D. KALIBO, AKLAN

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I. STUDY AREA AND HYDROGEOLOGICAL ANALYSIS

1. Description of the Study Area

1.1 Physical Description

1.1.1 Geographical Location and Area

Kalibo, the capital town of Aklan, is about 20 hours away from Manila by boat (via New Washington), or one hour and fifteen minutes from manila by plane. It has a geographical location of north to south between 11°40'22" N and 11°40'00" N and from west to east between 122°20'27" and 122°25'22" E. It lies on the northeastern border of the province and therefore is bounded on the northeast by the Sibuyan Sea. It is bordered on the southeast by the municipality of New Washington, on the southwest by Banga, on the west by Lezo and on the northwest by Numancia. It has a total land area of 3,345 ha covering 16 barangays. Location map is shown in FIGURE D-1.

1.1.2 Climate

The municipality has a climate belonging to Type III, i.e., wet and dry seasons are not very pronounced. This is chiefly characterized by uneven periods of rainfall throughout the year, heaviest of which occurs during the months of October to December and July. Monthly precipitation for October is 350 mm, November 410 mm, December 325 mm and July 310 mm. The area is relatively dry from November to April, wet the rest of the year. Temperature does not vary much. Coolest months are January and February with average temperature of 26.3°C and 26.0°C, respectively, while the warmest months are May and June with average temperatures of 29.4°C and 29.1°C, respectively.

1.1.3 Terrain/Topography

Characterized mostly of broad alluvial plain, Kalibo's terrain is generally flat. Lands are level to nearly level with slope ranging from 0-3%.

1.1.4 Soil

There are six type of soil found in Kalibo: the beach sand along the coast, San Manuel clay loan on the plains of lower Aklan River, Santa Rita clay on the central area, Bantog clay on the southeastern area, hydrosol and mountain soil.

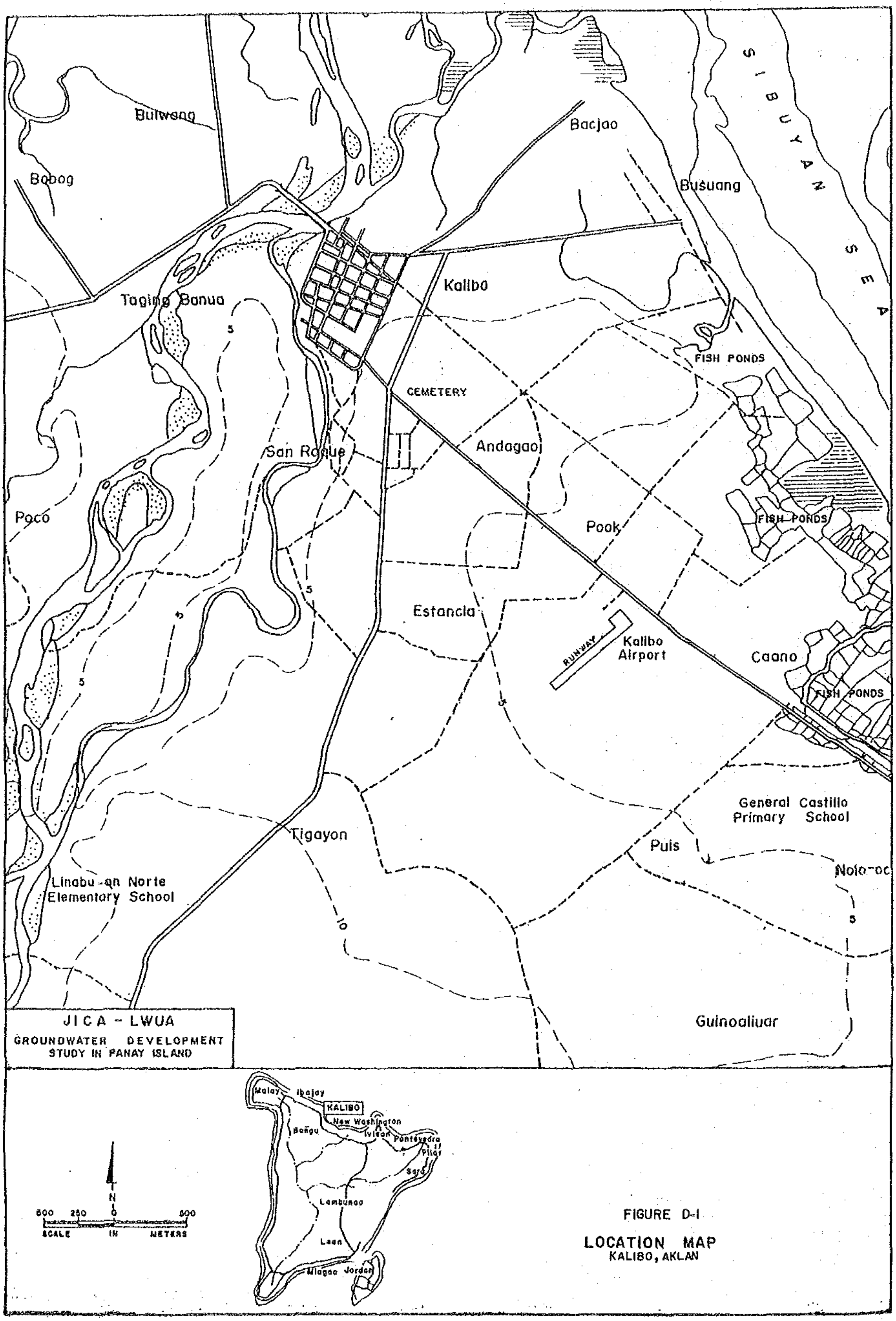


FIGURE D-1

LOCATION MAP
KALIBO, AKLAN

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 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 belongs to the 1st (C) class.

The municipality of Kalibo has 16 barangays, namely:

1. Andagaw
2. Bakkaw Norte
3. Bakkaw Sur
4. Briones
5. Buswang New
6. Buswang Old
7. Ca-ano
8. Estancia
9. Linabuan Norte
10. Mabilo
11. Mobo
12. Nalook
13. Poblacion
14. Pook
15. Tigayon
16. Tinigaw

Of the total land area, 62.2% are devoted to agriculture; 25.0%, residential; 3.8%, commercial; 1.0%, industrial; and 5.9% others.

1.1.6 Transportation

Buses, jeepney/jitneys, tricycles and cars-for-hire are the forms of passenger land conveyance. There are three bus lines operating in the municipality providing inter-provincial and inter-provincial transportation.

Air transportation is provided by the Philippine Air Lines with daily flights between Kalibo and Manila.

1.1.7 Infrastructure

As of 1987, Kalibo's road network totaled 104.398 km. There were 12.302 km of national roads, of which 56.9% were concrete, 19.9% asphalt and 23.2% gravel. Provincial roads totaled 22.488 km of which 80.8% were made of gravel and 19.2% concrete. Municipal roads, composed of 60.1% concrete, 39.3% gravel and 0.6% asphalt, reached a total of 13.658 km. the 55.95 km of barangay roads were all of the gravel surface type.

The Kalibo Airport is the main airport of the province although it is classified by the Civil Aeronautics Administration as a secondary airport. It includes 1,300 m of runway which is almost completely concreted.

As to status of electrification, of the 17 municipalities, Kalibo ranks highest in the total number of connections. As of end of 1986, only 5.24% of the 7,036 households remained unserved by the Aklan Electric Cooperatives, Inc. (AKELCO).

1.2 Population and Living Conditions

1.2.1 Population Trend From the Past

Kalibo, being the capital town, has the most population of 39,894 which accounts for 12.29% of the provincial population in 1980. From 1975 to 1980, its population grew at an average annual rate of 4.54%, the fastest among the municipalities and faster than the provincial average of 2.04%.

Aside from being the most populous, Kalibo is also the most thickly populated among Aklan's 17 municipalities. Its population density jumped from an already very high ratio of 956.5 persons per square kilometer in 1975 to 1,194.4 persons per square kilometer in 1980.

Rural population accounted for 72.05% of the total municipal population.

TABLE D-1 **Population and Number of Households by Barangay, Kalibo, Aklan, 1980**

Barangay	Population	No. of Households
Andagaw	4,673	830
Bakkaw Norte	1,422	245
Bakkaw Sur	715	119
Briones	756	146
Buswang New	3,311	567
Buswang Old	1,355	234
Ca-ano	928	150
Estancia	3,997	700
Linakuan Norte	2,050	375
Mabilo	1,464	275
Mobo	893	163
Nalook	1,565	269
Poblacion	11,150	1,913
Pook	2,516	444
Tigayon	2,319	462
Tinigan	780	144
Total	39,894	7,036

1.2.2 Age Distribution

The municipality's productive population constituted more than half or 55.8% of the total population. The dependent population composed of those below 15 years of age and those over 64 years of age accounted for 39.0% and 5.2%, respectively. Dependency rate was therefore registered at 79.1%, far better than the provincial rate of 88.07%.

Female population outnumbered the male population with a female-to-male ratio of 105:100.

1.2.3 Morbidity/Mortality

The morbidity rate in 1987 is 43.9% while mortality rate is 0.55%. Infant mortality rate is 38.59% per 1,000 population. Respiratory diseases are the major causes of sickness and deaths. Morbidity was mainly caused by acute bronchitis, upper respiratory tract infection, anemia, parasitism and hypertension. Mortality was mainly due to pneumonia and tuberculosis.

Malnutrition accounted for some morbidity cases and is prevalent among preschoolers. Results of the Operation Timbang in 1987 indicated malnutrition rate of 67.7% among the 6,560 preschool children weighed.

1.2.4 Sanitation

The water-sealed type with sewer/septic tank is the most common type of toilet facility with 38.3% of the total households using it. More than one-fourth or 29.4% use water-sealed with other depository; 21.7%, closed pit; 7.5%, open pit; and 0.5, others (pail system, etc.). There are only 2.6% of the total households without toilet facilities.

1.2.5 Public Services

Health facilities include1 public hospital, 2 private hospitals, 1 puericulture center and 15 barangay health stations. Public health services are being provided by 31 doctors, 2 dentists, 38 nurses, 15 midwives, 5 medical technologist, 25 nursing attendants and 2 dietitians. Doctor-to-population ratio is 1:1007; nurse-to-population ration is 1:845; and midwife-to-population ratio is 1:2101.

Educational facilities include 16 public schools and 2 barangay high schools, one in Nalook and the other in Nilabuan Norte. The Provincial Government has one public high school, the Science Development High School of Aklan located in the Provincial Capitol compound at Barangay Estancia, and another public national school, the Roxas National College of Arts and Trade which offers secondary and college education. There are also various private schools and colleges in the municipality.

Public educational facilities-to-population ratio in the elementary level is 1:109; 1:145 in the secondary level; and 1:100 in the tertiary level.

Teacher-pupil ratio is 1:28 in the elementary level and 1:24 in the secondary level.

There are adequate public communication and media facilities in the municipality. These include telephone facilities under the Bureau of Telecommunications, with 785 lines in the urban areas and 178 lines in the rural areas, 2 radio stations, six private ratio/telegraph stations, 2 local newspapers (aside from the daily regional and Manila newspapers which have outlets in Kalibo). Long distance phone calls can only be made from Kalibo.

1.3 Economy and Industry

1.3.1 Agriculture

Farming and fishing are the principal industries in Kalibo. With a total farm area of 1,123,73 ha, the total number of farms decreased by 18.3% from 1,843 farms in 1975 to 1,505 in 1980. Average farm size went up slightly by 3% from 1.00 ha in 1975 to 1.03 ha in 1980. total agricultural production in 1980 reached 6,888 metric tons. The dominant crops were palay which produced 4,856 metric tons or 70.51% of total followed by coconut with 1,480 metric tons or 21.49% of total. Other crops included fruits and vegetables (413 metric tons), corn and other cereals (137 metric tons).

The livestock population of the municipality as reported in the 1980 Census of Agriculture totaled 15,647 heads consisting of 147 carabaos, 579 cattles, 8 horses, 100 goats, 2,161 pigs and 12,652 fowls mostly chicken and ducks.

On the other hand, total fishpond area covers a total of 183.54 ha. Coastal fishing covers 7 km of Kalibo's coastline which has remained a potential source of animal protein. As of 1987, there were 225 full-time fishermen and 142 part-time fishermen with 80 motorized bancas and 120 non-motorized bancas. The estimated fish production in 1987 was 211.68 MT and 21.313 MT for coastal fishing and inland fishing, respectively.

1.3.2 Other Industries

As of 1987, there were 59 cottage industries registered with the DTI: 11 engaged in garments; 8 in furniture making; 8 in metalcraft; 11 in manufacturing (hollow block, ceramics, etc.); 3 in food processing; 9 in handicraft; 2 in fibercraft; 1 in wood/leathercraft; 3 in tinscraft; and 3 in industries related to other handicrafts.

Considered the commercial and industrial center of the province, Kalibo has 428 commercial establishments classified into 150 sari-sari stores, 30 drugstores, 42 rice and corn retailers, 12 hardware and lumber, 64 dry goods and general merchandise, 21 groceries and appliance, 20 auto supply and machineries, 11 manufacturing, 15 funeral homes, 13 bakeries and 50 other services including catering, restaurants, parlor shops, photo service and resthouses.

2. Analysis of Potential Water Source

2.1 Topography and Geology

The municipality of Kalibo is situated on the broad and flat alluvial plain along the Aklan River with the poblacion lying on the river delta.

The geology in the study area is characterized by alluvial deposits consisting of thick sand and clay with pebble layer.

The type of basement in the area could not be ascertained due to the absence of deep well data. Geological map is shown in FIGURE D-2.

Limestone (Pliocene Tertiary)

In Barangay Tigayon, 4 km distant from the Poblacion, the independent hill beside the Aklan River is known. This hill is called "Tigayon Hill" and it consists of limestone which is highly karstified, massive reef.

Alluvial Deposits (Quaternary)

The deposits are found in plain and flood plains along the Aklan River. These deposits are composed of materials removed from the upper river and their thickness appears to be more than 80 m based on LWUA's deep well, which was dug in March 1988.

The source of the existing water supply system is groundwater pumped up from said alluvial deposits. Also, there are few private free flowing deep wells in the zone near the beach.

At Numancia, which is located about 7.5 km west of Kalibo and lies on the left bank of the Aklan River, a lot of groundwater which yields 14 liter/sec or 1,200 c.m/day was obtained from gravel layer at 30 m below ground level by LWUA's constructed deep well.

2.2 Existing Water Source

Surface Water

The Aklan River, which has a drainage area of 852 sq.km, flows along the northwestern boundary of Kalibo. Despite the dry season, a great volume of river water flows to the Sibuyan Sea. Due to the deep water depth, rapid flow speed and intricate river bed condition, river flow measurement of the Aklan River was not possible.

Based on the historical records of the National Water Resources Council, the average daily discharge of the Aklan River was

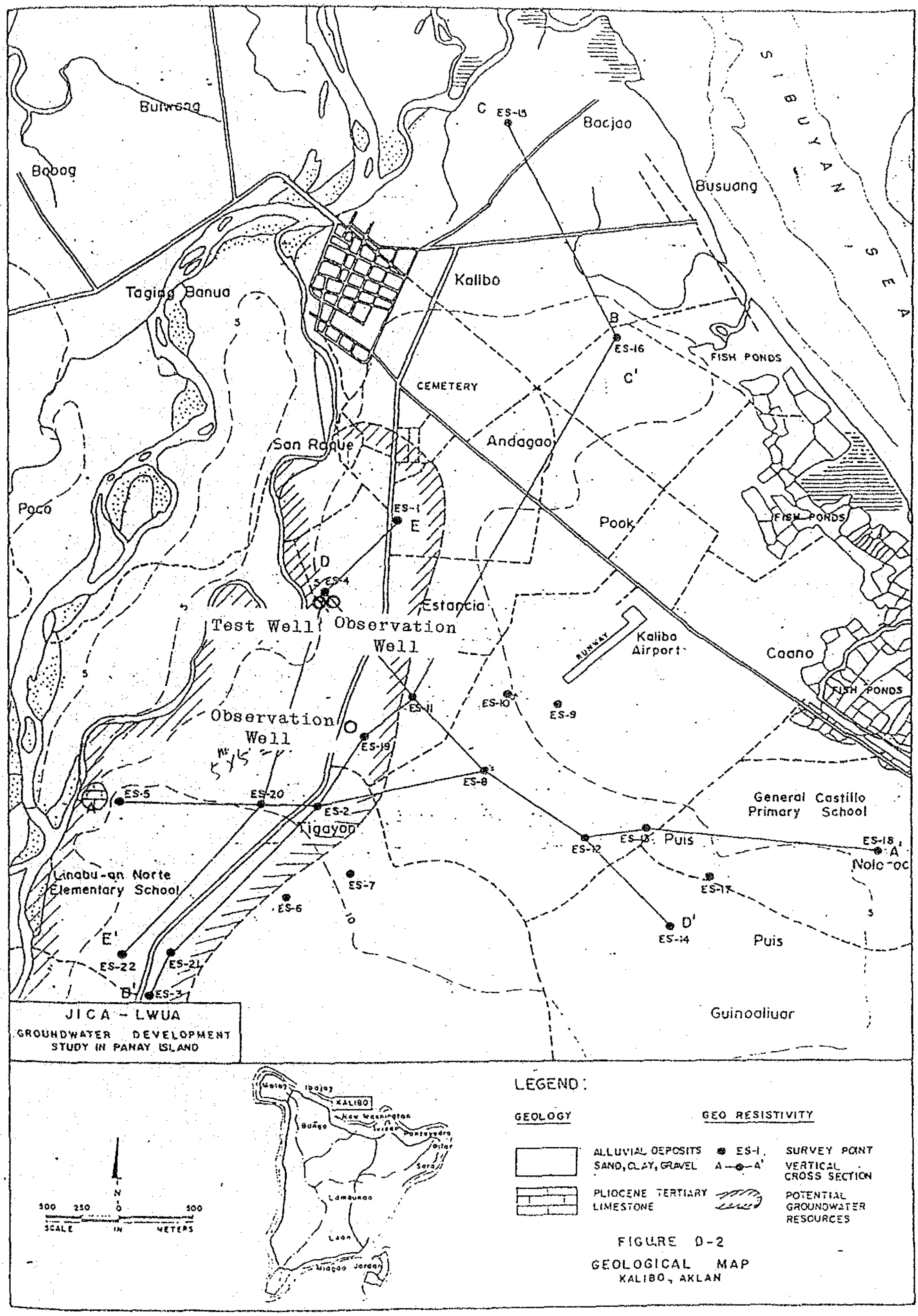


FIGURE D-2
GEOLOGICAL MAP
KALIBO, AKLAN

measured as shown in TABLE D-2.

The measuring station is located at Rosario, Malinao, 15 km upstream of the poblacion of Kalibo. The drainage area at the station measures 705 sq.km. The annual average daily discharge is calculated at 88.93 cu.m/sec or 7,684,000 cu.m/day, though the minimum average daily discharge is 57.50 cu.m/sec or 4,968,000 cu.m/day in April. However, the annual run-off which is calculated at 3978 mm is too large considering the precipitation and the evapotranspiration, which will be discussed later. On the other hand, the National Water Resources Council presents the estimated annual run-off of the Aklan River to be 1271.1 mm in their report "Principal River Basins of the Philippines". Considering the accuracy of measuring and the meteorological condition, the latter value is more reasonable.

Wells

The central area of the municipality of Kalibo is covered by the piped water supply service of the Kalibo Water District (KWD), obtaining its water supply from a deep well (67 m in depth) located south of the poblacion. Two other deep wells with depth of 30 m and 43 m respectively had been previously used for the system until the stoppage of pump operation due to the decline in production capacity and salt water intrusion.

For the purpose of securing a new water source, the KWD drilled a new deep well (80 m in depth) at a place located southeast of the poblacion based on the results of LWUA's georesistivity survey. However the well development was discontinued because of the prospective poor production capacity of well as a result of thick silt layer.

Residents living outside the KWD service area mostly depend on private or public constructed shallow wells.

In addition, several free flowing wells are utilized in the area near the sea shore. However, water quality analyses of these wells show the presence of total iron and ammonium nitrogen. This is caused by the aerobic decomposition of organic materials which sedimented in alluvial deposits, together with sand and clay, on the delta of Aklan River.

A well inventory survey was carried out in the whole area of Kalibo. Previous to the field survey, data collection was conducted at the official agencies concerned. Only two wells, however, were verified as to their exact location and lithologic log data. A total of 20 wells were visited during the field survey as shown in FIGURE D-3. Among these, 11 wells were surveyed for well depth and static water level. Survey results are presented in TABLE D-3.

TABLE D-2 AVERAGE DAILY DISCHARGE (AKLAN RIVER at Rosario, Malinao, Aklan) Unit: cu.m/sec

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1950	********	********	********	********	26.60	51.37	36.58	78.19	144.28	273.34	234.69	122.50
1951	110.70	89.16	89.85	43.38	120.57	98.26	141.86	131.86	141.10	122.66	171.42	328.14
1952	161.33	88.20	70.45	30.88	51.70	69.33	152.57	146.60	117.75	315.92	245.91	368.67
1953	261.54	185.88	207.80	207.80	119.26	200.17	********	185.16	178.23	178.41	********	********
1954	********	********	********	********	********	********	********	********	********	********	********	********
1955	********	********	********	********	********	********	********	********	********	********	********	********
1956	129.34	157.85	125.94	128.11	139.96	89.68	94.60	118.83	119.04	138.64	102.32	295.32
1957	262.91	122.92	58.62	103.51	31.65	32.59	131.01	110.56	125.77	103.62	96.66	74.89
1958	137.72	********	********	********	********	********	90.22	79.92	55.32	145.58	********	94.23
1959	94.76	42.77	112.46	35.78	54.26	69.06	114.54	95.49	51.12	86.64	192.44	197.57
1960	176.10	141.09	********	********	39.75	82.60	83.00	97.01	49.50	154.12	201.77	********
1961	********	********	********	32.78	38.51	42.75	59.32	87.22	41.46	67.63	90.68	69.08
1962	96.13	95.60	72.46	24.71	27.32	41.47	89.46	127.10	127.61	86.51	126.87	142.15
1963	145.08	122.42	94.64	63.69	60.75	********	59.66	96.12	89.19	84.54	117.76	108.37
1964	87.06	108.86	75.77	83.53	79.54	104.04	79.89	66.03	72.06	71.98	93.71	114.38
1965	78.95	71.86	69.35	61.25	51.72	46.29	********	********	56.20	82.31	81.19	121.54
1966	78.94	51.24	51.47	48.06	80.19	61.13	77.61	65.51	********	********	********	********
1967	137.12	83.46	61.76	28.93	22.78	35.55	48.65	49.47	36.87	44.84	87.81	70.84
1968	78.81	54.29	48.88	30.05	30.78	44.46	58.03	68.25	32.05	40.63	64.27	59.04
1969	38.61	20.32	11.57	9.79	15.64	30.29	73.20	73.35	62.37	56.59	56.86	105.38
1970	80.18	68.91	50.00	34.63	25.02	********	********	39.19	46.17	50.45	88.80	96.80
1971	********	********	********	********	********	********	********	********	********	********	********	********
1972	********	********	********	********	********	********	********	********	********	********	********	********
1973	34.03	51.00	28.70	24.95	********	********	********	84.11	72.72	83.19	********	********
1974	********	139.08	147.06	99.90	88.26	91.97	********	88.87	45.41	101.03	58.27	121.74
1975	********	88.93	52.68	81.99	68.15	55.18	59.12	51.43	72.75	58.99	95.97	181.67
1976	121.27	79.01	60.40	33.98	134.14	58.21	52.00	67.56	51.49	66.55	147.42	********
1977	79.56	150.83	74.43	37.87	31.69	32.99	70.58	59.75	68.70	30.14	47.23	51.38
1978	32.33	31.24	21.31	19.38	21.38	25.99	26.43	31.21	35.31	67.68	46.87	72.24
MAXIMUM	262.91	185.88	207.8	207.8	139.96	200.17	152.57	185.16	178.23	315.92	245.91	368.67
AVERAGE	115.36	92.95	75.50	57.50	59.11	64.92	79.92	87.45	78.85	104.67	116.62	139.80
MINIMUM	32.33	20.32	11.57	9.79	15.64	25.99	26.43	31.21	32.05	30.14	46.87	51.38
SampleNo	21	22	21	22	23	21	20	24	24	24	21	20
ST.DEV.	62.67	43.98	44.47	45.67	38.41	39.00	33.82	35.75	41.29	69.78	60.08	91.11

