社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

LOCAL WATER UTILITIES ADMINISTRATION
REPUBLIC OF THE PHILIPPINES

CAVITE WATER SUPPLY DEVELOPMENT STUDY IN THE REPUBLIC OF THE PHILIPPINES

VOLUME 1

SUMMARY

MAY 1995

KOKUSAI KOGYO CO., LTD.
NIPPON JOGESUIDO SEKKEI CO., LTD.

CAVITE WATER SUPPLY
DEVELOPMENT STUDY
IN
THE REPUBLIC OF THE PHILIPPINES

LIST OF REPORTS

The cost estimate was made based on Pesos in January 1995.
(1 dollar = 24.634 pesos = 100.77 yen)

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct the master plan and feasibility study on "CAVITE WATER SUPPLY DEVELOPMENT STUDY IN THE REPUBLIC OF THE PHILIPPINES" and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Dr. Akira Sugiyama, Kokusai Kogyo Co. Ltd. and composed of staff members of Kokusai Kogyo Co. Ltd. and Nippon Jogesuido Sekkei Co. Ltd., three times between April 1994 and March 1995.

The team held discussions with the officials concerned of the Government of the Philippines, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

May 1995

Kimio Fujita
President
Japan International Cooperation Agency

May 1995

Mr. Kimio Fujita
President,
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Mr. Fujita,

We are pleased to submit to you the Final Report on the "CAVITE WATER SUPPLY DEVELOPMENT STUDY IN THE REPUBLIC OF THE PHILIPPINES". This report has been prepared by the Study Team in accordance with the contract signed on March 15 and April 15, 1994 and January 20 and April 19, 1995 between the Japan International Cooperation Agency and the Joint Venture of Kokusai Kogyo Co. Ltd. and Nippon Jyogesuido Sekkei Co. Ltd.

The report contains the result of basic study on the existing state of groundwater and water supply facilities in Cavite, as well as results of the feasibility study of the project on groundwater development and water supply for the selected five areas.

The existing state of groundwater in Cavite is graphically presented in the "HYDROGEOLOGICAL MAP OF CAVITE PROVINCE" attached to the report. The target year for the groundwater development and water supply project in the five areas proposed in the report is 2005. Specific study were conducted on the population and water demand of the target year, site and discharge of water sources to be developed, water supply facilities, and personnel for the operation and maintenance of these facilities. Further, estimation of project cost, financial and economic evaluation were carried out, and the water supply projects for the five areas proposed in the report were found to be feasible.

We hope that the fruits of the study shall be utilized effectively not only for the development and sustainable use of groundwater resources, but also for the improvement of the living environment of the residents.

All members of the Study Team wish to express grateful acknowledgement to the personnel of your Agency, Embassy of Japan in the Republic of the Philippines, and also to officials and individuals of the Government of the Republic of the Philippines, especially to the Local Water Utilities Administration, for the assistance they have extended to the Study Team.

Very truly yours,

杉山明

Akira Sugiyama
Team Leader,
Cavite Water Supply Development Study
in the Republic of the Philippines

<OUTLINE OF THE PROPOSED PROJECTS>

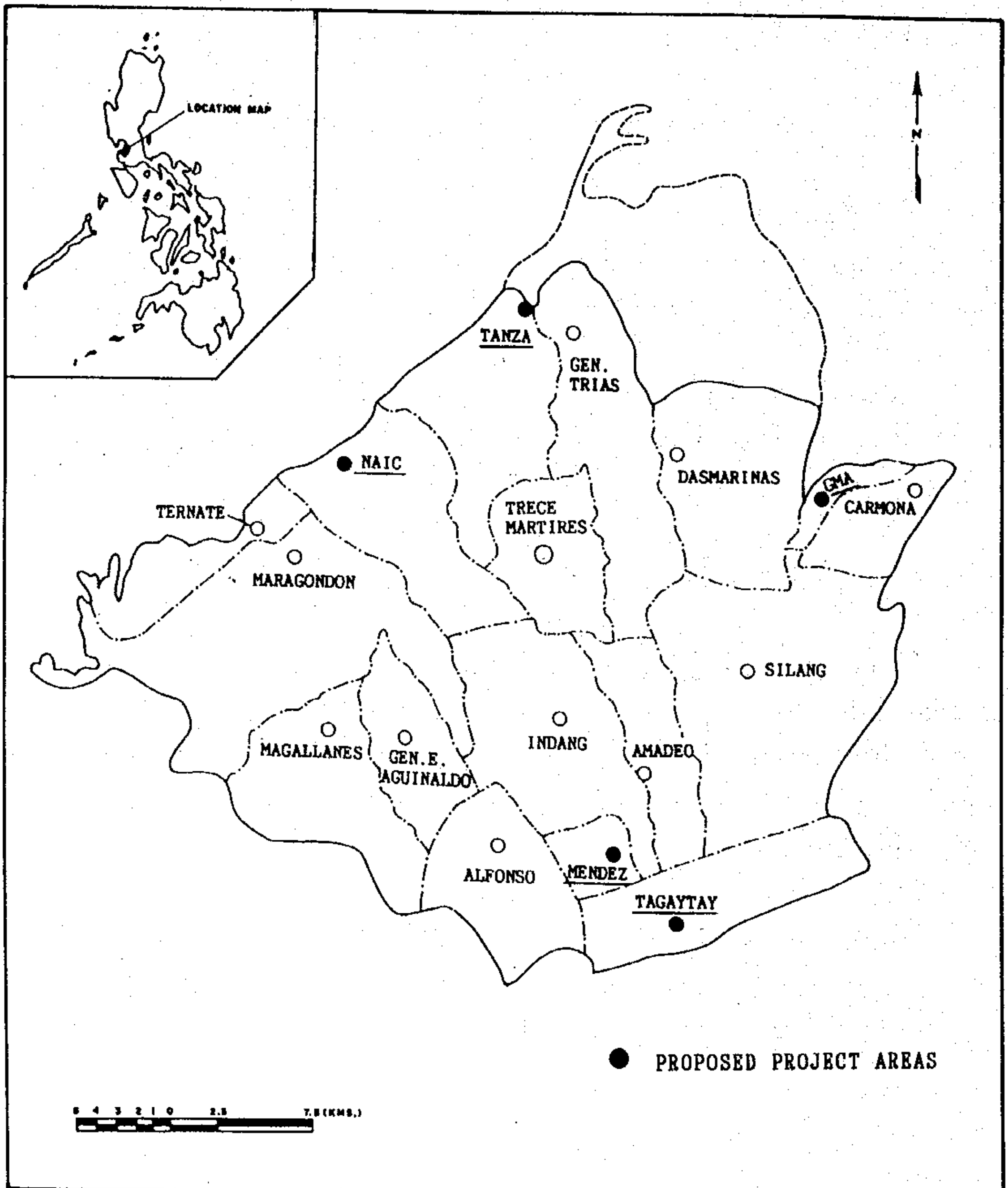
The objective areas of the water supply projects proposed in the Study are G.M.A., Mendez, Naic, Tagaytay City and Tanza as shown in Fig.1.

Table 1 summarizes population, water demand, water sources and project cost for the five areas. The total served population is estimated at 154,000 in 2005, and the total daily water demand is estimated at about 28,000 cum in average.

Fig. 2 shows the implementation schedule of the proposed project.

The project term is divided into Phase I with the target year of 2001 and Phase II with the target year of 2005. The water supply facilities used in Phase I and Phase II are scheduled to be completed by the end of the year-1997 and 2001, respectively. In Mendez and Tagaytay, however, the project shall be completed in Phase I since they have only one water source to be developed.

The project cost was calculated only for Phase I, and the total project cost for the five areas amounted about 183×10^6 pesos (about 730 million yen). According to the result of economic and financial analysis, the proposed projects are feasible for the five areas.

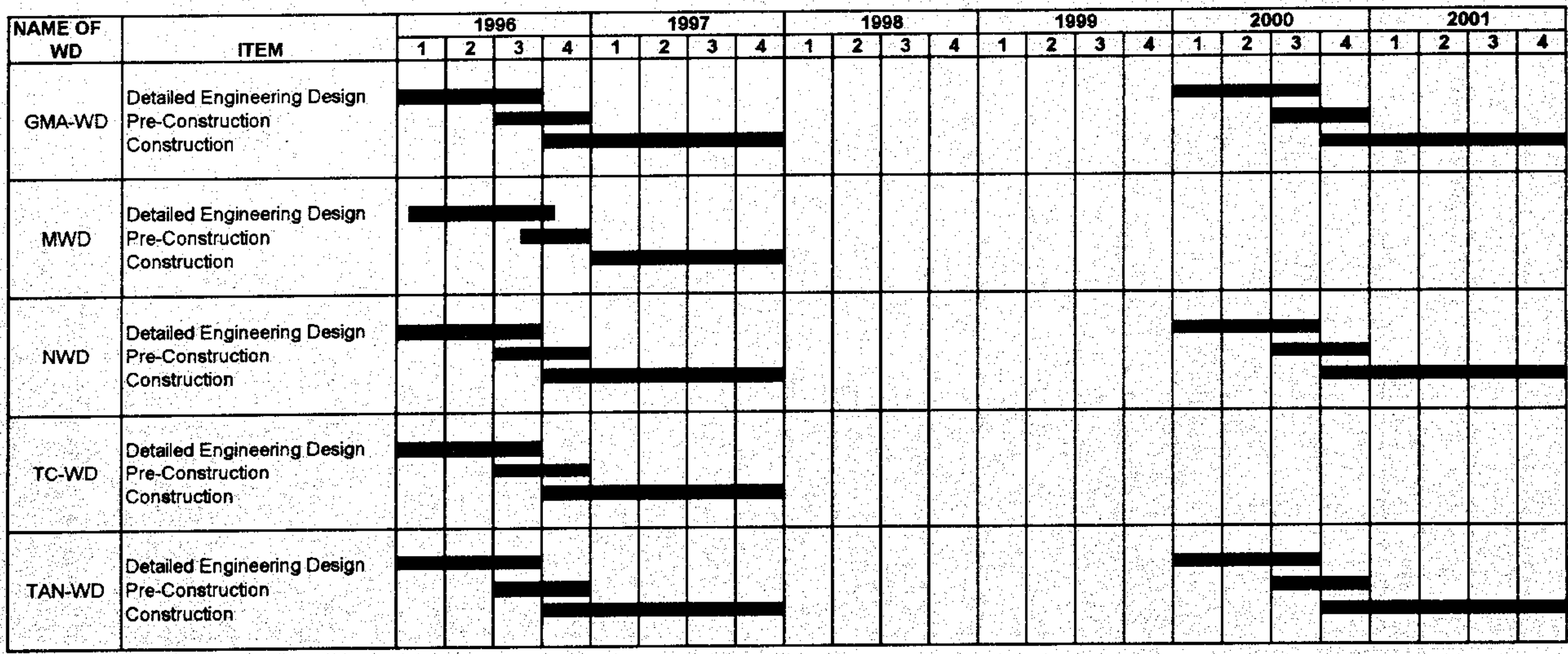


CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig.1
JAPAN INTERNATIONAL COOPERATION AGENCY	PROPOSED PROJECT AREAS

Table 1. SUMMARY OF PROPOSED PROJECT

Name of WD	Description	1994	1998	2005
G.M.A.	A. Population			
	1) Total Population	59,343	68,771	89,025
	2) Pop. in Service Area	53,404	62,461	80,104
	3) Served Population	20,504	46,151	56,892
	B. Water Demand (cum/d)			
	1) Daily Average	3,194	7,098	9,462
	2) Daily Maximum	4,152	9,227	12,300
	3) Peak Hour	6,388	14,276	18,924
	D. Water Sources	8 wells	12 wells	12 wells
	H. Project Cost (Million Peso) (Phase I only)	–	43.26	–
MENDEZ	A. Population			
	1) Total Population	14,891	15,914	17,908
	2) Pop. in Service Area	7,638	11,070	15,474
	3) Peak Hour	4,121	5,385	13,848
	B. Water Demand (cum/d)			
	1) Daily Average	603	924	2,336
	2) Daily Maximum	784	1,201	3,037
	3) Peak Hour	1,206	1,848	4,672
	D. Water Sources	1 well	2 wells	2 wells
	H. Project Cost (Million Peso) (Phase I only)	–	22.65	–
NAIC	A. Population			
	1) Total Population	25,375	28,526	35,275
	2) Pop. in Service Area	6,910	14,488	28,354
	3) Served Population	2,950	7,002	23,003
	B. Water Demand (cum/d)			
	1) Daily Average	472	1,333	4,673
	2) Daily Maximum	614	1,733	6,075
	3) Peak Hour	944	2,666	9,346
	D. Water Sources	1 spring	2 wells	4 wells
	H. Project Cost (Million Peso) (Phase I only)	–	26.32	–
TAGAYTAY CITY	A. Population			
	1) Total Population	24,316	28,326	37,080
	2) Pop. in Service Area	20,695	24,118	35,936
	3) Served Population	13,270	20,590	30,377
	B. Water Demand (cum/d)			
	1) Daily Average	1,948	4,063	6,079
	2) Daily Maximum	2,532	5,282	7,903
	3) Peak Hour	3,896	8,126	12,158
	D. Water Sources	3 springs	3 springs	3 springs
	H. Project Cost (Million Peso) (Phase I only)	–	79.46	–
TANZA	A. Population			
	1) Total Population	37,122	42,718	54,930
	2) Pop. in Service Area	5,294	31,344	43,952
	3) Served Population	1,315	13,958	29,829
	B. Water Demand (cum/d)			
	1) Daily Average	235	2,266	5,280
	2) Daily Maximum	305	2,946	6,864
	3) Peak Hour	470	4,532	10,560
	D. Water Sources	1 well	2 wells	4 wells
	H. Project Cost (Million Peso) (Phase I only)	–	11.53	–

Fig. 2 **PROPOSED IMPLEMENTATION SCHEDULE**



CONTENTS

1. SCOPE OF THE STUDY

1.1 Background and Objectives of the Study

Cavite Province, the Republic of the Philippines, is situated south of Metro Manila, where it corresponds to the hilly area along Manila Bay and the northern slope of a somma of Taal volcano. In Cavite Province, urbanization and industrialization are rapidly in progress not only along the coast but also inland due to congestions in Metro Manila.

As for six (6) municipalities/cities adjacent to Metro Manila, water supply is under the jurisdiction of the Metropolitan Waterworks and Sewerage System (MWSS), and tap water are being supplied mainly from groundwater sources. While, seventeen (17) municipalities/cities in the Study Area are under the jurisdiction of the Local Water Utilities Administration, and tap water are being supplied by spring and groundwater. Of these seventeen (17) municipalities/cities, however, only seven (7) have Water Districts, the other seven (7) municipalities have Rural Water Supply Associations, and the remained three have no organization for water supply.

The Philippine government has set forth the "Integral Water Supply Program 1980–2000" and water supply sanitation master plan, focusing on the development and improvement of water supply and environmental facilities, in compliance with the "International Water Supply and Sanitation Decade Program" launched at the General Meeting of the United Nations in 1980. This master plan is divided into two phases: the target of Phase I is to increase water supply coverage to 77% in the urban area and 92% in the rural area, and the target of Phase II is to increase water supply coverage to 95% in the urban area and 93% in the rural area under the condition of adequate operation of water supply facilities and improvement of sewerage.

Based on this master plan, LWUA conducted a preliminary study on the actual state of water supply in the seventeen (17) municipalities/cities. According to the results of this study, water sources and water supply facilities in these municipalities/cities are insufficient for the present water demand. In addition, it is pointed out that the budget necessary for the development and improvement of water supply facilities cannot be secured under the present state of national finance.

Further, almost all the rivers in Cavite Province have low discharge, and the construction of dams is difficult due to the topographical condition. Groundwater, however, has limited amount, and its unplanned development causes groundwater level drawdown, water quality deterioration and ground subsidence. Industrial estates and private residential subdivisions are rapidly being developed in areas adjacent to Metro Manila, including Cavite City, causing also groundwater level drawdown with saline water intrusion. Groundwater level drawdown is also found inland due to the results of expansion of urban areas and construction of industrial estates. In addition, groundwater quality deterioration is widely found, and damage to health is also reported.

With this background, the Philippine Government requested the Japanese Government in January, 1992 to execute the study on the water supply development with groundwater as source for the seventeen (17) municipalities/cities in the Cavite Province. On the basis of this request, JICA dispatched a preliminary study team in November, 1993, and drew up the Implementing Arrangement on the technical cooperation related to the execution of the Study.

The objectives of the Study are:

(1) to execute feasibility study (target year: 2005) on the water supply development with groundwater source for seventeen (17) municipalities/cities (total area: 1,241 km^2, total population: about 700,000) under LWUA's jurisdiction in Cavite Province, Republic of the Philippines

(2) to transfer techniques to the counterpart personnel through the Study

1.2 Objective Area for the Study

Objective area for the Study comprises fifteen (15) municipalities and two cities, as shown in Fig. 1-1.

(1) Dasmarinas, (2) Indang, (3) Gen. Mariano Alvarez (G.M.A.), (4) Mendez, (5) Silang, (6) Tanza, (7) Tagaytay City, (8) Amadeo, (9) Magallanes, (10) Maragondon, (11) Ternate, (12) Alfonso, (13) Naic, (14) Gen. E. Aguinaldo, (15) Carmona, (16) Trece Martirez City, and (17) Gen. Trias

1.3 Study Components and the Relationship among the Components

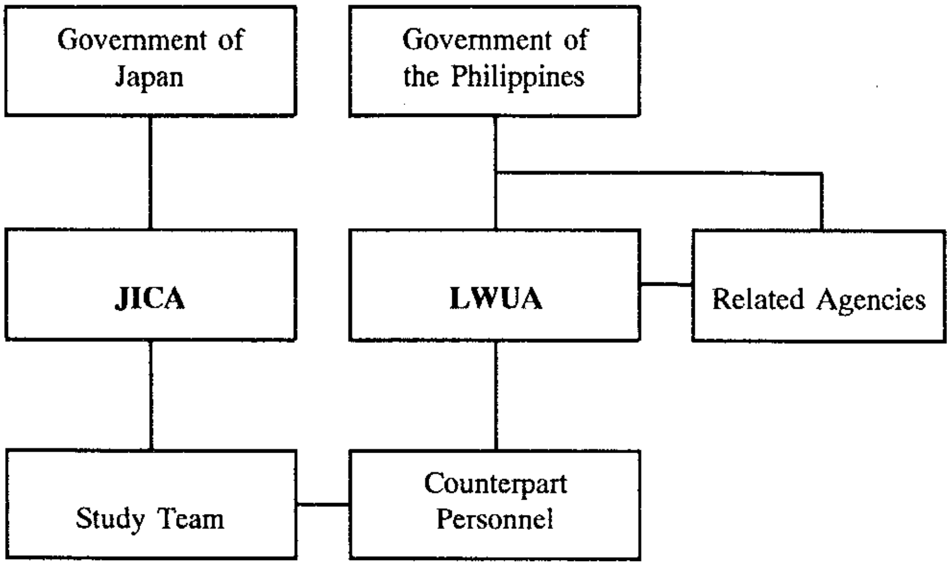
The Study consisted of the basic study intended for the whole Study Area and the feasibility study for the five areas selected from the results of the basic study. Study components and the interrelationship among the different components are shown in Fig. 1-2.

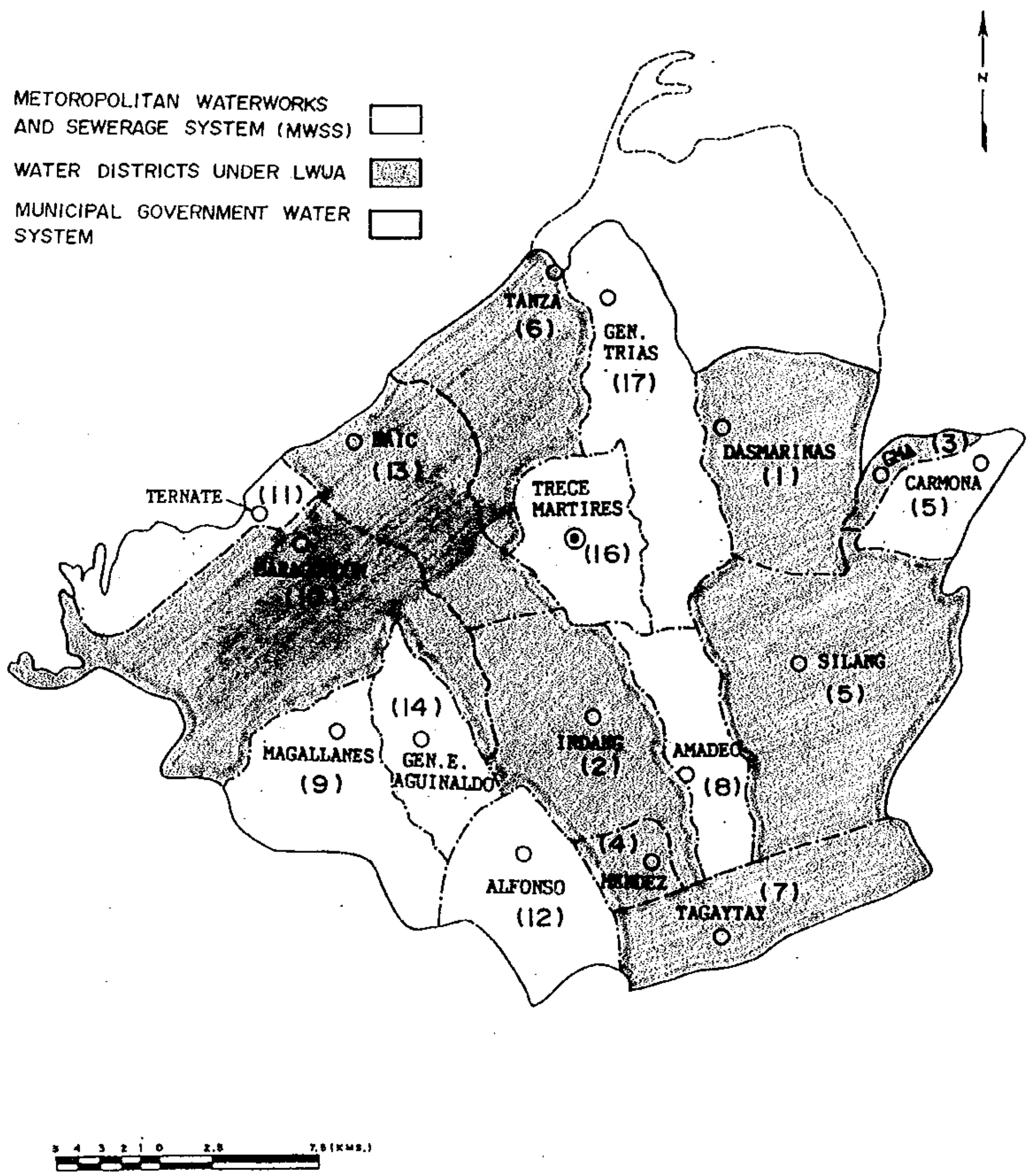
1.4 Study Schedule

The Study started in March, 1994 and was completed in April, 1995. In Phase I, the basic study for the whole Study Area was conducted from March to July, 1994 and in Phase II, the feasibility study for the selected five areas was implemented from August 1994 to April 1995.

1.5 Study Organization

The Study was conducted by the JICA Study Team consisted of KOKUSAI KOGYO Co., Ltd. and NIPPON JOGESUIDO SEKKEI Co., Ltd. with the cooperation of LWUA's engineers. The relationship among JICA, JICA Study Team and LWUA is shown in below. The members of JICA Study Team and counterpart personnel are listed in Tables 1-1 and 1-2.





CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 1-1 ADMINISTRATIVE UNITS AND WATER MANAGEMENT AUTHORITY
JAPAN INTERNATIONAL COOPERATION AGENCY	

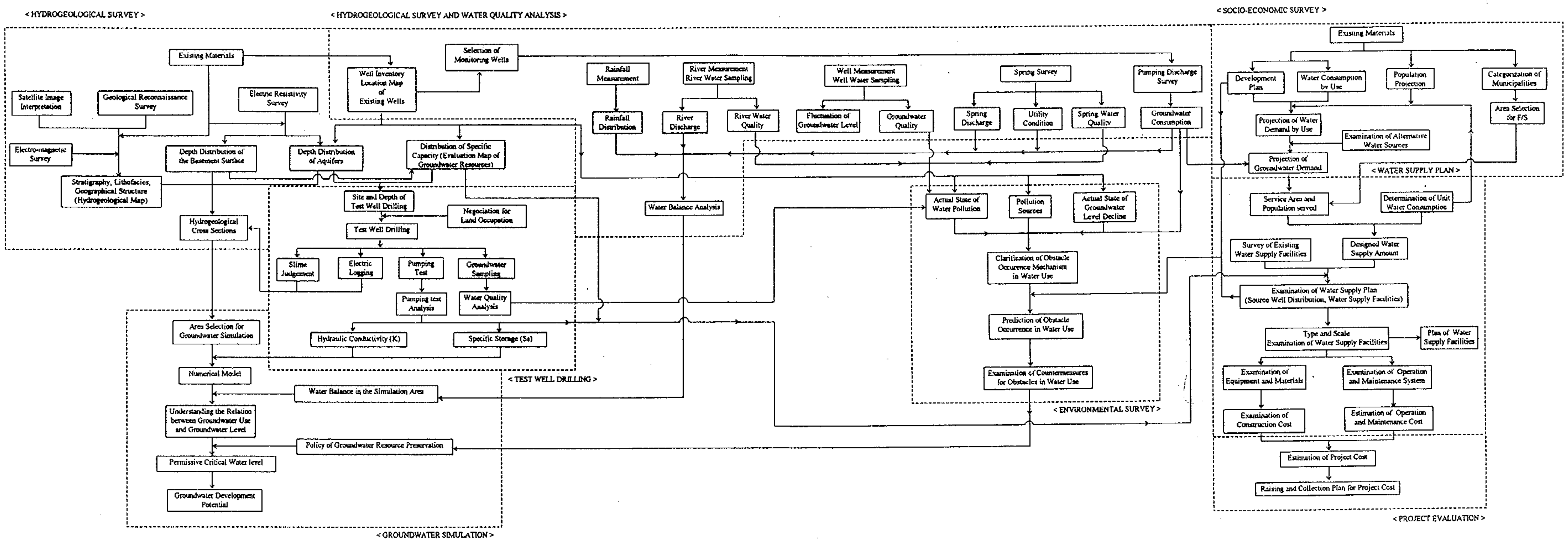


図１－２　調査の構成要素と要素相互の関係

Table 1-1 MEMBER LIST OF JICA STUDY TEAM

NAME	SPECIALTY
AKIRA SUGIYAMA	TEAM LEADER
TAKASHI ARAI	HYDROGEOLOGY
REYNALDO R. MEDINA	HYDROLOGY/WATER QUALITY
KENJI TAKAYANAGI	GEOPHYSICAL PROSPECTING
MITSUO TSUTSUMI	DRILLING SUPERVISION
PEIFENG LEI	ENVIRONMENT
TATSUYUKI KIKUTA	WATER SUPPLY PLANNING
MANABU FUJIKAWA	SOCIOECONOMICS
ANDREW DORMAN	COORDINATION (Phase I)
HIROHISA OHMORI	COORDINATION (Phase II)

Table 1-2 MEMBER LIST OF COUNTERPART PERSONNEL

NAME	SPECIALTY
CIRIO ERNANI CRUZ	TEAM LEADER/HYDROGEOLOGY
ROLAND TAN	WATER SUPPLY FACILITIES
ARISTOTLE DOCTOR	GEOPHYSICAL PROSPECTING
ELI CRUZ	DRILLING AND PUMPING TEST
FELIX DEL CASTILLO	WATER SUPPLY PLANNING
EFREN PEREZ	MESSENGER

2. GENERAL CONDITIONS OF THE STUDY AREA

2.1 Natural Conditions

As shown in Fig. 2-1, the Study Area was divided into three parts based on the topographical features: western, central and eastern. The central part occupies about 70% of the Study Area, forming a vast slope that declines from Tagaytay ridge, which is more than 600 m high, towards northwest. The western part shows a complicated topography with mountains of more than 600 m high in the center. Its slope is steeper than those of the central and eastern parts. In the eastern part, the slope declines towards northeast differing from the central part.

Major rivers in the Study Area are Maragondon, San Juan, Canas, Ilang-Ilang, Imus, etc., and their drainage basin never exceed 300 km^2 in area even that of the biggest one.

The Study Area belongs to the tropical monsoon climatic zone. Wet season is from May to October, and dry season is from November to April. Annual average precipitation is 2,000 mm in the coastal area, while it is 3,800 mm on the upstream part of the slope.

Minimum and maximum monthly mean temperatures are 20°C and 35°C, respectively. Annual average temperature is 25°C.

Primary tropical rain forest occupies less than 10% of the Study Area because of the deforestation that accompanied its development, while the total area of cultivated lands including orchards is seven times bigger than that of the former. Paddy fields are widely distributed in the lowlands below 100 m elevation, and coffee, banana and pineapple plantations are found uplands.

2.2 Socio-economic Conditions

As shown in Table 2-1, the population of the Study Area was 696,000 in 1990 and the population growth rate between 1980 and 1990 was 4.5% annually. Urban population was about 40% of the total population in 1980, and it expanded to about 60% in 1990.

