BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER	2. SUBJECT CLASSIFICATION
PN-AAJ-351	AP10-0000-G732

3. TITLE AND SUBTITLE (240)

Water supply, Lipa City Water District; feasibility study, technical final report; volume I (text)

4. PERSONAL AUTHORS (100)

5. CORPORATE AUTHORS (101)

Camp Dresser & McKee International, Inc.

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1976	193p.	RP628.1.C186b

9. REFERENCE ORGANIZATION (130)

CDM

10. SUPPLEMENTARY NOTES (500)

(Summary report, 37p.: PN-AAJ-350; Technical final report, vol.II, 235p.: PN-AAJ-352)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Water supply
Feasibility
Water services
Philippines
Urban areas
Municipalities
Municipal engineering
Water management

13. PROJECT NUMBER (150)

492026000

14. CONTRACT NO.(140)

AID-492-1281-T

15. CONTRACT TYPE (140)

16. TYPE OF DOCUMENT (160)

41

AID 590-7 (10-79)

LOCAL
WATER
UTILITIES
ADMINISTRATION

REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY
TECHNICAL FINAL REPORT

VOLUME I (TEXT)

WATER SUPPLY

LIPA CITY WATER DISTRICT

JUNE 1976

CAMP DRESSER & McKEE INTERNATIONAL INC.

CONSULTING ENVIRONMENTAL ENGINEERS

ONE CENTER PLAZA BOSTON, MA 02108 TEL. 617 742-5151 CABLE: CAMDRES

Local Address:
PHILCOMCEN BLDG., SEVENTH FLOOR
ORTIGAS AVENUE
PASIG, RIZAL
REPUBLIC OF THE PHILIPPINES
TEL. 70-11-76
70-11-77

Please Reply To:
CAMP DRESSER & McKEE INTERNATIONAL INC.
P.O. BOX 1251, MCC MAKATI, RIZAL
REPUBLIC OF THE PHILIPPINES

21 June 1976

Mr. Carlos C. Leaño, Jr.
General Manager
Local Water Utilities Administration
5th Floor, Philcomcen Bldg.
Ortigas Ave., Pasig, Rizal
Republic of the Philippines

Subject: Final Report - Feasibility Study for Water Supply - Lipa City Water District (LCWD)

Dear Mr. Leaño:

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

This report is presented in two parts: the Summary Final Report which provides the brief highlights of the study, and the Technical Final Report which provides the detailed analysis and support information.

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 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.

We wish to extend our thanks to the LWUA Board, all the members of the LWUA staff, our counterpart engineers from DCCD, the LCWD 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

PAUL W. PRENDIVILLE
Principal-In-Charge

FOREWORD

The Technical Final Report on the Water Supply Feasibility Studies for the Lipa City Water District, as submitted herein in two volumes, is a refinement of the Draft Final Report dated 30 April 1976.

The Draft Final Report was submitted for early review by the LWUA, USAID, LCWD, IBRD and CDM Technical Review Committee, of the findings and recommendations, early action guidelines, financial and economic analyses to upgrade the water supply and service to the district consumers. The Technical Final Report thus reflects the comments and suggestions of these parties, and the revisions and additions by the project staff. It is supported partly by the two volumes of the Methodology Manual on Water Supply Feasibility Studies published in August 1975.

The Technical Final Report contains 11 chapters dealing first with the existing conditions and then the proposed improvements to the LCWD water system. Chapter I summarizes the findings and recommendations. The scope of the project is defined in Chapter II, including a brief historical background on the LWUA and the LCWD. Chapters III and IV describe the physical, social and economic aspects of the study area and its existing water supply system. The criteria used in the planning, design, economic and cost studies are discussed in Chapter V. Chapter VI tabulates the population and water demand projections for the study area until the year 2000. The potential groundwater and surface water sources are presented in Chapter VII and compared in alternative studies in Chapter VIII. Chapter IX is a detailed description of the recommended plan covering the early action program and the two-stage, long-term construction program. Chapter X provides the projected financial costs to be incurred in the development, operation and maintenance of the water district. Chapter XI weighs the different economic benefits and costs associated with the establishment of a safe, potable and adequate water supply system.

The following have contributed significantly to the development of this Final Report:

A. Ulvi Gulbey, Chief Engineer
Gilbert S. Nicolson, Sanitary Engineer
Eugene Rumph, Hydrogeologist
James DeYoung, Water Supply Engineer
James Fort, Distribution Engineer
Mario Zabat, Counterpart Chief Engineer
Reynaldo Florendo, Sanitary Engineer
Emmanuel de la Cruz, Civil Engineer

Teofilo Palaganas, Professional Engineer
Bienvenido Viray, Professional Engineer
Dalia Castañeda, Economist/Technical Writer
Lourdes de Guzman, Technical Writer
Manuel Yoingco, Economist
Domingo Samonia, LCWD General Manager

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

Jean Caston, Economist
Angelito Sangalang, Assistant Engineer
Miguel Benavides, Junior Staff Engineer
Dandy Cruz, Chief Draftsman
Norma Custodio, Secretary/Typist

TABLE OF CONTENTS

VOLUME I

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Agencies

ADB	Asian Development Bank
BCWD	Butuan City Water District
CCWD	Cabanatuan City Water District
CDM	Camp Dresser and McKee International Inc.
CNWD	Camarines Norte Water District
DCCD	Design Consultation Construction and Development Engineering Corporation
EDF	Economic Development Foundation
IBRD	International Bank for Reconstruction and Development
LCWD	Lipa City Water District
LPTWD	Lucena-Pagbilao-Tayabas Water District
LUWD	La Union Water District
LWUA	Local Water Utilities Administration
MCWD	Metropolitan Cebu Water District
MOWD	Misamis Occidental Water District
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
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration (formerly Weather Bureau)
TWD	Tarlac Water District
USAID	United States Agency for International Development
ZCWD	Zamboanga City Water District

Units

AC	asbestos cement
CCI	centrifugally cast iron
CI	cast iron
CLCI	cement-lined cast iron
cm	centimeter
cum	cubic meter
cumd	cubic meter per day
cumd/m	cubic meter per day per meter
cumd/ha	cubic meter per day per hectare
cum/hr/sqkm	cubic meter per hour per square kilometer
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
mg/l	milligram per liter
mm	millimeter
mm/yr	millimeter per year
mo	month
m/sec	meter per second
%	per cent
P	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

CHAPTER I FINDINGS AND RECOMMENDATIONS

Existing Water System

The water supply of LCWD is presently obtained from 14 small springs east of the city, and from six deep wells within the distribution system (see Figure IV-2). The original waterworks system was constructed in the years 1929 to 1932 with seven small springs, some eight kilometers east of Lipa on Mount Malepunyo, as sources. Water flowed by gravity to serve the present downtown area of Lipa. To meet the increasing water demand, seven additional gravity springs and six pumped deep wells have been added since 1948.

At present, only 15 per cent of the study area population is served by the public water system. The majority of consumers receive water only a few hours daily; the fire-fighting capability of the system is nil.

Only 21 per cent of water production is accounted-for (billed). Only eight per cent of the connections are metered. Leakage and waste is estimated at 65 per cent of total production, and is especially a problem along the Santo Niño transmission mains.

Sixty-five per cent of distribution piping is 75 mm or smaller GS pipe. Over half of the distribution pipes have been in place for 45 years. Pipe carrying capacities are seriously reduced by tuberculation. Most gate valves are lost, and most fire hydrants are inoperable.

The LCWD is making a special effort to improve the water service to the customers since its formation in November 1974.

Projections

Population in the study area is expected to increase from 61,300 in 1975 to 121,800 in 2000. Served population for the same 25-year period is projected to increase from 9,100 to 88,700 or more than a nine-fold increase (see Figure VI-1).

Projections show that the domestic per capita daily demand will increase from 115 lpcd in 1975, assuming adequate supply and pressures, to 145 lpcd in 2000. Unaccounted-for-water is expected to decrease from 79 per cent in 1975 to 25 per cent in 1985 and to 20 per cent in 2000. Taking into account the water district's intent to implement a pricing policy and public relations program to discourage wasteful and extravagant water use, maximum daily water demand is estimated to increase from 9,300 cumd in 1985 to 15,800 cumd in 1990 and 24,500 cumd in 2000. (See Figure IX-1.)

Alternative Studies

Three basic alternative schemes have been established for detailed studies:

Alternative 1: Based on development of the groundwater well sources only, and related transmission, treatment and distribution feeder main systems;

Alternative 2: Based on development of the spring sources (assuming that no new wells would be constructed) and related transmission, treatment and distribution feeder main system; and development of a supply scheme of Taal Lake at a later stage.

Alternative 3: Based on development of the Taal Lake source only, with related transmission, treatment and distribution feeder main systems.

The net present worth costs of the source, transmission and treatment facilities for each of the three alternatives are shown below. The total net present worth cost of Alternative 1 is ₱27.37 million less than Alternative 2 and ₱29.65 million less than Alternative 3. The estimated net present worth unit cost of water produced (excluding distribution system piping costs) in each alternative is also indicated:

Alternative	Net Present Worth Cost (₱ x 1,000)	Net Present Worth Water Production (cum x 1,000)	Unit Cost per cum (₱)
1	10,679	14,536	0.73
2	38,049	14,536	2.62
3	40,330	14,536	2.78

Alternative 1, on the basis of economic present worth analysis, is the preferred and recommended alternative. It is least in: initial capital requirements, operating costs, foreign exchange requirements and power costs.

Alternatives 2 and 3 depend heavily upon Taal Lake as a future source of water supply. The uncertainty about what might happen to the solids content or salinity of Taal Lake water in the future is a real problem. At this time, it is not possible to postulate or even guess the future salinity content without a comprehensive study of Taal Lake and its volcano. If the solids content increases in time, brackish water treatment may be required. This would cause the unit cost of water to increase up to about P5.20/cum or more, excluding distribution system costs.

The variation in ground elevation within the future service area of the LCWD is considerable. The lowest elevation is 240 m in Barrio Antipolo south of Lipa City and the highest elevation is 365 m in Barrio Pinagtongulan west of Lipa City. It is not practical to serve an area with such a wide range in ground elevation from one pressure zone. Static water pressure which would be suitable for concessionaires at a ground elevation of 365 m would be excessive for concessionaires at a ground elevation of 240 meters. Also, as the LCWD service area expands, the range of ground elevation increases, making it more difficult to provide serv'ce from one pressure zone. As a result of the analysis, three pressure zones have been established.

Recommended Plan

An integrated water supply system utilizing groundwater wells and the existing springs as water sources is recommended for the LCWD service area. The long-term improvement program would be implemented in five construction phases of four to five years each (see Chapter IX). Prior to the initial construction phase, an Early Action Program must be undertaken.

The Early Action Program estimated at P1.19 million includes easily implementable steps in planning and administration; land acquisition and data collection; and operational improvements. Among the existing source facilities, the Santo Niño Spring supply and the Lipa Market Well would be retained after rehabilitation. About 2,000 cumd would be available from these sources.

Source Development. The long-term water supply for the LCWD will be derived primarily from groundwater wells. The number of wells required till the year 2000 is shown as follows:

	1990	2000
Total maximum-day demand, cumd	15,000	24,500
Flow from existing facilities, cumd (after the proposed modifications)	2,000	2,000
Required from new wells, cumd	13,000	22,500
Number of operational wells required	11	18
Stand-by wells	One each for Pressure Zones 1 and 2	One each for Pressure Zones 1, 2 and 3
Number of wells required	13	21

The only treatment required for these proposed well sources will be disinfection by chlorination.

Transmission/Distribution Facilities. The proposed transmission/distribution facilities for the long-term improvement program for the three pressure zones of the LCWD will include approximately 47.3 km of pipelines ranging in size from 100 to 250 millimeters. These will serve to connect the well sources with the proposed storage tanks and the internal network of the LCWD.

The ultimate (year 2000) distribution storage requirement in Lipa is 2,800 cum, with 1,400 cum to be provided in the first construction stage and the additional 1,400 cum to be provided in the second construction stage. Existing internal network systems for approximately 140 ha will be reinforced by 1990. New service areas will be provided with internal network covering 40 ha, 70 ha and 125 ha by 1982, 1986 and 1990, respectively, in the first stage of the long-term construction program. It is projected that by the year 2000 approximately 680 ha of service area will be covered by internal network piping (see Table I-1).

The long-term construction program involves a total of 14,600 additional service connections through the year 2000. During the first construction phase (Phase I-A) 2,050 new connections are scheduled to be installed. Metering all service connections is a goal of the water district.

The main features of the recommended long-term water supply improvement program for the projected service area are summarized in Table I-1 and shown in Figure IX-2, appended.

TABLE I-1

MAIN FEATURES OF LONG-TERM PROGRAM

	Early Action Works	Phase I-A	Phase I-B	Phase I-C	Phase II-A	Phase II-B
Construction Period	1977-78	1978-82	1982-86	1986-90	1990-95	1995-2000
Total Project Cost[1]	1,187	14,040	10,972	6,856	13,782	7,723
FEC ₱ x 10^3	726	6,700	5,210	3,512	6,427	3,846
Source Development	Strengthen legal basis for development of water sources; monitor production; acquire land required for proposed water sources	Retain Sto. Niño Spring and market well; construction of six operational wells and two stand-by wells equipped with pump and drive	Five operational wells to be constructed	-	Additional 8 wells will be constructed	-
Treatment (chlorination station)	Acquire disinfection equipment and install at all operating wells; routine water sampling program; additional 2 chlorinators to be installed at the collection chamber of lowest spring	Construction of chlorination room for each of the deep well stations	Chlorination will be provided for each well site		Chlorination will be provided for each well site	

[1] Based on July 1976 price levels

TABLE I-1 (Continued)

MAIN FEATURES OF LONG TERM PROGRAM

	Early Action Works	Phase I-A	Phase I-B	Phase I-C	Phase II-A	Phase II-B
Transmission and Distribution	Leakage surveys; acquire right-of-way; make repairs, alterations and operating improvements	See Table IX-3 100 mm-1.50 km 150 mm-3.59 km 200 mm-11.21 km	See Table IX-6 installation of distribution mains to Bo. Tibig, Balintawak, Mataas na Lupa and Tambo 150 mm-1.77 km 200 mm-4.95 km 250 mm-1.80 km	See Table IX-8 100 mm-0.90 km 150 mm-8.25 km 200 mm-0.50 km	See Table IX-11 150 mm-2.57 km 200 mm-3.81 km 250 mm-0.50 km	See Table IX-13 150 mm-1.75 km 200 mm-4.2 km
Storage Tanks	-	Utilize two existing storage tanks; renovation of elevated storage tank at Fernando Airfield	400 cum in Bo. Tibig, 1,000 cum in Bo. Balintawak; Existing storage facility be kept for emergency storage		Additional 500 cum in Bo. Balintawak; 200 cum operational plus 800 cum emergency storage in Bo. Lodlod	Additional 200 cum in Bo. Tibig, 500 cum at Bukal Hill in Barrio Pinagtongulan
Internal Network	Leakage survey	Reinforce 80 ha; new 40 ha	Replace 40 ha; new 70 ha	Reinforce 20 ha; new 125 ha	New 150 ha	New 155 ha

TABLE I-1 (Continued)

MAIN FEATURES OF LONG TERM PROGRAM

	Early Action Works	Phase I-A	Phase I-B	Phase I-C	Phase II-A	Phase II-B
Conversion Flat-Rate to Metered Connection	654 connections to be converted to metered connections					
Service Connections	New 200	Replace 200; new 2,050; master meter to Airfield distribution system	Replace 200; 2,700 new connections	Replace 314; new 2,700	New 3,450	New 3,450
Hydrants		41	37	43	67	65
Miscellaneous	Conduct survey related to drainage and sewerage system; purchase office equipment, service vehicles and tools	Recommend new office complex to be constructed with functional space for laboratory, meter shop, etc.				
Remarks			Existing storage tanks in Airfield and Poblacion will be kept for emergency storage		800 cum storage in Bo. Ledled will be kept for emergency storage	

Capital Cost Summary. The capital costs for each phase of construction, including the Early Action Works, are summarized in Table I-2.

A breakdown of escalated Phase I-A costs are shown in Table I-3.

TABLE I-2

CAPITAL COST SUMMARY 2/

Construction Phase	Construction Period	Construction Cost (P x 1,000)	Project Cost (P x 1,000) Local	FEC	Total
Early Action Works	1977-78	983	461	726	1,187
I-A	1978-82	10,774	7,340	6,700	14,040
I-B	1982-86	8,365	5,762	5,210	10,972
I-C	1986-90	5,262	3,344	3,512	6,856
II-A	1990-1995	10,517	7,355	6,427	13,782
II-B	1995-2000	5,927	3,877	3,846	7,723
TOTAL		41,828	28,139	26,421	54,560

2/ Based on July 1976 price levels

TABLE I-3

PROJECT COST OF RECOMMENDED PROGRAM
PHASE I-A (1978-82)
LIPA CITY WATER DISTRICT

₱ x 1,000
(ESCALATED)

Item	1977	1978	1979	1980	1981	1982	Total
Escalation Factor	(1.10)	(1.21)	(1.32)	(1.46)	(1.58)	(1.71)	
Source Development	220	1,492	3,019	1,656	-	-	6,387
Transmission-Distribution Mains and Valves	179	655	1,228	1,348	1,458	788	5,656
Storage Tanks and Appurtenances	8	51	101	57	-	-	217
Internal Network	78	287	537	590	640	345	2,477
Service Connections	90	330	614	674	730	398	2,836
Water District Buildings	64	434	878	482	-	-	1,358
TOTAL PROJECT COST	639	3,249	6,377	4,807	2,828	1,531	19,431

Annual Operation and Maintenance Costs. Annual operation and maintenance costs are expenses incurred for personnel, power, chemicals, maintenance and miscellaneous expenses. Estimates of the annual operation and maintenance costs of the water district (based on July 1976 price levels) are given in Table I-4.

TABLE I-4

ANNUAL OPERATION AND MAINTENANCE COSTS
LIPA CITY WATER DISTRICT
(UNESCALATED)

Item	Annual Costs (₱ x 1,000) 1980	1990	2000
Source Facilities	121	369	661
Treatment (Chlorine)	22	44	67
Transmission and Distribution	26	80	150
Administration and Personnel	143	273	362
Miscellaneous	15	30	50
TOTAL	327	796	1,290

Economic Feasibility

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

Two approaches were adopted in the calculation of the benefit-cost ratio and the internal economic rate of return (IERR). In the first approach where all five benefits[3] were included in 1976 prices and discounted at 12 per cent, the benefit-cost ratio is 1.61:1 while the IERR is 22 per cent. In the second approach where only two of the benefits[4] were considered, then escalated and discounted, the benefit-cost ratio is 1.88:1 and the IERR is 22 per cent.

---

[3] Increase in land values, health improvement, reduction in fire insurance, reduction in fire damage and incremental revenue.

[4] Reduction in fire damage and incremental revenue.

Financial Feasibility

The financial feasibility analysis made for the 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 was developed to indicate the manner and the time funds will be used to operate and maintain the system, implement the program, establish reserve funds, and retire the 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 LCWD householder.

The proposed water rates to effect self-sufficiency are as follows:

	Rate/cum
1976-78	₱1.00
1979-81	1.90
1982-84	2.45
1985-87	2.80
1988-90	2.95

CHAPTER II INTRODUCTION

A. SCOPE OF WORK

This feasibility study has been undertaken by Camp Dresser & McKee International Inc. (CDM) for the Local Water Utilities Administration (LWUA) as part of its effort to develop basic water supply plans for ten provincial urban areas of the Philippines (Figure II-1). It contains technical, economic and financial studies for the improvement of the water supply system in the Lipa City Water District.

The feasibility studies have been financed from proceeds of a loan to the Government of the Republic of the Philippines by the United States of America through the Agency for International Development. The duration of the studies is 19 months from December 9, 1974, the starting date of the LWUA-CDM contract. The project staff consisted of six US engineers and 35 Filipino personnel. Some assistance was also provided by the personnel of respective water districts during the course of the studies.

The project consists of four parts:

1. Preparing water supply master plans and feasibility studies for ten provincial urban areas of the Philippines, initially: Cebu, Zamboanga, Butuan, Ozamis, and Daet;

2. Developing a methodology for conducting these studies through training seminars for LWUA engineers (a Methodology Manual for Water Supply Feasibility Studies has been printed for this purpose);

3. Applying the training methodology by employing LWUA engineers in the preparation of master plans and feasibility studies for the second five areas, namely: Tarlac, Cabanatuan, San Fernando-La Union, Lucena and Lipa; and

4. Assisting LWUA in long-range planning by developing selection criteria, applying these criteria to 100 cities/municipalities and conducting pre-feasibility studies on 20-60 of the 100 cities/municipalities.

Training counterpart LWUA and local consulting engineering (DCCD Engineering Corporation) personnel is an important element in the conduct of such studies.

B. LOCAL WATER UTILITIES ADMINISTRATION

The Local Water Utilities Administration was established by Presidential Decree No. 198 issued on May 25, 1973. The decree seeks to establish, operate, maintain and develop reliable, adequate and economically viable municipal water supply and wastewater disposal systems. LWUA potentially covers urban areas throughout the country, except Metropolitan Manila which is served by the Metropolitan Waterworks and Sewerage System (MWSS).

In recognition of the vital role of water supply in national development, LWUA was organized on September 18, 1973 under the National Economic Development Authority, the highest economic planning body of the country. When Presidential Decree No. 768 was issued on August 15, 1975, LWUA was placed directly under the Office of the President. This new decree amends other salient provisions of Presidential Decree No. 198. On December 11, 1975, LWUA was transferred from the Office of the President to the Department of Public Works, Transportation and Communication by virtue of Letter of Implementation No. 31.

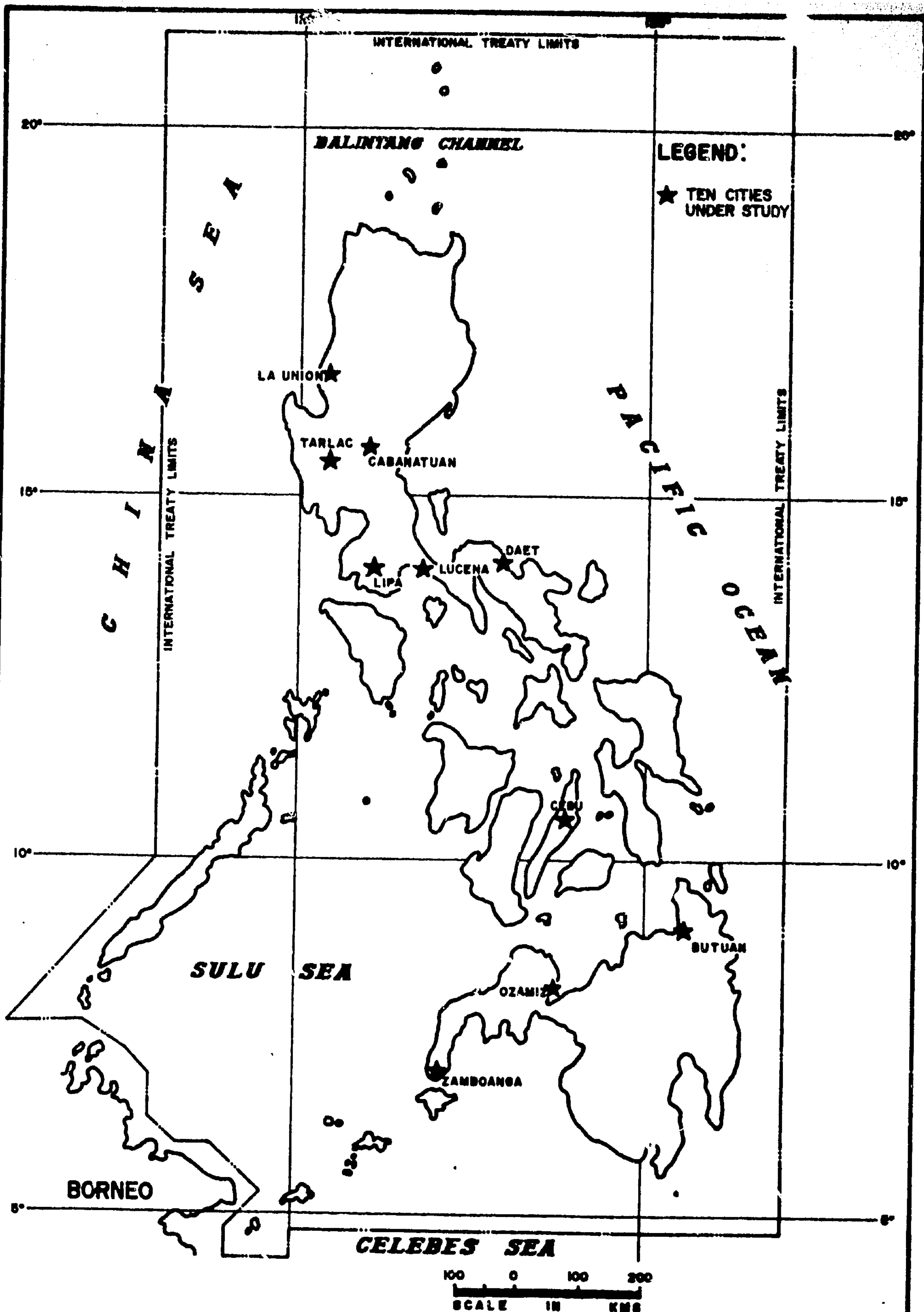
One of LWUA's primary activities is to encourage the formation of independent, locally controlled public water districts in provincial urban areas. This step is designed to ensure safe and sufficient potable water supply by the district and its operation on a businesslike basis.

LWUA renders assistance to local water districts in financial, training and technical matters. It also establishes standards for water quality and service, operations, management and administration including accounting practices. In addition, it prescribes activities necessary to ensure conformance with such standards.

<u>Organizational Set-Up</u>

Under Presidential Decree No. 198, LWUA is to be directed by a five-man Board of Trustees. At present, however, the Board has four members, with the General Manager as the fourth member. The Board formulates policies for LWUA and the General Manager is responsible for implementing such policies.

To carry out its functions, LWUA maintains four operating departments, each headed by a manager.



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS

CDM-LWUA

FIGURE II-1
LOCATION MAP

The Loans and Programs Department administers LWUA's revolving fund and relending program. It develops loan application criteria and covenants and processes loan applications of duly constituted local water districts. It also negotiates domestic and international loans.

The Technical Services Department provides technical assistance to water districts and develops design, construction and operational standards.

The Regulatory Department monitors the performance and operations of water districts. It also processes and administers LWUA's certification program for water districts.

The Administrative Department provides the necessary staff support to LWUA in terms of personnel recruitment, records management, general services and related functions.

The Management and Training Division under the Administrative Department conducts seminars among the boards of directors of water districts, their general managers and other key personnel and technicians. Such seminars aim to strengthen the institutional structure of water districts.

Only duly organized water districts which have been issued a Conditional Certificate of Conformance (CCC) are qualified for financial assistance from LWUA.

Funding

Under Presidential Decree No. 768, LWUA's funding and borrowing capacity was increased significantly. The original revolving fund of ₱20 million was increased to ₱50 million. The authorized loans from local sources were increased from ₱500 million to ₱1 billion and loans from foreign sources, from $100 million to $500 million.

Accomplishments

As of March 1976, LWUA issued Conditional Certificates of Conformance (CCC) to 21 out of 32 water districts with resolutions of organization officially filed with LWUA. A CCC is issued to a water district once it has taken significant steps towards the improvement of the public water supply, according to certain criteria prescribed by LWUA.

Among the ongoing and recently completed projects of LWUA are:

1. The design and construction of improved waterworks systems in the cities of Bacolod, San Pablo, Cagayan de Oro, Davao and Tacloban;

2. The feasibility study, design and construction of waterworks systems in the cities of Marawi and Batangas;

3. The water resources evaluation study for Baguio City;

4. The water supply feasibility studies of 10 provincial areas, which include this report; and

5. The water supply pre-feasibility studies of 100 cities throughout the country.

As part of its training program, LWUA has conducted seminars among key personnel of water districts. It has also developed the concept for long-range planning survey and interim demonstration program. Such plan is aimed at setting up a data bank for water needs and subsequently, undertaking immediate high-impact improvements on existing waterworks systems throughout the country.

C. HISTORICAL BACKGROUND LIPA CITY WATER DISTRICT

The Lipa City Water District was formed on November 18, 1974 by Resolution No. 182 of the Lipa City Board to serve primarily the water supply needs of the entire city. Several circumstances led to the formation of the district, the most important being the recognition for the need of 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 existing water supply system of Lipa City was constructed in 1929 under the city government management. In 1958, the National Waterworks and Sewerage Authority took over the system but which was reverted back to the city government in 1965. Following the formation of the LCWD, the ownership and management of the entire system were transferred to the LCWD in accordance with Presidential Decree No. 198.

On the same day the LCWD was established, the city board passed Ordinance No. 507 appropriating ₱75,000 as the city's counterpart fund for the water supply feasibility studies. With this appropriation, the LCWD complied with the minimum requirements of LWUA's certification program.

On December 26, 1974, Resolutions No. 182 and 184 organizing the LCWD were officially filed with LWUA. On January 30, 1975, LWUA granted the Conditional Certificate of Conformance to the LCWD in recognition of its efforts and commitment to improve the public water service. The CCC entitles the LCWD to all rights and privileges authorized under Presidential Decree No. 198.

Function and Operation

The LCWD is a quasi-public corporation with proprietary functions and is politically independent from the local government. As constituted, the water district is subject to the provisions of Presidential Decree No. 198 and the rules and regulations of LWUA. The LCWD can promulgate its operational laws through a five-member board of directors appointed by the City Mayor. The district can only be dissolved through the act of this board.

The LCWD was established for the purposes of acquiring, installing, improving, maintaining and operating the water supply and distribution systems as well as the wastewater collection, treatment and disposal facilities. To realize these objectives, financial and technical assistance may be granted to the water district through LWUA. The decree provides that the water district operate on a financially self-sufficient basis.

The LCWD is temporarily subsidized by the city government. On December 23, 1974, the city board approved Resolution No. 184 allocating ₱104,000 for the operation of the LCWD for fiscal year[1] 1974-75. For fiscal year 1973-74, its annual collection from water bills was ₱24,180 added to which was ₱53,622 from the city's General Fund. The operating expenses amounted to ₱52,603.

---

[1] From July 1 to June 30 of next year.

CHAPTER III DESCRIPTION OF THE STUDY AREA

A. PHYSICAL DESCRIPTION

Location

The Lipa City Water District which covers the entire city of Lipa is situated northeast of Batangas, a highland volcanic province in the southwestern region of Luzon island. Lipa, one of the two cities of the province, has a total area of about 206 sqkm.

The study area[1] (Figure III-1) is approximately 1,965 ha, located in the heart of Lipa City. The study area is divided into the present service area[2] (510 ha) of LCWD and its projected additional study area[3] through the year 2000. The present service area includes the poblacion[4] and 10 barrios[5] mostly located in the east-central part of the city. The projected study area extends mostly toward the city's west-central part.

Topography

Lipa City Poblacion is located in a terrace with an elevation of about 310 m above sea level. The city is flanked by a high mountain mass to the east and Taal Lake (at near sea level) to the west. The topography of the city varies from level to undulating.

---

[1] The study area encompasses the area considered in the projection of gross population and land use pattern. Study area limits have been determined after a careful review of development or zoning plans, physical limits and public facility projects in the region.

[2] The service area represents sections of the study area, which are currently served or intended to be served by the municipal water system. The served population projections in Chapter VI relate to the service area.

[3] Refer to Chapter VI.

[4] The poblacion also known as city or town proper is defined by pre-established political boundaries. It is determined by the location of the city or municipal hall. Ordinarily, the poblacion consists of the plaza or public square (which forms the central part), public market, schools, churches, commercial and residential blocks.

[5] A barrio is a political division of a city or municipality. The barrios currently served by LCWD are listed in Chapter VI.

Only minor streams drain the study area. The Panintahan River originates from five small springs and traverses across the poblacion. This river has a low flow draining into the southern barrios of the study area. Lipa River emerges from the Bulalacao Spring and flows in a south-northwest direction into Taal Lake.

Among the prominent springs are Bulalacao and Bucal to the west and the Santo Niño spring series in the mountain complex to the east.

Geology

The terrace where Lipa is situated consists of sedimentary rocks of Late Tertiary to Quaternary Age. (Geology is further discussed in Chapter VII.)

Soils

The study area has one of the most fertile soils in the country. The Lipa loam which is the predominant soil is known to have physical characteristics indicating lasting fertility. Dark brown and very friable, this residual soil originated from the underlying volcanic tuff. The Ibaan loam overlaying the western part is another productive soil ranging from brown to light reddish brown. The Ibaan loam (of the gravelly phase) in the western hilly portion of the study area developed from gravel and tuffaceous material.

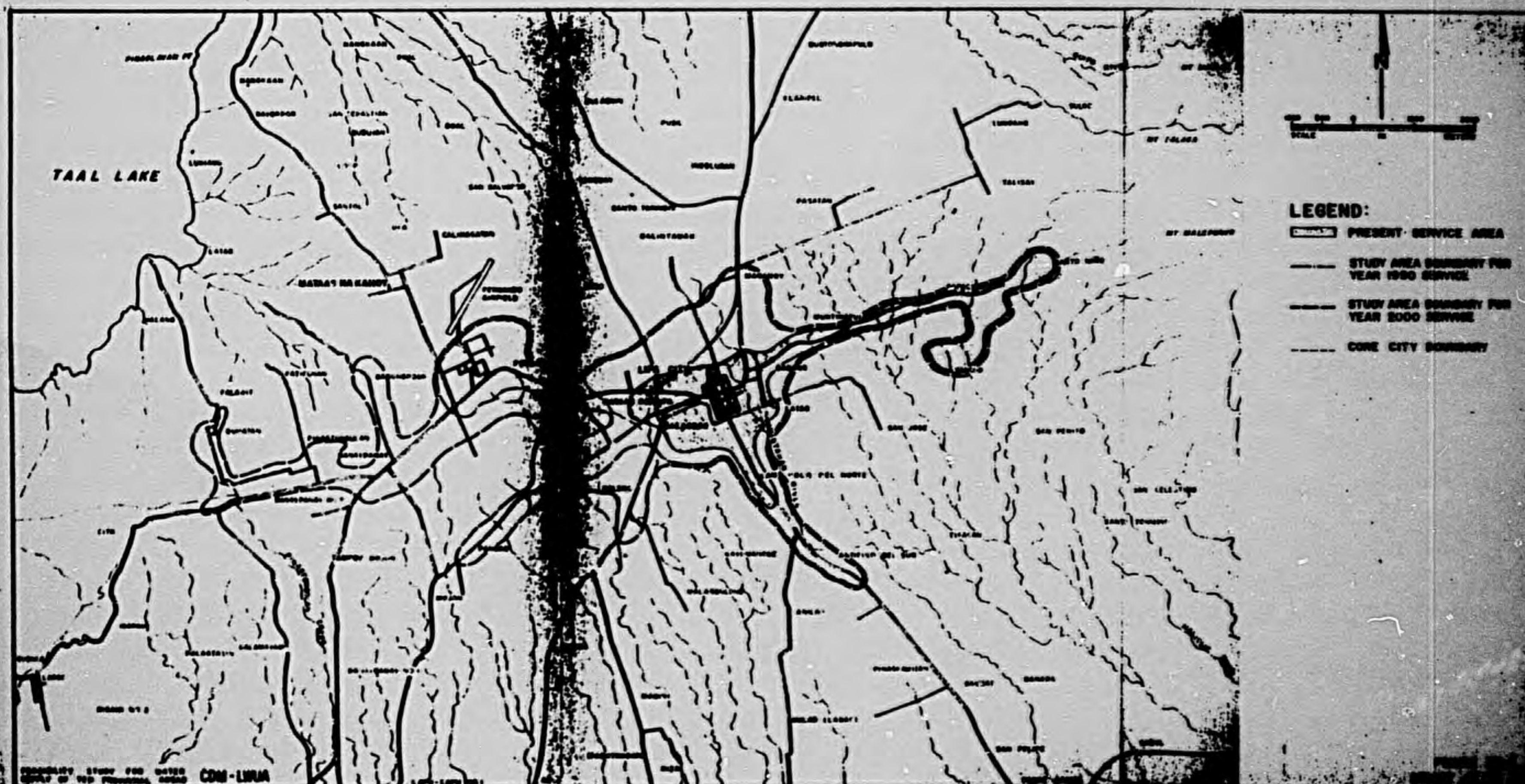
Climate

The Philippines has four types of climate (Figure III-2) based on rainfall. The climate in Lipa City is classified under the first type characterized by a dry season from November to April and a rainy season from May to October.

Because of its high elevation, Lipa is considered not as warm as other parts of the province. For the period 1971-74, average monthly temperature ranged from a minimum of 20°C to a maximum of 31°C; the average annual rainfall was approximately 2,500 millimeters and relative humidity was 81 per cent. The average frequency of typhoons for a five-year period (1970-74) was 24 per year. Climatological data for Lipa City are listed in Table III-1.

