BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER	2. SUBJECT CLASSIFICATION (695)
PN-AAJ-350	AP10-0000-G732

3. TITLE AND SUBTITLE (240)

Water supply, Lipa City Water District; feasibility study, summary final report

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	37p.	RP628.1.C186a

9. REFERENCE ORGANIZATION (130)

CDM

10. SUPPLEMENTARY NOTES (500)

(Technical final report, vol.I, 193p.: PN-AAJ-351; 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)	**15. CONTRACT TYPE (140)**
AID-492-1281-T	
16. TYPE OF DOCUMENT (160)	
41	

AID 590-7 (10-79)

RP
628.1
C186a

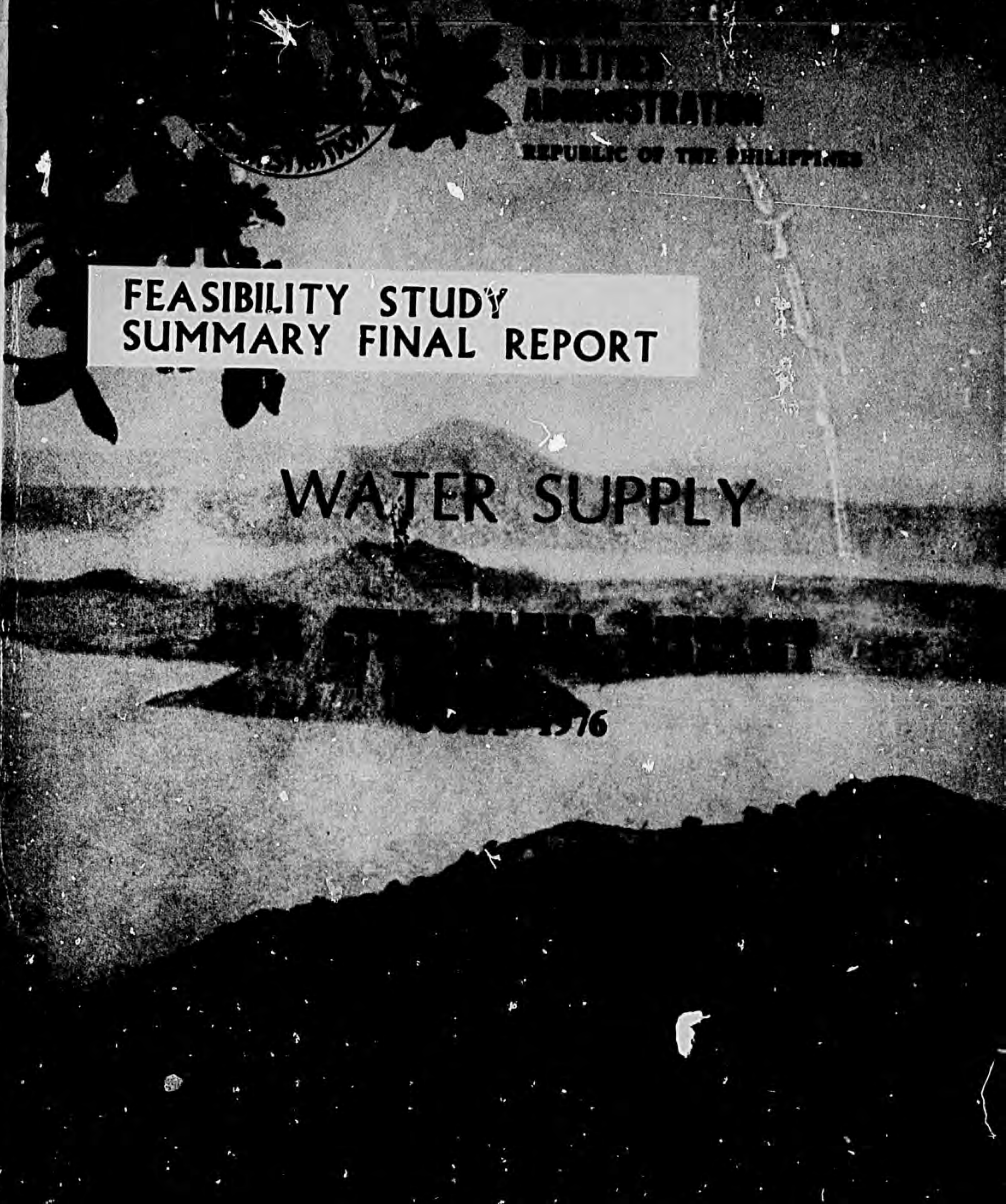
UTILITIES ADMINISTRATION

REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY SUMMARY FINAL REPORT

WATER SUPPLY

1976



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7 July 1976

Mr. Carlos C. Leaño, Jr.
General Manager
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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.
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Principal-in-Charge

WATER RESOURCES • WATER SUPPLY AND TREATMENT • WASTEWATER COLLECTION AND TREATMENT • INDUSTRIAL WASTE TREATMENT
DRAINAGE AND FLOOD CONTROL • WATER AND AIR POLLUTION CONTROL • SOLID WASTE MANAGEMENT • RESEARCH AND DEVELOPMENT

PREFACE

This water supply feasibility study and similar studies for nine other provincial urban areas have been undertaken by Camp Dresser & McKee International Inc. (CDM) for the Local Water Utilities Administration (LWUA) of the Republic of the Philippines. The studies have been financed from proceeds of a loan to the Philippine Government by the United States of America through the Agency for International Development (AID).

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, Ozamiz, and Daet;

2. Developing a methodology of conducting these studies through training seminars for LWUA engineers;

3. Applying the training methodology by employing LWUA trainees 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 to 60 of the 100 cities/municipalities.

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

The work officially started 9 December 1974. The project staff included six U.S. engineers and 35 Filipino personnel for the studies of the ten provincial urban areas. Some assistance was also provided by personnel of the respective water districts during the course of the studies.

This is a summary of the findings and recommendations that have resulted from the studies. This summary is based on the technical and economic/financial studies contained in the Draft Final Report for the Lipa City Water District, Methodology Manual on Water Supply Feasibility Studies and the Technical Final Report (Volumes I and II).

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
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Lourdes de Guzman, Technical Writer
Manuel Yoingco, Economist
Domingo Semania, LCWD General Manager

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

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

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/ha	cubic meter per day per hectare
cum/hr/sqkm	cubic meter per hour per square kilometer
cumd/m	cubic meter per day per meter
cum/mo	cubic meter per month
cum/sqkm/yr	cubic meter per square kilometer per year
FEC	foreign exchange component
GI	galvanized iron
GS	galvanized steel
ha	hectare
HGL	hydraulic grade line

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

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*Foldout at the back of the report

1. INTRODUCTION

Description of the Study Area

The study area[1/], which covers approximately 1,965 ha, lies in the heart of Lipa City which is situated northeast of Batangas, a highland volcanic province in the southwestern region of Luzon Island, Republic of the Philippines (Figure III-1). The present service area[2/] includes the poblacion[3/] and 10 barrios[4/] mostly located in the east-central portion of the city. The projected study area extends mostly towards the city's west-central part. The original water system, which was constructed some 44 years ago, has not been significantly improved to meet the increasing water demands.

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.

The present service area is approximately 190 hectares. The future area that will be served by the water system is projected to increase to about 510 ha by 1990, and 860 by the year 2000.

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.

3/ 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.

4/ A barrio is a political division of a city or municipality.

Local Water Utilities Administration and the Water District

The Local Water Utilities Administration (LWUA) was created to implement the objectives and provisions of Presidential Decree No. 198 dated May 25, 1973. This decree seeks to establish, operate, maintain and develop reliable, adequate and economically viable 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).

LWUA was formally organized on September 18, 1973 under the National Economic Development Authority (NEDA). When Presidential Decree No. 768 was issued on August 15, 1975, LWUA was placed directly under the Office of the President. 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. LWUA may provide financial, training and technical assistance to local water systems. However, only organized water districts which have complied with LWUA requirements and have been issued a Conditional Certificate of Conformance (CCC) by LWUA are qualified for financial assistance. As of March 1976, 21 out of 32 officially organized water districts, have been issued CCC's. The Zamboanga City Water District (ZCWD) is one of the districts which have been issued CCC's.

The Lipa City Water District was formed on November 18, 1974 and received the CCC on January 30, 1975.

Present Facilities

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. Figure IV-2 is a schematic plan of the existing water system. 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 increasing water demand, seven additional gravity springs and six pumped deep wells have been added since 1948. Chlorine is applied intermittently, in powder form and dosage control is arbitrary.

The distribution system consists of 12.7 km of piping, in sizes from 25 to 200 millimeters. All pipes 75 mm and smaller are GS; all pipes 100 mm and larger are CCI. In addition, there are about 6.5 km of 125 mm GI main, and 2.5 km of smaller diameter lateral pipe ranging from 50 to 75 mm, within the Santo Niño transmission system.

The only storage facility of any significance is a 760-cum reinforced concrete standpipe which was constructed in 1932. Water is pumped into this tank during a 21-hour period, and is later rationed to the distribution system. As of August 1975, there were 714 registered service connections, of which only 60 were metered. Domestic connections number 638 (594 flat-rate and 44 metered); commercial connections, 73 (57 flat-rate and 16 metered) and industrial connections, three (all flat-rate).

Present Water Use

The current water demands of Lipa City were analyzed to provide data for estimating future water requirements. For this purpose, data were obtained from records of the water district, and through field investigation, measurement and interviews with concessionaires.

Domestic consumption is estimated to be 570 cumd, with a corresponding unit per capita consumption of 63 lpcd. This estimate was based on the metered consumption of 0.8 cumd, recorded from 19 domestic connections over an eight-day period in July and August 1975.

Current commercial, institutional and industrial water demands have been difficult to estimate because of coincident domestic water consumption. The commercial and institutional demand has been assumed to be a percentage of the domestic demand and amounts to 140 cumd or 15 lpcd. Industrial consumption is estimated to be nil. Thus, the combined commercial, institutional and industrial water demand is 15 lpcd.

The present accounted-for-water of the Lipa City water system, defined as the sum of the metered water consumption and inferred water consumption at flat-rate connections, is very low, only 21 per cent of the total production. Unaccounted-for-water (79 per cent of total production), which is water lost as far as revenue to the water district is concerned, is estimated to be 183 lpcd. Part of the unaccounted-for-water (28.5 lpcd) is consumed at flat-rate connections due to underestimation of flat-rate use and at metered connections due to meter under-registration.

