

The Republic of the Philippines

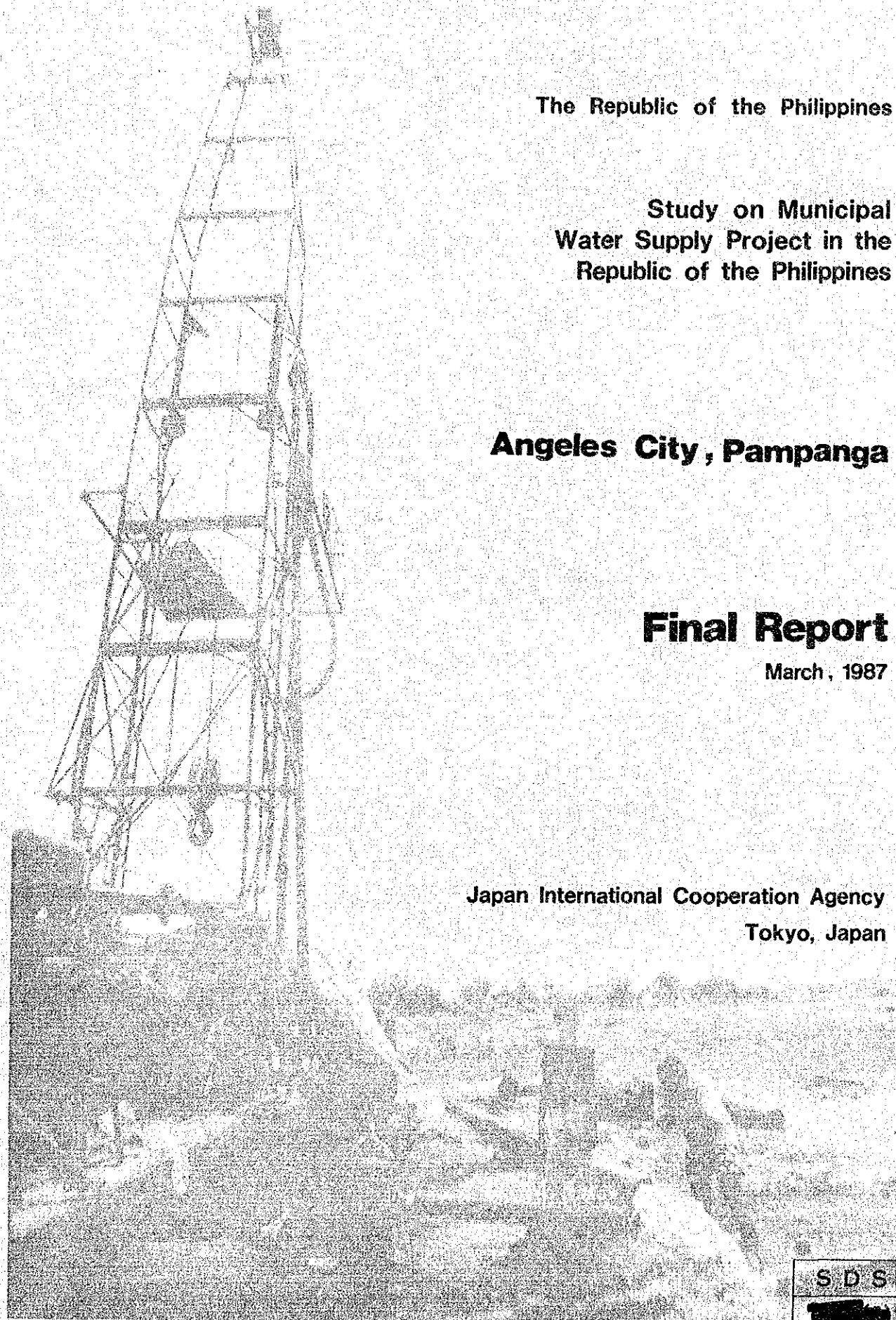
Study on Municipal  
Water Supply Project in the  
Republic of the Philippines


Angeles City, Pampanga

**Final Report**

March, 1987

Japan International Cooperation Agency  
Tokyo, Japan



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**THE REPUBLIC OF THE PHILIPPINES**

**STUDY  
ON  
MUNICIPAL WATER SUPPLY PROJECT  
IN  
THE REPUBLIC OF THE PHILIPPINES**

**ANGELES CITY, PAMPANGA**

**FINAL REPORT**

**MARCH, 1987**

**JAPAN INTERNATIONAL COOPERATION AGENCY  
TOKYO, JAPAN**

国際協力事業団

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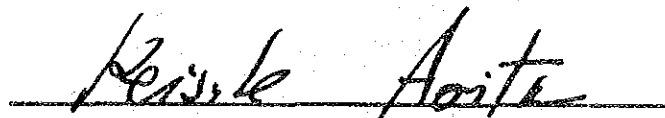
## PREFACE

In response to the request of the Government of the Republic of the Philippines, the Japanese Government has decided to conduct a Master Plan and a Feasibility Study on Municipal Water Supply Project and entrusted the Study to the Japan International Cooperation Agency (JICA). JICA organized a study team headed by Mr. Toru Hayashi, Director, Nippon Jogesuido Sekkei Co., Ltd. to conduct the said study, from February 1986 to March 1987.

The team had discussions with the officials concerned of the Government of the Philippines and conducted a field survey in the Study Area and Metropolitan Manila. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries. I wish to express my deep appreciation to the officials concerned of the Government of the Philippines for their close cooperation extended to the team.

March, 1987

A handwritten signature in black ink, reading "Keisuke Arita", is written over a horizontal line.

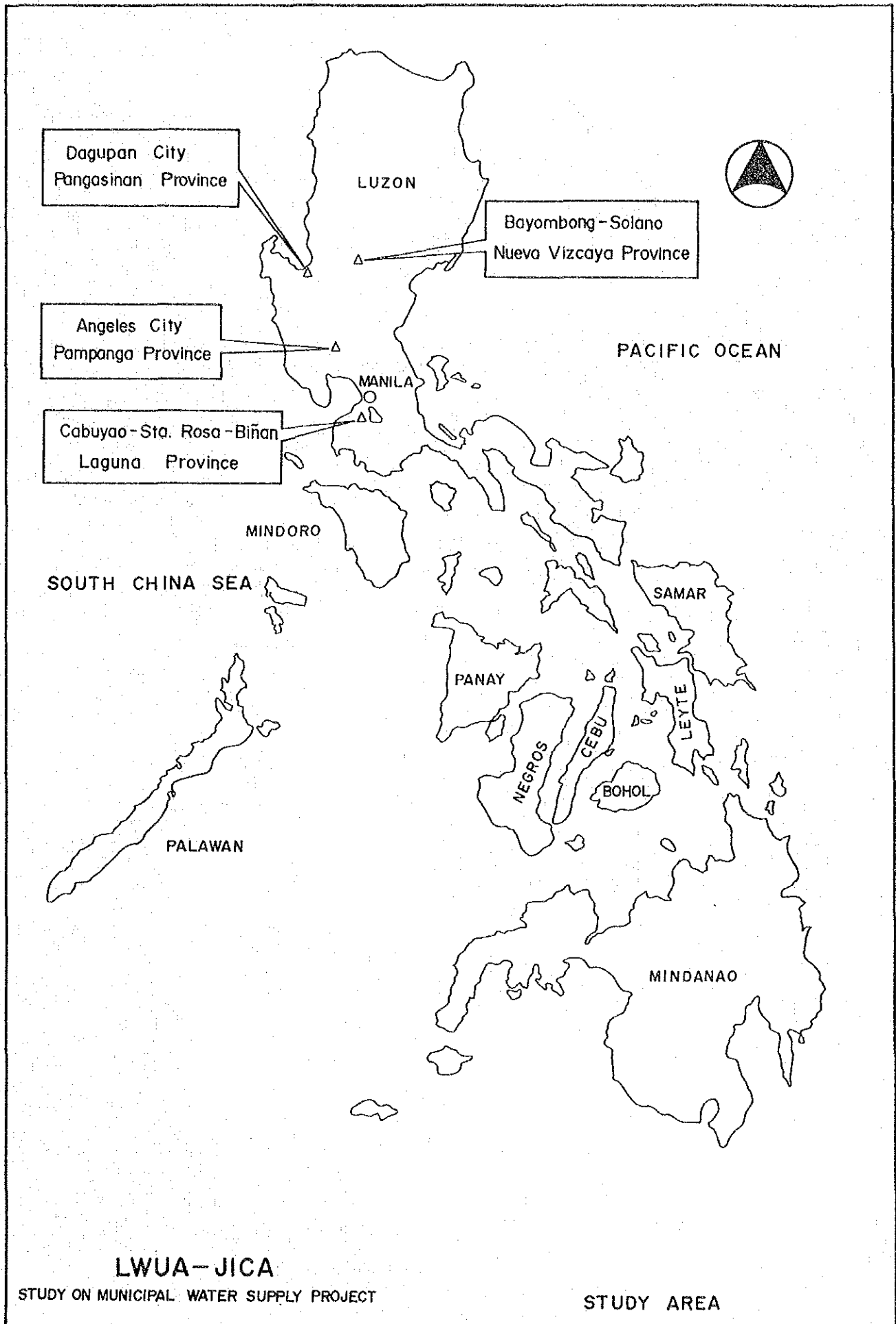
Keisuke ARITA

President

Japan International Cooperation Agency









## TABLE OF CONTENTS

	<u>Page</u>
PREFACE	
STUDY AREA MAP	
TABLE OF CONTENTS	i
LIST OF APPENDICES	vi
LIST OF TABLES	vii
LIST OF FIGURES	ix
LIST OF ACRONYMS AND ABBREVIATIONS	x
 <u>MAIN TEXT</u>	
CHAPTER 1	SUMMARY AND RECOMMENDATION
1.1	GENERAL 1- 1
1.2	FINDINGS AND PROJECTIONS 1- 1
1.2.1	Study Area 1- 1
1.2.2	Existing Water Supply and Sanitation Conditions 1- 3
1.2.3	Population and Water Demand Projection 1- 5
1.2.4	Water Resources 1- 7
1.2.5	Analysis and Evaluation of Alternatives 1- 8
1.2.6	Recommended Plan 1- 8
1.3	FINANCIAL ASPECTS 1-10
1.3.1	Financial Feasibility 1-10
1.3.2	Economic Feasibility 1-11
1.4	ORGANIZATION AND MANAGEMENT 1-12
1.4.1	Existing Management System 1-12
1.4.2	Proposed Organization Structure 1-12
1.4.3	Other Recommendations 1-13
1.5	CONCLUSIONS 1-14
CHAPTER 2	GENERAL BACKGROUND
2.1	AUTHORIZATION 2- 1
2.2	BACKGROUND OF THE PROJECT 2- 1
2.3	OBJECTIVE AND SCOPE OF WORK 2- 2
CHAPTER 3	DESCRIPTION OF THE STUDY AREA
3.1	GEOGRAPHICAL LOCATION AND PHYSICAL FEATURES 3- 1
3.2	ADMINISTRATIVE COMPOSITION AND LAND USE 3- 2
3.3	POPULATION AND LIVING CONDITIONS 3- 3
3.4	SOCIO-ECONOMIC CONDITIONS 3- 8

TABLE OF CONTENTS

	<u>Page</u>
3.4.1 City Revenue	3- 8
3.4.2 Family Income	3-10
3.4.3 Agriculture, Livestock Farming and Fisheries	3-10
3.4.4 Commerce and Industry	3-11
3.4.5 Transportation and Communication	3-11
3.4.6 Power Supply	3-12
3.5 CITY DEVELOPMENT PLAN	3-13
CHAPTER 4 EXISTING WATER SUPPLY AND SANITATION CONDITIONS	
4.1 PRESENT WATER SUPPLY IN THE CITY	4- 1
4.2 WATER SUPPLY FACILITIES BY DIFFERENT LEVEL OF SERVICES	4- 4
4.2.1 Level I System	4- 4
4.2.2 Level II System	4- 9
4.2.3 Level III System	4- 9
4.2.3.1 Angeles City Waterworks System	4- 9
4.2.3.2 Balibago Waterworks System	4-25
4.2.3.3 On-Going Project	4-27
4.2.4 Operation and Maintenance	4-27
4.2.5 Deficiencies of the Existing System	4-28
4.3 WATER PRODUCTION	4-30
4.4 WATER CONSUMPTION	4-31
4.4.1 General	4-31
4.4.2 Angeles City Waterworks	4-32
4.4.3 Balibago Waterworks	4-39
4.5 ANALYSIS ON WATER SUPPLY AND CONSUMPTION	4-43
4.5.1 Angeles City Waterworks	4-43
4.5.2 Balibago Waterworks	4-44
4.6 EXISTING SANITATION CONDITIONS	4-46
4.6.1 Drainage and Sewage Disposal	4-46
4.6.2 Solid Waste Disposal	4-46
CHAPTER 5 POPULATION AND WATER DEMAND PROJECTIONS	
5.1 GENERAL	5- 1
5.2 POPULATION PROJECTION	5- 1
5.2.1 Population Projection of the Province and City	5- 1
5.2.2 Population Projection by Barangay	5- 2
5.2.3 Projection of Number of Households	5- 2

