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SAN FERNANDO WATER DISTRICT

PREPARED BY: LOCAL WATER UTILITIES ADMINISTRATION
ENGINEERING DEPARTMENT
PLANNING DIVISION

WITH GUIDANCE FROM: CAMP DRESSER & McKEE INTERNATIONAL INC.
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TABLE OF CONTENTS

		Page
CHAPTER I	SUMMARY AND RECOMMENDATIONS	
	A. Summary of Studies	I-1
	B. Recommendations	I-3
Chapter II	INTRODUCTION	
	A. First Ten Provincial Urban Areas	II-1
	B. Second Ten Provincial Urban Areas	II-2
	C. Historical Background of San Fernando Water District	II-3
CHAPTER III	DESCRIPTION OF THE WATER DISTRICT	
	A. Physical Description	III-1
	B. Population	III-2
	C. Living Conditions	III-4
	D. Economy	III-4
CHAPTER IV	EXISTING WATER SUPPLY FACILITIES	
	A. General	IV-1
	B. Waterworks Facilities	IV-1
	C. Water Quality	IV-3
	D. Water Use Profile	IV-6
	E. Hydraulic Survey Data	IV-7
	F. Computer Studies	IV-9
	G. Deficiencies of the Existing System	IV-9
	Annex IV-D Pilot Area Survey	IV-D-1
	Annex IV-E Hydraulic Survey Data	IV-E-1
CHAPTER V	FEASIBILITY STUDY CRITERIA	
	A. General	V-1
	B. Planning Criteria	V-1
	C. Design Criteria	V-2
	D. Economic and Financial Criteria	V-4
	E. Basis of Cost Estimates	V-4
	F. Implementation Schedule	V-5

CHAPTER VI POPULATION AND WATER DEMAND PROJECTIONS

A. General VI-1
B. Population Projections VI-1
C. Projections for Served Population VI-3
D. Water Demand Projections VI-9

CHAPTER VII WATER RESOURCES

A. General VII-1
B. Groundwater Resources VII-1
C. Surface Water Resources VII-14
D. Water Quality of Potential Sources VII-15
Annex VII-B Groundwater Resources VII-B-1

CHAPTER VIII ANALYSIS AND EVALUATION OF ALTERNATIVES

A. General VIII-1
B. Water Supply Source Alternatives VIII-1
C. Treatment Alternatives VIII-2
D. Distribution Alternatives VIII-3
Annex VIII-B Schedule of Facilities for Alternative Studies VIII-B-1

CHAPTER IX DESCRIPTION AND COST OF RECOMMENDED PLAN

A. General IX-1
B. Immediate Improvement Program IX-3
C. First Stage of the Long-Term Construction Program IX-10
D. Second Stage of the Long-Term Construction Program IX-26
E. Capital Cost Summary IX-32
F. Annual Operation and Maintenance Costs IX-32
G. Sewerage/Drainage Concepts IX-32
H. Management of Water Resources IX-41
I. Updating the Water Supply Master Plan IX-41
J. Environmental Considerations IX-41
Annex IX-C Distribution System Growth IX-C-1

CHAPTER X FINANCIAL FEASIBILITY ANALYSIS

A. General X-1
B. The Existing System X-1
C. Development Costs X-2
D. Operating and Maintenance Costs X-3
E. Financing Policies Covering Local Water District Development X-3

F. Funds For Capital Development X-5
G. Analysis of Water Rates X-7
H. Financial Summary X-15
I. Financial Recommendations X-16
Annex X-C Development Costs X-C-1
Annex X-F Funds for Capital Development X-F-1
Annex X-G Analysis of Water Rates X-G-1
Annex X-H Financial Summary X-H-1

CHAPTER XI ECONOMIC FEASIBILITY ANALYSIS

A. Water and the Economy XI-1
B. Methodology XI-2
C. Quantifiable Benefits XI-4
D. Non-Quantifiable Benefits XI-6
E. Economic Costs XI-7
F. Benefit-Cost Analysis XI-10
G. Internal Economic Rate of Return XI-11
Annex XI-C Quantifiable Benefits XI-C-1
Annex XI-E Economic Costs XI-E-1
Annex XI-G Internal Economic Rate of Return XI-G-1

METHODOLOGY MEMORANDA

1. Pilot Area Survey MM1-1
2. Estimating Water Accountability MM2-1
3. Classification of Water Districts According to Future Water Requirements MM3-1
4. Probability Analysis of Stream Flows by Gumbel MM4-1
5. Quantity of Storage Versus Rate of Supply MM5-1
6. Economical Sizing of Pumped Waterlines MM6-1

LIST OF TABLES

Table		Page
I-1	Summary of Proposed Water Supply Improvements	I-4
I-2	Capital Cost Summary	I-5
I-3	Cost Summary of Immediate Improvement Program and Construction Stage I Phase A	I-6
I-4	Annual Operation and Maintenance Costs	I-7
III-1	Climatological Data	III-2
III-2	Municipal Population Characteristics	III-3
III-3	Classification of Households by Type of Facilities	III-5
III-4	Reported Morbidity and Mortality Due to Water-Borne Diseases	III-6
IV-1	Summary of Distribution Piping by Size, Material and Age	IV-4
IV-2	24-Hour Pressure Recordings on Distribution System	IV-4
IV-3	Water Quality Test Results	IV-5
IV-E-1	Test Data at Pump Station No. 1	IV-E-1
IV-E-2	Test Data at Pump Station No. 2	IV-E-2
IV-E-3	Test Data at Pump Station No. 3	IV-E-3
IV-E-4	Test Data at Pump Station No. 4	IV-E-4
IV-E-5	Test Data at Pump Station No. 5	IV-E-5
IV-E-6	Data on Hydrant Flow Test No. 1	IV-E-6
IV-E-7	Data on Hydrant Flow Test No. 2	IV-E-6
IV-E-8	Data on Hydrant Flow Test No. 3	IV-E-7
IV-E-9	Data on Hydrant Flow Test No. 4	IV-E-7
VI-1	Service Area Population Projections	VI-4
VI-2	Served Population Projections	VI-5
VI-3	Year-by-Year Projections of Served Population	VI-10
VII-1	Specific Capacity Versus Depth	VII-3
VII-2	Specific Capacity Versus Casing Diameter	VII-3
VII-3	FER-WD Well Pump Test Results	VII-5
VII-4	Static Water Levels near San Fernando Poblacion	VII-8
VII-5	Water Quality Test Results Potential Sources	VII-16
VII-6	Conductivities of Handpump Well Waters	VII-17
VII-B-1	Water Well Data Summary	VII-B-1
VII-B-2	Constant Rate Pumping Test - CDM Well No. 3	VII-B-11

VII-B-3	Constant Rate Pumping Test - CDM Well No. 4	VII-B-15
VII-B-4	Constant Rate Pumping Test - CDM Well No. 5	VII-B-16
VII-B-5	Constant Rate Pumping Test - CDM Well No. 6	VII-B-17
VII-B-6	Constant Rate Pumping Test - CDM Well No. 7	VII-B-18
VII-B-7	Constant Rate Pumping Test - CDM Well No. 8	VII-B-19
VIII-1	Alternative Storage Versus Additional Supply Analysis	VIII-6
VIII-2	Alternative Analysis on Operational Problem	VIII-10
VIII-B-1	Economic Service Life of Water Supply Facilities	VIII-B-1
IX-1	Distribution Pipelines, Immediate Improvement Program	IX-5
IX-2	Construction Cost Summary, Immediate Improvement Program	IX-11
IX-3	Phase I-A Distribution Pipelines	IX-16
IX-4	Cost Summary for Construction Stage I Phase A	IX-19
IX-5	Phase I-B Distribution Pipelines	IX-22
IX-6	Cost Summary for Construction Stage I Phase B	IX-23
IX-7	Phase II-A Distribution Pipeline	IX-27
IX-8	Cost Summary For Construction Stage II Phase A	IX-29
IX-9	Phase II-B Distribution Pipeline	IX-31
IX-10	Cost Summary for Construction Stage II Phase B	IX-33
IX-11	Capital Cost Summary	IX-35
IX-12	Annual Operation and Maintenance Costs	IX-35
IX-13	Average Daily Wastewater Flows	IX-39
IX-C-1	Served Population Projections	IX-C-2
IX-C-2	Total Service Area	IX-C-3
IX-C-3	Net Area To Receive Internal Network for Individual Communities	IX-C-4
IX-C-4	Total Area Served by Internal Network by Construction Phase	IX-C-6
IX-C-5	Net Area Served by Equivalent Network System by Construction Phase	IX-C-7
IX-C-6	Schedule of Service Connection Installation	IX-C-8
IX-C-7	Schedule of Service Connection Installation by Construction Phase	IX-C-9
IX-C-8	Schedule of Fire Hydrant Installation by Construction Phase	IX-C-10
IX-C-9	Computer Printout Year 2000 Peak-Hour	IX-C-12
IX-C-10	Computer Printout Year 2000 Minimum Flow	IX-C-22

X-C-1	Projected Cost of Recommended Program	X-C-1
X-C-2	Projected Cost of Recommended Program (Escalated)	X-C-2
X-F-1	Asset and Depreciable Value Forecast	X-F-1
X-F-2	Schedule of Depreciation Expenses	X-F-3
X-F-3	Working Capital Requirements	X-F-4
X-F-4a	Stratification of Service Connections	X-F-5
X-F-4b	Revenue Unit Forecast	X-F-5
X-G-1	Revenue Forecast	X-G-1
X-H-1	Debt Service Schedule of Total Project Loan	X-H-1
X-H-2	Projected Income Statement	X-H-2
X-H-3	Projected Sources and Applications of Funds	X-H-3
X-H-4	Projected Balance Sheet	X-H-4
X-H-5	Rate of Return of Total Investment	X-H-5
XI-C-1	Portion of Increased Land Values Attributable to Project	XI-C-2
XI-C-2	Health Benefits	XI-C-6
XI-C-3	Reduction in Fire Damage	XI-C-7
XI-C-4	Beneficial Values of Water	XI-C-10
XI-E-1	Conversion of Financial Cost to Economic Cost	XI-E-1
XI-E-2	Replacement Cost	XI-E-2
XI-E-3	Salvage Value in 2001	XI-E-3
XI-E-4	Summary of Economic Costs	XI-E-4
XI-G-1	Internal Economic Rate of Return	XI-G-1
MM3-1	Water District Grouping Criteria	MM3-2
MM3-2	Water Demand of Water District Groupings	MM3-6
MM3-3	Summary of Cities/Municipalities Subjected to the Water District Grouping Criteria	MM3-10
MM4-1	Mean-Day Discharge per Month	MM4-3
MM4-2	Mean Flow (Peñaranda River, San Vicente)	MM4-4
MM6-1	Sample "EVF" for Different Flow Patterns	MM6-6
MM6-2	"EVF" for Distribution System	MM6-8

LIST OF FIGURES

Figure		Following Page
II-1	Location Map	II-2
III-1	Location Map	III-2
III-2	Climate Map	III-2
IV-1	Existing Facilities	IV-2
IV-2	Existing Water Distribution Facilities	IV-2
IV-E-1	Pump Performance Curve at Pump Station No. 1	IV-E-7
IV-E-2	Pump Performance Curve at Pump Station No. 2	IV-E-7
IV-E-3	Pump Performance Curve at Pump Station No. 3	IV-E-7
IV-E-4	Pump Performance Curve at Pump Station No. 4	IV-E-7
IV-E-5	Pump Performance Curve at Pump Station No. 5	IV-E-7
IV-E-6	24-Hour Discharge Pressure at Pump Station No. 1	IV-E-7
IV-E-7	24-Hour Discharge Pressure at Pump Station No. 2	IV-E-7
IV-E-8	24-Hour Discharge Pressure at Pump Station No. 3	IV-E-7
IV-E-9a	24-Hour Discharge Pressure at Pump Station No. 4	IV-E-7
IV-E-9b	24-Hour Discharge Pressure at Pump Station No. 4	IV-E-7
IV-E-10	24-Hour Discharge Pressure at Pump Station No. 5	IV-E-7
IV-E-11	24-Hour System Pressure at Fire Hydrant No. 6	IV-E-7
IV-E-12	24-Hour System Pressure at Fire Hydrant No. 7	IV-E-7
IV-E-13	24-Hour System Pressure at Fire Hydrant No. 9	IV-E-7
IV-E-14	24-Hour System Pressure at Fire Hydrant No. 13	IV-E-7
IV-E-15	24-Hour System Pressure at Fire Hydrant No. 14	IV-E-7
IV-E-16	24-Hour System Pressure at Fire Hydrant No. 15	IV-E-7
IV-E-17	Hydrant Flow Measurement No. 1	IV-E-7
IV-E-18	Hydrant Flow Measurement No. 2	IV-E-7
IV-E-19	Hydrant Flow Measurement No. 3	IV-E-7
IV-E-20	Hydrant Flow Measurement No. 4	IV-E-7
V-1	Water Accountability First 10 Cities	V-2
V-2	Project Implementation Schedule	V-5
VI-1	Present and Future Service Area	VI-2
VI-2	Population Projection	VI-4
VI-3	Projected Water Demand	VI-10
VII-1	Well Location Map	VII-2
VII-2	Groundwater Contours, Central Luzon Plain	VII-2
VII-3	General Design-Gravel Packed Well Rotary Drilled	VII-12
VII-B-1	Well Data Sheet - Well CDM - 2	VII-B-19
VII-B-2	Well Data Sheet - Well CDM - 3	VII-B-19

VII-B-3	Well Data Sheet - Well CDM - 4	VII-B-19
VII-B-4	Well Data Sheet - Well CDM - 5	VII-B-19
VII-B-5	Well Data Sheet - Well CDM - 6	VII-B-19
VII-B-6	Well Data Sheet - Well CDM - 14	VII-B-19
VII-B-7	Well Data Sheet - Well CDM - 17	VII-B-19
VII-B-8	Well Data Sheet - Well CDM - 27	VII-B-19
VII-B-9	Well Data Sheet - Well CDM - 69	VII-B-19
VII-B-10	Constant Rate Pumping Test, Pumping Well CDM - 3	VII-B-19
VII-B-11	Recovery From Contant Rate Pumping Test-Pumping Well CDM - 3	VII-B-19
VII-B-12	Constant Rate Pumping Test Observation Well CDM - 3	VII-B-19
VII-B-13	Recovery From Constant Rate Pumping Test Observation Well CDM - 3	VII-B-19
VII-B-14	Constant Rate Pumping Test-Pumping Well CDM - 4	VII-B-19
VII-B-15	Constant Rate Pumping Test-Pumping Well CDM - 5	VII-B-19
VII-B-16	Constant Rate Pumping Test-Pumping Well CDM - 6	VII-B-19
VII-B-17	Constant Rate Pumping Test-Pumping Well CDM - 7	VII-B-19
VII-B-18	Constant Rate Pumping Test-Pumping Well CDM - 8	VII-B-19
VIII-1	Fire Protection Area	VIII-8
IX-1	Recommended Facilities	(Appended)
IX-2	Immediate Improvements	IX-4
IX-3	Projected Water Demand and Supply	IX-14
IX-4	Schematic Plan of Distribution System	IX-18
IX-5	Existing Sewerage/Drainage Facilities	IX-32
MM4-1	Monthly Mean flow (Peñaranda River, San Vicente)	MM4-6
MM5-1	Daily Usage Pattern	MM5-2
MM5-2	Storage Required to Meet Daily Peak Water Demand	MM5-3
MM6-1	Most Economic Water Transmission	MM6-4
MM6-2	Sample Flow Patterns	MM6-6
MM6-3	Typical Flow Variation for Distribution Mains	MM6-8

CHAPTER IX DESCRIPTION AND COST OF RECOMMENDED PLAN

A. GENERAL

The immediate improvement program and the first and second stages of the long-term construction program are described in this chapter. 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 (1991-1995)

5. Stage II Phase B of the Long-Term Construction Program (1996-2000)

Source

The current water supply sources of San Fernando are five wells located in the poblacion and nearby barrios. Because of poor productivity of two of the wells (in barrios Lourdes and Sto. Niño), an additional well will be required to meet the projected demands of the FER-WD beyond 1980. This well will be drilled near the San Fernando Southeast Diversion Road during the immediate improvement program, and will be completed and furnished with pumping equipment.

Future water demands of FER-WD will be supplied by wells (see Source Alternative, 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 and 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 2,725 cumd. By year 2000, a total of 14 wells will have been constructed.

Distribution Storage

The FER-WD currently utilizes one of two existing 380-cum elevated distribution storage tanks. The reinforced concrete elevated tank

currently in use at Barrio Dolores was constructed in 1956. The other reinforced concrete elevated tank, located in Barrio Lourdes, and constructed in 1929, was abandoned because of foundation failure. Based on the alternative studies conducted for storage facilities in FER-WD, as presented in Chapter VIII, the least costly alternative is maximization of well supply capacity and minimization of storage capacity. It was also determined that the currently utilized storage tank would be adequate until 1989. A total volume of storage equal to 760 cum is required by the year 2000 based on a well supply capacity equal to peak-hour consumption. Since the Barrio Lourdes storage tank will be abandoned, an additional 380 cum of elevated storage will be provided in 1990.

Distribution System

The existing distribution system of FER-WD serves the poblacion of San Fernando and the barrios of Sta. Lucia, San Pedro, Dolores, Juliana, Del Pilar, San Jose, San Juan and Sto. Niño. The majority of the pipelines were constructed in 1929.

The existing distribution system will be expanded to serve the barrios of San Nicolas, San Agustin and San Felipe by 1990 and the barrios of Quebiauan, San Isidro and Del Rosario by the year 2000.

A total of 40.8 km of pipelines with sizes ranging from 100 to 250 mm will be constructed by 1990. This includes 11.6 km of pipelines to replace the existing mains that are undersized and in poor condition. By the year 2000, an additional length of about 11.6 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 in newly served areas during the construction program. The distribution facilities proposed for the long-term development of the FER-WD are shown in Figure IX-1 (appended).

Administrative and Other Service Facilities

In addition to the source, storage and distribution facilities required for the production and transportation of water to consumers, it will be necessary to provide facilities to improve administrative, operation, maintenance and quality control capabilities within the water district. Administration and shop buildings, water meter repair and laboratory facilities will be constructed during the immediate improvement program.

Design Considerations

The recommended program of pipe construction presented in this chapter reflects the results of successive computer analysis on the FER-WD distribution system. The general design criteria and method

of analysis are discussed in Appendix K, Volume II, and Chapter XII, Methodology Manual.

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

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

During final design of the recommended facilities, it is imperative that the design engineer re-run the computer program to determine the critical condition 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 be conducted on the distribution system after some improvements are completed and the system operates with adequate pressure for 24 hours a day. The results of the new studies can be incorporated into any future designs. Other considerations in updating this report are discussed in Appendix Q, Volume II.

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

B. IMMEDIATE IMPROVEMENT PROGRAM

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

At present, about 33 percent of the service area population is actually served by the FER-WD system. By 1980, the total population served within the 1980 service area boundary will be 16,980 or about 38 percent of the total population in the service area.

The immediate improvement program will improve and expand water supply service primarily by the addition of source, distribution, administrative and operational facilities. The program consists of the following major items:

1) The completion of one production well and provision of a structure and pumping facilities;

2) The provision of effective and reliable disinfection equipment to provide full-time chlorination within the distribution system;

3) The installation of about 20.0 km of 100 to 250-mm diameter distribution pipelines;

4) The initiation of an extensive leakage detection survey and repair program;

5) The provision of meters for 1,245 existing service connections, the provision of about 1,250 new connections, and the repair or replacement of approximately 10 percent (125) of the existing connections (see Figure IX-2);

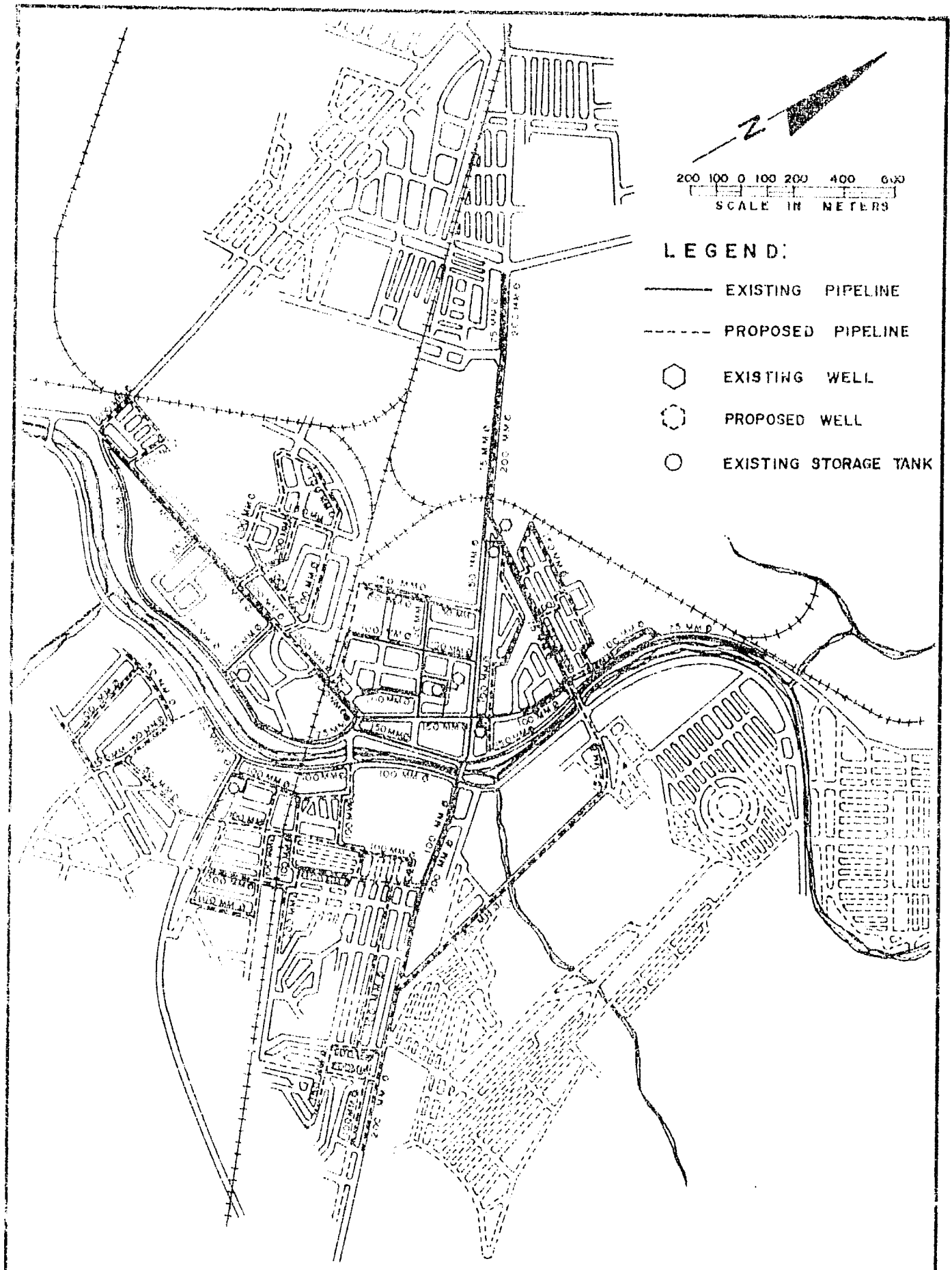
6) The construction of new administrative and shop buildings and provision of appurtenant equipment such as shop tools, water meter and laboratory facilities, vehicles, office machines and furniture, etc., to increase the operational capabilities of the water district.

The well, located near the San Fernando southeast diversion road, will be drilled and equipped with a pumphouse, pumpset, flow meter, valves, etc., and will produce about 2,725 cumd.

New distribution mains will be installed as shown in Figure IX-2 and summarized in Table IX-1. These mains will primarily serve areas outside the present service area. It is anticipated that the larger proposed pipelines will serve as main arteries in the future, while the proposed 100-mm pipelines will, in most cases, provide service to additional consumers within the present service area.

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

Chlorination equipment, complete with structures, will be provided at the sites of the proposed well and three existing wells to



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

FIGURE IX-2
IMMEDIATE IMPROVEMENTS
SAN FERNANDO WATER DISTRICT

TABLE IX-1

DISTRIBUTION PIPELINES
IMMEDIATE IMPROVEMENT PROGRAM

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
	Replacements		
420	Poblacion Well to Node 18	250	50
			50
408	Along San Fernando Northeast Diversion Road	200	80
409	Node 13 to Storage Tank	200	60
411	Along Gen. Hizon Avenue	200	550
448	Along Capitol Blvd.	200	300
449	Along Capitol Blvd.	200	175
463	San Pedro Well to Node 80	200	100
468	Along San Fernando Diversion Road	200	400
			1,665
403	Along San Fernando Northeast Diversion Road	150	50
404	Along San Fernando Northeast Diversion Road	150	100
405	Along San Fernando Northeast Diversion Road	150	150
406	Along San Fernando Northeast Diversion Road	150	125
407	Along San Fernando Northeast Diversion Road	150	175
441	Along High School Blvd.	150	250
			850
416	Along V. Tiomico Street	100	300
	Sub-total (Replacement Pipelines)		2,865
	New Pipelines		
196	From proposed well to Node 58	250	100
			100
114	Along Capitol Blvd.	200	80
122	Along San Fernando Subd. Road (Bo. Sto. Niño)	200	330

TABLE IX-1 (Continued)

Pipe Number	Description/Location	Pipe Diameter (mm)	Pipe Length (m)
124	Along San Fernando Subdivision Road (Bo. Sto. Niño)	200	90
127	Along San Fernando Northwest Diversion Road (Bo. Sto. Niño)	200	200
150	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	200	150
151	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	200	80
158	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	200	150
163	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	200	60
176	Along Gen. Hizon Ave.-MacArthur Highway	200	320
183	Along Gen. Hizon Ave.-MacArthur Highway	200	120
186	Along Franda Subdivision Road (Bo. San Nicolas)	200	80
187	Along Franda Subdivision Road (Bo. San Nicolas)	200	120
195	Along Gen. Hizon Ave.-MacArthur Highway	200	500
201	Node 13 to Node 14	200	70
202	Along Capitol Blvd.	200	100
203	Along Capitol Blvd.	200	100
204	Along Capitol Blvd.	200	125
205	Along Capitol Blvd.	200	50
206	Along Capitol Blvd.	200	150
207	Along Capitol Blvd.	200	250
208	Along Gen. Hizon Ave.-MacArthur Highway	200	125
209	Along Gen. Hizon Ave.-MacArthur Highway	200	350
210	Along Gen. Hizon Ave.-MacArthur Highway	200	100
211	Along Gen. Hizon Ave.-MacArthur Highway	200	200
			3,900
102	Along Juliana Subdivision Road (Bo. Juliana)	150	400
103	Along San Fernando Northeast Diversion Road	150	100
105	Along Juliana Subdivision Road (Bo. Juliana)	150	300
106	Along Juliana Subdivision Road (Bo. Juliana)	150	200
107	Along Juliana Subdivision Road (Bo. Juliana)	150	100
110	Along High School Blvd.	150	150
112	Along Teopaco Subdivision Road (Poblacion)	150	170
113	Along Teopaco Subdivision Road (Poblacion)	150	150
118	Along San Fernando Subd. Road (Bo. Sto. Niño)	150	80
119	Along San Fernando Subd. Road (Bo. Sto. Niño)	150	70

TABLE IX-1 (Continued)

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
120	Along San Fernando Subdivision Road (Bo. Sto. Niño)	150	70
128	Along San Fernando Northeast Diversion Road	150	250
130	Along San Fernando Southeast Diversion Road	150	670
166	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	150	340
168	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	150	200
169	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	150	50
170	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	150	140
171	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	150	70
185	Along Aurea Subdivision Road (Bo. Sta. Lucia)	150	100
191	Along Franda Subdivision Road (Bo. San Nicolas)	150	340
199	Along San Fernando Southeast Diversion Road	150	400
			4,350
101	Along V. Tiomico Street	100	400
104	Along Juliana Subdivision Road (Bo. Juliana)	100	230
108	Along Marin Subdivision Road (Bo. Juliana)	100	690
109	Along Marin Subdivision Road (Bo. Juliana)	100	130
111	Node 35 to Capitol Blvd. (Bo. Sto. Niño)	100	70
115	Along San Fernando Subdivision (Bo. Sto. Niño)	100	120
116	Along San Fernando Subdivision (Bo. Sto. Niño)	100	350
117	Along San Fernando Subdivision (Bo. Sto. Niño)	100	520
121	Along San Fernando Subdivision (Bo. Sto. Niño)	100	350
123	Along San Fernando Subdivision (Bo. Sto. Niño)	100	170
125	Along Magdalena Subdivision Road (Bo. Sto. Niño)	100	110
131	Along Aurea Subdivision Road (Bo. Sta. Lucia)	100	80
133	Along Aurea Subdivision Road (Bo. Sta. Lucia)	100	380
134	Along Aurea Subdivision Road (Bo. Sta. Lucia)	100	230

TABLE IX-1 (Continued)

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
137	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	80
138	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	50
139	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	130
141	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	240
142	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	220
143	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	150
144	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	120
145	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	90
146	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	150
147	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	130
148	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	120
149	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	120
152	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	70
153	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	70
154	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	100
155	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	150
156	Along Pampanga Capitol Subdivision Road (Bo. Sta.Lucia)	100	100
157	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	100	190
159	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	100	110

TABLE IX-1 (Continued)

Pipe Number	Description/Location	Pipe Diameter (mm)	Pipe Length (m)
160	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	100	120
161	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	100	150
162	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	100	130
165	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	100	50
167	Along Pampanga Capitol Subdivision Road (Bo. San Juan)	100	100
173	Along Pampanga Capitol Subdivision Road (Bo. San Juan)	100	280
174	Along Pampanga Capitol Subdivision Road (Bo. San Juan)	100	70
175	Along Pampanga Capitol Subdivision Road (Bo. San Juan)	100	70
177	Along Aurea Subdivision Road (Bo. Sta. Lucia)	100	520
179	Along Aurea Subdivision Road (Bo. San Nicolas)	100	70
180	Along Aurea Subdivision Road (Bo. San Nicolas)	100	50
181	Along Aurea Subdivision Road (Bo. San Nicolas)	100	60
184	Along Franda Subdivision Road (Bo. San Nicolas)	100	100
193	Along Franda Subdivision Road (Bo. San Nicolas)	100	420
197	Along V. Tiomico Street	100	100
198	Along Magdalena Subdivision Road (Bo. Sto. Niño)	100	250
			8,760
		Sub-total	17,110
		Total	19,975

provide an initial dosage of 2.0 mg/l, to maintain a minimum chlorine residual of 0.1 mg/l at all points within the distribution system.

The existing 1,245 flat-rate service connections will be provided with water meters. About 10 percent (125) of these connections will be repaired or replaced. An additional 1,250 new connections will be installed, increasing the served population to approximately 38 percent (16,980) of the total service area population in 1980.

The operational capabilities of the FER-WD will be significantly improved by the construction of a new administrative building, complete with office space for administration, billing and record keeping, and small library. This new building will be furnished with desks, chairs, filing cabinets, typewriters, addressograph and validating machines. A laboratory and plumbing shop will also be constructed and equipped with tools required for the installation, testing and repair of water meters and service connections, and for repair and installation work in the distribution system.

Table IX-2 presents the breakdown of cost (at July 1978 price levels) for the immediate improvement program. The total project cost of ₱8.25 million consists of ₱3.96 million in foreign exchange and ₱4.29 million in local currency.

C. FIRST STAGE OF THE LONG-TERM CONSTRUCTION PROGRAM (1980-1990)

As a result of alternative studies, a scheme for development of groundwater sources and construction of distribution facilities has been selected as the recommended program. The alternative studies are described in Chapter VIII. In the recommended scheme, the entire FER-WD service area, up to the year 2000, will be served by groundwater abstracted from locally constructed wells. The water produced will be conveyed to consumers by distribution pipelines to be constructed in existing road rights-of-way.

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 are incorporated into the recommended program to as great an extent as practical. About 87 percent of the existing distribution piping network, because of its extreme age and consequent poor hydraulic capacity, will be replaced between 1980 and 1990. During Phase I-A (1980-85), 37 percent of the existing piping will be replaced and 25 percent, during Phase I-B (1986-90). Thirty-

TABLE IX-2

CONSTRUCTION COST SUMMARY[1]
IMMEDIATE IMPROVEMENT PROGRAM

Item	Cost in Pesos		
	Local	Foreign[2]	Total
Source Facilities			
(One Production Well Complete)			
Materials and Equipment	216,000[3]	122,000	
Civil and Structural	215,000[3]	-	
(Disinfection Facilities for Four Wells)			
Materials and Equipment	9,600	69,200	
Civil and Structural	16,000	-	
	456,600	191,200	647,800
Distribution Facilities			
(Leakage Detection and Repair)			
Materials and Equipment	15,800	64,700	
Civil and Structural	58,900	29,000	
(250 mm x 150 m)			
Materials and Equipment	8,700	33,000	
Civil and Structural	18,200	-	
(200 mm x 5,565 m)			
Materials and Equipment	175,000	700,300	
Civil and Structural	471,400	-	
(150 mm x 5,200 m)			
Materials and Equipment	113,300	453,000	
Civil and Structural	377,500	-	
(100 mm x 9,060 m)			
Materials and Equipment	32,900	361,800	
Civil and Structural	482,400	-	
(Valves)			
Materials and Equipment	36,000	94,100	
Civil and Structural	32,600	-	
	1,822,700	1,735,900	3,558,600
Administrative Facilities			
(Administrative Building and Equipment)			
Materials and Equipment	37,600	55,800	
Civil and Structural	363,000	-	

1/ 1978 price levels.
2/ US $1.00 = ₱7.00.
3/ Well construction cost is based on actual bid received in October 1977 during the design phase of the Immediate Improvement Program.

TABLE IX-2 (Continued)

Item	Cost (₱) Local	Foreign	Total
(Laboratory, Plumbing and Meter Repair Shop and Equipment)			
Materials and Equipment	36,500	180,600	
Civil and Structural	159,200	-	
	596,300	236,400	832,700
Sub-total[4]			
Materials and Equipment	681,400	2,134,500	2,815,900
Civil and Structural	2,194,200	29,000	2,223,200
	2,875,600	2,163,500	5,039,100
Service Connections (Supply 1,245 connections with meters, replace 125 connections and install 1,250 new connections)			
Materials and Equipment	33,300	882,300	
Civil and Structural	490,000	-	
	523,300	882,300	1,405,600
Miscellaneous (Two Vehicles)			
Materials and Equipment	60,000	60,000	
Civil and Structural	-	-	
(Miscellaneous Items)			
Materials and Equipment	5,000	8,000	
Civil and Structural	-	-	
	65,000	68,000	133,000
Sub-total[5]			
Materials and Equipment	98,300	950,300	
Civil and Structural	490,000	-	
	588,300	950,300	1,538,600

4/ Contingencies and engineering are 15 and 10 percent, respectively, for these items.

5/ Contingencies and engineering are 10 and 5 percent, respectively for these items.

TABLE IX-2 (Continued)

Item	Cost (₱) Local	Foreign	Total
Total Construction Cost			
Materials and Equipment	779,700	3,084,800	3,864,500
Civil and Structural	2,684,200	29,000	2,713,200
Sub-total	3,463,900	3,113,800	6,577,700
Contingencies			
@ 15 percent	431,400	324,500	755,900
@ 10 percent	58,900	95,000	153,900
Sub-total	3,954,200	3,533,300	7,487,500
Engineering 6/			
@ 10 percent	202,800	376,700	579,500
@ 5 percent	29,600	55,000	84,600
Sub-total	4,186,600	3,965,000	8,151,600
Land	102,300	-	102,300
Total Project Cost	4,288,900	3,965,000	8,253,900

6/ Consist of 65 percent foreign exchange, based on recent similar contracts.

eight (38) percent of the existing piping will have been replaced during the immediate improvement program, including pipelines installed parallel to existing pipelines to be abandoned during Phase I-A. Also because of age and poor service, the remaining 90 percent of the existing 1,245 service connections will be repaired or replaced during Phase I-A (10 percent of the existing connections will have been replaced during the immediate improvement program).

Provisions have been made in this feasibility study to replace all existing pipelines between 1980 and 1990 due to their age. During the leakage survey and design of Stage I improvements, the condition of each of these pipelines should be verified by actual inspection. It may be possible to continue to use some of these pipelines in spite of their advanced age.

CONSTRUCTION PHASE I-A (1980-85)

Source Development

As previously discussed, alternative studies were made to determine the most economical and practical percentage of storage volume and source capacity to meet peak flow demands. The results of the studies indicate that the supply to meet peak-hour demand from wells is the most economical. Figure IX-3 shows the relationship between projected demand and well construction under these circumstances. As indicated, the well constructed in 1979 will provide adequate capacity, under peak-hour conditions until approximately 1981. At that time, another well will be constructed at node 44 (in Barrio Sto. Niño) and will provide sufficient source capacity until about 1984. This will be equipped with a dual (electric/diesel) drive. By 1984, another well will be constructed at node 1 (along Consunji Street in Barrio San Jose). The addition of these two wells will increase source capacity from 7,650 cumd to 13,100 cumd. This will satisfy the projected system water demand under peak-hour conditions up to the year 1986. All Phase I-A wells will be furnished with necessary structures, piping, meters, valves and appurtenances required for efficient operation. In addition, complete chlorination facilities will be installed in a chlorination building to be constructed at the site of every production well, to ensure adequate disinfection of water supplied to the distribution system.

Distribution System

The distribution system improvements included in construction Phase I-A are to replace 4,875 meters of existing pipelines and to install 8,375 meters of new pipes. These new lines will extend service to barrios San Nicolas and San Felipe and improve service to barrios Dolores, San Jose, San Juan, Sta. Lucia and San Pedro.

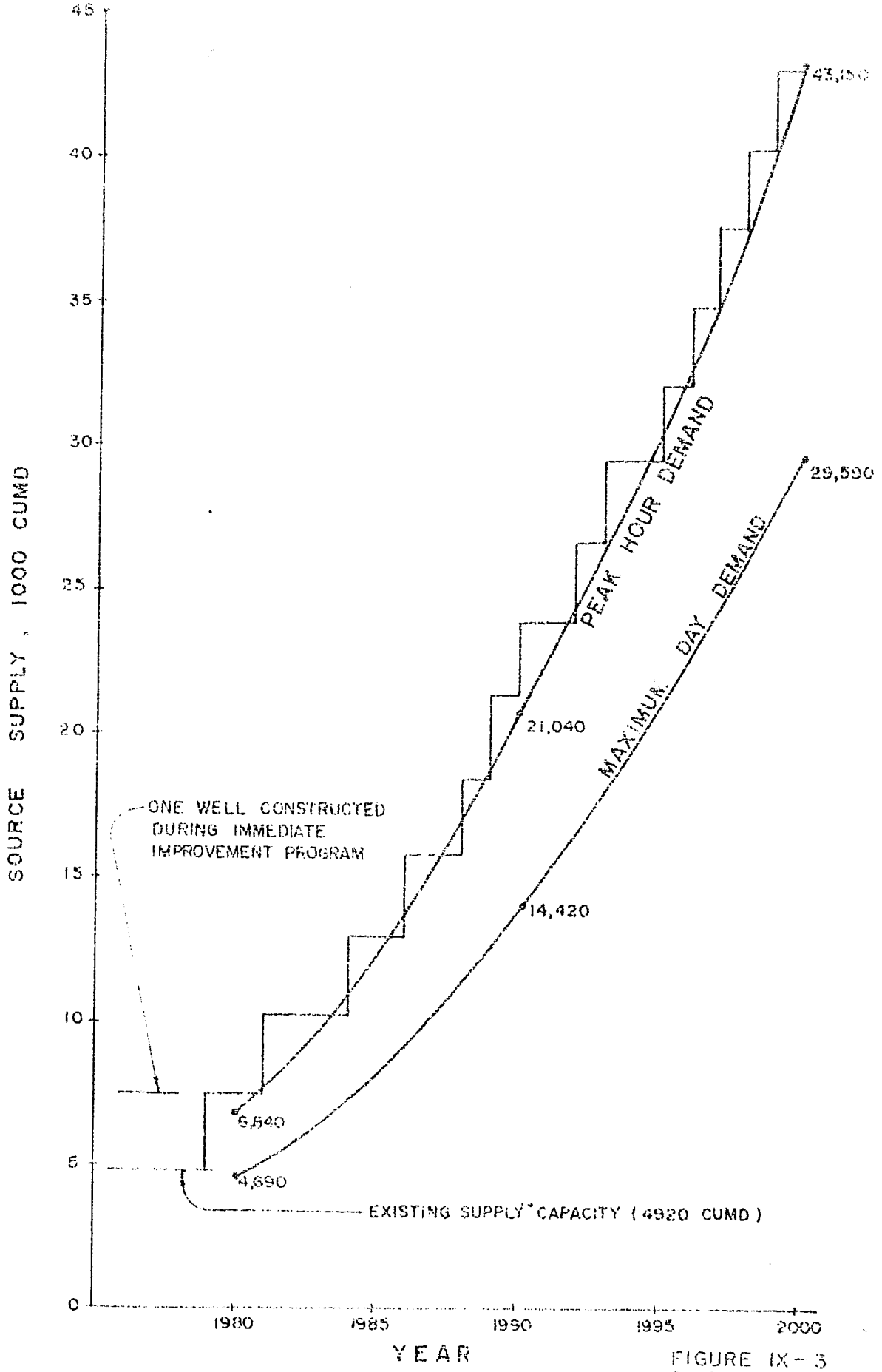


FIGURE IX-3
PROJECTED
WATER DEMAND AND SUPPLY
SAN FERNANDO WATER DISTRICT

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

The salient features of system piping installed during Phase I-A are: 1) the provision of a 200-mm diameter system "core" along Gen. Hizon Avenue, from Barrio Del Pilar through the poblacion center; and 2) the extension of 200-mm pipelines to the barrios of San Nicolas, San Felipe, San Juan, Dolores, Sta. Lucia, San Jose, and San Pedro. Details of all pipelines to be constructed during this phase are listed in Table IX-3 and shown in Figures IX-4 and IX-1 (appended).

All pipelines recommended for construction during Phase I-A are designed to provide hydraulic capacity for expected peak flows, although some pipelines will require reinforcement before the year 2000. Pipelines of 250 mm and larger have been considered for "phased" construction, if technically and economically feasible, with ultimate capacity made available only during the later phases of the project. All necessary valves and appurtenances have been included in the cost estimates for the project pipelines.

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

Internal Network

The schedule of additions to the internal network is presented in detail in Annex IX-C. The existing internal network system in San Fernando will be improved and expanded by replacing a portion of the existing pipelines and installing new pipelines in areas which are currently unserved. The existing pipelines, together with the recommended pipelines installed during the immediate improvement program, will provide service to approximately 275 hectares within the 1980 service area of FER-WD.

A total area of 42 hectares will receive service directly from distribution pipelines installed during Phase I-A. An additional area of approximately 151 hectares will be served by internal network installation. This will provide service to 100 percent of the 1980 service area, and 57 percent of the additional area to be served by 1990. A description of internal network system is presented in Appendix K, Volume II.

Service Connections

During Phase I-A, a total of 3,620 new service connections will be installed at a rate of about 600 connections per year. By 1985 the FER-WD will have a total of 6,115 service connections. In addition, about 1,120 existing service connections will be replaced or repaired. The detailed installation schedule of service connections is presented in Annex IX-C.

TABLE IX-3

PHASE I-A DISTRIBUTION PIPELINES

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
401	Along Consunji Street	200	250
402	Along Consunji Street	200	400
412	Along Gen. Hizon Avenue	200	300
413	Along Gen. Hizon Avenue	200	175
414	Along Gen. Hizon Avenue	200	225
422	Along Gen. Hizon Avenue	200	125
424	Along V. Tiomico Street	200	175
435	Along V. Tiomico Street	200	125
436	Along V. Tiomico Street	200	150
451	Along Road connecting Consunji Street and Capitol Blvd.	200	250
452	Along Consunji Street	200	75
454	Along Consunji Street	200	300
462	Along Pampanga Capitol Subd. Road (Bo. San Pedro)	200	100
464	Along Pampanga Capitol Subd. Road (Bo. San Pedro)	200	100
465	Along Pampanga Capitol Subd. Road (Bo. San Pedro	200	150
			2,900
430	Along High School Blvd.	150	100
437	Along V. Tiomico Street	150	50
450	Along Consunji Street	150	1,000
467	Along Consunji Street	150	250
			1,400
415	Along Consunji Street	100	300
447	Along Bulaclac Village Road (Bo.Sto.Niño)	100	125
456	Along Singian Subd. Road (Bo.Del Pilar)	100	150
			575
	Sub-total (Replacement Pipelines)		4,875
	New Pipelines		
313	From proposed Bo. Sto. Niño Well to Node 44	250	50
322	From proposed Bo.San Jose Well to Node 1	250	50
			100

TABLE IX-3 (Continued)

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
301	Along San Fernando Northwest Diversion Road (Bo. San Juan)	200	630
306	Along Villa Victoria Subdivision Road (Bo. San Juan)	200	680
307	Along Capati Subdivision Road (Bo. Dolores)	200	550
308	Along San Fernando Diversion Road	200	450
316	Along Singian Subdivision Road (Bo. San Nicolas)	200	570
317	Along J. Olivas Subdivision Road (Bo. San Felipe)	200	470
319	Along J. Olivas Subdivision Road (Bo. San Felipe)	200	480
325	Along Bridge Crossing (Bo. Sto. Nino - Bo. San Pedro)	200	140
326	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	200	420
330	Along Franda Subdivision Road (Bo. San Nicolas)	200	320
			4,710
321	Along Del Pilar Subdivision Road (Bo. Del Pilar)	150	930
327	Along San Fernando Southwest Subdivision Road (Bo. San Nicolas)	150	180
328	Along San Fernando Southwest Diversion Road (Bo. San Nicolas)	150	120
329	Along San Fernando Southwest Diversion Road (Bo. San Nicolas)	150	250
331	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	150	120
332	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	150	75
333	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	150	80
334	Along Pampanga Capitol Subdivision Road (Bo. Sta. Lucia)	150	280
335	Along Aurea Subdivision Road (Bo. Sta. Lucia)	150	520
			2,555
336	Along Pampanga Capitol Subdivision Road (Bo. San Pedro)	100	410
337	Along Pampanga Capitol Subdivision Road (Bo. San Juan)	100	250
338	Along Franda Subdivision Road (Bo. Sta. Lucia)	100	350
			1,010
		Sub-total	8,375
		Total	13,250

Fire Protection

The total areas to receive water service will be provided full fire protection coverage. Details of fire hydrant installation are presented in Annex IX-C.