B. POPULATION

According to the 1970 Census on Population and Housing, Batangas had a total population of 928,300, an increase of 35.9 per cent over the 1960 population. The annual growth rate for the past decade was



TAAL LAKE
LEGEND:
PRESENT SERVICE AREA
STUDY AREA BOUNDARY FOR YEAR 1980 SERVICE
STUDY AREA BOUNDARY FOR YEAR 2000 SERVICE
CORE CITY BOUNDARY
CDM - LWUA

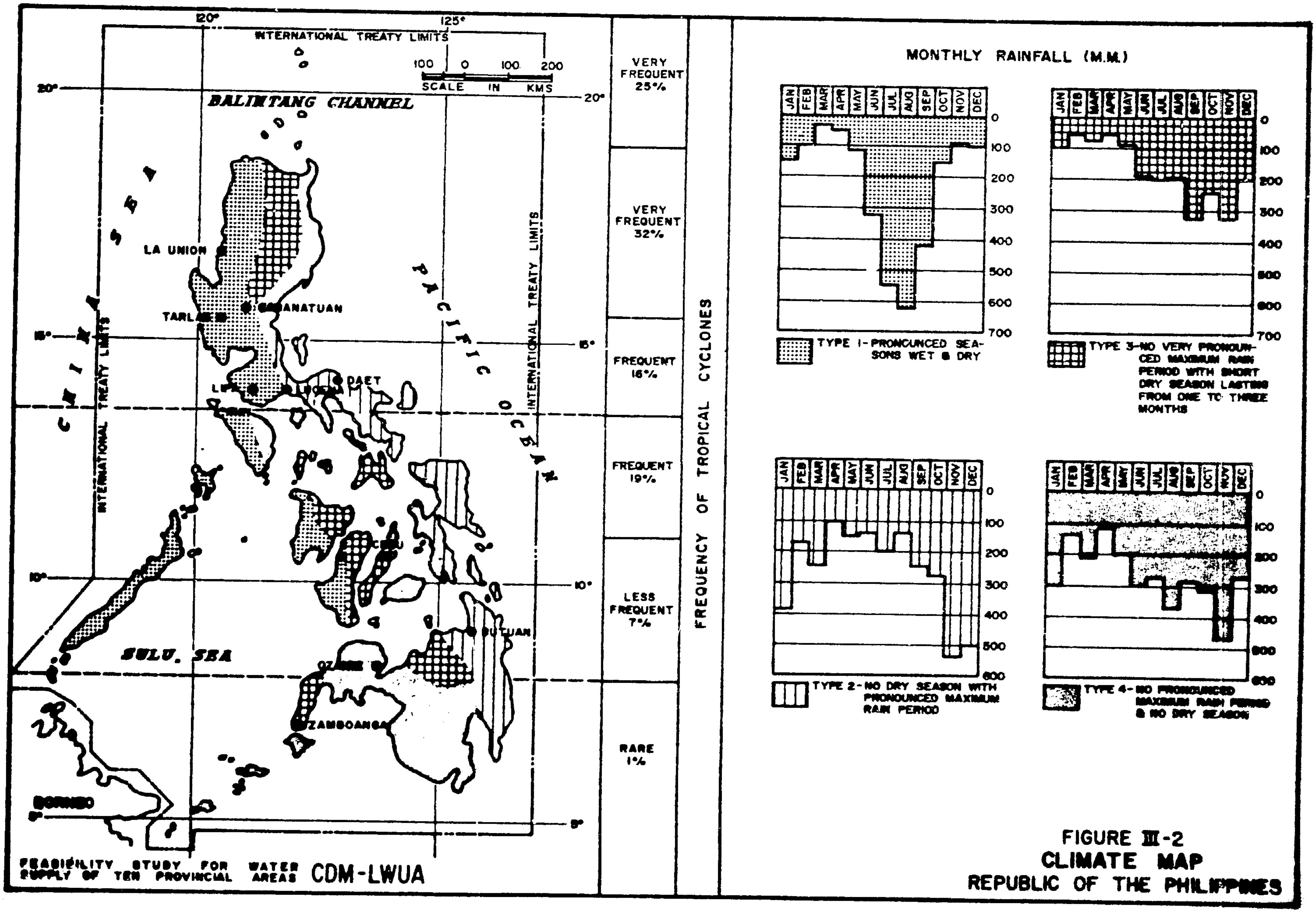


FIGURE III-2
CLIMATE MAP
REPUBLIC OF THE PHILIPPINES

3.05 per cent. The 1970 population of Lipa City was 93,970 or 10 per cent of that of the province.

The study area, considered the most urban part of the city, had a total population of 52,450 in 1970. The annual growth rate between 1960-70 was 3.4 per cent; population density was 27 persons per hectare.

TABLE III-1

CLIMATOLOGICAL DATA[6]

1971-74

	Maximum Temperature (°C)	Minimum Temperature (°C)	Rainfall (mm)	Relative Humidity (%)
January	26	20	27	80
February	28	20	6	78
March	28	20	23	74
April	30	21	48	69
May	31	22	272	78
June	29	23	336	82
July	28	23	510	86
August	28	22	307	84
September	29	22	183	85
October	28	22	405	86
November	27	22	286	86
December	26	21	214	85
Average	28	22		81
Annual			2,617	

[6] Source: Weather Detachment No. 2, 901st Weather Squadron, Philippine Air Force, Fernando Air Base, Lipa City.

Population Characteristics

Natural increase accounted mostly for the population growth in Lipa City. Those born in the city totalled to 87 per cent of its total residents. Those who migrated from other provinces represented eight per cent, greater than migrants from other municipalities of the province, who comprised only four per cent. Only one per cent composed residents from abroad.

The age composition is typically young, with 45 per cent of the 1970 city population under 15 years old. For the same year, there was almost an equal ratio of males to females. A household had an average of 6 members.

The 1970 Census indicated that 64 per cent of the total population was literate. Of those 25 years old and above (33,062), 60 per cent attended elementary school; 13 per cent, high school; and 10 per cent, college. The remaining 17 per cent had no formal education.

About 33 per cent of the city population in 1970 comprised the labor force. Thirty-six per cent of this workforce was engaged in agriculture; 19 per cent in services; 18 per cent in manufacturing, and 13 per cent in commerce. The remaining 14 per cent was employed in construction, public utilities and minor industries.

C. LIVING CONDITIONS[1/]

The standard of living in the study area may be measured by physical indicators like dwelling units, household facilities and utilities.

In 1970, there were 15,300 dwelling units in Lipa City, 95 per cent of which were of the single type. The remaining five per cent consisted of duplex, apartment/accesoria (low class apartment), "barong-barong" (makeshift houses), commercial, light industrial and institutional establishments. Based on local government statistics, 18 housing subdivisions have been developed in the city.

About 24 per cent of the city's 15,284 households in 1970 claimed to have been provided with piped water. Seventy-five per cent derived their water supply from groundwater sources. Only one per cent utilized surface water sources, including rainwater.

[1/] Source: National Census and Statistics Office.

Seventeen per cent of the 1970 households used the flush/water-sealed type of toilet. About 50 per cent used the open pit type; 18 per cent, the closed pit type; and one per cent, public toilet. The remaining 14 per cent did not have toilet facilities.

Lipa City has its own refuse collection service which is handled by the local government and financed from the general funds. Refuse is collected by one dump truck at each property served. Trash (non-organic wastes) and garbage (organic wastes) are not separated in the collection. The collected refuse is disposed by burning and by dumping on land surface.

Users of kerosene, the most common lighting source, included 60 per cent of the city's 15,284 households; electricity was used by 38 per cent. Wood as cooking fuel was used by 80 per cent of the households. The rest depended on other fuel and lighting sources.

Health

Water-borne diseases occur particularly in the more densely populated sections of the city. The lack of safe water supply, sanitary and sewerage facilities has contributed to the occurrence of diseases such as cholera, el tor, gastro-enteritis and diarrhea. Table III-2 shows the number of cases and deaths due to water-borne diseases in Lipa City.

The health needs of the city are served by 15 hospitals and clinics mostly located in the poblacion.

TABLE III-2

REPORTED CASES AND DEATHS[8] (1973)
LIPA CITY

Diseases	Cases		Deaths	
	Number	Rate[9]	Number	Rate[9]
Cholera El Tor	2	1.9	2	1.9
Typhoid and Paratyphoid	2	1.9	2	1.9
Gastro-enteritis	548	517.9	29	27.4
Dysentery	0	-	0	-

[8] Source: Disease Intelligence Center, Department of Health

[9] Per 100,000 population

D. ECONOMY

National Economy

Since the declaration of martial law in late 1972, the Philippine economic structure has been undergoing various reforms. Concrete results were achieved in 1973 when all economic indicators of the country reached unprecedented levels.

In 1974, however, inflationary and recessionary developments and domestic food shortages disturbed the improving economy. As a result, the growth rate of the gross national product (GNP) declined from 9.9 per cent in 1973 to 5.8 per cent in 1974. However, the country managed to realize a modest balance of payments (BOP) amounting to $110 million, despite the price decreases of some main export products, notably copper and wood products.

In 1975, the Philippine economy continued to bear the pressures of worldwide economic slowdown. While other countries approached the problem of inflation by cutting back production in order to depress demand, the Philippines took the unconventional approach of expanding production and investment. This policy proved to be advantageous to the country, as shown by the growth of practically all the sectors of the economy in that year.

Advanced estimates of the economic performance of the country in 1975 indicate that real GNP rose by 5.9 per cent, slightly higher than the growth rate in the previous year. This expansion could be attributed to the gains made by the agricultural sector during the year, posting a 12 per cent and 13.9 per cent increase in rice and corn harvest, respectively.

An unfavorable note on the economic picture, however, was the deficit in the country's balance of payments, which reached $250 million at the end of 1975. A substantial portion of this deficit was brought about by a trade deficit of $1,020 million which in turn resulted from the decline both in prices of and demand for Philippine products abroad.

An important economic achievement in 1975 was the drastic deceleration of the inflation rate. While consumer prices soared at an annual rate of 30 per cent in 1974, they were trimmed down to a manageable level of 8.7 per cent in 1975.

Traditionally, the country has been heavily dependent on agriculture. Statistics for 1974 and 1975 showed that agriculture, forestry and fishing accounted for 29.2 and 30 per cent, respectively, of the GNP. The construction industry posted the highest growth rate, 18.5 per cent in 1974 and 31.2 per cent in 1975. This overall growth of the economy had the effect of increasing the 1975 per capita income by 5.2 per cent from 1974 levels.

Prospects for 1976 have been invariably regarded with cautious optimism. NEDA foresees that 1976 could be as difficult as 1975. It has indicated that the increase in the country's oil import bill and the unattractive prices of its commodity exports are expected to affect adversely the balance of payments. It is generally believed that the performance of the country in 1976 will depend largely upon the recovery of the country's major trading partners like the United States and Japan.

Study Area Economy

Income Profile.[10] In 1971, the province of Batangas was estimated to include 165,400 families, 14 per cent classified as urban and 86 per cent, rural. Their combined annual income amounted to ₱499 million, with an average of ₱3,020. This figure was lower than the country's average family income of ₱3,740 for the same year. About 62 per cent of the families were considered low-income earners (annual earnings ranging from less than ₱500 to ₱3,000). The middle income (₱3,000-₱6,000) group included 26 per cent; the remaining two per cent received annual income of ₱6,000 and above.

Agriculture. Because of its excellent soils, Lipa City has a wide agriculturally productive land. Agriculture is the principal industry in the study area. Crops consist primarily of rice, sugar cane, coconut, fruits (mandarin oranges, lanzones and bananas) and coffee. Seventy per cent of vegetable-growing is done in small plots or backyards. Cattle, horses and hogs are the major livestock raised in the area.

Commerce and Industry. As of mid-1975, there were about 1,500 business establishments in Lipa City, mostly engaged in the wholesale and retail of consumer goods and agricultural products. A portion of these establishments are variety stores situated on street corners.

No known large manufacturing plant exists in the city, instead, minor manufactured goods mostly associated with weaving are produced. Some of these goods include mosquito nets, blankets, towels, saddles, harnesses, buri hats, and bamboo baskets.

---

[10] Source: National Census and Statistics Office.

Transportation and Communication. Except via Fernando Air Base which is used as a flying school, access to the city is entirely by land. From the city, paved roads lead to the surrounding towns. The city has 177 km of roads, 22 per cent of which are maintained by the national government. Nearly half of the roads are asphalted; the rest are unpaved and of substandard quality.

Communication needs of the city are served by two radio stations, and a telephone and a telegraph stations.

CHAPTER IV EXISTING WATER SUPPLY FACILITIES

A. GENERAL

Based on the studies of over 125 urban areas in the Philippines, the following have been found common to their water supply systems in varying degrees: water shortage, system age, water unaccountability, inadequate disinfection and unreliable service.

The existing waterworks facilities generally require repair and renovation. Field tests show that most distribution systems have old pipes with considerably reduced carrying capacity, resulting in low pressures and marginal fire-fighting capabilities. Operational personnel are mostly untrained and inadequately compensated. Widespread wastage of water is evident through leakage from old, corroded GS services and careless use by the average householder. Water rates have traditionally been so low that in most cases, operational costs of substandard facilities are not even covered by the collected revenues.

The water shortage affects the system pressures, fire-fighting potential and consumption patterns. Because water must be rationed, pressures fluctuate over a wide range and often become negative. The negative pressures increase the possibility of contaminated water entering the distribution system. Many water district consumers get water only during night-time hours, and others, only during day-time hours. Such service strains any goodwill developed between consumers and the water district. Unserved households are, in the best of circumstances, sub-users obtaining their water from dwellings connected to the distribution system. These unserved households pay water vendors rates much greater than water district rates.

In a typical provincial urban area, the studies on water unaccountability indicate that (1) leakage and waste are roughly one-half of the water production; (2) accounted-for-water or billed water is about one-third of water production; and (3) the remaining one-sixth consists of unauthorized (illegal) use, meter under-registration and underestimated flat rate. House connections without meters or with non-functioning meters are billed with flat rate accounts, a situation which encourages the wasting of water. There has been no prior leakage survey conducted in any of the water districts, except during this study. Water accountability for the second five areas is presented in Figure IV-1.

At best, delivered water is of poor quality and unsafe bacteriologically. The water supply system generally includes opportunities for cross-connections with polluted water from drains/sewers.

Financing is unplanned; collection is low. There is hardly any enforcement of penalty. In general, improvements have been made without any master plan. There is little preventive maintenance and hardly any operator training. Record-keeping is almost non-existent.

B. WATERWORKS FACILITIES

Lipa City is served by a waterworks system which was initially constructed in 1932. The water supply of Lipa City Water District (LCWD) is obtained from small-gravity springs east of the city, and from pumped deep wells within the distribution system. Figure IV-2 is a schematic plan of the existing water system.

History of the Water System

The original waterworks system was constructed in the years 1929 to 1932. The source was seven small springs some eight kilometers east of Lipa on Mt. Malepunyo. Water flowed by gravity to serve what is the present downtown area of Lipa. To meet increasing water demand, seven additional gravity springs and six pumped deep wells were added since 1948.

Water Source Facilities

At present, there are 14 small springs on Mt. Malepunyo, and six deep wells within the distribution system, which provide the water supply.

The group of 14 springs, locally referred to as Santo Niño Springs, is located at elevations estimated to range from 400 to 825 m on Mt. Malepunyo (summit 963 m). Water is collected in separate concrete intake boxes which are connected by small pipes to a 125-mm transmission main which delivers water to Lipa City by gravity. Total piped flow from those springs was measured (on the upstream end of the 125-mm main) in September 1975 as 880 cumd. Reportedly, seven of the springs were developed in 1932 as the original source, and the remaining seven, developed since 1959. Several barrios, along the route of the transmission line from the spring sources, obtain their water supply from the LCWD.

The six deep wells within the distribution system were measured in September 1975 to have a combined pumping rate of 2,090 cumd. However, all pumps are shut down for several hours daily, and accordingly, actual well production is estimated at 1,230 cumd. Table IV-1 gives available data for each well.

Treatment Facilities

Chlorine is applied at three points - Santo Niño intake box no. 3, the 760 cum storage tank, and the small storage tank at the public market. Chlorine is applied intermittently, in powder form and dosage control is arbitrary.

WATER ACCOUNTABILITY FOR SECOND 5 CITIES

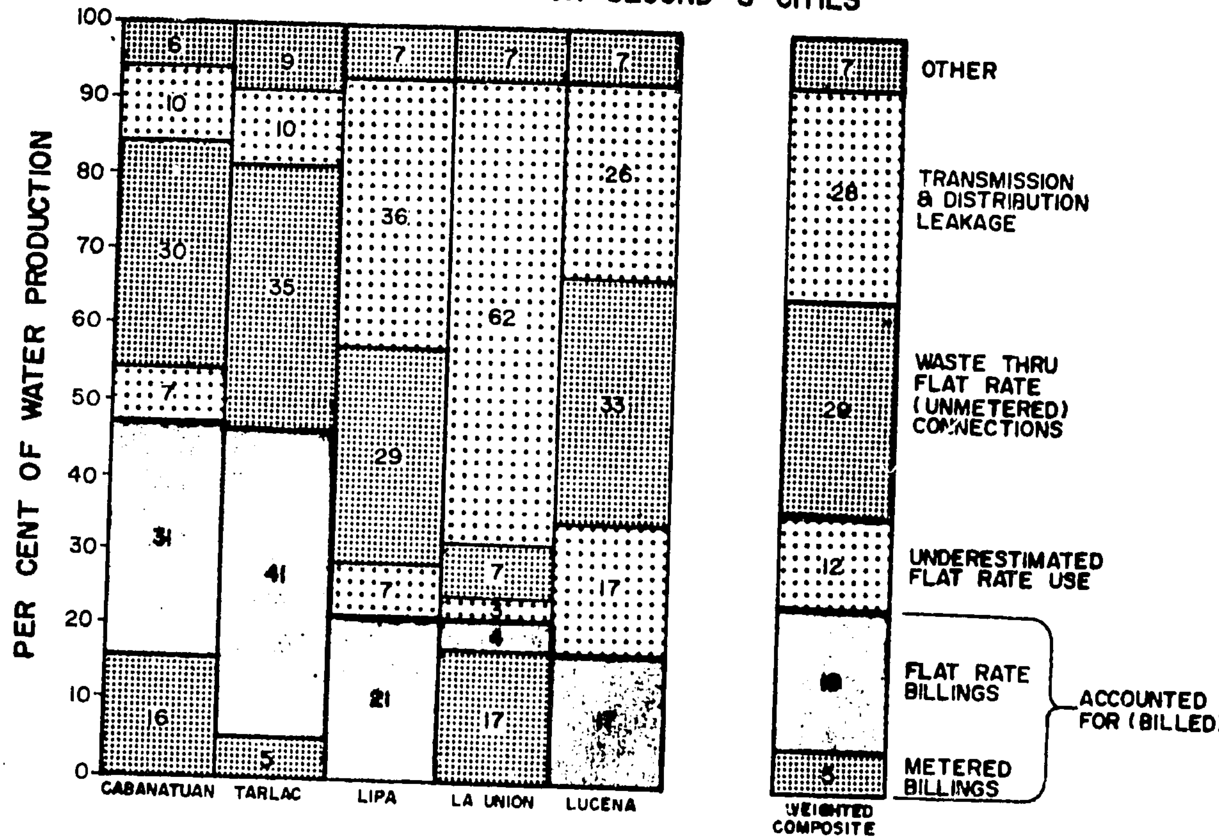


FIGURE IV-1
WATER ACCOUNTABILITY

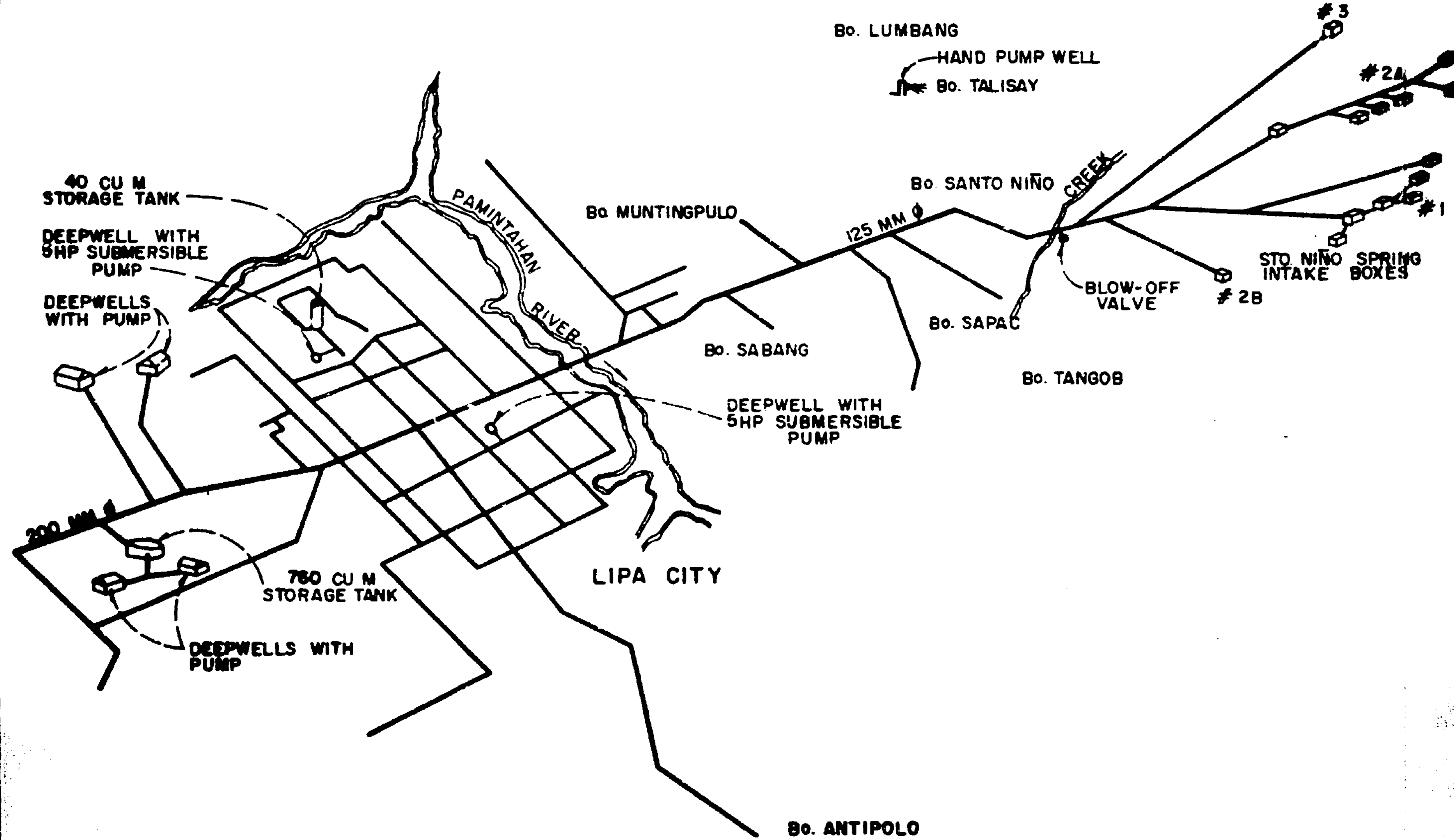


FIGURE IV-2
EXISTING WATER SUPPLY SYSTEM
SCHEMATIC

FEASIBILITY STUDY FOR WATER
SUPPLY OF TEN PROVINCIAL AREAS

CDM - LWUA

TABLE IV-1

DATA ON EXISTING WELLS[1]
LIPA CITY WATER DISTRICT

Well Number	Location	Pumps To	Year Constructed	Depth of Pump	Casing Diameter (mm)	Pump	Motor	Pumping Rate (cumd)	Reported Pumping Schedule	Approximate Hours Operated Daily	Approximate Daily Production (cumd)
1	Mataas na Lupa	Stand-pipe	1948	43	200	15 hp Turbine	Electric Horizontal	425	2200-1900	21	372
2	Mataas na Lupa	Stand-pipe	1948	41	150	15 hp Turbine	Electric Horizontal	265	2200-1900	21	232
3	City Hall Compound	Distribution system	1960	43	150	15 hp Turbine	Electric Horizontal	327	0400-1200 1300-1900	14	191
4	Engineering Compound	Distribution system	1958	41	150	15 hp Turbine	Electric Horizontal	366	0400-1200 1300-1900	14	214
5	Public Market	Market Tank	1968	-	150	5 hp Submersible	Electric	483	Irregular	5	101
6	G.A. Solis Street	Distribution system	1975	-	150	5 hp Submersible	Electric	225	0600-1900	13	122
							TOTAL	2,091			1,232

[1] No data on pump discharge heads.

Transmission Mains

Small diameter pipes from the 14 separate spring boxes converge to a larger 125-mm CI main (installed in 1932) which extends some 6.5 km to Lipa City through several small barrios. There are no plans of this transmission piping (see Figure IV-2).

Storage Facilities

There is only one storage facility of any significance. It is a reinforced concrete standpipe (11.5 m diameter by 7 m high) located adjacent to Wells No. 1 and 2. It was constructed in 1932 as part of the original system. It has a capacity of 760 cum and an overflow elevation of approximately 340 meters. Water is pumped into this reservoir from Wells No. 1 and 2 during a 21-hour period, and is rationed to the distribution system during the approximate hours of 0600 to 0800 and 1700 to 1900. The reservoir is kept a minimum half full for fire reserve.

An elevated steel tank of 40 cum capacity is located within the public market system. Water is pumped from Well No. 5 to the tank, for an estimated average of five hours daily. Water from the tank provides 24-hour service to the market area.

Distribution System

The existing distribution system is shown in Figure IV-3. The distribution system has undergone approximately 80 per cent expansion (in length of mains) since originally installed in 1932. The expansion has been mostly accomplished in 1962 when pipes ranging from 50-200 mm were installed. Today the system consists of some 12.7 km of piping, in sizes from 25 to 200 millimeters. Primary feeder pipes of 125, 150 and 200 mm support a gridwork of smaller secondary pipe. All pipes 75 mm and smaller are GS; all pipes 100 mm and larger are CCI.

Operationally, a small segment of the distribution piping serving the central market has recently been connected to the remainder of the system. Water supply for the market area, in general, comes from Well No. 5.

Wells No. 1 and 2 pump directly to the nearby reservoir, from which water is rationed to the distribution system during early morning and evening hours.

Wells No. 3, 4 and 6 pump directly to the distribution system, but during day hours only.

Water is unavailable for most hours of the day except for a few customers in the eastern fringes of the distribution system and along the Santo Niño transmission main east of the city. During the period when water is available, pressures are very low.

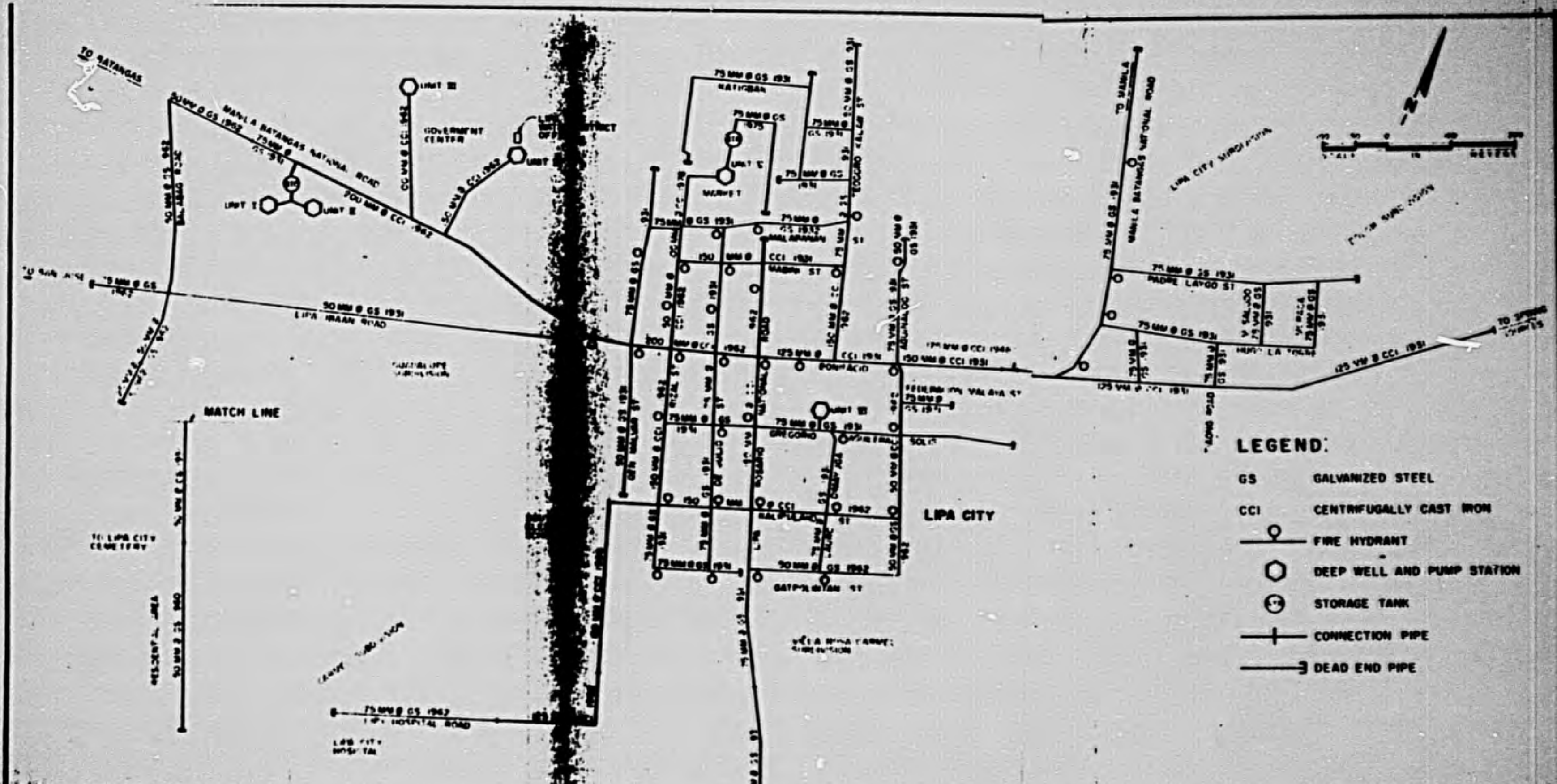


FIGURE III-3
EXISTING WATER DISTRIBUTION SYSTEM

Pipe Sizes and Lengths. There is approximately 12.7 km of distribution piping in the system. The length of distribution piping by size, material and age is given in Table IV-2. Sixty-five per cent (65%) of the piping is 75 mm or smaller GS pipe. Fifty-five per cent (55%) of all piping has been in place for 45 years.

In addition, there are about 6.5 km of 125-mm CI main, and 2.5 km of smaller diameter lateral pipe ranging from 50 to 75 mm, within the Santo Niño transmission system.

Pipe Carrying Capacities. Two pipe samples were cut from the distribution system for inspection:

(1) 50 mm, unlined GS, installed in 1932, removed 1975, T. M. Kalaw Street, tuberculation approximately 1 mm, equivalent Hazen-Williams "C" value approximately 90.

(2) 75 mm, unlined GS, installed 1932, removed 1975, front Lipa City Hospital, tuberculation approximately 6 mm, equivalent Hazen-Williams "C" value approximately 65.

Indications are that water from some of the supply sources is significantly corrosive.

TABLE IV-2

SUMMARY OF EXISTING DISTRIBUTION PIPING[2/]

Pipe Diameter (mm)	Pipe Material	Length of Pipe (m) 1930	1962-Present	Total
25	GS	-	40	40
50	GS	1,135	1,325	2,460
62.5	GS	-	30	30
75	GS	4,830	840	5,670
100	CCI	70	215	285
125	CCI	615	250	865
150	CCI	390	2,055	2,445
200	CCI	40	825	865
Total		7,080	5,580	12,660

[2/] Table IV-2 does not include the distribution piping (installed by consumers) in the outlying barrios along Santo Niño transmission main, and this transmission main.

System Pressures. In the higher west and central parts of the distribution system, pressures are zero and water is generally unavailable except during the short periods that water is rationed from the storage tank. In the lower east fringes of the system, water is generally available for 24 hours but pressures are low. Pressures are higher farther east, in the barrios along the Santo Niño transmission line (e.g. ranging from 24-33 m in Barrio Muntingpulo).

Results of 24-hour pressure recordings are summarised below:

Number	Location	Date	Pressure Range (m)
1	West end National Road	16-17 Sept 1975	0 - 4
2	National Road near Well No. 4	23-24 Sept 1975	0 - 2
3	Rizal at Solis	23-24 Sept 1975	0 - 1
4	Aquinal at Recto	16-17 Sept 1975	2 - 4
5	East and Malaya	22-23 Sept 1975	2 - 9
6	Bonifacio near National Road	24-25 Sept 1975	1 - 3
7	Barrio Muntingpulo	24-25 Sept 1975	24 - 33

Valves and Hydrants. There are some 18 known valves, and 40 fire hydrants (local-made with 75-mm GS riser). Most valves are buried and lost. Most fire hydrants are inoperable, and without sufficient water for fire-fighting.

Public Fountains. There are reportedly 30 public fountains[3/], located in the barrios along the Santo Niño transmission line. These fountains which are unmetered and unbilled supposedly, were previously given to the barrios by the City Government as payment for right-of-way for the pipeline.

Service Connections. As of August 1975 there were 714 registered service connections, of which 60 were metered. The following is a summary of registered connections by consumer category and meter status.

[3/] Santo Niño (6), Sapao (13), Muntingpulo (19) and Tangob (2)

Consumer Category	Metered Connections	Unmetered Connections	Total
Domestic	44	594	638
Commercial	16	57	73
Institutional	0	3	3
Total	60	654	714

Operation and Maintenance. The LCWD operates and maintains the spring and well sources, and the transmission and distribution systems. Operation and maintenance personnel include six pump operators, one plumber and five laborers. The operational daily program consists mainly of starting and stopping wells, pumps and rationing water from the reservoir.

The maintenance program consists mostly of repairs to well pumping units and leaking mains and services.

C. WATER QUALITY

Water samples were taken from two of the Santo Niño Springs and from the deep wells in the poblacion. The results of the water analyses are listed in Table IV-3. The spring water is slightly high in color. Water from five of the deep wells has more than the permissible4/ amount of manganese and from three wells, more than the permissible amount of iron. All other water quality parameters are within the permissible limits. Excessive concentrations of iron and manganese are observed only in the Wells No. 3 and 6. These values are compared with the standards as follows:

4/For evaluation of water quality test results, two sets of limits have been established by the Philippine National and WHO Standards: (1) The limit designated as "permissible" or "acceptable" applies to water that would generally be acceptable to consumers; (2) Values greater than "maximum allowable" or "excessive" would markedly impair the potability of the water.

TABLE IV-3

WATER QUALITY TEST RESULTS
LIPA CITY WATER DISTRICT

Test	Unit	Permissible Limit 5/	Santo Niño Spring Intake No. 1 16 Apr '75	Santo Niño Spring Intake No. 3 16 Apr '75	Deep Well No. 1 Mataas na Lupa 18 Apr '75	Deep Well No. 2 Mataas na Lupa 16 Jan '76	Deep Well No. 3 City Hall Cmpd. 16 Jan '76	Deep Well No. 4 Engr. Compound 16 Jan '76	Deep Well No. 5 Public Market 16 Jan '76	Deep Well No. 6 Cathedral 16 Jan '76
PHYSICAL										
Color	(unit)	15	20	20	10	2	2	2	2	2
Taste	"	3								
Odor	"									
Turbidity	"	5	6.5	1	0.5	2	2	2	2	5
Solids	(mg/1)									
a. TDS		500	136	194	309	221	182	182	231	494
b. Suspended			3	32	7	1	1	1	1	2
Conductivity (micromhos/cm)						340	280	285	355	780
CHEMICAL										
pH		7-8.5	7.8	7.6	8.0	8.2	8.0	8.1	7.8	8.0
Alkalinity	(mg/1) 6/									
a. Total			108	82	162	146	150	136	144	260
b. Phenolphthalein			0	0	0	0	0	0	0	0
Total Hardness	(mg/1) 6/		30	35	65	164	116	108	152	394
Calcium	(mg/1)	75	9.1	17.8	27.9	30.4	25.6	28.8	34.4	73.6
Magnesium	"	50	4.8	6.8	8.7	21.4	12.7	8.8	16.1	34.1
Iron	"	0.3	0.05	0.02	0.01	0.25	1.21	0.25	0.2	1.8
Fluoride	"	1.5	0.07	0.08	0.21	0	0	0	0	0
Chloride	"	200	10	12	14	18	15	20	35	155
Sulfate	"	200	4.8	12.5	10.3	11.5	11.5	10	13	30
Nitrate	"					1.3	1.2	1.2	1.25	2.6
Manganese	"	0.1	.032	nil	.006	.25	1.25	.25	.20	1.9
Copper	"	1	nil	.001	.009	.125	.125	.130	.135	.125
Zinc	"	5	.008	.006	.096					

5/ Philippine National Standard
6/ as $CaCO_3$
Underlined figures indicate excess over maximum allowable limits as defined in the Philippine National Standards.

Test/Chemical	Unit	Maximum Allowable (excessive) Limit	Measured Value Well No. 3	Measured Value Well No. 6
Iron	mg/l	1.0	1.25	1.80
Manganese	mg/l	0.5	1.25	1.90

Considering that the water from these wells is normally mixed with the rest of the supply, the overall average concentration of iron and manganese in the distribution system would be within the "permissible" limit.

D. WATER USE PROFILE

General

The current water demands of Lipa City have been analyzed to project future water requirements. Data on metered connections and revenue-producing water were obtained from the water district. Other data were taken from field measurements on water production and leakage and interviews with concessionaires. These data have been used to establish the present water use profile.

Population Served

In August 1975, the water district served 714 registered connections. Interviews with 20 concessionaires showed that an average of 12.75 persons are served at each connection. This number consists of 7.55 primary users per connection and 5.2 secondary users per connection. The secondary users obtain their water by hand-carried buckets or pails from the primary user. The secondary users often pay the primary user for the privilege of obtaining water. When improvements are made and better water service is provided, the water district should expect an increase in the number of connections as the secondary user becomes a primary user. Applying the average of 12.75 persons per connection to all connections yields a population served of approximately 9,100 persons.

Domestic Consumption

Domestic consumption is the water used for household purposes such as: cooking, bathing, washing, drinking, cleaning and toilet flushing. Estimation of domestic consumption is difficult because the majority of the service connections to residences are unmetered and low water pressures prevail throughout the distribution system (suppressed demand). However, metered consumption at 19 domestic connections over an eight-day period in July and August 1975 was 0.8 cumd. Applying this average consumption rate to all connections, assuming all connections have domestic consumption, yields a total domestic consumption of 570 cumd. The corresponding unit per capita consumption is 63 lpcd. It is estimated that the present domestic consumption would be 115 lpcd if water pressures were higher and 24-hour service was supplied to all concessionaires.

Commercial and Institutional Consumption

Commercial consumption is water use associated with business operations, hotels, restaurants, markets and family commercial establishments. Institutional consumption is water used by hospitals, schools, universities, government buildings and military units. It is difficult to estimate commercial and institutional consumption because a portion of it is actually domestic consumption. In most commercial establishments, the owner or operator lives in the premises with his family, and in some cases, with the employees. Based on studies in other water districts, the commercial and institutional demand is 20 to 30 per cent of the domestic demand. For the LCWD, the present commercial and institutional use is assumed to be 25 per cent of the domestic use. Therefore, the commercial and institutional demand would be approximately 140 cumd.

Industrial Consumption

Industrial water consumption is associated with the manufacture or processing of goods. Like commercial consumption, the actual industrial consumption is difficult to estimate because it also includes domestic consumption. At the present time, the LCWD serves no industrial concessionaires.

