 days (UPL Egll)
(3) Planting	
-Planting Method	Transplanting
-Amount of Seed	0.2kg per hectare
-Nursery Period	7-9 weeks
-Planting Density	Between rows : 1.0 m Between hills : 50 cm
(4) Land Preparation	Plowing : twice Harrowing: twice Furrowing: once
(5) Fertilization	
-Application Amount	Manure - 3 ton/ha N : 124kg- 3.0bags of urea(45-0-0) 8.0bags of comlete fertilizer(14-14-14) P : 56kg- 8.0bags of comlete fertilizer(14-14-14) K : 56kg- 8.0bags of comlete fertilizer(14-14-14)
-Time of Application	
Basal Dressing	N : 8.0bags of comlete fertilizer(14-14-14) P and K : all
Top Dressing	N : 3.0bags of urea(45-0-0) (bedding/banking time or after the second picking of fruits)
(6) Weeding	Manual: Tillage between rows with shallow plow Tillage between the plants by hoe (Mulches of dried plant materials are practical for weed control.)
(7) Control of pests and diseases	Insecticide: Lannate, Orthene , Basudin (against fruit borer) Sevin 85S, Malathion E57(against beetle) Pesticide: Manzate 200, Dithane, Zineb (against phomopsis rot) Manzate 200, Zineb (against fruit rot)
(8) Harvesting	Manual harvesting
(9) Water Management	Dry season : weekly irrigation of 35-40 mm : (biweekly irrigation of 60 mm) Wet season : the arrangement would help in early drainage of the root zone. In general, about 340-515 mm of water are required.

Table D.3.12

Squash

(1) Varieties	BPI Golden BPI Aroman
(2) Growth Period	75 - 80days(BPI Golden) 95 - 100days(BPI Aroman)
(3) Planting	
-Planting Method	Direct sowing
-Amount of Seed	4kg per hectare
-Planting Density	Between rows : 2.0 m Between hills : 1.0 m (3-5 seeds/hill)
(4) Land Preparation	Plowing : twice Harrowing: twice Furrowing: once
(5) Fertilization	
-Application Amount	Manure - 2 ton/ha N : 96kg- 4.0bags of complete fertilizer(14-14-14) 3.0bags of urea(45-0-0) P : 88kg- 6.0bags of solophos(0-20-0) K : 58kg- 1.0bag of muriate of potash(0-0-60)
-Time of Application	
Basal Dressing	4.0bags of complete fertilizer(14-14-14)
1st Top Dressing	3.0bags of urea(45-0-0) (2-3 weeks after planting)
2nd Top Dressing	6.0bags of solophos(0-20-0) (about 1 month after planting) 1.0bag of muriate of potash(0-0-60)
(6) Weeding	Manual: Handpulling and hoeing(about 2 weeks after planting)
(7) Control of pests and diseases	Insecticide: Sevin 85-S (against yellow squash beetle) Malathion E-57 (against aphids) Pesticide: Manzate D (against downy mildow) Benlate (against powdery mildow)
(8) Harvesting	Manual harvesting (before the rind begins to harden)
(9) Water Management	Generally, squash requires an abundant supply of moisture for their maximum plant and fruit development. Critical stages are at planting, during early vegetative and flowering stages and when the fruits have developed.

Taro(Gabi)

(1) Varieties	VISCA G-1 PSB VG-3 PSB VG-2
(2) Growth Period	240days
(3) Planting	
-Planting Method	Digging holes
-Amount of Setts	62kg per hectare (The setts are prepared from the suckers and main plants. It consists of the upper 1-2 cms. of the petioles.)
-Planting Density	50 x 75 cm
-Planting Depth	5 - 6cm
(4) Land Preparation	Plowing : twice Harrowing: twice Furrowing: once
(5) Fertilization	
-Application Amount	Manure - 2 ton/ha N : 70kg- 10.0bags of complete fertilizer(14-14-14) P : 70kg- 10.0bags of complete fertilizer(14-14-14) K : 70kg- 10.0bags of complete fertilizer(14-14-14)
-Time of Application	
Basal Dressing	N : 1/3 of total amount P and K : all
1st Top Dressing	N : 1/3 of total amount (1-2 weeks after planting)
2nd Top Dressing	N : 1/3 of total amount (3-4 weeks after planting)
(6) Weeding	Manual: Alternate hilling up and off-barring (3-4 weeks after planting, before weeds grow)
(7) Control of pests and diseases	Insecticide: Malathion,Servin (against leaf hoppers, aphids, cutworms, mealy bugs)
(8) Harvesting	Manual harvesting (by plowing, digging and pulling the plants)
(9) Water Management	To obtain a good yield, an adequate soil moisture throughout the growing period should be maintained. Occasional irrigation is necessary.

Figure D.3.1 Organization Chart of Office of City Agriculturist

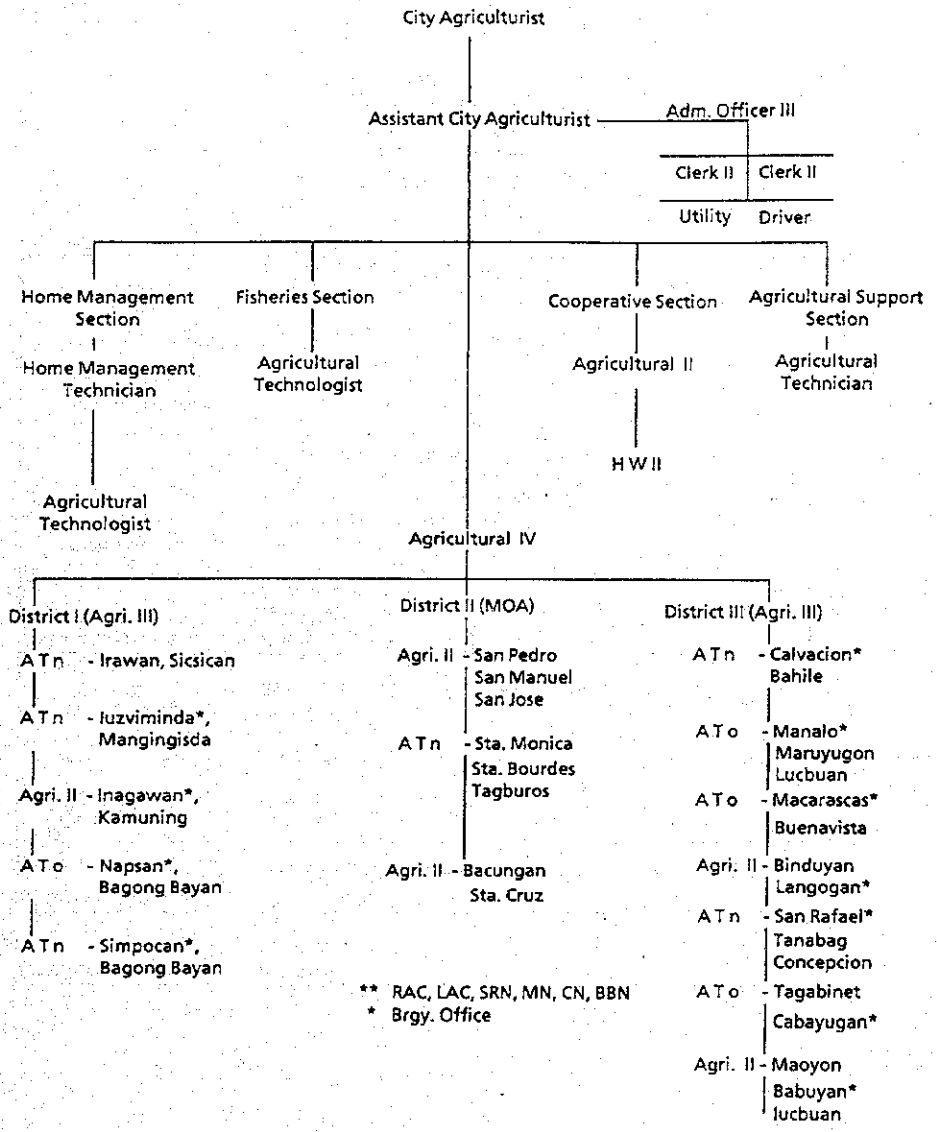
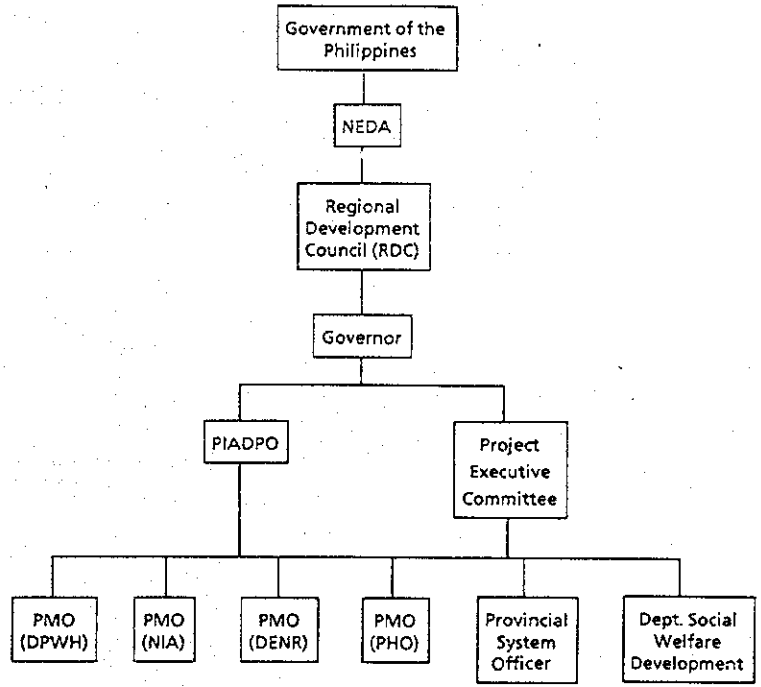
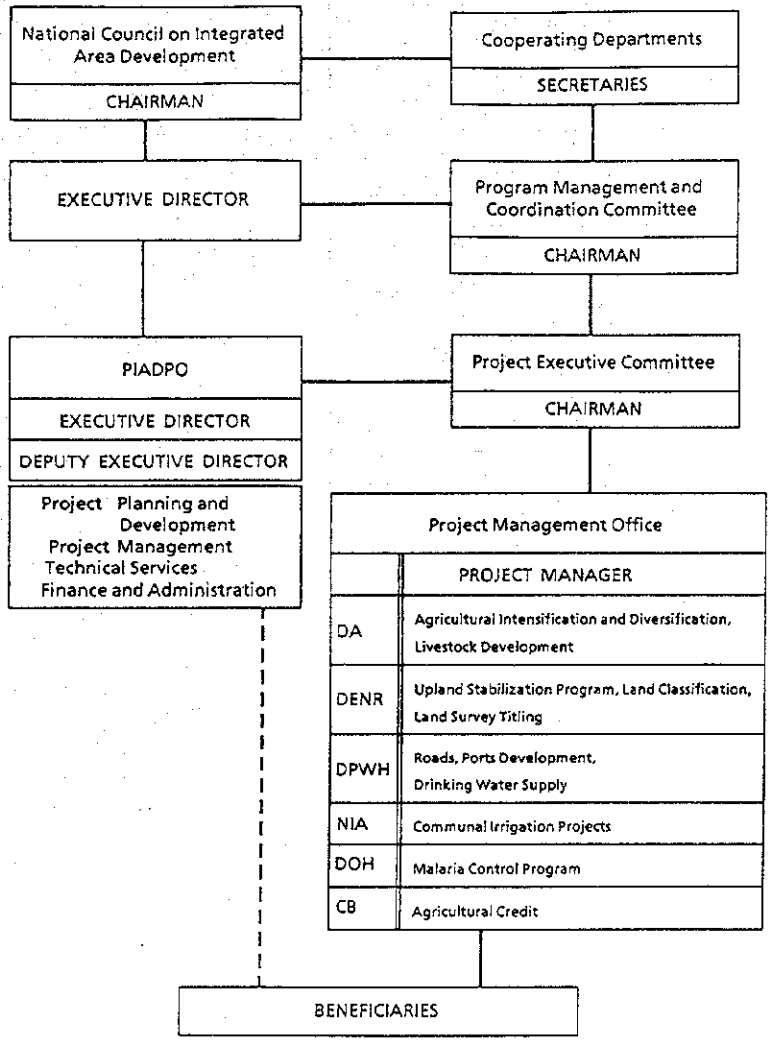


Figure D.3.2 Organization Chart of Second PIADP



Note : All the Provincial Offices of the line agencies are directly responsible to the National Offices through their Regional Offices.
PMO : Project Management Office

Figure D.3.3 Organization Chart of PIADP and Its Linkages



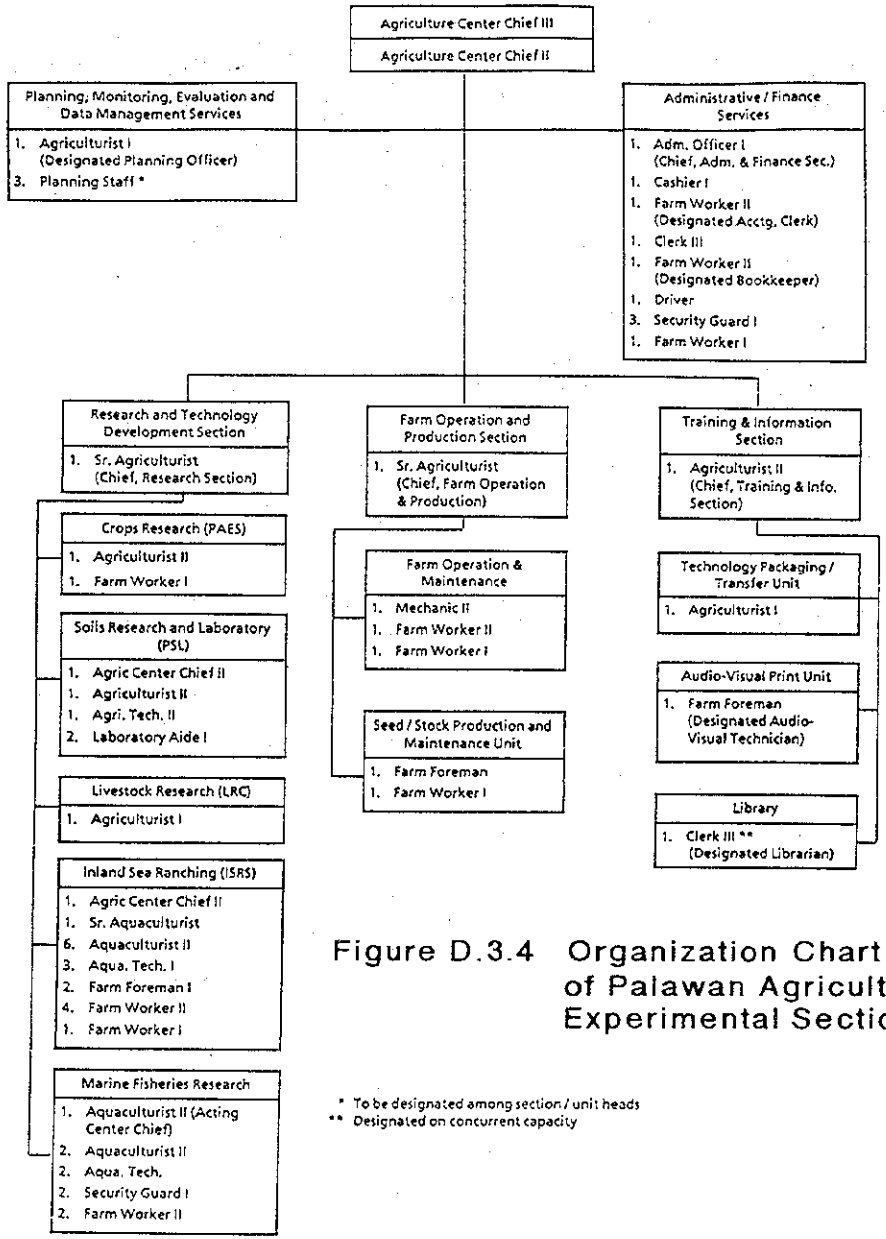


Figure D.3.4 Organization Chart of Palawan Agricultural Experimental Section

* To be designated among section / unit heads
** Designated on concurrent capacity

Figure D.3.5 Organization Chart of PhilRice, Palawan

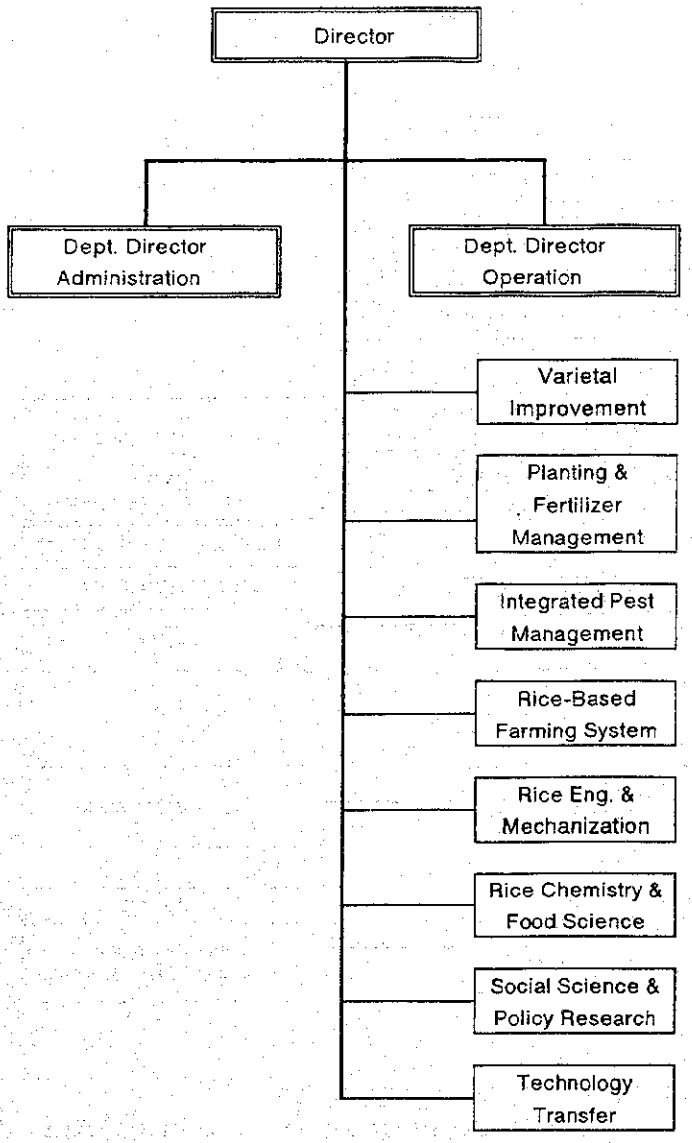


Figure D.3.6 Organization Chart of Agricultural Training Institute Head Office, Manila

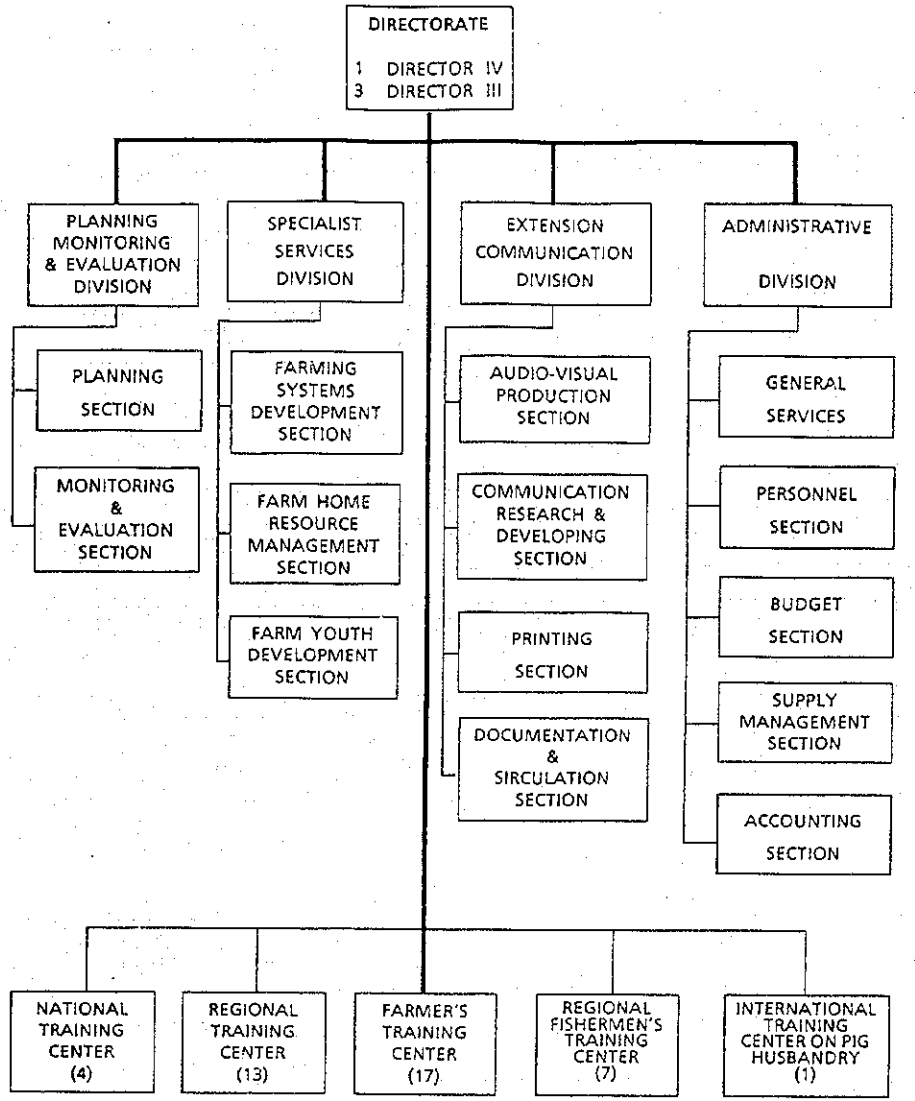


Figure D.3.7 Organization Chart of Agricultural Training Institute, Palawan

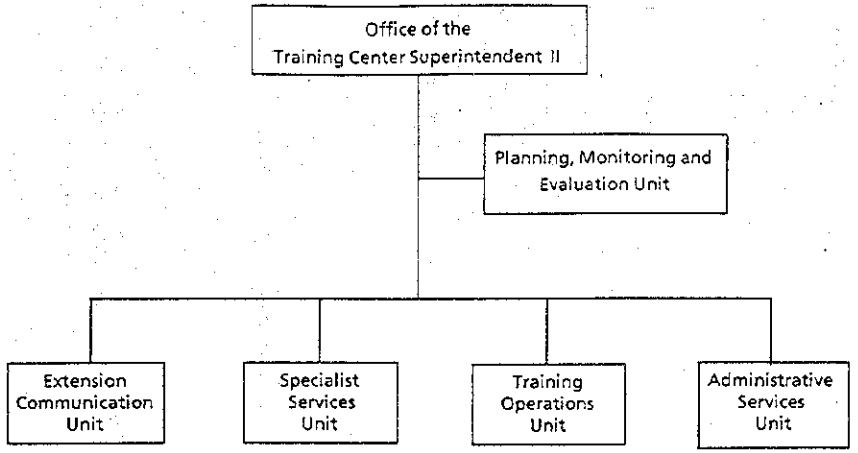


Figure D.3.8 Location of the Study Area on Marketing Activities

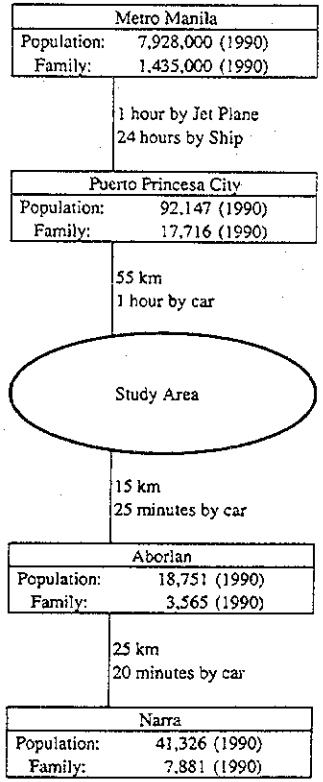
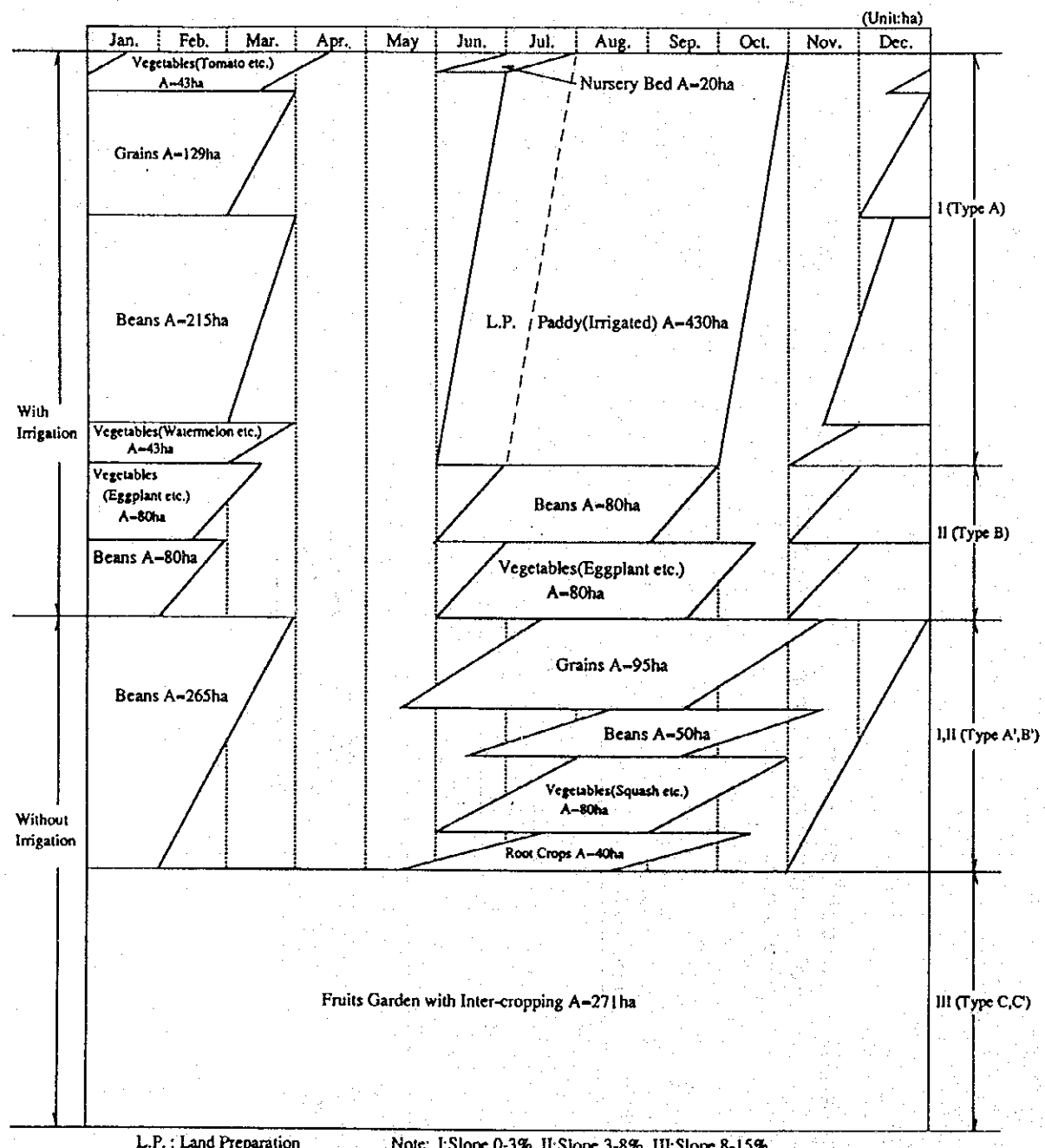


