F. IVISAN, CAPIZ

F. IVISAN, CAPIZ

I. STUDY AREA AND HYDROGEOLOGICAL ANALYSIS

1. Description of the Study Area

1.1 Physical Description

1.1.1 Geographical Location and Area

Ivisan is bounded on the west by Sapian, on the east by Panitan, on the south by Sigma and on the north by Roxas City. It has a total land area of 5,420 ha covering 14 barangays. Three barangays are located along the coastline facing the Sapian Bay in northern Panay. Location map is shown in FIGURE F-1.

1.1.2 Climate

The municipality has two distinct seasons, dry from February to April and wet from May to January. Highest temperature which occurs between March to April is 26.94°C while lowest temperature which occurs between November to December is 27.06°C. Normal wind speed is 5-10 km per hour.

1.1.3 Terrain/Topography

The municipality is generally mountainous. Of the 5,420 ha land area, about 50% are mountainous. Coastal plains include the two poblacions and neighboring barangays and alternate of mountainous backbone with lateral bands and spurs extending in outward direction. Inner slopes are steep and central part fairly level. Rivers are long and swift. Small coastal portion is swampy.

1.1.4 Soil

Predominant soil type in the western portion is Sapian Clay, hydrosol in the northern areas, Luisiana Clay loam in southwestern barangays and Bantog Clay in the northwestern areas of the municipality. The Sapian Clay and Bantog Clay are found on the western and northwestern.

1.1.5 Administrative Composition and Land Use

The municipality is headed by the Mayor and Vice Mayor with eight (8) members of the Sangguniang Bayan as the local legislative body. Under the municipality are the barangays, the smallest political subdivision, which are headed by Barangay Captains/Chairmen with the Sangguniang Barangay as the lawmaking body. All these local officials are selected by the

FIGURE F-1

LOCATION MAP
IVISAN, CAPIZ

people through popular election.

Municipalities are classified according to the annual revenues from taxes. This classification serves as a major indication of the socio-economic situation of the population in the municipalities. The municipality of Ivisan belongs to the 5th class, with a total annual income of less then ₱300,000.

There are 15 barangays constituting the municipality, namely:

1. Agmalobo
2. Agustin Navarra
3. Balaring
4. Basiao
5. Cabugao
6. Cudian
7. Ilaya-Ivisan
8. Malocloc Norte
9. Malocloc Sur
10. Matnog
11. Mianay
12. Ondoy
13. Poblacion Norte
14. Poblacion Sur
15. Sta. Cruz

1.1.6 Transportation

Transportation facilities in Ivisan are of two types, land and water transportation. within the municipality, buses, jeepneys and motortricycles are the primary mode of conveyance. For settlements along the coast, motor boats are the principal means of transportation. Due to its location along the national highway connecting Roxas City to Iloilo City, regular bus transportation provides Ivisan access to major population centers and transport modes in Capiz and Iloilo provinces.

1.1.7 Infrastructure

Composed to the other municipalities of Capiz, Ivisan has relatively adequate transport infrastructure in terms of roads and bridges. It is likewise near Roxas City where the jet airport, inter-island commercial port and the Panay railways terminal are located. As of 1980, the municipality has a total of 75 km of roads of which 17 km were national highways, around 17 km were provincial roads, 2 km were municipal roads and 39 kms were barangay roads. However, only the national road is concrete and the rest are either of gravel or earth surface. There were seven major bridges with a total combined length of 108 linear meters but only one national bridge of 14.5 m is made of concrete.

There is only one communal irrigation system in Ivisan municipality, tapping water through a dam constructed on the Ivisan River. Total service area is only 40 ha.

Since 1976, the municipality has been provided with power supply by the Capiz Electric Cooperative form its diesel power plant located in Panitan municipality.

1.2 Population and Living Conditions

1.2.1 Population Trend from the Past

Population increased from 15,374 in 1975 to 17,414 in 1980 showing a growth rate of 2.52%. Male-female ratio was almost 1:1. Population distribution by barangay is presented in the following table:

TABLE F-1 Population and Number of Households by Barangay, Ivisan, Capiz 1980

Barangay	Population	No. of Households
Agmalobo	779	144
Agusin Navarra	744	132
Balaring	981	178
Basiao	1,597	299
Cabugao	899	168
Cudian	920	158
Ilaya-Ivisan	1,654	303
Malocloc Norte	1,486	275
Malocloc Sur	1,147	208
Matnog	751	149
Mianay	1,011	178
Ondoy	1,198	215
Poblacion Norte	1,656	289
Poblacion Sur	1,621	263
Sta. Cruz	970	173
Total	17,414	3,132

Total number of households was 3,132 in 1980 with an average family size of six. Majority of the population (81.8%) live in the rural areas.

1.2.2 Age Distribution

The productive or working age group bracket (15 years and above) comprised 54.46% of the total population with 45.54% belonging to the dependent population (0-14 years old).

1.2.3 Morbidity/Mortality

Major causes of morbidity include urinary tract infection, bronchitis and anemia while primary causes of mortality include broncho pneumonia, congested heart disease, hyperstatic pneumonia, PTB and gastroenteritis.

Infant mortality rate was 82.94%, crude birth rate 4.19%, neonatal mortality rate 49.7%, crude death rate 10.4% and

morbidity rate 23.83%.

Malnutrition is prevalent in the area as 82.12% of pre-school children are suffering from varying degrees of malnutrition. Of the 1,861 children weighed under the Operation Timbang program, 35.67% are suffering from first degree malnutrition, 42.42% from second degree and 4.03% from third degree malnutrition.

1.2.4 Sanitation

There are no drainage and disposal system in Ivisan. Almost all households dispose their waste by dumping and burning.

Regarding toilet facilities, a high percentage of the households have toilet facilities due to the campaign of the health personnel.

1.2.5 Public Services

Access to all levels of education is relatively easy for the inhabitants of the municipality. There are 10 complete elementary schools and 4 primary schools with a total enrollment of almost 3,000 pupils. There is likewise one secondary school with a total enrollment of around 1,000 students. For college education, students can study in Roxas City, which is of community distance from the municipality.

In the area of health service, both curative and preventive facilities are provided by the government and private sector. The Ospital sang Ivisan is a 12-bed capacity private hospital that is staffed by rural health personnel of the Department of Health. Outside the town center are two health centers which are also staffed with rural health personnel of the Department of Health.

Protective services are provided by the Integrated National Police through its sub-station which is manned by 19 peace officers, giving a ratio of one policeman for around 900 population. The sub-station is part of the INP network and is equipped with the necessary arms and communication and a radio transmitter-receiver which can communicate with all other network stations.

The public communication facilities consist of one telegraph station and one postal station. Broadcast and print media also reach the municipality through stations and publication distributors in Roxas City.

1.3 Economy and Industry

1.3.1 Agriculture

The economy depends greatly on agriculture. Major crops include coconut, accounting for 34.50% of the total cultivated area, rice (15.11%), fruits and vegetable (5%), sugar cane (4.65%), bamboos (1.22%) and corn(1.11%). Pasture and cogon areas comprised 22.45% of the total land area.

Total agricultural production amounted to 12,253 metric tons of which 4,301 metric tons or 35.10% consisted of palay, 4,315 metric tons or 35.22% consisted of sugar cane, and 2,713 metric tons or 22.14% consisted of coconuts.

Total number of farms was 1,170 in 1980 covering an aggregate area of 2,425 hectares. Average farm size was 2.07 hectares.

Total livestock population of the municipality was recorded at 13,660 consisting of 1,289 carabaos, 212 cattle, 1,095 pigs, 75 goats and 10,989 fowls mostly chickens and ducks.

1.3.2 Other Industries

The most common industrial activities in Ivisan are agroprocessing and fish processing. There are two rice mills with a daily milling capacity of 600-800 cavans. There is one ice plant which produces 200 blocks of ice per day. This is used mainly for storing fish landed in two fishing ports located in the municipality.

In addition to a large Sheepskin Tanning and Manufacturing Company, which produces mostly for export, there are several cottage industries such as tailoring and dressmaking shops, bamboo craft and bag manufacturing.

Commercial establishments are limited in scale, consisting mostly of retail stores found in the public market and in village neighborhoods.

2. Analysis of Potential Water Source

2.1 Topography and Geology

The municipality of Ivisan is characterized by a plain that fronts a beach and mountains surrounding the Poblacion in the south, west and east.

The Ivisan River and Sigogan River which flow into the Syagas Bay and coastal plain are small and swampy.

The geology in the mountain area is composed of sandstone and shale with andesite of Sibala formation (Paleocene, Tertiary) which face the plain featuring a steeper slope. The low-land consists of alluvial deposits. Geological map is shown in FIGURE F-2.

Sibala Formation (Paleocene, Tertiary)

This unit consists mainly of sandstone, shale and andesitic to basaltic lava. Sedimentary rocks are found at the foot of the mountain and their general strike and dip is shown to be N70 W, 10 N.

Andesitic to basaltic lava is widely found in the mountain area. Fresh rocks are exposed on the surface of the slope by heavy rains during wet seasons, washing out the top soil. Thus, the retention of water is poor due to the sparse vegetation.

Alluvial Deposits (Quaternary)

This unit forms the coastal plain, flood plain and swamp. These are mainly sand and clay with pebble transported by river water from the upland due to erosion and weathering.

The thickness of this unit is not exactly known due to the lack of available drilling data.

2.2 Existing Water Source

Springs/Surface Water

The existing source of the water supply system in the Poblacion is the creek originating from the Tulalo Spring gushing out from cracks in the volcanics. Water form this creek is contained by a 1.5 m high 12 m wide concrete structure at a location 2.5 km west of the Poblacion.

Based on the survey results, the flow rate of the creek flowing into the lake of the intake dam was about 1.45 liter/sec or 125 cu.m/day in dry season and 3.26 liter/sec or 282 cu.m/day in rainy season. No surface water flow was observed downstream of the intake dam within sight from the dam. However, at the

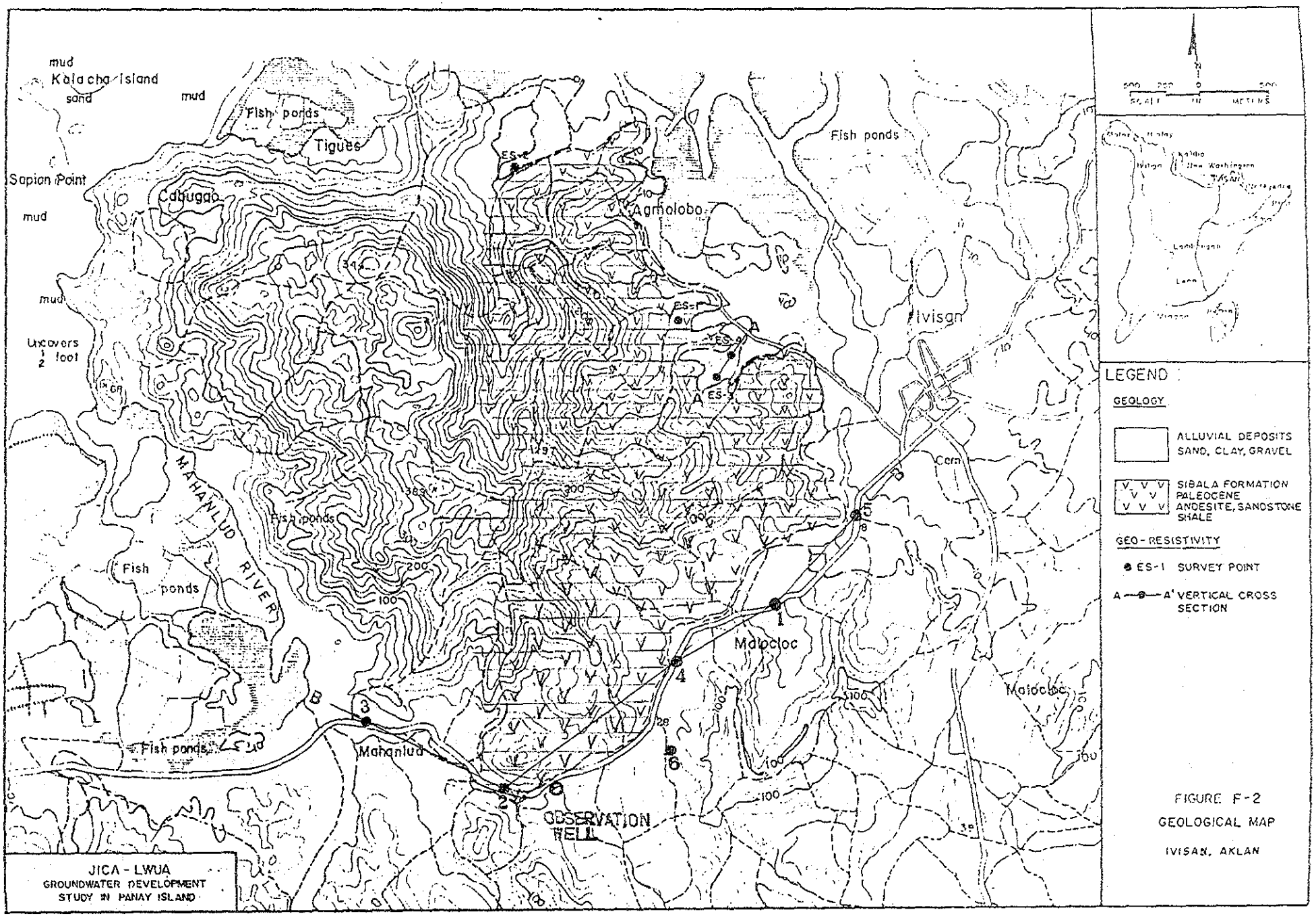


FIGURE F-2
GEOLOGICAL MAP
IVISAN, AKLAN

downstream of the creek, approximately 80 m lower than the dam site in ground elevation, a voluminous amount of water flow was observed. Water volume is approximately 0.56 liter/sec or 50 cu.m/day in dry season and 4.15 liter/sec or 359 cu.m/sec in rainy season based on the volumetric measurement method.

In addition, there is another spring called Cabugao Spring, which is tapped by the intake dam, located in the mountain, about 3.3 km west of the Poblacion. The water from this spring is being supplied to the barangays in the vicinity of spring by pipeline with a flow rate of 318 cu.m/day in dry season and 211 cu.m/day with 450 cu.m of overflow in rainy season. The flow rates of the said springs and creek are summarized as follows:

	Flow Rate	
	Dry Season (May 14)	Rainy Season (September 22)
Tulalo Spring (Dam)	125 cu.m/day	282 cu.m/day
Downstream of Tulalo Spring (Dam)	50 cu.m/day	359 cu.m/day
Cabugao Spring (Dam)	318 cu.m/day	661 cu.m/day

Wells

Residents of the Poblacion obtain their drinking water from the water supply system. In addition, they also fetch water for other uses from privately owned shallow wells.

Well inventory survey consisting of measurement of static water level and total depth of the well was conducted on nine wells out of a total of 16 water source points surveyed at that time. Besides the site survey, investigations on existing data on well inventory was conducted. However, no useful well data including lithologic log was available. (FIGURE F-3)

Collected data are presented in TABLE F-2.

FIGURE F-3

MAP OF INVESTIGATED WATER SOURCES

IVISAN, CAPIZ

TABLE F-2 Well Data Summary

JICA-LWUA Source Number	Well Depth (M)	Ground Level (MAMSL)	Static Water Level: Dry Season (May 14) (MBGL)	(MAMSL)	Rainy Season (September 22) (MBGL)	(AMSL)
F-2 Dug Well	3.47	3.8	-2.68	1.1	-0.74	3.1
F-3 Dug Well	2.91	1.8	-2.20	-0.4	-	-
F-4 Dug Well	1.79	2.2	-0.82	1.4	-	-
F-5 Dug Well	2.64	1.3	-1.46	-0.2	-0.71	0.6
F-6 Dug Well	4.46	4.0	-3.70	0.3	-0.65	3.3
F-9 Dug Well	3.43	4.4	-2.78	1.6	-1.34	4.1
F-11 Dug Well	2.43	2.6	-2.00	0.6	-0.84	1.8
F-15 Dug Well	2.50	11.1	-1.75	9.3	-	-
F-16 Dug Well	5.20	20.1	-3.45	16.6	-	-

* Estimated based on the topographic map of scale 1/50,000 and supplemental topographic survey.

Survey results are summarized as follows:

i) There is no deep well with a depth of more than 6 m in the Poblacion.

ii) Groundwater table declines toward the swamp adjacent to the north end of the Poblacion and to the creek flowing through the Poblacion.

iii) A site about 200 m far from the creek yields a groundwater table potential about 1 to 2 m above sea water level.

iv) Groundwater table is high in rainy season. Raise of groundwater level is bigger in the place with a higher ground elevation than that in the lower place.

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

The survey area occupies a part of the coastal plain that lies at the foot of a mountain.

The geology in this area features volcanic rock as basement and alluvial deposits extended to the low lands.

The resistivity survey is focused on the exploration of the thickness of alluvial deposits and the possibility of existing aquifers in volcanics.

A total of four (4) points, namely ES-1 to ES-4 are shown in FIGURE F-2.

Field activities are summarized below:

Date	:	May 14, 1988
No. of Survey Points	:	four (4) points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	100 meter

The results of the ρ-a curve analysis are shown in TABLE F-3 and georesistivity section is shown in FIGURE F-4.

1) The resistivity of volcanic rocks indicates a measurement of over 95 ohm.m. The depth of volcanic rocks is variable, namely 10 meters at ES-1, 5 meters at ES-2, 9 meters at ES-3 and 24 meters at ES-4.
2) The possibility of groundwater bearing structures in volcanic rocks is not certain since no correlation exists between resistivity and well log.

3) In Section A-A', resistivity layer with 43 - 50 ohm.m lies at the depth less than 9 - 24 mbgl. This layer is

Additional georesistivity survey was conducted on Bgy. Malocloc Sur. Six (6) survey points are shown in FIGURE F-2. This resistivity survey is focused on the exploration of the groundwater upon the basement underlaying andesite lava.

Field activities are summarized below:

Date	:	May 20, 21, 1989
No. of Survey Points	:	six (6) points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	100 to 150 m

TABLE F-3 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

IVISAN, CAPIZ

SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER											
			1		2		3		4		5		6	
			ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m
ES-1	15	flood plain	56	2.5	28	10	300							
ES-2	20	mountain foot	50	0.6	25	5	144	25	28	52	102	64	27	
ES-3	15	alluvial plain	130	1.2	43	9	96	46	144					
ES-4	11	alluvial plain	60	1.0	15	3	50	24	132					

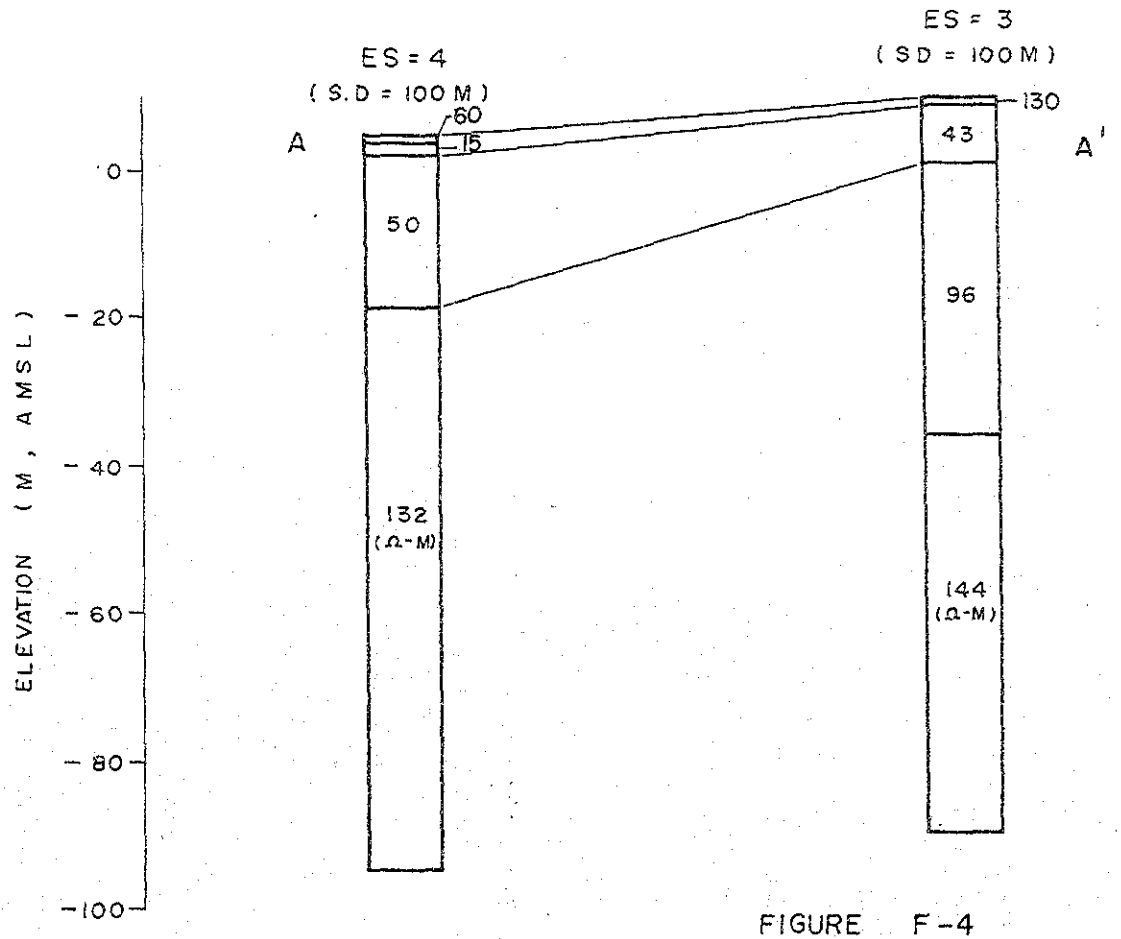


FIGURE F-4

SCALE H = 1: 5,000
V = 1: 1,000

GEORESISTIVITY SECTION A - A'
IVISAN , CAPIZ , PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

The results of the -a curve analysis are shown in TABLE F-3' and georesistivity section is shown in FIGURE F-4'.

Among these results ES-2 point had the highest potentiality bearing the groundwater under andesite, so the observation well was planned to drill near ES-2 point.

2.3.2 Observation/Test Well Drilling

Based on the results of the second field survey conducted in 1989, the location of the observation well was decided near ES-2 point. (cf. FIGURE F-2)

Observation Well No. 1

Date : June 16 to 26, 1989
Depth : 36.00 m

Well data are shown in FIGURE F-4. Between 0 and 31.00 meter is hard andesite and the deeper part is black slate with thin sand stone layers. Unfortunately, the groundwater enough to drinking water is not existing in the boundary of andesite and basement.

2.3.3 Well Design and Pumping Test

The well design of observation well is shown in FIGURE F-5. The groundwater is flowing from the well slightly.

