

MINISTRY OF INTERIOR
PROVINCIAL WATERWORKS AUTHORITY

FINAL REPORT
FOR
DEVELOPMENT PLAN AND FEASIBILITY STUDY
ON
PROVINCIAL WATER SUPPLY PROJECTS
IN
THE KINGDOM OF THAILAND

VOLUME IV-A
MAIN REPORT
FOR
SUPHANBURI

MARCH 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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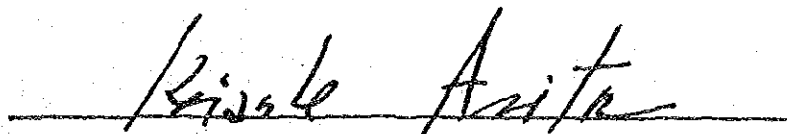
P R E F A C E

In response to the request of the Government of the Kingdom of Thailand, the Japanese Government has decided to conduct Development Plan and Feasibility Study on Provincial Water Supply Projects and entrusted the Study to the Japan International Cooperation Agency (JICA). JICA sent to the Thailand a study team headed by Mr. Osamu Wakamoto, Nihon Suido Consultants Co., Ltd. from December 1985 to December 1986.

The team had discussions with the officials concerned of the Government of the Thailand and conducted a field survey in the Study Areas and Bangkok. 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 Thailand for their close cooperation extended to the team.

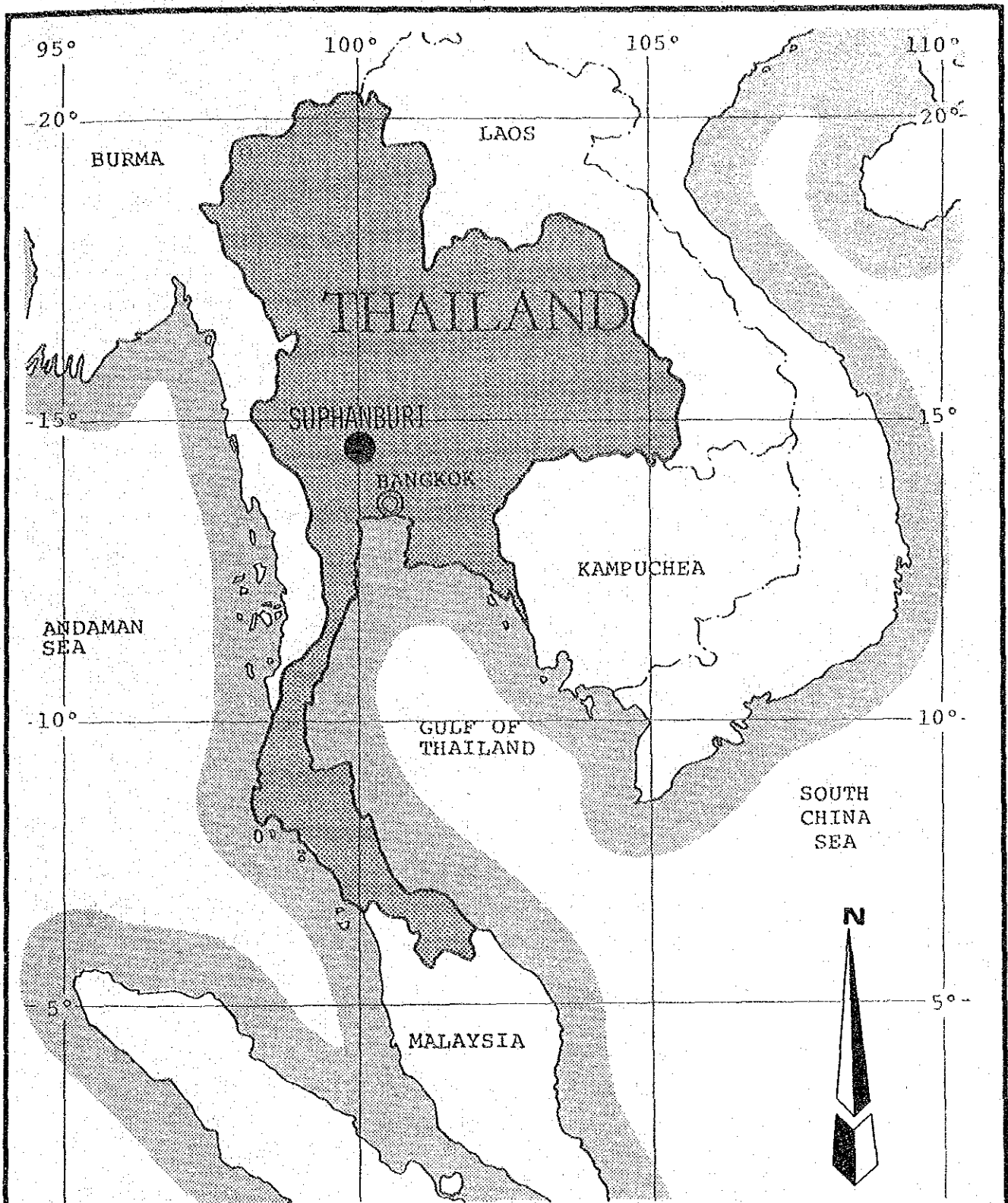
March 1987

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

Keisuke ARITA

President

Japan International Cooperation Agency



LEGEND

● : SUPHANBURI MUNICIPALITY

◎ : CAPITAL CITY

SCALE 1 : 10,000,000

FIGURE	LOCATION MAP
JAPAN INTERNATIONAL COOPERATION AGENCY	

A C K N O W L E D G E M E N T S

The members of JICA study team, Nihon Suido Consultants, express their sincere appreciation for the kind assistance and cooperation given by PWA staff especially to Dr. Wanchai Ghooprasert, Deputy Governor in charge of Planning and Finance; Khun Virusah Mahakkapong, Director of Operation and Maintenance (Area I); Khun Sitthichai Pissathanporn, Director of Operation and Maintenance (Area II); and Khun Virayu Amornlectrakul, Director of Accounting & Finance Department (AFD).

The Study Team is grateful for the assistance and participation of Khun Orapin Assavanig, Chief, International Cooperation Section, Corporate Planning Department; Khun Wanchai Lowatanatakul, Project Coordinator, Corporate Planning Department (CPD); Khun Jaroon Upanan, Water Supply Engineer, CPD; Khun Wirawan Kaeopradith, System Analyst, Planning Division, CPD; Khun Pinporn Phongsri, Economist, Planning Division, CPD; Khun Thavorn Nitipavachon, Water Resource Development Project, CPD; Khun Somkiat Piriyaakul, Water Resource Development Project, CPD; Khun Prathom Khoysomboon, Technician, Planning Div., CPD; Khun Supanee Thongsri, Clerk, Planning Div., CPD; Khun Anu Songsakchai, Typist, Planning Div., CPD; Khun Vanida Taechaesaen, Chief of Accounting Division, AFD; Khun Prakrit Chanurai, Chief of Work Plan Analysis Work, CPD; Khun Damrong Ratanasaengsakulthai, Coopers Lybrands' officer; Khun Sompis Amornrojanawonse, Head of Loan Account, AFD; Khun Chindarat Suwanapak, Analysis and Evaluation Dept.; Khun Chantira Jurotok, Head of General Ledger, AFD; Khun Somsong Pantaranontaka, Acting Director of Budget Division, AFD.

We would also like to take this opportunity to express our appreciation to all of the PWA staff (in Chonburi Regional Office No. I and Pattaya Waterworks; Saraburi Regional Office No. II and Suphanburi Waterworks; Ubon Ratchathani Regional Office No. VIII and Ubon-Warin Waterworks; Chiangmai Regional Office No. IX, Chiangmai, Mae Rim and San Kamphaeng Waterworks).

EXECUTIVE SUMMARY

A. Introduction

This report summarizes the results of a comprehensive master plan and feasibility study conducted by a study team of the Japan International Cooperation Agency (JICA), which are presented in this volume of the Report entitled "DEVELOPMENT PLAN AND FEASIBILITY STUDY ON PROVINCIAL WATER SUPPLY PROJECTS IN THE KINGDOM OF THAILAND, SUPHANBURI".

The study area covers Suphanburi Municipality and its neighboring Sanitary District, Phophraya, both located approximately 100 km northwest of Bangkok. Suphanburi is an administrative, educational and commercial center serving agricultural districts surrounding the municipality.

The combined population of Suphanburi and Phophraya is projected to increase from 28,600 in 1985 to 37,600 by 2010, the target year of the current project.

The service ratio of the area is comparatively high to register 79 % in 1985, but this is due chiefly to the hydrogeological features of the area, where potable water is unavailable from shallow wells. Despite the high rate of service ratio, the necessity to expand water supply in this area is urgent, as the unserved residents are forced to depend upon unsanitary rain and river water or to purchase unreasonable expensive water from vendors.

The current project purports to mitigate such immediate requirements, as well as to improve the service ratio in the long-run from 79 % at present to 94 % in 2010.

