社会開発協力部報告書

No. 9

LOCAL WATER UTILITIES ADMINISTRATION

MASTER PLAN AND FEASIBILITY STUDY OF THE LOCAL WATER SUPPLY PROJECTS IN THE REPUBLIC OF THE PHILIPPINES

TAGBILARAN WATER SUPPLY SYSTEM

JUNE 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of the Philippines, the Japanese Government decided to cooperate in formulating a master plan and making a feasibility study on the Local Water Supply Project and entrusted the work to the Japan International Cooperation Agency (JICA).

The JICA sent to the Philippines a survey team from 28 June 1981 to 27 December 1981. The team exchanged views with the officials concerned of the Government of the Philippines and conducted field surveys in the Ilocos Norte Province (Laoag City, Bacarra Municipality, Pasquin Municipality, Vintar Municipality and Paoay Municipality), the Albay Province (Legaspi City and Daraga Municipality) and the Bohol Province (Tagbilaran City). After the team returned to Japan, further studies were made and the present report has been prepared.

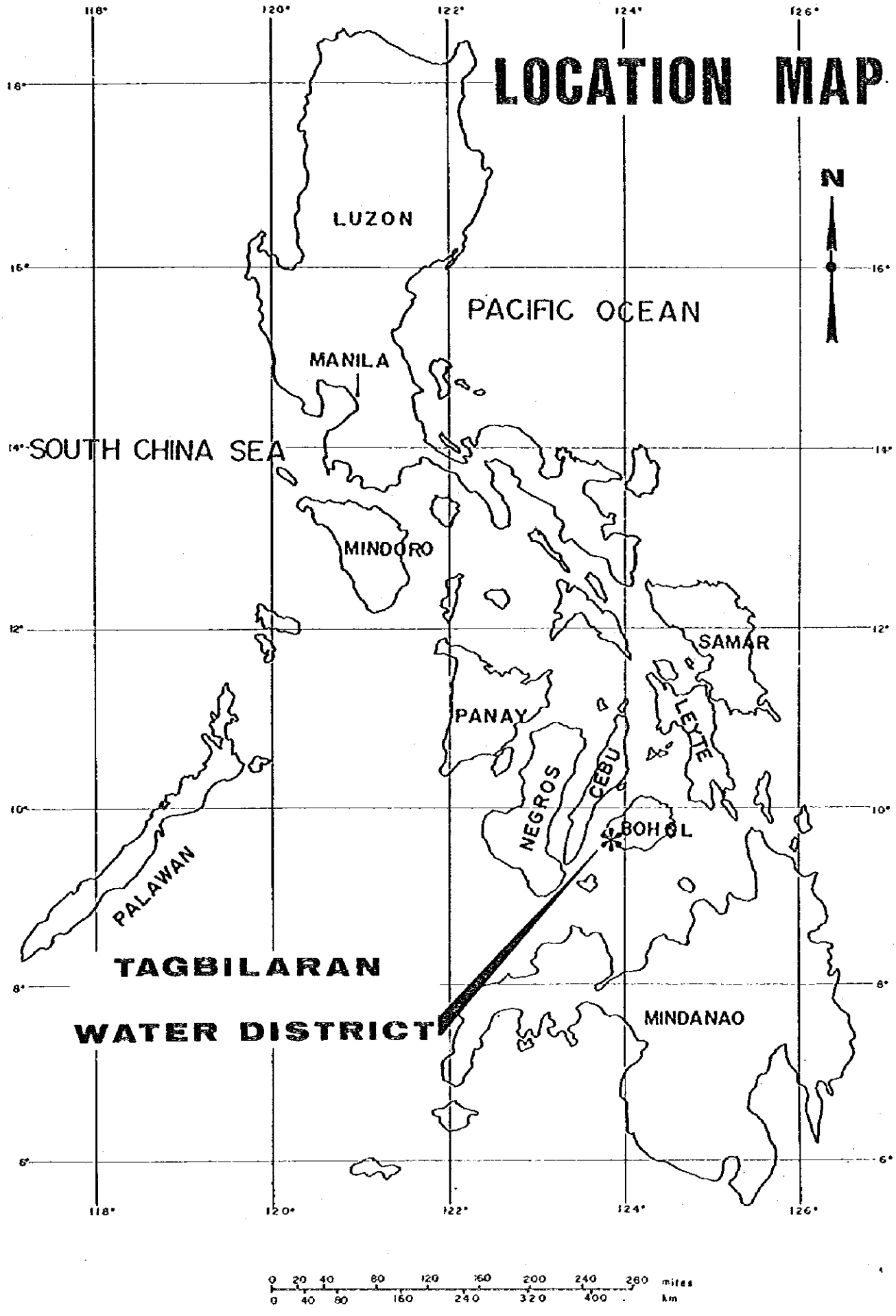
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

June, 1982

Keisuke Arita

Keisuke Arita
President
Japan International
Cooperation Agency


LOCATION MAP
N
LUZON
PACIFIC OCEAN
MANILA
SOUTH CHINA SEA
MINDORO
SAMAR
PANAY
LEYTE
NEGROS
CEBU
BOHOL
PALAWAN
TAGBILARAN
WATER DISTRICT
MINDANAO
118°
120°
122°
124°
126°
18°
16°
14°
12°
10°
8°
6°
0 20 40 80 120 160 200 240 280 miles
0 40 80 160 240 320 400 km

LIST OF CONTENTS

PART THREE: FEASIBILITY STUDY

APPENDIXES

ABBREVIATIONS

GOP	- the Government of the Republic of the Philippines
GOJ	- the Government of Japan
JICA	- the Japan International Cooperation Agency
LWUA	- the Local Water Utilities Administration
WD	- Water District
WTC	- willingness-to-connect
BPWS	- the Bohol Provincial Waterworks System
APWS	- the Albay Provincial Waterworks System
INMW	- the Ilocos Norte Metropolitan Waterworks
NEDA	- National Economic Development Authority
NCSO	- National Census and Statistics Office
BCGS	- Bureau of Coast and Geodetic Survey
NIA	- National Irrigation Administration
PAGASA	- Philippine Atmospheric, Geophysical and Astronomical Services Administration
NWRC	- National Water Resources Council
DPWTC	- Department of Public Works, Transportation and Communications
MPW	- Ministry of Public Works

mm	- millimeters
cm	- centimeters
m	- meters
km	- kilometers
cm^2, sq cm	- square centimeters
m^2, sq m	- square meters
km^2, sq km	- square kilometers
m^3, cu m	- cubic meters
cm/sec	- centimeters per second
m/sec	- meters per second
m^3/sec	- cubic meters per second
m^3/min, cu m/min	- cubic meters per minute

m^3/h, cu m/h	- cubic meter per hour
m^3/day, cu m/day	- cubic meters per day
l/sec	- liters per second
l/min	- liters per minute
l/c/d	- liters per capita per day
kg/cm^2, kg/sq cm	- kilograms per square centimeter
ha	- hectare
%	- percents
°C	- degrees centigrade
mg/l	- miligrams per liter
FTU	- function turbidity unit
pH	- potential of Hydrogen
ppm	- parts per million
mm/year	- millimeters per year
hp	- horse - power
rpm	- revolutions per minute
V	- volt
A	- ampere
kWh	- kilowatt-hour
kVA	- kilovolt-ampere
MVA	- mega volt-ampere
kW	- kilowatt
PVC	- polyvinyl chloride pipe
ACP	- asbestos cement pipe
CIP	- cast iron pipe
DIP	- ductile iron pipe
GSP	- galvanized steel pipe
SP	- steel pipe
Fig	- Figure

Currency Equivalent

US$1.00 = ₱7.80 (Philippine Peso)

Fiscal Year Period

from Jan. 1 to Dec. 31

SUMMARY

I. General

1.1 Physical and Socioeconomic Conditions

The Project Area consists of the whole of Tagbilaran City and the poblacion of Dauis Municipality. Tagbilaran City lies on the southwestern end of Bohol Island, and Dauis poblacion is located on another island opposite to the City. Most soil formations in the area are composed of limestone. Major features of the Area are as follows.

(1)	Location:	Southwestern end of the Bohol Island in the Philippines
(2)	Topography:	Limestone-rocky tableland with elevation of 20 - 50 m above sea level
(3)	Climate:	No pronounced dry/wet seasons Rainfall = 1,600 mm/year Not much variable temperature throughout the day and the year
(3)	Population:	42,275 in 1980, with 2.5% of annual growth rate
(4)	Socio-Economic Conditions:	Identified as a commercial, trading center and educational center Dialect: Cebuano (99%) Religion: Roman Catholic (98%) Road Condition: Ample in length and width, though not yet satisfactory in pavement Public Water Supply: Existing, however poorly supplying Sewerage System: Not existing Electricity: 48.7% in electrification Transportation: Accessible to various points in the island by roads and to neighboring provinces by water and air

1.2 Existing Water Supply

The existing water supply is operated by Bohol Provincial Waterworks System, covering two poblacions of Tagbilaran and Dauis. Water sources are all groundwater, being taken by means of deep well. As the area consists of porous limestone formations, withdrawal of groundwater is apt to cause seawater intrusion and some deep wells suffer from salinization of water, with some wells already abandoned. Generally the pipelines are deteriorated, with leaks, and supply conditions are very poor. Main features of the water supply are as follows.

(1)	System:	Started in 1924 with a deep well. Currently owned and operated by the Bohol Provincial Waterworks System.
(2)	Water Source:	Groundwater by 8 deep wells
(3)	Distribution System:	Storage facilities and a distribution network: Two reservoirs and 37,640 m of distribution mains with diameters of 150 - 38 mm
(4)	Present Water Use:	Maximum amount of supply = 4,700 cu m/day from 8 deep wells Served Population = 15,000 Service Connections = Total 2,556 including 2,130 domestic connections (715 of functioning meters)
(5)	Water Rate:	Peso 11.96 per month for domestic (Minimum charge for the first 14 cu m)

II. Master Plan

A period from the present up to the year 2010 was taken for the design period of the master plan of the Tagbilaran water supply system. Served population was planned to gradually increase from the present served population 15,000 (35% of the total population) to 68,085 (88%) at the end of the design period. Based on the served population, future water demand was projected.

Potential water sources to meet the projected water requirement were investigated in and around the project area, including groundwater and surface water, and groundwater was selected for future water supply use.

The whole master plan period was divided into three Phases I, II and III. Phase I covers a period up to the year 1987, and plans to increase the supply capacity by rehabilitation of the existing facilities and addition of reservoirs and pipelines. Phase II covers a period up to the year 1993 after Phase I, and increases the supply capacity by addition of new facilities. The rest period is Phase III.

Major figures and work items are tabulated below.

(1)	Target Year:	Phase I	= 1987
		Phase II	= 1993
		Phase III	= 2010
(2)	Service Area:	Present	: 480 ha
		1987	: 720 ha
		1993	: 1,980 ha
		2010	: 2,450 ha
(3)	Population Projection:	Present	: 42,275
		1987	: 49,910
		1993	: 56,870
		2010	: 77,020

(4) Served Population:

Present	:	15,000 (35%)
1987	:	24,840 (50%)
1993	:	39,440 (69%)
2010	:	68,085 (88%)

(5) Water Demand:

Present	:	4,700 cu m/day
1987	:	7,090 cu m/day
1993	:	9,800 cu m/day
2010	:	18,430 cu m/day

(6) Water Sources:

Present	:	8 deep wells
1987	:	9 deep wells
1993	:	11 deep wells
2010	:	16 deep wells

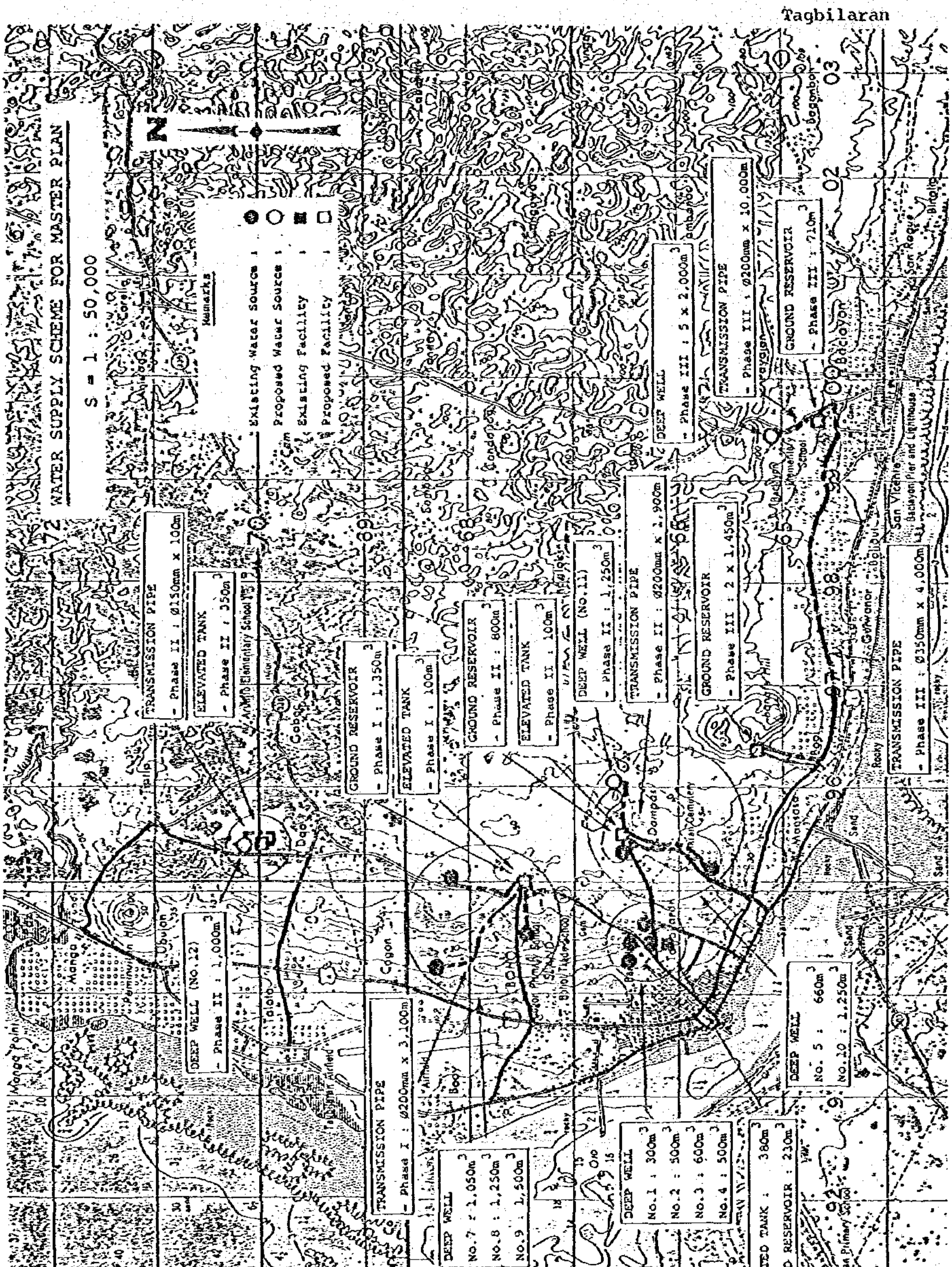
(7) Facilities to be Constructed:

See page 6.

(8) Project Cost:

	Phase I	Phase II	Phase III
Foreign	$1.26 M	$ 1.82 M	$ 3.86 M
Local	$0.78 M	$ 1.18 M	$ 2.46 M
Total	$2.04 M	$ 3.00 M	$ 6.32 M

(Costs as of July 1981: Not including price escalation)


WATER SUPPLY SCHEME FOR MASTER PLAN
S = 1 : 50,000
Remarks
Existing Water Source :
Proposed Water Source :
Existing Facility :
Proposed Facility :
TRANSMISSION PIPE - Phase II : Ø150mm x 100m
ELEVATED TANK - Phase II : 350m^3
GROUND RESERVOIR - Phase I : 1,350m^3
ELEVATED TANK - Phase I : 100m^3
GROUND RESERVOIR - Phase II : 800m^3
ELEVATED TANK - Phase II : 100m^3
DEEP WELL (No.11) - Phase II : 1,250m^3
TRANSMISSION PIPE - Phase II : Ø200mm x 1,900m
GROUND RESERVOIR - Phase III : 2 x 1,450m^3
TRANSMISSION PIPE - Phase III : Ø350mm x 4,000m
DEEP WELL - Phase III : 5 x 2,000m^3
TRANSMISSION PIPE - Phase III : Ø200mm x 10,000m
GROUND RESERVOIR - Phase III : 710m^3
DEEP WELL (No. 12) - Phase II : 1,000m^3
TRANSMISSION PIPE - Phase I : Ø200mm x 3,100m
DEEP WELL No. 7 : 1,050m^3 No. 8 : 1,250m^3 No. 9 : 1,500m^3
DEEP WELL No. 1 : 300m^3 No. 2 : 500m^3 No. 3 : 600m^3 No. 4 : 500m^3
ELEVATED TANK : 380m^3 GROUND RESERVOIR : 230m^3
DEEP WELL No. 5 : 660m^3 No. 10 : 1,250m^3

Facilities to be Constructed

Facilities	Phase I 1987	Phase II 1993	Phase III 2010
Deep Well	---	1 x (Ø 250mm x 60m) 1 x (Ø 250mm x 50m)	5 x (Ø 300mm x 80m)
Deep Well Pump Station	---	14.5 l/s, 29 Kw 11.6 l/s, 29 Kw	5 x (19.7 l/s, 29 Kw)
Elevated Tank	1 x100 m^3	1 x 100 m^3 1 x 350 m^3	---
Ground Reservoir	1 x 1350 m^3	1 x 800 m^3	1 x 710 m^3 2 x 1450 m^3
Pump Station	1 x (H=30 m, Q=62.9 l/s)	1 x (H=30 m, Q=39.1 l/s)	1 x (H=70 m, Q=98.7 l/s)
Transmission	Ø 200, L=3100 m	Ø 200mm, L= 1900m Ø 150mm, L= 100m	Ø 200mm, L=10000m Ø 350mm, L= 4000m
Distribution	Ø 250mm, L=3500m Ø 150mm, L=9600m Ø 100mm, L=5300m	Ø 200mm, L= 2500m Ø 150mm, L= 3500m Ø 100mm, L=16000m	Ø 350mm, L= 3000m Ø 200mm, L= 5000m Ø 150mm, L=20000m
Pump for No. 8 Well	1 x (H=70 m, Q=14.5 l/s)	---	---
Water Meter	1813 x Ø 13	---	---
Water Meter & Connection	2057 x Ø 13	3900 x Ø 13	6717 x Ø 13
Bulk Meter	13 x (Ø 250mm, Ø 200mm, Ø 150mm)	12 x (Ø 200mm, Ø150mm)	8 x (Ø 350mm, Ø200mm)
Chlorinator	2	2	2
Fire Hydrant	87	40	187
Valve	65 x (Ø 250mm, Ø 200mm, Ø150mm, Ø 100mm)	75 x (Ø 200mm, Ø 150mm, Ø 100mm)	101 x (Ø 350mm, Ø 200mm, Ø 150mm)
Pressure Gauge	10	---	---
Vehicle	2	1	1
Service Pipe	---	Ø50mm, L=39,000m	Ø50mm, L=67,000m

III. Feasibility Study

Feasibility study was carried out for two potential cases: Case 1 study was made on the Phase I project, and Case 2 study on the combined projects of Phases I and II. Phase I aims to increase the supply capacity by improvement of facilities adding reservoirs and pipelines. Phase II is to increase the capacity by constructing deep wells and some distribution facilities.

The results of the above study indicate that both projects are feasible. The only difference is that the Case 2 project is to given a government subsidy of 25% of the total investment cost.

