BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER	2. SUBJECT CLASSIFICATION (695)
PN-AAK-223	AP10-0000-G792

3. TITLE AND SUBTITLE (240) Water supply: Urdaneta Water District; final report, feasibility study; volume I (text)

4. PERSONAL AUTHORS (100)

5. CORPORATE AUTHORS (101)

Camp Dresser + McKee Intl., Inc.

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1977	309p.	

9. REFERENCE ORGANIZATION (130) CDM

10. SUPPLEMENTARY NOTES (500)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Philippines
water supply
water resources
water management
feasibility
sanitation
hydrology
public utilities
design criteria
financing
water use
water quality
demand
economic aspects
cost analyses
urban areas
project planning
engineering

13. PROJECT NUMBER (150) 492028200

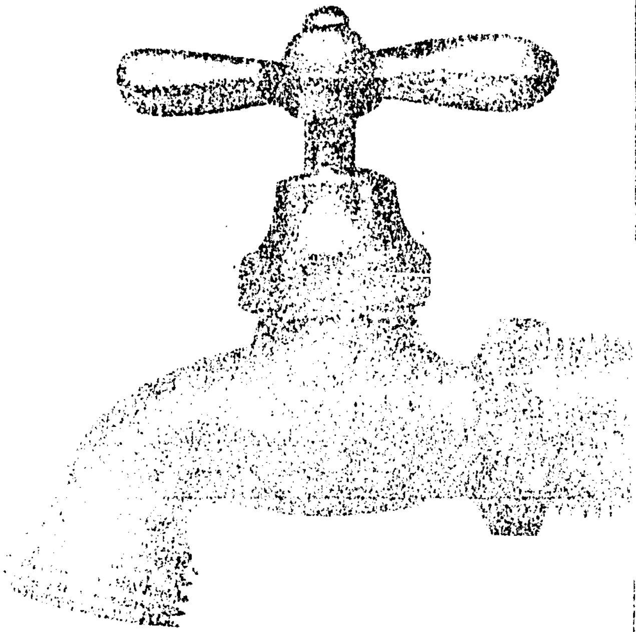
14. CONTRACT NO.(140) unknown

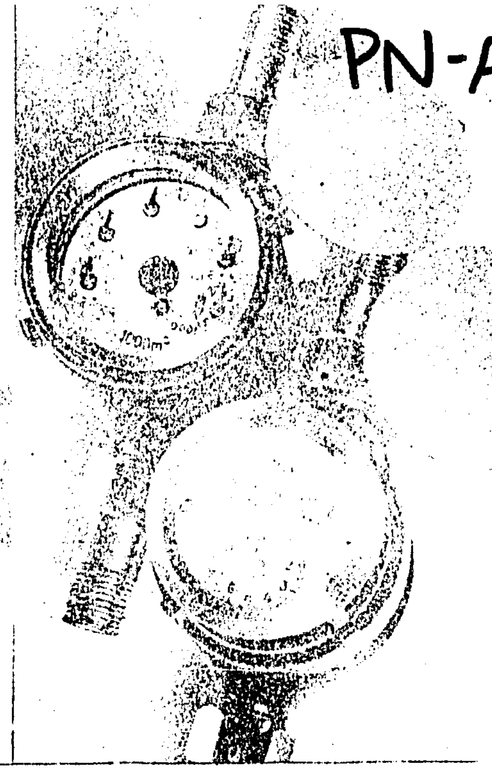
15. CONTRACT TYPE (140)

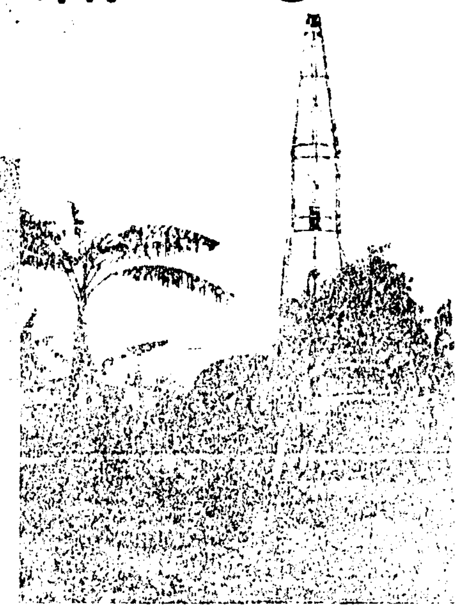
16. TYPE OF DOCUMENT (160)

AID 590-7 (10-79)

PN-AAK-223







TEXT
VOLUME I

WATER TUBIG

FINAL REPORT
FEASIBILITY STUDY

WATER SUPPLY

URDANETA WATER DISTRICT

AUGUST 1977

PREPARED JOINTLY:

LOCAL WATER UTILITIES ADMINISTRATION
PROJECT STAFF

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24 August 1977

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

Subject: Final Report - Feasibility Study for Water Supply - Urdaneta Water District (URD-WD)

Dear Mr. Leaño:

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

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

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

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

... PLAZA BOSTON MA 02108 USA TEL. 617-742-5151 CABLE: CAMDRES

Mr. Carlos C. Leaño, Jr.
General Manager
Local Water Utilities Administration
Re: Final Report - Feasibility Study
for Water Supply - Urdaneta Water
District (URD-WD)

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

Very truly yours,

CAMP DRESSER & MCKEE INTERNATIONAL, INC.

LEONARDO V. GUTIERREZ, JR.
Project Manager

ANTONIO DE VERA
Counterpart Project Manager

FOREWORD

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

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

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

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

The following have contributed significantly to the development of the Second Ten Areas Feasibility Studies.

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

Antonio de Vera, Counterpart Project Manager
Wilfredo Sevilleja, Counterpart Chief Engineer
Delia Castañeda, Economist
Jean Casten, Economist
Lourdes Gutierrez, Technical Writer
Diosdado Garcia, URD-WD General Manager

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

Eduardo Santos, Staff Engineer
Reynaldo Tabac, Staff Engineer
Rafael Luna, Junior Staff Engineer
Miguel Buenavides, Junior Staff Engineer
Alberto Machica, Draftsman
Meredith Maraño, Secretary/Typist
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A. SUMMARY OF STUDIES

Description

The Urdaneta Water District (URD-WD) was formed on 20 February 1976 by virtue of Resolution No. 6 passed by the municipal council of Urdaneta. Following its formation, the URD-WD acquired the ownership and management of the entire water supply system from the municipal government.

The municipality of Urdaneta is located in the eastern-central portion of Pangasinan province approximately 165 km north of Manila, on the highway along the western coast of the island of Luzon. The municipality consists of the poblacion and 26 surrounding barrios, with a total land area of 10,600 hectares. The topography within the municipality is of relatively low relief, with elevations varying between 21 and 36 meters above mean sea level. The area is traversed by four rivers which ultimately drain into Lingayen Gulf, approximately 30 km northwest of the poblacion.

The total population of the municipality in 1970 was 58,690, with an urban/rural breakdown of 13 and 87 percent, respectively. A major source (42 percent) of employment is in the fields of agriculture, forestry and fishing. The remaining 58 percent of employment is fairly evenly divided among manufacturing, commerce, services and construction/minor industries.

Existing Water System

The water system of the URD-WD was originally constructed in 1959, with moderate additions to the distribution system in 1965. The original water source for the system was a single 150 mm diameter x 78 meter deep well located near the municipal building in the central portion of the poblacion. At the time of field data collection for this report, a motor-driven centrifugal pump was installed at the well, producing 610 cumd. The safe yield and condition of the well are unknown.

A 380 cum reinforced concrete elevated storage tank was constructed adjacent to the well in 1959. The storage tank is in good condition and is currently in use on a fill-and-draw basis, serving the distribution system directly with tank discharge controlled by daily valve manipulation.

Disinfection facilities were added to the URD-WD system in September 1976 and consisted of the introduction of a granular hypochlorite into the elevated storage tank, daily on a single-dose basis. In November 1976 a hypochlorite solution feeder was installed in the existing pumphouse, and has since been operating continuously during pump operation, at an equivalent chlorine dosage rate of 0.7 mg/l. Spot checking of chlorine residual throughout the distribution system is performed by water district staff.

In 1959, about 5,400 meters of 75 to 150 mm diameter pipelines were installed. Most of these installed pipes are of asbestos-cement. In 1965, an additional 655 meters of 50 and 75 mm diameter galvanized-steel and asbestos-cement pipes were installed.

Projections

The present service area of the URD-WD includes the poblacion and portions of barrios San Vicente East, San Vicente West and Bayaoas. By the year 2000, the service area will include the additional barrios of Nancayasan, Nancamaliran East, Nancamaliran West, Dilan-Paurido, Sto. Domingo, Palina East, Mabanogbog, Bayaoas, Camanang, Pinmaludpod, Camantiles, Cabuloan and Bactad West.

The total population in the URD-WD was 9,192 in 1975 and is projected to increase to 74,920 by the year 2000, with average growth rates varying between 2.4 and 3.3 percent per year. During this same period, the population served by the URD-WD is expected to increase from 3,216 to 61,870.

The average per capita consumption of water is expected to be 198 lpcd by 1980, with a total average daily usage of 2,100 cumd. The per capita usage is projected to decrease to 193 lpcd by 1990, due to improved water accountability, and subsequently increases to 199 lpcd by the year 2000. Total average daily water demand is projected to be 6,690 and 12,310 cumd by 1990 and 2000, respectively.

Water Resources

Four potential sources of water for the URD-WD were identified: two surface water sources and two groundwater sources.

One of the surface water sources is the Agno River, passing closest to Urdaneta at a point 7 km to the east of the poblacion. The minimum flow of the river at this point is considerably greater than the requirements of the URD-WD. Use of this source for water supply to Urdaneta would require extensive diversion, treatment and transmission facilities. The second potential surface water source, the Sinocalan River (west of the poblacion), would probably require a longer transmission pipeline to obtain the minimum flows required, and would also require similar diversion and treatment facilities.

The Central Luzon Plain, in which the municipality of Urdaneta is situated, is an excellent widespread aquifer consisting of Recent alluvium originally eroded and transported from the Sierra Madre Mountains east of Urdaneta and the Zambales Mountains to the west. Recharge to this aquifer in the region of Urdaneta is from the Sierra Madre Mountains. Wells constructed in this aquifer, within the service area, can readily supply the projected water demands of the URD-WD beyond the year 2000. The lack of available data on aquifer parameters and recharge prevents accurate determination of regional drawdown due to projected groundwater withdrawal by the URD-WD. However, it is likely that this aquifer will be a useful source for the URD-WD, unless there is overexploitation of the aquifer for agricultural irrigation (in the area of Urdaneta there is currently little irrigation from groundwater).

A second potential groundwater source for the URD-WD is induced infiltration wells along the Agno River. Although these wells are technologically feasible, and could supply the amounts of water required, long pipelines would be required to transmit the water to the service area.

Alternative Studies

Studies of alternative water sources for the URD-WD service area indicate that continued use of groundwater, abstracted by wells from the underlying aquifer, is the most economical over the project planning period. Surface water from the Agno River and water from induced infiltration wells along the Agno River were found to be considerably more costly.

Economic analysis of distribution storage requirements indicates a cost advantage for supply of peak flows from wells. The existing 380 cum elevated storage tank will be retained to meet emergency demands.

The requirements for the distribution system, incorporating wells located throughout the service area, were analyzed with the aid of a computer. The resulting system is described in detail in Chapter IX. Based on the analysis of the pressure requirements of the system, a single-pressure service area has been established to operate off the hydraulic grade lines established by the installed well pumps.

B. RECOMMENDATIONS

General

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

TABLE I-1

SUMMARY OF PROPOSED WATER SUPPLY IMPROVEMENTS
URDANETA WATER DISTRICT

	Immediate Improvement Program	Construction Phase I-A	Construction Phase I-B	Construction Phase II-A	Construction Phase II-B
Construction Period	1978-79	1980-85	1986-90	1991-95	1996-2000
Total Project Cost (₱)	4,412,400	9,449,400	5,426,400	7,877,300	5,968,000
Foreign Exchange Component[1/] (₱)	2,017,500	4,314,300	2,679,200	3,813,300	2,993,000
Source Development	Obtain water rights, one pumpset, one well complete	Two wells complete	one well complete	two wells complete	one well complete
Distribution Facilities	4.93 km - 100 to 250 mm pipelines	8.27 km - 100 to 250 mm pipelines	2.33 km - 150 to 250 mm pipelines	6.28 km - 100 to 250 mm pipelines	0.75 km - 200 and 250 mm pipelines
Internal Network	Leakage survey and repair	244 hectares	163 hectares	193 hectares	191 hectares
Service Connections	414 conversions, 124 replacements, 930 new connections	290 replacements, 1,559 new connections	1,558 new connections	1,657 new connections	1,845 new connections
Fire Hydrants	Repair existing hydrants	190 hectares	200 hectares	336 hectares	300 hectares
Miscellaneous	Administrative building, equipment and vehicles	Plumbing shop	-	-	-

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

Source

The projected year 2000 peak-hour system demand of 21,540 cumd in the URD-WD will be supplied by one existing and seven additional wells to be constructed by that year. Chlorination will be the only treatment required, and will be performed by facilities constructed in a program parallel to the well construction program.

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

Distribution Facilities

The distribution system will be reinforced and expanded by the installation of 15.5 km of pipelines with diameters from 100 to 250 mm, by 1990. An additional 7.0 km of pipelines will be constructed by the year 2000 to provide service to additional consumers.

By the year 2000, 1,026 hectares within the URD-WD service area will receive internal network pipelines. Service connection installation will proceed in a program parallel to internal network construction. There will be approximately 4,460 and 7,960 service connections within the service area by 1990 and 2000, respectively.

Capital Cost Summary

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

TABLE I-2

CAPITAL COST SUMMARY

Construction Phase	Construction Period	Construction Cost (P)	Project Cost (P) Local	Project Cost (P) Foreign	Project Cost (P) Total
Immediate Improvements	1978-79	3,403,400	2,394,900	2,017,500	4,412,400
Phase I-A	1980-85	7,793,100	5,135,100	4,314,300	9,449,400
Phase I-B	1986-90	4,562,000	2,747,200	2,679,200	5,426,400
Phase II-A	1991-95	6,534,000	4,064,000	3,813,300	7,877,300
Phase II-B	1996-2000	5,040,800	2,975,000	2,993,000	5,968,000
		27,333,300	17,316,200	15,817,300	33,133,500

TABLE I-3

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

Item	Cost (₱) Local	Cost (₱) Foreign	Cost (₱) Total
Immediate Improvement Program			
Source Facilities (Pumping equipment for existing well, one new well, disinfection facilities for two wells)	494,500	422,000	916,500
Distribution Facilities (4.93 km - 100 to 250 mm pipe-lines)	427,000	398,100	825,100
(Leakage detection and repair)	27,000	98,000	125,000
Service Connections (Installation, conversion and repair)	380,400	566,400	946,800
Administrative and Miscellaneous (Administrative building and equipment)	383,000	69,000	452,000
(Vehicles)	60,000	60,000	120,000
(Miscellaneous)	7,000	11,000	18,000
Total Construction Cost	1,778,900	1,624,500	3,403,400
Contingencies	223,900	203,400	427,300
Engineering	102,100	189,600	291,700
Land	290,000	-	290,000
Total Project Cost	2,394,900	2,017,500	4,412,400
Stage I Phase A Construction			
Source Facilities (Two wells complete with disinfection facilities)	931,200	631,000	1,562,200

TABLE I-3 (Continued)

Item	Cost (₱) Local	Foreign	Total
Distribution Facilities (8.27 km - 100 to 250 mm pipelines)	825,200	825,100	1,650,300
Internal Network (244 hectares)	1,422,800	1,023,300	2,446,100
Service Connections (290 replacements and 1,559 new connections)	638,600	838,700	1,477,300
Fire Hydrants (190 hectares)	123,500	170,700	294,200
Plumbing Shop (Building only)	363,000	-	363,000
Total Construction Cost	4,304,300	3,488,800	7,793,100
Contingencies	518,300	421,700	940,000
Engineering	217,500	403,800	621,300
Land	95,000	-	95,000
Total Project Cost	5,135,100	4,314,300	9,449,400

Annual Operation and Maintenance Costs

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

TABLE I-4

ANNUAL OPERATION AND MAINTENANCE COSTS

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

Financial Feasibility

The financial feasibility analysis made for 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 has been developed to indicate the manner and 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 URD-WD householder.

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

Period	Water Rate P/RU
1978-80	0.65
1981-83	1.15
1984-87	1.40
1988-90	1.50
1991-93	1.60
1994-96	1.80
1997-2000	2.00

It is recommended that the implementation of these rates follow a socialized pricing policy to make the financial burden on the consumers proportionate to their ability-to-pay. A sample socialized rate structure for 1978-1980 that would generate sufficient revenue is as follows:

Usage (per month)	Cost (₱/cum)
first 16 cum	0.75
from 17 to 24 cum	1.55
greater than 25 cum	2.35

Borrowing requirements will include ₱5.221 million for the immediate improvement program (1978-81); ₱12.616 million for Phase I-A (1978-85); and ₱8.982 million for Phase I-B (1986-90).

Economic Feasibility

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

Two approaches were adopted to determine economic feasibility; the benefit-cost ratio and internal economic rate of return (IERR). In both approaches, four benefits valued at 1978 prices were included and discounted at 12 percent. The benefits considered are increase in land values, health, reduction in fire damage and beneficial value of water. Analysis shows a benefit-cost ratio of 1.54:1 and an IERR of 23.1 percent.

CHAPTER II INTRODUCTION

A. FIRST TEN PROVINCIAL URBAN AREAS

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

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

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

---

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

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

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

B. SECOND TEN PROVINCIAL URBAN AREAS

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

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

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

1. Training of counterpart LWUA engineers through on-the-job assignments on various aspects of water supply feasibility studies;
2. Preparing water supply feasibility studies for 5 provincial urban areas, using expatriate and local counterpart personnel for conducting such studies;
3. Preparing water supply feasibility studies for additional 5 urban areas, with LWUA engineers taking a dominant role in the conduct of such studies.

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

C. HISTORICAL BACKGROUND URDANETA WATER DISTRICT

The Urdaneta water supply system was constructed in 1959, operated and managed by the National Waterworks and Sewerage Authority (currently the Metropolitan Waterworks and Sewerage System). In May 1973, NWASA turned over the water system to the municipal government of Urdaneta.

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

5/Refer to Appendix A, Volume II for complete Terms of Reference.

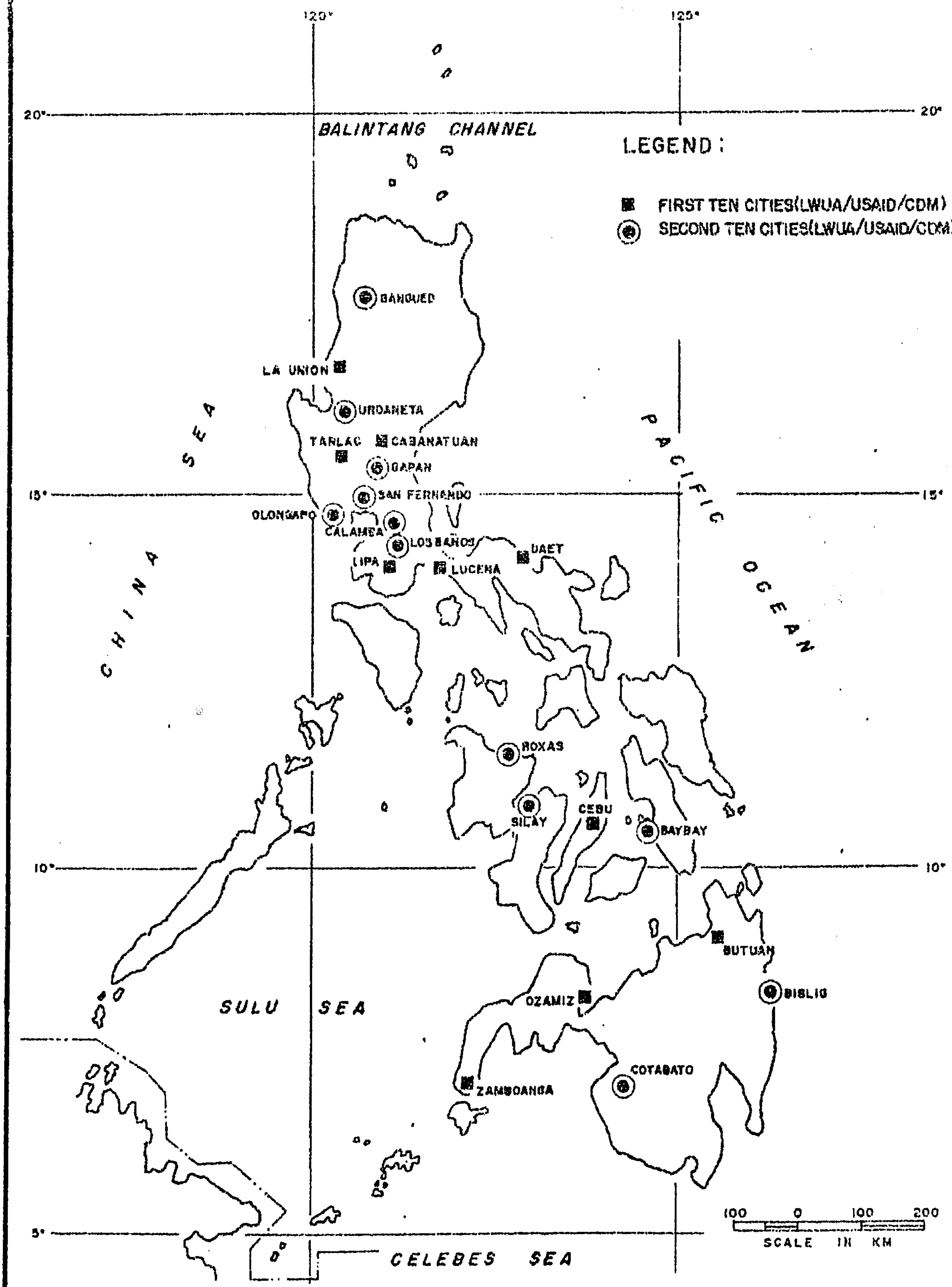

FIGURE II-1
LOCATION MAP
REPUBLIC OF THE PHILIPPINES

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

The URD-WD was established on 20 February 1975 by Resolution No. 6 of the Sangguniang Bayan (municipal council) to include the entire municipality of Urdaneta. Subsequently, the URD-WD acquired the ownership and management of the public waterworks from the municipal government in accordance with Presidential Decree (PD) No. 198 (The Provincial Water Utilities Act of 1973).

The formation of the URD-WD was prompted by the need for adequate water supply and an upgraded water system. Limited funding prevented substantial improvements to the system. Moreover, the local officials recognized the potential role of the water district in providing sufficient, safe and potable water supply.

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

On 11 June 1976, LWUA awarded the Conditional Certificate of Conformance to the URD-WD after compliance with the minimum requirements of LWUA's certification program. This certificate entitles the URD-WD to rights and privileges authorized under PD No. 198.

CHAPTER III DESCRIPTION OF THE WATER DISTRICT[1/]

A. PHYSICAL DESCRIPTION

Location

The municipality of Urdaneta is located centrally in Pangasinan province[2/] on the island of Luzon. With an area of about 10,600 hectares, Urdaneta is divided into the poblacion[3/] and 26 barrios[4/].

The present service area[5/] of the URD-WD is situated in the central portion of Urdaneta. It covers the more densely populated sections, namely, the poblacion and the barrios of Bayaoas and San Vicente. The service area in the year 2000 will extend to include the barrios of Camanang, Nancamaliran East, Nancamaliran West, Dilan-Paurido, Palina East, Sto. Domingo, Mabanogbog, Nancayasan, Pinmaludpod, Camantiles, Cabuloan and Baotad West (Figures III-I and VI-I).

Physical Features

Urdaneta is mostly flat, with elevations ranging from 21 to 36 meters above mean sea level. Elevations in the service area vary from 21 to 27 meters above mean sea level.

Four rivers traverse the municipality. The Macalong, Bulaoen and Miluro Rivers flow westward and drain into the Sinocalan River which finally empties into the Lingayen Gulf. The Macalong River passes the service area, along the northern boundary of the poblacion. The Bulaoen River flows along the eastern borders of Urdaneta and drains into the Miluro River. The Miluro River flows along the northern border of the municipality.

Pale brown to light gray silt loam of recent alluvial origin overlays the low-lying flat areas of Urdaneta. This soil forms the largest areal series in Pangasinan.

1/ The URD-WD covers all lands within the geographic boundaries of the municipality of Urdaneta.

2/ The province of Pangasinan occupies the northern portion of the central plains of Luzon. Its boundaries are Lingayen Gulf and the provinces of La Union and Benguet on the north; Nueva Vizcaya on the northeast; Nueva Ecija on the east; Tarlac on the south; and Zambales and the China Sea on the west.

3/ Town proper

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

5/ The term "service area" denotes sections of the water district which are currently served or intended to be served by the water system.

Urdaneta is classified under the first type of climate illustrated in Figure III-2 with 2 distinct seasons. The dry season occurs from October through May; the wet season, from June to September.

The average annual rainfall for the period 1961 to 1969 was 2,621 mm. During the years 1960-67 temperature ranged from 26°C in January to 29°C in April with the average at 27.5°C. These climatological data are listed in Table III-1.

TABLE III-1

CLIMATOLOGICAL DATA[6]

	Rainfall (mm)	Temperature (°C)
January	1.2	26.0
February	0.4	26.2
March	4.8	27.5
April	11.1	29.2
May	222.2	28.9
June	487.4	27.5
July	519.5	26.6
August	697.0	26.7
September	468.7	27.8
October	74.7	28.1
November	100.3	27.8
December	34.0	27.2
Total	2,621.3	
Average		27.5

B. POPULATION

The population of Urdaneta in 1970 was 58,690, an increase of 31 percent over the 1960 total of 44,740. The 1970 population was composed of 9,827 households, or an average of 6 members per household. The general characteristics of the population are listed in Table III-2.

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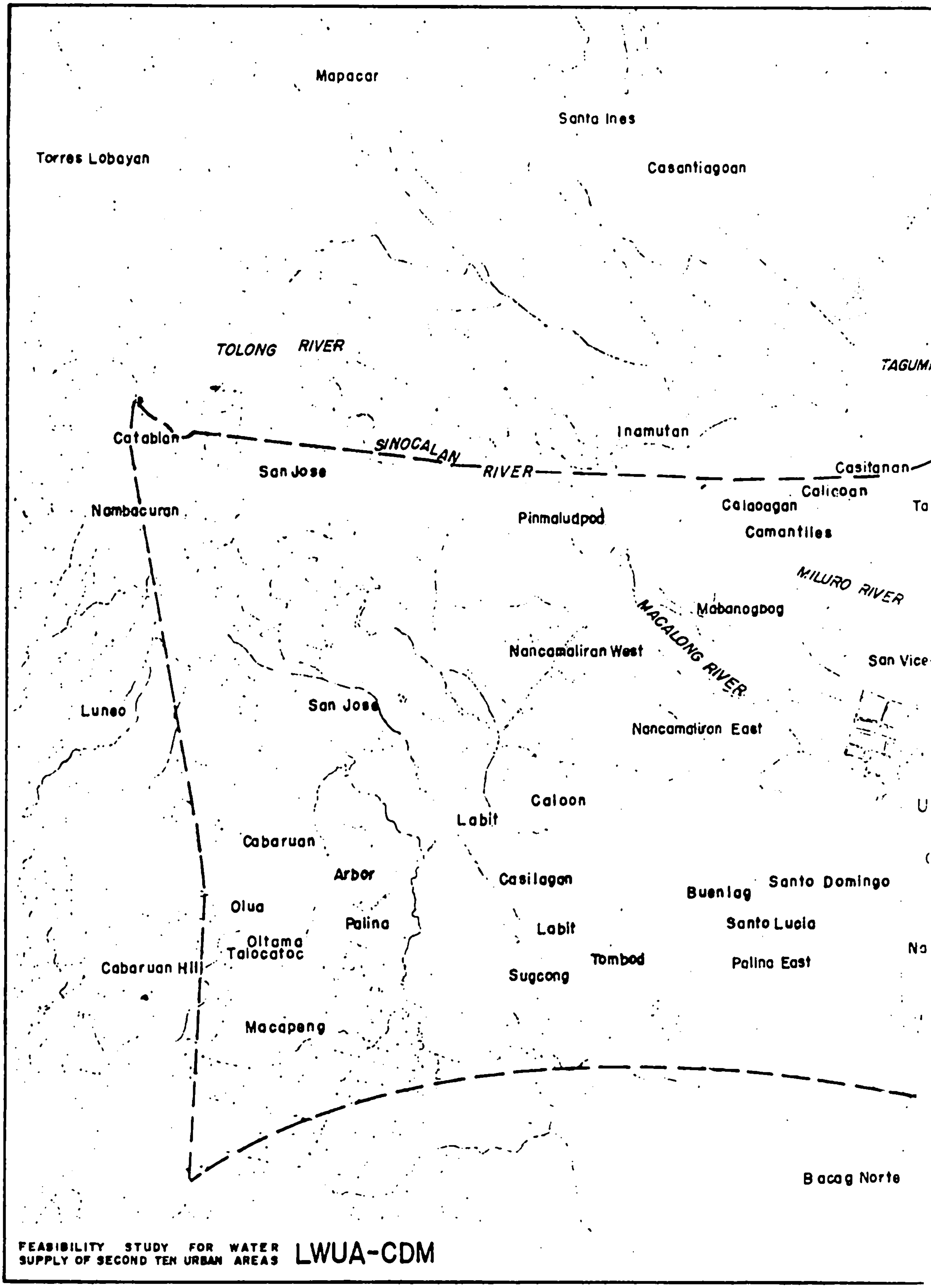
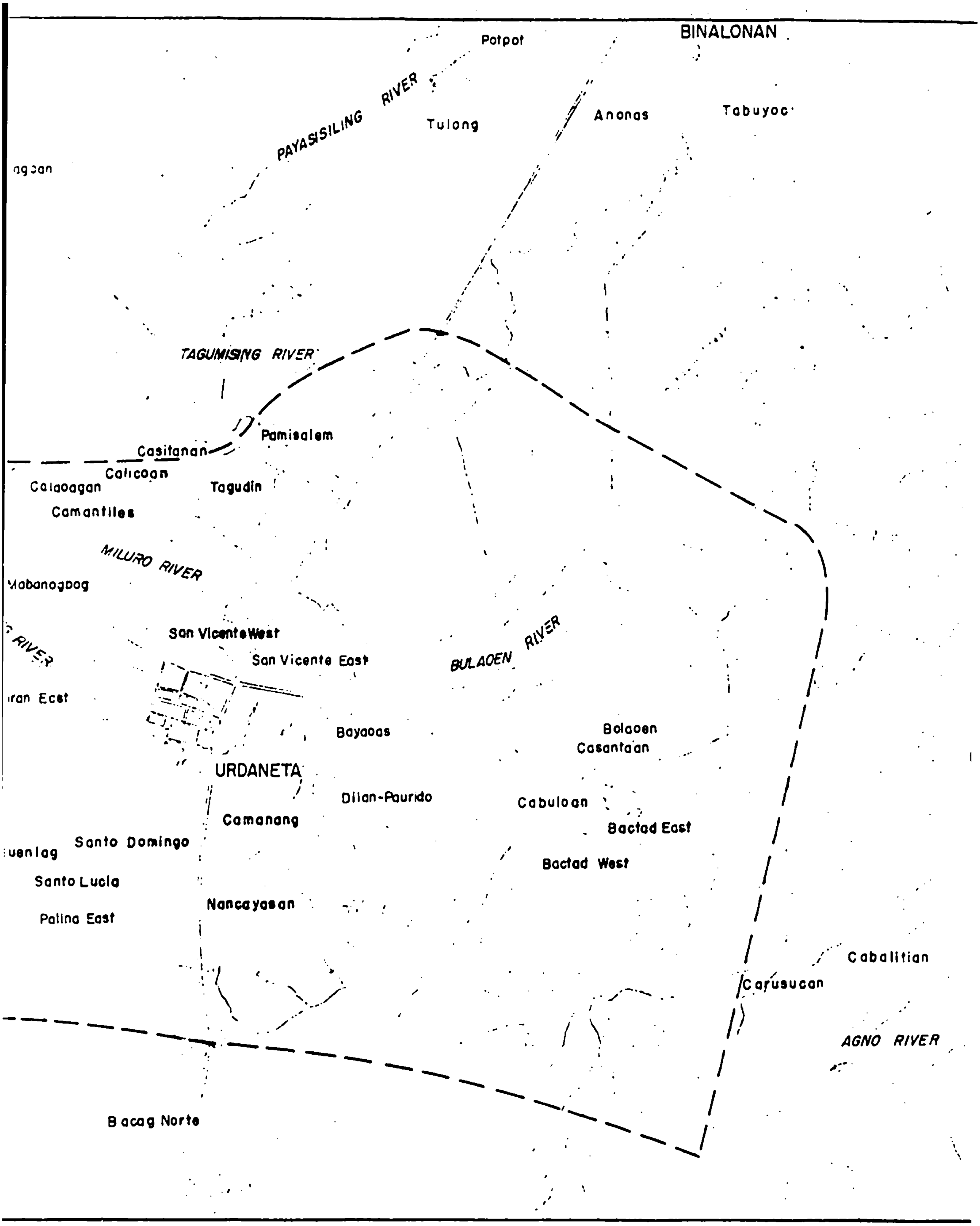
[6] Source: PAGASA Station in Bolinao, Pangasinan.


Mapacar
Santa Ines
Torres Lobayan
Casantiagoan
TOLONG RIVER
TAGUM
Catablan
SINOCALAN RIVER
Inamutan
San Jose
Casitanan
Calicoan
Nambacuran
Calaoagan
Pinmaludpod
Camantiles
MILURO RIVER
MACALONG RIVER
Mabanogbog
Nancamaliran West
San Vice
Luneo
San Jose
Nancamaliran East
Caloon
Labit
Cabaruan
Arbor
Casilagan
Santo Domingo
Buenlag
Olua
Palina
Labit
Santo Lucia
Oltama
Talocatoc
Cabaruan Hill
Tombod
Palina East
Sugcong
Macapeng
Bacag Norte
FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS
LWUA-CDM

a


Potpot
BINALONAN
PAYASISILING RIVER
Tulong
Anonas
Tabuyoc
agoan
TAGUMISING RIVER
Pamisalem
Casitanan
Calicoan
Calaoagan
Tagudin
Camantiles
MILURO RIVER
Mabanogbog
RIVER
San Vicente West
San Vicente East
BULAOEN RIVER
iran East
Bayaoas
Bolaoen
Casantaan
URDANETA
Dilan-Paurido
Cabuloan
Camanang
Bactad East
Santo Domingo
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Bactad West
Santo Lucia
Nancayasan
Palina East
Cabalitian
Carusucan
AGNO RIVER
Bacag Norte

b

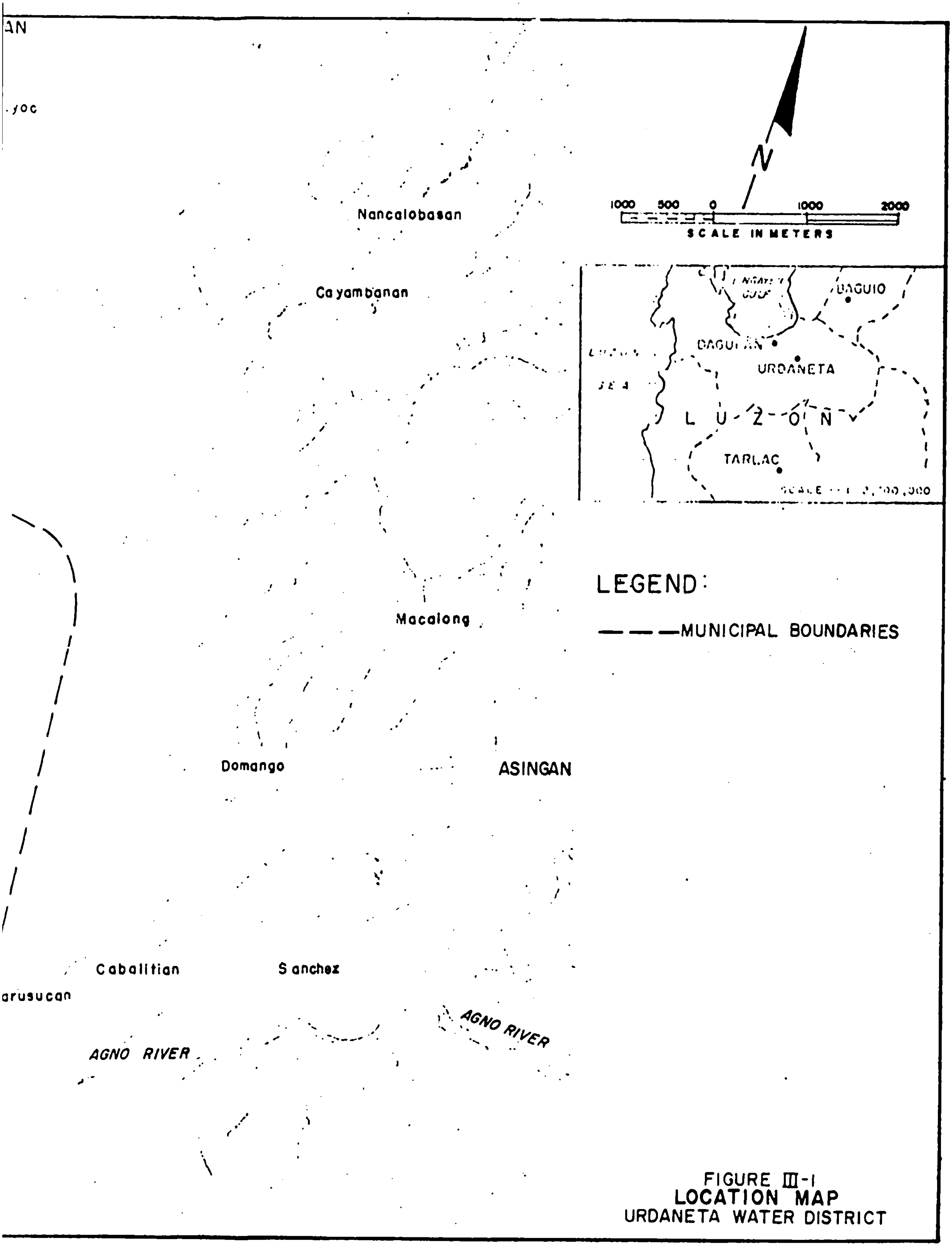

FIGURE III-1
LOCATION MAP
URDANETA WATER DISTRICT

C

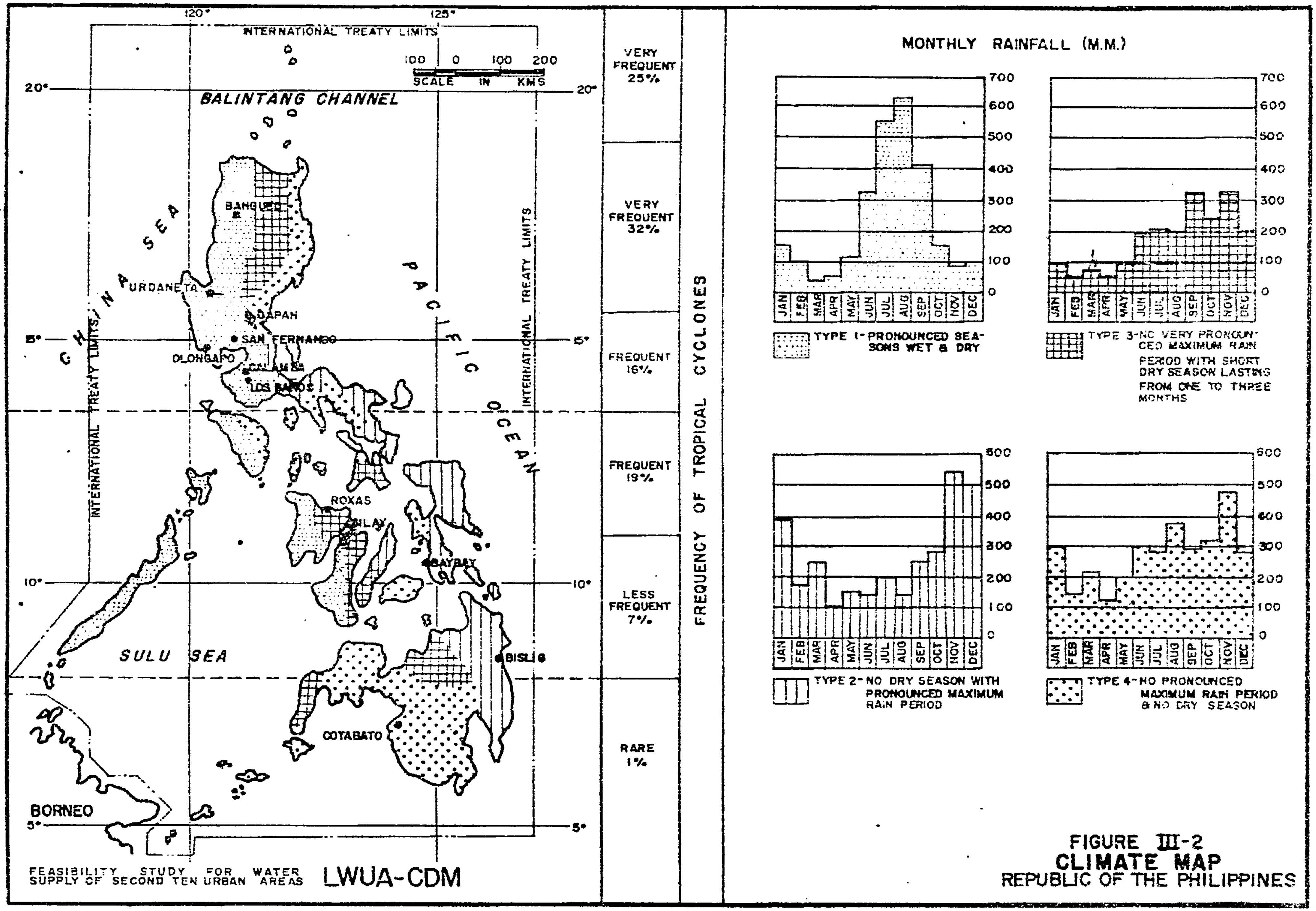

FIGURE III-2
CLIMATE MAP
REPUBLIC OF THE PHILIPPINES

TABLE III-2

MUNICIPAL POPULATION CHARACTERISTICS[7] (1970)

1.	Total Population	58,690
2.	Growth Rate (1960-1970)	2.8% per annum
3.	Density	5.5 persons per hectare
4.	Urban/Rural	urban, 13%; rural, 87%
5.	Sex Composition	male, 49%; female, 51%
6.	Age Composition	0-14 years, 43%; 15-64 years, 53%; 65 years and over, 4%
7.	Employment (% of those 10 years and over)	10 years and over, 40,593 employed, 35%; unemployed, 65%
	a) By class of worker (% of labor force)	wage and salary, 44%; own business, 43%; unpaid family workers, 13%
	b) By industry (% of labor force)	agriculture, forestry, fishing, 42%; manufacturing, 16%; commerce, 8%; services, 19%; construction, utilities, minor industries, 15%
8.	Education (% of those 6 years and over)	6 years and over, 47,655 literate, 80%; illiterate, 20%
	a) By attainment (% of those 25 years and over)	25 years and over, 21,395 elementary grades, 55%; high school, 18%; college, 10%; no formal education, 17%
	b) Number of Schools	elementary, 24; high school, 19; college, 4
9.	Dialects	Ilocano, 86%; Pangasinan, 11%; Tagalog, 2%; others, 1%
10.	Religion	Catholic, 88%; Aglipayan, 6%; others, 6%

---

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

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

C. LIVING CONDITIONS

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

Health

Water-borne diseases occur particularly in the more densely populated sections of the municipality. Public health authorities recognize the correlation between the lack of safe water supply and sewerage facilities and the incidence of water-borne diseases. Table III-4 shows the recorded morbidity and mortality rates per 100,000 population due to water-borne diseases in the province of Pangasinan[8] from 1964 to 1974. During this period, the average morbidity of 293.1 in this province was 2.3 times lower than the national average of 666.5. The average mortality of 41.1 was lower than the national average of 48.1.

D. ECONOMY[9]

Family Income[10]

In 1971, the province of Pangasinan was estimated to include 239,800 families, with a combined annual income of ₱789 million. The average family income of ₱3,290 was lower than the country's average of ₱3,736. About 78 percent of the families were considered low-income (₱500 - ₱2,999) earners. The middle income (₱3,000 - ₱5,999) group included 10 percent of the families in the province. The remaining 12 percent received annual incomes of ₱6,000 and over.

Municipal Income

Based on its annual income, Urdaneta is classified as a first-class municipality. The municipal income increased from ₱536,550 in fiscal year 1969-70 to ₱1.6 million in fiscal year 1974-75. The three-fold increase in income was attributed to the expansion of the livestock market in recent years. Nearly 40 percent of the income was derived from market and slaughterhouse operations. Over 15 percent represented fees from cattle registration.

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[8] The only records available are for the province. The morbidity and mortality trends in Urdaneta are assumed from these data (see Chapter XI).

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

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

TABLE III-3

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

1.	Total Households	9,827
2.	Average Household Size	6 members per household
3.	Water Facilities (% of total households)	piped water, 6%; artesian well, 21%; pump, 72%; other sources, 1%
4.	Toilet Facilities (% of total households)	flush/water sealed, 21%; closed pit, 32%; open pit, 42%; public toilet, 1%; no facilities, 4%
5.	Solid Waste Disposal Service	About 30 cumd of solid wastes are collected by the municipal engineering department. These wastes are disposed of by dumping directly at the Macalong River and a landfill site near Barrio Camantiles.
6.	Lighting Facilities (% of total households)	electricity, 23%; kerosene, 75%; others, 2%
7.	Appliances (% of total households)	radio, 62%; TV, 2%; refrigerator, 3%
8.	Cooking Fuel (% of total households)	electricity, 1%; kerosene, 9%; LPG, 7%; wood, 82%; others, 1%
9.	Total Dwelling Units	9,800
	a) Type of Dwelling Unit (% of total units)	single type, 95%; duplex, 1.5%; barong-barong (makeshift houses), 2%; apartment, commercial, etc., 1.5%
	b) Roofing Material (% of total units)	durable materials (aluminum/galvanized iron, asbestos, tile/concrete), 59%; non-durable materials (cogon, nipa, others), 41%

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

TABLE III-4

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

Year	Pangasinan Morbidity	Pangasinan Mortality	Philippines Morbidity	Philippines Mortality
1964	683.1	76.6	846.3	60.2
1965	381.8	34.9	715.8	51.6
1966	248.3	59.0	715.1	61.9
1967	216.1	34.3	572.1	47.6
1968	453.7	36.6	564.8	46.5
1969	276.5	32.8	706.9	46.0
1970	183.8	30.5	612.8	39.0
1971	180.2	35.2	422.5	35.8
1972	233.0	50.8	743.4	49.4
1973	189.3	34.0	768.4	50.4
1974	178.2	27.8	663.8	40.4
Total	3,224.0	452.5	7,331.9	528.8
Average	293.1	41.1	666.5	48.1

Agriculture

The principal occupation is farming. About 85 percent of the land area is cultivated, the principle crop being rice. Farm products also include mongo, corn, sugar cane, vegetables and fruits. Another important agricultural activity is livestock raising, Urdaneta being the central livestock market in Central Luzon.

Commerce and Industry

The growth of commerce and industry in Urdaneta has been largely enhanced by the fast-improving transportation and marketing facilities. Today, it is considered the center of commerce in Pangasinan and in Central Luzon.

At present, there are over 1,500 business establishments, the majority of which are engaged in the food, wholesale and retail business. Seven commercial banks have set up branches in Urdaneta.

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[12] Source: Diseases Intelligence Center, Department of Health.

The water-borne diseases of which records are available include typhoid, cholera, dysentery and gastro-enteritis.

Manufacturing consists mainly of food and cottage industries. These industries are fish drying and smoking, native cake making and weaving of bags and slippers. Many people are also engaged in making earthen, clay and cement products.

Transportation/Communications

Urdaneta is situated at the intersection of 2 principal routes — the national highway leading northward to the Ilocos Region and the national road leading to the key areas of Pangasinan. Roads in urban areas are asphalted. The municipality is served by only land transportation.

Communication facilities include 3 telegraph offices and a telephone company.

CHAPTER IV EXISTING WATER SUPPLY FACILITIES

A. GENERAL

The water system of URD-WD was initially constructed in 1959, with a well as the only source of supply. Initially, the distribution system covered the poblacion. Additional pipes were installed in 1965, extending the service to nearby barrios. Figure IV-1 is a schematic plan of the existing water system.

B. WATERWORKS FACILITIES

Source Facilities

The only source of supply of the URD-WD is a well located near the municipal building of Urdaneta. This well, with a diameter of 150 mm, is drilled to a depth of 78 meters. It reportedly has a 250-mm diameter upper casing of unknown length. No additional data on the well are available.

In June 1976, the old pump and motor were replaced after a major breakdown. The new pump is a horizontal centrifugal pump driven by a 15 hp, 3,530-rpm electric motor. Production as measured on 16 September 1976 was 7.06 lps (610 cumd) at a discharge pressure of 39 meters (3.78 kg/sqcm).

Storage Facilities

A reinforced concrete elevated storage tank was constructed in 1959 as a part of the original system. It has a capacity of 380 cum and an overflow elevation of about 52.0 meters above mean sea level. Water from the well flows to this tank 22 to 24 hours daily. About 95 cum of water is always retained in storage for emergency purposes. A 62-mm pipe is directly connected to the discharge pipe of the tank for the use of the municipal fire department. Two service connections tapped into the discharge pipe serve the municipal building and the police department building. The base of the tank is used for storing extra pipes and spare parts by the water district. A schematic diagram of the storage tank is shown in Figure IV-2.

Treatment Facilities

In September 1976, the regional office of the Department of Health (DOH) installed a chlorination unit for the URD-WD water system, using granular chlorine that was applied at the top of the storage tank. Prior to this date, no treatment was practiced by URD-WD. In November 1976, a hypochlorinator was installed by the

DOH. A schematic diagram of this unit is shown in Figure IV-2. Daily consumption of hypochlorite is estimated to be 425 grams, equivalent to a dosage of 0.7 mg/l. The regional health office provides the hypochlorite free of charge and monitors the chlorine residual of the treated water. A water district staff member trained by the DOH is in charge of measuring the residual chlorine with a comparator.

Distribution System

The original distribution system consisted mostly of AC pipes installed in 1959. New GI pipes were laid in 1965, extending the service area coverage. So far, the addition of distribution pipes is the only major improvement on the original system. A plan of the existing distribution system is shown in Figure IV-2.

Water from the storage tank flows to the distribution system by gravity, and is available 10 to 16 hours daily. Distribution is controlled by a throttling valve on the 150-mm main connecting the distribution system to the tank. Generally, water is not available at the extremities of the system when the distribution valve is throttled. There is 24-hour service at the municipal building and the police department building. Water for the fire department and other emergency uses is drawn directly from the 62-mm discharge pipe specifically provided for the purpose at the storage tank.

Pipe Size and Length. At present, the distribution system has a total length of 6,030 meters, 89 percent of which was installed in 1959 and the remaining 11 percent in 1965. Over 80 percent of the pipes are 100 mm in diameter. About 88 percent of the total piping network is made of asbestos cement.

Valves and Hydrants. There are 14 hydrants in the distribution system, all locally made, with 75-mm diameter GS riser, tee or elbow, valve, and nipple on top. Only one hydrant is not operational but the others have no significant fire-fighting value because of low distribution system pressures.

Based on the best available information, there are 11 valves in the water system, most of which are laid under paved streets. No existing data on their location and condition are kept by the water district.

DISTRIBUTION SYSTEM

DIAMETER (MM)	TYPE	LENGTH OF PIPE (M) BY YEAR INSTALLED 1959	1965	TOTAL (M)
50	GI	—	425	425
75	GI	—	230	230
	ACP	405	—	405
100	ACP	4020	—	4020
125	GI	80	—	80
150	ACP	870	—	870
TOTAL		5375	655	6030

APPURTENANCES

	SIZE	NUMBER	REMARKS
VALVES		UNKNOWN	MANY BURIED UNDER CONCRETE ROADWAYS
HYDRANTS	LOCALLY MADE 75MM GS RISER	14	INOPERABLE OR WITHOUT SUFFICIENT WATER
PUBLIC FAUCETS		1	

SERVICE CONNECTIONS SEPTEMBER, 1976

TYPE	METERED	FLAT-RATE	TOTAL
DOMESTIC	—	292	292
COMMERCIAL	—	110	110
INSTITUTIONAL	—	12	12
TOTAL	—	414	414

WELL

- CENTRIFUGAL
  DRIVEN BY A
  15 HP ELECT
- DISCHARGE
- WELL DIAME
- DEPTH OF WE

STORAGE T

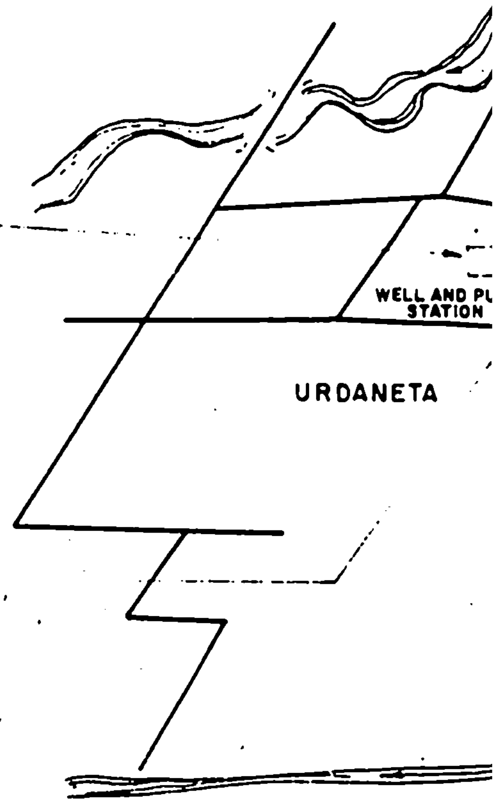
- 380 CUM CA
- OVERFLOW E
- REINFORCED

TREATMENT

- CHLORINE IS
  STORAGE T
  30 TABLESP
- TREATMENT

WELL (1959)

- CENTRIFUGAL PUMP DRIVEN BY A 3530 RPM, 15 HP ELECTRIC MOTOR
- DISCHARGE Q = 610 CUMD
- WELL DIAMETER = 150 MM
- DEPTH OF WELL = 78 M



STORAGE TANK (1959)

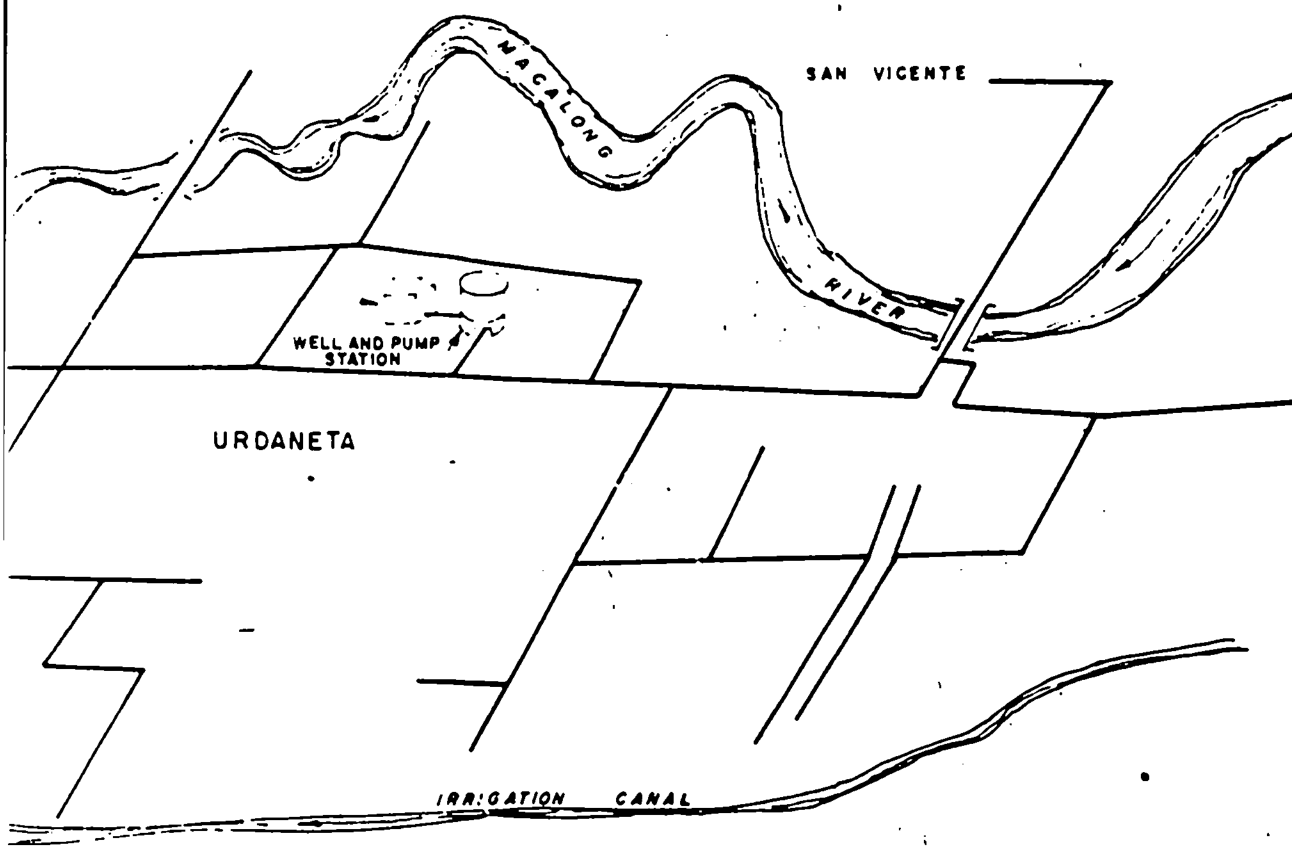
- 380 CUM CAPACITY
- OVERFLOW ELEVATION = 52M ABOVE MSL
- REINFORCED CONCRETE, ELEVATED

TREATMENT (PROJECT OF THE DEPARTMENT OF HEALTH REGIONAL OFFICE)

- CHLORINE IS APPLIED AT THE TOP OF THE STORAGE TANK EVERY DAY. DOSAGE IS 30 TABLESPOONS OF GRANULAR CHLORINE
- TREATMENT WAS STARTED IN SEPTEMBER 1976.

SYSTEM PRESSURE

- PRESSURE SUITABLE FOR SOME THE CITY EARLY IN THE MORNIN VERY LOW WHEN VALVE TO DISTR SYSTEM IS THROTTLED AT ABOUT



NOT TO SCALE

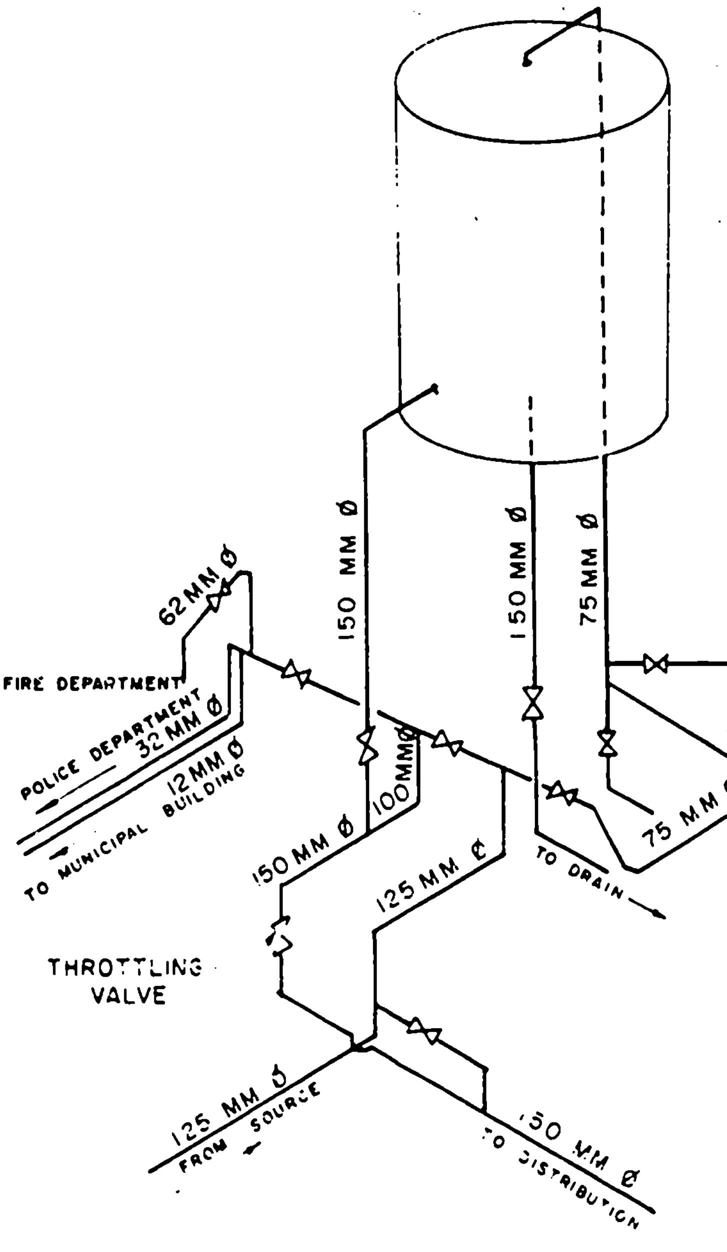
TEM PRESSURE

ESSURE SUITABLE FOR SOME PARTS OF
E CITY EARLY IN THE MORNING BUT
RY LOW WHEN VALVE TO DISTRIBUTION
STEM IS THROTTLED AT ABOUT 10:00 A.M.

SERVICE AREA OPERATION

- WATER FROM THE WELL IS PUMPED BY A CENTRIFUGAL PUMP INTO THE STORAGE TANK FROM 22 TO 24 HOURS PER DAY.
- FROM THIS STORAGE TANK WATER FLOWS BY GRAVITY TO THE DISTRIBUTION LINE FROM 5:00 A M TO 9:00 PM

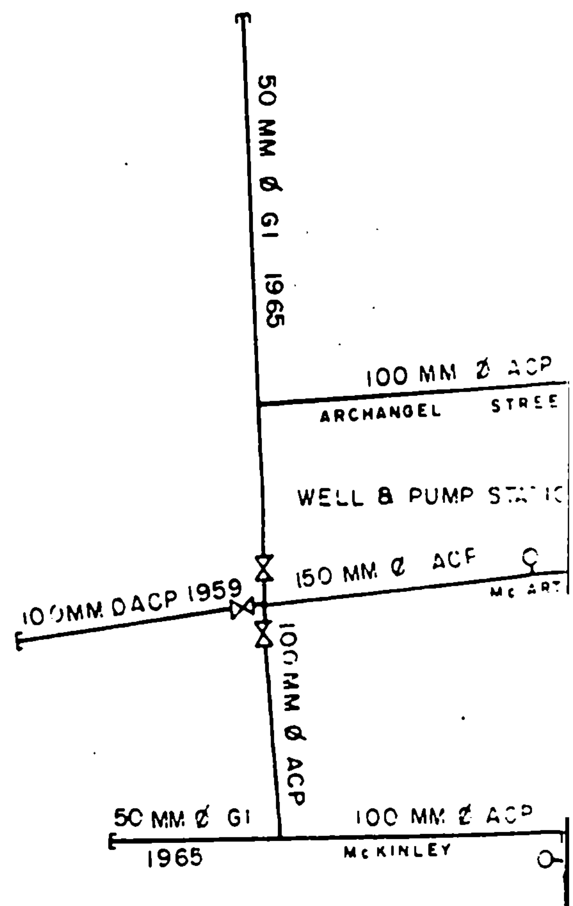
FIGURE IV-1
EXISTING FACILITIES
URDANETA WATER DISTRICT



SCHEMATIC DIAGRAM OF PIPING LAYOUT AT ELEVATED STORAGE TANK

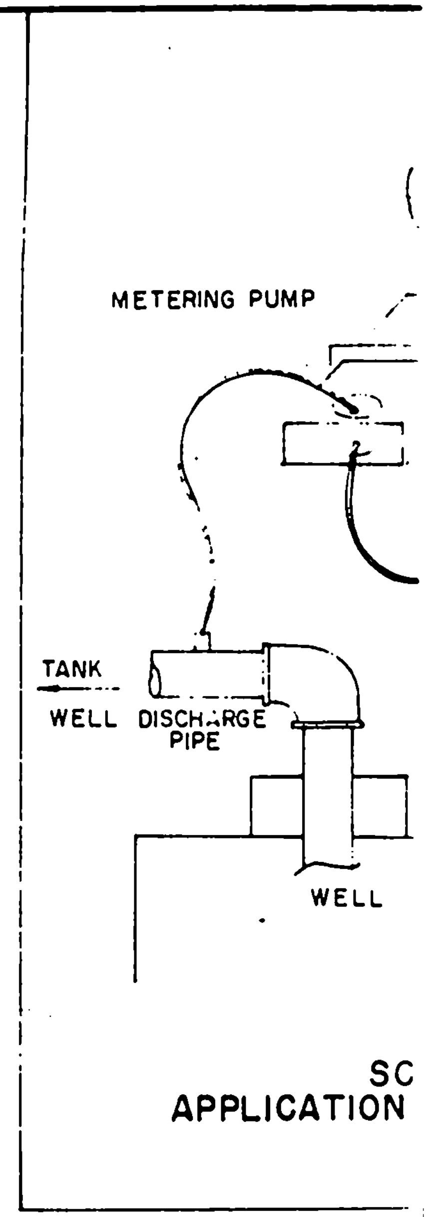
NOT TO SCALE
(INSET A)

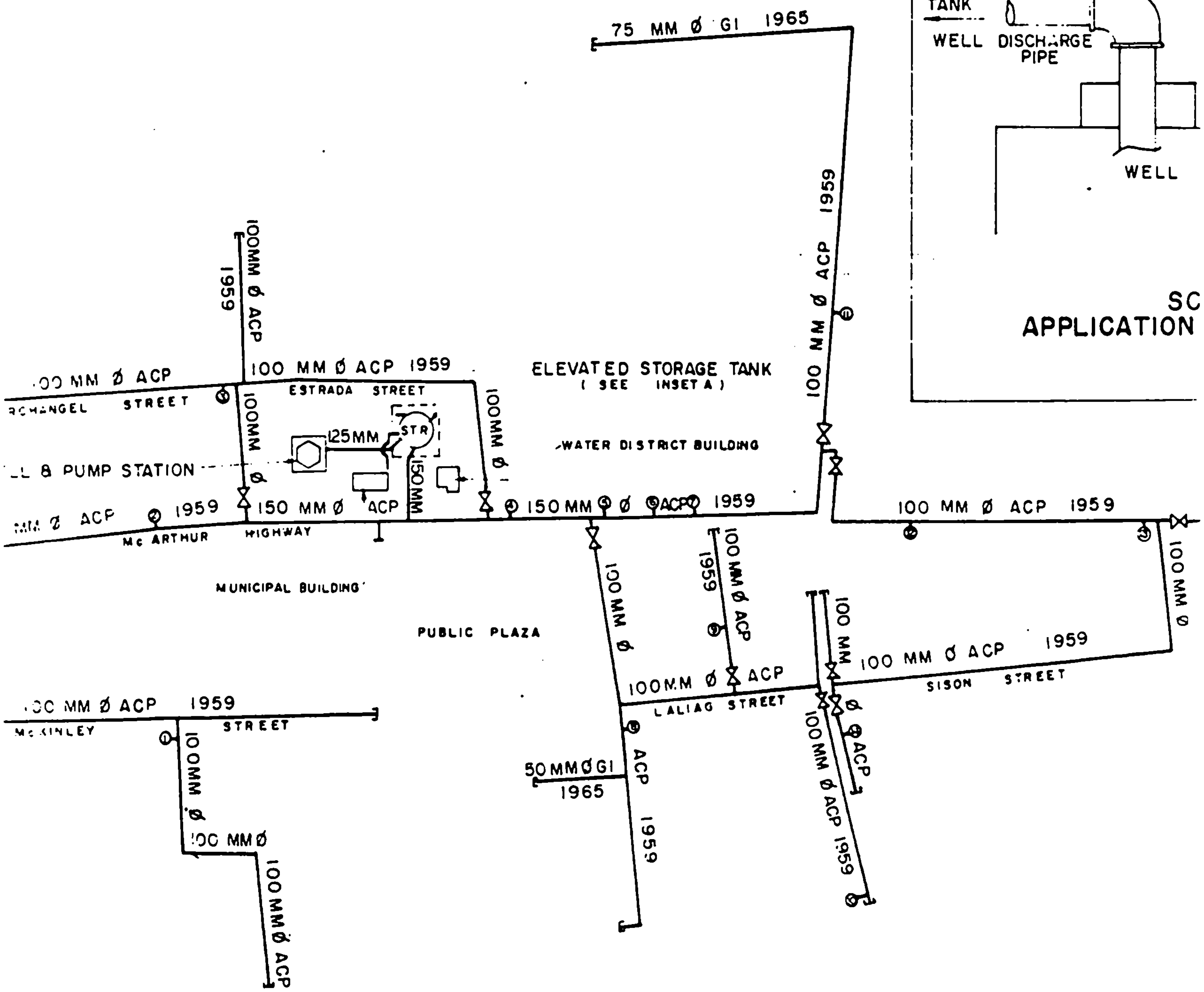
NOTE VALVE LOCATIONS HAVE
MANY ARE BURIED UNDER



:CATIONS HAVE NOT BEEN VERIFIED.

?E BURIED UNDER CONCRETE ROADWAYS.





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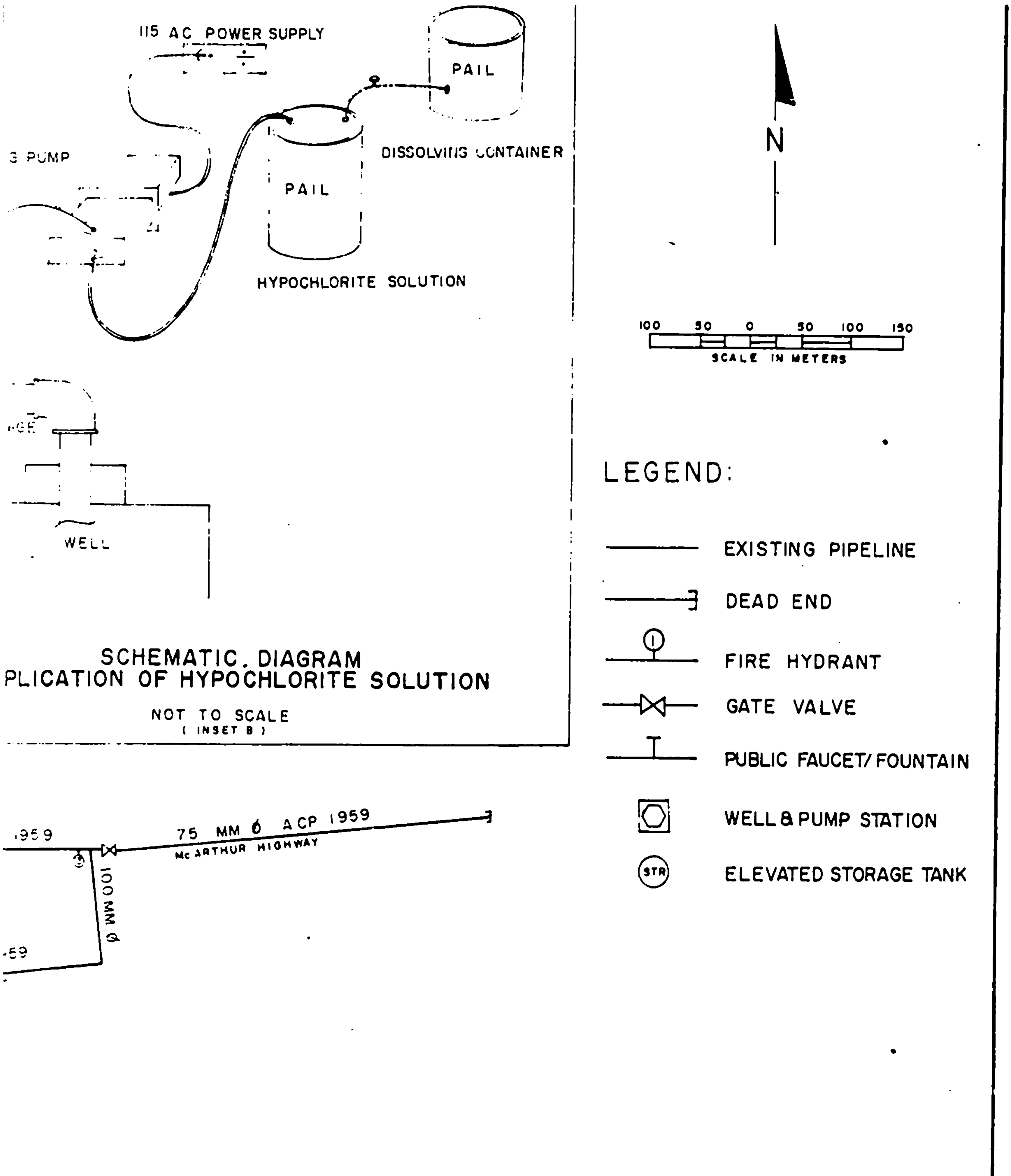

FIGURE IV-2
EXISTING WATER DISTRIBUTION SYSTEM
URDANETA WATER DISTRICT

Public Faucet. The URD-WD has only one public faucet, which is used for drinking. It has a 12-mm service connection installed at the public plaza and is maintained by a civic organization.

