REPUBLIC OF VIETNAM

WATER SUPPLY PROJECT
IN
SAIGON, DANANG AND LONGXUYEN

PRELIMINARY STUDY

MARCH 1971

Prepared for

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

by

JAPANESE SURVEY TEAM FOR WATER SUPPLY PROJECT

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PREFACE

The Government of Japan, in response to the request of the Government of the Republic of Vietnam, undertook to conduct a preliminary survey for the water supply expansion project for the Saigon Metroplotan Area, the Da Nang Metropolitan Area and Long Xuyen City and entrusted the execution of the survey to the Overseas Technical Cooperation Agency.

Being cognizant of the importance of water service for the improvement of the living environment for the people in the Saigon Metropolitan area, the Da Nang Metropolitan Area and Long Xuyen City and its importance as the basis for the stabilization of livelihood in these areas, the Agency organized a survey team comprising seven members, headed by Mr. Toshiharu Kobayashi and sent it to Vietnam for a period of 20 days from January 7 to 26, 1971.

Thanks to the kind cooperation of the Government of Vietnam, the survey could have been carried out guite satisfactorily. Upon completion of the survey for the water supply expansion project, including on-the-spot surveys of various water plants and facilities in each area, the team came to the following conclusion.

(1) For the expansion of the served area and for the elimination of poorly served districts in the Saigon Metropolitan area, it is essential that old and unserviceable pipe lines be replaced and additional distribution pipes be provided as early as possible. At the same time, a survey should be conducted and a basic plan formulated for the water supply expansion project, with 1985 as the target year of completion including the construction of a water treatment plant with a capacity of at least 500,000 m^3/d in order to meet an anticipated rapid growth of water demand in the future.

(2) For the Da Nang Metropolitan Area, detailed design and implementation of the water supply expansion project with special emphasis on the construction of a water treatment plant with a capacity of 70,000 m^3/d by 1980 should be initiated immediately.

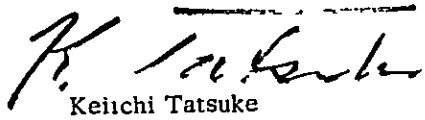
(3) With regard to Long Xuyen, detailed design and implementation of the water supply expansion project, centering on the construction of a water treatment plant with a capacity of 10,000 m^3/d by 1980 should be initiated immediately.

Based on the above conclusion reached upon completion of a comprehensive study of the findings of the survey, taking into consideration the opinions of the Government of the Republic of Vietnam, a report has been prepared and is now ready for presentation.

It is my sincere hope that the report will prove helpful to the construction of the water plants and facilities in the Republic of Vietnam and thus contribute to the stabilization of the people's livelihood and the promotion of industry of the country, as a token of the further advancement of economic relationship and friendship between Japan and the Republic of Vietnam.

Finally, I wish to take this opportunity of express my heartfelt gratitude to the officials of the Government of the Republic of Vietnam for their wholehearted cooperation and support extended to the team in the execution of the survey.

March 1971



Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

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CHAPTER 1. INTRODUCTION

1-1 Purpose of Survey

With the gradual deescalation of the Vietnam War, the Government of the Republic of Vietnam has commenced the task of economic rehabilitation in the war-torn country. The Vietnamese Government, made a request to the Japanese Government, and to the Abe Mission when it visited Vietnam last October, to provide large-scale economic and technical cooperation for development projects such as the construction of irrigation facilities, power plants and improvement and expansion of water supply systems. The purpose of the Survey Team for the Water Supply Project in the Republic of Vietnam was to make necessary studies and investigations on the water supply systems in the cities of Saigon, Danang and Longxuyen, where the security situation was considered to be relatively satisfactory at that time, as well as to conduct a study on the future expansion project. These three cities were selected out of the seven cities for which the Abe Mission had been requested to conduct a survey on the water supply system at time of its visit to Vietnam.

As will be discussed in detail in subsequent chapters, the water serves 60% of the inhabitants of Saigon (population estimated to be 3,000,000), 8% of Danang City (population estimated to be 570,000) and 40% of Longxuyen (population estimated to be 75,000), showing a wide divergence in the percentage of the population served. As for intake and water treatment facilities, Saigon has modern facilities which were constructed with the aid of a US loan, but the other two cities have only temporary facilities. With regard to the water distribution system, in Saigon old pipes which were installed when the country was under French rule in the 19th century are still in use, while in Danang City, the distribution pipes are of extremely short length. These local disparities and differences were already known to the Team before its departure from Japan.

In the current survey, therefore, due consideration was given to the existing conditions in each city. The Survey Team, first, gave consideration to the urgent counter-measures and the long-range measures separately, and then to plans for improvement in each phase of the project. On the basis of the foregoing, the Team also attempted to estimate the project cost and to determine the steps to be taken for the future survey.

1-2 Composition of Survey Team

Due to the circumstances mentioned in the previous section, the Survey Team was divided into three groups - the Over-all group, Saigon group and Danang-Longxuyen group - to fulfill the assignment through a division of responsibility.

Over-all group	Head	Mr. Toshiharu Kobayashi Japan Waterworks Association
	Member	Mr. Jiro Kuroda Overseas Technical Cooperation Agency
Saigon group	Member	Mr. Shinzo Kitamura Nihon Suido Consultant Co.
	Member	Mr. Katsuyoshi Tomono Nihon Suido Consultant Co.

Danang-Longxuyen group	Member	Mr. Togo Tsukamoto	Pacific Consultants Co.
	Member	Mr. Eijiro Ueno	Pacific Consultants Co.
	Member	Mr. Ryuji Yanai	Pacific Consultants Co.

1-3 Outline of Survey

1-3-1 Itinerary and Activities of Survey Team

Date \ Group	Over-all group Mr. Kobayashi, Mr. Kuroda	Saigon group Mr. Kitamura, Mr. Tomono	Danang-Longxuyen group Mr. Tsukamoto, Mr. Ueno, Mr. Yanai
January 1971			
7 (Thu)	Left Tokyo and arrived in Hong Kong.		
8 (Fri)	Left Hongkong and arrived in Saigon. Had meeting with the staff of the Japanese Embassy in Saigon and Officials of the Ministry of Public Works.		
9 (Sat)	Met with officials of the Ministry of Public Works (Arrival of Kuroda)		
10 (Sun)	Holiday		
11 (Mon)	Met with officials of the Saigon Metropolitan Water Office and the Ministry of Public Works.		
12 (Tue)	Made on-the-spot inspection of intake facilities and water treatment plant of Saigon Metropolitan Water Office.		
13 (Wed)	Travelled from Saigon to Longxuyen	Received briefings at Saigon Metropolitan Water Office and made an on-the-spot inspection of the facilities	Travelled from Saigon to Longxuyen
14 (Thu)	Made an on-the-spot inspection of Longxuyen's water facilities	↓	Made an on-the-spot inspection of Longxuyen's water facilities

15 (Fri)	Traveled from Longxuyen to Saigon	Travelled from Longxuyen to Saigon
16 (Sat)	Travelled from Saigon to Danang	Travelled from Saigon to Danang
17 (Sun)	Made an on-the-spot inspection of Danang's water facilities	Made an on-the-spot inspection of Danang's water facilities
18 (Mon)	Travelled from Danang to Saigon	
19 (Tue)	Made an on-the-spot inspection of proposed site of intake facilities and water treatment plant on the upper reach of the Saigon River.	
20 (Wed)	Held discussions with official of Saigon Metropolitan Water Office.	Travelled from Danang to Saigon.
21 (Thu)	Received briefings at the Ministry of Public Works.	
22 (Fri)	Reviewed and summarized the findings and data gathered by Japanese team.	
23 (Sat)	Held a meeting with Ministry of Public Works and the staff concerned.	
24 (Sun)	Holiday	
25 (Mon)	Reviewed and summarized the results of survey made by Japanese team	
26 (Thu)	Left Saigon and arrived in Tokyo.	

1-3-2 Officials Contacted in Vietnam

Officials who extened kind cooperation and assistance and were contacted by the Team for consultations and discussions during the survey period are listed below.

(1) Ministry of Public Works

Buu Don Han	Minister of Public Works
Bui Huu Tuan	Deputy Minister of Public Works
Buu Don	Assistant Minister of Public Works
Vo Dihn Han	Director, National Water Supply Agency
Tran Phuoc Tho	Deputy Director, National Water Supply Agency
Nguyen Van Sang	Chief, Metropolitan Water Division

(2) Saigon Metropolitan Water Office

Nguyen Huu Tuan	Director
Nguyen Kim Chi	Deputy Director
Tran Van Thach	Chief, Engineering Service
To Dang Que	Chief, Saigon Sector
Tran Huu Lai	Chief, Giadinh Sector
Dong Si Kiem	Chief, Water Treatment Plant

(3) Longxuyen

Col. Pham Jan Man	Governor, Angiang Province
Tran Dac Thanh	Deputy Governor, Angiang Province
Nguyen Van Dinh	Director of Longuxyen Office, Ministry of Public Works

(4) Danang

Nguyen Ngoc Khoi	Mayor, Danang Special City
Tueong Nhu Nguyen	Director, Danang Metropolitan Water Office

(5) Japanese Embassy in Saigon

Fumihiko Togo	Ambassador
Shinichi Yanai	Counsellor
Kimio Fujita	First Secretary
Hiroshi Kawashima	Second Secretary
Mitsuo Ishizaki	Resident Officer, OTCA Saigon Office

1-3-3 Main Items Discussed and Reported

(1) January 8, 1971. Meeting with officials of the Ministry of Public Works
Participants:

Vietnamese	Mr. Don, Assistant Minister of Public Works
	Mr. Tho, Deputy Director, National Water Supply Agency Ministry of Public Works
	Mr. Sang, Chief Metropolitan Water Division, Ministry of Public Works
	Mr. Tuan Director, Saigon Metropolitan Water Office
	Mr. Chi, Deputy Director, Saigon Metropolitan Water Office

	Mr. Thach, Chief, Engineering Service, Saigon Metropolitan Water Office
	Mr. Nguyun, Director, Danang Metropolitan Water Office
	Mr. Dinh, Director of Longxuyen Office Ministry of Public Works
Japanese	Messrs. Kobayashi, Kitamura, Tsukamoto, Ueno, Tomono, Yanai

Mr. Don, Assistant Minister of Public Works expressed his thanks to the Japanese Government for its cooperation in sending a survey team for the water supply project in the Republic of Vietnam, Mr. Kobayashi, head of the mission, replied that he hoped the current survey for the water supply project would prove conducive to the further promotion of friendship between the two countries. Consultations were held between the two parties on the itinerary and details of survey program and also on the required data and materials.

(2) January 11, 1971. Meeting with officials of Saigon Metropolitan Water Office.

Participants:

Vietnamese	Mr. Tuan Director, Saigon Metropolitan Water Office
	Mr. Chi Deputy Director, Saigon Metropolitan Water Office
	Mr. Thach Chief, Engineering Service, Saigon Metropolitan Water Office
Japanese	Messrs. Kobayashi, Kitamura, Tomono, Kuroda

The first meeting for briefings was held with officials of the Saigon Metropolitan Water Office which is responsible for supplying water to Saigon City and the Giadinh area, north of Saigon. The Vietnamese counterparts briefed the Japanese members on the capacity of the existing water intake and treatment plant and on the decrepit state of old water distribution pipes. It was also explained that under the circumstances the water treatment plant established in 1966 will reach its maximum capacity in a year or two.

(3) January 13, 1971. Meeting with officials of Angaing Province and of Longxuyen water office.

Participants:

Vietnamese	Col. Man Governor, Angiang Province
	Mr. Thanh Deputy Governor, Angiang Province
	Mr. Dinh Director of Longxuyen Office Ministry of Public Works
Japanese	Messrs. Kobayashi, Tsukamoto, Ueno, Yanai, Kuroda

The Japanese members met with the Governor and Deputy Governor of Angiang Province (Longxuyen is the capital of the province) and held general discussions on the security and economy of the province. The Governor informed the Japanese members of a new plan to establish an autonomous city with a population of 200,000 to the south of Longxuyen perhaps as early as next year. This comes as a surprise to the Japanese members. It was confirmed later in Saigon that the plan was still only under consideration. However the site selection for the intake and treatment plant, the determination of the capacities of these facilities and the distribution of water pipes will depend largely on when and in what form the new city is established. Therefore, this problem presented difficulties to the team in its later work.

(4) January 17, 1971. Meeting at Danang City.

Participants:

Vietnamese	Mr. Nguyen Director, Danang Metropolitan Water Office
Japanese	Messrs. Kobayashi, Tsukamoto, Ueno Yanai, and Kuroda

The city of Danang, the second largest city in Vietnam, lags far behind Saigon in water supply, with its served ratio being only 8%. The city is faced with the pressing need to construct additional water facilities as soon as possible. In the course of the discussion, it became clear that the city of Danang, as well as Longxuyen, has a difficult problem in estimating the future population growth, due to the fact that there is a sharp population increase caused by the influx of people and refugees from the adjoining areas. Incidentally, the population increase predicted in the Parson Report of the United States in 1964 had been already surpassed by the actual increase in 1966.

However, considering the fact that the water supply service in Saigon and Longxuyen as well as Danang is showing large profits and that the new city area (Second and Third districts) of Danang, in particular, does not have water service, prompt measures must be taken by all means.

(5) January 23, 1971. Meeting with the Minister of Public Works

Participants:

Vietnamese	Mr. Han Minister of Public Works
	Mr. Tuan Deputy Minister of Public Works
	Mr. Don Assistant Minister of Public Works
	Officials of the Ministry of Public Works concerned with water supply and officials from Saigon Metropolitan Water Office
Japanese	Seven members of the Survey Team

The findings of the survey and the opinions of the Survey Team, from a technical point of view, were reported to the Minister verbally. At the meeting the Minister asked the reasons for confining the current survey to only three cities out of seven citires for which Vietnam Government had originally requested the Japanese Government to make a study. It was felt that this question was evidence of Vietnam's desire that the survey be extended to cover all seven cities.

It appeared that the Minister placed much expectation not only on the results of the survey, but also on the future assistance from the Japanese Government for other projects (irrigation and power station projects). The Minister earnestly requested the Team to present a report of the survey as early as possible.

From the standpoint of the Japanese side, political stability and the security situation of the country are the important factors for the implementation of the project. But the officials of the Vietnamese Government including the Minister of Public Works, held the view that the country was already in the "Postwar Period", (This may be due to the fact that the Vietnamese people are less sensitive to the war than the Japanese people because their country has been in constant state of civil war ever since its foundation), and accordingly, they tend to demand the Japanese Government to make a quick decision on their request. However, since it is obvious that the country lacks adequate water supply facilities, it was keenly felt that large scale assistance, both quantitative and qualitative, should be started as early as possible.

1-4 Conclusions and Recommendations

In view of the fact that about half of Vietnam's national budget for fiscal 1971 (calendar year), amounting to VN$255,600 Million (=Piastre) is appropriated for defense purposes, it will be difficult for it to allocate sufficient funds for environmental improvenments for the people. In view of this stern reality, it is easy to understand that no substantial measures

have yet been taken for the expansion and improvement of the water supply system in Saigon, Danang and Longxuyen Cities, which were the object of the recent survey in spite of the urgent need. At any rate, it may be said that, from the standpoint of sanitation, the living environment in these cities is in danger.

In Saigon, for example, the daily supply of water for a population of three million amounts to 360,000 m^3, covering only 60% of the total population. The remaining 1.2 million people must depend on wells or river water to maintain life. For the 1.8 million people who benefit from the water supply, there are a total of 500 public fountains in addition to 87,000 private service connections. There are a number of cases in which one public fountain is used by about 1,000 people. Furthermore, river-dwellers who live in shacks on the Saigon River are depending on a small quantity of water delivered to them.

Meanwhile, the daily supply of water to a population of 570,000 in and around Danang (430,000 in the city itself) amounts to only 5,000 m^3, covering less than 10% of the total population. The remaining population are compelled to dig shallow wells and use underground water which is salty and polluted by sewage.

In Longxuyen the dail supply of water to a population of 75,000 amounts to only 3,500 m^3 and the served ratio is only 40%. The rest of the population get their water from the Longxuyen River, store it in drums, settle muddy water with alum and then use the skim.

Under such conditions, sanitation in these cities may be said to be in extreme danger. Besides, unless adequate measures are taken to meet the increasing demand for water caused by the annually growing population, the conditions in these cities will deteriorate further. As urgent countermeasures to improve the present water supply, the steps undermentioned are considered essential to take the following steps. As for long-range countermeasures, a full study should be made on the feasibility of the project during the implementation of the urgent countermeasures.

(1) Saigon

On the total length of water distribution pipes in Saigon extending over 750 km, approximately 20% or 150 km are old pipes laid more than 50 years ago. Most of these are clogged with lump of rust, causing a decrease of the flow coefficient and dirty rust-colored water. In addition, considerable damage has been caused to the outer surface of the pipe lines by carrosive soil thus weakening the strength of the pipe against the pressure both from outside and inside. For this reason, the water distribution pipes are being used under low pressure. Ruptures of the pipes are still frequently reported. It is essential therefore, that the old pipe lines be replaced at the earliest opportunity. Against the present population of 3 million in Saigon, the total length of water distribution pipes amounts to only 750 km with only the main streets of the city covered by the supply network.

For a population of 3 million, there should be at least 3,000 km of water distribution pipes to ensure a smooth and adequate water supply. The expansion of water distribution pipes is also necessary to meet the growing demand generated by an annual population increase about 80,000. Under these circumstances, it is hoped that prompt measures will be taken for the improvement and expansion of water supply system. In order to ensure an appropriate and reasonable supply of water following the expansion of the distribution pipes, it will be necessary to increase water meters and eliminate unauthorized use of water. The daily supply of water in Saigon amounts to 360,000 m^3, while the capacity of the water treatment plant is 450,000 m^3/d. It is anticipated, however, that the water treatment plant will operate to its maximum capacity in a year or two as a result of a sharp growth in demand. In order to continue the service of the water supply for another two or three

years, even after maximum operation has been reached, it will be necessary to increase the capacity of the plant by improving impellers of intake and transmission pumps. It is essential, however, that a study is made on the safety and the resistance of transmission pipes against high pressure.

As for the expansion of the water supply source for Saigon City, the question remains as to which of the three possible sources, namely, the Dong Nai River, the Saigon River and ground water, should be used, or whether a combined use should be adopted.

Moreover such important questions as the capacity of available water source and the effect of sea water are still left unanswered. It is advisable, therefore, that an immediate study be made of basic problems involved including the above.

Therefore, the following urgent countermeasures and long-range countermeasures are considered necessary for Saigon City.

(i) Urgent Countermeasures

Type of work	Purpose and description of work
Replacement of old distribution pipes	To eliminate the occurrence of red water; to prevent a decrease of pressure and to improve deficient supply pipes; and also to reduce leakage.
Installation of small size distribution pipes	To eliminate non-served district in the old city area where there is a dense population.
Installation of new distribution pipes	To eliminate unsanitary conditions, to supply water to newly developed areas, to ensure smooth water supply, to improve deficient supply lines and to provide a reasonable water supply network.
Installation of water meters	To ensure increased revenue and rationalize water rates and to prevent the abuse of water.
Enhancement of the capacity of intake pumps	Improvements are to be made to the impellers of intake pump to increase intake, transmission and supply capacity by about 20%.
Technical consulting	
i) Engineering and supervision of work for urgent project	i. In order to ensure smooth and adequate water supply from the existing sources, a hydraulic calculation of pipe lines and supply network should be made and an effecitve supply pipe improvement and expansion program should be formulated. ii. A water supply program should be worked out on the basis of hydraulic calculation so that the supply system from the future source will match the supply system from the existing source.

	iii. A careful study should be made to determine whether or not the existing transmission pipes are safe against the future increase of the pressure in the pipes due to the increase of the capacity of intake pump. iv. A study should be made from a technical and managerial point of view on the method of switching the public fountains to private meters to the extent possible. v. A study should be made on the selection of the type of distribution pipes, countermeasures for rusty water, measures for the prevention of leakage and water pollution. vi. Efforts should be made for mechanization and rationalization of distribution pipe installation. vii. Rationalization should be considered also in the management side such as water charge collection. viii. Technical consulting should be provided on the engineering and construction work for the urgent projects, including the items mentioned above.
ii) Surveys and planning of expansion project	Studies and surveys should be made on the following ing items for the future program. i. Estimation of population saturated and total population curve based on an appropriate city planning for the Saigon Metropolis. ii. Prediction of curve for served ratio, population served, supply quantity, count-for ratio up to the year 2,000 as a target. iii. Measurement of the discharge of the Saigon River and the Don Nai River, study on the effect of sea water and analysis of water quality. iv. Studies on ground water area and the quantity of water that can be pumped up and surveys on water quality and geology. v. Planning of intake station, water treatment plant, pumping station and distribution pipes in relation to the next expansion program. vi. Planning of water distribution facilities. vii. Estimation of project cost on the basis of the above-mentioned general plan. viii. A study on costs and benefits. ix. Financila program.

Estimated Cost of Construction For Urgent Countermeasures (The period of computation is for 3 years from 1971 - 1973 in principle but caluculation should be made also for a 5 year period for reference.)
US$1=VN275 (PLASTRE), VN$1=US$0.003636

Description	1971 - 1973			1974 - 1975			Total (1971 - 1975)		Total (1971 - 1975)
	Quantity	Foreign currency US$1,000	Local currency VN$1,000	Quantity	Foreign currency US$1,000	Local currency VN$1,000	Foreign currency US$1,000	Local currency VN$1,000	Foreign currency + Local currency US$1,000
Replacement of old distribution pipes	50 km	650	107,000	30 km	390	64,200	1,040	171,200	
Installation of small distribution pipes	150 km	240	225,000	100 km	160	150,000	400	375,000	
Installation of new distribution pipes	210 km	2,740	449,400	160 km	2,400	342,400	5,140	791,800	
Installation of water meters	75,000	1,125	75,000	50,000	750	50,000	1,875	125,000	
Improvement of intake pump	6	246	6,600	-	-	-	246	6,600	
Sub-total (Total of foreign currency and local currency in US$1,000)		5,001 (8,139)	863,000		3,700 (5,906)	606,600	8,701	1,469,600	(14,045)
Engineering fee									
i Engineering and supervision of construction	1.5 persons x 24 month	150	2,950		-	-	150	2,950	
ii Surveys and planning of expansion project	6 persons x 18 month	450	8,850		-	-	450	8,850	
Sub-total (Total of foreign currency and local currency in US$1,000)		600 (643)	11,800				600	11,800	(643)
Contingency reserve funds (Total of foreign currency and local currency in US$1,000)		199 (327)	35,200		100 (149)	13,400	299	48,600	(476)
Total		5,800	910,000		3,800	620,000	9,600	1,530,000	
Grand Total		9,109			6,055				(15,164)

(ii) Long-range Measures

Type of work	Purpose and description of work
Expansion of water Supply facilities	Although the final decision on the location of the water supply source, the scope of expansion and others should be determined on the basis of the results of surveys and the planning of the expansion project mentioned in item ii), Section (i), Urgent Countermeasures, the outline of the expansion project is as follows: i. The target should be set for around 1985. ii. The scope of work should be to provide capacity of about 500,000 m^3/d. iii. Water supply source should be selected from the Dong Nai River, the Saigon River and groundwater. iv. Total project cost is estimated at $70,000,000. v. The work should be divided into two phases, the first phase is to be from 1973 to 1975.