Deficiencies of the Existing Water System

The present level of service of the LCWD is very deficient. 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, and 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). 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

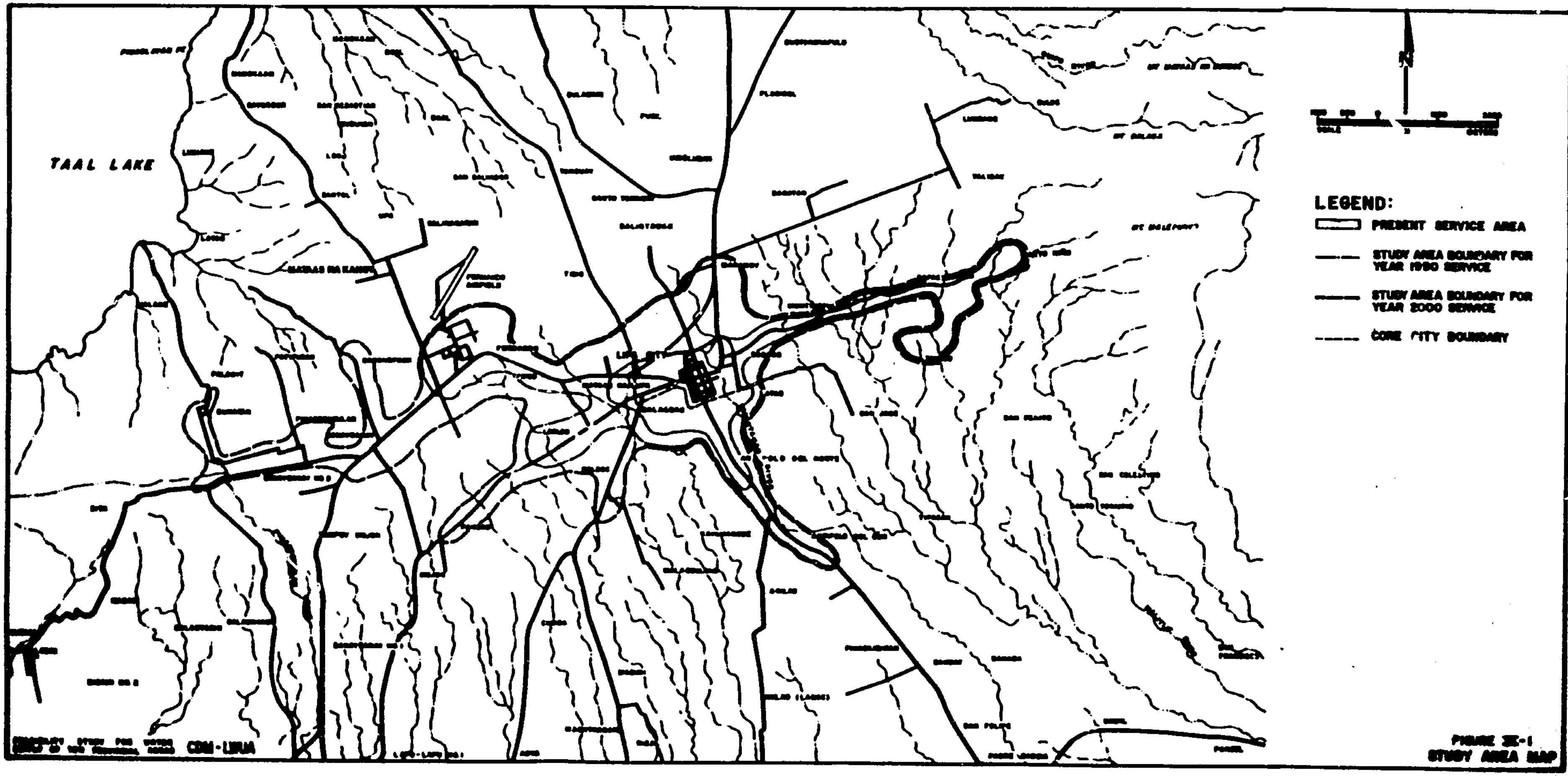
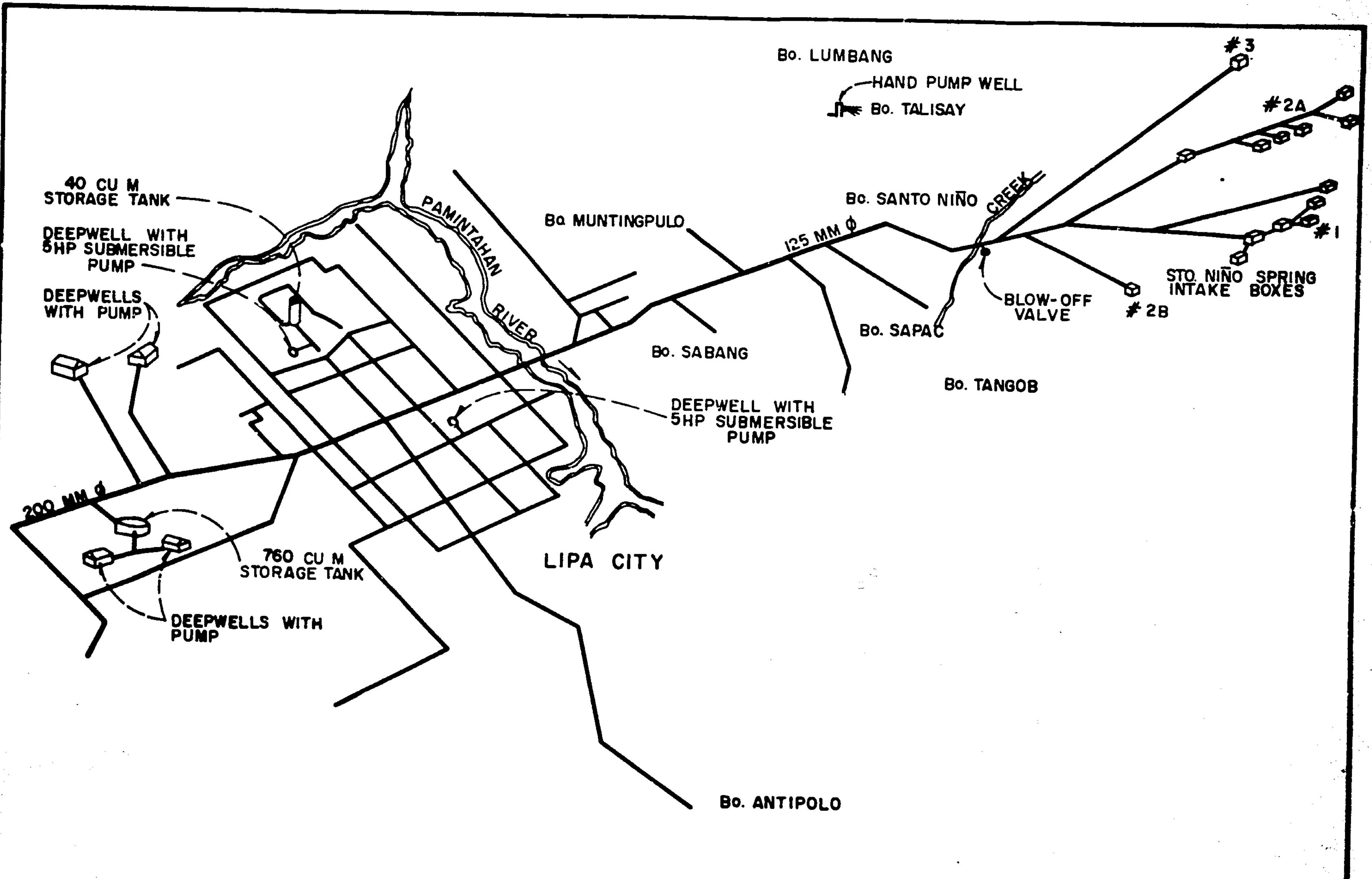


FIGURE II-1
STUDY AREA MAP



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

FIGURE IV-2
EXISTING WATER SUPPLY SYSTEM SCHEMATIC

Niño transmission mains. Well pumps are run, on the average, only 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 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; 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 and no routine water sampling and testing programs.

There is a dire shortage of transportation, equipment, tools and spare parts. There are no meter or plumbing shop facilities.

2. STUDY CRITERIA

The planning, design, and economic criteria used in the feasibility studies have been established from studies of local conditions, accepted practices, standards and methods in the Philippines and abroad. These criteria, together with unit cost estimates specifically prepared for the studies, were employed to evaluate and compare the various alternatives identified and developed during the course of the studies.

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 was made 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. *Source of Water:* Groundwater and surface water were given equal emphasis as potential sources of water.

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

4. *Conservation:* Selection of alternative plans 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 program would be implemented in stages to satisfy projected requirements of a specific design year.

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

7. *Skilled Manpower Shortage:* The recommended plan recognizes, in the short-term, the apparent shortage in skilled, technical and managerial expertise. Emphasis was given on the need for district personnel training and certification.

8. *Water Quality:* The feasibility study identifies present and future water quality problems and includes recommendations towards providing 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.

Design Criteria

Average per capita domestic water consumption in the study area has been estimated from field data and available records of past and present water use. Per capita domestic use will be increased each year to account for projected economic growth within the community.

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

There are currently few or almost no heavy and/or wet industries in the study area. Projection of future industrial water demand has been based on land zoning plans, where available.

Maximum daily and peak hourly demands have been estimated from field data and available records.

A review of the available records and consumption patterns indicates that the present unaccounted-for-water is high, amounting to 79 per cent of the water production. For preliminary design purposes, it has been assumed that unaccounted-for-water would be reduced gradually as positive improvements are added to the water system.

(Criteria and guidelines for planning and design of waterworks facilities are discussed in detail in Volume II of the Technical Final Report and Chapter 10 of the Methodology Manual.)

Economic Criteria

Discount Rate. The opportunity cost of capital or discount rate used in this feasibility study is 12 per cent. The discount rate was utilized for economic screening of the technically viable alternatives.

Inflationary Trends. From 1959 to 1969, the Philippines experienced an average inflation of five per cent per annum. The pace of inflation from 1969 to the present, however, has been at least twice that of the inflationary period after 1962. Price control policies failed to suppress the spiralling prices. In most recent years before 1973, external factors apparently played a relatively small role in the price increases. By contrast, the large price increases in 1973 were attributable to external factors i. e., the oil energy crisis and raw material shortages.

Recent statistics released by NEDA indicate that for the calendar year 1975, the government has 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 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:

- o no major changes in the structure and stability of international political relations:
- o no significant changes in production technology as to reduce dependence on oil;

- no dramatic increases in the price of energy originating from the cartel countries;
- the government will 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.

Basis of Cost Estimates

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 below.

