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VOLUME I

FINAL REPORT
FEASIBILITY STUDY

WATER SUPPLY

CALAMBA WATER DISTRICT

SEPTEMBER 1977

PREPARED JOINTLY:

LOCAL WATER UTILITIES ADMINISTRATION
PROJECT STAFF

CAMP DRESSER & McKEE INTERNATIONAL INC.
PROJECT CONSULTANTS

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4 November 1977

Mr. Carlos C. Leaño, Jr.
General Manager
Local Water Utilities Administration
7th Floor, NIA Building
EDSA, Quezon City

Subject: Final Report - Feasibility Study for Water Supply - Calamba Water District (CAL-WD)

Dear Mr. Leaño:

In accordance with the contract between Local Water Utilities Administration (LWUA) and Camp Dresser & McKee International Inc., dated 14 October 1974, and amended on 10 August 1976, we take pleasure in submitting this report.

This report is presented in two volumes: Volume I which contains the recommended plan and detailed analysis, and Volume II which contains the support information common to all urban areas covered in the contract.

Extensive improvements and additions to the present water supply system are needed to overcome current deficiencies and to meet future requirements. The recommended plan is the result of alternative studies and cost of optimization work. While the cost of the recommended long-range water system facilities is substantial, we consider it within the people's ability-to-pay.

The feasibility studies were done utilizing mostly the services of LWUA counterparts to fulfill the on-the-job training requirements of the LWUA/CDM contract. For the next phase, the LWUA counterparts will take the dominant role in the project studies.

Mr. Carlos C. Leaño, Jr.
General Manager
Local Water Utilities Administration
Re: Final Report - Feasibility Study
for Water Supply - Calamba Water
District (CAL-WD)
Page #2

We wish to extend our thanks to the LWUA Board, all the members of the LWUA staff, the CAL-WD staff and the officials of various agencies of the Government of the Philippines, who so generously assisted us during the course of our study.

Very truly yours,

CAMP DRESSER & MCKEE INTERNATIONAL, INC.

LEONARDO V. GUTIERREZ, JR.
Project Manager

ANTONIO DE VERA
Counterpart Project Manager

FOREWORD

This feasibility study presents the recommended plan for the upgrading and expansion of the water supply system of the Calamba Water District (CAL-WD). This study was made by the Local Water Utilities Administration (LWUA), with the technical assistance of Camp Dresser & McKee International Inc. This study is the result of many months of work in the municipality of Calamba in Laguna Province, and is supported by extensive experience with other water districts in the Philippines during the First Ten Provincial Urban Areas Feasibility Studies.

This study was prepared in two volumes: Volume I, the main report, which contains the recommended plan and the methodology memoranda; and Volume II, which contains detailed background information relating to specific sections of Volume I. A complete understanding of the two volumes would require reading the previously published Water Supply Feasibility Studies Methodology Manual (Volumes I and II), a compilation of the handouts used in the six-month long training seminar conducted in 1975 by CDM during the First Ten-Area Feasibility Studies.

The recommended plan is a technically and economically feasible program for providing the CAL-WD adequate water supply up to the year 2000. The plan should not be viewed as a rigid plan; every attempt was made to develop a plan compatible with the needs and desires of the water district and of the people. However, during the final engineering design of the recommended facilities, changes could still be made. Design changes would be based on more recent field data, changing priorities of the water district and more economical methods of providing the recommended facilities. Any changes considered in the final design should help to further reduce the expected financial impact of the project.

While the main objective of the Second Ten Provincial Urban Areas Feasibility Studies was the preparation of feasibility reports, another important objective was the training of Filipino counterpart engineers in water supply project planning. The training program which included lectures and on-the-job training aimed to develop local planning capability for water supply projects. The Filipino engineers learned by actually doing the work, with the CDM consultants providing the necessary expertise and guidance.

The following have contributed significantly to the development of the Second Ten-Area Feasibility Studies:

James Arbuthnot, Chief Engineer
Eugene Rumph, Hydrogeologist
James DeYoung, Water Supply Engineer
Bruce Conklin, Systems Engineer
Peter West, Distribution Engineer

Antonio de Vera, Counterpart Project Manager
Wilfredo Sevilleja, Counterpart Chief Engineer
Rene de Jesus, Group Leader
Jean Casten, Economist
Celso Razal, Jr., Economist
Lourdes Gutierrez, Technical Writer
Reynaldo Arlata, CAL-WD General Manager

The following project staff members have also contributed to the technical/non-technical work of the studies:

Roberto Binag, Professional Engineer
Reynaldo Tabac, Professional Engineer
Miguel Buenavides, Junior Staff Engineer
Pedrito Camilet, Jr., Field Technician
Aiberto Machica, Draftsman
Arlene Raymundo, Secretary/Typist
Cesar Florendo, Printing Assistant
Reynaldo Panuelos, Printing Assistant

LIST OF ABBREVIATIONS

Organizations

ADB	Asian Development Bank
BAN-WD	Bangued Water District
LB-WD	Los Baños Water District
BAY-WD	Baybay Water District
BIS-WD	Bislig Water District
CAL-WD	Calamba Water District
CDM	Camp Dresser & McKee International Inc.
COT-WD	Cotabato City Water District
DCCD	Design Consultation Construction and Development Engineering Corporation
FER-WD	San Fernando Water District
GAP-WD	Gapan Water District
IBRD	International Bank for Reconstruction and Development
LWUA	Local Water Utilities Administration
MWSS	Metropolitan Waterworks and Sewerage System (formerly National Waterworks and Sewerage Authority or NWASA)
NEDA	National Economic Development Authority
NIA	National Irrigation Administration
NWRC	National Water Resources Council
OLO-WD	Olongapo City Water District
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
ROX-WD	Roxas City Water District
SIL-WD	Silay City Water District
URD-WD	Urdaneta Water District
USAID	United States Agency for International Development

Units

AC	asbestos cement
CCI	centrifugally cast iron
CI	cast iron
cm	centimeter
cum	cubic meter
cumd	cubic meter per day
cumd/ha	cubic meter per day per hectare
cum/hr/sqkm	cubic meter per hour per square kilometer
cumd/m	cubic meter per day per meter
cum/mo	cubic meter per month
cum/sqkm/yr	cubic meter per square kilometer per year
FEC	foreign exchange component
GI	galvanized iron
GS	galvanized steel

ha	hectare
HGL	hydraulic grade line
hr	hour
kg	kilogram
km	kilometer
lpcd	liter per capita per day
lpd	liter per day
lps	liter per second
lps/m	liter per second per meter
m	meter
m/ha	meter per hectare
mg/l	milligram per liter
min	minute
mm	millimeter
mm/yr	millimeter per year
mo	month
m/sec	meter per second
MSL	mean sea level
%	percent
₱	Philippine peso
pH	logarithm (base 10) of the reciprocal of the hydrogen ion concentration in water, moles per liter
PVC	polyvinyl chloride
RU	revenue unit
sqkm	square kilometer
sqmd	square meter per day
$	United States dollar
yr	year

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CHAPTER I SUMMARY AND RECOMMENDATIONS

A. SUMMARY OF STUDIES

Description of Study Area

The Calamba Water District (CAL-WD) was formed on 7 August 1974 by virtue of Resolution No. 6 passed by the Municipal Council of Calamba. Following its formation, the CAL-WD acquired the ownership and management of the entire water supply system from the municipal government.

The municipality of Calamba is located in the western portion of Laguna Province approximately 50 kilometers south of Manila, along the southwestern shore of Laguna de Bay. The municipality consists of the poblacion and 54 surrounding barrios, with a total land area 18,500 hectares. Calamba is situated at the foot of Mt. Makiling and is of relatively low relief, with an average elevation of 10 meters above mean sea level. The municipality is traversed by two rivers, the San Juan and San Cristobal, both of which pass to the north of the existing CAL-WD service area and drain into Laguna de Bay which forms the eastern boundary of the municipality.

The total population of the municipality in 1970 was 82,714 with an urban/rural breakdown of 25 and 75 percent, respectively. Of the 57,423 people employed in the municipality, 35 percent are involved in agriculture, forestry and fishing; 19 percent in manufacturing; 12 percent in commerce; 20 percent in services; and 14 percent in construction and other industries.

Existing Water Supply System

The water supply system of the CAL-WD was originally constructed in 1926 and consisted of the Bukal and Tigbe spring sources, approximately 16.4 km of pipelines ranging in size from 75mm to 200mm in diameter and a 380-cum reinforced concrete storage tank located on the hill above the spring in Barrio Bukal. Water supply was by gravity from Tigbe Spring (a minor source), and via the Bukal Spring pump station (located about 10 meters above mean sea level).

In 1959/60 the Tigbe Spring source was abandoned, a well was constructed at "Crossing" in Barrio Real and approximately 3.5 km of additional pipelines were constructed. In 1971, a new collection chamber was constructed at Bukal Spring.

At present, approximately 1,500 cumd is being produced from each of the pump stations at Bukal and "Crossing", from a single electric pumpset installed at each station. The pump stations are in poor condition.

The Bukal storage tank is in fair condition, requiring some repairs, and is operated on a modified fill-and-draw basis, with tank filling during early evenings and flow to the distribution system from midnight to 4:00 a.m. when the Bukal pump station is shut down. The storage tank is permitted to "float" on the system during daylight hours.

Disinfection has been practiced since 1926 by means of a gas chlorinator installed at the Bukal pump station. Chlorination, however, is performed irregularly only when heavy rains and chlorine gas availability coincide.

The distribution system of the CAL-WD serves the poblacion and portions of Barrios San Juan, San Jose, Lecheria, Halang, Real, Palingon, Linga, Bukal and Pansol, by means of 75 and 100-mm diameter pipelines. There are at present approximately 1,100 registered service connections of 12 and 25 mm.

Projections

In addition to the areas presently served by the CAL-WD, Barrios Parian, Mayapa, P. Rizal and Sampiruhan will receive service by 1990, and Barrios Looc, Sucol, San Cristobal and Prinza by the year 2000.

The total population in the CAL-WD service area was 24,872 in 1975 and is projected to increase to 100,069 by the year 2000, with average annual growth rates varying between 2.65 and 3.17 percent. During this same period, the population served by the CAL-WD is expected to increase from 6,708 to 71,903.

The average per capita consumption of water is expected to be 230 lpcd by 1980, with a total average daily use of 2,650 cumd. The per capita usage is projected to decrease to 220 lpcd by 1990, due to improved water accountability, and subsequently increases to 225 lpcd by the year 2000. Total average daily water demand is projected to be 8,190 and 16,180 cumd by 1990 and 2000, respectively.

Water Resources

Six potential sources of water for the CAL-WD were identified: two groundwater sources, three surface water sources and one ground/surface water source.

The Bukal Spring, located at the bottom of Mt. Bijiang, a secondary peak of the Mt. Makiling complex, is the current water supply source for CAL-WD. This spring has an average flow in excess of 115,000 cumd and emerges from the fractured consolidated volcanic ash which constitutes the major rock component in the area. The spring emerges at an altitude of 10 meters above mean sea level and is located about 3 km from the center of the poblacion. Other springs in the area are either too distant from the CAL-WD service area, or produce flows too small compared with the projected water district requirements, to be considered further.

The groundwater aquifer underlying the CAL-WD service area consists of relatively permeable pyroclastic materials with ample recharge from rainwater, locally and from the nearby mountainous areas. Many wells have been constructed in the area, but the most productive of these have been constructed by NIA and are fairly distant from the CAL-WD service. Reasonably good wells can be expected within the service area, but should be preceded by a test program to confirm the preliminary estimates of aquifer characteristics inferred from existing nearby and more distant wells.

Neither the Arangilan (San Cristobal) River, nor the San Juan River, both passing near the CAL-WD service area, could provide sufficient water to meet the projected needs of CAL-WD without impounding reservoirs and extensive treatment facilities. These sources have, therefore, not been given further consideration as future water sources.

Laguna de Bay is a shallow body of surface water that constitutes the eastern boundary of Calamba. The water supply demands of CAL-WD could certainly be met by water taken from this source. However, the need for a long intake pipeline, pumping costs which would likely exceed those for the Bukal Spring source, the need for extensive water treatment, the potential for future industrial and agricultural pollution and the possibility of future saltwater contamination indicate that further consideration of Laguna de Bay as a water supply source is unwarranted.

Alligator Lake is a 500-m diameter circular pond located in the crater of an extinct volcano about 5 km from the Calamba Poblacion. The pond is located along the shore of Laguna de Bay and is probably fed by bottom springs. Because of the need for transmission and treatment facilities (the pond is subject to extensive surface contamination), further consideration has not been given to Alligator Lake as a future water supply source.

Alternative Studies

Studies of alternative water sources for the CAL-WD service area indicate that continued use of groundwater, utilizing the existing Bukal Spring, is the most economically/operationally favorable over the project planning period. The lower overall present worth cost of groundwater wells is offset by other non-economic/operational disadvantages.

Economic analysis of required distribution storage volume and location indicates a cost advantage for continued supply of peak flows from the Bukal pump station, utilizing the existing Bukal storage tank, until 1990, with subsequent supply of maximum-day demands from the Bukal pump station, together with a 2,700-cum storage tank located at Lecheria Hill, until the year 2000. After 1990, Barrios Pansol and Sucol will receive independent service from the existing Bukal storage tank.

The requirements for the distribution system, incorporating the Bukal Spring as source, were analyzed with the aid of a computer. The resulting system is described in detail in Chapter IX. Based on the analysis of the pressure requirements of the system, two single-pressure service areas have been established to operate off the hydraulic grade lines established by the storage tanks.

B. RECOMMENDATIONS

General

A water supply system utilizing Bukal Spring as the source of water through the year 2000 is recommended for the CAL-WD. Construction of source, storage, distribution and administrative facilities will be carried out during an immediate improvement program and a long-term construction program consisting of four phases. The main features of the recommended long-term project for the CAL-WD are summarized in Table I-1 and shown in Figure IX-1 (appended).

Source Facilities

The projected year 2000 maximum-day system demand of 19,420 cumd in the CAL-WD will be supplied by the source facilities to be constructed at Bukal Spring by that year. Chlorination will be the only treatment required, and will be performed by facilities constructed adjacent to the Bukal pump station.

The CAL-WD will be required to secure the necessary water rights from the National Water Resources Council.

Storage Facilities

The existing 380-cum Bukal storage tank will be utilized to supply all system peak flows until about 1990. After 1990, the existing tank will serve Barrios Pansol and Sucol and additional storage facilities to be constructed at Lecheria Hill will serve the remainder of the system.

Distribution Facilities

The distribution system will be reinforced and expanded by the installation of 22.7 km of pipelines with diameters from 100 to 450 mm,

TABLE I-1

SUMMARY OF PROPOSED WATER SUPPLY IMPROVEMENTS
CALAMBA WATER DISTRICT

	Immediate Improvement Program	Construction Phase I-A	Construction Phase I-B	Construction Phase II-A	Construction Phase II-B
Construction Period	1978-79	1980-85	1986-90	1991-95	1996-2000
Total Project Cost (₱)	5,117,300	13,378,900	6,086,600	10,535,100	6,543,500
Foreign Exchange Component (₱)1/	2,950,800	6,675,900	3,397,100	5,137,500	3,291,400
Source and Storage Facilities	Additional Bukal pumpset, repair existing tank	Improve intake, new Bukal pump station and chlorination facilities, new Crossing pumpset	Additional Bukal pumpset	Expand Bukal pump station and chlorination facilities, new Lecheria tank	Additional Lecheria storage tank
Distribution Facilities	9.65 km - 100 to 350-mm pipelines	9.94 km - 100 to 450-mm pipelines	3.08 km- 100 to 200-mm pipelines	10.76 km- 100 to 350-mm pipelines	1.15 km - 200 and 250-mm pipelines
Internal Network	Leakage survey and repair	149.9 ha	38.3 ha	131.2 ha	160.8 ha
Service Connections	1,098 conversions, 329 replacements, 824 new connections	1,926 new connections, 729 replacements	2,625 new connections	3,300 new connections	3,300 new connections
Fire Hydrants	Repair existing hydrants	155.0 ha	173.6 ha	198.7 ha	199.1 ha
Miscellaneous					

1/ All foreign exchange figures used in this report were synthesized from data based on actual costs in U.S. dollars. To be consistent with previous studies, these foreign exchange costs were converted to RP pesos at a rate of US$1.0 = RP ₱7.0. To obtain correct current foreign exchange costs, multiply those presented in this report by the ratio of the current exchange rate and 7.0. The actual local component of costs (in pesos) is as presented herein.

by 1990. An additional 11.9 km of pipelines will be constructed by the year 2000 to provide service to additional consumers.

By the year 2000, 430 hectares within the CAL-WD service area will receive internal network pipelines. Service connection installation will proceed in a program parallel to internal network construction. There will be approximately 6,470 and 13,070 service connections within the service area by 1990 and 2000, respectively.

Capital Cost Summary

The capital costs for each phase of construction, including the immediate improvement program, are summarized in Table I-2. More detailed breakdowns of costs for the immediate improvement and Phase I-A programs are presented in Table I-3.

TABLE I-2

CAPITAL COST SUMMARY

Construction Stage-Phase	Construction Cost (₱)	Project Cost (₱) Local	Foreign	Total
Immediate Improvement Program (1978-79)	4,158,400	2,166,500	2,950,800	5,117,300
I-A (1980-85)	10,789,800	6,703,000	6,675,900	13,378,900
I-B (1986-90)	5,062,800	2,689,500	3,397,100	6,086,600
II-A (1991-95)	8,706,900	5,397,600	5,137,500	10,535,100
II-B (1996-2000)	5,586,200	3,252,100	3,291,400	6,543,500
Total (1978-2000)	34,304,100	20,208,700	21,452,700	41,661,400

Annual Operation and Maintenance Costs

Annual operation and maintenance costs are expenses incurred for personnel, power, chemicals, maintenance and miscellaneous expenses. Estimates of these costs for the CAL-WD (based on July 1978 price levels) are presented in Table I-4.

TABLE I-3

COST SUMMARY OF IMMEDIATE IMPROVEMENT PROGRAM AND CONSTRUCTION STAGE I PHASE A

Item	Cost (₱) Local	Foreign	Total
IMMEDIATE IMPROVEMENT PROGRAM			
Source Facilities			
Additional Bukal Pumpset	6,000	32,000	38,000
Crossing Chlorination Facilities	2,400	17,300	19,700
Storage Facilities			
Repair Bukal Storage Tank	8,800	11,200	20,000
Distribution Facilities			
9.65 km - 100 to 350-mm Pipelines	1,256,900	1,417,700	2,674,600
Leakage Detection and Repair	22,000	83,600	105,600
Service Connections			
Installation, Conversion & Repair	432,300	707,200	1,139,500
Administrative and Miscellaneous			
Equipment, Tools, Vehicles & Misc.	55,000	106,000	161,000
TOTAL CONSTRUCTION COST	1,783,400	2,375,000	4,158,400
Contingencies	243,100	315,600	558,700
Engineering	140,000	260,200	400,200
TOTAL PROJECT COST	2,166,500	2,950,800	5,117,300
CONSTRUCTION STAGE I PHASE A			
Source Facilities			
Improve Bukal Intake, New Bukal Chlorination Facilities, New Crossing Well Pumpset and New Bukal Pump Station	1,120,300	1,173,200	2,293,500
Distribution Facilities			
9.94 km - 100 to 450-mm Pipelines	1,606,000	2,145,300	3,751,300
Administrative Building and Plumbing Shop	726,000	-	726,000
Internal Network			
149.9 Hectares	989,900	713,100	1,703,000

TABLE I-3 (Continued)

	Cost (₱) Local	Foreign	Total
Service Connections			
769 Replacements and 1,926 New Connections	918,300	1,155,200	2,073,500
Fire Hydrants			
155.0 Hectares	101,800	140,700	242,500
TOTAL CONSTRUCTION COST	5,462,300	5,327,500	10,789,800
Contingencies	718,800	698,700	1,417,500
Engineering	349,900	649,700	999,600
Land	172,000	-	172,000
TOTAL PROJECT COST	6,703,000	6,675,900	13,378,900

TABLE I-4

ANNUAL OPERATION AND MAINTENANCE COSTS

Item	Annual Costs (₱) 1976	1980	1990	2000
Administration and Personnel	73,200	180,900	391,600	485,000
Power and Fuel	101,600	54,500	133,500	287,800
Chemicals	-	9,700	29,900	59,100
Maintenance	29,000	89,700	121,400	194,800
Miscellaneous	7,300	57,700	86,700	130,900
Total	211,100	392,500	763,100	1,157,600

Financial Feasibility

The financial feasibility analysis made for this study establishes a detailed set of guidelines that the water district management may use in making crucial decisions during the next few years. A plan has been developed to indicate how and when funds will be used to operate and maintain the system; implement the recommended program; establish reserve funds; and retire indebtedness. Water rates have been developed on the basis that the system will be financially self-supporting. These rates appear to be within the ability-to-pay of the average CAL-WD householder.

The water rates by revenue unit in three-year increments are as follows:

Period	Water Rate (₱/RU)
1978-80	0.75
1981-83	1.20
1984-86	1.50
1987-90	1.80
1991-94	1.90
1995-97	2.00
1998-2000	2.10

It is recommended that the implementation of these rates follow a socialized pricing policy to make the financial burden on the consumers commensurate with their ability-to-pay. A sample socialized rate structure for 1978-80 that would generate sufficient revenue is as follows:

Usage (per month)	Cost (₱/cum)
First 16 cum	0.85
From 17 to 24 cum	1.85
25 or more cum	2.45

Borrowing requirements will include ₱6.003 million for the immediate improvement program (1978-80); ₱16.993 million for Phase I-A (1980-85); and ₱9.031 million for Phase I-B (1986-90).

Economic Feasibility

The recommended improvements to the CAL-WD water supply system will bring about numerous economic benefits to the study area. Economic feasibility studies show that the benefits will exceed the costs associated with the development and operation of the water system.

Two approaches were adopted to determine economic feasibility; the benefit-cost ratio and internal economic rate of return (IERR). In both approaches, four benefits valued at 1978 prices were included and discounted at 12 percent. The benefits considered are increase in land values, health, reduction in fire damage and beneficial value of water. Analysis shows a benefit-cost ratio of 1.80:1 and an IERR of 71.4 percent.

CHAPTER II INTRODUCTION

A. FIRST TEN PROVINCIAL URBAN AREAS

The study contract signed by the Local Water Utilities Administration[1] (LWUA) and Camp Dresser & McKee International Inc. (CDM) on 14 October 1974 provided for the feasibility studies for the First Ten Provincial Urban Areas[2] (Figure II-1). The feasibility studies are part of LWUA's effort to develop basic water supply plans for provincial urban areas of the Philippines.

During the first 10-area project, training seminars for LWUA engineers were conducted by the CDM staff. "The Methodology Manual for Water Supply Feasibility Studies" was also developed and printed. In addition to the 10 areas, prefeasibility studies were also made for 131 cities/municipalities[3]. As of August 1976, the feasibility studies were completed and submitted to LWUA.

The studies for five of the first 10 areas - Cebu, Zamboanga, Daet, Ozamiz and Butuan - have been appraised by the Asian Development Bank (ADB). On the basis of the interim reports, the ADB extended a $16.8 million loan to LWUA in December 1975 to provide design engineering services to these 5 areas and to implement Phase I-A of the recommended long-term construction program (except Cebu whose share of the loan covered only engineering services). In August 1976, the United States Agency for International Development (USAID) signed a $10 million loan with LWUA to provide engineering services and funds for the implementation of the interim improvements of selected waterworks covered by the prefeasibility studies. In April 1977, the International Bank for Reconstruction and Development (IBRD) allocated $18.8 million towards the final design and initial phase implementation of the remaining five of the first 10 areas, namely: Lipa, Lucena, Tarlac, Cabanatuan, and San Fernando (La Union).

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[1] A background on LWUA is given in Volume II, Appendix D.

[2] Refer to Appendix B for summary of first 10-area feasibility studies.

[3] Refer to Appendix C for summary of prefeasibility studies on 131 cities/municipalities.

B. SECOND TEN PROVINCIAL URBAN AREAS

On 10 August 1976, LWUA and CDM signed an amendment to the study contract, extending the feasibility studies to include the Second Ten Provincial Urban Areas[4]. These are: Urdaneta, Gapan, Calamba, Bislig, Silay City, Bangued, Baybay, Roxas City, Cotabato City, San Fernando (Pampanga), Olongapo City and Los Baños (Figure II-1). This report includes the technical, financial and economic studies for the improvement of the water supply system in Calamba, Laguna.

The dollar component of the second 10-area feasibility studies cost has been financed from proceeds of a loan to the Government of the Republic of the Philippines from the United States of America through the USAID, Loan No. 492-T04001 dated 9 September 1976. The peso component of the cost of the studies, approximately 41 percent, has been funded by the Government of the Philippines.

The study contract for the second 10 areas includes the following tasks:[5]

1. Training of counterpart LWUA engineers through on-the-job assignments on various aspects of water supply feasibility studies;

2. Preparing water supply feasibility studies for 5 provincial urban areas, using the counterpart and expatriate consultant personnel for conducting such studies;

3. Preparing water supply feasibility studies for an additional 5 urban areas, with the LWUA engineers taking a dominant role in the conduct of such studies.

The studies began on 1 September 1976 for a period of 18 months. The project staff was composed of 6 US engineers and 26 Filipino personnel. The personnel of the respective water districts also assisted during the course of the studies.

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[4] Although the inclusion of 10 areas is stipulated in the contract, feasibility studies for 12 areas have actually been made.

[5] Refer to Appendix A for complete "Terms of Reference."

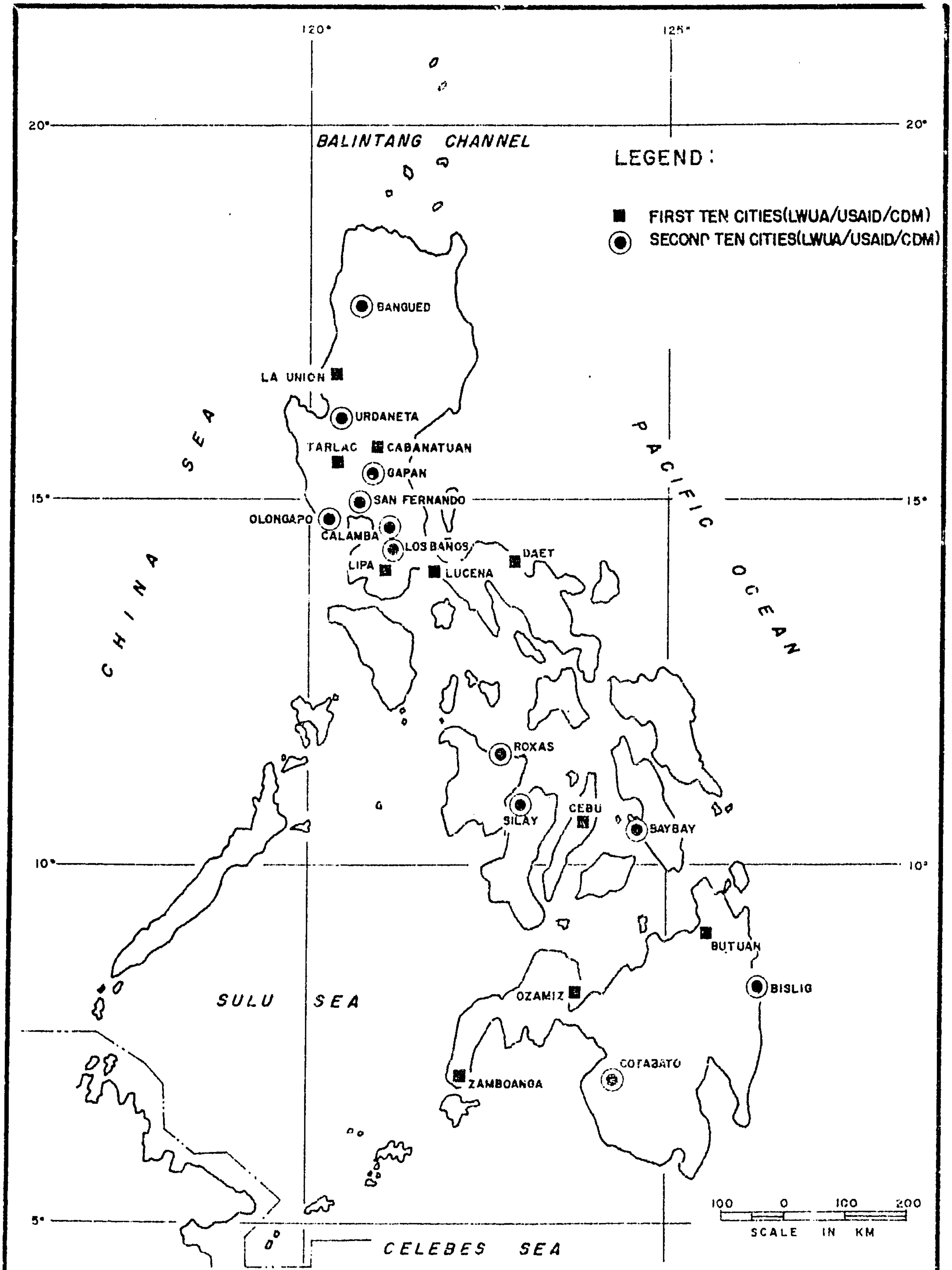

FIGURE II-1
LOCATION MAP
REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS
LWUA-CDM

C. HISTORICAL BACKGROUND OF CALAMBA WATER DISTRICT

When constructed in 1926, the Calamba water supply system was owned and managed by the municipal government. In 1956, however, the water system was placed under the National Waterworks and Sewerage Authority (currently Metropolitan Waterworks and Sewerage System) which was founded to take charge of provincial water utilities. NWASA turned over the system to the municipal government in 1964.

The CAL-WD was established on 7 August 1974 by Resolution No. 6 of the municipal council of Calamba to include the entire municipality of Calamba. Subsequently, CAL-WD acquired the ownership and management of the water system from the municipal government in accordance with Presidential Decree (PD) 198 (The Provincial Water Utilities Act of 1973).

The existing water system of Calamba has had no substantial improvements due to limited funds. The formation of the CAL-WD was prompted by the need for an upgraded water supply system. Moreover, the local officials recognized the potential role of the water district in providing sufficient, safe and potable water supply.

The CAL-WD was thus formed for the purposes of acquiring, installing, improving, maintaining and operating the water supply system, as well as the wastewater collection, treatment and disposal facilities. To perform these functions, the CAL-WD can obtain financial and technical assistance from LWUA. PD No. 198 provides that the water district shall operate eventually on a financially self-sufficient basis.

The CAL-WD is a quasi-public corporation and is politically independent from the local government. As constituted, the water district is subject to the provisions of PD No. 198 and the rules and regulations of LWUA. The CAL-WD can promulgate its own operating laws through its 5-member board of directors who are appointed by the municipal mayor. The district can only be dissolved through the act of this board.

On 4 September 1976, LWUA awarded the Conditional Certificate of Conformance to the CAL-WD after it had complied with the minimum requirements of LWUA's certification program. This certificate entitles the CAL-WD to rights and privileges authorized under PD No. 198.

CHAPTER III DESCRIPTION OF THE WATER DISTRICT

A. PHYSICAL DESCRIPTION

Location

Calamba is one of the municipalities bordering the western coast of Laguna de Bay in Laguna province[1] in the southwestern region of Luzon. With a land area of 18,500 hectares, Calamba is divided into the poblacion[2] and 54 barrios.[3]

The present service area[4] of the CAL-WD[5] covers the more densely populated sections, namely; the poblacion, the barrios of San Juan, San Jose, Lecheria, Halang, Real, Palingon, Linga, Bukal, and Pansol. The service area will extend to Barrio Parian by 1980; barrios Mayapa, P. Rizal and Sampiruhan by 1990; and barrios Looc, Sucol, San Cristobal and Prinza by 2000. (See Figures III-1 and VI-1.)

Physical Features

Calamba is generally flat with elevations averaging 10 meters above mean sea level. The major rivers are San Juan River located north of the present service area and draining portions of the future service area, and San Cristobal River bordering the northern portion of the municipality. These rivers drain into Laguna de Bay which constitutes the eastern border of the municipality.

The coastal plains have the most fertile soil and consist of light brown Quingua fine sandy loam. The upland soils include the Tagaytay sandy loam and Lipa loam. The Tagaytay loam which contains dark brown volcanic sand overlays the rolling uplands near the boundary of Batangas. Lipa loam is a residual soil formed from the decomposition of the underlying volcanic tuffaceous materials.

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[1] Laguna is an inland province situated at the southern end of Rizal province. Its boundaries are Laguna de Bay on the east; Quezon province on the east and south; and Batangas and Cavite on the west.

[2] Town proper

[3] A barrio is a political division of a city or municipality.

[4] The service area represents sections of the water district which are currently served or intended to be served by the water system.

[5] The CAL-WD covers all lands within the geographic boundaries of the municipality of Calamba.

Calamba is classified under the first type of climate, (Figure III-2), with 2 pronounced seasons. The dry season occurs from October to May; the wet season, during the rest of the year. The average annual rainfall for the period 1960-69 was 2,139.6 mm. For the same years, temperature ranged from 25°C in February to 29°C in May, with the average at 26.9°C. The climatological data are listed in Table III-1.

TABLE III-1

CLIMATOLOGICAL DATA[6]
(1960-69)

	Rainfall(mm)	Temperature(°C)
January	50.3	25.1
February	34.5	25.0
March	24.7	26.7
April	27.0	28.0
May	183.9	29.0
June	243.2	28.3
July	236.2	27.5
August	377.1	27.4
September	375.2	27.4
October	215.8	26.7
November	204.2	26.2
December	167.5	25.6
Total	2,139.6	
Average		26.9

B. POPULATION

Calamba's population in 1970 was 82,714, an increase of 43 percent over the 1960 total of 57,715. The 1970 population was composed of 13,366 households, or an average of 6.2 members per household. The general characteristics of the population are listed in Table III-2.

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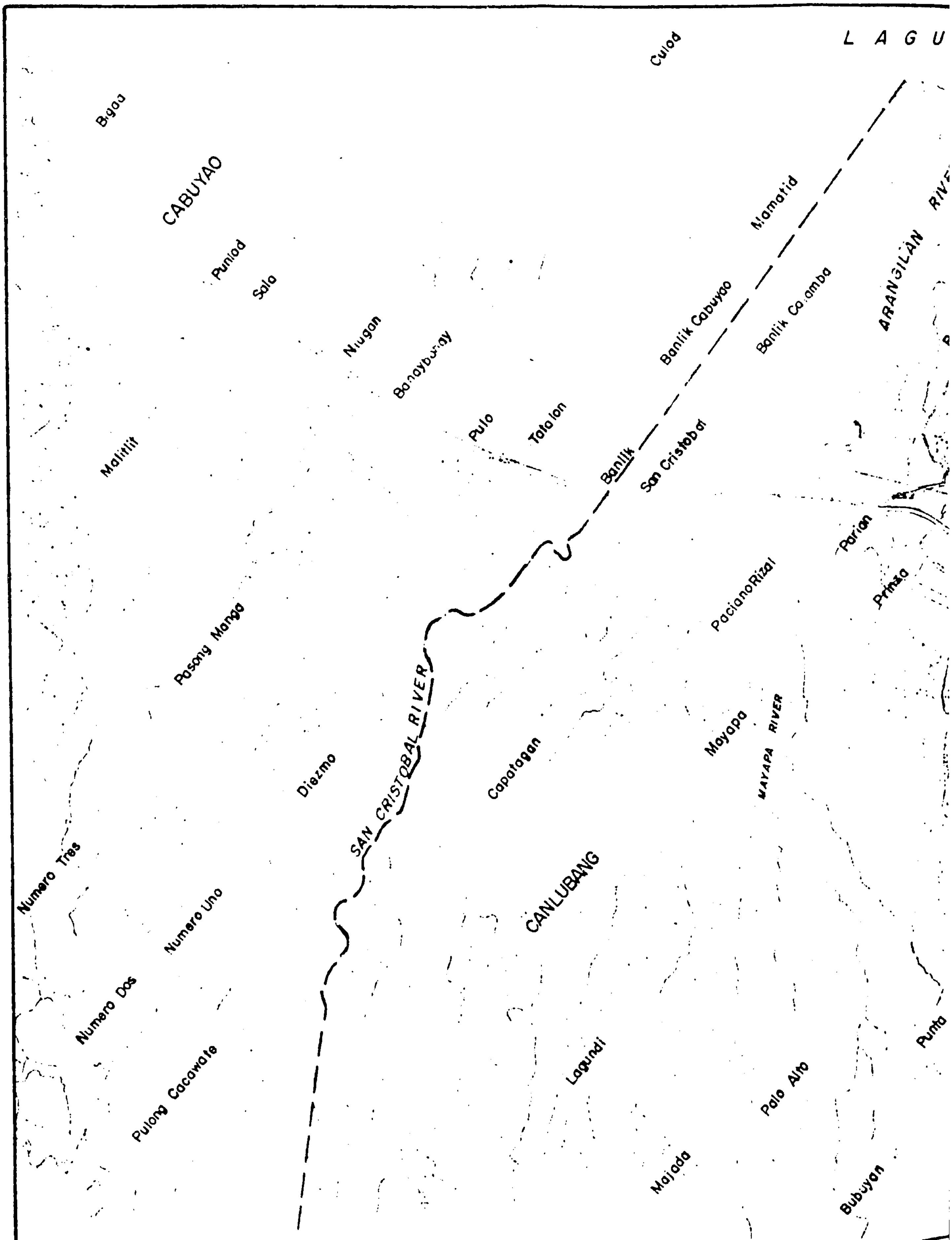
[6] Source: PAGASA Station in Los Baños, Laguna



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

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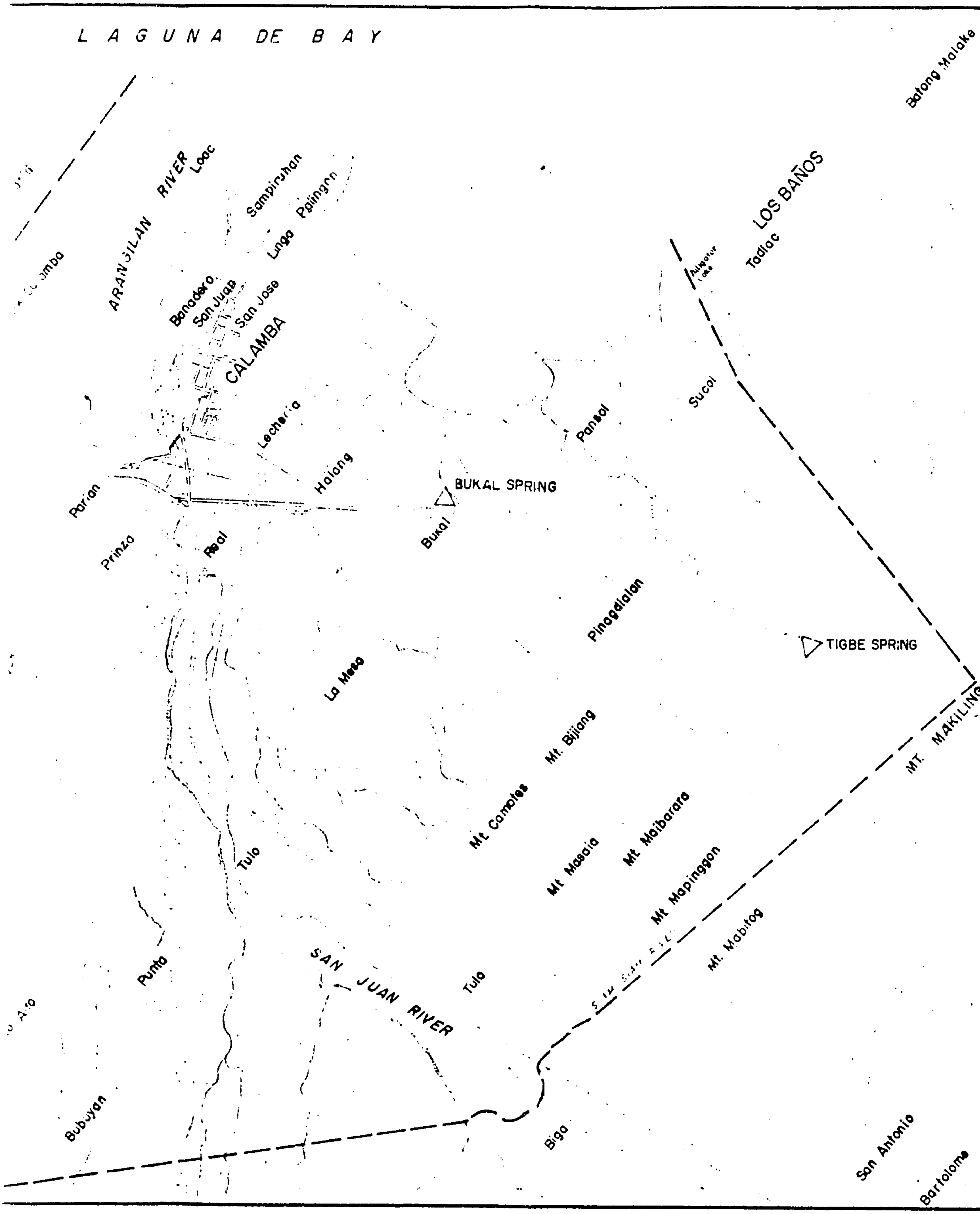
LAGUNA DE BAY
Batong Malake
LOS BAÑOS
Tadlac
Loac
RIVER
Sampiruhan
Palingon
Linga
Banadero
San Juan
San Jose
CALAMBA
Lecheria
Halang
Parian
Prinza
Real
Bukal
BUKAL SPRING
Pansol
Sucol
Pinagdialan
TIGBE SPRING
La Mesa
Mt. Bijiang
MT. MAKILING
Mt Camotes
Mt Maibarara
Mt Masaia
Mt Mapinggon
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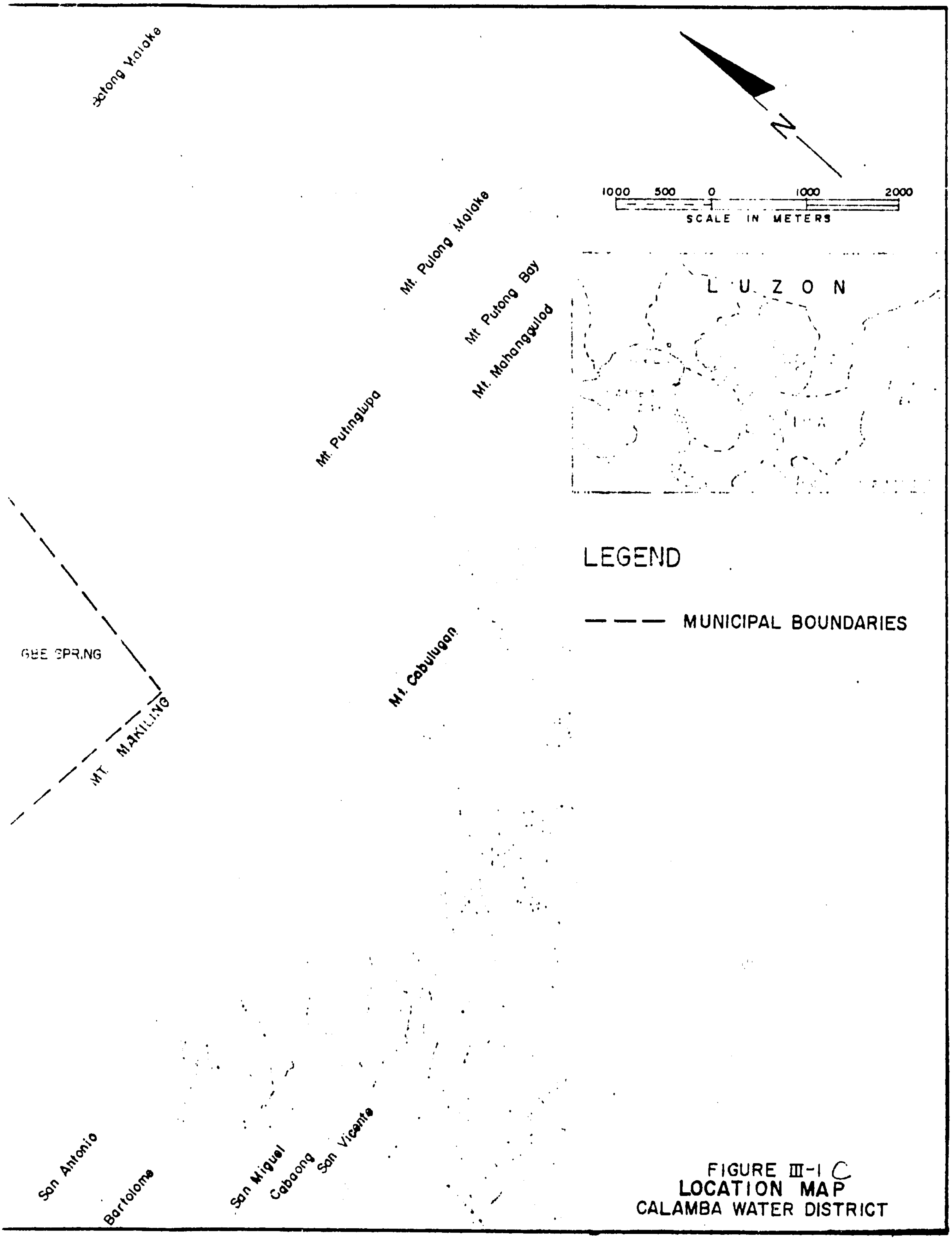
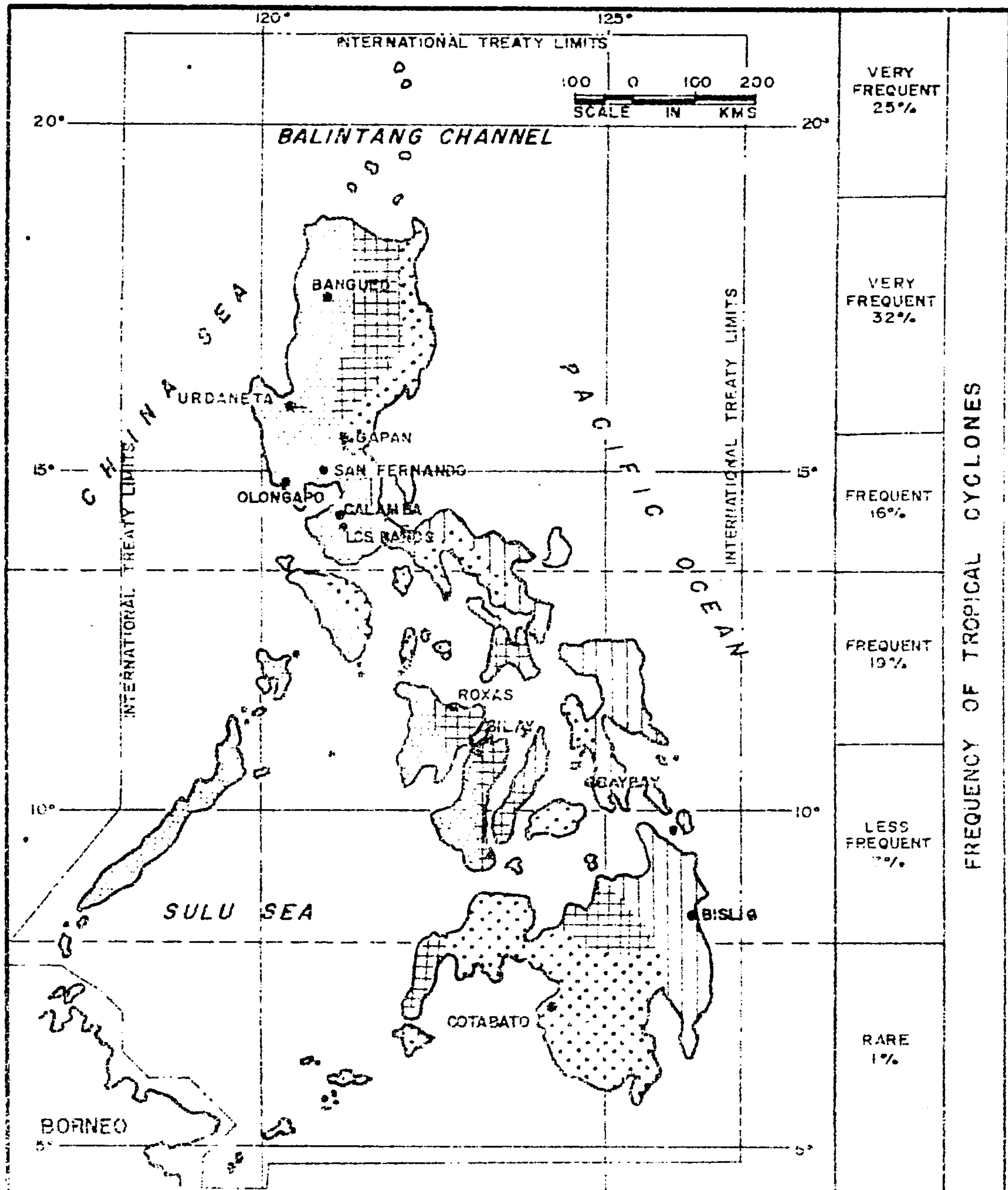
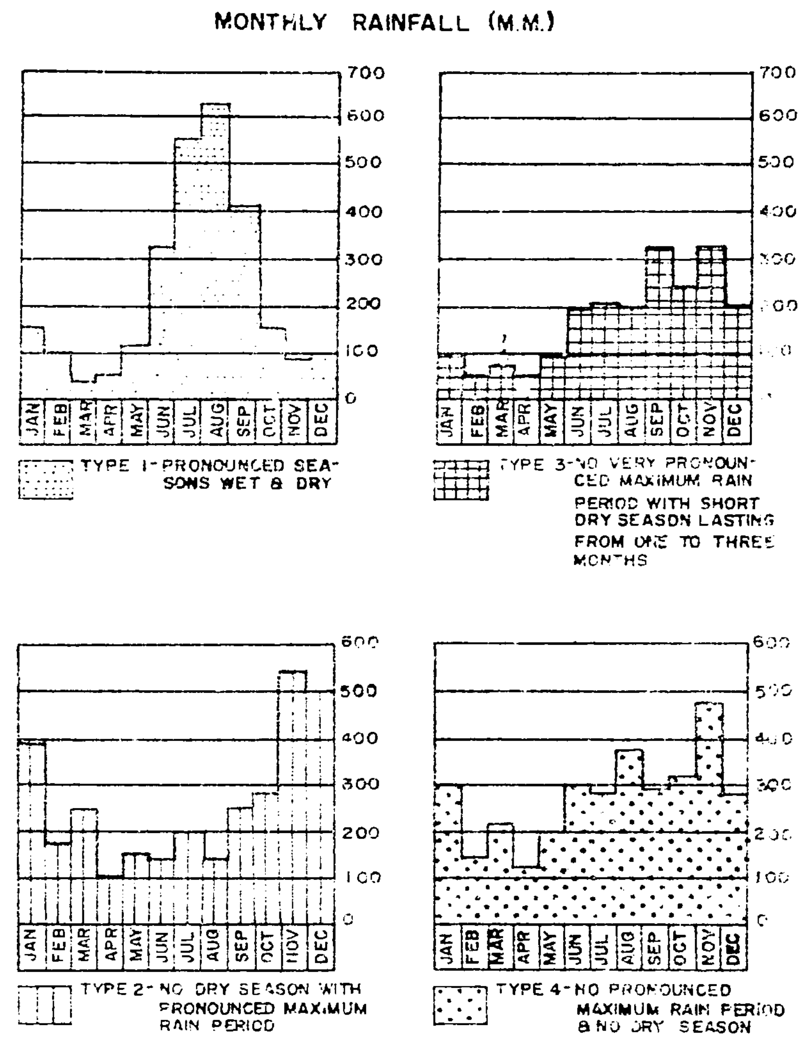


FIGURE III-1 C
LOCATION MAP
CALAMBA WATER DISTRICT





FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

FIGURE III-2
CLIMATE MAP
REPUBLIC OF THE PHILIPPINES

TABLE III-2

MUNICIPAL POPULATION CHARACTERISTICS[1] (1970)

1.	Total Population	82,714
2.	Growth Rate (1960-70)	3.7% per annum
3.	Density	4.5 persons per hectare
4.	Urban/Rural	urban, 25%; rural 75%
5.	Sex Composition	male, 49%; female 51%
6.	Age Composition	0-14 years, 44% 15-64 years, 53%; 65 years and above, 3%
7.	Employment (% of those 10 years and over)	10 years and over, 57,423 employed, 43%; unemployed, 57%
	a) By class of worker (% of labor force)	wage and salary, 61%; own business, 29%; unpaid family workers, 10%
	b) By industry (% of labor force)	agriculture, forestry and fishing, 35%; manufacturing, 19%; commerce, 12%; services, 20%; construction and other industries, 14%
8.	Education (% of those 6 years and over)	6 years and over, 66,806 literate, 84%; illiterate, 16%
	a) By attainment (% of those 25 years and over)	25 years and over, 28,223 elementary grades, 58%; high school, 17%; college, 11%; no formal education, 14%
	b) Number of schools	public, 51; private, 10
9.	Dialects	Tagalog, 96%; Ilocano, 1%; others, 3%
10.	Religion	Catholic, 95%; Protestant, 1.5%; Iglesia ni Cristo, 2%; others, 1.5%

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[1] Source: 1970 Census of Population and Housing, National Census and Statistics Office (NCSO).

These data apply to the municipality of Calamba as a whole.

C. LIVING CONDITIONS

Physical indicators showing the standard of living in the municipality are listed in Table III-3. These indicators include types of dwelling units, household facilities and utilities.

Health

Water-borne diseases occur particularly in the more densely populated sections of the municipality. Public health authorities recognize the correlation between the lack of safe water supply and sewerage facilities and the incidence of water-borne diseases. Table III-4 shows the recorded morbidity and mortality rates per 100,000 population due to water-borne diseases in the province of Laguna[8/] from 1964 to 1974. During this period, the average annual morbidity of 429.1 in this province was lower than the national average of 666.5; the average annual mortality of 41.4 was lower than the national average of 48.1.

D. ECONOMY[9/]

Family Income[10/]

In 1971, the province of Laguna was estimated to include 119,000 families, with a combined annual income of ₱443 million. The average family income of ₱3,723 was slightly lower than the country's average of ₱3,736. About 53 percent of the families were considered low-income (₱500-₱2,999) earners. The middle income (₱3,000-₱5,999) group included 33 percent. The remaining 14 percent received annual incomes of ₱6,000 and over.

Municipal Income

Calamba is classified as a first-class municipality by the Department of Finance. The average annual municipal income for fiscal years 1967-68 and 1969-70 was estimated at ₱816,000. The sources of income are taxes, incidental revenues and government operations. In addition to this income, the municipal government also receives financial aid from the provincial and national governments.

[8/] The only records available are for the province. The morbidity and mortality trends in Calamba are assumed from the data (see ChapterXI).

[9/] The Philippine economy from 1946 to 1976 is discussed in Appendix E, Volume II.

[10/] Only provincial data on family income are available at the NCSO.

TABLE III-3

CLASSIFICATION OF HOUSEHOLDS BY TYPE OF FACILITIES[11] (1970)

1.	Total Households	13,366
2.	Average Household Size	6.2 persons per household
3.	Water Facilities (% of total households)	piped water, 36%; artesian well, 17%; pump, 40%; open well, 6%; other sources, 1%
4.	Toilet Facilities (% of total households)	flush/water sealed, 29%; closed pit, 13%; open pit, 14%; public toilet, 6%; no facilities, 38%
5.	Solid Waste Disposal Service	About 12-15 metric tons of solid wastes are collected daily by the municipal health office. The wastes are disposed of in an area near the San Juan River in Barrio Banadero.
6.	Lighting Facilities (% of total households)	electricity, 50%; kerosene, 49% others, 1%
7.	Appliances (% of total households)	radio, 66%; TV, 11%; refrigerator, 8%
8.	Cooking Fuel (% of total households)	electricity, 3%; kerosene, 33%; LPG, 11%; wood, 52%; others, 1%
9.	Total Dwelling Units	13,329
	a) Type of dwelling unit (% of total units)	single type, 83%; duplex, 6%; apartment/accessoria, 5%; commercial, etc., 6%
	b) Roofing material (% of total units)	durable materials (aluminum/galvanized iron, asbestos, tile/concrete), 89%; non-durable materials (cogon, nipa, etc.), 11%

[11] Source, 1970 Census of Population and Housing, NCSO. These data apply to the municipality of Calamba as a whole.

TABLE III-4

REPORTED MORBIDITY AND MORTALITY
DUE TO WATER-BORNE DISEASES[12] (1964-74)
(PER 100,000 POPULATION)

Year	Laguna Morbidity	Laguna Mortality	Philippines Morbidity	Philippines Mortality
1964	711.9	39.5	846.3	60.2
1965	277.1	43.6	715.8	51.6
1966	178.5	47.5	715.1	61.9
1967	145.6	30.7	572.1	47.6
1968	198.3	34.6	564.8	46.5
1969	202.9	42.6	706.9	46.0
1970	254.4	35.5	612.8	39.0
1971	332.4	41.5	422.5	35.8
1972	570.5	55.5	743.4	49.4
1973	1,506.6	47.7	768.4	50.4
1974	341.8	37.1	663.8	40.4
Total	4,720.0	455.8	7,331.9	528.8
Average	429.1	41.4	666.5	48.1

Agriculture

Agriculture is the most important activity in Calamba, with rice, corn and sugar cane as the major crops. High-yielding rice varieties have been grown with the use of scientific farming. The modernization of agriculture in the area has been influenced by the University of the Philippines (Agriculture Department), and the International Rice Research Institute located in the nearby municipality of Los Baños. The Canlubang Sugar Estate in Barrio Canlubang is one of the biggest agro-industrial farms in Southern Luzon.

Commerce and Industry

Strategically located between Metropolitan Manila and other southern provinces, Calamba has become a commercial center in recent years. In 1975, Calamba had about 1,350 business establishments, 13 percent of which were industrial and 70 percent of which were engaged in the wholesale, retail and food business.

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[12] Source: Disease Intelligence Center, Department of Health. The water-borne diseases of which records are available include typhoid, cholera, dysentery and gastro-enteritis.

Some of the large manufacturing firms in Laguna are located in Calamba. These are the Canlubang Sugar Corporation, Alfa Integrated Textile Corporation and other textile mills. Manufacturing also consists of processing agricultural products and cottage industries.

Tourism

The well-known tourist spots in Calamba include: the shrine of the national hero, Dr. Jose Rizal; Mount Makiling; Laguna de Bay; and several hotsprings. The municipality has various recreational facilities.

Transportation and Communication

Only land transportation is available in Calamba. About 500 tricycles, numerous jeepney and bus units and the Philippine National Railway trains service the residents.

Communication facilities include a telephone company, 3 telegraph stations, 2 post offices and a messenger service agency. Calamba's proximity to Manila allows the fast circulation of national newspapers and magazines.

CHAPTER IV EXISTING WATER SUPPLY FACILITIES

A. GENERAL

The water system of the CAL-WD was originally constructed in 1926, with Bukal and Tigbe springs as sources. In 1959, another source, a well, was constructed. Only Bukal Spring and the well are currently used; Tigbe Spring was disconnected from the system in 1960. Existing facilities include an intake box, pump station, reservoir, well pump station, transmission and distribution pipes. A schematic diagram of the existing water system is shown in Figure IV-1.

B. WATERWORKS FACILITIES

Source Facilities

The current water sources of the CAL-WD are the Bukal Spring (major source) and the deepwell. Bukal Spring is located about 3 km south of the poblacion; the deepwell is located on the National Highway at the western portion of the poblacion.[1] The total production from these 2 sources is about 3,000 cumd based on the field studies. Tigbe Spring, a minor source in the past, was disconnected from the water system when its transmission main was damaged by a storm in 1960. At present, this spring is used by a private resort in Barrio Pansol.

The water sources are each provided with a pumping unit. In 1966, the diesel engines, which served as prime movers for the pumps, were replaced with electric motors. The capacities of these motors are 100 hp for the Bukal pump station and 25 hp for the well station.

The well station has a measured discharge of about 1,400 cumd, at 1.76-meter operating head. Well and casing data, however, are not available. The Bukal spring station has a measured discharge of about 1,600 cumd at 67-meter operating head, but the total measured overflow from the spring is 96,000 cumd. Both pumps are operated 20 hours a day.

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[1] This location is commonly known to residents of Calamba as "Crossing." Hence, the well is usually referred to as the "Crossing Well".

Intake Box. A square concrete intake box was constructed in 1926 behind the Bukal pump station. This was abandoned in 1971 and a trapezoidal concrete intake box was built on the other side of the road opposite the pump station. The second intake box has an overflow elevation of about 5 meters above mean seal level; however, the intake box does not overflow because of leakage under the structure and through several holes near the bottom of the structure. A 200-mm GI suction pipe connects the intake box to the pump station. Figure IV-2 is a plan of the existing intake box.

Treatment Facilities

Since 1926, chlorine gas has been used to treat the water supply at the Bukal pump station. Disinfection, however, is done irregularly only during heavy rains and when chlorine is available.

Storage Facilities

A reinforced concrete ground-level reservoir, constructed in 1926, is located about 150 meters southwest of the Bukal pump station. It has a capacity of 380 cum and an overflow elevation of about 48 meters above mean sea level.

The reservoir is filled every night from 8:00 p.m. to 11:00 p.m. It is currently used only for priming the pump and supplying water to the distribution system. The discharge valve of the reservoir is opened when the Bukal pump is off from midnight to 4:00 a.m. to prevent overflow at the reservoir. A schematic plan of the reservoir is shown in Figure IV-3.

Transmission Facilities

In 1926, a 5,000-meter long, 75 mm GS line was laid to transmit water from Tigbe Spring to the reservoir. This line, located between Barrios Pansol and Bukal, was damaged by a storm in 1960, cutting off the supply from Tigbe Spring.

Another transmission line was constructed in 1926, connecting the Bukal pump station to the poblacion (see Figure IV-4 for its plan and profile). This line is a combination of 150 and 200 mm CI pipes with a total length of 2,900 meters. Leakage has been found from this main which traverse a wide plain of ricefields. In 1959, two GI transmission lines were added to increase the service in the poblacion and to serve Barrio Pansol. The first line, which connects the Bukal Spring to Barrio Pansol, is a combination of 37, 50 and 75 mm pipes with a total length of 1,960 meters. The second line is a 650 meter, 150 mm pipe extending from the Crossing well to the poblacion.

TRANSMISSION AND DISTRIBUTION SYSTEM

DIAMETER (MM)	TYPE	LENGTH OF PIPE INSTALLED (M)			
		1926	1959	UNCERTAIN	TOTAL
37	GS	–	1,900	418	2,318
50	GS	–	20	472	492
75	GS	9,174	40	–	9,214
100	GS	4,333	–	–	4,333
150	CIP	1,600	650	–	2,250
200	CIP	1,300	–	–	1,300
		16,407	2,610	890	19,907

APPURTENANCES

	SIZE	NUMBER	REMARKS
VALVES	VARIOUS	14	REPORTEDLY INOPERABLE, BUT FULLY OPEN
HYDRANTS		16	ONLY TWO ARE OPERATIONAL
PUBLIC FAUCETS		22	

SERVICE CONNECTIONS, SEPTEMBER 1976

TYPE	METERED	FLAT-RATE	TOTAL
DOMESTIC	-	1059	1059
COMMERCIAL	-	39	39
TOTAL	-	1098	1098

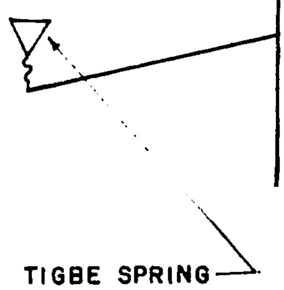
CROSSING WELL PU

- DISCHARGE - 1400
- DISCHARGE PRESSU
- TURBINE PUMP D
  25 HP HORIZONTA

DOME STORAGE TA

- GROUND COVERED
- CAPACITY - 380
- OVERFLOW ELEVA

CUT-OFF



TIGBE SPRING

- DISCHARGE 350 C
- 5 KM SOUTH WES
- CURRENTLY USED

BUKAL INTAKE BO

- FED BY BUKAL S
- REINFORCED CONC
- OVERFLOW - 96

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

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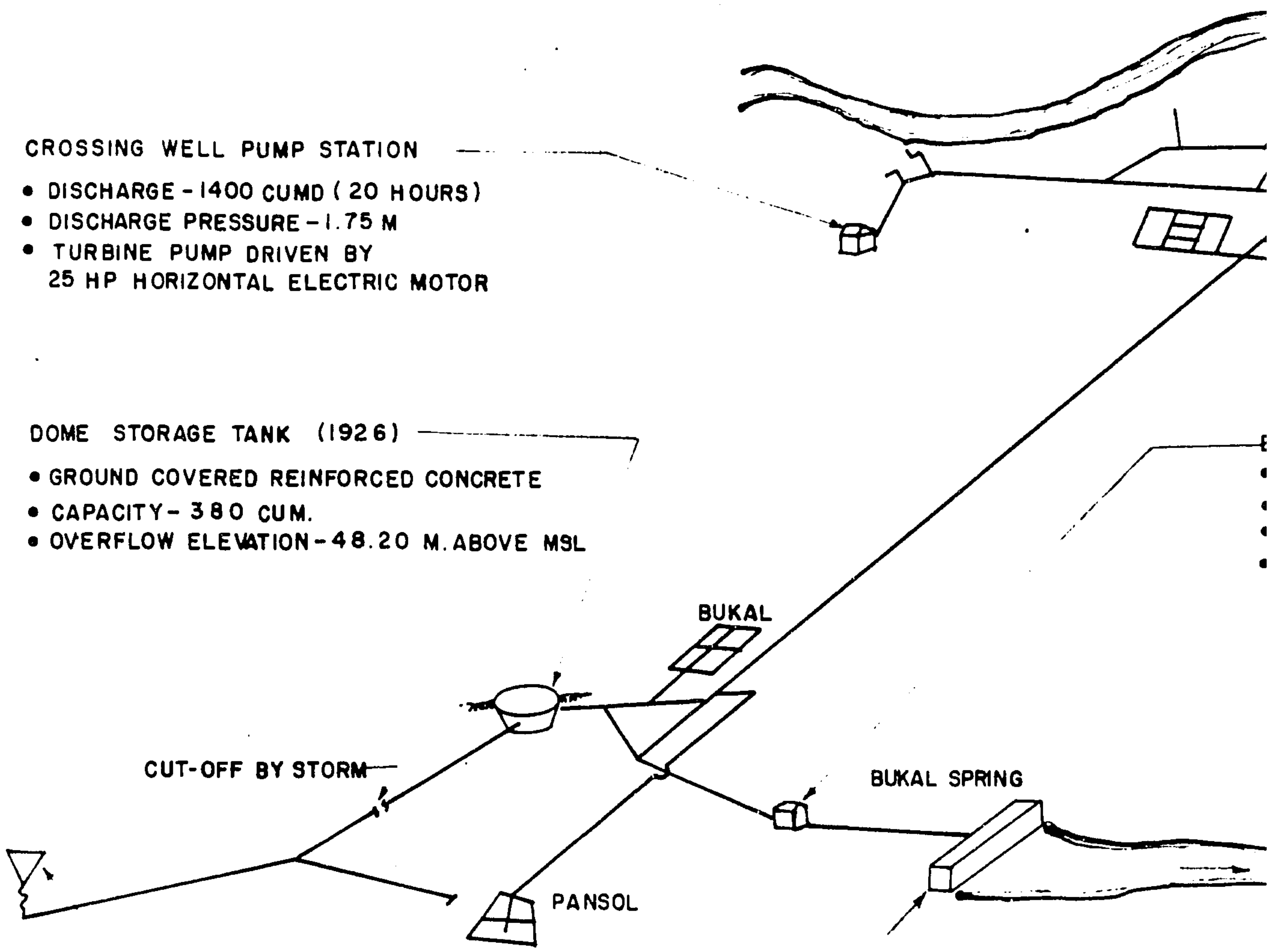
: (M)
OTAL
2,318
492
9,214
4,333
2,250
1,300
9,907

CROSSING WELL PUMP STATION

- DISCHARGE - 1400 CUMD (20 HOURS)
- DISCHARGE PRESSURE - 1.75 M
- TURBINE PUMP DRIVEN BY 25 HP HORIZONTAL ELECTRIC MOTOR

DOME STORAGE TANK (1926)

- GROUND COVERED REINFORCED CONCRETE
- CAPACITY - 380 CUM.
- OVERFLOW ELEVATION - 48.20 M. ABOVE MSL



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TIGBE SPRING

- DISCHARGE 350 CUMD AS REPORTED
- 5 KM SOUTH WEST FROM RESERVOIR
- CURRENTLY USED BY PRIVATE RESORTS

OTAL
059
39
.098

BUKAL INTAKE BOX (1971)

- FED BY BUKAL SPRING
- REINFORCED CONCRETE
- OVERFLOW - 96,000 CUMD

TREATMENT

- CHLORINATION OF WATER SUPPLY IS DONE AT BUKAL PUMPING STATIO HEAVY RAIN AND/OR WHEN CHLOR IS AVAILABLE.

SYSTEM PRESSURE

- VERY LOW AND UNEVENLY DIST IN THE SERVICE AREA.

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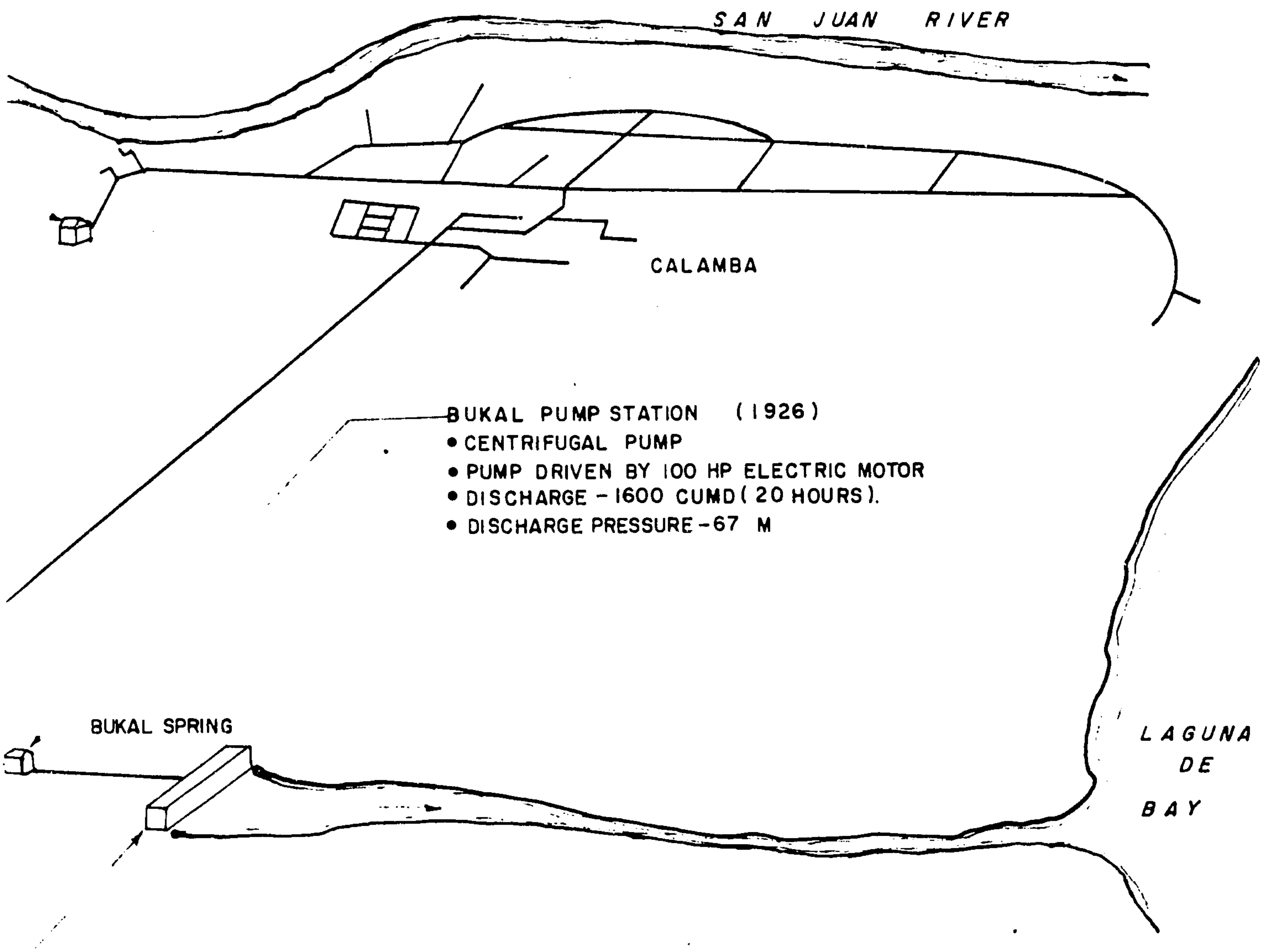


TREATMENT

- CHLORINATION OF WATER SUPPLY IS ONLY DONE AT BUKAL PUMPING STATION DURING HEAVY RAIN AND/OR WHEN CHLORINE GAS IS AVAILABLE.

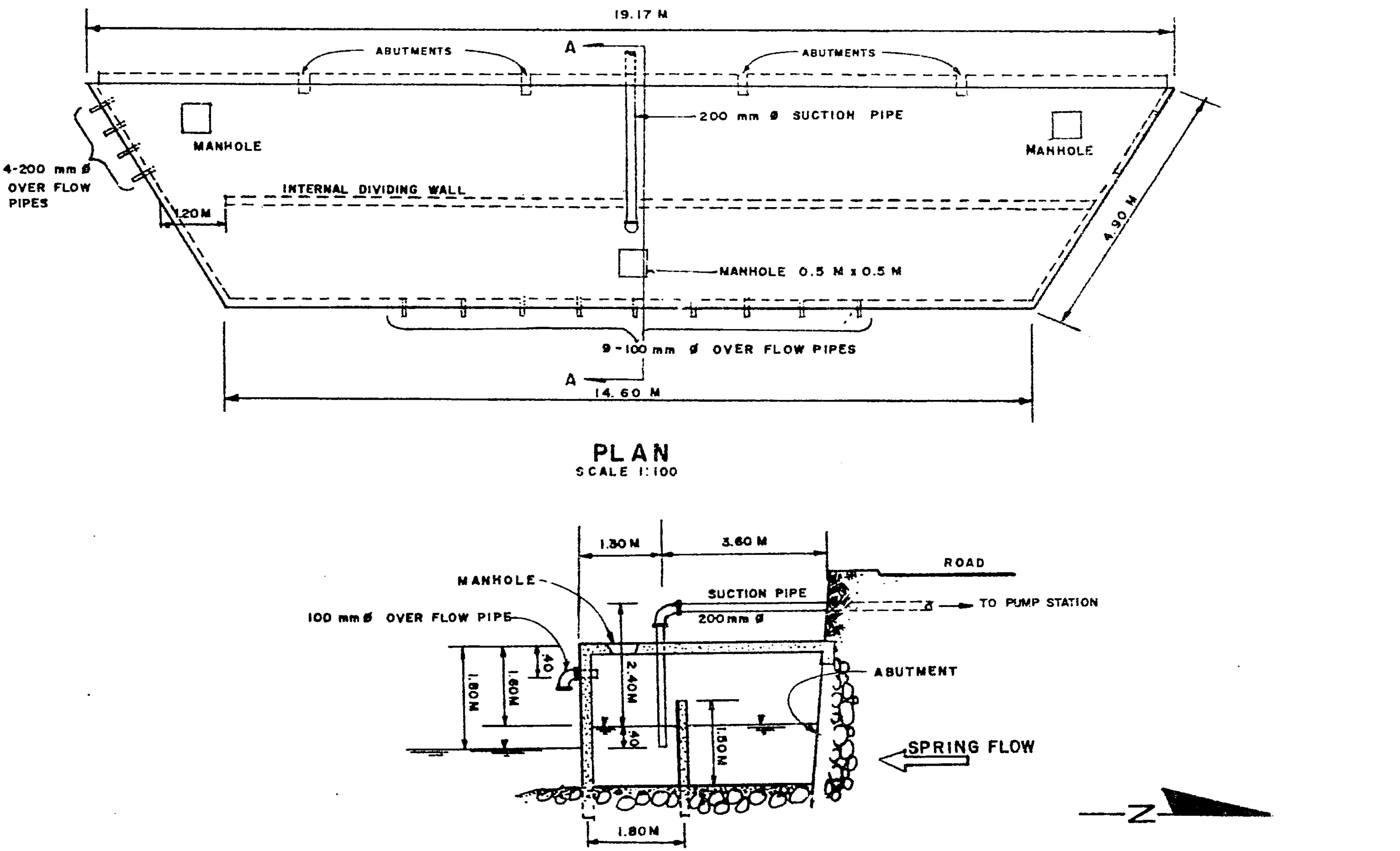
SYSTEM PRESSURE

- VERY LOW AND UNEVENLY DISTRIBUTED IN THE SERVICE AREA.

SERVICE AREA OPERATION

- THE BUKAL PUMPING STATION OPERATES FROM 0400 TO 2300 HOURS DELIVERING WATER TO THE RESERVOIR AND TO THE DISTRIBUTION SYSTEM. BUT AS SOON AS THE RESERVOIR IS FILLED, THE PUMP IS SHUT DOWN.
- THE RESERVOIR FEEDS WATER TO THE SYSTEM FROM 2300 TO 0400 HOURS UNTIL THE PUMP IS OPERATED AGAIN.
- CROSSING WELL STATION OPERATES FROM 0400 TO 2300 HOURS.