(2) Danang

Of the total population of 570,000 in Danang, approximately 50,000 people, or only 8%, are supplied with 5,000 m^3 of water daily. The total length of the existing distribution pipes is only 38 km. To supply water to the population of 570,000, approximately 570 km of distribution pipe is required. In view of the extremely unsanitary condition of the environment for the citizens of Danang, it is absolutely necessary to expand water supply facilities as soon as possible.

For this purpose, it is advisable to adopt the following urgent countermeasures and long-range measures. As the existing water treatment plant is of a temporary nature, it should be removed upon completion of the expansion work.

(i) Urgent Countermeasures

Type of work	Purpose and description of work
Works to be executed immediately	1971
Surveys and detailed design	Surveys and detailed design should be initiated immediately on the following items. (For a period of about one year)

	i. Confirmation of population saturated and total population curve for the Danang Metropolitan area on the basis of appropriate city planning. ii. Determination of curves on such factors as served ratio, population served, quantity of water demand, count-for ratio and quantity of charged water, etc. iii. Measurement of the discharge of the Cam Le River, the supply source of the system, and a survey of the water quality and the effect of sea water. iv. Geological survey and land surveying at proposed site of intake and treatment plant, pump station and the route of pipe lines for the first phase of expansion. v. Hydraulic calculation of main distribution pipes. vi. Comprehensive calculation of pipe line network consisting of the existing distribution pipes and the proposed expansion of distribution pipes. vii. Detailed design for the construction of intake and treatment plant, pump station and distribution pipes for the first phase of expansion. viii. Technical consulting on the management and maintenance of water supply facilities.
Works to be initiated a year later	1972 - 1974
i) Construction of intake and water treatment facilities	Details of the first phase of expansion. i. The target year is to be 1980. ii. The scope of work is to provide a capacity of 70,000 m^3/d (population supplied 415,000) iii. Water source is to be the Cam Le River. iv. The work is to be divided into the urgent project (1972 - 1974) and the continued project (1975 - 1979). v. The urgent project includes; Construction of intake and water treatment facilities (capacity 70,000 m^3/d).

	Installation of distribution pipes (diameter of 1,000 mm - 75 mm, totaling 100 km in length are to be laid). Installation of water meters (40,000 units are to be provided). vi. Continued project (not included in the urgent project) includes; Installation of distribution pipes totaling 200 km in length. Installation of 20,000 units of water meter.
ii) Installation of distribution pipes (to be included in the project mentioned in item v, par. i)	Installation of 1,000 mm - 75 mm pipe lines totaling 100 km in length to eliminate unsanitary conditions in the city area.
iii) Installation of water meters (to be included in the project mentioned in item v, par. i)	Installation of 40,000 water meters to increase revenue from water service, to rationalize water charge and to prevent abuse of water.
iv) Technical consulting and supervision of construction work for urgent countermeasure.	Technical consulting and supervision of construction work for urgent countermeasures.
v) Planning of a long-range program	Study, survey and planning of the continued project for the first pahse of expansion and of the second and third of expansion.

Estimated Cost of Construction for Urgent Countermeasures

US$1.00=VN$275 (PIASTRE)

Description of work	1971			1972 - 1974			Total (1971-1974)	
	Quantity	Foreign currency US$1,000	Local currency VN$1,000	Quantity	Foreign currency US$1,000	Local currency VN$1,000	Foreign currency US$1,000	Local currency VN$1,000
Surveys and detailed design	Field surveys and analysis 11 months	370	22,000				370	22,000
Construction of intake and water treatment facilities				70,000m^3 /d	3,150	288,750	3,150	288,750
Installation of distribution pipes				100 km	3,600	536,250	3,600	536,250
Installation of water meters				40,000	600	88,000	600	88,000
Sub-total					7,350	913,000	7,350	913,000
Technical consulting supervision of construction work for urgent counter measures				3 persons x 30 month 2 persons x 15 month	490	27,500	490	27,500
Planning of long-range project				some	120	6,600	120	6,600
Sub-total					610	34,100	610	34,100
Total		370	22,000		7,960	947,100	8,330	969,100

(ii) Long-range Measures

Type of Work	Purpose and description of work
	Although the details of the long-range measures should be determined when planning permanent measures as described in par. iv), Section (i), Long-range Measures, the outline of the measures is as follows.
Continued project of the first phase of expansion (Target year and others are the same as for the first phase of expansion)	i. Project period: 1975 - 1979 ii. Description of work: Installation of distribution pipes - 200 km Installation of water meters - 20,000 units iii. Project cost (In present value) Foreign currency: US$ 7.5 million Local currency: VN$1,116.5 million
Second phase of expansion	i. Target year: 1990 ii. Project period: 1976 - 1989 iii. Scope of work: Capacity of 70,000 m^3/d iv. Water source: The Cam Le River v. Project cost (In present value) Foreign currency: US$15.71 million Local currency: VN$2,079 million
Third phase of expansion	i. Target year: 2000 ii. Project period: 1986 - 1999 iii. Scope of work: Capacity of 140,000 m^3/d iv. Water source: The Cam Le River or the Cu De River v. Project cost (In present value) Foreign currency: US$31.42 million Local currency: VN$4,158 million

(3) Longxuyen

Out of the total population of 75,000 in Longxuyen, only about 35,000 people, or 47%, are being supplied with 3,500 m^3 of water daily. The total length of water distribution pipes in the city is only 23 km. To supply water to a population of 75,000, about 75 km of water distribution pipes as required. In view of the extreme unsainitary conditions of the living environment for the citizens of Longxuyen, it is essential to start the expansion of water supply facilities as soon as possible.

For this purpose, it is advisable to take following urgent counter-measures and long-range measures. As the existing water treatment facility is of a temporary nature, it should be removed upon completion of the expansion program.

(i) Urgent Countermeasures

Type of work	Purpose and description of work
Work to be initiated immediately	1971
Surveys and detailed design	Surveys and detailed design for the following items should be initiated immediately (For a period of one year) i. A study on population saturated and determination of total population curve for the Longxuyen area on the basis of appropriate city planning. ii. Determination of such factors as served ratio, population supplied, quantity of water demand, count-for ratio, etc. with the target set for the year 2000. iii. Observation of discharge and survey on water quanlity, flood and drought water level of the Bassac River. iv. Geological survey and land surveying of the proposed site of intake and treatment plant, pump station and the route of water distribution pipes for the first phase of expansion. v. Hydraulic calculation of main distribution pipes. vi. Integral calculation of pipeline network of the existing distribution pipes and the proposed expansion. vii. Detailed design for the construction of intake and treatment plant, pump station and installation of distribution lines for the first phase of expansion. viii. Technical consulting on management and maintenance of water supply system.

Works to be initiated a year later	1972 - 1974
i) Construction of intake and treatment facilities	Description of the first phase of expansion. i. Target year: 1980 ii. Scope of work: Capacity of 10,000 m^3/d (Population supplied - 73,000) iii. Water source: the Bassac River iv. The work is to be divided into the urgent project (1972 - 1974) and continued work (1975 - 1979). v. The urgent project includes: Construction of intake and water treatment facilities (capacity - 10,000 m^3/d) Installation of water distribution pipes (Diameter of 450 mm - 75 mm and 23 km in length) Installation of water meters (7,000 units) vi. Continued work (not included in the urgent project) includes: Installation of water distribution pipes totaling 25 km. Installation of 3,000 water meters.
ii) Installation of water distribution pipes (Included in par. V, Line i)	Installation of water distribution pipes of 450 mm - 75 mm in diameter and 23 km in length to eliminate unsanitary condition in the city area.
iii) Installation of water meters (Included in par. V, Line i)	Installation of 7,000 water meters to increase revenue from water service, to rationalize water charge and to prevent abuse of water.
iv) Technical consulting and supervision of construction work for the urgent project and planning of long-range project.	Parallel with technical consulting and supervision of construction for the urgent project, surveys, studies and planning should be implemented for the continued work of the first phase of expansion and for the second and third phase of expansion.

Estimated Cost of Construction for Urgent Countermeasures

US$1.00=VN$275 (PLASTRE)

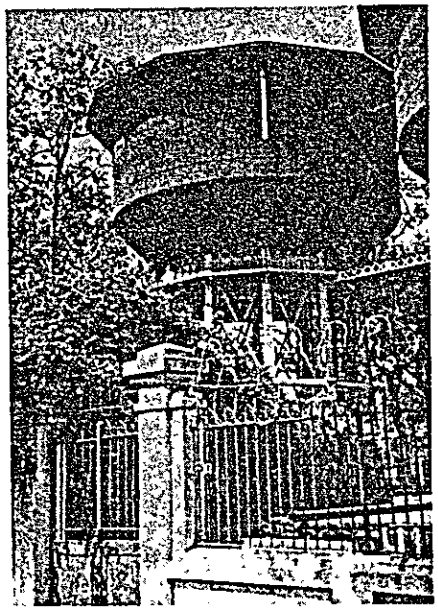
Description of work	1971			1972-1974	Total (1971-1974)			
	Quantity	Foreign currency US$1,000	Local currency VN$1,000	Quantity	Foreign currency US$1,000	Local currency VN$1,000	Foreign currency US$1,000	Local currency VN$1,000
Surveys and detailed design	Field surveys and analysis 9 months	115	4,125				115	4,125
Construction of intake and water treatment facilities				10,000m^3 /d	520	49,500	520	49,500
Installation of distribution pipes				23 km	440	55,000	440	55,000
Installation of water meters				7,000	105	15,400	105	15,400
Sub-total					1,065	119,900	1,065	119,900
Technical consulting supervision of construction work for urgent project and the planning of long-range measures.				2 persons x 20 month 2 persons x 10 month	240	13,750	240	13,750
Total		115	4,125		1,305	133,650	1,420	137,775

(ii) Long-range Measures

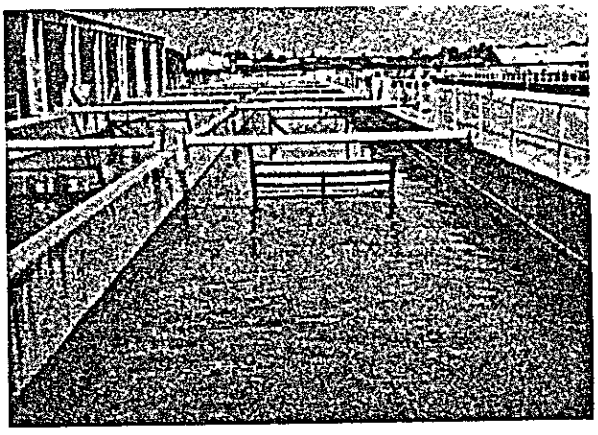
Type of work	Purpose and description of work		
	Although the details of the long-range measures should be determined when planning the long-range project as mentioned in par. iv), Section (i), Urgent Counter-measures, the outline of the plan is as follows:		
Continued work of the first phase of expansion (Target year and others are the same as for the first phase of expansion)	i.	Project period:	1975 - 1979
	ii.	Description of work:	Installation of distribution pipes - 25 km Installation of water meters - 3,000 units
	iii.	Project cost (In present value)	
		Foreign currency:	US$535,000
		Local currency:	VN$64,350,000
Second phase of expansion	i.	Target year:	1990
	ii.	Project period:	1977 - 1989
	iii.	Scope of work:	10,000 m^3/d
	iv.	Water source:	the Bassac River
	v.	Project cost (In present value)	
		Foreign currency:	US$1,955,000
		Local currency:	VN$202,125,000
Third phase of expansion	i.	Target year:	2000
	ii.	Project period:	1987 - 1999
	iii.	Scope of work:	10,000 m^3/d
	iv.	Water source:	The Bassac River
	v.	Project cost (In present value)	
		Foreign currency:	US$1,955,000
		Local currency:	VN$202,125,000

In the foregoing, the outline of the urgent countermeasures and the long-range measures for the water supply systems in the three citires of Vietnam has been discussed. As stated at the beginning, the Republic of Vietnam is faced with a difficult financial situation, and, moreover, the living environment and sanitary conditions in the three cities are considered very unsatisfactory It is strongly hoped that the above-mentioned measures be put into practive as early as poosible under conditions favorable to the Republic of Vietnam.

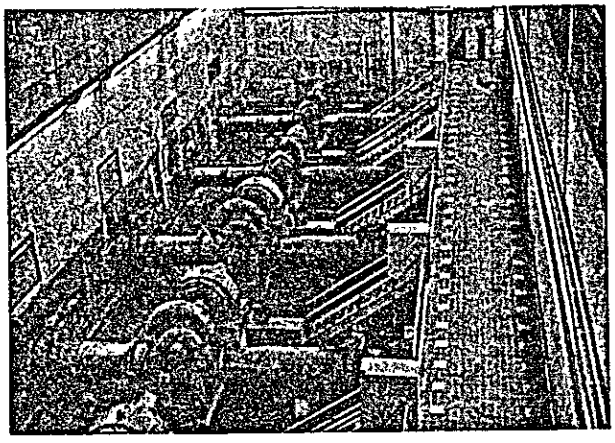
CHAPTER 2. WATER SUPPLY IN SAIGON METROPOLIS



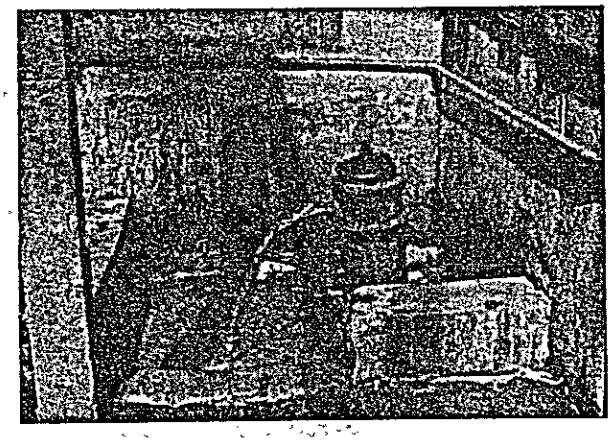
An Elevated Tunk



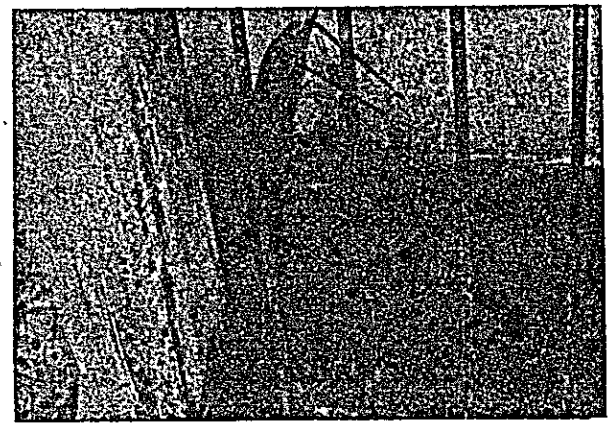
The Transmission Pump



An Old Pipe with Lump, Rust and Corrosion



A Public Standpost Discharging Water for 24 hrs.



An Example of Water-meter Installed

2-1 Water Supply at Present

2-1-1 Outline of Saigon Metropolis

The area served by water supply system of Saiton Metropolitan Water Office (SMWO) includes Saigon City and a part of the adjoining province of Gia Dinh. Saigon Metropolis is expanding at quick tempo. This is of course due to a sharp increase in its population. Such a sharp population increase has been brought about by an extensive concentration of refugees and jobseekers into Saigon in addition to the natural increase.

Though the industries are still in its early stage of development, efforts are being made to promote the industries in line with the national policy. As a result, the industries have been growing steadily and this trend is considered to be a contributing factor to the growth of population.

As a countermeasure for the population increase, bed towns with public apartments are being established in the city area and the suburbs. As for the industries, an industrial district has been provided in the east of the city and many factories have already been in operation. Along the national roads extending radially from the city, houses and stores stand side by side forming a rapidly growing city area and some factories have also been built along these roads. On the other hand, the congestion in old city area is beyond description, which is an indication of extreme concentration of population in this area.

The population of Saigon Metropolis was 500,000 in 1946 growing upto 1,800,000 in 1958 and now, it is said to have reached 3 million. However this is an extimated figure from a sampling survey. The main reason for a sharp increase in population in the past 20 years is the influx of the so-called refugees numbering 30,000 to 60,000 annually to the metropolis (There is a lull in the influx at present) in addition to 2.5% annual natural increase (Approximately 70,000 as of 1970). On the future of this exploding population there are two divided views. One says that the farmers who have evacuated from the war disasters and settled down in Saigon will return to their farm land after restoration of pease and therefore, the population in Saigon will not grow so greatly in the future. The other view is that the concentration of population into the city area is not a passing phenomenon, but it will continue also in the future.

Whether these views are right or wrong must be determined after further observation of the coming trends, but the Survey Team holds the latter view.

Concentration of population in the major cities, particularly the capital cities, is a world-wide tendency. Saigon would not be an exception. From a broad point of view, Saigon is situated at an important position in the East-West air transportation and to its airport some overseas airlines have already been extended. Moreover, ship transportation is widely available around the city as the Saigon River which runs through the city is said to allow the navigation of a ship as large as 10,000 tons ships without difficulty. Domestically, it is not only the center of administration and culture as capital city but also the center of commerce and transporation.

Because of the long war in this country, the industries are not much active yet. However, the Vietnamese Government aims to promote the industries and to realize domestic production of commodities as a part of the measures to save foreign exchange. It is easily imagined that the manufacturing industry will rise first in and around the metropolis where population is large and the largest demand is expected.

Under these circumstances, it is not probable that the population will dispurse from the metropolis where employment opportunity is great and city life can be enjoyed, and instead more concentration of population is very likely.

2-1-2 Management of Water Supply

The Saigon Metropolitan Water Office (SMWO) is under administrative control of the Ministry of Public Works. The highest decision-making organ of SMWO is the Board of Directors. The Board is chaired by the Minister of Public Works and made up of ministers concerned, mayor of Saigon City, two members of Saigon City Council and the Director of National Water Supply Agency. For the deliberation on public utilities rates, there is the other government committee.

The outline of the organization of SMWO is as follows. Directly under the Director of SMWO are two departments - Engineering Department and Managerial Department. The Engineering Department has under its wing four divisions - Supply, Planning - and - engineering, Construction and Production, and the Managerial Department consists of three divisions - Management, Commercial and Accounting. Though each division reports directly to the Director of SMWO, one staff is assigned to each division. Besides, there are three district offices directly under the Director of SMWO. In each district office there are Commercial Section and Construction Section. There is a plan to reinforce the organization of the district office to have three sections in the future. SMWO has a total of 990 employees, of which about 1/3 are assigned to the district offices and the remainder to the administration office, an intake pumping station, a water treatment plant, pumping stations and maintenance shops.

As mentioned previously, SMWO is rationally organized and efficiently maintained. Much consideration is also given in order to hold counterbalance between relevant sections, like as counter-check system is maintained between the Meter Reading Section and the Billing Section in an attempt to prevent irregularities and errors.

The team visited intake station, water treatment plant, meter shop and mintenance shop and found all of them in good condition. In particular, the meter shop was equipped with complete repair and testing facilities. That is an indication of vigorous efforts of the Water Office to secure revenue by netering, which forms the basis of management. Beiseds, there were not many surface leakages observed in the city. This is also an indication of prompt and efficient maintenance work.

The key to the successful management of water supply lies in the ability and the effort of the managerial staff to make use of the organization rather than in the organization itself. In this respect, SMWO may be said to be in a very favorable position. In spite of such hard conditions as a sharp increase in population and the superannuated pipelines, SMWO has so far accomplished some extension of distribution lines together with some replacement of old pipe-lines through effective use of loans and grants provided by US and Australia. As a ruselt, connections are increasing steadily in number. Judging from these achievements,

SMWO is considered to be fully capable of coping with difficulties which will be discussed later, if adequate financial aid is provided.

2-1-3 Water Supply Facilities

Saigon Metropolitan Water Office has modern water supply facilities which were just completed with the exception of water distribution lines, particularly small and medium size pipelines. This supply system originates in the Dong Nai River (See attached drawing) and was put in service in 1966. The master plan of this project was formulated by the Hydro-technic Co., a consultants firm of U.S.A., and the construction was financed by U.S. AID. The project consists of intake, raw water main, water tratment plant and trunk line of the distribution system. Small and medium size pipelines laid in the 1890 - 1930 period were utillized in their original form.

Besides the above-mentioned facilities, there is water supply system which utilizes groundwater, but it is now retained as standby facilities. Originally, there were two separate water supply systems in Saigon City, one for Saigon district and the other for Cholon district.

In both districts the supply source was the two well collectors of shallow wells. However, upon completion of the Don Nai water system, the supply source in Cholon district was abandoned completely partly due to unsatisfactory water quality while the supply source and the pump station in Saigon district are still maintained as standby facility for use in case of emergencies. Distribution lines of these two systems were connected to the trunk lines of the new Dong Nai system and are still in use, as mentioned previously. As may be imagined from the history of water supply mentioned above, the water distribution lines are the main problem in water supply in Saigon. On this point, however, a detailed discussion will be made at a later stage.

(a) Outline of Dong Nai water system

Intake pump station

Location :	Approximately 25 km northeast of Saigon City, on the right bank of the Dong Nai River (Opposite to Bien Hoa)
Intake pump :	6 units
Total capacity :	450,000 m^3/d.
Raw water main :	ϕ 72" PS concrete pipe, 11 km in length.
Capacity :	505,000 m^3/d.

Water treatment plant

Capacity : 480,000 m^3/d (a 30% increase possible)

Rectangular horizontal flow settling basin - 5.

Rapid sand filter bed (filtration rate 150 m/d) - 20.