Service Connections. As of September 1976, there were 414 registered service connections. All connections are billed flat rate and the billing rate is uniform for domestic, commercial and institutional connections. Below is a classification of the registered connections by size and type of consumer. About 80 percent of the connections have a diameter of 12 mm. Residential connections account for 71 percent of the total connections.

Size (mm)	Residential	Commercial	Government	Total
12	238	90	2	330
19	33	10	7	50
25	19	10	2	31
31	1	-	-	1
38	1	-	-	1
50	-	-	1	1
	292	110	12	414

Operation and Maintenance

The UR-WD operates and maintains the well source and the distribution system. As of November 1976, it had 6 employees, namely: a general manager, a treasurer, an administrative/commercial services manager, a pipe fitter, a pump operator and a plumber/collector. The pipefitter also acts as pump operator during the day.

The operation program consists mainly of operating the well pumping unit, applying hypochlorite solution at the pump discharge, and regulating the outlet valve at the storage tank.

The maintenance program includes repairing leaks and tapping new service connections. The pump operator and even the general manager help in emergency repair and maintenance work. At present, no extensive maintenance work can be done by the URD-WD because of the limited manpower and inadequacy of necessary tools/equipment. Tapping of new service connections is limited due to inadequate water supply.

C. WATER QUALITY

Water samples were taken from the existing well and 5 wells drilled by the Bureau of Public Works which are located in different barrios. Results of the analyses of the water samples are listed and compared with the Philippine National Standards for Drinking Water in Table IV-1. Although the manganese content[1/] of all sources is higher than the permissible limit, all other water quality parameters meet the standards.

D. WATER USE PROFILE

General

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

Pilot Area Survey

The pilot area, about 7.1 hectares, is located in the eastern portion of the present service area. It consists of 288 households or a total population of 1,721, with an average of 6 persons per household. Interviews show the following: 63 households are registered concessionaires of the water district; 19 households are "borrowers" from registered concessionaires; 109 households have their own private wells; 95 households are "borrowers" from private well owners; and 2 households are users of a public well. Sixteen of the registered concessionaires have their own private wells as an additional source of water, while 13 households have pumps attached to their respective service connections. These data have been used to derive the number of users of the URD-WD water supply.

1/ Limits for manganese have been established on the basis of aesthetic and economic considerations rather than physiological hazards. In concentrations not causing unpleasant taste, manganese is regarded to be of no toxicological significance in drinking water. In the URD-WD, it appears that the people using water from the sampled sources have raised no complaints concerning its chemical/physical quality.

TABLE IV-1

WATER QUALITY TEST RESULTS
URDANETA WATER DISTRICT

Test	Unit	Permissible Limits	Deep Well near Municipal Building 1 Sept 76	School Well Bo. Palina East 1 Sept 76	BPW-drilled Well Bo. Bayaoas 2 Sept 76	BPW-drilled Well No.56/76/1 Bo. Sto. Domingo 2 Sept 76	BPW-drilled Well Bo. San Vicente 2 Sept 76	BPW-drilled Well Bo. Mancamaliran 2 Sept 76
Physical								
Color	APHA	15	0	0	0	0	0	0
Turbidity	FTU	5	0	0	0	0	0	0
Total Dissolved Solids **	mg/l	500	202	195	189	208	198	195
Conductivity	micromhos/cm		310	300	290	320	305	300
Chemical								
pH		7-8.5	7.7	7.6	7.7	7.4	7.7	7.5
Total Alkalinity	mg/l CaCO3		115	105	100	140	115	125
Phenolphthalein Alkalinity	mg/l CaCO3		0	0	0	0	0	0
Total Hardness	mg/l CaCO3	400***	91	96	89	120	82	71
Calcium	mg/l	75	35.6	34.8	34.8	40	32.8	28.4
Magnesium	mg/l	50	0.5	2.2	0.5	4.9	0	0
Total Iron	mg/l	0.3	nil	0.07	0.09	0.48*	0.11	0.24
Fluoride	mg/l	1.5	0.1	0.1	0.15	0.1	0.15	0.1
Chloride	mg/l	200	14.6	20.0	17.6	12.1	17.6	22.4
Sulfate	mg/l	200	25.7	23.0	25.7	21.6	23.0	17.6
Nitrate	mg/l	50	11.16	11.74	11.52	8.59	2.83	3.19
Manganese	mg/l	0.1	0.2*	0.4*	0.2*	0.4*	0.25*	0.25*

*Exceeds the permissible limits set by the Philippine National Standards for Drinking Water, but is less than the concentrations considered to be excessive by the P.N.S.D.W.

**Computed to be 65 percent of conductivity.

***Limits inferred from limits of individual metals causing hardness.

Population Served

Users of the URD-WD water supply are classified as primary users (registered concessionaires) and secondary users (borrowers). Based on the pilot area survey, there are about 123 household borrowers from the URD-WD water system. The total of 414 service connections represents the number of households which are registered concessionaires. Applying the pilot area average of persons per household to the water district, total users of water from the URD-WD system are estimated to be 3,222, of which 2,484 are primary users and 738 secondary users.

Unit Consumption

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

Per capita daily consumption is estimated to be 136 liters for registered concessionaires; 61 liters for borrowers, and 144 liters for owners of private wells. However, avaialable data are not sufficient to estimate the different categories of consumption (domestic, commercial, institutional and industrial).

Accounted-for-Water

Accounted-for-water is the total volume of water consumed by consumers and not necessarily water paid for. For the URD-WD, the accounted-for-water is estimated to be 63 percent (384 cumd) of total water production. In the absence of records on actual consumption, estimates of water accountability in the URD-WD have been based on the pilot area survey data on unit consumption and population served.

The unit water consumption as estimated from the survey includes domestic, commercial, industrial and institutional consumption. These types of water consumption are difficult to estimate separately because all service connections are billed on a uniform, flat-rate basis.

Unaccounted-for-Water

Unaccounted-for-water can be divided into several categories - leakage, wastage at flat-rate connections, overestimated flat-rate use and other uses. The total estimated unaccounted-for-water in the URD-WD is 37 percent of total water production. It is difficult to estimate the volume of water for each category of unaccounted-for-water because of insufficient data.

Summary of Water Accountability

The water accountability in the URD-WD is summarized in Table IV-2. The accounted-for-water is based on the total consumption of registered concessionaires with a unit consumption of 136 lpcd and borrowers with a unit consumption of 61 lpcd. It is estimated to be 63 percent of total water production.

The unaccounted-for-water includes wastage at flat-rate connections, leakage, overestimated flat-rate use and other uses. The unaccounted-for-water is estimated to be 37 percent of total water production.

TABLE IV-2

SUMMARY OF WATER ACCOUNTABILITY

Category	Amount of Water cum/mo	Amount of Water Cumd	Percent of Production
1. Accounted-for-water			
a. Registered concessionaires' usage	10,143	338	55.4
b. Borrowers' usage	1,350	45	7.4
2. Unaccounted-for-water			
a. Wastage, leakage and others	6,807	227	37.2
Total	18,300	610	100.0

E. HYDRAULIC SURVEY

Hydraulic surveys of the URD-WD distribution system were conducted on December 14-16, 1976 and December 28-29, 1976. The purpose of these surveys was to obtain data for computer modeling of the existing system and to identify those portions of the system having operational problems. The surveys included the following:

System Flows. In order to investigate the firefighting capacity of the existing distribution system and determine the general ability of the system to distribute water to consumers, fire-flows were measured at eleven of the existing fire hydrants throughout the system . The resulting data (see Annex Figure IV-E-1 for details) indicate that poor fire flows can be expected throughout the existing system. Flows between 1 and 5 lps were observed within the vicinity of the existing well and elevated storage tank (western portion of the system), with only negligible flows observable east of the Manila-Baguio Road.

System Pressure. At each of the 11 fire hydrants tested for existing flow capacity, static pressure measurements were also observed. These pressures (see Table IV-3) were all obtained during a one-hour period (from 9:30 to 10:30 a.m. on December 16, 1976) and represent the average pressures throughout the system during a normal low-demand period. During this period system pressure varied from 3.3 to 3.9 meters in the western portion of the system near the existing well and elevated storage tank, to 2.5 to 2.8 meters west of the Manila-Baguio Road, and 1.1 to 2.1 meters east of the Manila-Baguio Road. The pressure observed at fire hydrant no. 14 (see Annex Figure IV-E-1), near the intersection of the Manila-Baguio Road and Sison Street, appears to be inconsistent with other observed data (as is the case, to a lesser degree, at fire hydrant no. 1). This is probably due to a combination of several factors, such as generally lower terrain south of McArthur Highway, errors in guage readings or pressure fluctuations during the period of observation.

In addition to the 11 "spot" pressure observations discussed, a continuous 24-hour recording of system pressure was made at fire hydrant no. 5, along McArthur Highway near the public plaza. This recording (see Annex Figure IV-E-2) indicates periods of peak demand at 9:00 a.m. and 7:00 p.m., with a high pressure peak at 7:00 a.m., during the 4-hour period from 4:00 a.m. to 8:00 a.m. when the valve at the elevated storage tank is fully open (this valve is partially closed during the remainder of the day).

TABLE IV-3

SPOT PRESSURE MEASUREMENTS

Hydrant Number	Location	Date	Time	Pressure (m)
1	Corner McKinley and Burgos St	15 Dec 1976	10:55 am	3.9
2	Along McArthur Highway (West)	15 Dec 1976	10:05 am	3.3
3	Corner Arcangel and Perez St	15 Dec 1976	11:00 am	3.8
4	Along McArthur Highway, near	15 Dec 1976	10:10 am	2.8
	del Prado St	3 Jan 1977	9:45 am	11.6
7	Along McArthur Highway, near	15 Dec 1976	10:15 am	2.7
	National Highway	3 Jan 1977	9:41 am	7.7
12	Along Ambrocio St	15 Dec 1976	10:30 am	1.8
	(east of National Highway)	3 Jan 1977	9:45 am	3.3
13	Along Ambrocio St (East)	15 Dec 1976	10:35 am	1.1
		3 Jan 1977	9:45 am	0.7
11	Along National Highway			
	(north of McArthur Highway)	15 Dec 1976	10:25 am	1.3
14	Along National Highway			
	near Sison St	15 Dec 1976	10:40 am	2.1
10	Along National Highway			
	corner Consejo St	15 Dec 1976	10:45 am	1.1
8	Along Alonzo St	15 Dec 1976	10:50 am	2.5
	near Laliag St			

Pipe Flow Capacities. In order to determine the general condition of pipes within the existing distribution system, a series of flow and pressure measurements was taken along McArthur Highway from fire hydrant no. 5 to fire hydrant no. 13 (see Annex Figure IV-E-1). A single Hazen Williams "C" value (C=88) was obtained for the 100 mm pipeline between fire hydrants no. 12 and 13, east of the Manila-Baguio Road. Corresponding "C" values were computed for the pipelines between fire hydrants no. 4 and 5, 5 and 7, and 7 and 12, but were disregarded because the actual flows in these pipelines were indeterminate, based on available data. Annex Table IV-E-1 presents the data obtained and computed "C" values. Annex Figure IV-E-3 presents the observed hydraulic grade line between fire hydrant no. 4 and fire hydrant no. 13.

F. COMPUTER STUDIES

The purpose of conducting computer studies on the existing distribution system is to duplicate the existing hydraulic conditions of the system to the greatest extent possible. By doing this, the impact of future improvement can be more accurately determined.

However, field survey data gathered in URD-WD have not been sufficient to conduct the computer studies needed. Generally, water is available for 10 to 16 hours daily. Thus, sufficient number of flow tests and 24-hour pressure measurements have not been possible. There have also been indications that blockages[2] of some kind exist in some of the pipelines. Verification would not be conclusive because flow into the system is controlled by a throttling valve in the system. To open fully this valve on a 24-hour would disrupt the service to a great extent.

Portions of the existing system have been retained and incorporated in the computer analyses of the future system. Assumptions based on engineering judgment have been made on conditions of pipes included in the retained portions. Additional data have been obtained from visual inspection of existing facilities.

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[2] Valves may have been left partially closed.

G. DEFICIENCIES OF THE EXISTING SYSTEM

The present water system and the level of service of the URD-WD have many deficiencies. There is only one source of supply, a well, without any stand-by facilities. In the event the present pumpset breaks down, the URD-WD has no service. Water is generally available in the distribution system for only 10 to 16 hours daily.

The piping network does not extend to many areas which should be covered. Most service connections have leaks due to age and low quality. System pressures are low, even zero, in some parts of the city. Many concessionaires obtain water from the system through pumps, hand or electric, attached to service connections. These pumps have reduced the system pressure to a point where pollution can enter through leaks in the distribution piping. The water district has no policy on the use of such pumps. The location and condition of valves are uncertain. Fire hydrants have little or no value for fire-fighting because of the low pressures in the distribution system. Potential cross-connections exist between the water pipes and the polluted drainage channels.

The water district has no routine water sampling or water quality analysis programs. No plans of the existing system are available. Operation and maintenance equipment, tools and spare parts are inadequate. There are no plumbing shop or transportation facilities.

ANNEX IV-E

HYDRAULIC SURVEY

ANNEX TABLE IV-E-1

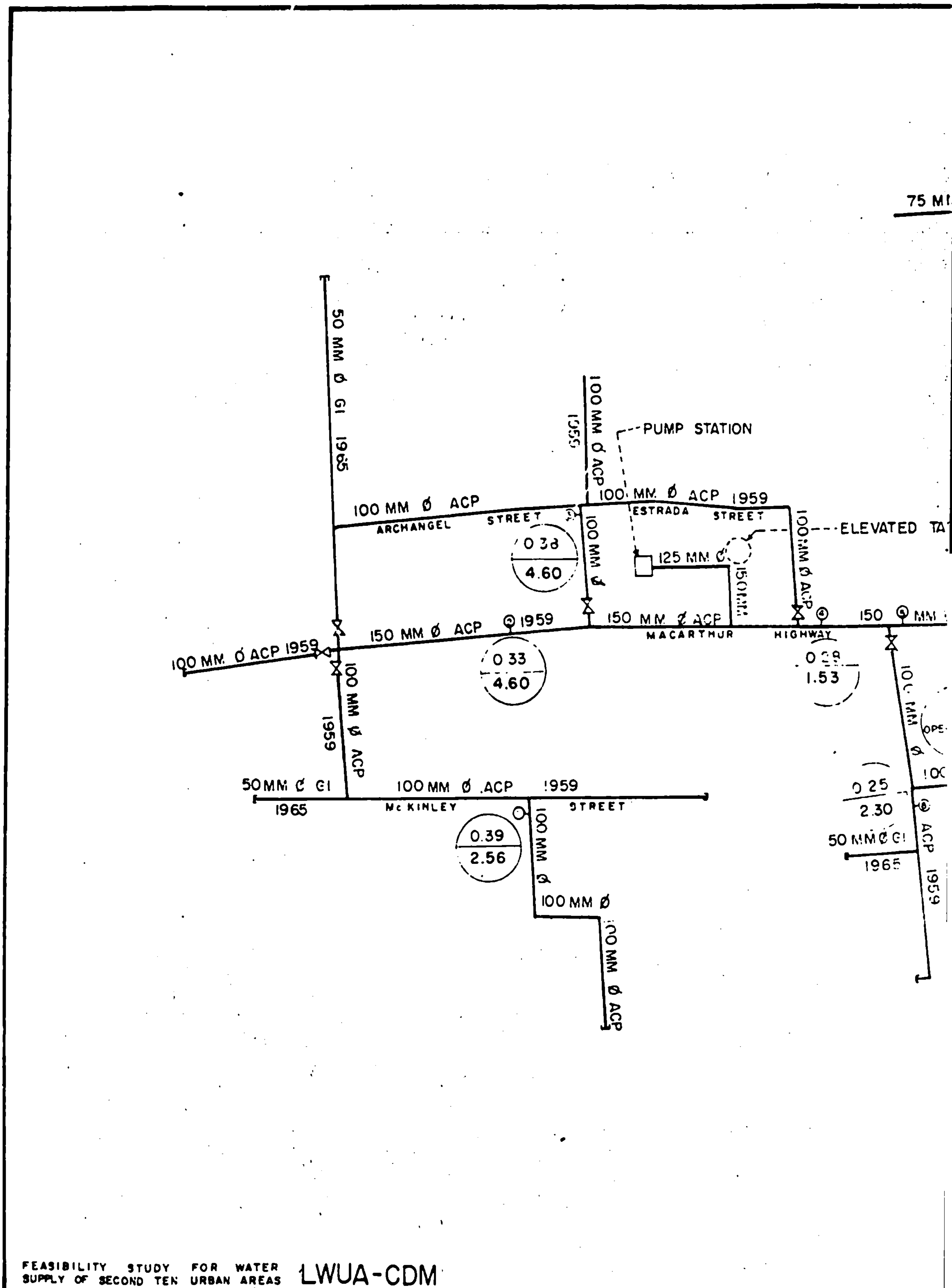
HAZEN WILLIAMS "C" VALUES

Fire Hydrant Number	Elevation (m)	Pressure (m)	Distance (m)	Q lps	"C"
4	14.8	11.62			
			85	5.55	19.64[1]
5	25.4	8.59			
			80	5.55	29 [1]
7	25.2	7.67			
			290	5.55	84.54[1] [2]
12	25.3	3.52			
			210	5.55	87.87
13	25.3	.70			

---

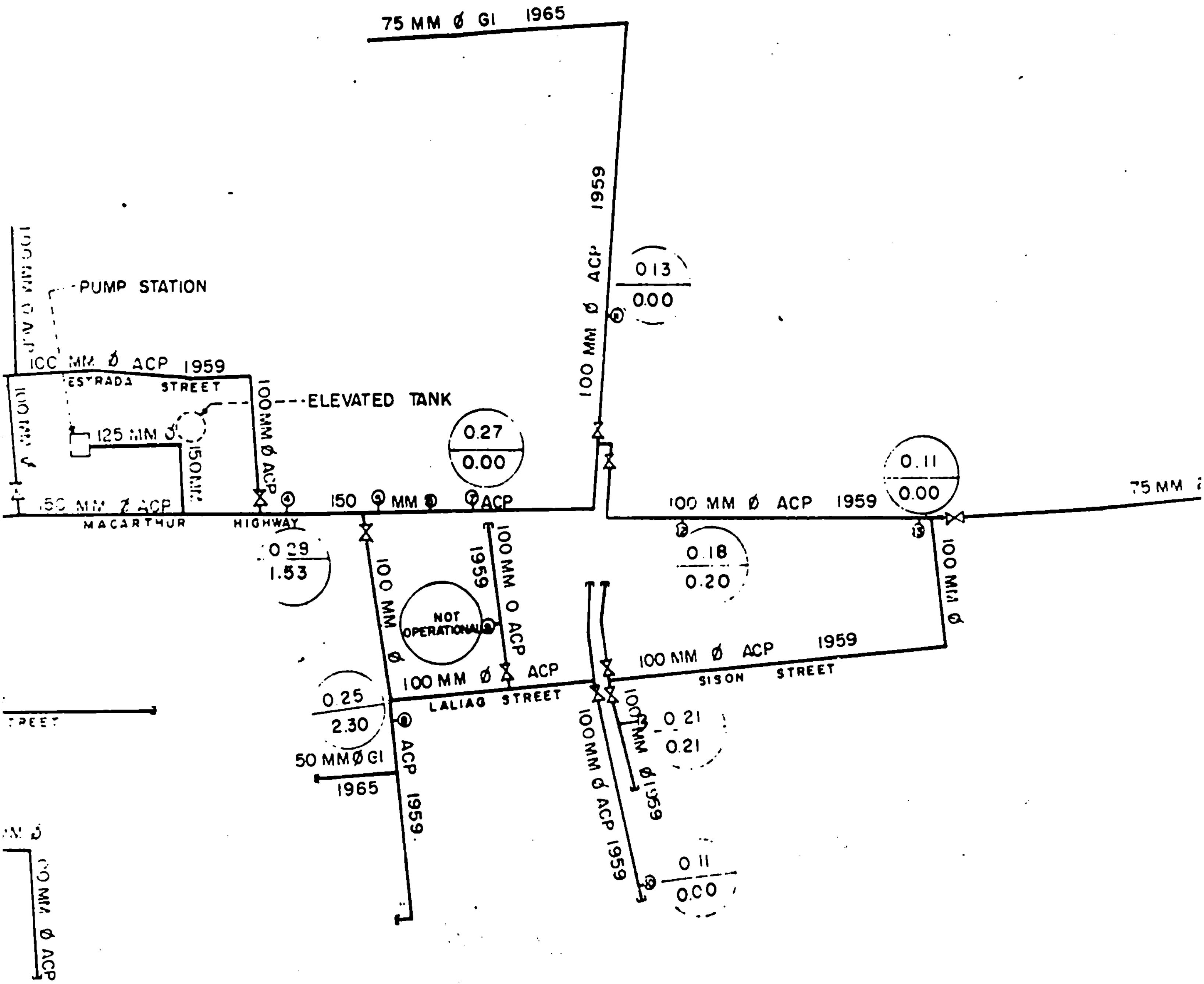
[1] These computed "C" values are unrealistic. The flows used for computation of "C" values do not consider off-takes at the Manila-Baguio Road and Alonzo Street. The additional flow measurements required for accurate computation of "C" values could not be performed because the pipelines concerned are "buried" under concrete street surfaces.

[2] Although this pipeline is a composite of two sizes, it was assumed to have a diameter of 100 mm for this computation.



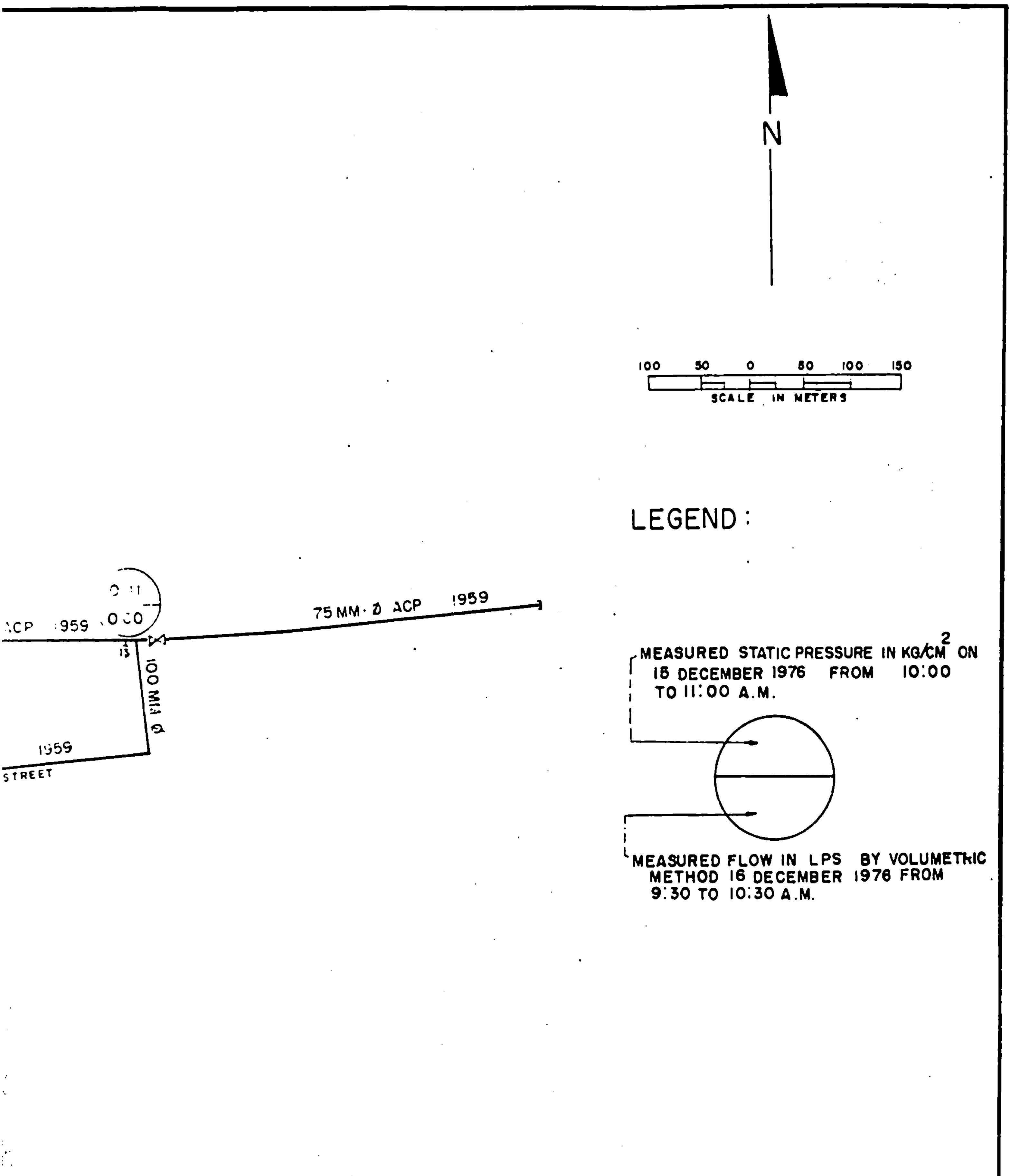
FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

F IV-E-1 a



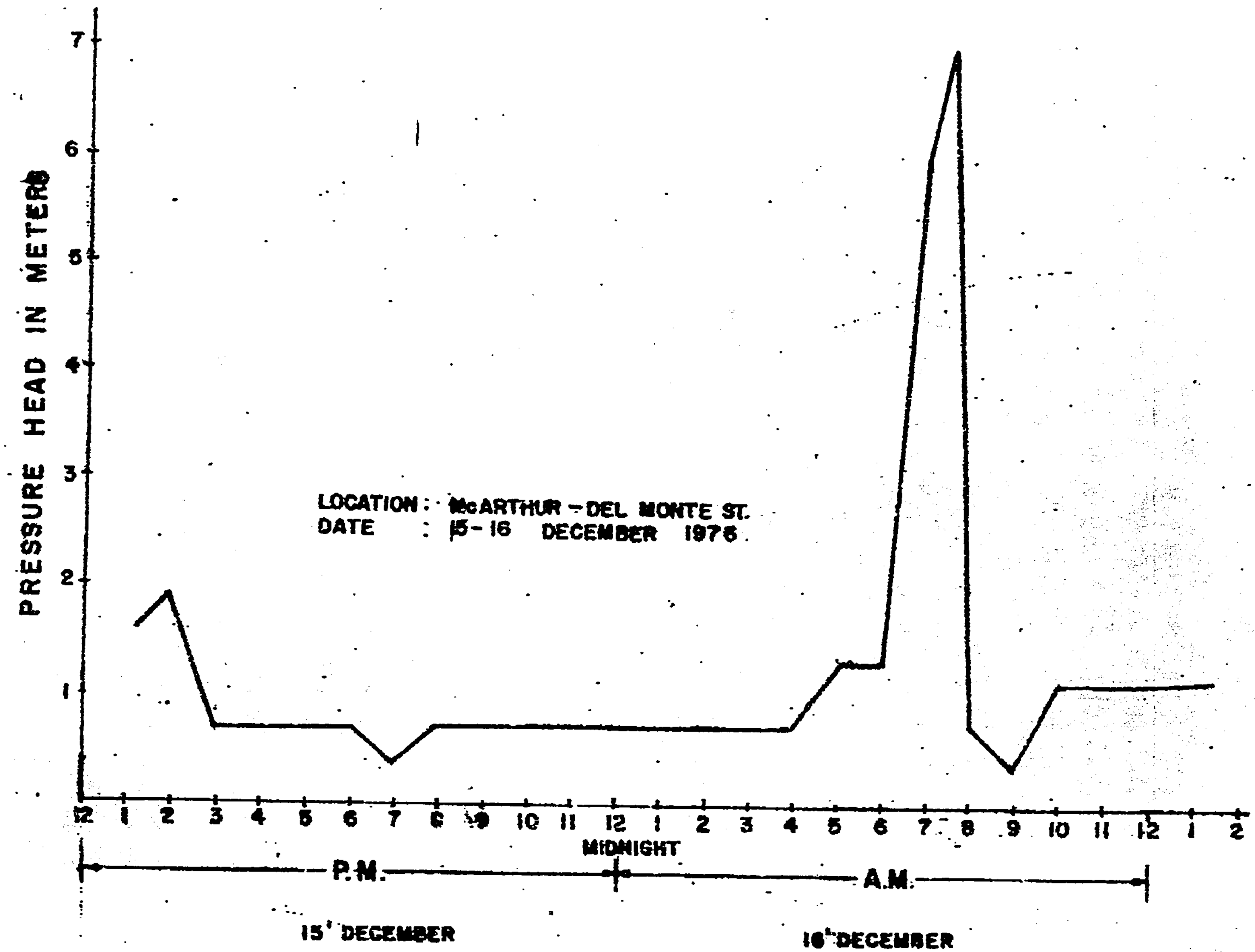
75 MM Ø GI 1965
100 MM Ø ACP 1959
0.13
0.00
PUMP STATION
ELEVATED TANK
ESTRADA STREET
125 MM Ø
150 MM
100 MM Ø ACP
MACARTHUR HIGHWAY
150 MM Ø ACP
0.27
0.00
0.29
1.53
100 MM Ø ACP 1959
0.11
0.00
75 MM
0.18
0.20
100 MM Ø
100 MM Ø
100 MM Ø ACP 1959
NOT OPERATIONAL
100 MM Ø ACP
LALIAG STREET
100 MM Ø ACP 1959
SISON STREET
0.25
2.30
ACP 1959
50 MM Ø GI 1965
0.21
0.21
100 MM Ø ACP 1959
100 MM Ø 1959
0.11
0.00

b

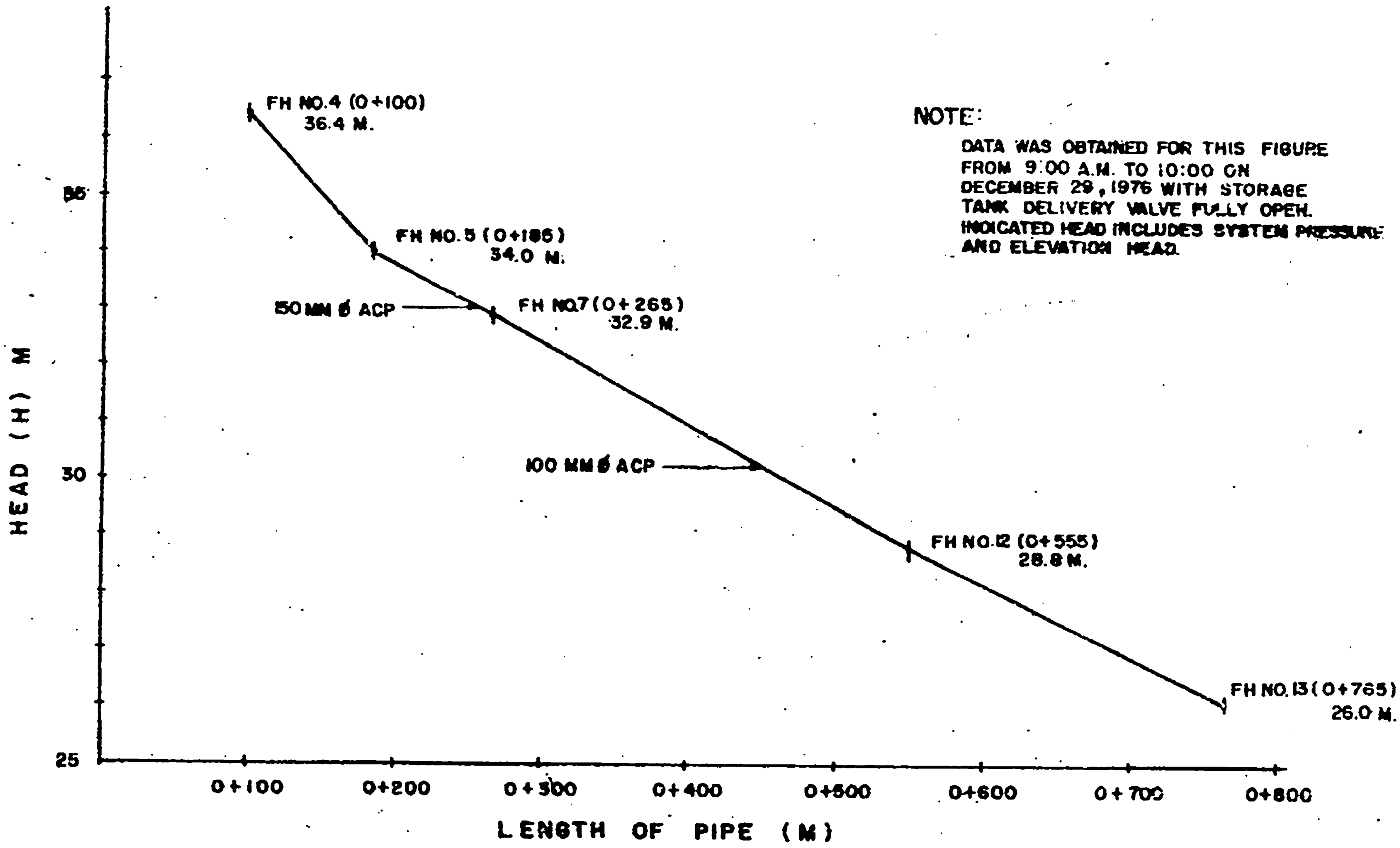


ANNEX FIGURE IV-E-1
LOCATION OF FLOW AND PRESSURE MEASUREMENTS
URDANETA WATER DISTRICT

C



ANNEX FIGURE IV-E-2
24-HOUR SYSTEM PRESSURE AT FIRE HYDRANT NO.5
URDANETA WATER DISTRICT



ANNEX FIGURE IV-E-3
HYDRAULIC GRADE LINE
FROM FH NO. 4 TO FH NO.13
URDANETA WATER DISTRICT

CHAPTER V FEASIBILITY STUDY CRITERIA

A. GENERAL

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

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

B. PLANNING CRITERIA

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

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

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

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

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

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

Stage	Construction Period	Target Design Year
Immediate Improvement*	1978 - 79	1980
Phase I-A	1980 - 85	1985
Phase I-B	1986 - 90	1990
Phase II-A	1991 - 95	1995
Phase II-B	1996-2000	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.

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

C. DESIGN CRITERIA

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

Water Accountability

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

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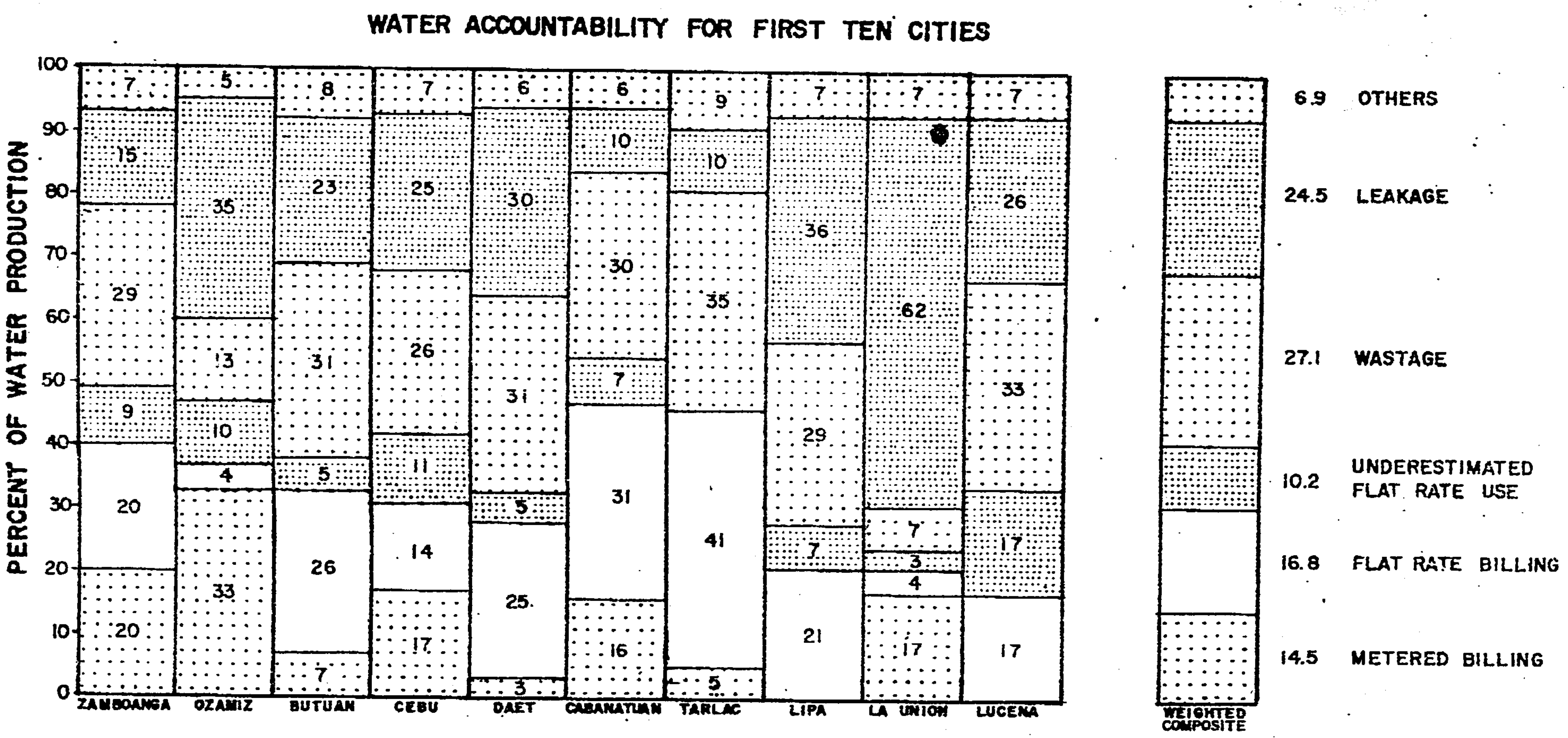
*Refer to the Interim Report February 1977, submitted to LWUA and USAID by CDM.



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

FIGURE V-1
WATER ACCOUNTABILITY
FIRST 10 CITIES

The breakdown of the water accountability is as follows:

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

Water Demand Grouping

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

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

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

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

Demand Variation

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

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

D. ECONOMIC AND FINANCIAL CRITERIA

Discount Rate

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

Inflationary Trends

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

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

Economic Justification

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

Financial Criteria

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

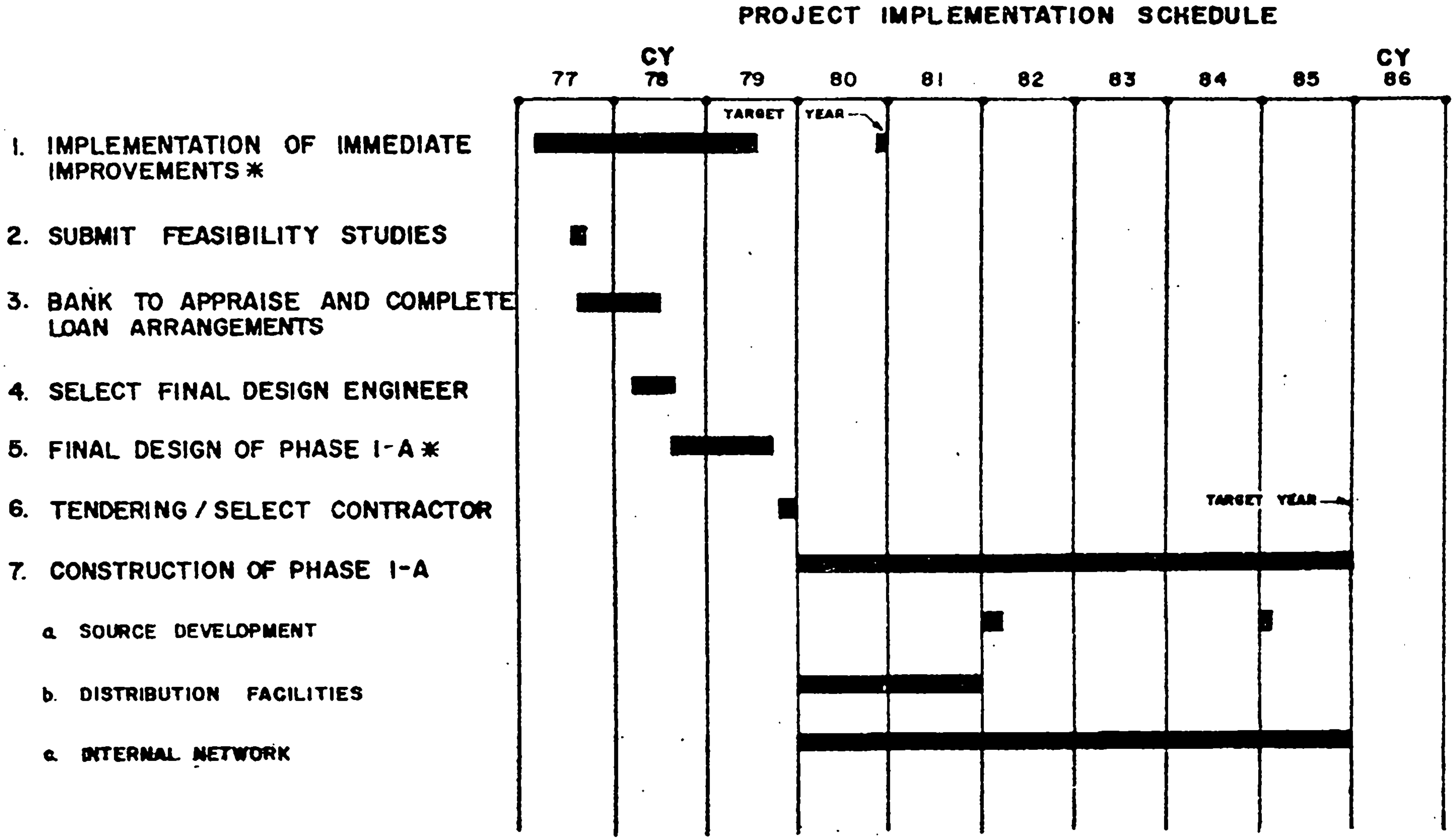
E. BASIS OF COST ESTIMATES

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

F. IMPLEMENTATION SCHEDULE

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

Final Report Submission	September 1977
Select Final Design Engineer	September 1978
Start Final Design	October 1978
Complete Final Design	September 1979
Start Construction	January 1980
Complete Construction:	
a) Source	2 wells in 1982 and 1985
b) Distribution	1980-81
c) Internal Network	1980-85



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

FIGURE V-2
PROJECT IMPLEMENTATION SCHEDULE
URDANETA WATER DISTRICT

CHAPTER VI POPULATION AND WATER DEMAND PROJECTIONS

A. GENERAL

A necessary step in developing the preliminary design of a water system is the projection of future population and water demand for the delineated service area. These projections materially affect facility layouts and sizes, construction staging and the cost of the project. These projections for the URD-WD are developed in this chapter.

B. POPULATION PROJECTIONS

Population projections have taken into account previous population trends in the municipality of Urdaneta, present land use and development plans, the physical limits of the urban areas, and current and proposed public facilities.

The population of Urdaneta from 1948 to 1975 has grown at an average annual rate of 2.23 percent. Annual growth rates in Urdaneta have been lower than those of the Philippines. The following table presents the population of Urdaneta and the corresponding growth rates from 1948 to 1975. The national growth rates for the same period are also presented.

	Urdaneta		National
Year	Population	Annual Growth (%)	Growth (%)
1948	35,811		
1960	44,744	1.87 (1948-1960)	3.10
1970	58,690	2.75 (1960-1970)	3.00
1975	64,882	2.03 (1970-1975)	2.66

While the national growth rate declined slightly during the period between 1960 and 1970, that of Urdaneta substantially increased during the same period. The decrease in growth rate for Urdaneta during the period between 1970 and 1975 corresponds with the decrease in national growth rate.

NEDA-POPCOM has made projections at 5-year intervals for the population of the Philippines, its provinces, cities and municipalities, up to year 2000. Assumptions and methodology used are discussed in Appendix H, Volume II. For national projections (low and medium assumptions), NEDA-POPCOM has assumed a general trend of decreasing annual growth rates from 1975 to 2000 but used fluctuating growth rates in its high assumption/projections.

For Urdaneta, the annual growth rate is expected to increase up to 1980 because of the present development of Urdaneta as a commercial center. Field conditions, however, indicate that from

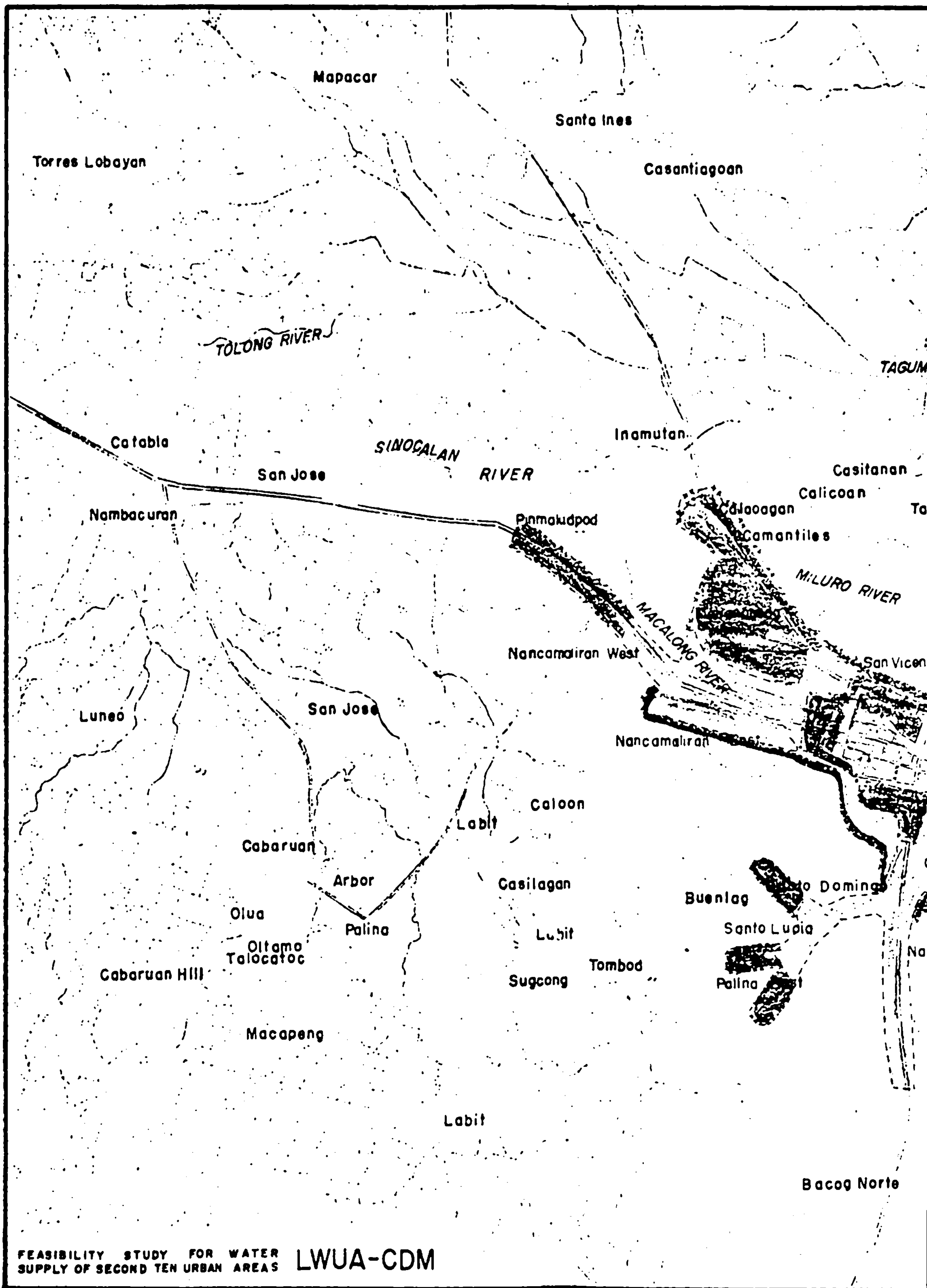
1980 to 2000, the decreasing annual growth rates are applicable in Urdaneta. This can be attributed to space limitations for further development and expansion and the anticipated wider acceptance of the family planning program of the government.

On the basis of field inspection and discussions with the water district personnel and local officials, Figure VI-1 has been developed to indicate the present, immediate, projected 1990, and 2000 service areas of the URD-WD. The projected service areas include the poblacion and nearby barrios which comprise the urbanized portion of Urdaneta. It is assumed that these areas will have higher growth rates than the rural areas. The population projections have been made by applying estimated annual growth rates for the poblacion and barrios in the service area (Table VI-1). The estimates of growth rates are based on observed field conditions and discussions with local officials and water district personnel. Field conditions primarily considered are development of housing subdivisions; current and proposed commercial establishments; geographical location of the area with respect to the poblacion and commercial activities; and accessibility from major existing roads. Estimated growth rates have been adjusted based on engineering judgment and population density per hectare. Results of the projections made are tabulated as follows:

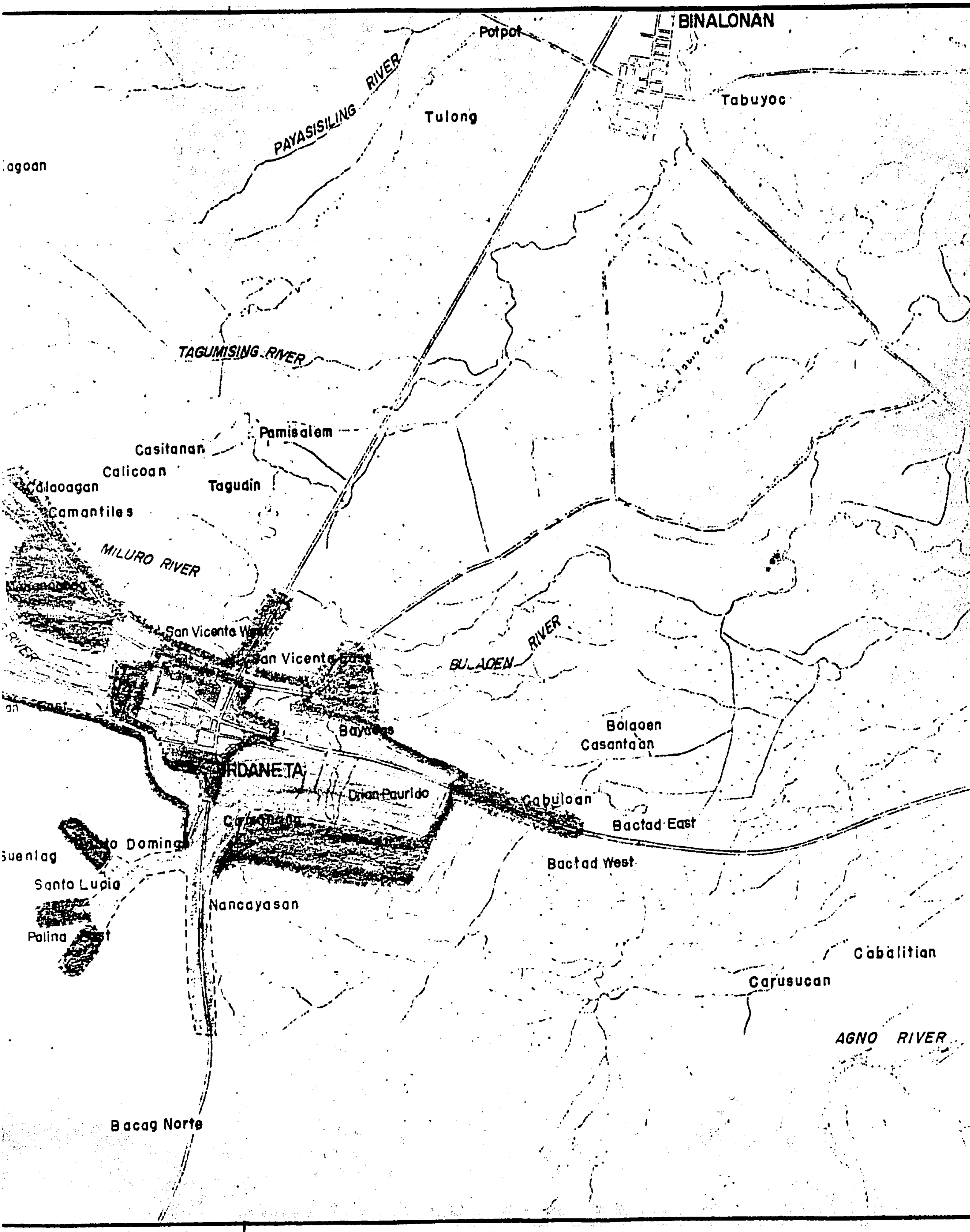
Year	Total Population 1/	Overall Annual Growth Rate (%)	Total Population in Service Area	Service Area (ha)	Average Density persons/ha
1975	41,645		9,192	126	73
1980	49,060	3.33 (1975-1980)	16,300	240	68
1990	65,360	2.91 (1980-1990)	45,160	725	62
2000	83,100	2.43 (1990-2000)	74,9[illegible]	1,179	64

The analysis shows that the population in the service area (see Figure VI-2 and Table VI-1) will increase from 9,192 in 1975 to 74,920 in the year 2000. Densities in the service area will average between 62-73 persons per hectare. The total population of the poblacion and barrios included in the projected service areas will increase from 41,645 in 1975 to 83,100 in 2000. Overall annual growth rates in these areas will decrease from 3.33 percent between 1975 and 1980 to 2.43 between 1990 and 2000.

1/ Of Urdaneta poblacion and other barrios included in the projected service areas.


Mapacar
Santa Ines
Torres Lobayan
Casantiagoan
TOLONG RIVER
TAGUM
Catabla
SINOCALAN
RIVER
Inamutan
San Jose
Casitanan
Calicoan
Nambacuran
Pinmaludpod
Camantiles
MILURO RIVER
MACALONG RIVER
Nancamaliran West
Luneo
San Jose
Nancamaliran
Caloon
Labit
Cabaruan
Arbor
Casilagan
Buenlag
Olua
Palina
Santo Lucia
Oltama
Talocatoc
Tombod
Cabaruan Hill
Sugcong
Macapeng
Labit
Bacog Norte
FEASIBILITY STUDY FOR WATER
SUPPLY OF SECOND TEN URBAN AREAS
LWUA-CDM

FVI-1 a


BINALONAN
Potpot
Tabuyoc
Tulong
PAYASISILING RIVER
agoan
TAGUMISING RIVER
Pamisalem
Casitanan
Calicoan
Tagudin
Calaoagan
Camantiles
MILURO RIVER
San Vicente West
San Vicente East
BULAOEN RIVER
Bolaoen
Casantaan
Bayaoas
URDANETA
Dilan Paurido
Cabuloan
Bactad East
Bactad West
Suenlag
Santo Lucia
Nancayasan
Palina
Cabalitian
Carusucan
AGNO RIVER
Bacag Norte

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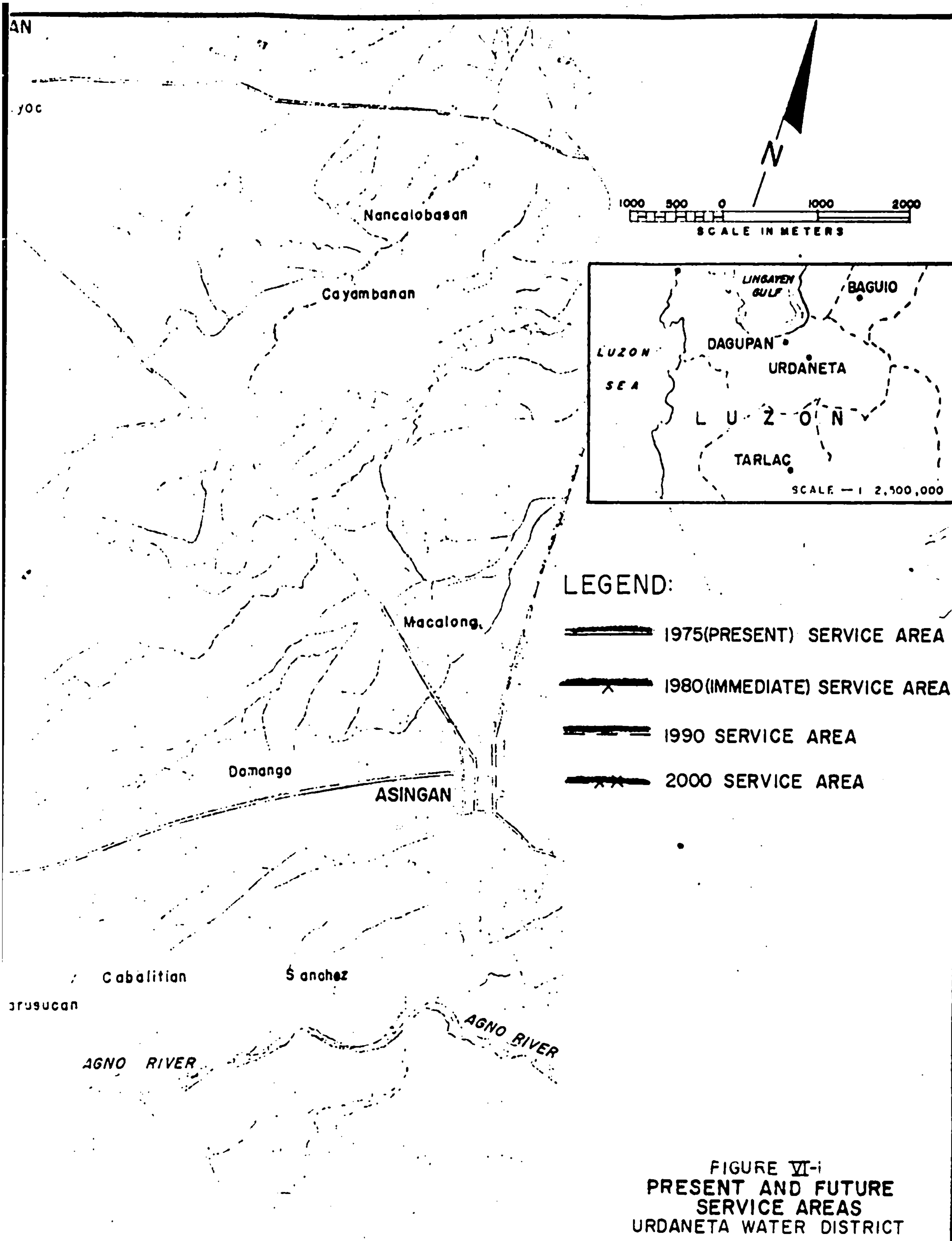
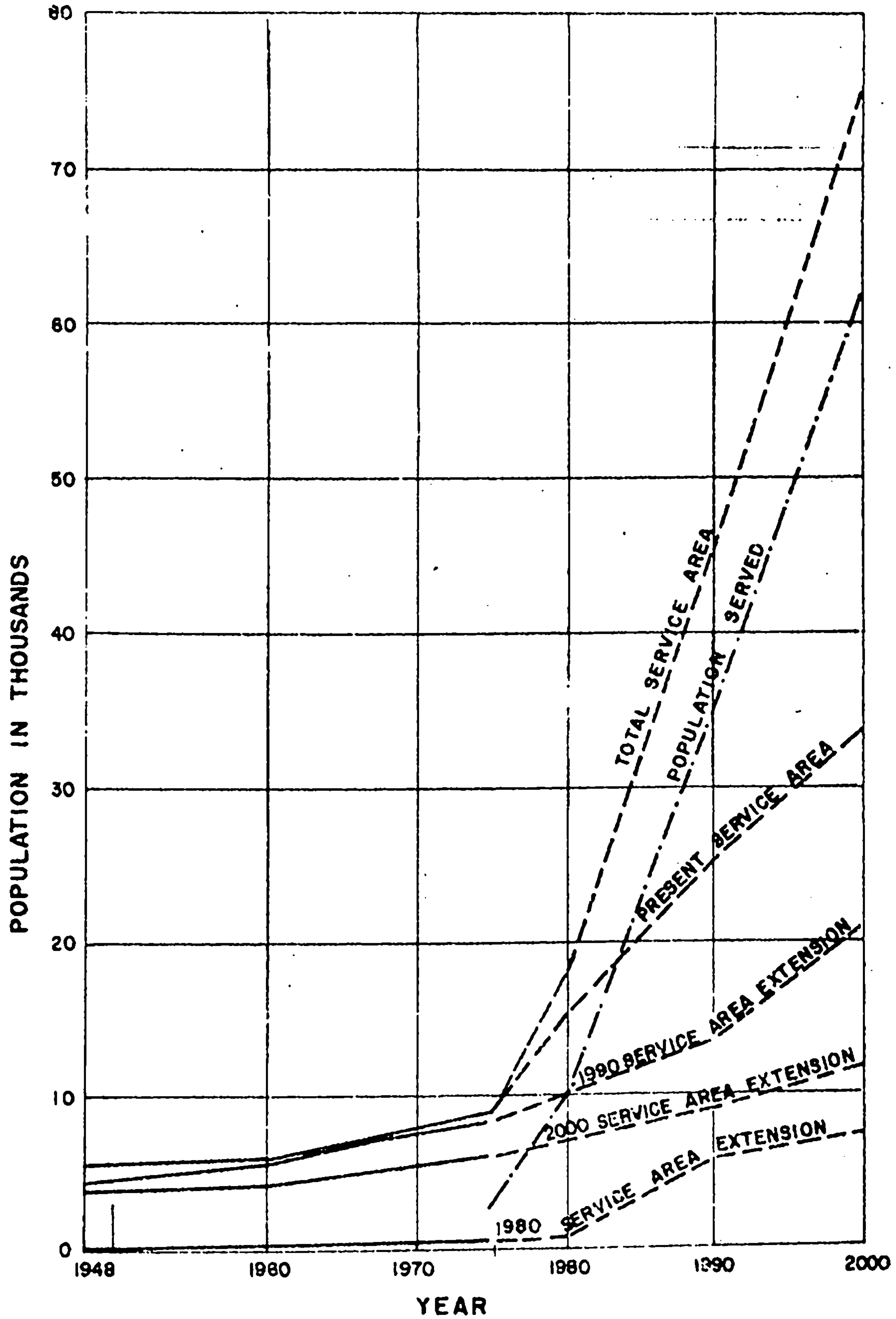


FIGURE VI-1
PRESENT AND FUTURE
SERVICE AREAS
URDANETA WATER DISTRICT



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

FIGURE VI-2
POPULATION PROJECTIONS
URDANETA WATER DISTRICT

TABLE VI-1

SERVICE AREA POPULATION PROJECTIONS
URDANETA WATER DISTRICT

	Population 1975	Present Service Area			Immediate Service Area			1990 Service Area			2000 Service Area		
		Population Service in Service Area	Area (ha)	Density Persons/Ha	Population Service in Service Area	Area (ha)	Density Persons/Ha	Population Service in Service Area	Area (ha)	Density Persons/Ha	Population Service in Service Area	Area (ha)	Density Persons/Ha
Poblacion	8,647	8,647	107	81	10,270	117	88	13,800	117	118	17,670	117	151
Nancamaliran East	2,044	-	-	-	-	-	-	3,300	55	60	4,140	85	49
Nancamaliran West	2,600	-	-	-	-	-	-	4,210	37	114	5,280	37	143
San Vicente East	2,322	46	3	15	550	8	69	1,790	34	53	3,590	71	51
San Vicente West	2,830	283	7	40	1,990	47	42	3,920	69	57	5,460	122	45
Bayaoas	3,602	216	9	24	2,570	25	103	5,710	102	56	7,160	126	57
Nancayasan	3,695	-	-	-	920	43	21	6,190	131	47	7,920	131	60
Dilan-Paurido	1,808	-	-	-	-	-	-	2,180	107	20	3,910	107	37
Palina East	2,125	-	-	-	-	-	-	1,660	14	119	3,340	48	70
Sto. Domingo	1,304	-	-	-	-	-	-	1,220	23	53	2,480	40	62
Kabanogtog	953	-	-	-	-	-	-	1,180	36	33	1,890	66	29
Pinmaludpod	2,363	-	-	-	-	-	-	-	-	-	3,300	32	103
Camantiles	2,748	-	-	-	-	-	-	-	-	-	2,600	36	72
Camanang	1,736	-	-	-	-	-	-	-	-	-	3,150	123	26
Cabuloan	1,773	-	-	-	-	-	-	-	-	-	2,000	28	71
Baotad West	1,095	-	-	-	-	-	-	-	-	-	1,030	10	103
Total	41,645	9,192	126	73	16,300	240	68	45,160	725	62	74,920	1,179	64

C. SERVED POPULATION PROJECTIONS

Served population in the URD-WD is expected to increase significantly in the next two decades. The projected increase in served population is a result of the intense campaign by the URD-WD to connect as many customers as possible; the stated desire of residents in URD-WD to have the benefits of a modern piped water system; and the increases in total population as well as geographical coverage of the URD-WD.

Table VI-2 shows the detailed breakdown of the served populations for the Urdaneta poblacion and the barrios within the URD-WD service area. These are summarized below:

Year	Projected Served Population	Population in the Service Area	Percent Served
1975	3,216	9,192	35
1980	10,590	16,300	65
1990	34,680	45,160	77
2000	61,870	74,920	83

The served population which was 35 percent of the total service area population in 1975 is projected to be 65 percent in 1980, 77 percent in 1990 and 83 percent in 2000. Hence, the served population will increase from 3,216 in 1975 to 61,870 in 2000, a twenty-fold increase in 25 years (see Figure VI-2).

Projected increases in served population are 24,090 from 1980 to 1990 and 27,190 from 1990 to 2000. The projected increases are concentrated in the present service area, where served population will increase from 35 percent in 1975 to 93 percent in 2000. The served population of 31,560 within the present service area in 2000 is 51 percent of total served population at that time.

A year by year tabulation of projected served population is shown in Table VI-3.

TABLE VI-2

SERVED POPULATION PROJECTIONS
URDANETA WATER DISTRICT

Location	Present Service Area	Immediate Service Area (1980)	1990 Service Area	2000 Service Area
1) Poblacion				
a. Population in Service Area	8,647	10,270	13,800	17,670
b. Number of Service Connections	386	1,105	1,687	2,199
c. Connected Population	2,997	8,730	13,110	17,086
d. Percent Connected	35	85	95	97
2) San Vicente East				
a. Population in Service Area	46	550	1,790	3,590
b. Number of Service Connections	2	21	164	349
c. Connected Population	15	167	1,277	2,712
d. Percent Connected	33	30	71	76
3) San Vicente West				
a. Population in Service Area	283	1,990	3,920	5,460
b. Number of Service Connections	19	88	439	637
c. Connected Population	148	681	3,410	4,951
d. Percent Connected	52	34	87	91
4) Bayaoas				
a. Population in Service Area	216	2,570	5,710	7,160
b. Number of Service Connections	7	101	605	877
c. Connected Population	56	783	4,702	6,814
d. Percent Connected	26	30	82	95
5) Nancayasan				
a. Population in Service Area		920	6,190	7,920
b. Number of Service Connections		29	593	957
c. Connected Population		229	4,609	7,436
d. Percent Connected		25	74	94

TABLE VI-2(Continued)

Location	Present Service Area	Immediate Service Area (1980)	1990 Service Area	2000 Service Area
6) Nancamaliran East				
a. Population in Service Area			3,300	4,140
b. Number of Service Connections			349	504
c. Connected Population			2,716	3,913
d. Percent Connected			82	94
7) Nancamaliran West				
a. Population in Service Area			4,210	5,280
b. Number of Service Connections			268	618
c. Connected Population			2,079	4,805
d. Percent Connected			49	91
8) Dilan-Paurido				
a. Population in Service Area			2,180	3,910
b. Number of Service Connections			147	399
c. Connected Population			1,146	3,098
d. Percent Connected			52	79
9) Sto. Domingo				
a. Population in Service Area			1,220	2,480
b. Number of Service Connections			63	233
c. Connected Population			490	1,809
d. Percent Connected			40	73
10) Palina East				
a. Population in Service Area			1,660	3,340
b. Number of Service Connections			85	311
c. Connected Population			664	2,417
d. Percent Connected			40	72

TABLE VI-2 (Continued)

Location	Present Service Area	Immediate Service Area (1980)	1990 Service Area	2000 Service Area
11) Mabanogbog				
a. Population in Service Area			1,180	1,890
b. Number of Service Connections			61	194
c. Connected Population			474	1,511
d. Percent Connected			40	80
12) Camanang				
a. Population in Service Area				3,150
b. Number of Service Connections				180
c. Connected Population				1,400
d. Percent Connected				44
13) Pinmaludpod				
a. Population in Service Area				3,300
b. Number of Service Connections				188
c. Connected Population				1,460
d. Percent Connected				44
14) Camantiles				
a. Population in Service Area				2,600
b. Number of Service Connections				148
c. Connected Population				1,150
d. Percent Connected				44
15) Cabuloan				
a. Population in Service Area				2,000
b. Number of Service Connections				112
c. Connected Population				870
d. Percent Connected				44

TABLE VI-2 (Continued)

Location	Present Service Area	Immediate Service Area (1980)	1990 Service Area	2000 Service Area
16) Baotad West				
a. Population in Service Area				1,030
b. Number of Service Connections				57
c. Connected Population				440
d. Percent Connected				43
Total Number of Connections[2/]	414	1,344	4,461	7,963
Total Population	9,192	16,300	45,160	74,920
Total Population Served	3,216	10,590	34,677	61,872
Percent Served Population	35	65	77	83

[2/] Average number of persons/connection is 7.77. This is greater than the average number of persons/household as obtained in the NCSO tables. However, water district records show that a 12 mm connection serves an average of 6.47 persons; a 19 mm connection serves an average of 11.32 persons; and a 25 mm connection serves an average of 14 persons. The overall average is 7.77 persons/connection. Field observations indicate that a 19 mm or a 25 mm connection serves two households. Water district records further show that twenty-one percent of existing connections are of 19 mm and 25 mm. This percentage is assumed to be the same for 1980, 1990 and 2000, thus the 7.77 persons/connection was used in the projections.

D. WATER DEMAND PROJECTIONS

Inherent in making water demand projections are assumptions about future conditions and increase in served population. Per capita domestic water use, commercial/industrial/institutional use, as well as unaccounted-for-water (expressed as percent of production), have been estimated for the years 1980, 1990 and 2000 for the service area. Based on analyses of water district characteristics (see Methodology Memorandum No. 3), URD-WD has been classified under Group III, which assumes the following average water use.

	1980	1990	2000
Domestic use, lpcd	105	120	135
Commercial/industrial/institutional, lpcd	14	19	24
Accounted-for-water	119	139	159
Percent unaccounted-for-water	40	28	20
Unaccounted-for-water, lpcd	79	54	40
Total water demand, lpcd	198	193	199

In 1976, unaccounted-for-water in URD-WD was estimated to be 37 percent of total water production . With the projected improvement in water service, the "borrowers" in 1976 are expected to become registered concessionaires and all connections are expected to be metered. Because of these improvements, unaccounted-for-water is projected to be 40 percent of total water production in 1980, 28 percent in 1990 and 20 percent in 2000. Table VI-3 presents the year-to-year projected water demands from 1978 to 2000.

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

	1980	1990	2000
Water demand, lpcd	198	193	199
Served population	10,590	34,680	61,870
Average daily water demand, cumd	2,100	6,690	12,310
Maximum-day water demand[3], cumd	2,520	8,030	14,770
Peak-hour water demand[4], cumd	3,680	11,710	21,540

3/Based on 1.2 times average daily water demand.
4/Based on 1.75 times average daily water demand.