Year	Escalation Factor
1976	1.000
1977	1.100
1978	1.210
1979	1.331
1980	1.464
1981	1.581
1982	1.708

3. POPULATION AND WATER DEMAND PROJECTIONS

Total Population

The study area population is projected to increase from 61,300 in 1975 to 121,800 in the year 2000. However, the average annual growth rates are projected to decline from 3.3 per cent in 1970-80 to 2.8 per cent in 1980-90 and 2.4 per cent in 1990-2000.

Served Population

The estimated population served in Lipa City (Figure VI-1) by the public water system in 1975 was 9,100 or 14.8 per cent of the total study area population. The population to be served by the water district will likewise increase during the study period. However, not all people living within the delineated service area are expected to be served by the water district. The projected population to be served by the year 2000 is 88,700 or 72.8 per cent of the total study area population.

Projected Water Demand

In estimating the probable future water requirements of the study area, it was assumed that there would be increasing economic growth in the area concurrent with a pricing policy for water and a public relations program of the water district that would discourage wasteful and extravagant water use.

The present total consumption in Lipa City is estimated to be 78 lpcd, of which 49.5 lpcd is accounted for and 28.5 lpcd is estimated unrecorded use. It is believed that the present domestic consumption would approach 115 lpcd if adequate supply and pressures are available. This unit domestic water demand has been adopted for 1975. For purposes of projection, it was assumed that the domestic demand would increase in the order of one per cent per year compounded annually between 1975 and 1990 and at a rate of 0.7 per cent between 1990 and year 2000. Based on these figures, the projected per capita domestic water demands are 127 lpcd, 135 lpcd and 145 lpcd for 1985, 1990 and year 2000, respectively.

The future combined commercial, industrial and institutional demand is estimated to the 15 per cent of the domestic demand. Since the Fernando Air Base lies within the water district's projected service area, demand estimates for its use are also included. The airfield's water demand is projected to be 1,750 cumd, 1,800 cumd, and 1,850 cumd in 1985, 1990 and year 2000, respectively. All concessionaires are assumed to have metered connections by 1982, and, therefore, the projections for domestic, commercial, institutional and industrial demands will be accounted-for-water. Unaccounted-for-water is primarily due to leakage and water wastage (65%) and secondarily to unrecorded consumption (14%). The unaccounted-for-water is expected to be reduced to 25 per cent in 1985, 22 per cent in 1990 and finally 20 per cent in the year 2000 through a program of metering flat-rate connections, replacing non-functioning meters, leakage surveys and elimination, and replacement of defective service connections.

On the basis of the future population to be served and the above projections, the average water demand of the service area will increase from 1,400 cumd in 1975 to 34,000 cumd by the year 2000 (Tables 1 and 2).

Variation in Water Demand

For any given year, water use on any one day may be either equal to or greater or less than the average for the year. During the dry season, for example, there will be one day

TABLE 1

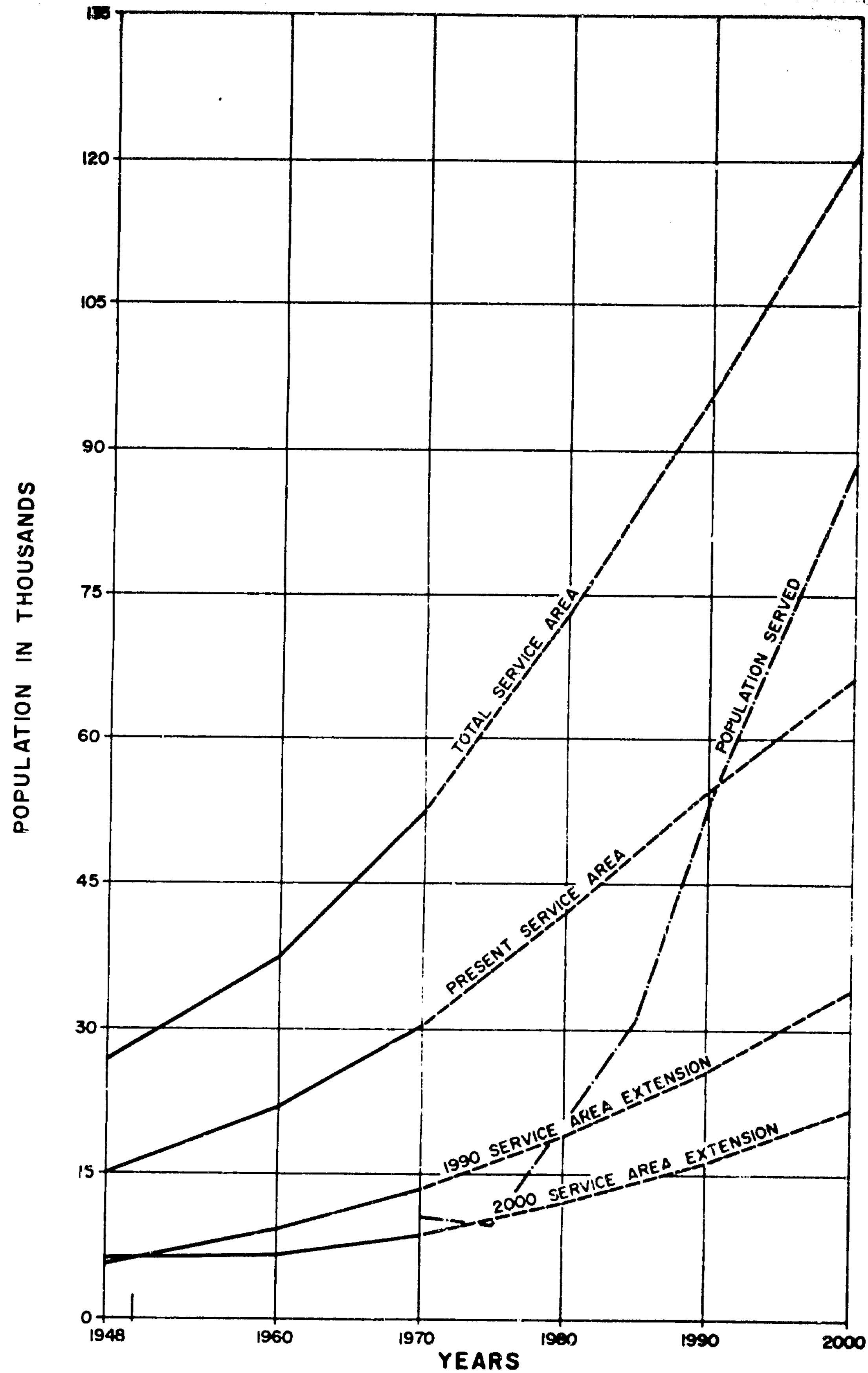
AVERAGE UNIT CONSUMPTION AND SUPPLY REQUIREMENT
LIPA CITY WATER DISTRICT

Category	1975[5/]	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[6/]	nil	56	34	21
Accounted-for-water, lpcd	78	202	189	188
Unaccounted-for-water, lpcd	154	48	45	42
(Percentage of Production)	(67)	(25)	(22)	(20)
Leakage, lpcd	82	29	27	25
Unrecorded Use, lpcd[7/]	72	19	18	17
Total Unit Demand and Supply Requirement, lpcd	232	250	234	230

5/ Based on October 1975 billing.

6/ 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.

7/ 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.



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

FIGURE VI-1
POPULATION PROJECTIONS

TABLE 2

AVERAGE DAILY WATER DEMAND AND SUPPLY REQUIREMENTS (cumd)

Category/Year	**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 [8/]	6,250	10,100	16,750
Unaccounted-for-water	1,400 [8/]	1,500	2,400	3,700
Total	2,110	7,750	12,500	20,450

during which more water will be used than on any other day. The water used on this day is referred to as the maximum-day water demand. Water use also varies from hour to hour throughout the 24-hour day, with one hour showing the maximum rate of use. The rate of water consumption on this hour is referred to as the peak-hour demand.

For the Lipa City service area, there are no reasonably accurate and reliable records of water use from which the relationships between maximum demands and average demands may be determined. On the basis of an evaluation of variations in water use in communities similar to the study area, however, the following ratios were adopted for this study:

Relationship of Flow	**Ratio**
Maximum Daily to Average Daily Demand	1.20:1.00
Peak-Hour to Average Daily Demand	1.50:1.00–2.00:1.00

8/ See Footnote 7.

4. WATER RESOURCES

Wells

Data were gathered on 58 wells and were used as a basis for the groundwater studies.

The studied wells ranged from 21 to 162 m deep and had specific capacities varying from 0.1 to 3.6 lps/m. Well construction generally is poor and so the better wells are considered more indicative of general aquifer characteristics than the poorer ones. Reliable pump test data are not available but the specific capacities of the two best wells (probably both in the aquifer bottoming at about 90 m depth in the poblacion) indicate a transmissivity of about 400 cumd/m for the aquifer tapped by the wells. Hydrogeological studies infer that wells with 30 lps capacity 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)	Drawdown	
		Central Well (m)	Peripheral Well (m)
5,000	500	54	52
5,0ᑕ0	1,000	50	48
5,000	2,000	45	43

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.

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

Springs

In the LCWD area, the springs are of two types. The springs in the mountains to the east are supplied by the volcanic aquifer (see Figure VII-1). 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 consequent to large-scale well development in Lipa City, the probable effect will be minor. This effect may 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.

The springs to the west, north and south of Lipa City (see Figure VII-1) and at a lower elevation are supplied by the sedimentary aquifers. In this case, large-scale well development in Lipa City will have a serious effect on those springs that are fed by the same aquifers that the wells will tap. The wells will intercept the groundwater that now flows from the recharge area to the springs and will reduce or dry up the spring flows.

Spring water quality is uniformly good except for excessive iron reported in some springs.