TABLE OF CONTENTS

	<u>Page</u>
5.3 POPULATION AND AREA TO BE SERVED BY THE PROPOSED WATER SUPPLY SYSTEM	5- 9
5.4 WATER DEMAND PROJECTION FOR THE PROPOSED SERVICES AREA	5-14
5.4.1 General	5-14
5.4.2 Design Unit Water Consumption by Consumer Type	5-15
5.4.3 Water Demand Projection	5-17
5.4.4 Demand Variations	5-18
5.4.5 Number of Connections	5-22
 CHAPTER 6 WATER RESOURCES	
6.1 GENERAL	6- 1
6.2 PHYSIOGRAPHY	6- 1
6.3 METEOROLOGY	6- 2
6.3.1 Rainfall	6- 2
6.3.2 Temperature	6- 2
6.4 GEOLOGY	6- 2
6.5 SURFACE WATER	6- 7
6.6 GROUNDWATER	6- 8
6.6.1 Water Point Inventory	6- 8
6.6.2 Groundwater Flow Conditions	6- 9
6.6.3 Aquifers	6-10
6.6.4 Groundwater Recharge	6-15
6.6.5 Test Well	6-16
6.6.6 Groundwater Availability	6-19
6.7 WATER QUALITY	6-23
6.8 RECOMMENDED WATER SOURCES	6-25
 CHAPTER 7 ANALYSIS AND EVALUATION OF ALTERNATIVES	
7.1 GENERAL	7- 1
7.2 FACTORS TO BE CONSIDERED FOR ALTERNATIVE STUDY	7- 2
7.2.1 Planning Stages	7- 2
7.2.2 Water Demand in Each Design Year	7- 2
7.2.3 Water Sources Considered	7- 3
7.2.4 Distribution System	7- 6

## TABLE OF CONTENTS

		<u>Page</u>
7.3	ALTERNATIVE STUDY OF WATER SUPPLY SYSTEM	7- 9
7.3.1	Water Source and Transmission	7- 9
7.3.2	Distribution System	7-15
7.3.3	Selection of Optimum Water Supply System	7-25
7.3.4	Phasing of Distribution Network Development	7-26
CHAPTER 8	RECOMMENDED PLAN	
8.1	GENERAL	8- 1
8.2	RECOMMENDED WATER SUPPLY SYSTEM	8- 1
8.2.1	Layout of the Water Supply System	8- 1
8.2.2	Implementation Program	8- 9
8.2.3	Project Cost	8- 9
CHAPTER 9	FINANCIAL FEASIBILITY ANALYSIS	
9.1	GENERAL	9- 1
9.2	EXISTING SYSTEM	9- 1
9.2.1	Rate Structure	9- 1
9.2.2	Revenue and Expenditure	9- 3
9.2.3	Bill Rendering and Collection	9- 6
9.3	MARKET SURVEY	9- 6
9.4	PROJECT COST AND FINANCING	9- 7
9.4.1	Project Implementation Schedule and Project Period	9- 7
9.4.2	Financial Conditions	9- 7
9.4.3	Project Cost	9- 9
9.4.4	Operating and Maintenance Cost	9- 9
9.4.5	Escalation of Costs	9- 9
9.4.6	Reserve Requirements	9-14
9.5	REVENUE ANALYSIS AND WATER RATES	9-14
9.5.1	Derivation of Revenue Units	9-14
9.5.2	Water Rate Structure	9-19
9.5.3	Feasibility of Charges	9-19
9.6	FINANCIAL SUMMARY	9-21
9.7	FINANCIAL INTERNAL RATE OF RETURN (FIRR)	9-25
9.8	FINANCIAL RECOMMENDATION	9-25

TABLE OF CONTENTS

	<u>Page</u>	
CHAPTER 10	ECONOMIC FEASIBILITY ANALYSIS	
10.1	GENERAL	10- 1
10.2	METHOD OF ANALYSIS	10- 1
10.3	ECONOMIC BENEFITS OF THE PROJECT	10- 1
10.3.1	Increase in Land Values	10- 2
10.3.2	Beneficial Value of Water	10- 3
10.4	ECONOMIC COSTS OF THE PROJECT	10- 3
10.4.1	Project Cost	10- 6
10.4.2	Salvage Value	10- 6
10.4.3	Operating and Maintenance Costs	10- 6
10.5	ECONOMIC INTERNAL RATE OF RETURN (EIRR)	10- 6
CHAPTER 11	ORGANIZATION AND MANAGEMENT	
11.1	PRESENT ORGANIZATION STRUCTURE	11- 1
11.2	PROPOSED ORGANIZATION STRUCTURE	11- 1
11.2.1	Introduction	11- 1
11.2.2	Examination of the LWUA Methodology Manual	11- 3
11.2.3	Proposed Guideline of the JICA Study Team	11- 6
11.2.4	Organization Structure	11- 7
11.3	MANAGEMENT	11-12
11.3.1	Importance of Management	11-12
11.3.2	Functions and Duties of General Manager/Staff	11-12
11.3.3	Problems Arising from the Transition of Administrations	11-16
11.3.4	Problems Arising from Rapid Expansion of the Systems	11-18
11.4	OTHER RECOMMENDATIONS	11-19
11.4.1	LWUA Assistance	11-19
11.4.2	Formation of Water Districts	11-19
<u>APPENDICES</u>		1
<u>LIST OF PERSONS CONCERNED</u>		PL- 1
<u>MINUTES OF MEETINGS</u>		
1.	March 25, 1986	MM- 1
2.	June 18, 1986	MM- 8
3.	September 22, 1986	MM-12
4.	December 8, 1986	MM-13

LIST OF APPENDICES

3.2.1	LIST OF SUBDIVISIONS (MARCH, 1983)	1
3.4.1	POWER RATE OF ANGELES ELECTRIC CORPORATION	5
4.1.1.A	WATER SUPPLY OF THE SUBDIVISIONS VISITED BY JICA STUDY TEAM	6
4.1.1.B	WATER CHARGES FOR THE SUBDIVISIONS VISITED BY JICA STUDY TEAM	7
4.1.2	POPULATION AND NUMBER OF HOUSEHOLDS SERVED BY TYPE OF WATER SOURCE (1980)	8
4.1.3	LEVEL I WATER SUPPLY SYSTEMS (AS OF DECEMBER 1984)	10
4.1.4	LEVEL II WATER SUPPLY SYSTEMS (AS OF 1985)	10
4.2.1	LEVEL I WATER SUPPLY SYSTEM	11
4.2.2	LEVEL II WATER SUPPLY SYSTEM	13
4.2.3	PUMP EFFICIENCY TEST AT NO.1 PUMP STATION	14
4.2.4	WATER PRESSURE IN THE SERVICE AREA	18
4.2.5	NUMBER OF CONNECTION BY METERED AND UNMETERED	27
4.4.1	NUMBER OF CONNECTIONS, CONSUMPTION AND WATER CHARGES	28
4.4.2	COMPOSITION OF EACH BARANGAY IN TERMS OF WATER ZONE	31
4.4.3	WATER CONSUMPTION	32
4.5.1	UNACCOUNTED-FOR WATER/NOT UTILIZED WATER	33
6.6.1	EXISTING WELL INVENTORY IN PAMPANGA PROVINCE	56
6.6.2	WELL LITHOLOGIC LOGS (ANGELES CITY, PAMPANGA)	57
6.7.1	SELECTION OF WATER QUALITY EXAMINATION POINTS	66
6.7.2	WATER QUALITY ANALYSIS - ANGELES CITY	68
7.2.1	DATA ON THE UNIT COST FOR ESTIMATION OF PROJECT COST	70
7.2.2	EXCERPT FROM LWUA METHODOLOGY MANUAL	79
7.3.1	COST ESTIMATES OF WATER SOURCE ALTERNATIVES	81
7.3.2	COMPUTER-AIDED HYDRAULIC ANALYSIS OF DISTRIBUTION SYSTEM (ANGELES CITY)	82
7.3.3	COST ESTIMATES OF ALTERNATIVE WATER SUPPLY SYSTEMS	95
8.2.1.A	BREAKDOWN OF COST ESTIMATES	98
8.2.1.B	PROJECT COST WITH FOREIGN AND LOCAL CURRENCY BREAKDOWN (1986 PRICE LEVEL, ANAGELES CITY)	101
8.2.1.C	OPERATION AND MAINTENANCE COST (ANGELES CITY)	107
9.3.1	MARKET SURVEY	108
9.7.1	FINANCIAL INTERNAL RATE OF RETURN (FIRR)	113
9.8.1	PROPOSED WATER RATE	114



LIST OF TABLES

<u>TABLE</u>		<u>Page</u>
1.1.1	SUMMARY OF PROPOSED PROJECT	1- 2
3.2.1	LAND USE AND POPULATION	3- 5
3.3.1	GENERAL CITY POPULATION CHARACTERISTICS	3- 6
3.3.2	MORBIDITY AND MORTALITY RELATED TO WATER-BORNE DISEASES	3- 8
4.1.1	SUBDIVISIONS RELATED TO THE WATER SUPPLY AREA	4- 2
4.1.2 A	SERVED POPULATION BY CITY WATERWORKS	4- 7
4.1.2 B	SERVED POPULATION BY BALIBAGO WATERWORKS	4- 8
4.2.1	PUMPING STATION IN ANGELES CITY WATERWORKS	4-11
4.2.2	DAILY WATER PRODUCTION	4-12
4.2.3	DISTRIBUTION NETWORK	4-17
4.2.4	NUMBER OF CONNECTION BY METERED AND UNMETERED	4-24
4.2.5	PUMPING STATION IN BALIBAGO WATERWORKS	4-26
4.3.1	DAILY WATER PRODUCTION OF THE CITY WATERWORKS	4-30
4.4.1	SUMMARY OF WATER CONSUMPTION AND CHARGES	4-32
4.4.2	UNIT WATER CONSUMPTION (METERED CONNECTIONS)	4-33
4.4.3	UNIT WATER CONSUMPTION (METERED)	4-35
4.4.4	NUMBER OF CONNECTIONS BY METERED AND UNMETERED BY CONSUMER TYPE	4-37
4.4.5	ESTIMATION OF WATER CONSUMPTION	4-38
4.4.6	UNIT WATER CONSUMPTION BY WATER USE (1986)	4-41
4.4.7	UNIT WATER CONSUMPTION BY WATER USE (1984)	4-42
4.5.1	ACCOUNTED-FOR WATER FOR THE WATERWORKS	4-45
5.2.1	POPULATION PROJECTION IN THE PROVINCE AND CITY	5- 2
5.2.2	POPULATION AND NUMBER OF HOUSEHOLDS IN URBAN AND RURAL AREAS	5- 4
5.2.3	POPULATION AND NUMBER OF HOUSEHOLDS PROJECTION IN URBAN AND RURAL AREAS	5- 5
5.2.4	POPULATION BY BARANGAYS	5- 6
5.2.5	PROJECTED POPULATION OF BARANGAYS	5- 7
5.2.6	PROJECTION OF PERSON PER HOUSEHOLD AND NUMBER OF HOUSEHOLDS BY URBAN AND RURAL AREAS	5- 8
5.3.1	POPULATION TO BE SERVED BY BARANGAY FOR THE DESIGN YEARS	5-13
5.4.1	ANNUAL RATE OF INCREASE AND PER CAPITA CONSUMPTION	5-15
5.4.2	DAILY AVERAGE COMMERCIAL UNIT WATER CONSUMPTION	5-16
5.4.3	CONNECTION DENSITY RATIO	5-16
5.4.4	FUTURE COMMERCIAL UNIT WATER CONSUMPTION AND CONNECTION RATIO	5-17
5.4.5	WATER CONSUMPTION BY DESIGN YEAR	5-17
5.4.6 A	WATER DEMAND PROJECTION (1990)	5-19
5.4.6 B	WATER DEMAND PROJECTION (1995)	5-20
5.4.6 C	WATER DEMAND PROJECTION (2010)	5-21
5.4.7	DAILY AVERAGE WATER DEMAND BY DESIGN YEAR	5-18
6.6.1	RATE OF GROUNDWATER DECLINE IN THE AREA	6- 9
6.6.2	SUMMARY OF SELECTED SHALLOW WELLS	6-13
6.6.3	SUMMARY OF SELECTED DEEP WELLS	6-14