In view of the uncertainties in the future development of Suphanburi and Phophraya as well as of the internal administrative reasons of PWA, project implementation is planned to be divided into two stages, i.e., Stage I up to the year 2000 and Stage II through 2010.

It is also to be noted that the unaccounted-for water ratio is increasing rapidly these years, with the water supply facilities deteriorating. Because of the increasing unaccounted-for ratio, recent expansion in production has not resulted in purported increase in supply.

In view of the above, the Development Plan proposes an immediate improvement program to rehabilitate the existing system, together with immediate modification works to increase the production-supply capacity of the existing facilities. These immediate actions are required to be carried out prior to the Stage I expansion program, or as part of its initial phase.

B. Strategies to the Targets

As a step to achieve the service ratio of 94 % in 2010, a ratio of 92 % will be targeted for the year 2000, probably one of the highest ratio among PWA Waterworks. For this purpose the share of public, commercial, industrial and other large-scale consumers are required to be increased.

The field survey and the questionnaire survey conducted in January 1986 revealed that the unstableness of water supply due to the deterioration of the production-supply facilities was pointed out as one of the main reasons why large-scale consumers evaded the use of PWA water. This unstableness of supply together with high priced water tariffs were iterated by large-scale consumers as the points to be rectified in PWA water-supply service.

It is projected that the share of large-scale consumers will gradually increase with improvement in services, as shown in Table-ES.1, i.e., from 36 % of the total consumers in 1985 to 41 % in 2000 and to 43 % in 2010. Such improvement in the share of large-scale consumers will doubtless contribute to the betterment of the waterworks' rate of return, as the average water-tariff level will be improved.

Table-ES.1 PROJECTED WATER DEMAND FOR SUPHANBURI WATERWORKS

<u>Item</u>	<u>1985</u>	<u>2000</u>	<u>2010</u>
1. Total Population	28,600	34,000	37,600
Suphanburi	24,300	29,100	32,300
Phophraya	4,300	4,900	5,300
2. Population Served	22,600	31,300	35,300
Suphanburi	19,200	26,800	30,300
Phophraya	3,400	4,500	5,000
3. Water Sales : (m ³ /day)	2,880	6,200	8,630
a) Domestic	1,840	3,660	4,940
Suphanburi	1,570	3,130	4,240
Phophraya	270	530	700
b) Public and Other Large-Scales	1,040	2,540	3,690
Suphanburi	1,000	2,330	3,340
Phophraya	40	210	350
4. Water Production (m ³ /day)	4,970	8,050	10,800
5. Unaccounted-for as % of Production	42	23	20

The use of groundwater as raw water source should be encouraged from the viewpoint of cost-consciousness. This not only reduces chemical and electricity cost but also cut down personnel expenses drastically. The number of personnel is projected to increase from 32 in 1986 only to 48 in 2000, while water sales will increase from 1,095 thousand cu m to 2,263 thousand cu m during the project period.

The domestic per-capita consumption is also projected to increase almost linearly from 82 lpcd in 1985 to 117 lpcd in 2000, and further to 140 lpcd in 2010.

Strategic plans are illustrated in Fig-ES.1 and the estimated costs therefor are summarized in Table-ES.2.

Table-ES.2 TOTAL COST FOR MASTER PLAN

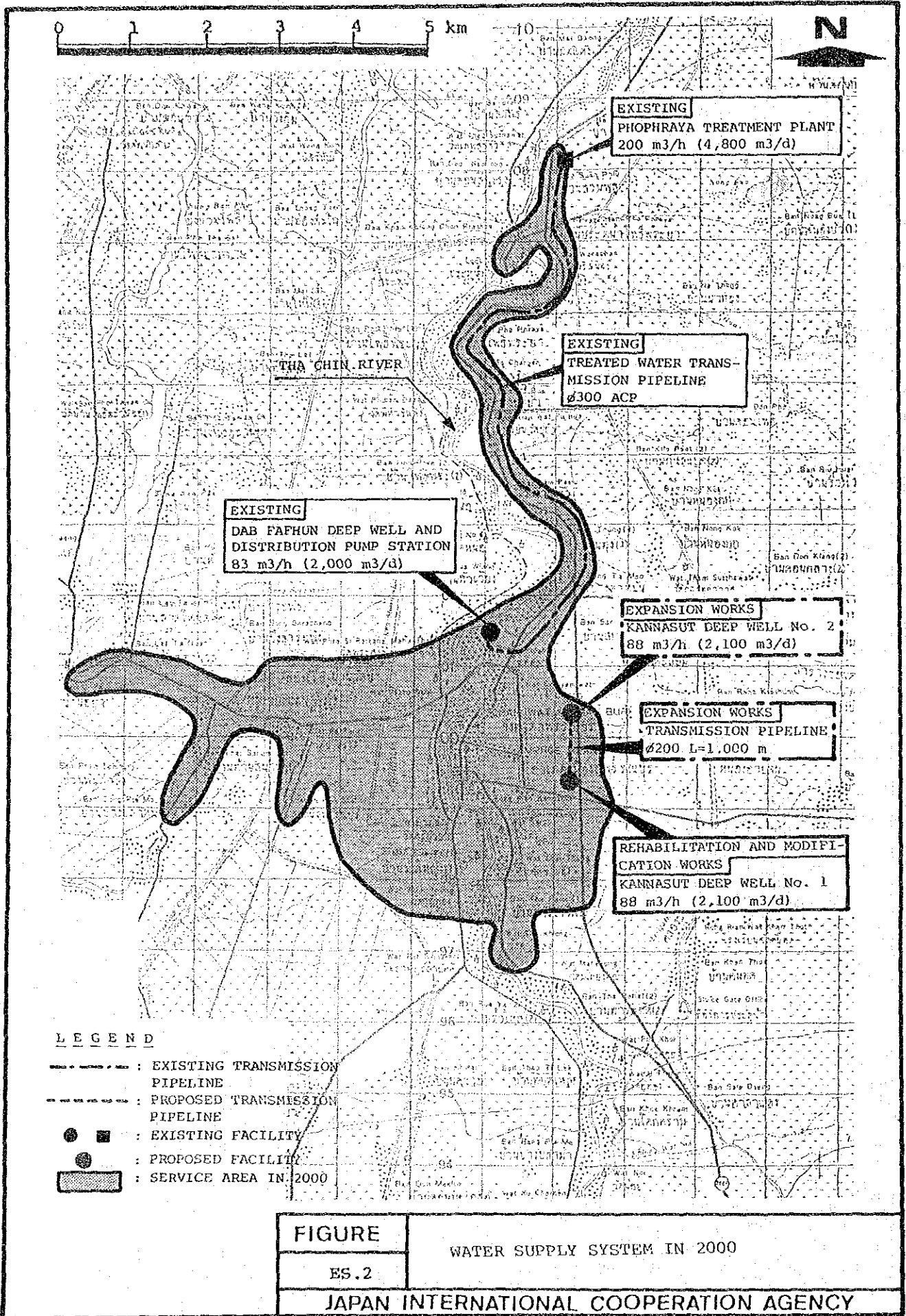
Unit:1,000 Baht

Item	Stage I		Stage II	Total
	Rehabili. and Modifi.	Sub- Expansion Total	(2000-2010) Expansion	Stages I and II
Land and Facilities	25,100	21,400	29,500	76,000
Engineering Service	2,600	2,300	3,000	7,900
Administration Cost	300	200	300	800
Physical Contingencies	1,900	1,700	2,300	5,900
Price Contingencies	2,600	4,300	18,400	25,300
Total	32,500	29,900	53,500	115,900

C. Proposed Water Supply, 1987-2000

The proposed water supply system for Stage I will cover the service area shown in Fig-ES.2. The rehabilitation and modification will provide needed improvement of existing facilities and to construct a 2,100 cu m/d deep well to meet the urgent water demand which is expected to intensity around 1988. The Stage I Expansion is designed to meet projected maximum day demand of 10,900 cu m/d, to serve 31,300 people by 2000, and to expand the service area to 2,300 ha. Additional 33 km distribution pipelines will be installed, with approximately 1,000 service connections. Implementation is proposed to proceed as Fig-ES.3.

The proposed project and its costs are summarized in Table-ES.3. The estimated cost of the project, totaling 62,400 thousand Baht at current prices allowing for price increases of 3.3 percent per annum is realistic, based on preliminary designs plus an allowance of 7 % for physical contingencies.