Total Consumption

The sum of domestic, commercial, institutional and industrial consumption is the total water consumption in the water district. The total consumption is summarized below:

Category of Water Use	Consumption (cumd)	Unit Consumption (lpcd)
Domestic	570	63
Commercial and Institutional	140	15
Industrial	nil	0
Total	710	78

The total consumption of 710 cumd is approximately 33 per cent of the total water production. The remaining two-thirds of the water is lost due to wastage and leakage. The water losses are described in a subsequent section on unaccounted-for-water.

Accounted-for-Water

Accounted-for-water is the sum of metered consumption and the inferred water consumption at flat-rate connections. The accounted-for-water is revenue-producing water for the water district. In July 1975 the metered billed consumption was nil and the flat-rate billed consumption was 450 cumd. The total water produced in the same month was 2,110 cumd. Therefore, the total accounted-for-water is 21 per cent of water production. This is a very low percentage for accounted-for-water. A reasonable accounted-for-water figure can only be achieved through a program of metering all connections and leakage elimination.

Unaccounted-for-Water

Unaccounted-for-water or unbilled water does not generate revenue for the water district. The unaccounted-for-water can be divided into several categories: leakage, underestimated flat-rate use, wastage at flat-rate connections and other uses.

Leakage. Water is lost due to leaks in the distribution mains and service connections. From field observations, leakage in the LCWD system is estimated to be 36 per cent of the total production or 750 cumd.

Underestimated Flat-Rate Use. Analysis of the metered consumption during the eight-day period in July and August 1975 indicates that flat-rate charges underestimate consumption at flat-rate connections by approximately 150 cumd. This is defined as underestimated flat-rate use and represents potential revenues if flat rates would be increased.

Wastage at Flat-Rate Connections. Because flat-rate connections are charged a fixed amount regardless of quantity of water used, the concessionaire has the tendency to waste water by leaving faucets running and by not repairing leaks. This wastage is estimated to be 100 per cent of the consumption at flat-rate connections (non-metered consumption plus underestimated flat-rate use). For the LCWD, the total wastage at flat-rate connections is estimated to be 600 cumd. The elimination of wastage can be achieved by metering flat-rate connections.

Other Uses. Water for public use (fire-fighting, main flushing, street cleaning), meter under-registration, and unauthorized use is lumped together under the category of other uses. Other uses are estimated to represent seven per cent of the total production or 160 cumd. The water use for public purposes is estimated to be equivalent to six lpcd and that for the unauthorised use and meter under-registration is estimated to be 12 lpcd.

Summary of Water Accountability

A summary of accounted-for-water is presented in Table IV-4. The accounted-for-water based on the July 1975 billing, was 21 per cent of total production. The accounted-for-water is the sum of the metered consumption plus estimated consumption at non-metered (flat-rate) connections. The unaccounted-for-water was 79 per cent of the water production. A portion of the unaccounted-for-water can be considered as consumed water, namely, underestimated flat-rate use and other uses which include meter under-registration and theft. This part of the unaccounted-for-water is defined as unrecorded consumption. Thus the total consumed water is apportioned as follows:

Accounted-for-Water	
Metered use	nil
Flat-rate use	49.5 lpcd
Unrecorded Consumption	
Underestimated flat-rate use	16.5 lpcd
Other uses (include unauthorised use and meter under-registration)	12 lpcd
Total Consumed Water	78 lpcd

The total consumption of 78 lpcd obtained from analysis of water accountability includes all categories of water use.

Adjusted 1975 Water Demand

In order to determine the proper staging of source alternatives, it is necessary to develop a supply-demand chart from the present to the end of the design study. This consists of establishing the present water demand and projecting water requirements for specified periods (1985, 1990 and year 2000). The water use profile described earlier is for the present situation of low water pressures, inade-

TABLE IV-4

SUMMARY OF WATER ACCOUNTABILITY

Category	Amount of Water cum/mo	cumd	lpcd	Percentage of Production
1. Accounted-for-water				
a. Metered consumption	nil	nil	nil	nil
b. Non-metered consumption at 714 connections	13,950	450	49	21
Sub-total	13,950	450	49	21
2. Unaccounted-for-water				
a. Leakage	23,250	750	82	36
b. Underestimated flat-rate use at 714 connections	4,650	150	16	7
c. Wastage at 714 flat-rate connections	18,600	600	67	29
d. Other uses	4,960	160	18	7
Sub-total	51,460	1,660	183	79
Total Production	65,410	2,110	232	100

quate water service and considerable wastage at flat-rate connections. In order to make a reasonable assessment of the present supply situation, an adjusted water demand is established assuming adequate pressures and a lower percentage of unaccounted-for-water.

Under adequate system pressures, it is assumed that the domestic unit consumption would be 115 lpcd and the commercial consumption would be 20 per cent of the domestic consumption. The unaccounted-for-water is assumed to be 40 per cent of the total production. The adjusted water demand is itemized in Table IV-5. The adjusted average daily demand is 2,100 cumd, exactly equal to the present supply of 2,100 cumd. However, the maximum daily demand exceeds the present supply by 400 cumd. The adjusted maximum daily demand estimate for 1975 is used as a basis for the subsequent studies.

TABLE IV-5

ADJUSTED 1975 WATER DEMAND

Category	Adjusted Demand (cumd)
Domestic	1,050
Commercial and Institutional	210
Accounted-for-water	1,260
Unaccounted-for-water	840
Total Average Daily Demand	2,100
Maximum Daily Demand (1.2 x Average Demand)	2,500

E. COMPUTER STUDIES

The purpose of computer studies of the existing transmission and distribution system is to duplicate, to the greatest extent practicable, the conditions observed in the field. By doing this, it is possible to evaluate the impact of immediate improvements to the existing system. For a computer study to be meaningful, there should be positive pressure over the entire system under study during a significant part of the day. As described earlier many portions of the water district receive water intermittently; and when water is available, water pressures are low. Because of the above conditions, a computer analysis of the existing system has very little practical significance and therefore, was not performed during these studies.

F. DEFICIENCIES OF THE EXISTING SYSTEM

The present level of service of the LCWD is very deficient. The majority of consumers receive water only a few hours daily; fire-fighting capabilities are nil. This is true even though present water production is equivalent to about 230 lpcd for present served population.

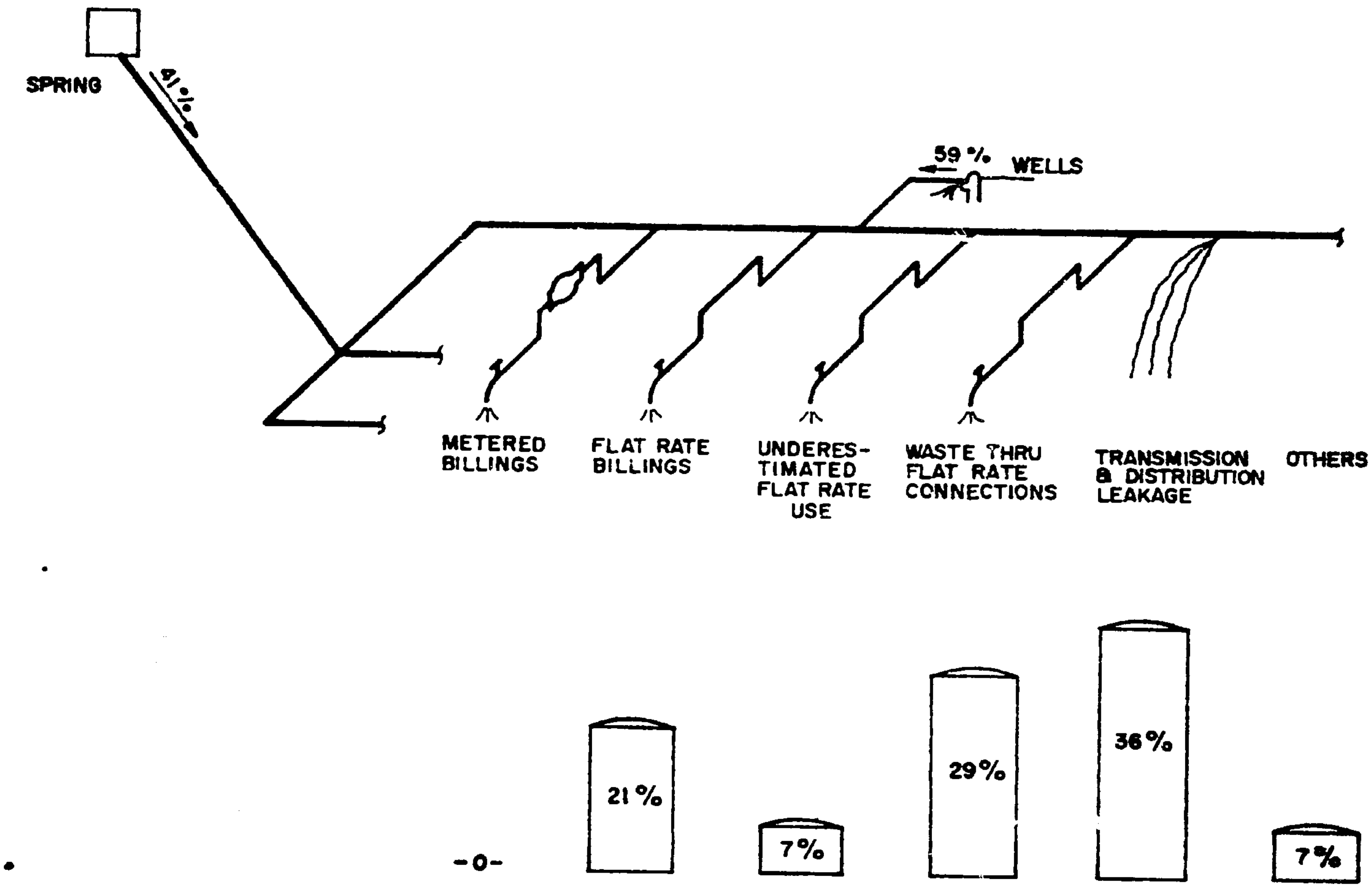
Only 21 per cent of water production is accounted-for (billed). Only eight per cent of connections are metered. Leakage and waste is estimated at 65 per cent of total production, and is especially a problem along the Santo Niño transmission mains (see Figure IV-4). Well pumps are run on an average of about 15 hours per day.

There are no plans of the existing system. Ratings of pumping units, and capacities of wells, are unknown.

Sixty-five (65) per cent of distribution piping is 75 mm or smaller GS pipe. Over half of the distribution pipes have been in place for 45 years. Pipe carrying capacities are seriously reduced by tuberculation. Most gate valves are lost and most fire hydrants are inoperable.

Potential cross-connections between water pipes and polluted drains are numerous. Pressures over most of the system are normally zero. The storage tanks are seldom cleaned. Wells do not have adequate sanitary protection. Chlorination of the water supply is not reliable. There are no water quality laboratory facilities, routine water sampling and testing programs.

Transportation, equipment, tools and spare parts are lacking. There are no meter or plumbing shop facilities.



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS CDM-LWUA

FIGURE IV-4
SCHEMATIC WATER AUDIT
(JULY 1975)

CHAPTER V FEASIBILITY STUDY CRITERIA

A. GENERAL

The planning, design and economic criteria used in the feasibility studies have been derived from studies of local conditions, accepted practices, standards and methods both here in the Philippines and abroad. These criteria, together with a developed basis of cost estimates, have been utilised 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. The key point, however, must be consistency. As long as each alternative to be analysed is subjected to similar criteria (or rules) the screening can 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 in order of importance):

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

2. Sources of Water: Groundwater and surface water have been given equal emphasis as potential sources of water.

3. Self-Sufficiency: The recommended plan has been based on a system which will provide the highest quality of water service within the "ability to pay" of the consumers.

4. Conservation: Selection of alternative plans has considered water, power, chemicals and foreign exchange as valuable resources which must be conserved to the greatest extent possible.

5. Stage Development: The long-range implementation program has based on two construction stages to satisfy the projected requirements for a specific design year.

Stage	Construction Implementation	Target Design Year
Early Action	1976-78	1982
First Stage	1977-90	1995
Second Stage	1990-2000	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. It has developed conceptually long-range water quality management plans to conserve the integrity of this valuable resource.

C. DESIGN CRITERIA[1]

Unit Water Demands

Average per capita domestic water consumption has been estimated for the study area, using field data and available records of past and present water use as well as those from similar cities. For the analysis of existing conditions, actual metered (or connected) customers and "borrowers" are considered separately. 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 (see Chapter VI for detailed unit water demands).

Institutional and commercial water demands have been estimated as a percentage of domestic demand. Where no reliable records are available, a unit flow of five cum/day/ha (gross) has been used.

---

[1] Refer to Appendix A, Volume II.

There are currently few or almost no heavy and/or 'wet' industries in the study area. Land zoning plans, where available, show those areas designated for future industrial development. Where no records are available, a unit flow of 10 cum/day/ha has been used in the water demand estimates.

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:

- o maximum-day to average-day ratio = 1.2 : 1
- o peak-hour to average-day ratio = 1.5 : 1 - 2.0 : 1

Unaccountable Water

Review of the available records and consumption patterns indicates present unaccountable water to be in the order of 76 per cent of total water production. The composite accountability of water in the second five urban areas (Lucena, Lipa, Cabanatuan, Tarlac and La Union) includes the following:

Metered billings.	5%
Flat-rate billings	19
Non-billed use through flat-rate connections	12
Non-billed waste through flat rate connections	29
Leakage	28
Others (unauthorized use, public use, meter under-registration)	7
Total	100%

For preliminary design purposes, it has been assumed that:

- o unaccountable water would be reduced gradually as positive improvements are added to the system.
- o by 1990, unaccountable water would be about 20-25 per cent of the total water production.
- o by 2000, unaccountable water would be reduced to 20 per cent.

D. ECONOMIC CRITERIA

Discount Rate

The opportunity cost of capital or discount rate used in this feasibility study is 12 per cent. The discount rate has been used for economic screening of the technically viable alternatives (see Chapter 9, Methodology Manual on Water Supply Feasibility Studies, Volume I).

Inflationary Trends

Over the two decades preceding 1970, the Philippines was enjoying quite a reasonable degree of price stability, marred only by a brief period of inflation resulting from the 1960-62 devaluation. From 1959 to 1969, the Philippines experienced an average inflation rate of five per cent per annum.

However, the pace of inflation from 1969 to the present has been at least double that of the 1962-69 inflationary period. Political unrest, extraordinary monetary expansion in 1969, typhoons, plant diseases, floods, a second devaluation early in 1970, and lately, the oil crisis and worldwide inflation explain the severity of the local inflation. Price control policies failed to suppress the spiralling prices.

(The NWASA Water Supply Study for Greater Manila in 1969 assumed a five per cent inflation rate based on 1965 prices. The LWUA project undertaken in 1972 assumed the same inflation rate based on mid-1972 prices.)

While it is difficult to separate clearly the effects of domestic and external factors on the price level, in most recent years before 1973, external factors apparently played a relatively small role in the price increases. In contrast, the large price increases in 1973 were attributable mainly to external factors, such as the oil crisis. The sharp increases in the price of crude oil, coupled with massive price increases in essential imports and raw material shortage, and the usual reinforcing inflation psychology, triggered the almost 40 per cent inflation rate in the country in 1973.

In 1974, inflationary and recessionary developments and domestic food shortages continued to put heavy pressures on the local economy. Due to these developments, consumer prices increased at an annual rate of 30 per cent in 1974.

Recent statistics released by NEDA indicate that for the calendar year 1975, the government effectively decelerated the annual inflation rate to 8.7 per cent. The dampening of prices was reflected in almost all categories of consumer items, notably food, fuel-light-water and clothing. Prices of principal commodity exports of the Philippines have declined and are expected to stabilize probably after 1977.

Projections made in this feasibility study assume a general price escalation rate of 10 per cent for the period 1976 through 1980; eight per cent for the period 1981-85; and six per cent for the period 1986-90. These are subject to the following conditions:

- no major changes in the structure and stability of international political relations;
- no significant changes in production technology which would reduce dependence on oil;
- no dramatic increases in the price of petroleum products originating from the cartel countries;
- the government would not retrench (i.e., fight inflation at the price of the recession that goes with it) as forecasted;
- no significant oil discoveries in the country; and
- no internal political upheavals of significant proportions.

E. BASIS OF COST ESTIMATES[2]

For the purpose of cost estimating, a construction cost index (CCI) for water supply projects has been developed, with 1965 as the base year (CCI = 100). Unit costs for the water supply feasibility studies have been projected to July 1976 price levels (CCI = 384). Construction cost curves have been developed for in-place costs of pipelines, deep wells, water treatment plants, pump stations, and storage reservoirs and used for estimating the relative cost magnitudes of alternative water supply plans. Escalation factors used in calculating the capital cost of recommended improvements are tabulated as follows:

---

[2] Details of cost estimates are presented in Appendix B, Volume II.

Year	Escalation Factor
1976	1.000
1977	1.100
1978	1.210
1979	1.331
1980	1.464
1981	1.581
1982	1.708
1983	1.844
1984	1.992
1985	2.151
1986	2.280
1987	2.417
1988	2.562
1989	2.716
1990	2.879

F. IMPLEMENTATION SCHEDULE

For purposes of feasibility study and economic/financial analyses, an implementation schedule has been assumed. The following is the probable time-table which covers the planning, design, Early Action Program and Stage I Phase A:

Final Report Submission	June	1976
Select Engineers	December	1976
Start Final Design	March	1977
Complete Early Action Works	July	1977
Complete Pre-design Surveys	September	1977
Complete Final Design	July	1978
Start Construction	October	1978
Complete Construction:		
a) Source		1980
b) Transmission		1982
c) Distribution		1982

CHAPTER VI POPULATION AND WATER DEMAND PROJECTIONS

A. GENERAL

One of the early steps in developing the preliminary design of a water system is the projection of future population and water demands in the delineated service area. These projections have a significant impact on facility layouts and sizes, construction staging and cost of the project.

B. POPULATION PROJECTIONS

Population projections took into account past population trends (Table VI-1), land use and development plan, physical limits of the urban areas, and current and proposed public facilities in the study area.

Population trends indicate that population in the study area would increase from 52,450 in 1970 to 121,800 in 2000 (see Figure VI-1 and Tables VI-2 and VI-3). The projected annual growth rate from 1970 to 1980 is 3.3 per cent. Annual growth rates will decrease to 2.8 per cent in 1980-90 and 2.4 per cent in 1990-2000. Population densities (Table VI-2) will increase from 27 persons per hectare in 1970 to 62 persons per hectare in 2000.

The served population which was 20 per cent of the total study area population in 1970 is projected to be 55 per cent in 1990 and 73 per cent in 2000 (see Tables VI-4 and VI-5). As shown in Figure VI-1, the served population decreased between 1970 and 1975 because of the poor water service provided by the LCWD. The served population is projected to increase from 9,100 in 1975 to 53,400 in 1990 and 88,700 in year 2000. This represents a more than nine-fold increase in 25 years.

Chapter 4 of the Methodology Manual provides a detailed discussion on population projections used in the water supply feasibility studies.

TABLE VI-1

PAST POPULATION TRENDS[1] IN THE STUDY AREA
LIPA CITY WATER DISTRICT

A. Present Service Area	1948	1960	1970
Poblacion[2]	8,663	12,521	17,765
Balagbag[2]			932
Latag	438	693	1,062
Mataas na Lupa	1,605	1,554	1,189
Muntingpulo	430	652	890
Sabang	974	2,890	2,890
Sapao	1,259	1,483	2,125
Santo Niño	425	446	683
Tangob	204	437	568
Antipolo[3] (partial)	1,030	1,085	
Antipolo del Norte[4]			
TOTAL	15,028	21,761	30,422

B. Study Area Extension for Year 1990 Service	1948	1960	1970
Antipolo (partial)[5]	1,030	1,085	
Antipolo del Sur[6]			2,318
Lodlod	1,358	1,683	2,483
Marauoy	1,626	2,059	3,315
Tambo	908	2,421	1,227
Fernando[7]	606	1,914	4,090
TOTAL	5,528	9,162	13,433

[1] Source: National Census and Statistics Office.

[2] Part of Mataas na Lupa in 1948 and 1960.

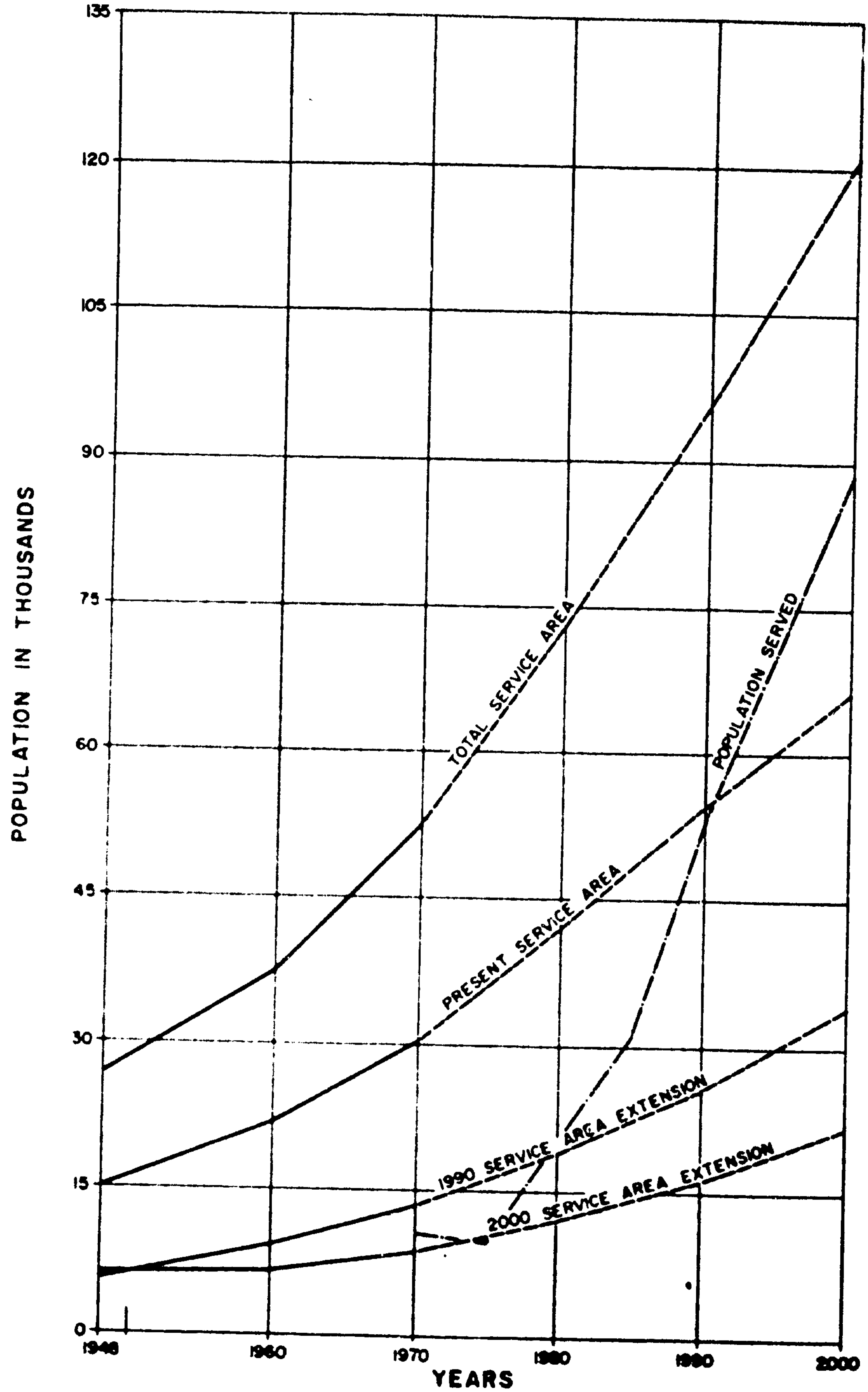
[3] Divided into Antipolo del Norte and Antipolo del Sur in 1970.

[4] Part of Antipolo in 1948 and 1960.

[5] Divided into Antipolo del Norte and Antipolo del Sur in 1970.

[6] Part of Antipolo in 1948 and 1960.

[7] Part of Tambo in 1948.



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS CDM-LWUA

FIGURE III-1
POPULATION PROJECTIONS

TABLE VI-1 (Continued)

C. Study Area Extension for Year 2000 Service

Barrio	1948	1960	1970
Bagongpook	810	936	1,402
Banaybanay	1,571	1,666	2,341
Bolbok	1,016	1,344	1,620
Dubatan[8]	600	630	675
Pangao	767	1,025	1,417
Pinagtongulan	1,326	1,070	1,139
TOTAL	6,090	6,671	8,594

---

[8] Part of Pinagtongulan in 1948 and 1960.

TABLE VI-2

POPULATION PAST TRENDS AND PROJECTIONS AND DENSITIES
LIPA CITY WATER DISTRICT

	Present Service Area (Poblacion) A = 130 Ha			Present Service Area: Outside Poblacion A = 380 Ha			Year 1990 Extension A = 785 Ha			Year 2000 Extension A = 670 Ha			Total Population A = 1,965 Ha		
Year	Pop.	Density P/Ha	Growth %	Pop.	Density P/Ha	Growth %	Pop.	Density P/Ha	Growth %	Pop.	Density P/Ha	Growth %	Pop.	Density P/Ha	Growth %
1948	8,663	67		6,365	17		5,528	7		6,090	9		26,646	14	
			3.1			3.2			4.3			0.8			3.5
1960	12,521	96		9,240	24		9,162	12		6,671	10		37,594	19	
			3.6			3.2			3.9			2.5			3.39
1970	17,765	137		12,657	33		13,433	17		8,594	13		52,449	27	
			3.5			3.0			3.5			3.4			3.34
1980	25,000	192		17,000	45		18,900	24		12,000	18		72,900	37	
			2.0			3.5			3.0			3.0			2.79
1990	30,500	235		24,000	63		25,400	32		16,100	24		96,000	49	
			1.0			3.0			3.0			3.0			2.41
2000	33,700	259		32,300	85		34,100	43		21,700			121,800	62	

TABLE VI-3

SUMMARY OF POPULATION PAST TRENDS AND PROJECTIONS
LIPA CITY WATER DISTRICT

Year	Present Service Area	Year 1990 Extension	Year 2000 Extension	Total Study Area
1948	15,028	5,528	6,090	26,646
1960	21,761	9,162	6,671	37,594
1970	30,422	13,433	8,594	52,449
1980	42,000	18,900	12,000	72,900
1990	54,000	25,400	16,100	96,000
2000	66,000	34,100	21,700	121,800

TABLE VI-4

SERVED POPULATION PROJECTION
LIMA CITY WATER DISTRICT

	Present Service Area											
	Población			Outside Población			Year 1990 Extension			Year 2000 Extension		
Year	Population Trend and Projection	Population Served	Percentage Served	Population Trend and Projection	Population Served	Percentage Served	Population Trend and Projection	Population Served	Percentage Served	Population Trend and Projection	Population Served	Percentage Served
1970	17,765	5,104	29	12,657	5,318	42	13,433			8,594		
1985	27,600	16,560	60	20,200	10,100	50	21,900	4,380	20	13,900		
1990	30,500	24,400	80	24,000	15,600	65	25,400	10,200	40	16,100	3,200	20
2000	33,700	30,300	90	32,300	25,800	[illegible]	34,100	23,900	70	21,700	8,700	40

TABLE VI-5

SUMMARY - POPULATION SERVED PROJECTION
LIPA CITY WATER DISTRICT

Year	Total Study Area Population	Population Served	Percentage Served
1970	52,449	10,400	20
1985	83,600	31,000	37
1990	96,000	53,400	55
2000	121,800	88,700	73

C. DEMAND PROJECTIONS

Water supply projections have been made for domestic, commercial, institutional and industrial demands, and for unaccounted-for-water. Water demand estimates for Fernando Air Base are also included. Inherent in making projections are assumptions about future conditions. These assumptions are discussed in this section for each category of water use.

Domestic Demand

The projected demands for domestic water have been based on a unit per capita consumption and the projections of served population. In Chapter IV the present average domestic unit consumption under conditions of adequate supply and pressures was estimated to be 115 lpcd. It is estimated that the unit consumption will increase at a rate of approximately one per cent compounded annually between 1975 and 1990 and at a rate of 0.7 per cent between 1990 and 2000. The projected domestic unit consumption is listed below:

Year	Projected Domestic Consumption, lpcd
1985	127
1990	135
2000	145

The proje .ions assume an increasing economic growth rate for the population in the study area concurrent with a pricing policy and public relations program on the part of the water district to discourage wasteful and extravagant water. The decreasing growth rate of water use reflects the long-term prospects of water shortage in the Lipa City area.

Commercial, Institutional, Industrial Demand

In Chapter IV the present commercial, institutional and industrial demand was estimated to be 20 per cent of the domestic demand. For projection purposes the sum of these demands is projected as a percentage of the domestic demand. As more of the residential population is served, the ratio of the commercial, institutional and industrial demand will decrease. It is projected that the commercial and institutional demand will be 15 per cent of domestic demand. The projected demands are listed as follows:

Year	Projected Commercial, Institutional and Industrial Demand as a Percentage of Domestic Demand
1985	15
1990	15
2000	15

Fernando Airfield

The Fernando Airfield lies within the water district's projected service area. Both the airfield and the LCWD obtain water supply from the groundwater resource. Since the two will be competing for the same resource, the supply for the airfield is included in the LCWD water demand projections. Also, it will be to the district's advantage to serve the airfield because of the added revenue and because of the need to closely monitor groundwater extraction.

The airfield presently obtains its water supply from 15 deep wells located on the airfield property. Because of pump failures and operational difficulties only 10 of the wells contribute to the total supply. The pumping capacities range from 10 to 60 gpm and pumping periods range from 12 to 24 hours per day. Total pumped water is estimated to be 1,200 cumd. Several areas on the airfield complain of low water pressure and at times the residents augment the airfield supply by using hand pump wells. By joining the water district, the airfield residents will receive better and more reliable water service and the airfield will eliminate inefficient operation and maintenance of 15 pumping units. The airfield's water demand is projected as follows:

Year	Projected Water Demand for Fernando Airfield (cumd)
1985	1,750
1990	1,800
2000	1,850

Unaccounted-for-Water

The present unaccounted-for-water is 79 per cent of water production. Field studies indicate that 35 per cent is caused by leakage and the remainder is unrecorded consumption (including wastage at flat-rate connections). The water district must implement a program to reduce unaccounted-for-water. As soon as possible, the water district should undertake a program for leakage detection and repair and a program to meter flat-rate connections. It is estimated that the water district can reduce the unaccounted-for-water to 25 per cent by 1985 and to 20 per cent by year 2000. The projections for unaccounted-for-water are listed below:

Year	Unaccounted-for-Water (%)	Leakage (lpcd)	Unrecorded Use (lpcd)	Total (lpcd)
1985	25	29	19	48
1990	22	27	18	45
2000	20	25	17	42

The leakage and the unrecorded usage are expected to decrease as shown. The unrecorded use will be mostly public use (because of improved fire-fighting potential) and a portion, due to meter underregistration. By year 2000 the leakage is expected to stabilize at 12 per cent of the production and the unrecorded usage at eight per cent. This is believed to be a reasonable goal which the water district can achieve through an effective metering program, periodic leakage survey and elimination, and good management practices.

Summary

The projected unit consumption figures for domestic, commercial, institutional, industrial uses and unaccounted-for-water are presented in this section. The projections are based on the assumption that the demands for each category of water use will be equivalent to the accounted-for-water in that category. The projected unit consumption and supply requirements are listed in Table VI-6.

The projected average daily demand and supply requirements are listed in Table VI-7. The total average daily demand is projected to be 12,500 cumd by 1990 and 20,450 cumd by year 2000.

The projected average daily demand and supply requirements listed in Table VI-7 are used to calculate the maximum daily demands and peak-hour demands listed in Table VI-8. The source development program discussed in subsequent chapters is scheduled on the basis of maximum daily demand projections. The transmission lines and distribution mains which convey water to the major demand centers are designed for peak-hour requirements.

TABLE VI-6

AVERAGE UNIT CONSUMPTION AND SUPPLY REQUIREMENT

Category	1975 9/	1985	1990	2000
Domestic, lpcd	63	127	135	145
Commercial, Institutional and Industrial, lpcd	15	19	20	22
(Percentage of Domestic)	(25)	(15)	(15)	(15)
Sub-total	78	146	155	167
Fernando Air Base, lpcd 10/	nil	56	34	21
Accounted-for-water, lpcd	78 11/	202	189	188
Unaccounted-for-water, lpcd	154 11/	48	45	42
(Percentage of Production)	(67) 11/	(25)	(22)	(20)
Leakage, lpcd	82	29	27	25
Unrecorded Use, lpcd 12/	72	19	18	17
Total Unit Demand and Supply Requirement, lpcd	232	250	234	230

9/ Based on October 1975 billing.

10/ Fernando Air Base unit supply calculated from LCWD population served. Fernando Air Base supply requirement is not included in the calculation for unaccounted-for-water.

11/ This figure does not agree with that in Table IV-4 because all of Item 2.b and part of Item 2.d are included in the domestic and non-domestic consumption.

12/ For 1975 the unrecorded use includes public use and wastage at flat-rate connections. The projected unrecorded use includes public use and meter under-registration.

TABLE VI-7

AVERAGE DAILY WATER DEMAND AND SUPPLY REQUIREMENTS (cumd)

Category	1975	1985	1990	2000
Domestic	570	3,900	7,200	12,900
Commercial, Institutional and Industrial	140	600	1,100	2,000
Sub-total	710	4,500	8,300	14,900
Fernando Air Base	nil	1,750	1,800	1,850
Accounted-for-water	710 13/	6,250	10,100	16,750
Unaccounted-for-water	1,400 13/	1,500	2,400	3,700
Total	2,110	7,750	12,500	20,450

TABLE VI-8

MAXIMUM DAILY AND PEAK-HOUR REQUIREMENTS (cumd)

Year	Average Daily Demand	Maximum Daily Demand 14/	Peak-Hour Demand 15/
1985	7,750	9,300	11,600
1990	12,500	15,000	18,800
2000	20,450	24,500	30,700

13/ See Footnote 12 of Table VI-6.

14/ Maximum daily demand is the maximum demand occurring on any day during the year. Maximum daily demand is assumed to be 120 per cent of average daily demand.

15/ Peak-hour demand is the highest demand for any hour period during the year. The peak-hour demand is assumed to be 150 per cent of average daily demand.

CHAPTER VII WATER RESOURCES

A. GENERAL

The Lipa City Water District (LCWD) is currently supplied water from 14 small springs on the flanks of Mount Malepunyo and Dilanan Hill and from six small production wells. A number of barrios within Lipa City obtain their water from separate piped supplies from small springs in the area. Fernando Air Base, four kilometers west of Lipa City, has a private water system fed by eight active deep wells, and various subdivisions in Lipa City have private deep well water supplies. Numerous individuals and commercial enterprises have small private wells and the remainder of the people in the area, not connected to a public or private supply, make use of public wells or springs. Figure VII-1 shows the location of the wells and springs.

B. GROUNDWATER RESOURCES

The LCWD is located on a terrace at about 310 m altitude between the high mountain mass of Mount Malepunyo (and associated peaks) to the east and Taal Lake at near sea level to the west. This high terrace slopes gently to lower elevations both north and south from Lipa City and drops abruptly to the west into Taal Lake. The topographic relationships are somewhat unfavorable to groundwater development through wells because recharge is limited.

Despite an unfavorable topographic environment, it may be concluded that the LCWD must utilize wells to exploit the underlying aquifers to their maximum safe yield. The convenient springs are too small to have any practical application and the larger springs are distant, insufficient except as a supplement, and liable to decrease in flow as more wells are drilled.

Geology

Lipa City lies in a volcanic area. Taal Lake, to the west, is in the crater of a volcano that erupted recently in geologic history. This volcano is still active, with Volcano Island in the lake representing the current crater and center of activity. The last eruption occurred in December, 1970.

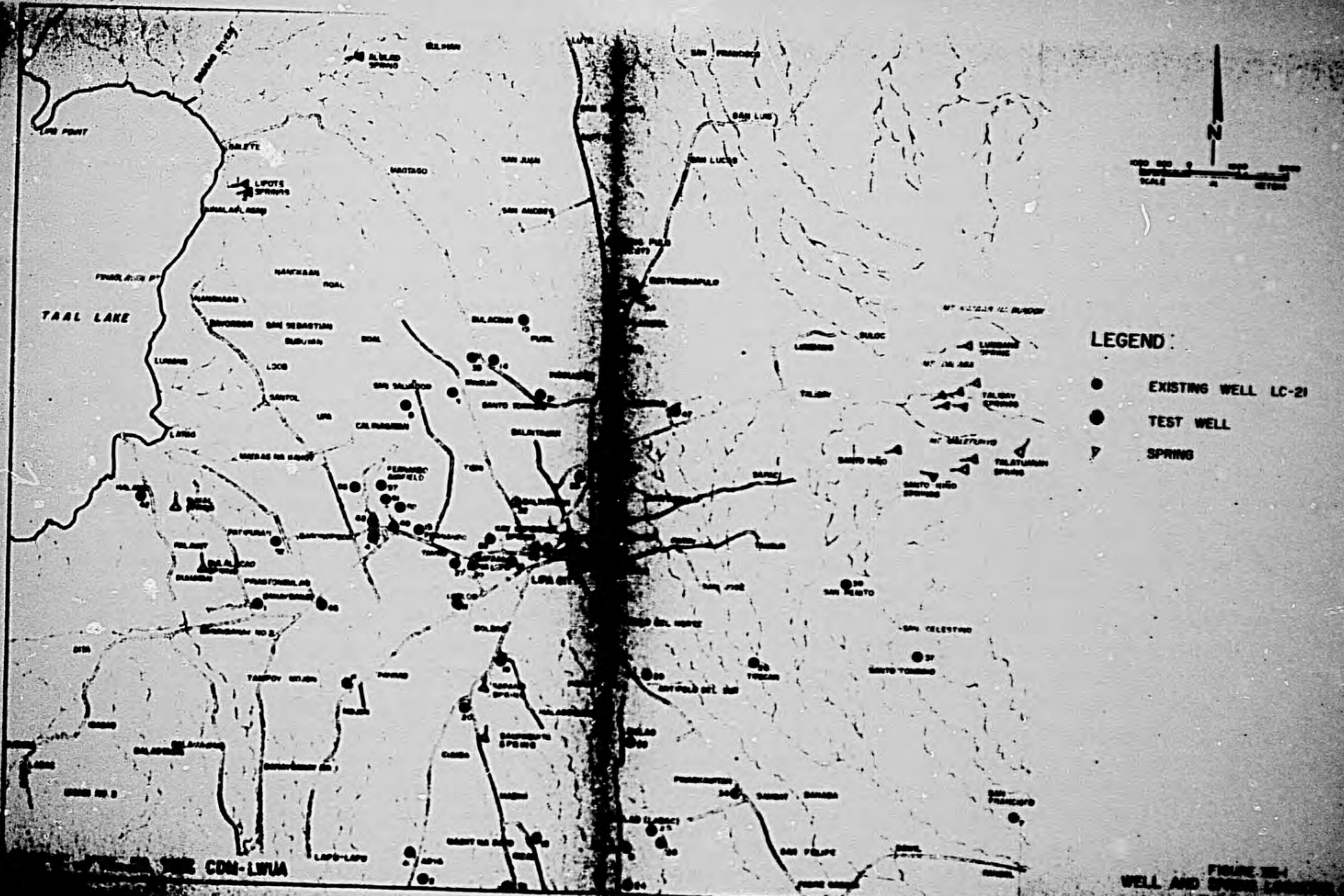
The mountain complex of Mount Malepunyo, Dilanan Hill, Mount Dalaga and Mount Mataas na Bundoc to the east is a non-active volcanic area composed of andesitic rock of Quaternary and Late Tertiary Age. Thirty km farther east, Mount Banahaw is classified as an active volcano with its last major eruptions over 200 years ago in 1743. Other non-active volcanoes exist to the north and south, essentially ringing Lipa City with exposed volcanic rocks.