LIST OF TABLES

<u>TABLE</u>		<u>Page</u>
7.2.1	DAILY AVERAGE AND MAXIMUM DEMAND	7- 3
7.2.2	EVALUATION OF EXISTING WELLS FOR FUTURE UTILIZATION	7- 4
7.3.1	FACILITY CONFIGURATION OF WATER SOURCE ALTERNATIVES	7-14
7.3.2	COST COMPARISON OF WATER SOURCE ALTERNATIVES	7-14
7.3.3	REQUIRED STORAGE VOLUME AND ADDITIONAL WATER SOURCES	7-21
7.3.4	COST COMPARISON OF GROUND RESERVOIR AND ELEVATED TANK	7-22
7.3.5	COST COMPARISON OF DIFFERENT STORAGE CAPACITIES	7-23
7.3.6	CONFIGURATION OF ALTERNATIVE DISTRIBUTION NETWORKS	7-24
7.3.7	CONSTRUCTION COST OF ALTERNATIVE DISTRIBUTION NETWORKS	7-24
7.3.8	OVERALL CONFIGURATION OF ALTERNATIVE WATER SUPPLY SYSTEMS	7-25
7.3.9	OVERALL COST COMPARISON OF ALTERNATIVE WATER SUPPLY SYSTEMS	7-26
7.3.10	CONFIGURATION OF ALTERNATIVE PHASING FOR DISTRIBUTION NETWORK DEVELOPMENT	7-28
7.3.11	COST COMPARISON OF ALTERNATIVE DISTRIBUTION NETWORK FOR PHASED DEVELOPMENT	7-29
7.3.12	ESCALATED PROJECT COST OF ALTERNATIVE DISTRIBUTION NETWORK FOR PHASED DEVELOPMENT	7-30
8.2.1	DESCRIPTION OF REQUIRED MAJOR FACILITIES BY PHASE	8- 6
8.2.2	SUMMARY OF MAJOR FACILITIES REQUIRED BY PHASE	8- 8
8.2.3	SUMMARY OF PROJECT COST	8-11
9.2.1	BREAKDOWN OF REVENUE OF ACWS	9- 4
9.2.2	EXPENDITURE OF ACWS	9- 5
9.4.1	BREAKDOWN OF PROJECT COST	9-10
9.4.2	PROJECTED DEBT SERVICE SCHEDULE	9-11
9.4.3	PROJECTED OPERATION AND MAINTENANCE COST (Unescalated)	9-12
9.4.4	PROJECTED OPERATION AND MAINTENANCE COST (Escalated)	9-13
9.5.1	SERVICE CONNECTIONS AND SERVICE CHARGE REVENUE UNITS	9-15
9.5.2	EQUIVALENT VOLUME OF WATER SOLD	9-16
9.5.3	PROJECTED REVENUE FORECAST	9-20
9.6.1	PROJECTED INCOME STATEMENT	9-22
9.6.2	PROJECTED CASH FLOW STATEMENT	9-23
9.6.3	PROJECTED BALANCE SHEET	9-24
9.7.1	FINANCIAL INTERNAL RATE OF RETURN	9-26
10.3.1	PORTION OF LAND VALUES ATTRIBUTABLE TO PROJECT	10- 4
10.3.2	INCREASE IN CONSUMER SATISFACTION	10- 5
10.4.1	ECONOMIC PROJECT COST	10- 7
10.4.2	SALVAGE VALUE IN YEAR 2007	10- 8
10.4.3	INCREMENTAL ECONOMIC OPERATION AND MAINTENANCE COST	10- 9
10.5.1	ECONOMIC INTERNAL RATE OF RETURN	10-10
11.2.1	STAFFING GUIDELINE	11- 8
11.2.2	SUMMARY OF PRESENT (1986) AND PROPOSED (1995 and 2010) STAFFING PATTERN (ANGELES CITY)	11-11

LIST OF FIGURES

<u>FIGURE</u>		<u>Page</u>
3.1.1	LOCATION MAP	3- 2
3.2.1	LOCATION OF BARANGAYS	3- 4
3.5.1	LAND USE PLAN OF ANGELES CITY	3-14
4.1.1	LOCATION OF SUBDIVISIONS RELATED TO WATER SUPPLY PLAN	4- 3
4.1.2	LOCATION OF WATER SUPPLY ZONES IN ANGELES CITY	
	WATERWORKS SYSTEM	4- 5
4.1.3	WATER SUPPLY SYSTEM	4- 6
4.2.1	EXISTING DISTRIBUTION SYSTEM	4-14
4.2.2	TYPICAL PUMPHOUSE CONNECTION	4-15
4.2.3	CONCRETE ELEVATED TANK	4-16
4.2.4	PRESENT SERVICE AREA	4-18
4.2.5	GROUND ELEVATION	4-20
4.2.6	CONTOUR LINE OF MAXIMUM WATER PRESSURE THROUGH THE DAY	4-21
4.2.7	CONTOUR LINE OF MINIMUM WATER PRESSURE THROUGH THE DAY	4-22
4.4.1	FLOW CHART FOR ESTIMATING UNIT WATER CONSUMPTION	4-40
5.2.1	HISTORICAL AND PROJECTED POPULATION	5- 3
5.3.1	WATER SUPPLY AREA OF ANGELES CITY	5-10
5.3.2	IMMEDIATE IMPROVEMENT PROJECT OF ANGELES CITY	5-11
6.3.1	RAINFALL DATA	6- 3
6.3.2	TEMPERATURE DATA	6- 4
6.4.1	HYDROGEOLOGICAL PROFILE OF SECTION A-A'	6- 5
6.4.2	HYDROGEOLOGICAL PROFILE OF SECTION B-B'	6- 6
6.6.1	PIEZOMETRIC MAP	6-11
6.6.2	LOCATION OF NEW WELL DEVELOPMENT AREA	6-17
6.6.3	EXPLORATORY WELL LOG	6-18
6.6.4	WELL CASING PROGRAM CORRESPONDING TO THE LITHOLOGIC AND ELECTRIC LOGGING RESULTS AT ANGELES EXPLORATORY WELL	6-20
6.6.5	JACOB'S METHOD	6-21
6.6.6	RECOVERY METHOD	6-22
7.3.1(A)	SCHEMATIC DRAWING FOR LONG TERM DEVELOPMENT (ALTERNATIVE S-1)	7-11
7.3.1(B)	SCHEMATIC DRAWING FOR LONG TERM DEVELOPMENT (ALTERNATIVE S-2)	7-12
7.3.1(C)	SCHEMATIC DRAWING FOR LONG TERM DEVELOPMENT (ALTERNATIVE S-3)	7-13
7.3.2(A)	SCHEMATIC LAYOUT OF ALTERNATIVE DISTRIBUTION SYSTEM (ALTERNATIVE D-1)	7-18
7.3.2(B)	SCHEMATIC LAYOUT OF ALTERNATIVE DISTRIBUTION SYSTEM (ALTERNATIVE D-2)	7-18
7.3.2(C)	SCHEMATIC LAYOUT OF ALTERNATIVE DISTRIBUTION SYSTEM (ALTERNATIVE D-3)	7-19
7.3.2(D)	SCHEMATIC LAYOUT OF ALTERNATIVE DISTRIBUTION SYSTEM (ALTERNATIVE D-4)	7-19
8.2.1	GENERAL LAYOUT OF THE RECOMMENDED WATER SUPPLY SYSTEM	
8.2.2	SCHEMATIC LAYOUT OF WATER SUPPLY SYSTEM	8- 2
8.2.3	WATER SUPPLY VS. DEMAND CURVE OF RECOMMENDED PLAN	8- 5
8.2.4	IMPLEMENTATION PROGRAM	8-10
11.1.1	ORGANIZATIONAL STRUCTURE OF ANGELES CITY WATERWORKS SYSTEM	11- 2
11.2.1	PROPOSED WATER DISTRICT STAFF BY LWUA METHODOLOGY MANUAL	11- 5
11.2.2	PROPOSED ORGANIZATION STRUCTURE	11-13

## LIST OF ACRONYMS AND ABBREVIATIONS

### ACRONYMS

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AC	-	Asbestos Cement
ACWS	-	Angeles City Waterworks System
BPW	-	Bureau of Public Works (now MPWH)
BWP	-	Barangay Water Program
CI	-	Cast Iron
EIRR	-	Economic Internal Rate of Return
FIRR	-	Financial Internal Rate of Return
GI	-	Galvanized Iron
GOJ	-	Government of Japan
GOP	-	Government of the Republic of the Philippines
HH	-	Household
JICA	-	Japan International Cooperation Agency
LWUA	-	Local Water Utilities Administration
MERALCO	-	Manila Electric Company
MPWH	-	Ministry of Public Works and Highways
NCSO	-	National Census and Statistics Office
NEDA	-	National Economic and Development Authority
NPC	-	National Power Corporation
PE	-	Polyethylene
PLDT	-	Philippine Long Distance Telephone Company
PT&T	-	Philippine Telegraph and Telephone Corporation
PVC	-	Polyvinyl Chloride
RCPI	-	Radio Communication of the Philippines, Incorporated
RWDC	-	Rural Waterworks Development Corporation

### ABBREVIATIONS

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#### Units

cm	-centimeter
cm/sec	-centimeter per second
cu.m	-cubic meter
cu.m/conn.day	-cubic meter per connection per day
cu.m/day	-cubic meter per day
cu.m/day/km	-cubic meter per day per kilometer
cu.m/month	-cubic meter per month

ABBREVIATIONS (CONTINUED)

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Units

cu.m/sec	-cubic meter per second
FTU	-formazin turbidity unit
ha	-hectare
hr	-hour
kg/day	-kilogram per day
kg/sq.cm	-kilogram per square centimeter
km	-kilometer
KVA	-kilo volt ampere
kw	-kilo watt
KWH	-kilo watt hour
l/day	-liter per day
l/min	-liter per minute
l/min/m	-liter per minute per meter
l/sec	-liter per second
lpcd	-liter per capita per day
lps	-liter per second
mbgs	-meter below ground surface
mH	-meter in Height
micro-S/cm or micro-Siemens/cm	-micro Siemens per centimeter
mm/day	-millimeter per day
mm	-millimeter
MM	-man month
m	-meter
m/sec	-meter per second
MWH	-mega watt hour
mm/year	-millimeter per year
ohm-m	-ohm meter
pc or pcs	-piece(s)
pc/ha	-piece per hectare
p/ha	-person per hectare
sq.cm/sec	-square centimeter per second
sq.km	-square kilometer
sq.m/day	-square meter per day



**CHAPTER 1**  
**SUMMARY AND RECOMMENDATION**





## CHAPTER 1 SUMMARY AND RECOMMENDATION

### 1.1 GENERAL

This Chapter presents a summary of the results and analyses of the field surveys conducted in Angeles City for the Project. The Short Term Development Plan and Long Term Development Plan with special emphasis on the water resources are also incorporated.

In the course of study, planning stages are considered as Phase I from 1986 to 1995 for the Short Term Development and Phase II for from 1996 to 2010 for the Long Term Development period, respectively. The Phase I project period is further divided into two stages; Stage 1 from 1986 to 1990 and Stage 2 from 1991 to 1995, considering the practical implementation period for the required facilities.

With regard to the criteria and approach of technical and financial studies, the Methodology Manual being established and adopted by the Local Water Utilities Administration (hereinafter referred to as LWUA) was employed through the thorough review with data and information collected during the field surveys. Some deviations to the Methodology Manual, such as system pressure during the Phase I period, were made by cost considerations. Also adopted at the request of the LWUA was the terms and conditions for the financial analysis of the Project. Those which referred to the LWUA Methodology Manual are contained in APPENDIX of this report.

The fundamentals used for planning and the study results are shown in TABLE 1.1.1.

### 1.2 FINDINGS AND PROJECTIONS

#### 1.2.1 Study Area

Angeles City lies on the western part of Pampanga about 80 km north of Manila. The City's terrain is relatively flat with an average elevation of 90 m about mean sea level. One of the major rivers, the Abacan River, divides the City into two. The northern part comprises one-third of the area where the tourist belt is located.

TABLE 1.1.1 SUMMARY OF PROPOSED PROJECT (Angeles City)

Description	Present (1986)	Phase I		Phase II
		Stage 1 (1990)	Stage 2 (1995)	(2010)
<b>A. Population</b>				
1. Total Population	224,290	247,750	274,570	363,740
2. Pop. in Service Area	158,800	173,250	189,380	239,330
% of Total Pop.	71	70	69	66
3. Served Population	27,600	37,050	101,940	168,200
% of Pop. in Service Area	17	21	54	70
% of Total Pop.	12	15	37	46
<b>B. Served Area (ha)</b>				
	340	340	750	1,590
<b>C. Water Demand (cu.m/day)</b>				
1. Domestic (Daily Ave.)	4,085	4,632	13,661	26,745
2. Commercial (Daily Ave.)	588	1,031	3,580	10,870
3. Institutional (Daily Ave.)	16	101	272	627
4. Industrial (Daily Ave.)	-	-	-	-
5. Total Water Demand				
a) Daily Ave.	11,545	9,608	25,019	47,814
b) Daily Max.	-	12,000	31,000	59,800
c) Peak Hour	-	20,400	49,600	89,700
<b>D. Number of Connection</b>				
1. Domestic (Individual)	3,539	7,128	19,678	33,571
2. Domestic (Public Faucet)	-	-	-	-
3. Commercial	586	937	2,753	6,393
4. Institutional	3	21	51	83
5. Industrial	-	-	-	-
6. Total	4,128	8,085	22,482	40,047
<b>E. Water Sources and Treatment</b>				
1. Existing Facility	12 wells	5 wells	5 wells	5 wells
(capacity: cu.m/day)	11,000	8,600	8,600	8,600
2. New Facility	-	2 wells	6 wells	10 wells
(capacity: cu.m/day)	-	5,800	17,400	29,000
<b>F. Transmission Facility</b>				
	-	-	ø200 - ø400 2,500m	ø200 - ø500 7,300m
<b>G. Distribution Facility</b>				
1. Reservoir	Elevated tank	Reservoir	-	Reservoir
(capacity: cu.m/day)	378	4,290		7,910
	x 1 unit			Elevated tank 460
				x 2 units
2. Main Pipeline	ø100 - ø150 14,670m	ø200 - ø700 12,030m	ø150 - ø350 2,100m	ø150 - ø700 12,560m
3. Internal Network	ø75 1,940m	ø150/ø100 11,190m	ø150/ø100 39,700m	ø150/ø100 59,760m
<b>H. Number of Workers</b>				
	37	46	72	112
<b>I. Project Cost (Peso)</b>				
<b>1. Construction Cost</b>				
a) Foreign Exchange	-	30,186,000	27,467,000	83,642,000
b) Local Currency	-	26,036,000	17,549,000	60,517,000
c) Total	-	56,222,000	45,016,000	144,159,000
2. O & M Cost (P/annum)	2,169,885 <sup>1/</sup>	2,989,000	6,916,000	12,115,000
<b>J. Ave. Family Income of</b>				
Low Income Group (P/month)	720	1,240	2,390	-
<b>K. Water Rate (P/cu.m; 0-10cu.m)</b>				
1. Domestic	1.4 (1/2")	3.0	7.75	-
2. Commercial	4.0 (1/2")	6.0	15.50	-
3. Institutional	6.4 (3/4")	3.0	7.75	-

The City has a total land area of 6,432 ha and is highly urbanized. It comprises 5,241.55 ha for the 28 urban barangays, 607.99 ha for the 4 rural barangays and 583.28 ha for military reservation and others.