TABLE F-3' DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

SURVEY POINT	ELEVATION (M. AMSL)	TOPOGRAPHY	1st LAYER			2nd LAYER			3rd LAYER		
			Ohm-m	m	GEOLOGY	Ohm-m	m	GEOLOGY	Ohm-m	m	GEOLOGY
ES - 1	20	ALLUVIAL PLANE	19 ~ 285 ~3	3.3	TOP SOIL	165	-	ANDESITE			
ES - 2	20	do	30	2.3	do	450 ~ 165	57.7	do	100	-	SEDIMENTARY ROCK
ES - 3	32	do	15	1.6	do	150	18.4	do	57 ~ 96	-	do
ES - 4	18	do	30 ~ 15	5.5	do	247	-	do			
ES - 5	8	do	16 ~ 10	2.8	do	125	41.0	do (WEATHERED)	54 ~ 140	-	do
ES - 6	50	do	25 ~ 17	3.0	do	180	-	do			

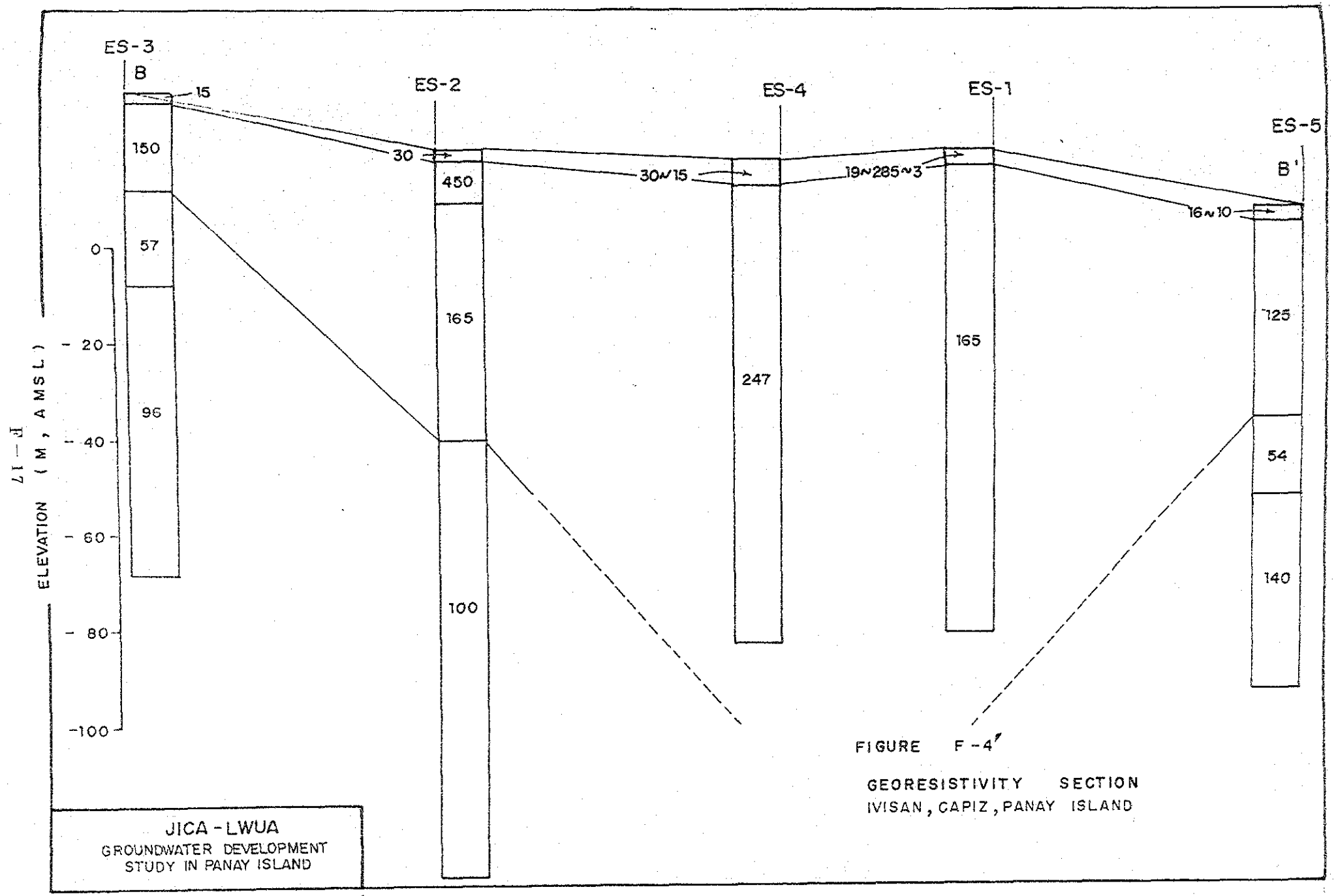


FIGURE F-4

GEORESISTIVITY SECTION
IVISAN, CAPIZ, PANAY ISLAND

FIG. F-5 OBSERVATION WELL DATA SCALE :

LOCATION : IVISAN , CAPIZ

WELL NO. : 1 DEPTH : 36.00m DIAMETER : Ø100 mm CASING PIPE : Ø 50mm PVC

DATE : 16 - 26 JUNE 1989 TOTAL DAYS 10

SCALE	DATE D.	DATE M.	DEPTH	GEOLOGICAL MAP	STRATA M. THKS.	GEOLOGICAL NAME	COLOUR
			1.30		1.30	CLAY	YELLOWISH BROWN
			2.90		1.60	CLAY GRAVEL	MILKY WHITE
5						WEATHERED ANDESITE	DARK GREEN
	6	19	9.30				
10			12.00		9.10		
	6	20	13.85			ANDESITE HARD CRACK POOR	DARK BLUWISH GRAY
15	6	21	17.37				
20	6	22	23.00				
25						ANDESITE WEATHERED SOFT	
30			31.00		19.00	▽ W 30.60	
	6	23	32.35			SLATE WITH THIN HARD SAND STONE LAYER	BLACK
35	6	24	36.00		5.00		
40							
45							

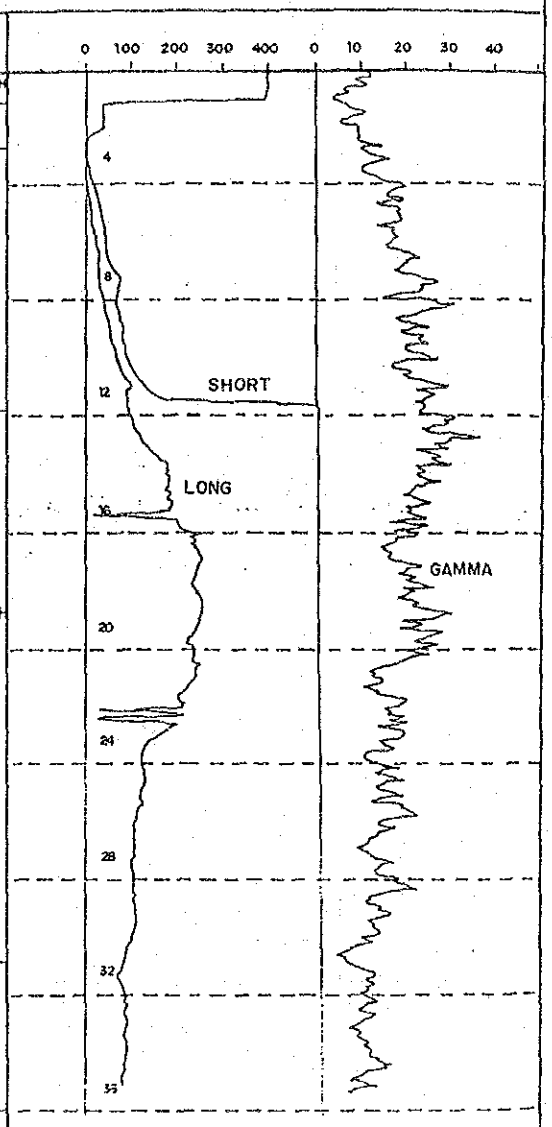
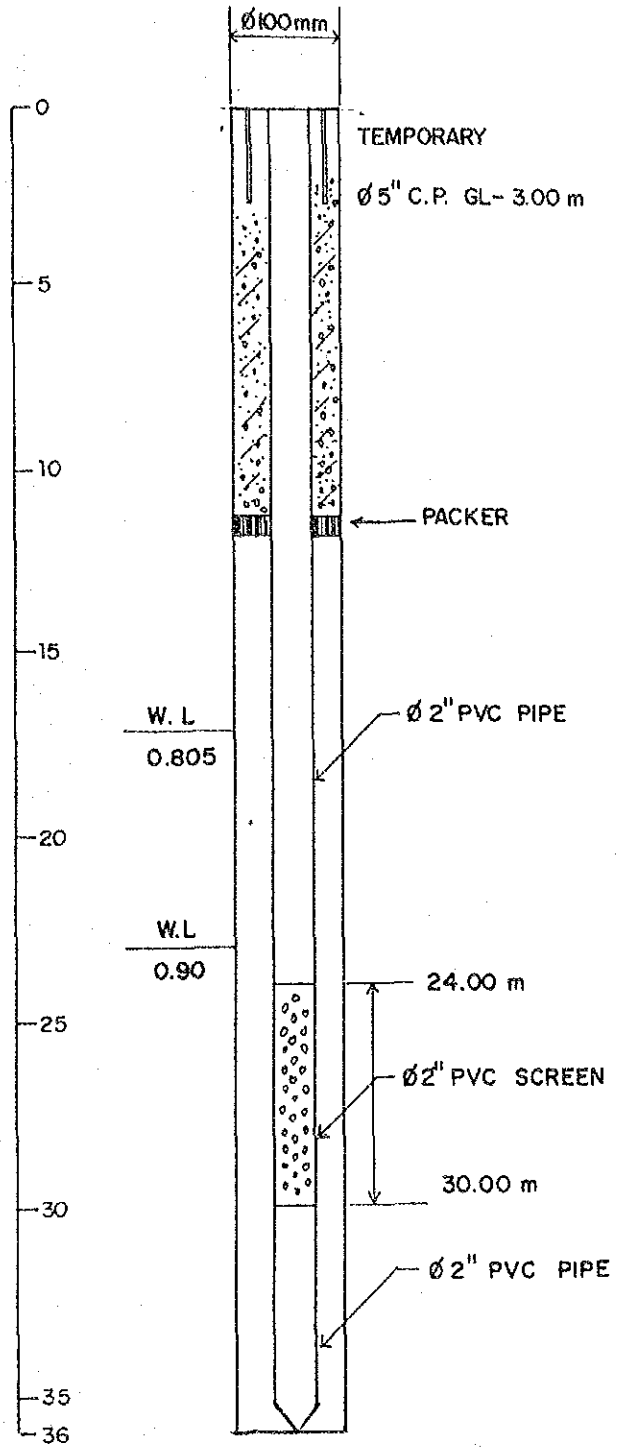


FIG.F-6 WELL DESIGN OF OBSERVATION WELL AT IVISAN



2.4 Water Quality Analysis

A total of 14 existing water sources was surveyed. Two water samples from Tulalo spring were collected for laboratory analysis. Survey sites and field analysis data are shown in FIGURE F-3 and TABLE F-4, respectively.

TABLE F-4 Water Quality Analysis Results

Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season						
F-1 Shallow Well	29.0	6.6	340	1.0	-	<0.4
F-5 Dug Well	29.0	6.8	750	2.0	-	1.6
F-6 Dug Well	28.5	6.7	500	nil	-	0.4
F-7 Public Well, No. 063-82-04	30.0	6.7	310	10<	-	4.0
F-8 Dug Well	29.5	6.5	500	<0.2	-	nil
F-10 Shallow Well	28.8	6.3	900	10<	-	<0.4
F-12 Tulalo Spring	29.0	8.1	160	nil	nil	nil
F-13 Cabugao Spring, Level II	32.5	8.3	160	nil	nil	nil
F-14 Shallow Well	29.5	7.1	500	0.4	nil	nil
Rainy Season						
F-1 Shallow Well	29.3	6.7	305	2.0	-	nil
F-2 Dug Well	28.3	7.2	690	-	-	-
F-3 Dug Well	30.0	6.7	495	1.0	-	nil
F-4 Dug Well	29.0	6.6	500	nil	-	-
F-5 Dug Well	29.3	6.9	830	-	-	-
F-6 Dug Well	28.4	6.8	500	nil	-	1.2
F-9 Dug Well	28.0	5.0	1,200	nil	-	nil
F-10 Shallow Well	28.2	6.4	790	0.2	-	0.8
F-11 Dug Well	29.2	6.8	490	0.2	-	nil

F-12 Tulalo Spring	26.2	8.0	152	nil	-	nil
F-13 Cabugao Spring	26.8	8.2	130	nil	-	nil

Shallow well water sources have a tendency to show a slightly low pH condition, while spring water sources have alkaline characteristics. Electric conductivity also defines differences of these two groups of water sources that spring water sources contain less chemical constituents nearly to rain water.

Following are the results of laboratory analysis for water samples collected from Tulalo Spring.

	Dry Season	Rainy Season
Date of Sampling	5.15.88	9.23.88
Turbidity (FTU)	2	2
Color (UNIT)	nil	116 (Apparent)
TDS (mg/l)	576	150
pH (-)	7.2	7.7
EC (µS/cm)	900	280
Alkalinity as $CaCO_3$ (mg/l)	105	100
Hardness as $CaCO_3$ (mg/l)	105	109
Major Cations (meq/l)		
Sodium	0.43	0.6
Potassium	0.10	0.05
Calcium	1.20	1.1
Magnesium	0.91	1.0
Total	2.64	2.75
Major Anions (meq/l)		
Carbonate	0	0
Bicarbonate	2.09	2.0
Chloride	0.64	0.6
Sulfate	0.02	0.2
Total	2.75	2.8

Geochemical characteristic of water at Tulalo Spring is a typical Carbonate-Hardness Type. Chemical constituent of the water are fairly good for drinking purpose. Apparent color as measured at 116 UNITS in rainy season is assumed to be caused by the presence of fine clay particles.

3. Conclusion and Recommendation

The other springs in the mountain area are not expected for the sources of water supply system due to poor retention of water.

The development of groundwater by deep well in the Poblacion is endangered by salt water intrusion. Moreover, drilling through the compact and thinly fissured volcanics is very difficult.

The utilization of the two springs for drinking use is therefore considered necessary expedient in order to increase the water supply capability of the system.

If another intake dam is constructed downstream of the existing intake dam, a total volume of 175 cu.m/day can be expected as a minimum supply amount during dry season.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

Two piped water supply systems are working: one Level III system for the Poblacion area and one Level II system for Barangays Tagican and Cabigao at the west of the Poblacion.

Approximately 400 households/concessionaires are presently served by the Level III system. Water supply service is continuous for 24 hours a day, but low water pressure is experienced by users during peak demand hours. A flat water rate of ₱10/month is charged at due to the absence of water meters.

Unserved residents in the Poblacion area obtain drinking water from private shallow dug wells which are usually unprotected.

Since Ivisan has been annexed to Roxas City with regard to municipal water supply service in early 1988, the said Level III system is being administered by the Roxas City Water District. Although the existing system has considerable water supply service coverage in the Poblacion area, the quality of service is fast deteriorating due to low water pressure, insufficient supply amount, leakage from aged pipe-lines, etc. When the potential water need in the Poblacion area, both for domestic and commercial use, is taken into account, thorough improvement on the present water supply conditions is a major requirement.

1.2 Existing Water Supply System and Problems Encountered

The Level III system was constructed during the late 1930's with Tulalo Spring utilized as a water source. A water intake dam (12.0 mW, 1.5 mH) was constructed downstream at about 135 m above sea level. The transmission main (CI, ø125 mm and ø150 mm) was laid from the dam to the Poblacion for a total length of about 3.5 km. Approximately 120 cu.m/day is estimated to be supplied by the gravity flow.

The water intake pipe is not properly protected to prevent the inflow of falling leaves and insects. During dry season and/or peak demand hours, this intake pipe is exposed to the open air. Muddy sand and leaves accumulate in the dam, despite periodical cleaning.

Leakages were observed on the rusted surface of the transmission line. Abusive use and/or wastage of water were observed along the route of the transmission pipeline, i.e., bathing of carabaos.

A Level II system was also constructed in 1982. Surface water is collected by a dam (6 mW, 1.5 mH) constructed at about 80 m above sea level. The transmission line is made of ø50 mm GI pipe. Flow

rate through this pipeline at approximately 220 liters per minute was measured by the use of an ultrasonic flow meter.

An additional intake structure was constructed beside the existing intake dam by the DPWH, but no pipeline has been installed yet.

No technical data or drawing are kept by the municipality and the pipeline route of the Level III system could not be readily determined.

2. Water Demand Projection

2.1 Criteria

There is one operational piped water supply system in the planned service area. Approximately 400 house- holds are reported to be served by the existing system. However, actual unit water consumption are not available due to the absence of water supply data. Per capita unit water consumption is, therefore, assumed at 100 lpcd in 1988 based on the LWUA Methodology Manual and in the experience in a similar water supply feasibility study, "Municipal Water Supply Project", conducted by JICA in 1987.

Design unit water consumption by consumer type is thereby estimated in accordance with the said Manual, as follows:

- Domestic per capita unit water consumption is estimated at 112 lpcd in the year 1995 with an annual increase ratio of 2% from 1988 to 1990 and 1.5% from 1990 to 1995 against 100 lpcd in 1988.

- Commercial unit water consumption is estimated at 1.4 cu.m/connection/day with its connection density ratio of 1.2 per 100 inhabitants.

- Institutional unit water consumption in 1995 is estimated at 5.2 cu.m/connection/day with its connection density ratio of 1.0 per 2,000 inhabitants in the service area.

The existing water supply system was constructed in the late 1930's. In this regard, the unaccounted-for water is considered to be 40% of the total distributed amount based on the LWUA Methodology Manual.

2.2 Areas to be Served

The target year for water supply planning is set for the year 1995 as an intermediate water supply development/improvement. In this regard, the planned service area of this target year is determined to be the densely populated area, with the present service area of the existing water supply system also given due attention. Poblacion Norte, Poblacion Sur and Barangay Agmalobo, where the transmission

line runs from Tulalao Spring to the Poblacion area, are likewise included in the planned service area.

2.3 Population Projection

The National Economic and Development Authority (NEDA) has projected the municipal population in each calendar year from 1981 to 2000 based on population census it conducted in 1980. The municipality, on the other hand, has no projected data of its own. In this regard, the NEDA population projection is referred to as the principal information.

Percentage share of barangay population to the municipal population in the year 1995 is assumed to be the same as that of the 1980 census result. The projected 1995 municipal population is then distributed to the respective service area barangays as shown in TABLE F-5.

TABLE F-5 Population Projection of Service Area

Year	Municipality	Service Area			Total
		Poblacion Norte	Poblacion Sur	Agmalobo	
1980	17,414	1,656	1,621	779	4,056
1985	19,830	1,890	1,850	890	4,630
1990	22,110	2,100	2,060	990	5,150
1995	24,200	2,300	2,250	1,080	5,630

The water supply service ratio is placed at 80% for the Poblacion area and 40% for barangay Agmalobo, taking into account habitation pattern in the planned service area as stated earlier. Average number of persons per household is assumed at 5.00 based on the standard figure adopted by the NEDA.

2.4 Water Demand Projection

The future water consumption in 1995 is estimated in accordance with the aforementioned planned service population and design unit water consumption by consumer type.

The estimated number of connections and future water consumption are shown in TABLE F-6.

TABLE F-6 Water Consumption in 1995

Service Area	Poblacion Norte	Poblacion Sur	Agmalobo	Total
Served Population	1,840	1,800	430	4,070
No. of Connection				
Domestic	368	360	86	814
Commercial	22	22	5	49
Institutional*	1	1	1	3
Total	391	383	92	866
Water Consumption (cu.m/day)				
Domestic	206	202	48	456
Commercial	31	31	7	69
Institutional	5	5	5	15
Total	242	238	60	540
Unaccounted-for Water	161	159	40	360
TOTAL	403	397	100	900

* At least one connection is considered for each barangay as the elementary school

The ratio of the daily maximum water demand to the daily average water demand is determined in relation to the planned service population based on the LWUA Methodology Manual as shown in TABLE F-7.

TABLE F-7 Demand Variation Factor for Daily Maximum Water Demand

Service Population	Ratio (Daily Max./Daily Ave.)
Less than 30,000	1.30 : 1
30,000 to 200,000	1.25 : 1
Over 20,000	1.20 : 1

The estimated daily maximum water demand is shown in TABLE F-8.

TABLE F-8 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Poblacion Norte	524
Poblacion Sur	516
Agmalobo	130
Total	1,170

The peak hour water demand is estimated in proportion to the daily maximum water demand and service population in accordance with the LWUA Methodology Manual as shown below:

C = (Peak Hour Demand x 24)/(Daily Maximum Demand)

= 2.2 -0.3 x log (Service Population/1,000)

The ratio of peak hour demand in the year 1995 is calculated at 2.02 and the peak hour water demand is estimated at 2,360 cu.m/day.

3. Proposed Water Supply Facilities

3.1 Basic Approach for Water Supply Improvement

3.1.1 Conditions and Constraints

The conceptual plan for water supply improvement is focused on major water supply facilities, such as water source, main transmission and distribution pipelines, and reservoir. Branch lines, service connections and fire hydrants are likewise excluded from conceptual planning. However, following conditions are taken into account as much as possible:

(1) Low cost in construction, operation and maintenance,
(2) Seasonal fluctuation of source capacity will not seriously affect stable water supply,
(3) Water source will be located within the administrative boundary of respective municipality.

3.1.2 Water Source Development

Present water sources for Ivisan area are only shallow wells at poblacion area and two springs in mountainous area in northwest from poblacion. Based on the analysis of electric logging and hydrogeological survey in observation well, it is concluded that development of new water source seems quite difficult.

Thus, in addition to Tulolo spring, Cobugao spring will be fully utilized for source of poblacion. However, amount of spring water from these two (443 cu.m/day : dry season) is largely less than daily maximum water demand (1,170 cu.m/day) at target year (1995), so spring water should be used only for drinking water and existing shallow well will be utilized for miscellaneous water as present state.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

Existing intake dam at Tulalo spring can be used at present state, but intake pipe (ø 400 mm, l= 15 m) shall be newly installed to prevent suspended solids and sands, mainly in rainy season.

New intake dam (W 15.0 m x H 2.5 m, EL + 60.0 m) at about 500 m downstream from Tulalo spring and intake pipe (ø 300 mm, l = 20m) will be installed.

Intake dam at Cabugao spring will be utilized at present condition but intake pipe (ø400 mm. l = 10 m) will be installed to avoid suspended solids and sands.

3.2.2 Transmission Facility

Transmission pipes must carry whole amount of water which can be obtained from each water sources during rainy season. Due to the deterioration and leakage, transmission pipe installed in 1930's will be renewed from Tulalo spring to intake dam at downstream: ø 100 mm, l = 500 m

Transmission pipe, from intake dam along Tulalo spring, to newly built reservoir, will be renewed due to the same reason described above: ø150 mm, l = 3,300 m

Junction box for gathering water from the spring and the dam will be constructed near the intake dam located at downstream of Tulalo spring : RC, W 3.0 m x L 5.0 M x H 3.0 m, 45 cu.m

As no transmission pipe is installed from Cobugao spring to poblacion area, transmission pipe from spring to new reservoir will be installed : ø 150 mm, l = 5,500 m

Likewise, since no reservoir with enough capacity exists in poblacion, new reservoir will be constructed on the hill (EL+30 m) about 1.6 km west from poblacion area. Capacity is 10% of daily maximum water demand : RC, W 6.0 m x L 6.0 m x D 3.5 m, 126 cu.m.

3.2.3 Distribution Facility

Diameter of distribution pipe must be determined base on hourly maximum water demand. New distribution main will be installed due to the deterioration of the existing pipe.

ø 200 mm, l= 600 m
ø 150 mm, l= 1,550 m

3.2.4 Required Water Supply Facilities

Location of major water supply facilities is shown in FIGURE F-7. flow diagram of facilities in F-8 and detail of distribution pipeline in proposed service area in FIGURE F-9.

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Intake pipe
Tulalo-1 : ø 400 mm, l = 15 m
Tulalo-2 : ø 300 mm, l = 20 m
Cabugao : ø 400 mm, l = 10 m

Intake dam :
W 15.0 m x H 2.5 m

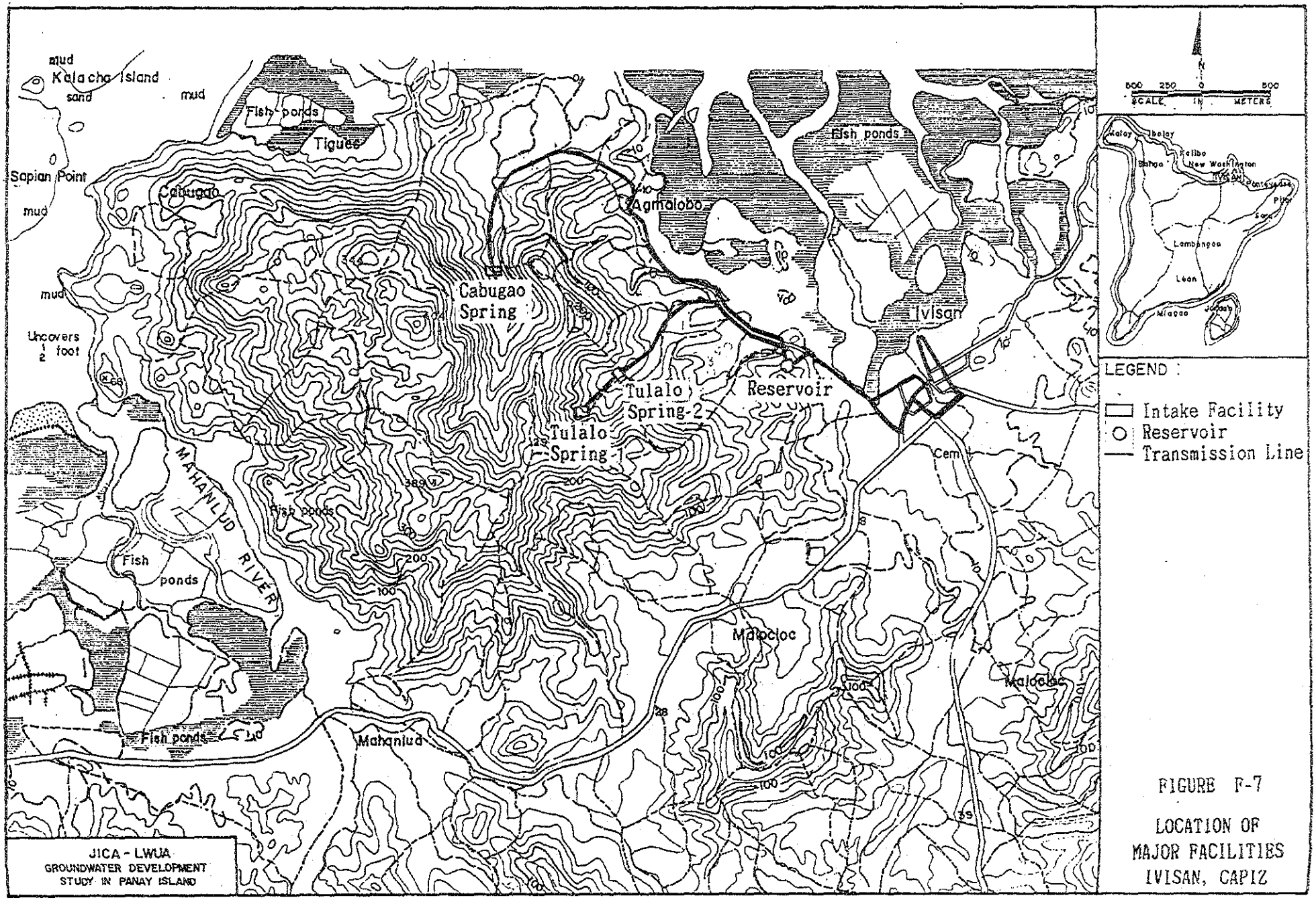
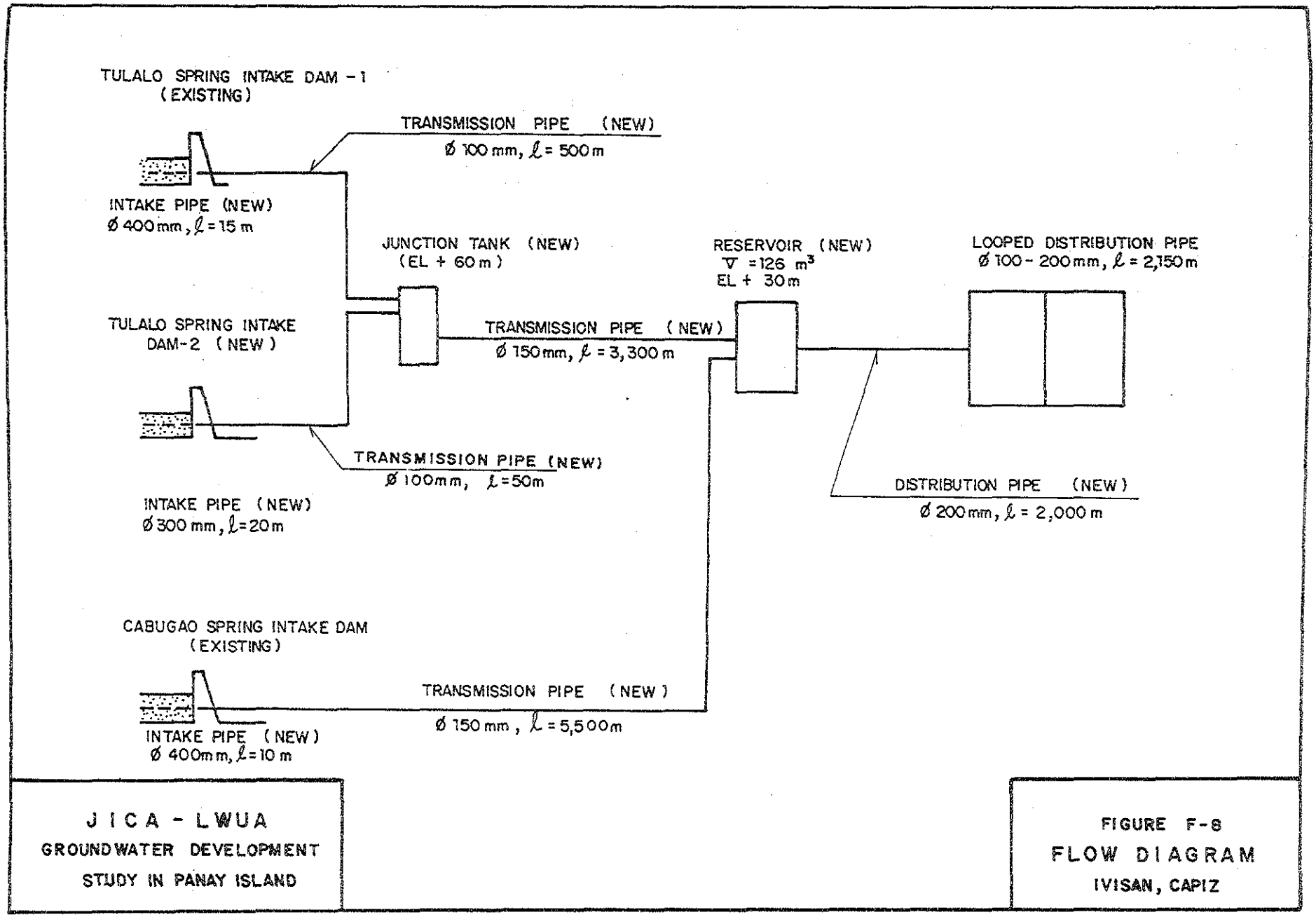