The bench or terrace that Lipa City occupies is composed of sedimentary rocks or Late Tertiary to Quaternary Age, probably deposited in the valley between Mount Malepunyo (et al) and the ancestral Taal Volcano. The section has been explored to about 160-m depth by several wells although most wells are shallower. The rocks identified in logs are largely adobe (tuff?), tuffaceous sandstone and clay, all derived from volcanic parent material. Correlation of individual rock units from well to well is unreliable or virtually impossible, probably in part because of inconsistent logging nomenclature and lenticular and discontinuous beds. Beds of "rock" are logged but it is uncertain if these represent volcanic flows. Most of the section consists of adobe and tuffaceous sandstone which are possible, but probably poor, aquifer materials.

Aquifers

The volcanic rocks of the Mount Malepunyo complex comprise an aquifer that supplies the high springs in the eastern part of Lipa City. The springs are numerous, but none on the Lipa City side of the mountain complex are of large capacity. However, infiltration in the volcanic mountains not only supplies the springs but undoubtedly is a source of recharge to the sedimentary aquifers to the west through subsurface transfer of water.

The sedimentary aquifer system lying between the mountains and Taal Lake, is complex. It consists of permeable beds (sandstones, adobe?) separated by impermeable beds (clays) but with no continuous patterns that can be recognized through a study of the available logs of existing wells. The fact that continuity of permeable zones (aquifers) and impermeable zones (aquicludes) exists from recharge area to outcrop area is evident from a study of piezometric head levels at various depths. For example, water can be heard falling rapidly from a higher aquifer to a lower aquifer in an abandoned well at the Capuchin Seminary in Lipa City, and local drillers report that wells drilled below 60 and 90 m have much lower static water levels than shallower wells. Data from a group of wells about three kilometers northwest of the poblacion are listed as follows:



TAAL LAKE
LIPOTE SPRINGS
SAN JUAN
SAN ANDRES
SAN FRANCISCO
SAN LUIS
SAN LUCAS
SAN SEBASTIAN
SAN SALVADOR
SANTOL
SANTO NIÑO
SANTO NIÑO SPRING
TALISAY SPRINGS
TALATURAN SPRING
SAN JOSE
SAN BENITO
SAN CELESTINO
SANTO TORIBIO
SAN FELIPE
LAPO-LAPO
CDN-LWUA
N
SCALE
LEGEND:
EXISTING WELL LC-21
TEST WELL
SPRING
WELL AND

Well Number	Total Depth (m)	Static Water Level (m below ground surface)
LO-21	29	16
LO-16	42	18
LO-8	77	44
LO-14	98	85
LO-33	158	131
LO-3	161	131

The multiple aquifers do not appear to be consistent but vary laterally in their inter-relationships from place to place. In the vicinity of the poblacion, there seems to be a relatively constant static water level in all wells down to 100-m depth (but not deeper), indicating that all the permeable zones above 100-m depth in this area (except for the very-near-surface zone) are inter-connected and form one aquifer, possibly under semi-water table conditions.

It is a rather unusual situation where the deeper aquifers naturally have much lower piezometric levels than the shallower aquifers. This situation is illustrated in Appendix Figure VII-B-1 as a simplified schematic cross-section of the aquifer system (this illustration is purely representational - the aquifers are neither necessarily positioned nor as uniform as shown, nor are there only three). The individual aquifers accept a large amount of recharge from the hills and mountains to the east, and discharge it in the form of springs and seeps on the steep escarpment of Taal Lake to the west and on the gentle slopes to the north and south. The piezometric level in each aquifer is the elevation of the outcrop and rises toward the recharge area at a rate determined by transmissivity and rate of flow of water. The implications of this situation are four-fold. Firstly, the deeper wells will require greater pumping lifts than shallower wells. Secondly, it is undesirable to tap two aquifers with the same well because the pumping level would be below the upper aquifer and water would fall freely in the well bore, entraining air. Thirdly, if a well taps two aquifers, the water from the upper aquifer will continue to cascade down the bore during non-pumping conditions and so will deplete the upper aquifer uselessly. Fourthly, all wells drilled below the uppermost aquifer must be carefully sealed where they pas through aquifers above the production zone and all abandoned holes must be sealed between aquifers.

Recharge to the sedimentary aquifer system comes from two sources. One source is from infiltration from precipitation and surface flow into the volcanic rocks of the mountains to the east, and consequent subsurface transfer to the permeable sedimentary rocks. There are no available data to quantify this recharge, but in other areas in the Philippines, the recharge potential of the volcanic mountain masses is very high. The other source is from infiltration from precipitation and surface flow directly into the upper aquifer zone. This recharge cannot be accurately quantified because data on runoff and other factors are not available. However, in similar environments in various parts of the world, infiltration is often about 10 per cent of precipitation. This would be an annual infiltration rate of about 170 mm, equivalent to about 450 cumd per sqkm. The aquicludes are probably not totally impermeable and some of this infiltration probably percolates down to lower aquifers.

Discharge from the sedimentary aquifers was originally from springs and seeps in the outcrop areas of the various aquifers. Recently, artificial discharge through wells has become more and more significant.

Prior to development by wells, aquifers are in a state of dynamic equilibrium, in which recharge and discharge effectively balance over long periods of time. Discharge from wells upsets this balance by removing water from groundwater storage and lowering the piezometric head in the aquifer. Equilibrium cannot be re-established until there is no further loss in groundwater storage. This can only be accomplished by an increase in recharge or a decrease in discharge or both. All water discharged from wells is balanced by a loss of water somewhere. If the pumping rate is greater than any possible increase in recharge or decrease in natural discharge, equilibrium can never be re-established, water will continue to be lost from storage, and the aquifer will eventually be dewatered.

In the Lipa City area direct recharge by infiltration probably will not increase under a regime of increased pumping. However, transfer of recharge from the volcanic rocks may increase somewhat at the expense of the springs and perennial streams in the mountains after a sufficient time has elapsed for the influence of pumping to reach the mountains. Likewise discharge from the existing springs and seeps west, north and south of Lipa City will decrease or cease when the influence of pumping reaches them. All these effects result from the withdrawal of groundwater from storage and the consequent decrease in head in the aquifer. If the pumping rate in any of the Lipa City aquifers is too great, the head will decrease until the piezometric level is below the top of the aquifer. The aquifer will then begin to be dewatered and eventually the pumping rate will have to be reduced. The maximum safe yield of the aquifers is the rate of withdrawal that, within the limits of economic practicability, intercepts all possible natural discharge. This will concurrently increase natural recharge to a practical limit. Artificial recharge to increase permissible pumping rates is a remote possibility but is not considered economically feasible or necessary at this time. Investigations for practical applications of artificial recharge would be costly, difficult and time-consuming. It is also possible that deep wells (over 350 m) might eventually induce recharge from Taal Lake, which might be beneficial or detrimental depending on the lake water quality.

Wells

Numerous wells have been drilled in the LCWD area both to supply the major part of the LCWD water and to supply government agencies, commercial establishments and private individuals in the area. LCWD has six operating wells with production capacities of 2.6 to 5.8 lps, which currently produce a total of approximately 1,230 cumd. Fernando Air Base, four kilometers west of the poblacion, has eight operating wells (out of 11 wells total) currently producing a total of about 2,180 cumd. The production of the other wells is not known but is much less.

Data were gathered on 58 existing wells and used as a basis for the groundwater studies. These data are summarized in Appendix Table VII-B-1 and the well locations are shown in Figure VII-1. Stratigraphic logs of varying reliability were obtained for most of these wells; examples are given in Appendix Figures VII-B-2 to VII-B-7.

One LCWD production well, LC-58, which is currently used only to supply the marketplace was tested during the studies. It has a submersible pump capable of producing 5.7 lps, but the well was found to be capable of supplying about 13 lps. The LCWD is equipping the well with a larger pump and will connect it into the system, thereby greatly increasing the quantity of available water.

The studied wells ranged from 21 to 162 m deep and had specific capacities varying from 0.1 to 3.6 lps/meter. Well construction generally is poor and so the better wells are considered more indicative of general aquifer characteristics than the poorer ones. No proper pump test data are available but the specific capacities of the two best wells in the poblacion (probably both in the aquifer bottoming at about 90-m depth) indicate a transmissivity of about 400 cumd/m for the aquifer tapped by the wells. It is assumed that 30-lps wells can be constructed for production use.

Under the conditions inferred at Lipa City, where water is needed a long distance from both recharge and discharge areas, the most efficient arrangement (to minimize drawdown) is to spread the wells uniformly throughout the area of use. The drawdown at different separations can be computed. Assuming no well loss, no recharge, production rate of 30 lps, transmissivity of 400 cumd/m, storage coefficient of 0.0001, and a pattern of seven wells, one in the center of a hexagon of six, all equally spaced, then:

Time Elapsed (days)	Well Spacing (m)	Drawdowns Central Well (m)	Drawdowns Peripheral Well (m)
500	500	45	43
5,000	500	54	52
500	1,000	41	40
5,000	1,000	50	48
500	2,000	36	34
5,000	2,000	45	43

Although the differences do not appear pronounced, considering a static water level of about 15 m or more and a maximum permissible well depth of about 90 m, pumping levels are relatively deep. It is necessary to minimize drawdown as much as possible to avoid interference with the upper productive portions of the aquifer and, consequently, the 2,000-m spacing is desirable for the first wells. As can be seen, increasing spacing has progressively less effect and 2,000-m spacing is probably a practical limit. This spacing can be altered later when better data will be available from the first new production wells. An additional factor to consider is that more wells than seven will eventually be required and each new well will increase the drawdown in all wells within its radius of influence. It may be necessary to decrease the assumed production rate of 30 lps to avoid excessive drawdown in the upper aquifer. Consequently a conservative production rate of 15.8 lps (1,350 cumd) for each well is used in the economic studies to assure that well costs are not assumed to be unrealistically low.

The problems of spacing and excessive drawdown will be of no less importance when wells are drilled into a lower aquifer. Although the upper 100 m or more of well bore will be sealed and absolute pumping levels may be lower without causing dewatering problems, the static water levels will likewise be very low and the drawdown available for production pumping may be even more limited than in the shallower wells. However, interference between various aquifers at different depths will be minimal and spacing considerations apply only within the individual aquifer. Thus wells in one aquifer can be added to a pattern of wells in another aquifer that already has wells at the minimum spacing without significant mutual interference.

Quality of well water in the Lipa City area is generally excellent except that iron content is somewhat higher than the permissible limits set by the Philippine National Standards, in a few cases, but in no analysis is the iron content extremely high.

Test Well Program

A test well was drilled in Lipa City in an attempt to further quantify the practical production rate that can be expected from one well and to evaluate various construction techniques. As there are no available substantive data to indicate areas of better than normal aquifer, the well was located for convenience in the yard of the G.B. Lontoc Memorial School (Figure VII-1). The site was donated by the school board and it is near the pipeline from the springs in the mountains to the east.

The well was specified to be:

1. 91 m deep so as to test the upper section, deeper wells in the Lipa City area tending to penetrate an aquifer with a distinctly lower static water level.

2. construction with 250-mm diameter casing and slotted casing to permit high production rates. To facilitate development, continuous wire-wound screen would have been used in place of slotted pipe if it had been available.

3. gravel-packed to avoid sand production in the event that a fine, loose section was encountered.

4. electric-logged to pick the most suitable sections for screening. The requirement for an electric log precludes the use of casing in drilling the hole and, therefore, makes it necessary to drill the hole with a rotary drilling rig.

It was difficult to find a contractor with a rotary drilling rig available; only two presently have rotary rigs. A contractor drilled the well, starting actual work on 10 February 1976. The work progress is very slow. The sampling techniques were poor, and the hole was allowed to stand full of mud for long periods, which tends to plug permeable zones of the formation. The general design of the test well is shown in Appendix Figure VII-B-8, the stratigraphic log and screen placement are shown in Appendix Figure VII-B-9, and the electric log is shown in Appendix Figure VII-B-10.

There was little difference shown in the samples from 8.8 m to the bottom of the well, all largely consisting of fine to very coarse, sub-angular to sub-rounded, dark gray to brown sand grains composed of fragments of volcanic rock. Some clay and gravel were noted. Therefore, the perforated sections of casing were placed at depths shown to be favorable by the electric log. The logging equipment used was a manually operated and plotted Keck-Johnson unit. Self-potential and three normal resistivity curves were plotted. The self-potential curve was featureless and of little value, probably because of instrument problems. The 0.25 foot normal curve was subdued because of the influence of the mud in the 330 mm borehole. The 2.5-ft normal curve was most distinctive and was used mainly to pick permeable zones. Since the self-potential curve could not be used in the interpretation, it was assumed that the high resistivity zones represented porous and permeable sands and the low resistivity zones represented clayey sections. Thus:

1. Very porous and permeable sand sections are inferred from the water table at about 42 ft (12.8 m) to 57 ft (17.4 m) and from 67 ft (20.4 m) to 110 ft (33.5 m). Although these sections are so high in the well that drawdown would be severely limited if the pumping level were to be maintained above the slots, it was essential to test these sections which appear to be the best in the well. Slotted casing was placed from 21.3 to 33.5 meters.

2. Relatively porous sands interbedded with thin clays are inferred from 130 ft (39.6 m) to 169 ft (51.5 m) and from 185 ft (56.4 m) to 223 ft (68.0 m). Slotted casing was placed to test these sections from 39.6 to 51.8 m and from 57.9 to 67.1 meters.

3. Relatively porous sands interbedded with thin clays are inferred from 235 ft (71.6 m) downward with the section becoming more porous and permeable toward the bottom of the borehole. Slotted casing was placed from 76.2 to 88.4 meters.

After drilling, electric logging, casing installation and gravel-pack placement the well was developed by alternate air-lift pumping and back-flow for a period of 63 hours. After this development, a small capacity pump was installed and a short term pumping test was performed. This pumping test produced only 1.9 lps with a drawdown of 24.1 meters, yielding a specific capacity of 0.1 lps/meter. Because of the unexpectedly poor results, the drilling contractor was instructed to withdraw the installed pump, perform additional development with a surge block or large bailer and re-test the well with a larger pumpset. Additional development was carried out for a period of nine hours, after which a second pumping test was performed. The data resulting from this pumping test could not be utilised for determination of aquifer parameters because of the many interruptions caused by contractor equipment failures. However, a second short term specific capacity was determined as 0.5 lps/meter, resulting from a pumping rate of 3.8 lps and a drawdown of 8.1 meters, from the test. This pumping test data is presented in Appendix Table VII-B-2 and Appendix Figure VII-B-11.

Although the test well constructed during this project did not prove to be as successful as anticipated it is felt that the principles discussed previously have been demonstrated to be generally correct. The need for strict technical supervision of drilling contractors is evident. Additional development and testing of the test well could possibly yield improved results with additional valuable data.

It must be recognised that one test well and pump test is not definitive with respect to the quantity of water which can be produced from production wells in the LCWD. There are numerous successful wells of small to moderate capacity throughout the area indicating a widespread aquifer system but not indicating the actual ability of the aquifer to sustain a certain level of well production at any one location. Thus, regardless of the test pump results from the test well, the previously assumed production rate of 15.8 pls (1,350 cumd) will be used for further economic studies. Additional recent reports concerning a 200 meter deep naturally-developed well located across the highway from Fernando Air Base, which produces approximately 32 lps with an estimated pumping water level of 76 meters, tends to confirm this average rate.

Future Test Program

Further tests should be run on the test well before a plan for exploiting Lipa City's groundwater resources is finalised. Four aquifer zones were identified from the electric log and were cased with slotted pipe. Each one of these zones should be tested separately for static water levels and specific capacities. Such test would require the use of packers or equivalent devices to isolate the tested zone. The equipment for this more elaborate test was not available during the program of this study. During such a test, interference will occur from the overlying and underlying zones through the gravel pack but the percentage of influence can be minimized by using high test pump rates or by other more complex means.

Production Well Design

Two general designs for production wells are given in Appendix Figures VII-B-12 and VII-B-13. A prime requirement is that the well be electric-logged as a guide to setting screen opposite permeable sections. This requirement, in turn, makes it necessary that the wells be drilled by a rotary rig so than an uncased hole may be maintained for logging.

The use of continuous wire-wound screen of at least 200-mm diameter is recommended. Galvanized, corrosion-resistant level is the recommended material (stainless steel is not considered necessary because the Lipa City area does not have a history of corrosion problems). Continuous wire-wound screen is recommended because it is resistant to plugging, permits more effective development of the aquifer than any other type, and has a large percentage of open area.

If the section encountered in any well consists of well-graded, medium to coarse sands or semi-consolidated materials, natural-development type of construction (Appendix Figure VII-B-12) is recommended. In places where the section is more varied and contains uniform, fine, loose materials, gravel pack construction (Appendix Figure VII-B-13) is recommended.

Production Drilling Program

The first production wells of a drilling program should be drilled into the upper aquifer at an average spacing of about two kilometers. Thus they will be scattered around the distribution system so that no served area is far from a well. If more water is needed in any area than can be produced by this pattern, wells should be drilled through the upper aquifer and completed in the next deeper major aquifer, with the upper aquifer sealed off. Successively deeper aquifers may be used in this way to the full vertical extent of the overall aquifer system.

For the preliminary designs used for further studies in this report, it has been assumed that approximately 50 per cent of all future wells will extend only to the shallow aquifers, with a total depth of 100 m, and that the balance will extend to a total depth of 200 m. all with a nominal casing diameter of 200 millimeters.

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 on steep slopes.

The rate of flow from a spring depends on several factors: the head of water against which the spring discharges, the local surface and subsurface obstructions to flow of water at the spring opening, the transmissivity of the aquifer, and the water table elevation (or the piezometeric head) within the aquifer. It can be seen that there may be several ways to increase spring flow: by lowering the discharge level, by pumping or by lowering the surface level of the discharge channel; by reducing obstructions to flow at the spring opening through cleaning or developing the area; or by installing a well-screen intake pipe in the spring opening. Normally nothing can be done about improving aquifer transmissivity or about artificially raising the water table except in rare cases where some form of artificial recharge may be practical. Any artificial increase in spring flow may be temporary in that the flow will then tend to regress and eventually stabilize somewhere between the original flow rate and the initial increased rates.

Alternatively, the rate of flow of a spring (which fluctuates naturally with changes in water table resulting from variations in recharge) will be reduced by various events: (1) by allowing the discharge water level to increase; (2) by allowing the spring opening to become dirty or otherwise obstructed; and (3) by lowering the water table generally. This can occur as a result of: pumping water from wells in the recharge area of the spring (or even down gradient from the spring), or of artificially reducing recharge by diverting water from the recharge area to other uses, or of lower infiltration in the recharge area because of deforestation.

Specifically in the LCWD area, the springs are of two types. The springs in the mountains to the east are supplied by the volcanic aquifer. These springs currently provide part of the LCWD water system supply and also provide water to Barrios Talisay and Lumbang. Although there might be some reduction of flow in these mountain springs subsequent to large-scale well development in Lipa City, the probable effect would be minor because it would result only from lowered head in the sedimentary aquifers inducing greater transfer of groundwater from the volcanic aquifers. Any such additional transfer of groundwater would reduce the flow from springs and seeps in the mountains but probably not to a significant degree.

The springs to the west, north and south of Lipa City and at lower elevations are supplied by the sedimentary aquifers. In this case, large-scale well development in Lipa City would have a serious effect on those springs that are fed by the same aquifers that the wells would tap. The wells would intercept the groundwater that now flows from the recharge area to the springs and would reduce or dry up the spring flows. It is not possible from available data to correlate aquifers well enough to determine when wells and springs are supplied by a common aquifer. Spring locations are shown in Figure VII-1.

Spring water quality is uniformly excellent, except for excessive iron reported in some analyses.

Santo Niño Springs. This is a group of 14 springs on the flanks of Mount Malepunyo and Dilanan Hill at 400 to 800 m altitude. These springs were developed as a LCWD source. The flows are channeled into a single pipeline with total discharge of 880 cumd, measured on 16 April 1975. Very little of this supply reaches the poblacion, most of it being consumed in the intermediate upstream barrios which are also served by LCWD.

Talisay Springs. This is a group of five springs on the flanks of Mount Malepunyo and Mount Dalaga at 670 to 700 m altitude. These springs supply water to Barrio Talisay about three kilometers to the west. The flow was estimated as 85 cumd on 17 April 1975.

Lumbang Spring. Lumbang Spring is located on the flank of Mount Dalaga at an altitude of about 750 meters. This spring supplies water to Barrio Lumbang about three kilometers to the west. The flow was measured as approximately 670 cumd on 13 March 1975.

Talatuanan Springs. Talatuanan is a series of mountain springs and seeps located in Barrio Talisay on the northeast flank of Mount Malepunyo at about 550-m altitude. This spring complex discharges to the east. It would be difficult to use the spring series as a source for Lipa City because water would be collected from small, multiple sources and the collected water would have to be delivered over a high mountain ridge. The total flow was measured as about 1,830 cumd on 12 November 1975.

Bulalacao Spring. Bulalacao Spring is an undeveloped spring located in Barrio Duhatan at about 300-m altitude in a valley on the escarpment on the east side of Taal Lake. It is about seven kilometers from the poblacion of Lipa City. The flow was measured as 920 cumd on 6 February 1976.

Buoal Spring. Buoal Spring is an undeveloped spring located in Barrio Halang at about 75-m altitude, about one kilometer downstream of Bulalacao Spring in the same valley near Taal Lake. It is about eight kilometers from Lipa City poblacion. The flow was measured as 5,700 cumd on 21 May 1975.

Alulod Spring. Alulod Spring is an undeveloped spring located at about 100-m altitude in Barrio Bulihan, Municipality of Malvar, about 11 km northeast of Lipa City poblacion. The measured flow was 4,000 cumd on 6 February 1976.

Kay Impierno Springs. This is a group of four small springs located near the Lipa City Public Market at an altitude of about 310 meters. The combined flow was estimated to be 90 cumd on 22 May 1975.

Sampaguita Springs. This is group of three small springs at about 270-m altitude in Barrio Sampaguita about four kilometers south of Lipa City poblacion. The combined flow was estimated to be about 65 cumd on 23 May 1975.

Sabang Spring. This is group of three small spring outlets at about 280-m altitude in Barrio Sampaguita about one kilometer north of Sampaguita Springs. The combined flow was estimated to be about 150 cumd.

Lipote Springs No. 1 and 2. These springs are located in Barrio Lipote, Municipality of Balete, at about 10-m altitude near the shore of Taal Lake. They are about 10 km from Lipa City poblacion. Lipote Spring No. 1 was measured as about 165 cumd and Lipote Spring No. 2 was estimated as about 520 cumd, both on 14 November 1975.

Summary of Spring Flows. The measured and estimated flows listed herein must be considered only as a tentative guide for resources analysis because they represent spot measurements and estimates. Annual minimum flows may be less and, ideally, several years of monitoring is required to provide reliable data for analysis.

In general, the long-term potential of springs is easier to determine than that of wells. The normal procedure is to install gaging devices on the springs (weirs are usually most convenient and applicable) and monitor the flow for an extended period of time which should preferably cover a number of wet and dry seasons. It must extend through at least one complete annual cycle because spring flow normally will fluctuate with the seasonal rainfall changes, as the water table fluctuates with the associated recharge. It should be noted that there will be a time lag in the cyclic rainfall change, water table change and spring flow change pattern. Seasonal low flow will not necessarily correspond with low rainfall but may lag considerably. The spring flow record can be correlated with the rainfall record for the same period and usually extrapolated on the basis of long-term rainfall records to develop a reliable figure for minimum, maximum and average spring flows.

However, in this instance, a major complicating factor is introduced. As major development of groundwater by wells becomes relatively certain in Lipa City. The aquifer relationships are such that, eventually this well development will almost certainly curtail flow in all springs except the mountain springs, which are the first two listed in the following table:

Spring	Approximate Altitude (m)	Approximate Discharge (cumd)	Measurement Method
Santo Niño	400 - 800	880	Pitot tube
Talatuanan	550	1,830	Float
Bucal	75	5,700	Weir
Bulalacao	300	920	Weir
Alulod	100	4,000	Weir
Lipote No. 2	10	520	Estimated
	Total	13,850	

This summary includes only springs of over 500-cumd capacity. Any other large springs are not believed to exist within an economically practical distance of Lipa City. Even many of these springs discussed would be costly to incorporate into the LCWD system because of distance, low elevation or intervening terrain. In addition, Alulod and Lipote Springs are outside the water district and the water rights may not be available. Even if not utilised by the LCWD, additional groundwater wells can be expected to be developed for private use and, hence a long-term decline in spring flow in all springs but Santo Niño and Talatuanan is anticipated. Springs therefore may not be a desirable supplemental source for LCWD.

Monitoring Program

A monitoring program for wells must be established to provide data for properly and safely developing the groundwater resources. A monitoring program for springs should also be established if there is any intent to use more spring water than that currently being utilised.

The well monitoring program should include facilities for measuring static water level, pumping water level, rate of pumping, volume pumped, and pumping time at each LCWD pumphouse. Periodic observations should be made of water levels and daily records kept of pumping. Water samples should be collected for bacterial analysis monthly and chemical analysis annually.

The spring monitoring program should include construction of a permanent (concrete) measuring weir at each spring considered for LCWD use. Flow measurements should be made monthly; water samples should be collected for bacterial analysis monthly and chemical analysis, yearly.

Summary of Groundwater Resources

It may be tentatively concluded that development of an integrated well field to tap the aquifer system to the fullest practical extent is the preferential method to develop groundwater resources for water supply to Lipa City. However, this tentative conclusion must be verified by further studies and additional groundwater data collection.

C. SURFACE WATER RESOURCES

Lipa City is located near the high point of a terrace that slopes gently from the crest at about 350 m to lower elevations to the north and south. This terrace drops abruptly to Taal Lake to the west. Thus, all the local streams originate in the vicinity of the study area. There are neither large streams within an economical distance from Lipa City, nor any feasibility surface water storage sites in the vicinity of the study area. The only surface source located within a practical distance for LCWD water needs is Taal Lake.

Taal Lake

Taal Lake is about 240 sqkm in area and occupies the caldera of an active volcano. The total drainage area is about 640 sqkm. The only outflow from the lake is the Pansipit River which drains to the southwest through a low portion of the caldera rim. The water surface of the lake is quite low, less than 10 m above sea level. The lake is very deep, almost 200 m in places. In the lake is a small island, Volcano Island, which is the current active cone of the volcano. The last recorded eruption (a minor one) occurred in December, 1970, according to the Commission on Volcanology. The lake is about nine kilometers from Lipa City poblacion at its closest point.

Records are available for lake discharges through the Pansipit River from late 1958 through 1972. The minimum daily flow recorded was 1,460 lps (126,000 cumd) and the average daily flow for the period of record was 1.27 million cumd (Appendix Tables VII-C-1 and VII-C-2). Thus, Taal Lake overflow to the sea greatly exceeds LCWD water supply requirements.

Water Quality. Recent water samples from Taal Lake indicate that the total solids and chloride content are both more than twice the permissible limits set by the Philippine National Standards, as shown in the following table. However, both these items fall below the excessive concentration limits set by the Philippine National Standards. Other parameters are satisfactory.

	Excessive (Phil. Natl. Standard)	Actual Taal Lake	Permissible (Phil. Natl. Standard
Total Solids	1,500 mg/l	1,028 mg/l	500 mg/l
Chlorides	600 mg/l	428 mg/l	200 mg/l

Thus Taal Lake water currently is marginal for use and may eventually require desalinisation, a very costly process.

Unfortunately, in addition to being only marginally suitable, the quality of Taal Lake water is suspected of being unstable. Unverified reports indicating Taal Lake water of low chloride content about 30 years ago. However, available records from the Commission on Volcanology for 1967 show a relatively constant chloride content, with minor fluctuations that reflect minor concentration changes over short-time periods or spatial variations in concentration throughout the lake.

Date		Commission on Volcanology Samples - Taal Lake: Ambulong, Tanauan Chlorides mg/l	Ambulong, Tanauan Total Solids mg/l	Pansipit River Inlet Chlorides mg/l	Pansipit River Inlet Total Solids mg/l
March	1967	386	1,016	395	976
May	1967	427	1,085	462	1,084
June	1967			427	1,060
July	1967	422	1,022		
August	1967			437	1,038
September	1967	437	1,008	447	1,020
October	1967			427	1,019
October	1967			407	1,017
November	1967			437	1,031
January	1968	447	1,039	447	1,053
March	1968	452	1,102	452	1,064
April	1968	462	1,053	467	1,065
May	1968	447	1,016		
June	1968	462	1,018	472	1,038
September	1968	446	1,031	491	1,038
October	1968			405	1,024
November	1968			422	1,013
January	1969			429	853
February	1969			424	1,054

During the period from 1967 to 1975, the sulfate content of Taal Lake water has significantly declined from about 140 mg/l to about 40 mg/l, perhaps, indicating a change in composition of the source of the salts.

To determine the long-term stability of the level of dissolved salts in Taal Lake, the following calculations have been made:

1. Outflow through the Pansipit River averages 464 million cum/year. This flow removes salts.

2. Evaporation losses from the lake average 336 million cum/yr (1,400 mm yearly evaporation at Barrio Ambulong). No salts are removed.

3. Total output averages 800 million cum/yr (ignoring infiltration losses).

4. Rainfall input directly to the lake averages 408 million cum/yr (1,700 mm yearly precipitation at Barrio Ambulong). No significant salts are added.

5. Inflow from the catchment area of the lake (surface and subsurface) equals total output (800) minus direct rainfall input (408) or 392 million cum/year. This flow adds salts.

6. The outflow from the Pansipit River contains about 665 mg/l of sodium chloride (equivalent to 400 mg/l chlorides), removing about 309 million kg of the salt per year.

7. The inflow from the catchment area contains about 25 mg/l of sodium chloride (equivalent to 15 mg/l chlorides), adding about 10 million kg of this salt per year.

8. The salt content of Taal Lake has remained relatively constant since 1967 despite a deficit of 299 million kg of sodium chloride per year between outflow and normal inflow. The most probable source for this salt is the active volcano in the lake. This supposition is supported by an analysis of the water in the Taal Volcano crater on Volcano Island (Table VII-1), which indicates very high total solids and chloride content. It is supported by informal reports that content of lake water before the latest eruption of the volcano in the mid-1960's had low salt content, implying that the salts are volcanic in origin. In this case, the salt content could increase any time as a result of further volcanic activity.

9. It is also possible that the salt deficit is being supplied from a body of very saline water deep in the lake. Such a body of saline water could exist because of density strati-

fication of this deep lake with abrupt sides and no major inflowing river. In this case, the salt content could increase any time as a result of disturbance to the water body by volcanic eruption, earth tremor, or volcanic heat causing thermal mixing.

10. The salt deficit is not replaced by ocean water because the Pansipit River flow is always seaward and the river is too shallow to sustain a reverse direction underflow current.

Summary of Surface Water Resources

Taal Lake is the only sufficiently large source of surface water within an economic distance of Lipa City. The volume and flow rates of Taal Lake are sufficient for all forseeable needs of Lipa City but its location and the water quality are both deterrents to its use.

Taal Lake is over 300 m lower than, and 9 km distant from, the Lipa City poblacion. This would require a long pipeline and a high-pumping lift for LCWD water supply use.

An even greater deterrent to the use of Taal Lake water is its high chloride content which is not permissible under Philippine National Standards and World Health Organization Standards. Although water of this quality is allowable under the Philippine National Standards and the World Health Organization Standards and is successfully used without significant complaints by numerous municipal water systems throughout the world, the Taal Lake water quality is suspected of being unstable and liable to variation. If Taal Lake were used as a water source for LCWD and the water quality deteriorated as a result of saline water contamination from the active volcano in the lake, either the facilities would have to be abandoned or desalinization facilities be added. Thus any development of Taal Lake for municipal water supply must be preceded by a thorough study of the source of the dissolved salts in the lake waters, and a careful and conservative analysis of the probability of increase of the salts concentration.

D. WATER QUALITY OF POTENTIAL SOURCES

Water samples were taken from many of the sources discussed in this chapter, including both groundwater (from wells and springs) and surface water (Taal Lake) sources. Chemical analyses of these samples were performed to determine the water quality with respect to potability and treatment requirements. The results of these analyses are shown in Table VII-1, and are briefly discussed in this section.[1/]

Groundwater

Since groundwater, while flowing through a granular aquifer, essentially passes through a filtration process (such as in the LCWD area), and is generally not exposed to surface pollution, color, 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.

Wells. The water quality analysis results for existing LCWD wells are presented in Table VI-5, and additional data for other wells in the Lipa City area are presented in Table VII-1. The results indicate the presence of high color, turbidity and iron concentrations in some of the samples. The presence of high iron concentrations is not common and is not reported to be a problem in the area. However, it is suspected that the occurrence of high color and turbidity concentrations in some samples collected may result from the precipitation of dissolved iron within the sample, after collection but before analysis.

Springs. The water quality analysis results for existing LCWD springs are presented in Table IV-5, and additional data for other springs in the Lipa City area are presented in Table VII-1. The quality of water from springs is generally very good with occasional minor occurrences of high concentrations of color, turbidity, iron and manganese. As previously mentioned there are no recorded complaints with respect to these parameters.

[1/] For evaluation of water quality test results, two sets of limits have been established by the Philippine National and World Health Organization Standards: (1) The limit designated as "permissible" or "acceptable" applies to water that generally would be acceptable to consumers; (2) Values greater than "maximum allowable" or "excessive" would markedly impair the potability of the water.

Surface Water

Taal Lake. An extensive discussion of the quality aspects of the waters of Taal Lake is presented in previous sections of this chapter. The results of chemical analysis of several samples collected are presented in Table VII-1. As previously stated, the high concentrations of chlorides and turbidity exceed the permissible limits set by the Philippine National Standards. In addition, the chemical quality of this water may be unstable due to the nature of the probable (volcanic) source of the polluting minerals.

TABLE VII-1

WATER QUALITY TEST RESULTS
LIPA CITY WATER DISTRICT

		Permissible Limits[2/]	Drilled Well- San Lucas (5-21-75)	Drilled Well Bulacnin (5-21-75)	Drilled Well Pinagkawitan (5-23-75)
A. GROUNDWATER WELLS					
PHYSICAL					
Color	(unit)	15	40	10	10
Taste	"	3.0			
Odor	"				
Turbidity	"	5.0	8.5	2.0	1.0
Solids					
a. Total	(mg/1)	500	263	471	285
b. Suspended	"		nil	45	2.0
CHEMICAL					
pH		7-8.5	7.3	6.8	7.0
Alkalinity					
a. Total	(mg/1 as $CaCO_3$)		150	128	136
b. Phenolphthalein	"		0	0	0
Total Hardness	"		120	205	126
Calcium	(mg/1)	75	17.8	28.6	16.6
Magnesium	"	50	10.6	19.8	11.0
Iron	"	0.3	<u>1.190</u>	0.125	0.055
Fluoride	"	1.5	<u>0.32</u>	0.22	0.33
Chloride	"	200	10	60	24
Sulfate	(mg/1)	200	4.4	30.9	10.4
Nitrate	"				
Manganese	"	0.1	0.052	0.006	0.005
Copper	"	1.0	0.011	0.003	0.002
Zinc	"	5.0	0.600	0.400	0.352

2/ Philippine National Standards

Underlined results indicate excess quantities over maximum allowable limits as defined in the standards.

TABLE VII-1 (Continued)

WATER QUALITY TEST RESULTS

		Drilled Well Plaridel Elementary School (5-23-75)	Drilled Well Pinagtungulan (5-21-75)	Faucet R. Tolentino's Chicken Farm (5-22-75)	Faucet R. Pesas's House (5-22-75)
PHYSICAL					
Color	(unit)	10	10	30	10
Taste	"				
Odor	"				
Turbidity	"	13.0	2.0	10.0	1.0
Solids					
a. Total	(mg/1)	275	234	241	149
b. Suspended	"	3.0	nil	9	3
CHEMICAL					
pH					
Alkalinity					
a. Total	(mg/1 $CaCO_3$)	136	118	144	60
b. Phenolphthalein	"	0	0	0	0
Total Hardness	"	110	116	118	82
Calcium	(mg/1)	12.4	14.8	14.2	7.4
Magnesium	"	9.5	9.6	8.2	4.2
Iron	"	0.450	0.128	0.045	0.368
Fluoride	"	0.32	0.19	0.24	0.01
Chloride	"	12	16	10	20
Sulfate	(mg/1)	9.9	30.9	6.1	10.2
Nitrate	"				
Manganese	"	0.018	nil	0.002	0.002
Copper	"	0.027	nil	0.006	0.003
Zinc	"	1.350	0.012	1.550	0.010

TABLE VII-1 (Continued)

WATER QUALITY TEST RESULTS

		Taal Volcano Crater (11-19-75)	Taal Lake Lipa River Delta (9-13-75)	Taal Lake Municipality of Balete (5-23-75)
B. SURFACE WATER: TAAL LAKE				
PHYSICAL				
Color	(unit)	<u>59</u>	3	10
Taste	"	Salty	Tasteless	
Odor	"		Odorless	
Turbidity	"	11	5	4.0
Solids				
a. Total	(mg/l)	<u>6,500+</u>	1,032	1,026
b. Suspended	"	2		21
CHEMICAL				
pH		2.4	8.5	9.0
Alkalinity				
a. Total	(mg/l $CaCO_3$)		168	146
b. Phenolphthalein	"		28	30
Total Hardness	"	<u>7,708</u>	212	99
Calcium	(mg/l)	<u>360.40</u>	32	36.6
Magnesium	"	<u>1,654.1</u>	32.68	38.6
Iron	"	<u>5</u>	nil	0.875
Fluoride	"	<u>1.475</u>	nil	0.63
Chloride	"	very high	429.44	426
Sulfate	(mg/l)	58.96	53.60	31.0
Nitrate	"	0.06	0.9	
Manganese	"	<u>5.3</u>	nil	0.005
Copper	"	0.987	nil	0.003
Zinc	"			0.012

Underlined results indicate excess quantities over maximum allowable limits as defined in the Standards.