The measured and estimated flows listed herein must be considered only as a tentative guide for water 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. Measured/estimated spring flows are as follows:

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

The approximate discharge of 13,850 cumd is not sufficient to provide the maximum-day demand of 1990. This summary includes only springs of over 500-cumd capacity. It is not believed that any other large springs exist within an economically practical distance of Lipa City. Many of these springs would be costly to incorporate into the LCWD system because of distance, low eleva-

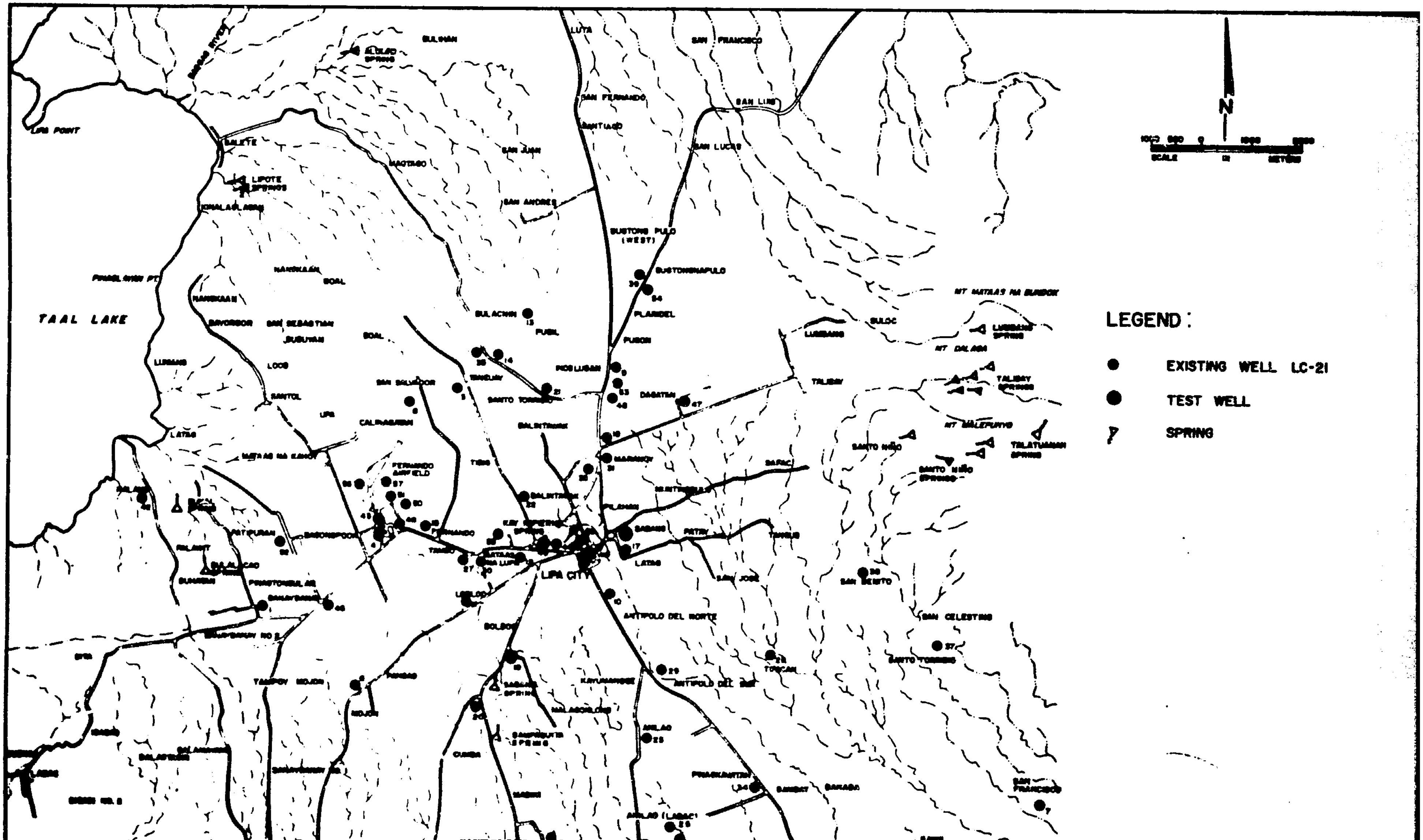


FIGURE III-1
WELL AND SPRING LOCATION MAP
LIPA CITY AREA

tion or intervening terrain. In addition, Alulod and Lipote Springs are outside the water district and the water rights may not be available. If the expected long-term decline in spring flow (because of an increased pumpage through wells) in all but Santo Niño and Talatuanan Springs is considered, springs do not appear to be a desirable supplemental source for LCWD.

Surface Water Sources

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 no large streams within an economical distance from Lipa City.

Taal Lake, a potential water source for LCWD, 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.

Taal Lake is the only sufficiently large source of surface water within an economic distance of Lipa City. The available water from Taal Lake is sufficient for the foreseeable 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 nine kilometers 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 (about 400 mg/l) which, under the Philippine National Standards, is classified between "permissible" and "excessive". Although water of this quality is tolerated without significant complaints in water-short areas (for example, in the Middle East), 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 increased salinity, 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 in concentration of these salts in the water.

5. ALTERNATIVES CONSIDERED

Three basic alternative schemes have been established for detailed studies:

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

Alterntive 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:

	Net Present Worth		
Alternative	Cost (₱ x 1,000)	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 ₱5.20/cum or more, excluding distribution system costs.

The water quality tests performed on samples taken from spring and well sources indicate, in general, that most of the physical and chemical quality parameters are within acceptable limits. Based on these analyses, disinfection will be the only treatment needed. Disinfection ensures safety of the water delivered to the consumers. Various disinfecting chemicals (chlorine, iodine, bromine, oxidizing agents) and processes (ozonation, ultraviolet radiation) were examined in this study. Chlorination, which is a universal disinfecting process for municipal water supplies and has a long history of successful application, has been determined to be the most practicable disinfection treatment process for the LCWD area.

Major distribution alternatives for the LCWD service area are concerned with pressure zones, feeder mains, storage facilities and internal distribution network (service mains).

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. As a result of the analysis, three pressure zones have been established.

Important considerations with respect to a distribution storage are location, elevation, and staging of required volume. The alternative for feeder mains includes the locations or routes, sizes, spacing in the network, and construction staging. The alignments for future feeder mains have been chosen along existing and planned road and street rights-of-way. As much as possible, the feeder mains have been looped to avoid dead-end service areas, minimize the number of customers affected by line shut-off, and provide adequate pressure during maximum demand periods as the water can be supplied from more than one direction. Two-hundred (200) mm has been taken as the minimum diameter of feeder mains and 1,000 m as the maximum spacing. The timing of construction of the feeder mains took into account the attainable level of growth in the distribution system, with priority given to areas having higher densities of potential customers.

Alternative studies on the internal network systems considered service both with and without fire protection. Other considerations included minimum pressures in the system, minimum pipe sizes, valve location and spacing, and type, location, and spacing of fire hydrants.

Alternatives available to counteract future (and present) water shortages include: (1) reuse of wastewater, (2) desalting, (3) precipitation augmentation, (4) land management, and (5) dual plumbing system. Except for land management, the above alternatives would have little or no applicability in the study area in the immediate future in view of economic and other factors unique to the study area.

6. RECOMMENDED PLAN

An integrated water supply system utilizing groundwater wells 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. Prior to the initial construction phase, an Early Action Program must be undertaken.

The following is the schedule for implementation of the recommended program:

Stage/Phase	Implementation/Construction Period
Early Action	1977–78
Stage I	1978–90
Phase I-A	1978–82
Phase I-B	1982–86
Phase I-C	1986–90
Stage II	1990–2000
Phase II-A	1990–95
Phase II-B	1995–2000

Early Action Program

The Early Action Program, estimated at ₱1.19 million, includes easily implementable steps in planning and administration, land acquisition and data collection, and operational improvements. Details of the program are presented in the Technical Final Report, Volumes I and II. Of importance are:

- strengthening the legal basis for development of water sources;
- initiating improvements to the management, engineering and maintenance procedures;
- land acquisition of sites for proposed improvements;
- installation of disinfection facilities at different source locations;
- routine collection of hydrologic, well and meteorological data;
- metering of all existing unmetered service connections;
- leakage survey and appropriate repairs to pipelines and valves; and
- acquisition of selected office and system equipment.

Modifications to the Existing System

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 retained after rehabilitation. About 2,000 cumd would be available from these sources.

Long-Term Program

Source Development. The long-term water supply for the LCWD will be derived primarily from groundwater wells. The number of wells required to meet maximum daily demands till the year 2000 (see Figure IX-1) is shown below:

	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

Based on the topography, pressure zone[9/] 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/Distribution Facilities. The proposed transmission/distribution facilities for the long-term improvement program of LCWD will include approximately 46.6 km of pipelines ranging in size from 100 to 250 millimeters (see Figure IX-3). These will serve to connect the well sources (and existing ones) with the proposed storage tanks and the internal network of the LCWD. During Phase I-A, the following mains are proposed for construction:

100 mm – 0.75 km

150 mm – 3.59 km

200 mm – 11.21 km

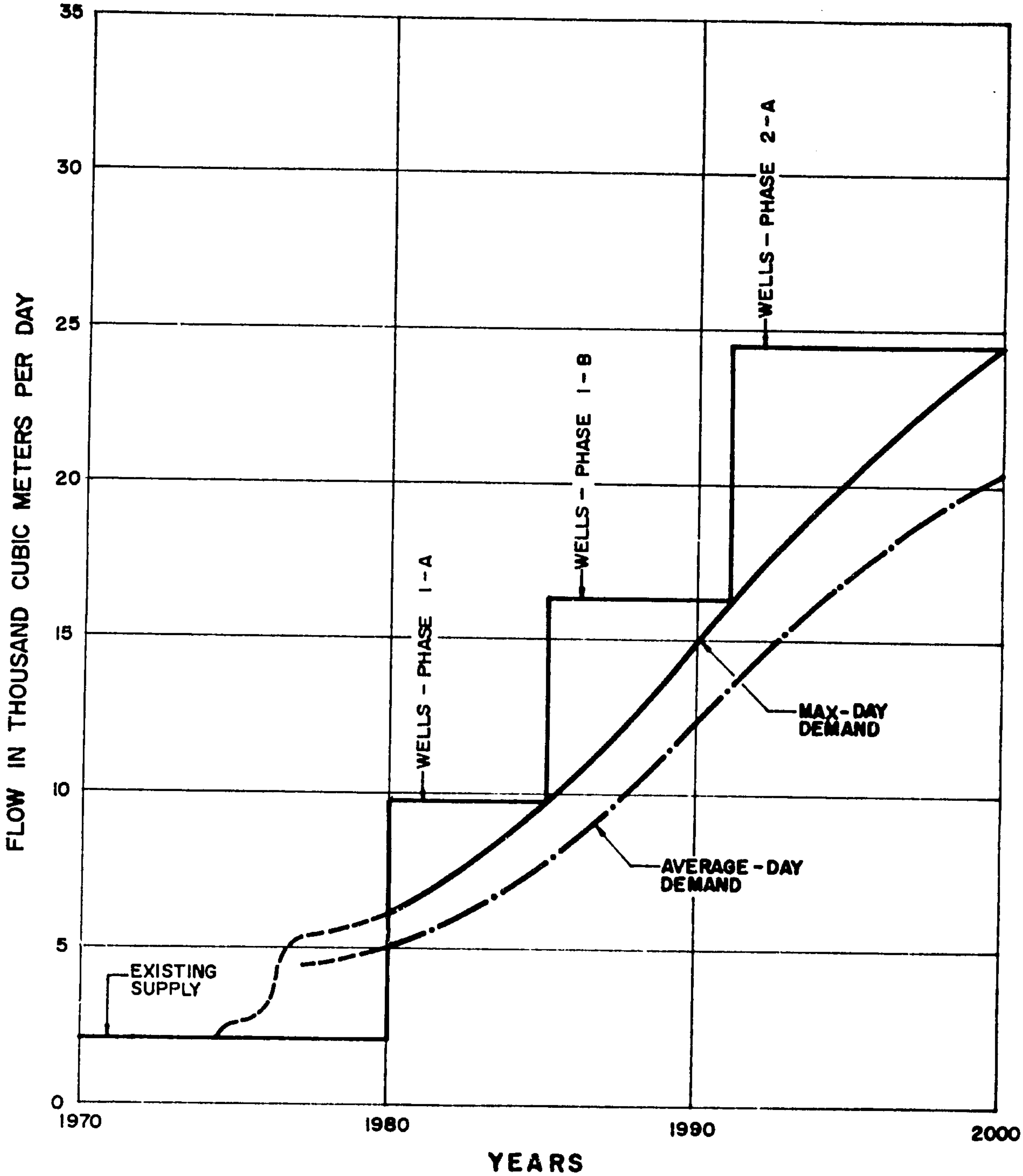
Water Treatment. The only treatment proposed for the water supplied to the LCWD system is disinfection by chlorination. Chlorination facilities will be provided for each of the additional wells constructed in every phase. During the Early Action Program, disinfection equipment will be provided at all operating wells with two spare units to be installed at the collection chamber of the present spring source of lowest elevation.