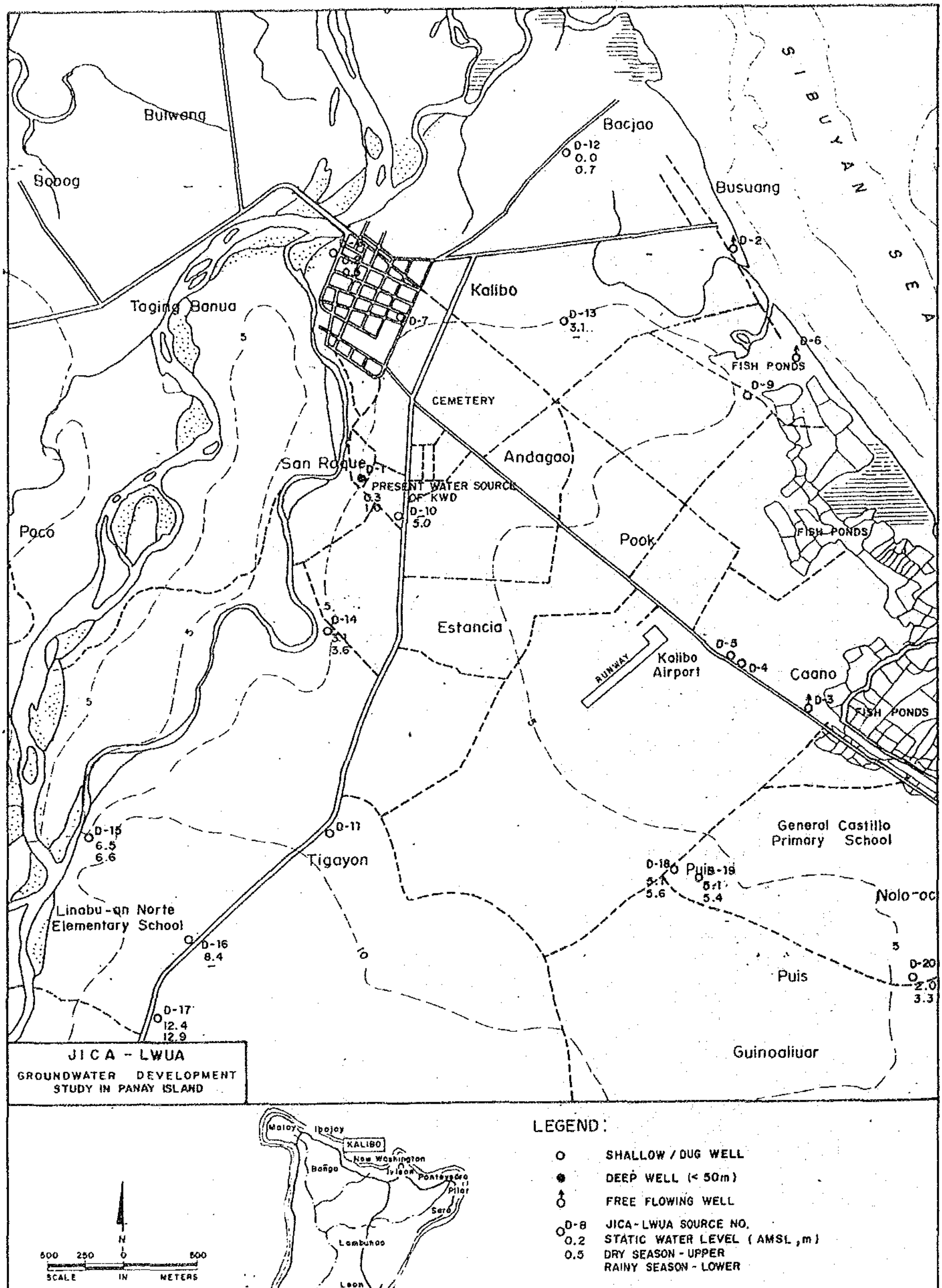


FIGURE D-3
MAP OF INVESTIGATED WATER SOURCES
KALIBO, AKLAN

TABLE D-3 Well Data Summary

JICA-LWUA Source Number	Well Depth (M)	Ground Level (MAMSL)	Static Water Level: Dry Season (April 23) (MBGL)	(MAMSL)*	Rainy Season (September 16) (MBGL)	(MAMSL)
D-1 Existing Pumping Stn.	67.00	5.0	-4.74	0.3	-4.00	1.0
D-8 Laserna St. Pumping Stn.	30.00	3.5	-3.30	0.2	-2.97	0.5
D-10 Shallow Well at ES-1	6.54	6.0	--	--	-0.96	5.0
D-12 Shallow Well at ES-15	5.04	2.0	-2.00	0.0	-1.29	0.7
D-13 Shallow Well at ES-16	5.44	4.9	-1.75	3.1	--	--
D-14 Shallow Well at ES-04	5.61	5.5	-2.37	3.1	-1.94	3.6
D-15 Shallow Well at ES-5	6.57	10.0	-3.51	6.5	-3.44	6.6
D-16 Well 06-1-85-22	5.31	10.0	-1.62	8.4	--	--
D-17 Shallow Well at ES-3	5.93	15.0	-2.62	12.4	-2.06	12.9
D-18 Dug Well at ES-13	2.90	6.0	-0.94	5.1	-0.41	5.6
D-19 Shallow Well at ES-13	7.23	5.9	-0.80	5.1	-0.52	5.4
D-20 Shallow Well at ES-18	4.09	4.0	-1.97	2.0	-0.66	3.3

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

Almost all wells in the area are shallow (<50 m) except for the well at the existing pump station of KWD. According to the well lithologic log collected at DPWH District Engineer's Office, at least 48 m below the ground level is filled with alluvial formation, i.e., clay, silt and sand.

Two wells at Barrios New Buswang and Ca-ano were flowing slightly with brown colored water freely at the rate of 0.1 to 0.3 liter/sec from a discharge pipe which has a diameter of 2".

At the prawn hatchery located on the coast of Barrio Pook, a lot of water is being pumped up forcibly from the well by a 6" dia. casing. According to the people concerned, this well has the capability to be free flowing.

It was noted that the well located at the operational pumping station of KWD is 67 m deep and is lined with 250/200 mm casing. It was constructed in 1980 and found to be highly productive (specific capacity = 12.66 l/s.m, by LWUA). Based on the results of investigation carried out during the field survey period, no drawing down of pumping water level was found, notwithstanding the pumping volume of 1.9 cu.m/min.

Continuous monitoring of water level at Well No. 8 was conducted from May 6 to September 19, under the maintenance by the engineer of KWD. During the said period, recording interruption of 5 days in total occurred due to maintenance trouble.

Based on the analysis of records, following are deduced:

1) Water level of the well was obviously influenced by the tidal movement, though the location of the well is 2.5 km far from the seashore. The difference in a day, however, is quite small. Usually it is about 5 cm and less than 10 cm at the maximum.

2) At the time of high tide, the water level is at the highest level in a day, and is at the lowest at low tide.

3) The lowest level is 3.18 m below ground level last May 20, 1988.

4) The highest level is 2.76 m below ground level last August 26, 1988. However, considering the rapid rise of water level, 20 cm inn 4 hours, it seems to be caused by heavy rain. The next highest level is 2.86 below ground level last September 17, 1988.

5) In general, water level is increasing slightly from May to September, that is, 3.15 m below ground level last May 7 to 2.95 m last September 18 as average daily water level.

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

Kalibo is located near the river mouth of the Aklan River and is spread on the vast flood plain being developed along the Aklan River and on the marine alluvial plain. Owing to this hydrogeological background, salt water intrusion has been observed in the deep wells in this area.

Georesistivity survey in this particular study area was conducted intensively to cover as wide an area as possible based on the high possibility of deep aquifers. Survey points are indicated on FIGURE D-2 covering 22 sounding points.

Field activities are summarized below:

Date	:	April 25 to may 3, 1988
No. of Survey Points	:	22 points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	100 to 150 meters

The analysis results of the ρ-a curve is shown in TABLE D-4 and georesistivity sections are presented in FIGURE D-4 to FIGURE D-8.

As of the present, the following interpretations and assessment have been obtained:

1) The national road Route 1 runs from Kalibo to the inland area toward Banga along the right bank of the Aklan River. Areas along this national road have a width of 1 to 1.5 km and show resistivity of more than 50 ohm.m.

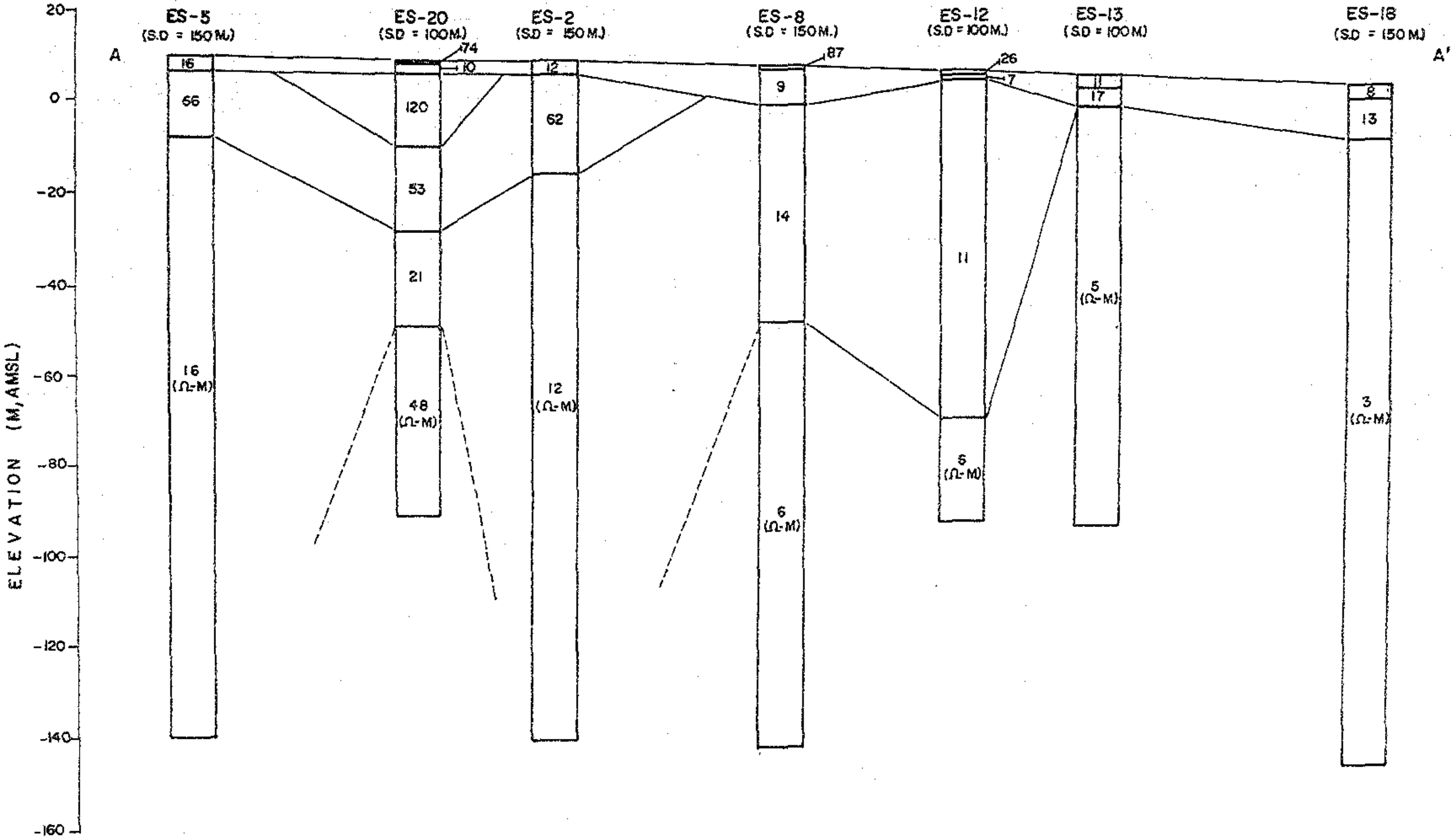
   This specific zone with a thickness of 20 to 40 meters is considered to be the flood deposit developed by Aklan River with highly possible layers of aquifer. This zone is shown in FIGURE D-2.

2) The resistivity layer (110 to 120 ohm.m) detected at survey points ES-20, ES-21 and ES-22 is considered to be the most promising aquifer-bearing which has a thickness of 15 to 20 meters.

3) The resistivity layer with 47 or 48 ohm.m is underlying at a depth deeper than -45 mamsl along the line ES-4 - ES-20 of FIGURE D-8. This layer is considered to be sandy deposits and aquifer.

TABLE D-4 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION
KALIBO, AKLAN

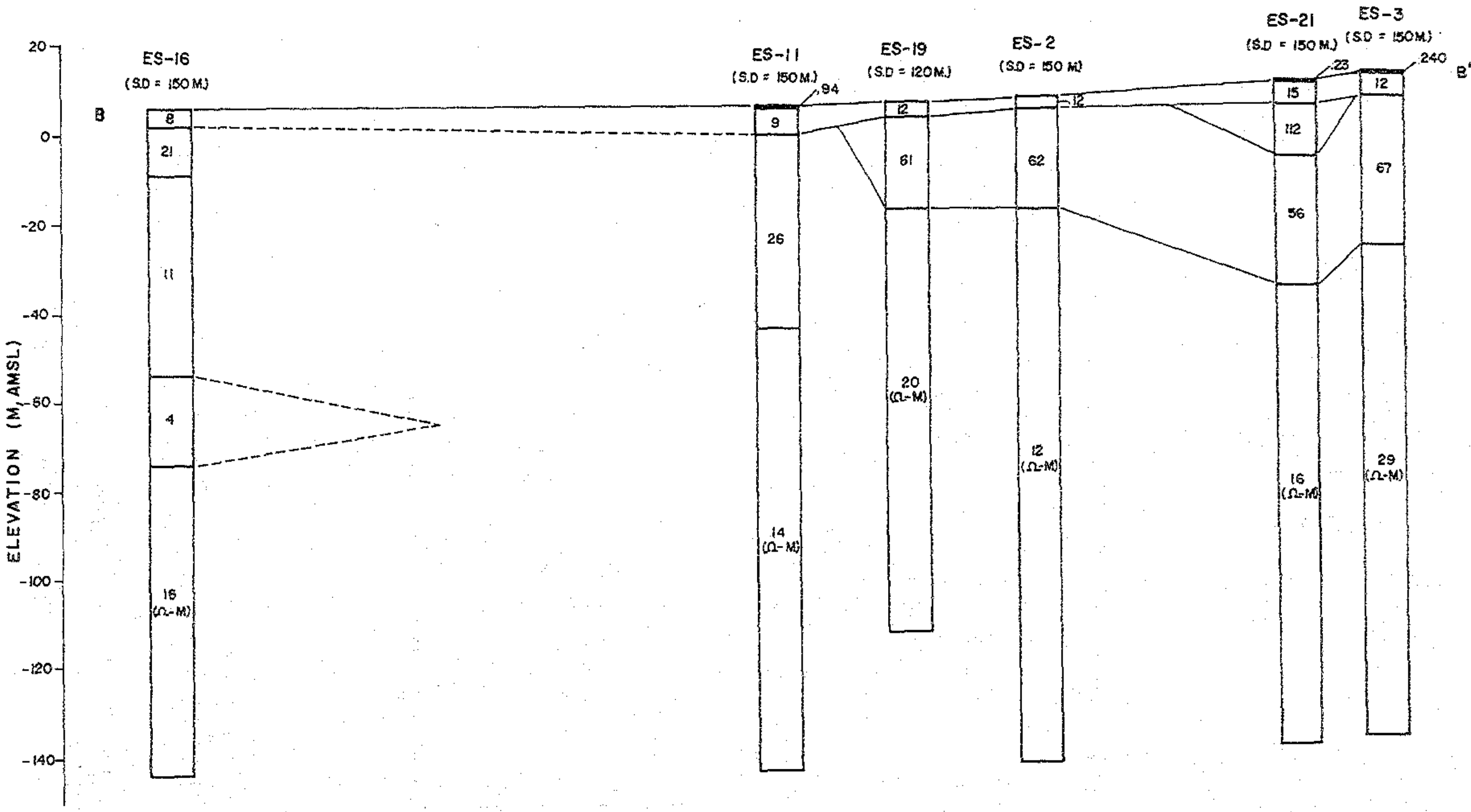
SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER 1 ohm.m	1 m	2 ohm.m	2 m	3 ohm.m	3 m	4 ohm.m	4 m	5 ohm.m	5 m	6 ohm.m	6 m
ES-1	6	flood plain	42	1.0	8	1.8	98	9	60	16	23			
ES-2	9	flood plain	12	2.4	62	25	12	58	21					
ES-3	15	flood plain	240	0.4	12	3	67	39	29					
ES-4	5	flood plain	140	0.3	23	4.3	172	11.5	27	56	47			
ES-5	10	flood plain	16	2.8	66	18	16							
ES-6	12	alluvial plain	13	0.5	9	3.4	23	36	9					
ES-7	9	alluvial plain	9	3.3	14	30	2							
ES-8	7	alluvial plain	87	0.8	9	8	14	56	6					
ES-9	4	alluvial plain	150	1.0	8	9	13	40	7					
ES-10	5	alluvial plain	100	1.0	13	7	21	16	10	84	16			
ES-11	7	allauvial plain	94	0.6	9	6.4	26	50	14					
ES-12	7	alluvial plain	26	0.6	7	2	11	76	6					
ES-13	6	alluvial plain	11	2.8	17	6.8	5							
ES-14	7	alluvial plain	7	1.0	19	12	2							
ES-15	2	alluvial plain	14	1.1	42	10	10	72	3					
ES-16	6	alluvial plain	8	4	21	20	11	60	4	80	16			
ES-17	6	alluvial plain	9	2.6	13	16	2							
ES-18	4	alluvial plain	32	13	12	3								
ES-19	8	alluvial plain	12	3.8	61	24	20							
ES-20	9	flood plain	74	0.6	10	3	120	19	53	38	21	58	48	
ES-21	13	flood plain	23	0.5	15	4	112	14	56	36	16			
ES-22	12	flood plain	175	0.5	18	4	120	24	25					



JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

SCALE H= 1: 20,000
V= 1: 1,000

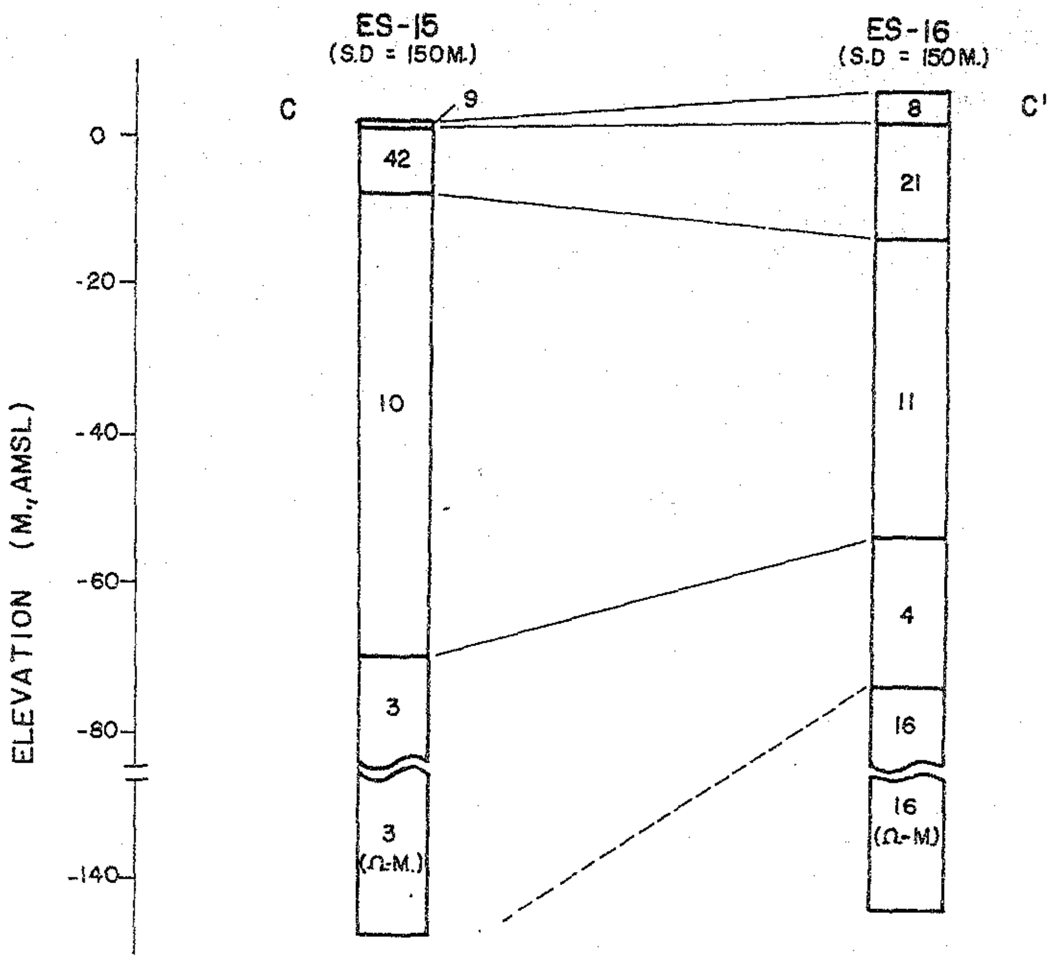
FIGURE D-4
GEORESISTIVITY SECTION A-A'
KALIBO, AKLAN, PANAY ISLAND



JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

SCALE H = 1: 20,000
V = 1: 1,000

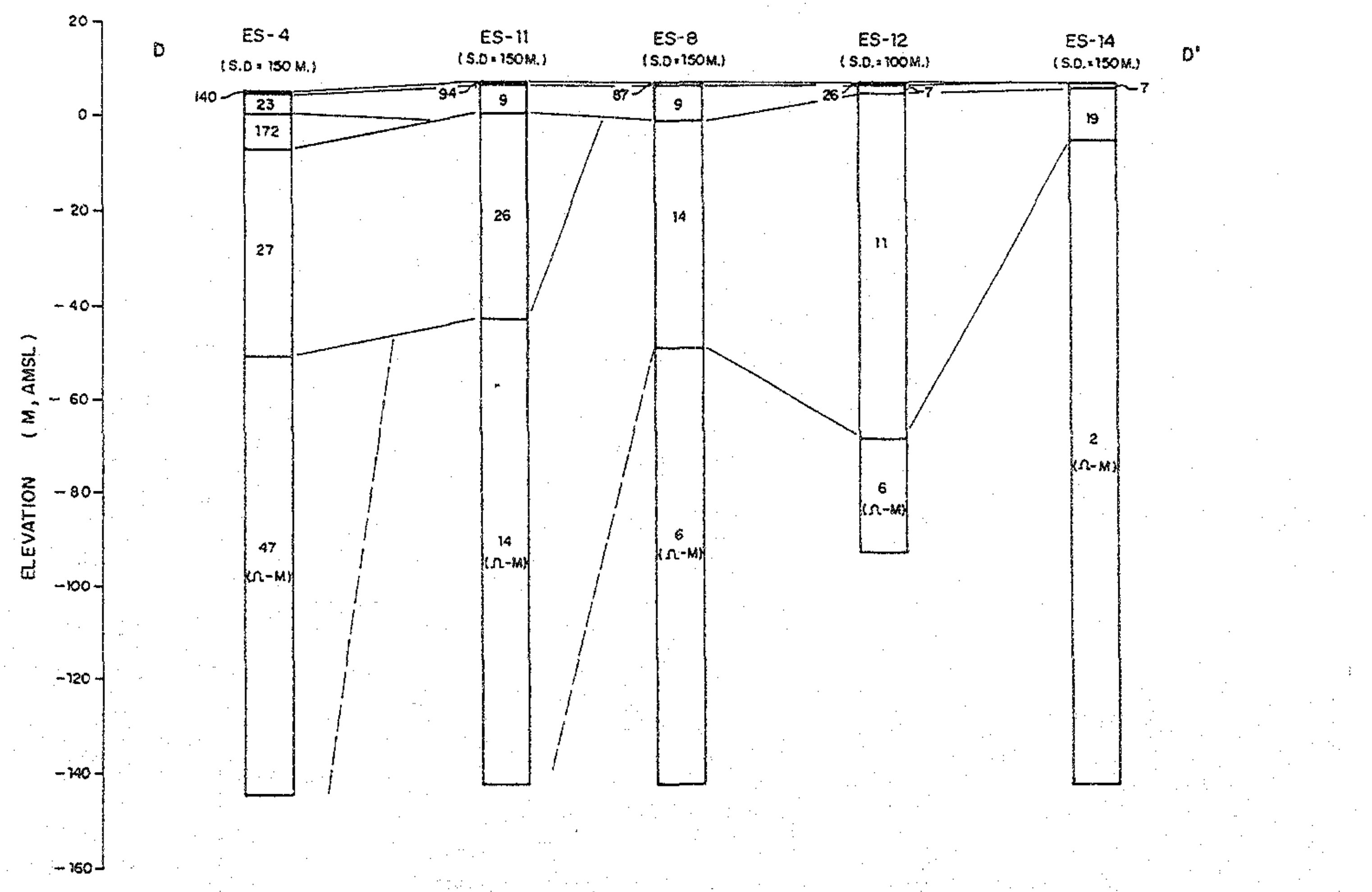
FIGURE D-5
GEORESISTIVITY SECTION B-B'
KALIBO, AKLAN PANAY ISLAND



SCALE H = 1: 20,000
V = 1: 1,000

FIGURE D-6
GEORESISTIVITY SECTION C-C'
KALIBO, AKLAN, PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND



SCALE H = 1 : 20,000
V = 1 : 1,000

FIGURE D - 7

GEORESISTIVITY SECTION D - D'

KALIBO , AKLAN , PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

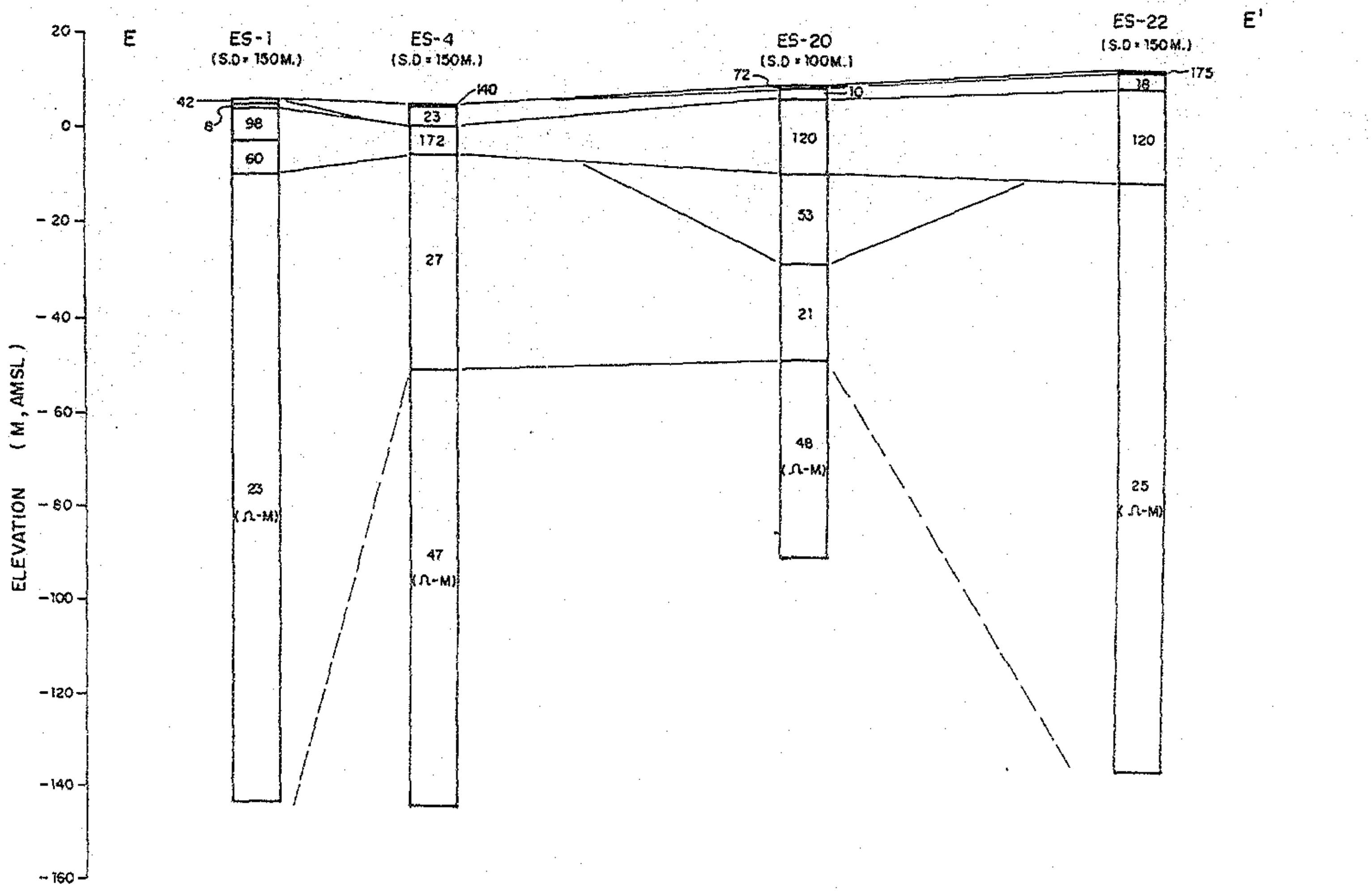


FIGURE D-8

GEORESISTIVITY SECTION E-E'

KALIBO, AKLAN, PANAY ISLAND

JICA-LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

2.3.2 Observation/Test Well Drilling

Based on the results of field survey, the site of observation well was appointed at near ES-4 point on the east bank of Aklan River. (cf. FIGURE D-2).