FIGURE IV-1
EXISTING FACILITIES
CALAMBA WATER DISTRICT



SECTION A-A
SCALE 1:100

FIGURE IV-2
EXISTING INTAKE STRUCTURE
CALAMBA WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM

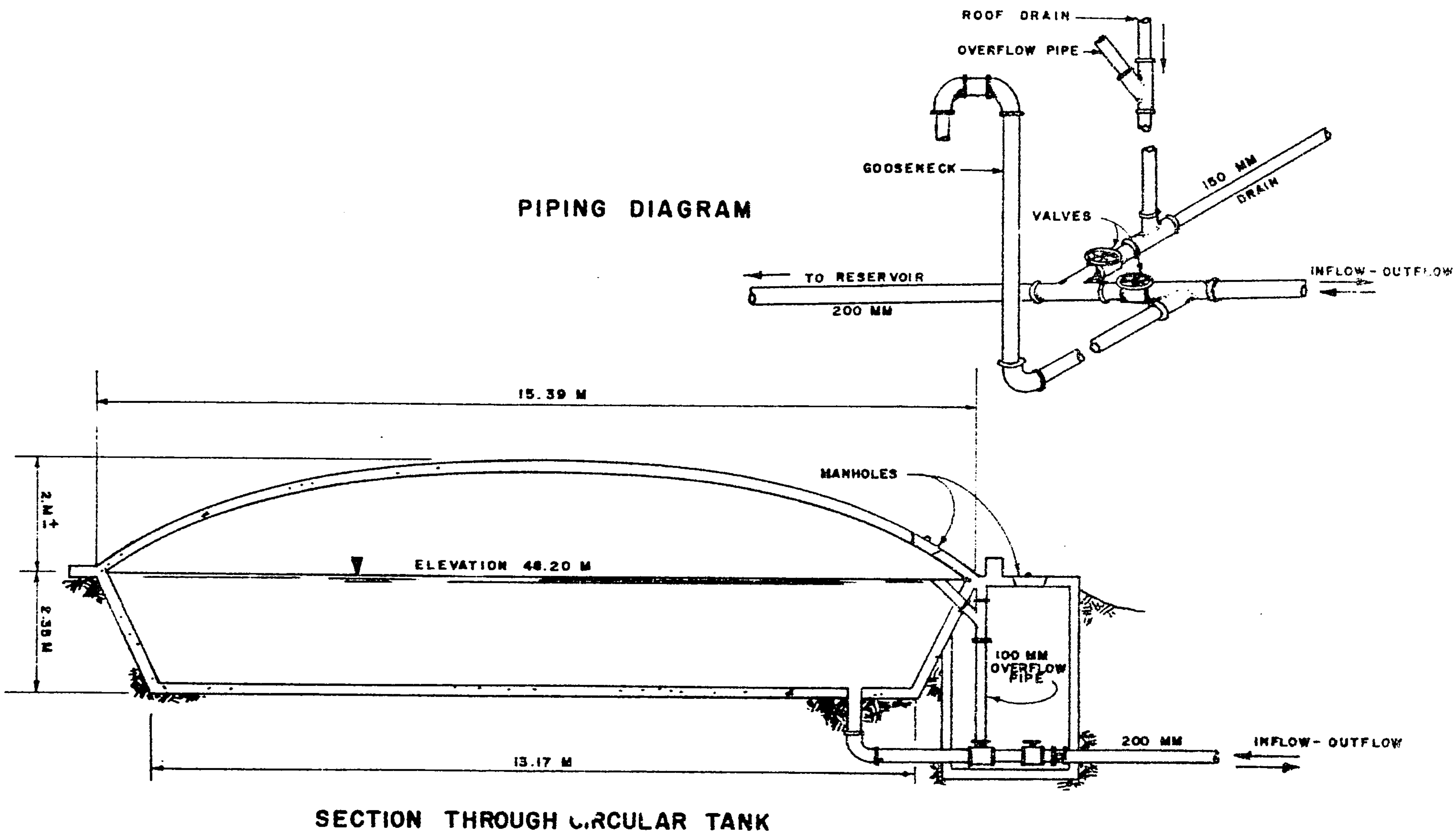


FIGURE IV - 3
SCHEMATIC DIAGRAM
EXISTING 380 CUM GROUND STORAGE TANK
CALAMBA WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS
LWUA-CDM

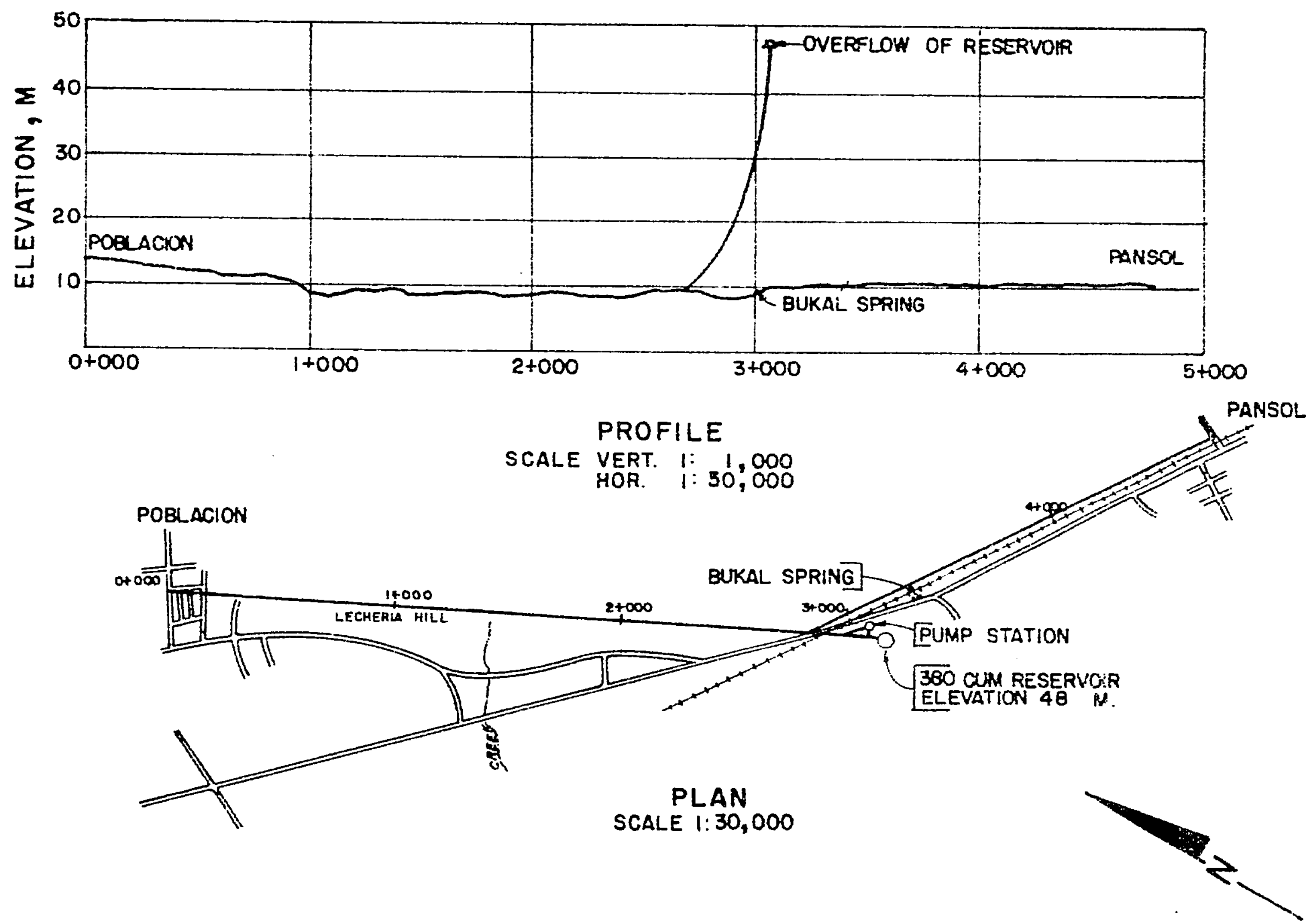


FIGURE IV-4
PLAN AND PROFILE
EXISTING BUKAL SPRING TRANSMISSION LINES
CALAMBA WATER DISTRICT

A description of the transmission lines by material, size, length and age is given as follows:

Description	Material	Size (mm)	Length of Pipe (m) 1926	1959	Total
Bukal Spring to poblacion	CI	200	1,300	-	1,300
	CI	150	1,600	-	1,600
Tigbe Spring to the reservoir	GS	75	5,000	-	5,000
Crossing deepwell to poblacion	GI	150	-	650	650
Bukal Spring to Barrio Pansol	GI	75	-	40	40
	GI	50	-	20	20
	GI	37	-	1,900	1,900
					9,510

Distribution System

The existing distribution system (Figure IV-5) covers portions of the poblacion and the barrios of San Juan, San Jose, Lecheria, Halang, Real, Palingon, Linga, Bukal and Pansol. The original system was constructed in 1926, with 75 and 100 mm pipes. A minor expansion included 37 and 50 mm pipes. All pipes are galvanized steel.

Pipe Size and Length. The distribution piping has a total length of about 9.4 km. Over 90 percent of the pipes have been in place for 50 years. The distribution pipes by size, material, length and age are as follows:

Size (mm)	Material	Date Installed	Total Length (m)
37	GS	uncertain	418
50	GS	uncertain	472
75	GS	1926	4,174
100	GS	1926	4,333
Total			9,397

Valves and Hydrants. Based on the best available information, there are 14 valves in the system. All valves in the distribution system are either defective or laid under paved streets; and hence, they could not be used. It appears that all inoperable system valves are open. Valves at the pumping stations, some of which are leaking, are operational.

There are 16 fire hydrants in the existing system. However, only two of these hydrants are reported to be operational.

Public Faucets. The system has about 22 public faucets, six of which are located at the public market. The CAL-WD neither monitors nor bills consumption at these faucets.

Service Connections. As of 30 September 1976, the CAL-WD had a total of 1,098 registered service connections, all unmetered. These are classified into 1,059 domestic and 39 commercial connections, with sizes varying from 12 to 25 mm.

Operation and Maintenance

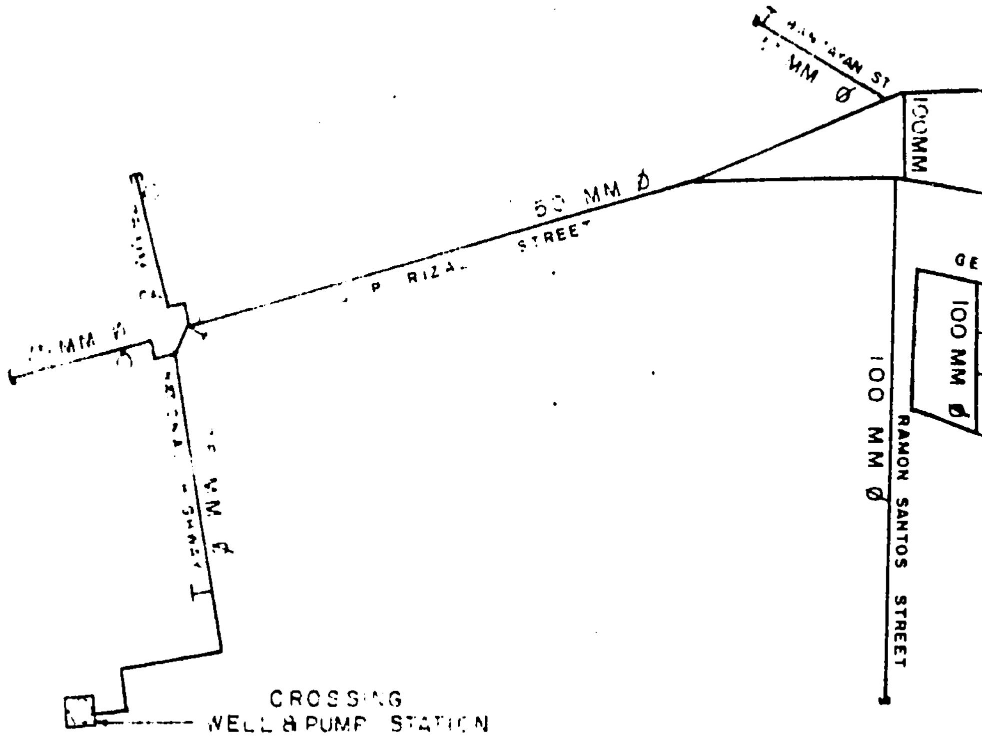
The CAL-WD operates and maintains the pump stations and the distribution system. The present staff for operation and maintenance includes 1 production chief, 1 plumber, 6 pump operators and 2 laborers.

The operation program consists primarily of operating the pump stations and controlling the valves to the reservoir and to the service area. The pump operators work in 2 shifts: the first, from 8:00 a.m. to 6:00 p.m.; and the second, from 6:00 p.m. to 8:00 a.m.

The maintenance program consists of servicing the pumping units and repairing leaking mains and service lines. The CAL-WD does not have its own vehicles, repair shop, tools or equipment; it borrows them whenever repair work is to be done.

C. WATER QUALITY

Water samples were taken from the Bukal Spring, the Crossing Well and Tigbe Spring on 1 September 1976. The results of the subsequent analyses are listed in Table IV-1. The analyses show that the manganese content of Tigbe is nearly 5 times the excessive limit set by the Philippine National Standards for Drinking Water (PNSDR). The pH of Tigbe Spring water is also lower than the permissible limit of the PNSDR. All the other water quality parameters from the 3 sources meet the standards.



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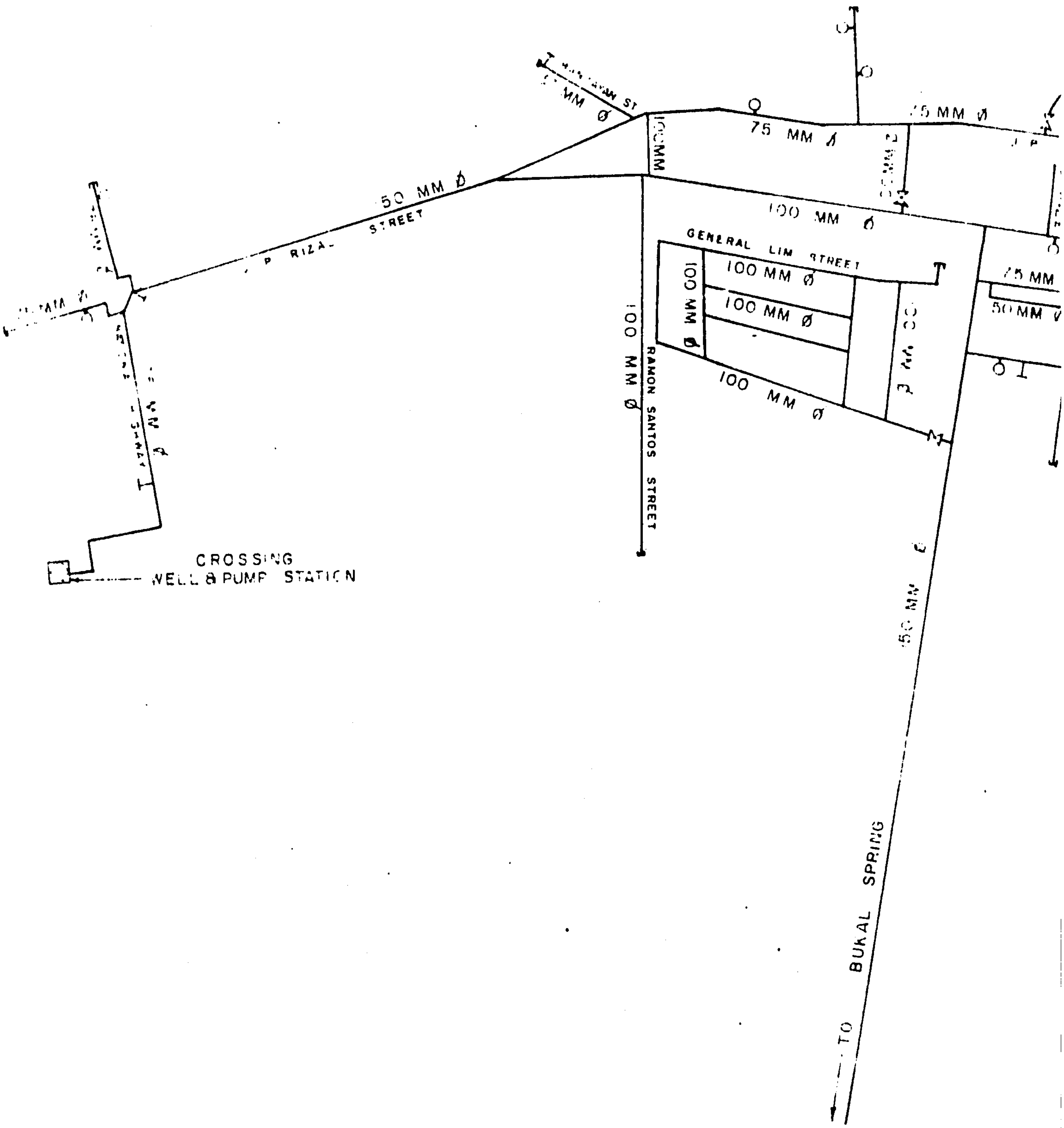

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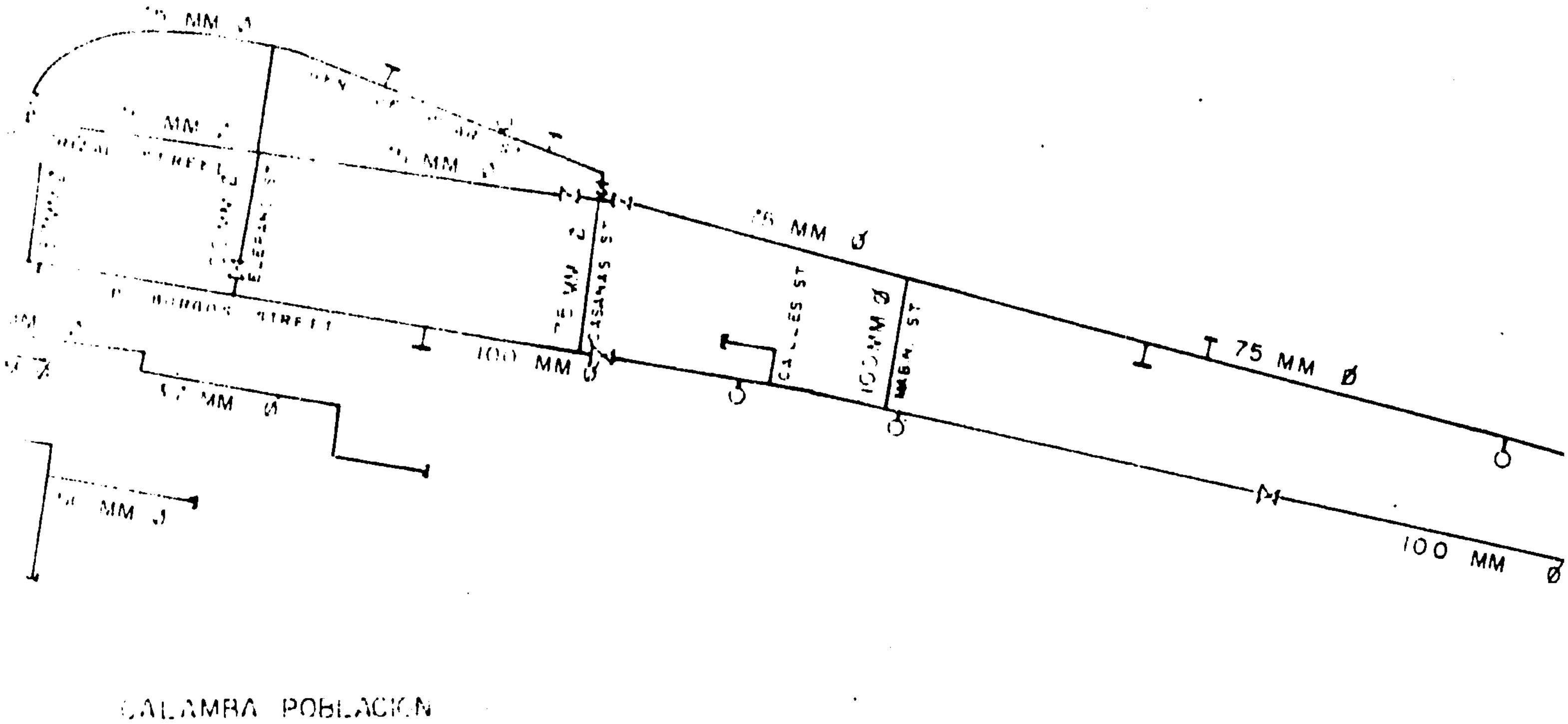


NOTES

1. VALVE LOCATIONS SHOWN HAVE NOT BEEN VERIFIED MOST VALVES SHOWN ARE LOCATED BENEATH CONCRETE ROADWAYS THE BALANCE OF SYSTEM VALVES ARE LOCATED IN BARRIOS BUKAL AND PANSOL.

2. THE BALANCE OF PUBLIC FAUCETS AND FIRE HYDRANTS NOT SHOWN IN THIS FIGURE ARE LOCATED IN BARRIOS BUKAL

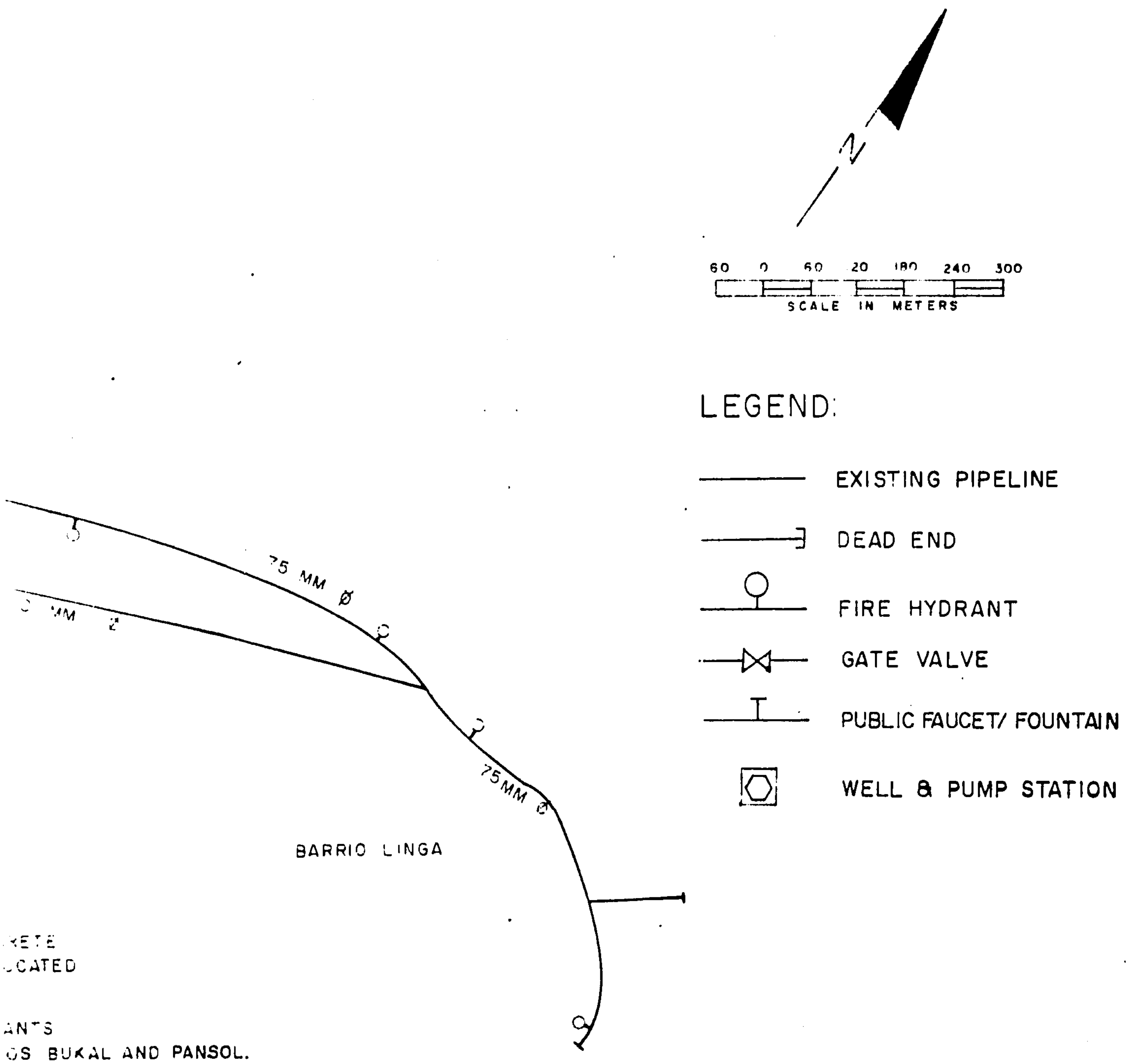


FIGURE IV-5 d
EXISTING WATER DISTRIBUTION SYSTEM
CALAMBA WATER DISTRICT

TABLE IV-1

WATER QUALITY TEST RESULTS
CALAMBA WATER DISTRICT

Test	Unit	Permissible Limits	Bukal Spring Bo. Bucal 1 Sept 76	Tigbe Spring Bo. Tigbe 2 Sept 76	Deepwell Poblacion 3 Sept 76
Physical					
Color	APHA	15	0	2	0
Turbidity	FTU	5	0	0	0
Total Dissolved Solids[2]	mg/l		273	57	247
Conductivity	Micromhos/cm		420	88	380
Chemical					
pH		7-8.5	7.4	6.5[3]	7.2
Total Alkalinity	mg/l CaCo3		180	40	210
Phenolphthalein Alkalinity	mg/l CaCO3		0	0	0
Total Hardness	mg/l CaCO3	400[4]	133	20	182
Calcium	mg/l Ca	75	14.4	2	16
Magnesium	mg/l Mg	50	2.4	0.5	4.6
Total Iron	mg/l Fe	0.3	nil	0.06	nil
Fluoride	mg/l F	1.5	0	0	0
Chloride	mg/l Cl	200	16.5	6.1	6.1
Sulfate	mg/l SO4	136	6.12	3.4	0.68
Nitrate	mg/l NO3		7.62	5.94	18.6
Manganese	mg/l Mn	0.1	0	2.35[3]	0.1

2/ Computed as 65 percent of conductivity.
3/ Exceeds the permissible limits set by the Philippine Standards for Drinking Water.
4/ Limits inferred from limits of individual metals causing hardness.

D. WATER USE PROFILE

The water consumption in the CAL-WD has been analyzed to quantify present water accountability. Data used have been obtained from interviews and field measurements in the absence of water meters and records on water production and consumption. Unit water consumption has been quantified through a pilot area survey. (See Methodology Memoranda No. 1 and 2).

Pilot Area Survey

The pilot area, about 1.4 hectares, is located in the northwestern portion of the poblacion. It has 52 households or a total population of 332, with an average of 6.4 persons per household. Interviews show the following: 29 households are registered concessionaires; 20 households are "borrowers" from registered concessionaires; and 3 households have illegal connections to the water system. These data have been used to derive the number of users of the CAL-WD water supply.

Population Served

The pilot area survey indicates that consumers of the CAL-WD water supply can be classified into primary users and secondary users (borrowers). The total of 1,098 registered connections in the present service area, plus an estimated 114 illegal connections, represents the number of households who are primary users. Based on the survey results, total borrowers from the CAL-WD system include about 743 households and those with illegal connections, 114 households. Applying the pilot area average of 6.4 persons per household to the CAL-WD, total consumers of the CAL-WD water supply are estimated to be 12,512, of which 7,027 are registered users; 4,755 secondary users; and 730 consumers with illegal connections.

Unit Consumption

The unit water consumption has been determined on the basis of pilot area survey results. The estimated daily consumption of each household and the number of persons per household, as given in the survey, have been used to estimate the unit consumption.

The unit consumption is estimated to be 56 lpcd for primary users and 23 lpcd for secondary users. The available data are not sufficient to estimate domestic and commercial consumption separately. At present, the CAL-WD does not serve any institutional or industrial establishments.

Accounted-for-Water

Accounted-for-water is ordinarily revenue-producing water for the water district. Accounted-for-water, however, in the CAL-WD is assumed to be the volume of water consumed by primary and secondary users. Revenue-producing water cannot be determined because the CAL-WD has no water meters nor an established amount of water presumed paid for with flat rates.

The total production of 90,720 cum/mo has been obtained from the measured flows at the pump stations in November 1976. From the pilot area data, accounted-for-water for the CAL-WD has been estimated to be 16,312 cum/mo or 18 percent of total production.

Unaccounted-for-Water

Unaccounted-for-water includes leakage, wastage, and other uses, including wastage and consumption at illegal connections. The total estimated unaccounted-for-water is 74,408 cum/mo or 82 percent of total production.

Summary of Water Accountability

Water accountability in the CAL-WD is summarized in Table IV-2. The accounted-for-water is based on the total consumption of primary and secondary users. It is estimated to be 16,312 cum/mo or 18 percent of total production. The unaccounted-for-water includes wastage, leakage, other uses, and consumption and wastage at illegal connections, and represents 82 percent of total production.

TABLE IV-2

SUMMARY OF WATER ACCOUNTABILITY

Category	Amount of Water (cum/mo)	Percent of Production
1. Accounted-for-water		
a) Connected households	13,031	
b) Borrowers	3,281	
	16,312	18%
2. Unaccounted-for-water		
a) Leakage, wastage, and other uses	74,408	82%
Total	90,720	

E. HYDRO-SURVEY DATA

Several trips were made to Calamba during November and December of 1976 by a hydro-survey group to obtain hydraulic information concerning the existing system of the CAL-WD. The major part of the hydro-survey work done involved analyses of the 3-km long transmission main from the Bukal pump station to the portion of the line near Elazequi Subdivision. Flow and pressure test points were installed along this main line to determine the hydraulic grade line and, consequently, the condition of the pipeline.

Flow and Pressure Data

Test point locations for flow and pressure measurements are shown on Figure IV-6. Test data are tabulated as follows:

Test Point	Flow (lps)	Pressure (m)	Date of Test
TP-1	16	5.3	24 November 1976
	-	6.3	22 December 1976
TP-2	16	17.6	24 November 1976
	20	21.1	20 December 1976
TP-3	-	56.3	20 December 1976
TP-4	36	65.5	24 November 1976
	45	67.6	19 December 1976
TP-6	11.5	1.2	18 November 1976
	12.4	1.3	29 November 1976
TP-7	26	39.4	22 December 1976

The latest flow measurements indicated an increase in pipe flow of 4 lps at TP-2 and 9 lps at TP-4, and increases in pressure at TP-1, TP-2 and TP-4 of 1, 3.5 and 2.1 meters, respectively, since the old pump was removed. The old pump previously installed at Bukal pump station was earlier removed and the 100-mm suction pipe plugged, as water was being wasted by flow through the old pump into the original spring box located adjacent to the pump station.

HGL and C-Values

The hydraulic grade line as plotted in Figure IV-E-1 indicates that the 200-mm transmission pipe is in fair condition (an estimated C-value of approximately 90). Computation results obtained likewise indicate C-values of 65 and 70 for the 150-mm pipeline.

A portion of the HGL has been assumed (shown as a dashed line) due to failure to actually locate the junction of the 200-mm and 150-mm pipes; although it has been assumed to be about 200 m upstream of TP-7.

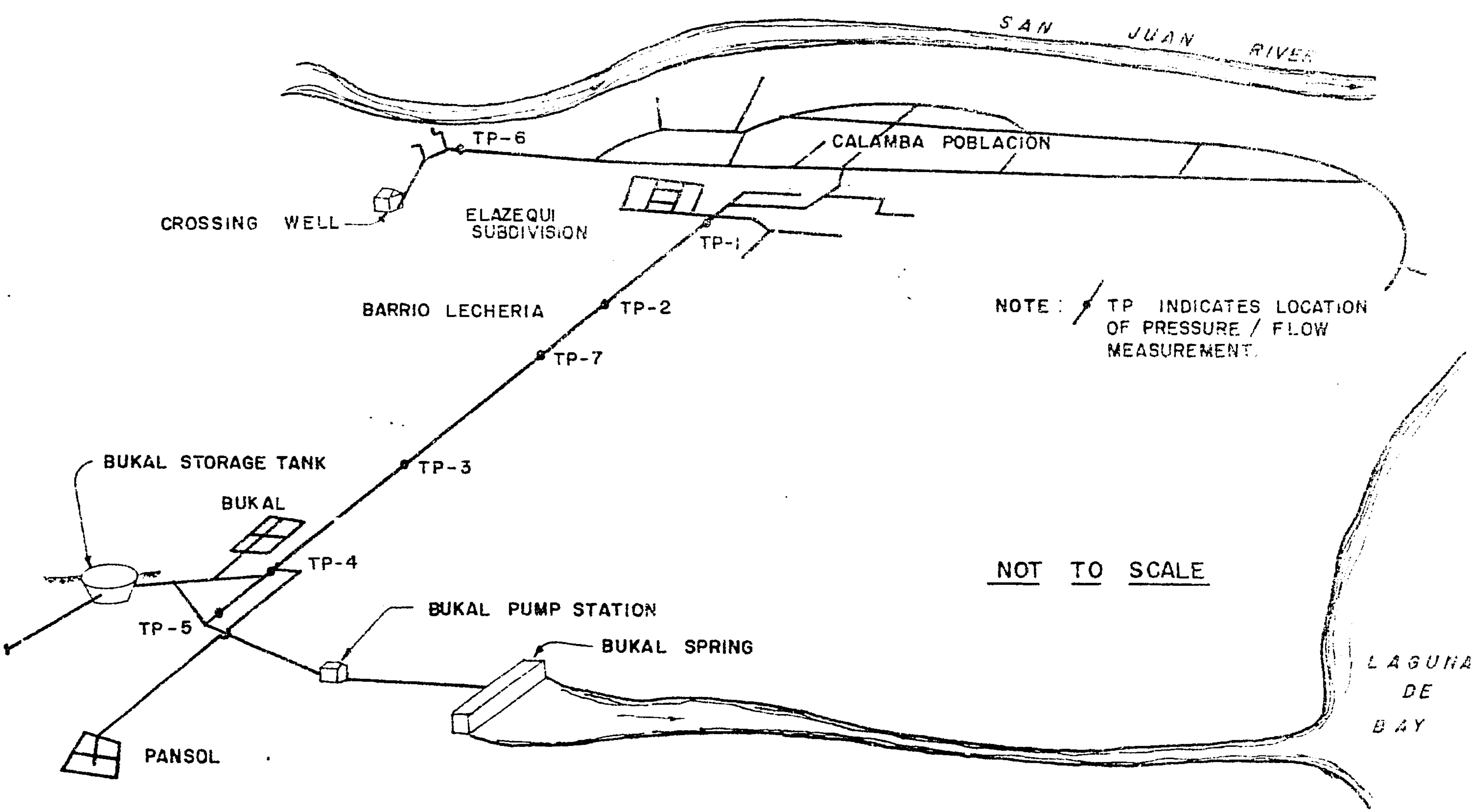


FIGURE IV-6
FLOW AND PRESSURE TEST POINTS
CALAMBA WATER DISTRICT

The 150-mm Crossing well transmission line was also examined and found to have a C-value of about 110.

Failure to determine C-values of distribution pipes was due to the occurrence of very low pressures throughout the distribution system.

24-Hour System Pressure Recordings

System pressure along the fringes of the system during an entire day was measured. A 24-hour automatic pressure recorder installed at TP-6 (near the Crossing well) shows a pressure variation of 0-2.2 meters (Figure IV-E-2), while that installed at TP-1 near Elazequi Subdivision indicates a pressure variation of 0-6.1 meters (Figure IV-E-3).

Crossing Pump Station

The static water level of the Crossing well, as measured on 29 November 1976 at 4:10 a.m., was 13.6 meters. The pumping water level exceeded 27 meters 3 minutes after the pump was started. System pressure was 1.76 meters, but at times dropped to 1.27 meters. Entrained air was noted at this discharge pressure head but ceased when the discharge pressure was throttled to 14.1 meters.

A pump test was conducted between 12:15 and 12:35 p.m. (see Figure IV-E-4 for the H-Q curve). The pump usually operates at very low discharge pressure. During average consumption periods the pump discharges (as indicated by the operating point on the curve) about 20.5 lps at 1.76-meter discharge head.

Bukal Pump Station

Flow test taken on 1 December 1976 indicated a flow of 22 lps at 72 meters TDH (suction head of 4 meters and discharge head of 67.5 meters). An attempt was made to test the pump but failed as the pressure gauge at the pump discharge pipe was malfunctioning. Moreover, the pump automatically shuts off when high pressures are induced by throttling.

F. COMPUTER STUDIES

The purpose of conducting studies on the existing distribution system is to model to the greatest extent practicable, the hydraulic conditions of the system observed in the field. The impact of future improvements on the system can be more accurately determined after a model of the existing distribution system has been made.

The hydraulic field survey on the distribution system indicates that the pressure is generally very low and even zero in some parts of the served area. The only meaningful data that could be obtained are mostly pressure readings and flow measurements along the transmission main. Flow measurements on the distribution system could not be made, simply because flow is negligible. The existing system could not be modelled with the available field data, and, therefore, computer studies on the existing system could not be made.

Field studies on the transmission main indicate that certain sections of the pipeline have seriously deteriorated. The computer model could not be checked using the field data on the existing main, because the main does not act as a continuous conduit. The C-values obtained in the field have been utilized where possible.

G. DEFICIENCIES OF THE EXISTING SYSTEM

The existing CAL-WD water supply facilities are inadequate. Majority of the consumers receive water only a few hours daily and the easternmost portion of the poblacion has no water at all. This condition has forced the consumers to install hand/electric pumps on their service lines to draw water. The CAL-WD has no existing policy on installing hand pumps.

The transmission line from Bukal Spring is inadequate to meet the present demand. Leakage has been verified in the transmission line from Bukal Spring to the distribution system. The reservoir is not fully utilized; it is mainly used for off-line storage and priming the Bukal pump.

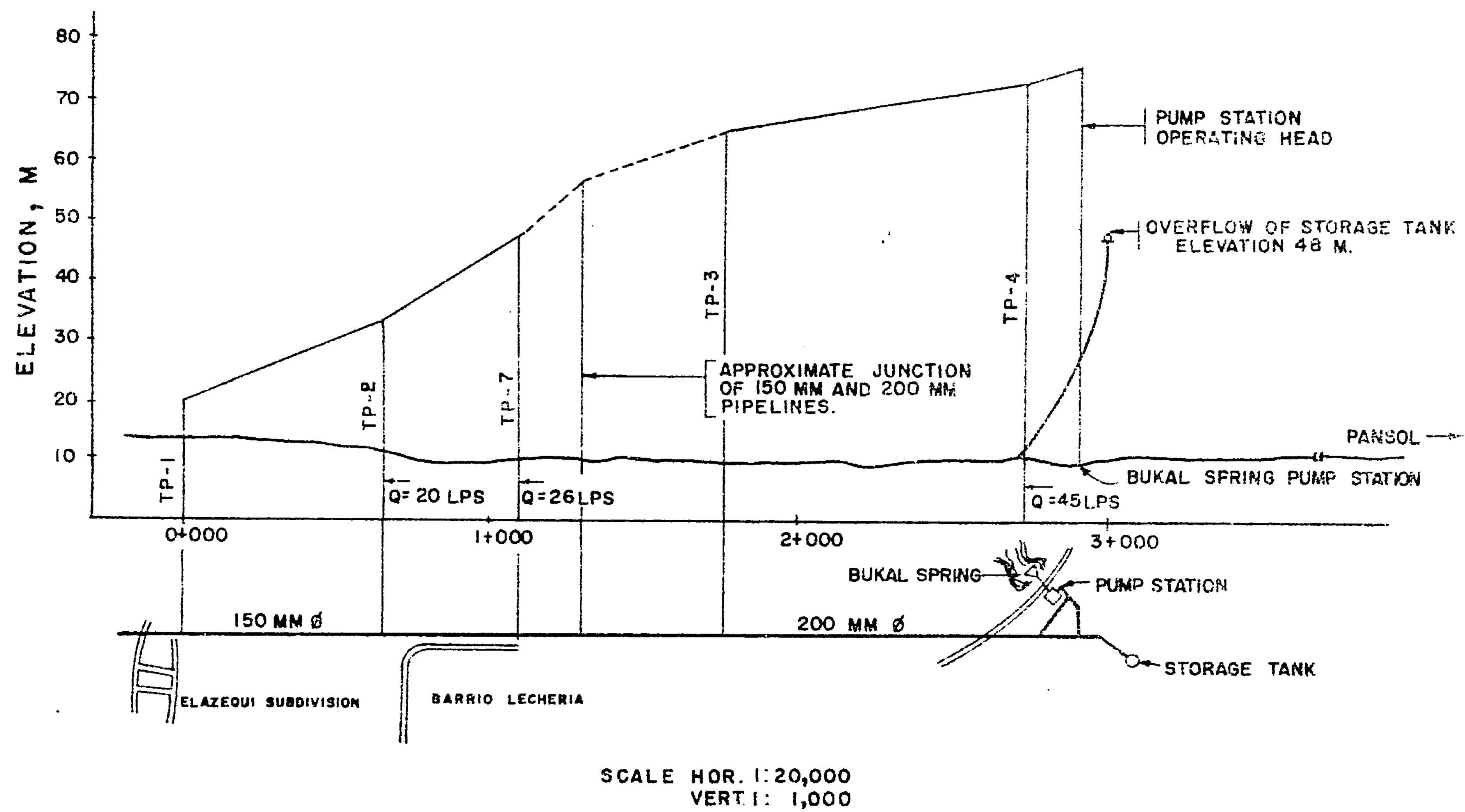
The 2 holes, about .09 sqm each, near the bottom of the Bukal intake box, require repair. The Bukal Spring area is widely used for bathing and washing, exposing this source to contamination. Disinfection of the water supply is irregularly done. Bacteriological examination of samples shows contamination of the water. Contamination of the distribution and transmission systems from polluted drains and surface water is likely to occur due to leaks and negative pressures in the transmission and distribution pipelines when the pumps are turned off.

Most distribution pipes have been in place for 50 years. All valves in the distribution system are either malfunctioning or are covered by street pavement. Fire hydrants are not maintained. The water district does not monitor consumption at its 22 public faucets; wastage from these faucets is presumed to be high.

The GAL-WD presently occupies a portion of a rented building near the municipal building. Office equipment, facilities and tools are lacking. It has no vehicle or shop for maintenance and repair purposes. There are no existing drawings of the system.

ANNEX IV-E

HYDRO-SURVEY DATA



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM

FIGURE IV-E-1
HYDRAULIC GRADE LINE
BUKAL PUMP STATION TO POBLACION
CALAMBA WATER DISTRICT

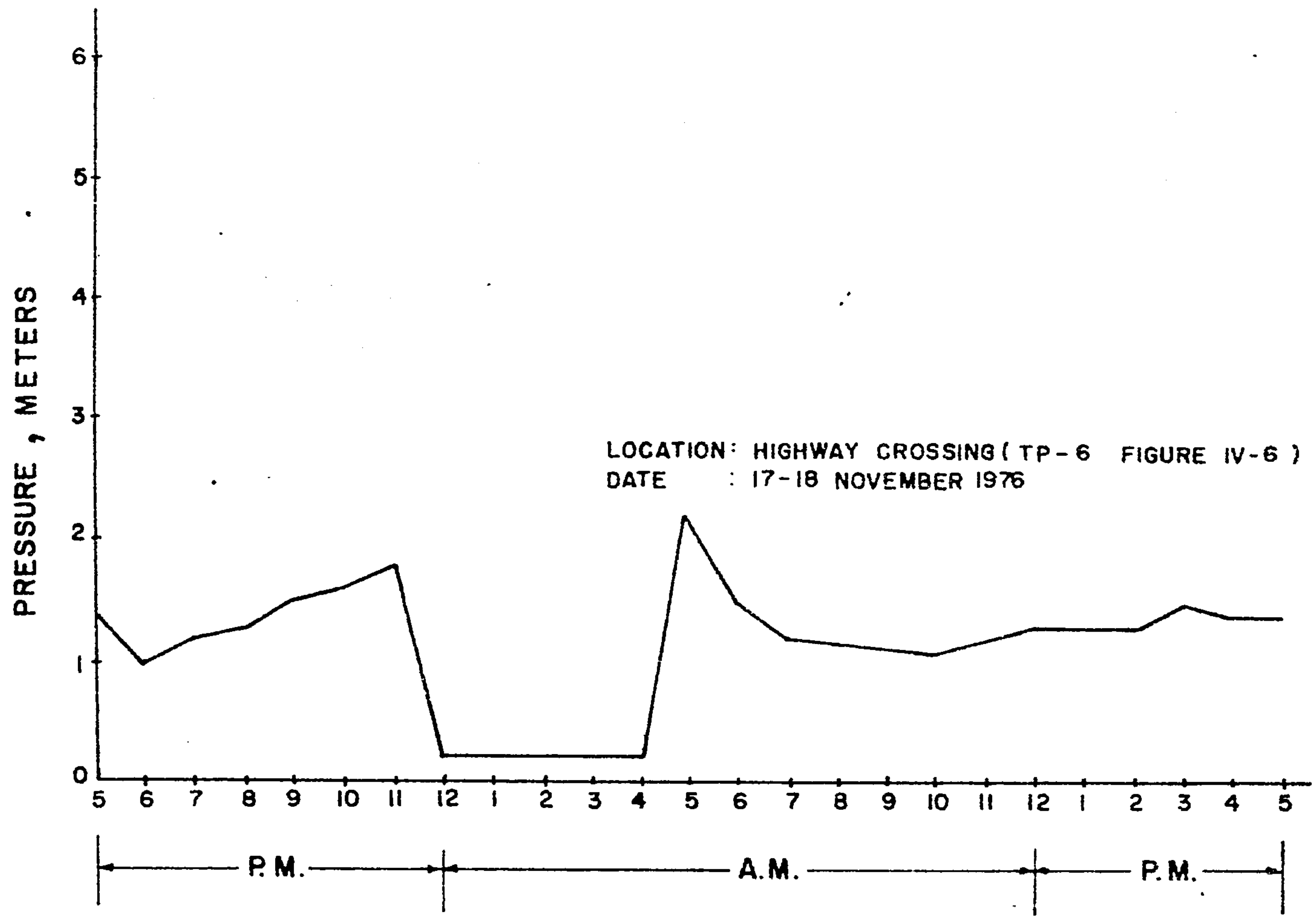


FIGURE IV-E-2
24 HOUR SYSTEM PRESSURE
AT TEST POINT NO.6
CALAMBA WATER DISTRICT

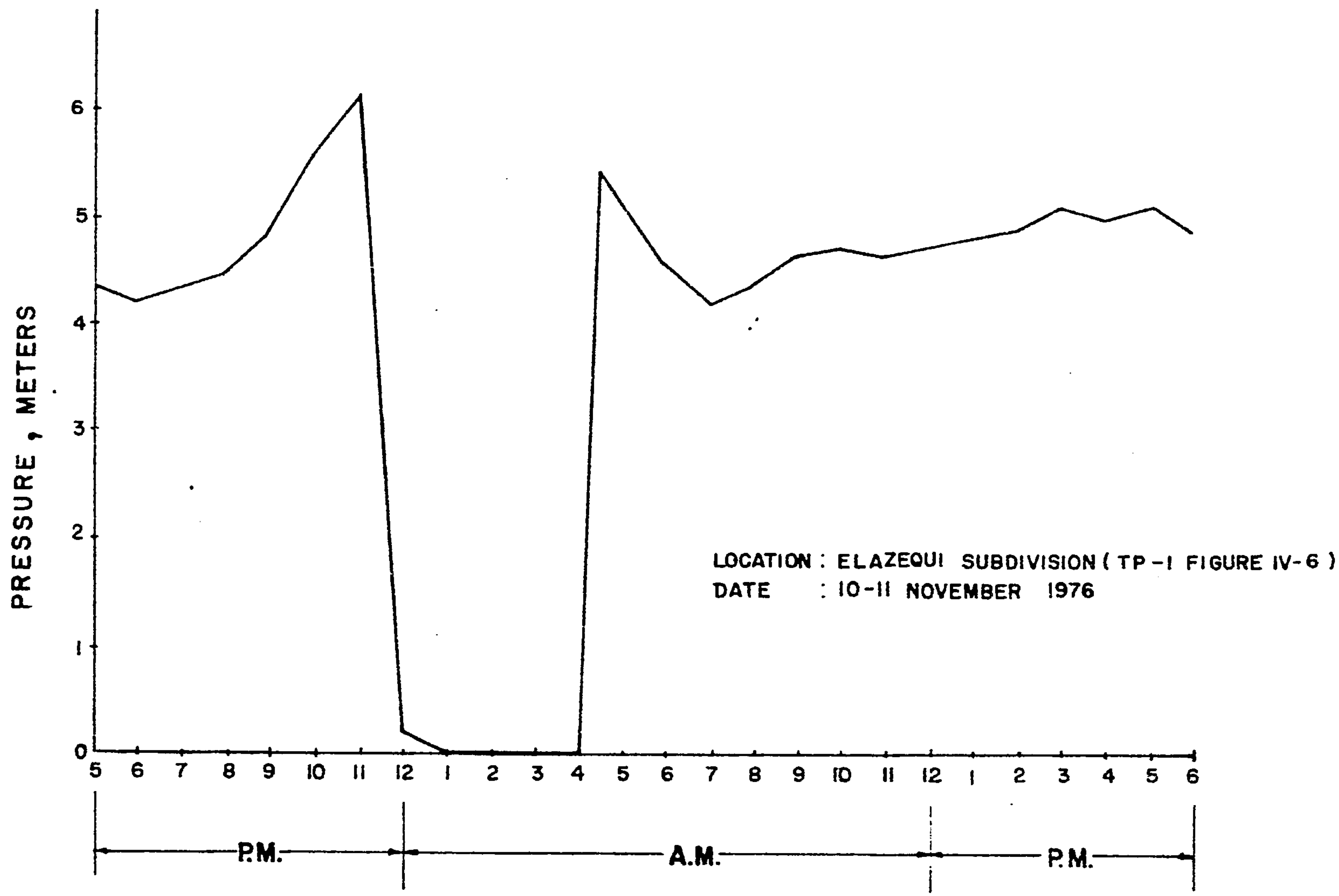


FIGURE IV-E-3
24 HOUR SYSTEM PRESSURE
AT TEST POINT NO.1
CALAMBA WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

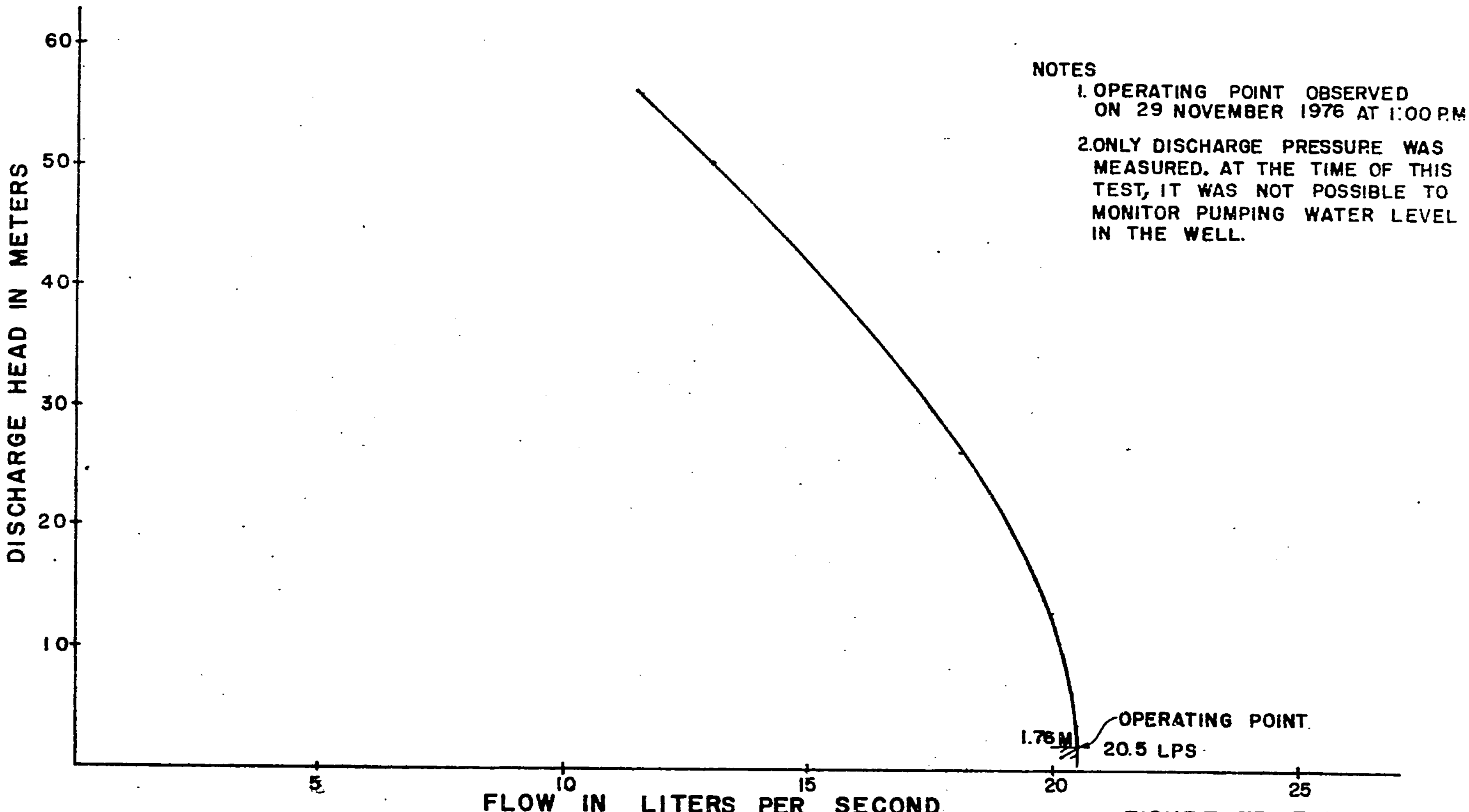


FIGURE IV - E-4
HEAD - CAPACITY CURVE AT CROSSING WELL PUMP STATION
CALAMBA WATER DISTRICT

CHAPTER V FEASIBILITY STUDY CRITERIA

A. GENERAL

The planning, design, economic, and financial criteria used in the water supply feasibility studies have been derived from studies of local conditions, accepted practices, standards and methods developed in the First Ten Provincial Urban Areas Feasibility Studies. These criteria, together with the developed basis of cost estimates, have been utilized to evaluate and compare the various alternatives identified in the course of the study.

In the analysis and evaluation of alternatives, feasibility study criteria need not be as refined as those used in the detailed development of the recommended scheme. Consistency is, however, essential. As long as each alternative to be analyzed is judged by similar criteria (or rules), evaluation of alternatives will be accomplished in a fair and consistent manner.

B. PLANNING CRITERIA

This water supply feasibility study has been guided by the following planning criteria (not listed in order of importance):

1. Areawide Approach: Planning of facilities has been done on a regional or areawide basis, taking into account the present district service boundaries and the logical long-term service areas beyond present district or political boundaries.

2. Source of Water: Groundwater and surface water have been given equal consideration as potential sources of water. However, based on the first 10 feasibility studies, groundwater derived from wells, when available, is expected generally to be more economical than conventionally treated surface water.

3. Self-Sufficiency: The recommended plan has been developed to provide the highest quality of water service within the "ability-to-pay" of the consumers.

4. Conservation: In the selection among alternative plans, water, power, chemicals and foreign exchange are considered valuable resources which must be conserved to the greatest extent possible.

5. Stage Development: The recommended long-range construction program has been divided into several stages, each of which satisfies the projected requirements for a specific design year:

Stage	Construction Started by Calendar Year	Target Design Year
Immediate Improvement	1978	1980
Phase I-A	1980	1985
Phase I-B	1986	1990
Phase II-A	1991	1995
Phase II-B	1996	2000

6. Alternative Plan Screening and Selection: From an array of identified plan alternatives, the recommended plan has been selected on the basis of least (present worth) cost and other non-economic parameters. The selected plan has been tested for economic/financial feasibility.

7. Skilled Manpower Shortage: The recommended plan has recognized, in the short term, the apparent shortage in skilled, technical and managerial expertise. Emphasis has been given to the need for district personnel training and certification.

8. Water Quality: The feasibility study has identified present and future water quality problems and includes recommendations for providing a water supply that is safe, healthful and wholesome.

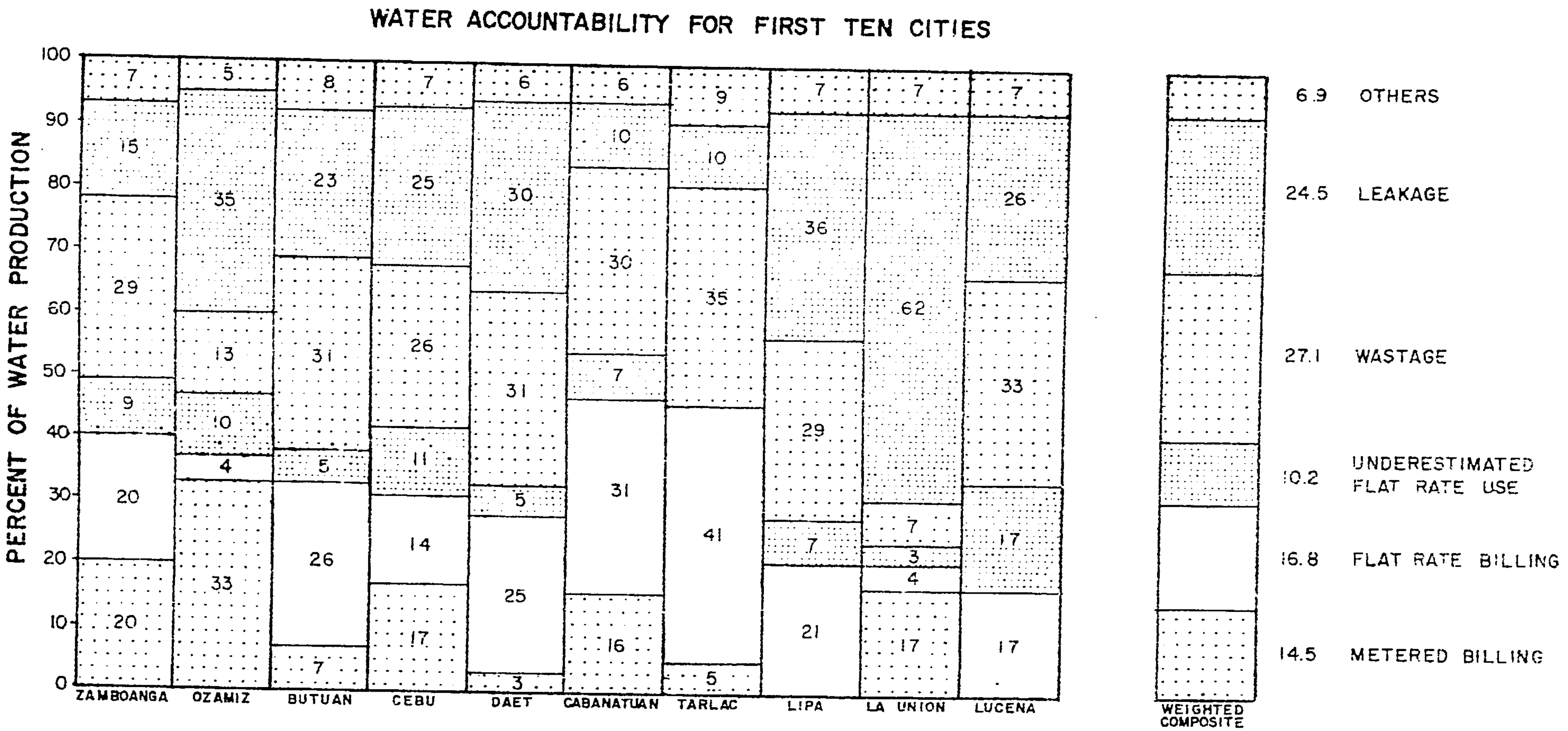
9. Social Soundness: The successful completion of any project must take into account the social acceptability of its recommended programs (Appendix S, Volume II).

C. DESIGN CRITERIA

The basis of design for these feasibility studies is presented in detail in Appendix F, Volume II of this Report. The design criteria are basically similar to those utilized in the First Ten Provincial Urban Areas Feasibility Studies. Minor improvements/modifications have been made as indicated in the Methodology Memoranda included in Volume I of this report.

Water Accountability

As much as possible, water accountability has been determined through field testing and measurement procedures, augmented by data gathered in the pilot area study surveys (see Methodology Memoranda No. 1 and 2). Where field data were not available and the pilot area study survey results were not conclusive, the weighted average of the water accountability results of the First Ten Provincial Areas was used (see Figure V-1).



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

FIGURE V-1
WATER ACCOUNTABILITY
FIRST 10 CITIES

The breakdown of the water accountability is as follows:

	Percent of Water Production
Metered Billing	14.5
Flat-Rate Billing	16.8
Underestimated Flat-Rate Use	10.2
Wastage	27.1
Leakage	24.5
Others	6.9
	100.0

Water Demand Grouping

A procedure has been developed to classify communities in the Philippines into one of 5 groups for purposes of water demand projections. Available data on population, population growth, housing, income and other economic and technical parameters are used in the classification, with a system of weighting (see Methodology Memorandum No. 3). In general, the water demand requirements per capita through the period 1980-2000 are as follows:

Group 1	261 - 273 lpcd
Group 2	220 - 230 lpcd
Group 3	193 - 199 lpcd
Group 4	174 - 181 lpcd
Group 5	157 - 165 lpcd

The above values include domestic water needs; allowances for nominal commercial, industrial and institutional use; and a decreasing percentage of unaccounted-for-water in time.

For the analysis of existing conditions, actual metered (or connected) customers and "borrowers" are considered separately (see Methodology Memorandum No. 2). However, for short- and long-range planning, it has been assumed that "borrowers" would eventually become metered consumers. Per capita domestic use has been increased each year to account for economic growth within the community. Institutional and commercial water demands have been estimated as a percentage of domestic demand (see Methodology Memorandum No. 3).

Demand Variation

Maximum daily and peak hourly demands have been estimated from field data and available records. For the basic analysis of the water supply facilities, the following ratios have been used:

maximum-day to average-day ratio = 1.2:1
peak-hour to average-day ratio = 1.5:1 - 1.75:1

D. ECONOMIC AND FINANCIAL CRITERIA

Discount Rate

The opportunity cost of capital or discount rate used in this feasibility study is 12 percent. The discount rate has been used for economic screening of the technically viable alternatives (see Chapter IX, Methodology Manual on Water Supply Feasibility Studies, Volume I).

Inflationary Trends

The national economy of the Philippines is discussed in Appendix E, Volume II.

Projections made in this feasibility study assume a general cost escalation rate of 10 percent for the period 1978 through 1980; 8 percent for the period 1981-1985; and 6 percent thereafter. The cost of maintenance and operation is assumed to escalate at 8 percent per annum.

Economic Justification

The economic feasibility of this water supply project is based on 2 parameters: benefit-cost ratio (B/C) and the internal economic rate of return (IERR). These parameters are discussed in Chapter XI.

Financial Criteria

The financial justification of this project is based on the district customers' ability-to-pay, a financial feasibility analysis (see Chapters XX and XXI, Methodology Manual) and a suggested socialized pricing scheme, based on increasing unit cost of water with increasing consumption (see Chapter X).

E. BASIS OF COST ESTIMATES

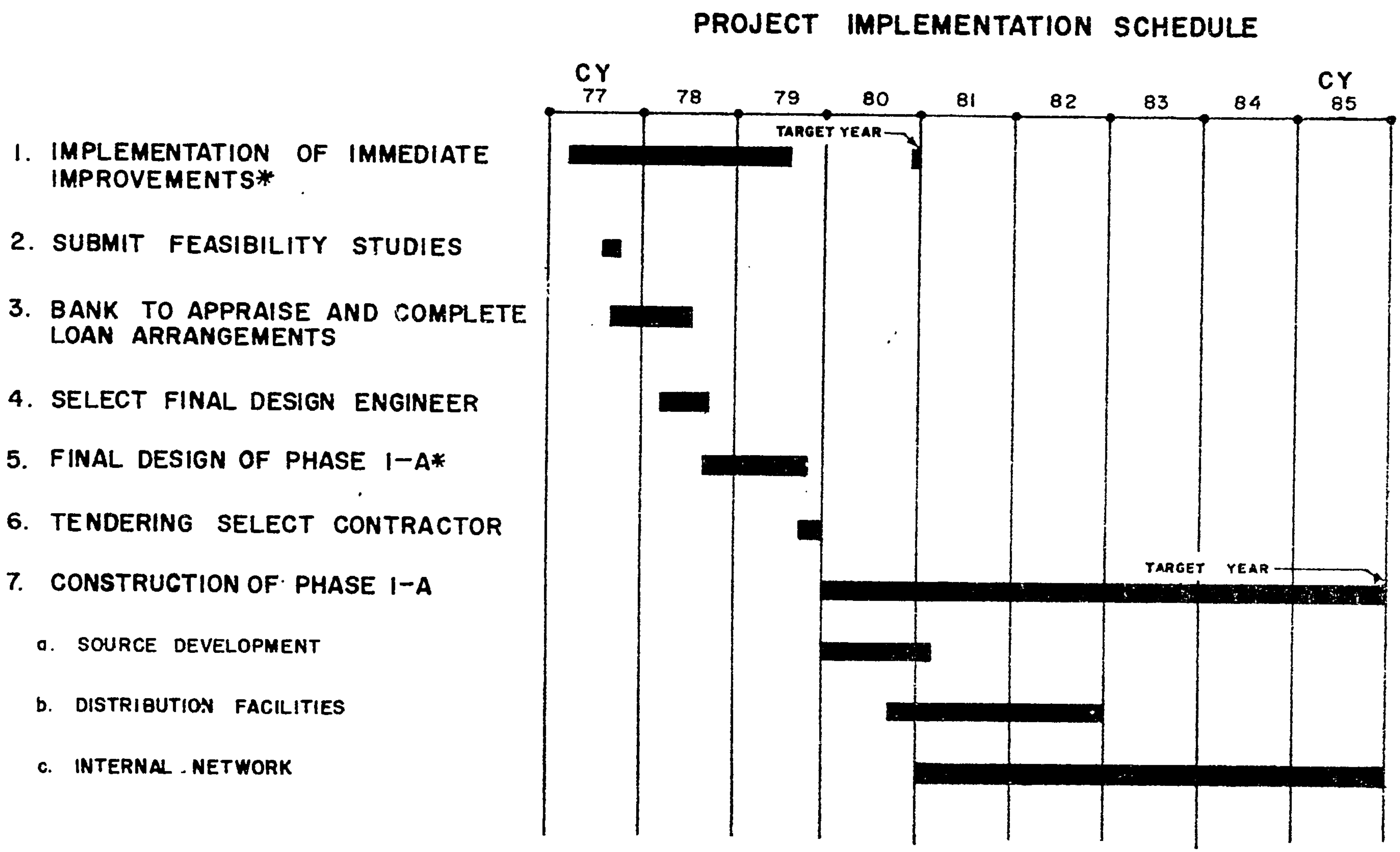
Construction cost curves have been developed for inplace costs of pipelines, deep wells, water treatment plants, pump stations, and storage reservoirs. These cost curves have been used for estimating the relative cost magnitudes of alternative water supply plans. Escalation factors used in calculating the capital cost of recommended improvements in July 1978 prices, as well as the above unit costs, are presented in Appendix G, Volume II.

F. IMPLEMENTATION SCHEDULE

For purposes of feasibility study and economic/financial analyses, an implementation schedule has been assumed. Figure V-2 shows the probable time-table which covers the planning, design, and implementation of Phase I-A. It is assumed in these feasibility studies that the recommended Immediate Improvement Program (see Interim Report, February, 1977) is to be fully implemented by the LWUA Interim Demonstration Program by 1980.

PHASE I-A PROJECT SCHEDULE

Final Report Submission	September 1977
Select Final Design Engineer	September 1978
Start Final Design	October 1978
Complete Final Design	September 1979
Start Construction	January 1980



* PHASE I-A ASSUMES THE FULL IMPLEMENTATION OF THE IMMEDIATE IMPROVEMENT PROGRAM

FIGURE V-2
PROJECT IMPLEMENTATION SCHEDULE
CALAMBA WATER DISTRICT

CHAPTER VI POPULATION AND WATER DEMAND PROJECTIONS

A. GENERAL

A necessary step in developing the preliminary design of a water system is the projection of future population and water demand for the delineated service areas. These projections significantly affect facility layouts and sizes, construction staging and cost of the project. This chapter develops these projections for the CAL-WD.

B. POPULATION PROJECTIONS

Past population trends, the physical limits of the urban areas and current and proposed industrial establishments have been considered in the population projections for the municipality of Calamba.

The growth of the population of Calamba from 1948 to 1975 shows decreasing rates from 3.87 to 3.33 percent. The following table gives the populations and the corresponding growth rates of Calamba, and the national growth rates from 1948 to 1975.

Year	Population	Calamba Annual Growth (%)	National Growth (%)
1948	36,586		
1960	57,715	3.87 (1948-1960)	3.1
1970	82,714	3.66 (1960-1970)	3.0
1975	97,432	3.33 (1970-1975)	2.66

The growth rates of Calamba were generally higher than those of the Philippines during the period 1948-1970. The population growth in Calamba during the period 1960-70 may be attributed to the establishment in Calamba of the Canlubang Sugar Estate which generated employment opportunities during the 1960's. A number of services and small shops were set up during the period, attracting migrants to Calamba.

During the period 1970-75, there was a decrease in Calamba's growth rate. The foremost reason is the limited additional employment generated by the Canlubang Sugar Estate. By this time employment opportunities offered by the biggest business establishments in Calamba had declined. The residents began to be attracted to the greater job prospects outside their municipality. In line with the new government program for dispersal of industries outside Metropolitan Manila, new industries were rapidly developed in provinces and municipalities in Southern Luzon, causing migration away from Calamba.

In the early part of 1975, several business firms, mainly textile and manufacturing, were established in Calamba. Further industrial expansion is anticipated in the area. This is expected to increase the growth rate for 1975-1980. Other factors that will affect the future growth of Calamba are:

1. The development of subdivisions in the poblacion and outlying areas as a result of the projected expansion of the Laguna de Bay regional area south of Manila;
2. The development of more hotspring resorts in Barrio Pansol to accommodate the growing number of local and foreign tourists in the area.

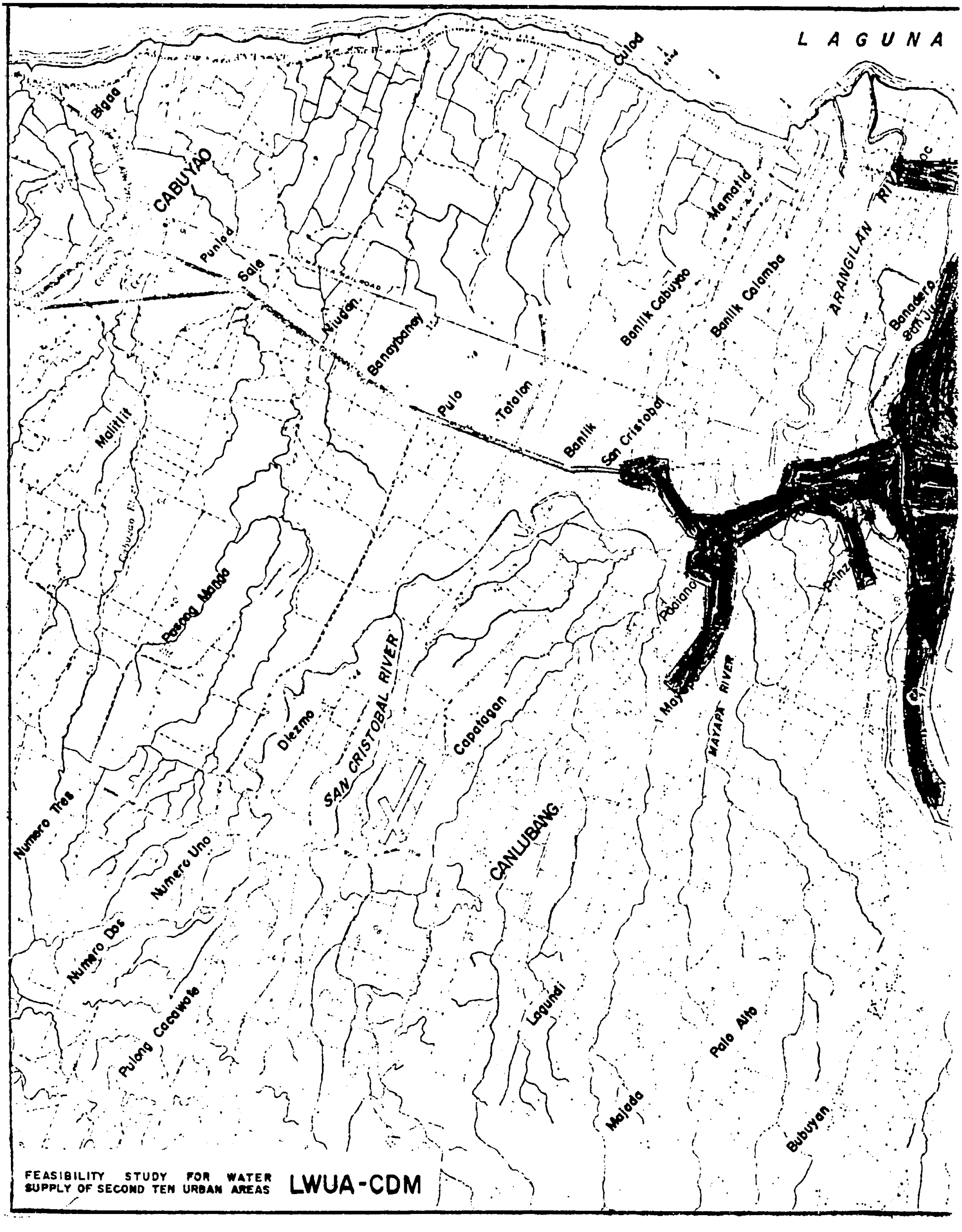
On the basis of field inspection and discussions with the water district and local officials, Figure VI-1 has been developed to show the present, 1980, 1990 and year 2000 service areas of the CAL-WD. By 2000, CAL-WD is expected to serve the poblacion and 17 barrios which are listed in Table VI-1.

The population projections have been made by applying annual growth rates for the poblacion and barrios in the service area. The estimates of growth rates are based on field observations, discussions with the water district and local officials, the ratio method of population projection and the NEDA/POPCOM projections of medium assumption. The ratio method of population projection is introduced in barrios whose growth potential is assumed similar to that of the province. Hence, the population of a particular barrio is projected by taking the ratio of the population of the barrio to that of province and comparing their growth rates. Slightly higher growth rates are anticipated in barrios where business establishments are currently being constructed and where housing subdivisions are expected to be developed.

The projected populations are shown in Table VI-1 and summarized as follows:

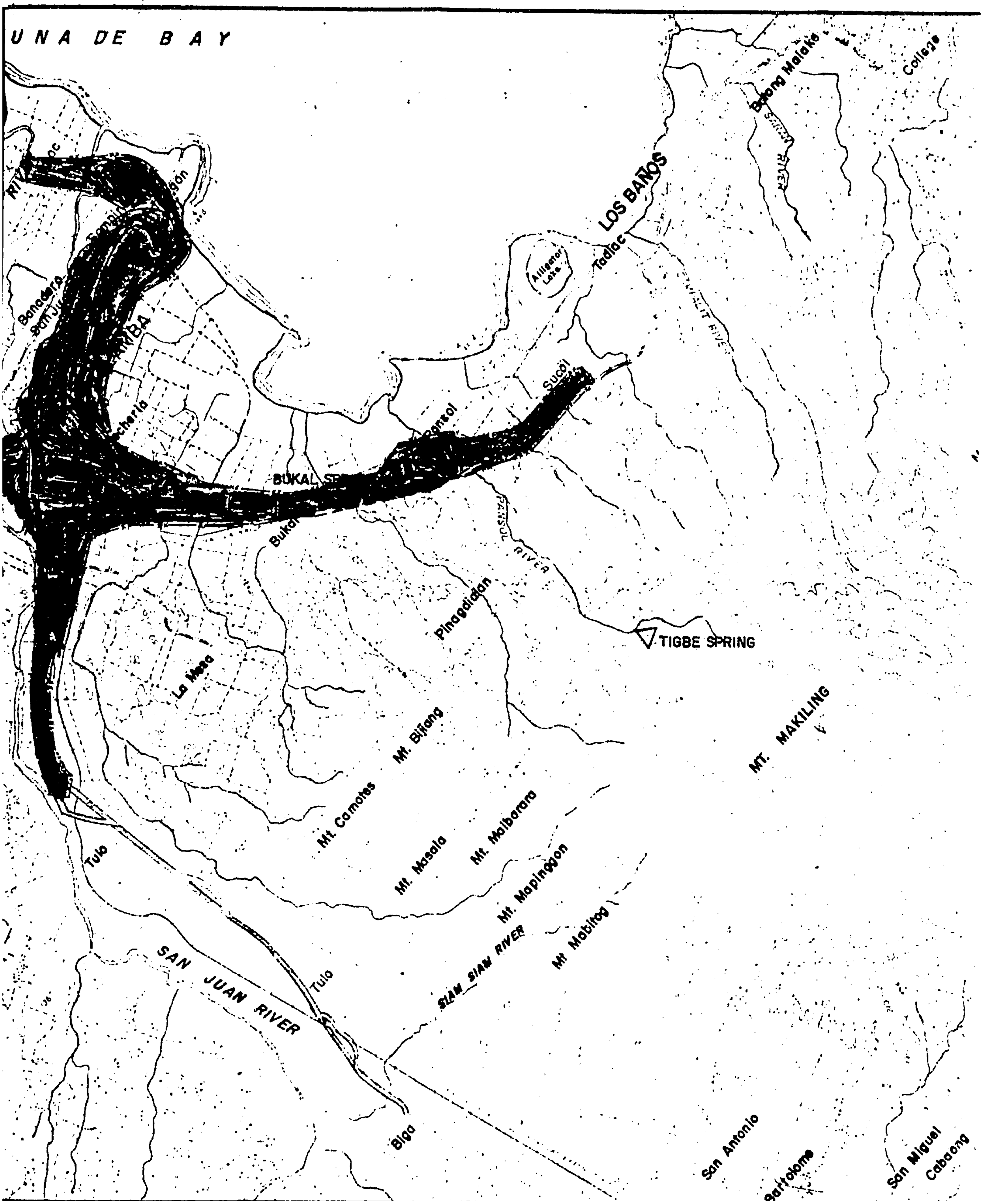
Year		Total Population 1/	Growth Rate (%)		Population in Service Area	Service Area (ha)	Average Density in Service Area (persons/ha)
1975	(Present)	60,618			24,870	170	146
1980	(Immediate)	70,868	3.17	(1975-1980)	36,620	272	123
1990		94,680	2.94	(1980-1990)	64,460	499	129
2000		122,932	2.65	(1990-2000)	100,070	826	121

1/ Poblacion and other barrios.