During Phase I-A, fire hydrants will be installed to cover approximately 468 hectares or 44 percent of the area to receive water service by the year 2000. This will provide fire protection to the poblacion, barrios Sta. Lucia, San Pedro, Dolores, Juliana, Del Pilar, San Jose, San Juan, Sto. Niño, San Nicolas and San Felipe. About 164 hectares of the total area covered by fire hydrants installed during Phase I-A will be provided with a higher level of hydrant service. High level service is provided to areas of high density residential, commercial or industrial development. This area consists of the poblacion, barrios Juliana and Sto. Niño and portions of barrios Del Pilar and San Nicolas. Normal residential-type service will be provided for the rest of the area.

Cost Summary-Phase I-A

The cost summary for the 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 ₱14.41 million with a foreign exchange component (FEC) of ₱6.95 million which includes direct and indirect import items. Table IX-4 is a cost breakdown based on materials and equipment procurement and required civil and structural works. Materials and equipment considered in this breakdown include pumps, pipes, valves, water meters, hydrants, and chlorinators.

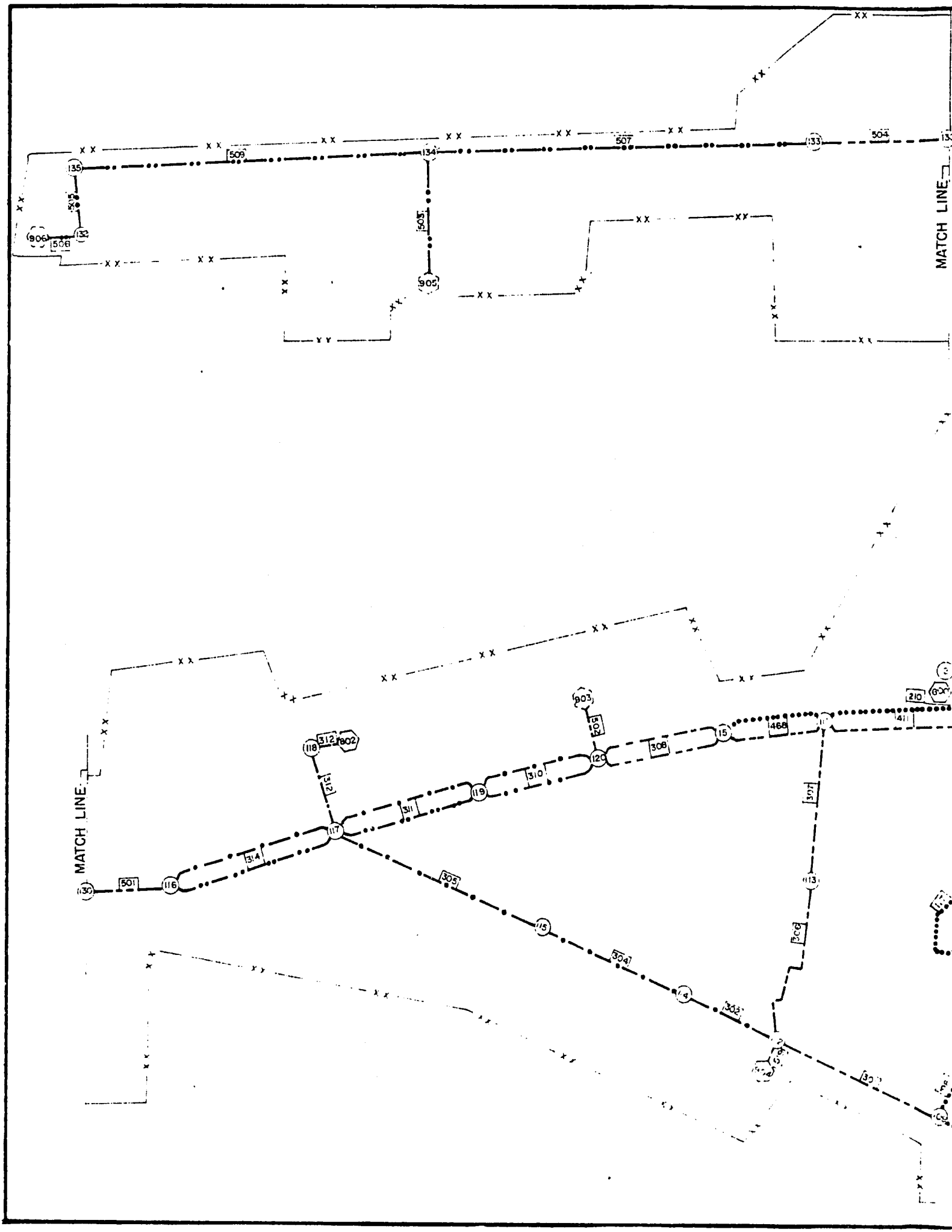
CONSTRUCTION PHASE I-B (1986-90)

Source Facilities

A new well will be constructed at node 118, along MacArthur Highway in Barrio San Agustin, in 1986. The well will have a capacity of 2,725 cumd, increasing the total source capacity to 15,825 cumd which is sufficient to meet system demands until 1988. By this year, another well will be required and will be constructed at node 123 in Barrio San Felipe. This well will be equipped with a dual (electric/diesel) drive. In 1989 another well will be constructed at node 51 in Barrio San Juan, increasing the total source capacity to 21,275 cumd which is sufficient to meet system demands until 1990 (see Figure IX-3).

Distribution System

About 3,320 meters of 100 and 150-mm pipelines will be constructed in Phase I-B to replace existing pipelines. New pipelines, with a total length of 4,290 meters and diameter of 200 and 250 mm, will be constructed to reinforce previously installed pipelines, to connect new sources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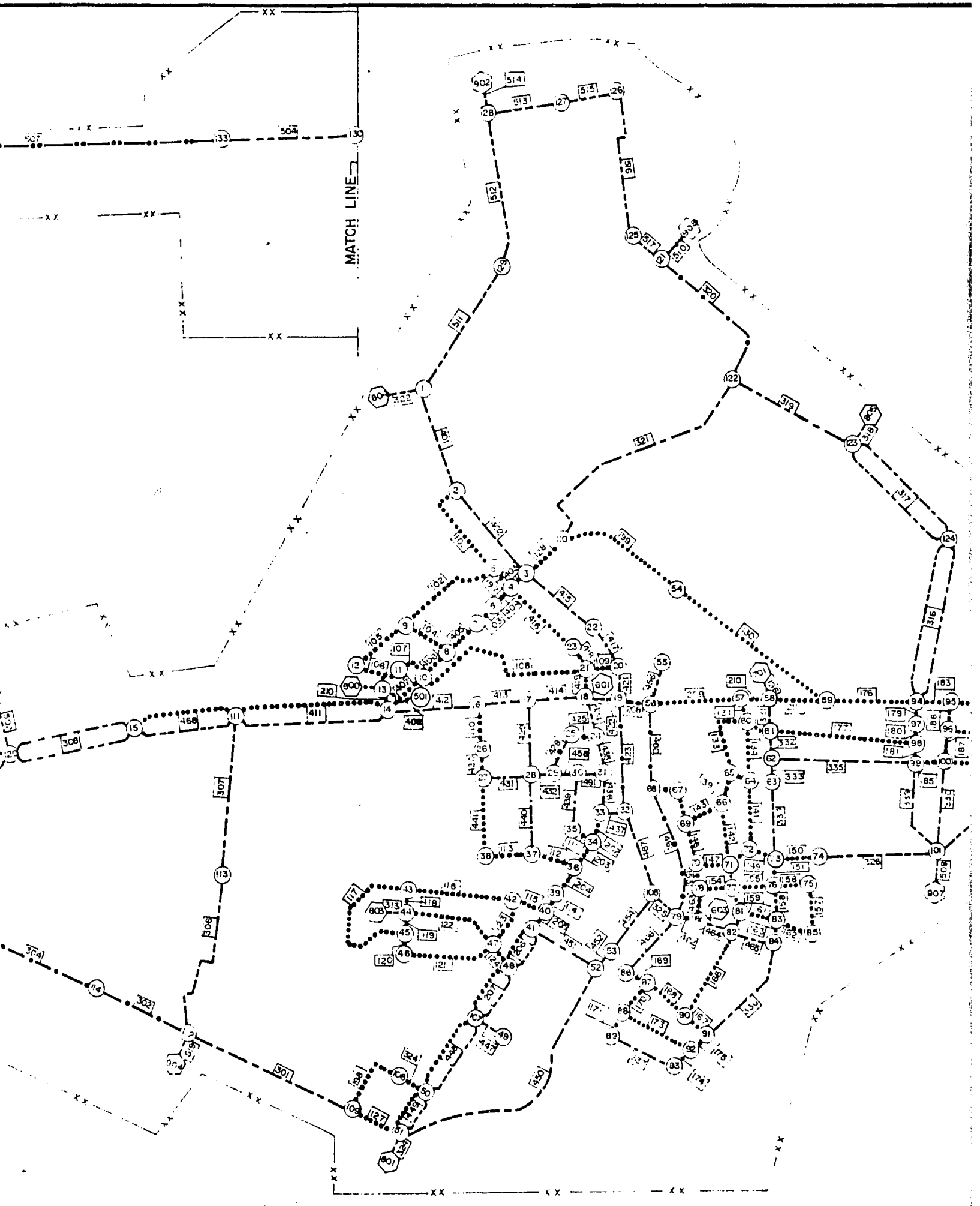
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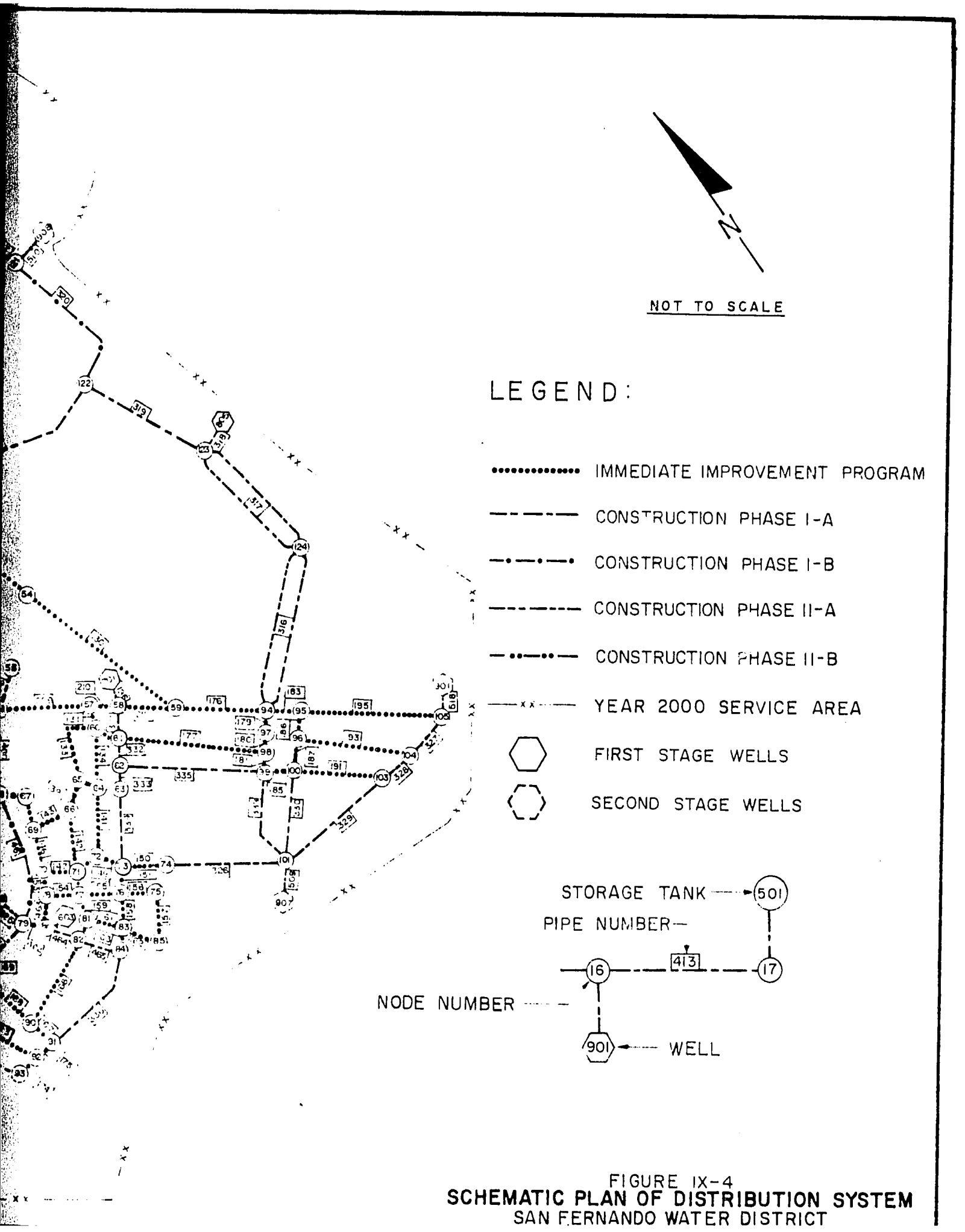

FIGURE IX-4
SCHEMATIC PLAN OF DISTRIBUTION SYSTEM
SAN FERNANDO WATER DISTRICT

TABLE IX-4

COST SUMMARY FOR CONSTRUCTION STAGE I PHASE A

Item	Cost in Pesos Local	Foreign 7/	Total
Source Facilities 8/			
(Two Production Wells Complete)			
Materials and Equipment	855,500	712,900	
Civil and Structural	967,300	51,400	
(Disinfection facilities for two wells)			
Materials and Equipment	4,800	34,600	
Civil and Structural	8,000	-	
	1,835,600	798,900	2,634,500
Pipelines 8/			
(250 mm x 100 m)			
Materials and Equipment	5,800	22,000	
Civil and Structural	12,100	-	
(200 mm x 7,610 m)			
Materials and Equipment	239,400	957,600	
Civil and Structural	644,600	-	
(150 mm x 3,955 m)			
Materials and Equipment	86,100	344,600	
Civil and Structural	287,100	-	
(100 mm x 1,585 m)			
Materials and Equipment	5,800	63,300	
Civil and Structural	84,000	-	
(Valves)			
Materials and Equipment	17,700	52,600	
Civil and Structural	17,600	-	
	1,400,200	1,440,100	2,840,300
Internal Network 8/			
(151 ha)			
Materials and Equipment	83,900	656,600	
Civil and Structural	828,600	-	
	912,500	656,600	1,569,100

7/ Computed at U.S. $1.00 to ₱7.00.

8/ Contingencies and engineering costs are 15 percent and 10 percent, respectively, for these items.

TABLE IX-4 (continued)

	Cost in Pesos		
	Local	Foreign 1/	Total
Fire Hydrants 8/			
(468 ha)			
Materials and Equipment	155,900	532,000	
Civil and Structural	228,800	-	
	384,700	532,000	916,700
Sub-Total 8/			
Materials and Equipment	1,454,900	3,376,200	4,831,100
Civil and Structural	3,078,100	51,400	3,129,500
	4,533,000	3,427,600	7,960,600
Service Connections 9/			
(3,620 new connections and 1,120 replacement)			
Materials and Equipment	114,700	2,077,300	
Civil and Structural	1,507,900	-	
	1,622,600	2,077,300	3,699,900
Sub-Total 9/			
Materials and Equipment	114,700	2,077,300	2,192,000
Civil and Structural	1,507,900	-	1,507,900
	1,622,600	2,077,300	3,699,900
Total Construction Cost			
Materials and Equipment	1,569,600	5,453,500	7,023,100
Civil and Structural	4,586,000	51,400	4,637,400
Sub-Total	6,155,600	5,504,900	11,660,500
Contingencies			
@ 15 percent	680,000	514,100	1,194,100
@ 10 percent	162,200	207,800	370,000
Sub-Total	6,997,800	6,226,800	13,224,600
Engineering 10/			
@ 10 percent	320,400	595,100	915,500
@ 5 percent	71,200	132,300	203,500
	7,389,400	6,954,200	14,343,600
Land	67,500	-	67,500
TOTAL PROJECT COST	7,456,900	6,954,200	14,411,100

9/ Contingencies and engineering costs are 10 percent and 5 percent, respectively, for these items.

10/ Consists of 65 percent foreign exchange and 35 percent local currency.

to the system, to provide service to unserved areas and to increase the hydraulic capacity of the basic large "loop" around the Northwest Diversion Road area established by pipelines of Phase I-A.

The proposed pipelines for Phase I-B are listed in Table IX-5 and shown in Figures IX-4 and IX-1 (appended).

Storage Facilities

In order to meet projected system demand fluctuations, a 380-cum elevated storage tank will be constructed in 1986. It is recommended that this storage tank be located as near as possible to the existing elevated storage tank in Barrio Dolores. This storage tank, together with the existing storage tank, will provide sufficient storage capacity to satisfy the projected requirements of FER-WD until the year 2000.

Internal Network

New internal network will be provided during Phase I-B for approximately 99 hectares, completing the area served within the 1990 service area. In addition, a total area of 16 hectares will be receiving water service directly from distribution pipelines (see Annex IX-C for details).

Service Connections

During Phase I-B, 3,015 new service connections will be installed, at a rate of about 600 connections per year. By 1990, the FER-WD will have a total of about 9,130 service connections (see Annex IX-C).

Fire Protection

An additional area of 115 hectares will be provided with fire protection service during Phase I-B, by the installation of fire hydrants. This will provide 100 percent coverage of the total areas to be covered by the year 1990. Normal residential type service will be installed during this phase. (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 ₱12.87 million, with a foreign exchange component of ₱5.55 million

TABLE IX-5

PHASE I-B DISTRIBUTION PIPELINES

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
	Replacements		
423	Along Consunji Street	150	400
425	Teopaco Subdivision (Poblacion)	150	100
428	Along Teopaco Subdivision Road (Poblacion)	150	70
431	Along Teopaco Subdivision Road (Poblacion)	150	175
432	Along Teopaco Subdivision Road (Poblacion)	150	100
433	Along Teopaco Subdivision Road (Poblacion)	150	100
434	Along Teopaco Subdivision Road (Poblacion)	150	100
460	Along Bo. Sta. Lucia Road	150	300
461	Along Bo. Sta. Lucia Road	150	450
466	Along Bo. San Juan Road	150	300
			2095
417	Along Consunji Street	100	200
418	Along V. Tiomico Street	100	100
419	Along V. Tiomico Street	100	100
421	Along Consunji Street	100	125
429	Along Arellano Street	100	250
439	Along Teopaco Subdivision Road (Poblacion)	100	200
440	Along Arellano Street	100	250
			1225
	Sub-Total (Replacement pipelines)		3320
	New Pipelines		
303	From proposed Bo. San Agustin Well to node 118	250	50
318	From proposed Bo. San Felipe Well to node 123	250	50
324	From proposed Bo. San Juan Well to node 51	250	80
			180
302	Along San Fernando Northwest Diversion Road	200	360
304	Along San Fernando Northwest Diversion Road	200	530
305	Along San Fernando Northwest Diversion Road	200	800
310	Along San Fernando Diversion Road (MacArthur Highway)	200	450
311	Along San Fernando Diversion Road (MacArthur Highway)	200	500
312	Along Don Ramon Village Road (Bo. San Agustin)	200	300
314	Along MacArthur Highway	200	600
320	Along University Site Subdivision Road (Bo. San Felipe)	200	570
			4110
		Sub-Total	4290
		Total	7640

TABLE IX-6

COST SUMMARY FOR CONSTRUCTION STAGE I PHASE B

Item	Cost in Pesos Local	Foreign[11]	Total
Source Facilities[12]			
(Three complete wells)			
Materials and Equipment	1,277,800	1,052,600	
Civil and Structural	1,438,200	77,100	
(Disinfection Facilities for three wells)			
Materials and Equipment	7,200	51,900	
Civil and Structural	12,000	-	
	2,735,200	1,181,600	3,916,800
Storage Facilities[12]			
(380 cum tank in 1986)			
Materials and Equipment	545,300	38,900	
Civil and Structural	233,700	155,800	
	779,000	194,700	973,700
Administrative Facilities[12]			
(Additional Laboratory Equipment)			
Materials and Equipment	-	162,700	
Civil and Structural	-	-	
	-	162,700	162,700
Pipelines[12]			
(250 mm x 189 m)			
Materials and Equipment	10,400	39,600	
Civil and Structural	21,800	-	
(200 mm x 4,110 m)			
Materials and Equipment	129,300	517,200	
Civil and Structural	348,100	-	
(150 mm x 2,095 m)			
Materials and Equipment	45,600	182,500	
Civil and Structural	152,800	-	

11/ Computed at US $1.00 to ₱7.00.

12/ Contingencies and engineering costs are 15 percent and 10 percent, respectively, for these items.

TABLE IX-6 (Continued)

Item	Cost in Pesos Local	Foreign[11]	Total
(100 mm x 1,225 m)			
Materials and Equipment	4,400	48,900	
Civil and Structural	65,200	-	
(Valves)			
Materials and Equipment	9,900	29,100	
Civil and Structural	9,700	-	
	797,200	817,300	1,614,500
Internal Network[12]			
(99 ha)			
Materials and Equipment	53,100	415,200	
Civil and Structural	524,200	-	
	577,300	415,200	992,500
Fire Hydrants[12]			
(115 ha)			
Materials and Equipment	22,900	78,100	
Civil and Structural	33,600	-	
	56,500	78,100	134,600
Sub-Total[12]			
Materials and Equipment	2,105,900	2,616,700	4,722,600
Civil and Structural	2,839,300	232,900	3,072,200
	4,945,200	2,849,600	7,794,800
Service Connections[13]			
(3,015 new connections)			
Materials and Equipment	73,000	1,459,300	
Civil and Structural	985,000	-	
	1,058,000	1,459,300	2,517,300
Sub-Total[12]			
Materials and Equipment	73,000	1,459,300	1,532,300
Civil and Structural	985,000	-	985,000
	1,058,000	1,459,300	2,517,300

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

TABLE IX-6 (Continued)

Item	Cost in Pesos		
	Local	Foreign[11]	Total
Total Construction Cost			
Materials and Equipment	2,178,900	4,076,000	6,254,900
Civil and Structural	3,824,300	232,900	4,057,200
	6,003,200	4,308,900	10,312,100
Contingencies			
@ 15 percent	741,800	427,400	1,169,200
@ 10 percent	105,800	145,900	251,700
	6,850,800	4,882,200	11,733,000
Engineering[14]			
@ 10 percent	313,700	582,700	896,400
@ 5 percent	48,500	90,000	138,500
	7,213,000	5,554,900	12,767,900
Land	101,200	-	101,200
TOTAL PROJECT COST	7,314,200	5,554,900	12,869,100

14/ Consists of 65 percent foreign exchange

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

The second stage of the recommended program includes provision of additional source, storage and distribution facilities and expansion of internal network, service connections and fire protection facilities. These works will be implemented in two construction phases.

CONSTRUCTION PHASE II-A (1991-95)

Source Facilities

Four additional wells will be constructed at the following nodes: node 105 (along MacArthur Highway in Barrio San Nicolas) in 1991; node 120 (along MacArthur Highway in Barrio Dolores in 1992; node 121 (in Barrio San Felipe) in 1993 and node 112 (in Barrio San Juan) in 1995. These source facilities will increase production capacity by 10,900 cumd, bringing the total capacity to about 32,175 which is sufficient to meet system demands until 1996 (see Figure IX-3). The well at node 120 will be equipped with a dual (electric/diesel) drive.

Distribution System

The distribution system improvements recommended for construction during Phase II-A will provide reinforcement to previously installed pipelines in barrios Sto. Niño, San Nicolas and Dolores and to extend service to unserved areas of San Felipe and San Agustin A total of 6,565 meters of pipelines, 200 mm and 250-mm in diameter, will be constructed. The pipelines for Phase II-A are described in Table IX-7 and shown in Figures IX-4 and IX-1 (appended).

Internal Network

Two-hundred and sixteen (216) hectares of internal network will be provided during Phase II-A in addition to the 32 hectares served directly by distribution pipelines. Hence, a total of 831 hectares will be receiving water service. This is 79 percent of the projected area to be served in year 2000.

Service Connections

An additional 5,400 service connections will be installed during Phase II-A, at a rate of about 1,080 connections per year. By 1995, the FER-WD will have a total of about 14,530 service connections.

Fire Protection

During Phase II-A, an additional area of 248 hectares will be provided with fire protection service by fire hydrant installation. This will provide 79 percent coverage of the total areas to be covered

TABLE IX-7

PHASE II-A DISTRIBUTION PIPELINES

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
510	From proposed Bo. San Felipe well to node 121	250	50
518	From proposed Bo. San Nicolas well to node 105	250	50
519	From proposed Bo. San Juan well to node 112	250	50
502	From proposed Bo. Dolores well to node 120	250	50
501	Along MacArthur Highway	250	300
504	Along MacArthur Highway	250	500
			1000
411	Along San Fernando Diversion Road (MacArthur Highway)	200	550
448	Along Capitol Blvd.	200	300
449	Along Capitol Blvd.	200	175
468	Along San Fernando Diversion Road (MacArthur Highway)	200	400
[illegible]	From node 13 to 14	200	70
306	Along Capitol Blvd.	200	150
307	Along Capitol Blvd.	200	250
308	Along San Fernando Diversion Road (MacArthur Highway)	200	450
316	Along Singian Subdivision Road (Bo. San Nicolas)	200	570
517	Along J. Olivas Subdivision Road (Bo. San Felipe)	200	470
511	Along San Fernando-Mexico Road	200	500
512	Along San Fernando-Mexico Road	200	550
513	Along San Jose Subdivision Road (Bo. San Jose)	200	270
515	Along San Jose Subdivision Road (Bo. San Jose)	200	200
516	Along San Jose Subdivision Road (Bo. San Jose)	200	510
517	Along San Jose Subdivision Road (Bo. San Jose)	200	150
			5565
		TOTAL	6565

by the year 2000 for FER-WD. About 28 hectares of the additional area to be covered by fire hydrant installation in Phase II-A will receive higher level of fire protection service. This represents additional area of the poblacion, barrios Juliana and Sto. Niño to receive water service from 1991 to 1995 (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 ₱17.37 million, with a foreign exchange component of ₱7.91 million.

CONSTRUCTION PHASE II-B (1996-2000)

Source Development

In order to provide the required source capacity in 1996, a new well will be constructed at node 132 (along MacArthur Highway in Barrio del Rosario). Three new wells will be constructed at node 101 (in Barrio Sta. Lucia), node 128 (in Barrio San Jose) and node 134 (in Barrio San Isidro) in 1997, 1998 and 1999, respectively. These wells will have a capacity of 10,900 cumd, bringing the total source capacity to about 43,000 cumd which is sufficient to meet projected demands through the year 2000. The well at node 134 will be equipped with dual (electric/diesel) drives.

Distribution System

About 2,800 meters of 200-mm diameter pipelines and 2,250 meters of 250-mm diameter pipelines will be constructed during Phase II-B to reinforce previously constructed pipelines to barrios Dolores and San Agustin; to provide service to barrios Quebiauan, San Isidro and Del Rosario; and to connect the wells located at nodes 132, 101, 128 and 134 to the distribution system. These pipelines are listed in Table IX-9 and shown in Figures IX-4 and IX-1 (appended).

Internal Network

An additional area of 195 hectares of internal network will be provided during Phase II-B. An area of 28 hectares will be served directly by distribution pipelines. This will provide service to 100 percent of the year 2000 service area by the end of the construction period in 2000.

Service Connections

During Phase II-B, about 5,410 service connections will be installed at a rate of 1,080 connections per year. By 2000, about 19,940 service connections will have been provided within the FER-WD.

TABLE IX-8

COST SUMMARY FOR CONSTRUCTION STAGE II PHASE A

Item	Cost in Pesos Local	Foreign 15/	Total
Source Facilities 16/			
(Four complete wells)			
Materials and Equipment	1,700,100	1,396,500	
Civil and Structural	1,909,100	102,800	
(Disinfection facilities for four wells)			
Materials and Equipment	9,600	69,200	
Civil and Structural	16,000	-	
	3,634,800	1,568,500	5,203,300
Pipelines 16/			
(250 mm x 1,000 m)			
Materials and Equipment	58,100	220,200	
Civil and Structural	121,000	-	
(200 m x 5,565 m)			
Materials and Equipment	175,100	700,300	
Civil and Structural	471,400	-	
(Valves)			
Materials and Equipment	4,700	16,500	
Civil and Structural	5,300	-	
	835,600	937,000	1,772,600
Internal Network 16/			
(216 ha)			
Materials and Equipment	116,700	913,100	
Civil and Structural	1,152,900	-	
	1,269,600	913,100	2,182,700
Fire Hydrants 16/			
(248 ha)			
Materials and Equipment	59,600	203,000	
Civil and Structural	87,300	-	
	146,900	203,000	349,900

15/ Computed at U.S. $1.00 to 7.00.

16/ Contingencies and engineering costs are 15 percent and 10 percent, respectively, for these items.

TABLE IX-8 (Continued)

Item	Cost in Pesos		
	Local	Foreign[15]	Total
Sub-Total[16]			
Materials and Equipment	2,123,900	3,518,800	5,642,700
Civil and Structural	3,763,000	102,800	3,865,800
	5,886,900	3,621,600	9,508,500
Service Connections[17]			
(5,300 new connections)			
Materials and Equipment	130,700	2,613,600	
Civil and Structural	1,764,200	-	
	1,894,900	2,613,600	4,508,500
Sub-Total[17]			
Materials and Equipment	130,700	2,613,600	2,744,300
Civil and Structural	1,764,200	-	1,764,200
	1,894,900	2,613,600	4,508,500
Total Construction Cost			
Materials and Equipment	2,254,600	6,132,400	8,387,000
Civil and Structural	5,527,200	102,800	5,630,000
	7,781,800	6,235,200	14,017,000
Contingencies			
@ 15 percent	883,100	543,200	1,426,300
@ 10 percent	189,500	261,400	450,900
	8,854,400	7,039,800	15,894,200
Engineering[18]			
@10 percent	382,700	710,800	1,093,500
@ 5 percent	86,800	161,200	248,000
	9,323,900	7,911,800	17,235,700
Land	135,000	-	135,000
TOTAL PROJECT COST	9,458,900	7,911,800	17,370,700

17/ Contingencies and engineering costs are 10 percent and 5 percent, respectively, for these items.

18/ Consists of 65 percent foreign exchange.

TABLE IX-9

PHASE II-B DISTRIBUTION PIPELINES

Pipe Number	Location/Description	Pipe Diameter (mm)	Pipe Length (m)
503	From proposed Bo. San Isidro well to node 134	250	500
505	Along Bo. Del Rosario Road	250	200
506	From proposed Bo. Del Rosario well to node 132	250	50
507	Along MacArthur Highway	250	1350
508	From proposed Bo. Sta. Lucia well to node 101	250	100
514	From proposed Bo. San Jose well to node 128	250	50
			2250
310	Along San Fernando Diversion Road	200	450
311	Along San Fernando Diversion Road	200	500
314	Along MacArthur Highway	200	600
509	Along MacArthur Highway	200	1250
	Sub-Total		2800
	Total		5050

Fire Protection

During Phase II-B, an additional area of 223 hectares will be provided with fire protection service by fire hydrant installation. This will provide complete coverage of the total area served by the year 2000 (see Annex IX-C for details of hydrant installation).

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 ₱16.76 million, with a foreign exchange component of ₱7.62 million.

E. CAPITAL COST SUMMARY

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

F. ANNUAL OPERATION AND MAINTENANCE COSTS

Annual operation and maintenance costs include personnel, power, chemicals, maintenance, rentals, office supplies and other miscellaneous expenses which are necessary to sustain the overall water supply system. The total annual budgeted cost of the existing system in 1977 was ₱288,400. Following implementation of the proposed improvement and construction program, the annual cost will increase due to the additional costs for personnel, chemicals, power and maintenance.

The annual costs of operating and maintaining the FWR-WD facilities are estimated to be ₱469,900, ₱1,157,500 and ₱2,250,400 in 1980, 1990 and 2000, respectively. The estimated breakdown of these costs is shown in Table IX-12. All costs shown are based on projected 1978 price levels.

G. SEWERAGE/DRAINAGE CONCEPTS

Existing Drainage System

The existing drainage system of San Fernando (see Figure IX-5) consists mainly of open and covered concrete rectangular canals ranging from 0.30 to 0.40 meter deep and 0.40 to 0.60 meter wide, in the pob-

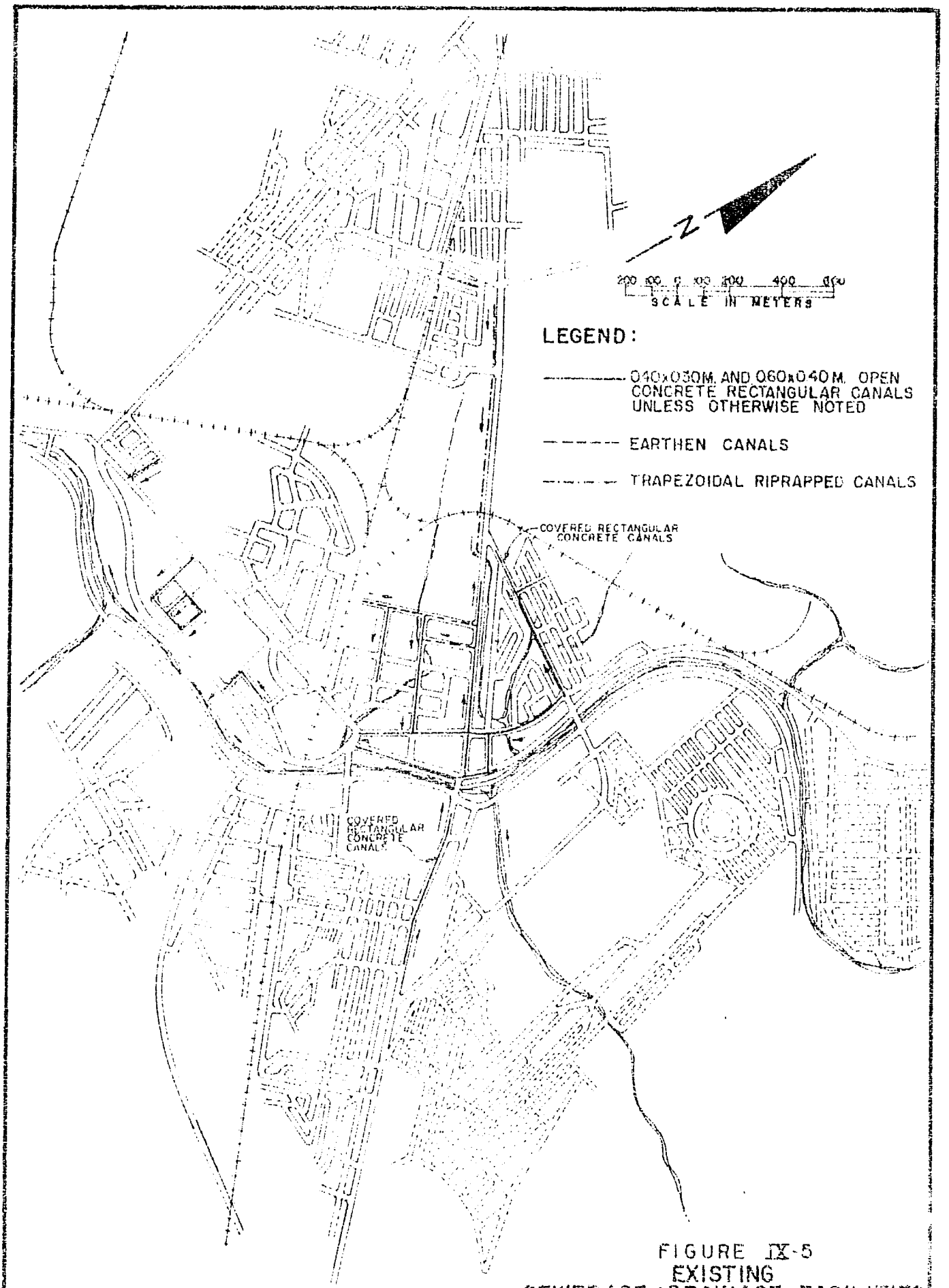

FIGURE IX-5
EXISTING
SEWERAGE/DRAINAGE FACILITIES
SCHEMATIC
SAN FERNANDO WATER DISTRICT

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

TABLE IX-10

COST SUMMARY FOR CONSTRUCTION STAGE II PHASE B

Item	Cost in Pesos Local	Foreign[19]	Total
Source Facilities[20]			
(Four complete wells)			
Materials and Equipment	1,700,100	1,396,500	
Civil and Structural	1,909,100	102,800	
(Disinfection facilities for four wells)			
Materials and Equipment	9,600	69,200	
Civil and Structural	16,000	-	
	3,634,800	1,568,500	5,203,300
Pipelines[20]			
(250 mm x 2,250 m)			
Materials and Equipment	130,700	495,500	
Civil and Structural	272,300	-	
(200 mm x 2,800 m)			
Materials and Equipment	88,100	352,400	
Civil and Structural	237,200	-	
(Valves)			
Materials and Equipment	3,700	14,500	
Civil and Structural	4,600	-	
	736,600	862,400	1,599,000
Internal Network[20]			
(195 ha)			
Materials and Equipment	104,500	817,800	
Civil and Structural	1,032,500	-	
	1,137,000	817,800	1,954,800
Fire Hydrants[20]			
(223 ha)			
Materials and Equipment	44,400	151,400	
Civil and Structural	65,100	-	
	109,500	151,400	260,900

[19] Computed at US $1.00 to ₱7.00.

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

TABLE IX-10 (Continued)

Item	Cost in Pesos		
	Local	Foreign	Total
Sub-Total[20]			
Materials and Equipment	2,081,100	3,297,300	5,378,400
Civil and Structural	3,536,800	102,800	3,639,600
	5,617,900	3,400,100	9,018,000
Service Connections[21]			
(5,410 new connections)			
Materials and Equipment	130,900	2,618,400	
Civil and Structural	1,767,500	-	
	1,898,400	2,618,400	4,516,800
Sub-Total[21]			
Materials and Equipment	130,900	2,618,400	2,749,300
Civil and Structural	1,767,500	-	1,767,500
	1,898,400	2,618,400	4,516,800
Total Construction Cost			
Materials and Equipment	2,212,000	5,915,700	8,127,700
Civil and Structural	5,304,300	102,800	5,407,100
	7,516,300	6,018,500	13,534,800
Contingencies			
@ 15 percent	842,700	510,000	1,352,700
@ 10 percent	189,900	261,800	451,700
	8,548,900	6,790,300	15,339,200
Engineering[22]			
@ 10 percent	363,000	674,100	1,037,100
@ 5 percent	86,900	161,500	248,400
	8,998,800	7,625,900	16,624,700
Land	135,000	-	135,000
TOTAL PROJECT COST	9,133,800	7,625,900	16,759,700

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

[22] Consists of 65 percent foreign exchange.

TABLE IX-11

CAPITAL COST SUMMARY

Construction Phase	Construction Period	Construction Cost	Project Cost (₱) Local	Foreign	Total
Immediate Improvement	1978-79	6,577,700	4,288,900	3,965,000	8,253,900
I-A	1980-85	11,660,500	7,456,900	6,954,200	14,411,100
I-B	1986-90	10,312,100	7,314,200	5,554,900	12,869,100
II-A	1991-95	14,017,000	9,458,900	7,911,800	17,370,700
II-B	1996-2000	13,534,800	9,133,800	7,625,900	16,759,700
Total		56,102,100	37,652,700	32,011,800	69,664,500

TABLE IX-12

ANNUAL OPERATION AND MAINTENANCE COSTS

Item	Annual Costs (₱)[23] 1977	1980	1990	2000
Administration and Personnel	102,400	181,000	359,200	542,200
Power and Fuel	125,000	176,000	510,600	1,031,600
Chemicals	-	32,100	91,300	184,000
Maintenance	51,000	67,500	161,700	403,100
Miscellaneous	10,000	13,300	34,500	89,500
Total	288,400	469,900	1,157,300	2,250,400

[23] Computed at 1978 price levels

lacion area. Open canals are located along Arellano Street, Tiomico and Consunji Streets, High School Boulevard, and Mendoza Street from corner Tiomico Street. Covered canals extend along Consunji Street from corner Del Pilar Street to the intersection of Tiomico and Consunji Streets. Concrete canals, 0.60 meter wide and 0.80 meter deep, are located on both sides of Highway Diversion Road from Consunji Street-Diversion Road intersection to Mendoza Street-Diversion Road intersection. The conrete canals have perforated covers and total about 2,000 meters long. A trapezoidal rip-rapped open canal extends along the national highway leading to Angeles City. This concrete canal has a base width of 1.50 meters, top width of 2.0 meters, a depth of 1.50 meters and total length of about 2 km. Earthen open canals are laid along the unpaved streets of the municipality. Open concrete rectangular canals are located in Barrio Sto. Niño, Bulaclac Village (Barrio San Juan) and Teopaco Subdivision.

The trapezoidal rip-rapped open canal which extends from the creek adjacent to Gemsville Subdivision collects wastewater and storm water from the subdivision. This canal traverses a portion of the national highway from Gemsville to Mendoza Street-Diversion Road intersection where the water flows into a large creek leading to San Fernando River. The creek also collects wastewater from Juliana and Sta. Teresita.

A small volume of wastewater from Teopaco subdivision and a portion of the poblacion discharges into a creek near the intersection of Tiomico and Consunji Streets. Wastewater and stormwater from the commercial and residential area of the poblacion drain into a creek located behind the old municipal market site. Both creeks dispose finally to San Fernando River.

The municipality has no comprehensive sewerage and drainage plan. The existing sewerage/drainage canals were first constructed by the District Engineer's Office, Department of Public Highways. Subsequent additions to the sewerage/drainage system were made by the municipal government (which also maintains the system). Construction of facilities, however, was often limited by the availability of funds.

Observations noted in the drainage system of San Fernando are as follows:

(1) The open and covered canals are used for transporting wastewater and stormwater during rainy season. During the dry season, these canals are mostly clogged and filled with solid wastes and soil particles.

(2) Stormwater in the open concrete canals located in the paved streets of Teopaco Subdivision flows only during and shortly after a downpour. Thereafter, water in canals remains stagnant.

(3). Solid waste is disposed in pit privies while wastewater goes directly into septic tanks, then into nearby creeks.

(4) Garbage from the municipal market is dumped at the two rectangular concrete boxes located at the back of the market: one along Consunji Street and the other along Tiomico Street. Garbage is collected by a dump truck which makes seven trips daily, and disposed at an 8-hectare sugar cane lot at Barrio Maimis, 14 km northeast of poblacion. Garbage is dumped without being burned.

(5) Wastewater coming from residential establishments along the San Fernando River flows directly into the river, while garbage is dumped along the river banks. Wastewater from the slaughterhouse located at the back of the town hall discharges to this river.

(6) During sugar milling operation, the Pampanga Sugar Development Company (PASUDECO) discharges its processing effluents to the San Fernando River. As a result, water quality in the river has continually deteriorated; and with the dumping of solid wastes, the direction of river flow backs up from south to north, especially during the sugar-milling operation.

(7) Flooding occurs at the lower portions of San Fernando Subdivision near the national road, and the Aurea Subdivision at Barrio Del Pilar, approximately 1 km southeast of poblacion.

(8) San Fernando River serves as the final disposal point of both storm water and wastewater from the numerous creeks.

elationship With Infrastructure and Other Engineering and conomic Factors

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

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

Information from the National Census and Statistics Office indicates that in 1970, 32 percent of San Fernando's households had water-borne toilet facilitieis; 28 percent had pit-type toilets; and 40 percent had no private toilet facilities. It is unlikely that such a low percentage of "modern" facilities can economically justify a near future sewerage program.