TABLE VI-3

YEAR BY YEAR SERVED POPULATION AND WATER DEMAND PROJECTIONS
URDANETA WATER DISTRICT

Year	Total Population Served	Average-Day Demand (cumd)	Maximum-Day Demand (cumd)	Peak-Hour Demand (cumd)
1978	6,570	1,300	1,560	2,280
1979	8,340	1,650	1,980	2,890
1980	10,590	2,100	2,520	3,680
1981	11,920	2,360	2,830	4,120
1982	13,430	2,640	3,170	4,620
1983	15,120	2,970	3,560	5,190
1984	17,020	3,330	4,000	5,830
1985	19,160	3,740	4,480	6,540
1986	21,580	4,200	5,030	7,340
1987	24,300	4,710	5,650	8,240
1988	27,360	5,290	6,340	9,250
1989	30,800	5,930	7,120	10,380
1990	34,680	6,690	8,030	11,710
1991	36,750	7,110	8,540	12,450
1992	38,940	7,560	9,070	13,230
1993	41,260	8,040	9,640	14,070
1994	43,720	8,540	10,250	14,950
1995	46,320	9,080	10,900	15,890
1996	49,080	9,650	11,580	16,890
1997	52,010	10,260	12,310	17,950
1998	55,110	10,900	13,080	19,080
1999	58,390	11,590	13,900	20,270
2000	61,870	12,310	14,770	21,540

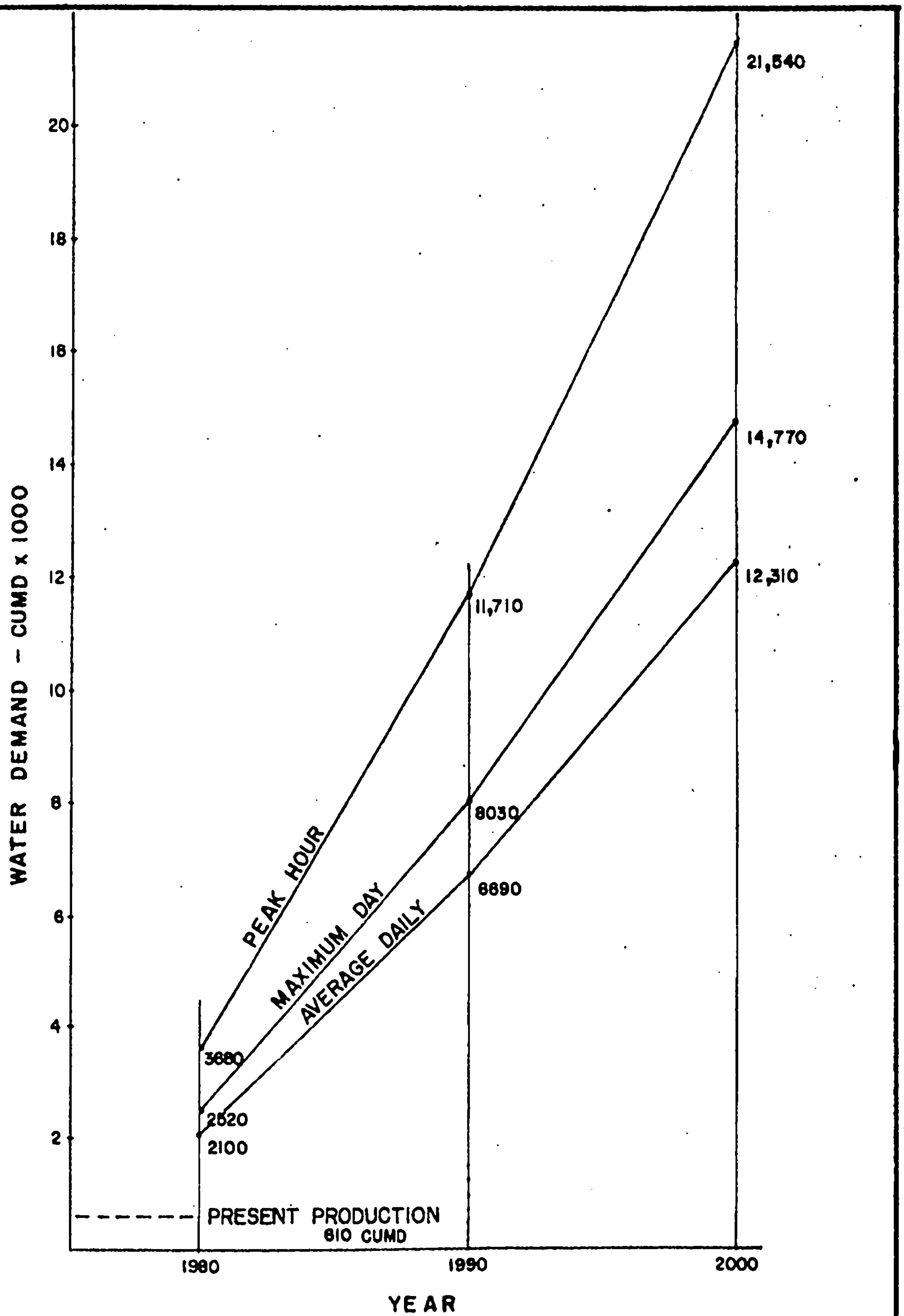


FIGURE VI-3
PROJECTED WATER DEMAND
URDANETA WATER DISTRICT

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

CHAPTER VII WATER RESOURCES

A. GENERAL

The URD-WD currently obtains all its water supply from one old well of small capacity. The possible sources of water for municipal supply are groundwater and surface water from the Agno and Sinocalan River systems.

B. GROUNDWATER RESOURCES

The URD-WD is located in the northern part of the Central Plain of Luzon, a very productive groundwater region. Wells are, in almost all cases, used for city, private and industrial water supply but not currently for large-scale irrigation near Urdaneta. The locations of most of the wells in the immediate vicinity of the URD-WD considered for this study are shown in Figure VII-1. Numerous additional distant wells were studied for regional analysis. The water well data are summarized in Annex Table VII-B-1. The critical factor in groundwater exploitation is control to avoid over-production, rather than the technical problems of production.

Geology

The Central Plain of Luzon is the physiographic expression of a large structural trough separating the Zambales Mountains to the west from the Sierra Madres to the east and the Caraballo Mountains to the north. This trough was depressed below sea level repeatedly during Tertiary and Early Quaternary times. The trough was last filled to its present extent with material washed down from the mountain slopes and deposited in the form of fan and deltaic deposits and, later, flood plain deposits. The deepest well in the Urdaneta area is over 250 meters deep and penetrates only part of the Quaternary alluvium; but the underlying rocks can be inferred from exposures of older rocks in the hills and mountains that lie to the north, east and southwest.

The basement complex exposed in the Sierra Madres consists of basic igneous and metamorphic rocks probably of Cretaceous to Early Tertiary Age. Overlying the basement are tuffaceous clastic sedimentary rocks (shales, siltstones, sandstones, conglomerates) of Middle to Late Tertiary Age. Limestones are observed locally. The Tertiary sediments in part are overlain by the Quaternary Guadalupe tuff, composed of waterlain, angular volcanic debris. These sediments, in turn, are overlain by the alluvium that fills the depressed plain.

The Quaternary alluvium is an intricately interbedded sequence of clays, sands and gravels with a small amount of local cementation. Most of the beds are relatively thin and each bed is of limited extent. The original complex pattern of deposition and reworking has resulted in a maze of fingers and lenses of sands and gravels that are difficult to trace and predict. Annex Figures VII-B-1 through VII-B-7 are stratigraphic logs of wells in the area that illustrate the situation. Many of the major units logged are sequences of thin beds lumped under the name of the major constituent, such as "clay with some gravel" or even just "clay." The Quaternary alluvium is more than 260 meters thick in the deepest well in the Urdaneta area and thins to zero thickness on the surrounding hill flanks as shown in Figure VII-2. Occasional beds of adobe (tuff) and limestone are encountered in some wells as would be expected in a depositional environment at the edge of volcanic islands.

Urdaneta Poblacion is situated in a pocket of the alluvium almost surrounded by more or less isolated outcrops of older rocks; the Cabaruan Hills, 6 km to the southwest; Mt. Balungao, 14 km to the southwest; and outlying fingers of the Caraballo Mountains, 12 km to the northwest and 14 km to the northeast (Figure VII-3). These older rocks were high areas sticking out of the sea (or above the plain) in which the Quaternary alluvium was deposited around and between them.

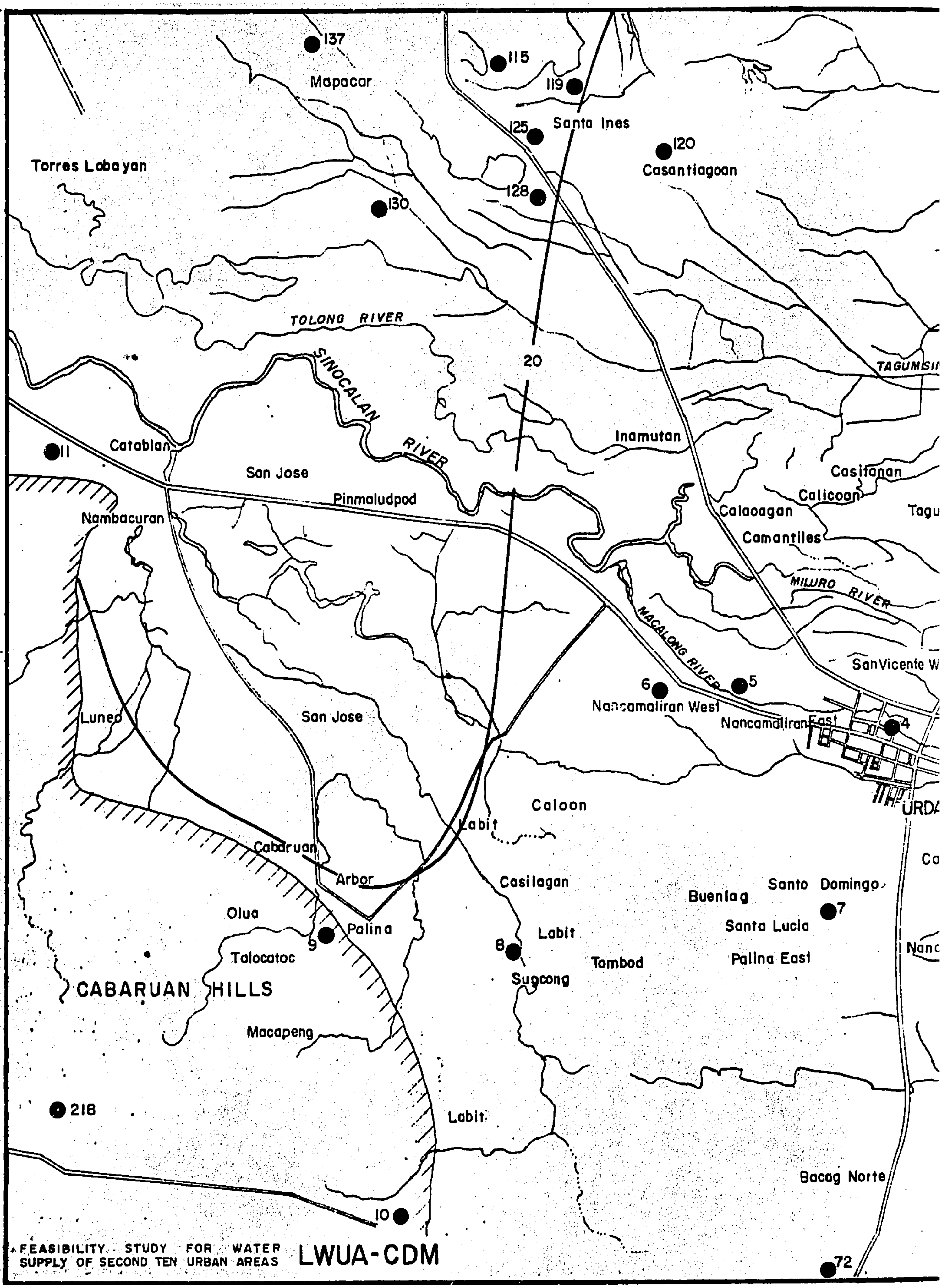
Springs

Springs and seeps exist along the edge of the Cabaruan Hills, about 7 km from the poblacion; but they are small and scattered, and are currently used for irrigation. They derive from groundwater in the older sediments of the hills. They are not considered an economical or suitable source for URD-WD.

Wells

Wells in the Urdaneta area range from shallow, hand-dug wells to bored holes over 250 meters deep. Tables VII-1, VII-2 and Annex Table VII-B-1 are summaries of pertinent records of BPW and private wells and the NIA test well for which logs, static water levels and pumping data are available. These wells were studied to evaluate the aquifer and to derive production well parameters.

The BPW wells range from 6 to 155 meters deep, and have 62 to 250 mm casing. They were constructed by percussion drilling methods and produce from either open-holes or slotted pipe at the bottom of the hole. The section tapped is generally not the only, or even the best, water-producing formation. These wells are of poor construction and design and, consequently, of low yield and low specific capacity.



137
115
119
Mapacar
Santa Ines
125
120
Torres Lobayan
Casantiagoan
128
130
TOLONG RIVER
SINOCALAN RIVER
20
TAGUMSI
Inamutan
11
Catablan
San Jose
Casitanan
Pinmaludpod
Calicoan
Calaoagan
Tagu
Nambacuran
Camantiles
MILURO RIVER
NACALONG RIVER
SanVicente W
6
5
Nancamaliran West
Nancamaliran East
4
Luneo
San Jose
Caloon
URDA
Labit
Cabaruan
Ca
Arbor
Casilagan
Santo Domingo
Buenlag
7
Olua
Palina
Santa Lucia
9
Labit
8
Talocatoc
Palina East
Nanc
Tombod
Sugcong
CABARUAN HILLS
Macapeng
218
Labit
Bacag Norte
10
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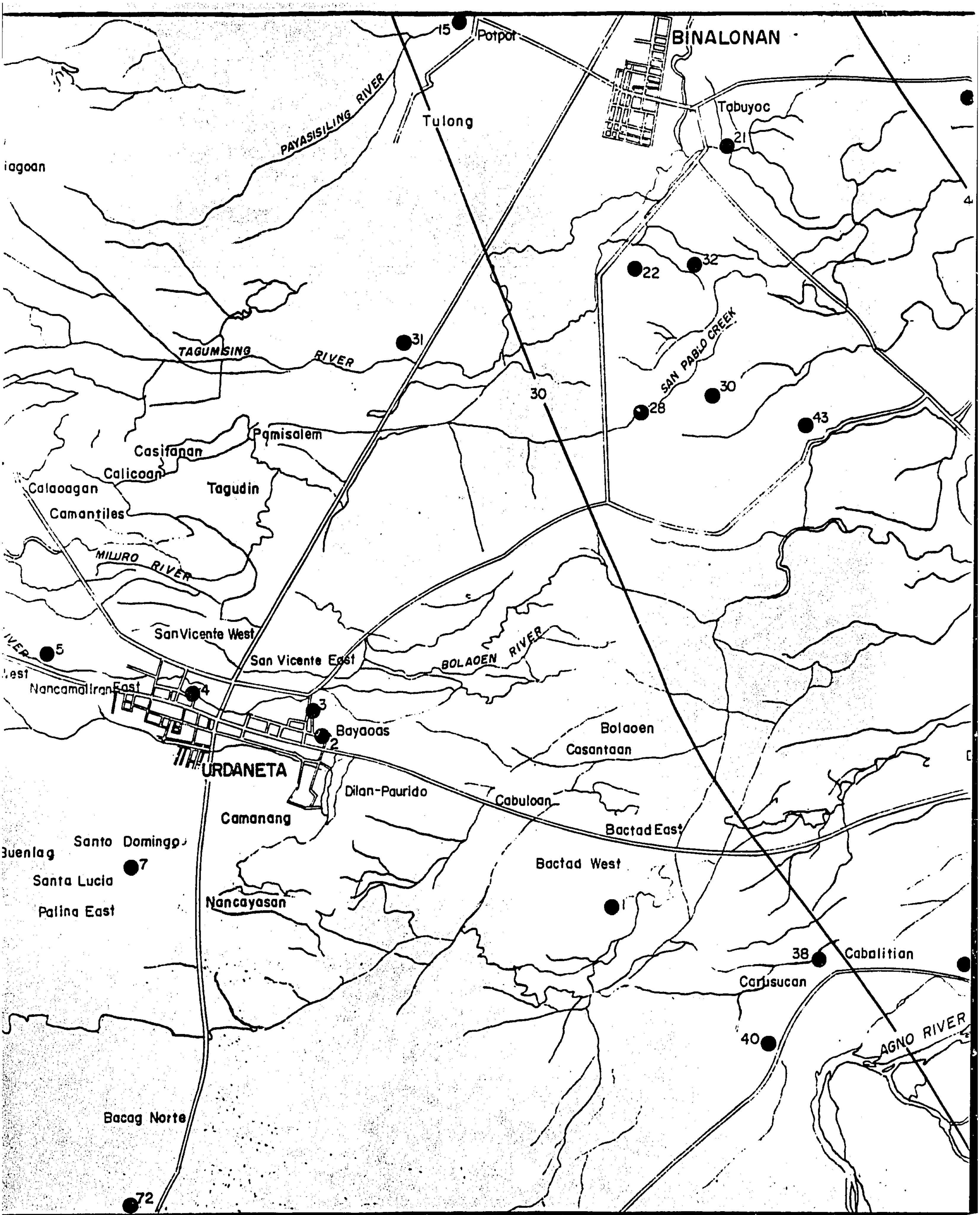
LWUA-CDM
72

a



BINALONAN
Potpot
15
Tabuyoc
21
Tulong
PAYASISILING RIVER
iagoan
22
32
SAN PABLO CREEK
31
TAGUMSING RIVER
30
30
28
43
Pamisalem
Casifanan
Calicoan
Calaoagan
Tagudin
Camantiles
MILURO RIVER
San Vicente West
San Vicente East
BOLAOEN RIVER
5
Nancamaliran East
4
3
Bayaoas
2
URDANETA
Bolaoen
Casantaan
Dilan-Paurido
Cabuloan
Camanang
Bactad East
Santo Domingo
Buenlag
7
Santa Lucia
Bactad West
Nancayasan
Palina East
1
38
Cabalitian
Carusucan
40
AGNO RIVER
Bacag Norte
72

b

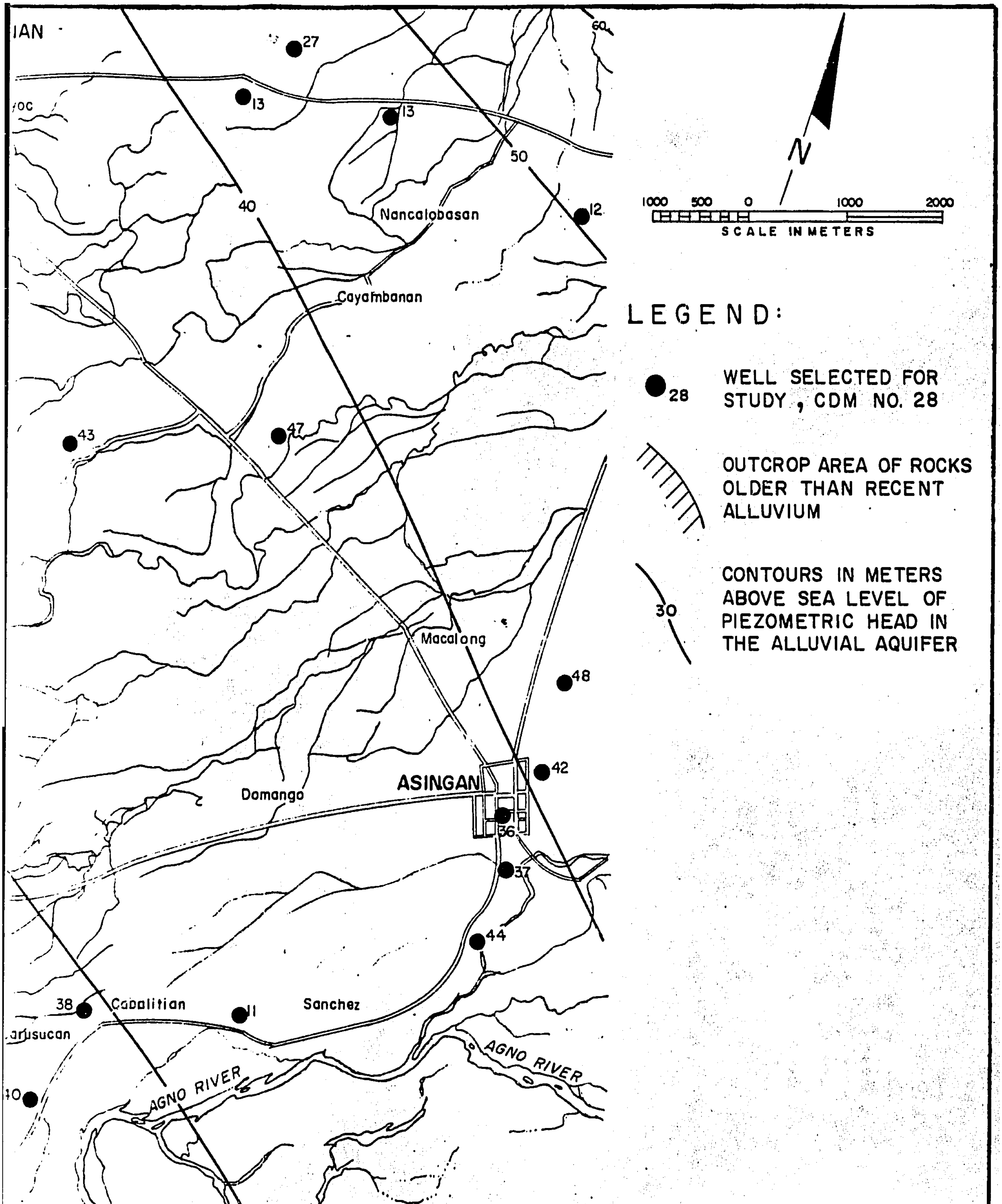


FIGURE VII-1
WELL LOCATION MAP
URDANETA AREA

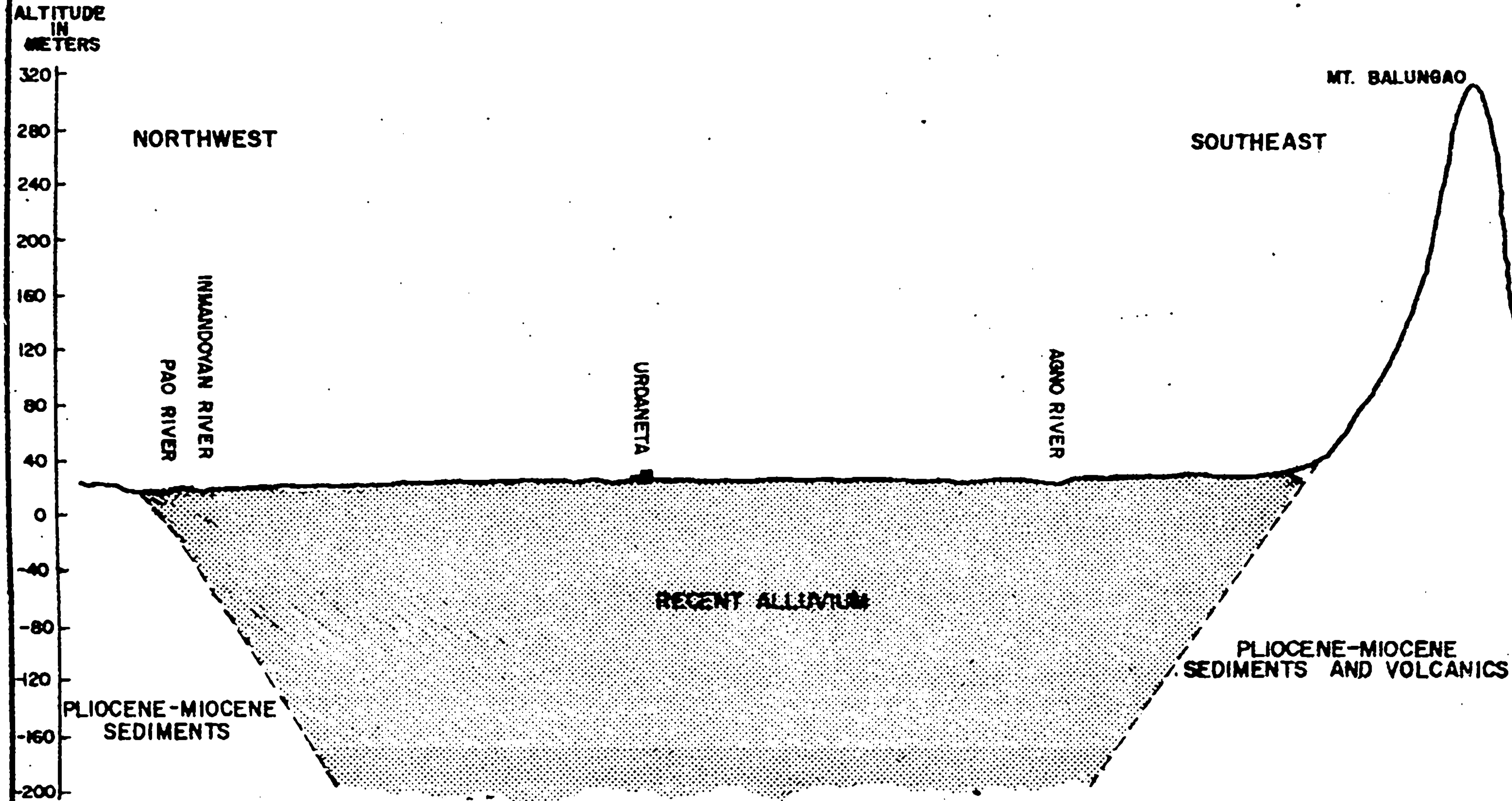


FIGURE VII—2
GENERALIZED
NORTHWEST-SOUTHEAST CROSS-SECTION
THROUGH URDANETA

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

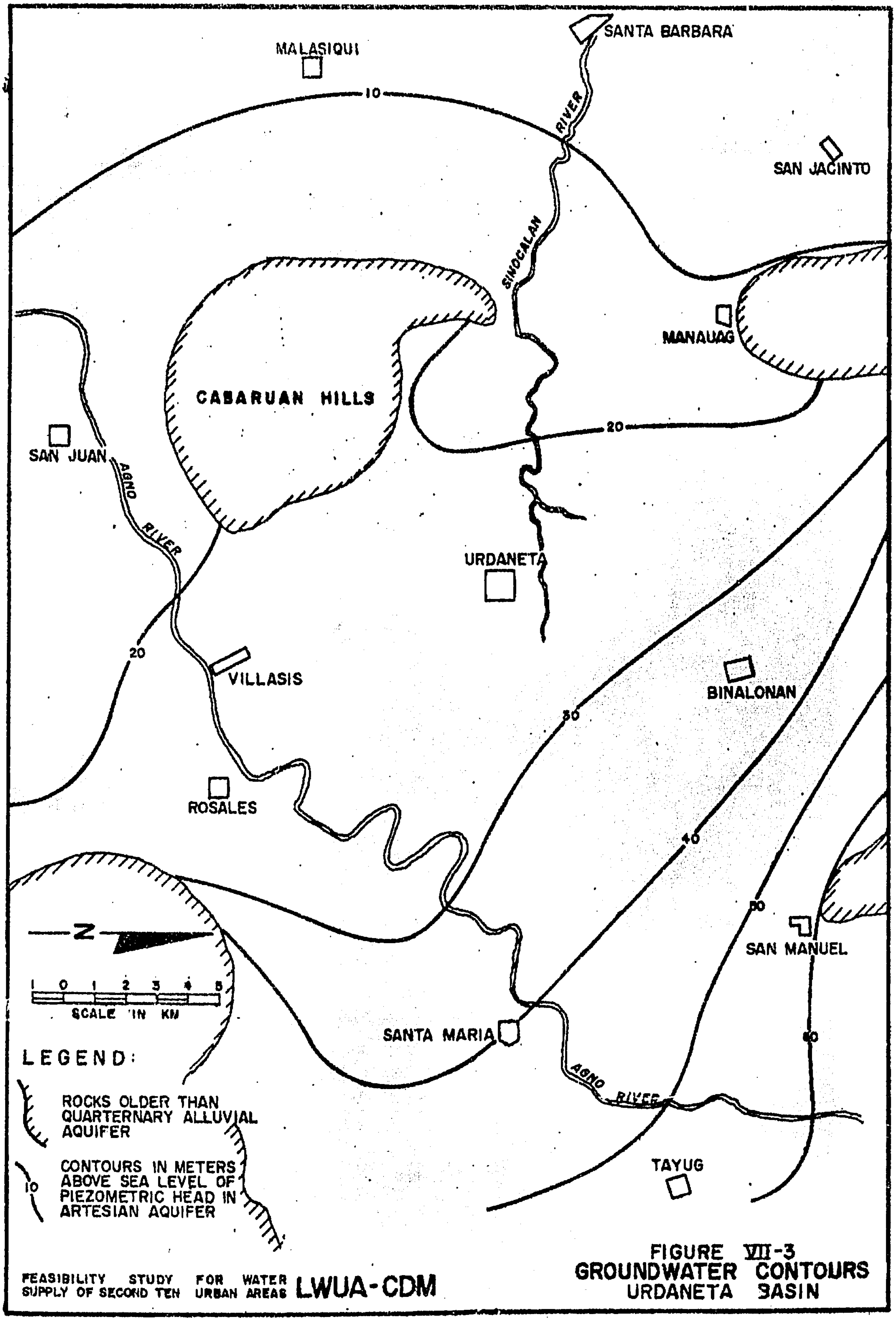


FIGURE VII-3
GROUNDWATER CONTOURS
URDANETA BASIN

TABLE VII-1

SPECIFIC CAPACITY VERSUS DEPTH

Depth Range (m)	Number of Wells in Sample	Average Specific Capacity (lps/m)	Maximum Specific Capacity (lps/m)	Minimum Specific Capacity (lps/m)
0–10	13	1.7	4.2	0.2
10–20	35	1.1	4.2	0.1
20–30	78	1.0	12.6	0.1
30–40	45	1.1	12.5	0.1
40–50	46	0.8	3.1	0.1
50–60	28	0.6	4.2	0.1
60–70	23	1.6	12.6	0.1
70–80	5	0.5	1.1	0.2
80–90	5	1.3	2.0	0.9
90–100	1	0.7	0.7	0.7
100–150	6	1.4	2.6	0.2
150–200	2	1.1	2.1	0.1
200–250	1	0.02	0.02	0.02
	288			

TABLE VII-2

SPECIFIC CAPACITY VERSUS CASING DIAMETER

Smallest Casing Diameter (mm)	Number of Wells in Sample	Average Specific Capacity (lps/m)	Maximum Specific Capacity (lps/m)	Minimum Specific Capacity (lps/m)
62	1	0.3	0.3	0.3
75	1	2.5	2.5	2.5
100	151	0.8	12.6	0.1
112	26	0.8	3.2	0.1
150	87	1.1	4.2	0.2
200	7	3.8	12.5	0.02
250	1	1.0	1.0	1.0
	274			

Data from a large number of BPW wells and a few private wells are listed in Tables VII-1 and VII-2 so as to show the relationships between specific capacity (rate of water production per meter of drawdown) and construction parameters of depth and casing size.

The preceding tables show no statistically significant variation in specific capacity with well depth or casing diameter (except for wells of 200-mm diameter, and here the sample is small). The data imply that the specific capacity, loosely the productivity at a reasonable pumping level, is independent of the depth and diameter of the well (except as noted above) and that the productivity of almost all these wells is very low. This is a result of poor design wherein only the bottom of the hole is productive, regardless of depth. It is assumed that wells cased with 200-mm pipe are anticipated or required to be more productive; thus, they are constructed with particular care and located in areas of known good aquifer, and consequently have fair specific capacities.

Without other data, the almost uniformly poor performance of the wells could be taken to indicate a poor aquifer in the area. However, poor performance of most existing water supply wells in the Central Luzon Plain is expected because of poor well design and construction practices. In many places where other wells are no better than those shown here, however, the NIA and a few qualified commercial drillers have constructed some excellent, large-capacity wells.

The NIA has drilled and tested a 256-meter deep well (CDM-1) at Barrio Tipuso, about 5 km east of Urdaneta. The well is of excellent design and construction. It produced 63 lps during test with a drawdown of 3.14 meters, a specific capacity of 20.1 lps/m. The transmissivity of the aquifer was computed at 2,800 cumd/m, a very high figure indicating an excellent aquifer. However, it must be recognized that this isolated well, encountering mainly gravels (Annex Figure VII-B-1), may be a fortunate, isolated occurrence. Thus it would be unwise to assume an extremely high transmissivity for the aquifer until future wells confirm the situation.

The BPW drilled a 155-meter deep well (CDM-2) about 25 years ago in the NIA compound in Barrio Bayaoas, at the east edge of Urdaneta Poblacion. It has recently been tested by the NIA and produced 3.5 lps at a drawdown of 1.68 meters, a specific capacity of 2.1 lps/m (Annex Figure VII-B-2). The transmissivity was computed at approximately 435 cumd/m, but this figure is low (less than the true aquifer transmissivity) because the well does not fully penetrate the aquifer. However, even this computed transmissivity indicates that a well with a specific capacity of nearly 4 lps/m should result from good construction at the same location.

Other isolated wells have good specific capacities as can be seen from Tables VII-1 and VII-2; although it is believed that even those wells with specific capacities of over 10 lps/m (implying transmissivities of over 1,200 cumd/m) do not represent the full potential of the aquifer because of partial penetration effects as well as typical poor design and construction. Thus the well data, taken in conjunction with the experiences of NIA and others using superior well construction methods, indicate an excellent aquifer capable of supporting wells with minimum specific capacities of 4 lps/m, and probably much more throughout the URD-WD area. For planning purposes, an average aquifer transmissivity of 1,500 cumd/m is assumed as a compromise based on existing data. This figure will be refined as more properly designed wells are drilled and tested in the Urdaneta area.

Aquifer

Within the projected service area of the URD-WD, the Quaternary alluvium contains a very productive artesian aquifer system. The thickness of this aquifer is unknown but it appears to encompass most of the alluvium which is at least 260 meters thick locally and is assumed to be much thicker. This artesian aquifer system may include some older underlying beds at depth and may be contiguous with the aquifer system in the surrounding hills.

The aquifer consists of lenses of water-bearing material ranging from fine sands to gravels deposited in a complex and random pattern and confined by equally complex clay lenses. The well logs indicate clay at the surface in essentially all cases. This clay inhibits direct recharge in the Urdaneta vicinity. Recharge to this aquifer is through infiltration from direct precipitation and from streams into the exposed permeable beds along the edge of the foothills east and north of Urdaneta. Initially the recharge water is under water-table conditions but becomes confined upon moving below the clay beds as shown by free-flowing wells in the Urdaneta area. Additional recharge may reach the Quaternary alluvium from infiltration of precipitation in the mountains and foothills to the east through transfer from older permeable beds where the alluvium abuts these beds along the buried edge of the hills. Although the sands and gravels of the Agno River channel probably extend through the surface clays, the shape of the contours of the piezometric surface (Figure VII-3) and the relative elevations of this surface and river levels indicate that no recharge currently comes from the Agno River near Urdaneta and probably not from the smaller rivers in this area. In fact, groundwater discharge into the Agno may occur.

The aquifer is anisotropic and will act as a semi-confined aquifer in that early response to pumping will be in the artesian aquifer range. However, if the piezometric head falls below the surface clay zone, response will be in the unconfined (water-table) aquifer range. The spreading of the piezometric surface contours (Figure VII-3) near Urdaneta indicates a general area of increased aquifer transmissivity, although the flow pattern is distorted by local outcrops of older, less permeable sediments. Overall transmissivity in this area is estimated to be at least 1,500 cumd/m and the long-term storage coefficient will be variable depending on the depth of aquifer dewatered and the contained clays in the dewatered zone.

Groundwater Flow, Recharge and Discharge Relationships

Before large-scale artificial withdrawal of water (pumping from large-capacity wells), the local and regional groundwater balance is in a state of dynamic equilibrium. In the Urdaneta area, there is little local recharge because of the widespread surface clays and the near-surface piezometric levels. There is also little natural discharge; perhaps, some groundwater discharges into the Agno and Sinocalan River systems where groundwater piezometric levels are above river levels. Thus the existing system is essentially one of groundwater underflow entering the Urdaneta area from distant recharge sources in the northeast and east and leaving the area to the west. The contour map of the groundwater piezometric surface of the Urdaneta area shown in Figure VII-3 illustrates this condition.

The regional situation is illustrated by the contour map of the groundwater piezometric surface of the Central Luzon Plain shown in Figure VII-4. This shows the source of the groundwater underflow to the northeast and east of Urdaneta, and the ultimate discharge of the groundwater underflow to Lingayen Gulf northwest of Urdaneta. However, the groundwater gradient becomes so flat in the middle of the Central Luzon Plain that all of the groundwater flowing from the east, south and west cannot be flowing into Lingayen Gulf. Much, if not most, of the groundwater underflow into the Agno River basin must rise to the surface in seeps into the swamps and streams of the northern Central Plain where the artesian head is above the ground surface. All of this water is lost by non-beneficial evapotranspiration and surface runoff into Lingayen. The piezometric levels shown are generally characteristic of the upper part of the aquifer and higher levels may exist in the lower part of the aquifer in some areas.

All well water produced must come from one or more of a limited number of sources; groundwater storage, increased recharge, or diverted groundwater discharge. The natural state is normally one of equilibrium with total recharge equal to total discharge and stable groundwater storage. When a well first begins to operate, all the pumped water comes from local groundwater storage (immediately surrounding the well) as a result of the decreased pressure in the well caused by pumping. This zone of decreased pressure (or lowered piezometric head) spreads radially from the well as stored groundwater flows from the aquifer to the well, and it continues to spread until the area of depressed piezometric levels causes either an increase in recharge (local or distant)

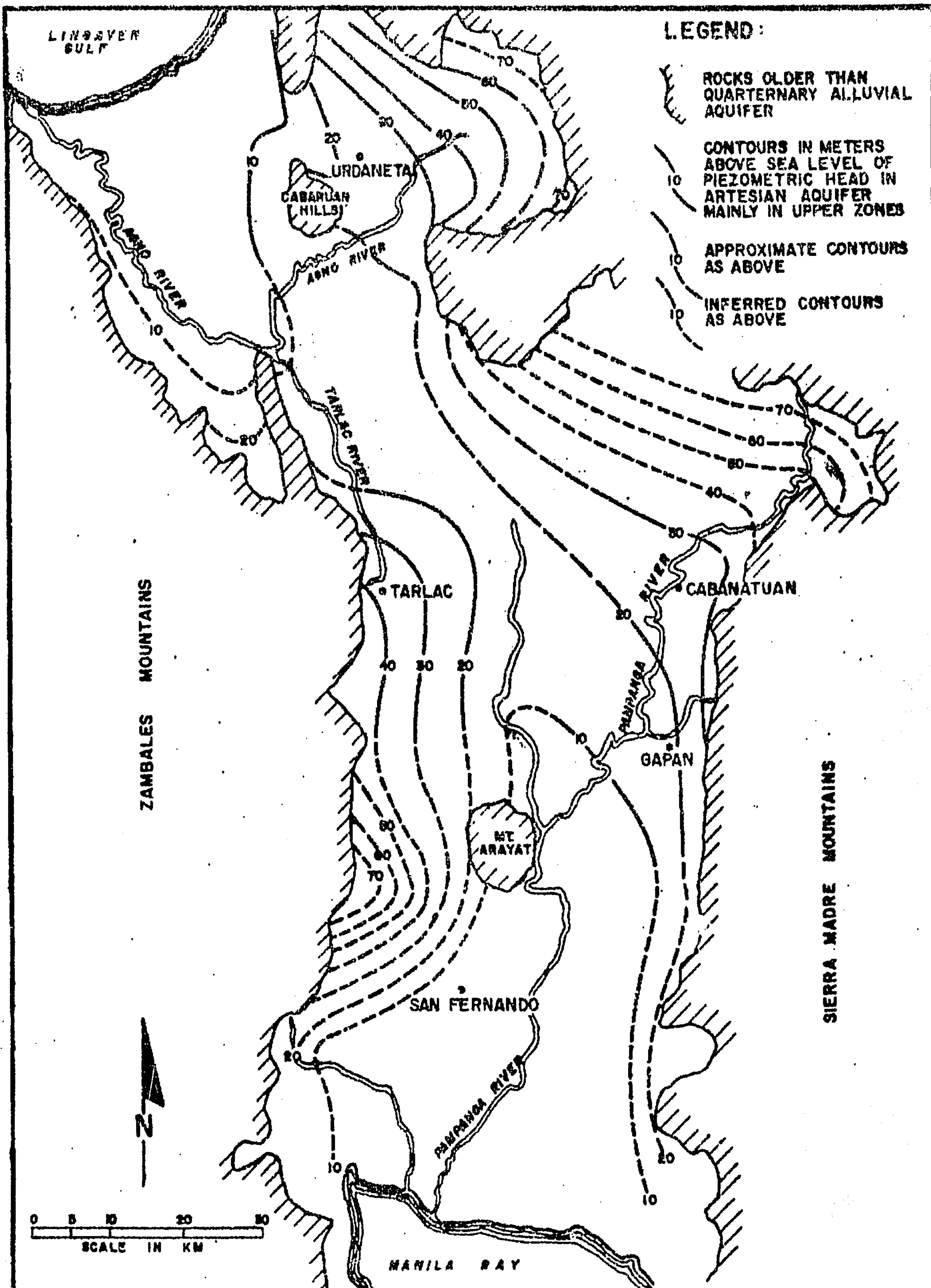


FIGURE VII-4
GROUNDWATER CONTOURS
CENTRAL LUZON PLAIN

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

or a decrease in pre-established groundwater discharge (local or distant) equal to the pumping rate of the well. When this occurs, a new equilibrium will be established with no further depletion of groundwater storage. If the increased recharge or diverted discharge (or combination thereof) is local, equilibrium will be quickly established with minimal lowering of the areal piezometric surface; but if they are distant, equilibrium will be long delayed resulting in a widespread and large depression in groundwater levels. If no sources of increased recharge or diverted discharge large enough to equal the pumped withdrawal rate can be tapped, then the groundwater levels will continue to drop until the well becomes inoperative or the aquifer is depleted.

In the case of Urdaneta, there are a number of prospective sources of additional recharge. The Agno River (and other local streams to a lesser extent) probably will contribute considerable recharge once the piezometric levels in the aquifer are depressed below stream level. At the same time, an appreciable amount of infiltration may begin through the more permeable parts of the generally clayey surface beds. These local effects will begin fairly soon after large-scale pumping begins and will increase with time as the area of depressed groundwater levels (cone of depression) spreads. However, the major existing source of recharge to the Urdaneta area is so distant to the northeast that no additional recharge could be expected from there for a very long time, if ever. An even more significant contribution to the water to be pumped at Urdaneta will be the reduction of existing natural groundwater discharge which is now being wasted to surface seeps in the Central Plain and to underground flow into Lingayen Gulf. This will occur as the expanding and deepening cone of depression (resulting from pumping) diverts groundwater underflow (now escaping to the west) to the wells to be installed in Urdaneta.

Current recharge to the aquifer is restricted largely to the edges where infiltration and transfer from surrounding areas can occur, as previously noted. Neither current recharge nor future additional recharge induced by pumping can be quantified with existing data, but groundwater underflow can be estimated. The groundwater flow is to the southwest at a gradient of about 0.001 in the Urdaneta area. The average overall transmissivity of the aquifer in this area is estimated at 1,500 cumd/m or more. According to Darcy's Law of flow:

$$Q/\text{km (of aquifer width)} = T \times G \times 1000 \text{ m/km}$$

where:

Q = Groundwater underflow (cumd)

T = Aquifer transmissivity (cumd/m)

G = Gradient of the piezometric surface

or:

$$Q/km = 1{,}500 \text{ cumd/m} \times 0.001 \times 1{,}000 \text{ m/km} = 1{,}500 \text{ cumd/km}$$
(minimum estimate).

The underflow of groundwater can be used to roughly determine the groundwater available for exploitation. The URD-WD average daily demand is projected to be about 6,700 cumd in 1990 and 12,300 cumd in 2000. To obtain all this water from underflow would require diverting and capturing all the underflow in a band about 4.5 km wide by the year 1990 and 8 km wide by the year 2000. Less than this computed amount of underflow would have to be captured because induced additional recharge, as noted previously, would supply some of the water to be pumped. Although projecting accurate pumping levels would require producing a model based on more than the available data, it is apparent that diverted groundwater underflow and induced additional local recharge would provide for Urdaneta's requirements beyond the year 2000 without a prohibitive decline in pumping and groundwater levels. However, this is true only if Urdaneta is the major large-scale user of groundwater in the small basin that surrounds it.

Unfortunately, there are numerous other fairly large towns in the basin under consideration (Figure VII-3). If these towns grow at the same rate as Urdaneta and ultimately consume the same per capita water quantities, the total domestic water requirements will be several times that projected for Urdaneta. Groundwater will undoubtedly be used to meet these requirements.

In addition, the area is short of irrigation water and, considering the good aquifer underlying, large-scale groundwater irrigation will undoubtedly be introduced. Assuming that one meter net of irrigation water will be required to supplement rainfall, an annual average of about 2,700 cumd of irrigation water would be required per 100 hectares (1 sqkm) of irrigated land. The full width of the Quaternary alluvial aquifer leaving the Urdaneta basin is less than 20 km, about 8 km north of the Cabaruan Hills and about 11 km southeast of the Cabaruan Hills. Assuming the same groundwater underflow as previously computed, 1,500 cumd/km, the total underflow from the basin would be perhaps 30,000 cumd. Thus, 1,100 hectares of groundwater-irrigated land would consume the entire groundwater underflow.

Since there are tens of thousands of hectares of irrigable land and numerous water-demanding towns in the Urdaneta basin, total water demand by the year 2000 could greatly exceed the sum of groundwater underflow and probable potential induced recharge. With available data, it is not possible to predict groundwater levels at various future dates with any certainty; but, as more data on aquifer characteristics and response become available, predictions should be made based on model studies. One favorable factor is that as groundwater piezometric levels drop below the clayey surface beds, the storage coefficient of the aquifer will increase greatly and more groundwater will be available from storage, thus slowing the drop in groundwater levels.

The implications are that the URD-WD must obtain firm water rights to its long-range requirements from the National Water Resources Council and introduce a groundwater monitoring and study program for planning purposes. Fortunately, it is true that agriculturists cannot afford to pay as much for water as municipalities, and if groundwater is depleted to an extreme degree, groundwater irrigation will be curtailed by economic factors, leaving the municipal water systems still viable.

Well Design and Drilling Program

A general design for an efficient production well for Urdaneta can be developed from available data. Such a design is illustrated in Annex Figure VII-B-8. To avoid excessive drawdown and minimize operating costs, these wells should be drilled to the same standards as those of recent NIA wells. For the same reasons, all stratigraphic zones down to a depth of 300 meters that are indicated as productive by the electric and stratigraphic logs should be screened, because in an anisotropic aquifer such as this, the specific capacity will increase greatly as the percentage of total permeable section screened increases. It is anticipated that such wells would produce 63 lps at an average of about 6 meters of initial drawdown, with the poorest wells at about 16 meters of initial drawdown. This is believed to be conservative and is used for preliminary design and estimation purposes because reliable data are very limited. The wells should be located in such a way that cost and operational complexity of the distribution system are minimized. The spacing between wells should be as great as practical (preferably an average of 1 km or more) to minimize drawdown interference. It should be recognized that few, if any, existing private well drilling firms have the necessary experience, equipment and ability to design and construct rotary-drilled wells of good quality without external professional supervision.

A drilling program consisting of two wells of 63 lps capacity, spaced 1 to 2 km apart in the existing URD-WD service area, is recommended. These wells should be carefully tested and the results from them used to modify the design of succeeding wells. They should be pumped intensively for several years and the aquifer response monitored. The data can then be used as guide for further development of the well system which probably will consist of 63-lps wells spaced about 1 to 2 km apart. Wells designed to produce 63 lps may be pumped at a lesser rate for the period that the local consumption does not require full production. However, this preliminary estimate must be revised and phased into the overall groundwater development plan for the Urdaneta area. Any future development of groundwater for irrigation must be taken into consideration in the design of URD-WD wells.

Induced Infiltration Wells

In anticipation of a possible major overexploitation of the deep aquifer that would make total reliance on deep wells undesirable, the design and use of relatively shallow, induced infiltration wells drilled in the sands and gravels of the Agno River channel were considered. Such wells probably could produce as much water at about the same pumping levels as the deep wells discussed previously. Since production would quickly be replaced by induced recharge from the Agno River, total well field production would be limited only by the minimum flow in the Agno River and conflicting rights to this water.

The wells would be of much the same design and construction as the deep wells, but being shallower would be less costly. However, the wells would be 9 km from the point of use and transmission costs (pipeline plus pumping costs) would be high. Also the wells would preferably be located in the river floodplain or on the river banks and the flood protection works would increase the overall costs of each well. Furthermore, the transmission pipeline would act as a point source requiring a somewhat more expensive distribution system than that based on scattered deep wells located near the areas of use. These considerations will probably make induced infiltration wells economically inferior to deep wells unless future aquifer overexploitation makes deep well water very costly. A further analysis is included in Chapter VIII.

Local rivers other than the Agno are incised and lack the broad sandy channels desirable for operation of good induced infiltration wells.

Monitoring

Basic planning for overall exploitation of groundwater resources in the Urdaneta area will be based on the limited data currently available and those derived from tests of the first production wells. However, records of water production from all large-capacity wells and of aquifer response to pumping are needed to refine the preliminary aquifer parameters and to revise the planning when necessary, in order to avoid the dangers of overexploitation or the waste of underexploitation. The URD-WD should monitor the performance of each of their production wells and observation wells to provide data and information for water district use and for distribution to other agencies for overall planning and control. In turn, other water districts and other groundwater users should monitor their operations and provide appropriate data to the URD-WD.

Each production well should have facilities for measuring the total amount of production or rate of production, times of operation and water levels. Routine monthly observations of static and pumping water levels should be recorded and daily records of pumping kept. Water samples for bacteriological analysis should be collected monthly and for chemical analysis, annually. It would also be desirable to monitor static water levels in several observation wells located within the area spanned by URD-WD wells but far enough from any well to minimize local drawdown effects. Similar routine static water level measurements should be taken in numerous observation wells surrounding the well field at a distance.

The data from this monitoring program will provide better aquifer parameters, indicate the magnitude of recharge, give early warning to URD-WD of deterioration in water quality or pump performance so that remedial action can be taken, and show any unforeseen decline in regional water level so that individual well yields (which affect local pumping levels) and design and spacing of future wells can be adjusted as necessary. For these purposes, copies of all URD-WD well monitoring data should be routinely analyzed by URD-WD (if they have competent staff for such analyses) or by some associated agency competent to perform such analyses.

<u>Summary of Groundwater Resources</u>

Urdaneta is located over an excellent, widespread, relatively uniform aquifer that can readily supply all its projected water demands past the year 2000 from deep wells each of 63 lps capacity. However, the regional drawdown of groundwater levels resulting from such pumping cannot be accurately quantified because available data on aquifer parameters and recharge are insufficient. Other data will become available from pumping tests of the new production wells and from the monitoring program of production and observation wells. Future well design and well field planning must be modified on the basis of the new data to maintain groundwater production for long-term use.

Induced infiltration wells at the Agno River are technologically feasible but may be economically undesirable.

If the intensive use of groundwater for irrigation eventually occurs in the Urdaneta area, overexploitation of the aquifer with its consequent dangers of failing wells and higher water costs will result unless careful and intelligent control of this multiple use is enforced.

C. SURFACE WATER RESOURCES

The most likely potential surface water sources for Urdaneta are the Agno and Sinocalan Rivers. The Agno River originates in the mountains northeast of Urdaneta, flows southwesterly passing about 7 km from the poblacion, and ultimately turns north and discharges into Lingayen Gulf. The Sinocalan River originates in the basin around Urdaneta and flows west into Lingayen Gulf. The tributaries of the Sinocalan River are adjacent to Urdaneta poblacion.

The NIA has constructed a number of irrigation projects using water from these two rivers. As of 1976, there were 6 existing NIA irrigation diversion dams tapping the Agno River and one on-going project to tap the Sinocalan River. These projects irrigate or will irrigate approximately 65,000 hectares of rice fields within Pangasinan Province. The biggest project using Agno River water is Ambuklao Dam which was constructed mainly as a hydroelectric project by the National Power Corporation at Ambuklao, Benguet, about 60 km northeast of Urdaneta.

Flow records for the Agno River are available from January 1932 to December 1937 and from September 1945 to the present for a total period of 39 years. The gaging station for the major course of the Agno River closest to Urdaneta is at Carmen, Rosales, about 10 km south of Urdaneta poblacion. This station recorded a minimum daily flow of 345×10^3 cumd in March 1964 and a maximum daily flow of 374×10^6 cumd in July 1946.

The Sinocalan River has a continuous flow record from November 1958 to December 1969 for a total period of 12 years. The only gaging station for this river is located at Poblacion Norte, Santa Barbara, about 17 km west of Urdaneta poblacion. The minimum daily flow was recorded in May 1968 with a reading of 138×10^3 cumd while maximum daily flow occurred in August 1960 with a discharge of 13×10^6 cumd. This maximum reading was duplicated in June 1963 and July 1965.

Surface water data from rivers within the vicinity of Urdaneta have been compiled and analyzed to establish the statistical recurrence of mean and minimum daily average flows. BPW records of 6 gaging stations with records spanning from 10 to 30 years were tabulated and analyzed using the Gumbel probability method of establishing 10-year, 5-year and 1-year recurring flows (see Methodology Memorandum No. 4).

Station	Longitude/ Latitude	Year of Records	Draingage Area (sqkm)	Minimum Flow (cumd/sqkm) at Return Period of 10 Years	5 Years	1 Year
Sinocalan River Poblacion Norte, Sta. Barbara	120°-28'-20" 16°-00'-00"	11	180	794	860	1,244
Agno River Carmen, Rosales	120°-35'-30" 15°-53'-30"	30	2,209*	193	227	453
Tagamusing River San Felipe, Binalonan	120°-30'-40" 16°-02'-50"	17	53	247	278	485
Toboy River Kalipkip, San Manuel	120°-38'-18" 16°-07'-36"	10	74	112	149	214
Agno River Poblacion, Bayambang	120°-27'-22" 15°-49'-07"	11	2,284**	89	115	332
Agno River San Roque, San Manuel	120°-41'-45" 16°-08'-45"	12	1,225**	220	225	476

Because the Agno River and its tributaries will be subject to increasing withdrawals by irrigation diversions, it is probably conservative to assume that its minimum 10-year flow would be about 100 cumd/sqkm. On the basis that the drainage area of the Agno River in the proximity of Urdaneta is about 2,100 sqkm, the theoretical minimum flow recurring once every 10 years will be 210,000 cumd. This is obviously sufficient to provide the maximum-day requirements of the URD-WD for the year 2000.

The situation regarding available water from the Sinocalan River is more complex. The minimum flow per square kilometer is relatively great but this may be due to an underestimated drainage area because the headwaters of the Sinocalan and Angalacan Rivers are poorly differentiated and streams such as the Tagamusing River may be tributary to either or both rivers. The large minimum flows may also result from groundwater additions where the peizometric head is above river level near Urdaneta or from irrigation drainage waters. In any case, although the minimum recorded and predicted Sinocalan River flows at Santa Barbara are sufficient for Urdaneta's water requirements for the year 2000, it is very doubtful that the small tributaries near Urdaneta would have sufficient minimum flow.

To use either the Agno or the Sinocalan River for a water supply source, it would be necessary to construct a diversion and intake structure, complete water treatment facilities, and the required transmission pipelines to assure an adequate potable water supply for the future needs

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*Affected by Ambuklao and Binga Dams and irrigation diversion.
**Affected by Ambuklao and Binga Dams.

of URD-WD. A surface water supply from these rivers would require a project of relatively great technical complexity and high cost. Development of groundwater sources with construction of deep wells would clearly be the economic and operational choice for the URD-WD. An economic analysis is presented in Chapter VIII.

D. WATER QUALITY OF POTENTIAL SOURCES

Water samples were taken from many of the sources, both groundwater and surface water, discussed previously. 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 Tables IV-1 and VII-3, and are briefly discussed below.

Groundwater

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

Water analyses of samples taken from the existing URD-WD well and 5 other Urdaneta wells are shown in Table IV-1. In the early samples all of the well waters analyzed fall below the excessive limits of the Philippine National Standards for Drinking Water, and below the permissible limits in all respects except for manganese content in all wells sampled and iron content in one well sampled. The wells were resampled and the results as shown differed considerably from the earlier results in regard to iron and manganese content. The later analyses show iron beyond the excessive limits in two wells, and iron and manganese between the permissible and excessive limits in 2 and 4 wells, respectively. The variation in analyses may reflect poor sampling or analytical technique or seasonal water changes (unlikely). However, the limits are not prohibitive but are only guidelines. In this case where the iron and manganese content is not extremely high and where no known complaints about the water have been received, the water probably will be acceptable for domestic use without extensive treatment although iron removal might be required in some cases. The water that would be produced from new URD-WD wells can be expected to be similar to the tested well waters.

TABLE VII-3

SURFACE WATER QUALITY TEST RESULTS
URDANETA WATER DISTRICT

Test	Unit	Permissible Limits	Agno River, Villasis 3 Mar '77	Sinocalan River, Urdaneta 3 Mar '77
Physical				
Color	APHA	15	5	5
Turbidity	FTU	5	346*	3.5
Total Dissolved Solids**	mg/1	500	283	306
Conductivity	micromhos/cm		435	470
Chemical				
pH		7-8.5	7.75	7.85
Total Alkalinity	mg/1 $CaCO_3$		96	185
Phenolphthalein Alkalinity	mg/1 $CaCO_3$		0	0
Total Hardness	mg/1 $CaCO_3$	400***	169	223
Calcium	mg/1	75	56	68
Magnesium	mg/1	50	7	13
Total Iron	mg/1	0.3	1.35*	0.3
Fluoride	mg/1	1.5	0.5	0.5
Chloride	mg/1	200	19	10
Sulfate	mg/1	200	21	37
Nitrate	mg/1	50	10.7	12.4
Manganese	mg/1	0.1	0.1	0

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

Surface Water

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

The results of chemical analyses performed on waters from the Agno and Sinocalan Rivers are shown in Table VII-3. The results indicate that concentration of color and turbidity is relatively low for surface waters in general (except for Agno River turbidity). However, complete treatment would be required particularly during the rainy season when turbidity would be much higher.

ANNEX VII-B

WELL DATA

ANNEX TABLE VII-B-1

WATER WELL DATA SUMMARY
URDANETA WATER DISTRICT

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
1	CL-1	Bo. Tipuso (NIA), Urdaneta	250	256.0	256.0	-1.87	-5.01	63.0	20.1	1976
2	9-R1	Bo. Bayaoas (NIA Compound), Urdaneta	100	155.5	140.2	-0.4	-2.0	3.5	2.1	1950
3		Bo. San Vicente (Divine Word Academy)	300-250	137+	102.4-137	Above GL *	-21.5	23.0	1.0	1966
4	7266	Urdaneta Poblacion	250-200	82.3	70.4-82.3	Above GL *	-3.66	8.2		1955
5	222	Bo. Nancamaliran East, Urdaneta	112	88.4	85.4	Above GL *		Flowing		1969
6	44702	Bo. Nancamaliran West, Urdaneta	112	86.9	86.9	+1.4		0.76	(flowing)	
7	56761	Bo. Sto. Domingo, Urdaneta	112	22.0	18.3	-1.5		1.26		
8	436271	Sugcong-Tucok, Urdaneta	100	60.6	44.1	-1.5	-2.1	0.95	1.6	1962
9	44637	Cabaruan, Urdaneta	100	36.0	34.8	-6.1				1963
10	54741	Bo. Talocatoc, Urdaneta	112	27.7	17.4	-7.3	-10.4	0.63	0.2	1974
11	436092	Catablan, Urdaneta	100	45.7	42.4	-6.1	-6.2	0.32	2.1	
12	446414	Labit, Urdaneta	112	61.0	51.8	-1.5	-1.5			1963
13	7892	San Felipe, Binalonan	112	14.3	10.1	-5.2		0.63		1955
14	7895	Manguzmana, Binalonan	150	9.8	9.8	-5.2	-6.1	0.63	0.70	1955
15	12263	Limansangan Elementary School, Binalonan	150 112	24.7	13.4 14.6	-0.6	-0.9	0.95	3.17	1956
16	435961	Casubiduan, Binalonan	100	20.1	19.8	-2.4	-2.4	0.76		1959
17	436231	Binalonan WWS, Binalonan	250 200	50.0	43.9 50.0	-4.3	-4.3	5.04		1962

* Ground Level

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface in Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
18	17547	Vacante East, Binalonan	100	20.4	18.4	-3.7	-7.0	1.58	0.48	1958
19	17548	Vacante West, Binalonan	100	29.6	29.0	-2.1	-2.4	3.78	12.6	1958
20	17543	Santa Maria Norte School Binanlonan	100	18.9	17.7	-4.3	-4.9	0.54	0.90	1958
21	17542	San Felipe Sur, Binalonan	100	28.0	18.6	-0.3	-4.6	1.26	0.29	1958
22	17540	Pasileng, Binalonan	100	18.9	15.5	-1.5	-4.0	1.89	0.76	1958
23	17538	Moreno, Binalonan	100	20.4	17.4	-4.9	-9.8	1.07	0.22	1958
24	17536	Celi Berao, Sto. Niño, Binalonan	100	20.7	18.9	-2.7	-4.9	0.63	0.29	1958
25	17534	Camangaan, Binalonan	100	20.4	17.7	-3.7	-5.0	1.58	1.22	1958
26	17533	Camangaan, Binalonan	100	22.0	18.6	-4.0	-5.8	0.95	0.53	1958
27	17530	San Felipe Norte, Binalonan	100	29.6	29.6	-8.2	-8.5	0.19	0.63	1958
28	17530	Balangobong School Site, Binalonan	100	23.5	18.9	-2.1	-3.0	0.63	0.70	1958
29	6975	Sta. Catalina, Binalonan	112	52.7	49.6					1956
30	6978	San Pablo, Binalonan	150	14.6	12.2	-2.1	-3.7	0.63	0.39	-
31	17545	Sumbabnit, Calaoagan, Binalonan	100	20.4	17.7	-3.4	-4.6	0.76	0.63	1958
32	17541	Pasileng East, Binalonan	100	20.4	16.8	-1.2	-2.7	1.89	1.26	1958
33	8091	Poblacion, Binalonan	200	19.8	18.3	-2.4	-2.7	1.26	4.20	1956
34	7699	Evangelista, Binalonan	150	9.8	9.8	-2.7	-3.0	0.63	2.10	1955
35	6500	Legaspi, Binalonan	150	21.3	19.8	-4.6	-5.2	0.63	1.05	1954

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
36	436242	Public Market, Asingan	100	18.0	17.7	-3.7	-7.0	0.63	0.19	1962
37	436241	Baro North, Asingan	100	16.2	14.9	-4.6	-7.6	0.63	0.21	1962
38	18967	Carosucan, Asingan	100	29.6	28.4	-2.7	-3.0	0.50	1.67	1959
39	17501	Macalong, Asingan	100	19.2	17.7	-2.4	-2.7	0.38	1.27	1959
40	18966	Carosucan, Asingan	100	25.0	22.6	-2.7	-3.0	0.38	1.27	1959
41	18965	Nagsa-ag (Bobonan), Asingan	100	17.4	15.8	-3.7	-4.0	0.50	1.67	1959
42	18964	Poblacion, Asingan	100	20.4	19.4	-4.3		0.95		1959
43	18963	Bola, Asingan	100	18.3	16.9	-0.6	-1.5	0.50	0.56	1959
44	18962	Baro, Asingan	100	23.5	21.6	-3.0	-3.4	0.50	1.25	1959
45	18961	Sobol, Asingan	100	17.4	17.1	-2.6	-3.2	0.44	0.73	1959
46	18960	Calipa-an, Asingan	100	19.2	18.6	-2.7	-3.0	0.44	1.47	1959
47	18959	Toboy, Asingan	100	16.8	15.6	-2.7	-3.0	0.44	1.47	1959
48	17500	Dupac, Asingan	100	19.2	17.7	-3.4	-7.3	0.63	0.16	1959
49	17499	Dumampot, Asingan	100	25.0	23.9	-4.3	-4.6	0.38	1.27	1958
50	5754	Cabalitian, Asingan	150	33.5	30.8	-1.8	-2.4	0.63	1.05	1953
51	19112	San Nicolas, Villasis	100	46.0	41.2	Ground	-1.2	0.63	0.53	1958
52	18569	Caramotan, Villasis	100	43.3	29.0	-0.6				
53	13981	Capuluan School, Villasis	112	19.8	14.6	-8 5	-9.5			

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
54	6734	Unsad, Villasis	150	25.0	20.7	-11.6	-13.7	0.50	0.24	
55	10231	Lipay, Villasis	112	27.7	26.2	-3.7	-5.2	0.63	0.42	
56	10229	Caramutan, Villasis	150	49.1	48.8	-1.8	-3.4	0.76	0.48	
57	10228	Pias, Villasis	150	44.8	42.7	-1.8	-3.4	0.76	0.48	
58	9434	Aman Perez, Villasis	150	24.4	22.9	-2.1	-3.7	0.63	0.39	
59	9433	Puelay, Villasis	150	35.1	31.4	-2.4	-4.3	0.95	0.50	
60	8568	Labit, Villasis	150 112	27.1	27.1	-4.3	-6.4	0.50	0.24	
61	9398	Aman Perez West, Villasis	150	42.4	39.3	-2.7	-4.6	0.63	0.33	
62	9397	West Puelay, Villasis	150	45.7	43.0	-2.4	-4.9	0.76	0.30	
63	9431	Barangobong West, Villasis	150	53.4	43.3	-5.2	-7.0	0.70	0.39	
64	9432	Barangobong, Villasis	150	32.9	31.7	-3.0	-4.9	0.63	0.33	
65	645	Puelay, Villasis		74.7		1.2				
66	630	Poblacion, Villasis		35.1		-0.6				
67	7267	Poblacion, Villasis	200	63.7	12.8	-1.5	-10.7	11.97	1.30	
68	436272	Bo. Labit, San Manuel, Villasis	100	74.7	33.2	-12.8	-13.7	0.95	1.06	
69	44631	Lomboy, Villasis	100	30.8	30.5	-0.6	-3.0	1.58	0.66	
70	44632	San Blas, Villasis	100	42.7	37.2	+0.2	-0.6			
71	19117	Pias Sur, Villasis	100	48.5	46.3	-1.5	-4.0	1.89	0.76	
72	19114	Baoag, Villasis	100	41.8	39.6	-0.3	-2.4	1.89	0.90	

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
73	8988	Bakit-bakit, Rosales	150	51.8	48.8	-3.7	-4.9	0.95	0.79	1955
74	8989	Balincannaway, Rosales	150	30.5	28.8	-4.9	-7.6	0.63	0.23	1955
75	8990	San Pedro Este, Rosales	150	40.7	27.4	-4.3	-5.2	0.76	0.40	1955
76	8991	Calanutan, Rosales	150 112	23.2	18.3 ?	-2.7	-3.7	0.76	0.76	1955
77	8992	Acop, Rosales	150 112	25.4	3.7 21.0	-12.2	-19.8	0.63	0.08	1955
78		Poblacion, Rosales		51.5		-3.7				1948
79	21171	Poblacion, Rosales	100	16.5	15.2	-4.6				1958
80	9581	San Luis, Rosales	150	45.7	42.7	-3.7	-5.2	0.63	0.42	1955
81	9583	Casanicolan, Rosales	150	22.9	22.6	-4.6	-6.4	0.76	0.42	1955
82	9584	Cabalasangan, Rosales	150	23.5	17.4	-4.3	-5.2	0.63	0.70	
83	9583	Cabasangan Norte, Rosales	150	24.4	17.4	-4.3	-5.2	0.63	0.70	1955
84	9852	Rabago, Rosales	150 112	78.0	25.3 52.7	-3.4	-5.2	0.95	0.53	1955
85	17697	Acop North, Rosales	100	25.0	21.3	-8.2	-8.8			1958
86	17698	Capitan Tomas, Rosales	100	18.3	16.2	-5.8	-6.1	1.26	4.20	1958
87	17699	Guiling, Rosales	100	38.7	38.7	-5.8	-6.1	1.26	4.20	1958
88	17700	Pangaoan, Rosales	100	50.3	50.3	-1.5	-2.7	0.63	0.53	1958
89	17702	Salvacion, Rosales	100	43.3	39.9	-10.7	-11.6	0.63	0.70	1958
90	154	Caltex-Carmen, Rosales	75	21.3	17.4	-1.5	-3.0	3.78	2.52	1968
91	8534	Cabalasangan, Rosales	150 112	65.9	31.6	-3.7	-4.9	0.76	0.63	1955

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Capacity (lps/m)	Year Completed
92	8567	Tomana, Rosales	150	14.0	10.1	-2.4	-4.3	0.50	0.26	1955
93	8987	San Antonio, Rosales	150	22.0	21.6	-3.0	-5.8	0.63	0.23	1955
94	21172	Rosales E.S., Rosales	100	18.3	17.4	-3.7				1959
95	435941	Carmen East, Rosales	100	22.9	21.3	-4.0	-5.5	0.95	0.63	1959
96	435942	Carmen West, Rosales	100	19.2	18.3	-5.2	-5.8	0.95	1.58	1960
97	436041	Carmen West, Rosales	100	19.2	18.3	-7.6				1960
98	436042	Rizal, Rosales	100	25.9	24.4	-4.6	-5.5	0.95	1.06	1960
99	436043	Carmen, Rosales	100	22.9	20.4	-4.6	-6.1	0.95	0.63	1960
100	436044	San Angel, Rosales	100	24.4	17.7	-4.6	-5.5	1.26	1.40	1960
101	446912	San Luis, Rosales	112	36.6	32.0	-7.3				1969
102	8535	Guiling-Coliling, Rosales	150	66.0	56.6	-3.4	-3.7	1.07	3.57	1955
103		Palaquepac, Rosales	200	29.3	28.0		-2.1			1968
104	9635	Carmay East, Rosales	150	20.7	20.1					1955
105	5420	Carmen, Rosales	150	100.6	81.4	-4.0	-4.6	1.58	2.63	1952
106	9634	Carmay East, Rosales	150	21.3	21.3	-3.7	-4.9	0.63	0.53	1955
107	17652	Babasit East, Manaoag	100	25.0	25.0	-4.9	-11.6	0.63	0.09	1958
108	436075	Nalsian East, Manaoag	100	25.3	23.9	0	-0.6	1.58	2.63	1960
109	8090	Poblacion, Manaoag	250	250.0	80.5	-21.3	-62.5	0.63	0.02	1956
			200		107.9					
110	20706	Sapang, Manaoag	100	33.5	28.8	-3.0	-9.1	0.63	0.10	1959
111	436074	Damillan, Manaoag	100	14.6	13.6	-6.1	-8.2	1.58	0.75	1960
112	5301	Army Camp, Manaoag	100	192.1	99.1	-4.6	-24.4	1.89	0.10	1957

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface in Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
113	7711	Pao, Manaoag	150	36.3	32.0	-4.6	-5.5	0.63	0.70	1955
114	17653	Baritao, Manaoag	100	29.3	29.3	-3.0	-5.5	0.32	0.13	1958
115	17654	Cabanbanan, Manaoag	100	19.8	19.8	-6.1	-6.7	0.32	0.53	1958
116	17655	Caaringayan, Maraoag	100	27.4	26.8	+0.6		1.26		1958
117	17657	Lelemaan, Manaoag	100	31.1	31.1	-1.5	-2.3	1.26	1.58	1958
118	17658	Pantal, Manaoag	100	16.2	16.2	-6.4	-12.8	0.48	0.08	1958
119	17660	Sta. Ines, Manaoag	100	22.9	20.1	-1.5	-2.4	1.58	1.76	1958
120	17661	Sta. Ines East, Manaoag	100	32.9	32.3	-0.3	-1.8	1.26	0.84	1958
121	17662	Talogtog, Manaoag	100	20.4	20.4	-1.1	-1.9	0.63	0.79	1958
122	19024	Sapang East, Manaoag	100	46.3	44.2	+0.6	-16.8	0.32	0.02	1958
123	19025	Maraboc, Manaoag	100	25.0	22.0	-3.0	-7.3	0.44	0.10	1958
124	19026	Caaringayan, Manaoag	100	27.6	26.8	-0.6	-1.5	1.26	1.40	1958
125	19027	Cabilaoan, Manaoag		40.2	34.1	-2.1	-2.4	0.94	3.13	1958
126	19031	Nalsian, Manaoag	100	23.5	7.5	-5.5	-8.2	0.32	0.12	1958
127	19032	Bucao, Manaoag	100	20.4	18.9	-5.5	-6.7	0.48	0.40	1958
128	19033	Inamotan, Manaoag	100	29.9	24.4	-2.1	-3.0	0.63	0.70	1958
129	19034	Cocoyot, Manaoag	100	33.5	18.3	-1.2	-2.1	0.63	0.70	1958
130	19035	Baguinay, Manaoag	100	36.6	36.0	-4.0	-4.9	0.32	0.36	1958
131	19037	Calaogan, Manaoag		25.0	22.2	-1.4	-1.5	0.63	6.30	1958
132	19038	Lipit North, Manaoag	100	20.4	18.3	-5.8	-11.6	0.63	0.11	1958
133	19039	Cabulalaan, Manaoag		25.0	22.3	-2.2	-2.7	0.95	1.90	1958