The population increased from 188,834 in 1980 to 224,290 in 1986. Based on the 1980 National Census and Statistics Office (hereinafter referred to as NCSO) report, 80% of the dwelling units are of simple house type. Electrical lighting facilities serves 93% of the City households.

Health and medical facilities are more than enough to serve the medical and dental needs of the people in the City.

The revenue of Angeles City is derived from the General Fund and Infrastructural Fund. The revenue and expenditure of the City in 1985 were ₱47,258,128 and ₱50,909,804, respectively.

As previously stated, the City is a highly urbanized place with activities more concentrated in commerce and trading as compared to agriculture. One factor that has contributed largely to this shift is the presence of the Clark Air Base and the businesses that this generates. As of 1983, there were a total of 14,166 commercial establishments in the City.

Telecommunication facilities include a branch of the Bureau of Telecommunications and two other commercial telegraph companies. It is also served by the Evangelista Telephone Company, a private company which has an inter-connecting arrangement with the Philippine Long Distance Telephone Company (hereinafter referred to as PLDT). Electricity is distributed by the Angeles Electric Corporation to thirty-one barangays of the City.

#### 1.2.2 Existing Water Supply and Sanitation Conditions

At present, approximately 65% of the total population relies on the Level I water supply. The remaining population is served by the Angeles City/Balibago Waterworks or by private sectors in subdivisions. The City and Balibago Waterworks cover 19 and 3 barangays respectively, while the percentage of population served in the covered barangays is 17.3% and 51.2% or 24.4% of the City's population. There exist 67 point source water supplies in 20 barangays constructed through the Barangay Water Program

(hereinafter referred to as BWP) of Ministry of Public Works and Highways (hereinafter referred to as MPWH) and Rural Waterworks Development Corporation (hereinafter referred to as RWDC) in addition to a number of privately-owned shallow/deep wells. There are six piped water supply systems (Level II) with public faucets constructed by the MPWH.

The Angeles City Waterworks System (hereinafter referred to as ACWS) was constructed by the city government in 1934 with a deep well as its source and an elevated storage tank. At present, eleven deep wells are being used and groundwater is directly pumped to the main distribution lines without any treatment. The storage tank is a reinforced concrete elevated tank with a capacity of 378 cu.m. However, at present, it is not in use because of the leakage from outer wall surface. Also, there are two steel elevated tanks used for fire protection with a capacity of 114 cu.m each.

The present service area includes the city core and the six adjacent barangays. Most of the main lines are dead-end and there is no proper distribution network in the system. The main pipes range from 75 mm to 150 mm in size with a total length of 16,610 m. At present, the ACWS a total of 4,128 registered service connections of which 3,539 are domestic and 586 are commercial.

With regard to the Balibago Waterworks, there are seven deep wells and two reinforced concrete elevated storage tanks. Chlorination is the only treatment applied to the system. Sizes of the main distribution pipes range from 100 mm to 150 mm. There are a total of 5,063 connections at present.

There is an on-going construction project for a small Level III system to serve 690 households in Barangay Cutcut.

Water quality test conducted during the field survey revealed that in general, the groundwater is acceptable for domestic consumption.

The main operation and maintenance works of the Waterworks are those for pump units and system's facilities.

In general, the conditions of public Level I and Level II systems are satisfactory. However, the facilities of the ACWS have some deficiencies associated with pumping stations, distribution pipes and accessories.

The total water production of the ACWS is measured to be approximately 11,000 cu.m/day, while Balibago Waterworks is approximately 6,200 cu.m/day.

The present water consumption in the ACWS and Balibago Waterworks was analyzed. The total daily consumption in the ACWS service area is taken at 4,700 cu.m. Per capita consumption is estimated at 148 lpcd. Daily average consumption in the Balibago Waterworks is reported to be 4,108 cu.m/day (Jan. 1986). Domestic unit water consumption is estimated at 115 lpcd.

The result of the analysis on the water supply and demand indicated that 70% of water produced in both the City and Balibago systems is utilized while the remaining 30% is lost due to leakage.

The percentage of unaccounted-for water was estimated at 70% and 30% for the City and Balibago Waterworks, respectively.

There is no drainage and sewage disposal system in the area. Sanitary sewage is disposed of at privately-owned septic tanks or pit privies. Surface run-off flows into the nearby channels and into the rivers.

The collection of garbage is done by six dump trucks and this is disposed of at a 10 ha site in Barangay Cauayan, 5 km west of the poblacion.

### 1.2.3 Population and Water Demand Projection

#### (1) Population Projection

Population projection was made using the breakdown method and by utilizing the provincial population. The projection was then compared to the National Economic and Development Authority (hereinafter referred to as NEDA) projections. The projected provincial population was then broken down into city/municipality using the "sharing method". These projections

were further broken down into urban and rural barangays by city/municipality using the same method.

The 1980 city population of 188,834 is projected to increase to 363,740 in 2010. TABLE 1.1.1 shows the projected population by design year.

### (2) Population and Area to be Served

The potential service area to be covered by the ACWS in the future was established by taking into consideration the existing water supply system, future development, result of market survey and special conditions in the locality.

The service area for the planned long and short term development covers 19 barangays with an area of 1,990 ha and 750 ha, respectively. The served population by barangay for the year 1995 and 2010 are recommended to be 60 and 80% of the total population respectively or 101,940 in 1995 and 168,200 in 2010.

### (3) Water Demand Projection

Future water consumption in the proposed service area was projected for the years 1986, 1990, 1995 and 2010.

The unit water consumption for the design years was estimated by the type of water consumer based on the analysis of the present water consumption. The increased rates for future figures are taken from the LWUA Methodology Manual. The unit water consumption employed for projection purposes is given below.

Consumer Type	Design Year			
	1986	1990	1995	2010
Domestic (lpcd)	115	124	134	159
Commercial (cu.m/conn.day)	1.0	1.1	1.3	1.7
Institutional (cu.m/conn.day)	3.8	4.5	5.3	7.5

The total water consumption (daily average) for the City for the following design years is summarized as follows:

Item	Design Year		
	1990	1995	2010
No. of connections	8,086	22,482	40,047
Water Consumption (cu.m/day)	5,700	17,500	38,200

The percentage of unaccounted-for water is assumed to be 40, 30 and 20% in 1990, 1995 and 2010, respectively considering the present figure obtained from the field investigation. Demand variations by design year are calculated using the LWUA Methodology Manual and are summarized below.

Water Demand (cu.m/day)	1990	1995	2010
Daily average	9,600	25,000	47,800
Daily maximum	12,000	31,300	59,800
Peak hour	20,400	50,100	89,700

#### 1.2.4 Water Resources

Water sources available for the short and long term development of the water supply system were studied based on the results of field investigations and the pumping test. Utilization of groundwater is a major concern. An alternative source for the long term development plan, an analysis of the surface water resource using the data on Gumain River was made.

Groundwater seems to be the only potential source for the water supply of the City. However, the Porac River is considered as an alternative potential surface water in the future.

Well yield was evaluated using the specific capacity based on the collected data and pumping test results in this study. An average yield of 2,900 cu.m/day may be expected in the entire city area, with the southern portion of the city as the potential area with sufficient groundwater.

#### 1.2.5 Analysis and Evaluation of Alternatives

The future city waterworks system is determined based on the source capacity and its location. Groundwater within the city area is not recommended to be the sole source of water owing to the groundwater potential.

An alternative water supply system was studied together with the existing system, location of the expansion area with reference to the existing service area, and location of potential wells. One integrated system is then recommended. The location of well sites are distributed in Sto. Domingo-Mining area, Pampang area, and the Municipality of Porac.

Economic cost comparison was made considering a 12% per annum of the discount rate as instructed in LWUA Methodology Manual.

#### 1.2.6 Recommended Plan

The short term development plan corresponds to the selected long term development plan. The plan of the major facilities in the two phases is as follows:

##### (1) Source

Consolidation of existing wells was given priority in order to maximize their use. Five of the existing wells are recommended to be utilized but the existing pumps must be replaced. A new well should be constructed at either well site No. 9 or No. 14 since a yield of more than 2,900 cu.m/day is expected in the two sites. In addition, the test well constructed in this study will be converted to a production well. A total amount of 11,500 cu.m/day will be directly distributed from the wells. Six additional wells will be constructed to meet the water demand in 1995 in the Sto. Domingo-Mining and Pampang areas. Seven wells are planned in the Municipality of Porac to supplement the water supply in 2010.



(2) Treatment

A constant flow chlorinator is planned to be provided at the reservoir and the wells from where water will be directly distributed.

(3) Distribution

New reservoir in Sto. Domingo (Phase I)

Expansion of the reservoir in Sto. Domingo (Phase II)

(4) Electricity

Substation in Sto. Domingo (Phase I/II)

Construction, and operation and maintenance costs by phase are estimated at the 1986 price level in accordance with the implementation plan. The following are the summary of the costs.

Construction Cost (thousand pesos)

Phase I	Stage 1	:	56,222
	Stage 2	:	45,016
Phase II		:	144,159

Operation and Maintenance Cost (thousand pesos per annum)

Phase I	Stage 1	:	2,989
	Stage 2	:	6,916
Phase II		:	12,115

### 1.3 FINANCIAL ASPECTS

#### 1.3.1 Financial Feasibility

The financial feasibility of the project was analyzed in line with the LWUA's guideline.

The balance sheet of revenue and expenditure shows substantial deficits since 1983. The water charge is the major source of the revenue and is presently collected on a basis of the flat rate for unmetered connections and the metered rate for metered connections. The present water rates for domestic use are ₱18.0 per month and ₱14.0 per month for the first 10 cu.m, respectively.

According to the result of the market survey, it is observed that the majority of respondents has willingness to connect a municipal water supply system in every revenue bracket.

The capital cost of the project is estimated to be ₱204.46 million of which 50% is presumed to be financed from the LWUA's regular loan, 45% from the LWUA's soft loan and remaining 5% from the Water District's equity participation. A 15% per annum of the escalation rate was taken into account as instructed in the LWUA Methodology Manual. The future water tariff structure as shown below was developed assuming that:

- (1) Minimum charge for the first 10 cu.m/month consumption must not exceed 5% of the monthly average family revenue of the low revenue group, and
- (2) Increase of the minimum charge must be limited to within 60% of that in the previous year.

## WATER TARIFF IN THE FUTURE

<u>Period</u>	<u>Rate/ Unit</u>	<u>Consumption (cu.m)</u>			
		<u>First 10</u>	<u>11-20</u>	<u>21-35</u>	<u>Above 35</u>
1988	₱1.0	₱25.0	₱ 3.1	₱ 4.0	₱ 5.3
1989	1.2	30.0	3.8	4.8	6.3
1990	1.2	30.0	3.8	4.8	6.3
1991	1.8	45.0	5.6	7.2	9.5
1992	2.7	67.5	8.4	10.8	14.2
1993	2.9	72.5	9.1	11.6	15.2
1994	3.1	77.5	9.7	12.4	16.3
1995	3.1	77.5	9.7	12.4	16.3
1996	3.3	82.5	10.3	13.2	17.3
1997	3.3	82.5	10.3	13.2	17.3

Although the rapid increase of the water rate will be inevitable due to the present water rate at comparatively low level, the estimated Financial Internal Rate of Return (hereinafter referred to as FIRR) is 13.7%. Accordingly, the recommended project for the Short Term Development Plan will be financially feasible.

### 1.3.2 Economic Feasibility

The proposed feasibility of the project was analyzed using LWUA's guideline.

The economic analyses presented in CHAPTER 10 evaluate the effectiveness of the project in terms of socio-economic factors. The method adopted to give a measure of effectiveness is the Economic Internal Rate of Return (hereinafter referred to as EIRR). The benefits considered are the increase in land value and the economic value of water. Results of the findings show that the EIRR is 17.6%.

## 1.4 ORGANIZATION AND MANAGEMENT

### 1.4.1 Existing Management System

The main root of problem regarding organization is institutional weakness. It is the shortcoming of human resources that gives rise to inadequate physical systems and deficient water service.