The rationale for the provision of wastewater facilities has traditionally been based on aesthetics and public health benefits. At present, there is an obvious water supply problem in the FER-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

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

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

The wastewater volume which could be collected was determined by estimating the percentage of water supply connections (domestic and commercial/industrial/institutional) with sewer connections during the design period from 1990 to 2025. It was assumed that 70 percent of the water supply connections would have sewer connections by 2025, and that in 1990, 20 percent of domestic and of commercial/industrial/institutional water supply connections will have sewer connections. It was assumed that there would be no unusually large water-consuming connections 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 sewer, based on projected percentage of physical area with sewers and an infiltration rate of 0.15 lps/hectare. The number of sewer connections required during the design period was checked to ensure that the annual rate of sewer connections was realistically within the capabilities of the water district.

Alternatives Available

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

A financially self-sufficient sewerage/drainage system is seldom achieved even in developed countries. It is likely that the FER-WD is no exception to this rule.

TABLE IX-13

AVERAGE DAILY WASTEWATER FLOWS
SAN FERNANDO WATER DISTRICT

Served Area	Design Year	Wastewater Flows (cumd) Domestic	Commercial/ Industrial/ Institutional	Infiltration Allowance	Total
Poblacion	1990	359	61	363	783
	2005	1,411	310	515	2,236
	2025	9,534	2,384	726	12,644
Barrio Sta. Lucia	1990	111	19	356	486
	2005	627	138	506	1,271
	2025	4,237	1,059	713	6,009
Barrio San Pedro	1990	113	19	104	236
	2005	624	137	147	908
	2025	4,217	1,054	207	5,478
Barrio Dolores	1990	281	48	84	413
	2005	1,534	338	120	1,992
	2025	10,364	2,591	168	13,123
Barrio Juliana	1990	112	19	65	196
	2005	401	88	92	581
	2025	2,712	678	130	3,520
Barrio del Pilar	1990	179	30	285	494
	2005	1,129	248	405	1,782
	2025	7,631	1,908	570	10,109
Barrio San Jose	1990	142	24	97	263
	2005	1,146	252	138	1,536
	2025	7,746	1,936	194	9,876
Barrio San Juan	1990	65	11	272	348
	2005	363	80	386	829
	2025	2,456	614	544	3,614
Barrio Sto. Niño	1990	271	46	531	848
	2005	1,533	337	754	2,624
	2025	10,358	2,590	1,063	14,011
Barrio San Nicolas	1990	114	19	117	250
	2005	1,212	267	166	1,645
	2025	8,192	2,048	233	10,473
Total	1990	1,747	296	2,274	4,317
	2005	9,980	2,195	3,229	15,404
	2025	67,447	16,862	4,548	88,857

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

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

2. Combined or separate sewerage/drainage system;

3. Various degrees of centralized sewerage treatment;

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

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

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

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

(1) Screening of gross solids high-rate lagoons and effluent discharge into the San Fernando River.

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

Recommendations

As soon as the first phase 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 a 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 FER-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 modern flush toilet with septic tank, the Department of Health (Division of Environmental Sanitation) has developed an inexpensive water-seal toilet.

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

Dumping solid wastes into waterways, canals and manholes, should be strictly prohibited. Solid wastes not only pollute the water, but are also 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 of water resources available for present and future demands of the FER-WD, certain technical and management steps must be considered. These considerations are primarily related to the collection of data concerning the chemical quality and amount of water produced by the district, and a data storage and retrieval system which would provide easy accessibility to those organizations dealing with 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 construction 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) 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 survey conducted within the present service area, the average number of persons served by a single service connection is 7.4. However, 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 be 6.8, 6.0 and 5.5 persons by 1980, 1990 and year 2000, respectively.

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 FER-WD water supply. These projections are presented in Annex Table IX-C-2.

Areas Served By Internal Network System

In order to project the net area to be served by internal network, the gross served areas presented in Annex IX-C-2 were reduced in proportion to the expected percentage of population served (see Annex Table IX-C-3). Served population in 1980, 1990 and 2000 were projected to be 38, 63 and 74 percent, respectively, of the total population within the corresponding service area. It was, therefore assumed that 82, 71 and 76 percent of the total service area would actually receive water service by the years 1980, 1990 and 2000, respectively. This was

ANNEX TABLE IX-C-1

SERVED POPULATION PROJECTIONS
SAN FERNANDO WATER DISTRICT

Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Poblacion	3,612	4,970	10,630	14,130
Sta. Lucia	825	1,440	3,290	6,280
San Pedro	555	1,360	3,340	6,250
Dolores	400	1,440	8,330	15,360
Juliana	924	1,440	3,330	4,020
Del Pilar	175	880	5,310	11,310
San Jose	910	2,020	4,220	11,480
San Juan	175	800	1,920	3,640
Sto. Niño	1,140	2,310	8,020	15,350
San Nicolas		320	3,360	12,140
San Agustin			2,390	5,770
San Felipe			510	1,240
Quebiauan				700
San Isidro				1,530
Del Rosario				380
Total Served Population	8,715	16,980	54,650	109,580
Total Service Area Population	26,498	44,620	86,510	148,090
Percent Served	33%	38%	63%	74%

ANNEX TABLE IX-C-2

TOTAL SERVICE AREA (ha)
SAN FERNANDO WATER DISTRICT

Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Poblacion	48	56	64	73
Sta. Lucia	37	55	72	78
San Pedro	11	16	25	52
Dolores	6	13	142	154
Juliana	8	10	15	15
Del Pilar	9	44	98	102
San Jose	8	15	26	108
San Juan	21	42	103	194
Sto. Niño	58	82	94	108
San Nicolas	-	18	44	78
San Agustin	-	-	63	122
San Felipe	-	-	78	68
Quebiauan	-	-	-	70
San Isidro	-	-	-	107
Del Rosario	-	-	-	38
Total Service Area	206	351	824	1,387

ANNEX TABLE IX-C-3

NET AREA TO RECEIVE INTERNAL NETWORK[1/]
FOR INDIVIDUAL COMMUNITIES (ha)

Community Served	1976 Service Area	1980 Service Area[2/]	1990 Service Area	2000 Service Area
Poblacion	40	50	61	69
Sta. Lucia	4	55	58	62
San Pedro	5	16	20	47
Dolores	6	8	114	139
Juliana	8	9	14	14
Del Pilar	9	32	49	71
San Jose	8	12	22	92
San Juan	4	32	82	165
Sto. Niño	25	57	61	81
San Nicolas	-	18	35	55
San Agustin	-	-	32	85
San Felipe	-	-	35	62
Quebiauan	-	-	-	35
San Isidro	-	-	-	54
Del Rosario	-	-	-	23
Total Net Area to be Served	109	289	583	1,054
Total Service Area	206	351	824	1,387
Percent of Total Service Area	53	82	71	76

1/ Includes areas to be served directly by distribution pipelines.

2/ Remainder of the 1980 service area not served by 1980 will be served by 1985.

calculated as a weighted average of the percent served areas of all the barrios. For the 1980 service area, the existing and recommended pipelines will cover about 275 hectares or 95 percent of the total area to be served (289 hectares). The remainder of the 1980 service area not covered by the existing and recommended pipelines would be served fully by the year 1985. The assumed percentages of area served for 1990 and 2000 are lower than those for 1980 because of the extension of water service area to outlying barrios. The area of these barrios included in the service area is relatively large compared to their projected served population.

The reduced served areas (see Annex Table IX-C-3) were further reduced based on the assumption that (1) some of the distribution system pipes included in the analyses are actually internal network; and (2) some of the proposed distribution pipelines will serve as equivalent internal network. It has been assumed that relevant distribution system pipelines can serve an area within 50 meters on each side of the pipeline.

The net areas to receive internal network are tabulated in Annex Table IX-C-4, according to service area and in Annex Table IX-C-5, according to construction phase.

Number of Service Connections

The number of service connections was projected by dividing the served population by the average number of persons per connection. The estimated number of service connections for each community within the service area is presented in Annex Table IX-C-6.

During the leakage survey which will be conducted as part of the immediate improvement program, it is expected that some existing service connections will be identified as major sources of leakage. It is projected that major repair and replacement will include 10 percent of the existing service connections by 1980, and the remaining 90 percent 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 San Fernando poblacion, barrios Sto. Niño and Juliana, and portions of barrio Del Pilar (20%) and barrio San Nicolas (25%) will receive high-level fire protection. The rest of the barrios served will be provided with normal residential-type fire hydrant service. The schedule of fire hydrant installation is listed in Annex Table IX-C-8.

TOTAL AREA SERVED BY INTERNAL NETWORK[3] 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)
Poblacion	(50)	11	-	8	-
Sta. Lucia	(55)	3	-	4	-
San Pedro	(14)	6	-	14	13
Dolores	(7)	63	44	13	12
Juliana	(9)	5	-	-	-
Del Pilar	(42)	17	-	22	.
San Jose	(12)	10	-	47	23
San Juan	(21)	36	25	42	41
Sto. Niño	(57)	4	-	20	-
San Nicolas	(18)	17	-	15	5
San Agustin		-	32	27	26
San Felipe		21	14	14	13
Quebiauan		-	-	22	13
San Isidro		-	-	-	54
Del Rosario		-	-	-	23
Total	(275)[4]	193	115	248	223
Cumulative Total		468	583	831	1,054

[3] Includes areas to be served directly by distribution pipelines.

[4] Area served by 1980.

ANNEX TABLE IX-C-5

NET AREA SERVED BY TERTIARY NETWORK
SYSTEM BY CONSTRUCTION PHASE (ha)

Community Served	Immediate Improvement (1978-1980)	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	50	11	-	8	-
Sta. Lucia	55	-	-	4	-
San Pedro	14	6	-	14	13
Dolores	7	44	44	13	12
Juliana	9	5	-	-	-
Del Pilar	32	17	-	22	-
San Jose	12	10	-	23	23
San Juan	21	36	25	42	41
Sto. Niño	57	4	-	20	-
San Nicolas	18	7	-	15	5
San Agustin	-	-	20	27	26
San Felipe	-	11	10	14	13
Quebiauan	-	-	-	14	13
San Isidro	-	-	-	-	41
Del Rosario	-	-	-	-	8
Total	275	151	99	216	195
Area Served by Distribution Pipelines (ha)	-	42	16	32	22
Cumulative Total Equivalent Internal Network (ha)	275	468	583	831	1,054

ANNEX TABLE IX-C-6

SCHEDULE OF SERVICE CONNECTION INSTALLATION

Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Poblacion	(516)*	214	1,040	800
Sta. Lucia	(118)*	92	340	590
San Pedro	(79)*	121	360	580
Dolores	(57)*	153	1,180	1,400
Juliana	(132)*	78	350	170
Del Pilar	(25)*	105	760	1,170
San Jose	(130)*	170	400	1,390
San Juan	(25)*	95	200	340
Sto. Niño	(163)*	177	1,000	1,450
San Nicolas		45	515	1,650
San Agustin			400	650
San Felipe			90	140
Quebiauan				130
San Isidro				280
Del Rosario				70
Total by Phase	(1245)*	1,250	6,635	10,810
Cumulative Total	1245	2,495	9,130	19,940

*Existing service connections

ANNEX TABLE IX-C-7

SCHEDULE OF SERVICE CONNECTION INSTALLATION
BY CONSTRUCTION PHASE

Location	Immediate Improvements	Phase I-A (1980-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	214	567	473	400	400
Sta. Lucia	92	185	155	295	295
San Pedro	121	196	164	290	290
Dolores	153	644	536	700	700
Juliana	78	190	160	85	85
Del Pilar	105	415	345	585	585
San Jose	170	220	180	695	695
San Juan	95	110	90	170	170
Sto. Niño	177	543	457	725	725
San Nicolas	45	280	235	820	830
San Agustin		220	180	325	325
San Felipe		50	40	40	70
Quebiauan				65	65
San Isidro				140	140
Del Rosario				35	35
Total	1,250	3,620	3,015	5,400	5,410
Cumulative Total	2,495	6,115	9,130	14,530	19,940

ANNEX TABLE IX-C-8

SCHEDULE OF 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	
Poblacion	(61)	61	-	(8)	8	-	(69)	69
Sta. Lucia		58	-		4	-		62
San Pedro		20	-		14	13		47
Dolores		70	44		13	12		139
Juliana	(14)	14	-		-	-	(14)	14
Del Pilar	(14)	49	-		22	-	(14)	71
San Jose		22	-		47	23		92
San Juan		57	25		42	41		165
Sto. Niño	(61)	61	-	(20)	20	-	(81)	81
San Nicolas	(14)	35	-		15	5	(14)	55
San Agustin		-	32		27	26		85
San Felipe		21	14		14	13		62
Quebiauan		-	-		22	13		35
San Isidro		-	-		-	54		54
Del Rosario		-	-		-	23		23
Total	(164)	468	115	(28)	248	223	(192)	1,054
Cumulative Total		468	583		831	1,054		

Note:

Figures in parenthesis indicate areas to receive higher level of hydrant service.

Computer Studies

The recommended program of pipe construction in Chapter IX reflects the results of successive computer analyses on the FER-WD distribution system. The general design criteria and method 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 a number of flow requirements and operating conditions and designing each pipe for the worst set of conditions. Since each computer analysis is critical to a different series of pipes there is no single program result that can be included herein as a "design run".

The computer printouts for the peak-hour and minimum-hour conditions are shown in Annex Tables IX-C-10 and IX-C-11 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.

The pipeline and node numbers on the computer printouts are the same as those in Figure IX-4. In general, pipes of series 0 to 99 are existing pipelines, pipes 100 to 199 are immediate improvements; pipes 200 to 299 are parallel lines to series 400 to 499 to be installed in Phase I-A; pipes 300 to 399 are Phase I improvement pipes; pipes 400 to 499 are replacement pipes in the immediate improvement program and Phase I; and pipes 500 to 599 are Phase II improvements .

ANNEX TABLE IX-C-9

COMPUTER PRINTOUT (PER-MD)
YEAR 2000 PEAK HOUR

SAN FERNANDO WATER DISTRICT 2000 WATER SYSTEM PEAK HOUR CONDITION

```
INPUT AND OUTPUT IN                LPS
NO OF NODES                        151
NO OF PIPES                        203
MAX NO OF ITERATIONS                20
PEAKING FACTOR                 1.75000
ALLOW P-DROP FR/STATIC - PCT      30.0
STATIC HGL FOR P-DROP CALC        34.0
MAX UNBAL - LPS                0.05000
MAX ALLOW VEL -MPS               3.000
MIN ALLOW VEL - MPS              0.400
MAX ALLOW HL -  M/1000 M         10.00
MIN ALLOW HL -  M/1000 M          0.30
MAX ALLOW PRESS - ATM            7.000
MIN ALLOW PRESS - ATM            0.700
NO OF HEADS TO BE READ                1
NO OF UNKNOWN CONSUMPTIONS            1
SUM OF FIXED DEMANDS               0.47
BANDWIDTH                            12
ITER   1 UNBAL    22.11 LPS
ITER   2 UNBAL    11.66 LPS
ITER   3 UNBAL     2.41 LPS
ITER   4 UNBAL     2.33 LPS
ITER   5 UNBAL     1.11 LPS
ITER   6 UNBAL      .22 LPS
ITER   7 UNBAL      .03 LPS

SOLUTION NO. 1 REACHED IN    7 ITERATIONS
        .0273 lps UNBALANCE
```

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	P-VALUE	[illegible]	--[illegible]-- 4PS--CK	--[illegible]--- 4T	MT/L[illegible]	CK
[illegible]	1	[illegible]	250.	110	0.309E-02	36.32	1.22	[illegible]	10.55	HI
[illegible]	[illegible]	[illegible]	400.	110	0.494E-02	23.98	0.76	1.77	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.299E-02	12.73	0.72	0.33	0.65	
[illegible]	[illegible]	[illegible]	100.	100	0.598E-02	5.08	0.29 LO	0.12	1.21	
[illegible]	7	[illegible]	150.	100	0.897E-02	0.57	0.03 LO	0.00	0.02	LO
[illegible]	[illegible]	[illegible]	125.	[illegible]	0.748E-02	4.33	1.27 LO	0.14	1.11	
[illegible]	14	[illegible]	175.	[illegible]	0.105E-01	14.98	0.85	1.57	0.93	
[illegible]	[illegible]	[illegible]	[illegible]	110	0.938E-03	0.47	0.02 LO	0.00	0.00	LO
[illegible]	[illegible]	[illegible]	[illegible]	110	0.741E-03	19.20	0.61	0.13	2.94	
[illegible]	[illegible]	[illegible]	150.	110	0.229E-02	37.84	0.63	1.31	2.33	
[illegible]	19	[illegible]	[illegible]	110	0.370E-02	27.57	0.88	1.72	5.75	
[illegible]	16	17 [illegible]	175.	110	0.216E-02	9.47	0.30 LO	0.14	0.79	
[illegible]	17	[illegible]	[illegible]	110	0.278E-02	1.29	0.04 LO	0.00	0.02	LO
[illegible]	[illegible]	[illegible]	[illegible]	100	0.129E 00	2.45	0.31 LO	0.43	2.27	
[illegible]	4	[illegible]	[illegible]	100	0.129E 00	1.38	0.24 LO	0.42	1.39	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.862E-01	0.86	0.11 LO	0.07	0.33	
[illegible]	23	21 [illegible]	[illegible]	[illegible]	0.431E-01	0.01	0.00 LO	0.00	0.00	LO
[illegible]	18	21 [illegible]	100.	100	0.431E-01	1.43	0.18 LO	[illegible]	0.83	
[illegible]	[illegible]	[illegible]	[illegible]	110	0.258E-03	27.00	0.55	0.09	1.86	
[illegible]	19	20 [illegible]	125.	100	0.539E-01	0.43	0.05 LO	0.01	0.00	LO
[illegible]	18	[illegible]	[illegible]	110	0.154E-02	7.81	0.25 LO	0.07	0.55	
[illegible]	19	[illegible]	400.	[illegible]	0.230E-01	4.42	0.25 LO	0.37	0.94	
[illegible]	16	24 [illegible]	175.	110	0.216E-02	16.37	0.52	0.38	2.19	
[illegible]	24	[illegible]	[illegible]	[illegible]	0.538E-02	6.97	0.39 LO	0.22	2.13	
[illegible]	25	[illegible]	75.	[illegible]	0.419E-02	4.85	0.27 LO	0.08	1.11	
[illegible]	17	[illegible]	250.	100	0.108E 00	3.24	0.41	0.95	3.79	
[illegible]	26	27 [illegible]	[illegible]	[illegible]	0.598E-02	7.80	0.44	0.27	2.68	
[illegible]	28	27 [illegible]	175.	100	0.105E-01	6.11	0.35 LO	0.30	1.71	
[illegible]	29	[illegible]	100.	100	0.598E-02	7.75	0.44	0.27	2.65	
[illegible]	33	[illegible]	[illegible]	110	0.598E-02	4.69	0.27 LO	0.10	1.04	
[illegible]	31	30 [illegible]	100.	100	0.598E-02	5.28	0.30 LO	0.13	1.30	
[illegible]	34	31 [illegible]	125.	110	0.154E-02	7.29	0.23 LO	0.06	0.49	
[illegible]	31	33 [illegible]	[illegible]	110	0.138E-02	0.47	0.01 LO	0.00	0.00	LO
[illegible]	32	[illegible]	50.	100	0.299E-02	0.17	0.01 LO	0.00	0.00	LO
[illegible]	35	[illegible]	[illegible]	[illegible]	0.862E-01	0.40	0.05 LO	0.02	0.03	LO
[illegible]	28	37 [illegible]	250.	[illegible]	0.138E 00	0.91	0.12 LO	0.09	0.35	
[illegible]	27	[illegible]	250.	100	0.150E-01	3.02	0.17 LO	0.12	0.46	
[illegible]	[illegible]	[illegible]	125.	[illegible]	0.529E-01	5.83	0.74	1.41	11.27	HI
[illegible]	[illegible]	107 [illegible]	300.	110	0.125E-02	30.17	0.61	0.69	2.29	
[illegible]	51	[illegible]	175.	110	1.729E-03	38.19	0.78	1.62	3.54	
[illegible]	51	[illegible]	[illegible]	[illegible]	0.598E-01	6.84	0.39 LO	2.10	2.10	
[illegible]	41	[illegible]	250.	110	0.309E-02	9.17	0.29 LO	0.10	0.75	
[illegible]	52	[illegible]	75.	110	1.926E-03	14.91	0.47	0.14	1.84	
[illegible]	[illegible]	136 [illegible]	300.	110	0.372E-02	11.74	0.37 LO	0.35	1.13	
[illegible]	56	[illegible]	150.	100	0.646E-01	4.25	0.54	0.94	6.24	
[illegible]	56	[illegible]	[illegible]	100	0.170E-01	5.91	0.33 LO	0.48	1.61	
[illegible]	[illegible]	77 [illegible]	150.	100	0.269E-01	2.43	0.14 LO	0.14	0.31	
[illegible]	[illegible]	[illegible]	100.	110	0.123E-02	7.79	0.25 LO	0.36	0.55	
[illegible]	[illegible]	[illegible]	[illegible]	110	0.123E-02	11.76	0.38 LO	0.12	1.21	
[illegible]	39	[illegible]	100.	110	0.123E-02	14.54	0.46	0.13	1.75	

BEST AVAILABLE DOCUMENT

ANNEX TABLE IX-C-9 (Continued)

PIPE	NODES	DIA	L	TEMP	K-VALUE	FLOW	--VEL--		--HEAD LOSS--	
NO	FROM-TO	MM	MTRS	C			MPS	--CK	MT	MT/1000	CK
[illegible]	[illegible]	[illegible]	[illegible]	15[illegible]	110	0.185E-02	5.22	0.17	LO	0.04	0.25 LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100	0.179E-01	3.35	0.30	LO	0.41	1.34
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	110	0.163E-01	2.71	0.15	LO	0.09	0.33
[illegible]	15	111	25.	[illegible]	110	0.167E-02	34.05	0.69		1.15	2.35
[illegible]	13	14	250	70.	110	0.292E-03	17.64	0.36	LO	0.06	0.85
[illegible]	14	3	[illegible]	[illegible]	110	0.123E-02	3.51	0.12	LO	0.00	0.00 LO
[illegible]	36	34	[illegible]	[illegible]	110	0.123E-02	4.51	0.14	LO	[illegible]02	0.20 LO
[illegible]	[illegible]	36	[illegible]	125.	110	0.154E-02	15.58	0.50		0.25	1.99
[illegible]	41	[illegible]	[illegible]	[illegible]	110	0.617E-03	17.25	0.55		0.12	2.41
[illegible]	[illegible]	41	[illegible]	150.	110	0.625E-03	27.82	0.57		0.30	1.97
[illegible]	[illegible]	[illegible]	[illegible]	250.	110	0.104E-02	21.93	0.45		0.32	1.27
[illegible]	19	[illegible]	[illegible]	125.	110	0.154E-02	1.51	0.05	LO	0.00	0.03 LO
[illegible]	57	56	[illegible]	[illegible]	110	0.432E-02	10.53	0.34	LO	0.34	0.97
[illegible]	58	57	[illegible]	[illegible]	110	0.123E-02	18.89	0.60		0.28	2.35
[illegible]	59	51	[illegible]	[illegible]	110	0.247E-02	1.39	0.04	LO	0.00	0.02 LO
101	2	[illegible]	100	[illegible]	100	0.172E 00	4.08	0.52		2.33	5.33
[illegible]	5	[illegible]	15	[illegible]	[illegible]	0.239E-01	3.17	0.18	LO	0.20	0.51
[illegible]	6	7	15	[illegible]	100	0.598E-02	3.28	0.19	LO	0.05	0.54
[illegible]	2	[illegible]	100	[illegible]	100	0.991E-01	1.65	0.21	LO	0.25	1.39
1[illegible]5	12	[illegible]	15	[illegible]	[illegible]	0.179E-01	0.05	0.00	LO	0.00	0.00 LO
1[illegible]6	14	12	150	[illegible]	100	0.120E-01	3.81	0.22	LO	0.14	0.71
1[illegible]7	10	11	15	[illegible]	[illegible]	0.598E-02	7.47	0.42		0.25	2.47
1[illegible]	[illegible]	21	[illegible]	[illegible]	100	0.297E 00	1.14	0.14	LO	0.38	0.55
1[illegible]	[illegible]	21	[illegible]	130.	100	0.560E-01	0.20	0.03	LO	0.00	0.02 LO
1[illegible]	18	26	15	150.	[illegible]	0.897E-02	13.54	0.77		1.12	7.45
111	34	35	[illegible]	70.	100	0.332E-01	2.05	0.26	LO	0.11	1.63
112	36	37	150	170.	100	0.102E-01	9.13	0.52		0.61	3.59
113	37	38	15	150.	100	0.897E-02	6.94	0.39	LO	0.32	2.16
114	[illegible]	39	250	80.	110	0.938E-03	17.33	0.55		0.19	2.43
115	42	41	[illegible]	120.	[illegible]	0.517E-01	1.56	0.20	LO	0.12	0.93
116	[illegible]	42	[illegible]	350.	100	0.151E 00	2.24	0.29	LO	0.57	1.92
117	[illegible]	43	100	520.	100	0.224E 00	0.56	0.07	LO	0.03	0.15 LO
118	44	43	15	80.	110	0.478E-02	7.00	0.40	LO	0.18	2.29
119	44	45	[illegible]	70.	[illegible]	0.419E-02	9.15	0.52		0.25	3.61
120	45	46	150	70.	100	0.419E-02	7.58	0.43		0.18	2.54
121	46	47	[illegible]	[illegible]	[illegible]	0.151E 00	0.59	0.08	LO	0.06	0.15 LO
122	44	47	250	130.	110	0.407E-02	13.25	0.42		0.49	1.43
123	47	48	150	170.	100	0.732E-01	2.36	0.30	LO	0.36	2.12
124	47	49	[illegible]	[illegible]	110	0.111E-02	3.80	0.28	LO	0.06	0.69
125	[illegible]	10[illegible]	100	110.	110	0.357E-01	4.35	0.55		0.50	5.50
127	1[illegible]9	51	[illegible]	[illegible]	110	0.247E-02	16.62	1.53		0.45	2.25
128	2	11[illegible]	150	[illegible]	100	0.150E-01	6.99	0.40	LO	0.55	2.19
129	55	54	150	270.	100	0.401E-01	5.67	0.32	LO	1.00	1.49
131	57	6[illegible]	[illegible]	[illegible]	[illegible]	0.345E-01	3.61	0.46		0.37	4.65
132	60	63	15	330.	100	0.164E 00	1.92	0.24	LO	0.55	1.44
136	60	64	100	230.	100	0.091E-01	2.49	0.32	LO	0.54	2.33
137	61	6[illegible]	[illegible]	[illegible]	100	0.345E-01	2.98	0.38	LO	0.26	3.26
138	64	65	100	50.	100	0.215E-01	0.67	0.09	LO	0.01	0.21 LO
139	65	66	[illegible]	130.	[illegible]	0.563E-01	1.74	0.22	LO	0.15	1.15
141	64	72	[illegible]	[illegible]	100	0.133E 00	0.85	0.11	LO	0.03	0.32

ANNEX TABLE IX-C-9 (continued)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	F-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/100	CK
[illegible]	66	71 [illegible]	220.	100		0.948E-01	0.46	0.06	LO	0.02	0.10	LO
[illegible]	66	69 [illegible]	150.	100		0.646E-01	0.46	0.06	LO	0.02	0.10	LO
[illegible]	67	69 100	120.	100		0.517E-01	1.22	0.15	LO	0.07	0.62	
[illegible]	68	67 [illegible]	90.	100		0.388E-01	2.35	0.30	LO	0.10	2.10	
[illegible]	69	7[illegible] [illegible]	150.	100		0.646E-01	0.44	0.06	LO	0.01	0.07	LO
[illegible]	71	70 100	130.	100		0.560E-01	0.31	0.04	LO	0.01	0.05	LO
[illegible]	72	71 [illegible]	110.	100		0.474E-01	1.54	0.20	LO	0.10	0.95	
[illegible]	73	72 [illegible]	120.	100		0.517E-01	1.45	0.18	LO	0.10	0.86	
[illegible]	74	73 [illegible]	150.	110		0.185E-02	13.85	0.44		0.24	1.60	
[illegible]	73	76 [illegible]	80.	110		0.938E-03	16.78	0.53		0.18	2.29	
152	71	77 100	70.	100		0.302E-01	0.85	0.11	LO	0.02	0.32	
[illegible]	78	7[illegible] [illegible]	70.	100		0.302E-01	0.04	0.01	LO	0.00	0.00	LO
[illegible]	79	77 [illegible]	100.	100		0.431E-01	0.59	0.07	LO	0.02	0.16	LO
155	76	77 100	150.	100		0.646E-01	0.84	0.11	LO	0.05	0.31	
[illegible]	76	75 [illegible]	100.	100		0.431E-01	4.22	0.54		0.62	6.20	
157	75	95 [illegible]	190.	100		0.819E-01	2.75	0.35	LO	0.53	2.31	
[illegible]	76	3[illegible] [illegible]	150.	110		0.185E-02	10.93	0.35	LO	0.16	1.04	
[illegible]	77	81 [illegible]	110.	100		0.474E-01	1.56	0.20	LO	0.11	0.93	
[illegible]	80	78 [illegible]	120.	100		0.517E-01	1.29	0.16	LO	0.08	0.69	
161	81	8[illegible] [illegible]	150.	100		0.646E-01	0.01	0.00	LO	0.00	0.00	LO
[illegible]	83	85 [illegible]	130.	100		0.560E-01	4.74	0.60		1.00	7.68	
[illegible]	82	84 [illegible]	60.	110		0.741E-03	3.63	0.12	LO	0.01	0.13	LO
165	82	81 [illegible]	50.	100		0.215E-01	1.23	0.16	LO	0.05	0.63	
[illegible]	82	[illegible] [illegible]	340.	100		0.203E-01	3.63	0.21	LO	0.22	0.65	
[illegible]	90	91 100	100.	100		0.431E-01	2.29	0.29	LO	0.20	1.99	
[illegible]	[illegible]	87 [illegible]	[illegible]	[illegible]		0.121E-01	0.09	0.00	LO	0.00	0.00	LO
169	86	87 150	50.	100		0.299E-02	4.65	0.26	LO	0.05	1.03	
170	87	88 150	140.	100		0.837E-02	3.39	0.19	LO	0.08	0.57	
171	88	89 [illegible]	70.	100		0.419E-02	1.79	0.10	LO	0.01	0.17	LO
173	93	92 100	280.	100		0.121E 00	1.01	0.13	LO	0.12	0.44	
174	92	93 [illegible]	70.	100		0.302E-01	0.31	0.04	LO	0.00	0.05	LO
175	91	92 [illegible]	70.	100		0.302E-01	0.35	0.05	LO	0.00	0.06	LO
176	94	95 [illegible]	520.	110		0.395E-02	14.27	0.45		0.54	1.70	
177	98	91 [illegible]	92[illegible].	100		0.224E 00	0.80	0.10	LO	0.15	0.29	LO
178	94	97 [illegible]	70.	100		0.302E-01	4.93	0.63		0.58	8.28	
179	97	98 100	50.	100		0.215E-01	3.46	0.44		0.21	4.29	
181	99	98 [illegible]	60.	100		0.259E-01	1.74	0.22	LO	0.07	1.20	
183	94	95 [illegible]	120.	110		0.148E-02	12.66	0.40		0.16	1.36	
[illegible]	96	97 100	100.	100		0.431E-01	2.18	0.28	LO	0.19	1.83	
185	[illegible]	99 [illegible]	100.	100		0.503E-02	6.49	0.37	LO	0.19	1.91	
186	95	96 [illegible]	90.	110		0.988E-03	19.13	0.61		0.23	2.92	
187	96	[illegible] [illegible]	120.	110		0.148E-02	11.42	0.36	LO	0.13	1.12	
191	[illegible]	103 [illegible]	340.	100		0.203E-01	0.54	0.03	LO	0.01	0.02	LO
192	96	104 [illegible]	420.	100		0.131E 00	0.22	0.03	LO	0.01	0.03	LO
193	[illegible]	96 [illegible]	510.	110		0.617E-02	12.26	0.39	LO	0.64	1.28	
195	[illegible]	98 [illegible]	100.	110		0.417E-03	31.50	0.64		0.25	2.48	
197	[illegible]	[illegible] 100	100.	100		0.431E-01	2.46	0.31	LO	0.23	2.23	
198	115	116 [illegible]	250.	100		0.108E 00	4.40	0.56		1.67	5.69	
199	110	94 [illegible]	400.	100		0.239E-01	5.49	0.31	LO	0.56	1.40	
201	112	109 [illegible]	430.	110		0.778E-02	24.11	0.77		2.82	4.43	

ANNEX TABLE IX-C-9 (continued)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	K-VALUE	FLOW	--VEL--	--HEAD LOSS---	
[illegible]	[illegible]	[illegible]	[illegible]	C			MPS--CK	MT	MT/1000 CK
[illegible]	114	112 [illegible]	360.	110	0.445E-02	13.43	0.43	0.56	1.52
[illegible]	[illegible]	[illegible]	[illegible]	110	[illegible]	31.50	0.64	.12	2.48
[illegible]	115	[illegible]	520.	110	0.654E-02	15.62	0.50	1.06	2.00
[illegible]	117	[illegible]	[illegible]	110	0.988E-02	17.96	0.57	2.78	2.60
[illegible]	112	[illegible]	[illegible]	110	0.945E-02	19.26	0.61	2.01	2.95
[illegible]	112	[illegible]	[illegible]	110	0.679E-02	5.22	0.17 LO	0.15	0.26 LO
[illegible]	1[illegible]	15 [illegible]	450.	110	0.137E-02	44.22	0.90	2.09	4.64
[illegible]	119	[illegible]	[illegible]	110	0.187E-02	26.63	0.54	0.82	1.32
[illegible]	117	[illegible]	[illegible]	110	0.208E-02	38.35	0.78	1.78	3.57
[illegible]	118	[illegible]	[illegible]	110	0.370E-02	19.76	0.63	0.93	3.10
[illegible]	[illegible]	[illegible]	[illegible]	11	0.208E-03	31.50	0.64	0.12	2.48
[illegible]	116	117 [illegible]	[illegible]	110	0.250E-02	44.92	0.92	2.87	4.73
[illegible]	124	[illegible]	[illegible]	110	0.237E-02	37.17	0.76	1.92	3.57
[illegible]	[illegible]	[illegible]	[illegible]	110	0.196E-02	38.07	0.79	1.73	3.58
[illegible]	[illegible]	12[illegible]	[illegible]	110	0.208E-03	31.50	0.64	0.12	2.48
[illegible]	[illegible]	[illegible]	[illegible]	110	0.593E-02	8.61	0.27 LO	0.32	0.66
[illegible]	121	122 [illegible]	[illegible]	110	0.704E-02	21.15	0.67	2.00	3.51
[illegible]	1[illegible]	[illegible]	[illegible]	100	0.556E-01	11.28	0.64	4.94	5.32
[illegible]	[illegible]	[illegible]	5[illegible]	110	0.208E-03	31.50	0.64	0.12	2.48
324	[illegible]	[illegible]	[illegible]	110	0.333E-03	31.50	0.64	0.20	2.48
[illegible]	1[illegible]	[illegible]	140.	110	0.173E-02	11.30	0.36 LO	0.15	1.10
[illegible]	131	[illegible]	42[illegible]	110	0.519E-02	17.16	0.55	1.00	2.34
327	1[illegible]	1[illegible]	180.	100	0.108E-01	10.82	0.61	0.89	4.92
[illegible]	1[illegible]	[illegible]	12[illegible]	[illegible]	0.718E-02	4.78	0.27 LO	0.13	1.18
[illegible]	[illegible]	[illegible]	25[illegible]	[illegible]	0.153E-01	2.21	0.13 LO	0.07	0.25 LO
[illegible]	1[illegible]	[illegible]	[illegible]	110	0.395E-02	4.29	0.14 LO	0.05	0.13 LO
331	[illegible]	[illegible]	12[illegible]	[illegible]	0.718E-02	8.72	0.49	0.40	1.30
332	[illegible]	[illegible]	75.	[illegible]	0.449E-02	5.46	0.31 LO	0.10	1.39
333	62	[illegible]	[illegible]	100	0.478E-02	7.71	0.44	0.21	2.53
334	[illegible]	7[illegible]	[illegible]	100	0.167E-01	5.96	0.34 LO	1.46	1.63
335	[illegible]	[illegible]	62[illegible]	100	0.311E-01	3.55	0.20 LO	0.33	0.63
[illegible]	[illegible]	[illegible]	41[illegible]	100	0.177E-00	1.51	0.19 LO	0.38	0.93
337	[illegible]	[illegible]	75[illegible]	[illegible]	0.108E-00	1.03	0.13 LO	0.11	0.46
338	101	[illegible]	35[illegible]	100	0.151E-00	1.31	0.17 LO	0.25	0.71
[illegible]	[illegible]	[illegible]	[illegible]	110	0.125E-02	51.12	1.04	1.82	3.03
[illegible]	[illegible]	[illegible]	5[illegible]	110	0.208E-03	31.50	0.64	0.12	2.48
343	935	[illegible]	[illegible]	110	0.208E-02	31.50	0.64	1.24	2.48
[illegible]	[illegible]	[illegible]	[illegible]	110	0.196E-02	54.30	1.11	3.19	5.79
[illegible]	132	[illegible]	[illegible]	110	0.833E-03	31.50	0.64	0.50	2.48
[illegible]	[illegible]	[illegible]	[illegible]	110	0.208E-03	31.50	0.64	0.12	2.48
[illegible]	[illegible]	[illegible]	[illegible]	110	0.362E-02	58.96	1.20	10.68	7.91
[illegible]	[illegible]	[illegible]	[illegible]	110	0.417E-03	31.50	0.64	0.25	2.48
[illegible]	[illegible]	[illegible]	[illegible]	110	0.154E-01	29.77	0.95	3.27	6.62
[illegible]	[illegible]	[illegible]	[illegible]	110	0.208E-03	31.50	0.64	0.12	2.48
[illegible]	129	[illegible]	[illegible]	110	0.617E-02	12.57	0.40	0.67	1.34
[illegible]	[illegible]	[illegible]	[illegible]	110	0.679E-02	18.79	0.60	1.55	2.32
[illegible]	123	[illegible]	[illegible]	110	0.333E-02	12.71	0.40	0.37	1.37
[illegible]	[illegible]	[illegible]	[illegible]	110	0.208E-03	31.50	0.64	0.12	2.48
[illegible]	[illegible]	[illegible]	[illegible]	110	0.247E-02	4.33	0.14 LO	0.04	0.10 LO
[illegible]	[illegible]	[illegible]	[illegible]	110	0.630E-02	3.51	0.11 LO	0.06	0.13 LO

TABLE IX-C-9 (continued)

PIPE NO.	LENGTH FROM-TO	DIA MM	[illegible] MPS	H-A C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/100)	CK
47	121 [illegible]	[illegible]	150.	110	0.185E-02	8.90	0.28	LO	0.11		0.71
51	9[illegible]1	[illegible]	50.	110	0.208E-03	31.50	0.64		0.12		2.43
54	914	[illegible]	50.	110	0.208E-03	31.50	0.64		0.12		2.43

ANNEX TABLE IX-C-9 (continued)

[illegible]	[illegible] ELEV	[illegible]	[illegible] ELEV	HEAD MTRS	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
1	[illegible]	[illegible]	34.160	28.16	2.73	-0.55
2	[illegible]	[illegible]	31.510	25.51	2.47	8.88
3	[illegible]	[illegible]	29.740	23.74	2.31	15.21
4	[illegible]	[illegible]	29.410	23.41	2.27	16.40
5	[illegible]	[illegible]	29.180	23.18	2.24	17.21
6	[illegible]	[illegible]	29.290	23.29	2.25	16.83
7	[illegible]	[illegible]	29.230	23.23	2.25	17.02
8	[illegible]	[illegible]	29.230	23.23	2.25	17.03
9	[illegible]	[illegible]	28.980	22.93	2.22	17.93
10	[illegible]	[illegible]	29.370	23.37	2.26	16.54
11	[illegible]	[illegible]	29.120	23.12	2.24	17.42
12	[illegible]	[illegible]	28.980	22.98	2.22	17.93
13	[illegible]	[illegible]	31.000	25.00	2.42	10.72
14	[illegible]	[illegible]	30.940	24.94	2.41	10.93
15	[illegible]	[illegible]	28.400	27.40	2.65	2.16
16	[illegible]	[illegible]	29.220	23.22	2.25	17.08
17	[illegible]	[illegible]	29.080	23.08	2.23	17.57
18	[illegible]	[illegible]	29.070	23.07	2.23	17.59
19	[illegible]	[illegible]	29.010	23.01	2.23	17.84
20	[illegible]	[illegible]	28.990	22.99	2.23	17.83
21	[illegible]	[illegible]	28.990	22.99	2.23	17.89
22	[illegible]	[illegible]	29.060	23.06	2.23	17.64
23	[illegible]	[illegible]	28.990	22.99	2.23	17.89
24	[illegible]	[illegible]	28.690	22.69	2.20	18.96
25	[illegible]	[illegible]	28.470	22.47	2.18	19.74
26	[illegible]	[illegible]	28.190	22.19	2.14	21.07
27	[illegible]	[illegible]	27.830	21.83	2.11	22.33
28	[illegible]	[illegible]	28.130	22.13	2.14	20.96
29	[illegible]	[illegible]	28.490	22.49	2.17	20.31
30	[illegible]	[illegible]	28.500	22.50	2.18	19.64
31	[illegible]	[illegible]	28.630	22.63	2.19	19.18
32	[illegible]	[illegible]	28.630	22.63	2.19	19.18
33	[illegible]	[illegible]	28.630	22.63	2.19	19.16
34	[illegible]	[illegible]	28.630	22.63	2.19	19.18
35	[illegible]	[illegible]	28.520	22.52	2.18	19.58
36	[illegible]	[illegible]	28.650	22.65	2.19	19.10
37	[illegible]	[illegible]	28.040	22.04	2.13	21.28
38	[illegible]	[illegible]	27.720	21.72	2.10	22.44
39	[illegible]	[illegible]	28.900	22.90	2.22	18.21
40	[illegible]	[illegible]	29.090	23.09	2.24	17.52
41	[illegible]	[illegible]	29.210	23.21	2.25	17.09
42	[illegible]	[illegible]	29.210	23.21	2.25	17.1[illegible]
43	[illegible]	[illegible]	29.880	23.88	2.31	14.7[illegible]
44	[illegible]	[illegible]	30.060	24.06	2.33	14.07
45	[illegible]	[illegible]	29.810	23.81	2.30	14.97
46	[illegible]	[illegible]	29.630	23.63	2.29	15.61
47	[illegible]	[illegible]	29.570	23.57	2.28	15.81
48	[illegible]	[illegible]	29.510	23.51	2.28	16.04
49	[illegible]	[illegible]	28.420	22.42	2.17	19.93
50	[illegible]	[illegible]	30.510	24.51	2.37	12.45

ANNEX TABLE IX-C-9 (continued)

NODE	GROUND ELEV	[illegible]	HSL ELEV	HEAD MTRS	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
51	[illegible]	[illegible]	31.130	25.13	2.45	10.24
52	[illegible]	-1.10	29.030	23.03	2.23	17.76
53	[illegible]	-1.17	28.390	22.89	2.22	18.25
54	[illegible]	-11.16	28.630	23.63	2.29	18.51
55	[illegible]	[illegible]	28.060	23.06	2.23	20.49
56	[illegible]	[illegible]	29.100	24.00	2.32	17.24
57	[illegible]	-[illegible].74	29.340	24.34	2.35	16.07
58	[illegible]	[illegible]	29.630	24.63	2.38	15.09
59	[illegible]	-7.21	29.630	24.63	2.38	15.07
60	[illegible]	[illegible]	28.570	23.97	2.32	17.35
61	[illegible]	-1.[illegible]	29.230	24.23	2.35	16.45
62	[illegible]	-1.29	29.130	24.13	2.34	16.81
63	[illegible]	-1.75	28.910	23.91	2.32	17.53
64	[illegible]	[illegible]	28.430	23.43	2.27	19.20
65	[illegible]	-1.8[illegible]	28.420	23.42	2.27	19.24
66	[illegible]	[illegible].77	28.270	23.27	2.25	19.75
67	[illegible]	-1.14	28.330	23.33	2.26	19.55
68	[illegible]	-1.12	28.520	23.52	2.28	18.89
69	[illegible]	-1.26	28.260	23.26	2.25	19.80
70	[illegible]	[illegible].70	28.240	23.24	2.25	19.85
71	[illegible]	[illegible].84	28.250	23.25	2.25	19.83
72	[illegible]	[illegible].77	28.350	23.35	2.26	19.47
73	[illegible]	-1.57	28.460	23.46	2.27	19.11
74	[illegible]	[illegible].31	28.700	23.70	2.29	18.28
75	[illegible]	-1.47	27.650	22.65	2.19	21.88
76	[illegible]	-1.73	28.270	23.27	2.25	19.74
77	[illegible]	[illegible].72	28.230	23.23	2.25	19.91
78	[illegible]	[illegible]	28.240	23.24	2.25	19.85
79	[illegible]	-1.59	28.380	23.38	2.25	19.37
80	[illegible]	[illegible].85	28.330	23.33	2.26	19.55
81	[illegible]	-2.76	28.120	23.12	2.24	20.28
82	[illegible]	-2.46	28.150	23.15	2.24	20.17
83	[illegible]	-2.57	28.120	23.12	2.24	20.28
84	[illegible]	-7.33	28.110	23.11	2.24	20.31
85	[illegible]	-7.49	27.120	22.12	2.14	23.72
86	[illegible]	[illegible].79	27.980	22.98	2.22	20.76
87	[illegible]	-1.33	27.930	22.93	2.22	20.93
88	[illegible]	[illegible].55	27.850	22.85	2.21	21.21
89	[illegible]	[illegible].75	27.840	22.84	2.21	21.25
90	[illegible]	-1.2[illegible]	27.930	22.93	2.22	20.93
91	[illegible]	[illegible].4[illegible]	27.730	22.73	2.20	21.62
92	[illegible]	-1.35	27.730	22.73	2.20	21.64
93	[illegible]	-1.35	27.720	22.72	2.20	21.65
94	[illegible]	-[illegible].3[illegible]	31.170	25.17	2.44	13.2[illegible]
95	[illegible]	[illegible].7[illegible]	31.010	25.01	2.42	13.76
96	[illegible]	[illegible].3[illegible]	29.780	24.78	2.40	14.57
97	[illegible]	-3.6[illegible]	29.590	24.59	2.38	15.20
98	[illegible]	-4.5[illegible]	29.380	24.38	2.36	15.94
99	[illegible]	-2.72	29.450	24.45	2.37	15.69
100	[illegible]	[illegible].51	29.640	24.64	2.39	15.03