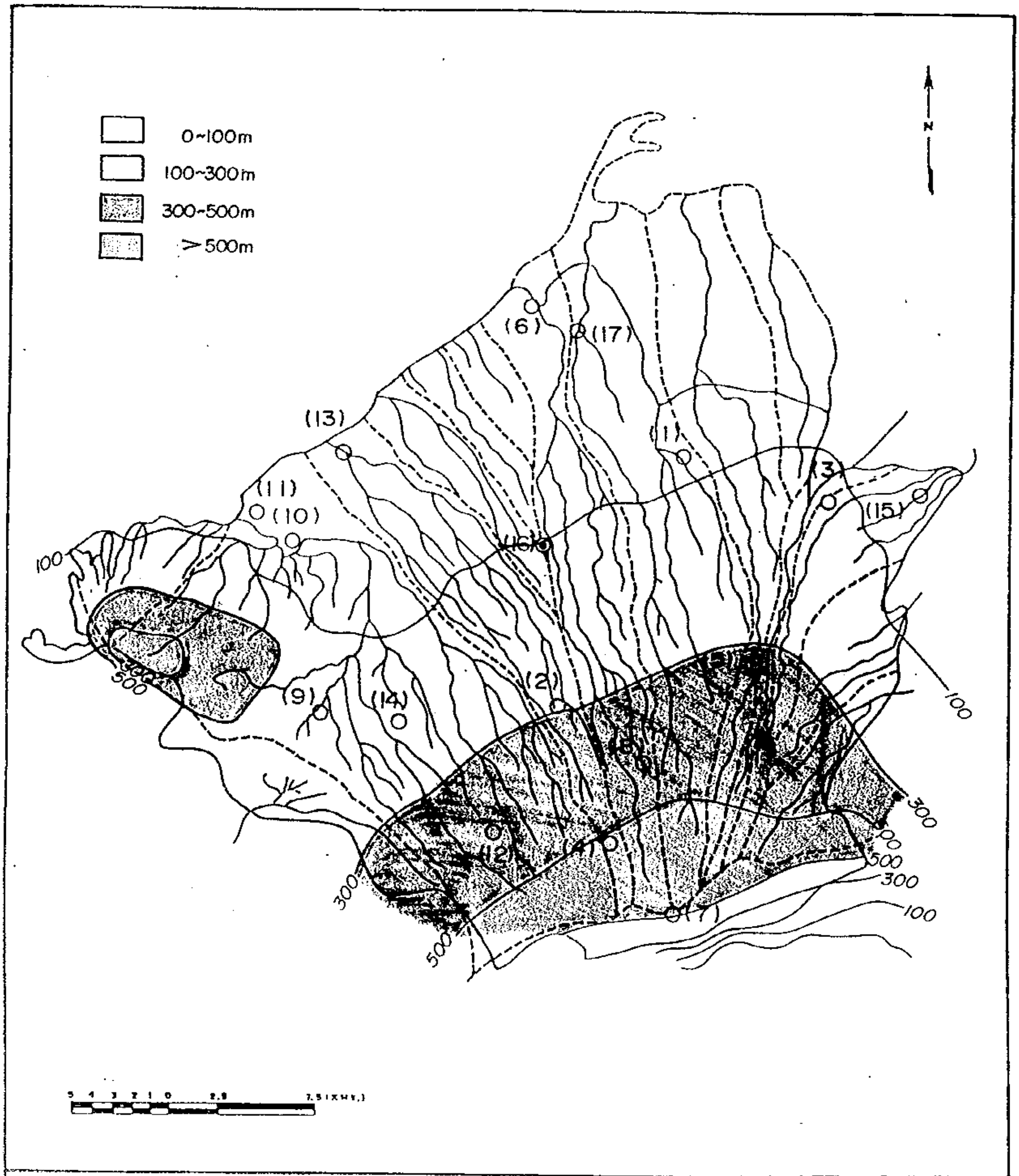
The population in 2000 is projected to be about 1,124,000 for the whole Study Area. The population growth rate is especially high in the industrial zones of Dasmarinas, Silang, Carmona and Trece Martirez.

Agriculture and fishery are still the major industries in almost all the municipalities in the Study Area. But, manufacturing and service industries are recently growing in the eastern area such as in Carmona and Dasmarinas.

As for the land use of Cavite Province, agricultural lands occupied 74% and built-up areas 15% in 1990.

The government classifies the level of water supply service into three (3): Level I with point source, Level II with communal faucets and Level III with individual house connections. In the Cavite Province, the number of households served by Level III in urban areas is less than 35%.

The Study Area has no public wastewater treatment system. Only about 13% of the population have septic tanks. However, most of these septic tanks are not sufficiently maintained and have low efficiency. Further, no solid disposal plant can be found in the Study Area, except for a landfill. Illegal dumping of solid waste to the rivers are practical. Under such circumstances, most rivers in the Study Area are polluted.



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 2-1
JAPAN INTERNATIONAL COOPERATION AGENCY	HEIGHT DISTRIBUTION AND RIVER SYSTEM

Table 2-1 POPULATION AND LAND AREA OF EACH ADMINISTRATIVE UNIT

No.	City/Municipality	Area Size (ha)	Population (1990)			Urban pop./ Rural pop.	Population Density per ha
			Total	Urban pop.	Rural pop.		
1	Dasmarinas	8,234	136,556	136,486	0	-	16.58
2	Indang	8,920	39,294	7,000	32,227	0.22	4.41
3	G. M. A.	938	65,977	65,973	0	-	70.34
4	Mendez	1,667	17,652	17,651	0	-	10.59
5	Silang	15,641	93,790	52,035	41,603	1.25	6.00
6	Tanza	9,630	61,785	37,147	24,607	1.51	6.42
7	Tagaytay City	6,615	23,739	9,230	13,764	0.67	3.59
8	Amadeo	4,790	21,022	6,793	14,220	0.48	4.39
9	Magallanes	7,860	12,556	2,047	10,503	0.19	1.60
10	Maragondon	16,549	22,814	4,546	18,263	0.25	1.38
11	Ternate	4,350	11,981	5,351	6,614	0.81	2.75
12	Alfonso	6,460	28,944	6,795	22,150	0.31	4.48
13	Naic	8,600	51,629	19,992	31,570	0.63	6.00
14	Gen. Aguinaldo	5,103	10,954	3,712	7,242	0.51	2.15
15	Carmona	3,092	28,247	22,339	5,894	3.79	9.14
16	Trece Martirez City	3,917	15,686	5,623	9,346	0.60	4.00
17	Gen. Trias	11,768	52,888	19,370	33,472	0.58	4.49
	Study Area Total	124,134	695,514	422,090	271,475	1.55	5.60

Sources:
(1) Provincial of Cavite Water Supply, Swerage and Sanitation Development Plan 1990-2000
(2) 1990 Census of Population and Housing, Socio-Economic and Demographic Characteristics, NSO

Note: Total population is not equal to the sum of the urban and rural population.

3. HYDROGEOLOGICAL CONDITIONS OF THE STUDY AREA

3.1 Study Method and Work Amount

Collection of existing topographical maps, geological maps, and 166 well data with hydrogeological information as well as field survey, interpretation of satellite image, geophysical prospecting and test drilling four (4) wells with 750 m total depth were conducted to make clear the hydrogeological structure in the Study Area.

3.2 Stratigraphy

Stratigraphic succession of the Study Area is shown in Table 3-1, which was established by the results of field survey focusing on the southern side of Tagaytay Cliff and the results of test drillings. Main lithology of each formation is described in this table.

The lower formations underlain by Caloocan formation are lumped as Basement in Table 3-1, since it is not used as aquifer in the Study Area. Above the Basement are the Caloocan, Talisay, Kaybubutong, Iruhin and Sungay formations, piling up in that order, and most of these formations are in Pleistocene age. Fig. 3-1 is the hydrogeological map of the Study Area.

3.3 Geological Structure and Geological Development History

According to the results of electric resistivity survey, the Study Area is separated from the lowlands, including Laguna de Bay, by a fault with north-south direction. This fault is considered to be an extension of the Marikina fault which extends over 100 km along the eastern margin of Metro Manila. On the southern cliff of Tagaytay idge, several faults with east-west direction are found by electro-magnetic survey.

Judging from the topographical feature around Taal lake as shown in Fig. 3-2 and the results of field survey, Cavite slope is not considered as a primary mountainside of a stratavolcano, but a structural slope formed by tilting movement of the blocks separated by the Marikina fault (with north-south direction) and by the faults (with east-west directions) developed on the southern cliff of Tagaytay ridge.

3.4 Hydrogeological Features of Main Aquifers

Aquifers developing in the Study Area are classified into three: the Upper aquifer, the Middle aquifer, and the Lower aquifer, as shown in Table 3-2.

Lower aquifer is a coarse or medium sandstone layer intercalated in Talisay formation and is developed in the area below 50 m elevation.

Middle aquifer is a conglomerate or coarse sandstone layer intercalated in the lower horizon of Kaybubutong formation and is developed in the area from 50 m to 200 m elevations.

Upper aquifer is a scoria or volcanic conglomerate layer or lava flow intercalated in the middle horizon of Kaybubutong formation and is developed in the area higher than 200 m elevation.

Groundwater potential evaluated by specific capacity of existing wells is shown in Fig. 3-3. Generally, specific capacity is more than 0.5 lps/m in areas with low elevations, while it is less than 0.5 lps/m in high-elevation areas.

Table 3-1 STRATIGRAPHIC TABLE FOR THE STUDY AREA

GEOLOGIC AGE				FORMATION	LITHOLOGY	HYDROGEOLOGICAL CLASSIFICATION	BMGS (1962)
ERA	PERIOD	EPOCH	AGE				
CENOZOIC	QUATERNARY	HOLOCENE		ALLUVIUM	Clay, Sand, Gravel Talus, Terrace Deposits		
		PLEISTOCENE	LATE	Mt. Sungay Lava	Andesite Lava	Upper Aquifer	Taal Tuff
				Iruhin Formation	Pisolite tuff, silt, Pumice tuff		
				Kaybubutong Formation(Upper)	Tuffaceous Sand-silt, pumice, scoria		
				Kaybubutong Formation(Middle)	Andesite lava. Mud flow		
			EARLY	Kaybubutong Formation(Lower)	Gravel and sand, scoria		
					Tuffaceous Sand-silt	Middle Aquifer	Guadalupe Formation
				Tslisay Formation	Gravel and sand, Tuffacious		
					Tuffacious Shale-sandstone	Lower Aquifer	
				Caloocan Formation	Conglomerate		Lobo Agglomerate
					Gravel and sand, Lava		
		PLIOCENE	LATE	BASEMENT	Sand Stone, Shale Limestone Andesite Lava Pyroclastic Rock, Tuff Sandstone	Impermeable layers	Pinamucan Formation Mapulo Limestone
			EARLY				
	TERTIARY	MIOCENE	LATE				Talahib Andesite
			MIDDLE				Dagatan Wacke

Fig. 3 – 1 HYDROGEOLOGICAL MAP OF CAVITE PROVINCE

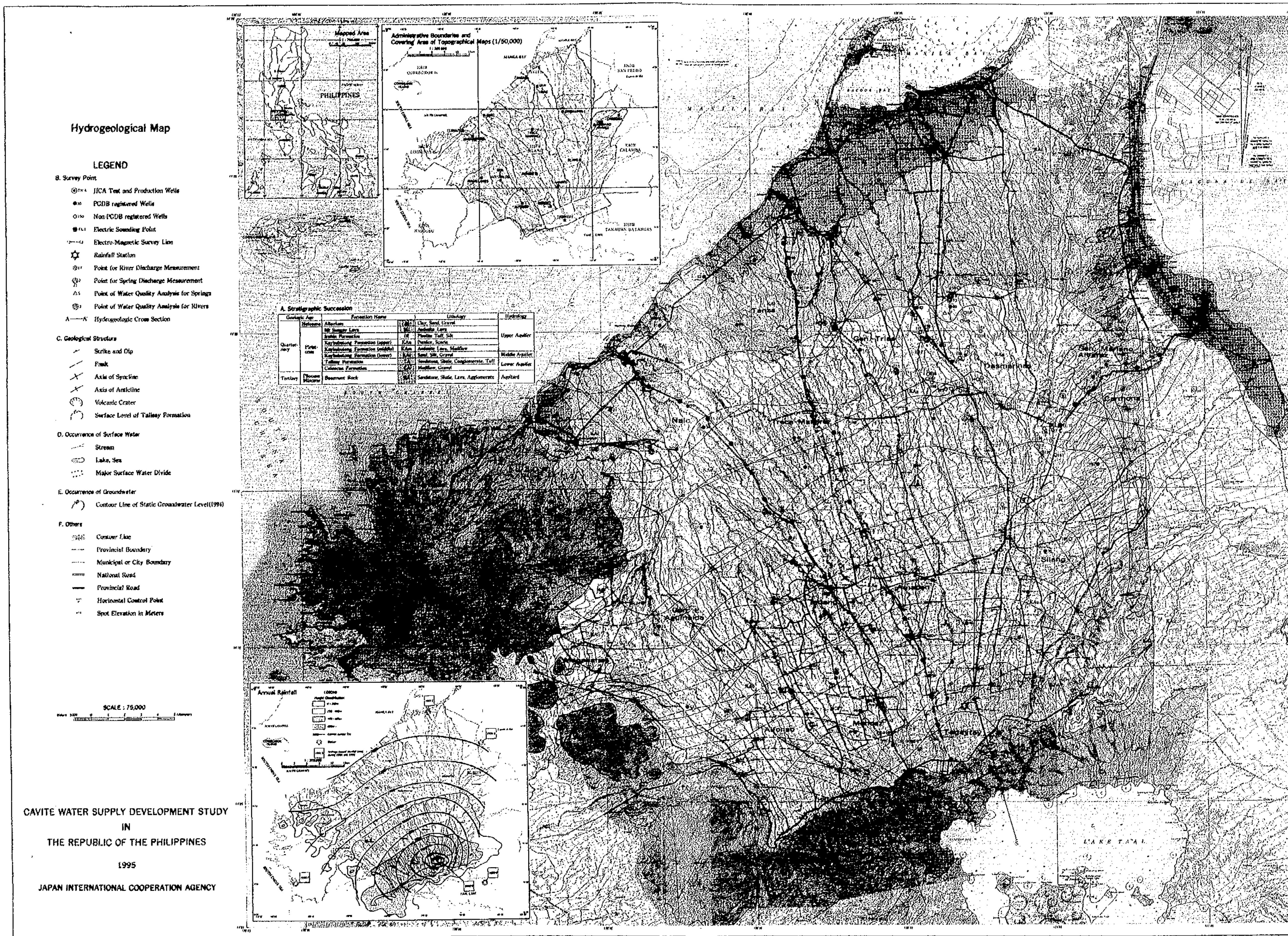


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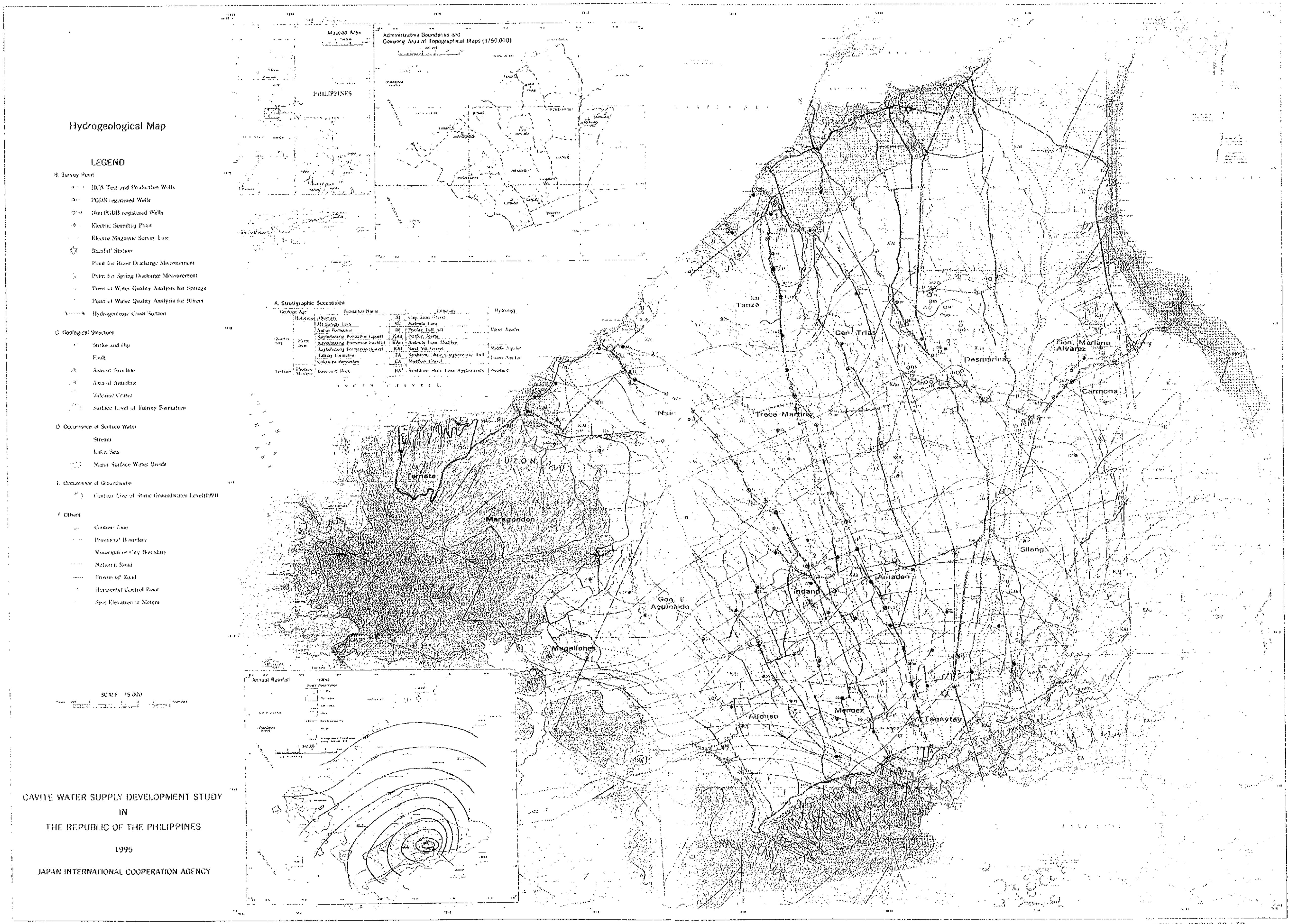
Fig. 3 – 1 HYDROGEOLOGICAL MAP OF CAVITE PROVINCE



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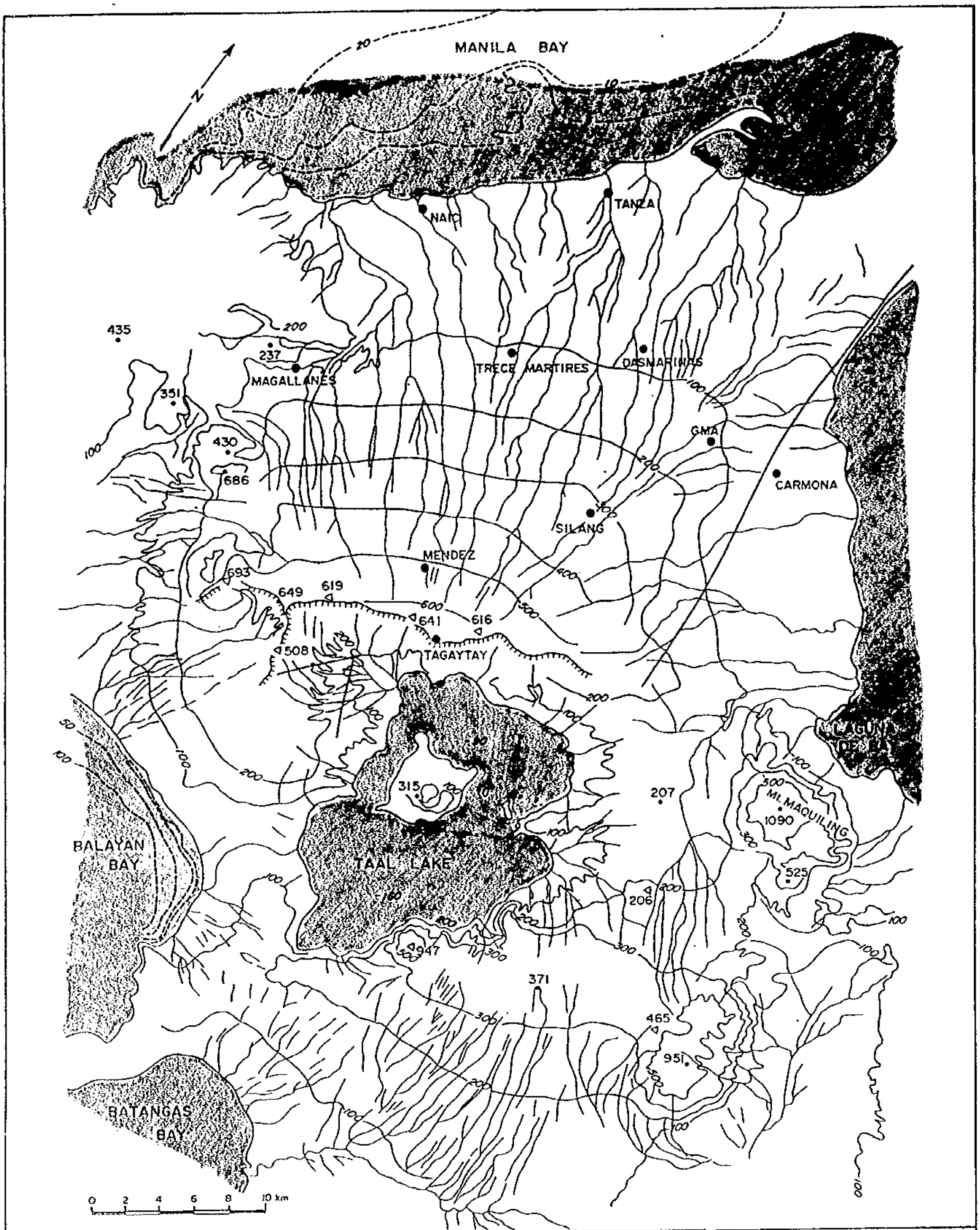
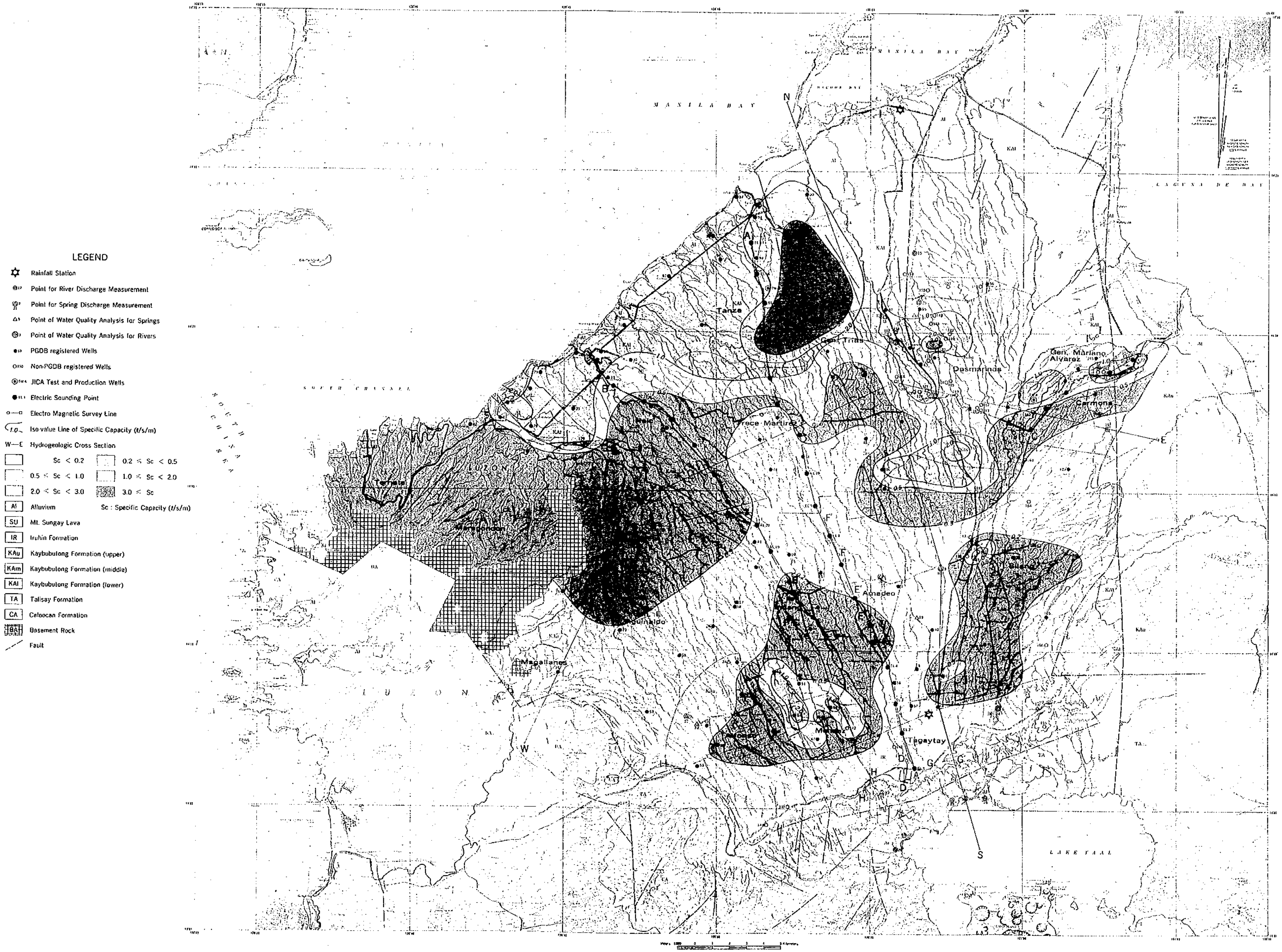


CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 3-2
JAPAN INTERNATIONAL COOPERATION AGENCY	GEOMORPHOLOGICAL MAP AROUND TAAL LAKE

TABLE 3-2 CLASSIFICATION OF THE AQUIFERS DISTINGUISHED IN THE STUDY AREA

	Stratigraphic Horizon	Lithology	Sc (l/s/m)	T (cm^2/s)	Temperature (℃)	Conductivity (μ s/cm)	Resistivity (ohm-m)	Test Well
Upper Aquifer	Middle horizon of Kaybubutong Formation	Scoria, Tuff, Volcanic Conglomerate lava	0.84	15.30	24.5	272	100~180	Mendez
Middle Aquifer	Lower horizon of Kaybubutong Formation	Conglomerate ~Coarse sand	1.60	36.0	29.5	450	20~60	Tanza
			1.007	34.0	26.5	370	20~40	G.M.A
Lower Aquifer	Talisay Formation	Coarse sandstone with gravel ~Medium Sandstone	1.05	22.2	30.2	510	30~50	Naic

Fig. 3-3 EVALUATION MAP OF GROUNDWATER RESOURCES



4. WATER BALANCE AND GROUNDWATER POTENTIAL

4.1 Calculation Method of Water Balance

The water balance of a certain area can be expressed by the following equation.

$$P = Et + R + O + \Delta G + \Delta S + I + M$$

where P is precipitation, Et is evapotranspiration, R is surface runoff, O is the groundwater from aquifers, ΔG is the groundwater storage increment, ΔS is the soil moisture increment, I is the amount of water intercepted and M is the water recharge or depletion due to human activity, all values are in millimeters.

P was calculated using the data obtained from seven (7) PAGASA observation stations distributed in the Study Area and its vicinity. R was estimated using the river discharge data measured at 30 stations established in the Study Area. In addition, groundwater discharge from 20 springs was also measured.

O was calculated using the results of well inventory survey and pumping discharge survey. The PGDB for Cavite was updated by registering the well and hydrogeological data of 81 wells inventoried during the study.

In addition, simultaneous groundwater level measurements in 20 deep wells were conducted in both dry and wet seasons. Furthermore, continuous observation of groundwater level was carried out from June to November, 1994 using automatic water level gage set in five deep wells located in the simulation area.