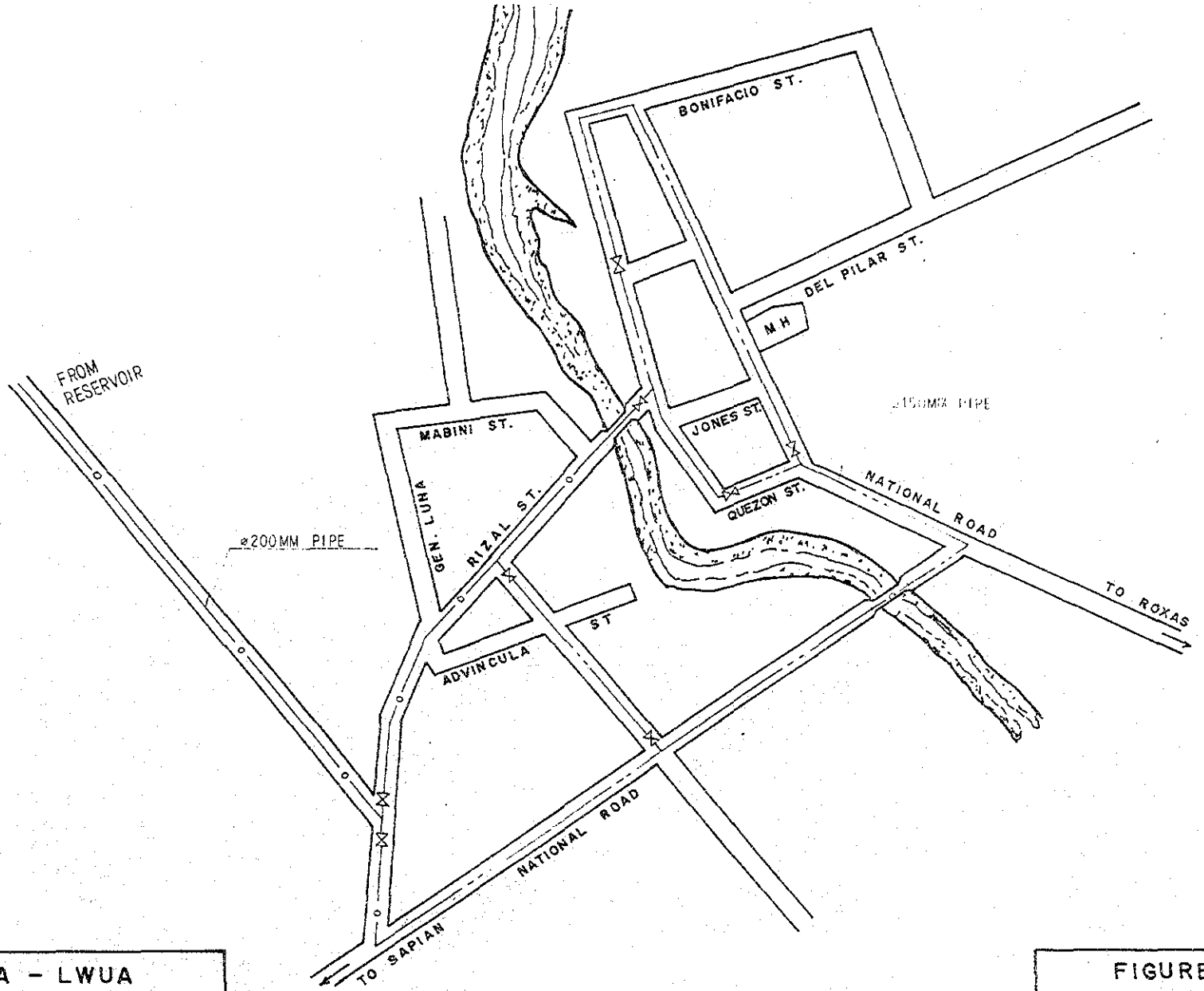
FIGURE F-7

LOCATION OF MAJOR FACILITIES IVISAN, CAPIZ



JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

FIGURE F-8
FLOW DIAGRAM
IVISAN, CAPIZ



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STUDY IN PANAY ISLAND

FIGURE F-9
DISTRIBUTION PIPELINE
IVISAN , CAPIZ

(2) Transmission Facility

Transmission main
from junction tank and Cabugao to reservoir :
ø 150 mm, l = 8,800 m
from Tulalo-1,-2 to junction tank :
ø 100 mm, l = 550 m

Junction tank :
RC, W 3.0 m x L 5.0 m x H 3.0 m, 45 cu.m
Reservoir :
RC, W 6.0 m x L 6.0 m x D 3.5 m, 126 cu.m

(3) Distribution Facility

Distribution main :
ø 150 mm, 1,550 m
ø 200 mm, 2,600 m

3.3 Rough Cost Estimate of Major Water Supply Facilities

3.3.1 Unit Construction Cost

Unit construction cost of required facilities is based on the "In-Place Cost of Waterworks Materials" (as of January 1989) of LWUA. Any unit cost not shown in this list is referred to "Unit Price Manual - Water Supply Feasibility Studies" (July 1983) upon consideration of price escalation that 15% per annum upto 1987 and 7% per annum from 1987 as adopted by LWUA.

All construction costs are estimated in Philippine Pesos and the total cost is only converted into U.S. Dollars and Japanese Yen based on the following exchange rate as of September 1989.

U.S. $1.00 = Yen 145.70 = Peso 20.78

Unit costs used in rough cost estimate are attached in Appendix-5.

3.3.2 Rough Cost Estimate

Facility	Cost (Thousand Peso)
Water Source	
Intake pipe (ø 400 mm, 25 m)	51.0
(ø 300 mm, 20 m)	22.4
Intake dam	
(W 15.0 m x H 2.5 m)	126.8
Transmission Line	
Transmission line	
(ø 100 mm, 550 m)	275.0
(ø 150 mm, 8,800 m)	5,544.0
Junction Tank	
(45 cu.m, 1 unit)	115.8
Reservoir	
(126 cu.m, 1 unit)	312.7
Distribution Facility	
Distribution line	
(ø 150 mm pipe, 1,550 m)	837.0
(ø 200 mm pipe 2,600 m)	1,638.0
(ø 150 mm valve 5 pcs.)	28.5
(ø 200 mm valve 3 pcs.)	25.5
Total	8,976.7

Total construction cost for improvement of major water supply facilities is estimated at approximately 8.98 million Pesos (62.9 million Yen or 0.43 million U.S. Dollar).

G. PONTEVEDRA, CAPIZ

G. PONTEVEDRA, CAPIZ

I. STUDY AREA AND HYDROGEOLOGICAL ANALYSIS

1. Description of the Study Area

1.1 Physical Description

1.1.1 Geographical Location and Area

Pontevedra is located at 122°46' North Longitude and 11°14' North Latitude. It is one of the coastal towns located on the western part of Capiz. It is bounded on the north by the municipality of Panay, on the northeast by the Pilar Bay and Sibuyan Sea, on the east by the municipality of President Roxas, on the southeast by Iloilo, on the south by Ma-ayon, and on the east by Panitan. It has a total land area of 133.1 sq. km. covering 26 barangays. Location map is shown in FIGURE G-1.

1.1.2 Climate

Its climate falls under Type III which is characterized by no pronounced seasonal change. It is relatively dry from January to May and wet during the rest of the year. Rainfall is heaviest during the month of October and the least in February. Average annual rainfall is 2,118.8 mm. Average annual temperature is 27.7°C with June as the hottest month and January as the coolest month.

1.1.3 Terrain/Topography

The area is made up mostly of plains. Extensive swamps and marshes are found along the coast and the northern plains are usually flooded during the rainy season. The southern portion are upland areas with gently rolling terrain.

1.1.4 Soil

There are five different types of soils in Pontevedra, namely: Hydrosol, Alimodian Clay Loam, Luisiana Clay Loam, Bantog Clay Loam and Sara Clay Loam. The predominant type is Alimodian Clay Loam which characterize 37.72% of the total land area. This soil as well as the other clay loams are suitable for sugar and rice. Hydrosol is found in the northern swampy portion and covers 33.84% of the area; most of which are presently devoted to fishpond production.

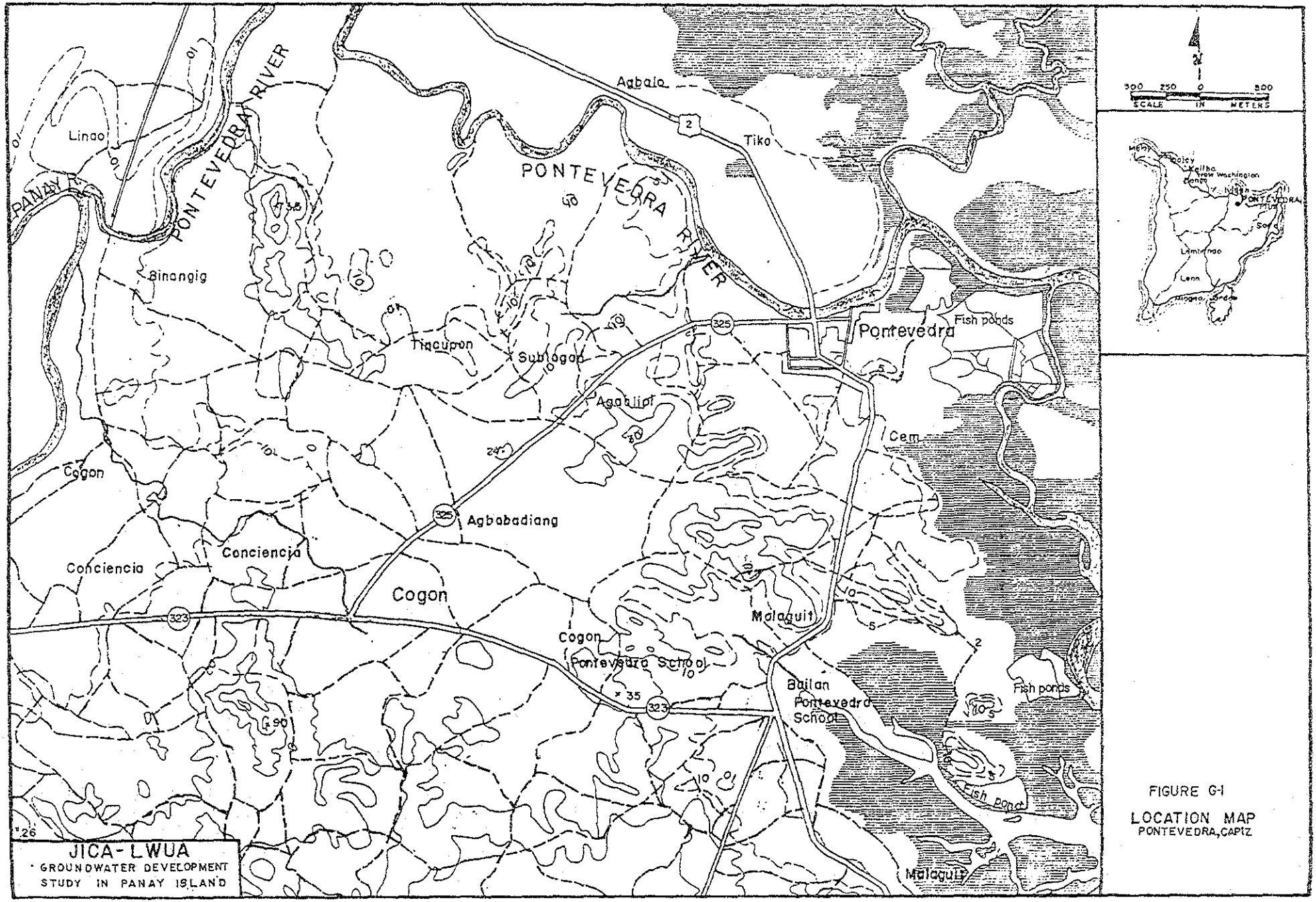

FIGURE G-1

LOCATION MAP
PONTEVEDRA, CAPIZ

1.1.5 Administrative Composition and Land Use

The municipality is headed by the Mayor and Vice Mayor with eight (8) members of the Sangguniang Bayan as the local legislative body. Under the municipality are the barangay organizations, which are headed by the barangay captains/chairmen with the Sangguniang Barangay as the lawmaking body. All these local officials are selected by the people through popular election.

Municipalities are classified according to the annual revenues from taxes. This classification serves as a major indication of the socio-economic situation of the population in the municipalities.

The municipality of Pontevedra belongs to the fourth class with an average annual income of less than ₱400,000.

Listed below are the 26 barangays composing the municipality:

1. Agbanog
2. Agdalipo
3. Ameligan
4. Bailan
5. Banate
6. Bantique
7. Binantucan
8. Cabugao
9. Caug-iat (Gabuc)
10. Guba
11. Hipona
12. Intungcan
13. Jolongajog
14. Lantangan
15. Linompongan
16. Malag-it
17. Manapao
18. Ilawod (Poblacion)
19. Ilaya (Poblacion)
20. Rizal
21. San Pedro
22. Solo
23. Sublangon
24. Tabuc
25. Tacas
26. Yatingan

1.1.6 Transportation

Land and water transportation from the municipality to the main market centers of the neighboring towns and the capital city makes possible the regular flow of agricultural and fishery products as well as people and services. The most common means of transporting passengers and cargo is by jeep and small buses and trucks and by motorized water-craft. Trucks, small buses and jeeps registered a total of 101 while motorized bancas were counted at 179. Daily bus trips are also scheduled between the town center and the cities of Roxas and Iloilo. Transportation to Manila is by commercial aircraft from Roxas City airport and by inter-island vessel from the port in Roxas City.

1.1.7 Infrastructure

The municipality has a total road network of 71.8 km of which 18.7 km are national roads, 17.5 km are provincial roads, 4 km are municipal roads and 32.2 km are barangay roads. Of these, only 4.52 km have concrete surface, 1 km asphalt, 30.00 km gravel and the remaining 35.29 km earth fill. There are only 4 existing bridges, all concrete, with a combined length of 130 linear meters.

Power supply is provided by the Capiz Electric Cooperative (CAPELCO) located in Panitan, 11 km away from the municipality. About 95% of the Poblacion households and 31% of the households of 13 adjoining barangays are served by CAPELCO. Eleven barangays which are mostly located in the coastal fishery areas do not have electric power supply.

1.2 Population and Living Conditions

1.2.1 Population Trend from the Past

Total population was recorded at 30,489 in 1980, registering an average annual growth rate of 2.25% from the 1975 population of 27,266. It grew faster than the provincial population, which averaged a 2.01% annual increase. However, from 1970 to 1975, the municipality's population grew at a slower rate of 1.50% annually compared to the province's 2.50%.

Among the 16 municipalities and 1 city of Capiz, Pontevedra ranked 5th in population having accounted for 6.2% of the total population of the province. On the other hand, its population density was posted at 229 persons per square kilometer, making Pontevedra one of the sparsely populated areas in Capiz. However, it was still greater than the provincial average density of 184.8 persons per square kilometer.

About 84% of the area's population lived in the rural areas.

Households registered a total of 5,120. Distribution among the barangays is presented in the following table.

TABLE G-1 Population and Number of Households by Barangay, Pontevedra, Capiz 1980

Barangay	Population	Number of Households
Agbanog	887	145
Agdalipo	452	79
Ameligan	1,030	172
Bailan	1,636	270
Banate	706	131
Bantique	335	56
Binantucan	3,488	572
Cabugao	217	32
Caug-iat (Gabuc)	404	69
Guba	188	39
Hipona	2,068	354
Intungcan	727	134
Jolongajog	1,853	347
Lantangan	1,536	268
Linompongan	764	124
Malag-it	959	156
Manapao	783	136
Ilawod (Poblacion)	1,594	244
Ilaya (Poblacion)	994	160
Rizal	2,039	334
San Pedro	774	129
Solo	436	69
Sublangon	1,262	223
Tabuc	2,151	354
Tacas	2,334	368
Yatingan	872	155
Total	30,489	5,120

1.2.2 Age Distribution

Of the total population, 50.5% belonged to the productive age groups (15-64 years old) while 45.9% were under 15 years of age and 3.6% were above 64 years of age. Dependency rate therefore was very high, i.e., there were 98 dependents for every 100 productive persons.

In terms of sex distribution, the population was evenly distributed with a ratio of almost 1:1.

1.2.3 Morbidity/Mortality

The leading causes of morbidity are upper respiratory tract infection, bronchitis, wounds (all types), parasitism and influenza. On the other hand, the leading causes of mortality are pneumonia, cardiovascular accident, violent death, hearth disease and tuberculosis.

1.2.4 Sanitation

Closed pit and open pit are the common types of toilet facilities in the municipality which are being used by 45.6% and 37.2%, respectively, of the 5,120 private households. The water-sealed with other depository type is being used by some 10.3% of the total households; water- sealed with sewer/septic tank by 1.5%; others (pail system, etc.) by 0.9%. There are still households (4.5%) without toilet facilities.

1.2.5 Public Services

The educational services in the municipality are mainly provided by the government through 12 complete elementary schools, 2 primary schools and two barangay high schools. Total enrollment exceeds 400 for the elementary schools and more than 1,000 students for the high schools. The Capiz Agricultural and Fishery School (CAFS) located in Barangay Bailan has an enrollment of more than 1,000 students from all over the province.

Health services are likewise mainly provided by the government. For curative services, a 50-bed provincial hospital is located in Barangay Bailan which serves the requirement of the eastern portion of the province. Two small health clinics are run by the private sector in the Poblacion. With regard to primary health care particularly for the rural areas, there are two rural health units, each of which is staffed by a physician, a nurse, several midwives and a sanitary inspector. There are also 5 Barangay Health Centers strategically located throughout the municipality. A midwife is stationed at each center and they are visited regularly by a rural physician form the Provincial Health Office.

Communication services are provided by two postal stations, and two telegraph stations. There are no telephone services and radio communication system. However, several weekly and monthly publications and at least one national daily newspaper are available in the municipality.

1.3 Economy and Industry

1.3.1 Agriculture

The total agricultural area as reported in the 1980 Census of Agriculture was 2,419 ha, which was divided into 1,004 farms giving an average farm size of 2.4 ha. A total of 997 farms are managed by individual operators while 3 farms are under corporate farming. Some 860 ha are fully owned by 189 households while 113 are under owner-like possession such as heirship or certificate of land transfer. There are 824 farms being rented or leased and the remaining 363 farms are on other forms of tenure.

Total agricultural production amounted to 56,940 metric tons of which 50,380 metric tons or 88.48% were contributed by sugar cane and 5,517 metric tons or 9.69% consisted of paddy. The remaining 1.83%, which amounted to some 1,043 metric tons were a combination of fruits, vegetables and root crops.

Total livestock population was recorded at 18,050 consisting of 1,573 carabaos, 17 cattle, 3 horses, 1,389 hogs, 196 goats and 14,872 fowls mostly chickens and ducks.

1.3.2 Other Industries

There are only 19 manufacturing establishments mostly related to agricultural production such as rice mills, feed mills and manufacturing of farm tools and equipment. There are also three small ice plants and several cottage industries producing rattan-craft and shell-craft.

Commercial establishments total 316. the higher number consists of retail stores (163), trading in fishery products (61), restaurants and refreshment parlors (26) and dress shop and tailoring (23). The rest consists of bakeries (5), gas stations (6), warehouse (9), motor repair shops (7), farm input dealers (6), drugstores (6) and beauty parlors (4).

2. Analysis of Potential Water Source

2.1 Topography and Geology

The municipality of Pontevedra is located near the mouth of the Pontevedra River, which flows towards Pilar Bay across a wide swamp. The coastal plain and swamp surround the Poblacion. A hilly area extends towards the western to southern area behind the Poblacion.

The hilly area consists of volcanics belonging to Sibala Formation while the coastal plain and swamp are composed of alluvial deposits. Geological map is shown in FIGURE G-2.

Sibala Formation (Poleocene, Tertiary)

This unit is known as basement in this study area. It is found in the hilly area towards the western to southern part of the municipality. This unit consists mainly of basaltic andesite lava, which is compact and hard. Top soil and weathered rocks are very thin, so fresh volcanics are found at shallow parts below surface.

Alluvial Deposits (Quaternary)

This unit forms coastal plain and swamp deposits. These are mainly resedimented materials such as sand, silt and clay transported from inland by the river water into low land.

2.2 Existing Water Source

Wells

There is a deep well (24 m in depth) in the Poblacion which was constructed by DPWH. This, however, is not functioning and can not be utilized for the water supply system. Further, data concerning the said well are not available. Residents in the area are mainly dependent on water from shallow wells or private dug wells (about 20 m in depth) especially in Barangay Tacas.

Residents of the town proper of Pontevedra depend on shallow/dug wells and water vendors. Water sold by these vendors is consumed for drinking purposes and the water taken from the shallow/dug wells is used mainly for non-drinking purposes.

In hilly areas at Barangay Bailan, although there are four (4) deep wells at present, namely 2 wells in the Panay State Polytechnic College (68 m, 24 m in depth) and 2 wells in Capiz Provincial Hospital (48 m, 24 m in depth), the qualities of water are not good for drinking purposes due to high iron content.