ANNEX TABLE IX-C-9 (continued)

[illegible]	[illegible] ELEV	[illegible]	HGL ELEV	HEAD MTRS	-------PRESSURE------- ATM---CK	PCT DROP---CK
[illegible]	[illegible]	[illegible]	24.700	24.70	2.39	14.83
[illegible]	[illegible]	-7.53	29.640	24.64	2.38	15.05
[illegible]	[illegible]	[illegible]	29.760	24.76	2.40	14.60
[illegible]	[illegible]	[illegible]	31.650	25.65	2.48	11.55
[illegible]	[illegible]	[illegible]	29.910	23.91	2.31	14.61
[illegible]	[illegible]	[illegible]	29.830	23.83	2.31	14.90
[illegible]	[illegible]	[illegible]	28.540	22.54	2.18	19.52
[illegible]	[illegible]	[illegible]	31.580	25.58	2.48	8.63
[illegible]	[illegible]	[illegible]	29.190	24.19	2.34	16.57
[illegible]	[illegible]	[illegible]	32.250	26.25	2.54	6.25
[illegible]	[illegible]	-1.56	34.400	28.40	2.75	-1.45
[illegible]	[illegible]	[illegible]	32.400	26.40	2.56	5.73
[illegible]	[illegible]	[illegible]	34.950	26.95	2.61	-3.66
[illegible]	[illegible]	[illegible]	36.010	26.01	2.52	-8.39
[illegible]	[illegible]	[illegible]	41.960	25.96	2.51	-36.63
[illegible]	[illegible]	[illegible]	33.090	26.09	2.53	-18.59
[illegible]	[illegible]	-11.74	39.020	27.02	2.62	-22.82
[illegible]	[illegible]	[illegible]	36.310	26.31	2.55	-9.61
[illegible]	[illegible]	[illegible]	35.490	27.49	2.66	-5.71
[illegible]	[illegible]	-1.45	36.140	31.14	3.01	-7.38
[illegible]	[illegible]	-1.26	34.140	29.14	2.82	-0.48
[illegible]	[illegible]	-1.14	33.320	28.32	2.74	0.62
[illegible]	[illegible]	[illegible]	32.190	27.09	2.62	6.58
[illegible]	[illegible]	[illegible]	35.340	30.04	2.91	-7.27
[illegible]	[illegible]	-7.84	35.970	29.97	2.90	-7.04
[illegible]	[illegible]	[illegible]	36.010	30.01	2.90	-7.17
[illegible]	[illegible]	0.0	36.380	30.38	2.94	-8.49
[illegible]	[illegible]	[illegible]	34.830	28.83	2.79	-2.95
[illegible]	18.	[illegible]	42.780	24.78	2.40	-54.89
[illegible]	25.0	0.0	65.430	40.43	3.91	-349.16
[illegible]	[illegible]	[illegible]	45.980	25.98	2.51	-85.54
[illegible]	[illegible]	[illegible]	56.660	31.66	3.06	-251.75
[illegible]	[illegible]	-1.73	64.930	34.93	3.38	-773.21
[illegible]	[illegible]	[illegible]	31.00	25.00	2.42	10.71
[illegible]	[illegible]	[illegible]	31.180	25.18	2.44	10.09
[illegible]	[illegible]	[illegible]	29.170	23.17	2.24	17.26
[illegible]	[illegible]	[illegible]	28.450	22.45	2.17	19.83
[illegible]	[illegible]	[illegible]	29.870	23.87	2.31	14.74
[illegible]	[illegible]	[illegible]	31.330	25.33	2.45	9.53
[illegible]	12.	[illegible]	39.140	27.14	2.63	-23.38
[illegible]	[illegible]	[illegible]	30.180	24.18	2.34	13.63
[illegible]	[illegible]	[illegible]	34.280	28.28	2.74	-1.00
[illegible]	[illegible]	[illegible]	33.940	27.94	2.71	0.20
[illegible]	[illegible]	[illegible]	30.770	24.77	2.40	11.52
[illegible]	[illegible]	[illegible]	36.500	30.50	2.95	-8.93
[illegible]	[illegible]	[illegible]	35.610	27.61	2.67	-6.19
[illegible]	[illegible]	[illegible]	34.530	28.53	2.76	-1.89
[illegible]	25.	[illegible]	57.900	32.90	3.18	-265.52
[illegible]	[illegible]	[illegible]	65.550	35.55	3.44	-788.71
[illegible]	[illegible]	[illegible]	29.950	24.95	2.42	13.97

ANNEX TABLE IX-C-9 (continued)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	PRESSURE ATM---CK	PRESSURE DCT CRCP---CK
908	5.0	31.50	36.270	31.27	3.03	-7.81

ANNEX TABLE IX-C-10

COMPUTER PRINTOUTS (FER-WD)
YEAR 2000 MINIMUM FLOW

SAN FERNANDO WATER DISTRICT [illegible] WATER SYSTEM MIN HOUR [illegible]

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INPUT AND OUTPUT IN                    LPS
NO OF NODES                            [illegible]
NO OF PIPES                            [illegible]
MAX NO OF ITERATIONS                   [illegible]
PEAKING FACTOR                         [illegible]
ALLOW P-DROP FOR STATIC - MGL          [illegible]
STATIC HGL FOR P-DROP CALC             [illegible]
MAX UNBAL - LPS                        [illegible]
MAX ALLOW VEL -MPS                     [illegible]
MIN ALLOW VEL - MPS                    [illegible]
MAX ALLOW HL - M/1000 M                [illegible]
MIN ALLOW HL - M/1000 M                [illegible]
MAX ALLOW PRESS - ATM                  [illegible]
MIN ALLOW PRESS - ATM                  [illegible]
NO OF HEADS IN [illegible] ROAD        1
NO OF UNKNOWN [illegible] ASSUMPTIONS  1
SUM OF FIXED DEMANDS                   [illegible]
BANDWIDTH                              [illegible]
ITER  1 UNBAL   [illegible] LPS
ITER  2 UNBAL   [illegible] LPS
ITER  3 UNBAL   [illegible] LPS
ITER  4 UNBAL   [illegible] LPS
ITER  5 UNBAL   [illegible] LPS
ITER  6 UNBAL   [illegible] LPS
ITER  7 UNBAL   [illegible] LPS
ITER  8 UNBAL   [illegible] LPS