TABLE VII-1 (Continued)

WATER QUALITY TEST RESULTS

		Alulod Spring (11-20-75)	Lipote Spring (11-14-75)	Talatuanan Spring (11-12-75)	Bulalacao Spring (4-15-75)
C. GROUNDWATER: SPRINGS					
PHYSICAL					
Color	(unit)	0	0	0	10
Taste	"				
Odor	"				
Turbidity	"	0	0	16	1.0
Solids					
a. Total	(mg/l)	234	361	65	287
b. Suspended	"	0	0	10	1
CHEMICAL					
pH		8.30			7.6
Alkalinity					
a. Total	(mg/l $CaCO_3$)	188	274	58	148
b. Phenolphthalein	"	10	0	0	0
Total Hardness	"	144	220	60	52
Calcium	(mg/l)	35.20	59.2	12.8	27.0
Magnesium	"	13.61	17.50	8.80	8.5
Iron	"	<u>2.5</u>	0.18	<u>1.55</u>	0.01
Fluoride	"	0.56	nil	nil	0.31
Chloride	"	10	14.03	6.0	10
Sulfate	(mg/l)	10.05	18.75	4.63	24.0
Nitrate	"	0.01	nil	nil	
Manganese	"	0.25	nil	nil	nil
Copper	"	0.19	nil	nil	nil
Zinc	"				0.005

Underlined results indicate excess quantities over maximum allowable limits as defined in the Standards.

TABLE VII-1 (Continued)

WATER QUALITY TEST RESULTS

		Sabang Spring Bo. Sampaguita (5-23-75)	Bucal Spring (5-21-75)	Infierno Spring II_1 (5-22-75)	Infierno Spring II_2 (5-22-75)
PHYSICAL					
Color	(unit)	10	10	10	10
Taste	"				
Odor	"				
Turbidity	"	3.5	1.0	3.5	2.0
Solids					
a. Total	(mg/l)	348	290	252	234
b. Suspended	"	5	7	33	9
CHEMICAL					
pH		7.2	7.6	6.9	7.0
Alkalinity					
a. Total	(mg/l $CaCO_3$)	112	198	126	120
b. Phenolphthalein	"	0	0	0	0
Total Hardness	"	100	136	105	9.8
Calcium	(mg/l)	13.2	20.7	13.4	13.4
Magnesium	"	8.8	13.2	8.2	8.2
Iron	"	0.045	0.232	0.020	0.915
Fluoride	"	0.14	0.25	0.13	0.13
Chloride	"	8	12	12	18
Sulfate	(mg/l)	14.0	13.5	8.8	8.2
Nitrate	"				
Manganese	"	0.002	0.001	0.005	0.011
Copper	"	0.002	nil	0.032	0.002
Zinc	"	0.002	0.010	1.350	0.020

TABLE VII-1 (Continued)

WATER QUALITY TEST RESULTS

		Infierno Spring II_3 (5-22-75)	Palagbag Spring Intake 1 (4-16-75)
PHYSICAL			
Color	(unit)	10	20
Taste	"		
Odor	"		
Turbidity	"	0.5	0.5
Solids			
a. Total	(mg/l)	230	136
b. Suspended	"	nil	3
CHEMICAL			
pH		6.7	7.8
Alkalinity		124	108
a. Total	(mg/l $CaCO_3$)	100	30
b. Phenolphthalein	"	0	0
Total Hardness	"		
Calcium	(mg/l)	13.4	9.1
Magnesium	"	8.0	4.8
Iron	"	0.025	0.05
Fluoride	"	0.11	0.07
Chloride	"	12	10
Sulfate	(mg/l)	7.7	4.8
Nitrate	"		
Manganese	"	0.0005	0.002
Copper	"	nil	nil
Zinc	"	0.005	0.008

TABLE VII-1 (Continued)

WATER QUALITY TEST RESULTS

		Lomtoc Elementary School Lipa City 20-Apr-76
PHYSICAL		
Color	(unit)	0
Taste	"	
Odor	"	
Turbidity	"	0
Solids		
a. TDS	(mg/l)	179
b. Suspended	"	
CHEMICAL		
pH		6.7
Alkalinity		0
a. Total	(mg/l as $CaCO_3$)	125
b. Phenolphthalein	"	0
Total Hardness	"	125
Calcium	(mg/l)	66
Magnesium	"	59
Iron	"	0.06
Fluoride	"	0
Chloride	"	21
Sulfate	(mg/l)	13
Nitrate	"	1.75
Manganese	"	2
	"	

CHAPTER VIII ANALYSIS AND EVALUATION OF ALTERNATIVES

A. GENERAL

This chapter identifies and evaluates the alternatives available for source development, transmission and treatment facilities and distribution system. Other water conservation and augmentation alternatives are also included.

Lipa City, because of its topographical location, has limited groundwater sources and no economically feasible surface water resources. Therefore, LCWD would have to exploit its groundwater sources to the maximum extent possible and then consider surface water sources (Taal Lake) as a last resort in the future. All of the proposed source development alternatives include pumpage for water transmission. The water transmission alternatives which are related to source alternatives have been analyzed for pipeline routes and sizes for a satisfactory hydraulic performance and economy. Furthermore an economic study has been carried out for optimizing pipe sizes against pumping costs. Water treatment alternatives include disinfection for springs and well supplies, and complete treatment for the Taal Lake supply. Distribution system alternatives include various considerations such as defining the number of pressure zones; storage tank sizes and locations; and details concerning feeder mains and internal network.

B. WATER SUPPLY SOURCE ALTERNATIVES

Surface Water Sources

The study area is located in a highland terrace from where most of the local streams originate. No major surface water source, except Taal Lake, is within an economical distance from the study area. Taal Lake is a volcanic lake with a drainage area of about 640 sqkm. Outflow from the lake has been measured at the Pansipit River which is the only outlet of the lake. The recorded minimum discharge from the lake is 1.5 cum/sec (130,000 cumd). This is much greater than the projected maximum daily demand (24,500 cumd) for LCWD in the year 2000. The lake has an ample storage capacity as far as the municipal water supply is concerned. However, economic/financial feasibility of a water supply scheme of Taal Lake for LCWD is doubtful for the following reasons:

1. The water surface elevation in the lake (about five meters) is quite low in comparison to the Lipa service

area (300-360 m). Therefore water from the lake would have to be pumped to a high head of about 375-400 meters. In addition, a pipeline of about 12 km would have to be constructed to convey the water to the service area.

2. The salinity (chloride content) of the lake water, determined from the two samples analyzed, is at a critical stage for domestic usage. As explained in Chapter VII, it is believed that the salinity of the lake water is adversely affected by the local volcanic eruptions. The lake water quality is expected to deteriorate further, following future eruptions. At that time treatment for brackish water would be required and might render Taal Lake water economically unattractive as a water source for LCWD.

Groundwater Well Sources

A significant portion of the present municipal and private water supply is obtained from groundwater wells. Available field data indicate that the study area is underlain by multiple separate aquifers. Because of the general topography and soil structure of the area, these aquifers have a limited recharge capacity. Therefore, allowable limits for groundwater drawdown would be an important factor in well design and spacing. The preliminary hydrogeological studies show that for each separate aquifer, wells with a production rate of about 1,300 to 2,000 cumd may be feasible at a spacing of two kilometers. However, evaluation of field test data from the new and future production wells would be essential to verify the design basis of a long-term well construction program.

Quality of well water in the study area is generally good, except that the iron content of some wells is marginally higher than accepted standards.

Groundwater Spring Sources

Eleven springs have been identified within a 10 km radius from the center of the city of Lipa. The spring flows have been measured and water samples have been taken during the field studies for quality analysis (see Chapter VII). The measured flows of these springs varied from 65 to about 7,000 cumd. The eastern springs (Santo Niño, Talisay, Lumbang and Talatuanan) originate at relatively high altitudes (400 to 800 m). The others at lower altitudes are located north of (Alulod, Kay Impierno and Lipote Springs), south of (Sabang and Sampaguita Springs) and west (Balalacao and Bukal Springs) of Lipa City. Seven of these spring groups have been eliminated from further studies for the following reasons:

Flows of the Talisay Spring (85 cumd) and Lumbang Spring (670 cumd) are consumed locally by the barrios of Talisay and Lumbang, respectively. The Talatuanan spring group which has a measured flow of 1,800 cumd, is located on the eastern side of Mount Malepunyo. Development of this spring for Lipa does not appear to be economical because either a pumping facility or a tunnel would be required to convey water across the mountain ridge. The Kay Impierno, Sampaguita and Sabang spring groups are too small to consider. The Lipote Springs (estimated at 700 cumd) are located in the municipality of Balete about 10 km from Lipa City, at an altitude of 10 meters. The pumpage and transmission line cost may make it uneconomical for development of this spring. Water rights may also be a problem.

The remaining Santo Niño, Bukal, Bulalacao and Alulod Springs are included in the alternative source studies. The Santo Niño spring group presently supplies the eastern sections of the LCWD system by gravity. Its measured discharge is about 800 cumd. The Alulod Spring is presently undeveloped but located in the municipality of Malvar. Therefore, water rights for this spring will require further clarification. The Bulalacao and Bukal Springs are the closest springs to the study area. The approximate distances from Lipa City, altitudes and measured flows of the proposed spring sources are given as follows:

Spring	Location	Altitude (m)	Discharge (cumd)	Date of Measurement
Bulalacao	7 km west of Lipa	300	950	May 21, 1975
			920	Feb. 6, 1976
Bukal	8 km west of Lipa	75	6,700	Oct. 27, 1975
			7,760	Nov. 21, 1975
			7,310	Feb. 6, 1976
Alulod	11 km north of Lipa	100	6,750	Nov. 20, 1975 (estimated by float method)
			4,000	Feb. 6, 1976

If a large-scale well source development is found to be the recommended scheme for Lipa City, recharge of these potential spring sources may be affected significantly since the wells and springs derive their source from the same recharge mechanism. This fact will have to be taken into account in the alternative source analysis. Also, for the same reason, continuous monitoring of the groundwater well and spring sources becomes very important for overall future management of the available water resources.

C. PROPOSED SOURCE, TRANSMISSION AND TREATMENT ALTERNATIVES

General

Evaluation of the alternative schemes is based on the following assumptions:

1. Water source development schedules would be in accordance with the projected maximum daily demands, with additional flows required during the peak hourly demands to be obtained from the distribution storage facilities.

2. Due to the lack of long-term records, safe yields of the springs would be taken as 75 per cent of the flows measured during the field studies.

3. Existing facilities would be incorporated in the future system to the maximum extent possible. Among these, the Santo Niño Spring supply and the Lipa market well would be maintained after rehabilitation. A total supply of about 2,000 cumd would be available from these sources.

4. Cost comparison of the alternative schemes would include source development, transmission and treatment facilities.

5. Depending upon the alternative being analysed, the study area would be divided into convenient pressure zones for hydraulic and practical reasons.

Three basic alternative schemes have been established for detailed studies:

Alternative 1: Based on development of the groundwater well sources only and related transmission, treatment and distribution feeder main systems;

Alternative 2: Based on development of the spring sources (assuming that no new wells would be constructed) and related transmission, treatment and distribution feeder main systems; and development of a supply scheme of Taal Lake at a later stage.

Alternative 3: Based on development of the Taal Lake source only, with related transmission, treatment and distribution feeder main systems.

Water source development schedule, with respect to above alternatives, is presented in Table VIII-1.

TABLE VIII-1

ALTERNATIVE SOURCE DEVELOPMENT SCHEDULE

Alternative Scheme	Source Development	Construction Period	Cumulative Supply (cumd)[1]	Year Augmented	Number of Pressure Zones
1	Existing		2,000		3
	Wells-Stage 1	1978-80	15,000	1980	
	Wells-Stage 2	1988-90	24,500	1990	
2	Existing		2,000		2
	Bulalacao and Bukal Springs	1978-80	7,700[2]	1980	
	Alulod Spring	1981-83	10,700[2]	1983	
	Taal Lake	1984-86	24,500	1986	
3	Existing		2,000		2
	Taal Lake - Stage 1	1978-80	15,000	1980	
	Taal Lake - Stage 2	1988-90	24,500	1990	

[1] Based on the projected maximum daily demands

[2] The spring yields are based on 75 per cent of the field measured flows (see Chapter VII).

Alternative I

For this alternative, it is assumed that all of the future requirements of LCWD (to the year 2000) would be derived from groundwater wells.

To date, the hydrogeological studies indicate the following design parameters for each operational well:

Design Yield	1,300 cumd
Casing Diameter	200 mm
Minimum Spacing	2 km

The maximum-day requirements, including the minimum number of wells required in 1990 and 2000, are as follows:

	1990	2000
Total maximum day demand, cumd	15,000	24,500
Flow from existing facilities, cumd	2,000	2,000
Flow required from new wells, cumd	13,000	22,500
Minimum number of operational wells required	10	18
Stand-by wells	One each for Pressure Zones 1 and 2	One each for Pressure Zones 1, 2 and 3
Minimum number of wells required	12	21

For Alternative I, the water distribution service area has been divided into three pressure zones with the following ground and hydraulic grade line elevations:

Pressure Zone	Ground Elevation (m)	Maximum Hydraulic Grade Line Elevation (m)	Storage Tank Overflow Elevation (m)
1	up to 320	346	340
2	320 - 345	366	365
3	345 - 365	387	385

Deep well pumps serving any one of the pressure zones would be selected to have adequate pumping head for that particular zone. Therefore, booster stations are not required in this alternative.

Based on the topography, pressure zone layout and maximum-day demand, a total of 11 operational wells would be required during the construction Stage I (1978-90). Six of these wells would penetrate into the first aquifer (about 100 m deep) and the remaining five wells would tap the second aquifer (about 200 m deep). One additional well would be provided as stand-by for each of the Pressure Zones 1 and 2.

Seven additional operational wells would be constructed during the construction Stage II (1990-2000), three extending to the first aquifer and four to the second aquifer. One additional unit would be provided as a stand-by for the third pressure zone.

The wells penetrating into any one of the two aquifers have to be spaced a minimum of two kilometers.

The well water would require chlorination before delivery to the distribution system.

Transmission line sizes are computed for the peak hourly demands and tank filling conditions, in accordance with project design criteria. (Appendix A, Volume II.)

The proposed transmission lines from the wells and the storage tanks would be staged in accordance with the increasing demands in the designated pressure zones and the well construction schedule. A schematic layout of the facilities involved in this alternative is shown in Figure VIII-1.

Alternative 2

In this alternative the Bulalacao and Bukal Springs would be developed first (1978-80). Development of the Alulod Spring would follow shortly so that it would be in service by 1983. Source development facilities basically would include a collection chamber and an appropriate pump station at each of the springs. First, water from the Bukal and Bulalacao Springs would be pumped into a source storage tank near Barrio Pinagtongulan, and then conveyed into the distribution system through a single pipeline from the west. The Alulod spring water would be pumped to the service area through a relatively long transmission line from the north. Both supply lines would be connected to a distribution storage tank located near Barrio Tibig (Figure VIII-2). To meet the projected demands (Figure VIII-3) additional supplies would have to be made available from Taal Lake about 1986. The Taal Lake scheme would include an intake structure; a two-stage raw water pumpage and transmission facilities; water treatment plant; treated water pipelines; and storage facilities (Figure VIII-2).

The spring water would only be treated using disinfection by chlorination; but the water from Taal Lake would require com[illegible]se treatment.

Since the source transmission lines from all of the above-mentioned sources would have to cross a high ridge (extending from the west to the north of Lipa, at elevation 360-365 m) to convey the water to the service area, limits of the first pressure zone would include areas up to the 345 m ground elevation. In contrast to the three pressure zones required in Alternative 1, Alternative 2 would require only two pressure zones for its distribution system. Service to the second pressure zone would be provided through a booster station located near the Fernando Air Base and would serve areas above elevation 345 meters.

Alternative 3

Development of the Taal Lake source would be considered in this alternative for the present and future water needs of the LCWD. A raw water intake and pump station would be constructed near Barrio Latag. Because of a relatively high lift (about 400 m) requirement, the raw water pumpage facilities would be constructed in two stages. The pumped water would be given conventional treatment at a plant located near Barrio Bagongpook.

For this alternative, there would be two pressure zones in the distribution system for the same reasons explained previously under Alternative 2. The first pressure zone (covering the central area up to elevation 345 m) would be served directly from the treatment plant. The second pressure zone, which covers the remaining part of the service area, would be served through a booster pump station located near the Fernando Air Base.

A general layout of the proposed facilities with the raw and treated water transmission lines and storage tanks is shown schematically in Figure VIII-4. Construction of these facilities would be implemented in two major stages: Stage 1, during the period 1978-80; Stage 2, during the period 1988-90.

Analysis of Alternatives

Criteria. The analysis and the evaluation of alternatives which are presented herein, are based largely on economic present worth cost studies. However, selection of the recommended plan may be influenced by non-economic parameters especially if the "best" and "second best" alternatives fall within the limit of cost estimating accuracy.

FIGURE VIII-1
ALTERNATIVE 1 LAYOUT

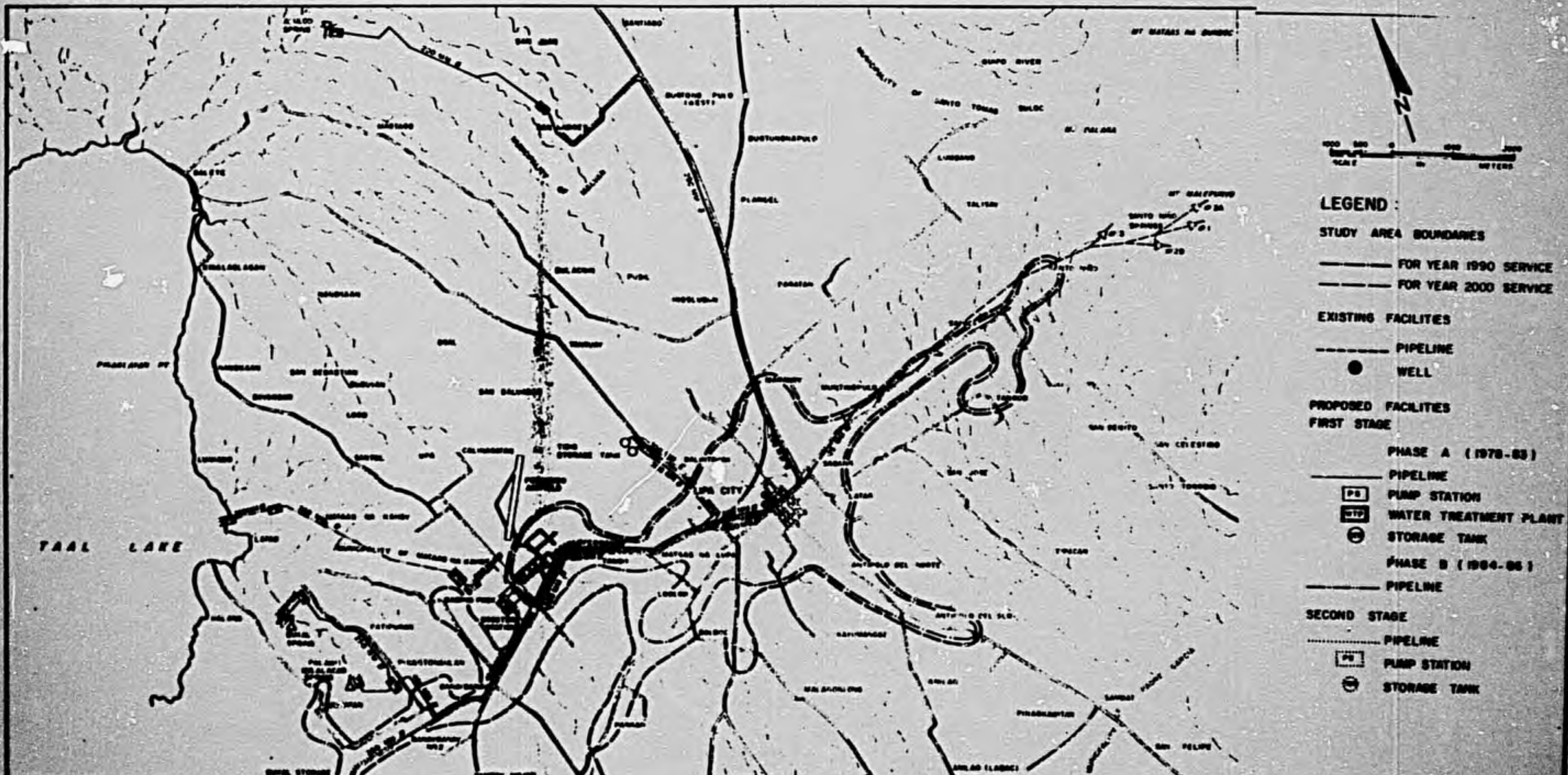
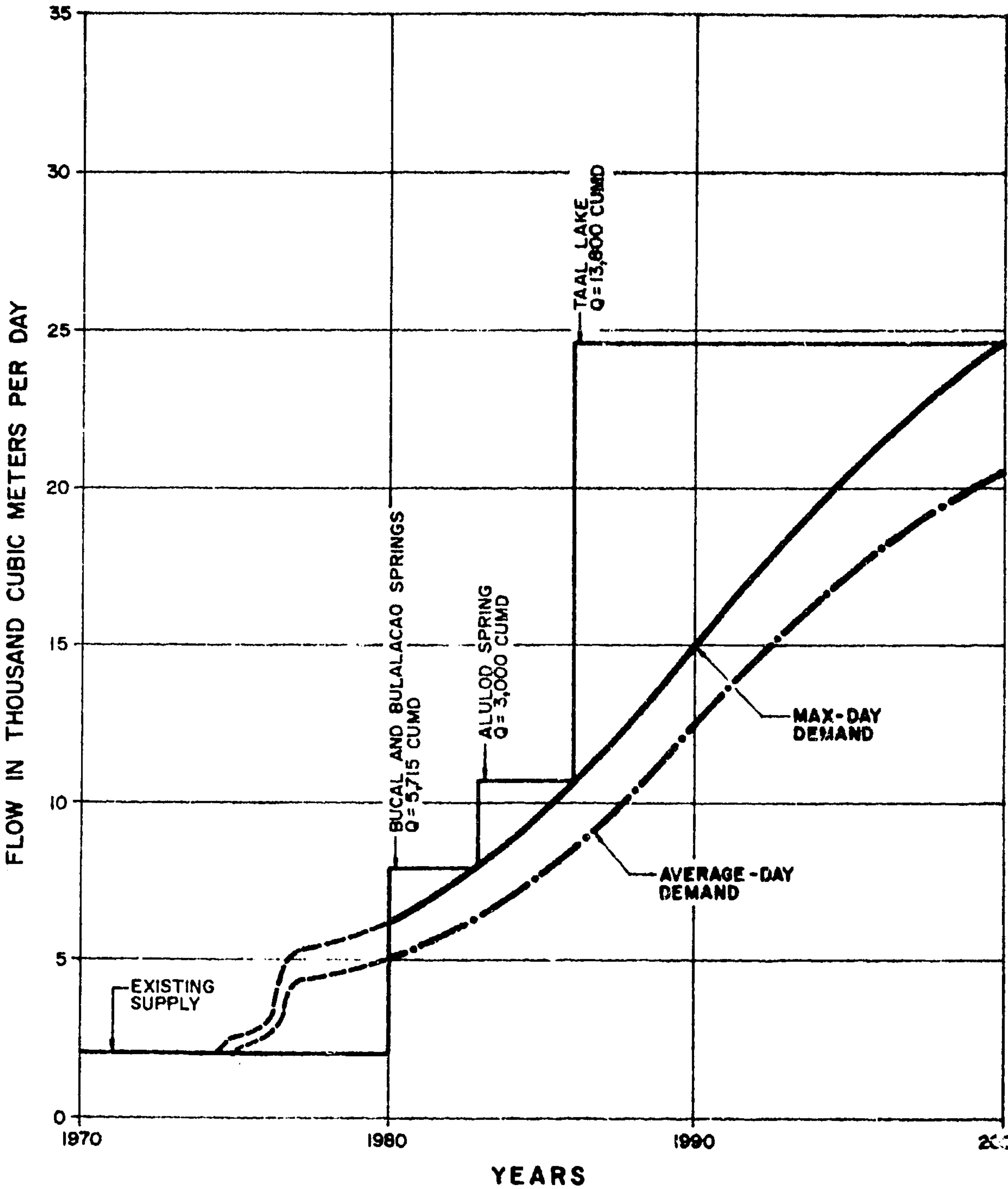


FIGURE VIII-2
ALTERNATIVE 2 LAYOUT



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS CDM-LWUA

FIGURE VIII-3
WATER SUPPLY-DEMAND CHART

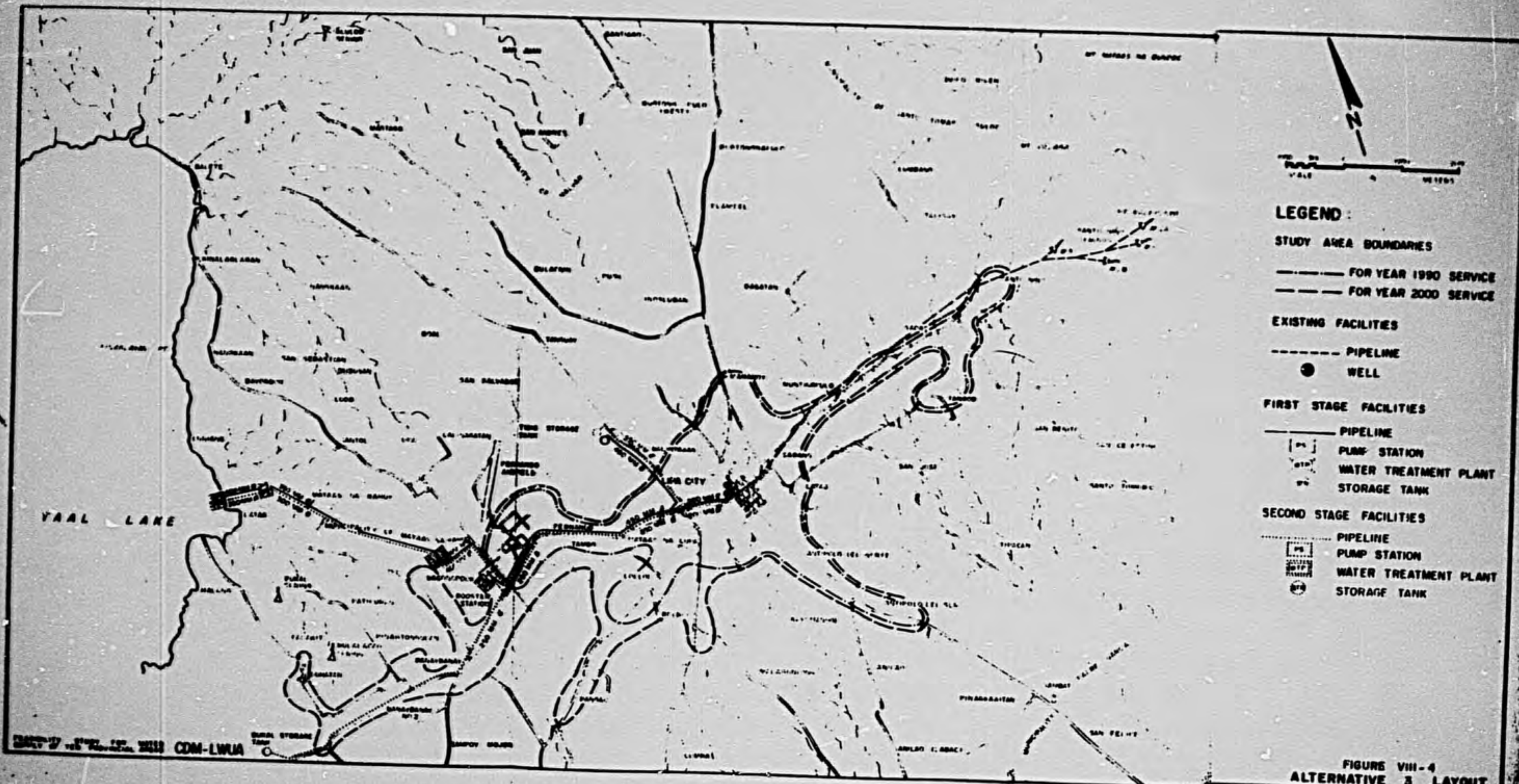


FIGURE VIII-4
ALTERNATIVE 3 LAYOUT

It is assumed that the engineering design of the initial works would start in 1977 and that the construction phase would be completed in 1980. Construction cost estimates of the proposed improvements are based on the projected July 1976 unit prices. All estimates on imported items are based on an exchange rate of seven pesos to one US dollar. It is assumed that no customs duty would be charged on items imported for this public water supply project.

Total project cost includes construction cost, engineering and contingencies, land cost and administrative and legal fees. The present worth of capital costs is calculated backward from the midpoint of construction period to 1976 at a discount rate of 12 per cent.

Annual costs include labor, power, chemical and maintenance costs, where applicable. These estimates are carried out for the period from 1980 to the year 2000. The present worth cost of annual expenditures is based on uniform and gradient series (where applicable) at a 12 per cent interest rate. The cost of any facility to be replaced during the design period (1977-2000) is included under the capital costs for that year.

During the period of the economic analysis, no escalation factor is applied to July 1976 unit prices as it is assumed that all the alternative schemes would be affected in approximately the same proportion.

Economic comparison of the alternative schemes is based on present worth of net disbursements during the period of 1977-2000. For comparative purposes, annual maintenance costs are estimated as a percentage of construction costs of the facilities; for structures and pipelines, 0.5 per cent; and for equipment, such as pumps and motors, two per cent of the estimated construction cost is used.

Personnel and maintenance costs may increase abruptly as additional facilities are put into operation. The power cost at a pump station and chemical costs at a treatment plant will increase gradually in direct proportion to the daily pumpage of water.

The salvage values of facilities at the end of the design period are important in calculating net present worth of the total expenditures. It is assumed that a facility depreciates linearly throughout its service life[3]. Therefore, a facility with longer

---

[3] Service life of facilities:

a) Structures and pipelines : 50 years
b) Mechanical equipment : 25 years
c) Land : infinite

service life will depreciate less than a facility with shorter service life during the same study period. Also, a facility constructed at a later stage will have a higher salvage value than a similar one constructed at an earlier date.

The difference between the total present worth of capital cost and annual expenditures and the present worth of salvage values, yields the net present worth cost of the alternative scheme.

Present Worth Cost Comparison. The net present worth costs of the source, transmission and treatment facilities for the three alternatives are shown in Table VIII-2, with construction periods, capital and annual costs and salvage values in the year 2000. As can be seen in this table, the total net present worth cost of Alternative 1 is ₱27.37 million less than Alternative 2 and ₱29.65 million less than Alternative 3. The estimated net present worth unit cost of water produced (excluding distribution system piping costs) in each alternative is also computed and the results are as follows:

Alternative	Net Present Worth Cost (₱ x 1000)	Net Present Worth Water Production (cum x 1000)	Net Present Worth Unit Cost per cum (₱)
1	10,679	14,536	0.73
2	38,049	14,536	2.62
3	40,330	14,536	2.78

Conclusions

Alternative 1, on the basis of economic present worth analysis, is the preferred and recommended alternative. Its economic advantages are as follows:

a. least in initial capital requirements.

b. least in annual operating and maintenance costs.

c. least in foreign exchange requirements.

d. least in power (or energy) requirements.

Alternatives 2 and 3 depend heavily upon Taal Lake as a future source of water supply. The uncertainty about what might happen to the solids content or salinity of Taal Lake water in the future is a real problem. At this time, it is not possible to postulate or even guess the future salinity content without a comprehensive study

TABLE VIII-2

COST COMPARISON OF ALTERNATIVES

Alternative	Stage	Construction Cost (P x 1000)	Project Cost (P x 1000)			Annual Cost (P x 1000)			Salvage Value in Year 2000 (P x 1000)	Total Present Worth of Net Disbursements (P x 1000)
			Local	FEC	Total	1980	1990	2000		
1 Deep Wells	1	11,283	8,201	6,651	14,852	260	909	909	7,431	8,225
	2	7,249	5,578	3,946	9,524	-	-	215	6,176	2,454
	Total	18,532	13,779	10,597	24,376	260	909	1,124	13,607	10,679
2 Springs and Taal Lake	1	54,487	38,447	33,002	71,449	402	1,724	1,724	33,759	34,921
	2	3,099	1,932	2,121	4,053	-	-	791	2,436	3,128
	Total	57,586	40,379	35,123	75,502	402	1,724	2,515	36,195	38,049
3 Taal Lake	1	32,460	24,850	17,870	42,720	962	1,646	1,817	16,700	33,748
	2	16,600	10,540	11,120	21,660	-	171	771	12,800	6,582
	Total	49,060	35,390	28,990	64,380	962	1,817	2,588	29,500	40,330

of Taal Lake and its volcano. If the solids content increases in time, brackish water treatment may be required. This would cause the unit cost of water to increase up to about P5.20/cum or more, excluding distribution system costs.

On the other hand, Alternative 1 depends primarily on the groundwater potential of the study area. Its economic advantages are obvious from the above analyses. Therefore, it is mandatory that production wells be carefully monitored on a continuous basis and adequate funds be incorporated in the LCWD operation and maintenance budget for such purpose (refer to Chapter VII).

Water Treatment Alternatives

Water quality test results of the various sources, which are available in the study area, are shown in Table VII-1.

Water from the springs and deep wells, if designed and constructed with proper safeguards, would not require any treatment. However, in order to preserve the good quality of water throughout the distribution system, disinfection of water would be necessary at these sources. Disinfection may be accomplished with various methods which are discussed in Appendix VIII-C, Volume II. For economic and practical reasons (ready availability of the equipment, easy supply and application and long lasting effectiveness), chlorination is the recommended process for disinfection.

Water from Taal Lake would require a complete treatment before delivery to the consumers. Complete treatment would include the following processes: coagulation with chemicals; flocculation; sedimentation; filtration; taste and odor control; and disinfection. Alternatives related to these processes are discussed in Appendix A, Volume II.

As stated previously, if the lake water salinity deteriorates further in the future, the water may become brackish to a degree that it can no longer be acceptable for municipal (potable) use. At that time brackish water conversion with one of the current methods (presently, electrodialysis, reverse osmosis or ion exchange) would be necessary.

D. DISTRIBUTION ALTERNATIVES

General

A general description of the components of the distribution system and the alternatives pertinent to each component is presented in Appendix VIII-D. A more specific discussion is presented in this section concerning pressure zone alternatives, distribution mains, storage facilities, system operation, and the internal network system, in relation to the recommended sources, transmission and treatment alternative, Alternative S-T-1.

The design of the components of the distribution system is based on various flow conditions - peak-hour flow, maximum daily flow, and fire flows - or pressure requirements for the flow conditions. The peak-hour and maximum daily flows for the LCWD are listed in Table VI-8.

Pressure Zone Designation

The variation in ground elevation within the future service area of the LCWD is considerable. The lowest elevation is 240 m in Barrio Antipolo south of Lipa City and the highest elevation is 365 m in Barrio Pinagtongulan west of Lipa City. It is not practical to serve an area with such a wide range in ground elevation from one pressure zone. Static water pressure which would be suitable for concessionaires at a ground elevation of 365 m would be excessive for concessionaires at a ground elevation of 240 meters. Also, as the LCWD service area expands, the range of ground elevation increases, making it more difficult to provide service from one pressure zone.

In order to establish the selection of pressure zones for future service the following factors were considered:

Maximum Static Water Pressure. In order to protect the water fixtures in the homes of concessionaires, a static water level of no more than 70 m is permitted.

Growth of the System. The designation of pressure zones should conform to the growth of the water district.

Well Spacing. The well spacing should be selected to minimize drawdown and provide adequate service area coverage.

Storage Tank Location. Each pressure zone must have sufficient distribution storage in order to satisfy peak-hour supply requirements. The highest ground elevation for each pressure zone should permit selection of a suitable site for location of storage. Storage located at ground level is preferable to elevated storage, for practical and economical reason.

Total Demand. If possible the location of water sources within pressure zones should permit each pressure zone to be served without water transfer from other pressure zones to eliminate energy waste.

Total Number of Pressure Zones. In order to simplify system operation and maintenance, it is desirable to minimize the total number of pressure zones.

To aid in the determination of the pressure zones, the future water demands were allocated throughout the water district to ground elevation intervals of 20 meters. The projected average daily demands are listed below:

	1990		2000	
Ground Elevation (m)	Projected Demand (cumd)	Percentage of Total	Projected Demand (cumd)	Percentage of Total
240–260	250	2	400	2
260–280	300	2.5	500	2.4
280–300	2,290	18	2,800	14
300–320	4,490	36	6,650	32
320–340[4/]	3,370	27	5,270	26
340–360	0	0	1,550	7.6
360	1,800	14.5	3,280	16
	12,500	100	20,450	100.0

From the figures listed above, it can be seen that 54 per cent of the 1990 demand and 46 per cent of the year 2000 demand are projected to be in the interval of 280 to 320 meters. The present storage facility in the LCWD has an overflow elevation of 340 m and can serve up to a ground elevation of 320 meters. Thus, a convenient pressure zone based on the area of highest demand and the present storage tank would be between ground elevations 280 m and 320 m with an HGL at 340 meters.

[4/] Includes a small area at 345 meters.

The area above ground elevation 320 m can be served by one pressure zone with an HGL of 385 m; or by a combination of two pressure zones, one with an HGL of 365 m, to serve areas from 320 to 345 m, and another with an HGL of 385 m, to serve areas above 345 meters. The single pressure zone would not be economical because, as shown in the previous table, 65 per cent of the 1990 demand and 52 per cent of the year 2000 demand in this area would have to be pumped 20 m higher than necessary. Therefore, those areas higher than 320 m should be served by two pressure zones.