Storage. Storage tanks will be provided for Lipa with total volumes equivalent to 12 per cent of projected maximum daily flows.

The ultimate (year 2000) storage requirement in Lipa is 2,800 cum, with 1,400 cum to be provided in the first construction stage and additional 1,400 cum to be provided in the second construction stage. The existing storage tank in the poblacion is recommended to be kept as emergency storage and the Fer-

9/ Pressure zone characteristics are:

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



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

FIGURE IX-1
WATER SUPPLY-DEMAND CHART

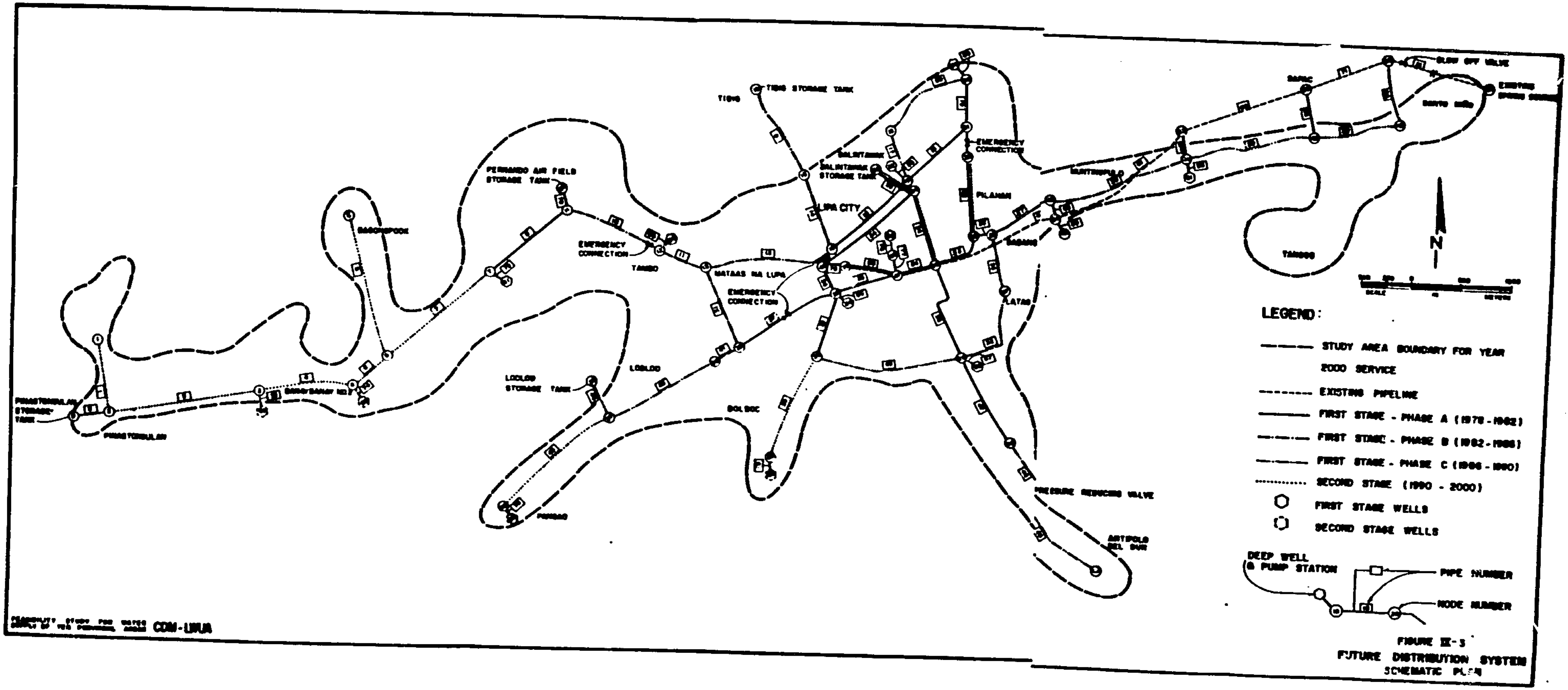


FIGURE IX-3
FUTURE DISTRIBUTION SYSTEM
SCHEMATIC PLAN

nando Air Base storage facilities should be restored and kept in service. In the first construction phase, the storage tank in the poblacion will be utilized and the storage tank at the Fernando Air Base will be renovated. During Phase I-B, the required 1,400-cum storage will be provided through a 1,000-cum storage tank, located in Barrio Balintawak at an elevation range of 335-340 m and through another 400-cum storage tank in Barrio Tibig at elevation range of 362-365 meters.

The remaining storage of 1,400 cum will be constructed in the second stage of the long-term construction program, with 500 cum in Barrio Balintawak and 200 cum at Barrio Lodlod during Phase II-A; 200 cum in Barrio Tibig; and 500 cum at Bukal Hill in the final phase.

Internal Network. Internal network piping (service mains) will be installed to reinforce the existing distribution system and to extend water service to new areas. 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. Hence, it is projected that by the year 2000, approximately 680 ha of service area will be covered by internal network piping.

Service Connections. 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.

Other Facilities. The LCWD presently occupies a small office space within the compound of the Lipa City Engineering Department. It is recommended that a new office complex be constructed and will include an administrative area and functional space for laboratory, meter shop, storage, garage and parking for the efficient operation of the water district.

Summary of Water System Improvements

The main features of the recommended long-term water supply improvement program for the projected service area are summarized in Table 3 and shown in Figures IX-2, appended, and IX-3. Details of the program, including transmission/distribution pipe diameters, lengths and node data, are presented in Chapter IX, Volume I of the Technical Final Report.

Capital Cost Summary

The capital costs for each phase of construction, including the Early Action Works, are summarized in Table 4. The total project cost shown in the table includes the construction cost of facilities, engineering and contingencies, land and easement cost, administrative and legal fees (interest during construction is incorporated in the financial analysis). Land cost for the proposed facilities is included in the Early Action Works cost. The foreign exchange component of the total project cost includes the cost of direct and/or indirect import items.

A breakdown of the Phase I-A costs is given in Table 5. All costs shown in Tables 4 and 5 are based on projected July 1976 unit prices. Escalated Phase I-A costs are shown in Table 6.

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 are given in Tables 7 and 8. The annual costs do not include repayment of the debt to be incurred for construction of the proposed facilities. Repayment costs are included in the financial analysis to determine the future water rates.

TABLE 3
SUMMARY OF PROPOSED WATER SUPPLY IMPROVEMENTS

	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[10/]	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	
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

10/ Based on July 1976 price levels

TABLE 3 (Continued)
SUMMARY OF PROPOSED WATER SUPPLY IMPROVEMENTS

	Early Action Works	Phase I-A	Phase I-B	Phase I-C	Phase II-A	Phase II-B
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
Conversion Flat-Rate to Metered Connections	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. Lodlod will be kept for emergency storage	

TABLE 4
CAPITAL COST SUMMARY[11/]

Construction Phase	Construction Period	Construction Cost (₱ x 1,000)	Project Cost (₱ 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

TABLE 5
PROJECT COST OF RECOMMENDED PROGRAM
PHASE I–A (1978-82)
LIPA CITY WATER DISTRICT

₱ x 1,000
(UNESCALATED)

Item	1977	1978	1979	1980	1981	1982	Total
Source Development	200	1,233	2,270	1,134	–	–	4,837
Transmission-Distribution Mains and Valves	163	541	923	923	923	461	3,934
Storage Tanks and Appurtenances	7	42	76	39	–	–	164
Internal Network	71	237	404	404	405	202	1,723
Service Connections	82	273	462	462	462	233	1,974
Water District Buildings	58	359	660	330	–	–	1,407
TOTAL PROJECT COST[12/]	581	2,685	4,795	3,292	1,790	896	14,039

11/ All costs are based on July 1976 prices.

12/ Includes design (first year of each major segment of development), supervision of construction, contingencies, legal and administrative costs spread uniformly during the period of construction.

TABLE 6
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	–	–	1,858
TOTAL PROJECT COST	639	3,249	6,377	4,807	2,828	1,531	19,431

TABLE 7
ANNUAL OPERATION AND MAINTENANCE COSTS
LIPA CITY WATER DISTRICT
(UNESCALATED)

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

TABLE 8
ANNUAL OPERATION AND MAINTENANCE COSTS
LIPA CITY WATER DISTRICT
(ESCALATED)

Item	Annual Costs (₱ x 1000)		
	1980	1990	2000
Source Facilities	165	1,084	4,191
Treatment (Chlorine)	30	129	425
Transmission and Distribution	35	235	951
Administration and Personnel	194	802	2,295
Miscellaneous	20	88	317
TOTAL	444	2,338	8,179

7. FINANCIAL FEASIBILITY

The financial feasibility analyses made for the study establish 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 water rates appear to be within the "ability to pay" of the average LCWD householder.