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM



UNA DE BAY
LOS BAÑOS
Tadlac
Alligator Lake
College
Sucol
Bukal
BUKAL SP
TIGBE SPRING
PANSOL RIVER
Pinagdidian
La Mesa
Mt. Bijiang
Mt. Camotes
Mt. Malbarara
Mt. Masala
Mt. Mapinggon
Mt Mabitog
MT. MAKILING
SIAM SIAM RIVER
SAN JUAN RIVER
Tulo
Biga
San Antonio
San Miguel
Cabaong
Banadero

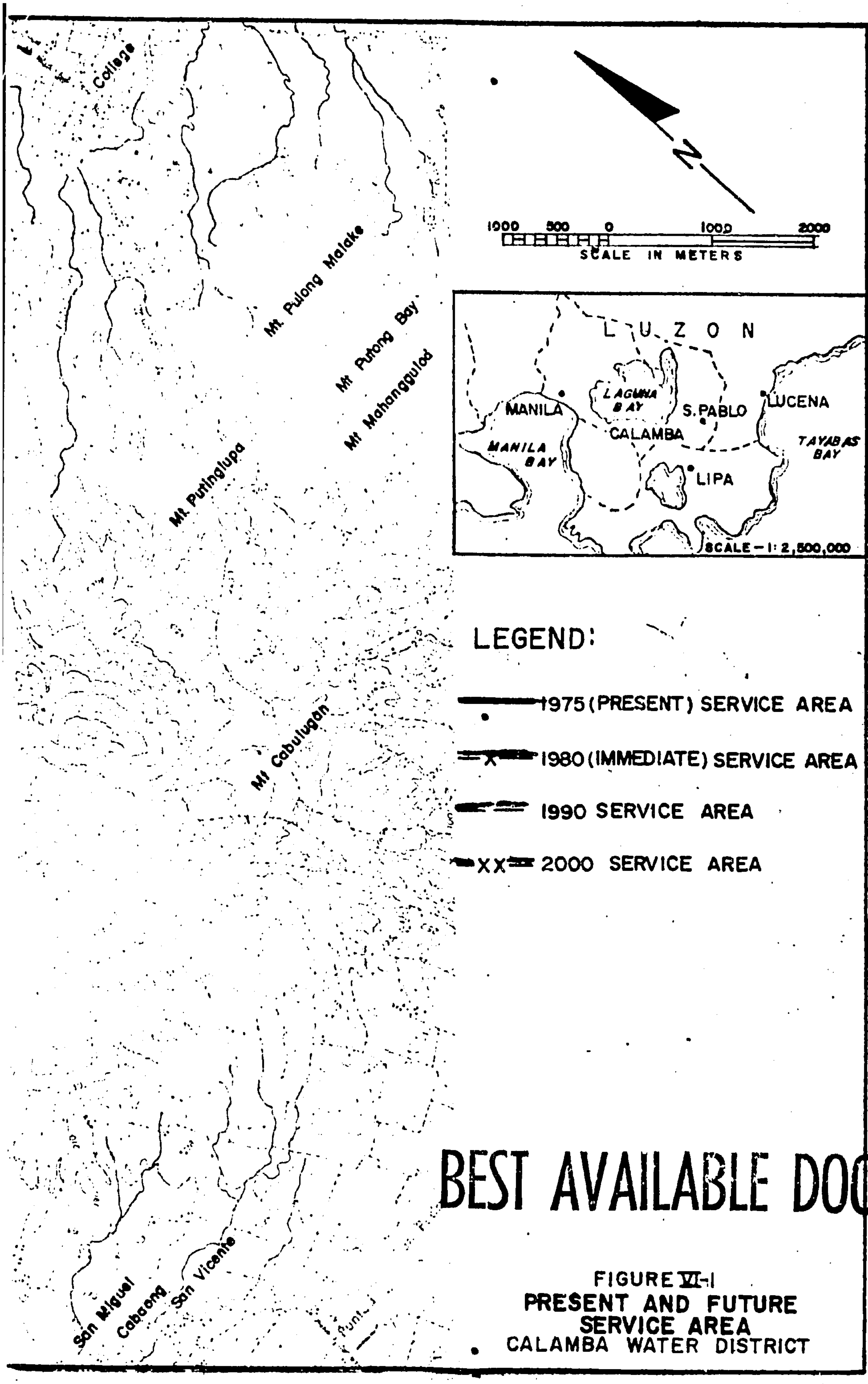


FIGURE VI-1
PRESENT AND FUTURE SERVICE AREA
CALAMBA WATER DISTRICT

TABLE VI-1

SERVICE AREA POPULATION PROJECTIONS
CALAMBA WATER DISTRICT

	Population 1975	Present Service Area: Population in Service Area	Present Service Area: Service Area (ha)	Present Service Area: Density in Persons Per Hectare	1980 Service Area: Population in Service Area	1980 Service Area: Service Area (ha)	1980 Service Area: Density in Persons Per Hectare	1990 Service Area: Population in Service Area	1990 Service Area: Service Area (ha)	1990 Service Area: Density in Service Area	2000 Service Area: Population in Service Area	2000 Service Area: Service Area (ha)	2000 Service Area: Density in Service Area
Poblacion	18,728	14,047	65.5	214	18,454	78	237	25,755	83.1	310	36,631	91.7	399
San Juan	2,477	1,983	22.6	88	2,241	22.6	99	3,166	22.6	140	4,287	22.6	190
San Jose	2,134	1,495	7.4	202	1,731	15.6	111	2,610	26.9	47	3,757	39.0	96
Linga	2,886	1,733	9.0	193	2,510	15.2	165	3,427	24.2	142	4,177	34.3	122
Lecheria	2,365	1,184	21.5	55	2,108	29.3	72	2,695	42.9	63	3,551	50.7	70
Palingon	2,621	1,575	6.6	239	1,778	9.0	196	2,581	10.5	246	3,145	10.5	300
Halang	957	191	2.0	96	455	5.9	77	857	14.4	60	1,674	24.6	68
Bucal	2,702	1,082	7.8	139	1,765	14.8	119	3,079	35.9	86	4,591	66.3	69
Pansol	2,509	503	7.8	65	1,192	17.4	69	2,450	42.3	58	4,115	66.6	62
Real	4,312	1,079	20.3	53	2,048	46.4	44	4,562	111.9	41	7,544	167.7	45
Parian	3,582	-	-	-	2,340	18.2	129	4,200	42.9	98	6,450	95.6	67
Mayapa	5,947	-	-	-	-	-	-	5,808	23.4	248	9,104	48.8	187
P. Rizal	2,100	-	-	-	-	-	-	2,051	3.9	526	3,214	15.6	206
Sampiruhan	1,589	-	-	-	-	-	-	1,214	14.4	84	1,865	29.3	64
Looc	2,887	-	-	-	-	-	-	-	-	-	2,824	21.8	130
Sucol	1,335	-	-	-	-	-	-	-	-	-	1,175	15.6	75
San Cristobal	1,099	-	-	-	-	-	-	-	-	-	1,441	13.3	106
Prinzá	388	-	-	-	-	-	-	-	-	-	524	11.7	45
Total	60,618	24,872	170.5	146	36,622	272.4	1,234	64,455	499.3	129	100,069	825.7	121

The analysis shows that the population in the service area (see Figure VI-2) will increase from 24,870 in 1975 to 100,070 in year 2000. Densities in the service area will average between 121 and 146 persons per hectare. The total population of the poblacion and the outlying areas will increase from 60,618 in 1975 to about 122,932 in year 2000. It is projected that the overall annual growth rates in this area will decrease from 3.17 percent in 1975-1980 to 2.65 percent in 1990-2000 primarily due to the saturation of the area, decreasing employment opportunities and the increasing acceptance of family planning.

C. PROJECTIONS FOR SERVED POPULATION

The present served population in the CAL-WD has been projected to increase more than 10 times up to year 2000. The increase will be a result of (a) the present large unsatisfied demand for piped water; (b) the campaign of the CAL-WD to connect as many customers as possible; and (c) the increase in population as well as in the service area coverage of the CAL-WD.

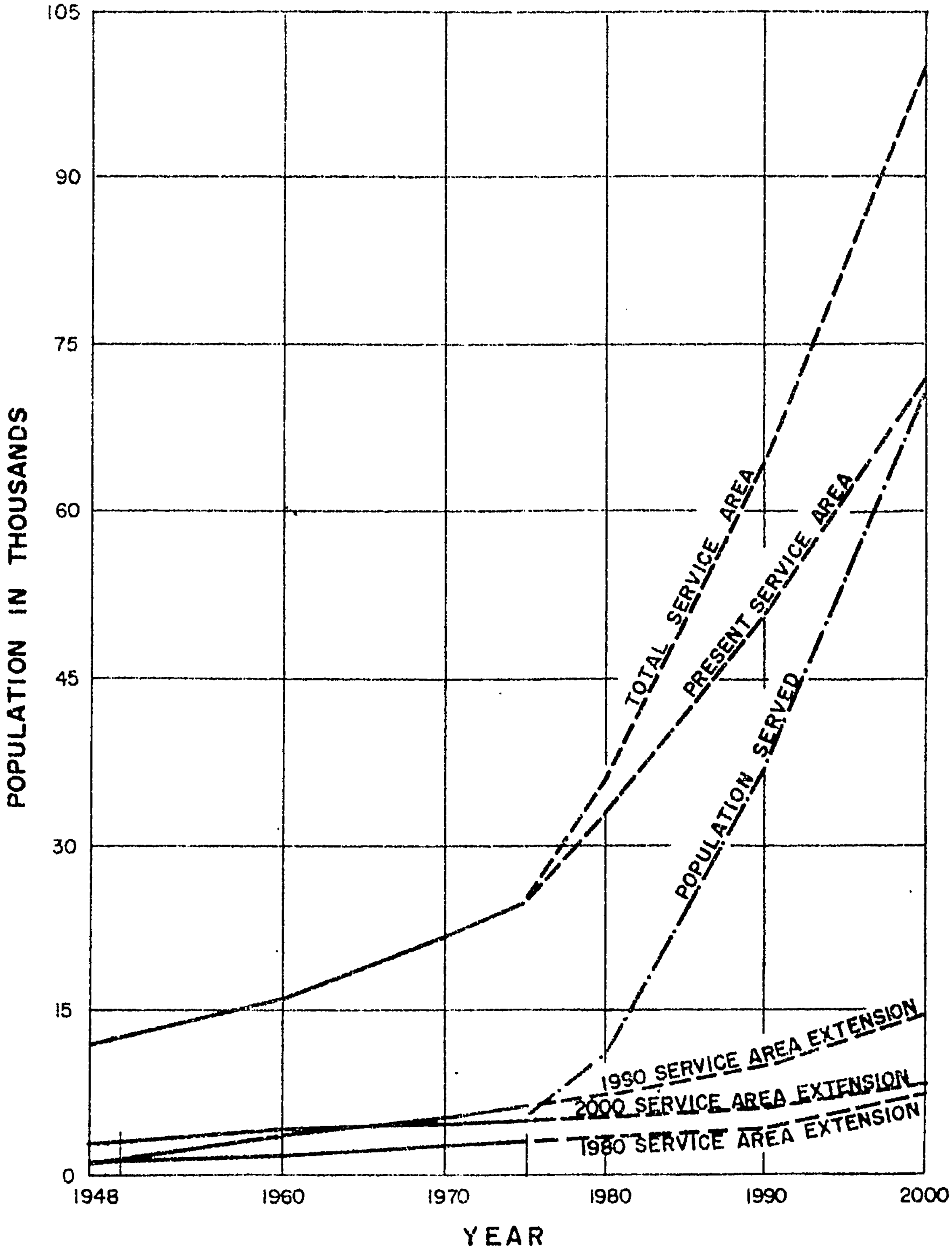
The served population projections for the CAL-WD are listed in Table VI-2 and are summarized as follows:

Year	Projected Served Population	Population in Service Area	Percent Served
1975 (Present)	6,708	24,872	27
1980 (Immediate)	11,532	36,622	31
1990	37,220	64,455	58
2000	71,903	100,069	72

The served population which was 27 percent of the total service area population in 1975 is projected to be 31 percent in 1980, 58 percent in 1990, and 72 percent in 2000. Hence, the served population will increase from 6,708 in 1975 to 71,903 in 2000, or a nearly eleven-fold increase in 25 years (see Figure VI-2).

The projected increases in served population are 4,824 from 1975 to 1980; 25,688 from 1980 to 1990; and 34,683 from 1990 to 2000. The projected increases are concentrated in the present service area, the served population of which would comprise 73 percent of the total serve population in 2000. The 2000 served population in the barrios outside the present service area represents the remaining 27 percent.

A year-by-year tabulation of the projected served population from 1978 to 2000 is given in Table VI-3.



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS **LWUA-CDM**

FIGURE VI-2
SERVICE AREA POPULATION PROJECTION
CALAMBA WATER DISTRICT

TABLE VI-2

SERVED POPULATION PROJECTIONS
CALAMBA WATER DISTRICT

		Present Service Area	Immediate Service Area (1980)	1990 Service Area	2000 Service Area	Remarks 2/
1.	Poblacion	14,047	18,454	25,755	36,631	
	Connected Population	5,322	6,468	17,497	30,541	
	Number of Connections	871	1,078	3,043	5,553	
	Percent Connected	38	35	68	83	
2.	San Juan	1,983	2,241	3,166	4,287	
	Connected Population	18	390	1,213	2,635	
	Number of Connections	3	65	211	479	
	Percent Connected	1	17	38	61	
3.	San Jose	1,495	1,731	2,610	3,757	Present = 6.11 persons/connection 1980 = 6.00 1990 = 5.75 2000 = 5.50
	Connected Population	104	450	1,662	2,360	
	Number of Connections	17	75	289	429	
	Percent Connected	7	26	64	63	
4.	Linga	1,733	2,510	3,427	4,177	
	Connected Population	-	600	1,823	3,278	
	Number of Connections	-	100	317	596	
	Percent Connected	-	24	53	78	
5.	Lecheria	1,184	2,108	2,695	3,551	
	Connected Population	391	720	1,990	3,432	
	Number of Connections	64	120	346	624	
	Percent Connected	33	34	74	97	
6.	Palingon	1,575	1,778	2,581	3,145	
	Connected Population	-	450	1,817	2,816	
	Number of Connections	-	75	316	512	
	Percent Connected	-	25	70	90	
7.	Halang	191	455	857	1,674	
	Connected Population	79	198	460	1,045	
	Number of Connections	13	33	80	190	
	Percent Connected	42	44	54	62	
8.	Bucal	1,082	1,765	3,079	4,591	
	Connected Population	525	720	1,880	3,020	
	Number of Connections	86	120	327	549	
	Percent Connected	49	41	61	66	

2/ The number of persons per connection, as derived from the pilot area survey, is 6.40. Because the pilot area is located within the poblacion, and allowances were not made for variation in household population from barrio to barrio, the average number of persons per household in 1976 was derived from the National Census Statistics for 1970.

TABLE VI-2 (Continued)

		Present Service Area	Immediate Service Area (1980)	1990 Service Area	2000 Service Area	Remarks
9.	Pansol	503	1,192	2,450	4,115	
	Connected Population	104	432	1,265	2,624	
	Number of Connections	17	72	220	477	
	Percent Connected	21	36	52	64	
10.	Real	1,079	2,048	4,562	7,544	
	Connected Population	165	336	1,564	2,574	
	Number of Connections	27	56	272	468	
	Percent Connected	15	16	34	34	
11.	Parian	-	2,340	4,200	6,450	
	Connected Population	-	768	2,064	3,240	
	Number of Connections	-	128	359	589	
	Percent Connected	-	33	49	50	
12.	Mayapa	-	-	5,808	9,104	Present = 6.11 persons/connection 1980 = 6.00 1990 = 5.75 2000 = 5.50
	Connected Population	-	-	2,426	6,666	
	Number of Connections	-	-	422	1,212	
	Percent Connected	-	-	42	73	
13.	P. Rizal	-	-	2,051	3,214	
	Connected Population	-	-	1,024	2,486	
	Number of Connections	-	-	178	452	
	Percent Connected	-	-	50	77	
14.	Sampiruhan	-	-	1,214	1,865	
	Connected Population	-	-	535	1,138	
	Number of Connections	-	-	93	207	
	Percent Connected	-	-	44	61	
15.	Looc	-	-	-	2,824	
	Connected Population	-	-	-	1,903	
	Number of Connections	-	-	-	346	
	Percent Connected	-	-	-	67	
16.	Sucol	-	-	-	1,175	
	Connected Population	-	-	-	638	
	Number of Connections	-	-	-	116	
	Percent Connected	-	-	-	54	
17.	San Cristobal	-	-	-	1,441	
	Connected Population	-	-	-	1,133	
	Number of Connections	-	-	-	206	
	Percent Connected	-	-	-	79	
18	Prinza	-	-	-	524	
	Connected Population	-	-	-	374	
	Number of Connections	-	-	-	68	
	Percent Connected	-	-	-	71	
Total Number of Connections		1,098	1,922	6,473	13,073	
Total Population Connected		6,708	11,532	37,220	71,903	
Total Population		24,872	36,622	64,455	100,069	
Served Population		27%	31%	58%	72%	

TABLE VI-3

YEAR BY YEAR SERVED POPULATION AND WATER DEMAND PROJECTIONS

Year	Served Population	Average-Day Demand, cumd	Maximum-Day Demand, cumd	Peak-Hour Demand, cumd
1978	8,037	1,718	2,062	3,007
1979	9,627	2,134	2,561	3,735
1980	11,532	2,650	3,180	4,640
1981	12,960	2,970	3,560	5,200
1982	14,580	3,320	4,000	5,810
1983	16,390	3,720	4,460	6,510
1984	18,420	4,160	5,000	7,290
1985	20,720	4,660	5,590	8,160
1986	23,290	5,220	6,260	9,130
1987	26,180	5,840	7,010	10,220
1988	29,440	6,540	7,840	11,440
1989	33,100	7,320	8,780	12,800
1990	37,220	8,190	9,830	14,330
1991	39,730	8,770	10,520	15,340
1992	42,460	9,380	11,260	16,420
1993	45,350	10,050	12,050	17,580
1994	48,440	10,750	12,900	18,820
1995	51,730	11,510	13,810	20,140
1996	55,250	12,320	14,780	21,560
1997	59,010	13,190	15,830	23,080
1998	63,030	14,120	16,940	24,710
1999	67,320	15,110	18,140	26,450
2000	71,903	16,180	19,420	28,320

D. WATER DEMAND PROJECTIONS

The water demand of the CAL-WD is projected to increase significantly as a result of continued growth in served population.

Per capita domestic water use, commercial/industrial/institutional use, as well as unaccounted-for-water (expressed as percent of production), have been estimated for the years 1980, 1990 and 2000 for the service area. Based on analyses (see Methodology Memorandum No. 3) CAL-WD has been classified under Group II, which has the following water use parameters:

	1980	1990	2000
Domestic use, lpcd	120	135	150
Commercial/industrial/institutional, lpcd	18	23	30
Accounted-for-water, lpcd	138	158	180
% Unaccounted-for-water	40	28	20
Unaccounted-for-water, lpcd	92	62	45
Total Water Demand, lpcd	230	220	225

The unaccounted-for-water forCAL-WD is estimated to decrease from 87 percent of the total water production in 1975 to 20 percent in 2000 mainly because of the extensive metering and leakage survey programs.

Using the above water demand parameters and the projected served populations, the water demands for the design years 1980, 1990 and 2000 are as follows (see Table VI-3 and Figure VI-3):

	1980	1990	2000
Water demand, lpcd	230	220	225
Served population	11,532	37,220	71,903
Average daily water demand, cumd	2,650	8,190	16,180
Maximum-day water demand[3], cumd	3,180	9,830	19,420
Peak-hour water demand[4], cumd	4,640	14,330	28,320

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[3] Based on 1.2 times average daily water demand.

[4] Based on 1.75 times average daily water demand.

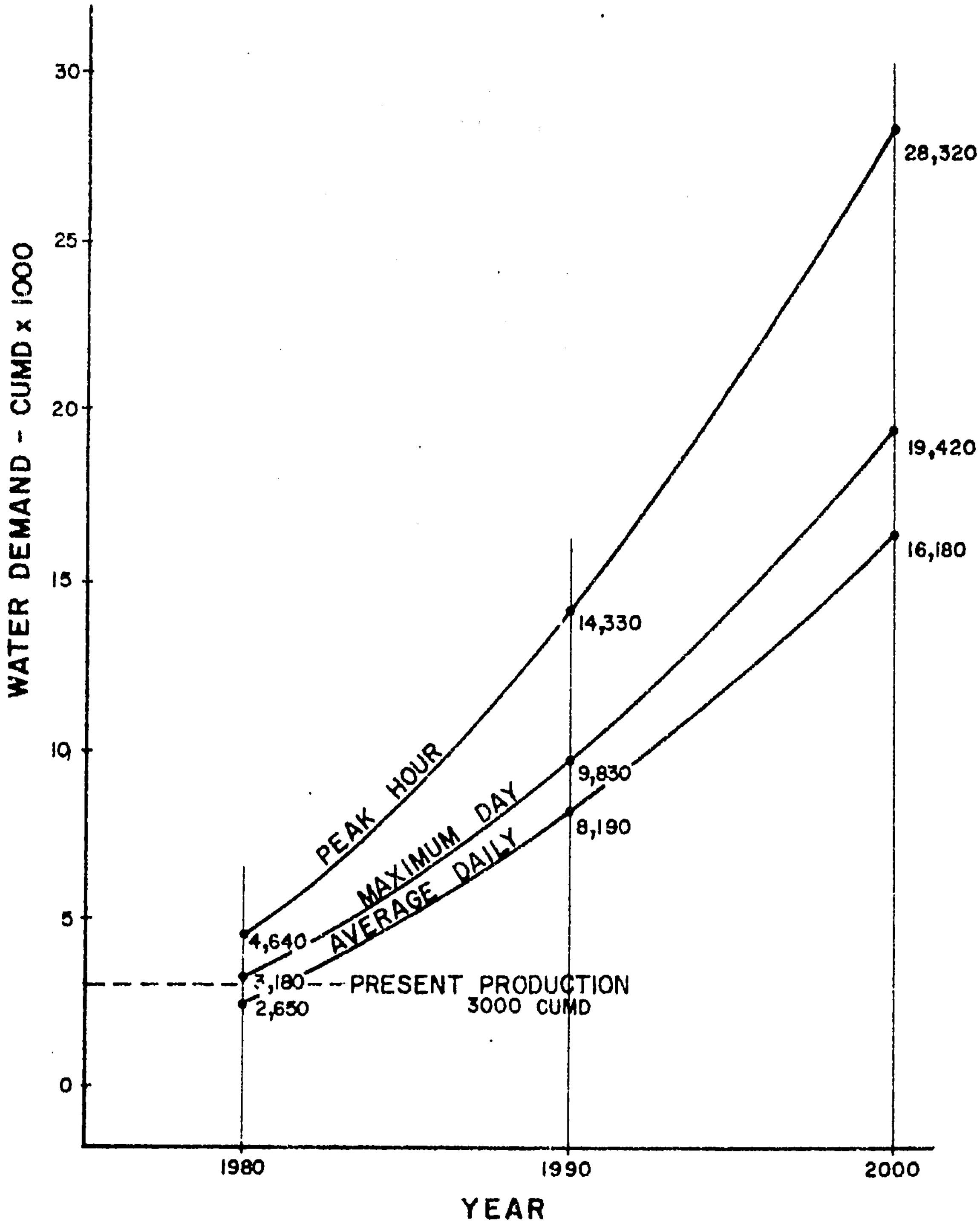


FIGURE VI-3
PROJECTED WATER DEMAND
CALAMBA WATER DISTRICT

CHAPTER VII WATER RESOURCES

A. GENERAL

The Calamba Water District currently obtains most of its water from Bukal Spring to the south and the remainder of its water from one well. The possible sources of water for further municipal supply are springs, wells, and surface water from Laguna de Bay or the Arangilan (San Cristobal) River.

B. GROUNDWATER RESOURCES

Calamba is located on a narrow, shoreline plain at the southwest corner of Laguna de Bay. The land to the west slopes gently upwards to the heights of Tagaytay Ridge about 20 km distant. A foothill of Mount Makiling, about 3 km south of the poblacion, is the site of Bukal Spring which is capable of supplying all of Calamba's needs beyond the year 2000. Wells are also probably capable of satisfying the year 2000 requirements.

Geology

The stratigraphy of the Calamba area is dominated by young volcanic and volcanic-derived rocks. Dominating the landscape south of Calamba is the peak of the Mount Makiling complex with a core of andesitic lava. The foothills toward Calamba are largely composed of fractured volcanic ash beds (tuff). The sediments underlying both the plain on which Calamba sits and the sloping land to the west are also volcanic or derived from volcanic source rocks. These sediments are described in the available local well logs as adobes (tuffs or volcanic pyroclastics), rocks (volcanic flows?), clays and sands (probably volcanic-derived).

Springs

Springs occur whenever an aquifer is intersected by the land surface or whenever a natural conduit extends to the land surface from an aquifer with enough hydraulic head to force the water out. Springs are common in areas of high water table, either from a fully saturated section or "perched" as a result of an underlying impervious bed, where erosion incises the land surface. Thus, they tend to occur in gulleys or canyons and at the foot of steep slopes.

In the Philippines, large springs are commonly found in areas of volcanic mountains for several reasons. The high mountains tend to cause higher than average rainfall on their upper slopes and flanks, the volcanic rocks are frequently very porous and permeable (intrinsic and fracture porosity), and consequently infiltration rates are high. The high infiltration rates result in the volcanic aquifers being saturated to a high elevation which, in combination with the large topographic relief of the volcanic mountain areas, causes springs and seeps where the land surface intersects the aquifer. The high permeability of some of the volcanic aquifer zones and the prevalence of fractures and other natural conduits in the volcanics lead to many of these springs producing large flows.

There are numerous springs of this type in the Calamba area. A large spring exists at Barrio Matangtubig, about 12 km west of Calamba poblacion, that supplies water to Santa Rosa and Cabuyao municipalities as well as to Canlubang Estate. Although this spring is high enough to supply Calamba by gravity flow, it is so far from the CAL-WD that it is not economically competitive with closer sources. Also, other users have prior rights.

Bukal Spring is a very large spring at the southern edge of CAL-WD and is the current major source for the water district.

Tigbe Spring is located about 7 km south of Calamba poblacion, high on the flank of Mount Makiling. Its estimated flow is about 1,900 cumd and it once supplied water to Calamba by gravity flow through a small pipeline. At present, its sole use is for the drinking water supply of Villa Pansol Resort.

Alligator Lake is an unusual lake, circular in plan and enclosed in a raised rim of volcanic rock and clay, that is about 2 km west of Los Baños. The rim extends into Laguna de Bay and is surrounded by Laguna de Bay on three sides. The landward side (south) is adjacent to a low-lying area and the lake rim obviously was once entirely surrounded by Laguna. Alligator Lake almost certainly occupies an extinct volcanic crater that is part of the Mount Makiling complex. The lake water level is somewhat higher in elevation than the level of Laguna de Bay, and Alligator Lake probably is fed by internal springs deriving water from the mountain mass to the south.

There are numerous hot springs in the area as well as the cold springs previously discussed. Hot springs usually result from the same general physical features as cold springs, except that some place between the recharge area and the spring opening the water passes through a zone of hot rocks and becomes heated. In some cases, the water is forced to great depths below the spring outlet before it reaches the water passages that conduct it back up to the spring outlet. In the Philippines, the source of heat is usually volcanic.

Such hot springs are very common between Mount Makiling and Laguna de Bay. There are numerous resorts in and around Pansol (4 km south of Calamba poblacion) that are based on swimming pools fed by hot springs emerging from volcanic rocks. The previously mentioned Villa Pansol Resort is one such resort. Other hot springs emerge in the swamps between the mountain and Laguna de Bay.

Bukal Spring. This spring is the best of the large springs for CAL-WD supply. It is about 3 km from the center of the poblacion along a route that provides customers for the water service. Figure VII-1 shows the location of Bukal Spring.

Bukal Spring is situated at the foot of the steep northern slope of Mount Bijiang, a secondary peak of the Mount Makiling complex. The spring comes from fractured volcanic ash (tuff) where the fractures provide the water channels to collect the water and deliver it to the outlet. The spring elevation is low, about 10-meter altitude, and the water must be pumped into the CAL-WD system.

The pumphouse is located on the west side of the highway and the old abandoned spring intake structure is located near the back of the pumphouse against the face of the hill. The new intake box is across the road at a lower elevation. The intake box site is built against the highway embankment at the edge of the pond formed by surplus spring flow trapped between the road embankment and the nearby railroad embankment. Drainage water from local run-off enters this pond through a large box culvert and several small pipe culverts in the highway embankment. The drainage water flow is usually negligible to small, but is a possible contaminant under existing conditions of collecting spring water when the drainage flow is great.

The spring flow occurs mainly inside the intake box but there are a number of nearby seeps from under the highway embankment. Currently, the excess water in the intake box (most of the spring flow) that is not pumped to the CAL-WD runs out into the pool through breaches in the lower part of the intake box wall. The pool discharge runs under a railroad trestle and forms a small stream running into Laguna de Bay. There is an irrigation pumping station on the stream a short distance from the spring.

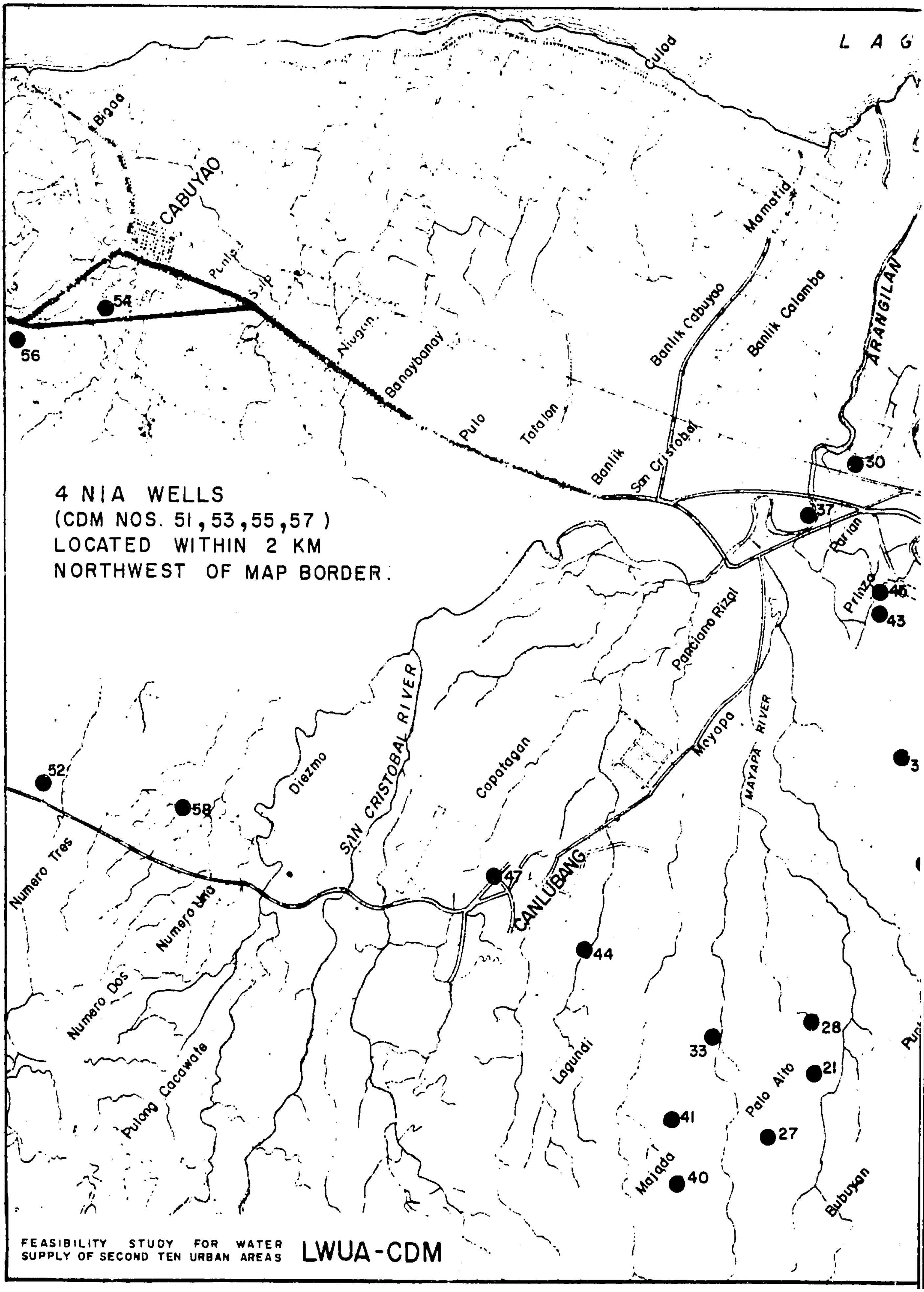
The spring discharge has been measured by gaging the flow of the stream discharging from the pond by current meter traverse across the stream. These measurements represent spring flow in excess of CAL-WD extractions because drainage inflow was negligible at times of flow measurement. To this figure, the estimated extractions pumped from the spring intake structure were added to provide the total spring flows tabulated below:

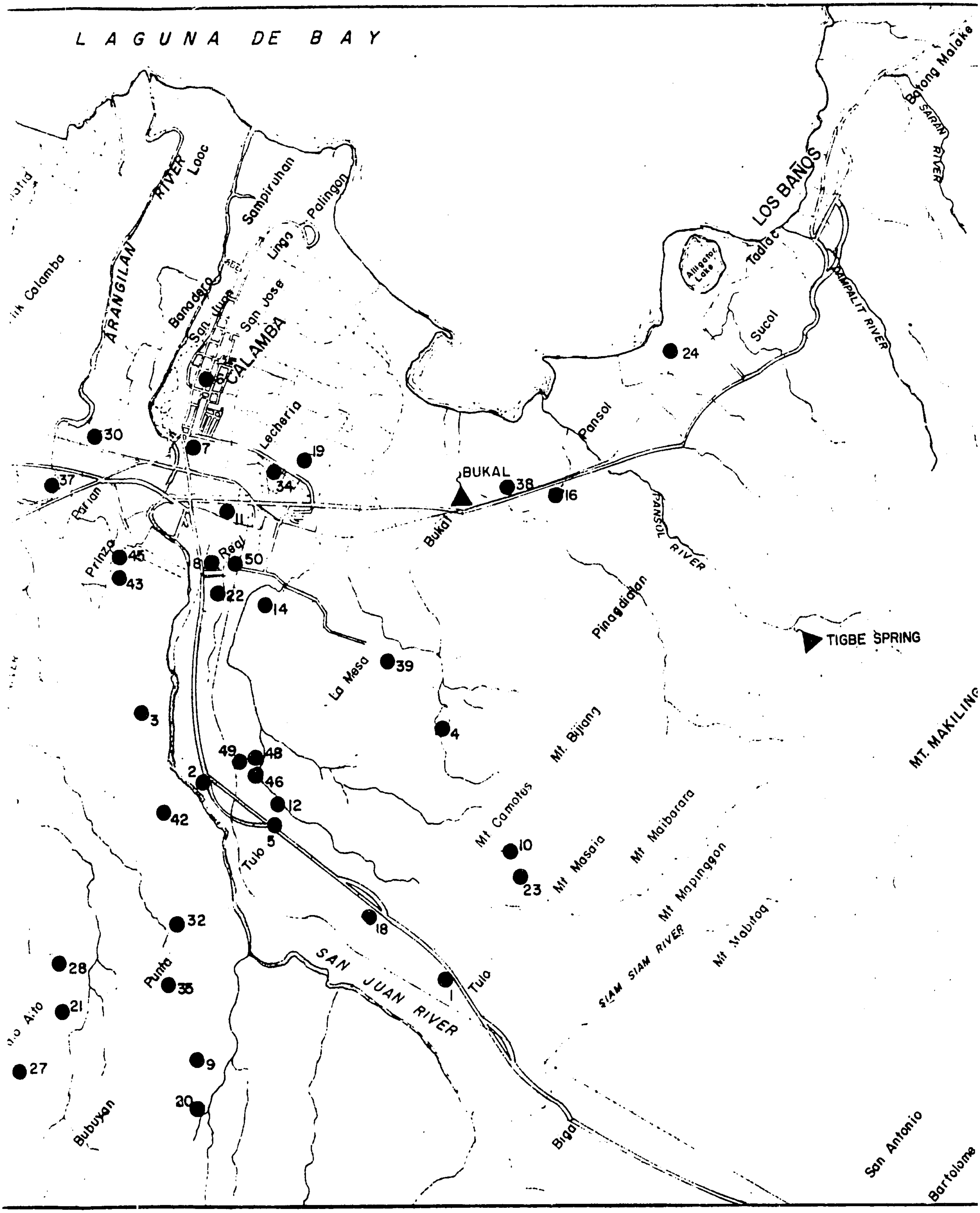
Date of Flow Measurement	Total Bukal Spring Flow
14 Oct 1976	126,000 cumd
11 Nov 1976	121,000 cumd
5 Jan 1977	99,000 cumd
24 Feb 1977	119,000 cumd
21 Mar 1977	118,000 cumd
22 Apr 1977	96,000 cumd

With an average flow of about 115,000 cumd or more, Bukal Spring produces a yearly flow of about 42 million cum. Other springs in the area probably produce another 10 million cum per year or more. The entire mountain mass of the Mt. Makiling complex is about 80 sqkm of which no more than half is an obvious recharge area for Bukal Spring and adjacent springs, considering topographic slopes and the dip of the beds on the flanks of the mountain mass. However, such a situation would imply infiltration and groundwater recharge rates of about 1.3 meters per year which appears to be much too high even considering the porous and permeable nature of the volcanic rocks and the high rainfall on the upper slopes of the mountain. It is considered much more likely that infiltration and recharge contributing to Bukal and adjacent springs occur over a wider area, perhaps 100 sqkm, including some of the sloping plain northwest of Mt. Makiling as well as most of the mountain mass itself where groundwater flow may tend toward the low-lying Laguna de Bay shore passing through fractures and other permeable channels across the direction of bedding of the rocks in many places. Even this situation requires an average areal infiltration and recharge rate of 0.5 meter per year, which is very high. A much larger recharge area than the postulated 100 sqkm seems unlikely.

Wells

Wells are commonly used throughout the Calamba area for domestic, industrial and irrigation water supply. Table VII-B-1 lists pertinent data of a number of such wells, and Figure VII-1 shows the location of those wells that can be conveniently plotted on a map. Annex Figures VII-B-1 to VII-B-12 are well logs that illustrate the geologic section penetrated by the wells. It should be noted that in the logs of the National Irrigation Administration (NIA) wells, CDM No. 51 through 58, Annex Figures VII-B-11 and VII-B-12 showing typical sections, the section is described as consisting of tuffs and volcanic ash beds while in all other well logs the section is described as consisting largely of sandstones (or sands), clays and some adobe beds. It is believed that the rocks described in both cases


L A G
Culod
Bigaa
CABUYAO
Mamatid
ARANGILAN
Banlik Calamba
Banlik Cabuyao
Pulo
Niugan
Banaybanay
Pulo
Tatalon
Banlik
San Cristobal
54
56
30
37
Parian
Prinza
46
43
4 NIA WELLS
(CDM NOS. 51, 53, 55, 57)
LOCATED WITHIN 2 KM
NORTHWEST OF MAP BORDER.
Paciano Rizal
SAN CRISTOBAL RIVER
Diezmo
Capatagan
Mayapa
MAYAPA RIVER
3
52
58
Numero Tres
Numero Uno
Numero Dos
47
CANLUBANG
44
Pulong Cacawate
Lagundi
28
33
21
Palo Alto
41
27
Majada
40
Bubuyan
FEASIBILITY STUDY FOR WATER
SUPPLY OF SECOND TEN URBAN AREAS
LWUA-CDM



LAGUNA DE BAY
LOS BAÑOS
CALAMBA
ARANGILAN RIVER
Looc
Sampiruhan
Palingon
Lingo
Banadero
San Juan
San Jose
Lecheria
Alligator Lake
Tadlac
Sucol
Batong Malake
SARAN RIVER
DAMPALIT RIVER
Pansol
PANSOL RIVER
BUKAL
Bukal
Parian
Prinza
Real
La Mesa
Pinagdadian
TIGBE SPRING
Mt. Bijiang
MT. MAKILING
Mt Camotes
Mt Masaia
Mt Maibarara
Mt Mapinggon
Mt Mabitog
SIAM SIAM RIVER
Tulo
SAN JUAN RIVER
Punta
Bubuyan
Bigaa
San Antonio
Bartolome

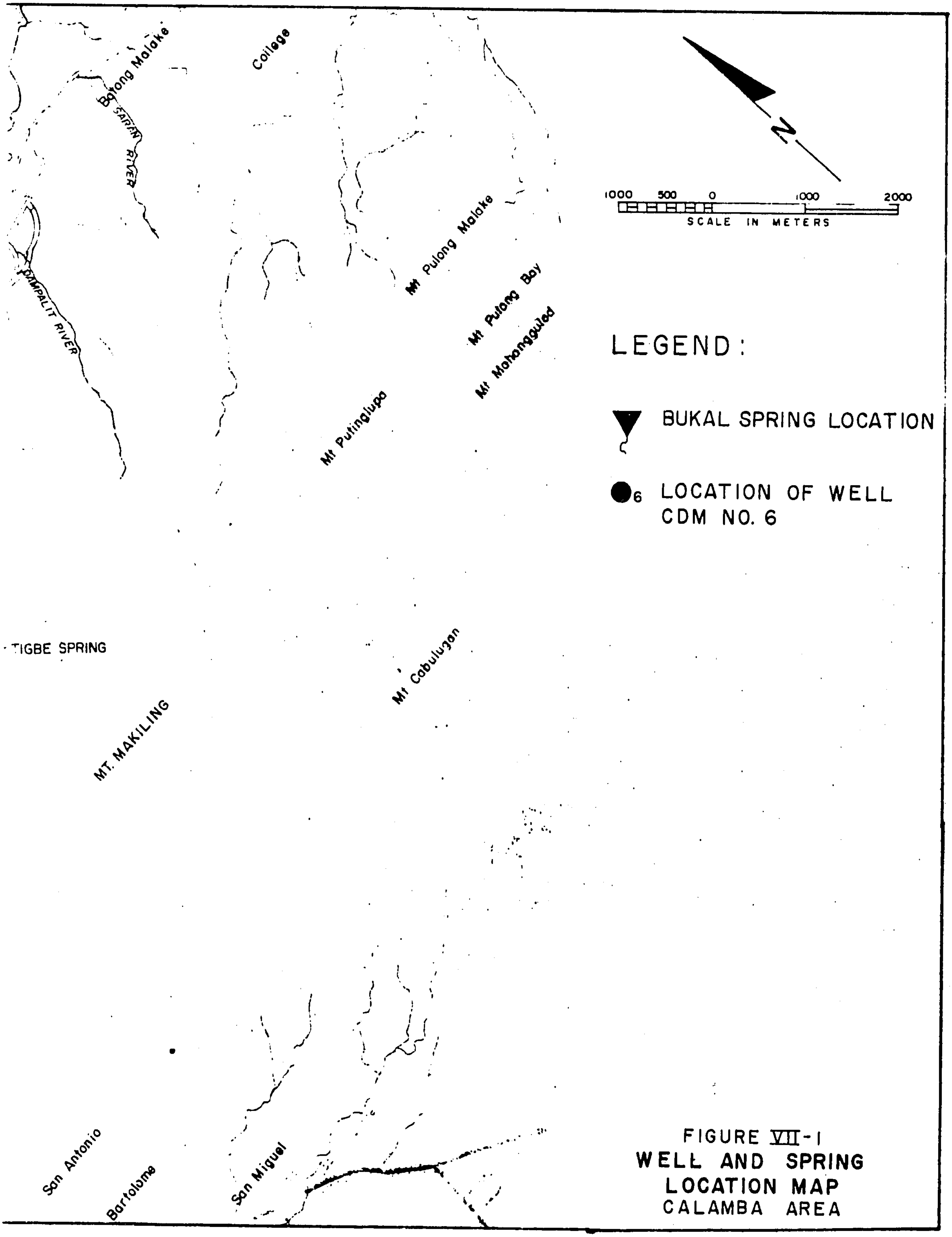


FIGURE VII-1
WELL AND SPRING LOCATION MAP
CALAMBA AREA

are essentially similar and the difference is a matter of terminology, the NIA terminology probably being better. Variation in terminology used by different drillers or geologists in describing a geologic section is a constant and troublesome problem that makes even general correlations of geologic sections and consequent predictions of aquifer characteristics difficult and uncertain.

Data on the 42 wells drilled by the Bureau of Public Works (BPW) in Table VII-B-1 show they generally range from 100 mm to 150 mm in nominal diameter, with two smaller and one larger. Well depths range from 12 meters to 163 meters and static water levels range from ground level to 120 meters below ground level with the wells of deeper static water levels located on higher land.

The productivity of the BPW wells is uniformly poor with a few exceptions:

1. The Crossing well (CDM No. 11) is the CAL-WD supply well. It has 250-mm casing and is 146.3 meters deep. The original specific capacity of the well was reported by the BPW to be 9.81 lps/m in 1962, indicating an excellent well capable of large production. This reported figure is so high that it is suspect, but it is almost certain that the well originally was very good.

2. One well (CDM No. 41) had a reported specific capacity of 7.83 lps/m in 1955 when it was constructed and four of the tabulated BPW wells had specific capacities of approximately 1 lps/m during pump test in the year completed.

3. The remaining 29 BPW wells for which pump test data are available had an average specific capacity of 0.31 lps/m, a poor figure indicating wells capable of yielding only small amounts of water.

Pump test data are available on four of the 8 deep, larger diameter private wells listed. One of these wells is fairly good and the others, relatively poor with specific capacities of 2.95, 0.85, 0.47 and 0.07 lps/m. It is believed that the generally poor performance of the BPW and private wells is largely related to poor design and construction rather than a uniformly poor aquifer. Such a situation is common; many areas underlain by good aquifers support only poor wells until good design and construction procedures are followed.

The 8 NIA wells for which data are tabulated are located about 10 km north of Calamba. Six of these, CDM No. 51, 52, 53, 55, 57 and 58, are located in a line about 5 to 8 km from the shore of Laguna de Bay. Five of them have excellent specific capacities of about 6.3 lps/m and the sixth has a good specific capacity of 3.7 lps/m. The other two NIA wells, CDM No. 54 and 56, are located much nearer the lakeshore and have lesser specific capacities of 3.3 and 1.0 lps/m. The implication is that the wells closer to the lakeshore are drilled in a less permeable part of the aquifer composed of finer material because it was deposited farther from the volcanic source of the sediments.

Although the very productive NIA wells are located far to the north of Calamba, the similarity of depositional environment, the similarity of geologic section (inferred after making allowances for differing descriptive terminology), and the high original specific capacities of wells CDM No. 11 and 41 make it probable that the aquifer in the Calamba area is equally or almost equally good. Thus, it is estimated that wells in the Calamba area, carefully designed and constructed, using good well screen, and drilled to 200-meter depth or more, should have specific capacities between 1 and 6 lps/m with the poorer wells being closer to the shore of Laguna de Bay. An estimate of about 2 lps/m for specific capacity for cost estimation purposes is suggested as a conservative figure. Annex Figure VII-B-13 is a suggested general design for production wells in the Calamba area. If wells are constructed by CAL-WD, this design could be a guide for the first well but the design should be modified for succeeding wells to reflect data derived from construction and test of the first well. The specified screen and upper casing are suitable for 30-lps production although a much larger pump could be installed. Gravel shrouding is recommended because it is anticipated that water will be produced from numerous horizons of varying grain size. Permeable zones should be determined by electric logging. Continuous wire-wound screen is recommended to minimize well losses and make development procedures more effective. Galvanized low-carbon steel is deemed suitable for screens because severe corrosion damage to wells in the Philippines is rare.

Recharge to the aquifer or aquifers in the area is believed to be plentiful because of the adequate rainfall and the porous nature of the pyroclastic rocks. Recharge is particularly high in the mountainous areas as evidenced by large springs with relatively small source areas, and some of this water undoubtedly is transferred in the subsurface to the sediments underlying Calamba. In the event the piezometric levels in the aquifer should fall below Laguna de Bay level, the groundwater flow which is now into the lake will reverse and the lake will become an additional source of recharge. Thus, there is more than sufficient current or potential recharge for all wells likely to be drilled in the Calamba area.

Monitoring

A monitoring program to gather and interpret water source data is necessary for proper operation and planning for any water district. In Calamba, Bukal Spring production and overflow must be monitored; well production and aquifer response to production must also be monitored.

At present the overflow from Bukal Spring is measured by use of a portable current meter in the discharge channel. It would be desirable to provide a permanent weir in the discharge channel, perhaps under the railroad trestle, with a calibrated staff gage to make it convenient to measure the overflow. The pumping station at the spring should also have flow measuring equipment installed so that both flow into the CAL-WD system and spring overflow may be routinely measured. Total flow measurements should be made twice monthly, water samples for bacterial analysis should be collected monthly and water samples for chemical analysis should be collected yearly. The collected data will give early warning of flow reduction or contamination so that remedial action can be taken early.

Each CAL-WD production well (if any) should have facilities for measuring the total amount of production or rate of production, times of operation and water levels. Routine monthly observations of static and pumping water levels should be recorded and daily records of pumping kept. Water samples for bacterial analysis should be collected monthly and for chemical analysis, annually. The data from the well monitoring program will provide better aquifer parameters, indicate the magnitude of recharge, give early warning to CAL-WD of deterioration in water quality or pump performance so that remedial action can be taken, and indicate any unforeseen decline in regional water level so that individual well yields (which affect local pumping levels) and design and location of future wells can be adjusted as necessary. For these purposes, copies of all CAL-WD well monitoring data should be routinely analyzed by CAL-WD (if it has competent staff for such analyses) or by some associated agency competent to perform such analyses.

Summary of Groundwater Resources

Bukal Spring is capable of supplying all of Calamba's water requirements past the year 2000 with good quality water requiring no treatment except chlorination. It is not high enough that water can be delivered to the water district by gravity flow, but it is only 3 km from Calamba poblacion along a transmission pipeline that will also serve water district customers enroute.

Wells can also be developed to supply the year 2000 requirements of Calamba with water requiring no treatment except chlorination. They would have the advantage of being closer to the poblacion and other centers of major use than Bukal Spring is, but would have the disadvantage of requiring multiple pumping stations with their consequent operating costs, mechanical complexity and operational complexity.

Bukal Spring has the additional advantage of being a certain source from a known location making planning and design simple and required costs definite. The exact or even general location of wells to supply Calamba is currently uncertain; and an exploration program would be necessary to positively identify the sites and thus permit detailed planning and design and defining costs.

C. SURFACE WATER RESOURCES

Possible surface water sources for CAL-WD are Laguna de Bay, the Arangilan and San Juan Rivers and Alligator Lake. None of these sources are remotely economically competitive with springs or wells and so are not considered for alternative analysis beyond this chapter.

Calamba is located on the southwest shore of Laguna de Bay, and the obvious surface water source for Calamba for first consideration would be Laguna de Bay. Although the lake could supply all Calamba's water requirements, a number of factors cause water from wells or Bukal Spring to be much less costly.

1. Laguna de Bay is very shallow and the surface water level fluctuates almost 4 meters each year. Consequently a very long intake pipeline (perhaps 3 or 4 km) would be necessary to reach water of reasonable depth at all seasons.

2. The water is frequently very turbid because of wind action on the shallows.

3. There is a large quantity of sewage and industrial and agricultural contaminants introduced into Laguna de Bay, causing both primary contamination and secondary algal growths.

4. A complete water treatment facility would be required to make the lake water fit for CAL-WD use.

5. Pumping costs would be as much or greater than pumping costs for the Bukal Spring source.

6. There is a remote possibility that the Calamba area of Laguna de Bay could some day be contaminated by saline water or some industrial waste that would be difficult to remove by normal water treatment method.

These factors make it evident that Laguna de Bay is not an economically practical source for CAL-WD as long as spring water or well water is readily available.

The San Juan River flows into Laguna de Bay passing directly along the northern edge of Calamba poblacion. The Arangilan (San Cristobal) River is about 1 km farther north. There is a stream gaging station on the Arangilan River about 4 km northwest of Calamba poblacion. The minimum recorded flow at the gaging station was 1,470 cumd in January 1967 and the projected minimum flow for a 10-year return period (Gumbel probability method - 19 years of record) is 2,570 cumd. (Methodology Memorandum No. 4 shows the Gumbel probability method of measuring river flow.) The drainage basin of the Arangilan River at Calamba poblacion is about 40 percent greater than at the gaging station, but even with a 40 percent addition, the minimum flow is too small for a reliable source for Calamba in the year 2000. The San Juan River is not gaged but the flow is less than that of the Arangilan River. Even if the combined flow of the rivers could be used to serve CAL-WD, the rivers are subject to contamination and seasonally carry a heavy sediment load. Thus, complete water treatment facilities would be required, in addition to intake structures, making river water use economically infeasible compared to well or spring water.

Alligator Lake is a 500-meter diameter circular pond in an extinct crater about 5 km from Calamba. The crater rim is surrounded on three sides by Laguna de Bay. The pond is probably fed by bottom springs of unknown flow rate, and the water level is slightly higher than the level in Laguna de Bay. The pond water is subject to surface contamination. The costs of transmission and water treatment make this source infeasible compared to closer springs and wells.

D. WATER QUALITY OF POTENTIAL SOURCES

Water samples were taken from Bukal and Tigbe Springs, the CAL-WD deep well in the poblacion, Laguna de Bay, and Alligator Lake. Chemical analyses were performed to determine the water quality of each potential source with respect to potability and treatment requirements. The results of these analyses are shown in Tables IV-1 and VII-1, and are briefly discussed below. (Tigbe Spring is not large enough to be a potential source.)

Bukal Spring Water

An analysis of water from Bukal Spring is shown in Table IV-1. The water is of excellent chemical and physical quality and meets the chemical and physical requirements of the Philippine National Stan-

TABLE VII-1

WATER QUALITY TEST RESULTS OF POTENTIAL SOURCES
CALAMBA WATER DISTRICT

Test	Unit	Permissible Limits	Laguna de Bay Bo. Pansol 1 Sept 1976	Alligator Lake Bo. Pansol 1 Sept 1976
Physical				
Color	APHA	15	10	0
Turbidity	FTU	5	10 **	0
Total Dissolved Solids *	mg/l	500	260	618 **
Conductivity	Micromhos/cm		400	950
Chemical				
pH		7-8.5	7.2	6.8 **
Total Alkalinity	mg/l $CaCO_3$		85	225
Phenolphthalein Alkalinity	mg/l $CaCO_3$		0	35
Total Hardness	mg/l $CaCO_3$	400 ***	71	118
Calcium	mg/l Ca	75	14	18
Magnesium	mg/l Mg	50	8	18
Total Iron	mg/l Fe	0.3	0.07	0.06
Fluoride	mg/l F	1.5	0	0
Chloride	mg/l Cl	200	82	189
Sulfate	mg/l SO_4	136	5	5
Nitrate	mg/l NO_3		8.9	14.2
Manganese	mg/l Mn	0.1	0.1	0.25 **

* Computed as 65 percent of conductivity.
** Exceeds the permissible limits set by the Philippine National Standards for Drinking Water.
*** Limits inferred from limits of individual metals causing hardness.

dard. for Drinking Water in all respects. Bacterial analyses of samples from the collection structure have shown coliform bacteria. This is believed to result from local contamination which can be prevented by improved collection methods. If the contamination should prove to originate from the spring itself, the local area immediately above the spring opening would have to be protected from possible contamination sources.

Well Water

Since groundwater essentially passes through a filtration process while flowing through a granular aquifer (such as in the CAL-WD area) and is not exposed to surface pollution, color and turbidity or suspended solids are usually not present. For this reason, unless other deleterious substances (such as excessive hardness, dissolved gases or dissolved iron) are present, treatment other than disinfection is generally not required.

An analysis of a water sample taken from the existing CAL-WD well is shown in Table IV-1. The water is of excellent quality and meets the allowable requirements of the Philippine National Standards for Drinking Water in all respects. Such water is acceptable for domestic use without treatment other than chlorination. The water that would be produced from new CAL-WD wells can be expected to be similar to the tested well water.

Surface Water

Water from surface sources is generally high in color, turbidity and suspended solids during periods of rainfall. Even during non-rainy periods surface water usually requires complete treatment including chemical addition, mixing, coagulation, flocculation, sedimentation, filtration and disinfection.

The results of chemical and physical analyses performed on waters from Laguna de Bay and Alligator Lake are shown in Table VII-2. The results indicate that concentration of turbidity in Laguna waters is excessive and treatment would be required particularly during the rainy season when turbidity would be much higher. Turbidity of Alligator Lake water would also probably be excessive during rainy periods when much surface run-off contributes to the supply. Alligator Lake water is also slightly saline and high in manganese content.

ANNEX VII-B

GROUNDWATER RESOURCES

TABLE VII-B-1

WATER WELL DATA SUMMARY

CDM Well Number	BPW Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
1	4995	Tulo	100	124.1	106.7	97.6	99.1	0.95	0.63	1949
2	256312	Tulo	100	36.6	30.5	21.3	22.9	1.58	1.04	1963
3	25592	Prinza	100	73.2	68.0	42.7	43.3	-	-	1959
4	50826	Saisim	100	122.0	122.0	61.0	64.0	0.63	0.21	1962
5	25661	Maunong	112.5	122.0	113.4	106.7	108.2	0.32	0.21	1966
6	16000	Julian Subdivision	-	36.6	-	4.5	7.6	-	-	1957
7	25618A	Bantayan	50	76.2	76.2	4.9	7.9	0.50	0.16	1961
8	25617	Real	100	30.5	20.4	12.2	14.0	0.50	0.28	1961
9	256323	Burol	100	45.1	36.6	27.4	29.0	0.50	0.33	1964
10	256317	Makiling	100	67.1	62.2	45.7	53.4	1.26	0.16	1963
11	10992	Calamba Crossing	250	146.3	-	14.0	15.6	15.75	9.81	1962
12	25638	Maunong	100	68.6	67.1	51.8	57.9	0.94	0.16	1963
13	25632	Palingan	100	36.6	33.5	1.2	4.6	0.44	0.13	1963
14	25618	Pasong Kalabao	100	25.9	23.5	15.5	16.5	0.50	0.50	1961
15	21117	Bungo East	150	45.7	38.1	32.0	32.0	0.63	-	1959
16	256061	Pansol (School Compound)	100	12.2	12.2	2.4	3.1	0.94	1.03	1960
17	256057	Sanpuruhan	100	39.6	39.6	0.9	1.8	0.44	0.48	1960
18	256311	Tulo	100	53.4	51.8	32.0	41.2	0.63	0.07	1963

TABLE VII-B-1 (Continued)

CDM Well Number	BPW Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
19	25631	Licheria Hill	100	41.5	32.0	15.8	17.4	0.50	0.31	1963
20	25664	Burol	112.5	76.2	59.4	53.4	56.4	0.32	0.10	1966
21	256165	Palo Alto School	100	85.4	66.6	62.5	63.4	2.50	0.55	1962
22	25621	Real	62.5	52.1	50.1	20.7	-	0.57	-	1962
23	7988	Makiling	150	57.9	50.3	51.8	53.4	0.32	0.20	1956
24	7044	Sukol	150	17.1	-	-	-	-	-	1954
25	256057	Sanpiruhan	100	39.6	39.0	0.9	1.8	0.44	0.49	1960
26	7042	Makimbul	100	116.5	91.5	94.5	-	0.63	-	1956
27	8926	Palo Alto	150	83.8	72.6	25.9	27.4	0.63	0.42	1955
28	7033	Palo Alto	112.5	89.9	67.7	53.4	54.9	0.95	0.63	1955
29	21116	Bungo	100	163.1	154.9	120.4	-	0.50	-	1959
30	256044	San Cristobal	100	50.3	38.1	0	0.9	0.63	0.70	1960
31	9331	Ulango	150	61.0	54.3	18.3	36.6	0.63	0.03	1956
32	9323	Kuyanlog	150	86.9	82.9	73.2	79.3	0.63	0.10	1956
33	9320	Sirang Lupa	150	77.7	66.5	21.3	25.9	0.63	0.14	1956
34	21231	Licheria Hill	100	44.8	37.2	30.5	33.5	0.32	0.11	1959
35	9322	Punta	150	107.6	95.7	53.4	56.4	0.63	0.21	1956
36	8561	Laguerta	150	103.7	92.7	81.7	82.3	0.32	0.53	1955

TABLE VII-B-1 (Continued)

CDM Well Number	BPW Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
37	7035	Mayapa	150	94.5	44.2	5.5	6.1	0.63	1.05	1955
38	7043	Masili	150	45.7	16.8	5.5	6.7	0.63	0.52	1954
39	7580	Lamesa	150	65.9	48.8	47.3	48.8	1.58	1.05	1955
40	7987	Majada	150	94.5	54.3	53.4	54.9	0.63	0.42	1950
41	8560	Majada	150	89.0	75.6	28.4	29.0	4.7	7.83	1955
42	256911	Kay-anlog	112.5	106.7	94.5	85.4	88.4	0.62	0.21	1969
43	Private well	Alfa Integrated Textile Mills, Calamba (WI)	300 200	243.8	152.4 240.8	22.9	-	-	-	1975
44	Private well	Laguna Estate Development Corporation, Sirang Lupa	400 300	182.9	61.0 176.8	17.7	27.1	27.72	2.95	1976
45	Private well	Alfa Integrated Textile Mills, Calamba (W2)	300 200	243.8	152.4 243.8	22.9	-	-	-	1975
46	Private well	Republic Flour Mills Tulo	250 200	155.4	91.4 149.3	71.0	79.2	6.93	0.85	1976
47	Private well	Canlubang Sugar Estate, Canlubang	400 300	292.1	152.4 260.1	3.0	-	-	-	1974

TABLE VII-B-1 (Continued)

CDM Well Number	BPW Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters				Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
				Total	Cased	Static Water Level	Pumping Water Level			
48	Private Well	Republic Flour Mills Calamba	200 175	92.1	64.0 91.8	42.1	-	3.15	–	1972
49	Private Well	Republic Flour Mills Calamba	200	93.0	93.0	40.6	76.2	5.36	0.07	1972
50	Private Well	ACI Fiberglass Real, Calamba	200 150	122.0	61.0 122.0	17.4	30.8	6.3	0.47	1975
51	p-12	Lat. 14-17-24 Long. 121-05-15	450 300 250	165.0	40.0 110.0 160.0	1.7	20.1	114.2	6.19	1972
52	p-13	Lat. 14-15-21 Long. 121-04-48	450 300 250	175.0	40.0 132.0 170.0	+3.4	15.6	119.3	6.27	1972
53	p-14	Lat. 14-16-54 Long. 121-05-09	450 300 250	190.0	40.0 130.0 184.0	-3.6	20.9	106.0	6.13	1974
54	p-15	Lat. 14-16-48 Long. 121-06-57	450 300 250	200.0	40.0 138.0 192.0	+2.2	26.1	96.2	3.40	1972
55	p-16	Lat. 14-16-18 Long. 121-04-59	450 300 250	200.0	40.0 145.0 191.0	+1.9	24.6	99.7	3.76	1972
56	p-17	Lat. 14-17-06 Long. 121-06-24	300 250	216.0	156.0 212.0	+4.0	35.9	41.6	1.04	1972
57	p-18	Lat. 14-15-54 Long. 121-04-49	450 300 250	200.0	40.0 144.0 190.0	+12.4	5.8	118.3	6.48	1973
58	p-24	Lat. 14-14-41 Long. 121-05-12	450 300 250	200.0	40.0 145.0 192.0	1.8	18.3	106.0	6.43	1973

DESCRIPTIVE DATA

WELL NO. (CDM) 1

(OTHER) 4995

LOCATION BARRIO TULO

CITY CALAMBA

PROVINCE LAGUNA

CONST. BY BPW

DRILLER A. Mc RAW

STARTED APRIL 7, 1949

COMPLETED JUNE 15, 1949

OWNER

STATUS

CASING DIAMETER 100 MM (4 IN.)

CASING LENGTH 106.7 M (350 FT.)

DRILLER'S TEST DATA:

DATE

STATIC WATER LEVEL 97.5 M (320 FT.)

PUMPING WATER LEVEL 99 M (325 FT)

TEST PUMP YIELD 16 GPM (97 LPS)

SPECIFIC CAPACITY 0.63 LPS/M (3 GPM/FT.)

REMARKS:

WATER QUALITY DATA:

GRAPHIC LOG

DEPTH (M)	DEPTH (FT)	STRATIFICATION
		GROUND SURFACE
		ADOBE ROCK
7.6	25	
		BROWN STICKY CLAY
15.2	50	
		HARD ROCK
22.8	75	
		BROWN STICKY CLAY
27.4	90	
		HARD ROCK
30.5	100	
		BROWN STICKY CLAY
64.0	210	
		ADOBE ROCK
93.0	305	
		HARD ROCK
106.7	350	
124.0	407	

CASING

ANNEX FIGURE VII-B-1
WELL DATA SHEET
WELL CDM-1

DESCRIPTIVE DATA	GRAPHIC LOG

WELL NO. (CDM) 4
(OTHER) 50826
LOCATION BARRIO SAIMSIM
CITY CALAMBA
PROVINCE LAGUNA
CONST. BY BPW
DRILLER D. BARORO
STARTED DECEMBER 18, 1961
COMPLETED JANUARY 10, 1962
OWNER
STATUS
CASING DIAMETER 100 MM (4 IN.)
CASING LENGTH 121.91 M (400 FT).

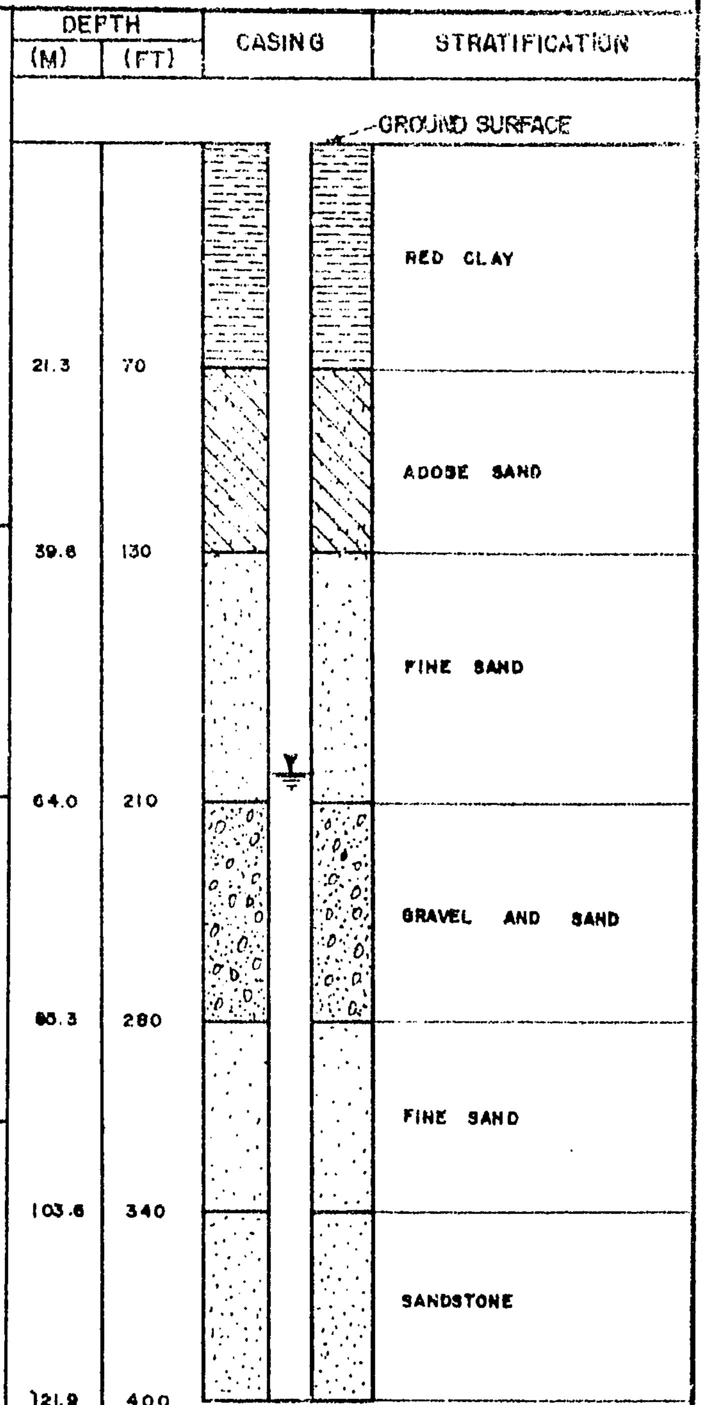
DRILLER'S TEST DATA:

DATE
STATIC WATER LEVEL 60.96 M (200 FT.)
PUMPING WATER LEVEL 64 M (210 FT.)
TEST PUMP YIELD 10 GPM (63 LPS)
SPECIFIC CAPACITY 021 LPS/M (1 GPM/FT.)

REMARKS:

WATER QUALITY DATA:

PH = 7.4
ODOR = OILY
COLOR = CLEAR
TASTE = BLAND
TURBIDITY = 2.5 PPM
ALKALINITY = 196
BICARBONATES = 239
ACIDITY = 78
CHLORIDES = 15
IRON = 0.4
HARDNESS = 168



ANNEX FIGURE VII-B-2
WELL DATA SHEET
WELL CDM-4

DESCRIPTIVE DATA

WELL NO. (CDM)	5
(OTHER)	BPW 2565
LOCATION	BARRIO MAUNONG
CITY	CALAMBA
PROVINCE	LAGUNA
CONST. BY	BPW
DRILLER	
STARTED	NOVEMBER 20, 1965
COMPLETED	JANUARY 14, 1966
OWNER	
STATUS	
CASING DIAMETER	115 MM (4 1/2 IN.)
CASING LENGTH	113.4 MM (372 FT.)

DRILLER'S TEST DATA:

DATE	
STATIC WATER LEVEL	106.7 M. (350 FT.)
PUMPING WATER LEVEL	108.2 M (335 FT.)
TEST PUMP YIELD	5 GPM (0.3 LPS)
SPECIFIC CAPACITY	0.21 LPS/M (1 GPM/FT)

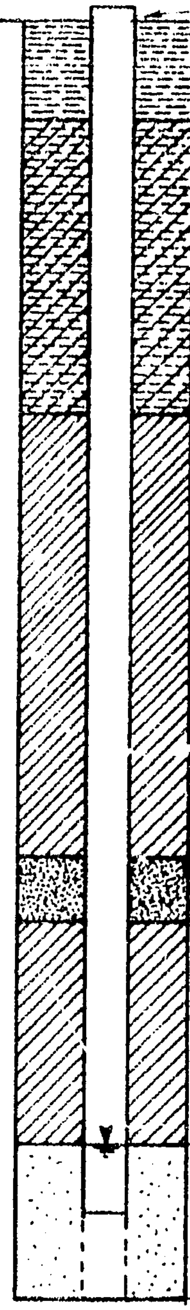
REMARK

WATER QUALITY DATA:

WATER IS GOOD FOR DRINKING AND LAUNDERING

GRAPHIC LOG

DEPTH (M)	DEPTH (FT)	STRATIFICATION
		GROUND SURFACE
		YELLOW CLAY
9.2	30	
		ADOBE CLAY
36.6	120	
		HARD ADOBE ROCK
79.2	260	
		SAND
85.3	280	
		HARD VOLCANIC ADOBE ROCK
106.7	350	
113.4	372	SANDSTONE
121.9	400	



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

ANNEX FIGURE VII-B-3
WELL DATA SHEET
WELL CDM-5

DESCRIPTIVE DATA

WELL NO. (COM) 11
(OTHER) 10992
LOCATION CALAMBA CROSSING
CITY CALAMBA
PROVINCE LAGUNA
CONST. BY BPW
DRILLER
STARTED DECEMBER 3, 1962
COMPLETED DECEMBER 22, 1962
OWNER
STATUS REDRILLED
CASING DIAMETER 254 MM (10 IN.)

DRILLER'S TEST DATA:

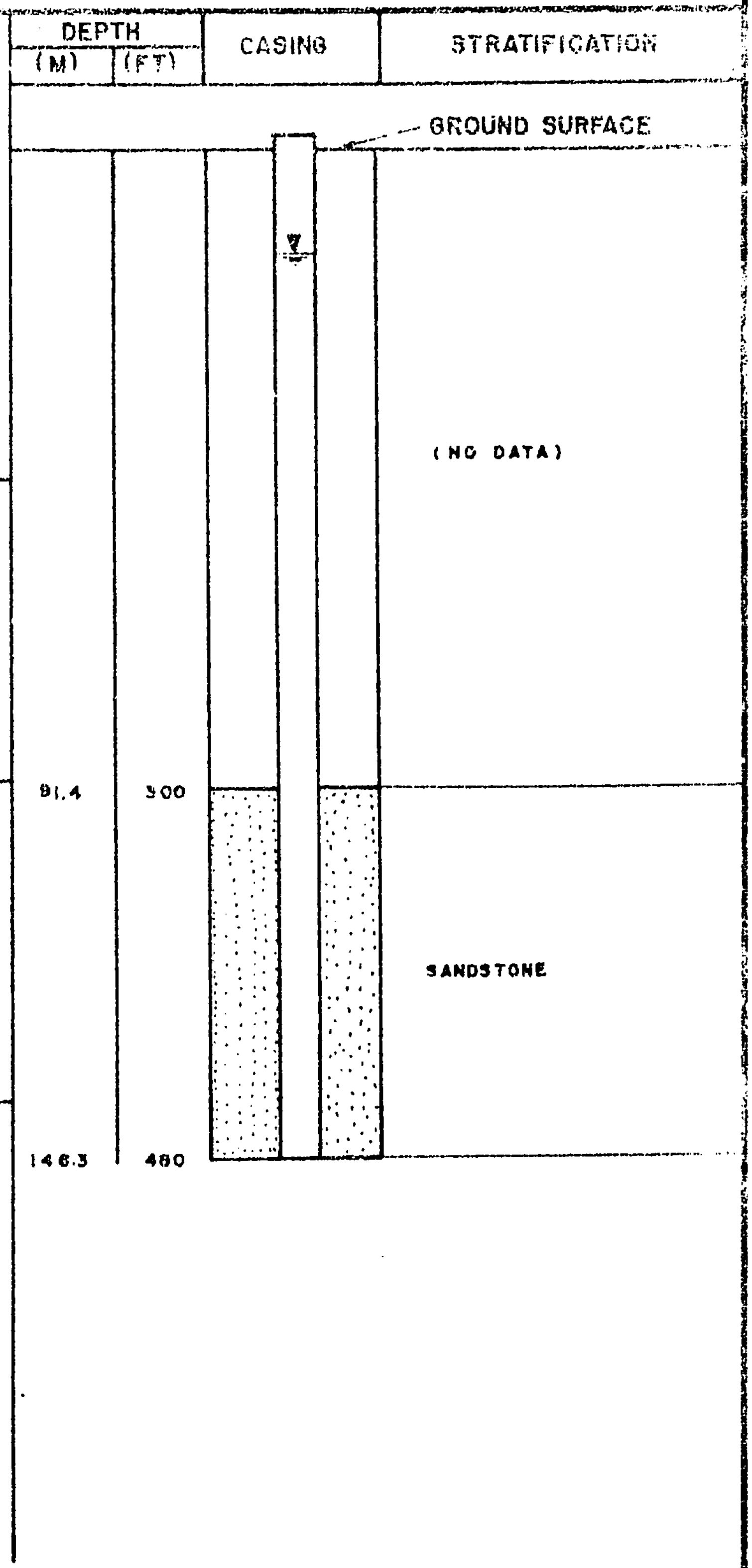
DATE
STATIC WATER LEVEL 14 M (46 FT.)
PUMPING WATER LEVEL 15.5 M (51 FT.)
TEST PUMP YIELD 250 GPM (15.75 LPS)
SPECIFIC CAPACITY 10.5 LPS/M (50 GPM/FT)

REMARKS:

STRATIGRAPHIC DATA NOT AVAILABLE FROM GROUND SURFACE TO 91.4 M. BELOW GROUND SURFACE.

WATER QUALITY DATA:

GRAPHIC LOG



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

ANNEX FIGURE VII-B-4
WELL DATA SHEET
WELL CDM-11

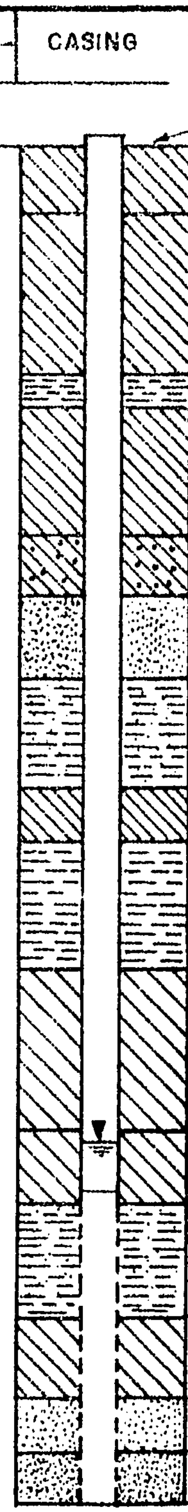
DESCRIPTIVE DATA	GRAPHIC LOG

WELL NO. (CDM) 21
OTHER BPW 256165
LOCATION PALO ALTO SCHOOL COMPOUND
CITY CALAMBA
PROVINCE LAGUNA
CONST. BY
DRILLER CES/?R CASTILLO
STARTED DECEMBER 24, 1961
COMPLETED FEBRUARY 16, 1962
OWNER
STATUS
CASING DIAMETER 100 MM (4 IN.)
CASING LENGTH 66 M (216 FT. AND 6 IN.)

DRILLER'S TEST DATA:
DATE
STATIC WATER LEVEL 62.5M. (205 FT.)
PUMPING WATER LEVEL 63.4 M (208 FT.)
TEST PUMP YIELD 8 GPM (0.5 LPS)
SPECIFIC CAPACITY 0.56 LPS. (2.67 GPM/FT.)