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
134	19040	Botigue, Manaoag	100	52.4	28.2	-1.7	-4.7	0.95	0.32	1958
135	19041	Bisal, Manaoag	100	51.8	48.8	-4.6	-5.5	0.63	0.70	1958
136	19042	Licsi, Manaoag	100	30.5	25.9	-3.7	-5.2	0.32	0.21	1958
137	19043	Maocat-tolong, Manaoag	100	54.0	53.4	-0.9	-1.2	1.26	4.20	1958
138	19044	Inmanduyan, Manaoag	100	18.9	18.9	-2.7	-4.5	0.63	0.35	1958
139	9585	San Leon, Balungao	150	17.7	13.1	-4.9	-6.7	4.41	2.45	
140	9586	Rajal, Balungao	150	6.1	4.3	-2.4	-3.0	0.63	1.05	1955
141	13982	San Aurelio III, Balungao	112	12.2	11.6	-3.0				1957
142	435951	Kita-kita, Balungao	100	15.2	12.2	-3.0				1959
143	436162	Kita-kita, Balungao	100	27.4	25.9	-4.6				1961
144	6690	Poblacion, Balungao	150	22.9	12.8	-4.6	-4.6	0.50		1955
145	7695	San Aurelio, Balungao	150	62.5	23.2	-5.2	-5.5	0.95	3.17	1955
146	7700	Pagaro, Balungao	150	18.3	13.4	-2.7	-3.4	0.63	0.90	
147	8540	Mabini, Balungao	150	22.0	17.7	-7.3	-9.1	0.63	0.35	1955
148	8541	Capulaan, Balungao	150	27.7	25.0	-2.4	-4.3	0.63	0.33	1955
149	8542	San Joaquin, Balungao	150	41.5	41.5	-2.7	-6.1	0.63	0.19	1955
150	8543	San Marcelino, Balungao	150	39.6	25.6	-2.1	-2.7	0.76	1.27	1955
151	8544	Esmeralda, Balungao	150	37.8	36.0	-9.8	-11.0	0.63	0.53	1955
152	8545	San Andres, Balungao	150	32.6	25.0	-16.2	-17.1	0.44	0.49	1955
153	8546	San Raymundo, Balungao	150	13.7	13.3	-0.9	-2.1	0.76	0.63	1956
154	7888	San Juan, San Manuel	150	8.5	8.5	-2.1	-3.0	0.47	1.57	1955
155	7889	Nagsaag, Manuel	150	9.5	7.0	-1.8	-2.1	0.95	3.17	1955

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
156	7891	Sto. Domingo, San Manuel		10.5		-10.1	-11.0	0.63		
157	8994	Sto. Domingo, San Manuel	150	31.1	29.1	-22.9	-25.3	0.32	0.13	1957
158	18549	San Vicente, San Manuel	62	7.3	7.3	-0.9	-2.1	0.32	0.27	1957
159	436122	Labot, San Manuel	100	13.9	13.4	-9.8	-11.6	0.63	0.35	1961
160	19089	Pias, Mapandan	150	44.2	44.2	-2.6	-3.0	0.95	2.38	1958
161	17687	Nilombot North, Mapandan	100	57.0	55.2	-2.1	-3.7	0.63	0.39	1958
162	17686	Luyan, Balandang, Mapandan	100	29.6	26.2	-4.9	-5.6	0.63	0.90	1958
163	17685	Luyan, Sta. Maria, Mapandan	100	25.0	19.5	-6.4	-7.6	0.95	0.79	1958
164	17684	Amanoacao, Mapandan	100	22.0	19.8	-3.0	-7.9	0.32	0.07	1958
165	17659	Amanoacao, Mapandan	100	27.4	22.9	-3.2	-4.6	0.32	0.23	1958
166	11328	Jimenez, Mapandan	100	32.0	28.7	-4.0	-4.6	0.50	0.83	1958
167	11329	Apaya, Mapandan		40.9	12.2	-2.4	-3.0	0.63	1.05	1957
168	11330	Nilombo, Mapandan		27.4		-3.0	-4.3	0.76		
169	436076	Pias, Mapandan	100	16.8	13.4	-4.6	-9.8	1.26	0.24	1960
170	8573	Pias, Mapandan	150 100	23.8	12.5 13.1	-4.3	-5.8	0.76	0.63	1956
171	8572	Apaya East, Mapandan	150 100	18.6	15.5 6.7	-4.3	-5.8	0.76	0.51	1956
172	436077	Baloling, Mapandan	100	17.4	15.5	-4.6	-4.9	0.32	1.07	1960
173	8571	Baloling, Mapandan	112	56.7	43.9	-3.7	-4.3	0.88	1.47	1956
174	6502	Torres, Mapandan	150	42.1	38.4	-4.6	-6.1	0.63	0.42	1954
175	436078	Poblacion, Mapandan	100	18.3	15.5	-5.5				1960

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface in Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
176	8404	Sto. Domingo East, Sto. Tomas	150	28.5	28.4	-3.4	-5.5	0.63	0.30	1955
177	8406	San Agustin, Sto. Tomas		21.3		-3.7	-8.2	0.95	0.21	1955
178	8407	Sto. Domingo, Sto. Tomas	150	28.4	28.4	-3.4	-5.5	0.63	0.30	1955
179	8476	Sto. Niño, Sto. Tomas		48.8	28.4	-3.7	-4.9	0.76	0.63	1955
180	8477	San Jose, Sto. Tomas	150	67.1	38.7	-3.7	-5.2	0.63	0.42	1955
181	8993	San Antonio, Sto. Tomas	150	28.4	28.4	-3.4	-5.5	0.63	0.30	1955
182	5463	Poblacion, Sto. Tomas	150	147.9	80.2	0	-1.5	3.15	2.10	1952
183	6694	San Antonio, Sto. Tomas	112	15.5	15.5	-3.0	-3.7	0.95	1.36	1955
184	6695	Salvacion, Sto. Tomas	112	35.7	32.3	-3.0	-3.7	0.95	1.36	1955
185	6696	La Luna, Sto Tomas	150	29.3	28.0	-3.4	-4.0	0.95	1.58	1955
186	446915	Salvacion, Sto. Tomas	112	45.7	45.4	-1.5	-2.1	1.58	2.63	1969
187	8423	Taluyan, Malasiqui	150	32.0	20.7	-9.1	-10.7	0.63	0.39	
188	8724	Guilig, Malasiqui	150	52.7	39.6	-0.9	-3.0	0.76	0.36	1955
189	8425	Malimpec, Malasiqui	150	58.8	44.2	-2.4	-3.4	0.95	0.95	
190	44662	Polong Sur, Malasiqui		18.3		-1.5		0.50		1967
191	17616	Aliaga West, Malasiqui	100	43.0	41.2	-1.5	-2.5	0.63	0.63	1958
192	9616	Mendoza, Malasiqui	150 112	62.5	23.5 61.3	-32.0	-33.5	0.50	0.33	1955
193	8424	Tobur, Malasiqui	150	37.8	24.4	-7.9	-8.8	0.63	0.70	
194	8725	Alacan, Malasiqui	150	48.8	43.3	-2.4				1955
195	8049	Pasima, Malasiqui	150	49.4	36.6	-1.8	-3.0	0.63	0.53	1955
196	8048	Cabatling, Malasiqui	150	48.8	44.2	-3.7	-4.3	1.26	2.10	1955

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
197	8041	Lareglareg, Malasiqui	150	98.2	26.5	-22.0	-22.9	0.63	0.70	1955
198	8046	Don Pedro, Malasiqui	150	44.2	39.6	-3.0	-4.0	0.95	0.95	1955
199	8045	Polong, Malasiqui	150	50.3	46.6	-3.0	-4.0	0.95	0.95	1955
200	8044	Bogtong, Malasiqui	150	39.6	38.1	-3.4	-4.3	1.26	1.40	1955
201	8043	Talos-Patang, Malasiqui	150	41.8	39.9	-3.0	-3.7	0.95	1.36	1955
202	17649	San Julian School Site, Malasiqui	100	100.6	58.7	-4.3	-10.1	0.95	0.16	1958
203	12268	Canan Elem.School, Malasiqui	112	56.4	32.9	-15.2	-18.3	0.44	0.14	1957
204	17617	Apaya East, Malasiqui	100	47.9	45.1	-1.5	-2.1	0.95	1.58	1958
205	17618	Apaya West, Malasiqui	100	43.3	43.0	-1.5	-2.4	0.95	1.06	1958
206	17621	Mabaletec, Malasiqui	100	54.1	50.0	-2.7	-7.6	0.50	0.10	1958
207	17623	Banaoang Center, Malasiqui	100	61.0	60.4	-2.1	-4.0	1.26	0.66	1958
208	17625	Banaoang North, Malasiqui	100	61.6	56.7	-2.5	-3.5	0.95	0.95	1958
209	17624	Banaoang East, Malasiqui	100	60.1	57.9	-2.7	-7.9	0.95	0.18	1958
210	17629	Butao, Malasiqui	100	42.1	38.4	-1.5	-2.1	1.26	2.10	1958
211	17632	Capes, Malasiqui	100	47.0	46.8	-3.0	-3.9	1.26	1.40	1958
212	17633	Gomez, Malasiqui	100	61.0	58.2	-2.7	-4.8	1.39	0.66	1958
213	17634	Goliman Center,Malasiqui	100	54.0	47.3	-1.8	-5.2	0.63	0.19	1958
214	17635	Ingalagala, Malasiqui	100	58.2	58.2	-2.1	-5.2	0.95	0.31	1958
215	17636	Lasip, Malasiqui	100	70.1	69.2	-3.0	-5.0	0.95	0.48	1958
216	17642	Talospatang Center, Malasiqui	100	67.7	57.6	-2.1	-4.3	0.95	0.43	1958
217	17643	Don Pedro, Malasiqui	100	46.6	44.5	-1.6	-2.5	0.32	0.36	1958
218	17644	Manggandupay, Malasiqui	100	57.9	54.9	-2.3	-4.6	0.63	0.27	1958

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
219	17645	Tambao South, Malasiqui	100	57.0	55.5	-1.7	-6.2	0.95	0.21	1958
220	17646	Nansangoan East, Malasiqui	100	52.4	50.6	-2.7	-4.9	1.26	0.51	1958
221	12267	Nalsian North, Malasiqui	112	16.8	16.8	-0.9	-1.5	0.76	1.27	1957
222	436081	Pasima Elem. School, Malasiqui	100	45.7	33.8	-4.6	-7.6	0.63	0.21	1960
223	19006	Cawayang Bogtong, Malasiqui		30.5		-6.1	-6.1	1.26	Infinite	1967
224	436082	Macoluet, Malasiqui	100	27.4	23.0	-6.1	-10.7	0.95	0.21	1960
225	8043	Tulaspatong, Malasiqui		32.0		-4.6	-4.6	1.26	Infinite	1967
226	1218	Public Market, Malasiqui		80.8		-0.9	-3.7	2.52	0.90	1948
227	19007	Olea, Malasiqui	100	34.1	33.2	-1.5	-3.0	1.26	0.84	1958
228	8040	Canan, Malasiqui	150	63.1	40.2	-7.9	-8.5	0.63	1.05	1955
229	8041	Bacundao East, Malasiqui	150	86.6	23.8	-20.1	-20.7	0.63	1.05	1955
230	8042	Bacundao West, Malasiqui	150	41.8	29.6	-21.3	-22.6	0.63	0.48	1955
231	8059	Poblacion, Malasiqui	250 200	62.5	45.1 62.2	-2.7	-4.0	6.93	5.33	1955
232	7111	Payar, Malasiqui	150	85.4	32.9	-2.1	-4.0	2.52	1.33	
233	6981	Palong, Malasiqui	150	84.7	37.2	-3.0	-3.7	2.52	3.60	1954
234	17646-A	Taluspatong, Malasiqui	100	54.9	50.0	-3.7	-6.4	0.63	0.23	1958
235	17648	San Julian, Malasiqui	100	60.0	57.3	-2.4	-7.3	1.58	0.41	1958
236	17650	Tomling East, Malasiqui	100	39.6	38.3	-4.0	-8.5	0.50	0.11	1958
237	17651	Tobur, Malasiqui	100	55.5	50.3	-17.7	-18.9	0.44	0.37	1958
238	19001	Lapa, Malasiqui	100	46.6	46.3	-2.4	-3.8	0.63	0.45	1958
239	19002	Taboy, Malasiqui	100	66.2	63.4	-4.3	-8.5	0.95	0.23	1958

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
240	19003	C. Bogtong, Malasiqui	100	40.9	40.2	-3.1	-5.0	0.82	0.43	1958
241	19004	Umando, Malasiqui	100	47.9	42.7	-2.4	-5.8	0.95	0.28	1958
242	19005	Tambao, Malasiqui	100	57.0	54.9	-1.8	-8.8	0.44	0.06	1958
243	12266	Nalsian Sur, Malasiqui	112	23.2	19.5	-1.5	-4.3	0.76	0.27	1956
244	5648	Rizal St., Sta. Maria	150	68.6	63.4	-3.7	-4.6	1.26		1953
245	8533	Pataquib, Sta. Maria	150	38.1	32.0	-5.2	-7.0	0.95	0.53	1955
246	7147	San Alejandro, Sta. Maria		12.2	7.3	-1.2	-1.5	0.32		
247	8532	San Pablo, Sta. Maria	150	22.0	21.6	-1.5	-2.7	0.95	0.79	1955
248	7148	Callitang, Sta. Maria	150	38.4	25.0	-3.8	-4.6	0.63		1954
249	7698	San Vicente, Sta. Maria	150	18.3	18.3	-3.4	-3.7	0.63	2.10	1955
250	7697	Sta. Cruz, Sta. Maria	150		25.0	-1.5	-1.8	0.63		1955
251	18948	San Vicente, Alcala	100	43.3	38.9	-3.0	-6.4	0.95	0.28	1958
252	18951	Pendangan East, Alcala	100	29.9	26.5	-3.0	-4.6	0.95	0.59	1958
253	18952	Vacanto, Alcala	100	29.3	29.0	-1.2	-3.0	1.89	1.05	1958
254	18954	Anulid, Alcala	100	38.7	33.5	-0.9	-4.6	1.26	0.34	1958
255	18955	San Pedro Eli, Alcala	100	43.3	42.4	-3.0	-6.7	0.95	0.26	1958
256	18956	San Pedro Eli Sur, Alcala	100	57.0	22.0	-3.0	-4.6	1.26	0.79	1958
257	18957	Laoac, Alcala	100	34.1	33.8	-1.5	-3.4	1.89	0.99	1958
258	18958	San Vicente Center H.S., Alcala	100	34.1	34.1	-2.1	-6.7	0.95	0.21	1958
259	8242	Caranglan, Alcala	150	60.7	37.5	-2.4	-3.0	0.63	1.05	1955
260	8243	Ataynan, Alcala	150	53.0	50.5	-2.1	-4.9	0.76	0.27	1955

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
261	6982	Camangaan, Alcala	150	37.2	33.2	−1.5				
262	7694	San Pedro Apartado, Alcala	150	42.7	40.2	−4.0	−4.3	0.63	2.10	
263	7699	Macayo Sur, Alcala	150		39.6					
				71.6		−2.4	−3.7			1956
			112		30.5					
264	446919	San Pedro Apartado, Alcala	112	25.9	11.0					1971
265	6693	Macayo, Alcala	100	37.8	22.9	0				1955
266	6122	Bersamin, Alcala	150	32.3	19.2	−0.9	−3.0	0.63	0.30	1954
267	6691	Pindangan, Alcala	150		20.4					
				70.4		−0.9	−2.1	0.63	0.53	1954
			100		26.8					
268	436071	San Pedro, Alcala	100	31.4	25.9	−6.1	−7.6	1.58	1.05	1961
269	436073	San Vicente, Alcala	100	30.5	27.4	−6.1	−9.1	1.58	0.53	1960
270	18552	Gualao, Alcala	100	36.6	32.9	−1.1	−1.5	0.32	0.80	1958
271	436072	Guinawedan, Alcala	100	15.9	14.6	−6.1				1960
272	6692	Anulid, Alcala	100	67.1	37.5	−2.4		0.76		1955
273	17495	Quisuquis, Alcala	100	57.9	55.5	−2.1	−4.6	1.26	0.50	1958
274	18946	Gualsic, Alcala	100	34.1	32.0	−1.8	−3.4	1.26	0.79	1958
275	18947	San Juan, Alcala	100	25.0	22.0	−4.6	−10.4	0.50	0.09	1958
276	19085	Patayao, Sta. Barbara	100	25.0	24.4	0	−2.7	1.89	0.70	1958
277	19084	Alibayo, Sta. Barbara	100	36.0	22.3	−2.4	−3.8	1.26	0.90	1958
278	19083	Nilombot, Sta. Barbara	100	22.0	22.0	−0.9	−2.1	1.89	1.58	1958
279	19082	Malanay, Sta. Barbara	100	33.5	31.1	−2.1	−4.3	0.63	0.29	1958
280	17742	Prov. Hi-School, Sta. Barbara	100	66.2	61.6	−0.9	−6.1	0.63	0.12	1958
281	17736	Nanzong East, Sta. Barbara	100	29.9	28.0	−4.1	−5.0	0.95	1.06	1958

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
282	17735	Banaoang, Sta. Barbara		30.5	28.7	-3.7	-4.6	1.26	1.40	1958
283	19088	Minien, Sta. Barbara	100	80.2	57.6	-2.4	-3.3	1.26	1.40	1958
284	16755	Minien, Sta. Barbara	112	41.2	38.4	-6.1	-7.0	0.95	1.06	1956
285	16754	Matic-matic, Sta. Barbara	112	41.2	39.9	-3.7	-5.2	0.95	0.63	1956
286	6975	Batao P. Cuison Farm, Sta. Barbara	200	30.5	27.6	-2.1	-4.6	31.12	12.45	1969
287	17738	Maningding, Sta. Barbara	62	68.6	67.1					
288	44633	Poblacion, Sta. Barbara	250		90.9					
			200	184	126.2	Flowing				1964
			150		155.5					
289	436083	Payas, Sta. Barbara	100	39.6	36.9	-0.6	-1.5	0.63	0.70	1961
290	17614	Payas School, Sta. Barbara	100	25.2	22.9	-3.2	-5.6	0.44	0.18	1958
291	19090	Cablong, Sta. Barbara	100	45.7	29.3	Ground	-4.9	0.44	0.09	1958
292	19091	Poblacion, Sta. Barbara	100	25.0	19.5	-3.7	-4.1	0.32	0.80	1958
293	9435	Tebag, Sta. Barbara	112	23.2	23.2	-6.7	-8.2	0.63	0.42	
294	19087	Sanguil, Sta. Barbara	100	49.5	48.5	-0.3	-5.8	0.95	0.17	1958
295	19086	Gueguesangan, Sta. Barbara	100	28.0	26.8	-3.4	-4.5	0.63	0.57	1958
296	436123	Turod, San Jacinto	100	27.4	27.1	-6.1	-12.2	0.63	0.10	1962
297	436210	Poblacion East, San Jacinto	100	54.9	50.9	-3.0				1962
298	8412	San Vicente, San Jacinto	150	44.8	43.6	-1.5	-1.5	0.63	Infinite	1956
299	8414	Sta. Maria, San Jacinto	112	79.6	78.8	-0.3	-3.0	0.63	0.32	1956
300	8415	Sto. Tomas, San Jacinto	112	53.0	45.7	+2.4	-0.3	3.15	0.24	1956
301	8444	Lubong, San Jacinto	150	48.5	36.3	-5.2	-6.4	0.63	0.53	1955
302	8722	Labnex, San Jacinto	112	90.5	88.1	A b a n d o n e d				1956

ANNEX TABLE VII-B-1 (Continued)

WATER WELL DATA SUMMARY

CDM Well Number	Well Number	Location	Nominal Diameter (mm)	Depth From Ground Surface In Meters: Total	Cased	Static Water Level	Pumping Water Level	Test Yield (lps)	Specific Capacity (lps/m)	Year Completed
303	8723	San Roque, San Jacinto	112	68.0	57.6	3.4	-4.9	0.63	0.42	1955
304	17628	Casibong School, San Jacinto	100	47.3	46.0	0.9	-1.8	0.63	0.70	1958
305	17724	San Roque South, San Jacinto	100	32.3	25.3	-1.8	-5.2	0.95	0.28	1958
306	17725	Poblacion Center, San Jacinto	100	35.1	29.3	-2.4	-7.0	0.95	0.21	1958
307	17726	Poblacion East, San Jacinto	100	45.7	45.4	Ground	-3.0	0.32	0.10	1958
308	17727	Poblacion Northwest, San Jacinto	100	59.5	57.3	+0.9	Flowing	0.44	-	1958
309	17729	Public Market, San Jacinto	100	27.1	27.1	-2.4	-4.6	0.95	0.43	1958
310	17732	San Jose East, San Jacinto	100	53.3	50.6	-1.5	-4.6	0.95	0.31	1958
311	17733	San Jose West, San Jacinto	100	40.2	40.2	-0.9	-7.5	0.63	0.10	1958
312	8539	Magallanes, Tayug	150 112	8.2	5.0 8.2	-1.8	-3.0	0.63	0.53	
313	8538	Magallanes, Tayug	150 112	8.2	8.2	-1.8	-3.0	0.63	0.53	1955
314	8538	Agno, Tayug	112	9.1	9.1	-0.3	-3.0	1.26	0.19	1956
315	8537	Libertad, Tayug	150 112	8.2	3.4 8.2	-1.8	-2.7	0.63	0.70	1955
316	6500	Legaspi, Tayug		21.3		-4.6	-5.2	0.63		
317	7708	Maasin, Mangaldan		65.2		-0.2	-0.3	1.26	12.6	
318	8443	Quesang, Mangaldan		42.9		-3.0	-4.0	1.01	1.0	
319	7709	Inlambo, Mangaldan	150	27.4		-3.0		3.15		
320	6736	Alitaya, Mangaldan	100	73.4	53.7	0.5	-0.6	0.44		
321	7710	Macapug, Mangaldan	150	33.5	28.7	1.7	-1.5	1.26		
322	8317	Poblacion, Mangaldan	150	104.9	99.7	12.2	-0.2	3.78		

DESCRIPTIVE DATA

WELL NO. (CDM) 1
(OTHER) NIA CL-9
LOCATION BARRIO TIPUSO
CITY URDANETA
PROVINCE PANGASINAN
CONST. BY NIA – UPRP
DRILLER
STARTED
COMPLETED 1976
OWNER NIA
STATUS
CASING DIAMETER

DRILLER'S TEST DATA:

DATE MARCH 17-19, 1976
STATIC WATER LEVEL -1.87 M. (6.14 FT.)
PUMPING WATER LEVEL -5 M. (16.43 FT.)
TEST PUMP YIELD 1001 GPM (63.1 LPS)
SPECIFIC CAPACITY 20.4 LPS/M (97.3 GPM/FT.)

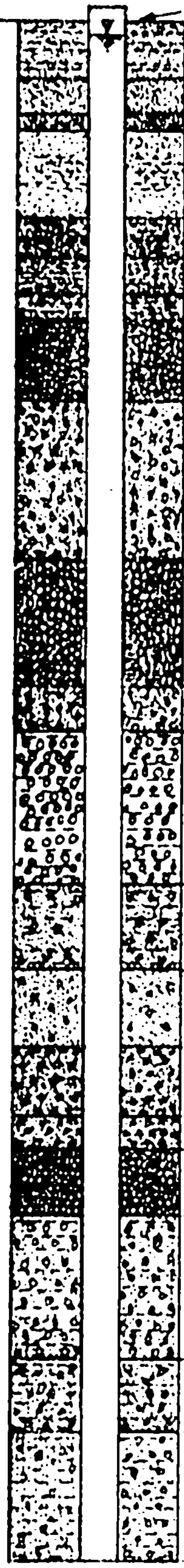
REMARKS:

PUMP SPEED – 1400 RPM
TRANSMISSIVITY – 2800 CUMD/M
(224,000 GPD/FT)

WATER QUALITY DATA:

WATER TEMPERATURE – 82° F

GRAPHIC LOG



DEPTH (M)	DEPTH (FT)	STRATIFICATION
8		TAN SILT AND FINE SAND
13		BROWN SAND
17		GRAY SAND WITH GRANULES
31		BROWN GRAY SAND WITH SILT LAYERED
34		BROWN SAND WITH SILT
37		BROWN GRAY SAND AND SILT
44		BROWN SILT WITH SAND
48		COARSE SAND & GRANULES W/SILT
61		GRAY GRAVEL WITH PEBBLES VERY CLEAN AND LAYERED
89		GRAVEL AND SAND
109		GRAY GRAVEL
119		GRAVEL WITH SAND
142		GRAY GRAVEL WITH SOME SILT
156		GRAY COARSE SAND WITH GRAVEL AND SOME SILT
169		COARSE, CLEAN GRAY SAND OCCASIONAL GRAVEL
181		SAND WITH GRAVEL
187		GRAY SAND AND GRAVEL
197		GRAY GRAVEL
222		GRAY GRAVEL WITH SAND OCCASSIONAL SILT
233		GRAY GRAVEL AND SAND WITH SILT
256		GRAY SILT AND CLAY WITH SAND AND GRAVEL

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

DESCRIPTIVE DATA

WELL NO. (CDM) 2
(OTHER) 9 - R1
LOCATION NIA COMPOUND, BARRIO BAYAOAS
CITY URDANETA
PROVINCE PANGASINAN
CONST. BY BPW
DRILLER BPW
STARTED JANUARY 24, 1958
COMPLETED FEBRUARY 24, 1958
OWNER
STATUS
CASING DIAMETER 100 MM (4 IN.)
CASING LENGTH 140.2 M. (460 FT.)

DRILLER'S TEST DATA:
DATE
STATIC WATER LEVEL -0.4 M (1.1 FT.)
PUMPING WATER LEVEL -2.0 M (6.6 FT.)
TEST PUMP YIELD 55 GPM (3.5 LPS)
SPECIFIC CAPACITY 10 GPM/FT. (2.1 LPS/M)

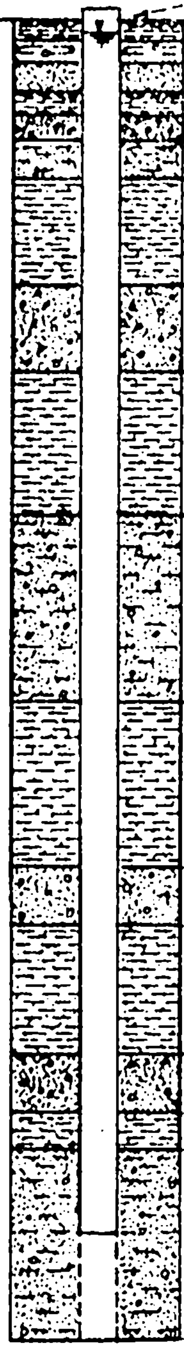
REMARKS:

SLOTTED CASING
35.4 — 38.4 M
75.6 — 78.6 M
98.7 — 101.6 M
120.1 — 123.4 M
135.9 — 134.3 M

TRANSMISSIVITY
DRAWDOWN 32,500 GPD/FT.
RECOVERY 26,500 GPD/FT.
(BPW 35,000 GPD/FT.).

WATER QUALITY DATA:

GRAPHIC LOG



GROUND SURFACE

DEPTH (M)	DEPTH (FT)	STRATIFICATION
1.5	5	SOIL
4.9	16	SANDY, PEBBLY CLAY
7.6	25	SAND
10.7	35	CLAY
12.2	40	SAND AND PEBBLES
18.0	59	CLAYEY AND PEBBLES
30.0	98	SANDY CLAY
39.6	130	SAND AND PEBBLES
56.7	186	SANDY CLAY
78.6	258	PEBBLY, CLAYEY SAND
97.8	321	SANDY CLAY
104.2	342	PEBBLY SAND
119.4	392	SANDY CLAY
126.2	414	PEBBLY SAND
130.4	428	SANDY CLAY
155.5	510	PEBBLY, CLAYEY SAND

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM

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

DESCRIPTIVE DATA

WELL NO. (CDM) 3
(OTHER)
LOCATION DIVINE WORD ACADEMY
BARRIO SAN VICENTE
CITY URDANETA
PROVINCE PANGASINAN
CONST. BY
DRILLER
STARTED
COMPLETED
OWNER DIVINE WORD ACADEMY
STATUS FREE-FLOWING AT 30 GPM (1.9 LPS)
REDRILLED TO 137 M. (450 FT.) OR MORE.
CASING DIAMETER 300 MM. (12 IN.)
SCREENED AT 11-41.3 M. (36-136 FT)
AND 66.4-96.3 M. (218 - 316 FT.)
ORIGINAL CASING DEPTH 0 - 102 M

DRILLER'S TEST DATA:
DATE
STATIC WATER LEVEL FREE - FLOWING
PUMPING WATER LEVEL - 21.5 M. (70 FT.-8 IN.)
TEST PUMP YIELD 365 GPM (23 LPS)
SPECIFIC CAPACITY

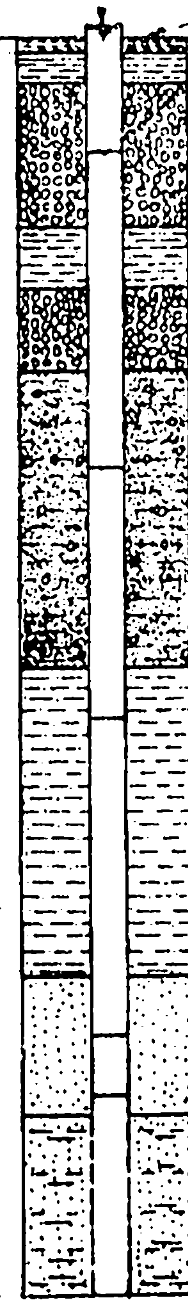
REMARKS:
EXISTING WELL -
SOUTHERN CROSS CENTRIFUGAL PUMP
3530 RPM 15 HP ELIN MOTOR.
OPEN HOLE AT 102-121.2M. (336-400FT.)
OPEN HOLE COLLAPSED DURING
EARTHQUAKE - REDRILLED
(BY LOPEZ ; Q. C.) TO
137 M. (450 FT.) OR MORE AND
LOWER HOLE CASED WITH
250 MM. (10 IN.) SLOTTED PIPE.

WATER QUALITY DATA:

GRAPHIC LOG

DEPTH (M)	DEPTH (FT)	STRATIFICATION
		GROUND SURFACE
1.5	5	TOP SOIL
4.5	15	LIGHT BROWN CLAY
18.3	60	CLEAN GRAVEL
24.4	80	SANDY SHALE
32.3	106	CLEAN GRAVEL
61.3	201	CONGLOMERATE (CEMENTED WITH SAND)
90.9	298	SANDY SHALE
104.2	342	SANDSTONE (SILICEOUS)
121.9	400	SHALY, MEDIUM GRADE SANDSTONE

CASING



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

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

DESCRIPTIVE DATA	
WELL NO. (CDM)	4
(OTHER)	BPW 7256
LOCATION	POBLACION
CITY	URDANETA
PROVINCE	PANGASINAN
CONST. BY	
DRILLER	AMADO CRUZ
STARTED	MAY 11, 1955
COMPLETED	JULY 27, 1955
OWNER	
STATUS	
CASING DIAMETER	250 MM (10 IN.), 200 MM (8 IN.)
CASING LENGTH	70.4 M. (231 FT.), 20.7 M (68 FT.)

DRILLER'S TEST DATA:

DATE	
STATIC WATER LEVEL	FLOWING
PUMPING WATER LEVEL	-3.6 M. (12 FT.)
TEST PUMP YIELD	130 GPM (8.2 LPS)
SPECIFIC CAPACITY	

REMARKS:

PRODUCES 15 GPM (0.9 LPS WHILE FREE FLOWING).

SAMPLE SHIPPED TO MANILA ON JULY 28, 1955.

WATER QUALITY DATA:

WATER IS FRESH AND CLEAN

GRAPHIC LOG

DEPTH (M)	DEPTH (FT)	STRATIFICATION
		GROUND SURFACE
		YELLOW STICKY CLAY
4.6	15	
		BLUE STICKY CLAY
15.2	50	
		SANDY CLAY
18.9	62	
		BLUE STICKY CLAY
25.0	82	
		SANDY CLAY
28.9	95	
		COARSE SAND WITH GRAVEL
30.5	100	
		COARSE SAND
32.6	107	
		GRAVEL
38.4	126	
		YELLOW STICKY CLAY
46.9	154	
		SAND
53.4	175	
		FINE SAND
68.6	237	
		BLUE STICKY CLAY
72.2	237	
		SANDY CLAY
73.2	240	
		SAND
77.7	255	
		FINE SAND
79.8	261	
		FINE SAND AND GRAVEL
82.3	270	

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

DESCRIPTIVE DATA

WELL NO. (CDM) : 5
(OTHER) BPW 222
LOCATION: BARRIO NANCAMALINAN EAST
CITY: URDANETA
PROVINCE: PANGASINAN
CONST. BY: NWSA, PACD 80. PROJECT
DRILLER: VENERANDO T. OCAMPO
STARTED: NOVEMBER 11, 1968
COMPLETED: JANUARY 9, 1969
OWNER:
STATUS:
CASING DIAMETER: 112 MM (4 1/2 IN)
CASING LENGTH: 85.4 M. (280 FT.)

DRILLER'S TEST DATA:

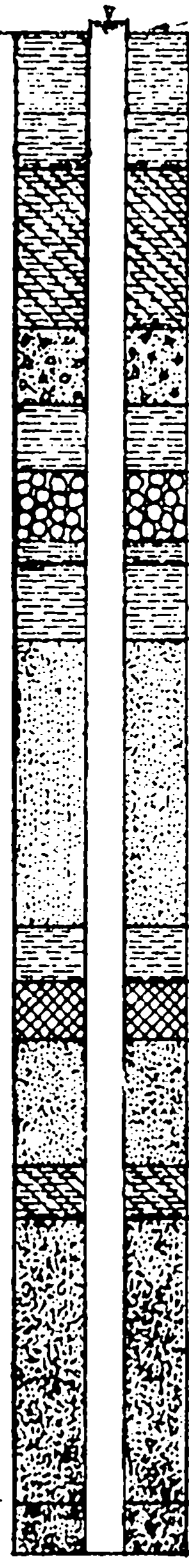
DATE:
STATIC WATER LEVEL: FLOWING
PUMPING WATER LEVEL:
TEST PUMP YIELD: NOT DETERMINED

REMARKS:

BPW INSTALLED WELL PUMP

WATER QUALITY DATA:

GRAPHIC LOG



DEPTH (M)	DEPTH (FT)	STRATIFICATION
		YELLOW CLAY
4.6	15	BLUE STICKY CLAY
7.6	25	ADOBE CLAY
16.9	55	SAND AND GRAVEL
21.3	70	YELLOW STICKY CLAY
25.3	83	BOULDERS
29.3	96	BLUE CLAY
30.5	100	YELLOW STICKY CLAY
35.1	115	SAND
51.8	170	BLUE STICKY CLAY
54.9	180	HARD ROCK
58.9	193	SAND
65.5	215	ADOBE CLAY
68.6	225	SAND
85.4	280	SAND AND STONES
89.4	240	

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM

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

DESCRIPTIVE DATA

WELL NO (CDM) 6
(OTHER) BPW 44702
LOCATION BARRIO NANCAMALINAN WEST
CITY URDANETA
PROVINCE PANGASINAN
CONST BY
DRILLER HILARION CASTRO
STARTED DECEMBER 14, 1970
COMPLETED SEPTEMBER 7, 1972
OWNER
STATUS
CASING DIAMETER 112 MM (4 1/2 IN.)
CASING LENGTH 86.9 M (285 FT)

DRILLER'S TEST DATA:

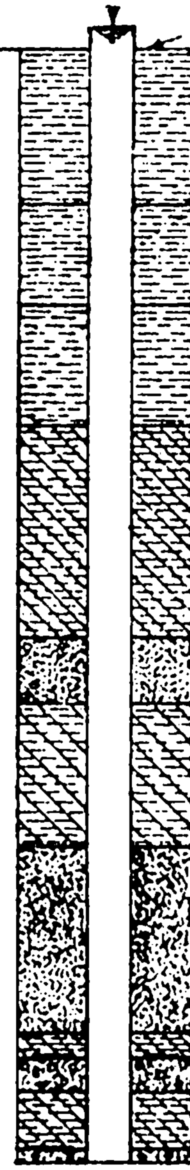
DATE
STATIC WATER LEVEL +1.4 M. (4 1/2 FT.)
PUMPING WATER LEVEL
TEST PUMP YIELD FLOWING AT 12 GPM)
(0.76 LPS)

REMARKS:

WATER QUALITY DATA:

PH - 7.2
ODOR - ODORLESS
COLOR - COLORLESS
TASTE - BLAND
CHLORIDE - 20.00
FREE CO_2 - 7.04
ACIDITY - 8.0
BICARBONATE - 141.52
ALKALINITY - 110.00
TURBIDITY - LESS THAN 10.8

GRAPHIC LOG



DEPTH (M)	DEPTH (FT)	STRATIFICATION
		GROUND SURFACE
		BROWN CLAY
12.2	40	
		BLUE STICKY CLAY
20.1	66	
		YELLOW STICKY CLAY
28.9	95	
		ADOBE CLAY
45.7	150	
		BLUE SAND
50.6	166	
		BLUE ADOBE CLAY
61.9	203	
		BLUE FINE SAND
76.5	251	
		BLUE ADOBE CLAY
78.4	257	
		BLUE SAND WITH GRAVEL
81.1	266	
		BLUE ADOBE CLAY
85.7	281	
		COARSE SAND WITH GRAVEL
86.0	282	

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

ANNEX FIGURE VII B - 6
WELL DATA SHEET
WELL CDM-6

DESCRIPTIVE DATA

WELL NO (CDM) 8
(OTHER) DPW 436271
LOCATION SUGCONG – TUCOK
CITY URDANETA
PROVINCE PANGASINAN
CONST. BY
DRILLER BRAULIO FERNANDEZ
STARTED MARCH 1, 1962
COMPLETED APRIL 27, 1962
OWNER
STATUS
CASING DIAMETER 100 MM ([illegible] IN.)
CASING LENGTH 44.1 M (144 FT. 7 IN.)

DRILLER'S TEST DATA:

DATE
STATIC WATER LEVEL -1.5 M. (5 FT.)
PUMPING WATER LEVEL -2.1 M. (7 FT.)
TEST PUMP YIELD 15 GPM (0.9 LPS)
SPECIFIC CAPACITY 1.5 LPS/M (7.5 GPM/FT.)

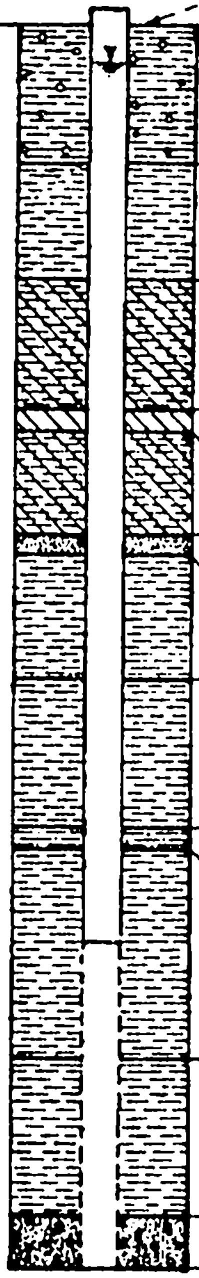
REMARKS:

WATER QUALITY DATA:

GRAPHIC LOG

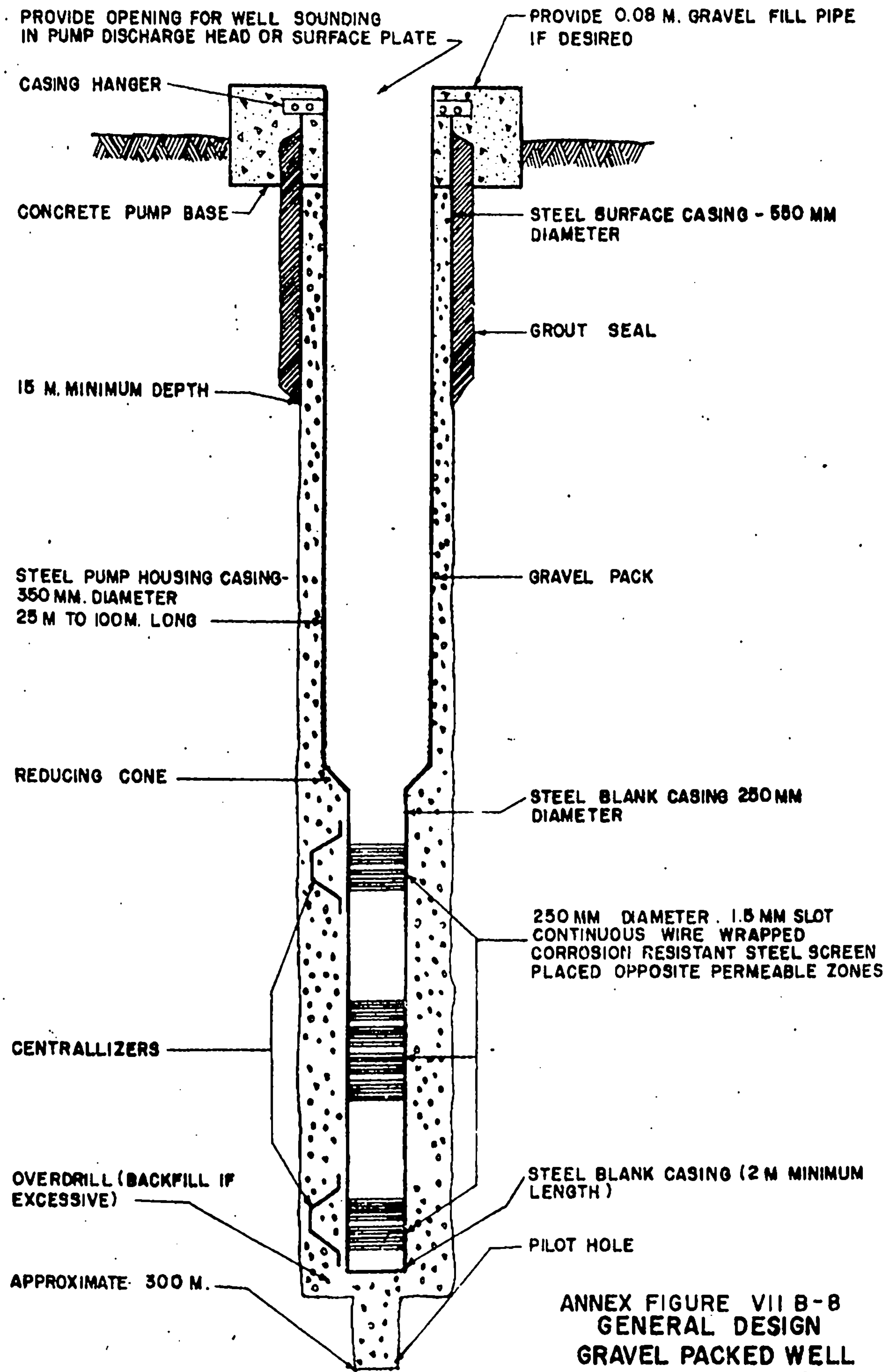
DEPTH (M)	DEPTH (FT)	STRATIFICATION
		GROUND SURFACE
		YELLOW CLAY WITH STONES
6.4	21	YELLOW STICKY CLAY
12.2	40	HARD ADOBE CLAY
18.6	61	ADOBE ROCK
19.5	64	ADOBE CLAY
24.7	81	FINE SAND
25.6	84	LOOSE CLAY
31.4	103	BLUE STICKY CLAY
38.7	127	SANDY CLAY
39.6	130	YELLOW STICKY CLAY
49.7	163	BLUE STICKY CLAY
57.6	189	SAND WITH GRAVEL
60.1	197	

CASING



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

ANNEX FIGURE VII B-7
WELL DATA SHEET
WELL CDM-8



ANNEX FIGURE VII B-8
GENERAL DESIGN
GRAVEL PACKED WELL
ROTARY DRILLED
URDANETA WATER DISTRICT

SUPPLEMENT TO ANNEX FIGURE VII-B-8

GENERAL CONSTRUCTION SUGGESTIONS

Gravel Packed Well - Rotary Drilled

1. Drill oversized hole to 15 m minimum depth (more if conditions require), set and grout 550 mm surface casing.

2. Drill small diameter pilot hole inside surface casing to 300 meters.

3. Run electric log.

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

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

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

7. Place gravel.

8. Clean and develop well thoroughly.

9. Test well.

10. Design pump.

11. Construct well head facilities.

12. Install pump.

CHAPTER VIII ANALYSIS AND EVALUATION OF ALTERNATIVES

A. GENERAL

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

B. WATER SUPPLY SOURCE ALTERNATIVES

Surface Water Sources

The Sinocalan River, which is near Urdaneta, frequently has no flow during the dry season. The area through which the river passes is also relatively flat and not suitable for the construction of a dam and storage reservoir. Hence, this river is not practical as a source of water for Urdaneta.

The Agno River is a large river which, at its closest point, is 7 km from Urdaneta. Its minimum flow at Rosales is less than a half million cumd only about once in 4 years and below a quarter million cumd only once in about 30 years. The Agno River has adequate water to supply Urdaneta well beyond the year 2000. The quality of the river is also satisfactory (see Table VII-3). The use of surface water from the Agno River as a source of water for Urdaneta is therefore technically feasible.

The use of the Agno River as a direct source would, however, entail the construction of a diversion structure and pumping station, and complete water treatment works, including a second set of pumps for pumping the treated water. Practically the same volume of water, but without the natural turbidity in river water, could be obtained from induced infiltration wells along the banks of the river. As treatment and double pumping of the well water would not be necessary, supply directly from the Agno River would obviously be more costly than supply from induced infiltration wells along the banks of the river. The Agno River as a direct source has thus been eliminated as an alternative.

Springs

No springs large enough to supply Urdaneta are known to exist within a reasonable distance of the city.

Groundwater Sources

The banks of the Agno River about 9 km from Urdaneta appear to be satisfactory for the installation of induced infiltration wells.

The Urdaneta water system has been supplied with water from wells within the service area since 1959. The NIA has an irrigation well with a capacity of 63 lps, less than 4 km from the center of Urdaneta. Large quantities of groundwater appear to be available within the URD-WD service area.

Comparison of Alternatives

Water supply to Urdaneta is technically feasible either from wells constructed within the URD-WD service area (Alternative I) or from induced infiltration wells along the Agno River about 9 km from the poblacion (Alternative II). A comparison of the present worth costs of these two alternatives, to the year 2000, has been made. A summary of these costs is presented in Table VIII-1. The ₱2.24 million cost of utilizing wells within the service area is ₱2.72 million lower than the corresponding cost of water supply from induced infiltration wells.

As has been stated previously, the aquifer underlying Urdaneta is a good source of groundwater. If a large amount of additional groundwater were to be extracted within the vicinity of Urdaneta for irrigation or other purposes, the aquifer could be overpumped, with resultant rapidly declining water levels in the vicinity. In this event it would become necessary to construct deeper wells within the service area, with resulting higher construction and operating costs, or to transport additional water to the service area from sources such as induced infiltration wells along the Agno River. In order to determine the potential impact of declining water levels on the use of wells within the service area, an extreme case was briefly analyzed and is included herein as Alternative I-A For this alternative it was assumed that wells would be constructed within the service area until 1990, that the wells would decline in capacity between 1986 and 1996 at which time only 30 percent of original capacity would remain and that additional capacity required after 1990 would be obtained from induced infiltration wells along the Agno River. The results of this analysis are also presented in Table VIII-1. Because the circumstances of this alternative represent a situation between the conditions described by Alternative I and Alternative II, and verify the economic advantage of well construction during the early stages of the program, no further attempts were made to analyze obviously less costly alternatives utilizing wells within the service area. Even under the very pessimistic conditions outlined above, the present worth cost of obtaining water from wells located within the service area is ₱1.19 million less than the cost of obtaining all water from induced infiltration wells along the Agno River.

Alternative I-A and Alternative II contain distribution system additions required to allow for distribution of additional water transmitted from a source outside the service area. The estimated costs of these additions are included in Table VIII-1.

Based on the results of the above analysis, the most economical source alternative is Alternative I. For purposes of analysis of the treatment and distribution system alternatives discussed later in this chapter, it is assumed that water demands of the URD-WD will be met by wells constructed within the service area.

TABLE VIII-1

SUMMARY OF PRESENT WORTH COSTS OF SOURCE ALTERNATIVES[1]

Item[2]	Construction Cost (₱)	Present Worth Cost (₱)[3]
Alternative I Wells within URD-WD Service Area		
Source Facilities	3,220,000	1,107,000
Operation and Maintenance	-	1,138,000
	3,220,000	2,245,000
Alternative I-A Initial Wells within URD-WD Service Area, Additional Supply From Induced Infiltration Wells along Agno River		
Source Facilities	4,580,000	1,543,000
Transmission Facilities	5,310,000	824,000
Distribution Facilities	150,000	24,000
Operation and Maintenance	-	1,380,000
	10,040,000	3,771,000
Alternative II Induced Infiltration Wells along Agno River		
Source Facilities	1,675,000	430,000
Transmission Facilities	8,910,000	2,914,000
Distribution Facilities	300,000	107,000
Operation and Maintenance	-	1,509,000
	10,885,000	4,960,000

1/ A detailed breakdown of required facilities, construction periods and individual costs is presented in Annex Tables VIII-B-1, VIII-B-2 and VIII-B-3.

2/ Those items which would be common to all the alternatives studied have not been included in the cost comparison (e.g. only those portions of distribution systems which would not be common to all three alternatives have been included).

3/ Present worth costs are 1978 present worth costs, based on 1978 price levels. Information concerning the expected service life of water supply facilities used for this report is presented in Annex Table VIII-B-4.

C. TREATMENT ALTERNATIVES

The potential sources of water for the URD-WD are surface water from the Agno River, water from induced infiltration wells along the Agno River and groundwater abstracted from wells located within the service area. The results of analyses of water samples taken from the Agno River and wells within the service area are presented in Tables VII-3 and IV-1, respectively.

As previously discussed in Chapter VII and Section B of this chapter, water taken directly from the Agno River would require extensive treatment and multiple pumping before delivery to the URD-WD distribution system, and has been eliminated, based on high cost, as a potential supply source. Treatment of water from this source would be based on removal of turbidity, a standard process requiring chemical addition, mixing, flocculation, coagulation, sedimentation and filtration (see Appendix F, Volume II). All other parameters listed in Table VII-3 fall within the permissible limits of the Philippine National Standards for Drinking Water, with the exception of the observed concentration of iron. Since it is likely that much of the iron present is carried in the suspended load of the river, which would be removed in a turbidity removal treatment process, it is not likely that additional iron removal facilities would be required.

Water abstracted from induced infiltration wells located along the Agno River would essentially have the same dissolved chemical content as water taken directly from the river itself, and would therefore require no treatment since these concentrations are within acceptable limits. Likewise, because the river bank induced infiltration process essentially involves filtration within the aquifer materials intervening between the well and the river, additional treatment for removal of turbidity (and probably most of the iron present) would not be required.

The results of water analyses presented in Table IV-1 for well waters within the URD-WD service area indicate that these waters are all acceptable potable sources. With the exception of the iron concentration in the sample taken from BPW 56/76/1 in Barrio Sto. Domingo, and the manganese concentration in all samples represented, the parameters presented fall within the permissible limits established by the Philippine National Standards for Drinking Water (PNSDW). Because high iron concentration occurs in only one of the six samples analyzed, and in that case only slightly exceeds the permissible limit, it is assumed that the resultant blend of waters abstracted from wells within the service area, if used as a water supply source, would contain iron concentrations well below the permissible limit. Although the manganese concentration in all well water samples analyzed exceeds the permissible limit of the PNSDW, in no case does it exceed the "excessive" limit (0.5 mg/l) of the PNSDW (i.e. the concentration above which water potability would be "markedly impaired"). Because of the acceptability of this water according to the PNSDW, the lack of physiological hazard associated with manganese concentrations of the order indicated by analyses and the general lack of public objection to water of this quality after prolonged use, it is suggested that no treatment be utilized for removal of manganese.

As may be inferred from the above discussion, treatment for removal of physical or chemical constituents of the groundwater within the service area or water produced from induced infiltration wells along the Agno River would not be required if those waters were used as sources by the URD-WD. However, in order to preserve the quality of these waters throughout the distribution system, disinfection would be required. Disinfection could be accomplished utilizing various methods which are discussed in Appendix J, Volume II. For economic and practical reasons (ready availability of disinfection chemicals and dosing equipment, ease of application and monitoring, and long-lasting effectiveness) chlorination is the recommended disinfection process.

D. DISTRIBUTION ALTERNATIVES

General

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

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

Particular attention has been given to the requirements of fire flow in the URD-WD. In general, fire flow is applied at various locations in a system coincidentally with maximum-day demands, and the pipelines are sized to convoy the required flow at specified head losses. In large communities, the total peak-hour is greater than the maximum-day flow plus fire flow and therefore relatively minor adjustments are required in the pipe system to provide fire flow. In the smaller communities, especially small barrios some distance from the poblacion, the fire flow alone can be 3 or 4 times the total peak-hour demand.

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

The flows used for the design of the various components of the distribution system for the URD-WD are as follows (see Water Demand Projections, Chapter VI).

	1980	1990	2000
Water demand, lpcd	198	193	199
Served population	10,590	34,680	61,870
Average daily water demand, cumd	2,100	6,690	12,310
Maximum-day water demand, cumd	2,520	8,030	14,770
Peak-hour water demand, cumd	3,680	11,710	21,540

Pressure Zones

The terrain in the proposed service area of the URD-WD through the year 2000 is generally flat. Ground elevations range from 21 to 27 meters above mean sea level. The larger portion of the service area including the poblacion is situated at an average elevation of 24 meters. The system could be operated adequately at a static HGL of 52 meters at the existing storage tank; therefore, only a single pressure zone has been considered for the URD-WD.

Storage Facilities

Storage facilities are provided in a distribution system to meet hourly fluctuations in demand over the day. The usual requirement for operational storage is 15-20 percent of the maximum-day volume, assuming the source of supply is capable of providing water at a rate equal to maximum-day demand.

In the flat areas of Central Luzon, storage is usually provided by means of an elevated storage tank. This type of tank is very costly in the Philippines because it must be designed to withstand high seismic loadings. An alternative method of meeting demand fluctuations has been investigated for Urdaneta.

As previously discussed, the least-cost source alternative for Urdaneta is groundwater pumped from within the service area. As an alternative, it is possible to install additional pumping capacity above the maximum-day demand rate in order to meet part of the peak-hour fluctuations and thereby reduce the amount of storage required. Methodology Memorandum No. 5 discusses the rationale for providing additional pumping capacity and presents a curve to be used in estimating the required storage volume based on various supply rates. An economic analysis comparing the costs of providing additional supply and of storage for Urdaneta is presented in Table VIII-2.

Table VIII-2 shows that, in Urdaneta, additional pumping capacity to meet hourly fluctuations in demand would be less costly than extra storage volume. Distribution alternatives were analyzed on the basis that additional pumping capacity would be provided in URD-WD and the volume of storage would be minimized.

TABLE VIII-2

ADDITIONAL STORAGE VERSUS ADDITIONAL SUPPLY ANALYSIS[4]

	Alternative 1 (Minimum Storage)	Alternative 2 (Intermediate Storage)	Alternative 3 (Maximum Storage)
Storage Required			
(Percent)[5]	2.5	8.5	12.6
(Volume, cum)	369	1,255	1,480
Present Worth Cost (₱ x 1000)			
Storage[6]	-	842	983
Wells	2,271.4	1,736	1,702
Operation and Maintenance	15.6	14.9	15.9
	₱2,287.0	₱2,592.90	₱2,700.90

Distribution System

The analysis for the distribution system of Urdaneta generally followed the guidelines given in Appendices F and K. Unlike the First Ten Areas Feasibility Studies, computer analysis for the Second Ten Provincial Urban Areas considered pipelines smaller than 200 mm in diameter. For a municipality the size of Urdaneta, there would be very few pipelines greater than 250 mm in diameter even in the year 2000. Therefore, the minimum pipe size used in the computer analysis is 100 mm.

The locations of the future distribution mains have been planned along existing roads or proposed street rights-of-way. The distribution mains in the outer barrios could not be economically looped because of the tentacle-shaped service area of URD-WD.

The alternative locations of wells in the URD-WD have been analyzed. A well location is controlled by the distance between wells to minimize

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[4] Analysis includes all facilities to the year 2000.

[5] Percentage of maximum daily demand.

[6] Storage in addition to the existing 380-cum storage tank.

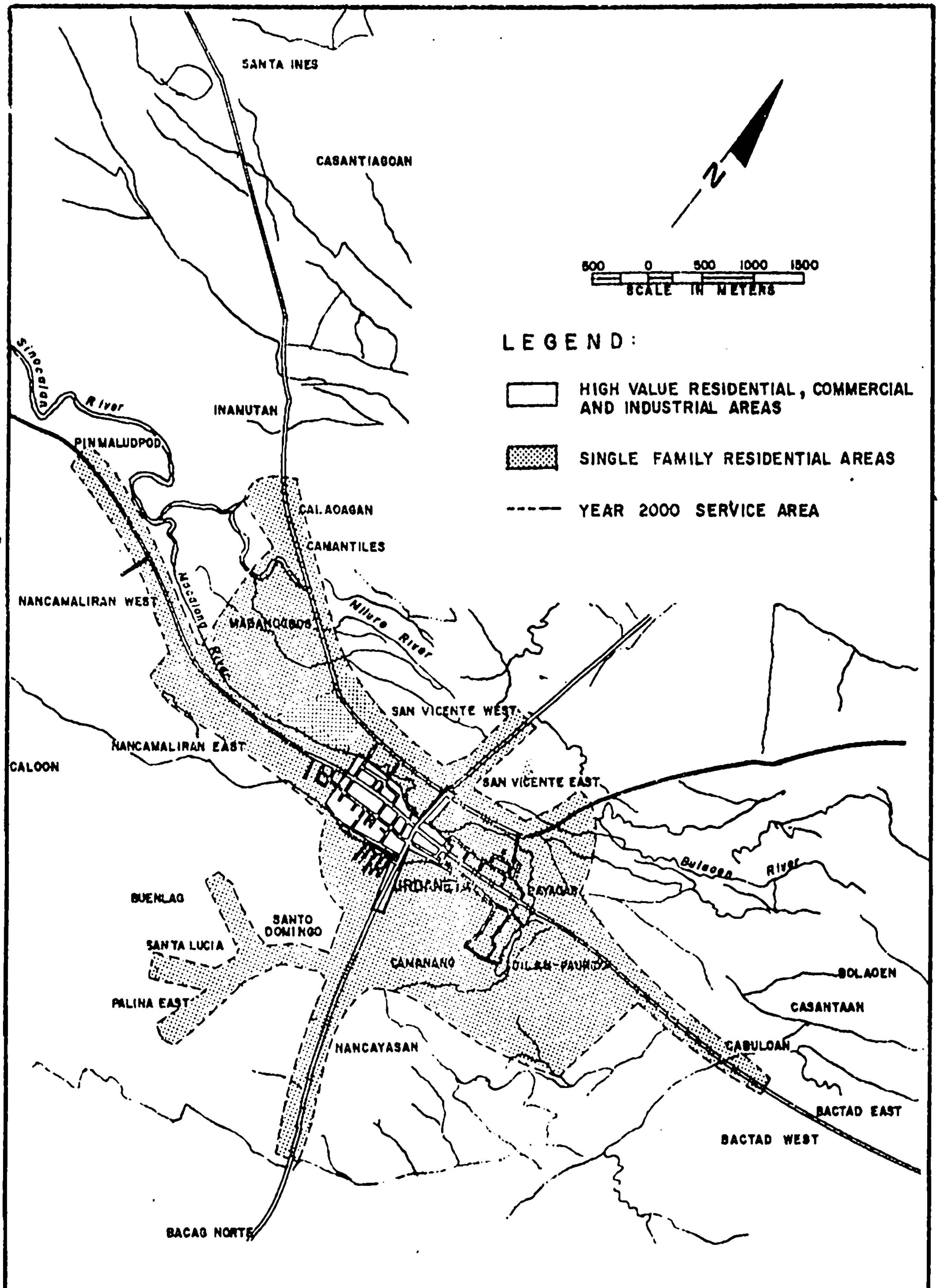
drawdown interference and by the location of the high demand centers. Studies made for other communities indicate that it is economical to locate wells as close to the centers of demand as possible. This reduces the required pipe capacity to other parts of the distribution system. The capacity of wells must also be considered in locating wells near the demand centers. Hydraulically, the most efficient well capacity would be equal to the water demand in the area of the well. However, it would be more practical to have wells of about the same capacity for easier operation and control of the pumping rate as demand fluctuates.

It appears that the maximum well capacity in Urdaneta would be about 63 lps (1,000 gpm). If wells of this capacity were constructed, relatively few wells would be required. Having few large-capacity wells presents 2 problems. The first is that the overall cost of pipelines would increase as larger sizes would be needed to supply water to remote parts of the system. The second problem is that, with relatively few large-capacity wells, flow rates could only be changed in large increments. During periods of low demand, the large pumps would have short cycling time. A more efficient method of operation is to have smaller capacity wells so that the operator can control the flow to match the changes in demand closely. The rate of increase in the yearly water demand of URD-WD is gradual, thus, making medium-capacity wells of about 25.2 to 31.5 lps (400 to 500 gpm) more desirable than the high-capacity wells. Distribution main sizes have been analyzed based on the medium-capacity wells. The locations of wells are shown in Figures IX-1, IX-4 and IX-5. The locations of the proposed wells would have to be confirmed after collecting adequate pump testing data during construction of the initial well. The proposed wells should be coordinated with the NIA to prevent any conflict with the locations of its future irrigation wells. If future well locations and capacities are significantly different from those proposed in this study, additional analyses will have to be made to determine sizes of the distribution mains.

Fire Protection

Fire protection presently does not exist in most sections of Urdaneta because there is little or no water pressure most of the day. In order to provide fire protection there must be adequate pressure in all water pipelines 24 hours per day.

As outlined in Appendix K, Volume II, fire protection is classified into two types - one for the high-value residential, commercial and industrial areas; and another for the single-family residential areas. In the high-value residential, commercial and industrial areas, an available fire flow of 20 lps at 2 adjacent fire hydrants should be provided; in the single-family residential areas, only 10 lps at 2 adjacent hydrants should be provided. The percentages of fire protection for the design years 1980, 1990 and 2000 are based on the required flows for these two types of fire protection. Figure VIII-1 shows the outline of the fire service areas in Urdaneta.



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

FIGURE VIII-1
FIRE PROTECTION AREAS
URDANETA WATER DISTRICT

The immediate improvement program (1978-1980), which is aimed at providing adequate domestic service to existing consumers and increasing the number of consumers to provide a larger financial base to pay for future improvements, does not include full fire protection. If the program were designed to provide full fire protection to the consumers, the cost of the improvements required would likely become too high for the program to be feasible. The recommended pipe sizes in the immediate improvement program have been analyzed for available fire protection through computer studies. The analysis showed that the improved distribution system could provide 50 percent of the fire flow requirements for the single-family residential area and 100 percent for the high value residential and commercial area. In order to provide this quantity of fire protection, the existing hydrants must be rehabilitated and new hydrants be added in some areas.

In design year 1990, full fire protection could be provided for the poblacion while a range of 40 to 100 percent of adequate flow could be provided for areas outside the poblacion. Barrio Palina East could be provided with 85 percent of adequate flow and Dilan Paurido, 40 percent.

For the year 2000, the recommended improvements could provide full fire protection for areas within and adjacent to the poblacion, and 35 to 65 percent of the required flow for some areas outside the poblacion. An alternative study was made to determine the additional system cost if these areas were to be provided with full fire protection by increasing the pipe size in affected areas from 100 to 150 mm. The estimated costs are shown in Table VIII-3 and would amount to ₱210,000.

TABLE VIII-3

ADDITIONAL COST TO PROVIDE
FULL FIRE PROTECTION FOR URD-WD

Length (m)	Size for Partial Fire Protection (mm)	Size for Full Fire Protection (mm)	Additional Cost
1960	100	150	₱ 165,000
		Contingencies (15%)	25,000
			190,000
		Engineering (10%)	20,000
			₱ 210,000

The preceding discussion of fire protection relates only to the capacities of the distribution mains. In providing fire protection, an adequate number of fire hydrants has also to be considered for the various service areas. The primary criterion for providing fire hydrants would be the degree of development in a specific area. In Chapter IX, a schedule of fire hydrant construction is included, based on the projected development in Urdaneta. This schedule can be modified as development requires, provided the required distribution mains have been provided.

System Operation

While there are no distribution alternatives for Urdaneta, the alternative source locations and capacities could present definite operational problems.

As previously discussed, the location and capacity of the wells can affect the operation of the system with regard to meeting demands and pressure requirements. Computer analyses were conducted on several combinations of demands and operating wells, assuming that the distribution system would be capable of meeting required pressures for average-day demands. In the analyses, only usual operating problems, such as one well being out of service or an error in judgment as to which wells should be operating, were considered.

Unusual operating problems such as meeting maximum or peak demands at minimum pressures when 2 or more wells are not in operation, were not considered. The cost of providing adequate service under all possible operational conditions would be prohibitive so that only those operating conditions that would reasonably occur were analyzed.

As a general rule, the distribution system should be operated by utilizing as many wells as possible outside the poblacion to meet water demands. This operational procedure has the effect of maintaining a high HGL in the outlying areas, while the storage tank maintains an adequate gradeline within the poblacion.

Besides problems of pressure in the system due to well operation, the schedule of operation has also to be considered. The pump operation schedule is based on the water level within the tank and pressures in various sections of the system. If the tank level drops, a sufficient number of wells would have to be operated to refill the tank. However, the major problem in this operation schedule is the time available to control the number of wells in operation as the water level and pressure fluctuate.

As experience is gained in the operation of wells, a schedule of operation based on normal demand schedules may be devised. If a satisfactory schedule is devised, the system may go unattended for several hours.

Internal Network

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

E. OTHER ALTERNATIVES FOR WATER CONSERVATION AND AUGMENTATION

In Urdaneta, groundwater is also used for irrigation and other purposes. There is a possibility for the groundwater source to be overpumped, causing a decline in water availability in the area. Steps should be taken to conserve water and possibly to augment present sources.

There are several alternative measures for conserving water. These alternatives depend on sophisticated technology in the case of water reuse and desalting or on governmental policy in the case of land management. Appendix M, Volume II is a discussion of these conservation and augmentation alternatives.

ANNEX VIII-B

SCHEDULE OF FACILITIES FOR ALTERNATIVE ANALYSIS

ANNEX TABLE VIII-B-1

COMPARATIVE PRESENT WORTH COST OF ADDITIONAL SUPPLY FROM WELLS IN SERVICE AREA[1]
(BASED ON ANTICIPATED WELL FIELD LIFE)

Item	Date Constructed	Construction Cost ₱ x 1,000	Present Worth Cost (Less Year 2000 Salvage Value) ₱ x 1,000
Well and Pumphouse	1978	630	624
Improve Existing Well	1979	70	63
Well and Pumphouse	1986	630	232
Well and Pumphouse	1990	630	130
Well and Pumphouse	1995	630	50
Well and Pumphouse	1999	630	8
Operation and Maintenance	(1978-2000)	-	1,138
Total 1978 Present Worth Cost			₱2,245 x 1,000

ANNEX TABLE VIII-B-2

COMPARATIVE PRESENT WORTH COST OF ADDITIONAL SUPPLY FROM WELLS ON BANK OF AGNO RIVER[2]

Item	Date Constructed	Construction Cost ₱ x 1,000	Present Worth Cost (Less Year 2000 Salvage Value) ₱ x 1,000
Transmission Main	1982	3,600	2,205
Power Line	1982	100	60
Well and Pumphouse	1982	315	193
Distribution Additions	1982	150	87
Well and Pumphouse	1987	315	101
Connection Pipe	1987	125	37
Transmission Main	1992	4,860	657
Distribution Additions	1992	150	20
Well and Pumphouse	1992	315	47
Well and Pumphouse	1995	315	25
Connection Pipe	1995	200	14
Well and Pumphouse	1999	315	4
Connection Pipe	1999	125	1
Operation and Maintenance Costs	(1978-2000)		1,509
Total 1978 Present Worth Cost			₱4,960 x 1,000

[1] Economic life taken as:
Well and Pumphouse - 25 years
Improve Existing Well - 15 years
For the remaining items, refer to Appendix F, Volume II.

[2] Economic life taken as:
Well and Pumphouse - 25 years
Power Line - 30 years
For the remaining items, refer to Appendix F, Volume II.

ANNEX TABLE VIII-B-3

COMPARATIVE PRESENT WORTH COST OF ADDITIONAL SUPPLY FROM WELLS IN SERVICE AREA[3/]
(ASSUMING EARLY FAILURE OF WELL FIELD FOR PURPOSES OF COMPARISON ONLY)

Item	Date Constructed	Construction Cost ₱ x 1,000	Present Worth Cost (Less Year 2000 Salvage Value) ₱ x 1,000
Well and Pumphouse	1978	630	624
Improve Existing Well	1979	70	63
Well and Pumphouse	1986	630	232
Well and Pumphouse	1988	630	176
Well and Pumphouse	1989	630	152
Well and Pumphouse	1990	630	130
Transmission Main	1991	4,860	784
Well and Pumphouse	1991	315	56
Power Line	1991	100	17
Distribution Additions	1991	150	24
Well and Pumphouse	1992	315	47
Connecting Pipe	1992	125	17
Well and Pumphouse	1994	315	32
Connecting Pipe	1994	200	18
Well and Pumphouse	1997	315	14
Connecting Pipe	1997	125	5
Operation and Maintenance	(1978-2000)		1,380
Total 1978 Present Worth Cost			₱3,771

[3/] Economic Life taken as:
Well and Pumphouse - 25 years
Improve Existing Well - 15 years
Power Line - 30 years
For the remaining items, refer to Appendix F, Volume II

ANNEX TABLE VIII-B-4

ECONOMIC SERVICE LIFE OF WATER SUPPLY FACILITIES[1]

Item	Economic Service Life, Years
Embankment Dams[2]	
Embankment	50
Structure	50
Equipment	50
Water Treatment Plants	
Structure	50
Equipment	15
Groundwater Wells	
Well	25
Structure	25
Equipment	15
Transmission Facilities	
Pipes	50
Valves	50
Distribution Facilities	
Pipes	50
Valves	50
Internal Network	
Pipes	50
Valves	50
Hydrants	50
Service Connections	
Service Pipes	50
Water Meter	15
Disinfection Facilities	
Structure	50 (may depend on associated facility)
Equipment	15
Storage Facilities	
Structure	50
Equipment (specialized, other than pipes and valves)	15

ANNEX TABLE VIII-B-4 (continued)

Item	Economic Service Life, Years
Miscellaneous Structures	50
Miscellaneous Mechanical Equipment	15
Vehicles	7

1/The economic service lives presented here have been used throughout this report wherever facility replacement or present-worth analysis has been required.

2/Although the physical life expectancy of certain facilities, such as dam embankments, is greater than the economic service life indicated, the latter more realistically reflects the useful life of the facility.

CHAPTER IX DESCRIPTION AND COST OF THE RECOMMENDED PLAN

A. GENERAL

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

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

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

Source

The present source of water supply utilized by URD-WD is a well located near the municipal building. As discussed in Chapter IV, the present capacity of the facility is approximately 610 cumd. This is inadequate to meet the current demands of URD-WD consumers. An additional well will be constructed in the eastern part of Barrio Bayaoas, to supply approximately 2,700 cumd, during the immediate improvement program. As soon as the new well is operational, the existing well will be tested to determine its present capacity and a new pumpset will be installed to increase its pumping yield to 2,180 cumd, if possible. The total supply of the two wells will be sufficient to meet the projected water demand beyond 1980.

Future water demands of URD-WD will be supplied by wells (see Source Alternatives, Chapter VIII) to be constructed during successive construction phases to meet projected increases in demand. These wells will be located within the year 2000 service area located at an average distance of 1 to 2 km from one another, to minimize the effects of mutual interference. Each additional well will have an anticipated capacity of approximately 2,700 cumd.

Distribution Storage

URD-WD currently utilizes an existing 380-cum elevated distribution storage tank located adjacent to the existing well. The existing storage tank is a reinforced concrete structure constructed in 1959. Based on the alternative studies conducted for URD-WD, as presented in Chapter VIII, the least costly alternative involves maximization of well supplies and minimization of storage capacity. The URD-WD will therefore utilize wells to meet peak demands. The existing distribution storage tank will be retained to meet emergency demands.

Distribution System

The existing distribution system will be expanded to serve the barrios of San Vicente East, San Vicente West, Bayaoas, Nancayasan, Nancamaliran East, Nancamaliran West, Dilan-Paurido, Sto. Domingo, Palina East and Mabanogbog by the year 1990. Barrios Camanang, Pinmaludpod, Camantiles, Cabuloan and Bactad West will be served by the year 2000.

A total length of about 15.5 km of 100 to 250 mm pipelines will be constructed by 1990. This includes pipe replacements for those undersized pipelines in the existing system. By the year 2000, an additional length of about 7.0 km will be added to the system to serve additional outlying barrios. The above lengths of pipelines do not include the new internal network pipelines that will be installed during the construction program. The distribution facilities proposed for the long-term development of the URD-WD are shown in Figure IX-1 (appended).