Clear water reservoir : 2 x 40,000 m^3 = 80,000 m^3

2 x 95,000 m^3 = 190,000 m^3

Total 270,000 m^3

High lift service pump : 5 (2 pumps are of speed control type)

Capacity : 680,000 m^3/d

Distribution facilities :

Trunk main : ϕ 76" PS concrete pipe, 12 km in length.

Elevated storage tank : 8 main tanks with a total capacity of 49,000 m^3.

Distribution lines : Consist mainly of the existing lines. Trunk lines linking the existing small size distribution lines and the newly constructed Dong Nai water system are the new installation.

(b) Facilities of old well collectors now placed on standby status are as follows :

Source : Groundwater

Location : Govap in the North of Saigon City (This belongs to the Province of Gia Dinh, but supplied with water by SMWO).

Composition of water source : A group of about 20 shallow wells with a diameter of 2.00 m and another group of 12 wells supply water to well collectors by means of siphon.

Capacity : No.1 well collector - 30,000 m^3/d
No.2 well collector - 16,000 m^3/d

Water treatment and distribution facilities : The water collected from wells is pumped to the treatment plant in the city, where it is treated for pH adjustment and sterilization, and is pumped up to the elevated storage tank. From there the water is distributed to the entire city area by means of gravity flow. The facilities are maintained in good operating condition for use in an emergency.

(c) Deep well

So far, about 50 deep wells have been sunk in various parts of the city. These deep wells were connected directly to the distribution lines and the bore-hole pumps were installed to each well. However, a certain number of deep wells has been put out of commission due to deterioration of water quality. It is said that about 30 deep wells are still serviceable but the appropriateness of their use cannot be determined unless checks are made on individual wells. The total capacity of these wells is said to be 110,000 m^3/d. Though all of these wells are out of service at present, they are well maintained so that they may be put into service when required.

2-1-4 Conditions of Water Supply

The present served area covered by the Dong Nai system may be divided into two parts, the commercial and residential districts of Saigon including both Cholon and a part of the province of Gia Dinh, and the industrial district adjacent to Bien Hoa. The total water supply as of 1970 was about 360,000 m^3/d. comprising 340,000 m^3/d for Saigon district and 20,000 m^3/d for the industrial district. In terms of water consumption, the share of the industrial district is not significant yet. However, judging from its rapid growth rate in the recent years, the industrial district is expected to hold a larger share in water consumption in the near future.

The Thu Duc water treatment plant of the Dong Nai water system is located almost midway between the center of Saigon City and the intake point. In the area extending to Bien Hoa City to the east of the water treatment plant, new industrial districts, housing districts and a school district have been established. A military camp is also seen in this area. As the area is a vast plain with a few undulations extending over some several tens km^2, to 100 km^2, a rapid development of the area is expected in the near future. At present, a cement plant, farm machnery manufacturing plants, a paper mill and a power plant are in operation in this area while construction of housing areas is under way. These are important factors which must be taken into consideration in the future planning of water supply facilities.

Annual growth in the quantities os intake and distribution, and the number of water meters are shown in the following table. Particulalry noteworthy is the quick increase in the consumption of water. A sharp annual increase of 50,000 m^3/d is probably due to changing pattern of water use similar to that in other major cities of the world as well as to an increase of served population. Many buildings that are being built in the city are not so tall but their size is becoming larger. Equipment and furnishings are also modernized, requiring a large quantity of water. Meanwhile, construction of housing areas is also being accelarated. Consumption of water in these areas will be much greater than that in the present average households. As stated previously, the industries in the city just got underway and the consumption of industrial water will gradually increase in the future, making per capita consumption of water grow further. This tendency will continue for some time.

Annual Intake & Distribution

Year	Quantity of Intake	Consumption	Number of meters
1967	179,600 m^3/d	172,400 m^3/d	46,108
1968	243,000	229,900	52,093
1969	284,200	272,100	68,635
1970	368,000	333,000	74,659

(As of May 1971)

The water pressure in the city is generally very low. This is due to the fact that the increase of pressure may result in bursting of old cast iron pipes that have been in use for the past 50 years in Saigon and Cholon districts and also due to the decrease in the carrying capacity and the increase of frictional resistance in the pipe line. Therefore, the supply of water is not satisfactory in general. As the water is supplied from elevated storage tanks by gravity flow, the pressure varies with the hight of elevated tanks. As the lowest water level of tanks is about 20 m, it will be necessary to shift from the tank system to the direct pumping system when many tall buildings are built in the future.

At the pump station in the Thu Duc water treatwent plant, appropriate water transmission is maintained by relying on pumping during the day and on gravity flow at night, and further by regulating the operation of pumps in accordance with the fluctuation of demand in an attempt to abate leakage in the distribution lines and to save power cost.

2-1-5 Problems

The water supply system as a whole is equipped with good facilities and has been under satisfactory management with financial and technical aid of the US and has met the requirement within the limit of its capacity. However, the problems the management is now facing are very serious. These are the low water pressure, exploding increase in population, the requirement for the enhancement of supply capacities and the funds required for expansion project. These problems will be given further analysis hereinafter. These questions may be divided largely into two types. The following paragraphs (2) through (4) are of the type which requires continuous work, and paragraphs (5) and (6) are of another type which require an immediate planning for the sake of the future of Saigon Metropolis.

(1) Suspension of Foreign Aid

The Dong Nai water system was constructed with a US loan amounting to $17 million and with the investment of local funds amounting to VN$2,000 million (Piastre). After its completion, the US and Australian Governments have been providing grants amounting to 2 million dollars annually for the expansion of distribution lines. However, the US aid was suspended from fiscal 1970, thus leaving the Australian aid the sole source of assistance. This aid, however, is not ensured for fiscal 1971 either. As no local materials are available for water works at present, all of the required materials must be imported. When the foreign aid is suspended, Vietnam, which has only very limited amount of foreign exchange, will be unable to purchase foreign materials and will have to suspend its water supply construction. After using up the stock of pipes the whole work will inevitably have to be stopped. Such circumstances may arise within this year or the next year. Under this situation, the Vietnamese Government and SMWO are now compelled to seek a new foreign aid to purchase required materials.

(2) Insufficiency of Small Size Distribution Lines and The Public Standposts

While the main streets of the city are mostly provided with water distribution lines, the back streets and small alleys are totally lacking water distribution lines. Also, many shanties are built densely on the bank of the river and public open spaces are also lacking water facilities. The people living in these shanties are using nearby public standposts. The public standopsts are the memento of the days when the water supply system was operated by Saigon municipal office prior to the establishment of

SMWO and now water is lavishly used from them. As the standposts are used by many people and located by roadsides, their proper use and maintenance is almost impossible, and the water is running out from these faucets for 24 hours. The people who get benefit even from the standposts must be considered lucky because the majority of the people in non-served area live on the well water which cannot be said sanitary in every respect. On the other hand, however, wealthy people in the back streets have their pulmbing system connected with that of the house which has the plumbing system connected with the main in the street. Such a practice may not be illegal but overlooking of this practice will provide every possibility of illegal use of waterworks. Expanded coverage of small size distribution lines will eliminate most of these problems. At present, with the installation of small size pipelines, public standposts are being removed and each household is requested to pay for water from its own tap. This will serve a double purpose, the increase in water revenue and the prevention of abuse of water.

(3) Old Pipeline and Related Problems

The 30 to 50 years old cast iron pipelines are still in use but they are so incrusted that they can hardly be serviceable any longer. Tubercles grow with years inside the pipe, thus decreasing the carrying capacity. Moreover, these is a problem of pitting through of the pipe wall, which may cause the rupture of the pipe and the resultant leakage of the pipe. The pipe length under this condition amounts over 150 km. Unless these problems are solved, an increase of water pressure to aim satisfactory water distribution cannot be hoped. Even when the increase of water pressure may be realized, it will only accelerate the leakage, falling short of the purpose.

(4) Expansion of Service Area

With the increase in population and the advent of the industries built-up streets are expanding rapidly toward outlying suburbs. The rapid expansion of city area is particularly remarkable in the area along Saigon-Bien Hoa National Highway in the east of Saigon City, area along the National Highway I leading to the Cambodian border in the north of the city, area along the National Highway leading to Long Xuyen in the west and certain areas in the south. A good example is the Province of Gia Dinh, which surrounds the City of Saigon and is naturally within the service area by SMWO. It is not provided with distribution facilities in most parts. In these areas people are using water from shallow wells, which might have been polluted and, in most cases, are originally highly saline and strongly impregnated with iron, and they may be living under dangerous condition from a sanitary point of view. It is strongly hoped that distribution lines be laid in these areas as soon as possible so that adequate and good water may be supplied.

(5) Lack of Master Plan

So far a couple of programs have been formulated and surveys have been conducted for some of the water supply projects. Despite the fact that the Dong Nai water system (This was originally planned for the demand in 1980) has been almost completed, the system will be forced to operate to its full capacity within this year or the next year. Unfortunately, there is no comprehenxive master plan for the furture expansion of water supply. Lack of master plan at time of impending water shortage is a serious problem. Whatever the water supply scheme may be, it cannot

be put into practice unless there are reasonable master plan, reliable basic survey, well-planned construction schedule and sound financial program. The plan under consideration at present includes a small scale supplemental work on the Dong Nai water system, a large scale expansion of the system, full utilization of standby facilities, construction of a new water supply system utilizing ground-water, construction of a new water supply system using water from the Saigon River or through combined use of water from the Saigon River and groundwater. For this purpose, a program that will bring satisfactory results promptly with least investment must be worked out.

(6) Domestic Supply of Materials and Machinery

At present, items required for water supply works including materials, machinery and equipment are not available in Vietnam except small size cast iron specials. This is of course a problem of the whole industries and the priority production of items for water supply alone may not be practical. Nevertheless, early domestic production of often-used equipement and materials should be planned by incorporating the water supply in the national industrialization program. When the counry is facing a severe shortage of foreign exchange, the total reliance on import for materials and equipment will not be favorable to the promotion of water supply enterprise.

2-2 Measures Required

As pointed out in the previous section, the most serious problem that faces the water supply in Saigon is inadequate supply capacity resulting from superannuating as well as extremely small size distribution pipes. Improvement of this situation should come first. The next important question is the supply of water to the populated area that is not covered by the distribution network presently. In view of the present trend of rapid increase in population in the metropolitan area, formulation of a future plan must urgently be initiated, preparating for the expansion of the system in addition to the implementation of the urgent countermeasures.

2-2-1 Urgent Countermeasure (1) - Replacement of Old Pipes

Of the total length of pipe lines in Saigon Metropolitan area extending over 750 km, about 50% were laid before than 1940 and of which the lines 150 km in length are over 50 years old. Moreover, the pipelines are generally too small in size for demand and this fact, coupled with the presence of incrustation in the pipe, degrades the carrying capacity considerably. Also in view of many leaks in the system, replacement of old pipelines is a pressing need. In doing this, however, old pipelines which are not usable should be abandoned in their original location to save money for digging-up.

According to the data obtained during the recent survey, old pipelines are located mostly in the center of old Saigon City district and old Cholon City district, and the total length of pipeline requiring replacement is estimated at about 140 km. The diameter of these pipelines ranges from 80 mm to 600 mm, and all the pipes are cast iron pipes with lead joint with a few exceptions. Though the material of pipe to be used depends on conditions under

which pipe is used, use of ductile cast iron pipe, which is reliable, durable and easy for laying, is desirable as permanent facilities are intended.

Shown below are the estimated length of replacement, through the replacement of these old pipelines, the supply condition will be improved considerably and some new service connections may also be possible. There must be a necessity for several types of joints and couplings in order to connect new pipelines to the existing lines. Because of various restrictions encountered, including traffics, the amount of annual work will be about 15 km judging from the experience here in Saigon.

Estimated Length of Pipe Replacement

Year	1971	1972	1973	Total
Length of pipelines to be replaced (Average diameter, 250 mm)	15km	15 km	20 km	50 km

2-2-2 Urgent Countermeasure (2) - Extension of Distribution Pipes and Others

The explosive increase of population particularly after 1963 has brought to Saigon City a rapid expansion of commercial and residental area. However, the expansion of water supply facilities lags far behined other fields in urban development. As residents in these non-served areas are using water from unsanitary private wells, the extension of distribution pipes to these areas is a matter of urgency. As the transmission capacity has been increased considerably after completion of feed trunk lines from the new water treatment plant, even small extension of distribution pipes will benefit many areas to large extent. The following table shows the length of new pipelines, the number of intake pumps to be improved at the Dong Nai intake and water meters to be provided along with the laying of new pipelines under the urgent program. The areas to be covered by this program are mostly the outlying city areas but also include some sections in the center of Cholon district. The engineering cost is added to the cost estimate for the work of engineering and supervision.

Work Estimate for Extension of Distribution Pipe and Related Items

Description	1971	1972	1973	Total
Laying of distribution pipes (Adverage diameter, 250 mm)	65 km	75 km	70 km	210 km
Laying of small size distribution pipe (Diameter ranging from 50 mm to 75 mm)	50 km	50 km	50 km	150 km
Installation of water meters (Average diameter, 20 mm)	25,000	25,000	25,000	75,000
Increase of capacity of intake				
a. (580 kW)	-	2	1	3
b. (400 kW)	-	1	2	3
Engineering	L.S	L.S	L.S	L.S

* Estimated cost is given in section 2-3.

* * As the replacement of pump runner alone is considered difficult in some cases, the estimate of the cost should be made on the replacement including pump casings.

As the amount of work in laying of distribution pipe by SMWO is said to be about 10 km per month at most, the amount of annual work will be about 100 km. Therefore, if the urgent countermeasures are carried out for a period of 3 years from 1971 to 1973, the total amount of work will be 300 km and if the program is extended over to 1975, the appropriate amount of work will be about 500 km. However, laying of small size distribution pipes which is such a great amount as 50 km per year must also be accomplished during the same period. For this reason, the amount of annual work is to be 70 km for the first three years and 80 km for the remaining two years in anticipation of the increase in work efficiency in the latter period. The ratio of small size pipes to the larger size distribution pipes shown here is not definite and therefore more information will be needed to make more accurate estimate. It is needless to say that before the end of the urgent program, the funds required for the subsequent distribution pipe laying must be provided.

As a provisional measure until the completion of the new water supply system, strengthing of pumps at the Dong Nai Intake must be done to increase supply capacity by about 100,000 m^3/d. For the implementation of this plan, however, some studies and surveys will be necessary. It is needless to say that the expanded facilities will require laying of additional distribution pipes and a financial preparation must be initiated immediately so that the work may smoothly start upon completion of the urgent program. On this point, detailed discussion will be made in the following section.

2-2-3 Planning of Long-range Measures

In the past quarter century, it has been most difficilt to forecast ecological activities in Vietnam for the long future. And it will remain the same for the time being. When the Dong Nai water system was first projected for Saigon Metropolis around 1960, the scope of facilities was determined on a long-range outlook that the facilities would serve adequately until 1980. In reality, however, a serious situation that the facilities will have to be operated to their full capacities in the early 1970's, much earlier than the predicted year, is now developing. In view of such a development, the following daring assumption was attempted in the basic study on the future plan.

It must be pointed out, however, that this assumption was made only in an attempt to take a far-sighted view of SMWO's future water supply. It is essential therefore, that a dependable master plan is made in the near future on the basis of detailed and accurate data.

2-2-3-1 Basis for Planning

(1) Population Projection

For the estimation of the future population, it is important to know the actual state of population increase in the past, and if possible, in such details as natural increase and social one. As a specific factor for the estimation of future increase in population, the data on the industrial and housing development project is also absolutely necessary. During this survey such data were not available to the Team. The only available data was an estimate on the increase in population used for a drainage project by a foreign consultants firm. This data also deals with population increase by dividing it into natural increase and social increase and the figures contained are almost identical with those offered to the Team at several meetings with Vietnamese Authorities.

However, as there is a considerable difference between the actual population and the forecast population at the end of 1970, the forecast population must be revised to 3,000,000, namely the estimate of present population, and this figure and an annual increase rate of 2.5% in the past few years are to be used as the base of calculation. It estimated that the increase rate will decline gradually and come close to 1% in 2000 and that there will be no social decrease in the next few years but there will be a social increase of migration reaching the peak around 1990. Thouth the growth of industry is usually accompanied by the social increase in population, it may be said empirically that the social increase will stop and start declining after a certain period. The future population thus estimated is shown in the chart, "Estimated Population in Saigon Metropolis" which will appear later. According to the chart, the population in 1980 is estimated at 3,800,000 and that in 1990 is estimated at 4,700,000. The potential land space for urbanization in and around Saigon City is roughly estimated at 47,000 ha at most. Through multiplication of this figure by the average population density of 100 person/ha, the figure of 4,700,000, which is equal to the population in 1990, as mentioned above, may be obtained. However, in view of the living pattern in this area, a greater saturation density is expected. Therefore, the population in the year 2000 will be far greater (about 5,600,000).

(2) Served Population

It is impossible to estimate served population under SMWO from the number of connections. The reason is that rebranching from the regular connections is done freely without going through the required form of SMWO. Therefore, the actual ratio can not be known though the present served ratio* is said to be 60%. For the determination of the scope of the expansion project in question, absolutely accurate figure may not necessarily be required. Therefore, the present served ratio is assumed to be 60% and the target is to be set for the increase of served ratio to 80% in the next 10 years and then close to 90% thereafter.

$$\text{Served ratio} = \frac{\text{Served population}}{\text{Total population}}$$

(3) Water Consumption

(i) Percapita Consumtion

On the basis of 3,000,000 of the present population, 60% of the served ratio and 360,000 m^3/d of the total consumption, percapita consumption per day is estimated at about 200 litter. Though there are some uncertainties about the figures of served ratio and the total population, they will cause no major obstacles to a rough estimation of future demand. With use of these figures as they are and by judging the living pattern of the people, consumption of water is estimated to approach 300 ℓ/c/d from a long-range point of view.

(ii) Water Requirement

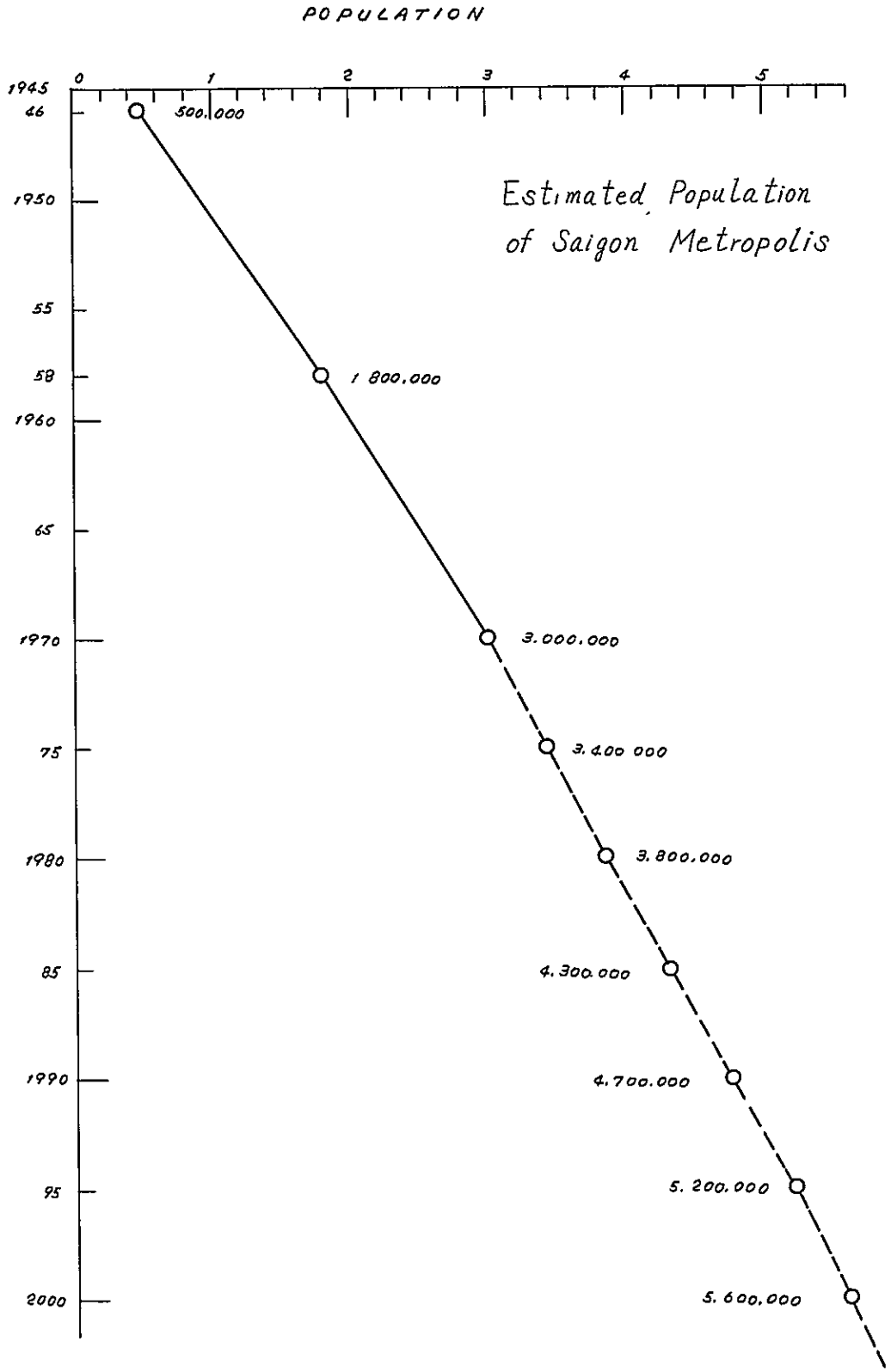
On the basis of the estimated population discussed in the previous section and from the above-mentioned per-capita water consumption, the following water consumption curve will be obtained.