REMARKS:

WATER QUALITY DATA:



DEPTH (M)	DEPTH (FT)	STRATIFICATION
		BROWN ADOBE CLAY
3.1	10	BLACK HARD ADOBE
14.0	46	BROWN STICKY CLAY
15.8	52	HARD ADOBE
24.4	80	ADOBE STONE
28.1	92	SANDSTONE
33.5	110	BROWN SANDY CLAY
40.5	133	ADOBE STONE
43.9	144	BROWN CLAY
51.8	170	SOFT BROWN ADOBE
62.2	204	SOFT ADOBE
66.7	219	BLUE SANDY CLAY
74.6	243	SOFT ADOBE
79.2	260	SANDSTONE
82.6	271	COARSE SAND
85.3	280	

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS **LWUA-CDM**

ANNEX FIGURE VII-B-?
WELL DATA SHEET
WELL CDM-21

DESCRIPTIVE DATA	
WELL NO. (CDM)	43
(OTHER)	ALFA WELL I
LOCATION	
CITY	CALAMBA
PROVINCE	LAGUNA
CONST. BY	
DRILLER	PUMP INTERNATIONAL WELL DRILLING
STARTED	DECEMBER 7, 1974
COMPLETED	JANUARY 31, 1975
OWNER	ALFA INTEGRATED TEXTILE MILLS INC.
STATUS	
CASING DIAMETER	300 MM AT 0-152.4 M) 200MM 149.4 M - 240.8 M

DRILLER'S TEST DATA:

DATE	
STATIC WATER LEVEL	22.9 M(75 FT.)
PUMPING WATER LEVEL	
TEST PUMP YIELD	
SPECIFIC CAPACITY	

REMARKS:

PERFORATED CASINGS AT

DEPTHS OF:

a. 48.8 M - 70.1 M.

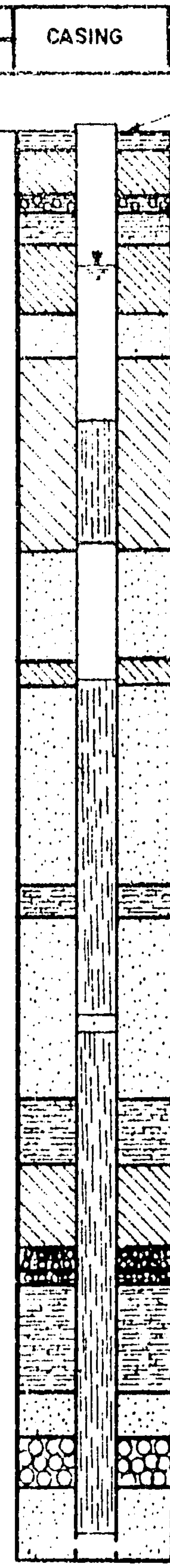
b. 94.5 M - 149.4 M

c. 152.4 M. - 240.8 M.

WATER QUALITY DATA:

GRAPHIC DATA

DEPTH (M)	DEPTH (FT.)	STRATIFICATION
		GROUND SURFACE
		BROWN CLAY
1.8	6	BLACK ADOBE
9.1	30	BROWN CLAY W/ GRAVEL
12.2	40	DARK BROWN SANDY CLAY
18.9	62	
	75	BLACK ADOBE
30.5	100	SANDSTONE
38.1	125	ADOBE
71.6	235	SANDSTONE
89.9	295	ADOBE
94.5	310	SANDSTONE
128.0	420	BROWN SANDY CLAY
133.5	438	SANDSTONE
164.8	540	BROWN SANDY CLAY
176.8	580	ADOBE
190.5	625	GRAVEL WITH SANDY CLAY
193.6	635	GRAVEL WITH CLAY
196.1	640	BROWN SANDY CLAY
213.4	700	SANDSTONE
222.2	729	BOULDERS
231.4	759	SANDSTONE
243.4	800	



ANNEX FIGURE VII-8-6
WELL DATA SHEET
WELL CDM-43

DESCRIPTIVE DATA	GRAPHIC LOG

WELL NO (CDM) 44

(OTHER)

LOCATION BARRIO SIRANG LUPA

CITY CANLUBANG

PROVINCE LAGUNA

CONST. BY

DRILLER PUMP INTERNATIONAL WELL DRILLING

STARTED APRIL 12, 1976

COMPLETED MAY 11, 1976

OWNER LAGUNA STATE DEVELOPMENT CORP.

STATUS

CASING DIAMETER 400MM AT 0-61.0 M
300 MM AT 60.5 M-176.8 M.

DRILLER'S TEST DATA:

DATE

STATIC WATER LEVEL 17.7 M. (58 FT.)

PUMPING WATER LEVEL 27.1 M (89 FT.)

TEST PUMP YIELD 440 GPM (27.72 LPS)

SPECIFIC CAPACITY 3.0 LPS/M (14.2 GPM/FT.)

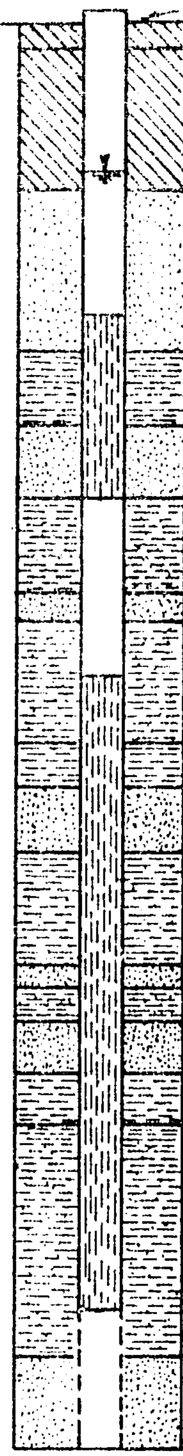
REMARKS:

PERFORATED CASING AT DEPTHS OF:

a) 36.6 M – 61.0 M

b) 82.3 M – 176.4 M.

WATER QUALITY DATA:



DEPTH (M)	DEPTH (FT)	STRATIFICATION
3.1	10	BROWN ADOBE
21.3	70	ADOBE
42.7	140	SANDSTONE
51.9	170	BROWN CLAY
61.0	200	SANDSTONE
73.2	240	SANDY CLAY
76.2	250	SANDSTONE
91.5	300	SANDY CLAY
97.2	320	BROWN SHALE
106.7	350	HARD SANDSTONE
120.4	395	SANDY CLAY
122.0	400	HARD SANDSTONE
128.0	420	BROWN SANDY CLAY
134.1	440	HARD SANDSTONE
140.2	460	BROWN CLAY
170.7	560	BROWN SANDY CLAY
182.9	600	SANDSTONE

ANNEX FIGURE VII-B-7
WELL DATA SHEET
WELL CDM - 44

DESCRIPTIVE DATA	GRAPHIC LOG

WELL NO. (CDM) 45
(OTHER) ALFA WELL [illegible]

LOCATION
CITY CALAMBA
PROVINCE LAGUNA
CONST. BY
DRILLER PUMP INTERNATIONAL WELL DRILLING
STARTED FEBRUARY 17, 1975
COMPLETED APRIL 7, 1975
OWNER ALFA INTEGRATED TEXTILE MILLS INC.
STATUS
CASING DIAMETER 300 MM AT 0-152.2 M.
200 MM AT 149.2-240.8 M.

DRILLER'S TEST DATA:

DATE
STATIC WATER LEVEL 22.9 M.(75 FT.)
PUMPING WATER LEVEL
TEST PUMP YIELD

REMARKS:

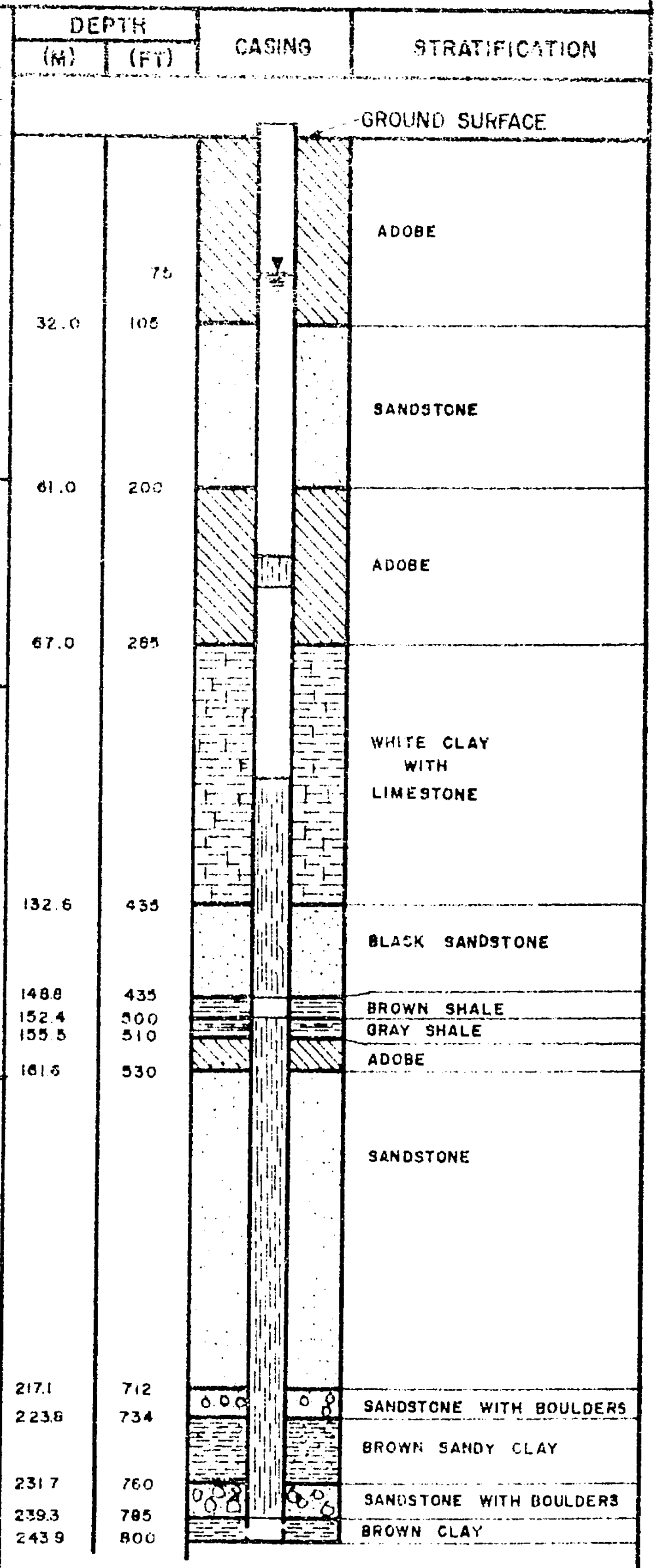
PERFORATED CASINGS AT DEPTHS OF :

a) 73.2 M — 76.4 M

b) 109.7 M — 149.3 M

c) 152.4 M — 240.8 M

WATER QUALITY DATA :



ANNEX FIGURE VII-B-8
WELL DATA SHEET
WELL CDM-45

DESCRIPTIVE DATA

WELL NO. (CDM) 46

(OTHER)

LOCATION BARRIO TULO

CITY CALAMBA

PROVINCE LAGUNA

CONST. BY

DRILLER PUMP INTERNATIONAL WELL DRILLING

STARTED APRIL 21, 1976

COMPLETED MAY 7, 1976

OWNER REPUBLIC FLOUR MILLS INC.

STATUS

CASING DIAMETER 250 MM AT 0 - 91.5 M
200 MM AT 98.4 - 149 M.

DRILLER'S TEST DATA:

DATE

STATIC WATER LEVEL 71.0 M (233 FT)

PUMPING WATER LEVEL 79.3 M (260 FT.)

TEST PUMP YIELD 110 GPM (6.93 LPS)

SPECIFIC CAPACITY 0.9 LPS/M (4.1 GPM/FT.)

REMARKS:

PERFORATED CASINGS AT DEPTHS OF:

a) 45.7 M — 88.4 M

b) 94.5 M — 143.3 M

WATER QUALITY DATA:

GRAPHIC LOG

GROUND SURFACE

DEPTH (M)	DEPTH (FT)	STRATIFICATION
1.2	4	BROWN CLAY
6.7	22	ADOBE
14.6	48	BROWN SANDY CLAY
25.0	82	GRAY ADOBE
33.5	110	GRAY CLAY
44.2	145	BROWN SANDY CLAY
64.0	210	GRAY ADOBE
67.7	222	BLACK SHALE
77.7	255	BLACK ADOBE
83.8	275	BROWN SANDY CLAY
115.8	380	SANDSTONE
134.1	440	BROWN SANDY CLAY
155.5	510	SANDSTONE

ANNEX FIGURE VII-B-9
WELL DATA SHEET
WELL CDM-46

DESCRIPTIVE DATA

WELL NO. (CDM) 50
(OTHER)
LOCATION BARRIO REAL
CITY CALAMBA
PROVINCE LAGUNA
CONST. BY ANCIEN EQUIPMENT CORPORATION
DRILLER
STARTED MARCH 10, 1975
COMPLETED APRIL 3, 1975
OWNER ACI FIBERGLASS PHILIPPINES INC.
STATUS OPERATIONAL
CASING DIAMETER
CASING LENGTH 200 MM (8 IN.) - 0 TO 61.0 M.
150 MM (6 IN.) - 58.0 TO 122.0 M.

DRILLER'S TEST DATA:
DATE
STATIC WATER LEVEL 17.4 M (58 FT.)
PUMPING WATER LEVEL 30.5 M.
TEST PUMP YIELD 9.46 LPS (150 GPM)
SPECIFIC CAPACITY 0.71 LPS/M.
TRANSMISSIVITY

REMARKS:

PERFORATED CASING:

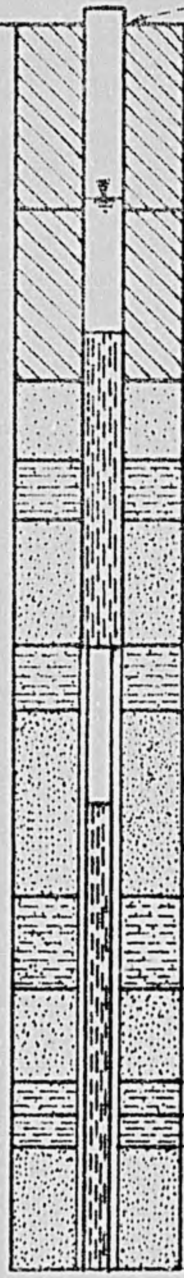
200 MM - 30.5 TO 61.0 M.
150 MM - 73.2 TO 122.0 M.

WATER QUALITY DATA:

GRAPHIC LOG

DEPTH (M)	DEPTH (FT)	STRATIFICATION
		GROUND SURFACE
		BLACK ADOBE
18.3	60	
		BROWN ADOBE
35.1	115	
		SANDSTONE
42.7	140	
		SANDY CLAY
48.8	160	
		SANDSTONE
61.0	200	
		SANDY CLAY
67.1	220	
		SANDSTONE
85.4	280	
		BLACK SANDY SHALE
94.5	310	
		BLACK SANDSTONE
103.7	340	
		BROWN SANDY CLAY
106.7	350	
		BROWN CLAY
109.8	360	
		BLACK SANDSTONE
122.0	400	

CASING



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

ANNEX FIGURE VII-B-10
WELL DATA SHEET
WELL CDM-50

DESCRIPTIVE DATA

WELL NO. (CDM) 54
(OTHER) NIA P-15
LOCATION LATITUDE 14-16-48
LONGITUDE 121-06-57
CITY CABUYAO
PROVINCE LAGUNA
CONST. BY NIA
DRILLER
STARTED
COMPLETED 1972
OWNER NIA
STATUS OPERATIONAL
CASING DIAMETER 450 MM (18 IN.)-0 TO 38 M.
CASING LENGTH 300 MM (12 IN.)-38 TO 138 M.
250 MM (10 IN.)-138 TO 192 M.

DRILLER'S TEST DATA:

DATE
STATIC WATER LEVEL + 2.24 M.
PUMPING WATER LEVEL - 26.06 M.
TEST PUMP YIELD 96.2 LPS (1525 GPM)
SPECIFIC CAPACITY 3.4 LPS/M (16.4 GPD/FT.)
TRANSMISSIVITY 37,700 GPD/FT.

REMARKS:

PERFORATED CASING:
300 MM - 52 TO 59 M
65 TO 82 M
87 TO 100 M
112 TO 125 M
250 MM 138 TO 192 M

PERFORATED CASING IS A MIXTURE OF SLOTTED PIPE AND COMMERCIAL WELL SCREEN.

WATER QUALITY DATA:

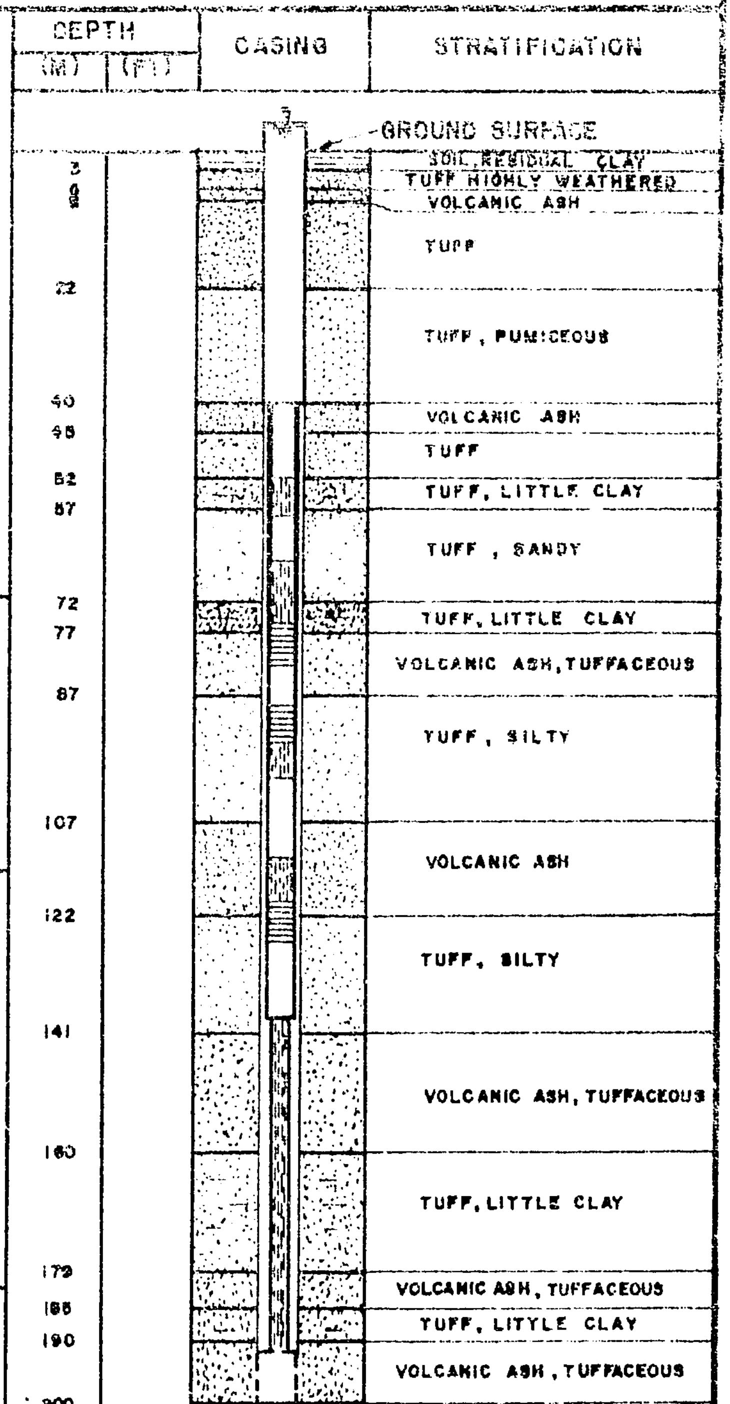
COLLECTED: 3-11-72, 15:00 HOURS
ANALYZED: BPW LAB
TEMP. AT COLLECTION: 28 °C
CONDUCTIVITY: 460 MICROMHOS
TOTAL DISSOLVED SOLIDS: 322 PPM
pH: 7.70
SAR: 1.42

MEQ./LIT.

Ca = 1.80	Cl = 0.34
Mg = 1.40	SO_4 = 0.81
Na = 1.80	CO_3 = 0.00
K = 0.06	HCO_3 = 3.70

TOTAL CATIONS: 5.06
TOTAL ANIONS: 4.85

GRAPHIC LOG



ANNEX FIGURE VII-B-11
WELL DATA SHEET
WELL CDM-54

DESCRIPTIVE DATA

WELL NO. (CDM) 58

(OTHER) NIA P-24

LOCATION LATITUDE 14-14-41

LONGITUDE 121-05-12

CITY CABUYAO

PROVINCE LAGUNA

CONST. BY NIA

DRILLER

STARTED

COMPLETED 1973

OWNER NIA

STATUS OPERATIONAL

CASING DIAMETER 450 MM (18 IN.) - 0 TO 40 M.

CASING LENGTH 335 MM (13 3/8 IN.) 40 TO 145 M

250 MM (10 IN.) - 145 M. TO 192 M.

DRILLER'S TEST DATA:

DATE

STATIC WATER LEVEL 1.81 M

PUMPING WATER LEVEL 18.28 M

TEST PUMP YIELD 106 LPS (1680 GPM)

SPECIFIC CAPACITY 6.43 LPS/M (31.09 GPD/FT.)

TRANSMISSIVITY

REMARKS:

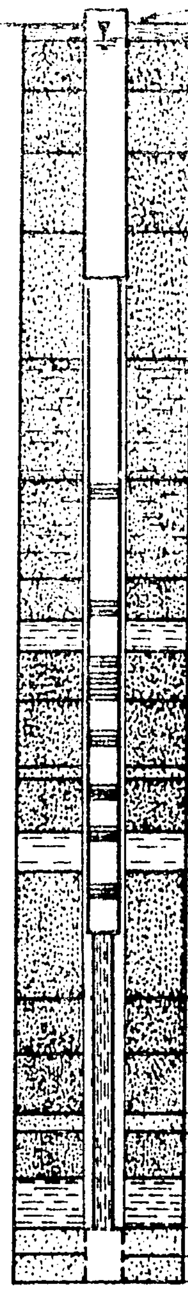
PERFORATED CASING:
335 MM (SURESCREEN)

75 TO 77 M
92 TO 94 M
101 TO 108 M
113 TO 115 M
121 TO 123 M
129 TO 131 M
138 TO 140 M

250 MM (SLOTTED PIPE)
145 TO 192 M

WATER QUALITY DATA:

GRAPHIC LOG

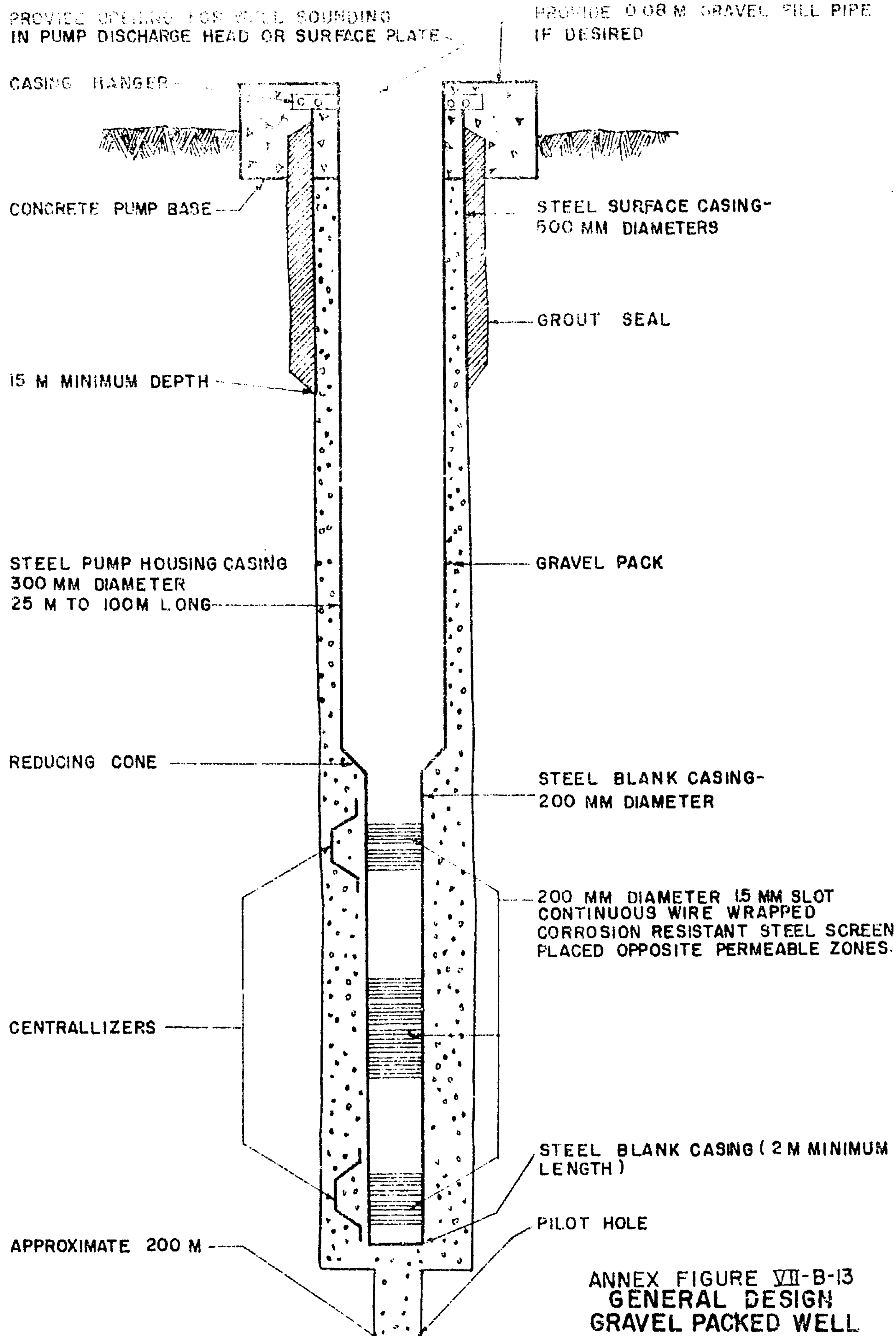


DEPTH (M)	DEPTH (FT)	STRATIFICATION
2		RESIDUAL CLAY
10		VOLCANIC ASH
20		VOLCANIC TUFF
33		VOLCANIC TUFF, PUMICEOUS
54		VOLCANIC TUFF, PUMICEOUS CLAYEY
72		VOLCANIC ASH, CLAYEY TUFFACEOUS
88		VOLCANIC TUFF, CLAYEY
94		VOLCANIC ASH
100		CLAY, TUFFACEOUS
108		VOLCANIC TUFF, PUMICEOUS
118		VOLCANIC ASH, TUFFACEOUS
120		VOLCANIC TUFF, CLAYEY
130		VOLCANIC TUFF, SANDY PUMICEOUS
135		PUMICE, CLAYEY
155		VOLCANIC ASH, TUFFACEOUS
164		VOLCANIC TUFF, SANDY
174		VOLCANIC ASH, TUFFACEOUS
176		PUMICE
184		VOLCANIC TUFF, SANDY
192		CLAY
196		VOLCANIC TUFF
200		VOLCANIC ASH

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM

ANNEX FIGURE VII - B-12
WELL DATA SHEET
WELL CDM - 58



ANNEX FIGURE VII-B-13
GENERAL DESIGN
GRAVEL PACKED WELL
ROTARY DRILLED
CALAMBA WATER DISTRICT

SUPPLEMENT TO FIGURE VII-B-13

GENERAL CONSTRUCTION SUGGESTIONS

Gravel Packed Well - Rotary Drilled

1. Drill oversized hole to 15-meter minimum depth (more if conditions require), set and grout 500 mm surface casing.

2. Drill small diameter pilot hole inside surface casing to 200 or 300 meters (or less if in an area where saline groundwater at depth is anticipated).

3. Run electric log.

4. Examine samples and electric log to locate suitable permeable sources. Abandon site if sufficient permeable material is not found.

5. Ream pilot hole diameter to largest diameter that can be drilled inside the surface casing to a depth about 5 meters below the lowest permeable zone.

6. Install string of casing and screen with screen opposite all permeable zones. Pump housing casing to be 25-meter minimum length, maximum length dependent on depth of upper screened zone and anticipated maximum water levels during life of well.

7. Place gravel of proper size and gradation.

8. Clean and develop well thoroughly.

9. Test well.

10. Design pump.

11. Construct well head facilities.

12. Install pump.

CHAPTER VIII ANALYSIS AND EVALUATION OF ALTERNATIVES

A. GENERAL

This chapter identifies and evaluates the alternatives available for source development, transmission, treatment, storage and distribution system facilities. Water conservation and augmentation alternatives are also discussed.

B. WATER SUPPLY SOURCE ALTERNATIVES

Five sources could possibly supply the requirements for water of the CAL-WD: three surface water sources -- Laguna de Bay, San Cristobal River and the San Juan River; Bukal Spring, the present CAL-WD source; and ground water through wells. These will be discussed separately hereafter.

Surface Water

Laguna de Bay, the eastern boundary of Calamba, is a very large body of fresh water which has been considered as a water source for Metropolitan Manila. The water sample collected on 1 September 1976 was of satisfactory chemical quality. However, this large lake is at times somewhat saline due to backflow from Manila Bay. The national government is currently designing control works at the lake outlet which will prevent this salinity. Besides salinity, the lake is currently subject to pollution from industries on its shores. The Laguna Lake Development Authority is planning measures to control this pollution; but the full benefits from such an industrial pollution abatement program will probably not be realized immediately. The lake is also subject to blooms of algae which may at times produce taste and odor problems in the water.

Laguna de Bay water would, therefore, have to be given complete treatment, including coagulation, sedimentation, filtration, and chlorination. It would sometimes require special treatment for taste and odors before it could be supplied to CAL-WD. The CAL-WD, the Laguna Lake Development Authority or the National Pollution Control Commission would have to monitor the industrial-waste pollution of the lake to plan preventive measures or additional treatment by CAL-WD.

Both the San Juan and San Cristobal Rivers are flashy streams which become very turbid and muddy after rains. Water from either of these rivers would also need complete treatment before it could be used by CAL-WD. Much of the dry season flow of both these rivers is used for irrigation, and use by CAL-WD would involve conflict with existing irrigation rights. At present, the NIA is planning a dam and additional development of the San Juan River for irrigation.

Spring Water

Bukal Spring has satisfactory chemical and physical quality; however, its bacteriological quality can be improved by simple chlorination. The lowest recorded flow of this spring is over four times the predicted need for water of CAL-WD in the year 2000. Bukal Spring would therefore be a satisfactory source of water for CAL-WD.

Groundwater Wells

Since 1952, CAL-WD has obtained part of its water supply from the "Crossing" well. This water is also of satisfactory physical and chemical quality, and will meet bacteriological standards as pumped from the ground. Although this well is of moderate capacity (higher capacity wells of modern design may be expected), and has been in operation for over 25 years, a groundwater investigation and test pumping program would still be necessary before CAL-WD could be certain of obtaining its long-range water requirements from wells.

Source Evaluation

As Bukal Spring is a satisfactory and reliable source and large enough to supply CAL-WD throughout the design period, other sources should be used only if they have advantages over Bukal Spring. The three potential surface water sources (Laguna de Bay, San Juan and San Cristobal Rivers) do not have any advantage over Bukal Spring. These sources would require complete treatment which is expensive and complicated, whereas Bukal does not require any treatment other than simple chlorination. The point of supply of all three sources would be somewhat farther away from the city than that of Bukal; hence, a surface water supply would require longer transmission lines. Diversion or inlet structures would be considerably more expensive for the surface sources than the spring intake for Bukal. Power costs for pumping Laguna de Bay water would be equal to or greater than that of Bukal Spring. Although it may be theoretically possible to obtain water from the surface streams at such an elevation that would make pumping unnecessary, possible dam sites are not readily apparent. Dams are, of course, relatively very costly. Water rights conflicts would be anticipated with current irrigational use of the surface streams. Industrial wastes and algae problems in Laguna de Bay are expected to continue in the future. For these reasons, the CAL-WD should therefore use Bukal Spring as a source of water over any of the three surface sources examined.

Groundwater wells may, however, also be satisfactory as sources of water for CAL-WD. A comparative analysis of the costs of supplying water to CAL-WD either from Bukal Spring or from wells was therefore made. The results are shown in Tables VIII-1 and VIII-2. The supply from wells appears to be less costly by 1.4 million pesos, in 1978 present worth costs, over supply from Bukal Spring. This difference represents about 8 to 10 percent of the overall present worth project costs through the year 2000. Since the accuracy of the cost estimating data and the preliminary design basis is considered to be in order of ±15 percent, these two alternatives are basically equal. In calculating these comparative costs, it was assumed that the immediate improvement program would be implemented by 1980 since CAL-WD needs these new facilities critically. The facilities proposed in the immediate improvement program do not create a bias in the choice between springs and wells.

The choice of long-term source appears to be, therefore, between Bukal Spring and deep wells in the service area. As mentioned earlier, cost considerations alone do not seem to favor one source over the other. Further analysis based on non-quantifiable or non-economic factors was therefore made and discussed as follows under four major headings:

1. Health/Environmental Considerations - Factors such as susceptibility to contamination (total and localized) and effect on the system, when disinfectants are unavailable, favor the deep well over the spring. The intake portion of Bukal can potentially be contaminated; in the event that localized contamination occurs, the well alternative is more flexible in the sense that the contamination may be prevented from spreading to the entire system or polluting the entire water source.

2. Technical Considerations - If the CAL-WD were supplied primarily from wells located at sites closest to the demand centers, the distribution system would operate at better pressures under conditions of stress such as during a fire. This advantage will, in all probability, not occur often. On the other hand, it will be more complicated to operate several wells rather than a single pump station. Certain wells must be turned on as they are needed, and turned off as demand diminishes. More operational decisions must be made, more staff employed and more pumpsets kept in operation if the supply were from wells.

TABLE VIII-1

COMPARATIVE COST OF ADDITIONAL SUPPLY FROM BUKAL SPRING

Year Constructed	Item Constructed	Construction Cost ₱ x 1000	1978 Present Worth Cost
1982	Pumping Station	910	571
1981	Additional Piping	957	632
1986	Additional Piping	2,561	882
1987	Pumping Station Additions	1,120	371
1993	Pumping Station Additions	1,310	169
1997	Replace Machinery	400	20
1978-2000	Operation and Maintenance		1,710
	Total 1978 P.W. Cost		₱4,355 x 1000

TABLE VIII-2

COMPARATIVE COST OF ADDITIONAL SUPPLY FROM DEEP WELLS

Year Constructed	Item Constructed	Construction Cost ₱ x 1000	1978 Present Worth Cost
1982	Well and Pump House	485	304
1986	Well and Pump House	485	184
1990	Well and Pump House	485	104
1993	Well and Pump House	485	63
1996	Well and Pump House	485	31
1996	Additional Piping	174	9
1997	Well and Pump House	485	14
1998	Replace Pumps and Motor	80	4
1978-2000	Operation and Maintenance		2,217
	Total 1978 P.W. Cost		₱2,926 x 1000

Notes:

1. This comparison assumes a common program for immediate improvement.
2. The immediate improvement program, storage and all other elements common to both alternatives have been omitted from the comparison.
3. It is also assumed that wells will be located conveniently at points of maximum demand.
4. Above costs include the results of distribution system alternatives (refer to Section D, hereafter).

Water from Bukal Spring is quite certain in quantity and in quality, at present and in the foreseeable future. Adequate water is considered probably available from wells though production capacity from the underground aquifer would need testing and verification. A comprehensive groundwater investigation would be required (at a cost close to ₱1.0 million) over a two-year period to ascertain the groundwater potential in Calamba. If groundwater is available, it could conceivably be depleted later, especially if other large wells are drilled into the same aquifer by other private firms or competing irrigation interests.

3. Socio-Political Factors - Although Calamba has been using the spring and a deep well as their main sources of supply, the continued utilization of the spring is believed to be more acceptable to the people rather than adding new wells to serve the community. Moreover, the deep well scheme could have future conflicts concerning water rights with irrigation interests.

4. Resource Conservation Factors - Power and land that would otherwise be utilized in the deep well scheme, could be utilized elsewhere with the use of Bukal Spring. A possibility exists for a nearby water district (such as Los Baños) to share sources with Calamba. If Bukal Spring becomes an economic alternative for a nearby water district then both districts may share common source facilities. The conservation of skilled labor, which is an advantage for Bukal Spring, will be offset by the generation of employment opportunities by the deep well source.

The table below shows the summary comparison of the two alternative sources considering the non-economic parameters.

Factor	Bukal Spring	Deep Wells
1. Health/Environmental		has the advantage
2. Technical	has the advantage	
3. Socio-Political	has the advantage	
4. Resource Conservation	has the advantage	

Based on the above, it is recommended that Bukal Spring be adopted as the long-term source for the CAL-WD.

Table VIII-3 shows a quantitative comparison of the alternative sources using the non-economic parameters. The greater points are assigned to the alternative source where the benefits derived would be maximum. The alternative source with the most number of points is considered the "best" alternative. As Table VIII-3 shows, the best alternative source for Calamba is the Bukal Spring.

C. TREATMENT ALTERNATIVE

Water from Bukal Spring and wells within the service area has satisfactory quality, requiring no treatment for removal of chemical or physical constituents. However, to preserve its potability within the distribution system, chlorine application at suitable points of the system would be required. A residual chlorine concentration of 0.2 mg/l would provide adequate protection against potential contamination in the distribution system.

D. DISTRIBUTION ALTERNATIVES

General

This section presents the distribution alternatives considered for the CAL-WD. The recommended improvement program for the the water system is dicussed in Chapter IX.

The long-term source of water could not be selected for the CAL-WD without the results of the preliminary analysis of the distribution system. The distribution system for the two desirable source alternatives - Bukal Spring and deepwells - has been analyzed and the cost difference is included in the source alternative analysis in Section B of this chapter.

The components of a water distribution system and some of the alternatives in planning a system are discussed in Appendix K. The design criteria for the distribution system are given in Appendix F. Appendices F and K were largely developed for the First Ten Provincial Urban Areas and are applicable to moderate-size communities. The Second Ten Provincial Urban Areas are generally much smaller and the parameters presented in Appendices F and K must be applied with discretion.

Particular attention has been given to the requirements of fire flow in the CAL-WD. In general, fire flow is applied at various locations in a system coincidentally with maximum-day demands, and the pipelines are sized to convey the required flow at specified head losses. In large communities, the total peak-hour flow is greater then the maximum-day flow plus fire flow and

TABLE VII -3

COMPARISON OF ALTERNATIVE SOURCES BY NON-ECONOMIC PARAMETERS

Non-Economic Parameters	Assigned Points Sub-Total	Assigned Points Distribution	Points for Alternative Source: Bukal Spring	Points for Alternative Source: Deep Wells	Remarks
Health/Environmental	30				
a. Probability of surface water (spring) contamination		12	8	12	The intake portion of Bukal Spring can potentially be contaminated; deep wells are safer.
b. Availability of disinfectants		6	4	6	In the event of chlorine shortage, deep well water would be preferable.
c. Probability of salinization of groundwater		12	12	8	Bukal Spring usage will not lead to groundwater salinization, unlike deep wells.
Technical	26				
a. Reliability (certainty) of source		18	18	16	Bukal Spring is a reliable source. Deep well water needs further studies (may not be certain).
b. Simplicity of operation and maintenance		8	8	4	The Bukal Spring system will require only one pump station, whereas the deep well scheme will have several pumps.
Socio-Political Acceptability	20				
a. Potential irrigation conflict on water rights		10	10	8	The deep well scheme could have future conflicts on water rights with irrigation interests.
b. Public attitude about a traditional source		10	10	10	Bukal Spring as a traditional source will be more acceptable to the citizenry.
Resource Conservation	24				
a. Economy-of-scale (sharing sources)		4	4	0	The Bukal Spring is a potential source for the Los Baños WD. Sharing source facilities is an advantage.
b. Power conservation		8	8	6	Bukal Spring has an advantage over deep wells.
c. Land use conservation		6	6	4	Bukal Spring has an advantage over deep wells.
d. Skilled labor conservation		6	6	3	Bukal Spring has an advantage over deep wells.
Grand Total	100	100	94	55	

therefore relatively minor adjustments are required in the pipe system to provide fire flow. In the smaller communities, especially small barrios some distance from the poblacion, the fire flow alone can be in the order of 3 to 5 times the total peak-hour demand.

Providing adequate fire flow to areas where the fire flow may be far greater than the ultimate peak demand is rarely justified economically; but, as a general rule, some fire protection should be provided. Included in this study is information on the available fire flow at various locations where the system has been designed for conditions other than fire flow.

The flows used for design of the various components of the distribution system are based on the water demand projections given in Chapter VI.

Pressure Zones

The ground elevation within the future service area of the CAL-WD through the year 2000 ranges from a low of 8 meters in Barrio Pansol to a high of 25 meters in Barrio Real. The larger portion of the service area, including the poblacion is situated at an elevation of 13 meters. The system can be operated adequately at a HGL of 50 meters; therefore, only a single pressure zone has been considered for the CAL-WD. The single pressure zone is adequate whether the spring or deepwells are selected as the water source.

Source/Distribution Analysis

The analysis of various source alternatives generally does not require complete analysis of the alternative distribution systems. Simplifying assumptions can be made so that a complete distribution analysis is not required. However, the source analysis for CAL-WD required a complete analysis of the distribution system because the different alternative sources significantly affected the configuration of the distribution systems.

With Bukal Spring as the source, large transmission mains from the source to the poblacion would be required for the distribution system. The distribution system pipelines for the deep well source would be generally smaller since the source would be located closer to the demand centers. Table VIII-4 presents the cost comparison of the distribution systems for both source locations. The difference of ₱3.35 million in the costs of the distribution systems was used in Section B of this chapter to analyze which source would be most cost effective.

TABLE VIII-4

COMPARISON OF COSTS[1] FOR ALTERNATIVE TRANSMISSION AND DISTRIBUTION SYSTEMS FOR CAL-WD

Year Pipelines Constructed	Deep Wells	Bukal Spring
1981	₱1,790,000	₱2,750,000
1986	4,130,000	6,690,000
1996	550,000	380,000
	₱6,470,000	₱9,820,000

Bukal Spring was recommended in Section B of this chapter as the long-term source for CAL-WD. All further discussions in this chapter are based on using the Bukal Spring as the long-term source.

Storage Facilities

Distribution storage tanks provide water to meet demand fluctuations during peak hour, fire flow and emergency conditions as discussed in Appendix F.

When the supply rate from the source equals maximum-day demand, the usual storage volume required is 15 to 20 percent of maximum-day demand. However, it is not always cost-effective to provide that amount of storage because there are some instances where providing additional supply capacity is less costly. An example would be for flat areas where the primary means of providing storage is by elevated storage tanks. This type of storage tank is very costly since it must be designed to withstand seismic loadings. Hence, it may be less expensive to provide additional supply capacity. A curve used in estimating storage volume required for various source supply rates is discussed and presented in Methodology Memorandum No. 5.

In Calamba, locations for ground storage are available either at the present site or at Lecheria Hill, which is nearer the center of demand. The source at Bukal Spring is adequate even beyond 2000; therefore, it will be considered as the source if the storage were at either location.

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[1] Costs are based on 1978 prices. These are not "present worth" costs. Present worth costs are presented in Section B, Tables VIII-1 and VIII-2.

Three alternatives have been investigated for the location of distribution storage. Alternative 1 assumes that CAL-WD would continue to use the present tank site for all future storage. The transmission main for Alternative 1 would be sized to convey peak-hour flows from the tank site to the poblacion.

Alternative 2 assumes that storage would be constructed at Lecheria Hill. The advantage of this alternative is that the transmission main sizes are reduced. The transmission main from Bukal Spring to Lecheria Hill would be designed for maximum-day flow. Only that portion of the transmission main from Lecheria Hill to the poblacion would be designed for peak-hour flow.

Alternative 3 assumes utilization of the existing storage facilities as long as possible, thereafter abandoning them and constructing a new distribution storage tank on Lecheria Hill.

Two situations were investigated for Alternatives 1 and 2 - one using the maximum amount of storage to minimize pipeline construction, and the other using a minimum amount of storage.

Table VIII-5 presents the cost analysis of the three distribution storage alternatives. Costs common to these alternatives are not included in the analysis. Table VIII-6 is a list of facilities considered in the cost analysis.

The present worth cost analysis does not include a cost for abandoning the existing storage tank for any of the alternatives. According to the guidelines for present worth analysis, the useful life of a storage tank is 50 years and the present tank is already over 50 years old. Practically speaking, the existing tank is reasonably useful and still has remaining economic value as a storage tank.

The present worth cost difference between Alternative 3 and the minimum storage situation for Alternative 1 is about ₱350,000. If the value of the existing tank is assumed equal to the new cost of a 380-cum tank, then the present worth of the salvage value of the tank to be abandoned in 1990 in Alternative 3 would reduce the cost difference to less than ₱100,000, which is within the range of cost estimating accuracy.

Alternative 3 is the most cost-effective for construction of the storage and transmission facilities. A complete description of the recommended facilities is included in Chapter IX.

TABLE VIII-5

PRESENT WORTH COST ANALYSIS OF DISTRIBUTION STORAGE ALTERNATIVES[2]

	Present Worth Costs (₱ x 1,000)
Alternative 1	
Maximum Storage at Present Site:	
Supply	₱1,696
Transmission mains	1,350
Storage tanks	566
Additional power costs	-
	₱3,612
Minimum Storage at Present Site:	
Supply	₱2,125
Transmission mains	1,335
Storage tanks	33
Additional power costs	-
	₱3,493
Alternative 2	
Maximum Storage at Lecheria Hill:	
Supply	₱1,696
Transmission mains	978
Storage tanks	692
Additional power costs	188
	₱3,554
Minimum Storage at Lecheria Hill:	
Supply	₱2,125
Transmission mains	1,337
Storage tanks	160
Additional power costs	188
	₱3,810
Alternative 3	
Storage at present site to 1990 then Constructing Storage at Lecheria Hill:	
Supply	₱1,721
Transmission mains	1,015
Storage tanks	303
Additional power costs	99
	₱3,138

[2] See Table VIII-5a for facilities considered in the analysis.

TABLE VIII-6

FACILITIES CONSIDERED IN DISTRIBUTION STORAGE ANALYSIS

	Supply Facilities		Transmission Mains			Storage Tanks	
	Capacity (cumd)	Year Installed	Size (mm)	Length (m)	Year Constructed	Size (cum)	Year Constructed
Alternative 1							
Maximum Storage (at present site)	3,270	1982	600	1,460	1982	700	1982
	3,270	1985	400	750	1982	500	1985
	4,090	1989	250	650	1994	500	1989
	5,460	1994				700	1994
Minimum Storage (at present site)	6,550	1982	600	1,460	1982	500	1994
	4,910	1985	400	650	1982		
	6,550	1989	300	100	1982		
	8,180	1994	250	650	1994		
Alternative 2							
Maximum Storage (at Lecheria Hill)	3,270	1982	400	1,460	1982	1,000	1982
	3,270	1985	300	790	1982	500	1985
	4,090	1989	250	1,460	1994	500	1989
	5,460	1994				700	1994
Minimum Storage (at Lecheria Hill)	6,550	1982	600	1,460	1982	300	1982
	4,910	1985	400	650	1982	200	1989
	6,550	1989	250	140	1982		
	8,180	1994	250	650	1994		
Alternative 3							
Minimum Storage at present site to 1990 then Maximum Storage at Lecheria Hill	6,550	1982	450	1,460	1982	2,000	1989
	4,910	1985	350	650	1982	700	1994
	4,910	1994	300	140	1989		

Alternative 3 has been selected not only because of the potential cost savings but also because of its technical advantages. If the storage tank is located at Lecheria Hill by the year 2000, it would be possible to supply even the most distant barrios in the service area with full fire protection. The entire service area in general would also have higher average pressures since the tank is closer to the center of demand.

Transmission Main

The basic transmission alternatives are closely related to storage location and the supply versus storage analysis presented in the preceding section. The recommended transmission main which is based on the storage analysis is described in Chapter IX.

The proposed transmission main will be constructed along the existing and proposed street right-of-way to minimize land cost and also to utilize the transmission main as a distribution main. The existing transmission main is assumed to be abandoned in the 1990 and 2000 analyses because of its age. However, the district could continue to use the main as long as it remains operative.

Distribution System

The analysis for the distribution system of CAL-WD generally followed the guidelines given in Appendices F and K. Unlike the First Ten Areas Feasibility Studies, computer analysis for the Second Ten Provincial Urban Areas considered pipelines smaller than 200 mm in diameter. Calamba has many pipelines smaller than 200 mm even in the year 2000.

Alignments for the distribution pipelines would follow existing roadways, to minimize land cost and to locate them as close as possible to areas of demand. These would be looped to avoid dead-ends.

No alternatives in the analysis of the distribution system were considered since the source of supply is in one location and different storage locations only affect the transmission main sizing and location. Several alternative analyses in connection with fire protection were made and are discussed in the succeeding section.

Fire Protection

The distribution system analysis for Calamba included the investigation of available fire protection in the service area for each design period. Fire flow requirements for two types of area-commercial, industrial or high-value residential, and single-family residential areas - are 20 lps and 10 lps at two adjacent hydrants, respectively, as outlined in Appendix K. Available fire flows for areas where full fire protection is not satisfied are presented in this section as a percentage of these requirements for fire protection. Figure VIII-1 shows the extent of the fire service areas in Calamba for the year 2000 service area.

At present, there is no fire protection in most parts of Calamba. The hydraulic field survey data indicate that pressures throughout the system, except along the transmission line, are very low or zero in some parts of the town. For an area to have full fire protection, there must be adequate pressure in all pipelines throughout the day.

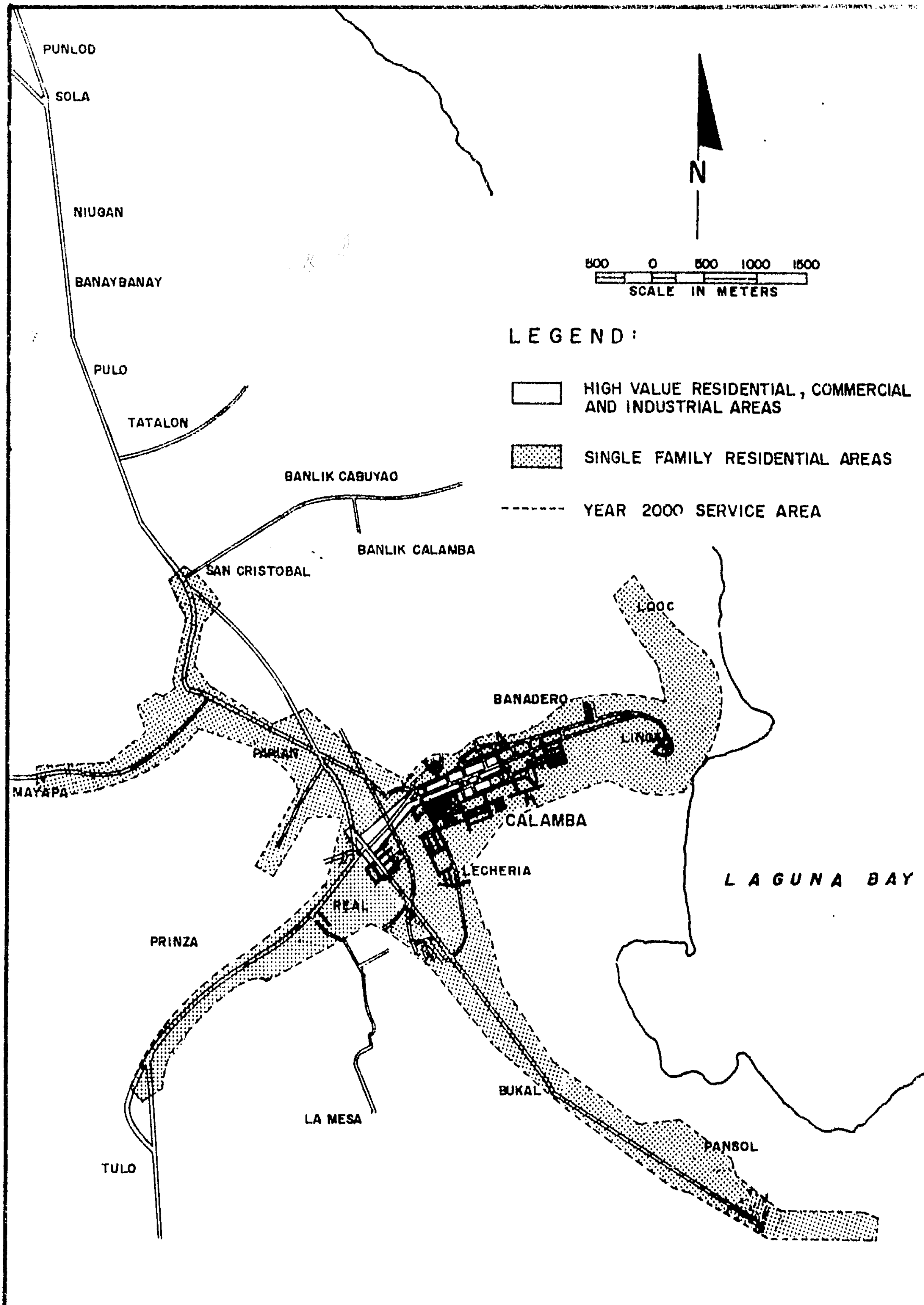
In the immediate improvement program, full fire protection in the service area is not provided due to cost consideration. However, partial fire protection would be provided by the additional recommended improvements in the distribution system. Available fire flow at remote areas of the service area, Barrios Linga and Real, would be about 50 to 60 percent of the required flow for full fire protection. The existing fire hydrants would have to be repaired to obtain fire flow by 1980.

Full fire protection is not a design target for the 1990 distribution system. However, since by 1990 all existing pipelines would have been replaced, available fire flow in almost all areas, except at extreme limits of Barrios Real and Mayapa, is more than the specified requirement for fire protection. Barrio Mayapa and the extreme limits of Barrio Real would have an available flow of 50 and 70 percent, respectively, of required flow for full fire protection.

The proposed system for year 2000 would provide full fire protection in all parts of the city except Barrio Sucol and the extreme limits of Barrio Real where fire flow alone is 5 to 8 times the peak-hour flow. Partial fire protection equal to 20 and 30 percent, respectively, of the required fire flow for those barrios would be provided. Additional costs of providing full fire protection in these areas are presented on Table VIII-7.

System Operation

This section includes various operational aspects of the alternative distribution systems.



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS **LWUA-CDM**

FIGURE VIII-1
FIRE PROTECTION AREAS
CALAMBA WATER DISTRICT

TABLE VIII-7

ADDITIONAL PIPELINE COSTS IN 2000

Length (m)	Size for Partial Protection (mm)	Size for Full Protection (mm)	Additional Cost (₱)
2,150	150	200	₱ 129,000
2,000	100	200	290,000
	Sub-total		419,000
	Contingencies (15%)		63,000
			482,000
	Engineering (10%)		48,000
	Total Cost		₱ 530,000

The CAL-WD water supply system is a relatively simple system to operate, considering that it would have only a single source, Bucal Spring, for 1990 and 2000. From the present until the early 1980's, the existing well pumping station in Barrio Real would continue to be part of the CAL-WD system. The only operational consideration of the system is to meet the varying demands in the service area. The system operator would be responsible for deciding the number of pumps to be operated during any given period of the day.

Computer analysis of the 1980 system conditions was conducted to determine the effect if the Crossing well pumping station becomes inoperative. The analysis indicated that under this condition, the distribution system could meet average-day and maximum-day demands with adequate pressures throughout the service area.

Internal Network

A general but complete discussion of the internal network for distribution systems is included in Appendix K. The small size of the CAL-WD does not affect the application of the recommendations contained in Appendix K since these are the minimum pipeline sizes recommended for any municipality.

E. ALTERNATIVES FOR WATER CONSERVATION AND AUGMENTATION

In areas where water is a scarce resource, there are several alternative methods of conserving water. These alternatives depend on sophisticated technology in the case of water reuse and desalting or on governmental policy in the case of land management. Appendix M, Volume II is a discussion of these conservation and augmentation alternatives.

CHAPTER IX DESCRIPTION AND COST OF THE RECOMMENDED PLAN

A. GENERAL

This chapter describes the immediate improvement program, and the first and second stages of the long-term construction program. In addition, the capital and operation and maintenance costs of the recommended program, concepts concerning sewerage and drainage, comments regarding the management of water resources and a statement regarding the environmental impact of this project are included. Appendices F, G, N and O, Volume II, contain discussions of Design Criteria, Basis of Cost Estimates, Construction Methods and Materials, and Outline Specifications, respectively. The recommended construction program consists of the following five implementation steps:

1. Immediate Improvement Program (1978-79)
2. Stage I Phase A of the Long-Term Construction Program (1980-85)
3. Stage I Phase B of the Long-Term Construction Program (1986-90)
4. Stage II Phase A of the Long-Term Construction Program (1991-95)
5. Stage II Phase B of the Long-Term Construction Program (1996-2000)

Source

The present source of water supply to CAL-WD is the Bukal Spring, approximately 3 km south of the Calamba Poblacion and the Crossing well near the poblacion. Bukal Spring serves the community via an existing pipeline consisting of 200 and 150-mm diameter pipes. The total measured discharge of Bukal Spring is about 96,000 cumd, with approximately 1,500 cumd flowing into the CAL-WD system, while the Crossing well currently discharges about 1,500 cumd. The spring will be utilized as a water supply source for the water district and will be adequate to provide projected maximum-day demand well past the year 2000, at which time maximum-day demand is expected to be about 19,420 cumd.

Storage

CAL-WD currently utilizes an existing 380 cum ground-level covered concrete storage tank located 150 meters southwest of the Bukal pump station. The storage tank was constructed in 1926. It is recommended that the existing storage tank be retained in service until 1991. At that time the existing tank will be abandoned and a 2,000 cum ground-level reinforced concrete storage tank will be constructed on Lecheria Hill. This will provide adequate storage to meet system demand until 1995 at which time an additional 700cum of storage will be constructed at the same location to meet year 2000 requirements.

Transmission-Distribution System

The existing transmission conduit from Bukal Spring to Calamba Poblacion consists of 1.6 km of 200 mm and 1.3 km of 150-mm pipeline. During the immediate improvement program a portion of the existing 150-mm pipeline near the poblacion will be abandoned; a portion of the existing 150-mm pipeline near Lecheria Hill will be replaced; and the 200-mm section from Lecheria Hill to Bukal Spring will be retained.

During Phase I-A the existing transmission pipeline route will be abandoned. The transmission pipeline to be installed during this phase will follow the alignment of the Los Baños Road from Bukal Spring to the Ramon Santos Street intersection, subsequently following Ramon Santos Street to the poblacion.

Subsequent additions or reinforcements to the transmission system will be along Ramon Santos Street or along the Manila Road.

The system of existing distribution pipelines will be replaced by 1990. In addition, barrios Mayapa, P. Rizal and Sampiruhan will receive service from distribution system extensions between 1980 and 1990. Similarly, barrios Looc, Sucol, San Cristobal and Prinza will receive service between 1990 and 2000. Approximately 27.2 km of 100 to 450-mm diameter pipelines will be installed before 1990, with an additional 11.9 km to be installed between 1990 and 2000. These pipelines do not include internal network pipelines which will be constructed throughout the entire program.

All distribution and other recommended facilities are shown in Figure IX-1 (appended).

Administrative and Other Service Facilities

In addition to the source and distribution facilities required for the production and transportation of water to consumers, it will be necessary to provide other facilities to improve administrative, operation, maintenance and quality control capability within the water district. The operational capabilities of the CAL-WD will be significantly increased by the construction of a new administration building and plumbing shop during Phase I-A. These facilities will be provided with furniture, appliances, equipment and tools required to efficiently handle the administrative and technical aspects of a new and rapidly expanding organization. It has been assumed that an arrangement will be made to meet the water meter repair and laboratory requirements of CAL-WD by sharing the relatively larger facilities of other nearby water districts, such as San Pablo or Lipa City.

Design Considerations

The recommended program of pipe construction described in this chapter reflects the results of successive computer analyses of the CAL-WD distribution system. The general design criteria and methods of analysis are discussed in Appendix K of Volume II and Chapter XII of the Methodology Manual, respectively.

The method of selecting pipeline sizes consists of analyzing each pipe under the anticipated future hydraulic conditions. Since each computer analysis is critical to a different series of pipes, there is no single program result that can be included herein as a "design run".

The computer printouts for the peak-hour and minimum-hour conditions are included in Annex IX-C as representative of the worst conditions for pipe design. The peak-hour condition can, in general, be considered as the "design run" for the majority of pipes. However, certain variations in operational modes can be more critical for some pipelines.

During the design of the recommended facilities, it is imperative that the design engineer re-run the computer program to determine the critical conditions for each pipeline to be designed. It is also important to revise the program during each design phase to take into account the actual system conditions at that time. It is recommended that a new series of hydraulic studies be conducted on the distribution system after some improvements have been completed and the system operates with adequate pressures 24 hours a day. The results of the additional studies can be incorporated into any future designs. Additional considerations to update this report are discussed in Appendix Q, Volume II.

In some cases facilities included in the last phases of construction are only designed for a short term, to the year 2000. These facilities are included in the cost analyses of this study to determine the economic impact on the overall program. However, from a technical point of view, they may not be the most practical or economical facilities to construct. During the design of the last phases of the construction program, the design engineers should study alternatives beyond the year 2000 and design facilities accordingly.

B. IMMEDIATE IMPROVEMENT PROGRAM

While the findings and recommendations of this report are being reviewed, pending their approval by the CAL-WD, LWUA and financial agencies, certain steps may be taken to facilitate immediate improvements in the CAL-WD water supply system. These "high-impact" improvements will provide improved service to existing consumers and additional service to a limited number of new connections to the system, before implementation of the initial phase of the long-term construction program.

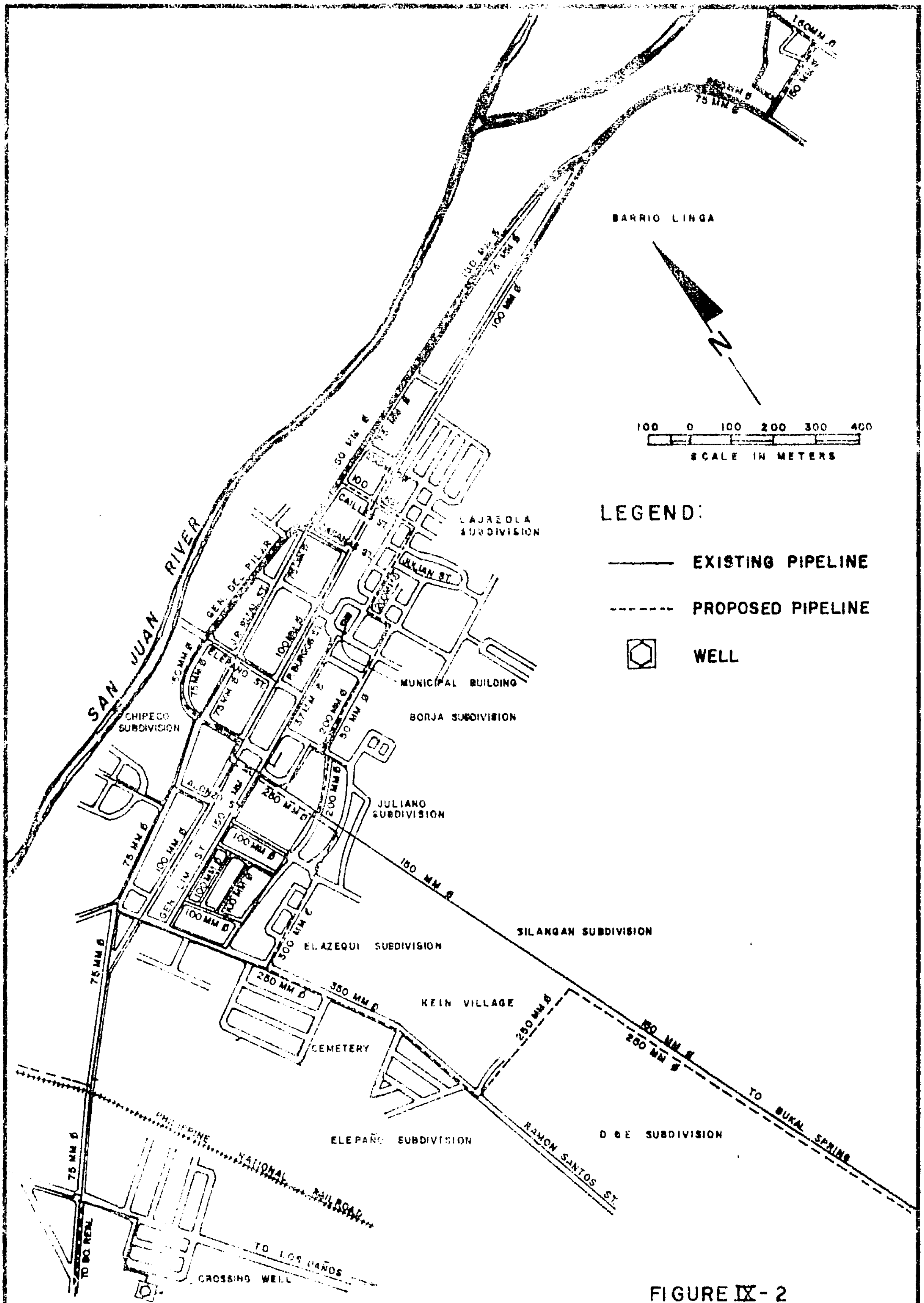
As discussed in Chapter IV, the existing system has many deficiencies and some corrective measures are recommended in the immediate improvement program.

The immediate improvement program will improve and increase water supply service primarily by the addition of sources, transmission and distribution facilities. The program will consist of the following:

1. The provision of additional pumping equipment at the Bukal pump station.
2. The installation of about 9.65 km of transmission and distribution mains with diameters ranging from 100 to 350 mm.
3. The initiation of an extensive leakage detection survey and repair program.
4. The addition of full-time reliable disinfection facilities at the Crossing well to provide an initial concentration of 2.0 mg/l of chlorine in nearby distribution pipes.
5. The addition of 824 service connections within the service area, as well as provision of meters for 1,098 existing service connections, and major repairs to about 30 percent of existing service connections.
6. The provision of office equipment and plumbing tools and other appurtenant equipment to upgrade the water district's operational capabilities.
7. New distribution pipelines will be installed as shown in Figures IX-2 and IX-6 and listed in Table IX-1.
8. Repairs will be made to the existing 380 cum reinforced concrete storage tank located in Barrio Bukal.

Additional source facilities will be provided at the existing Bukal Spring pump station and the Crossing well. A new pump set will be installed in the existing Bukal pump station to provide sufficient additional pumping capacity (2,800 cumd) to meet expected peak hour demand in 1982 (5,800 cumd). In addition, chlorination facilities will be provided at the Crossing well.

The pipelines recommended for construction during the immediate improvement program consist of 9.65 km of 100 to 350-mm pipes. This includes replacement of 770 meters of existing transmission main east



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM

FIGURE IX-2
IMMEDIATE IMPROVEMENTS
CALAMBA WATER DISTRICT

TABLE IX-1

DISTRIBUTION PIPELINES
IMMEDIATE IMPROVEMENT PROGRAM

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
105	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	350	40
106	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	350	190
107	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	350	150
108	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	350	150
			530
109	South of Elazequi Subdivision	300	340
			340
103	Existing Bukal Pipeline from Lecheria Road	250	770
104	Lecheria Road	250	240
131	Lopez Jaena St. - P. Burgos St. to South of Elazequi Subdivision	250	140
132	Lopez Jaena St. - P. Burgos St. to South of Elazequi Subdivision	250	80
133	Lopez Jaena St. - P. Burgos St. to South of Elazequi Subdivision	250	70
134	Lopez Jaena St. - P. Burgos St. to South of Elazequi Subdivision	250	70
136	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	250	50
			1,420
101	Bukal Spring to Bo. Pansol	200	1,500
117	Rizal/Burgos Intersection to Bo. Linga	200	380
121	Lopez Jaena St. to Mabini St. South of Gen. Lim St.	200	320
122	Lopez Jaena St. to Mabini St. South of Gen. Lim St.	200	130
123	Mabini St. near Public Market	200	220
124	Cailles St. South of P. Burgos St.	200	110
			2,660
110	Lopez Jaena St. - P. Burgos St. to J. P. Rizal St.	150	100
111	Del Pilar St. - J. P. Rizal St. to Elepaño St.	150	200

TABLE IX-1 (Continued)

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
112	Del Pilar St. - Elepaño St. to Casañas St.	150	360
113	J. P. Rizal St. - Casañas St. to Cailles St.	150	120
114	J. P. Rizal St. - Cailles St. to Mabini St.	150	110
115	J. P. Rizal St. - Mabini St. to Bo. Palingon	150	400
116	J. P. Rizal St. - Mabini St. to Bo. Palingon	150	460
118	Bo. Linga	150	100
119	Bo. Linga	150	380
120	Bo. Linga	150	150
126	Bo. Parian from road to Bo. Real	150	260
127	Bo. Parian from road to Bo. Real	150	400
128	Bo. Prinza near Manila Road	150	400
129	Bo. Prinza near Manila Road	150	400
130	To Bo. Real from Manila Road	150	650
135	Gen. Lim St. from Lope Jaena St.	150	650
	to Elazequi Subdivision	150	110
			4,600
125	Cailles St. - J. P. Rizal St. to P. Burgos St.	100	100
			100
		Total	9,650

of Lecheria Hill; provision of 240 meters of new pipeline along the north side of Lecheria Hill; provision of 530 meters of new pipeline along Ramon Santos Street; provision of a reinforcing trunk main along Lopez Jaena, del Pilar and J. P. Rizal Streets; provision of a major distribution loop south of Silangan and Juliana subdivisions; and provision of new pipelines to barrios Real, Farian and Pansol.

It has been observed that vegetal roots have intruded through the wall of the existing storage tank. The root mass is growing over nearly an entire quadrant of the wall, with actual perforation of the wall covering approximately 10 percent of the quadrant. It has been assumed that repairs will be made to this tank by removing the roots and filling the resulting holes and cracks with epoxy grout. This will permit utilization of the tank until about 1991. Because of its extreme age (constructed in 1926), and its relatively great distance from the center of demand, this storage tank is not expected to provide service beyond 1991.

The provision of additional water at increased pressures on a 24-hour basis will tend to increase the current levels of leakage and wastage. It is, therefore, imperative that an extensive program of leakage and wastage surveys and associated system repairs be undertaken during the immediate improvement program.

The existing 1,098 service connections will be provided with water meters. Of these, 30 percent (329) will receive major repair, or be replaced. In addition, 824 new service connections will be installed by 1979. By 1980, 31 percent of the total population within the 1980 service area will receive service from the CAL-WD.

The operational capabilities of the CAL-WD will be significantly increased by provision of office equipment, plumbing tools, a vehicle and other miscellaneous items (i.e. waterworks publications, chlorine residual analyzers and minor repair items).

Table IX-2 presents a breakdown of costs (July 1978 price levels) for the immediate improvement program. The total project cost, including contingencies and engineering, is ₱5.12 million, with a foreign exchange component (FEC) of ₱2.95 million.

TABLE IX-2

COST SUMMARY-IMMEDIATE IMPROVEMENTS

Item	Cost (₱)[1/] Local	Foreign[2/]	Total
Source Facilities			
(Additional Pumpset in Existing Pump Station)			
Materials and Equipment	-	32,000	
Civil and Structural	6,000	-	
(Install Chlorination Facilities at Existing Crossing well)			
Materials and Equipment	2,400	17,300	
Civil and Structural	-	-	
	8,400	49,300	57,700
Storage Facilities			
(Repair Bo. Bukal Storage Tank)			
Materials and Equipment	-	11,200	
Civil and Structural	8,800	-	
	8,800	11,200	20,000
Distribution Facilities			
(Leakage Detection and Repair)			
Materials and Equipment	4,000	8,800	
Civil and Structural	18,000	74,800	
(530 m x 350 mm)			
Materials and Equipment	29,700	207,800	
Civil and Structural	109,200	-	
(340 m x 300 mm)			
Materials and Equipment	28,900	102,700	
Civil and Structural	49,300	-	
(1,420 m x 250 mm)			
Materials and Equipment	82,400	312,400	
Civil and Structural	171,800	-	
(2,660 m x 200 mm)			
Materials and Equipment	85,100	335,200	
Civil and Structural	226,100	-	
(4,600 m x 150 mm)			
Materials and Equipment	101,200	400,200	
Civil and Structural	335,800	-	

[1/] Based on 1978 price levels.

[2/] U.S. $1.0 = ₱7.0

TABLE IX-2 (Continued)

Item	Cost (₱) Local	Foreign	Total
(100 m x 100 mm)			
Materials and Equipment	400	4,000	
Civil and Structural	5,300	-	
(Valves)			
Materials and Equipment	14,300	55,400	
Civil and Structural	17,400	-	
	1,278,900	1,501,300	2,780,200
Sub-Total[3]			
Materials and Equipment	348,400	1,487,000	1,835,400
Civil and Structural	947,700	74,800	1,022,500
	1,296,100	1,561,800	2,857,900
Service Connections			
(1,098 Conversions)			
Materials and Equipment	-	213,000	
Civil and Structural	39,500	-	
(329 Replacements)			
Materials and Equipment	7,900	95,400	
Civil and Structural	95,700	-	
(824 New Connections)			
Materials and Equipment	19,800	398,800	
Civil and Structural	269,400	-	
	432,300	707,200	1,139,500
Administrative and Miscellaneous			
(Equipment for Administrative Facilities and Tools for Plumbing Shop - separate buildings to be provided during Phase I-A)			
Materials and Equipment	20,000	69,000	
Civil and Structural	-	-	
(Miscellaneous Items - publications, minor repair items and chlorine residual analyzers)			
Materials and Equipment	5,000	7,000	
Civil and Structural	-	-	
(Vehicle - van or pick-up type)			
Materials and Equipment	30,000	30,000	
Civil and Structural	-	-	
	55,000	106,000	161,000

[3] Contingencies and engineering costs for these items are calculated @ 15 percent and 10 percent, respectively.

TABLE IX-2 (Continued)

Item	Cost (₱) Local	Foreign	Total
Sub-Total[4/]			
Materials and Equipment	82,700	813,200	895,900
Civil and Structural	404,600	-	404,600
	487,300	813,200	1,300,500
Total Construction Cost			
Materials and Equipment	431,100	2,300,200	2,731,300
Civil and Structural	1,352,300	74,800	1,427,100
	1,783,400	2,375,000	4,158,400
Contingencies			
@ 15%	194,400	234,300	428,700
@ 10%	48,700	81,300	130,000
Sub-Total	2,026,500	2,690,600	4,717,100
Engineering[5/]			
@ 10%	115,000	213,700	328,700
@ 5%	25,000	46,500	71,500
Total Project Cost	2,166,500	2,950,800	5,117,300

4/ Contingencies and engineering costs for these items are calculated @ 10 percent and 5 percent, respectively.

5/ Consists of 65 percent foreign exchange based on recent similar projects.

C. FIRST STAGE OF THE LONG-TERM CONSTRUCTION PROGRAM (1980-90)

The first stage of the recommended construction program, including source development, pipelines, internal network, service connections and administrative and plumbing facilities, will be implemented in two construction phases. The first construction phase will be implemented between 1980 and 1985, and the second, between 1986 and 1990.

Source development to take place during the first construction stage will include improvements to the intake structure at Bukal Spring, reconstruction of the Bukal pump station, construction of chlorination facilities at the Bukal pump station and provision of pumping equipment at the Crossing well.

During this stage transmission/distribution pipelines will be constructed along the Los Baños-Manila road from Barrio Bukal to Barrio Mayapa. An additional main pipeline will be provided along J. P. Rizal Street, in the poblacion, and distribution system reinforcements will be constructed within the poblacion. Existing facilities will be incorporated into the recommended scheme to the maximum extent practical. Existing distribution system pipelines were constructed more than 50 years ago, are in poor condition, and will be replaced during this construction stage.

The existing 380-cum storage tank located in Barrio Bukal is also more than 50 years old. However, it will be retained in service until 1991, at which time additional storage facilities will be constructed at Lecheria Hill and the existing tank will be abandoned.

CONSTRUCTION PHASE I-A (1980-85)

Source Development

During Phase I-A improvements to the existing Bukal Spring intake structure will be made; the Bukal pump station will be reconstructed; and new pumping equipment will be installed at the Crossing well.

The existing reinforced concrete spring intake structure, located along the Los Baños-Manila road opposite the Bukal pump station, serves to capture flows from Bukal Spring as they emerge through the existing road embankment. The structure serves as a suction chamber for the existing Bukal pump and is connected to the pump via a 200-mm suction pipe which passes under the intervening roadway. Extensive leakage occurs under the walls of the intake structure, with consequent loss of head possibly in excess of 1.2 meters. It is recommended that repairs and alterations of this facility be made including placement of steel sheet piling around the downstream periphery of the structure, pouring and bonding of a concrete wall between the sheet piling and existing structure, and provision of two 450-mm suction pipes from the structure to the pump station. These modifications will extend the useful life of the intake structure beyond the year 2000.

The existing Bukal pump station was constructed in 1926, and is currently in very poor condition. It is recommended that a new pump station be constructed on the same site during this construction phase. Several alternative pump station locations were reviewed during the course of this study including 1) at the southeastern extremity of the existing spring pool, where several squatter houses are currently located; 2) on the northeastern side of the PNR railway line, opposite the existing pump station, where landfill of rice paddies would be required; and 3) atop the existing spring intake structure, where the strength of the structure and potential traffic hazards would have to be considered. These alternative pump station sites are indicated in Figure IX-3. The site of the existing pump station is recommended, but should be reviewed in detail during the final design of the pump station. The cost of this pump station includes all required piping, valves, meters and appurtenances. Existing pumping equipment will be incorporated, with additional pumping equipment to be installed as necessary to meet peak-hour demands to 1986 (see Figure IX-4) when additional equipment will be required. The pump station itself will be adequate to meet system demands until 1995, when modifications will be required.

A separate chlorination building will be constructed during this phase, adjacent to the proposed pump station. This facility will include all required chlorinators, scales, ejectors, meters, miscellaneous piping and valves and storage space to meet projected requirements until 1991, when additional facilities will be required. The existing chlorinator will be incorporated into the proposed facilities or installed at the Crossing well.