Administrative and Other Service Facilities

In addition to the source and distribution facilities required for the production and transportation of water to consumers, it will be necessary to provide other facilities to improve administrative, operation, maintenance and quality control capabilities within the water district. An administration building will be constructed during the immediate improvement program and will temporarily house a plumbing shop and associated equipment. A separate building for the plumbing shop will be provided during Phase I-A. It has been assumed that an arrangement will be made to meet the water meter repair and laboratory requirements of URD-WD by sharing the relatively larger facilities of other nearby water districts, such as Tarlac or San Fernando (La Union).

Design Considerations

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

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

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

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

B. IMMEDIATE IMPROVEMENT PROGRAM

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

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

The immediate improvement program will improve and expand water supply service primarily by the addition of source and distribution facilities. The program will consist of the following:

1. The construction of a new well and provision of pumping equipment.

2. The rehabilitation of the existing well and the provision and installation of a new pumpset.

3. The initiation of an extensive leakage detection survey and repair program.

4. The addition of reliable disinfection equipment to provide full-time chlorination of the distribution system.

5. The installation of about 4.9 km of 100 to 250 mm diameter pipelines.

6. The provision of meters for 414 existing service connections, as well as the provision of 930 new connections and repair of approximately 30 percent (124) of the existing connections.

7. The construction of a new administrative building (temporarily to house a plumbing shop) and provision of appurtenances such as shop tools, vehicles, office equipment and furniture to upgrade the water district's operational capabilities.

8. Installation of new distribution mains as shown in Figure IX-2 and listed in Table IX-1.

The 150 mm pipelines to be provided in Barrio San Vicente West, will serve as segments of anticipated future water mains and permit the installation of additional service connections in this area. The provision of additional 100 mm pipelines in the poblacion and 200 mm pipes to Barrio Bayacas will permit the installation of additional service connections and provide additional loops for better pressure and flow distribution.

The provision of better pressure distribution throughout the URD-WD distribution system on a 24-hour basis will tend to aggravate the current level of system leakage and wastage. It is therefore essential that an intensive program of leakage and wastage surveys and associated system repairs be undertaken during the immediate improvement program.

Water meters will be provided for the existing 414 flat-rate connections, about 30 percent of which require major piping repairs or replacement. In addition, approximately 930 new connections will be installed, bringing the 1980 served population to 65 percent of the total population within the 1980 service area.

Disinfection equipment consisting of structures, chlorinators, booster pumps and scales will be installed at each of the two well

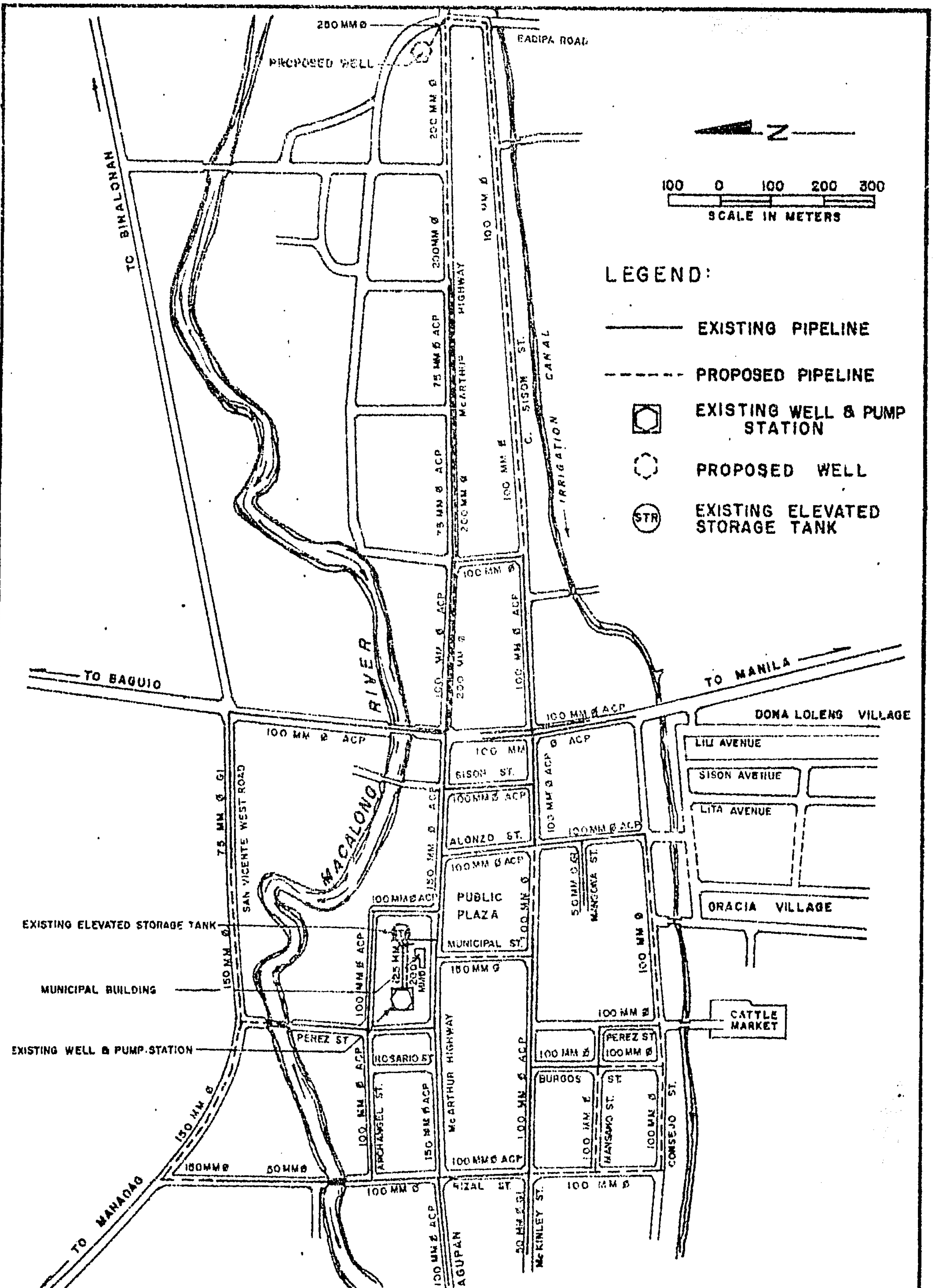


FIGURE IX-2
IMMEDIATE IMPROVEMENTS
URDANETA WATER DISTRICT

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

TABLE IX-1

IMMEDIATE IMPROVEMENT PROGRAM
PIPELINES (1978-1979)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
47	Rizal St. - McKinley St. to Mansano St.	100	110
48	Rizal St. - Mansano St. to Consejo St.	100	105
49	Consejo St. - Rizal St. to Burgos St.	100	175
50	Mansano St. - Rizal St. to Burgos St.	100	180
51	Burgos St. - Mansano St. to Consejo St.	100	110
52	Consejo St. - Burgos St. to Perez St.	100	65
53	Consejo St. - Perez St. to Alonzo St.	100	330
55	McKinley St. - South of Public Plaza to Alonzo St.	100	195
57	Along C. Sison St.	100	400
59	Along C. Sison St.	100	360
60	Along C. Sison St.	100	250
62	Along Badipa Road	100	130
			2,410
43	Along Rizal St. from San Vicente West Road	150	120
44	Along San Vicente West Road	150	300
45	Along San Vicente West Road	150	320
46	Along Perez Street from San Vicente West Road	150	150
54	Along Municipal St.	150	160
56	Along C. Sison St.	150	25
			1,075
42	Well Line near Storage Tank	200	60
58	Along MacArthur Highway	200	330
61	Along MacArthur Highway	200	280
64	Along MacArthur Highway	200	400
65	Along MacArthur Highway	200	320
			1,390
63	Well Line in Bo. Bayaoas	250	50
		Total	4,925

sites located near the municipal building and in the eastern section of Barrio Bayaoas. This will provide adequate disinfection of water supplied to consumers.

The operational capabilities of the URD-WD will be significantly enhanced by the acquisition of land and the construction of a new administrative building, complete with office space for administration, billing and record keeping, as well as a small library. This new building will be furnished with desks, filing cabinets, typewriters, addressograph and validating machines. Vehicles, production meters for the two wells, plumbing tools and some minor distribution appurtenances will be provided.

Table IX-2 presents the breakdown of costs (at 1978 price levels) for the immediate improvement program. The total project cost of ₱4.41 million consists of ₱2.02 million in foreign exchange and ₱2.39 million in local currency.

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

As a result of the alternative studies discussed in Chapter VIII, the URD-WD will exploit the groundwater aquifer within the Urdaneta area as its future source of water supply.

The first stage of the recommended construction program, including source development, treatment and distribution facilities, will be implemented in two construction phases. The first construction phase will be implemented between 1980 and 1985 and the second, between 1986 and 1990.

Existing facilities will be incorporated into the recommended scheme to the maximum extent practical. Most of the existing distribution facilities constructed in 1959 will be retained and incorporated into the proposed system.

As previously discussed, URD-WD will meet projected peak demands with source supply from wells. The existing storage tank will be retained to meet emergency demands. This tank has an overflow elevation of 52 meters above MSL, which is sufficient to maintain required pressures within the service area.

CONSTRUCTION PHASE I-A (1980-85)

Source Development

The URD-WD will begin a long-term program of well drilling by 1982. The first two wells will be drilled in 1982 and 1985. For construction of the new wells, the following parameters have been established,

TABLE IX-2

CONSTRUCTION COST SUMMARY [1]
IMMEDIATE IMPROVEMENT PROGRAM

Item	Cost in Pesos: Local	Foreign [2]	Total	Remarks
Source Facilities [3]				
Materials and Equipment	228,200	409,000		Pumping equipment:
Civil and Structural	266,300	13,000		for existing well –
	494,500	422,000	916,500	new well complete – Disinfection facilities for two wells
Distribution Pipelines [3]				
Materials and Equipment	9,600	96,400		2,410 m x 100 mm
Civil and Structural	127,700	–		
Materials and Equipment	23,600	93,500		1,075 m x 150 mm
Civil and Structural	78,500	–		
Materials and Equipment	44,500	175,100		1,390 m x 200 mm
Civil and Structural	118,200	–		
Materials and Equipment	2,900	11,000		50 m x 250 mm
Civil and Structural	6,000	–		
Materials and Equipment	8,300	22,100		valves
Civil and Structural	7,700	–		
	427,000	398,100	825,100	

1/ 1978 price levels

2/ US$1.00 = ₱7.00

3/ Contingencies @ 15% and engineering @ 10% for these items.
For all other items, contingencies @ 10% and engineering @ 5%.

TABLE IX-2 (Continued)

Item	Cost in Pesos Local	Foreign	Total	Remarks
Service Connections				
Materials and Equipment	22,300	450,100		930 new connections
Civil and Structural	304,100	-		
Materials and Equipment	3,000	36,000		124 replacements
Civil and Structural	36,100	-		
Materials and Equipment	-	80,300		414 conversions
Civil and Structural	14,900	-		
	380,400	566,400	946,800	
Leakage Detection and Repair				
Materials and Equipment	9,000	12,000		Specialist fees, travel, equipment and miscellaneous valve repair and replacement
Civil and Structural	18,000	86,000		
	27,000	98,000	125,000	
Administrative Building and Equipment				
Materials and Equipment	20,000	69,000		Includes 300 sqm of floor space; office equipment and plumbing tools.
Civil and Structural	363,000	-		
	383,000	69,000	452,000	
Vehicles				
Materials and Equipment	60,000	60,000		Two van or pick-up type vehicles
Civil and Structural	-	-		
	60,000	60,000	120,000	

TABLE IX-2 (Continued)

Item		Cost in Pesos Local	Foreign	Total	Remarks
Miscellaneous Items					
Materials and Equipment		6,000	11,000		Includes production meter for existing well, miscellaneous publications and equipment and chlorine residual analyzers.
Civil and Structural		1,000	-		
		7,000	11,000	18,000	
Total Construction Cost					
Materials and Equipment		437,400	1,525,500	1,962,900	
Civil and Structural		1,341,500	99,000	1,440,500	
		1,778,900	1,624,500	3,403,400	
Contingencies	@ 15%	138,200	123,000	261,200	
	@ 10%	85,700	80,400	166,100	
	Sub-total	2,002,800	1,827,900	3,830,700	
Engineering[4]	@ 10%	70,100	130,200	200,300	
	@ 5%	32,000	59,400	91,400	
	Sub-total	2,104,900	2,017,500	4,122,400	
Land[5]		290,000	-	290,000	
Total Project Cost		2,394,900	2,017,500	4,412,400	

[4] Consists of 65% foreign exchange based on recent similar projects.

[5] Consists of one well site 100 sqm @ ₱100/sqm and one administrative building site 1,400 sqm @ ₱200/sqm.

based on limited existing well data available: (1) well spacing 1 to 2 km; (2) well depth 200 m; and (3) size of casing, 250 mm.

The addition of these two wells will increase source capacity from 4,900 cumd to 10,300 cumd. This will satisfy the projected system water demand under peak-hour conditions up to the year 1989, as indicated in Figure IX-3. Final selection of pumping equipment will be made after well completion and pump tests. In order to ensure that adequate stand-by pumping equipment is at all times available, sufficient dual-drive (diesel/electric) units will be provided to meet projected average-day requirements.

Chlorination units will be installed adjacent to each of the wells to disinfect the water supply as it is pumped into the distribution mains. A separate chlorination structure will be provided, as well as all required equipment such as chlorinator, booster pump, scale, piping and metering equipment.

Distribution System

The distribution system improvements to be made during Phase I-A are to replace existing pipelines with presently poor hydraulic capacity and to extend service in Barrios Bayaoas, Nancayasan, San Vicente East, San Vicente West and Nancamaliran East.

Recommended distribution system piping installed during Phase I-A will (1) provide 100 to 150 mm reinforcement along the National Highway, Rizal Street, Perez Street and MacArthur Highway and (2) permit expansion of distribution mains to Barrios Nancayasan, San Vicente East, San Vicente West, Nancamaliran East, Nancamaliran West, Bayaoas and Dilan-Paurido. Details of all pipelines to be constructed during this phase are listed in Table IX-3 and shown in Figures IX-4, IX-5 and IX-1 (appended).

All pipelines recommended for construction during Phase I-A will provide hydraulic capacity for projected peak flows. The recommended pipe sizes will be adequate up to the year 2000, as they are incorporated into the proposed system during succeeding construction phases. The pipeline (pipe 113) along MacArthur Highway in Barrio Nancamaliran West has been phased for economic and technical reasons. The first 200 mm pipe will be installed in Phase I-A to provide water service to the additional consumers in this area, while a 200 mm parallel reinforcement pipe will be installed in Phase II-A to provide additional hydraulic capacity when a new well (node 74) is constructed in the western part of Barrio Nancamaliran West in 1997.

All necessary valves and appurtenances have been included in the cost estimates for the subject pipelines.

The final computer printouts for the year 2000 peak-hour and minimum flow conditions are included in Annex IX-C for reference.

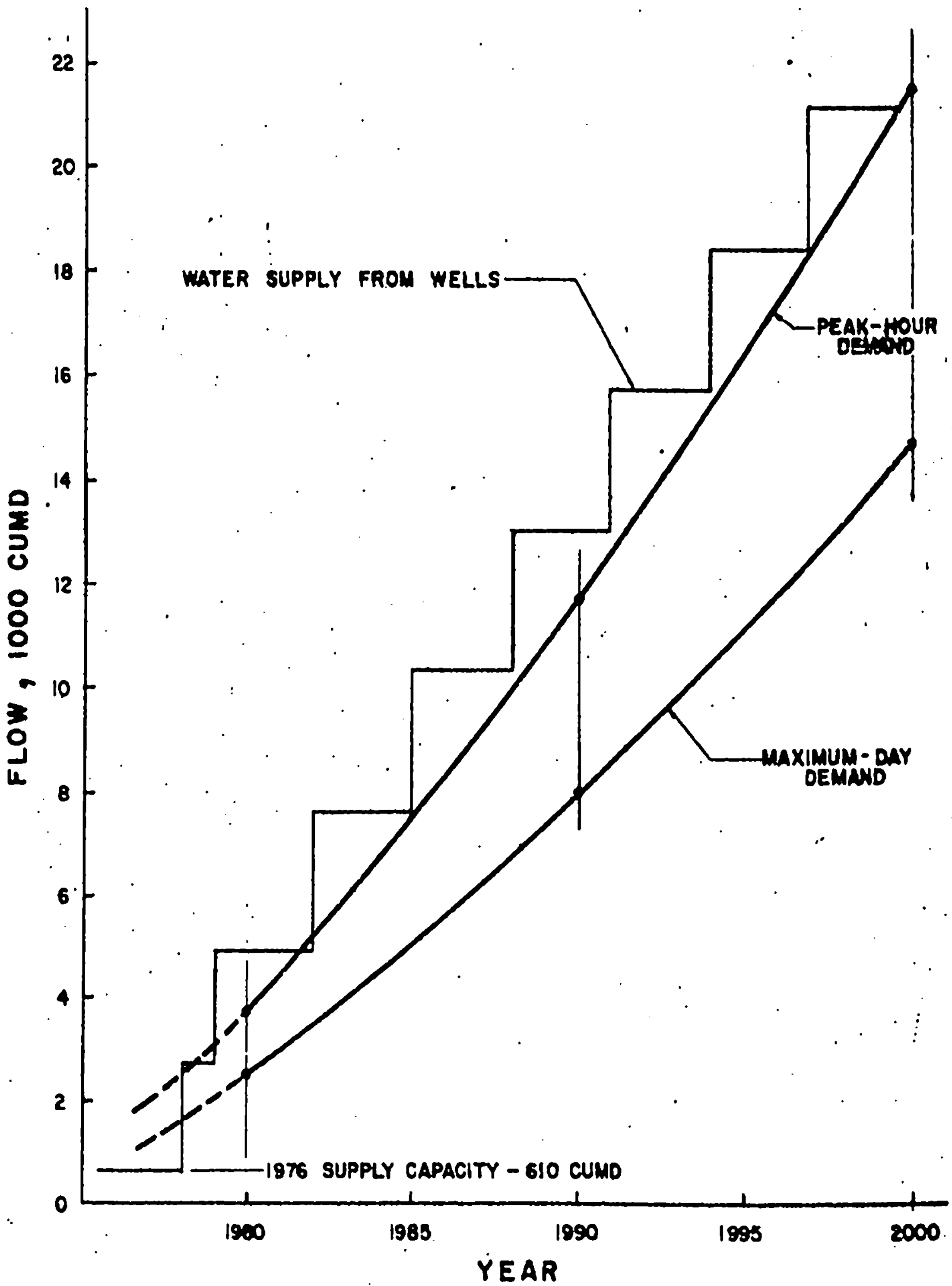


FIGURE IX-3
WATER SUPPLY / DEMAND CHART
URDANETA WATER DISTRICT

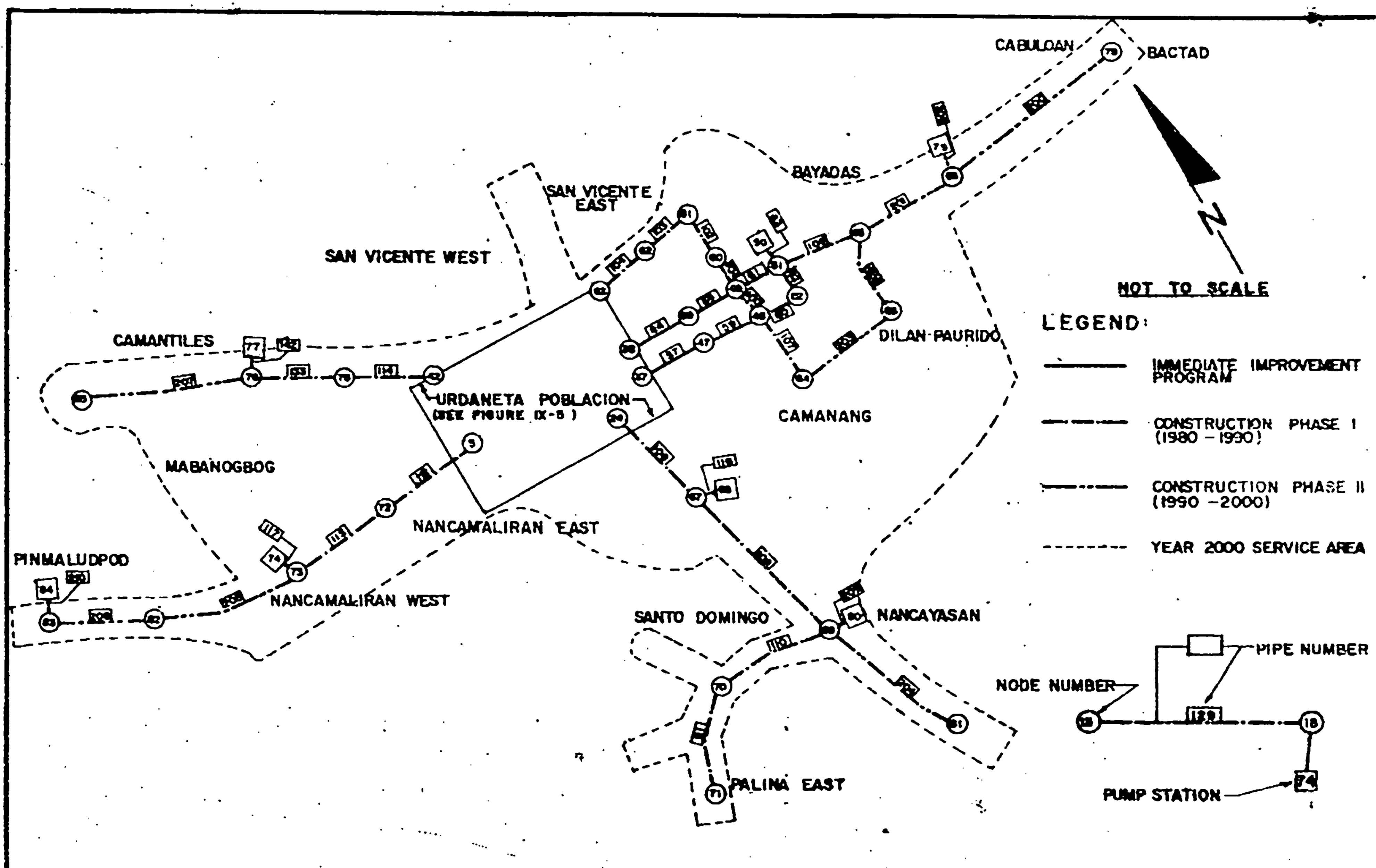


FIGURE IX-4
SCHEMATIC PLAN OF DISTRIBUTION SYSTEM
URDANETA WATER DISTRICT

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

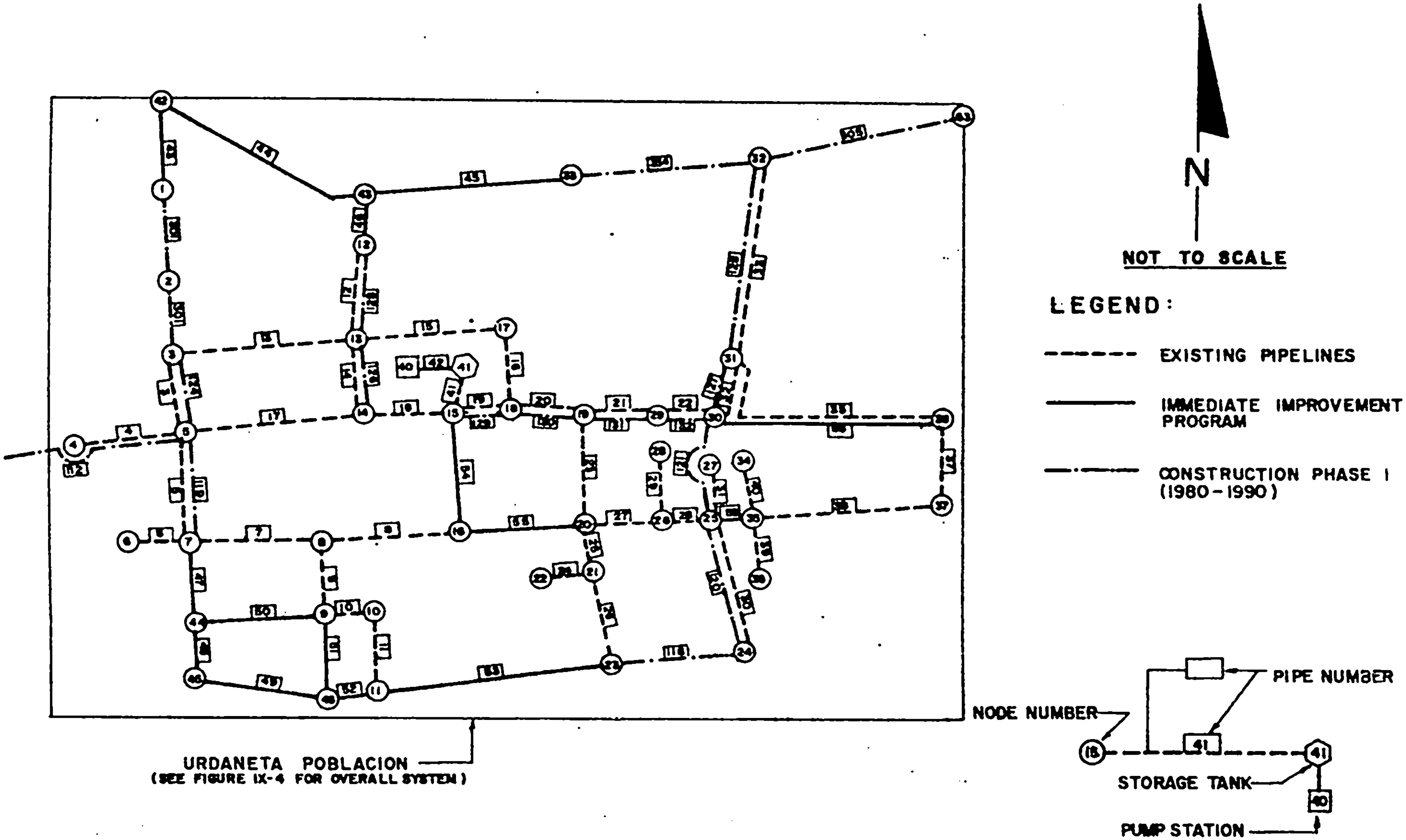


FIGURE IX-5
SCHEMATIC PLAN OF DISTRIBUTION SYSTEM
(POBLACION)
URDANETA WATER DISTRICT

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

TABLE IX-3

DISTRIBUTION PIPELINES- PHASE I-A (1980-1985)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
103	Along San Vicente East Road	100	320
104	Along San Vicente East Road	100	360
105	Along San Vicente East Road	100	280
107	Along Badipa Road	100	480
118	Alonzo-Consejo St. to Consejo St. National Highway	100	200
119	Rizal St. - MacArthur Highway to Rizal - McKinley St.	100	145
124	Rizal St. - MacArthur Highway to Rizal - Archangel St.	100	125
125	Along Perez St.	100	130
126	MacArthur Highway - Perez St. to Perez - Archangel St.	100	120
			2,160
100	Along the road in Barrio Bayaoas	150	140
101	Along the road in Barrio Bayaoas	150	140
120	Consejo St. - National Highway to C. Sison St. - National Highway	150	190
121	C. Sison St. - National Highway to MacArthur - National Highway	150	160
127	Along National Highway near bridge	150	55
128	Along National Highway near San Vicente West	150	420
129	Along MacArthur Highway	150	70
130	Along MacArthur Highway	150	90
131	Along MacArthur Highway	150	120
132	Along MacArthur Highway	150	80
301	Pipe replacement along Rizal St.	150	140
302	Pipe replacement along Rizal St.	150	100
334	Pipe replacement along San Vicente West Road	150	225
			1,930
106	Along the road in Barrio Bayaoas	200	420
108	Along National Highway in Barrio Nancayasan	200	600
109	Along National Highway in Barrio Nancayasan	200	1,120
112	Along MacArthur Highway in Barrio Nancamiliran East	200	700
113	Along MacArthur Highway in Barrio Nancamaliran West	200	680
114	Along San Vicente West Road	200	500
123	Reinforcement to existing storage tank line	200	60
			4,080
116	Well line in Barrio Nancayasan	250	50
117	Well line in Barrio Nancamaliran West	250	50
			100
		Total	8,270

Internal Network

The existing distribution system and internal network piping, together with the pipelines installed during the immediate improvement program will provide service to approximately 92 hectares within the URD-WD service area by 1980. The remainder of the 1980 service area will be provided with internal network piping by 1985.

During Phase I-A, an additional area of approximately 244 hectares will be served by internal network installation. This will bring the total area served by equivalent internal network system to 394 hectares by 1985. This consists of 92 hectares served by the existing system and immediate improvements; 58 hectares covered by distribution pipelines installed during Phase I-A; and the 244 hectares of internal network installed during Phase I-A. A description of internal network systems is presented in Appendix K, Volume II and details of internal network system piping installation for the URD-WD are presented in Annex IX-C.

Service Connections

During Phase I-A, approximately 1,560 service connections will be installed in Urdaneta Poblacion and the barrios of San Vicente East, San Vicente West, Bayaoas, Nancayasan, Nancamaliran East, Nancamaliran West, Dilan-Paurido, Sto. Domingo, Palina East and Mabanogbog. Including the 414 existing connections and the 930 connections installed during the immediate improvement program, the total number of connections installed by 1985 will be about 2,900. The rate of installation of service connections during this phase will be approximately 260 per year.

In addition to the new service connections proposed for this phase, 70 percent (290) of the existing connections will be repaired or replaced because of their age and poor installation and materials.

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

Fire Protection

During Phase I-A, fire protection will be provided for Urdaneta Poblacion, barrios San Vicente East, San Vicente West, Bayaoas, Nancayasan, Nancamaliran East, Nancamaliran West and Dilan-Paurido. About 30 hectares within Urdaneta poblacion and 160 hectares within outlying barrios covering about 25 percent of the total area to be served by 2000, will receive fire protection service by fire hydrant installation. A higher level of hydrant service will be provided for the poblacion and portions of barrios San Vicente East, San Vicente West and Nancayasan because of the high-value property associated with commercial areas. Normal residential-type service will be provided for the rest of the area.

Cost Summary: Phase I-A

The cost summary for proposed construction during Phase I-A is presented in Table IX-4. Based on 1978 price levels, the total project cost for this phase is ₱9.45 million with a foreign exchange component (FEC) of ₱4.31 million, which includes direct and indirect import items. Table IX-4 also presents a cost breakdown based on materials and equipment procurement and required civil and structural work. Materials and equipment considered in this breakdown include pipes, valves, pumping equipment, water meters, hydrants and chlorinators.

CONSTRUCTION PHASE I-B (1986-1990)

Source Facilities

A new well will be constructed in 1988 in Barrio San Vicente West along the road to Barrio Camantiles (see Figure IX-4). This well will provide an additional supply of 2,700 cumd and will increase the total available supply capacity to 13,000 cumd, sufficient to meet system demands until 1991 (see Figure IX-3).

Distribution System

In Phase I-B, an additional length of approximately 2,330 meters of 150 to 250 mm pipelines will be installed to extend service to previously unserved areas, to provide system loops for better pressure distribution in some areas and to connect the proposed well to the distribution system.

Details of these proposed pipelines are listed in Table IX-5 and shown in Figures IX-4, IX-5 and IX-1 (appended).

Internal Network

New internal network will be provided during Phase I-B for approximately 163 hectares, completing the area served within the 1990 service area. Internal network will be provided at an approximate annual rate of 32.6 hectares per year uniformly over the period 1986-1990 (see Annex IX-C for details).

Service Connections

During Phase I-B, 1,560 service connections will be installed within the 1990 service area. The total number of service connections within the service area of URD-WD by the year 1990 will then be about 4,460. The rate of service connection installation during this phase will be 310 per year (see Annex IX-C).

TABLE IX-4

CONSTRUCTION COST SUMMARY[1]

PHASE I-A

Item	Cost in Pesos Local	Cost in Pesos Foreign[2]	Cost in Pesos Total	Remarks
Source Facilities[3]				
Materials and Equipment	436,700	605,000		Two wells complete with pumping and chlorination facilities
Civil and Structural	494,500	26,000		
	931,200	631,000	1,562,200	
Distribution Pipelines[3]				
Materials and Equipment	8,600	86,400		2,160 m x 100 mm
Civil and Structural	114,500	-		
Materials and Equipment	42,500	167,900		1,930 m x 150 mm
Civil and Structural	140,900	-		
Materials and Equipment	130,600	514,100		4,080 m x 200 mm
Civil and Structural	346,800	-		
Materials and Equipment	5,800	22,000		100 m x 250 mm
Civil and Structural	12,100	-		
Materials and Equipment	11,800	34,700		valves
Civil and Structural	11,600	-		
	825,200	825,100	1,650,300	
Internal Network				
Materials and Equipment	130,800	1,023,300		244 ha
Civil and Structural	1,292,000	-		
	1,422,800	1,023,300	2,446,100	

1/ 1978 price levels

2/ US $ 1.00 = ₱7.00

3/ Contingencies @ 15% and engineering @ 10% for these items. For all other items, contingencies @ 10% and engineering @ 5%.

TABLE IX-4 (Continued)

Item	Cost in Pesos: Local	Foreign	Total	Remarks
Service Connections				
Materials and Equipment	44,400	838,700		1,559 new connections and 290 replacements
Civil and Structural	594,200	-		
	638,600	838,700	1,477,300	
Fire Hydrants				
Materials and Equipment	50,000	170,700		150 ha of residential and 40 ha of high-value area
Civil and Structural	73,500	-		
	123,500	170,700	294,200	
Plumbing Shop				
Materials and Equipment	-	-		building only (tools provided in immediate improvements)
Civil and Structural	363,000	-		
	363,000	-	363,000	
Total Construction Cost				
Materials and Equipment	861,200	3,462,800	4,324,000	
Civil and Structural	3,443,100	26,000	3,469,100	
	4,304,300	3,488,800	7,793,100	
Contingencies @ 15%	263,500	218,400	481,900	
@ 10%	254,800	203,300	458,100	
Sub-total	4,822,600	3,910,500	8,733,100	

TABLE IX-4 (Continued)

Item		Cost in Pesos Local	Foreign	Total	Remarks
Engineering[4/]	@ 10%	129,300	240,100	369,400	
	@ 5%	88,200	163,700	251,900	
	Sub-total	5,040,100	4,314,300	9,354,400	
Land[5/]		95,000	-	95,000	
Total Project Cost		5,135,100	4,314,300	9,449,400	

4/ Consists of 65% foreign exchange based on recent similar projects.

5/ Consists of 2 well sites 100 sqm @ ₱100/sqm and one plumbing shop site 1,500 sqm @ ₱50/sqm.

TABLE IX-5

DISTRIBUTION PIPELINES - PHASE I-B (1986-1990)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
102	Along the road in Barrio San Vicente East	150	460
111	Along the road in Barrio Palina East	150	600
			1,060
110	Along the road in Barrio Sto. Domingo	200	720
133	Along the road in Barrio San Vicente West	200	500
			1,220
142	Well line in Barrio San Vicente West	250	50
			50
		Total	2,330

Fire Protection

During Phase I-B, an additional area of 30 hectares within the poblacion of Urdaneta and 170 hectares for the outlying barrios will be provided with fire protection service by the installation of fire hydrants. This will provide approximately 51 and 49 percent coverage of the total areas to be covered by the year 2000 for Urdaneta poblacion and the outlying barrios, respectively. Normal residential-type service will be provided for all areas except Urdaneta poblacion, which will receive a higher level of service. (See Annex IX-C for details of hydrant installation.)

Cost Summary: Phase I-B

The cost summary for proposed construction during Phase I-B is presented in Table IX-6. Based on 1978 price levels, the total project cost for this phase is P5.43 million, with a foreign exchange component of P2.68 million.

TABLE IX-6

CONSTRUCTION COST SUMMARY[1]
PHASE I-D

Item	Cost in Pesos: Local	Cost in Pesos: Foreign[2]	Cost in Pesos: Total	Remarks
Source Facilities[3]				
Materials and Equipment	220,800	326,700		One well complete with pumping and chlorination equipment
Civil and Structural	251,500	13,000		
	472,300	339,700	812,000	
Distribution Pipelines[3]				
Materials and Equipment	23,300	92,200		1,060 m x 150 mm
Civil and Structural	77,400	-		
Materials and Equipment	39,000	153,700		1,220 m x 200 mm
Civil and Structural	103,700	-		
Materials and Equipment	2,900	11,000		50 m x 250 mm
Civil and Structural	6,000	-		
Materials and Equipment	3,200	10,900		valves
Civil and Structural	3,600	-		
	259,100	267,800	526,900	
Internal Network				
Materials and Equipment	87,400	683,600		163 ha
Civil and Structural	863,100	-		
	950,500	683,600	1,634,100	
Service Connections				
Materials and Equipment	37,400	754,100		1,558 new connections
Civil and Structural	509,500	-		
	546,900	754,100	1,301,000	

1/ 1978 price levels
2/ US$1.00 = P7.00
3/ Contingencies @ 15% and engineering @ 10% for these items. For all items, contingencies @ 10% and engineering @ 5%.

TABLE IX-6 (Continued)

Item	Cost in Pesos Local	Foreign	Total	Remarks
Fire Hydrants				
Materials and Equipment	49,000	167,100		170 ha of residential and 30 ha of high-value area
Civil and Structural	71,900	-		
	120,900	167,100	288,000	
Total Construction Cost				
Materials and Equipment	463,000	2,199,300	2,662,300	
Civil and Structural	1,886,700	13,000	1,899,700	
	2,349,700	2,212,300	4,562,000	
Contingencies @ 15%	109,700	91,100	200,800	
@ 10%	161,800	160,500	322,300	
Sub-total	2,621,200	2,463,900	5,085,100	
Engineering 4/ @ 10%	53,900	100,100	154,000	
@ 5%	62,100	115,200	177,300	
Sub-total	2,737,200	2,679,200	5,416,400	
Land 5/	10,000	-	10,000	
Total Project Cost	2,747,200	2,679,200	5,426,400	

4/ Consists of 65% foreign exchange based on recent similar projects.

5/ One well site @ 100 sqm @ ₱100/sqm.

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

The second stage of the recommended program includes provision of additional source and distribution facilities and expansion of the internal network system, service connections and fire protection facilities. These works will be implemented in two construction phases. The first phase of the second stage program will be implemented from 1991 to 1995, and the second phase, from 1996 to 2000.

CONSTRUCTION PHASE II-A (1991-1995)

Source Facilities

During this phase, two additional wells will be constructed. One well at node 80, located in Barrio Nancayasan along the National Road, will be constructed by 1991; and the other at node 79 in Barrio Cabuloan along the National Road, will be constructed by 1994. These two wells will provide an additional capacity of 5,400 cumd, for a total source capacity of 18,400 cumd which will meet projected system demand until 1997 (see Figure IX-3).

Distribution System

The distribution improvements recommended for URD-WD during Phase II-A will consist of the installation of additional pipelines to provide additional service to the barrios of Camanang, Camantiles, Cabuloan and Bactad West and to provide reinforcement to previously installed pipelines. An additional length of about 6.3 km of 100 to 250 mm pipelines will be installed during this phase. These are described in Table IX-7 and shown in Figures IX-4, IX-5 and IX-1 (appended).

Internal Network

An additional 193 hectares of internal network will be provided during Phase II-A of the long-term program. This will provide service to 56 percent of the additional area to be served between 1990 and 2000, and will result in service to 81 percent of the total year 2000 service area.

Service Connections

During Phase II-A, the additional number of service connections installed within Urdaneta Poblacion will be 256; within the remainder of communities previously served, 1,152; and within the additional barrios of Camanang, Camantiles, Cabuloan and Bactad West, 249. A total of 1,657 additional service connections will therefore be

TABLE IX-7

DISTRIBUTION PIPELINES -PHASE II-A (1991-1995)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
200	Along the road in Bo. Cabuloan to Bo. Baotad	100	1,000
			1,000
202	Along the road near Barrio Cabuloan	150	520
203	Road to Barrio Dilan-Paurido	150	540
204	Along National Highway in Barrio Nancayasan	150	900
207	Along the road to Barrio Camantiles	150	1,000
			2,960
113	Pipe reinforcement in Barrio Nancamaliran West	200	680
201	Along the road in Barrio Cabuloan	200	600
205	Along the highway in Barrio Nancamaliran West	200	940
			2,220
208	Well line in Barrio Cabuloan	250	50
209	Well line in Barrio Nancayasan	250	50
			100
		Total	6,280

installed within URD-WD by the year 1995, at a rate of 331 connections per year. This will bring the total number of service connections installed in URD-WD to 6,118 by 1995.

Fire Protection

During Phase II-A, an additional 29 hectares within the poblacion of Urdaneta, and 307 hectares within the barrios of San Vicente East, San Vicente West, Bayaoas, Nancayasan, Namcamaliran East, Namcamaliran West, Dilan-Paurido, Sto. Domingo, Palina East and Mabanogbog, will be provided with fire protection service by fire hydrant installation. This will provide 75 and 74 percent coverage of the total areas to be covered by the year 2000 for Urdaneta Poblacion and the other areas, respectively. Normal residential-type service will be provided for all areas except Urdaneta Poblacion, which will receive a higher level of service. See Annex IX-C for details of hydrant installation.

Cost Summary: Phase II-A

A cost summary for construction during Phase II-A is presented in Table IX-8, based on 1978 price levels. The total project cost for this phase is ₱7.88 million, with a foreign exchange component of ₱3.81 million.

CONSTRUCTION PHASE II-B (1996-2000)

Source Facilities

To meet projected year 2000 demand, an additional well will be constructed at node 86, located in Barrio Pinmaludpod, by 1997. This will provide additional supply capacity of 2,700 cumd, or a total supply of 21,100 cumd by the year 2000.

Distribution System

During Phase II-B, an additional length of approximately 750 meters of 200 and 250 mm distribution pipelines will be installed to connect the new well to the system and to provide service to the additional barrio of Pinmaludpod. These pipelines are listed in Table IX-9 and shown in Figures IX-4 and IX-1 (appended).

TABLE IX-8

CONSTRUCTION COST SUMMARY[1]
PHASE II-A

Item	Costs in Pesos Local	Foreign[2]	Total	Remarks
Source Facilities[3]				
Materials and Equipment	436,700	605,000		Two wells complete with pumping and chlorination facilities
Civil and Structural	494,500	26,000		
	931,200	631,000	1,562,200	
Distribution Pipelines[3]				
Materials and Equipment	4,000	40,000		1,000 m x 100 mm
Civil and Structural	53,000	-		
Materials and Equipment	65,100	257,500		2,960 m x 150 mm
Civil and Structural	216,100	-		
Materials and Equipment	71,000	279,700		2,220 m x 200 mm
Civil and Structural	168,700	-		
Materials and Equipment	5,800	22,000		100 m x 250 mm
Civil and Structural	12,100	-		
Materials and Equipment	8,900	27,300		Valves
Civil and Structural	9,100	-		
	633,800	626,500	1,260,300	
Internal Network				
Materials and Equipment	103,400	809,400		193 ha
Civil and Structural	1,021,900	-		
	1,125,300	809,400	1,934,700	

1/ 1978 price levels
2/ US $1.00 = ₱7.00
3/ Contingencies @ 15% and engineering @ 10% for these items.
For all other items, contingencies @ 10% and engineering @ 5%.

TABLE IX-8 (Continued)

Item		Costs in Pesos: Local	Foreign	Total	Remarks
Service Connections					
Materials and Equipment		39,800	802,000		1,657 new connections
Civil and Structural		541,900	-		
		581,700	802,000	1,383,700	
Fire Hydrants					
Materials and Equipment		66,900	228,100		336 ha of residential area
Civil and Structural		98,100	-		
		165,000	228,100	393,100	
Total Construction Cost					
Materials and Equipment		801,600	3,071,000	3,872,600	
Civil and Structural		2,635,400	26,000	2,661,400	
		3,437,000	3,097,000	6,534,000	
Contingencies	@ 15%	234,800	188,600	423,400	
	@ 10%	187,200	184,000	371,200	
	Sub-total	3,859,000	3,469,600	3,728,600	
Engineering[4]	@ 10 %	113,600	211,000	324,600	
	@ 5%	71,400	132,700	204,100	
	Sub-total	4,044,000	3,813,300	7,857,300	
Land[5]		20,000	-	20,000	
Total Project Cost		4,064,000	3,813,300	7,877,300	

[4] Consists of 65% foreign exchange based on recent similar projects.
[5] Consists of 2 well sites @ 100 sqm @ ₱100/sqm.

TABLE IX-9

DISTRIBUTION PIPELINES - PHASE II-B (1996-2000)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
206	Along the highway in Barrio Pinmaludpod	200	700
210	Well line in Barrio Pinmaludpod	250	50
			750

Internal Network

An additional area of 191 hectares of internal network will be provided during Phase II-B. This will provide service to 100 percent of the year 2000 service area by the end of the construction period in 2000.

Service Connections

Service connections will be installed at an annual rate of 369 connections per year during Phase II-B, to provide a total of 1,845 new connections by the year 2000. At this time, the number of service connections within the area served by URD-WD will be 7,963.

Fire Protection

During Phase II-B, an additional 28 hectares within the poblacion of Urdaneta, plus 272 hectares within the remaining barries of the URD-WD, will be provided with fire protection service by fire hydrant installation. This will provide complete coverage of the total areas to be covered by the year 2000. See Annex IX-C.

Cost Summary: Phase II-B

The cost summary for construction during Phase II-B is presented in Table IX-10. Based on 1978 price levels, the total project cost of this phase is ₱5.97 million, with a foreign exchange component of ₱2.99 million.

TABLE IX-10

CONSTRUCTION COST SUMMARY 1/
PHASE II-B

Item	Cost in Pesos: Local	Foreign 2/	Total	Remarks
Source Facilities 3/				
Materials and Equipment	220,800	326,700		One well complete with pumping and chlorination facilities
Civil and structural	251,500	13,000		
	472,300	339,700	812,000	
Distribution Pipelines 3/				
Materials and Equipment	22,400	88,200		700 m x 200 mm
Civil and Structural	59,500	-		
Materials and Equipment	2,900	154,000		50 m x 250 mm
Civil and Structural	84,700	-		
Materials and Equipment	1,800	6,800		Valves
Civil and Structural	2,200	-		
	173,500	249,000	422,500	
Internal Network				
Materials and Equipment	102,400	801,100		191 ha
Civil and Structural	1,011,300	-		
	1,113,700	801,100	1,914,800	
Service Connections				
Materials and Equipment	44,200	893,000		1,845 new connections
Civil and Structural	603,300	-		
	647,500	893,000	1,540,500	

1/ 1978 price levels
2/ US $1.00 = ₱7.00
3/ Contingencies @ 15% and engineering @ 10% for these items.
For all other items, contingencies @ 10% and engineering @ 5%.

TABLE IX-10 (Continued)

Item		Cost in Pesos Local	Foreign	Total	Remarks
Fire Hydrants					
Materials and Equipment		59,700	203,700		300 ha of residential area
Civil and Structural		87,600	-		
		147,300	203,700	351,000	
Total Construction Cost					
Materials and Equipment		454,200	2,473,500	2,927,700	
Civil and Structural		2,100,100	13,000	2,113,100	
		2,554,300	2,486,500	5,040,800	
Contingencies	@ 15%	96,900	88,300	185,200	
	@ 10%	190,800	189,800	380,600	
	Sub-total	2,842,000	2,764,600	5,606,600	
Engineering4/	@ 10%	49,700	92,300	142,000	
	@ 5%	73,300	136,100	209,400	
	Sub-total	2,965,000	2,993,000	5,958,000	
Land5/		10,000	-	10,000	
Total Project Cost		2,975,000	2,993,000	5,968,000	

4/ Consists of 65% foreign exchange based on recent similar projects.
5/ Consists of 1 well site @ 100 sqm @ ₱100/sqm.

E. CAPITAL COST SUMMARY

The capital costs for each phase of the long-term construction program, including the immediate improvement program, are summarized in Table IX-11. In general, the total project costs shown in this table include the estimated construction cost of facilities, engineering and contingencies and cost of land. Construction cost estimates of the proposed facilities are based on projected 1978 unit prices. The foreign exchange component of the total project cost includes the costs of direct and/or indirect import items.

TABLE IX-11

CAPITAL COST SUMMARY

Construction Phase	Construction Period	Construction Cost (P)	Project Cost (P) Local	Foreign	Total
Immediate Improvements	1978-79	3,403,400	2,394,900	2,017,500	4,412,400
Phase I-A	1980-85	7,793,100	5,135,100	4,314,300	9,449,400
Phase I-B	1986-90	4,562,000	2,747,200	2,679,200	5,426,400
Phase II-A	1991-95	6,534,000	4,064,000	3,813,300	7,877,300
Phase II-B	1996-2000	5,040,800	2,975,000	2,993,000	5,968,000
		27,333,300	17,316,200	15,817,300	33,133,500

F. ANNUAL OPERATION AND MAINTENANCE COSTS

Annual operation and maintenance costs include personnel, power, chemicals, maintenance, office supplies and other miscellaneous expenses which are necessary to sustain the overall water supply system. The total cost of the existing system in 1976 was ₱63,300 (at 1978 price levels). Following implementation of the proposed program, the annual cost will increase due to additional costs for personnel, power, chemicals and maintenance. The annual costs (see Table IX-12) do not include repayment of the debt incurred for construction of the proposed facilities.

The annual costs of operating and maintaining the water district facilities are estimated to be approximately ₱279,300, ₱704,000 and ₱991,100 in 1980, 1990 and 2000, respectively.

G. SEWERAGE/DRAINAGE CONCEPTS

Existing Drainage System

The existing drainage system in Urdaneta consists of a system of 1-meter diameter drainage pipes surrounding the core city, along MacArthur Highway and Sison Street, and a 0.60 m x 0.60 m box culvert along the Baguio-Manila Road. These relatively large pipes are fed by a system of small peripheral open street canals. All water drained by this system is carried to the Macalong River via three routes located at the center and eastern and western extremities of the core city area. Existing drainage facilities are shown in Figure IX-6.

The street canals consist mainly of open unlined ditches varying in width from 0.30 to 0.60 meter with depths varying from 0.25 to 0.45 meter. Although flow from some street canals is directed to the larger network of 1-meter diameter drainage pipes, many of the street canals periodically overflow into nearby rice fields or other low-lying land.

The majority of existing drainage facilities have been constructed since 1946. A complete set of drainage plans has been developed by the Municipal Engineering Department which is the agency currently maintaining the system. In the past, drainage facility improvements or extensions have coincided with improvements and paving of roads. Municipal, provincial and national tax allocations are periodically made available for improvements to the drainage system, but have so far not been adequate to provide a complete integrated system. The municipality currently employs 15 laborers who spend a portion of their time cleaning and maintaining the existing drainage facilities.

TABLE IX-12

OPERATION AND MAINTENANCE COST[1] SUMMARY

Year	Administration and Personnel	Power[2] and Fuel	Chemicals[3]	Maintenance[4]	Miscellaneous[5]	Total
1976	45,100	11,900	-	4,800	1,500	63,300
1980	160,200	55,000	10,600	51,300	2,200	279,300
1985	292,100	98,200	19,000	89,400	3,500	502,200
1990	404,700	141,300	27,400	124,900	5,700	704,000
1995	458,000	194,000	37,700	175,200	9,200	874,100
2000	464,600	246,800	47,900	217,000	14,800	991,100

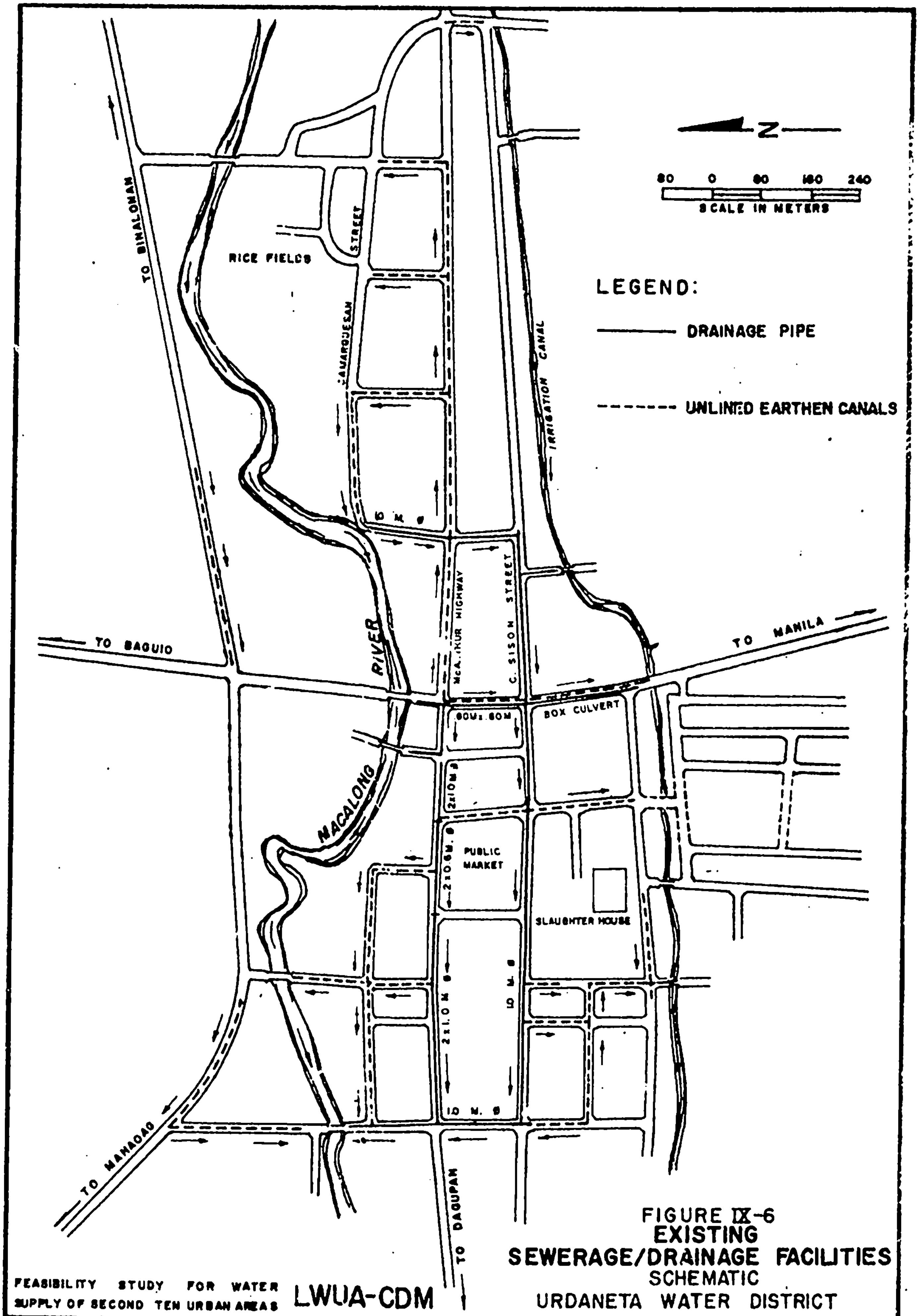
1/ 1978 price levels.

2/ Includes pump power consumption @ P0.25/kwh, general power and fuel for vehicles.

3/ Includes chlorine costs @ P5.0/kg and laboratory chemicals.

4/ Includes mechanical equipment @ 2% per annum and other items @ ½% per annum.

5/ Based on 1976 budget, increased @ 10% per annum.



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS

LWUA-CDM

FIGURE IX-6
EXISTING SEWERAGE/DRAINAGE FACILITIES
SCHEMATIC
URDANETA WATER DISTRICT

The existing drainage facilities were constructed for the collection and disposal of storm water run-off. Most of the street canals are dry during non-rainy periods. During rainy periods, surface run-off, as well as some miscellaneous solid waste, is carried by the street canals, with very little domestic sewage permitted to enter the system.

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

1. The major disposal area for storm water run-off is the Macalong River, which runs along the north side of the municipality, with some storm water disposal into an irrigation canal traversing the southern side of the area.

2. Domestic wastewater is discharged into septic tanks and pit privies. Some roof drainage is transported to these facilities, with occasional flooding during rainy periods. Although direct discharge of domestic wastewater to storm water facilities is discouraged and uncommon, it is likely that an appreciable amount of domestic wastewater travels overland during rainy periods.

3. The public market and slaughterhouse drain their wastewaters directly into the existing drainage system.

4. The municipality maintains the existing drainage system with funds periodically allocated from municipal, provincial and national sources.

5. There are no existing industries producing significant wastewaters.

6. Approximately 30 cumd of solid wastes are collected daily by the Municipal Engineering Department, and disposed of either directly into the Macalong River (near Camarquesan Street) or at a land-fill site near Barrio Camantiles(about 4 km from Urdaneta). The solid wastes from the slaughterhouse are included in the daily collections.

7. Clogging of drainage conduits is caused by deposition of locally eroded soils and the dumping of solid wastes into the drainage canals. The lack of gratings on drainage conduit inlets aggravates this problem.

8. No significant flood problems have been experienced in Urdaneta. Periodic flooding does occur in the southwestern portion of the area, but persists only from 2 to 4 hours.

Relationship with Infrastructure and Other Engineering and Economic Factors

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

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

Information from the Department of Health indicates that in 1975, 28 percent of Urdaneta households had water-borne toilet facilities, 63 percent had closed-pit type toilets and only 9 percent were without toilet facilities. Although these statistics indicate that the general level of occurrence of satisfactory toilet facilities is higher in Urdaneta than in most other comparable urban communities in the Philippines, it is unlikely that such a low percentage of "modern" facilities can economically justify a near-future sewerage program.

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

Projected Wastewater Volumes

Wastewater flows in URD-WD have been projected for the years 1990, 2005 and 2025. These estimates are shown in Table IX-13.

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

The wastewater volume which could be collected was determined by estimating the percentage of water supply connections (domestic and commercial/industrial/institutional) receiving sewer connections during the design period from 1990 to 2025. It was assumed that all water supply connections would have sewer connections by 2025, and that in 1990, 30 percent of domestic and 50 percent of commercial/industrial/institutional water supply connections would have sewer

TABLE IX-13

AVERAGE DAILY WASTEWATER FLOWS
URDANETA WATER DISTRICT

	1990	2005	2025
Percentage of Water Connections with Sewer Connections :			
Domestic	30%	60%	100%
Commercial, etc...	50%	85%	100%
Wastewater Flows, cumd :			
Domestic	634	1,939	6,047
Commercial, etc...	169	549	1,512
Infiltration	1,555	2,239	3,110
Total	2,358	4,727	10,669

connections. It was assumed that no unusually large water consuming connections would occur during the design period and that 90 percent of water consumed would therefore be returned to the sewers. An allowance was made for groundwater infiltration into the sewers, based on projected percentage of physical area with sewers and an infiltration rate of 0.15 lps/hectare. The resultant number of sewer connections required during the design period was then checked to ensure that the annual rate of sewer connections was realistically within the physical capabilities of the water district.

Alternatives Available

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

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

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

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

2. combined or separate sewerage/drainage systems;

3. various degrees of centralised community sewage treatment;

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

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

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

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

1. Screening of gross solids, high-rate lagoons and effluent discharge into the Macalong River.

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

Recommondations

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

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

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

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

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

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

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

H. MANAGEMENT OF WATER RESOURCES

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

I. UPDATING THE WATER SUPPLY MASTER PLAN

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

J. ENVIRONMENTAL CONSIDERATIONS

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

ANNEX IX-C

DISTRIBUTION SYSTEM GROWTH

ANNEX IX-C

DISTRIBUTION SYSTEM GROWTH

General

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

Served Population

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

Number of Persons Per Connection

Based on the pilot area study carried out within the present (1976) service area, the present number of people served by a single service connection is approximately 8.0. It is estimated that the overall served population per service connection within the water district service area is slightly less. It has been assumed that the effects of future increased living standards and family planning will be offset by the effects of future inward migration, and that the resultant per-connection population will remain at approximately 7.8 persons throughout the study period.

Total Served Area for Individual Communities

The total areas of individual served communities have been projected on the basis of field studies and locations with potential consumers of the URD-WD water supply. These projections are presented in Annex Table IX-C-2.

Area Served By Internal Network System

In order to project the net area to be served by internal network piping, the gross served areas presented in Annex Table IX-C-2 were reduced in proportion to the expected percentage of population served (as shown in Annex Table IX-C-1). Served populations in 1980, 1990 and 2000 are expected to be approximately 65, 77 and 83 percent, respectively, of the total population within the corresponding service areas. It has therefore been assumed that 80 and 87 percent of

ANNEX TABLE IX-C-1

SERVED POPULATION PROJECTIONS
URDANETA WATER DISTRICT

Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Urdaneta Poblacion	2,997	8,730	13,110	17,086
San Vicente East	15	167	1,277	2,712
San Vicente West	148	681	3,410	4,951
Bayaoas	56	783	4,702	6,814
Nancayasan	-	229	4,609	7,436
Nancamaliran East	-	-	2,716	3,913
Nancamaliran West	-	-	2,079	4,805
Dilan-Paurido	-	-	1,146	3,098
Sto. Domingo	-	-	490	1,809
Palina East	-	-	664	2,417
Kabanogbog	-	-	474	1,511
Camanang	-	-	-	1,400
Pinmaludpod	-	-	-	1,460
Camantiles	-	-	-	1,150
Cabuloan	-	-	-	870
Bactad West	-	-	-	440
Total Served Population	3,216	10,590	34,677	61,872
Total Service Area Population	9,192	16,300	45,160	74,920
Percent Served	35	65	77	83

ANNEX TABLE IX-C-2

TOTAL SERVICE AREA (ha)
URDANETA WATER DISTRICT

Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Urdaneta Poblacion	107	117	117	117
San Vicente East	3	8	34	71
San Vicente West	7	47	69	122
Bayaoas	9	25	102	126
Nancayasan	-	43	131	131
Nancamaliran East	-	-	55	85
Nancamaliran West	-	-	37	37
Dilan - Paurido	-	-	107	107
Sto. Domingo	-	-	23	40
Palina East	-	-	14	48
Mabanoghog	-	-	36	66
Camanang	-	-	-	123
Pinmaludpod	-	-	-	32
Camantiles	-	-	-	36
Cabuloan	-	-	-	28
Bactad West	-	-	-	10
Total Service Area	126	240	725	1,179

the total service area will actually receive water service by the years 1990 and 2000, respectively. For the 1980 service area, about 38 percent of the total area or 92 hectares will receive water service by 1980. The remainder of the 1980 service area will be served fully by the year 1985.

The resultant areas to receive internal network system are tabulated in Annex Table IX-C-3, according to service area, and Annex Table IX-C-4, according to construction phase. It has also been assumed that relevant distribution system pipelines passing through the service area will provide service to the areas within 50 meters on each side of the pipelines. The corresponding areas served by the distribution system pipelines are tabulated in Annex Table IX-C-5, according to construction phase. The net area to be served by internal network system is tabulated in Annex Table IX-C-6.

Number of Service Connections

The number of service connections to be installed is obtained by dividing the served population (see Annex Table IX-C-1) by the average number of persons per connection. The estimated number of service connections for each community within the service area is presented in Annex Table IX-C-7 by service area and Annex Table IX-C-8 by construction phase.

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

Areas Receiving Fire Protection

The total area to receive water supply service by 2000 will also receive fire protection service by the same year. A high level of fire protection will be provided for areas where high property values or high population densities are expected. Hence the entire Urdaneta Poblacion and portions of barrios San Vicente East, San Vicente West and Nancayasan will receive high level fire protection. The rest of the barrios served will be provided with normal residential-type fire hydrant service. The schedule for fire hydrant installation is listed in Annex Table IX-C-9.

Distribution System Computer Printouts

The following two computer printouts (Annex Tables IX-C-10 and IX-C-11) indicate the estimated hydraulic conditions within the URD-WD distribution system in the year 2000. The peak-hour and minimum-flow conditions are included as representative of the design conditions at that time. The critical conditions for some pipelines may not have

ANNEX TABLE IX-C-3

TOTAL AREA SERVED BY INTERNAL NETWORK SYSTEM, BY SERVICE AREA (ha)

Community Served	1980 Service Area[1]	1990 Service Area	2000 Service Area
Urdaneta Poblacion (70)	117	117	117
San Vicente East (2)	8	27	60
San Vicente West (12)	47	62	116
Bayaoas (6)	25	87	123
Nancayasan (2)	43	111	127
Nancamaliran East	-	46	82
Nancamaliran West	-	30	35
Dilan-Paurido	-	70	91
Sto. Domingo	-	10	34
Palina East	-	6	41
Mabanogbog	-	14	59
Camanang	-	-	74
Pinmaludpod	-	-	19
Camantiles	-	-	21
Cabuloan	-	-	17
Baotad West	-	-	10
Cumulative Total (92)[2]	240	580	1,026

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[1] Remainder of the 1980 service area not served by 1980 will be served by 1985.

[2] Area served by 1980, including the immediate improvement program pipelines.

ANNEX TABLE IX-C-4

TOTAL AREA SERVED BY INTERNAL NETWORK SYSTEM
BY CONSTRUCTION PHASE (ha)

Community Served	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)	Total
Urdaneta Poblacion (70)	47	-	-	-	117
San Vicente East (2)	15	10	17	16	60
San Vicente West (12)	42	8	27	27	116
Bayaoas (6)	50	31	18	18	123
Nancayasan (2)	75	34	16	-	127
Nancamaliran East	23	23	18	18	82
Nancamaliran West	15	15	3	2	35
Dilan - Paurido	35	35	11	10	91
Sto. Domingo	-	10	12	12	34
Palina East	-	6	18	17	41
Mabanogbog	-	14	23	22	59
Camanang	-	-	37	37	74
Pinmaludpog	-	-	-	19	19
Camantiles	-	-	21	-	21
Cabuloan	-	-	17	-	17
Baotad West	-	-	10	-	10
Total (92)[3/]	302	186	248	198	1,026
Cumulative Total	394	580	828	1,026	1,026

3/ Area served by 1980

ANNEX TABLE IX-C-5

INTERNAL NETWORK ALLOWANCE FOR
DISTRIBUTION PIPES (ha)

Community Served	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)	Total
Urdaneta Poblacion	-	-	-	-	-
San Vicente East	10	-	-	-	10
San Vicente West	5	5	-	-	10
Bayaoas	5	5	-	-	10
Nancayasan	19	-	9	-	28
Nancamaliran East	7	-	-	-	7
Nancamaliran West	7	-	-	-	7
Dilan-Paurido	5	-	5	-	10
Sto. Domingo	-	7	-	-	7
Palina East	-	6	-	-	6
Mabanogbog	-	-	9	-	9
Camanang	-	-	6	-	6
Pinmaludpod	-	-	-	7	7
Camantiles	-	-	10	-	10
Cabuloan	-	-	6	-	6
Bactad West	-	-	10	-	10
Total	58	23	55	7	143

ANNEX TABLE IX-C-6

NET AREA SERVED BY INTERNAL NETWORK SYSTEM (ha)

Community Served	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Urdaneta poblacion	47	-	-	-
San Vicente East	5	10	17	16
San Vicente West	37	3	27	27
Bayaoas	45	26	18	18
Nancayasan	56	34	7	-
Nancamaliran East	16	23	18	18
Nancamaliran West	8	15	3	2
Dilan-Paurido	30	35	6	10
Sto. Domingo	-	3	12	12
Palina East	-	-	18	17
Mabanogbog	-	14	14	22
Camanang	-	-	31	37
Pinmaludpod	-	-	-	12
Camantiles	-	-	11	-
Cabuloan	-	-	11	-
Bactad West	-	-	-	-
Total	244	163	193	191
Equivalent Internal Network by 1980 (ha)	92			
Area Served by Distribution Pipelines (ha)	58	23	55	7
Cumulative Total Equivalent Internal Network (ha)	394	580	828	1,026

ANNEX TABLE IX-C-7

SCHEDULE FOR SERVICE CONNECTION INSTALLATION

Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Urdaneta Poblacion	(386)*	719	582	512
San Vicente East	(2)*	19	143	185
San Vicente West	(19)*	69	351	198
Bayaoas	(7)*	94	504	272
Nancayasan	-	29	564	364
Nancamaliran East	-	-	349	155
Nancamaliran West	-	-	268	350
Dilan - Paurido	-	-	147	252
Sto. Domingo	-	-	63	170
Palina East	-	-	85	226
Mabanogbog	-	-	61	133
Camanang	-	-	-	180
Pinmaludpod	-	-	-	188
Camantiles	-	-	-	148
Cabuloan	-	-	-	112
Bactad West	-	-	-	57
Total by Phase	(414)*	930	3,117	3,502
Cumulative Total	414	1,344	4,461	7,963

*Existing service connections

ANNEX TABLE IX-C-8

SCHEDULE FOR SERVICE CONNECTION INSTALLATION
BY CONSTRUCTION PHASE

Community Served	Immediate Improvements (1978-79)	Phase I-A (1980-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Urdaneta Poblacion	719	291	291	256	256
San Vicente East	19	72	71	92	93
San Vicente West	69	175	176	99	99
Bayaoas	94	252	252	136	136
Nancayasan	29	282	282	182	182
Nancamaliran East	-	175	174	78	77
Nancamaliran West	-	134	134	175	175
Dilan - Paurido	-	73	74	126	126
Sto. Domingo	-	32	31	85	85
Palina East	-	42	43	113	113
Mabanogbog	-	31	30	66	67
Camanang	-	-	-	90	90
Pinmaludpod	-	-	-	-	188
Camantiles	-	-	-	74	74
Cabuloan	-	-	-	56	56
Baotad West	-	-	-	29	28
Total	930	1,559	1,558	1,657	1,845
Cumulative Total (including existing connections)	1,344	2,903	4,461	6,118	7,963
Rate per year	465	260	312	331	369

ANNEX TABLE IX-C-9

SCHEDULE FOR FIRE HYDRANT INSTALLATION
BY CONSTRUCTION PHASE

Community Served	Area Receiving Fire Protection (ha.)				
	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)	Total
Urdaneta Poblacion	(30) 30	(30) 30	29	28	117
San Vicente East	(2) 15	15	15	15	60
San Vicente West	(3) 29	29	29	29	116
Bayaoas	31	31	31	30	123
Nancayasan	(5) 32	32	32	31	127
Nancamaliran East	21	21	20	20	82
Nancamaliran West	9	9	9	8	35
Dilan - Paurido	23	23	23	22	91
Sto. Domingo	-	10	12	12	34
Palina East	-	-	21	20	41
Mabanogbog	-	-	30	29	59
Camanang	-	-	37	37	74
Pinmaludpod	-	-	-	19	19
Camantiles	-	-	21	-	21
Cabuloan	-	-	17	-	17
Bactad West	-	-	10	-	10
Total	(40)190*	(30)200*	336	300	1,026
Cumulative Total	190	390	726	1,026	1,026

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* Total area receiving fire protection includes both the high-value residential, commercial and industrial areas and the single-family residential areas. Figures in parentheses indicate areas to receive higher level of hydrant service.

been the peak or minimum conditions, but the majority of proposed pipelines are carrying capacity flows during peak-hour conditions.

The format of Annex Tables IX-C-10 and IX-C-11 is discussed in Chapter XII of the Methodology Manual. Pipeline numbers from 0 to 42, shown on the computer printouts, are existing pipelines. If an existing pipeline is replaced, the "0 to 42" series pipes are replaced by "300" series pipes. The pipelines with numbers between 43 and 63 are recommended for installation during the immediate improvement program. The "100" series pipelines are to satisfy 1990 design conditions. The "200" series pipelines are to satisfy year 2000 design conditions.

Some of the pipelines in the recommended construction program may appear to be in a construction phase not indicated by appropriate pipe numbers. This may result from other conditions governing the staging of recommended facilities. An example might be a "200" series pipeline included within the Phase I-B (1986-90) construction program. The "200" series indicates a pipeline required for year 2000 service, to be installed after 1990. A well, required before 1990, might be located along the "200" series pipeline, and would require installation of the pipeline before 1990.