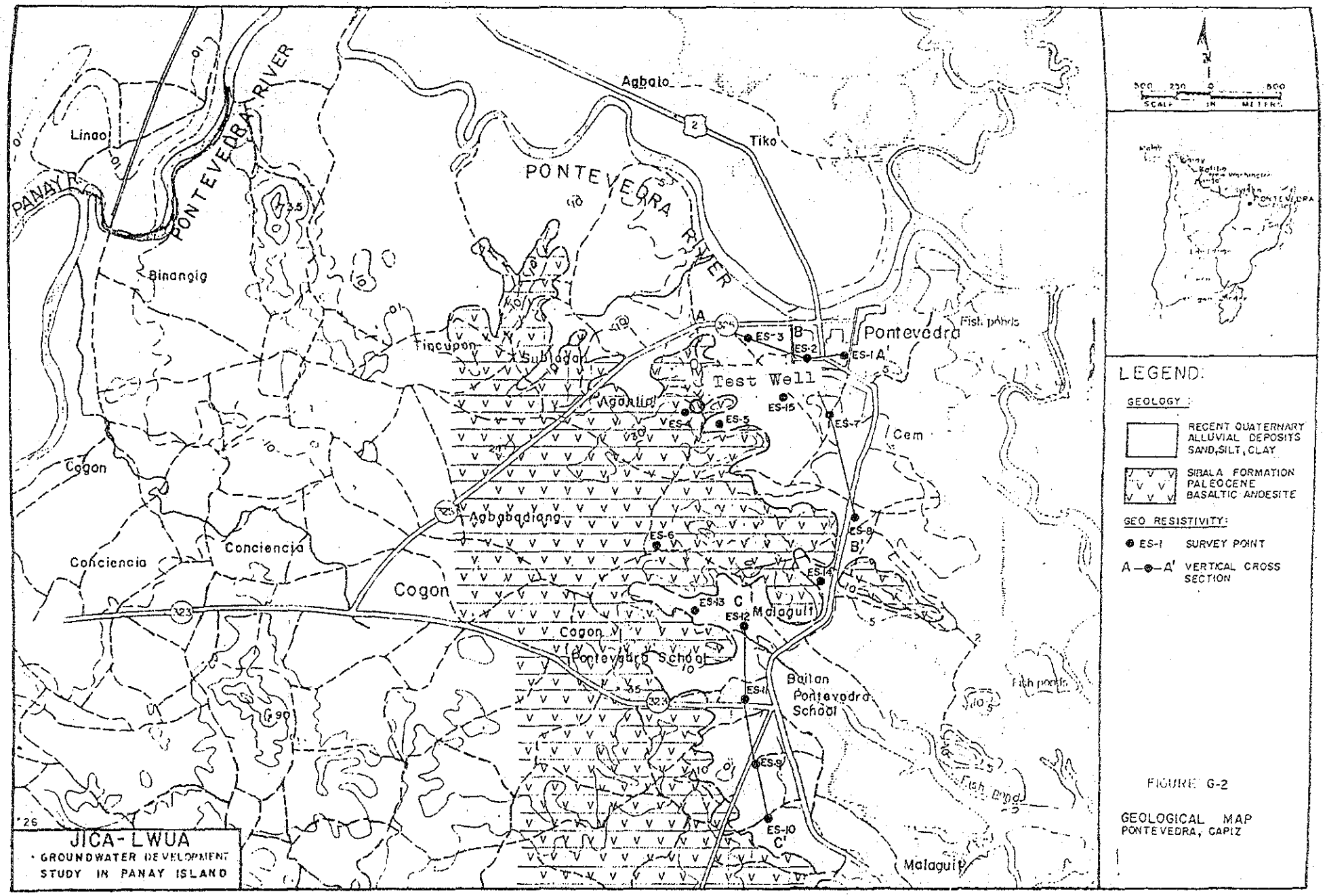

FIGURE G-2

GEOLOGICAL MAP
PONTEVEDRA, CAPIZ

The distance between Barangay Tacas and Barangay Bailan is only 3.5 km. Both are also located on the same volcanic rock. It is not clear why the qualities of water in these areas are different. It is presumed that a geochemical difference exists in the contents of volcanic rocks in both area.

In addition, there are several springs gushing out from the cracks of rock with a limited amount in barangays located approximately 5 km from the town proper, i.e., Rizal and Bailan.

A well inventory survey was carried out in the town proper and its surrounding areas as shown in FIGURE G-3. Site surveys were conducted for 16 well, 14 of which were examined for static water levels and total depths. The statistical data gathered is presented in TABLE G-2.

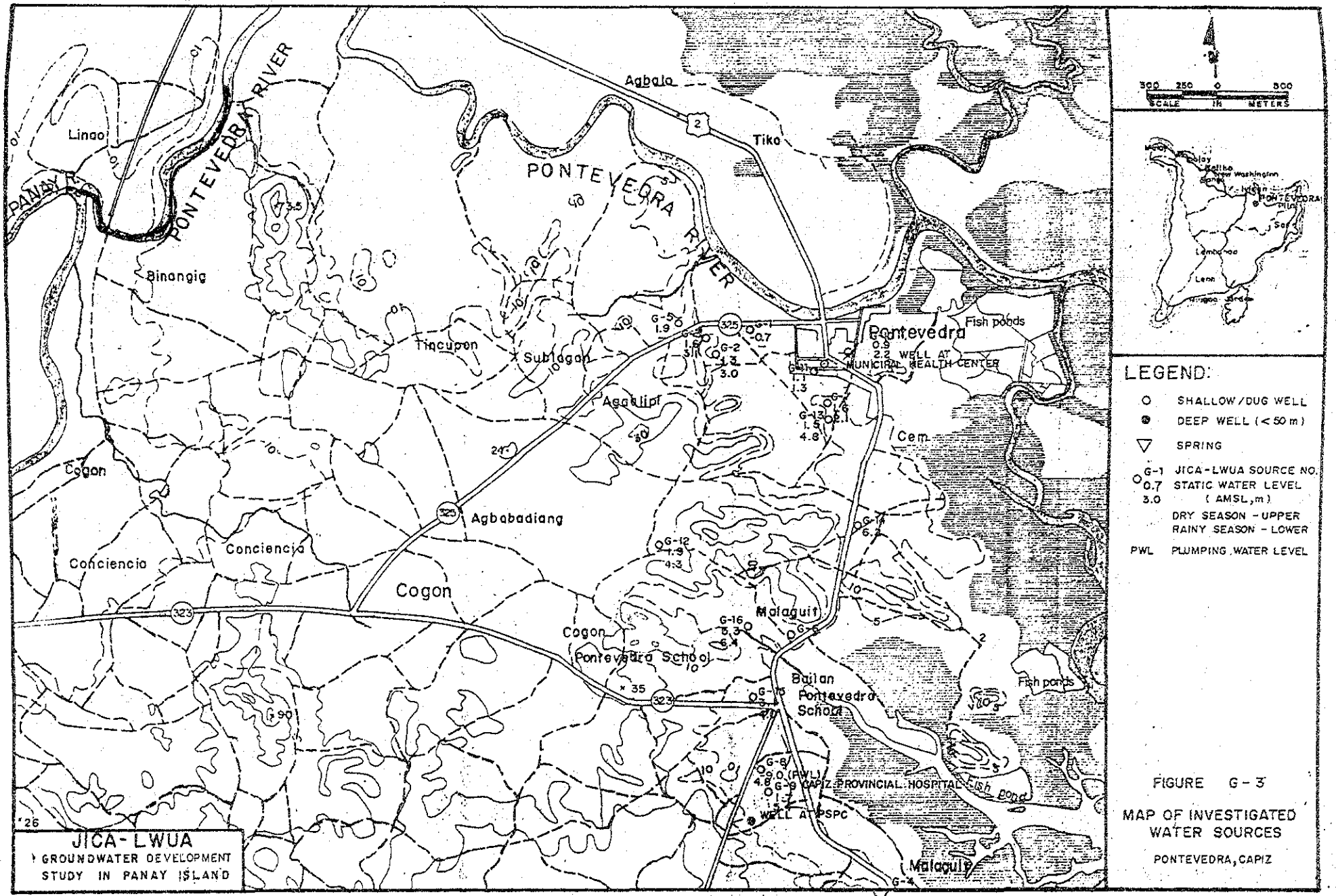
Agbalo
Tiko
Linao
PANAY R.
PONTEVEDRA RIVER
PONTEVEDRA RIVER
Binangig
Tinopon
Subagan
Agsalipi
Pontevedra
Fish ponds
WELL AT MUNICIPAL HEALTH CENTER
Cem.
Agbabadiang
Cogon
Conciencia
Conciencia
Cogon
Malaguit
Cogon
Pontevedra School
Bajlan
Pontevedra
School
Fish ponds
Fish pond
WELL AT PSPC
CAPIZ PROVINCIAL HOSPITAL
Malaguit
JICA-LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND
LEGEND:
SHALLOW/DUG WELL
DEEP WELL (< 50 m)
SPRING
G-1 JICA-LWUA SOURCE NO.
0.7 STATIC WATER LEVEL
3.0 (AMSL, m)
DRY SEASON - UPPER
RAINY SEASON - LOWER
PWL PUMPING WATER LEVEL
FIGURE G - 3
MAP OF INVESTIGATED WATER SOURCES
PONTEVEDRA, CAPIZ

TABLE G-2 Well Data Summary

JICA-LWUA Source Number		Well Depth (M)	Ground Level (MAMSL)	Static Water Level: Dry Season (May 13) (MBGL)	Dry Season (May 13) (MAMSL)*	Rainy Season (September 22) (MBGL)	Rainy Season (September 22) (MAMSL)
G-1	Bgy. Soblagon	6.00	4.5	-5.20	-0.7	-	-
G-2	Bgy. Ilaya	2.15	3.0	-1.69	1.3	0	3.0
G-3	Bgy. Ilaya	4.35	5.0	-3.45	1.5	-2.01	3.0
G-5	Bgy. Soblagon	8.04	5.0	-3.15	1.8	-	-
G-7	Bgy. Tacas	5.08	6.0	-4.45	1.5	-3.92	2.1
G-8	Capiz Prov. Hosp.	48.00	9.0	(-17.95) PWL**	-9.0	-4.22	4.8
G-9	Capiz Prov. Hosp.	24.00	9.0	(-7.28)	1.7	-3.56	5.4
G-10	ES-1	2.90	3.6	-2.70	0.9	-1.40	2.2
G-11	ES-2	7.24	8.0	-6.86	1.1	-6.66	1.3
G-12	ES-6	3.40	5.0	-3.10	1.9	-0.74	4.4
G-13	ES-7	5.25	7.0	-4.50	2.5	-2.16	4.8
G-14	ES-8	2.70	8.0	-1.80	6.2	-	-
G-15	ES-11	4.10	7.0	-3.94	3.1	-3.04	4.0
G-16	ES-12	2.00	7.0	-1.67	5.3	-0.60	6.4

* Estimated based on the topographic map of 1/50,000 scale and supplemental topographic survey.

** Pumping water level

The survey results are summarized as follows:

i) In the town proper, only shallow/dug wells are utilized and the groundwater table is situated about 1.5 m above mean sea water level.

ii) At the wells tapped by the water vendors (G-7, G-13) which are located south of the town proper, water is drawn up from free aquifers.

Continuous monitoring of water level in the well at the Municipal Health Center was conducted from May 12 to September 16 under the maintenance by the engineer of the Roxas City Water District. Based on the analysis of records, the following are deduced:

1) Water level in the well was slightly influenced by the tidal movement. However, difference of water level variation is quite small.

2) The lowest level is 9.53 m below ground level on May 14, 1988.

3) The highest level is 6.97 m below ground level on July 13, 1988. This may be influenced by a rainfall. This conjecture is deduced from the following:

   (a) The water level was raised rapidly from 4 cm during 10 hours.

   (b) The water level was falling down for 6 days after the peak. The water level on September 16, the last day of monitoring, is 7.22 m below ground level.

   (c) After the peak, the water level is varying up and down of 8 m below ground level.

4) From the day of lowest, the water level was continuously rising up to July 13, 1988.

Evaluation

The volcanic rocks in this study area are bearing groundwater in spite of their compact and hard characteristic. However, it could not be easily ascertained whether the quantity of the groundwater is enough as a source of water supply without pumping test in the deep well.

Although the Pontevedra River flows along the side of the town proper, its flow is affected by tidal movement. Thus, the construction of deep well in the low land areas must consider the aspect of salt water intrusion.

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

The Poblacion of Pontevedra lies on the delta of Pontevedra River and coastal plain extends to the surrounding rolling

hills which are consisted of volcanics.

The georesistivity survey was focused on the exploration of the possible presence of aquifers in the volcanics. A total of 15 survey points, namely ES-1 to ES-15, are indicated in FIGURE G-2.

Date	:	May 11 to 16, 1988
No. of Survey Points	:	15 points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	100 to 150 meters

The results of an ρ-a curve analysis is shown in TABLE G-3 and the geresistivity section as shown in FIGURE G-4 to 6.

The existence of aquifers in the volcanic rocks on the basis of the resistivity could not be ascertained of the absence of reliable well log data. However, the following interpretations and assessments have been performed:

1) The resistivity of alluvial deposits under the groundwater level range in values from 3 to 20 ohm.m and are considered to consist mainly of clayey or silty materials. Therefore, groundwater has poor potential in alluvial deposits.

2) The thickness of alluvium is less than 18 m.

3) The layer with resistivity values ranging from 20 to 100 ohm.m support the presence of aquifer in the volcanics.

2.3.2 Observation/Test Well Drilling

Based on the results of the georesistivity survey the location of the test well was appointed near ES-4 point. (cf. FIGURE G-2)

Test well No. 1
Date : June 3 to July 22, 1989
Depth : 47.00 m

Well data are shown in FIGURE G-7. From 0 to 7.50 m, the strata were topsoil, clay, boulder. The hard andesite progressed deeper than 7.50 m, so the operation was continuing for a long time.

But test well hit the plenty groundwater (2.0 m^3/min = 2,880 m^3/day) from the fissures of andesite.

The water quality of this groundwater is shown below table.

TABLE G-3 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

PONTEVEDRA, CAPIZ

SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER													
			1		2		3		4		5		6		7	
			ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m
ES-1	3	alluvial plain	28	0.9	19	7	76	28	19	50	100					
ES-2	6	hill top	86	1.8	22	11	46									
ES-3	3	alluvial plain	4	2.3	66											
ES-4	15	hill foot	140	0.4	28	4	200	64	73	86	147	110	73			
ES-5	4	alluvial plain	18	3.0	90	26	44	44	135	120	57					
ES-6	15	alluvial plain	126	1.8	25	18	81									
ES-7	6	hill top	124	1.0	248	2.6	19	10	77							
ES-8	8	hill foot	16	1.0	8	3	99	80	45							
ES-9	8	low angle slope	27	0.7	18	2.5	76	22	32	30	2100	62	32	100	99	
ES-10	7	hill foot	82	1.0	27	7	90									
ES-11	7	gentle slope	66	2.1	13	5.4	60	84	106							
ES-12	7	alluvial plain	78	0.7	5	1.4	21	30	78							
ES-13	9	alluvial plain	21	1.2	14	3	77									
ES-14	9	alluvial plain	150	1.1	3	1.8	19	12	171	110	30					
ES-15	3	alluvial plain	7	0.8	105	6.5	21	9	85	64	53	90	130			

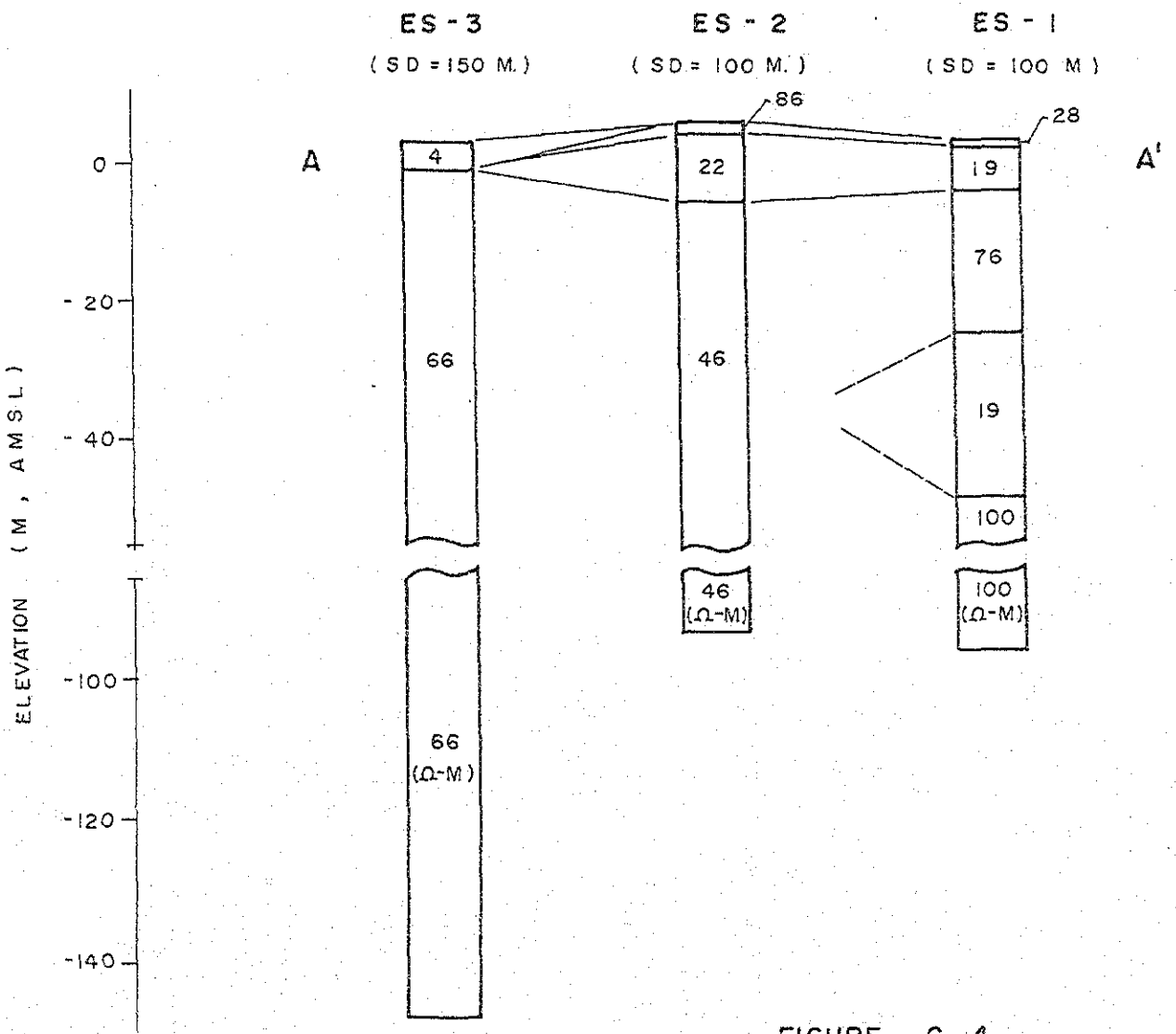

FIGURE G-4

GEORESISTIVITY SECTION A-A'

PONTEVEDRA , CAPIZ , PANAY ISLAND

SCALE H = 1 : 10,000
V = 1 : 1,000

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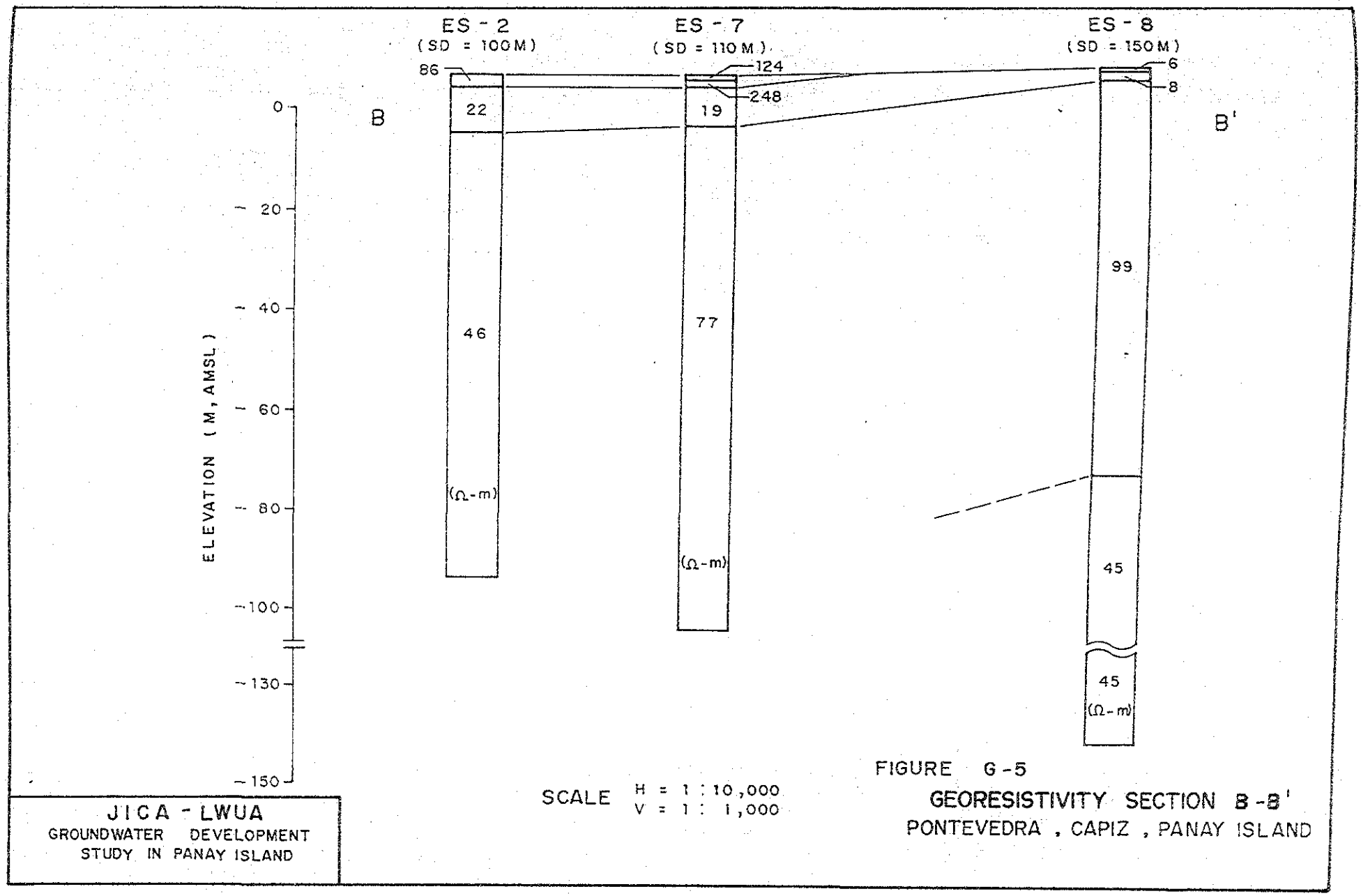

FIGURE G-5

GEORESISTIVITY SECTION B-B'

PONTEVEDRA , CAPIZ , PANAY ISLAND

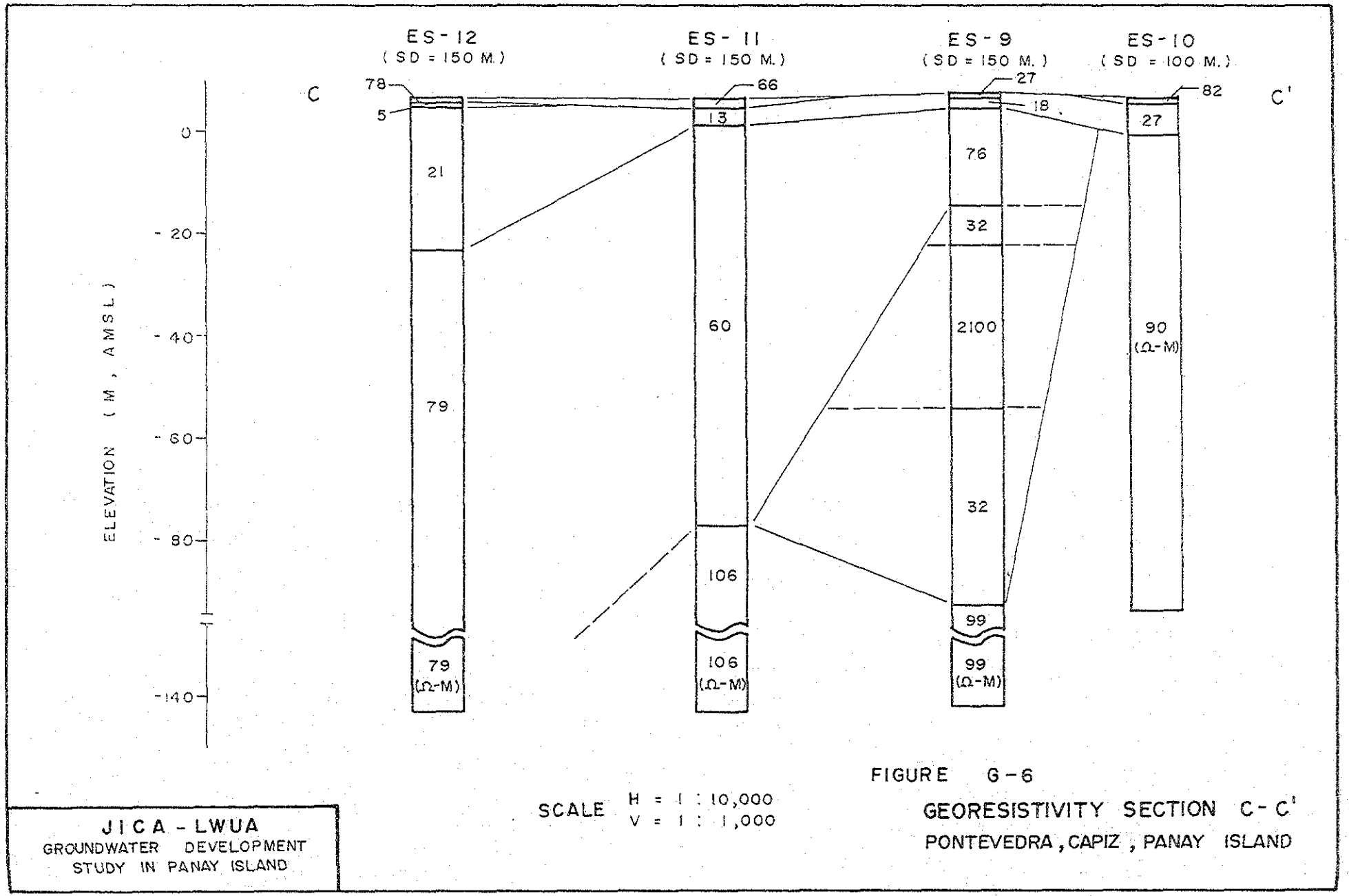

FIGURE G-6

SCALE H = 1 : 10,000
V = 1 : 1,000

GEORESISTIVITY SECTION C - C'
PONTEVEDRA , CAPIZ , PANAY ISLAND

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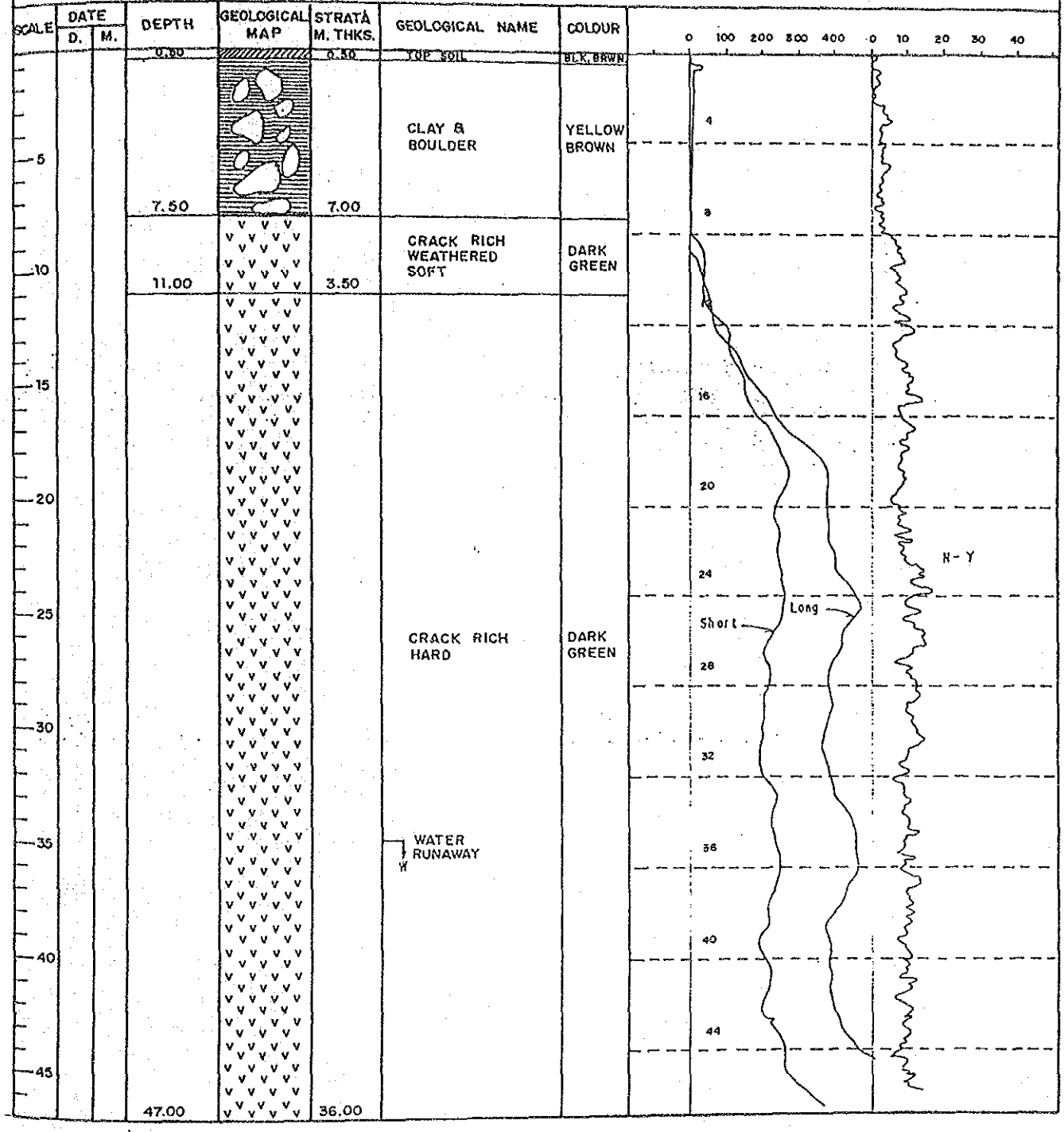
FIG. G-7 TEST WELL DATA SCALE :