The existing pumpset installed at the Crossing well is currently producing approximately 20 lps against an average discharge pressure of 1.76 meters. A new pumpset will be required to produce the same quantity of water (no increase is anticipated due to the age and uncertain condition of the well) against a discharge pressure of about 40 meters. It is anticipated that this well will be utilized until 1985, when it will be abandoned.

The improvements and additions to source facilities to be implemented during Phase I-A will provide sufficient flow capacity

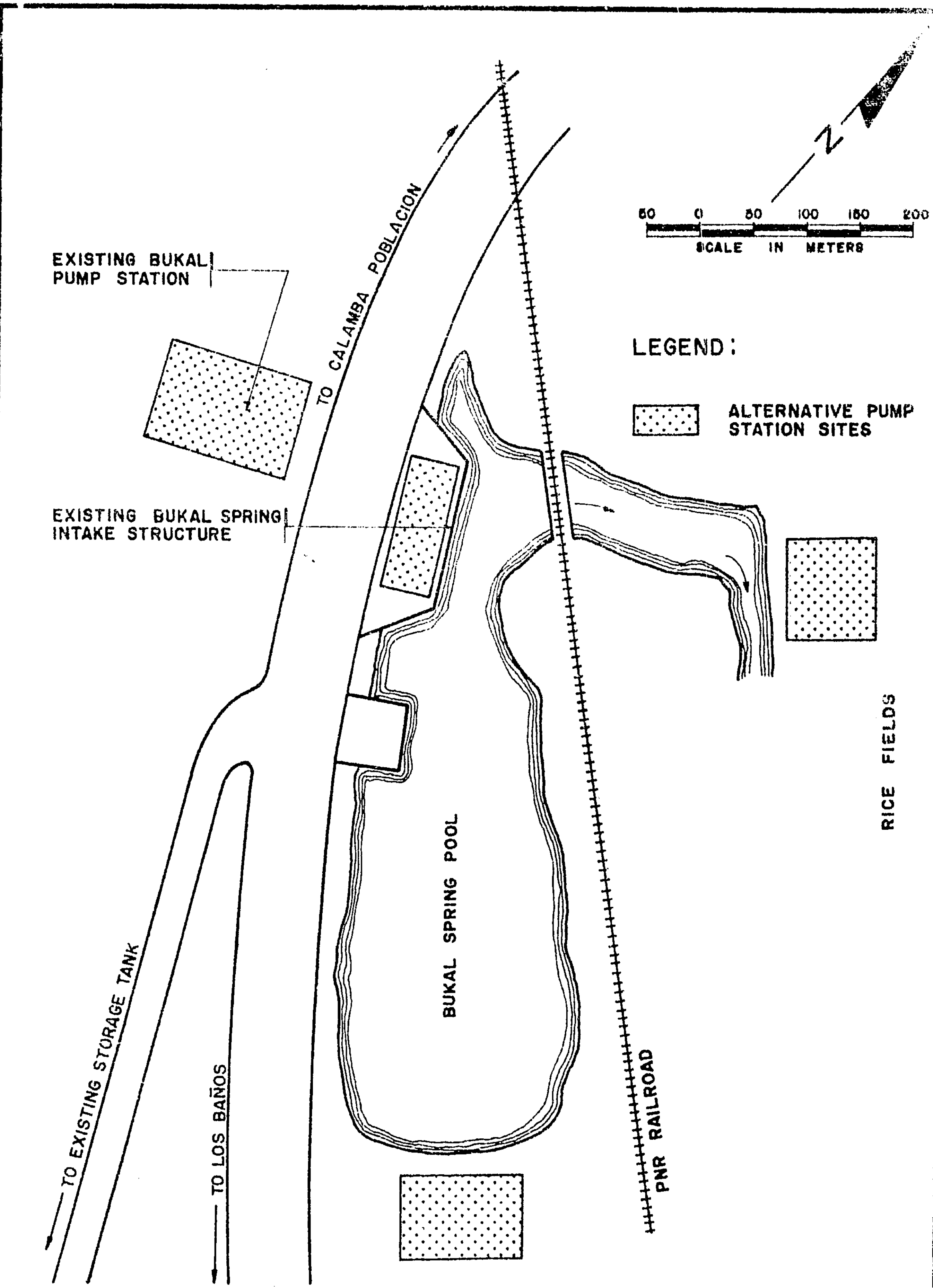


FIGURE IX - 3
PLAN OF BUKAL SPRING AREA
CALAMBA WATER DISTRICT

to meet projected demands until 1986, when additional facilities will be required (see Figure IX-4).

Storage Facilities

During the alternative studies previously discussed in Chapter VIII, it was found to be most economical to supply peak-hour demand directly from the source facilities at the Bukal pump station, until 1991. During the period from 1980 to 1991, the existing storage tank will be utilized to meet emergency conditions and to provide additional capacity to meet minor variations in projected peak demands. After 1991, it becomes more economical to supply projected maximum-day demands from Bukal pump station and to supply the difference between maximum-day and peak-hour demands from storage facilities to be constructed at Lecheria Hill by 1991.

Transmission/Distribution Facilities

During Phase I-A, 9.94 km of 100 to 450-mm diameter pipelines will be constructed. About one-half of existing pipelines will be replaced during this phase. The total length of pipelines to be installed consists of 4.56 km of reinforcements (or replacements) to the existing system and 5.38 km of additional pipelines. The subject pipelines are listed in Table IX-3 and shown in Figures IX-5, IX-6 and IX-1 (appended).

These pipelines will provide reinforcement to the existing pipelines in the vicinity of Bukal pump station; a new "transmission route" from the pump station along the Los Baños-Manila road to the Ramon Santos Street intersection (the existing 200-mm pipeline upstream of Lecheria Hill will be abandoned); an additional "trunk" main along P. Burgos Street from the Manila Road to Barrio Palingon; additional distribution pipes in Elazequi Subdivision; and service to Barrios Real and Sampiruhan and Elepaño Subdivision.

All proposed pipelines will be furnished with required specials, air/vacuum relief valves, isolation valves and necessary appurtenances.

Internal Network

It has been estimated that by 1980 approximately 131 hectares within the poblacion and barrios San Juan, San Jose, Lecheria, Halang, Bukal, Pansol, Real, Linga, Palingon and Parian will be served by internal network or equivalent distribution system piping. During Phase I-A it is proposed that an additional 149.9 hectares of internal network be installed. This, together with approximately 40.1 hectares to be served by distribution pipes installed during this phase, will bring the total area served with equivalent internal network to 321 hectares, about 64 percent of the 1990 service area.

TABLE IX-3

PHASE I-A PIPELINES

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
	Reinforcement Pipelines		
403	Bo. Bukal to Calamba	450	180
			180
401	Bukal pump to existing line from reservoir	400	30
			30
407	Crossing well to Bo. Real Road	300	140
			140
474	Silangan Subdivision	250	80
			80
402	From existing reservoir to Bukal pump discharge	200	100
408	Manila Road from road to Bo. Real	200	100
409	Bo. Real from Manila Road	200	280
410	Bo. Real Road to Rizal/Burgos St. Intersection	200	230
428	P. Burgos St. - Rizal St. Inter-section to Belarmino St.	200	140
431	P. Burgos St. - Belarmino St. to T. Alonzo St.	200	310
433	P. Burgos St. - T. Alonzo St. to Lopez Jaena St.	200	150
435	P. Burgos St. - Lopez Jaena St. to Elepaño St.	200	160
437	P. Burgos St. - Elepaño St. to Casañas St.	200	340
439	P. Burgos St. - Casañas St. to Cailles St.	200	130
440	P. Burgos St. - Cailles St. to Mabini St.	200	100
442	P. Burgos St. - Mabini St. to Rizal St. Intersection	200	830
459	Ramon Santos St. - west of Elazequi Subdivision	200	150
			3,020
443	Gen. Lim St. (Elazequi Subdivision)	150	60
444	Gen. Lim St. (Elazequi Subdivision)	150	190
445	Gen. Lim St. (Elazequi Subdivision)	150	50
446	Gen. Lim St. (Elazequi Subdivision)	150	120
			420
449	Elazequi Subdivision	100	60

TABLE IX-3 (continued)

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
451	Elazequi Subdivision	100	60
454	Elazequi Subdivision	100	50
456	Elazequi Subdivision	100	50
461	Elazequi Subdivision	100	60
463	Elazequi Subdivision	100	60
465	Elazequi Subdivision	100	190
469	Silangan Subdivision	100	110
470	Silangan Subdivision	100	50
			690
		Sub-total	4,560
	New Pipelines		
102	Bo. Bukal - Los Baños Road to Calamba	450	700
201	Bo. Bukal - Los Baños Road to Calamba	450	180
202	Bo. Bukal - Los Baños Road to Calamba	450	760
			1,640
204	Ramon Santos St. from Los Baños Road	350	650
206	Ramon Santos St. from Lecheria Road	350	100
			750
213	Ramon Santos St. - Elazequi Subdivision	200	70
214	Ramon Santos St. - Elazequi Subdivision	200	80
215	Silangan Subdivision	200	160
			310
216	Bo. Sampiruhan	150	300
217	Bo. Real	150	1,500
			1,800
207	Elepaño Subdivision	100	130
208	Elepaño Subdivision	100	150
209	Elepaño Subdivision	100	130
210	Elepaño Subdivision	100	170
211	Elepaño Subdivision	100	120
212	Elepaño Subdivision	100	180
			880
		Sub-total	5,380
		Total	9,940

Areas adjacent to distribution system pipelines will receive service directly from these pipelines and have been deducted from the total internal network requirement. A description of internal network systems is presented in Appendix K, Volume II, with details of the installation schedule presented in Annex IX-C.

Service Connections

During Phase I-A, 1,926 new service connections will be installed within the poblacion and barrios San Juan, San Jose, Lecheria, Halang, Bukal, Pansol, Real, Linga, Palingon, Parian, and Sampiruhan, at a rate of 321 per year. In addition, the remaining 70 percent (769) of existing service connections, not repaired or replaced during the immediate improvement program, will receive major repairs or be replaced during this phase.

Details of service connection installation are presented in Annex IX-C.

Fire Protection

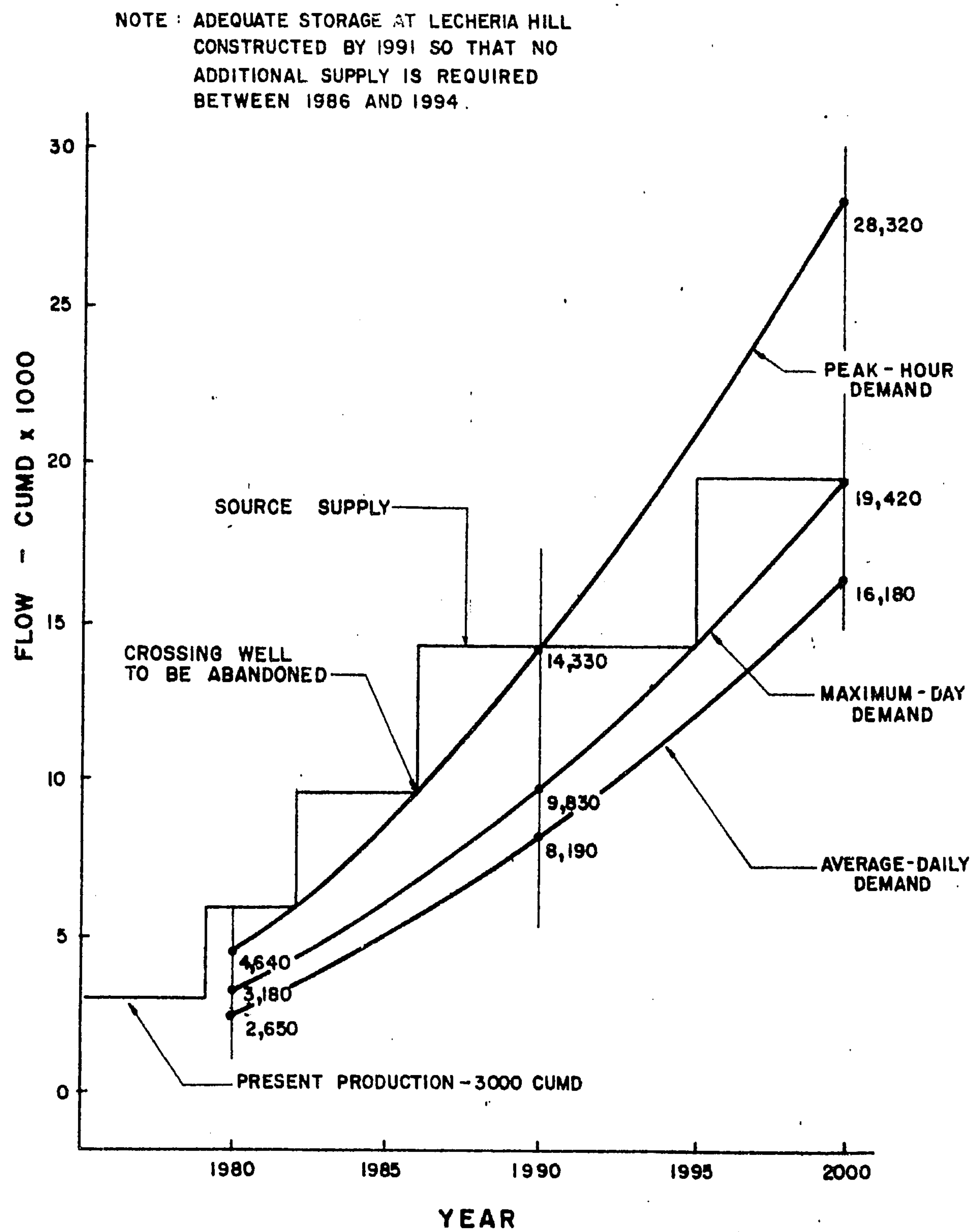
The details of fire hydrant installation are presented in Annex IX-C. During Phase I-A, 155.0 hectares within the service area will receive fire protection by the installation of fire hydrants. Most of this area will receive normal residential-type hydrant service, with only 12.3 hectares within the poblacion to receive a higher level of protection because of the higher property values associated with commercial areas. By 1985, approximately 21 percent of the area to be covered by the year 2000 will receive fire protection service.

Administrative and Plumbing Facilities

During the immediate improvement program, office equipment, plumbing tools and furniture would have been purchased to increase the administrative and operational capabilities of the water district. Because of the relatively high cost of new buildings and the relative adequacy of recently occupied rented office space, the construction of an administration building and plumbing shop has not been recommended during the immediate improvement program but would be deferred to a later time. During Phase I-A, both of these facilities will be constructed. Costs have been included in this report for the construction of buildings, each having 300 sqm of floor space, to house administrative and plumbing facilities. The costs of required land for this construction have also been included.

Water Meter Repair and Laboratory Facilities

For the efficient operation of the CAL-WD, it is considered essential that the water district have the capability to monitor the



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

FIGURE IX- 4
WATER SUPPLY / DEMAND CHART
CALAMBA WATER DISTRICT

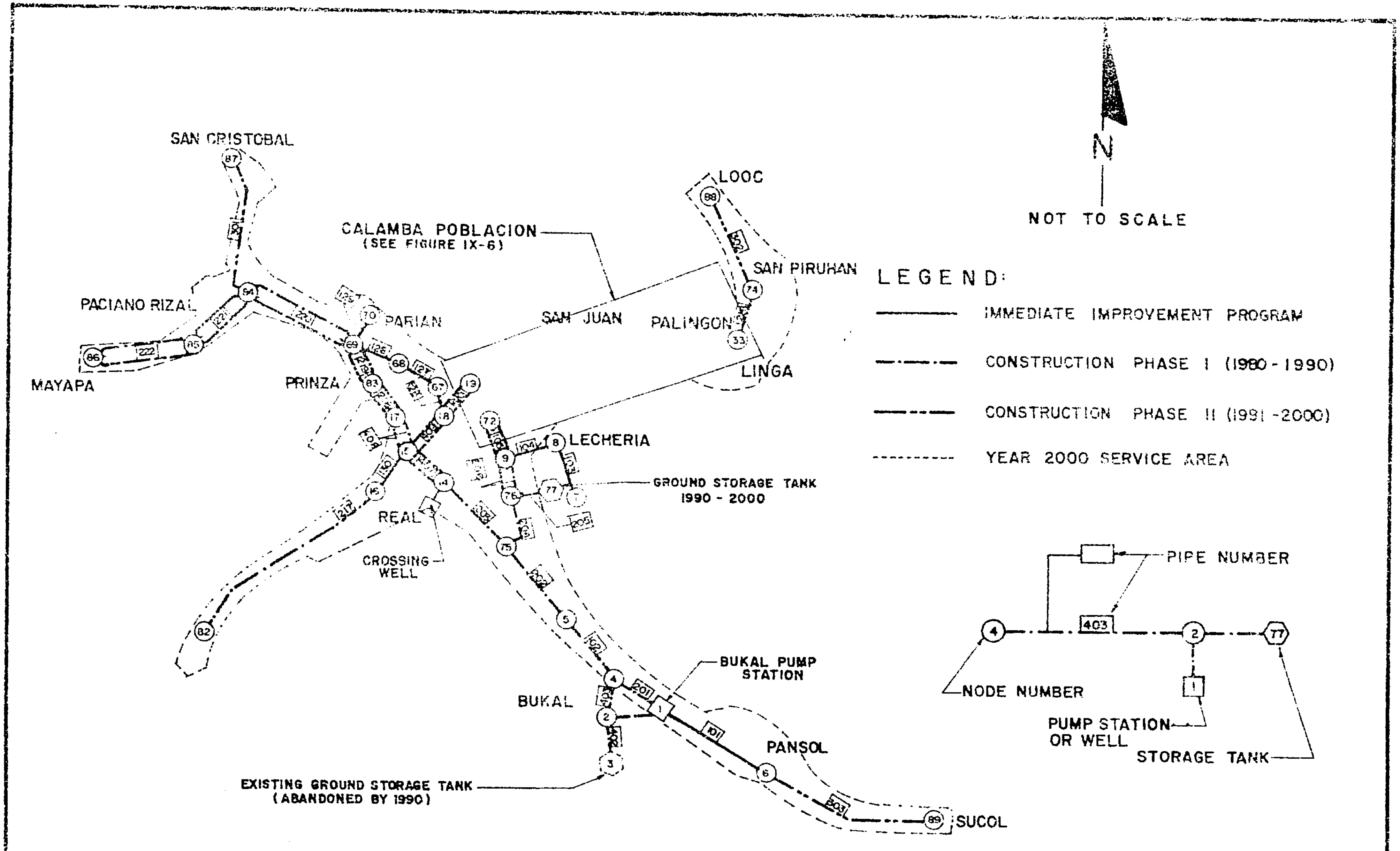
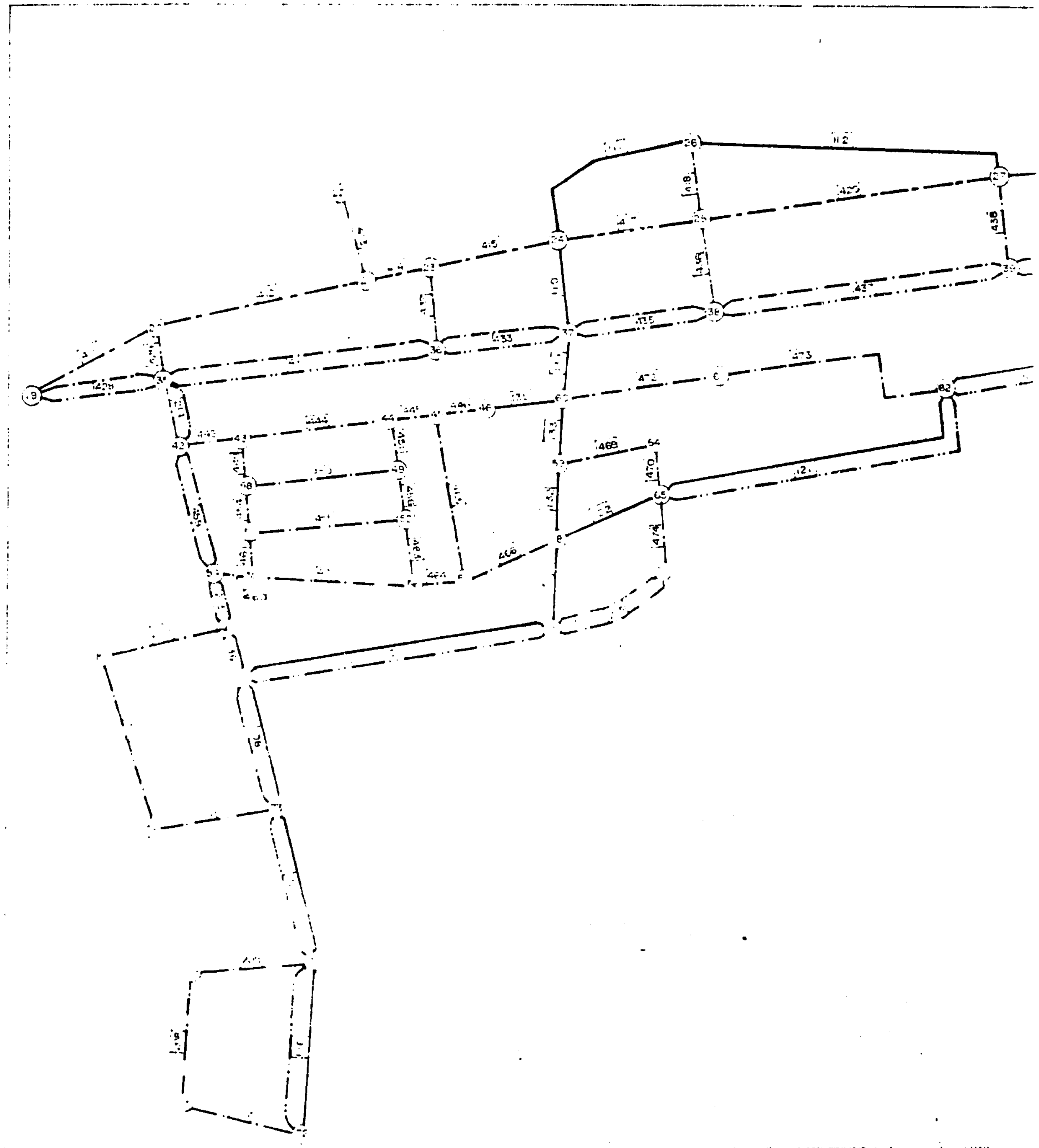
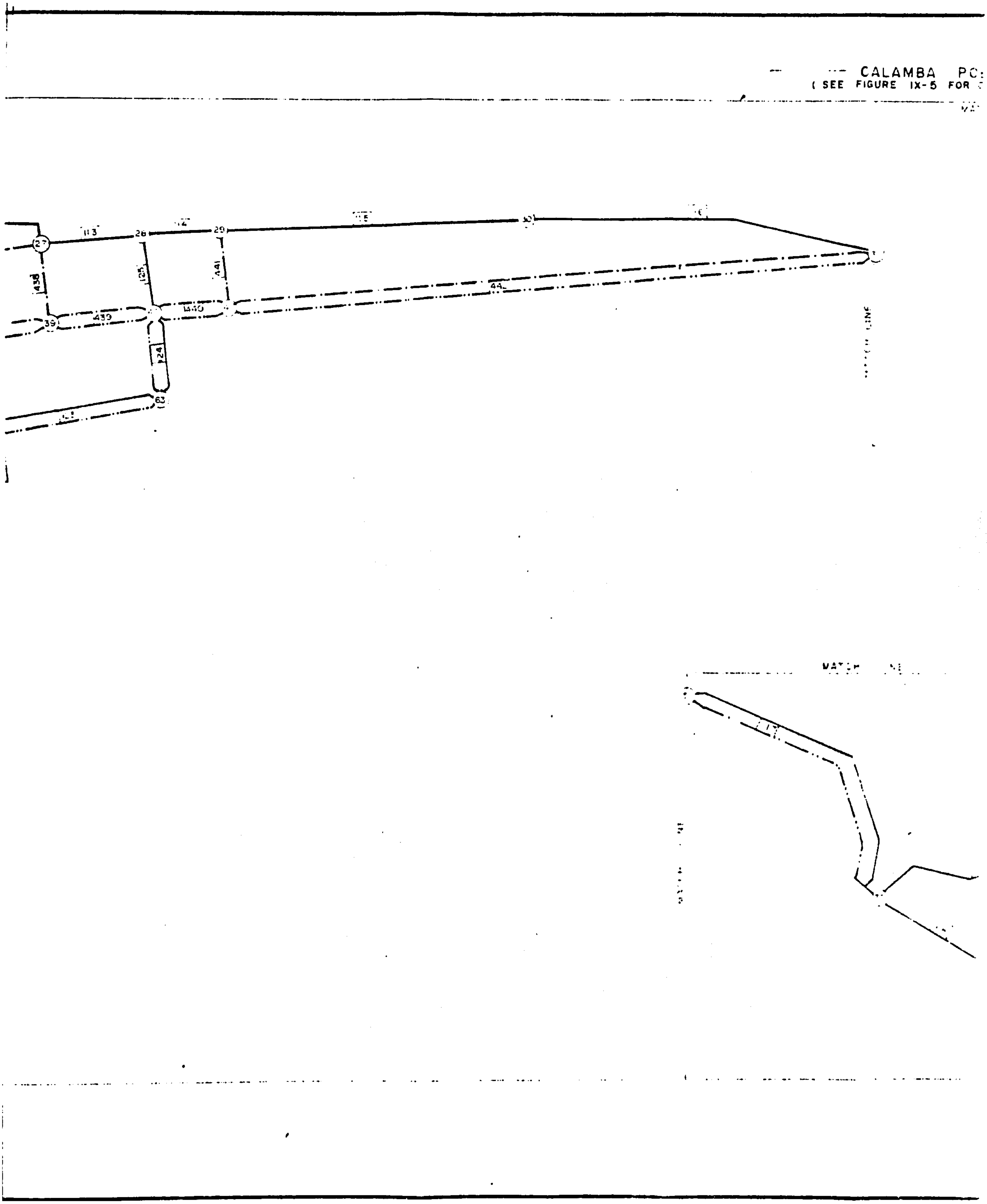


FIGURE IX-5
SCHEMATIC PLAN OF DISTRIBUTION SYSTEM
(OVERALL)
CALAMBA WATER DISTRICT



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM



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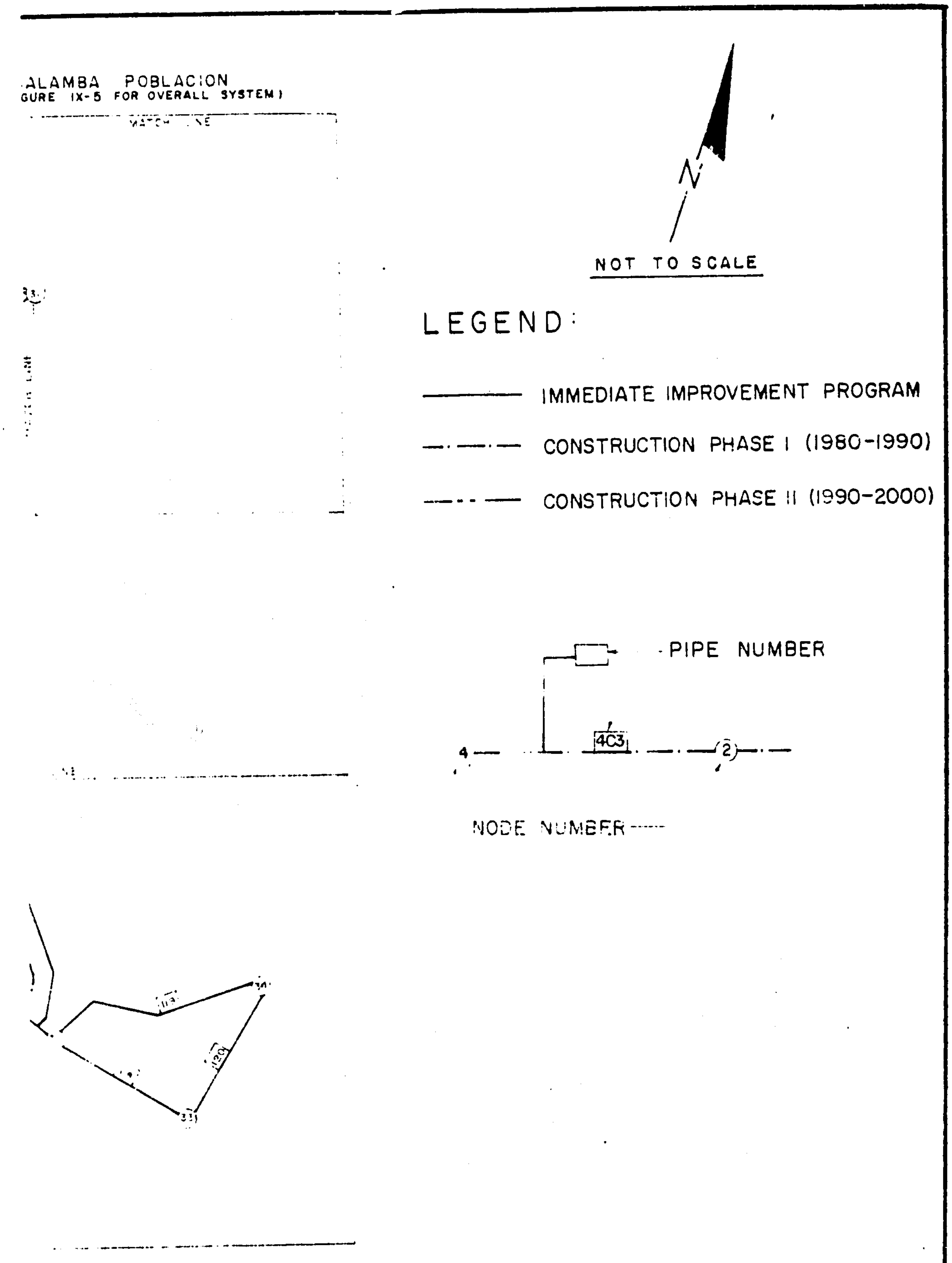

FIGURE IX-6
SCHEMATIC PLAN OF DISTRIBUTION SYSTEM
(POBLACION)
CALAMBA WATER DISTRICT

quality of water derived from its sources and distributed to consumers and to service and maintain the water meters installed throughout its system. Because of the relatively small size of the CAL-WD with respect to other nearby communities with similar needs, and to avoid a proliferation of smaller and probably less efficient facilities throughout the Philippines, it has been assumed that these facilities will not be provided within Calamba itself, but will be shared with larger communities, such as San Pablo or Lipa City.

An allowance, equivalent to Calamba's share of the cost of these shared laboratory and meter repair facilities, is included in the miscellaneous expenses tabulated for annual operation and maintenance costs presented in a subsequent section of this chapter.

Cost Summary: Phase I-A

The cost summary for proposed construction during Phase I-A is presented in Table IX-4. Based on 1978 price levels, the total project cost, including contingencies, engineering and land, is ₱13.38 million, with a foreign exchange component of ₱6.68 million, which includes direct and indirect import items. A cost breakdown, based on materials and equipment procurement and required civil and structural work, is also included. Materials and equipment considered in this breakdown include pipes, valves, pumpsets, water meters, hydrants and chlorinators.

TABLE IX-4

COST SUMMARY FOR CONSTRUCTION
STAGE I PHASE A

Item	Cost (₱)[6/] Local	Foreign[7/]	Total
Source Facilities			
(Intake Improvement)			
Materials and Equipment	17,700	132,300	
Civil and Structural	56,400	4,800	
(New Pump Station and Equipment)			
Materials and Equipment	90,000	851,900	
Civil and Structural	929,800	96,800	
(Chlorination Facilities)			
Materials and Equipment	4,200	39,400	
Civil and Structural	19,200	-	
(Pumpset for Crossing Well)			
Materials and Equipment	-	48,000	
Civil and Structural	3,000	-	
	1,120,300	1,173,200	2,293,500
Pipelines			
(1,820 m x 450 mm)			
Materials and Equipment	125,600	997,400	
Civil and Structural	484,100	-	
(30 m x 400 mm)			
Materials and Equipment	2,000	14,400	
Civil and Structural	7,600	-	
(750 m x 350 mm)			
Materials and Equipment	42,000	294,000	
Civil and Structural	154,500	-	
(140 m x 300 mm)			
Materials and Equipment	11,900	42,300	
Civil and Structural	20,300	-	
(80 m x 250 mm)			
Materials and Equipment	4,600	17,600	
Civil and Structural	9,700	-	
(3,330 m x 200 mm)			
Materials and Equipment	106,600	419,600	
Civil and Structural	283,000	-	
(2,220 m x 150 mm)			
Materials and Equipment	48,800	193,100	
Civil and Structural	162,100	-	
(1,570 m x 100 mm)			
Materials and Equipment	6,300	62,800	
Civil and Structural	83,200	-	
(Valves)			
Materials and Equipment	22,200	104,100	
Civil and Structural	31,500	-	
	1,606,000	2,145,300	3,751,300

6/ Based on 1978 price levels.

7/ U.S. $1.00 = ₱7.00.

TABLE IX-4 (Continued)

Item	Cost (₱) Local	Foreign	Total
Administrative Building and Plumbing Shop			
(Buildings Only)			
Materials and Equipment	-	-	
Civil and Structural	726,000	-	
	726,000	-	726,000
Sub-Total[8]			
Materials and Equipment	481,900	3,216,900	3,698,800
Civil and Structural	2,970,400	101,600	3,072,000
	3,452,300	3,318,500	6,770,800
Internal Network			
(149.9 ha)			
Materials and Equipment	91,300	713,100	
Civil and Structural	898,600	-	
	989,900	713,100	1,703,000
Service Connections			
(769 Replacements)			
Materials and Equipment	18,500	223,000	
Civil and Structural	223,800	-	
(1,926 New Connections)			
Materials and Equipment	46,200	932,200	
Civil and Structural	629,800	-	
	918,300	1,155,200	2,073,500
Fire Hydrants			
(155.0 ha)			
Materials and Equipment	41,300	140,700	
Civil and Structural	60,500	-	
	101,800	140,700	242,500
Sub-Total[9]			
Materials and Equipment	197,300	2,009,000	2,206,300
Civil and Structural	1,812,700	-	1,812,700
	2,010,000	2,009,000	4,019,000

[8] Contingencies and engineering costs for these items are calculated @ 15 percent and 10 percent, respectively.

[9] Contingencies and engineering costs for these items are calculated @ 10 percent and 5 percent, respectively.

TABLE IX-4 (Continued)

Item	Cost (₱) Local	Foreign	Total
Total Construction Cost			
Materials and Equipment	679,200	5,225,900	5,905,100
Civil and Structural	4,783,100	101,600	4,884,700
	5,462,300	5,327,500	10,789,800
Contingencies			
@ 15%	517,800	497,800	1,015,600
@ 10%	201,000	200,900	401,900
Sub-Total	6,181,100	6,026,200	12,207,300
Engineering 10/			
@ 10%	272,500	506,100	778,600
@ 5%	77,400	143,600	221,000
Sub-Total	6,531,000	6,675,900	13,206,900
Land 11/	172,000	-	172,000
Total Project Cost	6,703,000	6,675,900	13,378,900

10/ Consists of 65 percent foreign exchange based on recent similar projects.

11/ 1,400 sqm @ ₱80 sqm and 1,500 sqm @ ₱40/sqm.

CONSTRUCTION PHASE I-B (1986-90)

Source Development

During Phase I-B additional pumping equipment will be installed in the Bukal pump station constructed during Phase I-A. This pumping equipment will provide an additional 6,000 cumd of source capacity to the Calamba system. The resultant total source capacity (14,300 cumd) will be sufficient to meet projected 1991 peak-hour demand. However, the alternative studies discussed in Chapter VIII indicate that it is more economical to provide storage facilities at Lecheria Hill in 1991 to supply projected future peak-hour demands. Thus, after 1991 Bukal pump station will only be required to supply maximum-day demands and the equipment installed during Phase I-B will be adequate until 1995.

Transmission/Distribution Facilities

A total of 7.62 km of 100 to 350 mm-diameter pipelines will be constructed during Phase I-B, including 3.08 km of reinforcements (or replacements) and 4.54 km of additional pipelines. The remainder of existing pipelines, which were not replaced during Phase I-A, will be replaced during this phase. These additional pipelines are described in Table IX-5 and shown in Figures IX-5, IX-6 and IX-1 (appended).

The subject pipelines provide reinforcement along the western end of J. P. Rizal Street from the intersection with P. Burgos Street to Casañas Street; provide additional reinforcements within the distribution systems in the poblacion and Elazequi and Chipeco Subdivisions; and extend service along the Manila Road from the intersection with Ramon Santos Street through Barrios Halang, Parian, Prinza and P. Rizal to Barrio Mayapa.

Internal Network

During Phase I-B 38.3 hectares within previously served areas and Barrio Mayapa will receive internal network piping. Together with the 45.4 hectares served directly from distribution system pipelines installed during this phase, and 321 hectares served before 1986, the total area served with equivalent internal network by 1990 will be 404.7 hectares. This amounts to 81 percent of the total 1990 service area. Details of internal network installation are presented in Annex IX-C.

Service Connections

During Phase I-B 2,625 new service connections will be installed within the areas previously served and Barrios Mayapa and P. Rizal. Service connections will be installed at a rate of 525 per year. By 1990 there will be a total of 6,473 service connections within the area served by CAL-WD.

TABLE IX-5

PHASE I-B PIPELINES

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
	Reinforcement Pipelines		
459	Ramon Santos St. - West of Elazequi Subdivision	200	150
460	Elazequi Subdivision	200	60
462	Elazequi Subdivision	200	190
464	Elazequi Subdivision	200	50
			450
411	J. P. Rizal St. - Burgos St. Inter-section to Belarmino St.	150	150
412	J. P. Rizal St. - Belarmino St. to Chipeco Subdivision	150	240
414	J. P. Rizal St. - Chipeco Subdivision to T. Alonzo St.	150	70
415	J. P. Rizal St. - T. Alonzo St. to Lopez Jaena St.	150	150
417	J. P. Rizal St. - Lopez Jaena St. to Elepaño St.	150	160
420	J. P. Rizal St. - Elapaño St. to Casañas St.	150	340
472	Gen. Lim St. from Lopez Jaena St.	150	180
473	Gen. Lim St. from Public Market	150	220
			1,510
413	Chipeco Subdivision	100	100
418	Elepaño St. - Del Pilar St. to J. P. Rizal St.	100	90
429	Belarmino St. - J. P. Rizal St. to P. Burgos St.	100	60
432	T. Alonzo St. - J. P. Rizal St. to P. Burgos St.	100	100
436	Elepaño St. - J. P. Rizal St. to P. Burgos St.	100	100
438	Casañas St. - J. P. Rizal St. to P. Burgos St.	100	100
441	Mabini St. - J. P. Rizal St, to P. Burgos St.	100	100
450	Elazequi Subdivision	100	190
455	Elazequi Subdivision	100	190
466	Elazequi Subdivision	100	90
			1,120
		Sub-total	3,080

TABLE IX-5 (Continued)

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
	New Pipelines		
203	Los Baños Road - Bo. Halang	350	1,140
			1,140
218	Manila Road - Bo. Parian	200	350
219	Manila Road - Bo. Prinza	200	600
220	Manila Road to Bo. P. Rizal	200	1,250
221	Bo. P. Rizal	200	600
222	Bo. Mayapa	200	600
			3,400
		Sub-total	4,540
		Total	7,620

Details of service connection installation are presented in Annex IX-C.

Fire Protection

During Phase I-B 173.6 hectares within the service area will receive fire protection by installation of fire hydrants. A major portion of this area will receive normal residential-type hydrant service, with only 12.3 hectares within the poblacion to receive a higher level of protection because of the higher property values associated with commercial areas. By 1990, approximately 45 percent of the area to be covered by 2000 will receive fire protection service.

Cost Summary: Phase I-B

The cost summary for proposed construction during Phase I-B is presented in Table IX-6. Based on 1978 price levels, the total project cost, including contingencies and engineering, is ₱6.09 million, with a foreign exchange component of ₱3.40 million. Table IX-6 also shows a cost breakdown based on materials and equipment procurement and required civil and structural work.

D. SECOND STAGE OF THE LONG-TERM CONSTRUCTION PROGRAM (1991-2000)

The second stage of the recommended construction program, including source development, storage facilities, pipelines, internal network, service connections and fire protection, will be implemented in two construction phases. The first construction phase will be implemented between 1991 and 1995, and the second between 1996 and 2000.

Source development during the second construction stage will include expansion of the Bukal pump station. Work will include structural modifications to the pump station and provision of additional pumping equipment. These modifications will provide sufficient source capacity to enable the CAL-WD to meet projected maximum-day system demand until the year 2000.

In 1991, the existing 380-cum storage tank located in Barrio Bukal will be abandoned. During the second construction stage, 2,700 cum of ground-level storage tank capacity will be constructed at Lecheria Hill, to meet projected system peak-hour demands until the year 2000.

Pipeline construction during this construction stage will include 11.91 km of 100 to 350-mm diameter pipelines. Reinforcements

TABLE IX-6

COST SUMMARY FOR CONSTRUCTION
STAGE I PHASE B

Item	Cost (₱)[12] Local	Foreign[13]	Total
Source Facilities			
(Additional Pumping Equipment for Bukal Pump Station)			
Materials and Equipment	7,000	35,100	
Civil and Structural	4,200	4,200	
	11,200	39,300	50,500
Pipelines			
(1,140 m x 350 mm)			
Materials and Equipment	63,800	446,900	
Civil and Structural	234,800	-	
(3,850 m x 200 mm)			
Materials and Equipment	123,200	485,100	
Civil and Structural	327,200	-	
(1,510 m x 150 mm)			
Materials and Equipment	33,200	131,400	
Civil and Structural	110,200	-	
(1,120 m x 100 mm)			
Materials and Equipment	4,500	44,800	
Civil and Structural	59,400	-	
(Valves)			
Materials and Equipment	9,900	36,400	
Civil and Structural	11,500	-	
	977,700	1,144,600	2,122,300
Sub-Total[14]			
Materials and Equipment	241,600	1,179,700	1,421,300
Civil and Structural	747,300	4,200	751,500
	988,900	1,183,900	2,172,800
Internal Network			
(38.3 ha)			
Materials and Equipment	22,100	172,300	
Civil and Structural	217,300	-	
	239,400	172,300	411,700

[12] Based on 1978 price levels.

[13] U.S. $1.00 = ₱7.00.

[14] Contingencies and engineering costs for these items are calculated at 15 percent and 10 percent, respectively.

TABLE IX-6 (Continued)

Item	Cost (₱) Local	Foreign	Total
Service Connections (2,625 new connections)			
Materials and Equipment	63,000	1,270,500	
Civil and Structural	858,400	-	
	921,400	1,270,500	2,191,900
Fire Hydrants (173.6 ha)			
Materials and Equipment	48,800	166,100	
Civil and Structural	71,500	-	
	120,300	166,100	286,400
Sub-Total[15]			
Materials and Equipment	133,900	1,608,900	1,742,800
Civil and Structural	1,147,200	--	1,147,200
	1,281,100	1,608,900	2,890,000
Total Construction Cost			
Materials and Equipment	375,500	2,788,600	3,164,100
Civil and Structural	1,894,500	4,200	1,898,700
	2,270,000	2,792,800	5,062,800
Contingencies			
@ 15%	148,300	177,600	325,900
@ 10%	128,100	160,900	289,000
Sub-Total	2,546,400	3,131,300	5,677,700
Engineering[16]			
@ 10%	87,500	162,400	249,900
@ 5%	55,600	103,400	159,000
TOTAL PROJECT COST	2,689,500	3,397,100	6,086,600

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[15] Contingencies and engineering costs for these items are calculated at 10 percent and 5 percent, respectively.

[16] Consists of 65 percent foreign exchange based on recent similar projects.

of the pipeline along P. Burgos Street from the Manila Road to Barrio Linga, reinforcement of the pipeline along the Manila Road from the site of the abandoned crossing well to Barrio Mayapa, new pipelines to provide service to Barrios Sucol, San Cristobal and Looc and reinforcement of pipelines in Elazequi, Silangan and Juliano Subdivisions are to be constructed during this period.

Construction of 292.0 hectares of internal network, installation of 6,600 service connections and provision of fire protection service to 397.8 hectares will also take place between 1991 and 2000.

CONSTRUCTION PHASE II-A (1991-95)

Source Facilities

As previously stated, as a result of the alternative studies discussed in Chapter VIII, projected peak-hour system demands within the CAL-WD will be met by direct pumping from the Bukal pump station until 1991. In 1991 storage facilities will be constructed at Lecheria Hill, and it will subsequently be required to provide only sufficient flow capacity at the Bukal pump station to meet projected maximum-day system requirements. As a result, pumping facilities previously constructed to serve until 1991 will now be adequate until 1995.

In 1995 the Bukal pump station capacity (14,300 cumd) will coincide with maximum-day demand and expansion of this facility will be required to meet subsequent future demands. It is proposed that general pump station revisions be made to increase the station capacity to 19,420 cumd, adequate to meet projected year 2000 maximum-day demand. This will require structural and station piping additions, as well as the installation of additional pumping equipment.

Because of increasing water demands, with consequent increasing chlorine requirements, it is recommended that the chlorination facilities constructed during Phase I-A be expanded during Phase II-A. The expansion of chlorination facilities will provide adequate chlorination capacity beyond the year 2000. The facilities required consist of minor structural alteration of the existing facility to incorporate the storage space and equipment necessary to convert from the use of "100 pound" cylinders to "ton" containers. The scales and lifting equipment required will also be included.

Storage Facilities

The year 2000 storage volume required to meet peak-hour demand is 2,700 cum. It is recommended that 2,000 cum of the year 2000 storage requirement be constructed in 1991. This will be adequate to meet system demands until 1995, at which time an additional 700 cum of storage will be constructed. The required storage tank will be constructed at Lecheria Hill, much closer to the center of demand than the existing storage tank. The existing 380-cum storage tank will be abandoned because of its extreme age and greater distance from the area of major demand. The proposed storage tank will be provided with all required piping and valves.

Transmission/Distribution Facilities

During Phase II-A 10.76 km of 100 to 350-mm diameter pipelines will be constructed, including 7.62 km of reinforcements and 3.14 km of additional pipelines. These pipelines are described in Table IX-7, and shown in Figures IX-5, IX-6 and IX-1 (appended). The Phase II-A pipelines will provide reinforcement of the pipeline along Ramon Santos Street from the new storage tank pipeline to P. Burgos Street, provide reinforcement of the pipeline along P. Burgos Street from the Manila Road to Barrio Linga, provide reinforcement of the pipeline along the Manila Road from the site of the Crossing well (abandoned) to Barrio Mayapa, and provide service to the previously unserved barrios of Sucol, San Cristobal and Looc.

Internal Network

During Phase II-A 131.2 hectares within previously served areas and Barrios San Cristobal, Looc and Prinza, will receive internal network piping (Barrio Sucol will be served directly from distribution pipelines). Together with the 30.0 hectares served directly from distribution system pipelines installed during this phase, and 404.7 hectares served before 1991, the total area served with equivalent internal network by 1995 will be 565.9 hectares. This amounts to 78 percent of the area to receive service by the year 2000. Details of internal network installation are presented in Annex IX-C.

Service Connections

During Phase II-A 3,300 new service connections will be installed within the areas previously served, and Barrios Sucol, San Cristobal, Looc and Prinza. Service connections will be installed at a rate of 660 per year. By 1995 there will be a total of 9,773 service connections within the area served by CAL-WD.

Fire Protection

During Phase II-A 198.7 hectares within the service area will receive fire protection by the installation of fire hydrants. Nearly all of this area will receive normal residential-type hydrant

TABLE IX-7

PHASE II-A PIPELINES

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
	Reinforcement Pipelines		
105	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	350	40
106	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	350	190
107	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	350	150
108	Ramon Santos St. - Lecheria Road to Elazequi Subdivision	350	150
206	Ramon Santos St. from Lecheria Road	350	100
			630
117	Rizal/Burgos intersection to Barrio Linga	200	380
213	Ramon Santos St. - Elazequi Subdivision	200	70
214	Ramon Santos St. - Elazequi Sub-division	200	80
218	Manila Road - Bo. Parian	200	350
219	Manila Road - Bo. Prinza	200	600
220	Manila Road to Bo. P. Rizal	200	1,250
221	Bo. P. Rizal	200	600
222	Bo. Mayapa	200	600
408	Manila Road from road to Bo. Rizal	200	100
409	Bo. Real Road from Manila Road	200	280
410	Bo. Real Road to Rizal/Burgos St. Intersection	200	230
428	P. Burgos St. - Rizal St. Inter-section to Belarmino St.	200	140
431	P. Burgos St. - Belarmino St. to T. Alonzo St.	200	310
433	P. Burgos St. - T. Alonzo St. to Lopez Jaena St.	200	150
435	P. Burgos St. - Lopez Jaena St. to Elepaño St.	200	160
437	P. Burgos St. - Elepaño St. to Casañas St.	200	340
439	P. Burgos St. - Casañas St. to Cailles	200	130
440	P. Burgos St. - Cailles St. to Mabini St.	200	100

TABLE IX-7 (continued)

Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
442	P. Burgos St. - Mabini St. to Rizal St. intersection	200	830
459	Ramon Santos St. - West of Elazequi Subdivision	200	150
			6,850
407	Crossing well to Bo. Real Road	250	140
			140
	Sub-total		7,620
	New Pipelines		
205	To elevated tank - Bo. Lecheria	300	140
			140
301	To Bo. San Cristobal	150	300
302	To Bo. Looc	150	700
			1,000
303	To Bo. Sucol	100	2,000
			2,000
	Sub-total		3,140
	Total		10,760

service, with only 12.3 hectares within the poblacion to receive a higher level of protection because of the higher property values associated with commercial areas. By 1995, approximately 73 percent of the area to be covered by 2000 will receive fire protection service.

<u>Cost Summary: Phase II-A</u>

The cost summary for proposed construction during Phase II-A is presented in Table IX-8. Based on 1978 price levels, the total project cost, including contingencies, engineering and land, is ₱10.54 million, with a foreign exchange component of ₱5.14 million.

TABLE IX - 8

COST SUMMARY FOR CONSTRUCTION
STAGE II PHASE A

Item	Cost (₱)17/ Local	Foreign 18/	Total
Source Facilities			
(Bukal pump station expansion and provision of additional pumping equipment)			
Materials and Equipment	5,600	93,100	
Civil and Structural	199,700	14,600	
(Additional chlorination facilities at Bukal pump station)			
Materials and Equipment	-	35,000	
Civil and Structural	13,400	-	
	218,700	142,700	361,400
Pipelines			
(630 m x 350 mm)			
Materials and Equipment	35,300	247,000	
Civil and Structural	129,800	-	
(140 m x 300 mm)			
Materials and Equipment	11,900	42,300	
Civil and Structural	20,300	-	
(140 m x 250 mm)			
Materials and Equipment	8,100	30,800	
Civil and Structural	16,900	-	
(6,850 m x 200 mm)			
Materials and Equipment	219,200	863,100	
Civil and Structural	582,200	-	
(1,000 m x 150 mm)			
Materials and Equipment	22,000	87,000	
Civil and Structural	73,000	-	
(2,000 m x 100 mm)			
Materials and Equipment	8,000	80,000	
Civil and Structural	106,000	-	

17/ Based on 1978 price levels.

18/ U.S. $1.00 = ₱7.00

TABLE IX-8 (Continued)

Item	Cost (₱) Local	Foreign	Total
(Valves)			
Materials and Equipment	16,400	60,100	
Civil and Structural	19,200	-	
	1,268,300	1,410,300	2,678,600
Storage Facilities (2,000 cum storage tank at Lecheria Hill)			
Materials and Equipment	677,600	48,400	
Civil and Structural	290,400	193,600	
	968,000	242,000	1,210,000
Sub-Total[19]			
Materials and Equipment	1,004,100	1,586,800	2,590,900
Civil and Structural	1,450,900	208,200	1,659,100
	2,455,000	1,795,000	4,250,000
Internal Network (131.2 ha)			
Materials and Equipment	74,100	580,000	
Civil and Structural	731,700	-	
	805,800	580,000	1,385,800
Service Connections (3,300 new connections)			
Materials and Equipment	79,200	1,597,200	
Civil and Structural	1,079,100	-	
	1,158,300	1,597,200	2,755,500
Fire Hydrants (198.7 ha)			
Materials and Equipment	53,700	183,100	
Civil and Structural	78,800	-	
	132,500	183,100	315,600
Sub-Total[20]			
Materials and Equipment	207,000	2,360,300	2,567,300
Civil and Structural	1,889,600	-	1,889,600
	2,096,600	2,360,300	4,456,900
Total Construction Cost			
Materials and Equipment	1,211,100	3,947,100	5,158,200
Civil and Structural	3,340,500	208,200	3,548,700
	4,551,600	4,155,300	8,706,900

19/ Contingencies and engineering costs for these items are calculated at 15 percent and 10 percent, respectively.

20/ Contingencies and engineering costs for these items are calculated at 10 percent and 5 percent, respectively.

TABLE IX-8 (Continued)

Item	Cost (₱) Local	Foreign	Total
Contingencies			
@ 15%	368,200	269,200	637,400
@ 10%	209,700	236,000	445,700
Sub-total	5,129,500	4,660,500	9,790,000
Engineering 21/			
@ 10%	171,100	317,700	488,800
@ 5%	85,800	159,300	245,100
Sub-total	5,386,400	5,137,500	10,523,900
Land 22/	11,200	-	11,200
TOTAL PROJECT COST	5,397,600	5,137,500	10,535,100

21/ Consists of 65 percent foreign exchange based on recent similar projects.

22/ 375 sqm @ ₱30/sqm

CONSTRUCTION PHASE II-B (1996-2000)

Distribution Facilities

During Phase II-B 1.15 km of 200 and 250 mm-diameter pipelines will be constructed. All of these pipelines will be constructed as reinforcements to previously installed pipelines. The pipelines form part of a loop around the southern portion of the poblacion, passing around Elazequi, Silangan and Juliano Subdivisions from Ramon Santos Street to Cailles Street. They are listed in Table IX-9 and shown in Figures IX-6 and IX-1 (appended).

TABLE IX-9

PHASE II-B PIPELINES

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
	Reinforcement Pipelines		
109	South of Elazequi Subdivision	250	340
			340
121	Lopez Jaena St. to Mabini St. south of Gen. Lim St.	200	320
123	Mabini St. near Public Market	200	220
124	Cailles St. south of A. Burgos St.	200	110
215	Silangan Subdivision	200	160
			810
		Total	1,150

Storage Facilities

In order to provide sufficient flow to meet projected peak-hour demands in the CAL-WD distribution system until the year 2000, additional storage capacity will be required. A 700-cum ground level storage tank will be constructed adjacent to the tank constructed during Phase II-A at Lecheria Hill. The tank will be constructed of reinforced concrete and be furnished with all required valves, piping and fittings.

Internal Network

During this construction phase 160.8 hectares of additional area will receive internal network piping. The details of internal network installation are presented in Annex IX-C. The internal network installed during Phase II-B, together with the total equivalent internal network installed before 1996, will provide service to 726.7 hectares within the CAL-WD service area or 100 percent of the projected year 2000 requirement.

Service Connections

Service connections will be installed at a rate of 660 per year during Phase II-B to provide a total of 3,300 additional service connections during this phase. By the year 2000 there will be a total of 13,073 service connections within the area served by the CAL-WD. Details of service connection installation are presented in Annex IX-C.

Fire Protection

An additional 199.1 hectares within th service area will receive fire protection by the installation of fire hydrants during Phase II-B. This consists of 12.2 hectares within the poblacion to receive high-level service and 186.9 hectares within the remaining barrios of the CAL-WD. By the year 2000, 726.7 hectares will be provided with fire protection service.

Cost Summary: Phase II-B

The cost summary for proposed construction during Phase II-B is presented in Table IX-10. The total project cost for this phase, based on 1978 price levels, is ₱6.54 million, including contingencies and engineering costs. The foreign exchange component of this cost is ₱3.29 million, and includes direct and indirect import items.

TABLE IX-10

COST SUMMARY FOR CONSTRUCTION
STAGE II PHASE B

Item	Cost (₱)[23/] Local	Foreign[24/]	Total
Pipelines			
(340 m x 250 mm)			
Materials and Equipment	19,700	74,800	
Civil and Structural	41,100	-	
(610 m x 200 mm)			
Materials and Equipment	25,900	102,100	
Civil and Structural	68,800	-	
(Valves)			
Materials and Equipment	2,500	9,700	
Civil and Structural	3,100	-	
	161,100	186,600	347,700
Storage Facilities			
(700 cum storage tank addition at Lecheria Hill)			
Materials and Equipment	271,000	19,400	
Civil and Structural	116,200	77,400	
	387,200	96,800	484,000
Sub-Total[25/]			
Materials and Equipment	319,100	206,000	525,100
Civil and Structural	229,200	77,400	306,600
	548,300	283,400	831,700
Internal Network			
(160.8 ha)			
Materials and Equipment	90,000	704,200	
Civil and Structural	888,500	-	
	978,500	704,200	1,682,700

[23/] Based on 1978 price levels.

[24/] U.S. $1.00 = ₱7.00.

[25/] Contingencies and engineering costs for these items are calculated at 15 percent and 10 percent, respectively.

TABLE IX-10 (Continued)

Item	Cost (₱) Local	Foreign	Total
Service Connections (3,300 new connections)			
Materials and Equipment	79,200	1,597,200	
Civil and Structural	1,079,100	-	
	1,158,300	1,597,200	2,755,500
Fire Hydrants (199.1 ha)			
Materials and Equipment	53,800	183,500	
Civil and Structural	79,000	-	
	132,800	183,500	316,300
Sub-Total 26/			
Materials and Equipment	223,000	2,484,900	2,707,900
Civil and Structural	2,046,600	-	2,046,600
	2,269,600	2,484,900	4,754,500
Total Construction Cost			
Materials and Equipment	542,100	2,690,900	3,233,000
Civil and Structural	2,275,800	77,400	2,353,200
	2,817,900	2,768,300	5,586,200
Contingencies			
@ 15%	82,200	42,500	124,700
@ 10%	227,000	248,500	475,500
Sub-Total	3,127,100	3,059,300	6,186,400
Engineering 27/			
@ 10%	33,500	62,100	95,600
@ 5%	91,500	170,000	261,500
TOTAL PROJECT COST	3,252,100	3,291,400	6,543,500

26/Contingencies and engineering costs for these items are calculated at 10 percent and 5 percent, respectively.

27/Consists of 65 percent foreign exchange based on recent similar projects.

E. CAPITAL COST SUMMARY

The capital costs for construction during each phase of the recommended project are summarized in Table IX-11. In general, the total project costs shown in this table include contingencies, engineering and land costs. All construction cost estimates are based on 1978 price levels. The foreign exchange component of the total project cost includes the costs of direct and indirect import items.

TABLE IX-11

CAPITAL COST SUMMARY

Construction Stage-Phase	Construction Cost (₱)	Project Cost (₱) Local	Foreign	Total
Immediate Improvement Program (1978-79)	4,158,400	2,166,500	2,950,800	5,117,300
I-A (1980-85)	10,789,800	6,703,000	6,675,900	13,378,900
I-B (1986-90)	5,062,800	2,689,500	3,397,100	6,086,600
II-A (1991-95)	8,706,900	5,397,600	5,137,500	10,535,100
II-B (1996-2000)	5,586,200	3,252,100	3,291,400	6,543,500
Total (1978-2000)	34,304,100	20,208,700	21,452,700	41,661,400

F. ANNUAL OPERATION AND MAINTENANCE COSTS

Annual operation and maintenance costs include personnel, power, fuel, chemicals, maintenance, office supplies and other miscellaneous expenses which are necessary to sustain the overall water supply system. The total annual budgeted cost of the existing system in 1976 was ₱211,100 (at 1978 price levels). Following implementation of the proposed construction program, the annual cost will increase due to the additional costs for personnel, chemicals, power and maintenance.

The costs of operating and maintaining the CAL-WD facilities are estimated to be approximately ₱392,500, ₱763,100 and ₱1,157,600 in 1980, 1990 and 2000, respectively. The breakdown of these estimates is shown in Table IX-12. All costs shown are based on projected 1978 price levels.

TABLE IX-12

ANNUAL OPERATION AND MAINTENANCE COSTS

Item	Annual Costs (₱)[28/] 1976	1980	1990	2000
Administration and Personnel	73,200	180,900	391,600	485,000
Power and Fuel[29/]	101,600	54,500	133,500	287,800
Chemicals[30/]	-	9,700	29,900	59,100
Maintenance[31/]	29,000	89,700	121,400	194,800
Miscellaneous[32/]	7,300	57,700	86,700	130,900
Total	211,100	392,500	763,100	1,157,600

[28/] Based on 1978 price levels.

[29/] Power cost = ₱0.25/kwh. Includes miscellaneous power costs @ ₱500/mo and operation of two vehicles @ ₱400/mo. The high level of current power cost is caused by the poor efficiency of existing equipment under poor operating conditions.

[30/] Chlorine cost = ₱5.00/kg. Includes miscellaneous chemicals @ ₱4,000/year from 1980 to 1989 and ₱5,000/year from 1990 to 2000.

[31/] In general, includes equipment maintenance @ 2 percent per year and pipeline and building maintenance @ 0.5 percent per year.

[32/] Includes present costs increased at 10 percent per year and an allowance for rent of shared laboratory and meter repair facilities.

G. SEWERAGE/DRAINAGE CONCEPTS

Studies of the western portion of Laguna de Bay have recently been completed by consultants to the Laguna Lake Development Authority (LLDA). These detailed studies concern the present and future water quality of Laguna de Bay and the steps required to minimize future pollution by agricultural and urban runoff and municipal/industrial wastewater disposal. Because of its location, the municipality of Calamba has been included in these studies and preliminary (pre-design) plans for development of its sewerage and stormwater systems have been compiled. Because of the general and broad conceptual nature of the following paragraphs, the details of the LLDA report have not been included here. However, it should be pointed out that the regional approach adopted in the LLDA studies will certainly lead to more technically flexible and economically viable projects. It is intended that the following paragraphs briefly describe existing wastewater facilities within the CAL-WD and the magnitude of future collection, treatment and disposal systems.

Existing Drainage System

The existing drainage system in Calamba (see Figure IX-7) is based on an existing NIA irrigation canal system which traverses the center of the municipal area from west to east along J. P. Rizal and P. Burgos Streets. These large open concrete-lined canals are paralleled and cross-connected by a network of municipal drainage channels and smaller street drains. Most of the water drained by this system is transported to a disposal point located on a branch of the San Juan River north of Barrio Linga, although some irrigation flows are diverted to the ricefields south of the poblacion via Elazequi and Juliano Subdivisions and west of Barrio Linga. The ultimate disposal area for all wastewater derived from this system is Laguna de Bay.

The majority of NIA irrigation canals are concrete-lined, varying in width from approximately 0.20 to 1.20 meters, with depths varying from 0.30 to 1.50 meters. The larger municipal drainage channels are concrete-lined, varying in width from approximately 0.20 to 0.40 meter, with depths varying from 0.20 to 0.50 meter. Smaller unlined earthen street drains exist along smaller roads, draining into the larger channels. These street drains are from 0.20 to 0.30 meter wide, and from 0.10 to 0.30 meter deep. Many of the street drains simply transport drainage into adjacent low-lying areas, principally those north of Del Pilar and J. P. Rizal Streets and the ricefields south of the poblacion.

The NIA irrigation canal system is very old (construction date unknown), and was constructed to supply water to the agricultural areas which are now located south of the poblacion. The principal municipal concrete-lined drainage channels are also very old. The smaller lined and unlined municipal street drains were constructed as the need became obvious during expansion of the community and its road system. NIA maintains its irrigation canal system, with the municipality responsible for its own drainage system. Municipal funds covering drainage system maintenance are included in the allocation for road repair. A comprehensive plan for future drainage requirements does not exist, and additional drainage facility development is hampered by the lack of available funds.

The existing drainage facilities were constructed for the collection and disposal of stormwater runoff, although much of the system usually contains a significant amount of irrigation water from the inter-connected NIA canal system. Even during non-rainy periods significant flows are observed. During even moderate rains, floods occur along major roads due to the presence of surface runoff, irrigation water, some miscellaneous solid wastes and a relatively small amount of domestic wastewaters.

Field observations of the drainage system in Calamba are as follows:

1. The major disposal area for stormwater runoff is the San Juan River, which runs along the north side of the poblacion, with some stormwater disposal into the ricefields south of the poblacion.

2. Most of the domestic wastewater (except for effluents from excreta disposal facilities) is discharged either directly into street drains or into open areas which subsequently drain into surrounding low-lying areas.

3. The municipal slaughterhouse and public market drain their wastewaters into NIA irrigation canals.

4. The municipality maintains its drainage system with funds allocated for road maintenance. There are no comprehensive long-term plans for development of the sewerage/drainage systems of Calamba.

5. There are presently no industries producing significant wastewaters.

6. Approximately 12-15 metric tons/day of solid wastes is collected by the Municipal Health Office, and disposed of in an area adjacent to the San Juan River in Barrio Banadero (across the San Juan River, north of Barrio San Juan).

7. Periodic flooding occurs in several areas during moderate rains, due primarily to the presence of irrigation water in conduits used for stormwater drainage, and also due to the

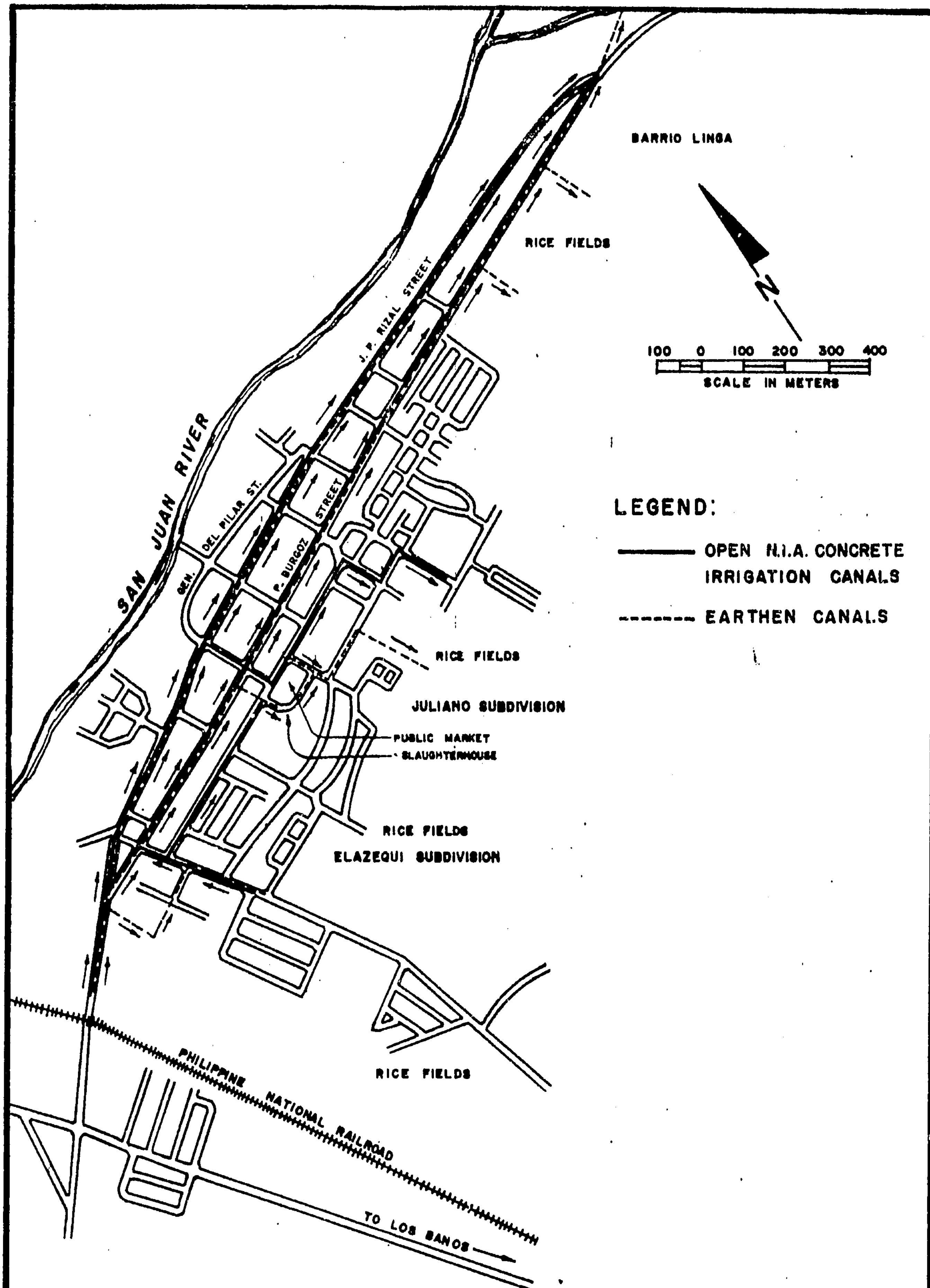

FIGURE IX-7
EXISTING DRAINAGE FACILITIES
SCHEMATIC
CALAMBA WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM

presence of significant amounts of solid waste materials which reduce the capacity of these conduits. This problem is aggravated when the water level in Laguna de Bay, the receiving body of the San Juan River, is unusually high. Normally, local flooding occurs for periods not exceeding 2-3 hours.

Relationship with Infrastructure and Other Engineering and Economic Factors

The provision of sewerage and drainage facilities within the CAL-WD has a significant impact on water supply and other infrastructure components. Economics (public's ability-to-pay) and the status of public health directly affect the feasibility of providing sewerage and drainage facilities.

In view of the current relatively minor stormwater drainage problems being experienced in the CAL-WD area, it appears that drainage facilities do not warrant high priority in Calamba's list of infrastructure components. Before decisions can be made concerning the implementation of sewerage and/or drainage programs additional technical and economic data must be collected and evaluated.

Information from the Department of Health indicates that in 1976, 21 percent of Calamba households had water-seal toilet facilities, 53 percent had open flush-type toilets, 22 percent had closed-pit type and 4 percent had other pit-type toilet facilities. It is unlikely that such a low percentage of "modern" facilities can economically justify a near future sewerage program.

The rationale for the provision of wastewater facilities has traditionally been based on aesthetics and public health benefits. At present, there is an obvious water supply problem in the CAL-WD. As the water supply problem is resolved wastewater volumes will increase. Related aesthetic and public health standards will rise in time, increasing the urgency for solution of the wastewater problem.

Projected Wastewater Volumes

Projections have been made for wastewater flows in CAL-WD for the years 1990, 2005 and 2025. These estimates are presented in Table IX-13.

The service area considered for the wastewater projections was the core area to receive water supply by 1980. This area is the most densely populated area in the water district, and is the area where public health and nuisance problems associated with wastewater will be greatest.

TABLE IX-13

AVERAGE DAILY WASTEWATER FLOWS
CALAMBA WATER DISTRICT

Design Year	1990	2005	2025
Percentage of Water Connections with Sewer			
Connections:			
Domestic	30%	60%	100%
Commercial, etc.	50%	85%	100%
Wastewater Flows (cumd):			
Domestic	800	2,534	7,744
Commercial, etc.	227	790	2,323
Infiltration	1,762	2,538	3,525
Total	2,789	5,862	13,592

The wastewater volume which could be collected was determined by estimating the percentage of water supply connections (domestic and commercial/industrial/institutional) with sewer connections during the design period from 1990 to 2025. It was assumed that all water supply connections would have sewer connections by 2025, and that in 1990, 30 percent of domestic and 50 percent of commercial/industrial/institutional water supply connections would have sewer connections. It was assumed that no unusually large water consuming connections would occur during the design period, and that 90 percent of water consumed would therefore be returned to the sewers. An allowance was made for groundwater infiltration into the sewers, based on projected percentage of physical area with sewers and an infiltration rate of 0.15 lps/hectare. The resultant number of sewer connections required during the design period was then checked to ensure that the annual rate of sewer connection construction was realistically within the capabilities of the water district.

Alternatives Available

The economic cost of sewerage/drainage facilities for the CAL-WD area is expected to be significant.

The provision of a financially self-sufficient sewerage/drainage system is seldom achieved even in developed countries. It is likely that the CAL-WD is no exception to this rule.

Feasible alternatives for sewerage in the CAL-WD area appear to be as follows:

1. individual (septic tanks) or unified public collection system;

2. combined or separate sewerage/drainage system;

3. various degrees of centralized community sewage treatment;

4. disposal system (river or land disposal) for treated sewage.

The question of whether the CAL-WD should construct a combined or a separate sewerage/drainage system depends on economic circumstances.

An alternative to the combined system, which must be investigated in detail during the sewerage feasibility study, is the provision of open canals (peripheral drains).

Alternative treatment and disposal methods for intercepted wastewater may consist of:

1. Screening of gross solids; high-rate lagoons and effluent discharge into the San Juan River.

2. Some form of treatment such as conventional primary and/or high rate secondary treatment may be applied. Treated wastes may be used potentially for agricultural irrigation.

Recommendations

As soon as the first-phase water supply program is underway, a comprehensive sewerage/drainage feasibility study should be undertaken. This study must address the issue of combined versus separate sewers. It should also update the population and water demand projections of this water supply study.

Once the decision has been made to use either the combined or separate system, the water district must embark as promptly as possible on a street sewering and house connection program.

A plumbing code should be developed by the CAL-WD to coordinate plumbing requirements for water, wastewater and surface runoff facilities. This code becomes very important and meaningful particularly if a separate system of sewers is adopted.

In the meantime, a house-to-house survey should be conducted to inventory existing wastewater and toilet facilities. As-built drawings of storm drains and peripheral canals must be compiled and accurately recorded in preparation for the sewerage/drainage feasibility study.

The provision of an alternative distribution network for NIA irrigation water, such as the construction of another main canal south of the poblacion (immediately adjacent to the agricultural lands presently served by NIA), would permit full use by the municipality of the existing NIA canals on J. P. Rizal and P. Burgos Streets for stormwater drainage, resulting in a large increase in stormwater disposal capability for the municipality.

For residences and establishments that currently lack waste disposal facilities and are financially unable to provide the modern flush toilet with septic tank, the Department of Health (Division of Environmental Sanitation) has developed an inexpensive water-seal toilet.

Permanent rights-of-way should be acquired for the main routes that will be used for drainage/sewerage canals.

The current practice of dumping solid wastes into waterways, canals and manholes, should be strictly prohibited. Solid wastes not only pollute the water, but also are very unsightly and serve as habitats for flies, rodents and parasites. The proper handling of solid wastes should be studied and planned carefully.

H. MANAGEMENT OF WATER RESOURCES

In order to make the best use of water resources available for present and future use of CAL-WD, certain technical and management steps must be considered. These considerations are primarily related to the collection of data concerning the chemical quality and amount of water produced by the district, and a data storage and retrieval system which would provide easy accessibility to those organizations dealing with subject. These are discussed further in Appendix P, Volume II of this report.

I. UPDATING THE WATER SUPPLY MASTER PLAN

To be a meaningful working document, this water supply master plan must be periodically updated. Changes related to technological developments, social goals, land use concepts, unforeseen population growth or movement, etc., must be reviewed for possible long-range impact on the program recommended in this report. An outline of the steps required for such periodic updating is presented in Appendix Q, Volume II.

J. ENVIRONMENTAL CONSIDERATIONS

Appendix R, Volume II discusses some of the ways the recommended program may affect the environment of the study area. Some of the natural resources affected by the program are irreplaceable, requiring due consideration before actual construction.

ANNEX IX-C

DISTRIBUTION SYSTEM GROWTH

ANNEX IX-C

DISTRIBUTION SYSTEM GROWTH

General

It is necessary to project the growth of the distribution system in order to estimate the required expenditures for internal network piping, service connections, and fire hydrant requirements. The projection of distribution system growth is based on 1) an apportionment of the served population among individual sections within the service area, 2) the projected number of people served by each connection, and 3) the anticipated total area of individual served sections within the service area. The details of these items are discussed below.

Served Population

The projections of served population presented in Chapter VI are presented in Annex Table IX-C-1 according to individual community served and respective service areas in 1976, 1980, 1990 and 2000.

ANNEX TABLE IX-C-1

SERVED POPULATION PROJECTIONS
CALAMBA WATER DISTRICT

Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Poblacion	5,322	6,468	17,497	30,541
San Juan	18	390	1,213	2,635
San Jose	104	450	1,662	2,360
Lecheria	391	720	1,990	
Halang	79	198	460	1,045
Bukal	525	720	1,880	3,020
Pansol	104	432	1,265	2,624
Real	165	336	1,564	2,574
Linga	-	600	1,823	3,278
Palingon	-	450	1,817	2,816
Parian	-	768	2,064	3,240
Mayapa	-	-	2,426	6,666
P. Rizal	-	-	1,024	2,486
Sampiruhan	-	-	535	1,138
Looc	-	-	-	1,903
Sucol	-	-	-	638
San Cristobal	-	-	-	1,133
Prinza	-	-	-	374
Total Served Population	6,708	11,532	37,220	71,903
Total Service Area Population	24,872	36,662	64,455	100,069
Percent Served	27	31	58	72

Number of Persons per Connection

Based on the pilot area studies within the present service area, the present number of people served by a single service connection is 6.1 on the average. With an anticipated rise in standard of living this figure has been assumed to decrease to 6.0 by 1980, 5.75 by 1990 and 5.5 by the year 2000.

Area Served By Internal Network

In order to project the net area to be served by internal network piping, the gross service areas (presented in Annex Table IX-C-2) were modified, taking into consideration the percentage of population served for the years 1990 and 2000 (i.e., 58 and 72 percent as indicated in Annex Table IX-C-1), as well as actual area served by installed piping by 1980 (i.e., 130.7 ha). The modified areas resulting from the above considerations correspond to served areas of approximately 130, 404 and 726 ha in 1980, 1990 and 2000, respectively (i.e., 48, 81 and 88 percent of the 1980, 1990 and 2000 total service areas), as indicated in Annex Table IX-C-3.