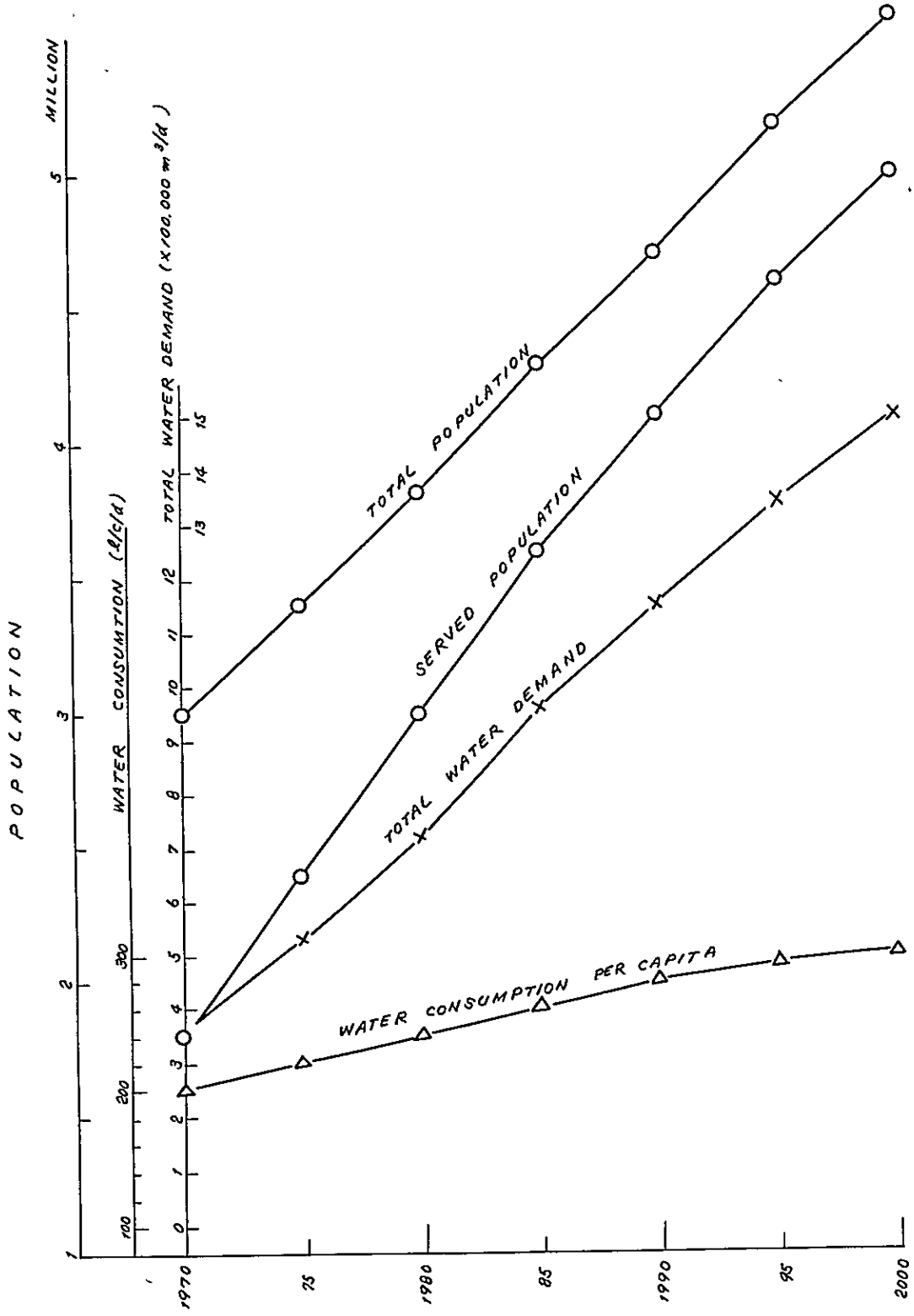
Future Population, Total Water Consumption and Water Shortage

Year	1970	1975	1980	1985	1990	2000
Total population (x1,000)	3,000	3,400	3,800	4,300	4,700	5,600
Served ratio (%)	60	70	80	84	87	90
Served population (x1,000)	1,800	2,400	3,000	3,600	4,100	5,000
Consumption (ℓ/c/d)	200	220	240	260	280	300
Total water demand (m^3/d)	360,000	530,000	720,000	960,000	1,150,000	1,500,000
Water shortage (1) (-45,000) m^3/D	---	80,000	270,000	510,000	700,000	1,050,000
Water shrtage (2) (-550,000) m^3/D	---	---	170,000	410,000	600,000	950,000

Notes : (1) Water shortage to be expected when the present capacity of the Thu Duc water system is maintained.

(2) Water shortage to be expected when the capacity of the Thu Duc water system is increased by 100,000 m^3/d.


POPULATION
0
1
2
3
4
5
1945
46
500.000
1950
Estimated Population
of Saigon Metropolis
55
58
1.800.000
1960
65
1970
3.000.000
75
3.400 000
1980
3.800.000
85
4.300.000
1990
4.700.000
95
5.200.000
2000
5.600.000


POPULATION
MILLION
WATER CONSUMPTION (L/c/d)
TOTAL WATER DEMAND (X100,000 m³/d)
TOTAL POPULATION
SERVED POPULATION
TOTAL WATER DEMAND
WATER CONSUMPTION PER CAPITA
1970
75
1980
85
1990
95
2000

2-2-3-2 Long-range Measure

As stated in the previous section, the population and the total water demand in Saigon in 1980 are expected to be 3,800,000 and 720,000 m^3/d respectively and those in 1990 are estimated at 4,700,000 and 1,150,000 m^3/d respectively. Against this estimate, the capacity of the existing water supply facilities is only 450,000 m^3/d which is provided by the Dong Nai water system. As mentioned previously in section 2-1-4, water consumption in 1970 was 360,000 m^3/d. As there is an annual increase of 50,000 m^3/d in demand, capacity operation of the Thu Duc water treatment plant will come within two years or in 1972. Although the standby groundwater facilities have a total capacity of about 150,000 m^3/d, the groundwater not only has a pH value less than 5 (acidic water) but is strongly impregnated with iron. For this reason, SMWO considers the quality of groundwater unsatisfactory for drinking and has suppended its use. Even if this sytem can be incorporated in the regular water supply facilities, the available amount of well water is decreasing annually. Therefore, the groundwater cannot be used as a means to alleviate chronic water shortage. As an absolute water shortage is foreseeable in the next few years, an immediate step must be taken to plan and to execute expansion of the water facilities. At present, the following three programs are conceivable. The merits and demerits of these programs will be discussed hereinafter.

1) Expansion of the Don Nai River water system.
2) Development of groundwater in the north of Saigon City.
3) Intake from the upper stream of the Saigon River.

(1) Expansion of the Dong Nai River Water System

For this purpose, two different approaches are conceivable. One is a small expansion project involving minor improvement work of the existing system and the other is a large expansion project requiring additional facilities almost equipvalent to the existing one in size.

(1-i) Small Scale Expansion Project

While the design capacity of the Thu Duc water treatment plant is 480,000 m^3/d, the capacity of the pumps at the Dong Nai intake station is 450,000 m^3/d and therefore the present water supply is held down to 450,000 m^3/d. However, due to the fact that the raw water main is not large enough and that it is made of PS concrete which is inferior in strength to steel or cast iron pipe, an increase in the delivery pressure at the intake station will be restricted by hydraulic and mechanical reasons. For this reason, any substantial transmission increase cannot be expected under present circumstances. When the mechanical safety of the raw water main is taken into consideration, only 20%, increase can be expected at most. This means an increase of only about 100,000 m^3/d. Fortunately, however, the motors for intake pumps have some surplus capacity (the rated output of the larger pump, for example, is 1,000 KW against the actual output of 500 KW) and replacement of only the runner or only the pump body with runner will make it possible to produce the above-mentioned increase.

With regard to the water treatment plant, handling of a 20% increase of production without the expansion of the facilities will necessitate an increase in the filteration rate close to 190 m^3/d and require careful operation of the plant. This increase is acceptable, however. As the service reservoir in the treatment plant alone has a large capacity of 270,000 m^3, no remarkable fluctuation in the operation of water treatment are expected because the sufficient reservoir volume will equalize the hourly fluctuation in consumption.

The transmission main is also made of PS concrete as in the case of the raw water main, and its diameter is 2000 mm and the total length is about 12 km. Assuming that the hydraulic water level at the treatment plant is + 64 m and that at the destination ± 34 (effective hydraulic head being 30 m), the carrying capacity is estimated at about 650,000 m^3/d. Even when the ratio of peak flow to the average 24-hour (assume 550,000 m^3/d, is assumed to be only 130 %, the peak flow is still 720,000 m^3/d, which exceeds the flow capacity of the above-mentioned main. Moreover, as the design capacity of transmission pumps is 680,000 m^3/d, accordingly this is the maximum hourly discharge. For this reason, substantial pressure drop in the city area at the peak hours will be unavoidable with the existing transmission facilities.

As the pipe itself also presents some problems, it is not known to what extent it can withstand the pressure increase accrued when transmission discharge is increased. On this point, a further study will be necessary. If the facility as a whole has no room to handle an increase in transmission, it does not make sense to increase the intake.

(1-ii) Large Scale Expansion Project

According to the forecast of population and water demand, the water demand in the middle of the 1980's will reach the level exceeding today's level by 500,000 m^3/d. If new facilities are to be provided in addition to the existing ones by 1975 to meet the demand, an investment of $17 million in foreign currency and VN$2,000 million in local currency, the similar amount as required for the existing facilities, will be necessary on the assumption that there will be no change in the value of money. In reality, however, the next project will have to be affected by price escalation and by addition of distribution pipes totaling nearly 1,000 km in length.

However, depending on the way the water of the Dong Nai River is uesed at that time, tidal effect of the intake point is also conceivable. In such an event, intake point must be moved farther upstream. The present transmission line is laid on Saigon - Bien Hoa Highway on which traffic has recently been getting heavy. Installation of an additional pipe of a large diameter on this highway will involve many difficulties in the work. And the crossing work of the Saigon River, an essential part of the work, also presents problem. In the furture when the intake of water at the Saigon River is determined to be unappropriate as a result of survey, another development of this water system will be inevitable.

(2) Development of Groundwater

To north of Saigon there is a town named "HOC-MON" where water is supplied from a deep well. The water quality of the well is said to be satisfactory.

There is a plan to develop groundwater in this area and to make the era one of the new water sources in the expansion project for Saigon Water system. If groundwater is available, investment for facilities will be relatively small and the withdrawal can be increased gradually in accordance with need. The results of a desk study show, however, that the total land area that can be developed for groundwater is only about 100 Km^2 and 50 wells can be sunk at most. Judging from the experience in Saigon, the quantity of water available from one well will be 3,000 m^3/d or so at most for long period of use. Consequently, the total discharge of groundwater

available in the area is estimated at 150,000 m^3/d.

This quantity, however, is considered inadequate when an expansion of facilities by some 500,000 m^3/d is urgently required. There is also a possibility of certain difficulties arising from operation and maintenance of the 50 deep wells. Consideration must also be given to the possibility of subsidence of ground as a result of pumping of a large quantity of water. It must also be taken into consideration that quality of groundwater in Saigon district has been deteriorating year by year. In planning the devlopment of groundwater, discharge, location, and intake method must be determined by taking into account the abovementioned merits and demerits of groundwater, and decision must be made only after confirming the potential capacity and quality of groundwater and in due consideration of the timing of completion of the expansion project in which surface water is applied.

(3) Intake of water from the Saigon River

While the intake from the Saigon River near the city is not practical because of the tidal effect, the upper reaches of the river will be free from salinity. Thus the proposed intake point is located about 25 km north of the city and the water quality at this point is expected satisfactory. Advantages of the development of this system may be the satisfactory water quality, closeness to the northwest part of the city, namely one of the major service areas, and elimination of the difficulty in crossing a large span of a river as was necessary for the Dong Nai system. Only problems involved are the probale insufficient river discharge during the dry season and the ambiguity of tidal effect in salinity. On these points, a survey should be conducted immediately to obtain reliable data.

As estimated in the previous section 2-2-3-1, the Basis for Planning, the water requirement for the entire metroplis in the 1980's is estimated at about 1,000,000 m^3/d. Substraction of 500,000 m^3/d, the capcity of the Dong Nai water system, from this figure leaves 500,000 m^3/d. This is the capacity required for the new system.

The facilities will mainly consist of an intake station, a raw water main, a water treatment plant and a transmission main. A distribution system corresponding to this supply quantity must also be provided at the same time. Even when collective procurement of required fund is not possible, at least the half of the above-mentioned capacity should be attained by a single project in consideration of the economic benefit which may be obtained from larger size of a project. Even in such a case, it is essential to provide at the beginning an intake work, a raw water main and a transmission main of the size large enough to meet the flow at the end. Shown in the following table are the contents of the work.

Saigon Metroplitan Water System

Description of works under large scale expansion project

Capacity of the project

500,000 m^3/d.		
First phase	-	250,000 m^3/d
Second phase	-	250,000 m^3/d

Main Facilities

First phase:

Item	Design capacity
Intake work:	500,000 m^3/d (+ waste at treatment plant)
Intake pump:	250,000 m^3/d (- do. -)
Raw water main (15 km):	500,000 m^3/d (- do. -)
Treatment plant:	250,000 m^3/d (- do. -)
Transmission pump:	250,000 m^3/d
Transmission main (15 km):	500,000 m^3/d
Clear water reservoir:	250,000 m^3/d
Distribution line:	250,000 m^3/d

Second phase

Intake pump	250,000 m^3/d (+ waste at treatment plant)
Treatment plant	250,000 m^3/d (- do. -)
Transmission pump	250,000 m^3/d (- do. -)
Clear water reservoir	250,000 m^3/d (- do. -)
Distribution pipe	250,000 m^3/d (- do. -)

2-3 Conclusions and Recomendations

2-3-1 Management

(1) Early Abolition of Free Water Supply

The water used from public standposts, park sprinklers and fire hydrants has been free of charge. Mainly public standposts must be questioned. At present, the public standposts number about 500 and water is running out from them 24 hours. A survey made by SMWO on some of them revealed the waste of about 50 m^3/d per faucet and another check made on the spot by the Team showed a close result. Accordingly, 500 public standposts are discharging 25,000 m^3/d of water, most of which is wasted. Besides, some water is taken from fire hydrants in another case. Thus, total quantity of water being used free of charge is estimated at more than 10% of the total water production. Though SMWO took over this old free water supply system by public fountains at its birth, it should be abolished as soon as possible since SMWO stands on the principle of the self-supporting accounting system. Also, the abuse of fire hydrants should be prohibited. Frequent operation of fire hydrants is a main cause of leakage and breakage and may not work erea in case of an emergency.

(2) Revision of Water Rate

SMWO now adopts a flat water rate of VN$14.4/$m^3$. This is equivalent to about 19 yen/m^3, which is very low even in comparison with the average of rates in Japan. In principle the water rate must be determined on the basis of production cost of water and therefore the rate naturally varies with each water system. On the other hand, water is used by all the citizens regardless of their relative wealth and it is needless to say that the consumer's living standard must also be taken into consideration. The present water rate is believed to have been determined on the full consideration of these factors.

In view of the present state of Sagion Metroplis, however, the water supply system must be expanded and improved continuously for the time being as well as over a period of 10 or 15 years. In order to secure sufficient funds to meet the cost of expansion projects and also to minimize the project cost through water savings on the side of the citizen, it is considered essential to set the water rate as high as possible.

(3) Management of the Utility, Future Panning and Others

For the functional management of overall water supply business inculding the elimination of illegal service connections, prevention of leakage, operation of water treatment facilities and maintenance of standby facilities, it is desirable that the guidance and assistance from the outside, since there are advanced contries which have much experience in this field.

Though not directly related to the subject in this section, Japan is ready to render assistance for planning, engineering and supervision of the work for the urgent program which will be discussed in the sections hereinafter and for a series of preliminary surveys and planning of a master plan for the future. It is recommended that the cooperation extended by Japan is utilized to the full extent.

2-3-2 Urgent Countermeasure

2-3-2-1 Contents of Urgent Countermeasures

The work to be accomplished in the next few years begining this year as urgent program includes the followings.

1. Installation of small size distribution pipes.
2. Installation of water meters for houses increased by new small distribution pipes.
3. Replacement of old pipe lines.
4. Laying of distribution pipes in new towns with high population density.
5. Reinforcement of intake pumps at the Dong Nai River Intake.
6. Reexamination of the existing water distribution network and the planning of an overall distribution network including the extension.

7. Making a master plan for the next expansion project.

As the next expansion project requires a period of 3 to 5 years at least in execution, drafting of its master plan must now be started at once. For this reason, it is included in the urgent program.

2-3-2-2 Purpose and Effect of the Urgent Countermeasure

1. Elimination of non-served districts in the congested old city area (Installation of small size distribution pipes)

2. Increase of revenue and prevention of extravagant use of water (Installation of water meters)

3. Increase of the rate of accounted-for water by minimizing leakage and abatement of water production increase to yield substantial time until an expansion work is needed. (Replacement of old pipelines)

4. Elimination of unsanitary conditions. (Installation of distribution pipes in the newly-populated area)

5. Reinforcement of intake pumps to increase the capacity of the Dong Nai water system to the full extent as a means to meet the requirement until the first installation of the next expansion project.

6. Establishment of master plan to ensure smooth changeover to the next expansion project.

2-3-2-3 Cost of the Urgent Countermeasure and Financial Balance

a. The total cost for the urgent program and the contents of the cost in terms of currencies are shown in the following table.

Estimated Cost of Construction for Urgent Countermeasure
US$1.00 = VN$275 (PIASTRE), VN$1.00=US$0.003636

(The period of computation is for 3 years from 1971 - 1973 in principle but the calculation should be made also for a 5-year period for reference)

Description	1971 - 1973			1974 - 1975			Total (1971-1975)		Total (1971 - 1975)
	Quantity	Foreign currency US$1,000	Local currency VN$1,000	Quantity	Foreign currency US$1,000	Local currency VN$1,000	Foreign currency US$1,000	Local currency VN$1,000	Foreign currency + Local currency US$1,000
Replacement of old distribution pipes	50	650	107,000	30	390	64,200	1,040	171,200	
Laying of small size distribution pipes	150	240	225,000	100	160	150,000	400	375,000	
Extension of distribution pipes	210	2,740	449,400	160	2,400	342,400	5,140	791,800	
Installation of water meters	75,000	1,125	75,000	50,000	750	50,000	1,875	125,000	
Reinforcement of intake pumps	6	246	6,600	-	-	-	246	6,600	
Sub-total (Total of foreign and local currency in US$1,000)		5,001	863,000 (8,139)		3,700	606,600 (5,906)	8,701	1,469,600	(14,045)
Engineering fee									
i. Engineering and supervision of construction for urgent program	1.5 men x 24 months	150	2,950		-	-	150	2,950	
ii. Surveys and planning of expansion project	6 men x 18 months	450	8,850		-	-	450	8,850	
Sub-total (Total of foreign and local currency in US$1,000)		600	11,800 (643)		-	-	600	11,800	(643)
Contingencies (Total of foreign and local currency in US$1,000)		199	35,200 (327)		100	13,400 (149)	299	48,600	(476)
Total		5,800	910,000		3,800	620,000	9,600	1,530,000	
Grand Total (US$1,000)		9,109			6,055				(15,164)

Break-up of Cost for Urgent Program by Year

Year	Description	Foreign currency US$1,000		Local currency VN$1,000; US$1,000		Total US$1,000
1971	Construction	1,500		271,200		
	Engineering	215	1,782	4,240	286,440	2,823
	Contingency	67		11,000	(1,041)	
1972	Construction	1,761		296,000		
	Engineering	340	2,167	6,670	315,870	3,316
	Contingency	66		13,200	(1,149)	
1973	Construction	1,740		295,800		
	Engineering	45	1,851	890	307,690	2,970
	Contingency	66		11,000	(1,119)	
1974	Construction	1,850		292,600		
	Engineering (1)	---	1,900	---	299,300	2,989
	Contingency	50		6,700	(1,089)	
1975	Construction	1,850		314,000		
	Engineering (2)	---	1,900	---	320,700	3,066
	Contingency	50		6,700	(1,166)	
Total	Construction	8,701	1,469,600			
	Engineering	600	9,600	11,800	1,530,000	15,164
	Contingency	299		48,600	(5,564)	

Note: Engineering fees for 1974 and 1975 noted by (1) and (2) must be provided again when the expansion project does not start in these years.

b. Repayment of Loans

In the case of SMWO, repayment of principal and interest of borrowed money must be made mainly from the water revenue. Since the management of SMWO is sound as a whole and it is capable to repay all the liabilities, it is possible and desirable that repayment of new borrowings is also carried out smoothly.

For the study of the repayment plan, some financial data were presented to the Team by SMWO upon request, but it is regretable to say that they were not sufficient enough to serve the pupose, In particular, no clear-cut explanation was made on the repayment of several existing loans. It is obvious, however, that as far as the statement of financial position (1967 - 1969 period) presented to the Team is concerned, the utility account has been in the black as asserted by high officers of SMWO. When the details of all loans and their repayment schedule are not known definitely, however, it is almost impossible to check the balance in whole utility account including new investments. For this purpose, a further detailed study will be necessary. For this reason, it is rather difficult to discuss only the amortization of the loans which are expected for this urgent program. Nonetheless, as the existing system yields a certain profit, it is acceptable to leave the system as it is and to study on the economic feasibility derived from the expanded portion of facilities financed by a new investment. The World Bank often applies such a method when making a study on the economic feasibility derived from small facilities financed by its own loan attached to a large water utility.

Based on this concept, a study was roughly made on the economic feasibility as follows.

Repayment of the Loan

(The condition expected for the loan will be described in the subsequent paragraph)

1. Water charge revenue produced by urgent program

a. Estimation from the number of water meters installed.
75,000 x 50 m^3/month x 12 month = 45,000,000 m^3/year

Assuming that the average water consumption per meter during the repayment period is 50 m^3/month, the above figure may be regarded as the chargeable quantity.

b. Estimation

Estimation from the curve of increase (illustrated before) in the water consumption.

Consumption in 1971	-	390,000 m^3/d
Consumption in 1974	-	500,000 m^3/d
Increase	-	110,000 m^3/d

$$\text{Ratio of subsequent increase} = \frac{\text{250 (average per-capita-per-day consumption during repayment period}}{\text{210 (per capita-per-day consumption at the beginning of repayment)}}$$

$$= 1.19$$

Average consumption during repayment period = 110,000 x 1.19

= 130,000 m^3/d

Annual consumption = 130,000 x 365 = 47,500,000 m^3/year

Annual accounted-for quantity (Accounted-for ratio: 70%)

= 33,250,000 m^3/year

c. Estimation from pipe length

Total elgnth of distribution lines (For 3 years of laying)

= 150 km + 210 km = 360 km

Assuming that the pipe length per a consumer is one meter, the served population produced by the urgent program will be:

360,000 m ÷ 1 m/capita = 360,000

Water consumption: 360,000 x 0.25 x 365 = 90,000 m^3/d

90,000 m^3/d x 365 = 32,850,000 m^3/year

Annual accounted-for water:

32,850,000 x 0.7 = 23,000,000 m^3/year

On the basis of the above results, the annual accounted-for water is roughtly estimated at 33,800,000 m^3. Accordingly, the water charge revenue (US$1.00 = VN$275.00) will be:

33,800,000 x 14.4 VN$/$m^3$ = VN$487,000,000

= US$1,738,000

2. Amount of Repayment (Foreign currency portion)

a. Repayment of borrowed money is to be made under the following condition.