4.2 Water Balance in the Study Area

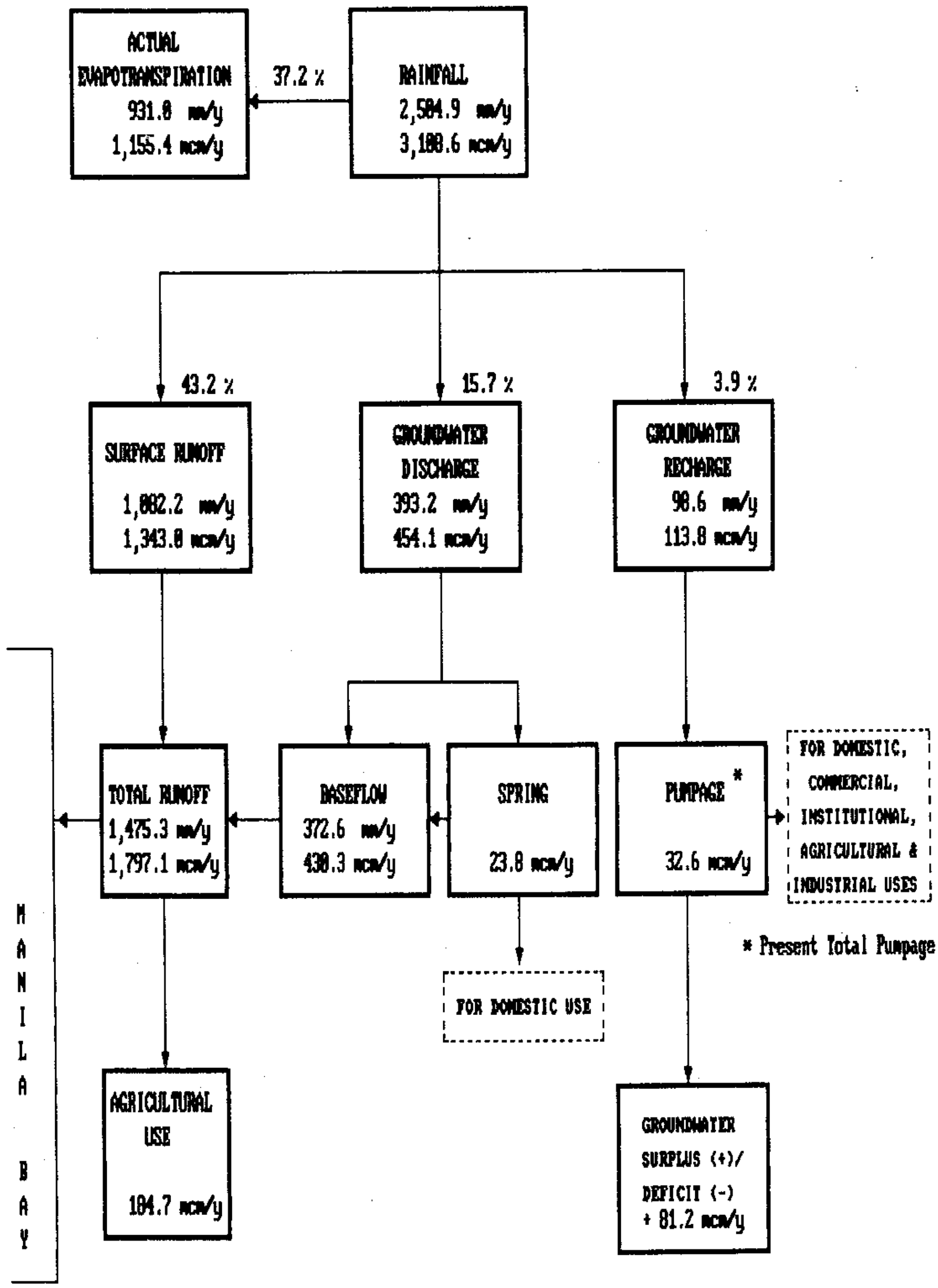
Fig. 4–1 shows the results of the water balance calculation for the whole Study Area. Annual average precipitation in the Study Area is 2,505 mm, and 4.6% (580 lps) of this amount are spring discharges. Average annual surface runoff is 1,082 mm, and 70% of the 1,475.3 mm total runoff flows in wet season and 30% discharges in dry season. Annual average evapotranspiration is 931 mm. Furthermore, the 1993 pumpage was estimated at 32.573 x 10^6 cum.

According to this result, 37.2% of the annual total precipitation is lost to evapotranspiration, 43% to rivers, and 15.7% to baseflow and springs. Only 3.9% is recharged and stored in the aquifers. At present, 33% of the groundwater recharge amount is used for human activities.

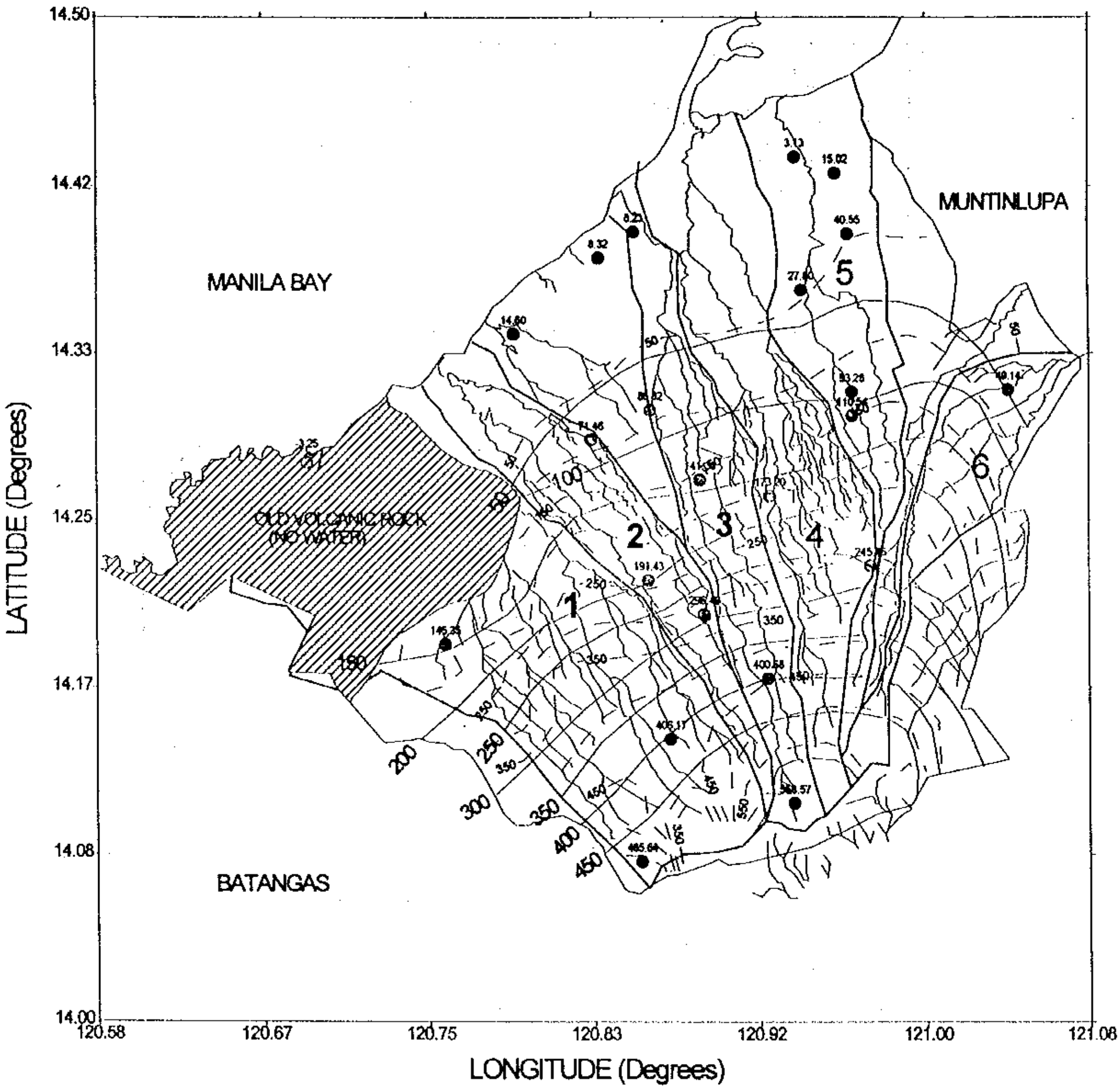
4.3 Groundwater Level and Groundwater Potential

Fig. 4–2 shows the annual average groundwater level drawn based on the results of the simultaneous measurements. Groundwater table is concordant with the topographic surface as a whole, and it is 450 m in Tagaytay, Mendez and Alfonso and about 50 m in Tanza, Maragondon and Ternate.

In the southern part of Alfonso, the groundwater level in the wet season is 7.5 m higher than that in dry season, while it continues to lower due to overpumping in some areas.



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 4 - 1
JAPAN INTERNATIONAL COOPERATION AGENCY	ANNUAL AVERAGE WATER BALANCE FOR THE STUDY AREA



MAJOR RIVER BASIN

1 MARAGONDON RIVER BASIN
2 LABAC RIVER BASIN
3 CAÑAS RIVER BASIN
4 SAN JUAN RIVER BASIN
5 IMUS RIVER BASIN
6 BIÑAN RIVER BASIN

LEGEND:

-- 100 --	TOPOGRAPHIC ELEVATION (Masl)
—— 100 ——	GROUNDWATER LEVEL ELEVATION (Masl)
//////	OLD VOLCANIC ROCK

CAVITE WATER SUPPLY DEVELOPMENT STUDY	**Fig. 4-2**
JAPAN INTERNATIONAL COOPERATION AGENCY	**GROUNDWATER LEVEL AVERAGE, 1994**

5. RELATIONSHIP BETWEEN GROUNDWATER USE AND GROUNDWATER LEVEL FLUCTUATION

5.1 Objective of Groundwater Simulation

Accompanying the development of the Study Area, groundwater use increases and causes water level drawdowns when pumpage volume exceeds recharge amount. Finally the groundwater resource will deplete, and it will become impossible to secure water. Then abolition of existing wells will follow. To avoid such situations, it is necessary to clarify the relationship between groundwater use and groundwater level fluctuation and to predict groundwater level corresponding to future pumping discharge. Groundwater simulation was carried out to examine such relationship.

5.2 Objective Area for Groundwater Simulation

The San Juan River Basin was selected as an objective area for groundwater simulation since groundwater level drawdown caused by overpumping is conspicuous within this basin. This river basin has an area of 155 km^2, comprising the Tagaytay City, Silang, Dasmarinas and Gen. Trias.

5.3 Method of Groundwater Simulation

MODFLOW, a three-dimensional finite element model developed by U.S.G.S., was used for the groundwater simulation.

5.4 Model Construction and Boundary Conditions

Though the simulation area is the San Juan River Basin, the modeled area is larger than the simulation area to improve precision of calculation around its boundaries. The basic grid size is 1 km × 1 km, but larger outside of the basin. Total grid number is 3,483.

Since there are three main aquifers in the Study Area, the simulation model was constructed with three layers. The modeled area was divided into three (3) zones considering the distribution pattern of the main aquifers. Upper, Middle and Lower aquifers are distributed in Zones 1 and 2, Zones 2 and 3, and Zones 1, 2 and 3, respectively.

Boundary conditions of each aquifer were established based on the hydrogeological information.

5.5 Aquifer Parameter

MODFLOW needs the elevation of the upper and bottom surfaces of each aquifer, the aquifer type, porosity, specific storage, hydraulic conductivity, vertical hydraulic conductivity, initial water level and recharge rate as aquifer parameters. These parameters were obtained from the results of the hydrogeological survey, test drilling and well inventory survey.

5.6 Calibration of the Model

The simulated static water level under condition of no recharge and no pumpage was compared with the water level obtained from the simultaneous measurement. Then, the groundwater level calculated with inputted recharge and pumpage data from January to December, 1994 was compared with the water level obtained from the continuous measurement at JICA monitoring stations. During this process, aquifer parameters were maintained constant, and only the boundary conditions were adjusted.

5.7 Examination of the Relationship between Future Water Demand and Groundwater Fluctuation

Future annual average groundwater level was calculated, inputting the projected yearly water demands after 1993. The following three schemes, which are prepared using the projected water demands, were used in the calculations.

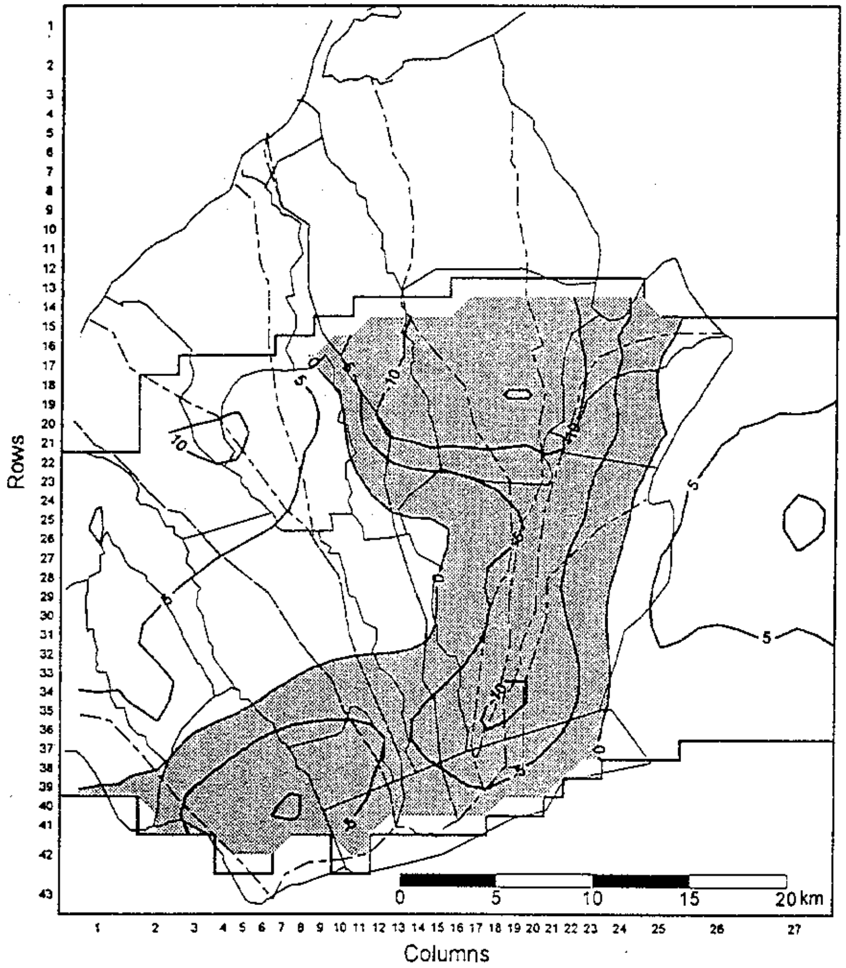
Scheme 1: Future domestic, industrial, commercial and institutional groundwater uses were assumed to increase linearly from 1993 to 2005.

Scheme 2: Industrial water demand is assumed constant at the 1995-level after 1995. Other conditions are the same as those of Scheme 1.

Scheme 3: It is assumed that the annual increases after 1995 in industrial water demands are transferred to the industrial zones along the road from Carmona to Trece Martirez. Other conditions are the same as those of Scheme 1.

Calculation results of the above three schemes are shown in Figs. 5-1, 5-2 and 5-3. As for Scheme 1, groundwater level is estimated to lower by about 10 m in the Upper aquifer and 50 m in the Middle and Lower aquifers by year-2005.

As for Scheme 2, the groundwater level drawdown is almost the same as that of Scheme 1 for the Upper aquifer, but it is confined to 15 - 35 m for the Middle and Lower aquifers. As for Scheme 3, groundwater level depression is broader than that for Scheme 1 in the southern parts of the Middle and Lower aquifers, but no discernible difference is found in the northern parts.

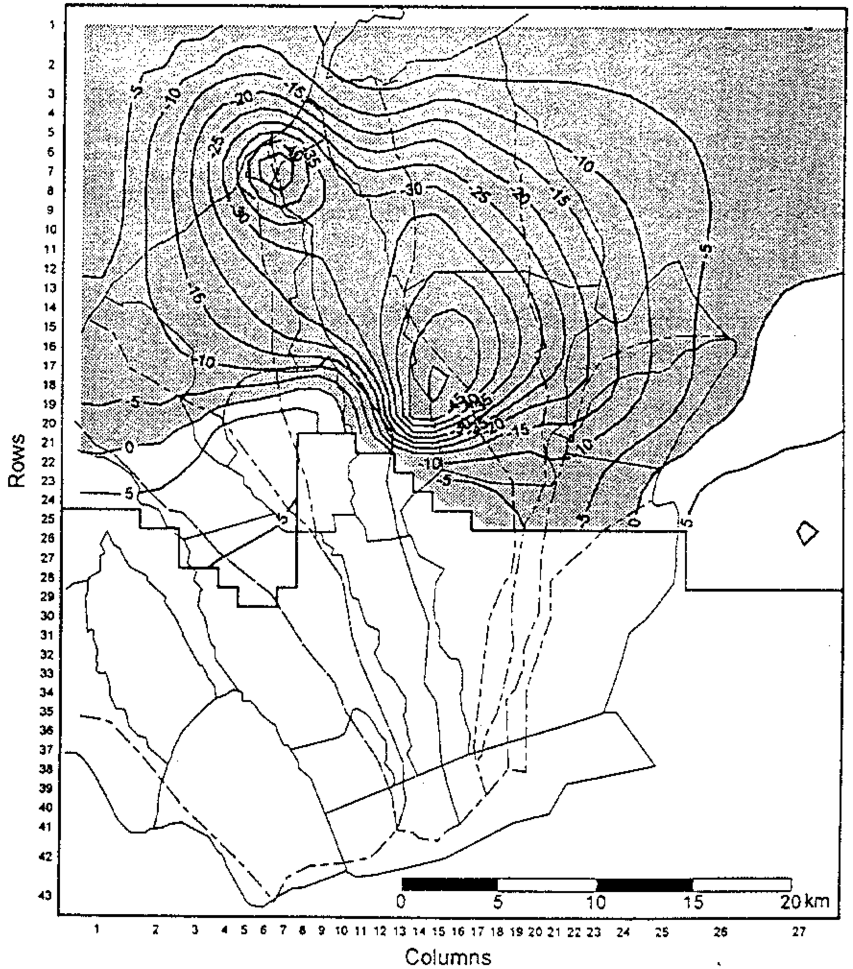


Simulated groundwater level change from 1995 to 2005 (m)

Simulated groundwater level declining area

Boundary of aquifer

Fig. 5-1(a)	SIMULATED GROUNDWATER LEVEL CHANGE IN UPPER AQUIFER BY PUMPING SCHEME 1
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.



Simulated groundwater level change from 1995 to 2005 (m)

Simulated groundwater level declining area

Boundary of aquifer

Fig. 5-1(b)	SIMULATED GROUNDWATER LEVEL CHANGE IN MIDDLE AQUIFER BY PUMPING SCHEME 1
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

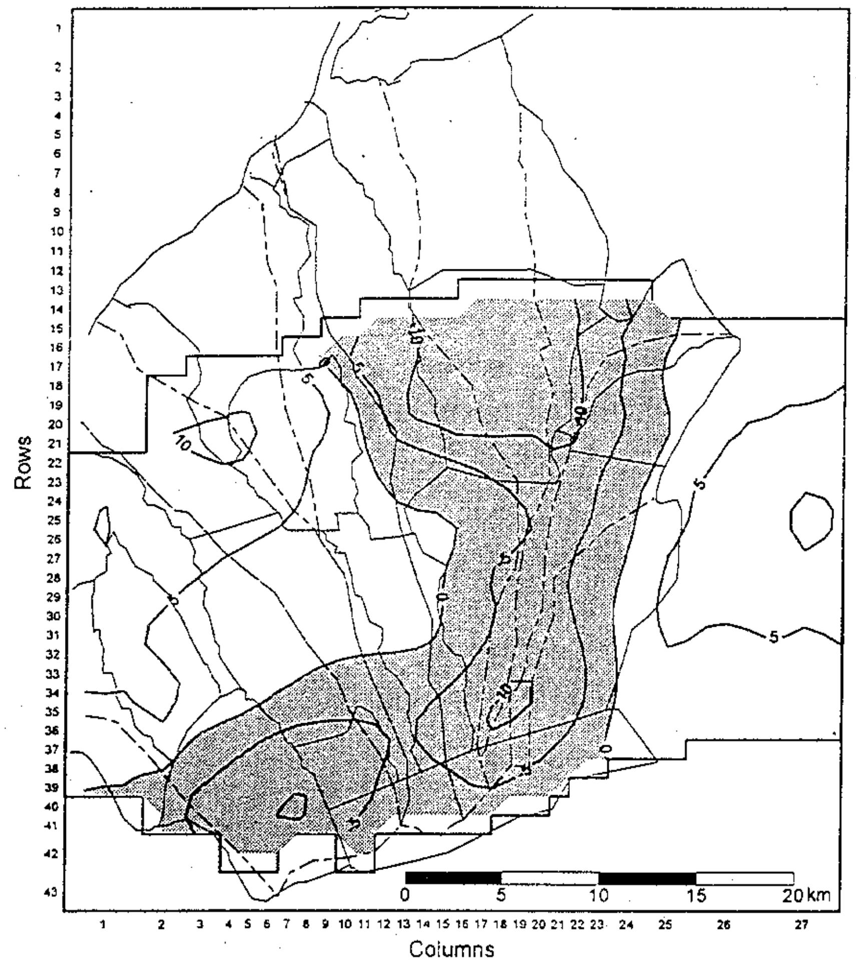


Fig. 5-2(a)	SIMULATED GROUNDWATER LEVEL CHANGE IN UPPER AQUIFER BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

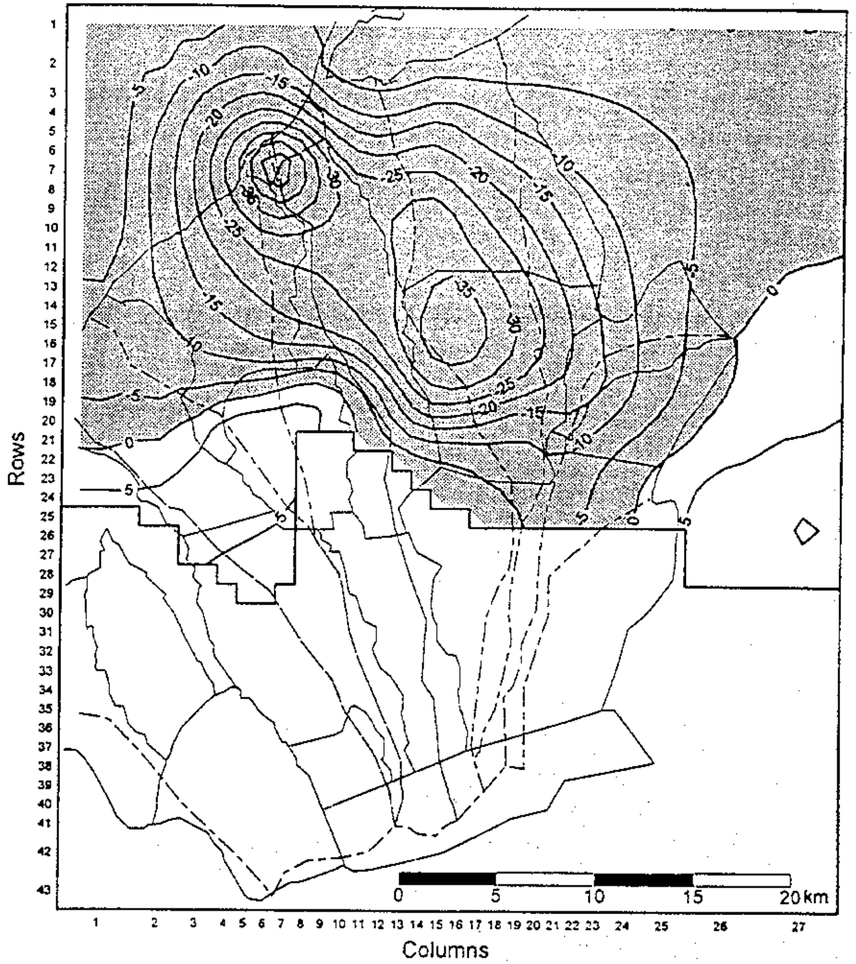


Fig. 5-2(b)	SIMULATED GROUNDWATER LEVEL CHANGE IN MIDDLE AQUIFER BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

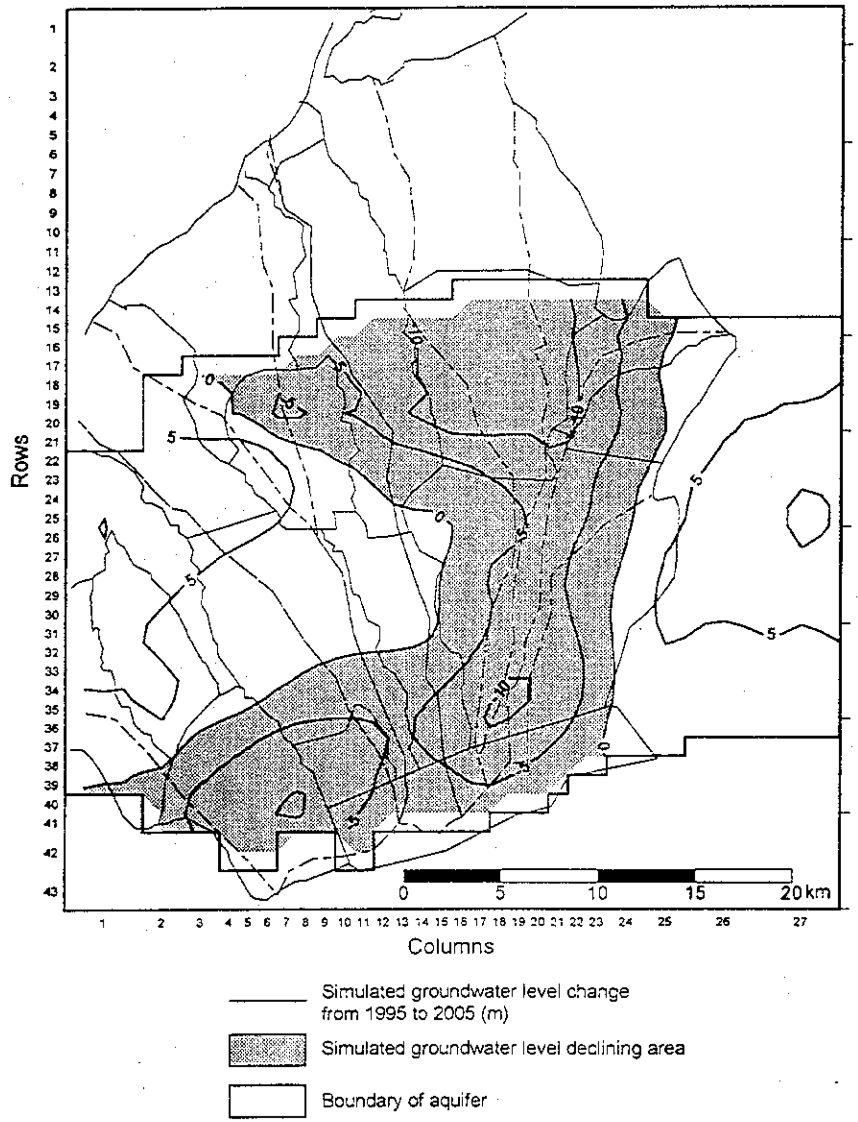


Fig. 5-3(a) SIMULATED GROUNDWATER LEVEL CHANGE IN UPPER AQUIFER BY PUMPING SCHEME 3

CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) | KOKUSAI KOGYO CO., LTD.

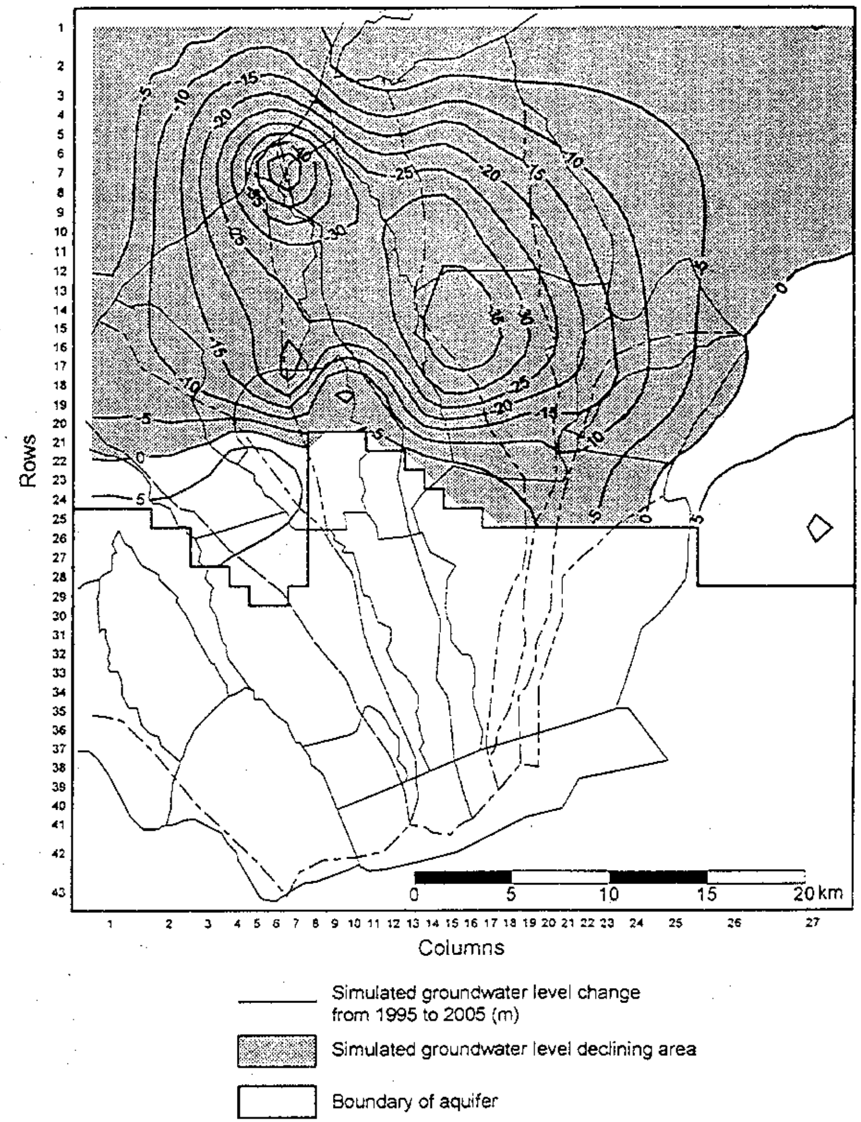


Fig. 5-3(b) SIMULATED GROUNDWATER LEVEL CHANGE IN MIDDLE AQUIFER BY PUMPING SCHEME 3

CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) | KOKUSAI KOGYO CO., LTD.