(1) Implementation Schedule:

Phase I	:	1982 - 1984
Phase I + II	:	1982 - 1988

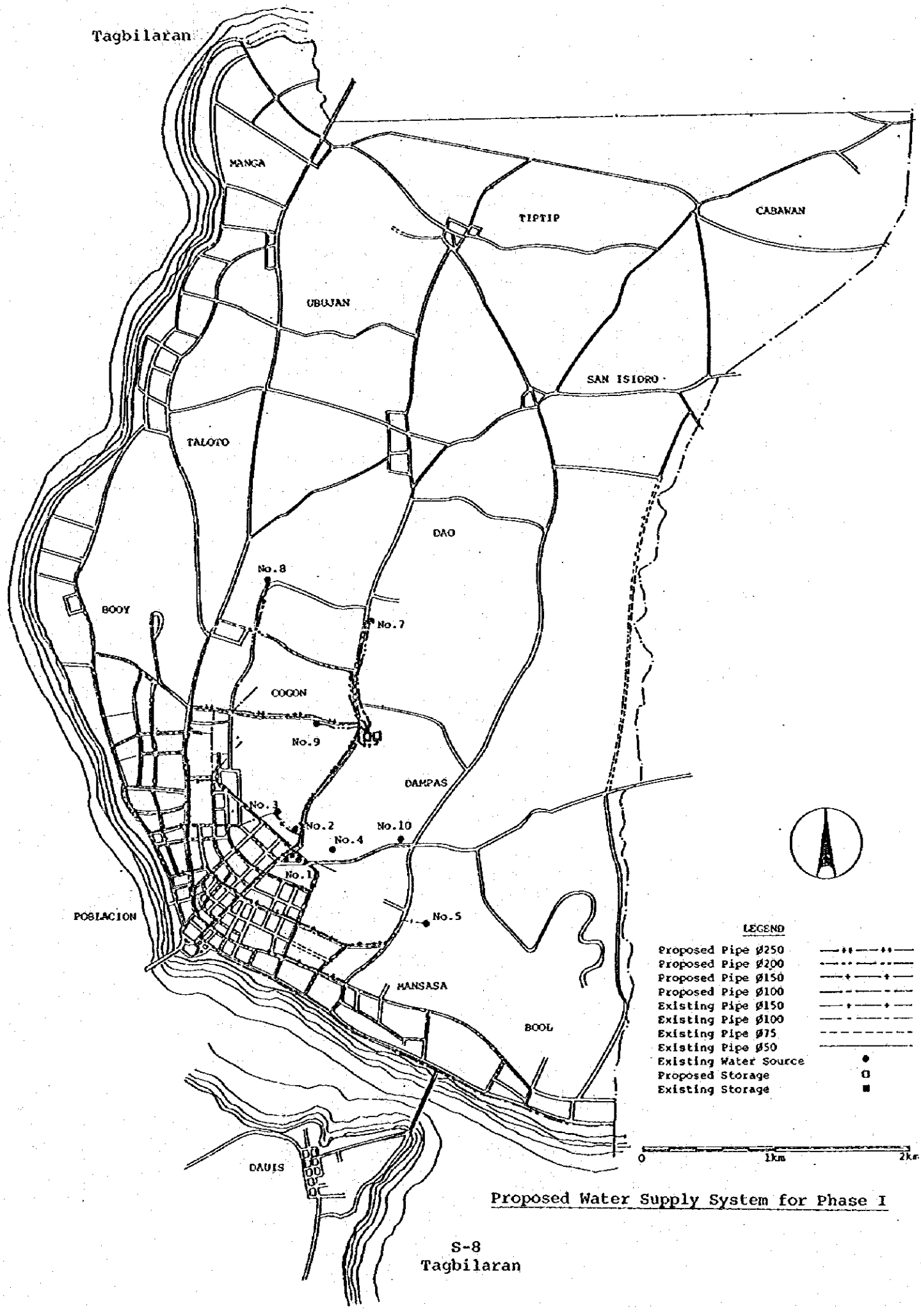
(2) Project Costs:

	Phase I	Phase I + II
Foreign	$1.89 M	$4.05 M
Local	$1.17 M	$2.51 M
Total	$3.06 M	$6.56 M

(Costs including price escalation according to implementation schedule)

(3) Financial Feasibility:

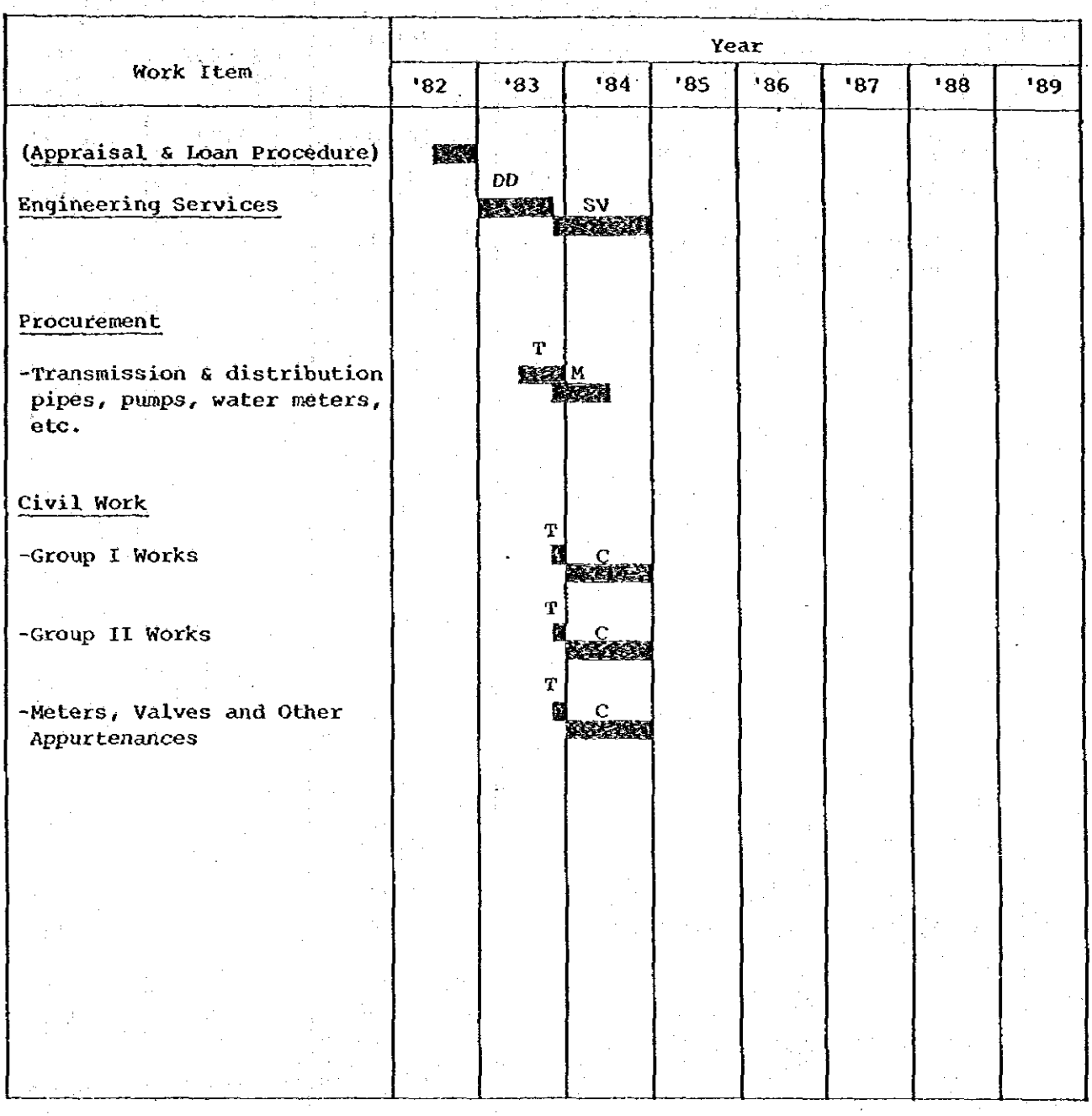
Phase I	:	Feasible
Phase I + II	:	Feasible with government subsidy of 25% of total investment cost



Proposed Water Supply System for Phase I

Construction Schedule for Phase I

(Target Year: 1987)



Note: DD = Detailed Design
SV = Supervision of Construction
T = Tendering Procedure (Advertisement/Tendering/Evaluation/Award)
M = Manufacturing & Shipping
C = Construction/Installation

Tagbilaran

Project Cost for Phase I

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Items	Cost		
	Total Cost	Foreign Currency Component	Local Currency Component
A. Group I Works	4,165	2,791	1,374
B. Group II Works	5,425	2,817	2,608
C. Meters, Valves and Other Appurtenances	3,045	2,233	812
Sub Total	12,635	7,841	4,794
Detailed Design Cost (10.5%)	1,327	796	531
Supervision Cost (3.5 %)	442	265	177
Land Cost	37	-	37
Total	14,441	8,902	5,539
Physical Contingency (10 %)	1,444	890	554
Total	15,885	9,792	6,093
Price Contingency	7,085	4,927	3,058
Grand Total (Project Cost)	23,870 (Equivalent to US$3.06 M)	14,719 (Equivalent to US$1.89 M)	9,151 (Equivalent to US$1.17 M)

Water Rate Schedule

(Phase I)

DOMESTIC AND GOVERNMENTAL SERVICE CONNECTIONS, 1/2"

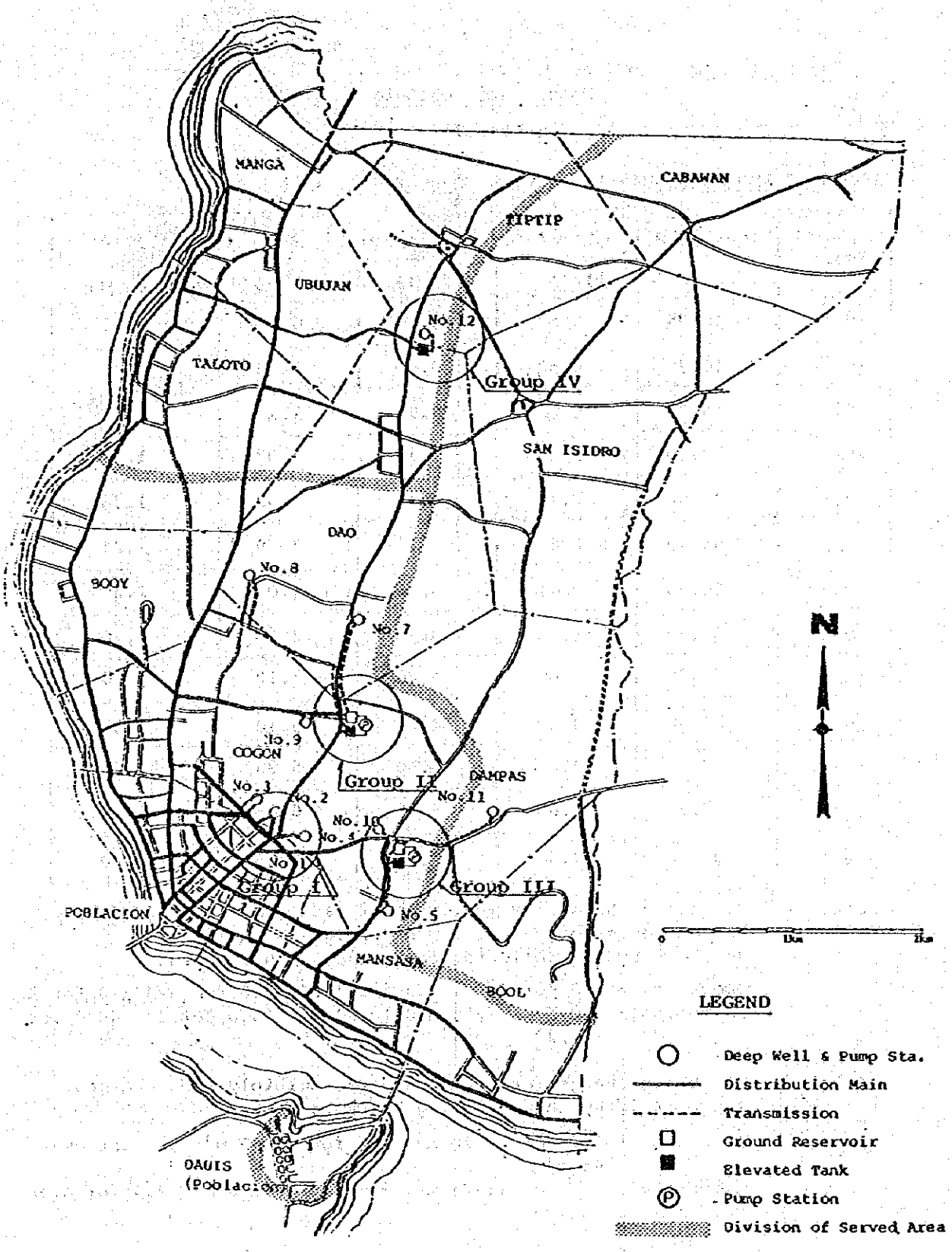
Year	First 10 m^3 1/	Charge for Each Added m^3 2/			Charge 3/ per Revenue Unit
		11-20	21-45	over 45	
1981	10.75	0.52	0.60	0.73	0.43
1982	10.75	0.52	0.60	0.73	0.43
1983	16.75	0.80	0.94	1.14	0.67
1984	27.50	1.32	1.54	1.87	1.10
1985	44.00	2.11	2.46	2.99	1.76
1986	55.75	2.68	3.12	3.79	2.23
1987	60.00	2.88	3.36	4.08	2.40
1988	67.50	3.24	3.78	4.59	2.70
1989	75.00	3.60	4.20	5.10	3.00
1990	75.00	3.60	4.20	5.10	3.00
1991	87.50	4.20	4.90	5.95	3.50
1992	97.50	4.68	5.46	6.63	3.90
1993	97.50	4.68	5.46	6.63	3.90

Note: 1/ To obtain charge per m^3 for the first 10 m^3 classified by connection size, multiply R.U. charge shown in 3/ above by the following connection size factors.

Domestic : 1.0 for 3/8"; 2.5 for 1/2"; 4.0 for 3/4"; 8 for 1"
Commerical: 5.0 for 1/2"; 8.0 for 3/4"; 16.0 for 1"; 40.0 for 1 1/2"

2/ To obtain charge for each added m^3, multiply R.U. charges shown in 3/ by the following block factors.

Domestic : 1.2 for 11-20 m^3; 1.4 for 21-45 m^3; 1.7 for over 45 m^3.
Commercial: 2.4 for 21-45 m^3; 2.8 for 45-100 m^3; 2.4 for over 100 m^3

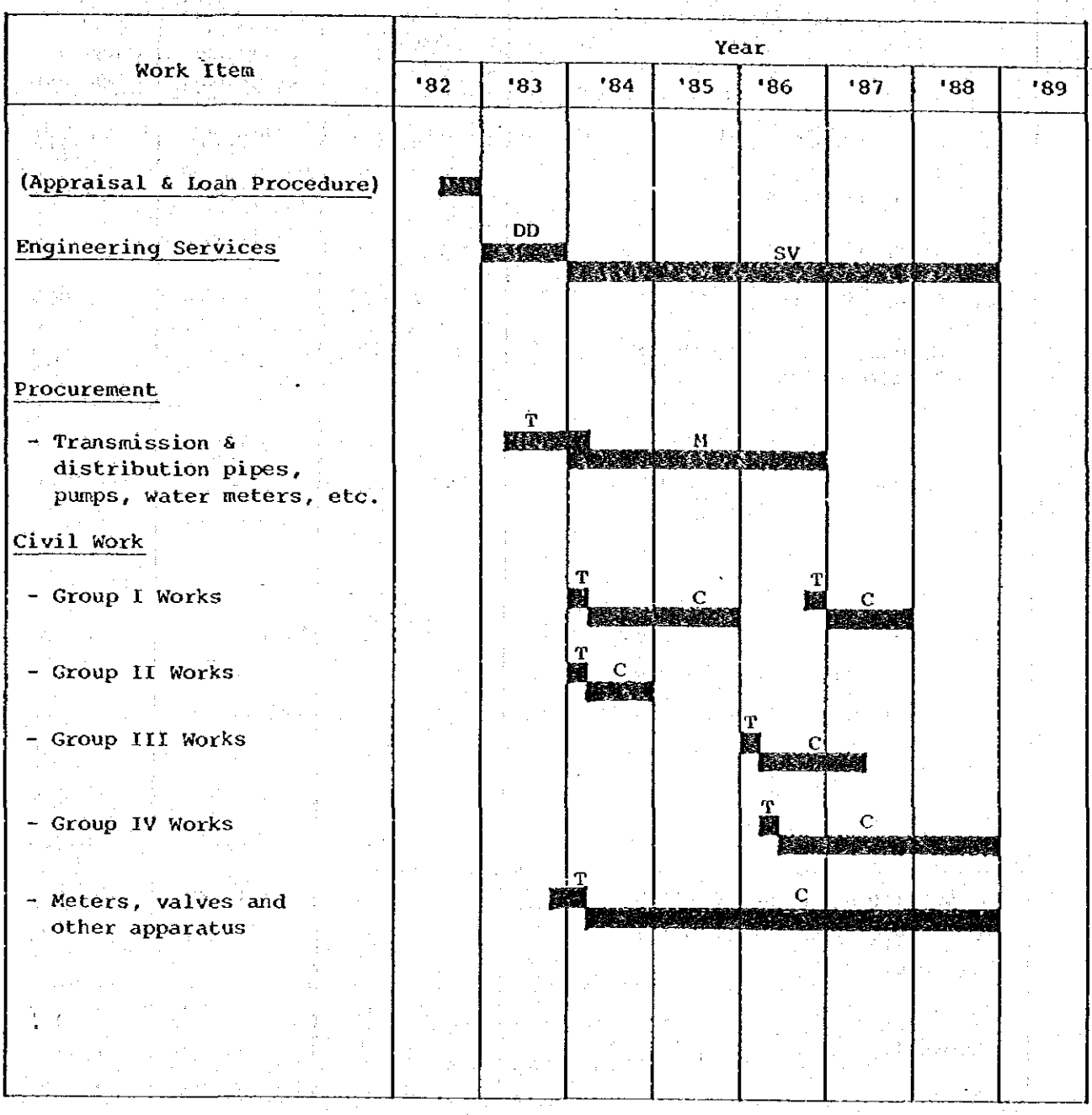


Proposed Water Supply System for Year 1993

(Phase I + II)

Construction Schedule for Phase I + II

(Target Year: 1993)



Note: DD = Detailed Design
SV = Supervision of Construction
T = Tendering Procedure (Advertisement/Tendering/Evaluation/Award)
M = Manufacturing & Shipping
C = Construction/Installation

Tagbilaran Project Cost for Phase I + II (Target Year: 1993)

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Items	Cost		
	Total Cost	Foreign Currency Component	Local Currency Component
A. Group I Works	4,457	2,987	1,470
B. Group II Works	5,425	2,817	2,608
C. Group III Works	4,090	1,968	2,122
D. Group IV Works	2,645	1,645	1,000
E. Meters, Valves and Other Appurtenances	6,370	4,742	1,628
Sub Total	22,987	14,159	8,828
Detailed Design Cost (10.5%)	2,414	1,448	966
Supervision Cost (3.5 %)	805	483	322
Land Cost	71	-	71
Total	26,277	16,090	10,187
Physical Contingency (10 %)	2,628	1,609	1,019
Total	28,905	17,699	11,206
Price Contingency	22,286	13,887	8,399
Grand Total (Project Cost)	51,191 (Equivalent to US$6.56 M)	31,586 (Equivalent to US$4.05M)	19,605 (Equivalent to US$2.51 M)

RECOMMENDATIONS

1. Implementation of the Project

The water supply Master Plan proposed a long term development program up to the year of 2010, and recommended its implementation by stages, namely, Phase I up to 1987, Phase II up to 1993, and Phase III up to the final target year 2010.

In accordance with the above recommendation, the present feasibility study was made with regard to two cases, i.e., Case 1 for Phase I project, of which the major intention is to maximize use of the existing facilities, together with urgent improvements and reinforcement works, and Case 2 for a combined project to Phase I and II, which includes, in addition to the Phase I works, development of a new water source/s and pipeline extension works.

The results of the study of the two cases indicate that both cases are technically and financially feasible, meeting satisfactorily the basic requirements concerning loan ceiling, water rate and consumers' paying ability. Case 2, however, is based on the given conditions that a national subsidy equivalent to 25% of the total project cost will be provided to the project.

As regards implementing the water supply development project, it is desirable to consider the Case 2 project, because it can meet the water requirement over a medium term future, contributing to the unimpeded social development of the community concerned. Decision of the implementation must be made solely depending on the national policy. If case 1 should be selected for implementation, the Phase II project should, needless to say, follow immediately the Phase I project.