Figure D.3.9 Proposed Cropping Pattern
(Cropping Intensity 200%)



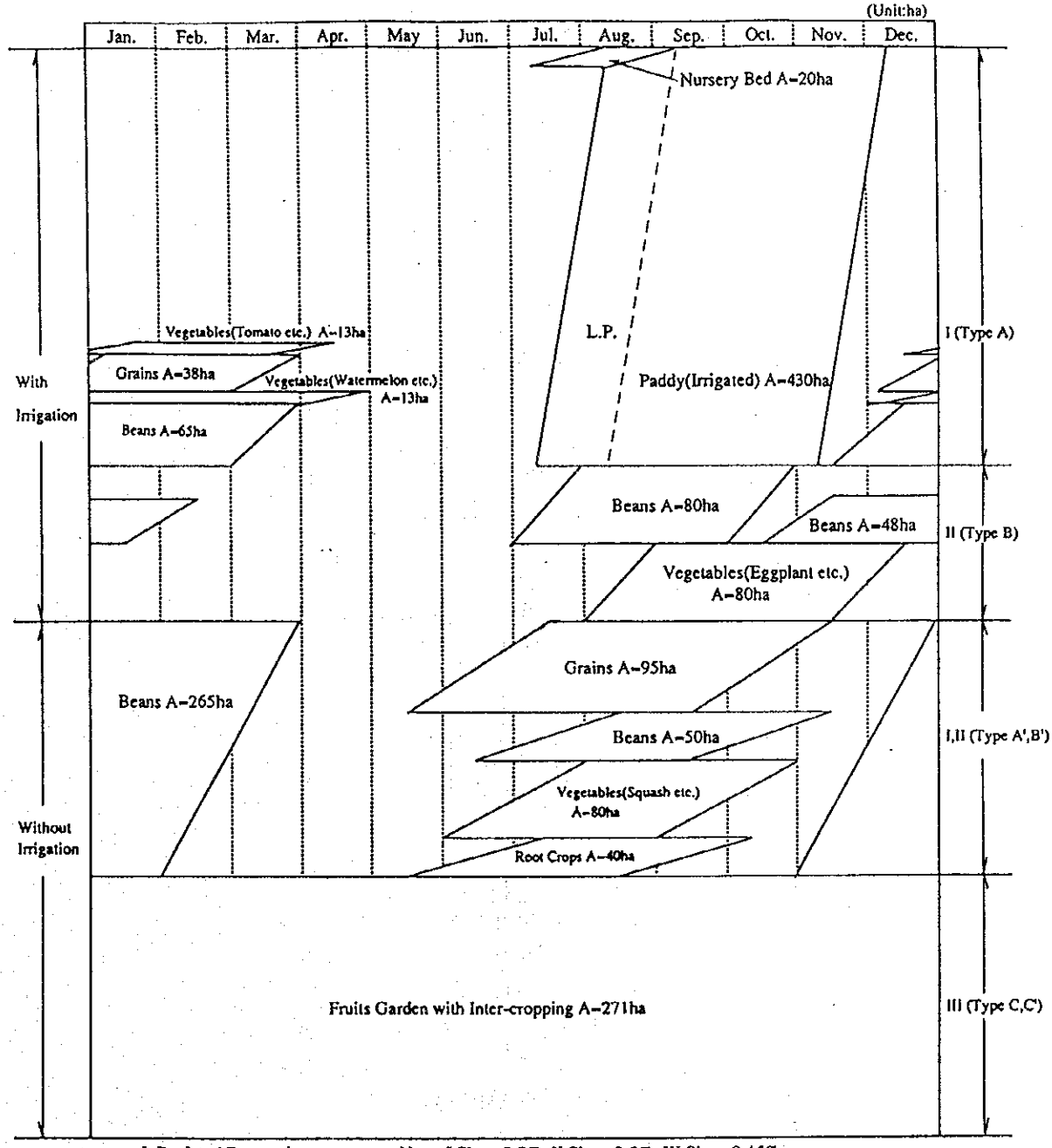
L.P. : Land Preparation

Note: I:Slope 0-3%, II:Slope 3-8%, III:Slope 8-15%

The figure is gross area.

Figure D.3.10 : Proposed Cropping Pattern
(Cropping Intensity 130%)

Figure D.3.10. Proposed Cropping Pattern(130% Crop Intensity)

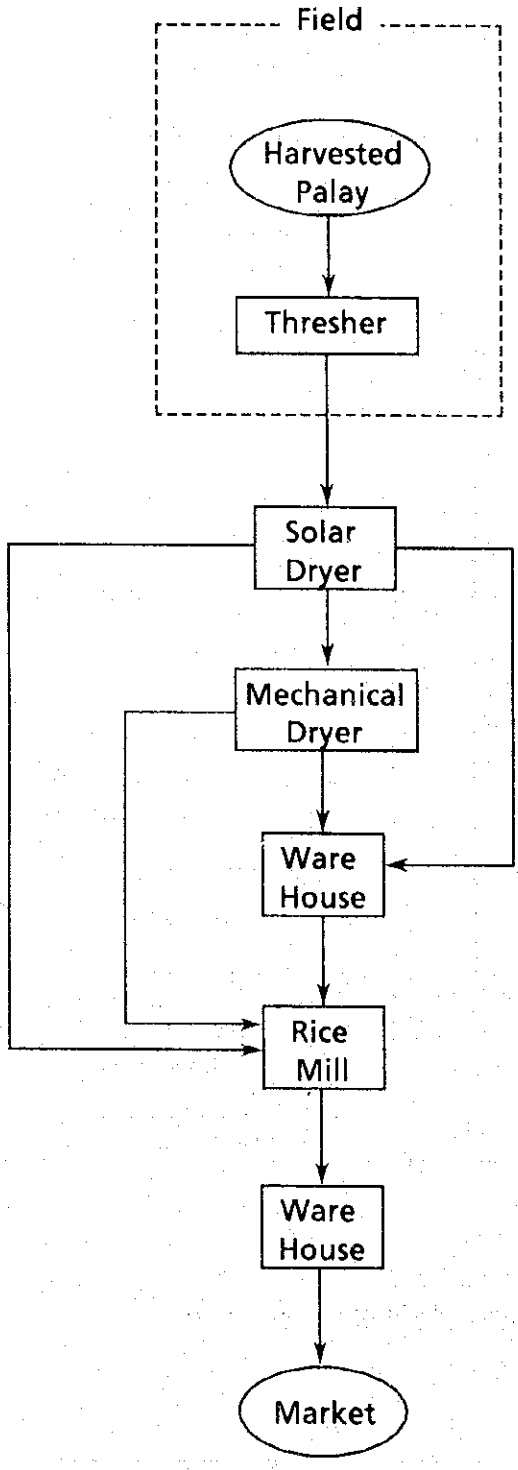


L.P. : Land Preparation

Note: I:Slope 0-3%, II:Slope 3-8%, III:Slope 8-15%

The figure is gross area.

Figure D.3.11 Post-Harvest Flow Chart of Paddy



D. 4 PROPOSED LAND USE PLAN

Considering the various factors such as land slope, elevation of land, soil conditions, present land use and vegetation of its outlying area, irrigable area, etc., the land use plan is determined. The land use categories are agricultural land (irrigation area and non-irrigation area), village area, right-of-way of roads and canals, and others (reserved forest, etc.).

The following acreage of the Study Area was measured on the topo-map with a scale of 1/4,000 prepared by JICA and has been made in July, 1994. The Study Area excludes Air Force Bombing Range (AFBR) of about 137 ha, which is located within the Study Area, because the land holding is not yet fixed and the area is still used by Philippines Air Force.

(unit: ha)

Area	Tagumpay Area	Outlying Area	Total
Study area	1,067	999	2,066
AFBR	44	93	137
Total	1,023	906	1,929

D. 4. 1 Basic Concept of Proposed Land Use

a) Land Slope

The land slope of the Study Area is classified as the following six (6) categories.

Category	specification	Area (ha)
Slope class-1	land slope 0 to 3%	639
Slope class-2	land slope 3 to 8%	394
Slope class-3	land slope 8 to 15%	428
Slope class-4	land slope 15 to 18%	193
Slope class-5	land slope 18 to 30%	120
Slope class-6	land slope more than 30%	154
Total		1,929

The acreage by slope class is each measured on the said topo-map. The area in gentle slope categories with a slope less than 15%, which is suitable for agriculture, covers an area of about 76% of the Study Area, while an area of

24% in steep slope categories should be reserved as forest to conserve the natural forest and to prevent soil erosion which can be expected after any development such as logging.

The most of the lower part of the Study Area is categorized into the gentle slope area excepting the small valley with steep slope on the both side slopes. A gentle slope area with land slope of less than 15% is classified as a suitable area for agricultural development. An area categorized in slope calss-4 would be proposed as an agro-forest and/or fuel timber area on condition that reforestation should taken place after cutting trees. The area in the land slope category with more than slope class-5 is not suitable for agricultural land development due to soil erosion and soil conservation, environmental conservation, etc. (refer to Figure D.4.1)

b) Elevation

An irrigable area is determined depending on the water level of the water resource. In the Study Area, the natural water resource has lower water level, and this is one of the main factors to determine the proposed irrigable area and acreage. The elevation of the Study Area ranges from 1.4 to 100 m above mean sea level (MSL), and areas with an elevation of less than 40 m and less than 50 m MSL occupy 68% and 80% of the Study area, respectively. In consideration to the above mentioned constrains of land slope, the suitable areas of agricultural development in elevation 40 m and elevation 50 m are limited to 56% (equivalent to 1,078.9 ha) and 68% (equivalent to 1,303.5 ha), respectively. Among them, the irrigation area could be determined based on the location of the proposed irrigation canals and proposed water levels under the gravity irrigation system. (refer to Table D.4.1 and Figure D.4.2)

c) Soil

The area with an elevation of less than 20 m MSL at the confluence of both rivers of Inagawan and Pinagsaluran is classified into the slope calss-1. Since the area of about 40 ha has thin top soil layer and might be the flooded area of the rivers, crop cultivation can not be introduced, and the area would be proposed as fruit garden. At present, in the area, nurseries of coconut are already planted. At other areas of the Study Area, no remarkable constraint on soil was observed. (refer to Appendix D.1 for more details)

d) Land Classification

A land classification mapping was conducted in the Study Area during this survey period. The land classification scheme was patterned from the land classification specification of the U.S Bureau of Reclamation with some specifications modified to suit local conditions. The soils were classified and land classes were delineated so as to reflect the productive potential of the land according to the soil, surface configuration and drainage limitation. The arable land is divided into two (2) categories, namely: rice land and diversified crop land. Further subdivisions with 14 categories were also made according to the degree of limiting factors such as soil, topography, etc.

Based on the results of the land classification, the potential area of rice land is about 1,200 ha and the diversified crop area, about 300 ha. The non-arable land of about 600 ha includes the steep slope area, the watering area of rivers and streams and housing area. The detailed acreage is being finalized at present. (refer to Appendix D.2 for more details)

e) Present Land Use and Vegetation of its Outlying Area

At areas with comparatively high altitude, the natural forest is dominant and land slope is steep. In these areas tree cutting should be banned because soil erosion might occur. The area with an elevation of about 60 m or more, is located in the hinterland of the Area and is covered by dense forest. The area should be allocated as the reserved forest area. (refer to Appendix D.2 for more details)

f) Irrigable Area

Judging from the location of the area, education and farmer's technical level of farming at present, the cultivation of high value crops could not be introduced. And the kind and prices of farm products may limit the introduction of highly equipped irrigation system, like sprinkler system to supply water to the field, due to economic justification. A gravity irrigation system, therefore, shall be recommended. The service area of the gravity system will, however, be affected by the intake water level of the available water resources. (refer to Appendix G)

D. 4. 2 Proposed Land Use Plan

The following proposed land use was determined by studying and considering the above mentioned conditions.

Land Use	Area	Ratio
	(ha)	(%)
Agricultural Land	1,341	70
- Irrigation area	(590)	(31)
- Non-Irrigation area	(751)	(39)
Right-of-Way	150	8
Home Lot Area	48	2
Reserved Forest, etc.	390	20
Total	1,929	100

The home lot area for new beneficiaries in the outlying area is planed at two (2) places out of Tagumpay Area and its necessary acreage is 16 ha. In the reserved forest area, the necessary area for a water resource facility is inclusive. The right-of-way is assumed at 10%. of the project area based on Tagumpay Settlement Area plan. In the reserved forest area, within a boundary of the irrigable area. (refer to Appendix I.1)

Table D.4.1 Acreage by Slope and Elevation

(including AFBR)

(unit:ha)

EL	Slope Classification ① 0to 3%	② 3to 8%	③ 8to15%	④ 15to18%	⑤ 18to30%	⑥ 30%over	Total
0~ 10	54.8	15.0	26.1	7.6	5.2	0.3	109.0
10~ 20	149.2	51.9	100.9	46.6	18.3	11.7	378.6
20~ 30	392.5	93.8	68.7	31.2	23.6	12.2	622.0
30~ 40	103.1	102.6	47.7	25.4	11.2	6.0	296.0
40~ 50	29.3	108.4	87.7	21.2	10.4	7.0	264.0
50~ 60	4.2	28.2	64.7	23.4	11.5	13.1	145.1
60~ 70	0.0	6.8	24.8	19.8	12.9	21.6	85.9
70~ 80	0.0	10.4	10.3	12.6	9.5	25.4	68.2
80~ 90	0.0	1.3	5.7	8.5	8.5	28.9	52.9
90~100	0.0	0.0	1.7	3.9	10.4	28.2	44.2
Total	733.1	418.4	438.3	200.2	121.5	154.4	2,065.9

Note: Based on the Topo-map with a scale of 1/4,000 prepared by JICA

(excluding AFBR)

EL	Slope Classification ① 0to 3%	② 3to 8%	③ 8to15%	④ 15to18%	⑤ 18to30%	⑥ 30%over	Total
0~ 10	54.8	15.0	24.0	7.6	5.2	0.3	106.9
10~ 20	149.2	50.4	95.7	45.2	17.4	11.7	369.6
20~ 30	339.4	81.6	66.7	30.9	23.6	12.1	554.3
30~ 40	62.3	92.9	46.9	22.8	11.0	6.0	241.9
40~ 50	29.2	107.7	87.7	18.9	10.4	7.0	260.9
50~ 60	4.2	28.2	64.7	22.7	11.5	13.1	144.4
60~ 70	0.0	6.8	24.8	19.8	12.9	21.6	85.9
70~ 80	0.0	10.4	10.3	12.6	9.5	25.4	68.2
80~ 90	0.0	1.3	5.7	8.5	8.5	28.9	52.9
90~100	0.0	0.0	1.7	3.9	10.4	28.2	44.2
Total	639.1	394.3	428.2	192.9	120.4	154.3	1,929.2