Development Costs

The cost estimates of the facilities needed to improve and expand water services of the district over the development planning period were based on the projected July 1976 unit prices. To account for the effects of inflation, capital cost estimates have been escalated on a year by year and item by item basis. Escalation factors derived from the projected or assumed inflationary trends were used.

Financing Policies

Major potential sources of funds which can be utilized by the district are (1) operating sources, (2) non-operating sources, and (3) reserve funds, Non-operating sources include loans, charges and assessments, and grants or credits.

Funds from revenues derived from the operations of the water district can be devoted to financing developmental costs to the extent that the revenues exceed annual cash requirements for all purposes.

Funds may be borrowed by the water district for development. From the district's point of view, LWUA is the primary, if not the only, realistic source of funds. LWUA borrows both local and foreign currencies at varying terms and lends them to the water district.

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.

Credit available to the water district may include funds that the national government may advance during the early years of the development at little or no interest to assist the local utility in building its financial capacity. It may also be possible to obtain outright grants from the national government. In addition, LWUA has also access to loan funds on concessionary terms and is thus able to relend funds at rates that may be lower than market rates. This in itself is a "grant" available to the local water district.

Reserve requirements are tied directly to obtaining development loans from LWUA. They are considered funds required to support capital development.

Revolving Fund for Service Connections

The cost analysis for service connections in this study assumes the establishment of a revolving fund. Cost of the connection will be shared by the customer and the water district. The customer will pay for the cost of the water meter and two-thirds of the cost of the rest of the service line. The district will bear the remaining one-third of the cost.

To assist new customers in financing service connection charges, it will be necessary to provide working capital for a revolving fund. LWUA has a current policy which provides for service connection costs to be payable at ₱5.00 per month over a 10-year period. It is proposed that this rate be increased to ₱5.65 per month to cover the increase in the cost of the meters. Net inflow funds will be required over a period of 10 years to build sufficient income to support the annual cost of connections.

Funds for Capital Development

Funds required to cover development costs have been determined in the financial study. Also included in the financial analyses are (1) assets and depreciation forecasts, (2) annual depreciation expenses, (3) revolving fund for service connections, (4) debt service requirements, (5) revenue unit forecasts, (6) revenue forecasts, (7) feasibility of charges, (8) external borrowing required, (9) projections of financial statements, (10) cash flow statements, (11) rate of return, and (12) other financial statements. Detailed data are presented in the Technical Final Report. The following have been derived from the financial studies.

1. The recommended plan for the first construction phase (Phase I-A) of LCWD is financially feasible.

2. 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.

3. Revenues are adequate for most years assuming some flexibility is taken on setting up the reserve fund and depreciation expense.

4. The cash flow analysis shows adequate working capital. Positive net cumulative cash balance is realized immediately.

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

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

Cash Flow and Other Financial Statements

The cash flow statement (sources and applications of funds statement) provides an indication of the adequacy of working capital. It is generally not sufficient to cover cash outlays with revenues because of the tendency of cash receipts to lag behind the cash outlays. Also, an organization that is expanding operations, conducting a capital development program and generally increasing its level of activities will need increasing quantities of working capital.

Table 9 presents the cash flow statement until 1982 for the study area. As can be seen, potential net decreases are expected in 1980 and 1982. However, cumulative cash projections until year 2000 indicate positive increases in 23 of the 25-year (1976-2000) study period even if cash at the beginning of 1976 is assumed to be zero.

The Balance Sheet for LCWD is shown in Table 10.

Rate of Return

Discount rate of return on total investments (Table 11) 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.

The 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.

The rate of return for LCWD is estimated to be 9.6 per cent.

8. ECONOMIC FEASIBILITY

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

Economic Benefits

The economic benefits that will be derived from an improved, upgraded, and expanded water system can be classified into quantifiable and non-quantifiable. Quantifiable benefits are those which can be expressed in monetary terms while non-quantifiable benefits are intangible but real, and are extremely difficult to express in monetary terms.

The quantifiable benefits that have been identified and for which monetary values have been determined are increase in land values, health improvement, reduction in fire insurance cost, reduction in fire damage and incremental revenue. Significant non-quantifiable benefits are improved standard of living and economic linkages.

Economic Costs

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 (1) project costs, (2) replacement costs, (3) operating and maintenance costs.

Benefit-Cost Ratio and IERR

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 were included in 1976 prices and discounted at 12 per cent, the benefit-cost ratio is 1.61:1, while the IERR is 23 per cent. In the second approach where only two of the benefits, reduction in fire damage and incremental revenue, were considered, then escalated and discounted, the benefit-cost ratio is 1.88:1 and the IERR is 22 per cent.

TABLE 9

PROJECTED SOURCES AND APPLICATIONS OF FUNDS
LIPA CITY WATER DISTRICT
₱ x 1000

	1976	1977	1978	1979	1980	1981[13]	1982[13]
SOURCES OF FUNDS							
Net Income Before Interest	84	207	306	1122	1245	1216	2141
Add: Depreciation	67	92	126	155	194	490	540
Total Internal Cash Generation	151	299	432	1277	1439	1706	2681
Long-Term Borrowing	664	1169	3219	6213	4601	2882	3299
Capital Contributions	19	24	30	164	205	276	328
Total External Cash Generation	683	1193	3249	6377	4806	3158	3627
TOTAL SOURCES OF FUNDS	834	1492	3681	7654	6245	4864	6308
APPLICATIONS OF FUNDS							
Capital Expenditures	683	1193	3249	6377	4806	3158	3627
Debt Service: Interest	–	60	165	454	1014	1428	1687
Principal	–	–	–	–	–	–	–
Sub-Total	–	60	165	454	1014	1428	1687
Replacements	–	–	–	–	1070	–	1927
Decrease in Working Capital	86	42	94	321	75	91	305
TOTAL APPLICATIONS OF FUNDS	769	1295	3508	7152	6965	4677	7546
Increase (Decrease) in Cash Balance	65	197	173	502	(732)	187	(1238)
Cash Balance Beginning of Year	0	65	262	435	937	217	404
Cash Balance End of Year	65	262	435	937	217	404	(834)
Debt Service Ratio	–	5.00	2.61	2.80	1.42	1.19	1.59

[13] Includes portion of Stage I Phase B.

TABLE 10

PROJECTED BALANCE SHEET
LIPA CITY WATER DISTRICT
₱ x 1000

	1976	1977	1978	1979	1980	1981[14]	1982[14]
ASSETS							
Fixed Assets:							
Gross Value of Fixed Assets	4067	4969	6241	8620	11569	23187	27339
Less: Accumulated Depreciation	2210	2302	2428	2583	2044	2534	1947
Net Value of Fixed Assets	1857	2667	3813	6037	9525	20653	25392
Work in Process	–	291	2268	6266	8460	–	275
Total Fixed Assets	1857	2958	6081	12303	17985	20653	25667
Current Assets:							
Cash	65	262	435	937	217	404	(834)
Accounts Receivable	77	119	160	383	462	548	817
Provision for Bad Debts	(1)	(1)	(2)	(8)	(5)	(5)	(16)
Inventories	37	41	101	212	235	255	319
Total Current Assets	178	421	694	1524	909	1202	286
TOTAL ASSETS	2035	3379	6775	13827	18894	21855	25953
EQUITIES AND LIABILITIES							
Current Liabilities:							
Accounts Payable	27	31	37	44	74	89	106
Current Maturities of Long-Term Debt	–	–	–	–	–	–	165
Total Current Liabilities	27	31	37	44	74	89	271
Long-term Debt (Less: Current Maturities)	664	1833	5052	11265	15866	18748	21882
Equities:							
Government Contribution	1241	1241	1241	1241	1241	1241	1241
Capital Contribution	19	43	73	237	442	718	1046
Reserves	9	23	42	88	143	274	470
Unappropriated Retained Earnings	75	208	330	952	1128	785	1043
Total Equities	1344	1515	1686	2518	2954	3018	3800
TOTAL EQUITIES AND LIABILITIES	2035	3379	6775	13827	18894	21855	25953

[14] Includes portion of Stage I Phase B.

TABLE 11

RATE OF RETURN ON TOTAL INVESTMENTS (DISCOUNTED CASH FLOW METHOD) LIPA CITY WATER DISTRICT (₱ x 1000)

Year	Debt Service	Net Increase in Cash	Total Cash Inflow	Investments	Net Cash Inflow	First Trial Present Value: 8% Factor	First Trial Present Value: 8% Value	Second Trial Present Value: 10% Factor	Second Trial Present Value: 10% Value
1976	–	(65)	(65)	683	(618)	1.000	(618)	1.000	(618)
1977	60	197	257	1,193	(936)	0.926	(867)	0.909	(851)
1978	165	173	338	3,249	(2,911	0.857	(2,495)	0.826	(2,404)
1979	454	502	956	6,377	(5,421)	0.794	(4,304)	0.751	(4,071)
1980	1,014	(732)	282	5,876	(5,594)	0.735	(4,112)	0.683	(3,821)
1981	1,428	187	1,615	3,158	(1,543)	0.681	(1,051)	0.621	(958)
1982	1,687	(1,238)	499	5,554	(5,105)	0.630	(3,216)	0.564	(2,879)
1983	2,149	628	3,777	5,044	(1,267)	0.583	(739)	0.513	(650)
1984	2,544	666	3,210	7,149	(3,949)	0.540	2,132	0.467	(1,844)
1985	3,125	873	3,998	5,954	(1,956)	0.500	(978)	0.424	(829)
1986	3,686	1,121	4,807	4,113	694	0.463	321	0.386	268
1987	3,972	1,647	7,619	3,892	1,727	0.429	741	0.350	604
1988	4,230	2,463	1,767	4,116	(2,349)	0.397	(933)	0.319	(749)
1989	4,664	3,010	7,674	4,361	3,313	0.368	1,219	0.290	961
1990	4,932	3,617	8,549	2,488	6,061	0.340	2,061	0.263	1,594
1991	5,404	3,894	9,298	238	9,060	0.315	2,854	0.239	2,165
1992	5,331	3,773	9,104	132	8,972	0.292	2,620	0.218	1,956
1993	5,422	3,448	8,870	264	8,606	0.270	2,324	0.198	1,704
1994	5,450	3,716	9,166	515	8,651	0.250	2,163	0.180	1,557
1995	5,352	3,965	9,317	601	8,716	0.232	2,022	0.164	1,429
1996	5,254	3,681	8,935	800	8,135	0.215	1,749	0.149	1,212
1997	5,557	3,675	9,232	1,264	7,968	0.199	1,586	0.135	1,076
1998	5,422	2,703	8,125	2,575	5,550	0.184	1,021	0.123	683
1999	5,521	3,787	9,308	1,210	8,098	0.170	1,377	0.112	907
2000	5,366	3,048	8,414	1,684	17,396[15]	0.158	2,749	0.102	1,774
							+ 7,626		– 1,784

RATE OF RETURN = 9.6%

15/ Includes net asset value of ₱10,666

Total Assets	₱ 99,102
Total Liabilities	(39,555)
Cash	(48,881)
Net Asset Value	₱ 10,666

9. IMPLEMENTATION PLAN

Implementation Schedule

The recommended water supply improvements and facilities may be implemented in increments or stages. The following is the proposed schedule for implementation of the early action, interim and Phase I-A improvements:

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

Cash Outflow from 1976 to 1982

Estimates of funding requirements are important information in the implementation of the recommended water system improvements. The projected cash outflows of LCWD for Phase I-A design and construction (1976-1982) are listed in Table 12. This includes local costs and foreign exchange components.