2. Technical Recommendations

1) Periodic Review of Master Plan

In preparing and drawing out the present water supply master plan and feasibility study some assumptions were inevitably made owing to insufficiency of necessary data, and furthermore, the projected development of the area, together with water consumption, may possibly differ from the actual future development. Therefore, review and revision of the present report is recommended from time to time as required, at least once every five years after the commencement of the operation of Phase I or before implementation of the subsequent phases.

2) Population and Water Demand

Population growth may be influenced by changes in the social conditions and industrial development in the area, and water demand will be affected accordingly. Therefore, population, both total and served, and water demand should be continuously reviewed, and in addition the categorized water demand should be calculated. It is advisable to revise the projected figures in the master plan according to the above review.

3) Prevention of Water Loss

Loss of water from the water supply system means insufficient operation and maintenance of resources and loss of revenue to the district. To maintain sound management and self-sustaining Water District, loss of water must be prevented by all means. Water sources in the Water District are limited extremely, so minimization of water loss is of vital importance. In order to realize this purpose, detection and prompt repair of leaks must be routinely practiced, and wasteful use of water by the consumers must be discouraged. It is, therefore, recommended that the Water District provide a special section staffed with technicians and equipment for abatement of water loss.

4) Metering

Metering includes installation of bulk meters to measure production and house meters to measure consumption. By analyzing the readings of the meters, major causes of and remedies for water loss can be known. The balance of the production and the consumption is principally leakage of the water supply system. By the readings of house meters, wasteful use will be known, and in addition it will be discouraged, because the consumer has to pay his charge according to the reading.

4) Water Rate Structure

It is a good practice to set a higher unit price for consumption which exceeds the normal consumption, when the supply capacity of the water supply system is restricted. Currently, however, the water rate schedule has a rate structure which is opposite. The present water rate structure should, it is recommended, be amended as early as possible, so as to raise the revnue from water sales and prevent water wastage.

6) Observation of Salinity

Salinity of groundwater should regularly be observed. If the salinity rises, withdrawal of groundwater must be reduced or stopped according to the case. Relocation of such a well must be planned in accordance with the directions as described in Appendix 3 of this Report.

7) Groundwater Survey in Adjoining Areas

As detailed in the main text of the present master plan, the long-range future water requirement cannot be met by groundwater in the Water District. Therefore, a new water source must be explored outside of the city. Preliminary investigation of groundwater in the adjoining

areas was conducted in the present investigation. However, detailed investigations needed to locate new wells and determine other design factors should be conducted before the supply capacity of the Phase I project is exhausted.

8) Measures to be Immediately Taken

Reduction of leakage and wastage is the most effective measure to substantially increase water supply. As water shortage in the served area is presently very acute, it is recommended, that the newly formed water district, should concentrate its effort on reduction of leakage and wastage even before the proposed project is started. Water thus saved can alleviate the suffering of the customers from water shortage, and may in addition be supplied to new customers. Besides, the financial position of the water district will be accordingly improved.

At present, leakage and wastage from the plumbing systems account for more than half that of the whole water supply system. Therefore, to maximize the results of the leakage abatement activities, all existing service systems should be inspected, and all leaks thereof be repaired. Further, to discourage wasteful use of water, all the connections should be metered. If required, fund necessary for metering should be borrowed on a short term basis, though the cost for meter procurement and installation is provided in the present project cost.

9) Future Relocation of Wells

As described in Appendix 3, the distribution of the existing wells is rather concentrated in the poblacion. Seawater intrusion may be accelerated by this unfavourable concentration of wells. Therefore, when any existing wells should have trouble of salinity or become unoperative, such wells should, it is recommended, be relocated farther inland in such a manner as detailed in the same Appendix.

10) Water Right

Intake of water for water supply from water sources of groundwater, and construction of facilities for such water intake should be authorized/approved by authorities in charge in compliance with relevant raws and regulations. It is, therefore, recommended that formal procedures for such authorization/approval be taken before the implementation of the present project.

PART ONE: GENERAL

1. Introduction
   - 1.1 Authorization
   - 1.2 Objective and Scope
   - 1.3 Terminology

2. Present Conditions of the Study Area
   - 2.1 Natural Conditions
   - 2.2 Population
   - 2.3 Socio-Economic Conditions

3. Existing Water Supply
   - 3.1 General
   - 3.2 Water Sources
   - 3.3 Distribution System
   - 3.4 Present Water Use
   - 3.5 Present Water Rates
   - 3.6 Present Institutional Water Supply Practice

1. Introduction

1.1 Authorization

The present report on water supply master plan and feasibility study is prepared in accordance with the terms of reference of the Contract for the Engineering Services (the work) made between the Japan International Cooperation Agency (JICA) and Nihon Suido Consultants, Co., Ltd. (the Consultant) on June 22, 1981. The work was earlier requested by the Government of the Philippines to the Government of Japan, and the latter decided to undertake the work through JICA within the frame of the international cooperation program. With regard to execution of the present work, the leading agency of the Government of the Philippines is the Local Water Utilities Administration (LWUA).

The work consists of two parts, namely, preparation of the master plan for the water supply of the Tagbilaran Water District to be formed and preparation of the feasibility study of the initial portion of the project envisaged in the said master plan.

1.2 Objective and Scope

The objective of the work is to establish a comprehensive water supply plan for the Tagbilaran Water District covering Tagbilaran City and the Municipality of Dauis (the study area) for a long term period up to the year of 2010, including preparation of a project having a highest priority for immediate implementation. The project, with such priority, will be studied with regard to its feasibility in the aspects both technical and financial in Part Three.

The scope of the master plan covers:

1) Data collection and analysis,

2) Establishment of the target year for planning,
3) Definition of served area for planning,
4) Estimation of population,
5) Estimation of water demand,
6) Study of present status of waterworks,
7) Study of water source,
8) Planning of water supply system,
9) Rough estimation of costs for construction, operation and maintenance,
10) Preparation of implementation schedule,
11) Study of Interim Program,
12) Socio-economic study, and
13) Studies of organization, operation and management plan.

The scope of the feasibility study covers:

1) Definition of the target year,
2) Definition of project area,
3) Estimation of population to be served,
4) Estimation of the water demand,
5) Study of improvement of existing facilities,
6) Study of water source,
7) Study of required facilities and layout of facilities,
8) Study of design criteria,
9) Preliminary design,
10) Preparation of construction schedule,
11) Study of construction materials and labour force and study of construction ability of local contractors,
12) Preparation of construction method and procurement method of materials and equipments,
13) Estimation of costs for construction, operation and maintenance,
14) Estimation of benefits,
15) Financial analysis,
16) Studies of organization, operation and management plan, and
17) Preparation of implementation program.

1.3 Terminology

The following words and terms in the present report mean as set forth below:

(a) Water District - local water district formed pursuant to the Provincial Water Utilities Act.
(b) Rural Waterworks Association - a rural waterworks association organized pursuant to the Executive Order No. 577.
(c) Level I system - developed point source, such as artesian well or protected spring, generally suited for clusters of around 15 households for a shallow well and 50 households for a deep well.
(d) Level II system - Level I plus a system of communal faucets, generally suited for more dense clusters of around 100 households.
(e) Level III system - system of individual house connections.
(f) Point Source - generally a protected well or a spring with no distribution system, which has a distance to the farthest user of no more than 250 m.
(g) Poblacion - an urbanized area in a city/town
(h) Barangay - a political unit or community in a city/town, however "Barangay" in this Report refers to that which is located outside of a poblacion.

2. Present Conditions of the Study Area

2.1 Natural Conditions

2.1.1 Location

The study area is located on the southwestern end of the Bohol Island, which is the tenth largest island of the Philippines. The area consists of Tagbilaran City and the Municipality of Dauis being located at northeastern part of the neighboring small island, Panglao. The city is the capital of the Bohol Province and has developed as a port, which is strategically situated on the marine route connecting Manila and the Mindanao Island. Tagbilaran City is bounded on its western and southwestern sides by 12.3 km of coastal line; on its north side by Cortes Municipality; on its north-northeast side by Corella; and on its east side by Baclayon Municipality.

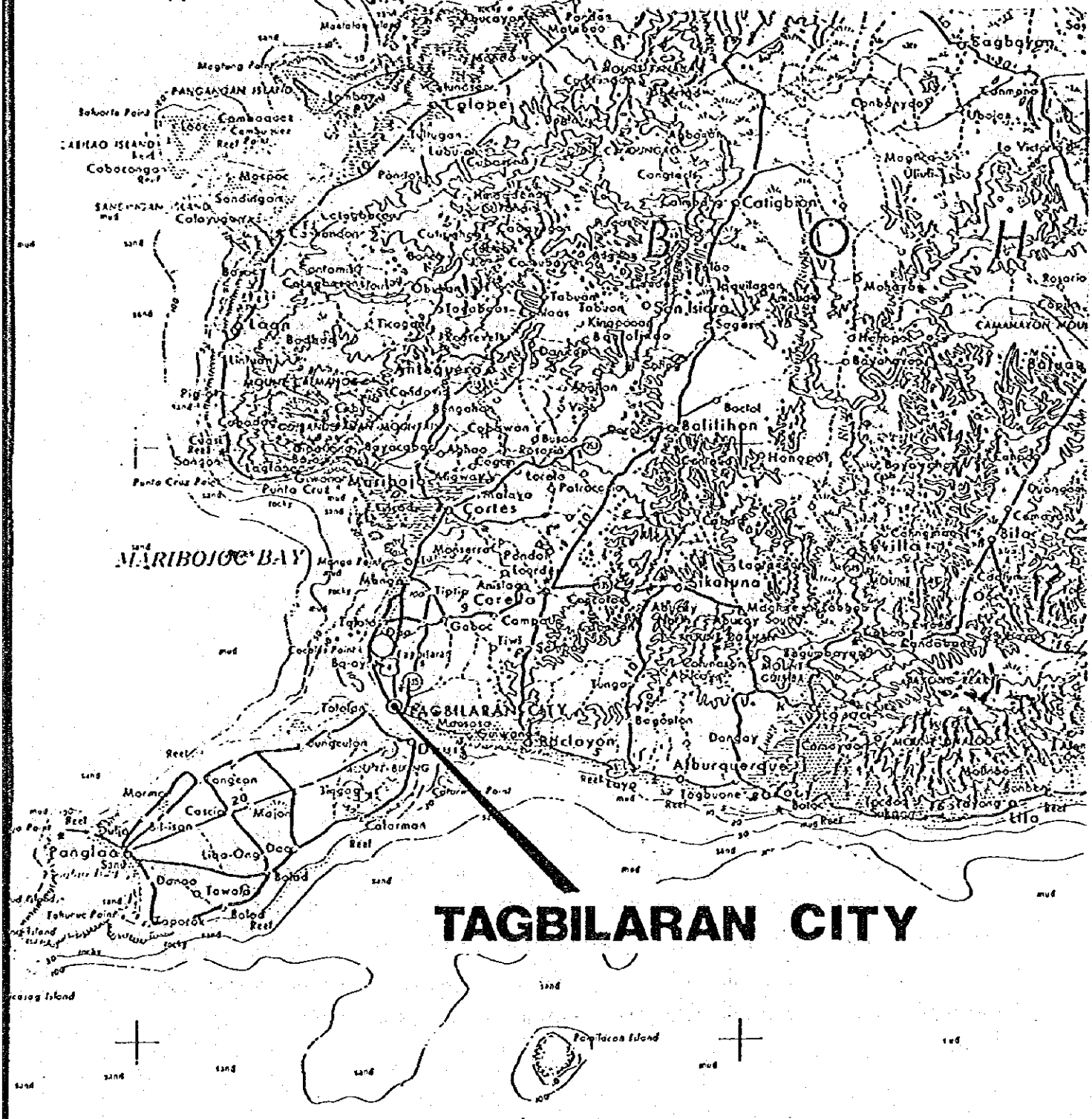
2.1.2 Geography and Topography

The study area has a very characteristic topography, namely, it is mostly a tableland with an elevation of about 20 to 50 m above sea level. The fringe of the tableland composes a coastline of rocky cliffs, 7 to 8 m high.

One of the geological characteristics of the city is that the area is generally rocky with limestone, especially in the central business district, extending as far as the barangays of Mansasa, Bool, Dampas, Dao, Cogon and Booy. The eastern end of the area is hilly with an elevation of about 80 m above sea level, and at the northern end and southern end of the area two small mountains rise each with a height of more than 100 m above sea level.

Tagbilaran

Location Map of the Project Area



There are no rivers nor streams of considerable importance in the study area; the reason is that due to seepages,the limestone below the surface has been slowly dissolved and drained down to the sea, leaving behind countless caverns and caves.

The southwest coast of the Bohol Island contains the Tagbilaran port, which has contributed to the development of the city.

2.1.3 Climate

The study area has no pronounced two seasons, dry and wet, with rainfalls rather evenly distributed over the year, as shown in Table 1.2.1. The average annual rainfall of the area, around 1,600 mm, is smaller than that of the whole country, 2,500 mm.

Though the area is located at low latitude, the climate is moderate and the temperature is not much variable throughout the day and the year, also as shown in the table, due to the specific location of the area surrounded by the sea.

Typhoons have not been observed in recent years, whereas the northern half of the Philippines is frequently struck by typhoons.

Table 1.2.1 Climate Record
(1972 - 1974)

Month	Rainfall (mm)			Relative Humidity (%)			Average Temperature (°C)		
	1972	1973	1974	1972	1973	1974	1972	1973	1974
January	166	17.9	70.4	84	81	85	22.5	25.8	25.1
February	83.5	10.3	131.7	80	73	86	26.3	25.6	25.4
March	130.8	36.2	129.5	82	77	84	25.9	26.5	25.5
April	25.4	70.2	196.1	79	78	84	27.1	27.8	26.8
May	137.2	50.7	167.2	78	78	83	27.9	28.1	27.1
June	105.7	30.9	267.1	81	80	85	27.7	28.0	27.0
July	10.4	231.1	144.8	71	82	84	29.3	27.7	26.9
August	164.1	185.6	11.0	79	82	78	27.6	27.6	24.2
September	200.2	326.5	62.5	84	88	84	27.2	26.5	27.0
October	71.4	119.0	316.8	81	83	85	27.6	27.3	26.9
November	169.1	383.3	131.3	83	88	86	26.8	26.2	26.5
December	118.1	175.8	98.4	81	89	89	26.6	25.9	25.5
Average	115.2	136.4	143.9	80.3	81.6	84.4	27.1	26.8	26.2
T O T A L	1,381.9	1,637.5	1,776.7						

Source: PAGASA, Tagbilaran City

2.2 Population

In 1980, the latest NCSO censual year, Tagbilaran City had a population of 42,475 people. It shows an increase of 4,940 persons from the preceding censual figure of 37,335 in 1975. The average annual growth rate during the above 5 years is 2.5 percent which is slightly greater than that of the Bohol Province.

Among the total 15 barangays in the city, there are 7 barangays classified as urban. The total urban population of the city amounted to 30,126 while that in the rural areas numbered 12,149, giving an urban-rural ratio of 2.5 to 1.0. It is noteworthy characteristic of the city that the urban population is larger than the rural population.

City population by barangay is shown in Table 1.2.2.

Table 1.2.2 Past Population Trend: Tagbilaran City
(1970 - 1980)

Barangay	Population			Average Annual Growth Rates (%)		
	1970	1975	1980	1970-75	1975-80	1970-80
1. First Dist. (POB) (u)		2,233	2,480	-	2.1	
2. Second Dist. (POB) (u)	13,240	7,703	6,872	-	-2.3	0.2
3. Third Dist. (POB) (u)		4,137	4,210	-	0.4	
4. Bool	1,256	1,450	1,558	2.9	1.4	2.2
5. Booy (u)	1,899	2,402	2,947	4.3	4.2	4.5
6. Cabawan	363	304	354	-3.6	3.1	-0.3
7. Cogon (u)	5,736	7,363	8,731	5.1	3.5	4.3
8. Dao	1,180	1,395	2,185	3.4	9.4	6.4
9. Dampas	1,371	1,669	2,012	4.0	3.8	3.9
10. Manga (u)	1,850	1,998	2,358	1.6	3.4	2.5
11. Mansasa (u)	1,950	2,225	2,528	2.7	2.6	2.6
12. Taloto	1,243	1,127	1,686	-2.0	8.4	3.1
13. Tiptip	880	1,089	1,397	4.4	5.0	4.7
14. Ubjan	1,186	1,334	1,484	2.4	2.2	2.3
15. San Isidoro	851	906	1,103	1.3	4.0	2.6
Total of above	33,005	37,335	41,900			
*Collective Households	-	-	375			
T O T A L	33,005	37,335	42,275	2.5	2.5	2.5

Note: (u) Urban

* "Collective Households" appeared in the census data obtained. Population projection was made on the basis of the total population including the figure of this item.

2.3 Socio-Economic Conditions

The study area consists of the City of Tagbilaran and the Municipality of Dauis.

The City of Tagbilaran is primarily identified as a commercial and trading center. It is also known as the educational center of the Province of Bohol. The number of students reportedly amounts to more than 25,000 and nearly 15,000 of them are commuting students who are listed as population of other municipalities.

The municipality of Dauis depends basically on fishing and farming, but most of those living in Poblacion and barangay Totelan, the area being served by the Provincial Waterworks, are employees of businesses in Tagbilaran City and students enrolled in schools in the city. They spend most of day-time in the city.

The population census conducted in May 1980 registered 42,275 as the total population of Tagbilaran, a gain of 4,940 over 1975, and 18,254 as that of Dauis, a gain of 299. In terms of average annual changes, Tagbilaran showed an increase of 2.5% which is lower than the national average rate of 2.64% while Dauis revealed a slow increase of 0.25%.

Cebuano is the major dialect of both Tagbilaran and Dauis, and is spoken by more than 99% of the population. Nearly 98% of the population in Tagbilaran and 100% of the population in Dauis are Roman Catholic.

The level of educational attainment in Tagbilaran is among the highest not only in Bohol but also nationwide.

Roads in Tagbilaran and Dauis are ample in length and width, though the pavement conditions are not yet satisfactory.

Water supply service is being provided by a provincial system, the service of which is, however, poor as described in 3. Existing Water Supply. The area has no sewerage systems.

Electric power service is being supplied by a provincial system, with the rate of electrification being 48.7% in Tagbilaran and 0.4% in Dauis.

Tagbilaran is directly accessible to various points in the province by a system of major highways and likewise accessible to neighboring provinces by water and air transportation. The mode of transportation in the city depends largely on that of motorcycles and jeepneys.

The ten leading causes of morbidity in Tagbilaran in the past five years include gastro-enteritis as 2nd highest and dysentery and cholera as 8th and 9th. This is to be noted particularly in contrast with the fact that the city is boasting of quite a number of hospitals, clinics, health centers and other health facilities. Dyspepsia and scabbies are found in the five leading causes of morbidity in Dauis. Inadequate clean and potable water supply and poor garbage disposal remain as contributing factors to these diseases.

For details, please refer to Appendix 5.

3. Existing Water Supply

3.1 General

The study area is currently served by a Level III system owned and operated by the Bohol Provincial Waterworks System and also by Level II systems and a number of Level I systems. The Level III water supply systems was started in 1924 when the first deep well was constructed. Since then, additional eight wells have been constructed, which compose the present Level III system and serve the poblacion core area. Fig 1.3.1 shows the served area by the above system, the locations of the Level II systems and the barangays with Level I systems.

3.2 Water Source

Due to the characteristic geology, as reported in Appendix 3. Study on Water Sources, water sources are very scarce in the study area. Surface water is not available; groundwater is available but has salinity problems. The water source hitherto utilized by the Provincial Waterworks is exclusively groundwater, as shown in Fig. 1.3.2 and Table 1.3.1.

The water table of groundwater in the area is rather low and is not confined because of the porosity of the limestone formation. When withdrawal of the groundwater is excessive, sea water intrudes into the area concerned. Therefore, the yield of each well has been kept at a low rate.

The power used for the pumps is either electricity or diesel engine, and the types of pump are turbine or submersible, details of which are shown in the above-mentioned table.