SOLUTION NO. 1  ACHIEVED IN  [illegible] ITERATIONS
        [illegible] LPS UNBALANCE
```

ANNEX TABLE IX-C-10 (continued)

PIPE NO	[illegible]	[illegible]	L MPS	F-A C	K-VALUE	FLOW	--VEL-- MPS	--GR	--HEADLOSS--- MT MT/100	GR
401	2	1 [illegible]	[illegible]	110	0.[illegible]E-02	2.29	0.07	LO	0.01	0.06 L
402	3	1 [illegible]	[illegible]	110	0.[illegible]E-02	3.48	0.11	LO	[illegible]	0.12 LO
403	4	3 [illegible]	[illegible]	100	0.[illegible]E-02	2.17	0.12	LO	0.01	0.25 LO
404	5	1 [illegible]	100.	100	0.[illegible]E-02	1.49	0.05	LO	0.01	0.12 LO
405	5	7 [illegible]	100.	100	0.[illegible]E-02	2.26	0.13	LO	0.04	0.27 LO
406	10	5 [illegible]	120.	100	0.[illegible]E-02	3.51	0.26	LO	0.06	0.61
407	14	10 [illegible]	170.	100	0.[illegible]E-01	5.77	0.33	LO	0.27	1.54
408	15	[illegible]	[illegible]	110	0.[illegible]E-03	28.06	0.59		0.47	5.95
409	501	15 [illegible]	[illegible]	110	0.[illegible]E-03	19.20	0.01		0.15	2.94
411	111	[illegible]	[illegible]	110	0.[illegible]E-02	13.73	0.28	LO	0.29	2.53
412	15	29 [illegible]	[illegible]	110	0.[illegible]E-02	2.27	0.07	LO	0.02	0.06 LO
413	17	20 [illegible]	170.	110	0.[illegible]E-02	3.12	0.10	LO	0.02	0.10 LO
414	19	17 [illegible]	220.	110	0.[illegible]E-02	3.63	0.12	LO	0.03	0.13 LO
415	22	3 [illegible]	300.	100	0.[illegible]E 00	1.11	0.14	LO	0.16	0.52
416	23	4 [illegible]	300.	100	0.[illegible]E 00	1.23	0.16	LO	0.19	0.64
417	24	22 [illegible]	200.	100	0.[illegible]E-01	1.38	0.18	LO	0.15	0.78
418	21	22 [illegible]	100.	100	0.[illegible]E-01	1.55	0.20	LO	0.18	0.97
419	1[illegible]	21 [illegible]	100.	100	0.[illegible]E-01	2.25	0.29	LO	0.19	1.93
420	601	1[illegible] [illegible]	[illegible]	110	0.[illegible]E-03	0.0	0.0	LO	0.0	0.0 L
421	19	22 [illegible]	1[illegible]	100	0.[illegible]E-01	2.02	0.26	LO	0.20	1.99
422	19	1[illegible] [illegible]	1[illegible]	110	0.[illegible]E-02	3.81	0.12	LO	0.02	0.15 LO
423	32	19 [illegible]	400.	100	0.[illegible]E-01	1.44	0.06	LO	0.05	0.12 L
424	24	16 [illegible]	170.	110	0.[illegible]E-02	2.53	0.08	LO	0.01	0.07 LO
425	24	23 [illegible]	100.	100	0.[illegible]E-02	0.91	0.05	LO	0.01	0.05 L
426	25	27 [illegible]	70.	100	0.[illegible]E-02	0.55	0.03	LO	0.00	0.[illegible] L
429	23	27 [illegible]	250.	100	0.[illegible]E 00	0.33	0.04	LO	0.01	0.06 LO
430	27	29 [illegible]	100.	100	0.[illegible]E-02	0.91	0.05	LO	0.01	0.05 LO
431	23	27 [illegible]	170.	100	0.[illegible]E-01	1.07	0.09	LO	0.03	0.15 LO
432	29	29 [illegible]	100.	100	0.[illegible]E-02	2.01	0.11	LO	0.02	0.22 L
433	31	29 [illegible]	100.	100	0.[illegible]E-02	1.76	0.10	LO	0.02	0.17 L
434	31	30 [illegible]	100.	100	0.[illegible]E-02	1.15	0.07	LO	0.01	0.08 LO
435	31	29 [illegible]	1[illegible]	110	0.[illegible]E-02	3.81	0.12	LO	0.02	0.15 LO
436	33	31 [illegible]	150.	110	0.[illegible]E-02	5.22	0.17	LO	0.04	0.26 LO
437	33	34 [illegible]	[illegible]	100	0.[illegible]E-02	1.26	0.07	LO	0.00	0.09 LO
439	35	36 [illegible]	260.	100	0.[illegible]E-01	0.78	0.10	LO	0.05	0.27 LO
440	37	29 [illegible]	2[illegible]	100	0.[illegible]E 00	0.68	0.09	LO	0.05	0.21 LO
441	33	27 [illegible]	2[illegible]	100	0.[illegible]E-01	1.11	0.06	LO	0.02	0.07 LO
447	107	49 [illegible]	120.	100	0.[illegible]E-01	1.00	0.13	LO	0.05	0.43
448	107	30 [illegible]	300.	110	0.[illegible]E-02	4.93	0.10	LO	0.02	0.08 LO
449	37	31 [illegible]	170.	110	0.[illegible]E-03	3.31	0.07	LO	0.01	0.04 LO
450	31	32 [illegible]	1000.	100	0.[illegible]E-01	1.93	0.11	LO	0.20	0.20 L
451	41	32 [illegible]	250.	110	0.[illegible]E-02	7.81	0.23	LO	0.14	0.55
452	32	33 [illegible]	70.	110	0.[illegible]E-03	9.55	0.30	LO	0.06	0.81
454	53	1[illegible] [illegible]	300.	110	0.[illegible]E-02	9.00	0.29	LO	0.22	0.72
456	57	57 [illegible]	1[illegible]	100	0.[illegible]E-01	0.73	0.09	LO	0.04	0.[illegible]4 L
460	58	59 [illegible]	3[illegible]	100	0.[illegible]E-01	1.67	0.09	LO	0.05	0.10 L
461	63	79 [illegible]	400.	100	0.[illegible]E-01	0.62	0.04	LO	0.01	0.02 L
462	74	[illegible] [illegible]	1[illegible]	110	0.[illegible]E-02	0.66	0.21	LO	0.04	0.[illegible]
463	603	[illegible] [illegible]	1[illegible]	110	0.[illegible]E-02	0.0	0.0	LO	0.0	0.0 LO
464	1	[illegible] [illegible]	1[illegible]	110	0.[illegible]E-02	5.42	0.17	LO	0.05	0.25 L

BEST AVAILABLE DOCU

ANNEX TABLE IX-C-10 (continued)

PIPE NO	NODES FROM	-TO	DIA IN	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/1000	CK
465	52	54	200	150.	110	0.185E-02	3.56	0.12	LO	0.02	0.15	LO
466	79	65	100	900.	100	0.179E-01	1.86	0.11	LO	0.06	0.19	LO
467	108	32	150	250.	100	0.150E-01	0.44	0.03	LO	0.00	0.01	LO
468	15	111	200	400.	110	0.107E-02	11.46	0.23	LO	0.15	0.38	
201	14	13	200	70.	110	0.292E-03	9.21	0.19	LO	0.02	0.25	LO
202	34	43	200	200.	110	0.123E-02	6.67	0.21	LO	0.04	0.42	
203	36	34	200	100.	110	0.123E-02	3.08	0.20	LO	0.06	0.59	
204	39	35	200	120.	110	0.154E-02	12.44	0.40	LO	0.10	1.31	
205	41	40	200	50.	110	0.617E-03	9.49	0.30	LO	0.04	0.80	
206	45	41	200	150.	110	0.625E-03	17.54	0.36	LO	0.15	0.94	
207	45	107	200	250.	110	0.104E-02	6.34	0.13	LO	0.03	0.13	LO
208	55	14	200	125.	110	0.154E-02	4.64	0.15	LO	0.03	0.21	LO
209	57	56	200	350.	110	0.432E-02	7.36	0.23	LO	0.17	0.50	
210	58	57	200	100.	110	0.123E-02	10.34	0.33	LO	0.09	0.93	
211	65	59	200	200.	110	0.247E-02	13.63	0.43		0.31	1.56	
101	5	2	100	400.	100	0.172E 00	0.58	0.07	LO	0.06	0.16	LO
102	9	5	100	400.	100	0.239E-01	1.17	0.07	LO	0.03	0.08	LO
103	7	6	100	100.	100	0.598E-02	1.80	0.10	LO	0.02	0.18	LO
104	8	9	100	250.	100	0.591E-01	0.60	0.08	LO	0.04	0.17	LO
105	12	9	100	300.	100	0.179E-01	1.40	0.08	LO	0.03	0.11	LO
106	11	12	100	200.	100	0.120E-01	2.04	0.12	LO	0.04	0.22	LO
107	17	21	100	100.	100	0.598E-02	2.67	0.15	LO	0.04	0.37	
108	21	16	100	690.	100	0.297E 00	0.67	0.09	LO	0.14	0.20	LO
109	20	21	100	150.	100	0.560E-01	0.45	0.06	LO	0.01	0.10	LO
110	15	25	100	150.	100	0.597E-02	0.07	0.00	LO	0.00	0.00	LO
111	34	35	100	70.	100	0.302E-01	1.07	0.14	LO	0.03	0.48	
112	35	37	100	170.	100	0.102E-01	4.03	0.23	LO	0.13	0.79	
113	37	35	100	150.	100	0.897E-02	2.82	0.16	LO	0.06	0.41	
114	40	39	100	60.	110	0.968E-03	12.74	0.41		0.11	1.37	
115	42	40	100	120.	100	0.517E-01	3.50	0.45		0.53	4.33	
116	43	42	100	350.	100	0.151E 00	3.20	0.41		1.50	3.71	
117	43	45	100	520.	100	0.224E 00	0.12	0.01	LO	0.00	0.01	LO
118	44	45	100	60.	100	0.478E-02	4.04	0.23	LO	0.06	0.79	
119	44	45	100	70.	100	0.419E-02	4.49	0.25	LO	0.07	0.96	
120	45	46	100	70.	100	0.419E-02	4.24	0.24	LO	0.06	0.87	
121	46	47	100	350.	100	0.151E 00	3.04	0.39	LO	1.18	3.38	
122	44	47	200	330.	110	0.407E-02	22.61	0.72		1.31	3.98	
123	47	42	100	170.	100	0.732E-01	0.82	0.10	LO	0.05	0.30	LO
124	47	40	100	90.	110	0.111E-02	24.38	0.78		0.41	4.57	
125	50	100	100	110.	110	0.397E-01	0.99	0.15	LO	0.04	0.36	
127	51	107	200	200.	110	0.247E-02	0.85	0.03	LO	0.00	0.01	LO
128	110	3	100	250.	100	0.150E-01	0.51	0.03	LO	0.00	0.02	LO
130	59	54	100	370.	100	0.401E-01	3.59	0.20	LO	0.43	0.54	
131	57	60	100	60.	100	0.345E-01	2.17	0.26	LO	0.14	1.00	
133	63	65	100	350.	100	0.164E 00	0.77	0.10	LO	0.10	0.28	LO
134	63	64	100	230.	100	0.991E-01	1.00	0.15	LO	0.10	0.43	
137	60	61	100	50.	100	0.345E-01	0.02	0.00	LO	0.00	0.00	LO
138	64	65	100	50.	100	0.215E-01	0.10	0.01	LO	0.00	0.01	LO
139	65	66	100	130.	100	0.550E-01	0.71	0.09	LO	0.03	0.25	LO
141	64	72	100	240.	100	0.103E 00	0.74	0.09	LO	0.06	0.25	LO

PIPE NO	NODES FROM-TO	DIA MM	L METRS	H-W C	K-VALUE	FLOW	--VEL-- MPS--CK	--HEADLOSS--- M M/1000 LK	
142	65 71	100	220.	100	0.948E-01	0.51	0.05 LO	0.03	0.12 LO
143	65 69	100	100.	100	0.040E-01	0.07	0.01 LO	0.00	0.00 LO
144	67 69	100	120.	100	0.517E-01	0.66	0.08 LO	0.02	0.20 LO
145	65 67	100	90.	100	0.388E-01	0.80	0.11 LO	0.03	0.32
146	69 70	100	150.	100	0.646E-01	0.52	0.07 LO	0.02	0.13 LO
147	70 71	100	150.	100	0.388E-01	0.32	0.04 LO	0.01	0.05 LO
148	71 72	100	110.	100	0.474E-01	0.21	0.03 LO	0.00	0.02 LO
149	72 73	100	120.	100	0.517E-01	0.82	0.10 LO	0.04	0.36 LO
150	73 74	100	150.	110	0.182E-02	4.49	0.14 LO	0.03	0.20 LO
151	75 73	100	50.	110	0.988E-03	1.77	0.06 LO	0.00	0.04 LO
152	71 77	100	70.	100	0.302E-01	0.48	0.06 LO	0.01	0.11 LO
153	73 75	100	70.	100	0.302E-01	0.07	0.01 LO	0.00	0.00 LO
154	73 77	100	100.	100	0.431E-01	0.55	0.07 LO	0.01	0.14 LO
155	77 76	100	100.	100	0.040E-01	0.63	0.08 LO	0.03	0.16 LO
156	75 76	100	100.	100	0.431E-01	0.67	0.09 LO	0.02	0.20 LO
157	75 [illegible]	100	150.	100	0.219E-01	0.42	0.05 LO	0.02	0.09 LO
158	65 75	100	150.	110	0.189E-02	1.95	0.06 LO	0.01	0.04 LO
159	77 81	100	110.	100	0.474E-01	0.25	0.04 LO	0.00	0.04 LO
160	80 75	100	120.	100	0.517E-01	0.60	0.08 LO	0.02	0.17 LO
161	81 80	100	100.	100	0.040E-01	0.48	0.06 LO	0.02	0.11 LO
162	85 85	100	130.	100	0.560E-01	0.87	0.11 LO	0.04	0.35
163	84 83	100	50.	110	0.741E-03	2.77	0.09 LO	0.00	0.02 LO
165	82 81	100	50.	100	0.215E-01	0.68	0.09 LO	0.01	0.21 LO
166	82 80	100	240.	100	0.203E-01	0.12	0.01 LO	0.00	0.00 LO
167	90 91	100	100.	100	0.431E-01	0.57	0.07 LO	0.02	0.15 LO
168	87 90	100	200.	100	0.120E-01	0.66	0.04 LO	0.01	0.03 LO
169	85 87	150	50.	100	0.299E-02	1.74	0.10 LO	0.01	0.17 LO
170	87 88	150	140.	100	0.237E-02	0.64	0.05 LO	0.01	0.04 LO
171	88 89	150	70.	100	0.419E-02	0.44	0.02 LO	0.00	0.01 LO
173	88 92	100	250.	100	0.121E 00	0.30	0.04 LO	0.01	0.05 LO
174	93 92	100	70.	100	0.302E-01	0.08	0.01 LO	0.00	0.00 LO
175	92 91	100	70.	100	0.302E-01	0.20	0.03 LO	0.00	0.02 LO
176	59 94	100	320.	110	0.395E-02	8.80	0.28 LO	0.22	0.69
177	61 93	100	320.	100	0.224E 00	1.14	0.15 LO	0.29	0.93
179	94 97	100	70.	100	0.302E-01	0.23	0.03 LO	0.00	0.03 LO
180	98 97	100	50.	100	0.215E-01	0.69	0.09 LO	0.01	0.22 LO
181	99 93	100	60.	100	0.259E-01	0.31	0.04 LO	0.00	0.05 LO
183	94 93	100	120.	110	0.148E-02	2.22	0.07 LO	0.01	0.05 LO
184	97 96	100	100.	100	0.431E-01	0.29	0.04 LO	0.00	0.04 LO
185	99 100	100	100.	100	0.596E-02	1.72	0.10 LO	0.02	0.16 LO
186	95 95	100	50.	110	0.988E-03	0.32	0.01 LO	0.00	0.00 LO
187	100 96	100	120.	110	0.148E-02	1.19	0.04 LO	0.00	0.02 LO
191	100 103	100	340.	100	0.203E-01	0.76	0.04 LO	0.01	0.04 LO
193	95 104	100	420.	100	0.181E 00	0.25	0.03 LO	0.01	0.03 LO
195	95 105	100	500.	110	0.017E-02	1.54	0.05 LO	0.01	0.03 LO
196	701 96	250	100.	110	0.417E-03	31.50	0.04	0.25	2.40
197	5 4	100	100.	100	0.431E-01	0.01	0.00 LO	0.00	0.00 LO
198	109 106	100	250.	100	0.105E 00	0.51	0.05 LO	0.03	0.12 LO
199	94 110	100	400.	100	0.239E-01	1.68	0.09 LO	0.06	0.10 LO
501	112 109	100	650.	110	0.778E-02	0.19	0.01 LO	0.00	0.00 LO

PIPE NO	NODE FROM-TO		L MTRS	H-W COEF	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/1000	CK
302	114	112	300.	110	0.449E-02	6.58	0.21	LO	0.15	0.50	
303	102	113	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	L
304	115	114	330.	110	0.654E-02	8.96	0.22	LO	0.24	0.45	
305	117	115	300.	110	0.980E-02	7.36	0.23	LO	0.40	0.80	
306	112	115	300.	110	0.940E-02	6.13	0.20	LO	0.24	0.35	
307	113	111	350.	110	0.674E-02	3.72	0.12	LO	0.06	0.14	L
308	120	115	450.	110	0.187E-02	13.20	0.27	LO	0.22	0.50	
310	119	118	450.	110	0.157E-02	15.59	0.32	LO	0.30	0.67	
311	117	119	500.	110	0.208E-02	17.59	0.36	LO	0.42	0.84	
312	117	116	300.	110	0.370E-02	2.01	0.06	LO	0.01	0.03	LO
313	103	44	250.	110	0.208E-03	31.50	0.64		0.12	2.48	
314	115	117	300.	110	0.450E-02	28.40	0.58		1.23	4.09	
316	94	124	370.	110	0.237E-02	5.45	0.11	LO	0.05	0.13	L
317	124	125	470.	110	0.190E-02	5.15	0.10	LO	0.04	0.09	LO
318	105	121	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO
319	125	122	450.	110	0.375E-02	4.95	0.10	LO	0.11	0.24	LO
320	122	121	570.	110	0.704E-02	3.71	0.17	LO	0.06	0.14	LO
321	122	110	930.	110	0.350E-01	1.02	0.06	LO	0.00	0.05	LO
322	104	1	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO
324	101	91	80.	110	0.333E-03	0.0	0.0	LO	0.0	0.0	LO
325	108	77	140.	110	0.173E-02	5.02	0.26	LO	0.08	0.56	
326	4	101	420.	110	0.319E-02	3.92	0.12	LO	0.07	0.16	LO
327	105	104	180.	100	0.106E-01	0.10	0.01	LO	0.00	0.00	LO
328	103	104	120.	100	0.718E-02	0.72	0.04	LO	0.00	0.03	LO
329	101	103	250.	100	0.150E-01	1.26	0.07	LO	0.02	0.09	LO
330	101	100	320.	110	0.395E-02	1.71	0.05	LO	0.01	0.03	LO
331	93	81	120.	100	0.718E-02	6.62	0.37	LO	0.24	1.98	
332	81	82	75.	100	0.449E-02	5.31	0.30	LO	0.10	1.32	
333	82	83	80.	100	0.476E-02	2.47	0.14	LO	0.03	0.32	
334	83	73	280.	100	0.167E-01	2.17	0.12	LO	0.07	0.25	L
335	82	99	520.	100	0.311E-01	2.62	0.15	LO	0.19	0.36	
336	91	84	410.	100	0.177E 00	0.18	0.02	LO	0.01	0.02	L
337	84	73	250.	100	0.108E 00	0.31	0.04	LO	0.01	0.05	LO
338	99	101	350.	100	0.151E 00	0.17	0.02	LO	0.01	0.02	LO
501	130	110	300.	110	0.125E-02	29.46	0.50		0.56	2.19	
502	903	120	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	L
503	905	134	500.	110	0.208E-02	0.0	0.0	LO	0.0	0.0	LO
504	133	130	470.	110	0.190E-02	30.01	0.61		1.06	2.27	
505	132	135	200.	110	0.833E-03	31.50	0.64		0.50	2.48	
506	905	132	50.	110	0.208E-03	31.50	0.64		0.12	2.48	
507	134	133	1350.	110	0.562E-02	30.81	0.63		3.21	2.38	
508	907	101	100.	110	0.417E-03	0.0	0.0	LO	0.0	0.0	L
509	135	134	1250.	110	0.154E-01	31.20	0.99		9.03	7.22	
510	903	121	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO
511	1	124	500.	110	0.017E-02	1.31	0.04	LO	0.01	0.02	LO
512	124	126	550.	110	0.079E-02	0.24	0.01	LO	0.00	0.00	LO
513	123	127	270.	110	0.335E-02	0.24	0.01	LO	0.00	0.00	L
514	902	126	50.	110	0.208E-03	0.0	0.0	LO	0.0	0.0	LO
515	126	127	200.	110	0.247E-02	1.19	0.04	LO	0.00	0.02	L
516	125	128	510.	110	0.630E-02	2.54	0.08	LO	0.04	0.07	LO

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
517	121	145	150.	110	0.285E-02	3.46	0.11	LD	0.02	0.12	L
518	901	[illegible]	50.	110	0.200E-03	0.0	0.0	LD	0.0	0.0	[illegible]
519	904	112	50.	110	0.208E-03	0.0	0.0	LD	0.0	0.	[illegible]

ANNEX TABLE IX-C-10 (continued)

NOD	GROUND ELEV	FLOW	PIEZ ELEV	HEAD MTRS	PRESSURE ATM---GR	PRESSURE PCT DROP---GR
1	0.0	-0.55	34.000	28.00	2.71	0.00
2	0.0	-1.70	34.010	28.01	2.71	-0.05
3	0.0	-0.32	34.080	28.08	2.72	-0.23
4	0.0	-0.37	34.080	28.08	2.72	-0.27
5	0.0	-0.52	34.080	28.08	2.72	-0.27
6	0.0	-0.31	34.090	28.09	2.72	-0.32
7	0.0	-0.40	34.110	28.11	2.72	-0.36
8	0.0	-0.04	34.150	28.15	2.72	-0.52
9	0.0	-0.33	34.110	28.11	2.72	-0.39
10	0.0	-0.26	34.220	28.22	2.73	-0.00
11	0.0	-1.03	34.190	28.19	2.73	-0.07
12	0.0	-0.34	34.140	28.14	2.72	-0.51
13	0.0	-0.35	34.470	28.47	2.76	-1.34
14	0.0	-1.02	34.490	28.49	2.76	-1.76
15	0.0	-1.74	34.540	28.54	2.80	-3.35
16	0.0	-1.78	34.510	28.51	2.76	-1.52
17	0.0	-0.33	34.530	28.53	2.76	-1.33
18	0.0	-0.45	34.550	28.55	2.75	-1.99
19	0.0	-0.29	34.580	28.58	2.77	-2.03
20	0.0	-0.19	34.550	28.55	2.75	-1.35
21	0.0	-0.48	34.500	28.50	2.75	-1.30
22	0.0	-0.27	34.220	28.22	2.73	-0.79
23	0.0	-0.32	34.270	28.27	2.74	-0.95
24	0.0	-0.33	34.570	28.57	2.77	-2.03
25	0.0	-0.36	34.560	28.56	2.77	-2.01
26	0.0	-0.98	34.510	28.51	2.76	-1.82
27	0.0	-1.37	34.510	28.51	2.76	-1.64
28	0.0	-0.03	34.540	28.54	2.76	-1.93
29	0.0	-0.31	34.560	28.56	2.77	-2.01
30	0.0	-0.17	34.550	28.55	2.77	-2.07
31	0.0	-0.26	34.590	28.59	2.77	-2.10
32	0.0	-0.20	34.620	28.62	2.77	-2.22
33	0.0	-0.19	34.630	28.63	2.77	-2.24
34	0.0	-0.34	34.670	28.67	2.78	-2.39
35	0.0	-0.23	34.630	28.63	2.77	-2.27
36	0.0	-0.33	34.730	28.73	2.79	-2.60
37	0.0	-0.33	34.590	28.59	2.77	-2.12
38	0.0	-1.71	34.530	28.53	2.76	-1.90
39	0.0	-0.36	34.890	28.89	2.80	-3.19
40	0.0	-0.23	35.000	29.00	2.81	-3.55
41	0.0	-0.24	35.040	29.04	2.81	-3.72
42	0.0	-0.52	35.030	29.03	2.80	-3.46
43	0.0	-0.7[illegible]	30.030	30.03	2.98	-10.10
44	0.0	-0.30	30.090	30.09	2.99	-10.33
45	0.0	-0.37	30.020	30.02	2.98	-10.08
46	0.0	-1.2[illegible]	30.760	30.76	2.98	-9.87
47	0.0	-0.46	35.050	29.05	2.86	-5.04
48	0.0	-0.50	35.170	29.17	2.82	-4.17
49	0.0	-1.00	35.080	29.08	2.82	-3.80
50	0.0	-0.03	35.110	29.11	2.82	-3.97

ANNEX TABLE IX-C-10 (continued)

NODE	GROUND ELEV	FLOW	HOL ELEV	HEAD MTRS	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
51	5.0	-0.53	35.100	29.10	2.82	-3.45
52	5.0	-0.19	34.900	29.90	2.90	-3.22
53	5.0	-0.34	34.840	29.84	2.79	-3.01
54	5.0	-1.91	34.130	29.13	2.82	-0.45
55	5.0	-0.75	34.570	29.57	2.86	-1.95
56	5.0	-0.32	34.500	29.00	2.87	-2.05
57	5.0	-0.81	34.780	29.78	2.88	-2.08
58	5.0	-0.91	34.670	29.67	2.89	-2.00
59	5.0	-1.24	34.560	29.56	2.86	-1.92
60	5.0	-0.37	34.630	29.63	2.87	-2.15
61	5.0	-0.19	34.630	29.63	2.87	-2.15
62	5.0	-0.22	34.530	29.53	2.86	-1.84
63	5.0	-0.36	34.510	29.51	2.86	-1.75
64	5.0	-0.16	34.530	29.53	2.86	-1.84
65	5.0	-0.15	34.530	29.53	2.86	-1.83
66	5.0	-0.13	34.500	29.50	2.86	-1.73
67	5.0	-0.19	34.530	29.53	2.86	-1.81
68	5.0	-0.19	34.500	29.50	2.86	-1.91
69	5.0	-0.21	34.500	29.50	2.86	-1.73
70	5.0	-0.15	34.480	29.48	2.85	-1.66
71	5.0	-0.14	34.480	29.48	2.85	-1.64
72	5.0	-0.13	34.470	29.47	2.85	-1.63
73	5.0	-0.27	34.440	29.44	2.85	-1.51
74	5.0	-0.37	34.410	29.41	2.85	-1.41
75	5.0	-0.25	34.420	29.42	2.85	-1.45
76	5.0	-0.15	34.440	29.44	2.85	-1.52
77	5.0	-0.12	34.470	29.47	2.85	-1.61
78	5.0	-0.11	34.460	29.46	2.85	-1.66
79	5.0	-0.10	34.540	29.54	2.86	-1.88
80	5.0	-0.06	34.500	29.50	2.85	-1.73
81	5.0	-0.48	34.460	29.46	2.85	-1.60
82	5.0	-0.70	34.470	29.47	2.85	-1.63
83	5.0	-0.44	34.450	29.45	2.85	-1.54
84	5.0	-1.26	34.450	29.45	2.85	-1.56
85	5.0	-1.25	34.400	29.40	2.85	-1.39
86	5.0	-0.12	34.490	29.49	2.85	-1.66
87	5.0	-0.23	34.480	29.48	2.85	-1.65
88	5.0	-0.10	34.470	29.47	2.85	-1.63
89	5.0	-0.13	34.470	29.47	2.85	-1.63
90	5.0	-0.22	34.470	29.47	2.85	-1.63
91	5.0	-0.59	34.460	29.46	2.85	-1.56
92	5.0	-0.10	34.460	29.46	2.85	-1.59
93	5.0	-0.23	34.460	29.46	2.85	-1.59
94	5.0	-0.91	34.340	29.34	2.84	-1.16
95	5.0	-0.99	34.330	29.33	2.84	-1.14
96	5.0	-0.91	34.330	29.33	2.84	-1.14
97	5.0	-0.63	34.330	29.33	2.84	-1.15
98	5.0	-0.75	34.350	29.35	2.84	-1.19
99	5.0	-0.43	34.350	29.35	2.84	-1.20
100	5.0	-1.49	34.330	29.33	2.84	-1.14

ANNEX TABLE IX-C-10 (continued)

NUM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]		[illegible]	MTRS	ATM---CK	PCT TROP---CK
101	[illegible]	-1.12	34.340	29.34	2.84	-1.10
103	[illegible]	[illegible]	34.320	29.32	2.84	-1.10
104	[illegible]	-1.07	34.320	29.32	2.84	-1.09
105	[illegible]	-1.44	34.320	29.32	2.84	-1.09
106	[illegible]	-1.50	35.070	29.07	2.81	[illegible]
107	[illegible]	[illegible]	35.140	29.14	[illegible]	[illegible]
108	[illegible]	[illegible]	34.030	28.03	2.77	-2.23
109	[illegible]	[illegible]	35.100	29.10	2.82	-3.94
110	[illegible]	-2.19	34.070	29.07	2.81	-0.23
111	[illegible]	-1.43	34.790	28.79	2.79	[illegible]
112	[illegible]	-0.27	35.100	29.10	2.82	-3.94
113	[illegible]	-2.41	34.350	28.35	2.79	[illegible]
114	[illegible]	-0.37	33.250	27.25	2.64	[illegible]
115	[illegible]	[illegible]	33.490	28.49	2.47	-0.19
116	[illegible]	-1.06	37.110	22.11	2.14	-16.38
117	[illegible]	-1.43	33.880	23.88	2.31	[illegible]
118	[illegible]	-2.01	35.870	23.87	2.31	-3.51
119	[illegible]	[illegible]	35.480	25.48	2.47	-5.10
120	[illegible]	-2.39	35.100	27.10	2.63	-4.46
121	[illegible]	-0.25	34.020	29.02	2.81	-0.10
122	[illegible]	-0.22	34.130	29.13	2.82	-0.43
123	[illegible]	-0.19	34.240	29.24	2.83	[illegible]
124	[illegible]	-0.31	34.230	29.23	2.83	-0.97
125	[illegible]	[illegible]	34.030	28.03	2.71	-0.10
126	[illegible]	-1.34	33.990	27.99	2.71	0.03
127	[illegible]	-1.44	33.990	27.99	2.71	[illegible]
128	[illegible]	[illegible]	33.990	27.99	2.71	0.04
129	[illegible]	-1.[illegible]	33.990	27.99	2.71	0.04
130	10.0	-0.55	37.770	19.77	1.91	-23.56
132	[illegible]	[illegible]	31.570	20.57	2.57	-195.10
133	[illegible]	[illegible]	38.830	18.83	1.82	-34.53
134	[illegible]	-0.40	42.050	17.05	1.65	-89.39
135	[illegible]	[illegible]	51.070	21.07	2.04	-426.76
501	[illegible]	-23.00	34.00	28.00	2.71	0.00
600	[illegible]	19.20	34.050	28.05	2.77	-2.32
601	[illegible]	0.0	34.560	28.56	2.75	-1.99
603	[illegible]	0.0	34.500	28.50	2.76	-1.79
701	0.0	31.50	35.120	29.12	2.82	-3.99
801	0.0	0.0	35.100	29.10	2.82	-3.95
802	12.0	[illegible]	35.870	23.87	2.31	-8.51
803	[illegible]	31.50	37.020	31.02	3.00	-10.77
804	[illegible]	0.0	34.000	28.00	2.71	0.00
805	[illegible]	[illegible]	34.240	28.24	2.73	-0.86
901	[illegible]	0.0	34.320	28.32	2.74	-1.13
902	[illegible]	0.0	33.990	27.99	2.71	0.04
903	[illegible]	0.0	35.100	27.10	2.63	-4.46
904	[illegible]	0.0	35.100	29.10	2.82	-3.94
905	25.0	0.0	42.050	17.05	1.65	-89.39
906	[illegible]	31.50	51.690	21.69	2.10	-442.25
907	[illegible]	0.0	34.340	29.34	2.84	-1.10

ANNEX TABLE IX-C-10 (continued)

NUMBER	[illegible] ELEV	FLOW	[illegible] ELEV	[illegible] MIPS	[illegible] ATM---CK	[illegible] PCT DROP---CK
908	[illegible]	[illegible]	[illegible]	[illegible]	2.81	-[illegible]

BEST AVAILABLE DOCUMEN

CHAPTER X FINANCIAL FEASIBILITY ANALYSIS

A. GENERAL

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

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

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

B. THE EXISTING SYSTEM

Personnel

As of 30 November, 1977, the FER-WD had a total of 26 personnel. With the program of expansion, there is a need to augment the present staff. The district is currently upgrading the quality of its staff to comply with LWUA guidelines in personnel management.

Water Rates

As of April, 1977, FER-WD had 1,245 connections all charged on a flat-rate basis.

During the later part of December 1977, the district sought an increase in its water charges. These new rates have been approved by LWUA and took effect on 1 January 1978. The rates are as follows:

Metered connections:

Domestic/Government	₱1.00/R.U.
Commercial/Industrial	₱2.00/R.U.

Flat Rate Connections:

Domestic/Government:	1/2"	-	₱ 30.00 per month
	3/4"	-	48.00 per month
Commercial/Industrial:	1/2"	-	60.00 per month
	3/4"	-	96.00 per month
	1"	-	192.00 per month
	1½"	-	480.00 per month

Financial Statements

The financial statements of PEN-WD for the period 1 January - 30 November 1977 show operating revenues of ₱226,649.60 or an average of ₱20,600 per month. Operating expenses for the same period totalled ₱253,032.15 or an average of ₱23,000 per month. The district, therefore, incurred an average monthly deficit of about ₱2,400. A bigger deficit would result if allowances were made for depreciation.

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

C. DEVELOPMENT COSTS

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

Project Costs

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

Escalation of Costs

To account for the effects of inflation, capital cost estimates are escalated. This has been done year by year on an item-by-item basis

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

D. OPERATING AND MAINTENANCE COSTS

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

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

E. FINANCING POLICIES COVERING LOCAL WATER DISTRICT DEVELOPMENT

The following are the major potential sources of funds which can be utilized by FER-WDs

Operating Source

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

Non-Operating Sources

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

1. Loans - funds may be borrowed by the water district for development. One of LWUA's primary functions is lending funds for development to water districts. From the water district's

point of view, LWUA is the primary, if not the only realistic, source of funds. LWUA borrows both foreign currencies and pesos at varying terms and relends needed funds to water districts according to the composite terms needed to support the blend of debt service terms LWUA itself must meet. At present, LWUA's terms include:

	Immediate Improvements Loan	Phase I-A and I-B Loan
Interest-	9 percent per annum to be computed at $\frac{3}{4}$ percent per month. Interest due on the local component is paid annually. Interest on foreign exchange is capitalized during construction. 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 learn 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 Assesments - consist of payments made by new customers and benefiting property owners for the costs of specific portions of the facilities being developed. Typically, such charges are made for the costs of new construction and water meters and for all or a portion of the costs of new distribution system extensions. LWUA guidelines suggest that customers may pay for connections and water meters, but currently do not include an assessment for distribution system costs. For purposes of this analysis new customers were assumed to be paying for the new connections and water meters on a revolving fund basis.

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 montly 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 is 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 system. Another approach is for the government to advance a portion of the funds needed during the early years of development at little or no interest to assist the local utility in building its financial capacity. This is another form of "credit" as referred to above. Later, as the revenue base expands and development expenditures decline, the local utility refunds such advances as permitted by its cash position. At the present time, however, the local water district is expected to undertake its development programs with no equity participation by government or assistance other than the LWUA loans.

Reserve Requirements

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

F. FUNDS FOR CAPITAL DEVELOPMENT

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

Depreciable Assets/Depreciation Expenses

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

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

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

Revolving Fund for Connections

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

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

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

Revenue Unit Forecast

The present LWUA rate policy incorporates the use of "revenue units"(RU) in determining the basic cost per cubic meter of water to

domestic consumers. Commercial and industrial customers are charged twice the unit price for domestic use and wholesale water distributors are charged thrice the basic price. As defined, a "revenue unit" is an arbitrary unit of measure into which discharges from pipes of various sizes are reduced to 3/8-inch connection by the use of conversion factors.

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

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

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

G. ANALYSIS OF WATER RATES

Ability-To-Pay Issue

Presidential Decree No. 198 stipulates that water districts must be financially self-sufficient. In the past, most water systems have not been able to generate sufficient revenues to cover even the operation and 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 being served by the water district have such low incomes and, hence, are not in a financial position to pay the full costs of the system. Therefore, before a water system is improved and expanded, the ability-to-pay of the population targeted to be served must be ascertained.

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

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

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

1) Though 10 of the water districts were revenue-producing prior to the change in management of the water district, 13 imposed increased water rates upon takeover.

2) Water consumers generally accepted the increase after some explanations justifying it. Only five received formal complaints about the increased rates while eight received formal complaints about the poor quality of water supply.

3) Ten had difficulty in the collection of water bills primarily due to dissatisfaction of consumers with the water service.

4) Assuming that capital and service improvements were made, the general managers indicated they could increase their rates by as low as 25 percent and as high as 447 percent for the average and below average households.

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

The survey covered 556 families, classified into 4 income groups. Approximately 28 percent came from the low-income class (below ₱220/month); 55 percent from the middle-income (₱221 - ₱750); 12 percent from the upper-middle-income group (₱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	₱220	₱221-750	₱751-1,500	₱1,500	
% Distribution	28%	55%	12%	5%	
Probable Ability-to-Pay on Basis of Improved Service	₱13.50	₱24.50	₱37.00	₱67.50	₱25.00/mo

Estimated Average Income	₱220	₱660	₱1,000	₱2,700	₱680/household
Ability-to-Pay Divided by Average Income	6.1%	3.7%	3.7%	2.5%	3.7%

A second survey on ability-to-pay was conducted in San Fernando, Pampanga in April 1977. The respondents included 298 families, all water district concessionaires. The results of the survey are summarized as follows:

	Low	Middle	Upper Middle	High	Weighted Average
Income Group	₱300	₱301-800	₱801-1,500	₱1,500	
% Distribution	13	52	24	11	
Probable Ability to Pay on Basis of Improved Service	18.90	22.80	36.50	42.60	27.76
Estimated Average Income	213	555	1,157	2,682	889
Ability-to-Pay Divided by Average Income	8.9%	4.1%	3.1%	1.6%	3.0%

In terms of absolute values the results of the San Fernando survey update the results of the previous survey in Lipa/Tanauan, Batangas. The above tables indicate that the low income group may be able to pay ₱13.50 - 18.90 a month for water (6.1 - 8.9 percent of their average incomes). In the extreme end, the high income group may be able to pay a ₱42.60 - 67.50 a month for water (only 1.6 - 2.5 percent of their average income). This disparity in the percentage of income allocated to water by the two income groups may be the best argument for advocating a socialized price structure.

Family Income

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

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

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

By July 1977, the annual income for "other urban areas" cited above, escalated at 10 percent per year, would be about ₱6,800/year.

The report, "The Filipino Family, Community, and Nation" by Emma Porio, Frank Lynch and Mary R. Hollensteiner published by the Institute of Philippine Culture of Ateneo de Manila University in April 1975, cites in Table A9, page 99 the results of a survey in April 1974. The families surveyed were distributed among 15 urban areas, and included 373 families in Metro Manila. Excluding the families in Metro Manila, mean monthly income of the remaining 1,599 families was ₱572, or ₱6,864 per year. Escalating this income at an annual rate of 10 percent, by 1 July 1977, it would be an income of about ₱9,400 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 1979 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 1977, somewhere between the ₱6,800 per year (developed from the 1970/71 data of the NCSO) and the ₱9,400 per year (developed from the data of Porio, Lynch and Hollensteiner). For purposes of this analysis the upper limit of ₱9,400 per year or ₱800 per month was chosen as the average income of a water-using family. This is close to the income data obtained from the San Fernando survey wherein average monthly income was ₱889.

Initial Rate Determination

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

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

Period	Water Rate (₱/RU)
1978-1980	₱0.75
1981-1984	1.10
1985-1987	1.20
1988-1990	1.30
1991-1993*	1.50
1994-1996*	1.70
1997-2000*	1.90

The first step of ₱0.75/RU was selected as an intermediate rate, in anticipation of the second step (₱1.10/RU) which is indicative of the required cost to make the system financially viable. The rate of ₱1.10/RU in 1982 cost levels is equivalent to ₱0.75 in 1978 prices (based on a 10 percent discount rate). Likewise ₱1.20/RU in 1985 is equivalent to ₱0.62 in 1978 prices.

Feasibility of Charges

The question of feasibility is a matter of analyzing whether or not 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 (₱800/mo) also represents the "mean". Probable use of water

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

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

	1979	1983	1986	1989	1992	1995	1999
Escalated income of household earning ₱800/mo in 1977 (8% per year)	930	1,270	1,600	2,010	2,540	3,200	4,350
Expenditure for 24-cum water consumption-minimum charge (first 10 cum)	18.75	27.50	30.00	32.50	37.50	42.50	47.50
Commodity charge (Rate/RU x 14 cum)	10.50	15.40	16.80	18.20	21.00	23.80	26.60
Income allocation to water for existing consumers (%)	3.1	3.4	2.9	2.5	2.3	2.1	1.7
Connection charge for new customers (₱6.83/mo in 1978)	7.51	10.40	12.86	15.31	18.23	21.71	27.40
Income allocation to water for new customers	4.0	4.2	3.7	3.3	3.0	2.8	2.3

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[3] Probable use of water by income groups:

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

In the example shown above, the proportions of the household income required for water services (except in 1983 which is the crucial year) are considered within the limits of the ability-to-pay studies done in San Fernando, Pampanga where willingness-to-pay fees for improved services were found to be about 3.0 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 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 ₱18.75 and the subsequent consumption, ₱0.75/cum. Thus, the monthly rates for the following water consumption will be:

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

The estimated impact on the average income household (assumed to have a monthly 1976 income of ₱660) and the below average income household (assumed to have an adjusted monthly 1977 income of ₱300) is as follows:

---

*For ½-inch connection, domestic classification.

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

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

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

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

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

Usage (cum)	Cost/month (₱)
16	13.70
18	17.30
20	21.00
22	24.70
24	28.40
30	43.10
32	48.00
44	77.40

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

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

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

Revenue Forecast

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 forecast of financial statements of the FER-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 ₱9.837 million. The Phase I-A loan will cover the 5-year period 1979 inclusive and will amount to ₱20.469 million. The Phase I-B loan will cover the 5-year period 1986-90 inclusive and will be about ₱21.298 million.

The immediate improvement loan of ₱9.837 million consists of ₱8.461 million in escalated capital expenditures (see Table X-C-2) and ₱1.376 million capitalized interest. The Stage I loans of ₱20.469 million in 1978 and ₱21.298 million in 1986 include escalated capital expenditures (see Table X-C-2) less revenues from the service connection revolving fund (see Table X-F-3).

Projections of Financial Statements

Annex Table X-H-2 shows the net income (loss) on a yearly basis. Net losses are forecasted in 1978, 1979, 1987 and 1990. Net income cumulative would show positive values in twenty of the 23-year study period.

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

Cash Flow Statements

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

Annex Table X-H-3 presents the annual "Projected Sources and Applications of Funds." Potential net decreases are expected in 1978, 1993 and 1999. By 2000, positive net cumulative cash balance will be ₱18.793 million even if "cash at the beginning of 1978" has been assumed equal to zero.

Other Financial Statements

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

Rate of Return

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

Net asset salvage value of ₱4.235 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 FER-WD, the rate of return, with the assumptions made, is estimated to be 7.9 percent.

I. FINANCIAL RECOMMENDATIONS

1. The water district should establish a revolving fund to assist new customers in financing service connection charges.

2. The proposed water rates (for domestic consumers) to effect self-sufficiency are as follows:

Period	Water Rate ₱/RU
1978-1980	₱0.75
1981-1984	1.10
1985-1987	1.20
1988-1990	1.30
1991-1993*	1.50
1994-1996*	1.70
1997-2000*	1.90

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 FER-WD is financially feasible. Borrowing for that period would be ₱20.469 million.

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

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

ANNEX X-C

DEVELOPMENT COSTS

ANNEX TABLE X-C-1

PROJECT COST OF RECOMMENDED PROGRAM
SAN FERNANDO WATER DISTRICT
WITHOUT EGALIZATION
(P x 1,000)

Item		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Phases I-A and I-B															
Source Facilities	a) Equipment		30		221			221	43	213		212	212		1,152
	b) Wells		166		1,219			1,218	249	1,219		1,219	1,218		6,508
	c) Structure		16		121			120	24	116		115	115		627
Transmission and Distribution Facilities			229		673	673	673	673	802	383	383	382	382	382	5,635
Internal Network			126		372	372	372	372	451	236	235	235	235	235	3,241
Fire Hydrants			74		218	217	217	217	228	32	32	32	32	31	1,330
Service Connections	a) Meters		32		186	186	186	186	212	155	155	155	154	154	1,761
	b) Pipes		110		641	641	640	640	710	408	408	407	407	407	5,419
Storage Facilities									78	1,154					1,232
Laboratory Equipment									13	193					206
Immediate Improvements	a) Source Facilities 1. Equipment	269													269
	2. Wells	423													423
	3. Structure	128													128
	b) Transmission and Distribution Facilities	4,502													4,502
	c) Administration Building 1. Equipment	118													118
	2. Structure	459													459
	d) Laboratory, Plumbing Meter Repair 1. Equipment	275													275
	2. Structure	201													201
	e) Vehicles	139													139
	f) Miscellaneous	15													15
	g) Service Connection 1. Meters	441	111	111											663
	2. Pipes	378	291	291											960
Feasibility Studies 1/		83		273											356
Sub-total 2/		7,431	1,185	675	3,651	2,089	2,088	3,647	2,810	4,109	1,213	2,757	2,755	1,209	35,619