ANNEX TABLE IX-C-2

TOTAL SERVICE AREA BY INDIVIDUAL COMMUNITIES (hectares)

Community Served		1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Poblacion	(30.8)	65.5	78	83.1	91.7
San Juan	(10.6)	22.6	22.6	22.6	22.6
San Jose	(3.5)	7.4	15.6	26.9	39.0
Lecheria	(10.1)	21.5	29.3	42.9	50.7
Halang	(0.9)	2.0	5.9	14.4	24.6
Bukal	(3.7)	7.8	14.8	35.9	66.3
Pansol	(3.6)	7.7	17.4	42.3	66.6
Real	(9.5)	20.3	46.4	111.9	167.7
Linga	(4.2)	9.0	15.2	24.2	34.3
Palingon	(3.1)	6.6	9.0	10.5	10.5
Parian		-	18.2	42.9	95.6
Mayapa		-	-	23.4	48.8
P. Rizal		-	-	3.9	15.6
Sampiruhan		-	-	14.4	29.3
Looc		-	-	-	21.8
Sucol		-	-	-	15.6
San Cristobal		-	-	-	13.3
Prinza		-	-	-	11.7
TOTAL	(80.0)	170.4	272.4	499.3	825.7

Note: Numbers in parentheses are net areas served in 1976.

ANNEX TABLE IX-C-3

TOTAL AREA SERVED BY INTERNAL NETWORK SYSTEM (HECTARES)

Community Served		Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	(37.4)	43.2	2.6	4.3	4.3
San Juan	(10.8)	11.8	-	-	-
San Jose	(7.5)	10.4	2.3	7.5	7.4
Lecheria	(14.1)	16.7	1.4	5.4	5.5
Halang	(2.8)	4.9	1.8	5.2	5.1
Bukal	(7.1)	13.8	6.0	14.7	14.8
Pansol	(8.4)	15.1	6.1	13.5	13.5
Real	(22.3)	42.8	18.8	29.3	29.3
Linga	(7.3)	10.0	2.1	5.8	5.7
Palingon	(4.3)	5.2	0.5	0.2	0.3
Parian	(8.7)	11.4	18.5	23.7	23.7
Sampiruhan		4.7	4.7	7.7	7.8
Mayapa		-	15.2	13.1	13.2
P. Rizal		-	3.7	5.6	5.5
Looc		-	-	8.7	8.7
Sucol		-	-	6.5	6.0
San Cristobal		-	-	5.3	5.3
Prinza		-	-	4.7	4.7
Total	(130.7)	190.0	83.7	161.2	160.8
Cumulative Total		320.7	404.4	565.6	726.4

Note: Numbers in parentheses are net areas served by 1980.

It has also been assumed that relevant distribution system pipelines passing through the service areas will provide service to the areas within 50 meters on each side of the pipelines (see Table IX-C-4). The resultant net areas to receive internal network systems are tabulated in Annex Table IX-C-5 according to construction phase.

Number of Service Connections

The projection of the number of service connections to be installed is obtained by dividing the served population (see Annex Table IX-C-1) by the average number of persons per connection. The estimated number of service connections for each community within the service area is presented in Annex Table IX-C-6.

ANNEX TABLE IX-C-4

[illegible]
INTERNAL NETWORK, BY CONSTRUCTION PHASE (hectares)

Community Served	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	1.0	-	-	-
San Juan	-	-	-	-
San Jose	-	-	-	-
Lecheria	6.5	-	-	-
Halang	2.6	1.0	-	-
Bukal	12.0	-	-	-
Pansol	-	-	13.5	-
Real	15.0	13.9	-	-
Linga	-	-	-	-
Palingon	-	-	-	-
Parian	-	18.5	-	-
Sampiruhan	3	-	-	-
Mayapa	-	8.3	-	-
P. Rizal	-	3.7	-	-
Looc	-	-	7	-
Sucol	-	-	6.5	-
San Cristobal	-	-	3	-
Prinza	-	-	-	-
Total	40.1	45.4	30.0	0.0
Cumulative Total	40.1	85.5	115.5	115.5

ANNEX TABLE IX-C-5

NET AREA SERVED BY INTERNAL NETWORK (hectares)

Community Served	1980 Served Area	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1990-95)	Phase II-B (1996-2000)
Poblacion	37.4	42.2	2.6	4.3	4.3
San Juan	10.8	11.8	-	-	-
San Jose	7.5	10.4	2.3	7.5	7.4
Lecheria	14.1	10.2	1.4	5.4	5.5
Halang	2.8	2.3	0.8	5.2	5.1
Bukal	7.1	1.8	6.0	14.7	14.8
Pansol	8.4	15.1	6.1	-	13.5
Real	22.3	27.8	4.9	29.3	29.3
Linga	7.3	10.0	2.1	5.8	5.7
Palingon	4.3	5.2	0.5	0.2	0.3
Parian	8.7	11.4	-	23.7	23.7
Sampiruhan	-	1.7	4.7	7.7	7.8
Mayapa	-	-	6.9	13.1	13.2
P. Rizal	-	-	-	5.6	5.5
Looc	-	-	-	1.7	8.7
Sucol	-	-	-	-	6.0
San Cristobal	-	-	-	2.3	5.3
Prinza	-	-	-	4.7	4.7
Total	130.7	149.9	38.3	131.2	160.8
Cumulative Total	130.7	280.6	318.9	450.1	610.9

ANNEX TABLE IX-C-6

SCHEDULE FOR SERVICE CONNECTION INSTALLATION

Community Served		Immediate Improvements	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	(871)	207	933	1,032	1,255	1,255
San Juan	(3)	62	73	73	134	134
San Jose	(17)	58	107	107	70	70
Lecheria	(64)	56	113	113	139	139
Halang	(13)	20	24	23	55	55
Bukal	(86)	34	103	104	111	111
Pansol	(17)	55	74	74	129	128
Real	(27)	29	108	108	98	98
Linga		100	109	108	139	140
Palingon		75	121	120	98	98
Parian		128	115	116	115	115
Mayapa		-	-	422	395	395
P. Rizal		-	-	178	137	137
Sampiruhan		-	45	47	57	57
Looc		-	-	-	173	173
Sucol		-	-	-	58	58
San Cristobal		-	-	-	103	103
Prinza		-	-	-	34	34
Total	(1,098)[1]	824	1,925	2,625	3,300	3,300
Cumulative Total		1,922	3,847	6,472	9,772	13,072

During the leakage survey which will be conducted during the immediate improvement program, it is expected that some existing service connections will be identified as major sources of leakage. It has therefore been anticipated that 30 percent of existing service connections will require major repair or replacement by 1980. The remaining 70 percent will be repaired or replaced during Phase I-A.

Areas Receiving Fire Protection

All of the areas to receive internal network piping by the year 2000 will also be provided with fire protection service by the year 2000. Normal residential type fire hydrant service will be provided except in those areas where high property values are expected. Within the Calamba poblacion, 49.1 hectares will receive a higher level of fire protection service. The schedule for fire hydrant installation is presented in Annex Table IX-C-7.

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[1] Numbers in parentheses are existing connections in 1976.

ANNEX TABLE IX-C-7

SCHEDULE FOR FIRE HYDRANT INSTALLATION (hectares)

Community Served	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	22.9(12.3)*	22.9(12.3)*	23.0(12.3)*	23.0(12.2)*
San Juan	5.6	5.6	5.7	5.7
San Jose	8.7	8.8	8.8	8.8
Leoberia	10.8	10.8	10.8	10.7
Halang	4.9	4.9	5.0	5.0
Bukal	14.1	14.1	14.1	14.1
Pansol	14.2	14.2	14.1	14.1
Real	35.6	35.6	35.6	35.7
Linga	7.8	7.7	7.7	7.7
Palingon	2.7	2.6	2.6	2.6
Parian	21.5	21.5	21.5	21.5
Sampiruhan	6.2	6.2	6.2	6.3
Mayapa	-	13.8	13.8	13.9
P. Rizal	-	4.9	4.9	5.0
Looc	-	-	8.7	8.7
Sucol	-	-	6.2	6.3
San Cristobal	-	-	5.3	5.3
Prinza	-	-	4.7	4.7
Total	155.0(12.3)*	173.6(12.3)*	198.7(12.3)*	199.1(12.2)*
Cumulative Total	155.0(12.3)*	328.6(24.6)*	527.3(36.9)*	726.4(49.1)*

Computer Studies

The recommended program of pipeline construction presented in Chapter IX reflects the results of successive computer analyses of the CAL-WD distribution system. The general design criteria and method of analysis are discussed in Appendix K, Volume II, and Chapter XII, Methodology Manual, respectively.

The method of selecting pipeline sizes consists of analyzing a number of flow requirements and operating conditions and designing each pipe for the worst set of conditions. Since each computer analysis is critical to a different series of pipes there is no single program result that can be included herein as a "design run".

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*Areas to receive high-level hydrant service are shown in parentheses.

The computer printouts for the peak hour and minimum hour conditions are included (Annex Tables IX-C-8 and IX-C-9) as representative of the worst conditions for the design of most pipes. The peak-hour condition may, in general, be considered as the "design run" for the majority of pipes. However, certain variations in operational modes, can be critical to some pipelines.

Pipeline numbers from 1 to 89 shown in the computer printouts are existing pipelines. If an existing pipeline is replaced, the "1 to 89" series are replaced by 400 series pipe numbers. The "100" series pipelines are recommended for installation during the immediate improvement program. The "200" series pipelines are to satisfy 1990 design conditions. The "300" series pipes are to satisfy the year 2000 design conditions.

Some of the pipelines in the recommended construction program may appear to be in a construction phase not indicated by appropriate pipe numbers. This may result from other conditions governing the staging of recommended facilities. An example might be a "200" series pipeline included within the immediate improvement program because the "200" series pipeline was not sufficiently large to economically justify staging.

ANNEX TABLE IX-C-8

COMPUTER PRINTOUT (CAL-WD)
YEAR 2000 PEAK-HOUR

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CALAMBA WATER DISTRICT 2000 WATER SYSTEM ANALYSIS PEAK HOUR CONDITION