LOCATION : BGY. SUBLANGON, PONTEVEDRA, CAPIZ

WELL NO. : 1 DEPTH : 47.00m DIAMETER : Ø 300 mm CASING PIPE : Ø 250 mm

DATE : 3 JUNE TO 22 JULY, 1989 TOTAL DAYS : 50



Total Fe	1.0 ppm
NO_2	nil
NH_4	nil
Mn	nil
pH	6.7
EC	550 s/cm

2.3.3 Well Design and Pumping Test

The well design showed in FIGURE G-8. As FIGURE G-8, it is remarkable the bottom of casing is open at two reasons.

One of them is not including sand or clay in the fissure water of andesite. Another is to be able to drill the additional hole by the small diameter bit if the water quality changes to be not suitable for the drinking water.

The pumping tests were conducted by two methods. One of them is the test of drawdown by four (4) steps and the results are shown in FIGURE G-9. Also, another is 2.0m^3/min x 72 H pumping test continued driving and recovery test. The results are shown in FIGURE G-10. After 2.0 m^3/min x 72 H pumping test continued driving, the drawdown is 3.70 m and recovery is very fast.

In FIGURE G-9 S-Q curve, pumping yield is 1,170 l/min but in FIGURE G-10, the stability of drawdown shows to be possible to pump up 2,000 l/min.

The groundwater coming out from this test well is fissure water, so the hydraulic constants are not calculated.

2.4 Water Quality Analysis

The water quality of 22 existing water source was examined during the field survey . Seven water samples were collected for laboratory analysis at LWUA. Survey points are indicated on FIGURE G-3 and field analysis results are presented in TABLE G-4.

FIG. G-8 WELL DESIGN OF TEST WELL AT PONTEVEDRA

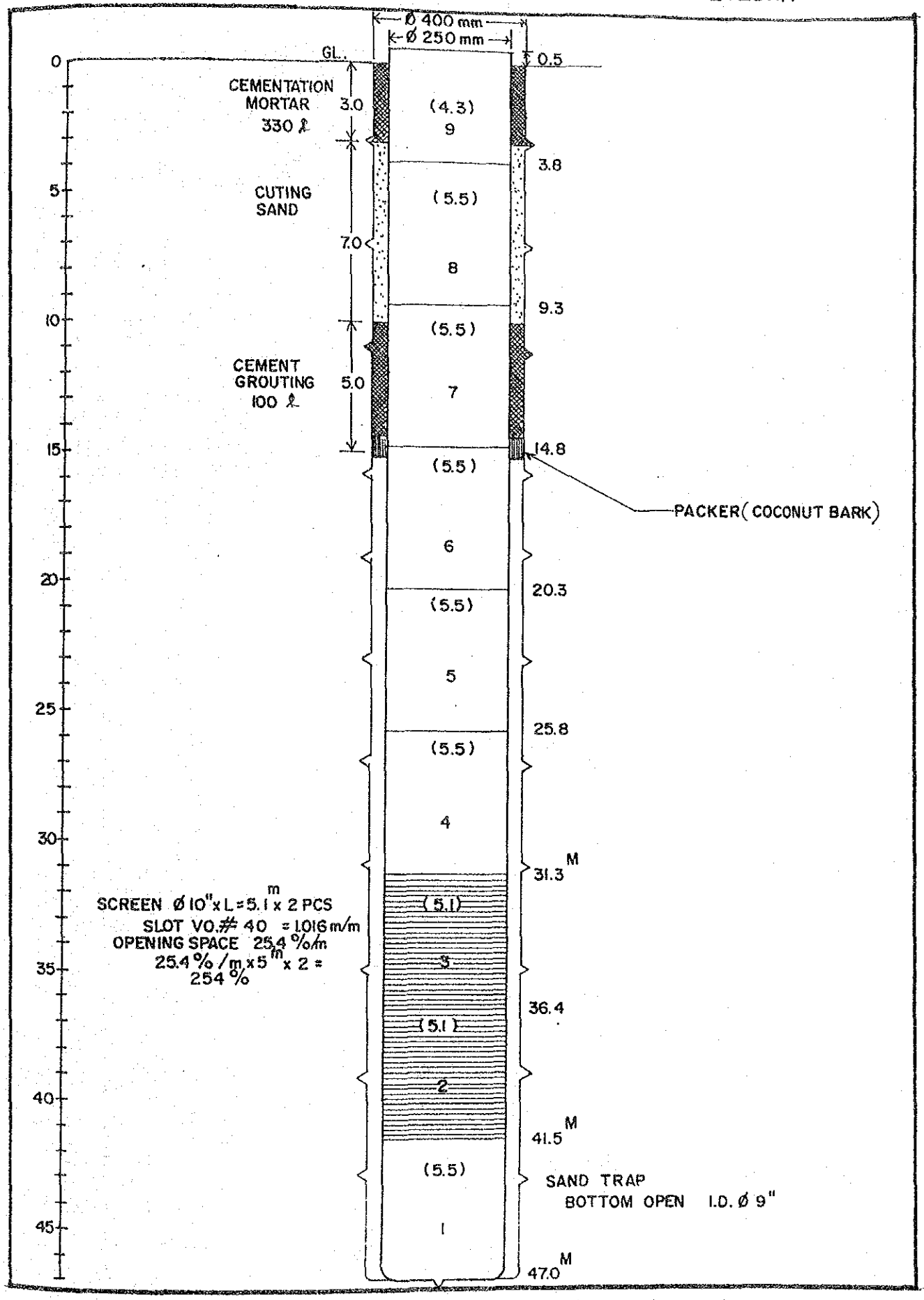


FIG. G - 9

STEP DRAWDOWN

LOC. PONTEVEDRA TEST WELL

DATE: 1989.7.17

STEP	PUMPING VOLUME (m^3/d)	WATER LEVEL (m.)	DRAWDOWN (m.)	SPECIFIC CAPACITY ($m^3/d/m$)
1	720 (500 l/min.)	- 3.44	0.42	1.714
2	1.440 (1,000 l/min.)	- 4.15	1.13	1.274
3	2.160 (1,500 l/min.)	- 5.08	2.06	1.048
4	2.880 (2,000 l/min.)	- 6.34	3.32	867

STEP PUMPING TEST (S - Q CURVE)

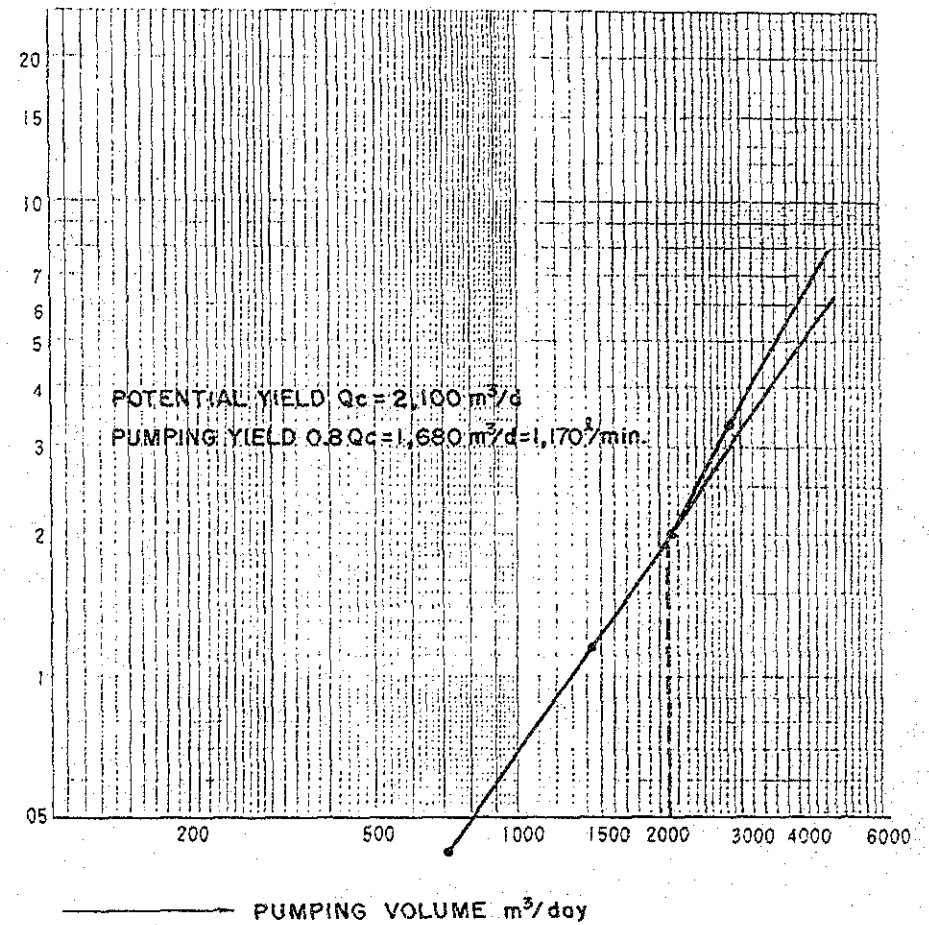


FIG. G-10

$2\ m^3/min.$ CONTINUOUS PUMPING TEST AND RECOVERY TEST (PONTEVEDRA TEST WELL)

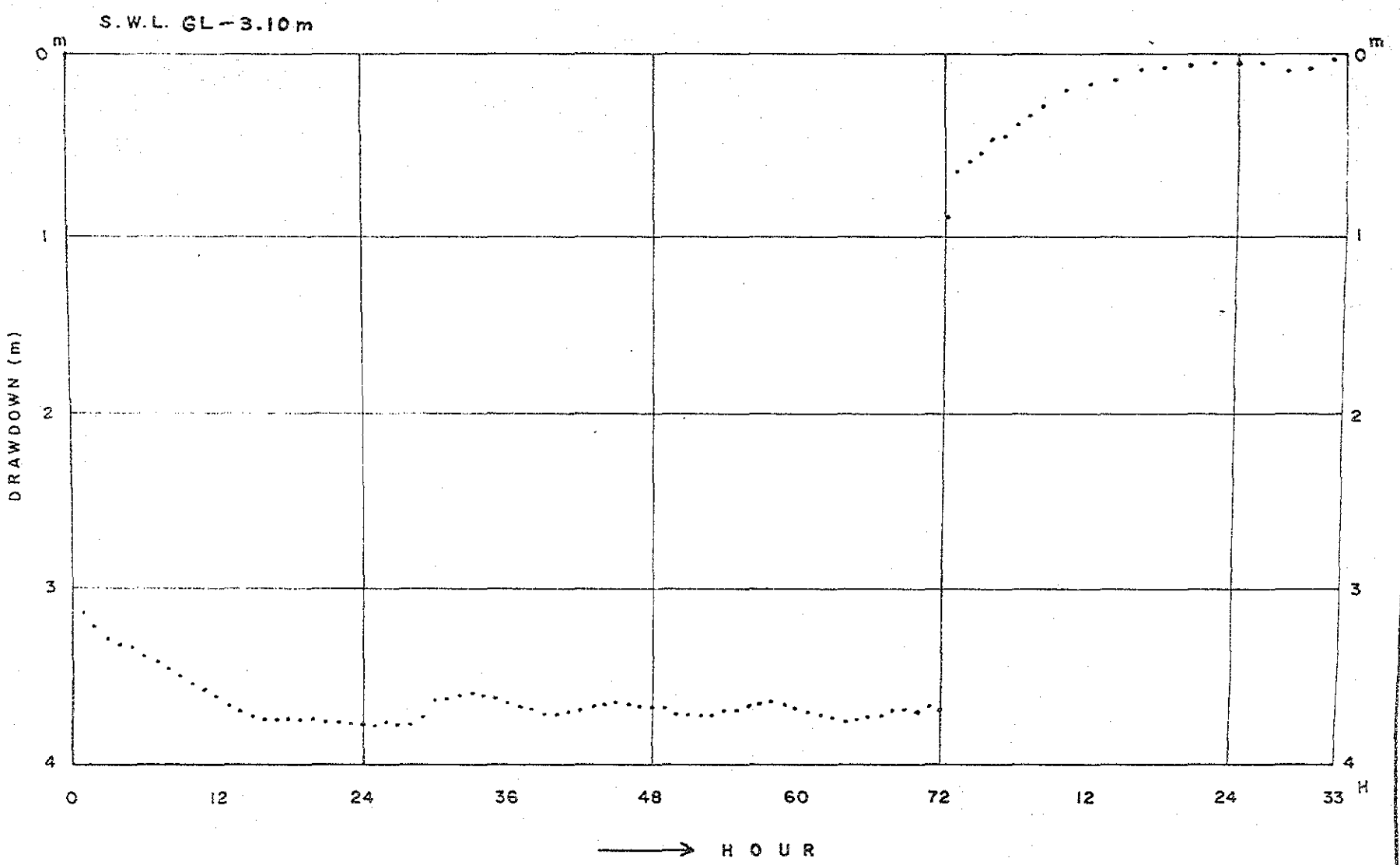


TABLE G-4 Water Quality Analysis Results

Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season						
G-1 Dug Well, Bgy. Sublagon	28.0	6.1	130	<0.2	-	nil
G-2 Dug Well, Hill Foot	28.0	6.5	370	0.5	-	<0.4
G-3 Dug Well, Bgy. Ilaya	28.0	6.8	300	-	-	nil
G-4 Spring, Bgy. Bailan	28.0	6.7	340	1.5	nil	nil
G-5 Public Shallow Well, Bgy. Sublagon	28.4	6.7	480	1.0	nil	0.4
G-6 Shallow Well, Bgy. Malaquit	29.0	6.8	370	<0.2	nil	nil
G-7 Dug Well, Bgy. Tacas	29.0	6.5	385	1.0	1.0	<0.8
G-8 Deep Well #1 Bailan Hosp.	-	7.3	270	<0.5	nil	0.4
G-9 Deep Well #2 Bailan Hosp.	28.7	6.7	190	10<	nil	<0.4
Rainy Season						
G-2 Dug Well, Hill Foot	27.8	6.1	195	-	-	-
G-3 Dug Well, Bgy. Ilaya	28.0	6.4	340	-	-	-
G-6 Shallow Well, Bgy. Malaquit	28.3	6.3	700	nil	-	nil
G-7 Dug Well, Bgy. Tacas	27.5	5.9	430	-	-	-

TABLE G-4 Water Quality Analysis Results (Cont'd)

Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
G-8 Deep Well # 1, Bailan Hosp.	29.2	7.0	197	nil	-	nil
G-9 Deep Well # 2, Bailan Hosp.	28.7	6.9	150	2.0	-	0.6
G-10 ES-1	27.6	6.2	580	-	-	-
G-11 ES-2	30.0	6.5	335	-	-	-
G-12 ES-6	28.5	6.9	216	-	-	-
G-13 ES-7	27.5	5.9	130	nil	-	nil
G-14 ES-8	28.4	6.8	450	0.2	-	nil
G-15 ES-11	28.6	6.6	478	-	-	-
G-16 ES-12	27.8	5.7	235	-	-	-
- Deep Well, PSPC	28.2	7.6	260	nil	-	nil
- Spring, PSPC	27.7	7.4	215	-	-	-
- Mun. Health Center	30.1	6.2	190	10<	-	0.6
JB Ice Plant at the Poblacion						
Dug Well # 1	28.1	6.2	1,840	nil	-	0.4
Dug Well # 2	27.9	5.4	1,380	nil	-	nil
Dug Well # 3	27.6	6.0	1,210	nil	-	0.6

Groundwater analyzed in this study area tends to show a slightly low pH value attesting to its acidic condition. Equally noted is the common presence of iron in groundwater regardless of type and depth of water source. These commonly observed characteristics are presumed to bear a geochemical relationship to the presence of volcanic bed rock.

Following are the results of laboratory analysis.

	Dug Well (G-7)	Deep Well PSPC		Deep Well # 1 (G-8)		Deep Well # 2 (G-9)	
Date of Sampling	6.16.88	5.16.88	9.22.88	5.18.88	9.22.88	5.16.88	9.22.88
Turbidity (FTU)	3	25	4.4	30	3	130	85
Color (UNIT)	nil	nil	44 (apparent)	nil	nil	nil	2,500 (apparent)
TDS (mg/l)	205	115	259	166	160	160	214
pH (-)	7.2	7.2	7.7	7.2	7.8	7.3	7.7
EC (µS/cm)	320	180	360	260	260	250	340
Alkalinity as $CaCO_3$ (mg/l)	114	162	144	76	90	19	100
Hardness as $CaCO_3$ (mg/l)	158	173	152	113	87	75	50
Major Cations (meq/l)							
Sodium	0.13	0.3	0.6	0.22	0.7	0.13	2.0
Potassium	0.10	0.02	0.02	0.13	0.1	0.10	0.1
Calcium	1.65	2.10	1.7	1.66	0.9	0.90	0.9
Magnesium	1.50	1.34	1.3	0.60	0.8	0.60	0.3
Total	3.38	3.78	3.6	2.61	2.5	1.73	3.3
Major Anions (meq/l)							
Carbonate	0	0	0	0	0	0	0
Bicarbonate	2.28	3.23	2.9	1.52	1.8	0.38	2.0
Chloride	1.28	0.51	0.4	0.77	0.6	0.26	0.5
Sulfate	0.03	0.03	0.2	0.21	0.2	1.00	0.9
Total	3.59	3.77	3.5	2.50	2.6	1.64	3.4

All these analysis results show the common geochemical characteristics of groundwater as the Carbonate-Hardness Type. Turbidity and apparent color are generally high that require appropriate water treatment for the use in drinking purpose. Considerably high pH values observed in laboratory analysis are assumed to be caused by gas exchange during the preservation/ transportation of water samples.

3. Conclusion and Recommendation

The test well drilled at Pontevedra by JICA-LWUA team produced over 2,800 m^3/day groundwater surprisingly.

This is the epoch-making matter for the poblacion of Pontevedra has no water supply system. Therefore it is necessary to plan the system in early time.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

No piped water supply system exists in the Poblacion area. Unprotected shallow dug wells are dominant water sources. Small scale springs are also used. Due to a limited number of readily accessible water sources, private water purveyors are selling water obtained from dug wells to many households (₱2 per 20 liters). Rain water storages were observed in many households, but these are not sufficient to cope with water demand during the dry season.

As described above, access to potable drinking water is quite difficult and hygienic conditions are not favorable. The establishment of piped water supply system is therefore urgently needed in this specific area.

1.2 Existing Water Supply System and Problems Encountered

One deep well (ø150 mm, 24 m depth) equipped with an electric motor driven centrifugal pump (5 HP, 1.1 to 1.3 cu.m/min) has been constructed by DPWH as a source for a Level III water supply system. GI pipes for distribution lines were purchased by the municipality, but these were not installed. The construction of an elevated water tank and installation of pipelines were not carried out due to lack of funds. This well was operated by means of a jetmatic pump installed by the municipal health office, but its use was discontinued because the hand pump was reportedly stolen.

A few public wells constructed by DPWH were observed outside the Poblacion area, but these were found to be inoperational due to lack of funds for repair.

2. Water Demand Projection

2.1 Criteria

There is no operational piped water supply system in the planned service area and the poor water supply conditions make it difficult to assess per capita unit water demand. Per capita unit water consumption is, therefore, assumed at 90 lpcd in 1988 based on the LWUA Methodology Manual and the experience in a similar water supply feasibility study, "Municipal Water Supply Project" conducted by JICA in 1987.

Design unit water consumption by consumer type is thereby estimated in accordance with the said Manual, as follows:

- Domestic per capita unit water consumption is estimated at 100 lpcd in the year 1995 with an annual increase ratio of 2% from 1988 to 1990 and 1.5% from 1990 to 1995 against 90 lpcd in 1988.

- Commercial unit water consumption is estimated at 1.4 cu.m/connection/day with its connection density ratio of 1.2 per 100 inhabitants.

- Institutional unit water consumption in 1995 is estimated at 5.2 cu.m/connection/day with its connection density ratio of 1.0 per 2,000 inhabitants in the service area.

There is no piped water supply system in the planned service area. In this connection, the ratio of unaccounted-for water is considered to be 25% of the total distributed amount which is the standard ratio for new pipelines.

2.2 Areas to be served

The target year for water supply planning is set for the year 1995 as an intermediate water supply development/ improvement. In this regard, the planned service area of this target year is determined to be the densely populated area. Barangays Ilawod and Ilaya in the Poblacion and Barangay Tacas are likewise designated as the planned service area.

2.3 Population Projection

The National Economic Development Authority (NEDA) has projected the municipal population in each calendar year from 1981 to 2000 based on population census it conducted in 1980. The municipal government, on the other hand, projected the future population up to the year 1990 based on the same census result. The NEDA population projection is, therefore, adopted as it is the only available data for the target year.

Percentage share of barangay population to the municipal population in the year 1995 is assumed to be the same as that of the 1980 census result. The projected 1995 municipal population is then distributed to the respective service area barangays as shown in TABLE G-5.

TABLE G-5 Population Projection of Service Area

Year	Municipality	Service Area			
		Ilawod	Ilaya	Tacas	Total
1980	30,489	1,594	994	2,334	4,922
1985	34,510	1,800	1,130	2,640	5,570
1990	38,259	2,000	1,250	2,930	6,180
1995	41,645	2,180	1,360	3,190	6,730

The water supply service ratio is considered to be 80% for the Poblacion area (Ilawod and Ilaya) and 40% for Barangay Tacas, taking into account the habitation pattern in the planned service area. It was observed that houses are densely gathered in the Poblacion area while in Tacas, houses are clustered along the major streets.

Average number of persons per household is assumed at 5.00 based on the standard figure adopted by NEDA.

2.4 Water Demand Projection

The future water consumption in 1995 is estimated based on the aforementioned planned service population and design unit water consumption by consumer type.

The estimated number of connection and future water consumption are shown in TABLE G-6.

TABLE G-6 Water Consumption in 1995

Service Area	Ilawod	Ilaya	Tacas	Total
Served Population	1,740	1,090	1,280	4,110
No. of Connection				
Domestic	348	218	256	822
Commercial	21	13	15	49
Institutional*	1	1	1	3
Total	370	232	272	874
Water Consumption (cu.m/day)				
Domestic	174	109	128	411
Commercial	29	18	21	68
Institutional	5	5	5	15
Total	208	132	154	494
Unaccounted-for Water	69	44	51	164
TOTAL	277	176	205	658

* At least one connection is considered for each barangay as the elementary school

The ratio of the daily maximum water demand to the daily average water demand is determined in relation to the planned service population based on the LWUA Methodology Manual as shown in TABLE G-7.