6. QUALITY OF WATER RESOURCES IN THE STUDY AREA

6.1 Objectives of Water Quality Analysis

River, spring and deep well waters were analyzed to make clear the groundwater flow system and the state of pollution of water resources in the Study Area.

6.2 Samples Collected

Twenty (20) groundwater samples each collected in dry and wet seasons from the existing twenty (20) deep wells, ten (10) river water samples, ten (10) spring water samples and four (4) groundwater samples collected from the test wells were analyzed.

6.3 Analytical Items and Analytical Method

Analytical items are Coliform, Bacteria, Color, Smell, Turbidity (SiO_2), pH, TDS, Hardness, EC, Na, K, Ca, Mg, Zn, Cu, Fe, Mn, As, Pb, Se, Phenols, HCO_3, Cl, SO_4, NO_2-N, NO_3-N and NH_3-N. In addition, Thiodan (Endosulfan) and Cymbush (Cypermethrin), the most popular pesticides used in the Study Area, were analyzed from several samples collected from deep and shallow wells. The analytical method followed that of EPA.

6.4 Analytical Results and Fitness for Water Quality Standards

According to the analytical results, all the spring waters conform to the Class AA standard established by the WSPWA and are potable without treatment.

Almost all the groundwater samples collected from deep wells conform to the Class AA standard on all the analytical items. But, the concentration of Phenol, NO_3-N or Fecal Coliform of several samples fell short of this standard. Pesticides were not detected from both deep and shallow wells.

River waters, on the other hand, mostly do not conform to the NSDW standard on color and pH. As for the other items, more than half of the samples fell short of the NSDW standard.

6.5 Groundwater Flow System

Usually, groundwater quality in the recharge area is similar to that of rain water, and the more the concentrations of HCO_3, Na+K and Ca in the groundwater the longer the storing time. Hexa-diagrams in Figs. 6-1 and 6-2 reflect such tendency, and the zone around 300-m elevation separates the recharge area from the discharge area.

6.6 Pollution of Water Resources

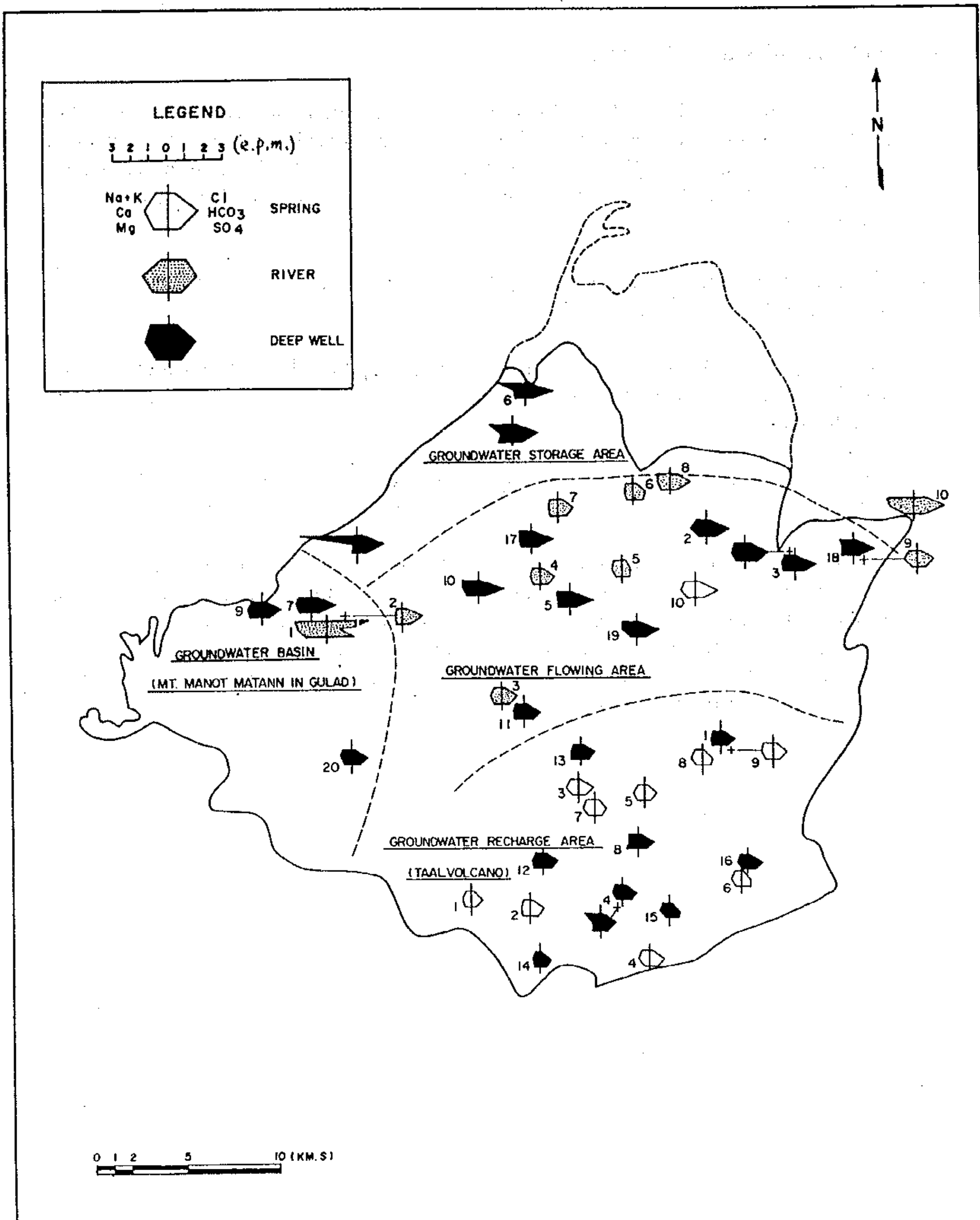
Fig. 6–3 shows the distribution of industries and solid waste disposal sites as possible pollution sources in the Study Area. There are 181 factories in the Study Area, and less than 30% treat their wastewaters. Factories discharging potential harmful substances are 35, and 66% of them have wastewater treatment facilities which have generally low efficiency.

The pesticides widely used in the Study Area are Thiodan and Cymbush, however, both were banned by FPA last year (1994).

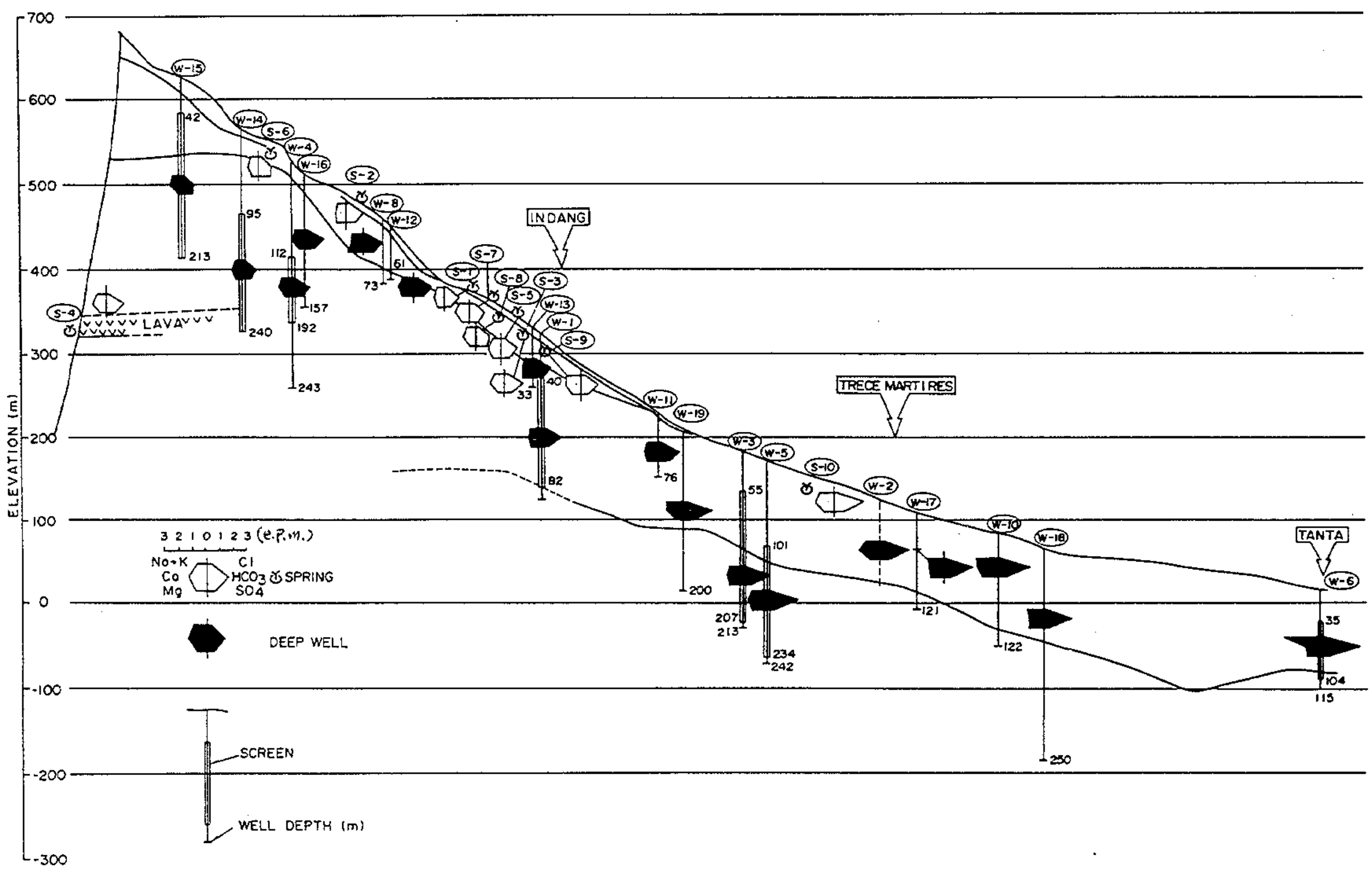
Domestic wastewater is usually discharged through septic tanks to stormwater drainage canals or rivers. But septic tanks have no or low purification function and no sufficient maintenance.

All the solid waste disposal sites are open–dump type, and no measure for leakage is taken.

Fig. 6–4 shows the distribution pattern of groundwater pollution index (Ii) calculated from the analytical results, using spring water quality as the criteria. Except for saline water intrusion, groundwater pollution does not extend over the whole aquifer, but only in limited areas. Such type of pollution usually occurs when wastewater infiltrates the well through its upper section which is not completely protected and when the well is located near to a pollution source.



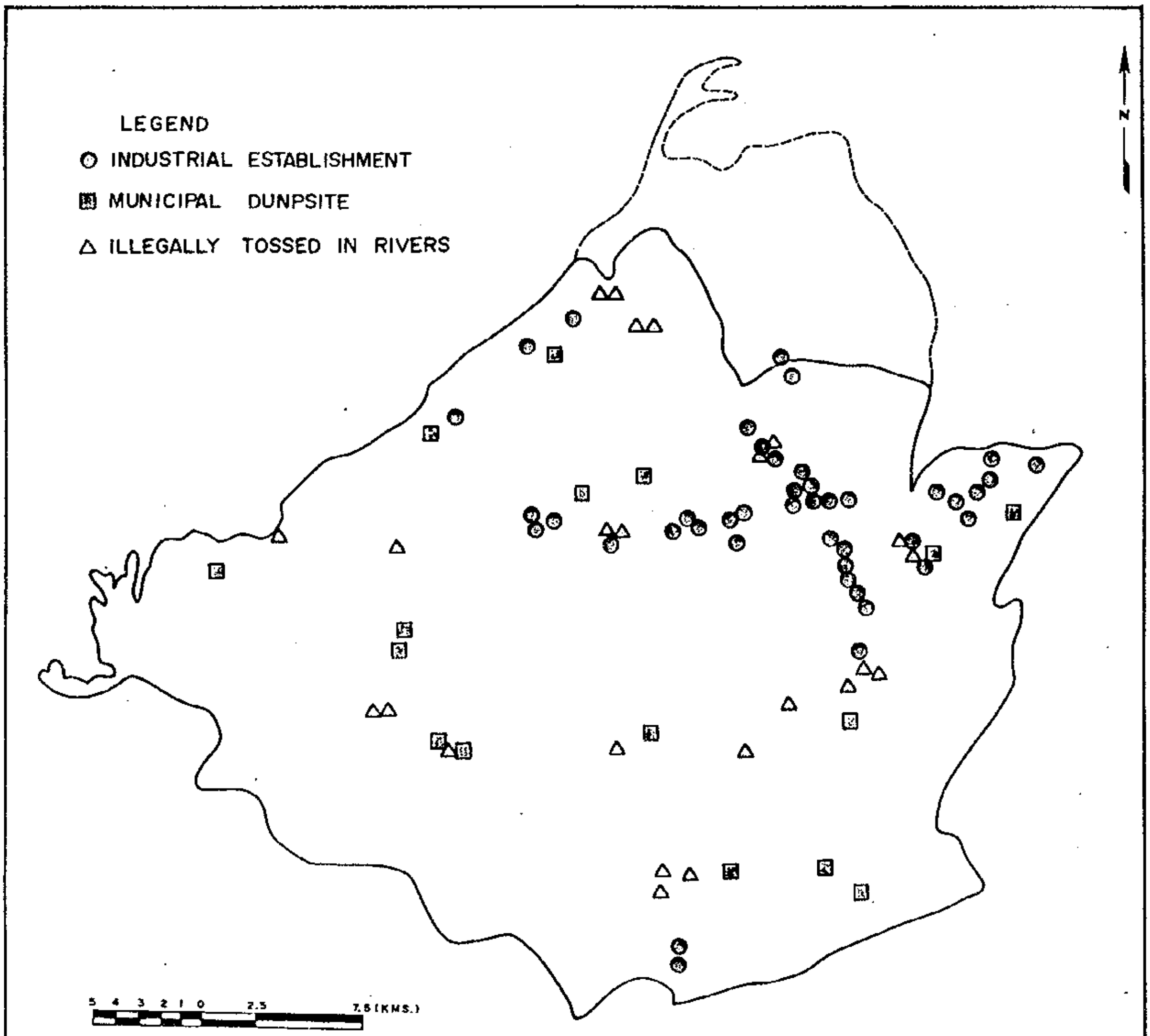
CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 6-1
JAPAN INTERNATIONAL COOPERATION AGENCY	WATER QUALITY TYPE OF WATER RESOURCES IN THE STUDY AREA



CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 6-2
RERATIONSHIP BETWEEN WATER QUALITY TYPE AND DEPTH.

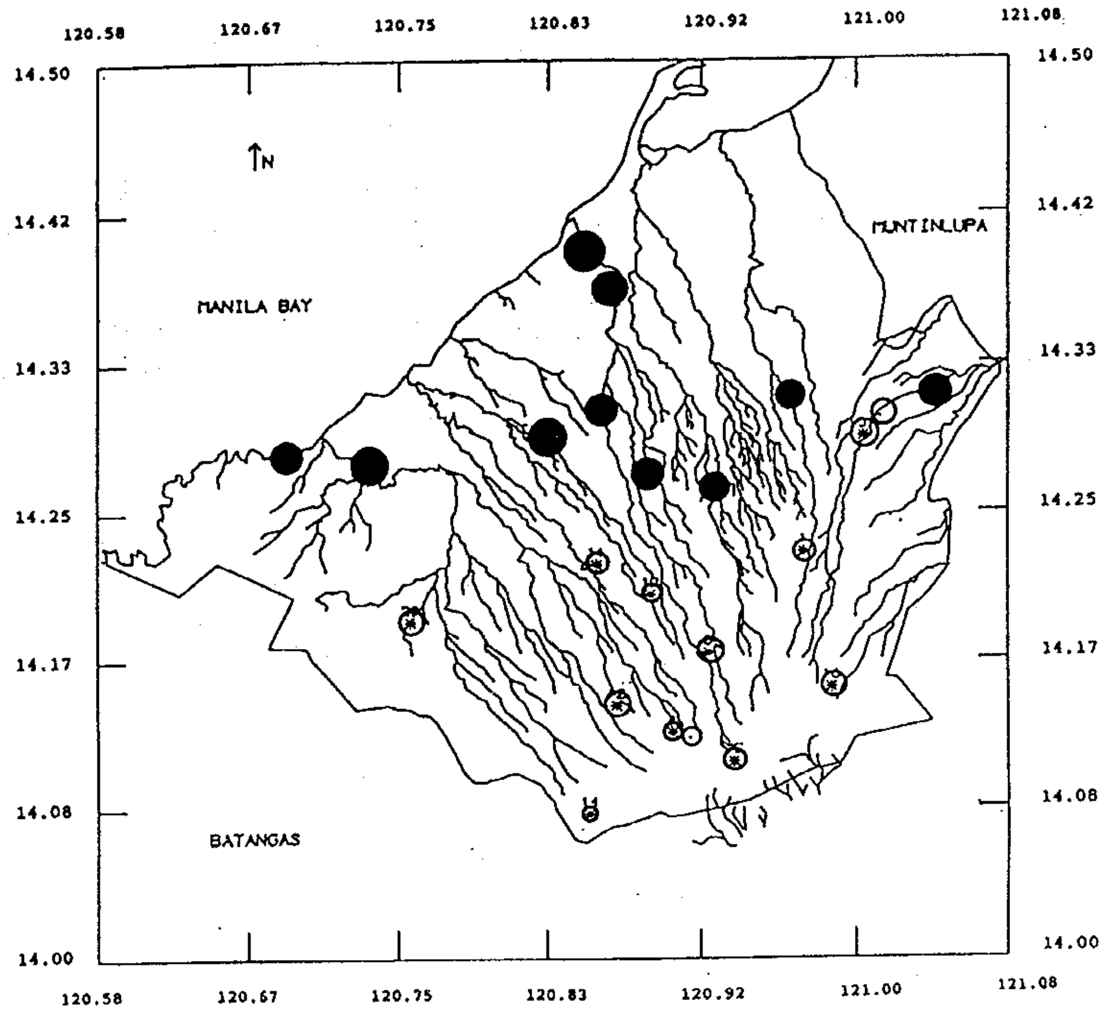


CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 6-3

DISTRIBUTION OF POLLUTION SOURCES



● Deep well with TDS pollution index equal or greater than 1.

○ Deep well with TDS pollution index less than 1.

CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 6-4
JAPAN INTERNATIONAL COOPERATION AGENCY	DISTRIBUTION OF TDS POLLUTION INDEX FOR DEEP WELL WATER

7. SOCIAL SYSTEMS RELATED WITH DEVELOPMENT AND PRESERVATION OF WATER RESOURCES

7.1 Low and Regulations

Planning, implementation and finance of water supply projects outside the service area of Metropolitan Waterworks and Sewerage System (MWSS) are handled by LWUA under the Provincial Water Utilities Act of 1973. But, LWUA is restricted to Level III water supply projects which are financially feasible. The other projects are implemented by the local government in cooperation with the Provincial Planning and Development Coordinator (PPDC) or the Municipality/City Planning and Development Coordinator (MPDC/ CPDC).

Operation and maintenance of water supply facilities are the responsibilities of the Water District or the Rural Waterworks and Sanitation Association, a nonprofit organization of the local government.

7.2 Administrative Organizations

Several government agencies are involved in policy formulation, project planning, implementation and management related to water resources. They are DPWH, DILG, DOH and DENR as central agencies and MWSS, LWUA, WD, RWSA and LGUs as local agencies are involved. The relationship among these agencies is shown in Fig. 7–1.

7.3 Water Quality Standard

Standard for drinking water quality in the Philippines was established in 1976 based on the standard of WHO and revised in 1994.

The first water usage classification and water quality standard was established by NPCC in 1978 and revised in 1990 by DENR. In the new regulation, fresh water area is classified into five (5), and coastal or marine water area is classified into four (4).

Effluent water quality standard was established in 1982 and revised in 1990 by DENR. In the new regulation, it is stated that "No industrial or domestic sewage effluent shall be discharged into class AA and SA waters", and that "no industrial or manufacturing plant shall be operated without the control facilities or wastewater treatment system in good order or in proper operation".

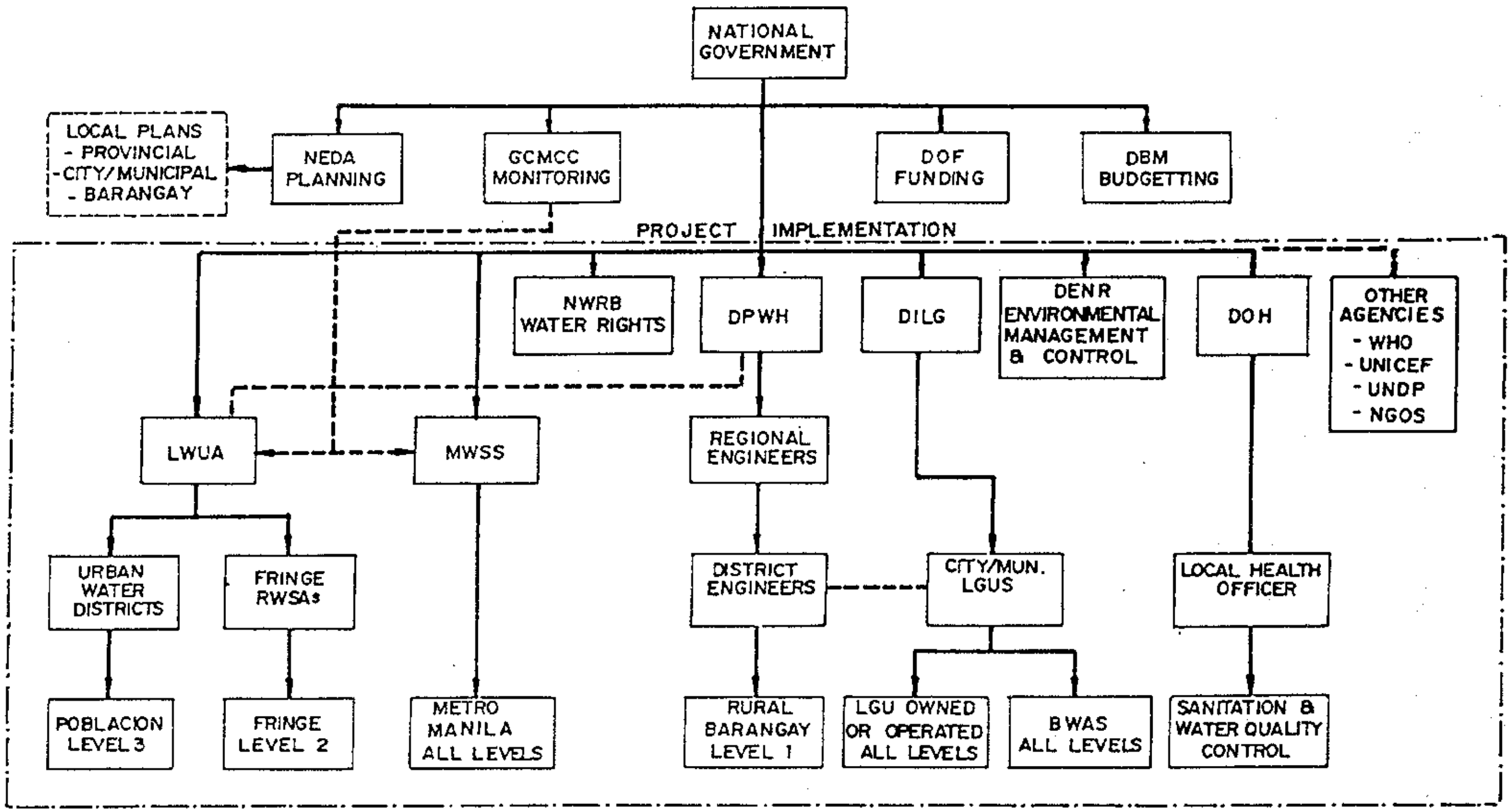
7.4 Water Rate and Its Collection System

In LWUA's methodology manual, several conditions to be considered and three basic methods of computing water rates are shown. LWUA's financial division, however, actually decides water rate according to more simple trial and error calculation in the financial statements program considering the two basic conditions that the water rate should be within 5% of the family income in the low income class and should not be increased by more than 60% in a year and the existing water rate system.

Water rate of WD and RWSA in the Study Area in March 1994 is shown in Table 7-1.

Water tariffs are collected in a monthly basis in response to the bill through meter reading.

There are considerable amount of unaccounted water due to illegal connection, faulty meters, lack of meters and other causes. Then the Water District in the Study Area are aiming to reduce the ratio of the unaccounted water in the year 2000 to about 20-25%.



CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 7–1
ADMINISTRATIVE ORGANIZATIONS RELATED WATER RESOURCES FUNCTIONAL RELATIONSHIPS

Table 7-1 Water Rates in the Study Area (1994)

(1) Water Districts

Unit: Peso

No.	Water Districts	Minimum Charge 1-10 cum	Commodity Charge 11-20	21-30	31-40	41-50	51 above
1	Dasmarinas I	35.00	4.00	4.75	5.75	6.90	6.90
1	Dasmarinas II	35.00	4.35	4.60	5.00	5.65	6.70
2	Indang	48.00	5.00	6.00	7.00	7.00	7.00
3	G. M. A.	80.00	8.80	9.20	11.50	11.50	11.50
4	Mendez	95.00	10.00	10.75	11.75	11.75	11.75
5	Silang	50.00	5.30	6.30	7.45	7.45	7.45
6	Tanza	45.00	4.50	4.65	4.75	4.75	4.75
7	Tagaytay City	110.00	5.80	7.05	9.05	11.85	13.55
10	Maragondon	45.00 *	2.00	2.50	3.00	3.00	5.00

Source: Local Water Utility Administration (LWUA)
Note: *Less than 15 cum is 45 peso and 2 peso is charged between 16-20 as commodity charge.

(2) RWSA and LGU

Unit: Peso

No.	Municipality/City	Rates	Remarks
8	Amadeo	50.00	Minimum Charge per month
9	Magallanes	40.00	Flat rate for Level III per month; 30.00 peso for Level II
12	Alfonso	50.00	Flat rate per month
13	Naic	30.00	Flat rate per month
14	Gen. Aguinaldo	2.84	per cubic meter
16	Trece Martirez City	2.40	per cubic meter

Source: JICA Study Team; Based on the Survey of Existing Water Supply Facilities

8. EXISTING WATER SUPPLY SYSTEMS

8.1 Study Methods

The Study Team conducted a survey on existing water supply facilities, including operation and maintenance, through questionnaires, actual interviews and visual inspection.

8.2 Problems of Existing Facilities and Recommended Future Plans

A summary of the surveyed data from existing water supply system in poblacion and adjacent barangays is presented in Table 8-1. As shown in this table, there are significant differences in terms of capacities, facilities and operation and maintenance conditions.

In the municipality of Dasmarinas, the present Level III service area covers 73 barangays with a total served population of about 170,000. The total length of transmission pipelines is approximately 186 km. In the other municipalities, such as Ternate, Carmona and Gen. Trias, there is no existing piped water system. Most of the residents rely on shallow wells. For those municipalities located upland, deep wells and springs are the major sources of water supply.

Considering the rapid population growth in the municipalities of Dasmarinas and G.M.A., the development of new water sources and expansion of existing water supply systems are necessary. Rehabilitation of the existing water supply system is necessary in the municipalities of Indang, Naic and Gen. Aguinaldo since a leak of water and decrepit facilities are remarkable. Moreover, in other municipalities such as Indang, Tanza, Amadeo and Gen. Aguinaldo, fee collection is low due to lack of personnel; correspondingly, operation and maintenance system is inefficient. In this regard, there is a need to strengthen the present organization of such water districts.