For the ACWS, the constraints to effective management are caused by the lack of well trained and qualified personnel. The low salaries offered may well be a factor that does not attract qualified personnel, while the lack of training programs hampers better technical and management operations. As a result, much needed improvement cannot be effected resulting to a low level of water service. Also, much of the current operations do not encourage the development of good utility managers.

### 1.4.2 Proposed Organization Structure

It is recommended that the ACWS be formed into a water district. As such, the entire management process will not be split as is the existing set-up; but will be handled by well trained and qualified management.

Using the LWUA Methodology Manual, the number of personnel for the ACWS is 179 for 1996 and 411 for 2010. Although the formula presented in the LWUA Methodology Manual is based on statistical data, no evaluation has been indicated whether the figures derived from the formula are appropriate or not.

The Study Team of the Japan International Cooperation Agency (hereinafter referred to as JICA) is proposing a new staffing guideline regarding the number of personnel based on the appropriate performance of individual work. This is intended to help management carry policy into effect efficiently within the limits assigned in order to attain maximum performance at minimum cost. In other words, all resources particularly human resources, should be optimally utilized to realize the objectives of the water district.

Based on this guideline, the number of personnel needed to man Angeles City Water District once formed, is 72 for 1995 and 112 for 2010.

Organization wise, the JICA Study Team also proposes to divide the water district organization into two main branches or divisions: the administrative and commercial division, and the engineering and technical division.

#### 1.4.3 Other Recommendations

It is believed that the promotion of the water district concept should be more aggressively undertaken by the LWUA. Many municipalities are interested in forming its water system into a Water District if only the LWUA package of assistance is explained to them. Therefore, LWUA should address itself to effective information measures to promote water district formation through grass-roots and media based information campaigns. All taken together, LWUA's assistance in all aspects of water district operations; that is, technical, financial, institutional, training and public information will greatly enhance the water system's capability to provide adequate and efficient water service to its consuming public.

Another recommendation is in the area of water resources. Some areas in the Philippines have difficulties in finding adequate water sources, quality or quantity wise. In the near future, it may be necessary to amend further the Presidential Decree No. 198 (hereinafter referred to as PD 198) to enable LWUA to implement without much difficulty the "bulk water supply" concept. For areas close to Metro Manila, a "mutual interdependence" between MWSS and a water resource difficult water district may be made to solve such problems.

It is also worth noting that for an effective management of two or more water districts, PD 198 provide for a "consolidation and joint operation" of these districts. It is believed that a merger or consolidation of the facilities or operation of two or more water districts can lower the cost of the operating the system. This will result in lower water rates charged to the consumers. If not, then subsidy may be granted to water districts where construction costs may be too high for such districts to afford.

Subsidy is recommended especially if the resulting water rates would be unreasonably high. For example, a guideline would be to subsidize for the development of water resources that would double the quantity of the existing water source or for systems where the raw conduit or transmission pipeline's length exceeds 20 km.

## 1.5 CONCLUSION

Since the existing water supply system was constructed more than 20 years ago, the system is no longer effective to the present and future needs. A Short Term and Long Term Development Plan to improve and expand the existing city water supply system was established with the target years 1995 and 2010. It is urgently recommended that the Short Term Plan be implemented as this is technically and financially feasible. However, several notes should be taken into consideration to effectively and efficiently implement the project in the future.

The proposed water source composed of existing and newly constructed deep wells, can afford to supply water up to the year 1995, however a surveillance system is necessary to check the fluctuation of groundwater table and the relationship between water source and the flow rate of the Porac River, in order to provide a better review of water sources in the future.

Full metering of the system should be made a priority for this increases revenue and encourages the conservation of water. The cooperation of the residents is needed here since the installation of house connections is the concessionaires' responsibility. The water district may attract the residents who are willing to connect to the system by making it easier for them to connect by giving financial assistance at low interest or by giving discounts.

In relation to the full metering program, it is inevitable to repair all the not functioning water meters or replace with new one during the early stage of the project implementation. The leakage detection survey on all the existing service connections shall be carried out at the

same time. Through these activities, it is believed that the ACWS will eventually regain the reasonable level of the unaccounted-for water.

The promulgation of the appropriate manner of water conservation to consuming public and the provision of the preventive maintenance program, especially periodical check up of water meters are indispensable for sound operation of the ACWS.





**CHAPTER 2**  
**GENERAL BACKGROUND**



## CHAPTER 2 GENERAL BACKGROUND

### 2.1 AUTHORIZATION

In response to the request of the Government of the Republic of the Philippines (hereinafter referred to as GOP), the Government of Japan (hereinafter referred to as GOJ) decided on the conduct of a study on the Municipal Water Supply Project in the Philippines.

The JICA is the official agency responsible for the implementation of the technical cooperation programs of the GOJ and the LWUA is the official agency responsible for the municipal water supply in the GOP. Both agreed on an Implementing Arrangement for technical cooperation for the Study on 23 October 1985. The Study was started mid-February 1986 and completed on March 1987.

### 2.2 BACKGROUND OF THE PROJECT

Many of the water supply facilities of the local cities and municipalities in the Philippines do not meet the needs of the people due to the rapid increase of population and deterioration of such facilities.

The LWUA is responsible in promoting countryside waterworks development in cities and municipalities with a population of 20,000 or more except the Manila metropolitan area. Its aim is to improve public health and sanitation, and raise the standard of living.

This study is on four local cities and municipalities, one of which is Angeles City, Pampanga. Despite the fact that this city is one of the biggest cities in the Philippines, water supply conditions are extremely unsatisfactory. The GOP, therefore, with water supply as one of its priorities requested the GOJ to cooperate in conducting a study to improve and develop the water supply system of Angeles City.

## 2.3 OBJECTIVE AND SCOPE OF WORK

The basic objective of this study is to assist the implementing agency (LWUA) in the preparation of a Long Term Development Plan and a Short Term Development Plan for the water supply in Angeles City, Pampanga. The major elements of the Scope of Work are as follows:

### A. General

1. Review and evaluate all the data and previous studies directly relevant to the Study and conduct field investigations.
2. Conduct analysis mainly on the general background, study area, existing system facilities, population, water demand projection and water resources.
3. Examine and evaluate schemes to seek the most favorable plan for feasibility analysis.

### B. Specific

1. Data collection, review and field investigations. Collect and review the existing data and information including topography, hydrogeology, meteorology, population, existing land use and city planning, socio-economy, water supply statistics and existing water supply facilities.
2. Conduct the following field investigations:
  - field reconnaissance and demand survey
  - pumping test of existing well and test well drilling
  - existing system hydraulic survey
  - present unaccounted-for water survey
  - water quality survey
3. Preparation of Long Term Development Plan (up to the year 2010)
4. Preparation of Short Term Development Plan
5. Financial and Economic Study
6. Organizational and Managerial Study

**CHAPTER 3**  
**DESCRIPTION OF THE STUDY AREA**



## CHAPTER 3 DESCRIPTION OF THE STUDY AREA

### 3.1 GEOGRAPHICAL LOCATION AND PHYSICAL FEATURES

Angeles City lies on the western portion of Pampanga Province located on the central part of the Central Plain of Luzon. Its boundaries include the Provinces of Tarlac on the north and Nueva Ecija on the north-west; Bulacan on the east; Zambales on the west; and on the south by Manila Bay. The Province is about 80 km north of Manila (See FIGURE 3.1.1).

The city terrain is relatively flat with an average elevation of 90 m above mean sea level. There are two major rivers, namely: Abacan and Sapang Balen. The Abacan River divides the City into two: the southern part being the largest area comprising two-thirds of the whole land area; and the northern section, where Barangay Balibago, the tourist belt of the City is located, together with the main gate of Clark Air Base, the vast American Military Complex.

Angeles City has two pronounced climates, the dry and wet season. The dry season starts from November to April with January registering the lowest rainfall of 1.27 cm. Wet season is from May to October with the heaviest rainfall of 35.56 cm on the month of August.

The highest monthly average temperature is 29°C in April, and the lowest is 26°C in January and December.

### 3.2 ADMINISTRATIVE COMPOSITION AND LAND USE

Angeles City, a highly urbanized city, has a total land area of 6,432.82 ha composed of 28 urban barangays and 4 rural barangays. A land area of 2,169.14 ha is devoted to residential use and 113.20 ha is utilized for commercial/industrial use. The general land use of the city is summarized as follows:

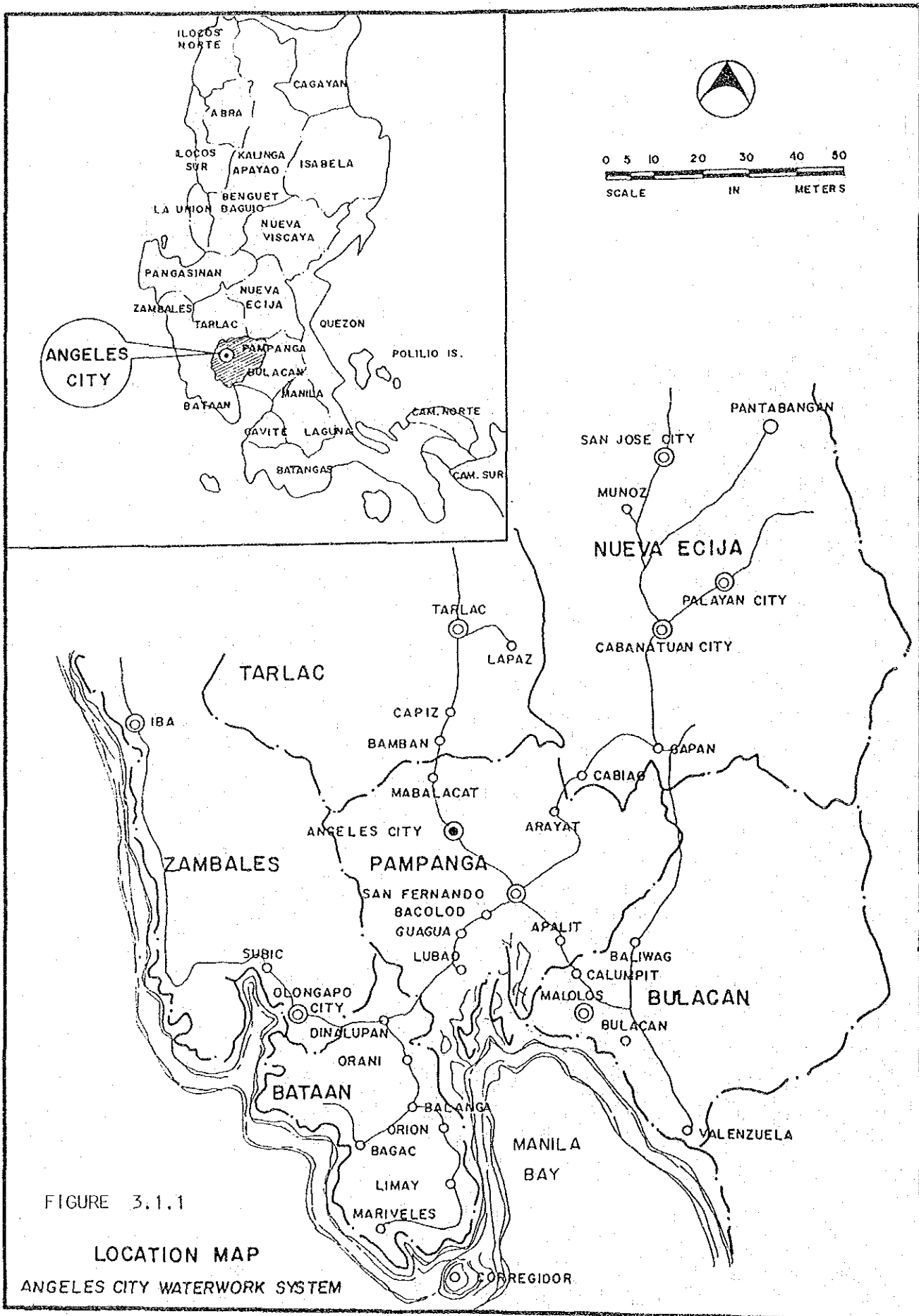


FIGURE 3.1.1

LOCATION MAP

ANGELES CITY WATERWORK SYSTEM



Use/Classification	Area (ha)	Percentage(%)
1. Urban	5,241.55	21.48
2. Rural	607.99	9.45
3. Military reservation, gov't. properties and others	447.72	6.96
4. Non-productive commercial forest	135.56	2.11
<b>Total</b>	<b>6,432.82</b>	<b>100.00</b>

FIGURE 3.2.1 shows the location of barangays and TABLE 3.2.1 shows the land area of each barangay.

There are more than 70 private subdivisions in the study area. It was the promotion of the subdivision concept that has been a driving force for the development of residential land (See APPENDIX 3.2.1)

### 3.3 POPULATION AND LIVING CONDITIONS

The population of Angeles City as of 1983 is reported to be 221,235, indicating an increase of 17% over the 1980 NCSO report of 188,834. The population in 1986 is estimated to be 224,290 based on the historical trend (Refer to CHAPTER 5). The urban area has a population of 221,370 while the rural area has a population of 2,920 (See TABLE 3.2.1). The general city population characteristics based on the 1980 NCSO report are presented in TABLE 3.3.1.