Note: Based on the Topo-map with a scale of 1/4,000 prepared by JICA

Figure D.4.1 Cumulative Acreage by Slope and Elevation

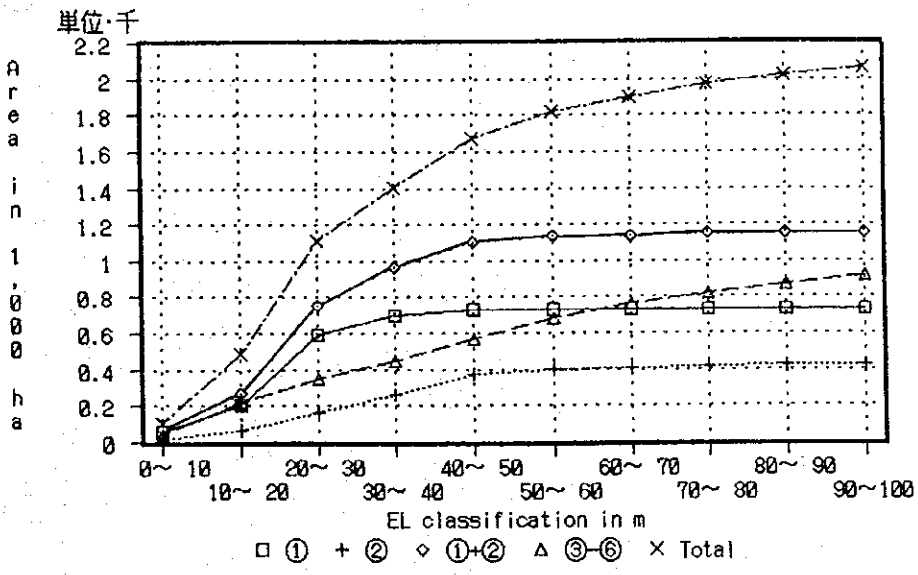


Figure D.4.2 Land Slope Map

Map No.4

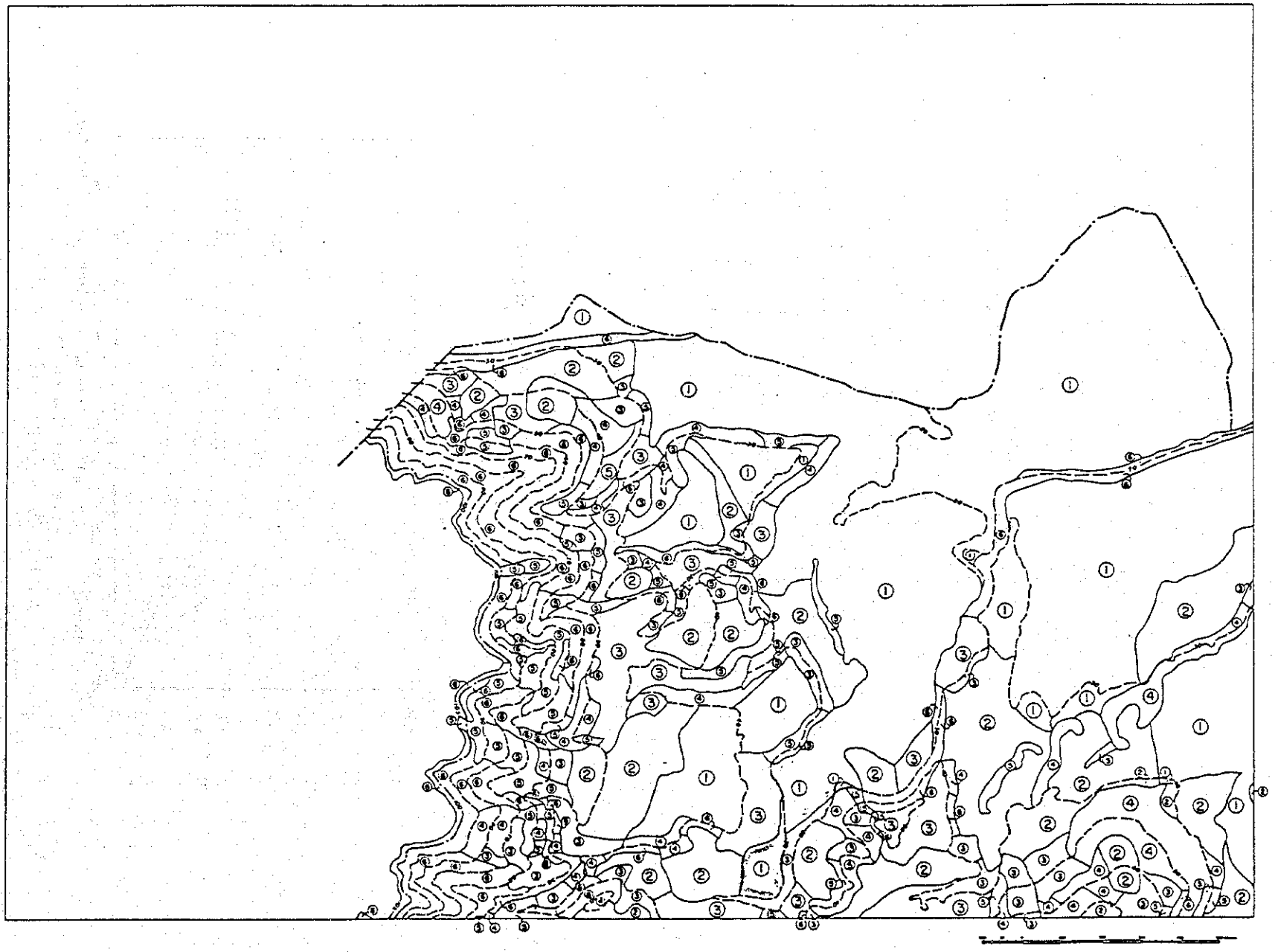


Figure D.4.2 Cont'd

Map No.5

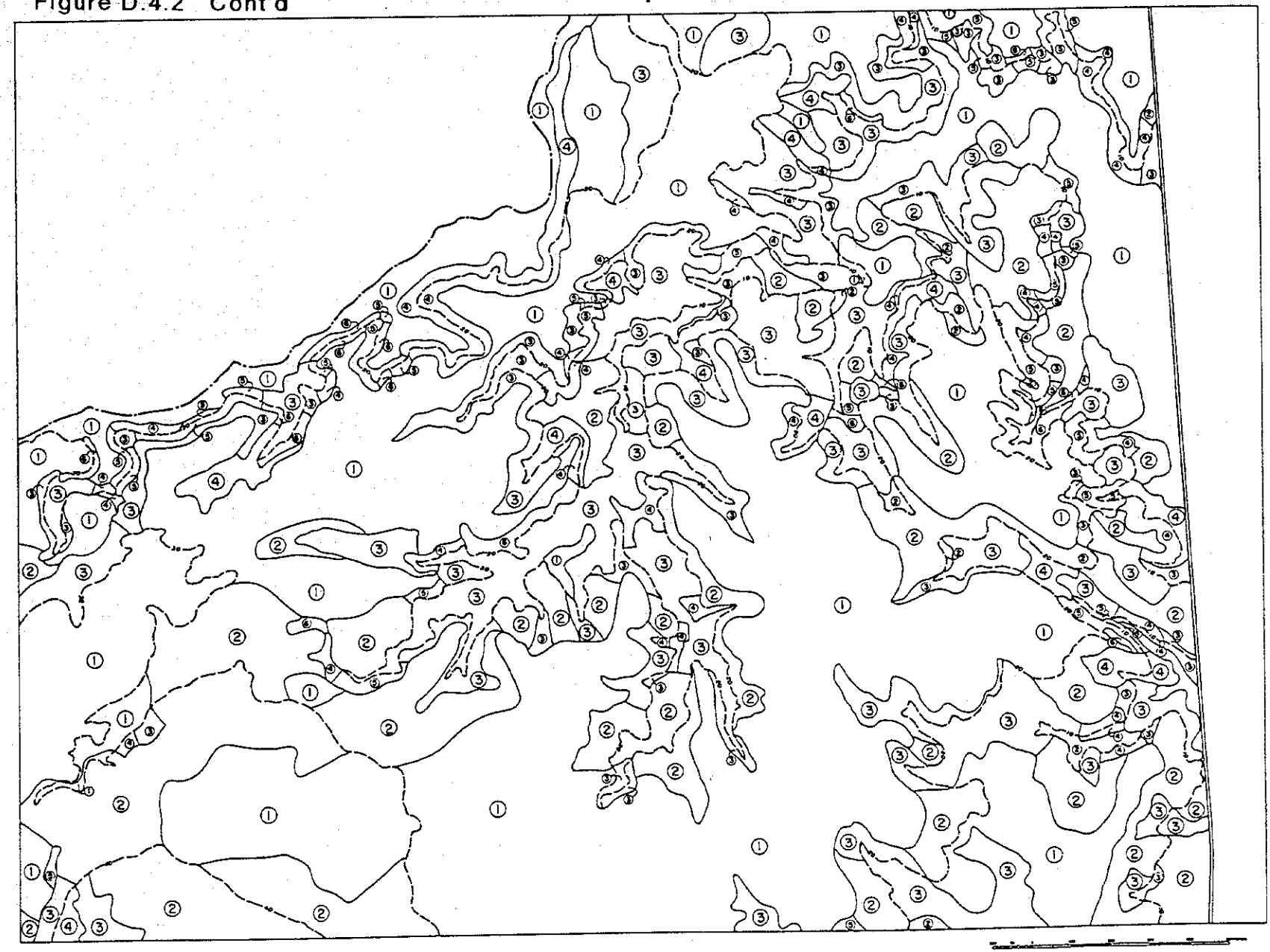
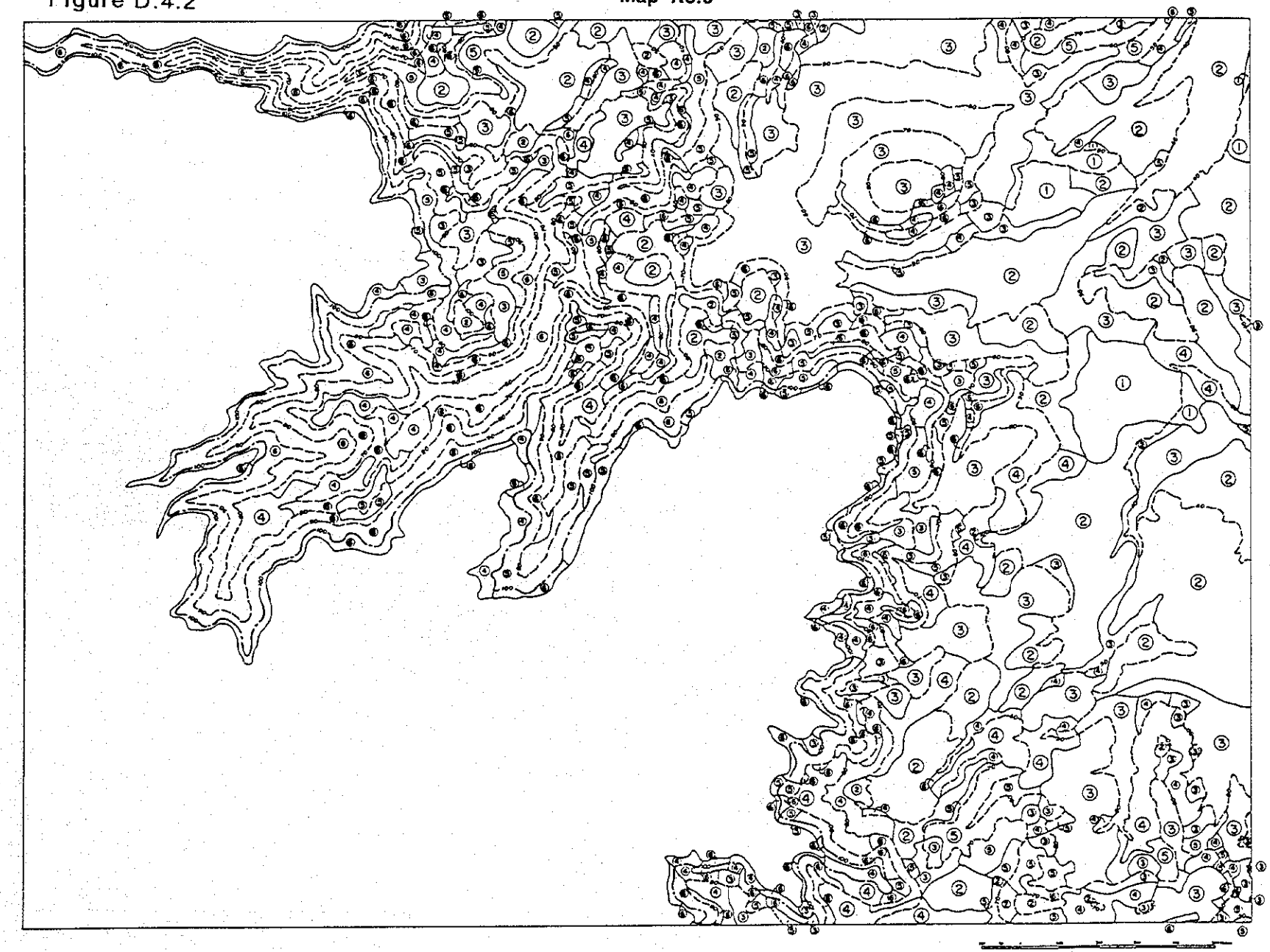
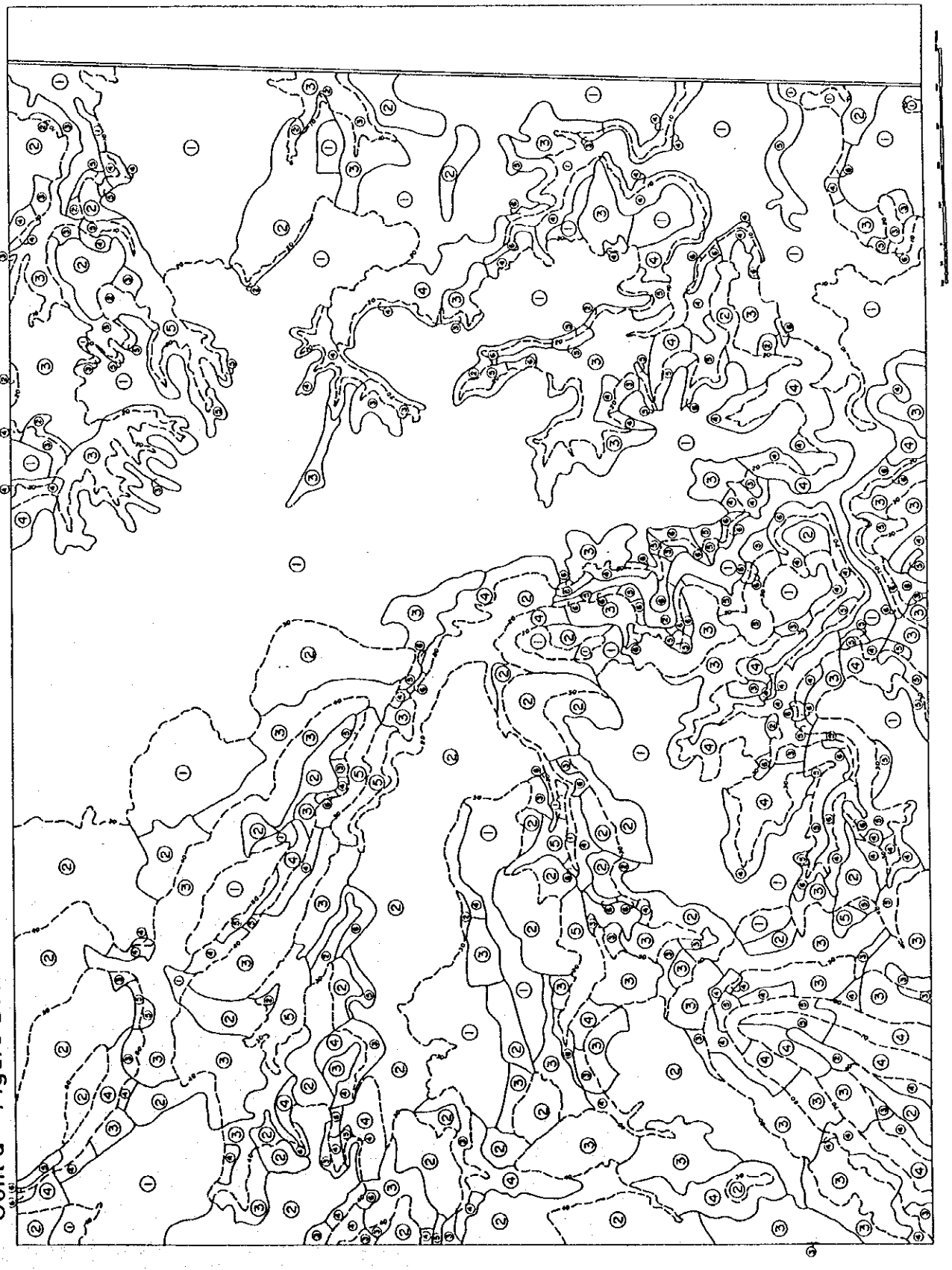


Figure D.4.2

Map No.6



Cont'd Figure D.4.2



APPENDIX E. GEOGRAPHY, GEOLOGY AND HYDROGEOLOGY

E. 1 GEOGRAPHY

E. 1. 1 Proposed Dam Site

Five (5) proposed dam sites as potential water sources are suggested as follows:

(1) Proposed dam site C
(2) Proposed dam site D
(3) Proposed dam site LD
(4) Proposed dam site Eu
(5) Proposed dam site El

The proposed dam sites, C, D and LD are located at the immediate downstream where the Inagawan river flows from the mountain area to the hilly area. The location of the proposed dam sites from the final wide meander point to the downstream direction are approximately 100 m, 700 m and 1,100 m for dam sites C, D and LD, respectively. The Inagawan river is 46.5 km long and originates from the highest mountain with top elevation of 1,340 m MSL at the Anepahan peak. It is meandering at the Central Peak at the left side of the bank and at Mt. Aborlan at the other side of the bank, flowing down at the northern part of the Study Area, out into the Sulu Sea through the diluvial hill and alluvial plains.

The topographical condition of dam site C is composed of a V-shaped valley. Both abutments of this dam site have steep slopes and cliffs. However, the left side abutment forms a thin ridge, which maybe due to the erosion of the meandering river flow.

The proposed dam site D has a similar geographical condition to that of proposed dam site C, except that the valley width is broad, about 180 m. Both abutments of this dam site are part of a mountain slope, but left side abutment forms a thin ridge like that of dam site C.

The proposed dam site LD has steep slope at the left abutment but with some gentler slope at the right abutment in comparison with the above two proposed dam sites. It is characterized by broad and nearly level valley floor, about 200 m in width.

The proposed dam sites, Eu and El are located at the right tributary of the Inagawan river at the Pinagsaluran river.

The proposed dam site Eu is located approximately 700 m from the proposed dam site El at the upstream direction along the Pinagsaluran river. Its left side abutment has steep slope while the right side abutment, which is made up of isolated small mountain, about 90 m in elevation, presents somewhat gentler slope. Furthermore, the terrain found within and in the neighboring area is characterized by small hills sporadically scattered, which one may think to consider that the original terrain have been eroded, leaving only a series of hills with approximately the same height.

The proposed dam site El is located just upstream of the place where the Pinagsaluran river flows into the hill area. The left side abutment of this dam site shows steeper slope and is accompanied with small fan shaped features. The right side abutment, which is composed of the same isolated small mountain of proposed dam site Eu, has somewhat gentler slope.

E. 1. 2 Study Area

The Study Area is mainly situated on a hilly area and is characterized by a rolling and undulating terrain with the existence of many valleys. These valleys have tributaries widely located at the downstream to the central part of the Study Area. The bottom width of the valley ranges from 10 m at the upstream to about 100 to 200 m at the downstream. Furthermore, small mountains which were probably made up of basement rocks ranging in elevation from 55 to 90 m are sporadically distributed at northwest direction of the Study Area.

The hill areas consists mainly of diluvial deposits and are covered by reddish loam at the surface. The alluvial plains are partially located at the southeast direction, near the national highway. In addition, deposits covering the alluvial plains have the same geological age as those located along the Inagawan river and its tributaries.

E. 2 GEOLOGY

E. 2. 1 Geological Conditions

The geology of the proposed dam sites and reservoir area, including the Study Area, are roughly divided into five (5) categories as follows:

(1) Sedimentary rocks
(2) Metamorphic rocks
(3) Igneous rocks
(4) Diluvium deposits, and
(5) Alluvium deposits

The sedimentary rocks, which are called the Panas Formation, are distributed at the upstream of Pinagsaluran river, with turbiditic formations which are composed of shale, mudstone and alternating with arkoase sandstone. This formation is found to be of Eocene age.

The metamorphic rocks, which are called the Inagawan Metamorphics, are distributed extensively around the above mentioned sedimentary rocks, the Panas formation, as a result of thrusting events which continued from Eocene to middle Miocine, and consists of finely grained green phyllitic schist, amphibolite and metamorphosed turbidities. Most of the original rocks are considered to have been a member of the Panas formation. Furthermore, it is worth to note that the distribution area of the formation is almost identical with the flow of direction of the Inagawan river, resulting from less resistance against river flow.

The base of the proposed dam sites C, D, Eu, and El (the last two, especially at the left side abutment) are made up of amphibolite, weak altered shale and sandstone, which belong to the Inagawan Metamorphics.

The igneous rocks are also present at the left side steep and rugged mountain area toward the downstream of the Inagawan river and in the small mountains sporadically scattered in the hill area. They are composed of thrusted ultramafics, which are called the Mt. Beaufort Ultramafics, and the associated gabbro, which is called the Stavely Range Gabbro. The Mt. Beaufort Ultramafics are mainly made up of serpentinited peridotite and lenses of

dunite. On the other hand, the Stavely Range Gabbro consists of isotropic gabbro with minor layered gabbro. These igneous rocks are presumed to be of Eocene age.

The proposed dam sites, LD, Eu and El (the last two, especially right-side abutment) is considered to be underlain by serpentinited peridotite, which belong to the Mt. Beaufort Ultramafics.

The Study Area is mainly underlain by the diluvium fan (talus) deposits, which are called the Iwahig Formation and are made up of poorly consolidated sand and grave layer with intercalated thin beds of sand, silt and clay. Color of this formation is reddish brown which changes to light gray at depth. The gravel fragments are sub-angular to sub-rounded, and are composed mainly of weathered sandstone, chart and ultramafic rocks. This formation is found to be pleistocene in age.

The alluvium deposits, which correspond to the recent deposits, are distributed as flood plain from the national highway to the coast line and along the downstream of Inagawan river. This deposits are made up of poorly sorted and unconsolidated sand, silt, clay and gravel. Especially, the deposits along the recent river, the Inagawan river, the Tagbarungis river etc. are characterized by fine to coarse sand and gravel, which are suitable for concrete aggregate because of abundant quantities and good qualities.

The standard stratigraph of the Study Area and its surrounding area are presented below.

Quaternary	Holocene	Alluvial Deposits
	Pleistocene ..	Diluvial Deposits
		(Iwahig Formation)
Tertiary	Eocene to	Inagawan Metamorphics
	Miocine	(Original rock: Panas Formation)
	Eocene	Panas Formation
	.....	Mt. Beaufort Ultramafics
	.....	Stavely Range Gabbro

* Panas Formation is thrusted by Mt. Beaufort Ultramafics and Stavely Range Gabbro

E. 2. 2 Geological Investigations and Soil Tests

a) General

The investigation works were undertaken to verify the geological conditions of the dam foundation and to confirm the quantity of suitable embankment materials for the fill-dam. Soil tests were also performed to verify the soil characteristics for embankment materials.

The item and volume of investigation works were as follows:

(1)	Geological mapping		
	- Proposed dam sites	55 ha	
	- Reservoir areas	L.S.	
(2)	Drilling and in-situ test		
	- Drilling*	8 holes	185 m
(3)	Test pitting	24 pits	75 m
(4)	Auger hole drilling	15 holes	45 m
(5)	Soil and rock test	L.S.	

* including standard penetration test and permeability test

b) Geological Mapping

The purpose of the geological mapping is to confirm the distribution of rock bed, rock mass, etc. and to verify the geological structures including the strike, dip of bedding and existence of fault, fracture zone, etc.

The results of the geological mapping are shown in the Main Report as Geological Map. The details of the geological characteristics (rock type, geological structure etc.) are shown, as follows:

1) Proposed Dam Site C, D and LD

The prevailing rock types in these proposed dam sites and reservoir areas mainly consist of Inagawan Metamorphics and Mt. Beaufort Ultramafics.

The Inagawan Metamorphics is composed of grayish amphibolite and/or grayish green phyllitic schist and are generally fairly hard which breaks

into thin sheets or slabs. It principally trends northeast (20° to 40°) and dips steeply southeast (60° to 70°). The outcrops of this base rock are sporadically distributed along the river, excluding the proposed dam site LD.

The Mt. Beaufort Ultramafics consists of unaltered and slightly serpentinited peridotite, dunite and pyroxinite. This rock unit is dark gray, hard to very hard, slightly weathered to fresh and dominated by a series of parallel joints, which are slightly open but with quartz in-filling.

At about 1.2 km from the confluence of Inagawan and Taraw-tawan rivers, Panas formation is recognized with massive, medium-grained hard sandstone including thin interbeds of dark gray indurated silty shale. This formation is characterized by turbiditic facies as a whole.

At the proposed dam site D and LD, the alluvial deposits as flood plain and terrace deposits, which are composed of sand, gravel and small boulder, are widespread at the river bed and its vicinity.

A thrust fault trending northwest to south east direction was inferred to have existed between Inagawan Metamorphics and Mt. Beaufort Ultramafics. However, the outcrops for litholegic contract point of thrust fault are not observable in the field because the presence of thick overburden deposits. It is observed that widely spaced joints were frequently discerned near the inferred contact point for thrust fault. They variously strike northeast to northwest and dip moderately to steeply northeast and southeast.

2) Proposed Dam Site Eu and El

The proposed dam site Eu, EL and its reservoir area are composed of Inagawan Metamorphics, Mt. Beaufort Ultramafics and Iwahig Formation.

The Inagawan Metamorphics is predominantly observed at the Eu (left abutment) and reservoir area. This rock unit is dark gray, fairly hard amphibolite or amphibolitic schist which likewise contain thin to very thin lenses of argillaceous sandstone or quartzite with siltstone. Some alterations in this rock type were observed such as the presence of brownish red very hard piemontite schist which contains numerous quartz veining, and altered andesites which basically occur as thin lenses of amphibolites.

The Mt. Beaufort Ultramafics consisting of unaltered slightly serpentinited peridotite, dunite and pyroxinite is observed at the peak of the hills situated at the right abutment of proposed dam site El. The results of drilling works revealed the presence of this rock type.

The Iwahig Formation is mainly identified at both abutments of the proposed dam site El. This formation consists of sporadic occurrences of various kinds of gravels, for example grayish amphibolite, greenish phyllitic schist and grayish fine to medium grained sandstone etc., in a matrix of sand, silt and clay. At the left abutment of proposed dam site El inferred to correspond to the old talus deposits.

A thrust fault which is trending to the northeast and moderately dipping to the southeast and inferred to be the lithologic contract between the Inagawan Metamorphics and Iwahig Formation. Nevertheless the outcrop just at the contact point at the field are not evident, the existence of the thrust fault seem to be warranted by large difference of topographically contour line as regards two geological facies. Furthermore, localized minor folding and shearing (about 10 m in width) are particularly observed at the tributaries of the Pinagsaluran river. The prevailing rock formation is scarcely jointed, which shows generally steep dipping, and are basically tight and discontinuous.

c) Drilling Investigation

Drilling investigation have been planned at three (3) points in proposed dam sites D and LD, and five (5) points in proposed dam site E. The bill of quantities for drilling are as follows:

Hole No.	Dam Site	Drilling Depth
No.D1	Proposed dam site LD	25.5 m
No.D2	Proposed dam site D	20.5 m
No.D3	Proposed dam site D	20.0 m
No.E1	Proposed dam site Eu	20.0 m
No.E2	Proposed dam site Eu	25.0 m
No.E3	Proposed dam site El	31.0 m
No.E4	Proposed dam site El	25.5 m
No.E5	Proposed dam site Eu	19.0 m

The results of drilling investigation are shown in Figure E. 2. 1, and the results of standard penetration test and permeability test are shown in Table E. 2. 1 and Table E. 2. 2, respectively. Presented below is a brief description of geological condition on the basis of drilling investigation results, including geological mapping results, for each dam site.

1) Proposed Dam Site C

Drilling investigation is not performed at this proposed dam site. According to the results of geological mapping of this site, a continuous outcrop of the Inagawan Metamorphics with hard schist are recognized along the river side and a part of both abutments. At the river bed, outcrops also are found in a scattered pattern. Based on these fact, it can be stated that highly weathered zone of both abutments show less than 5 m in depth, and sand and gravel layer (alluvial deposit) at the river bed has merely less than 5 m thickness on the average. It can be concluded that the geological condition for the dam foundation is excellent in comparison with the proposed dam site D and LD.

2) Proposed Dam Site D

Two boreholes, No.D2 and No.D3, were performed in this proposed dam site.

Borehole No.D3, which is located in the proposed dam axis at the right abutment, is underlain by a 5.5 m thick highly weathered rock (N value 16 - 50) and a 14.5 m thick moderately weathered rock. Highly weathered rock shows clayey silt facies including extremely weathered sandstone fragments and moderately weathered rock consists of highly fractured, oxidized along fractured, weathered sandstone. Beneath the above rocks, fresh rock was encountered up to the bottom of the borehole. Geological facies are mainly made up of sandstone, which weakly metamorphosed, excluding amphibolite (1.0 m in thickness) encountered at the bottom of borehole. Coefficient of permeability of highly weathered rock zone and moderately weathered rock zone indicate 2.0×10^{-3} cm/sec and $2.6\text{-}3.0 \times 10^{-4}$ cm/sec, respectively.

Borehole No. D2 located on the flood plain is underlain by unconsolidated sand and gravel layer up to the bottom of borehole (20.5 m in depth). This sand and gravel layer correspond to alluvial deposit near the

surface portion. However, judging from the sedimentary facies including color of formation, there is a large possibility that layer the beneath approximately 4.5 m in depth corresponds to the diluvial deposit (old river deposit). Coefficient of permeability of this sand and gravel layer shows 1.1-2.4$\times 10^{-3}$ cm/sec with high permeable characteristic.