Observation Well No.1
Date : 8 April to 4 May, 1989
Depth : 120.00 m

As well data are shown in FIGURE D-9, the gravel bed with rich groundwater between 33.6 m and 63.1 m is existing.

It is the new remarkable fact the basement rock of Kalibo area is consisting of tuff and conglomerate from 101.5 m under ground level.

The another additional observation well was drilled at near ES-19 point. (cf. FIGURE D-2)

Observation Well No.2
Date : 2 to 14 June, 1989
Depth : 63.25m

Well data are shown in FIGURE D-10. In this hole the gravel bed with plenty groundwater is not existing and conglomerate situated below 43.0 m which more shallow than No. 1 well, is containing the enough water for the barangay people only.

For the development of groundwater was successful by the observation well No. 1, the test well was drilled at near No.1 site.

Also in this test well, the successful development of groundwater was dramatic.

The Water Quality of Test Well

Total Fe	<0.2 ppm
No_2	nil
No_4	0.5 to 0.6
Mn	nil
pH	6.3
EC	370 μs/cm

2.3.3 Well Design and Pumping Test

The well designs of above-mentioned No.1, No.2 observation well and test well are shown in FIGUREs D-11, D-12 and D-13.

The pumping test were conducted by two methods. One of them is the test of drawdown by four (4) steps and the results are shown in FIGURE D-14.

FIG. D-9 OBSERVATION WELL DATA

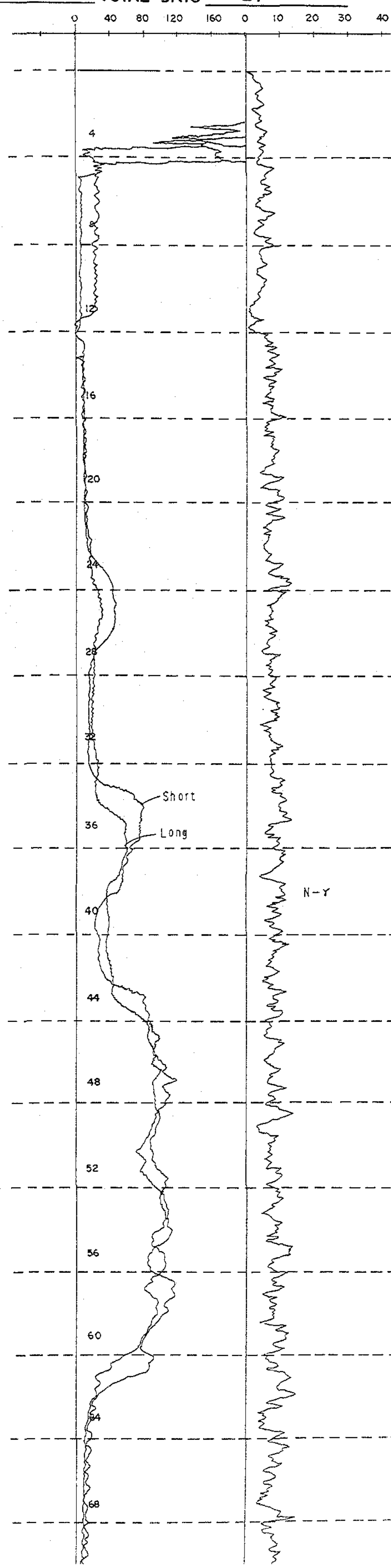
SCALE

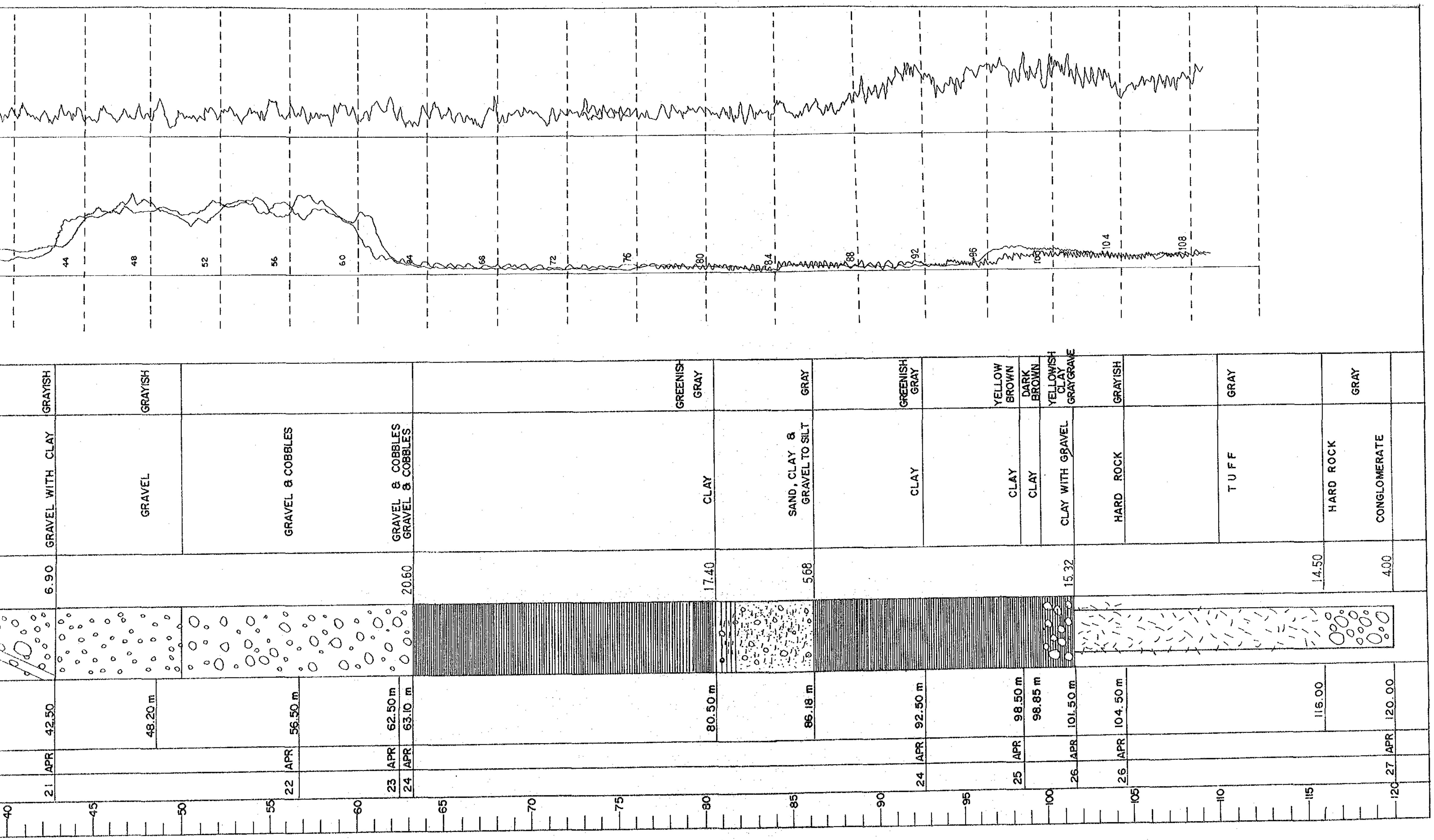
LOCATION : BARANGAY TINIGAO, KALIBO AKLAN

WELL. NO : 1 DEPTH : 120 m DIAMETER : Ø 100 mm CASING PIPE : Ø 50 mm PVC

DATE : 8 APRIL TO 4 MAY, 1989 TOTAL DAYS 27

DATE D.	DATE M.	DEPTH (M)	STRATA M. T.K.S	GEOLOGICAL NAME	COLOUR
			5.00	CLAY	BROWNISH / BROWNISH
14	APR	8.00 m			
		9.70 m	4.70	SAND & GRAVEL	GRAYISH
		11.50 m	9.50	CLAY	GRAYISH
18	APR	20.50	1.30	CLAY & SILT	GRAYISH
18	APR	23.50	3.00	CLAY & GRAVEL	GRAYISH
19	APR	26.50		CLAY & GRAVEL	GRAYISH
		28.10	4.60	CLAY & GRAVEL	GRAYISH
		29.50	1.40	CLAY	GRAY
		32.80	3.30	CLAY & GRAVEL	GRAY
		33.60	0.80	GRAVEL	GRAYISH
20	APR	35.60	2.00	CLAY & GRAVELS TRACES OF SAND	GRAYISH
21	APR	42.50	6.90	GRAVEL WITH CLAY	GRAYISH
		48.20 m		GRAVEL	GRAYISH
22	APR	56.50 m		GRAVEL & COBBLES	
23	APR	62.50 m		GRAVEL & COBBLES	
24	APR	63.10 m	20.60	GRAVEL & COBBLES	





GRAYISH
GRAVEL WITH CLAY
6.90
42.50
APR
21
GRAYISH
GRAVEL
48.20 m
GRAVEL & COBBLES
56.50 m
APR
22
GRAVEL & COBBLES
GRAVEL & COBBLES
20.60
62.50 m
63.10 m
APR
APR
23
24
GREENISH GRAY
CLAY
17.40
80.50 m
GRAY
SAND, CLAY & GRAVEL TO SILT
5.68
86.18 m
GREENISH GRAY
CLAY
92.50 m
APR
24
YELLOW BROWN
CLAY
98.50 m
APR
25
DARK BROWN
CLAY
98.85 m
YELLOWISH CLAY GRAYGRAVEL
CLAY WITH GRAVEL
15.32
101.50 m
APR
26
GRAYISH
HARD ROCK
104.50 m
APR
26
GRAY
TUFF
14.50
116.00
GRAY
HARD ROCK
CONGLOMERATE
4.00
120.00
APR
27
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
44
48
52
56
60
64
68
72
76
80
84
88
92
96
100
104
108

FIG. D-10 OBSERVATION WELL DATA

SCALE :

LOCATION : KALIBO, AKLAN

WELL NO : 2 DEPTH : 63.25 DIAMETER : Ø 110 mm CASING PIPE : Ø 50mm PVC

DATE : 2-14 JUNE 1989 TOTAL DAYS : 13

DATE D.	DATE M.	DEPTH	STRATA M.T.K.S	GEOLOGICAL NAME	COLOUR
		0.20	0.20		BLAC BROWN
		1.50	1.30	CLAY	
		3.70	2.20	CLAY	YELLOW BROWN
		5.50	1.80	SAND GRAVEL	BROWNISH
5	6	9.50		(LEAKAGE) GRAVEL COBBLE	BLUE GRAY
		10.70	5.20		
6	6	14.50		CLAY	BLUE GRAY
		14.70	4.00		
		19.15	4.45	SAND GRAVEL (HUMIC MATERIAL) CLAY	BLACK BROWNISH
		23.70	4.55	GRAVEL SAND (HUMIC MATERIAL)	DARK GRAY
7	6	26.50		CLAY GRAVEL	DARK GRAY
		28.20	4.50		
		34.60	6.40	CLAY	
		35.50	0.90	CLAY & GRAVEL	DARK GRAY
		43.00	7.50	CLAY	
8	6	54.50		CONGLOMERATE (CONTAIN DISCOLORATED PEBBLE)	BLUE GRAY / DARK YELLOW / BROWNISH
9	6	62.50			
10	6	63.25	20.25		