Annual interest rate 5% (Uniform semiannual instalment of principal and interest)

Term of repayment: 18 years (Grace period included)

Grace period: 5 years (Interest is to be paid even during the grace period)

b. Annual interest during the grace period

US$5,800,000 (Foreign currency required for the 3 years urgent program) x 0.05 = US$290,000

c. Annual instalment of principal and interest after the grace period (In the 6th ~ 18th year) Rate of uniform semiannual instalment:

0.05278

Annual instalment: 0.0527 x US$5,800,000 x 2
= US$306,000 x 2 = US$612,000

3. Balance

Annual amortization of forign currency after the grace period amounts to US$612,000 as shown above. Besides, amortization of local currency must also be made, but the condition for its amortization is not known. However, even such a severe condition as 7.5 % annual interest rate and 20 years amortization, the amount of the annual instalment is around US$322,000. Since there must be no great increase in the operation cost and overhead from the present ones, repayment of US$934,000, the total of the above two items, is quite possible. Thus this program will be able to offer definite feasibility.

2-3-3 Long-range Measure

At present two alternative plans are conceivable for the future project. One calls for the expansion of the Dong Nai water system and the other calls for construction of a new water supply system intaking surface water from the Saigon River and/or groundwater in and around Hoc Mon.

In the first plan (Dong Nai water system), some increase of its capacity may be realized through minor improvement of the existing facilties. However, such an increase falls short of the future requirement. In order to meet the future demand, a new water system of the similar size as the existing one must be provided.

In the second plan calling for intake from the Saigon River and Groundwater, a completely new water system must be provided. The proposed intake sites are situated to the north of Saigon City.

The Saigon River system will supply water to the metropolis from the north while the Dong Nai River system does from the east. Thus, the Saigon River system is very advantageous as it is able to supply water more economically to the northern and western sections of the city, where the feeding system of water only from the east can hardly cover. However, a survey must be made on the streamflow of the Saigon River with respect to intake quantity. In any event, as the new system will have to have a large capacity of at least 500,000 m^3/d, preparation of the master plan and execution of the work for the new system will require a considerably lengthy period of time and a great amount of investment. Also, unless the new system is put into service by 1975 at the latest, Saigon Metropolis will suffer from a serious water shortage again. It is absolutely necessary, therefore, to start planning this project immediately. The Team summarized its view on the future program as in the succeeding two sections.

2-3-3-1 Outline of the Future Water Supply Expansion Project

1) Scale of the Expansion Project and the Target Year

The project will provide facilities having a capacity of 500,000 m^3/d.

The target year of the project is to be around 1985. The facilities are of the same size as the existing ones. Extending the target year further will require larger facilities with a need for a larger advance investment and the therefore is not necessary economical. As the Dong Nai river and Saigon river are relatively in close proximity to the metropolis, intake of water from these rivers and the expansion of the facilities will be easily accomplished when another expansion is required in the furture. From the above two reasons, the size of the new system shall be determined to be the similar to the existing one.

ii) Construction Schedule

Both raw water and treated water mains are to be designed and constructed for the full capacity in the beginning and pumping facilities and treatment facilities are to be built in two phases.

iii) Estimate of the Project Cost

Judging from the recent experience in Japan, the unit cost of construction is estimated at 50,000 yen/(m^3/d). Thereofre, the total project cost for the supply of 500,000 m^3/d will be: 50,000 yen/(m^3/d) x 500,000 m^3/d = 25,000,000,000 yen (≒ $70,000,000) Assuming that the first phase project cost is 60% of the above, it will be: 25,000,000,000 x 0.6 = 15,000,000,000 yen (≒ $42,000,000)
Of this, foreign currency is estimated at about 70% or:
15,000,000,000 x 0.7 ≒ 10,000,000,000 yen (= $30,000,000)
It is essential, however, that a more accurate estimate taking into account the price escalation, etc. is to be made when drawing the master plan. If the development of groundwater is feasible, the initial investment may be reduced considerably.

2-3-3-2 Approaches to the Future Project

i) Drafting of a master plan for the future project must be initiated immediately

ii) Items for preliminary survey must be as follows:

a. Projection of population and water demand.

b. Measurement of the discharge of the Saigon River, surveys on the intrusion of sea water and water quality.

c. For ground water, surveys on the area to be developed, feasible intake quantity, water quality and geological property.

iii) Items for planning

a. Capacity of water supply system.

b. Selection of water sources, combination of sources, quantity of intake and schedule of the works.

c. Basic idea for intake station, water treatment plant, pump station and the route of pipe lines, etc.

d. Distribution facilities.

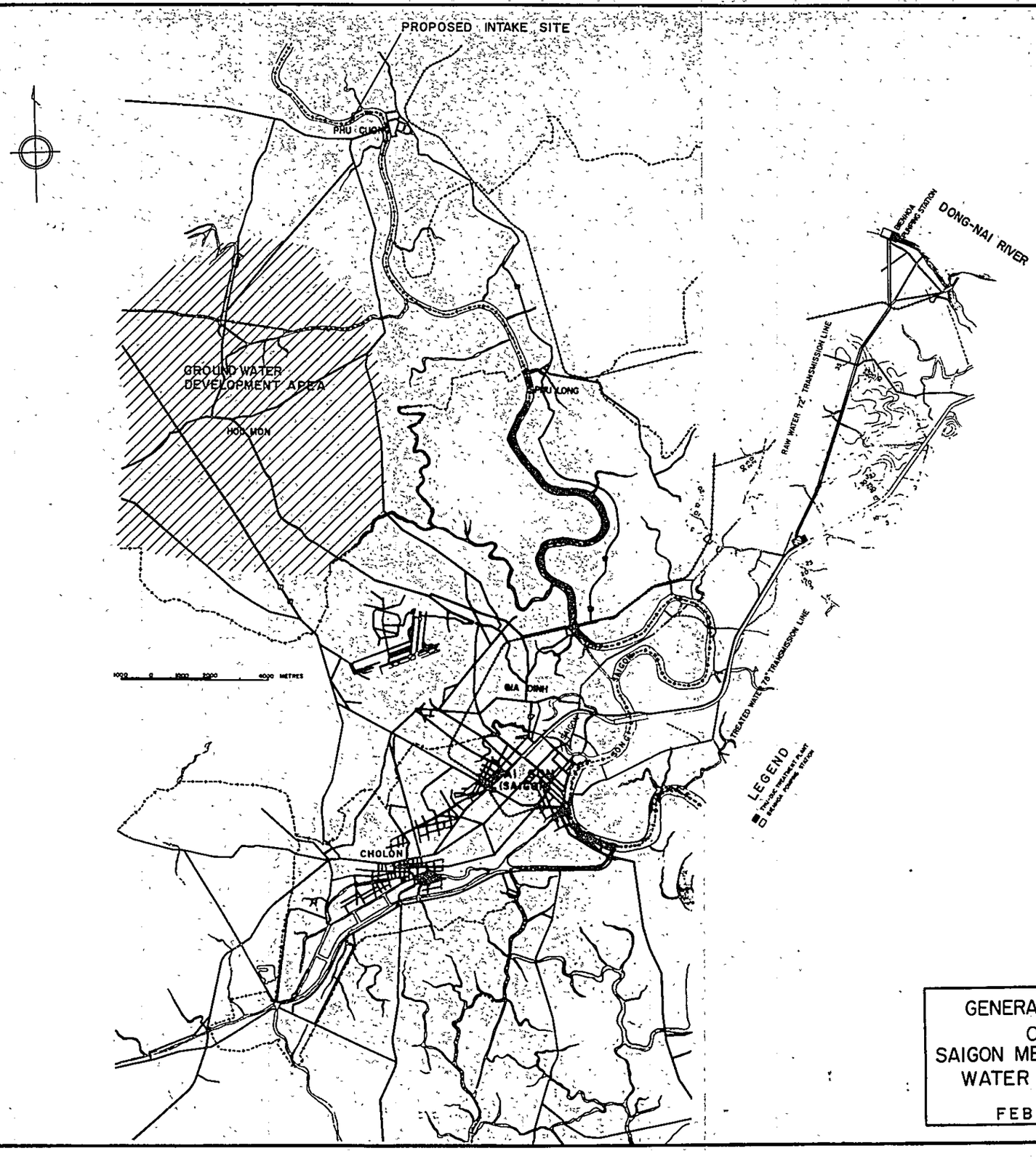
e. Cost estimation on the basis of the above-mentioned preliminary study.

f. A study on economic feasibility.

g. Financial program

iv) Minimum time required for surveys and planning

One and half years.

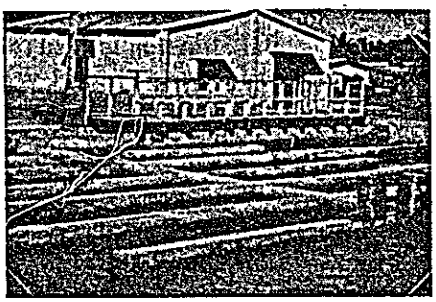


GENERAL PLAN
OF
SAIGON METROPOLITAN
WATER SYSTEM

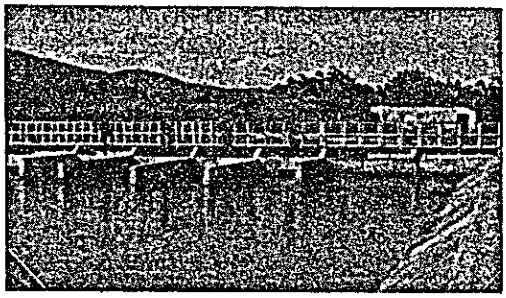
FEB 1971

CHAPTER 3. WATER SUPPLY IN DA-NANG CITY

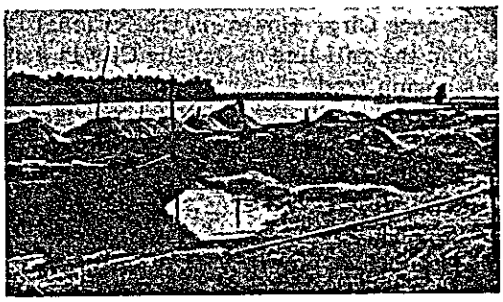
Da-Nang City



Existing Treatment Plant
(capacity: 300 m^3/H)



Existing Treatment Plant
Sedimentation and Filtration



The Cam Le River,
Upstream of the Intaking
Site

Da-Nang City and
a Shallow Well

3-1 Water Supply at Present

3-1-1 Outline of Danang City

Danang City, situated in lat. 16°N and long. 108°E, is the second largest city in the Republic of Vietnam. Its population at the end of 1970 is estimated to have been about 430,000 within the city limits. An additional 140,000 people reside in the adjacent villages.

Topographically, Danang City is generally flat, with an elevation of 4 m to 6 m above sea level. The north side of the city faces Danang Bay. To the northwest a mountain range rises about 1,000 m above sea level; the northeastern side of the city is flanked by the peninsular-shaped Monkey Mountain, while the east side faces the east China Sea.

The city seems reasonably secure. The Survey Team detected no particular tension during the period of its study. Indeed, the stability of the social situation is said to be one of the primary reasons behind the sharp increase in the city population in recent years. The population of Danang City is expected to increase due to the continuing influx of refugees from the north, and the tendency of people from adjacent villages to seek employment within the city. For forecasting of the future population of Danang, careful consideration must be paid to these demographic changes.

Although it is difficult to make an accurate prediction of the future commercial and industrial growth of Danang City, several promissing features should be mentioned. First there is the sharp increase in population previously mentioned. Second, from the standpoint of transportation, Danang City is well situated. National Highway Route 1 connects the city with Saigon, and twice daily a jetliner flies from Danang Airport to Saigon. Furthermore, the Vietnamese Government is keenly interested in the development of a deep sea and fishery port for the city, Once the government's project has materialized, Danang City may become the center of trade and also the center of the Vietnamese fishing industry.

At present there is no train service at Danang City. However, the National Railroad has already extended service to Hue and Saigon; the rail line to Danang City is expected to reopen as soon as the security of the country is normalized.

It is quite difficult to predict, at present, the industrial growth of the city, but rich natural resources, adequate human resources and favorable transportation conditions make future prospects seem very favorable.

Anthracite coal deposits, estimated at about 140,000 tons, have been found in Nong Song, 45 km southwest of Danang. Limestone deposits have been discovered in Quang Nam (20 km south of Danang), Vinh Phuac (north of Nong Song), and in Marble Mountain (adjoining Danang City).

Phosphate, which may be used to make fertilizer, has been found on Paracel Island, about 370 km east of Danang. Silica sand of good quality is being produced in the area adjoining Danang City. This provides an important base for glass manufacturing.

Additionally, agricultural products such as cereals, rice, sugar, tobacco, coffee and silk are cultivated nearby. As the security of the city is restored, production of these items is expected to increase. Such items as handicraft products, bamboo ware and rattan work are also promissing.

A textile factory has already begun production in Danang City. A refrigeration plant midway between Danang and Hue is also planned, once the fishery port (mentioned earlier) has been completed. Southeast of Danang a tract of land has been purchased for the construction of a foreign-capitalized brewery.

Since 1959, the Vietnamese Government has shown a great interest in the water service in Danang, and has sponsored the following studies:

Study period		Studies made by
1959	1960	Hydrotechnic Corporation
1962	1963	Brown's Engineers
1965		Ralph M. Parsons Co.

Of the above studies, the Feasibility Study Report prepared by Ralph M. Parsons Co. was presented to the Team. The Team found the report accurate in general, although the Parson's report grossly underestimated the city's sharp rise in population. Although the plans must be revised to reflect the new population, an additional feasibility study is unnecessary.

On the basis of the Parson's report, the Vietnamese Government has secured a tract of about 130,000 m^2 on the left bank of the Cam Le River, about 10 km southwest of the city. This will be the site for water purification plant. However, financial aid from the US for the water service expansion project has been appropriated for other purposes. As a result, the project has not yet been materialized.

Previously 6 deep wells supplied 800 m^3 of water daily through 13 km of distribution pipes and a system of elevated tanks having a total capacity of 550 m^3. However, the water shortage which followed the sharp increase in the population in 1963 prompted the Danang Metropolitan Water Office, (assisted by the Central Government) to establish intake and purification facilities on the Cam Le River as an emergency measure. These facilities have supply approximately 5,000 m^3/D of purified water since February 1970.

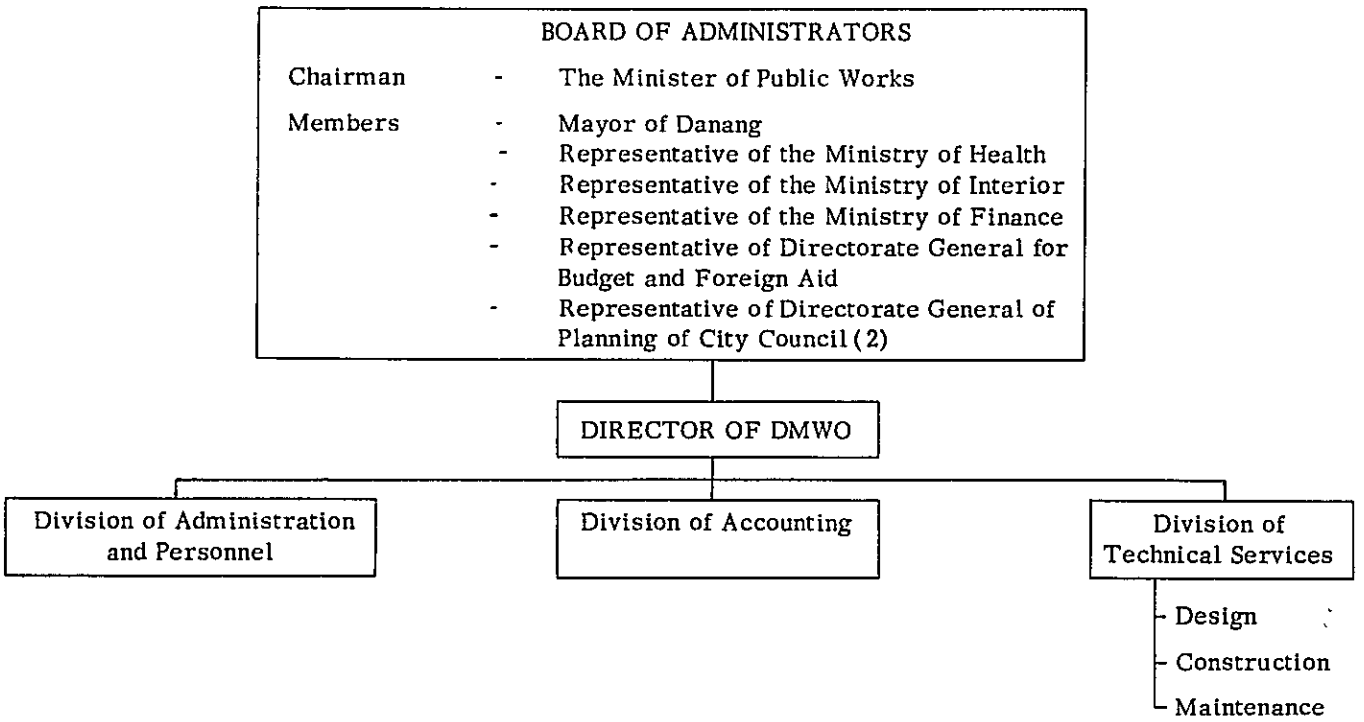
However, this is only 1/10 of the amount of water required by the present population. Furthermore, although this purification plant has an expected service life of 3 years, one year has already passed and part of the facility has begun to deteriorate.

The sewerage system in Danang City is woefully inadequate. Waste water from households is either soaked into the ground or spilled over the ground. Rainwater in the city is drained into side-gutters filled-up with wastes, since hardly any maintenance is performed on the sewers. This filthy mixture penetrates many of the privately owned shallow wells dug to help ease the serious water shortage. This creates a very dangerous sanitary situation. Clearly an immediate expansion of Danang's water supply facility is urgently required.

3-1-2 Management of Water Supply

The waterworks in Danang City is a self-paying enterprise managed by the Danang Metropolitan Water Office (hereafter referred to as DMWO). As shown in (Fig. 3-1) DMWO is an autonomous body under the control of the Ministry of Public Works. The Board of Administrators of DMWO is chaired by the Minister of Public Works. Other members of the board of Administrators are mayor of Danang, two representatives of the city council and the representatives of the National Finance and Interior. The employees of DMWO as of January 1971 total 43, including the Director. They are organized as follows.

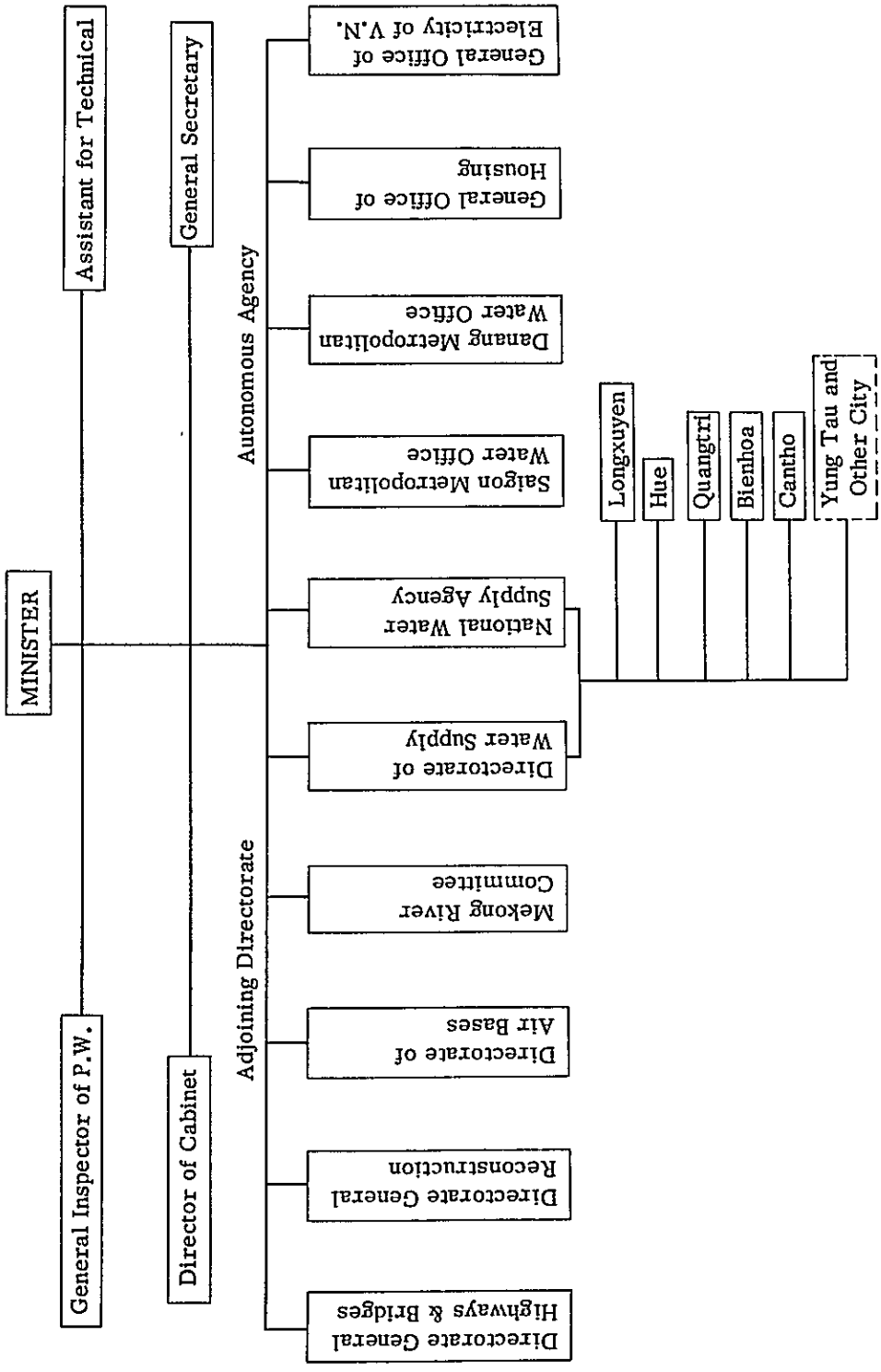
ORGANIZATION CHART OF DMWO



(Fig. 3 - 1)

(Fig. 3-2)

ORGANIZATION CHART OF THE MINISTRY OF PUBLIC WORKS



Director	1
Division of Administration & Personnel	5
Division of Accounting & Finance	13
Division of Technical Services	24

3-1-3 Water Supply Facilities

The existing water purification facility was planned as an "interim project" with a service life of 3 years and a capacity of 300 m^3/hr. It was completed in 1969 and put in service in February 1970. Though the facility is temporary in nature the plant is equipped with a complete water purification system. The design of the purification system is relatively simple, and therefore the equipment is unable to provide the rapid mix flocculation with appropriate mixing time and flow velocity.