ANNEX TABLE IX-C-10

COMPUTER PRINTOUT
YEAR 2000 PEAK-HOUR
URDANETA WATER DISTRICT

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URDANETA WATER DISTRICT 2000 PEAK HOUR CONDITION


INPUT AND OUTPUT IN                    LPS
NO OF NODES                             70
NO OF PIPES                            108
MAX NO OF ITERATIONS                    20
PEAKING FACTOR                     1.75000
ALLOW P-DROP FR/STATIC - PCT 30.0
STATIC HGL FOR P-DROP CALC           50.0
MAX UNBAL - LPS                    0.10000
MAX ALLOW VEL -MPS                   3.000
MIN ALLOW VEL - MPS                  0.400
MAX ALLOW HL -   M/1000 M            10.00
MIN ALLOW HL -   M/1000 M             0.30
MAX ALLOW PRESS - ATM                7.000
MIN ALLOW PRESS - ATM                0.700
NO OF HEADS TO BE READ                   1
NO OF UNKNOWN CONSUMPTIONS               1
SUM OF FIXED DEMANDS                  2.52
BANDWIDTH                               10
ITER  1 UNBAL    15.32 LPS
ITER  2 UNBAL     6.20 LPS
ITER  3 UNBAL     2.35 LPS
ITER  4 UNBAL     0.67 LPS
ITER  5 UNBAL     0.05 LPS