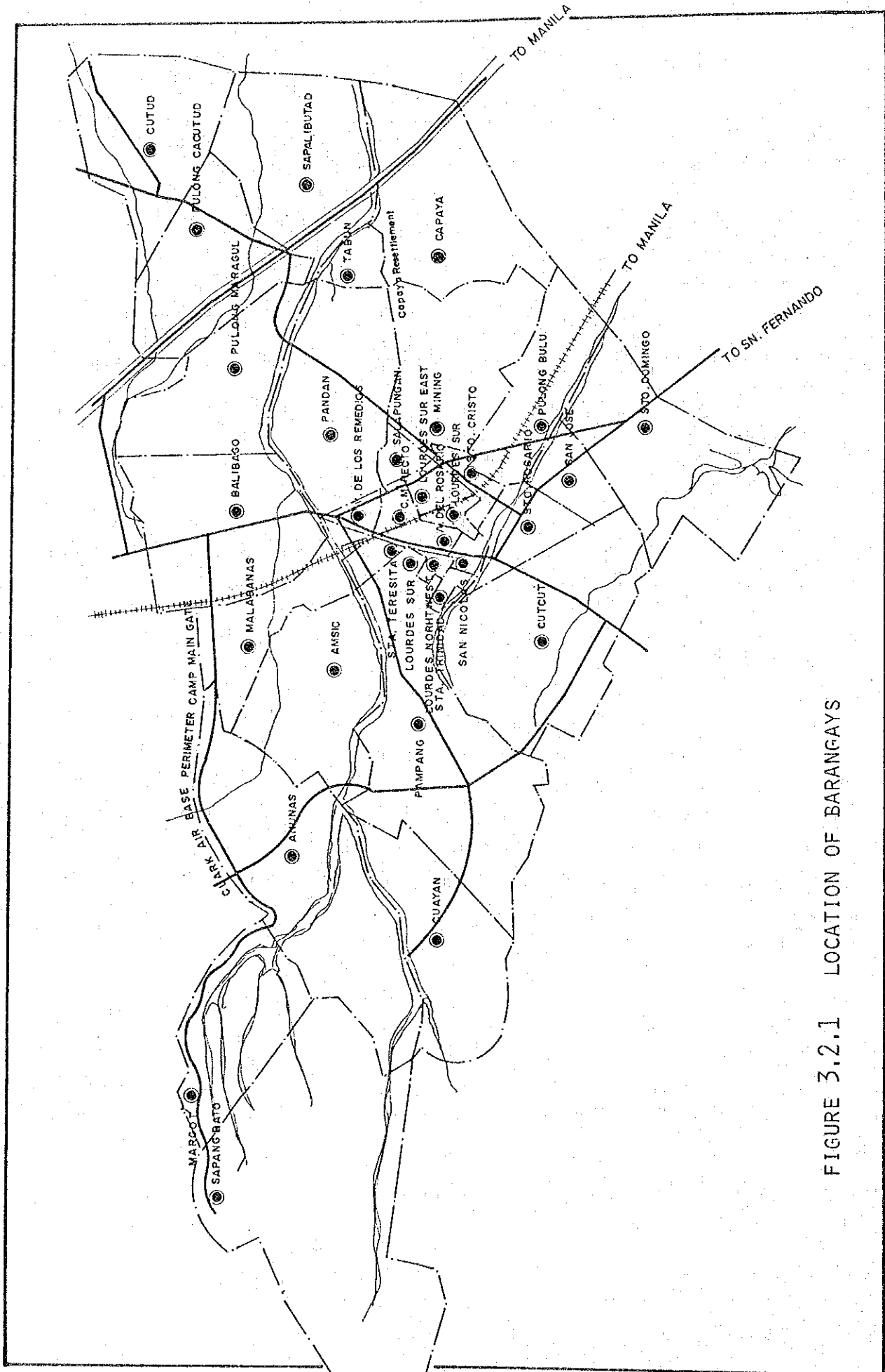


FIGURE 3.2.1 LOCATION OF BARANGAYS

TABLE 3.2.1 LAND USE AND POPULATION

Area	Barangay	Land Area (ha)	1986 Population	Population Density (p/ha)	Dist. From Poblacion (km)	Remarks	
Urban	1. A. del Rosario	12.45	5,070	407	1.0		
	2. Amsik	165.70	1,330	8	3.5	Part of Anunas & Pampang	
	3. Anunas	710.24	5,760	8	5.5		
	4. Balibago	271.26	33,470	123	3.0		
	5. Capaya	255.60	3,760	15	4.0		
	6. Claro M. Recto	17.51	7,660	437	1.5		
	7. Cutcut	408.50	16,230	40	0.5		
	8. Lourdes Northwest	22.71	11,200	493	1.0		
	9. Lourdes Sur	21.38	7,840	367	0.5		
	10. Lourdes Sur East	20.79	7,500	361	1.0		
	11. Malabanas	171.66	16,290	95	2.5		
	12. Margot	180.71	1,900	11	8.0		
	13. Pampang	497.01	2,350	5	3.5		
	14. Pandan	269.21	15,080	56	2.5		
	15. Plulungbulu	151.43	7,840	52	1.0		
	16. Pulung Cacutud	194.49	1,150	6	5.5		
	17. Pulung Maragul	229.37	4,760	21	4.0		
	18. Salapungan	27.74	7,620	275	2.0		
	19. San Jose	54.16	7,390	136	1.0		
	20. San Nicolas	16.75	4,190	250	0.5		
	21. Sapalibutad	270.41	2,220	8	5.5		
	22. Sapangbato	817.84	8,210	10	11.0		
	23. Sta. Teresita	52.19	11,870	227	1.5		
	24. Sta. Trinidad	9.70	6,090	628	1.0		
	25. Sto. Cristo	34.26	2,810	82	0.5		
	26. Sto. Domingo	294.66	14,570	49	1.5		
	27. Sto. Rosario	54.64	5,270	96	-		Poblacion
	28. Virgen delos Remedios	9.18	1,940	211	2.0		
	Sub-total	5,241.55	221,370	42			
Rural	29. Cuayan	121.50	340	3	5.0		
	30. Cutud	246.17	940	4	6.5		
	31. Mining	198.78	890	4	2.5		
	32. Tabun	41.54	750	18	4.0		
	Sub-total	607.99	2,920				
Others	Military Reservation Non-Productive	447.72					
	Commercial Forest	135.56					
	Sub-total	583.28					
	TOTAL	6,432.82	224,290	35			

TABLE 3.3.1 GENERAL CITY POPULATION CHARACTERISTICS

Classification	% to City Population
General Composition	
Urban	98.61
Rural	1.39
Sex Composition	
Male	48.09
Female	51.91
Age Composition	
0 - 14	40.94
15 - 64	56.73
65 & above	2.33
Education*	
No grade Completed	3.68
Elementary	44.08
High School	30.95
College	20.79
Not Stated	0.50
Dialects	
Pampanga	77.47
Tagalog	16.31
Ilocano	1.43
All others	4.79

Physical indicators of the living standard of the City are listed below. These indicators include dwelling units and household facilities and utilities based on the 1980 NCSO report.

Health and medical facilities in the City include 47 hospitals and clinics, 14 medical clinics and 8 dental clinics. This indicates that there are more than enough hospitals and clinics dispensing all kinds of medical and dental services. Aside from this regular health care delivery, specialized clinics catering to the vanity of clientele like dermatology and aesthetology clinics also abound. Backing these up are the various laboratories and drugstores vital to the dispensation of medical supplies.

\* For population 25 years and above

Classification	% to Total Households
<b>Type of Dwelling Units</b>	
Single House	80.21
Duplex	3.60
Apartment/Accessoria	10.77
Barong-Barong	2.64
Others	2.78
<b>Lighting Facilities</b>	
Electricity	92.52
Kerosene	6.80
Liquefied Petroleum Gas (LPG)	0.49
Oil	0.07
Others	0.12
<b>Water Facilities</b>	
Pipe Water	42.93
Artesian Well	35.69
Pumped Well	20.68
Open Well	0.53
Spring	0.04
Lake, Rivers, Streams, others	0.13
<b>Toilet Facilities</b>	
Flush/Water Sealed	81.72
Closed Pit (Antipolo)	7.79
Open Pit	1.96
Others	0.67
None	7.86

The death rate of the City decreased from 7.52 deaths for every 1,000 population in 1976 to 6.4 deaths for every 1,000 population in 1982. This trend shows that health services are improving. The government has also put up more rural health centers who cater to the needs of lower income earners.

On the other hand, birth rate decreased from 59.46 birth per 1,000 population in 1976 to 39.10 per 1,000 population in 1982. This means that the family planning program of the Government has had a positive impact in the City. Morbidity and mortality cases due to water-borne diseases per 1,000 population are given below.

TABLE 3.3.2 MORBIDITY AND MORTALITY RELATED TO  
WATER-BORNE DISEASES (GASTRO-ENTERITIS)

YEAR	MORBIDITY		MORTALITY	
	NO.	RATE	NO.	RATE
1981	2,174	24	93	52.94
1982	201	32	61	34.00
1983	2,647	141	51	27.8
1984	598	320.1	40	21.4
1985	3,306	1,736.19	38	19.95

Source : Office of the City Health Officer, Angeles City

### 3.4 SOCIO-ECONOMIC CONDITIONS

#### 3.4.1 City Revenue

The City's revenue came from the General Fund and Infrastructure Fund. The General Fund's sources of revenue are; a) Revenue from real property taxes, amusement taxes, business taxes and internal revenue allotment, b) Operating and miscellaneous revenues consisting of receipts from the City's economic enterprises, i.e., market, slaughter house, etc., and c) Public borrowings and transfers.

The Infrastructure Fund's sources of revenue are from; a) Revenue from taxation which includes garbage and general sanitation service and specific tax allotment, b) Operating and miscellaneous revenue, like receipt from waterworks, and c) Borrowings and interfund transfers.

The contribution to the City's revenue of General Fund and Infrastructure Fund in percentage, and their respective values for the last 3 years are as follows:

Year	General Fund	%	Infrastructure Fund	%	Total Revenue
1983	₱20,566,613	53	₱18,530,267	47	₱39,096,880
1984	22,164,106	55	18,147,113	45	40,311,219
1985	24,122,471	51	23,135,657	49	47,258,128

Based on 1982 figures, the largest sources of revenue of the General Fund come from:

	Type of Revenue	%
a)	Real Property Tax	22.95
b)	Tax on Business	19.74
c)	Internal Revenue Allotment	19.20
d)	Amusement Tax	11.26
e)	Receipts from Market	6.17

On the Infrastructure Fund, the largest sources of revenue for 1982 come from:

	Type of Revenue	%
a)	Specific Tax Allotment	52.61
b)	Receipt from Waterworks	5.41

The total revenue of Angeles City from 1983 to 1985 increased tremendously by ₱8,161,349 or 21%. However, its expenditure increased by ₱11,291,731 or 29% thereby increasing its deficit by ₱3,130,482 or 60% for the said period.

A comparative review of Angeles City's revenue and expenditure from 1983 to 1985 are as follows:

Year	Revenue	Expenditure	Deficit
1983	₱39,096,880	₱39,618,073	₱ 521,193
1984	40,311,219	42,982,393	2,671,174
1985	47,258,128	50,909,804	3,651,676

### 3.4.2 Family Income

The average monthly household income of the City is approximately ₱2,900, taken from the Market Survey result. (Refer to CHAPTER 9 FINANCIAL ANALYSIS). Its labor force, in 1983 was reported to be 161,895, with only 35.72% gainfully employed.

### 3.4.3 Agriculture, Livestock Farming and Fisheries

Angeles City is a highly urbanized place so the people tends to be more active in commerce and trading instead of agriculture. Because of the presence of Clark Air Base in the City and the business that it generates, the city people have been shifting from agriculture activities to commerce and trading. Now, agriculture is more visible in the rural areas of the City.

As of 1983, the total agricultural land area was 2,003 ha, while it was 3,674 ha in 1975, and the classification of the land by crops is sugar cane (59.91%), root crops (17.72%), rice (12.58%), vegetables (0.80%), fruits and sorghum (7.79%) and corn (1.20%). Crops being produced are sugar cane (75.19%), root crops (11.38%), rice (7.50%), vegetables (1.25%), fruits and sorghum (1.29%), corn (0.83%), and others (2.56%).

The total agricultural land area from 1975 to 1983 decreased by 1,671 ha or 45%. These are due to the following factors:

- a) Agricultural lands have been converted to residential land to accommodate the increasing number of population.
- b) Agricultural land devoted in 1975 for sugar cane was 2,762 ha while in 1983 it became 1,200 ha or a reduction of 1,362 ha or 49%. This may be due to the low price of sugar in the world market so the people no longer utilize their land to sugar cane.

In livestock, both production and consumption increased. The supply of hogs and chicken exceeded the demand while supply of cows, carabaos and horse is less than the demand.



#### 3.4.4 Commerce and Industry

In 1983, there were 14,166 commercial establishments in the City, while in 1975, there were only 8,194 or a 64% increase.

There are 6,585 trading establishments or 46.48% of the commercial sector, followed by transport at 33.05%, services at 8.09%, eateries at 5.69% and the least is the commercial entities at 0.06%.