From the results of the drilling investigations and geological mapping, the geological condition of proposed dam site D is summarized and presented below, as follows:

1. Base rock is composed of member of the Inagawan Metamorphics, weakly metamorphosed sandstone and amphibolite.
2. Base rock of both abutments are highly weathered up to 5 to 6 m in depth and N value shows 16 to 50.
3. Below the highly weathered zone at the both abutments occurs about 10 m in thickness of moderately weathered zone. Fresh rock zone is found out 15 m below.
4. At the river place as flood plain, unconsolidated sand and gravel layer as alluvial deposit and diluvial deposit (old river deposit) is recognized up to 20.5 m of the bottom of the borehole.
5. Coefficient of permeability of highly weathered zone and sand and gravel layer (alluvial deposit and diluvial deposit) indicates n$\times 10^{-3}$ cm/sec in order, and that of moderately weathered and fresh zone shows n$\times 10^{-4}$ cm/sec in order.
6. As to the above thick alluvial deposit and diluvial deposit, sand and gravel layer, special foundation treatment (diaphragm method etc.) for dam construction is proposed to prevent seepage flow.

3) Proposed Dam Site LD

Borehole No.D1 was drilled at the proposed dam axis at the alluvial terrace plain. The existence of predominant unconsolidated sand and gravel layer, which is equivalent to formation of No. D2 borehole, up to bottom of the borehole (25.5 m in depth) was revealed by this drilling work. This formation is also considered as corresponding to alluvial deposit and diluvial deposit. Coefficient of permeability of this sand and gravel layer shows 1.8-4.6$\times 10^{-3}$ cm/sec with high permeable characteristic.

Geological conditions of this dam site are summarized as follows:

1. Base rock mainly consists of member of the Mt. Beaufort Ultramafics and the Stavely Range Gabbro.
2. At the flood plain, the predominant sand and gravel layer (alluvial deposit and diluvial deposit) is located up to 25.5 m of the bottom of the borehole.
3. Geological conditions as to weathered zone are inferred to be similar to that of the case of proposed dam site D.

3 Coefficient of permeability of sand and gravel layer (alluvial deposit and diluvial deposit) indicates $n \times 10^{-3}$ cm/sec in order.

4. As to the thick alluvial deposit and diluvial deposit, sand and gravel layer, a special foundation treatment for dam construction is also proposed.

4) Proposed Dam Site Eu

A total of three (3) drilling investigation, No.E1, No.E2 and No.E5, were performed at proposed dam site E.

Borehole No.E1 and No.E2, located at the left abutment and near the top of the small hill on the proposed dam axis, respectively, indicates similar geological facies including thickness of highly weathered rock zone. Thickness of overburden soil consist of silty clay shows 4.0 m (No.E1) to 7.0 m (No.E2). This overburden deposit indicates 8 - 32 in N value. The two (2) boreholes is underlain by approximately 1.5 m thick highly weathered rock, which indicates silty sand facies with base rock fragment. Moderately weathered rock, 1.6 m (No.E1) and 8.5 m (No.E2) in thickness and are composed of hard and fractured base rock were also indicated. Beneath the above rocks, fresh rock was observed up to the bottom of the borehole. Geological facies are made up of weakly metamorphosed sandstone and amphibolite.

Borehole No.E5 is located at the right abutment of the proposed dam site. This borehole is underlain by 1.5 m thick overburden deposit with sandy gravel and lacks highly weathered rock. Moderately weathered rock has 5.5 m in thickness and shows moderately cemented rock facies. Beneath these formation, fresh rock is encountered at the bottom of the borehole. Geological facies is composed of serpentinited peridotite on the whole.

Coefficient of permeability of overburden deposit and highly weathered rock indicates 1.5-4.7$\times 10^{-3}$ cm/sec and moderately weathered rock and fresh rock shows 1.3-2.0$\times 10^{-4}$ cm/sec.

Geological conditions of this proposed dam site is summaized and presented below.

1. Base rock is made up of member of the Inagawan Metamorphics (mainly amphibolite) and the Mt. Beaufort Ultramafics (serpentinited peridotite).
2. At the left abutment and near the top of the small hill approximately at the middle place of both abutments, overburden deposit exist 4 to 7 m in thickness and shows 4 to 32 in N value. Below the overburden deposit occurs about 1.5 m thick of highly weathered zone. At the right abutment, overburden deposit is observed as thin layer (1.5 m in thickness). However, highly weathered rock zone is not very evident.
3. The moderately weathered rock zone is 4 to 9 m thick as a whole. Fresh rock zone is observed about 13 to 14 m depth, except at the right abutment. At the right abutment, fresh rock zone can be encountered at the depth of 7 m.
4. The thickness of alluvial deposit (river deposit) at the Pinagsaluran river and its tributaries is observed as less than 5 m.
5. Coefficient of permeability of the overburden deposit and highly weathered rock zone indicates n$\times 10^{-3}$ cm/sec in order and that of moderately rock zone and fresh rock zone shows n$\times 10^{-4}$ cm/sec in order.
6. It is worth noting that thrust fault is known to be present at the base rock near the right abutment.
7. From the engineering geological viewpoint, it has been pointed out that particular attention to foundation treatment is not proposed, excluding existence of thrust fault, in this dam site.

5) Proposed Dam Site El

Two (2) boreholes, No.E3 and No.E4, were drilled at this proposed dam site. Borehole No.E3 is located at the foot of the left abutment. This hole is underlain by 4.0 m thick overburden deposit (recent talus deposit), which are composed of clayey silt with some sand and gravel, and 11.0 m of thick diluvial deposit. This diluvial deposit corresponds to the Iwahig Formation (old talus deposit) and consists of sandy gravel with highly fractured and oxidized sandstone boulder. Overburden deposit and diluvial deposit shows 2 - 15 and 25

- 34 in N value, respectively. Beneath this formation, another diluvial deposit is found at a scale of 14.2 m in thick. This diluvial deposit also correspond to the Iwahig Formation (old river deposit), which contains rounded to sub-rounded gravels and cobbles. The top of this deposit (3.0 m thick) consists of clayey silt as old top soil. Base rock (moderately weathered rock) as weakly metamorphosed sandstone is encountered at depth of 29.2 m.

Borehole No.E4, which is located near the river bed of Pinagsaluran river, is underlain by 3.7 m thick alluvial deposit (recent river deposit) and 15.3 m thick diluvial deposit. This diluvial deposit correspond to the Iwahig Formation (old river deposit) and is made up of sand and gravel with rounded cobbles and boulders. Alluvial deposit and diluvial deposit indicate 2 - 15 and 25 - 50 in N value, respectively. Base rock (moderately weathered rock) as surpentinited peridotite is found out at 19.0 m in depth.

Coefficient of permeability of diluvial deposit and base rock shows 1.5×10^{-3} to 1.1×10^{-2} cm/sec with high permeable characteristic.

Geological condition of proposed dam site El is summarized as follows:

1. Base rock consists of member of the Inagawan Metamorphics (weakly metamorphosed sandstone), the Mt. Beaufort Ultramafics (serpentinited peridotite) and the Iwahig Formation.
2. The sand and gravel layer as recent talus deposit and the Iwahig Formation (old talus deposit and old river deposit) is widespread at the foot of the left abutment. The thickness of this layer is about 29 m.
3. At the river bed of Pinagsaluran river, the sand and gravel layer as recent river deposit and the Iwahig Formation (old river deposit) is also observed with a total thickness of about 19 m.
4. Coefficient of permeability of these sand and gravel layers indicate $n\times10^{-3}$ to $n\times10^{-4}$ cm/sec in order as high permeable characteristic.
5. It is worth noting that thrust fault is known to be present near this dam site.
6. Taking both the large-scale distribution and high permeable characteristic of sand and gravel layer (alluvial deposit and diluvial deposit) into consideration, it is judged that this site is not recommendable for dam construction because of the need for special foundation treatment, diaphragm method, special grouting method and blanket method etc. Large treatment cost is needed to prevent seepage flow.

d) Test Pitting

Test pits have been excavated at five (5) sites designated as A to E, borrow areas. The bill of quantities for test pitting are as follows:

Borrow Area	No. of Test pit	Excavation Depth	Borrow Area	No. of Test Pit	Excavation Depth
Borrow area A	TP1	1.0 m	Borrow area B	TP9	3.0 m
	TP1-1	4.0 m		TP9-1	2.0 m
	TP2	5.0 m		TP10	5.0 m
	TP3	3.0 m		TP11	5.0 m
	TP3-1	2.0 m		TP12	5.0 m
	TP4	3.0 m		TP13	5.0 m
	TP4-1	2.0 m	Borrow area E	TP14	1.5 m
	TP5	5.0 m		TP15	1.5 m
	TP6	5.0 m	Borrow area C	TP16	3.0 m
	TP7	5.0 m		TP16-1	2.0 m
	TP8	2.1 m	Borrow area D	TP17	1.0 m
	TP8-1	3.0 m		TP18	1.0 m

The results of test pitting are shown in Figure E. 2. 2 Furthermore, soil test was carried out using collected samples from test pit.

TP1 to TP8 (TP8-1) are dug at the borrow area A, which is situated at the right side of the downstream area at the proposed dam site El. As a general aspect of these test pit investigations, it is worth noting that suitable core material, which corresponds to the impervious material, occurs in three (3) varieties. The first is gravelly silt and gravelly clay, reddish in color. The second is gravelly clay in grayish and the last is gravelly silt, which have been derived/originated principally from the highly weathered igneous rocks, in reddish brown. The thickness of core materials for dam embankment, which mainly consist of gravely clay, gravely silt, clayey sand and silty clay, which is GC, GM, SC and CL as soil type for material, can be detected at depths between 2 to 5 m with 3 m on the average.

TP9 to TP13 are excavated at the borrow area B, which is mainly situated near the proposed dam site Eu. In this area, soil materials occur in many varieties, which are composed of gravelly clay, gravelly silt, sandy clay and silt. The soil type for material is of GC, GM, SC and MH. Taking the various kinds of soil materials into consideration, this borrow area can be used as random material, which corresponds to so-called semi-pervious material, for dam embankment.

TP16 (16-1) has been carried out at the borrow area C which is located at the foot of the left side abutment of the proposed dam site E. In this area, soil facies show gravelly clay, GC and GM as soil type, which is characterized by large amount of gravel in the formation. The feature described above, of C borrow area, can be also used as random material for dam embankment.

TP16 and TP17 has been excavated at the borrow area D which is located along the Pinagsaluran river at the downstream of proposed dam site El. In these test pits, sandy and gravely materials can be observed up to the bottom of the pit. The same materials can be traced at the downstream area of proposed dam site El. In effect, it is considered that these materials can be used as filter material for dam embankment and a part of fine aggregate for concrete.

TP14 and TP15 has been carried out at the borrow area E which is located at the flood plain near the confluence point of the Inagawan and the Pinagsaluran river. The results of test pits and field survey works reveal that riprap material and some coarse aggregate for concrete, in sufficient quality as well as gravel size, can be collected from this borrow area.

The results of test pitting at the proposed sites for borrow area are summarized below. In addition, the quantity of each material is expected to be sufficient enough for the need of the project.

Proposed Borrow Area

Core material ..... (Impervious Material)	Borrow area A
Random material ..... (Semi-pervious material)	Borrow area B, C
Filter material	Borrow area D
Riprap material	Borrow area E
Fine aggregate	Borrow area D Inagawan river and Tagbarungis river
Coarse aggregate	Borrow area E Inagawan river and Tagbarungis river

e) Auger Hole Drilling

Auger hole drilling, totaling 15 holes (45.0 m), were performed at the borrow area A. The results of auger hole drilling are shown in Figure E. 2. 3. The collected sample condition of each auger hole mainly consists of GC, CL and CH as soil type for material and is similar to the case of test pitting results. Furthermore, soil test were carried out using a part of the collected sample by auger hole drilling.

f) Soil and Rock Test

Two (2) kinds of soil test, physical and mechanical test, and rock test were carried out the purpose of evaluating / confirmating the property of soil and rock material. The test samples were collected from test pits, auger hole drilling and boring core.

Item and quantity for soil and rock test are as follows:

	Core	Random	Filter	Rock
(1) Physical test				
Specific gravity	31	10	4	-
Grain size analysis	31	10	4	-
Field moisture content	31	10	-	-
Plastic / liquid limit	31	10	-	-
(2) Mechanical test				
Compaction test (150 mm)	4	4	1	-
Permeability test (100 mm)	4×2	2×2	-	-
Direct shear test	4	-	-	-
(3) Rock test				
Specific gravity	-	-	-	9
Water absorption	-	-	-	9
Soundness	-	-	-	9
Unconfined compress. test	-	-	-	9

* For the soil tests by auger hole sampling only physical test were performed.

* The results of soil test are shown in Table E. 2. 3 to E. 2. 5. The grain size distribution curve in material is shown in Figure E. 2. 4 to E. 2. 7 and plastic index is also shown in Figure E. 2. 8 to E. 2. 9, respectively.

The core material will be taken from the borrow area A. The soil type for the material is mainly GC, CM, SC and CL (CH)*. It is evaluated that the materials have good grain size distribution curve as a whole but large amount

of fine particle of grain size are included. According to the field observation of each test pit, they usually contain gravel (1 to 5 cm in diameter). It is considered that this material is characterized by large compaction effect (maximum dry density 1.51 to 1.82 kg/sq.cm, excluding TP2 sample) and has impermeable characteristic and large shearing strength on the condition that compaction is satisfactorily carried out.

* The soil type based on the soil test by auger hole sample mainly indicates SC, CH and CL . It may be inferred that a part of gravel is removed on the condition of sampling.

The random material can be taken from that of borrow areas B and C. The soil type for material is composed of GC, GM, SC and MH. They also have good grain size distribution curve as a whole, which are similar to that of borrow area A though it has somewhat a rich coarse grain size. Excavated test pit of these borrow areas A, however, shows a soil material that is usually found associated with large size of gravel in comparison with the borrow area A. (borrow area B includes 1 to 10 cm in diameter as gravel and borrow area D remarkably contain 10 cm or over in diameter as gravel.) The result of compaction test indicates 1.64 to 1.77, excluding TP9 sample, in maximum dry density. This value corresponds to that of a material of large compaction effect. Taking these soil characteristic into consideration, it is judged that the material of these borrow area has sufficient shearing strength for random material.

The filter material will be collected from the D borrow area. The material is characterized by a rich gravel and sand (total 90% or over) and shows GW, GC and SW as soil type. The result of compaction test indicates 1.85 g/cm^3 as maximum dry density. Information provided by soil test shows that material of this borrow area can be sufficiently used as filter zone for fill-dam.

Rock test was performed by the use of boring core sample. All sampling targets located into the base rock, consist of sandstone and peridotite etc. As to the result of rock test, the unconfined compressive strength values are distributed at the range of 90 to 430 kg/sq.km except that low value due to fractured piece condition. The specific gravity is widely distributed over a range of 2.44 to 3.15, while absorption also indicates a wide range of 0.7 to 8.6%. As to the rock properties, it is judged that the base rock has sufficient bearing capacity and strength for dam foundation.

Table E. 2. 1 Results of Standard Penetration Test

Borehole No.	Depth of Tested Section (m)	N-value	Remarks
No. D2	1.0~1.45	18	River Deposit
	2.0~2.45	25	River Deposit
	3.0~3.45	32	River Deposit
	4.0~4.45	50 over	River Deposit
No. D3	1.0~1.45	16	Highly Weathered Rock
	2.0~2.45	19	Highly Weathered Rock
	3.0~3.45	25	Highly Weathered Rock
	4.0~4.45	32	Highly Weathered Rock
	5.0~5.45	50 over	Highly Weathered Rock
No. E1	1.0~1.45	8	Talus Deposit
	2.0~2.45	11	Talus Deposit
	3.0~3.45	12	Talus Deposit
	4.0~4.45	22	Talus Deposit
	5.0~5.45	20	Talus Deposit
	6.0~6.45	24	Talus Deposit
No. E2	1.0~1.45	4	Talus Deposit
	2.0~2.45	11	Talus Deposit
	3.0~3.45	31	Old Talus Deposit (Iwahig Formation)
	4.0~4.45	32	Old Talus Deposit (Iwahig Formation)
No. E3	1.0~1.45	4	Talus Deposit
	2.0~2.45	8	Talus Deposit
	3.0~3.45	11	Talus Deposit
	4.0~4.45	27	Old Talus Deposit (Iwahig Formation)
	5.0~5.45	25	Old Talus Deposit (Iwahig Formation)
	6.0~6.45	26	Old Talus Deposit (Iwahig Formation)
	7.0~7.45	31	Old Talus Deposit (Iwahig Formation)
	8.0~8.45	34	Old Talus Deposit (Iwahig Formation)
	15.0~15.45	33	Old River Deposit (Iwahig Formation)
	16.0~16.45	38	Old River Deposit (Iwahig Formation)
	17.0~17.45	50 over	Old River Deposit (Iwahig Formation)
No. E4	1.0~1.45	2	River Deposit
	2.0~2.45	5	River Deposit
	3.0~3.45	15	River Deposit
	7.0~7.45	25	Old River Deposit (Iwahig Formation)
	8.0~8.45	32	Old River Deposit (Iwahig Formation)
	9.0~9.45	26	Old River Deposit (Iwahig Formation)
	10.0~10.45	34	Old River Deposit (Iwahig Formation)
	12.0~12.45	36	Old River Deposit (Iwahig Formation)
	13.0~13.45	50 over	Old River Deposit (Iwahig Formation)
	14.0~14.45	50 over	Old River Deposit (Iwahig Formation)
	18.0~18.45	50 over	Old River Deposit (Iwahig Formation)

※ No. SPT are conducted at No. E5 and No. D1 since SPT is not applicable.

Table E.2.2 Summary of Permeability Test Results

Borehole No.	Depth of Tested Section (m)	Depth of Tested Section (EL.m)	K (cm/s)	Lu	Pt (kg/cm²)	Testing Method	Water Table (EL.m)	Remarks
No. D1	5.0~5.5	EL15.8~EL15.3	4.6×10^{-3}	-	-	C.T.	EL17.6	River Deposit
	10.0~10.5	EL10.8~EL10.3	3.1×10^{-3}	-	-	C.T.	EL17.6	River Deposit
	15.0~15.5	EL5.8~EL5.3	2.4×10^{-3}	-	-	C.T.	EL17.6	River Deposit
	20.0~20.5	EL0.8~EL0.3	2.8×10^{-3}	-	-	C.T.	EL17.6	River Deposit
	25.0~25.5	EL (-) 4.2~EL (-) 4.7	1.8×10^{-3}	-	-	C.T.	EL17.6	River Deposit
No. D2	5.0~5.5	EL20.2~EL19.7	2.0×10^{-3}	-	-	C.T.	EL21.2	River Deposit
	10.0~10.5	EL15.2~EL14.7	2.4×10^{-3}	-	-	C.T.	EL21.2	River Deposit
	15.0~15.5	EL10.2~EL9.7	1.1×10^{-3}	-	-	C.T.	EL21.2	River Deposit
	20.0~20.5	EL5.2~EL4.7	2.2×10^{-3}	-	-	C.T.	EL21.2	River Deposit
No. D3	5.0~5.5	EL51.8~EL51.3	2.0×10^{-3}	-	-	C.T.	EL51.1	Highly Weathered Rock (Ss)
	5.45~10.0	EL51.35~EL46.8	3.0×10^{-4}	23.6	>3.35	W.P.	EL51.1	Moderately Weathered Rock (Ss)
	10.0~15.0	EL46.8~EL41.8	2.6×10^{-4}	20.1	>3.52	W.P.	EL51.1	Moderately Weathered Rock (Ss)
	15.0~20.0	EL41.8~EL36.8	2.7×10^{-4}	20.7	>3.67	W.P.	EL51.1	Fresh Rock (Ss)
No. E1	5.0~5.5	EL57.0~EL56.5	4.7×10^{-3}	-	-	C.T.	EL57.9	Talus Deposit
	10.0~10.5	EL52.0~EL51.5	1.5×10^{-3}	-	-	C.T.	EL57.9	Moderately Weathered Rock (Amp)
	10.0~15.0	EL52.0~EL47.0	2.0×10^{-4}	15.6	>3.47	W.P.	EL57.9	Moderately Weathered ~Fresh Rock (Amp)
	15.0~20.0	EL47.0~EL42.0	2.0×10^{-4}	15.2	>3.43	W.P.	EL57.9	Fresh Rock (Amp)
No. E2	5.0~5.5	EL47.0~EL46.5	2.2×10^{-3}	-	-	C.T.	EL46.8	Highly Weathered Rock (Amp)
	10.0~10.5	EL42.0~EL41.5	1.9×10^{-3}	-	-	C.T.	EL46.8	Moderately Weathered Rock (Amp)
	10.0~15.0	EL42.0~EL37.0	1.6×10^{-4}	12.3	>3.34	W.P.	EL46.8	Moderately Weathered ~Fresh Rock (Amp)
	15.0~20.0	EL37.0~EL32.0	1.5×10^{-4}	11.8	>3.50	W.P.	EL46.8	Fresh Rock (Amp)
	20.0~25.0	EL32.0~EL27.0	1.6×10^{-4}	12.3	>3.54	W.P.	EL46.8	Fresh Rock (Amp)
No. E3	5.0~5.5	EL41.0~EL40.5	3.7×10^{-3}	-	-	C.T.	EL42.0	Old Talus Deposit (Iwa.F)
	10.0~10.5	EL36.0~EL35.5	2.5×10^{-3}	-	-	C.T.	EL42.0	Old Talus Deposit (Iwa.F)
	15.0~15.5	EL31.0~EL30.5	2.1×10^{-3}	-	-	C.T.	EL42.0	Old Talus Deposit (Iwa.F)
	20.0~20.5	EL26.0~EL25.5	1.5×10^{-3}	-	-	C.T.	EL42.0	Old River Deposit (Iwa. F)
	25.0~25.5	EL21.0~EL20.5	1.5×10^{-3}	-	-	C.T.	EL42.0	Old River Deposit (Iwa. F)
	29.5~30.0	EL16.5~EL16.0	2.5×10^{-3}	-	-	C.T.	EL42.0	Moderately Weathered Rock (Ss)
No. E4	10.0~10.5	EL20.5~EL20.0	5.7×10^{-3}	-	-	C.T.	EL29.2	Old River Deposit (Iwa. F)
	15.0~15.5	EL15.5~EL15.0	1.1×10^{-2}	-	-	C.T.	EL29.2	Old River Deposit (Iwa. F)
	20.0~20.5	EL10.5~EL10.0	9.1×10^{-3}	-	-	C.T.	EL29.2	Old River Deposit (Iwa. F)
	25.0~25.5	EL5.5~EL5.0	4.0×10^{-3}	-	-	C.T.	EL29.2	Old River Deposit (Iwa. F)
No. E5	5.0~5.5	EL63.0~EL62.5	3.7×10^{-3}	-	-	C.T.	EL66.6	Moderately Weathered Rock (Per)
	10.0~10.5	EL58.0~EL57.5	2.6×10^{-3}	-	-	C.T.	EL66.6	Fresh Rock (Per)
	10.0~15.0	EL58.0~EL53.0	1.3×10^{-4}	10.0	>3.14	W.P.	EL66.6	Fresh Rock (Per)
	14.0~19.0	EL54.0~EL49.0	1.4×10^{-4}	10.5	>3.15	W.P.	EL66.6	Fresh Rock (Per)

※ K ; Coefficient of permeability Lu ; Lugeon value

Pt ; Critical Pressure (>3.35; Critical pressure corresponds to 3.35 kg/cm² over)

Item of testing method ; C.T. (Constant head test), W.P. (Water pressure test)

Item of remarks ; Ss (Sandstone), Amp (Amphibolite), Per (Peridotite), Iwa. F (Iwahig formation)

Table E.2.3 Results of Soil Test (Test Pit Sample)