Sewerage/Drainage Concepts

Lipa does not have central sanitary sewage collection and disposal systems. Septic tanks are used in the larger houses and establishments. The effluents from the septic tanks are piped to leaching pits, or overflow into the nearest drainage ditches. The latter practice results in grossly polluted open drains and gives rise to offensive and unaesthetic conditions.

As the water supply problem is resolved, wastewater quantities will increase. Consequently, related public health and aesthetic problems will also increase. Therefore, as soon as the first phase of the water supply program is underway, appropriate steps should be taken by the water district towards the satisfactory solution of the anticipated wastewater problem.

The initial effort should be directed in developing a comprehensive sewerage/drainage feasibility study. This study must address the issue of whether a combined or a separate system should be provided, and should include various alternative studies relating to ultimate disposal of wastewater such as ultimate disposal of wastewater such as primary treatment and river disposal, wastewater reclamation, etc.

In the meantime, an inventory of existing facilities and collection of pertinent data and information should be conducted in preparation for the sewerage/drainage feasibility study. These activities will include a house-to-house survey of wastewater and toilet facilities and compilation of available and as-built drawings of the storm drains and canals.

Monitoring of Water Quality and Flows

To provide accurate and reliable data for operation and planning and for detailed design of future facilities, it is imperative that the flow and water quality of the wells to be constructed for the LCWD be monitored. The collection of associated rainfall records will aid in the determination of the long-term prospects as water supply sources of the wells to be developed.

TABLE 12

CASH OUTFLOW (1976-1982)
LIPA CITY WATER DISTRICT

Year	Project Cost ₱ x 10^6	Local Cost ₱ x 10^6	Foreign Exchange Component[16/] ₱ x 10^6	Foreign Exchange Component[16/] \$ x 10^3
1976	0.649	0.286	0.363	51.857
1977	1.196	0.486	0.710	101.428
1978	3.249	1.708	1.541	220.143
1979	6.377	3.363	3.014	430.571
1980	4.807	2.472	2.335	333.571
1981	2.828	1.353	1.475	210.714
1982	1.531	0.732	0.799	114.142
TOTAL	20.637[17/]	10.400	10.237	1462.426

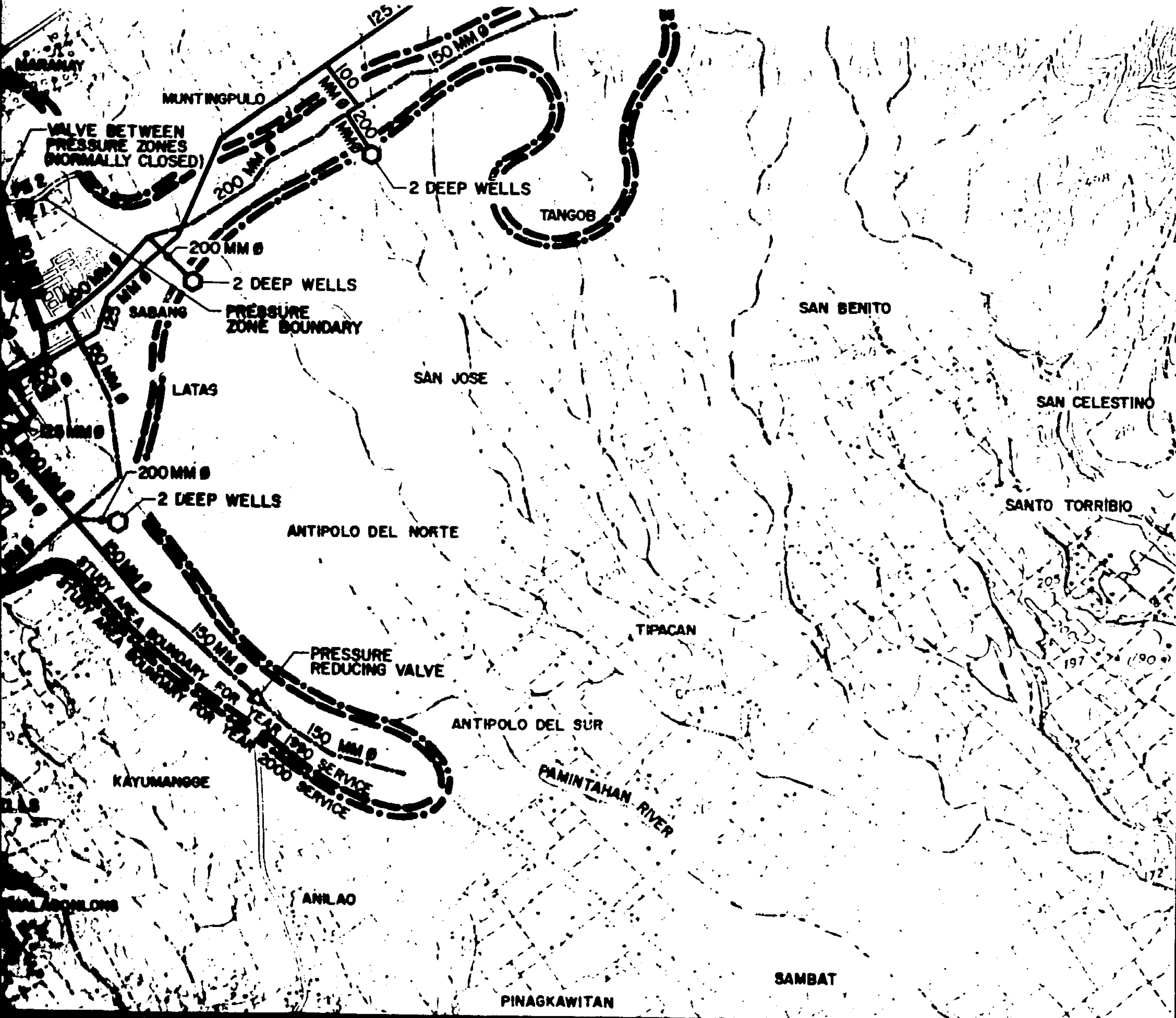
The monitoring program should include measurements of flow rates, pumping time, static water levels, and pumping water levels at each LCWD pumphouse. Periodic observations should be made of water levels and daily records kept of pumping. Water samples should be collected for bacterial analysis monthly and chemical analysis, annually. The LWUA and the National Water Resources Council should be furnished copies of monthly reports on the monitoring program. The water district and its consultants should update and review the monitoring program as the goals and needs of the study area change.

Updating the Water Supply Master Plan

After the water supply master plan has been adopted and initially implemented, it will be necessary to undertake a program for continuously updating and keeping the plan current. Plan updating should take place at least once every five years, or sooner if significant changes occur. Updating is required to assess the effectiveness of the current plan, the benefits gained, the actual costs, the problems encountered, and to provide overall review, refinement, and direction for the future.

[16/] Dollar costs are based on ₱7.00 to \$1.00.

[17/] Costs include Stage 1 Phase A and early action works.