TABLE G-7 Demand Variation Factor for Daily Maximum Water Demand

Service Population	Ratio (Daily Max./Daily Ave.)
Less than 30,000	1.30 : 1
30,000 to 200,000	1.25 : 1
Over 20,000	1.20 : 1

The estimated daily maximum water demand is shown in TABLE G-8.

TABLE G-8 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Ilawod	360
Ilaya	230
Tacas	270
Total	860

The peak hour water demand is estimated in proportion to the daily maximum water demand and service population in accordance with the LWUA Methodology Manual as shown below:

C = (Peak Hour Demand x 24)/(Daily Maximum Demand)

= 2.2 -0.3 x log (Service Population/1,000)

The ratio of peak hour demand in the year 1995 is calculated at 2.02 and the peak hour water demand is estimated at 1,740 cu.m/day.

3. Proposed Water Supply Facilities

3.1 Basic Approach for Water Supply Improvement

3.1.1 Conditions and Constraints

The conceptual plan for water supply improvement is focused on major water supply facilities, such as water source, main transmission and distribution pipelines, and reservoir. Branch lines, service connections and fire hydrants are likewise excluded from conceptual planning. However, following conditions are taken into account as much as possible:

(1) Low cost in construction, operation and maintenance,
(2) Seasonal fluctuation of source capacity will not seriously affect stable water supply,
(3) Water source will be located within the administrative boundary of respective municipality.

3.1.2 Water Source Development

At present, drinking water served within poblacion area is mainly supplied by shallow wells which was constructed in Barangay Tacas and it's delivered by water purveyor.

Although there are also deep wells which were drilled by DPWH, they are not functioning as water supply facilities, moreover, data for wells are obscure.

At this investigation, hydrogeological survey and test well drilling were carried out to ensure water sources for deep wells and by test well, it was confirmed that 2.0 cu.m/min of crack water can be obtained from volcanic rocks.

Consequently, this test well (ø250 mm, Depth=47 m) will be utilized as water source for poblacion area.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

Submersible pump, which can produce the daily maximum water demand at target year, will be installed.

Intake pump:
Submersible motor pump for deep wells (H=40m)
ø100 mm x 0.9 cu.m/min x 40 m x 11 kW, 1 unit

Chlorinator:
Calciumm hypochlorite injection method x 1 set

3.2.2 Transmission Facility

New transmission main from test well to new reservoir will be installed:

ø150 mm pipe, l = 500 m

New reservoir will be constructed on the will (EL + 30 m) located 500 m north from test well. Capacity of this reservoir will be 10% of daily maximum water demand:

RC, 5 mW x 5 mL x 3.5 mD, 87 cu.m.

3.2.3 Distribution Facility

New distribution pipe will be installed within poblacion area.

ø150 mm pipe, l = 2,350 m
ø100 mm pipe, l = 1,550 m

3.2.4 Required Water Supply Facilities

Location of major water supply facilities is shown in FIGURE G-11, flow diagram of facilities in FIGURE G-12 and detail of distribution pipeline in proposed service area FIGURE G-13.

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Intake pump :

Submersible motor pump for deep wells
ø100 mm x 0.9 cu.m/min x 40 mH x 11 kW, 1 unit

(2) Transmission Facility

Transmission main :

from test well to new reservoir :
ø150 mm pipe, 500 m

Reservoir :
RC, 5.0 mW x 5.0 mL x 3.5 mH, 87 cu.m

(3) Distribution Facility

Distribution line
ø150 mm pipe, 2,350 m
ø100 mm pipe, 1,550 m

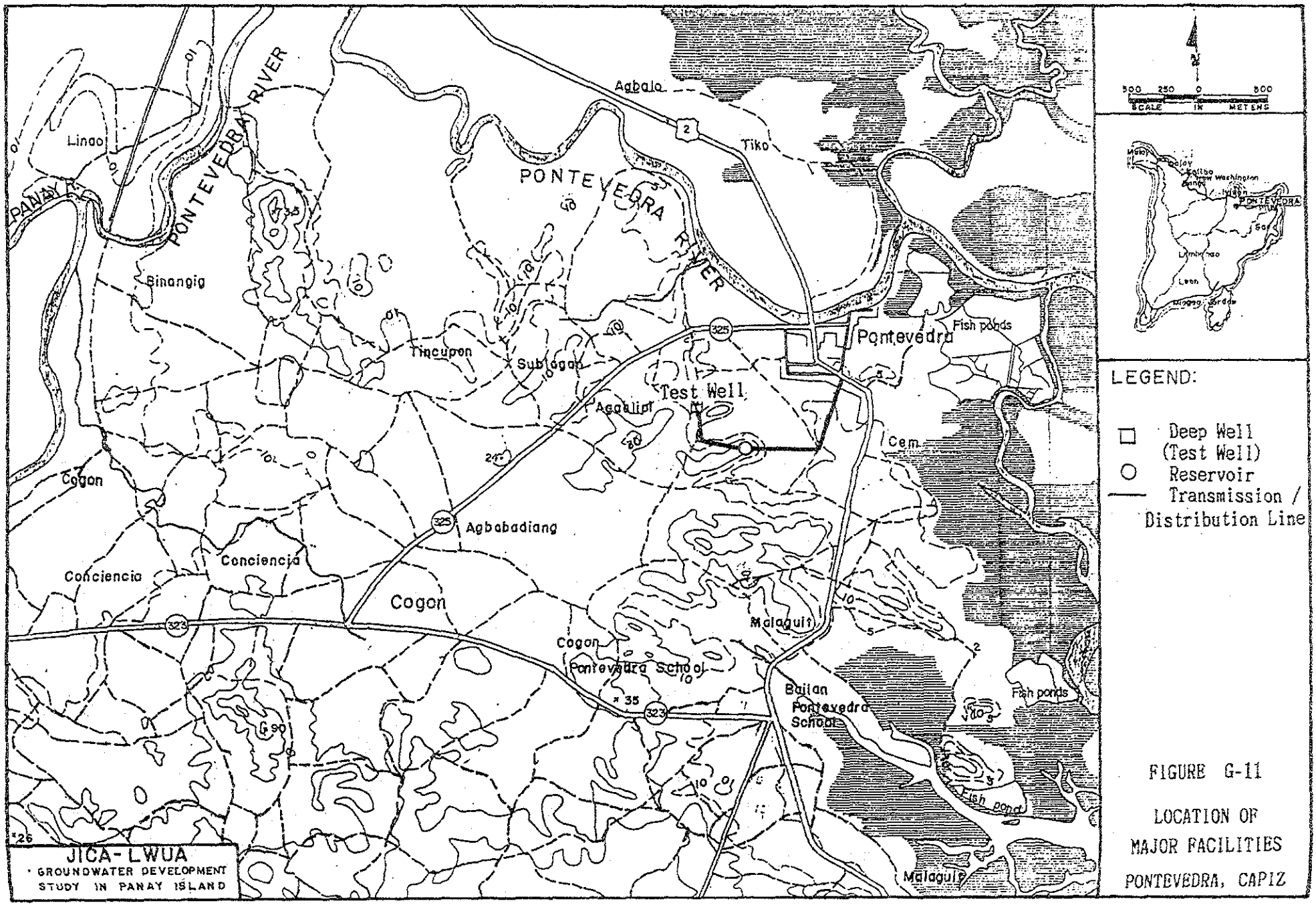


FIGURE G-11

LOCATION OF
MAJOR FACILITIES
PONTEVEDRA, CAPIZ

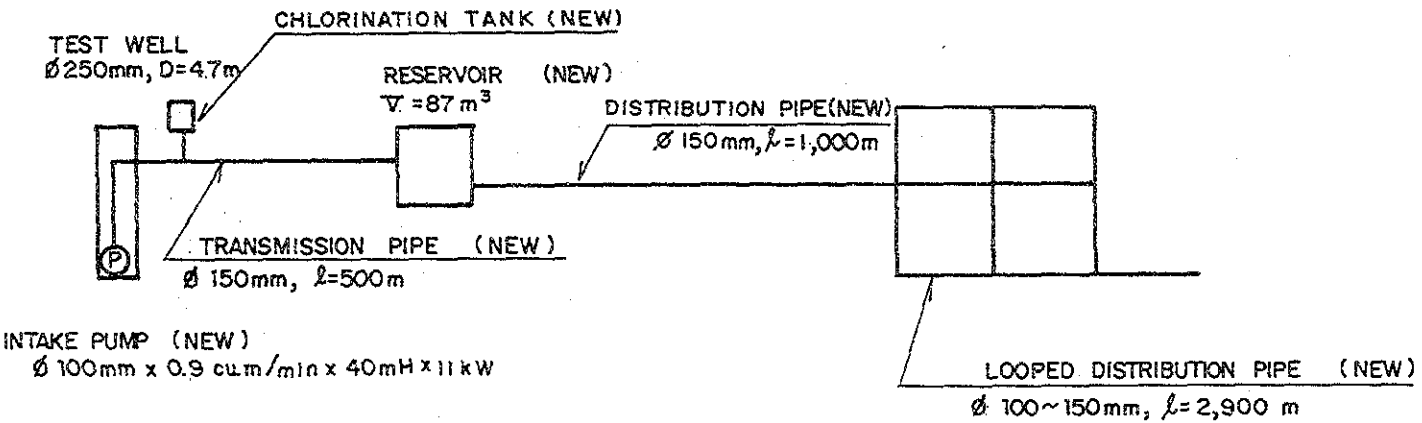


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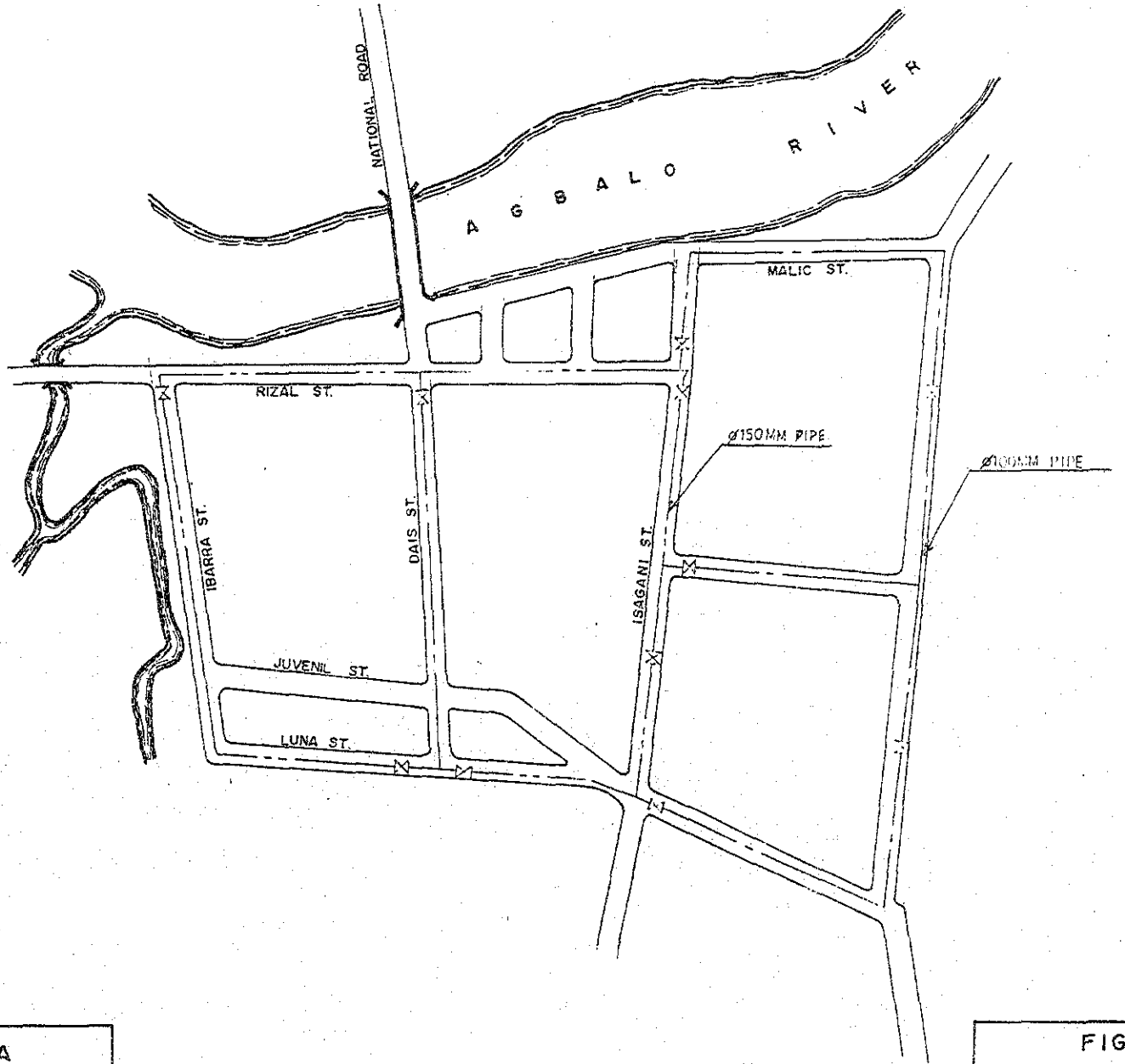
FIGURE G-12
FLOW DIAGRAM
PONTEVEDRA, CAPIZ



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STUDY IN PANAY ISLAND

FIGURE G-13
DISTRIBUTION PIPELINE
PONTEVEDRA, CAPIZ

3.3 Rough Cost Estimate of Major Water Supply Facilities

3.3.1 Unit Construction Cost

Unit construction cost of required facilities is based on the "In-Place Cost of Waterworks Materials" (as of January 1989) of LWUA. Any unit cost not shown in this list is referred to "Unit Price Manual - Water Supply Feasibility Studies" (July 1983) upon consideration of price escalation that 15% per annum upto 1987 and 7% per annum from 1987 as adopted by LWUA.

All construction costs are estimated in Philippine Pesos and the total cost is only converted into U.S. Dollars and Japanese Yen based on the following exchange rate as of September 1989.

U.S. $1.00 = Yen 145.70 = Peso 20.78

Unit costs used in rough cost estimate are attached in Appendix-5.

3.3.2 Rough Cost Estimate

Facility	Cost (Thousand Peso)
Water Source	
Intake pump	
(0.9 cu.m/min x 40 mH, 1 unit)	635.0
Chlorination tank	14.5
Transmission Facility	
Reservior	
(87 cu.m, 1 unit)	217.2
Transmission line	
(ø 150 mm Pipe, 500 m)	315.0
Distribution Facility	
(ø 100 mm pipe 1,550 m)	418.5
(ø 150 mm pipe 2,350 m)	1,269.0
(ø 100 mm valve 6 pcs.)	27.0
(ø 150 mm valve 5 pcs.)	28.5
Total	2,924.7

Total construction cost for improvement of major water supply facilities is estimated at approximately 4.15 million Pesos (31.7 million Yen or 0.22 million U.S. Dollar).

H. PILAR, CAPIZ

H. PILAR, CAPIZ

I. STUDY AREA AND HYDROGEOLOGICAL ANALYSIS

1. Description of the Study Area

1.1 Physical Description

1.1.1 Geographical Location and Area

The municipality of Pilar lies on the eastern part of the province of Capiz and located at distance of 46 km. from Roxas City, the Provincial Capital. A coastal town, it is bounded on the north by the Pilar Bay/Sibuyan Sea, on the east and southeast by the province of Iloilo, on the west and southwest by the municipality of President Roxas. It has a total land area of 115.6 sq.km covering 24 barangays. Location map is shown in FIGURE H-1.

1.1.2 Climate

The climate of Pilar falls under Type III which is characterized by no pronounced seasonal change. It is relatively dry from November to April and wet during the rest of the year. Average annual rainfall is 2,237.8 mm. while average temperature is 28.1°C.

1.1.3 Terrain/Topography

The area is generally flat, mostly made up of plains and extensive swamps and marshes along the coast. Around 70% of the total land belong to the slope category of less than 10% and 16% is moderately sloping or rolling (10%-15%). The remaining 14% have slopes of 15-25% only.

1.1.4 Soil

There are three general soil types in the Beach sand while Hydrosol is found in fishpond and marshy areas. In the level areas which are mostly planted to rice are the Sara Clay Loam and Faraon Clay. Hilly land and mountain soils are the Luisiana Clay Loam, San Rafael Loam and Alimodian Clay Loam. These are found on the Southern and Southeast to Northeast portion of the municipality.

1.1.5 Administrative Composition and Land Use

The municipality is headed by the Mayor and Vice-Mayor with eight (8) members of the Sangguniang Bayan as the local legislative body. Under the municipality are the barangays, the smallest political subdivision, which are headed by baran-

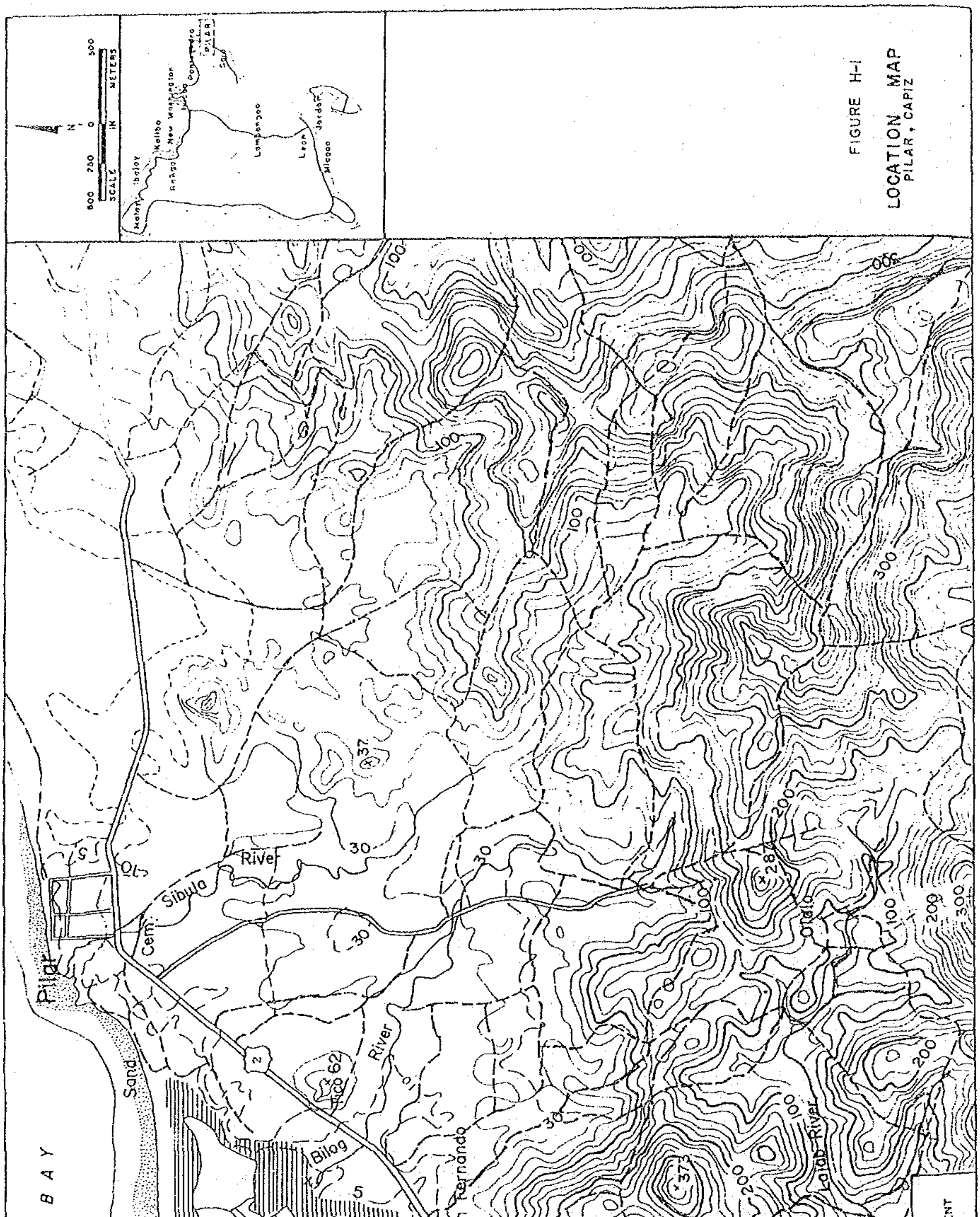


FIGURE H-1
LOCATION MAP
PILAR, CAPIZ
JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND
SCALE IN METERS
PILAR BAY
Pilar
Sand
Fish ponds
Bilog
San Fernando
Cem.
Sibula River
River
Lalab River
Baldive

gay chairmen with the Sangguniang Barangay as the lawmaking body. All these local officials are selected by the people through popular election.

Municipalities are classified according to the annual revenues from taxes. This classification serves as a major indication of the socio-economic situation of the population in the municipalities. The municipality of Pilar belongs to the 5th class, with a total annual income of less than ₱300,000.

At present the municipality has 24 barangays, namely:

1.	Balogo	13.	San Antonio
2.	Binawbawan	14.	San Blas
3.	Blasco	15.	San Esteban
4.	Casanayan	16.	San Fernando
5.	Cayus	17.	San Nicolas
6.	Dayhagan	18.	San Pedro
7.	Dulangan	19.	San Ramon
8.	Monteflor	20.	San Silvestre
9.	Natividad	21.	Sinamongan
10.	Olalo	22.	Santa Fe
11.	Poblacion	23.	Tabunacan
12.	Rosario	24.	Yating

1.1.6 Transportation

The location of the municipality at the extreme end of the province is a disadvantage considering the inadequacy of transportation infrastructure and facilities. Because of the poor road condition of the national highway, there is very little investment in public transportation conveyances. Vehicle count in 1979 amounted to 12 buses and 14 jeeps servicing the routes between Pilar and other municipalities including Roxas City and Iloilo City. Transportation to Manila by air is through the Roxas City airport and by sea through the commercial port at Culasi in Roxas City.

1.1.7 Infrastructure

The road network of the municipality consist of national, provincial, municipal and barangay roads totaling in all around 68 km.. Of this, less than one kilometer is concrete and the rest are surfaced with gravel and earth. Five barangays are not connected by motorable road to the town center.

Since 1976, power has been supplied to the Poblacion and seven neighboring barangays serving a total of 3,000 residential, industrial and commercial connections.

1.2 Population and Living Conditions

1.2.1 Population Trends From the Past

As of 1980, Pilar, which covers 5,260 households, had a total population of 30,104, reflecting an increase of 5.30% over the 1975 population of 28,589 or a geometric annual growth rate of 1.04% which is lower than the provincial average of 2.01%. Among the 16 municipalities and one city of Capiz, Pilar ranked 6th in number of population having accounted for 6.1% of total provincial population.

Population density increased from 247 persons per square kilometer in 1970 to 260 persons per square kilometer in 1980. This ratio higher than the provincial average population density of 184.8 persons per square kilometer.

Rural population registered the majority population, accounting for 93% of the municipal population.

Population distribution by barangays is presented in the following table:

TABLE H-1 Population and Number of Households by Barangay, Pilar, Capiz, 1980

Barangay	Population	No. of Households
Balogo	738	136
Bina	727	118
Blasco	515	83
Casanayan	1,985	336
Cayus	1,259	218
Dayhagan	966	181
Dulangan	3,478	577
Monteflor	587	98
Natividad	1,996	357
Olalo	531	91
Poblacion	2,029	349
Rosario	802	149
San Antonio	966	176
San Blas	775	134
San Esteban	1,458	253
San Fernando	1,264	209
San Nicolas	1,414	248
San Pedro	1,014	202
San Ramon	1,465	269
San Silvestre	627	115
Sinamongan	1,404	249
Santa Fe	2,009	341
Tabunacan	1,260	224
Yating	835	147
TOTAL	30,104	5,260

1.2.2 Age Distribution

Of the total population, 51.7% belonged to the productive population composed of persons aged 15 to 64 years old. Non-productive population, on the other hand, comprised of those under 15 years of age and above 65 years of age accounted for 44.4% and 3.8%, respectively. Dependency therefore was placed at a high rate of 93.4%.

Sex ratio of the town's population showed a predominance of males, i.e., there were 104 males for every 100 families.

1.2.3 Morbidity/Mortality

The leading causes of morbidity are upper respiratory tract infection, bronchitis, wounds (all types), parasitism and influenza. On the other hand, the leading causes of mortality are pneumonia, cardiovascular accident, violent death, heart disease and tuberculosis.

1.2.4 Sanitation

Closed pit and open pit are the common types of toilet facilities in the municipality. These are being used by 33.7% and 32.2%, respectively, of the 5,260 households. The other households use water-sealed with sewer/septic tank (6.0%), water-sealed with depository (3.2%), and pail and other systems (1.7%). A number of households (23.2%) still do not have any waste disposal system.

1.2.5 Public Services

The municipality has a total of 22 primary schools, 2 complete elementary schools and 3 barangay high schools with a total capacity of around 200 classrooms and a teaching force of around 200 teachers. Total enrollment recorded for 1979 was approximately 7,000 students.

The municipality has one community hospital with 15 beds and equipment with x'ray apparatus, laboratory for routine analysis, a pharmacy, an operating room and an ambulance. It has a staff of 13 but only one physician and two nurses can handle only minor surgeries. In addition, the municipality has one Rural Health Unit and 11 barangay health centers which are served only by one physician, nurses and midwives under the Department of Health.

There are no telephone or telegraph services at present in the municipality. The only public communication facility is the postal service which has one main office in the town center and a substation in the outer barangays. The radio network system of the Integrated National Police has a radio transceiver which is made available to the public in case of emergency. The nearest telegraph office is located 10 km. away in President Roxas municipality.