DESCRIPTION	YEAR							
	86	87	88	89	90	91	92	93
1) Feasibility Study	■	■						
2) Loan Procedure of Expansion	■	■						
3) Selection of Consultants		■						
4) D/D of Expansion		■	■	■				
5) D/D of R/M		■	■					
6) Loan Procedure of Expansion			■	■				
7) Selection of Consultants				■	■			
8) Qualification of Contractors					■	■		
9) Tender Evaluation			■	■	■			
10) Construction				■	■			
(a) R/M Works				■	■			
(b) Expansion Works						■	■	
Deep Well & Pump Station						■	■	
Distribution Facilities						■	■	

NOTE : D/D : Detailed Design
R/M : Rehabilitation and Modification

FIGURE	IMPLEMENTATION SCHEDULE
ES.3	
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Table-ES.3 ESTIMATED PROJECT COSTS FOR STAGE I IMPLEMENTATION

	(x 1,000 Baht)
A. Rehabilitation and Modification	25,100
Land Acquisition	2,000
Phophraya Treatment Plant	2,350
Clear Water Transmission Pipeline	650
Dab Fafhun Deep Well and Distribution Pump Station	2,100
Kannasut Deep Well (No.1) and Pump Station	10,000
Distribution Pipeline	8,000
B. Expansion	21,400
Land Acquisition	200
Kannasut Deep Well (No.2)	2,200
Clear Water Transmission Pipeline	1,000
Distribution Facilities:	
- Distribution Pump	200
- Pipelines	17,800
C. Engineering Services	4,900
D. Administration Cost	500
E. Physical Contingencies	3,600
F. Price Contingencies	6,900
Total	62,400

The tentative financing plan, summarized in Table-ES.4, assumes loans from a foreign financial institutions totaling 49,900 thousand Baht, or 80 % of capital expenditure, and local loans totaling 12,500 thousand Baht, or 20 % of capital expenditure. The total fund requirement through the project

period is projected to amount to 116,700 thousand Baht on a cash-flow basis, of which 46.5 % will be covered by internal cash generation and the rest (53.5 %) will be financed with foreign and local loans, and with no internal financial help of PWA.

Table-ES.4 TENTATIVE FINANCING PLAN FOR STAGE I IMPLEMENTATION
[SUPHANBURI WATERWORKS] x 1,000 Baht

Item	Before Depreciation	% of Total
1. Sources of Funds		
Internal Cash Generation	54,300	46.5%
Outside Sources:		
- Foreign Financial Institution such as OECF	49,900	42.8%
- Local Financial Institution	12,500	10.7%
Total	116,700	100.0%
2. Application of Funds		
Capital Expenditure	62,400	53.5%
Debt Service	54,300	46.5%
Total	116,700	100.0%

The Financial Internal Rate of Return which is calculated as 3.3 % and the Economic Internal Rate of Return of 9.4 % are not considered so favorable. One of the reasons is that capital investment of this project has to be directed largely to the improvement of the deteriorated facilities.

Another consideration to be paid in this respect is the unfairness of the calculation formula of allocating Head and Regional Office Overhead expenses to waterworks, which is placing undue financial burdens on small-scale waterworks.

This report suggests a new trial formula of share calculation which may work more fair both to large and small sized waterworks.

If this trial formula is applied, FIRR and EIRR of the current project for Suphanburi Waterworks will register 4.0 % and 11.1 %, respectively.

Moreover, there are indications that all such data as unit cost and rate of return are showing improvement toward the target year 2000. It is well assumed that Suphanburi Waterworks will demonstrate more favorable indicators in the coming Stage II period.

Several key actions are necessary if the project is to succeed.

1. Financing for project implementation must be confirmed. This confirmation includes the checking of a possibility of obtaining Government subsidies for project capital investment, which is now being suspended temporarily for Government budgetary reasons. Such subsidy will ease the financial conditions of waterworks in making capital investment, particularly for such waterworks as Suphanburi whose earning positions should yet to be strengthened.
2. Changes in structure of PWA's water tariff, as recommended in the Main Report, are needed together with periodic increases in tariffs (to cover the effects of price escalation).
3. The formula of allocating Head and Regional Office overhead expenses to waterworks is recommended to be revised to be more fair particularly to small waterworks still poor in their rates of return.

4. Suitable land sites should be secured at the earliest time possible for the deep wells and distribution pumping station which are proposed to be constructed in Stage I.
5. A leakage survey team should be formed in the waterworks to pursue a program of reducing water leakage in accordance with the Framework prepared by JICA Team.

The project is technically feasible and provides the least cost solution for providing water supply as needed in the project area through the year 2000. The project is also significant to improve the existing facilities which are deteriorating. Implementation of the project will significantly improve the water supply and other environmental situation and health of the people in Suphanburi and Phophraya.

COMPILATION OF THE REPORT

The Development Plan and Feasibility Study of the Provincial Water Supply Projects cover four areas; Chiangmai, Ubon and Warin, Suphanburi, and Pattaya. The study report on the Development Plan and Feasibility Study is composed of the following nine volumes.

Volume I	Summary
Volume II-A	Main Report for Chiangmai
Volume II-B	Appendices for Chiangmai
Volume III-A	Main Report for Ubon and Warin
Volume III-B	Appendices for Ubon and Warin
Volume IV-A	Main Report for Suphanburi
Volume IV-B	Appendices for Suphanburi
Volume V-A	Main Report for Pattaya
Volume V-B	Appendices for Pattaya

This report (Volume IV-A) represents a main report relating to Suphanburi, and consists of the following four parts;

Executive Summary	
Part I	Background
Part II	Development Plan
Part III	Feasibility Study

The report conforms to the Scope of Work given in the Appendices, but does not always follow that of the order of the Scope of Work, both for the convenience of report preparation and better understanding for the readers.

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ABBREVIATIONS, ACRONYMS AND UNITS

EGAT	Electricity Generating Authority of Thailand
LAD	Local Administration Department
NESDB	National Economic and Social Development Board
NHA	National Housing Authority
NSO	National Statistical Office
PCDA	Population and Community Development Association
PWA	Provincial Waterworks Authority
PWD	Public Works Department
MWA	Metropolitan Waterworks Authority
RID	Royal Irrigation Department
RTG	Royal Thai Government
DOH	Department of Health
NEB	National Environmental Board
TAT	Tourist Authority of Thailand
DTCP	Department of Town and City Planning
WHO	World Health Organization
AWWA	American Water Works Association
JICA	Japan International Cooperation Agency
OECF	Overseas Economic Cooperation Fund
NSC	Nihon Suido Consultants Co., Ltd., Tokyo Japan
A.D.	Christian Era
B.E.	Buddhist Era; (B.E.) - 543 = (A.D.)
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GNP	Gross National Product
NNP	Net National Product
MSL	Mean Sea Level
DWS	Drinking Water Standard OF PWA
S.D.	Sanitary District
Fig-	Figure
L.M.	Linear Meter
L.S.	Lump Sum
D.T.	Detention Time
NPV	Net Present Value
CMD	cubic meters per day
MCM	million cubic meter
El.	elevation
φ or D	diameter
O & M	Operation and Maintenance
d	depth
h	height or hour
H	Head
hr	hour
%	percentage
฿	Thai Baht
\$	US Dollar
¥	Japanese Yen

mm	millimeter
cm	centimeter
m	meter
km	kilometer
sq cm or cm ²	square centimeter
sq m or m ²	square meter
sq km or km ²	square kilometer
ha	hectare
Rai	area unit of Thailand (1 Rai = 1,600 sq m)
cu mm or mm ³	cubic millimeter
cu cm or cm ³	cubic centimeter
cu m or m ³	cubic meter
ml	milliliter
l	liter
mg	milligram
g	gram
kg	kilogram
t	metric ton
kg/sq cm or kg/cm ²	kilogram per square centimeter
t/sq m or t/m ²	metric ton per square meter
cm/s	centimeter per second
m/s	meter per second
m/d	meter per day
cu m/s or m ³ /s	cubic meter per second
cu m/min or m ³ /min	cubic meter per minute
cu m/h or m ³ /h	cubic meter per hour
cu m/d or m ³ /d	cubic meter per day
l/s	liter per second
mg/l	milligram per liter
ppm	parts per million
V	volt
kV	kilovolt
kW	kilowatt
A	ampere
kVA	kilovolt ampere
DC	direct current
AC	altering current
rpm	revolutions per minute
Q	flow
V	volume
DIP	Ductile Cast Iron Pipe
ACP	Asbestos Cement Pipe
PVC	Polivinyll Chloride Pipe
SP	Steel Pipe
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
ABS	Alkyl Benzyl Sulfonates

Pt-Co scale	Platinum-Cobalt Scale
NTU	Nephelometric Turbidity Units
JTU	Jackson Turbidity Units
CaCO ₃	Calcium Carbonate
KMnO ₄	Potassium Permanganate
M-Alkalinity	Methylorange-Alkalinity
P-Alkalinity	Phenolphthalein-Alkalinity
T-Hardness	Total-Hardness
SiO ₂ Units	Silica Scale Units
Ammonia-N	Ammonia-Nitrogen
Nitrite-N	Nitrite-Nitrogen
Nitrate-N	Nitrate-Nitrogen
No.	number
N/ml	number per milliliter
N/100 ml	number per 100 milliliter
g/cu m or g/m ³	gram per cubic meter
MPN	most probable number
ST.	station
N.D.	not to be detected
C	degrees Celsius

PART ONE

BACKGROUND

CHAPTER 1 AUTHORIZATION

CHAPTER 2 OBJECTIVES AND SCOPE OF WORKS

CHAPTER 3 WATER SUPPLY ADMINISTRATION IN THAILAND

PART ONE

CHAPTER 1 AUTHORIZATION

CHAPTER 1 AUTHORIZATION

On the basis of the arrangements for the Provincial Water Supply Projects in Thailand made between the Governments of Thailand and Japan, the Japan International Cooperation Agency (JICA) dispatched a study team headed by Mr. Osamu Wakamoto, Nihon Suido Consultants Co., Ltd. under the assistance and guidance of the Technical Advisory Committee. The Study Team was engaged in preparation of the said Projects over the period from November 1985 to March 1987 based on the Scope of Works agreed between PWA and JICA.