Land		102		68						101					271
Total Project Cost 3/		7,533		743						4,210					35,890

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

ANNEX TABLE X-C-2

PROJECT COST OF RECOMMENDED PROGRAM
SAN FERNANDO WATER DISTRICT
WITH ESCALATION
($ x 1,000)

Item			1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Escalation Factor		1.00	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	
Phases I-A and I-B																
Sources Facilities	a) Equipment			33		289			364	76	402		449	476		2,089
	b) Wells			183		1,593			2,006	443	2,299		2,583	2,736		11,843
	c) Structure			18		158			199	43	219		244	259		1,138
Transmission and Distribution Facilities				252		880	950	1,026	1,108	1,427	722	766	809	858	910	9,708
Internal Network				139		486	525	567	613	662	445	470	498	528	560	5,633
Fire Hydrants				81		285	306	331	357	406	60	64	68	72	74	2,104
Service Connections	a) Meters			35		243	263	284	306	377	292	310	328	346	367	3,151
	b) Pipes			121		838	905	976	1,054	1,263	769	816	865	914	969	9,487
Storage Facilities										139	2,176					2,315
Laboratory Equipment										23	364					387
Immediate Improvements	a) Source Facilities	1. Equipment	269													269
		2. Wells	433													433
		3. Structure	128													128
	b) Transmission and Distribution Facilities		4,502													4,502
	c) Administration Building	1. Equipment	118													118
		2. Structure	459													459
	d) Laboratory, Plumbing, Meter Repair	1. Equipment	275													275
		2. Structure	201													201
	e) Vehicles		139													139
	f) Miscellaneous		15													15
	g) Service Connections	1. Meters	441	122	134											697
		2. Pipes	378	320	352											1,050
Feasibility Studies			83		330											413
Sub-total			7,431	1,304	816	4,772	2,949	3,154	6,006	4,999	7,746	2,426	5,841	6,188	2,880	56,544
Land			102		82						190					374
Total Project Cost			7,533	1,304	898	4,772	2,949	3,154	6,006	4,999	7,938	2,426	5,841	6,188	2,880	56,918

ANNEX X-F

FUNDS FOR CAPITAL DEVELOPMENT

ANNEX TABLE X-F-1

ASSET AND DEPRECIABLE VALUE FORECAST
SAN FERNANDO WATER DISTRICT
(₱ x 1,000)

		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
I. ASSETS ADDED BY THE YEAR END																								
Source Facilities	a) Equipment		33		239			364	76	402		449	476											
	b) Wells		123		1593			2006	443	2239		2583	2736											
	c) Structure		18		153			198	43	219		244	253											
Transmission and Distribution Facilities			252		880	950	1026	1108	1427	722	766	809	858	910										
Internal Network			139		486	525	567	613	802	445	470	498	528	560										
Service Connections	a) Meters		35		243	263	284	306	377	292	310	328	346	367										
	b) Pipes		121		838	905	975	1054	1263	769	816	862	914	969										
Fire Hydrants			31		285	306	331	357	406	50	64	68	72	74										
Storage Facilities									139	2176														
Laboratory Equipment									23	364														
Immediate Improvements	a) Source Facilities																							
	1. Equipment	269																						
	2. Wells	123																						
	3. Structure	126																						
	b) Distribution Facilities	1502																						
	c) Administrative Facilities																							
	1. Equipment	118																						
	2. Structure	459																						
	d) Laboratory, Plumbing, Meter Repair																							
	1. Equipment	275																						
	2. Structure	201																						
	e) Vehicles	139																						
	f) Miscellaneous Items	15																						
	g) Service Connections																							
	1. Meters	441	122	134																				
	2. Pipes	378	320	352																				
Feasibility Studies		83		330																				
Replacements	a) Source Facilities-Equipment																763			746			889	
	b) Service Connection-Meters																1251	334	354	628	666	706	748	789
	c) Administrative Facilities-Equipment																335							
	d) Laboratory, Plumbing, Meter Repair-Equipment																780						539	
	e) Vehicles								238							358								
	f) Miscellaneous																43							
Total Assets Added by Year End		7431	1304	816	4772	2949	3184	6006	5237	7748	2426	5841	6188	2880		358	3172	334	354	1374	666	706	2176	789

ANNEX TABLE X-F-1 (Continued)

	1976	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
II. DEPRECIABLE VALUES																						
A. 50 Years Service Life																						
Existing Facilities	2223	2167	820	721	622	523	424	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325
Source Facilities-Structure	–	126	126	126	304	304	304	502	545	764	764	1008	1266	1266	1266	1266	1266	1266	1266	1266	1266	1266
Transmission and Distribution Facilities	–	4502	4754	4754	5634	6554	7610	8718	10145	10867	11633	12422	13300	14210	14210	14210	14210	14210	14210	14210	14210	14210
Internal Network	–	–	139	139	625	1150	1717	2330	3132	3577	4047	4545	5073	5633	5633	5633	5633	5633	5633	5633	5633	5633
Service Connection-Pipes	–	378	819	1171	2009	2914	3890	4944	6207	6976	7792	8654	9568	10507	10537	10537	10537	10537	10537	10537	10537	10537
Fire Hydrants	–	–	81	81	366	672	1003	1360	1766	1826	1890	1958	2030	2104	2104	2104	2104	2104	2104	2104	2104	2104
Storage Facilities	–	–	–	–	–	–	–	–	139	2315	2315	2315	2315	2315	2315	2315	2315	2315	2315	2315	2315	2315
Administration Building-Structure	–	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459
Laboratory, Plumbing, Meter Repair-Structure	–	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201
Total 50 Years Service Life	2223	7835	7419	7672	10220	12607	15608	18839	22919	27310	29426	31907	34537	37050	37050	37050	37050	37050	37050	37050	37050	37050
B. 30 Years Service Life																						
Feasibility Studies	–	83	83	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413
Total 30 Years Service Life	–	83	83	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413	413
C. 25 Years Service Life																						
Existing Facilities	2027	1591	756	756	756	756	326	326	326	326	326	326	326	326	326	326	326	326	326	326	326	–
Source Facilities-Wells	–	423	606	606	2199	2199	2199	4205	4648	6947	6947	9530	12266	12266	12266	12266	12266	12266	12266	12266	12266	12266
Total 25 Years Service Life	2027	2014	1362	1362	2955	2955	2525	4531	4974	7273	7273	9856	12592	12592	12592	12592	12592	12592	12592	12592	12592	12266
D. 15 Years Service Life																						
Existing Facilities	133	133	133	133	133	133	133	133	133	133	133	133	133	–	–	–	–	–	–	–	–	–
Source Facilities-Equipment	–	269	302	302	591	591	591	955	1031	1433	1433	1882	2358	2358	2358	2358	2852	2819	2819	3276	3276	3276
Service Connection-Meters	–	441	595	732	975	1238	1522	1828	2205	2497	2807	3135	3481	3548	3548	3548	4658	4835	5055	5443	5443	6269
Administrative Facilities-Equipment	–	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	317	335	335	335	335	335
Laboratory, Plumbing, Meter Repair-Equipment	–	275	275	275	275	275	275	275	298	662	662	662	662	662	662	662	1167	1167	1167	1167	1167	1167
Miscellaneous Items	–	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	43	43	43	43	43	43
Total 15 Years Service Life	133	1251	1441	1575	2107	2370	2654	3324	3500	4858	5168	5945	6767	7001	7001	7001	9055	9195	9419	10261	10662	11066
E. 7 Years Service Life																						
Vehicles	–	139	139	139	139	139	139	139	238	238	238	238	238	238	238	358	358	358	358	358	358	358
Total 7 Years Service Life	–	139	139	139	139	139	139	139	238	238	238	238	238	238	238	358	358	358	358	358	358	358
TOTAL DEPRECIABLE VALUE	4383	11322	10444	11161	15834	16684	21339	27246	32344	40092	42518	48359	54547	57294	57414	59466	59612	59832	60672	61077	61499	[illegible]
BOOK VALUE OF ASSETS OTHER THAN LAND	11514	12626	11260	15933	18783	21868	27345	32453	40092	42518	48359	54547	57427	57294	57652	60586	59802	59966	61206	61340	61783	63675
LAND	102	102	184	184	184	184	184	184	374	374	374	374	374	374	374	374	374	374	374	374	374	374
TOTAL BOOK VALUE OF ALL CAPITAL ASSETS	11916	12728	11444	16117	18967	22052	27529	32667	40466	42892	48733	54921	57801	57668	58026	60960	60176	60340	61580	61714	62157	64049

ANNEX TABLE X-F-2

SCHEDULE OF DEPRECIATION EXPENSES
SAN FERNANDO WATER DISTRICT
(₱ x 1,000)

Year	50 Yr	30 Yr	25 Yr	15 Yr	7 Yr	Total Annual Depreciation Expenses	Accumulated Depreciation Prior Year	Book Value of Assets Retired During the Year					Net Accumulated Depreciation Year End
								50 Yr	23 Yr	15 Yr	7 Yr	Total	
1978	44		31	9	-	134	3,197						3,331
1979	157	3	81	83	20	344	3,331	56	436			492	3,183
1980	148	3	54	96	20	321	3,183	1,347	835			2,182	1,322
1981	153	14	54	105	20	346	1,322	99				99	1,569
1982	204	14	118	140	20	496	1,569	99				99	1,966
1983	256	14	118	158	20	566	1,966	99				99	2,433
1984	312	14	101	177	20	624	2,433	99	430			529	2,528
1985	377	14	181	222	20	814	2,528	99				99	3,243
1986	458	14	199	253	34	958	3,243				139	139	4,062
1987	546	14	291	324	34	1,209	4,062						5,271
1988	589	14	291	345	34	1,273	5,271						6,544
1989	638	14	394	396	34	1,476	6,544						8,020
1990	691	14	504	451	34	1,694	8,020						9,714
1991	741	14	504	467	34	1,760	9,714			133		133	11,341
1992	741	14	504	467	34	1,760	11,341						13,101
1993	741	14	504	467	51	1,777	13,101				238	238	14,640
1994	741	14	504	604	51	1,914	14,640			1,118		1,118	15,436
1995	741	14	504	613	51	1,923	15,436			190		190	17,169
1996	741	14	504	628	51	1,938	17,169			134		134	18,973
1997	741	14	504	684	51	1,994	18,973			532		532	20,435
1998	741	14	504	711	51	2,021	20,435			263		263	22,193
1999	741	14	504	739	51	2,049	22,193			284		284	23,958
2000	741	14	491	804	77	2,127	23,958		326	670	358	1,354	24,731

ANNEX TABLE X-F-3

WORKING CAPITAL REQUIREMENTS
FOR REVOLVING FUND FOR NEW CONNECTIONS
SAN FERNANDO WATER DISTRICT

Year	Number of New Connections	Number of Installment Plan Added	Number of Installment Plan Paid	Total Paying Monthly Installment (Cumulative)	Monthly Installment Plan (Escalated)	₱ x 1,000 Increment Added[2]	Increment Deducted[2]	Cash Receipts: Lump Sum Payments[5] (Escalated)	Cash Receipts: Installment Payments (Cumulative)	Cash Receipts: Total Payments	Annual Construction Cost[4]	Working Capital Required	Cumulative Capital Requirements
1979	417	250		250	6.83	20		106	10	116	264	148	148
1980	417	250		500	7.51	23		116	32	148	290	142	290
1981	416	250		750	8.26	25		128	56	184	319	135	425
1982	724	434		1,184	8.92	46		240	91	331	596	265	691
1983	724	434		1,618	9.63	50		259	139	398	647	249	942
1984	724	434		2,052	10.40	54		280	191	471	699	228	1,170
1985	724	434		2,486	11.23	58		302	247	549	755	206	1,376
1986	724	434		2,920	12.13	63		326	308	634	815	181	1,557
1987	603	362		3,282	12.56	56		286	367	653	720	65	1,622
1988	603	362		3,644	13.63	59		305	425	730	763	33	1,655
1989	603	362	125	3,881	14.45	63	10	324	476	800	809	(9)	1,664
1990	603	362	250	3,993	15.31	67	22	343	519	862	857	(5)	1,659
1991	603	362	250	4,105	16.23	71	24	364	564	928	909	(19)	1,640
1992			342	3,763	17.20		36		563	563		(563)	1,077
1993			434	3,329	18.23		48		515	515		(515)	562
1994			434	2,859	19.32		52		463	463		(463)	99
1995			434	2,461	20.48		56		407	407		(407)	(308)
1996			434	2,027	21.71		61		346	346		(346)	(654)
1997			398	1,629	23.01		60		286	286		(286)	(940)
1998			362	1,267	24.39		58		228	228		(228)	(1,168)
1999			362	905	25.85		61		167	167		(167)	(1,335)
2000			362	543	27.40		65		102	102		(102)	(1,437)
				181	29.04		69		33	33		(33)	(1,470)

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

ANNEX TABLE X-F-4a

STRATIFICATION OF SERVICE CONNECTIONS
SAN FERNANDO WATER DISTRICT

Year	Domestic/Government 1/2"	3/4"	1"	Sub-Total	Commercial/Industrial 1/2"	3/4"	1"	Sub-Total	Total
1978	1,134	75	37	1,246	241	83	92	416	1,662
1980	1,703	112	56	1,871	362	125	137	624	2,495
1985	4,173	275	138	4,586	887	306	336	1,529	6,115
1990	6,231	410	206	6,847	1,325	457	501	2,283	9,130

ANNEX TABLE X-F-4b

REVENUE UNIT FORECAST[8/]
SAN FERNANDO WATER DISTRICT

Year	Domestic/Government 1/2" (2.5)	3/4" (4.0)	1" (8.0)	Sub-Total	Commercial/Industrial 1/2" (5.0)	3/4" (8.0)	1" (16.0)	Sub-Total	Grand Total[9/]	Minimum Charge (RUs)[10/]	Estimated Consumption (cum/yr) Domestic	Commercial	Commodity Charge (RUs) Domestic[11/]	Commercial[12/]	Total Revenue Units
1978	2,835	300	296	3,431	1,205	564	1,472	3,341	6,772	812,640	236,520	70,080	87,000	40,380	939,960
1980	4,258	448	448	5,154	1,810	1,000	2,192	5,002	10,156	1,218,720	744,600	111,690	520,080	73,620	1,812,420
1985	10,432	1,100	1,104	12,636	4,435	2,448	5,376	12,259	24,895	2,987,400	1,423,500	222,285	873,180	77,610	3,938,190
1990	15,578	1,640	1,648	18,866	6,625	3,656	8,016	18,297	37,163	4,459,560	2,701,000	452,605	1,879,360	369,690	6,708,610

8/ Computation of revenue units based on LWUA Guidelines on structuring water rates.
9/ Grand total of number of connections multiplied by their respective conversion factors for computing revenue units (RUs).
10/ Multiply grand total by 120 (derived from 10 cum/month, the minimum amount covered by the minimum charge 12 months per year) in RUs.
11/ Domestic consumption - (120 x number of domestic connections) x use factor. Use factor for domestic/institutional classification is 1.
12/ Commercial consumption - (120 x number of commercial connections) x use factor. Use factor for commercial classification is 2.

ANNEX X-G

ANALYSIS OF WATER RATES

ANNEX TABLE X-G-1

REVENUE FORECASTS
SAN FERNANDO WATER DISTRICT

Year	Rate/RU ₱	Estimated Number of R.U.s (Yearly in 000s)	Income from Sales	(Bad Debt)	Other Income[13]	Total Net Income
1978	0.75	940	705	14	14	705
1979	0.75	1,376	1,032	10	21	1,043
1980	0.75	1,812	1,359	14	27	1,372
1981	1.10	2,237	2,461	49	49	2,461
1982	1.10	2,662	2,928	29	59	2,958
1983	1.10	3,088	3,397	34	68	3,431
1984	1.10	3,513	3,864	39	77	3,902
1985	1.20	3,938	4,726	95	95	4,726
1986	1.20	4,492	5,390	54	108	5,444
1987	1.20	5,046	6,055	61	121	6,115
1988	1.30	5,601	7,281	146	146	7,281
1989	1.30	6,155	8,002	80	160	8,082
1990	1.30	6,709	8,722	87	174	8,809
1991	1.50		10,064	201	201	10,064
1992	1.50		10,064	101	201	10,164
1993	1.50		10,064	101	201	10,164
1994	1.70		11,405	228	228	11,405
1995	1.70		11,405	114	228	11,519
1996	1.70		11,405	114	228	11,519
1997	1.90		12,747	255	255	12,747
1998	1.90		12,747	127	255	12,875
1999	1.90		12,747	127	255	12,875
2000	1.90	6,709	12,747	127	255	12,875

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

ANNEX X-H

FINANCIAL SUMMARY

ANNEX TABLE X-H-1

DEBT SERVICE SCHEDULE OF TOTAL PROJECT LOAN
SAN FERNANDO WATER DISTRICT
(₱ x 1,000)

Year	Outstanding Loan End of Year			Capital Repayments			Interest Payments			Total Debt Service
	Immediate Improvement	Phases 1-A and 1-B	Total	Immediate Improvement	Phases 1-A and 1-B	Total	Immediate Improvement	Phases 1-A and 1-B	Total	
1978	7,695	-	7,695	-			177	-	177	177
1979	8,488	714	9,202	-			361	-	361	361
1980	9,381	942	10,323	-			379	64	443	443
1981	9,837	5,383	15,220	-			388	85	473	473
1982	9,765	7,934	17,699	72		72	885	484	1,369	1,441
1983	9,687	10,647	20,334	78		78	879	714	1,593	1,671
1984	9,602	16,104	25,706	85		85	872	958	1,830	1,915
1985	9,509	20,469	29,978	93		93	864	1,449	2,313	2,406
1986	9,408	27,598	37,006	101	154	255	856	1,996	2,852	3,107
1987	9,298	29,140	38,438	110	154	264	847	2,638	3,485	3,749
1988	9,178	34,027	43,205	120	154	274	837	2,777	3,614	3,888
1989	9,047	39,123	48,170	131	230	361	826	3,292	4,118	4,479
1990	8,904	40,845	49,749	143	230	373	814	3,751	4,565	4,938
1991	8,748	40,455	49,203	156	390	546	801	4,066	4,867	5,413
1992	8,578	39,911	48,489	170	544	714	787	4,185	4,972	5,686
1993	8,393	39,367	47,760	185	544	729	772	4,136	4,908	5,637
1994	8,191	38,590	46,781	202	777	979	755	4,320	5,075	6,054
1995	7,971	37,813	45,784	220	777	997	737	4,250	4,987	5,984
1996	7,731	36,884	44,615	240	929	1,169	717	4,332	5,049	6,218
1997	7,470	35,794	43,264	261	1,090	1,351	696	4,410	5,106	6,451
1998	7,185	34,704	41,889	285	1,090	1,375	672	4,311	4,983	6,358
1999	6,875	33,454	40,329	310	1,250	1,560	647	4,373	5,020	6,580
2000	6,537	32,049	38,586	338	1,405	1,743	619	4,416	5,035	6,778

ANNEX TABLE X-H-2

PROJECTED INCOME STATEMENT
SAN FERNANDO WATER DISTRICT

	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 (',000 cum)	176	876	1427	1427	1427	1427	1427	2502	2502	2502	2502	2502	4388	4388	4388	4388	4388	4388	4388	4388	4388	4388	4388
Water Sales per Year ,000 cum)	307	307	796	856	856	856	856	1646	1646	1646	1646	1646	3160	3160	3160	3160	3160	3160	3160	3160	3160	3160	3160
Unaccounted-for-water (%)	65	65	40	40	40	40	40	34	34	34	34	34	34	28	28	28	28	28	28	28	28	28	28
Connections	1662	1662	2495	2495	2495	2495	2495	6115	6115	6115	6115	6115	9130	9130	9130	9130	9130	9130	9130	9130	9130	9130	9130
Consumption (lpcd)	61	61	120	120	120	120	120	128	128	128	128	128	135	135	135	135	135	135	135	135	135	135	135
OPERATING REVENUE																							
Water Sales	705	1032	1359	2461	2928	3397	3364	4726	5390	6055	7281	8002	8722	10064	10064	10064	11405	11405	11405	12747	12747	12747	12747
Less: Uncollectibles	14	10	14	49	29	34	39	95	54	61	146	80	87	201	101	101	228	114	114	255	127	127	127
Other Revenue	14	21	27	49	59	68	77	95	108	121	141	160	179	201	201	201	228	228	228	255	255	255	255
Total Revenue	705	1043	1372	2461	2958	3431	3902	4726	5444	6115	7281	8082	8809	10064	10164	10164	11405	11519	11519	12747	12875	12875	12875
OPERATING EXPENSES																							
Administration and Personnel	115	183	211	376	406	441	477	522	564	690	754	825	905	976	1055	1138	1231	1328	1436	1551	1673	1806	1953
Power and Fuel	264	336	205	246	294	353	425	508	614	740	888	1067	1288	1390	1502	1520	1753	1891	2044	2006	2381	2570	2780
Chemicals	8	10	37	45	53	65	76	92	111	132	160	191	229	248	268	268	312	337	364	393	424	458	495
Maintenance	64	106	80	86	92	100	108	130	141	152	164	177	408	441	476	514	556	599	648	700	755	815	881
Miscellaneous	11	13	15	19	22	26	32	36	44	52	63	72	88	95	103	111	120	130	140	151	163	176	190
Depreciation	134	344	321	348	496	566	624	814	958	1209	1273	1476	1694	1760	1760	1777	1914	1923	1938	1956	2021	2029	2127
Total Operating Expenses	599	992	869	1120	1365	1551	1742	2102	2432	2975	3302	3808	4612	4910	5164	5448	5886	6208	6570	6937	7417	7874	8446
Operating Income	106	51	503	1341	1593	1880	2160	2624	3012	3140	3979	4274	4197	5154	5000	4716	5519	5311	4949	5750	5458	5001	4429
Plus: Interest on Reserves	1	5	10	18	29	42	57	75	96	120	148	180	215	276	361	446	536	632	760	929	1108	1386	1685
Net Income Before Interest	107	56	513	1359	1622	1922	2217	2699	3108	3260	4127	4454	4412	5430	5361	5162	6055	5943	5709	6679	6566	6387	5914
Interest on Debt	177	361	443	473	1369	1593	1830	2313	2852	3485	3614	4118	4565	4867	4872	4908	5075	4987	5049	5106	4958	5020	5035
Net Income (Loss)	(70)	(305)	70	886	253	329	387	386	256	(225)	513	336	(153)	563	389	254	980	956	660	1573	1563	1367	879
Cumulative Net Income (Loss)	(70)	(375)	(305)	581	834	1163	1550	1936	2192	1967	2480	2816	2663	3221	3610	3864	4844	5800	6465	8038	9601	10968	11847
Appropriation to Reserves	21	31	41	74	85	102	117	142	162	182	218	240	262	604	604	604	684	684	1140	1275	1275	1275	1275
Average Net Fixed Assets in Operation	4967	9403	10620	13622	17290	19825	23825	25728	34429	38528	41420	46060	69009	48722	47141	47138	47045	45471	44404	43458	42137	41543	40937
Rate of Return (%)	2.13	0.54	4.74	9.84	9.21	9.40	9.07	9.13	8.75	8.15	9.61	9.25	8.56	10.58	10.61	10.00	11.73	11.65	11.15	13.23	12.95	12.04	10.87

ANNEX TABLE X-H-3

PROJECTED SOURCES AND APPLICATIONS OF FUNDS
SAN FERNANDO WATER DISTRICT

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SOURCES OF FUNDS																							
Net Income Before Interest	107	50	513	1359	1622	1922	2217	2699	3108	3260	4127	4454	4412	5430	5361	5162	6055	5343	5709	6679	6666	6287	5914
Add: Depreciation	134	344	321	346	456	546	624	814	958	1209	1273	1416	1694	1760	1760	1777	1916	1923	1938	1994	2031	2049	2127
Total Internal Cash Generation	241	400	834	1705	2118	2468	2841	3513	4066	4469	5400	5930	6106	7190	7121	6939	7969	7266	7647	8673	8697	8336	8041
Long-Term Borrowing	7695	1507	1121	4897	2551	2713	5457	4365	7283	1696	5041	5326	1952										
Capital Contributions	116	148	184	331	395	471	549	634	655	730	800	862	928	563	515	463	407	346	286	228	167	102	33
Total External Cash Generation	7811	1655	1305	5228	2949	3184	6006	4999	7938	2426	5841	6188	2880	563	515	463	407	346	286	228	167	102	33
Total Sources of Funds	8052	2055	2139	6933	5067	5672	6847	8512	12004	6895	11241	12118	8986	7753	7636	7402	8376	8212	7933	8901	8754	8438	8074
APPLICATIONS OF FUNDS																							
Capital Expenditures	7533	1304	895	4772	2949	3184	6006	4999	7935	2426	5841	6185	2880										
Capitalized Interest	162	351	477	456																			
Debt Service: Interest	177	361	443	473	1369	1593	1830	2313	2852	3455	3614	4118	4565	4867	4972	4908	5075	4987	5049	5106	4983	5020	5033
Principal	–	–	–	–	72	78	85	93	255	264	274	361	373	546	714	729	979	997	1169	1351	1575	1560	1743
Sub-total (Debt Service)	177	361	443	473	1441	1671	1915	2406	3107	3749	3888	4479	4938	5413	5686	5637	6054	5984	6218	6457	6558	6580	6776
Replacements								235							355	3178	334	354	1374	662	704	2176	711
Increase in Working Capital	370	(73)	182	429	139	131	129	215	17	144	271	181	120	(172	(11	379	(65	(9	43	262	71	45	(5
Total Applications of Funds	8242	1944	1670	6130	4529	4986	8050	7855	11062	6319	10000	10845	7938	5241	6033	9188	6343	6329	7634	7385	7334	8710	7482
Internal (Deficit) in Cash Balance	(190)	111	469	603	538	686	797	654	943	576	1241	1270	1041	2512	1603	(1766	2035	1883	993	1516	[illegible]	1871	81
Cash Balance Beginning of Year	–	(190)	(79)	190	993	1531	2217	3014	3668	4610	5186	6427	7697	8745	11257	12860	11074	13107	14990	15983	[illegible]	17499	17580
Cash Balance End of Year	(190)	(79)	190	993	1531	2217	3014	3668	4610	5186	6427	7697	8745	11257	12860	11074	13107	14990	15983	17499	[illegible]	17580	17661
Debt-Service Ratio (Times)	1.36	1.44	1.81	3.60	1.47	1.49	1.45	1.46	1.31	1.19	1.39	1.34	1.24	1.33	1.25	1.23	1.32	1.31	1.26	1.34	1.35	1.27	1.[illegible]
Ratio of Internally Generated Cash Less Debt Service to Capital Expenditure	0.03	0.36	29.96	23.57	22.96	25.66	15.42	20.14	12.05	27.49	25.89	23.45	40.56										

ANNEX TABLE X-H-4

PROJECTED BALANCE SHEET
SAN FERNANDO WATER DISTRICT

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ASSETS																							
Fixed Assets:																							
Gross Value of Fixed Assets	12078	13241	13364	17493	20342	23426	26905	34043	41842	44268	50109	56297	59177	59044	59402	62336	61552	61716	63956	63090	63533	65425	64[illegible]
Less: Accumulated Depreciation	3331	3183	1383	1569	1966	2433	2526	3243	4062	5271	6545	8020	9714	11341	13101	14[illegible]	16436	17169	18973	20035	21[illegible]	23[illegible]	24[illegible]
Net Value of Fixed Assets	8747	10058	11[illegible]	15924	18377	20995	26377	30800	37780	38997	43567	48277	49463	47703	46301	47696	46116	44547	43983	42055	41[illegible]	41267	40[illegible]
Work in Process																							
Total Fixed Assets																							
Current Assets:																							
Cash	(190)	(79)	190	993	1531	2217	3014	3668	4610	5186	6427	7697	8745	11257	12860	11074	13107	14990	15289	16805	18505	18233	18793
Accounts Receivable	176	258	340	615	732	849	966	1182	1348	1514	1820	2001	2181	2516	2516	2516	2851	2851	2851	3187	3187	3187	3187
Provision for Bad Debt	4	3	3	12	7	8	10	24	13	15	36	20	22	50	25	25	57	29	29	64	32	32	32
Inventories	276	151	174	375	405	442	478	520	391	419	449	484	521	83	89	513	215	230	230	353	376	406	438
Total Current Assets	258	327	701	1971	2664	3500	4448	5346	6336	7104	8660	10162	11427	13806	15440	14078	16116	18042	18441	20281	22036	21790	22376
Total Assets	9005	10385	11743	17895	21041	24495	30825	36146	44116	46101	52225	58439	60890	61509	61741	61774	62232	62589	62424	62939	63376	63257	62509
EQUITY AND LIABILITIES																							
Current Liabilities:																							
Accounts Payable	78	105	91	129	145	164	186	215	246	294	338	389	486	525	567	612	662	714	772	834	899	971	1050
Current Maturities on Long-Term Debt	–	–	–	72	78	85	93	255	264	274	361	373	546	714	729	979	997	1169	1351	1375	1560	1743	1932
Total Current Liabilities	78	105	91	201	223	249	279	470	510	568	699	762	1032	1239	1296	1591	1659	1883	2123	2209	2459	2714	2982
Long-Term Debt (Less Current Maturities)	7695	9202	10323	15148	17621	20249	25613	29723	36742	38164	42844	47797	49203	48459	47760	46781	45784	44615	43264	41859	40329	38586	36652
Equity:																							
Government Contribution	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186	1186
Capital Contribution	116	264	448	779	1177	1648	2197	2831	3486	4216	5016	5878	6806	7369	7884	8347	8754	9100	9386	9612	9781	9863	9916
Reserves	21	52	93	167	255	357	474	616	778	960	1178	1418	1680	2284	2888	3492	4176	4660	6000	7275	8550	9825	11100
Unappropriated Retained Earnings	(91)	(427)	(328)	412	579	806	1076	1320	1414	1007	1302	1395	983	342	727	377	673	845	465	563	1271	1063	657
Total Equity	1232	1075	1399	2546	3197	3997	4933	5953	6864	7369	8682	9850	10655	11781	12685	13402	14789	16091	17037	18835	20588	21597	22869
Total Equity and Liabilities	9005	10385	11743	17895	21041	24495	30825	36146	44116	46101	52225	58439	60890	61509	61741	61774	62232	62589	62424	62939	63376	63257	62509

ANNEX TABLE X-H-5

RATE OF RETURN ON TOTAL INVESTMENT
(DISCOUNTED CASH FLOW METHOD)
SAN FERNANDO WATER DISTRICT
(₱ x 1,000)

Year	Debt Service	Net Increase in Cash	Total Cash Inflow	Investments	Net Cash Inflow	1st Trial Present Factor	1st Trial Value: 8% Value	2nd Trial Present Factor	2nd Trial Value: 6% Value
1978	177	(190)	(13)	7,695	(7,708)	1.000	(7,708)	1.000	(7,708)
1979	361	111	472	1,655	(1,183)	.926	(1,095)	.943	(1,116)
1980	443	269	712	1,305	(593)	.857	(508)	.890	(528)
1981	473	803	1,276	5,228	(3,952)	.794	(3,138)	.840	(3,120)
1982	1,441	538	1,972	2,949	(970)	.735	(713)	.792	(758)
1983	1,671	686	2,357	3,184	(827)	.681	(563)	.747	(618)
1984	1,915	797	2,712	6,006	(3,294)	.630	(2,075)	.705	(2,322)
1985	2,406	654	3,060	5,237	(2,177)	.583	(1,269)	.665	(1,448)
1986	3,107	942	4,049	7,938	(3,889)	.540	(2,100)	.627	(2,438)
1987	3,749	576	4,325	2,426	1,899	.500	950	.592	1,124
1988	3,888	1,247	5,135	5,841	(706)	.463	(327)	.558	(394)
1989	4,479	1,270	5,749	6,188	(439)	.429	(188)	.527	(231)
1990	4,938	1,048	5,986	2,880	3,106	.397	1,233	.497	1,544
1991	5,413	2,512	7,925	-	7,925	.368	2,916	.469	3,717
1992	5,686	1,603	7,289	358	6,931	.340	2,357	.442	3,064
1993	5,637	(1,786)	3,851	3,172	679	.315	214	.417	283
1994	6,054	2,033	8,087	334	7,753	.292	2,264	.394	3,055
1995	5,984	1,883	7,867	354	7,513	.270	2,029	.371	2,787
1996	6,218	299	6,517	1,374	5,143	.250	1,286	.350	1,800
1997	6,457	1,516	7,973	666	7,307	.232	1,695	.331	2,419
1998	6,358	1,700	8,058	706	7,352	.215	1,581	.312	2,294
1999	6,580	(272)	6,308	2,176	4,132	.199	822	.294	1,215
2000	6,778	560	7,338	789	10,625 14/	.184	1,955	.278	2,954
							-382		+5,565

RATE OF RETURN = 7.9%

14/ Includes net asset value of ₱4,026

Total Assets	₱ 62,505
Total Liabilities	(39,636)
Cash	(18,793)
Net Asset Value	₱ 4,076

CHAPTER XI ECONOMIC FEASIBILITY ANALYSIS

A. WATER AND THE ECONOMY

Introduction

Water is a basic requirement in any country's economic development and no economic activity can take place without it. However, this basic function diminishes in relative importance as a higher level of economic development is attained by a country. In most instances, the availability of water alone will not spur economic growth for there are other significant factors that influence development, such as peace and order, political stability, rate of taxation and availability of infrastructure facilities. Hence, a water supply project must be considered as only one part of a regional development program. It must be viewed within the context of the overall government program.

Considering that the Philippine is still a developing country, water supply plays a fairly important role in the national or regional economy. Traditionally, water has been made available to the consuming public at very nominal rates. There is a tendency for the consumers to use water wastefully. As a consequence, the regard given to it is far below its true importance.

To the water consumer, the value of water is measured by its contribution to the satisfaction of the family group which uses the water. His perspective includes himself and his household and all the health, well-being and productivity aspects of family life. To the businessman, water is valued for all it does to improve business. From the national viewpoint, the benefits to the water user, both householder and businessman, are only a part of the total.

Major Uses of Water Supply

Domestic. Water for domestic use is usually given top priority because water is essential to life and, up to a point, essential to general well-being. Estimation of the beneficial value of water for domestic purposes is best viewed in terms of average willingness to pay for water rather than do without it. It will be noted that the willingness-to-pay is higher than the price charged insofar as most users are concerned.

Industrial Use. Water is used by industry primarily as a factor of production. In some instances, it goes into the production process as an input. This is the case for the soft drinks industry. One method of determining the value of water to industry is to analyze the

cost of alternative industrial processes which produce the same product but use less water. This is not, however, always possible and may be unduly laborious.

Other Uses. Crop irrigation is one of the major uses of water. The value of water used for irrigation purposes can be estimated by an elaborate calculation of "with" and "without" project conditions. All other costs are assumed to be paid and water becomes the residual claimant under "with" and "without" project conditions. Detailed analysis of the area to be irrigated is required.

Another important use is hydropower generation. Water used for this purpose may be valued by comparison with the lowest-cost alternative of providing electric power. Lastly, bodies of water serve a basic role in many recreational activities. Ordinarily, water quality is not adversely affected by recreational use. Water value in this case depends on a number of factors such as accessibility, setting, beauty and quality.

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

B. METHODOLOGY

Recommended and Next-Best System

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

Benefit-Cost Ratio

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

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

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

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

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

Internal Rate of Return

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

Method(s) Adopted

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

Calculation of Benefit and Cost Streams

The economic studies cover only Stage I of the proposed water supply program, which extends from 1978 to 1990. Benefits, however, were projected up to 2000. 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 replacements costs and the operation and maintenance costs which were projected up to 2000. This is due to the fact that proper maintenance of the facilities will have to be undertaken regularly for as long as benefits are desired to be realized from the system.

Estimates of benefits and costs were based on 1978 prices. In recognition of inflationary pressures, all benefits were escalated by 10 percent from 1978 to 1980, by 8 percent from 1981 to 1985 and by 6 percent from 1986 to 1990. All project costs were also escalated in the same manner, with the exception of operation and maintenance costs which were escalated uniformly by 8 percent all throughout the study period. In both cases, however, the escalation factor for 1990 was held constant up to 2000. This is because only Stage I of the proposed project is being considered in the economic analysis; hence, only partial inflation has been adopted.

C. QUANTIFIABLE BENEFITS

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

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

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

Increase in Land Values

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

The portion of land values attributable to the provision of an improved public water supply system was estimated in the household survey in Lipa City (May 1975) to be about 22.6 percent of the

market value of a piece of land. It is reasonable to assume that this figure represents the incremental value of a piece of land, given access to water supply. In a specific instance, a residential lot about 400 sqm has the following market values:

Without Water	400 sqm x ₱50	= ₱20,000
With Water	400 sqm x ₱65	= ₱26,000
	Ratio	= 1.3 or 30% increase

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

On the basis of this information, it may be conservative to assume that 10 percent of the value of land served by the water distribution system could be attributed to the water supply project.

Assumptions made for this analysis are explained in Annex XI-C. Annex Table XI-C-1 shows the computations of this benefit, which amounts to a present worth of ₱28.55 million.

Health Benefits

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

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

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

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

Calculation for the health benefits and associated assumptions used are presented in Annex XI-C. Annex Table XI-C-2 shows the health benefits on a yearly basis, with a total present worth of ₱777,505.

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 ₱7.60 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 ₱21.50 million.

D. NON-QUANTIFIABLE BENEFITS

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

The proposed water supply project will set off a chain of events beyond its construction period. Those activities include among others the inducement to industry to establish plants in the service area due

to availability of a dependable water supply. Without such supply, new industrial and commercial establishments would be forced to develop their own supply system or relocate elsewhere. The overall cost of providing separate water systems is normally large and represents a deterrent to invest in the area and consequently to industrial development.

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

E. ECONOMIC COSTS

General

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

Project Costs

Project costs include the construction cost of the proposed facilities such as pipes, meters and equipment, as well as,, engineering services and contingencies, 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. From the balance of the domestic cost, 5 percent was assumed to be in the form of hidden taxes.

Adjustment of Project Costs

In the determination of the project costs, adjustments were made for those items which are not properly valued by the price mechanism. A price other than the market price (called the shadow price) was imputed to these items. In this way, most of the effects of price discrepancies which could be identified, whether primary or secondary, were incorporated directly into the project analysis and imputed as direct costs to project investment. The 'shadow prices' used in this analysis are those employed by international lending institutions and the Infrastructure Computer Center of the Department of Public Works, Transportation and Communication.

One of the items where 'shadow pricing' was applied is the price of unskilled labor (otherwise known as common labor). In a perfectly competitive market, the price of labor is determined by the marginal value of its product. In this case, therefore, the price of labor is equal to the value of the output which an extra laborer hired would produce. However, this is not applicable in an economy such as that of the Philippines where there is a surplus of labor. Since there is widespread disguised unemployment in such an economy, unskilled labor is normally valued below the actual wage rate likely to be paid. In this study, the opportunity cost of unskilled labor or its potential in other employment was valued at one half of its estimated cost in the project. The net effect is to reduce the cost of unskilled labor by 50 percent, thereby reducing the summation of project 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 or better wage.

Adjustments were also made with respect to cost of project facilities which use up the limited foreign exchange reserves. Foreign exchange used to import project components was valued at 1.2 times their actual peso cost. This effectively increased foreign exchange cost by 20 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. The present value (see Table XI-E-4) of total economic project cost for FER-WD amounts to ₱31.06 million.

Replacement Costs

Based on the criteria used in the financial studies, vehicles have a life expectancy of 7 years while meters are expected to be replaced every 15 years. Other items which have a service life of 15 years are the equipment of the laboratory and source facilities as well as those of the source and administrative facilities, laboratory, plumbing and meter repair and miscellaneous items of the immediate improvement program. Wells are expected to last for 25 years while feasibility studies are assumed to be good for 30 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 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 replacement costs (see Table XI-E-4) for FER-WD amounts to ₱1.078 million.

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 FER-WD, the present worth of the salvage value (see Table XI-E-4) is ₱1.31 million.

Operating and Maintenance Cost