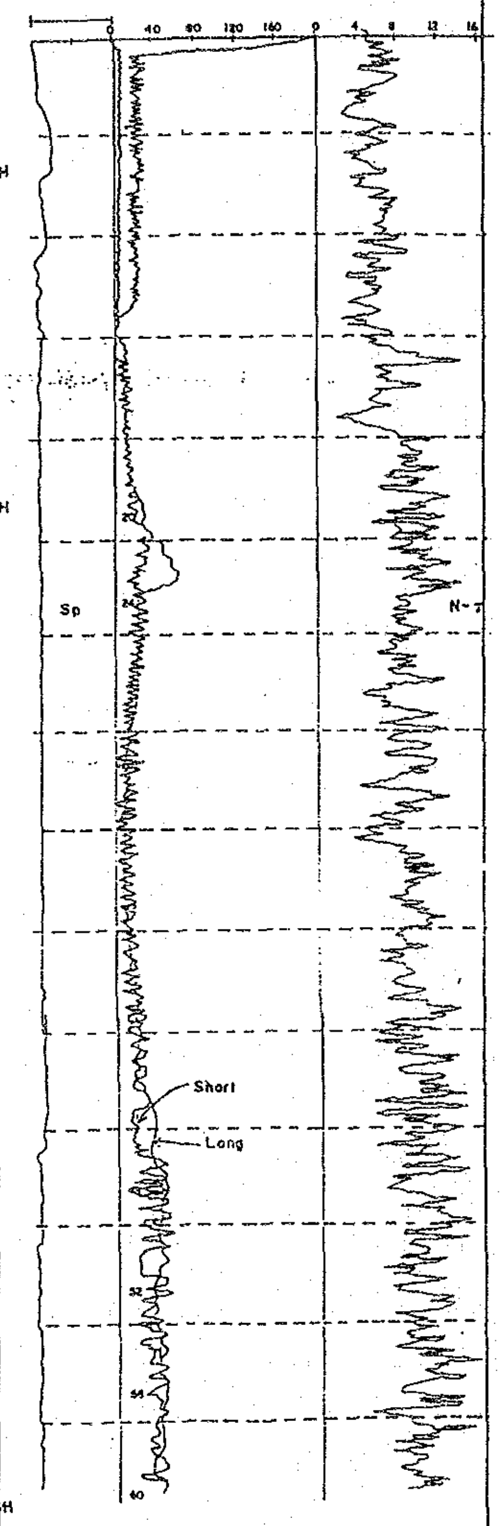


FIG.D-11 WELL DESIGN OF No.1 OBSERVATION WELL AT KALIBO

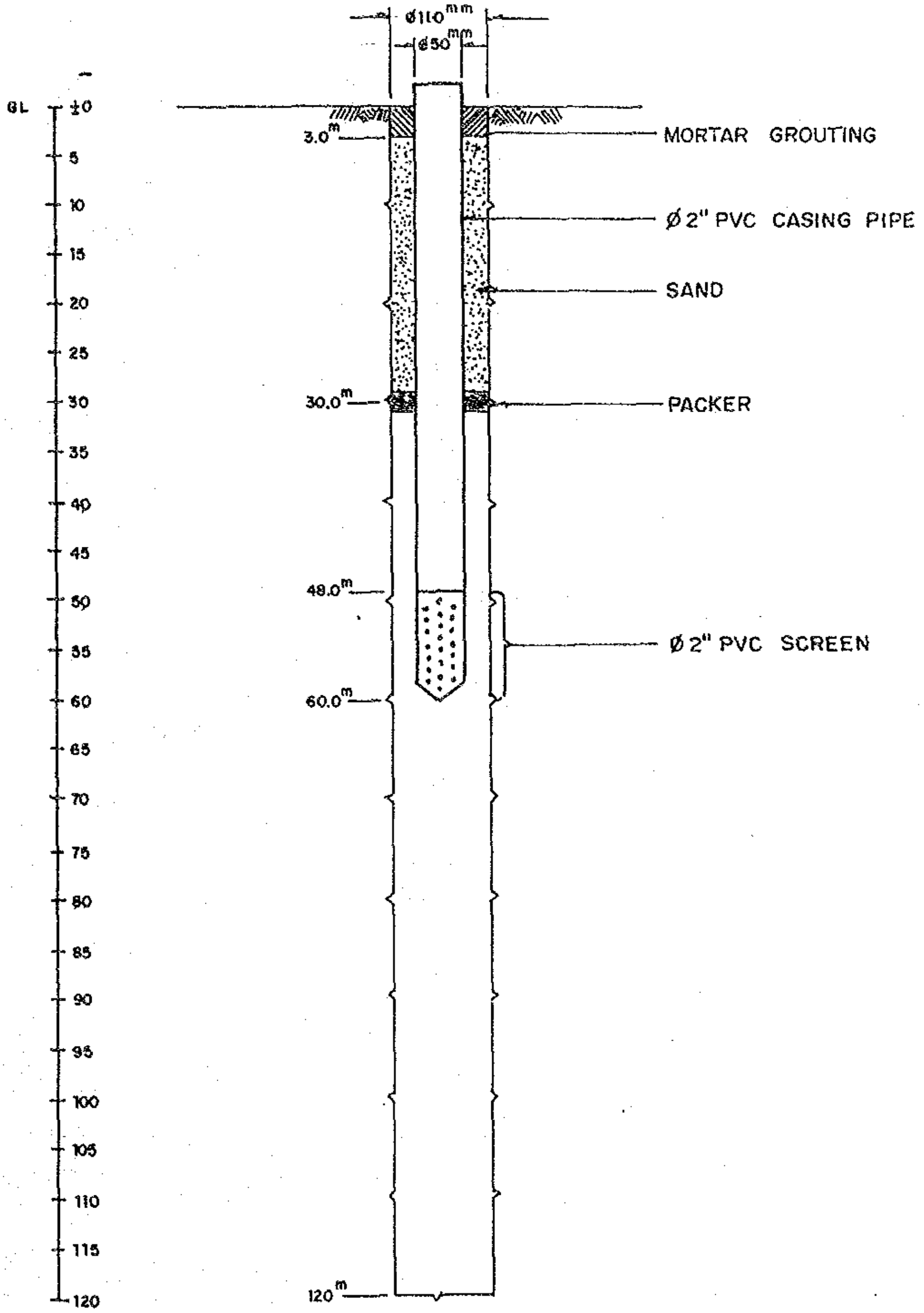


FIG.D-12 WELL DESIGN OF No.2 OBSERVATION WELL AT KALIBO

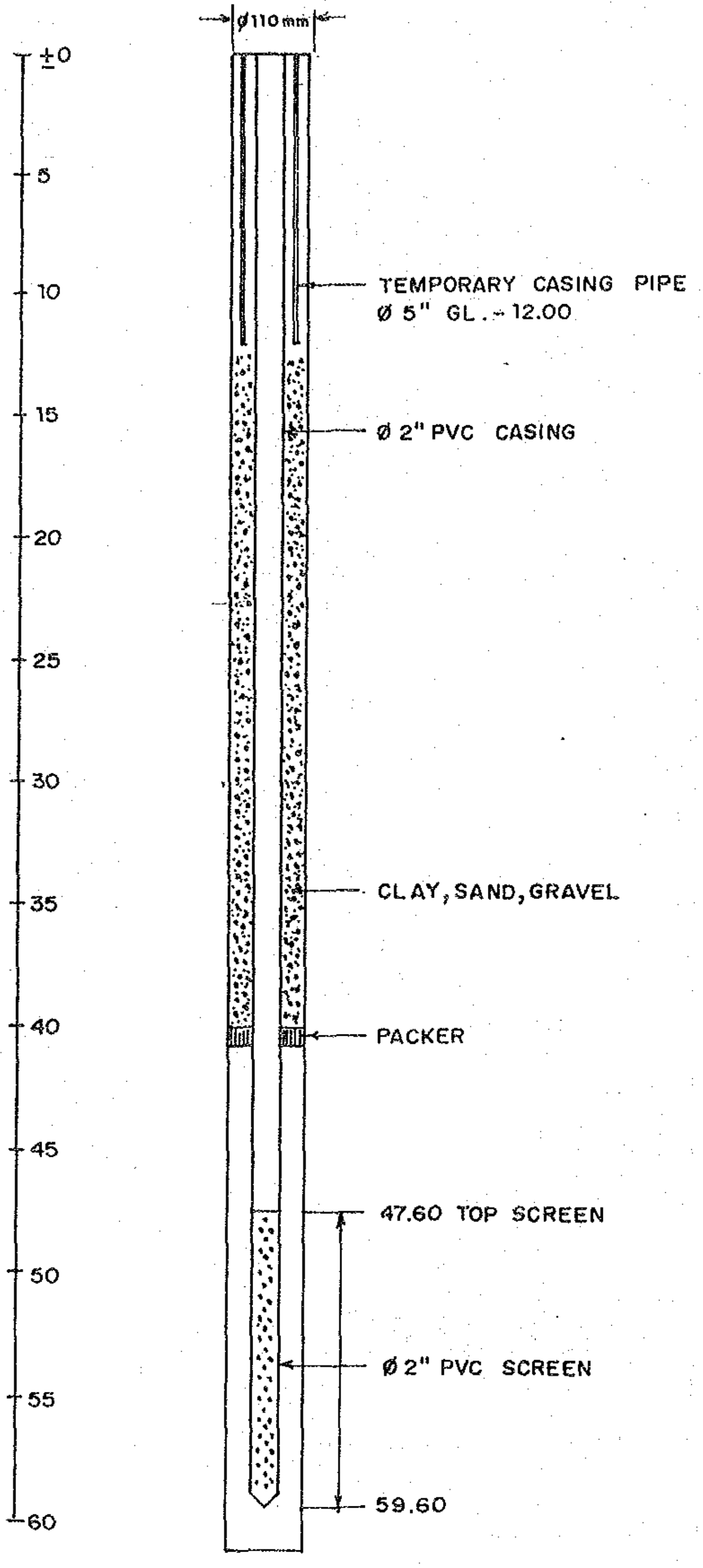


FIG.D-13 WELL DESIGN OF TEST WELL AT KALIBO

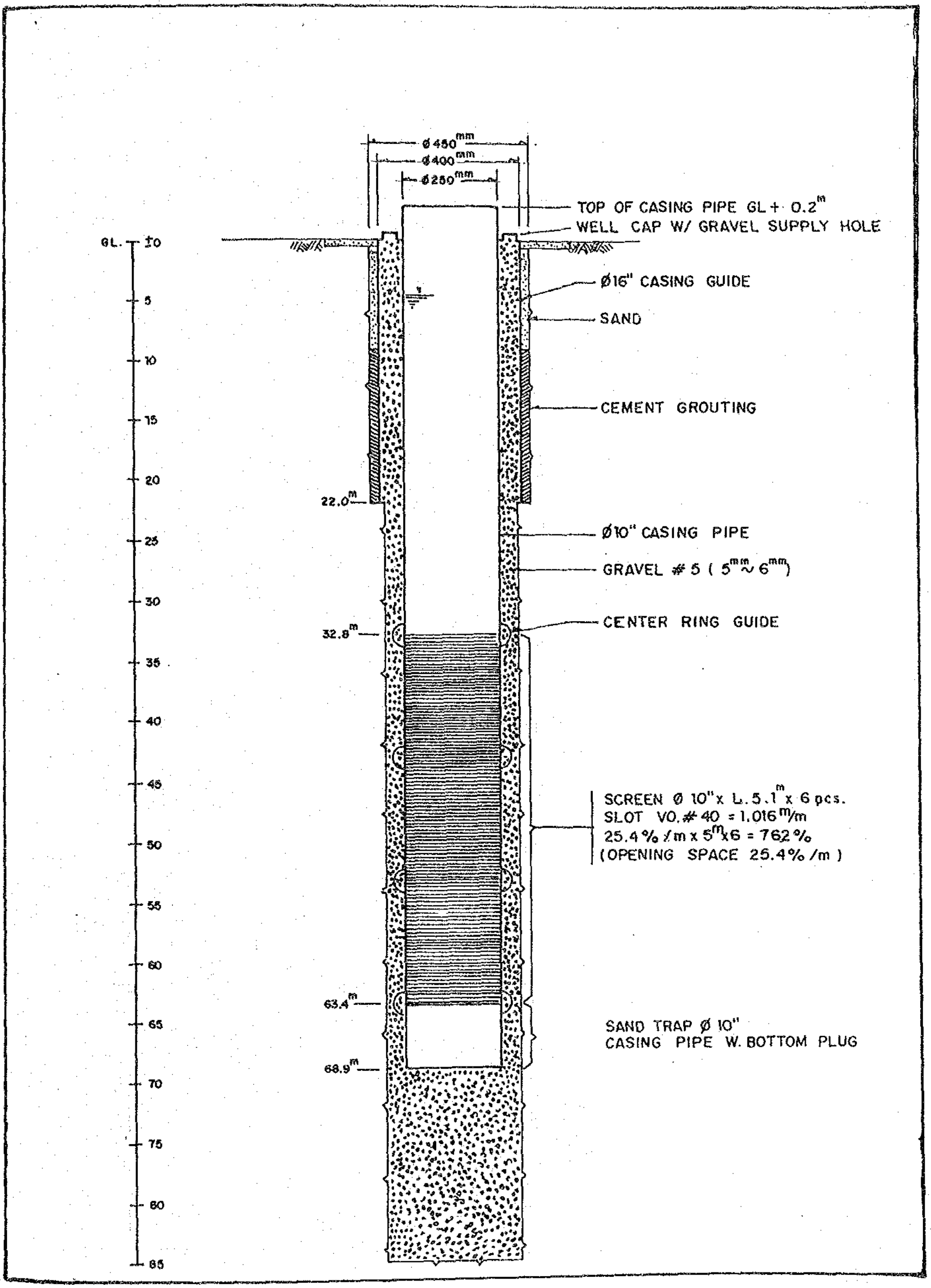


FIG. D-14

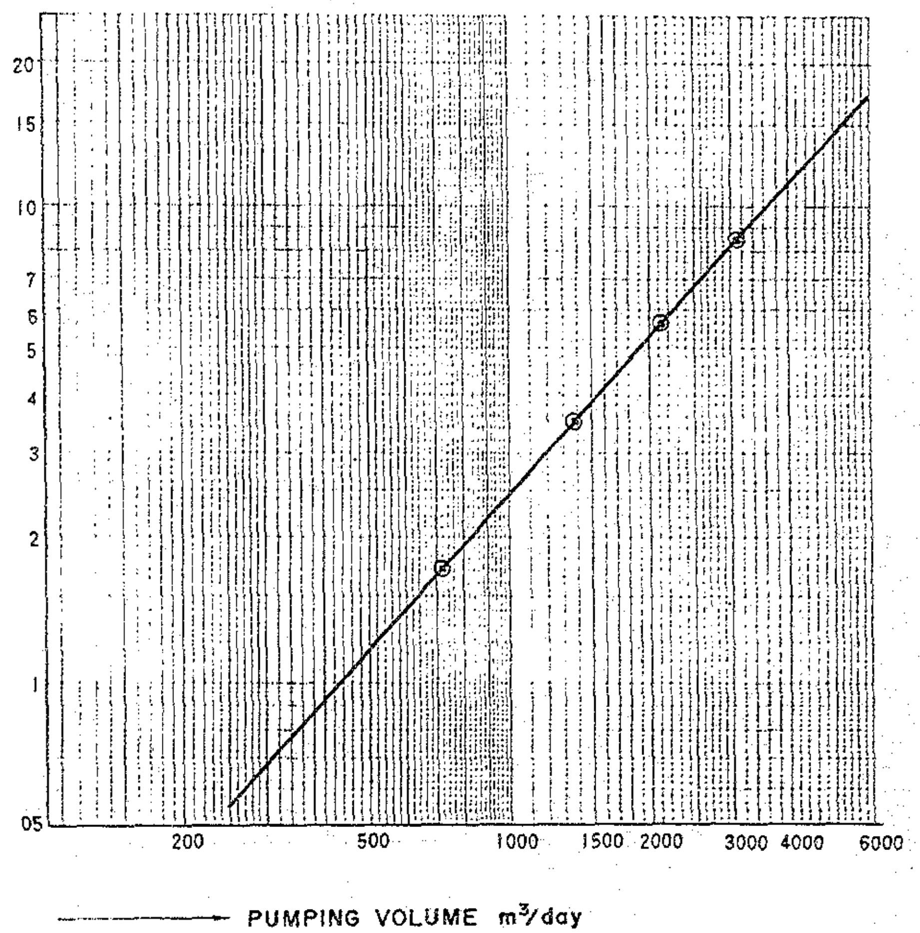
STEP DRAWDOWN

LOC. KALIBO TEST WELL

DATE: 1989. 5. 10

STEP	PUMPING VOLUME (m^3/d)	WATER LEVEL (m)	DRAWDOWN (m)	SPECIFIC CAPACITY ($m^3/d/m$)
1	720 (500ℓ/min)	- 4.36	0.17	4.235
2	1.440 (1,000ℓ/min)	- 4.53	0.35	4.114
3	2.160 (1,500ℓ/min)	- 4.88	0.57	3.789
4	3.024 (2,100ℓ/min)	- 5.45	0.85	3.557

STEP PUMPING TEST (S - Q CURVE)



S-Q curve is linear for the capacity of pump is small, so potential yield and pumping yield are not able to calculate. Another test is 2.0m^3/minx72H continued driving pumping test and recovery test. The results are shown is FIGURE D-15. After 2.0m^3/minx72H continued driving pumping test, the drawdown is only 1.12m.

The hydraulic constants calculated by the analyses of JACOB METHOD (FIGURE D-17), THIS'S FORMULA (FIGURE D-18), RECOVERY METHOD (FIGURE D-19) are summarized in TABLE D-6.

This pumping yield is enough to the demand of Kalibo W.D.

In other side, the pumping yield was discussed from the view point of the well engineering.

diameter of screen (2r) = ø10" = 0.254m
square of screen/m = 2πxr = 0.7976m
length of screen = 5.0mx6pcs = 30m
ratio of opening space = 25.4%
total square of opening space = 0.7976x30x0.254=6.077m^2
closing ratio of opening space = 60%
effective opening space = 6.077x0.40 = 2.43m^2
passing velocity = 3.0cm/sec = 0.03m/sec
pumping yield = 2.43m^2x0.03m/sec = 0.073m^3/sec
=6,300m^3/d

These studies prove that the pumping yield of the Kalibo test well is possible to pump up over 6,000m^3/d groundwater.

2.4 Water Quality Analysis

Nine (9) existing water sources were examined during the field survey and 3 water samples were collected for laboratory analysis. Field analysis results are shown in TABLE D-7 and survey points are indicated on FIGURE D-3.

Most of the existing water sources showed the presence of iron and ammonium nitrogen. Flowing wells (D-2 and D-3) in barangay New Buswang and Ca-ano are typical example that anaerobically decomposed organic deposits are absorbed into the confined aquifer. This particular geochemical characteristics bear a direct correlation with groundwater in New Washington.

Groundwater in Kalibo generally seems to decline alkaline conditions as indicated by pH.

FIG.D-15 2.0 m^3/min. CONTINUOUS PUMPING TEST AND RECOVERY TEST

LOCATION : KALIBO TEST WELL
DATE : 10 - 13 MAY, 1989

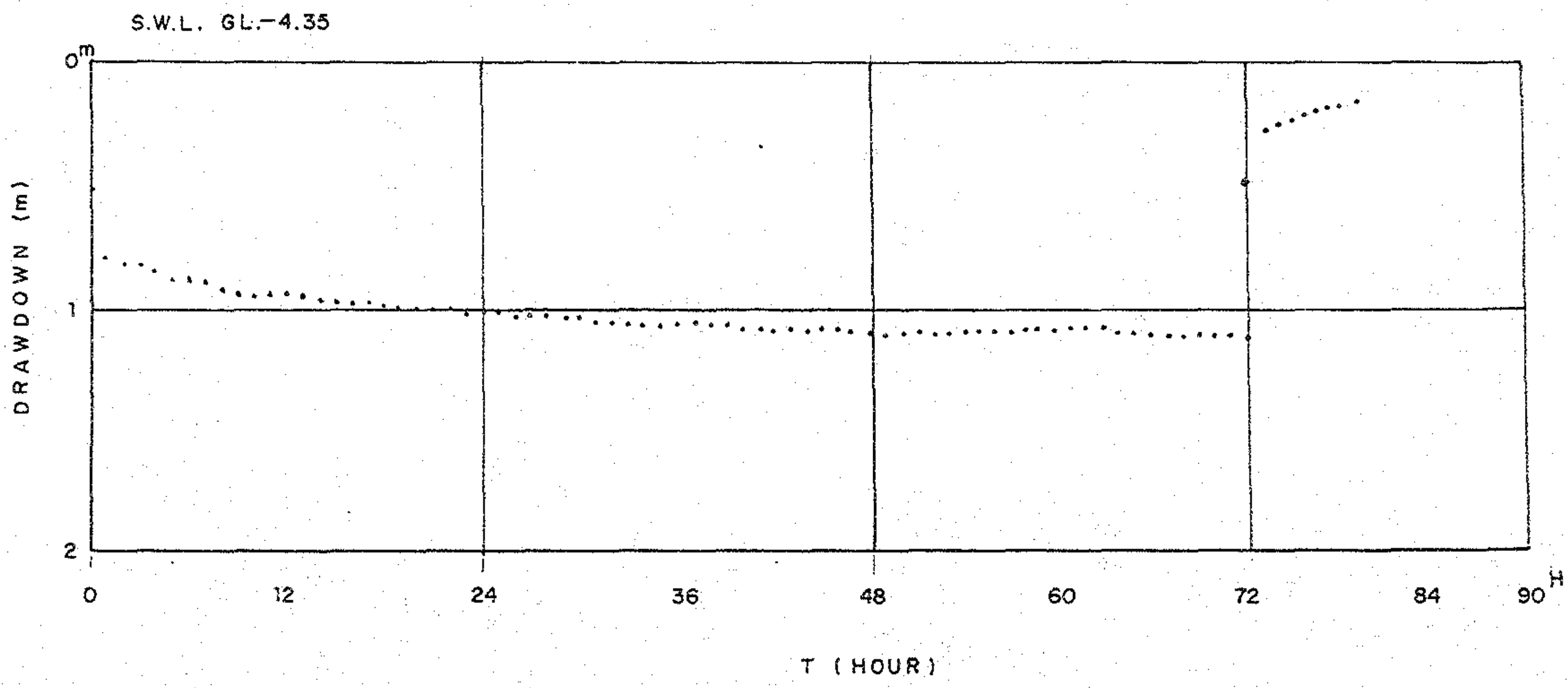
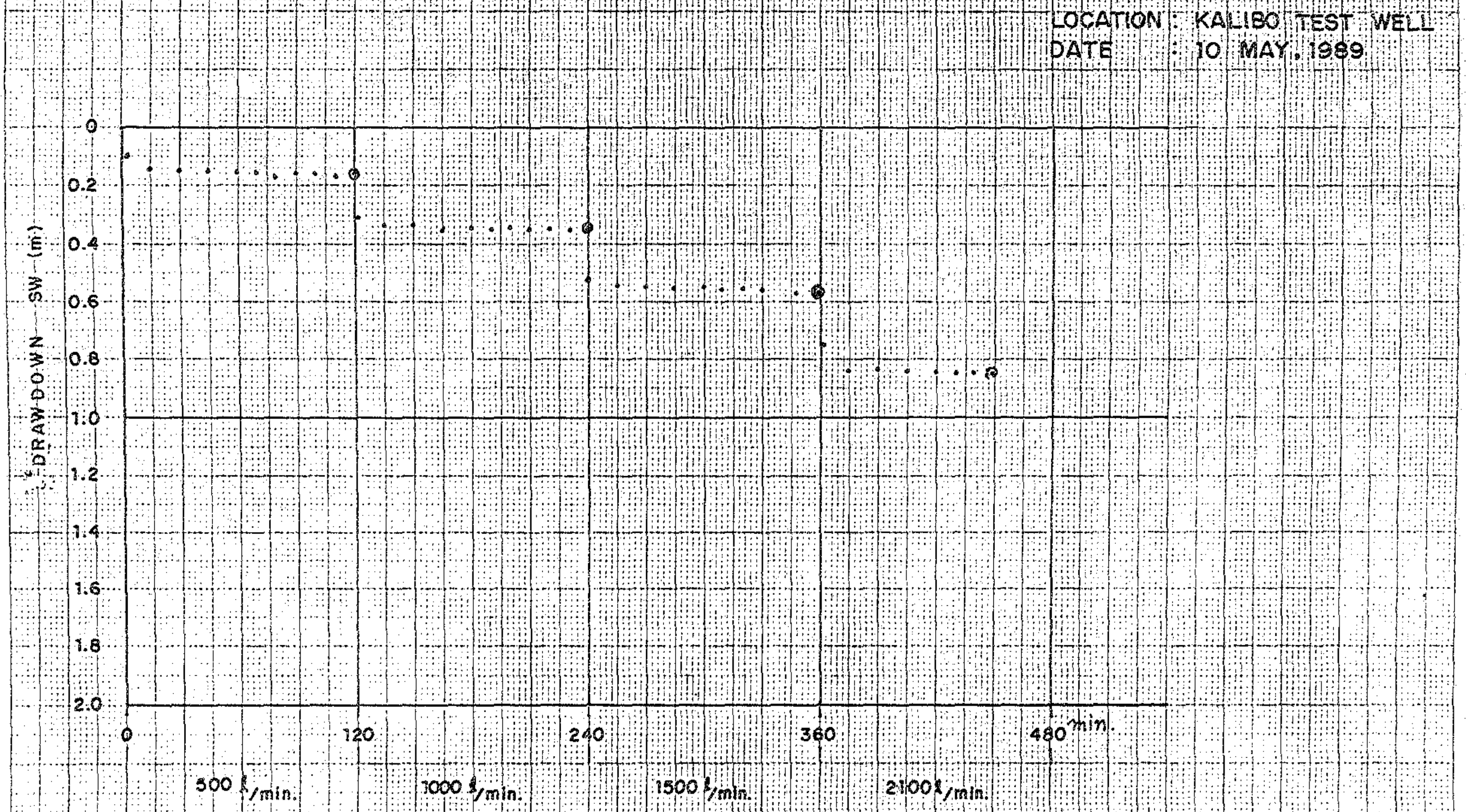


FIG. D-16 RESULTS OF STEP PUMPING TEST



JIS A4 180×250mm

FIG.D-17 ANALYSIS OF JACOB METHOD

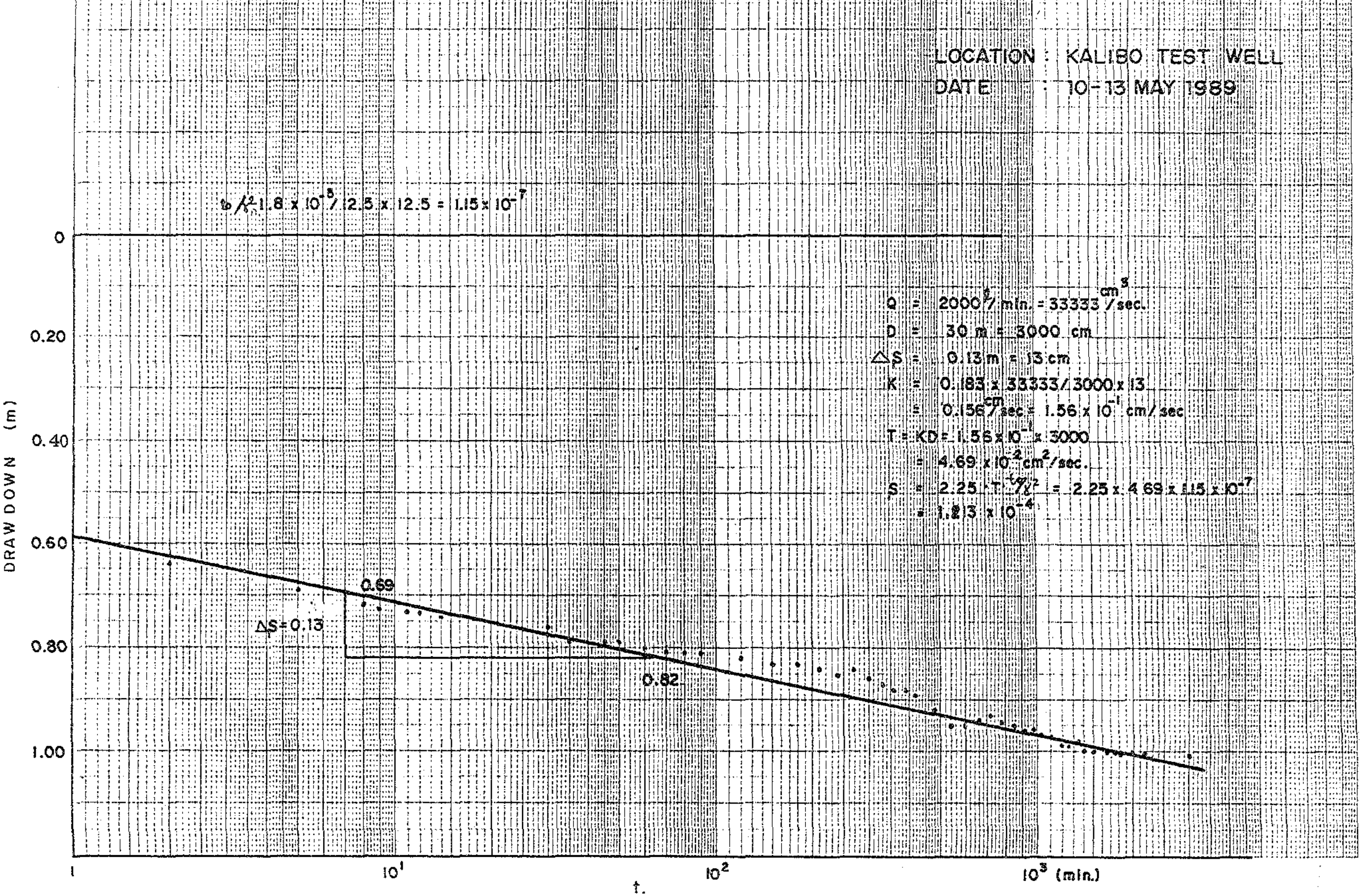
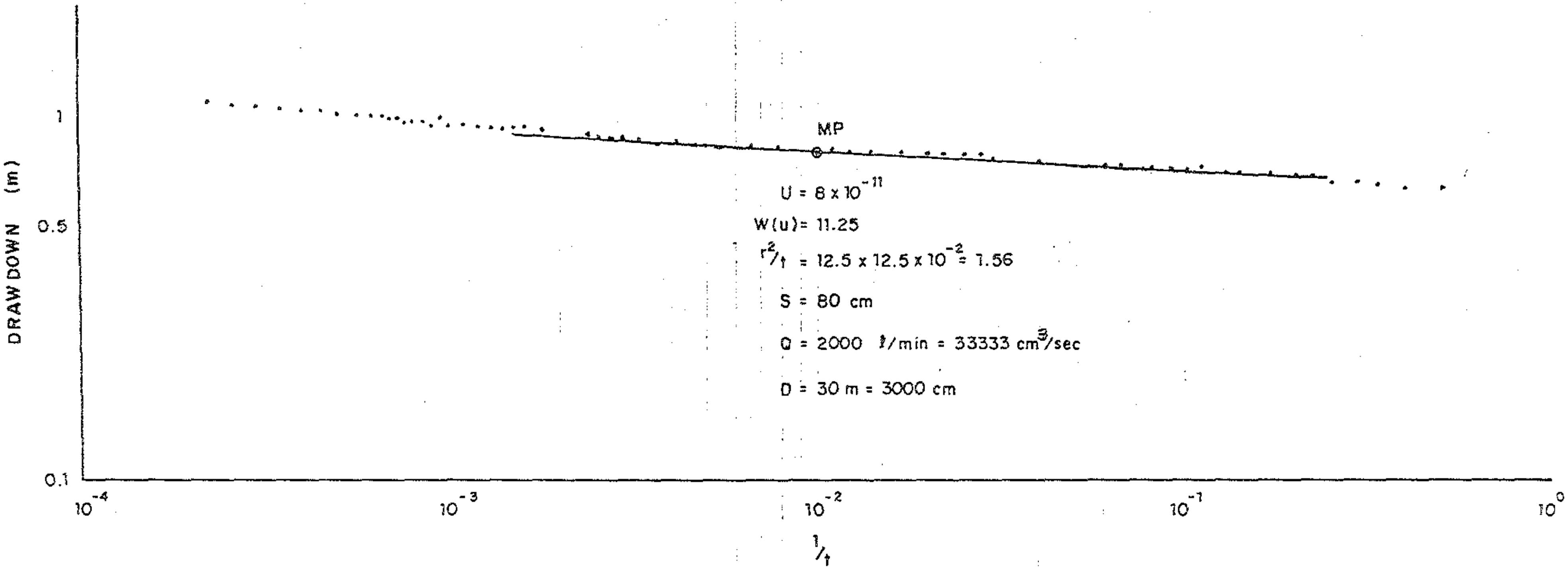


FIG.D-18 ANALYSIS OF THEIS'S FORMULA

LOCATION : KALIBO No.1 TEST WELL

DATE : 10 - 13 MAY, 1989



$T = \frac{Q}{4\pi S} W(u) = \frac{33333 \times 11.25}{4\pi \times 80} = 373\ cm^2/sec. = 3.73 \times 10^2 cm^2/sec$

$K = \frac{T}{D} = \frac{373}{3000} = 1.24 \times 10^{-1} cm/sec$

$S = \frac{4T}{r^2/t} \times u = 4 \times 3.73 \times 10^2 \times 8 \times 10^{-11} / 1.56 = 7.65 \times 10^{-8}$