Regarding the manufacturing sector, the trend is in the production of goods such as shell, bamboo and rattan items, which mostly attract foreign market. Other major industries are an ice plant, vinegar production, and furniture manufacturing.

In 1983, the number of manufacturing establishments was 954 with the cottage industry leading 83.8%, followed by industrial at 15.6% and the least being agro-industrial at 0.6%.

#### 3.4.5 Transportation and Communication

Transportation and communication are vital to a city like Angeles. The 1983 figures for transport vehicles are; jeepneys - 1,915, tri-cycles - 2,455 and horse driven calesas - 240, of which the last two are only allowed in local and secondary streets. A government owned train service, the Philippine National Railways, also serves the City. Because of the number of vehicles, traffic congestion is a problem particularly during the rush hours.

Angeles City can be reached through; a) the North Expressway, b) the MacArthur Highway, c) the Fil-Am Friendship Highway, and d) the railroad system.

In 1982, total length of city roads was 171 km, 65 km or 38% of which was concrete, asphalt road was 40 km or 23%, earth-road was 59 km or 35%, and gravel road was 7 km or 4%.

In communication facilities, there is a branch of the Bureau of Telecommunication, a government telecommunication agency, plus 2 commercial

telegraph companies, RCPI and the PT&T which service the telegraph requirements of the City.

Mail service is maintained by the City Postal Office. Also, there are three private firms engaged in more efficient messengerial services.

In addition, there are two radio stations in the city and two local papers.

The city telephone system is managed by the Evangelista Telephone Company, a private company which has an inter-connecting agreement with the PLDT on the latter's national and international network. In 1983, the phone company had a total of 4,721 subscribers.

#### 3.4.6 Power Supply

The city's electrical power is served by the Angeles Electric Corporation, a privately-owned company which has the distinction of being the second largest utility company in Central Luzon, next to the Manila Electric Company (hereinafter referred to as MERALCO) of Metro-Manila. The company on its own can only generate one million KWH, hence, to provide the power requirements of the city it has to purchase annually from the National Power Corporation (hereinafter referred to as NPC) over 95 million kwh. The rates charged to the subscriber are being regulated by the government.

The utility company, with its liaison with the NPC, is still capable of energizing future power requirements for new institutions that may be established in the City.

The current electric charges of the Angeles Electric Corporation by consumer class are shown in APPENDIX 3.4.1.

### 3.5 CITY DEVELOPMENT PLAN

The demands of a growing and increasing population and an expanding economy call for a realistic physical and infrastructure development program.

The proposed land use plan as shown in FIGURE 3.5.1, presents a pattern for the urban growth of Angeles City. Zoning of the land is recommended as implementing tools for controlling development. The strategic location of the central business district indicates strongly a dominant commercial nucleus. The industrial district clings along the eastern portion of the City. Residential communities with their auxiliary activities cluster around the central business area. The institutional area is situated on the eastern portion of the central business area. Roads should be constructed without destroying valuable land. Regulation and guides to control the development of new subdivisions are an integral part of comprehensive planning.

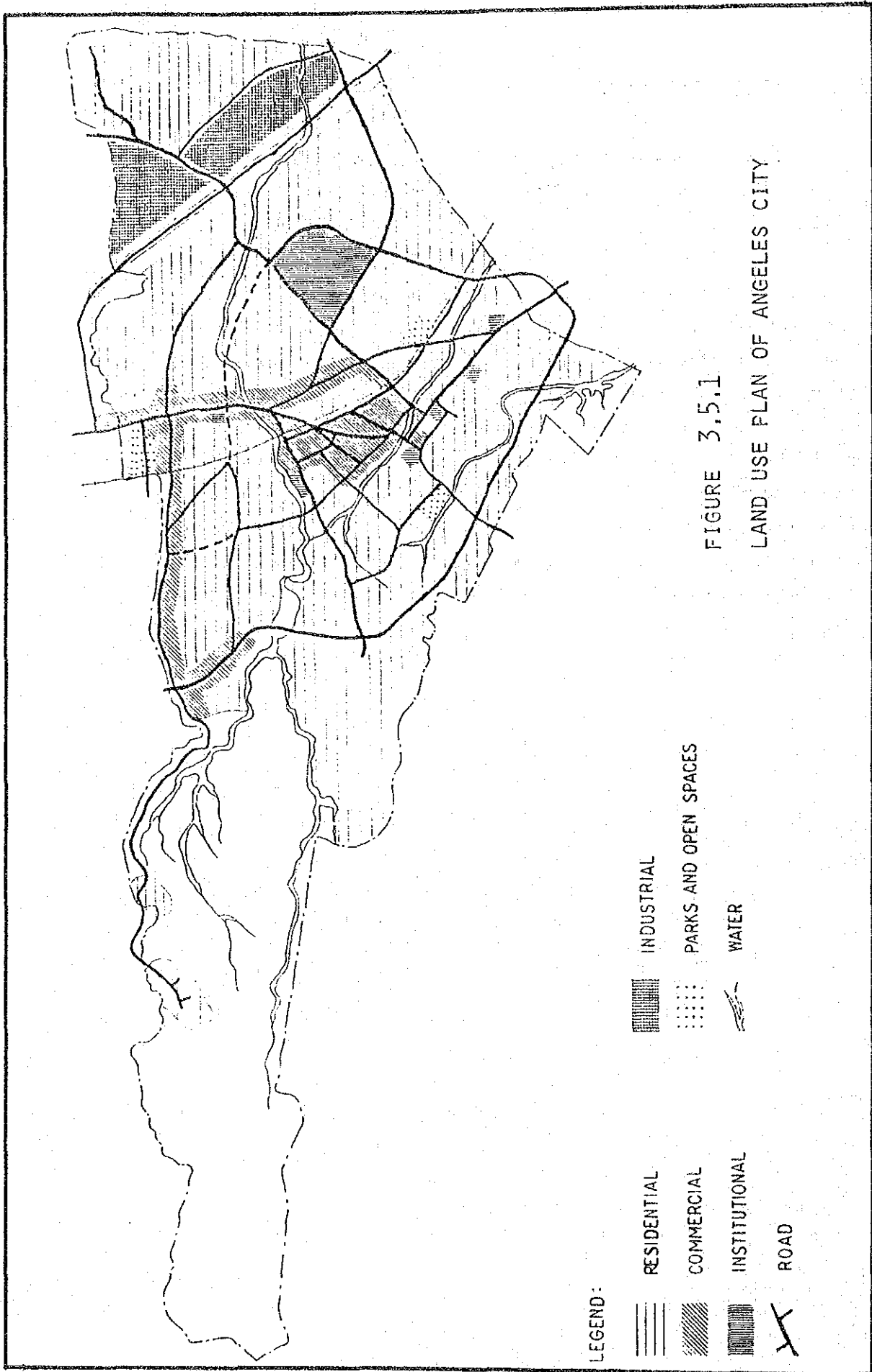









FIGURE 3.5.1  
LAND USE PLAN OF ANGELES CITY

LEGEND:

- |   |               |   |                       |
|---|---------------|---|-----------------------|
|  | RESIDENTIAL   |  | INDUSTRIAL            |
|  | COMMERCIAL    |  | PARKS AND OPEN SPACES |
|  | INSTITUTIONAL |  | WATER                 |
|  | ROAD          |   |                       |

**CHAPTER 4**  
**EXISTING WATER SUPPLY AND SANITATION CONDITIONS**



## CHAPTER 4 EXISTING WATER SUPPLY AND SANITATION CONDITIONS

### 4.1 PRESENT WATER SUPPLY IN THE CITY

The water supply of the City is categorized into three as follows:

1. Waterworks (Level III)
  - 1) City Waterworks System
  - 2) Balibago Waterworks system
  - 3) Subdivision Water Supply System
2. Public Piped Water Supply (Level II)
3. Private and Point Water Supply (Level I)
  - 1) Private piped supply with pump
  - 2) Point source with pitcher pump

As of 1980, approximately 65% of the total population relied on the private and point source water supply, about 80% of which uses point sources including artesian wells with pneumatic pumps, spring, river water, rain water and others. In addition, 67 wells were constructed by MPWH/RWDC as of December 1985.

The main waterworks in the city are the City and the Balibago Water Supply Systems. In addition, many subdivisions developed by private sectors are provide their own water to the residents.

TABLE 4.1.1 shows the subdivisions with reference to the barangays related to the present service area (19 barangays). Those related to the existing service area are also shown in the same TABLE. The location of the subdivisions with water supply status is given in FIGURE 4.1.1. The summary of the observation visits to six subdivisions is attached in APPENDIX 4.1.1.

The aggregate population served by these systems is approximately 35% of the city's total. The served population and number of households by different water supply levels as of 1980 are shown in APPENDIX 4.1.2.

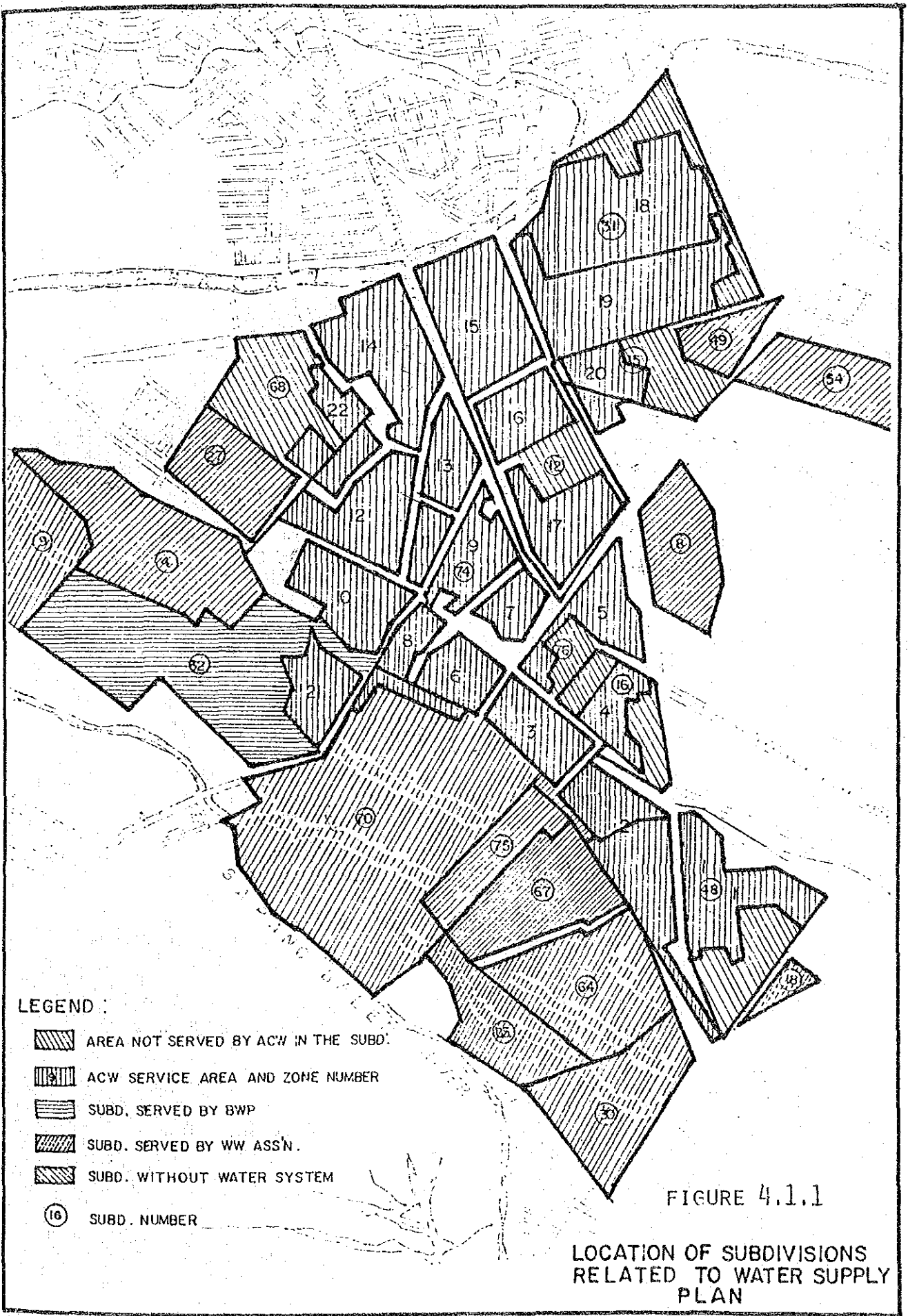
TABLE 4.1.1 SUBDIVISIONS RELATED TO THE WATER SUPPLY AREA

Name of Subdivision	Subdivision Number *	Location	Existing Water Supply	Remarks
① Doña Agripina	15	Pandan	ACWS	
② El Cano	16/17	Pulung Bulu	ACWS	
③ Kalaya-an	27	Lourdes N.W.	None	
④ Marisol	31	Pandan	ACWS	
⑤ Pacimar	76	Pulung Bula	ACWS	
⑥ San Angelo	48	Sto. Domingo	ACWS	
⑦ San Jose	55/56/57	Pulung Bulu	ACWS	
⑧ Nepumuce	32/33/34/35	Cutcut	ACWS & BWP	On going- Level III
9 Carmen-ville	9	Cutcut	Ass'n.	
10 Essel Park	18	Sto. Domingo	Ass'n.	
11 I. and S	30	Sto. Domingo	Ass'n.	Supply from Villa Angela
12 Sunset	79	Cutcut	Ass'n.	
13 Timog Park	59	Cutcut	Ass'n	
14 Timog-Silangan	60	Cutcut	Ass'n.	Supply from Timog Park
15 Villa Angela	64	St. Domingo	Ass'n.	
16 Villa Dolores	65	St. Domingo	Ass'n	Supply from Villa Angela
17 Villa Teresa	70	Cutcut	Ass'n.	
18 Angelina	3/79	San Jose	None	
19 Bagong Bayan	4	Cutcut	None	
20 Belen Homesite	8	Sto. Cristo	None	
21 Clemente Dayrit	12	Lourdes S.E.	ACWS	
22 Eastwest	74	Lourdes S.E.	ACWS	
23 Leonica	29	St. Domingo	None	
24 San Ignacio	54	Pandan	None	
25 Springside	49	Pandan	None	
26 Villa Gloria	67	San Jose	None	
27 Villa Henson	68	Lourdes N.W.	ACWS	

Note: \* The number corresponds to those in APPENDIX 3.2.1

Subdivisions located in the existing service area by ACWS are shown with circle in number.