CHAPTER 2 OBJECTIVES AND SCOPE OF WORKS

2.1 Objectives of the Study

2.2 Coverage of the Report

2.3 Scope of Works

CHAPTER 2 OBJECTIVES AND SCOPE OF WORKS

2.1 Objectives of the Study

The objectives of the study are firstly to prepare a long term water supply expansion program to A.D. 2010 for each of the provincial areas named in 2.2 below, identified as the "Development Plan", and secondly to conduct feasibility study for the first phase of the Development Plan, hereinafter called Stage I.

The terminology "Development Plan" has been adopted for this study in lieu of master plan to reflect the conceptual nature of the long term planning which can be appropriately refined in the future when more extensive studies are conducted separately in each of the provincial areas.

The planning is based on the best judgment on existing facts combined with historical trends, government policies, most reasonable assumptions and professional experience. In view of the changing situation, however, the plan is subject to periodic review and updating and refinement as appropriate.

2.2 Coverage of the Report

The present report covers Suphanburi Municipality and Phophraya Sanitary District, one of the four study areas of the Provincial Water Supply Projects, which are listed below.

- Study Areas : - Chiangmai Municipality and surrounding sanitary districts, San Sai, San Kamphaeng, Saraphi, Hang Dong and Mae Rim,
- Ubon Ratchathani Municipality and Warin Chamrap Municipality, including Ban Pak Huai Wang Nong, Ubon Sanitary District (including Ban Don Klang), Ban Tha Bong Mang, Ban Hat Suan Ya, and Ban Mai Klang.

- Suphanburi Municipality, and Phophraya Sanitary District.
- Pattaya City, Nong Preo Sanitary District and Ban Rong Po.

The areas underlined in the above list were not originally included in the study area. During the course of study, however, they were added from the viewpoint of optimizing the effects of the project, with the consent of both JICA and PWA.

2.3 Scope of Works

Development Plan

The scope of works for the Development Plan is defined as follows:

Target Year : A.D. 2010

Outline of the Study :

- 1) Basic Survey
 - a) Data collection and analysis
 - b) Study of existing water supply system
- 2) Served Population and Water Demand
 - a) Delineation of served area
 - b) Projection of population and water demand
- 3) Planning of Water Supply System
 - a) Study of water sources
 - b) Planning of appropriate water supply system
- 4) Construction Cost and Finance
 - a) Cost estimation for construction and operation/maintenance.
 - b) Study of financial aspects
 - c) Preparation of implementation schedule

- 5) Identification of Stage I Project for Feasibility Study (including immediate improvement and rehabilitation)

Feasibility Study

As regards the urgently required stage of the Development Plan identified as 2.3 5) above, Feasibility Study will be carried out as described below:

Study Areas : Identified Areas

Target Year : A.D. 2000

Outline of the Study :

- 1) Served Population and Water Demand
 - a) Delineation of service area
 - b) Estimation of served population
 - c) Estimation of water demand
- 2) Rehabilitation and Improvement
 - a) Study for improvement of existing facilities
 - b) Leakage survey and estimation of unaccounted-for water
- 3) Plan of Water Supply Systems
 - a) Study of water sources
 - b) Preliminary design
 - c) Study of alternative plans and layout of facilities
 - d) Study of construction materials and labor force
 - e) Study for the construction method and procurement method of material/equipment

- 4) Construction and Management
 - a) Cost estimation of construction and operation/maintenance
 - b) Study of water revenue and cost
 - c) Study of water tariff
 - d) Economic and financial analysis
 - e) Study of organization and operation/maintenance plan
 - f) Implementation schedule

CHAPTER 3 WATER SUPPLY ADMINISTRATION IN THAILAND

3.1 Water Supply Sector

3.2 Role of PWA

3.3 Status of Suphanburi Waterworks in PWA

CHAPTER 3 WATER SUPPLY ADMINISTRATION IN THAILAND

The following is the description of the water supply sector and the role of PWA therein, which owns and administers approximately 180 waterworks, inclusive of the four waterworks of Chiangmai, Ubon and Warin, Suphanburi and Pattaya, i.e., the study areas of the Provincial Water Supply Projects in Thailand.

3.1 Water Supply Sector

The Government of Thailand has been taking positive steps to organize the sector of water supply and upgrade its efficiency. The sector is under the responsibility of the Ministry of Interior. The Metropolitan Water Works Authority, whose jurisdiction covers the Bangkok Metropolitan area and its suburbs, started its activity under the name of "The Siam Waterworks" in the Fifth Reign of Maha Chakri Dynasty. Its activities were first assigned to be under the responsibility of the Public Works Department, Ministry of Interior. In 1967, a greater part of the waterworks was taken over by the Metropolitan Waterworks Authority (MWA). Prior to the creation of the Provincial Waterworks Authority (PWA) by the Act of February 28, 1979, the water supply activities in the entire country except the Bangkok Metropolitan Area were under the responsibility of the Public Works Department of Ministry of Interior and Public Health Department of Ministry of Health.

3.2 Role of PWA

When PWA was established, 182 urban waterworks operating in provincial town areas were transferred to the PWA from the Public Works Department and Public Health Department, with exception of some designated local waterworks and sanitary districts, which still continue to remain under the responsibility of the Public Works Department.

The activities of PWA are divided into two categories: (1) the Urban Water Supply Program and (2) the Rural Water Supply Program.

Under the Urban Water Supply Program, PWA constructs, invests, owns and operates water supply systems in provincial districts or sanitary districts

with 5,000 residents or more, which meet the following requirements as PWA waterworks. The requirements are (1) substantial population density; (2) suitable water resources; (3) relatively good economic and social status; and (4) suitability for investment which involves special political and national securities as well as the residents ability to pay.

The Rural Water Supply Program relates to small sanitary districts or communities with populations of approximately 1,500 or more and other rural areas in need of water supply service. Under this Program, PWA finances part of the investment, with the remainder by the communities in need of water supply. PWA also undertakes the necessary investigation, design, cost estimating, construction and training. Upon completion of construction, the systems are handed over to the communities for operation. Thereafter, PWA furnishes technical guidance only.

At the end of 1985, PWA provided services to 181 provincial towns (with integration of some water supply activities for efficiency in operation), including 90 areas within municipalities, 154 sanitary districts and 25 other districts. In addition, technical service was furnished to 675 water supply systems. The total production capacity was about 700,000 cu m per day, serving a total of approximately 405,000 consumers (connections).

3.3 Status of Suphanburi Waterworks in PWA

Suphanburi Waterworks is under the supervision of Regional Office No. 2, one of the 10 Regional Offices, through which PWA is controlling its 181 urban waterworks in Thailand.

Regional Office No. 2 controls 23 waterworks under its jurisdiction and the combined revenue of these 23 waterworks assumed the weight of 10.82 % in the total PWA revenue for 1985.

Suphanburi Waterworks is one of the largest waterworks in the jurisdiction of the Regional Office No.2, sharing 5.78 % of the 1985 combined total sales of the waterworks in the jurisdiction and 0.58 % of the total PWA revenue.

PART TWO

DEVELOPMENT PLAN

- CHAPTER 4 DESCRIPTION OF THE STUDY AREA
- CHAPTER 5 EXISTING WATERWORKS
- CHAPTER 6 POPULATION AND WATER DEMAND
- CHAPTER 7 PROPOSED WATER SUPPLY SYSTEM
- CHAPTER 8 PROJECT COST AND IMPLEMENTATION SCHEDULE
- CHAPTER 9 ORGANIZATION AND FINANCE
- CHAPTER 10 SCOPE OF THE PROJECT FOR FEASIBILITY STUDY

PART TWO

CHAPTER 4 DESCRIPTION OF STUDY AREA

4.1 Natural Features

4.1.1 Coverage

4.1.2 Location and Geography

4.2 Socio-Economic Features

CHAPTER 4 DESCRIPTION OF STUDY AREA

4.1 Natural Features

4.1.1 Coverage

The study area is composed of Suphanburi Municipality and Phophraya Sanitary Districts neighboring each other, as shown in Fig-4.1.

4.1.2 Location and Geography

Suphanburi is located in a northern part of a flat deltoid named Lower Central Chao Phraya Plain which extends along the Tha Chin River (another name is The Suphanburi River) about 115 km upstream from the coast of the Gulf of Thailand and about 100 km northwest from Bangkok.

Suphanburi and Phophraya are situated at approximately long. 100 06' east and lat. 14 30' north. Their elevation ranges from 4 m to 9 m above the sea level. The meteorological data of the area for the past ten years record their annual average precipitation at around 710 - 1,580 mm. The annual weather is divided into the dry (November - February) and the rainy (May - September) seasons. The temperature ranges from 15 - 35 degrees C.