FIG.D-19 ANALYSIS OF RECOVERY METHOD

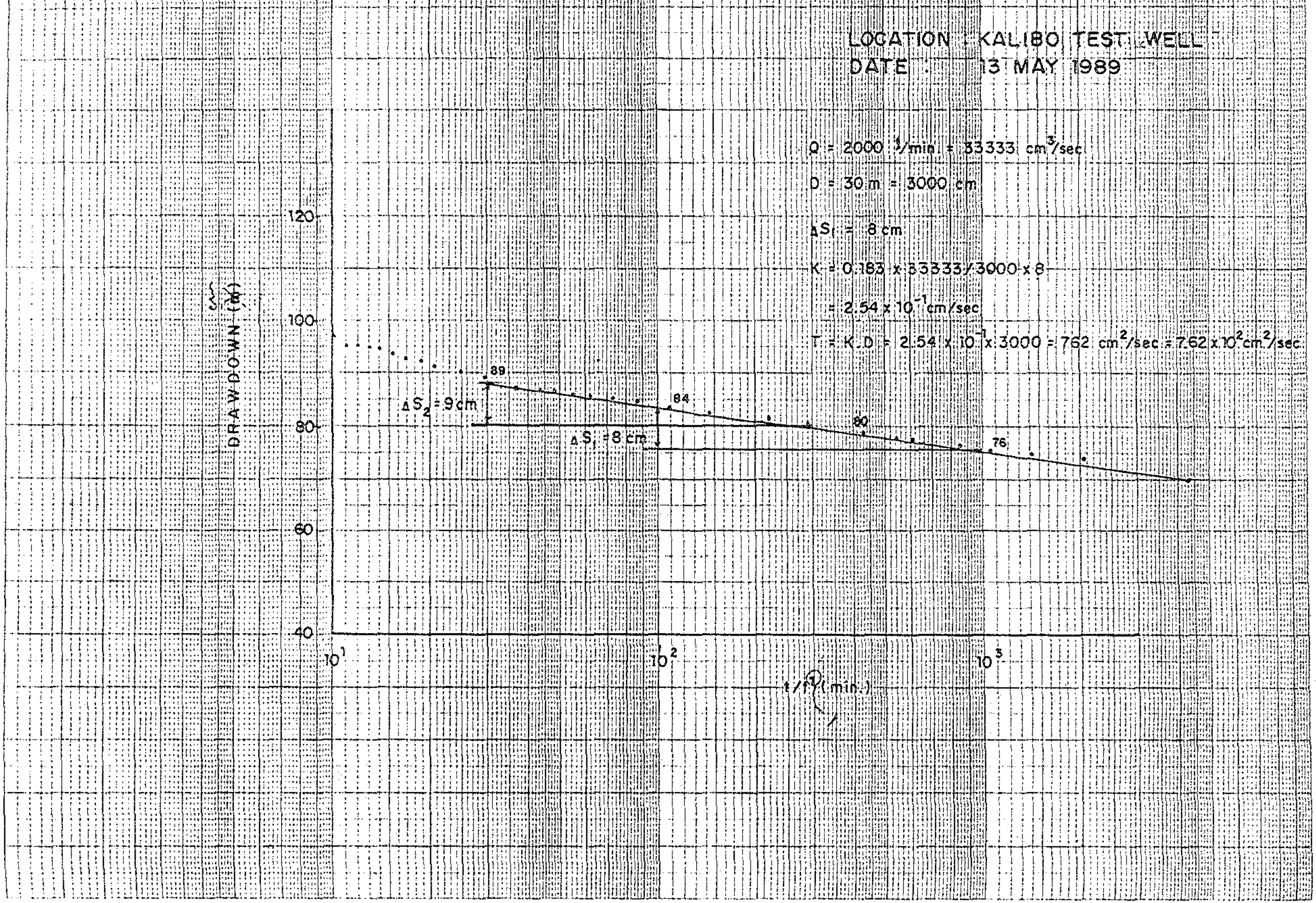


FIG.D-20 ANALYSIS OF JACOB METHOD

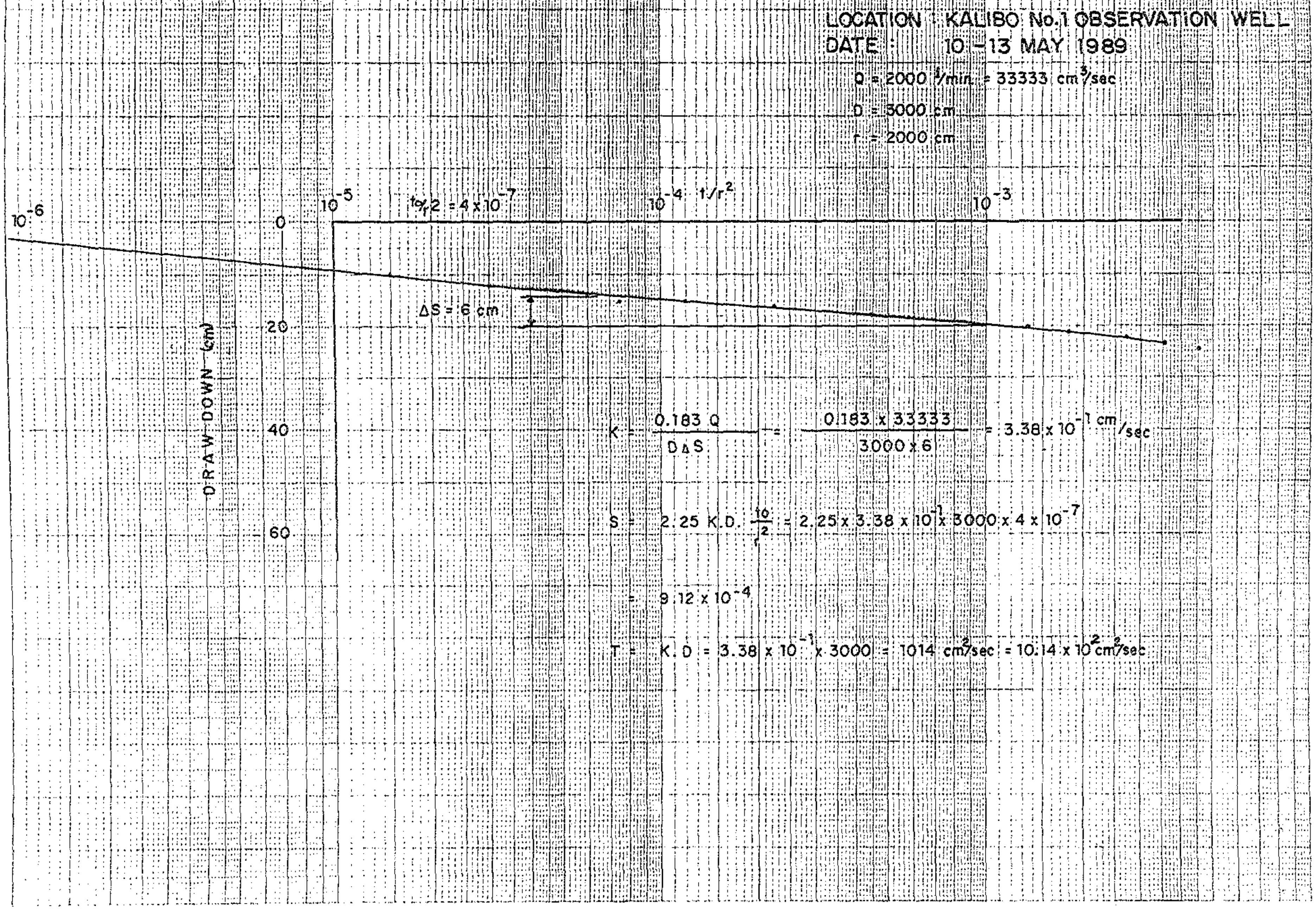


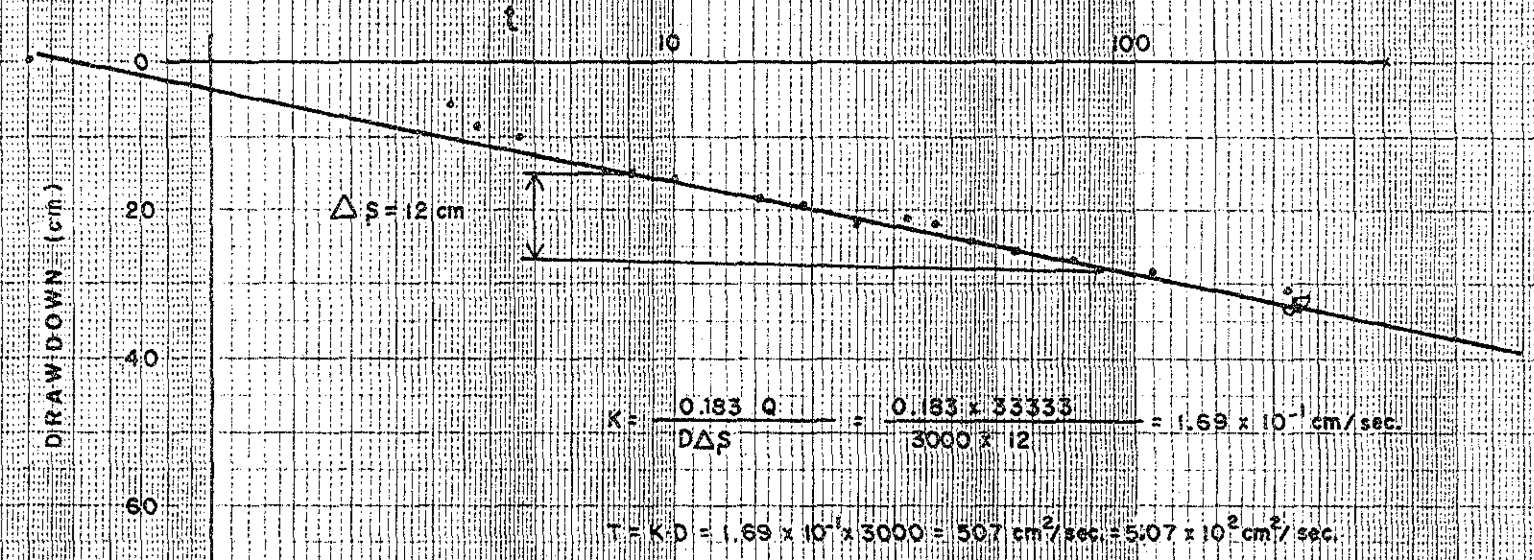
FIG.D-21 ANALYSIS OF RECOVERY METHOD

LOCATION : KALIBO No.1 OBSERVATION WELL

DATE : 13 MAY 1989

$Q = 2000\ \ell/min. = 33333\ cm^3/sec.$

$D = 3000\ cm.$



$$K = \frac{0.183\ Q}{D \Delta s} = \frac{0.183 \times 33333}{3000 \times 12} = 1.69 \times 10^{-1}\ cm/sec.$$

$$T = K \cdot D = 1.69 \times 10^{-1} \times 3000 = 507\ cm^2/sec. = 5.07 \times 10^2\ cm^2/sec.$$

TABLE D-5 S - t/r^2 OF KALIBO No.1 OBSERVATION WELL

LOCATION : KALIBO No.1 OBSERVATION WELL
DATE : 10 MAY, 1989

$r = 2000$ cm $r^2 = 4 \times 10^6 cm^2$

t (sec)	60	120	240	480	900	1800	3600	5400
t/r^2 (sec/cm²)	1.5×10^{-5}	3.0×10^{-5}	6.0×10^{-5}	1.2×10^{-4}	2.25×10^{-4}	4.5×10^{-4}	9×10^{-4}	1.35×10^{-3}
S (cm)	10	12	14	15	16	18	20	20.5

t (sec)	7200	10,800	14,400	18,000				
t/r^2 (sec/cm²)	1.8×10^{-3}	2.7×10^{-3}	3.6×10^{-3}	4.5×10^{-3}				
S (cm)	21	22.3	23.5	24.6				

TABLE D-6 Summary of Well Analysis

	TEST WELL			OBSERVATION WELL		AVE.
METHOD	JACOB	THEIS'S	RECOVERY	JACOB	RECOVERY	
K cm/sec	1.56×10^{-1}	1.24×10^{-1}	2.54×10^{-1}	3.38×10^{-1}	1.69×10^{-1}	2.08×10^{-1}
T cm²/sec	4.69×10^{2}	3.73×10^{2}	7.62×10^{2}	* 10.14×10^{2}	5.07×10^{2}	5.27×10^{2}
S cm²/sec	1.213×10^{-4}	* 7.65×10^{-8}	—	9.12×10^{-4}	—	5.16×10^{-4}

except *

K ... permeability coefficient

T ... coefficient of transmissivility

S ... storage coefficient

The pumping yield is estimated by Sichardt's formula.

$$Sw = \frac{R}{3000 \quad K}$$

Sw : drawdown (m)

R : influence radius (m)

K : permeability coefficient (m/sec)

For example, R = 500 m

$$Sw = \frac{500}{3000 \quad 20.8 \times 10^{-4}} = \frac{500}{3000 \times 4.56 \times 10^{-2}} = 3.65 \text{ (m)}$$

Permitable drawdown is 3.65 m. If safety drawdown is 1.50 m, Q is next.

$$Q = \frac{2\pi KB\ Sw}{2.3 \log_{10} (R/r)}$$

Q : pumping yield (m³/d)

K : permeability coefficient (m/d)

B : thickness of aquifer (m) = 30 m

Sw : drawdown (m) = 1.50 m

R : influence radius (m) = 500 m

r : well radius (m) = 0.125 m

$$Q = \frac{2 \times 3.14 \times 20.8 \times 10^{-4} \times 86{,}400 \times 30 \times 1.5}{2.3 \log_{10} (500 / 0.125)}$$

$$= \frac{50{,}786}{2.3 \times 3.6} = 6{,}133 \text{ (m}^3\text{/d)} = 4.25 \text{ (m}^3\text{/min)}$$

This pumping yield is enough to the demand of Kalibo W.D.

TABLE D-7 Water Quality Analysis Results

Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season						
D-1 Deep Well, KWD	27.6	8.4	340	0.3	nil	0.3
D-2 Flowing Well, Bgy. New Buswang	28.2	9.0	530	0.2	nil	0.8
D-3 Flowing Well, Bgy. Ca-ano	27.5	7.9	1,500	0.2	nil	4.8
D-4 Public Well, MPWH 061-86-03 Ca-ano Elem. School	28.8	6.5	750	10.0	nil	0.5
D-5 Public Well, MPWH 061-86-28 Bgy. Ca-ano	28.8	7.5	160	0.5	nil	0.7
D-6 Flowing Well, Pacific Aquaculture	28.2	8.8	850	0.3	nil	0.5

TABLE D-7 **Water Quality Analysis Results** (Cont'd)

Sample	WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Rainy Season						
D-1 Deep Well, KWD	27.8	8.6	360	0.2	-	0.4
D-2 Flowing Well, Bgy. New Buswang	27.5	8.9	550	0.2	-	0.8
D-3 Flowing Well, Bgy. Ca-ano	30.5	7.8	1,500	0.2	-	6.0
D-4 Public Well, MPWH 061-86-03 Ca-ano Elem. School	28.8	6.7	700	10.0	-	2.8
D-5 Public Well, MPWH 061-86-28 Bgy. Ca-ano	28.9	7.6	1,530	0.5	-	0.8
D-6 Flowing Well, Pacific Aquaculture	27.5	8.9	860	Tr.	-	1.6
D-9 Private Well	28.5	9.2	1,380	0.7	-	8.02
D-12 Shallow Well at ES-15	28.3	6.9	450	2.0	-	1.2
D-15 Shallow Well at ES-5	28.3	7.1	470	nil	-	nil

The following are results of laboratory analysis.

Sample	D-1		D-5	Flowing Well at Bgy. Pook
Date of Sampling	6.09.88	9.19.88	9.16.88	6.07.88
Turbidity (FTU)	0.7	0.6	0.9	0.7
Color (UNIT)	nil	60	350	20
TDS (mg/l)	275	265	850	461
pH (-)	8.0	7.9	7.7	8.5
EC (µS/cm)	430	400	1,450	720
Alkalinity as $CaCO_3$ (mg/l)	180	165	657	313
Hardness as $CaCO_3$ (mg/l)	60	43	43	37
Major Cations (meq/l)				
Sodium	3.0	3.0	13.0	6.4
Potassium	0.02	0.05	0.4	0.1
Calcium	0.6	0.4	0.3	0.4
Magnesium	0.6	0.4	0.6	0.3
Total	4.22	3.85	14.3	7.2
Major Anions (meq/l)				
Carbonate	0	1.4	3.6	0
Bicarbonate	3.6	1.9	9.5	6.3
Chloride	0.7	0.6	1.1	0.6
Sulfate	0.04	0.04	0.1	0.04
Total	4.34	3.94	14.3	6.94

The above results show that all these water samples are typical Carbonate-Alkali Type groundwater. Influence of salt water intrusion was not observed, but ammonium nitrogen was commonly present in these water sources. Among these three wells, D-1 (deep well of KWD) presents the favorable water quality for drinking purpose provided however that chlorination is required.

3. Conclusion and Recommendation

Groundwater potential in the basin of Aklan River can be roughly examined as follows:

Groundwater potential may be expressed as:

$$Q = P - E - D - M$$

Where, Q - groundwater potential
P - precipitation
E - evapotranspiration
D - discharge of river
M - moisture increase in soil

In this case study, precipitation "P" can be taken from meteorological data at Libacao, Aklan, which is located at the middle stream of the river. This may be considered adequate to represent the meteorological characteristics of the basin.

Evapotranspiration "E" maybe calculated using the equation by Thornthwaite as:

$$EX = 1.6\ (10\ T/I)^{a}$$

Where,

EX - Evapotranspiration (cm/month)

T - Mean Temperature (°C)

I - $(Ti/5)^{1.514}$

a - $(492{,}390 + 17{,}920I - 77.1I^{2} + 0.675I^{3}) \times 10^{-6}$

Ti - Mean temperature in month of i

However, in the month with mean temperature of more than 26.5 °C, Et may be gleaned from TABLE D-8.

TABLE D-8 Et for Month with Mean Temperature of more than 26.5 °C

°C	Et	°C	Et	°C	Et	°C	Et
26.5	13.50	29.5	15.89	32.5	17.53	35.5	18.37
27.0	13.95	30.0	16.21	33.0	17.72	36.0	18.43
27.5	14.37	30.5	16.52	33.5	17.90	36.5	18.47
28.0	14.78	31.0	16.80	34.0	18.05	37.0	18.49
28.5	15.17	31.5	17.07	34.5	18.18	37.5	18.50
29.0	15.54	32.0	17.31	35.0	18.29	38.0	18.50

Et gained through the above procedure shall be revised based on the variation of the length of day time.

Calculation results are shown in TABLE D-9.

TABLE D-9 Precipitation and Evapotranspiration

MONTH	JAN.	FEB.	MAR.	APR.	MAY.
Ave. Precipitation (mm)	531.9	364.6	299.2	204.9	253.2
Ave. Temperature (°C)	26.3	26.9	27.9	28.4	28.2
Evapotranspiration (mm)	125.4	126.1	151.4	155.4	162.8
Surplus Amount (mm)	406.5	238.5	147.8	49.5	90.4

MONTH	JUN.	JUL.	AUG.	SEP.	OCT.
Ave. Precipitation (mm)	327.4	263.5	278.1	391.0	491.8
Ave. Temperature (°C)	28.0	27.5	27.7	27.1	27.5
Evapotranspiration (mm)	156.7	156.6	155.5	143.1	146.6
Surplus Amount (mm)	170.7	106.9	122.6	247.9	345.2

MONTH	NOV.	DEC.	ANNUAL
Ave. Precipitation (mm)	646.1	704.5	4756.2
Ave. Temperature (°C)	27.4	26.5	
Evapotranspiration (mm)	138.6	133.7	1751.9
Surplus Amount (mm)	507.5	570.9	3004.3

In this calculation, average monthly temperature in Kalibo is based only in the available record during the period from 1975 to 1985.

Discharge of the river "D" is 1271.1 mm as discussed before. Moisture increase in soil "M" is negligible in this case. Therefore, the groundwater potential "Q" is calculated as:

$$Q = (4756.2 - 1751.9 - 1271.1) \times 852 \times 10^3$$

$$= 1477 \times 10^6 \text{ cu.m/year}$$

$$= 4 \text{ M cu.m/day}$$

As a result, 4 M cu.m/day is calculated as a total groundwater potential in the Aklan River Basin.

Based on the georesistivity survey, the existence of thick alluvial deposits composed of sand and pebble is confirmed along the Aklan River. Considering the hydrogeological condition discussed before, it is advisable to develop the groundwater resource through deep wells in inland area along the Aklan River.

In addition, the Aklan River is a great potential stale water resource. However, treatment cost of surface water will be high and is not feasible for the water supply system. Therefore, in case the Aklan River is utilized as a water source, it is desirable to use the river bed water instead of surface water.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

Kalibo Water District (KWD) supplies potable water to 2,200 service connections or about 13,200 service population. A deep well produces approximately 2,600 cu.m/day of groundwater during a 23 hours per day service time with a one hour suspension from 11:00 - 12:00 p.m.

The present service area of KWD is limited to the Poblacion and its adjacent barangays. One truck-mounted water tanker (approx. 2 cu.m) owned by KWD delivers water to a limited number of consumers in the unserved area.

The rest of the population is depending on deep/shallow wells which are usually equipped with hand pumps.

Likewise, the water supply conditions in the poblacion area is fairly good. However, when the size and population of the subject area are taken into account, an additional water source is indispensable to insure stable drinking water supply and to meet the potential water demand. Provision of appropriate hygienic condition through a supply of sufficient amount of potable water is also indispensable in the densely populated areas.

1.2 Existing Water Supply System and Problems Encountered

The Kalibo Water District (KWD) has the following water supply facilities:

- one deep well (ø250 mm, 70 m in depth) equipped with engine driven pump,
- one chlorination equipment,
- one RC cylindrical elevated water tank (400 cu.m), and
- distribution network (ø50 to ø200 mm) with 20 fire hydrants/blow-off valves.

Only one out of three deep wells is operating. The two other wells are not in use due to several reasons, i.e., salt water intrusion and small discharge capacity.

Chlorination equipment is installed at the pumping station. The pumped water is directly transmitted to the distribution lines. The elevated tank stores water during high water pressure in lower demand hours and distributes it to maintain water pressure in peak demand hours.

KWD is trying to put up a new deep well to strengthen its water supply capacity and to secure the stability of water supply service. An attempt to construct a new deep well has failed after drilling up to a depth of 80 m. Further trials are now suspended pending the result of this study.

2. Water Demand Projection

2.1 Criteria

The existing water supply system is producing approximately 2,600 cu.m/day from one deep well. The consumed amount is estimated at about 1,820 cu.m/day after deducting 30% of the water production as unaccounted-for water based on the interview at Kalibo Water District.

An overall average of per capita unit water consumption is calculated at about 146 lpcd based on the estimated water consumption and the served population. This figure includes such consumption for commercial, industrial and institutional purposes. Actual number of connections are, however, not available.

When the contribution of non-domestic water consumption to the said average per capita consumption and the presence of water borrowers to the registered connections and unmetered connections are taken into account, the actual per capita unit water consumption shall decrease to about 80% or about 115 lpcd. Similar assumption was also adopted in the previous feasibility study for "Municipal Water Supply Project" conducted by JICA in 1987.

Design unit water consumption is also estimated in accordance with the said Manual for domestic, commercial and institutional purposes, as follows:

- Domestic unit water consumption is estimated at 130 lpcd for the year 1995 with an annual increase ratio of 2.0% from 1988 to 1990 and 1.5% from 1990 to 1995 against 115 lpcd in 1988.

- Commercial unit water consumption is estimated at 1.4 cu.m/connection/day in 1995 with its connection density ratio of 1.2 per 100 inhabitants.

- Institutional unit water consumption is estimated at 5.2 cu.m/connection/day in 1995 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 at 25% of the total distribution amount, an improvement from the present 30% average ratio.

2.2 Areas to be Served

The target year for water supply planning is set for the year 1995 for the purpose of intermediate water supply development/improvement.

With regard to the planned water supply service area of the said target year, priority shall be given to the increase in water supply service ratio of the present service area. Inclusion of unserved barangay shall be considered upon accomplishment of the intermediate improvement. Likewise, Poblacion and barangays Andagaw, Bachao Sur, New Buswang, Old Buswang, Estancia and Pook are designated to the planned service area.

2.3 Population Projection

The National Economic Development Authority (NEDA) has projected the municipal population in each year from 1981 to 2000 based on population census conducted in 1980.

The municipal government also estimated the municipal and barangay population in 1987 based on the 1980 population census conducted by NEDA. Base figures of 1980 adopted for population projection in 1987 is, however, different form the NEDA census data and the projection was made only for the year 1987.

These population projections are presented in TABLE D-10.

TABLE D-10 Population Projection of Kalibo

Year	NEDA Projection	Municipal Projection
1980	40,019	39,830
1985	46,830	---
1987	49,580	48,330
1990	53,660	---
1995	60,200	---

Based on the above-mentioned limitation on population data, the NEDA population projection is adopted in principle. Percentage share of barangay population to municipal population in 1995 is assumed to be unchanged from 1980 census result. The result of population projection is shown in TABLE D-11.

TABLE D-11 Population Projection of Service Area

	1980	1985	1990	1995
Municipality	40,019	46,830	53,660	60,200
Service Area				
Poblacion	11,150	13,050	14,950	16,770
Andagaw	4,673	5,470	6,270	7,030
Bachao Sur	715	840	960	1,080
New Buswang	3,311	3,870	4,440	4,980
Old Buswang	1,355	1,590	1,820	2,040
Estancia	3,997	4,680	5,360	6,010
Pook	2,516	2,940	3,370	3,780
TOTAL	26,362	32,440	37,170	41,690

With regard to the water supply service ratio, the Kalibo Water District is presently distributing drinking water to about 2,200 service connections or about 12,500 persons in the present service area, which means about 37% of the population coverage based on the present service area population estimated at about 33,560 from NEDA population projection for 1988.

Planned water supply service ratio in 1995 is assumed at 70% for poblacion and 40% for other barangays considering the magnitude of water source development and pipe installation as well as project cost requirement.

Average number of persons per household is assumed to be 5.00 in 1995 based on the standard figure adopted by the NEDA. TABLE D-12 shows served population and number of house-hold.

Table D-12 Served Population and Number of Household in 1995

Service Area	Served Population	No. of Household
Poblacion	11,740	2,348
Andagaw	2,810	562
Bachao Sur	430	86
New Buswang	1,990	398
Old Buswang	820	164
Estancia	2,400	480
Pook	1,510	302
TOTAL	21,700	4,340

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 connections and the future water consumption are presented in TABLE D-13.

TABLE D-13 Water Consumption in 1995

Service Area	Poblacion	Andagaw	Bachao Sur	New Buswang	Old Buswang	Estancia	Pook	Total
Served Population	11,740	2,810	430	1,990	820	2,400	1,510	21,700
No. of Connection								
Domestic	2,348	562	86	398	164	480	302	4,340
Commercial	141	34	5	24	10	6	4	224
Institutional*	12	1	1	1	1	1	1	18
Total	2,501	597	92	423	175	487	307	4,582
Water Consumption (cu.m/day)								
Domestic	1,526	365	56	259	107	312	196	2,821
Commercial	197	48	7	34	14	8	6	314
Institutional	62	5	5	5	5	5	5	92
Total	1,785	418	68	298	126	325	207	3,227
Unaccounted-for Water	595	139	23	99	42	108	69	1,075
TOTAL	2,380	557	91	397	168	433	276	4,302

* 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 D-14.

TABLE D-14 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 D-15.

TABLE D-15 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Poblacion	3,090
Andagaw	730
Bachao Sur	120
New Buswang	520
Old Buswang	220
Estancia	560
Pook	360
Total	5,600

The peak hour 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 1.80 and the peak hour water demand is estimated at 10,080 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

Groundwater resource at right bank of Aklan River is quite abundant and favorable for the use in water supply. Test well constructed under this study revealed that one properly constructed deep well will yield approximately 3,000 cu.m/day. Likewise, a total of three deep wells including one existing well of Kalibo Water District and test well will be planned for water sources.

Part of water production by these three wells in Kalibo will be shared for New Washington where is no available water source for their water supply. Thus, the conceptual water supply improvement plan will involve two municipalities, Kalibo and New Washington.

3.1.3 Transmission and Distribution Facilities

The existing transmission and distribution facilities in the present service area of Kalibo Water District will be augmented by additional two elevated water tanks and transmission/distribution lines. New pipelines will expand the service area coverage where there is potential but urgent need for water supply.

In addition to the above, part of transmission facility will be utilized for the water supply to New Washington.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

The existing deep well being operated by the Kalibo Water District will be used as it is and the test well constructed under this study will be converted to the production well (new deep well-1) for producing 3,000 cu.m/day. In addition, one more deep well (new deep well-2) with a water production of 3,000 cu.m/day will be constructed in barangay Tinigao which locates on the right bank of Aklan River. Test well and new deep well will be equipped with booster pumping station and chlorination facility.

The existing deep well will be used mainly to serve for poblacion area, while other two wells will be for new service and New Washington.

3.2.2 Transmission Facility

The existing transmission facility will be used as it is.

Two booster pumping stations will be constructed at the test well and new well and will equip with each one unit of booster pumping having capacity of 2.2 cu.m/min and total dynamic head of 60 m.