Tagbilaran

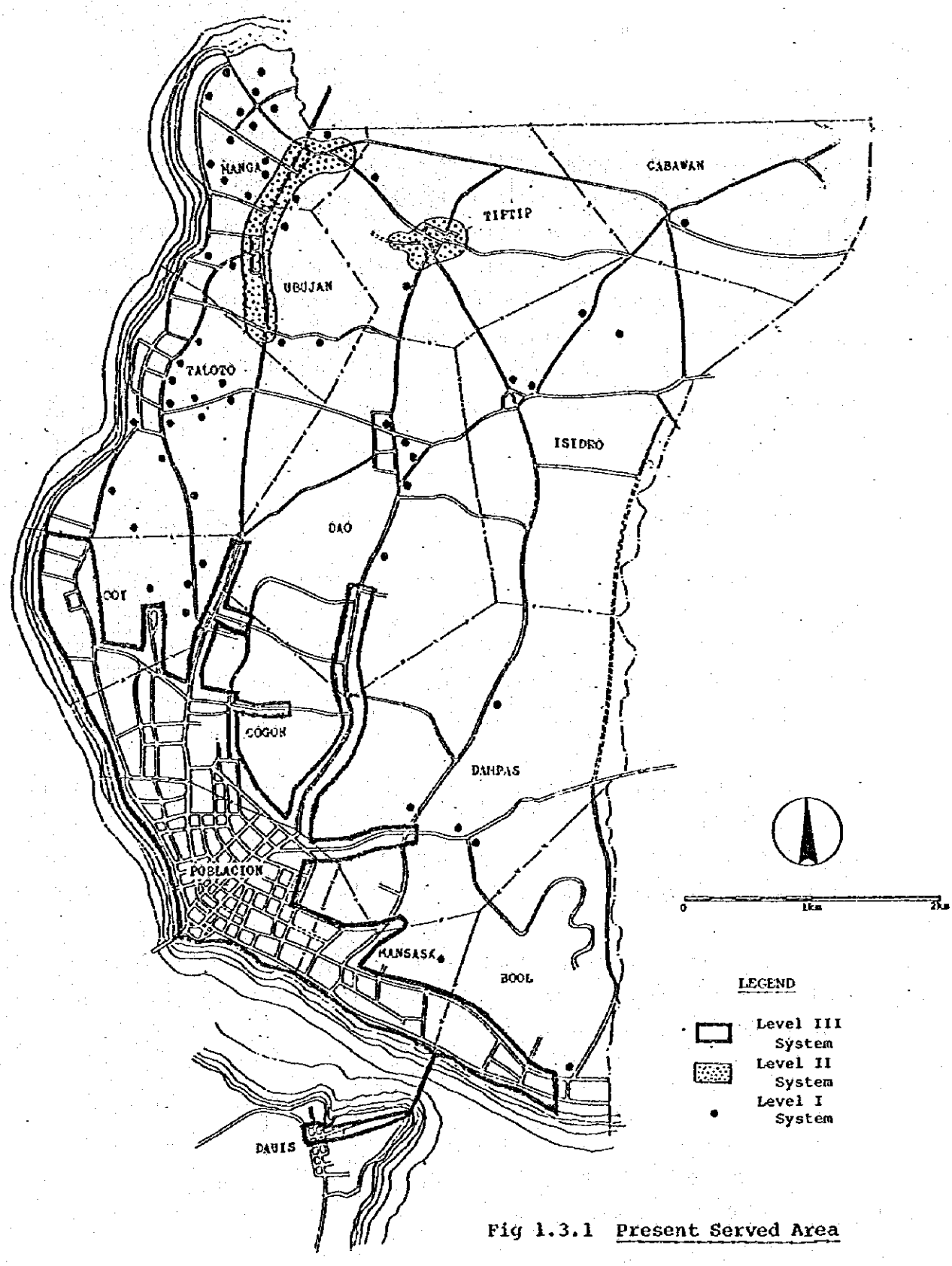


Fig 1.3.1 Present Served Area

Table 1.3.1 Existing Water Sources

Well Number	Well			Pump				
	Year Built	Casing (mm) Diameter	Depth (m)	Discharge (m^3/day) 2/	Pressure (kg/cm^2)	Type	Drive	Year Lastly Replaced
1	1924	150	25	300	3.5	Submersible	Electric	1980
2	1932	150	34	500	1.4	Submersible	Electric	1980
3	1954	200	35	600	1.4	Turbine	Diesel	1978
4	1956	150	43	500	-	Submersible	Electric	1978
5	1961	200	43	660	1.8	Turbine	Diesel	1980
6 1/	1968	250	20	-	-	Turbine	Diesel	
7	1971	150	-	600	1.4	Submersible	Electric	1981
8	1978	200	27	500	1.4	Turbine	Diesel	
9	1981	250	53	1,050	2.8	Submersible	Electric	
	Total Discharge			4,710				

1/ The well was abandoned July in 1981.
2/ Based on the actual pumping discharge test carried out by the Study Team in October 1981.

3.3 Distribution System

The distribution system of the Provincial Waterworks consists of storage facilities and a distribution network. However, wells Nos. 5, 6, 8 and 9 are directly connected with the distribution network. (See Fig 1.3.3).

3.3.1 Storage Facilities

There are two reinforced concrete storage tanks: one an elevated tank and the other a ground level reservoir. Their locations are shown in Fig 1.3.2 and details are shown in the following table.

Table 1.3.2 Storage Facilities

	Capacity	Overflow El.	Year Built	Dimensions
Elevated Tank	380 cu m	57 m	1932	D9 m x 6 m
Ground Reservoir	230 cu m	37 m	1928	D8 m x 4.5 m
Total Capacity	610 cu m			

3.3.2 Distribution Network

The distribution network in the city is shown in Fig 1.3.2 and its details are shown in Table 1.3.3.

Conditions of water supply are variable in different parts of the city and service hours range from almost zero to 24 hours because of the inadequately low pressure and shortage of water. Water pressure records surveyed at six different places in the city area show it clearly. (See Appendix 2) There was almost no water at two places out of six.

Table 1.3.3 Existing Distribution Pipelines

Diameter(mm)	Materials	Length(m)
150	CCIP/ACP	3,890
100	CCIP/ACP/GIP	17,070
75	GIP	2,690
50	GIP	6,120
38	GIP	7,870
		37,640

As regards leakage, visible leaks on the ground surface are very rare, but this fact leads to suspicion that invisible underground leaks may exist. To ascertain actual conditions of the existing pipelines, some representative spots were dug to inspect the soil and the conditions of pipe corrosion. Major findings of the investigation were that pH of the soil was generally higher than 7, sulfate concentrations ranged from 154 ppm to 494 ppm, and chloride contents were in a range of 4 ppm to 56 ppm. Exterior surface of the laid pipe had encrustations, but pittings of the pip wall were not detected.

From the above conditions, as well as the results of water analysis, leaks may, it is concluded, be attributable to the aging of the pipelines and the poor maintenance of all the facilities; it may not be caused by soil corrosiveness.

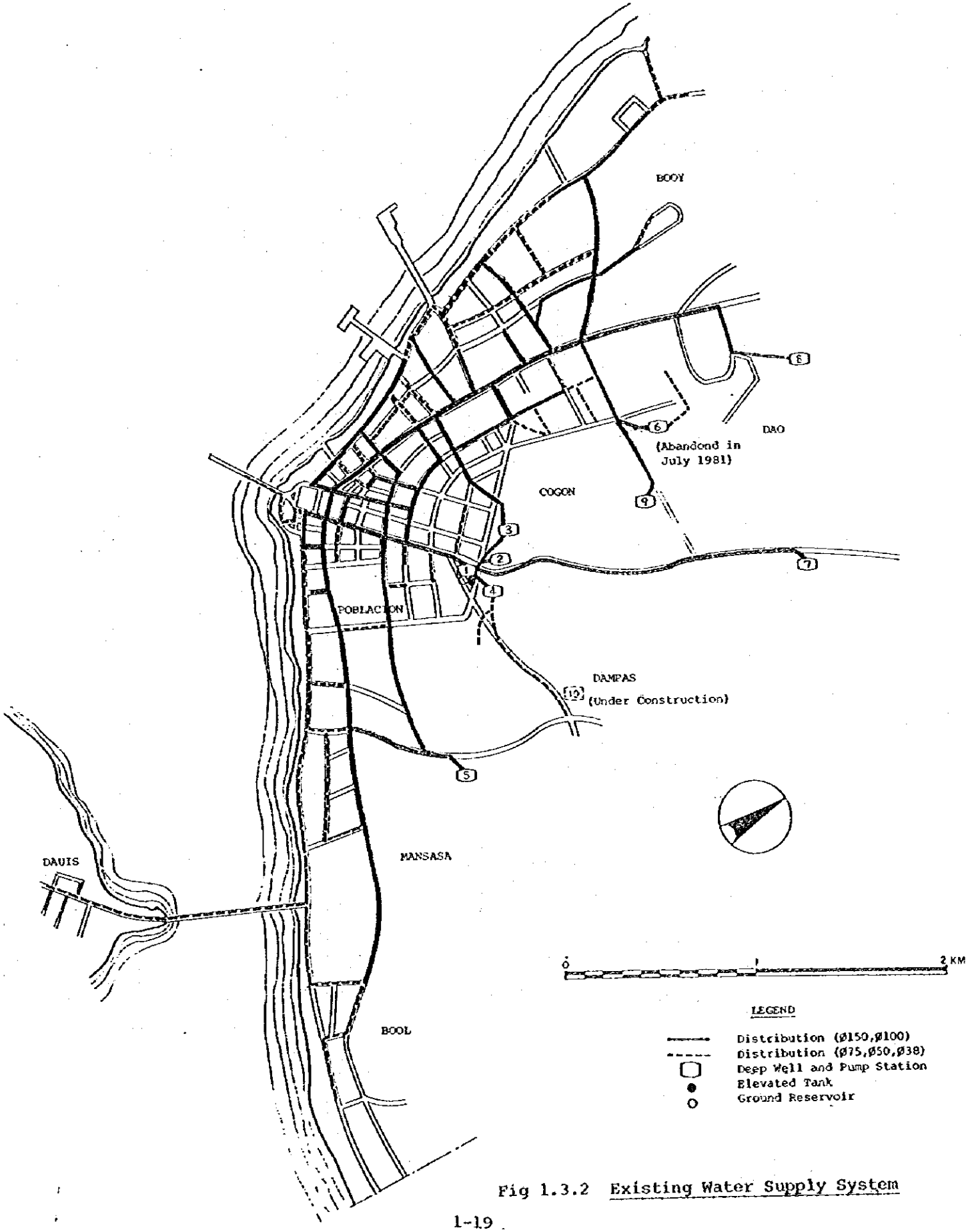


Fig 1.3.2 Existing Water Supply System

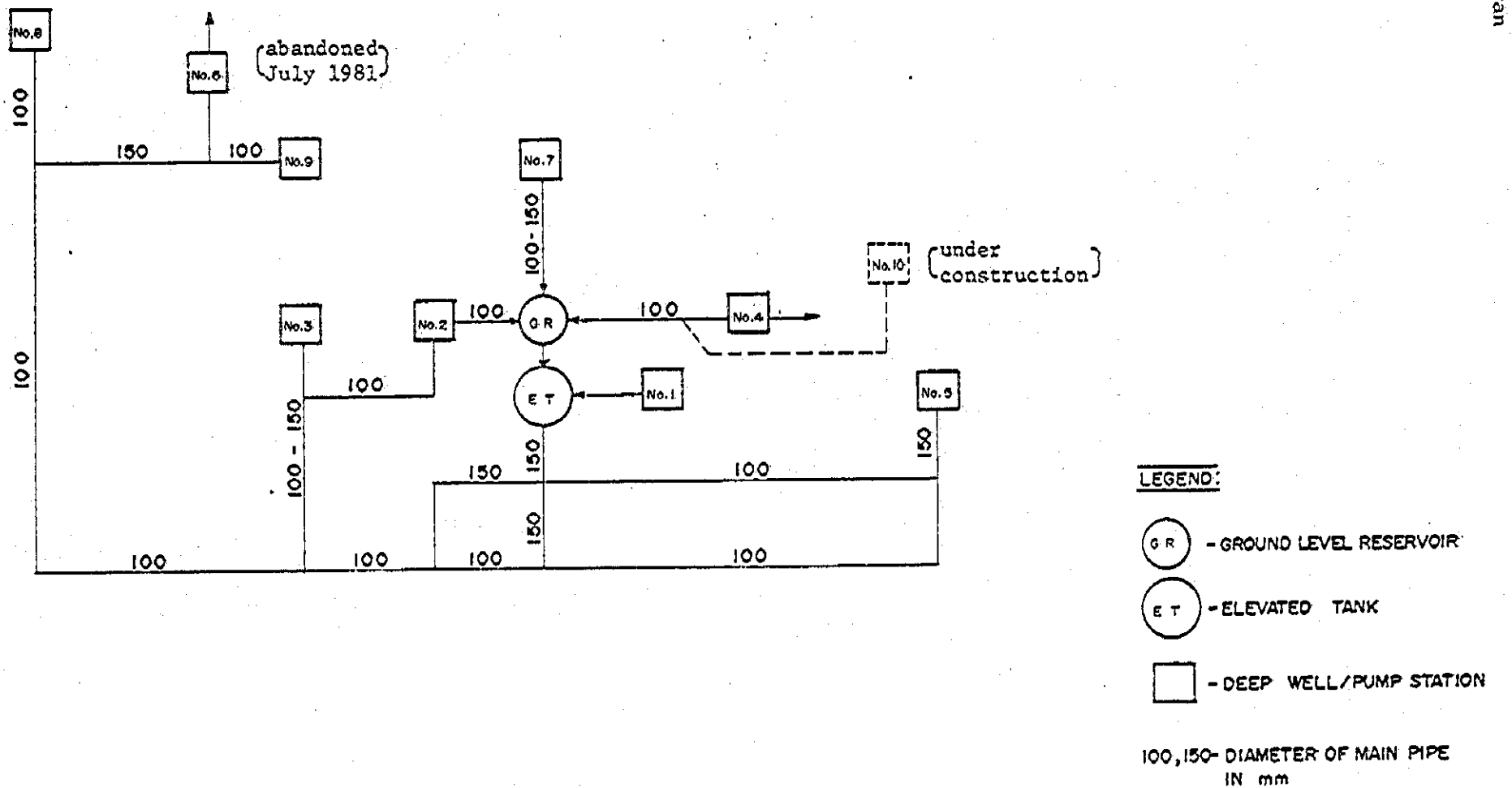


Fig 1.3.3 Skeleton of Existing Water Supply System

3.4 Present Water Use

Present water use in the Bohol Provincial Waterworks System (BPWS) is estimated by the production amount from the existing sources. The field investigation revealed the maximum amount of supply from the existing sources of 8 deep wells is 4,710 cu m/day as indicated in the preceding section.

The total served population is not known accurately, however, an approximate 25,000 people including non-registered residents and Dauis poblacion residents is assumed to be supplied by BPWS.

Present total service connections in the BPWS are 2,556, of which 715 connections are equipped with functioning meters and the rest are with non-functioning meters and/or no meters.

The breakdown of service connections by use categories is shown in the table below.

Table 1.3.4 Present Service Connections

Domestic	2,130
Commercial	381
Industrial	5
Institutional	39
Others	1
Total	2,556

System loss and leakage are not obtainable from the balance of supply and consumption due to the very low pressure in the system, which is causing a suppressed supply condition for the consumer. A trial calculation for estimation of the system loss and leakage can be done as in the following.

The average water use per service connection is 1.84 cu m/day or 55.2 cu m/month in the BPWS, while the average metered water consumption in the other water districts in the Philippines, ref. Appendix 7, is 32.4 cu m/month per connection as experienced in 1978. Assuming that the average water consumption in BPWS will be the same as in the other WDs, the balance of supply and consumption is 22.8 cu m/month per connection, which can be taken as the system loss and leakage in BPWS. Thus, the system loss and leakage will be equivalent to 41 per cent of the total supply.

3.5 Present Water Rates

3.5.1 Procedure for Determining Water Rates

The original establishment of water rates and their changes are recommended by the Waterworks superintendent through the Provincial Treasurer to the Provincial Governor. Based on the initiative of the Provincial Governor, the Sangguniang Panlalawigan (Provincial Board) deliverates upon and approves the recommended water rates. A public bearing is sometimes conducted by the Sangguniang Panlalawigan for this purpose.

3.5.2 Present Schedule of Water Rates

The present water rates were approved in 1975. As shown in Table 1.3.5, the minimum water rates are ₱11.96 for domestic consumption; ₱17.55 for commercial consumption; and ₱43.55 for industrial consumption.

3.5.3 Billing and Disconnection

Water bills are rendered monthly by meter readers. The bills are then paid within a period of 20 days. When consumers fail to pay within this period, disconnection is ordered for the delinquent consumers.

Tagbilaran

Table 1.3.5 Present Schedule of Water Rates

1.	Domestic -	₱11.96	Minimum charge for the first 14 cu.m. with consumers' own watermeters
		₱15.21	Minimum charge for the first 14 cu.m. with watermeters supplied by the Provincial Waterworks or with defective watermeters
		₱ 0.78	Per cu.m. for consumption in excess of the first 14 cu.m.
2.	Commercial -	₱17.55	Minimum charge for the first 20 cu.m. with consumers' own watermeters
		₱20.80	Minimum charge for the first 20 cu.m. with watermeters supplied by the Provincial Waterworks or with defective watermeters
		₱ 0.84	Per cu.m. for consumption in excess of the first 20 cu.m.
3.	Industrial -	₱43.55	Minimum charge for the first 30 cu.m. with consumers' own watermeters
		₱46.80	Minimum charge for the first 30 cu.m. with watermeters supplied by the Provincial Waterworks or with defective watermeters
		₱ 0.97	Per cu.m. for consumption in excess of the first 30 cu.m.

Source of Data: Bohol Provincial Waterworks System

3.6 Present Insitutional Water Supply Practice

3.6.1 Responsible Agency

The Bohol Provincial Waterworks System is owned and operated by the Provincial Government of Bohol. Its superintendent and other staff members are all provincial government officials and employees.

3.6.2 Policy-making Function

The policy-making function relating to water supply and the implementation of those policies are carried out by the Provincial Governor, subject to the resolutions or approval of the Sangguniang Panlalawigan (Provincial Board).

3.6.3 Direct Responsibility

The direct responsibility for important matters such as the preparation and execution of annual budgets for the Waterworks System and the recommendation of changes in water rates is placed in the Provincial Treasurer. In these important matters, the role of the Waterworks superintendent is indirect and limited to the presentation of necessary reference data to the Provincial Treasurer.

3.6.4 Accounting and Finance

The accounting of the Waterworks System is not separated from that of the Provincial Government, and the income and expenditures of the Waterworks System are accounted as part of the Provincial income and expenditures. The expenditures of the Waterworks System consist of

"personal services", "maintenance and other operating expenses" and "capital outlay", which are further divided into 14 sub-items. They are financed by collected water rates, other consumers contributions and provincial government subsidies. Table 1.3.6 shows the income and expenditures of the Waterworks for the three years 1978 to 1980. The annual surplus or deficit of the Waterworks System is not carried over the following fiscal term, but is incorporated with the surplus or deficit of the Provincial Government accounts. The Provincial Auditor's Office audits the accounts.

3.6.5 Relationship with Consumers

The relationship of the Waterworks System with the consumers is governed by the Provincial Tax Code and the Contract on Water Services which is made between the Provincial Government and each consumer.

3.6.6 Organization

The staff of the Waterworks System is organized as Fig 1.3.4, and consists of the superintendent, the assistant superintendent and other 44 staff members, who are grouped into three divisions, i.e., "Billing Complaint & Collection", "Production Division" and "Planning, Programming, Construction & Maintenance". These three divisions are further sub-divided into ten units.

3.6.7 Office Procedures

The description of the assignments to each staff member is given by the Provincial Governor, but the functional relationship among the staff members is not clear enough to show the definite chains of command. Delegation of authority and inter-division communication are being done at the discretion of each staff member in charge. The Waterworks System has no written office procedures and no manuals for the maintenance and operation of water supply facilities.

3.6.8 Personnel Management

The Waterworks System has no established system of recruitment. The Waterworks Superintendent recommends placements and promotions of the personnel to the Provincial Governor. The Waterworks System has no program for personnel training. Newcomers are usually trained by senior staff members on the job.