SOLUTION NO. 1 REACHED IN   5 ITERATIONS
       0.0490  LPS UNBALANCE
```

ANNEX TABLE IX-C-10 (CONTINUED)

PIPE NO	NODES FROM	-TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/1000	CK
301	1	2	150	140.	100	0.837E-02	5.36	0.30	LO	0.19	1.34	
302	2	3	150	100.	100	0.598E-02	3.66	0.21	LO	0.07	0.66	
3	5	2	100	125.	100	0.529E-01	0.65	0.08	LO	0.02	0.19	LO
124	5	2	100	125.	100	0.529E-01	0.65	0.08	LO	0.02	0.19	LO
4	5	4	100	155.	100	0.768E-01	1.89	0.24	LO	0.22	1.40	
5	5	7	100	145.	100	0.625E-01	5.01	0.64		1.23	8.52	
119	5	7	100	145.	100	0.625E-01	5.01	0.64		1.23	8.52	
6	7	6	100	90.	100	0.388E-01	1.40	0.18	LO	0.07	0.80	
7	7	8	100	185.	100	0.797E-01	2.06	0.26	LO	0.30	1.65	
8	16	8	100	190.	100	0.819E-01	2.92	0.37	LO	0.60	3.13	
9	8	9	100	120.	100	0.517E-01	3.67	0.47		0.57	4.79	
10	9	10	100	60.	100	0.259E-01	1.67	0.21	LO	0.07	1.12	
11	10	11	100	110.	100	0.474E-01	0.83	0.11	LO	0.03	0.31	
12	13	12	100	130.	100	0.560E-01	1.84	0.23	LO	0.17	1.34	
125	13	12	100	130.	100	0.560E-01	1.84	0.23	LO	0.17	1.34	
13	3	13	100	260.	100	0.112E 00	2.87	0.37	LO	0.79	3.03	
14	14	13	100	120.	100	0.517E-01	2.23	0.28	LO	0.23	1.91	
126	14	13	100	120.	100	0.517E-01	2.23	0.28	LO	0.23	1.91	
15	13	17	100	215.	100	0.926E-01	1.23	0.16	LO	0.14	0.64	
16	18	17	100	120.	100	0.517E-01	0.36	0.05	LO	0.01	0.06	LO
17	5	14	150	255.	100	0.153E-01	7.15	0.40		0.53	2.09	
18	14	15	150	145.	100	0.867E-02	0.79	0.04	LO	0.01	0.04	LO
19	15	18	150	70.	100	0.419E-02	10.95	0.62		0.35	5.03	
129	15	18	150	70.	100	0.419E-02	10.95	0.62		0.35	5.03	
20	18	19	150	90.	100	0.538E-02	10.36	0.59		0.41	4.54	
130	18	19	150	90.	100	0.538E-02	10.36	0.59		0.41	4.54	
21	19	29	150	120.	100	0.718E-02	8.60	0.49		0.39	3.22	
131	19	29	150	120.	100	0.718E-02	8.60	0.49		0.39	3.22	
22	29	30	150	80.	100	0.478E-02	8.17	0.46		0.23	2.93	
132	29	30	150	80.	100	0.478E-02	8.17	0.46		0.23	2.93	
23	19	20	100	160.	100	0.689E-01	1.77	0.23	LO	0.20	1.24	
24	21	22	100	65.	100	0.280E-01	0.40	0.05	LO	0.01	0.08	LO
25	20	21	100	60.	100	0.259E-01	2.54	0.32	LO	0.14	2.41	
26	21	23	100	125.	100	0.539E-01	1.10	0.14	LO	0.06	0.51	
27	20	26	100	105.	100	0.452E-01	0.75	0.10	LO	0.03	0.25	LO
28	25	26	100	75.	100	0.323E-01	0.79	0.10	LO	0.02	0.28	LO
29	26	28	100	135.	100	0.582E-01	0.69	0.09	LO	0.03	0.21	LO
30	24	25	100	190.	100	0.819E-01	4.30	0.55		1.22	6.42	
120	24	25	150	190.	100	0.114E-01	12.49	0.71		1.22	6.42	
121	25	30	150	160.	100	0.957E-02	7.67	0.43		0.42	2.60	
31	25	27	100	80.	100	0.345E-01	0.23	0.03	LO	0.00	0.03	LO
32	30	31	100	55.	100	0.237E-01	2.39	0.31	LO	0.17	3.07	
127	30	31	150	55.	100	0.329E-02	8.39	0.47		0.17	3.07	
33	31	32	100	420.	100	0.181E 00	1.51	0.19	LO	0.39	0.92	
128	31	32	150	420.	100	0.251E-01	4.38	0.25	LO	0.39	0.92	
334	33	37	150	225.	100	0.135E-01	5.33	0.30	LO	0.30	1.32	
35	31	38	100	355.	100	0.153E 00	1.04	0.13	LO	0.16	0.45	
65	30	38	200	320.	110	0.395E-02	10.96	0.35	LO	0.33	1.04	
64	39	38	200	400.	110	0.494E-02	1.25	0.04	LO	0.01	0.02	LO
37	38	37	100	110.	100	0.474E-01	5.60	0.71		1.15	10.47	HI

ANNEX TABLE IX-C-10 (CONTINUED)

PIPE NO	NODES FROM	NODES TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	CK	---HEADLOSS--- MT	MT/1000	CK
38	35	37	100	295.	100	0.137E 00	4.23	0.54		1.84	6.24	
39	35	36	100	95.	100	0.409E-01	0.44	0.06	LO	0.01	0.09	LO
40	35	34	100	80.	100	0.345E-01	0.35	0.04	LO	0.00	0.06	LO
42	40	41	200	75.	110	0.926E-03	25.20	0.80		0.36	4.86	
41	41	15	150	60.	100	0.359E-02	8.71	0.49		0.20	3.29	
123	41	15	200	60.	110	0.741E-03	20.41	0.65		0.20	3.29	
43	42	1	150	120.	100	0.718E-02	6.97	0.39	LO	0.26	2.18	
44	42	43	150	300.	100	0.179E-01	11.08	0.63		1.54	5.14	
45	43	33	150	320.	100	0.191E-01	9.25	0.52		1.18	3.68	
46	12	43	150	150.	100	0.897E-02	2.90	0.16	LO	0.06	0.43	
47	7	44	100	110.	100	0.474E-01	4.67	0.59		0.82	7.47	
48	44	45	100	105.	100	0.452E-01	2.08	0.26	LO	0.18	1.67	
49	46	45	100	175.	100	0.754E-01	0.35	0.04	LO	0.01	0.06	LO
50	44	9	100	180.	100	0.776E-01	0.85	0.11	LO	0.06	0.32	
51	9	46	100	110.	100	0.474E-01	1.55	0.20	LO	0.11	0.98	
52	11	46	100	65.	100	0.280E-01	0.44	0.06	LO	0.01	0.10	LO
53	23	11	100	330.	100	0.142E 00	1.88	0.24	LO	0.46	1.39	
54	15	16	150	160.	100	0.957E-02	7.05	0.40	LO	0.36	2.22	
55	16	20	100	195.	100	0.840E-01	2.90	0.37	LO	0.60	3.09	
56	25	35	150	25.	100	0.150E-02	7.35	0.42		0.06	2.40	
57	37	47	100	400.	100	0.172E 00	2.73	0.35	LO	1.11	2.77	
58	49	39	200	330.	110	0.486E-02	9.70	0.31	LO	0.33	0.99	
59	48	47	100	360.	100	0.155E 00	4.04	0.51		2.06	5.72	
60	52	48	100	250.	100	0.280E 00	2.43	0.31	LO	1.44	2.22	
61	51	49	200	280.	110	0.412E-02	30.64	0.98		2.32	8.33	
62	51	52	100	130.	100	0.560E-01	5.73	0.73		1.42	10.93	HI
63	50	51	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
100	49	48	150	140.	100	0.837E-02	9.43	0.53		0.53	3.81	
101	49	60	150	140.	100	0.837E-02	9.62	0.54		0.55	3.95	
102	60	61	150	460.	100	0.275E-01	6.97	0.39	LO	1.00	2.18	
103	61	62	100	320.	100	0.139E 00	2.53	0.32	LO	0.77	2.40	
104	63	62	100	360.	100	0.155E 00	1.22	0.15	LO	0.22	0.62	
105	32	63	100	280.	100	0.121E 00	3.96	0.50		1.55	5.52	
106	65	51	200	420.	100	0.251E-01	8.34	0.47		1.27	3.03	
107	48	64	100	480.	100	0.207E 00	2.96	0.38	LO	1.55	3.22	
108	67	24	200	600.	110	0.741E-02	24.97	0.79		2.87	4.78	
109	67	69	200	1120.	110	0.138E-01	0.23	0.01	LO	0.00	0.00	LO
110	69	70	200	720.	110	0.889E-02	17.04	0.54		1.70	2.36	
111	70	71	150	600.	100	0.359E-01	9.75	0.55		2.43	4.05	
112	72	5	200	700.	110	0.864E-02	22.21	0.71		2.69	3.85	
113	73	72	250	680.	110	0.283E-02	34.70	0.71		2.02	2.97	
114	75	42	200	500.	110	0.617E-02	20.88	0.66		1.72	3.43	
116	68	67	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
117	74	73	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
118	24	23	100	200.	100	0.862E-01	4.54	0.58		1.42	7.11	
133	76	75	200	500.	110	0.617E-02	25.06	0.80		2.41	4.81	
142	77	76	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
200	66	78	100	1000.	100	0.431E 00	1.77	0.23	LO	1.24	1.24	
201	66	65	200	600.	110	0.741E-02	26.23	0.84		3.14	5.24	
202	66	86	150	520.	100	0.311E-01	15.15	0.86		4.77	9.17	

ANNEX TABLE IX-C-10 (CONTINUED)

PIPE NO	NODES FROM	NODES TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	VEL MPS	CK	HEADLOSS MT	HEADLOSS MT/1000	CK
203	86	64	150	540.	100	0.323E-01	6.08	0.34	LO	0.91	1.69	
204	69	81	150	900.	100	0.538E-01	6.28	0.36	LO	1.62	1.80	
205	82	73	200	940.	110	0.116E-01	17.87	0.57		2.42	2.57	
206	83	82	200	700.	110	0.364E-02	25.62	0.82		3.51	5.01	
207	76	85	150	1000.	100	0.593E-01	4.64	0.26	LO	1.02	1.02	
208	79	66	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
209	80	69	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
210	84	83	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	

ANNEX TABLE IX-C-10 (CONTINUED)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
1	23.0	-1.61	47.62U	24.62	2.38	8.81
2	23.0	-1.70	47.43U	24.43	2.37	9.51
3	23.0	-2.08	47.37U	24.37	2.36	9.75
4	23.0	-1.89	47.17U	24.17	2.34	10.47
5	23.0	-1.85	47.39U	24.39	2.36	9.66
6	23.0	-1.40	46.08U	23.08	2.23	14.50
7	23.0	-1.89	46.16U	23.15	2.24	14.24
8	23.0	-1.31	45.85U	22.85	2.21	15.37
9	23.0	-1.29	45.28U	22.28	2.16	17.49
10	23.0	-0.84	45.21U	22.21	2.15	17.74
11	23.0	-2.27	45.18U	22.18	2.15	17.87
12	23.0	-0.79	46.41U	23.41	2.27	13.31
13	23.0	-2.41	46.58U	23.58	2.28	12.67
14	24.0	-1.89	46.81U	22.81	2.21	12.28
15	24.0	-0.96	46.80U	22.80	2.21	12.30
16	24.0	-1.22	46.45U	22.45	2.17	13.67
17	24.0	-1.59	46.44U	22.44	2.17	13.68
18	24.0	-0.82	46.45U	22.45	2.17	13.65
19	24.0	-1.75	46.04U	22.04	2.13	15.22
20	24.0	-1.38	45.84U	21.84	2.11	15.99
21	24.0	-1.03	45.70U	21.70	2.10	16.54
22	24.0	-0.40	45.69U	21.69	2.10	16.56
23	23.0	-3.76	45.63U	22.63	2.19	16.17
24	24.0	-3.64	47.06U	23.06	2.23	11.32
25	24.0	-0.75	45.84U	21.84	2.11	16.01
26	24.0	-0.86	45.82U	21.82	2.11	16.09
27	24.0	-0.23	45.84U	21.84	2.11	16.02
28	24.0	-0.68	45.79U	21.79	2.11	16.20
29	24.0	-0.86	45.66U	21.66	2.10	16.71
30	24.0	-1.78	45.42U	21.42	2.07	17.61
31	24.0	-4.34	45.25U	21.25	2.06	18.26
32	24.0	-7.26	44.86U	20.86	2.02	19.75
33	24.0	-3.92	45.16U	21.16	2.05	18.60
34	24.0	-0.35	45.77U	21.77	2.11	16.26
35	24.0	-2.33	45.78U	21.78	2.11	16.24
36	24.0	-0.44	45.77U	21.77	2.11	16.27
37	24.0	-7.10	43.94U	19.94	1.93	23.32
38	24.0	-7.65	45.09U	21.09	2.04	18.89
39	24.0	-8.45	45.10U	21.10	2.04	18.86
40	24.0	25.20	47.36U	23.36	2.26	10.14
41	24.0	3.92U	47.00	23.00	2.23	11.54
42	24.0	-2.83	47.88U	23.88	2.31	8.15
43	24.0	-4.72	46.34U	22.34	2.16	14.07
44	24.0	-1.73	45.33U	21.33	2.07	17.94
45	24.0	-2.43	45.16U	21.16	2.05	18.62
46	24.0	-1.64	45.17U	21.17	2.05	18.58
47	24.0	-6.77	42.83U	18.83	1.82	27.58
48	24.0	-4.85	44.89U	20.89	2.02	19.66
49	24.0	-1.89	45.42U	21.42	2.07	17.60
50	24.0	31.50	47.88U	23.88	2.31	8.16

ANNEX TABLE IX-C-10 (CONTINUED)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	-------PRESSURE------- ATM---CK	PCT DROP---CK
51	24.0	-3.46	47.75U	23.75	2.30	8.64
52	24.0	-3.31	46.33U	22.33	2.16	14.10
60	24.0	-2.64	44.87U	20.87	2.02	19.73
61	25.0	-4.44	43.87U	18.87	1.83	24.54
62	26.0	-3.74	43.10U	17.10	1.66	28.76
63	25.0	-2.75	43.32U	18.32	1.77	26.72
64	25.0	-9.05	43.34U	18.34	1.78	26.63
65	25.0	-2.75	49.03U	24.03	2.33	3.88
66	25.0	-3.50	52.17U	27.17	2.63	-8.68
67	25.0	-6.30	49.92U	24.92	2.41	0.30
68	25.0	31.50	50.05U	25.05	2.42	-0.19
69	26.0	-8.40	49.92U	23.92	2.32	0.32
70	24.0	-7.30	48.23U	24.23	2.35	6.82
71	24.0	-9.75	45.79U	21.79	2.11	16.18
72	23.0	-12.49	50.08U	27.08	2.62	-0.31
73	22.0	-14.66	52.10U	30.10	2.91	-7.50
74	22.0	31.50	52.22U	30.22	2.93	-7.94
75	22.0	-4.18	49.60U	27.60	2.67	1.44
76	23.0	-1.80	52.00U	29.00	2.81	-7.42
77	23.0	31.50	52.13U	29.13	2.82	-7.88
78	27.0	-1.77	50.93U	23.93	2.32	-4.06
79	25.0	31.50	52.29U	27.29	2.64	-9.18
80	26.0	31.50	50.05U	24.05	2.33	-0.20
81	25.0	-6.28	48.31U	23.31	2.26	6.78
82	22.0	-7.75	54.52U	32.52	3.15	-16.13
83	22.0	-5.88	58.03U	36.03	3.49	-28.66
84	22.0	31.50	58.15U	36.15	3.50	-29.10
85	24.0	-4.64	50.98U	26.98	2.61	-3.76
86	26.0	-9.06	44.26U	18.26	1.77	23.92

ANNEX TABLE IX-C-11

COMPUTER PRINTOUT
YEAR 2000 MINIMUM FLOW
URDANETA WATER DISTRICT

URDANETA WATER DISTRICT 2000 MINIMUM FLOW CONDITION

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INPUT AND OUTPUT IN              LPS
NO OF NODES                       79
NO OF PIPES                      108
MAX NO OF ITERATIONS              20
PEAKING FACTOR               0.30000
ALLOW P-DROP FR/STATIC - PCT  30.0
STATIC HGL FOR P-DROP CALC    50.0
MAX UNBAL - LPS              0.10000
MAX ALLOW VEL -MPS             3.000
MIN ALLOW VEL - MPS            0.400
MAX ALLOW HL -  M/1000 M       10.00
MIN ALLOW HL -  M/1000 M        0.30
MAX ALLOW PRESS - ATM          7.000
MIN ALLOW PRESS - ATM          0.700
NO OF HEADS TO BE READ             1
NO OF UNKNOWN CONSUMPTIONS         1
SUM OF FIXED DEMANDS          -20.21
BANDWIDTH                         10
ITER  1 UNBAL   12.70 LPS
ITER  2 UNBAL    7.45 LPS
ITER  3 UNBAL    3.53 LPS
ITER  4 UNBAL    1.16 LPS
ITER  5 UNBAL    0.82 LPS
ITER  6 UNBAL    0.33 LPS
ITER  7 UNBAL    0.06 LPS

SOLUTION NO. 1 REACHED IN   7 ITERATIONS
       0.0557 LPS UNBALANCE
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ANNEX TABLE IX-C-11 (CONTINUED)

PIPE NO	NODES FROM	NODES TO	DIA MM	L. MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	CK	--HEADLOSS--- MT	MT/1000	CK
301	2	1	150	140.	100	0.837E-02	4.75	0.27	LO	0.15	1.07	
302	3	2	150	100.	100	0.598E-02	5.04	0.29	LO	0.12	1.20	
3	5	3	100	125.	100	0.539E-01	3.76	0.48		0.62	4.99	
124	5	3	100	125.	100	0.539E-01	3.76	0.48		0.62	4.99	
4	5	4	100	155.	100	0.668E-01	0.32	0.04	LO	0.01	0.05	LO
5	5	7	100	145.	100	0.625E-01	3.23	0.41		0.55	3.79	
119	5	7	100	145.	100	0.625E-01	3.23	0.41		0.55	3.79	
6	7	6	100	90.	100	0.388E-01	0.24	0.03	LO	0.00	0.03	LO
7	7	8	100	185.	100	0.797E-01	2.79	0.36	LO	0.53	2.88	
8	8	16	100	190.	100	0.819E-01	2.35	0.30	LO	0.40	2.09	
9	8	9	100	120.	100	0.517E-01	0.22	0.03	LO	0.00	0.03	LO
10	9	10	100	60.	100	0.259E-01	0.92	0.12	LO	0.02	0.37	
11	10	11	100	110.	100	0.474E-01	0.78	0.10	LO	0.03	0.27	LO
12	12	12	100	130.	100	0.560E-01	0.37	0.05	LO	0.01	0.07	LO
125	13	12	100	130.	100	0.560E-01	0.37	0.05	LO	0.01	0.07	LO
13	2	13	100	260.	100	0.112E 00	2.11	0.27	LO	0.45	1.72	
14	14	13	100	120.	100	0.517E-01	0.43	0.05	LO	0.01	0.09	LO
126	14	13	100	120.	100	0.517E-01	0.43	0.05	LO	0.01	0.09	LO
15	13	17	100	215.	100	0.923E-01	1.82	0.23	LO	0.28	1.31	
16	17	18	100	120.	100	0.517E-01	1.55	0.20	LO	0.12	0.97	
17	5	14	150	295.	100	0.153E-01	9.88	0.56		1.06	4.16	
18	14	15	150	145.	100	0.867E-02	8.70	0.49		0.48	3.29	
19	18	15	150	70.	100	0.419E-02	4.51	0.26	LO	0.07	0.97	
129	18	15	150	70.	100	0.419E-02	4.51	0.26	LO	0.07	0.97	
20	19	18	150	90.	100	0.528E-02	3.80	0.22	LO	0.06	0.71	
130	19	18	150	90.	100	0.530E-02	3.80	0.22	LO	0.06	0.71	
21	29	19	150	120.	100	0.718E-02	4.37	0.25	LO	0.11	0.92	
131	29	19	150	120.	100	0.718E-02	4.37	0.25	LO	0.11	0.92	
22	30	29	150	80.	100	0.478E-02	4.44	0.25	LO	0.08	0.95	
132	30	29	150	80.	100	0.478E-02	4.44	0.25	LO	0.08	0.95	
23	19	20	100	160.	100	0.689E-01	0.83	0.11	LO	0.05	0.31	
24	21	22	100	65.	100	0.200E-01	0.07	0.01	LO	0.00	0.00	LO
25	20	21	100	60.	100	0.299E-01	0.56	0.07	LO	0.01	0.15	LO
26	21	23	100	125.	100	0.539E-01	0.31	0.04	LO	0.01	0.05	LO
27	26	20	100	105.	100	0.452E-01	0.48	0.06	LO	0.01	0.11	LO
28	25	26	100	75.	100	0.323E-01	0.74	0.09	LO	0.02	0.25	LO
29	26	28	100	135.	100	0.582E-01	0.12	0.01	LO	0.00	0.01	LO
30	25	24	100	190.	100	0.819E-01	1.51	0.19	LO	0.18	0.92	
120	25	24	150	190.	100	0.114E-01	4.38	0.25	LO	0.18	0.92	
121	30	25	150	160.	100	0.957E-02	5.23	0.30	LO	0.20	1.23	
31	25	27	100	80.	100	0.345E-01	0.04	0.00	LO	0.00	0.00	LO
32	31	30	100	55.	100	0.237E-01	0.65	0.08	LO	0.01	0.19	LO
127	31	30	150	55.	100	0.329E-02	1.99	0.11	LO	0.01	0.19	LO
33	37	31	100	420.	100	0.181E 00	0.43	0.05	LO	0.04	0.09	LO
128	32	31	150	420.	100	0.231E-01	1.24	0.07	LO	0.04	0.09	LO
334	33	32	150	225.	100	0.135E-01	1.28	0.07	LO	0.02	0.10	LO
35	33	31	100	355.	100	0.153E 00	1.63	0.21	LO	0.38	1.06	
65	20	30	200	320.	110	0.395E-02	11.88	0.38	LO	0.39	1.21	
64	39	38	200	400.	110	0.496E-02	16.16	0.51		0.85	2.13	
37	38	37	100	110.	100	0.474E-01	1.34	0.17	LO	0.08	0.74	

ANNEX TABLE IX-C-11 (CONTINUED)

PIPE NO	NODES FROM	TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	CK	--HEADLOSS--- MT	MT/1000	CK
38	37	35	100	295.	100	0.227E 00	2.11	0.27	LO	0.51	1.72	
39	35	36	100	95.	100	0.409E-01	0.07	0.01	LO	0.00	0.00	LO
40	35	34	100	80.	100	0.345E-01	0.06	0.01	LO	0.00	0.00	LO
42	40	41	200	75.	110	0.926E-03	0.0	0.0	LO	0.0	0.0	LO
41	15	41	150	60.	100	0.359E-02	6.04	0.34	LO	0.10	1.67	
123	15	41	200	60.	110	0.741E-03	14.17	0.45		0.10	1.67	
43	1	42	150	120.	100	0.728E-02	4.47	0.25	LO	0.12	0.96	
44	42	43	150	300.	100	0.179E-01	2.17	0.12	LO	0.08	0.25	LO
45	43	33	150	320.	100	0.191E-01	1.96	0.11	LO	0.07	0.21	LO
46	12	43	150	150.	100	0.857E-02	0.60	0.03	LO	0.00	0.02	LO
47	7	44	100	110.	100	0.474E-01	3.12	0.40	LO	0.39	3.54	
48	44	45	100	105.	100	0.452E-01	1.41	0.18	LO	0.09	0.81	
49	45	46	100	175.	100	0.754E-01	0.99	0.13	LO	0.07	0.42	
50	44	9	100	180.	100	0.776E-01	1.41	0.18	LO	0.15	0.82	
51	9	46	100	110.	100	0.474E-01	0.49	0.06	LO	0.01	0.11	LO
52	46	11	100	65.	100	0.280E-01	1.20	0.15	LO	0.04	0.60	
53	11	23	100	330.	100	0.142E 00	1.58	0.20	LO	0.33	1.01	
54	16	15	150	160.	100	0.957E-02	2.65	0.15	LO	0.06	0.36	
55	20	16	100	195.	100	0.840E-01	0.52	0.07	LO	0.02	0.13	LO
56	35	25	150	25.	100	0.150E-02	1.58	0.09	LO	0.00	0.14	LO
57	47	37	100	400.	100	0.172E 00	1.99	0.25	LO	0.61	1.54	
58	49	39	200	330.	100	0.486E-02	17.61	0.56		0.99	2.99	
59	48	47	100	360.	100	0.155E 00	3.15	0.40		1.30	3.60	
60	52	48	100	250.	100	0.280E 00	2.03	0.26	LO	1.04	1.60	
61	51	49	200	280.	100	0.412E-02	22.87	0.73		1.36	4.85	
62	51	52	100	130.	100	0.560E-01	2.60	0.33	LO	0.33	2.52	
63	50	51	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
100	49	48	150	140.	100	0.837E-02	0.99	0.06	LO	0.01	0.06	LO
101	49	60	150	140.	100	0.837E-02	3.95	0.22	LO	0.11	0.76	
102	60	61	150	460.	100	0.275E-01	3.50	0.20	LO	0.28	0.61	
103	61	62	100	320.	100	0.138E 00	2.73	0.35	LO	0.89	2.78	
104	62	63	100	360.	100	0.155E 00	2.09	0.27	LO	0.61	1.69	
105	63	32	100	280.	100	0.121E 00	1.62	0.21	LO	0.30	1.05	
106	51	65	150	420.	100	0.251E-01	5.44	0.31	LO	0.58	1.38	
107	64	46	100	480.	100	0.207E 00	0.96	0.12	LO	0.19	0.40	
108	24	67	200	600.	110	0.741E-02	6.52	0.21	LO	0.24	0.40	
109	67	69	200	1120.	110	0.138E-01	5.44	0.17	LO	0.32	0.28	LO
110	69	70	200	720.	110	0.889E-02	2.92	0.09	LO	0.06	0.09	LO
111	70	71	150	600.	100	0.359E-01	1.67	0.09	LO	0.09	0.15	LO
112	72	5	200	700.	110	0.864E-02	24.51	0.78		3.23	4.62	
113	73	72	250	680.	110	0.283E-02	26.65	0.54		1.24	1.82	
114	42	75	200	500.	110	0.617E-02	1.82	0.06	LO	0.02	0.04	LO
116	67	68	250	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO
117	74	73	250	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
118	23	24	100	200.	100	0.862E-01	1.25	0.16	LO	0.13	0.65	
133	75	76	200	500.	110	0.617E-02	1.10	0.04	LO	0.01	0.01	LO
142	76	77	250	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO
200	66	78	100	1000.	100	0.431E 00	0.30	0.04	LO	0.05	0.05	LO
201	65	66	200	600.	110	0.741E-02	0.90	0.03	LO	0.01	0.01	LO
202	65	86	150	520.	100	0.311E-01	4.07	0.23	LO	0.42	0.80	

ANNEX TABLE IX-C-11 (CONTINUED)

PIPE NO	NODES FROM-TO		DIA MM	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/1000	CK
203	36	64	150	540.	100	0.323E-01	2.51	0.14	LO	0.18	0.33	
204	69	81	150	900.	100	0.538E-01	1.08	0.06	LO	0.06	0.07	LO
205	73	82	200	940.	110	0.116E-01	2.34	0.07	LO	0.06	0.06	LO
206	82	83	200	700.	110	0.364E-02	1.01	0.03	LO	0.01	0.01	LO
207	76	85	150	1000.	100	0.598E-01	0.79	0.04	LO	0.04	0.04	LO
208	79	66	250	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO
209	69	80	250	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO
210	84	83	250	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO

ANNEX TABLE IX-C-11 (CONTINUED)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	--------PRESSURE-------- ATM---CK	PCT DROP---CK
1	23.0	-0.28	47.24U	24.24	2.35	10.21
2	23.0	-0.29	47.39U	24.39	2.36	9.65
3	23.0	-0.36	47.51U	24.51	2.37	9.21
4	23.0	-0.32	48.13U	25.13	2.43	6.93
5	23.0	-0.32	48.14U	25.14	2.43	6.90
6	23.0	-0.24	47.59U	24.59	2.38	8.94
7	23.0	-0.32	47.59U	24.59	2.38	8.93
8	23.0	-0.22	47.06U	24.06	2.33	10.90
9	23.0	-0.22	47.05U	24.05	2.33	10.92
10	23.0	-0.14	47.03U	24.03	2.33	11.00
11	23.0	-0.39	47.00U	24.00	2.32	11.11
12	23.0	-0.13	47.06U	24.06	2.33	10.90
13	23.0	-0.41	47.07U	24.07	2.33	10.87
14	24.0	-0.32	47.08U	23.08	2.23	11.24
15	24.0	-0.16	46.60U	22.60	2.19	13.08
16	24.0	-0.21	46.66U	22.66	2.19	12.85
17	24.0	-0.27	46.78U	22.78	2.21	12.37
18	24.0	-0.14	46.67U	22.67	2.19	12.81
19	24.0	-0.30	46.73U	22.73	2.20	12.57
20	24.0	-0.24	46.68U	22.68	2.20	12.76
21	24.0	-0.18	46.67U	22.67	2.20	12.79
22	24.0	-0.07	46.67U	22.67	2.20	12.79
23	23.0	-0.64	46.67U	23.67	2.29	12.34
24	24.0	-0.62	46.54U	22.54	2.18	13.31
25	24.0	-0.13	46.71U	22.71	2.20	12.64
26	24.0	-0.15	46.70U	22.70	2.20	12.71
27	24.0	-0.04	46.71U	22.71	2.20	12.64
28	24.0	-0.12	46.69U	22.69	2.20	12.72
29	24.0	-0.15	46.84U	22.84	2.21	12.14
30	24.0	-0.31	46.92U	22.92	2.22	11.85
31	24.0	-0.74	46.93U	22.93	2.22	11.81
32	24.0	-1.24	46.97U	22.97	2.22	11.67
33	24.0	-0.67	46.99U	22.99	2.23	11.59
34	24.0	-0.06	46.72U	22.72	2.20	12.63
35	24.0	-0.40	46.72U	22.72	2.20	12.63
36	24.0	-0.07	46.72U	22.72	2.20	12.63
37	24.0	-1.22	47.22U	23.22	2.25	10.68
38	24.0	-1.31	47.30U	23.30	2.26	10.37
39	24.0	-1.49	48.16U	24.16	2.34	7.08
40	24.0	0.0	46.50U	22.50	2.18	13.46
41	24.0	-20.21U	46.50	22.50	2.18	13.46
42	24.0	-0.49	47.13U	23.13	2.24	11.04
43	24.0	-0.81	47.05U	23.05	2.23	11.33
44	24.0	-0.30	47.20U	23.20	2.25	10.77
45	24.0	-0.42	47.11U	23.11	2.24	11.10
46	24.0	-0.28	47.04U	23.04	2.23	11.38
47	24.0	-1.16	47.84U	23.84	2.31	8.31
48	24.0	-0.83	49.14U	25.14	2.43	3.32
49	24.0	-0.32	49.14U	25.14	2.43	3.29
50	24.0	31.50	50.62U	26.62	2.58	-2.40

ANNEX TABLE IX-C-11 (CONTINUED)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	--------PRESSURE-------- ATM---CK	PCT DROP---CK
51	24.0	-0.59	50.50U	26.50	2.57	-1.93
52	24.0	-0.57	50.17U	26.17	2.53	-0.67
60	24.0	-0.45	49.04U	25.04	2.42	3.70
61	25.0	-0.76	48.76U	23.76	2.30	4.97
62	26.0	-0.64	47.87U	21.87	2.12	8.88
63	25.0	-0.47	47.26U	22.26	2.16	10.96
64	25.0	-1.55	49.33U	24.33	2.36	2.69
65	25.0	-0.47	49.92U	24.92	2.41	0.31
66	25.0	-0.60	49.92U	24.92	2.41	0.33
67	25.0	-1.08	46.30U	21.30	2.06	14.80
68	25.0	0.0	46.30U	21.30	2.06	14.80
69	26.0	-1.44	45.98U	19.98	1.93	16.74
70	24.0	-1.25	45.92U	21.92	2.12	15.71
71	24.0	-1.67	45.82U	21.82	2.11	16.06
72	23.0	-2.14	51.37U	28.37	2.75	-5.07
73	22.0	-2.51	52.61U	30.61	2.96	-9.31
74	22.0	31.50	52.73U	30.73	2.97	-9.75
75	22.0	-0.72	47.11U	25.11	2.43	10.32
76	23.0	-0.31	47.10U	24.10	2.33	10.73
77	23.0	0.0	47.10U	24.10	2.33	10.73
78	27.0	-0.30	49.87U	22.87	2.21	0.57
79	25.0	0.0	49.92U	24.92	2.41	0.33
80	26.0	0.0	45.98U	19.98	1.93	16.74
81	25.0	-1.08	45.92U	20.92	2.03	16.32
82	22.0	-1.33	52.55U	30.55	2.96	-9.11
83	22.0	-1.01	52.54U	30.54	2.96	-9.08
84	22.0	0.0	52.54U	30.54	2.96	-9.08
85	24.0	-0.79	47.06U	23.06	2.23	11.29
86	26.0	-1.55	49.51U	23.51	2.28	2.06

CHAPTER X FINANCIAL FEASIBILITY ANALYSIS

A. GENERAL

The financial 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 cost of the recommended plan have been presented in Chapter IX. Its economic justification follows in Chapter XI. In this chapter, a plan is developed to indicate how and when funds will be used to operate and maintain the system, implement the program, establish reserve funds, and retire indebtedness.

Water rates have been developed on the basis that the system will be financially self-supporting. Capital funds for the recommended plan will be 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.

The financial analysis includes only those revenues and disbursements for the proposed construction program from 1978 to 1990 (Immediate Improvements, Phase I-A and Phase I-B). All revenues and disbursements included for the period from 1991 to 2000 are those attributable to continued service and expenses resulting from the facilities constructed from 1978 to 1990.

B. THE EXISTING SYSTEM

Personnel

As of mid-1976, the URD-WD was operated by a 5-man organization. Lack of funds has prevented the district from expanding its manpower to the desired level. With the recent developments on the system, priority has been given to the improvement in the quality and number of its personnel to meet the requirements of a growing water district.

Water Rates

The present system has a total of 414 connections with no functioning meters. Thus all billings are made on a flat rate basis. As of August 1, 1976, the district effected an increase in rate from ₱6.00 per month to ₱16.80 per month plus ₱4.10 for every additional faucet in excess of two. This uniform rate is charged for residential and commercial users.

Financial Statements

Based on available records of monthly collection and expenditures, URD-WD is operating on a deficit which is expected to increase if allowances are made for depreciation. Average monthly collection and expenditure are roughly estimated to be ₱2,800 and ₱4,400, respectively.

With the recent installation of the Commercial Practices Manual as prescribed by LWUA, a systematic accounting system will be put to practice. This will take into account rigid billing and collection procedures to improve the district's collection efficiency.

Inasmuch as data on past finances are inadequate to form sound basis for future projections, it is necessary that certain assumptions be made for the financial feasibility analysis. These are discussed later in the chapter. Validity of these assumptions will be tested as the project is implemented.

C. DEVELOPMENT COSTS

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

Project Costs

Project costs of facilities recommended for implementation by 1990 are summarized on an annual basis in Annex Table X-C-1. Engineering services for design and construction supervision are broken down. It has been assumed that 70 percent of the engineering services applies to surveys and design and 30 percent to construction supervision. Design costs are shown in the year preceding construction. Contingencies (15/10 percent) are distributed uniformly during the construction period. Foreign exchange component of total project cost includes cost of direct and indirect import items, as well as a portion of the engineering costs.

Escalation of Costs

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

D. OPERATING AND MAINTENANCE COSTS

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

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

E. FINANCING POLICIES COVERING LOCAL WATER DISTRICT DEVELOPMENT

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

Operating Source

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

Non-Operating Sources

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

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

	Immediate Improvements Loan	Phase I-A and I-B Loan
Interest –	9 percent per annum to be computed at $\frac{3}{4}$ percent per month. Interest due on the local component is paid annually. Interest on foreign exchange is capitalized during construction. Total loan outstanding at the end of construction period earns another full year interest before repayment.	9 percent per annum to be computed monthly at $\frac{3}{4}$ percent per month from the year following the date of disbursement.
Duration –	30-year loan, disbursement assumed made at mid-year, thus will earn interest for 6 months.	30-year loan from the date of initial disbursement.
Principal –	amortized equally for 30 years to start one year after construction.	No principal payments due during construction periods (Construction periods of Stage I-Phases A and B are explained in Chapter IX). Principal repayment period is 30 years less the duration of the disbursement period.

2. Charges and Assessments – consist of payments made by new customers and benefiting property owners for the costs of specific portions of the facilities being developed. Typically, such charges are made for the costs of new construction and water meters and for all or a portion of the costs of new distribution system extensions. LWUA 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 or Credits - LWUA has access to loan funds on concessionary terms and is thus able to relend funds at rates that are below market rates. This in itself is a 'credit' available to the local water district borrower. In some countries, the national government makes outright grants to local water districts in recognition of the overall national 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 refunds such advances as permitted by its cash position. At the present time, however, the local water district is expected to undertake its development programs with no equity participation by government or assistance other than the LWUA loans.

Reserve Requirements

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

F. FUNDS FOR CAPITAL DEVELOPMENT

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

Depreciable Assets/Depreciation Expenses

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

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

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

Revolving Fund for Connections

To assist new customers in financing service connection charges, it is necessary to provide working capital for a revolving fund. It is proposed that LWUA's present policy which provides for the costs to be payable at ₱5.00/month over a 10-year period be increased to ₱6.85 by 1978 to cover the increased unit price of meters. Net inflow funds will be required over a period of 10 years to build sufficient income to support the annual costs of connections. At some future point, income exceeds annual expenditures and the revolving fund can be used to refund the earlier advances of working capital.

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

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 those who would be connected to the system in 1978 to account for the escalation of construction costs.
2. Sixty (60) percent of all new customers would utilize the installment method of financing connection charges.

Revenue Unit Forecast

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

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

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

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

G. ANALYSIS OF WATER RATES

Ability-To-Pay Issue

Presidential Decree No. 198 stipulates that water districts must be financially self-sufficient. In the past, most water systems have not been able to generate sufficient revenues to cover even the operation and maintenance expenses, due to various factors including poor pricing schemes, defective collection system and inadequate consumer promotion. The major reason for insufficient revenues, however, is that certain consumers 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 for service must first be ascertained.

Since water districts are not expected to be extended government subsidy, the analysis of the factors affecting ability-to-pay has been significantly simplified. The factors that affect ability-to-pay are the annual income of families covered by the water district and the percentage of their incomes allocable 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 water districts received formal complaints about the increased rates while eight received formal complaints about the poor quality of water supply.
3. Ten water districts had difficulty in the collection of water bills primarily due to dissatisfaction of consumers regarding water service.
4. Assuming that capital and service improvements will be made, the general managers indicated they could increase their rates by as low as 25 percent and as high as 447 percent for the average and below average households.

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

The survey covered 556 families, classified into 4 income groups. Approximately 28 percent came from the low-income class (below ₱220/month); 55 percent from the lower-middle-income group (₱221-750); 12 percent from the middle-income group (₱751-1,500); and 5 percent from the high-income group (above ₱1,500).

The table below presents the highlights and pertinent findings of the survey.

ESTIMATED ABILITY-TO-PAY BY INCOME GROUPING

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

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

The probable maximum ability-to-pay of the pilot area average household is about ₱25.00 per month.[1]

Family Income

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

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

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

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

The report, "The Filipino Family, Community, and Nation" by Emma Porio, Frank Lynch and Mary R. Hollnsteiner published by the Institute of Philippine Culture of Ateneo de Manila University in

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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.

April 1975, cites in Table 49, page 99 the results of a survey in April 1974. The families surveyed were distributed among 15 urban areas, and included 373 families in Metro Manila. Excluding the families in Metro Manila, mean monthly income of the remaining 1,599 families was ₱572, or ₱6,864 per year. Escalating this income at an annual rate of 10 percent, by 1 July 1978, it would be an income of about ₱8,510 per year. These 14 urban areas are among the more urbanized in the country. They included, for instance, only 3 municipalities, the other eleven being classified as cities. The median population of the 14 urban areas in the 1970 census was about 70,000.

Based on these data, the mean family income of the people residing in the water service areas of the communities whose water systems are proposed to be improved might be, by 1 July 1976, somewhere between the ₱6,200 per year (developed from the 1970/71 data of the NCSO) and the ₱8,510 per year (developed from the data of Porio, Lynch and Hollnsteiner). For lack of other data, the average water-using family may have an income of about ₱7,900 during 1976 (or ₱660 per month, which is close to the Lipa household survey). This is equivalent to an annual income of $1,000 for a family of six or seven.

<u>Initial Rate Determination</u>

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

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

Period	Water Rate ₱/RU
1978-1980	₱0.65
1981-1983	1.15
1984-1987	1.40
1988-1990	1.50
1991-1993	1.60
1994-1996	1.80
1997-2000	2.00

The rates from 1990 to 2000 only cover debt service and operation and maintenance costs for facilities constructed by 1990. The water rates from 1990 to 2000 would be higher if the URD-WD continued to construct facilities during this period.

The first step of ₱0.65/RU was selected as an intermediate rate, in anticipation of the second step (₱1.15/RU) which is indicative of the required cost to make the system financially viable. The rate of ₱1.15/RU in 1982 cost levels is equivalent to ₱0.79 in 1978 prices (based on 10 percent discount rate). Likewise ₱1.40/RU in 1985 is equal to ₱0.72 in 1978 prices.

Feasibility of Charges

The question of feasibility is a matter of analyzing whether or not the customers of the water district are able to pay the required charges both now and in the future in order to obtain safe and reliable water services. Inasmuch as the proposed water rates represent the "mean", determination has been made for that group of households whose income (₱700/mo) also represents the "mean". Probable use of water by this group was calculated at 24 cum per month.[2] For present purposes, the study covers consumers with ½-inch connections inasmuch as they comprise the bulk of the domestic/government consumers. Working back, the 1979 rate of ₱0.65 per revenue unit will yield a monthly service charge of ₱16.25. The commodity charge for a 24-cum consumption is ₱9.10 (₱0.65 x 14). For newly connected customers who avail of the 10-year installment plan, monthly expenditure for water will increase by ₱6.83 to account for the service connection charge. Since both water and household incomes increase each year, the impact of the installment charge on the expenditure pattern of the household will decline over the 10-year period of payment. The estimated impact of the increased rates and connection charges on household patterns is shown below for the mid-point of each rate block.

	1979	1982	1985	1989	1992	1995	1998
Escalated income of household earning ₱700/mo in 1976 (8% per year)	882	1,111	1,400	1,904	2,400	3,020	3,806
Expenditure for 24 cum water consumption-service charge (first 10 cum)	16.25	28.76	35.00	37.52	40.02	45.02	50.02
Commodity charge (Rate/RU x 14 cum)	9.10	16.10	19.60	21.00	22.40	25.20	28.00
Income allocation to water for existing consumers (%)	2.9	4.0	3.9	3.1	2.6	2.3	2.0
Connection charge for new customers (₱6.83/mo in 1978)	7.51	9.63	12.13	15.31	18.23	21.71	25.85
Income allocation to water for new customers (%)	3.7	4.9	4.8	3.9	3.4	3.0	2.7

[2] Probable use of water by income groups:

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

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

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

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

Socialized Water Rates

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

In the preceding sections, specific rates established meet the cash requirements for an improved system and at the same time fall within the average consumer's ability-to-pay. Under this scheme, the cost for the first 10 cum consumed is ₱16.25 and the subsequent consumption, ₱0.65/cum. Thus the monthly rates for the following water consumption will be:

Usage (cum/mo)	Cost/month (₱)*
16	20.15
18	21.45
20	22.75
22	24.05
24	25.35
30	29.25
32	30.55
44	38.35

*For ½-inch connection, domestic classification.

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

Income Level	Projected 1978 Monthly Income	Monthly Usage of Water	Cost of Water/mo	Percent of Income Allocated to Meter
Below Average	₱350	16 cum	₱20.15	5.8
Average	770	22 cum	24.05	3.1

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

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

first 16 cum/mo at	₱0.75/cum
from 17-24 cum/mo at	₱1.55/cum
from 25 or more cum/mo at	₱2.35/cum

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

Usage (cum)	Cost/month (₱)
16	12.00
18	15.10
20	18.20
22	21.30
24	24.40
30	38.50
32	43.20
44	71.40

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

Income Level	Projected 1978 Monthly Income	Monthly Usage of Water	Cost of Water/mo	Percent of Income Allocated to Water
Below Average	₱ 350	16 cum	₱12.00	3.4
Average	770	24 cum	24.40	3.2
Upper Middle	1,170	32 cum	43.20	3.7
High	2,700	44 cum	71.40	2.6

The preceding table shows that across the income profile of the community, the monthly costs range from 2.6-3.4 percent of household income.

Revenue Forecasts

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

H. FINANCIAL SUMMARY

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

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

External Borrowing Required

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

Borrowing will start in 1978 and continue through 1990. The immediate improvement loan (1978-1981) will amount to ₱5.221 million. The Phase I-A loan will cover the 8-year period 1978-85 inclusive and will amount to ₱12.616 million. The Phase I-B loan will cover the 5-year period 1986-90 inclusive and will be about ₱8.982 million.

Projections of Financial Statements

Annex Table X-H-2 shows the net income (loss) on a yearly basis. Net loss is forecasted for only four years. Net cumulative income will show positive values in 22 of the 23-year study period.

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

Cash Flow Statements

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

Annex Table X-H-3 presents the annual "Sources and Applications of Funds." Potential net decreases are expected in 1978, 1994 and 2000. By 2000, positive net cumulative cash balance will be ₱8.384 million even if cash at the beginning of 1978 is assumed equal to zero.

Other Financial Statements

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

Rate of Return

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

Net asset value of ₱3.882 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 URD-WD, the rate of return, with the assumptions made, is estimated to be 7.37 percent.

I. FINANCIAL RECOMMENDATIONS

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

Period	Water Rate ₱/RU
1978-1980	₱0.65
1981-1983	1.15
1984-1987	1.40
1988-1990	1.50
1991-1993	1.60
1994-1996	1.80
1997-2000	2.00

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

3. The recommended plan for the first construction phase (Phase I-A) of URD-WD is financially feasible. Borrowing for that period would be ₱12.616 million.

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

ANNEX X-C

DEVELOPMENT COSTS

ANNEX TABLE X-C-1

PROJECT COST OF RECOMMENDED PROGRAM
URDANETA WATER DISTRICT
(WITHOUT ESCALATION)
(₱ x 1000)

Item	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Source Facilities a) Wells	23	69		678			678	23	23	683				2,177
b) Equipment	9	25		247			247	10	9	279				626
Distribution Pipes	33	100	489	977	488	-	21	21	312	312				2,753
Internal Network	24	70	-	341	683	683	683	372	260	456	456	456	228	4,712
Fire Hydrants	3	8	-	41	82	82	82	47	47	80	80	80	41	673
Plumbing Shop	4	10	-	-	405									419
Service Connections a) Pipes	11	32	-	156	312	313	313	174	150	263	263	263	132	2,382
b) Meters	4	10	-	50	100	100	100	58	57	100	100	100	50	829
Immediate Improvements a) Source Facilities 1. Well	735													735
2. Equipment	424													424
b) Distribution Facilities	1,044													1,044
c) Leakage Detection/Repair	144													144
d) Service Connections 1. Pipes	263	237	237											737
2. Meters	127	115	115											357
e. Administration Building 1. Structure	419													419
2. Equipment	103													103
f) Vehicles	139													139
g) Miscellaneous Items	21													21
Feasibility Studies[1]	44		149											193
Sub-total[2]	3,574	676	990	2,490	2,070	1,178	2,124	705	858	2,173	899	899	451	19,087
Land	290	-	95	-	-	-	-	-	10	-	-	-	-	395
TOTAL PROJECT COST[3]	3,864	676	1,085	2,490	2,070	1,178	2,124	705	868	2,173	899	899	451	19,482

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

ANNEX TABLE X-C-2

PROJECT COST OF RECOMMENDED PROGRAM
URDANETA WATER DISTRICT
(WITH ESCALATION)
(P x 1000)

Item	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Escalation Factor	1.000	1.100	1.210	1.307	1.412	1.525	1.647	1.779	1.886	1.999	2.119	2.246	2.381	
Source Facilities a) Wells	23	76		886			1,117	41	43	1,365				3,551
b) Equipment	9	28		323			407	18	17	558				1,360
Distribution Pipes	33	110	592	1,277	689		35	37	589	624				3,935
Internal Network	24	77		446	964	1,042	1,125	662	490	912	966	1,024	543	8,275
Fire Hydrants	3	9		54	116	125	135	84	89	160	170	180	98	1,223
Plumbing Shop	4	11			572									587
Service Connections a) Pipes	11	35		204	441	477	516	310	283	526	557	531	314	4,265
b) Meters	4	11		65	141	153	165	103	108	200	212	225	119	1,506
Immediate Improvements a) Source Facilities 1. Well	735													735
2. Equipment	424													[illegible]
b) Distribution Facilities	1,024													
c) Leakage Detection/Repair	144													
d) Service Connections 1. Pipes	263	261	287											
2. Meters	127	127	139											
e) Administration Building 1. Structure	419													
2. Equipment	103													
f) Vehicles	139													139
g) Miscellaneous Items	21													21
Feasibility Studies	44		180											224
Sub-total	3,574	745	1,198	3,255	2,923	1,797	3,500	1,255	1,618	4,345	1,905	2,020	1,074	29,209
Land	290	–	115	–	–	–	–	–	19	–	–	–	–	424
TOTAL PROJECT COST	3,864	745	1,313	3,255	2,923	1,797	3,500	1,255	1,637	4,345	1,905	2,020	1,074	29,633

ANNEX X-F

FUNDS FOR CAPITAL DEVELOPMENT

[illegible]

[illegible]

[illegible]

(P x 1000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
I. WORK-IN-PROGRESS																							
Source Facilities																							
a) Wells	23	99	99	985	985	985	2100	41	84	1449													
b) Equipment	9	37	37	360	350	360	767	18	35	593													
Plumbing Shop	4	15	15	15	567																		
Total Work-In-Progress	36	151	151	1360	1332	1345	2869	59	119	2042													
II. ASSETS ADDED BY YEAR END																							
Distribution Pipes	33	110	592	1277	629	–	35	37	588	624													
Internal Network	24	77	–	446	964	1022	1125	652	430	912	965	1024	543										
Fire Hydrants	3	9	–	54	116	125	135	84	89	160	170	150	98										
Service Connections																							
a) Pipes	11	35	–	202	441	477	515	310	233	526	557	591	314										
b) Meters	4	11	–	65	141	153	165	103	108	200	212	225	119										
Immediate Improvements																							
a) Source Facilities 1. Well	735																						
2. Equipment	424																						
b) Distribution Facilities	1024																						
c) Leakage Detection/Repair	144																						
d) Service Connections 1. Pipes	263	261	287																				
2. Meters	127	127	139																				
e) Administration Building 1. Equipment	103																						
2. Structure	419																						
f) Vehicles	139																						
g) Miscellaneous Items	21																						
Feasibility Studies	44	–	180																				
Replacements																							
a) Source Facilities – Equipment																	1193						2106
b) Service Connections – Meters																	346	366	358	179	380	402	426
c) Administration Bldg. – Equipment																	298						
d) Vehicles									253								403						
e) Miscellaneous Items																	60						
Total Assets Added By Year End	3535	630	1198	2046	2351	1757	1976	1195	1811	2422	1905	2020	1074				2300	366	358	179	380	402	2532
III. DEPRECIABLE VALUES																							
A. 50 Years Service Life																							
Existing Facilities	1141	1123	1097	1071	1045	1019	993	993	993	993	993	993	993	993	993	993	993	993	993	993	993	993	993
Distribution Pipes	–	1077	1187	1719	3056	3745	3745	3760	3917	4405	5029	5029	5029	5029	5029	5029	5029	5029	5029	5029	5029	5029	5029
Internal Network	–	24	101	101	547	1511	2553	3673	4320	4930	5742	6108	7732	8275	8275	8275	8275	8275	8275	8275	8275	8275	8275
Plumbing Shop	–	–	–	–	–	567	587	551	597	587	597	597	587	587	587	587	587	597	587	587	557	587	587
Fire Hydrants	–	3	12	12	66	182	307	442	526	615	775	945	1125	1223	1223	1223	1223	1223	1223	1223	1223	1223	1223
Service Connection – Pipes	–	274	570	857	1061	1502	1979	2495	2805	3083	3616	4171	4762	5076	5075	5075	5076	5075	5076	5075	5076	5076	5076
Leakage Detection/Repair	–	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Administration Building – Structure	–	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419
Total 50 Years Service Life	1141	3064	3530	4393	6345	9109	10727	12533	13531	15081	17303	18996	20791	21745	21745	21746	21746	21745	21746	21746	21746	21746	21745
B. 30 Years Service Life																							
Feasibility Studies	–	44	44	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224
Total 30 Years Service Life	–	44	44	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224
C. 25 Years Service Life																							
Existing Facilities	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98
Source Facilities – Wells	–	735	735	735	735	735	735	2837	2837	2837	4286	4286	4286	4286	4286	4286	4286	4286	4286	4286	4286	4286	4286
Total 25 Years Service Life	98	833	833	833	833	833	833	2935	2935	2935	4384	4384	4384	4384	4384	4384	4384	4384	4384	4384	4384	4384	4384
D. 15 Years Service Life																							
Source Facilities – Equipment	–	424	424	424	424	424	424	1191	1191	1191	1784	1784	1784	1784	1784	1784	1360	2553	2553	2553	2553	2553	1786
Service Connection – Meters	–	131	269	408	473	614	767	932	1035	1143	1343	1555	1780	1899	1899	1899	1768	1976	2203	2426	2462	2691	2528
Administration Building – Equipment	–	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103	–	298	298	298	298	298	298
Miscellaneous Items	–	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	–	60	60	60	60	60	60
Total 15 Years Service Life		679	817	956	1021	1162	1315	2247	2350	2458	3251	3463	3688	3807	3807	3807	3128	4857	5114	5337	5375	5602	5072
E. 7 Years Service Life																							
Vehicles	–	139	139	139	139	139	139	139	–	253	253	253	253	253	253	253	–	403	403	403	403	403	403
Total 7 Years Service Life	–	139	139	139	139	139	139	139	–	253	253	253	253	253	253	253	–	403	403	403	403	403	403
TOTAL DEPRECIABLE VALUES	1239	4759	5363	6535	8555	11467	13238	18083	19140	20951	25415	27320	29340	30414	30414	30414	29422	31644	31971	32094	32132	32359	31829
BOOK VALUE OF ASSETS OTHER THAN LAND	4813	5540	6712	9941	12838	14609	18083	19338	21070	25415	27320	29340	30414	30414	30414	30414	31782	32010	32259	32273	32512	32761	34361
LAND	290	290	405	405	405	405	405	405	424	424	424	424	424	424	424	424	424	424	424	424	424	424	424
TOTAL BOOK VALUE OF ALL CAPITAL ASSETS	5103	5830	7117	10346	13243	15014	18488	19743	21494	25839	27744	29764	30838	30838	30838	30838	32206	32434	32683	32697	32936	33185	34785

ANNEX TABLE X-F-2

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

Year	Service Life Category: 50 Years	30 Years	25 Years	15 Years	7 Years	Total Annual Depreciation Expenses	Accumulated Depreciation Prior Year	Book Value of Assets Retired During the Year: 50 Years	25 Years	15 Years	7 Years	Total	Net Accumulated Depreciation Year End
1978	23	-	4	-	-	27	408	18				18	417
1979	61	1	33	46	20	161	417	18				18	560
1980	71	1	33	54	20	179	560	26				26	713
1981	88	7	33	64	20	212	713	26				26	899
1982	127	7	33	68	20	255	899	26				26	1,128
1983	182	7	33	77	20	319	1,128	26				26	1,421
1984	215	7	33	88	20	363	1,421	26				26	1,758
1985	251	7	117	150	20	545	1,758						2,303
1986	273	7	117	157	-	554	2,303				139	139	2,718
1987	302	7	117	164	36	626	2,718						3,344
1988	346	7	175	217	36	781	3,344						4,125
1989	380	7	175	231	36	829	4,125						4,954
1990	416	7	175	246	36	880	4,954						5,834
1991	435	7	175	254	36	907	5,834						6,741
1992	435	7	175	254	36	907	6,741						7,648
1993	435	7	175	254	36	907	7,648						8,555
1994	435	7	175	209	-	826	8,555			679	253	932	8,149
1995	435	7	175	326	58	1,001	8,449			138		138	9,312
1996	435	7	175	341	58	1,016	9,312			139		139	10,189
1997	435	7	175	356	58	1,031	10,189			165		165	11,055
1998	435	7	175	358	58	1,033	11,055			141		141	11,947
1999	435	7	175	373	58	1,048	11,947			153		153	12,842
2000	435	7	175	383	58	1,013	12,842			932		932	12,923

ANNEX TABLE X-F-3

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

Year	Number of New Connections	Number of Installment Plan Added	Installment Plan Paid	Total Paying Monthly Installment (Cumulative)	Monthly Installment Plan (Escalated)	₱ x 1000: Increment Added 5/	Increment Deducted 5/	Cash Receipts: Lump Sum Payments 6/ (Escalated)	Installment Payments (Cumulative)	Total Payments	Annual Construction Cost 7/	Working Capital Required	Cumulative Capital Requirements
1978	310	186	0	186	6.83	15	0	78	8	86	196	110	110
1979	310	185	↓	372	7.51	17	↓	86	31	117	216	99	209
1980	310	186	↓	558	8.26	18	↓	95	41	136	237	101	310
1981	312	187	↓	745	8.92	20	↓	102	60	162	256	94	404
1982	312	187	↓	932	9.63	22	↓	111	81	192	278	86	490
1983	312	187	↓	1,119	10.40	23	↓	120	104	224	300	76	566
1984	312	187	↓	1,306	11.23	25	↓	130	128	258	324	66	632
1985	312	187	↓	1,493	12.13	27	↓	140	154	294	350	56	688
1986	312	187	↓	1,680	12.86	29	↓	149	182	331	372	41	729
1987	312	187	0	1,867	13.63	31		158	212	370	394	24	753
1988	311	187	93	1,961	14.45	32	8	167	235	402	417	15	768
1989	311	187	186	1,962	15.31	34	11	177	257	434	442	8	776
1990	311	187	186	1,963	16.23	36	18	188	274	462	469	7	783
1991	0	0	186	1,777	17.20	0	19	0	273	273	0	(273)	510
1992	↓	↓	187	1,590	18.23	↓	21	↓	252	252	↓	(252)	258
1993	↓	↓	187	1,403	19.32	↓	23	↓	229	229	↓	(229)	29
1994	↓	↓	187	1,216	20.48	↓	24	↓	205	205	↓	(205)	(176)
1995	↓	↓	187	1,029	21.71	↓	26	↓	179	179	↓	(179)	(355)
1996	↓	↓	187	842	23.01	↓	28	↓	151	151	↓	(151)	(506)
1997	↓	↓	187	655	24.39	↓	30	↓	121	121	↓	(121)	(627)
1998	↓	↓	187	468	25.85	↓	32	↓	89	89	↓	(89)	(716)
1999	↓	↓	187	281	27.40	↓	33	↓	56	56	↓	(56)	(772)
2000	0	0	187	94	29.04	0	35	0	21	21	0	(21)	(793)

4/Accumulated installment payments are calculated on the basis of 100 percent incremental additions during the previous years and 50 percent of the last year.
5/Based on the assumption that installment plan will be paid back in 10 years.
6/Assumed to be 40 percent of construction cost.
7/Amount to be shouldered by the customers which is: 2/3 of pipes + meters.

ANNEX TABLE X-F-4a

STRATIFICATION OF SERVICE CONNECTIONS
URDANETA WATER DISTRICT

Year	Domestic/Government 1/2"	3/4"	1"	1½"	1¼"	2"	Sub-total	Commercial/Industrial 1/2"	3/4"	1"	Sub-total	Total
1978	407	74	42	2	2	2	529	158	17	20	195	724
1980	755	137	77	4	4	4	981	294	33	36	363	1,344
1985	1,632	297	170	7	7	7	2,120	635	71	78	784	2,904
1990	2,508	456	260	11	11	11	3,257	975	106	121	1,204	4,461

ANNEX TABLE X-F-4b

REVENUE UNIT FORECAST [a]

Year	Domestic/Government 1/2" (2.5)	3/4" (4.0)	1" (8.0)	1½" (14.0)	1¼" (20.0)	2" (50.0)	Sub-total	Commercial/Industrial 1/2" (5.0)	3/4" (8.0)	1" (16.0)	Sub-total	Grand Total
1978	1,018	295	336	28	40	100	1,818	790	136	320	1,246	3,064
1980	1,887	548	616	56	80	200	3,387	1,470	264	576	2,310	5,697
1985	4,080	1,188	1,360	98	140	350	7,216	3,175	568	1,248	4,991	12,207
1990	6,270	1,824	2,080	154	220	550	11,098	4,875	864	1,936	7,675	18,773

Year	Estimated Consumption (cum) Domestic	Commercial	Service Charge	Commodity Charge (RUs) Domestic	Commercial	Total RUs
1978	282,875	28,835	367,680	219,395	10,870	597,945
1980	405,880	54,020	683,640	288,160	20,920	992,720
1985	790,225	112,055	1,464,840	535,825	35,950	2,036,615
1990	1,519,130	240,170	2,252,760	1,128,250	191,380	3,572,430

[a] Computation of revenue units based on LWUA guidelines on structuring water rates.

ANNEX X-G

ANALYSIS OF WATER RATES

ANNEX TABLE X-G-1

REVENUE FORECASTS
URDANETA WATER DISTRICT

Year	Rate/RU (₱)	Estimated Number of RUs (Yearly in 000's)	₱ x 1000: Income from Sales	Bad Debt	Other Income [a]	Total Net Income
1978	0.65	598	389	8	8	389
1979	0.65	796	517	5	10	522
1980	0.65	993	645	6	13	652
1981	1.15	1,202	1,382	28	28	1,382
1982	1.15	1,411	1,623	16	32	1,639
1983	1.15	1,619	1,862	17	37	1,882
1984	1.40	1,828	2,559	51	51	2,559
1985	1.40	2,037	2,852	29	57	2,880
1986	1.40	2,344	3,282	33	66	3,315
1987	1.40	2,651	3,711	37	74	3,748
1988	1.50	2,958	4,437	89	89	4,437
1989	1.50	3,265	4,898	49	98	4,947
1990	1.50	3,572	5,358	54	107	5,411
1991	1.60	3,572	5,715	114	114	5,715
1992	1.60	3,572	5,715	57	114	5,772
1993	1.60	3,572	5,715	57	114	5,772
1994	1.80	3,572	6,430	129	129	6,430
1995	1.80	3,572	6,430	64	129	6,495
1996	1.80	3,572	6,430	64	129	6,495
1997	2.00	3,572	7,144	143	143	7,144
1998	2.00	3,572	7,144	71	143	7,216
1999	2.00	3,572	7,144	71	143	7,216
2000	2.00	3,572	7,144	71	143	7,216

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[a] Other income (derived from meter replacement charges, contingency fees of new connections, service fees, etc), is about 2% of sales.

ANNEX X-H

FINANCIAL SUMMARY

ANNEX TABLE X-H-1

DEBT SERVICE SCHEDULE OF TOTAL PROJECT LOAN
URDANETA WATER DISTRICT
(P x 1000)

Year	Outstanding Loan End of Year			Capital Repayments			Interest Payments			Total Debt Service
	Immediate Improvement	Phase 1-A and 1-B	Total	Immediate Improvement	Phase 1-A and 1-B	Total	Immediate Improvement	Phase 1-A and 1-B	Total	
1978	3,626	25	3,651	-	-	-	96	-	96	96
1979	4,367	265	4,632	-	-	-	199	2	201	201
1980	4,992	1,016	6,008	-	-	-	213	24	237	237
1981	5,221	4,109	9,330	-	-	-	220	91	311	311
1982	5,183	6,840	12,023	38	-	38	470	370	840	878
1983	5,141	8,413	13,554	42	-	42	466	616	1,082	1,124
1984	5,096	11,655	16,751	45	-	45	463	757	1,220	1,265
1985	5,047	12,616	17,663	49	-	49	459	1,049	1,508	1,557
1986	4,993	13,827	18,820	54	95	149	454	1,135	1,589	1,738
1987	4,934	17,707	22,641	59	95	154	449	1,244	1,653	1,807
1988	4,870	19,115	23,985	64	95	159	444	1,593	2,037	2,196
1989	4,800	20,559	25,359	70	142	212	438	1,720	2,158	2,370
1990	4,724	21,029	25,753	76	142	218	432	1,850	2,282	2,500
1991	4,641	20,820	25,461	83	209	292	425	1,892	2,317	2,609
1992	4,551	20,516	25,067	90	304	394	418	1,873	2,291	2,685
1993	4,453	20,212	24,665	98	304	402	410	1,846	2,256	2,658
1994	4,346	19,780	24,126	107	432	539	401	1,819	2,220	2,759
1995	4,229	19,348	23,577	117	432	549	391	1,780	2,171	2,720
1996	4,102	18,822	22,924	127	526	653	381	1,741	2,122	2,775
1997	3,963	18,228	22,191	139	594	733	369	1,694	2,063	2,796
1998	3,812	17,634	21,446	151	594	745	357	1,640	1,997	2,742
1999	3,647	16,973	20,620	165	661	826	343	1,587	1,930	2,756
2000	3,467	16,265	19,732	180	708	888	328	1,527	1,855	2,743

ANNEX TABLE X-B-2

PROJECTED INCOME STATEMENT
URDANETA WATER DISTRICT
(P x 1000)

		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Water Production per Year	(1,000 x cum)	547		767					1371					2443										2443
Water Sales per Year	(1,000 x cum)	312		460					902					1759										1759
Unaccounted-for-Water	(%)	43		40					34					28										28
Connections – Metered		724		1344					2904					4461										4461
Consumption	(lpcd)	136		119					129					139										139
OPERATING REVENUE																								
Water Sales		389	517	645	1382	1623	1862	2559	2852	3282	3711	4437	4698	5358	5715	5715	5715	6430	6430	6430	7144	7144	7144	7144
Less: Uncollectibles		8	5	6	28	16	17	51	29	33	37	89	49	54	114	57	57	129	64	64	143	71	71	17
Other Revenue		8	10	13	28	32	37	51	57	66	74	89	96	107	114	114	114	129	129	129	143	143	143	143
Total Revenue		389	522	652	1382	1639	1882	2559	2880	3315	3748	4437	4547	5411	5715	5772	5772	6430	6495	6495	7144	7216	7216	7216
OPERATING EXPENSES																								
Administration and Personnel		87	134	187	289	343	416	464	499	701	758	818	883	1020	1101	1190	1283	1433	1695	1832	1979	2134	2337	2528
Power and Fuel		28	44	64	80	98	119	142	168	198	231	268	309	356	421	477	548	629	718	818	929	1052	1188	1343
Chemicals		3	9	12	16	19	23	28	33	38	45	52	60	69	80	93	106	122	139	159	180	195	231	261
Maintenance		2	2	3	3	4	4	5	6	7	9	10	12	14	17	20	24	28	34	40	48	52	67	81
Miscellaneous		20	38	60	74	90	109	130	153	188	215	245	277	315	385	441	502	572	648	756	847	914	1056	1180
Depreciation		27	161	179	212	255	319	363	545	554	626	781	829	880	907	907	907	826	1001	1016	1031	1033	1028	1013
Total Operating Expenses		167	387	505	674	809	990	1132	1404	1686	1834	2174	2370	2654	2911	3128	3370	3610	4235	4621	5014	5380	5927	6406
Operating Income		222	135	147	708	830	892	1427	1476	1629	1864	2263	2577	2757	2804	2644	2402	2820	2260	1874	2130	1836	1289	810
Plus: Interest on Reserves		1	3	5	9	15	22	31	42	55	70	87	107	129	164	212	260	311	365	437	532	632	732	832
Net Income Before Interest		223	138	152	717	845	914	1458	1518	1684	1934	2350	2684	2886	2968	2856	2662	3131	2625	2311	2662	2465	2021	1642
Interest on Debt		96	201	237	311	840	1082	1220	1508	1589	1693	2037	2158	2282	2317	2291	2256	2220	2171	2122	2063	1997	1930	1855
Net Income (Loss)		127	(63)	(85)	406	5	(168)	238	10	95	241	313	526	604	651	565	406	911	454	189	599	471	91	(213)
Cumulative Net Income (Loss)		127	64	(21)	385	390	222	460	470	565	806	1119	1645	2249	2900	3465	3871	4782	5236	5425	6024	6455	6566	6373
Appropriation to Reserves		12	16	19	41	49	56	77	86	98	111	133	147	161	343	343	343	386	386	643	714	714	714	714
Average Net Fixed Assets in Operation		2786	5034	6011	7710	9789	11870	13709	16275	18673	20209	22790	24869	25561	25205	24298	23391	23674	24094	23462	22722	21970	21320	21756
Rate of Return		8.0	2.7	2.4	9.2	8.5	7.7	10.4	9.7	8.7	9.2	9.9	10.4	10.8	11.1	10.9	10.3	11.9	9.4	8.0	9.4	8.4	6.0	3.7

ANNEX TABLE X-H-3

PROJECTED SOURCES AND APPLICATIONS OF FUNDS
URDANETA WATER DISTRICT
(₱ x 1000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	19990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SOURCES OF FUNDS																							
Net Income Before Interest	223	138	152	717	845	914	1458	1518	1684	1934	2350	2684	2886	2968	2856	2662	3131	2625	2311	2662	2468	2021	1642
Add: Depreciation	27	161	179	212	255	319	363	545	554	626	781	829	880	907	907	907	826	1001	1016	1031	1033	1048	1013
Total Internal Cash Generation	250	299	331	929	1100	1233	1821	2063	2238	2560	3131	3513	3766	3875	3763	3569	3957	3626	3327	3693	3501	3069	2655
Long-Term Borrowing	3851	781	1376	3322	2731	1573	3242	961	1306	3975	1503	1586	612										
Capital Contributions	86	117	136	162	192	224	258	294	331	370	402	434	462	273	252	229	205	179	151	121	89	56	21
Total External Cash Generation	3937	898	1512	3484	2923	1797	3500	1255	1637	4345	1905	2020	1074	273	252	229	205	179	151	121	89	56	21
Total Sources of Funds	4187	1197	1843	4413	4023	3030	5321	3318	3875	6905	5036	5533	4840	4148	4015	3798	4162	3805	3478	3814	3590	3125	2676
APPLICATIONS OF FUNDS																							
Capital Expenditures	3864	745	1313	3255	2923	1797	3500	1255	1637	4345	1905	2020	1074										
Capitalized Interest	73	153	199	229																			
Debt Service: Interest	96	201	237	311	840	1082	1220	1508	1589	1693	2037	2158	2282	2317	2291	2256	2220	2171	2122	2063	1997	1930	1855
Principal	–	–	–	–	38	42	45	49	149	154	159	212	218	292	394	402	539	549	653	733	745	826	888
Sub-total	96	201	237	311	878	1124	1265	1557	1738	1847	2196	2370	2500	2609	2685	2658	2759	2720	2775	2796	2742	2756	2743
Replacements									253								2300	366	388	179	380	402	2532
Increase in Working Capital	190	32	29	106	153	57	175	(45)	54	215	163	119	(49)	(105)	(18)	(37)	229	(47)	(48)	33	29	(47)	(90)
Total Applications of Funds	4223	1131	1778	3901	3954	2978	4940	2767	3682	6407	4264	4509	3525	2504	2667	2621	5288	3039	3115	3008	3151	3111	5185
INCREASE (DECREASE) IN CASH BALANCE	(36)	66	65	512	69	52	381	551	193	498	772	1024	1315	1644	1348	1177	(1126)	766	363	806	439	14	(2509)
CASH BALANCE BEGINNING OF YEAR	0	(36)	30	95	607	676	728	1109	1660	1853	2351	3123	4147	5462	7106	8454	9631	8505	9271	9634	10440	10879	10893
CASH BALANCE END OF YEAR	(36)	30	95	607	676	728	1109	1660	1853	2351	3123	4147	5462	7106	8454	9631	8505	9271	9634	10440	10879	10893	8384
DEBT SERVICE RATIO	2.6	1.5	1.4	3.0	1.3	1.1	1.4	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.4	1.3	1.4	1.3	1.2	1.3	1.3	1.1	0.97
RATIO OF INTERNALLY GENERATED CASH LESS DEBT SERVICE TO CAPITAL EXPENDITURE (%)	3.9	10.9	6.2	17.7	7.6	6.1	15.9	40.3	30.5	16.4	49.1	56.6	117.9										

ANNEX TABLE X-H-4

PROJECTED BALANCE SHEET
URDANETA WATER DISTRICT
(P x 1000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
ASSETS											
Fixed Assets:											
Gross Value of Fixed Assets	5140	5905	7391	9640	11965	14323	16273	20338	22029	24451	28398
Less: Accumulated Depreciation	417	560	713	899	1128	1421	1758	2303	2718	3344	4125
Net Value of Fixed Assets	4723	5345	6678	8741	10837	12902	14515	18035	19311	21107	24273
Work in Process	36	151	151	1360	1932	1345	2869	59	119	2042	–
Total Fixed Assets	4759	5496	6829	10101	12769	14247	17384	18094	19430	23149	24273
Current Assets:											
Cash	(36)	30	95	607	676	728	1109	1660	1853	2351	3123
Accounts Receivable	97	129	161	346	406	466	640	713	821	926	1109
Provision for Bad Debts	2	1	2	7	4	5	6	7	8	9	22
Inventory	118	132	146	95	200	218	236	134	127	257	274
Total Current Assets	177	290	400	1041	1278	1407	1979	2500	2793	3527	4424
Total Assets	4936	5786	7229	11142	14047	15654	19363	20594	22223	26676	28757
EQUITY AND LIABILITIES											
Current Liabilities:											
Accounts Payable	23	38	54	77	92	112	128	143	189	210	232
Current Maturities on Long-Term Debt	–	–	–	38	42	45	49	149	154	159	212
Total Current Liabilities	23	38	54	115	134	157	177	292	343	369	444
Long-Term Debt (Less Current Maturities)	3851	4632	6008	9292	11981	13509	16702	17514	18666	22482	23772
Equity:											
Government Contribution	849	849	849	849	849	849	849	849	849	849	849
Capital Contribution	86	203	339	501	693	917	1175	1469	1800	2170	2572
Reserves	12	28	47	88	137	193	270	356	454	565	698
Unappropriated Retained Earnings	115	36	(68)	297	253	29	190	114	111	241	421
Total Equity	1062	1116	1167	1735	1932	1983	2484	2788	3214	3825	4540
Total Equity and Liabilities	4936	5786	7229	11142	14047	15654	19363	20594	22223	26676	28757

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ASSETS												
Fixed Assets:												
Gross Value of Fixed Assets	30418	31492	31492	31492	31492	32860	33088	33337	33351	33590	33839	35439
Less: Accumulated Depreciation	4554	5834	6741	7648	8555	8449	9312	10189	11055	11947	12842	12923
Net Value of Fixed Assets	25464	25658	24751	23844	22937	24411	23776	23148	22296	21643	20997	22516
Work in Process	–	–	–	–	–	–	–	–	–	–	–	–
Total Fixed Assets	25464	25658	24751	23844	22937	24411	23776	23148	22296	21543	20997	22516
Current Assets:												
Cash	4147	5462	7105	8454	9631	8505	9271	9634	10440	10879	10893	8384
Accounts Receivable	1125	1340	1429	1429	1429	1608	1608	1608	1786	1786	1786	1786
Provision for Bad Debts	12	13	28	14	14	32	16	16	36	18	18	18
Inventory	292	168	27	31	35	156	168	182	120	192	233	229
Total Current Assets	5652	6957	8534	9900	11081	10237	11031	11408	12310	12839	12894	10381
Total Assets	31116	32615	33285	33744	34018	34648	34807	34556	34606	34482	33891	32897
EQUITY AND LIABILITIES												
Current Liabilities:												
Accounts Payable	257	296	334	370	411	464	539	601	664	725	813	899
Current Maturities on Long-Term Debt	218	292	394	402	539	549	653	733	745	826	888	971
Total Current Liabilities	475	588	728	772	950	1013	1192	1334	1409	1551	1701	1870
Long-Term Debt (Less Current Maturities)	25141	25461	25067	24665	24126	23577	22924	22191	21446	20620	19732	18761
Equity:												
Government Contribution	849	849	849	849	849	849	849	849	849	849	849	849
Capital Contribution	3006	3468	3741	3993	4222	4427	4606	4757	4873	4967	5023	5044
Reserves	845	1006	1349	1652	2035	2421	2807	3450	4164	4878	5592	6306
Unappropriated Retained Earnings	800	1243	1551	1773	1836	2361	2429	1975	1960	1617	994	67
Total Equity	5500	6566	7490	8307	8942	10058	10691	11031	11751	12311	12458	12266
Total Equity and Liabilities	31116	32615	33285	33744	34018	34648	34807	34556	34606	34482	33891	32897

ANNEX TABLE X-H-5

RATE OF RETURN ON TOTAL INVESTMENT
(DISCOUNTED CASH FLOW METHOD)
URDANETA WATER DISTRICT
₱ x 1000

Year	Debt Service	Net Increase in Cash	Total Cash Inflow	Investments	Net Cash Inflow	1st Trial Present Factor	1st Trial Value: 10% Value	2nd Trial Present Factor	2nd Trial Value: 5% Value
1978	96	(36)	60	3,937	(3,877)	1.000	(3,877)	1.000	(3,877)
1979	201	66	267	898	(631)	.909	(574)	.952	(601)
1980	237	65	302	1,512	(1,210)	.826	(999)	.907	(1,097)
1981	311	512	823	3,484	(2,661)	.751	(1,998)	.864	(2,299)
1982	878	69	947	2,923	(1,976)	.683	(1,350)	.823	(1,626)
1983	1,124	52	1,176	1,797	(621)	.621	(386)	.784	(487)
1984	1,265	381	1,646	3,500	(1,854)	.564	(1,046)	.716	(1,383)
1985	1,557	551	2,108	1,255	853	.513	438	.711	606
1986	1,738	193	1,931	1,890	41	.467	19	.677	28
1987	1,847	498	2,345	4,345	(2,000)	.424	(848)	.645	(1,290)
1988	2,196	772	2,968	1,905	1,063	.386	410	.614	653
1989	2,370	1,024	3,394	2,020	1,374	.350	481	.585	804
1990	2,500	1,315	3,815	1,074	2,741	.319	874	.557	1,527
1991	2,609	1,644	4,253	-	4,253	.290	1,233	.530	2,254
1992	2,685	1,348	4,033	-	4,033	.263	1,061	.505	2,037
1993	2,658	1,177	3,835	-	3,835	.239	917	.481	1,845
1994	2,759	(1,126)	1,633	2,300	(667)	.218	(145)	.458	(305)
1995	2,720	766	3,486	366	3,120	.198	618	.436	1,360
1996	2,775	363	3,138	388	2,750	.180	495	.416	1,144
1997	2,796	806	3,602	179	3,423	.164	561	.396	1,356
1998	2,742	439	3,181	380	2,801	.149	417	.377	1,056
1999	2,756	14	2,770	402	2,368	.135	320	.359	850
2000	2,743	(2,509)	234	2,532	1,584*	.123	195	.342	542
							-3,424		+3,097

RATE OF RETURN = 7.37%

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* Includes net asset value of ₱3,882
Total Assets - ₱32,897
Total Liabilities - (20,631)
Cash - (8,384)
Net Asset Value - ₱ 3,882

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 other 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

<u>Domestic</u>. 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. It will be noted that willingness to pay is higher than the price charged insofar as most users are concerned.

<u>Industrial Use</u>. 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 analyse 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, beauty and quality.

In the Philippines, the National Water Resources Council establishes the water priorities, in pursuance of the policies laid down by its charter, Presidential Decree No. 424. In general, the system of priorities for the development, conservation and utilization of the country's water resources reflects the current usage of water and is responsive to the changing demand for water. Another presidential decree (Presidential Decree No. 198) has declared that the creation, operation. maintenance and expansion of water supply and wastewater disposal systems are a national policy of high priority.

B. METHODOLOGY

Recommended and Next-Best System

One approach in determining the economic feasibility of a water supply project involves a comparison of the benefits and costs of the recommended system and those of the next best system. In this method, the capital expenditure costs and the operating and maintenance costs for both alternative systems are transformed to an equivalent annual cost basis during the projection period. The comparison will show which of the alternative systems will generate the same level of benefits at lower costs.

Benefit-Cost Ratio

A second approach in determining the economic feasibility of water supply project involves the following steps:

1. The identification of the economic benefits and costs that can be attributed to the establishment, operation and maintenance of an improved water supply system;

2. The determination of the possible bases for quantifying these benefits and costs; and

3. The comparison of the present value of the benefits likely to be generated and the present value of the costs.

The results of the economic analysis are then expressed as a single ratio called the benefit-cost ratio. The project is considered feasible if the ratio is equal to or greater than 1:1.

Internal Rate of Return

Another method involves the calculation of the economic internal rate of return of the proposed project. The total amount of the benefits as well as of the costs is determined throughout the projection period. By trial and error, the interest rate at which the present worth of the benefits is equal to the present worth of the costs is then calculated. The project is considered feasible if its internal economic rate of return is higher than the minimum rate generally acceptable in such projects, which is usually the opportunity cost of capital.

Method(s) Adopted

Both the second and third methods were employed in determining this project's economic feasibility. These two were considered more appropriate than the first method because in this case, the recommended plan has already been selected from several alternatives on the basis of present worth cost comparisons (as discussed in Chapters VIII and IX).

Calculation of Benefit and Cost Streams

The economic studies cover only Stage I of the proposed water supply program, which extends from 1978 to 1990. Benefits, however, were projected up to 2000. This is because the benefits from the facilities to be constructed up to 1990 would continue to accrue beyond their construction period.

The construction costs included in the analysis are those which will be incurred up to 1990, except replacement costs and the operation and maintenance costs which were projected up to 2000. This is due to the fact that proper maintenance of the facilities will have to be undertaken regularly for as long as benefits are to be realized from the system.

Estimates of benefits and costs were based on 1978 prices. In recognition of inflationary pressures, all benefits were escalated by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985 and by 6 percent from 1985 to 1990. All project costs were also escalated in the same manner, with the exception of operation and maintenance costs which were escalated uniformly by 8 percent all throughout the study period. In both cases, however, the escalation factor for 1990 was held constant up to 2000. This is because only Stage I of the proposed project is being considered in the economic analysis; hence, only partial inflation was adopted.

C. QUANTIFIABLE BENEFITS

The economic benefits that will be derived from the proposed water supply improvement program for the water district may be classified into quantifiable and non-quantifiable. Quantifiable benefits are those which can be expressed in monetary terms. On the other hand, non-quantifiable benefits are intangible but real, and are extremely difficult to express in monetary terms.

Benefits resulting from the proposed project were evaluated on an incremental basis, i.e., on a "with" or "without" principle. Hence, the benefit figures reflect only those that will accrue to the service area as a result of the improvement of the water supply system. They exclude the benefits arising from the present system.

The quantifiable benefits that are discussed in the following sections are: increase in land values, improved health conditions, reduction in fire damage and beneficial value of water.

Increase in Land Values

The implementation of the water supply project will result in an increase in the land values of the service area. However, it must be pointed out that the increase in land values cannot be attributed solely to the water supply project. Any difference between the acquisition cost and the present market value of a piece of land evolves from a series of market and public forces which exist whether or not the water supply project is undertaken. Such forces include the general pace of industrialization, construction activity, inflation, land speculation, taxation and public land acquisition and selling. More particularly, such difference could be the result of a general re-estimation of productivity due to infrastructure investments which include a water supply project.

The portion of land values attributable to the provision of an improved public water supply system was estimated in the household survey in Lipa City (May 1975) to be about 22.6 percent of the market value of a piece of land. It is reasonable to assume that this figure represents the incremental value of a piece of land given access to water supply. In a specific instance, a residential lot of 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 pump, electric controls, etc.) to serve the premises.

On the basis of this information, it may be conservative to assume that 20 percent of the value of land served by the water distribution system could be attributed to the water supply project.

Assumptions made for this analysis are explained in Annex XI-C. Annex Table XI-C-1 shows the computations of this benefit, which has a present value of ₱13.2 million.

Health Benefits

The establishment of a water supply system in a community will necessarily bring about health benefits to the population. Undoubtedly, the provision of safe, potable water to the population is a prerequisite for the maintenance of minimum health standards. These health benefits are ordinarily manifested in the following:

1. A significant reduction in the incidence of water-borne diseases such as cholera, dysentery, gastro-enteritis, and typhoid/paratyphoid. As a result, there will be a decrease in the amount of time lost by income earners who are afflicted with such diseases.

2. A subsequent reduction in premature deaths due to the lower incidence of water-borne diseases.

3. A corresponding reduction in medical expenses for the same reason.

Calculations of the health benefits and associated assumptions used are presented in Annex XI-C. Annex Table XI-C-2 shows the health benefits on a yearly basis, with a total present value of ₱198,951.

Reduction in Fire Damage

With the installation of suitable fire hydrants, especially in the high-value as well as the residential districts in the service area, as part of the proposed project, savings due to reduced fire damages will result from the availability of an adequate amount of water and increased water pressure for fire-fighting purposes. Calculations relative to this benefit are explained in Annex XI-C and shown in detail in Annex Table XI-C-3. The present value of this benefit amounts to ₱3.8 million.

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

Beneficial Value of Water

This benefit (sometimes called "consumer satisfaction") is quantified by the additional revenue generated by the water district as a result of an improved water supply project. In the case of a community which previously did not have any piped water system, the "consumer satisfaction" benefit may be measured by the full amount of the economic value of the accounted-for-water.

For a community where the proposed project involves merely the expansion and improvement of the existing system, this benefit may be measured by the economic value of the incremental water production directly resulting from the improvement of the system.

For this benefit the concept of consumers' surplus was adopted. This concept takes into account not only what households and commercial establishments are actually paying for water but also how much more the consumers are willing to pay for this essential commodity. Calculations for the beneficial value of water are shown in Annex XI-C and Annex Table XI-C-4. The present value of this benefit amounts to ₱12.9 million.

D. NON-QUANTIFIABLE BENEFITS

The non-quantifiable benefits arising from a water supply project are generally as important as the quantifiable benefits. However, they do not easily lend themselves to valuation. The approach taken herein is to acknowledge their existence and importance. No attempt has been made to quantify or include them in the benefit-cost calculations.

The proposed water supply project will set off a chain of events beyond its construction period. Those activities include among others the inducement to industry to establish plants in the service area due to availability of a dependable water supply. Without such supply, new industrial and commercial establishments would be forced to develop their own supply system or relocate elsewhere. The overall cost of providing separate water systems is normally large and represents a deterrent to invest in the area and, consequently, to industrial development.

Because of the employment generated by the project, hired laborers are able to spend their wages for purchasing goods at the local stores. Hence, such peso they spend is returned to the income stream of the local economy. In the operation and maintenance of the project, the water district would find it advantageous to purchase required supplies locally and engage local service.

E. ECONOMIC COSTS

General

The total cost of the proposed water supply system is the sum of all expenditures required to 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 while benefits are sometimes intangible.

Project Costs

Project costs include the construction cost of the proposed facilities such as pipes, meters and equipment, as well as, engineering service, contingencies, land cost, administrative and legal fees. The cost of the feasibility studies has also been included.

Annex Table XI-E-1 shows the construction costs of the proposed water supply project for the water district. They are listed by component as to type of expenditure in 1978 prices. They are further broken down into foreign and domestic components.

The cost of unskilled labor is shown separately from the domestic component of the project cost. From the balance of the domestic cost, 5 percent was assumed to be in the form of hidden taxes.

Adjustment 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 (called the shadow price) other than the market price was imputed to these items. In this way, most of the effects of price discrepancies which could be identified, whether primary or secondary, were incorporated directly into the project analysis and imputed as direct costs to project investment. The 'shadow prices' used in this analysis are those employed by international lending institutions and the Planning and Project Development Office (PPDO) of the Department of Public Works, Transportation and Communication.

One of the items to which 'shadow pricing' was applied is the price of unskilled labor (otherwise known as common labor). In a perfectly competitive market, the price of labor is determined by the marginal value of its product. In this case, therefore, the price of labor is equal to the value of the output which an extra laborer hired would produce. However, this is not applicable in an economy such as that of the Philippines where there is a surplus of labor. Since there is widespread disguised unemployment in such an economy, unskilled labor is normally valued below the actual wage rate likely to be paid. In this study, the opportunity cost of unskilled labor or its potential in other employment was valued at one half of its estimated cost in the project. The net effect is to reduce the cost of unskilled labor by 50 percent, thereby reducing the 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 service area, it would probably migrate elsewhere to obtain employment at better wages.

Adjustments were also made with respect to cost of project facilities which use up limited foreign exchange reserves. Foreign exchange used to import project components was valued at 1.2 times actual peso cost. This effectively increased the foreign exchange cost by 20 percent, thereby affecting project cost in a similar manner. This was done to reflect the opportunity cost or alternative value of foreign exchange. Domestic components, on the other hand, were priced at their actual cost.

Interest was likewise not included since this is considered a financial instead of an economic cost.

Annex Table XI-E-1 shows the conversion of financial costs to economic costs through shadow pricing and other adjustments. As converted from financial costs, total economic project cost for URD-WD amounts to ₱19.9 million, with a present value of ₱17.2 million as shown in Annex Table XI-E-4.

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 items which have a service life of 15 years are the equipment for source facilities, the administration building, the plumbing shop and miscellaneous items of the immediate improvement program. The feasibility studies were assumed to be good for 30 years, while the wells and their structures were assumed to last for 25 years. All other facilities in the system are expected to last for 50 years.

During the 23-year period from 1978 to 2000, therefore, vehicles, meters, equipment with a service life of 15 years and the miscellaneous items will have to be replaced. Annex Table XI-E-2 shows the replacement schedule and costs of vehicles, meters, equipment and miscellaneous items. The present value of total escalated replacement costs for URD-WD amounts to ₱657,200 (see Annex Table XI-E-4).

Salvage Value

Annex Table XI-E-3 shows the salvage value in 2001 of all the capital equipment to be used in the project. The percentage of salvage value was based on the remaining service life of the facilities in 2001. For URD-WD, the present worth of the salvage value is ₱1.8 million (see Annex Table XI-E-4).

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, and communication needs. Only the operating and maintenance costs of the proposed project (i.e., excluding those of the present system) were considered in this study.

Annex Table XI-E-4 presents the incremental annual recurring costs associated with running and operating the water district up to 2000. The present value of these costs is ₱3.6 million.

Calculation of Economic Cost

The economic cost may be expressed as the adjusted (shadow priced) project cost plus replacement cost plus operating/maintenance cost less salvage value. Appendix Table XI-E-4 shows the computation of total economic cost for URD-WD, amounting to a present value of ₱19.7 million.