New transmission main having diameters ranging from ø 150 to 200 mm for a total length of 7.6 km will be installed. These new pipelines will be laid from respective pumping stations to new elevated water tanks and part of them will be used for water transmission to New Washington.

These transmission facilities will have a capacity to meet with the daily maximum water demand in 1995 (5,590 cu.m/day) in addition to the supply for New Washington.

3.2.3 Distribution Facility

The existing RC elevated tank will be used mainly for poblacion area. Two new RC elevated tanks will serve for expanded service area and transmit water to New Washington.

Total storage volume of these distribution tanks will have capability to meet with 13.5 % of the daily maximum water demand as operation storage, 2 hours of the said demand as emergency storage and 120 cu.m as fire fighting storage.

The service area coverage will be divided into three groups, but each area will be interconnected by main transmission line:

- poblacion area by the existing elevated tank,
- barangays of Andagao, Pook and Estansia by new elevated tank-1,
- barangays of Bachau Sur, Old Busuwang and New Busuwang by new elevated tank-2.

Distribution main in each area will be planned to form a looped line for effective and stable water supply.

These distribution facilities will have a capacity to cope with the hourly maximum water demand.

3.2.4 Required Water Supply Facilities

Location of major water supply facilities is shown in FIGURE D-22, flow diagram of facilities in FIGURE D-23 and detail of distribution pipeline in proposed service area in FIGURE D-24.

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Deep well-2 : ø 250 mm x 85.0 m, 1 unit

Intake/booster pumping station:
ø 125 mm x 2.2 cu.m/min x 60.0 m x 37 kW, 2 units

(2) Transmission Facility

Construction of transmission main:
from deep well-1 to elevated tank-1
ø 200 mm, 2,800 m
from deep well-2 to elevated tank-2
ø 200 mm, 2,800 m
from elevated tank-2 to booster pumping station for New Washington
ø 150 mm, 2,000 m

(3) Distribution Facility

Elevated water tank-1:
RC, ø12.0 m x 6.0 mH, total height 30 m, 680 cu.m, 1 unit

Elevated water tank-2:
RC, ø9.0 m x 6.0 mH, total height 30 m, 380 cu.m, 1 unit

Distribution main:
ø 150 mm pipe, 7,000 m
ø 200 mm pipe, 3,600 m

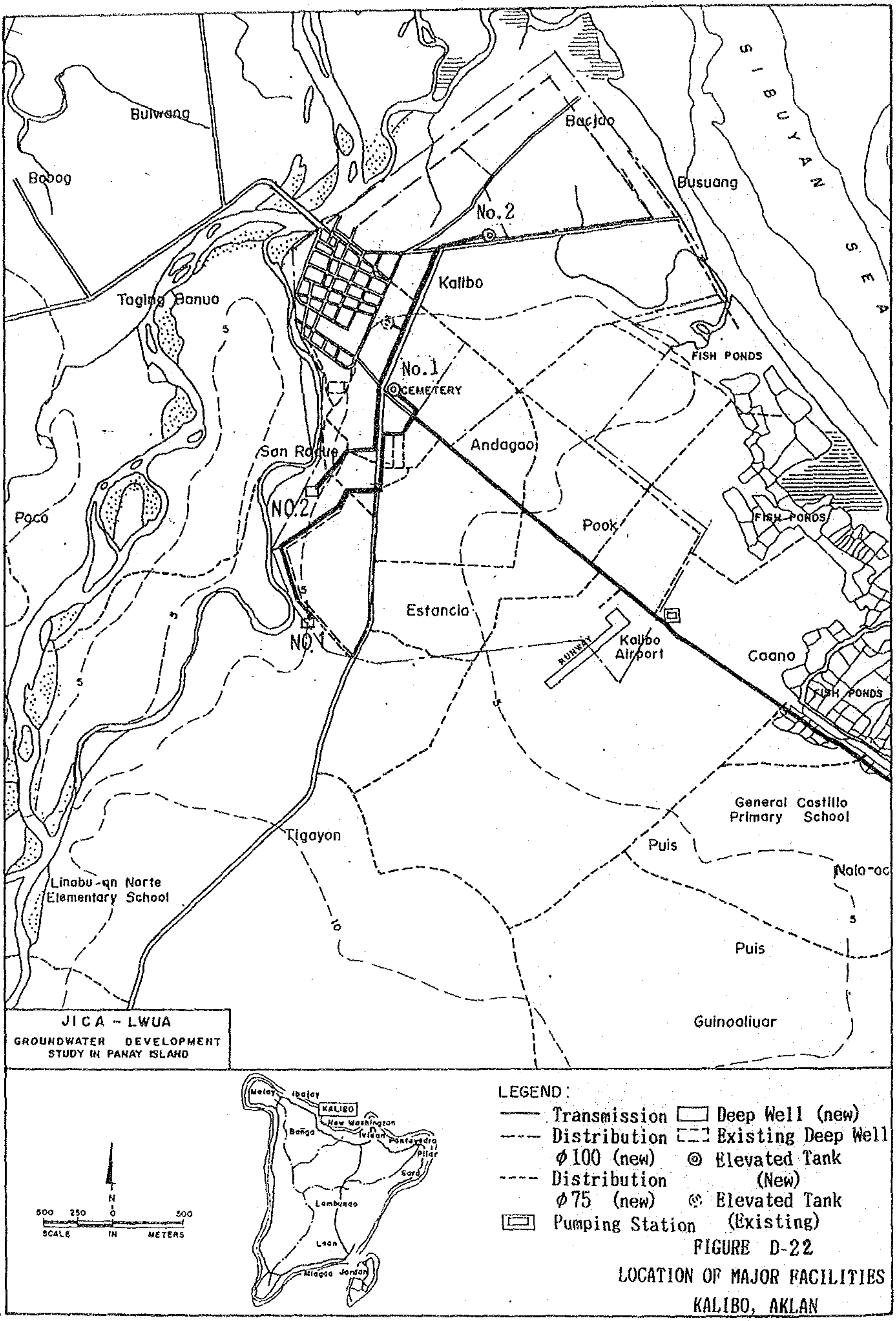


FIGURE D-22

LOCATION OF MAJOR FACILITIES

KALIBO, AKLAN

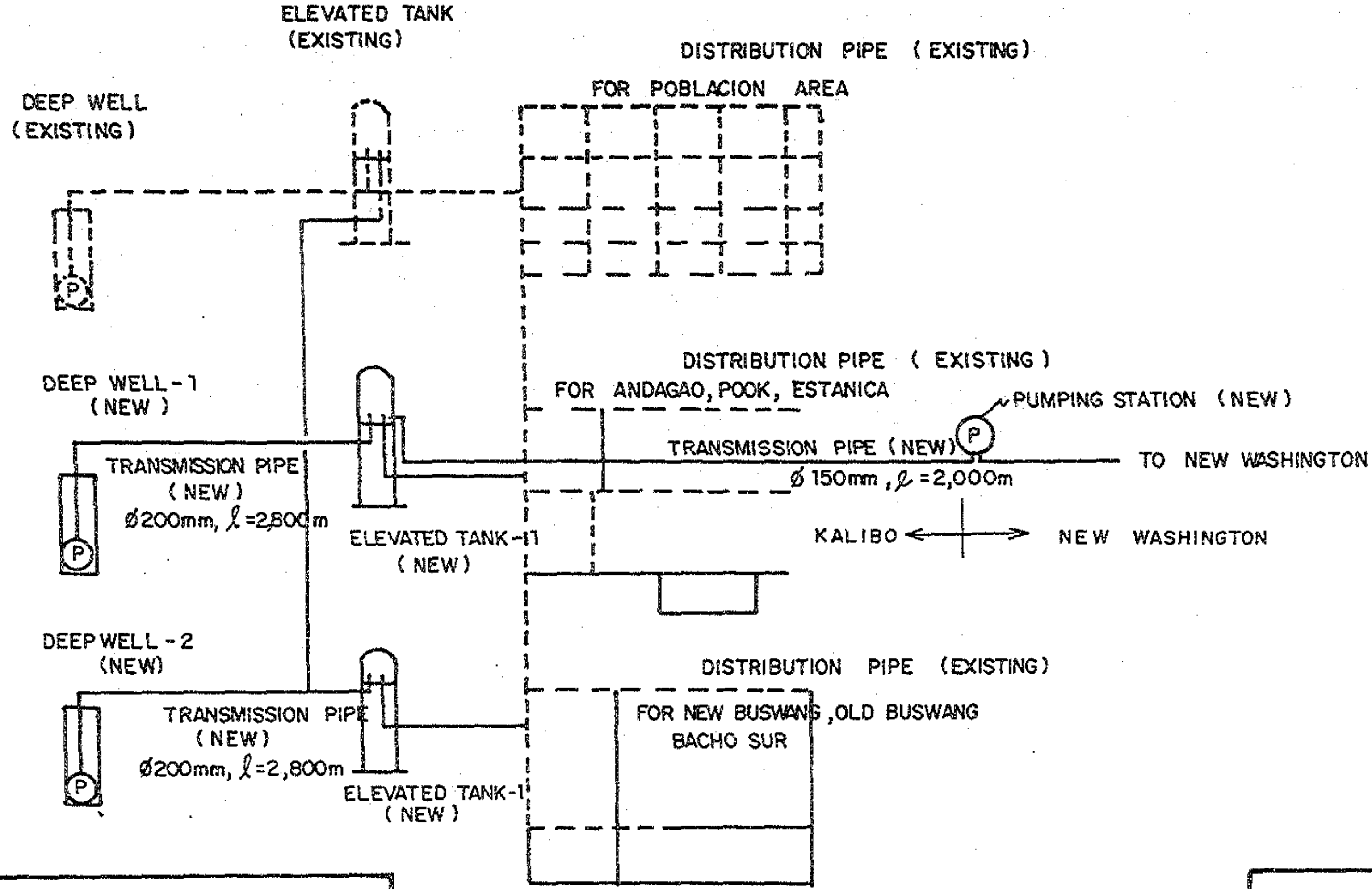


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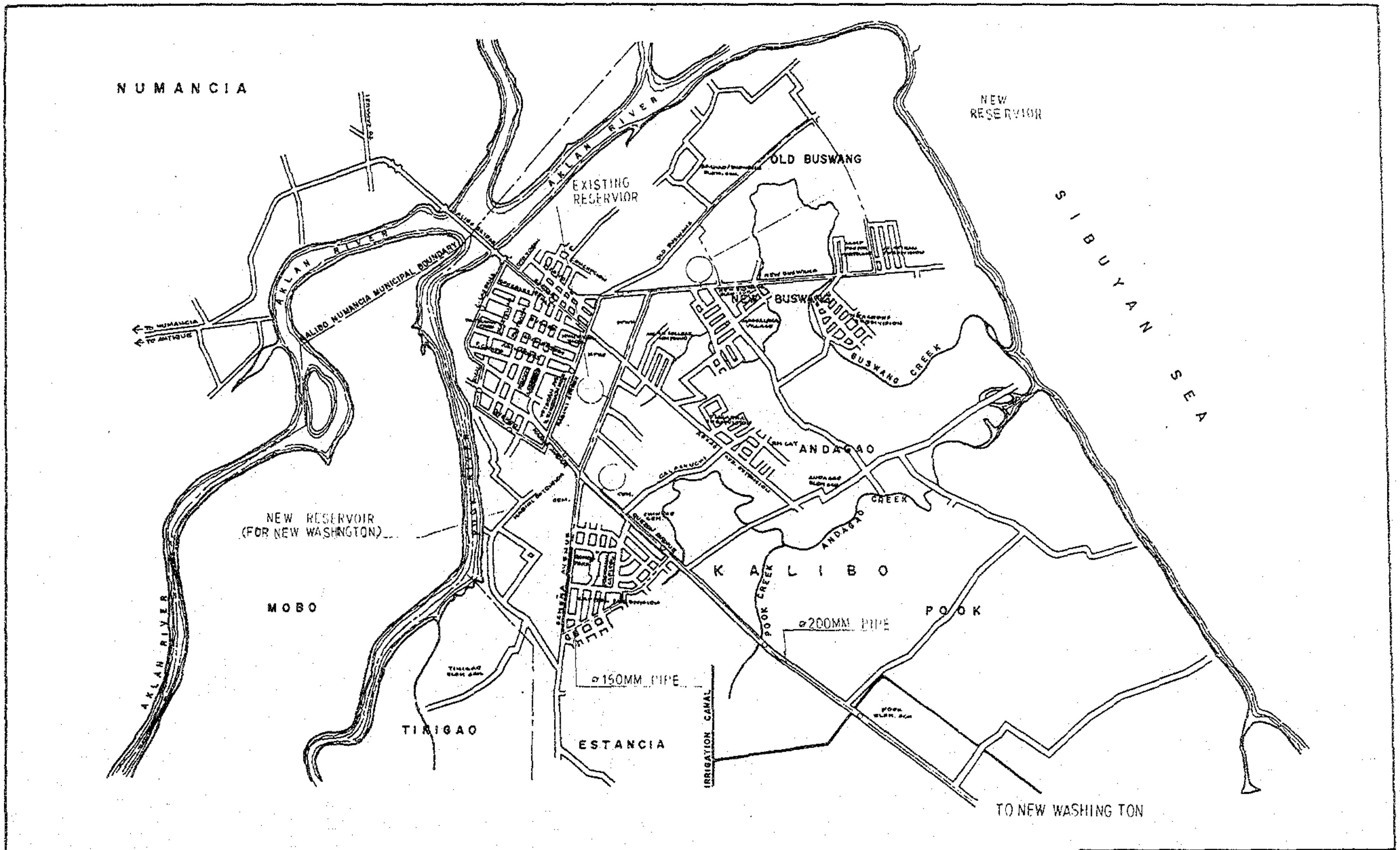
FIGURE D-23
FLOW DIAGRAM
KALIBO, AKLAN



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GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

FIGURE D-24
DISTRIBUTION PIPELINE
KALIBO , AKLAN

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	
Deep well (ø250 mm, 85 m)	557.1
Booster pump station (RC, 2.2 cu.m/min, 60.0 m H, 37 kW, 2 units)	1,712.4
Transmission Facility	
Transmission main	
(ø200 mm, 5,600 m)	4,200.0
(ø150 mm, 2,000 m)	1,260.0
Distribution Facility	
Elevated water tank-1 (RC, ø12.0 m, 30 mH, 680 cu.m)	4,601.3
Elevated water tank-2 (RC, ø9.0 m, 30 mH, 380 cu.m)	2,571.3
Distribution main	
(ø 150 mm pipe, 7,000 m)	3,780.0
(ø 200 mm pipe, 3,600 m)	2,268.0
(ø 150 mm valve, 24 pcs.)	136.8
(ø 200 mm valve, 12 pcs.)	102.0
Total	21,188.9

Total construction cost for improvement of major water supply facilities is estimated at approximately 21.19 million Pesos (148.5 million Yen or 1.02 million U.S. Dollar).

E. BANGA, AKLAN

E. BANGA, AKLAN

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 Banga is centrally located in the province of Aklan and is about 9 km. from the provincial capital, Kalibo. On the east lies the municipality of New Washington, Kalibo on the north, Lezo on the northwest, Malinao on the west, Madalag on the southwest, Libacao on the south, and Balete on the southeast. It has a total land area of 6,468 ha covering 30 barangays. Location map is shown in FIGURE E-1.

1.1.2 Climate

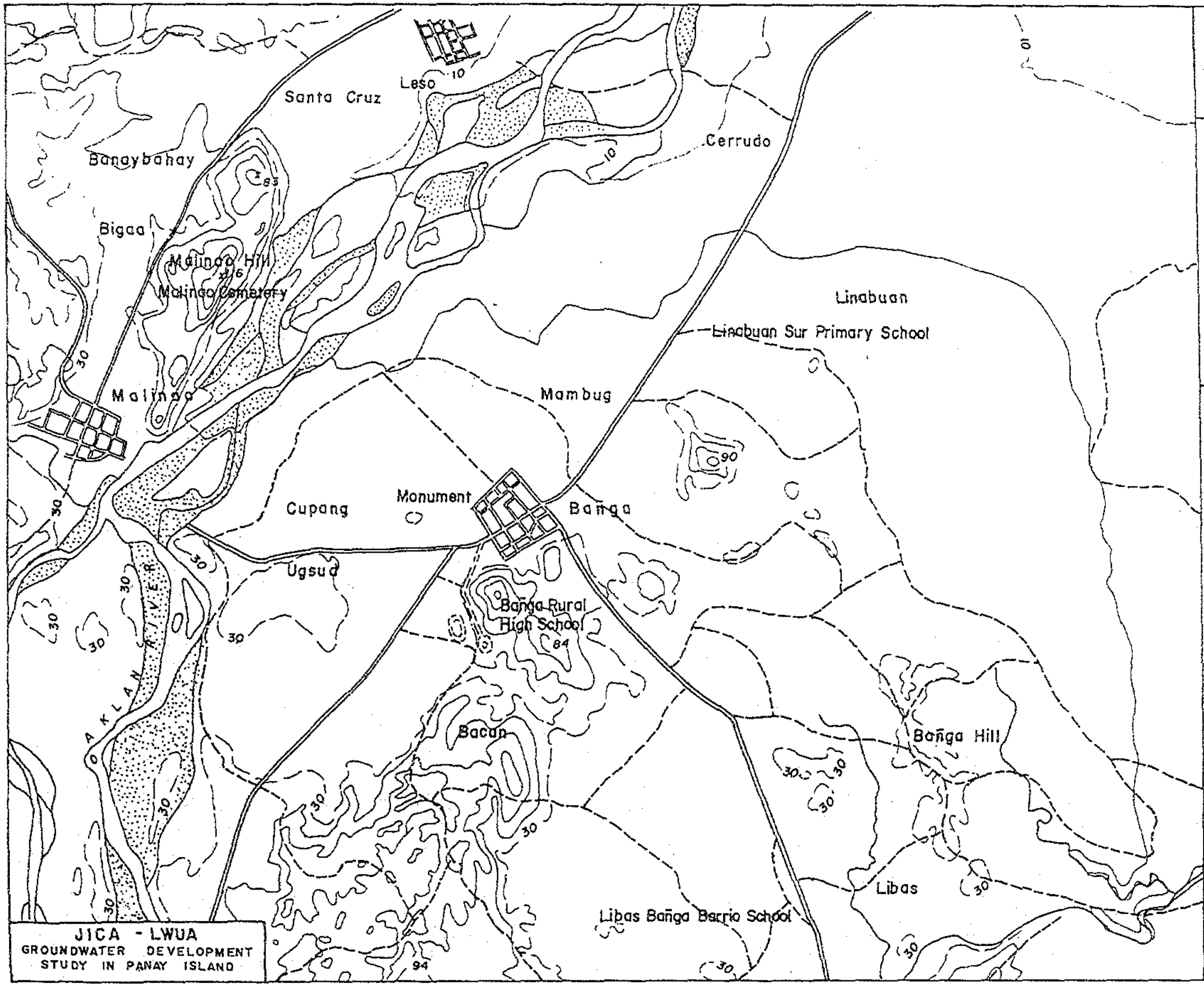
Banga's climate belongs to the third type with not so distinctive wet and dry seasons, i.e., dry months are not so dry and wet months are not so wet. The months of January to March have the least rainfall averaging at 36.2 mm. while the months from August to October have the heaviest rainfall registering an average of 215 mm. Temperature almost remains constant throughout the year. The coolest month is January with an average temperature of 26^{o}C while the hottest month is May with an average temperature of 29^{o}C.

1.1.3 Terrain/Topography

With about two-thirds of its area included in the Aklan River major basin, Banga has a generally flat terrain. About 68% of its land area have slope ranging from 0-3%. Gently sloping and undulating areas with slope ranging from 3-8% account for 26% of the total municipal land area. The remaining areas (6%) are moderately sloping (8-18%) and steeply sloping (18-30%).

1.1.4 Soil

The different six soil types that are found in Banga are the Sara clay loam (Central Banga), Bantog clay (northeastern part), San Manuel clay loam (lower Aklan River), Umingan sandy loam (upper plain of Aklan River), Sigcay clay (southwestern part), and Alimodian clay loam.



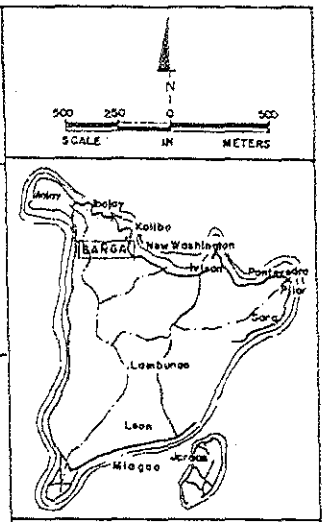


FIGURE E-I
LOCATION MAP
BAÑGA, AKLAN

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 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 Banga belongs to the 4th class.

Listed below are the 30 barangays composing the municipality:

1.	Agbanawan	16.	Maguing
2.	Bacan	17.	Pagsanghan
3.	Badiangan	18.	Palale
4.	Cerrudo	19.	Poblacion
5.	Cupang	20.	Polo
6.	Daguitan	21.	Polocate
7.	Daja Norte	22.	San Isidro
8.	Daja Sur	23.	Sibaliw
9.	Dingle	24.	Sigcay
10.	Jumarap	25.	Taba-ao
11.	Lapnag	26.	Tabayon
12.	Libas	27.	Tinapway
13.	Linabuan Sur	28.	Torralba
14.	Mambug	29.	Ugsod
15.	Mangan	30.	Venturanza

Of the total land area, 98.4% were agricultural lands as of December 1983. The rest were grasslands (0.1%) and used for residential, commercial and institutional purposes. (1.5%).

1.1.6 Transportation

The proximity of Banga to Kalibo and the financial stability of some of the residents haveencouraged the use and operation of motor vehicles either for private use or for business. The prevalent modes of transportation include jeepneys and tricycles. Presently, the total number of motor vehicles of various types including motorcycles and motortricycles is 216.

1.1.7 Infrastructure

There are a total of 90.45 kms. comprising Banga's road network. Of these, 8.395 kms. (48.8% concrete and 51.2% gravel) are national roads; 24.50 kms. (5.2% concrete and 94.8% gravel) are provincial; 5.226 kms. (37.5% concrete and 62.5% gravel) are municipal; and 52.33 kms. (all gravel) are barangay roads.

Electricity is provided by the Aklan Electric Cooperative, Inc. However, as of 1986, 58.55% of Banga's 4,445 households were still without electricity.

1.2 Population and Living Conditions

1.2.1 Population Trends from the Past

Among the 17 municipalities of Aklan, Banga is the fourth most populous, having a total population of 25,034 or 7.7% of the provincial population 1980. Its population rose at an average growth rate of .82% annually from 1970 to 1975, and at 2.19% annually from 1975 to 1980, outpacing the provincial population growth rate of 2.04%.

The municipal population density is 386.92 persons per square kilometer making it the 5th most thickly populated municipality in Aklan.

Rural population accounts for 92.5% of the total municipal population.

TABLE E-1 Population and Number of Households By Barangay, Banga, Aklan 1980

Barangay	Population	No. of Households
Agbanawan	1,073	189
Bacan	919	161
Badiangan	1,498	258
Cerrudo	628	107
Cupang	274	54
Daguitan	404	70
Daja Norte	653	106
Daja Sur	1,147	197
Dingle	605	111
Jumarap	1,012	188
Lapnag	419	69
Libas	707	137
Linabuan Sur	1,987	332
Mambug	926	172
Mangan	1,118	200
Maguing	435	84
Pagsanghan	1,079	185
Palale	317	57

TABLE E-1 **Population and Number of Households By Barangay, Banga, Aklan 1980 (Cont'd)**

Barangay	Population	No. of Households
Poblacion	1,881	339
Polo	979	156
Polocate	1,314	220
San Isidro	224	39
Sibaliw	651	120
Sigcay	629	120
Taba-ao	758	129
Tabayon	716	137
Tinapway	399	83
Torralba	1,233	237
Ugsod	665	126
Venturanza	384	64
TOTAL	25,034	4,447

1.2.2 Age Distribution

The productive age group composed of persons 15 to 64 years old reached a total of 13,824 or 55.2% of the municipal population. Those below 15 years of age totalled 9,396 or 37.%% while those above 64 years of age totalled 1,814 or 7.3%. Age dependency was therefore at the rate of 81.1%.

1.2.3 Morbidity/Mortality

Respiratory diseases along with gastrointestinal diseases lead the causes of illnesses and death.

Poor nutrition has also been a major problem. Based on the results of Operation Timbang in 1987, of the 3,672 children under six years of age who were weighed, 53.7% were found to be malnourished.

1.2.4 Sanitation

Closed pit (Antipolo) is the most common type of toilet facility in Banga with 33.0% of the 4,450 households using it. More than one-fourth or 28.5% use open pit; 24.6%, water-sealed with septic tank; and 5.7%, flush with septic tank. There are still 8% of the total households without toilet facilities.

1.2.5 Public Services

Educational facilities in the District of Banga include 23 schools of which 13 provide complete elementary education, 8 complete primary education and 2 incomplete primary education.

These elementary/primary schools have a total force of 219 teachers and a total enrollment of 5,229.

There are also 3 Barangay High Schools in the district (located in Daja Sur, Badiangan and Torralba) with a total of 11 teachers and 547 students.

There is also the Aklan Agricultural College, considered to be the oldest agricultural institution of learning in Western Visayas. It has a staff of 25 highs school teachers, 15 college instructors and 30 other personnel serving a total population of 1,909 students.

In addition, there exists a private secondary school, the Central Visayan Institute, providing education to 564 students.

Per the 1979 National Census Report, Banga posted a literacy rate of 80.21%.

Health facilities in the municipality include 8 barangay health centers and 1 rural health unit manned by 1 doctor, 1 dentist, 3 nurses and 9 midwives. Providing additional medical services are 2 private clinics.