Republic of the Philippines
Province of Bohol
City of Tagbilaran

Office of the Provincial Treasurer

TAGBILARAN WATERWORKS SYSTEM
Income and Expenditures
For the CY 1978, 1979 & 1980

	1978		1979		1980
INCOME -					
Billing Charges, Waterworks	558,074.92	642,664.66		642,230.18	
Penalties, Waterworks	9,650.15	17,825.94		14,674.94	
Total income	567,725.07		660,490.66		656,905.12
EXPENDITURES -					
Personal Services	277,393.65		308,469.43		368,622.03
Salaries and wages	255,250.82	282,680.86		333,644.05	
Life & Ret. Ins. prem.	17,271.16	19,897.56		25,018.81	
Workmen's Compensation	801.62	-		3,375.54	
Medicare	2,031.25	3,360.91		3,386.02	
State Ins. Fund	2,028.80	2,330.10		3,197.61	
Maintenance & other Operating Expenses	271,558.24		320,630.89		465,347.97
Travelling expenses	5,725.70	4,164.00		2,477.25	
Communications	40.00	495.00		128.75	
Repair of Fixed Assets	30,693.00	38,961.00		15,187.00	
Freight & Del. expenses	-	-		222.12	
Other Services	7,208.02	12,019.96		591.80	
Supplies and Materials	17,422.91	17,661.43		3,972.55	
Sup. & Mat. (Fuel & spare parts)	175,296.01	222,372.50		207,178.00	
Repair of Equipment	35,169.60	24,957.00		235,590.50	
Capital Outlays	6,209.00		8,200.00		2,250.00
Total expenditures	555,150.89		657,300.32		836,220.00
D i f f e r e n c e	12,574.18		23,190.28		(179,314.88)

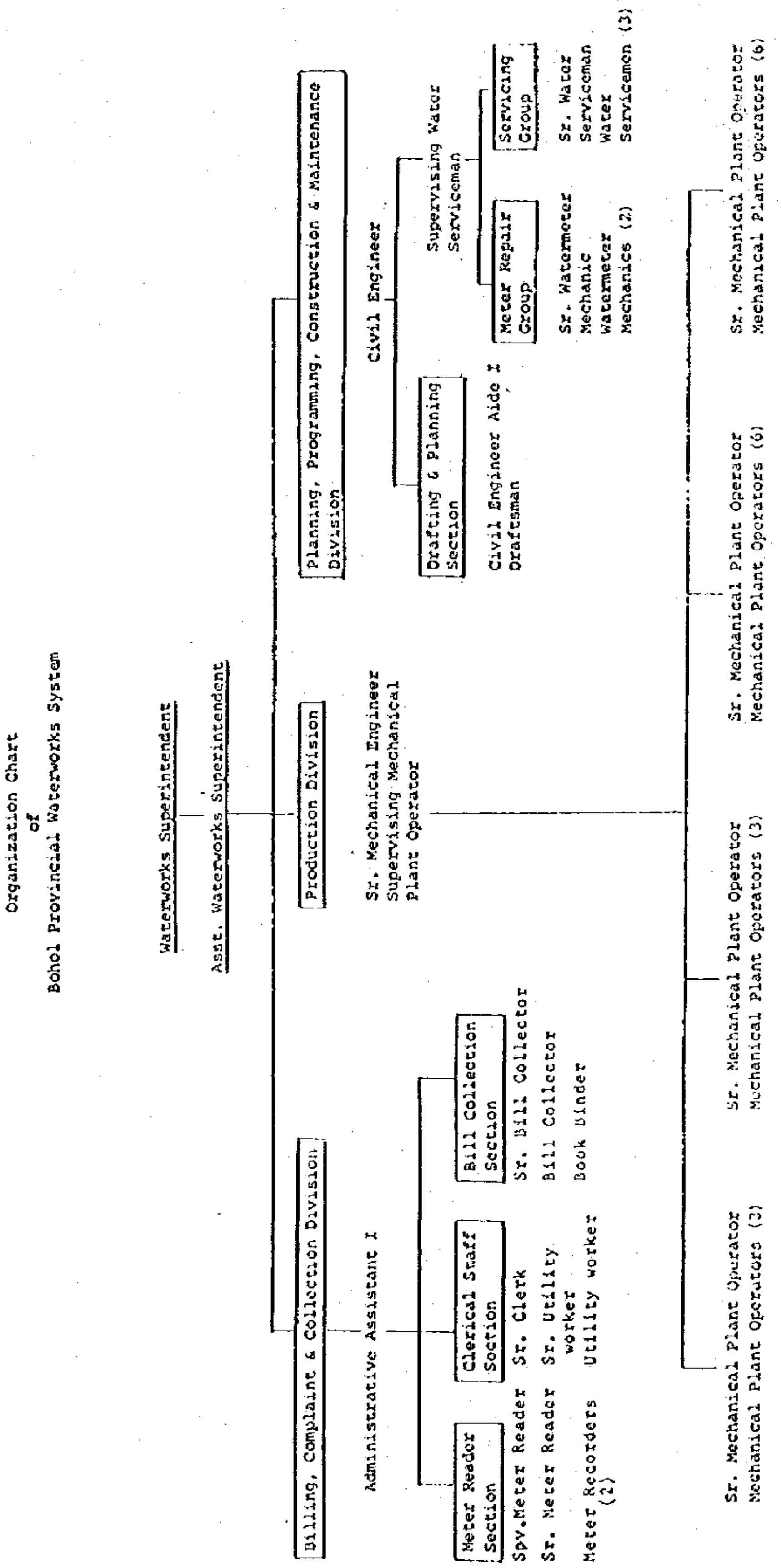
NOTE: Above expenditures do not include energy charges as follows:

1978 - P168,043.36
1979 - 141,691.40
1980 - 257,598.19

Certified Correct:

LUCAS B. CAÑICO
Provincial Treasurer

Fig 1.3.4 Organization Chart



Source of Data: Bohl Provincial Waterworks System

PART TWO: MASTER PLAN

1. General
2. Target Year and Served Area
3. Projection of Population and Water Demand
4. Water Sources
5. Proposed Water Supply System
6. Cost Estimate
7. Implementation Schedule
8. Organization and Management

1. General

This Part Two discusses and draws out a water supply master plan for the Tagbilaran Water District to be newly formed taking over the water supply system presently owned and operated by the Bohol Provincial Waterworks System. The master plan will deal with the Level III system which constitutes the major water supply in the District. Level II and Level I systems in the rural area in the District may separately be implemented in compliance with the Executive Order 577.

With regard to immediate and near-future requirement of water supply, as detailed descriptions as practicable will be given, which compose bases for the feasibility study to be presented in Part Three of this report.

2. Target Year and Served Area

2.1 Target Year

2.1.1 Phase I

Basically the purpose of this Phase project is to satisfy the present water requirement which has not been met in recent years due to deterioration of the water supply facilities, by rehabilitatation, improvement and some additional works, within as short a period as possible.

Taking into account the work volume, financial constraints and the required time for foreign financing, six years time is considered optimal. As illustrated in Fig 2.7.1, the Phase I project will require three and a half years from the commencement of the master planning and feasibility study until the completion of construction works, that is, the completion is at the end of 1984. Therefore, the target year, which is defined as the year when the designed supply capacity equals to the water demand, must be at least a few years after 1985. And during the period between the completion of the work and the target year, preparation for the succeeding Phase II project must be made. As is known from the barchart in the figure, 3 years for this period is most realistic solution, not giving much inconvenience to the consumers, nor making the construction cost of Phase I unbearably high. After all considered as above, the target year of Phase I is proposed as 1987.

2.1.2 Phase II

Major purpose of this Phase project is to provide water for all consumers of the served area which is realized in the previous Phase and for additional population in the thereafter extended built-up area, and to upgrade the level of consumption in accordance with the improvement of the whole national living standard.

For this Phase, six years time is also considered appropriate from the same standpoint as Phase I. Therefore, the target year is proposed as 1993.

2.1.3 Phase III

Long range planning of public facilities in the Philippines 1/ is currently being made with the year of 2010 as the target year. As water supply is one of the public utilities, the said year is employed as the target year of the present master planning.

Remarks: 1/ The LWUA's recent project, Water Supply of Ten Provincial Areas (5th Package), also aims to prepare a Master Plan upto the year 2010.

2.2 Served Area

The Local Water District Law stipulates that a water district, when formed, covers all the municipal or city area, but on the other hand the Executive Order 577 allows that Level I and II systems be constructed and maintained in the area of the water district in consideration of economy and early realization of water supply services.

Served area, for which water supply is being planned by the present master plan is, in accordance with the intention of the above Law and Executive Order, delineated to confine such an area to the existing built-up area for the short term plan, and to the anticipated built-up area as the final served area for the long range plan.

General topography, natural barriers, and zoning plans are also considered in determining served area limits by each phase. Based on technical, topographic, and socio-economic considerations, the served area boundaries for different phases of program implementation are determined as follows, and shown in Fig 2.2.1.

1. Present Served Area- the area presently served by existing system, 480 ha approximately.
2. Phase I Served Area- the reinforcement and the extension of present served area, where minimum investment is required but maximum number of persons can be served to create a high impact/effectiveness on the consumers in the WD. The Phase I served area is extended approximately by 240 ha totaling to 720 ha.
3. Phase II Served Area- further extension of served area into 1,980 ha, taking into account the extent of development within the design year of 1993 in the WD.
4. Phase III Served Area- the total area within the WD jurisdiction where service can be provided technically and financially. In this study, the main objective is to provide water service to the maximum number of persons within the area

in the master plan period. The expanded served area is 2,450 ha in total in the year 2010.

Note: This study is conducted for Tagbilaran City. However, Dauis poblacion, which is located opposite side of Tagbilaran City, is presently served by BPWS. So future water demand in Dauis poblacion is considered and projected in this study. (See Table 3.3.3)

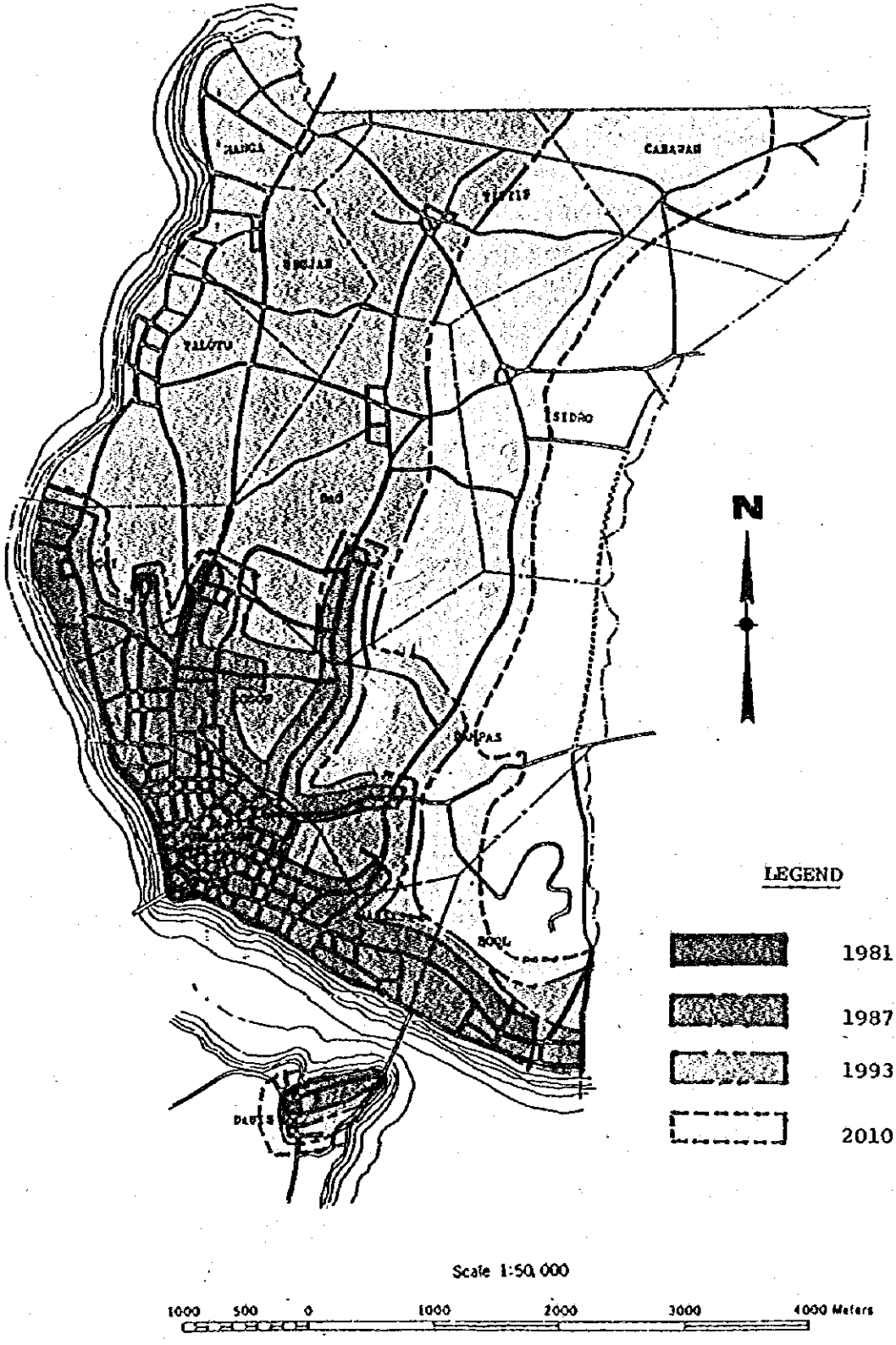


Fig 2.2.1 Served Area

3. Projection of Population and Water Demand

3.1 Population Projection

To estimate the study area population which is one of the basic factors of water requirement, the past censuses made by the National Census and Statistics Office (NCSO) are used as most reliable demographic data.

The total study area population is projected on the basis of separate projections for barangays both in the city core or poblacion and rural areas within the study area. The method of past trend extrapolation is applied for population projection of such "micro-economic" areas of barangays in this study.

The procedure or the methodology of population projection for this study is included in Appendix 7. Based on the said methodology, population projections for the study area have been worked out.

Population trend indicates that the population in the study area would increase from 42,275 in 1980 to 77,020 in the year 2010. The projected population by the design year is tabulated in Table 2.3.1 and graphically shown in Fig. 2.3.1 Population projections by barangay are shown in Table 2.3.2.

The high and low growth of population projections in the study area have been made separately from the adopted one. Regarding the high projection, the high series of NEDA-POPCOM projection is introduced as a useful data for the high population projection. While, the low growth of population in the study area is projected as shown in Table 2.3.3.

The population in the served area is projected by design year based on the served area which is discussed in the proceding section of 2.2 Served Area. The population in the served area is shown in Table 2.3.4.

The coverage of served population for the master plan has been projected based on the above population in the served area taking account of the willingness-to-connect (WTC) of the projected consumers and future improvement of the consumers living standard.

The average percentage of WTC in the Phase II project area is 65%, which is obtained by the market research made in this study. Based on the market study the percentages of WTC of the urban and rural areas for future planning are projected as shown below:

Average Percentage of WTC

	1987	1993	2010
Urban Area	70	80	100
Rural Area	30	50	70

The served population which is estimated approximately 15,000 or 35% of the total population in 1980 would increases to 24,840 or 50% in 1987, 39,440 or 69% in 1993, and 68,085 or 88% in 2010, respectively. The served population by design year is shown in Table 2.3.5 and graphically shown in Fig 2.3.2. The served population by barangay is shown in Table 2.3.6.

Table 2.3.1 Population Projection
(Tagbilaran City)

	1980	1987	1993	2010
1. Urban	30,126	34,949	38,664	47,215
2. Rural	12,149	14,961	18,206	29,805
Total	42,275	49,910	56,870	77,020
Average annual increase (%)	2.4	2.2	1.8	

Table 2.3.3 High and Low Growth Population Projections
(Tagbilaran City)

	1980 T.P	A.G.R (%)	1987 T.P	A.G.R. (%)	1993 T.P	A.G.R. (%)	2010 T.P
1. High Projection	49,620	4.2	66,190	3.9	83,270	3.9	159,570
2. Medium Projection	42,275	2.4	49,910	2.2	56,840	1.8	97,020
3. Low Projection	42,275	2.16	49,100	1.76	54,520	1.44	69,520

Remarks: T.P - Total population
A.G.R - Average annual growth rate

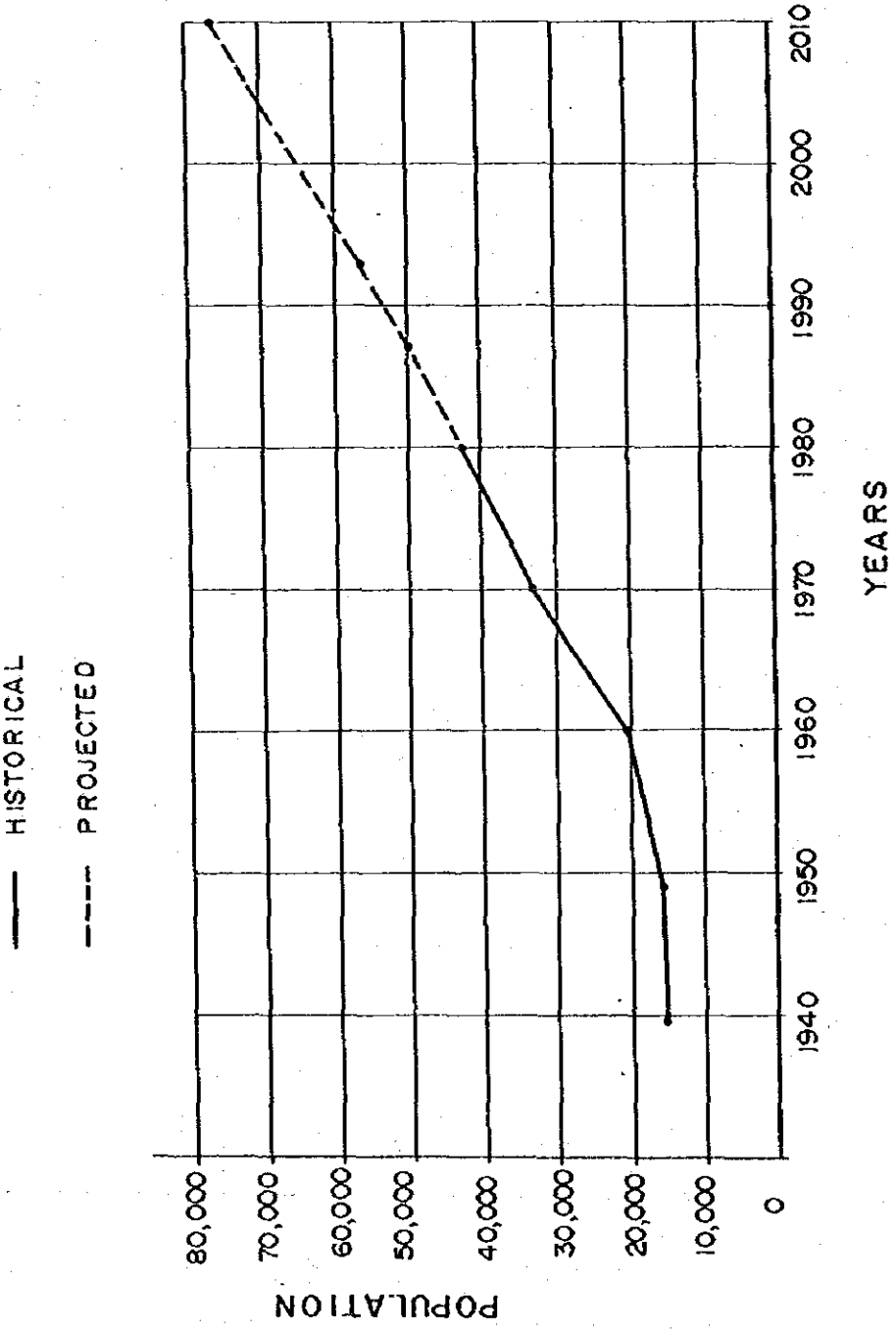


Fig 2.3.1 Population Projection in Tagbilaran City

Table 2.3.2 Population Projection by Barangay

Barangay	Area (ha)	1980 Population	1980 Population Density	1980 - 1987 Ave. Annual Growth Rate (%)	1987 Population	1987 Population Density	1987 - 1993 Ave. Annual Growth Rate (%)	1993 Population	1993 Population Density	1993 - 2010 Ave. Annual Growth Rate (%)	2010 Population	2010 Population Density
1. First District	25.9	2,480	95.8	0.2								
2. Second District	70.2	6,872	97.9	0.2	13,753	82.5	0.2	13,927	83.5	0.2	14,408	86.4
3. Third District	70.7	4,210	59.5	0.2								
4. Bool	348.8	1,558	4.5	2.2	1,814	5.2	2.2	2,067	5.9	2.0	2,894	8.3
5. Booy	146.4	2,947	20.1	4.0	3,878	26.5	4.0	4,907	33.5	2.5	7,467	51.0
6. Cabawan	267.3	354	1.3	2.0	407	1.5	2.0	458	1.7	2.0	641	2.4
7. Cogon	204.4	8,731	42.7	4.0	11,489	56.2	2.2	13,070	63.9	1.0	15,480	75.7
8. Dao	390.9	2,185	5.6	5.5	3,179	8.1	4.0	4,028	10.3	3.6	7,342	18.8
9. Dampas	443.7	2,012	4.5	3.9	2,630	5.9	4.0	3,328	7.5	3.8	6,267	14.1
10. Manga	117.3	2,358	20.1	2.5	2,803	23.9	2.5	3,251	27.7	2.5	4,947	42.2
11. Mansasa	82.9	2,528	30.5	2.6	3,026	36.5	2.5	3,509	42.3	2.0	4,913	59.3
12. Taloto	244.5	1,686	6.9	3.1	2,088	8.5	3.0	2,493	10.2	3.0	4,120	16.9
13. Tiptip	282.1	1,392	4.9	3.6	1,783	6.3	4.5	2,318	8.2	2.5	3,527	12.5
14. Ubujan	145.6	1,484	10.1	2.3	1,740	12.0	2.2	1,983	13.6	2.2	2,870	19.7
15. San Isidoro	429.4	1,103	2.6	2.6	1,320	3.1	2.5	1,531	3.6	2.0	2,144	5.0
16. Collective Households		375		-	-	-	-	-	-	-	-	-
Total	3,270.1	42,275	12.9	2.4	49,910	15.3	2.2	56,870	17.4	1.8	77,020	23.6
Dauis Poblacion		1,786		1.0	1,915	-	1.0	2,033	-	0.5	2,213	-