The ACWS serves the inhabitants in the core city and the area south of Abacan River, covering 19 barangays. The service area is divided into 22 zones for collection purposes. FIGURE 4.1.2 shows the location of zones with reference to barangays. On the other hand, the Balibago Waterworks System, Inc. covers those areas on the left bank of the river, including Balibago, Malabañas, and Pulung Maragul.

Piped water supply systems with public faucets (Level II) were constructed since 1981 in six areas through the Barangay Water Program. The small network system in Barangay Cutcut is under development based on the same program.

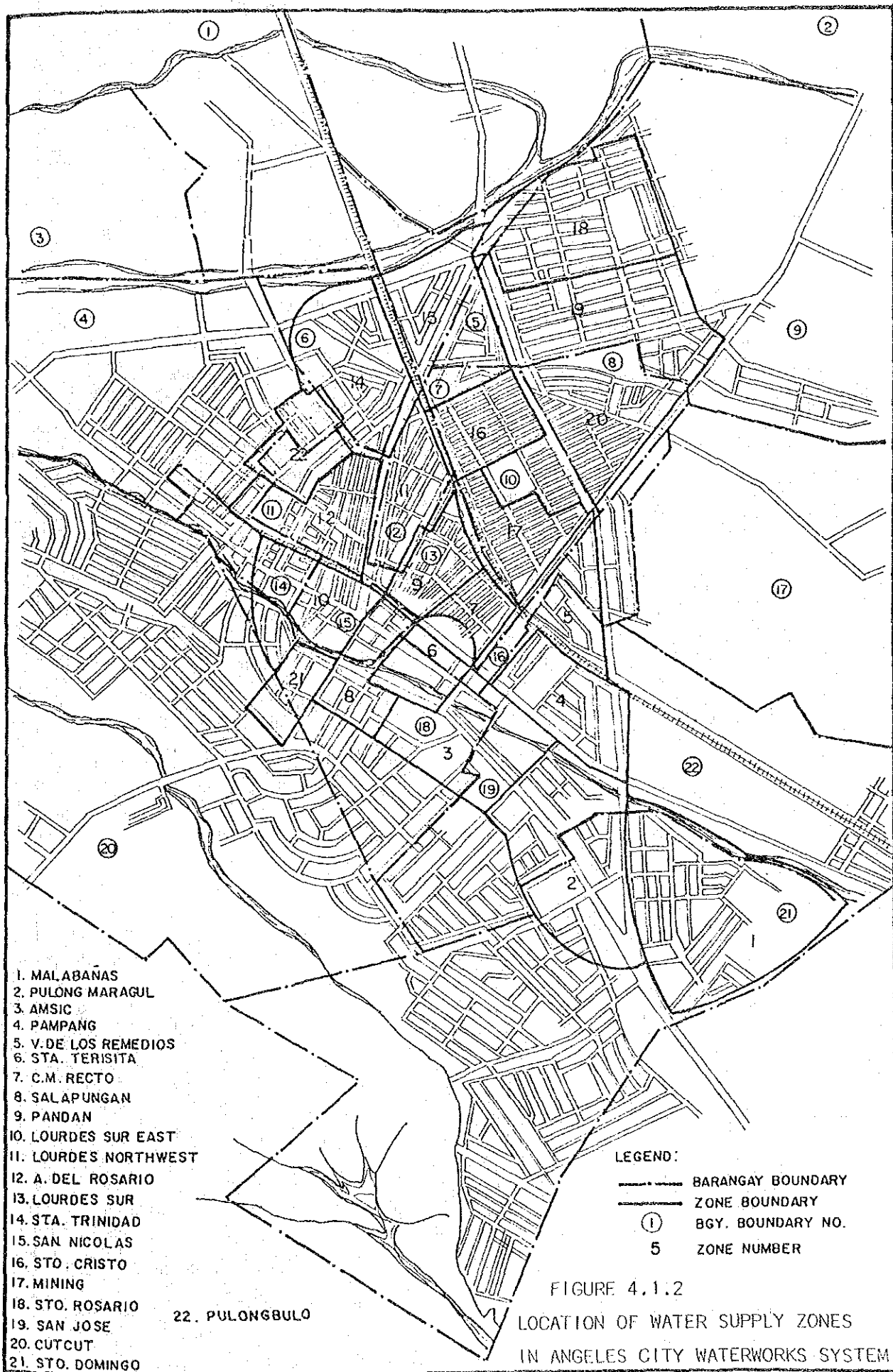
The location of the major water supply systems is delineated in FIGURE 4.1.3.

The existing Level I and Level II Water Supply Systems constructed by the MPWH/RWDC or Barangay Program are shown in APPENDIX 4.1.3 and 4.1.4. For the covered barangays, the percentage of population served by Level I and Level II Systems are 3.5 and 16.6, respectively. TABLE 4.1.2 shows the approximate served population covered by the two major Waterworks. As of 1986, the percentage of population served of the covered barangays for the City and Balibago Waterworks are 17.3 and 51.2, respectively.

## 4.2 WATER SUPPLY FACILITIES BY DIFFERENT LEVEL OF SERVICES

### 4.2.1 Level I System

There were 67 point source water supplies (Level I) in 20 identified barangays constructed under the BWP of the MPWH/RWDC as of December 1985. Service population for each of the facility ranges from 40 to 70 persons. The depth of these wells ranges from 12.2 m to 42.7 m and size of casings from 38 mm to 125 mm.



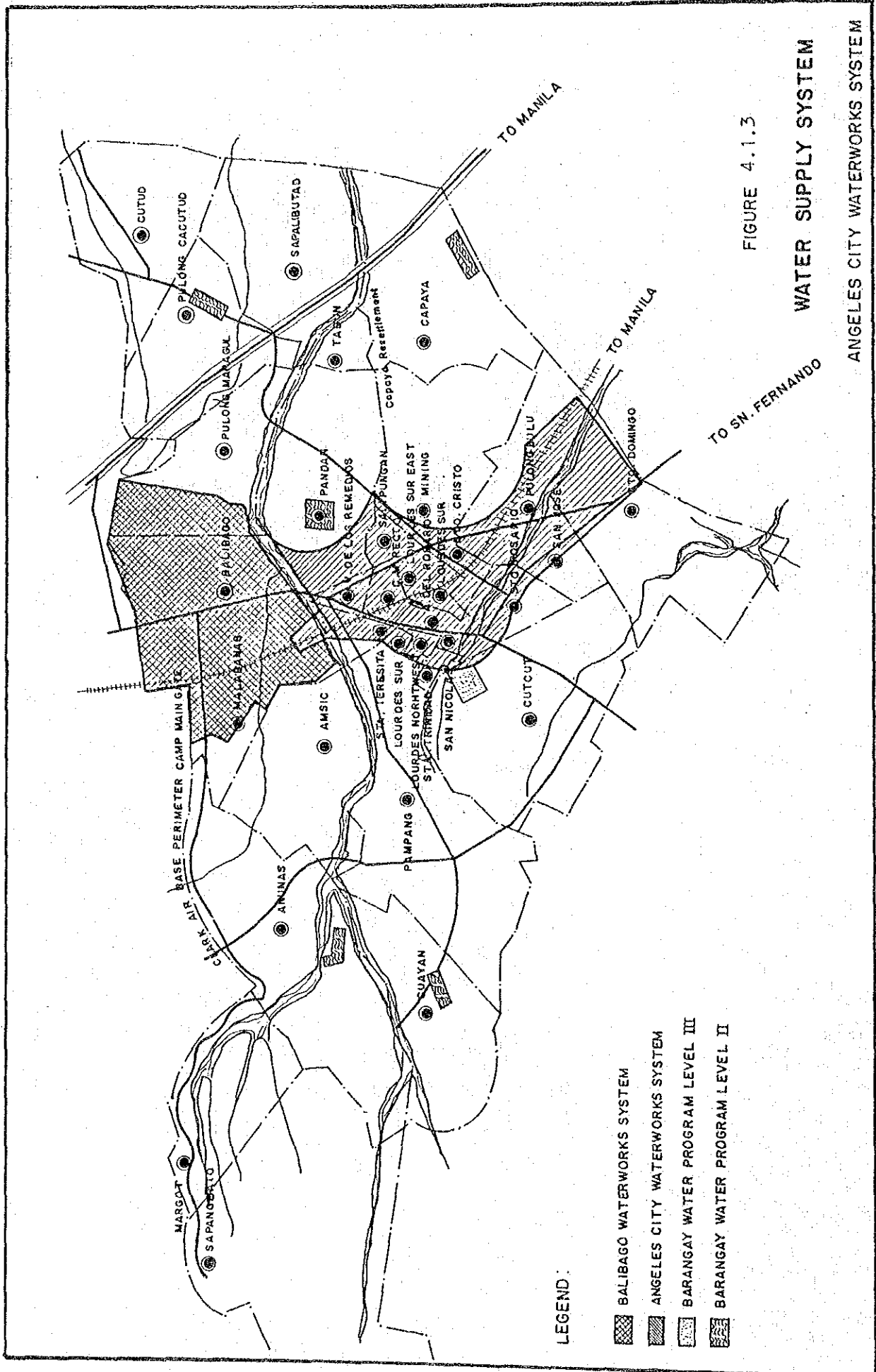


FIGURE 4.1.3

**WATER SUPPLY SYSTEM**

ANGELES CITY WATERWORKS SYSTEM

TABLE 4.1.2.A SERVED POPULATION BY CITY WATERWORKS

Barangay	Barangay Pop.		Served Pop.		Percent		Remarks
	Barangay Pop.	Total	Primary	Total	Primary	Total	
1. A. Del Rosario	5,070	210	162	210	3.2	4.1	
2. Claro M. Recto	7,660	1,860	1,434	1,860	18.7	24.3	Estimated Served Pop.
3. Cutcut	16,230	300	228	300	1.4	1.8	= Primary User x 1.30
4. Lourdes North-west	11,200	3,090	2,376	3,090	21.2	27.6	
5. Lourdes Sur	7,840	2,500	1,920	2,500	24.5	31.9	
6. Lourdes Sur East	7,500	1,410	1,086	1,410	14.5	18.8	
7. Malabañas	16,290	750	576	750	3.5	4.6	
8. Pampang	2,350	260	198	260	8.4	11.1	
9. Pandan	15,080	5,140	3,954	5,140	26.2	34.1	
10. Pulung Bulu	7,840	2,220	1,704	2,220	21.7	28.3	
11. Salapungan	7,620	480	366	480	4.8	6.3	
12. San Jose	7,390	1,350	1,038	1,350	14.0	18.3	
13. San Nicholas	4,180	1,190	918	1,190	22.0	28.5	
14. Sta. Teresita	11,870	1,170	900	1,170	7.6	9.9	
15. Sta. Trinidad	6,090	660	570	660	8.4	10.8	
16. Sto. Cristo	2,810	1,360	1,044	1,360	37.2	48.4	
17. St. Domingo	14,570	2,610	2,004	2,610	13.8	17.9	
18. Sta. Rosario	5,270	680	522	680	9.9	12.9	
19. Virgen de los Remedios	1,940	380	294	380	15.2	19.6	
Sub-Total	158,800	27,600	21,234	27,600	13.4	17.3	
City Total	224,290	27,600	21,234	27,600	9.5	12.3	

TABLE 4.1.2.B SERVED POPULATION BY BALIBAGO WATERWORKS

Barangay	No. of Domestic		Population (1986)	Served		Remarks
	Connection	Estimated Served Pop.		Percentage	Served Percentage	
1. Balibago	3,474	20,844	33,470	62.3	62.3	Estimated served pop. = No. of HH x 6 x 1.1
2. Malabañas	366	2,196	14,660	15.0	15.0	
3. Pulung Maragul	678	4,068	4,760	85.5	85.5	
Sub-Total	4,518	27,108	52,890	51.2	51.2	
Total	8,057	54,708	211,690	25.8	25.8	
City Total	8,057	54,708	224,290	24.4	24.4	

Note: Population in 1986 of Malabañas consists of those in the ACWS and Balibago Waterworks.