As a result, the water in the settling basin has a turbidity of about 20 degrees, which is rather high. The pump is driven by power supplied directly from a diesel generator. Two pumps are provided for both intake and distribution but the total capacity each of the two sets of pumps is only 280 m^3/hr. Furthermore, no stand by pump has been provided.

The rapid sand filter is situated next to the settling basin, and is provided with the flow rate controller.

The outline of each facility is as follows.

1) Intake facility

a) Intake site

A cast iron pipe line with a diameter of 12 inches is anchored to the river bed, with a 90^0 bent pipe facing upward attached to the line. The pipe line is protected by a mass of pebbles, which also serves as a type of screen.

b) Intake pump

12 inches in diameter: two horizontal centrifugal pumps
Q = 140 m^3/H

2) Water purification facility

The rapid mixing basin, flocculation basin, settling basin and rapid sand filters are arranged in a row along a 10 cm thick concrete trapezoidal channel (10 m x 22 m x 4 x 4 m). The channel has a total length of 92 m.

The clear well is also a concrete lined (10 cm in thickness) basin with a trapezoidal section (5m x 10 m x 2.5 m). It is enclosed by a galvanized iron sheet roof.

Its effective capacity is 600 m^3.

3) Facility for water distribution

Distribution pump
Two diesel driven pumps, 64 HP, Q = 140 m^3/hr each
Distribution pipe
ϕ 12" - ϕ 2" - 1/3, Total length - 38,000 m

3-1-4 Conditions of Water Supply

The capacity of the existing water purification plant is 300 m^3/hr and the daily water consumption is about 5,000 m^3/D. The served area is 365 ha. which is only 13% of the administrative district of Danang. The served population is estimated at 50,000 and the served ratio is 50,000 persons - 600,000 persons = 8.3%.

The residents not served by city water system get water primarily from shallow wells. During the rainy season (July - December) they keep rainwater in tanks and use it for drinking water.

The existing water purification facility was completed in 1969 at a cost of VN$10,000,000 and put in service in February 1970. Present charges for water are:

Water rates

Domestic use	VN$20/$m^3$
Industrial use	VN$25/$m^3$
Commercial use	VN$30/$m^3$
Official use	VN$12/$m^3$

Charge for house connection:
VN$14,600 (with 4 m of service pipe)

Rent for water meter: VN$60/month

The following is the settlement of accounts of DMWO.

1969		Profit: VN$2,030,936
1970	Revenue-VN$42,665,235	
	Expenditure - VN$34,662,268	Profit: VN$8,002,967

3-1-5 Problems

Some of the problems confronting today's water supply system in Danang are pointed out as follows:

Problems of water quality:

i) As the mixing (coagulation) time and flow velocity in the rapid mixing (coagulation) basin are not appropriate, flocculation is not sufficient and the sedimentation effect is not satisfactory.

ii) As the mechanism for the control of flow rate of water at the rapid sand filter is not functioning properly, uniformity of water quality is not maintained.

Problems of facilities:

i) Though two pumps are provided for both the intake and distribution facilities, the total capacity of the two pumps is only 280 m^3/hr, and in addition the continuous operation of the pumps is impossible. As a result, sufficient water purification and supply cannot be expected.

ii) Intrusion of ground water into the clear well has been observed. This situation is not desirable from a sanitary point of view.

iii) Since the number of sluice valves at the distribution facility is limited, suspension of water supply to a wide area is unavoidable during periods of maintenance work on the distribution pipes.

iv) Removal of sludge from the sedimentation basin requires 24 hours to accomplish. However, since there is only one settlement basin in the plant, cleaning of the basin of sludge would keep the whole city without a source for fresh water for 24 hrs. This is impossible.

Problems of served area:

The present percentage of the population served is only 8.3%, most of the residents not served by the water supply get water from shallow wells polluted by domestic and storm sewage. This situation is quite unsatisfactory from a sanitary point of view.

3-2 Measures

3-2-1 Urgent countermeasure

1) In order to meet an expected sharp increase in population in the future and also in view of the present unsanitary living environment in Danang City, there is an urgent need to establish a permanent water supply system.

To meet this critical situation, it is vitally important to formulate a long-term water supply program and to initiate immediately the first phase project (target year - 1980).

The suggested timing for the urgent countermeasure and for the long-range measures is shown below.

1st phase project 1971 '74 '79

(dotted line indicates the period of the urgent countermeasures)

2nd phase project '76_____'89

3rd phase project '86_____'99

The urgent countermeasure calls for the construction of 1) an intake tower in the vicinity of the existing facility at the Cam Le River and 2) a water purification plant having a daily capacity of 70,000 m^3, located at the same site as the existing water purification plant. It also calls for 3) an additional 100 km of distribution pipes to be laid and connected to the existing pipes.

Once the urgent countermeasure has been completed, the population served will rise from the present level of 50,000 to 270,000.

When the distribution pipes under the 1st phase project is extended, the population served will increase to 415,000.

2) Project cost

The project under the urgent countermeasure requires about one year for survey and design and additional 2-1/2 years for construction work. An estimated cost of the project is shown on Table 3-1.

3) Profitability evaluation

The project cost under the urgent countermeasure is shown below.

Project cost US$10,790,000 = VN$2,967,250,000

Foreign currency: US$7,610,000
= VN$2,092,750,000

Local currency: VN$874,500,000

Although the project is expected to be undertaken by the Danang Metropolitan Water Office (DMWO), the project involves the work several times greater than the financial scale of the present DMWO's undertaking. For this reason it is considered essential to introduce funds from other authorities to meet the requirement for both foreign and local currency.

The following is a feasibility study of the project, which assumes that all the required funds are obtained from the other authorities and repaid under the indicated conditions. A profitability study based on the cost-benefit ratio is included in this study.

Conditions for amortization

Foreign currency

Interest rate:	5%
Term of amortization:	18 years (including a 5-year grace period)

(Table 3 - 1) Exchange rate: VN$275=US$1.00

Type of Work		Description of Work	Foreign currency US$	Estimated Project Cost	
				Local currency VN$	Total US$
Construction	Intake and water purification facilities	Capacity: 70,000 m^3/D	3,150,000	288,750,000	4,200,000
	Facility for water distribution	ø 1,100 mm ø 75 mm L = 100 km	3,600,000	536,250,000	5,550,000
	Sub-total		6,750,000	825,000,000	9,750,000
Engineering	Survey & design	Field survey & work in Japan 11 months	370,000	22,000,000	450,000
	Supervision of construction	3 men x 30 months + 2 men x 15 months = 120 man-months	490,000	27,500,000	590,000
	Sub-total		860,000	49,500,000	1,040,000
Total			7,610,000	874,500,000	10,790,000
Water meter		40,000 units	600,000	88,000,000	920,000
Grand total			8,210,000	962,500,000	11,710,000

Local currency

The vietnamese Government has been providing the water service project with Loans bearing low interest rates for periods from 20 - 35 years. This report assumes an interest rate on the local currency 0% and 6.5% and an amortization period of 30 years (including a 5-year grace period).

Water charges

The water rate was revised to the present rate of VN$20/$m^3$ in 1970. This rate is considered rather high compared to VN$14.4 m^3 in Siagon and VN$12/$m^3$ in Longxygen and further increase in the water rate would be very difficult. Therefore, the water rate is assumed to remain at VN$20/$m^3$.

Operation cost

The operation cost is assumed to be VN$10/$m^3$ of chargeable water, based on the financial statement concerning the water works in Longxuyen City.

The project cost under study for the amortization program does not include the cost required for the procurement and installation of water meters. Those are to be covered by charges of house connection (DMWO charges VN$14,600 per work) and the rent of water meter (VN$60/month).

A combination of the above conditions is shown below. The term of amortization indicated includes a 5 year grace period in all cases.

	CASE I	CASE II
Conditions for amortization (Foreign currency)	5%, 18 years	5%, 18 years
Conditions for amortization (Local currency)	0%, 30 years	6.5%, 30 years
Water rate	VN$20/$m^3$	VN$20/$m^3$
Operation cost	VN$10/$m^3$	VN$10/$m^3$

On the basis the above conditions, the following calculation is made:

(Revenue from water charge) - (Amortization with interest) - (Operation cost)

The results of the calculation are shown below.

	CASE I	CASE II
1st year - 5th year (Grace period)	- VN$ 73,927,500	- VN$ 130,770,000
6th year - 18 year (Amortization of both foreign currency and local currency)	-128,072,943	-166,156,683
19th year - 30th year (Amortization of local currency)	+104,280,000	+66,196,260
31st year - 45th year	+138,360,000	+138,360,000

From the above table it is evident that in both cases the revenue from water rate alone is not sufficient to cover the expenditure of amortization and operation costs during the term of amortization of foreign currency (1st year - 18th year).

Though the revenues from the charges for house connections and the rent of water meters may cover a large portion of the deficit, this study assumes that the deficit will be covered by the loans of the government and other sources.

The periods required to pay out the initial deficits after the foreign currency has been fully amortized are as shown below.

	CASE I	CASE II
Total amount of deficit	2,034,585,760	2,813,886,880
Pay-out time	18 years	27 years
Total pay-out time	36 years	45 years

Assuming that the service life of the proposed water supply system is 45 years, each of the cases studied so far shows a balanced finance. Although there is need of subsidies during the term of amortization of foreign currency.

Next, profitability evaluation of the project will be made on the basis of cost-benefit ratio which may be calculated as follows:

$$\text{Cost-benefit ratio} = \text{Benefit} \div \text{Cost}$$

$$\text{Cost} = \text{Project cost}$$

$$\text{Benefit} = \text{Project cost} + \text{residual value}$$

The residual value at time when benefit and cost are equal in Case I and Case II respectively will be:

Case I	0.28 x Project cost
Case II	0.10 x Project cost

From the above, the cost-benefit ratio in each case is:

Case I	1.28
Case II	1.10

In the calculation of the benefit, only the direct benefit has been taken into account. However, the waterworks system will provide such indirect benefits as the promotion of industrial and commercial activities, a decrease in the loss of lives and property by fires, and the decrease of deaths resulting from the contaminated water.

Originally, the waterworks enterprise is a strongly public-oriented enterprise. Even if the cost-benefit ratio (direct benefit) is lower than 1, the enterprise may be said to be quite profitable when indirect benefits are also considered.

Of the two cases studied so far, CASE I is considered preferable to CASE II. In CASE I the profitability can still be maintained even at the present water rates although it is necessary to introduce subsidies from other accounts during the term of amortization of foreign currency.

3-2-2 Planning of Long-range Measure

1) Population Projection

The administrative district of Danang City extends over 80.0 km^2, consisting of 22.3 km^2 (27.9%) of populated area. 41.8 km^2 (52.5%) of mountain area and 15.9 km^2 (19.9%) of airport and military installations. The population density of Danang averages 154 ppha.

The population of the city as of the end of September 1970 is 427,834; this includes those living in the above mentioned 27.9 km^2 of populated area and also the inhabitants of the mountain area. Danang is steadily expanding toward the outlying areas, and the increase in population is particularly noticeable along National Highway Route 1. The expansion of the urban area is so extraordinary that seven villages, including Hoaphat in Vanghoa District (which surrounds Danng City) are now considered part of the city.

The population in these outlying villages as of the end of September 1970 is 140,247, and the total area of these villages is about 41.5 km^2.

As a result, the population and area of Danang City as of the end of 1970 is estimated at (430,000 + 140,000 = 570,000) and (27.7 km^2 + 41.5 km^2) respectively. This gives an average population density of 82 ppha.

The many unknown factors resulting from the war situation make it extremely difficult to forecast accurately the population of Danang City.

In this report, however, the following forecasts have been made.

i) The urban area in Danang Basin will have a saturated population of 1,900,000.

ii) The population of the urban area has been estimated using the logarithmic, exponent and linear methods. The population predicted using these

three methods was 1.6 million, 1.75 million and 9.5 million. Finally these three results, and the estimated impact of various social factors were used in arriving at the final forecast of 1.4 million.

i) Forecast of Future Population on the Basis of Land Use

Land use and population distribution in Danang City and the surrounding area will be discussed on the basis of "The Five Northern Provinces of the Republic of Vietnam" (by the Development and Resources Corporation), published in 1969.

The present city of Danang lies at the northeast corner of Danang Basin, which extends over a total area of 435 km. Approximately 51% of the basin is to be reserved as an agricultural area, while the remainder will be for urban area. In the latter area, facilities for water supply, electricity, and sewage must be provided.

In the urban area there will be commercial, industrial, recreational, and residential districts.

A residential district having a total area of 106.3 km^2 will be planned. This includes a high population density area, a medium population density area (150 ppha) and a low population density area (8 ppha). When the population of the commercial district (with a density of 250 ppha) is added to the future population of residential component, a 1,900,000 is estimated in the urban area. The average population density of the urban area will be approximately 90 ppha.

Adding the population of the nearby rural area (200,000) and that of the other districts, we predict that the saturated population will be 2,250,000.

This analysis reveals that 85% of the total population in the Danang Basin will be living in the urban area, while the remaining 15% remain in the rural area.

ii) Future Population Projection on the Basis of Past Population Statistics

The population of Danang City in the prewar days was 25,000. It has since increased steadily, and reaching a population of 30,000 in 1950. With the intensification of the war, the city population sharply increased. This trend is particularly evident after 1963.

The two following tables illustrate population statistics of Danang City.

(Table 3-2) Population Statistics of Danang City

Year	Population	Rate of Increase	Year	Population	Rate of Increase
1956	96,197		1963	128,000	5.0
1957	97,652	1.5	1964	148,580	16.0
1958	107,868	10.0	1965	164,000	10.0
1959	108,762	1.0	1966	198 500	22.0
1960	110,630	2.0	1967	238,000	22.0
1961	110,630		1969	334,229	40.0
1962	121,400	10.0	1970	400,000	20.0

(Table 3-3) Population Statistics, Danang City Area
(as of September, 1970)

Location	Population	Area	Population Density
District I	159,501	365 ha.	437 ppha
District II	165,080	987	167
District III	103,253	1,420	73
Total	427,834	2,772	154
Suburbs Communities	140,247	4,100	34

The sharp increase in population, particularly after 1963, has been primarily caused by the influx of refugees due to the escalation of war. However, the increase of the city's population may also have been influenced by other factors, such as the world-wide trend toward concentration of population in the urban area. Since the reasons for the increase cannot be completely clarified, the above data has been used without any correction.

(Forecast by means of Logarithmic Curve Method)

The logarithmic curve method based on the statical data shown in (Table 3-2) and (Table 3-3) and figure of 1.9 million; representing the saturated population of the urban area, gives an estimated population in Danang of 1,600,000 in the year 2000.

(Forecast by means of Exponential Curve Method)

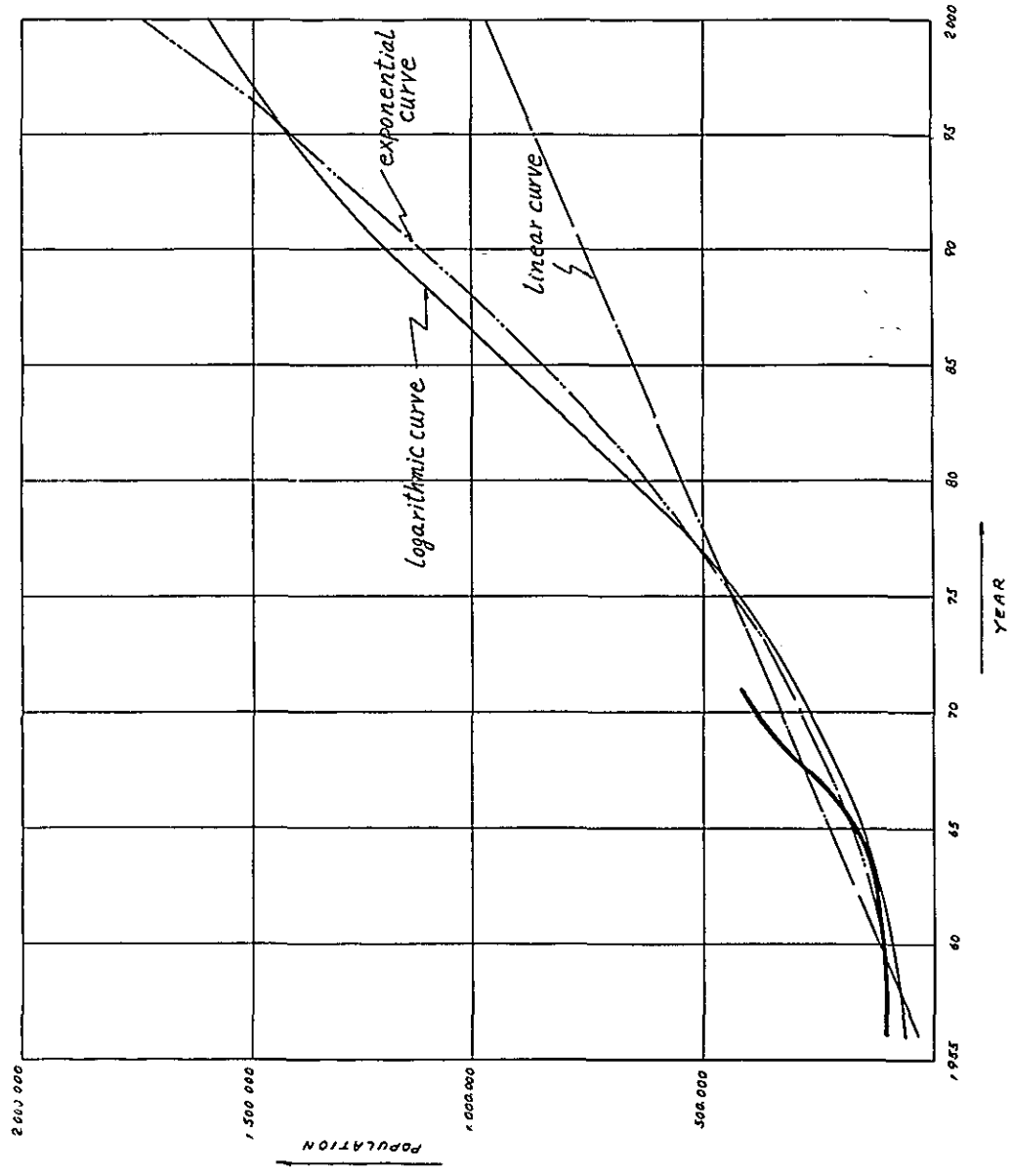
The exponential curve method based only on statistical data predicts population of 1,750,000.

(Forecast by means of Linear Curve Method)

The population calculated by this method is 950,000. Results of the above calculation are shown in (Fig. 3-3).

(Fig 3-3)

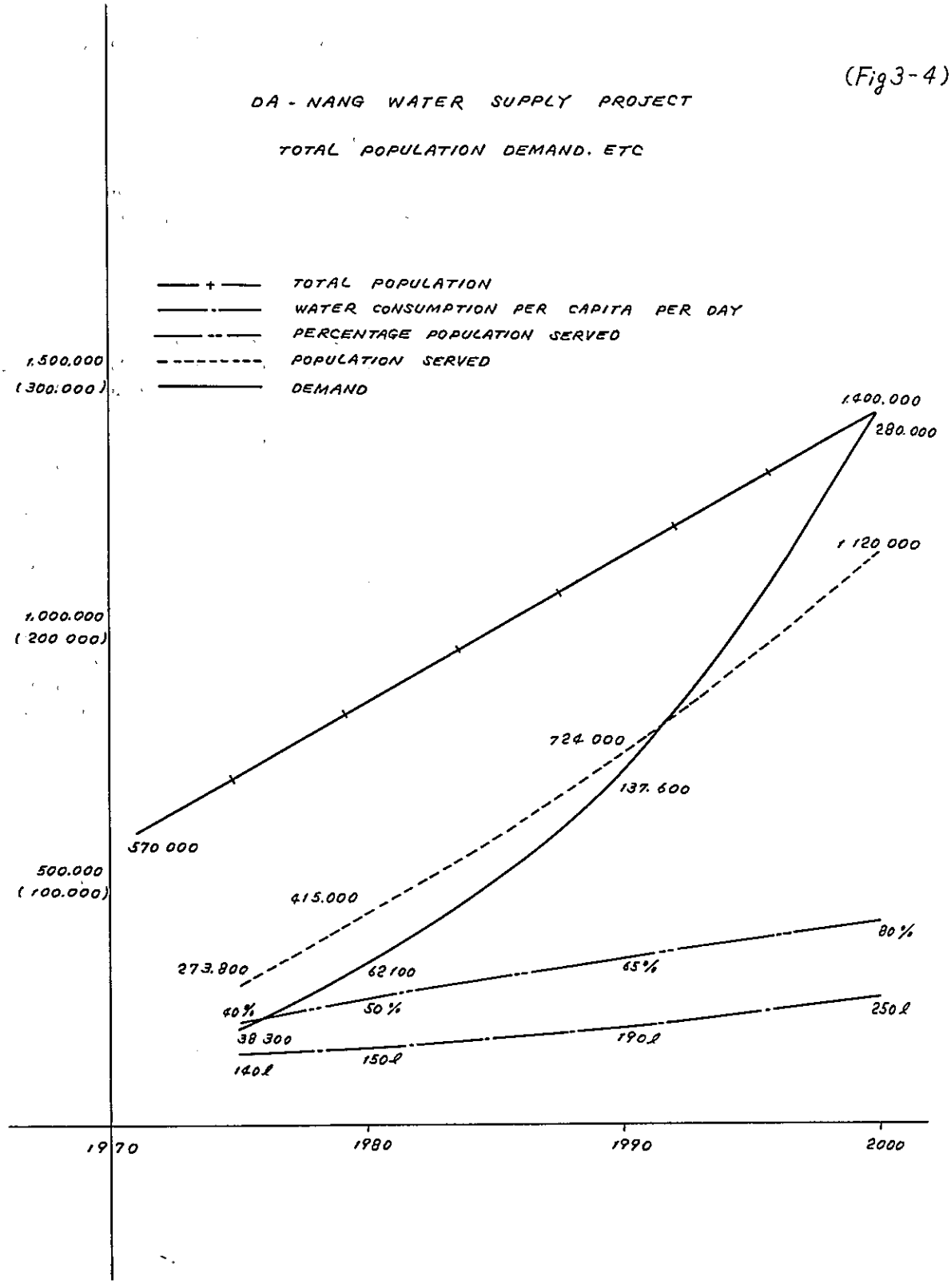
PREDICTING POPULATION



(Fig 3-4)

DA - NANG WATER SUPPLY PROJECT

TOTAL POPULATION DEMAND. ETC



(Combined Population Forecast)

The arithmetic mean of the results of the above calculations is assumed to be the population of the urban area in the year 2000.

$$(1{,}600{,}000 + 1{,}750{,}000 + 950{,}000) \div 3 = 1{,}430{,}000$$
$$= 1{,}400{,}000$$

However, the curve used to forecast the future population shows a significant difference between the actual current population and the population predicted on the basis of the population curve. (See Fig. 3-4).