Table 8-1 SUMMARY OF EXISTING WATER SUPPLY FOR POBLACION AND ADJACENT BARANGAYS

NO.	STUDY AREA	SYSTEM SCALE			WATER SUPPLY FACILITIES						WATER MANAGEMENT			IMPROVEMENT PROGRAM
		Level	Service Area	Population	Source	Pumping Facilities	Pipelines (km)	Storage	Treatment	Service Connection	In-Charge	Water Use	Min. Water Fee	
1	DASMARINAS	Level III	Poblacion 73-barangays	169,556	Spring -1 Deep Well-27 units	Pumping stations -27	186 km	Elevated -22 Ground -2	-	Domestic -20693 Commercial -1480 Inst -223	Dasmarinas Water District	Domestic/ Commercial/ Institutional	P 35/mo.	Water District recently availed to a loan from LWUA (1987-1990)
2	INDANG	Level III	Poblacion 1-barangay	1,100	Spring-2	Pumping stations -2	7.345 km	Ground -2	None	Domestic -905 Commercial -104	Indang Water District	Domestic/ Commercial	P 48/mo.	Water district prepared an Engineering Study (Nov. '93) for the proposed improvement program
3	G.M.A.	Level III	Poblacion 23-barangays	20,504	Spring-1 Deep Well-8	Pumping station -8	17.8 km	Elevated -4 Ground -1	None	Domestic -3648 Commercial -70 Inst -26	GMA Water District	Domestic/Comm- ercial/Institutional	P 40/mo.	Water district prepared an Engineering Study (Jul '92) for the proposed Improvement/Expansion program.
4	MENDEZ	Level III	1-barangay	4,121	Deep Well-1	Pumping station -1	6.8 km	Ground -1	None	Domestic -783 Commercial -10 Inst -8	Mendes Water District	Domestic	P 25/mo.	Water district prepared an Engineering Study (Apr. '93) for the proposed improvement program
5	SILANG	Level II/III	Poblacion 9-barangays	45,168	Spring-1 Deep Well-10	Pumping station -13	122.6 km	Ground -1 Elevated -6	None	Domestic -3434 Commercial -169	Silang Water District	Domestic/ Commercial	P 50/mo.	Water district prepared an Engineering Study (Jul '93) for the proposed improvement program
6	TANZA	Level III	Poblacion	1,315	Deep Well-1	Pumping station -1	10.34 km	Elevated -1	None	Domestic -210	Tanza Water District	Commercial	P 45/mo.	Tanza Water District was created in 1988 and has started operation only this year
7	TAGAYTAY	Level III	Poblacion 17-barangays	13,270	Spring-3	Pumping station -5	48.98 km	Ground -1	None	Domestic -2371 Commercial -140 Inst -41	Tagaytay Water District	Domestic/ Commercial	P 110/mo.	Water district prepared an Engineering Study (Mar '92) for the proposed improvement program
8	AMADEO	Level II/III	Poblacion 8-barangays	4,042	Deep Well-1	Pumping station -1	2.5 km	None	None	-	Municipal Water Supply	Domestic	P 50/mo.	The municipal government intends to rehabilitate the pipe network but does not have the budget
9	MAGALLANES	Level II/III	Poblacion 4-barangays	4,833	Spring-2	None	1.5 km	Ground -2	None	-	Municipal Water Supply	Domestic	P 30/mo.	The municipality has no immediate plan to expand the system
10	MARAGONDON	Level III	Poblacion 6-barangays	3,800	Deep Well-1	Pumping station -1	9.82 km	Elevated -1	None	624	Maragondon Water District	Domestic	P 45/mo.	Water district prepared an Engineering Study (Sep '92) for the proposed improvement program
11	TERNATE	Level I	-	-	Private wells	-	-	-	-	-	-	-	-	The municipality has no plans to put up a piped water system
12	ALFONSO	Level II/III	Poblacion	5,300	Deep Well-2 Spring-1	Pumping station -2	1.70 km	None	None	520	Municipal Water Supply	Domestic	P 50/mo.	Municipal government is presently rehabilitating the system
13	NAIC	Level II/III	5-barangays	2,950	Spring-1	None	8.53 km	Intake box	None	Domestic -558	Naic Water District	Domestic	P 30/mo.	The present association is intending to convert the system to Water District and will include Poblacion in the proposed expansion
14	GEN. AGUINALDO	Level II/III	Poblacion 2-barangays	6,694	Spring-1	None	10 km	Intake box	None	-	Municipal Water Supply	Domestic	P 25/mo.	The system is presently undergoing major rehabilitation
15	CARMONA	Level I	-	-	-	-	-	-	-	-	-	-	-	The municipal intends to create a Water District due to the industrialization of the area
16	TRECE MARTIRES	Level III	Poblacion 4-barangays	7,242	Deep Well-4	Pumping station -4	4.8 km	None	None	1,107	City Water Works System	Domestic/ Commercial	P 36/mo.	City government has allotted a budget for rehabilitation works
17	GEN. TRIAS	Level I	-	-	Private Wells	-	-	-	-	-	-	-	-	Creation of Water District is being studied by Municipal Council

9. BASIC POLICY FOR WATER SUPPLY DEVELOPMENT

9.1 Future Socio-economical Framework in the Study Area

The Study Area, especially its eastern part, is rapidly changing from agricultural to industrial/residential zone in the last ten years. The Provincial Development Plan of Cavite (1990-2000) emphasizes total development through industrialization, agricultural modernization and rapid urbanization. The development plan for each municipal/city also intends to have a balanced development of agriculture, industry and tourism.

Fig. 9-1 shows the existing land use, while Fig. 9-2 shows the future land use plan reflecting the above mentioned policy.

9.2 Water Demand Projection in 2005

Table 9-1 shows the projected population from 1990 to 2005 as estimated from NSO's data. As for domestic water use, the demand projection is based on the estimated population by level of water supply system in 2005 and the unit consumption level. Unit consumption level is assumed at 30 lpcd for Level I, 80 lpcd for Level II and 130 lpcd for Level III. The estimated domestic water demand in the year 2005 amounts to 40,063 x 10^3 cum.

Commercial water demand was estimated from the number of commercial connections and the unit consumption level. The former was assumed for every 100 residents and the latter was assumed at 1.0 cum/day (1.5 cum/day for Tagaytay only). Institutional water demand was estimated from the number of institutional connections and the unit consumption level. The former was assumed for every 1,000 residents and the latter was assumed at 3.0 cum/day. The total estimated demand for commercial and institutional water amounts to 1,432 x 10^3 cum.

Most of the major industries in the Study Area are located in the large-scale industrial estates. Industrial water demand was estimated by assuming that all the lots in the existing industrial estates shall all be occupied by the year 2005. The unit consumption level was assumed at 55 cum/day/ha. The estimated industrial water demand in the year 2005 amounts to 17,566 x 10^3 cum.

Agriculture will still depend on the river flows in the future as in the present, and it is assumed at 145,000 x 10^3 cum, the same as the present level.

Table 9-2 shows the water demand in the year 2005 by municipality/city and by type of use as calculated by the above mentioned methodology. According to this table, commercial, institutional and industrial water demands occupy 37% of the total water demand, which is higher than the average ratio of 15 - 20% for areas under LWUA's jurisdiction.

9.3 Alternative Water Resources

The Study Area is poor in surface water. Especially in high elevation area, river water is unreliable quantitatively. Some rivers have big discharge downstream, but if the water districts use river water for domestic use, a conflict of water rights may arise since NIA utilizes a considerable water amount for irrigation. Further, river water use as domestic water requires an expensive treatment because most rivers are polluted as mentioned in 2.2, and the cost of treatment will result to high water rate.

Though 129 springs are known in the Study Area, only those with large discharge are being utilized as source for water supply.

Based on the results of the water balance calculations, there is just enough groundwater for new development in the Study Area as a whole. But, pumpage amount has exceeded recharge amount in the San Juan and Imus River Basins, resulting in continuous lowering of groundwater level.

There are plans to use the water of Taal lake or Laguna de Bay for domestic or agricultural use, but they may not be feasible because of an inferior grade of water quality and large expense for water conduction facilities.

9.4 Examination of the Impact on the Environment

Typical impacts on the environment caused by groundwater development are groundwater level drawdown, saline water intrusion and ground subsidence. The former two are widely found in Metro Manila and tangible signs are also observed in the Study Area. Ground subsidence, however, has not occurred in the Philippines, and it will remotely occur in the Study Area, judging from the geological conditions. Consequently, environmental impact assessment should be conducted on groundwater level drawdown and saline water intrusion.

9.5 Basic Policy for Groundwater Management in the Study Area

The following basic policies for groundwater management are recommended, taking into consideration the hydrological and hydrogeological conditions and the existing organizations and systems.

(1) Establishment of Priority for Groundwater Use

As already mentioned, groundwater level drawdown caused by over pumpage is conspicuous in the Study Area, and the pumpage control is therefore indispensable.

Though a large amount of groundwater is pumped up for industrial use, the priority of groundwater use should be given to domestic demands, since drinking water is indispensable for human life and groundwater is the safest water resource in the Study Area.

Viewed in this light, it is necessary to form consensus between residents and enterprises on the priority of groundwater use.

(2) Establishment of the Committee for Groundwater Management

Though groundwater development is permitted by NWRB, criteria for authorization is not always clear. Further, Water District can order an industry to stop pumping when it becomes difficult for them to pump up groundwater for domestic use. But, no concrete procedure in such a case exists.

The residents want to use groundwater sustainably. Thus, it is necessary to establish groundwater management committee, to establish a permissive yield (or permissive water level), to monitor groundwater level and water quality and to re-examine the regional development plan.

(3) Examination of Permissive Yield or Permissive Critical Water Level

Permissive yield (or permissive critical water level) is defined as the critical pumpage amount through which benefits brought about by pumpage exceeds risks. It cannot be decided by scientific method alone. Thus, the final decision on setting the permissive yield is judged by the residents themselves.

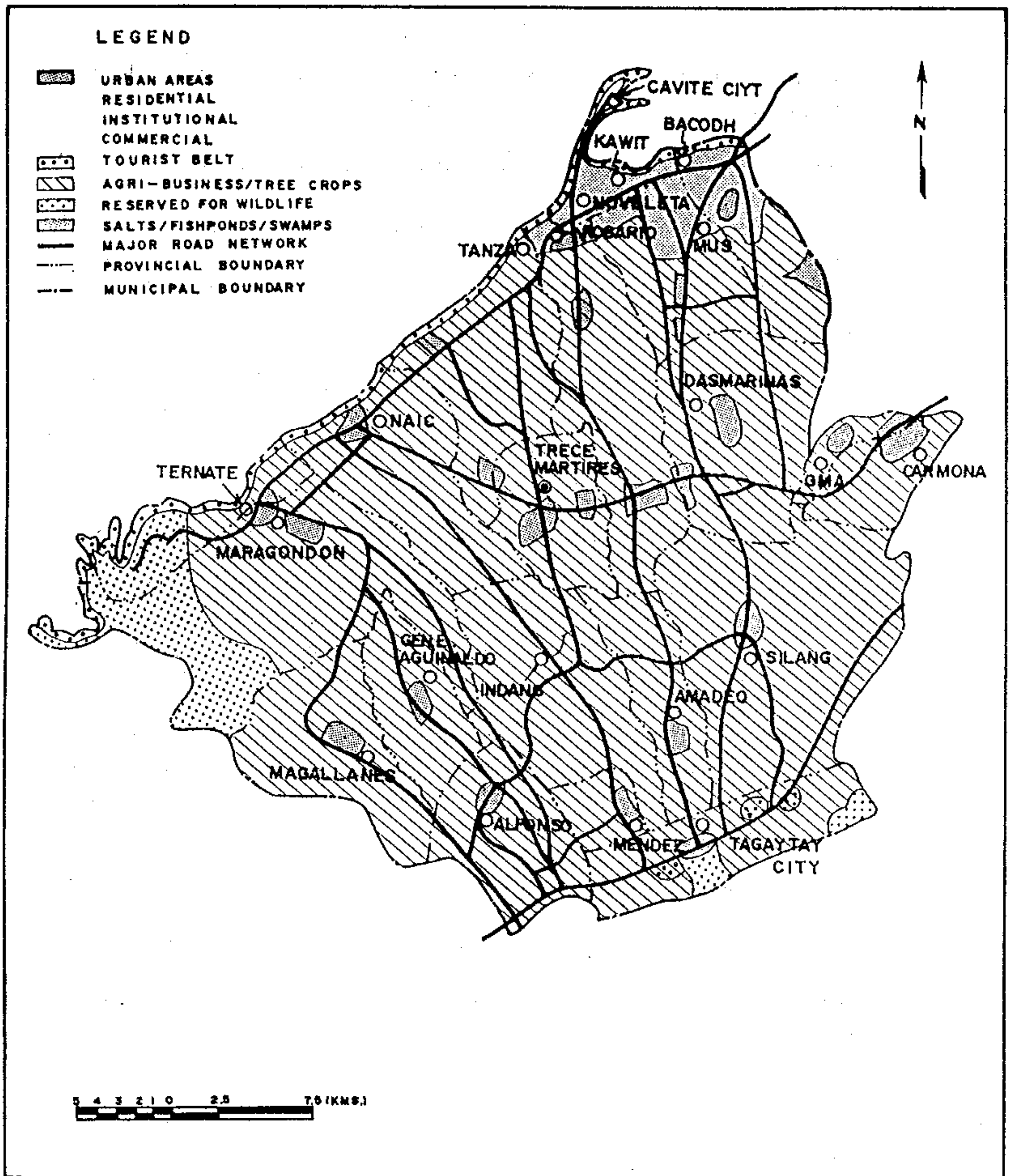
The committee for groundwater management should present the data on the relationship between pumpage and groundwater level and always monitor them. Further, it is also necessary to predict future groundwater level by simulation method using the results of monitoring.

(4) Re-examination of Regional Development Plan and Land Use Plan

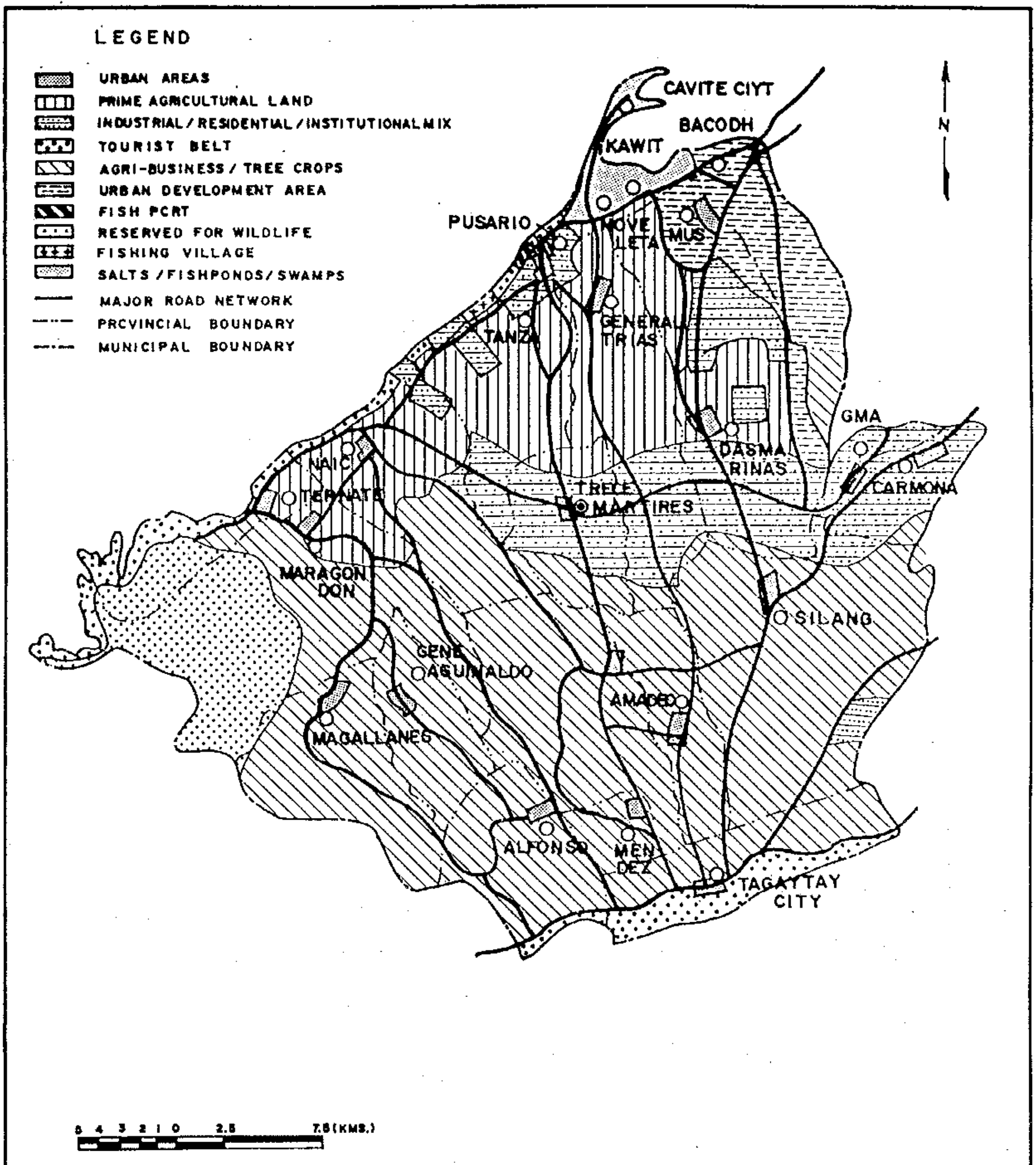
Designation of a tourism zone centering on Tagaytay City, and an industrial/ residential mix zone centering on Carmona/Dasmarinas/Trece Martirez as shown in Fig. 9-2 is problematic from the viewpoint of groundwater development and preservation.

The development of tourism zone aggravates deforestation and wastewater discharge in the recharge area, and the development of industrial/residential mix zone increases pumpage from the Middle aquifer. Thus, both developments accelerate groundwater level drawdown and water quality deterioration.

To avoid such situations, re-examination of existing land use plan, improvement of wastewater facilities in Tagaytay area, and control of industrial use of groundwater in Carmona/Dasmarinas/Trece Martirez area are necessary.



CAVITEWATER SUPPLY DEVELOPMENT STUDY	Fig. 9-1
JAPAN INTERNATIONAL COOPERATION AGENCY	GENERAL EXISTING LAND USE (PROVINCE OF CAVITE)



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 9-2 GENERAL FUTURE LAND USE PLAN (PROVINCE OF CAVITE)
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table 9-1 POPULATION PROJECTION IN THE STUDY AREA BY MUNICIPALITY IN 1991-2005

City/Municipality	Annual Growth Rate (%)			1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2005
	1980-1990	1990-2000	2000-2005												
1 Dasmarinas	10.16	10.16	3.07	136,556	150,430	165,714	182,550	201,097	221,529	244,036	268,830	296,144	326,232	359,377	418,034
2 Indang	2.41	2.41	2.41	39,294	40,241	41,211	42,204	43,221	44,263	45,329	46,422	47,541	48,686	49,860	56,164
3 G. M. A.	n. a.	3.76	3.76	65,977	68,458	71,032	73,703	76,474	79,349	82,333	85,428	88,641	91,973	95,432	114,774
4 Mendez	1.61	1.61	1.61	17,652	17,936	18,225	18,518	18,817	19,119	19,427	19,740	20,058	20,381	20,709	22,431
5 Silang	6.01	3.15	3.15	93,790	97,074	100,472	103,990	107,109	110,322	113,631	117,039	120,550	124,166	127,890	149,342
6 Tanza	3.53	3.52	3.52	61,785	63,960	66,211	68,542	70,955	73,452	76,038	78,714	81,485	84,353	87,322	103,811
7 Tagaytay City	3.82	3.82	3.82	23,739	24,646	25,587	26,565	27,580	28,633	29,727	30,862	32,041	33,265	34,536	41,656
8 Amadeo	2.62	2.62	2.62	21,022	21,573	22,138	22,718	23,313	23,924	24,551	25,194	25,854	26,532	27,227	30,985
9 Magallanes	2.62	2.62	2.62	12,556	12,885	13,223	13,569	13,924	14,289	14,664	15,048	15,442	15,847	16,262	18,507
10 Maragondon	2.39	2.39	2.39	22,814	23,359	23,918	24,489	25,074	25,674	26,287	26,916	27,559	28,218	28,892	32,514
11 Ternate	2.09	2.09	2.09	11,981	12,231	12,487	12,748	13,014	13,286	13,564	13,848	14,137	14,433	14,734	16,340
12 Alfonso	2.79	2.79	2.79	28,944	29,752	30,582	31,435	32,312	33,213	34,140	35,093	36,072	37,078	38,112	43,734
13 Naic	3.05	3.04	3.04	51,629	53,199	54,816	56,482	58,199	59,968	61,792	63,670	65,606	67,600	69,655	80,906
14 Gen. Aguinaldo	1.36	1.36	1.36	10,954	11,103	11,254	11,407	11,562	11,719	11,879	12,040	12,204	12,370	12,538	13,414
15 Carmona	-	4.00	4.00	28,247	29,374	30,546	31,765	33,033	34,351	35,722	37,148	38,630	40,172	41,775	50,826
16 Trece Martirez City	6.22	6.22	3.07	15,686	16,662	17,698	18,799	19,968	21,210	22,529	23,931	25,419	27,000	28,680	33,361
17 Gen. Trias	2.90	2.90	2.90	52,888	54,422	56,000	57,624	59,295	61,015	62,784	64,605	66,478	68,406	70,390	81,206
Study Area Total	4.52	4.91	3.09	695,514	727,303	761,113	797,108	834,948	875,318	918,433	964,528	1,013,860	1,066,712	1,123,391	1,308,004

Sources for the annual growth rates in 1990-2000:
All municipalities and cities except G. M. A., Silang, Tanza, Naic and Carmona; NSO, Cavite Provincial Office
G. M. A. ; Engineering Study of Water District, 1992
Silang; Water Supply Feasibility Study, Silang Water District, 1993, LWUA
Tanza and Naic; JICA/LWUA Study Team based on the ratio method
Carmona; Municipal Development Plan
Source for the annual growth rates in 2000-2005: JICA Study Team

Notes
(1) Population in 1990 is the census results by NSO.
(2) Annual growth rate of Dasmarinas and Trece Martirez City in 2001-2005 is assumed to be the same of the average growth rate (3.07%) in the Study Area excluding Dasmarinas and Trece Martirez City in 1990-2000.

Table 9–2 ESTIMATED WATER DEMAND IN THE STUDY AREA BY MUNICIPALITY IN 2005

Unit: 1000 cum

No.	City/Municipality	Population	Domestic		Commercial 1)		Institutional 2)		Industrial 3)		Total
		(Person)	Consumption	(%)	Consumption	(%)	Consumption	(%)	Consumption	(%)	
1	Dasmarinas	418,034	17,219	67.5	1,526	6.0	458	1.8	6,294	24.7	25,497
2	Indang	56,164	1,759	86.8	205	10.1	62	3.0		0.0	2,026
3	G. M. A.	114,774	4,191	65.7	419	6.6	126	2.0	1,641	25.7	6,377
4	Mendez	22,431	786	88.1	82	9.2	25	2.8		0.0	892
5	Silang	149,342	4,247	82.6	545	10.6	164	3.2	186	3.6	5,141
6	Tanza	103,811	2,174	74.0	379	12.9	114	3.9	271	9.2	2,938
7	Tagaytay City	41,656	1,721	81.7	228	10.8	46	2.2	113	5.4	2,108
8	Amadeo	30,985	811	84.6	113	11.8	34	3.5		0.0	958
9	Magallanes	18,507	373	75.4	68	13.6	20	4.1	34	6.9	495
10	Maragondon	32,514	789	83.6	119	12.6	36	3.8		0.0	943
11	Ternate	16,340	170	68.7	60	24.1	18	7.2		0.0	248
12	Alfonso	43,734	1,440	81.6	160	9.0	48	2.7	118	6.7	1,766
13	Naic	80,906	1,766	81.6	295	13.6	89	4.1	16	0.7	2,166
14	Gen. Aguinaldo	13,414	328	83.7	49	12.5	15	3.8		0.0	391
15	Carmona	50,826	529	24.1	186	8.4	56	2.5	1,426	64.9	2,196
16	Trece Martirez City	33,361	866	45.5	122	6.4	37	1.9	881	46.2	1,905
17	Gen. Trias	81,206	894	11.4	296	3.8	89	1.1	6,587	83.7	7,866
	Study Area Total	1,308,004	40,063	62.7	4,850	7.6	1,432	2.2	17,566	27.5	63,912

Source: JICA Study Team

Notes:

1) Commercial water includes small and cottage industries based on LWUA methodology manual. Unit consumption level is set at 1.0 cumd per 100 population except Tagaytay, which is 1.5 cumd.

2) Unit consumption is set at 3.0 cumd per 1,000 population.

3) Large water users

10. WATER SUPPLY DEVELOPMENT PLANS FOR THE SELECTED AREAS

In the preparation stage of the Study, JICA and LWUA agreed to select five (5) out of the seventeen (17) municipalities to be included in the Feasibility Study based on the criteria related to water supply development.

As agreed, the municipalities were categorized based on the natural condition (represented by elevation) and socio-economic development trends. Sixteen (16) categories were established combining these two parameters and the presence of a water district, urgency for water supply development, etc. were also considered. As a result, Gen. Mariano Alvarez (G.M.A.), Mendez, Tanza, Tagaytay City and Naic were selected to comprise the Feasibility Study areas.

In Tagaytay City, groundwater development is not encouraging because of low groundwater potential and difficulty in pumping water. The Philippine Government, however, is pushing to develop Tagaytay City as a prime tourist and recreational destination. To consider this development, it was proposes to maximize the use of the spring which is gushing out on Tagaytay cliff and has been utilized as source of water supply for the City.

In developing the plan for the proposed water supply system in each municipality, existing water supply facilities and their problems were reviewed, and the water demand in a target year was predicted based on the projections of population, the number of household, water consumption pattern, water accountability and etc.. Then, additional water sources and a scale of water supply facilities were examined based on the above mentioned data and the data obtained from JICA test wells. The summaries of water supply plan for the five areas are shown in Table 10-1 to 5.

Water supply facilities were designed basically by LWUA's design manual. The recommended water supply systems are shown in Fig. 10-1 to 5.

The construction of the proposed water supply system will be divided into two phases, except for Mendez and Tagaytay City which have relatively small system and one source development. Phase I covers years 1998 to 2001 while Phase II includes up to year 2005. Phases I and II will be completed by the end of 1997 and 2001, respectively. Fig. 10-6 presents the proposed implementation schedule for the Water Supply Development Project.

The relations between water demand and water supply for each area when the proposed projects were implemented are shown in Fig. 10-7 to 11.