INPUT AND OUTPUT IN                  LPS
NO OF NODES                          [illegible]
NO OF PIPES                          1[illegible]9
MAX NO OF ITERATIONS                 20
PEAKING FACTOR                       1.75000
ALLOW P-DROP FR/STATIC - PCT         30.0
STATIC HGL FOR P-DROP CALC           50.0
MAX UNBAL - LPS                      0.05000
MAX ALLOW VEL - MPS                  3.000
MIN ALLOW VEL - MPS                  0.400
MAX ALLOW HL - M/1000 M              10.00
MIN ALLOW HL - M/1000 M              0.30
MAX ALLOW PRESS - ATM                7.000
MIN ALLOW PRESS - ATM                0.700
NO OF HEADS TO BE READ               1
NO OF [illegible] CONSUMPTIONS       1
SUM OF FIXED DEMANDS                 1[illegible]3.26
BANDWIDTH                            9
ITER  1 UNBAL    59.68 LPS
ITER  2 UNBAL    11.46 LPS
ITER  3 UNBAL     4.01 LPS
ITER  4 UNBAL     1.27 LPS
ITER  5 UNBAL     0.21 LPS
ITER  6 UNBAL     0.01 LPS
```

ANNEX TABLE IX-C-8 (Continued)

PIPE NO	NODES FROM	TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	VEL MPS	CK	HEADLOSS MT	MT/1000	CK
407	14	15	250	140.	120	0.[illegible]48E-04	135.71	1.10		0.54	3.86	
408	15	17	250	150.	110	0.417E-03	[illegible].76	1.0[illegible]		[illegible]	[illegible]	
409	15	18	250	280.	110	0.117E-02	40.19	0.82		1.09	3.89	
410	18	19	250	230.	110	0.553E-03	25.11	0.53		0.37	1.63	
411	19	20	150	150.	100	0.297E-02	8.73	0.49		0.50	3.36	
412	20	21	150	240.	100	0.14[illegible]E-01	6.96	0.51		0.84	3.48	
413	21	22	100	160.	100	0.431E-01	1.19	0.15	LO	0.06	0.39	
414	21	23	150	70.	100	0.419E-02	5.90	0.33	LO	0.11	1.60	
415	23	24	150	150.	100	0.397E-02	7.79	0.44		0.40	2.68	
417	24	25	150	160.	100	0.957E-02	7.82	0.44		0.43	2.70	
418	25	26	100	90.	100	0.388E-01	0.95	0.12	LO	0.03	0.37	
420	25	27	150	340.	100	0.[illegible]3E-01	5.27	0.30	LO	0.44	1.30	
428	15	35	250	140.	110	0.[illegible]E-03	13.81	0.28	LO	0.08	0.54	
429	35	26	100	60.	100	0.259E-01	4.51	0.57		0.42	7.00	
431	35	30	250	210.	110	0.129E-02	32.76	0.67		0.33	2.07	
432	36	29	100	100.	100	0.431E-01	3.92	0.50		0.54	5.41	
433	36	37	250	130.	110	0.625E-03	24.42	0.50		0.23	1.89	
435	37	38	250	160.	110	0.669E-03	37.83	0.77		0.56	3.48	
436	38	29	100	100.	100	0.431E-01	4.09	0.52		0.59	5.90	
437	38	39	150	340.	110	0.142E-02	29.92	0.61		0.77	2.25	
438	39	27	100	100.	100	0.431E-01	2.65	0.34	LO	0.26	2.61	
439	39	40	250	130.	110	0.541E-03	24.07	0.49		0.20	1.50	
440	40	41	250	160.	110	0.417E-03	46.39	0.94		[illegible].51	3.06	
441	41	29	100	100.	100	0.431E-01	2.91	0.37	LO	0.31	3.12	
442	41	31	250	620.	110	0.346E-02	31.38	0.64		2.04	2.46	
443	42	43	150	60.	100	0.359E-02	7.18	0.41		0.14	2.30	
444	43	44	150	150.	100	0.11[illegible]E-01	5.51	0.31	LO	0.27	1.41	
445	44	45	150	50.	100	0.299E-02	6.65	0.39	LO	0.11	2.11	
446	45	46	150	120.	100	0.714E-02	7.50	0.42		0.33	2.49	
449	43	46	100	60.	100	0.259E-01	0.44	0.06	LO	0.01	0.09	LO
450	46	45	100	150.	100	0.31[illegible]E-01	1.20	0.15	LO	0.11	0.60	
451	45	44	100	60.	100	0.259E-01	2.56	0.33	LO	0.15	2.46	
454	51	43	100	50.	100	0.216E-01	1.99	0.25	LO	0.04	0.79	
455	51	57	100	150.	100	0.[illegible]E-01	0.97	0.12	LO	0.07	0.35	
456	52	49	100	50.	100	0.216E-01	2.59	0.33	LO	0.13	2.51	
457	54	42	250	190.	110	0.623E-03	34.74	0.71		0.45	2.37	
460	54	55	200	60.	110	0.741E-03	18.11	0.58		0.16	2.64	
461	55	51	100	60.	100	0.259E-01	4.11	0.52		0.35	5.95	
462	55	56	200	150.	110	0.[illegible]E-02	11.95	0.38	LO	0.23	1.57	
463	56	57	100	60.	100	0.259E-01	2.92	0.37	LO	0.19	3.14	
464	56	57	200	500.	110	0.[illegible]E-02	6.75	0.22	LO	0.24	0.48	
465	57	45	100	190.	100	0.819E-01	2.11	0.27	LO	0.33	1.72	
466	57	58	100	90.	100	0.389E-01	3.49	0.44		0.39	4.36	
469	59	60	100	110.	100	0.474E-01	0.57	0.07	LO	0.02	0.15	LO
470	[illegible]	[illegible]	[illegible]	50.	100	0.215E-01	2.21	0.28	LO	[illegible]	1.37	
472	60	61	150	190.	100	0.103E-01	3.22	0.47		0.53	2.96	
473	61	62	250	270.	100	[illegible]	6.21	0.35	LO	0.37	1.70	
474	71	62	250	80.	110	0.[illegible]E-03	31.21	0.64		0.20	2.44	
101	1	2	200	1500.	110	0.186E-01	25.97	0.83		7.71	5.14	
102	4	5	450	700.	120	0.[illegible]E-03	201.13	1.26		2.61	3.73	

ANNEX TABLE IX-C-8 (Continued)

PIPE NO	NODES FROM	NODES TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	VEL MPS	CK	HEADLOSS MT	MT/1000	CK
103	8	7	250	770.	110	0.321E-02	2.20	0.04	LO	0.01	0.02	LO
104	9	[illegible]	250	240.	110	0.100E-02	4.41	0.09	LO	0.02	0.07	LO
105	9	72	450	40.	120	0.810E-05	171.38	1.08		0.11	2.73	
106	72	10	450	190.	120	0.335E-04	166.42	1.05		0.50	2.63	
107	10	73	450	150.	120	0.304E-04	164.21	1.03		0.38	2.56	
108	73	11	450	150.	120	0.304E-04	159.96	1.01		0.37	2.44	
109	11	12	350	340.	120	0.234E-03	97.57	1.01		1.13	3.33	
110	37	24	150	100.	100	0.593E-02	13.20	0.75		0.71	7.11	
111	24	26	150	200.	100	0.120E-01	7.22	0.41		0.47	2.33	
112	26	27	150	360.	100	0.215E-01	4.89	0.28	LO	0.41	1.13	
113	27	29	150	120.	100	0.718E-02	7.95	0.45		0.33	2.78	
114	28	29	150	110.	100	0.658E-02	9.42	0.53		0.42	3.81	
115	29	30	150	400.	100	0.239E-01	9.25	0.52		1.47	3.66	
116	30	31	150	400.	100	0.275E-01	3.35	0.19	LO	0.26	0.66	
117	31	32	250	580.	110	0.153E-02	25.06	0.51		0.62	1.02	
118	32	33	150	100.	100	0.598E-02	12.88	0.73		0.68	6.77	
119	34	33	150	380.	100	0.227E-01	3.22	0.18	LO	0.20	0.52	
120	32	34	150	150.	100	0.897E-02	8.59	0.49		0.48	3.21	
121	69	62	250	320.	110	0.135E-02	39.28	0.80		1.19	3.73	
122	58	68	200	130.	110	0.161E-02	13.01	0.42		0.19	1.44	
123	62	63	250	220.	110	0.916E-03	31.65	0.64		0.55	2.50	
124	63	40	250	110.	110	0.458E-03	27.46	0.56		0.21	1.92	
125	40	25	100	100.	100	0.451E-01	3.33	0.42		0.40	4.00	
126	18	67	150	260.	100	0.155E-01	15.45	0.76		1.91	7.36	
127	67	68	150	400.	100	0.239E-01	9.41	0.53		1.52	3.80	
128	68	69	150	400.	100	0.239E-01	5.37	0.30	LO	0.54	1.34	
129	69	70	150	400.	100	0.239E-01	1.73	0.10	LO	0.07	0.17	LO
130	15	17	150	650.	100	0.389E-01	11.86	0.67		3.79	5.84	
131	12	53	250	140.	110	0.583E-03	47.95	0.98		0.76	5.40	
132	58	55	250	80.	110	0.333E-03	36.70	0.75		0.26	3.29	
133	59	60	250	70.	110	0.292E-03	35.80	0.69		0.20	2.82	
134	60	37	250	70.	110	0.292E-03	30.43	0.62		0.16	2.33	
135	40	64	150	110.	100	0.658E-02	6.78	0.38	LO	0.23	2.07	
136	11	66	250	50.	110	0.208E-03	58.00	1.18		0.38	7.63	
201	1	4	450	180.	120	0.365E-04	201.13	1.26		0.67	3.73	
202	5	75	450	760.	120	0.154E-03	189.21	1.19		2.53	3.33	
203	75	14	350	1140.	120	0.785E-03	107.58	1.12		4.54	3.98	
204	75	76	300	650.	110	0.111E-02	77.52	1.10		3.51	5.40	
205	77	76	300	140.	110	0.240E-03	100.26	1.42		1.22	8.70	
206	76	9	450	100.	120	0.203E-04	177.77	1.12		0.30	2.97	
207	72	73	100	130.	100	0.586E-01	2.67	0.34	LO	0.35	2.66	
208	76	79	100	150.	100	0.676E-01	1.62	0.21	LO	0.16	1.05	
209	20	79	100	130.	100	0.586E-01	0.23	0.03	LO	0.00	0.03	LO
210	73	90	100	170.	100	0.732E-01	3.12	0.40	LO	0.60	3.55	
211	80	81	100	120.	100	0.517E-01	1.71	0.22	LO	0.14	1.16	
212	61	60	100	180.	100	0.776E-01	0.29	0.04	LO	0.01	0.04	LO
213	56	54	250	60.	110	0.275E-03	56.26	1.15		0.48	7.25	
214	42	59	250	80.	110	0.333E-03	26.32	0.54		0.14	1.78	
215	12	71	250	160.	110	0.666E-03	44.34	0.90		0.73	4.67	
216	13	74	150	300.	100	0.179E-01	12.00	0.68		1.79	5.96	

ANNEX TABLE IX-C-8 (Continued)

PIPE NO	NODES FROM-TO		DIA MM	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/1000	CK
217	16	82	150	1500.	100	0.897E-01	4.36	0.25	LO	1.33	0.89	
218	17	83	250	350.	110	0.146E-02	48.55	0.99		1.93	5.52	
219	82	85	250	600.	110	0.250E-02	41.95	0.85		2.53	4.21	
220	85	86	250	1250.	110	0.521E-02	41.89	0.85		5.25	4.20	
221	84	83	250	600.	110	0.250E-02	36.12	0.74		1.92	3.19	
222	85	86	250	600.	110	0.250E-02	26.35	0.54		1.06	1.77	
301	84	87	150	300.	100	0.179E-01	5.77	0.33	LO	0.46	1.54	
302	74	88	150	700.	100	0.419E-01	7.51	0.42		1.75	2.50	
303	0	84	100	2000.	100	0.862E 00	2.52	0.32	LO	4.77	2.39	

ANNEX TABLE IX-C-8 (Continued)

NODE	GROUND ELEV	FLOW	HGL ELEV.	HEAD MTRS	PRESSURE ATM---CK	PRESSURE FCT DROP---CK	
1	7.4	227.10	55.110	47.71	4.62	-12.03	
4	8.0	0.0	54.440	46.44	4.50	-10.57	
5	12.5	-11.92	51.830	39.33	3.80	-4.31	
6	12.0	-23.45	47.400	35.40	3.43	6.83	
7	9.0	-2.20	45.460	36.46	3.53	11.09	
8	12.9	-2.2[illegible]	45.470	32.57	3.15	12.21	
9	12.9	-1.93	45.430	32.58	3.15	12.17	
10	12.0	-1.93	44.870	32.87	3.18	13.49	
11	12.0	-4.33	44.120	32.12	3.11	15.47	
12	12.7	-5.25	42.990	30.29	2.93	18.79	
14	15.0	-1.87	44.750	29.75	2.88	14.99	
15	15.0	-2.92	44.210	29.21	2.83	16.54	
16	20.0	-7.45	40.420	20.42	1.98	31.94	HI
17	15.	-2.23	43.610	28.61	2.77	18.25	
18	14.0	-1.65	43.120	29.12	2.82	19.10	
19	13.5	-2.57	42.750	29.25	2.83	19.87	
20	13.5	-4.25	42.250	28.75	2.78	21.23	
21	13.5	-1.85	41.420	27.92	2.70	23.52	
22	13.5	-1.19	41.360	27.86	2.70	23.68	
23	13.5	-2.33	41.300	27.80	2.69	23.82	
24	13.5	-5.55	40.900	27.40	2.65	24.93	
25	13.0	-5.72	40.470	27.47	2.66	25.76	
26	13.0	-3.25	40.440	27.44	2.66	25.85	
27	13.0	-4.86	40.030	27.03	2.62	26.95	
28	13.	-1.85	39.700	26.70	2.58	27.85	
29	13.0	-3.03	39.280	26.28	2.54	28.93	
30	13.0	-5.90	37.800	24.80	2.40	32.96	HI
31	13.0	-9.03	37.550	24.55	2.38	33.56	HI
32	13.0	-5.59	36.530	23.53	2.32	35.33	HI
33	13.	-4.05	36.250	23.25	2.25	37.16	HI
34	13.	-5.37	36.450	23.45	2.27	36.63	HI
35	13.0	-2.83	42.670	29.67	2.87	19.80	
36	13.0	-4.44	41.850	28.85	2.79	22.04	
37	13.0	-3.81	41.610	28.61	2.77	22.07	
38	13.0	-3.81	41.060	28.06	2.72	24.17	
39	13.0	-3.25	40.290	27.29	2.64	26.24	
40	13.0	-1.82	40.100	27.10	2.62	26.77	
41	13.0	-12.64	39.590	26.59	2.57	28.14	
42	13.0	-1.24	42.820	29.82	2.89	19.42	
43	13.0	-1.22	42.680	29.68	2.87	19.79	
44	13.0	-1.22	42.410	29.41	2.85	20.52	
45	13.0	-1.47	42.300	29.30	2.84	20.80	
46	13.0	-0.72	42.000	29.00	2.81	21.51	
48	13.0	-1.22	42.670	29.67	2.87	19.81	
49	13.0	-1.22	42.560	29.56	2.86	20.12	
51	13.0	-1.22	42.750	29.75	2.88	19.60	
52	13.0	-1.22	42.640	29.64	2.87	19.78	
54	13.0	-3.41	43.260	30.26	2.93	18.21	
55	13.0	-2.[illegible]	43.130	30.13	2.91	18.64	
56	13.0	-2.24	42.870	29.87	2.89	19.27	

ANNEX TABLE IX-C-8 (Continued)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	PRESSURE ATM	CK	PCT DROP	CK
57	13.0	-1.19	42.630	29.63	2.87		19.32	
58	13.0	-1.75	42.240	29.24	2.83		20.08	
59	13.0	-2.35	41.970	28.97	2.80		21.09	
60	13.0	-1.92	41.780	28.78	2.79		22.23	
61	13.0	-2.01	41.240	28.24	2.73		23.07	
62	13.0	-15.44	40.860	27.86	2.70		24.71	
63	13.0	-4.15	40.310	27.31	2.64		26.20	
64	13.0	-2.78	41.560	28.56	2.76		21.74	
65	13.0	-2.73	42.050	29.05	2.81		21.48	
66	13.0	-2.03	43.740	30.74	2.98		16.32	
67	14.0	-4.04	41.210	27.21	2.63		24.42	
68	14.0	-4.04	39.690	25.69	2.49		28.57	
69	14.0	-3.69	39.150	25.15	2.43		30.13	HI
70	14.0	-1.75	39.090	25.09	2.43		30.32	HI
71	13.0	-12.11	42.250	29.25	2.83		20.96	
72	13.0	-2.23	45.370	32.37	3.13		12.50	
73	13.0	-1.12	44.490	31.49	3.05		14.85	
74	13.0	-4.30	34.460	21.46	2.08		42.00	HI
75	13.0	-4.11	49.290	36.29	3.51		1.91	
76	13.0	0.0	45.790	32.79	3.17		11.40	
77	44.0	100.200	47.00	3.00	0.29	LO	50.00	HI
78	13.0	-1.03	45.030	32.03	3.10		13.44	
79	13.0	-1.85	44.870	31.87	3.09		13.86	
80	13.0	-1.42	43.890	30.89	2.99		16.52	
81	13.0	-1.42	43.750	30.75	2.98		16.90	
82	25.	-4.31	39.340	14.34	1.39		43.84	HI
83	15.0	-6.05	41.680	26.68	2.58		23.77	
84	20.0	0.0	33.900	13.90	1.35		53.67	HI
85	20.0	-9.32	31.980	11.98	1.16		60.06	HI
86	20.0	-26.30	30.920	10.92	1.06		53.61	HI
87	20.	-5.77	33.440	13.44	1.30		55.21	HI
88	13.	-7.51	32.710	19.71	1.91		46.73	HI
89	10.0	-2.52	42.630	32.63	3.16		13.42	

ANNEX TABLE IX-C-9

COMPUTER PRINTOUT (CAL-WD)
YEAR 2000 MINIMUM FLOW

CALAMBA WATER DISTRICT 2000 WATER SYSTEM ANALYSIS MINIMUM FLOW COND

INPUT AND OUTPUT IN	LPS
NO OF NODES	33
NO OF PIPES	103
MAX NO OF ITERATIONS	20
PEAKING FACTOR	0.30000
ALLOW P-DROP FR/STATIC - PCT	30.0
STATIC HGL FOR P-DROP CALC	50.0
MAX UNBAL - LPS	0.05000
MAX ALLOW VEL - MPS	3.000
MIN ALLOW VEL - MPS	0.400
MAX ALLOW HL - M/1000 [illegible]	10.00
MIN ALLOW HL - M/1[illegible] M	0.30
MAX ALLOW PRESS - ATM	7.000
MIN ALLOW PRESS - ATM	0.700
NO OF HEADS TO BE READ	1
NO OF UNKNOWN CONSUMPTIONS	1
SUM OF FIXED DEMANDS	-125.00
BANDWIDTH	9

ITER 1 UNBAL 73.78 LPS
ITER 2 UNBAL 18.12 LPS
ITER 3 UNBAL 1.75 LPS
ITER 4 UNBAL 0.85 LPS
ITER 5 UNBAL 0.29 LPS
ITER 6 UNBAL 0.14 LPS

SOLUTION NO. 1 REACHED IN 6 ITERATIONS
[illegible] GPM UNBALANCE

ANNEX TABLE IX-C-9 (Continued)

PIPE NO	NODES FROM-TO		DIA MM	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	CK	--HEADLOSS--- MT	MT/1000	CK
407	14	15	350	140.	120	0.964E-04	66.73	0.69		0.23	1.65	
408	15	17	250	100.	110	0.417E-03	14.73	0.30	LO	0.06	0.61	
409	15	18	250	280.	110	0.117E-02	49.51	1.01		1.60	5.73	
410	18	19	250	230.	110	0.958E-03	52.96	1.08		1.49	6.49	
411	19	20	150	150.	100	0.897E-02	8.73	0.49		0.50	3.31	
412	20	21	150	240.	100	0.144E-01	5.49	0.31	LO	0.34	1.40	
413	21	22	100	100.	100	0.431E-01	0.20	0.03	LO	0.00	0.02	LO
414	21	23	150	70.	100	0.419E-02	4.96	0.28	LO	0.08	1.15	
415	23	24	150	150.	100	0.897E-02	4.32	0.24	LO	0.13	0.90	
417	24	25	150	160.	100	0.957E-02	2.05	0.11	LO	0.04	0.22	LO
418	25	26	100	90.	100	0.388E-01	0.08	0.01	LO	0.00	0.00	LO
420	25	27	150	340.	100	0.203E-01	1.39	0.08	LO	0.04	0.11	LO
428	19	35	250	140.	110	0.583E-03	43.79	0.89		0.64	4.56	
429	20	35	100	60.	100	0.259E-01	2.51	0.32	LO	0.14	2.37	
431	35	36	250	310.	110	0.129E-02	18.23	0.37	LO	0.28	0.90	
432	33	37	100	100.	100	0.431E-01	0.29	0.04	LO	0.00	0.04	LO
433	36	37	250	150.	110	0.625E-03	17.76	0.36	LO	0.13	0.85	
435	37	38	250	160.	110	0.666E-03	7.65	0.16	LO	0.03	0.18	LO
436	38	29	100	100.	100	0.431E-01	0.42	0.05	LO	0.01	0.09	LO
437	38	39	250	340.	110	0.142E-02	6.58	0.13	LO	0.05	0.14	LO
438	27	39	100	100.	100	0.431E-01	0.09	0.01	LO	0.00	0.01	LO
439	39	40	250	130.	110	0.541E-03	6.11	0.12	LO	0.02	0.12	LO
440	40	41	250	100.	110	0.417E-03	7.76	0.16	LO	0.02	0.16	LO
441	41	29	100	100.	100	0.431E-01	0.36	0.05	LO	0.01	0.06	LO
442	41	31	250	830.	110	0.346E-02	5.34	0.11	LO	0.08	0.09	LO
443	42	43	150	60.	100	0.359E-02	5.32	0.30	LO	0.08	1.32	
444	43	44	150	190.	100	0.114E-01	3.29	0.19	LO	0.10	0.54	
445	44	45	150	50.	100	0.299E-02	2.91	0.16	LO	0.02	0.43	
446	45	46	150	120.	100	0.718E-02	2.38	0.13	LO	0.04	0.30	LO
449	43	48	100	60.	100	0.259E-01	1.82	0.23	LO	0.08	1.31	
450	48	49	100	190.	100	0.819E-01	0.53	0.07	LO	0.03	0.13	LO
451	44	49	100	60.	100	0.259E-01	0.16	0.02	LO	0.00	0.02	LO
454	48	51	100	50.	100	0.215E-01	1.08	0.14	LO	0.02	0.49	
455	51	52	100	190.	100	0.819E-01	0.25	0.03	LO	0.01	0.03	LO
456	49	52	100	50.	100	0.215E-01	0.49	0.06	LO	0.01	0.11	LO
459	12	54	250	150.	110	0.625E-03	22.05	0.45		0.19	1.28	
460	54	55	200	60.	110	0.741E-03	1.08	0.03	LO	0.00	0.01	LO
461	51	55	100	60.	100	0.259E-01	0.61	0.08	LO	0.01	0.17	LO
462	55	56	200	190.	110	0.235E-02	1.35	0.04	LO	0.00	0.02	LO
463	52	56	100	60.	100	0.259E-01	0.53	0.07	LO	0.01	0.13	LO
464	56	57	200	560.	110	0.692E-02	1.49	0.05	LO	0.01	0.03	LO
465	45	57	100	190.	100	0.819E-01	0.28	0.04	LO	0.01	0.04	LO
466	57	58	100	90.	100	0.388E-01	1.57	0.20	LO	0.09	1.00	
469	59	64	100	110.	100	0.474E-01	0.78	0.10	LO	0.03	0.27	LO
470	64	65	100	50.	100	0.215E-01	0.30	0.04	LO	0.00	0.05	LO
472	60	61	150	180.	100	0.108E-01	1.90	0.11	LO	0.04	0.20	LO
473	61	62	150	220.	100	0.132E-01	1.55	0.09	LO	0.03	0.13	LO
474	71	65	250	80.	110	0.333E-03	0.37	0.01	LO	0.00	0.00	LO
101	1	2	250	1500.	110	0.135E-01	4.45	0.14	LO	0.29	0.20	LO
102	4	5	450	700.	120	0.142E-03	170.67	1.11		2.05	2.94	

ANNEX TABLE IX-C-9 (Continued)

PIPE NO	NODES FROM	TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	CK	--HEADLOSS--- MT	MT/1000	CK
103	6	7	250	770.	110	0.221E-02	0.38	0.01	LO	0.00	-0.00	LO
104	9	6	250	240.	110	0.100E-02	0.76	0.02	LO	0.00	0.00	LO
105	72	9	450	40.	120	0.810E-05	19.27	0.12	LO	0.00	0.05	LO
106	10	72	450	190.	120	0.385E-04	19.77	0.12	LO	0.01	0.05	LO
107	73	10	450	150.	120	0.304E-04	20.50	0.13	LO	0.01	0.05	LO
108	11	73	450	150.	120	0.304E-04	20.47	0.13	LO	0.01	0.05	LO
109	12	11	350	340.	120	0.234E-03	1.90	0.02	LO	0.00	0.00	LO
110	27	24	150	100.	100	0.598E-02	0.54	0.03	LO	0.00	0.02	LO
111	24	26	150	200.	100	0.120E-01	1.81	0.10	LO	0.04	0.18	LO
112	26	27	150	360.	100	0.215E-01	1.34	0.08	LO	0.04	0.10	LO
113	27	25	150	120.	100	0.718E-02	1.80	0.10	LO	0.02	0.16	LO
114	28	29	150	110.	100	0.658E-02	1.85	0.10	LO	0.02	0.18	LO
115	29	30	150	400.	100	0.239E-01	1.65	0.09	LO	0.06	0.15	LO
116	30	31	150	460.	100	0.275E-01	0.62	0.04	LO	0.01	0.02	LO
117	31	32	250	380.	110	0.158E-02	4.30	0.09	LO	0.02	0.06	LO
118	32	35	150	100.	100	0.598E-02	2.21	0.12	LO	0.03	0.26	LO
119	34	37	150	380.	100	0.227E-01	0.55	0.03	LO	0.01	0.02	LO
120	32	34	150	150.	100	0.897E-02	1.47	0.08	LO	0.02	0.12	LO
121	65	62	250	320.	110	0.133E-02	3.81	0.08	LO	0.02	0.05	LO
122	62	65	200	130.	110	0.161E-02	3.62	0.12	LO	0.02	0.13	LO
123	62	63	250	220.	110	0.916E-03	2.99	0.06	LO	0.01	0.05	LO
124	63	43	250	110.	110	0.458E-03	2.28	0.05	LO	0.00	0.02	LO
125	40	25	150	100.	100	0.431E-01	0.32	0.04	LO	0.01	0.05	LO
126	17	16	150	260.	100	0.155E-01	3.72	0.21	LO	0.18	0.68	
127	68	67	150	400.	100	0.239E-01	4.42	0.25	LO	0.37	0.94	
128	69	68	150	400.	100	0.239E-01	5.11	0.29	LO	0.49	1.23	
129	65	70	150	400.	100	0.239E-01	0.30	0.02	LO	0.00	0.01	LO
130	15	16	150	650.	100	0.389E-01	2.03	0.12	LO	0.14	0.22	LO
131	59	12	250	140.	110	0.583E-03	5.45	0.11	LO	0.01	0.10	LO
132	59	58	250	80.	110	0.333E-03	7.76	0.16	LO	0.01	0.19	LO
133	60	59	250	70.	110	0.292E-03	8.94	0.18	LO	0.02	0.24	LO
134	37	60	250	70.	110	0.292E-03	8.91	0.18	LO	0.02	0.24	LO
135	40	25	150	110.	100	0.658E-02	2.26	0.13	LO	0.03	0.27	LO
136	66	11	250	50.	110	0.208E-03	19.32	0.39	LO	0.05	1.00	
201	1	4	450	180.	120	0.365E-04	176.67	1.11		0.53	2.94	
202	5	75	450	760.	120	0.154E-03	174.62	1.10		2.18	2.87	
203	75	11	350	1140.	120	0.785E-03	67.10	0.70		1.89	1.66	
204	75	76	300	650.	110	0.111E-02	106.82	1.51		6.36	9.79	
205	76	77	300	140.	110	0.240E-03	125.00	1.77		1.83	13.09	HI
206	9	76	450	100.	120	0.203E-04	18.16	0.11	LO	0.00	0.04	LO
207	72	77	100	130.	100	0.560E-01	0.10	0.01	LO	0.00	0.01	LO
208	79	78	100	150.	100	0.646E-01	0.08	0.01	LO	0.00	0.00	LO
209	80	79	100	130.	100	0.560E-01	0.39	0.05	LO	0.01	0.03	LO
210	[illegible]	78	100	170.	100	0.732E-01	0.22	0.03	LO	0.00	0.03	LO
211	81	80	100	120.	100	0.517E-01	0.47	0.06	LO	0.01	0.11	LO
212	77	81	100	180.	100	0.776E-01	0.71	0.09	LO	0.04	0.23	LO
213	54	60	250	66.	110	0.275E-03	20.38	0.42		0.07	1.11	
214	39	42	250	80.	110	0.333E-03	27.58	0.56		0.16	1.94	
215	12	71	250	160.	110	0.666E-03	2.62	0.05	LO	0.00	0.02	LO
216	33	74	150	300.	100	0.179E-01	2.06	0.12	LO	0.07	0.25	LO

ANNEX TABLE IX-C-9 (Continued)

PIPE NO	NODES FROM	NODES TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	VEL MPS	VEL CK	HEADLOSS MT	HEADLOSS MT/1000	HEADLOSS CK
217	16	82	150	1500.	100	0.857E-01	0.75	0.04	LO	0.05	0.04	LO
218	17	63	250	350.	110	0.146E-02	14.35	0.29	LO	0.20	0.58	
219	33	69	250	600.	110	0.250E-02	13.22	0.27	LO	0.30	0.50	
220	65	64	250	1250.	110	0.521E-02	7.18	0.15	LO	0.20	0.16	LO
221	44	65	250	600.	110	0.250E-02	6.19	0.13	LO	0.07	0.12	LO
222	69	66	250	600.	110	0.250E-02	4.51	0.09	LO	0.04	0.07	LO
301	64	87	150	500.	100	0.179E-01	0.99	0.06	LO	0.02	0.06	LO
302	74	88	150	700.	100	0.419E-01	1.29	0.07	LO	0.07	0.10	LO
303	6	89	100	2000.	100	0.802E 00	0.45	0.06	LO	0.18	0.09	LO

ANNEX TABLE IX-C-9 (Continued)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	--------PRESSURE-------- ATM	---CK	PCT DROP	---CK
57	13.0	-0.20	48.970	35.97	3.48		2.79	
58	13.0	-0.29	48.880	35.88	3.47		3.03	
59	13.0	-0.40	48.890	35.89	3.47		2.99	
60	13.0	-0.33	48.910	35.91	3.48		2.94	
61	13.0	-0.34	48.880	35.88	3.47		3.04	
62	13.0	-2.37	48.850	35.85	3.47		3.12	
63	13.0	-0.72	48.840	35.84	3.47		3.14	
64	13.0	-0.48	48.860	35.86	3.47		3.07	
65	13.0	-0.40	48.860	35.86	3.47		3.08	
66	13.0	-0.35	48.920	35.92	3.48		2.93	
67	14.0	-0.69	51.640	37.64	3.64		-4.57	
68	14.0	-0.65	52.620	38.62	3.68		-5.61	
69	14.0	-0.63	52.510	38.51	3.73		-6.97	
70	14.0	-0.33	52.510	38.51	3.73		-6.96	
71	13.0	-2.25	48.860	35.86	3.47		3.08	
72	13.0	-0.39	48.840	35.84	3.47		3.14	
73	13.0	-0.15	48.860	35.86	3.47		3.09	
74	13.0	-0.77	48.620	35.62	3.45		3.72	
75	13.0	-0.73	55.250	42.25	4.08		-14.04	
76	13.0	0.0	48.830	35.83	3.47		3.15	
77	44.0	-125.000	47.000	3.00	0.29	LO	50.00	HI
78	13.0	-0.13	48.840	35.84	3.47		3.14	
79	13.0	-0.32	48.840	35.84	3.47		3.14	
80	13.0	-0.24	48.860	35.86	3.47		3.08	
81	13.0	-0.24	48.870	35.87	3.47		3.04	
82	25.0	-0.75	52.870	27.87	2.70		-11.49	
83	15.0	-1.15	52.810	37.81	3.66		-8.02	
84	20.0	0.0	52.310	32.31	3.13		-7.69	
85	20.0	-1.08	52.230	32.23	3.12		-7.45	
86	20.0	-4.51	52.190	32.19	3.12		-7.31	
87	20.0	-0.59	52.290	32.29	3.13		-7.63	
88	13.0	-1.29	48.560	35.56	3.44		3.90	
89	10.0	-0.43	55.490	45.49	4.70		-23.71	

ANNEX TABLE IX-C-9 (Continued)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
1	7.0	131.12	59.560	52.56	5.09	-23.39
4	8.0	0.0	59.430	51.43	4.98	-22.46
5	12.0	-2.04	57.580	45.58	4.39	-19.42
6	12.0	-4.02	59.070	47.07	4.61	-25.44
7	9.0	-0.33	48.840	39.84	3.86	2.84
8	12.9	-0.33	48.840	35.94	3.48	3.14
9	12.9	-0.34	48.840	35.94	3.48	3.13
10	12.0	-0.34	48.850	36.85	3.57	3.03
11	12.0	-0.75	48.870	36.87	3.57	2.99
12	12.7	-0.91	48.870	36.17	3.50	3.04
14	15.0	-0.32	53.300	38.30	3.71	-9.43
15	15.0	-0.51	53.070	38.07	3.69	-8.77
16	20.0	-1.23	52.920	32.92	3.19	-9.75
17	15.0	-0.33	53.010	38.01	3.68	-8.60
18	14.0	-0.28	51.470	37.47	3.63	-4.07
19	13.5	-0.44	49.970	36.47	3.53	0.07
20	13.5	-0.75	49.480	35.98	3.48	1.43
21	13.5	-0.32	49.140	35.64	3.45	2.35
22	13.5	-0.20	49.140	35.64	3.45	2.36
23	13.5	-0.35	49.060	35.56	3.44	2.57
24	13.5	-1.02	48.930	35.43	3.43	2.94
25	13.0	-0.53	48.890	35.89	3.47	3.00
26	13.0	-0.56	48.890	35.89	3.47	3.00
27	13.0	-0.83	48.850	35.85	3.47	3.10
28	13.0	-0.32	48.830	35.83	3.47	3.16
29	13.0	-0.53	48.810	35.81	3.47	3.21
30	13.0	-1.01	48.750	35.75	3.46	3.37
31	13.0	-1.06	48.740	35.74	3.46	3.40
32	13.0	-0.61	48.720	35.72	3.46	3.46
33	13.0	-0.70	48.690	35.69	3.45	3.53
34	13.0	-0.92	48.700	35.70	3.46	3.51
35	13.0	-0.49	49.340	36.34	3.52	1.80
36	13.0	-0.76	49.060	36.06	3.49	2.55
37	13.0	-0.65	48.930	35.93	3.48	2.90
38	13.0	-0.65	48.900	35.90	3.48	2.98
39	13.0	-0.56	48.850	35.85	3.47	3.10
40	13.0	-0.31	48.840	35.84	3.47	3.14
41	13.0	-2.06	48.820	35.82	3.47	3.19
42	13.0	-0.21	49.180	36.18	3.50	2.21
43	13.0	-0.21	49.100	36.10	3.49	2.43
44	13.0	-0.21	49.000	36.00	3.48	2.71
45	13.0	-0.25	48.980	35.98	3.48	2.77
46	13.0	-0.12	48.940	35.94	3.48	2.86
48	13.0	-0.21	49.020	36.02	3.49	2.64
49	13.0	-0.21	49.000	36.00	3.48	2.71
51	13.0	-0.21	49.000	36.00	3.48	2.71
52	13.0	-0.21	48.990	35.99	3.48	2.73
54	13.0	-0.58	48.990	35.99	3.48	2.73
55	13.0	-0.35	48.990	35.99	3.48	2.74
56	13.0	-0.38	48.980	35.98	3.48	2.75

CHAPTER X FINANCIAL FEASIBILITY ANALYSIS

A. GENERAL

The financial feasibility analysis herein establishes a detailed set of guidelines that the water district management may use in making crucial decisions during the next years. The technical aspects and project cost of the recommended plan have been presented in Chapter IX. Its economic justification follows in Chapter XI. In this chapter, a plan is developed to indicate how and when funds will be used to operate and maintain the system, implement the program, establish reserve funds, and retire indebtedness.

Water rates have been developed on the basis that the system will be financially self-supporting. Capital funds for the recommended plan will be obtained by borrowing from international lending agencies and LWUA. The water rates that have been developed appear to be within the ability-to-pay of the average householder in the water district.

The financial analysis includes only those revenues and disbursements for the proposed construction program from 1978 to 1990 (Immediate Improvements, Phases I-A and Phase I-B). All revenues and disbursements shown between 1990 and 2000 are those directly attributable to continued service and expenses occurring from facilities constructed between 1978 and 1990.

B. THE EXISTING SYSTEM

Personnel

As of December 1976, the CAL-WD employed a total of 14 personnel. Key positions are currently being filled and the quality of the staff is being upgraded to comply with LWUA guidelines in personnel organization.

Water Rates

The present system has a total of 1,098 flat-rate connections. As of January 1977, the water rates were as follow:

Residential/Government		Commercial/Industrial	
1/2"	₱15.00 per month	1/2"	₱ 60.00 per month
3/4"	25.00	3/4"	80.00
		1"	250.00

Financial Statements

From the available income statements for 1977, average monthly[1/] revenue is ₱34,400.00 while average monthly expense is ₱29,000. Income exceeds expenses by only a small margin and will result in deficit if allowances were to be made for depreciation.

1/Monthly revenues and expenses for 1977 of ₱34,400 and ₱29,000, respectively, were obtained from available financial statements. The 1976 operating and maintenance expenses of ₱14,500 per month reflected in Table IX-2 were obtained from the district's budget for the period July - December 1976.

The district is now in the process of installing the Commercial Practices Manual which prescribes detailed accounting procedures. However, historic financial records have not been based on organized basic accounting systems. Therefore, data on the past finances of the present system are inadequate to form a sound basis for future projections. It is therefore necessary to make certain assumptions. The financial feasibility of those assumptions will be tested as the project is implemented.

C. DEVELOPMENT COSTS

The cost estimates of the facilities needed to improve and expand water services of the water district over the development planning period are presented in Chapter IX. Cost estimates of the facilities are based on the projected July 1978 prices.

Project Costs

Project costs of facilities recommended for implementation in Stage I are summarized on an annual basis in Annex Table X-C-1. Engineering services for design and construction supervision are broken down. It has been assumed that 70 percent of the engineering services applies to surveys and design and 30 percent to construction supervision. Design costs are shown in the year preceding construction. Contingencies (15/10 percent) are distributed uniformly during the construction period. Foreign exchange component of total project cost includes cost of direct and indirect import items, as well as a portion of the engineering costs.

Escalation of Costs

To account for the effects of inflation, capital cost estimates are escalated. This has been done year by year on an item-by-item basis using escalation factors computed from assumed inflationary trends and applied to the basic current cost data as shown in Annex Table X-C-2. The escalation factors used are based on an average annual rate of inflation of 10 percent per year from 1978 through 1980, 8 percent from 1981 to 1985 and 6 percent per year thereafter. On the other hand, annual operation and maintenance costs and family income are escalated at a rate of 8 percent all throughout the 23-year study period. These escalation factors have been assumed to apply equally to the local and foreign exchange costs.

D. OPERATING AND MAINTENANCE COSTS

This cost category covers cash expenses required to keep the system operating and adequately maintained. It assures the continued maintenance of the water district's revenue-producing capacity and protection of its investment. Included in this cost category are: personnel, power, chemicals, maintenance, rental, and other miscellaneous expenses which are necessary to run the overall water system. Most items increase in accordance with the quantity of water produced; the number of customers served; and the extent to which the physical plant will be operated and maintained.

The operating costs of the existing and future systems are presented in Chapter IX.

E. FINANCING POLICIES COVERING LOCAL WATER DISTRICT DEVELOPMENT

The following are the major potential sources of funds which can be utilized by the CAL-WD:

Operating Source

To the extent that revenues from the operations of the local water district exceed annual cash requirements for all other purposes, funds can be devoted to financing development costs. As a practical matter, it is highly desirable to finance a significant proportion of development costs in this manner in order to reduce the amount that must be borrowed and the associated debt service costs.

Non-Operating Sources

Non-operating sources of funds for development include 3 basic groups:

1. Loans - funds may be borrowed by the water district for development. One of LWUA's primary functions is lending funds for development to water districts. From the water district's point of view, LWUA is the primary, if not the only realistic, source of funds. LWUA borrows both foreign currencies and pesos at varying terms and relends needed funds to water districts according to the composite terms needed to support the blend of debt service terms LWUA itself must meet. At present, LWUA's terms include:

	Immediate Improvements Loan	Phase I-A and I-B Loan
Interest-	9 percent per annum to be computed at $\frac{3}{4}$ percent per month. Interest due on the local component is paid annually. Interest on foreign exchange is capitalized during construction.	9 percent per annum to be computed monthly at $\frac{3}{4}$ percent per month from the year following the date of disbursement.

	Immediate Improvements Loan	Phase I-A and I-B Loan
	Total loan outstanding at the end of construction period earns another full year interest before re-payment	
Duration -	30-year loan, disbursement assumed made at mid-year, thus will earn interest for 6 months.	30-year loan from the date of initial disbursement.
Principal -	amortized equally for 30 years to start one year after construction.	No principal payments due during construction periods (Construction periods of Stage I-Phases A and B are explained in Chapter IX). Principal repayment period is 30 years less the duration of the disbursement period.

2. Charges and Assessments - consist of payments made by new customers and benefiting property owners for the costs of specific portions of the facilities being developed. Typically, such charges are made for the costs of new construction and water meters and for all or a portion of the costs of new distribution system extensions. LWUA guidelines suggest that new customers may pay for connections and water meters, but currently do not include an assessment for distribution system costs. For purposes of this analysis, new customers were assumed to be paying for new connections and water meters on a revolving fund basis. These sources are referred to as "contribution in aid of construction" in accounting terminology and have the effect of reducing the amounts to be borrowed. Since many new customers will not be in a position to pay connection fees (or benefit assessment charges) in cash, it will be necessary to provide financing assistance. Present practice is to allow such payments to be made at a flat monthly rate of ₱5.00 over a period of 10 years.
3. Grants or Credits - LWUA has access to loan funds on concessionary terms and is thus able to relend funds at rates that are below market rates. This in itself is a 'credit' available to the local water district borrower. In some countries, the national government makes outright grants to local water districts in recognition of the overall national benefits of having safe and reliable water systems. Another approach is for the government to advance a portion of the funds needed during the early years of development at little or no interest to assist the local utility in building its

financial capacity. This is another form of 'credit' as referred to above. Later, as the revenue base expands and development expenditures decline, the local utility refunds such advances as permitted by its cash position. At the present time, however, the local water district is expected to undertake its development programs with no equity participation by government or assistance other than the LWUA loans.

Reserve Requirements

Since reserve requirements are tied directly to obtaining development loans from LWUA, they are considered as funds required to support capital development. After total revenue requirements are determined, LWUA guidelines suggest that 10 percent be set aside for reserve funds. For purposes of this study, a lower percentage will be used, starting at 3 percent progressively increasing to 10 percent.

F. FUNDS FOR CAPITAL DEVELOPMENT

Once the basic data requirements are met and the financing policies outlined, funds required to cover development costs are then determined. The most important document in this regard is the breakdown of costs as escalated and shown in Annex Table X-C-2.

Depreciable Assets/Depreciation Expenses

Capital assets acquired each year become subject to depreciation in their first full year of service. Thus a pipeline completed in 1978 becomes "depreciable" in 1979. If it has a 50-year life, depreciation continues for 50 years and it is assumed to be retired in the 51st year. The cost of large facilities that require several years to construct is carried as "work-in-process" until completed.

Annex Table X-F-1 shows the water district's assets and depreciable value forecasts, the initial purpose of which is to show the appropriate "depreciable" values for use in calculating replacement costs and annual depreciation expenses. At the same time, year-end book values of assets are shown as well as the value of work-in-process.

Based on the schedule of assets, annual depreciation expenses were calculated and are shown in Annex Table X-F-2.

Revolving Fund for Connections

To assist new customers in financing service connection charges, it is necessary to provide working capital for a revolving fund. It is proposed that LWUA's present policy which provides for the costs to be payable at ₱5.00/month over a 10-year period be increased to ₱6.83 by 1978 to cover the increased unit price of meters. Net inflow funds will be required over a period of 10 years to build sufficient income to support the annual costs of connections. At some future point, income exceeds annual expenditures and the revolving fund can be used to refund the earlier advances of working capital.

Annex Table X-F-3 indicates the working capital requirements. In this table, the two key assumptions are:

a. The monthly installment payments are based on actual costs of constructing service connections and meters; thus, the monthly payments by customers connected to the system in 1981 would be greater than those who would be connected to the system in 1978 to account for the escalation of construction costs.
2. Sixty (60) percent of all new customers would utilize the installment method of financing connection charges.

Revenue Unit Forecast

The present LWUA rate policy incorporates the use of "revenue units" (RU) in determining the basic cost per cubic meter of water to domestic consumers. Commercial and industrial customers are charged twice the unit price for domestic use and wholesale water distributors are charged thrice the basic price. As defined, a "revenue unit" is an arbitrary unit of measure into which discharges from pipes of various sizes are reduced to a 3/8-inch connection by the use of conversion factors.

Thus, the discharge of a 3/8-inch connection (actually a ½-inch connection, but regulated by a water meter to give the discharge of a 3/8-inch connection) is multiplied by 1.0; that of a ½-inch by 2.5; that of a ¾-inch by 4; that of 1-inch by 8; and so forth, to get the total RUs delivered.

Two charges are levied on metered connections — the service charge and the commodity charge. The service charge is the fixed charge which covers the first 10 cum of water. It varies according to the size of the connection. The commodity charge is payment for water consumed after the first 10 cum. The unit price is uniform for every size and type of connection.

Annex Tables X-F-4a and X-F-4b give the revenue unit forecast.

G. ANALYSIS OF WATER RATES

Ability-To-Pay Issue

Presidential Decree No. 198 stipulates that water districts must be financially self-sufficient. In the past, most water systems have not been able to generate sufficient revenues to cover even the operation and maintanance expenses due to various factors including poor pricing schemes, defective collection system and inadequate consumer promotion. The major reason for insufficient revenues, however, is that certain consumers being served by the water district have such low incomes and hence, are not in a financial position to pay the full costs of the system. Therefore, before a water system is improved and expanded, the ability-to-pay of the population targeted to be served, must be ascertained.

Since water districts are not expected to be extended government subsidy, the analysis of the factors affecting ability-to-pay has been significantly simplified. The factors that affect ability-to-pay are the annual income of families covered by the water district and the percentage of their income allocated to water supply.

In March 1975, an informal survey was conducted among Water District General Managers to help gather data needed for the ability-to-pay studies. Questionnaires were distributed to 15 water districts covering provincial areas that differed in size, location and economic conditions.

The answers given by the general managers of the 15 water districts are summarized as follows:

1) Though 10 of the water districts were revenue-producing prior to the change in management of the water district, 13 imposed increased water rates upon takeover.
2) Water consumers generally accepted the increase after some explanations justifying it. Only five received formal complaints about the increased rates while eight received formal complaints about the poor quality of water supply.
3) Ten had difficulty in the collection of water bills primarily due to dissatisfaction of consumers with the water service.
4) Assuming that capital and service improvements were made, the general managers indicated they could increase their rates by as low as 25 percent and as high as 447 percent for the average and below average households.

A formal survey was conducted in April and May, 1975 in the city of Lipa and the Municipality of Tanauan. These pilot areas were selected because (a) they are at present experiencing water supply problems, (b) the income level of their families is similar to that of the national income figure, and (c) they are near Manila, only about 2 hours away by bus.

The survey covered 556 families, classified into 4 income groups. Approximately 28 percent came from the low-income class (below ₱220/month); 55 percent from the middle-income (₱221 – ₱750); 12 percent from the upper-middle-income group; and 5 percent from the high-income group (above ₱1,500).

The table below presents the highlights and pertinent findinds of the survey:

ESTIMATED ABILITY-TO-PAY BY INCOME GROUPING

					Weighted Average
Income Group % Distribution	₱220 28%	₱221-750 55%	₱751-1,500 12%	₱1,500 5%	
Probable Ability-to-Pay on Basis of Improved Service	₱13.50	₱24.50	₱37.00	₱67.50	₱25.00/mo
Estimated Average income	₱220	₱660	₱1,000	₱2,700	₱680/household
Ability-to-Pay Divided by Average Income	6.1%	3.7%	3.7%	2.5%	3.7%

The foregoing table indicates that the low-income group may be able to pay a maximum of ₱13.50 a month for water (about 6.1 percent of their average income). In the extreme end, the high-income group may be able to pay a maximum of ₱67.50 a month for water (only 2.5 percent of their average income). This disparity in the percentage of income allocated to water by the 2 income groups may well be the best argument of those advocating a socialized price structure.

The probable maximum ability-to-pay of the pilot area average household is about ₱25.00 per month.2/

2/ This figure includes appropriate allowances for the respondents understating their income or willingness to pay and the increase in amount they are willing to pay as a result of improved services.

Family Income

In the Survey of Households Bulletin Series No. 34, published July 1973 by the NCSO, Manila, (page 3, Table 5), the following data are given:

	Total Families	Total Urban	Manila and Suburbs	Other Urban Areas	Rural
Median Family Annual Income, Pesos	₱2,454	₱3,972	₱5,202	₱3,650	₱1,954
Size of Sample, Families	6,347	1,913	525	1,388	4,434

The above data are for the 12-month period May 1970 to April 1971, more or less. The figure for "other urban areas", ₱3,650 median family annual income, may approximate, or may be a little less, than the median family income in the areas served with piped water. As the figures cited above show, in general, people in urban areas tend to be financially better off than people in rural areas. The term "urban areas" includes all urban areas in the country. The inhabitants of the central urban area of a city or municipality are expected to be somewhat wealthier than the other areas of the city or municipality.

By July 1976, the annual income for "other urban areas" cited above, escalated at 10 percent per year, would be about ₱6,200/year.

The report, "The Filipino Family, Community, and Nation" by Emma Porio, Frank Lynch and Mary R. Hollensteiner published by the Institute of Philippine Culture of Ateneo de Manila University in April 1975, cites in Table A9, page 99 the results of a survey in April 1974. The families surveyed were distributed among 15 urban areas, and included 373 families in Metro Manila. Excluding the families in Metro Manila, mean monthly income of the remaining 1,599 families was ₱572, or ₱6,864 per year. Escalating this income at an annual rate of 10 percent, by 1 July 1976, it would be an income of about ₱8,510 per year. These 14 urban areas are among the more urbanized in the country. They included, for instance, only 3 municipalities, the other eleven being classified as cities. The median population of the 14 urban areas in the 1970 census was about 70,000.

Based on these data, the mean family income of the people residing in the water service areas of the communities whose water systems are proposed to be improved might be, by 1 July 1976, somewhere between the

₱6,200 per year (developed from the 1970/71 data of the NCSO) and the ₱8,510 per year (developed from the data of Porio, Lynch and Hollensteiner). For lack of other data, the average water-using family may have an income of about ₱7,900 during 1976 (or ₱660 per month, which is close to the Lipa household survey). This is equivalent to an annual income of $1,000 for a family of six or seven.

Initial Rate Determination

Several trials were made to come up with "revenue unit" (RU) prices that can be used for a period of several years. It is good practice for the water district to adjust prices every 3 years or so, instead of annually.

Based on the trials made, the water rates established at 3-year intervals are as follows:

Period	Water Rate (₱/RU)
1978-1980	₱0.75
1981-1983	1.20
1984-1986	1.50
1987-1990	1.80
1991-1994*	1.90
1995-1997*	2.00
1998-2000*	2.10

The first step of ₱0.75/RU was selected as an intermediate rate, in anticipation of the second step (₱1.20/RU) which is indicative of the required cost to make the system financially viable. The rate of ₱1.20/RU in 1982 cost levels is equivalent to ₱0.82 in 1978 prices (based on a 10 percent discount rate). Likewise ₱1.50/RU in 1985 is equivalent to ₱0.77 in 1978 prices.

Feasibility of Charges

The question of feasibility is a matter of analyzing whether or not the customers of the water district are able to pay the required charges both now and in the future in order to obtain safe and reliable water services. Inasmuch as the proposed water rates represent the "mean", determination has been made for that group of households whose income (₱700/mo) also represents the "mean". Probable use of water

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*These rates only cover expenses of debt service and operation and maintenance costs incurred for facilities constructed before 1990. Water rates from 1990-2000 would be higher if the CAL-WD continued to construct additional facilities from 1990 to 2000.

by this group was calculated at 24 cum per month.[3] For present purposes, the study covers consumers with ½-inch connections inasmuch as they comprise the bulk of the domestic/government consumers. Working back, the 1979 rate of ₱0.75 per revenue unit will yield a monthly service charge of ₱18.75. The commodity charge for a 24-cum consumption is ₱10.50 (₱0.75 x 14). For newly connected customers who avail of the 10-year installment plan, monthly expenditure for water will increase by ₱6.83 to account for the service connection charge. Since both water and household incomes increase each year, the impact of the installment charge on the expenditure pattern of the household will decline over the 10-year period of payment. The estimated impact of the increased rates and connection charges on household patterns is shown below for the mid-point of each rate block.

	1979	1982	1985	1989	1993	1996	1999
Escalated income of household earning ₱700/mo in 1976 (8% per year)	880	1,110	1,400	1,900	2,600	3,300	4,100
Expenditure for 24-cum water consumption-service charge (first 10 cum)	18.75	30.00	37.50	45.00	47.50	50.00	52.50
Commodity charge (Rate/RU x 14 cum)	10.50	16.80	21.00	25.20	26.60	28.00	29.40
Income allocation to water for existing consumers (%)	3.3	4.2	4.2	3.7	2.9	2.4	2.0
Connection charge for new customers (₱6.83/mo in 1978)	7.51	9.63	12.13	15.31	19.32	23.01	27.40
Income allocation to water for new customers	4.2	5.1	5.0	4.5	3.6	3.1	2.7

Since the mid-point of the period was selected for comparison, it should be noted that the proportions shown would be slightly higher in the year preceding the mid-point and lower in the succeeding year of each rate block.

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[3] Probable use of water by income groups:

Income Grouping	Below Average	Average	Upper Middle	High	Weighted Mean
Probable Water Use cum/mo	16	24	32	44	23.7

In the example shown above, the proportions of the household income required for water services (except in 1982 and 1985 which are the crucial years) are considered within the upper range limit of the ability-to-pay studies done in Lipa City where willingness to pay fees for improved services was found to be about 3.7 percent of the household income.

In the final analysis, if any significant improvement is to be achieved in the scope and quality of public water service and if the requirement for commercially viable and financially self-supporting water districts is to be maintained, all groups of water customers will have to pay substantially higher charges for water services than they have paid in the past.

Socialized Water Rates

A policy guideline in the structuring of water rate charges is that they must be reasonable and realistic. Since water is a prime commodity both for the poor and the rich, the socialized rate may be determined such that a greater financial burden is carried by those who can afford it(but not to the point that it becomes oppressive to them).

In the preceding sections, specific rates established meet the cash requirements for an improved system, and at the same thime, fall within the average consumer's ability-to-pay. Under this scheme, the cost for the first 10 cum consumed is ₱18.75 and the subsequent consumption, ₱0.75/cum. Thus, the monthly rates for the following water consumption will be:

Usage (cum/mo)	Cost/month (₱)*
16	23.25
18	24.75
20	26.25
22	27.75
24	29.25
30	33.75
32	35.25
44	44.25

The estimated impact on the average income household (assumed to have a monthly 1976 income of ₱660) and the below average income household (assumed to have an adjusted monthly 1976 income of ₱300) is as follows:

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*For ½-inch connection, domestic classification.

Income Level	Projected 1979 Monthly Income	Monthly Usage of Water	Cost of Water/mo	Percent of Income Allocated to Water
Below Average	₱380	16 cum	₱23.25	6.1
Average	830	24 cum	29.25	3.5

The preceding table shows that the financial burden to the below average income group is heavy.

A socialized pricing alternative has been developed to relieve the low income groups of the high financial cost of water with the following rate structure:

first 16 cum/mo at	₱0.85/cum
from 17-24 cum/mo at	1.85/cum
25 or more cum/mo at	2.45/cum

The resulting monthly rates for the various water usages will be:

Usage (cum)	Cost/month (₱)
16	13.60
18	17.30
20	21.00
22	24.70
24	28.40
30	43.10
32	48.00
44	77.40

The corresponding impact on the various income levels is as follows:

Income Level	Projected 1979 Monthly Income	Monthly Usage of Water	Cost of Water/mo	Percent of Income Allocated to Water
Below Average	₱ 380	16 cum	₱13.60	3.6
Average	830	24 cum	28.40	3.4
Upper Middle	1,260	32 cum	48.00	3.8
High	2,910	44 cum	77.40	2.7

The preceding table shows that across the income profile of the community, the monthly costs range from 2.7 - 3.8 percent of household income.

Revenue Forecasts

Estimated future levels of income from water sales are shown in Annex Table X-G-1.

H. FINANCIAL SUMMARY

Several trials have been conducted in developing the forecasts of financial statements of the CAL-WD. These statements are based on the following major assumptions:

1. Reserve Fund: 3 percent of sales for 1978-1990; 6 percent for 1991-1995; and 10 percent for 1996-2000.
2. Uncollectibles: 2 percent of gross revenue requirements for the first year of a new rate application, and 1 percent for the second and third years.
3. Accounts Receivable: equivalent to 3 months of sales.
4. Accounts Payable: equivalent to 2 months of operating expenses.

External Borrowing Required

Annex Table X-H-1 shows a summary of the external borrowing required and the annual debt servicing of the loans. Two separate analyses were made for the immediate improvement loan and the Phase I-A and I-B loans to comply with prevailing LWUA terms.

Borrowing will start in 1978 and continue through 1990. The immediate improvement loan (1978-1980) will amount to ₱6.003 million. The Phase I-A loan will cover the 5-year period 1980-85 inclusive and will amount to ₱16.993 million. The Phase I-B loan will cover the 5-year period 1986-90 inclusive and will be about ₱9.031 million.

The immediate improvement loan of ₱6.003 million consists of ₱5.397 million in escalated capital expenditures (see Table X-C-2) and ₱0.606 capitalized interest. The Stage I loans of ₱16.993 million in 1978 and ₱9.031 million in 1986 include escalated capital expenditures (see Table X-C-2) less revenues from the service connection revolving fund (see Table X-F-3).

Projections of Financial Statements

Annex Table X-H-2 shows the net income (loss) on a yearly basis. Net loss is forecasted in 1980 through 1985. Net income cumulative would show positive values in fifteen of the 23-year study period.

Other related data such as water production, water sales, unaccounted-for-water and rate of return based on net fixed assets in operation are also presented in the table.

Cash Flow Statements

The cash flow statement provides an indication of the adequacy of working capital. It is not generally sufficient to cover cash outlays with revenues because of the tendency of cash receipts to lag behind cash outlays. In general, an expanding organization with an active capital development program and increasing level of activities will require similarly increasing quantities of working capital.

Annex Table X-H-3 presents the annual "Projected Sources and Applications of Funds". Potential net decreases are expected in 1978, 1981 through 1983 and 1996. By 2000, positive net cumulative cash balance will be ₱23,597 million even if "cash at the beginning of 1978" has been assumed equal to zero.

Other Financial Statements

Appendix Table X-H-4 presents the "Projected Balance Sheet" which shows the projected fixed and current assets, liabilities and equity of the water district from 1978 to 2000.

Rate of Return

Discount rate of return on total investments (Annex Table X-H-5) measures the true efficiency of mobilizing investments on the project from a broader perspective. Taken from a different perspective, it measures the effective utilization of total investments employed in the project. It shows what the compounded growth of investment within the project cycle would be based on the interplay of cash outflows and the resulting inflows from such investment.

Net asset salvage value of ₱5.747 million is added to net cash inflow in the year 2000. This is done based on the assumption that the project will terminate in the last projection year. Hence, assets are to be liquidated and all liabilities are to be paid from the proceeds of the assets.

Several trials were made in finding the rate of interest that equated the present value of the cash inflows to the unrecovered investments. In the CAL-WD, the rate of return, with the assumptions made, is estimated to be 8.41 percent.

I. FINANCIAL RECOMMENDATIONS

1. The water district should establish a revolving fund to assist new customers in financing service connection charges.
2. The proposed water rates (for domestic consumers) to effect self-sufficiency are as follows:

Period	Water Rate ₱/RU
1978–1980	₱0.75
1981–1983	1.20
1984–1986	1.50
1987–1990	1.80
1991–1994*	1.90
1995–1997*	2.00
1998–2000*	2.10

It is recommended, however, that in the implementation of these rates, the water district follow the socialized pricing approach which will generate the same amount of income to meet its requirements.

3. The recommended plan for the first construction phase (Phase I-A) of CAL-WD is financially feasible. Borrowing for that period would be ₱16.993 million.

External borrowing would still be necessary for the Phase I-B period.

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*This rate is recommended to cover expenses incurred by implementing and operating facilities included in immediate improvement program and Phase I only.

ANNEX X-C

DEVELOPMENT COSTS

ANNEX TABLE X-C-1

PROJECT COST OF RECOMMENDED PROGRAM
CALAMBA WATER DISTRICT
WITHOUT ESCALATION
(₱ x 1,000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Source Facilities														
a) Equipment	21	63	61	1,167				4	60					1,376
b) Structure	25	76	250	1,239										1,590
Distribution Facilities	76	226	2,221	2,222				171	1,257	1,257				7,430
Administration Bldg. & Plumbing Shop	15	43	860											918
Service Connections														
a) Pipes	16	47	304	304	303	303	303	364	355	355	355	354	354	3,717
b) Meters	4	13	83	83	83	82	82	105	135	135	135	135	134	1,209
Internal Network	17	49	-	380	380	380	380	397	92	92	92	92	92	2,443
Fire Hydrants	2	7	-	54	54	54	54	66	64	64	64	64	64	611
Feasibility Studies[1]	51		195											246
Immediate Improvements														
a) Source Facilities Equipment	73													73
b) Storage Facilities	25													25
c) Distribution Facilities	1,870	1,647												3,517
d) Service Connections														
1. Pipes	416	389												805
2. Meters	264	247												511
e) Administrative & Miscellaneous	117													117
f) Vehicles	69													69
Sub-Total[2]	3,061	2,807	3,974	5,449	820	819	819	1,107	1,963	1,903	646	645	644	24,657
Land	-	-	172	-	-	-	-	-	-	-	-	-	-	172
TOTAL PROJECT COST[3]	3,061	2,807	4,146	5,449	820	819	819	1,107	1,963	1,903	646	645	644	24,829

[1] Computed at approximately 1% of the total project cost.
[2] Includes design (first year of each major segment of development), supervision of construction and contingencies spread uniformly during the period of construction.
[3] Does not include interest during construction. For calculated interest see Table X-H-1.

ANNEX TABLE X-C-2

PROJECT COST OF RECOMMENDED PROGRAM
CALAMBA WATER DISTRICT
WITH ESCALATION
(₱ x 1,000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Escalation Factor	1.000	1.100	1.210	1.307	1.412	1.525	1.647	1.779	1.886	1.999	2.119	2.246	2.381	
Source Facilities														
a) Equipment	21	69	74	1,526				7	113					1,810
b) Structure	25	84	302	1,619										2,030
Distribution Facilities	76	249	2,687	2,904				304	2,371	2,513				11,104
Administration Bldg. & Plumbing Shop	15	47	1,041											1,103
Service Connections														
a) Pipes	16	52	368	397	428	462	499	648	670	710	752	795	843	6,640
b) Meters	4	14	100	108	117	125	135	187	255	270	286	303	319	2,223
Internal Network	17	54		497	537	580	626	706	174	184	195	207	219	3,996
Fire Hydrants	2	8		71	76	82	89	117	121	128	136	144	152	1,126
Feasibility Studies	51		236											287
Immediate Improvements														
a) Source Facilities	73													73
b) Storage Facilities	25													25
c) Distribution Facilities	1,870	1,812												3,682
d) Service Connections														
1. Pipes	416	428												844
2. Meters	264	272												536
e) Administrative & Miscellaneous	117													117
f) Vehicles	69													69
Sub-Total	3,061	3,089	4,808	7,122	1,158	1,249	1,349	1,969	3,704	3,805	1,369	1,449	1,533	35,665
Land	-	-	208											208
TOTAL PROJECT COST	3,061	3,089	5,016	7,122	1,158	1,249	1,349	1,969	3,704	3,805	1,369	1,449	1,533	35,873

ANNEX X-F

FUNDS FOR CAPITAL DEVELOPMENT

ANNEX TABLE X-F-1

ASSET AND DEPRECIABLE VALUE FORECAST
CALAMBA WATER DISTRICT
(₱ x 1000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
I. ASSETS ADDED BY YEAR END																							
Source Facilities a) Equipment	21	69	74	1526				7	113														
b) Structure	25	84	302	1619																			
Distribution Facilities	76	249	2687	2904				304	2371	2513													
Administration Bldg. and Plumbing Shop	15	47	1041																				
Service Connection a) Pipes	16	52	368	397	428	462	499	648	670	710	752	795	843										
b) Meters	4	14	100	108	117	125	135	187	255	270	286	303	319										
Internal Network	17	54		497	537	580	626	706	174	184	195	207	219										
Fire Hydrants	2	8		71	76	82	89	117	121	128	136	144	152										
Feasibility Studies	51		236																				
Immediate Improvements a) Source Facilities																							
1. Equipment	73																						
b) Storage Facilities	25																						
c) Distribution Facilities	1870	1812																					
d) Service Connection																							
1. Pipes	416	428																					
2. Meters	264	272																					
e) Administrative and Miscellaneous	117																						
f) Vehicles	69																						
Replacements a) Source Facilities – Equipment																193			3941				
b) Administrative and Miscellaneous																320							
c) Service Connection – Meters																700	742	264	280	297	311	330	350
d) Vehicles								119							179							270	
e) Storage Facilities														61									
Total Assets Added By Year End	3061	3089	4808	7122	1158	1249	1349	2088	3704	3805	1369	1449	1533	61	179	1213	742	264	4221	297	311	600	350
II. DEPRECIABLE VALUES																							
A. 50 Years Service Life																							
Existing Facilities	2064	2064	572	465	397	329	261	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193	193
Source Facilities – Structure	–	25	109	411	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030	2030
Distribution Facilities	–	1946	4007	6694	9598	9598	9598	9598	9902	12273	14786	14786	14786	14786	14786	14786	14786	14786	14786	14786	14786	14786	14786
Administration Bldg. and Plumbing Shop	–	15	62	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103
Service Connection – Pipes	–	432	912	1280	1677	2105	2567	3066	3714	4384	5094	5846	6641	7484	7484	7484	7484	7484	7484	7484	7484	7484	7484
Internal Network	–	17	71	71	568	1105	1685	2311	3017	3191	3375	3570	3777	3996	3996	3996	3995	3996	3995	3996	3996	3996	3996
Fire Hydrants	–	2	10	10	81	157	239	328	445	566	694	830	974	1126	1126	1126	1126	1126	1126	1126	1126	1126	1126
Total 50 Years Life	2064	4501	5743	10034	15454	16427	17483	18629	20404	23740	27275	28358	29504	30718	20718	30718	30718	30718	30718	30718	30718	30718	30718
B. 30 Years Service Life																							
Feasibility Studies	–	51	51	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287
Total 30 Years Life	–	51	51	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287

ANNEX TABLE X-F-1 (Continued)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
C. 15 Years Service Life																							
Source Facilities – Equipment	–	94	163	237	1763	1763	1763	1763	1770	1883	1883	1883	1883	1883	1883	1883	1982	1913	1839	4254	4254	4254	4254
Service Connection – Meters	–	268	554	654	762	879	1004	1139	1326	1551	1851	2137	2440	2759	2759	2759	3191	3647	3811	3983	4163	4349	4544
Administrative and Miscellaneous	–	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	320	320	320	320	320	320	320
Total 15 Years Life	–	479	834	1008	2642	2759	2884	3019	3213	3581	3851	4137	4440	4759	4759	4759	5493	5880	5970	8557	8737	8923	9118
D. 13 Years Service Life																							
Storage Facilities	–	25	25	25	25	25	25	25	25	25	25	25	25	25	61	61	61	61	61	61	61	61	61
Total 13 Years Life	–	25	25	25	25	25	25	25	25	25	25	25	25	25	61	61	61	61	61	61	61	61	61
E. 7 Years Service Life																							
Vehicles	–	69	69	69	69	69	69	69	119	119	119	119	119	119	119	179	179	179	179	179	179	179	270
Total 7 Years Life	–	69	69	69	69	69	69	69	119	119	119	119	119	119	119	179	179	179	179	179	179	179	270
TOTAL DEPRECIABLE VALUES	2064	5125	6722	11423	18477	19567	20748	22029	24068	27752	31557	32926	34375	35908	35944	36004	36738	37125	37215	39802	39982	40168	40254
TOTAL BOOK VALUE OF ASSETS OTHER THAN LAND	5125	8214	11530	18545	19635	20816	22097	24117	27752	31557	32926	34375	35908	35969	36423	37217	37480	37389	41436	40099	40293	40768	40804
LAND	–	–	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208
TOTAL BOOK VALUE OF ALL CAPITAL ASSETS	5125	8214	11738	18753	19843	21024	22305	24325	27960	31765	33134	34583	36116	36177	36331	37425	37688	37597	41644	40307	40501	40976	41012

ANNEX TABLE X-F-2

SCHEDULE OF DEPRECIATION EXPENSES
CALAMBA WATER DISTRICT
(₱ x 1000)

Year	Service Life Category: 50 Yrs	30 Yrs	15 Yrs	13 Yrs	7 Yrs	Total Annual Deprec. Expenses	Accum. Deprec. Prior Year	Book Value of Assets Retired During The Year: 50 Yrs	15 Yrs	13 Yrs	7 Yrs	Total	Net Accum. Deprec. Year End
1978	41	–	–	–	–	41	1,844					–	1,885
1979	90	2	32	2	10	136	1,885						2,021
1980	115	2	56	2	10	185	2,021	1,492				1,492	714
1981	201	10	67	2	10	290	714	107				107	897
1982	309	10	76	2	10	507	897	68				68	1,336
1983	329	10	84	2	10	535	1,336	68				68	1,803
1984	350	10	192	2	10	564	1,803	68				68	2,299
1985	373	10	201	2	10	596	2,299	68				68	2,827
1986	408	10	214	2	17	651	2,827				69	69	3,409
1987	475	10	239	2	17	743	3,409					–	4,152
1988	546	10	256	2	17	831	4,152					–	4,983
1989	567	10	276	2	17	872	4,983					–	5,855
1990	590	10	296	2	17	915	5,855					–	6,770
1991	614	10	317	2	17	960	6,770					–	7,730
1992	614	10	317	5	17	953	7,730			25		25	8,668
1993	614	10	317	5	26	972	8,668				119	119	9,521
1994	614	10	366	5	26	1,021	9,521		479			479	10,063
1995	614	10	392	5	26	1,047	10,063		355			355	10,755
1996	614	10	398	5	26	1,053	10,755		174			174	11,634
1997	614	10	571	5	26	1,226	11,634		1,634			1,634	11,226
1998	614	10	583	5	26	1,238	11,226		117			117	12,347
1999	614	10	595	5	26	1,250	12,347		125			125	13,472
2000	614	10	608	5	38	1,275	13,472		135		179	314	14,433

ANNEX TABLE X-F-3

WORKING CAPITAL REQUIREMENTS FOR REVOLVING FUND FOR NEW CONNECTIONS CALAMBA WATER DISTRICT

Year	Number of New Connections	Number of Installment Plan Added	Number of Installment Plan Paid	Total Paying Monthly Installment (Cumulative)	Monthly Installment Plan (Escalated)	P x 1,000: Increment Added 4/	Increment Deducted 5/	Cash Receipts: Lump Sum Payments 6/ (Escalated)	Cash Receipts: Installment Payments (Cumulative)	Cash Receipts: Total Receipts	Annual Construction Cost 7/	Working Capital Required	Cumulative Capital Requirements
1978	412	247		247	6.83	20		104	10	114	261	147	147
1979	412	247		494	7.51	22		115	31	146	267	141	288
1980	321	193		687	8.26	19		93	52	150	246	96	384
1981	321	193		880	8.92	21		105	72	178	265	88	472
1982	321	193		1,073	9.63	22		115	93	208	267	79	551
1983	321	193		1,266	10.40	24		124	116	240	310	70	621
1984	321	193		1,459	11.23	26		134	141	275	335	60	681
1985	321	193		1,652	12.13	28		144	168	312	361	49	730
1986	525	315		1,967	12.86	49		251	207	458	627	169	899
1987	525	315		2,282	13.63	52		266	257	523	564	141	1,040
1988	525	315	124	2,473	14.45	55	10	282	301	583	704	121	1,161
1989	525	315	247	2,541	15.31	58	21	298	336	634	746	112	1,273
1990	525	315	220	2,636	16.23	61	21	316	315	631	791	160	1,433
1991			193	2,443	17.20		20		385	385		(385)	1,048
1992			193	2,250	18.23		22		363	363		(363)	1,070
1993			193	2,057	19.32		23		340	340		(340)	730
1994			193	1,864	20.48		25		315	315		(315)	415
1995			193	1,671	21.71		27		288	288		(288)	127
1996			254	1,417	23.01		39		249	249		(249)	(122)
1997			315	1,102	24.39		51		198	198		(198)	(320)
1998			315	787	25.85		54		144	144		(144)	(464)
1999			315	472	27.40		57		87	87		(87)	(551)
2000			315	157	29.04		60		27	27		(27)	(578)

4/ Accumulated installment payments are calculated on the basis of 100 percent incremental additions during previous years and 50 percent of the last year.

5/ Based on the assumption that installment plan will be paid back in ten years.

6/ Assumed to be 40 percent of construction cost.

7/ Amount to be shouldered by the customers which is 2/3 of pipes + meters.

ANNEX TABLE X-F-4a

STRATIFICATION OF SERVICE CONNECTION
CALAMBA WATER DISTRICT

Year	Domestic/Government 1/2"	3/4"	1"	Sub-Total	Commercial/Industrial 1/2"	3/4"	1"	Sub-Total	Total
1978	917	39	10	966	99	21	12	132	1,098
1980	1,606	68	17	1,691	173	37	21	231	1,922
1985	3,217	135	34	3,386	346	74	42	462	3,848
1990	5,411	228	57	5,696	583	124	70	777	6,473

ANNEX TABLE X-F-4b[8]

REVENUE UNIT FORECAST

Year	Domestic/Government 1/2" (2.5)	3/4" (4.0)	1" (8.0)	Sub-Total	Commercial/Industrial 1/2" (5.0)	3/4" (8.0)	1" (16.0)	Sub-Total	Grand Total[9]	Service Charge (RUs)[10]	Estimated Consumption (cum/year) Domestic	Commercial	Commodity Charge (RUs) Domestic[11]	Commercial[12]	Total Revenue Units
1978	2,293	156	80	2,529	495	168	192	855	3,384	406,080	343,100	37,960	227,180	44,240	677,500
1980	4,015	272	136	4,423	865	296	336	1,497	5,920	710,400	505,160	75,555	302,240	95,670	1,108,310
1985	8,043	540	272	8,855	1,730	592	672	2,994	11,849	1,421,880	967,980	151,475	561,660	192,070	2,175,610
1990	13,528	912	456	14,896	2,915	992	1,120	5,027	19,923	2,390,760	1,834,125	312,440	1,150,605	438,400	3,979,765

8/ Computation of revenue units based on LWUA guidelines on structuring of water rates.
9/ Grand total of number of connections multiplied by their respective conversion factors for computing revenue units (in RUs).
10/ Multiply grand total by 120 (derived from 10 cum/month, the minimum amount covered by the service charge x 12 months/year) in RUs.
11/ Domestic consumption - (120 x number of domestic connections)/ x use factor. Use factor for domestic/institutional classification is 1.
12/ Commercial consumption - (120 x number of commercial connections)/ x use factor. Use factor for commercial classification is 2.

ANNEX X-G

ANALYSIS OF WATER RATES

ANNEX TABLE X-G-1

REVENUE FORECASTS
CALAMBA WATER DISTRICT

Year	Rate/RU ₱	Estimated Number of R.U.s (Yearly) (in 000s)	₱ x 1000 Income from Sales	(Bad Debt)	Other[13/] Income	Total Net Income
1976						
1977						
1978	678	0.75	509	10	10	509
1979	893	0.75	670	7	13	676
1980	1,108	0.75	831	8	17	840
1981	1,322	1.20	1,586	32	32	1,586
1982	1,535	1.20	1,842	18	37	1,861
1983	1,749	1.20	2,099	21	42	2,120
1984	1,962	1.50	2,943	59	59	2,943
1985	2,176	1.50	3,264	33	65	3,296
1986	2,537	1.50	3,806	38	76	3,844
1987	2,898	1.80	5,216	104	104	5,216
1988	3,258	1.80	5,864	59	117	5,922
1989	3,619	1.80	6,514	65	130	6,579
1990	3,980	1.80	7,164	72	143	7,235
1991		1.90	7,562	151	151	7,562
1992		1.90	7,562	76	151	7,637
1993		1.90	7,562	76	151	7,637
1994		1.90	7,562	76	151	7,637
1995		2.00	7,960	159	159	7,960
1996		2.00	7,960	80	159	8,039
1997		2.00	7,960	80	159	8,039
1998		2.10	8,358	167	167	8,358
1999		2.10	8,358	84	167	8,441
2000	3,980	2.10	8,358	84	167	8,441

[13/] Other income (derived from meter replacement charges, contingency fees of new connections, service fees, etc.), is about 2% of sales.

ANNEX X-H

FINANCIAL SUMMARY

ANNEX TABLE X-H-1

DEBT SERVICE SCHEDULE OF TOTAL PROJECT LOAN
CALAMBA WATER DISTRICT
(₱ x 1000)

Year	Outstanding Loan End of Year			Capital Repayments			Interest Payments			Total Debt Service
	Immediate Improvement	Phase I-A and I-B	Total	Immediate Improvement	Phase I-A and I-B	Total	Immediate Improvement	Phase I-A and I-B	Total	
1978	2,961	62	3,023	-	-	-	54	-	54	54
1979	5,696	493	6,189	-	-	-	157	6	163	163
1980	6,003	5,359	11,362	-	-	-	205	44	249	249
1981	5,959	12,303	18,262	44	-	44	540	482	1,022	1,066
1982	5,911	13,253	19,164	48	-	48	536	1,107	1,643	1,691
1983	5,859	14,262	20,121	52	-	52	532	1,193	1,725	1,777
1984	5,802	15,336	21,138	57	-	57	527	1,284	1,811	1,868
1985	5,740	16,993	22,733	62	-	62	522	1,380	1,902	1,964
1986	5,673	20,112	25,785	67	127	194	517	1,529	2,046	2,240
1987	5,600	23,267	28,867	73	127	200	511	1,810	2,321	2,521
1988	5,520	23,926	29,446	80	127	207	504	2,094	2,598	2,805
1989	5,433	24,550	29,983	87	191	278	497	2,153	2,650	2,928
1990	5,338	25,261	30,599	95	191	286	489	2,210	2,699	2,985
1991	5,234	25,002	30,236	104	259	363	480	2,273	2,753	3,116
1992	5,121	24,615	29,736	113	387	500	471	2,250	2,721	3,221
1993	4,998	24,228	29,226	123	387	510	461	2,215	2,676	3,186
1994	4,864	23,679	28,543	134	549	683	450	2,181	2,631	3,314
1995	4,718	23,130	27,848	146	549	695	438	2,131	2,569	3,264
1996	4,559	22,455	27,014	159	675	834	425	2,082	2,507	3,341
1997	4,385	21,712	26,097	174	743	917	410	2,021	2,431	3,348
1998	4,196	20,969	25,165	189	743	932	395	1,954	2,349	3,281
1999	3,990	20,159	24,149	206	810	1,016	378	1,887	2,265	3,281
2000	3,765	19,221	22,986	225	938	1,163	359	1,814	2,173	3,336

ANNEX TABLE X-H-2

PROJECTED INCOME STATEMENT
CALAMBA WATER DISTRICT
(₱ x 1000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Water Production per Year (1,000 x cum)	953		968					1702					2989										2989
Water Sales per Year (1,000 x cum)	381		581					1119					2147										2147
Unaccounted-for-water (%)	60		50					34					28										28
Connections – Metered	1098		1922					3648					6473										6473
Consumption (lpcd)	117		120					128					135										135
OPERATING REVENUE																							
Water Sales	509	670	831	1586	1842	2099	2943	3264	3806	5216	5864	6514	7164	7562	7562	7562	7562	7960	7960	7960	8358	8358	8358
Less: Uncollectibles	10	7	8	32	18	21	59	33	38	104	59	65	72	151	76	76	76	159	80	80	167	84	84
Other Revenue	10	13	17	32	37	42	59	65	76	104	117	130	143	151	151	151	151	159	159	159	167	167	167
Total Revenue	509	676	840	1586	1861	2120	2943	3296	3844	5216	5922	6579	7235	7562	7637	7637	7637	7960	8039	8039	8358	8441	8441
OPERATING EXPENSES																							
Administration and Personnel	109	157	212	266	301	403	445	479	638	690	745	883	987	1065	1151	1241	1343	1449	1566	1692	1825	1970	2130
Power and Fuel	50	56	64	79	96	115	137	161	189	220	254	293	336	363	392	423	458	494	534	577	622	672	726
Chemicals	3	7	11	15	19	23	28	34	40	48	56	65	75	81	88	95	103	111	120	129	139	150	163
Maintenance	43	57	105	130	158	167	177	182	221	259	274	296	306	330	357	385	416	449	486	524	566	611	660
Miscellaneous	9	10	67	74	81	90	100	110	122	136	151	168	218	236	255	275	297	321	347	375	404	436	472
Depreciation	41	136	185	290	507	535	564	596	651	743	831	872	915	960	963	972	1021	1047	1053	1226	1238	1250	1275
Total Operating Expenses	255	423	644	854	1152	1333	1451	1562	1861	2096	2311	2577	2837	3035	3206	3391	3638	3871	4106	4523	4784	5089	5426
Operating Income	254	253	196	732	699	787	1492	1734	1983	3120	3611	4002	4393	4527	4431	4246	3999	4089	3933	3516	3564	3352	3015
Plus: Interest on Reserves	1	3	6	11	18	26	37	50	65	84	107	133	167	209	273	337	401	466	555	666	780	897	1014
Net Income Before Interest	255	256	202	743	717	813	1529	1784	2048	3204	3718	4135	4560	4736	4704	4583	4400	4555	4488	4182	4344	4249	4029
Interest on Debt	54	163	249	1022	1643	1725	1811	1902	2046	2321	2598	2650	2699	2753	2721	2676	2631	2569	2507	2431	2349	2265	2173
Net Income (Loss)	201	93	(47)	(279)	(926)	(912)	(282)	(118)	2	883	1120	1485	1861	1983	1983	1907	1769	1986	1981	1751	1995	1984	1856
Cumulative Net Income (Loss)	201	294	247	(32)	(958)	(1870)	(2152)	(2270)	(2268)	(1385)	(265)	1220	3081	5064	7047	8954	10723	12709	14690	16441	18436	20420	22276
Appropriation to Reserves	15	20	25	48	55	63	88	98	114	156	178	195	215	454	454	454	454	478	796	796	836	836	836
Average Net Fixed Assets in Operation	1768	4904	9061	15046	18787	19470	20219	21358	23630	26688	28488	29045	29643	29503	28661	28389	28370	27839	29032	30151	29223	28435	27647
Rate of Return (%)	14.4	5.6	2.2	4.9	3.7	4.0	7.4	8.1	8.4	11.7	12.7	13.8	14.8	15.3	15.5	15.0	14.1	14.7	13.5	11.7	12.2	11.8	10.9

ANNEX TABLE X-H-3

PROJECTED SOURCES AND APPLICATIONS OF FUNDS
CALAMBA WATER DISTRICT
(₱ x 1000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
SOURCES OF FUNDS												
Net Income Before Interest	255	256	202	743	717	813	1529	1784	2048	3204	3718	4135
Add: Depreciation	41	136	185	290	507	535	564	596	651	743	831	872
Total Internal Cash Generation	296	392	387	1033	1224	1348	2093	2380	2699	3947	4549	5007
Long-Term Borrowing	3023	3166	5173	6944	950	1009	1074	1657	3246	3282	786	815
Capital Contributions	114	146	150	178	208	240	275	312	458	523	583	634
Total External Cash Generation	3137	3312	5323	7122	1158	1249	1349	1969	3704	3805	1369	1449
Total Sources of Funds	3433	3704	5710	8155	2382	2597	3442	4349	6403	7752	5918	6456
APPLICATIONS OF FUNDS												
Capital Expenditures	3061	3089	5016	7122	1158	1249	1349	1969	3704	3805	1369	1449
Capitalized Interest	76	223	307									
Debt Service: Interest	54	163	249	1022	1643	1725	1811	1902	2046	2321	2598	2650
Principal	–	–	–	44	48	52	57	62	194	200	207	278
Sub-Total	54	163	249	1066	1691	1777	1868	1964	2240	2521	2805	2928
Replacements								119				
Increase in Working Capital	301	52	(64)	179	67	55	203	143	125	334	174	148
Total Applications of Funds	3492	3527	5508	8367	2916	3081	3420	4195	6069	6660	4348	4525
INCREASE (DECREASE) IN CASH BALANCE	(59)	177	202	(212)	(534)	(484)	22	154	334	1092	1570	1931
CASH BALANCE BEGINNING OF YEAR	0	(59)	118	320	108	(426)	(910)	(888)	(734)	(400)	692	2262
CASH BALANCE END OF YEAR	(59)	118	320	108	(426)	(90)	(888)	(734)	(400)	692	2262	4193
DEBT-SERVICE RATIO (TIMES)	5.48	2.40	1.55	0.97	0.72	0.76	1.12	1.21	1.20	1.57	1.62	1.71
RATIO OF INTERNALLY GENERATED CASH LESS DEBT SERVICE TO CAPITAL EXPENDITURE (%)	7.7	6.9	2.6	–	–	–	16.7	21.1	12.4	37.5	127.4	143.5

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SOURCES OF FUNDS											
Net Income Before Interest	4560	4736	4704	4583	4400	4555	4488	4182	4344	4249	4029
Add: Depreciation	915	960	963	972	1021	1047	1053	1226	1238	1250	1275
Total Internal Cash Generation	5475	5676	5667	5555	5421	5602	5541	5408	5582	5499	5304
Long-Term Borrowing	902										
Capital Contributions	631	385	363	340	315	288	249	198	144	87	27
Total External Cash Generation	1533	385	363	340	315	288	249	198	144	87	27
Total Sources of Funds	7008	6031	6030	5895	5736	5890	5790	5606	5726	5586	5331
APPLICATIONS OF FUNDS											
Capital Expenditures	1533										
Capitalized Interest											
Debt Service: Interest	2699	2753	2721	2676	2631	2569	2507	2431	2349	2265	2173
Principal	286	363	500	510	683	695	834	917	932	1016	1163
Sub-Total	2985	3116	3221	3186	3314	3264	3341	3348	3281	3281	3336
Replacements		61	179	1213	742	264	4221	297	311	600	350
Increase in Working Capital	148	(331)	(7)	207	(17)	(113)	(10)	(32)	43	(16)	(41)
Total Applications of Funds	4666	2846	3393	4606	4039	3415	7552	3613	3635	3865	3645
INCREASE (DECREASE) IN CASH BALANCE	2342	3235	2637	1289	1697	2475	(1762)	1993	2091	1721	1686
CASH BALANCE BEGINNING OF YEAR	4193	6535	9770	12407	13696	15393	17868	16106	18099	20190	21911
CASH BALANCE END OF YEAR	6535	9770	12407	13696	15393	17868	16100	18099	20190	21911	23597
DEBT-SERVICE RATIO (TIMES)	1.83	1.83	1.76	1.74	1.64	1.72	1.66	1.62	1.70	1.68	1.59
RATIO OF INTERNALLY GENERATED CASH LESS DEBT SERVICE TO CAPITAL EXPENDITURE (%)	162.4										

ANNEX TABLE X-H-4

PROJECTED BALANCE SHEET
CALAMBA WATER DISTRICT
(₱ x 1000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
ASSETS												
Fixed Assets:												
Gross Value of Fixed Assets	5201	8513	12344	19559	20449	21630	22911	24931	28566	37371	33740	35189
Less: Accumulated Depreciation	1885	2021	714	897	1336	1803	2299	2827	3409	4152	4983	5855
Net Value of Fixed Assets	3316	6492	11630	18462	19113	19827	20612	22104	25157	28219	28757	29334
Work in Process												
Total Fixed Assets												
Current Assets:												
Cash	(59)	118	320	108	(426)	(310)	(883)	(734)	(400)	692	2262	4193
Accounts Receivable	127	167	208	397	461	525	736	816	952	1304	1466	1629
Provision for Bad Debt	3	2	2	8	5	5	15	8	10	26	15	16
Inventories	213	236	160	173	188	203	220	289	321	343	365	388
Total Current Assets	278	519	686	670	218	(187)	53	363	863	2313	4078	6194
Total Assets	3594	7011	12316	19132	19331	19640	20665	22467	26020	30532	32835	35528
EQUITY AND LIABILITIES												
Current Liabilities:												
Accounts Payable	36	48	77	94	109	133	148	161	202	226	247	284
Current Maturities on Long-Term Debt	–	–	44	48	52	57	62	194	200	207	278	286
Total Current Liabilities	36	48	121	142	161	190	210	355	402	433	525	570
Long-Term Debt (Less Current Maturities)	3023	6189	11318	18214	19112	20064	21076	22539	25585	28660	29168	29697
Equity:												
Government Contribution	220	220	220	220	220	220	220	220	220	220	220	220
Capital Contributions	114	260	410	588	796	1036	1311	1623	2081	2604	3187	3821
Reserves	15	35	60	108	163	226	314	412	526	682	860	1055
Unappropriated Retained Earnings	186	259	187	(140)	(1121)	(2096)	(2465)	(2682)	(2794)	(2067)	(1125)	165
Total Equity	535	774	877	776	58	(614)	(621)	(427)	33	1439	3142	5261
Total Equity and Liabilities	3594	7011	12316	19132	19331	19640	20665	22467	26020	30532	32835	35528

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ASSETS											
Fixed Assets:											
Gross Value of Fixed Assets	36722	36783	36937	38031	38294	38203	42250	40913	41107	41582	41618
Less: Accumulated Depreciation	6770	7730	8668	9521	10063	10755	11634	11226	12347	13472	14433
Net Value of Fixed Assets	29952	29053	28269	28510	28231	27448	30616	29687	28760	28110	27185
Work in Process											
Total Fixed Assets											
Current Assets:											
Cash	6535	9770	12407	13696	15393	17868	16106	18099	20190	2191	23597
Accounts Receivable	1791	1891	1891	1891	1891	1990	1990	1990	2090	2090	2090
Provision for Bad Debt	18	38	19	91	91	40	20	20	42	21	21
Inventories	412	27	29	265	281	125	133	142	150	160	171
Total Current Assets	8720	11650	14308	15833	17546	19943	18209	20211	22388	24140	25837
Total Assets	38672	40703	42577	44343	45777	47391	48825	49898	51148	52250	53022
EQUITY AND LIABILITIES											
Current Liabilities:											
Accounts Payable	320	346	374	403	436	471	509	550	593	640	692
Current Maturities on Long-Term Debt	363	500	510	683	695	834	917	932	1016	1163	1250
Total Current Liabilities	683	846	884	1086	1131	1305	1426	1482	1609	1803	1942
Long-Term Debt (Less Current Maturities)	30236	29736	29226	28543	27848	27014	26097	25165	24149	22986	21736
Equity:											
Government Contribution	220	220	220	220	220	220	220	220	220	220	220
Capital Contributions	4452	4837	5200	5540	5855	6143	6392	6590	6734	6821	6848
Reserves	1270	1724	2178	2632	3086	3564	4360	5156	5992	6828	7664
Unappropriated Retained Earnings	1811	3340	4869	6322	7642	9145	10330	11285	12444	13592	14612
Total Equity	7753	10121	12467	14714	16798	19072	21302	23251	25390	27461	29344
Total Equity and Liabilities	38672	40703	42577	44343	45777	47391	48825	49898	51148	52250	53022

ANNEX TABLE X-H-5

RATE OF RETURN ON TOTAL INVESTMENT
(DISCOUNTED CASH FLOW METHOD)
CALAMBA WATER DISTRICT
(₱ x 1000)

Year	Debt Service	Net Increase in Cash	Total Cash Inflow	Investments	Net Cash Inflow	1st Trial Present Value: 8% Factor	1st Trial Present Value: 8% Value	2nd Trial Present Value: 10% Factor	2nd Trial Present Value: 10% Value
1978	54	(59)	(5)	3,137	(3,132)	1.000	(3,132)	.909	(3,132)
1979	163	177	340	3,312	(2,972)	.926	(2,752)	.909	(2,702)
1980	249	202	451	5,323	(4,872)	.857	(4,175)	.826	(4,024)
1981	1,066	(212)	854	7,122	(6,268)	.794	(4,977)	.751	(4,707)
1982	1,691	(534)	1,157	1,158	(1)	.735	(1)	.683	(1)
1983	1,777	(484)	1,293	1,249	44	.681	30	.621	27
1984	1,868	22	1,890	1,349	541	.630	341	.564	305
1985	1,964	154	2,118	2,088	30	.583	17	.513	15
1986	2,240	334	2,574	3,704	(1,130)	.540	(610)	.467	(528)
1987	2,521	1,092	3,613	3,805	(192)	.500	(96)	.424	(81)
1988	2,805	1,570	4,375	1,369	3,006	.463	1,392	.386	1,160
1989	2,928	1,931	4,859	1,449	3,410	.429	1,463	.350	1,194
1990	2,985	2,342	5,327	1,533	3,794	.397	1,506	.319	1,210
1991	3,116	3,235	6,351	446	5,905	.368	2,173	.290	1,712
1992	3,221	2,637	5,858	542	5,316	.340	1,807	.263	1,398
1993	3,186	1,289	4,475	1,553	2,922	.315	920	.239	698
1994	3,314	1,697	5,011	1,057	3,954	.292	1,155	.218	862
1995	3,264	2,475	5,739	552	5,187	.270	1,400	.198	1,027
1996	3,341	(1,762)	1,579	4,470	(2,891)	.250	(723)	.180	(520)
1997	3,348	1,993	5,341	495	4,846	.232	1,124	.164	795
1998	3,281	2,091	5,372	455	4,917	.215	1,057	.149	733
1999	3,281	1,721	5,002	687	4,315	.199	859	.135	583
2000	3,336	1,686	5,022	377	10,392 14/	.184	1,912	.123	1,278
							+690		-2,698

14/ Includes net asset value of ₱5,747

Total Assets		53,022
Total Liabilities	53,022	23,678
Cash	23,597	23,597
Net Asset Value		5,747

Rate of Return - 8.41%

CHAPTER XI ECONOMIC FEASIBILITY ANALYSIS

A. WATER AND THE ECONOMY

Introduction

Water is a basic requirement in any country's economic development and no economic activity can take place without it. However, this basic function diminishes in relative importance as a higher level of economic development is attained by a country. In most instances, the availability of water alone will not spur economic growth for there are other significant factors that influence development, such as peace and order, political stability, rate of taxation and availability of infrastructure facilities. Hence, a water supply project must be considered as only one part of a regional development program. It must be viewed within the context of the overall government program.

Considering that the Philippines is still a developing country, water supply plays a fairly important role in the national or regional economy. Traditionally, water has been made available to the consuming public at very nominal rates. There is a tendency for the consumers to use water wastefully. As a consequence, the regard given to it is far below its true importance.

To the water consumer, the value of water is measured by its contribution to the satisfaction of the family group which uses the water. His perspective includes himself and his household and all the health, well-being and productivity aspects of family life. To the businessman, water is valued for all it does to improve business. From the national viewpoint, the benefits to the water user, both householder and businessman, are only a part of the total.

Major Uses of Water Supply

Domestic. Water for domestic use is usually given top priority because water is essential to life and, up to a point, essential to general well-being. Estimation of the beneficial value of water for domestic purposes is best viewed in terms of average willingness to pay for water rather than do without it. It will be noted that the willingness to pay is higher than the price charged insofar as most users are concerned.

Industrial Use. Water is used by industry primarily as a factor of production. In some instances, it goes into the production process as an input. This is the case for the soft drinks industry. One method of determining the value of water to industry is to analyze the cost of alternative industrial processes which produce the same product but use less water. This is not, however, always possible and may be unduly laborious.

Other Uses. Crop irrigation is one of the major uses of water. The value of water used for irrigation purposes can be estimated by an elaborate calculation of "with" and "without" project conditions. All other costs are assumed to be paid and water becomes the residual claimant under "without" and "with" project conditions. Detailed analysis of the area to be irrigated is required.

Another important use is hydropower generation. Water used for this purpose may be valued by comparison with the lowest-cost alternative of providing electric power. Lastly, bodies of water serve a basic role in many recreational activities. Ordinarily, water quality is not adversely affected by recreational use. Water value in this case depends on a number of factors such as accessibility, setting, beauty and quality.

In the Philippines, the National Water Resources Council establishes the water priorities, in pursuance of the policies laid down by its charter, Presidential Decree No. 424. In general, the system of priorities for the development, conservation and utilization of the country's water resources reflects the current usage of water and is responsive to the changing demand for water. Another presidential decree (Presidential Decree No. 198) has declared that the creation, operation, maintenance and expansion of water supply and wastewater disposal systems are a national policy of high priority.

B. METHODOLOGY

Recommended and Next-Best System

One approach in determining the economic feasibility of a water supply project involves a comparison of the benefits and costs of the recommended system and those of the next best system. In this method, the capital expenditure costs and the operating and maintenance costs for both alternative systems are transformed to an equivalent annual cost basis during the projection period. The comparison will show which of the alternative systems will generate the same level of benefits at less cost.

Benefit-Cost Ratio

A second approach in determining the economic feasibility of water supply project involves the following steps:

1. The identification of the economic benefits and costs that can be attributed to the establishment, operation and maintenance of an improved water supply system;

2. The determination of the possible bases for quantifying these benefits and costs; and

3. The comparison of the present value of the benefits likely to be generated and the present value of the costs.

The results of the economic analysis are then expressed as a single ratio called the benefit-cost ratio. The project is considered feasible if the ratio is equal to or greater than 1:1.

Internal Rate of Return

Another method involves the calculation of the economic internal rate of return of the proposed project. The total amount of the benefits as well as of the costs is determined throughout the projection period. By trial and error, the interest rate at which the present worth of the benefits is equal to the present worth of the costs is then calculated. The project is considered desirable if its internal economic rate of return is higher than the minimum rate generally acceptable in such projects, which is usually the opportunity cost of capital.

Method(s) Adopted

Both the second and third methods were employed in determining this project's economic feasibility. These two were considered more appropriate than the first method because in this case, the recommended plan has already been selected from several alternatives on the basis of present worth cost comparisons (as discussed in Chapters VIII and IX).

Calculation of Benefit and Cost Streams

The economic studies cover only Stage I of the proposed water supply program, which extends from 1978 to 1990. Benefits, however, were projected up to 2000 except for land values which stop at 1990. This is because the benefits (except for land values) from the facilities to be constructed up to 1990 would continue to accrue beyond their construction period.

The construction costs included in the analysis are those which will be incurred up to 1990, except replacement costs and the operation and maintenance costs which were projected up to 2000. This is due to the fact that proper maintenance of the facilities will have to be undertaken regularly for as long as benefits are desired to be realized from the system.

Estimates of benefits and costs were based on 1978 prices. In recognition of inflationary pressures, all benefits were escalated by 10 percent from 1978 to 1980, by 8 percent from 1981 to 1985 and by 6 percent from 1986 to 1990. All project costs were also escalated in the same manner, with the exception of operation and maintenance costs which were escalated uniformly by 8 percent all throughout the study period. In both cases, however, the escalation factor for 1990 was held constant up to 2000. This is because only Stage I of the proposed project is being considered in the economic analysis; hence, only partial inflation has been adopted.

C. QUANTIFIABLE BENEFITS

The economic benefits that will be derived from the proposed water supply improvement program for the water district may be classified into quantifiable and non-quantifiable. Quantifiable benefits are those which can be expressed in monetary terms. On the other hand, non-quantifiable benefits are intangible but real, and are extremely difficult to express in monetary terms.

Benefits resulting from the proposed project were evaluated on an incremental basis, i.e., on a "with" or "without" principle. Hence, the benefit figures reflect only those that will accrue to the service area as a result of the improvement of the water supply system. They exclude the benefits arising from the present system.

The quantifiable benefits that are discussed in the following sections are: increase in land values, improved health conditions, reduction in fire damage, and beneficial value of water.

Increase in Land Values

The implementation of the water supply project will result in an increase in the land values of the service area. However, it must be pointed out that the increase in land values cannot be attributed solely to the water supply project. Any difference between the acquisition cost and the present market value of a piece of land evolves from a series of market and public forces which exist whether or not the water supply project is undertaken. Such forces include the general pace of industrialization, construction activity, inflation, land speculation, taxation, public land acquisition and selling. More particularly, such a difference could be the result of a general estimation of productivity due to infrastructure investments which include a water supply project.