Table 2.3.4 Projected Population in the Served Area
(Tagbilaran City)

	1980			1987			1993			2010		
	T.P	P.S.A	%	T.P	P.S.A	%	T.P	P.S.A	%	T.P	P.S.A	%
Urban area	27,768	25,000	90	32,146	32,146	100	38,664	38,664	100	47,215	47,215	100
Rural area	14,507	-	-	17,764	7,627	43	18,206	16,214	89	29,805	29,805	100
Total	42,275	25,000	59	49,910	39,773	80	56,870	54,878	96	77,020	77,020	100

Remarks: T.P - Total population in Tagbilaran City
P.S.A - Population in the served area
% - per cent of the total population, (P.S.A/T.P) x 100

Table 2.3.5 Projected Served Population

	1980			1987			1993			2010		
	P.S.A	S.P	%	P.S.A	S.P	%	P.S.A	S.P	%	P.S.A	S.P	%
Urban area	25,000	15,000	60	32,146	22,500	70	38,664	30,940	80	47,215	47,215	100
Rural area	-	-	-	7,627	2,340	30	16,214	8,500	52	29,805	20,870	70
Sub total	25,000	15,000	60	39,773	24,840	62	54,878	39,440	72	77,020	68,085	88
Non-registered residents	11,000	8,800	80	11,000	8,800	80	11,000	8,800	80	11,000	8,800	80
Dauis poblacion	-	800	-	-	1,300	-	-	1,600	-	-	2,200	-
Total		24,600			34,940			49,840			79,085	

Remarks: P.S.A - Population in the served area
S.P - Served population
% - per cent of the P.S.A, (S.P/P.S.A) x 100

Note: " Non-registered residents " in the above table means students who are studying at schools in Tagbilaran City and living in the city; but not registered.

Total number of students in the city is presently estimated 15,000. This number is supposed to be unchanged in the future. Of the above number, 4,000 is considered registered-citizens. Percentage of water supply to whole non-registered students is estimated 80 %.

Thus, Population served of non-registered residents is : 11,000 x 80 % = 8,800.

Fig 2.3.2 Served Population by Design Year

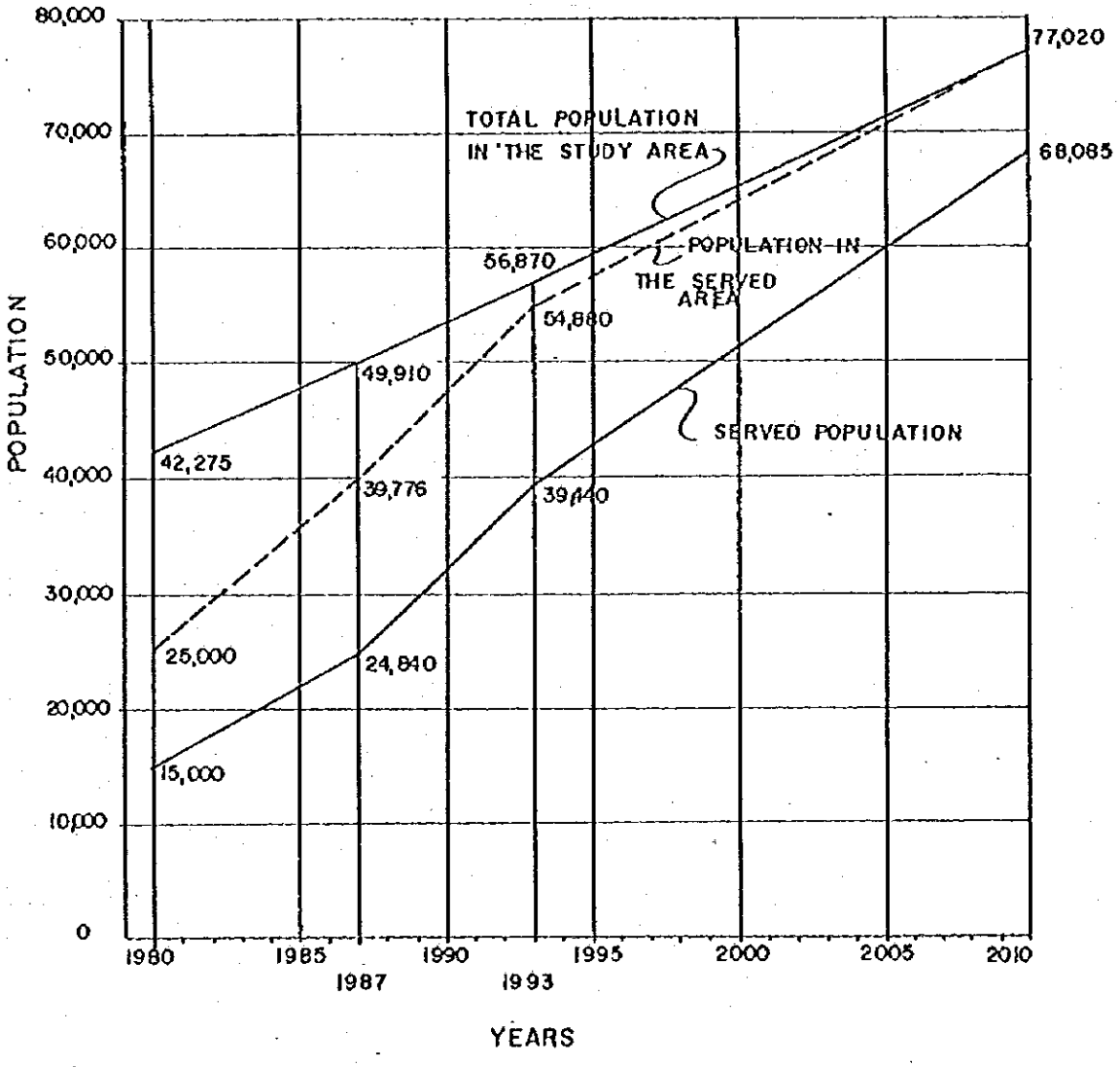


Table 2.3.6 Served Population and Served Area in Tagbilaran City

Barrangay	1980-Present Served Area				1987-Served Area (Phase I Program)				1993-Served Area (Phase II Program)				2010-Served Area (Phase III Program)			
	S.P	% T.P	S.A (ha)	P.D (p/ha)	S.P	% T.P	S.A (ha)	P.D (p/ha)	S.P	% T.P	S.A (ha)	P.D (p/ha)	S.P	% T.P	S.A (ha)	P.D (p/ha)
Urban Area																
Poblacion	15,000	35	480	31.3	9,630	70	130	74.1	11,140	80	150	74.3	14,408	100	160	90.1
Cogon					8,040	70	160	50.3	10,460	80	180	58.1	15,480	100	200	77.4
Booy					2,710	70	120	22.6	3,930	80	140	28.1	7,467	100	140	53.3
Mansasa					2,120	70	70	30.3	2,810	80	80	35.1	4,913	100	80	61.4
Manga									2,600	80	110	23.6	4,947	100	110	45
Rural Area																
Dao					640	20	80	8	2,010	50	280	7.2	5,140	70	320	16.1
Dampas					790	30	90	8.8	1,660	50	320	5.2	4,390	70	370	11.9
Bool					910	50	70	13	1,030	50	250	4.1	2,030	70	290	7
Ubujan									1,390	70	100	13.9	2,010	70	110	18.3
Tiptip									1,160	50	200	5.8	2,470	70	230	10.7
Taloto									1,250	50	170	7.4	2,880	70	190	15.2
Cabawan													450	70	50	9
San Isidoro													1,500	70	200	7.5
Total	15,000		480		24,840		720		39,440		1,980		68,085		2,450	
Average				31.3				34.5				19.9				27.8

Remarks: S.P - Served population
% T.P - Per cent to the total population
S.A - Served area in hectare
P.D - Served population density, persons per hectare

3.2 Water Demand

Water demand projection in this section is undertaken to obtain a basis for a long range water supply plan until the master plan target year 2010. The water demand projection years are 1987, 1993 and 2010 conforming to the design years of this study. The water demand projections for this study are worked out based on the concept or the methodology indicated in the Procedure of Projection of Population and Water Demand in Appendix 7.

Water demand projections have been made separately for domestic, commercial and industrial, and institutional demands, and for unaccounted-for-water. The categories of water use adopted herein are those presently prescribed in the LWUA's Methodology Manual.

The average unit consumption figure, which is the amount of water required to satisfactorily supply to all consumers on a continuous 24-hour basis, was developed for each of urban and rural demand areas. The unit consumption figures are qualified as theoretical since there is insufficient data available to develop accurate unit consumptions. The theoretical unit consumption figures are therefore subject to careful review and adjustment after the Phase I program is completed and consumers have an adequate continuous supply of water.

Summary of water demand projections by the design year and category of water use is shown in Table 2.3.7 and Table 2.3.8. Served population and average day water demand by demand area are shown in Table 2.3.9. Based on the design criteria for planning, included in Appendix 6, maximum day water demands and peak hour water demands are calculated and shown in Table 2.3.10.

Table 2.3.7 Average Day Water Demand in Urban Area (Tagbilaran City)

(In m^3/day)

Use Category \ Year	1987	1993	2010
Domestic	2,880	4,177	7,318
Commercial and Industrial	315	650	1,936
Institutional	45	93	189
Accounted-for-water	3,240	4,920	9,443
Unaccounted-for-water	1,665	1,639	2,361
Total	4,905	6,559	11,804
Population Served	22,500	30,940	47,215
Per Capita Use(lpcd)	218	212	250

Table 2.3.8 Average Day Water Demand in Rural Area (Tagbilaran City)

(In m^3/day)

Use Category \ Year	1987	1993	2010
Domestic	161	663	2,087
Commercial and Industrial	-	-	-
Institutional	5	26	83
Accounted-for-water	166	689	2,170
Unaccounted-for-water	47	170	543
Total	213	859	2,713
Population Served	2,340	8,500	20,870
Per Capita Use(lpcd)	91	101	130

Table 2.3.9 Served Population and Average Day Water Demand

	1981			1987			1993			2010		
	S.P	lpcd	A.D (m^3/day)	S.P	lpcd	A.D (m^3/day)	S.P	lpcd	A.D (m^3/day)	S.P	lpcd	A.D (m^3/day)
Tagbilaran												
Urban	(15,000)	-	-	22,500	218	4,905	30,940	212	6,559	47,215	250	11,804
rural	-	-	-	2,340	91	213	8,500	101	859	20,870	130	2,713
Total	(15,000)		4,700	24,840	206	5,118	39,440	188	7,418	68,085	213	14,517

Remarks: S.P - Served population
lpcd - litters per capita per day
A.D - Average day demand in cu m/day.

Table 2.3.10 Fluctuations in Water Demand

(In m^3/day)

Water District	1981			1987			1993			2010		
	A.D	M.D	P.H	A.D	M.D	P.H	A.D	M.D	P.H	A.D	M.D	P.H
Tagbilaran	-	4,700	-	5,908	7,090	8,862	8,170	9,804	12,255	15,360	18,432	23,040

Remarks: A.D = Average day demand
M.D = Maximum day demand = A.D x 1.2
P.H = Peak hour demand = A.D x 1.5

4. Water Sources

This section discusses water sources to be used in each phase in accordance with the projected water demand and based on the general conditions of potential sources mentioned in Appendix 3. Potential water sources and water demand in the master plan period are shown in Table 2.4.1.

4.1 Phase I

Water demand in Phase I is 7,090 cu m/day. While the available total yield of the existing deep wells is estimated as 7,650 cu m/day by improvement of Nos. 7, 8 and 9 wells facilities and contribution of No. 10 well.

With regard to the existing deep wells and distribution system, however, the following must be considered.

1) Construction of new reservoir is needed for effective use of water.

2) Extension of pipelines shall be limited within the built-up area of the poblacion. And reinforcement of main pipelines is also needed in order to improve the poor supply condition in the poblacion.

   Potential water sources within or near the study area are quite limited due to the fact that all the area is composed of limestone with poor storage capacity, as reported in Appendix 3. Therefore, economical use of water is of primary importance.

3) Leakage of the pipelines shall be reduced as much as possible.

Reduction of wastage and leakage is imperative to use the full production effectively for supply.

4.2 Phase II

As is seen in the afore-mentioned table, the production capacity of the existing deep wells can not meet the water demand in Phase II. For new water sources and full utilization of the capacity, the following works are needed.

1) It is necessary to develop two deep wells of total 2,250 cu m/day capacity.

2) Construction of new reservoirs to balance the production and the hourly fluctuating demand.

3) Expansion of pipelines and water meters to meet new demand in the built-up area.

4.3 Phase III

Water demand in Phase III up to the year 2010 exceeds the production capacity of the existing deep wells in Phase II by 9,900 cu m/day. Therefore, additional deep wells have to be built. Major works will be similar to that of Phase II. Furthermore, location of new deep wells to be developed will be at the outside of the city area.

Table 2.4.1 Water Sources for Master Plan

	Present	Phase I 1987	Phase II 1993	Phase III 2010
Served Population	24,800	34,940	49,840	79,085
a) Resident in Tagbilaran	(15,000)	(24,840)	(39,440)	(68,085)
b) Non-Registered Resident	(8,800)	(8,800)	(8,800)	(8,800)
c) Resident in Dauis Poblacion	(1,000)	(1,300)	(1,600)	(2,200)
Total Water Demand Max. Day (m^3/day)	(Estimated Supplied Water) 4,700	7,090	9,800	18,430
Water Source & Capacity (m^3/day)	Eight Deep Wells 4,700	Nine Deep Wells 7,650	Nine Deep Wells 7,650	11 Deep Wells 9,900
Additional Water Needed (m^3/day)	-	0	2,250	8,530
Additional Source	-	Not Needed	Two Deep Wells	Five Deep Wells

5. Proposed Water Supply System

5.1 General

The water supply system to be provided for the Water District is planned hereunder based on the present conditions of the existing water supply system, the projected water demand and available water sources, so far described. Design criteria to be used for the planning are prepared as presented in Appendix 6 which are worked out taking into account the Technical Standard Manual prepared by LWUA.

5.2 Concept of Planning and Works in Each Phase

5.2.1 Phase I

Urgent problems of the Tagbilaran water supply are 1) to improve the poor supply conditions, generally low water pressure or no water at times, by making most effective use of the present supply capacity, and 2) to prevent further sea water intrusion. For the item 1), a reservoir will be constructed, which will perform multiple purposes, namely, to store water during low demand hours, mix water of different salinities and maintain proper water pressure in the distribution network. And further for this purpose, deteriorated pipelines will be rehabilitated and all service connections will be metered, which will discourage wasteful use of water. As for the item 2), retarding the increase of the production by the above measures of the item 1) will effectively contribute to curb the advance of sea water intrusion.

5.2.2 Phase II

This phase requires an increase of supply capacity. Two deep wells will be drilled. As the productivity of groundwater in the poblacion area is almost exhausted, the new wells will be located

at the periphery of the study area and as far away from the seacoast as possible. In accordance with the increase of water demand, distribution mains will be extended as required.

5.2.3 Phase III

The incremental water requirement in this phase will be met by developing groundwater sources outside of the study area. In the present planning, deep wells are proposed in the neighboring municipality (Baclayon) which has high possibility of groundwater, because the soil formations are very similar to that in the study area. However, detailed investigations should be undertaken before the target year of Phase II.

5.3 Proposed Water Supply Facilities

All the works mentioned in the foregoing subsection, including appurtenant facilities, are presented by the phase in Table 2.5.1.

Further, the concept of the proposed water supply system covering Phase I and II are shown in Fig 2.5.1, of which details are described in Part III of this report.

The above approach to meeting future requirements is presented in Fig 2.5.2. As illustrated, only maximum day demand will be met from the sources; peak hour demand will be furnished by additional supply from the proposed storage facilities.