The remaining areas to be considered are those at ground elevations less than 280 meters. The service area of the first pressure zone can be extended to the ground elevation 270 m, without exceeding the allowable maximum pressure. The total estimated demand in the area between elevation 240 m and 270 m is approximately 400 cumd in 1990 and 650 cumd in year 2000, which are relatively very small. Therefore, this area is recommended to be served from the first pressure zone through a pressure-reducing valve to eliminate excessive static pressures.

In summary three pressure zones are recommended. The ground elevations, HGLs and projected demand requirements are listed in Table VIII-3. The pressure zones are shown in Figure VIII-5. Also shown in this figure are the locations of future distribution storage sites and deep wells. The recommended pressure zones permit the location of one ground storage tank in each zone. Also, adequate spacing of deep wells can be maintained. The groundwater supply for each pressure zone can be developed within the distribution system of the pressure zone, minimizing transmission piping and HGL fluctuation.

TABLE VIII-3

RECOMMENDED PRESSURE ZONES

Pressure Zone Number	Ground Elevations (m)	Approximate HGL (m)	Projected Average Daily Demand (cumd) 1990	2000
1	240-320[5/]	340	7,330	10,350
2	320-345	365	3,370	5,270
3	340-365	385	1,800	4,830
			12,500	20,450

[5/] Ground elevation below 270 m must be served through a pressure-reducing valve.

Distribution Mains

As discussed in Appendix VIII-D, the minimum size for distribution mains is generally 200 mm and, under some circumstances, 150 millimeters. Since these are minimum acceptable sizes, it is not recommended that these sizes be staged. Except in densely populated areas of the core city, distribution mains have been staged by recommending the installation of two parallel mains with an equivalent capacity that would satisfy the year 2000 design requirements.

The location of the future distribution mains has been planned along existing or proposed street rights-of-way. Distribution main spacing has been maintained at approximately 1,000 m intervals. To avoid dead-ends in the system, the distribution main network has been looped as much as possible.

Storage Facilities

For the LCWD, distribution storage volume of about 15 per cent of maximum daily demand would be required to meet the excess water demands during peak-hour periods. However, for those distribution systems which obtain the major portion of the water supply from deep wells, as in this case, the percentage can be reduced. The reasons for this are: first, in the proposed system there are stand-by wells which can be used to supplement supply during peak-hour periods; and second, the required pumping heads would decrease at peak-hour thereby increasing the supply from an individual well. Therefore, the required storage volume was reduced from 15 per cent of the maximum daily demand to 12 per cent for the LCWD system. Based on this, the required storage for each pressure zone is listed below for design years 1990 and 2000.

Pressure Zone		Required Volume (cum)	
		1990	2000
1		1,000	1,500
2		500	800
3		300	700
	Total	1,800	3,000

For Pressure Zone 1 the required overflow level of the storage tank would be elevation 340 meters. The existing storage facility in Lipa City has an overflow level of 340 m and can therefore be

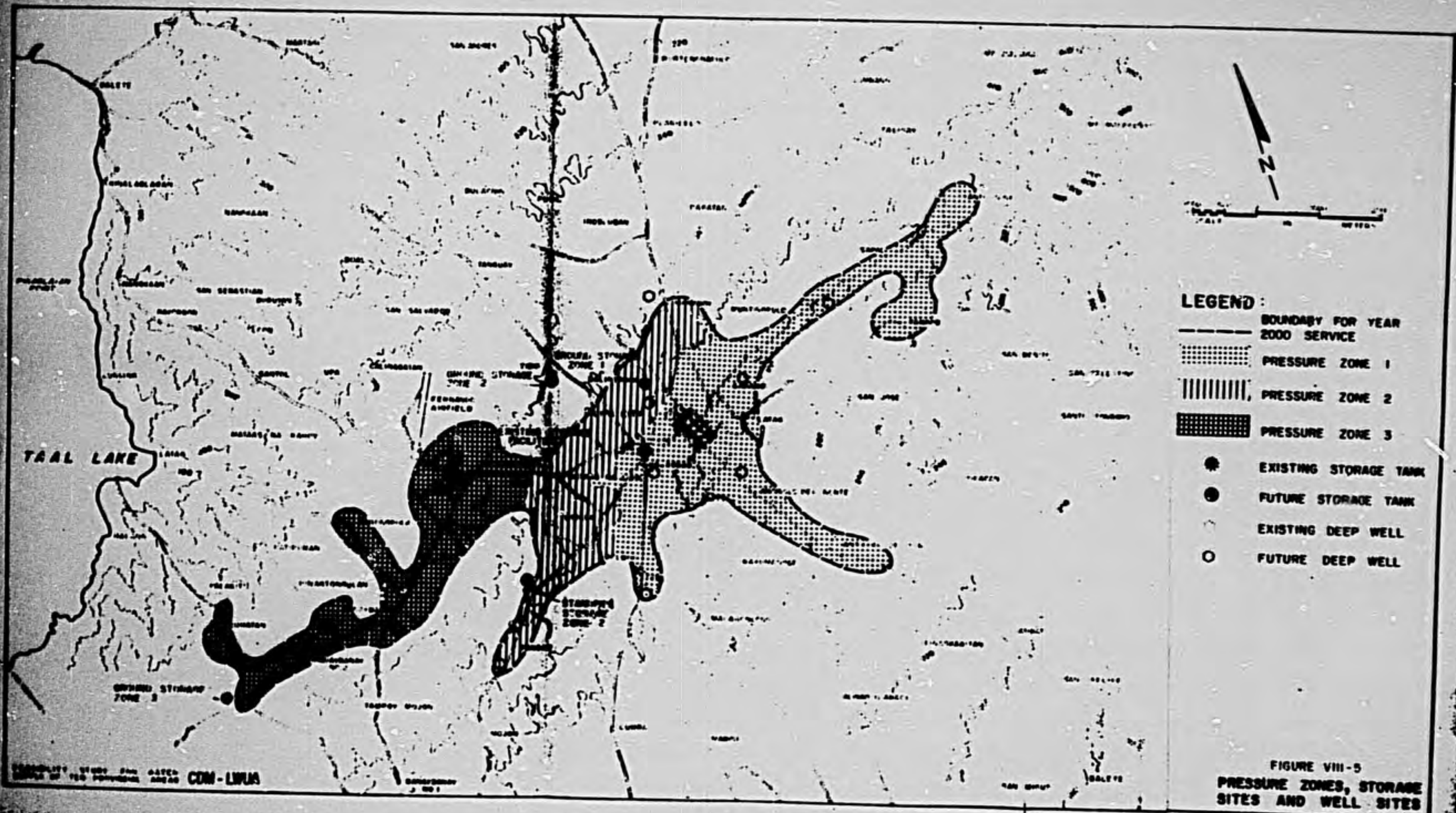


FIGURE VIII-5
PRESSURE ZONES, STORAGE SITES AND WELL SITES

incorporated into the first-phase system. By 1984, a new storage facility for Pressure Zone 1 would be constructed just north of the proposed diversion road in Barrio Balintawak approximately one kilometer from the core city area. This facility would be located at a ground elevation of about 355 m and would have a five-meter operational range. When this tank is completed, the present storage facility can be abandoned or used only for emergency storage.

The storage locations for Pressure Zone 2 are in Barrio Tibig and Barrio Lodlod. The Tibig storage facility would be a ground storage tank located at approximately 360 meters. The tank would have a five-meter operational level and an overflow level at 365 meters. The Lodlod tank would be a standpipe located at a ground elevation of 340 meters. The overflow level would be at 365 m and an operational range of five meters would be used for computation of useful storage volume. The lower 20 m of storage would be considered dead storage, although this portion can be utilized during emergencies. Computer analysis of peak-hour flow requirements shows that no more than 25 per cent of the Pressure Zone 2 storage should be located at Barrio Lodlod.

The HGL in Pressure Zone 3 would be at 385 meters. The existing elevated tank at the Fernando Air Base, having a 380 cum capacity, can be renovated and used in the long-term recommended plan. In 1990 all of the demand in Pressure Zone 3 is at the airfield, and the storage requirement can be satisfied by the existing facility. By year 2000, additional storage in Pressure Zone 3 would be required as the service area expands. The storage can be located in Barrio Pinagtongulan at a ground elevation of 380 meters. The overflow level would be at 385 m and a five-meter operational range should be provided.

In summary, four new storage sites would be required for the three pressure zones. The recommended staging and volume for each site are listed in Table VIII-4. The future storage sites are shown in Figure VIII-5.

System Operation

Distribution systems, with deep wells as the principal source of water, present special operating and maintenance requirements to the LCWD. The total water pumped at any instant during the day should be equal to the total system demand, except during peak demand periods when additional supply is provided from storage facilities. When demands are highest all, or nearly all, deep wells would be pumping; and when demands are lowest, only those wells required for

TABLE VIII-4

RECOMMENDED STORAGE STAGING AND VOLUME

Pressure Zone/Location	Construction Period	Storage Volume (cum)	Overflow Level (m)
1. Barrio Balintawak	1982-84 1990-92	1,000 500	340
2. Barrio Tibig	1982-84 1994-96	400 200	365
3. Barrio Lodlod	1990-92	200[6/]	365
4. Barrio Pinagtongulan	1994-96	500	385

minimum demand would be operating. Matching system output with system demand would minimize pressure fluctuation in the distribution system and would minimize energy requirements and corresponding operating costs. In order to accomplish this mode of system operation, certain control features are required at the pump station and storage facilities in each pressure zone.

The best parameter for controlling system operation is the system pressure. During periods of peak demand the system pressure will be lowest and during periods of minimum demand system pressure will be highest. A pressure regulated shut-off switch can be installed on the discharge line of each pumping unit. By observing system pressures during several days of operation, it is possible to select the system pressure at which each pumping unit should be shut-off. The switch can be adjusted to the selected shut-off pressure. (It is likely that each pumping unit would have a different shut-off pressure.) When pump discharge pressure approaches the selected pressure the switch will automatically shut-off the pump. The pump operator can restart the pump after system pressure drops to a predetermined level. Each pumping unit should also be provided with a swing check valve on the discharge line to prevent water from being forced into the well when the pump is not operating.

6/ This facility will be a standpipe having a total volume of 1,000 cum - 200 cum operational volume plus 800 cum of dead-storage volume.

The distribution storage facilities must be controlled in such a manner that the storage tank supplies water to the distribution system during peak-hour periods and fills up during low demand periods. Also, once the tank is filled a valve should close to prevent water from overflowing to waste. Proper control at the storage facility can be achieved by the installation of a double-acting altitude valve. Such a valve permits two-way flow. It is installed on the supply line to the storage tank. The valve closes to prevent overflow when the tank is full and opens to return water to the distribution system when pressures drop below the full tank head. A double-acting altitude valve with a delayed opening feature can be obtained to prevent flow from the storage tank until the system pressure drops below a certain level.

An alternative to a double-acting altitude valve is manual regulation of a valve on the supply line to the storage tank. Three shifts of valve operators would be required to man the valve on a 24-hour basis. The valve would be opened in early morning to supply peak-hour water demands and closed at night after the tank fills. At other times during the day the valve would be opened or closed depending upon the daily fluctuation of water demands and occasional emergency situations such as fires, line breaks, or pump failures.

In Pressure Zone 1, a pressure-reducing valve should be installed on the line to Barrio Antipolo. This barrio is located at ground elevations which would experience excessive pressures if the static HGL in Pressure Zone 1 would not be reduced. The valve should be installed at a ground elevation of 270 m and adjusted to reduce water pressure to 20 meters. Thus all water passing through the valve would be at a constant HGL of 290 meters.

All of the control features described above would require special maintenance to insure proper operation. A system of preventive maintenance should be instituted to accomplish this.

Internal Network

The existing internal network of the LCWD would require reinforcement in order to provide adequate service to concessionaires within the poblacion. The reinforcement would consist of replacing all pipe less than 100 mm in diameter, replacing 100 mm pipe whose carrying capacity has been reduced due to corrosion, installing new valves and fire hydrants, looping dead-end mains, and serving streets previously unserved. To determine the cost of reinforcing the existing internal network system, the internal network system within the poblacion was studied in detail. The construction cost for reinforcing the existing system is listed in Item A of Table VIII-5.

The design of the internal network extension to new service areas is discussed in Appendix VIII-D. The minimum recommended pipe size in the internal network is 100 millimeters. For estimating the construction cost of internal network extension, a total length of 100 m of internal network pipe per hectare was assumed and a 4:1 ratio of 100 mm pipe to 150 mm pipe was used. The cost of extension to new service areas is listed in Item B of Table VIII-5.

The desired spacing and other details of fire hydrants are discussed in Appendix VIII-D. The construction cost for fire hydrants is listed in Item C of Table VIII-5.

TABLE VIII-5

CONSTRUCTION COST OF INTERNAL NETWORK COMPONENTS

Description of Area	Internal Network Component		Average Requirement per Hectare Served	Construction Cost (P/ha)	Foreign Exchange Component (P/ha)
A. Reinforcement of Existing System	Pipe:	100 mm	95 m/ha	7,600	3,135
		150 mm	3 m/ha	450	216
	Valves:	100 mm	.4/ha	560	308
		150 mm	.2/ha	380	228
			Total (Rounded)	9,000	3,900
B. Service Area	Pipe:	100 mm	80 m/ha	6,400	2,640
		150 mm	20 m/ha	3,000	1,440
	Valves:	100 mm	.4/ha	560	308
		150 mm	.1/ha	190	114
			Total (Rounded)	10,200	4,500
C. Fire Protection Service					
High-Value Area	150 mm hydrant		.57/ha	3,100	1,800
Residential Area	100 mm hydrant		.20/ha	770	450

Hand Pump Wells

The hand pump well as an alternative water source for urban area is discussed in Appendix VIII-D. In summary, the hand pump well is not preferable to a piped water system because of the less satisfactory service and marginal cost advantage. However, in rural areas not likely to be near the piped water system, the hand pump well is favored from an economic viewpoint.

E. OTHER ALTERNATIVES FOR WATER CONSERVATION AND AUGMENTATION

In areas where water is a scarce resource, there are several alternative measures 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 VIII-E is a discussion of these conservation and augmentation alternatives.

CHAPTER IX DESCRIPTION AND COST OF THE RECOMMENDED PLAN

A. GENERAL

The long-range water supply to the LCWD will require an extensive construction program including source development and treatment, transmission and distribution facilities. As a result of the alternative analyses presented in Chapter VIII, Alternative 1 has been selected as the recommended scheme for the source/transmission system. Accordingly, deep wells drilled into the local aquifer will supply water to the area until the maximum practical and economical safe yield from this source is utilized. Continuous monitoring of wells and springs is essential in evaluating precisely the groundwater potential of the LCWD area. In the future, it may be necessary to implement certain revisions to the recommended program, as more groundwater data become available relative to the wells and aquifer performance.

The field surveys conducted during the course of this study have shown that a major portion of the present supply in the LCWD is lost through leakage (36 per cent) and wastage at flat-rate connections (29 per cent). Unaccounted-for-water is estimated at about 79 per cent of the total production. Therefore, a leakage survey, pipeline repairs and metering program must be given high priority.

This chapter describes the early action works, and the first-stage and second-stage facilities of the long-term construction program. In addition, the capital and annual costs of the recommended program, concepts concerning sewerage and drainage, comments regarding the management of water resources; and a statement concerning the environmental impact of this project are included. (Appendices A, B, C and D, Volume II are discussions of the Design Criteria, Basis of Cost Estimates, Construction Materials and Methods, and Outline Specifications.)

The recommended plan will be implemented in six steps:

1. The early action works to be implemented as soon as possible;

2. Stage I Phase A of the long-term construction program (1978-82);

3. Stage I Phase B of the long-term construction program (1982-86);

4. Stage I Phase C of the long-term construction program (1986-90);

5. Stage II Phase A of the long-term construction program (1990-95);

6. Stage II Phase B of the long-term construction program (1995-2000).

B. EARLY ACTION GUIDELINES

While planning, design and construction works of the long-range program are in progress, certain steps may be taken to facilitate "early action" in the LCWD water supply system. These steps will decrease the amount of unaccounted-for-water, improve the water quality, increase system pressures and maximize the amount of water available from the present well sources, as well as raise additional revenues. These early action guidelines are as follows (see Table IX-1 for cost estimates):

I. Planning and Administration

1. Continue the publicity and promotional campaign concerning the water supply feasibility studies so that water district customers are kept fully aware of the impending improvements and prepare them for the anticipated water rate increases. Also, discuss in detail within the water district ideas relative to raising the implementation funds (both peso and foreign exchange components) required for the recommended program.

2. Strengthen the legal basis for development of new water sources, and prepare for the implementation and enforcement of policies involved.

3. Initiate a sewerage/drainage feasibility study after the planning of water supply facilities is completed.

4. Initiate improvements to the management, engineering and maintenance procedures of the water district in accordance with established LWUA guidelines, in anticipation of future requirements that may be imposed by lending agencies.

5. Purchase calculators, typewriters, addressograph and validating machines, and other office equipment/furniture.

II. Data Collection/Technical Planning

6. Acquire the land required for proposed water sources, storage tanks, buildings and rights-of-way for proposed transmission pipelines. Conduct detailed topographic surveys of all sites for existing and proposed facilities.

7. Initiate a continuous program to monitor daily water production. A monthly record of water accountability should be maintained to recognize improvements from the current level of 21 per cent accounted-for-water. Purchase and install master meters at all operating wells and on the present transmission pipeline from the spring sources.

8. Conduct a survey and compile an inventory of all physical facilities of the existing water supply and sewerage systems, and all connections to private premises. Private wells, septic tanks and drainage systems should be included.

9. With consultation, adopt a flexible and enforceable plumbing code in anticipation of the proposed water supply facility improvements and future sewerage/drainage schemes. The abandonment of thin-wall steel pipe used for service connections should be incorporated into this code. It is recommended that PVC pipe be used for service connections.

10. Acquire an adequate waterworks library for use by water district personnel.

III. Operational Improvements

11. Purchase two additional vehicles (one ½ or ¾ ton pick-up truck and one jeep-type, four-wheel drive vehicle) for use by water district personnel.

12. Acquire disinfection equipment and install it at all operating wells. Only a single unit will be installed at each well site, with two spare units to be retained in the water district for stand-by service. Two additional chlorinator units will be installed at the collection chamber of the present spring source of lowest elevation. High-pressure water from the nearby discharge pipeline of springs of higher elevation will be used to operate the chlorinator injectors.

13. Initiate a routine water sampling program within the existing distribution system. Purchase the equipment for and initiate a program of regularly analyzing water samples collected to detect the possible presence of harmful pollutants within the system. Areas of the system where residual chlorine is low or non-existent should be examined for possible sources of contamination.

14. Convert all existing service connections to metered connections. At present there are approximately 650 unmetered connections within the LCWD, as well as approximately 60 metered connections which were recently installed. Cost have been included for conversion of the unmetered connections and approximately 200 new connections (the meters required will be supplied through an existing LWUA program).

15. Purchase two sets of pipe drilling/tapping equipment for the installation of customer service connections on distribution pipes, and additional hand and shop tools for use by water district plumbers.

16. Recruit or train existing personnel to obtain qualified staff for the distribution system, service connection and transmission pipeline works, as well as the operation and maintenance of wells. LWUA or other qualified consultant's assistance will be required for this purpose.

17. Initiate a program of leakage surveys in order to minimize wastage within the system. Perform the necessary pipeline repairs and valve repairs/replacements discovered during the surveys. Identify actual and potential cross-connections between the water supply system and pollution sources, and carry out the necessary works to eliminate them.

18. Make repairs, alterations and operating improvements as indicated in the list of miscellaneous improvements (Appendix IX-B). These improvements will increase customer service and potentially increase the quantity of available water.

TABLE IX-1

COST ESTIMATES FOR EARLY ACTION WORKS

Item	Local Component (P)	Foreign Exchange Component (P)	Total (P)
1. Land	145,000	-	145,000
2. Disinfection Facilities	39,000	149,000	188,000
3. Service Connections	82,000	76,000	158,000
4. Leakage Survey and Repairs	23,000	139,000	162,000
5. Vehicles	40,000	60,000	100,000
6. Pipeline Equipment and Tools	13,000	25,000	38,000
7. Production Metering	2,000	19,000	21,000
8. Office Equipment	3,000	44,000	47,000
9. Basic Library	-	2,000	2,000
10. Chlorine Residual Analyzers	-	2,000	2,000
11. Miscellaneous System Improvements	35,000	85,000	120,000
Sub-total	382,000	601,000	983,000
Contingencies @ 15%	57,000	90,000	147,000
Sub-total	439,000	691,000	1,130,000
Training @ 5%	22,000	35,000	57,000
TOTAL	461,000	726,000	1,187,000

C. FIRST STAGE OF THE RECOMMENDED LONG-TERM CONSTRUCTION PROGRAM

The first stage of the long-term construction program includes source development, as well as treatment (disinfection), transmission and distribution facilities. This stage of construction will be carried out in three construction phases. The following is a brief description of the proposed facilities in these construction phases.

Construction Phase I-A (1978-82)

Source Development. The LCWD obtains its present water supply from six operating wells and from the Santo Niño Springs (see Chapter IV). Studies on the existing water district wells have shown that the typical well construction is generally poor and the resulting production capacity is relatively small, ranging from 2.6 to 5.8 lps. Four of the existing wells are more than 18 years old and the remaining two are about eight years old. Among them, only the Market well was tested during the field investigations. The tests show that the production capacity of the Market well can be doubled with the installation of a new pump set. Because of the minimum spacing requirement for wells (see Chapter VII) to prevent excessive drawdown of groundwater, the remaining five wells, which are 50 to 400 m apart, should be phased out as the proposed new wells are put into service. Therefore, from the existing sources, a total supply of 2,000 cumd (880 cumd from the Santo Niño Springs and 1,120 cumd from the Market well) is included in the long-term program.

For construction of the new wells in the LCWD, the following criteria have been established, based on the limited well data available and pump test results:

a. Well spacing	:	2 km for wells in each one of the separate aquifers.
b. Well depth	:	100 m, in the upper aquifer; 200 m, in the lower aquifer.
c. Size of casing	:	20 cm
d. Average yield from one well	:	1,300 cumd
e. Pumping water level	:	45 m in the upper aquifer; 135 m in the lower aquifer.

A typical recommended well section is shown in Appendix Figure VII-B-12, Volume II.

The future service area of the LCWD has been divided into three pressure zones, as described in Chapter VIII. During Phase I-A, three operational and one stand-by wells will be constructed in the first pressure zone; one operational and one stand-by wells in the second pressure zone; and two operational wells in the third pressure zone to supplement the supply to Fernando Air Base. Four of the wells will be 100 m deep and the other four will be 200 m deep. With these wells and existing sources, the LCWD will have adequate supply until 1985, as shown in Figure IX-1. Each one of the proposed wells will be equipped with an appropriate pump and drive assembly. The pump and drive should be selected after a complete well development and testing. As explained in Chapter VII, the two aquifers under consideration are, in general, independent from each other as far as piezometric head is concerned. Therefore, the upper aquifer should be sealed off in the 200 m deep wells to protect the piezometric head in the upper zone.

Power transmission lines will be extended from the existing NPC substation in Lipa City to the future deep well sites and a voltage transformer will be provided at each site.

A chlorination room will be constructed next to each of the deep well pump station.

Construction of an access road to some of the well sites will be necessary.

Approximate locations of the Phase I-A wells are shown in Figure IX-2, appended, and data on these wells are summarized in Table IX-2:

TABLE IX-2

PHASE I-A (1978-80) WELLS

Pressure Zone	Number of Wells: Operational	Number of Wells: Stand-by	Approximate Depth (m)	Pumping Water Level (m)
1	2	-	100	45
	1	1	200	135
2	1	-	100	45
	-	1	200	135
3	1	-	100	45
	1	-	200	135

Transmission/Distribution Pipelines. Water pumped from the proposed deep wells will be conveyed to the consumers through transmission and distribution pipelines. Pipe sizes have been determined by utilizing a computer program, which considered various conditions, such as: (a) peak hourly demand, and (b) minimum demand plus tank filling (see Chapter 12, Methodology Manual and Appendix A, Volume II). The computer print-outs of the final runs are presented in Appendix Tables IX-C-4 through IX-C-9. The phased construction of the distribution system in each pressure zone is based on intermediate analysis for 1990 peak-hour and storage filling conditions, as part of the year 2000 system.

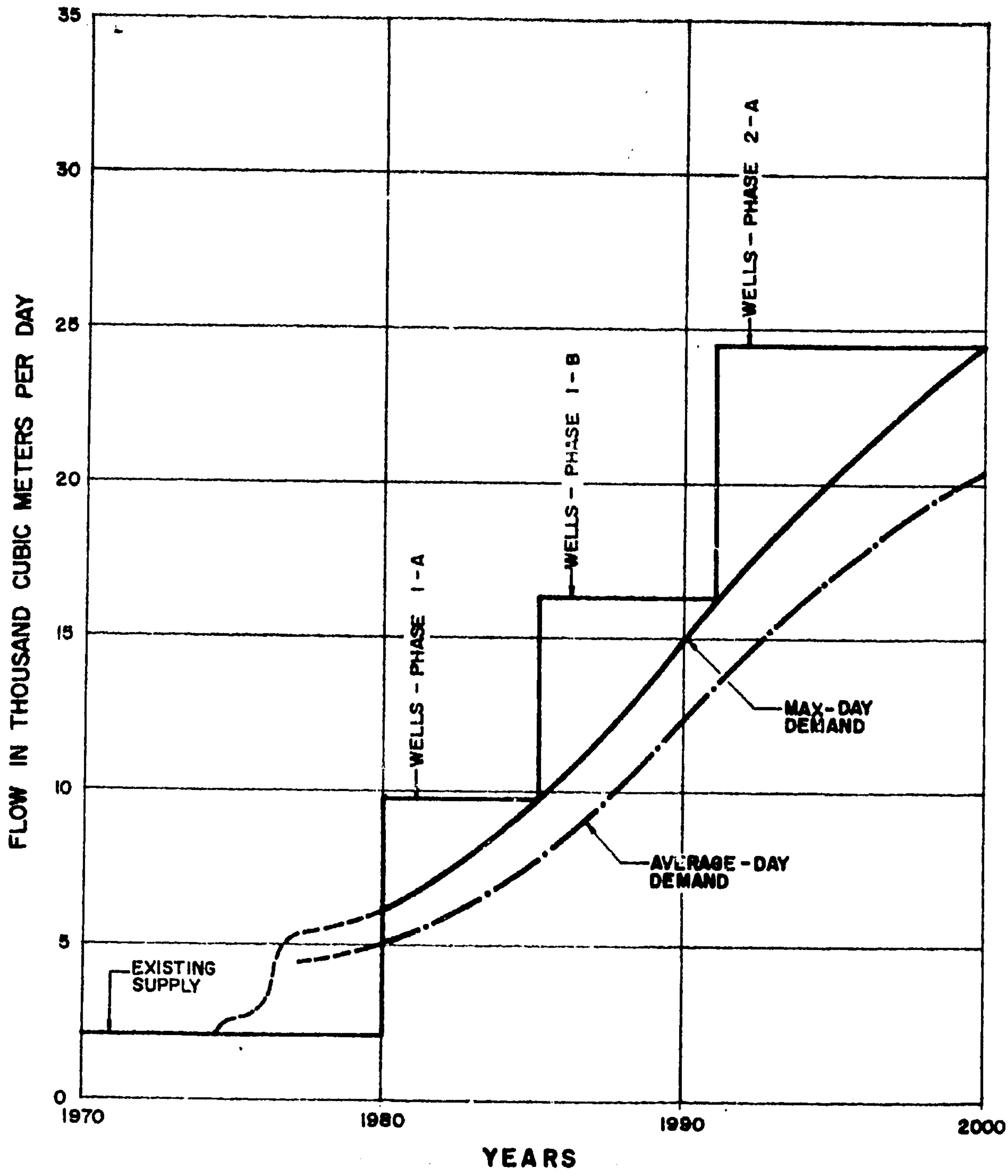
The transmission/distribution mains to be installed in Phase I-A will connect the new deep wells to the demand centers in the three pressure zones. A general layout of the proposed facilities is shown schematically in Figure IX-2, appended. The transmission/distribution mains are listed in Table IX-3 for each pressure zone. The pipe numbers listed in the table refer to those shown in Figure IX-3.

In Pressure Zone 1, the present service area, the distribution mains will be installed along the principal streets in the poblacion. In addition to improving service in the present service area, the water district will extend service to new areas southwest of the poblacion in Barrio Balagbag.

In Pressure Zone 2, a distribution main will be installed along the diversion road serving new concessionaires north of the poblacion. In Pressure Zone 3, a distribution main will be installed to connect the new deep wells to the Fernando Air Base.

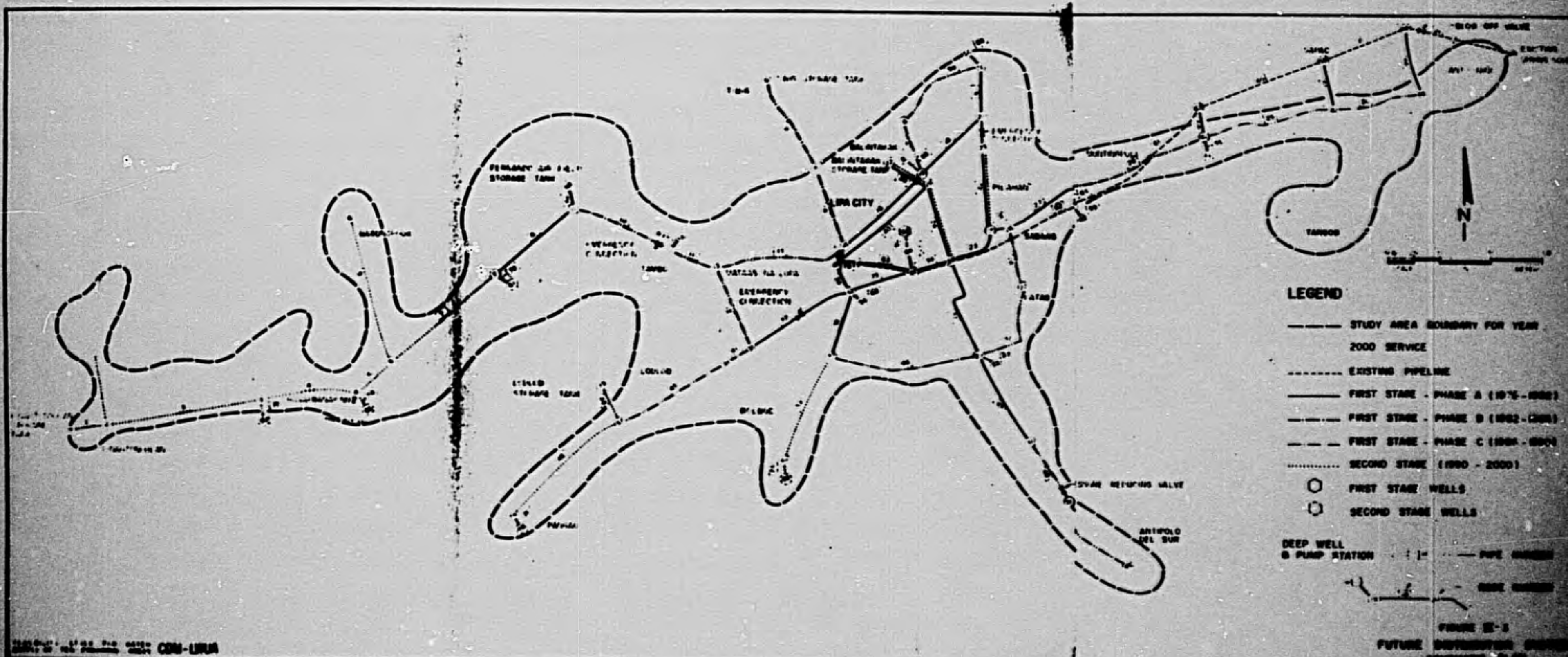
It is proposed that the water district install a master meter at the points where connections are made to the airfield distribution system. By utilizing the existing facilities at the airfield and having only two or three master meters to inspect, the water district can reduce its capital and operating cost of serving the airfield. This will make water supply service more economically attractive to both the airfield and the water district. The airfield benefits by having more reliable water service and by eliminating its operating and maintenance problems at its 15 deep wells. The water district benefits by serving a large-demand consumer and by being able to monitor more accurately groundwater extraction from the aquifers in the area.

The pipelines and valves to be installed in Phase I-A are summarized as follows:



FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS CDM-LWUA

FIGURE IX-1
WATER SUPPLY-DEMAND CHART


LIPA CITY
ANTIPOLO
DEL SUR
N
LEGEND
STUDY AREA BOUNDARY FOR YEAR
2000 SERVICE
EXISTING PIPELINE
FIRST STAGE - PHASE A
FIRST STAGE - PHASE B
FIRST STAGE - PHASE C
SECOND STAGE
FIRST STAGE WELLS
SECOND STAGE WELLS
DEEP WELL
& PUMP STATION
FUTURE
SCHEMATIC PLAN
CDM-LIPA

Pipe Size (mm)	Pipe Length (m)	Valve Size (mm)	Number of Valves
100	1,500	100	6
150	3,590	150	48
200	11,210		

The valve sizes are reduced one nominal size from the pipe diameter for all pipe sizes larger than 150 millimeters. One fire hydrant will be installed on the main in Barrio Balagbag for occasional main flushing.

Storage Tanks. In Phase I-A, the existing storage facilities in the poblacion and at the Fernando Air Base will be utilized. In order to use the existing storage facility in Lipa City it will be necessary to install a 200-mm, double-acting altitude valve (automatic control) on the supply line to the storage tank. The valve will close when the water in the storage tank reaches the overflow level and it will open when the system pressure is less than the full tank head. (Alternatively, the tank can be manned 24 hours a day, for manual valve operation.)

The elevated storage tank at the Fernando Air Base will be renovated in Phase I-A (assuming the water district supplies the airfield). Leakages will be sealed and the tank will be cleaned and restored to nearly new conditions. A 200-mm, double-acting altitude valve will also be installed on the supply line to the Fernando Air Base tank for automatic control of flow in and out the tank.

Internal Network and Service Connections. The schedule of improvements to the internal network system is described in Appendix IX-C. During Phase I-A the water district will reinforce the existing internal network system by replacing all pipe smaller than 100 mm in diameter, by looping dead-end lines, by installing new valves and fire hydrants and serving streets previously unserved. It is estimated that an 80-ha area within the poblacion will be reinforced in this manner.

Also during Phase I-A, a new internal network will be extended to a 40-ha area in the fringe of the existing service area. Such areas to receive new piping will be the Dolor and Lipa City Subdivisions east of the poblacion and the Carmel Subdivision south of the poblacion.

TABLE IX-3

STAGE I PHASE A CONSTRUCTION PROGRAM
FOR TRANSMISSION/DISTRIBUTION SYSTEM (1978-82)
LIPA CITY WATER DISTRICT

Description/Location	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m
PRESSURE ZONE I					
Along Manila-Batangas Road from Bonifacio St.	22	25	23	150	800
From Recto Ave. - Kalaw St. to Bonifacio St. - Manila Batangas Road	23	28	25	200	540
From Bonifacio St. - Manila - Batangas Road to Bonifacio - Tiaong Road	25	25	26	200	200
From Recto Ave. - Kalaw St. to Mabini Academy	24	24	28	200	800
From Recto Ave. to Carmelite Convent Along Lipa Rosario Road	33	28	29	200	1,100
From Batangas - Tanguay Road to Mabini Academy	34	46	24	200	1,150
From Balagbag Road to Lipa - Ibaan - Manila Batangas Road	35	32	47	200	660
Along Balagbag Road	36	32	46	200	300
Along Recto Ave. - From Lipa - Ibaan Road to Kalaw St.	54	47	28	200	400
Along Laygo St.	27	40	26	200	870
Along Lodlod - Pangao Road	37	35	32	150	1,140
Along Balagbag Road	38	32	33	150	650
Along Lipa - Rosario Road to Antipolo Norte	47	29	30	150	1,000
Along Manila - Batangas Road from Existing Reservoir to Recto St.	53	70	47	200	550
Near Bo. Muntingpulo	63	64	40	200	250
Proposed Well and Pump Station Line	68	54	32	200	200
Proposed Well and Pump Station Line	59	48	64	200	200
From Balagbag Road to Existing Reservoir	78	46	70	200	230

TABLE IX-3 (Continued)

Description/Location	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m)
Between Bo. Muntingpulo and Sapac	64	41	63	100	300
Near Bo. Sapac	65	59	42	100	500
Between Bo. Sapac and Santo Niño	66	60	43	100	700
PRESSURE ZONE 2					
Near Bo. Balintawak	16	16	19	200	1,040
From Mabini Academy to Manila - Batangas Road	18	21	19	200	800
Along Manila-Batangas Road	19	20	21	200	470
Proposed Well and Pump Station Line	58	50	20	200	250
PRESSURE ZONE 3					
Along Manila - Batangas Road to Fernando Air Base	8	7	11	200	1,000
Proposed Well and Pump Station Line	72	61	7	200	200

During Phase I-A only the distribution system within the poblacion will receive fire protection service. The fire protection service will be extended to 40 ha of high-value area and 90 ha of residential area. The internal network piping, valves and fire hydrants to be installed in Phase I-A are summarized below:

Item		Reinforcement of Existing System	Service Area Extension	Total
Pipe	: 100 mm	7,600 m	3,200 m	10,800 m
	150 mm	240 m	800 m	1,040 m
Valves	: 100 mm	32	16	48
	150 mm	16	4	20
Hydrants	: 100 mm	18		18
	150 mm	23		23

It is estimated that the water district will replace 200 of the existing service connection in Phase I-A. The connections to be replaced will be identified in the leakage survey, which is part of the Early Action Program. Also, the water district will install 2,050 new service connections.

Administrative and Functional Buildings. The LCWD presently occupies a small office space within the compound of the Lipa City Engineering Department. The existing office is not adequate for proper operation and management of the district. Therefore, it is recommended that a new office complex be constructed for the LCWD, during the Phase I-A. This office complex will include an administrative area and functional space for laboratory, meter shop, storage, garage and parking which are, in general, needed for efficient operation of a water district. Depending on the availability of the land area, which is scheduled for purchase during the Early Action Program, all of these spaces can be ideally located at one site.

Cost Summary - Phase I-A. The cost summary for constructing Phase I-A is presented in Table IX-4. Based on 1976 price levels, the total project cost of this phase is P14.04 million with a foreign exchange component (FEC) of P6.70 million which includes direct and indirect import items. Table IX-4 shows also a cost breakdown based on material-equipment procurement and civil-structural work. Materials and equipment considered in this breakdown are pipes, valves, water meters, hydrants, pumps, motors and chlorinators.