The portion of land values attributable to the provision of an improved public water supply system was estimated in the household survey in Lipa City (May 1975) to be about 22.6 percent of the market value of a piece of land. It is reasonable to assume that this figure represents the incremental value of a piece of land, given access to water supply. In a specific instance, a residential lot about 400 sqm has the following market values:

Without Water	400 sqm x P50	=	P20,000
With Water	400 sqm x P65	=	P26,000
	Ratio	=	1.3 or 30% increase

In this particular case, the incremental cost of P6,000 closely represents the market value of a private well (complete with pump, electric controls, etc) to serve the premises.

On the basis of this information, it may be conservative to assume that 20 percent of the value of land served by the water distribution system could be attributed to the water supply project.

Assumptions made for this analysis are explained in Annex XI-C. Annex Table XI-C-1 shows the computations of this benefit, which amounts to a present worth of P28.1 million.

Health Benefits

The establishment of a water supply system in a community will necessarily bring about health benefits to the population. Undoubtedly, the provision of safe, potable water to the population is a prerequisite for the maintenance of minimum health standards. These health benefits are ordinarily manifested in the following:

1. A significant reduction in the incidence of water-borne diseases such as cholera, dysentery, gastro-enteritis, and typhoid/paratyphoid. As a result, there will be a decrease in the amount of time lost by income earners who are afflicted with such diseases.

2. A subsequent reduction in premature deaths due to the lower incidence of water-borne diseases.

3. A corresponding reduction in medical expenses for the same reason.

Calculation for the health benefits and associated assumptions used are presented in Annex XI-C. Annex Table XI-C-2 shows the health benefits on a yearly basis, with a total present worth of P409,554.

Reduction in Fire Damage

With the installation of suitable fire hydrants especially in the high-value as well as the residential districts in the service area as part of the proposed project, savings due to reduced fire damages will result from the availability of an adequate amount of water and increased water pressure for fire-fighting purposes. Calculations relative to this benefit are explained in Annex XI-C and shown in detail in Annex Table XI-C-3. The present value of this benefit amounts to ₱6.3 million.

No attempt was made to quantify the inconvenience to the people rendered homeless and the value of human lives lost due to fire.

Beneficial Value of Water

This benefit (sometimes called "consumer satisfaction") is quantified by the additional revenue generated by the water district as a result of an improved water supply project. In the case of a community which previously did not have any piped water system, the "consumer satisfaction" benefit may be measured by the full amount of the economic value of the accounted-for-water.

For a community where the proposed project involves merely the expansion and improvement of the existing system, this benefit may be measured by the economic value of the incremental water production directly resulting from the improvement of the system.

For this benefit, the concept of consumers surplus was adopted. This concept takes into account not only what households and commercial establishments are actually paying for water but also how much more the consumers are willing to pay for this essential commodity. Calculations for the beneficial value of water are shown in Annex XI-C and Annex Table XI-C-4. The present value of this benefit amounts to ₱15.8 million.

D. NON-QUANTIFIABLE BENEFITS

The non-quantifiable benefits arising from a water supply project are generally as important as the quantifiable benefits. However, they do not easily lend themselves to valuation. The approach taken herein is to acknowledge their existence and importance. No attempt has been made to quantify or include them in the benefit-cost calculations.

The proposed water supply project will set off a chain of events beyond its construction period. Those activities include among others the inducement to industry to establish plants in the service area due to availability of a dependable water supply. Without such supply, new industrial and commercial establishments would be forced to develop their own supply system or relocate elsewhere. The overall cost of providing separate water systems is normally large and represents a deterrent to invest in the area and consequently to industrial development.

Because of the employment generated by the project, hired laborers are able to spend their wages for purchasing goods at the local stores. Hence, each peso they spend is generated back into the income stream of the local economy. In the operation and maintenance of the project, the water district would find it advantageous to purchase required supplies locally and engage local service.

E. ECONOMIC COSTS

General

The total cost of the proposed water supply system is the sum of all expenditures required to realise project objectives and benefits.

Costs have been divided into the following:

1. Project costs
2. Replacement costs
3. Operating and maintenance costs

In general, economic costs are easier to identify and quantify than benefits. This is because most of the costs are incurred in real, monetary terms to pay for either goods or services while benefits are usually intangible.

Project Costs

Project costs include the construction cost of the proposed facilities such as pipes, meters and equipment, as well as, engineering services and contingencies and land cost. The cost of the feasibility studies has also been included.

Annex Table XI-E-1 shows the construction costs of the proposed water supply project for the water district. They are listed by component as to type of expenditure in 1978 prices. They are further broken down into foreign and domestic components.

The cost of unskilled labor is shown separately from the domestic component of the project. From the balance of the domestic cost, 5 percent was assumed to be in the form of hidden taxes.

Adjustment of Project Costs

In the determination of the project costs, adjustments were made for those items which are not properly valued by the price mechanism. A price other than the market price (called the shadow price) was imputed to these items. In this way, most of the effects of price discrepancies which could be identified, whether primary or secondary, were incorporated directly into the project analysis and imputed as direct costs to project investment. The 'shadow prices' used in this analysis are those employed by international lending institutions and the Planning and Project Development Office (PPDO) of the Department of Public Works, Transportation and Communication.

One of the items where 'shadow pricing' was applied is the price of unskilled labor (otherwise known as common labor). In a perfectly competitive market, the price of labor is determined by the marginal value of its product. In this case, therefore, the price of labor is equal to the value of the output which an extra laborer hired would produce. However, this is not applicable in an economy such as that of the Philippines where there is a surplus of labor. Since there is widespread disguised unemployment in such an economy, unskilled labor is normally valued below the actual wage rate likely to be paid. In this study, the opportunity cost of unskilled labor or its potential in other employment was valued at one half of its estimated cost in the project. The net effect is to reduce the cost of unskilled labor by 50 percent, thereby reducing the summation of project costs.

Skilled labor, on the other hand, was valued at its going rate. It was assumed that if skilled labor were not employed in the service area, it would probably migrate elsewhere to obtain employment or a better wage.

Adjustments were also made with respect to cost of project facilities which use up limited foreign exchange reserves. Foreign exchange used to import project components was valued at 1.2 times their actual peso cost. This effectively increased foreign exchange cost by 20 percent, thereby affecting project cost in a similar manner. This was done to reflect the opportunity cost or alternative value of foreign exchange. Domestic components, on the other hand, were priced at their actual cost.

Interest was not included since this is considered a financial instead of an economic cost.

Annex Table XI-E-1 shows the conversion of financial costs to economic costs through shadow pricing and other adjustments. The present value (see Table XI-E-4) of total economic project cost for CAL-WD amounts to ₱22.8 million.

Replacement Costs

Based on the criteria used in the financial studies, vehicles have a life expectancy of 7 years while meters are expected to be replaced every 15 years. Other items which have a service life of 15 years are the equipment of the source facilities as well as miscellaneous items of the immediate improvememt program. The feasibility studies were assumed to be good for 30 years. The storage facilities which will be merely repaired are expected to last for 13 years, after which another repair will be undertaken. All other facilities in the system are expected to last for 50 years.

During the 23-year period from 1978 to 2000, therefore, vehicles, meters, equipment with a service life of 15 years and the miscellaneous items will have to be replaced while the storage facilities will be repaired after 13 years. Annex Table XI-E-2 shows the replacement schedule and costs of vehicles, meters, equipment and miscellaneous items and cost of repair of the storage facilities. The present value of total replacement costs (see Table XI-E-4) for CAL-WD amounts to ₱680,900.

Salvage Value

Annex Table XI-E-3 shows the salvage value in 2001 of all the capital equipment to be used in the project. The percentage of salvage value was based on the remaining service life of the facilities in 2001. For CAL-WD, the present worth of the salvage value (see Table XI-E-4) is ₱2.4 million.

Operating and Maintenance Cost

Operating and maintenance costs refer to the costs associated with the maintenance, operation and management of the project. Otherwise known as annual costs, they include personnel, power, chemicals, and other miscellaneous maintenance expenses such as fuel and lubrication, repairs, communication needs and office rental. Only the operating and maintenance costs of the proposed project (i.e., excluding those of the present system) were considered in this study.

Annex Table XI-E-4 presents the incremental annual recurring costs associated with running and operating the water district up to 2000. The present value of these costs amounts to ₱7.6 million.

Calculation for Economic Costs

The economic cost may be expressed as the adjusted (shadow priced) project cost plus replacement cost plus operating/maintenance cost less salvage value. Annex Table XI-E-4 shows the computation of total economic costs for CAL-WD, amounting to ₱28.9 million.

F. BENEFIT-COST ANALYSIS

The summary of the quantifiable economic benefits and economic costs for CAL-WD is shown below. They are expressed in their present values (discounted at 12 percent) after the 1978 prices have been escalated.

SUMMARY OF BENEFITS AND COSTS
(₱ x 10^6)

Benefits		Costs	
Increase in Land Values	₱28.143	Project Cost	₱22.823
Health	.410	(+)	
Reduction in Fire Damage	6.278	Replacement Cost	.881
Beneficial Value	17.096	(+)	
	₱51.927	Operating and Maintenance Cost	7.559
		Sub-total	₱31.263
		(-)	
		Salvage Value	2.362
			₱28.901

Benefit Cost Ratio - 1.80 : 1

The preceding table shows that the quantifiable benefits exceed the economic costs associated with the improvement of the water supply system in CAL-WD. Under the principle of benefit-cost ratio, the project is, therefore, considered economically feasible.

The actual benefits of the proposed project may really be greater than what the benefit-cost ratio represents because the non-quantifiable benefits have not been incorporated into the analysis.

G. INTERNAL ECONOMIC RATE OF RETURN

The internal economic rate of return (IERR) is the rate at which the present value of the quantifiable benefits is equal to the present value of the economic costs of the proposed project. It is generally held that for a project to be feasible and desirable, its IERR should be higher than the prevailing opportunity cost of capital. In this particular study, the opportunity cost of capital is 12 percent.

For CAL-WD, the IERR is 71.4 percent as shown in Annex Table XI-G-1. On the basis of the above stated principle of IERR, the proposed project appears to be economically feasible and justified.

ANNEX XI-C

QUANTIFIABLE BENEFITS

ANNEX XI-C

QUANTIFIABLE BENEFITS

Portion of Land Values Attributable to Water Supply Project

Annex Table XI-C-1 shows the present value of the portion of land values attributable to the proposed water supply project, based on the following assumptions:

1. In accordance with the staging program of the construction of facilities, the 1980 service area of 272 hectares was projected to increase in the following manner: by 17 hectares from 1980 to 1981; by 35 hectares from 1981 to 1982; by 19 hectares from 1982 to 1983; by 21 hectares from 1983 to 1984; by 21 hectares from 1984 to 1985; by 23 hectares from 1985 to 1986; by 25 hectares from 1986 to 1987; by 26 hectares from 1987 to 1988; by 28 hectares from 1988 to 1989; and by 29 hectares from 1989 to 1990.

2. Land use was assumed to be 87 percent residential and 13 percent commercial/institutional/industrial throughout the projection period. This classification was based on the water demand projections in 1980 by consumer category, as shown in Chapter VI.

3. The 1977 costs of land based on estimated market values in Calamba are:

Residential	:	₱30 per sqm
Industrial/Commercial/Institutional	:	₱40 " "

These costs were assumed to be constant over the projection period.

4. The portion of the total cost of land specifically attributable to the provision of water supply was assumed to be 20 percent of the cost of land. This land value benefit was escalated by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990.

5. A discount factor of 12 percent was used to obtain the present values of the benefits. This is believed to be the opportunity cost of capital and is commonly used for public investment projects like water supply development.

For CAL-WD, the land value benefit in its present worth amounts to ₱28.1 million.

ANNEX TABLE XI-C-1

PORTION OF INCREASED LAND VALUES ATTRIBUTABLE TO PROJECT
CALAMBA WATER DISTRICT

Year	Land Use (sqm)		Cost of Land (P x 1000)		Total Cost of Land (P x 1000)	20 Percent Benefit Due to Project (P x 1000)	Escalation Factor	Escalated Benefit (P x 1000)	Discount Factor at 12%	Present Value of Benefit (P x 1000)
	Residential	Commercial/ Institutional/ Industrial	Residential	Commercial/ Institutional/ Industrial						
1980	2,366,400	353,600	P70,992.0	P14,144.0	P85,136.0	P17,027.2	1.210	P20,602.9	.797	P16,420.5
1981	147,900	22,100	4,437.0	884.0	5,321.0	1,064.2	1.307	1,390.9	.712	990.3
1982	304,500	45,500	9,135.0	1,820.0	10,955.0	2,191.0	1.412	3,093.7	.636	1,967.6
1983	165,300	24,700	4,959.0	988.0	5,947.0	1,189.4	1.525	1,813.8	.567	1,028.4
1984	182,700	27,300	5,481.0	1,092.0	6,573.0	1,314.6	1.647	2,165.1	.507	1,097.7
1985	182,700	27,300	5,481.0	1,092.0	6,573.0	1,314.6	1.779	2,338.7	.452	1,057.1
1986	200,100	29,900	6,003.0	1,196.0	7,199.0	1,439.8	1.886	2,715.5	.404	1,097.0
1987	217,500	32,500	6,525.0	1,300.0	7,825.0	1,565.0	1.999	3,128.4	.361	1,129.4
1988	226,200	33,800	6,786.0	1,352.0	8,138.0	1,627.6	2.119	3,448.9	.322	1,110.5
1989	243,600	36,400	7,308.0	1,456.0	8,764.0	1,752.8	2.246	3,936.8	.288	1,133.8
1990	252,300	37,700	7,569.0	1,508.0	9,077.0	1,815.4	2.381	4,322.5	.257	1,110.9
								P48,957.2		P28,143.2

Health Benefits

To determine the amount of benefit arising from the reduction of income lost of those afflicted with water-borne diseases, pertinent statistics on morbidity rate were gathered from the Department of Health. From 1964 to 1974, an average of 429.1 out of every 100,000 population in the province of Laguna were afflicted with primary water-borne diseases every year, regardless of age, sex, and income class. The same rate was assumed for the municipality of Calamba in the absence of specific data. The morbidity rate in the service area was assumed to remain constant during the 21-year projection period.

Since not all of those afflicted with said diseases are wage-earners, an adjustment was made accordingly. Based on the 1970 Census on Population and Housing of the National Census and Statistics Office, 45 percent of the municipality's population was economically active.1/ It was assumed, therefore, that only 45 percent of 429.1 per 100,000 who were afflicted with primary water-borne diseases were economically active. Hence, this is the only segment of the population who would suffer a reduction in income due to said diseases. Furthermore, these afflicted wage-earners were assumed to be earning ₱8 a day and unable to work for 15 days on the average because of their illness. The final figure corresponding to the economic cost of time lost due to water-borne diseases was thereby arrived at by multiplying the number of people afflicted with water-borne diseases by 45 percent, by ₱8 a day and then by 15 days.

Another health benefit that could be associated with the establishment of a safe public water supply system is the reduction of the economic cost of the premature death of those afflicted with water-borne diseases in the service area. Obviously, the reduction of the life span of the population caused by said diseases is an economic loss to the community.

This economic loss due to premature death was determined by multiplying the number of people who die because of water-borne diseases (assuming that a water supply improvement program were not undertaken) by 35 percent and then by ₱11,629. The projected number of such deaths was based on the average of the 10-year mortality rate for primary water-borne diseases in the province of Calamba, as gathered from the Department of Health. These figures indicated that 49.0 persons died of the 429.1 per 100,000 who were

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1/ Economically active population includes those who are 10 years old and over, whether employed or unemployed, excluding retired persons, students and housewives.

afflicted with water-borne diseases. This mortality rate was assumed to be constant over the projection period. The 45 percent corresponds to the portion of the service area population who are income earners. The ₱11,629 represents the monetary value of each death. This was derived from the estimated income to be earned by the average wage-earner over a period of five years discounted at 12 percent plus 20 percent associated economic costs (summation of ₱200 a month x 12 months x discount factor + 20 percent associated costs).

The third health benefit that can be derived from the improvement of the water supply in the service area is the reduction of the medical expenses of persons afflicted with water-borne disease. According to the Lipa City pilot survey on "Ability-to-Pay",2/ an afflicted person spends ₱113.00 annually on the average for medical expenses, which include hospitalization, medicine and doctor's fee. Based on this finding, the total medical expenses incurred due to water-borne diseases were arrived at by multiplying ₱113.00 by the number of people afflicted with such diseases in the service area.

The sum of all three economic costs related to health benefits had to undergo three final adjustments to arrive at more meaningful figures. First, 40 percent of the total economic loss due to water-borne diseases was taken as the health benefit directly resulting from the water supply improvement program. This reduction was made to account for the fact that not all water-borne diseases are caused by a poor water system and may also be due to less than ideal personal hygiene or lack of sewerage facilities. Second, the 40 percent health benefit was escalated by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000. Third, the escalated health benefit was discounted to its present worth at 12 percent. Annex Table XI-C-2 shows the calculations associated with the health benefits for CAL-WD. The total present value of said benefits after the adjustments amounts to ₱409,554.

Reduction in Fire Damage

The proposed water supply improvement program will result in increased water pressure and reliable supply for domestic as well as for fire-fighting purposes. At present, none of the fire hydrants in Calamba are effectively operating; hence, no fire protection is accorded it.

2/ Refer to Methodology Manual, Chapter 20 for "Ability to Pay" studies.

ANNEX TABLE XI-C-2

HEALTH BENEFITS
CALAMBA WATER DISTRICT

Year	Served Population	Cost of Time Lost Due to Illness(1)	Economic Loss Due to Premature Death(2)	Cost of Medical Expenses(3)	Total Economic Losses Due to Diseases	40 Percent Reduction Due To Project (Benefit)	Escalation Factor	Escalated Reduction Due to Project (Benefit)	Discount Factor at 12 Percent	Present Value of Health Benefit
1980	11,530	P2,672	P29,565	P 5,591	P 37,828	P15,131	1.210	P 18,309	.797	P 14,592
1981	12,954	3,024	33,242	6,286	42,532	17,013	1.307	22,235	.712	15,832
1982	14,575	3,377	37,373	7,067	47,817	19,127	1.412	27,007	.636	17,176
1983	16,388	3,797	42,022	7,946	53,765	21,505	1.525	32,797	.567	18,596
1984	18,425	4,269	47,245	8,934	60,448	24,179	1.647	39,823	.507	20,190
1985	20,716	4,800	53,120	10,045	67,965	27,186	1.779	48,364	.452	21,860
1986	23,292	5,397	59,725	11,294	76,416	30,566	1.886	57,648	.404	23,290
1987	26,187	6,068	67,149	12,698	85,915	34,366	1.999	68,693	.361	24,800
1988	29,443	6,822	75,498	14,276	96,596	38,638	2.119	81,875	.322	26,364
1989	33,104	7,671	84,885	16,052	108,608	43,443	2.246	97,573	.288	28,101
1990	37,220	8,624	95,439	18,047	122,110	48,844	2.381	116,298	.257	29,888
1991									.229	26,632
1992									.205	23,841
1993									.183	21,282
1994									.163	18,957
1995									.146	16,979
1996									.130	15,119
1997									.116	13,491
1998									.104	12,095
1999									.093	10,816
2000	37,220	8,624	95,439	18,047	122,110	48,844	2.381	116,298	.083	9,653
								P1,773,608		P409,554

Total Municipal Population: 57,423
Economically Active : 25,630
or 45%

Morbidity Rate: 429.1/100,000
Mortality Rate: 49.0/100,000

1) $45\% \times \frac{429.1}{100,000} \times S.P. \times P8 \times 15$

2) $45\% \times \frac{49.0}{100,000} \times S.P. \times P11,629$

3) $\frac{429.1}{100,000} \times S.P. \times P113$

With the implementation of the program which will involve the installation of new fire hydrants, the fire protection coverage will be provided to the service area. Hence, a reduction in fire damage is expected in the service area.

This reduction was assumed to be 0.75 percent of the combined assessed values of all structures in the service area. For Calamba, the average assessed value of each structure was assumed to be ₱18,800.[3] The number of structures was derived from the projected population to be served by the system, assuming that each household has an average of 6.0 members[4].

The fire protection benefit was based on the assumed overall reduction in fire damage, but correlated with the schedule of fire hydrant installation in the service area. Percentage of fire protection starts at 48 percent in 1980, gradually increasing to 90 percent in 1990 in accordance with the extent of the service area to be covered by the fire hydrants.

The net reduction in fire damage was escalated by 8 percent from 1980 to 1985; by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000. It was then discounted at 12 percent. The present value of the fire protection benefit, as shown in Annex Table XI-C-3 amounts to ₱6.3 million.

Beneficial Value of Water

Since water is essential to human life, all members of the served population in the service area presumably would be willing to obtain it in sufficient quantities at some given price. With the proposed improvement of the system's facilities, the volume of water production is expected to increase considerably to serve the needs of the growing population. This will bring about additional revenues to the water district, especially since a price increase of water may be justified in view of the improved service.

In general, water rates charged by the water district do not reflect the true value of water. Moreover, it is recognized that households and commercial users are really willing to pay more than what they are actually being charged for water consumed. From the economic viewpoint, therefore, there is a consumers' surplus. This consumers' surplus refers to the additional amount consumers are willing to pay over and above what they are paying for water. For

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[3] In the absence of assessed value records on Calamba, the figure on Capan was used.

[4] Based on the 1970 Census on Housing in Laguna province.

ANNEX TABLE XI-C-3

REDUCTION IN FIRE DAMAGE
CALAMBA WATER DISTRICT

Year	Number of Structures[5]	Total Value at ₱18,800 each[6]	Overall Reduction in Fire Damage (.0075)	Percentage Protection (Benefit)	Net Reduction in Fire Damage (Benefit) ₱ x 1000	Escalation Factor[7]	Escalated Value of Net Reduction (₱ x 1000)	Discount Factor at 12%	Present Value of Net Benefit (₱ x 1000)
1980	1,922	36,133.6	271.0	0	0	1.210	0	.797	0
1981	2,161	40,626.8	304.7	48%	146.3	1.307	191.2	.712	136.1
1982	2,429	45,665.2	342.5	53	181.6	1.412	256.3	.636	163.0
1983	2,731	51,342.8	385.1	59	227.2	1.525	346.5	.567	196.4
1984	3,071	57,734.8	433.0	66	285.8	1.647	470.7	.507	238.6
1985	3,453	64,916.4	486.9	73	355.4	1.779	632.3	.452	285.8
1986	3,882	72,981.6	547.4	81	443.4	1.886	836.2	.404	337.8
1987	4,365	82,062.0	615.5	83	510.8	1.999	1,021.2	.361	368.6
1988	4,907	92,251.6	691.9	86	595.0	2.119	1,260.9	.322	406.0
1989	5,517	103,719.6	777.9	88	684.5	2.246	1,537.5	.288	442.8
1990	6,203	116,616.4	874.6	90	787.2	2.381	1,874.2	.257	481.7
1991								.229	429.2
1992								.205	384.2
1993								.183	343.0
1994								.163	305.5
1995								.146	273.6
1996								.130	243.7
1997								.116	217.4
1998								.104	194.9
1999								.093	174.3
2000	6,203	116,616.4	874.6	90	787.2	2.381	1,874.2	.083	155.6
							₱27,169.0		₱6,278.2

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[5] Derived from the served population projections in Chapter VI.
[6] Based on the assessed value records in Gapan, in the absence of similar data on Calamba.
[7] Escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985 and by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

purposes of this study, this additional value has been estimated to be 50 percent higher than domestic water rates and 25 percent higher than commercial/industrial/institutional water rates[8].

In the determination of this benefit, the following steps were taken:

1. Only the incremental volume of accounted-for-water was considered; hence, the 1977 accounted-for-water amounting to 200,088 cum was deducted from total accounted-for-water projections in Chapter VI. The water demand projections in Chapter VI, expressed in liters per capita per day, were converted to cubic meters per year.

2. Classification of accounted-for-water into domestic and others (commercial/institutional/industrial) was based likewise on Chapter VI.

3. The price per cubic meter of water was obtained from the unescalated rate per revenue unit in Chapter X, Annex Table X-C-1. The rates were, however, adjusted upwards to reflect consumers' surplus: 50 percent higher for domestic water and 25 percent higher for others.

4. The total economic revenues were then escalated by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation values were discounted at 12 percent to obtain their present values.

For CAL-WD, the beneficial value of water amounts to a present value of ₱17.1 million, as shown in Annex Table XI-C-4.

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[8] Refer to Procedures for the Economic and Financial Analysis of Water Projects, LWUA, May 1976.

ANNEX TABLE XI-C-4

BENEFICIAL VALUES OF WATER
CALAMBA WATER DISTRICT

Year	Incremental Accounted-for-Water[9] cum/Year	Domestic (cum/Year)	Others (cum/Year)	Price Per cum[10] Domestic	Price Per cum[10] Others	Economic Value per cum[11] Domestic	Economic Value per cum[11] Others	Economic Water Revenues Domestic	Economic Water Revenues Others	Total Economic Revenues	Escalation Factor[12]	Escalated Economic Revenues	Discount Factor at 12%	Present Value of Net Economic Revenues
1977	200,688	174,599	26,089											
1978	85,300	74,211	11,089	0.75	1.50	1.13	1.88	83.9	20.8	104.7	1.000	104.7	1.000	104.7
1979	206,856	179,965	26,891	0.69	1.38	1.03	1.73	185.4	46.5	231.9	1.100	255.1	.893	227.8
1980	380,078	330,668	49,410	0.64	1.28	0.96	1.60	317.5	79.1	396.6	1.210	479.9	.797	382.5
1981	447,502	389,327	58,175	0.95	1.90	1.43	2.38	556.7	138.5	695.2	1.307	908.6	.712	646.9
1982	526,887	458,392	68,495	0.88	1.76	1.32	2.20	605.1	150.7	755.8	1.412	1,067.2	.636	678.7
1983	620,354	539,708	80,646	0.82	1.64	1.23	2.05	663.8	165.3	829.1	1.525	1,264.4	.567	716.9
1984	730,402	635,450	94,952	0.94	1.88	1.41	2.35	896.0	223.1	1,119.1	1.647	1,843.2	.507	934.5
1985	859,972	748,176	111,796	0.88	1.76	1.32	2.20	987.6	246.0	1,233.6	1.779	2,194.6	.452	991.9
1986	1,012,527	880,898	131,629	0.81	1.62	1.22	2.03	1,074.7	267.2	1,341.9	1.886	2,530.8	.404	1,022.5
1987	1,192,144	1,037,165	154,979	0.90	1.80	1.35	2.25	1,400.2	348.7	1,748.9	1.999	3,496.1	.361	1,262.1
1988	1,403,625	1,221,154	182,471	0.83	1.66	1.25	2.08	1,526.4	379.5	1,905.9	2.119	4,038.6	.322	1,300.4
1989	1,625,622	1,414,291	211,331	0.77	1.54	1.16	1.93	1,640.6	407.9	2,048.5	2.246	4,600.9	.288	1,325.1
1990	1,945,789	1,692,836	252,953	0.71	1.42	1.07	1.78	1,811.3	450.3	2,261.6	2.381	5,384.9	.257	1,383.9
1991				0.70	1.40	1.05	1.75	1,777.5	442.7	2,220.2		5,286.3	.229	1,210.6
1992				0.65	1.30	0.98	1.63	1,659.0	412.3	2,071.3		4,931.8	.205	1,011.0
1993				0.60	1.20	0.90	1.50	1,523.6	379.4	1,903.0		4,531.0	.183	829.2
1994				0.55	1.10	0.83	1.38	1,405.1	349.1	1,754.2		4,176.8	.163	680.8
1995				0.54	1.08	0.81	1.35	1,371.2	341.5	1,712.7		4,077.9	.146	595.4
1996				0.50	1.00	0.75	1.25	1,269.6	316.2	1,585.8		3,775.8	.130	490.9
1997				0.46	0.92	0.69	1.15	1,168.1	290.9	1,459.0		3,473.9	.116	403.0
1998				0.45	0.90	0.68	1.13	1,151.1	285.8	1,436.9		3,421.3	.104	355.8
1999				0.42	0.84	0.63	1.05	1,066.5	265.6	1,332.1		3,171.7	.093	295.0
2000	1,945,789	1,692,836	252,953	0.39	0.78	0.59	0.98	998.8	247.9	1,246.7	2.381	2,968.4	.083	246.4
												67,983.9		17,096.0

9/ The 1977 volume of 200,688 cum per year of accounted-for-water was deducted from the water demand projections throughout the study period to obtain the incremental volume.

10/ The price per cum of water for domestic use was derived by de-escalating the rate per revenue unit of water in Table X-G-1, Chapter X; the rate of water for other uses (commercial, institutional and industrial) was assumed to be twice that for domestic use.

11/ Assumed to be 50 percent higher than domestic rates and 25 percent higher than rate for 'others'.

12/ Escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

ANNEX XI-E

ECONOMIC COSTS

ANNEX TABLE XI-E-1

CONVERSION OF FINANCIAL COST TO ECONOMIC COST
CALAMBA WATER DISTRICT

	Financial Project Cost	Foreign Exchange Component	Domestic Cost Component	Unskilled Labor	Balance of Domestic Component 14/	Taxes 15/ (5%)	Others (95%)	Shadow Pricing: Foreign Exchange Component x 1.2	Shadow Pricing: Unskilled Labor x .5	Shadow Pricing: Others x 1.0	Economic Project Cost 16/	Economic Construction Cost 17/
Source Facilities												
a) Equipment	1,376,000	1,206,643	169,357	58,885	110,472	5,524	104,948	1,447,972	29,443	104,948	1,582,363	1,250,880
b) Structure	1,590,000	362,946	1,227,054	92,685	1,134,369	56,718	1,077,651	435,535	46,343	1,077,651	1,559,529	1,232,829
Distribution Facilities	7,430,000	4,222,437	3,207,563	675,395	2,532,168	126,608	2,405,560	5,066,924	337,698	2,405,560	7,810,182	6,174057
Administration Bldg. and Plumbing Shop	918,000	54,269	863,731	125,235	738,496	36,925	701,571	65,123	62,618	701,571	829,312	655,583
Service Connections												
a) Pipes	3,717,000	1,812,149	1,904,851	596,978	1,307,873	65,394	1,242,479	2,174,579	298,489	1,242,479	3,715,547	3,216,924
b) Meters	1,209,000	1,008,610	200,390	62,602	137,588	6,879	130,709	1,210,332	31,401	130,709	1,372,442	1,188,261
Internal Network	2,443,000	1,049,540	1,393,460	271,480	1,121,980	56,099	1,065,881	1,259,448	135,740	1,065,881	2,461,069	2,130,796
Fire Hydrants	611,000	356,388	254,612	58,300	196,312	9,816	186,436	427,666	29,150	186,496	643,312	556,980
Feasibility Studies	246,000	162,360	83,640	-	83,640	4,182	79,458	194,832	-	79,458	274,290	274,290
Immediate Improvement												
a) Source Facilities	73,000	61,008	11,992	3,565	8,427	421	8,006	73,210	1,783	8,006	82,999	[illegible],612
b) Storage Facilities	25,000	14,375	10,625	1,150	9,475	474	9,001	17,250	575	9,001	26,826	21,206
c) Distribution Facilities	3,517,000	1,934,315	1,582,685	319,700	1,262,985	63,149	1,199,836	2,321,178	159,850	1,199,836	3,680,864	2,909,774
d) Service Connections												
1. Pipes	805,000	392,779	412,221	245,984	166,327	8,316	158,011	471,335	122,947	138,011	752,293	651,336
2. Meters	511,000	425,878	85,122	50,776	34,346	1,717	32,629	511,054	25,388	32,629	569,071	492,702
e) Administrative and Miscellaneous	117,000	87,211	29,789	-	29,789	1,489	28,300	104,653	-	28,300	132,953	115,111
f) Vehicles	69,000	35,145	33,855	-	33,855	1,693	32,162	42,174	-	32,162	74,336	64,360
Sub-Total	24,657,000	13,186,053	11,470,947	2,562,845	8,908,102	445,404	8,462,698	15,823,265	1,281,425	8,462,698	15,567,388	21,000,701
Land	172,000	-	172,000	-	172,000	8,600	163,400	-	-	163,400	163,400	163,400
Total Project Cost	24,829,000	13,186,053	11,642,947	2,562,845	9,080,102	454,004	1,626,098	15,823,265	1,281,425	8,626,098	25,730,788	21,164,101

14/ Domestic cost component less unskilled labor cost.
15/ Computed at 5 percent of domestic cost component after unskilled labor cost was deducted from it.
16/ Obtained by adding foreign exchange cost, unskilled labor cost and cost of 'others' after they have been adjusted through shadow pricing.
17/ Derived by subtracting contingencies and engineering services from the economic project cost.

ANNEX TABLE XI-E-2

REPLACEMENT COST
CALAMBA WATER DISTRICT
1978 PRICES
(₱ x 1000)

Year	Vehicles	Meters	Equipment	Storage Facilities 18/	Administrative and Miscellaneous	Total
1978						
1979						
1980						
1981						
1982						
1983						
1984						
1985	₱ 64.4					₱ 64.4
1986						
1987						
1988						
1989						
1990						
1991				₱ 21.2		21.2
1992	64.4					64.4
1993		₱ 258.2	₱ 18.8		₱115.1	392.1
1994		251.1	57.5			308.6
1995		80.8	55.0			135.8
1996		80.8	1,060.8			1,141.6
1997		80.8				80.8
1998		80.8				80.8
1999	64.4	80.8				145.2
2000		103.4				103.4
TOTAL	₱193.2	₱1,016.7	₱1,192.1	₱ 21.2	₱115.1	₱2,538.3

18/ Storage facilities will be merely repaired, not replaced.

ANNEX TABLE XI-E-3

SALVAGE VALUE IN 2001
CALAMBA WATER DISTRICT
(₱ x 1000)

Year	50 Years: Economic Value	50 Years: Remaining Service Life in 2001 (Percent)	50 Years: Salvage Value	30 Years: Economic Value	30 Years: Remaining Service Life in 2001 (Percent)	30 Years: Salvage Value	15 Years: Economic Value	15 Years: Remaining Service Life in 2001 (Percent)	15 Years: Salvage Value	10 Years: Economic Value	10 Years: Remaining Service Life in 2001 (Percent)	10 Years: Salvage Value	7 Years: Economic Value	7 Years: Remaining Service Life in 2001 (Percent)	7 Years: Salvage Value	Infinite: Economic Value	Infinite: Remaining Service Life in 2001 (Percent)	Infinite: Salvage Value	Total Salvage Value[a]
1978	₱ 2,013.0	56%	₱1,127.3	₱ 56.8	27%	₱ 15.3													₱ 1,142.6
1979	2,042.2	58	1,184.5	217.5	30%	65.3													1,249.8
1980	2,917.6	60	1,750.6													₱163.4	100%	₱163.4	1,914.0
1981	3,449.5	62	2,138.7																2,138.7
1982	643.1	64	411.6																411.6
1983	649.1	66	428.4																428.4
1984	643.1	68	437.3																437.3
1985	864.8	70	605.4																605.4
1986	1,488.4	72	1,071.6				₱ 188.1	7%	₱ 13.2										1,084.8
1987	1,488.4	74	1,101.4				133.1	13	17.3										1,118.7
1988	445.0	76	338.2				133.1	20	26.6										364.8
1989	445.0	78	347.1				133.1	27	35.9										383.0
1990	445.0	80	356.0				131.9	33	43.5										399.5
1991										₱21.2	31%	₱ 6.6							6.6
1992																			
1993							457.7	53	242.6										242.6
1994							308.6	60	185.2										185.2
1995							135.8	67	91.0										91.0
1996							114.2	73	83.4										833.4
1997							80.8	80	64.6										64.6
1998							80.8	87	70.3										70.3
1999							80.8	93	75.1				₱64.4	86%	₱ 55.4				130.5
2000							107.2	100	107.2										107.2
	₱17,528.2		₱11,294.1	₱274.3		₱ 80.6	₱3,112.6		₱1,805.9	₱21.2		₱ 6.6	₱64.4		₱ 55.4	₱163.4		₱163.4	₱13,406.0

Total Economic Value: ₱21,164.1
Total Salvage Value : ₱13,406.0

[a] Salvage values for each year represent the salvage value of the item in year 2001.

ANNEX TABLE XI-E-4

SUMMARY OF ECONOMIC COSTS
CALAMBA WATER DISTRICT
(P x 1000)

Year	Project Cost	Replacement Cost	Salvage Value[20]	O and M Costs	Total Costs	Escalation Factor For Other Costs[21]	Escalation Factor For O and M Costs[22]	Escalated Project Cost	Escalated Replacement Cost	Escalated O and M Cost	Escalated Total Costs	Discount Factor at 12 Percent	Present Value of Project Cost	Present Value of Replacement Cost	Present Value of O and M Costs	Present Value of Total Costs
1978	P 3,201.9		1,142.6	14.8	3,216.7	1.000	1.000	3,201.9	-	14.8	3,216.7	1.000	3,201.9	-	14.8	3,216.7
1979	2,901.6		1,249.8	25.3	2,926.9	1.100	1.000	3,191.8	-	27.3	3,219.1	.893	2,850.3	-	24.4	2,874.7
1980	4,205.7		1,914.0	358.1	4,563.8	1.210	1.166	5,088.9	-	417.5	5,506.4	.797	4,055.9	-	332.7	4,388.6
1981	5,728.2		2,138.7	415.4	6,143.6	1.307	1.260	7,486.8	-	523.4	8,010.2	.712	5,330.6	-	372.7	5,703.3
1982	836.1		411.6	442.4	1,278.5	1.412	1.360	1,180.1	-	601.7	1,781.8	.636	750.5	-	382.7	1,133.2
1983	836.1		424.4	516.4	1,352.5	1.525	1.469	1,275.1	-	758.6	2,033.7	.567	723.0	-	430.1	1,153.1
1984	836.1		437.3	533.7	1,369.8	1.647	1.587	1,377.1	-	847.0	2,224.1	.507	698.2	-	429.4	1,127.6
1985	1,138.7	64.4	605.4	545.2	1,748.3	1.779	1.714	2,025.8	114.6	934.5	3,074.9	.452	915.7	51.8	422.4	1,389.9
1986	2,057.2		1,084.8	635.5	2,692.7	1.886	1.851	3,879.9	-	1,176.3	5,056.2	.404	1,567.5	-	475.2	2,042.7
1987	2,987.6		1,118.7	659.9	2,647.5	1.999	1.999	3,973.2	-	1,319.1	5,292.3	.361	1,434.3	-	476.2	1,910.5
1988	667.7		364.8	672.0	1,339.7	2.119	2.159	1,414.9	-	1,450.8	2,865.7	.322	455.6	-	467.2	922.8
1989	667.7		383.0	717.9	1,385.6	2.246	2.332	1,499.7	-	1,674.1	3,173.8	.288	431.9	-	482.2	914.1
1990	666.2		399.5	755.1	1,421.3	2.381	2.518	1,586.2	-	1,901.3	3,487.5	.257	407.7	-	488.6	896.3
1991		21.2	6.6		21.2			-	50.5		1,951.8	.229	-	11.6	435.4	447.0
1992		64.4			64.4			-	153.3		2,054.6	.205	-	31.4	389.8	421.2
1993	-	392.1	242.6		392.1			-	933.6		2,834.9	.183	-	170.8	347.9	518.7
1994		308.6	185.2		308.6			-	734.8		2,636.1	.163	-	119.8	309.9	429.7
1995		135.8	91.0		135.8			-	323.3		2,224.6	.146	-	47.2	277.6	324.8
1996		1,141.6	833.4		1,141.6			-	2,718.2		4,619.5	.130	-	353.4	247.2	600.6
1997		80.8	64.6		80.8			-	192.4		2,093.7	.116	-	22.3	220.6	242.9
1998		80.8	70.3		80.8			-	192.4		2,093.7	.104	-	20.0	197.7	217.7
1999		145.2	130.5		145.2			-	345.7		2,247.0	.093	-	32.2	176.8	209.0
2000		103.4	107.2	755.1	103.4	2.381	2.518	-	226.2	1,901.3	2,127.5	.083	-	20.4	157.8	178.2
	P25,730.8	2,538.3		13,842.7	42,111.8			37,181.4	6,005.0	30,659.4	73,845.8		22,823.1	880.9	7,559.3	31,263.3
Salvage Value			13,406.0			2.381					31,919.7	.074				-2,362.1
																28,901.2

20/ The annual salvage values were not escalated individually since they represent values for 2001; hence, only their sum was escalated by the factor used for project and replacement costs.

21/ Project cost and replacement cost were escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

22/ Operating and maintenance costs were escalated annually by 8 percent from 1978 to 1990, after which the escalation factor was held constant up to 2000.

ANNEX XI-G

INTERNAL ECONOMIC RATE OF RETURN

ANNEX TABLE XI-G-1

INTERNAL RATE OF RETURN
CALAMBA WATER DISTRICT
(₱ x 1,000)

Year	Escalated Values Benefits	Escalated Values Costs	Discount Factor at 70%	Present Value Benefits	Present Value Costs	Discount Factor at 75%	Present Value Benefits	Present Value Costs
1978	104.7	3,216.7	1.000	104.7	3,216.7	1.000	104.7	3,216.7
1979	255.1	3,219.1	.588	150.0	1,892.8	.571	145.7	1,838.1
1980	21,101.1	5,506.4	.346	7,301.0	1,905.2	.327	6,900.1	1,800.6
1981	2,512.9	8,010.2	.204	512.6	1,634.1	.187	470.0	1,497.9
1982	4,444.2	1,781.8	.120	533.3	213.8	.107	475.5	190.7
1983	3,457.5	2,033.7	.070	242.0	142.4	.061	210.9	124.1
1984	4,518.8	2,224.1	.041	185.3	126.1	.035	158.2	77.8
1985	5,214.0	3,074.9	.024	125.1	73.8	.020	104.3	61.5
1986	6,140.1	5,056.2	.014	86.0	70.8	.011	67.5	55.6
1987	7,714.4	5,292.3	.008	61.7	42.3	.006	46.3	31.8
1988	8,830.3	2,865.7	.005	44.2	14.3	.004	35.3	11.5
1989	10,172.8	3,173.8	.003	30.5	9.5	.002	20.3	6.3
1990	11,697.9	3,487.5	.002	23.4	7.0	.001	11.7	3.5
1991	7,276.8	1,951.8	.001	7.3	2.0	.001	7.3	2.0
1992	6,922.3	2,054.6	.001	6.9	2.1	-	-	-
1993	6,521.5	2,834.9	-	-	-	-	-	-
1994	6,167.3	2,636.1	-	-	-	-	-	-
1995	6,068.4	2,224.6	-	-	-	-	-	-
1996	5,766.3	4,619.5	-	-	-	-	-	-
1997	5,464.4	2,093.7	-	-	-	-	-	-
1998	5,411.8	2,093.7	-	-	-	-	-	-
1999	5,162.2	2,247.0	-	-	-	-	-	-
2000	4,958.9	2,147.5	-	-	-	-	-	-
	145,883.7	73,845.8		9,414.0	9,352.9		8,757.8	8,918.1
Salvage Value		31,919.7			- 0.0			- 0.0
		41,926.1			9,352.9			8,918.1
B/C	3.48			1.01			0.98	

Present Value at 70% = 61.1
Present Value at 75% = (160.3)
221.4

IRR = .70 + .05 (61.1) / 221.4
= .70 + .014
= 71.4%

METHODOLOGY

MEMORANDA

Methodology Memorandum No. 1

To : L. V. Gutierrez, Jr.

From : A. de Vera

Date : 4 January 1977

Subject: Pilot Area Survey

A. Need

In estimating water accountability, data on the ratio of borrowers to primary users, average persons per household, and per capita consumption are necessary. Information on capacity and willingness-to-pay would greatly aid financial analysis. In all cases, these data are not readily available in the Philippines. The only way to get these data would be to actually perform a house-to-house survey within the served areas of the water district (WD). Considering time and financial constraints, a pilot area survey would be the best approach. This is merely surveying a representative area within the WD and projecting the data obtained for the entire served area of the WD.

B. Methodology

1. Choose a pilot area within the WD. Desirable requirements for the area are as follows:

   a. adequate line pressures, preferably with 24-hour service;
   b. metered connections;
   c. presence of domestic as well as commercial connections. Ratio of commercial to domestic connections for the area must not exceed that for the entire WD;
   d. representative income levels of the concessionaires.

2. Devise a one-page questionnaire so that it:

   a. is easily understood by WD personnel (who will serve as interviewers);
   b. provides relevant information;
   c. provides a means of cross-checking some answers given by respondents;
   d. would make tabular analysis easy.

   A sample questionnaire is attached.

3. Get assistance from the WD personnel in the house-to-house survey. It is suggested that they do the actual interview because of their familiarity with local customs and dialects. However, before allowing the WD enumerators to proceed on their own, it is necessary that:

   a. the enumerators be given a thorough briefing on the importance of the survey, as well as the purpose of each item in the questionnaire.
   b. the enumerators be accompanied to the first few houses, and given additional pointers or feedback before they proceed on their own.

4. Conduct a house-to-house survey of all households within the pilot area. A map at this point indicating the existing houses (with their code numbers) would be necessary. The following would be helpful during the survey:

   a. brief the respondents about the purpose of the survey before asking questions. It is very important that they be receptive to the interviewers. Otherwise data given could be misleading.
   b. in asking for estimates of consumption, avoid using technical terms, i.e., liters, gallons, etc. Use local containers like pails, drums or whatever they use. Note the capacity of the container in the questionnaire.

C. <u>Data</u>

The following data may be obtained from the survey:

1. Pilot area density
2. Average persons/household
3. Borrowers from connected households and percentage of households dependent on the WD
4. Potential concessionaires
5. Consumption estimates
6. Income levels and the respective rates showing willingness to pay for improved service
7. Water accountability

________ WATER DISTRICT
PILOT AREA QUESTIONNAIRE

DATE ______________
TIME ______________

INTERVIEWEE ______________ ADDRESS ______________

TYPE OF DWELLING ______________ CONSTRUCTION MATERIAL ______________

WD CONCESSIONAIRE

1. NO. OF OCCUPANTS: ________
2. CLASSIFICATION:
   - ☐ Domestic
   - ☐ Commercial
   - ☐ Institutional
   - ☐ Industrial
   - ☐ ____________
3. SIZE OF CONNECTION:
   - ☐ ½" ☐ 1" ☐ 2"
   - ☐ ¾" ☐ 1½" ☐ ____
4. TYPE OF CONNECTION:
   - ☐ metered: meter functioning
   - ☐ metered: meter damaged
   - ☐ flat rate (unmetered)
5. APPURTENANCES (Connected to System)
   - ☐ with hand pump
   - ☐ with electric motor pump
     - HRS used/day ________
     - Pump rated HP ________
     - GPM ________
     - ______________
6. OTHER SOURCE ASIDE FROM WD:

Own	Other HH
☐ wells	☐ wells
☐ springs	☐ springs
☐ rainwater	☐ rainwater
☐ ______	☐ ______

NON-WD CONCESSIONAIRE

1. NO. OF OCCUPANTS: ____
2. SOURCE OF SUPPLY:
   - ☐ own private well
   - ☐ rainwater
   - ☐ spring
   - ☐ public faucet
   - ☐ WD concessionaire
     HH Code No. ______
   - ☐ public well
   - ☐ others' private well
   - ☐ ______________
3. CONSUMPTION:
   - ☐ free
   - ☐ paying
     - volume used per day ________
     - Paying ₱ ________
     - for ________.

REMARKS:

FOR ALL HOUSEHOLDS

1. WD-WATER AVAILABLE:
   - No. of hours ______
   - Time ______
2. FAUCETS:
   - ☐ 1 ☐ 3 ☐ 5
   - ☐ 2 ☐ 4 ☐ ___
3. SHOWERS:
   - ☐ 1 ☐ 2 ☐ 3 ☐ ___
4. FLUSH WATER CLOSET:
   - ☐ 1 ☐ 2 ☐ 3 ☐ ___
5. MANUAL WATER CLOSET:
   - ☐ 1 ☐ 2 ☐ 3 ☐ ___
6. ☐ w/septic tank ☐ w/o septic tank
7. AVERAGE MONTHLY:

	Consumption	Billing/PMT
WD:	______	______
wells:	______	______
others:	______	______

8. USER:
   - ☐ w/ borrowers
   - ☐ w/o borrowers
   - Total no. of HH borrowers ______
   - Total no. of HH borrowers' occupants ______
9. How much would you be willing to pay if water service were improved?
   ________/month.

(TO BE FILLED UP AT THE WD OFFICE)

1. HOUSEHOLD CODE NO. ________
2. INCOME:
   - ☐ below average (₱220 below)
   - ☐ average (₱221 - 750)
   - ☐ upper middle (₱751 - 1,500)
   - ☐ high (₱1,500 above)
3. WD CONCESSIONAIRE:
   - ☐ registered
   - ☐ unregistered
4. PAYMENTS:
   - ☐ up-to-date
   - ☐ delinquent

____
ENUMERATOR

____
POSITION

Methodology Memorandum No. 2

To : L. V. Gutierrez, Jr.

From : A. de Vera

Date : 31 January 1977

Subject: Estimating Water Accountability

A. Need

To be able to determine future water demand per capita, need for leak detection and survey program, and the level of development possible for reducing wastage and leakage, the following information must first be available.

1. Ratio of accounted-for and unaccounted-for-water.

2. Ratio of wastage and leakage in relation to total production.

3. Domestic consumption per capita.

Although there are various methods for estimating water accountability, the selection of a method depends on the purpose for which it is to be used and the level of accuracy desired. Accounted-for-water as used herein refers to the revenue-producing water for the water district. It is the sum of the billed metered consumption and inferred water consumption at flat-rate connections.

B. Methodology

1. Pilot Area Survey

a. Objective - To be able to estimate total accounted-for and unaccounted-for-water. Accuracy will depend on the reliability of the consumption figures as obtained in the pilot area survey.[1]

b. Data Necessary - Monthly production; number of metered and unmetered connections; water rate schedule; pilot area data; and total monthly metered consumption.

[1] Refer to Methodology Mem[illegible]ndum No. 1.

MISSING PAGE

NO. MM2-2

c. Steps

Multiply monthly production by:

.31 to get accounted-for-water
.11 to get underestimated flat-rate use
.26 to get wastage
.25 to get leakage
.07 for others

3. Field Study Method

a. Objective - To be able to determine within ± 5 percent accuracy water accountability figures. This method, however, is time-consuming and very expensive.

b. Data Necessary - All data received shall be generated in the field. The number of concessionaires and the water rate schedule are basic requirements.

c. Steps

1) For each section of transmission and distribution line in the water system, appropriate measuring devices shall be installed in order to determine the amount of water flowing in and out, water used by the concessionaires, and water leakage.

2) Desk-top analysis is then necessary to determine water accountability.

METHODOLOGY MEMORANDUM NO. 3

To : L. V. Gutierrez, Jr.

From : P. del Rosario

Date : 8 February 1977

Subject: Classification of Water Districts According to Future Water Requirements

A. Introduction

The purpose of this methodology manual is to classify water districts (WD) so that future water requirements may be estimated. The factors to be considered in classifying WD's are economic and social development in the district's boundaries, probable sources of additional water supply and the people's ability-to-pay for improved water service.

The group with the probable highest per capita consumption is labelled Group I; and the group with the probable lowest water consumption, Group V. Affluent and highly urbanized water districts may fall under Group I, while less developed and small water districts, under Group V.

B. Methodology

The initial service area of the WD will most likely include the central urban area or core city (poblacion). To classify it according to future water demands, the WD and its central urban area are judged according to 5 grouping criteria - 1975 urban income, 1975 standard of living, 1975 business index, 1980 cost of water, and served population in 1980. For each criterion, a number of points, from 0 to 20, are allotted to each water district. The total number of points under the 5 criteria determines the classification of the WD.

Table MM 3-1 lists the 5 criteria by which the WD can be classified, and the points allotted to rankings in each criterion.

The grouping of the WD's based on the range of total points under the 5 criteria is as follows:

TABLE MX 3-1

WATER DISTRICT GROUPING CRITERIA

1975 Urban Income

Income Taxes Paid by Urban Residents (P)	Points 20
more than 30,000,000	20
10,000,001-30,000,000	18
5,000,001-10,000,000	16
1,000,001- 5,000,000	14
500,001- 1,000,000	12
100,001- 500,000	10
50,001- 100,000	8
20,001- 50,000	6
8,001- 20,000	4
4,001- 8,000	2
4,000 or less	1

1975 Standard of Living

% of Households with Refrigerators in Urban Area	Points 10	% of Households with Flush Toilets in Urban Area	Points 10
more than 30	10	more than 60	10
25.1 - 30	9	50.1 - 60	9
20.1 - 25	8	[illegible] - 50	8
15.1 - 20	[illegible]	30.1 - 40	7
10.1 - 15	6	20.1 - 30	6
5 - 10	5	10 - 20	5
less than 5	4	less than 10	4

1975 Business Index

% of Commercial Establishments in Urban Area	Points 20
more than 6.6	[illegible]
4.6 - 6.6	16
3.1 - 4.5	11
1.7 - 3.0	7
1.0 - 1.6	4
less than 1	2

1980 Cost of Water

Source of Additional Water Supply	Points 20
Spring, gravity type	20
Spring with booster pump	17
Infiltration with short transmission line/ well points	14
Infiltration with long transmission line/ wells	11
Surface water without reservoir	7
Surface water with reservoir	5

1980 Served Population

Population Served in Urban Area	Points 20
more than 150,000	20
100,001 - 150,000	18
80,001 - 100,000	16
65,001 - 80,000	14
52,001 - 65,000	12
41,001 - 52,000	10
31,001 - 41,000	9
22,001 - 31,000	8
15,001 - 22,000	7
10,001 - 15,000	6
less than 10,000	5

Group	Total Points
I	70 and above
II	60 - 69
III	50 - 59
IV	40 - 49
V	39 and below

In allotting points under each criterion, readily available data are taken from the latest NCSO report (1970 or 1975 census). These data are: total population in the city or municipality; total households; number of urban households; number of commercial establishments; number of industrial establishments; number of households with refrigerators; and number of households using flush water-sealed toilets. The data on total income taxes paid in the city/municipality in 1975 were obtained from the BIR office. Data on the probable sources of additional water supply were taken from the recent preliminary hydro-survey conducted by LWUA and the WD.

The following is a procedure for assigning points to a WD on the basis of the 5 criteria.

1. 1975 Urban Income

Urban income is based on the total income taxes paid by individuals and business entities and the percentage of urban households with respect to total households in the city/municipality. If the 1975 data are not available, the percentage of urban households is projected to 1975 by applying an increase of 0.1 to 0.4 percent per year. In projecting the percentage of urban households, growth characteristics and urban development must be considered. The projected percentage is multiplied by 1975 total income. Table MM 3-1 shows the breakdown of the annual income with points ranging from 1 to 20.

2. 1975 Standard of Living

The standard of living is measured by the number of households in the urban area with refrigerators and those with flush water-sealed toilets.

The percentage of urban households with refrigerators with respect to total urban households is projected to 1975, if the 1975 census is not available. An increase of 1 to 4 percent per annum is applied, depending upon the recent economic and social development in the city/municipality. The same procedure is applied to the percentage of urban households using flush water-sealed toilets. Table MM 3-1 shows the percentages of households with refrigerators and those with flush toilets with respect to total urban households, with points ranging from 4 to 10.

3. 1975 Business Index

The business index is measured by the percentage of commercial establishments with respect to total urban households in 1975. One industrial establishment (data from NCSO census) is assumed to be equivalent to 10 commercial establishments (except when the 1975 census is available). An increase of 1 to 20 establishments per year is applied, depending on the recent business activities and urban development in the city/municipality. The number of urban households in 1975 is obtained by multiplying the 1975 total households (total population + average of 7 persons/household) by the 1975 percentage of urban households as derived in the methodology for 1975 urban income. The 1975 sum of commercial establishments divided by the number of 1975 urban households is the business index of the city/municipality. Table MM 3-1 shows the various levels of business index, with corresponding points ranging from 2 to 20.

4. 1980 Cost of Water

The cost of water is inferred from the probable source of additional water supply by 1980. The probable source of additional water supply is weighted according to its apparent economic viability. A spring source that is located within the 1980 service area and can flow by gravity is considered the most economical. Surface water requiring complete water treatment with impounding reservoir is the most expensive. Infiltration galleries with short or long transmission lines, wells, or spring source requiring booster pump, are considered to have weights between the most and least expensive (see Table MM 3-1).

5. Served Population in 1980

The served population in 1980 is projected by delineating the future service areas of the WD and projecting the population of the city/municipality and of the service areas. The 1980 served population is determined as a portion of the service area population. In projecting the population served and the future service areas, economic growth and urban development, availability of water supply and capability of the water district to provide service must be considered.

C. Expected Water Demand By Class of WD

The experience of the LWUA-CDM staff, especially during the First Ten Urban Areas Project in the Philippines, has been used to assign values of expected water demand to the 5 classes of water districts. These expected water demands are shown in Table MM 3-2.

D. Example of Water District Classification

This method of classifying a water district is illustrated, with the Silay City Water District as an example. Available data for Silay City are taken from the NCSO and BIR reports, and from the preliminary hydro-survey by LWUA and the SIL-WD. The following data were obtained:

Total income taxes paid in the city - ₱20,049,139 (1974-1975)

Total population in the city - 103,493 (1975)

Total number of households in the city - 10,915 (1970)

Total number of households in the urban area - 3,693 (1970)

Total number of commercial establishments in the city - 36 (1970)

Total number of industrial establishments in the city - 1 (1970)

Total urban households with refrigerators - 266 (1970)

Total urban households using flush water-sealed toilets - 807 (1970)

Probable source of additional water supply - wells (1980)

Population in the service area - 21,280 (1980)

To determine the specific weights of the above data for each grouping criterion, the methodology developed is applied as follows:

TABLE MM 3-2

WATER DEMAND OF WATER DISTRICT GROUPINGS

Classification	Year 1980	Year 1990	Year 2000
Group I			
Domestic use, lpcd	140	155	175
Commercial/Industrial/Institutional			
% of domestic	17	21	25
Equivalent, lpcd	24	33	35
Accounted-for-water, lpcd	164	188	210
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	109	73	52
Total production required, lpcd	273	261	262
Group II			
Domestic use, lpcd	120	135	150
Commercial/Industrial/Institutional			
% of domestic	15	17	20
Equivalent, lpcd	18	23	30
Accounted-for-water, lpcd	138	158	180
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	92	62	45
Total production required, lpcd	230	220	225
Group III			
Domestic use, lpcd	105	120	135
Commercial/Industrial/Institutional			
% of domestic	13	16	18
Equivalent, lpcd	14	19	24
Accounted-for-water, lpcd	119	139	159
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	79	54	40
Total production required, lpcd	198	193	199

TABLE MM 3-2 (Continued)

WATER DEMAND OF WATER DISTRICT GROUPINGS

Classification	Year 1980	1990	2000
Group IV			
Domestic use, lpcd	95	110	125
Commercial/Industrial/Institutional			
% of domestic	12	14	16
Equivalent, lpcd	12	15	20
Accounted-for-water, lpcd	107	125	145
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	71	49	36
Total production required, lpcd	178	174	181
Group V			
Domestic use, lpcd	90	100	110
Commercial/Industrial/Institutional			
% of domestic	10	13	15
Equivalent, lpcd	9	13	17
Accounted-for-water, lpcd	99	113	127
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	66	44	32
Total production required, lpcd	165	157	159

1. 1975 Urban Income

In 1970, the urban households accounted for 33.8 percent of the total households in the city. But due to recent developments in the local economy and subdivision housing projects in the urban sector of the city, the number of urban households was projected to increase to 35 percent in 1975. The product of the total 1974-1975 income taxes and the 1975 percentage of urban households represents the urban income taxes which amount to about ₱7.017 million. Table MM 3-1 gives this a weight of 16 points.

2. 1975 Standard of Living

This is measured by:

a. 1975 urban households using refrigerators

In 1970, 7.2 percent of the urban households had refrigerators. Due to economic and housing developments, the percentage was estimated to increase to about 12 percent in 1975. Table MM 3-1 gives this a weight of 6 points.

b. 1975 urban households using flush water-sealed toilet facilities

In 1970, the households with toilet facilities represented 21.9 percent of urban households. Due to the recent housing developments in the urban area, the households with toilet facilities were projected to be about 32 percent in 1975. Table MM 3-1 gives this a weight of 7 points.

3. 1975 Business Index

It is assumed that one industrial establishment is equivalent to 10 commercial establishments. Based on the 1970 census, the number of commercial establishments (equivalent industrial establishments included) was 46 (36 + 10). These establishments were expected to have increased to 96 (at 10 establishments per year) in 1975. Total urban households increased from 3,693 in 1970 to about 5,180 in 1975 (1975 population of 103,493 ÷ average 7 persons/household). Hence, the business index in 1975 was 1.9 percent (commercial establishments divided by the number of urban households in 1975). Table MM 3-1 gives this a weight of 7 points.

4. 1980 Cost of Water

Based on the hydro-survey of LWUA-CDM and SIL-WD, deepwells appear to be the most probable economical source of additional supply. Table MM 3-1 gives a weight of 11 points for this source.

5. 1980 Served Population

By 1980, the served population is expected to be about 15,630[1] as projected from the 1975 NCSO Census of Population and Housing. Table MM 3-1 gives this a weight of 7 points.

Therefore, the SIL-WD has a total of 54 points under the 5 criteria, indicating that it belongs to Group III. The water demands of this group from 1980 to year 2000 are listed in Table MM 3-2.

Table MM 3-3 classifies 16 water districts in the Philippines according to the 5 grouping criteria.

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[1] See Chapter VI, Table VI-3, of the Silay City Feasibility Study Report.

TABLE MM 3-3

SUMMARY OF CITIES/MUNICIPALITIES SUBJECTED TO THE WATER DISTRICT GROUPING CRITERIA

City/Municipality	1975 Urban Income (Points)	1975 Standard of Living: Urban Households with Refrigerators (Points)	1975 Standard of Living: Urban Households with Flush Toilets (Points)	1975 Business Index (Points)	1980 Cost of Water Source of Supply (Points)	1980 Served Population (Points)	Total Points	Group
Bislig, Surigao del Sur	14	6	7	11	14	7	59	3
Urdaneta, Pangasinan	6	7	9	11	11	6	50	3
Calamba, Laguna	14	9	10	7	17	6	63	2
Gapan, Nueva Ecija	6	8	9	7	11	6	47	4
Silay City	16	6	7	7	11	7	54	3
Cebu City	20	10	10	7	5	20	72	1
Davao City	16	9	9	16	11	10	71	1
Bacolod City	20	9	9	7	11	18	74	1
Zamboanga City	14	7	9	7	7	16	62	2
Digos, Davao del Sur	12	6	9	7	11	5	50	3
Bacacay, Albay	1	5	9	11	20	5	51	3
Bangued, Abra	1	6	8	7	20	6	48	4
Dalaguete, Cebu	1	5	8	4	11	5	34	5
Baybay, Leyte	10	9	8	16	9	6	58	3
Roxas City	10	9	8	16	7	6	56	3
Cotabato City	12	9	8	11	11	7	58	3
Olongapo City	18	9	10	20	11			1
Subic	4	5	6	16	11	5	47	4
San Fernando (Pampanga)	14	6	7	20	11	7	65	2
Tarlac	12	8	8	16	11	8	63	2
Cabanatuan City	12	8	10	11	11	9	61	2
Lipa City	8	8	10	16	11	7	60	2
Lucena-Pagbilao-Tayabas	14	6	8	7	17	12	64	2
Daet	10	5	4	4	20	10	53	3

Methodology Memorandum No. 4

To : L. V. Gutierres, Jr.

From : E. Jacildo

Date : 20 January 1977

Subject: Probability Analysis of Stream Flows by Gumbel

A. Need

In evaluating the surface water sources for water supply purposes, the analyst has to focus his interest on statistical frequency of extreme low flows. Since the exact sequence of streamflow for future years can not be predicted, he also has to consider the probable variations in flows in order to develop a design on the basis of calculated risk.

In 1941, E. J. Gumbel devised a probability method by which recurring flows can be computed for design requirements. Under this method, the hydrologic data are analyzed as an "extreme value" distribution and the sets of hydrologic data are plotted as straight lines. Gumbel's method has been found advantageous to use.

B. Basic Data

The hydrologic data are found in Surface Water Supply Bulletins published by the Water Resources Division of the Bureau of Public Works (BPW). Data are presented in the following sequence:

1. Name of river basin
2. Name of stream
3. Location of gaging station in latitude and longitude
4. Drainage area in square kilometers
5. Records available: months and year
6. Gage elevation
7. Extremes; magnitude and dates of maximum and minimum flows
8. Remarks
9. Revisions
10. Presentation of daily discharge for one year

It should be noted that Surface Water Supply Bulletins after 1967 have not been published; they are on file at the BPW Water Resources Division.

C. Methodology

Below are the steps in Gumbel's probability analysis of streamflows.

Table MM4-1

1. Tabulate the monthly flows (mean, minimum or maximum, whatever is desired).
2. Take note of any changes in the yearly records as stated under "Remarks" or "Revisions" of the Bulletin. Write them under remarks in Table MM4-1.

Table MM4-2

1. Arrange all monthly flows in ascending order, i.e., from lowest to highest. Any flow that occurs more than once should be listed.
2. Rank the arranged flows under "m".
3. Take the logarithm of Q.
4. Solve for the probability flow by the formula

$$\frac{m}{n+1} \times 100$$

   where, m is the rank of a particular flow
   n is the total number of recorded flows.
5. Solve for the return period by the formula

$$\frac{n+1}{m}.$$

Figure MM4-1

1. Plot log Q as ordinate against probability as abscissa. Figure MM4-1 is Gumbel's special probability paper.
2. Draw a straight line (month line) passing through the points marked in step C-1. If not all the points fall on the line, adjust the line such that it passes on the average path of the points. Any return period which falls on the line is in month's term. The line may be extended in order to reach periods not covered by it.
3. Take the antilogarithms of the values of return periods in months as projected on the log Q scale (ordinate). The antilogs are the recurring flows in cubic meters per day.

TABLE MM4-1

MEAN-DAY DISCHARGE PER MONTH

Basin: Pampanga (San Vicente)
Station: Peñaranda River
Location: lat. 15°18'46"; long. 120°56'30"
Drainage Area: 575 sqkm

Gage Elevation: 11,050 m
Units: cumd x 1,000

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Minimum-Day Discharge/ Year	Remarks
1965	-	2,283	753	351	372	1,313	-	-	-	3,239	5,156	4,358		
1966	-	2,915	-	-	8,941	1,595	2,682	4,215	5,425	1,413	9,801	5,380		
1967	4,922	857	1,189	547	873	425	1,012	6,614	4,415	5,707	5,896	125		
1968	66	77	120	540	96	-	-	-	-	-	-	117		
1969	141	32	336	689	664	301	3,203	2,394	2,248	1,175	1,785	2,190		
1970	1,989	814	279	17	17	3,561	2,928	1,628	9,590	11,726	9,689	6,915		
1971	3,123	642	732	294	1,499	4,567	4,021	1,824	1,377	11,161	5,229	15,007		
1972	5,992	4,873	406	1,461	767	415	18,347	15,977	6,306	216	4,701	2,896		
1973	697	823	82	108	95	686	2,525	2,650	4,405	14,582	4,149	2,124		
1974	1,405	1,332	2,191	471	621	3,781	3,497	10,761	10,014	12,567	16,317	13,693		

TABLE MM4-2

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability ($\frac{m}{n+1}$ x 100)	Return Period (Months) ($\frac{n+1}{m}$)
1	17	4.230	0.93	108.00
2	17	4.230	1.85	54.00
3	32	4.505	2.78	36.00
4	66	4.820	3.70	27.00
5	77	4.886	4.63	21.60
6	82	4.914	5.56	18.00
7	95	4.978	6.48	15.43
8	96	4.982	7.41	13.50
9	108	5.033	8.33	12.00
10	117	5.068	9.26	10.80
11	120	5.079	10.18	9.82
12	125	5.097	11.11	9.00
13	141	5.149	12.04	8.31
14	216	5.334	12.96	7.71
15	279	5.446	13.89	7.20
16	294	5.468	14.82	6.75
17	301	5.478	15.74	6.35
18	336	5.526	16.67	6.00
19	351	5.545	17.59	5.68
20	372	5.570	18.52	5.40
21	406	5.608	19.44	5.14
22	415	5.618	20.37	4.91
23	425	5.628	21.30	4.70
24	471	5.673	22.22	4.50
25	540	5.732	23.15	4.32
26	547	5.738	24.07	4.15
27	621	5.793	25.00	4.00
28	642	5.808	25.93	3.86
29	664	5.822	26,85	3.72
30	686	5.836	27.78	3.60
31	689	5.838	28.70	3.48
32	697	5.843	29.63	3.38
33	732	5.864	30.56	3.27
34	753	5.877	31.48	3.18
35	767	5.885	32.41	3.08
36	814	5.911	33.33	3.00
37	823	5.915	34.26	2.92
38	857	5.933	35.18	2.84

TABLE MM4-2 (continued)

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability ($\frac{m}{n+1}$ x 100)	Return Period (Months) ($\frac{n+1}{m}$)
39	873	5.941	36.11	2.77
40	1,012	6.005	37.04	2.70
41	1,175	6.070	37.96	2.63
42	1,189	6.075	38.889	2.57
43	1,313	6.118	39.815	2.51
44	1,332	6.124	40.741	2.45
45	1,377	6.139	41.667	2.40
46	1,405	6.148	42.592	2.35
47	1,413	6.150	43.518	2.30
48	1,461	6.165	44.444	2.25
49	1,499	6.176	45.370	2.20
50	1,595	6.203	46.296	2.16
51	1,628	6.212	47.222	2.12
52	1,785	6.252	48.148	2.08
53	1,824	6.261	49.074	2.04
54	1,989	6.299	50.000	2.00
55	2,124	6.327	50.926	1.96
56	2,190	6.340	51.852	1.93
57	2,191	6.341	52.778	1.89
58	2,248	6.352	53.704	1.86
59	2,283	6.358	54.630	1.83
60	2,394	6.379	55.555	1.80
61	2,525	6.402	56.481	1.77
62	2,650	6.423	57.407	1.74
63	2,680	6.428	58.333	1.71
64	2,896	6.462	59.259	1.69
65	2,915	6.465	60.185	1.66
66	2,928	6.466	61.111	1.64
67	3,123	6.494	62.037	1.61
68	3,203	6.506	62.963	1.59
69	3,209	6.510	63.889	1.56
70	3,497	6.544	64.815	1.54
71	3,561	6.552	65.741	1.52
72	3,781	6.578	66.667	1.50
73	4,021	6.604	67.592	1.48
74	4,149	6.618	68.518	1.46
75	4,215	6.625	69.444	1.44
76	4,358	6.639	70.370	1.42

TABLE MM4-2 (continued)

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability ($\frac{m}{n+1}$ x 100)	Return Period (Months) ($\frac{n+1}{m}$)
77	4,405	6.644	71.296	1.40
78	4,415	6.645	72.222	1.38
79	4,567	6.660	73.148	1,37
80	4.701	6.672	74.074	1.35
81	4,873	6.688	75.000	1.33
82	4,922	6.697	75.926	1.32
83	5,156	6.712	76.852	1.30
84	5,229	6.718	77.778	1.28
85	5,380	6.731	78.704	1.27
86	5,425	6.734	79.630	1.26
87	5,707	6.756	80.556	1.24
88	5,896	6.770	81.481	1.23
89	5,992	6.778	82.407	1.21
90	6,306	6.800	83.333	1.20
91	6,614	6.820	84.259	1.19
92	6,915	6.840	85.185	1.17
93	8,941	6.951	86.111	1.16
94	9,590	6.982	87.037	1.15
95	9,689	6.986	87.963	1.14
96	9,801	6.991	88.889	1.12
97	10,014	7.001	89.815	1.11
98	10,761	7.032	90.741	1.10
99	11,161	7.048	91.667	1.09
100	11,726	7.069	92.592	1.08
101	12,567	7.099	93.518	1.07
102	13,693	7.136	94.444	1.06
103	14,582	7.164	95.370	1.05
104	15,007	7.176	96.296	1.04
105	15,977	7.203	97.222	1.03
106	16,317	7.213	98.148	1.02
107	18,347	7.264	99.074	1.01

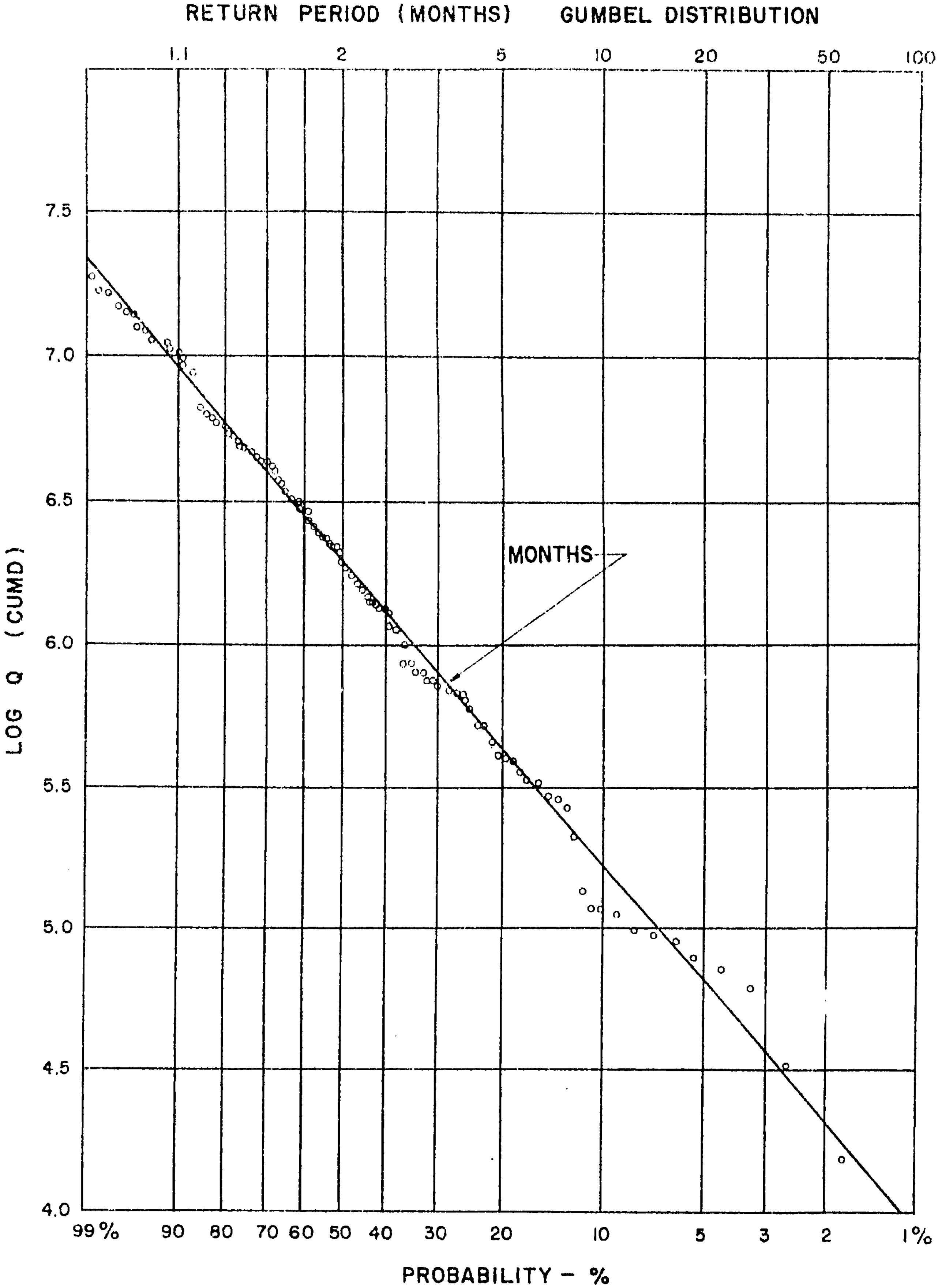

FIGURE MM4-1
MONTHLY MEANFLOW
(PENARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

Methodology Memorandum No. 5

To : L. V. Gutierrez, Jr.

From : J. B. Arbuthnot/B. R. Conklin

Date : 16 May 1977

Subject: Quantity of Storage Versus Rate of Supply

A. General

The demand for water in a water system is not uniform, therefore, the system must be designed to supply water at varying rates of demand.

One common method of supplying water at varying rates is to provide a specific amount of source pumping capacity and supply the difference between demand and pumping capacity from a water storage facility.

The most economical amount of pumping capacity and storage volume is selected based on cost studies of alternative combinations of facilities that would meet a community's needs. Some of the factors that should be considered in these cost studies and some basic guidelines for selecting properly sized facilities are presented in this memorandum.

B. Discussion

The amount of water a community needs at any particular instant is primarily dependent on the following factors:

1. The number of people within the community
2. The number of water-consuming facilities within the average home (faucets, toilets, showers, automatic washing appliances, etc.)
3. The habits of people (what times people eat, shower, sleep, etc.)

In general, daily usage of water follows a pattern with two peak usage periods during the day and low usage late at night. Figure MM5-1 shows a typical variation measured in a section of the Cebu City distribution system.

The relationship of the peak usage on an average day can be determined statistically for a given community. The statistical peak is an average of each person's peak usage and has two important properties:

1. The statistical peak is a function of the number of people in the community. The fewer people, the higher the peak may be because each person's peak usage could more easily affect the total flow.

2. The statistical peak should be recognized as a mathematical average, and on some days the peak usage could be much higher or lower than the statistical peak.

The common engineering practice for water systems is to supply water from a source at maximum-day rates either by pumping or gravity. Maximum-day demand is the maximum quantity of water used during an entire day in a single year. Water usage can be at or near maximum-day demand for a period of weeks during summer months. Source capacity must equal maximum-day demand because it would be impractical to store sufficient water to supply maximum-day demand rates for more than a few days.

The difference in demand between the peak-hour demands and the supply (which is equal to maximum-day demands) occurs during a period of short duration where demand exceeds supply. Stored water is used to meet this short period of excess demand and is called operational storage. It should be noted at this time that there are three categories of storage:

1. Operational storage - used to meet hourly fluctuations in demand.

2. Emergency storage - used to meet demands in case of breakdowns in source facilities; typically equal to a full day's demand.

3. Fire storage - used to meet the required volume of water used to extinguish the worst fire expected in the community.

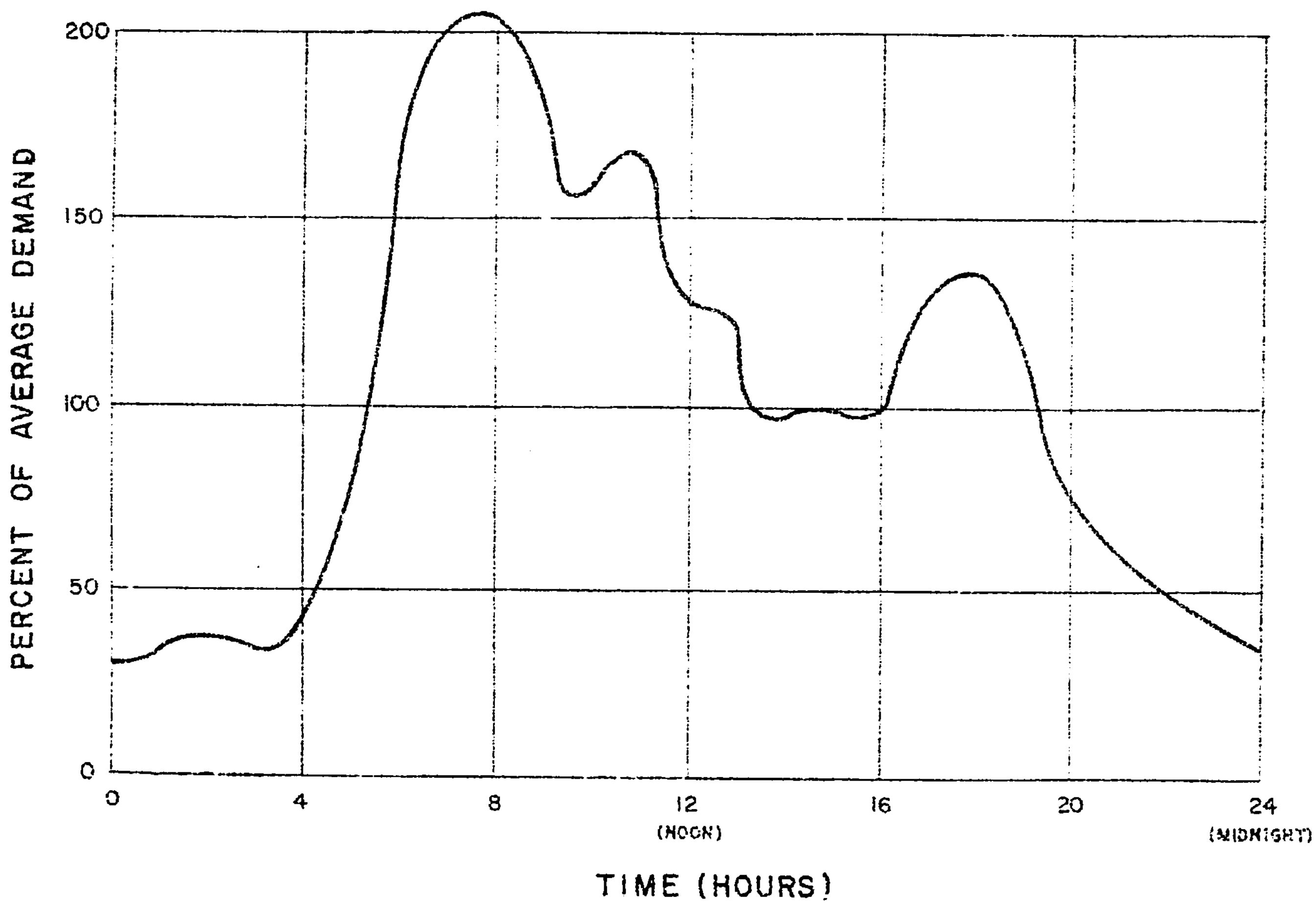

FIGURE MM5-1
DAILY USAGE PATTERN

Storage requirements for the last two categories have been largely neglected in these studies because of the excessive cost involved to provide the storage.

C. Methodology

The engineer must determine the amount of storage and source capacity to meet the demands in a specific community. A set of curves that relate the peak hourly usage to the number of people in a community has been developed by CDM and others.[1] Practice has shown that a volume of about 15 to 20 percent of the maximum-day usage is required as operational storage if source facilities can supply maximum-day demands. Combining the "peaking curves" with the operational storage requirement, a second set of curves relating the quantity of storage to the number of people, at different rates of source supply, has been developed (see Figure MM5-2).

Up to this point, the only option that has been discussed is to supply peak-hour demands from storage facilities. In many cases, the cost of storage facilities is so high that it may be more economical to provide additional source capacity and reduce the quantity of storage. This is especially true where storage is provided in elevated structures that are very costly, since they are built to withstand earthquakes. The curves in Figure MM5-2 have been used in this study to determine the requirements for storage at various supply rates in order to prepare cost comparisons of alternative supply and storage combinations.

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[1] ASCE Manual of Practice No. 37.

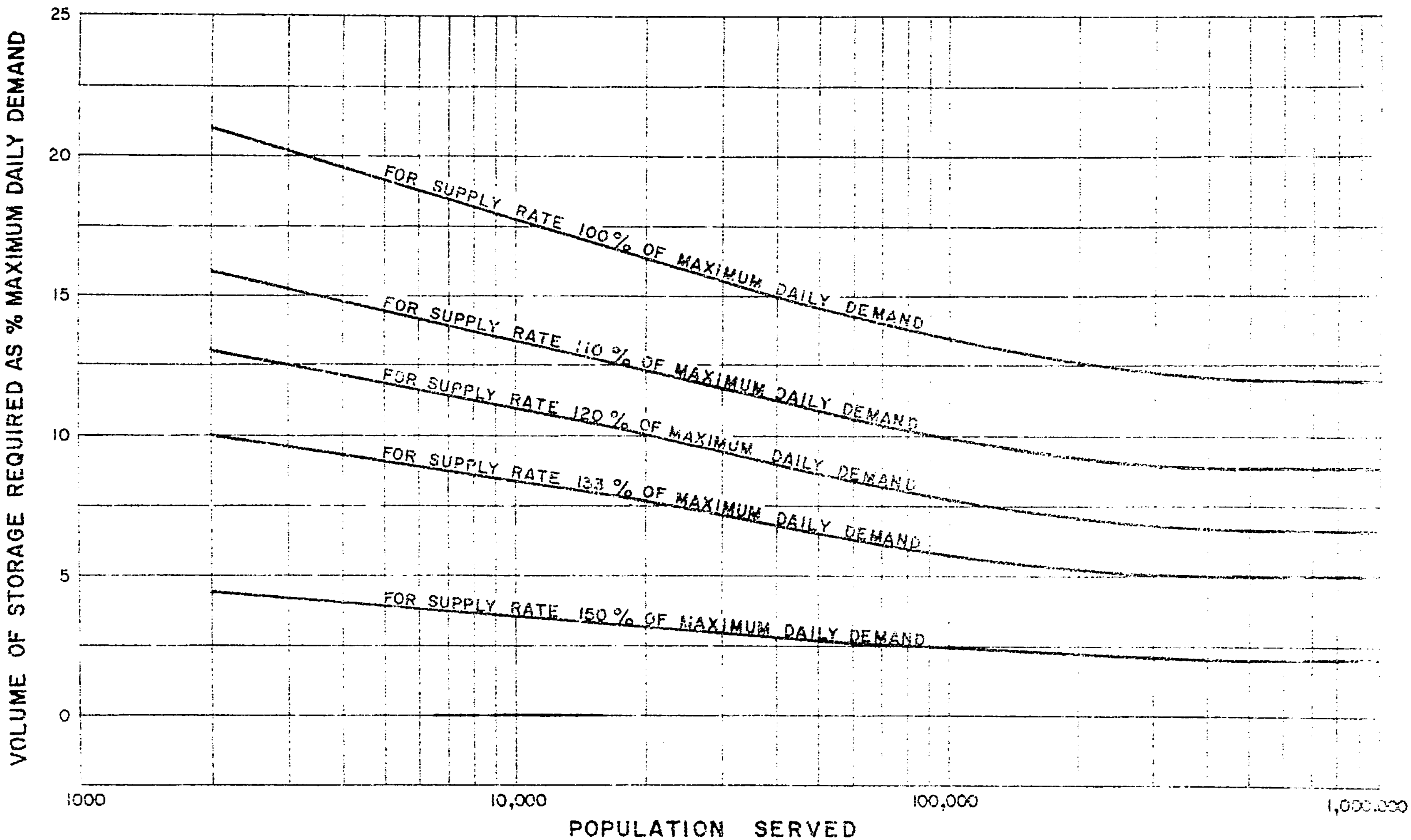


FIGURE MM 5-2
STORAGE REQUIRED
TO MEET
DAILY PEAK WATER DEMAND

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

Methodology Memorandum No. 6

To : L. V. Gutierrez, Jr.

From : J. Arbuthnot; B. Conklin

Date : 22 March 1977

Subject: Economical Sizing of Pumped Waterlines

A. General

This memorandum develops an expression for the most economic size of a pipeline for pumped water systems based on two cost factors: cost of pipe-in-place and cost of pumping (energy). The larger the pipe the greater the cost of construction. Also, the larger the pipe the lesser the cost of energy required to pump water through the pipe. The most economic pipe sizes would be where the incremental cost of pumping is equal to the incremental cost of pipe construction.

In most situations, the above cost factors are the most important factors in determining the economical size of transmission mains. Even when these are not the only important factors, it is still advantageous to know what is the most economic size of pipe with regard to these two factors.

B. General Relationship

The total annual cost of a pipe line is equal to the sum of its construction cost (expressed on an amortized annual basis) plus its annual pumping cost.

$$C_t = C_c + C_p \text{ [1/]}$$

To determine the most economic pipe diameter both the factors on the right hand side of the equation were expressed in terms of the diameter of the pipe. The equation was then differentiated with respect to the diameter, and solved for the diameter for which the resulting expression was equal to zero.[2/]

[1/] Total Annual Cost = Annual Construction Cost + Annual Pumping Cost.

[2/] $\frac{d(C_t)}{dx} = \frac{d(C_c)}{dx} + \frac{d(C_p)}{dx} = 0$, where X = pipe diameter

C. Annual Construction Cost

The construction cost of the pipe was taken from Table G-4 of Appendix G, Basis of Cost Estimates, in Volume II of the final report. Costs were adjusted by adding a value for necessary valves and by escalating these by 10 percent per year for 2 years to obtain July 1978 construction costs. These costs were then increased by 15 percent for contingencies and then by 10 percent for engineering. The following equation was derived and represents the adjusted construction costs in Table G-4 in terms of the diameter.

$$C = 2845\ (\text{Dia.})^{1.292} \quad \text{---- Equation 1}$$

C is the installed cost of pipe in pesos per meter, and Dia, the diameter of the pipe in meters.

The amortized annual cost of construction is the cost of construction multiplied by the capital recovery factor (as influenced by the economic life of the pipe and discount factor). The general equation is:

$$\text{Annual Cost of Construction} = \text{CRF} \times 2845(\text{Dia.})^{1.292} \quad \text{---- Equation 2}$$

where CRF is the capital recovery factor; for n = 50 years, discount rate = 12%, CRF is equal to 0.12042.

D. Annual Pumping Cost

The annual cost of pumping energy may be expressed in terms of the amount of water pumped, the energy required to overcome the frictional loss in the pipe, the price of electrical energy and the efficiency of the pumping machinery. The general equation may be written as:

$$\text{Annual Cost of Pumping Energy} = \frac{\text{Mass/Year} \times g \times Hf \times ₱/\text{kwh}}{\text{efficiency} \times 3.6 \times 10^{6}} \quad \text{---- Equation 3}$$

where mass/Year is the amount of water pumped in kilograms; g, the gravitational constant; Hf, the energy lost by friction of flow in the pipe expressed in meters; ₱/kwh, the cost of energy in pesos per kilowatt hour; and 3.6×10^{6}, the number of newton-meters per kilowatt hour.

The friction loss of energy in the pipe may be expressed in terms of the diameter utilizing the Hazen-Williams (H&W) equation,

$$Hf = \frac{L \times MLD^{1.852}}{361.27\ C^{1.852}\ D^{4.87}} \quad \text{---- Equation 4}$$

where L is the length of pipe in meters; MLD, the flow of water in million liters per day; C, the Hazen & Williams roughness coefficient; and Dia, the diameter of the pipe in meters.

E. Minimum Cost Diameter

The expression for minimum cost diameter may be obtained by inserting the expression for Hf in the equation for the cost of pumping energy, combining this with the expression for the annual cost of construction, differentiating, setting the resulting expression equal to zero and solving for the diameter:

$$\text{Minimum Cost Diameter} = \frac{MLD^{0.4628} \times (\text{pesos/kwh})^{0.1623}}{2.391\ (\text{efficiency})^{0.1623}\ C^{0.3005}\ (A/P,\ i\%,\ n)^{0.1623}}$$

using a C value of 120 and a capital recovery factor of 0.12042, the following equation is obtained:

$$\text{Minimum Cost Diameter} = \frac{MLD^{0.4628}(\text{pesos/kwh})^{0.1623}}{7.149\ (\text{efficiency})^{0.1623}} \text{ - - - - Equation 5}$$

The above equation is expressed graphically in Figure MM 6-1.

F. Limitations of the Analysis

How reliable is the preceding relationship (Equation 5), between water carried and economic pipe diameter? The derivation is rigorous but the relation is no more exact than are the simplifying assumptions upon which the derivation was based:

1. Construction Cost Relationship

The construction cost relation (Equation 1) has a standard deviation of just under 10 percent. This means that two-thirds of the time the formula will represent the adjusted costs tabulated, within 10 percent. The largest difference observed was 20 percent. Even so, economic conditions and the cost of pipe may change in time. Probably, a new table of pipe costs has to be made every 2 or 3 years, and the formulas, along with Figure MM 6-1, adjusted accordingly.

2. Other Assumptions

Other assumptions are:

C = 120 (Hazen & Williams coefficient)
i = 12% (Discount rate)
n = 50 years (Economical life of pipe)

The derivation also assumes that for the changes in pumping head, using various pipe sizes for a design flow, the total construction cost of the pumping station remains constant. This assumption is reasonable since the difference in cost between one pump selection and another for different heads at the same flow would not alter the cost of the complete station by significant amount. Generally, the installed motor horsepower would also be the same since the motors come in standard sizes and one size may be used for a number of different pump selections at a given flow.

The relative rate of inflation for pipeline construction is assumed equal to that of power costs.

3. Flow Quantities are Based on Constant Flow

The derivation of the most economic pipe diameter is based on a constant rate of flow within the pipe. This is probably the most general and therefore the least accurate of any of the assumptions.

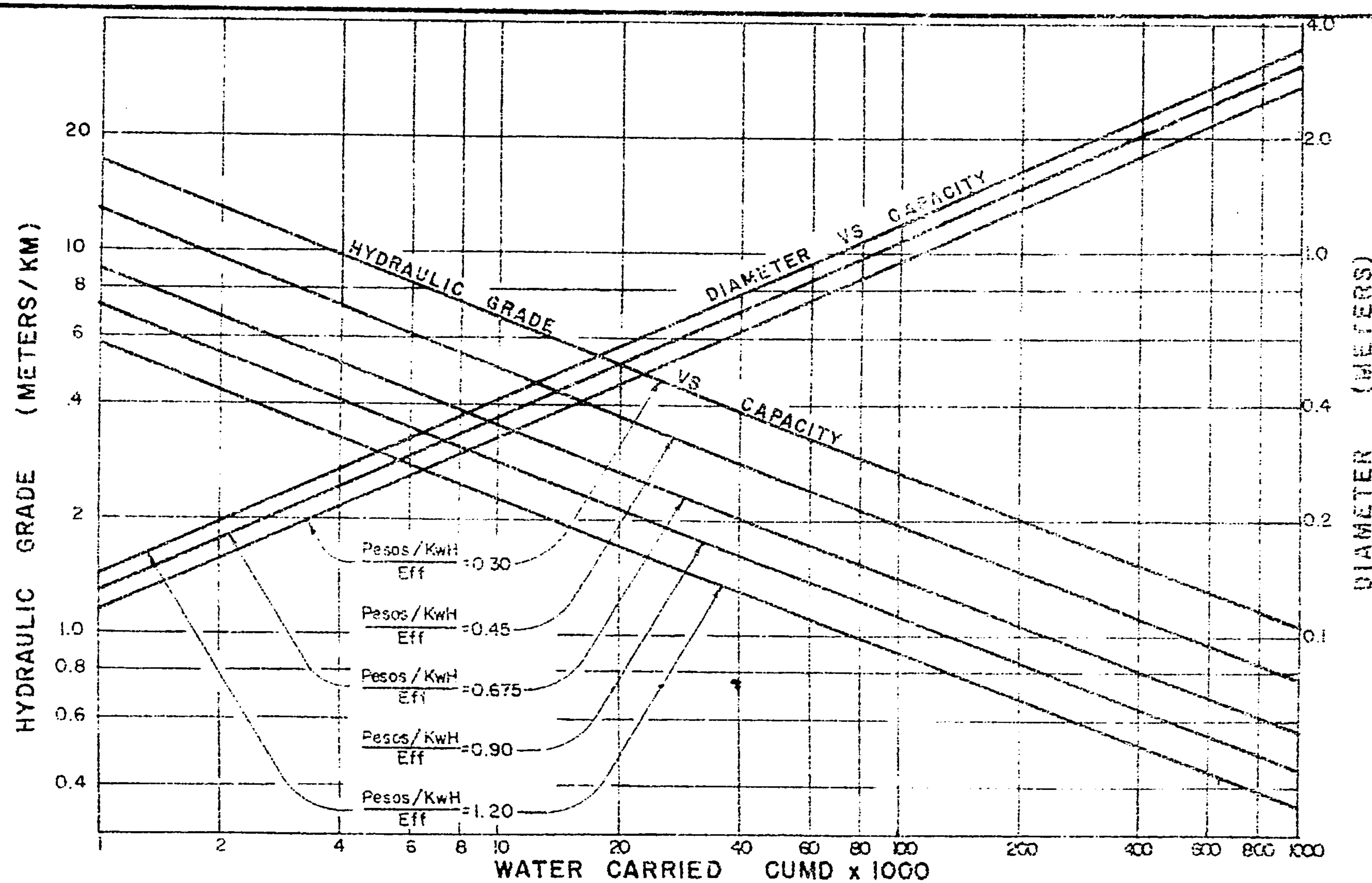
Normally a pipeline is designed for a specific flow condition; even under design conditions that flow may occur only part of the time. The flow in a transmission main could be expected to nearly equal the design flow for long period of time. However, in a distribution main, sized for peak-hour flows, the flow may not be equal to the design flow except for very short periods of time.

The variation in energy costs due to a fluctuating pumping rate through a pipeline can be calculated and applied to adjust the most economic pipe diameter determined from Figure MM 6-1. This so-called "energy variability factor" is discussed in the following section.

G. Energy Variability Factor

Figure MM 6-1 is based on selecting a pipeline where the flow will be constant throughout the year. In most cases, pipeline sizes are selected on a maximum expected rate of flow. If the flow through the pipeline is less than the design flow, the pumping head (which directly affects energy costs) would decrease according to the 2.852 power of the flow (Q). Conversely, if flow greater than design flow rate is pumped through a pipeline, the energy cost would be increased by the 2.852 power.

The overall difference in energy costs over the day or year can be calculated by comparing the costs of pumping at a constant flow rate with the cost of pumping at the expected flow variation. This value is the so-called "energy variability factor" (EVF). The design flow for the pipe is used as the base flow and the actual flow to the design flow over the day is expressed as a percent.



Note : 1. CONSIDERS CONSTRUCTION AND PIPELINE FRICTION COSTS ONLY INCLUDING ENGINEERING AND CONTINGENCIES
2. AVERAGE C = 120 OVER 50 YEARS
3. ECONOMIC DISCOUNT RATE = 12 %
4. PIPE COST (MID 1978 PRICES) = $2845D^{1.29}$ PER METER, (D IN METERS)

FIGURE MM6 - 1
MOST ECONOMIC WATER TRANSMISSION

The method used is to raise the difference between actual flow and the base flow (expressed as a percentage) to the 2.852 power. The ratio of the sum for the day of the actual flow to the design flow each raised to the 2.852 power is equal to the EVF. Figure MM 6-2 and Table MM 6-1 present two possible flow variations and the calculated energy variability factor for each.

The two flow patterns selected for Figure MM 6-2 are not commonly used design curves. Pattern 1 was selected to show that if a higher rate of flow than the design flow is pumped through the pipeline during a portion of the day, the EVF is greater than 1.0. Pattern 2 shows that if the actual flow rate is nearly equal to the design flow, the EVF would be nearly equal to 1.0.

An EVF of less than 1.0 would be a more common occurrence since the majority of pipelines are designed for some maximum future flow. The suggested EVF in a following section is an example of an EVF less than 1.0.

I. Application of EVF

The EVF can be used with Figure MM 6-1 in calculating the minimum cost pipe diameter. The EVF is inserted into the annual energy cost equation (equation 3) and then included in the differentiation, resulting in a revised equation as follows:

$$\text{Minimum Cost Diameter} = EVF^{0.1623}\ \frac{MLD^{0.4626}\ (\text{Pesos/kwh})^{0.1623}}{7.749\ (\text{efficiency})^{0.1623}} \quad \text{-- Equation 6}$$

The application of EVF requires 2 steps: first, design a minimum economic pipeline for some flow using Figure MM 6-1; and second, calculate the EVF for the actual flow variation and multiply the pipe size calculated in Step 1 by the EVF raised to the 0.1623 power.

J. Suggested EVF

The feasibility report on the Second Ten Provincial Urban Areas deals mainly with distribution pipelines; therefore, a suggested EVF that is applicable to distribution systems is presented herein.

The calculation of an EVF depends entirely on the flow data or assumed flow within a specific pipeline. The only accurate data produced during the feasibility studies are the diurnal flow variations measured in a portion of Cebu. The peak flow in the Cebu data was 2.06 which is greater than the design flows

TABLE MM 6-1

SAMPLE "EVF" FOR DIFFERENT FLOW PATTERNS

Hour	Flow Pattern No. 1 Percent of Average Day Demand	Flow Pattern No. 1 Energy Variation	Flow Pattern No. 2 Percent of Average Day Demand	Flow Pattern No. 2 Energy Variation
1	32	0.039	48	0.123
2	36	0.054	48	0.123
3	39	0.068	48	0.123
4	33	0.042	100	1.000
5	46	0.109	100	1.000
6	95	0.864	100	1.000
7	193	6.522	120	1.682
8	206	7.855	120	1.682
9	198	7.016	120	1.682
10	156	3.554	120	1.682
11	169	4.466	120	1.682
12	129	2.067	120	1.682
13	123	1.805	120	1.682
14	95	0.864	120	1.682
15	99	0.972	120	1.682
16	96	0.890	120	1.682
17	107	1.212	120	1.682
18	133	2.255	120	1.682
19	130	2.113	120	1.682
20	87	0.672	100	1.000
21	64	0.280	100	1.000
22	54	0.172	100	1.000
23	42	0.084	48	0.123
24	38	0.063	48	0.123
		44.038		28.481

$EVF_1 \frac{44.038}{24.000} = 1.83$ $EVF_2 \frac{28.481}{24.000} = 1.19$

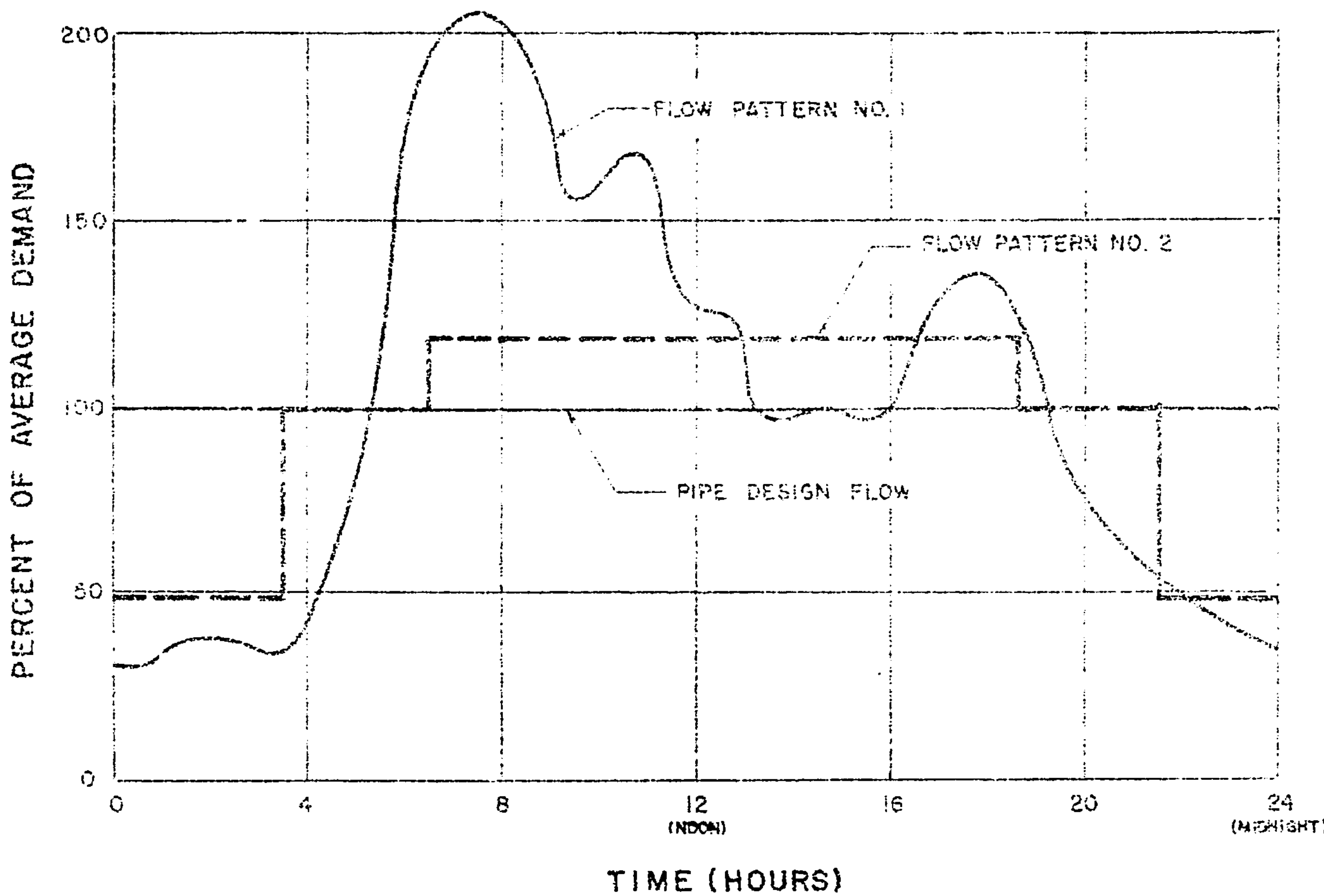


FIGURE MM6-2
SAMPLE FLOW PATTERNS

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

used for this study. Figure MM 6-3 presents an adjusted graph of diurnal flow using the shape of the Cebu curve but a maximum peak of 1.75. The EVF for this curve is equal to 0.32 (see Table MM 6-2) and when raised to the 0.1623 power, equals 0.83.

In practice, the EVF used for distribution systems in this study is only significant when the pipeline size is greater than 300 mm (significant means that EVF changes the recommended pipe size by a large incremental size).

K. Example

Problem: Select an economical distribution pipe size to convey a peak-hour flow of 20 MLD. The cost of power is 49 centavos per kilowatt hour, the pump efficiency is 81 percent, and the motor efficiency is equal to 90 percent.

Solution:

$$\frac{\text{Pesos/kwh}}{\text{Eff}} = \frac{.49}{.81 \times .90} = .672, \quad \text{say } .675$$

From Figure MM 6-1 using the flow of 20 MLD and Pesos/kwh/Eff = .675 select a pipe size of 500 mm.

For a flow variation in a distribution main, the EVF is equal to 0.32 and the EVF raised to the 0.1623 power is equal to 0.83. The most economical pipe size for the actual flow variation is equal to 0.83 x 500 m or 415 mm; so choose 400 mm pipe size.

TABLE MM 6-2

"EVF" FOR DISTRIBUTION SYSTEM

Hour	Percent of Average Day Demand	Percent of Design Flow 3/	Energy Variation 4/
1	35	20	0.010
2	40	23	0.015
3	39	22	0.013
4	37	21	0.012
5	73	42	0.084
6	134	77	0.475
7	164	94	0.838
8	175	100	1.000
9	174	99	0.972
10	163	93	0.813
11	162	93	0.813
12	134	77	0.475
13	118	67	0.317
14	94	54	0.172
15	94	54	0.172
16	94	54	0.172
17	105	60	0.233
18	129	74	0.424
19	123	70	0.362
20	96	55	0.182
21	72	41	0.079
22	58	33	0.042
73	47	27	0.024
24	40	23	0.015
			7.716

$$EVF = \frac{7.716}{24.000^*} = -.32 \qquad EVF^{0.1623} = 0.83$$

3/ Using 175 percent of average day as base flow for pipe design.
4/ Equals Percent Design Flow raised to the 2.852 power.
* Energy variation at constant flow

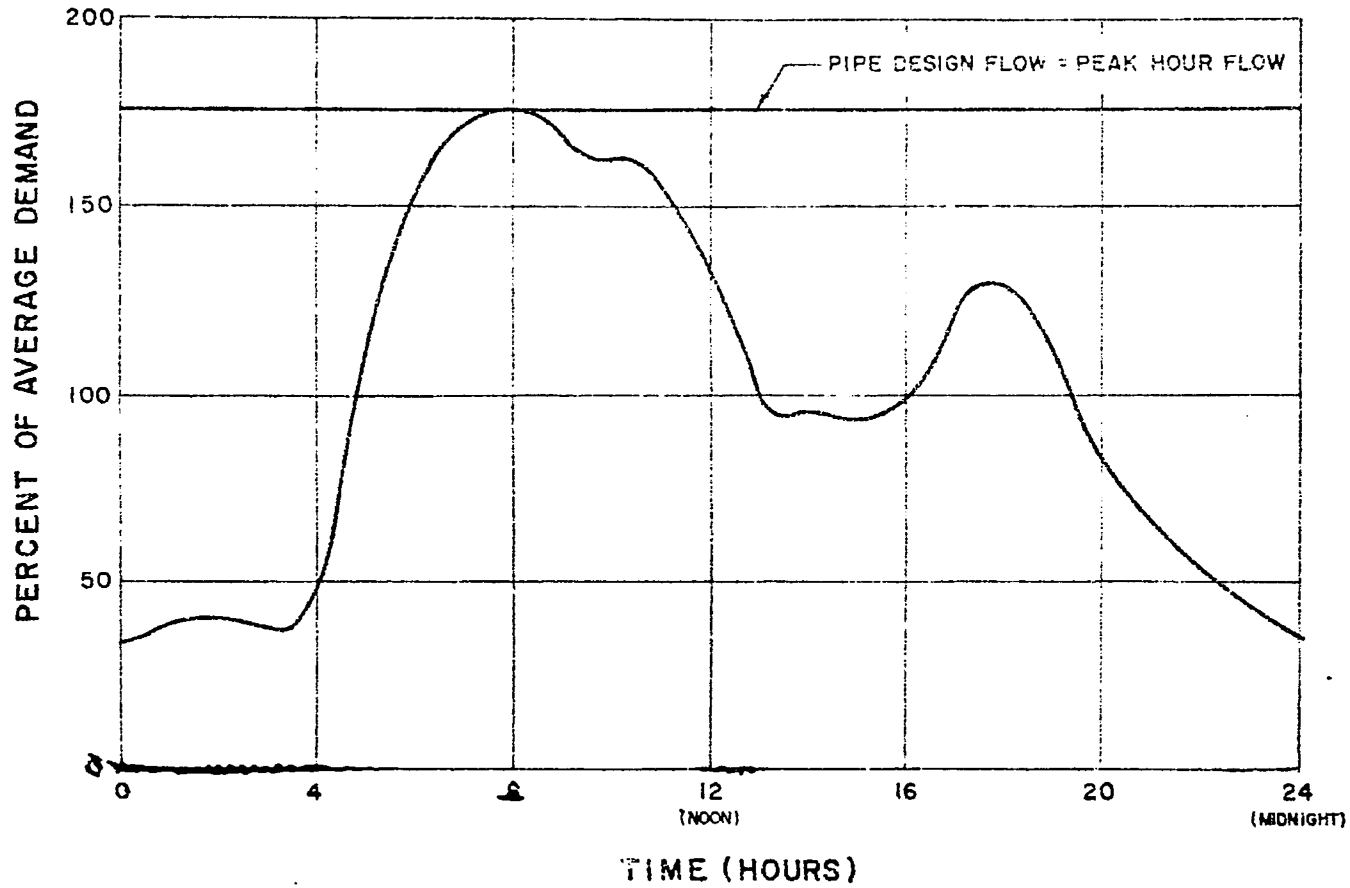
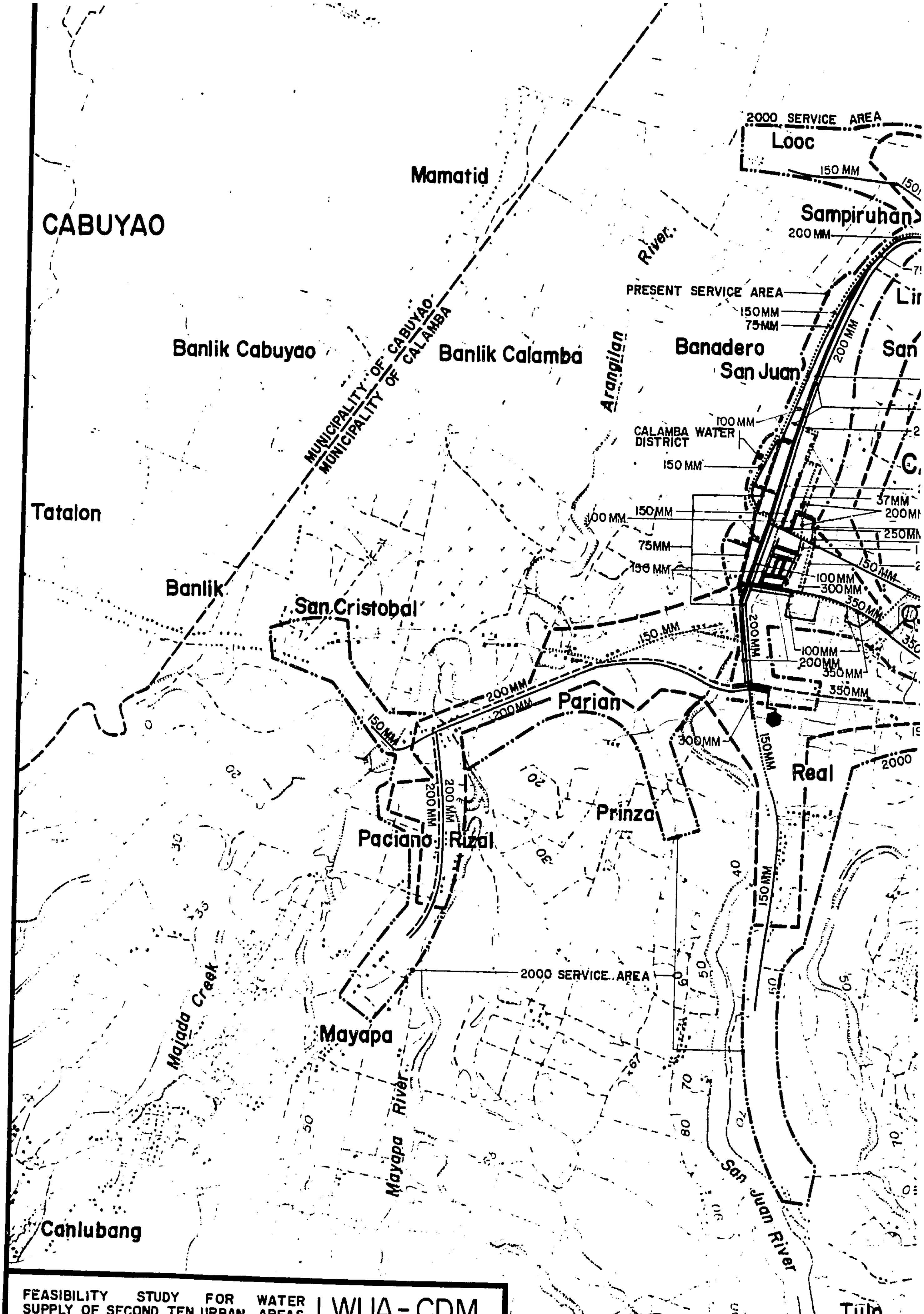
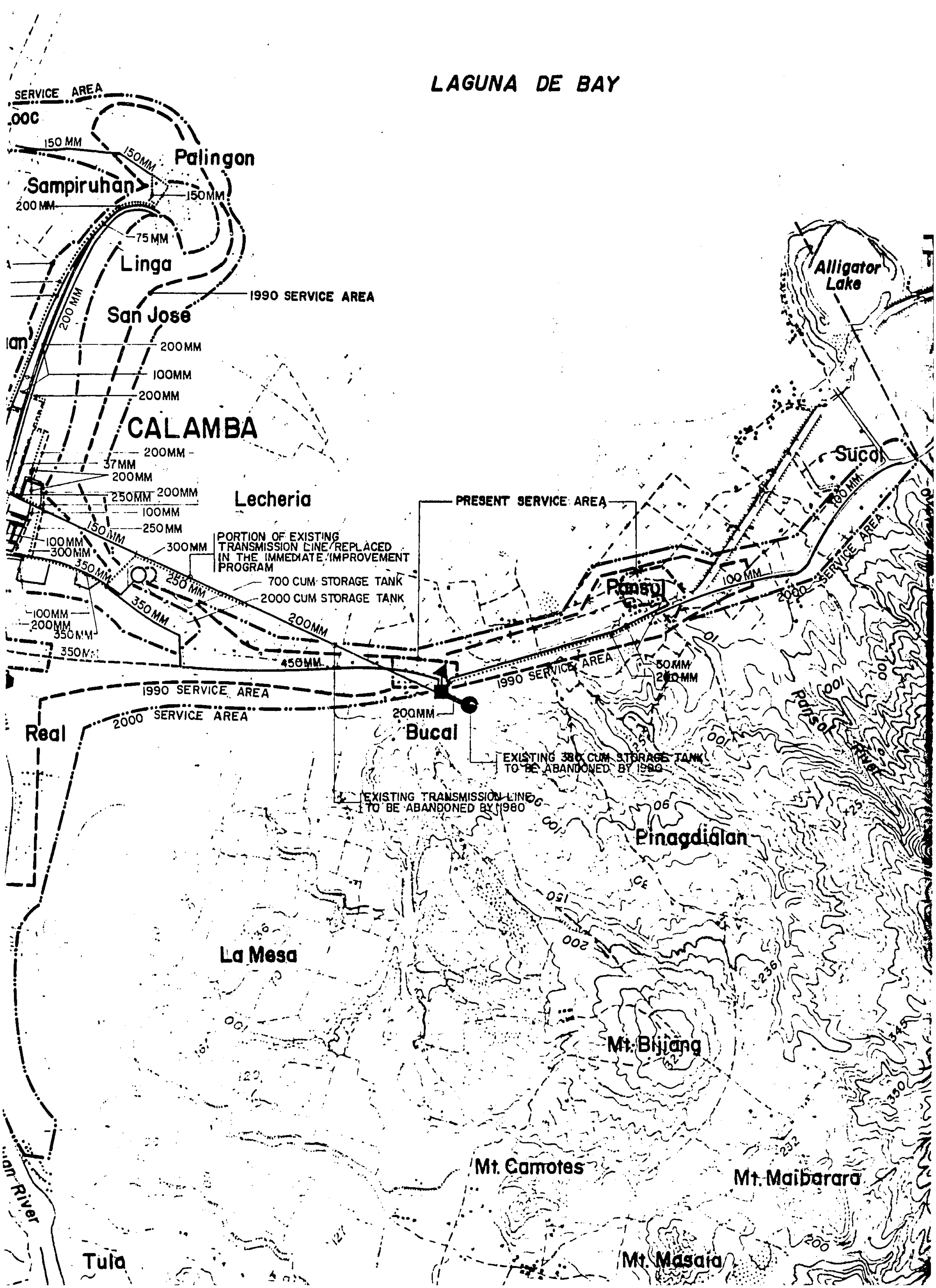


FIGURE MM6-3
TYPICAL FLOW VARIATION FOR DISTRIBUTION MAINS



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM



LAGUNA DE BAY
SERVICE AREA
Palingon
Sampiruhan
150 MM
150MM
200 MM
75 MM
Linga
1990 SERVICE AREA
San Jose
200MM
100MM
CALAMBA
37MM
250MM
Lecheria
PRESENT SERVICE AREA
PORTION OF EXISTING TRANSMISSION LINE REPLACED IN THE IMMEDIATE IMPROVEMENT PROGRAM
300MM
350MM
700 CUM STORAGE TANK
2000 CUM STORAGE TANK
450MM
2000 SERVICE AREA
Real
Bucal
EXISTING 380 CUM STORAGE TANK TO BE ABANDONED BY 1980
EXISTING TRANSMISSION LINE TO BE ABANDONED BY 1980
Pansol
Sucol
Alligator Lake
50MM
Pinagdialan
La Mesa
Mt. Bijiang
Mt. Camotes
Mt. Maibarara
Mt. Masaia
Tula
Pansol River

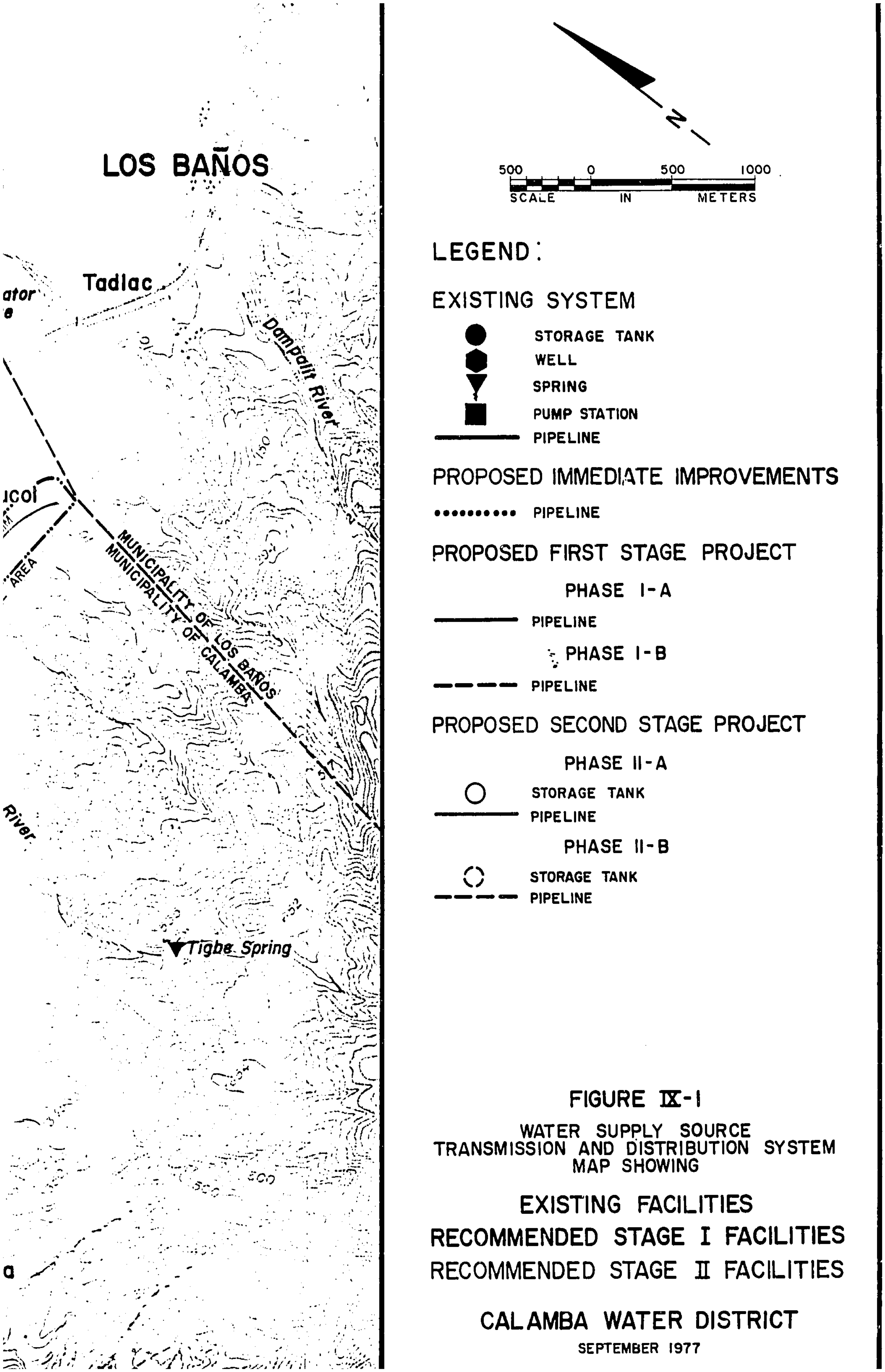


FIGURE IX-1

WATER SUPPLY SOURCE
TRANSMISSION AND DISTRIBUTION SYSTEM
MAP SHOWING

EXISTING FACILITIES
RECOMMENDED STAGE I FACILITIES
RECOMMENDED STAGE II FACILITIES

CALAMBA WATER DISTRICT

SEPTEMBER 1977