F. BENEFIT-COST ANALYSIS

The summary of the quantifiable economic benefits and economic costs for URD-WD is shown below. They are expressed in their present values (discounted at 12 percent) after the 1978 prices have been escalated.

Summary of Benefits and Costs
(in ₱10^6)

Benefits		Costs	
Increase in Land Values	₱13.226	Project Cost	₱17.204
Health	.199	Replacement Cost	.657
Reduction in Fire Damage	3.829	Operating and	
Beneficial Value	12.994	Maintenance Cost	3.598
	₱30.248	Sub-total	21.459
		Salvage Value	1.779
			₱19.680

Benefit-Cost Ratio - 1.54:1

The preceding table shows that the quantifiable benefits exceed the economic costs associated with the improvement of the water supply system in URD-WD. Under the principle of benefit-cost ratio, the project is, therefore, considered economically feasible.

The actual benefits of the proposed project may be considerably greater than indicated by the benefit-cost ratio because the non-quantifiable benefits have not been incorporated into the analysis.

G. INTERNAL ECONOMIC RATE OF RETURN

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

For URD-WD, the IERR is 28.1 percent as shown in Annex Table XI-G-1. On the basis of the above stated principle of IERR, therefore, the proposed project appears to be economically feasible and justified.

ANNEX XI-C

QUANTIFIABLE BENEFITS

ANNEX XI-C

QUANTIFIABLE BENEFITS

<u>Portion of Land Values Attributable to Water Supply Project</u>

Annex Table XI-C-1 shows the present value of the portion of land values attributable to the proposed water supply project, based on the following assumptions:

1. In accordance with the staging program of the construction of facilities, the 1980 service area of 240 hectares was projected to increase in the following manner; by 28 hectares from 1980 to 1981; by 31 hectares from 1981 to 1982; by 35 hectares from 1982 to 1983; by 39 hectares from 1983 to 1984; by 44 hectares from 1984 to 1985; by 49 hectares from 1985 to 1986; by 54 hectares from 1986 to 1987; by 61 hectares from 1987 to 1988; by 68 hectares from 1988 to 1989; and by 76 hectares from 1989 to 1990.

2. Land use was assumed to be 88 percent residential and 12 percent commercial/institutional/industrial throughout the projection period. This classification was based on the water demand projections in 1980 by consumer category, as shown in Chapter VI.

3. The 1977 costs of land based on estimated assessed values are:

Residential	: ₱ 10 per sqm
Industrial/Commercial/Institutional	: ₱ 20 per sqm

   These costs were assumed to be constant over the projection period.

4. The portion of the total cost of land specifically attributable to the provision of water supply was assumed to be 20 percent of the cost of land. This was escalated by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

5. A discount factor of 12 percent was used to obtain the present values of the benefits. This is the opportunity cost of capital and is commonly used for public investment projects like water supply development.

For URD-WD, the land value benefit amounts to ₱13.2 million in present worth.

ANNEX TABLE XI-C-1

PORTION OF LAND VALUES ATTRIBUTABLE TO RECOMMENDED PROJECT
URDANETA WATER DISTRICT

Year	Land Use (sqm)		Cost of Land (P x 1000)		Total Cost of Land (P x 1000)	20 Percent Benefit Due to Project (P x 1000)	Escalation Factor	Escalated Benefit (P x 1000)	Discount Factor at 12 %	Present Value of Benefit (P x 1000)
	Residential	Commercial/ Institutional/ Industrial	Residential	Commercial/ Institutional/ Industrial						
1980	2,131,200	268,800	P21,312.0	P5,376.0	P26,688.0	P5,337.6	1.210	P 6,458.5	.797	P 5,147.4
1981	246,400	33,600	2,464.0	672.0	3,136.0	627.2	1.307	819.8	.712	583.7
1982	272,800	37,200	2,728.0	744.0	3,472.0	634.4	1.412	980.5	.636	623.6
1983	308,000	42,000	3,080.0	840.0	3,920.0	784.0	1.525	1,195.6	.567	677.9
1984	343,200	46,800	3,432.0	936.0	4,368.0	873.6	1.647	1,438.8	.507	729.5
1985	387,200	52,800	3,872.0	1,056.0	4,928.0	985.6	1.779	1,753.4	.452	792.5
1986	431,200	58,800	4,312.0	1,176.0	5,486.0	1,097.6	1.826	2,070.1	.404	836.3
1987	475,200	64,800	4,752.0	1,296.0	6,048.0	1,209.6	1.999	2,418.0	.361	872.9
1988	536,800	73,200	5,368.0	1,464.0	6,832.0	1,366.4	2.119	2,895.4	.323	935.2
1989	596,400	81,600	5,984.0	1,632.0	7,616.0	1,523.2	2.246	3,421.1	.288	985.3
1990	668,800	91,200	6,688.0	1,824.0	8,512.0	1,702.4	2.381	4,053.4	.257	1,041.7
								P27,504.5		P13,225.0

Health Benefits

To determine the amount of benefit arising from the reduction of income lost of those afflicted with water-borne diseases, pertinent statistics on morbidity rate were gathered from the Department of Health. From 1964 to 1974, an average of 293.1 out of every 100,000 population in the province of Pangasinan were afflicted with primary water-borne diseases every year, regardless of age, sex, and income class. The same rate was assumed for the municipality of Urdaneta in the absence of specific data. The morbidity rate in the service area was assumed to remain constant during the 20-year projection period.

Since not all of those afflicted with said diseases are wage-earners, an adjustment was made accordingly. Based on the 1970 Census on Population and Housing of the National Census and Statistics Office, 27 percent of the municipality's population was economically active.[1] It was assumed, therefore, that only 27 percent of 293.1 per 100,000, who were afflicted with primary water-borne diseases were economically active. Hence, this is the only segment of the population who would suffer a reduction in income due to said diseases. Furthermore, these afflicted wage-earners were assumed to be earning ₱8 a day and unable to work for 15 days on the average because of their illness. The final figure corresponding to the economic cost of time lost due to water-borne diseases was thereby arrived at by multiplying the number of people afflicted with water-borne diseases by 27 percent, by ₱8 a day and then by 15 days.

Another health benefit that could be associated with the establishment of a safe public water supply system is the reduction of the economic cost of the premature death of those afflicted with water-borne diseases in the service area. Obviously, the reduction of the life span of the population caused by said diseases is an economic loss to the community.

This economic loss due to premature death was determined by multiplying the number of people who die because of water-borne diseases (assuming that a water supply improvement program were not undertaken) by 27 percent and then by ₱11,629. The projected number of such deaths was based on the average of the 11-year mortality rate for primary water-borne diseases in the province of Pangasinan, as gathered from the Department of Health. These figures indicated that 41.1 persons died of the 293.1 per 100,000 who

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[1] Economically active population includes those who are 10 years old and over, whether employed or unemployed, excluding retired persons, students and housewives.

were afflicted with water-borne diseases. This mortality rate was assumed to be constant over the projection period. The 27 percent corresponds to the portion of the service area population who are income earners. The ₱11,629, on the other hand, represents the monetary value of each death. This was derived from the estimated income to be earned by the average wage-earner over a period of five years discounted at 12 percent plus 20 percent associated economic costs (summation of ₱200 a month x 12 months x discount factor + 20 percent associated costs).

The third health benefit that can be derived from the improvement of the water supply in the service area is the reduction of the medical expenses of persons afflicted with water-borne diseases. According to the Lipa City pilot survey on "Ability-to-Pay",2/ an afflicted person spends ₱113.00 annually on the average for medical expenses, which include hospitalization, medicine and doctors' fee. Based on this finding, the total medical expenses incurred due to water-borne diseases were arrived at by multiplying ₱113.00 by the number of people afflicted with such diseases in the service area.

The sum of all three economic costs related to health benefits had to undergo three final adjustments to arrive at more meaningful figures. First, 40 percent of the total economic loss due to water-borne diseases was taken as the health benefit directly resulting from the water supply improvement program. This reduction was made to account for the fact that not all water-borne diseases are caused by a poor water system and may also be due to less than ideal personal hygiene or lack of sewerage facilities. Second, the 40 percent health benefit was escalated by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000. Third, the escalated health benefit was discounted to its present worth at 12 percent. Annex Table XI-C-2 shows the calculations associated with the health benefits for URD-WD. The total present value of said benefits after the adjustments amounts to ₱198,951.

Reduction in Fire Damage

The proposed water supply improvement program will result in increased water pressure and reliable supply for domestic as well as for fire-fighting purposes. At present, of the 14 fire hydrants in Urdaneta one is inoperable and low system pressure renders the others ineffective. With the implementation of the recommended

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2/Refer to Methodology Manual, Chapter 20 for "Ability-to-Pay" studies.

ANNEX TABLE XI-C-2

HEALTH BENEFITS
URDANETA WATER DISTRICT

Year	Served Population	Cost of Time Lost due to Illness(1)	Economic Loss due to Premature Death(2)	Cost of Medical Expenses(3)	Total Economic Losses due to Illness	40% Reduction due to Project (Benefit)	Escalation Factor	Escalated Reduction due to Project	Discount Factor at 12 Percent	Present Value of Health Benefit
1980	10,590	₱1,006	₱13,666	₱ 3,507	₱18,179	₱ 7,272	1.210	₱ 8,799	.797	₱ 7,013
1981	11,924	1,132	15,383	3,949	20,469	8,188	1.307	10,702	.712	7,620
1982	13,426	1,275	17,326	4,447	23,048	9,219	1.412	13,018	.636	8,279
1983	15,116	1,436	19,507	5,007	25,950	10,380	1.525	15,830	.567	8,975
1984	17,020	1,616	21,964	5,637	29,217	11,687	1.647	19,248	.507	9,759
1985	19,164	1,820	24,731	6,347	32,898	13,159	1.779	23,410	.452	10,581
1986	21,578	2,049	27,846	7,147	37,042	14,817	1.885	27,945	.404	11,290
1987	24,295	2,307	31,352	8,047	41,706	16,682	1.999	33,347	.361	12,038
1988	27,355	2,598	35,301	9,060	46,959	18,783	2.119	39,802	.322	12,816
1989	30,801	2,925	39,748	10,201	52,874	21,150	2.246	47,503	.288	13,681
1990	34,680	3,293	44,754	11,486	59,533	23,813	2.381	56,699	.257	14,572
1991									.229	12,984
1992									.205	11,623
1993									.183	10,376
1994									.163	9,242
1995									.146	8,278
1996									.130	7,371
1997									.116	6,577
1998									.104	5,897
1999									.093	5,273
2000	34,680	3,293	44,754	11,486	59,533	23,813	2.381	56,693	.083	4,706
								₱863,293		₱198,951

Note:

Total Municipal Population(1970) 6,690
All persons 10 years and over 40,593
Economically Active 15,775 or 27%

Morbidity Rate: 293.1 per 100,000 people
Mortality Rate: 41.1 per 100,000 people

(1) $27\% \times \frac{293.1}{100,000} \times S.Pt \times ₱8 \times 15$

(2) $27\% \times \frac{41.1}{100,000} \times S.Pt \times ₱11,629$

(3) $\frac{293.1}{100,000} \times S.Pt \times ₱113$

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*Served Population

program, which will involve the installation of new fire hydrants, fire protection coverage will be extended to the service area on an increasing basis. Hence, a reduction in fire damage is expected in the service area.

This reduction was assumed to be 0.75 percent of the combined assessed values of all structures in the service area. For Urdaneta, the average assessed value of each structure was assumed to be ₱18,800.[3] The number of structures was derived from the projected population to be served by the system, assuming that each household has an average of 5.9 members.[4]

The fire protection benefit was based on the assumed overall reduction in fire damage, but correlated with the schedule of fire hydrant installation in the service area. Percentage of fire protection starts at 6 percent in 1980, gradually increasing to 35 percent in 1990 in accordance with the extent of the service area to be covered by the fire hydrants.

The net reduction in fire damage was escalated by 8 percent from 1980 to 1985, by 5 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000. It was then discounted at 12 percent. The present value of the fire protection benefit, as shown in Annex Table XI-C-3, amounts to ₱3.8 million.

Beneficial Value of Water

Since water is essential to human life, all members of the served population in the service area presumably would be willing to obtain it in sufficient quantities at some given price. With the proposed improvement of the system's facilities, the volume of water production is expected to increase considerably to serve the needs of the growing population. This will bring about additional revenues to the water district, especially since a price increase of water may be justified in view of the improved service.

In general, water rates charged by the water district do not reflect the true value of water. Moreover, it is recognized that households and commercial users are really willing to pay more than what they are actually being charged for water consumed. From the economic viewpoint, therefore, there is a consumers' surplus. This consumers' surplus refers to the additional amount consumers are willing to pay over and above what they actually pay for water. For

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[3] Based on the records of the assessor's office in Gapan, in the absence of similar data on Urdaneta.

[4] Based on the 1970 Census on Housing in Pangasinan province.

ANNEX TABLE XI-C-3

REDUCTION IN FIRE DAMAGE
URDANETA WATER DISTRICT

Year	Number of Structures 5/	Total Value at ₱18,800 each 6/	Overall Reduction in Fire Damage (.0075) ₱ x 1000	Percentage of Fire Protection	Net Reduction in Fire Damage (Benefit) ₱ x 1000	Escalation Factor 7/	Escalated Value of Net Reduction ₱ x 1000	Discount Factor at 12 Percent	Present Value of Net Benefit ₱ x 1000
1980	1,795	₱ 33,746.0	₱253.1	0	₱ –	1.210	–	.797	–
1981	2,021	37,994.8	285.0	25	71.2	1.307	₱ 93.1	.712	₱ 66.3
1982	2,276	42,788.8	320.9	29	93.1	1.412	131.4	.636	83.6
1983	2,562	48,165.6	361.2	35	126.4	1.525	192.8	.567	109.3
1984	2,885	54,238.0	406.8	41	166.8	1.647	274.7	.507	139.3
1985	3,248	61,062.4	458.0	48	219.8	1.779	391.1	.452	176.8
1986	3,657	68,751.6	515.6	51	263.0	1.886	496.0	.404	200.4
1987	4,118	77,418.4	580.6	55	319.4	1.999	635.4	.361	230.5
1988	4,636	87,156.8	653.7	59	385.7	2.119	817.2	.322	263.1
1989	5,221	98,154.8	736.2	63	463.8	2.246	1,041.7	.288	300.0
1990	5,878	110,506.4	828.8	67	555.3	2.381	1,322.2	.257	339.8
1991								.229	302.8
1992								.205	271.1
1993								.183	242.0
1994								.163	215.5
1995								.146	193.0
1996								.130	171.9
1997								.116	153.4
1998								.104	137.5
1999								.093	123.0
2000	5,878	110,506.4	828.8	67	555.3	2.381	1,322.2	.083	109.7
							₱18,620.6		₱3,829.0

5/ Derived from the served population projections, assuming that there are 5.9 members per household according to the 1975 Census on Housing in Pangasinan.

6/ Based on the assessed value records in Gapan in the absence of similar data on Urdaneta.

7/ Escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985 and by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

purposes of this study, this additional value has been estimated to be 25 percent higher than commercial/industrial/institutional water rates and 50 percent higher than domestic water rates.[8]

In the determination of this benefit, the following steps were taken.

1. Only the incremental volume of accounted-for-water was considered; hence, the 1977 accounted-for-water amounting to 194,702 cum was deducted from total accounted-for-water projections in Chapter VI. The water demand projections in Chapter VI, expressed in liters per capita per day, were converted to cubic meters per year.

2. Classification of accounted-for-water into domestic and others (commercial/institutional/industrial) was based likewise on Chapter VI. For URD-WD, water use was classified into 88 percent domestic and 12 percent commercial/institutional/industrial.

3. The price of water per cum for domestic use was derived by de-escalating the rate per revenue unit of water in Annex Table X-C-1; the rate of water for other uses (commercial/institutional/industrial) was assumed to be twice that for domestic use. The rates were, however, adjusted upwards to reflect consumers' surplus: 50 percent higher for domestic water and 25 percent higher for others.

4. The net economic revenues were obtained by subtracting the assumed 1977 revenues of URD-WD of ₱31,600 from total economic revenues. The net economic revenues may be considered as benefits of the proposed project since revenues of the existing system have been duly excluded.

5. The net economic revenues were then escalated by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the esclation factor was held constant up to 2000. Finally, the escalated values were discounted at 12 percent to obtain their present values.

For URD-WD, the beneficial value of water amounts to ₱12.9 million, as shown in Annex Table XI-C-4.

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[8] Refer to Procedures for the Economic and Financial Analysis of Water Projects, LWUA, May 1976.

ANNEX TABLE XI-C-4

BENEFICIAL VALUE OF WATER
URDANETA WATER DISTRICT

Year	Incremental Accounted-for-Water cum/year	Domestic cum/year	Others cum/year	Price per cum Domestic	Price per cum Others	Economic Value per cum Domestic	Economic Value per cum Others	Economic Water Revenues Domestic	Economic Water Revenues Others	Total Economic Revenues	Escalation Factor	Escalated Economic Revenues	Discount Factor at 12%	PV of Economic Revenues
1977	133,600													
1978	151,100	132,968	18,132	₱.65	₱1.30	₱ .98	₱1.62	130.3	29.4	159.7	1.000	159.7	1.000	159.7
1979	227,800	200,464	27,336	.60	1.20	.90	1.50	180.4	41.0	221.4	1.100	243.5	.893	217.5
1980	326,300	287,144	39,156	.56	1.12	.84	1.40	241.2	54.8	296.0	1.210	358.2	.797	285.5
1981	393,600	346,368	47,282	.91	1.82	1.36	2.27	471.1	107.2	578.3	1.307	755.8	.712	538.2
1982	467,700	411,576	56,124	.85	1.70	1.27	2.12	522.7	119.0	641.7	1.412	906.1	.636	576.3
1983	555,900	489,192	66,708	.78	1.56	1.17	1.95	572.4	130.1	702.5	1.525	1,071.3	.567	607.4
1984	654,000	575,520	78,480	.88	1.76	1.32	2.20	759.7	172.7	932.4	1.647	1,535.7	.507	778.6
1985	767,400	675,312	92,088	.82	1.64	1.23	2.05	830.6	183.8	1,019.4	1.779	1,813.5	.452	819.7
1986	896,600	789,008	107,592	.76	1.52	1.14	1.90	899.5	204.4	1,103.9	1.886	2,082.0	.404	841.1
1987	1,042,300	917,224	125,076	.70	1.40	1.05	1.75	963.1	218.9	1,182.0	1.999	2,362.8	.361	853.0
1988	1,210,300	1,065,064	145,236	.69	1.38	1.03	1.72	1,097.0	249.8	1,346.8	2.119	2,853.9	.322	918.9
1989	1,398,800	1,230,944	167,856	.64	1.28	.96	1.60	1,181.7	268.6	1,450.3	2.246	3,257.4	.287	938.1
1990	1,624,500	1,429,560	194,940	.60	1.20	.90	1.50	1,286.6	292.4	1,579.0	2.381	3,759.6	.257	966.2
1991				.59	1.18	.88	1.47	1,258.0	286.6	1,544.6		3,677.7	.229	842.2
1992				.54	1.08	.81	1.35	1,157.9	263.2	1,421.1		3,383.6	.205	693.6
1993				.50	1.00	.75	1.25	1,072.2	243.7	1,315.9		3,133.2	.183	573.4
1994				.53	1.06	.79	1.32	1,129.4	257.3	1,386.7		3,301.7	.163	538.2
1995				.49	.96	.73	1.22	1,043.6	237.8	1,281.4		3,051.0	.146	445.4
1996				.45	.90	.67	1.12	957.8	218.3	1,176.1		2,800.3	.130	364.0
1997				.46	.92	.69	1.15	986.4	224.2	1,210.6		2,882.4	.116	334.4
1998				.43	.86	.64	1.07	914.9	208.6	1,123.5		2,675.1	.104	278.2
1999				.40	.80	.60	1.00	857.7	194.9	1,052.6		2,506.2	.093	233.1
2000	1,624,500	1,429,560	194,940	.37	.74	.55	.92	786.3	179.3	965.6	2.381	2,299.1	.083	190.8
												50,869.8		12,993.5

ANNEX XI-E

ECONOMIC COSTS

ANNEX TABLE XI-E-1

CONVERSION OF FINANCIAL COST TO ECONOMIC COST
URDANETA WATER DISTRICT

	Financial Project Cost	Foreign Exchange Component	Domestic Component	Unskilled Labor	Balance of Domestic Component 1/	Taxes (5%) 2/	Others (95%)	Shadow Pricing: Foreign Exchange Component x 1.2	Shadow Pricing: Unskilled Labor x .5	Shadow Pricing: Others x 1.0	Economic Project Cost 3/	Economic Construction Cost 4/
Source Facilities												
a) Wells	2,177,000	577,144	1,599,856	117,338	1,482,518	74,126	1,408,392	692,573	58,669	1,408,392	2,159,634	1,707,220
b) Equipment	826,000	716,594	109,406	8,024	101,328	5,069	96,313	859,913	4,012	96,313	960,238	759,081
Distribution Pipes	2,753,000	1,419,581	1,333,419	270,963	1,062,456	53,123	1,009,333	1,703,497	135,482	1,009,333	2,848,312	2,251,630
Internal Network	4,712,000	2,023,457	2,688,543	549,896	2,138,647	106,932	2,031,715	2,428,148	274,948	2,031,715	4,734,811	4,099,403
Fire Hydrants	673,000	392,394	280,606	67,221	213,385	10,669	202,716	470,873	33,611	202,716	707,200	612,294
Plumbing Shop	419,000	12,977	406,023	62,832	343,191	17,160	326,031	15,572	31,416	326,031	373,019	322,960
Service Connections												
a) Pipes	2,382,000	1,337,524	1,044,476	328,745	715,731	35,787	679,944	1,605,029	164,373	679,944	2,449,346	2,120,645
b) Meters	829,000	513,881	315,119	99,183	215,936	10,797	205,139	616,657	49,592	205,139	871,388	754,448
Immediate Improvements												
1. Source Facilities												
a) Well	735,000	192,952	542,048	39,996	502,052	25,103	476,949	231,542	19,998	476,949	728,489	575,681
b) Equipment	424,000	360,856	63,144	4,659	58,485	2,924	55,561	433,027	2,330	55,561	490,918	388,077
2. Distribution Facilities	1,044,000	519,491	524,509	111,320	413,189	20,659	392,530	623,389	55,660	392,530	1,071,579	847,098
3. Leakage Detection/Repair	144,000	112,269	31,731	-	31,731	1,587	30,144	134,723	-	30,144	164,867	142,742
4. Service Connections												
a) Pipes	737,000	421,108	315,892	115,371	200,521	10,026	190,495	505,330	57,686	190,495	753,511	652,390
b) Meters	357,000	235,780	121,220	44,272	76,948	3,847	73,101	282,936	22,136	73,101	378,173	327,423
5. Administration Building												
a) Structure	419,000	12,977	406,023	64,988	341,035	17,052	323,983	15,572	32,494	323,983	372,049	322,120
b) Equipment	103,000	79,083	23,917	3,828	20,089	1,004	19,085	94,900	1,914	19,085	115,899	100,345
6. Vehicles	139,000	70,290	68,710	-	68,710	3,436	65,274	84,348	-	65,274	149,622	129,543
7. Miscellaneous	21,000	12,744	8,256	-	8,256	413	7,843	15,293	-	7,843	23,136	20,031
Feasibility Studies	193,000	108,080	84,920	-	84,920	4,246	80,674	129,696	-	80,674	210,370	166,300
Sub-total	1,908,000	9,119,182	9,967,818	1,888,636	8,079,182	403,960	7,675,222	10,943,018	944,321	7,675,222	19,562,561	16,299,632
Land	395,000	-	395,000	-	395,000	19,750	375,250	-	-	375,250	375,250	296,640
Total	19,482,000	9,119,182	10,362,818	1,888,636	8,474,182	423,710	8,050,472	10,943,018	944,321	8,050,472	19,937,811	16,596,272

1/ Domestic cost component less unskilled labor cost.
2/ Computed at 5 percent of domestic component after unskilled labor was deducted from it.
3/ Obtained by adding together foreign exchange cost, unskilled labor cost and cost of 'others' after they have been adjusted through shadow pricing.
4/ Derived by subtracting contingencies and engineering services from the economic project cost.

ANNEX TABLE XI-E-2

REPLACEMENT COST
URDANETA WATER DISTRICT
1978 PRICES
(₱ x 1000)

Year	Vehicles	Meters	Equipment	Miscellaneous Items	Total
1978					
1979					
1980					
1981					
1982					
1983					
1984					
1985					
1986	₱129.5				₱129.5
1987					
1988					
1989					
1990					
1991					
1992					
1993					
1994	129.5	₱120.3	₱496.8	₱20.0	766.6
1995		114.5	22.8		137.3
1996		105.4			105.4
1997		44.5	227.0		271.5
1998		91.3			91.3
1999		91.3			91.3
2000		91.3	227.0		318.3
	₱259.0	₱658.6	₱973.6	₱20.0	₱1,911.2

ANNEX TABLE XI-E-3

SALVAGE VALUE IN 2001
URDANETA WATER DISTRICT
1978 PRICES
(P x 1000)

Year	50 Years Economic Value		50 Years Salvage Value	30 Years Economic Value		30 Years Salvage Value	25 Years Economic Value		25 Years Salvage Value	15 Years Economic Value		15 Years Salvage Value	7 Years Economic Value		7 Years Salvage Value	Infinite Economic Value		Infinite Salvage Value	Total Salvage Value 2/
1978	P 1,608.0	56%	P 900.5	P 37.9	27%	P102.3	P 594.7	12%	P 71.4							P 217.7	100%	P217.7	P 1,291.9
1979	397.4	58	230.5	123.4	30	38.5	54.6	16	8.7										277.7
1980	610.9	60	366.5													71.5	100	71.5	438.0
1981	1,271.2	62	788.1				530.9	24	127.4										915.5
1982	1,657.4	64	1,060.7																1,060.7
1983	946.9	66	625.0																625.0
1984	964.9	68	656.1				530.9	36	191.1										847.2
1985	541.7	70	379.2				18.8	40	7.5										386.7
1986	656.4	72	472.6				18.8	44	8.3	P 60.2	7	P 4.2				7.4	100	7.4	492.5
1987	958.2	74	709.1				534.4	48	256.5	347.9	13	45.2							1,010.8
1988	703.8	76	534.9							91.3	20	18.3							553.2
1989	703.8	78	549.0							91.3	27	24.7							573.7
1990	350.8	80	280.6							45.3	33	14.9							295.5
1991																			
1992																			
1993																			
1994										637.1	60	382.3	129.5	14%	P18.1				400.4
1995										137.3	67	92.0							92.0
1996										105.4	73	76.9							76.9
1997										271.5	80	217.2							217.2
1998										91.3	87	79.4							79.4
1999										91.3	93	84.9							84.9
2000										379.5	100	379.5							379.5
	P11,371.4		P7,552.8	P166.3		P140.8	P2,283.1		P670.9	P2,349.4		P1,419.5	P129.5		P18.1	P 296.6		P296.6	P10,098.7

Total Economic Value P16,596.3
Total Salvage Value P10,098.7

2/ Salvage values for each year represent the salvage value of the item in year 2001.

ANNEX TABLE XI-E-4

SUMMARY OF ECONOMIC COSTS
URDANETA WATER DISTRICT
(P x 1000)

Year	Project Cost	Replacement Cost	Salvage Value 6/	O and M Costs	Total Costs	Escalation Factor For Other Costs 7/	Escalation Factor For O and M Costs 8/	Escalated Project Cost	Escalated Replacement Cost	Escalated O and M Cost	Escalated Total Costs	Discount Factor at 12 Percent	Present Value of Project Cost	Present Value of Replacement Cost	Present Value of O and M Costs	Present Value of Total Costs
1978	P 3,938.2		1,291.9	36.8	3,995.0	1.000	1.000	3,958.2		36.8	3,995.0	1.000	3,958.2		36.8	3,995.0
1979	698.1		277.7	73.5	771.6	1.100	1.080	767.9		79.4	847.3	.893	685.7		70.9	756.6
1980	1,124.2		438.0	110.2	1,234.4	1.210	1.166	1,360.3		128.5	1,488.8	.797	1,084.2		102.4	1,186.6
1981	2,566.3		915.5	197.5	2,763.8	1.307	1.260	3,354.2		248.9	3,603.0	.712	2,388.2		177.2	2,565.3
1982	2,063.6		1,060.7	202.0	2,265.6	1.412	1.360	2,913.8		274.7	3,183.5	.636	1,853.2		174.7	2,027.9
1983	1,199.1		625.0	233.3	1,432.4	1.525	1.469	1,828.6		342.7	2,171.3	.567	1,036.8		194.3	1,231.2
1984	2,180.7		847.2	242.1	2,422.8	1.647	1.587	3,591.6		384.2	3,975.8	.507	1,820.9		194.8	2,015.7
1985	723.0		386.7	242.1	965.1	1.779	1.714	1,286.2		415.0	1,701.2	.452	581.4		187.6	768.9
1986	880.5	129.5	492.5	328.9	1,338.9	1.886	1.851	1,660.6	244.2	608.8	2,513.7	.404	670.9	98.7	246.0	1,015.5
1987	2,250.1		1,010.8	328.9	2,579.0	1.999	1.999	4,497.9		657.5	5,155.4	.361	1,623.8		237.3	1,861.1
1988	918.3		553.2	328.9	1,247.2	2.119	2.159	1,945.9		710.1	2,656.0	.322	626.6		228.7	855.2
1989	918.3		573.7	328.9	1,247.2	2.246	2.332	2,062.5		767.0	2,829.5	.288	594.0		220.9	814.9
1990	457.4		295.5	354.7	812.1	2.381	2.518	1,089.1		893.1	1,982.2	.257	279.9		229.5	509.4
1991			-		354.7					893.1	893.1	.229			204.5	204.5
1992			-		354.7					893.1	893.1	.205			183.1	183.1
1993			-		354.7					893.1	893.1	.183			163.4	163.4
1994		766.6	400.4		1,121.3				1,825.3	893.1	2,718.4	.163		297.5	145.6	443.1
1995		137.3	92.0		492.0				326.9	893.1	1,220.0	.146		47.7	130.4	178.1
1996		105.4	76.9		460.1				251.0	893.1	1,144.1	.130		32.6	116.1	148.7
1997		271.5	217.2		626.2				646.4	893.1	1,539.5	.116		75.0	103.6	178.6
1998		91.3	79.4		446.0				217.4	893.1	1,110.5	.104		22.6	92.9	115.5
1999		91.3	84.9		446.0				217.4	893.1	1,110.5	.093		20.2	83.1	103.3
2000		318.3	318.3	354.7	673.0	2.381	2.518		757.9	893.1	1,151.0	.083		62.9	74.1	137.0
	P19,937.8	P1,911.2		P6,554.8	P28,403.8			P30,316.8	P4,486.5	P14,477.7	P49,281.0		P17,203.8	P657.2	P3,597.9	P21,458.9
	Salvage Value		P10,098.7			2.381					-24,045.0	.074				-1,779.3
											P25,236.0					P19,679.6

6/ The annual salvage values were not escalated since they represent values for 2001; hence, only their sum was escalated by the factor used for project and replacement costs.

7/ Project cost and replacement cost were escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985 and by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

8/ Operating and maintenance costs were escalated annually by 8 percent from 1978 to 1990, after which the escalation factor was held constant up to 2000.

ANNEX XI-G

INTERNAL ECONOMIC RATE OF RETURN

ANNEX TABLE XI-G-1

INTERNAL RATE OF RETURN
URDANETA WATER DISTRICT
(₱ x 1000)

Year	Escalated Values: Benefits	Escalated Values: Costs	Discount Factor at 25 Percent	Present Values: Benefits	Present Values: Costs	Discount Factor at 35 Percent	Present Values: Benefits	Present Values: Costs
1978	₱ 159.7	₱ 3,995.0	1.000	₱ 159.7	₱ 3,995.0	1.000	₱ 159.7	₱ 3,995.0
1979	243.5	847.3	.800	194.8	677.8	.769	187.3	651.5
1980	6,821.6	1,488.8	.640	4,365.8	952.8	.592	4,038.4	881.4
1981	1,679.4	3,603.0	.512	859.9	1,844.7	.455	764.1	1,639.4
1982	2,031.0	3,188.5	.410	832.7	1,307.3	.350	710.9	1,116.0
1983	2,475.5	2,171.3	.328	812.0	712.2	.269	665.9	584.1
1984	3,268.5	3,975.8	.262	856.3	1,041.7	.207	676.5	823.0
1985	3,981.4	1,701.2	.210	836.1	357.3	.159	633.0	270.0
1986	4,676.0	2,513.7	.168	785.6	422.3	.123	575.1	309.2
1987	5,452.6	5,155.4	.134	730.6	690.8	.094	512.5	484.6
1988	6,606.3	2,656.0	.107	706.9	284.2	.073	482.3	193.9
1989	7,767.7	2,829.5	.086	668.0	243.3	.056	435.0	158.5
1990	9,191.9	1,982.2	.069	634.2	136.7	.043	395.3	85.2
1991	5,056.6	893.1	.055	278.1	49.1	.033	166.9	29.5
1992	4,762.5	893.1	.044	209.6	39.3	.025	119.1	22.3
1993	4,512.1	893.1	.035	157.9	31.1	.020	90.2	17.9
1994	4,680.6	2,718.4	.028	131.1	76.1	.015	70.2	40.8
1995	4,429.9	1,220.0	.023	101.9	28.1	.012	53.2	14.6
1996	4,179.2	1,144.1	.018	75.2	20.6	.009	37.6	10.3
1997	4,261.3	1,539.5	.014	59.7	21.6	.007	29.8	10.8
1998	4,054.0	1,110.5	.012	48.6	13.3	.005	20.3	5.6
1999	3,885.1	1,110.5	.009	35.0	10.0	.004	15.5	4.4
2000	3,678.0	1,651.0	.007	25.7	11.6	.003	11.0	5.0
Total Benefits	97,854.4			13,565.4			10,849.9	
Total Costs		49,281.0			12,967.1			11,353.6
Less: Salvage Value		24,045.0	.006		144.3	.002		48.1
	3.86	25,236.0		1.06	12,822.8			11,305.5

Present Value at 25% = 742.6
Present Value at 30% = (455.6)
1,197.6

IERR = .25 + .05(742.6)
1,198.2
= .25 + .031
= 28.1%

METHODOLOGY MEMORANDA

Methodology Memorandum No. 1

To : L. V. Gutierrez, Jr.

From : A. de Vera

Date : 4 January 1977

Subject: Pilot Area Survey

A. Need

In estimating water accountability, data on the ratio of borrowers to primary users, average persons per household, and per capita consumption are necessary. Information on capacity and willingness-to-pay would greatly aid financial analysis. In all cases, these data are not readily available in the Philippines. The only way to get these data would be to actually perform a house-to-house survey within the served areas of the water district (WD). Considering time and financial constraints, a pilot area survey would be the best approach. This is merely surveying a representative area within the WD and projecting the data obtained for the entire served area of the WD.

B. Methodology

1. Choose a pilot area within the WD. Desirable requirements for the area are as follows:

   a. adequate line pressures, preferably with 24-hour service;
   b. metered connections;
   c. presence of domestic as well as commercial connections. Ratio of commercial to domestic connections for the area must not exceed that for the entire WD;
   d. representative income levels of the concessionaires.

2. Devise a one-page questionnaire so that it:

   a. is easily understood by WD personnel (who will serve as interviewers);
   b. provides relevant information;
   c. provides a means of cross-checking some answers given by respondents;
   d. would make tabular analysis easy.

   A sample questionnaire is attached.

3. Get assistance from the WD personnel in the house-to-house survey. It is suggested that they do the actual interview because of their familiarity with local customs and dialects. However, before allowing the WD enumerators to proceed on their own, it is necessary that:

   a. the enumerators be given a thorough briefing on the importance of the survey, as well as the purpose of each item in the questionnaire.
   b. the enumerators be accompanied to the first few houses, and given additional pointers or feedback before they proceed on their own.

4. Conduct a house-to-house survey of all households within the pilot area. A map at this point indicating the existing houses (with their code numbers) would be necessary. The following would be helpful during the survey:

   a. brief the respondents about the purpose of the survey before asking questions. It is very important that they be receptive to the interviewers. Otherwise data given could be misleading.
   b. in asking for estimates of consumption, avoid using technical terms, i.e., liters, gallons, etc. Use local containers like pails, drums or whatever they use. Note the capacity of the container in the questionnaire.

C. Data

The following data may be obtained from the survey:

1. Pilot area density
2. Average persons/household
3. Borrowers from connected households and percentage of households dependent on the WD
4. Potential concessionaires
5. Consumption estimates
6. Income levels and the respective rates showing willingness to pay for improved service
7. Water accountability

________ WATER DISTRICT
PILOT AREA QUESTIONNAIRE

DATE ______________
TIME ______________

INTERVIEWEE ______________ ADDRESS ______________

TYPE OF DWELLING ______________ CONSTRUCTION MATERIAL ______________

WD CONCESSIONAIRE

1. NO. OF OCCUPANTS: ________
2. CLASSIFICATION:
   - ☐ Domestic
   - ☐ Commercial
   - ☐ Institutional
   - ☐ Industrial
   - ☐ ________
3. SIZE OF CONNECTION:
   - ☐ ½" ☐ 1" ☐ 2"
   - ☐ ¾" ☐ 1½" ☐ ____
4. TYPE OF CONNECTION:
   - ☐ metered: meter functioning
   - ☐ metered: meter damaged
   - ☐ flat rate (unmetered)
5. APPURTENANCES (Connected to System)
   - ☐ with hand pump
   - ☐ with electric motor pump
   - HRS used/day ________
   - Pump rated HP ________
   - GPM ________
   - ________
6. OTHER SOURCE ASIDE FROM WD:

Own	Other HH
☐ wells	☐ wells
☐ springs	☐ springs
☐ rainwater	☐ rainwater
☐ ________	☐ ________

NON-WD CONCESSIONAIRE

1. NO. OF OCCUPANTS: ____
2. SOURCE OF SUPPLY:
   - ☐ own private well
   - ☐ rainwater
   - ☐ spring
   - ☐ public faucet
   - ☐ WD concessionaire HH Code No. ____
   - ☐ public well
   - ☐ others' private well
   - ☐ ________
3. CONSUMPTION:
   - ☐ free
   - ☐ paying
   - volume used per day ________
   - Paying ₱ ________
   - for ________.

REMARKS:

FOR ALL HOUSEHOLDS

1. WD-WATER AVAILABLE:
   - No. of hours ________
   - Time ________
2. FAUCETS:
   - ☐ 1 ☐ 3 ☐ 5
   - ☐ 2 ☐ 4 ☐ ____
3. SHOWERS:
   - ☐ 1 ☐ 2 ☐ 3 ☐ ____
4. FLUSH WATER CLOSET:
   - ☐ 1 ☐ 2 ☐ 3 ☐ ____
5. MANUAL WATER CLOSET:
   - ☐ 1 ☐ 2 ☐ 3 ☐ ____
6. ☐ w/septic tank ☐ w/o septic tank
7. AVERAGE MONTHLY:

	Consumption	Billing/PYMT
WD:	________	________
wells:	________	________
others:	________	________

8. USER:
   - ☐ w/ borrowers
   - ☐ w/o borrowers
   - Total no. of HH borrowers ________
   - Total no. of HH borrowers occupants ________
9. How much would you be willing to pay if water service were improved? ________/month.

(TO BE FILLED UP AT THE WD OFFICE)

1. HOUSEHOLD CODE NO. ________
2. INCOME:
   - ☐ below average (₱220 below)
   - ☐ average (₱221 – 750)
   - ☐ upper middle (₱751 – 1,500)
   - ☐ high (₱1,500 above)
3. WD CONCESSIONAIRE:
   - ☐ registered
   - ☐ unregistered
4. PAYMENTS:
   - ☐ up-to-date
   - ☐ delinquent

____
ENUMERATOR

____
POSITION

Methodology Memorandum No. 2

To : L. V. Gutierrez, Jr.

From : A. de Vera

Date : 31 January 1977

Subject: Estimating Water Accountability

A. Need

To be able to determine future water demand per capita, need for leak detection and survey program, and the level of development possible for reducing wastage and leakage, the following information must first be available.

1. Ratio of accounted-for and unaccounted-for-water.

2. Ratio of wastage and leakage in relation to total production.

3. Domestic consumption per capita.

Although there are various methods for estimating water accountability, the selection of a method depends on the purpose for which it is to be used and the level of accuracy desired. Accounted-for-water as used herein refers to the revenue-producing water for the water district. It is the sum of the billed metered consumption and inferred water consumption at flat-rate connections.

B. Methodology

1. Pilot Area Survey

a. Objective - To be able to estimate total accounted-for and unaccounted-for-water. Accuracy will depend on the reliability of the consumption figures as obtained in the pilot area survey.[1/]

b. Data Necessary - Monthly production; number of metered and unmetered connections; water rate schedule; pilot area data; and total monthly metered consumption.

[1/] Refer to Methodology Memorandum No. 1.

c. Steps

1) Obtain total number of households dependent on water system. To do this, first obtain ratio of households dependent on the system to total households in the pilot area and apply ratio to the whole service area. Compute for number of primary and secondary users.

2) Compute for inferred flat-rate use per month.

3) Compute total accounted-for-water by adding average monthly metered consumption and total inferred flat-rate use per month.

4) Unaccounted-for-water is total production less accounted-for-water. It is also the total of potentially billable water plus wastage, leakage and other uses.

5) Potentially billable water is the sum of:

- o Usage of borrowers from flat-rate primary users;
- o Unbilled flat-rate use
- o Wastage of flat-rate users

2. Weighted Average of First 10-City Survey

a. Objective - In a water system with all usage billed as flat-rate, computing for water accountability is impossible without resorting to detailed surveys. However, this method implies that the figures obtained during the first 10-area survey (CDM - 1975) approximate those of other water districts. Accuracy, however, is not determined.

b. Data Necessary - Total monthly production and figures obtained during the First 10-Area Survey of CDM.

c. <u>Steps</u>

Multiply monthly production by:

.31 to get accounted-for-water
.11 to get underestimated flat-rate use
.26 to get wastage
.25 to get leakage
.07 for others

3. <u>Field Study Method</u>

a. <u>Objective</u> - To be able to determine within ± 5 percent accuracy water accountability figures. This method, however, is time-consuming and very expensive.

b. <u>Data Necessary</u> - All data received shall be generated in the field. The number of concessionaires and the water rate schedule are basic requirements.

c. <u>Steps</u>

1) For each section of transmission and distribution line in the water system, appropriate measuring devices shall be installed in order to determine the amount of water flowing in and out, water used by the concessionaires, and water leakage.

2) Desk-top analysis is then necessary to determine water accountability.

METHODOLOGY MEMORANDUM NO. 3

To : L. V. Gutierrez, Jr.

From : P. del Rosario

Date : 8 February 1977

Subject: Classification of Water Districts According to Future Water Requirements

A. Introduction

The purpose of this methodology manual is to classify water districts (WD) so that future water requirements may be estimated. The factors to be considered in classifying WD's are economic and social development in the district's boundaries, probable sources of additional water supply and the people's ability-to-pay for improved water service.

The group with the probable highest per capita consumption is labelled Group I; and the group with the probable lowest water consumption, Group V. Affluent and highly urbanized water districts may fall under Group I, while less developed and small water districts, under Group V.

B. Methodology

The initial service area of the WD will most likely include the central urban area or core city (poblacion). To classify it according to future water demands, the WD and its central urban area are judged according to 5 grouping criteria - 1975 urban income, 1975 standard of living, 1975 business index, 1980 cost of water, and served population in 1980. For each criterion, a number of points, from 0 to 20, are allotted to each water district. The total number of points under the 5 criteria determines the classification of the WD.

Table MM 3-1 lists the 5 criteria by which the WD can be classified, and the points allotted to rankings in each criterion.

The grouping of the WD's based on the range of total points under the 5 criteria is as follows:

TABLE MM 3-1

WATER DISTRICT GROUPING CRITERIA

1975 Urban Income		1975 Standard of Living				1975 Business Index		1980 Cost of Water		1980 Served Population	
Income Taxes Paid by Urban Residents (P)	Points 20	% of Households with Refrigerators in Urban Area	Points 10	% of Households with Flush Toilets in Urban Area	Points 10	% of Commercial Establishments in Urban Area	Points 20	Source of Additional Water Supply	Points 20	Population Served in Urban Area	Points 20
more than 30,000,000	20	more than 30	10	more than 60	10	more than 6.6	20	Spring, gravity type	20	more than 150,000	20
10,000,001-30,000,000	18	25.1 - 30	9	50.1 - 60	9	4.6 - 6.6	16			100,001 - 150,000	18
5,000,001-10,000,000	16	20.1 - 25	8	40.1 - 50	8	3.1 - 4.5	11				
1,000,001- 5,000,000	14	15.1 - 20	7	30.1 - 40	7	1.7 - 3.0	7	Spring with booster pump	17	80,001 - 100,000	16
500,001- 1,000,000	12	10.1 - 15	6	20.1 - 30	6	1.0 - 1.6	4	Infiltration wells with short transmission line/ well points	14	65,001 - 80,000	14
100,001- 500,000	10	5 - 10	5	10 - 20	5	less than 1	2			52,001 - 65,000	12
50,001- 100,000	8	less than 5	4	less than 10	4			Infiltration wells with long transmission line/wells within service area	11	41,001 - 52,000	10
20,001- 50,000	6									31,001 - 41,000	9
8,001- 20,000	4							Surface water without reservoir	7	22,001 - 31,000	8
4,001- 8,000	2							Surface water with reservoir	5	15,001 - 22,000	7
4,000 or less	1									10,001 - 15,000	6
										less than 10,000	5

Group	Total Points
I	70 and above
II	60 - 69
III	50 - 59
IV	40 - 49
V	39 and below

In allotting points under each criterion, readily available data are taken from the latest NCSO report (1970 or 1975 census). These data are: total population in the city or municipality; total households; number of urban households; number of commercial establishments; number of industrial establishments; number of households with refrigerators; and number of households using flush water-sealed toilets. The data on total income taxes paid in the city/municipality in 1975 were obtained from the BIR office. Data on the probable sources of additional water supply were taken from the recent preliminary hydro-survey conducted by LWUA and the WD.

The following is a procedure for assigning points to a WD on the basis of the 5 criteria.

1. 1975 Urban Income

   Urban income is based on the total income taxes paid by individuals and business entities and the percentage of urban households with respect to total households in the city/municipality. If the 1975 data are not available, the percentage of urban households is projected to 1975 by applying an increase of 0.1 to 0.4 percent per year. In projecting the percentage of urban households, growth characteristics and urban development must be considered. The projected percentage is multiplied by 1975 total income. Table MN 3-1 shows the breakdown of the annual income with points ranging from 1 to 20.

2. 1975 Standard of Living

   The standard of living is measured by the number of households in the urban area with refrigerators and those with flush water-sealed toilets.

   The percentage of urban households with refrigerators with respect to total urban households is projected to 1975, if the 1975 census is not available. An increase of 1 to 4 percent per annum is applied, depending upon the recent economic and social development in the city/municipality. The same procedure is applied to the percentage of urban households using flush water-sealed toilets. Table MM 3-1 shows the percentages of households with refrigerators and those with flush toilets with respect to total urban households, with points ranging from 4 to 10.

3. 1975 Business Index

The business index is measured by the percentage of commercial establishments with respect to total urban households in 1975. One industrial establishment (data from NCSO census) is assumed to be equivalent to 10 commercial establishments (except when the 1975 census is available). An increase of 1 to 20 establishments per year is applied, depending on the recent business activities and urban development in the city/municipality. The number of urban households in 1975 is obtained by multiplying the 1975 total households (total population + average of 7 persons/household) by the 1975 percentage of urban households as derived in the methodology for 1975 urban income. The 1975 sum of commercial establishments divided by the number of 1975 urban households is the business index of the city/municipality. Table MM 3-1 shows the various levels of business index, with corresponding points ranging from 2 to 20.

4. 1980 Cost of Water

The cost of water is inferred from the probable source of additional water supply by 1980. The probable source of additional water supply is weighted according to its apparent economic viability. A spring source that is located within the 1980 service area and can flow by gravity is considered the most economical. Surface water requiring complete water treatment with impounding reservoir is the most expensive. Infiltration wells with short or long transmission lines, wells, or spring source requiring booster pump, are considered to have weights between the most and least expensive (see Table MM 3-1).

5. Served Population in 1980

The served population in 1980 is projected by delineating the future service areas of the WD and projecting the population of the city/municipality and of the service areas. The 1980 served population is determined as a portion of the service area population. In projecting the population served and the future service areas, economic growth and urban development, availability of water supply and capability of the water district to provide service must be considered.

C. Expected Water Demand By Class of WD

The experience of the LWUA-CDM staff, especially during the First Ten Urban Areas Project in the Philippines, has been used to assign values of expected water demand to the 5 classes of water districts. These expected water demands are shown in Table MM 3-2.

D. Example of Water District Classification

This method of classifying a water district is illustrated, with the Silay City Water District as an example. Available data for Silay City are taken from the NCSO and BIR reports, and from the preliminary hydro-survey by LWUA and the SIL-WD. The following data were obtained:

Total income taxes paid in the city - ₱20,049,139 (1974-1975)

Total population in the city - 103,493 (1975)

Total number of households in the city - 10,915 (1970)

Total number of households in the urban area - 3,693 (1970)

Total number of commercial establishments in the city - 36 (1970)

Total number of industrial establishments in the city - 1 (1970)

Total urban households with refrigerators - 266 (1970)

Total urban households using flush water-sealed toilets - 807 (1970)

Probable source of additional water supply - wells (1980)

Population in the service area - 21,280 (1980)

To determine the specific weights of the above data for each grouping criterion, the methodology developed is applied as follows:

TABLE MM 3-2

WATER DEMAND OF WATER DISTRICT GROUPINGS

Classification	Year 1980	Year 1990	Year 2000
Group I			
Domestic use, lpcd	140	155	175
Commercial/Industrial/Institutional			
% of domestic	17	21	20
Equivalent, lpcd	24	33	35
Accounted-for-water, lpcd	164	188	210
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	109	73	52
Total production required, lpcd	273	261	262
Group II			
Domestic use, lpcd	120	135	150
Commercial/Industrial/Institutional			
% of domestic	15	17	20
Equivalent, lpcd	18	23	30
Accounted-for-water, lpcd	138	158	180
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	92	62	45
Total production required, lpcd	230	220	225
Group III			
Domestic use, lpcd	105	120	135
Commercial/Industrial/Institutional			
% of domestic	13	16	18
Equivalent, lpcd	14	19	24
Accounted-for-water, lpcd	119	139	159
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	79	54	40
Total production required, lpcd	198	193	199

TABLE MM 3-2 (Continued)

WATER DEMAND OF WATER DISTRICT GROUPINGS

Classification	Year 1980	Year 1990	Year 2000
Group IV			
Domestic use, lpcd	95	110	125
Commercial/Industrial/Institutional			
% of domestic	12	14	16
Equivalent, lpcd	12	15	20
Accounted-for-water, lpcd	107	125	145
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	71	49	36
Total production required, lpcd	178	174	181
Group V			
Domestic use, lpcd	90	100	110
Commercial/Industrial/Institutional			
% of domestic	10	13	15
Equivalent, lpcd	9	13	17
Accounted-for-water, lpcd	99	113	127
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	66	44	32
Total production required, lpcd	165	157	159

1. 1975 Urban Income

In 1970, the urban households accounted for 33.8 percent of the total households in the city. But due to recent developments in the local economy and subdivision housing projects in the urban sector of the city, the number of urban households was projected to increase to 35 percent in 1975. The product of the total 1974-1975 income taxes and the 1975 percentage of urban households represents the ban income taxes which amount to about ₱7.037 million. Table MM 3-1 gives this a weight of 10 points.

2. 1975 Standard of Living

This is measured by:

a. 1975 urban households using refrigerators

In 1970, 7.2 percent of the urban households had refrigerators. Due to economic and housing developments, the percentage was estimated to increase to about 12 percent in 1975. Table MM 3-1 gives this a weight of 6 points.

b. 1975 urban households using flush water-sealed toilet facilities

In 1970, the households with toilet facilities represented 21.9 percent of urban households. Due to the recent housing developments in the urban area, the households with toilet facilities were projected to be about 32 percent in 1975. Table MM 3-1 gives this a weight of 7 points.

3. 1975 Business Index

It is assumed that one industrial establishment is equivalent to 10 commercial establishments. Based on the 1970 census, the number of commercial establishments (equivalent industrial establishments included) was 46 (36 + 10). These establishments were expected to have increased to 96 (at 10 establishments per year) in 1975. Total urban households increased from 3,693 in 1970 to about 5,180 in 1975 (1975 population of 103,493 ÷ average 7 persons/household). Hence, the business index in 1975 was 1.9 percent (commercial establishments divided by the number of urban households in 1975). Table MM 3-1 gives this a weight of 7 points.

4. 1980 Cost of Water

Based on the hydro-survey of LWUA-CDM and SIL-WD, deepwells appear to be the most probable eocnomical source of additional supply. Table MM 3-1 gives a weight of 11 points for this source.

5. 1980 Served Population

By 1980, the served population is expected to be about 15,630[1] as projected from the 1975 NCSO Census of Population and Housing. Table MM 3-1 gives this a weight of 7 points.

Therefore, the SIL-WD has a total of 54 points under the 5 criteria, indicating that it belongs to Group III. The water demands of this group from 1980 to year 2000 are listed in Table MM 3-2.

Table MM 3-3 classifies 24 water districts in the Philippines according to the 5 grouping criteria.

1/ See Chapter VI, Table VI-3, of the Silay City Feasibility Study Report.

TABLE MM 3-3

SUMMARY OF CITIES/MUNICIPALITIES SUBJECTED
TO THE WATER DISTRICT GROUPING CRITERIA

City/Municipality	1975 Urban Income (Points)	1975 Standard of Living: Urban Households with Refrigerators (Points)	1975 Standard of Living: Urban Households with Flush Toilets (Points)	1975 Business Index (Points)	1980 Cost of Water Source of Supply (Points)	1980 Served Population (Points)	Total Points	Group
Bislig, Surigao del Sur	14	6	7	11	14	7	59	3
Urdaneta, Pangasinan	6	7	9	11	11	6	50	3
Calamba, Laguna	14	9	10	7	17	6	63	2
Gapan, Nueva Ecija	6	8	9	7	11	6	47	4
Silay City	16	6	7	7	11	7	54	3
Cebu City	20	10	10	7	5	20	72	1
Davao City	16	9	9	16	11	10	71	1
Bacolod City	20	9	9	7	11	18	74	1
Zamboanga City	14	7	9	7	7	16	62	2
Digos, Davao del Sur	12	6	9	7	11	5	50	3
Bacacay, Albay	1	5	9	11	20	5	51	3
Bangued, Abra	1	6	8	7	20	6	48	4
Dalaguete, Cebu	1	5	8	4	11	5	34	5
Baybay, Leyte	10	9	8	16	9	6	58	3
Roxas City	10	9	8	16	7	6	56	3
Cotabato City	12	9	8	11	11	7	58	3
Olongapo City	18	9	10	20	11			1
Subic	4	5	6	16	11	5	47	4
San Fernando (Pampanga)	14	6	7	20	11	7	65	2
Tarlac	12	8	8	16	11	8	63	2
Cabanatuan City	12	8	10	11	11	9	61	2
Lipa City	8	8	10	16	11	7	60	2
Lucena-Pagbilao-Tayabas	14	6	8	7	17	12	64	2
Daet	10	5	4	4	20	10	53	3

Methodology Memorandum No. 4

To : L. V. Gutierrez, Jr.

From : E. Jacildo

Date : 20 January 1977

Subject: Probability Analysis of Stream Flows by Gumbel

A. Need

In evaluating the surface water sources for water supply purposes, the analyst has to focus his interest on statistical frequency of extreme low flows. Since the exact sequence of streamflow for future years cannot be predicted, he also has to consider the probable variations in flows in order to develop a design on the basis of calculated risk.

In 1941, E. J. Gumbel devised a probability method by which recurring flows can be computed for design requirements. Under this method, the hydrologic data are analyzed as an "extreme value" distribution and the sets of hydrologic data are plotted as straight lines. Gumbel's method has been found advantageous to use.

B. Basic Data

The hydrologic data are found in Surface Water Supply Bulletins published by the Water Resources Division of the Bureau of Public Works (BPW). Data are presented in the following sequence:

1. Name of river basin
2. Name of stream
3. Location of gaging station in latitude and longitude
4. Drainage area in square kilometers
5. Records available: months and year
6. Gage elevation
7. Extremes; magnitude and dates of maximum and minimum flows
8. Remarks
9. Revisions
10. Presentation of daily discharge for one year

It should be noted that Surface Water Supply Bulletins after 1967 have not been published; they are on file at the BPW Water Resources Division.

C. Methodology

Below are the steps in Gumbel's probability analysis of streamflows.

Table MM4-1

1. Tabulate the monthly flows (mean, minimum or maximum, whatever is desired).
2. Take note of any changes in the yearly records as stated under "Remarks" or "Revisions" of the Bulletin. Write them under remarks in Table MM4-1.

Table MM4-2

1. Arrange all monthly flows in ascending order, i.e., from lowest to highest. Any flow that occurs more than once should be listed.
2. Rank the arranged flows under "m".
3. Take the logarithm of Q.
4. Solve for the probability flow by the formula

   $$\frac{m}{n+1} \times 100$$

   where, m is the rank of a particular flow
   n is the total number of recorded flows.
5. Solve for the return period by the formula

   $$\frac{n+1}{m}.$$

Figure MM4-1

1. Plot log Q as ordinate against probability as abscissa. Figure MM4-1 is Gumbel's special probability paper.
2. Draw a straight line (month line) passing through the points marked in step C-1. If not all the points fall on the line, adjust the line such that it passes on the average path of the points. Any return period which falls on the line is in month's term. The line may be extended in order to reach periods not covered by it.
3. Take the antilogarithms of the values of return periods in months as projected on the log Q scale (ordinate). The antilogs are the recurring flows in cubic meters per day.

TABLE MM4-1

MEAN-DAY DISCHARGE PER MONTH

Basin: Pampanga (San Vicente)

Station: Peñaranda River

Location: lat. 15°18'46"; long. 120°56'30"

Drainage Area: 575 sqkm

Gage Elevation: 11,050 m

Units: cumd x 1,000

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Minimum-Day Discharge/ Year	Remarks
1965	-	2,283	753	351	372	1,313	-	-	-	3,239	5,156	4,358		
1966	-	2,915	-	-	8,941	1,595	2,682	4,215	5,425	1,413	9,801	5,380		
1967	4,922	857	1,189	547	873	425	1,012	6,614	4,415	5,707	5,896	125		
1968	66	77	120	540	96	-	-	-	-	-	-	117		
1969	141	32	336	689	664	301	3,203	2,394	2,248	1,175	1,785	2,190		
1970	1,989	814	279	17	17	3,561	2,928	1,628	9,590	11,726	9,689	6,915		
1971	3,123	642	732	294	1,499	4,567	4,021	1,824	1,377	11,161	5,229	15,007		
1972	5,992	4,873	406	1,461	767	415	18,347	15,977	6,306	216	4,701	2,896		
1973	697	823	82	108	95	686	2,525	2,650	4,405	14,582	4,149	2,124		
1974	1,405	1,332	2,191	471	621	3,781	3,497	10,761	10,014	12,567	16,317	13,693		

TABLE MM4-2

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability ($\frac{m}{n+1}$ x 100)	Return Period (Months) ($\frac{n+1}{m}$)
1	17	4.230	0.93	108.00
2	17	4.230	1.85	54.00
3	32	4.505	2.78	36.00
4	66	4.820	3.70	27.00
5	77	4.886	4.63	21.60
6	82	4.914	5.56	18.00
7	95	4.978	6.48	15.43
8	96	4.982	7.41	13.50
9	108	5.033	8.33	12.00
10	117	5.068	9.26	10.80
11	120	5.079	10.18	9.82
12	125	5.097	11.11	9.00
13	141	5.149	12.04	8.31
14	216	5.334	12.96	7.71
15	279	5.446	13.89	7.20
16	294	5.468	14.82	6.75
17	301	5.478	15.74	6.35
18	336	5.526	16.67	6.00
19	351	5.545	17.59	5.68
20	372	5.570	18.52	5.40
21	406	5.608	19.44	5.14
22	415	5.618	20.37	4.91
23	425	5.628	21.30	4.70
24	471	5.673	22.22	4.50
25	540	5.732	23.15	4.32
26	547	5.738	24.07	4.15
27	621	5.793	25.00	4.00
28	642	5.808	25.93	3.86
29	664	5.822	26,85	3.72
30	686	5.836	27.78	3.60
31	689	5.838	28.70	3.48
32	697	5.843	29.63	3.38
33	732	5.864	30.56	3.27
34	753	5.877	31.48	3.18
35	767	5.885	32.41	3.08
36	814	5.911	33.33	3.00
37	823	5.915	34.26	2.92
38	857	5.933	35.18	2.84

TABLE MM4-2 (continued)

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability ($\frac{m}{n+1}$ x 100)	Return Period (Months) ($\frac{n+1}{m}$)
39	873	5.941	36.11	2.77
40	1,012	6.005	37.04	2.70
41	1,175	6.070	37.96	2.63
42	1,189	6.075	38.889	2.57
43	1,313	6.118	39.815	2.51
44	1,332	6.124	40.741	2.45
45	1,377	6.139	41.667	2.40
46	1,405	6.148	42.592	2.35
47	1,413	6.150	43.518	2.30
48	1,461	6.165	44.444	2.25
49	1,499	6.176	45.370	2.20
50	1,595	6.203	46.296	2.16
51	1,628	6.212	47.222	2.12
52	1,785	6.252	48.148	2.08
53	1,824	6.261	49.074	2.04
54	1,989	6.299	50.000	2.00
55	2,124	6.327	50.926	1.96
56	2,190	6.340	51.852	1.93
57	2,191	6.341	52.778	1.89
58	2,248	6.352	53.704	1.86
59	2,283	6.358	54.630	1.83
60	2,394	6.379	55.555	1.80
61	2,525	6.402	56.481	1.77
62	2,650	6.423	57.407	1.74
63	2,680	6.428	58.333	1.71
64	2,896	6.462	59.259	1.69
65	2,915	6.465	60.185	1.66
66	2,928	6.466	61.111	1.64
67	3,123	6.494	62.037	1.61
68	3,203	6.506	62.963	1.59
69	3,209	6.510	63.889	1.56
70	3,497	6.544	64.815	1.54
71	3,561	6.552	65.741	1.52
72	3,781	6.578	66.667	1.50
73	4,021	6.604	67.592	1.48
74	4,149	6.618	68.518	1.46
75	4,215	6.625	69.444	1.44
76	4,358	6.639	70.370	1.42

TABLE MM4-2 (continued)

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability $(\frac{m}{n+1} \times 100)$	Return Period (Months) $(\frac{n+1}{m})$
77	4,405	6.644	71.296	1.40
78	4,415	6.645	72.222	1.38
79	4,567	6.660	73.148	1,37
80	4.701	6.672	74.074	1.35
81	4,873	6.688	75.000	1.33
82	4,922	6.697	75.926	1.32
83	5,156	6.712	76.852	1.30
84	5,229	6.718	77.778	1.28
85	5,380	6.731	78.704	1.27
86	5,425	6.734	79.630	1.26
87	5,707	6.756	80.556	1.24
88	5,896	6.770	81.481	1.23
89	5,992	6.778	82.407	1.21
90	6,306	6.800	83.333	1.20
91	6,614	6.820	84.259	1.19
92	6,915	6.840	85.185	1.17
93	8,941	6.951	86.111	1.16
94	9,590	6.982	87.037	1.15
95	9,689	6.986	87.963	1.14
96	9,801	6.991	88.889	1.12
97	10,014	7.001	89.815	1.11
98	10,761	7.032	90.741	1.10
99	11,161	7.048	91.667	1.09
100	11,726	7.069	92.592	1.08
101	12,567	7.099	93.518	1.07
102	13,693	7.136	94.444	1.06
103	14,582	7.164	95.370	1.05
104	15,007	7.176	96.296	1.04
105	15,977	7.203	97.222	1.03
106	16,317	7.213	98.148	1.02
107	18,347	7.264	99.074	1.01

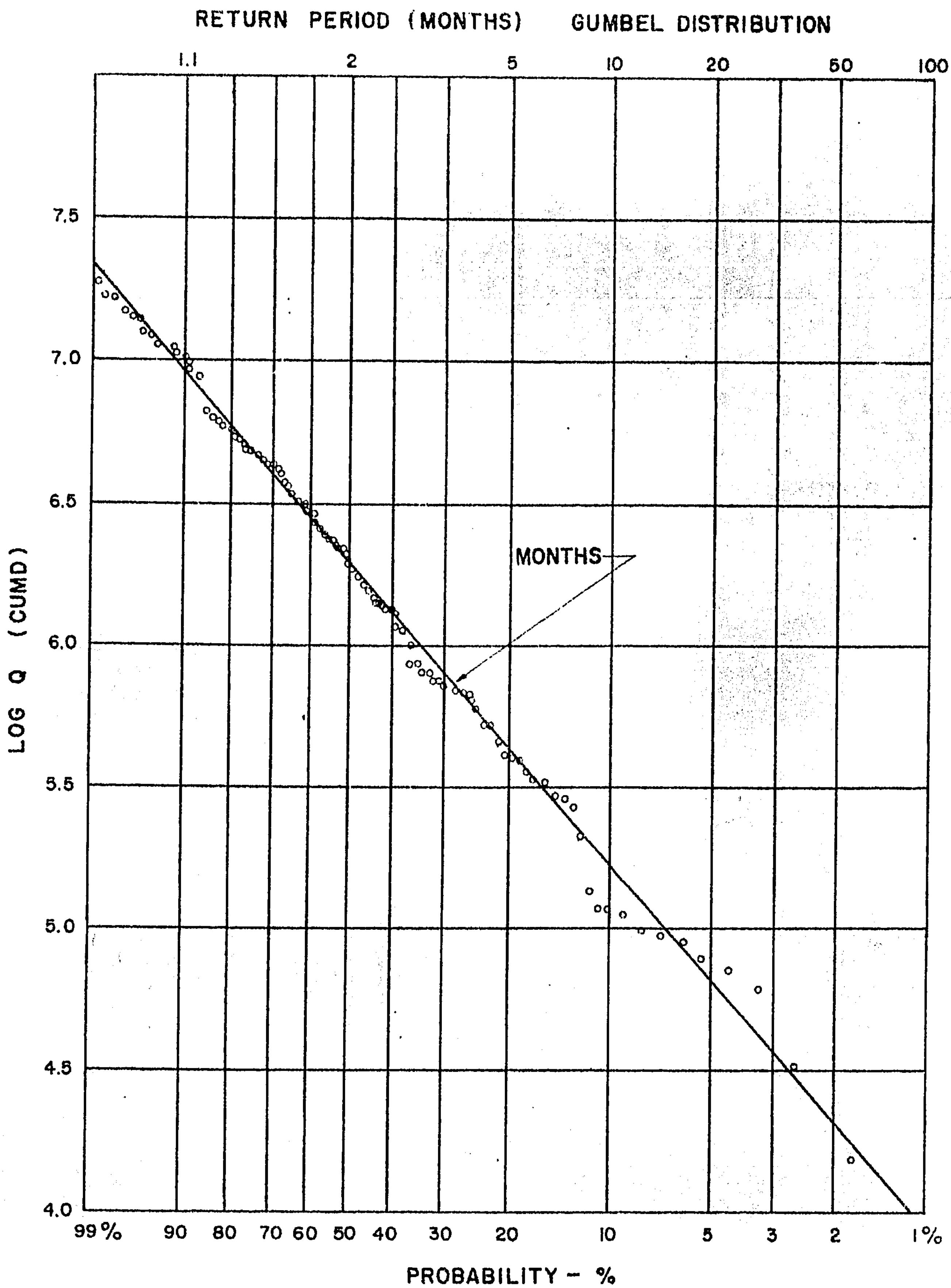


FIGURE MM4-1
MONTHLY MEANFLOW
(PENARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

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

Methodology Memorandum No. 5

To : L. V. Gutierrez, Jr.

From : J. B. Arbuthnot/B. R. Conklin

Date : 16 May 1977

Subject: Quantity of Storage Versus Rate of Supply

A. General

The demand for water in a water system is not uniform, therefore, the system must be designed to supply water at varying rates of demand.

One common method of supplying water at varying rates is to provide a specific amount of source pumping capacity and supply the difference between demand and pumping capacity from a water storage facility.

The most economical amount of pumping capacity and storage volume is selected based on cost studies of alternative combinations of facilities that would meet a community's needs. Some of the factors that should be considered in these cost studies and some basic guidelines for selecting properly sized facilities are presented in this memorandum.

B. Discussion

The amount of water a community needs at any particular instant is primarily dependent on the following factors:

1. The number of people within the community
2. The number of water-consuming facilities within the average home (faucets, toilets, showers, automatic washing appliances, etc.)
3. The habits of people (what times people eat, shower, sleep, etc.)

In general, daily usage of water follows a pattern with two peak usage periods during the day and low usage late at night. Figure KM5-1 shows a typical variation measured in a section of the Cebu City distribution system.

The relationship of the peak usage on an average day can be determined statistically for a given community. The statistical peak is an average of each person's peak usage and has two important properties:

1. The statistical peak is a function of the number of people in the community. The fewer people, the higher the peak may be because each person's peak usage could more easily affect the total flow.

2. The statistical peak should be recognized as a mathematical average, and on some days the peak usage could be much higher or lower than the statistical peak.

The common engineering practice for water systems is to supply water from a source at maximum-day rates either by pumping or gravity. Maximum-day demand is the maximum quantity of water used during an entire day in a single year. Water usage can be at or near maximum-day demand for a period of weeks during summer months. Source capacity must equal maximum-day demand because it would be impractical to store sufficient water to supply maximum-day demand rates for more than a few days.

The difference in demand between the peak-hour demands and the supply (which is equal to maximum-day demands) occurs during a period of short duration where demand exceeds supply. Stored water is used to meet this short period of excess demand and is called operational storage. It should be noted at this time that there are three categories of storage:

1. Operational storage - used to meet hourly fluctuations in demand.

2. Emergency storage - used to meet demands in case of breakdowns in source facilities; typically equal to a full day's demand.

3. Fire storage - used to meet the required volume of water used to extinguish the worst fire expected in the community.

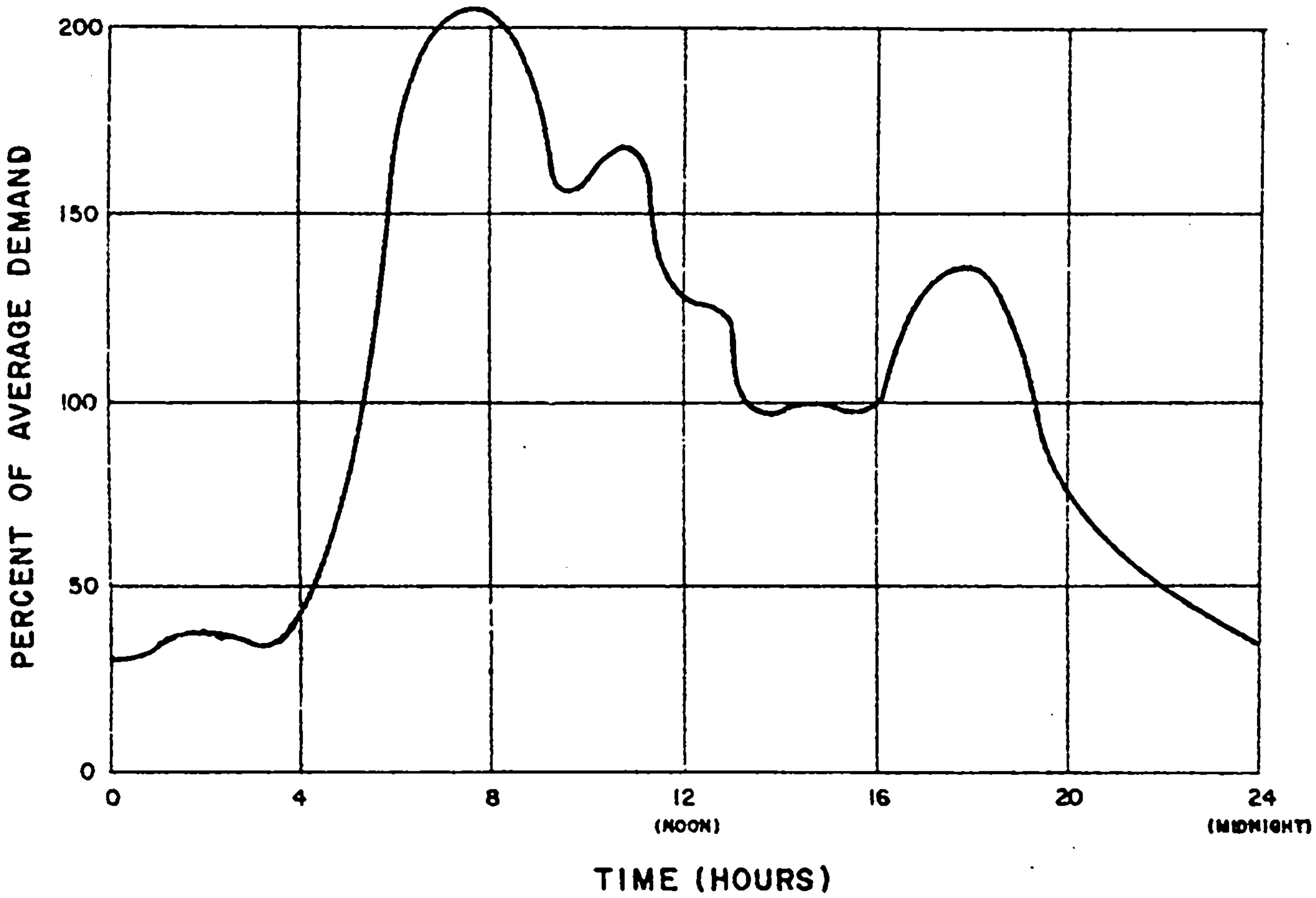


FIGURE MM5-1
DAILY USAGE PATTERN

Storage requirements for the last two categories have been largely neglected in these studies because of the excessive cost involved to provide the storage.

C. Methodology

The engineer must determine the amount of storage and source capacity to meet the demands in a specific community. A set of curves that relate the peak hourly usage to the number of people in a community has been developed by CDM and others.[1/] Practice has shown that a volume of about 15 to 20 percent of the maximum-day usage is required as operational storage if source facilities can supply maximum-day demands. Combining the "peaking curves" with the operational storage requirement, a second set of curves relating the quantity of storage to the number of people, at different rates of source supply, has been developed (see Figure MM5-2).

Up to this point, the only option that has been discussed is to supply peak-hour demands from storage facilities. In many cases, the cost of storage facilities is so high that it may be more economical to provide additional source capacity and reduce the quantity of storage. This is especially true where storage is provided in elevated structures that are very costly, since they are built to withstand earthquakes. The curves in Figure MM5-2 have been used in this study to determine the requirements for storage at various supply rates in order to prepare cost comparisons of alternative supply and storage combinations.

[1/] ASCE Manual of Practice No. 37.

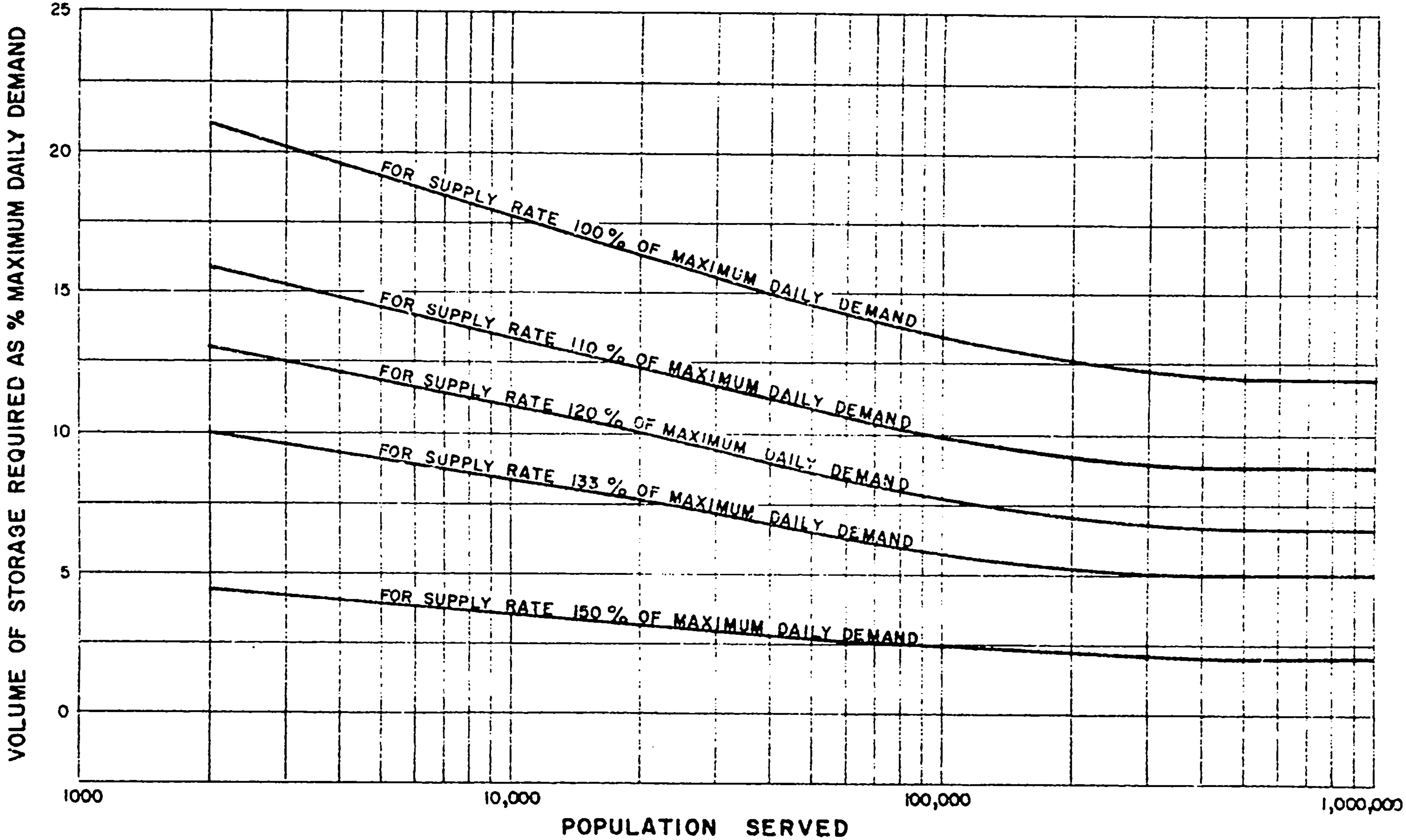


FIGURE MM 5-2
STORAGE REQUIRED
TO MEET
DAILY PEAK WATER DEMAND

Methodology Memorandum No. 6

To : L. V. Gutierrez, Jr.

From : J. Arbuthnot; B. Conklin

Date : 22 March 1977

Subject: Economical Sizing of Pumped Waterlines

A. General

This memorandum develops an expression for the most economic size of a pipeline for pumped water systems based on two cost factors: cost of pipe-in-place and cost of pumping (energy). The larger the pipe the greater the cost of construction. Also, the larger the pipe the lesser the cost of energy required to pump water through the pipe. The most economic pipe sizes would be where the incremental cost of pumping is equal to the incremental cost of pipe construction.

In most situations, the above cost factors are the most important factors in determining the economical size of transmission mains. Even when these are not the only important factors, it is still advantageous to know what is the most economic size of pipe with regard to these two factors.

B. General Relationship

The total annual cost of a pipe line is equal to the sum of its construction cost (expressed on an amortized annual basis) plus its annual pumping cost.

$$C_t = C_c + C_p \quad 1/$$

To determine the most economic pipe diameter both the factors on the right hand side of the equation were expressed in terms of the diameter of the pipe. The equation was then differentiated with respect to the diameter, and solved for the diameter for which the resulting expression was equal to zero.2/

1/ Total Annual Cost = Annual Construction Cost + Annual Pumping Cost.

2/ $\frac{d(C_t)}{dx} = \frac{d(C_c)}{dx} + \frac{d(C_p)}{dx} = 0$, where X = pipe diameter

C. Annual Construction Cost

The construction cost of the pipe was taken from Table G-4 of Appendix G, Basis of Cost Estimates, in Volume II of the final report. Costs were adjusted by adding a value for necessary valves and by escalating these by 10 percent per year for 2 years to obtain July 1978 construction costs. These costs were then increased by 15 percent for contingencies and then by 10 percent for engineering. The following equation was derived and represents the adjusted construction costs in Table G-4 in terms of the diameter.

$$C = 2845\ (\text{Dia.})^{1.292} \quad \text{- - - - Equation 1}$$

C is the installed cost of pipe in pesos per meter, and Dia, the diameter of the pipe in meters.

The amortized annual cost of construction is the cost of construction multiplied by the capital recovery factor (as influenced by the economic life of the pipe and discount factor). The general equation is:

$$\text{Annual Cost of Construction} = \text{CRF} \times 2845(\text{Dia.})^{1.292}$$

- - - - Equation 2

where CRF is the capital recovery factor; for n = 50 years, discount rate = 12%, CRF is equal to 0.12042.

D. Annual Pumping Cost

The annual cost of pumping energy may be expressed in terms of the amount of water pumped, the energy required to overcome the frictional loss in the pipe, the price of electrical energy and the efficiency of the pumping machinery. The general equation may be written as:

$$\text{Annual Cost of Pumping Energy} = \frac{\text{Mass/Year} \times g \times \text{Hf} \times \text{₱/kwh}}{\text{efficiency} \times 3.6 \times 10^{6}}$$

- - - - Equation 3

where mass/Year is the amount of water pumped in kilograms; g, the gravitational constant; Hf, the energy lost by friction of flow in the pipe expressed in meters; ₱/kwh, the cost of energy in pesos per kilowatt hour; and 3.6×10^{6}, the number of newton-meters per kilowatt hour.

The friction loss of energy in the pipe may be expressed in terms of the diameter utilizing the Hazen-Williams (H&W) equation,

$$Hf = \frac{L \times MLD^{1.852}}{361.27\ C^{1.852}\ D^{4.87}} \quad \text{- - - - Equation 4}$$

where L is the length of pipe in meters; MLD, the flow of water in million liters per day; C, the Hazen & Williams roughness coefficient; and Dia, the diameter of the pipe in meters.

E. Minimum Cost Diameter

The expression for minimum cost diameter may be obtained by inserting the expression for Hf in the equation for the cost of pumping energy, combining this with the expression for the annual cost of construction, differentiating, setting the resulting expression equal to zero and solving for the diameter:

$$\text{Minimum Cost Diameter} = \frac{MLD^{0.4628} \times (pesos/kwh)^{0.1623}}{2.391\ (efficiency)^{0.1623}\ C^{0.3005}\ (A/P,\ X\%,\ n)^{0.1623}}$$

using a C value of 120 and a capital recovery factor of 0.12042, the following equation is obtained:

$$\text{Minimum Cost Diameter} = \frac{MLD^{0.4628}(pesos/kwh)^{0.1623}}{7.149\ (efficiency)^{0.1623}} \quad \text{- - - - Equation 5}$$

The above equation is expressed graphically in Figure MM 6-1.

F. Limitations of the Analysis

How reliable is the preceding relationship (Equation 5), between water carried and economic pipe diameter? The derivation is rigorous but the relation is no more exact than are the simplifying assumptions upon which the derivation was based:

1. Construction Cost Relationship

The construction cost relation (Equation 1) has a standard deviation of just under 10 percent. This means that two-thirds of the time the formula will represent the adjusted costs tabulated, within 10 percent. The largest difference observed was 20 percent. Even so, economic conditions and the cost of pipe may change in time. Probably a new table of pipe costs has to be made every 2 or [illegible] years, and the formulas, along with Figure MM 6-1, adjusted accordingly.

2. Other Assumptions

Other assumptions are:

C = 120 (Hazen & Williams coefficient)
i = 12% (Discount rate)
n = 50 years (Economical life of pipe)

The derivation also assumes that for the changes in pumping head, using various pipe sizes for a design flow, the total construction cost of the pumping station remains constant. This assumption is reasonable since the difference in cost between one pump selection and another for different heads at the same flow would not alter the cost of the complete station by significant amount. Generally, the installed motor horsepower would also be the same since the motors come in standard sizes and one size may be used for a number of different pump selections at a given flow.

The relative rate of inflation for pipeline construction is assumed equal to that of power costs.

3. Flow Quantities are Based on Constant Flow

The derivation of the most economic pipe diameter is based on a constant rate of flow within the pipe. This is probably the most general and therefore the least accurate of any of the assumptions.

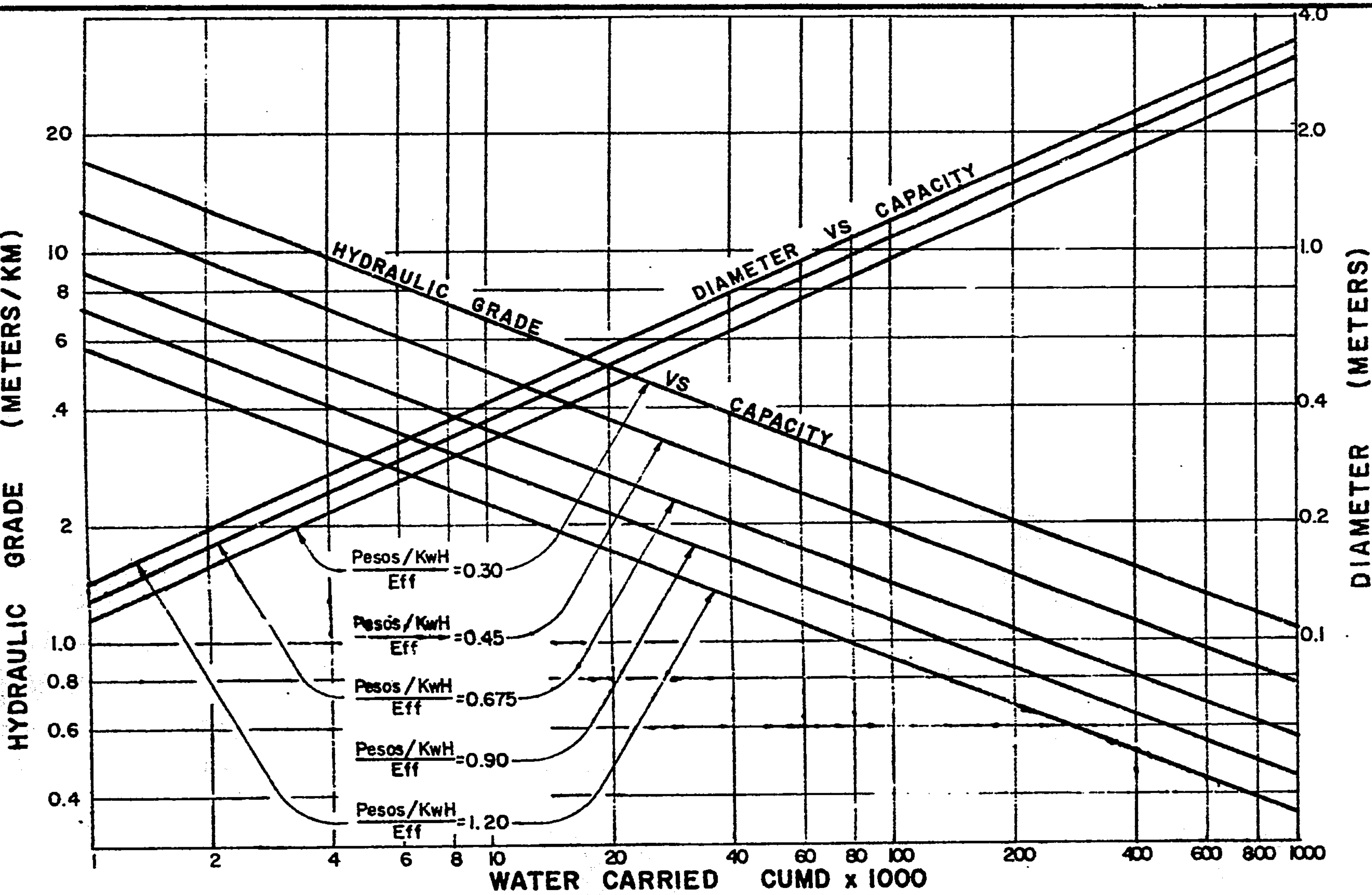
Normally a pipeline is designed for a specific flow condition; even under design conditions that flow may occur only part of the time. The flow in a transmission main could be expected to nearly equal the design flow for long period of time. However, in a distribution main, sized for peak-hour flows, the flow may not be equal to the design flow except for very short periods of time.

The variation in energy costs due to a fluctuating pumping rate through a pipeline can be calculated and applied to adjust the most economic pipe diameter determined from Figure MM 6-1. This so-called "energy variability factor" is discussed in the following section.

G. Energy Variability Factor

Figure MM 6-1 is based on selecting a pipeline where the flow will be constant throughout the year. In most cases, pipeline sizes are selected on a maximum expected rate of flow. If the flow through the pipeline is less than the design flow, the pumping head (which directly affects energy costs) would decrease according to the 2.852 power of the flow (Q). Conversely, if flow greater than design flow rate is pumped through a pipeline, the energy cost would be increased by the 2.852 power.

The overall difference in energy costs over the day or year can be calculated by comparing the costs of pumping at a constant flow rate with the cost of pumping at the expected flow variation. This value is the so-called "energy variability factor" (EVF). The design flow for the pipe is used as the base flow and the actual flow to the design flow over the day is expressed as a percent.



Note : 1. CONSIDERS CONSTRUCTION AND PIPELINE FRICTION COSTS ONLY INCLUDING ENGINEERING AND CONTINGENCIES
2. AVERAGE C = 120 OVER 50 YEARS
3. ECONOMIC DISCOUNT RATE = 12 %
4. PIPE COST (MID 1978 PRICES) = $2845D^{1.29}$ PER METER, (D IN METERS)

FIGURE MM6-1
MOST ECONOMIC WATER TRANSMISSION

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

The method used is to raise the difference between actual flow and the base flow (expressed as a percentage) to the 2.852 power. The ratio of the sum for the day of the actual flow to the design flow each raised to the 2.852 power is equal to the EVF. Figure MM 6-2 and Table MM 6-1 present two possible flow variations and the calculated energy variability factor for each.

The two flow patterns selected for Figure MM 6-2 are not commonly used design curves. Pattern 1 was selected to show that if a higher rate of flow than the design flow is pumped through the pipeline during a portion of the day, the EVF is greater than 1.0. Pattern 2 shows that if the actual flow rate is nearly equal to the design flow, the EVF would be nearly equal to 1.0.

An EVF of less than 1.0 would be a more common occurrence since the majority of pipelines are designed for some maximum future flow. The suggested EVF in a following section is an example of an EVF less than 1.0.

I. Application of EVF

The EVF can be used with Figure MM 6-1 in calculating the minimum cost pipe diameter. The EVF is inserted into the annual energy cost equation (equation 3) and then included in the differentiation, resulting in a revised equation as follows:

$$\text{Minimum Cost Diameter} = EVF^{0.1623} \frac{MLD^{0.4628} \, (\text{Pesos/kwh})^{0.1623}}{7.149 \, (\text{efficiency})^{0.1623}} \quad \text{-- Equation 6}$$

The application of EVF requires 2 steps: first, design a minimum economic pipeline for some flow using Figure MM 6-1; and second, calculate the EVF for the actual flow variation and multiply the pipe size calculated in Step 1 by the EVF raised to the 0.1623 power.

J. Suggested EVF

The feasibility report on the Second Ten Provincial Urban Areas deals mainly with distribution pipelines; therefore, a suggested EVF that is applicable to distribution systems is presented herein.

The calculation of an EVF depends entirely on the flow data or assumed flow within a specific pipeline. The only accurate data produced during the feasibility studies are the diurnal flow variations measured in a portion of Cebu. The peak flow in the Cebu data was 2.06 which is greater than the design flows

TABLE MM 6-1

SAMPLE "EVF" FOR DIFFERENT FLOW PATTERNS

Hour	Flow Pattern No. 1		Flow Pattern No. 2	
	Percent of Average Day Demand	Energy Variation	Percent of Average Day Demand	Energy Variation
1	32	0.039	48	0.123
2	36	0.054	48	0.123
3	39	0.068	48	0.123
4	33	0.042	100	1.000
5	46	0.109	100	1.000
6	95	0.864	100	1.000
7	193	6.522	120	1.682
8	206	7.855	120	1.682
9	198	7.016	120	1.682
10	156	3.554	120	1.682
11	169	4.466	120	1.682
12	129	2.067	120	1.682
13	123	1.805	120	1.682
14	95	0.864	120	1.682
15	99	0.972	120	1.682
16	96	0.890	120	1.682
17	107	1.212	120	1.682
18	133	2.255	120	1.682
19	130	2.113	120	1.682
20	87	0.672	100	1.000
21	64	0.280	100	1.000
22	54	0.172	100	1.000
23	42	0.084	48	0.123
24	38	0.063	48	0.123
		44.038		28.481

$EVF_1 \frac{44.038}{24.000} = 1.83$ $EVF_2 \frac{28.481}{24.000} = 1.19$

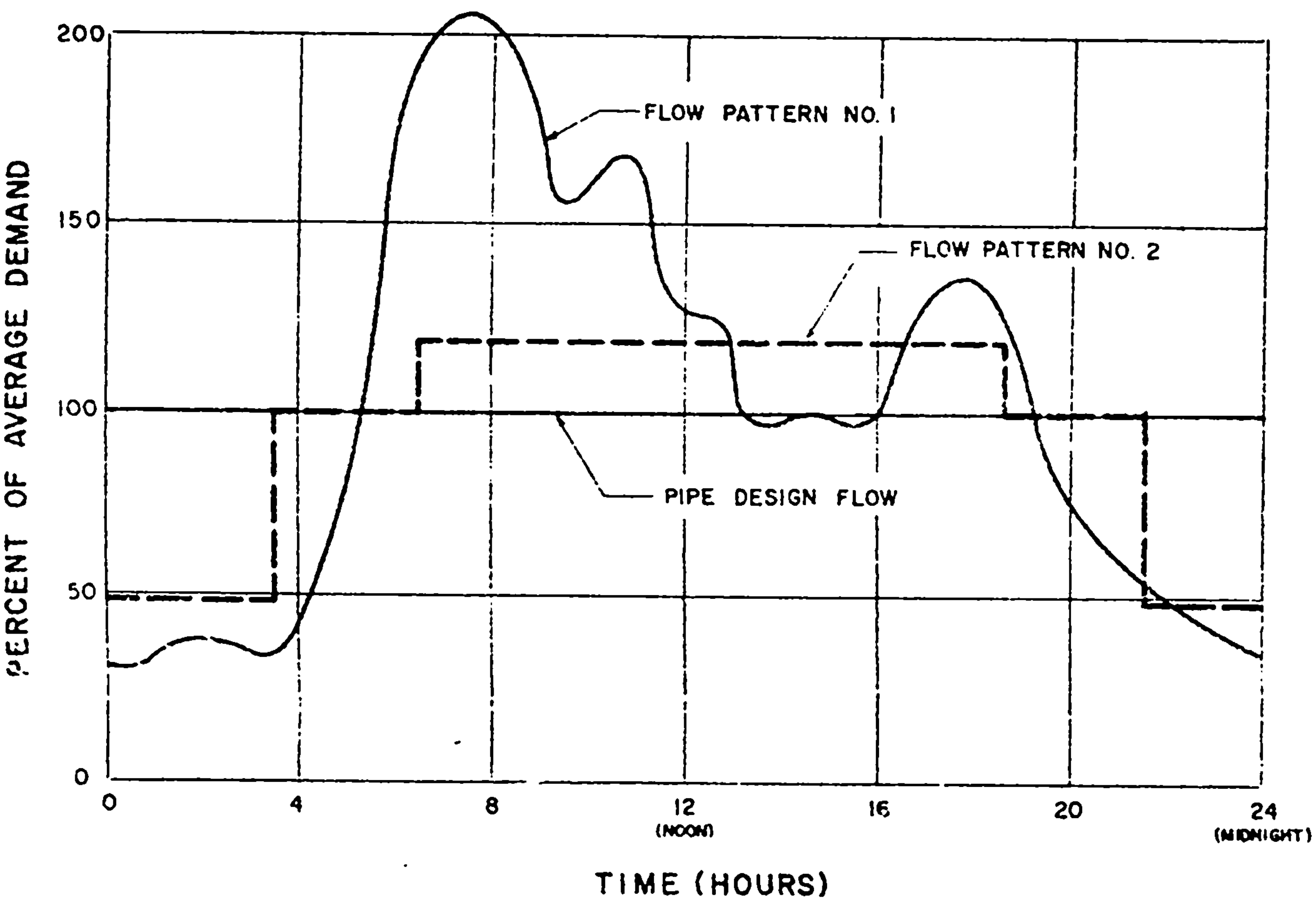


FIGURE MM6-2
SAMPLE FLOW PATTERNS

used for this study. Figure MM 6-3 presents an adjusted graph of diurnal flow using the shape of the Cebu curve but a maximum peak of 1.75. The EVF for this curve is equal to 0.32 (see Table MM 6-2) and when raised to the 0.1623 power, equals 0.83.

In practice, the EVF used for distribution systems in this study is only significant when the pipeline size is greater than 300 mm (significant means that EVF changes the recommended pipe size by a large incremental size).

K. Example

Problem: Select an economical distribution pipe size to convey a peak-hour flow of 20 MLD. The cost of power is 49 centavos per kilowatt hour, the pump efficiency is 81 percent, and the motor efficiency is equal to 90 percent.

Solution:

$$\frac{\text{Pesos/kwh}}{\text{Eff}} = \frac{.49}{.81 \times .90} = .672, \quad \text{say } .675$$

From Figure MM 6-1 using the flow of 20 MLD and Pesos/kwh/Eff = .675 select a pipe size of 500 mm.

For a flow variation in a distribution main, the EVF is equal to 0.32 and the EVF raised to the 0.1623 power is equal to 0.83. The most economical pipe size for the actual flow variation is equal to 0.83 x 500 m or 415 mm; so choose 400 mm pipe size.

TABLE MN 6-2

"EVF" FOR DISTRIBUTION SYSTEM

Hour	Percent of Average Day Demand	Percent of Design Flow[3]	Energy Variation[4]
1	35	20	0.010
2	40	23	0.015
3	39	22	0.013
4	37	21	0.012
5	73	42	0.084
6	134	77	0.475
7	164	94	0.838
8	175	100	1.000
9	174	99	0.972
10	163	93	0.813
11	162	93	0.813
12	134	77	0.475
13	118	67	0.317
14	94	54	0.172
15	94	54	0.172
16	94	54	0.172
17	105	60	0.233
18	129	74	0.424
19	123	70	0.362
20	96	55	0.182
21	72	41	0.079
22	58	33	0.042
73	47	27	0.024
24	40	23	0.015
			7.716

$$EVF = \frac{7.716}{24.000^*} = -.32 \qquad EVF^{0.1623} = 0.83$$

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[3] Using 175 percent of average day as base flow for pipe design.
[4] Equals Percent Design Flow raised to the 2.852 power.
* Energy variation at constant flow

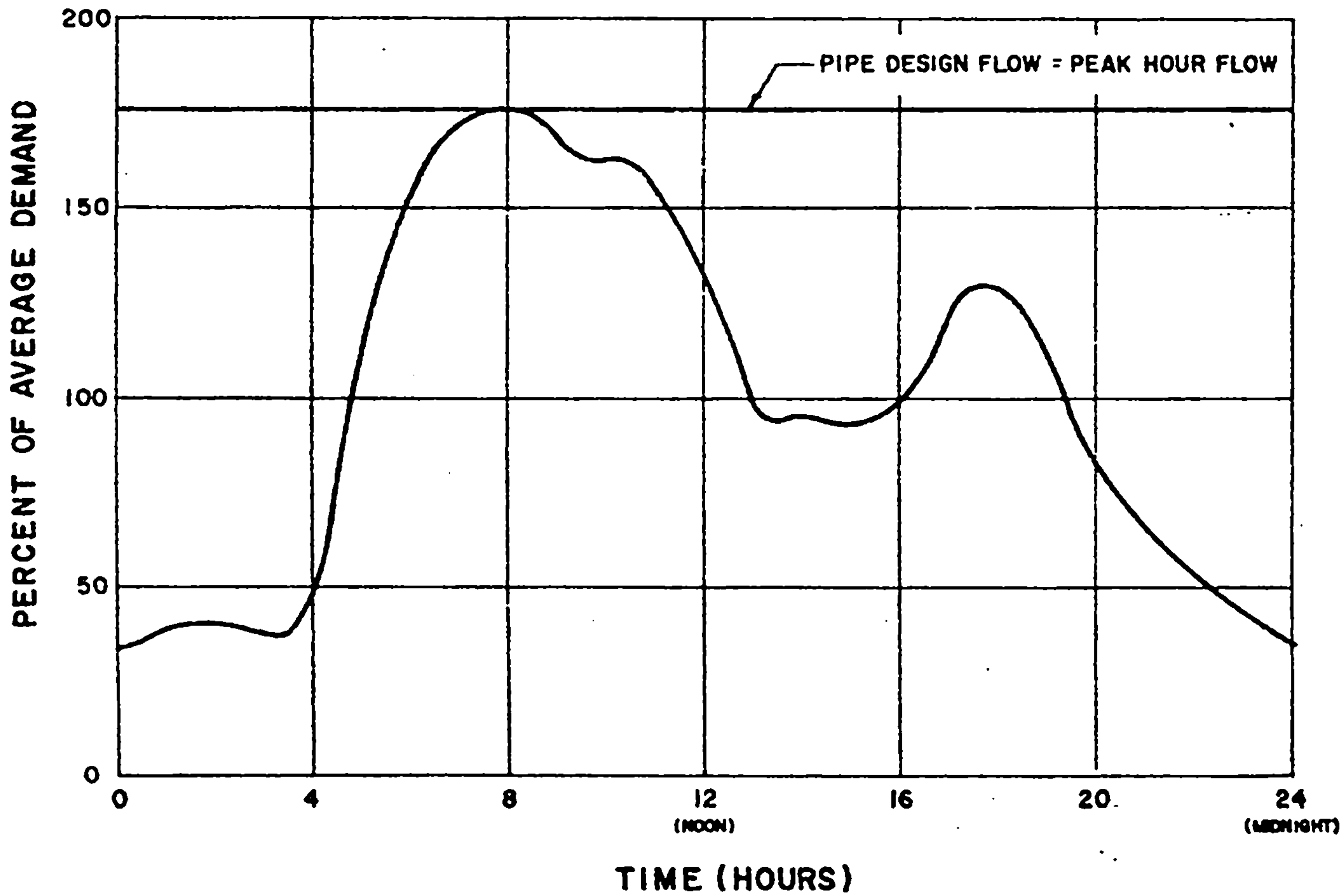
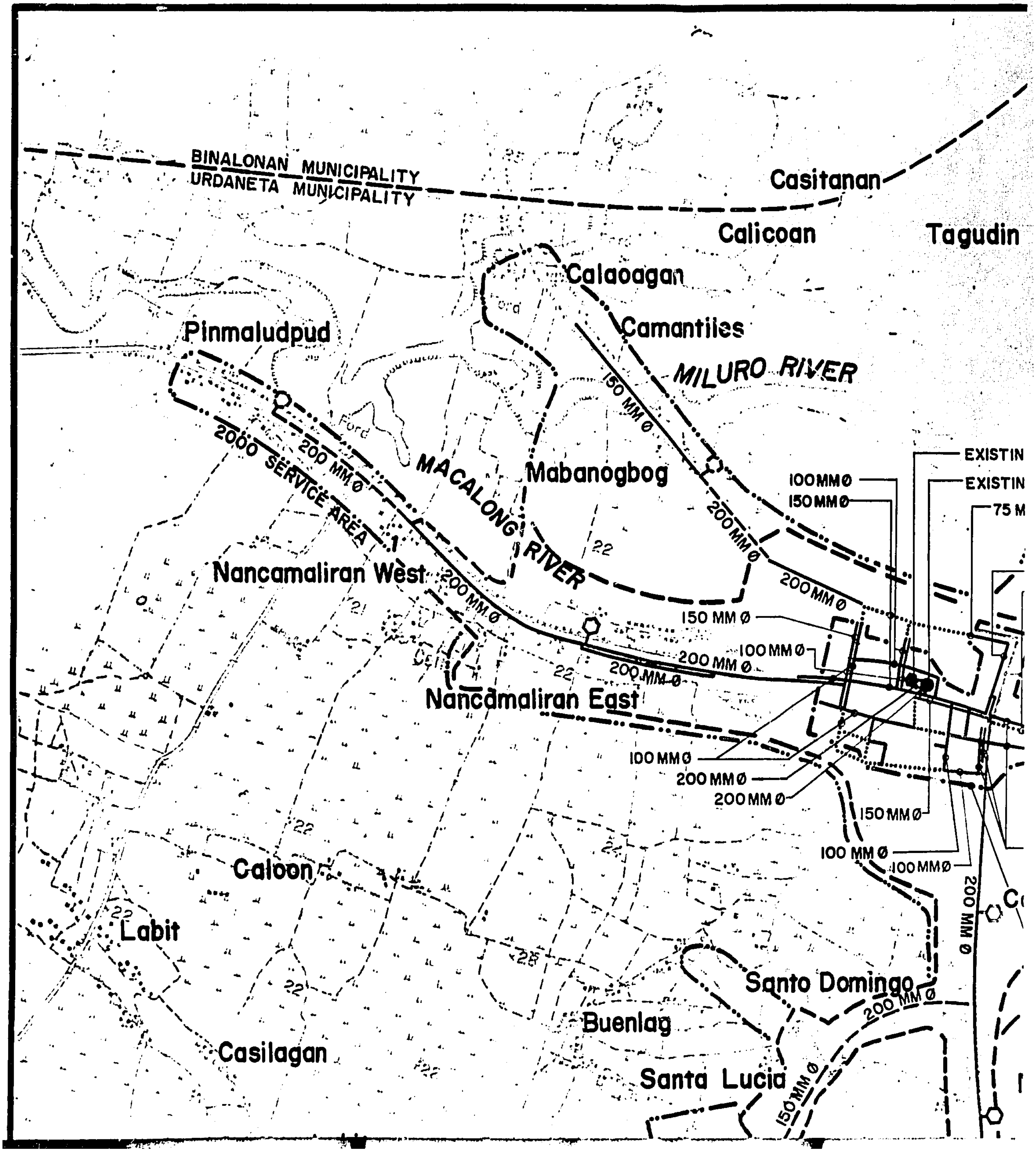


FIGURE MM6-3
TYPICAL FLOW VARIATION
FOR DISTRIBUTION MAINS

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



BINALONAN MUNICIPALITY
URDANETA MUNICIPALITY
Casitanan
Calicoan
Tagudin
Calaoagan
Camantiles
Pinmaludpud
MILURO RIVER
150 MM Ø
Ford
200 MM Ø
2000 SERVICE AREA
MACALONG RIVER
Mabanogbog
EXISTIN
100MMØ
150MMØ
EXISTIN
75 M
200 MM Ø
Nancamaliran West
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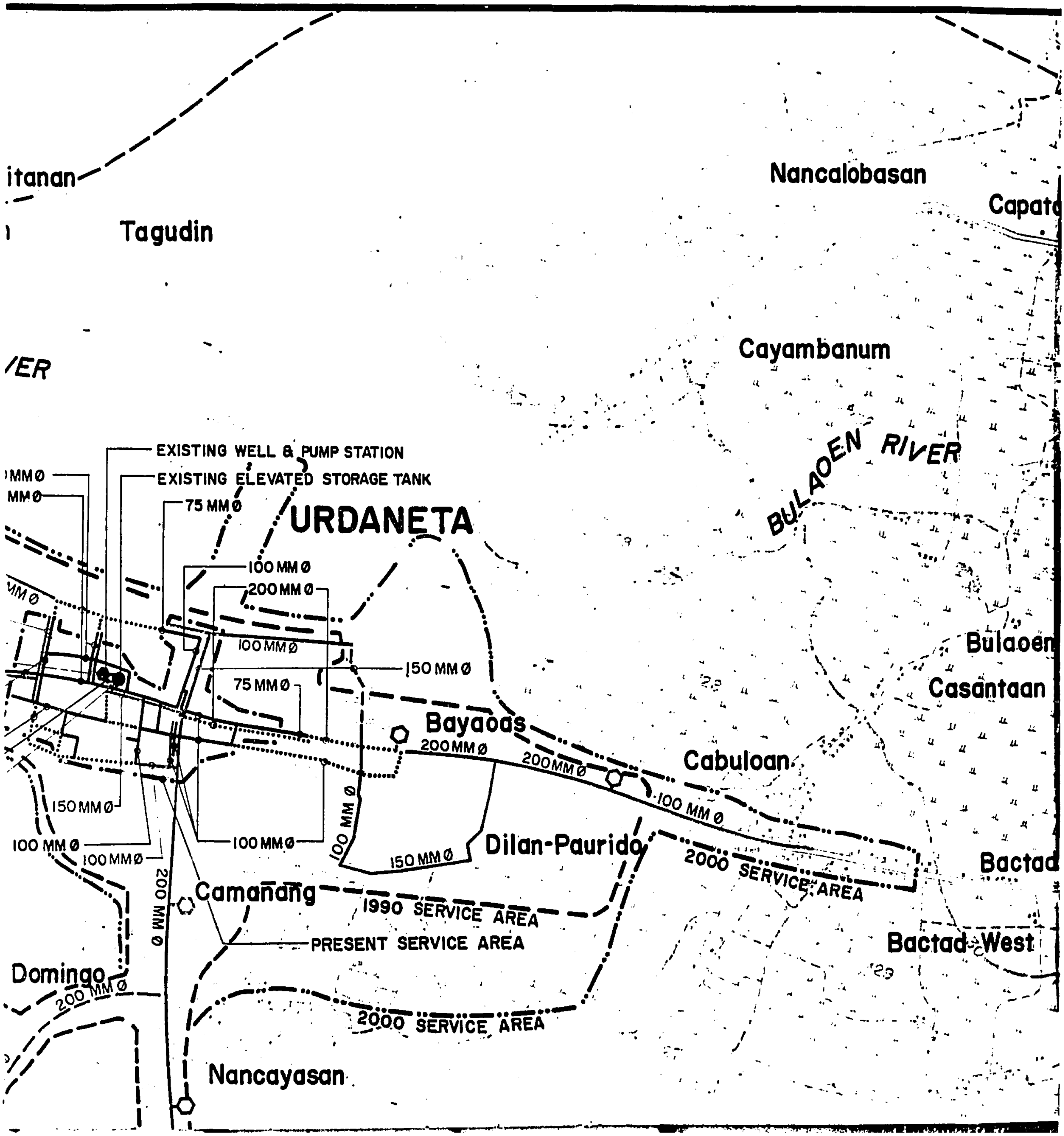
Buenlag
Casilagan
Santa Lucia
150 MM Ø



itanan
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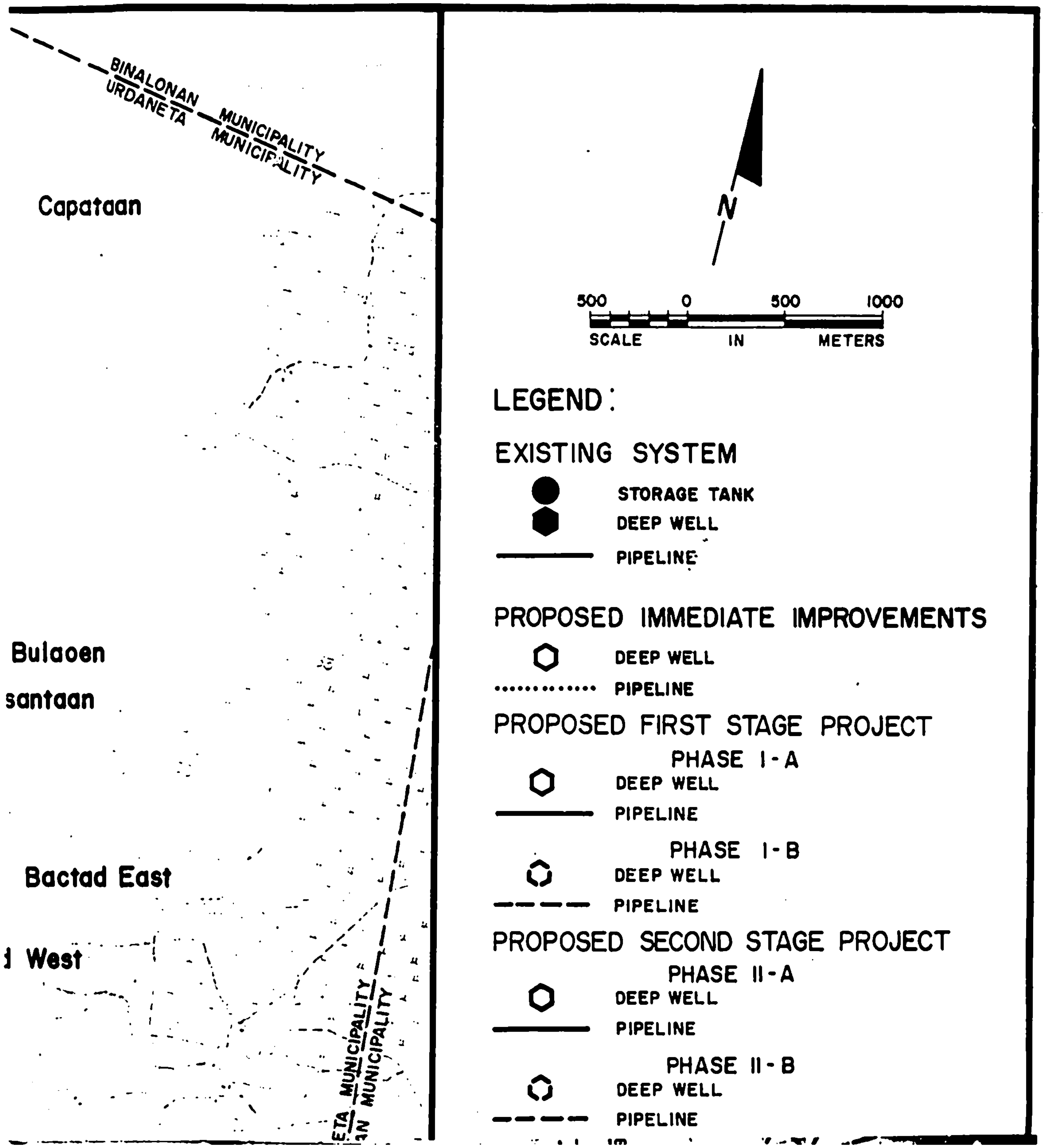
Nancalobasan
Capat
Cayambanum
/ER
BULAOEN RIVER
EXISTING WELL & PUMP STATION
EXISTING ELEVATED STORAGE TANK
75 MM Ø
URDANETA
100 MM Ø
200 MM Ø
100 MM Ø
150 MM Ø
75 MM Ø
Bulaoen
Casantaan
Bayaoas
200 MM Ø
200 MM Ø
Cabuloan
100 MM Ø
150 MM Ø
100 MM Ø
100 MM Ø
100 MM Ø
100 MM Ø
150 MM Ø
Dilan-Paurido
2000 SERVICE AREA
Bactad
200 MM Ø
Camanang
1990 SERVICE AREA
PRESENT SERVICE AREA
Bactad West
Domingo
200 MM Ø
2000 SERVICE AREA
Nancayasan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URDANETA MUNICIPALITY
Capataan
Bulaoen
santaan
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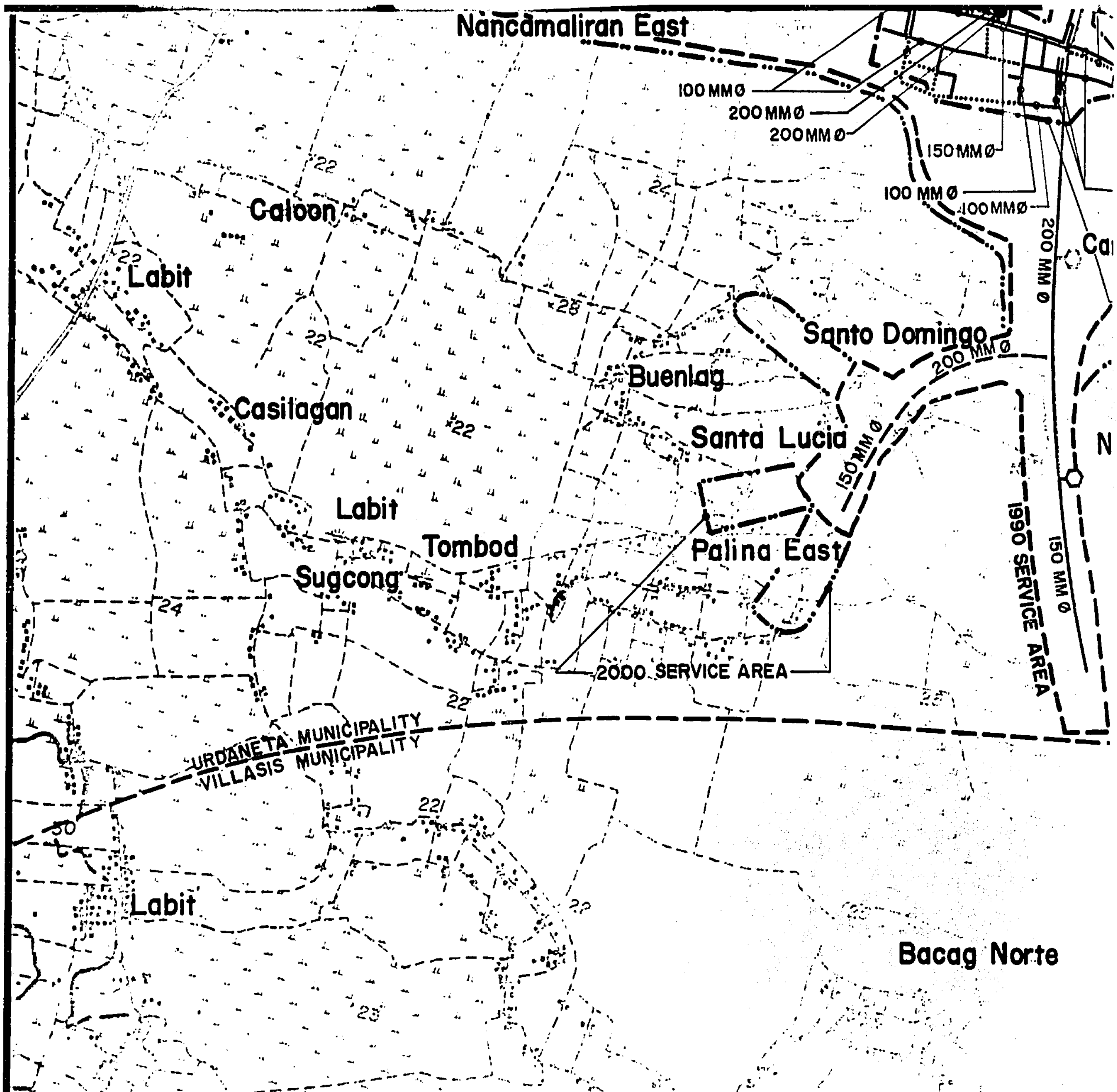
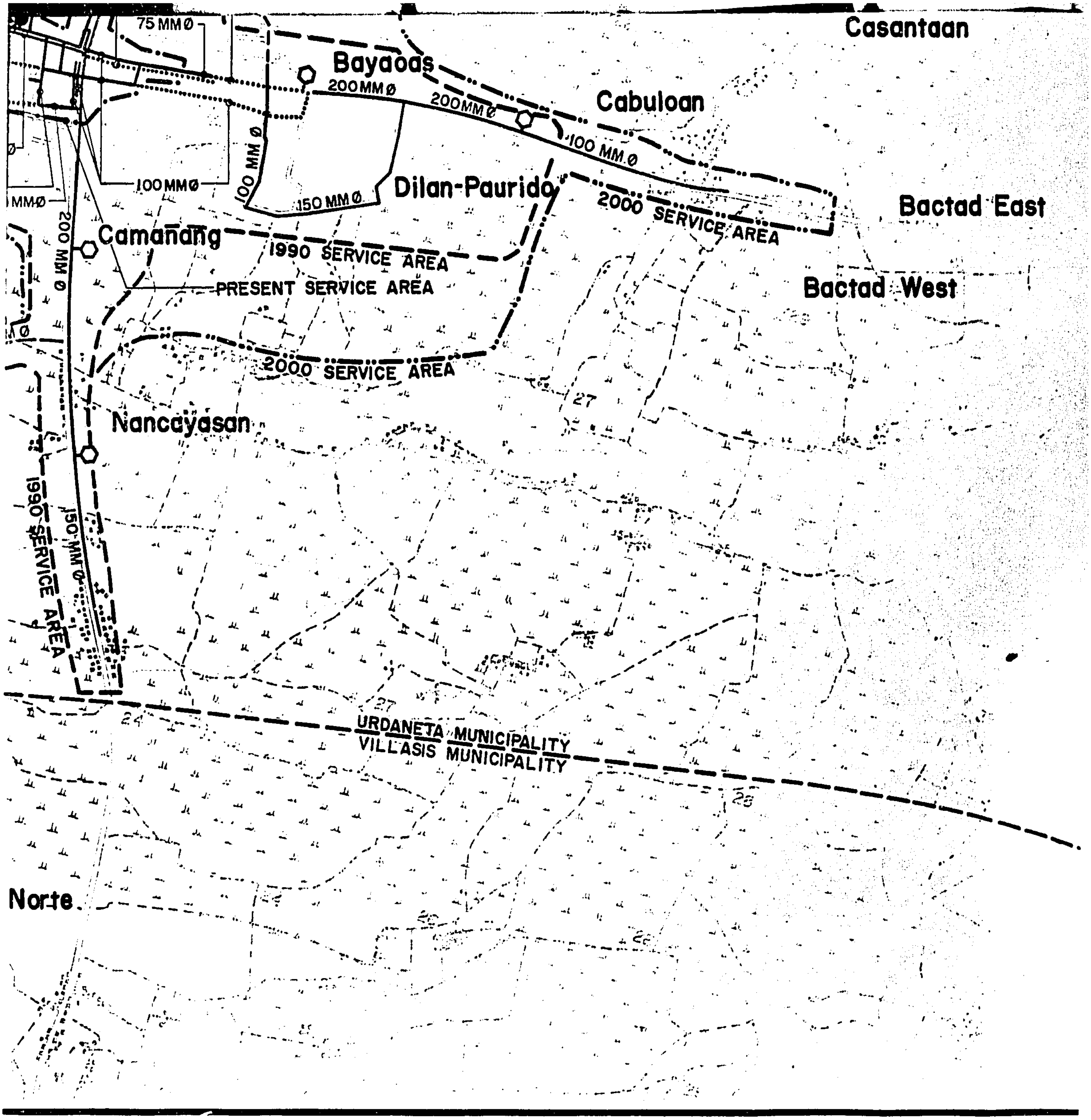
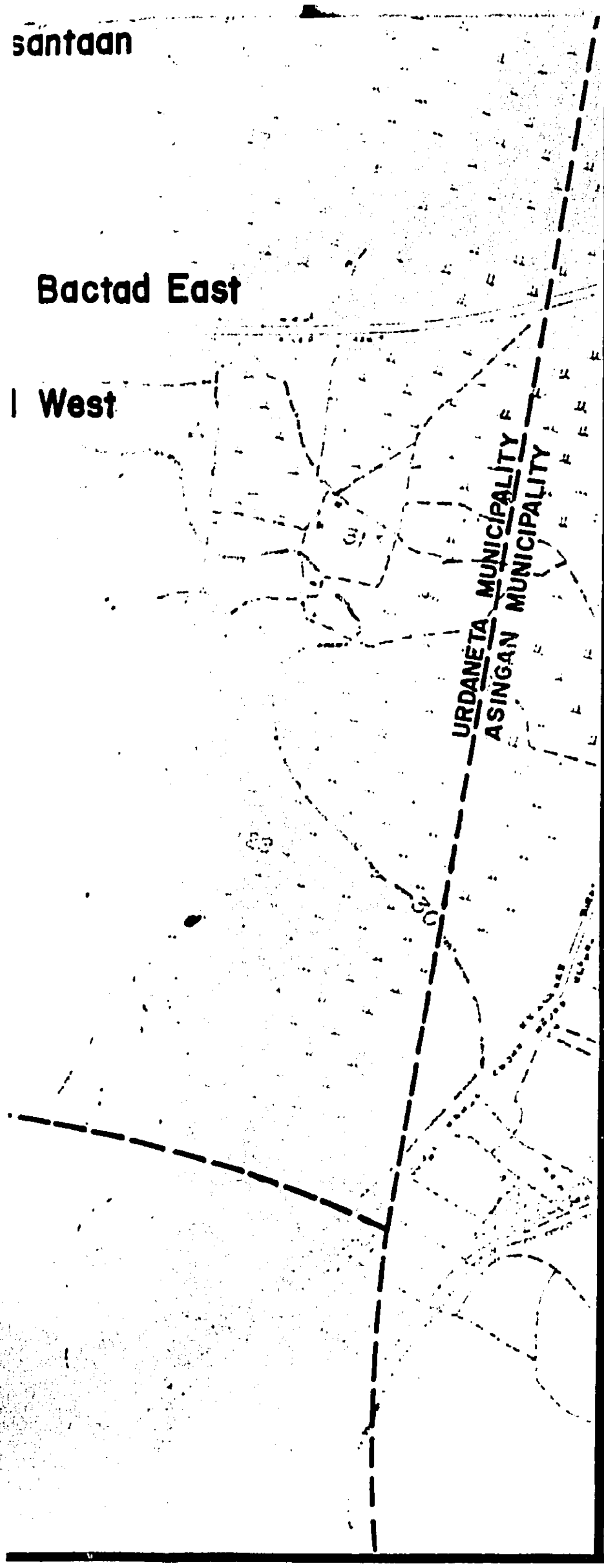
N
500 0 500 1000
SCALE IN METERS
LEGEND:
EXISTING SYSTEM
STORAGE TANK
DEEP WELL
PIPELINE
PROPOSED IMMEDIATE IMPROVEMENTS
DEEP WELL
PIPELINE
PROPOSED FIRST STAGE PROJECT
PHASE I-A
DEEP WELL
PIPELINE
PHASE I-B
DEEP WELL
PIPELINE
PROPOSED SECOND STAGE PROJECT
PHASE II-A
DEEP WELL
PIPELINE
PHASE II-B
DEEP WELL
PIPELINE



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



Casantaan
75 MM Ø
Bayaoas
200 MM Ø
200 MM Ø
Cabuloan
100 MM Ø
100 MM Ø
100 MM Ø
150 MM Ø
Dilan-Paurido
2000 SERVICE AREA
Bactad East
MM Ø
200 MM Ø
Camanang
1990 SERVICE AREA
PRESENT SERVICE AREA
Bactad West
2000 SERVICE AREA
Nancayasan
1990 SERVICE AREA
150 MM Ø
URDANETA MUNICIPALITY
VILLASIS MUNICIPALITY
Norte



PIPELINE

PROPOSED FIRST STAGE PROJECT

PHASE I-A

DEEP WELL

PIPELINE

PHASE I-B

DEEP WELL

PIPELINE

PROPOSED SECOND STAGE PROJECT

PHASE II-A

DEEP WELL

PIPELINE

PHASE II-B

DEEP WELL

PIPELINE

FIGURE IX-1

WATER SUPPLY SOURCE
TRANSMISSION AND DISTRIBUTION SYSTEM
MAP SHOWING

EXISTING FACILITIES
RECOMMENDED STAGE I FACILITIES
RECOMMENDED STAGE II FACILITIES

URDANETA WATER DISTRICT