1.3 Economy and Industry

1.3.1 Agriculture

The total agricultural area as reported in the 1980 Census of Agriculture was 8,834 ha. which was divided into 1,932 farms giving an average farm size of 4.57 ha.. Of these farms, 876 covering 4,706 ha. were fully owned, 251 covering 2,396 ha. were under ownerlike possession and 943 covering 1,682 ha. were rented or leased. The remaining 51 farms covering 51 ha. were tilled rent free or by squatters.

Total agricultural production amounted to 58,003 metric tons of which 10,216 metric tons or 17.61% consisted of palay, 35,003 metric tons or 60.35% consisted of sugar cane, 11,534 metric tons or 19.89% consisted of coconuts, and the remaining 1,250 metric tons or 2.16% were a combination of fruits and

vegetables, coffee and cacao.

The total livestock population of the municipality was recorded at 37,228 consisting of 2,268 carabaos, 638 cattle, 4 horses, 2,654 pigs, 927 goats and 30,737 fowls mostly chickens and ducks.

1.3.2 Other Industries

There is only one significant industrial activity which is the copper mines of the Azure Mining Corporation. Other processing activities are small scale and consist mostly of grain milling for home consumption, handicraft and garment making. Commercial activities are likewise limited to small retail establishments located mostly in the public market area of the municipality.

2. Analysis of Potential Water Source

2.1 Topography and Geology

The poblacion of Pilar is situated on a gentle coastal plain and mountain area, about 400 m in elevation, and extending towards the southern portion of the poblacion.

The geology of the study area is complex. The mountain area consists of basaltic andesite belonging to the Sibala Formation. Sara Diorite intrudes into andesite as a small chimney. Agudo Volcanics cover andesite of Sibala Formation.

On the other hand, the low land is composed of alluvial deposits with minor limestone outcrops in the east and southeast of the town proper. Geological map is shown in FIGURE H-2.

Sibala Formation (Paleocene, Tertiary)

Known to be the oldest formation in the region, this unit comprises the basement of the study area. It is characterized by the presence of predominantly volcanic (basaltic andesite) materials interbedded with basic clastic sedimentary rocks.

Sara Diorite (Paleocene, Tertiary)

Named after the municipality of Sara where it has extensive distribution, this unit occupies a small portion of the hilly region some 4 km southeast of poblacion. Near the intake of the existing sources upstream of Sibala River, this unit, intruded in volcanic rock exposures in small scale window, is present.

Pilar Limestone (Lower Miocene, Tertiary)

Outcrop of this unit is prominent along the shore. It sits on the basement rock and forms cliffs which are highly karstified, massive reef.

Agudo Volcanics (Middle-Upper Miocene, Tertiary)

This unit occupies the mountain peaks, covering Sibala Formation. It appears at basalt to andesite although it is described to be unaltered and porphyritic in texture.

Alluvial Deposits (Quaternary)

This unit is found near the shore and is composed of beach, flood plain and swamp deposits. These are largely reworked materials originating from the upland as a result of erosion and weathering and transported mainly by water into river valleys and the low land.

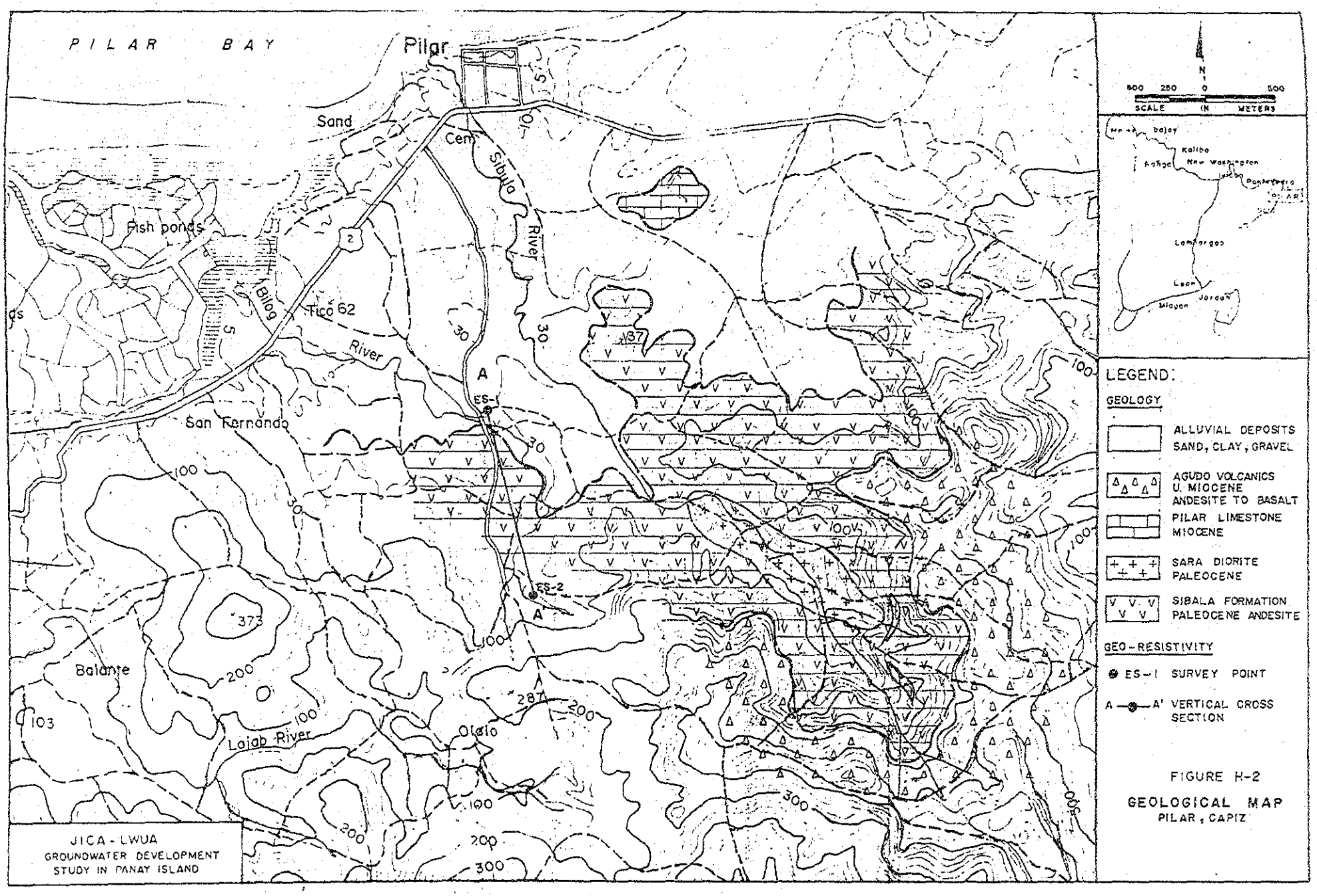


FIGURE H-2

GEOLOGICAL MAP
PILAR, CAPIZ

2.2 Existing Water Source

Surface Water

Two concrete structure intake dams are utilized as water sources for the water supply system of the Pilar Water District. However, the residents in the Poblacion cannot use the water adequately due to a characteristically small intake amount and a probable leakage from the deteriorated transmission pipeline.

The flow of creeks upstream of the dams was measured by means of the volumetric measurement method. The results of measurement are presented in TABLE H-2.

TABLE H-2 Flow Rate at Intake Dams

Location	Flow Rate Dry Season (May 20)	Flow Rate Rainy Season (September 24)
No. 1 Intake Dam	50 cu.m/day	520 cu.m/day
No. 2 Intake Dam	65 cu.m/day	135 cu.m/day
Total	115 cu.m/day	655 cu.m/day

Flow rate of the creek flowing into Intake Dam No. 1, which is located at a height of approximately 140 m, is measured at 0.57 liter/sec or about 50 cu.m/day in dry season and 600 liter/sec or about 520 cu.m/day in rainy season. Flow rate of the creek flowing into the Intake Dam No. 2, which is located at a height of approximately 90 m, is measured at 0.76 liter/sec or about 65 cu.m/day in dry season and 1.56 liter/sec or 135 cu.m/day in rainy season.

As a result, a total amount of about 115 cu.m/day can be expected as a minimum water intake amount during the dry season.

Wells

Only one deep well with complete and reliable data is existing. It is a test well constructed during the conduct of a Water Supply Feasibility Study in 1980 to explore the deeper probable aquifer.

The well is located in Barangay Natividad, where a preceding georesistivity survey suggested a potential aquifer. The well is 80 m deep and was drilled by percussion method in the alluvial deposits near Sibala River. According to drilling records, the penetrated formations include a supervidical soil cover of slightly silty loam with sub-angular gravel, followed

by a series of compacted clay, silt and sand formation up to about 50 m. This porous consolidated sequence was found to be highly sedimented, which resulted in low penetration rate during the drilling process. Below is another porous yet slightly compacted sequence of silty and clayey but predominantly sandy layers which appear to be the probable aquifer. A subsequent aquifer test performed after the well completion, however, showed a rather poor well performance with a low yield of 2.3 liter/sec (drawdown = 32 m) and computed transmissivity of 3.5 x 10 m/s. According to standards, these values represent poor aquifer characteristics.

At present, the shallow aquifer in the area is utilized through a number of handpump wells plus a few motor-driven pumps. Well construction is either by drill or dig method and almost all wells are intended only for small scale production. Depths of these wells rarely exceed 20 meters and were described to encounter hard rock formations below 1.5 m on the eastern part of the area and below 8 m on the southwest. Although there are inconsistencies in formation description, the identified strata include the surface clayey formation underlain either by sandstone, adobe stone or simply hard/solid rock. In the short pumping test records conducted in the three dug wells in 1980, very low transmissivity values in the order of 2 x 10 m/s were obtained, implying poor aquifer characteristics.

Well inventory surveys was carried out on 12 water sources, as shown in FIGURE H-3, five of which were surveyed for their static water level and total depths.

The following table presents a summary of collected data:

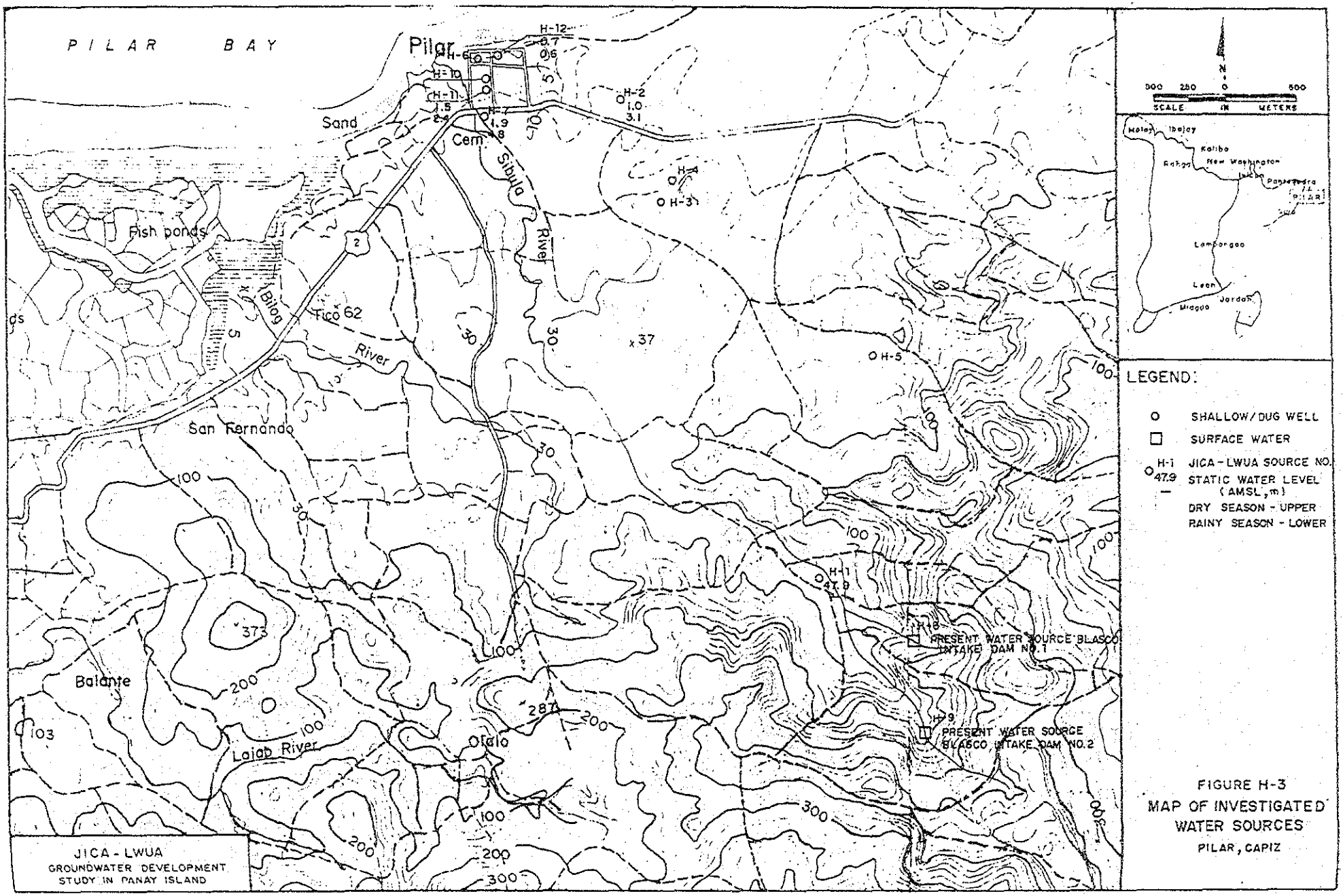


FIGURE H-3
MAP OF INVESTIGATED WATER SOURCES
PILAR, CAPIZ

TABLE H-3 Well Data Summary

JICA-LWUA Source Number		Well Depth (M)	Ground Level (MAMSL)*	Static Water Level Dry Season (May 20) (MBGL)	(MAMSL)	Rainy Season (September 22) (MBGL)	(MAMSL)
H-1	Dug well	2.38	50.0	-2.13	47.9	-	-
H-2	Shallow Well	6.90	7.0	-6.00	1.0	-3.88	3.1
H-7	Dug Well	6.30	7.2	-6.10	1.1	-2.42	4.8
H-11	Dug Well Mabini St.	4.06	3.8	-3.50	0.3	-1.36	2.4
H-12	Dug Well Burgo St.	4.15	2.0	-2.35	-0.4	-1.43	0.6

* Estimated based on the topographic map of 1/50,000 scale and supplemental topographic survey.

The results are summarized as follows:

i) The groundwater table approached the height of mean sea level.

ii) There are no deep wells in the Poblacion because the bases rock lies at a very shallow level.

iii) The groundwater table in rainy season is higher than that in dry season.

Springs

Several springs were also observed to gush out of various sites in the mountainous areas near intake dams. Water from these springs are utilized for daily consumption and irrigation.

Although there were several springs with a poor yield capacity in the flat lands outside of the Poblacion, only the population residing adjacent to springs avail of water from these sources. However, the quantities of the water from these sources are now worth developing for the water supply system.

Evaluation

The geological formations discussed earlier may serve the potential aquifer for groundwater development. From available well log descriptions, these are reported to be compact and cemented generally 8 meters below ground. Hence, their production and storage capacities are limited according to the frac-

ture/cracks and to the degree of sedimentation. Although these porous rocks tend to provide more uniform types of groundwater system, they generally have reduced permeabilities and transmissivities. The thickness of this unit is believed to reach about 500 m near the Poblacion. Based on the above, only the alluvial deposits appear to be worth exploring for groundwater development. The Sibala Formation, which may be expected to have secondary porosity due to fracturing is yet to be fully expected, hence its water bearing potential is undefined. In the study area, almost all wells, both shallow and deep, were drilled in the alluvial deposits.

Relative to the above discussions, it can therefore, be concluded that the prospect of groundwater utilization in the area is very limited. The available data confirms the suitability of the aquifer only for small scale development due to the reduced porosity and permeability of the rock formations caused by consolidation/cementation. Although there is no distinct information on the seasonal variation of the groundwater condition, it can be inferred that:

- recharge to the system may also be limited due to the relatively fast surface run-off caused by the denuded condition of the basin and relatively steep slope.

- not much change in the storage capacity of the aquifer would take place between dry and wet period due to the reduced porosity of the aquifer caused by sedimentation.

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

The geology in this survey area consists of volcanic rocks and detritus (alluvial deposits) overlays on volcanics.

A georesistivity survey was performed by LWUA in 1980. A supplemental survey has been performed for the purpose of this study.

A total of 2 points, namely ES-1 and ES-2 are shown in FIGURE H-2.

Field activities are summarized below:

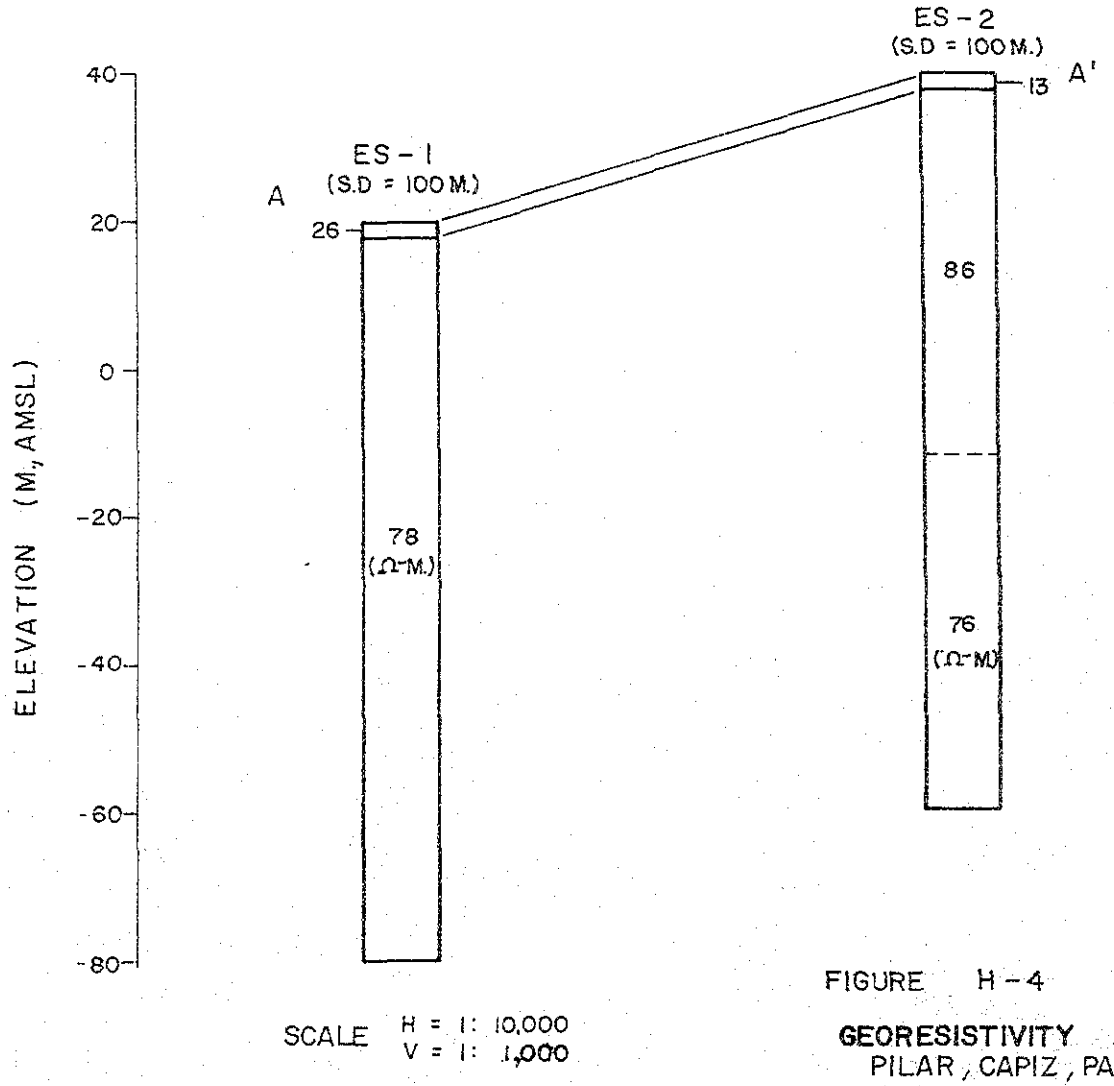
Date	:	May 18, 1988
No. of Survey Points	:	two (2) points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	100 meters

The results of the ρ-a curve analysis is shown in TABLE H-4 and the georesistivity section is shown in FIGURE H-4.

TABLE H-4 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

PILAR, CAPIZ

SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER							
			1		2		3		4	
			ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m
ES-1	20	allivial plain	26	1.9	78					
ES-2	40	flood plain	100	0.9	13	2.1	84	52	76	



SCALE H = 1: 10,000
V = 1: 1,000

FIGURE H - 4

GEORESISTIVITY SECTION A-A'
PILAR, CAPIZ, PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

1) The alluvial deposits are about 2 meters in thickness and consist of clay to silty facies with the resistivity 13 - 26 ohm.m.

2) The results of the resistivity survey show remarkable weathering on existing rich fissures in basement volcanic rock.

3) The possibility of water bearing ground structures in the volcanic rock is not likely as there is no deep well data.

2.4 Water Quality Analysis

Water quality survey covered a total of 12 existing water sources. Survey points are indicated in FIGURE H-3 and analysis results are presented in TABLE H-5.

Generally, groundwater in this study area possess water characteristics similar to other study areas. However, two water sources (H-8 and H-9) of the existing Level III system show comparatively high pH values which are different from other water sources. It is assumed to be characterized by various hydrogeological backgrounds in the subject area.

TABLE H-5 Water Quality Analysis Results

Sample		WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season							
H-1	Dug Well, downstream of Spring No. 1	30.0	7.1	430	<0.2	-	0.6
H-2	Shallow Well	29.0	6.8	410	nil	-	nil
H-3	Dug Well	31.5	7.1	410	-	-	-
H-4	Dug Well	29.0	7.2	420	-	-	-
H-5	Spring	31.5	7.1	480	-	-	-
H-6	Shallow Well	29.0	6.9	540	0.5	-	8.0
H-7	Dug Well	28.1	6.3	410	2.0	nil	-
H-8	Water Intake No.1, Level III	27.5	8.1	370	nil	nil	-
H-9	Water Intake No. 2, Level III	27.5	8.1	500	nil	nil	-
H-10	Shallow Well, Mabini St.	28.5	6.6	500	4.0	0.5	-
H-11	Dug Well, Mabini St.	28.0	6.9	410	nil	0.5	-
H-12	Dug Well, Burgo St.	29.0	7.1	750	nil	nil	-
Rainy Season							
H-2	Shallow Well	28.2	6.8	365	nil	-	nil
H-3	Dug Well	28.8	7.0	442	-	-	-
H-4	Dug Well	27.7	7.2	560	-	-	-
H-6	Shallow Well	28.3	7.1	433	2.0	-	8.0<

TABLE H-5 Water Quality Analysis Results (Cont'd)

Sample		WT (°C)	pH (-)	EC (µS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
H-7	Dug Well	27.5	6.2	278	nil	-	nil
H-8	Water Intake No. 1	25.7	7.3	450	nil	-	nil
H-9	Water Intake No. 2	25.7	8.2	457	nil	-	nil
H-10	Shallow Well, Mabini St.	28.5	6.5	495	2.0	-	nil
H-11	Dug Well, Mabini St.	28.2	5.7	500	nil	-	0.4
H-12	Dug Well, Burgo St.	28.3	7.2	760	nil	-	0.8

The following are the results of laboratory analysis for samples collected from water sources of Pilar Water District and private shallow well.

Sample	Water Intake No. 1		Water Intake No. 2		Private Shallow Well
Date of Sampling	5.20.88	9.24.88	5.18.88	0.24.88	9.27.88
Turbidity (FTU)	10	3	1	3.3	3
Color (UNIT)	nil	5	nil	5	nil
TDS (mg/l)	307	280	160	285	260
pH (-)	7.7	7.7	7.8	7.8	6.7
EC (µS/cm)	480	500	250	505	440
Alkalinity as $CaCO_3$ (mg/l)	190	170	200	180	155
Hardness as $CaCO_3$ (mg/l)	218	232	248	234	181
Major Cations (meq/l)					
Sodium	0.35	0.3	0.39	0.3	0.8
Potassium	0.05	0.05	0.03	0.05	0.05
Calcium	2,86	2.8	3.0	2.8	2.0
Magnesium	1.50	1.9	1.96	1.9	1.6
Total	4.76	5.05	5.38	5.05	4.45

Major Anions (meq/l)

Carbonate	0	1.1	0	1.4	0
Bicarbonate	3.8	2.3	3.99	2.1	3.1
Chloride	0.38	0.8	0.55	0.9	0.1
Sulfate	0.44	0.8	0.55	0.9	0.1
Total	4.62	5.0	5.18	5.0	4.3

The above results indicate that these water sources have geochemical characteristics of the Carbonate-Hardness Type. Two water sources of Pilar WD are alkaline condition, while the private shallow well is slightly acidic. As a whole, these water sources possess favorable water quality for drinking purpose, provided however appropriate measure is necessary to remove turbidity.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

Pilar Water District (PWD) supplies drinking water to only 200 service connections in the poblacion area. Water supply service is continuous for 24 hours a day. Water rates are ₱12.00/month for the first 12 cu.m and ₱1.25/cu.m for excess consumption. Majority of the people, however, are depending on a limited number of unprotected shallow dug wells.

People residing outside of the poblacion proper utilize small springs which usually decrease their discharge or dry up during dry season.