2) Water Supply Program

Under this program, the entire urban area of 213 km^2 will be served. The project period is to be divided into three phases, namely, 1st phase, 2nd phase, and 3rd phase. The target years of the successive phases are 1980, 1990 and 2000 respectively.

In forecasting the future population for the water supply project, 1971 is taken to be the base year. The population is assumed to increase linearly between 1971 and 2000. The result of this assumption are shown in (Fig. 3-4). In addition to the predicted population, the figure also shows curves indicating changes in the percentage of population served, maximum water demand per capita per day, and maximum daily demand. The percentage of population served is estimated at 40% upon the completion of the urgent countermeasure (presumed to be 1975), 50% in 1980, 65% in 1990 and 80% in the year 2000. The maximum planned water demand per capita per day in Vietnamese cities is generally 140 liters (100 ℓ in average). This has been proved reasonable by the achievements of Hue City (population in 1968 at 171,000), approximately 50 km north of Danang. However, the water demand per capita per day should increase as the standard of living rises. Therefore, under this water supply project the maximum projected water demand per capita per day is to be 140 ℓ (100 ℓ in average) in the initial year (1975), 150 ℓ (110 ℓ in average) in 1980, 200 ℓ (140 ℓ in average) in 1990 and 250 ℓ (180 ℓ in average) in the year 2000.

On the basis of the above planning, the attainment in each target year will be as follows.

1st phase project (target year - 1980)

Total population	830,000
Percentage population served	50%
Planned population served	415,000
Planned maximum water demand per day	70,000 m^3/D
Planned maximum water demand per capita per day	150 ℓ
Planned average water demand per capita per day	110 ℓ
Total length of distribution pipes	300 km (350 km)*
Number of water meters	60,000

Note: *Figure in parentheses shows the total length including that of the existing pipes.

2nd phase project (target year - 1990)

Total population	1,110,000
Percentage population served	65%
Planned population served	724,000
Planned maximum water demand per day	140,000 m^3/D (Expansion - 70,000 m3/D)
Planned maximum water demand per capita per day	190 ℓ
Planned average water demand per capita per day	140 ℓ

3rd phase project (target year - 2000)

Total population	1,400,000
Percentage population served	80%
Planned population served	1,120,000
Planned maximum water demand per day	280,000 m^3/D (Expansion - 140,000 m^3/D)
Planned maximum water demand per capita per day	250 ℓ
Planned average water demand per capita per day	180 ℓ

The following is an outline of the future program. As stated previously in section 3-2-1, Urgent Contermeasure, the 1st phase project calls for the construction of a water purification plant, which intakes water from the Cam Le River. The site for this proposed project has already been acquired. Once a water purification plant is operational and the distribution pipes have been extended by 100 km, the urgent countermeasure will have been realized. The only remaining work to be accomplished by the end of the 1st phase project is an additional 200 km extension of the distribution pipes.

It is considered essential that work on the 2nd phase project is started by 1976. During the 2nd phase project, the intake site and the water purification plant may remain in the same location as that of the 1st phase project. For the 3rd phase project, however, a study such as the one mentioned in section 3-2-3 will be required to determine the project's water source.

The following is an estimated project cost of the future program.

	Foreign currency US$	Local currency VN$	Total US$
1st phase project (1971 - 1979)	15,710,000	2,079,000,000	23,270,000
Urgent countermeasure (1971 - 1974)	8,210,000	962,500,000	11,710,000
After completion of urgent countermeasure	7,500,000	1,116,500,000	11,560,000
2nd phase project (1976 - 1989)	15,710,000	2,079,000,000	23,270,000
3rd phase project (1986 - 1999)	31,420	4,158,000,000	46,540,000

The estimated project cost shown above is based on the calculation made in 1971.

3-2-3 Problems

In this section some problems associated with the Urgent Countermeasure, Long-range Measure and the Future Project will be pointed out, and the basic survey designed to cope with these problems will be discussed.

The problems are as follows:

i) Future population projection

ii) Discharge of the Cam Le River, the proposed water source of the project.

iii) Effect of seawater on the Cam Le River.

First, the outline of these problems will be given and then the measures to cope with them will be discussed.

i) Future population projection

The population estimates discussed in section 3-2-2 have been calculated using past population statistics as a base. However, these figures are relatively high, due to social dislocations resulting from the war situation.

Therefore it will be necessary to revise the population estimate during the period that the proposed project is actually being carried out.

ii) The water purification plant planned under the urgent countermeasure will intake water from the Cam Le River at the point near the existing intake.

Data of the drought flow of the river is not available due to present security conditions in the drainage basin area. Precipitation records in Danang City covering the past 60 years were therefore used in the discharge study. From this information the drought flow of the Cam Le River was estimated to be 6 m^3/Sec. This would be sufficient to supply water purification system having a capacity of 70,000 m^3/D (0.8 m^3/Sec.)

However, a large quantity of water is expected to be diverted for irrigation purposes by a dam located in the upper stream of the proposed intake site. It will therefore be necessary to enter into agreement concerning the allocation of the flow. The implementation of the future program will also require precipitation records for the entire catchment basin, as well as data concerning the water flow of the Cam Le River.

iii) Salt-water intrusion into the water of the Cam Le River

The proposed intake site is approximately 15 km up the river from the estuary, and there is a possibility that the sea water will reach the site. The construction of a raw water reservoir or of clear wells under the urgent countermeasure may

solve this problem. However, a further study will be required during the 2nd and 3rd phase projects.

The problems discussed above are critical, and must be met immediately under the urgent countermeasure project. The following studies are needed in solving these problems.

i) Revision of the population estimates based on-to-date population statistics.

ii) Collection of hydrological data through observation of the river flow and of the meteorological characteristics of the Cam Le River Drainage Basin.

iii) A survey indicating the effect of salt-water intrusion into the Cam Le River.

iv) Collection of hydrological data pertaining to the Cu De River. This river is an alternative water source of the project.

The cost for the basic survey has been estimated below. However, the report considers only the expense required for the engineers assigned for the basic survey.

Outline of basic survey

Number of engineers to be assigned - 3 persons

Period of assignment - 2 persons x 12 months + 1 person x 6 months
= 30 man-months.

Expenses

Foreign currency	US$120,000
Local currency	VN$6,600,000
Total	US$144,000

3-3 Conclusions and Recommendations

The Danang City Waterworks is inadequate to meet the rising need of the city population. Even more disturbing, the sanitary conditions are extremely poor, and should be improved as quickly as possible.

The measures required are:

i) The immediate implementation of the urgent countermeasure.

ii) The execution of a series of surveys called the "Basic Survey", to determine data needed in effectuating the subsequent projects.

The countermeasures are outlined below.

i) Urgent countermeasure

Construction of an intake and a water purification facility

The intake tower would be constructed on the Cam Le River, near the present intake facility. A water purification plant having a capacity of 70,000 m^3/D is to be constructed at the proposed site along the river.

Extension of distribution pipes

The distribution pipes should be extended by 100 km.

Survey and design for the above work

Supervision of construction for the above work

ii) Basic Survey

The basic survey will provide information required for the implementation of the 2nd and 3rd phase projects.

The principal survey items are:

a) Future population trends.

b) Collection of hydrological information concerning catchment area.

c) Surveys determining flow of the Cam Le River and of an alternative river.

The cost of the countermeasures mentioned is shown on Table 3-4.

Figures for the urgent countermeasure represent the costs of each year. Those for the basic survey indicate the total costs.

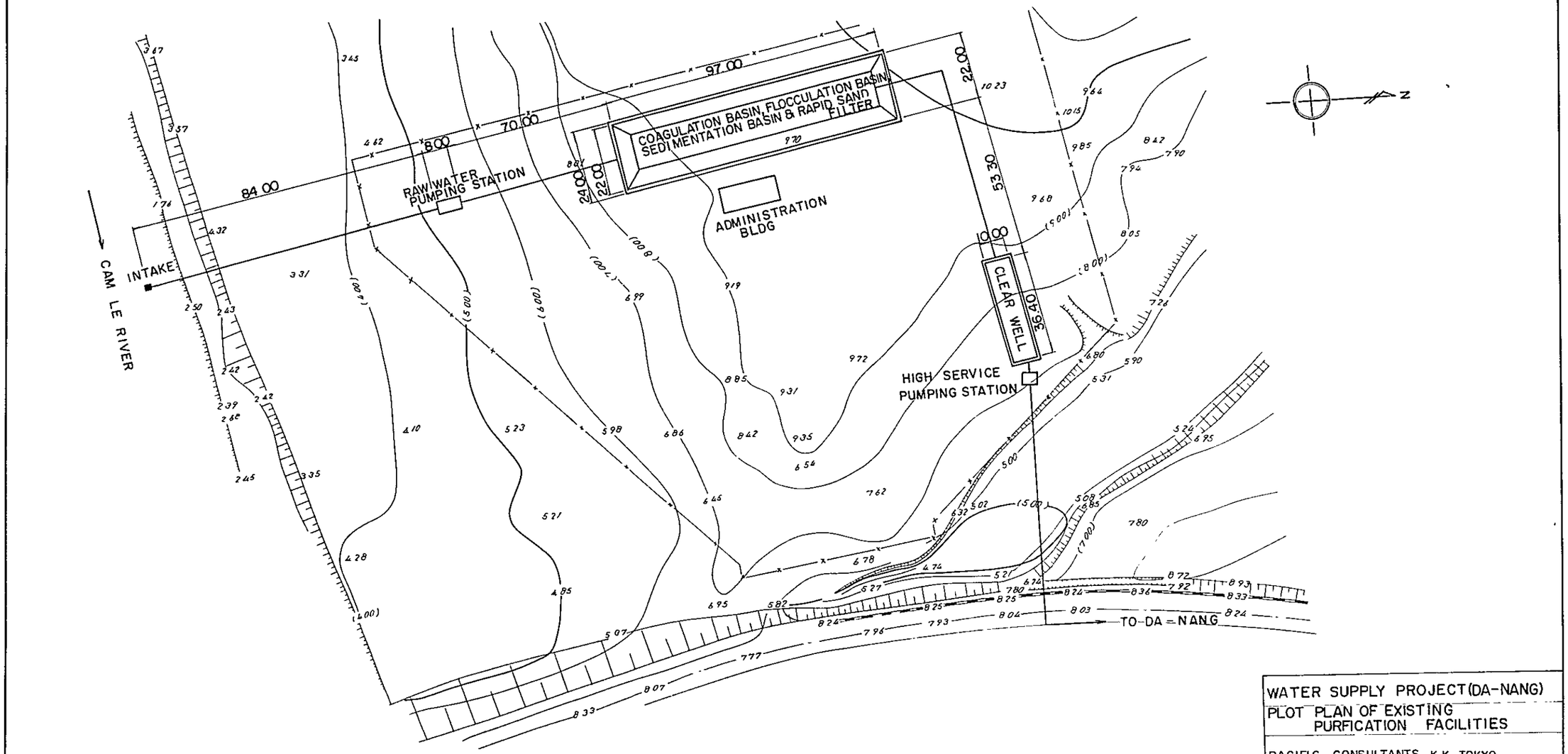
i) Urgent Countermeasure (Table 3-4)

Project Year		Construction Cost	Engineering Fee	Total
1st year	Foreign currency US$	-	370,000	370,000
	Local currency VN$	-	22,000,000	22,000,000
2nd year	Foreign currency US$	4,300,000	180,000	4,480,000
	Local Currency VN$	440,000,000	10,500,000	450,500,000
3rd year	Foreign Currency US$	3,050,000	180,000	3,230,000
	Local currency VN$	384,000,000	10,500,000	394,500,000
4th year	Foreign currency US$	-	130,000	130,000
	Local currency VN$	89,000,000	6,500,000	95,500,000
Total	Foreign currency US$	7,350,000	860,000	8,210,000
	Local currency VN$	913,000,000	49,500,000	962,500,000

Exchange rate: VN$275 = US$1.00

ii) Basic Survey

Foreign currency	US$120,000
Local currency	VN$6,600,000

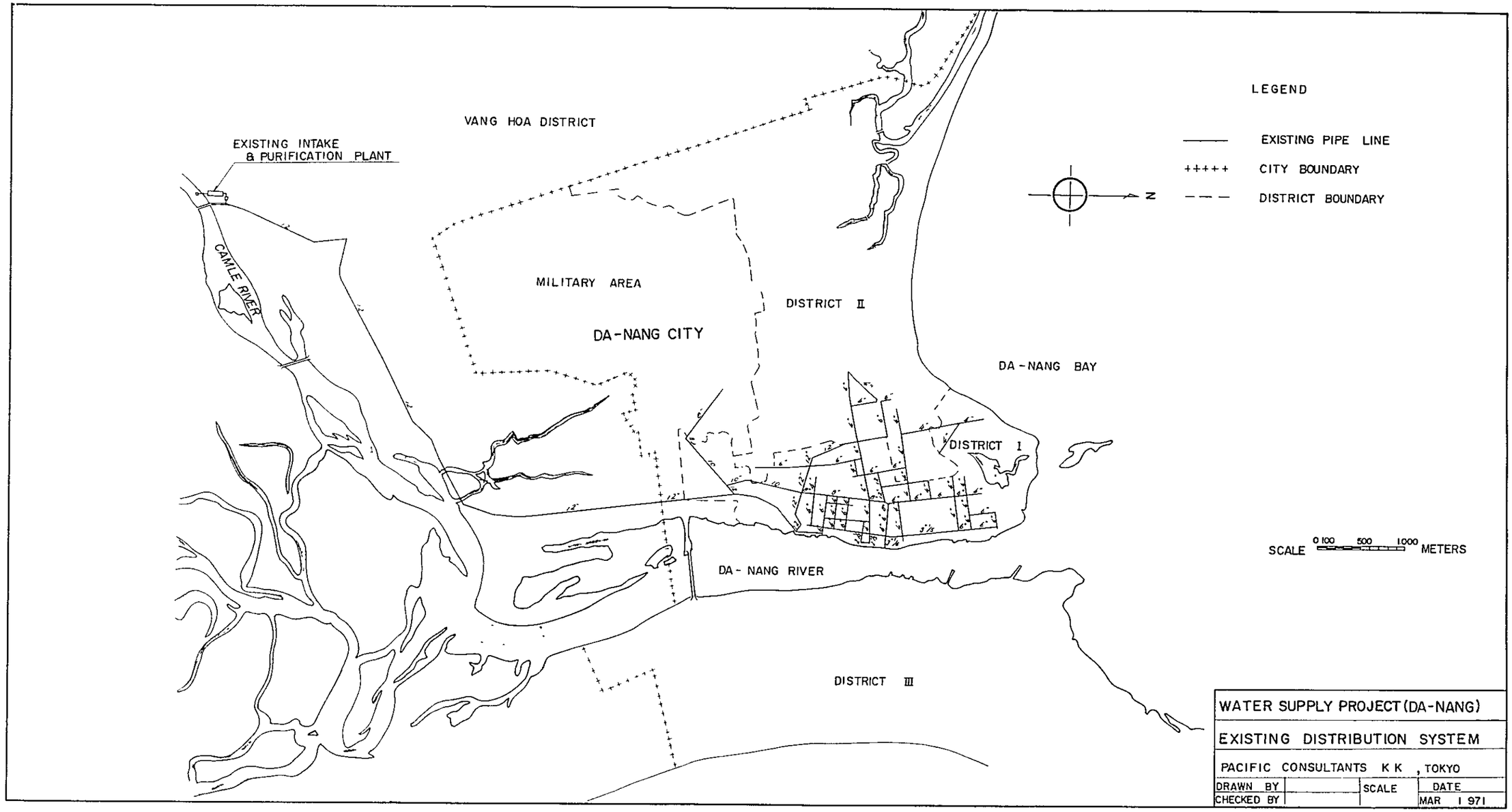


WATER SUPPLY PROJECT (DA-NANG)

PLOT PLAN OF EXISTING PURFICATION FACILITIES

PACIFIC CONSULTANTS K K TOKYO

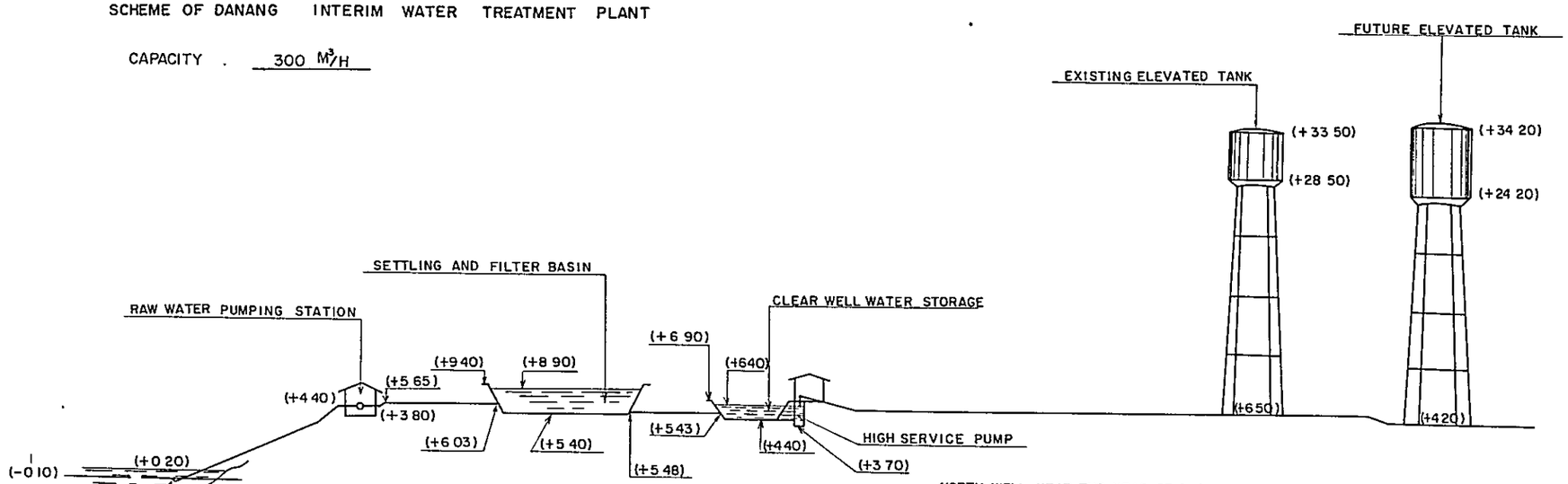
DRAWN BY		SCALE	DATE
CHECKED BY		1 1000	MAR 1971


LEGEND
EXISTING PIPE LINE
CITY BOUNDARY
DISTRICT BOUNDARY
N
VANG HOA DISTRICT
EXISTING INTAKE & PURIFICATION PLANT
CAMLE RIVER
MILITARY AREA
DA-NANG CITY
DISTRICT II
DA-NANG BAY
DISTRICT I
DA-NANG RIVER
DISTRICT III
SCALE 0 100 500 1000 METERS
WATER SUPPLY PROJECT (DA-NANG)
EXISTING DISTRIBUTION SYSTEM
PACIFIC CONSULTANTS K K , TOKYO
DRAWN BY
CHECKED BY
SCALE
DATE
MAR 1971

DANANG METROPOLITAN WATER OFFICE

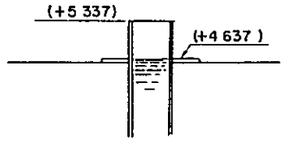
SCHEME OF DANANG INTERIM WATER TREATMENT PLANT

CAPACITY . 300 M^3/H



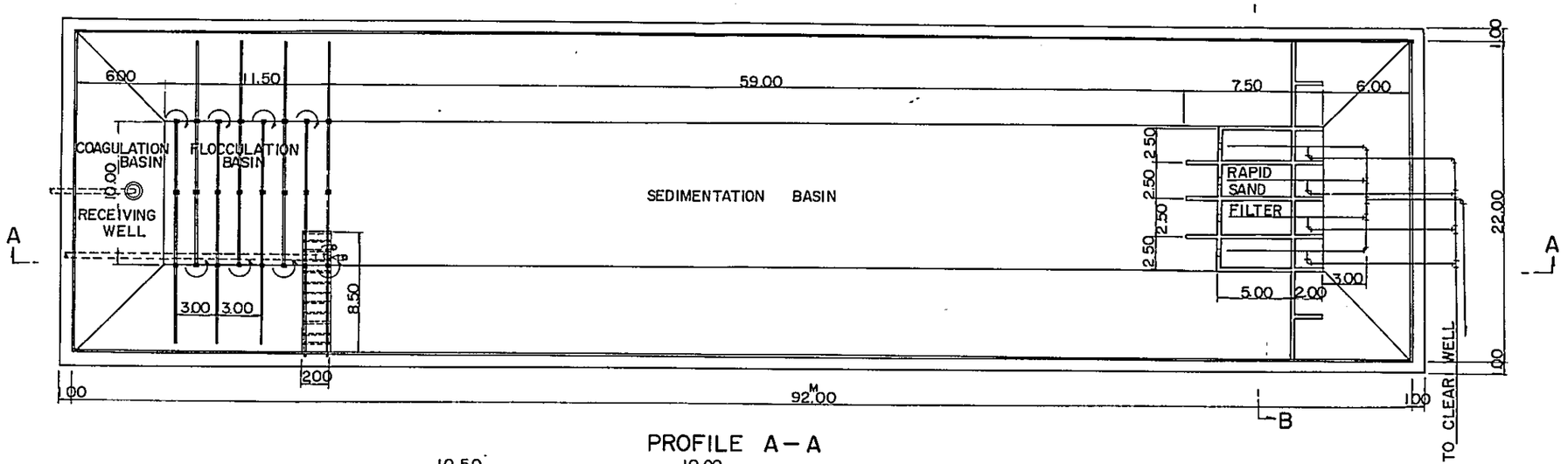
LOWEST LEVEL OF WATER IN DRY SEASON (+0 20)
ELEVATION OF SUCTON HEAD (− 0 10)
ELEVATION OF FOUNDATION OF U S ARMY PUMPING STATION (+6 83)
ELEVATION OF FOUNDATION OF EXISTING PUMPING STATION (+2 13)
ELEVATION OF FOUNDATION OF RED BRIDGE (+5 60)
LEVEL OF ANNUAL FLOOD (+4 17)
LEVEL OF THE HIGHEST FLOOD (+6 62)
STANDARD ELEVATION OF DANANG COMMERCIAL PART T BRIDGE (+3 832)