Table 10-1 SUMMARY OF RECOMMENDED PLAN FOR GMA-WD

Description	1994	1998	2005
A. Population			
(1) Total Population	59,348	68,771	89,025
(2) Pop. in Service Area	53,404	62,461	80,104
(3) Served Population	20,504	46,151	56,892
B. Water Demand (cu.m./d)			
(1) Domestic (Daily Ave.)	3,194	5,431	7,258
(2) Commercial (Daily Ave.)	-	159	194
(3) Institutional (Daily Ave.)	-	90	120
(4) Total Water Demand			
1) Daily Average	3,194	7,098	9,462
2) Daily Maximum	4,152	9,227	12,300
3) Peak Hour	6,388	14,276	18,924
C. Number of Connection			
(1) Domestic	3,648	8,266	10,144
(2) Commercial	70	159	194
(3) Institutional	26	30	40
(4) Total	3,744	8,415	10,368
D. Water Sources			
(1) Existing Source	8 wells	8 wells	8 wells
(capacity: cu.m/d)	5,766	5,766	5,766
(2) New Source	-	1-JICA well & 3 wells	-
(capacity: cu.m/d)		7,705	
(3) Pumping Facilities		Submersible	
1) Pump	8 sets	3 sets-60 HP 1 set-25 HP	-
2) Pumphouse	8 units	4 units	-
3) Standby Generator	-	4-Generator sets	-
E. Pipelines/Appurtenances			
(1) Pipelines	50mm-150mm 17,800m	100mm-200mm 6,078m	50mm-200mm 3,510m
(2) Gate Valve	37 pcs	17 pcs	11 pcs
(3) Fire Hydrant	5 units	7 units	7 units
F. Storage Facilities			
(1) Reservoir	5 units	1 unit	2 units
(capacity: cu.m/d)	1,665	292	584
(2) Rehabilitation	-	3 units	2 units
G. Disinfection Facilities	-	Hypochlorinator 10 units	-
H. Land Acqisition	-	1,000 sq.m	600 sq.m

Table 10-2 SUMMARY OF RECOMMENDED PLAN FOR MWD

Description	1994	1998	2005
A. Population			
(1) Total Population	14,891	15,914	17,908
(2) Pop. in Service Area	7,638	11,070	15,474
(3) Served Population	4,121	5,385	13,848
B. Water Demand (cu.m./d)			
(1) Domestic (Daily Ave.)	603	692	1,783
(2) Commercial (Daily Ave.)	-	13	25
(3) Institutional (Daily Ave.)	-	33	60
(4) Total Water Demand			
1) Daily Average	603	924	2,336
2) Daily Maximum	-	1,201	3,037
3) Peak Hour	-	1,848	4,672
C. Number of Connection			
(1) Domestic	783	1,110	2,639
(2) Commercial	10	13	25
(3) Institutional	8	11	20
(4) Total	801	1,134	2,684
D. Water Sources			
(1) Existing Source	1 well	1 well	1 well
(capacity: cu.m/d)	864	864	864
(2) New Source	-	1-JICA well	-
(capacity: cu.m/d)		2,160	
(3) Pumping Facilities	Submersible	Submersible	-
1) Pump	1 set	1 set-75 HP	
2) Pumphouse	1 unit	1 unit	
3) Standby Generator	1-Generator set	1-Generator set	
E. Pipelines/Appurtenances			
(1) Pipelines	50mm-150mm 6,800m	50mm-200mm 5,378m	-
(2) Gate Valve		12 pcs	-
(3) Fire Hydrant		2 units	-
F. Storage Facilities			
(1) Reservoir	1 unit	1 unit	-
(capacity: cu.m/d)	212	577	
(2) Rehabilitation	-	-	-
G. Disinfection Facilities	Hypochlorinator 1 set	Hypochlorinator 1 set	-
H. Land Acquisition	-	400 sq.m	-

Table 10-3 SUMMARY OF RECOMMENDED PLAN FOR NWD

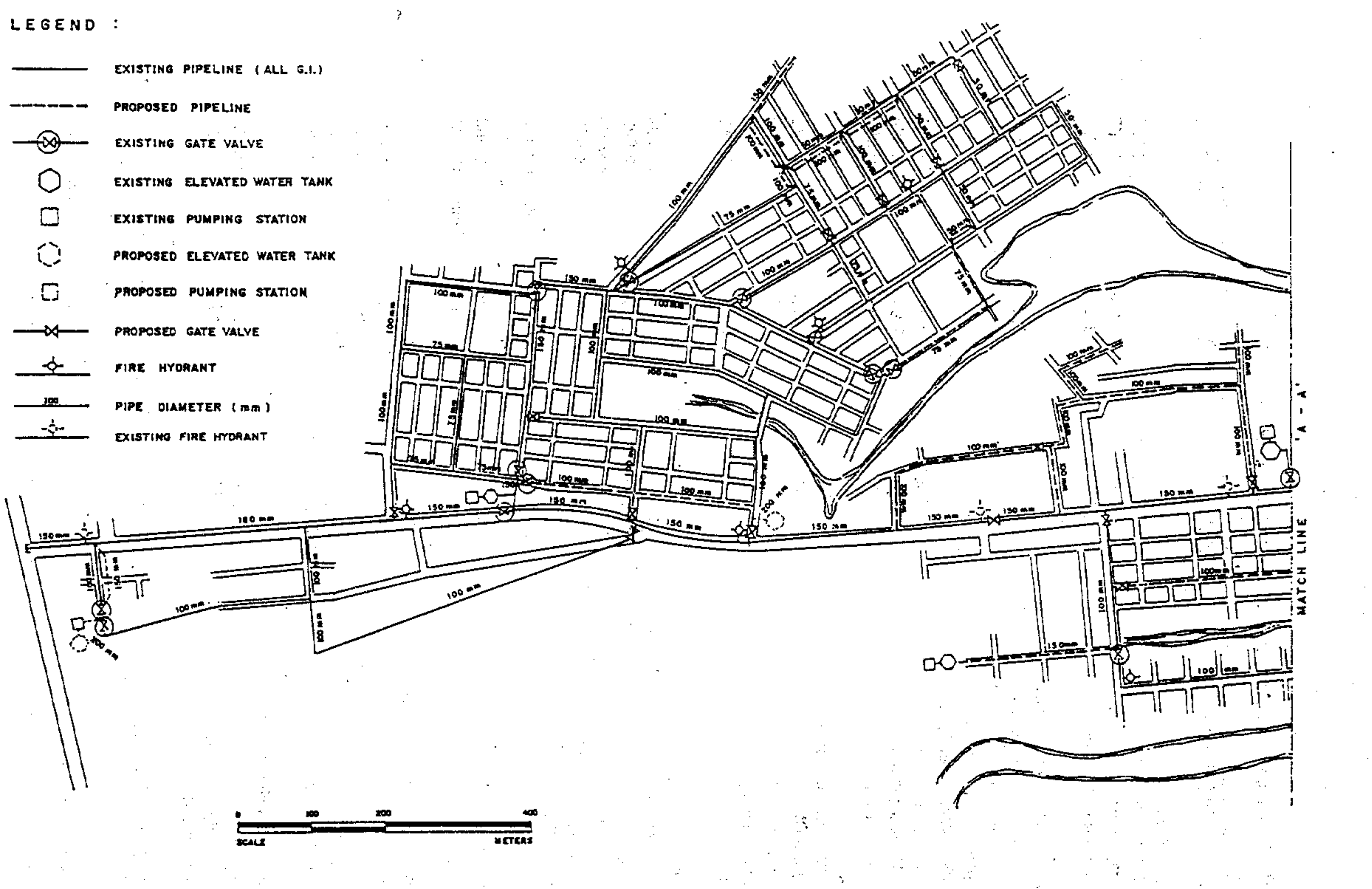
Description	1994	1998	2005
A. Population			
(1) Total Population	25,376	28,527	35,275
(2) Pop. in Service Area	6,910	14,488	28,354
(3) Served Population	2,950	7,002	23,003
B. Water Demand (cu.m./d)			
(1) Domestic (Daily Ave.)	472	721	2,931
(2) Commercial (Daily Ave.)	-	235	488
(3) Institutional (Daily Ave.)	-	43	85
(4) Total Water Demand			
1) Daily Average	472	1,333	4,673
2) Daily Maximum	613	1,733	6,075
3) Peak Hour	944	2,666	9,346
C. Number of Connection			
(1) Domestic	558	1,092	3,807
(2) Commercial	-	181	375
(3) Institutional	-	14	28
(4) Total	558	1,287	4,211
D. Water Sources			
(1) Existing Source	1 spring	-	-
(capacity: cu.m/d)	371	-	-
(2) New Source	-	1-JICA well & 1 well	2 wells
(capacity: cu.m/d)		4,925	3,283
(3) Pumping Facilities		Submersible/Turbine	Turbine
1) Pump	-	1 set-50 HP 1 set-30 HP	2 sets-30 HP
2) Pumphouse	-	2 units	2 units
3) Stanby Generator	-	1-Diesel Engine Drive 1-Generator set	2-Diesel Engine Drive
E. Pipelines/Appurtenances			
(1) Pipelines	38mm-200mm 8,530m	50mm-250mm 8,378m	100mm-200mm 5,340m
(2) Gate Valve	3 pcs	31 pcs	3 pcs
(3) Fire Hydrant	-	9 units	5 units
F. Storage Facilities			
(1) Reservoir	-	1 unit	1 units
(capacity: cu.m/d)	-	292	436
(2) Rehabilitation	-	-	-
G. Disinfection Facilities	-	Hypochlorinator 2 sets	Hypochlorinator 2 sets
H. Land Acquisition	-	500 sq.m	1,000 sq.m

Table 10-4 SUMMARY OF RECOMMENDED PLAN FOR TC-WD

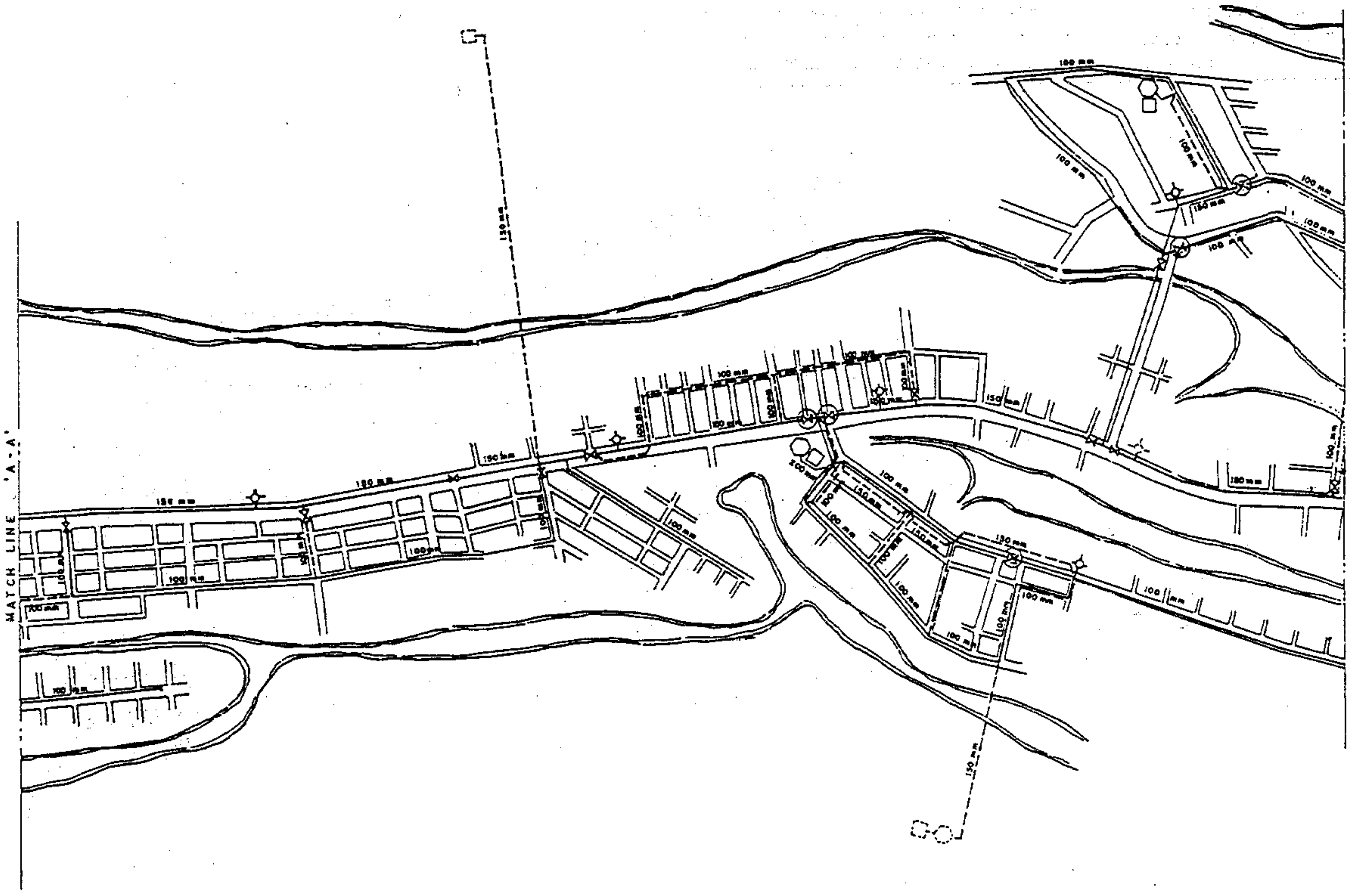
Description	1994	1998	2005
A. Population			
(1) Total Population	24,316	28,326	37,080
(2) Pop. in Service Area	20,695	24,118	35,936
(3) Served Population	13,270	20,590	30,377
B. Water Demand (cu.m./d)			
(1) Domestic (Daily Ave.)	1,948	2,646	4,094
(2) Commercial (Daily Ave.)	-	467	556
(3) Institutional (Daily Ave.)	-	66	102
(4) Total Water Demand			
1) Daily Average	1,948	4,063	6,079
2) Daily Maximum	2,532	5,282	7,903
3) Peak Hour	3,896	8,126	12,158
C. Number of Connection			
(1) Domestic	2,371	3,285	10,144
(2) Commercial	140	467	556
(3) Institutional	41	22	34
(4) Total	2,552	3,774	4,990
D. Water Sources			
(1) Existing Source	3 Springs	3 Springs	3 Springs
(capacity: cu.m/d)	3,591	-	-
(2) New Source	-	-	-
(capacity: cu.m/d)		8,325	-
(3) Pumping Facilities	Three Stage Booster	Single Stage Booster	-
1) Pump	Turbine/Submersible 8 sets	Turbine/Centrifugal 3 sets-375 HP 1 set- 7.5 HP	
2) Pumphouse	2 units	1 unit	
3) Standby Generator	1-Diesel Engine Drive	1-Diesel Engine Drive	
E. Pipelines/Appurtenances			
(1) Pipelines	38mm-250mm 48,980m	50mm-300mm 29,067m	- -
(2) Gate Vales	68 pcs	20 pcs	-
(3) Fire Hydrant	6 units	5 units	-
F. Storage Facilities			
(1) Reservoir	1 unit	8 units	-
(capacity: cu.m/d)	950	925	
(2) Rehabilitation	-	1 unit	-
G. Disinfection Facilities	Gas chlorinator 1 set	-	-
H. Land Acquisition	-	2,000 sq.m	-

Table 10-5 SUMMARY OF RECOMMENDED PLAN FOR TAN-WD

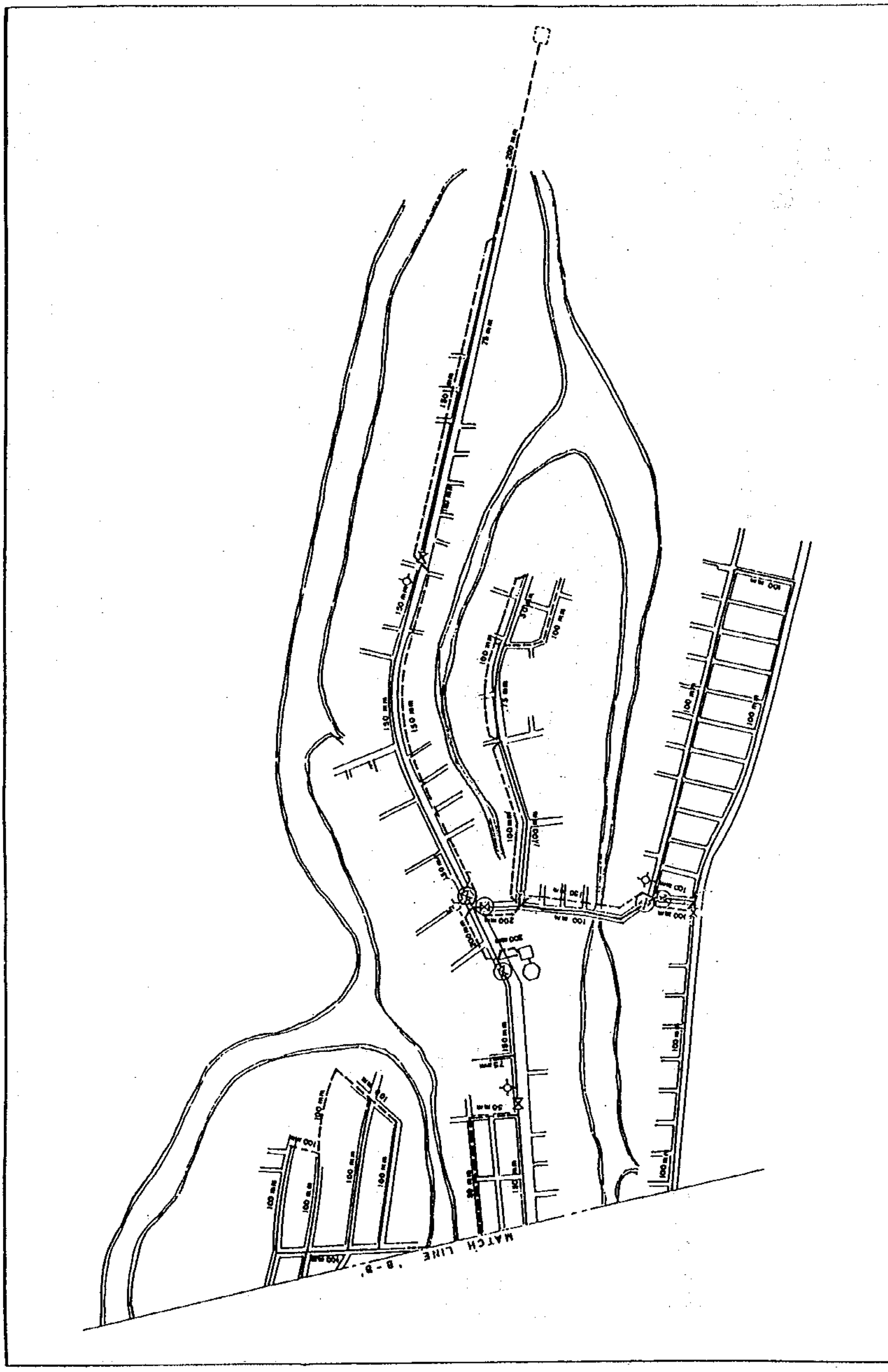
Description	1994	1998	2005
A. Population			
(1) Total Population	37,122	42,718	54,930
(2) Pop. in Service Area	5,294	31,344	43,952
(3) Served Population	1,315	13,958	29,829
B. Water Demand (cu.m/d.)			
(1) Domestic (Daily Ave.)	235	1,656	3,848
(2) Commercial (Daily Ave.)	-	31	45
(3) Institutional (Daily Ave.)	-	12	66
(4) Total Water Demand			
1) Daily Average	235	2,266	5,280
2) Daily Maximum	305	2,946	6,864
3) Peak Hour	470	4,532	10,560
C. Number of Connection			
(1) Domestic	210	2,653	5,676
(2) Commercial	-	31	45
(3) Institutional	-	4	66
(4) Total	210	2,688	5,743
D. Water Sources			
(1) Existing Source	1 well	1 well	1 wells
(capacity: cu.m/d)	2,592	2,592	2,592
(2) New Source	-	1-JICA well	2 wells
(capacity: cu.m/d)		1,382	4,925
(3) Pumping Facilities			
1) Pump	Turbine 1 set	Submersible 1 set-20 HP	Submersible 2 sets-40 HP
2) Pumphouse	1 unit	1 unit	1 unit
3) Standby Generator	-	1-Generator set	2-Generator set
E. Pipelines/Appurtenances			
(1) Pipelines	50mm-200mm 10,136m	100mm-200mm 4,935m	150mm-250mm 3,708m
(2) Gate Valve	30 pcs	5 pcs	8 pcs
(3) Fire Hydrant	5 units	3 units	2 units
F. Storage Facilities			
(1) Reservoir	1 unit	1 unit	2 units
(capacity: cu.m/d)	250	171	604
(2) Rehabilitation	-	-	-
G. Disinfection Facilities	Hypochlorinator 1 set	Hypochlorinator 1 set	Hypochlorinator 2 sets
H. Land Acquisition	-	300 sq.m	600 sq.m



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 10-1(a) PROPOSED WATER SUPPLY SYSTEM GMA WATER DISTRICT G M A , CAVITE
JAPAN INTERNATIONAL COOPERATION AGENCY	



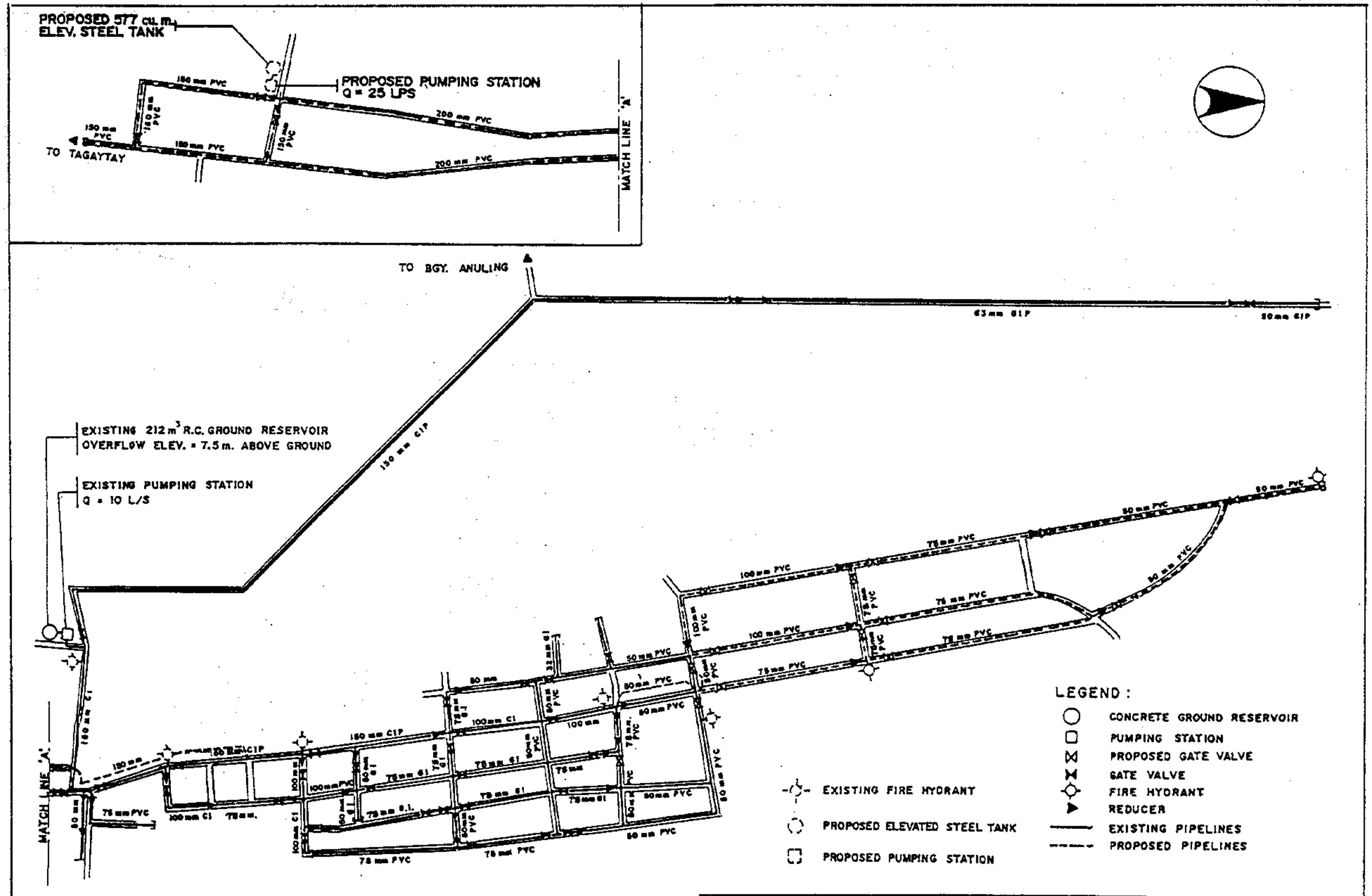
CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 10-1(b) PROPOSED WATER SUPPLY SYSTEM
JAPAN INTERNATIONAL COOPERATION AGENCY	GMA WATER DISTRICT G M A, CAVITE



CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

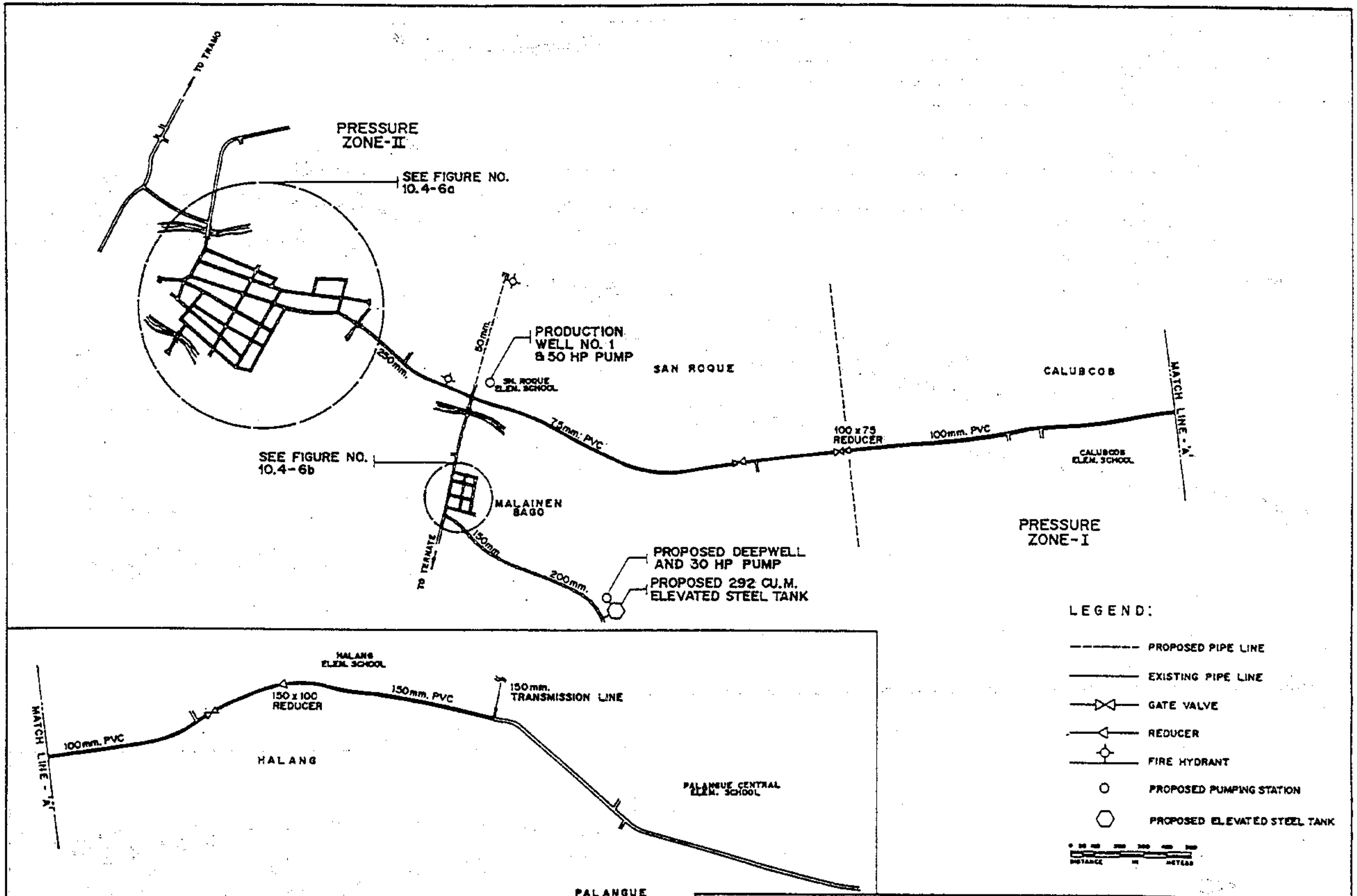
Fig. 10-1(c)
PROPOSED WATER SUPPLY SYSTEM
GMA WATER DISTRICT
G M A , CAVITE



CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 10-2
PROPOSED DISTRIBUTION SYSTEM
MENDEZ WATER DISTRICT
MENDEZ, CAVITE



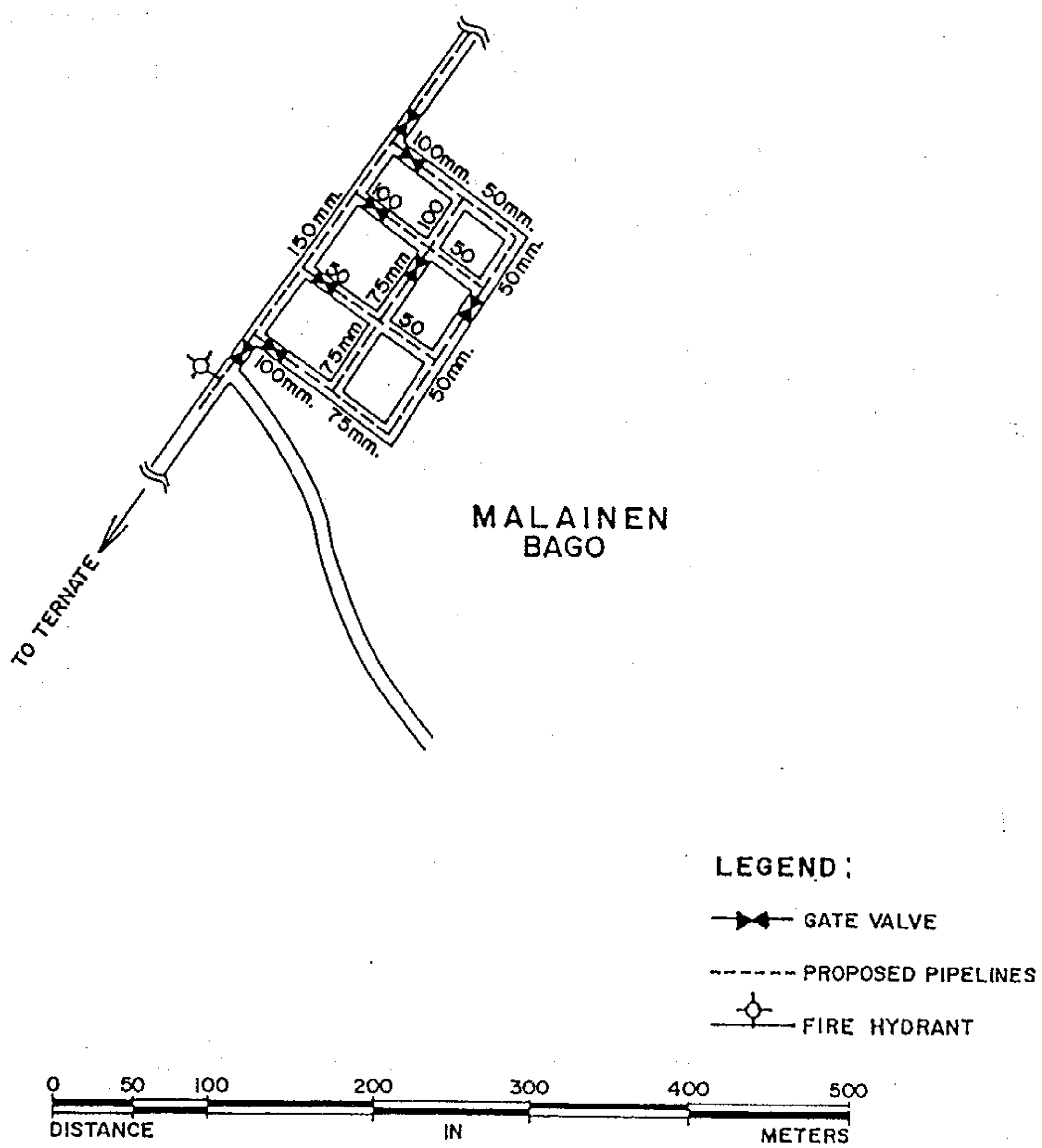
CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