TABLE IX-4

COST SUMMARY OF CONSTRUCTION
STAGE I - PHASE A (1978-82)

Item	Construction Period	Cost in Thousand Pesos		
		Local	FEC	Total
Source Development	1978-80			
Material and Equipment		208	1,039	1,247
Civil and Structural		1,850	616	2,466
Construction Cost		2,058	1,655	3,713
Transmission - Distribution Mains and Valves	1978-82			
Material and Equipment		382	1,549	1,931
Civil and Structural		1,088	-	1,088
Construction Cost		1,470	1,549	3,019
Storage Tanks and Appurtenances	1978-80			
Material and Equipment		3	50	53
Civil and Structural		61	10	71
Construction Cost		64	60	124
Internal Network	1978-82			
Material and Equipment		119	605	724
Civil and Structural		599	-	599
Construction Cost		718	605	1,323
Service Connections	1978-82			
Material and Equipment		45	868	913
Civil and Structural		602	-	602
Construction Cost		647	868	1,515
Water District Buildings	1978-80	-	-	-
Material and Equipment				
Civil and Structural		685	395	1,080
Construction Cost		685	395	1,080

TABLE IX-4 (Continued)

Item	Construction Period	Cost in Thousand Pesos Local	FEC	Total
TOTAL CONSTRUCTION COST				
Material and Equipment		757	4,111	4,868
Civil and Structural		4,885	1,021	5,906
Total		5,642	5,132	10,774
Contingencies (15%)		848	768	1,616
Sub-total		6,490	5,900	12,390
Engineering (10%)[1]		440	800	1,240
Sub-total		6,930	6,700	13,630
Land Costs[2]		-	-	-
Administrative and Legal Fees (3%)		410		410
TOTAL PROJECT COST		7,340	6,700	14,040

[1] Broken down into 65 per cent in FEC and 35 per cent in Local Costs

[2] Included in the Early Action Program

Construction Phase I-B (1982-86)

Source Development. Five operational wells will be constructed during Phase I-B. Well characteristics would, in general, be based on the criteria stated under Phase I-A. Three of the five operational wells will be constructed in the first pressure zone and the other two in the second pressure zone. Three of the wells will be 100 m deep and the remaining two will be 200 m deep. Facilities for electric power supply, and chlorination will be provided for each well site. Access roads to the sites will be constructed wherever necessary.

Approximate locations of the Phase I-B wells are shown in Figure IX-2, appended, and data on these wells are summarized in Table IX-5.

TABLE IX-5

PHASE I-B (1983-85) WELLS

Pressure Zone	Number of Wells: Operational	Number of Wells: Stand-by	Approximate Depth (m)	Pumping Water Level (m)
1	2	-	100	45
	1	-	200	135
2	1	-	100	45
	1	-	200	135
3	-	-	-	-

Transmission/Distribution Mains. Though distribution mains will be installed in each pressure zone, the major effort under this phase will be to increase the service area in Pressure Zone 2. Distribution mains will be installed in Barrios Tibig, Balintawak, Mataas na Lupa and Tambo. The distribution main program is listed in Table IX-6 and the pipes and valves are summarized below:

Pipe Size (mm)	Pipe Length (m)	Valve Size (mm)	Number of Valves
150	1,770	150	18
200	4,950	200	4
250	1,800		

TABLE IX-6

STAGE I PHASE B CONSTRUCTION PROGRAM FOR TRANSMISSION/DISTRIBUTION SYSTEM (1982-86)

Description/Location	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m)
PRESSURE ZONE 1					
Located in Bo. Muntingpulo	28	40	41	200	1,450
Proposed Storage Tank Line in Bo. Balintawak	20	24	22	200	500
PRESSURE ZONE 2					
Along Manila - Batangas Rd near Bo. Mataas na Lupa	13	16	13	200	1,300
Along Road to Bo. Tibig	14	15	16	250	800
Along Bo. Tibig Rd to Proposed Tibig Storage Tank	9	10	15	250	1,000
Along Manila - Batangas Rd near Bo. Tambo	11	12	13	200	500
Along Mataas na Lupa - Lodlod Road	12	13	35	150	870
Along Lodlod Road	41	35	36	150	300
Along Balintawak - Marauoy Road	17	18	19	150	600
Proposed Well and Pump Station Line in Bo. Tambo	69	56	12	200	200
PRESSURE ZONE 3					
Along Manila - Batangas Rd to Fernando Air Base	10	12	11	200	1,000

During this phase, all pressure zones will be interconnected for transferring water from one zone to another during emergency periods. Under normal operating conditions no water will be transferred between pressure zones as the valve at the interconnection will be closed.

Storage Tanks. In Phase I-B, storage tanks will be constructed for both Pressure Zones 1 and 2. In Pressure Zone 1, a 1,000-cum storage tank will be constructed in Barrio Balintawak between ground elevations 335 and 340 meters. The tank will have a five-meter operational range with the overflow elevation at 340 meters. A 200-mm altitude valve assembly should be installed (or the tank should be manned for 24 hours a day) to control the inflow and outflow of the storage tank. It is recommended that the existing storage facility be taken out of routine operation and kept as emergency storage. The altitude valve installed at the existing tank in Phase I-A can be transferred to the Balintawak storage tank.

The storage tank for Pressure Zone 2 will be constructed in Barrio Tibig. The tank should be located between ground elevations 360 to 365 m and have a volume of 400 cum. The tank will have a five-meter operational range and a 365 m overflow elevation. A 250-mm altitude valve will be installed on the supply line to the storage tank.

Internal Network and Service Connections. The water district will replace the internal network in a 40-ha area within the present service area outside the poblacion. The area will be east of the poblacion in Barrios Sabang and Muntingpulo.

New internal network will be installed in 70 ha of area in the fringe of the poblacion and in the new areas receiving service in Pressure Zone 2. Some 30 ha of high-value area and 100 ha of residential area will receive fire protection service. The internal network pipes and valves and fire hydrants to be installed in Phase I-B are summarized below:

Item			Reinforcement of Existing System	Service Area Extension	Total
Pipe	:	100 mm	3,200 m	5,600 m	8,800 m
		150 mm	800 m	1,400 m	2,200 m
Valves	:	100 mm	16	28	44
		150 mm	4	7	11
Hydrants	:	100 mm	8	12	20
		150 mm	8	17	17

The water district will replace 200 of the existing service connections and install 2,700 new service connections during Phase I-B.

Cost Summary - Phase I-B. A cost summary for constructing Phase I-B is presented in Table IX-7. Based on 1976 price levels, the total project cost of this phase is P10.97 million, with a foreign exchange component of P5.21 million. A breakdown of the construction costs, for certain material and equipment to be procured and civil-structural work, is also given in Table IX-7.

TABLE IX-7

COST SUMMARY OF CONSTRUCTION STAGE I PHASE B (1982-86)

Item	Construction Period	Cost in Thousand Pesos		
		Local	FEC	Total
Source Development	1983-85			
Material and Equipment		131	656	787
Civil and Structural		1,128	396	1,524
Construction Cost		1,259	1,052	2,311
Transmission/Distribution Mains and Valves	1982-86			
Material and Equipment		256	997	1,253
Civil and Structural		642	-	642
Construction Cost		898	997	1,895
Storage Tank and Appurtenances	1983-85			
Material and Equipment		37	126	163
Civil and Structural		651	90	741
Construction Cost		688	216	904
Internal Network	1982-86			
Material and Equipment		125	594	719
Civil and Structural		573	-	573
Construction Cost		698	594	1,292
Service Connections	1982-86			
Material and Equipment		58	1,128	1,186
Civil and Structural		777	-	777
Construction Cost		835	1,128	1,963
TOTAL CONSTRUCTION COST				
Material and Equipment		607	3,501	4,108
Civil and Structural		3,771	486	4,257
Total		4,378	3,987	8,365
Contingencies (15%)		657	598	1,255
Sub-total		5,035	4,585	9,620
Engineering (10%)[3/]		337	625	962

[3/] Tentatively broken down as 65 per cent FEC and 35 per cent local; FEC may be reduced as more engineering design is performed locally.

TABLE IX-7 (Continued)

Item	Construction Period	Cost in Thousand Pesos		
		Local	FEC	Total
Sub-total		5,372	5,210	10,582
Land Costs		70	-	70
Sub-total		5,442	5,210	10,652
Administrative and Legal Fees (3%)		320	-	320
TOTAL PROJECT COST		5,762	5,210	10,972

Construction Phase I-C (1986-1990)

Source Development. No new well construction will be required during this phase.

Transmission/Distribution Mains. The water mains to be installed in Phase I-C will improve service in Barrios Sapac, Santo Niño, Tangob, Antipolo del Sur and will extend service to Barrios Latag and Lodlod. The proposed mains are listed in Table IX-8. A summary of the pipes and valves to be installed in Phase I-C is listed below:

Pipe Size (mm)	Pipe Length (m)	Valve Size (mm)	Number of Valves
100	900	100	2
150	8,250	150	20
200	500		

Two fire hydrants will be installed on dead-ends of distribution mains for occasional main flushing. A pressure-reducing valve will be installed in the distribution main extending to Antipolo del Sur. The valve should be placed at a ground elevation of 270 m and should control the HGL in Barrio Antipolo del Sur at a maximum of 290 meters.

Internal Network and Service Connections. An additional 20-ha area of the existing internal network system will be reinforced in Barrios Sapac and Tangub. This will complete the program to reinforce the existing internal network system. The internal network will be extended to 125 ha in the fringe of the water district in Barrios Latag and Lodlod and other residential areas being developed within the service area. By 1990 the water district will have reinforced all 140 ha of the existing service area and will have extended the internal network to an additional 235 hectares.

During Phase I-C the water district will install fire hydrants in 30 ha of high-value area and 130 ha of residential area. By 1990 the water district will provide fire protection service to 420 ha within the service area. The internal network pipes and valves and fire hydrants to be installed in Phase I-C are summarised as follows:

TABLE IX-8

STAGE I PHASE C CONSTRUCTION PROGRAM FOR TRANSMISSION/DISTRIBUTION SYSTEM (1986-90)

Description/Location	Pipe Number	Node		Pipe	
		From	To	Size (mm)	Length (m)
PRESSURE ZONE 1					
Along Tiaong Road	26	26	27	150	600
Along Road near Bo. Sapao	29	41	42	150	1,200
Along Road near Bo. Sapao	30	42	43	100	900
Located near Bo. Latag - Antipolo del Norte	32	29	27	150	950
Pipeline along Carmel Subdivision	46	33	29	150	1,500
Proposed Well and Pump Station Line	67	53	29	200	200
Along Road near Bo. Antipolo del Norte	48	30	31	150	700
Along Road near Bo. Antipolo del Sur	49	31	45	150	1,000
PRESSURE ZONE 2					
Along Road near Bo. Lodlod	43	36	37	150	1,200
Along Balintawak - Marauoy Road	50	20	18	150	1,000
Proposed Well and Pump Station Line in Bo. Balintawak	56	52	19	200	300

Item		Reinforcement of Existing System	Service Area Extension	Total
Pipe :	100 mm	1,600 m	10,000 m	11,600 m
	150 mm	400 m	2,500 m	2,900 m
Valves :	100 mm	4	50	54
	150 mm	2	13	15
Hydrants :	100 mm	4	22	26
	150 mm		17	17

The program to replace all of the existing connections will be completed during Phase I-C by replacing 314 service connections. Two thousand seven hundred (2,700) new service connections will be installed, bringing the total connections to 8,400 by 1990.

Cost Summary - Phase I-C. A cost summary for the construction Phase I-C is presented in Table IX-9. Based on 1976 price levels, the total project cost of this phase is ₱6.86 million, with a foreign exchange component (FEC) of ₱3.51 million. A breakdown of the construction cost, including certain material and equipment to be procured and civil-structural work, is also given in Table IX-9.

TABLE IX-9

COST SUMMARY OF CONSTRUCTION STAGE I PHASE C (1986-90)

Item	Construction Period	Cost in Thousand Pesos Local	FEC	Total
Source Development	-	-	-	-
Transmission/Distribution Mains and Valves	1986-90			
Material and Equipment		177	791	968
Civil and Structural		602	-	602
Construction Cost		779	791	1,570
Internal Network	1986-90			
Material and Equipment		158	765	923
Civil and Structural		749	-	749
Construction Cost		907	765	1,672
Service Connections	1986-90			
Material and Equipment		60	1,156	1,216
Civil and Structural		804	-	804
Construction Cost		864	1,156	2,020
TOTAL CONSTRUCTION COST				
Material and Equipment		395	2,712	3,107
Civil and Structural		2,155	-	2,155
Total		2,550	2,712	5,262
Contingencies (15%)		382	407	789
Sub-total		2,932	3,119	6,051
Engineering (10%)[4/]		212	393	605
Sub-total		3,144	3,512	6,656
Administrative and Legal Fees (3%)		200	-	200
TOTAL PROJECT COST		3,344	3,512	6,856

[4/] Tentatively broken down as 65 per cent FEC and 35 per cent local; FEC may be reduced as more engineering design is performed locally.

D. SECOND STAGE OF THE RECOMMENDED LONG-TERM CONSTRUCTION PROGRAM

The second stage of the recommended program includes construction of additional deep wells, water transmission and distribution mains, storage tanks and expansion of the internal network. These works will be implemented in two phases.

Construction Phase II-A (1990-95)

Source Development. By this time, the LCWD will have sufficient data on the well performances and local aquifers. Based on the operational data, if it is found to be feasible, eight more wells will be constructed to meet the maximum daily demands projected for the year 2000. It is estimated that three additional operational wells, one 100-m and two 200-m deep, will be constructed in the first pressure zone; two operational wells, one 100-m and one 200-m deep, in the second pressure zone; and two operational and one stand-by wells, one 100-m and two 200-m deep, in the third pressure zone. Facilities for electric power supply and chlorination will be provided for each well site. Construction of access roads may be required for some of the sites.

Approximate locations of the wells in Phase I-B are shown in Figure IX-2, appended, and data on these wells are summarized in Table IX-10.

TABLE IX-10

PHASE II-A (1989-91) WELLS

Pressure Zone	Number of Wells		Approximate Depth (m)	Pumping Water Level (m)
	Operational	Stand-by		
1	1	-	100	45
	2	-	200	135
2	1	-	100	45
	1	-	200	135
3	1	-	100	45
	1	1	200	135

__Transmission/Distribution Mains.__ In Pressure Zone 1, the distribution mains to the storage facility in Barrio Balintawak will be reinforced and service will be extended to Barrio Bolboc. In Pressure Zone 2, the new well in Barrio Balintawak and the storage facilities in Barrio Lodlod will be connected to the distribution system.

In Pressure Zone 3, service will be extended to Barrio Banaybanay along the National Road and to Barrio Bagongpook north of the National Road. The distribution mains to be installed in Phase II-A are listed in Table IX-11 and summarized below:

Pipe Size (mm)	Pipe Length (m)	Valve Size (mm)	Number of Valves
150	2,570	150	20
200	3,810	200	2
250	500		

One 100-mm fire hydrant will be installed in Barrio Bagongpook for the purpose of occasional main flushing.

TABLE IX-11

STAGE II PHASE A CONSTRUCTION PROGRAM
FOR TRANSMISSION/DISTRIBUTION SYSTEM (1990-95)

Description/Location	Pipe Number	Node		Pipe	
		From	To	Size (mm)	Length (m)
PRESSURE ZONE 1					
Along Road near Bo. Bolbco	39	33	62	150	1,100
Proposed Well and Pump Station Line in Bo. Muntingpulo	55	51	41	200	200
Proposed Well and Pump Station Line in Bo. Bolbok	73	65	62	200	200
Proposed Storage Line in Bo. Balintawak	20	22	24	250	500
From Recto Ave to Mabini Academy along Kalaw St	24	24	28	200	800
PRESSURE ZONE 2					
Proposed Well and Pump Station Line in Bo. Pangao	70	55	38	200	200
Proposed Storage Tank Line in Bo. Pangao	44	39	37	200	400
PRESSURE ZONE 3					
From Bo. Banaybanay to Bo. Bagongpook	5	5	6	150	1,470
From Bo. Banaybanay to Road Junction near Cemetery	6	4	5	200	470
From Bo. Banaybanay to Fernando Air Base	7	5	7	200	1,340
Proposed Well and Pump Station Line in Bo. Banaybanay	74	66	4	200	200

Storage Tanks. The volume of storage located in Barrio Balintawak and serving Pressure Zone 1 will be increased by 500 cum with the construction of a new storage tank. The tank will have a five-meter operational range and a 340 m overflow elevation. A 250-mm, double-acting altitude valve will be installed (or a continuous manual control will be provided) on the supply line to the storage tank.

In Pressure Zone 2, a 25-m high, standpipe-type storage tank will be constructed in Barrio Lodlod. The overflow elevation will have a 200-cum volume within the top five meters of operational range. The lower 20 m of the standpipe will contain 800 cum of dead storage which can be used only in emergencies. A 200-mm, double-acting altitude valve will be installed on the supply line (or a continuous manual control will be provided as a substiture for the altitude valve).

Internal Network and Service Connections. The water district will install the internal network system in 150 ha during Phase II-A. Fire protection service will be provided to 40 ha of high-value area and 220 ha of residential area. The required internal network pipes and valves and fire hydrants to be installed in Phase II-A are summarized as follows:

Item		Service Area Extension
Pipe	: 100 mm	12,000 m
	150 mm	3,000 m
Valves	: 100 mm	60
	150 mm	15
Hydrants	: 100 mm	44
	150 mm	23

A total of 3,450 service connections are projected to be installed during Phase II-A.

Cost Summary - Phase II-A. A cost summary for the construction Phase II-A is presented in Table IX-12. Based on 1976 price levels, the total project cost of this phase is ₱13.78 million with a foreign exchange component of ₱6.43 million which includes the direct and indirect import items. Table IX-12 shows also a breakdown of the construction cost for certain materials and equipment and civil-structural work. The materials and equipment considered in this breakdown are pipes, valves, water meters, hydrants, pumps, motors and chlorinators.

TABLE IX-12

COST SUMMARY OF CONSTRUCTION STAGE II-A (1990-95)

Item	Construction Period	Cost in Thousand Pesos		
		Local	FEC	Total
Source Development	1989-91			
Material and Equipment		214	1,070	1,284
Civil and Structural		2,014	661	2,675
Construction Cost		2,228	1,731	3,959
Transmission/Distribution Mains and Valves	1990-95			
Material and Equipment		179	700	879
Civil and Structural		480	-	480
Construction Cost		659	700	1,359
Storage Tank and Appurtenances	1990-92			
Material and Equipment		39	147	186
Civil and Structural		708	100	808
Construction Cost		747	247	994
Internal Network	1990-95			
Material and Equipment		184	846	1,030
Civil and Structural		794	-	794
Construction Cost		978	846	1,824
Service Connections				
Material and Equipment		69	1,380	1,449
Civil and Structural		932	-	932
Construction Cost		1,001	1,380	2,381
TOTAL CONSTRUCTION COST				
Material and Equipment		685	4,143	4,828
Civil and Structural		4,928	761	5,689
Total		5,613	4,904	10,517
Contingencies (15%)		842	736	1,578
Sub-total		6,455	5,640	12,095
Engineering (10%)[5/]		423	787	1,210
Sub-total		6,878	6,427	13,305
Land Cost		76	-	76
Sub-total		6,954	6,427	13,381
Administrative and Legal Fees (3%)		401	-	401
TOTAL PROJECT COST		7,355	6,427	13,782

[5/] Tentatively broken down as 65 per cent FEC and 35 per cent local; FEC may be reduced as more engineering design is performed locally.

Construction Phase II-B (1995-2000)

Source Development. Construction of additional new wells will not be required during this phase.

Transmission/Distribution Mains. During Phase II-B the water district will extend service to new areas in Pressure Zones 2 and 3. The distribution mains to be installed are listed in Table IX-13. In Pressure Zone 2, service will be extended to Barrio Pinagtongulan. By year 2000, the water district's service area will be 860 ha, of which 180 ha will be served by direct connection to the distribution mains. The pipes and valves to be installed in the Phase II-B program are summarized below:

Pipe Size (mm)	Pipe Length (m)	Valve Size (mm)	Number of Valves
150	1,750	150	14
200	4,200		

A 100-mm fire hydrant will be installed in the distribution main in Barrio Duhatan for occasional main flushing.

Storage Tanks. The volume in Pressure Zone 2 will be increased by 200 cum with the construction of a second storage facility in Barrio Tibig. The tank will have a five-meter operational range and an overflow elevation of 365 meters. The tank should be interconnected to the Phase I-B storage facility. A second double-acting altitude valve (if this automatic flow control system was provided in the early phases of construction) will not be required as the interconnection can be made on the storage tank side of the altitude valve installed in Phase I-B.

A 500-cum storage tank will be constructed at Bukal Hill in Barrio Pinagtongulan. The tank will have a 385-m overflow elevation and serve Pressure Zone 3. The storage facility should be located between elevations 380 to 385 meters. A five-meter operational range should be provided. In order to control the inflow and outflow at the tank, a double-acting altitude valve should be installed (or the tank should be manned for 24 hours a day for a continuous manual control).

Internal Network and Service Connections. The water district will install internal network system in 155 ha within the service area. The total area served by connection to the internal network system will be 680 ha by year 2000. During Phase II-B it is pro-

TABLE IX-13

STAGE II PHASE B CONSTRUCTION PROGRAM
FOR TRANSMISSION/DISTRIBUTION PIPELINES (1995-2000)

Description/Location	Pipe Number	Node From	Node To	Pipe Size (mm)	Pipe Length (m)
PRESSURE ZONE 1					
Along Manila - Batangas Road from Bonifacio St	22	25	23	150	800
PRESSURE ZONE 2					
Pipe Line to Bo. Pangao	45	38	37	200	1,400
PRESSURE ZONE 3					
From Bo. Pinagtongulan to Bo. Duhatan	1	2	1	150	750
Proposed Storage Tank Line in Bo. Pinagtongulan	2	9	2	200	400
From Bo. Pinagtongulan to Bo. Banaybanay 2	3	3	2	200	1,500
From Bo. Banaybanay 2 to Road Junction near Cemetery	4	4	3	200	900
Proposed Well and Pump Station Line in Bo. Banaybanay 2	75	67	3	150	200

jected that 50 ha of residential area having fire protection service will be upgraded to high-value service by the installation of 150-mm fire hydrants. An additional 180 ha of residential area will be given fire protection service bringing the total area receiving fire protection to 860 hectares. The Phase II-B internal network pipes and valves and fire hydrants to be installed are summarized below:

Item			Service Area Extension
Pipe	:	100 mm	12,400 m
		150 mm	3,100 m
Valves	:	100 mm	62
		150 mm	16
Hydrants	:	100 mm	36
		150 mm	29

The water district will install 3,450 additional service connections. By year 2000, the water district is projected to serve 15,300 concesssionaires.

Cost Summary - Phase II-B. A cost summary for the construction Phase II-B is presented in Table IX-14. Based on 1976 price levels, the total project cost of this phase is ₱7.72 million, with a foreign exchange component of ₱3.85 million. A breakdown of the construction costs for certain materials and equipment to be procured and civil-structural work, is also given in Table IX-4.

TABLE IX-14

COST SUMMARY OF CONSTRUCTION STAGE II-B (1995-2000)

Item	Construction Period	Cost in Thousand Pesos Local	FEC	Total
Source Development	-	-	-	-
Transmission/Distribution Mains and Valves	1995-2000			
Material and Equipment		147	581	728
Civil and Structural		405	-	405
Construction Cost		552	581	1,133
Storage Tank and Appurtenances	1995-1997			
Materials and Equipment		21	79	100
Civil and Structural		387	50	437
Construction Cost		408	129	537
Internal Network				
Material and Equipment		188	869	1,057
Civil and Structural		819	-	819
Construction Cost		1,007	869	1,876
Service Connections				
Material and Equipment		69	1,380	1,449
Civil and Structural		932	-	932
Construction Cost		1,001	1,380	2,381
TOTAL CONSTRUCTION COST				
Material and Equipment		425	2,909	3,334
Civil and Structural		2,543	50	2,593
Total		2,968	2,959	5,927
Contingencies (15%)		445	444	889
Sub-total		3,413	3,403	6,816
Engineering (10%)[6]		239	443	682
Sub-total		3,652	3,846	7,498
Administrative and Legal Fees (3%)		225	-	225
TOTAL PROJECT COST		3,877	3,846	7,723

[6] Tentatively broken down as 65 per cent FEC and 35 per cent local; FEC may be reduced as more design work is performed locally.

E. CAPITAL COST SUMMARY

Capital costs for each construction phase, including the Early Action Works are summarized in Table IX-15. Land costs for the proposed facilities, with the exception of well sites in the latter phases of construction, are included in the Early Action Program. The total project costs shown in the table, in general, include estimated construction costs of proposed facilities, surveys and engineering, contingencies, cost of land and easements and administrative and legal fees. As indicated previously, the construction cost estimates for the proposed facilities are based on the projected July 1976 unit prices. The foreign exchange component of the total project cost which is also shown in Table IX-15, includes the cost of directly and/or indirectly imported items.

The water supply and demand chart shown in Figure IX-1 indicates the scheduling of construction stages for source development with respect to the LCWD water system maximum daily demand curve for the study area.

TABLE IX-15

CAPITAL COST SUMMARY

Construction Phase	Construction Period	Construction Cost (₱ x 1000)	Project Cost (₱ x 1000) Local	FEC	Total
Early Action Works	1977-78	983	461	726	1,187
I-A	1978-82	10,774	7,340	6,700	14,040
I-B	1982-86	8,365	5,762	5,210	10,972
I-C	1086-90	5,262	3,344	3,512	6,856
II-A	1990-1995	10,517	7,355	6,427	13,782
II-B	1995-2000	5,927	3,877	3,846	7,723
Total		41,828	28,139	26,421	54,560

F. ANNUAL OPERATION AND MAINTENANCE COSTS

Annual operation and maintenance costs include personnel, power, chemicals, maintenance, rentals, office supplies, and other miscellaneous expenses which are necessary for the operation of the overall water system. The total operation and maintenance cost for the existing system in 1975 was about ₱150,000. Following implementation of the recommended construction program, the annual cost of operation and maintenance will increase due to the additional personnel, power, chemicals and maintenance required. The annual costs discussed here do not include the annual repayment of the loan for construction of the new facilities.

The annual costs for operating the LCWD facilities are estimated to be approximately ₱327,000, ₱796,000 and ₱1.29 million in 1980, 1990 and 2000, respectively (see Table IX-16). The annual operational and maintenance costs are based on the estimated July 1976 price levels.

TABLE IX-16

ANNUAL OPERATION AND MAINTENANCE COSTS

Item	Annual Costs (₱ x 1000)		
	1980	1990	2000
Source Facilities	121	369	661
Treatment (Chlorine)	22	44	67
Transmission and Distribution	26	80	150
Administration and Personnel	143	273	362
Miscellaneous	15	30	50
TOTAL	327	796	1,290

G. SEWERAGE/DRAINAGE CONCEPTS

Existing Drainage System

There are no adequate sewerage and drainage facilities in the LCWD area. Most residences have septic tanks with effluent discharging into open drains or storm drainage conduits. Where septic tanks are not provided, wastewater is disposed of directly into open drains or street gutters.

The existing sewerage/drainage system of Lipa, originally constructed for surface runoff collection, is currently loaded with wastewater, thus making it essentially a combined system. A city ordinance requires that adequate sanitary facilities be provided with new construction. Gasoline service stations are also required to comply with anti-pollution laws. "Barangay" councils have regulations that all households should have sanitary toilet facilities. Enforcement of these ordinances and regulations is a problem and at this time the degree of compliance is unknown.

Field observations of the sewerage/drainage system in Lipa are as follows:

1. There are no industries producing significant amount of (industrial) wastes.

2. Wastewater and storm runoff are discharged to Pamintahan River which in turn is being used for irrigating ricefields downstream.

3. National and subdivision roads have concrete-lined gutters and street inlets at intersections, at spacing of about 25 meters. Street inlet opening is about 8 cm x 40 cm, without steel gratings.

4. About 30 per cent of roads have underground drainage conduits. The remaining 70 per cent have open unlined canals which serve as combined wastewater and drainage canals, measuring about 65 cm top width and 36 cm depth (See Figure IX-4).

5. The public market and slaughterhouse drain their wastewater directly into Pamintahan River. There is only one public toilet which is located inside the public market and this exists under very objectionable and unsanitary condition.

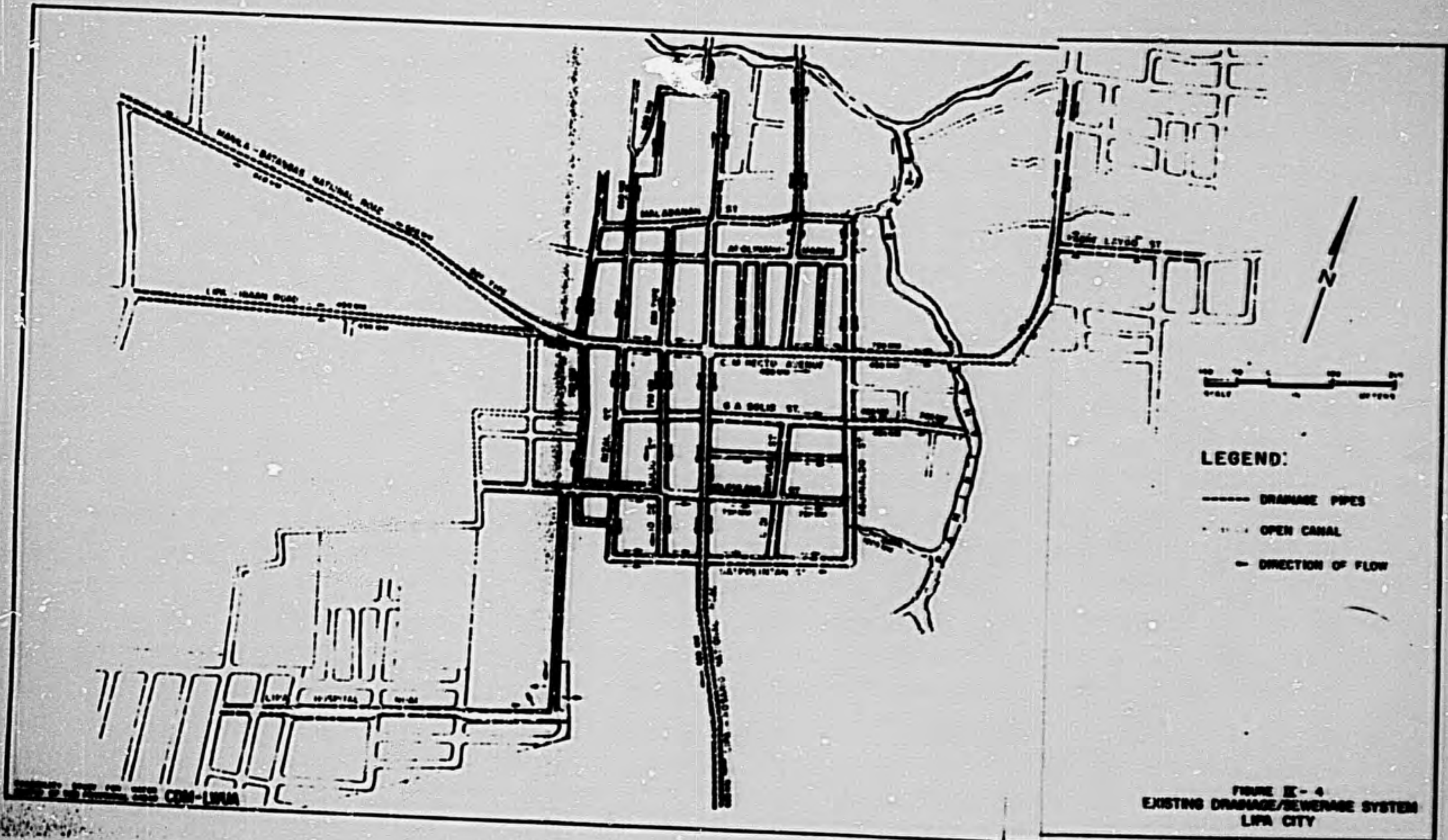


FIGURE III-4
EXISTING DRAINAGE/SEWERAGE SYSTEM
LIPA CITY

6. Solid wastes are dumped and burned at Tanguay dumping area. The Pamintahan River (now very polluted) is also used as a solid waste dump.

7. Less than five per cent of the residents of Lipa City are connected to the combined system.

8. Many water service connections have been observed to cross the sewerage/drainage canals. Because of this situation, there are many potential opportunities for cross-connections between the potable water system and wastewater.

9. There are no serious flood problems in Lipa, except for occasional and localized street flooding resulting from clogged canals after heavy rains.

Relationships with Infrastructure and Other Engineering and Economic Factors

The provision of sewerage and drainage facilities in Lipa City has a significant impact on water supply and other infrastructure. On the other hand, economics (that is, "ability to pay") and public health affect the feasibility of providing sewerage/drainage either on a separate or a combined basis.

Before decisions can be made on the implementation of drainage and/or sewerage facilities, it must be determined whether the works should be designed on the basis of separate piping for storm runoff and wastewater or as a combined system.

The 1970 census reported that only 17 per cent of the households in Lipa City have flush toilets. Most likely, these households with water-sealed (flush) toilets are concentrated in the core city area where the underground drainage system is located. Such a low percentage of modern toilets could preclude immediate implementation of a wastewater system.

The rationale for the provision of wastewater collection facilities has traditionally been based on aesthetics and public health benefits. At present, there is a distinct water supply problem in the LCWD. As the water supply problem is resolved, wastewater volumes will increase. Related public health and aesthetic problems will in turn compound and aggravate the wastewater problem.

Projected Wastewater Volumes

For LCWD, it has been established that collected wastewater[1] would be approximately as follows (see Table IX-17 for breakdown):

Year	Wastewater Flow (cumd)
1990	1,000
2005	3,500
2025	7,200

Alternatives Available

The economic cost of sewerage/drainage facilities for the LCWD 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 LCWD is no exception to that rule.

Feasible alternatives for sewerage in the LCWD area appear to be as follows:

1. Individual (septic tanks or a unified public collection system;

---

[1]The service area considered for the wastewater projection is the poblacion or present water service area within the water district. These areas are the most densely populated in the water district, and because of this, they will be the areas where public health and nuisance problems associated with wastewater will be highest.

The wastewater volume which could be collected was determined by estimating the number of sewer connections per year the water district could reasonable be expected to maintain on a long-term basis. The number of people connected to the sewerage system was estimated. The total population with sewerage service was expressed as a percentage of the population having water service. Using this percentage, the domestic wastewater volume was calculated as a percentage of the domestic water demand assuming that 90 per cent of the water is returned to the sewer. In the early years of sewer construction, it was assumed, the most densely populated and highly commercialized core city areas would be sewered first, and therefore, a higher percentage of the commercial, institutional and industrial demand within the poblacion was assumed to be collected by the sewerage system.

TABLE IX-17

WASTEWATER FLOWS
LIPA CITY WATER DISTRICT

Design Year	Annual Connection Rate	Percentage of Water Connections with Sewer Connections	Wastewater Flows (cumd)			
			Domestic	Commercial, Institutional and Industrial	Allowance for Infiltration[a]	Total
1990	100	10	600	200	200	1,000
2005	150	56	2,300	500	700	3,500
2025	187	100	5,300	800	1,100	7,200

[a] Assumed at 0.15 lps/ha

2. Combined or separate systems;

3. Centralized community treatment (with varying degrees of treatment);

4. Disposal system (Pamintahan River or land treatment).

The question of whether the LCWD should construct a combined or a separate sewerage/drainage system depends to a certain extent on economic priorities.

An alternative to the separate system which must be investigated in detail during the sewerage feasibility study is the provision of open or covered 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 Pamintahan River.

2. It is possible that some form of treatment such as conventional primary or high-rate secondary treatment may be applied with eventual reuse of the processed wastewater for irrigation purposes.

<u>Recommendations</u>

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 vs. 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 [2] and house connection program.

---

[2] The rate of sewering is influenced by the following factors:

1. The limited rate local street sewers can physically be constructed by available sources with acceptable traffic dislocation;
2. The administrative and social constraints on the rate at which premises can actually be connected to the sewer system;
3. The availability of funds.

A plumbing code should be developed by the LCWD to coordinate plumbing requirements for water, wastewater and surface runoff facilities. This code becomes very important and meaningful particularly if 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.

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, squat-type toilet.

Permanent rights-of-way should be acquired for the main canals that are now used for drainage/irrigation canals.

The use of combined (wastewater and storm water runoff) sewage for irrigation of vegetables that are eaten raw should be discontinued. Such combined wastes may be used with care in irrigating vegetables or plants that are well cooked.

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

H. MANAGEMENT OF GROUNDWATER RESOURCES

In order to preserve the quantity and quality of groundwater available for present and future use of LCWD, certain technical and management steps must be considered. These considerations are primarily related to the collection of data concerning the chemical quality and overall productivity of the groundwater aquifers in the vicinity of LCWD, and a data storage and retrieval system which would provide easy accessibility to those organizations dealing with the subject, and are discussed further in Appendix IX-H, 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, un-anticipated population growth or movement, etc., must be reviewed for possible long-range impact on the programs recommended in this report. An outline of the steps required for such periodic updating is presented in Appendix IX-I, Volume II.

J. ENVIRONMENTAL CONSIDERATIONS

Appendix IX-J, Volume II discusses some of the ways the recommended program may affect the environment of the study area. The natural resources affected by the program are all available and some are irreplaceable, requiring due consideration before construction is initiated.

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 few years. The technical aspects and project costs of the recommended plan are 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 the 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 derived 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.

B. 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 1976 unit prices.

Project Costs

Project costs of facilities recommended for implementation are summarized annually in Appendix Table X-B-1. Engineering services for design and construction supervision are broken down. It has been assumed that 70 per cent of the engineering services apply to surveys and design and 30 per cent to construction supervision. Design costs are shown in the year preceding construction. All other items such as legal and administrative fees (three per cent), and contingencies (15 per cent) 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 Appendix Table X-B-2. The escalation factors used are based on an average annual rate of inflation of 10 per cent per year from 1976 through 1980, eight per cent per year from 1981 through 1985 and six per cent per year thereafter. On the other hand, annual costs and family income are escalated at a rate of eight per cent all throughout the 25-year study period. These escalation factors have been assumed to apply equally to the local and foreign exchange costs.