<Physical Test>

No. of Test Pit	Depth (m)	Specific Gravity	Grain Size Distribution				Field Moisture Content (%)	Atterberg Limit			Unified Soil Classification
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)		L.L (%)	P.L (%)	P.I	
TP-1-1	0.00~1.00	2.66	32.0	38.0	12.0	18.0	26.0	49.0	23.0	26.0	SC
	0.15~1.40	2.70	21.0	58.0	6.0	15.0	22.0	42.0	23.0	19.0	SC
TP-2	0.30~1.05	2.72	26.0	13.0	12.0	49.0	25.0	63.0	31.0	32.0	CH
	1.05~3.15	2.75	10.0	16.0	30.0	44.0	68.0	71.0	32.0	39.0	CH
TP-3	0.70~1.70	2.73	28.0	25.0	21.0	26.0	21.0	49.0	24.0	25.0	GC
	2.00~3.00	2.72	28.0	19.0	30.0	33.0	26.0	46.0	20.0	26.0	CL
TP-4	0.90~2.00	2.72	2.0	32.0	37.0	29.0	43.0	67.0	36.0	31.0	MH
	1.40~3.00	2.74	50.0	12.0	21.0	17.0	29.0	70.0	35.0	35.0	GM
TP-5	0.90~2.70	2.71	2.0	17.0	33.0	48.0	53.0	81.0	36.0	45.0	CH
	2.70~4.00	2.70	13.0	16.0	32.0	39.0	53.0	62.0	27.0	35.0	CH
TP-6	0.30~1.40	2.74	24.0	50.0	5.0	21.0	27.0	48.0	26.0	22.0	SC
	4.10~5.00	2.76	3.0	26.0	53.0	18.0	46.0	57.0	34.0	23.0	MH
TP-7	0.80~1.70	2.69	33.0	20.0	15.0	32.0	18.0	43.0	24.0	19.0	GC
	4.00~5.00	2.71	55.0	24.0	7.0	14.0	16.0	38.0	21.0	17.0	GC
TP-8	0.20~0.90	2.79	38.0	33.0	13.0	16.0	19.0	53.0	23.0	30.0	GC
TP-8-1	2.10~3.00	2.74	51.0	12.0	9.0	28.0	31.0	78.0	32.0	46.0	GC
TP-9	0.20~2.00	2.69	6.0	61.0	13.0	20.0	23.0	23.0	17.0	6.0	SC-SM
	2.00~3.00	2.66	22.0	52.0	11.0	15.0	18.0	23.0	17.0	6.0	SC-SM
TP-10	0.20~4.00	2.78	40.0	6.0	44.0	10.0	33.0	68.0	42.0	26.0	MH
	4.00~5.00	2.79	1.0	13.0	65.0	21.0	43.0	54.0	35.0	19.0	MH
TP-11	1.50~2.00	2.67	45.0	22.0	9.0	24.0	23.0	58.0	28.0	30.0	GC
TP-12	0.30~0.10	2.64	44.0	20.0	13.0	23.0	27.0	44.0	22.0	22.0	GC
	1.50~3.00	2.62	24.0	31.0	20.0	25.0	21.0	43.0	19.0	24.0	SC
TP-13	0.15~4.00	2.72	11.0	13.0	44.0	32.0	49.0	55.0	32.0	23.0	MH
	4.00~5.00	2.73	18.0	31.0	35.0	16.0	23.0	43.0	33.0	10.0	ML
TP-16	0.25~3.00	2.66	55.0	19.0	11.0	15.0	20.0	32.0	20.0	12.0	GC
TP-17	0.20~1.00	2.68	60.0	32.0	4.0	4.0	6.0	22.0	15.0	7.0	GW-GC
TP-18	0.40~1.00	2.63	42.0	55.0	0.0	3.0	8.0	-	-	-	SW

* The soil classification by grain size;
Gravel ..... > 4.76 mm Sand .... 4.76 ~ 0.074 mm Silt .... 0.074 ~ 0.005 mm
Clay ..... < 0.005 mm

Table E.2.3 Cont'd

<Mechanical Test>

No. of Test Pit	Depth (m)	Compaction Test		Direct Shean Test		Permeability Test
		Max-γd (gr/cm³)	Wopt (%)	C (kgf/cm²)	φ (°)	Coetticient of Permeability K(cm/s)
TP-2	1.05~3.15	1,190	42.5	0.40	30.0°	8.2×10^{-8} (OMC) 1.1×10^{-7} (95 % MDD)
TP-3	0.70~1.70	1,614	23.6	0 22	29.0°	3.6×10^{-7} (OMC) 6.5×10^{-7} (95 % MDD)
TP-4	1.40~3.00	1,514	25.6	0.10	25.5°	1.8×10^{-6} (OMC) 3.1×10^{-6} (95 % MDD)
TP-7	4.00~5.00	1,820	13.1	0.18	28.0°	3.5×10^{-7} (OMC) 6.2×10^{-7} (95 % MDD)
TP-9	0.20~4.00	1,359	33.7	-	-	-
TP-10	0.20~4.00	1,769	15.3	-	-	1.2×10^{-7} (OMC) 1.6×10^{-7} (95 % MDD)
TP-13	4.00~5.00	1,635	22.5	-	-	-
TP-16	0.25~3.00	1,650	17.0	-	-	5.9×10^{-7} (OMC) 8.9×10^{-7} (95 % MDD)
TP-18	0.40~1.00	1,854	8.7	-	-	-

※ Item of direct shear test; testing point corresponds to 95 % MDD(wet side W.C. at D valve 95 %)
※ Item of permeability test; testing points correspond to OMC (optimum moisture content), and 95 % MDD (wet side W.C. at D valve 95 %)

Table E.2.4 Results of Soil Test (by Auger Hole Sample)

Hole No.	Depth (m)	Specific Gravity	Grain Size Distribution				Field Moisture Content (%)	Atterberg Limit			Unified Soil Classification
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)		L.L (%)	P.L (%)	P.I	
AH-5	0.20 ~ 1.30	2.70	31.0	43.0	6.0	20.0	18.0	46.0	24.0	22.0	SC
	1.30 ~ 2.10	2.73	30.0	17.0	12.0	41.0	31.0	69.0	33.0	36.0	CH
	2.10 ~ 3.00	2.71	28.0	13.0	13.0	46.0	32.0	70.0	31.0	41.0	CH
AH-6	1.00	2.67	23.0	25.0	16.0	36.0	19.0	48.0	17.0	31.0	CL
	1.70	2.65	3.0	30.0	20.0	47.0	27.0	45.0	19.0	26.0	CL
	2.00	2.65	35.0	22.0	16.0	27.0	19.0	47.0	17.0	30.0	GC
AH-11	0.25 ~ 1.50	2.76	41.0	33.0	8.0	18.0	18.0	47.0	25.0	22.0	GC
	1.50 ~ 2.50	2.77	15.0	32.0	16.0	37.0	29.0	59.0	29.0	30.0	CH
	2.50 ~ 3.00	2.78	19.0	25.0	17.0	39.0	33.0	58.0	26.0	32.0	CH
AH-14	0.30 ~ 1.10	2.69	23.0	31.0	19.0	27.0	22.0	42.0	21.0	21.0	SC
	1.10 ~ 2.00	2.64	1.00	25.0	36.0	38.0	21.0	31.0	18.0	13.0	CL
	2.00 ~ 3.00	2.68	0	17.0	26.0	57.0	28.0	54.0	23.0	31.0	CH
AH-15	1.00	2.72	32.0	28.0	21.0	19.0	19.0	53.0	30.0	23.0	GM
	2.00	2.73	28.0	19.0	30.0	27.0	37.0	68.0	34.0	34.0	MH
	3.00	2.74	25.0	27.0	26.0	22.0	42.0	51.0	39.0	12.0	SM

* The soil classification by grain size;
  Gravel ..... > 4.76 mm Sand .... 4.76 ~ 0.074 mm Silt .... 0.074 ~ 0.005 mm
  Clay ..... < 0.005 mm

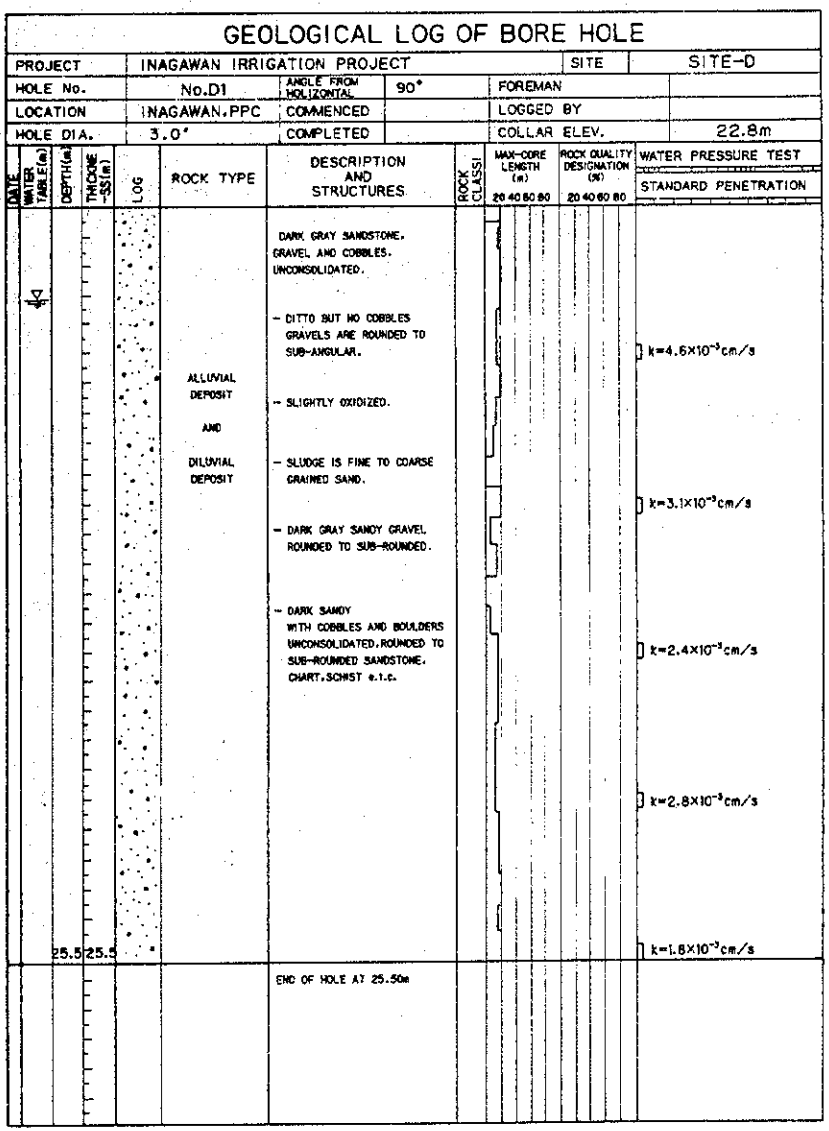
Table E.2.5 Results of Rock (by Boring Core Sample)

Hole No.	Depth (m)	Moisture Content (%)	Bulk Specific Gravity (g/cm³)	Unconfined Compression Test			Absorption (%)	Soundness (%)	Remarks
				Wet Density γt (g/cm³)	Compressive※1 Strength qu (kgf/cm²)	Failure Strain (%)			
No. E1	14.0	1.0	2,649	2.68	207.7	2.19	0.72	2.24	Sandstone
No. E2	15.0	1.0	3,153	3.05	30.3	0.65	0.75	2.43	Amphibolite
	20.0	1.0	3,088	3.06	90.7	0.90	3.16	1.59	Amphibolite
	25.0	1.0	2,950	3.07	26.1	0.30	3.07	3.43	Amphibolite
No. E5	15.0~16.0	3.0	2,508	2.57	115.9	0.95	3.28	2.29	Peridotite
No. D3	14.0	0.4	2,442	2.48	154.5	1.20	3.91	6.05	Sandstone
	16.0	0.9	2,451	2.30	304.6	2.39	8.58	5.28	Sandstone
	17.0	0.5	2,521	2.55	409.3	1.80	6.01	6.90	Sandstone
	18.0	0.3	2,725	2.65	432.3	2.59	5.21	4.97	Sandstone

※1 qu; Unionfined compressive strength

Figure E. 2. 1 Results of Drilling Investigation

Borehole No. D1



Borehole No. D2

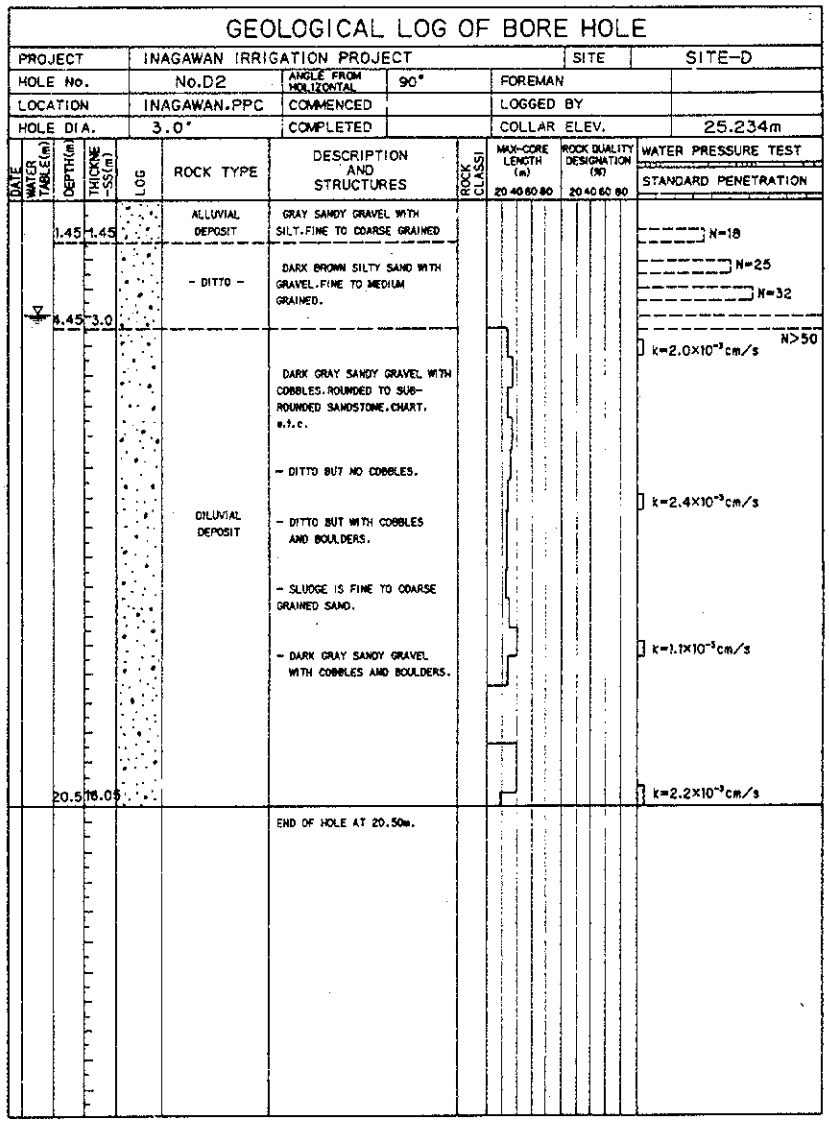
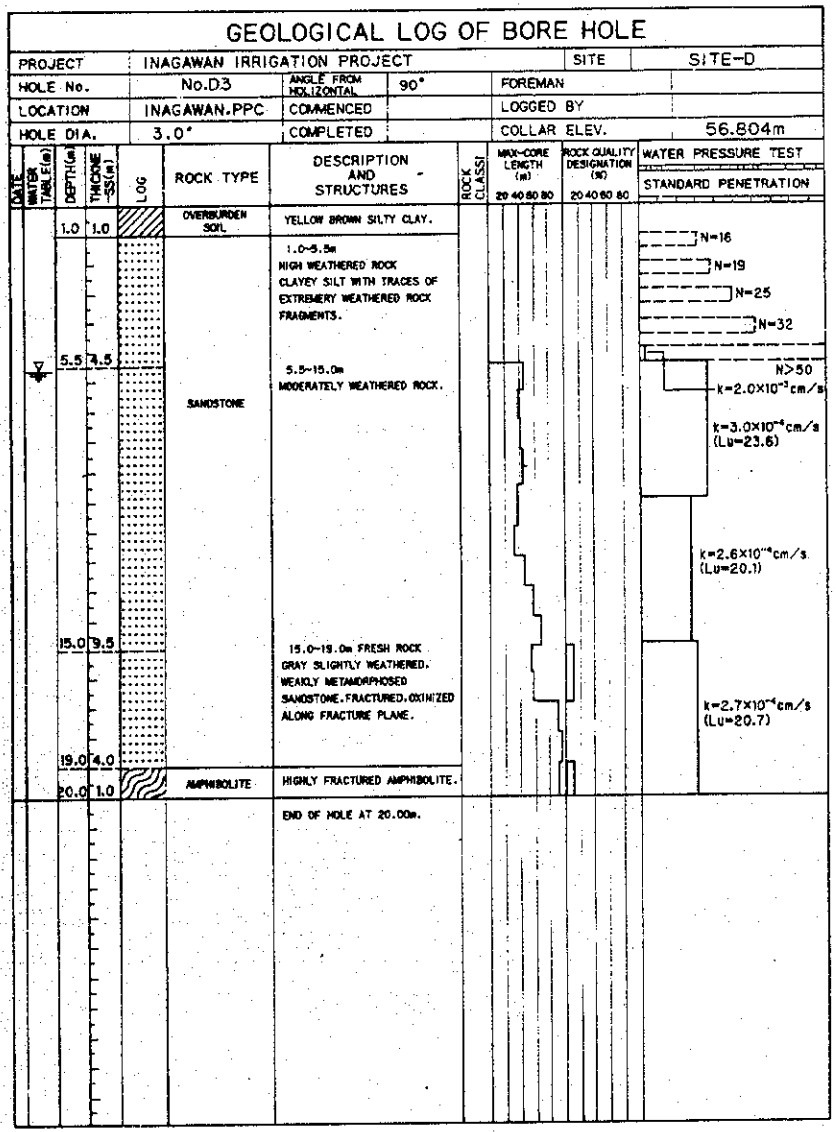


Figure E. 2. 1 (Continued)

Borehole No. D3



Borehole No. E1

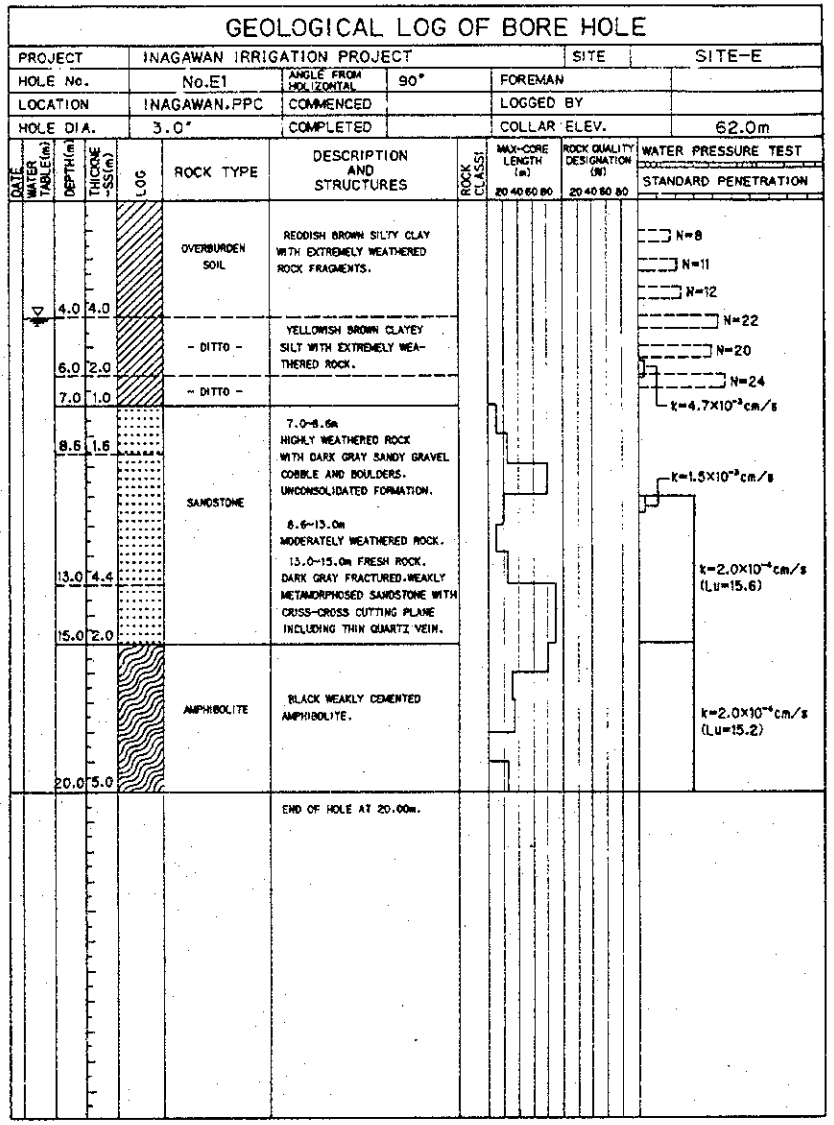
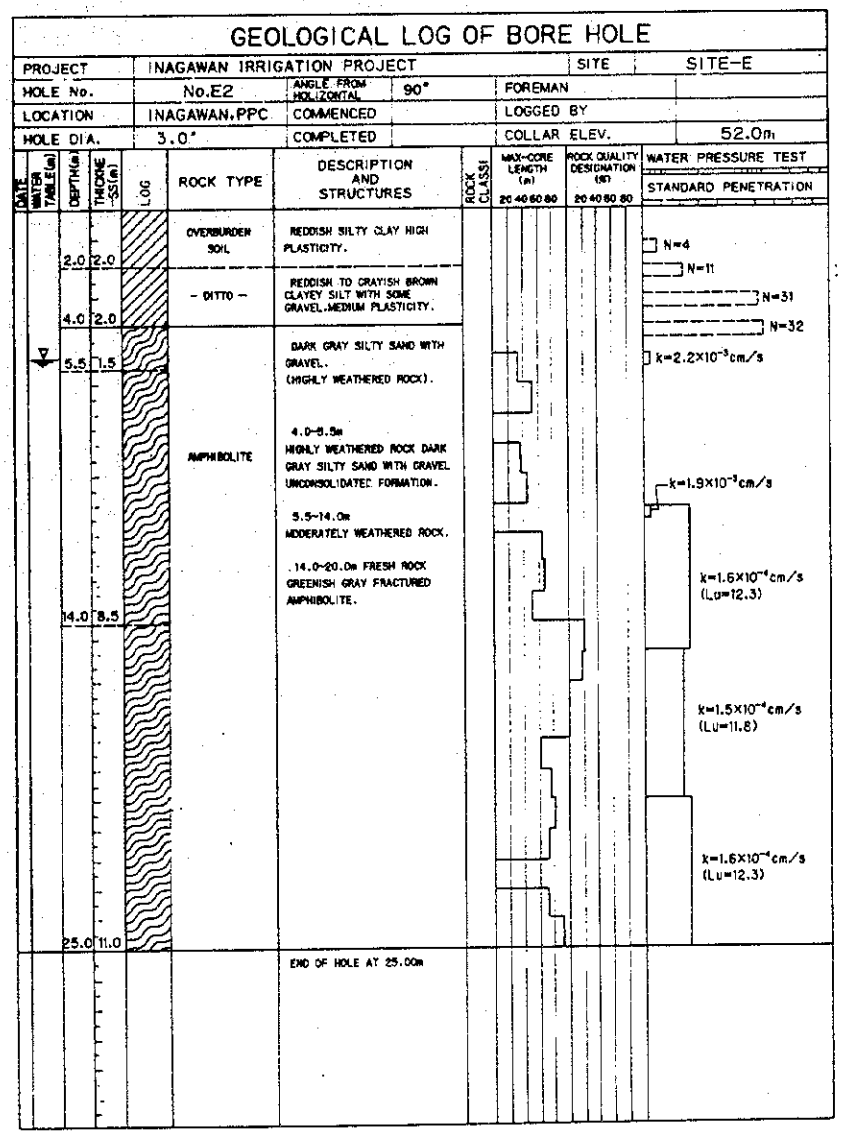


Figure E. 2. 1 (Continued)