As a whole, access to safe drinking water is quite limited in this particular study area and the main problem of present water use may be focused on the significant gap between supply amount and water demand.

1.2 Existing Water Supply System and Problems Encountered

The existing Level III system consists of spring water source, transmission pipeline, elevated water tank and distribution pipeline. Although no technical data and drawing exist, the following information were obtained from PWD.

- two springs are utilized as water sources. Water intake dams were constructed downstream of each spring. Flow rate measurement show 50 cu.m/day and 65 cu.m/day of water production. These water source facilities have accumulated deposits of muddy sand and leaves.

- the transmission pipeline has a total length of about 5 km with following composition:

Section	Size and Material
Water intake - 1 km	ø50 mm, GI
1 km - 3 km	ø150 mm, HDPE
3 km - 4 km (elevated tank)	ø100 mm, GI
4 km - 5 km (Poblacion)	ø150 mm and ø100 mm, GI

These inappropriate pipe alignments are due to the scarcity of funds allotted for repair and replacement at the time they were needed. The existing pipeline near the water intakes appear to have incurred leakages.

- an elevated concrete tank with a capacity of about 110 cu.m is connected to the transmission line by only one pipeline for

in/out flow. Water storage shall be managed by valve control. This elevated tank is not in use due to clogging of pipe.

- the distribution pipeline consists of various sizes of GI pipes ranging from ø19 mm to ø50 mm.

- All 200 service connections have water meters, but their functional conditions are not clear.

Aside from the above facilities, Pilar Water District (PWD) has a chlorine gas disinfection equipment with an injection pump. These equipment are not being used since the line was severed during a typhoon. Reconnection costs in the amount of ₱100,000 is beyond the financial capability of PWD.

2. Water Demand Projection

2.1 Criteria

The water supply services by the existing system is observed far from satisfactory. Distribution pipelines can not draw water from the source to the faucets due to poor water pressure and large gap between supply amount and water demand. These situations lead to the difficulty of assessing the per capita potential water demand.

The per capita unit water consumption is, therefore, assumed to be 90 lpcd in 1995 based on the LWUA Methodology Manual and in the experience in a similar water supply feasibility study, "Municipal Water Supply Project", conducted by JICA in 1987.

Design unit water consumption by consumer type is thereby estimated in accordance with the said Manual, as follows:

- Domestic per capita unit water consumption is estimated at 100 lpcd in the year 1995 with an annual increase ratio of 2% from 1988 to 1990 and 1.5% from 1990 to 1995 against 90 lpcd in 1988.

- Commercial unit water consumption is estimated at 1.4 cu.m/connection/day with its connection density ratio of 1.2 per 100 inhabitants.

- Institutional unit water consumption in 1995 is estimated at 5.2 cu.m/connection/day with its connection density ratio of 1.0 per 2,000 inhabitants in the service area.

In accordance with the LWUA Methodology Manual, the unaccounted-for water is considered to be 40% of the total distributed amount which is the standard ratio for old and new combined pipelines.

2.2 Areas to be Served

The target year for water supply planning is set for the year 1995 for the purpose of an intermediate water supply development/improvement. In this regard, the planned service area of this target year is determined to be the densely populated area where the existing water supply system is presently serving 200 service connections. Poblacion is likewise given due priority as the planned service area considering the urgent need for water supply improvement.

2.3 Population Projection

The National Economic and Development Authority (NEDA) has projected the municipal population in each calendar year from 1981 to 2000 based on population census it conducted in 1980. The municipal government also estimated the future population based on the same census result, but the population projection was made only up to 1990. In this regard, the NEDA population projection is adopted as the principal data for 1995 municipal population.

Percentage share of barangay (Poblacion) population to the municipal population in 1995 is assumed to be the same as that of 1980 census result. The result of population projection is shown in TABLE H-6.

TABLE H-6 Population Projection of Service Area

Year	Municipality	Service Area (Poblacion)
1980	(30,104)	(2,029)
1985	33,110	2,230
1990	35,740	2,410
1995	37,960	2,560

Note : ( ) shows census result.

The water supply service ratio is considered to be 80% of the service area population taking into account the present population coverage of about 50% in Poblacion area and the habitation pattern. Likewise, design population in 1995 is estimated at 2,050 and average number of persons per household is assumed to be 5.00 based on the standard figure adopted by NEDA.

2.4 Water Demand Projection

The future water consumption in 1995 is estimated based on the aforementioned planned service population and design unit water consumption by consumer type.

The estimated number of connection and future water consumption are shown in TABLE H-7.

TABLE H-7 Water Consumption in 1995

Service Area	Poblacion
Served Population	2,050
No. of Connection	
Domestic	410
Commercial	25
Institutional	1
Total	436
Water Consumption	
(cu.m/day)	
Domestic	205
Commercial	35
Institutional	5
Total	245
Unaccounted-for Water	163
TOTAL	408

The ratio of the daily maximum water demand to the daily average water demand is determined in relation to the planned service population based on the LWUA Methodology Manual as shown in TABLE H-8.

TABLE H-8 Demand Variation Factor for Daily Maximum Water Demand

Service Population	Ratio (Daily Max./Daily Ave.)
Less than 30,000	1.30 : 1
30,000 to 200,000	1.25 : 1
Over 20,000	1.20 : 1

The estimated daily maximum water demand is shown in TABLE H-9.

TABLE H-9 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Poblacion	530

The peak hour water demand is estimated in proportion to the daily maximum water demand and service population in accordance with the LWUA Methodology Manual as shown below:

C = (Peak Hour Demand x 24)/(Daily Maximum Demand)

= 2.2 -0.3 x log (Service Population/1,000)

The ratio of peak hour demand in the year 1995 is calculated at 2.11 and the peak hour water demand is estimated at 1,120 cu.m/day.

3. Proposed Water Supply Facilities

3.1 Basic Approach for Water Supply Improvement

3.1.1 Conditions and Constraints

The conceptual plan for water supply improvement is focused on major water supply facilities, such as water source, main transmission and distribution pipelines, and reservoir. Branch lines, service connections and fire hydrants are likewise excluded from conceptual planning. However, following conditions are taken into account as much as possible:

(1) Low cost in construction, operation and maintenance,
(2) Seasonal fluctuation of source capacity will not seriously affect stable water supply,
(3) Water source will be located within the administrative boundary of respective municipality.

3.1.2 Water Source Development

Evaluation and analysis of field survey results including georesistivity survey and test well which was constructed by LWUA in 1980 revealed that groundwater resource in the vicinity of poblacion area is quite scarce for the use in water supply development. In this regard, priority is given to the maximum utilization of existing two water sources which have a total water production of 115 cu.m/day in dry season. The gap of this source capacity to the planned daily maximum water demand of 530 cu.m/day in 1995 shall be fulfilled by developing additional water source.

One additional water source was then found at mountain slope in barangay Yating which was about 16 km southwest of poblacion. The origin of this water source is a spring and flows down through a waterfall which has a height of approximately 60 m. During the field survey, approximately 60 liter/sec (equivalent to 5,180 cu.m/day) of flow rate was measured at the altitude of about 85 to 90 m which was downstream of the waterfall. Barangay people noticed that there is no artificial structure and resident beyond that point as possible source of water pollution. Likewise, the utilization of this water source is considered the most reliable measure for planning of water supply improvement in this study.

In addition, the municipality of President Roxas, which is neighboring town of pilar, has formed water district to establish its water supply system, but no water source has been developed yet due to similar hydrogeological constraints. Considering the distance of new water source from poblacion of Pilar and source capacity which exceeds the projected water demand of Pilar in 1995, it is planned that intake facility of this water source shall have enough capacity to share water to

President Roxas. Upon mutual arrangement between these two municipalities, cost for water source development can be shared corresponding to the water use and it will help compress capital expenditure for water source development of each municipality.

3.1.3 Transmission and Distribution Facilities

The existing major pipelines are superannuated with considerable amount of leakage which results insufficient water pressure at the entrance of poblacion. In this regard, all the existing transmission and distribution mains shall be renewed to have a flow capacity for utilizing the maximum water production of existing water sources in rainy season (665 cu.m/day). The existing distribution reservoir is however still serviceable upon minor repair and improvement. This reservoir will be therefore repaired/improved and utilized.

In addition to the above, a series of water intake, transmission and distribution facilities will be required to utilize the new water source in barangay Yating.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

Intake pipes at existing two intake dams will be reconstructed to be embedded under the sand layer to avoid inflow of turbid water, especially during rainy season.

For new water source, an intake dam (10 mW x 2.0 mH) with intake pipe embedded under the sand layer will be constructed.

3.2.2 Transmission Facility

The existing transmission lines will be completely renewed and a junction box of new transmission lines from two existing water sources will be provided and single transmission line will be laid from this junction box to the existing reservoir.

The new transmission line from new water source will have a flow capacity of 1,005 cu.m/day to meet with the hourly maximum water demand in excess of the existing water source capacity.

3.2.3 Distribution Facility

The existing reservoir shall be cleaned and repaired for waterproofing. Existing inflow/outflow pipes will be renewed, especially inflow pipes has been clogged by stones and sands. Chlorination facility will be installed at the existing reservoir.

A new distribution reservoir with an effective storage capacity of approximately 100 cu.m will be located on the mountain slope with an elevation of about 40 m which is about 3.0 km southwest of poblacion. This reservoir will equip with chlorination facility.

These two reservoirs will be connected to poblacion by independent distribution main. New distribution main in poblacion will form a looped line to surround the proposed service area. These distribution mains will have flow capacity to meet with the hourly maximum water demand and the water will be distributed by gravity flow from reservoirs.

3.2.4 Required Water Supply Facilities

Location of major water supply facilities is shown in FIGURE H-5 and flow diagram of facilities in FIGURE H-6 and detail of distribution pipeline in proposed service area in FIGURE H-7.

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Intake pipe at existing sources:
ø 300 mm pipe, 30 m

Intake dam at new water source:
RC, 10.0 mW x 2.0 mD x 2.0 mH, GL+90 m, 1 unit

Intake pipe for new intake dam:
ø 300 mm, pipe 20 m

(2) Transmission Facility

Transmission lines from existing sources to existing reservoir:
ø 100 mm pipe, 4,600 m

Junction box for replaced transmission lines:
RC, 5 cu.m, EL+80 m, 1 unit

Transmission line from new water source to new reservoir:
ø 150 mm pipe, 12,000 m

(3) Distribution Facility

Rehabilitation of existing reservoir:
RC, 115 cu.m, EL+40 m, 1 unit

Reservoir:
RC, 100 cu.m, EL+90 m, 1 unit

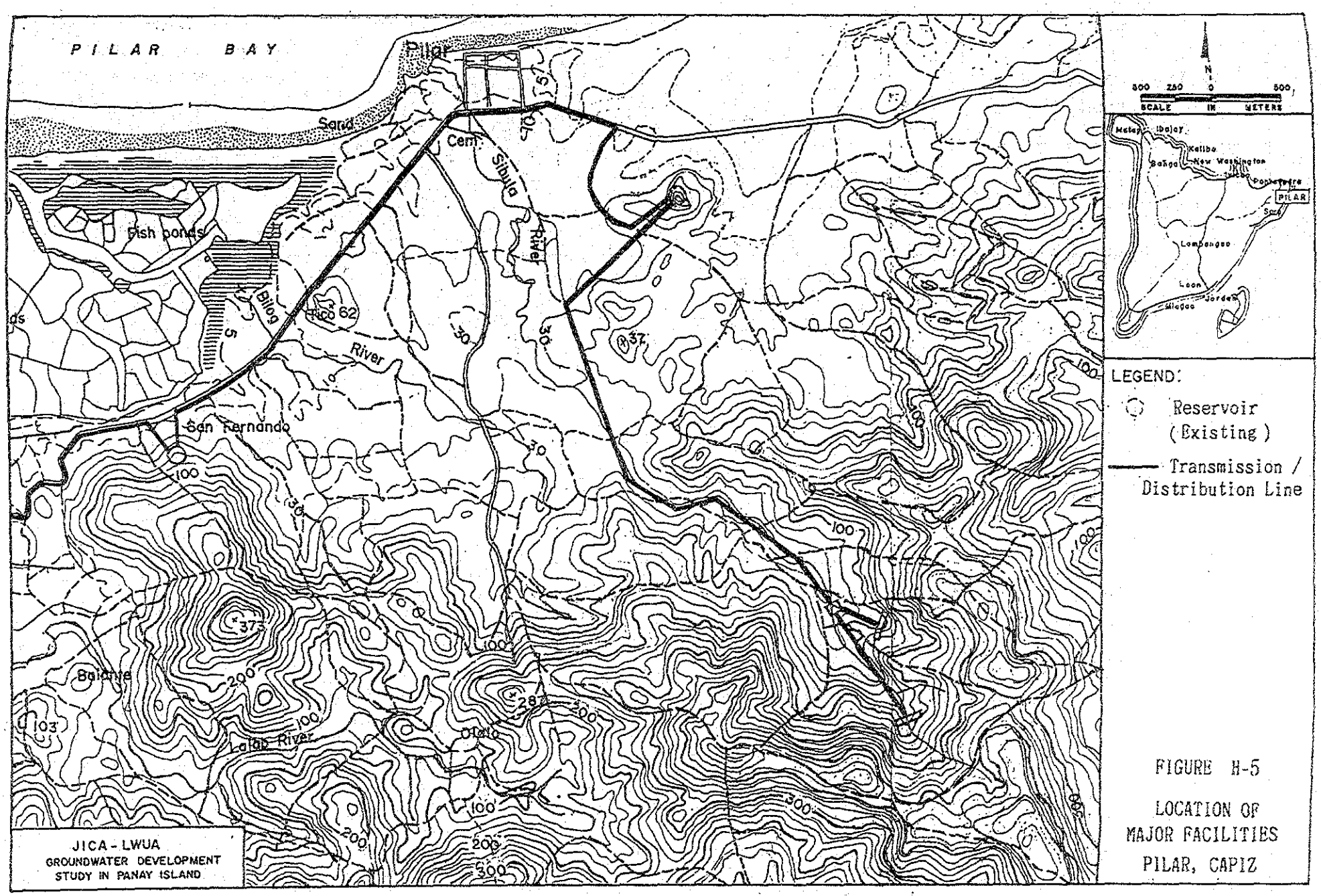
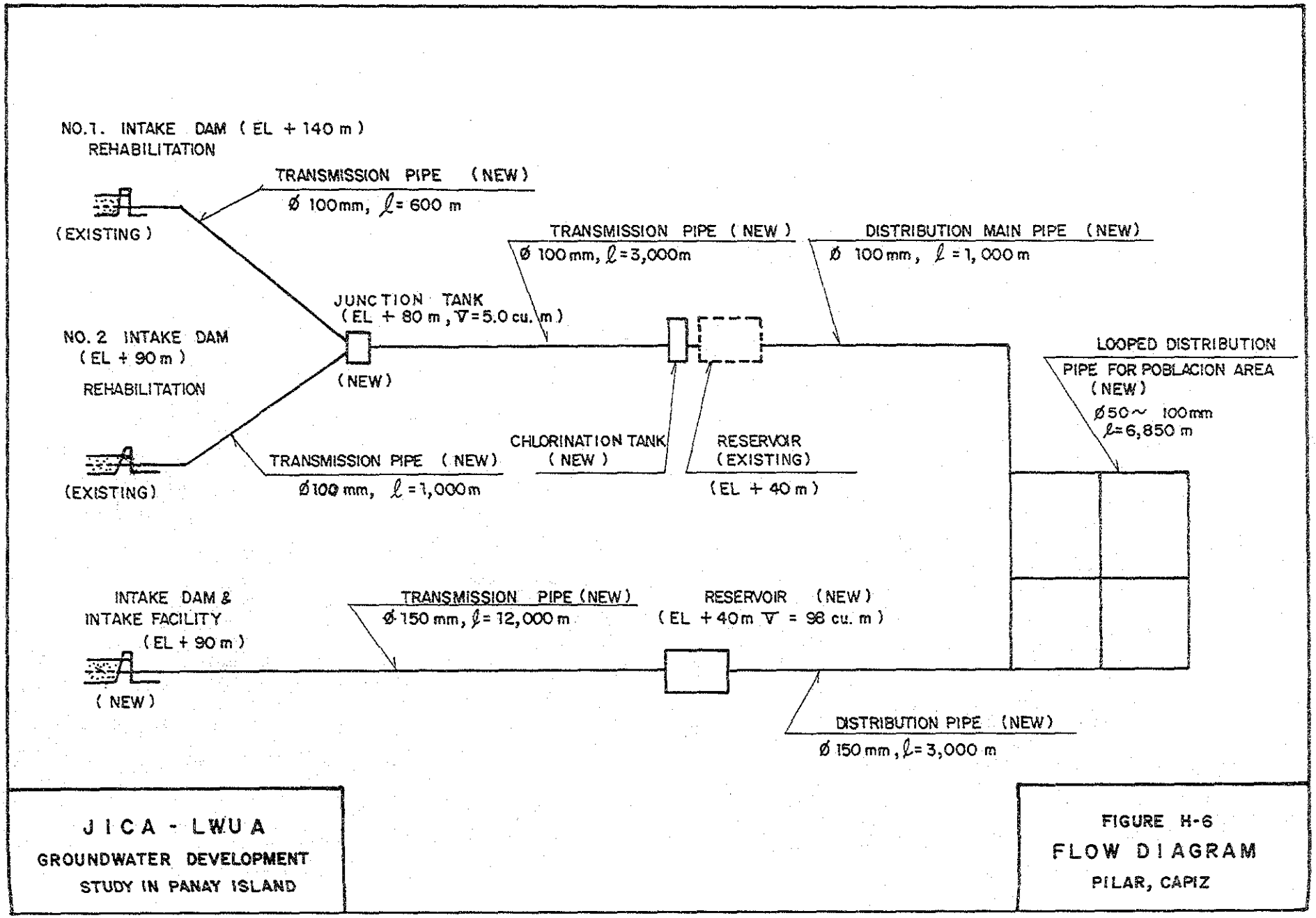


FIGURE H-5

LOCATION OF
MAJOR FACILITIES
PILAR, CAPIZ


NO.1. INTAKE DAM (EL + 140 m)
REHABILITATION
TRANSMISSION PIPE (NEW)
Ø 100mm, ℓ= 600 m
(EXISTING)
TRANSMISSION PIPE (NEW)
Ø 100 mm, ℓ=3,000m
DISTRIBUTION MAIN PIPE (NEW)
Ø 100 mm, ℓ = 1, 000 m
JUNCTION TANK
(EL + 80 m , ∇=5.0 cu. m)
NO. 2 INTAKE DAM
(EL + 90 m)
REHABILITATION
(NEW)
LOOPED DISTRIBUTION
PIPE FOR POBLACION AREA
(NEW)
Ø50～ 100mm
ℓ=6,850 m
CHLORINATION TANK
(NEW)
RESERVOIR
(EXISTING)
(EL + 40 m)
(EXISTING)
TRANSMISSION PIPE (NEW)
Ø100 mm, ℓ =1,000m
INTAKE DAM &
INTAKE FACILITY
(EL + 90 m)
TRANSMISSION PIPE (NEW)
Ø 150 mm, ℓ= 12,000 m
RESERVOIR (NEW)
(EL +40m ∇ = 98 cu. m)
(NEW)
DISTRIBUTION PIPE (NEW)
Ø 150 mm, ℓ= 3,000 m
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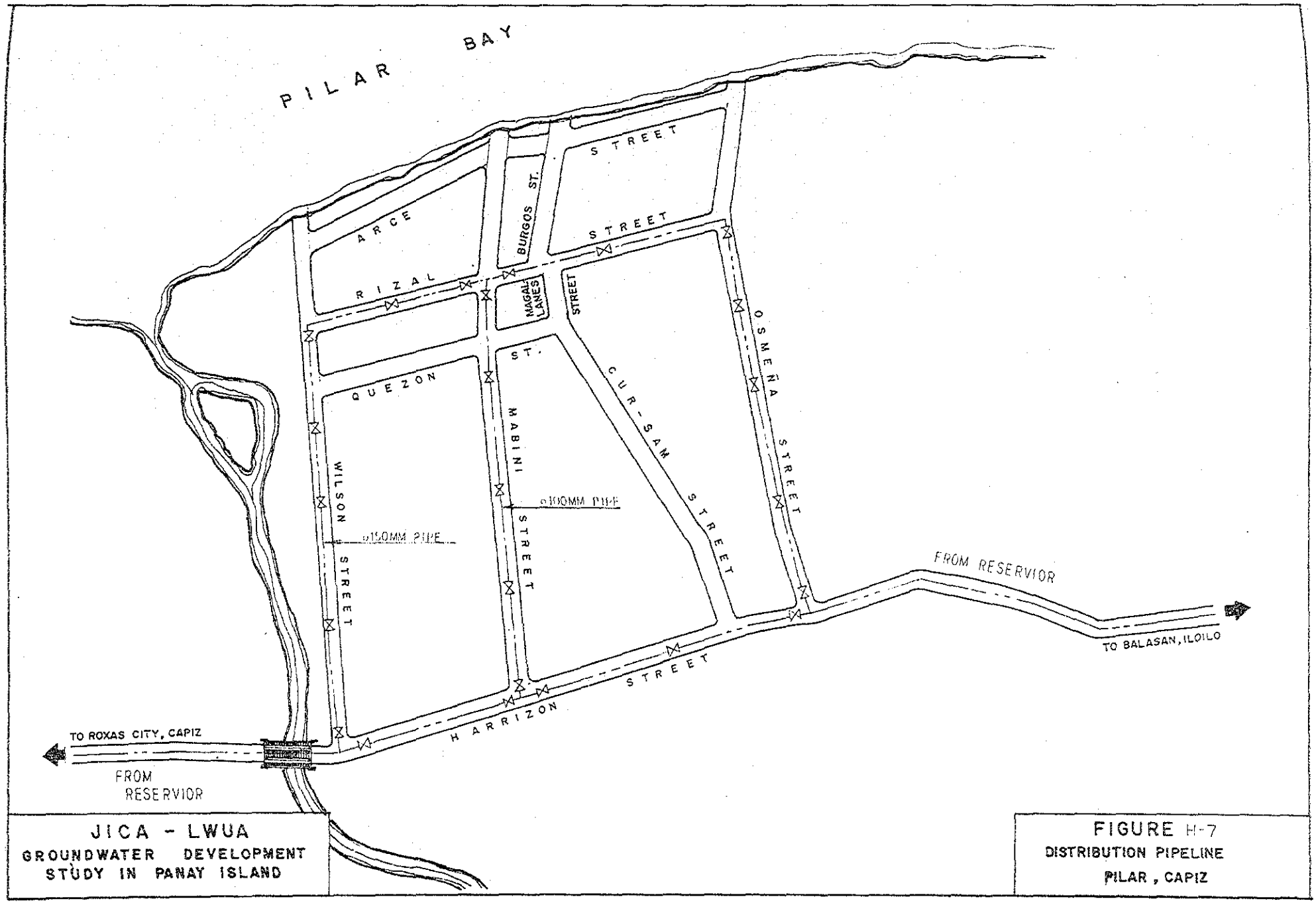
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND
FIGURE H-6
FLOW DIAGRAM
PILAR, CAPIZ



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GROUNDWATER DEVELOPMENT STUDY IN PANAY ISLAND

FIGURE H-7
DISTRIBUTION PIPELINE
PILAR, CAPIZ

Chlorination tank:
RC, 1.5 mW x 2.5 mL x 2.0 mH, 2 units

Distribution main from existing reservoir to entrance of poblacion:
ø 100 mm pipe, 1,000 m

Distribution main in poblacion to form looped line:
ø 100 mm pipe, 1,500 m
ø 150 mm pipe, 5,350 m

Distribution main from new reservoir to entrance of poblacion:
ø 150 mm pipe, 3,000 m

3.3 Rough Cost Estimate of Major Water Supply Facilities

3.3.1 Unit Construction Cost

Unit construction cost of required facilities is based on the "In-Place Cost of Waterworks Materials" (as of January 1989) of LWUA. Any unit cost not shown in this list is referred to "Unit Price Manual - Water Supply Feasibility Studies" (July 1983) upon consideration of price escalation that 15% per annum upto 1987 and 7% per annum from 1987 as adopted by LWUA.

All construction costs are estimated in Philippine Pesos and the total cost is only converted into U.S. Dollars and Japanese Yen based on the following exchange rate as of September 1989.

U.S. $1.00 = Yen 145.70 = Peso 20.78

Unit costs used in rough cost estimate are attached in Appendix-5.

3.3.2 Rough Cost Estimate

Facility	Cost (Thousand Peso)
Water Source Facility	
Infiltration pipe at existing sources (ø 300 mm pipe, 15 m each)	33.6
New intake dam (RC, 40 cu.m)	67.6
Infiltration pipe (ø 300 mm, 20 m)	23.2
Transmission Facility	
Replacement of existing line (ø 100 mm pipe, 4,600 m)	2,300.0
Construction of junction box (RC, 5 cu.m)	9.7
Construction of new line (ø 150 mm pipe, 12,000 m)	7,560.0
Distribution Facility	
Rehabilitation of existing reservoir (RC, 115 cu.m, 10% of construction cost)	22.2
Reservoir (RC, 100 cu.m)	257.3
Chlorination tank (RC, 7.5 cu.m, 2 units)	29.0
Replacement of existing line (ø 100 mm pipe, 1,000 m)	270.0
Replacement of existing line in poblacion	
(ø 100 mm pipe, 1,500 m)	405.0
(ø 150 mm pipe, 5,350 m)	2,889.0
(ø 100 mm valve, 5 pcs.)	22.5
(ø 150 mm valve, 19 pcs.)	108.3
Distribution line from new reservoir	
(ø 150 mm pipe, 3,000 m)	1,620.0
Total	15,617.4

Total construction cost for improvement of major water supply facilities is estimated at approximately 15.6 million Pesos (109.5 million Yen or 0.75 million U.S. Dollar).