As for telecommunication services, there exists a telegraph station under the Bureau of Telecommunications located in the municipal building. Unlike Kalibo, the municipality has no telephone system. In addition, mail services are provided by a postal office.

1.3 Economy and Industry

1.3.1 Agriculture

Agriculture continues to be the dominant economic activity in the municipality.

Average farm size was reported at 1.19 ha. in 1980 reflecting a 50% drop in size from the 1971 average. The number of farms totalled 3,750 covering an aggregate area of 3,737.44 ha.

Major agricultural crops include palay, coconut, fruits and vegetables. Of a total agricultural production of 12, 178 metric tons in 1980, rice constituted 5,807 metric tons or 47.70%, and coconut constituted 4,269 metric tons or 35.06%. Fruits and vegetables have a significant figure of 1,891 metric tons or 16.47%. Other products include sugarcane, coffee and cacao, abaca and other fiber-crops.

The livestock and poultry population of the municipality as reported in the 1980 Census of Agriculture totalled 10,951 heads consisting of 1,503 carabaos, 3 horses, 1,231 cattle, 50 goats, 4,668 pigs and 3,496 fowls mostly chickens and ducks.

1.3.2 Other Industries

As of 1980, there were a total of 115 manufacturing establishments in the municipality. In addition, there were 7 cottage industries registered with the NACIDA in 1987: 1 engaged in food processing, 1 in furniture-making, 2 in manufacturing (hollow-blocks, ceramics) and 3 in tailoring/ dressmaking.

2. Analysis of Pontential Water Source

2.1 Topography and Geology

The municipality of Banga is located at the middle part of the Aklan with the Poblacion lying on the terrace along the right bank of the Aklan River. Banga is characterized by farmed plain and hilly lands extending towards the east and south east of the Poblacion.

The geology of Banga consists of pyroclastics and terrace deposits on both river sides, while alluvial deposits are found along the river. Geological map is shown in FIGURE E-2.

Pyroclastics (Miocene, Tertiary)

Pyroclastics composed of tuff or tuff breccia form the basement. Coneshaped independent peaks consisted of this material are found in the hilly parts of the study area.

Terrace Deposits (Quaternary)

Terrace deposits found on both sides of the river, consist of sand, pebble or boulder, the thickness of which is not over 5 m.

2.2 Existing Water Source

Surface Water

The Aklan River, which has a drainage area of about 700 sq.km, flows along the western boundary of Banga. Not only in dry season but in rainy season, a great volume of river water flows down northward. Due to the deep water, rapid flow speed and intricate river bed condition, river flow measurement of the Aklan River was not possible.

Based on the historical records available at the National Water Resources Council, the average daily discharge of the Aklan River was measured as shown in TABLE E-2.

The measuring station is located at Rosario, Malinao, 8 km upstream of the Poblacion of Banga. The drainage area at the station measures 705 sq.km. The annual average daily discharge is calculated at 88.93 cu.m/sec or 7,684,000 cu.m/day, though the minimum average daily discharge is 57.50 cu.m/sec or 4,968,000 cu.m/day in April. However, the annual run-off calculated at 3978 mm is too large considering the precipitation and the evapotranspiration to be discussed later. On the other hand, the National Water Resource Council estimated the annual run-off of the Aklan River to be 1271.1 mm in their report "Principal River Basins of the Philippines." Considering the accuracy of measuring and the meteorological condition, the latter value is considered more reasonable.

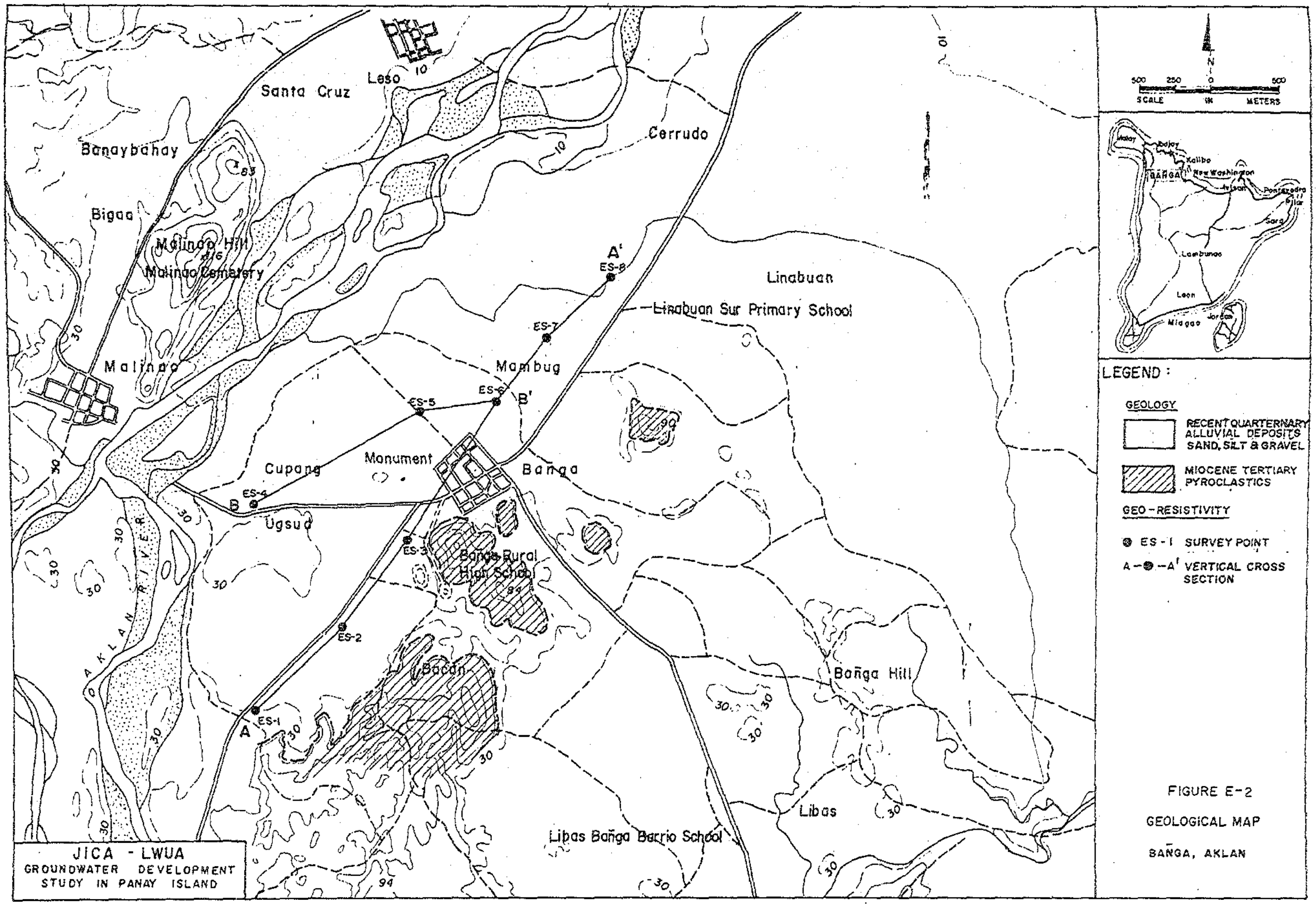


FIGURE E-2

GEOLOGICAL MAP

BAÑGA, AKLAN

TABLE E-2 AVERAGE DAILY DISCHARGE (AKLAN RIVER at Rosario, Malinao, Aklan) Unit: cu.m/sec

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1950	********	********	********	********	26.60	51.37	36.58	78.19	144.28	273.34	234.69	122.50
1951	110.70	89.16	89.85	43.38	120.57	98.26	141.86	131.86	141.10	122.66	171.42	328.14
1952	161.33	88.20	70.45	30.88	51.70	69.33	152.57	146.60	117.75	315.92	245.91	368.67
1953	261.54	185.88	207.80	207.80	119.26	200.17	********	185.16	178.23	178.41	********	********
1954	********	********	********	********	********	********	********	********	********	********	********	********
1955	********	********	********	********	********	********	********	********	********	********	********	********
1956	129.34	157.85	125.94	128.11	139.96	89.68	94.60	118.83	119.04	138.64	102.32	295.33
1957	262.91	122.92	58.62	103.51	31.65	32.59	131.01	110.56	125.77	103.62	96.66	74.89
1958	137.72	********	********	********	********	********	90.22	79.92	55.32	145.58	********	94.23
1959	94.76	42.77	112.46	35.78	54.26	69.06	114.54	95.49	51.12	86.64	192.44	197.57
1960	176.10	141.09	********	********	39.75	82.60	83.00	97.01	49.50	154.12	201.77	********
1961	********	********	********	32.78	38.51	42.75	59.32	87.22	41.46	67.63	90.68	69.08
1962	96.13	95.60	72.46	24.71	27.32	41.47	89.46	127.10	127.61	86.51	126.87	142.15
1963	145.08	122.42	94.64	63.69	60.75	********	59.66	96.12	89.19	84.54	117.76	108.37
1964	87.06	108.86	75.77	83.53	79.54	104.04	79.89	66.03	72.06	71.98	93.71	114.33
1965	78.95	71.86	69.35	61.25	51.72	46.29	********	********	56.20	82.31	81.19	121.54
1966	78.94	51.24	51.47	48.06	80.19	61.13	77.61	65.51	********	********	********	********
1967	137.12	83.46	61.76	28.93	22.78	35.55	48.65	49.47	36.87	44.84	87.81	70.84
1968	78.81	54.29	48.88	30.05	30.78	44.46	58.03	68.25	32.05	40.63	64.27	59.04
1969	38.61	20.32	11.57	9.79	15.64	30.29	73.20	73.35	62.37	56.59	56.86	105.38
1970	80.18	68.91	50.00	34.63	25.02	********	********	39.19	46.17	50.45	88.80	96.80
1971	********	********	********	********	********	********	********	********	********	********	********	********
1972	********	********	********	********	********	********	********	********	********	********	********	********
1973	34.03	51.00	28.70	24.95	********	********	********	84.11	72.72	83.19	********	********
1974	********	139.08	147.06	99.90	88.26	91.97	********	88.87	45.41	101.03	58.27	121.74
1975	********	88.93	52.68	81.99	68.15	55.18	59.12	51.43	72.75	58.99	95.97	181.67
1976	121.27	79.01	60.40	33.98	134.14	58.21	52.00	67.56	51.49	66.55	147.42	********
1977	79.56	150.83	74.43	37.87	31.69	32.99	70.58	59.75	68.70	30.14	47.23	51.38
1978	32.33	31.24	21.31	19.38	21.38	25.99	26.43	31.21	35.31	67.68	46.87	72.24
MAXIMU	262.91	185.88	207.8	207.8	139.96	200.17	152.57	185.16	178.23	315.92	245.91	368.67
AVERAG	115.36	92.95	75.50	57.50	59.11	64.92	79.92	87.45	78.85	104.67	116.62	139.80
MINIMU	32.33	20.32	11.57	9.79	15.64	25.99	26.43	31.21	32.05	30.14	46.87	51.38
SampleNo	21	22	21	22	23	21	20	24	24	24	21	20
ST.DEV.	62.67	43.98	44.47	45.67	38.41	39.00	33.82	35.75	41.29	69.78	60.08	91.11

Wells

In spite of the construction of a water supply system consisting of a deep well (depth is unknown), a steel elevated tank and distribution pipeline network by the DPWH, the system has not been operated due to the projected high operation cost owing to the large amount of water leakage.

The residents in the Poblacion and its surrounding areas mostly depend on shallow wells equipped with pitcher pumps, jetmatic pumps or electric motor pump.

An inventory survey was conducted on 13 wells, as shown in FIGURE E-3, five of which are located in the Poblacion, and the other eight wells at the geoelectric survey point. The inventory consists of verification of exact location, measurement of static water level and the total depth of the well. Water samples from selected wells were also taken for water quality check at field.

TABLE E-3 Well Data Summary

JICA-LWUA Source Number		Well Depth (M)	Ground Level (MAMSL)	Static Water Level: Dry Season (May 4) (MBGL)	(MAMSL)*	Static Water Level: Rainy Season (September 19) (MBGL)	(MAMSL)
E-1	Public Market	3.87	25.6	-2.73	22.9	-1.13	24.5
E-6	ES-1	5.60	31.0	-3.30	27.7	-3.17	27.8
E-7	Poblacion	5.35	26.7	-2.62	24.1	-2.33	24.4
E-8	Poblacion	36.00	26.9	-1.21	25.7	-1.03	25.9
E-9	Poblacion	6.92	25.8	-3.16	22.6	-2.01	23.8
E-10	Poblacion	7.00	26.6	-3.15	23.4	-1.67	24.9
E-11	ES-3	N.A.	27.0	-2.58	24.4	-2.27	24.7
E-12	ES-4	5.87	28.0	-2.37	25.6	-2.17	25.8
E-13	ES-2	4.10	27.0	-2.43	24.6	-2.85	24.1
E-14	beside Irrigation Canal	11.81	28.0	-3.31	24.7	-3.03	25.0

TABLE E-3 Well Data Summary (Cont'd)

JICA-LWUA Source Number	Well Depth (M)	Ground Level (MAMSL)	Static Water Level Dry Season (May 4) (MBGL)	(MAMSL)*	Rainy Season (September 19) (MBGL)	(MAMSL)
E-15 ES-5	5.47	25.0	-2.32	22.7	-2.01	23.0
E-16 ES-7	5.76	23.0	-1.69	21.3	-1.73	21.3
E-17 ES-8	6.40	20.0	-3.35	16.7	-3.56	16.4

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

The results are summarized as follows:

i) Free groundwater table exists at about 2.5 to 3.5 m below the ground level, and it declines in proportion to slope of the ground.

ii) Well data at E-8 reveals that there is a possibility of the existence of a second aquifer with pressure of about 36 m below the ground level in the Poblacion.

iii) Groundwater table in rainy season is at slightly higher level than that in dry season. This survey results imply the fluent recharge of groundwater in this area not only in rainy season but in dry season.

2.3 Survey for Potential Water Source

2.3.1 Evaluation of Georesistivity Survey

The Banga, the study area, is situated on the terrace that extends along the right bank of the Aklan River. Part of the survey area is located at or near the eastern end of the terrace.

Survey efforts were therefore concentrated on the exploration of the possible presence of aquifers in the quaternary deposit which forms the said terrace and the determination of the depth of the basement rock (tuffacious rhyolite). Survey points are exhibited on FIGURE E-2.

Shown below is a summary of field activities:

Date	:	May 4 to 5, 1988
No. of Survey Points	:	8 points
Type of Survey	:	Vertical Sounding
Configuration	:	Wenner Method
Sounding Depth	:	150 meters

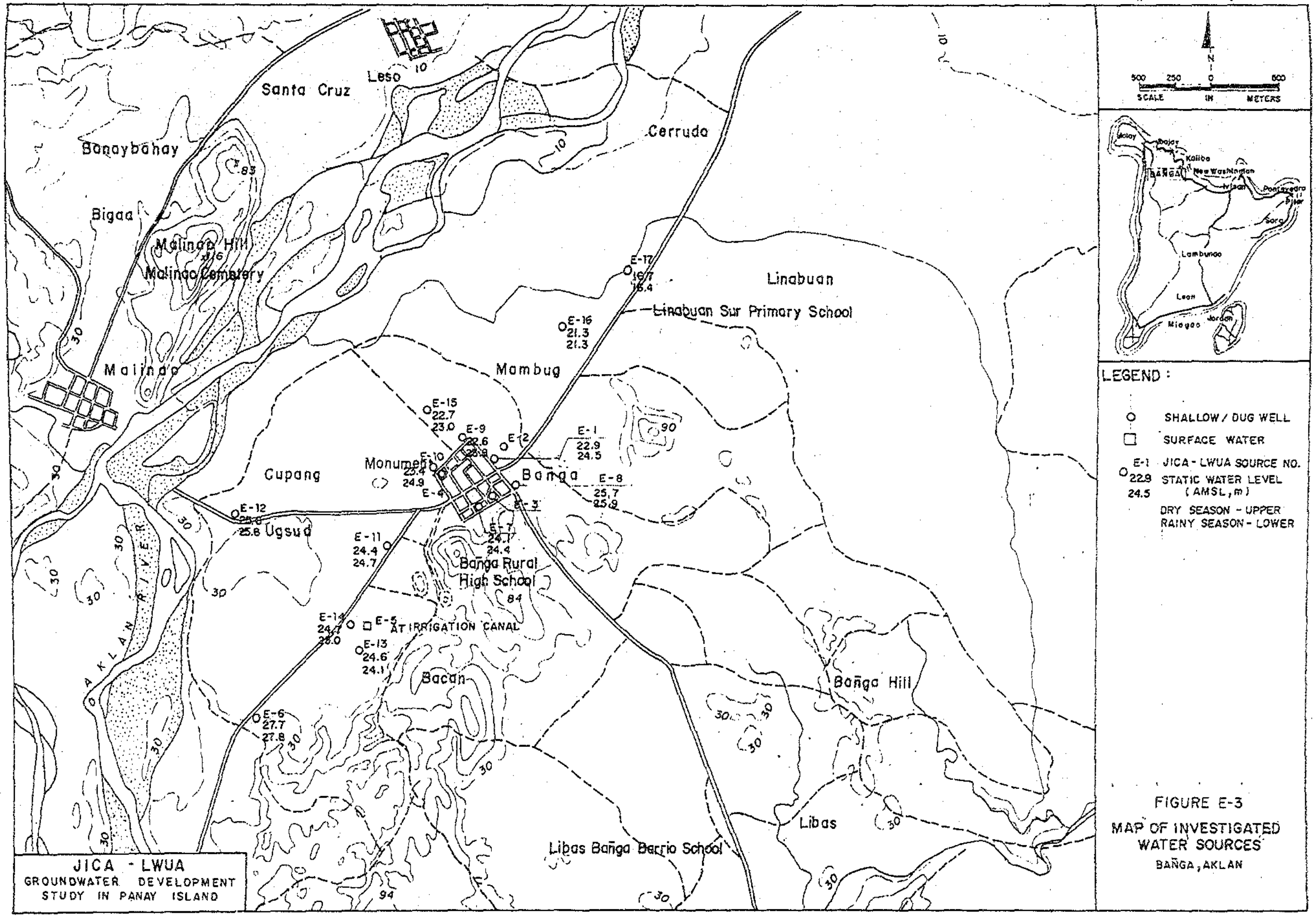


FIGURE E-3
MAP OF INVESTIGATED WATER SOURCES
BAÑGA, AKLAN

The analysis results of the ρ-a curve is shown in TABLE E-4 and the resistivity sections consequently developed are presented on FIGURE E-4 and FIGURE E-5.

As of the present, the following interpretations and assessments have been formed:

1) There is a continuous resistivity layer (103 to 220 ohm.m) having a thickness ranging from 7 to 22 m at depths shallower than 10 to 24 mbgl. It is highly probable that this particular layer bears the aquifer.

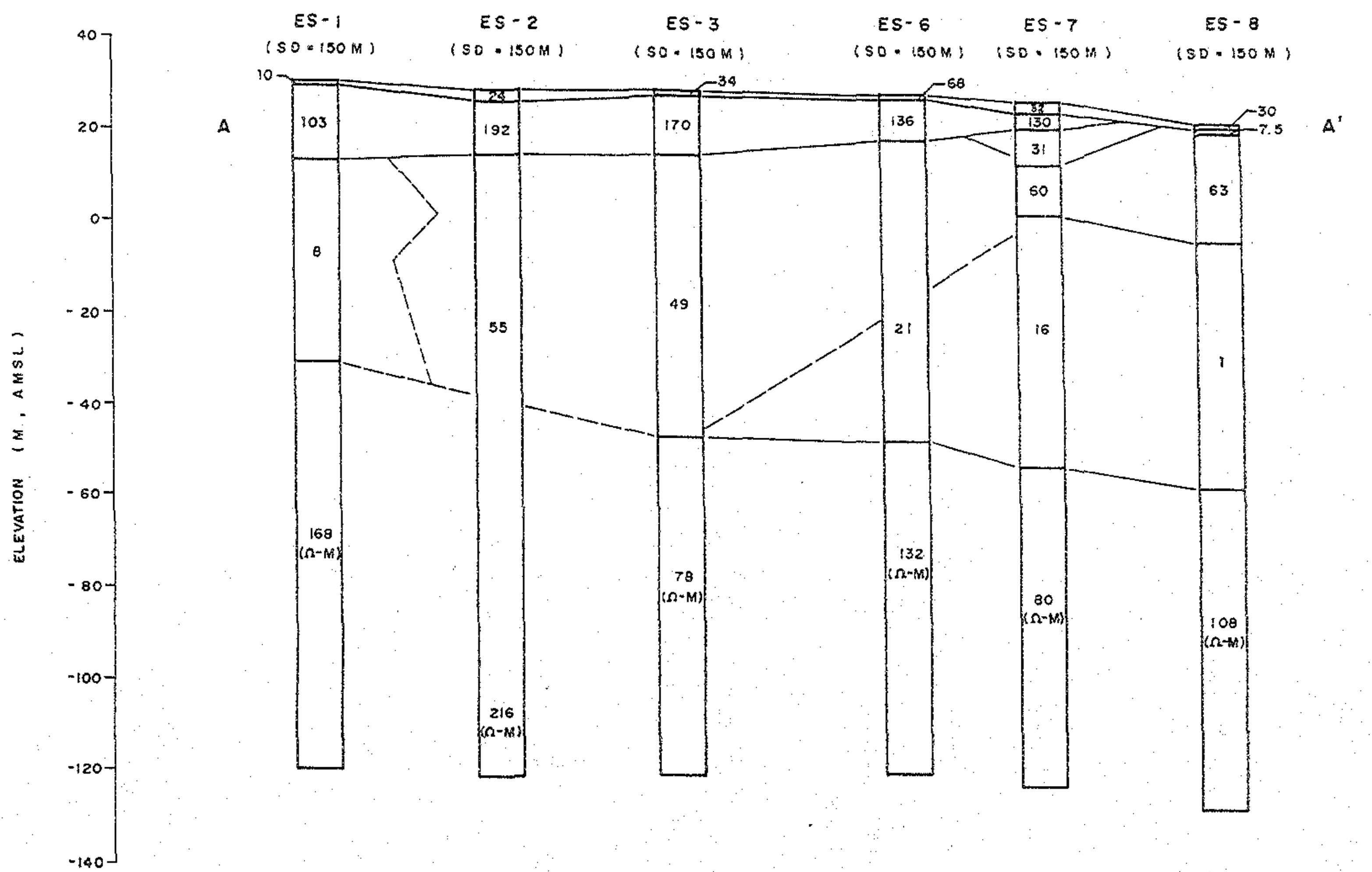
2) There is a low resistivity layer having a thickness of 45 to 65 m at depths ranging from 60 to 80 mbgl. This is considered to be the non-permeable layer.

3) A resistivity layer (60 to 216 ohm.m) is underlying at depths deeper than 60 to 80 mbgl and is distributed regularly corresponding to the topography of the area. This resistivity layer is considered to be the aquifer consisting of sandy to gravelly facies or the top of basement.

TABLE E-4 DEDUCTED VALUES OF GEORESISTIVITY READING INTERPRETATION

BANGA, AKLAN

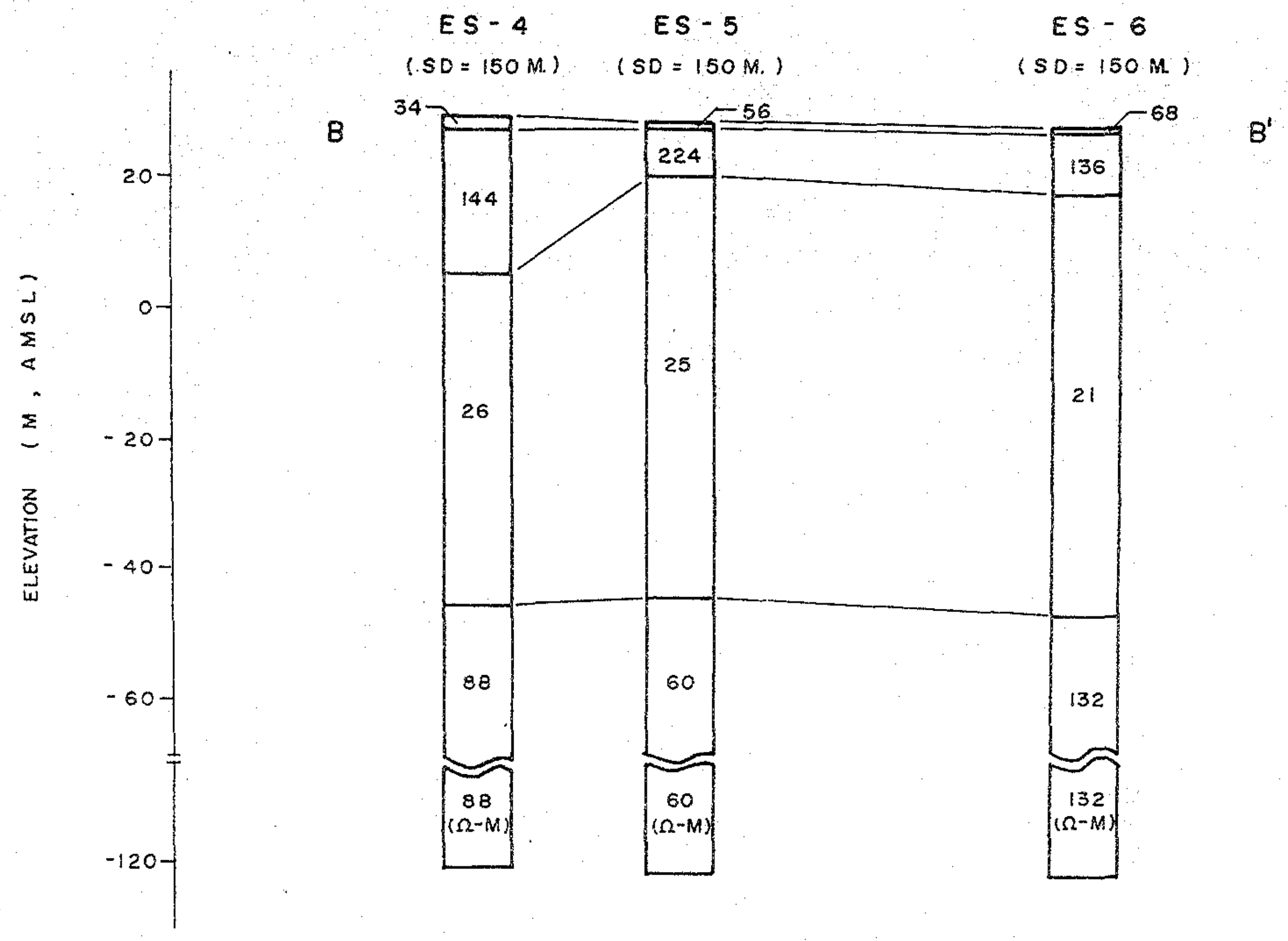
SURVEY POINT	ELEVATION (M,AMSL)	TOPOGRAPHY	RESISTIVITY LAYER 1		2		3		4		5		6	
			ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m	ohm.m	m
ES-1	31	terrace	10	1.3	103	17	8	75	168					
ES-2	28	terrace	24	2.5	192	14	55	120	216					
ES-3	27	terrace	34	1.5	170	14	49	76	78					
ES-4	28	terrace	18	2.1	144	24	26	76	88					
ES-5	27	terrace	56	0.8	224	25	8	60	73					
ES-6	26	terrace	68	1.0	136	9.8	21	75	132					
ES-7	23	terrace	32	2.3	130	6.2	31	14	60	25	16	70	80	
ES-8	20	terrace	30	1.2	8	2.3	63	26	1	80	108			



SCALE H = 1 : 20,000
V = 1 : 1,000

FIGURE E-4
GEORESISTIVITY SECTION A - A'
BAÑGA, AKLAN, PANAY ISLAND

JICA-LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND



SCALE H = 1 : 20,000
V = 1 : 1,000

FIGURE E - 5
GEORESISTIVITY SECTION B - B'
BAÑGA, AKLAN, PANAY ISLAND

JICA - LWUA
GROUNDWATER DEVELOPMENT
STUDY IN PANAY ISLAND

2.4 Water Quality Analysis

A total of five wells (one deep and four shallow) and two sur face water related to the Aklan River were examined during the field survey. Two water samples from private deep well (E-8) was collected in dry and rainy seasons for laboratory analysis.