Table 2.5.1 Facilities to be Constructed by Phase

Facilities	Phase I 1987	Phase II 1993	Phase III 2010
Deep Well	---	1 x (Ø 250mm x 60m) 1 x (Ø 250mm x 50m)	5 x (Ø 300mm x 80m)
Deep Well Pump Station	---	14.5 l/s, 29 Kw 11.6 l/s, 29 Kw	5 x (19.7 l/s, 29 Kw)
Elevated Tank	1 x100 m^3	1 x 100 m^3 1 x 350 m^3	---
Ground Reservoir	1 x 1350 m^3	1 x 800 m^3	1 x 710 m^3 2 x 1450 m^3
Pump Station	1 x (H=30 m, Q=62.9 l/s)	1 x (H=30 m, Q=39.1 l/s)	1 x (H=70 m, Q=98.7 l/s)
Transmission	Ø 200, L=3100 m	Ø 200mm, L= 1900m Ø 150mm, L= 100m	Ø 200mm, L=10000m Ø 350mm, L= 4000m
Distribution	Ø 250mm, L=3500m Ø 150mm, L=9600m Ø 100mm, L=5300m	Ø 200mm, L= 2500m Ø 150mm, L= 3500m Ø 100mm, L=16000m	Ø 350mm, L= 3000m Ø 200mm, L= 5000m Ø 150mm, L=20000m
Pump for No. 8 Well	1 x (H=70 m, Q=14.5 l/s)	---	---
Water Meter	1813 x Ø 13	---	---
Water Meter & Connection	2057 x Ø 13	3900 x Ø 13	6717 x Ø 13
Bulk Meter	13 x (Ø 250mm, Ø 200mm, Ø 150mm)	12 x (Ø 200mm, Ø150mm)	8 x (Ø 350mm, Ø200mm)
Chlorinator	2	2	2
Fire Hydrant	87	40	187
Valve	65 x (Ø 250mm, Ø 200mm, Ø150mm, Ø 100mm)	75 x (Ø 200mm, Ø 150mm, Ø 100mm)	101 x (Ø 350mm, Ø 200mm, Ø 150mm)
Pressure Gauge	10	---	---
Vehicle	2	1	1
Service Pipe	---	Ø50mm, L=39,000m	Ø50mm, L=67,000m

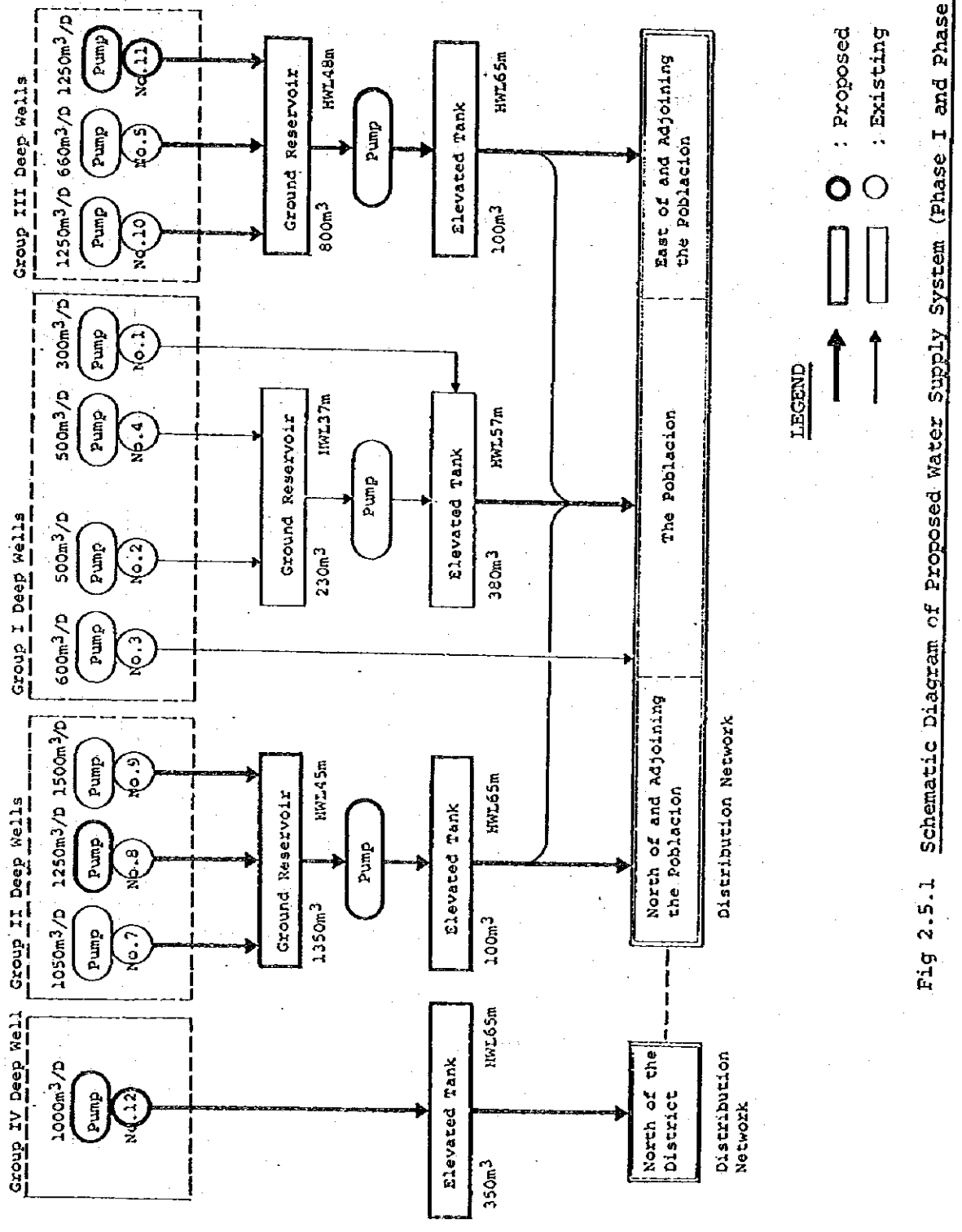


Fig 2.5.1 Schematic Diagram of Proposed Water Supply System (Phase I and Phase II)

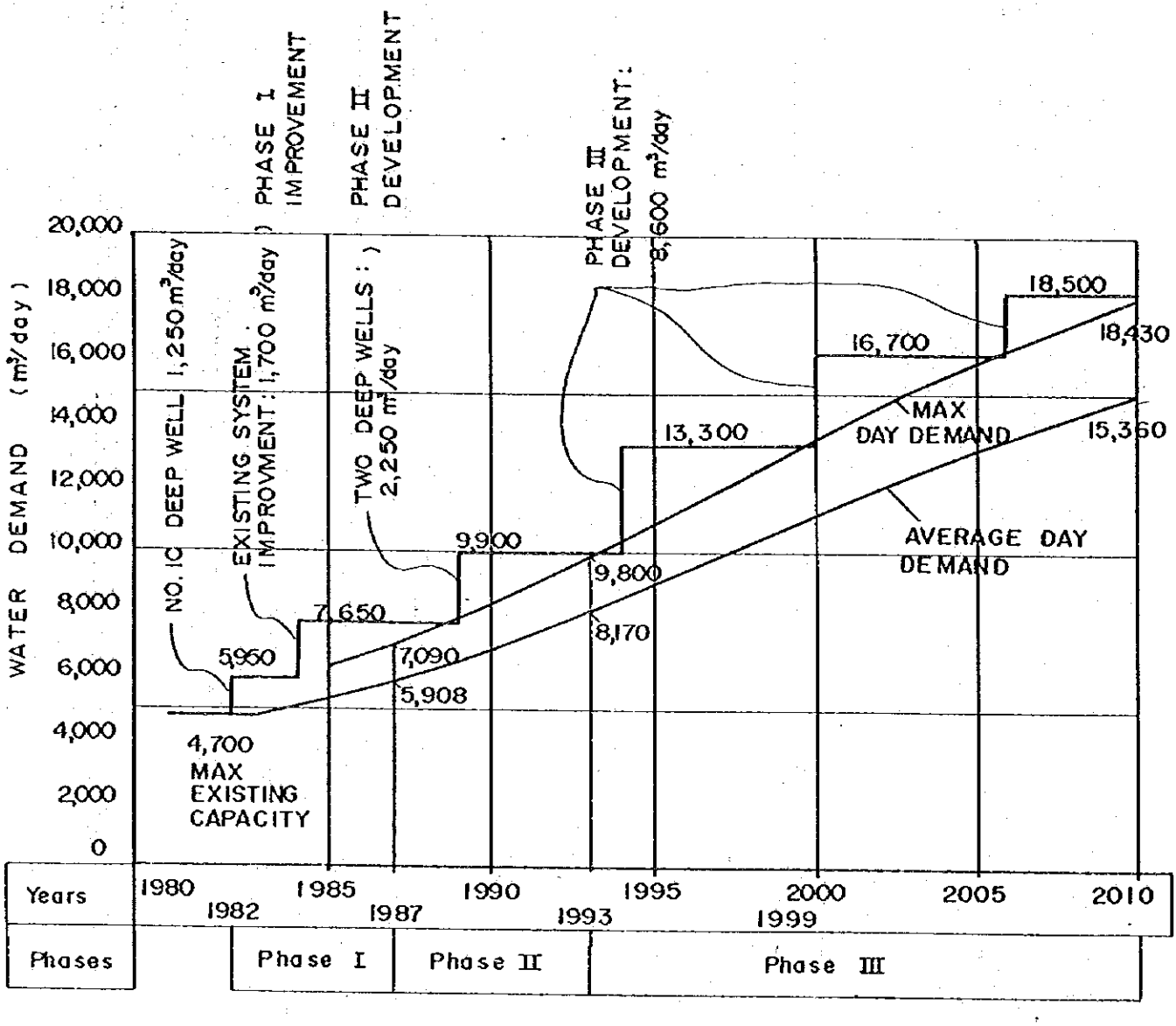
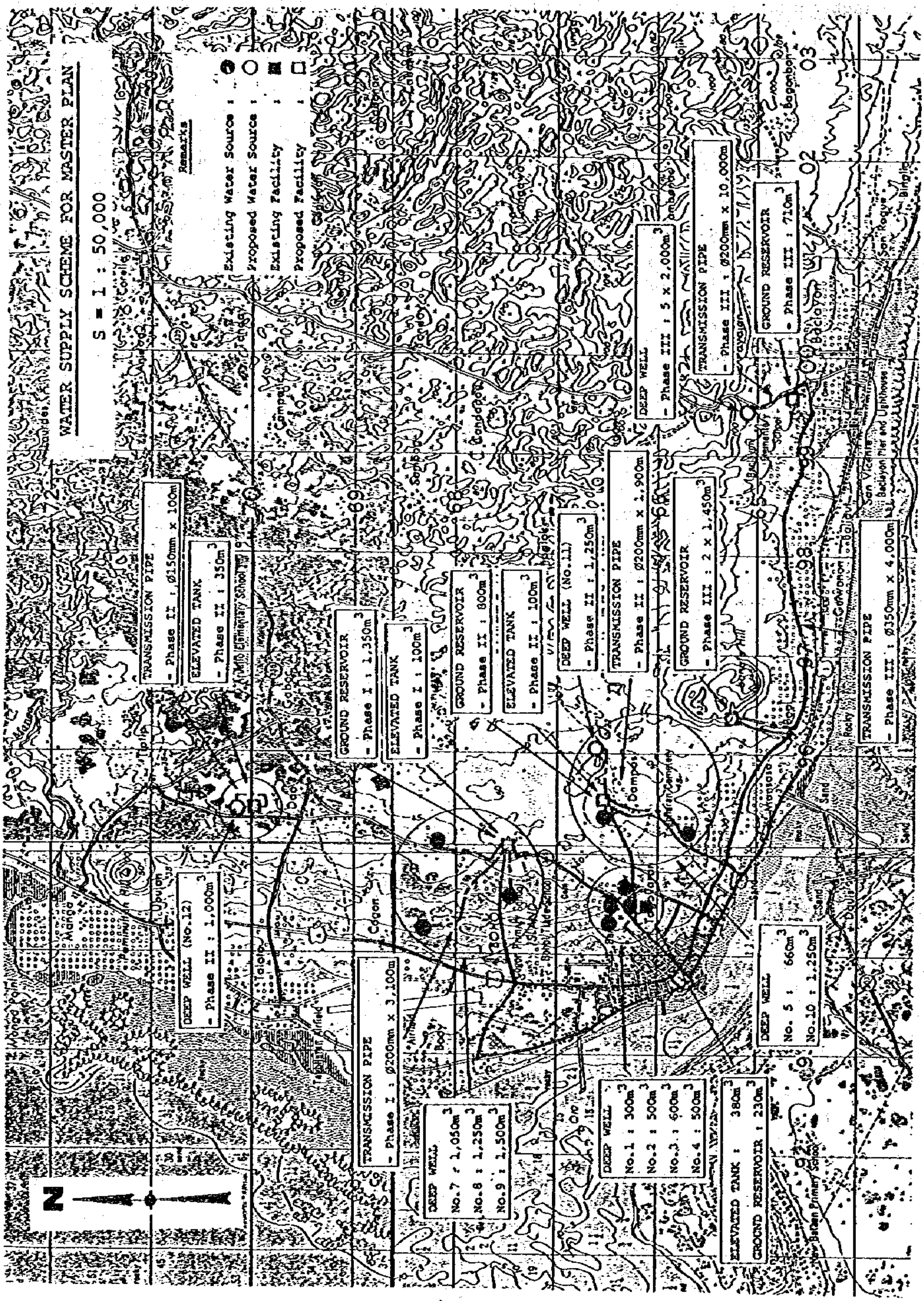


Fig 2.5.2 Water Demand vs. Sources


WATER SUPPLY SCHEME FOR MASTER PLAN
S = 1 : 50,000
Remarks
Existing Water Source :
Proposed Water Source :
Existing Facility :
Proposed Facility :
TRANSMISSION PIPE - Phase II : Ø150mm x 100m
ELEVATED TANK - Phase II : 350m3
GROUND RESERVOIR - Phase I : 1,350m3
ELEVATED TANK - Phase I : 100m3
GROUND RESERVOIR - Phase II : 800m3
ELEVATED TANK - Phase II : 100m3
DEEP WELL (No.11) - Phase II : 1,250m3
TRANSMISSION PIPE - Phase II : Ø200mm x 2,900m
GROUND RESERVOIR - Phase III : 2 x 1,450m3
DEEP WELL - Phase III : 5 x 2,000m3
TRANSMISSION PIPE - Phase III : Ø200mm x 10,000m
GROUND RESERVOIR - Phase III : 710m3
TRANSMISSION PIPE - Phase III : Ø350mm x 4,000m
DEEP WELL (No.12) - Phase II : 1,000m3
TRANSMISSION PIPE - Phase I : Ø200mm x 3,100m
DEEP WELL No.7 : 1,050m3 No.8 : 1,250m3 No.9 : 1,500m3
DEEP WELL No.1 : 300m3 No.2 : 500m3 No.3 : 600m3 No.4 : 500m3
ELEVATED TANK : 380m3
GROUND RESERVOIR : 230m3
DEEP WELL No.5 : 66m3 No.10 : 1,250m3
N
Cogon
Dampas
Bacayan
Ubujan

6. Cost Estimate

Summary of the project costs of Master Plan are shown in Table 2.6.1, 2.6.2 and 2.6.3. The costs are broken down into foreign and local currency components. Cost for engineering and physical contingency are allowed in addition to the construction costs.

Conditions and assumptions on which the estimation is carried out are as below, and cost data relating to the estimation are attached to the Report as Appendix 4.

1) All of costs and prices presented in the Table are as of July 1981.
2) Unit costs, as far as available, are taken from the list of costs prepared by LWUA[1/].
3) Unit costs not included in the above list are current prices in the market.
4) Some of the unit costs of LWUA are modified so as to fit for the present project.
5) Local currency portion for the above includes costs for handling, storage and local transportation.
6) Engineering costs are assumed as following percentages of the basic construction cost:
   - For feasibility study = 2.5%,
   - For detailed design = 10.5%, and
   - For construction supervision = 3.5%
7) Physical contingency is allowed by 10 percent of the basic construction cost and engineering cost.
8) Foreign currency exchange rate applied is: US$1.00 = ₱7.80.

1/ Addendum to Methodology Manual, 1981.

Table 2.6.1 Project Cost of Phase I

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Item	Description	Cost		
		Total Cost	Foreign Currency Component	Local Currency Component
Group I Works				
Distribution	ø250 mm, L=1,000 m	570	382	188
	ø150 mm, L=9,600 m	2,641	1,770	871
	ø100 mm, L=5,300 m	954	639	315
Group II Works				
Transmission	ø200 mm, L=3,100 m	1,209	810	399
Ground Reservoir	1,350 m^3, HWL 45 m	1,372	343	1,029
Pump Station	62.9 l/s, H=30 m	879	527	352
Elevated Tank	100 m^3, HWL 65 m	407	102	305
Distribution	ø250 mm, L=2,500 m	1,425	955	470
Pump for No.8 Well	14.5 l/s, H=70 m	133	80	53
Meters, Valves and Other Appurtenances				
Water Meter	ø13 mm, 1,813 pcs	272	209	63
Water Meter & Connection	ø13 mm, 2,057 pcs	1,337	1,029	308
Bulk Meter	ø250 mm, 3 pcs	30	24	6
	ø200 mm, 3 pcs	30	24	6
	ø150 mm, 7 pcs	47	38	9
Chlorinator	2 pcs	20	18	2
Fire Hydrant	87 pcs	623	411	212
Valve	ø250 mm, 12 pcs	100	73	27
	ø200 mm, 3 pcs	18	13	5

- to be continued -

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Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Item	Description	Cost		
		Total Cost	Foreign Currency Component	Local Currency Component
	ø150 mm, 32 pcs	136	99	37
	ø100 mm, 18 pcs	60	44	16
Pressure Gauge	10 pcs	3	2	1
Vehicle	2 cars	140	70	70
Stored Materials		229	179	50
Sub Total		12,635	7,841	4,794
Feasibility Study Cost (2.5%)		-	-	-
Detailed Design Cost (10.5%)		1,327	796	531
Supervision Cost (3.5%)		442	265	177
Land Cost		37	0	37
Sub Total		14,441	8,902	5,539
Physical Contingency (10%)		1,444	890	554
Total		15,885	9,792	6,093
Equivalent to US $		2.036M	1.255 M	0.781 M

Table 2.6.2 Project Cost of Phase II

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Item	Description	Cost		
		Total Cost	Foreign Currency Component	Local Currency Component
Group I Works				
Distribution	ø200 mm, L=750 m	292	196	96
Group III Works				
Deep Well	ø250 mm x 60 m	275	80	195
Deep Well Pump Station	14.5 l/s, 29 kW	340	190	150
Transmission	ø200 mm, L=1,900 m	741	496	245
Ground Reservoir	800 m^3, HWL 48 m	982	246	736
Pump Station	39.1 l/s, H=30 m	662	397	265
Elevated Tank	100 m^3, HWL 65 m	407	102	305
Distribution	ø200 mm, L=1,750 m	683	457	226
Group IV Works				
Deep Well	ø250 mm x 50 m	235	68	167
Deep Well Pump Station	11.6 l/s, 29 kW	340	190	150
Transmission	ø150 mm, L=100 m	28	19	9
Elevated Tank	350 m^3, HWL 65 m	1,343	336	1,007
Distribution	ø150 mm, L=3,500 m	963	645	318
	ø100 mm, L=16,000m	2,880	1,930	950
Meters, Valves and Other Appurtenances				
Water Meter & Connection	ø13 mm, 3,900 pcs	2,535	1,952	583

- to be continued -

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Item	Description	Cost		
		Total Cost	Foreign Currency Component	Local Currency Component
Bulk Meter	ø200 mm, 6 pcs	60	48	12
	ø150 mm, 2 pcs	13	10	3
Chlorinator	2 pcs	20	18	2
Fire Hydrant	40 pcs	278	183	95
Valve	ø200 mm, 10 pcs	61	45	16
	ø150 mm, 12 pcs	51	37	14
	ø100 mm, 53 pcs	178	130	48
	ø50 mm, 130 pcs	195	142	53
Service Pipe	ø 50 mm, L=39,000 m	3,120	2,090	1,030
Vehicle	1 car	70	35	35
Stored Material		160	125	35
Administrative Building		710	568	142
Operation Center		540	346	194
Sub Total		18,162	11,081	7,081
Feasibility Study Cost (2.5%)		454	272	182
Detailed Design Cost (10.5%)		1,907	1,144	763
Supervision Cost (3.5%)		636	382	254
Land Cost		124	0	124
Sub Total		21,283	12,879	8,404
Physical Contingency (10%)		2,128	1,288	840
Total		23,411	14,167	9,244
Equivalent to US $		3.001 M	1.816 M	1.185 M

Table 2.6.3 Project Cost of Phase III

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Item	Description	Cost		
		Total Cost	Foreign Currency Component	Local Currency Component
Deep Well				
Deep Well	5 x (Ø300 mm x 80m)	2,050	595	1,455
Deep Well Pump Station	5 x (19.7 l/s,29kW)	1,700	952	748
Storage				
Ground Reservoir	2 x 1,450 m^3	2,872	718	2,154
	1 x 710 m^3	910	228	682
Pump Station				
Transportation Pump Station	98.7 l/s, H = 70m	1,486	892	594
Pipe				
Transmission	ø200 mm, L=10,000m	3,900	2,613	1,287
	ø350 mm, L=4,000 m	3,160	2,117	1,043
Distribution	ø350 mm, L=3,000 m	2,370	1,588	782
	ø200 mm, L=5,000 m	1,950	1,307	643
	ø150 mm, L=2,000 m	5,500	3,685	1,815
Equipment				
Water Meter & Connection	ø13 mm, 6,167 pcs	4,366	3,362	1,004
Bulk Meter	ø350 mm, 3 pcs	30	24	6
	ø200 mm, 5 pcs	50	40	10
Chlorinator	2 pcs	20	18	2
Fire Hydrant	ø150 mm, 28 pcs	328	216	112
	ø100 mm, 159 pcs	1,065	703	362

- to be continued -

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Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Item	Description	Cost		
		Total Cost	Foreign Currency Component	Local Currency Component
Valve	ø350 mm, 12 pcs	204	149	55
	ø200 mm, 22 pcs	134	98	36
	ø150 mm, 67 pcs	285	208	77
	ø 50 mm,223 pcs	335	245	90
Service Pipe	ø50 mm, L=67,000 m	5,360	3,591	1,769
Vehicle	1 car	70	35	35
Stored Material		269	210	59
Sub Total		38,414	23,594	14,820
Feasibility Study Cost (2.5%)		960	576	384
Detailed Design Cost (10.5%)		4,033	2,420	1,613
Supervision Cost (3.5%)		1,344	806	538
Land Cost		90	0	90
Sub Total		44,841	27,396	17,445
Physical Contingency (10%)		4,484	2,740	1,744
Total		49,325	30,136	19,189
Equivalent to US $		6.324 M	3.864 M	2.460 M

7. Implementation Schedule

In accordance with the target years set forth in Section 2 and in consideration of works described in Section 5, the implementation schedule of the whole project of the master plan is worked out and shown in Fig 2.7.1. Major points to be noted about the implementation schedule are as follows.