The Tha Chin River flows across Suphanburi from north to south, with abundant waters serving varied purposes including navigation and industrial uses as well as irrigation and water supply. Its discharge varies from 30 - 40 cu m/sec in February - March to 200 cu m/sec in September - November, according to the records of Phophraya Regulator (1982 - 1985).

As to groundwater, a good quality of water enough in quantity to meet growing demand is available from aquifers lying 100 to 150 m underground which can yield water sufficiently, 2,000 to 3,000 cu m/day per well.

4.2 Socio- Economic Features

Of the total land use excluding that for roads, rivers and spaces, the area used by provincial and rural administrative offices amount to 17 % next to 45 % by residence, as shown in Table-4.1. This shows the characteristics

of Suphanburi Municipality as a center of government and administration. Next come 10.45 % by religion and 9.00 % by education, demonstrating another characteristics of Suphanburi as a town of education and old cultures.

Suphanburi is also a commercial center which chiefly deals in farm products of surrounding agricultural areas including rice and sugar cane and also necessities for farmers such as fertilizer and farming machinery and tools.

Manufacturers in the municipality are of small scales mostly engaged in food processing and include liquor factories, rice mills, construction and farming equipment makers and water-vehicle repairers.

Electricity is supplied to approximately 90 % of the municipal area by Provincial Electricity Authority (PEA). Suphanburi has no planning yet for systemized drainage, with domestic and industrial drains being discharged into the Tha Chin River which is a water source for Suphanburi Waterworks.

PWA supplies potable water to the municipality and the service ratio in 1984 stood at about 75 %. Suphanburi and Phophraya were populated at about 23,700 and 3,100 respectively in 1984, with their served population amounting to 20,100 in the both area.

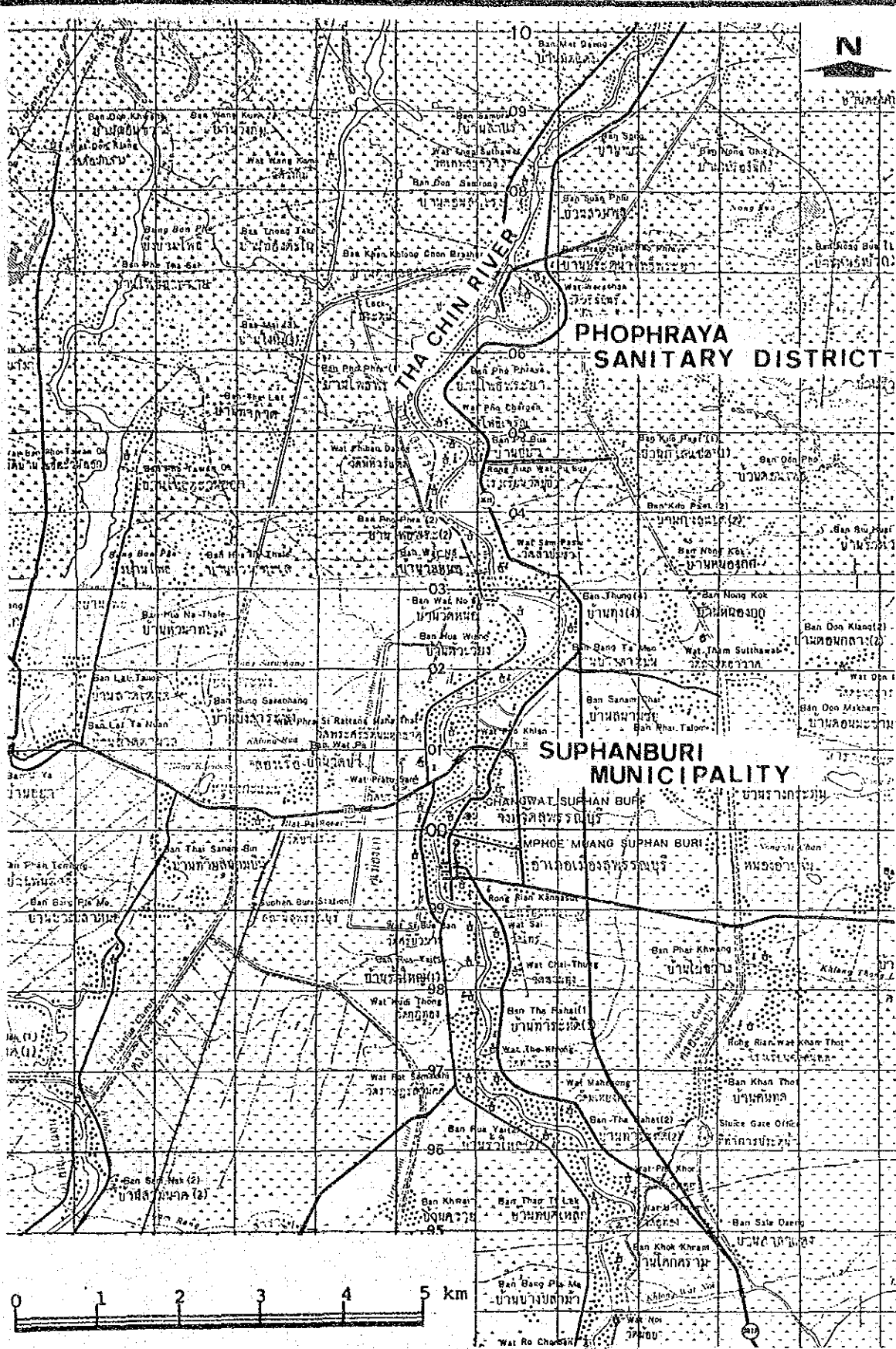


FIGURE	STUDY AREA
4.1	
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table- 4.1 EXISTING LAND USE OF SUPHANBURI IN 1984

Category of Land Use	Area (Rai*)	% of Total	Area excl. Roads, Rivers & Space	% of Area excl. Roads, Rivers & Spaces
Residence	1,656.8	8.34%	1,656.8	45.27%
Commerce	193.8	0.98%	193.8	5.30%
Government & Administration	618.8	3.11%	618.8	16.91%
Industry	170.0	0.86%	170.0	4.65%
Warehouses	96.3	0.48%	96.3	2.63%
Religion	382.5	1.93%	382.5	10.45%
Public Utility	33.2	0.17%	33.2	0.91%
Recreation	126.8	0.64%	126.8	3.46%
Husbandry	51.9	0.26%	51.9	1.42%
Education	329.4	1.66%	329.4	9.00%
Roads	675.2	3.40%		
Rivers & Canals	579.1	2.91%		
Space	14,955.7	75.27%		
Total Area	19,869.5	100.00%	3,659.5	100.00%

Source: Survey Division, DTCP

Note: Rai = 1,600 sq m

CHAPTER 5 EXISTING WATERWORKS

5.1 Water Supply Conditions

5.2 Water Sources

5.3 Intake, Water Treatment Facilities and Transmission Pipeline

5.3.1 Intake

5.3.2 Phophraya Treatment Plant

5.3.3 Transmission Pipeline

5.3.4 Dab Fafhun Deep Well and Distribution Pump Station

5.4 Distribution Pipelines

5.5 Rehabilitation and Modification Works

CHAPTER 5 EXISTING WATERWORKS

The present PWA service area consists mainly of the central municipal area of Suphanburi and a part of Phophraya Sanitary District.

Currently 20,200 population or 75 % population of study area is served, supplied by the Phophraya Treatment Plant and newly constructed deep well, through more than 4,300 service connections. A field questionnaire survey disclosed that about three-quarters of the served population, feel the present supply is not stable.

Of those people who are not benefited by the water supply system, about 85 % depends on river water or stored rain water, and remaining 15 % uses groundwater and water bought from vendors.

The study team conducted the questionnaire survey to study the relation between the water supply conditions and socio-economic conditions. The results are summarized in Appendix 5.

In this chapter, existing conditions of the waterworks are described below.

5.1 Water Supply Conditions

In 1956 the first treatment plant was constructed near the central part of Suphanburi Municipality, of a convenient location to take water from nearby Tha Chin River and to deliver to the consumers. The second treatment plant was constructed at Dab Fafhun in 1965, about 1 km north to the first plant. Both plants were suspended of operation and abandoned, since the river's water quality had been heavily deteriorated by domestic and industrial pollution.

The Phophraya Treatment Plant was constructed to replace the first and second plants and to produce 200 cu m/hr (4,800 cu m/d), at about 10 km upstream of Suphanburi where the water quality was better. The plant design followed the PWA standards.

As the Phophraya Treatment Plant capacity could not catch up with the increasing demand, a deep well facility of 2,000 cu m/d capacity was

constructed in the site of the abandoned water treatment plant at Dab Fafhun and put in operation in April 1986. Total production capacity of the Waterworks, therefore, increased to 6,800 cu m/d, nearly equal to the present water demand.