Borehole No. E2



Borehole No. E3

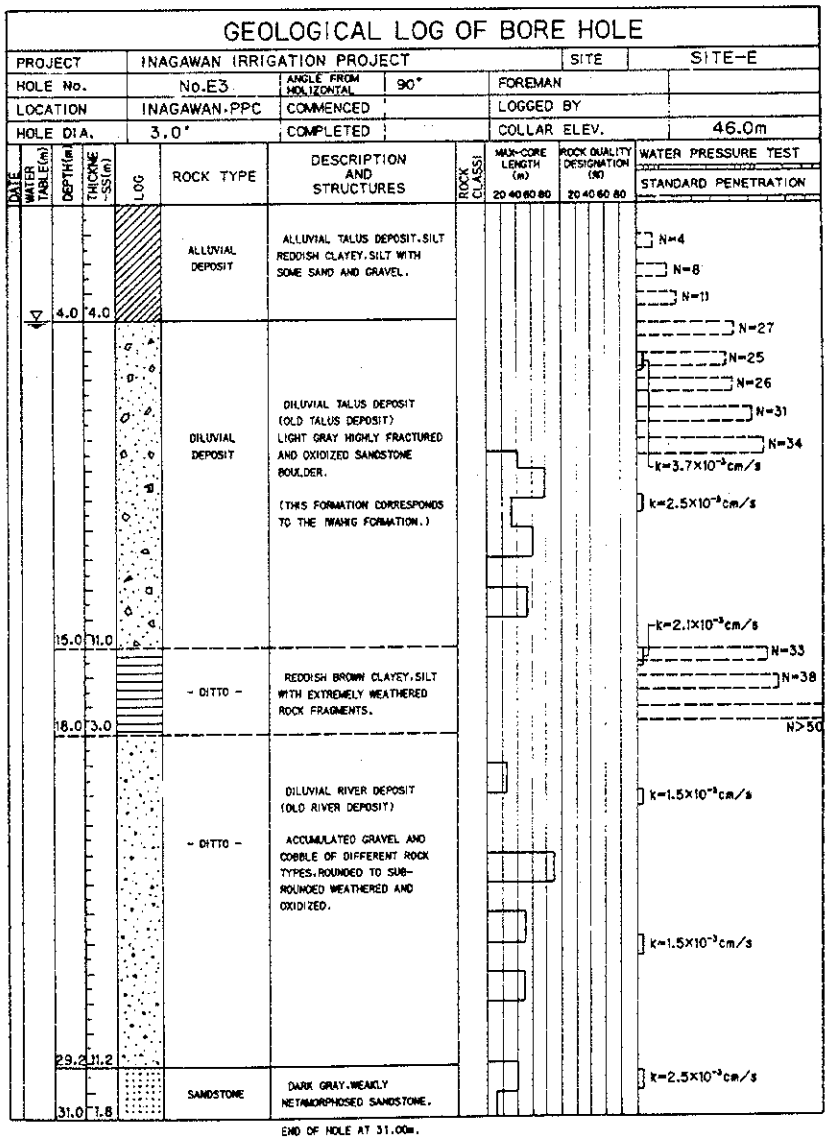
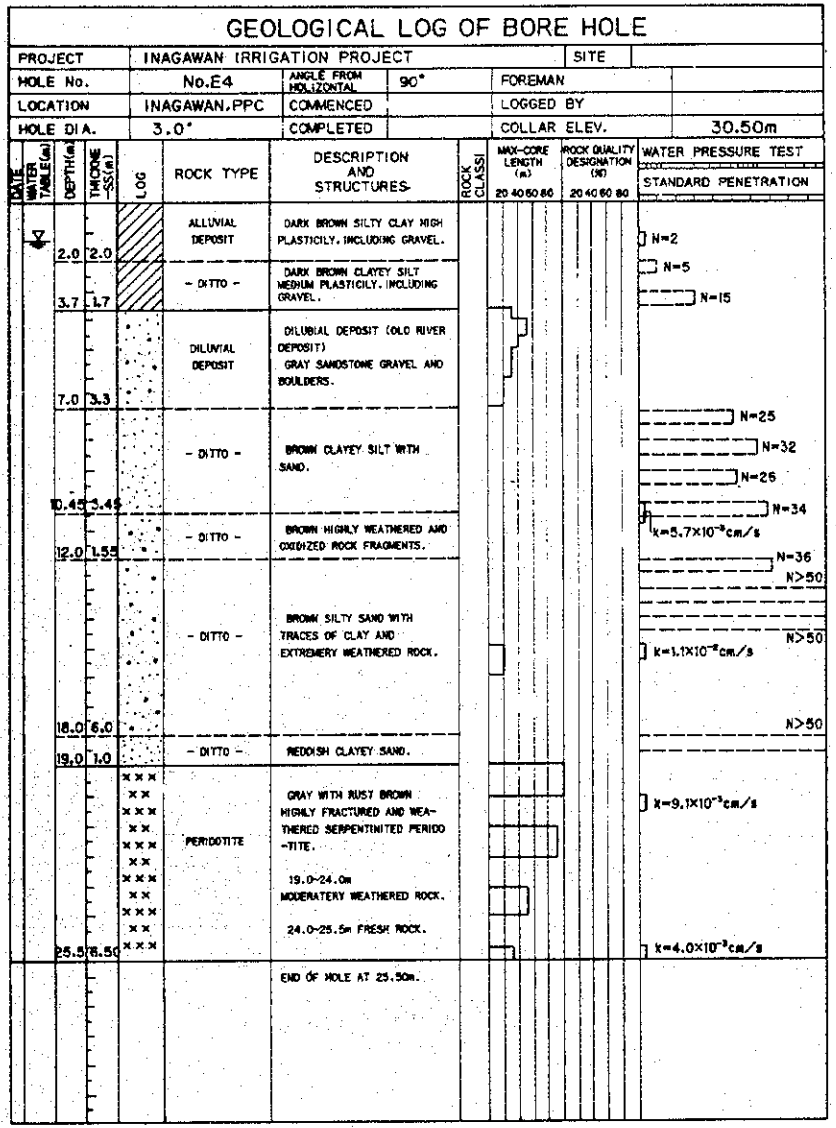


Figure E. 2. 1 (Continued)

Borehole No. E4



Borehole No. E5

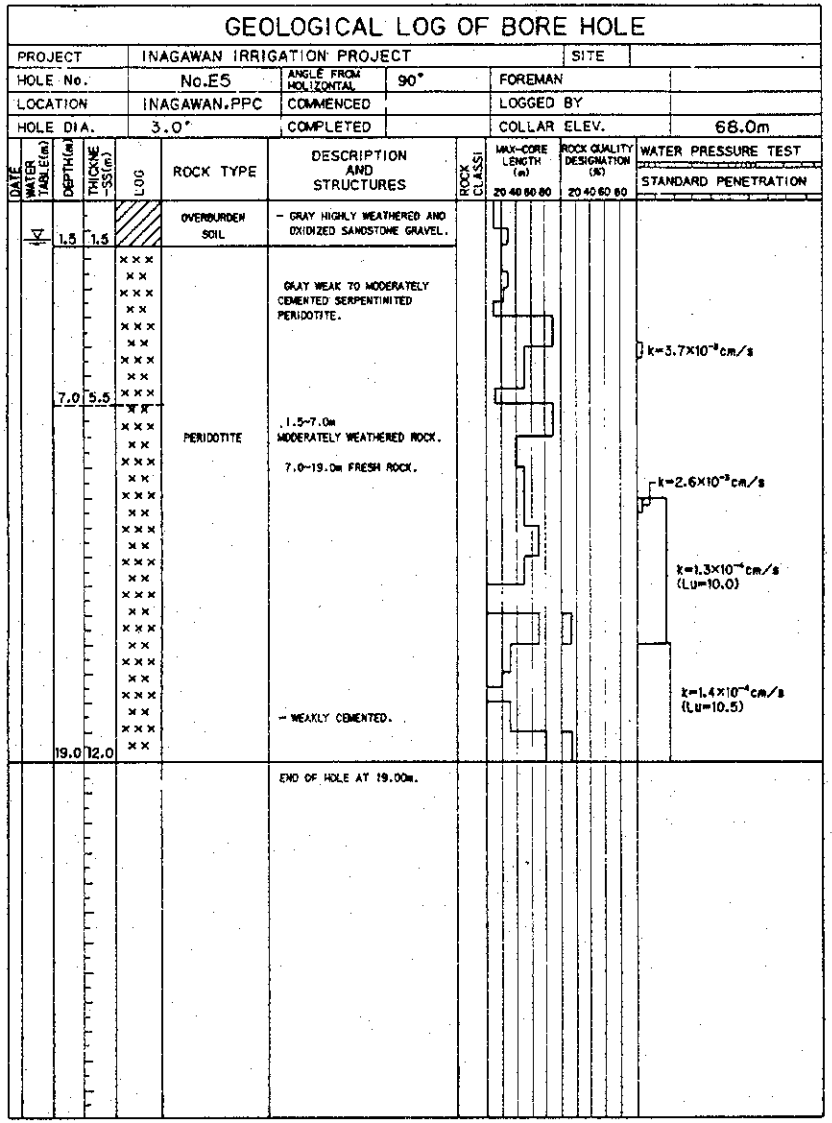
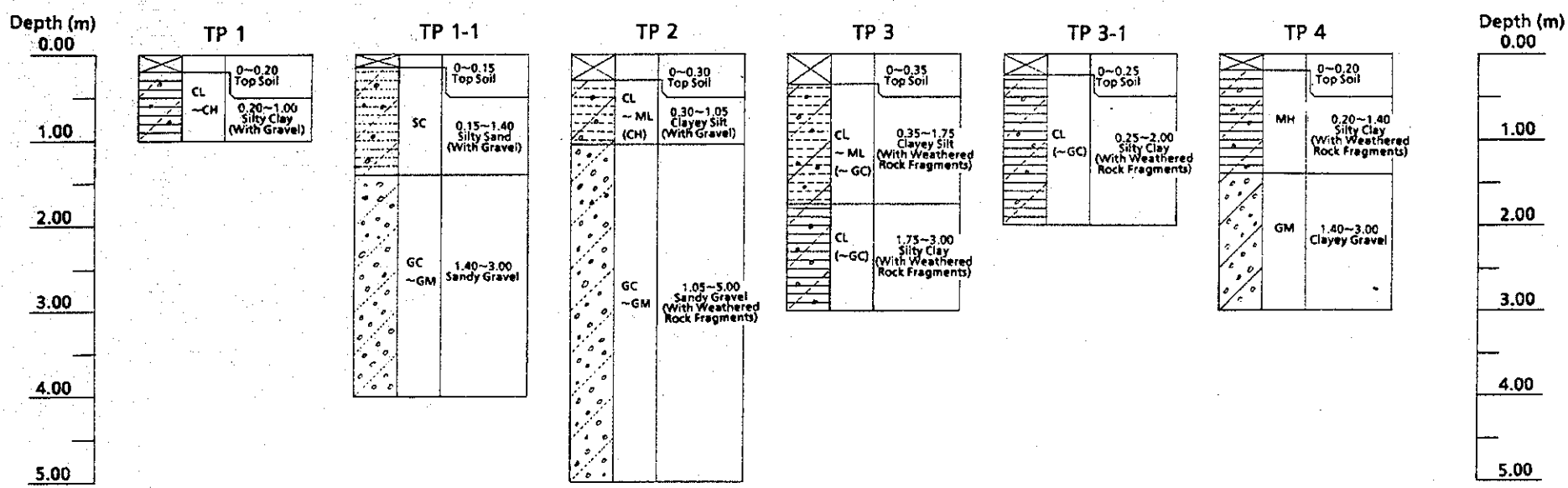
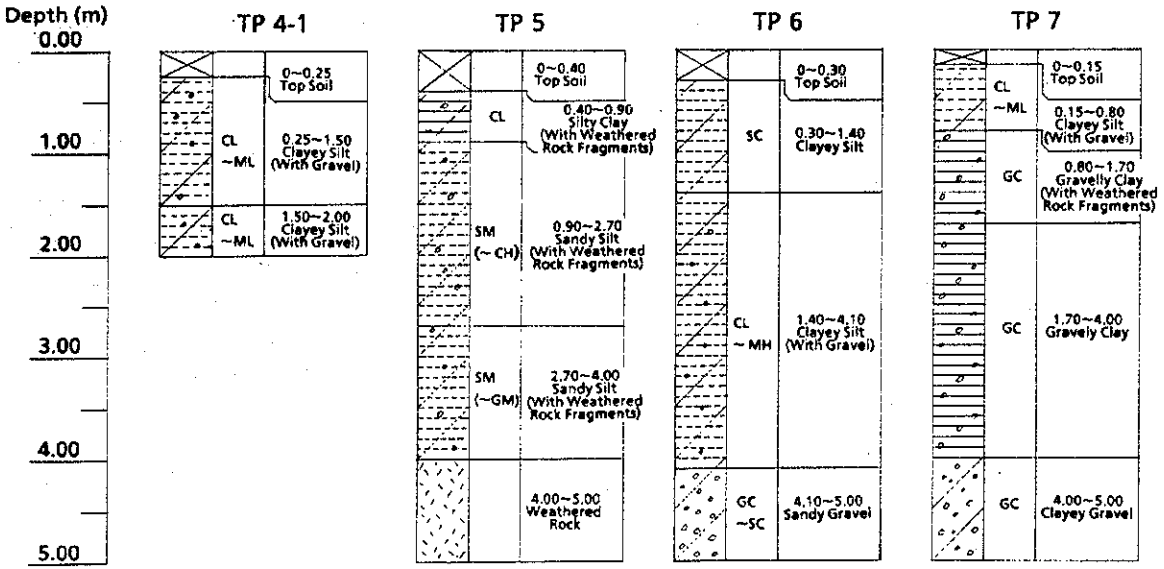


Figure E. 2. 2 Results of Test Pit Investigation





LEGEND

GROUP SYMBOLS	TYPICAL NAMES
GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
GM	Silty gravels, gravel-sand-silt mixtures.
GC	Clayey gravels, gravel-sand-clay mixtures.
SW	Well-graded sands, gravelly sands, little or no fines.
SP	Poorly graded sands, gravelly sands, little or no fines.
SM	Silty sands, sand-silt mixtures.
SC	Clayey sands, sand-clay mixtures.
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity.
CL	Inorganic clays of low to medium plasticity, gravelly clay, sandy clays, silty clays, lean clays.
OL	Organic silts and organic silty clays of low plasticity.
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
CH	Inorganic clays of high plasticity, fat clays.
OH	Organic clays of medium to high plasticity, organic silts.
PT	Peat and other highly organic silts.

USCS : Unified Soil Classification System.

Figure E. 2. 2 (Continued)

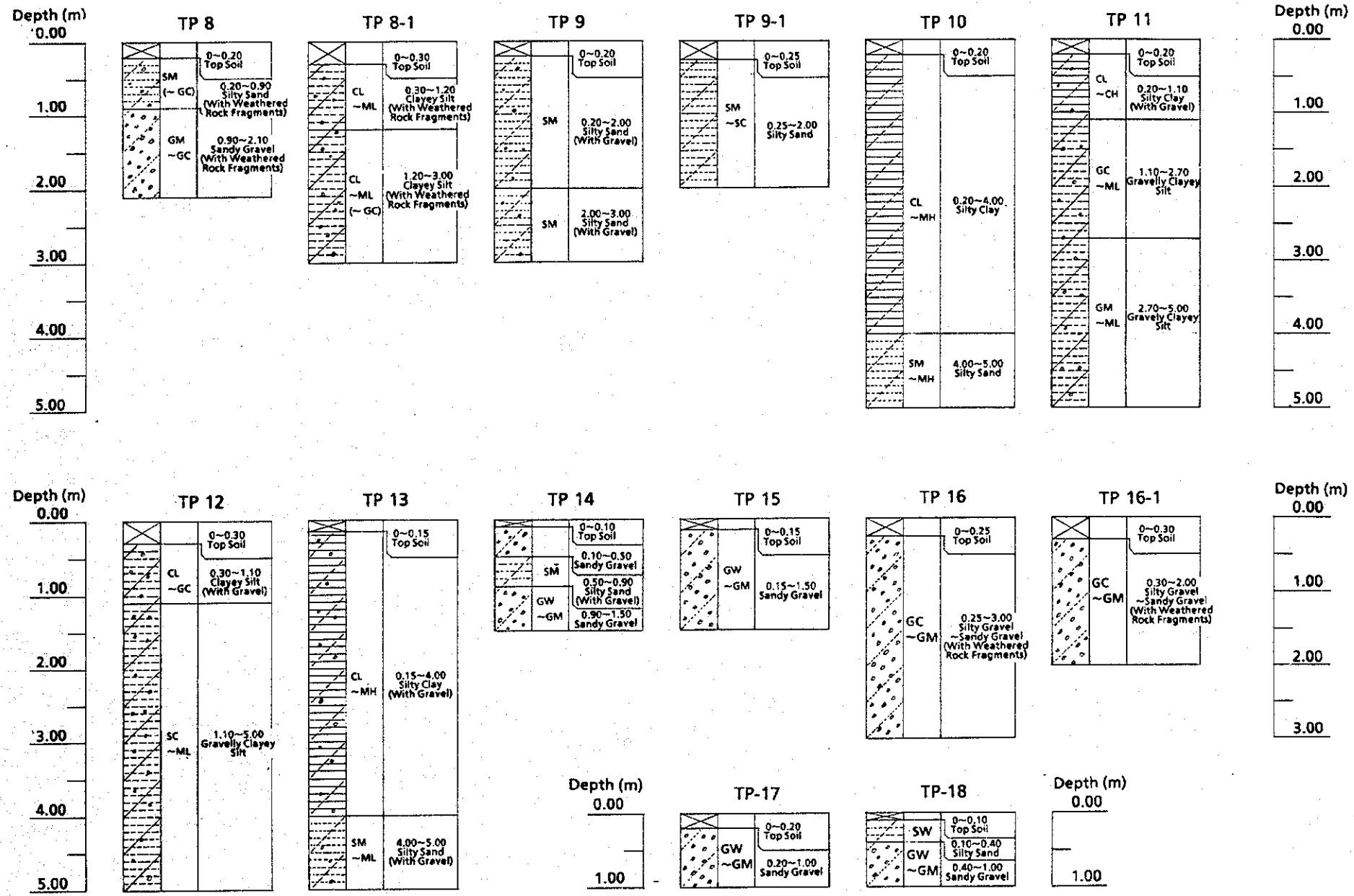
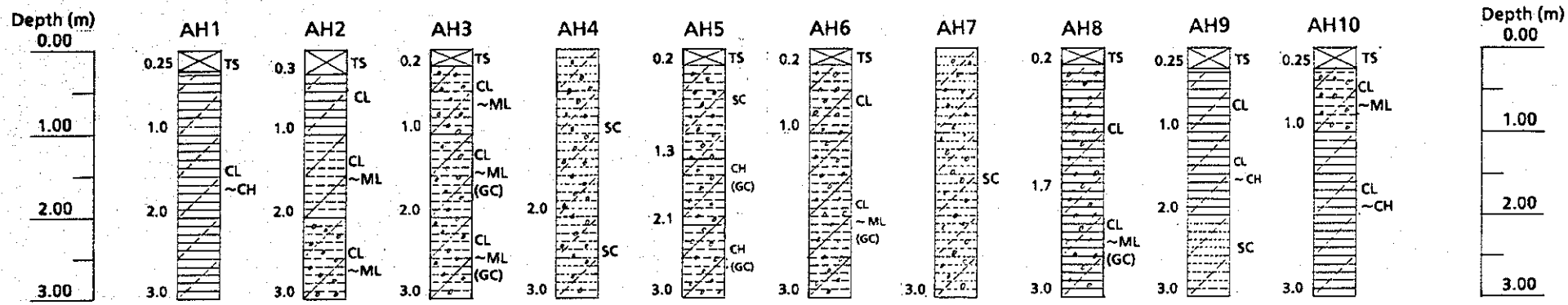
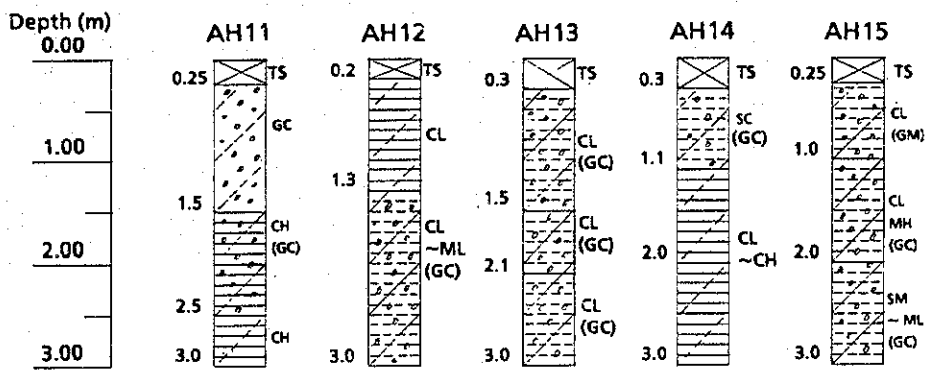


Figure E. 2. 3 Results of Auger Hole Investigation





LEGEND

GROUP SYMBOLS	TYPICAL NAMES
GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
GM	Silty gravels, gravel-sand-silt mixtures.
GC	Clayey gravels, gravel-sand-clay mixtures.
SW	Well-graded sands, gravelly sands, little or no fines.
SP	Poorly graded sands, gravelly sands, little or no fines.
SM	Silty sands, sand-silt mixtures.
SC	Clayey sands, sand-clay mixtures.
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity.
CL	Inorganic clays of low to medium plasticity, gravelly clay, sandy clays, silty clays, lean clays.
OL	Organic silts and organic silty clays of low plasticity.
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
CH	Inorganic clays of high plasticity, fat clays.
OH	Organic clays of medium to high plasticity, organic silts.
PT	Peat and other highly organic silts.

USCS : Unified Soil Classification System.

Figure E. 2. 4 **Grain Size Distribution Curve of Soil (by Test Pit Sample, Borrow Area A)**

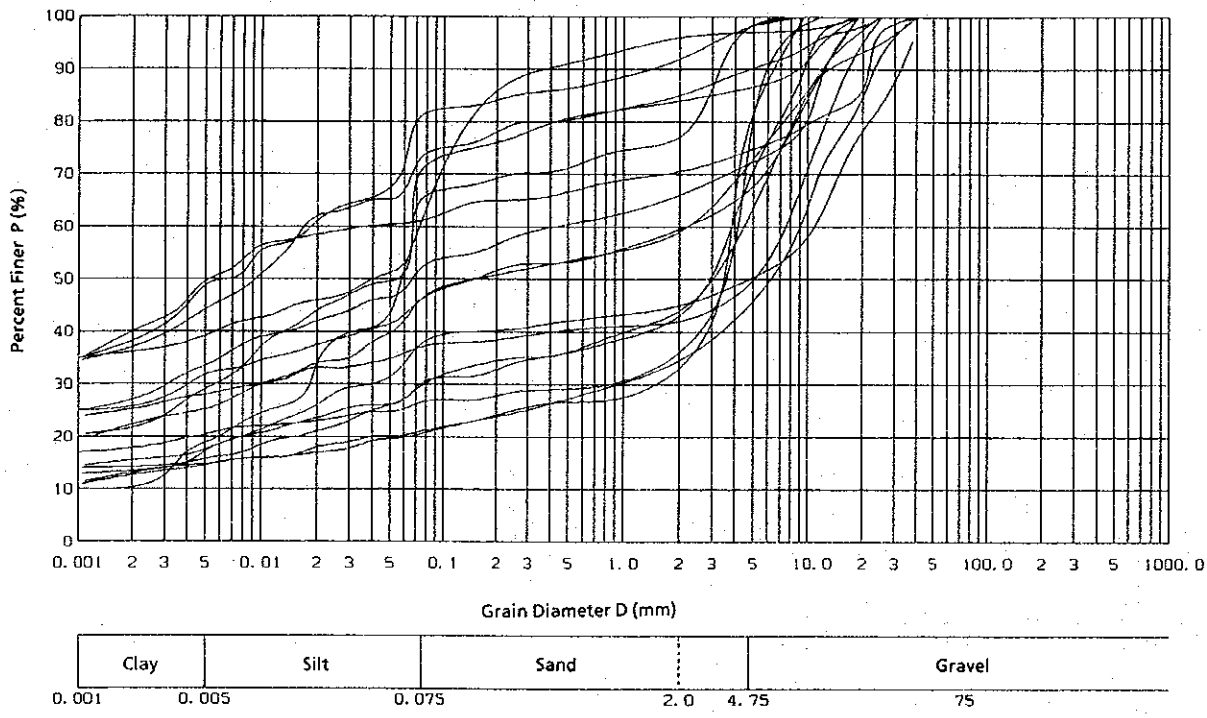


Figure E. 2. 5 **Grain Size Distribution Curve of Soil (by Test Pit Sample, Borrow Area B, C)**