C. 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 cost of the existing system in 1976 is estimated at P0.160 million. Cost estimates needed to operate and maintain the system in the future are presented in Chapter IX.

D. FINANCING POLICIES COVERING LOCAL WATER DISTRICT DEVELOPMENT

The following are the major potential sources of funds which can be utilized by the district:

Operating Sources

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 amounts that must be borrowed and the associated debt service costs.

Non-Operating Sources

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

1. Loans - funds may be borrowed by LCWD 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:

   Interest - 9% per annum to be computed monthly at ¾% per month from the year following date of disbursement.

   Duration - 30-year loan from the date of initial disbursements.

   Principal - no principal payments due during disbursement periods (Construction periods of Stage I - Phases A, B and C 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 policy requires new customers to pay for connections and water meters, but currently does not include an assessment for distribution system costs. These sources are referred to as "contributions 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 of 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 benefit 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 funds 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 per cent be set aside for reserve funds. For purposes of this study, a lower percentage will be used, starting at three per cent progressively increasing to 10 per cent.

E. 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 project costs as escalated and shown in Appendix Table X-B-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 1977 becomes "depreciable" in 1978. 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.

Appendix Table X-E-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 replacements 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 Appendix Table X-E-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 ₱5.65 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.

Appendix Table X-E-3 indicates the working capital requirements based on preliminary data for Lipa City. In this table, the two key assumptions are:

1. 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 by those who would be connected to the system in 1978 to account for the escalation of construction costs.

2. Sixty per cent 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 1/2 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 1/2-inch by 2.5; that of a 3/4-inch by 4; that of a 1-inch by 8, and so forth, to get the total RUs delivered.

Appendix Table X-E-4 gives the revenue unit forecast which is summarized as follows:

1975	850	Revenue Units
1980	2,666	"
1985	5,138	"
1990	9,470	"

F. 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 just the operation and maintenance expenses due to various factors including poor pricing schemes, defective collection system and inadequate consumer promotion. The major reason that has been pointed out, however, is that the consumers being served by the water district have such low incomes and hence, they 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 first be ascertained.

Since water districts are not expected to be extended government subsidy, this has significantly simplified the analysis of the factors affecting ability-to-pay. The factors that affect ability-to-pay are the annual income of families covered by the water district and 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 to 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 per cent and as high as 447 per cent 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 two hours away by bus.

The survey covered 556 families, classified into four income groups. Approximately 28 per cent came from the low-income class (below ₱220/month); 55 per cent from the middle-income (₱221-₱750/month); 12 per cent from the upper middle-income (₱751-₱1,500/month); and five per cent from the high-income group (above ₱1,500).

The following table presents the highlights and pertinent findings of the survey:

ESTIMATED ABILITY-TO-PAY BY INCOME GROUPING

Income Group / % Distribution	₱220 / 28%	₱221-750 / 55%	₱751-1,500 / 12%	₱1,500 / 5%	Weighted Average
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 per cent 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 25 per cent of their average income). This disparity in the percentage of income allocated to water by the two 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.1/

Family Income

In the Survey of Households Bulletin Series No. 34, published July 1973 by the Bureau of the Census and Statistics (BCS), 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

1/ 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.

The preceding 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 be approximate, or a little less than the median family income at 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. In general, piped water systems are proposed to be developed for the central, most urban area of the city or municipality. The inhabitants of the central urban area 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 per cent per year, would be about ₱6,260/year.

The report, "The Filipino Family, Community, and Nation" by Emma Porio, Frank Lynch and Mary R. Hollnsteiner 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 suvey on the income of 1,972 families during the period November 1973 to 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 per cent, by 1 July 1976 it would be an income of about ₱8,640 per year. These 14 urban areas are among the more urbanized in the country. They included, for instance, only three 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 ₱6,260 per year (developed from the 1970-71 data of the Bureau of Census and Statistics) and ₱8,640 per year (developed from the data of Porio, Lynch and Hollnsteiner). For lack of other data, the average water-using family may have an income of about ₱7,400 during 1976 (or ₱700 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 prices that can be used for a period of several years. It is good practice for the water district to adjust prices every three years or so, instead of annually.

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

Period	Water Rate ₱/cum
1976-1978	₱ 1.00
1979-1981	1.90
1982-1984	2.45
1985-1987	2.80
1988-1990	2.95
1991-1993	3.00
1994-1996	3.30
1997-2000	3.70

The first step of ₱1.00/cum was selected as an intermediate rate, in anticipation of the second step (₱1.90/cum) which is indicative of the required cost to make the system financially viable. The rate of ₱1.90/cum in 1980 cost levels is equivalent to ₱1.30 in 1976 prices (based on 10% discount rate). Likewise ₱2.45/cum in 1983 is equal to ₱1.26 in 1976 prices.

Assuming that an average household will consume 24 cum per month[2/], the average monthly cost would be ₱24.00. Based on the Lipa household survey, this monthly cost would be about the probable ability-to-pay of ₱25.00/month.

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. In as much as the proposed water rates represent the "weighted mean", determination has been

---

[2/] Probable use of water by income groups:

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

made for those groups of households whose income (₱700/mo) also represents the "mean". Probable use of water by this group was calculated at 24 cum per month. At ₱1.00 per cubic meter, a 24-cum consumption thus represents 3.4 per cent of the customer's monthly income. For newly connected customers, the monthly cost will be ₱5.65 greater if it is assumed that the low-income customer will choose the installment payment plan. Assuming the new customer also limits his consumption to 24 cum or less, the monthly expenditure for water will then be 4.2 per cent. The monthly installment charge for new connections is fixed in the year of connection and remains constant throughout the 10-year payment period. Since both the water rates and the household income 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".

Item	1980	1983	1986	1989	1992	1995	1998
1. Escalated income of household earning ₱700/mo in 1976 (8% per year)	₱950	₱1,200	₱1,510	₱1,900	₱2,400	₱3,020	₱3,810
2. Expenditure for 24-cum water consumption (₱)	45.60	58.80	67.20	70.80	72.00	79.20	88.80
3. Income allocation to water for existing customers (%)	4.8	4.9	4.4	3.7	3.0	2.6	2.3
4. Connection charge for new customers (₱5.65/mo in 1976)	8.25	10.45	12.88	15.31	18.24	21.75	25.93
5. Income allocation to water for new customers (%)	5.7	5.8	5.3	4.5	3.8	3.3	3.0

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 slightly lower in the succeeding year of each rate block.

In the example shown above, the proportions of the household income required for water services (except for years 1979 through 1987 which are within the upper range limit) are considered in line with the ability-to-pay studies done in Lipa City where willingness among this income group to pay fees for improved services was found to be about 3.7 per cent of their income.

In the final analysis, if any significant improvement is to be achieved in the scope and quality of public water services 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 (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 time fall within the average consumer's ability-to-pay . However, the "below average" group will carry a financial burden of about 7.3 per cent ($\frac{1.00 \times 16}{220} = 7.3\%$).

By trial and error techniques, a possible socialized water rate stucture is as follows:

Monthly Use (cum)	Rate (₱/cum)
0 - 15	₱ 0.75
16 - 30	₱ 1.35
31 - 40	₱ 1.95
> 40	₱ 2.55

The impacts on the various income levels are as follows:

		Below Average	Average	Upper Middle	Upper	Weighted Mean
Average monthly income		₱220	₱660	₱1,000	₱2,700	₱680
Probable monthly water use (cum)		16	24	32	44	23.7
Use of Water	Rate/ cum					
0-15	₱0.75	₱ 11.25	₱ 11.25	₱ 11.25	₱ 11.25	
16-30	₱1.35	1.35	12.15	20.25	20.25	
31-40	₱1.95	-	-	3.90	19.50	
> 40	₱2.55	-	-	-	10.20	
	Total	₱ 12.60	₱ 23.40	₱ 35.40	₱ 61.20	₱ 23.71 or ₱1.00/cum
	% of Income	5.7	3.5	3.5	2.3	3.5

The group classified as "below average" will pay about ₱12.60 monthly, and equivalent to a 5.7 per cent of income allocated to water supply. The above figure, ₱12.60 is less than the calculated ₱13.50 derived from the Lipa survey.

<u>Revenue Forecasts</u>

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

G. FINANCIAL SUMMARY

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

1. Reserved Fund: three per cent of sales for 1976-1980; six per cent for 1981-1985; and 10 per cent for 1986-2000.
2. Uncollectibles: two per cent of gross revenue requirements for first year of a new rate application, and one per cent for the second and third years.
3. Accounts Receivable: equivalent to three months of sales.
4. Accounts Payable: equivalent to two months of operating expenses.

External Borrowing Required

Appendix Table X-G-1 shows the Financing Plan and Debt Service where the "Amount Disbursed" column represents the external borrowing required. This table also presents the debt servicing necessary on a yearly basis.

Borrowing will start in 1976 and will continue through 1990. The first loan will cover the seven-year period 1976-82 inclusive, and will amount to ₱22.047 million. The second loan will cover the eight-year period 1983-1990 inclusive, and will be about ₱31.048 million.

Projections of Financial Statements

Appendix Table X-G-2 shows the net income (loss) on a yearly basis. Net loss is forecasted in 1981. However, net income cumulative would show positive values all throughout.

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

Cash Flow Statement

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.

Appendix Table X-G-3 presents the annual "Sources of Funds" and the yearly "Applications of Funds". Potential net decreases are expected in 1980 and 1982. By 2000, positive net cumulative cash balance will be ₱48.881 million even if "cash at the beginning of 1976" was assumed to be equal to zero.

Other Financial Statements

Appendix Table X-G-4 presents the "Projected Balance Sheet" which shows the projected fixed and current assets, and equity and liabilities of the water district from 1976 to 2000.

Rate of Return

Discount rate of return on total investments (Appendix Table X-G-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 ₱10.666 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 LCWD, the rate of return, with the assumptions made, is estimated to be 9.6 per cent.

II. 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:

1976-1978	₱ 1.00/cum
1979-1981	1.90
1982-1984	2.45
1985-1987	2.80
1988-1990	2.95
1991-1993	3.00
1994-1996	3.30
1997-2000	3.70

3. The recommended plan for the first construction phase (Phase I-A) of LCWD is financially feasible. Borrowing for that period would be ₱22.047 million.

   External borrowing would still be necessary for the second and third construction phases (Phases I-B and I-C).

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 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 demands 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

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 a 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 rate 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

In the economic analysis, benefits were projected up to 2000. Construction costs included those that would be incurred up to 1990; while incremental operating and maintenance costs were projected up to 2000. This is because the benefits from the facilities to be constructed up to 1990 would continue to accrue way beyond their construction period. On the other hand, operating and maintenance of the facilities will have to be undertaken regularly for as long as benefits are desired to be realized from the system.

Two approaches were adopted in the computation of the benefits and costs. In the first approach, all benefits and costs were calculated on the basis of constant 1976 prices which were afterwards discounted at 12 per cent to obtain their present worth. The benefits considered in this approach were: increase in land values, health improvement, reduction in fire insurance costs, reduction in fire damage and incremental revenue.

In the second approach, only two benefits were included, namely: reduction in fire damage and incremental revenue. These two benefits as well as the costs were escalated annually throughout Stage I of the construction period (1976 to 1990). Thereafter up to 2000, the benefits and costs were maintained at their 1990 level. The escalated values were then discounted at 12 per cent to obtain their present worth.

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 study 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 insurance costs, reduction in fire damage, and incremental revenue.

Increase in Land Values

The implementation of the water supply project will result in an increase in the land values of the study area. However, it must be pointed out that the increase in land values cannot be attributed soley 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 increase in land values due 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 per cent 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 ₱50	=	₱20,000
With Water	400 sqm x ₱65	=	₱26,000
	Ratio	=	1.3 or 30% increase

In this particular case, the incremental cost of ₱6,000 closely represents the market value of a private well (complete with pumps, electric controls etc.) to serve the premises.

On the basis of this information, it may be conservative to assume that land served by the water distribution system will experience a 20 per cent increase in value during the year that water service is extended to such premises.

Assumptions made for this analysis are explained in Appendix XI-C. Appendix Table XI-C-1 shows the computations of this benefit.

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.

Calculations for the health benefits and associated assumptions used are presented in Appendix XI-C. Appendix Table XI-C-2 shows the health benefits on a yearly basis.

Reduction in Fire Insurance Costs

With the increase in water pressure and the availability of an adequate amount of water for fire-fighting purposes, it is reasonable to expect that the present level of insurance costs would be reduced significantly. This is because the cost of fire insurance normally reflects the extent of risks due to fires. With improved fire protection, the burden of insurance expenses of households, commercial, industrial and institutional establishments would be reduced.

In determining the benefit arising from the reduction in fire insurance costs, a number of factors were taken into consideration. These include the number of insurable dwelling units in the study area, projected increase in dwelling units and insurance premium rate for buildings in provincial areas. The present value of total fire insurance benefits, is shown in Appendix Table XI-C-3.

Reduction in Fire Damage

With the installation of suitable fire hydrants especially in the high-value as well as the residential districts in the study 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 Appendix XI-C and shown in detail in Appendix Table XI-C-4.

(No attempt was made to quantify the inconvenience to the people rendered homeless and the value of human lives lost due to fire.)

Incremental Revenue

This benefit (sometimes called "consumer satisfaction") is quantified by the additional revenue generated by the 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 market 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 market value of the incremental water production directly resulting from the improvement of the system.

Another approach in quantifying this benefit is by considering the incremental total revenue rather than the incremental volume only (it is assumed that a higher water rate is associated with the new project). Calculations for the incremental benefit using the above two approaches are shown in Appendix XI-C and Appendix Table XI-C-5 and Appendix Table XI-C-6.

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 study 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.

Another way of viewing the benefits of the project is to assess its implication through the "with" or "without" principle. Following is a table which clearly illustrates the implications if the project is undertaken or not.

Hypothesis	"Without" Project	"With" Project
1. Water Adequacy	will continue to become in short supply; service will be intermittent and unreliable.	supply will be adequate at continuous pressure.
2. Water Quality	will continue to provide unsafe water and water-borne diseases will continuously be a threat.	supply will be safe, wholesome and healthful.
3. Personal Hygiene of Served Population	because of current water shortage, personal cleanliness is expected to range from marginal to lacking.	will enhance personal hygiene and overall appearance and cleanliness of the population.
4. Personal Satisfaction	will be minimal; significant time spent in fetching water.	releases time for other productive activities; provides "modernization" benefits; enhances self-reliance.
5. Employment Benefits	no improvement.	will provide short and long-term employment benefits.
6. Fire Protection and Fire Insurance	no improvement; area vulnerable to extensive fire damage because of water shortage; no reduction in fire insurance costs because the level of fire risks will remain essentially the same.	will improve the fire-fighting capabilities of the area; reduction in fire insurance cost since availability of water with adequate pressure will reduce fire risks.
7. Water-Using Industries in Area	no inducement to industries which use water as a primary or secondary input to locate in the area.	water-using industries will be encouraged to expand facilities, or relocate in the area.
8. Local Tourism	non-availability of piped potable water and poor sanitation facilities will be a deterrent to local tourism.	availability of water, if accompanied by sanitation program, will help boost local tourism.
9. Development of Areas Adjacent to Core City Area into Housing Subdivisions	no impetus to the development of areas adjacent to core city since not much economic activity can occur without adequate water supply	will help spur the development of areas adjacent to core city into housing subdivisions because water supply availability somehow enhances standard of living.
10. Wastage of Water – a Valuable Natural Resource	wasteful consumption of water will continue because of the absence of safeguards to check its use.	undertaking of metering program and adoption of new realistic water rates will definitely minimise water wastage.
11. Land Values	market value of land will remain at present levels except for effect of inflation	will increase land values by at least 20 per cent since water availability is a major consideration in market values of land.

E. ECONOMIC COSTS

General

The total cost of the proposed water supply system is the sum of all expenditures required to realize 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.

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, land cost, administrative and legal fees.

Appendix 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 1976 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, five per cent was assumed to be in the form of hidden taxes.

Adjustments on 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 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 .5 times its estimated cost in the project. The net effect is to reduce the cost of unskilled labor by one-half, thereby reducing also the summation of project cost.

Skilled labor, on the other hand, was valued at its going rate. It was assumed that if skilled labor were not employed in the study area, it would probably migrate elsewhere to obtain employment or better wage.

Adjustments were also made with respect to cost of project facilities which use up the 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 per cent, 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.

Taxes were excluded in this analysis since the project will be undertaken by the government for the benefit of the community and hence, will involve merely the transfer of funds among governmental agencies. It was assumed that some amount of taxes in one way or the other was hidden in the project costs.

Interest was likewise excluded since this is considered a financial instead of an economic cost.

Adjusted project costs with the shadow pricing are presented in Appendix Table XI-E-1.

Replacement Costs

Based on the criteria used in the financial studies, vehicles have a life expectancy of seven years while meters are expected to be replaced every 15 years. Other equipment used for source development, storage tanks and for the early action program have a life expectancy of 25 years. All other facilities in the system are expected to last for 50 years.

During the 24-year period from 1976 to 2000, therefore, only vehicles and meters will have to be replaced. Appendix Table XI-E-2 shows the replacement schedule and costs of vehicles and meters.

Salvage Value

Appendix Tables XI-E-3 and XI-E-4 show the salvage value schedule for all the capital equipment to be used in the project. The capital equipment are listed together with their assumed life expectancy.

Operating and Maintenance Costs

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.

Appendix Table XI-E-5 presents the incremental annual recurring costs associated with running and operating the water district up to 2000.

Calculation for Economic Costs

The economic cost may be expressed as the adjusted (shadow priced) project cost plus replacement cost plus operation/maintenance cost less salvage value. Appendix Table XI-E-5 shows the computation of total economic costs under the first approach while Appendix Table XI-E-6 shows the costs under the second approach.

F. BENEFIT-COST ANALYSIS

The summary of the quantifiable economic benefits and economic costs, using the first approach is shown below (benefit and costs expressed in constant 1976 prices and then discounted at 12 per cent to their present worth):

FIRST APPROACH
(in M ₱)

Benefits	
Increase in Land Values	₱13.76
Health	.28
Reduction in Fire Insurance	2.56
Reduction in Fire Damage	.22
Incremental Revenue (Consumer Satisfaction)	13.40
Total	₱30.22

Costs	
Adjusted Project Cost	₱17.41
(+) Replacement Cost	.37
(+) Operating and Maintenance Cost	2.33
(-) Salvage Value	1.18
Total	₱18.93

Benefit-Cost Ratio = 1.61:1

For the second approach, benefits included were confined to reduction in fire damage and the incremental revenue (taking into account the overall revenue resulting from the new project). Both economic benefit and cost streams were expressed in their escalated values to 1990 (beyond 1990, costs and benefits were held constant). The annual values were in turn discounted at 12 per cent. The summary of the economic benefit and cost streams is as follows:

SECOND APPROACH
(in M ₱)

Benefits	
Reduction in Fire Damage	₱ .63
Incremental Revenue	53.85
Total	₱54.48

Costs	
Adjusted Project Cost	₱28.23
(+) Replacement Cost	1.74
(+) Operation and Maintenance Cost	6.41
(-) Salvage Value	6.45
Total	₱28.93

Benefit-Cost Ratio = 1.88:1

The preceding tables show that by either approach or methodology shows that the quantifiable benefits exceed the economic costs associated with the improvement of the water supply system in Lipa City. Under the principle of benefit-cost ratio, the project is, therefore, considered economically feasible.

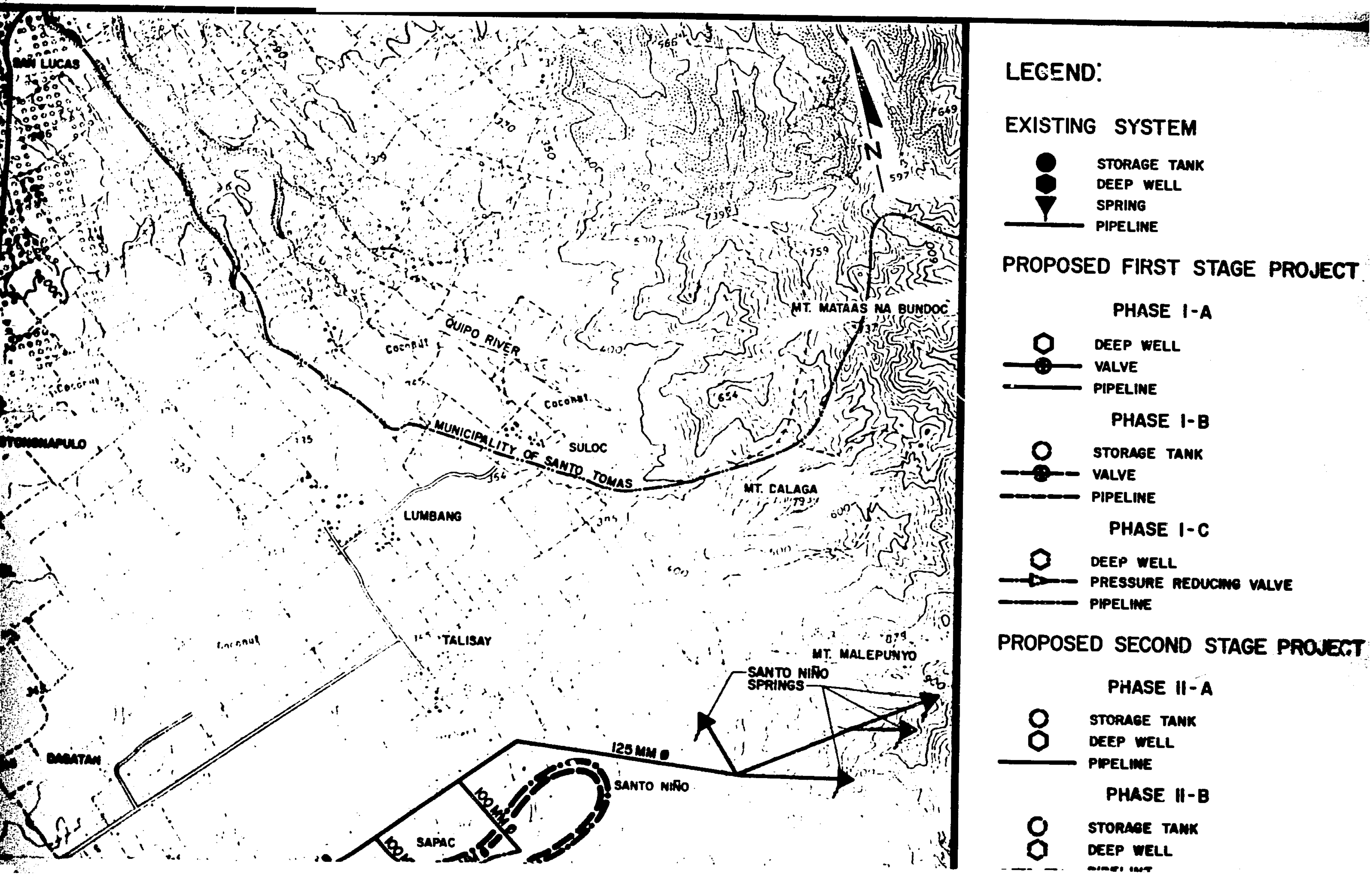
The actual benefits of the proposed project may be really greater than what the benefit-cost ratio represents because the non-quantifiable benefits have not been incorporated into the analysis for obvious reasons.

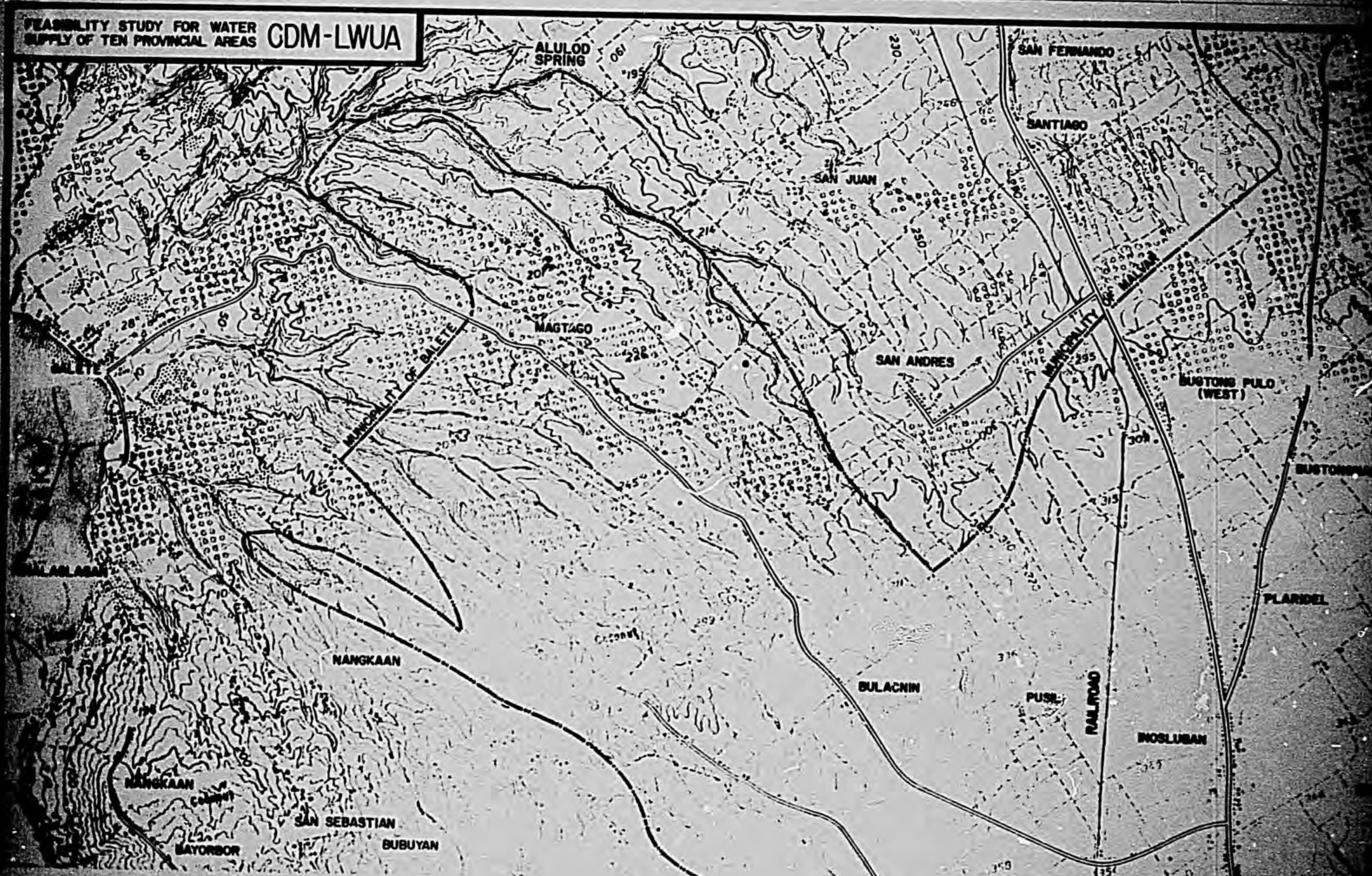
G. INTERNAL ECONOMIC RATE OF RETURN

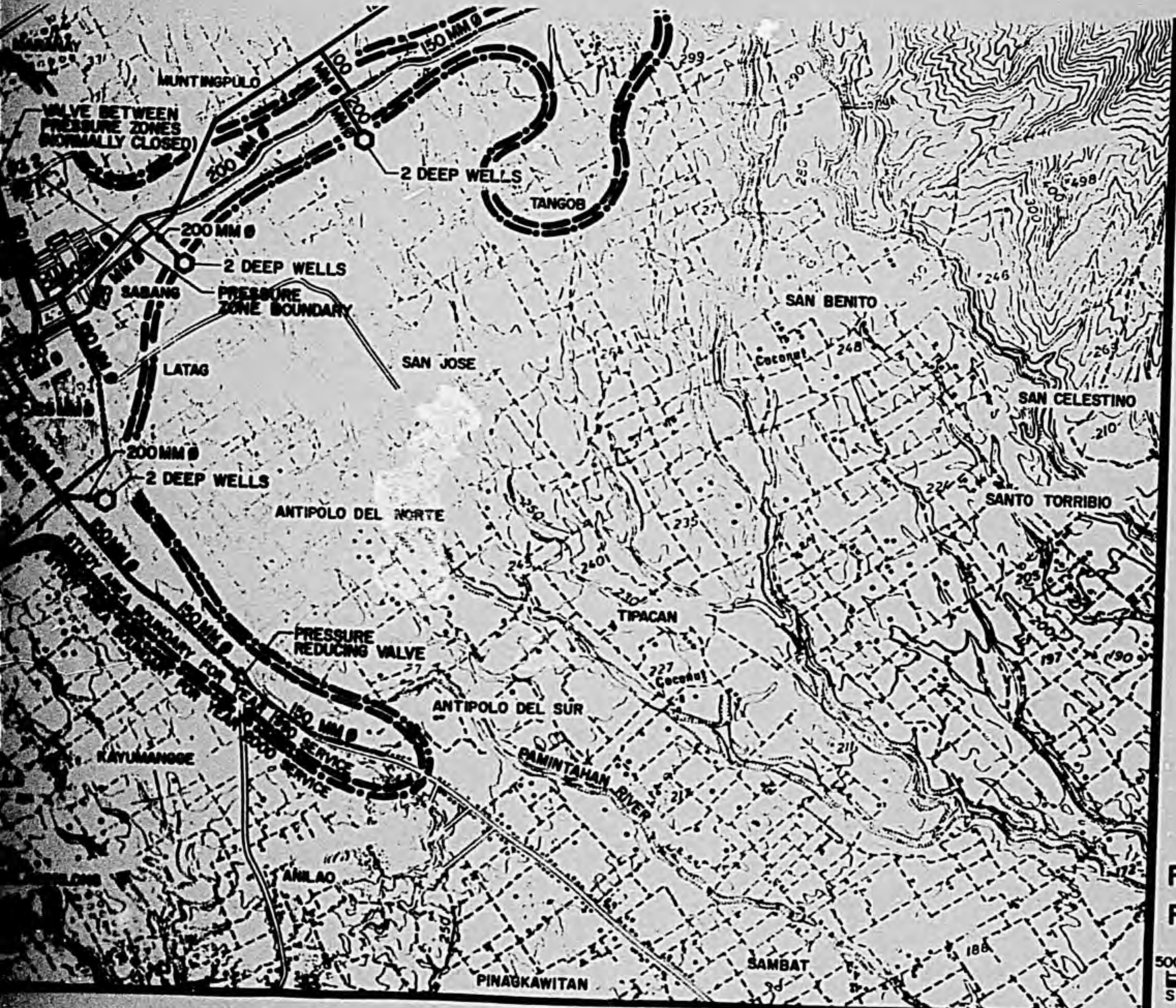
The internal economic rate of return (IERR) is the rate at which the present value of the quantifiable benefits is equal to the present value of the economic costs of the proposed project. It is generally held that for a project to be feasible and desirable, its IERR should be higher than the prevailing opportunity cost of capital. In this particular study, the opportunity cost of capital is 12 per cent.

As in the computations of the benefit-cost ratio, data of the two approaches were used in the determination of the IERR. Under the first approach where all five quantifiable benefits were considered, the IERR is 23 per cent. Using the second approach, the IERR is 22 per cent. These are shown in Appendix Table XI-E-7.

On the basis of the above stated principle of IERR, the proposed project appears to be economically feasible and justified.


SAN LUCAS
QUIPO RIVER
MUNICIPALITY OF SANTO TOMAS
SULOC
LUMBANG
MT. MATAAS NA BUNDOC
MT. CALAGA
TALISAY
MT. MALEPUNYO
SANTO NIÑO SPRINGS
125 MM ø
SANTO NIÑO
100 MM ø
SAPAC
BAGATAN
N
LEGEND:
EXISTING SYSTEM
STORAGE TANK
DEEP WELL
SPRING
PIPELINE
PROPOSED FIRST STAGE PROJECT
PHASE I-A
DEEP WELL
VALVE
PIPELINE
PHASE I-B
STORAGE TANK
VALVE
PIPELINE
PHASE I-C
DEEP WELL
PRESSURE REDUCING VALVE
PIPELINE
PROPOSED SECOND STAGE PROJECT
PHASE II-A
STORAGE TANK
DEEP WELL
PIPELINE
PHASE II-B
STORAGE TANK
DEEP WELL


FEASIBILITY STUDY FOR WATER SUPPLY OF TEN PROVINCIAL AREAS
CDM-LWUA
ALULOD SPRING
SAN FERNANDO
SANTIAGO
SAN JUAN
MAGTAGO
MUNICIPALITY OF BALETE
MUNICIPALITY OF MALVAR
SAN ANDRES
BALETE
BUGTONG PULO (WEST)
PLARIDEL
NANGKAAN
BULACNIN
PUSIL
RAILROAD
INOSLUBAN
SAN SEBASTIAN
BUBUYAN
MAYORBOR



LIPA CITY WATER DISTRICT

WATER SUPPLY SOURCE TRANSMISSION AND DISTRIBUTION SYSTEM MAP SHOWING

EXISTING FACILITIES

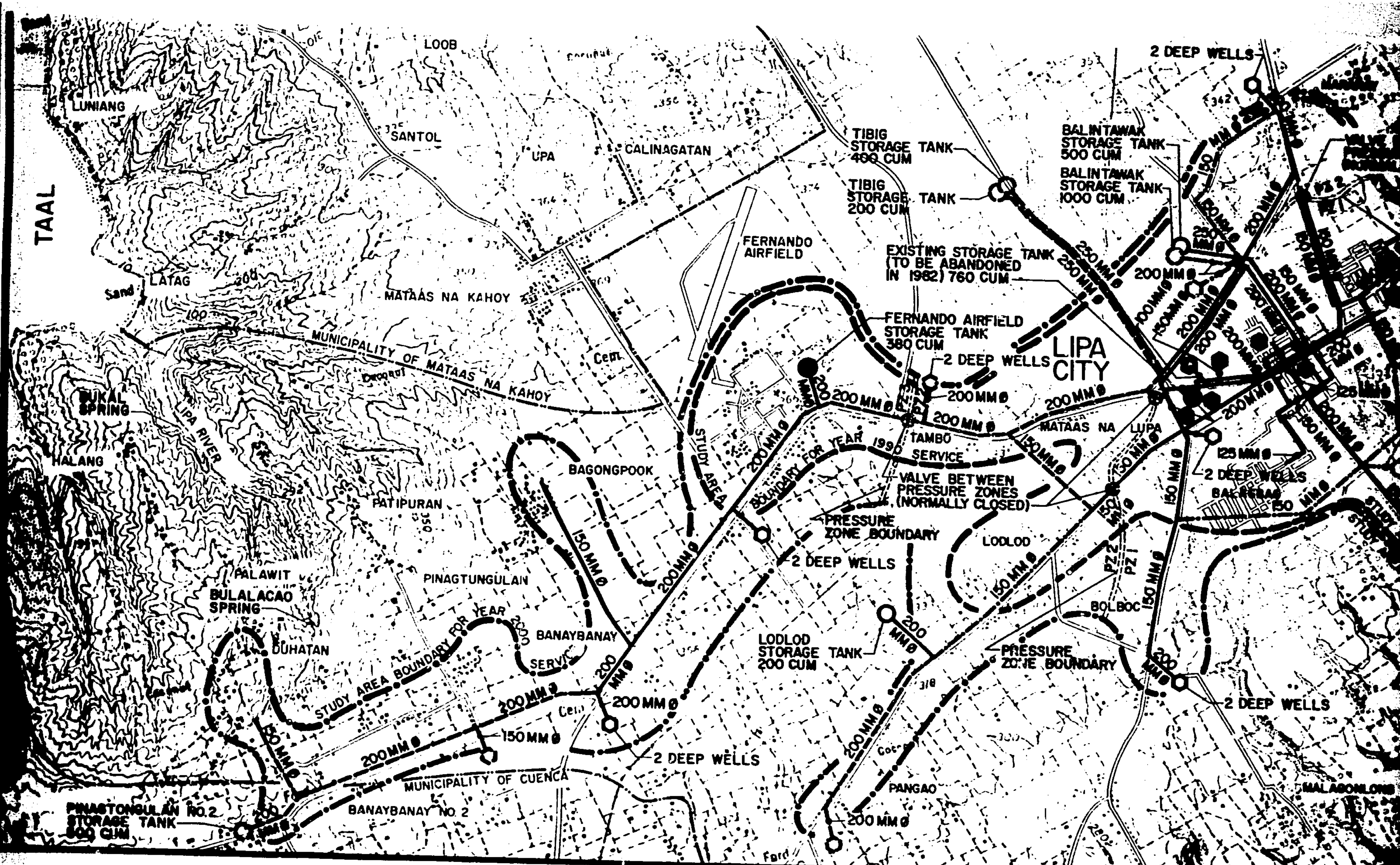
RECOMMENDED STAGE I FACILITIES

RECOMMENDED STAGE II FACILITIES

500 0 500 1000
SCALE IN METERS

FIGURE IX - 2

JUNE 1976


TAAL
LUNIANG
LOOB
SANTOL
UPA
CALINAGATAN
LATAG
Sand
MATAAS NA KAHOY
MUNICIPALITY OF MATAAS NA KAHOY
BUKAL SPRING
LIPA RIVER
HALANG
PATIPURAN
BAGONGPOOK
PINAGTUNGULAN
PALAWIT
BULALACAO SPRING
DUHATAN
BANAYBANAY
STUDY AREA BOUNDARY FOR YEAR 2000 SERVICE
150 MM Ø
200 MM Ø
2 DEEP WELLS
MUNICIPALITY OF CUENCA
BANAYBANAY NO. 2
PINAGTONGULAN NO. 2 STORAGE TANK 500 CUM
FERNANDO AIRFIELD
STUDY AREA
FERNANDO AIRFIELD STORAGE TANK 380 CUM
TIBIG STORAGE TANK 400 CUM
TIBIG STORAGE TANK 200 CUM
EXISTING STORAGE TANK (TO BE ABANDONED IN 1982) 760 CUM
BALINTAWAK STORAGE TANK 500 CUM
BALINTAWAK STORAGE TANK 1000 CUM
250 MM Ø
LIPA CITY
TAMBO
MATAAS NA LUPA
BOUNDARY FOR YEAR 1990 SERVICE
VALVE BETWEEN PRESSURE ZONES (NORMALLY CLOSED)
PRESSURE ZONE BOUNDARY
LODLOD
LODLOD STORAGE TANK 200 CUM
BOLBOC
PZ 2
PZ 1
125 MM Ø
PANGAO
MALAGONLONG
Ford