Fig-5.1 and 5.2 show the present service area and location of water production facilities, and the scheme of present water supply conditions, respectively.

5.2 Water Sources

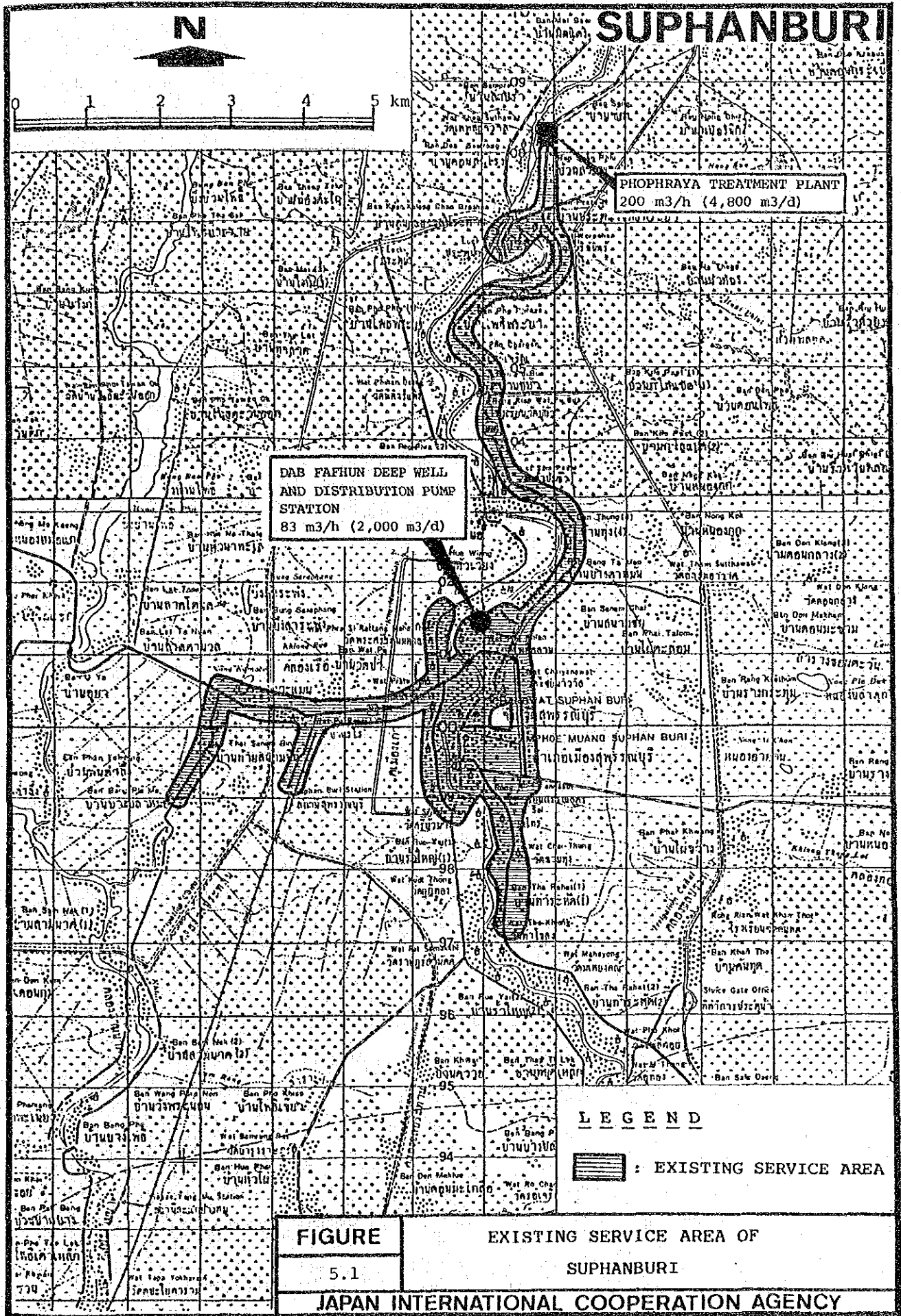
The existing water source is mainly surface water from the Tha Chin River. The Phophraya Treatment Plant is located on the left bank of the river and the water is drawn into the intake pump pit from upstream of the Phophraya Regulator(water gate) which is managed by RID.

The river water level is controlled by the regulator. The river flow of 10 to 20 cu m/s (315 to 630 MCM/year) is maintained steadily at the regulator even in the dry season. The present intake amounts 1.75 MCM/year, a fraction of the river flow.

As to the water quality of the river, seasonal variation of the turbidity ranges from 4 to 58 SiO₂ units, comparatively low. pH value and Alkalinity range from 7.0 to 8.3 and 68 to 86 mg/l as CaCO₃, respectively. Though iron concentration tends to be raised during the rainy season, it can be removed by conventional treatment processes like the presently adopted in the Phophraya Plant, to conform to the PWA Drinking Water Standard.

The results of analysis of the raw water and treated water of the Phophraya plant are summarized in Appendix 4.

The Waterworks recently developed groundwater, constructing a deep well in the site of the abandoned water treatment plant at Dab Fafhun, to yield 83 cu m/hr (2,000 cu m/d). The quality of the groundwater was proved to be good and the well has been incorporated in the system.



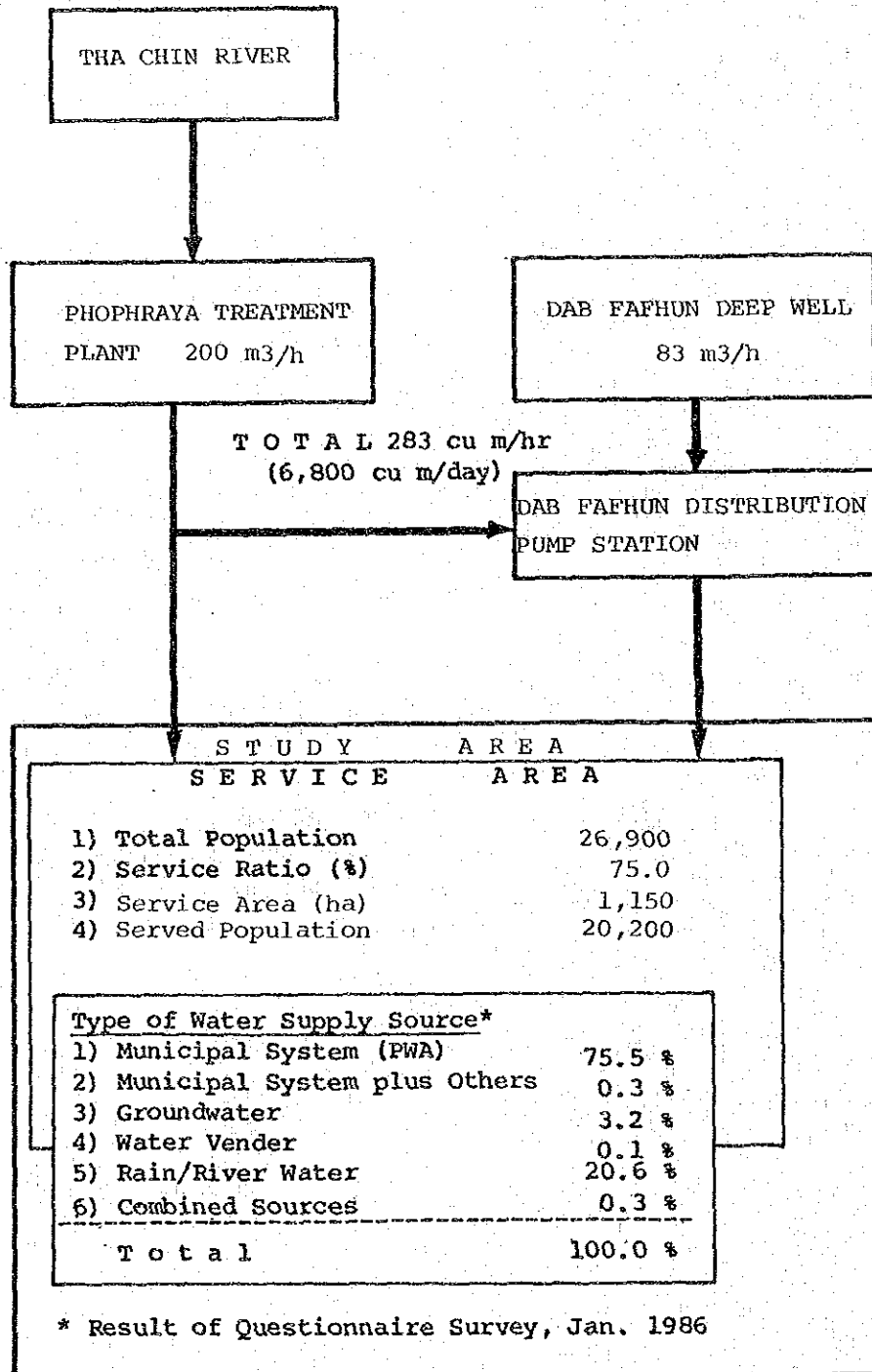


FIGURE	SCHEME OF PRESENT WATER SUPPLY CONDITIONS
5.2	
JAPAN INTERNATIONAL COOPERATION AGENCY	

5.3 Intake, Water Treatment Facilities and Transmission Pipeline

5.3.1 Intake

The raw water of Phophraya Treatment Plant is abstracted from the intake facilities on the left bank of the River, at 10 km upstream of the City. The water level is stable at the intake site due to the operation of the Phophraya Lock Gate of RID, located at 1 km downstream of the intake.