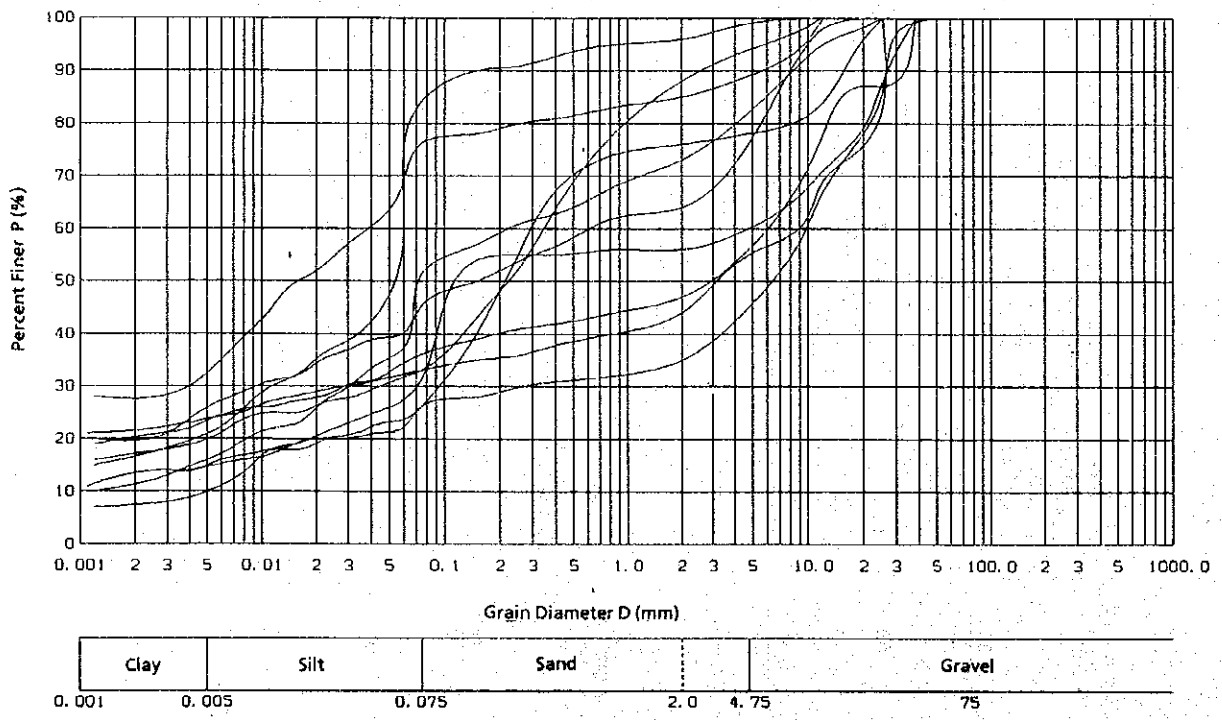


Figure E. 2. 6 **Grain Size Distribution Curve of Soil (by Test Pit Sample, Borrow Area D)**

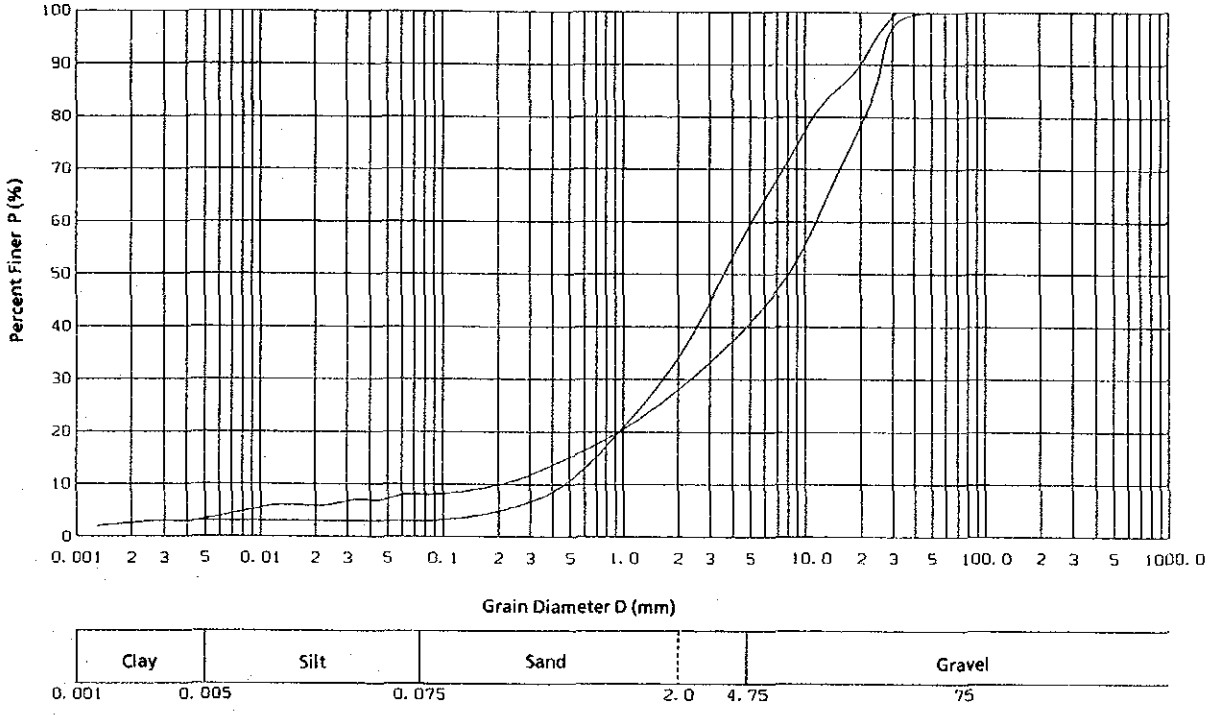


Figure E. 2. 7 **Grain Size Distribution Curve of Soil (by Auger Hole Sample)**

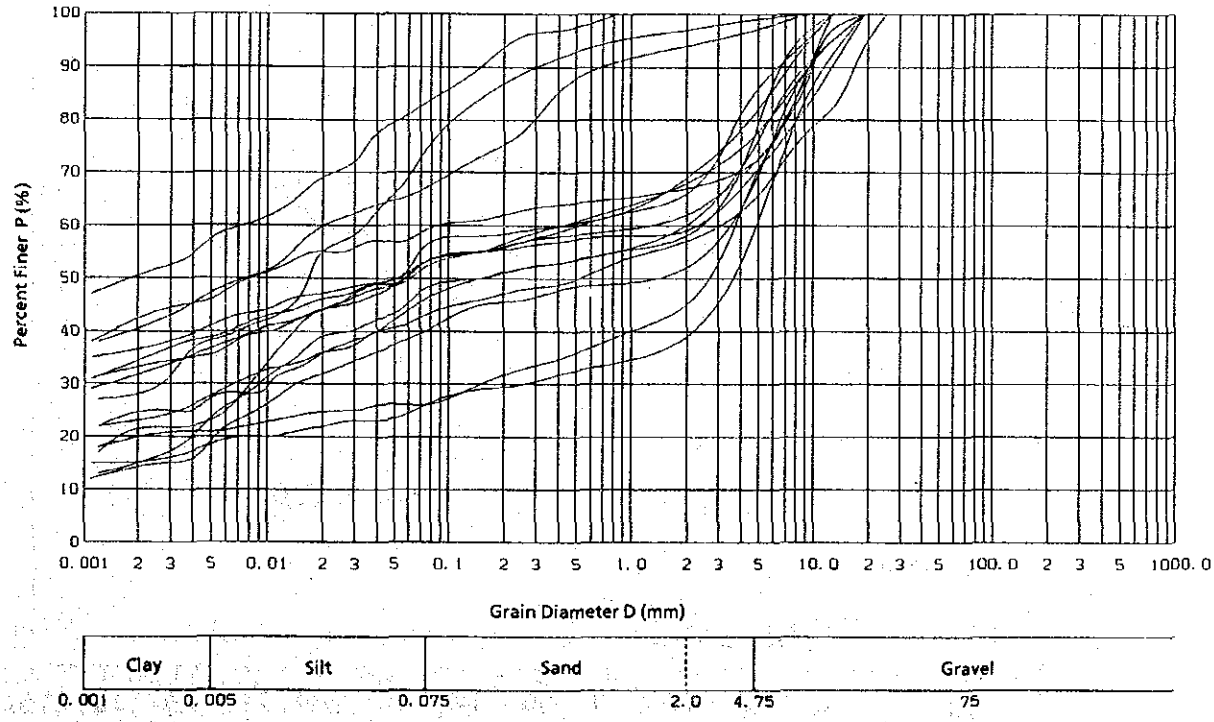


Figure E. 2. 8 Plasticity Chart of Soil (by Test Pit Sample)

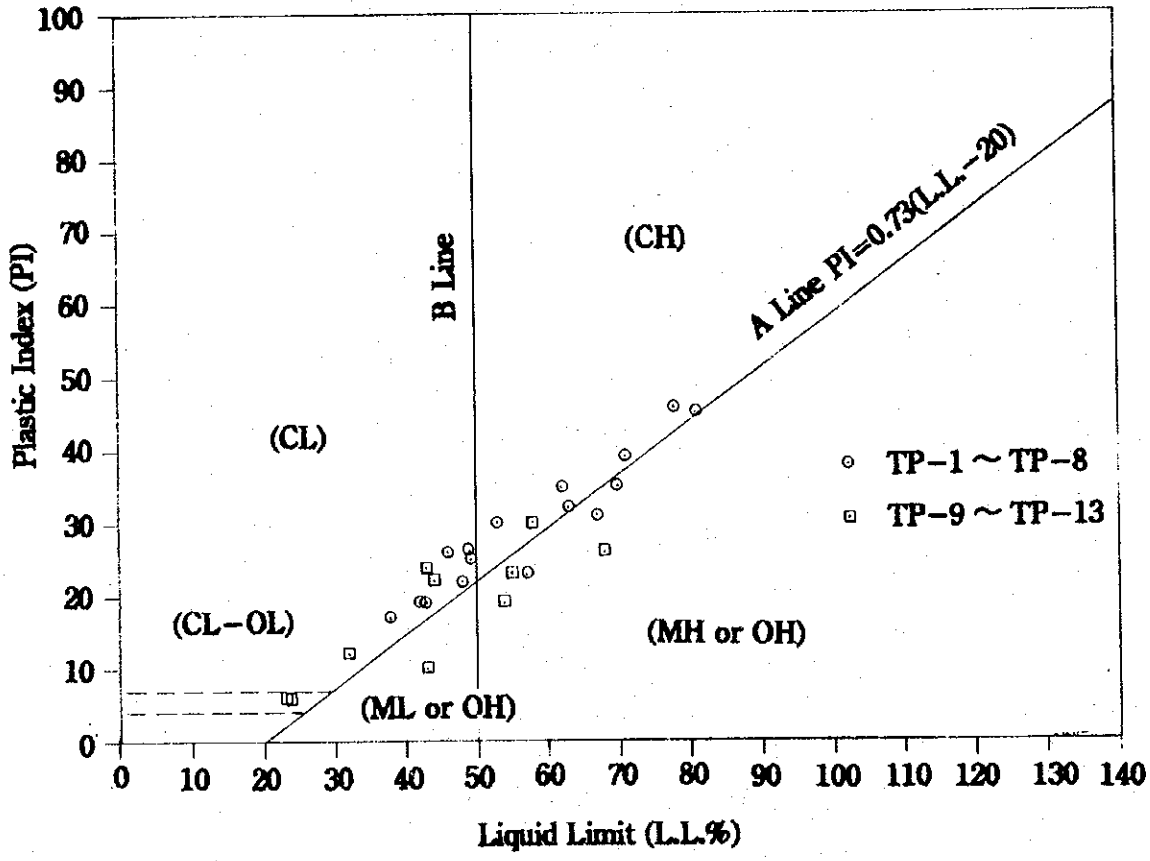
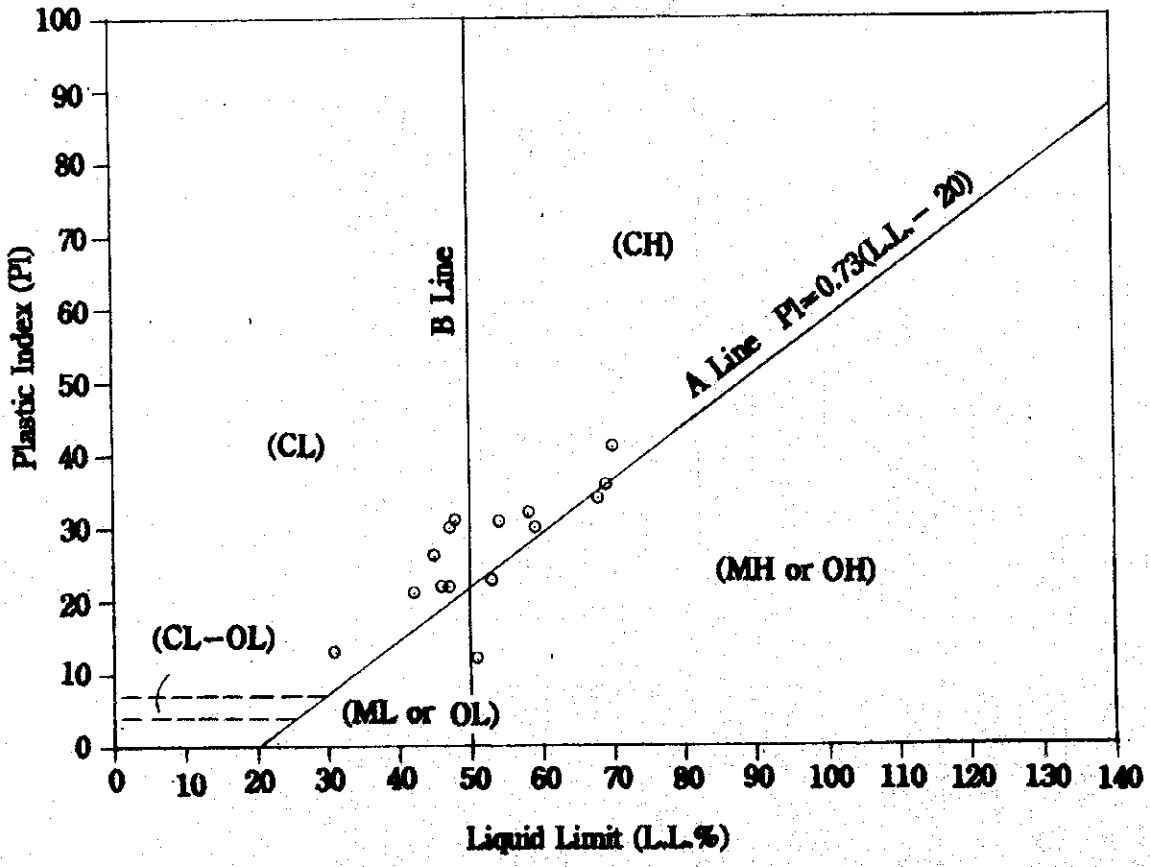


Figure E. 2. 9 Plasticity Chart of Soil (by Auger Hole Sample)



E. 3 HYDROGEOLOGY

E. 3. 1 General

Taking the hydrogeological conditions of the area into consideration, the two possible sources of groundwater for the village water supply are the confined and unconfined groundwater. However, the unconfined groundwater, which is yielded from the shallow well, is subject to rapid fluctuations according to the seasons of the year and local demand for water. Therefore, the aquifer for developmental target is restricted to confined groundwater. The confined groundwater is taken from the deep well and has an overlying, confining layer of low permeability than the aquifer with very limited and/or indirect contact with the atmosphere.

E. 3. 2 Pumping Test

Groundwater surveys were performed by pumping test method, including electrical logging test, in order to confirm the critical discharge of confined aquifer in the Study Area. Borehole logging was performed immediately after completion of drilling to decide the screen location. The location of two testing wells were at the alluvial plain area and diluvial hill area within the home lot area.

The details of each holes are as follows:

- Drilling depth ..... 30 m
- Drilling diameter ..... 150 m (6 inch)
- Installed casing pipe
  (PVC casing) diameter ..... 100 mm (4 inch)

The log of each hole, including results of the electric logging test, are shown in Figure E. 3. 1. The results of investigation works revealed that coarse sand layer as potential aquifer exists underneath, about 15 m deep from the ground surface. Furthermore, the electric logging test shows that the specific resistance value of the above potential aquifer correspond to about 80 to 240 Ω-m.

Pumping test was performed using constant discharge test and recovery test. The results of the pumping test (time-drawdown curve and time residual drawdown curve) are shown in Figure E. 3. 2 to E. 3. 5.

The result of pumping test of each of the well are summarized below.

-	Well No.1	Static water level	1.40 m
		Final pumping water level ...	15.82 m
		Drawdown at test level	14.42 m
		Average water discharge	47.71 l/min
			(68.70 cu.m/day)
-	Well No.2	Static water level	4.69 m
		Final pumping water level ...	14.73 m
		Drawdown at test level	10.04 m
		Average water discharge	57.65 l/min
			(83.02 cu.m/day)

The computed transmissivity and coefficient of permeability on the basis of pumping test results are as follows:

Jacob's solution for the nonequilibrium equation

$$T = \frac{2.303Q}{4\pi\Delta s} = \frac{0.183Q}{\Delta s}$$

Where : T = transmissivity
Q = discharge of well
Δs = drawdown over one log cycle

Recovery analysis

$$T = \frac{2.303Q}{4\pi\Delta s} = \frac{0.183Q}{\Delta s}$$

Where : Δs = change in residual drawdown over one log cycle
t/t'

K = T/m

Where : K = coefficient of permeability
m = thickness of aquifer

- Well No.1

$$T = \frac{0.183 \times 68.70}{2.6} = 4.84\ m^2/day = 3.36 \times 10^{-3}\ m^2/min$$

(T shows equivalent value for both Jacob's equation and recovery analysis)

m = 11.0 m (length of well screen)

$$K = \frac{4.84}{11.0} = 0.44\ m/day = 5.1 \times 10^{-4}\ cm/sec$$

- Well No.2

$$T = \frac{0.183 \times 83.02}{2.2} = 6.91\ m^2/day = 4.80 \times 10^{-3}\ m^2/min$$

(T shows equivalent value for both Jacob's equation and recovery analysis)

m = 10.0 m (length of well screen)

$$K = \frac{6.91}{10.0} = 0.691\ m/day = 8.0 \times 10^{-4}\ cm/sec$$

Consequently, the transmissivity and coefficient of permeability of aquifer is summarized as follows:

Transmissivity	: 4.8 - 6.9 m^2/day ($3.4 - 4.8 \times 10^{-3}\ m^2$/sec)
Coefficient of permeability	: 0.44 - 0.69 m/day ($5.1 - 8.0 \times 10^{-4}$ cm/sec)

E. 3. 3 Estimated Well Capacity

Based on the above hydraulic constant, the potential discharge of confined groundwater by single deep well of this site, which is computed by Theim's steady state equations, are estimated roughly the 60 to 100 cu.m/day on the condition that the diameter of well has a range of 100 to 300 mm and the radius of influence area has a range of 300 to 1,000 m. In case of practical well, with a diameter 100 mm and influence area 300 to 500 m, well capacity is approximately 75 cu.m/day. (refer to bellow Table)

Potential Discharge of Well

Diameter of well (mm)	Area of influence 300 m (cu.m/day)	Area of influence 500 m (cu.m/day)	Area of influence 1,000 m (cu.m/day)
100	66.7-93.4	63.0-88.3	58.6-82.0
150	70.0-98.0	65.9-92.3	61.1-85.6
200	72.5-101.5	68.2-95.4	63.0-88.3
250	74.6-104.4	70.0-98.0	64.6-90.4
300	76.4-106.9	71.6-100.2	65.9-92.3

Theim's steady state equation;

$$Q = \frac{2\pi km\,(he - hw)}{\ln re / rw}$$

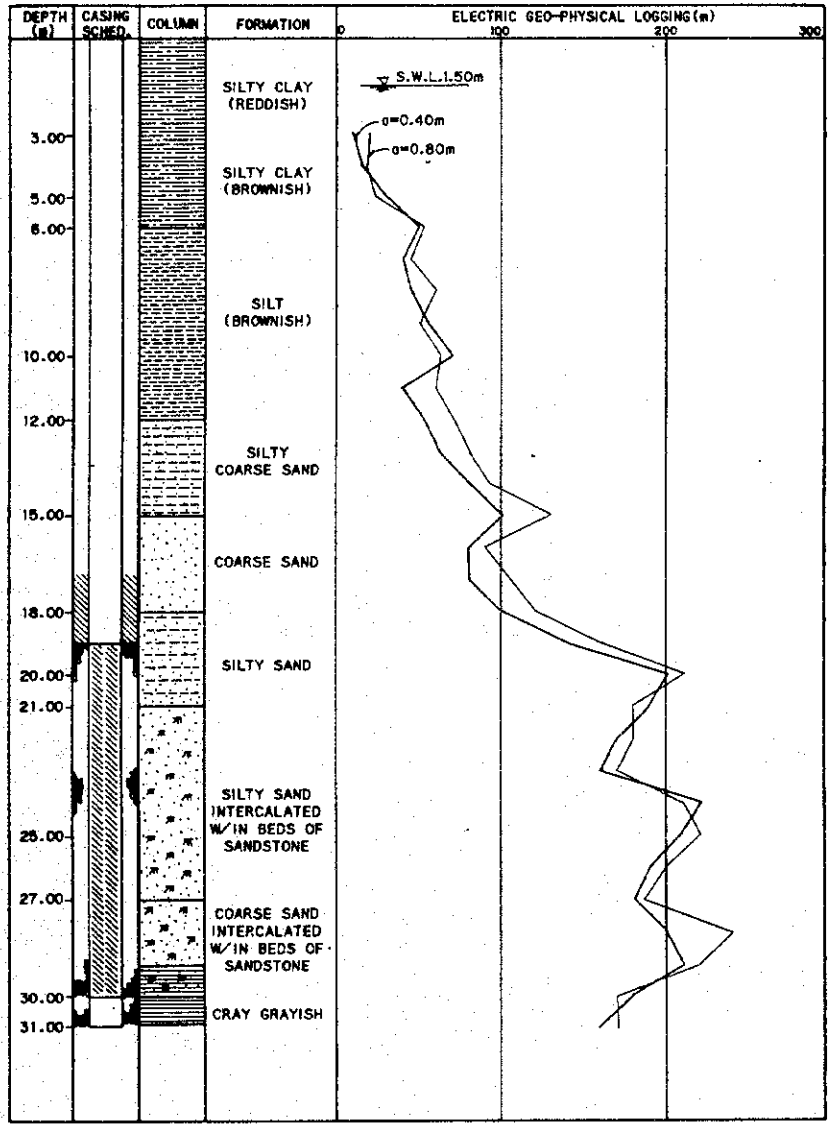
Where : Q = discharge of well
K = coefficient of permeability. (0.44~0.69m/day)
m = thickness of aquifer (15 m)
he = piezometric pressure at the circumference of the area of influence
hw = piezometric pressure at well
well effectiveness 50 % ∴ he-hw = 14.0~12.5 m
re = radius of area of influence (300, 500, 1,000 m)
rw = radius of well (100~300 m)

The study was carried out using hydraulic constant of aquifer based on the pumping test results. However, the obtained hydraulic constant of aquifer is essentially confined around pumping well because the pumping test by singular well was performed. It is therefore suggested that pumping test by plural well, pumping well and observation wells, be performed in order to confirm a more detailed hydraulic constant of aquifer, including decision of influence area, during the detailed design stage.