Operating and maintenance costs refer to the costs associated with the maintenance, operation and management of the project. Otherwise known as annual costs, they include personnel, power, chemicals, and other miscellaneous maintenance expenses such as fuel and lubrication, repairs, 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 amounts to ₱7.73 million.

Calculation for Economic Costs

The economic cost may be expressed as the adjusted (shadow priced) project cost plus replacement cost plus operating/maintenance cost less salvage value. Annex Table XI-E-4 shows the computation of total economic costs for FER-WD, amounting to ₱38.6 million.

F. BENEFIT-COST ANALYSIS

The summary of the quantifiable economic benefits and economic costs for FER-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 million pesos)

Benefits		Costs	
Increase in Land Values	₱ 28.552	Project Cost	₱ 31.057
Health	.778	(+)	
Reduction in Fire Damage	7.596	Replacement Cost	1.078
Beneficial Value	21.495	(+)	
	₱ 58.421	Operating and Maintenance Cost	7.731
		Sub-total	₱ 39.866
		(-)	
		Salvage Value	1.313
			₱ 38.553

Benefit Cost Ratio - 1.52:1

The preceding table shows that the quantifiable benefits exceed the economic costs associated with the improvement of the water supply system in FER-WD. Under the principle of benefit-cost ratio, the project is, therefore, considered economically feasible.

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

G. INTERNAL ECONOMIC RATE OF RETURN

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

For FER-WD, the IERR is 42.72 percent as shown in Annex Table XI-G-1. On the basis of the above stated principle of IERR, the proposed project appears to be economically feasible and justified.

ANNEX XI-C

QUANTIFIABLE BENEFITS

ANNEX XI-C

QUANTIFIABLE BENEFITS

Portion of Land Values Attributable to Water Supply Project

Annex Table XI-C-1 shows the present value of the portion of land values attributable to the proposed water supply project, based on the following assumptions:

1. In accordance with the staging program of the construction of facilities, the 1980 service area of 351 hectares was projected to increase in the following manner: by 31 hectares from 1980 to 1981; by 34 hectares from 1981 to 1982; by 37 hectares from 1982 to 1983; by 40 hectares from 1983 to 1984; by 44 hectares from 1984 to 1985; by 47 hectares from 1985 to 1986; by 52 hectares from 1986 to 1987; by 57 hectares from 1987 to 1988; by 61 hectares from 1988 to 1989; and by 67 hectares from 1989 to 1990.

2. Land use was assumed to be 87 percent residential and 13 percent commercial/institutional/industrial throughout the projection period. This classification was based on the water demand projections in 1980 by consumer category, as shown in Chapter VI.

3. The 1977 costs of land based on estimated market values in San Fernando are:

Residential	:	₱ 40 per sqm
Industrial/Commercial/Institutional	:	₱ 50 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 10 percent of the cost of land. This land value benefit was escalated by 8 percent from 1980 to 1985, and by 6 percent from 1985 to 1990.

ANNEX TABLE XI-C-1

PORTION OF LAND VALUES ATTRIBUTABLE TO RECOMMENDED PROJECT
SAN FERNANDO WATER DISTRICT

Year	Land Use (sqm)		Cost of Land (₱ x 1,000)		Total Cost of Land (₱ x 1000)	10 Percent Benefit Due to Project (₱ x 1000)	Escalation Factor	Escalated Benefit (₱ x 1000)	Discount Factor at 12 %	Present Value of Benefits (₱ x 1000)
	Residential	Commercial/ Institutional/ Industrial	Residential	Commercial/ Institutional/ Industrial						
1980	3,053,700	456,300	₱122,148.0	₱22,815.0	₱144,963.0	₱14,496.3	1.210	₱17,540.5	.797	₱13,979.[illegible]
1981	269,700	40,300	10,788.0	2,015.0	12,803.0	1,280.3	1.307	1,673.4	.712	1,191.[illegible]
1982	295,800	44,200	11,832.0	2,210.0	14,042.0	1,404.2	1.412	1,982.7	.636	1,261.[illegible]
1983	321,900	48,100	12,876.0	2,405.0	15,281.0	1,528.1	1.525	2,330.4	.567	1,321.[illegible]
1984	348,000	52,000	13,920.0	2,600.0	16,520.0	1,652.0	1.647	2,720.8	.507	1,378.[illegible]
1985	382,800	57,200	15,312.0	2,860.0	18,172.0	1,817.2	1.779	3,233.8	.452	1,461.[illegible]
1986	408,900	61,100	16,356.0	3,055.0	19,411.0	1,941.1	1.886	3,660.9	.404	1,479.[illegible]
1987	452,400	67,600	18,096.0	3,380.0	21,476.0	2,147.6	1.999	4,293.1	.361	1,549.[illegible]
1988	495,900	74,100	19,836.0	3,705.0	23,541.0	2,354.1	2.119	4,988.3	.322	1,606.[illegible]
1989	530,700	79,300	21,228.0	3,965.0	25,193.0	2,519.3	2.246	5,658.3	.288	1,629.[illegible]
1990	582,900	87,100	23,316.0	4,355.0	27,671.0	2,767.1	2.381	6,588.5	.257	1,693.[illegible]
								₱54,669.7		₱28,552.[illegible]

5. A discount factor of 12 percent was used to obtain the present values of the benefits. This is believed to be the opportunity cost of capital and is commonly used for public investment projects like water supply development.

For FER-WD, the land value benefit in its present worth amounts to ₱28.55 million.

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 1,248.9, out of every 100,000 population in the province of Pampanga 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 San Fernando in the absence of specific data. The morbidity rate in the service area was assumed to remain constant during the 21-year projection period.

Since not all of those afflicted with said diseases are wage-earners, an adjustment was made accordingly. Based on the 1970 Census on Population and Housing of the National Census and Statistics Office, 67 percent of the municipality's population was economically active.[1/] It was assumed, therefore, that only 67 percent of 1,248.9 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 by multiplying the number of people afflicted with water-borne diseases by 67 percent, by ₱8 a day and then by 15 days.

1/ Economically active population includes those who are 10 years old and over, whether employed or unemployed, excluding retired persons, students and housewives.

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 67 percent and then by ₱11,629. The projected number of such deaths was based on the average of the 10-year mortality rate for primary water-borne diseases in the province of Pampanga, as gathered from the Department of Health. These figures indicated that 23.4 persons died of the 1,248.9 per 100,000 who were afflicted with water-borne diseases. This mortality rate was assumed to be constant over the projection period. The 67 percent corresponds to the portion of the service area population who are income earners. The ₱11,629 represents the monetary value of each death. This was derived from the estimated income to be earned by the average wage-earner over a period of five years discounted at 12 percent plus 20 percent associated economic costs (summation of ₱200 a month x 12 months x discount factor + 20 percent associated costs).

The third health benefit that can be derived from the improvement of the water supply in the service area is the reduction of the medical expenses of persons afflicted with water-borne 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 doctor's fee. Based on this finding, the total medical expenses incurred due to water-borne diseases were arrived at by multiplying ₱113.00 by the number of people afflicted with such diseases in the service area.

The sum of all three economic costs related to health benefits had to undergo three final adjustements 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

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2/ Refer to Methodology Memorandum, Chapter 20 for "Ability to Pay" studies.

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 calculation associated with the health benefits for FER-WD. The total present value of said benefits after the adjustments amounts to ₱777,505.

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, it is estimated that approximately 15 percent of the total poblacion of San Fernando is covered by the existing effective fire hydrant service. With the implementation of the program which will involve the installation of new fire hydrants, the extent of fire protection coverage will be expanded. 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 San Fernando, the average assessed value of each structure was assumed to be ₱25,000[3/]. The number of structures was derived from the projected population to be served by the system, assuming that each household has an average of 6.9 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 31 percent in 1981, gradually increasing to 71 percent in 1990 in accordnace with the extent of the service area to be covered by the fire hydrants.

The net reduction in fire damage was escalated by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000. It was then discounted at 12 percent. The present value of the fire protection benefit as shown in Annex Table XI-C-3 amounts to ₱7.60 million.

[3/] Based on the Census data on the number of structures by type of material.

[4/] Based on the 1970 Census on Housing in Pampanga province.

APPEN TABLE XI-C-2

HEALTH BENEFITS
SAN FERNANDO 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	16,980	$17,050	$30,998	$23,963	$71,971	$28,788	1.210	$34,833	.797	$27,[illegible]
1981	19,080	19,159	34,787	26,927	80,873	32,349	1.307	42,280	.712	30,103
1982	21,450	21,538	39,100	30,271	90,917	36,367	1.410	51,350	.636	32,659
1983	24,110	24,209	43,957	34,025	102,191	40,876	1.525	62,326	.567	35,345
1984	27,100	27,212	49,409	38,245	114,866	45,946	1.647	75,673	.507	38,336
1985	30,460	30,585	55,535	42,987	129,107	51,643	1.779	91,873	.453	41,627
1986	34,240	34,381	62,436	48,321	145,128	58,051	1.886	109,484	.404	44,133
1987	38,480	38,638	70,157	54,305	163,100	65,240	1.999	130,415	.361	47,080
1988	43,[illegible]	43,[illegible]	78,871	61,051	183,150	73,344	2.119	155,416	.322	50,044
1989	48,[illegible]	48,[illegible]	88,644	68,615	206,079	82,432	2.246	185,143	.287	53,131
1990	54,050	54,[illegible]	99,638	77,135	231,638	92,655	2.381	220,613	.257	56,[illegible]
1991									.229	[illegible]
1992									.205	[illegible]
1993									.182	[illegible]
1994									.163	[illegible]
1995									.145	[illegible]
1996									.130	[illegible]
1997									.116	[illegible]
1998									.104	[illegible]
1999									.093	[illegible]
2000	54,050	54,375	99,638	77,135	231,638	92,655	2.381	220,613	.083	[illegible]
								$3,165,582		$[illegible]

Note:

Total Municipal Population 54,[illegible]
Economically Active 36,[illegible] or 67%

Morbidity Rate: 1,[illegible].9
Mortality Rate: 23.4

(1) $67\% \times \frac{1,[illegible].9}{100,000} \times 1.7\% \times 75 = [illegible]$

(2) $67\% \times \frac{23.4}{100,000} \times 1.7\% \times [illegible]$

(3) $\frac{1,[illegible].9}{100,000} \times 1.7\% \times [illegible]$

BEST AVAILABLE DOCUMEN

ANNEX TABLE XI-C-3

REDUCTION IN FIRE DAMAGE
SAN FERNANDO WATER DISTRICT

Year	Number of Structures[5]	Total Value at ₱25,000 each (₱ x 1000)[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 Fire Reduction (₱ x 1000)	Discount Factor at 12%	Present Value of Net Benefit (₱ x 1000)
1980	2,461	61,525.0	461.4	0	0	1.210	0	.797	0
1981	2,765	69,125.0	518.4	31%	160.7	1.307	210.1	.712	149.6
1982	3,109	77,725.0	582.9	38	221.5	1.412	312.8	.636	198.9
1983	3,494	87,350.0	655.1	44	288.3	1.525	439.6	.567	249.2
1984	3,929	98,225.0	736.7	51	375.7	1.647	618.8	.525	324.9
1985	4,414	110,350.0	827.6	57	471.7	1.779	839.2	.452	379.3
1986	4,962	124,050.0	930.4	60	558.2	1.886	1,052.8	.404	425.3
1987	5,577	139,425.0	1,045.7	63	658.8	1.999	1,316.9	.361	475.4
1988	6,270	156,750.0	1,175.6	65	764.2	2.119	1,619.2	.322	521.4
1989	7,046	176,150.0	1,321.1	68	898.4	2.246	2,017.7	.288	581.1
1990	7,920	198,000.0	1,485.0	71	1,054.4	2.381	2,510.4	.257	645.2
1991	↓	↓	↓	↓	↓	↓	↓	.229	574.9
1992								.205	514.6
1993								.183	459.4
1994								.163	409.2
1995								.146	366.5
1996								.130	326.4
1997								.116	291.2
1998								.104	261.1
1999								.093	233.5
2000	7,920	198,000.0	1,485.0	71%	1,054.4	2.381	2,510.4	.083	208.4
							36,041.5		7,595.5

5/ Derived from the served population projections in Chapter VI.
6/ Based on the assessed value records in Pampanga.
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.

Beneficial Value of Water

Since water is essential to human life, all members of the served population in the service area presumably would be willing to obtain it in sufficient quantities at some given price. With the proposed improvement of the system's facilities, the volume of water production is expected to increase considerably to serve the needs of the growing population. This will bring about additional revenues to the water district, especially since a price increase of water may be justified in view of the improved service.

In general, water rates charged by the water district do not reflect the true value of water. Moreover, it is recognized that households and commercial users are really willing to pay more than what they are actually being charged for water consumed. From the economic viewpoint, therefore, there is a consumers' surplus. This consumers' surplus refers to the additional amount consumers are willing to pay over and above what they are paying for water. For purposes of this study, this additional value has been estimated to be 50 percent higher than domestic water rates and 25 percent higher than commercial/industrial/institutional water rates[8].

In the determination of this benefit, the following steps were taken:

1. Only the incremental volume of accounted-for-water was considered; hence, the 1977 accounted-for-water amounting to 232,000 cum was deducted from total accounted-for-water projections in Chapter VI. The water demand projections in Chapter VI, expressed in liters per capita per day, were converted to cubic meters per year.

2. Classification of accounted-for-water into domestic and others (commercial/institutional/industrial) was based likewise on Chapter VI.

3. The price per cubic meter of water was obtained from the unescalated rate per revenue unit in Chapter X, Annex Table X-C-1. The rates were, however, adjusted upwards to reflect consumers' surplus: 50 percent higher for domestic water and 25 percent higher for others.

8/ Refer to Revised Procedures for the Economic and Financial Analysis of Water Projects, LWUA, May 1977.

4. The total economic revenues were then escalated by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000. Finally, the escalated values were discounted at 12 percent to obtain their present values.

For FER-WD, the beneficial value of water amounts to a present value of ₱21.50 million, as shown in Annex Table XI-C-4.

ANNEX TABLE XI-C-4

BENEFICIAL VALUE OF WATER
SAN FERNANDO WATER DISTRICT

Year	Incremental Accounted-For-Water cum/year[9]	Domestic (cum/year)	Others (cum/year)	Price per cum[10] Domestic	Price per cum[10] Others	Economic Value per cum[11] Domestic	Economic Value per cum[11] Others	Economic Water Revenue Domestic (₱ x 1000)	Economic Water Revenue Others (₱ x 1000)	Total Economic Revenues (₱ x 1000)	Escalation Factor[12]	Escalated Economic Revenues (₱ x 1000)	Discount Factor at 12 Percent	Present Value of Economic Revenues (₱ x 1000)
1977	232,000													
1978	110,960	96,535	14,425	₱.75	₱1.50	₱1.13	1.88	109.1	27.1	136.2	1.000	136.2	1.000	136.2
1979	309,597	269,349	40,248	.69	1.38	1.03	1.73	277.4	69.6	347.0	1.100	381.7	.893	340.9
1980	623,282	542,255	81,027	.64	1.28	.96	1.60	520.6	129.6	650.2	1.210	786.7	.797	627.0
1981	722,259	625,765	96,494	.87	1.74	1.31	2.18	846.0	210.4	1,056.4	1.307	1,380.7	.712	983.1
1982	878,135	764,020	114,164	.81	1.62	1.22	2.03	932.1	231.8	1,163.9	1.412	1,643.4	.636	1,045.2
1983	1,032,849	898,579	134,270	.75	1.50	1.13	1.88	1,015.4	252.4	1,267.8	1.525	1,933.4	.567	1,096.2
1984	1,209,059	1,051,881	157,178	.69	1.38	1.03	1.73	1,083.4	271.9	1,355.3	1.647	2,232.1	.507	1,131.7
1985	1,409,817	1,226,541	183,276	.70	1.40	1.05	1.75	1,287.9	320.7	1,608.6	1.779	2,861.7	.452	1,293.5
1986	1,636,544	1,423,533	213,011	.65	1.30	.98	1.65	1,397.0	347.2	1,744.2	1.886	3,289.6	.404	1,329.0
1987	1,899,135	1,652,247	246,888	.60	1.20	.90	1.50	1,487.0	370.3	1,857.3	1.999	3,712.7	.361	1,340.3
1988	2,196,030	1,910,546	285,484	.60	1.20	.90	1.50	1,719.5	428.2	2,147.7	2.119	4,551.0	.322	1,465.4
1989	2,534,286	2,204,829	329,457	.56	1.12	.84	1.40	1,852.1	461.2	2,313.3	2.246	5,195.7	.288	1,496.4
1990	2,919,666	2,540,109	379,557	.52	1.04	.78	1.30	1,981.3	493.4	2,474.7	2.381	5,892.2	.257	1,514.3
1991	↓	↓	↓	.55	1.10	.83	1.38	2,108.3	523.8	2,632.1	↓	6,267.0	.229	1,435.1
1992	↓	↓	↓	.51	1.02	.77	1.28	1,955.9	485.8	2,441.7	↓	5,813.7	.205	1,191.8
1993	↓	↓	↓	.47	.94	.71	1.18	1,803.5	447.9	2,251.4	↓	5,360.6	.183	981.0
1994	↓	↓	↓	.50	1.00	.75	1.25	1,905.1	474.4	2,379.5	↓	5,665.6	.163	923.5
1995	↓	↓	↓	.46	.92	.69	1.15	1,752.7	436.5	2,189.2	↓	5,212.5	.146	761.0
1996	↓	↓	↓	.43	.86	.65	1.08	1,651.1	409.9	2,061.0	↓	4,907.2	.130	637.9
1997	↓	↓	↓	.44	.88	.66	1.10	1,676.5	417.5	2,094.0	↓	4,985.8	.116	578.4
1998	↓	↓	↓	.41	.82	.62	1.03	1,574.9	390.9	1,965.8	↓	4,680.6	.104	486.8
1999	↓	↓	↓	.38	.76	.57	0.95	1,447.9	360.6	1,808.5	↓	4,304.0	.093	400.5
2000	2,919,666	2,540.109	379,557	.35	.36	.53	0.45	1,346.3	170.8	1,517.1	2.381	3,612.2	.083	299.8
												84,808.3		21,495.0

9/ The 1977 volume of 232,000 cum per year of accounted-for-water was deducted from the water demand projections throughout the study period to obtain the incremental volume.

10/ The price per cum of water for domestic use was derived by de-escalating the rate per revenue unit of water in Table X-C-1, Chapter X; the rate of water for other uses (commercial, institutional, and industrial) was assumed to be twice that for domestic use.

11/ Assumed to be 50 percent higher than domestic rates and 25 percent higher than rate for 'others'.

12/ Escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, and by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

ANNEX XI-E

ECONOMIC COSTS

ANNEX TABLE XI-B-1

CONVERSION OF FINANCIAL COST TO ECONOMIC COST
SAN FERNANDO WATER DISTRICT

	Financial Project Cost	Foreign Exchange Component	Domestic Component	Unskilled Labor	Balance of Domestic Component 1/	Taxes (50%) 2/	Others (50%)	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 Contribution 4/
Table I-1 and I-2												
Source Facilities												
a) Equipment	1,158,000	866,720	285,280	51,800	233,480	11,674	221,806	1,040,064	25,900	221,806	1,287,770	1,018,000
b) Wells	6,508,000	1,863,489	4,644,511	643,200	4,001,311	200,066	3,801,245	2,236,187	321,600	3,801,245	6,359,032	5,086,903
c) Structure	627,000	-	627,000	66,100	560,900	28,045	532,855	-	33,050	532,855	565,905	447,356
Distribution Pipelines	5,835,000	2,929,006	2,905,994	445,500	2,260,494	113,025	2,147,469	3,514,807	222,750	2,147,469	5,885,026	4,658,154
Internal Network	3,241,000	1,424,049	1,816,951	298,600	1,518,351	75,918	1,442,433	1,708,859	149,300	1,442,433	3,300,592	2,609,184
Storage Facilities	1,232,000	296,689	935,311	118,800	816,511	40,826	777,685	356,027	59,400	777,685	1,193,012	942,302
Hydrants	1,330,000	780,199	549,801	122,600	427,201	21,360	405,841	936,239	61,300	405,841	1,403,380	1,109,391
Service Connections												
a) Pipes	5,419,000	2,645,045	2,773,955	594,400	2,179,555	108,978	2,070,577	3,174,054	297,200	2,070,577	5,541,831	4,378,128
b) Meters	1,761,000	1,467,479	293,521	254,200	39,321	1,966	37,355	1,760,975	127,100	37,355	1,925,430	1,657,039
Laboratory Equipment	206,000	199,267	6,733	-	6,733	337	6,396	239,120	-	6,396	245,516	194,054
Feasibility Studies	356,000	231,400	124,600	-	124,600	6,230	118,370	277,680	-	118,370	396,050	313,053
Immediate Improvement												
Source Facilities												
a) Equipment	269,000	207,727	61,273	10,700	50,573	2,529	48,044	249,272	5,350	48,044	302,666	239,268
b) Wells	423,000	120,992	302,008	41,800	260,208	13,010	247,198	145,190	20,900	247,198	413,288	326,710
c) Structure	128,000	-	128,000	13,500	114,500	5,725	108,775	-	6,750	108,775	115,525	91,324
Transmission and Distribution	4,502,000	2,262,290	2,239,710	355,900	1,883,810	94,191	1,789,619	2,714,748	177,950	1,789,619	4,682,317	3,701,436
Service Connections												
a) Pipes	960,000	468,974	491,026	105,300	385,726	19,286	366,440	562,769	52,650	366,440	981,859	850,094
b) Meters	663,000	551,806	111,194	95,600	15,594	780	14,814	662,167	47,800	14,814	724,781	627,516
Administrative Facilities												
a) Equipment	118,000	71,152	46,848	6,200	40,648	2,032	38,616	85,382	3,100	38,616	127,098	100,473
b) Structure	459,000	-	459,000	54,400	404,600	20,230	384,370	-	27,200	384,370	411,570	325,352
Laboratory, Plumbing, Meter Repair												
a) Equipment	275,000	223,918	51,082	14,500	36,582	1,829	34,753	268,702	7,250	34,753	310,705	245,617
b) Structure	201,000	-	201,000	23,900	177,100	8,855	168,245	-	11,950	168,245	180,195	142,447
Miscellaneous Items	15,000	9,265	5,735	-	5,735	287	5,448	11,118	-	5,448	16,566	14,343
Vehicles	139,000	70,290	68,710	-	68,710	3,436	65,274	84,348	-	65,274	149,622	129,563
Sub-total	35,619,000	16,689,757	18,929,243	3,315,000	15,614,243	780,715	14,833,528	20,027,708	1,657,500	14,833,528	36,515,736	29,571,754
Land	271,000	-	271,000	-	271,000	13,550	257,450	-	-	257,450	257,450	257,450
Total	35,890,000	16,689,757	19,200,243	3,315,000	15,885,243	794,265	15,090,978	20,027,708	1,657,500	15,090,978	36,773,186	29,829,204

1/ Domestic cost less unskilled labor cost.
2/ Computed at 5 percent of domestic cost component after unskilled labor cost was deducted from it.
3/ Obtained by adding foreign exchange cost, unskilled labor cost and cost of others after they have been adjusted through the shadow of pricing.
4/ Derived by subtracting contingencies and engineering services from the economic project cost.

ANNEX TABLE XI-E-2

REPLACEMENT COST
SAN FERNANDO WATER DISTRICT
1978 PRICES
₱ x 1000

Year	Vehicles	Meters	Equipment	Miscellaneous	Laboratory Equipment	Total
1978						
1979						
1980						
1981						
1982						
1983						
1984						
1985	129.5					129.5
1986						
1987						
1988						
1989						
1990						
1991						
1992	129.5					129.5
1993		417.9	585.4	14.3		1,017.6
1994		134.8	26.4			161.2
1995		104.8	-			104.8
1996		176.7	195.5			372.2
1997		176.7	-			176.7
1998		176.7	-			176.7
1999	129.5	176.7	195.5			501.7
2000		200.1	37.7		12.2	250.0
	388.5	1,564.4	1,040.5	14.3	12.2	3,019.9

ANNEX TABLE XI-E-3

SALVAGE VALUE IN 2001
SAN FERNANDO WATER DISTRICT
1978 PRICES
(₱ x 1000)

Year	50 Years			30 Years			25 Years			15 Years			7 Years			Infinite			Total Salvage Value[17]
	Economic Value		Salvage Value	Economic Value		Salvage Value	Economic Value		Salvage Value	Economic Value		Salvage Value	Economic Value		Salvage Value	Economic Value		Salvage Value	
1978	₱4,535.4	56%	₱2,573.4	₱ 73.0	27%	19.7	₱ 326.7	12%	39.2							96.8	100%	96.8	2,729.1
1979	712.5	58	417.3				128.2	16	20.5										437.8
1980	257.6	60	154.6	240.1	33	79.2										62.6	100	62.6	296.4
1981	1,692.3	62	1,049.2				941.5	24	226.0										1,675.2
1982	1,605.0	64	1,027.2																1,027.2
1983	1,810.2	66	1,196.1																1,196.1
1984	1,[illegible].1	68	1,146.5				941.1	36	338.8										1,485.3
1985	1,984.0	70	1,388.8				192.0	40	76.8										1,465.6
1986	1,855.4	72	1,338.0				941.5	44	414.3	516.9	7%	36.2				96.1	100	96.1	1,884.6
1987	932.0	74	660.1							146.7	13	19.1							679.2
1988	973.9	76	740.2				941.5	52	489.6	334.0	20	66.8							1,296.6
1989	973.9	78	759.6							332.3	27	89.7							849.3
1990	890.9	80	712.7				941.1	60	564.7	145.0	33	47.9							1,345.3
1991																			-
1992																			-
1993										1,017.6	53	539.3							539.3
1994										161.2	60	96.7							96.7
1995										104.8	67	70.2							70.2
1996										372.2	73	271.7							271.7
1997										176.7	80	141.4							141.4
1998										176.7	87	153.7							153.7
1999										372.2	93	346.1	129.5	86%	111.4				457.5
2000										250.0	100	250.0							250.0
	19,659.2		12,931.7	313.1		98.9	5,353.6		2,169.9	4,106.3		2,128.8	129.5		111.4	257.5		257.5	17,748.2

17/ Salvage values for each year represent the salvage value of the item in the year 2001.

ANNEX TABLE XI-B-4

SUMMARY OF ECONOMIC COSTS
SAN FERNANDO WATER DISTRICT
(₱ x 1000)

Year	Project Cost	Replacement Cost	O and M Costs	Total Costs	Escalation Factor For Other Costs 19/	Escalation Factor For O and M Costs 20/	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	₱ 7,768.4		176.6	7,945.0	1.000	1.000	7,768.4		176.6	7,945.0	1.000	7,768.4		176.6	7,945.0
1979	1,222.7		311.6	1,534.3	1.100	1.080	1,345.0		336.5	1,681.5	.893	1,201.1		300.5	1,501.6
1980	756.3		191.6	948.4	1.210	1.166	952.0		211.7	1,163.7	.797	758.7		168.7	927.4
1981	3,720.6		325.6	4,046.2	1.307	1.260	4,862.8		410.3	5,273.1	.712	3,462.3		292.1	3,754.4
1982	2,171.6		350.6	2,522.2	1.412	1.360	3,066.3		476.8	3,543.1	.636	1,950.2		303.2	2,253.4
1983	2,165.9		381.6	2,547.5	1.525	1.469	3,303.0		560.6	3,863.6	.567	1,872.8		317.9	2,190.7
1984	3,712.2		414.6	4,126.8	1.647	1.587	6,114.0		658.0	6,772.0	.507	3,099.2		333.6	3,432.4
1985	2,901.8	129.5	464.6	3,495.9	1.779	1.714	5,162.3	230.4	796.3	6,189.0	.452	2,333.4	104.1	359.9	2,797.4
1986	4,336.0		508.6	4,744.6	1.886	1.851	7,989.1		941.4	8,930.5	.404	3,227.6		380.3	3,607.9
1987	1,273.2		579.6	1,852.8	1.999	1.999	2,515.1		1,188.6	3,703.7	.361	908.0		429.1	1,337.1
1988	2,789.8		650.6	3,440.4	2.119	2.159	5,911.6		1,404.6	7,316.2	.322	1,903.5		452.3	2,355.8
1989	2,787.3		712.6	3,499.9	2.246	2.332	6,260.3		1,661.8	7,922.1	.288	1,803.0		478.6	2,281.6
1990	1,854.9		868.6	2,123.5	2.381	2.518	2,387.9		2,187.1	5,175.0	.257	767.9		562.1	1,330.0
1991	0			868.6			0			2,187.1	.229			500.8	500.8
1992		129.5		998.1				308.3		2,495.4	.205		63.2	448.4	511.6
1993		1,017.6		1,886.2				2,422.9		4,610.0	.183		443.4	400.2	843.6
1994		161.2		1,029.8				383.8		2,570.9	.163		62.6	356.5	419.1
1995		104.8		973.4				249.5		2,436.6	.146		36.4	319.3	355.7
1996		372.2		1,240.8				886.2		3,073.3	.130		115.2	284.3	399.5
1997		176.7		1,045.3				420.7		2,607.8	.116		48.8	253.7	302.5
1998		176.7		1,045.3				420.7		2,607.8	.104		43.8	227.5	271.3
1999		501.7		1,370.3				1,134.5		3,351.6	.093		111.1	203.4	314.5
2000		250.0	868.6	1,118.6	2.381	2.518		595.3	2,187.1	2,782.4	.083		49.4	181.5	230.9
	₱36,776.2	3,019.9	14,627.8	54,423.9			58,237.8	7,112.3	32,881.3	98,231.4		31,056.7	1,078.0	7,730.5	39,865.2
	Salvage Value in 2001 18/			=17,748.2	2.381						.074				1,313.4
															38,551.8

19/ The annual salvage values were not escalated individually since they represent values in 2001; hence, only their sum was escalated by the factor used for the project and replacement cost.

18/ Project cost and replacement cost were escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

20/ 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
SAN FERNANDO WATER DISTRICT
(₱ x 1000)

Year	Escalated Value Benefits	Escalated Value Costs	Discount Factor at 40 Percent	Present Value Benefits	Present Value Costs	Discount Factor at 45 Percent	Present Value Benefits	Present Value Costs
1978	136.2	7,945.0	1.000	136.2	7,945.0	1.000	136.2	7,945.0
1979	381.7	1,681.5	.714	272.5	1,200.6	.690	263.4	1,160.2
1980	18,362.1	1,163.7	.510	9,364.7	593.5	.476	8,740.4	553.9
1981	3,306.5	5,273.1	.364	1,203.6	1,919.4	.328	1,084.5	1,729.6
1982	3,990.3	3,543.1	.260	1,037.5	921.2	.226	901.8	800.7
1983	4,765.7	3,863.6	.186	886.4	718.6	.156	743.4	602.7
1984	5,647.4	6,772.0	.133	751.1	900.7	.108	609.9	731.4
1985	7,025.6	6,189.0	.095	667.4	588.0	.074	519.9	458.0
1986	8,112.8	8,930.0	.068	551.7	607.2	.051	413.8	455.3
1987	9,453.1	3,703.7	.048	453.7	177.8	.035	330.9	129.6
1978	11,313.9	7,316.2	.035	396.0	256.1	.024	271.5	175.6
1989	13,056.9	7,922.1	.025	326.4	198.1	.017	222.0	134.7
1990	15,211.7	5,175.0	.018	273.8	93.2	.012	182.5	62.1
1991	8,998.0	2,187.1	.013	117.0	28.4	.008	72.0	17.5
1992	8,544.7	2,495.4	.009	76.9	22.5	.006	51.3	15.0
1993	8,091.6	4,610.0	.006	48.5	27.7	.004	32.4	18.4
1994	8,396.6	2,570.9	.005	42.0	12.9	.003	25.2	7.7
1995	7,943.5	2,436.6	.003	23.8	7.3	.002	15.9	4.9
1996	7,638.2	3,073.3	.002	15.3	6.1	.001	7.6	3.1
1997	7,716.8	2,607.8	.002	15.4	5.2	.001	7.7	2.6
1998	7,411.6	2,607.8	.001	7.4	2.6	.001	7.4	2.6
1999	7,037.0	3,381.6	.001	7.0	3.4	-	-	-
2000	6,343.2	2,782.4	.001	6.3	2.8	-	-	-
	178,885.1	98,231.4		16,680.6	16,238.3		14,639.7	15,010.6
Salvage Value		17,748.2			0.0			-0.0
		80,483.2			16,238.3			15,010.6

Present Value at 40% = 442.3
Present Value at 45% = 370.9
813.2

$$IERR = \frac{.40 + .05\ (442.3)}{813.2}$$

$$.40 + .0272$$

$$= 42.72\%$$

M E T H O D O L O G Y

M E M O R A N D A

Methodology Memorandum No. 1

To : L. V. Gutierrez, Jr.

From : A. de Vera

Date : 4 January 1977

Subject: Pilot Area Survey

A. Need

In estimating water accountability, data on the ratio of borrowers to primary users, average persons per household, and per capita consumption are necessary. Information on capacity and willingness-to-pay would greatly aid financial analysis. In all cases, these data are not readily available in the Philippines. The only way to get these data would be to actually perform a house-to-house survey within the served areas of the water district (WD). Considering time and financial constraints, a pilot area survey would be the best approach. This is merely surveying a representative area within the WD and projecting the data obtained for the entire served area of the WD.

B. Methodology

1. Choose a pilot area within the WD. Desirable requirements for the area are as follows:

   a. adequate line pressures, preferably with 24-hour service;
   b. metered connections;
   c. presence of domestic as well as commercial connections. Ratio of commercial to domestic connections for the area must not exceed that for the entire WD;
   d. representative income levels of the concessionaires.

2. Devise a one-page questionnaire so that it:

   a. is easily understood by WD personnel (who will serve as interviewers);
   b. provides relevant information;
   c. provides a means of cross-checking some answers given by respondents;
   d. would make tabular analysis easy.

   A sample questionnaire is attached.

3. Get assistance from the WD personnel in the house-to-house survey. It is suggested that they do the actual interview because of their familiarity with local customs and dialects. However, before allowing the WD enumerators to proceed on their own, it is necessary that:

   a. the enumerators be given a thorough briefing on the importance of the survey, as well as the purpose of each item in the questionnaire.
   b. the enumerators be accompanied to the first few houses, and given additional pointers or feedback before they proceed on their own.

4. Conduct a house-to-house survey of all households within the pilot area. A map at this point indicating the existing houses (with their code numbers) would be necessary. The following would be helpful during the survey:

   a. brief the respondents about the purpose of the survey before asking questions. It is very important that they be receptive to the interviewers. Otherwise data given could be misleading.
   b. in asking for estimates of consumption, avoid using technical terms, i.e., liters, gallons, etc. Use local containers like pails, drums or whatever they use. Note the capacity of the container in the questionnaire.

C. <u>Data</u>

The following data may be obtained from the survey:

1. Pilot area density
2. Average persons/household
3. Borrowers from connected households and percentage of households dependent on the WD
4. Potential concessionaires
5. Consumption estimates
6. Income levels and the respective rates showing willingness to pay for improved service
7. Water accountability

_____ WATER DISTRICT
PILOT AREA QUESTIONNAIRE

DATE _____
TIME _____

INTERVIEWEE _____ ADDRESS _____

TYPE OF DWELLING _____ CONSTRUCTION MATERIAL _____

WD CONCESSIONAIRE

1. NO. OF OCCUPANTS: _____

2. CLASSIFICATION:
   - ☐ Domestic
   - ☐ Commercial
   - ☐ Institutional
   - ☐ Industrial
   - ☐ _____

3. SIZE OF CONNECTION:
   - ☐ ½" ☐ 1" ☐ 2"
   - ☐ ¾" ☐ 1½" ☐ _____

4. TYPE OF CONNECTION:
   - ☐ metered: meter functioning
   - ☐ metered: meter damaged
   - ☐ flat rate (unmetered)

5. APPURTENANCES (Connected to System)
   - ☐ with hand pump
   - ☐ with electric motor pump
     - HRS used/day _____
     - Pump rated HP _____
     - GPM _____

6. OTHER SOURCE ASIDE FROM WD:

Own	Other HH
☐ wells	☐ wells
☐ springs	☐ springs
☐ rainwater	☐ rainwater
☐ _____	☐ _____

NON-WD CONCESSIONAIRE

1. NO. OF OCCUPANTS: _____

2. SOURCE OF SUPPLY:
   - ☐ own private well
   - ☐ rainwater
   - ☐ spring
   - ☐ public faucet
   - ☐ WD concessionaire HH Code No. _____
   - ☐ public well
   - ☐ others' private well
   - ☐ _____

3. CONSUMPTION:
   - ☐ free
   - ☐ paying
     - volume used per day _____
     - Paying ₱ _____ for _____.

REMARKS:

FOR ALL HOUSEHOLDS

1. WD-WATER AVAILABLE:
   - No. of hours _____
   - Time _____

2. FAUCETS:
   - ☐ 1 ☐ 3 ☐ 5
   - ☐ 2 ☐ 4 ☐ _____

3. SHOWERS:
   - ☐ 1 ☐ 2 ☐ 3 ☐ _____

4. FLUSH WATER CLOSET:
   - ☐ 1 ☐ 2 ☐ 3 ☐ _____

5. MANUAL WATER CLOSET:
   - ☐ 1 ☐ 2 ☐ 3 ☐ _____

6. ☐ w/septic tank ☐ w/o septic tank

7. AVERAGE MONTHLY:

	Consumption	Billing/Amount
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:

- Usage of borrowers from flat-rate primary users;
- Unbilled flat-rate use
- Wastage of flat-rate users

2. Weighted Average of First 10-City Survey

a. Objective - In a water system with all functions 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. Steps

Multiply monthly production by:

.31 to get accounted-for-water
.11 to get underestimated flat-rate use
.26 to get wastage
.25 to get leakage
.07 for others

3. Field Study Method

a. Objective - To be able to determine within ± 5 percent accuracy water accountability figures. This method, however, is time-consuming and very expensive.

b. Data Necessary - All data received shall be generated in the field. The number of concessionaires and the water rate schedule are basic requirements.

c. Steps

1) For each section of transmission and distribution line in the water system, appropriate measuring devices shall be installed in order to determine the amount of water flowing in and out, water used by the concessionaires, and water leakage.

2) Desk-top analysis is then necessary to determine water accountability.

METHODOLOGY MEMORANDUM NO. 3

To : L. V. Gutierrez, Jr.

From : P. del Rosario

Date : 8 February 1977

Subject: Classification of Water Districts According to Future Water Requirements

A. Introduction

The purpose of this methodology manual is to classify water districts (WD) so that future water requirements may be estimated. The factors to be considered in classifying WD's are economic and social development in the district's boundaries, probable sources of additional water supply and the people's ability-to-pay for improved water service.

The group with the probable highest per capita consumption is labelled Group I; and the group with the probable lowest water consumption, Group V. Affluent and highly urbanized water districts may fall under Group I, while less developed and small water districts, under Group V.

B. Methodology

The initial service area of the WD will most likely include the central urban area or core city (poblacion). To classify it according to future water demands, the WD and its central urban area are judged according to 5 grouping criteria - 1975 urban income, 1975 standard of living, 1975 business index, 1980 cost of water, and served population in 1980. For each criterion, a number of points, from 0 to 20, are allotted to each water district. The total number of points under the 5 criteria determines the classification of the WD.

Table MM 3-1 lists the 5 criteria by which the WD can be classified, and the points allotted to rankings in each criterion.

The grouping of the WD's based on the range of total points under the 5 criteria is as follows:

TABLE MN 3-1

WATER DISTRICT GROUPING CRITERIA

1975 Urban Income: Income Taxes Paid by Urban Residents ($)	Points 20	1975 Standard of Living: % of Households with Refrigerators in Urban Area	Points 10	% of Households with Flush Toilets in Urban Area	Points 10	1975 Business Index: % of Commercial Establishments in Urban Area	Points 20	1980 Cost of Water: Source of Additional Water Supply	Points 20	1980 Served Population: 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	Spring with booster pump	17	80,001 - 100,000	16
1,000,001- 5,000,000	14	15.1 - 20	7	30.1 - 40	7	1.7 - 3.0	7	Infiltration with short transmission line/ well points	14	65,001 - 80,000	14
500,001- 1,000,000	12	10.1 - 15	6	20.1 - 30	6	1.0 - 1.6	4			52,001 - 65,000	12
100,001- 500,000	10	5 - 10	5	10 - 20	5	less than 1	2	Infiltration with long transmission line/ wells	11	41,001 - 52,000	10
50,001- 100,000	8	less than 5	4	less than 10	4					31,001 - 41,000	9
20,001- 50,000	6							Surface water without reservoir	7	22,001 - 31,000	8
8,001- 20,000	4							Surface water with reservoir	5	15,001 - 22,000	7
4,001- 8,000	2									10,001 - 15,000	6
4,000 or less	1									less than 10,000	5

Group	Total Points
I	70 and above
II	60 - 69
III	50 - 59
IV	40 - 49
V	39 and below

In allotting points under each criterion, readily available data are taken from the latest NCSO report (1970 or 1975 census). These data are: total population in the city or municipality; total households; number of urban households; number of commercial establishments; number of industrial establishments; number of households with refrigerators; and number of households using flush water-sealed toilets. The data on total income taxes paid in the city/municipality in 1975 were obtained from the BIR office. Data on the probable sources of additional water supply were taken from the recent preliminary hydro-survey conducted by LWUA and the WD.

The following is a procedure for assigning points to a WD on the basis of the 5 criteria.

1. 1975 Urban Income