7.1 Phase I

1) The period from present up to the commissioning of the completed facilities is estimated based on the detailed time elements of individual work items.

2) The period between the above commissioning and the target year is set so that actual data on water supply planning factors can be collected.

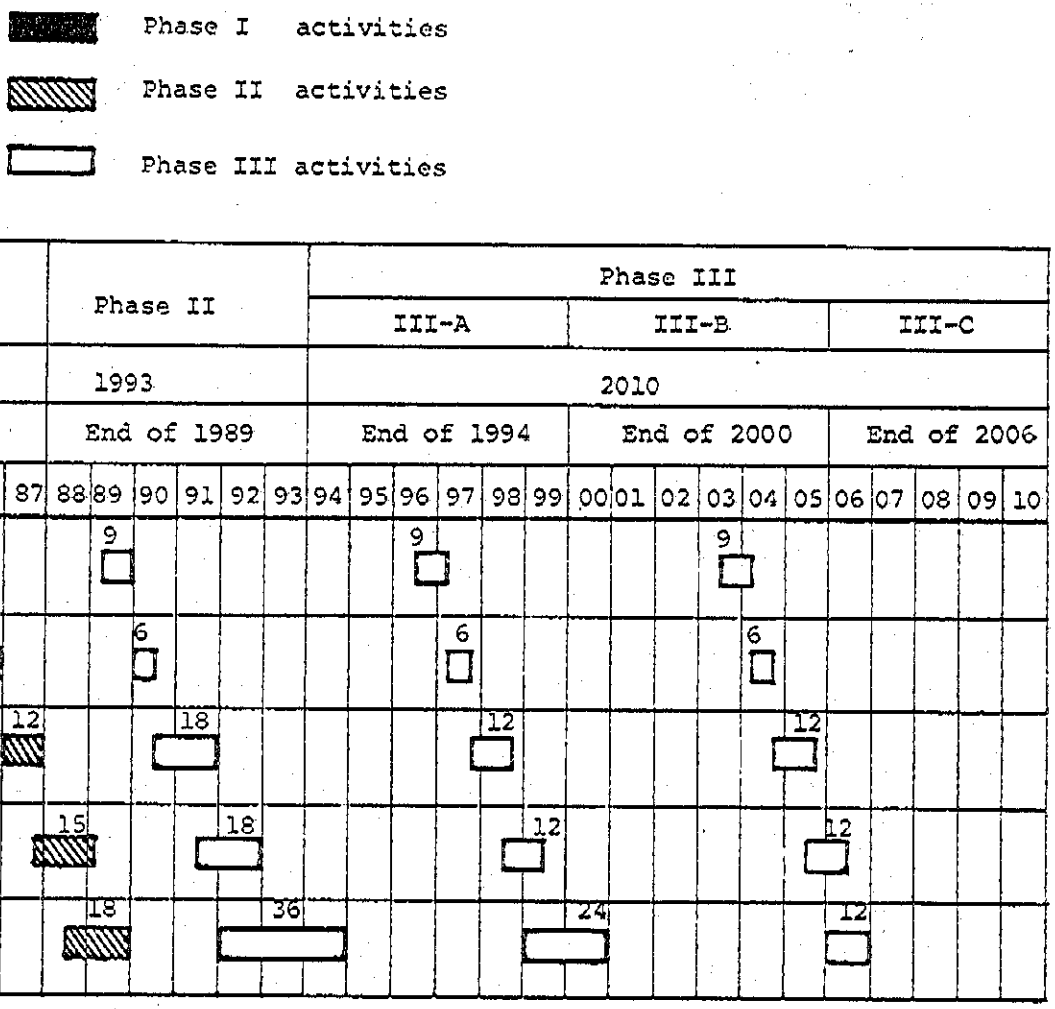
3) Start of preparation for the Phase II project is placed after the commissioning and before the target year, so that the planning of the Phase II project can be made employing actual data and the construction of the said project can be commenced as early as possible.

7.2 Phases II and III

1) Commissioning of the Phase II facilities is scheduled two years after the Phase I target year. It may result in slight shortage of the supply capacity. But, depending on the actual development of the supply conditions, the time of commissioning can be advanced to some extent, or a small cut of maximum day demand may be unavoidable.

2) Implementation of the Phase III project is planned in a similar way to Phase II. All explanations above are applicable to this phase as well.

Fig 2.7.1 Implementation Schedule



8. Organization and Management

The existing organization as described in 3. "Existing Water Supply" of Part One is recommended to be reorganized into a "water district" as defind under PD 198 (as amended by PD 768 and 1479), whose organizational set-up is required to conform with LWUA guidances and requirements.

These LWUA guidances and requirements are found to be effective and practical to strengthen the functional capacity of the organization in the following three respects:

a. Technical
b. Commercial
c. Administrative and Financial

The review of the functional capacities of the existing management reveals that its commercial capacity is comparatively weaker than other capacities. It is therefore recommended that the personnel for commercial activities be strengthened. With future expansion of the Water District, a manager responsible for commercial functions will become necessary in addition to those for administrative and technical functions.

The number of water district employees depends primarily on the total number of service connections; or more employees for more connections.

Regards should be paid to the quality of water districts employees. Employees need training to enhance their capability. Salaries should also be attractive enough to recruit efficient employees.

PART THREE: FEASIBILITY STUDY

1. General
2. Target Year and Project Area
3. Estimation of Population Served and Water Demand
4. Immediate Improvement and Expansion Works
5. Water Source
6. Design Criteria, Alternative Plans and Preliminary Design
7. Construction, Operation and Management Schedule
8. Materials, Labor Force and Contractor's Ability
9. Construction and Procurement Methods
10. Cost Estimate
11. Organization and Operation and Management Plan
12. Financial Feasibility Analysis
13. Economic Feasibility Analysis
14. Alternative Feasibility Study

1. General

This Part Three treats the feasibility study for two different cases of project formation. One case (Case 1) is for a project of Phase I (Target Year: 1987) defined in Part Two: Master Plan, and the other case (Case 2) is intended to make, in addition, an alternative study for a project comprising Phase I and Phase II (Target Year: 1993) as defined in the Master Plan.

The project of Case 1 aims, basically, to meet the currently unsatisfied water demand and also increasing needs in the immediate future by rehabilitating the existing deteriorated water facilities and adding some expansion works. On the other hand, the alternative study for Case 2 explores the feasibility and suitability of the project with Phases I and II combined, as stated above, which extends over a medium terms of about ten years after the commencement of project construction. The main purpose of this project, if found to be feasible, is to secure reliable drinking water supply over a fairly long period and remove restraints of poor water service, experienced long since, on the development of the city as a local commercial and industrial center.

2. Target Year and Project Area

2.1 Target Year for Study

As described in the preceding section the present feasibility study deals with the two cases, thus the target year for study, in this section, represents two different periods of Phase I and Phase II defined in the master plan. Phase I program is starting from the year 1982 up to the year 1987 and Phase II program covers the period of another 6 years from 1988 up to 1993.

2.2 Project Area

The project area for the feasibility study is delineated as the poblacion area including adjoining barangays presently served by the existing water supply systems and their surrounding areas which are considered to develop and require water supply within the period until the end of target year of the study.

The Tagbilaran WD's project area for the Phase I covers approximately 720 ha mostly in the poblacion area including the present served area of 480 ha. In Phase II the served area is expanded to 1,980 ha in 1993; takes in the thereafter extended built-up area.

Present served area and projected areas by phase are shown in Fig 2.2.1 and Table 2.2.6.

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3. Estimation of Population Served and Water Demand

3.1 Estimation of Population Served

Based on the projected total population in the study area and the projected served area by design year, which are described in the Part Two: Master Plan, the population in the served area is estimated annually for the feasibility study period of Phase I (1987) and Phase II (1993).

The annual population in the served area in each demand area is extrapolated based on the master plan projection figures in the design years of 1987 and 1993, as shown in Table 3.3.1.

The coverage of served population for the feasibility study in the projected served area has been estimated based on the above population in the served area taking account of the willingness-to-connect of the projected consumers and future improvement of the consumer's living standard.

The annual served population in each demand area is estimated up to the year 1993 and shown in Table 3.3.2 and Fig 3.3.1.

3.2 Estimation of Water Demand

The overall average day water demand for the WD is estimated based on the served population and the average unit water demand, which is including demands for domestic, commercial/industrial, institutional and unaccounted-for-water. The annual average day demand is extrapolated from the demands in the design years of 1987 and 1993, taking account of the sources of supply and the extended served area as well as the served population, and shown in Table 3.3.3.

Table 3.3.1 Projected Population in Served Area
(Tagbilaran City)

Year	Urban Area		Rural Area		Total Area	
	Total Population in the Study Area	Population in the Served Area	Total Population in the Study Area	Population in the Served Area	Total Population in the Study Area	Population in the Served Area
1980	27,768	25,000	14,507	-	42,275	25,000
1981	28,350	25,520	14,930	-	43,280	25,520
1982	28,950	26,060	15,370	-	44,320	26,060
1983	29,570	26,610	15,820	1,580	45,390	28,190
1984	30,190	28,680	16,280	3,260	46,470	31,940
1985	30,830	29,290	16,760	5,030	47,590	34,320
1986	31,480	31,480	17,250	6,900	48,730	38,380
1987	32,146	32,146	17,764	7,627	49,910	39,773
1988	33,150	33,150	17,840	8,920	50,990	42,070
1989	34,190	34,190	17,910	12,540	52,100	46,730
1990	35,250	35,250	17,980	16,180	53,230	51,430
1991	36,360	36,360	18,050	16,200	54,410	52,560
1992	37,490	37,490	18,120	16,210	55,610	53,700
1993	38,664	38,664	18,206	16,214	56,870	54,878
2010	47,215	47,215	29,805	29,805	77,020	77,020

Table 3.3.2 Projected Population Served
(Tagbilaran City)

Year	Urban Area		Rural Area		Total Area	
	Total Population in the Study Area	Population in the Served Area	Total Population in the Study Area	Population in the Served Area	Total Population in the Study Area	Population in the Served Area
1980	25,000	15,000	-	-	25,000	15,000
1981	25,520	15,800	-	-	25,520	15,800
1982	26,060	16,700	-	-	26,060	16,700
1983	26,610	18,750	1,580	500	28,190	19,250
1984	28,680	21,300	3,260	800	31,940	22,100
1985	29,290	22,400	5,030	1,200	34,320	23,600
1986	31,480	22,500	6,900	1,700	38,380	24,200
1987	32,146	22,500	7,627	2,340	39,773	24,840
1988	33,150	23,700	8,920	3,200	42,070	26,900
1989	34,190	25,000	12,540	4,200	46,730	29,200
1990	35,250	26,400	16,180	5,200	51,430	31,600
1991	36,360	27,800	16,200	6,300	52,560	34,100
1992	37,490	29,400	16,210	7,400	53,700	36,800
1993	38,664	30,940	16,214	8,500	54,878	39,440
2010	47,215	47,215	29,805	20,870	77,020	68,085

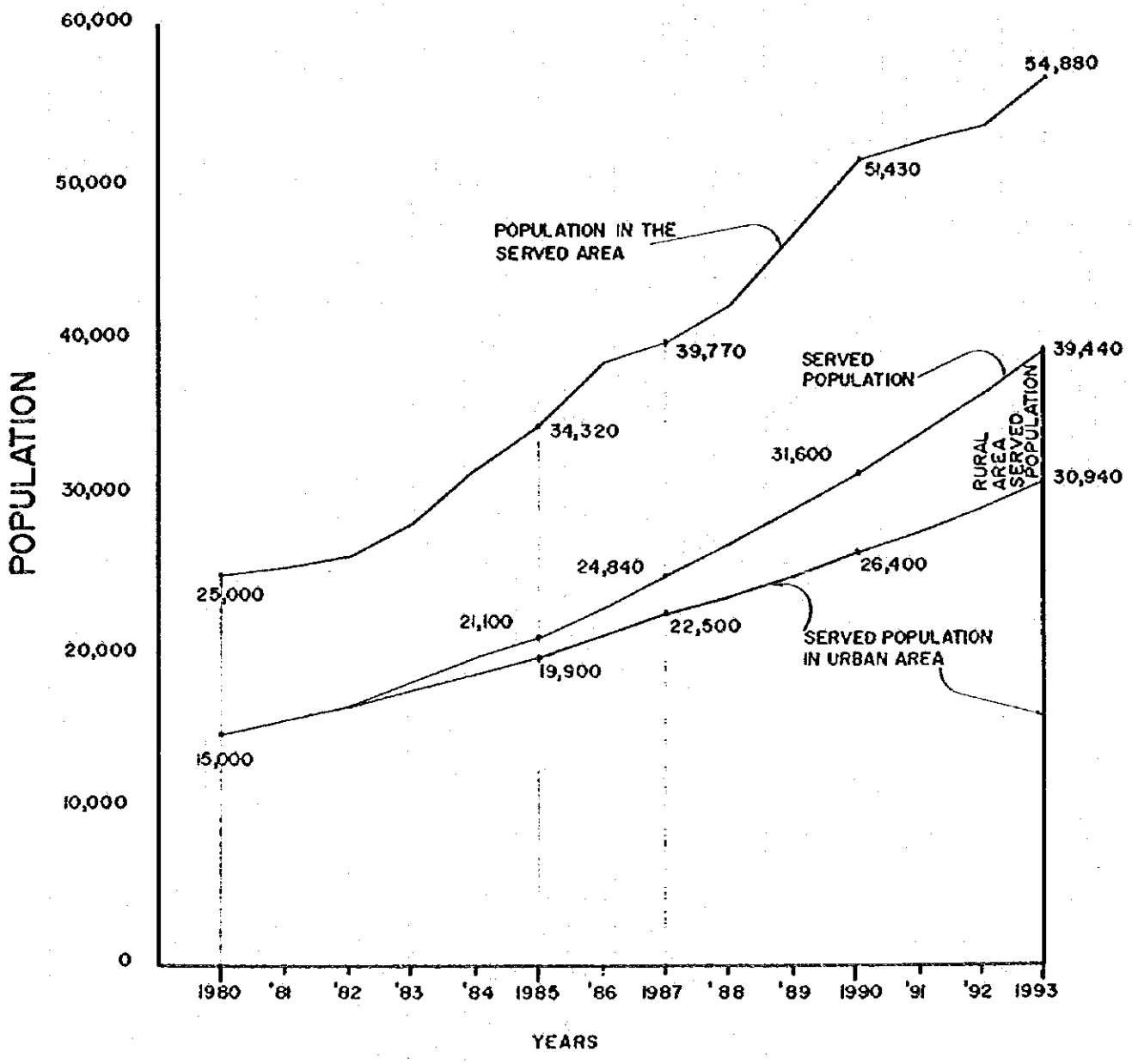

Fig 3.3.1 Projected Served Population
(Tagbilaran City)

Table 3.3.3 Estimated Water Demand in Tagbilaran WD

Year	Urban Area		Rural Area		Sub-total		Non-Registered Residents		Dauis Poblacion		Total	
	Population Served	Average Day Water Demand (m^3/day)	Population Served	Average Day Water Demand (m^3/day)	Population Served	Average Day Water Demand (m^3/day)	Population Served	Average Day Water Demand (m^3/day)	Population Served	Average Day Water Demand (m^3/day)	Population Served	Average Day Water Demand (m^3/day)
1980	15,000	3,800	-	-	15,000	3,800	8,800	800	1,000	100	24,800	4,700
1981	15,800	3,800	-	-	15,800	3,800	8,800	800	-	100		4,700
1982	16,700	3,970	-	-	16,700	3,970	8,800	800	-	100		4,870
1983	17,700	4,116	500	44	19,250	4,160	8,800	800	-	100		5,060
1984	18,800	4,300	800	70	22,100	4,370	8,800	800	-	100		5,270
1985	19,900	4,380	1,200	107	23,600	4,445	8,800	730	-	110		5,285
1986	21,100	4,600	1,700	153	24,200	4,753	8,800	700	-	115		5,518
1987	22,500	4,905	2,340	213	24,840	5,118	8,800	670	1,300	120	34,940	5,908
1988	23,700	5,143	3,200	298	26,900	5,441	8,800	650	-	125		6,216
1989	25,000	5,400	4,200	399	29,200	5,799	8,800	630	-	130		6,559
1990	26,400	5,676	5,200	499	31,600	6,175	8,800	610	-	135		6,920
1991	27,800	5,949	6,200	617	34,100	6,566	8,800	590	-	140		7,296
1992	27,400	6,262	7,400	733	36,800	6,995	8,800	590	-	150		7,735
1993	30,940	6,559	8,500	859	39,440	7,418	8,800	590	1,600	160	49,840	8,170
2010	47,215	11,804	20,870	3,713	68,085	14,517	8,800	550	2,200	290	79,085	15,357

4. Immediate Improvement and Expansion Works

Water supply conditions which require immediate improvement and expansion works are summed up from descriptions in Part One, Existing Water Supply, as below.

1) Water pressure is too low throughout the served area with some places where piped water is unavailable.
2) Sea water is intruding into the aquifer where the deep wells are sunk.
3) Leakage and wastage appear to be sizable.
4) Pipelines are insufficient in the present served area.

Works needed to remedy the above poor conditions are recapitulated from the master plan in Part Two.

1) Construction of Reservoirs and Incidental Pipelines
The existing water supply system cannot accommodate the hourly peak demand due to insufficient storage. Therefore, new reservoirs are proposed for the project at three sites, which will augment the supply capacity so as to cope with the fluctuating demands and improve the poor supply. In Phase I, a ditribution reservoir is to be constructed connecting with transmission mains from Nos. 7, 8, and 9 deep wells.

2) Construction of Deep Wells
The existing deep wells are rather clustered in the poblacion, and some wells are producing saline water. In the present project, new wells will be drilled outside of the poblacion for the purposes of increasing production and avoiding sea water intrusion. However, the maximization of present wells capacity is firstly taken into consideration. In Phase I, Nos. 7, 8, and 9 wells capacities are to be increased by the improvement of transmission mains and the replacement of No. 8 well's pump.

3) Metering

New meters should be installed at all service connections that do not presently have meters. Existing meters that cannot be repaired should also be replaced with new meters. Metering proposed has the following multipurposes: to prevent wasteful use of water on the part of the consumers, charge the water consumption on a fair base, and know the amount of water loss as the difference between the readings of bulk meters and house meters.

4) Extension and Reinforcement of Pipelines

Additional pipelines will be installed to reinforce the distribution network in the present served area, and new pipelines will be installed in the developing areas. In Phase I , following primary and secondary distribution mains are to be installed.

Ø250 mm	L=1,000 m
Ø150 mm	L=9,600 m
Ø100 mm	L=5,300 m

5. Water Source

Potential water sources for the Water District are groundwater found in the city area and its vicinity and surface water of the Loboc River, as reported in detail in Appendix 3: Study on Water Sources. Of the two potential water sources, the Loboc River is too far located from the Water District, so it is economically unfeasible to take the surface water from the River.

On the other hand, groundwater is available widely in the District. However, the present production capacity, about 8,000 cu m/day, of the existing deep wells has almost reached the limit of the availability of groundwater, though the average production is currently around 5,000 cu m/day, and some wells are producing somewhat saline water. Therefore, the production of all the existing wells must be kept to the present capacity at most, and if possible, it must be reduced to an extent to prevent further intrusion of sea water into inland.

The present distribution of the deep wells is not uniform but rather concentrated in the poblacion causing depression of the groundwater table and inviting sea water intrusion. Around the poblacion and within the city area, there are still areas where groundwater is not tapped. These areas have the same soil formation as the poblacion area. Therefore, some deep wells can be drilled in such areas without effecting the saline intrusion in the poblacion area.

From the past experience of deep wells in the District, the safe yield of a deep well is expected to be around 1,000 cu m/day, and the spacing between two neighboring wells is considered preferably to be more than 1,000 m.