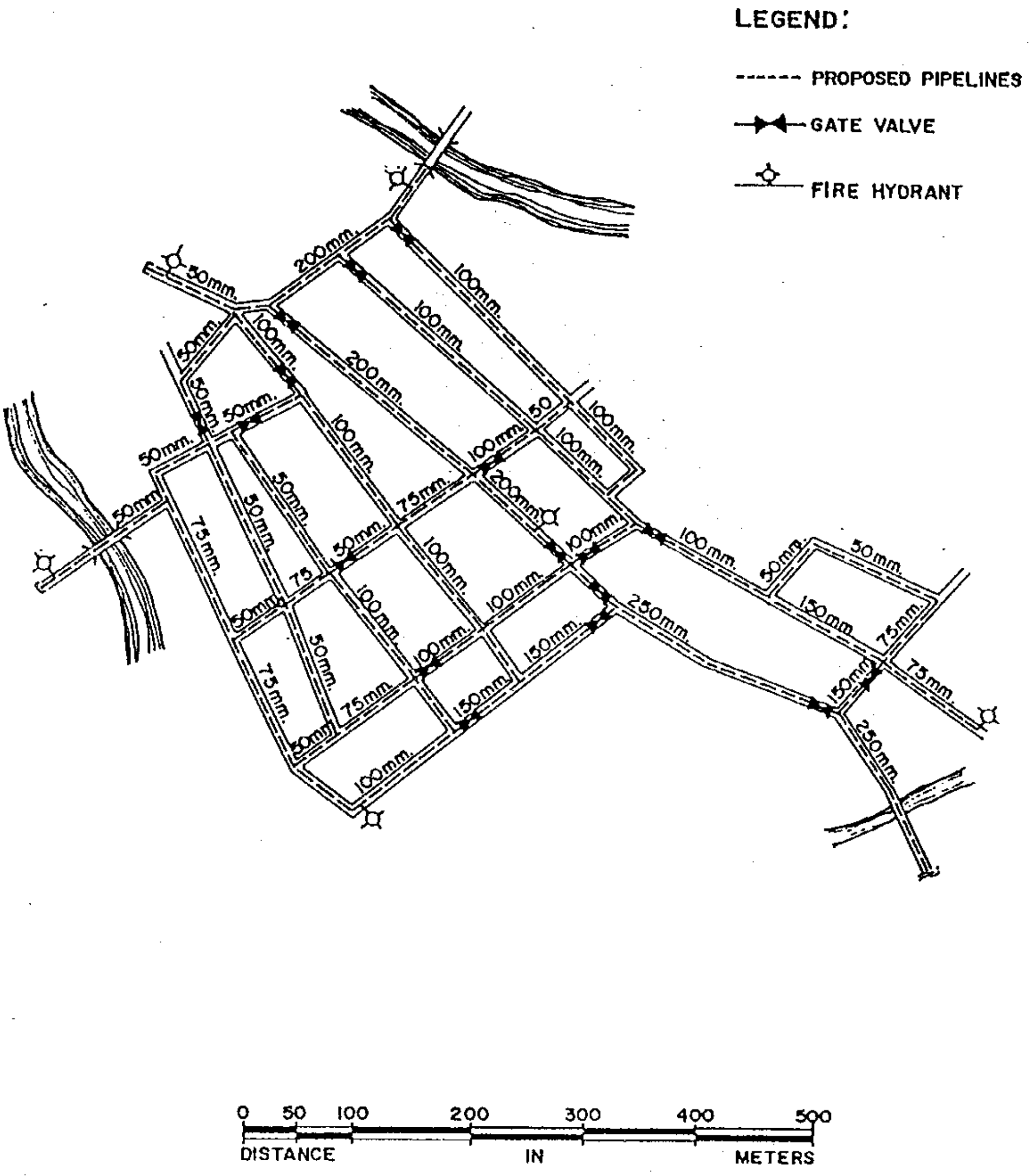
Fig. 10-3(a)

PHASE -I IMPROVEMENT

NAIC



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 10-3(b) PHASE-I IMPROVEMENT
JAPAN INTERNATIONAL COOPERATION AGENCY	NAIC



CAVITE WATER SUPPLY DEVELOPMENT STUDY

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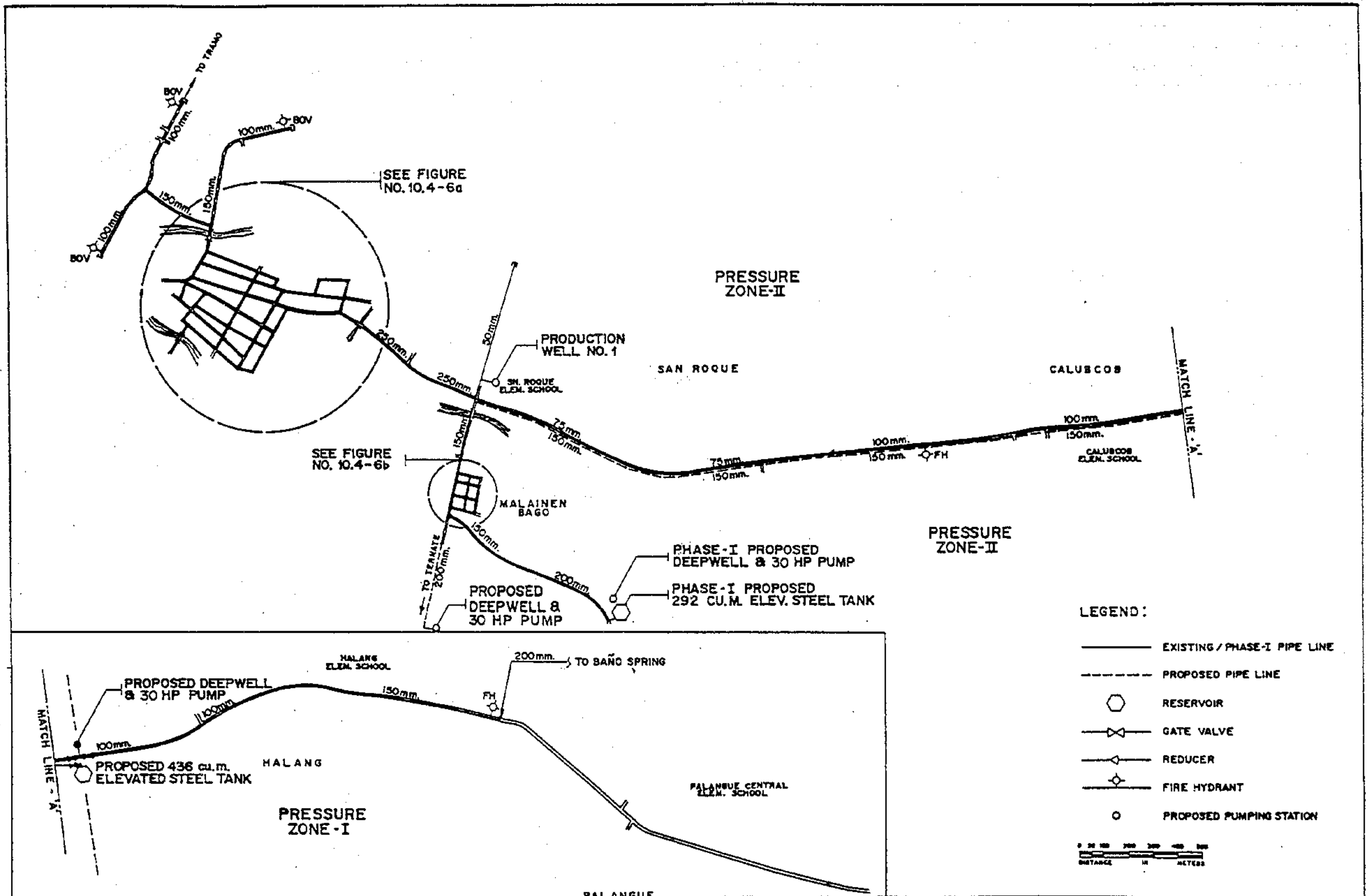
Fig. 10-3(c)

PHASE-I IMPROVEMENT

NAIC



CAVITE WATER SUPPLY DEVELOPMENT STUDY

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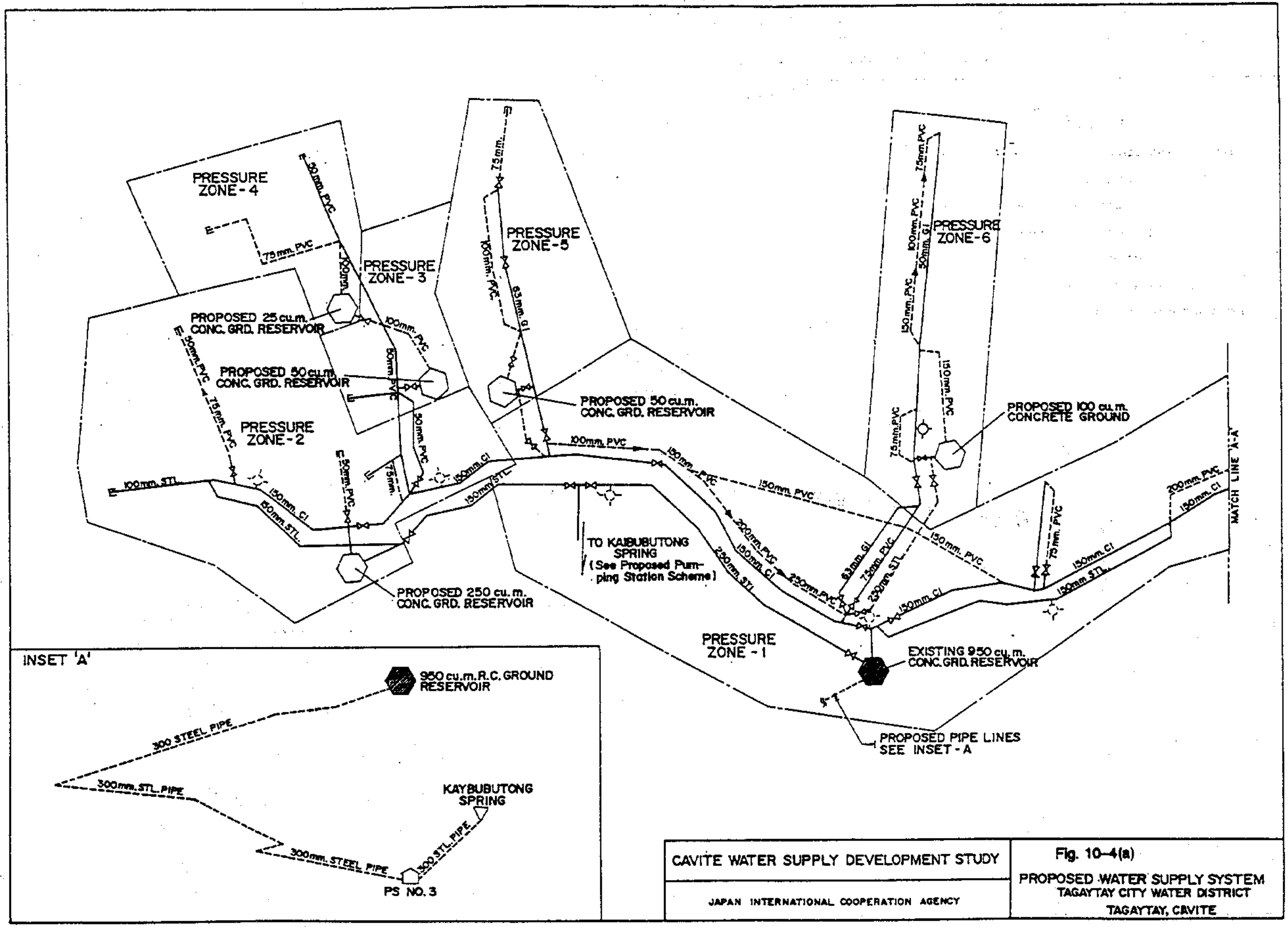
Fig. 10-3(d)

PHASE-II IMPROVEMENT

NAIC

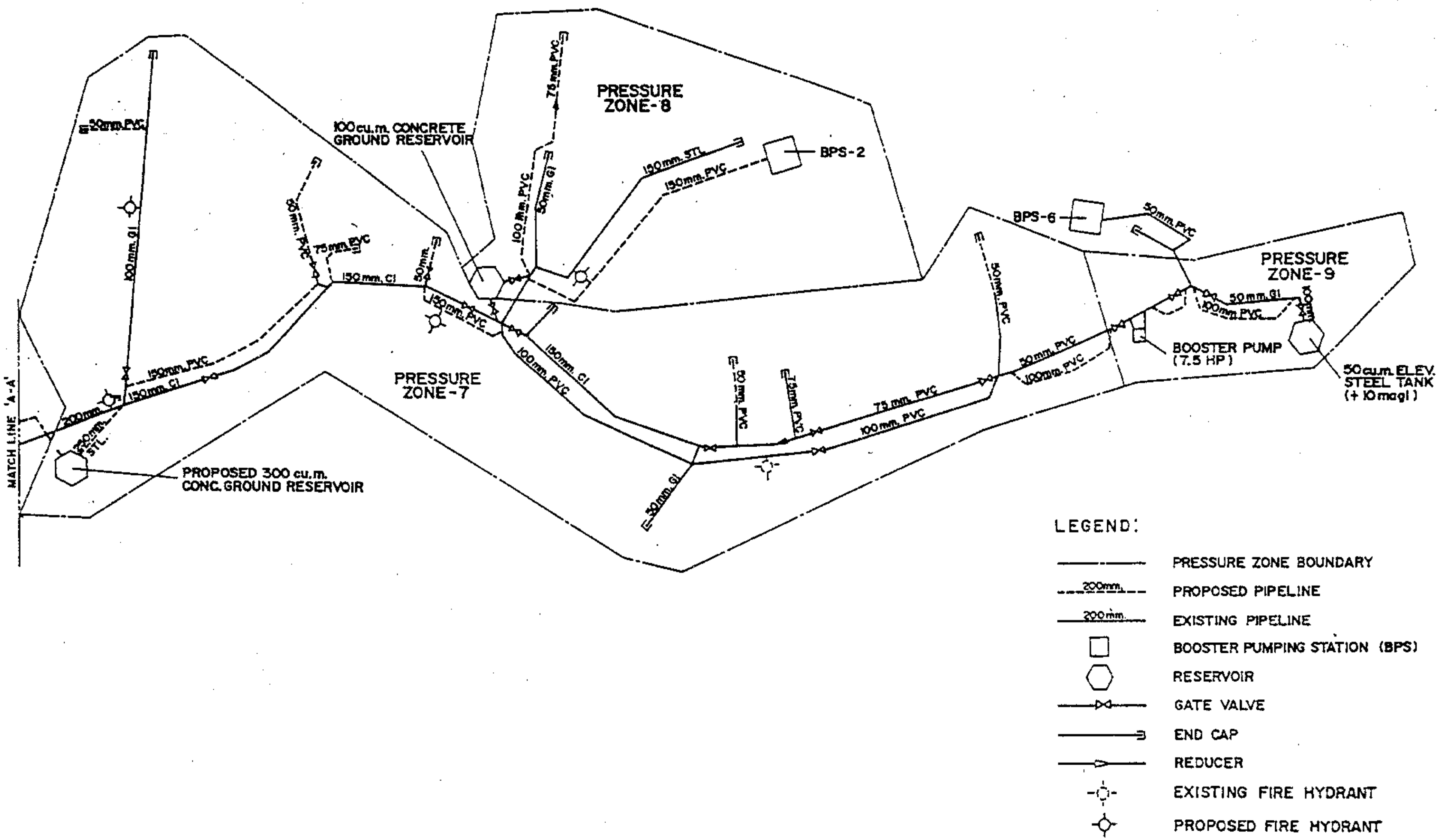


CAVITE WATER SUPPLY DEVELOPMENT STUDY

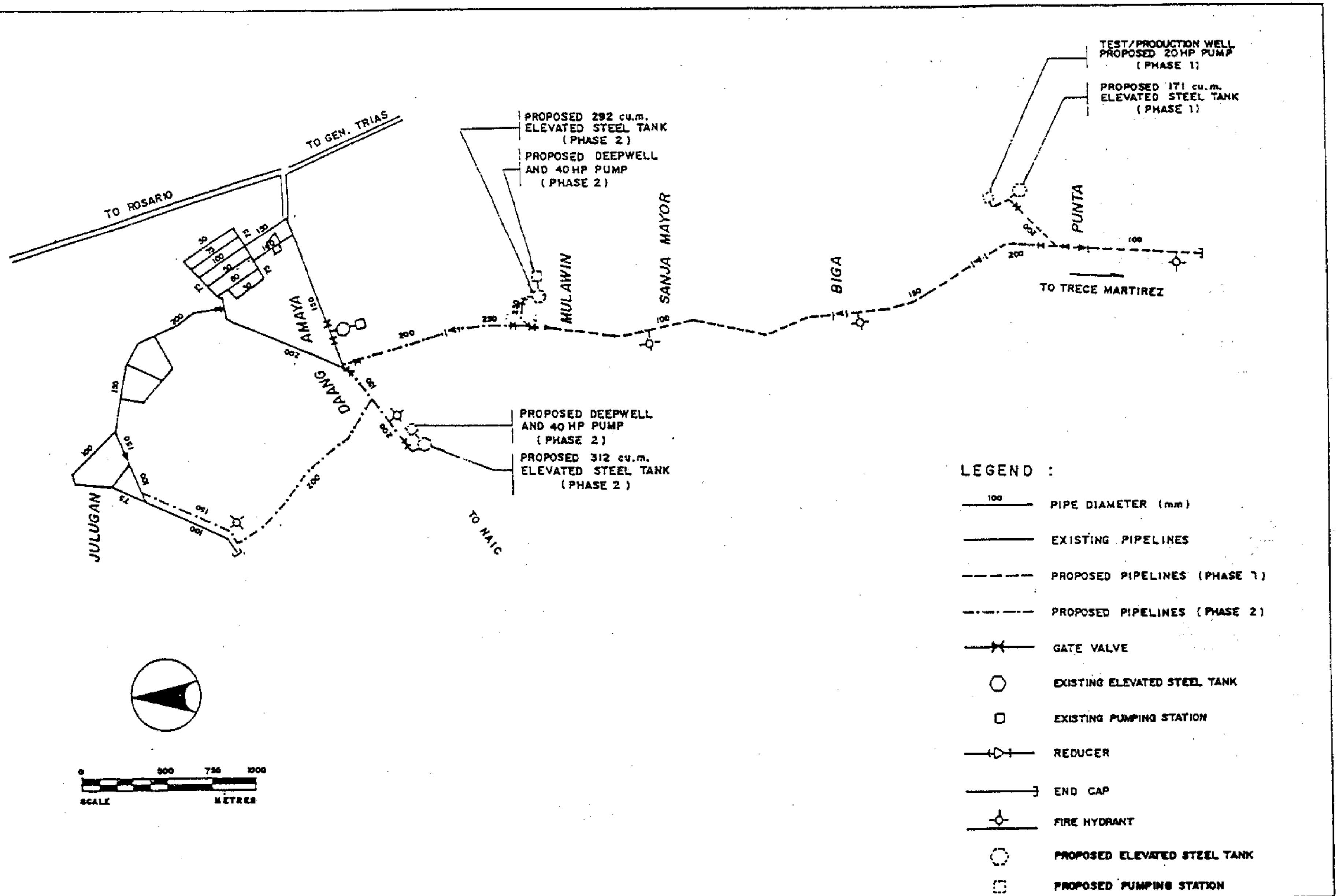
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 10-4(a)

PROPOSED WATER SUPPLY SYSTEM
TAGAYTAY CITY WATER DISTRICT
TAGAYTAY, CAVITE



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 10–4(b)
JAPAN INTERNATIONAL COOPERATION AGENCY	PROPOSED WATER SUPPLY SYSTEM TAGAYTAY CITY WATER DISTRICT TAGAYTAY, CAVITE



CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 10-5
RECOMMENDED PLAN
TANZA WATER DISTRICT
TANZA , CAVITE

Fig.10-6 **PROPOSED IMPLEMENTATION SCHEDULE**

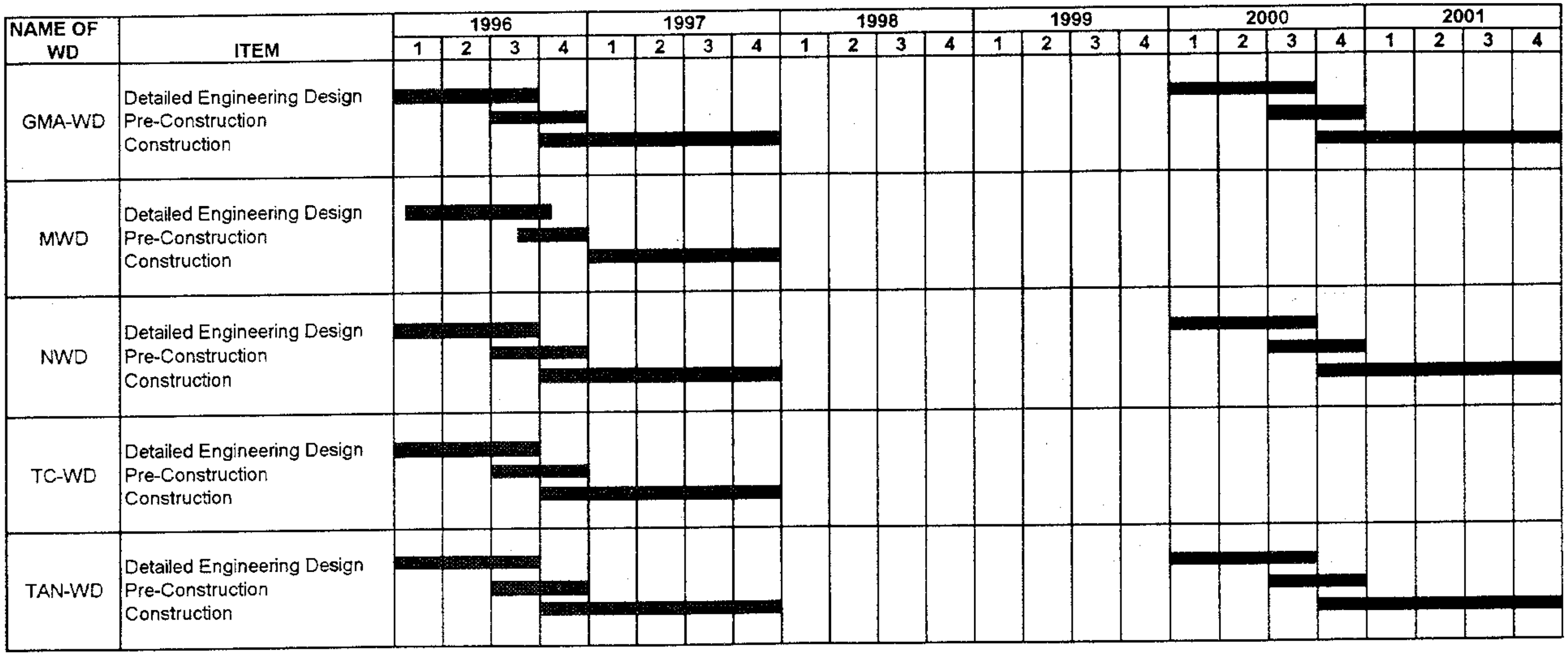


Fig. 10-7

WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN
GMA

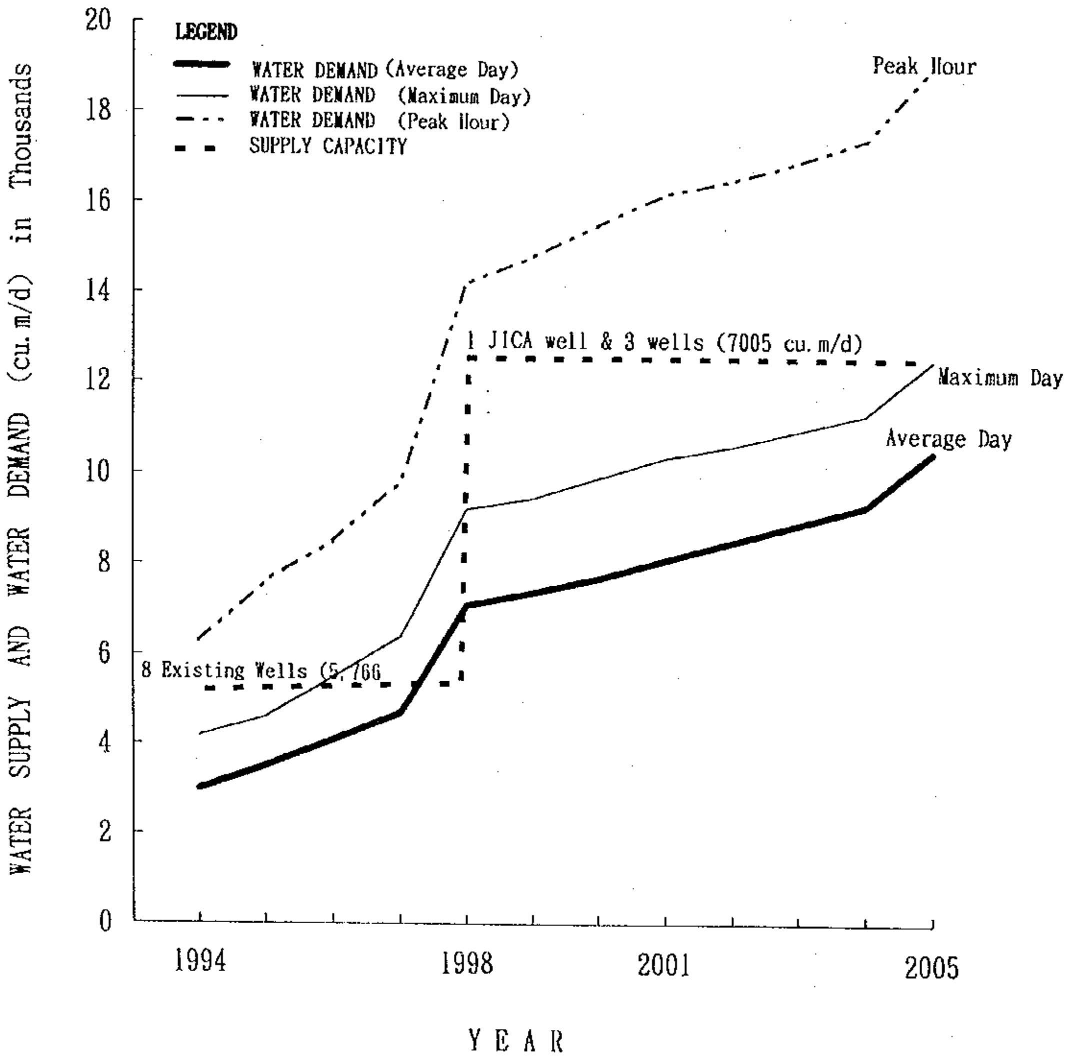


Fig. 10-8

WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN
MENDES

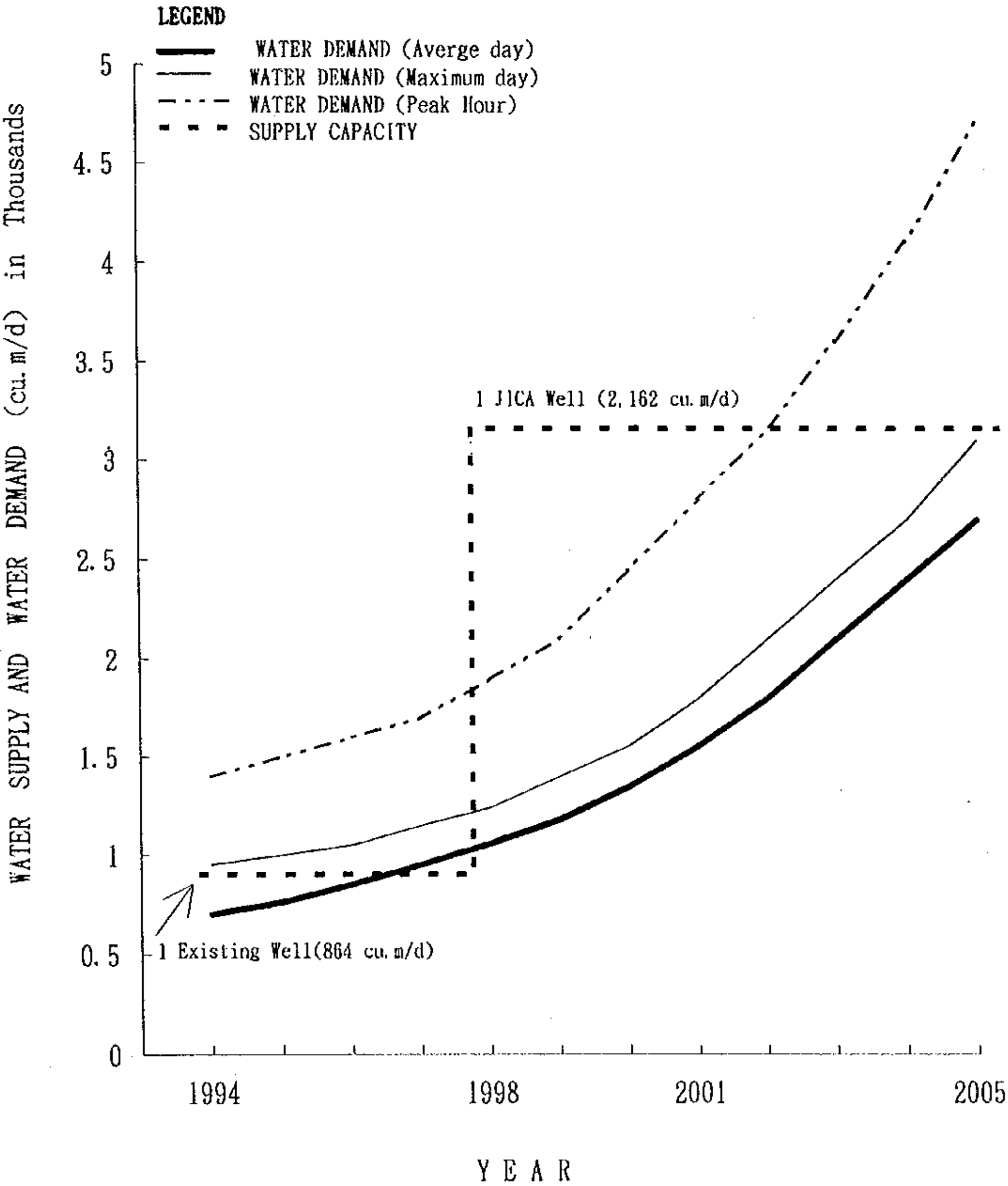


Fig. 10-9

WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN
NAIC

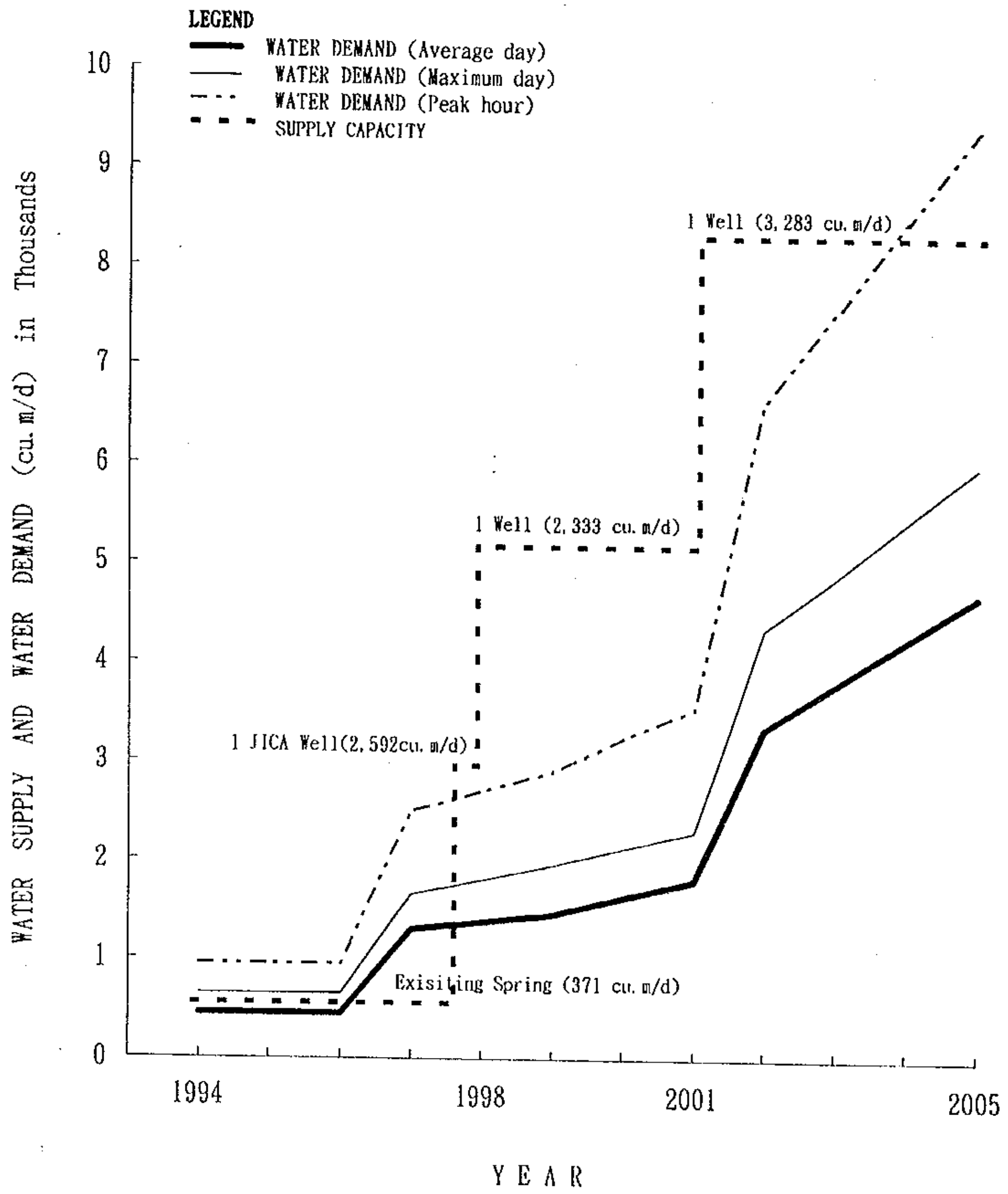


Fig. 10-10

WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN
TAGAYTAY

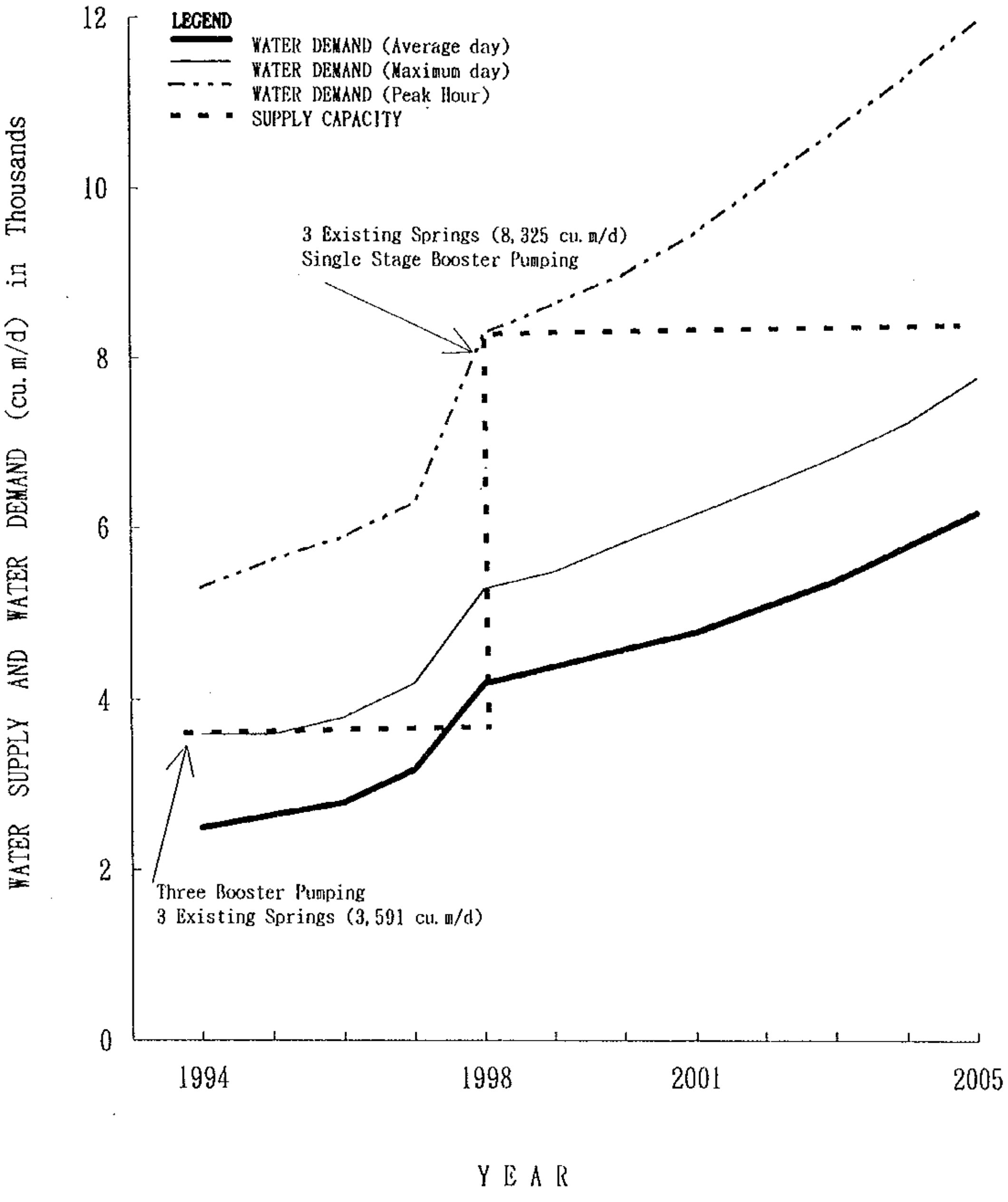
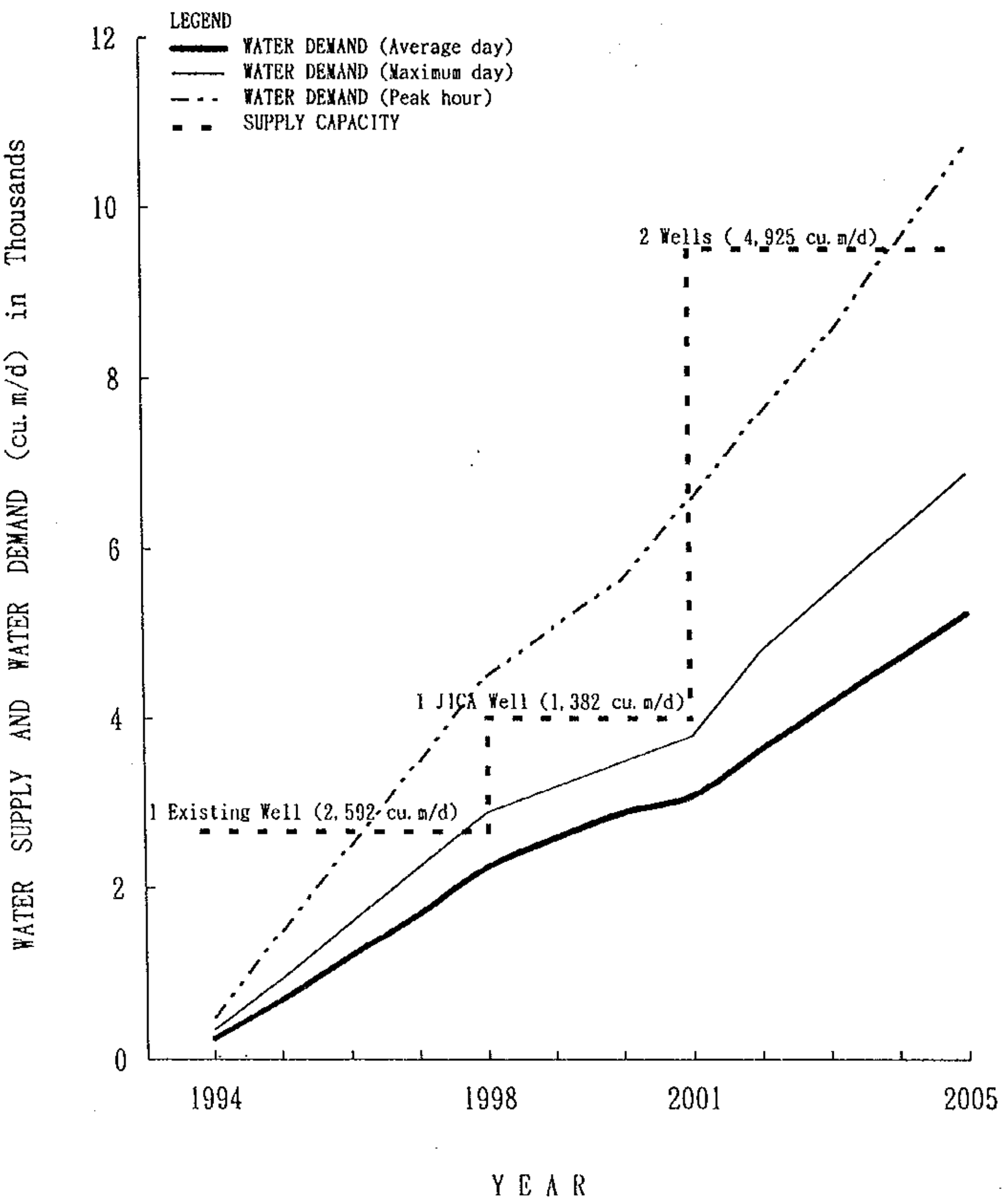


Fig. 10-11

WATER SUPPLY VS DEMAND CURVE OF RECOMMENDED PLAN
TANZA



11. EVALUATION OF THE WATER SUPPLY PROJECT FOR THE SELECTED AREAS

11.1 General Conditions and Common Assumptions for Project Evaluation

The construction cost for the water supply system facilities is estimated using the current market price at the 1994 price level. A stand-by generator for a stable supply of electricity and the disinfection facilities for safe water are considered for all the objective areas. The operation and maintenance costs include expenses for salaries (administrative personnel), power, chlorination, office rental and others.

The project costs include the basic construction cost, physical and price contingencies, engineering studies, construction supervision, and land acquisition. Cost including interest during construction amount to 43.3 x 10^6 pesos for G.M.A. (Phase I only), 22.7 x 10^6 pesos for Mendez, 26.3 x 10^6 pesos for Naic (Phase I only), 79.5 x 10^6 pesos for Tagaytay, and 11.5 x 10^6 pesos for Tanza (Phase I only). Operation and maintenance costs are escalated using inflation rates of 12% for the year 1995 and 10% for the year 1996 onwards.

For G.M.A., Mendez, Naic and Tagaytay, 100% of the cost is assumed to be financed by a loan from LWUA, of which 50% is from a regular loan and another 50% is from a soft loan. On the other hand, for Tanza, 90% loan financing, of which 70% is from a regular loan and 30% from a soft loan, is assumed with 10% equity of the water district. The interest rate of a regular loan is 8.5 - 12.5%, and repayment will start one year after the project completion for 26 years. Repayment of a soft loan shall start on the 11th year to coincide with the remaining repayment years of the regular loan portion.

In the economic analysis, (a) consumer satisfaction, (b) health benefits and (c) fire protection were selected as components of economic benefits in the projects.

11.2 Results of Financial and Economic Analysis

In the financial analysis, financial statements (income statement, cash flow table and balance sheet) were made, and several financial parameters were calculated. The results showed that the projected financial performance is almost sound for all the objective areas.

Financial Internal Rate of Return (FIRR) is used as a key indicator for the test of financial viability. Since FIRRs of the all objective areas are beyond the weighted cost of capital even through cased in the sensitivity analysis, it is concluded that the proposed projects are financially feasible.

The recommended minimum rate in 2005 is 111 pesos for G.M.A., 255 pesos for Mendez, 96 pesos for Naic, 269 pesos for Tagaytay and 186 pesos for Tanza, while the minimum rate in 1994 is 40 pesos for G.M.A., 80 pesos for Mendez, 30 pesos for Naic, 110 pesos for Tagaytay and 60 pesos for Tanza. These proposed rates are subject to the following criteria of LWUA: (a) Minimum charge must not exceed 5% of the average family income of the low income group, (b) Any increase must be limited to 60% of the prevailing rates.

As for the economic analysis, a project was evaluated by Economic Internal Rate of Return (EIRR) and Benefit Cost Ratio. For all the water districts, EIRRs of the base case and the case for 20% increase of O&M coasts in sensitivity analysis show the proposed projects are economically feasible although two other cases in Mendez and Tagaytay are below the opportunity cost of capital. Benefit Cost Ratio expressed as net present value at 15% discount rate is 1.31 for G.M.A., 1.07 for Mendez, 1.49 for Naic, 1.01 for Tagaytay and 1.58 for Tanza.

Table 11-1 RESULT OF FINANCIAL ANALYSIS

	G.M.A.	Mendez	Naic	Tagaytay	Tanza
Project Cost including interest during construction (1000 pesos)	43,261	22,652	26,320	79,455	11,527
Construction Cost (1000 pesos)	36,698	19,809	22,612	67,235	10,627
Regular loan	x (50%)	x (50%)	x (50%)	x (50%)	x (63%)
Soft loan	x (50%)	x (50%)	x (50%)	x (50%)	x (27%)
Equity	-	-	-	-	x (10%)
Minimum water rate in 1994 (pesos)	40	80	30	110	60
Minimum water rate in 2005 (pesos)	111	255	96	269	186
Financial Statements	Sound	Sound	Sound	Sound	Sound
FIRR					
(a) Base Case	26.7	21.3	19.7	23.7	28.5
(b) 20% increase of construction cost	23.1	18.4	16.7	20.3	24.1
(c) 20% increase of O&M cost	18.4	17.4	16.1	18.9	18.8
(d) 20% decrease of revenue	12.8	13.2	12.0	13.8	12.3
(Weighted cost of capital)	*11.9*	*11.3*	*11.1*	*12.1*	*12.0*

Table 11-2 RESULT OF ECONOMIC ANALYSIS

	G.M.A.	Mendez	Naic	Tagaytay	Tanza
Economic Construction Cost (1000 pesos)	39,014	21,452	23,389	71,006	11,443
Economic Benefits at discount rate of 15% (1000 pesos)					
(a) Consumer Satisfaction	52,986	15,277	18,952	56,050	20,176
(b) Health benefits	347	169	85	347	66
(c) Fire protection	22,264	7,684	17,836	2,321	8,836
EIRR					
(a) Base Case	24.5	16.3	26.0	15.2	34.4
(b) 20% increase of construction cost	20.7	13.9	21.9	12.7	29.0
(c) 20% increase of O&M cost	21.6	15.0	24.7	14.6	31.0
(d) 20% decrease of revenue	16.7	11.8	19.6	11.3	24.3
(Opportunity cost of capital)	*15.0*	*15.0*	*15.0*	*15.0*	*15.0*
B/C ratio at 15% discount rate	1.31	1.07	1.49	1.01	1.58

12. ENVIRONMENTAL IMPACT ASSESSMENT OF WATER SUPPLY PROJECT

12.1 E.I.A. for G.M.A.

Groundwater potential around G.M.A. is relatively high, but the projected population in 2005 is about 1.6 times of 1994's. The projected water demand is about 1.7 times of 1994's as a result of progressing urbanization and industrialization. Distribution density of deep wells is the highest in the whole Study Area, and the groundwater level has been declining at an average of 2 m per year during the past ten (10) years. According to the result of simulation, the groundwater level in 2005 is estimated at 40 m below the present water level, and the water quality deterioration is conspicuously possible. Consequently, the establishment of a groundwater management system, which include groundwater monitoring and pumpage control, based on the relationship between pumpage and groundwater level are necessary for the sustainable use of good quality groundwater. Further, a consensus that the priority of groundwater use is given to domestic water is necessary prior to the implementation of pumpage control.

12.2 E.I.A. for Mendez

Mendez is in high elevation area, and its groundwater as well as surface water resources are poor. But the projected water demand in 2005 can be supplied by the test well drilled during the Study. Since Mendez is an agricultural area with a projected population of about 22,000, the annual water demand will be about 900 cum in 2005. South to this area is Tagaytay City, and north to Mendez are springs with large discharge. Consequently, it is necessary to monitor the influence of the development in Mendez and Tagaytay City on the spring discharges.

12.3 E.I.A. for Naic

Naic is in low elevation area, and its groundwater potential is relatively high. The projected population in 2005 is about 1.4 times of 1994's, and the corresponding projected water demand is about 2.3 times of 1994's. Thus, the groundwater development will be accelerated since the surface water is difficult to develop in this area. It is feared that saline water intrusion will occur because this area is near the coast. Pumpage control and monitoring are necessary to avoid such situation, and monitoring of water quality is especially important.

12.4 E.I.A. for Tagaytay City

Tagaytay City is in the highest part of the Study Area, and its groundwater potential is low. Inspite of this problem, its development as tourism or resort zone is now in progress. The projected population in 2005 is about 1.6 times of 1994's, and the corresponding projected water demand is about 1.9 times of 1994's. It is feared that deforestation will decrease the recharge rate, and increase in volume of wastewater will deteriorate both surface water and groundwater. Consequently, it is important to preserve the forest and improve wastewater treatment facilities. Further, it is expected that the construction of water supply facilities must avoid marring the scenery since the area is designated as a tourism and resort area.

12.5 E.I.A. for Tanza

Tanza is in the low elevation area, and its groundwater potential is relatively high. The projected population and water demand in 2005 are about 1.5 times and 2.3 times of 1994's, respectively. Groundwater will be developed since surface water is not usable. Since Tanza is near the coast like Naic, pumpage control and monitoring of water level and water quality are necessary to avoid saline water intrusion.

13. CONCLUSIONS AND RECOMMENDATIONS

As shown in Fig. 13–1, the Study Area is divided into four (4) sub–areas from the view point of groundwater potential and future water demand (year 2005).

Sub–area A which comprises Dasmarinas, G.M.A., Tanza, Naic, Carmona as well as parts of Silang and Trece Martirez covers the low elevation area. Though groundwater potential is comparatively high, the projected water demand is also large since the area is rapidly developing as an Industrial/Residential/Institutional Mix Zone. As mentioned earlier, groundwater level drawdown and saline water intrusion are in progress in Sub–area A. According to the results of groundwater simulation, these phenomena shall be accelerated drastically, considering the projected water demand. Consequently, permissive yield (or permissive critical water level) should be decided for Sub–area A, and monitoring of groundwater level and water quality is vital and should be conducted. It is also necessary to re–examine the existing development plans and to establish measures to control the use of groundwater by industries and secure its use for domestic purpose.

Sub–area B which comprises Mendez, Tagaytay, Amadeo, Alfonso as well as the southern part of Silang covers the middle to high elevation area. Though groundwater potential is low in Sub–area B, the projected water demand is not as large as that of Sub–area A since its designated land use is agri–business and tree crops zone. It is desirable therefore to maintain its present land use and use groundwater sustainably since Sub–area B is part of the recharge area of the groundwater basin and has many springs which are at present valuable domestic water sources.

Sub–area C which comprises Tagaytay and the southern part of Alfonso covers the highest elevation area. Groundwater development is difficult in this area not only because groundwater potential is low, but also groundwater level is deep. Springs on Tagaytay cliff, however, have been utilized as domestic water sources because of its large discharge. Still they have plenty of discharge to be developed to meet future water demand if the consumers are willing to pay a high water rate equivalent to the high operation and maintenance cost. When this area is developed as a tourist zone, it is necessary to preserve forest and improve wastewater treatment facilities, because Sub–area C is also a part of the recharge area of the groundwater basin.

Sub–area D which comprises Magallanes, Maragondon, Ternate and Gen. Aguinaldo covers the western end of the Study Area. The groundwater potential of this area is low since the basement rocks crop out widely. But the future water demand is also low because the development of this area as predicted will be left behind mainly due to insufficient road network. Thus, the groundwater development in Sub–area D has no special problem with regards to the conditions of the projected water demand.

As mentioned above, pumpage control is necessary for Sub–area A as well as monitoring of pumping discharge and groundwater level. The following four measures were recommended in section 9.5.

(1) Establishment of the priority of groundwater use,
(2) Establishment of the groundwater management committee,

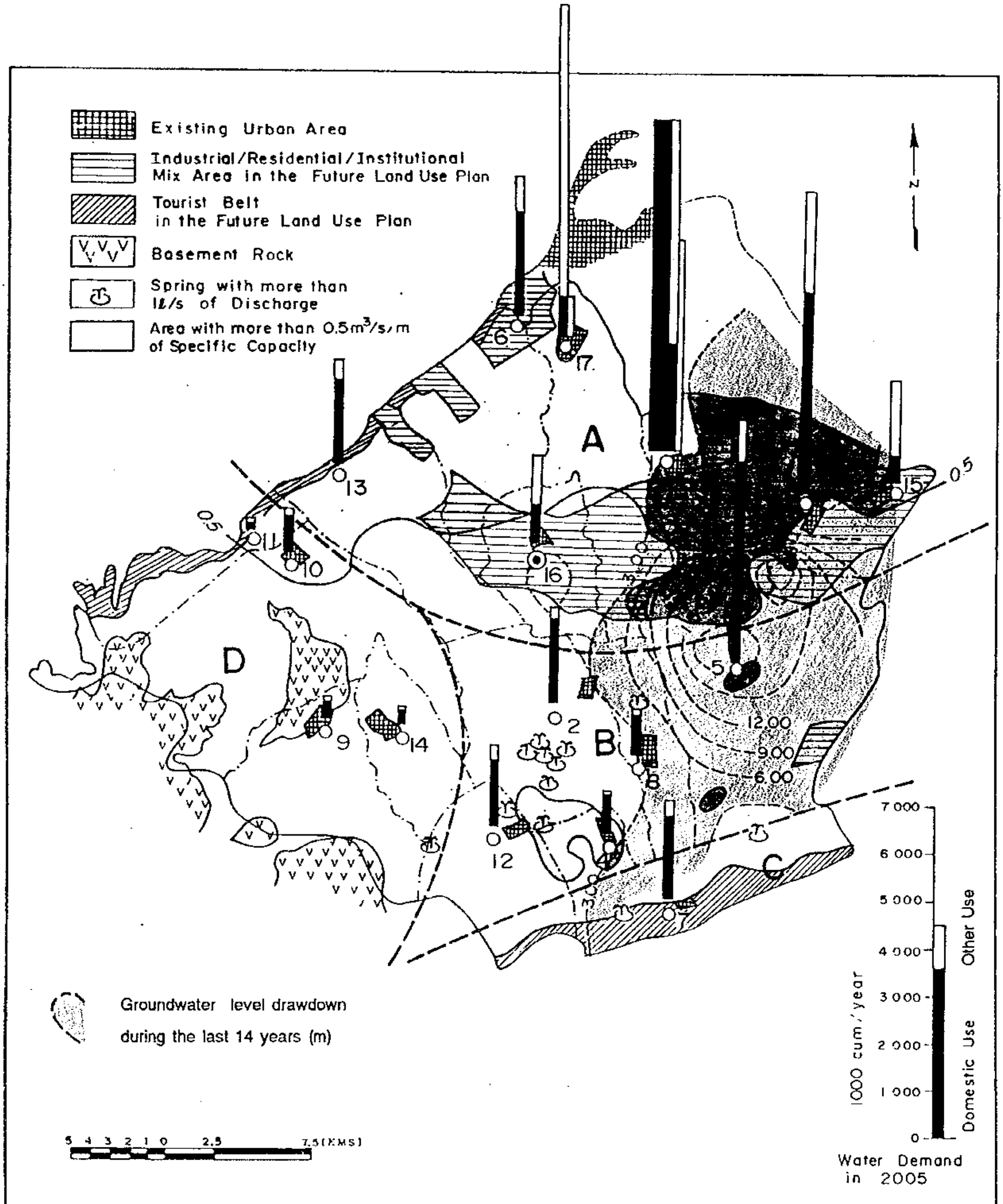
(3) Examination of the permissive pumping discharge, and
(4) Re-examination of the regional development and land use plans.

These measures should be implemented for sustainable use of groundwater, which is at present valuable water resource available for water supply in the Study Area.

Feasibility studies of water supply projects for the urban areas of G.M.A., Mendez, Naic, Tagaytay and Tanza were conducted on the assumptions that the measures recommended would be implemented. The project data are summarized in Table 13-1.

Table 13-1 SUMMARY OF PROPOSED PROJECT

Name of WD	Description	1994	1998	2005
G.M.A.	A. Population			
	1) Total Population	59,343	68,771	89,025
	2) Pop. in Service Area	53,404	62,461	80,104
	3) Served Population	20,504	46,151	56,892
	B. Water Demand (cum/d)			
	1) Daily Average	3,194	7,098	9,462
	2) Daily Maximum	4,152	9,227	12,300
	3) Peak Hour	6,388	14,276	18,924
	D. Water Sources	8 wells	12 wells	12 wells
	H. Project Cost (Million Peso) (Phase I only)	-	43.26	-
MENDEZ	A. Population			
	1) Total Population	14,891	15,914	17,908
	2) Pop. in Service Area	7,638	11,070	15,474
	3) Peak Hour	4,121	5,385	13,848
	B. Water Demand (cum/d)			
	1) Daily Average	603	924	2,336
	2) Daily Maximum	784	1,201	3,037
	3) Peak Hour	1,206	1,848	4,672
	D. Water Sources	1 well	2 wells	2 wells
	H. Project Cost (Million Peso) (Phase I only)	-	22.65	-
NAIC	A. Population			
	1) Total Population	25,375	28,526	35,275
	2) Pop. in Service Area	6,910	14,488	28,354
	3) Served Population	2,950	7,002	23,003
	B. Water Demand (cum/d)			
	1) Daily Average	472	1,333	4,673
	2) Daily Maximum	614	1,733	6,075
	3) Peak Hour	944	2,666	9,346
	D. Water Sources	1 spring	2 wells	4 wells
	H. Project Cost (Million Peso) (Phase I only)	-	26.32	-
TAGAYTAY CITY	A. Population			
	1) Total Population	24,316	28,326	37,080
	2) Pop. in Service Area	20,695	24,118	35,936
	3) Served Population	13,270	20,590	30,377
	B. Water Demand (cum/d)			
	1) Daily Average	1,948	4,063	6,079
	2) Daily Maximum	2,532	5,282	7,903
	3) Peak Hour	3,896	8,126	12,158
	D. Water Sources	3 springs	3 springs	3 springs
	H. Project Cost (Million Peso) (Phase I only)	-	79.46	-
TANZA	A. Population			
	1) Total Population	37,122	42,718	54,930
	2) Pop. in Service Area	5,294	31,344	43,952
	3) Served Population	1,315	13,958	29,829
	B. Water Demand (cum/d)			
	1) Daily Average	235	2,266	5,280
	2) Daily Maximum	305	2,946	6,864
	3) Peak Hour	470	4,532	10,560
	D. Water Sources	1 well	2 wells	4 wells
	H. Project Cost (Million Peso) (Phase I only)	-	11.53	-



CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 13-1
GROUNDWATER POTENTIAL AND WATER DEMAND IN 2005