Urban income is based on the total income taxes paid by individuals and business entities and the percentage of urban households with respect to total households in the city/municipality. If the 1975 data are not available, the percentage of urban households is projected to 1975 by applying an increase of 0.1 to 0.4 percent per year. In projecting the percentage of urban households, growth characteristics and urban development must be considered. The projected percentage is multiplied by 1975 total income. Table MM 3-1 shows the breakdown of the annual income with points ranging from 1 to 20.

2. 1975 Standard of Living

The standard of living is measured by the number of households in the urban area with refrigerators and those with flush water-sealed toilets.

The percentage of urban households with refrigerators with respect to total urban households is projected to 1975, if the 1975 census is not available. An increase

of 1 to 4 percent per annum is applied, depending upon the recent economic and social development in the city/municipality. The same procedure is applied to the percentage of urban households using flush water-sealed toilets. Table MM 3-1 shows the percentages of households with refrigerators and those with flush toilets with respect to total urban households, with points ranging from 4 to 10.

3. 1975 Business Index

The business index is measured by the percentage of commercial establishments with respect to total urban households in 1975. One industrial establishment (data from NCSO census) is assumed to be equivalent to 10 commercial establishments (except when the 1975 census is available). An increase of 1 to 20 establishments per year is applied, depending on the recent business activities and urban development in the city/municipality. The number of urban households in 1975 is obtained by multiplying the 1975 total households (total population + average of 7 persons/household) by the 1975 percentage of urban households as derived in the methodology for 1975 urban income. The 1975 sum of commercial establishments divided by the number of 1975 urban households is the business index of the city/municipality. Table MM 3-1 shows the various levels of business index, with corresponding points ranging from 2 to 20.

4. 1980 Cost of Water

The cost of water is inferred from the probable source of additional water supply by 1980. The probable source of additional water supply is weighted according to its apparent economic viability. A spring source that is located within the 1980 service area and can flow by gravity is considered the most economical. Surface water requiring complete water treatment with impounding reservoir is the most expensive. Infiltration galleries with short or long transmission lines, wells, or spring source requiring booster pump, are considered to have weights between the most and least expensive (see Table MM 3-1).

5. Served Population in 1980

The served population in 1980 is projected by delineating the future service areas of the WD and projecting the population of the city/municipality and of the service areas. The 1980 served population is determined as a portion of the service area population. In projecting the population served and the future service areas, economic growth and urban development, availability of water supply and capability of the water district to provide service must be considered.

C. Expected Water Demand By Class of WD

The experience of the LWUA-CDM staff, especially during the First Ten Urban Areas Project in the Philippines, has been used to assign values of expected water demand to the 5 classes of water districts. These expected water demands are shown in Table MM 3-2.

D. Example of Water District Classification

This method of classifying a water district is illustrated, with the Silay City Water District as an example. Available data for Silay City are taken from the NCSO and BIR reports, and from the preliminary hydro-survey by LWUA and the SIL-WD. The following data were obtained:

Total income taxes paid in the city - ₱20,049,139 (1974-1975)

Total population in the city - 103,493 (1975)

Total number of households in the city - 10,915 (1970)

Total number of households in the urban area - 3,693 (1970)

Total number of commercial establishments in the city - 36 (1970)

Total number of industrial establishments in the city - 1 (1970)

Total urban households with refrigerators - 266 (1970)

Total urban households using flush water-sealed toilets - 807 (1970)

Probable source of additional water supply - wells (1980)

Population in the service area - 21,280 (1980)

To determine the specific weights of the above data for each grouping criterion, the methodology developed is applied as follows:

TABLE MM 3-2

WATER DEMAND OF WATER DISTRICT GROUPINGS

Classification	Year 1980	1990	2000
Group I			
Domestic use, lpcd	140	155	175
Commercial/Industrial/Institutional			
% of domestic	17	21	25
Equivalent, lpcd	24	33	35
Accounted-for-water, lpcd	164	188	210
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	109	73	52
Total production required, lpcd	273	261	262
Group II			
Domestic use, lpcd	120	135	150
Commercial/Industrial/Institutional			
% of domestic	15	17	20
Equivalent, lpcd	18	23	30
Accounted-for-water, lpcd	138	158	180
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	92	62	45
Total production required, lpcd	230	220	225
Group III			
Domestic use, lpcd	105	120	135
Commercial/Industrial/Institutional			
% of domestic	13	16	18
Equivalent, lpcd	14	19	24
Accounted-for-water, lpcd	119	139	159
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	79	54	40
Total production required, lpcd	198	193	199

TABLE MM 3-2 (Continued)

WATER DEMAND OF WATER DISTRICT GROUPINGS

Classification	Year 1980	1990	2000
Group IV			
Domestic use, lpcd	95	110	125
Commercial/Industrial/Institutional			
% of domestic	12	14	16
Equivalent, lpcd	12	15	20
Accounted-for-water, lpcd	107	125	145
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	71	49	36
Total production required, lpcd	178	174	181
Group V			
Domestic use, lpcd	90	100	110
Commercial/Industrial/Institutional			
% of domestic	10	13	15
Equivalent, lpcd	9	13	17
Accounted-for-water, lpcd	99	113	127
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	66	44	32
Total production required, lpcd	165	157	159

1. 1975 Urban Income

In 1970, the urban households accounted for 33.8 percent of the total households in the city. But due to recent developments in the local economy and subdivision housing projects in the urban sector of the city, the number of urban households was projected to increase to 35 percent in 1975. The product of the total 1974-1975 income taxes and the 1975 percentage of urban households represents the urban income taxes which amount to about ₱7.017 million. Table MM 3-1 gives this a weight of 16 points.

2. 1975 Standard of Living

This is measured by:

a. 1975 urban households using refrigerators

In 1970, 7.2 percent of the urban households had refrigerators. Due to economic and housing developments, the percentage was estimated to increase to about 12 percent in 1975. Table MM 3-1 gives this a weight of 6 points.

b. 1975 urban households using flush water-sealed toilet facilities

In 1970, the households with toilet facilities represented 21.9 percent of urban households. Due to the recent housing developments in the urban area, the households with toilet facilities were projected to be about 32 percent in 1975. Table MM 3-1 gives this a weight of 7 points.

3. 1975 Business Index

It is assumed that one industrial establishment is equivalent to 10 commercial establishments. Based on the 1970 census, the number of commercial establishments (equivalent industrial establishments included) was 46 (36 + 10). These establishments were expected to have increased to 96 (at 10 establishments per year) in 1975. Total urban households increased from 3,693 in 1970 to about 5,180 in 1975 (1975 population of 103,493 ÷ average 7 persons/household). Hence, the business index in 1975 was 1.9 percent (commercial establishments divided by the number of urban households in 1975). Table MM 3-1 gives this a weight of 7 points.

4. 1980 Cost of Water

Based on the hydro-survey of LWUA-CDM and SIL-WD, deepwells appear to be the most probable economical source of additional supply. Table MM 3-1 gives a weight of 11 points for this source.

5. 1980 Served Population

By 1980, the served population is expected to be about 15,630[1] as projected from the 1975 NCSO Census of Population and Housing. Table MM 3-1 gives this a weight of 7 points.

Therefore, the SIL-WD has a total of 54 points under the 5 criteria, indicating that it belongs to Group III. The water demands of this group from 1980 to year 2000 are listed in Table MM 3-2.

Table MM 3-3 classifies 16 water districts in the Philippines according to the 5 grouping criteria.

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[1] See Chapter VI, Table VI-3, of the Silay City Feasibility Study Report.

TABLE MM 3-3

SUMMARY OF CITIES/MUNICIPALITIES SUBJECTED TO THE WATER DISTRICT GROUPING CRITERIA

City/Municipality	1975 Urban Income (Points)	1975 Standard of Living: Urban Households with Refrigerators (Points)	1975 Standard of Living: Urban Households with Flush Toilets (Points)	1975 Business Index (Points)	1980 Cost of Water Source of Supply (Points)	1980 Served Population (Points)	Total Points	Group
Bislig, Surigao del Sur	14	6	7	11	14	7	59	3
Urdaneta, Pangasinan	6	7	9	11	11	6	50	3
Calamba, Laguna	14	9	10	7	17	6	63	2
Gapan, Nueva Ecija	6	8	9	7	11	6	47	4
Silay City	16	6	7	7	11	7	54	3
Cebu City	20	10	10	7	5	20	72	1
Davao City	16	9	9	16	11	10	71	1
Bacolod City	20	9	9	7	11	18	74	1
Zamboanga City	14	7	9	7	7	16	62	2
Digos, Davao del Sur	12	6	9	7	11	5	50	3
Bacacay, Albay	1	5	9	11	20	5	51	3
Bangued, Abra	1	6	8	7	20	6	48	4
Dalaguete, Cebu	1	5	8	4	11	5	34	5
Baybay, Leyte	10	9	8	16	9	6	58	3
Roxas City	10	9	8	16	7	6	56	3
Cotabato City	12	9	8	11	11	7	58	3
Olongapo City	18	9	10	20	11			1
Subic	4	5	6	16	11	5	47	4
San Fernando (Pampanga)	14	6	7	20	11	7	65	2
Tarlac	12	8	8	16	11	8	63	2
Cabanatuan City	12	8	10	11	11	9	61	2
Lipa City	8	8	10	16	11	7	60	2
Lucena-Pagbilao-Tayabas	14	6	8	7	17	12	64	2
Daet	10	5	4	4	20	10	53	3

Methodology Memorandum No. 4

To : L. V. 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 can not be predicted, he also has to consider the probable variations in flows in order to develop a design on the basis of calculated risk.

In 1941, E. J. Gumbel devised a probability method by which recurring flows can be computed for design requirements. Under this method, the hydrologic data are analyzed as an "extreme value" distribution and the sets of hydrologic data are plotted as straight lines. Gumbel's method has been found advantageous to use.

B. Basic Data

The hydrologic data are found in Surface Water Supply Bulletins published by the Water Resources Division of the Bureau of Public Works (BPW). Data are presented in the following sequence:

1. Name of river basin
2. Name of stream
3. Location of gaging station in latitude and longitude
4. Drainage area in square kilometers
5. Records available: months and year
6. Gage elevation
7. Extremes; magnitude and dates of maximum and minimum flows
8. Remarks
9. Revisions
10. Presentation of daily discharge for one year

It should be noted that Surface Water Supply Bulletins after 1967 have not been published; they are on file at the BPW Water Resources Division.

C. Methodology

Below are the steps in Gumbel's probability analysis of streamflows.

Table MM4-1

1. Tabulate the monthly flows (mean, minimum or maximum, whatever is desired).
2. Take note of any changes in the yearly records as stated under "Remarks" or "Revisions" of the Bulletin. Write them under remarks in Table MM4-1.

Table MM4-2

1. Arrange all monthly flows in ascending order, i.e., from lowest to highest. Any flow that occurs more than once should be listed.
2. Rank the arranged flows under "m".
3. Take the logarithm of Q.
4. Solve for the probability flow by the formula

$$\frac{m}{n+1} \times 100$$

where, m is the rank of a particular flow
n is the total number of recorded flows.

5. Solve for the return period by the formula

$$\frac{n+1}{m}.$$

Figure MM4-1

1. Plot log Q as ordinate against probability as abscissa. Figure MM4-1 is Gumbel's special probability paper.
2. Draw a straight line (month line) passing through the points marked in step C-1. If not all the points fall on the line, adjust the line such that it passes on the average path of the points. Any return period which falls on the line is in month's term. The line may be extended in order to reach periods not covered by it.
3. Take the antilogarithms of the values of return periods in months as projected on the log Q scale (ordinate). The antilogs are the recurring flows in cubic meters per day.

TABLE MM4-1

MEAN-DAY DISCHARGE PER MONTH

Basin: Pampanga (San Vicente)

Station: Peñaranda River

Location: lat. 15°18'46"; long. 120°56'30"

Drainage Area: 575 sqkm

Gage Elevation: 11,050 m

Units: cumd x 1,000

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Minimum-Day Discharge/ Year	Remarks
1965	-	2,283	753	351	372	1,313	-	-	-	3,239	5,156	4,358		
1966	-	2,915	-	-	8,941	1,595	2,682	4,215	5,425	1,413	9,801	5,380		
1967	4,922	857	1,189	547	873	425	1,012	6,614	4,415	5,707	5,896	125		
1968	66	77	120	540	96	-	-	-	-	-	-	117		
1969	141	32	336	689	664	301	3,203	2,394	2,248	1,175	1,785	2,190		
1970	1,989	814	279	17	17	3,561	2,928	1,628	9,590	11,726	9,689	6,915		
1971	3,123	642	732	294	1,499	4,567	4,021	1,824	1,377	11,161	5,229	15,007		
1972	5,992	4,873	406	1,461	767	415	18,347	15,977	6,306	216	4,701	2,896		
1973	697	823	82	108	95	686	2,525	2,650	4,405	14,582	4,149	2,124		
1974	1,405	1,332	2,191	471	621	3,781	3,497	10,761	10,014	12,567	16,317	13,693		

TABLE MM4-2

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability $(\frac{m}{n+1} \times 100)$	Return Period (Months) $(\frac{n+1}{m})$
1	17	4.230	0.93	108.00
2	17	4.230	1.85	54.00
3	32	4.505	2.78	36.00
4	66	4.820	3.70	27.00
5	77	4.886	4.63	21.60
6	82	4.914	5.56	18.00
7	95	4.978	6.48	15.43
8	96	4.982	7.41	13.50
9	108	5.033	8.33	12.00
10	117	5.068	9.26	10.80
11	120	5.079	10.18	9.82
12	125	5.097	11.11	9.00
13	141	5.149	12.04	8.31
14	216	5.334	12.96	7.71
15	279	5.446	13.89	7.20
16	294	5.468	14.82	6.75
17	301	5.478	15.74	6.35
18	336	5.526	16.67	6.00
19	351	5.545	17.59	5.68
20	372	5.570	18.52	5.40
21	406	5.608	19.44	5.14
22	415	5.618	20.37	4.91
23	425	5.628	21.30	4.70
24	471	5.673	22.22	4.50
25	540	5.732	23.15	4.32
26	547	5.738	24.07	4.15
27	621	5.793	25.00	4.00
28	642	5.808	25.93	3.86
29	664	5.822	26,85	3.72
30	686	5.836	27.78	3.60
31	689	5.838	28.70	3.48
32	697	5.843	29.63	3.38
33	732	5.864	30.56	3.27
34	753	5.877	31.48	3.18
35	767	5.885	32.41	3.08
36	814	5.911	33.33	3.00
37	823	5.915	34.26	2.92
38	857	5.933	35.18	2.84

TABLE MM4-2 (continued)

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability ($\frac{m}{n+1}$ x 100)	Return Period (Months) ($\frac{n+1}{m}$)
39	873	5.941	36.11	2.77
40	1,012	6.005	37.04	2.70
41	1,175	6.070	37.96	2.63
42	1,189	6.075	38.889	2.57
43	1,313	6.118	39.815	2.51
44	1,332	6.124	40.741	2.45
45	1,377	6.139	41.667	2.40
46	1,405	6.148	42.592	2.35
47	1,413	6.150	43.518	2.30
48	1,461	6.165	44.444	2.25
49	1,499	6.176	45.370	2.20
50	1,595	6.203	46.296	2.16
51	1,628	6.212	47.222	2.12
52	1,785	6.252	48.148	2.08
53	1,824	6.261	49.074	2.04
54	1,989	6.299	50.000	2.00
55	2,124	6.327	50.926	1.96
56	2,190	6.340	51.852	1.93
57	2,191	6.341	52.778	1.89
58	2,248	6.352	53.704	1.86
59	2,283	6.358	54.630	1.83
60	2,394	6.379	55.555	1.80
61	2,525	6.402	56.481	1.77
62	2,650	6.423	57.407	1.74
63	2,680	6.428	58.333	1.71
64	2,896	6.462	59.259	1.69
65	2,915	6.465	60.185	1.66
66	2,928	6.466	61.111	1.64
67	3,123	6.494	62.037	1.61
68	3,203	6.506	62.963	1.59
69	3,209	6.510	63.889	1.56
70	3,497	6.544	64.815	1.54
71	3,561	6.552	65.741	1.52
72	3,781	6.578	66.667	1.50
73	4,021	6.604	67.592	1.48
74	4,149	6.618	68.518	1.46
75	4,215	6.625	69.444	1.44
76	4,358	6.639	70.370	1.42

TABLE MM4-2 (continued)

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability ($\frac{m}{n+1}$ x 100)	Return Period (Months) ($\frac{n+1}{m}$)
77	4,405	6.644	71.296	1.40
78	4,415	6.645	72.222	1.38
79	4,567	6.660	73.148	1,37
80	4.701	6.672	74.074	1.35
81	4,873	6.688	75.000	1.33
82	4,922	6.697	75.926	1.32
83	5,156	6.712	76.852	1.30
84	5,229	6.718	77.778	1.28
85	5,380	6.731	78.704	1.27
86	5,425	6.734	79.630	1.26
87	5,707	6.756	80.556	1.24
88	5,896	6.770	81.481	1.23
89	5,992	6.778	82.407	1.21
90	6,306	6.800	83.333	1.20
91	6,614	6.820	84.259	1.19
92	6,915	6.840	85.185	1.17
93	8,941	6.951	86.111	1.16
94	9,590	6.982	87.037	1.15
95	9,689	6.986	87.963	1.14
96	9,801	6.991	88.889	1.12
97	10,014	7.001	89.815	1.11
98	10,761	7.032	90.741	1.10
99	11,161	7.048	91.667	1.09
100	11,726	7.069	92.592	1.08
101	12,567	7.099	93.518	1.07
102	13,693	7.136	94.444	1.06
103	14,582	7.164	95.370	1.05
104	15,007	7.176	96.296	1.04
105	15,977	7.203	97.222	1.03
106	16,317	7.213	98.148	1.02
107	18,347	7.264	99.074	1.01

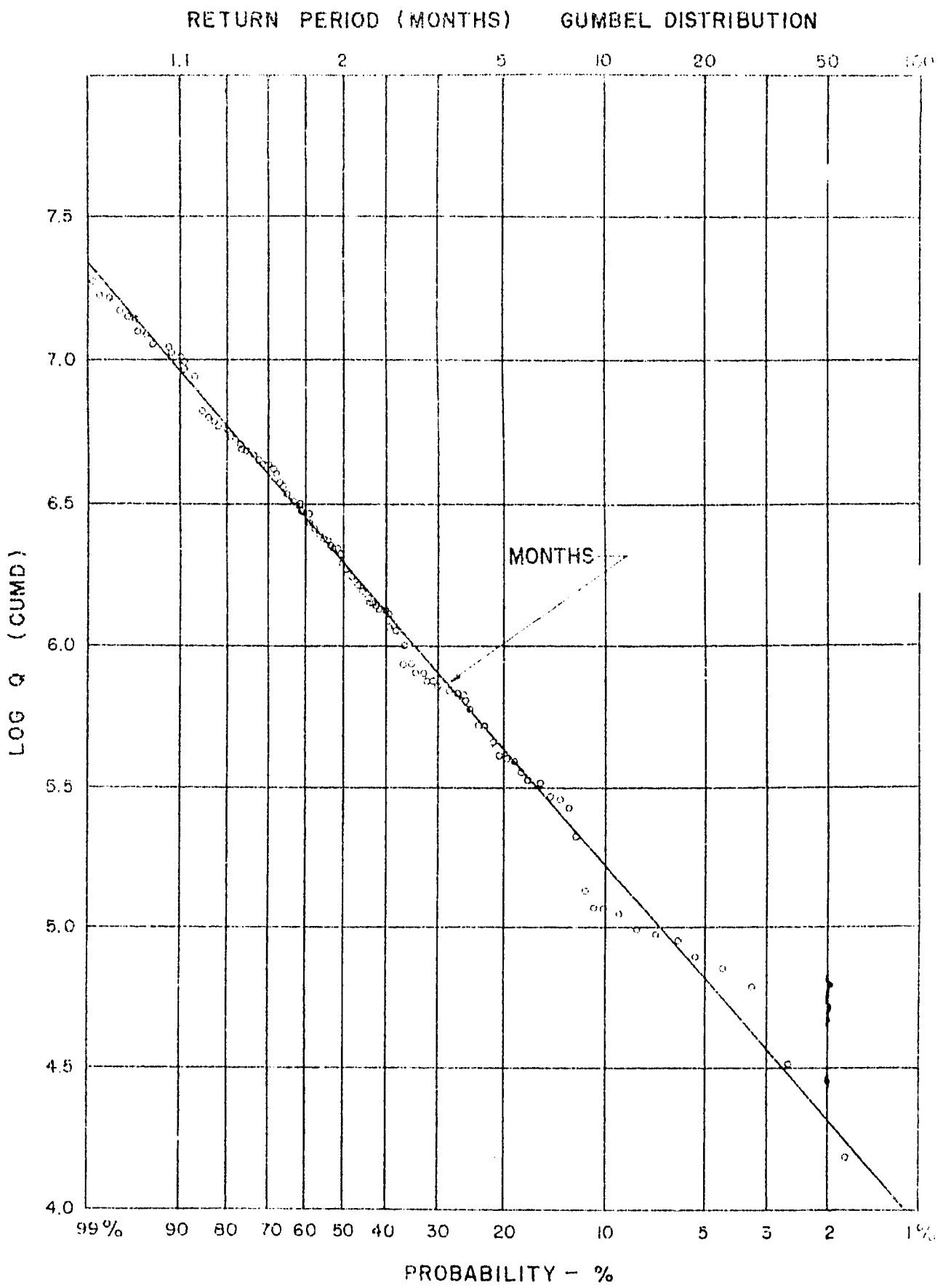

FIGURE MM4-1
MONTHLY MEANFLOW
(PENARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

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

Methodology Memorandum No. 5

To : L. V. Gutierrez, Jr.

From : J. B. Arbuthnot/B. R. Conklin

Date : 16 May 1977

Subject: Quantity of Storage Versus Rate of Supply

A. General

The demand for water in a water system is not uniform, therefore, the system must be designed to supply water at varying rates of demand.

One common method of supplying water at varying rates is to provide a specific amount of source pumping capacity and supply the difference between demand and pumping capacity from a water storage facility.

The most economical amount of pumping capacity and storage volume is selected based on cost studies of alternative combinations of facilities that would meet a community's needs. Some of the factors that should be considered in these cost studies and some basic guidelines for selecting properly sized facilities are presented in this memorandum.

B. Discussion

The amount of water a community needs at any particular instant is primarily dependent on the following factors:

1. The number of people within the community
2. The number of water-consuming facilities within the average home (faucets, toilets, showers, automatic washing appliances, etc.)
3. The habits of people (what times people eat, shower, sleep, etc.)

In general, daily usage of water follows a pattern with two peak usage periods during the day and low usage late at night. Figure MM5-1 shows a typical variation measured in a section of the Cebu City distribution system.

The relationship of the peak usage on an average day can be determined statistically for a given community. The statistical peak is an average of each person's peak usage and has two important properties:

1. The statistical peak is a function of the number of people in the community. The fewer people, the higher the peak may be because each person's peak usage could more easily affect the total flow.

2. The statistical peak should be recognized as a mathematical average, and on some days the peak usage could be much higher or lower than the statistical peak.

The common engineering practice for water systems is to supply water from a source at maximum-day rates either by pumping or gravity. Maximum-day demand is the maximum quantity of water used during an entire day in a single year. Water usage can be at or near maximum-day demand for a period of weeks during summer months. Source capacity must equal maximum-day demand because it would be impractical to store sufficient water to supply maximum-day demand rates for more than a few days.

The difference in demand between the peak-hour demands and the supply (which is equal to maximum-day demands) occurs during a period of short duration where demand exceeds supply. Stored water is used to meet this short period of excess demand and is called operational storage. It should be noted at this time that there are three categories of storage:

1. Operational storage - used to meet hourly fluctuations in demand.

2. Emergency storage - used to meet demands in case of breakdowns in source facilities; typically equal to a full day's demand.

3. Fire storage - used to meet the required volume of water used to extinguish the worst fire expected in the community.

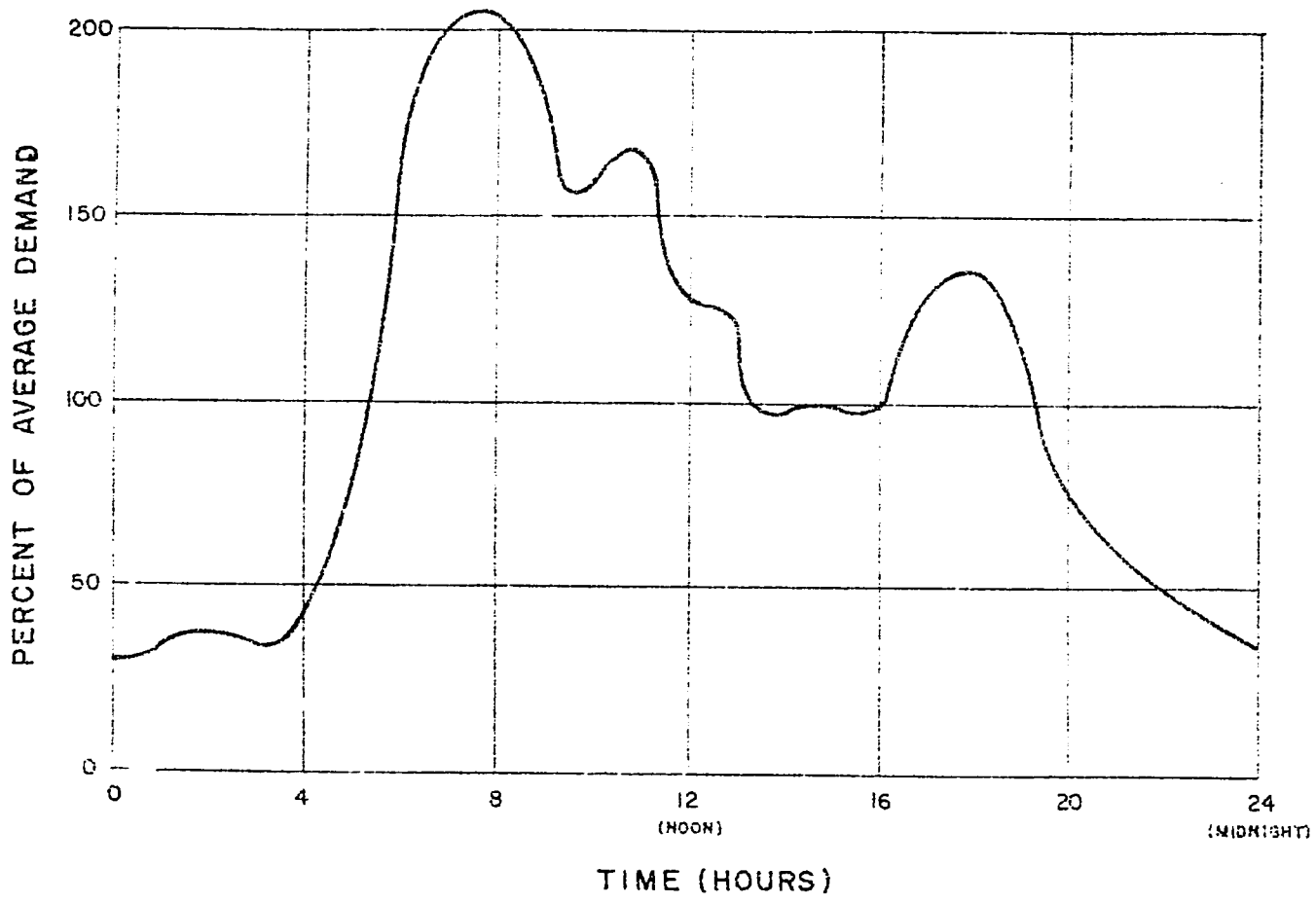

FIGURE MMS-1
DAILY USAGE PATTERN

Storage requirements for the last two categories have been largely neglected in these studies because of the excessive cost involved to provide the storage.

C. Methodology

The engineer must determine the amount of storage and source capacity to meet the demands in a specific community. A set of curves that relate the peak hourly usage to the number of people in a community has been developed by CDM and others.[1] Practice has shown that a volume of about 15 to 20 percent of the maximum-day usage is required as operational storage if source facilities can supply maximum-day demands. Combining the "peaking curves" with the operational storage requirement, a second set of curves relating the quantity of storage to the number of people, at different rates of source supply, has been developed (see Figure MM5-2).

Up to this point, the only option that has been discussed is to supply peak-hour demands from storage facilities. In many cases, the cost of storage facilities is so high that it may be more economical to provide additional source capacity and reduce the quantity of storage. This is especially true where storage is provided in elevated structures that are very costly, since they are built to withstand earthquakes. The curves in Figure MM5-2 have been used in this study to determine the requirements for storage at various supply rates in order to prepare cost comparisons of alternative supply and storage combinations.

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[1] ASCE Manual of Practice No. 37.

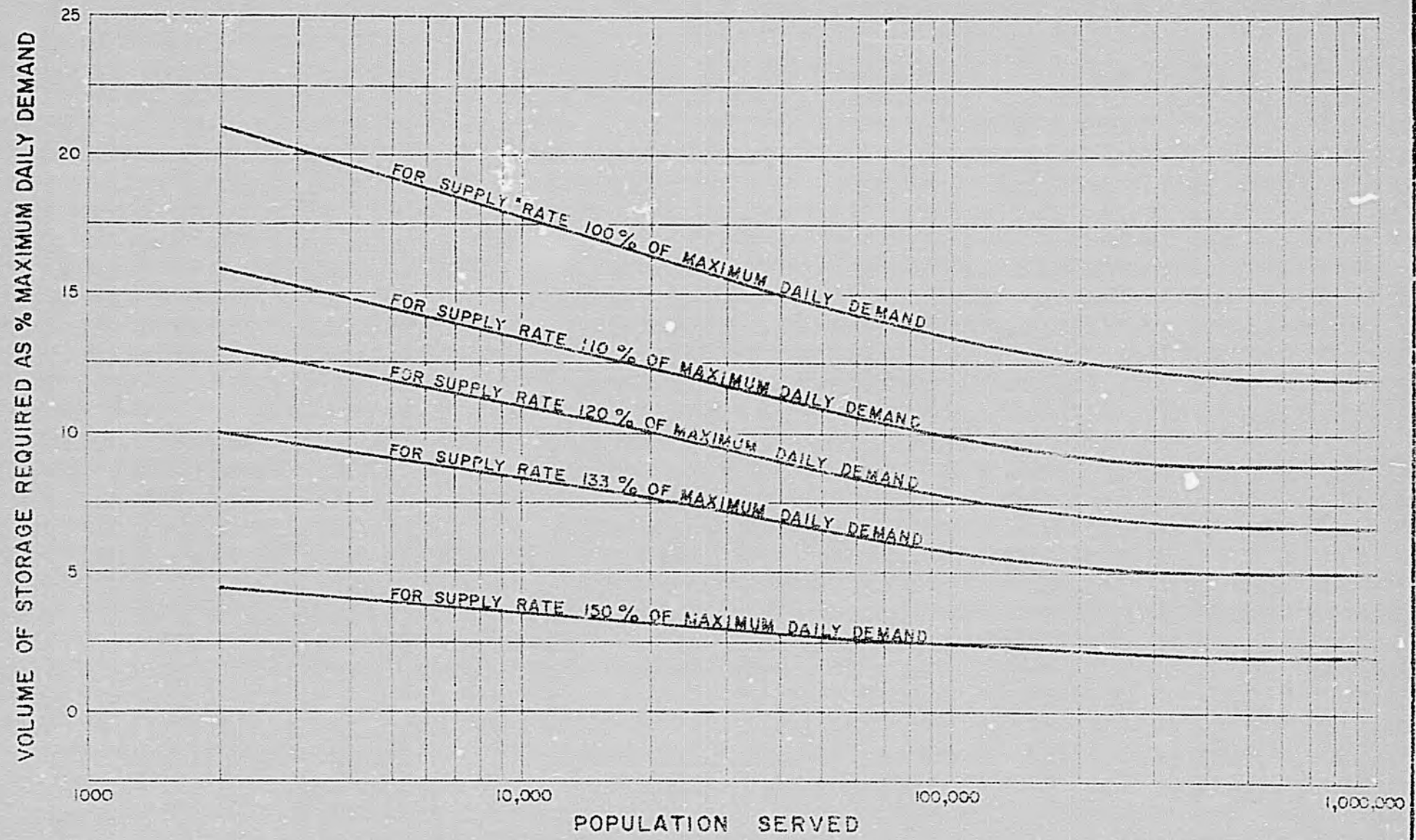

FIGURE MM 5-2
STORAGE REQUIRED
TO MEET
DAILY PEAK WATER DEMAND

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

Methodology Memorandum No. 6

To : L. V. Gutierrez, Jr.

From : J. Arbuthnot; B. Conklin

Date : 22 March 1977

Subject: Economical Sizing of Pumped Waterlines

A. General

This memorandum develops an expression for the most economic size of a pipeline for pumped water systems based on two cost factors: cost of pipe-in-place and cost of pumping (energy). The larger the pipe the greater the cost of construction. Also, the larger the pipe the lesser the cost of energy required to pump water through the pipe. The most economic pipe sizes would be where the incremental cost of pumping is equal to the incremental cost of pipe construction.

In most situations, the above cost factors are the most important factors in determining the economical size of transmission mains. Even when these are not the only important factors, it is still advantageous to know what is the most economic size of pipe with regard to these two factors.

B. General Relationship

The total annual cost of a pipe line is equal to the sum of its construction cost (expressed on an amortized annual basis) plus its annual pumping cost.

$$C_t = C_c + C_p \text{ [1]}$$

To determine the most economic pipe diameter both the factors on the right hand side of the equation were expressed in terms of the diameter of the pipe. The equation was then differentiated with respect to the diameter, and solved for the diameter for which the resulting expression was equal to zero.[2]

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[1] Total Annual Cost = Annual Construction Cost + Annual Pumping Cost.

[2] $\frac{d(C_t)}{dx} = \frac{d(C_c)}{dx} + \frac{d(C_p)}{dx} = 0$, where X = pipe diameter

C. Annual Construction Cost

The construction cost of the pipe was taken from Table G-4 of Appendix G, Basis of Cost Estimates, in Volume II of the final report. Costs were adjusted by adding a value for necessary valves and by escalating these by 10 percent per year for 2 years to obtain July 1978 construction costs. These costs were then increased by 15 percent for contingencies and then by 10 percent for engineering. The following equation was derived and represents the adjusted construction costs in Table G-4 in terms of the diameter.

$$C = 2845\ (\text{Dia.})^{1.292} \quad \text{---- Equation 1}$$

C is the installed cost of pipe in pesos per meter, and Dia, the diameter of the pipe in meters.

The amortized annual cost of construction is the cost of construction multiplied by the capital recovery factor (as influenced by the economic life of the pipe and discount factor). The general equation is:

$$\text{Annual Cost of Construction} = \text{CRF} \times 2845(\text{Dia.})^{1.292} \quad \text{---- Equation 2}$$

where CRF is the capital recovery factor; for n = 50 years, discount rate = 12%, CRF is equal to 0.12042.

D. Annual Pumping Cost

The annual cost of pumping energy may be expressed in terms of the amount of water pumped, the energy required to overcome the frictional loss in the pipe, the price of electrical energy and the efficiency of the pumping machinery. The general equation may be written as:

$$\text{Annual Cost of Pumping Energy} = \frac{\text{Mass/Year} \times g \times \text{Hf} \times ₱/\text{kwh}}{\text{efficiency} \times 3.6 \times 10^6} \quad \text{---- Equation 3}$$

where mass/Year is the amount of water pumped in kilograms; g, the gravitational constant; Hf, the energy lost by friction of flow in the pipe expressed in meters; ₱/kwh, the cost of energy in pesos per kilowatt hour; and 3.6×10^6, the number of newton-meters per kilowatt hour.

The friction loss of energy in the pipe may be expressed in terms of the diameter utilizing the Hazen-Williams (H&W) equation,

$$\text{Hf} = \frac{L \times \text{MLD}^{1.852}}{361.27\ C^{1.852}\ D^{4.87}} \quad \text{---- Equation 4}$$

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 HT in the equation for the cost of pumping energy, combining this with the expression for the annual cost of construction, differentiating, setting the resulting expression equal to zero and solving for the diameter:

$$\text{Minimum Cost Diameter} = \frac{MLD^{0.4628} \times (\text{pesos/kwh})^{0.1623}}{2.391\ (\text{efficiency})^{0.1623}\ C^{0.3005}\ (A/P,\ I\%,\ n)^{0.1623}}$$

using a C value of 120 and a capital recovery factor of 0.12042, the following equation is obtained:

$$\text{Minimum Cost Diameter} = \frac{MLD^{0.4628}(\text{pesos/kwh})^{0.1623}}{7.149\ (\text{efficiency})^{0.1623}} \quad \text{- - - - Equation 5}$$

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 3 years, and the formulas, along with Figure MM 6-1, adjusted accordingly.

2. Other Assumptions

Other assumptions are:

C = 120 (Hazen & Williams coefficient)
i = 12% (Discount rate)
n = 50 years (Economical life of pipe)

The derivation also assumes that for the changes in pumping head, using various pipe sizes for a design flow, the total construction cost of the pumping station remains constant. This assumption is reasonable since the difference in cost

between one pump selection and another for different heads at the same flow would not alter the cost of the complete station by significant amount. Generally, the installed motor horsepower would also be the same since the motors come in standard sizes and one size may be used for a number of different pump selections at a given flow.

The relative rate of inflation for pipeline construction is assumed equal to that of power costs.

3. Flow Quantities are Based on Constant Flow

The derivation of the most economic pipe diameter is based on a constant rate of flow within the pipe. This is probably the most general and therefore the least accurate of any of the assumptions.

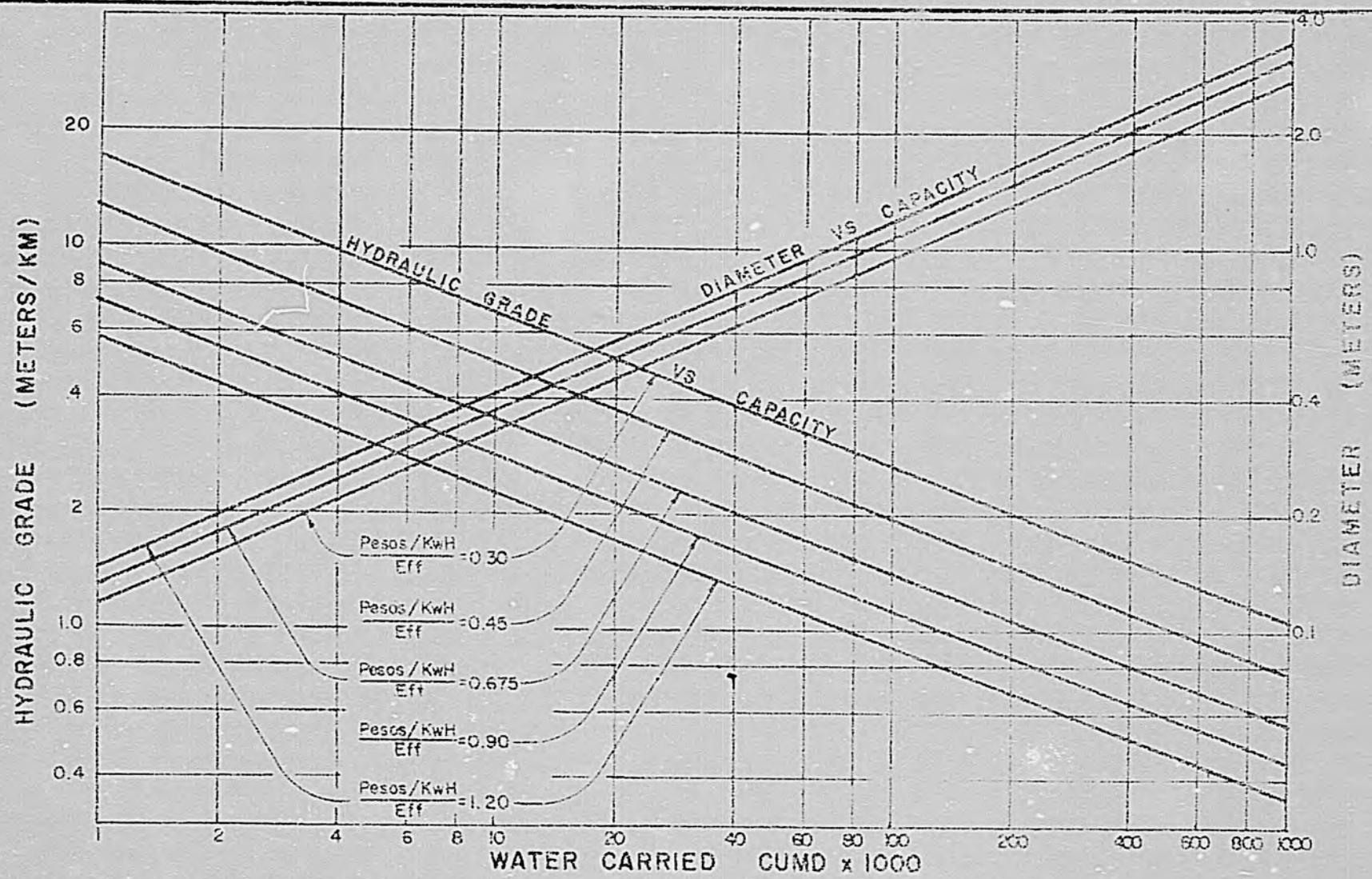
Normally a pipeline is designed for a specific flow condition; even under design conditions that flow may occur only part of the time. The flow in a transmission main could be expected to nearly equal the design flow for long period of time. However, in a distribution main, sized for peak-hour flows, the flow may not be equal to the design flow except for very short periods of time.

The variation in energy costs due to a fluctuating pumping rate through a pipeline can be calculated and applied to adjust the most economic pipe diameter determined from Figure MM 6-1. This so-called "energy variability factor" is discussed in the following section.

G. Energy Variability Factor

Figure MM 6-1 is based on selecting a pipeline where the flow will be constant throughout the year. In most cases, pipeline sizes are selected on a maximum expected rate of flow. If the flow through the pipeline is less than the design flow, the pumping head (which directly affects energy costs) would decrease according to the 2.852 power of the flow (Q). Conversely, if flow greater than design flow rate is pumped through a pipeline, the energy cost would be increased by the 2.852 power.

The overall difference in energy costs over the day or year can be calculated by comparing the costs of pumping at a constant flow rate with the cost of pumping at the expected flow variation. This value is the so-called "energy variability factor" (EVF). The design flow for the pipe is used as the base flow and the actual flow to the design flow over the day is expressed as a percent.



Note : 1. CONSIDERS CONSTRUCTION AND PIPELINE FRICTION COSTS ONLY INCLUDING ENGINEERING AND CONTINGENCIES
2. AVERAGE C = 120 OVER 50 YEARS
3. ECONOMIC DISCOUNT RATE = 12 %
4. PIPE COST (MID 1978 PRICES) = $2845D^{1.29}$ PER METER, (D IN METERS)

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

FIGURE MM6-1
MOST ECONOMIC WATER TRANSMISSION

The method used is to raise the difference between actual flow and the base flow (expressed as a percentage) to the 2.852 power. The ratio of the sum for the day of the actual flow to the design flow each raised to the 2.852 power is equal to the EVF. Figure MM 6-2 and Table MM 6-1 present two possible flow variations and the calculated energy variability factor for each.

The two flow patterns selected for Figure MM 6-2 are not commonly used design curves. Pattern 1 was selected to show that if a higher rate of flow than the design flow is pumped through the pipeline during a portion of the day, the EVF is greater than 1.0. Pattern 2 shows that if the actual flow rate is nearly equal to the design flow, the EVF would be nearly equal to 1.0.

An EVF of less than 1.0 would be a more common occurrence since the majority of pipelines are designed for some maximum future flow. The suggested EVF in a following section is an example of an EVF less than 1.0.

I. Application of EVF

The EVF can be used with Figure MM 6-1 in calculating the minimum cost pipe diameter. The EVF is inserted into the annual energy cost equation (equation 3) and then included in the differentiation, resulting in a revised equation as follows:

$$\text{Minimum Cost Diameter} = EVF^{0.1623} \frac{MLD^{0.4628} \, (\text{Pesos/kwh})^{0.1623}}{7.149 \, (\text{efficiency})^{0.1623}} \quad \text{-- Equation 6}$$

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 Percent of Average Day Demand	Flow Pattern No. 1 Energy Variation	Flow Pattern No. 2 Percent of Average Day Demand	Flow Pattern No. 2 Energy Variation
1	32	0.039	48	0.123
2	36	0.054	48	0.123
3	39	0.068	48	0.123
4	33	0.042	100	1.000
5	46	0.109	100	1.000
6	95	0.864	100	1.000
7	193	6.522	120	1.682
8	206	7.855	120	1.682
9	198	7.016	120	1.682
10	156	3.554	120	1.682
11	169	4.466	120	1.682
12	129	2.067	120	1.682
13	123	1.805	120	1.682
14	95	0.864	120	1.682
15	99	0.972	120	1.682
16	96	0.890	120	1.682
17	107	1.212	120	1.682
18	133	2.255	120	1.682
19	130	2.113	120	1.682
20	87	0.672	100	1.000
21	64	0.280	100	1.000
22	54	0.172	100	1.000
23	42	0.084	48	0.123
24	38	0.063	48	0.123
		44.038		28.481

$EVF_1 \frac{44.038}{24.000} = 1.83$

$EVF_2 \frac{28.481}{24.000} = 1.19$

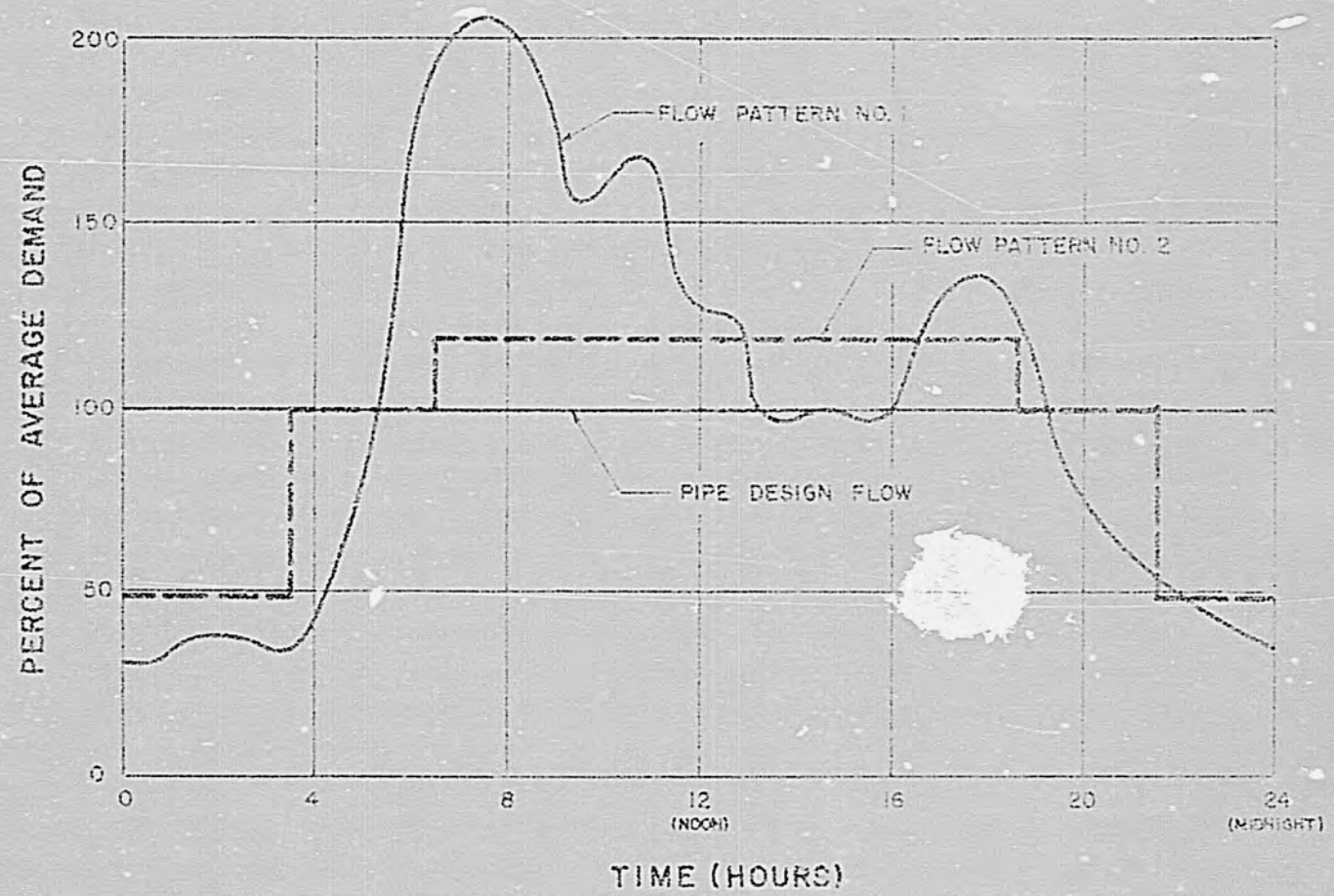


FIGURE MM6-2
SAMPLE FLOW PATTERNS

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

used for this study. Figure MM 6-3 presents an adjusted graph of diurnal flow using the shape of the Cebu curve but a maximum peak of 1.75. The EVF for this curve is equal to 0.32 (see Table MM 6-2) and when raised to the 0.1623 power, equals 0.83.

In practice, the EVF used for distribution systems in this study is only significant when the pipeline size is greater than 300 mm (significant means that EVF changes the recommended pipe size by a large incremental size).

K. Example

Problem: Select an economical distribution pipe size to convey a peak-hour flow of 20 MLD. The cost of power is 49 centavos per kilowatt hour, the pump efficiency is 81 percent, and the motor efficiency is equal to 90 percent.

Solution:

$$\frac{\text{Pesos/kwh}}{\text{Eff}} = \frac{.49}{.81 \times .90} = .672, \quad \text{say } .675$$

From Figure MM 6-1 using the flow of 20 MLD and Pesos/kwh/Eff = .675 select a pipe size of 500 mm.

For a flow variation in a distribution main, the EVF is equal to 0.32 and the EVF raised to the 0.1623 power is equal to 0.83. The most economical pipe size for the actual flow variation is equal to 0.83 x 500 m or 415 mm; so choose 400 mm pipe size.

TABLE MM 6-2

"EVF" FOR DISTRIBUTION SYSTEM

Hour	Percent of Average Day Demand	Percent of Design Flow[3]	Energy Variation[4]
1	35	20	0.010
2	40	23	0.015
3	39	22	0.013
4	37	21	0.012
5	73	42	0.084
6	134	77	0.475
7	164	94	0.838
8	175	100	1.000
9	174	99	0.972
10	163	93	0.813
11	162	93	0.813
12	134	77	0.475
13	118	67	0.317
14	94	54	0.172
15	94	54	0.172
16	94	54	0.172
17	105	60	0.233
18	129	74	0.424
19	123	70	0.362
20	96	55	0.182
21	72	41	0.079
22	58	33	0.042
73	47	27	0.024
24	40	23	0.015
			7.716

$$EVF = \frac{7.716}{24.000^*} = -.32 \qquad EVF^{0.1623} = 0.83$$

3/ Using 175 percent of average day as base flow for pipe design.
4/ Equals Percent Design Flow raised to the 2.852 power.
* Energy variation at constant flow

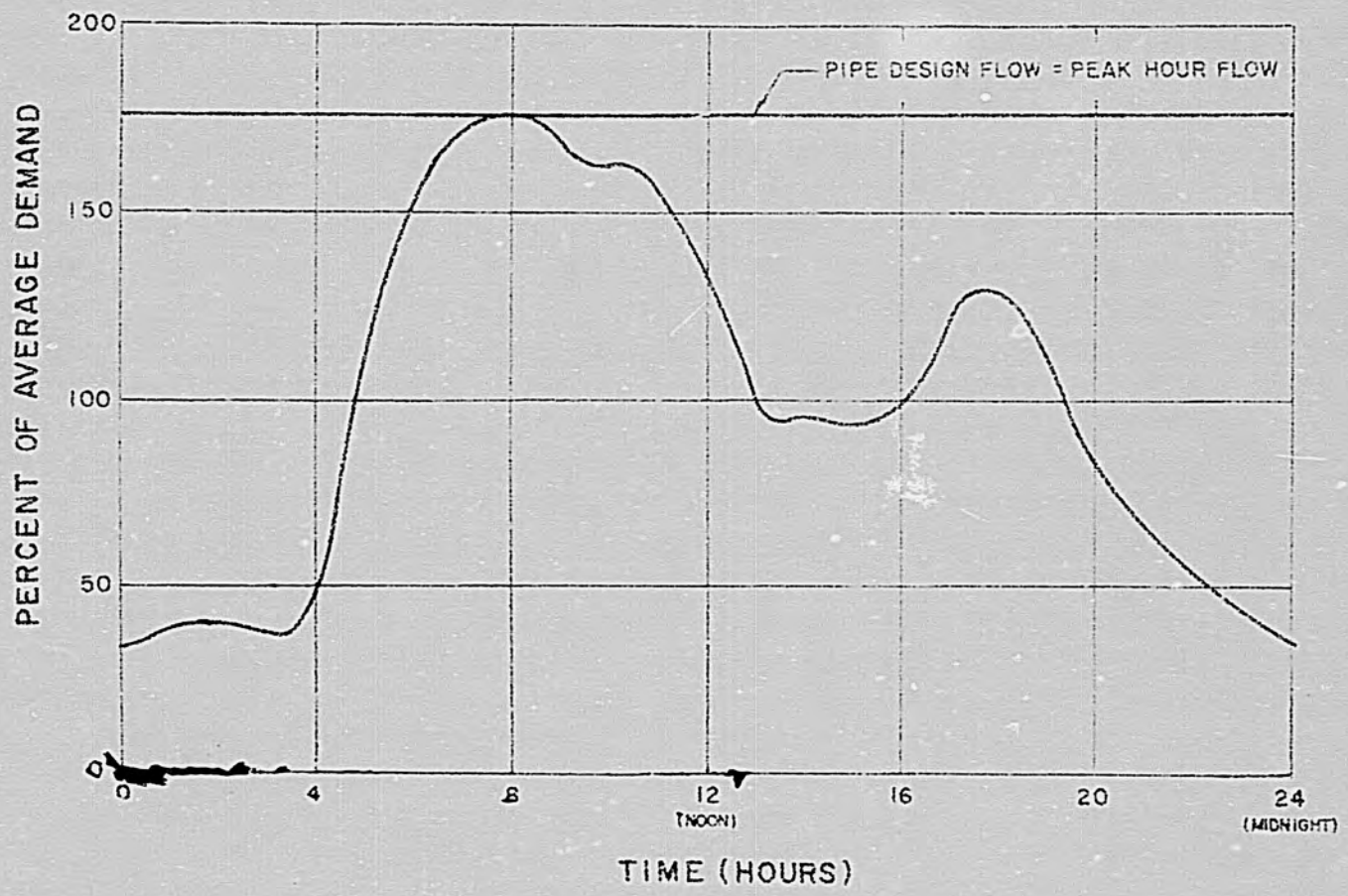
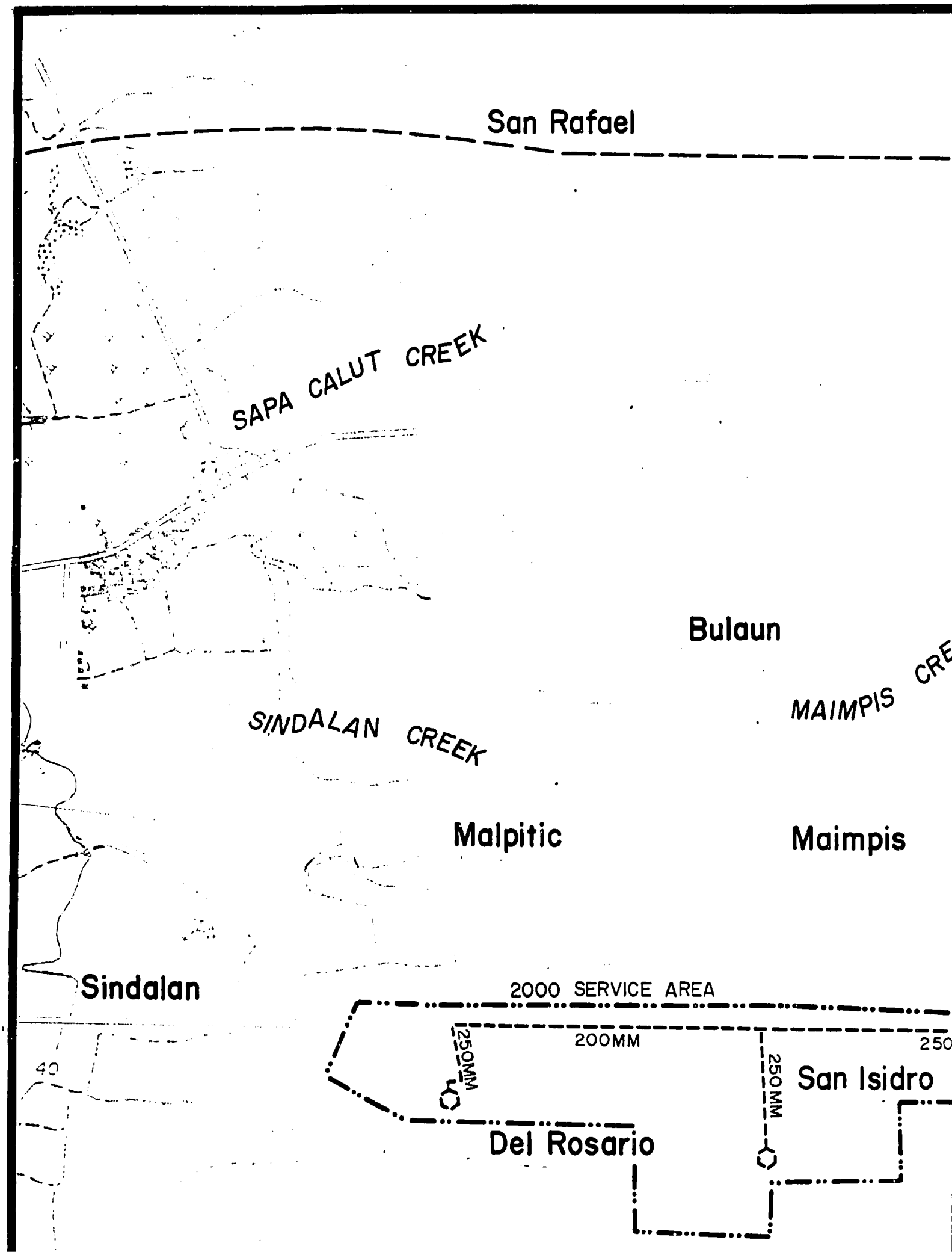
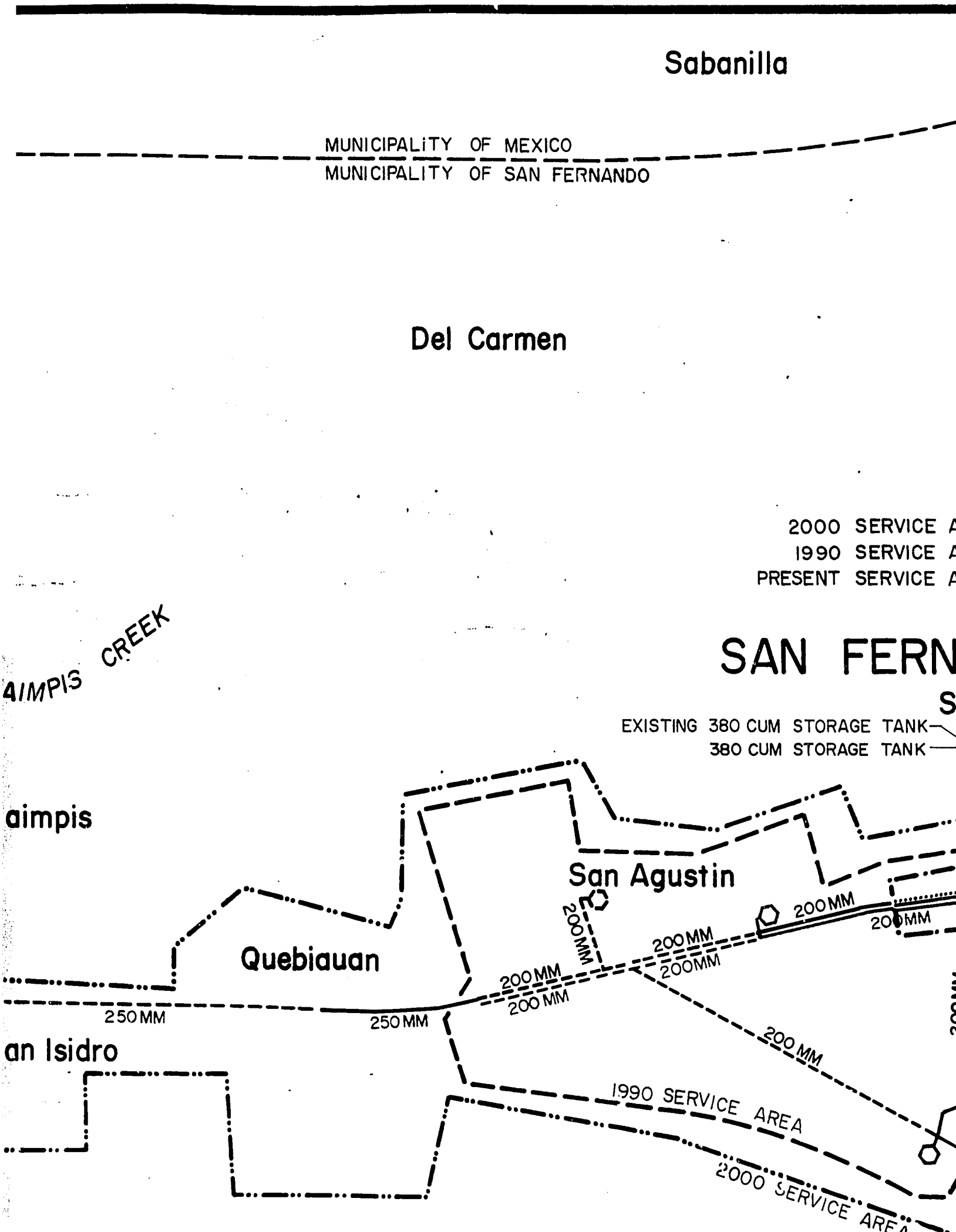
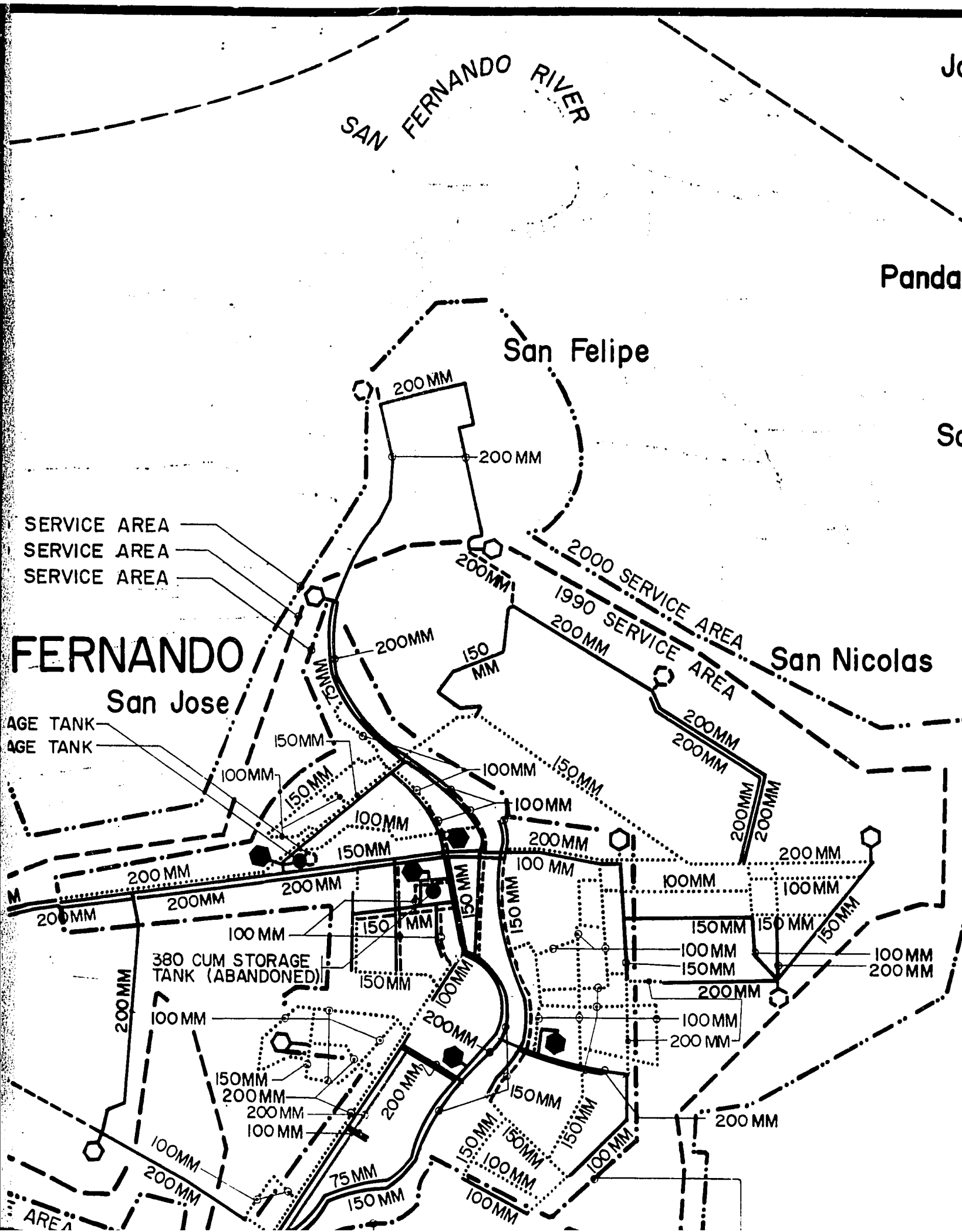
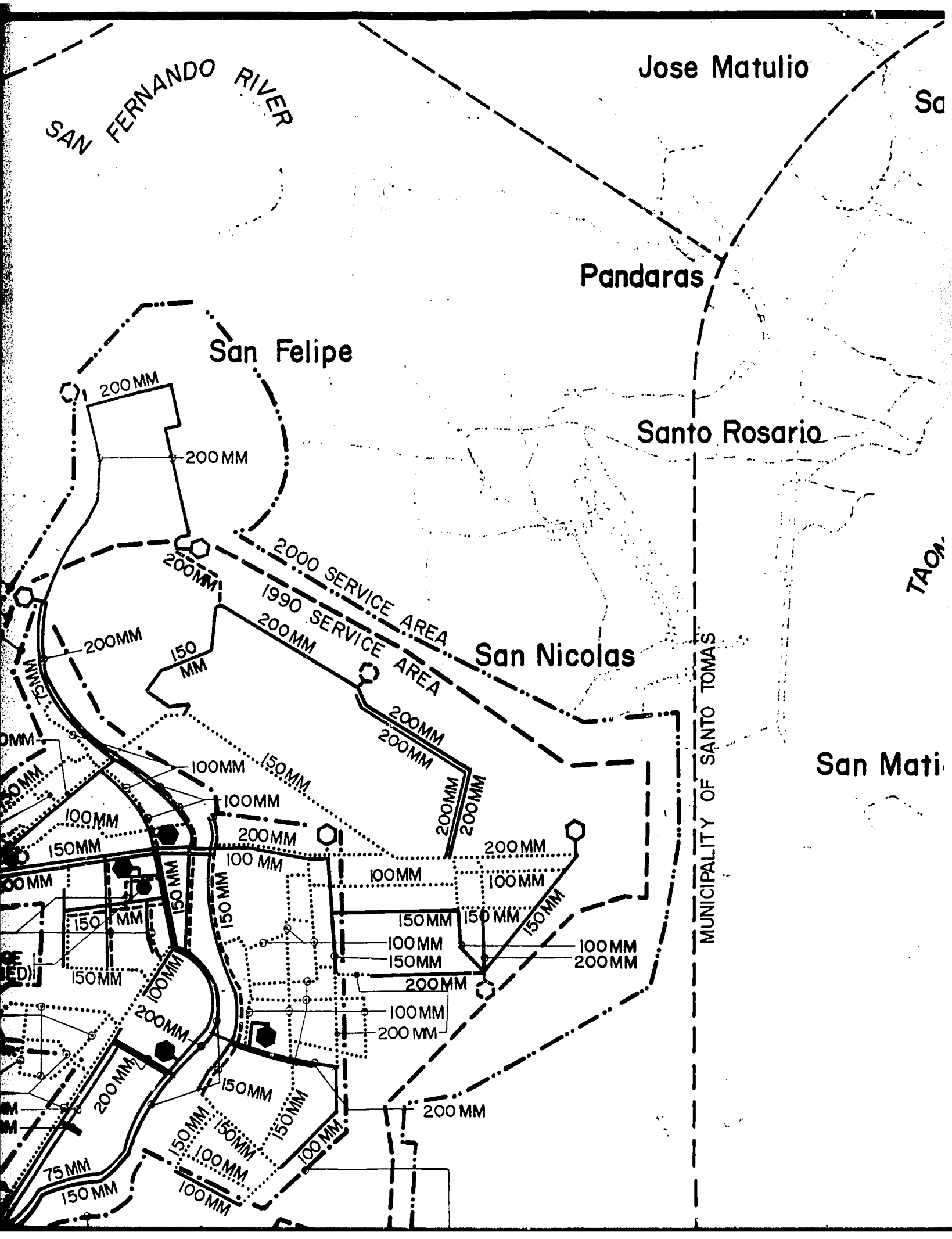


FIGURE MM6-3
TYPICAL FLOW VARIATION
FOR DISTRIBUTION MAINS


San Rafael
SAPA CALUT CREEK
Bulaun
MAIMPIS CRE
SINDALAN CREEK
Malpitic
Maimpis
Sindalan
2000 SERVICE AREA
200MM
250
250MM
250 MM
San Isidro
Del Rosario
40


Sabanilla
MUNICIPALITY OF MEXICO
MUNICIPALITY OF SAN FERNANDO
Del Carmen
2000 SERVICE A
1990 SERVICE A
PRESENT SERVICE A
CREEK
SAN FERN
S
EXISTING 380 CUM STORAGE TANK
380 CUM STORAGE TANK
aimpis
San Agustin
Quebiauan
200 MM
200 MM
200 MM
200 MM
200 MM
200 MM
200 MM
250 MM
250 MM
an Isidro
1990 SERVICE AREA
2000 SERVICE AREA


SAN FERNANDO RIVER
San Felipe
200 MM
200 MM
SERVICE AREA
SERVICE AREA
SERVICE AREA
2000 SERVICE AREA
1990 SERVICE AREA
200MM
200MM
150 MM
FERNANDO
San Jose
San Nicolas
AGE TANK
AGE TANK
150MM
100MM
150 MM
100MM
150MM
100MM
100MM
200 MM
200MM
200 MM
200MM
200MM
200MM
200MM
200 MM
100 MM
100MM
100MM
150 MM
150 MM
150 MM
150 MM
150MM
150 MM
150MM
100 MM
380 CUM STORAGE
TANK (ABANDONED)
150MM
100MM
150MM
100MM
200MM
200MM
200MM
100 MM
100MM
200 MM
150MM
200MM
200MM
100 MM
150MM
150MM
150MM
150MM
100 MM
200 MM
100MM
200MM
75 MM
150 MM
100MM
AREA


SAN FERNANDO RIVER
Jose Matulio
Pandaras
San Felipe
Santo Rosario
2000 SERVICE AREA
1990 SERVICE AREA
San Nicolas
MUNICIPALITY OF SANTO TOMAS
200 MM
200 MM
200MM
200MM
150 MM
200MM
200MM
200MM
200MM
200MM
100MM
150MM
100MM
100MM
100MM
150MM
200MM
100 MM
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150 MM
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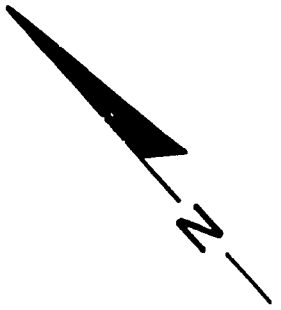
100 MM
150MM
100 MM
200MM
150MM
100MM
200 MM
200MM
200 MM
150MM
150MM
150MM
150MM
100 MM
100MM
75 MM
150 MM
100MM
200 MM

San Pablo

Polo

TAONG RIVER

n Matias



500 0 500 1000

SCALE IN METERS

LEGEND:

EXISTING SYSTEM

STORAGE TANK

WELL

PIPELINE

PROPOSED IMMEDIATE IMPROVEMENTS

WELL

PIPELINE

PROPOSED FIRST STAGE PROJECT

PHASE I - A

WELL

PIPELINE

PHASE I - B

STORAGE TANK

WELL

PIPELINE

PROPOSED SECOND STAGE PROJECT

PHASE II - A

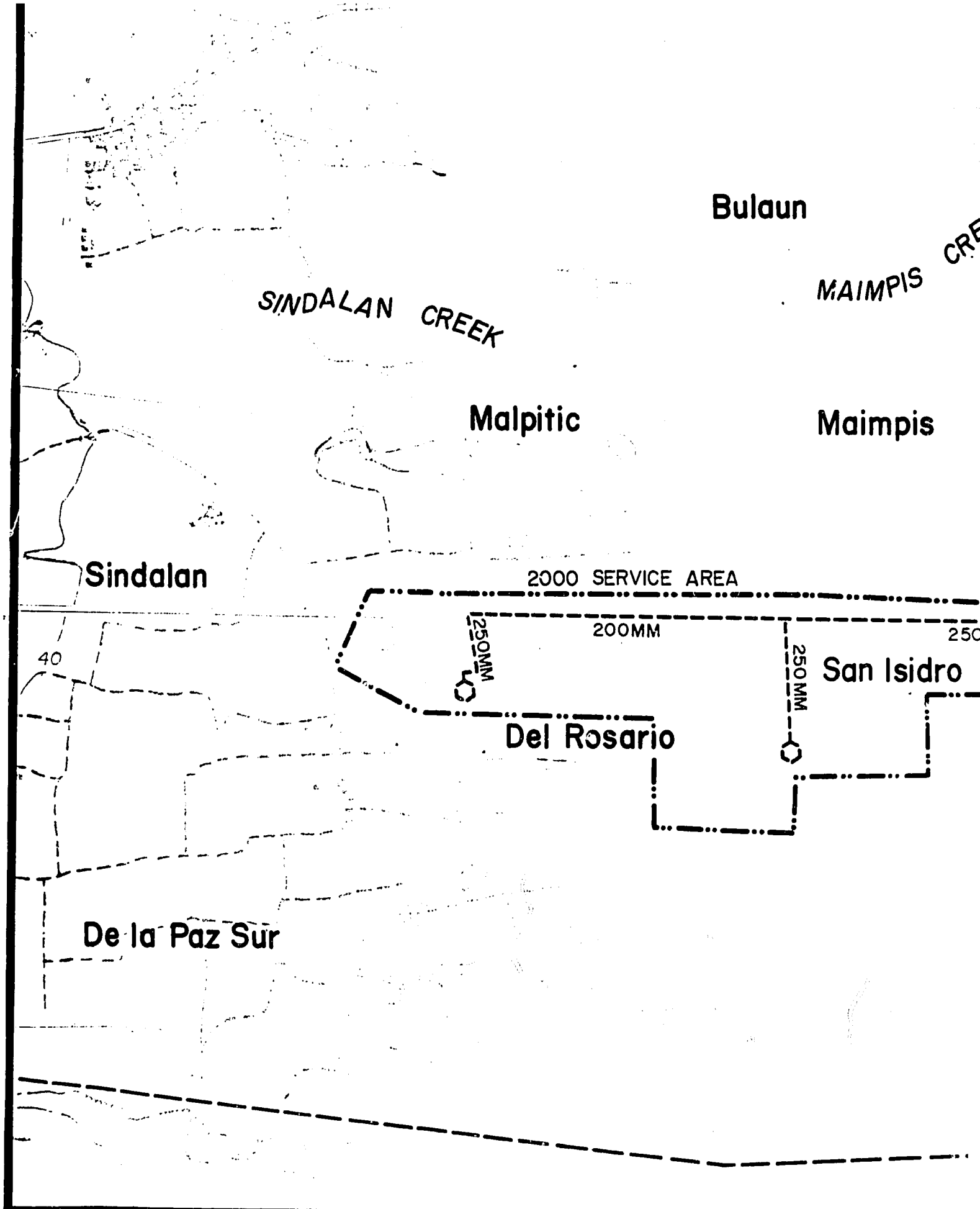
WELL

PIPELINE

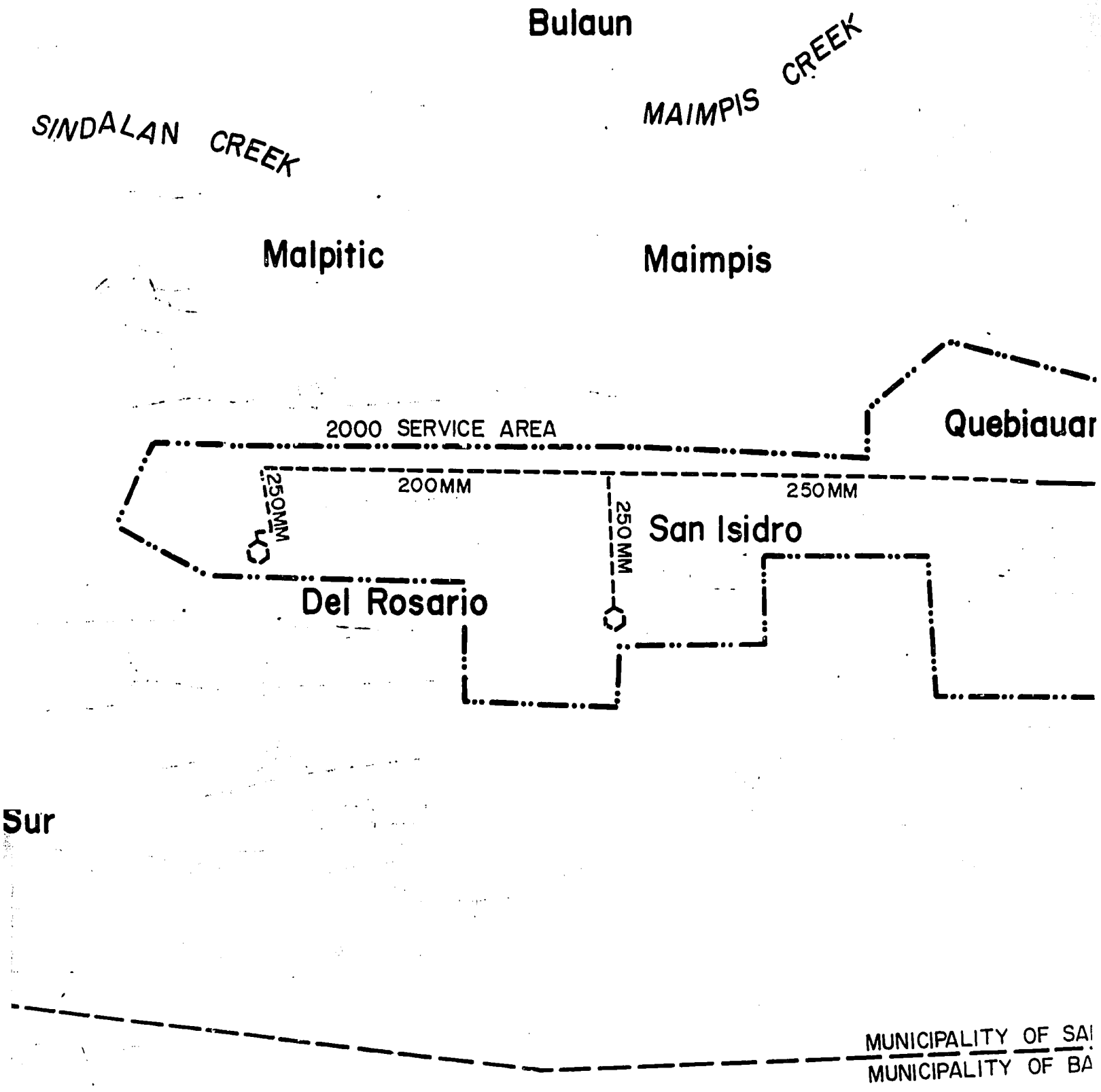
PHASE II - B

WELL

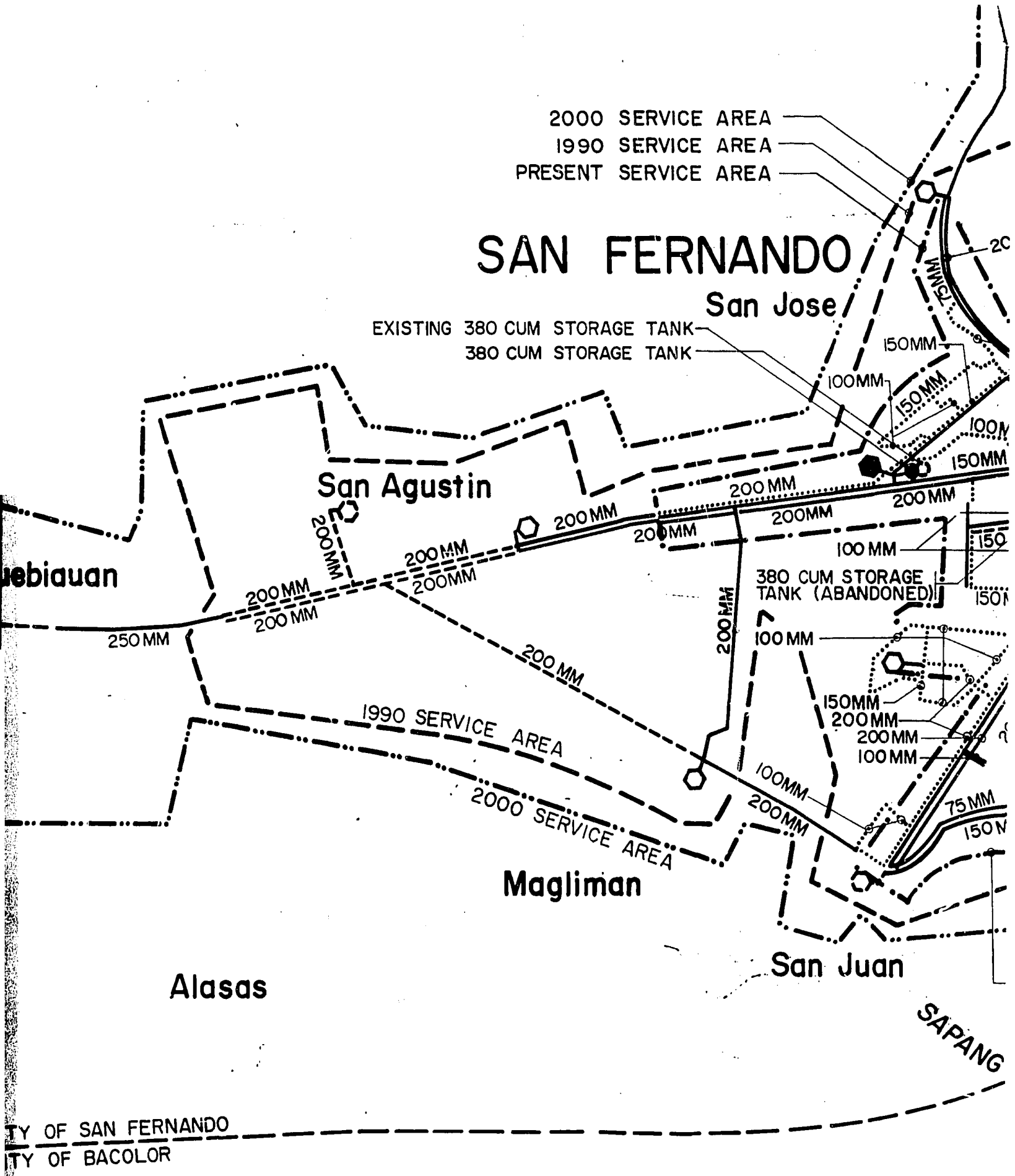
PIPELINE

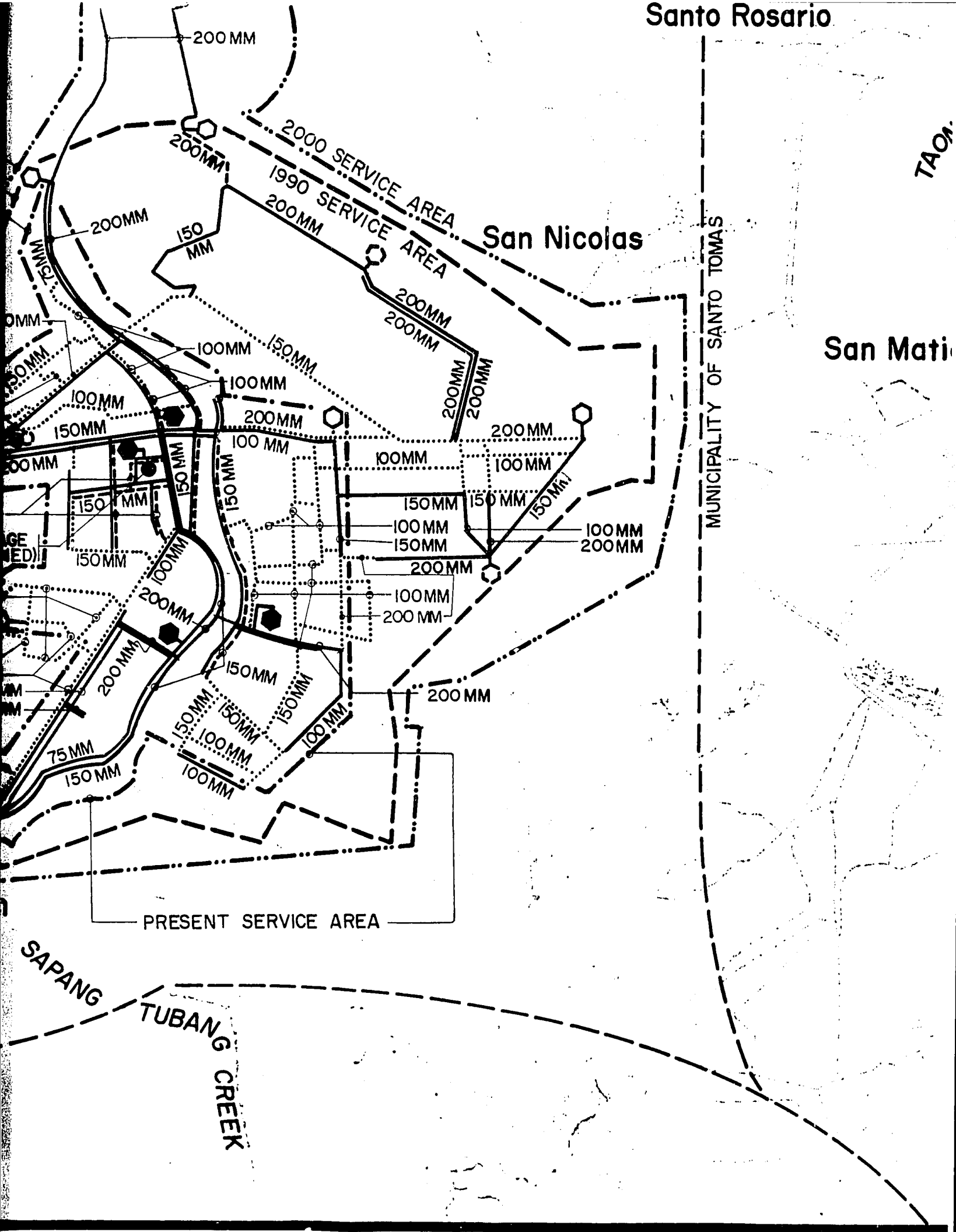


FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM



TUDY FOR WATER
D TEN URBAN AREAS LWUA-CDM


2000 SERVICE AREA
1990 SERVICE AREA
PRESENT SERVICE AREA
SAN FERNANDO
San Jose
EXISTING 380 CUM STORAGE TANK
380 CUM STORAGE TANK
150MM
100MM
150MM
150MM
San Agustin
200 MM
200 MM
200 MM
200 MM
200 MM
200 MM
200 MM
200 MM
200 MM
200 MM
200 MM
100 MM
380 CUM STORAGE TANK (ABANDONED)
250 MM
200 MM
200 MM
200 MM
100 MM
150MM
200MM
200MM
100MM
1990 SERVICE AREA
2000 SERVICE AREA
100MM
200MM
75MM
Magliman
San Juan
Alasas
SAPANG
TY OF SAN FERNANDO
TY OF BACOLOR


Santo Rosario
San Nicolas
San Mati
TAON
2000 SERVICE AREA
1990 SERVICE AREA
MUNICIPALITY OF SANTO TOMAS
PRESENT SERVICE AREA
SAPANG TUBANG CREEK
200 MM
200MM
150 MM
150MM
100MM
100 MM
75MM

TAONG RIVER

n Matias

STORAGE TANK

WELL

PIPELINE

PROPOSED IMMEDIATE IMPROVEMENTS

WELL

PIPELINE

PROPOSED FIRST STAGE PROJECT

PHASE I - A

WELL

PIPELINE

PHASE I - B

STORAGE TANK

WELL

PIPELINE

PROPOSED SECOND STAGE PROJECT

PHASE II - A

WELL

PIPELINE

PHASE II - B

WELL

PIPELINE

FIGURE IX-1

WATER SUPPLY SOURCE
TRANSMISSION AND DISTRIBUTION SYSTEM
MAP SHOWING

EXISTING FACILITIES
RECOMMENDED STAGE I FACILITIES
RECOMMENDED STAGE II FACILITIES

SAN FERNANDO WATER DISTRICT

MARCH 1978