LIPA CITY WATER DISTRICT

WATER SUPPLY SOURCE
TRANSMISSION AND DISTRIBUTION SYST
MAP SHOWING

EXISTING FACILITIES

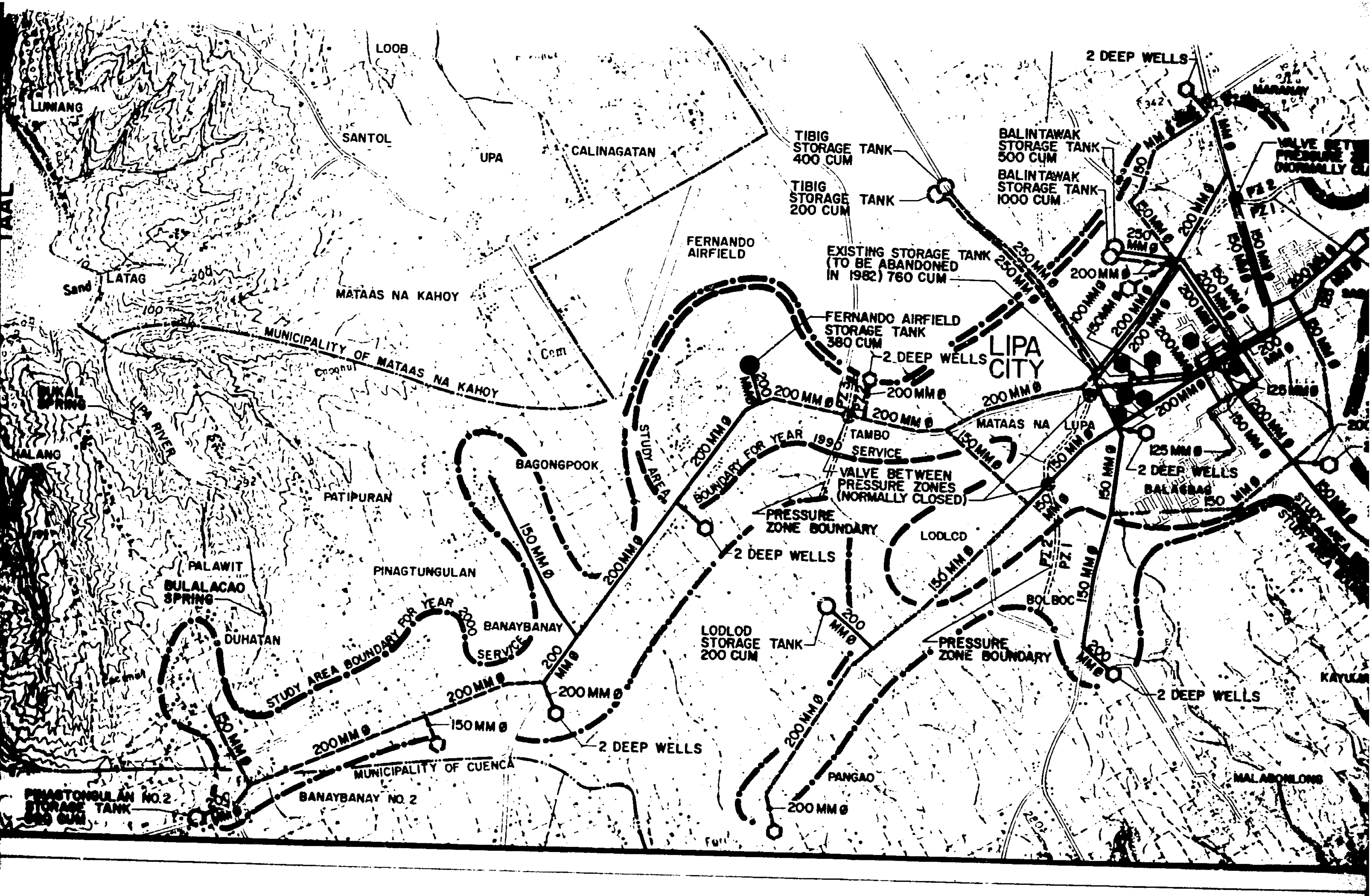
RECOMMENDED STAGE I FACILIT

RECOMMENDED STAGE II FACILIT

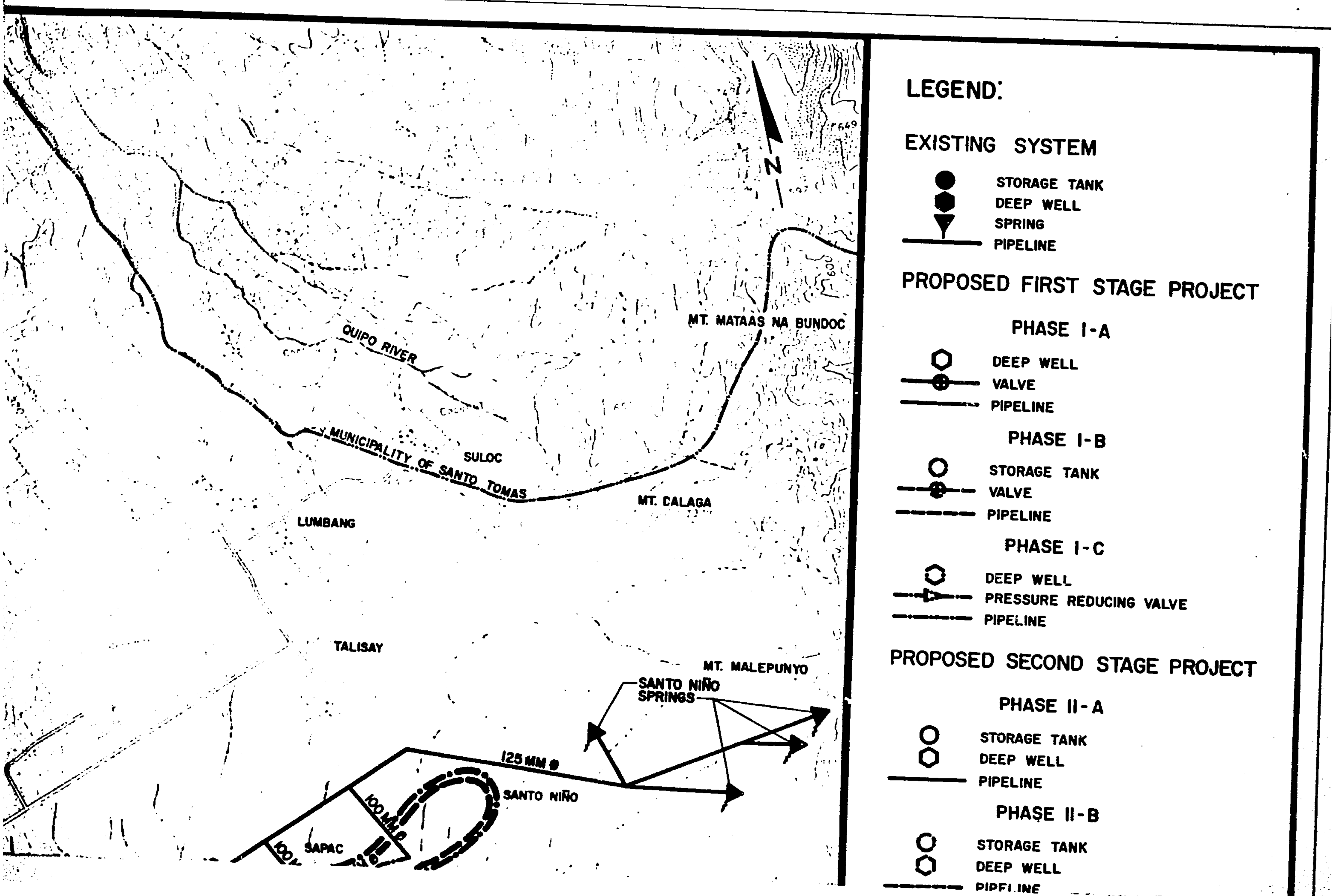
500 0 500 1000
SCALE IN METERS

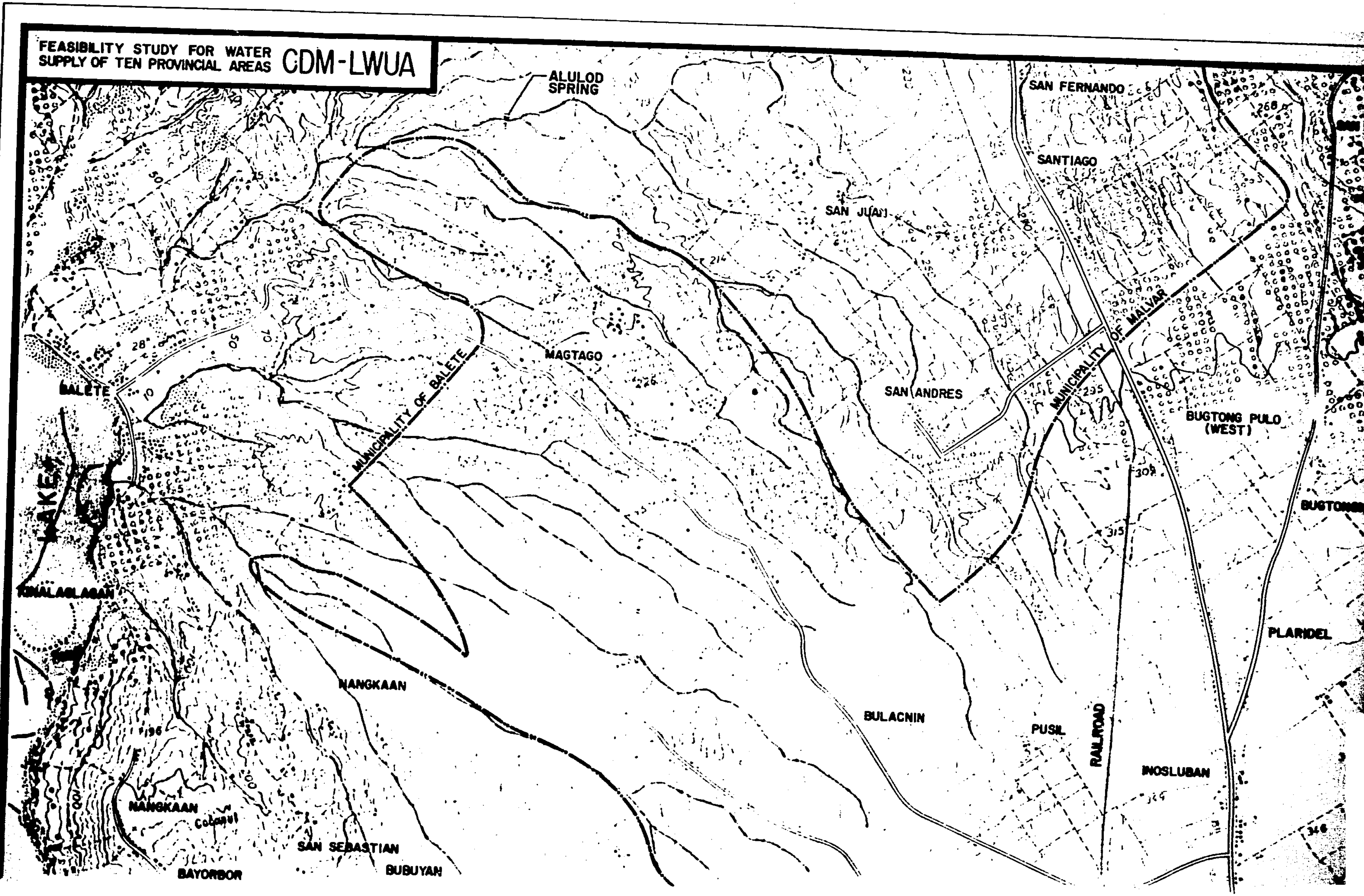
FIGURE IX-

JUNE 1976



TAAL
LUMANG
LOOB
SANTOL
UPA
CALINAGATAN
LATAG
MATAAS NA KAHOY
MUNICIPALITY OF MATAAS NA KAHOY
BUKAL SPRING
LIPA RIVER
PATIPURAN
BAGONGPOOK
PALAWIT
BULALACAO SPRING
PINAGTUNGULAN
DUHATAN
BANAYBANAY
STUDY AREA BOUNDARY FOR YEAR 2000 SERVICE
150 MM Ø
200 MM Ø
2 DEEP WELLS
MUNICIPALITY OF CUENCA
BANAYBANAY NO. 2
FERNANDO AIRFIELD
FERNANDO AIRFIELD STORAGE TANK 380 CUM
STUDY AREA BOUNDARY FOR YEAR 1990 SERVICE
TAMBO
VALVE BETWEEN PRESSURE ZONES (NORMALLY CLOSED)
PRESSURE ZONE BOUNDARY
LODLOD STORAGE TANK 200 CUM
LODLOD
PANGAO
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
100 MM Ø
125 MM Ø
LIPA CITY
MATAAS NA LUPA
BALAGBAG
BOLBOC
PZ 1
PZ 2
MARAWOY
MALABONLONG
KAYUMANGGI


N
649
600
MT. MATAAS NA BUNDOC
QUIPO RIVER
MUNICIPALITY OF SANTO TOMAS
SULOC
MT. CALAGA
LUMBANG
TALISAY
MT. MALEPUNYO
SANTO NIÑO SPRINGS
125 MM ø
SANTO NIÑO
100 MM ø
SAPAC
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
PIPELINE


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