The intake channel conveys raw water to the intake pump sump. A screen is provided for removal of foreign materials. The raw water pumping facilities consist of 2 motor- and 1 engine-driven pumps.

A 250 mm diameter transmission pipeline conveys the pumped raw water to the treatment plant about 200 m apart.

5.3.2 Phophraya Treatment Plant

The treatment plant was constructed in 1966 with a capacity of 4,800 cu m/day (200 cu m/hr) and with the following unit operations: flush mixing, flocculation, sedimentation, rapid sand filtration, and chlorination. The major facilities are summarized in Table-5.1, and shown in Fig-5.3. The plant has no significant problems except those of obsolete instrumentation, such as the flow meters and level gauge of clear water reservoir.

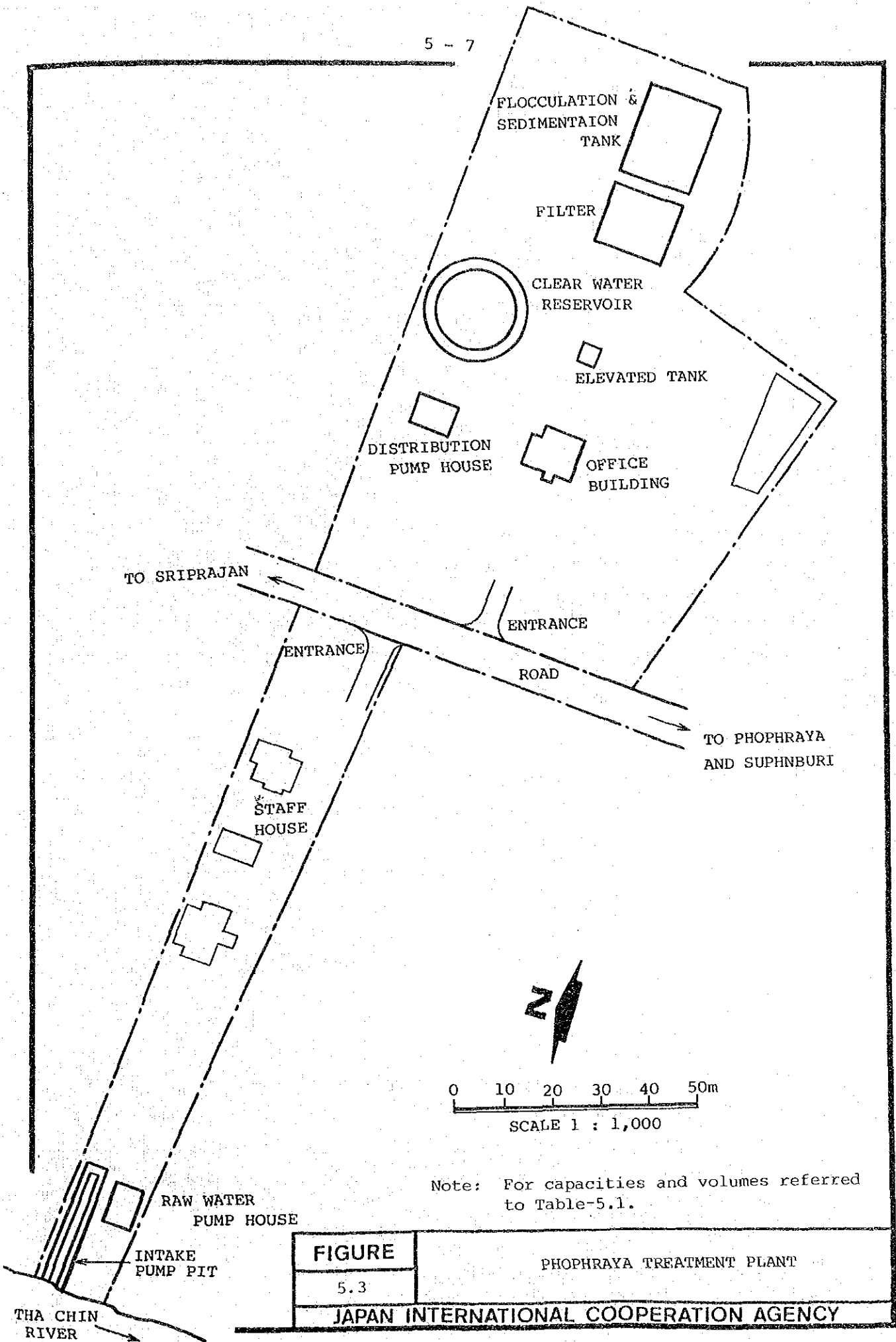
Recently, the filter media and underdrain were entirely replaced to improve the deteriorated conditions, as a part of PWA project called the Immediate Improvement Program (IIP).

Right before entering the reservoir, chlorine is added to the filtered water for disinfection. But the container scale for measuring consumption is not equipped.

Table 5.1 MAJOR FACILITIES OF PHOPHRAYA
TREATMENT PLANT

Facilities	Type/Capacity
<u>Water Source</u>	Tha Chin River
<u>Design Capacity</u>	200 m ³ /h
<u>Facilities</u>	
Mixing Well and Flocculation Basin	Hydraulic Mixing 2 Basins
Sedimentation Basin	Horizontal Flow 2 Basins Volume: 620 m ³ D.T. : 3.1 h
Filter	Rapid Sand Filtration 4 Beds Area: 10.4 m ² /bed F.R.: 115 m/d
<u>Chemical Application</u>	
Coagulant	Aluminum Sulfate
Chlorine	Chlorine Gas

Note D.T.: Detention Time
F.R.: Filtration Rate



Note: For capacities and volumes referred to Table-5.1.

FIGURE	PHOPHRAYA TREATMENT PLANT
5.3	
JAPAN INTERNATIONAL COOPERATION AGENCY	

5.3.3 Transmission Pipeline

Treated water is conveyed, from the Phophraya Treatment Plant to the clear water reservoir of the abandoned Dab Fafhun Treatment Plant, through a 300 mm diameter transmission pipeline of asbestos-cement over 10 km, by pumps.

Leakage appears at a number of spots along the pipeline and approximately 500 m long, in total, pipes need repair and/or replacement. The works should better be done earlier.

5.3.4 Dab Fafhun Deep Well and Distribution Pump Station

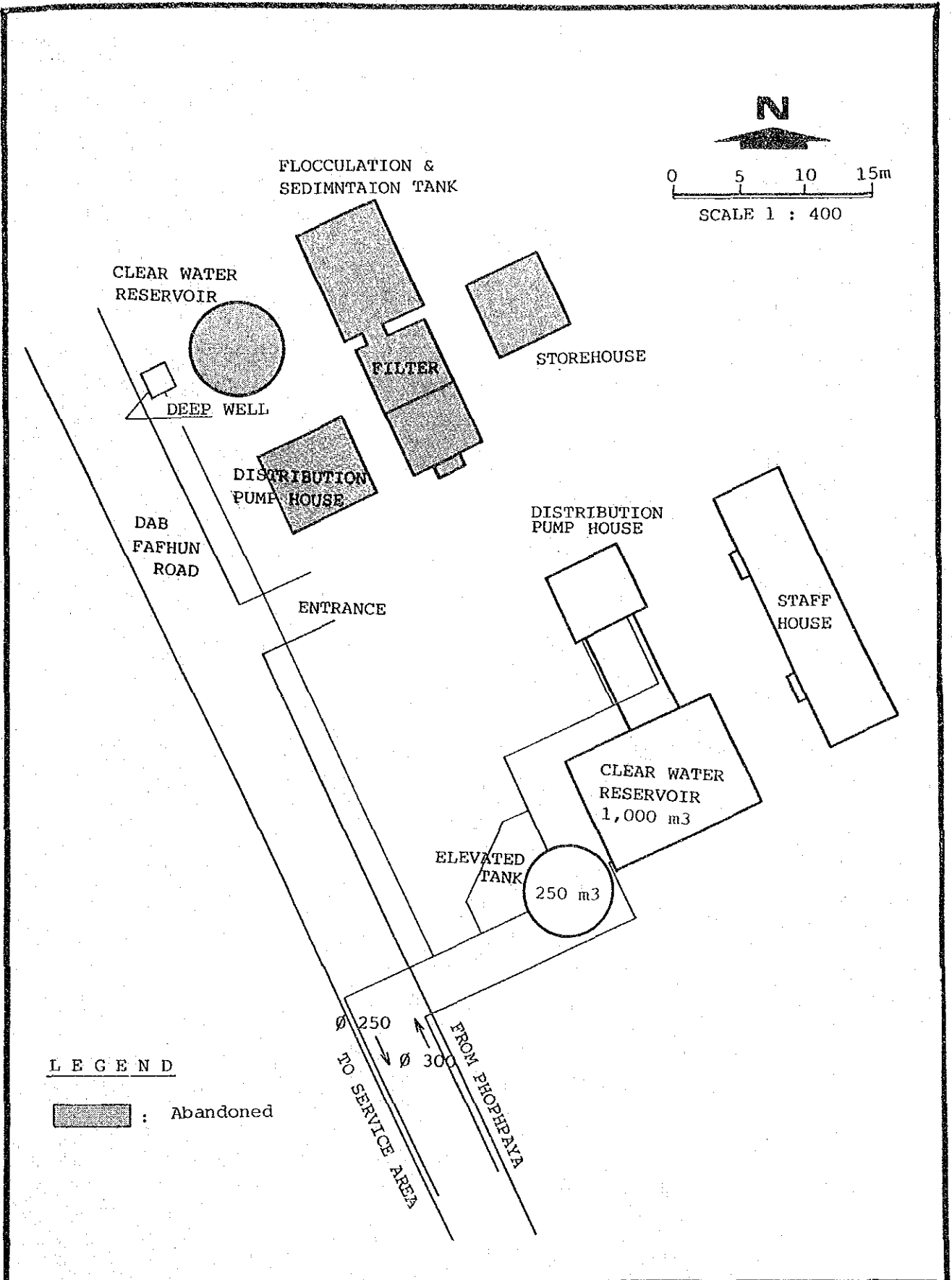
As mentioned before, the 960 cu m/d capacity treatment plant built in 1965 was abandoned by reason of obsolescence and raw water pollution which had occurred in the Tha Chin River by discharged domestic and industrial wastewater. As also mentioned previously, a deep well on 2,000 cu m/d capacity was constructed, under an aid program of the World Bank, in the site and started operation in April 1986, to meet the increasing water demand.