TABLE E-5 presents field analysis results and their survey points are indicated on FIGURE E-3.

TABLE E-5 Water Quality Analysis Results

Sample		WT (°C)	pH (-)	EC (μS/cm)	T-Fe (ppm)	Mn (ppm)	NH_4-N (ppm)
Dry Season							
E-1	Shallow Well, Market	28.8	7.0	300	0.2	nil	nil
E-2	Shallow Well, Slaughterhouse	28.5	6.9	400	nil	-	nil
E-3	Shallow Well	30.5	7.2	220	0.2	-	nil
E-4	Shallow Well	26.8	6.8	300	nil	-	nil
E-5	Irrigation Canal	30.2	7.8	130	nil	-	nil
Rainy Season							
E-1	Shallow Well at Market	28.5	7.0	360	0.3	-	0.4
E-2	Shallow Well at Slaughter-house	26.2	7.1	420	nil	-	0.4
E-3	Shallow Well	27.0	6.9	427	2.0	-	nil
E-4	Shallow Well	28.2	7.2	295	0.2	-	nil
E-5	Irrigation Canal	30.4	7.8	173	0.2	-	0.4
E-8	Private Deep Well	28.2	7.6	395	0.2	-	<0.4
--	NIA Intake	29.1	8.4	175	0.2	-	0.6

Owing to favorable groundwater potential, wells in this study area show satisfactory characteristics of groundwater for drinking purpose, except for slight presence of ammonium nitrogen during rainy season.

Surface water in the NIA Intake and the irrigation canal branched from the Aklan River show high pH value. This characteristic is similar to that of the groundwater examined in the Kalibo area and it is presumed that the Aklan River is a recharge source of groundwater to the downstream area. Shallow wells in Banga, on the other hand, are not influenced by the Aklan River.

The following are the results of laboratory analysis for samples collected from E-8 (private deep well in the Poblacion).

		Dry Season	Rainy Season
Date of Sampling		6.08.88	9.17.88
Turbidity	(FTU)	1	0.6
Color	(UNIT)	nil	nil
TDS	(mg/l)	320	237
pH	(-)	7.8	8.0
EC	(μS/cm)	500	400
Alkalinity as $CaCO_3$	(mg/l)	209	140
Hardness as $CaCO_3$	(mg/l)	165	145
Major Cations	(meq/l)		
Sodium		1.7	1.1
Potassium		0.02	0.02
Calcium		1.9	2.0
Magnesium		1.3	0.9
Total		4.9	4.0
Major Anions	(meq/l)		
Carbonate		0	1.8
Bicarbonate		4.2	1.0
Chloride		0.6	0.9
Sulfate		0.1	0.2
Total		4.9	3.9

Geochemical feature of the groundwater at this particular deep well is the Carbonate-Hardness Type. This characteristic is different from deep well (D-1) in Kalibo, which shows the Carbonate-Alkali Type.

3. Conclusion and Recommendation

Groundwater potential in the basin of Aklan River can be roughly examined as follows:

Groundwater potential may be expressed as:

$$Q = P - E - D - M$$

Where,
- Q - groundwater potential
- P - precipitation
- E - evapotranspiration
- D - discharge of river
- M - moisture increase in soil

In this case study, precipitation "P" can be taken from meteorological data at Libacao, Aklan, which is obtained from the middle stream of the river and may be considered adequate to represent the meteorological characteristics of the basin.

Evapotranspiration "E" maybe calculated using the equation by Thornthwaite as:

$$EX = 1.6\,(10\,T/I)^{a}$$

Where,

EX - Evapotranspiration (cm/month)

T - Mean Temperature (°C)

I - $(Ti/5)^{1.514}$

a - $(492{,}390 + 17{,}920xI - 77.1xI^2 + 0.675xI^3) \times 10^{-6}$

Ti - Mean temperature in month of i

However, in the month with a mean temperature of more than 26.5 °C, Et may be obtained from the following table:

TABLE E-6 **Et for Month with Mean Temperature of more than 26.5 °C**

°C	Et	°C	Et	°C	Et	°C	Et
26.5	13.50	29.5	15.89	32.5	17.53	35.5	18.37
27.0	13.95	30.0	16.21	33.0	17.72	36.0	18.43
27.5	14.37	30.5	16.52	33.5	17.90	36.5	18.47
28.0	14.78	31.0	16.80	34.0	18.05	37.0	18.49
28.5	15.17	31.5	17.07	34.5	18.18	37.5	18.50
29.0	15.54	32.0	17.31	35.0	18.29	38.0	18.50

Et gained through the above procedure shall be revised based on the variation of the length of day time.

Calculation results are shown in the following table:

TABLE E-7 **Precipitation and Evapotranspiration**

MONTH	JAN.	FEB.	MAR.	APR.	MAY
Ave. Precipitation (mm)	531.9	364.6	299.2	204.9	253.2
Ave. Temperature (°C)	26.3	26.9	27.9	28.4	28.2
Evapotranspiration (mm)	125.4	126.1	151.4	155.4	162.8
Surplus Amount (mm)	406.5	238.5	147.8	49.5	90.4

MONTH	JUN.	JUL.	AUG.	SEP.	OCT.
Ave. Precipitation (mm)	327.4	263.5	278.1	391.0	491.8
Ave. Temperature (°C)	28.0	27.5	27.7	27.1	27.5
Evapotranspiration (mm)	156.7	156.6	155.5	143.1	146.6
Surplus Amount (mm)	170.7	106.9	122.6	247.9	345.2

MONTH	NOV.	DEC.	ANNUAL
Ave. Precipitation (mm)	646.1	704.5	4756.2
Ave. Temperature (°C)	27.4	26.5	
Evapotranspiration (mm)	138.6	133.7	1751.9
Surplus Amount (mm)	507.5	570.9	3004.3

In this calculation, average monthly temperature in Kalibo is based only in the available record during the period from 1975 to 1985.

Discharge of the river "D" is 1271.1 mm as discussed earlier. Moisture increase in soil "M" is negligible in this case. The groundwater potential "Q" is, therefore, calculated as:

$$Q = (4756.2 - 1751.9 - 1271.1) \times 705 \times 10^3$$

$$= 1222 \times 10^6 \text{ cu.m/year}$$

$$= 3.3 \text{ M cu.m/day}$$

As a result, 3.3 M cu.m/day is calculated as the total groundwater potential in the Aklan River Basin.

The sources of the existing deep well and another private deep well (36 m in depth) are considered to be ground water in terrace deposits lying on the basement. In addition, from the results of the georesistivity survey, distinct signs suggesting aquifer are found. Based on geological exploration and georesistivity survey, the potential of developing groundwater is very positive.

In addition, the Aklan River has a great potential for being a stale water source. However, treatment cost of surface water will be high and not feasible for the water supply system. Therefore, in case the Aklan River is utilized as a water source, it is desirable to use the riverbed water instead of surface water.

II. CONCEPTUAL WATER SUPPLY SYSTEM

1. Existing Water Supply Conditions

1.1 Water Use Condition

As described in the previous subsection, there is no piped water supply system currently operating in the Poblacion area. Most of the households in the area have independent private shallow tube wells equipped with jetmatic pumps owing to high grounwater potential. Some households were observed to have electric motor pumps.

People residing along the Aklan River and the irrigation canal use surface water for washing. The irrigation canal diverts water from the Aklan River and runs through the Poblacion area.

Likewise, the favorable hydrogeological background of this specific area allows easy access to the groundwater in shallow aquifer. The problem faced by the existing piped water supply system, however, depresses the economic activities and public hygiene, i.e., food processing at public market and restaurants in the Poblacion, etc. Reactivation of the said facility is, therefore, indispensable in the densely populated area, such as the Poblacion area.

1.2 Existing Water Supply System and Problems Encountered

The Department of Public Works and Highways (DPWH) constructed one Level III water supply system at the center of the Poblacion in 1979 with the following system configuration:

- one deep well (ø150 mm, depth unknown) equipped with submersible motor pump
- one steel elliptical elevated tank (H = 10 m, 110 cu.m)
- distribution lines (GI, ø75 mm, length unknown)
- 16 service connections including municipal hall and health center

Many leakages in the distribution lines were observed during test operation, but no repair work was performed. Since then, service connections could not be adequately served by the system, except for the municipal hall and health center which was also discontinued due to high running cost.

The municipal government intends to purchase an engine generator as a power source to the submersible pump. However, no budgetary measure has been taken up yet.

Major facilities were observed to be in good condition. With complete check up and repair of leakages, the system can resume its normal operation.

No technical data and drawing of the system are being kept by the municipality and DPWH.

2. Water Demand Projection

2.1 Criteria

The absence of an operational piped water supply system and poor water supply conditions make it difficult to assess the per capita unit water demand. Per capita unit water consumption is, therefore, assumed to be 100 lpcd in 1988 based on the LWUA Methodology Manual and on the experience gained 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 esti mated 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 water supply facilities was abandoned due to leakages in the distribution lines. For the said facilities is to be reactivated, thorough repair/improvement is a prerequisite. Taking into account the above conditions, the unaccounted-for water is assumed to be at 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 for the purpose of intermediate water supply development/improvement.

With regard to the planned water supply service area of the said target year, priority shall be given to the densely populated areas. Likewise, the poblacion area is only taken up for water supply planning.

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 conducted in 1980.

Population data of 1982 and 1987 are presented in the "Socio-Economic Profile - 1988". However, no data source and indications on whether there are actual registered population or projected population are specified. Furthermore, the 1982 population is smaller than the 1980 census result.

The difference between the above data are shown in TABLE E-8.

TABLE E-8 Population Projection of Banga

Year	NEDA Projection	Municipal Projection
1980	25,112*	---
1982	26,220	24,873
1985	27,840	---
1987	28,880	31,064
1990	30,340	---
1995	32,510	---
2000	33,980	---

* 1980 census data

Based on the above comparison, it is deemed advisable to adopt in principle the NEDA population projection.

Percentage share of barangay population to the municipal population for the year 1995 is assumed to be the same as that of the 1980 census result. The projected 1995 municipal population is being distributed to the respective service area barangays as shown in TABLE E-9.

TABLE E-9 Population Projection of Service Area

Year	Municipality	Service Area Poblacion
1980	25,112	1,881
1985	27,840	2,090
1990	30,340	2,270
1995	32,510	2,440

The water supply service ratio is placed at 80% for the Poblacion considering the habitation pattern in the planned service area as stated earlier. 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 connections and future water consumption are shown in TABLE E-10.

TABLE E-10 Water Consumption in 1995

	Poblacion
Served Population	1,952
No. of Connection	
Domestic	390
Commercial	23
Institutional*	1
Total	414
Water Consumption (cu.m/day)	
Domestic	219
Commercial	35
Institutional	5
Total	259
Unaccounted-for Water	86
TOTAL	345

* 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 Methodlogy Manual as shown in TABLE E-11.

TABLE E-11 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 E-12.

TABLE E-12 Daily Maximum Water Demand

Service Area	Water Demand (cu.m/day)
Poblacion	449

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

$$C = (\text{Peak Hour Demand} \times 24)/(\text{Daily Maximum Demand})$$

$$= 2.2 - 0.3 \times \log(\text{Service Population}/1{,}000)$$

The ratio of peak hour demand in the year 1995 is calculated at 2.08 and the peak hour water demand is estimated at 934 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 1979, water supply facility including deep well was constructed, but because of coarse plumbing and expensive maintenance fee, now left unused.

Based on the analysis of hydrogeological survey and condition of existing wells, it is concluded that groundwater of this poblacion area is quite abundant and in case of deep well, groundwater can be obtained from pressured second aquifer.

Though the drinking water can easily ensure from shallow wells at each home, domestic sewage has polluted the water of them, thus, groundwater from deep well is considered adequate to be served in this area.

Therefore, groundwater from deep well will be utilized for water source of this district.

3.2 Plan for Improvement of Water Supply Facilities

3.2.1 Water Source Facility

Although the deep well, drilled in 1979 is left non-functioning and depth is also indefinite, groundwater can be procured from pressured second aquifer, so existing wells will be utilized with rehabilitation, namely washing.

Intake pump facility and chlorination facility will be newly installed.

Intake pump facility :
Submersible water pump for deep well
ø80 mm x 0.6 cu.m/min x H 20.0 m x 3.7 kW

Chlorination facility : Calcium hypochlorite injector

3.2.2 Transmission Facility

There is existing steel plate elevated tank and its capacity (110 cu.m) is considered sufficient, thus, it will be utilized with some repairs.

3.2.3 Distribution Facility

Because of inadequate plumbing and lot of leakage, the existing distribution main has not been used for a long time.

Consequently, distribution pipe will be replaced through this project.

Project : ø 100 mm pipe, 2,100 m
ø 200 mm pipe, 1,000 m

3.2.4 Required Water Supply Facilities

Location of major water supply facilities is shown in FIGURE E-6 and flow diagram of facilities in FIGURE E-7 and detail of distribution pipeline in proposed service area in FIGURE E-8.

Size and quantity of required facilities are listed below:

(1) Water Source Facility

Intake pump facility:
Submersible motor pump for deep well
ø80 mm x 0.6 cu.m/min x H 20.0 m x 3.7 kW

Chlorination tank

(2) Transmission Facility

Repair of existing elevated tank.

(3) Distribution Facility

Distribution line
ø100 mm pipe, 2,100 m
ø200 mm pipe, 1,000 m

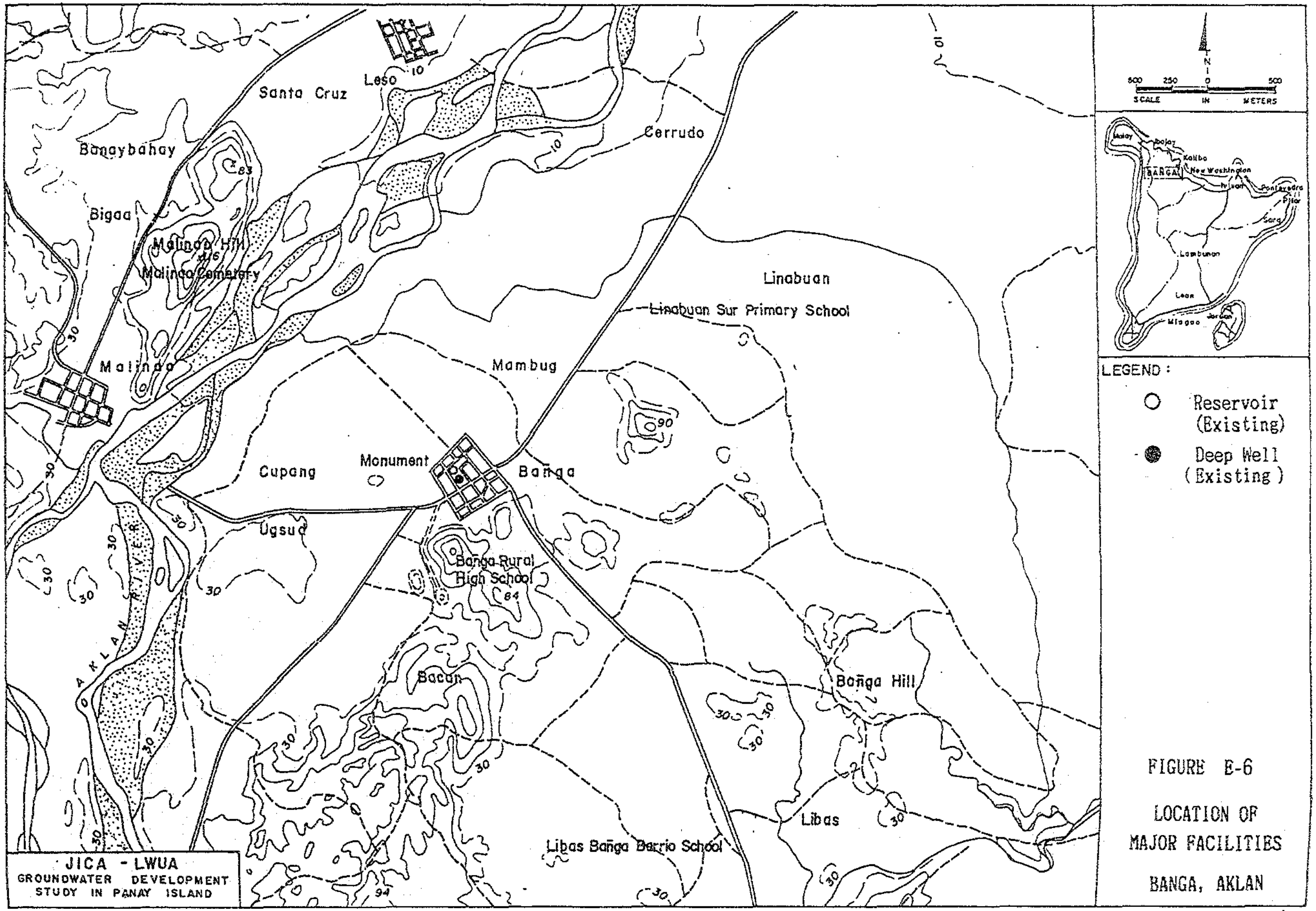


FIGURE E-6

LOCATION OF MAJOR FACILITIES

BANGA, AKLAN

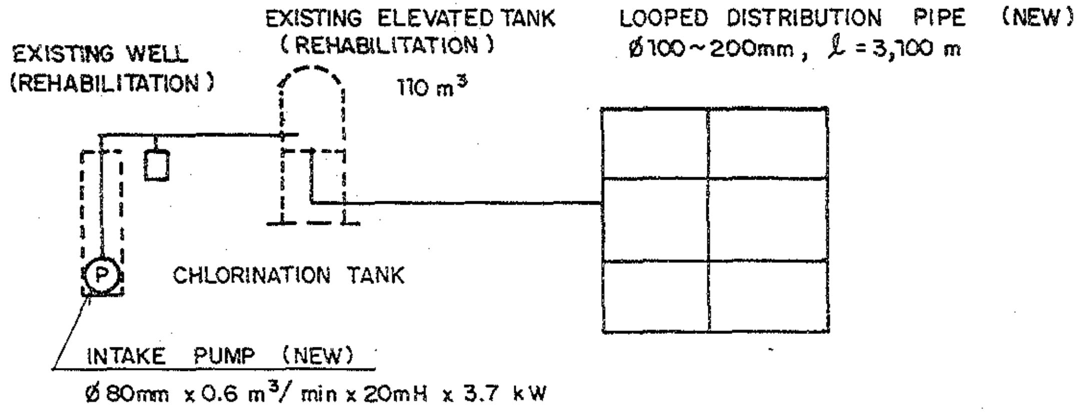


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FIGURE E-7
FLOW DIAGRAM
BANGA, AKLAN

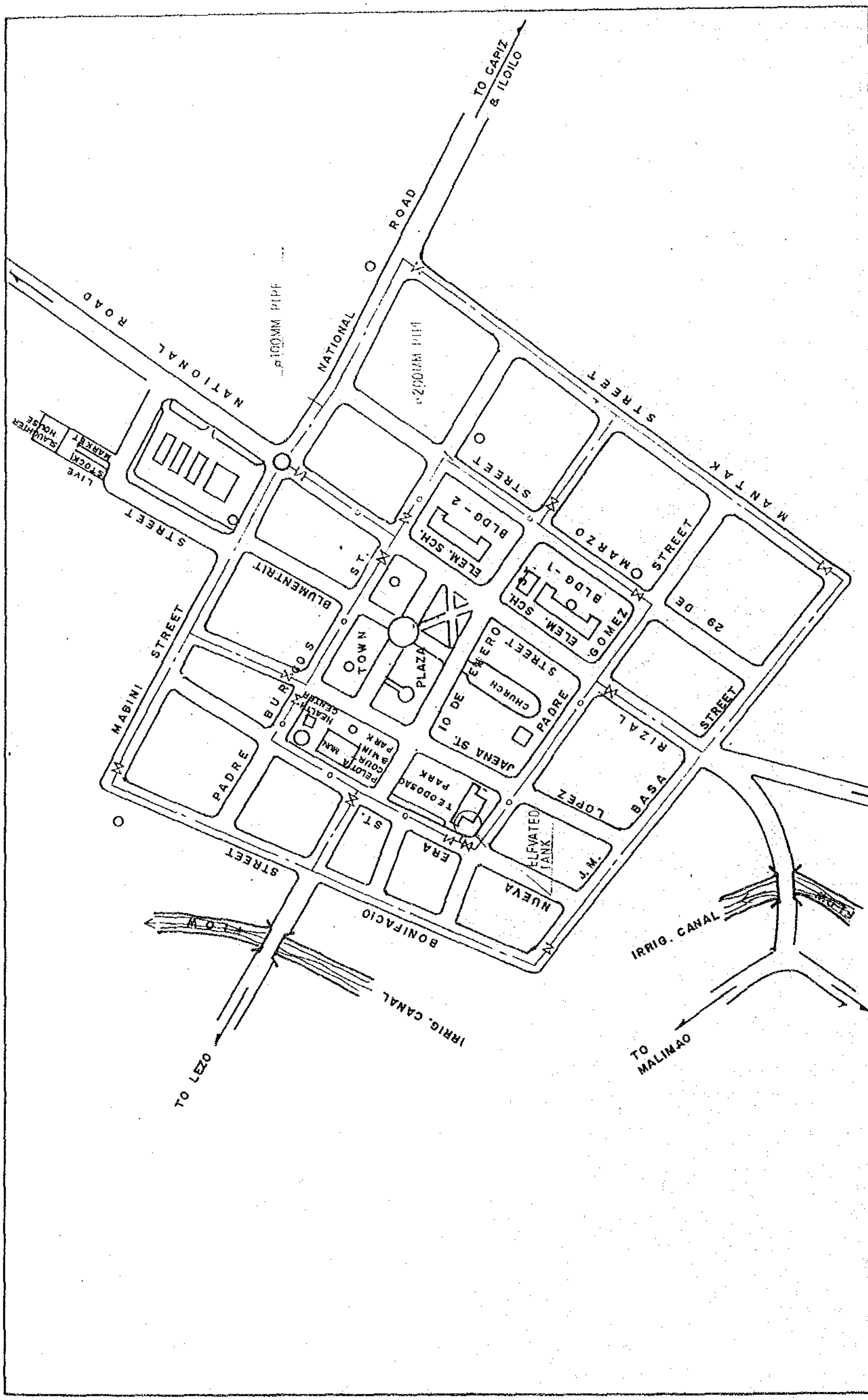

FIGURE E-8
DISTRIBUTION PIPELINE
BANGA, AKLAN

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STUDY IN PANAY ISLAND

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	
Deep well pump (0.6 cu.m/min, 20 mH)	904.0
Chlorination tank	14.5
Transmission Line	
Repair of existing elevation tank (110 cu.m x 0.1)	63.8
Distribution Facility	
Distribution line	
(ø 100 mm pipe, 2,100 m)	567.0
(ø 200 mm pipe, 1,000 m)	630.0
(ø 100 mm valve, 8 pcs.)	36.0
(ø 200 mm valve, 7 pcs.)	59.5
Total	2,274.8

Total construction cost for improvement of major water supply facilities is estimated at approximately 2.27 million Pesos (15.9 million Yen or 0.11 million U.S. Dollar).