Figure E. 3. 1 Results of Well Investigation

Well No. 1

LOCATION: SITE W1.SITIO TAGUMPAY.BRGY. INAGAWAN.PTO.PRIN.CITY.
WELL DEPTH: 30.00m
BOREHOLE DIA: 165mm(6-1/2")
CASING DIA: 110mm O.D.(4")



Well No. 2

LOCATION: SITE W2.SITIO TAGUMPAY.BRGY. INAGAWAN.PTO.PRIN.CITY.
WELL DEPTH: 30.00m
BOREHOLE DIA: 165mm(6-1/2")
CASING DIA: 110mm O.D.(4")

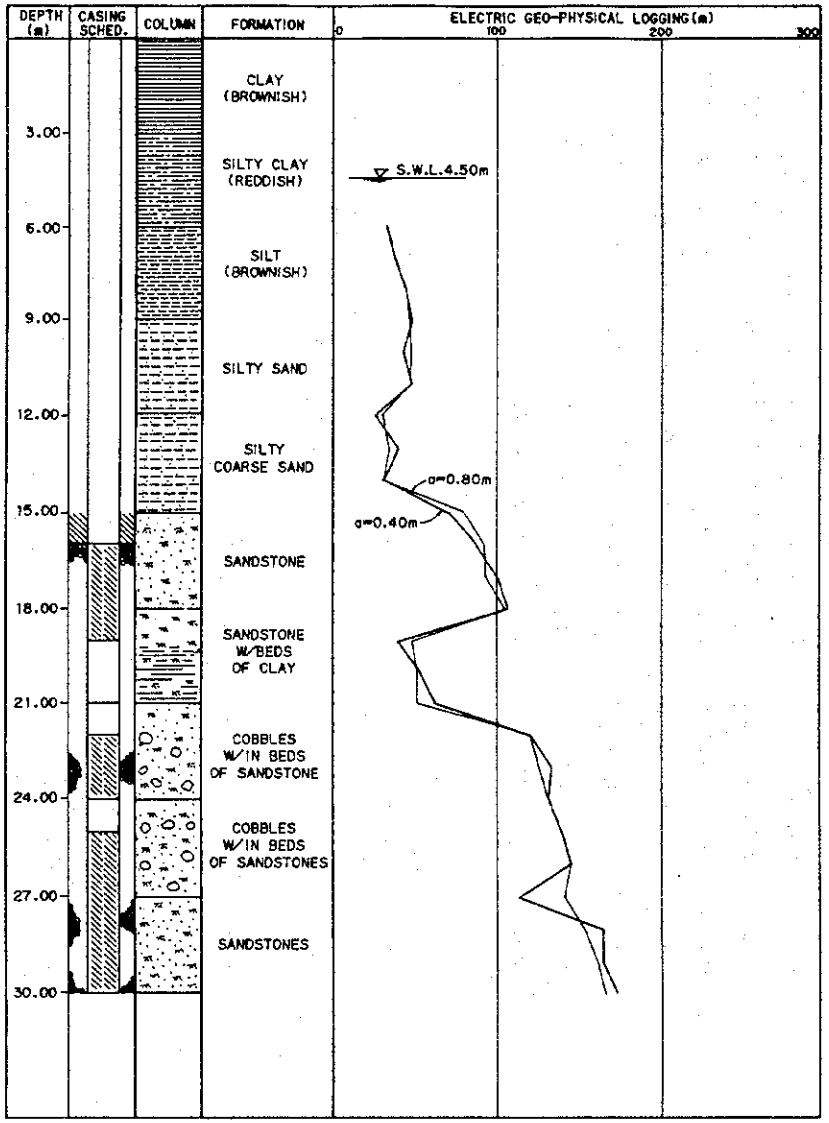


Figure E. 3. 2 **Relationship between Drawdown of Water Table and Pumping Time (Well No.1)**

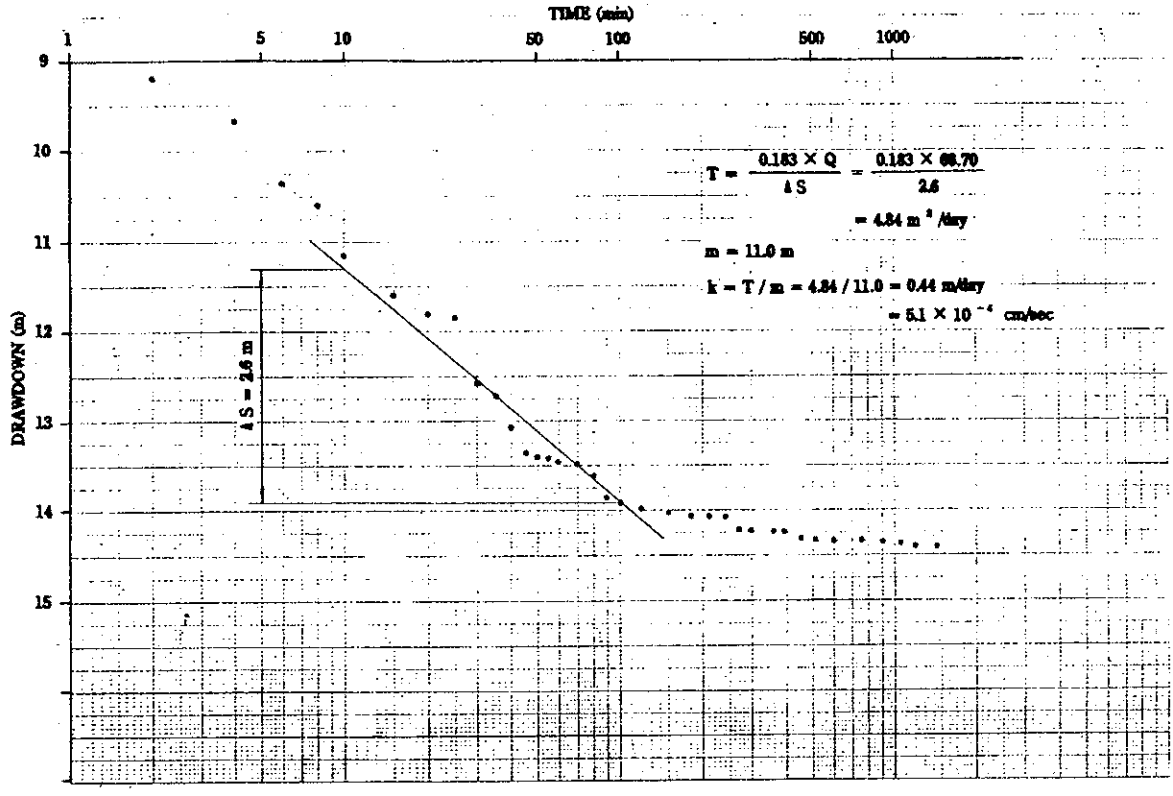


Figure E. 3. 3 **Relationship between Residual Drawdown of Water Table and Ratio t/t' (Well No.1)**

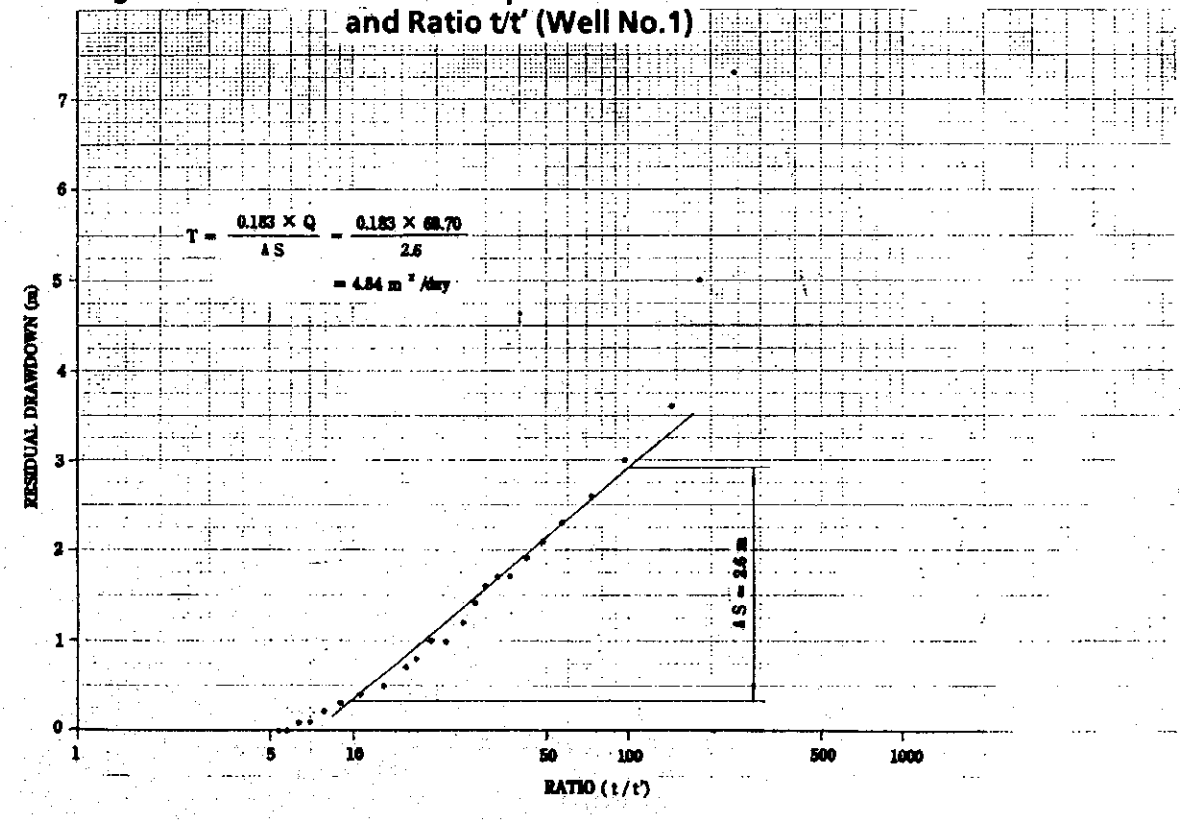


Figure E. 3. 4 Relationship between Drawdown of Water Table and Pumping Time (Well No.2)

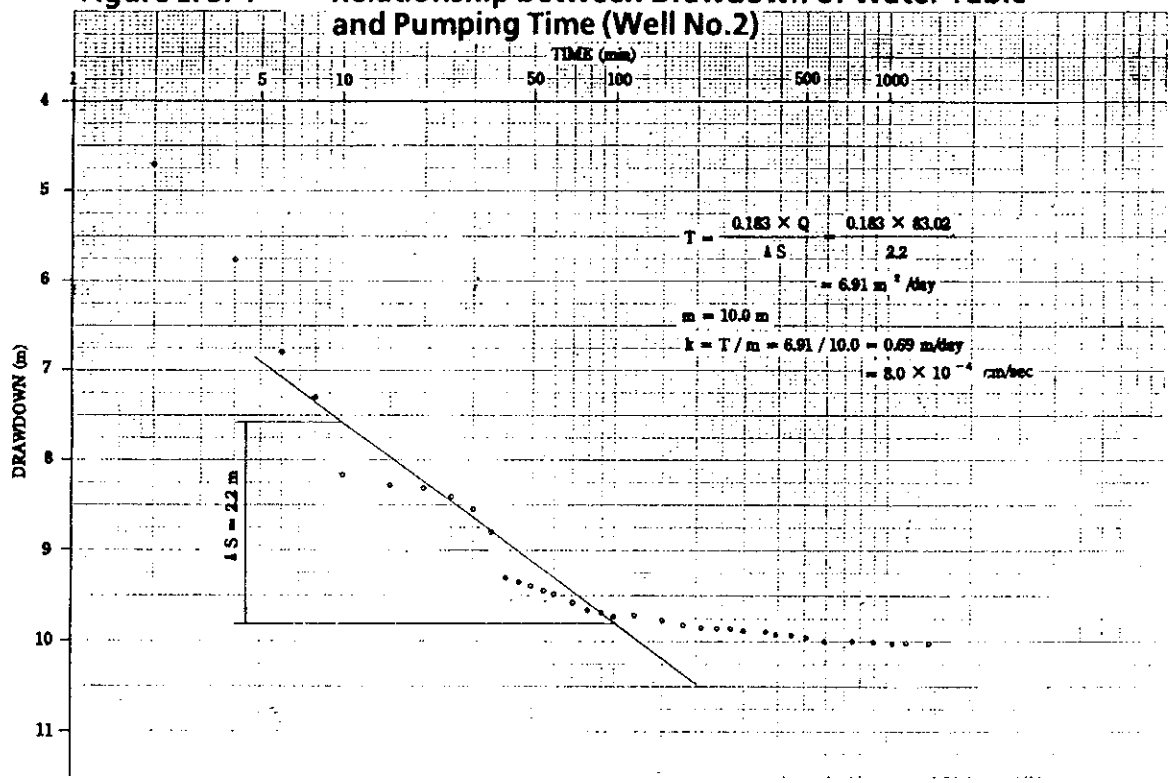
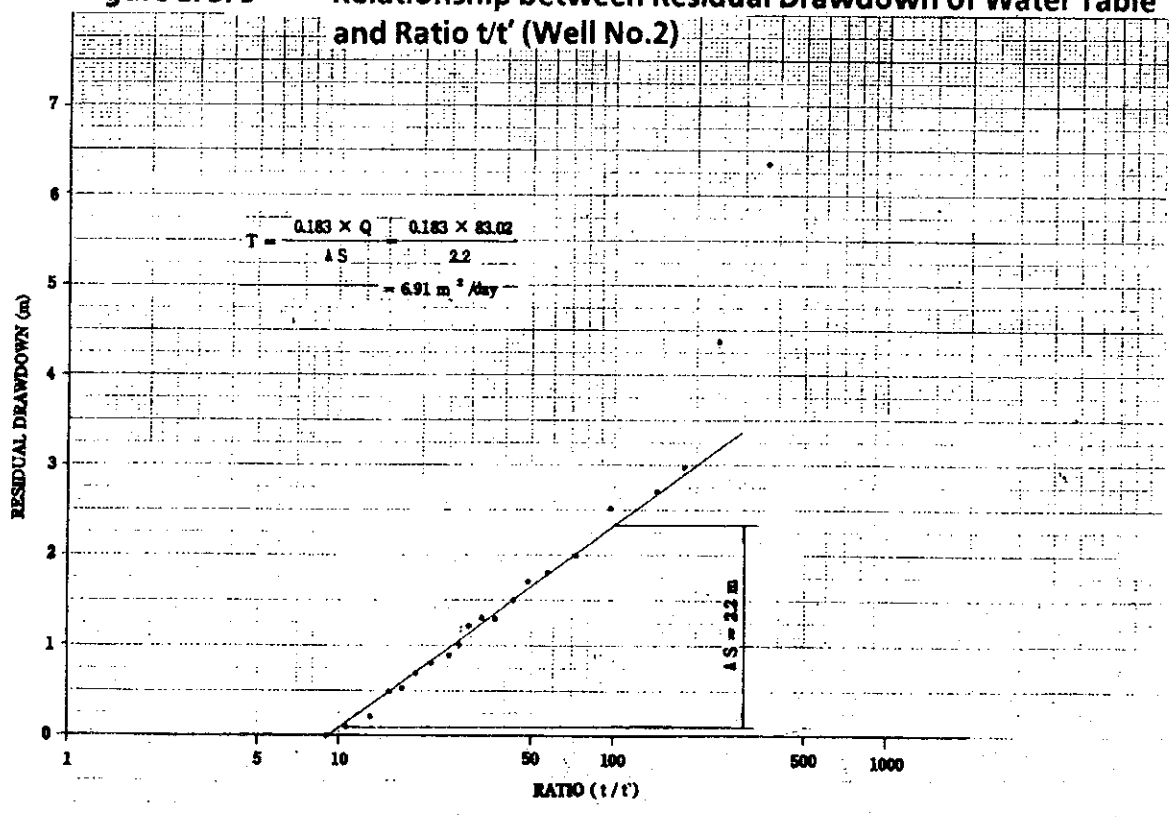


Figure E. 3. 5 Relationship between Residual Drawdown of Water Table and Ratio t/t' (Well No.2)



APPENDIX F. WATER RESOURCES

F. 1 PRESENT PLAN

F. 1. 1 Inagawan River and Its Tributaries

The two (2) rivers, Inagawan and its tributary, Pinagsaluran, are the only surface water resources for the proposed beneficial area.

The Inagawan river which maybe considered a medium scale river basin has watershed area of 179.3 sq.km and a river length of 46.5 km, originates from the Anepahan Peak, the highest mountain with a top elevation of 1,340 m MSL, located almost at the center of palawan Island. It is meandering at the Central Peak, the left side of the bank and at Mt. Aborlan, the right side of the bank, and flows down to the northern part of the Study Area, (about 15 km from the river mouth) into the Sulu sea through the alluvial fan and plain areas.

On the otherhand, the Pinagsaluran river, categorized as a small scale river, has watershed area of 16.5 sq.m. and a river length of 8.7 km, originates from the mountain with a top elevation of 800 m MSL and flows down into the confluence of Inagawan main river to the northern part of the beneficiary area.

The mountainous area is covered with dense and wild vegetation which is reserved as forest area. The water quality test indicates that the quality of the river water is generally good except for drinking purposes, because it contains no particular injurious materials except low iron, some colitis germs and other bacteria with pH 7.6 to 7.8.

The average annual rainfall in the Inagawan river basin where the Study Area is located is observed to be about 1,600 mm. The average annual river runoff is estimated to be about 0.80 MCM/sq.km under the condition of 50% of runoff coefficient. There are two (2) diversion facilities along the Inagawan river. One is the NIA diversion dam, about 10 km from the river mouth to the Inagawan Communal Irrigation System (CIS, 270 ha of irrigated area). The other one is the intake facility, about 12 km from the mouth to the Inagawan Sub-colony (70 ha of irrigated area). The total amount of water used annually for these irrigation areas is about 12 MCM, which is equivalent to only 10% of the annual river runoff of, 111 MCM/year. So that about 90% of the runoff amount flows into the Sulu sea, indicating the abundance of water

resources within the Inagawan river basin. However, about 90% of the water resources from the basin is yielded during the rainy season from May to December, thereby requiring storage type dam for the effective utilization of water resources.

Also, based on the topographical map with a scale of 1 to 4,000, the river bed elevation of the Inagawan river is lower than that of the proposed beneficiary area, about 20 m lower. This will in effect be a big constraint in the introduction of gravity intake system to irrigate the Study Area.

F. 1. 2 Groundwater

There are nine (9) shallow wells and six (6) springs at the depressions in the Tagumpay Settlement area. These water resources may have originated from Inagawan river possibly due to seepage of water. The water quality containing some colitis germs are the same as the surface water. The three (3) springs were observed to yield only 1 to 13 lit/min but continues to flow even during the dry season.

Based on the results of the groundwater survey conducted during the work two field survey, the yield of well was approximately 100 cu.m/day/sq.km, i.e the estimated potential groundwater is 0.7 MCM/year, if the project area is 2,000 ha. Even if all water are drawn by pump, only about an area of 75 ha could be irrigated.

Therefore, groundwater is recommended to be used for domestic water purposes only.

F. 2 DEVELOPMENT PLAN

F. 2. 1 Water Requirement

In addition to irrigation water, water requirements as water permit of existing irrigation systems and river maintenance flow are considered in the surface-water resources development plan.

a) Water Permit of Existing Irrigation Systems

There are two (2) diversion facilities at the Inagawan river. One is the NIA diversion dam at about 10 km from the river mouth for the Inagawan CIS and the other one, the intake facility for Inagawan Sub-colony, about 12 km from the mouth of the river. The water permit of these irrigation systems are as follows:

Project	Irrigable Area	Water Permit
Inagawan Sub-coloy	80 ha	100 lit/sec (0.26 MCM/month)*
Inagawan CIS	270 ha	330 lit/sec (0.86 MCM/month)
		430 lit/sec (1.11 MCM/month)
Total	350 ha	

Note: * estimated based on the Inagawan CIS

b) River Maintenance Flow

From the view point of the environment, certain water flow of the river are required to be considered in the water resources development, for such purposes as habitation of fish and shells, animal and vegetation near the river, stabilization of groundwater and navigation of boat, to maintain river function.

Five (5)% of drought river discharge is generally adopted for the river maintenance flow in the Philippines, although maintenance flow differ depending on each river condition. Five (5)% of drought discharge with 10 years return period estimated in the runoff analysis is adopted in this study.

Subject place	:	The third gauging station
Watershed	:	110.7 sq.km
Drought discharge with 10	:	0.327 cu.m/sec

years return period
5% of discharge : 14.7 lit/sec/100 sq.km

However, based on the runoff data of Inagawan river measured by PIADP (April 1985, Watershed 118.8 sq.km, Drought discharge 0.254 cu.m/sec), the maintenance discharge was estimated at 11 lit/sec/100 sq.km. Therefore, the design maintenance discharge of 15 lit/sec/100 sq.km will be adopted.

F. 2. 2 Sedimentation

Sedimentation in the reservoir depends upon such various conditions in the watershed as topography, soil and geology, vegetation, rainfall, riverbed slope, etc. In and/or near the Study Area, there are no available data for sedimentation. At present, serious soil erosion problem by rain will not occur because of the dense vegetation of the watershed, but at the right bank of the Inagawan river where Eocene turbidities are formed, a heavy rain will cause erosion problems under the condition of poor vegetation in the area.

Based on the previous studies, the specific sediment volume for the Pinagsaluran river basin and Inagawan main river basin area assumed to be 300 and 200 cu.m/year/sq.km, respectively (refer to Figure F.2.1). Thus the design period of 100 years of sediment accumulation for the reservoir is applied.

F. 2. 3 Potential Water Resources Sites

Water resources development is one of the indispensable means for the agricultural development in the Study Area. There are two (2) types of water resources, surface water (river water) and groundwater available in the Study Area. The latter source will not be applicable for irrigation purposes due to limitation of the source and high operation and maintenance cost of a pump. On the other hand, the surface water will be suitable for the water resources development because of abundant excess water during the rainy season.

The Inagawan river upstream basin from the confluence of Inagawan main river and its tributary, i.e., the Pinagsaluran river up to the mountainous

area of the river basin is the only potential surface water resources in the Study Area.

a) Preliminary Water Resources Sites

Based on the topo-map with a scale fo 1:50,000, six (6) potential water resources sites were preliminarily nominated taking into account the storage capability and simplicity of design. Field investigations for the said nominated sites were carried out. The location and general features of the nominated potential water resources sites are shown in Figure F.2.2 and Table F.2.1, respectively.

The major characteristics of these sites are as follows:

Site A and B:

These sites are expected to be good potential sites because of effective storage capacity and wider watershed area. But in addition to construction of storage dams at each site, introduction of diversion dam at Site D will be required for water utilization at these sites due to its far distance from the beneficial area. In this connection the construction of the storage dam in the Inagawan main river will affect the vast reserved forest together due to long construction period, which may cause environmental problems in the basin. Further, construction of both facilities, storage and diversion dams are not economical in these sites.

Site C:

The site is located just upstream where the Inagawan main river flows into the plain land, the most narrow portion among the river course. The site has a comparatively small storage capacity due to its topographic condition, with a very low right river bank. A tunnel type diversion channel will be required for the construction of the dam facility at the site. In addition, the alignment of the leading canal from the site will pass through a steep mountainous side and will have to run across a comparatively big tributary. Hence, construction cost of facilities requiredwill be very high.

Site D:

The site has no serious problems as to water resources, as Site C, because of its location, being downstream where the Inagawan main

river flows into the plain land. However, its riverbed elevation of about 20 m MSL is so low compared with that of the beneficial area, hence would require a dam with 20 to 30 m in height in order to take the river water by gravity. In case of high dam construction, the same environmental problems as Site A and B may occur.

Site E:

The site which is located at the right tributary of Inagawan river, does not have abundant water resources as the main river due to small watershed area of 15.0 sq.km. However, since its riverbed elevation with about 30 m MSL is higher than Site D, the gravity irrigation method can be applied to most part of the beneficial area. But the wide section of riverbed, and the foundation of Miocene and Quaternary sediments will require much attention during dam construction.

Site F:

Since the site is located on the further right branch of Pinagsaluran, gravity irrigation will cover a higher portion than that of Site E. However, the watershed of site F is so small, only 3.7 q.km as to omit good potentiality of water resources development.

From the above considerations, Sites D and E were preliminarily proposed as potential water resources sites.

b) Available Water Resources

The available water resources for the Inagawan river at Site D and the Pinagsaluran river at Site E subtracting the water permit for the existing irrigation system and the river maintenance flow from the river runoff, were estimated as follows:

River (Site)	Watershed (sq.km)	Annual Average Discharge (MCM)			
		River Runoff *1	Existing water Right*2	River Maint.*3	P. Water *4 = *1-*2-*3
Inagawan (Site D)	118.1	105.9*1	13.6*2	0.6*3	91.7
Pinagsaluran (Site E)	15.0	13.5	-	0.1	13.4

*1: (106.547 MCM/118.8 sq.km)×118.1 sq.km = 105.9 MCM/year

*2: 0.43 cms × 86,400 sec×365 days = 13.6

*3: 0.15 cms×100 sq.km ×86,400 sec×365 days×118.1 sq.km = 0.6 MCM/year

The available annual average water from the two rivers, Inagawan and Pinagsaluran river are 91.7 MCM and 13.4 MCM, respectively, which exceed the annual average water requirement of 4.7 MCM for the 590 ha irrigable area with 200 % cropping intensity.

However, about 90% of the available water is yielded during the rainy season, from May to December. The low water discharge of Inagawan river is 0.58 cms the average, for 17 years, which is a less beyond the existing water right of 0.43 cms so as not to cover the water requirement of 0.84 cms for the project.

Therefore, in case of 590 ha irrigation area with 200% cropping intensity, the application of storage type water resources development is required for any of the rivers, Pinagsaluran river and even Inagawan main river.

c) Potential Water Resources Sites

There are such water resources development types as storage dam type, diversion dam type and mountain stream diversion type, and gravity intake and pumping intake from the view of intake method.

Based on the topo map with a scale of 1 to 4,000 and field reconnaissance survey, the development type applicable for each of the preliminary sites selected were identified, as follows:

River	Site	W.A (sq.km)	Development Type
Inagawan River	Site C	110.7	Gravity Intake, Diversion*1
	Site D	118.1	ditto
	Site LD	118.5	Pumping Intake, Diversion
Pinagsaluran River	Site E		
	Site E	14.5	Gravity Intake, Storage Dam
	Site E1	15.0	ditto
	Site EuM	13.9	Gravity Intake, Mountain Stream Diversion*1

*1: with small storage capacity