Fig-5.4 shows the layout of the Dab Fafhun Plant. The site encloses the new well, existing 1,000 cu m capacity clear water reservoir, 250 cu m capacity elevated tank and distribution pump station.

The treated water sent from the Phophraya Treatment Plant, disinfected by chlorination at the plant, lose a part of residual chlorine when stored here. For the well water, no chlorination equipment have been provided. A chlorination system for both the stored water and well water should be installed.

Regarding the measurement of flows: 1) production of the Phophraya Plant is not known because of the existing faulty meter, 2) branch flow to the Phophraya Sanitary District is not metered, 3) production of the new well is not metered also, but 4) outflow of the clear water is metered. Measurement of the flows, 1) to 3), is necessary and meters will be prepared under this plan.

The level indicators of the elevated tank and clear water reservoir are faulty and they will be replaced under this plan.



LEGEND


 : Abandoned

FIGURE	DAB FAFHUN DEEP WELL AND
5.4	DISTRIBUTION PUMP STATION
JAPAN INTERNATIONAL COOPERATION AGENCY	

5.4 Distribution Pipelines

The consumers of Phophraya Sanitary District living close to the transmission pipeline are directly served by the pipeline. While, the majority of the served population living in Suphanburi is supplied by the distribution pump at Dab Fafhun. The distribution pipelines are tabulated in Table-5.2 and shown in Fig-5.5.

The distribution pipelines are mostly made of locally produced asbestos cement pipes. Of the total length of 31 km, about 3 km length was installed during the period of the water supply foundation in 1950s and has been used until now.

Table-5.2 LIST OF DISTRIBUTION PIPELINE

Diameter (mm)	Material	Approximate Length (km)
300	Asbestos cement	10
200	Asbestos cement	6
200	Galvanized steel	0.12
150	Asbestos cement	5
150	Galvanized steel	0.04
100	Asbestos cement	10
Total		31

The questionnaire survey resulted in finding that the southern and northern ends of the present service area were under-pressurized and about 20 % of the answerers were dissatisfied with the unstableness of supply. Presumably, the extended distribution pipes are small in size for the flow conditions.

About 50 valves for controlling distribution and about 30 fire hydrants for protection against fire are located at the strategic points and air valves are installed mainly on pipe bridges, the peak points in the pipelines' profile.

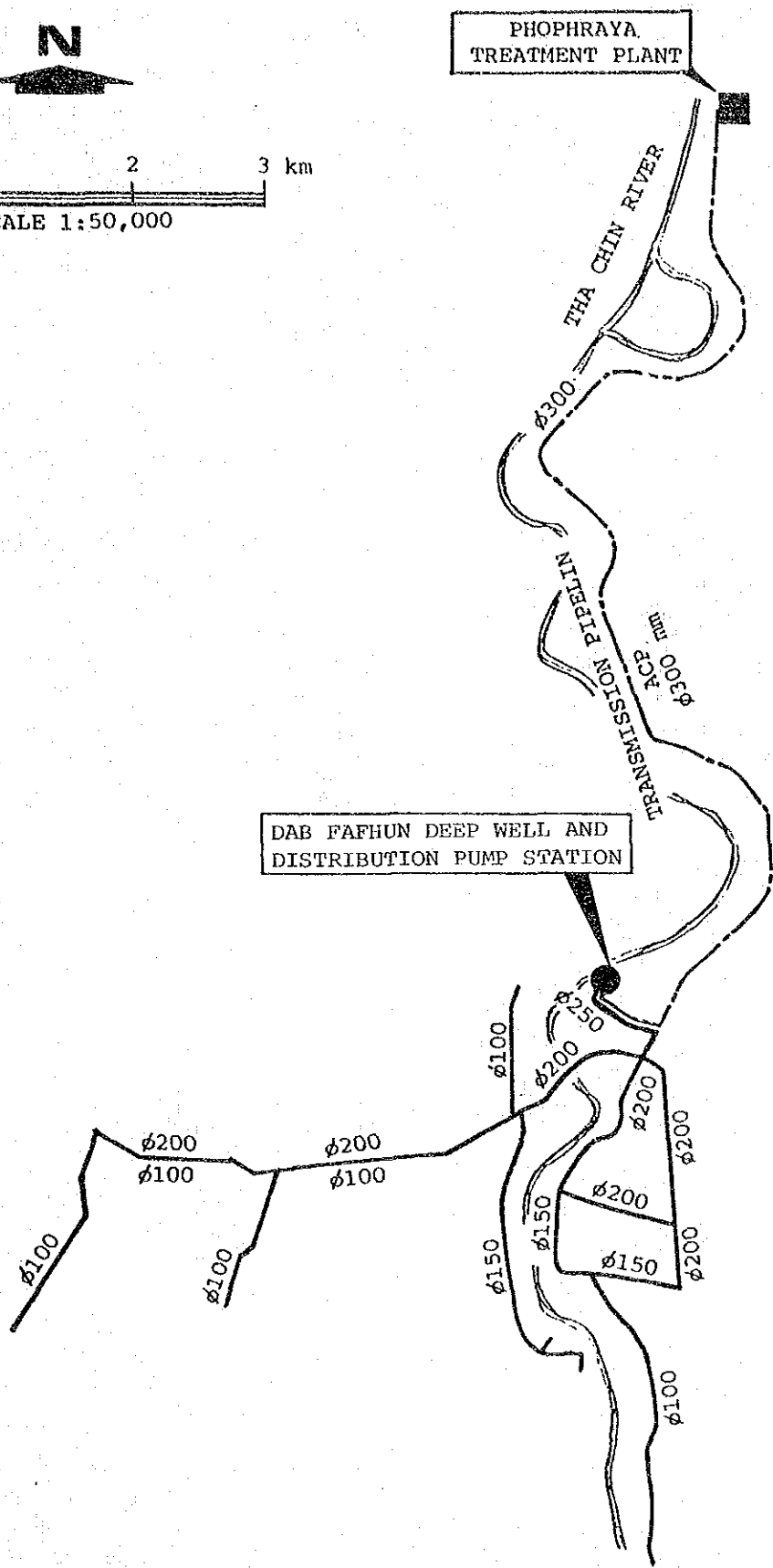
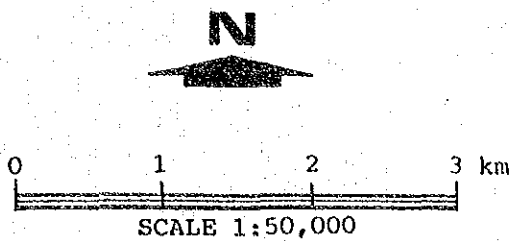


FIGURE	EXISTING DISTRIBUTION PIPELINES
5.5	
JAPAN INTERNATIONAL COOPERATION AGENCY	

The house-connections, numbering about 4,500 as of September 1985, are mostly provided with a water meter and stop valve.

5.5 Rehabilitation and Modification Works

The facilities described heretofore are planned for use in future.

To prepare for the future increase of water demand, rehabilitation and modification of the existing facilities are of absolute necessity.

The planned rehabilitation, modification and expansion works will be detailed in Chapter 7 later.