NORTH WELL NEAR THR HEAD OF CLEAR WELL STORAGE
ELEVATION OF SURFACE OF THE HEAD OF THE WELL (+5 337)
ELEVATION OF FOUNDATION OF THE WELL (+4 637)

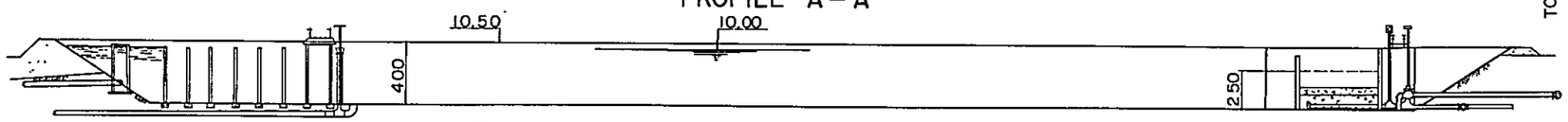


WATER SUPPLY PROJECT (DA-NANG)			
FLOW DIAGRAM			
PACIFIC CONSULTANTS K K TOKYO			
DRAWN BY		SCALE	DATE
CHECKED BY			MAR 1 971

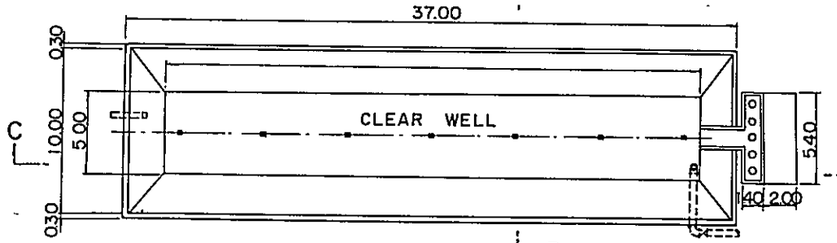
PLAN



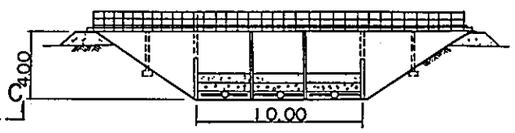
PROFILE A – A



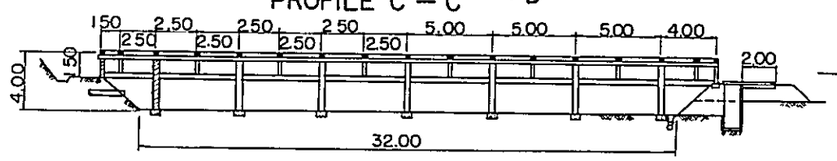
PLAN



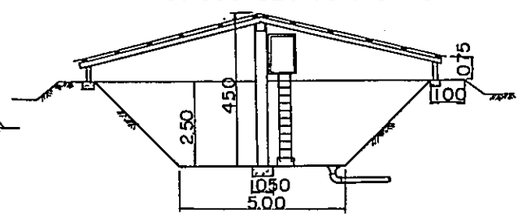
CROSS SECTION B – B



PROFILE C – C

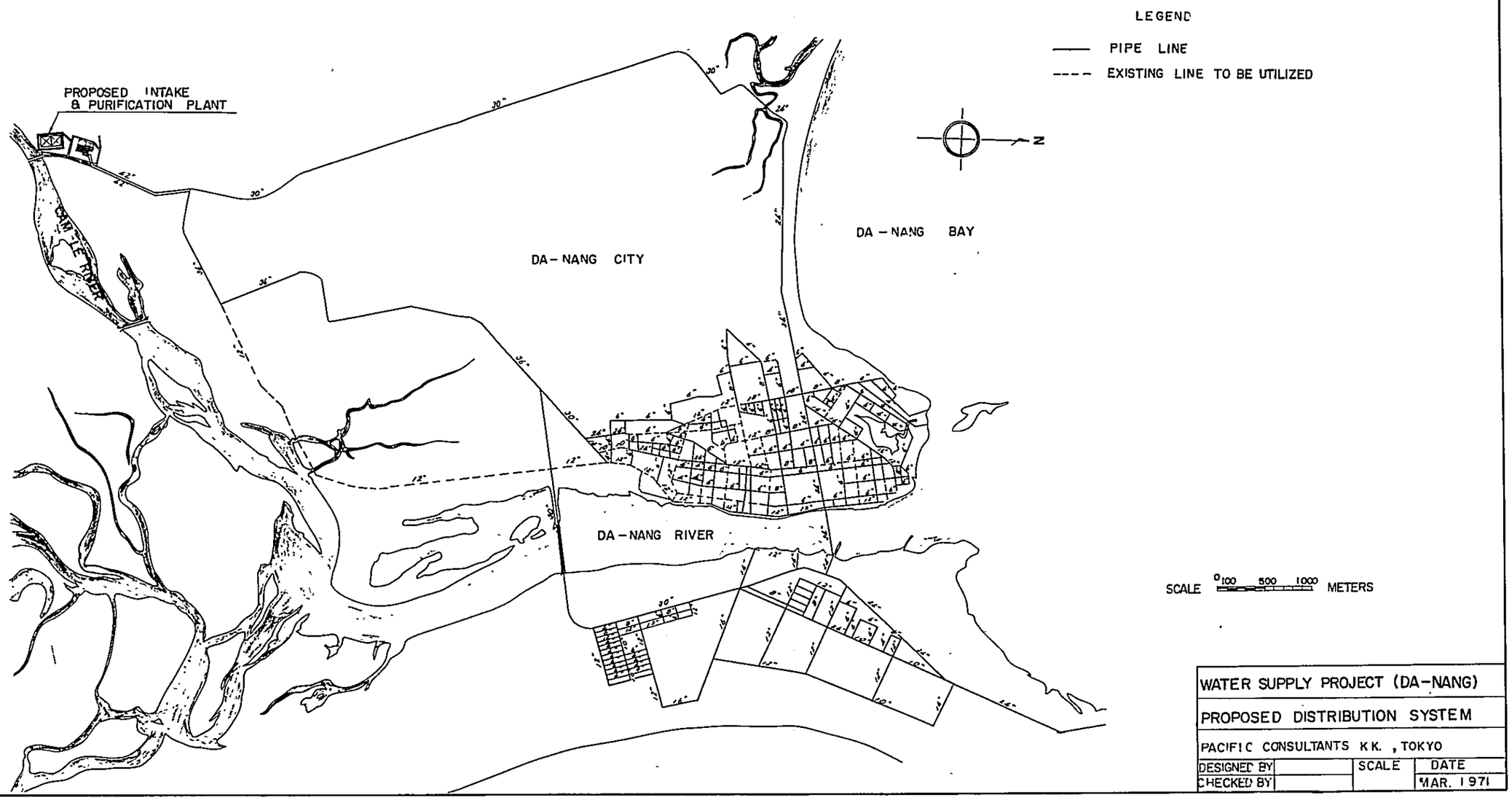


CROSS SECTION D – D

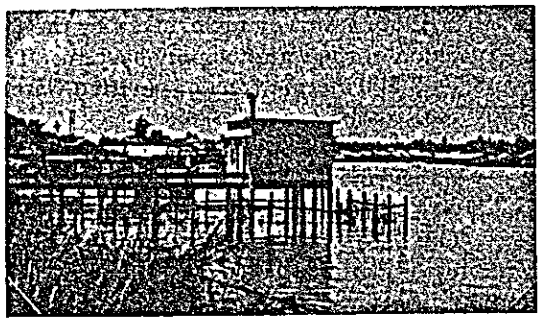


WATER SUPPLY PROJECT (DA-NANG)			
TEMPORARY PURIFICATION FACILITIES			
PACIFIC .CONSULTANTS K.K , TOKYO			
DRAWN BY		SCALE	DATE
CHECKED BY		AS SHOWN ON DWG	MAR. 1971

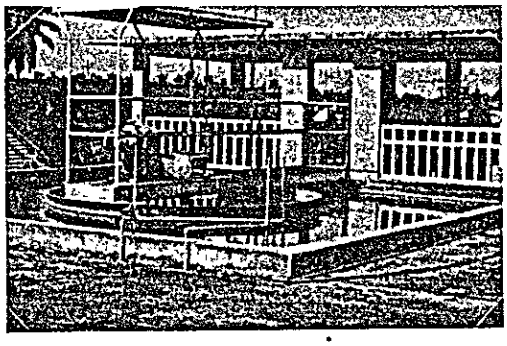
CHAPTER 4. WATER SUPPLY IN LONGXUYEN


LEGEND
PIPE LINE
EXISTING LINE TO BE UTILIZED
PROPOSED INTAKE & PURIFICATION PLANT
CAM LE RIVER
DA-NANG CITY
DA-NANG BAY
DA-NANG RIVER
N
SCALE 0 100 500 1000 METERS
WATER SUPPLY PROJECT (DA-NANG)
PROPOSED DISTRIBUTION SYSTEM
PACIFIC CONSULTANTS K.K., TOKYO
DESIGNED BY
CHECKED BY
SCALE
DATE
MAR. 1971

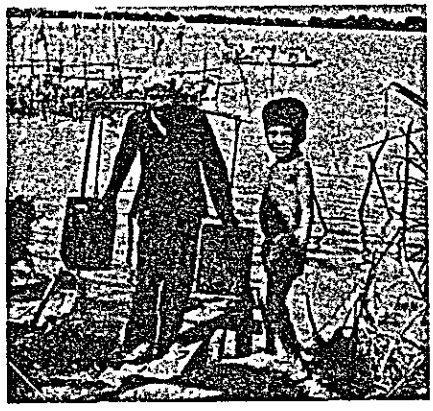
Longxuyen City



The Longxuyen River and the Existing Intake Plant
Wasted Water from the shacks along the river is discharged directly into the river



The Existing Plant
Rapid Flocculation and the Corridor



Water Intaking in the Non-served Area and the Bassac River
They intake the water from the river and treat it with alum.

4-1 Water Supply at Present

4-1-1 Outline of Longxuyen

Longxuyen is one of the major cities in the Mekong Delta, and it's the capital of Angiang Province. The city is situated in lat. 10^{o}N and long. 105^{o}E, approximately 150 km southwest-by-west of Saigon. The present population of Longxuyen, including its suburbs, is 75,000. Especially good security conditions and fertile soil have attracted an increasing number of people to the city.

The Longxuyen City water supply system was built in 1934. In this system, water was taken from the Bassac River, a tributary of the Mekong River. The water purification plant had a capacity of 720 m^3/D.

In 1960, a survey undertaken by the Hydrotechnic Corporation (New York) resulted in the expansion of the water supply system. The present system completed in 1962, purification provides 3,500 metric tons of purified water daily (3,500 m^3/D).

4-1-2 Management of Water Supply

The waterwork system of Longxuyen City is owned by the Directorate of Water Supply, Ministry of Public Works (hereafter referred to as DWS). It is operated by the National Water Supply Agency (hereafter referred to as NWA). The NWA is an autonomous body under jurisdiction of the Ministry of Public Works.

DWS and NWA are regarded almost as one body. Most of the staff including the Director, hold corresponding positions in both agencies. Recently the DWS has been concerned with the less profitable waterworks such as those found in rural areas, while the NWA has tended to manage the more profitable urban waterworks. A total amount of VN$9,382,000 was appropriated from the DWS budget for the Longxuyen City waterworks during the period from 1957 to 1962. Since 1963, VN$3,880,000 has been obtained from the NWA.

The staffs assigned to waterworks is as follows:

Administration and accounting division	12
Engineering division	8
Construction division	17
	37

4-1-3 Water Supply Facilities

The present water purification facility is located in the center of the city. Water is taken from the Longxuyen, a branch of the Bassac, which is a tributary of the Mekong River. The water purification facility contains a sludge contact clarifier, two rapid sand filter, a clear well, high service pump room and chemical feeding room.

The outlines of main facilities are as follows:

Intake facility

Intake tower (Reinforced concrete tower)
Intake pump: 200 m^3/hr, 10 HP - 2 units

Water purification facility

Sludge contact clarifier (Accelerator)	300 m^3 - one
Rapid sand filter:	140 m^2 - Two
Clear well:	650 m^3 - One
Chemical feeder:	Alum & Chlorine

Facility for water distribution

High service pump:	200 m^3/hr, 40 HP - Two
Elevated tank:	300 m^3 - One
	150 m^3 - One

Distribution pipe

ø 200 mm cast iron pipe	- 1,495 m
ø 150 mm cast iron pipe	- 2,984 m
ø 100 mm cast iron pipe	-16,074 m
ø 50 mm cast iron pipe	- 1,147 m

Number of water meters installed: 2,657

Fire hydrant (Surface-type): 11

4-1-4 Conditions of Water Supply

The capacity of the existing water purification facility is 200 m^3/hr, and the daily supply of water is 3,500 m^3/D. The area served extends over approximately 200 ha, covering the majority of the city administrative district (230 ha.), but only 40% of the entire city area area (500 ha.).

As estimated 47% of the population is being served at present. This figure is based on a total of 2,657 water meters as December 1970, and the assumption that the water consumption per capita per day is 100 ℓ. This indicates that approximately 35,000 people are currently being served. Thus the percentage of the population served is: 35,000 ÷75,000 = 47%. The remaining 53% of the population get water from the Bassac River or from its branches either by use of a pump or simply by human power. The water is then purified with alum, and the top is used for drinking. Currency for the procurement of the machinery, equipment, and other items was provided by the U.S.. Local currency amounting to VN$ 4,500,000 was financed through loans from the Vietnamese Government.

Shown below are various water rates now in effect.

Water rates:

Domestic use	VN$12/$m^3$
Commercial use	VN$13/m3
Official use	VN$6/$m^3$

The following is the settlement of accounts.

Fiscal year 1969	Profit: VN$2,891,222
Fiscal year 1970	Profit: VN$5,877,940

4-1-5 Problems

The problems associated with the present water supply in Longxuyen City are as follows.

Problems of water source.

1) Crowded acquatic dwellers along the River waste water directly into the Longxuyen River.

2) A large hospital located on the bank opposite the present intake site also discharges untreated wastes water directly into the Longxuyen River.

3) For 2 or 3 days every year during the drought season water intake from the Longxuyen River is impossible.

Problems of the limited water supply

The percentage of the population served is only 47%. The remaining 53% of the population get their water from the Bassac River and treat it by themselves. The quality of water treated in this way is very unsatisfactory.

4-2 Measures

4-2-1 Urgent Countermeasure

1) Outline

A water purification plant having a capacity of 10,000 m^3/D would be constructed on the bank of the Bassac River, 6 km east of Longxuyen City. The intake site will be located in the same area.

Once the work contemplated under the urgent countermeasure has been finished, the existing water purification plant will be closed down. Under the urgent countermeasure, 23 km of new distribution pipes will be connected to the existing pipes, for a total length of 45 km.

When the urgent countermeasure has been completed, the population served will increase from the present level of 35,000 to 51,000. After an additional 25 km of pipes have been connected under the 1st phase project, the population served will rise to 76,500.

2) Project cost

Approximately one year will be needed for technical consulting and for the survey of the project, and construction work will take an additional two years. The breakdown of the project cost is indicated in the following table.

(Table 4-1)

Exchange rate: VN$275 = US$1.00

Type of work		Description of Work	Estimated project cost		
			Foreign currency US$	Local currency VN$	Total US$
Construction	Intake and water purification facilities	Capacity: 10,000 m^3/D	520,000	49,500,000	700,000
	Facility for water distribution	ø 450 mm - ø 75 mm L = 23 km	440,000	55,000,000	640,000
	Sub-total		960,000	104,500,000	1,340,000
Engineering	Survey and design	9 months	115,000	4,125,000	130,000
	Supervision of construction	2 men x 2 months + 2 men x 10 months = 60 man-months	240,000	13,750,000	290,000
Sub-total			355,000	17,875,000	420,000
Total			1,315,000	122,375,000	1,760,000
Water meter		7,000 units	105,000	15,400,000	161,000
Grand Total			1,420,000	137,775,000	1,921,000

3) Profitability evaluation

The project cost under the urgent countermeasure is shown below.

Project cost: US$1,760,000 = VN$484,000,000

of which

Foreign currency	US$1,315,000 = VN$ 361,625,000
Local currency	= VN$112,375,000

The project cost shown above is several times larger than the present water supply budget for Longxuyen. Therefore, it is essential that these funds are obtained from outside authorities. The suggested terms for repayment and a profitability study based on the cost-benefit ratio are outlined below.

Conditions for amortization

Foreign currency

Interest rate:	5%
Term of amortization:	18 years (including a 5-year grace period)

Local currency

The Vietnamese Government has provided water supply projects with loans bearing low interest rates that are payable within 30 - 35 years. This report assumed that interest rate on the local currency will be either 0% or 6.5%. The term of amortization is assumed in both cases to be 30 years (including a 5-year grace period).

Water charges

The present water rate is VN$12/$m^3$. This is rather low compared with VN$14.1/$m^3$ charges in Saigon and VN$20/$m^3$ in Danang. Repayment seem very difficult if the present water rate is remained. This study will examine the feasibility of the loan repayment if the VN$15/$m^3$ level adopted in Saigon or the VN$20/$m^3$ in Danang is adopted by Longxuyen City.

Operation cost

The operation cost is assumed to be VN$10/$m^3$ of chargeable water, based on the records of water supply in Longxuyen City.

The project cost under study for the amortization program does not include the cost for the procurement and installation of water meters. This cost is to be met by the revenue from the charges for house connection (DMWO charges VN$14.500 per work), and from the rent of water meters (VN$60/month).

The term of amortization given below includes a 5-year grace period.

	CASE I	CASE II	CASE III	CASE IV
Condition for amortization (Foreign currency)	5% 18 years	5% 18 years	5% 18 years	5% 18 years
Condition for amortization (Local currency)	- 30 years	0% 30 years	0% 30 years	6.5% 30 years
Water rate	VN$12/$m^3$	VN$15/$m^3$	VN$20/$m^3$	VN$20/$m^3$
Operation cost	VN$10/$m^3$	VN$10/$m^3$	VN$10/$m^3$	VN$10/$m^3$

The annual net profit (or deficit) is calculated by the following formula:

(Annual net profit) = (Revenue of water charge) - (Amortization with interest) - (Operation cost)

The result of these calculations are shown below.

	CASE I	CASE II	CASE III	CASE IV
1st year - 5th year (Grace period)	-16,838,050	-14,973,250	-11,865,250	-19,819,625
6th year - 18th year (Amortization of both foreign currency and local currency)	-34,493,522	-33,370,060	-23,339,391	-28,542,676
19th year - 30th year (Amortization of local currency)	+4,364,000	+6,015,000	+16,925,000	+11,721,615
31st year - 45th year	"	+10,910,000	+21,820,000	+21,820,000

The above table indicates that revenue from water charges alone will not sufficient to cover the amortization and operation cost for the first 18 years. Although revenues derived from charges for house connections and the rent of water meters might cover a large portion of the deficit, this study assumes that the entire deficit will be covered by loans at 0% interest from the national and municipal government as well as other sources.

The period required to pay out initial deficit after the foreign currency has been fully amortized are shown below.

	CASE I	CASE II	CASE III	CASE IV
Total amount of deficit	708,667,160	508,677,040	362,736,040	470,152,920
Pay-out time	122 yr.	52 yr.	20 yr.	28 yr.
Total pay-out time	140 yr.	70 yr.	38 yr.	46 yr.

Assuming that the service life of the proposed water supply system is 45 years, only the CASE III give a balanced account within the service life of the system. In this case, the cost-benefit ratio may be calculated as follows:

Cost = Project cost

Benefit = Project cost + Residual Value

$$\text{Residual Value} = \left(1 - \frac{38}{45} \times 0.9\right) \times \text{Project cost} = 0.24 \times \text{Project cost}$$

Therefore:

$$\text{Cost-benefit ratio} = \frac{\text{benefit}}{\text{cost}} = 1.24$$

In the calculation of the benefit, only the direct benefit has been considered. However, the waterworks provide such indirect benefits as the promotion of the industrial and commercial activities, a decrease in the loss of lives and property by fire and the decrease of death rate due to sickness. Originally, the waterworks

enterprise is a strongly public-oriented enterprise. Therefore, even if the cost-benefit ratio (direct benefit) may be lower than 1, the enterprise may be regarded as a quite profitable enterprise after various indirect benefits are considered.

In the implementation of the urgent countermeasure under the conditions given in CASE III, it is necessary to raise the water rates and introduce subsidies from other accounts during the amortization period of foreign currency, but the enterprise may be said to be fully justified and payable.

4-2-2 Planning of Long-range Measure

1) Future population projection

Changes in the population of Longxuyen City are shown below.

1960	28,000
1963	31,000
1968	47,401
1970	49,135 (Surveyed on Dec. 30, 1970)

The above population statistics include only the population within the administrative district (230 ha) of Longxuyen City. However, the concentration of population in the city had been so high during the past few years that the actual city area has expanded far beyond the designated administrative city boundary.

In order to forecast the future population, population statistics are needed. However, due to the limited time available to the Team, it was unable to gather enough information to make such forecasts.

The population forecast therefore assumed that the population would increase at the same rate as Danang City.

1971 - 1980	Population increase rate = 4.3%
1981 - 1990	Population increase rate = 3.0%
1991 - 2000	Population increase rate = 2.4%

The future population thus estimated is shown in Fig. 4-1. From this table, the population is estimated at 109,300 in 1980, 146,000 in 1990 and 184.300 in 2000.

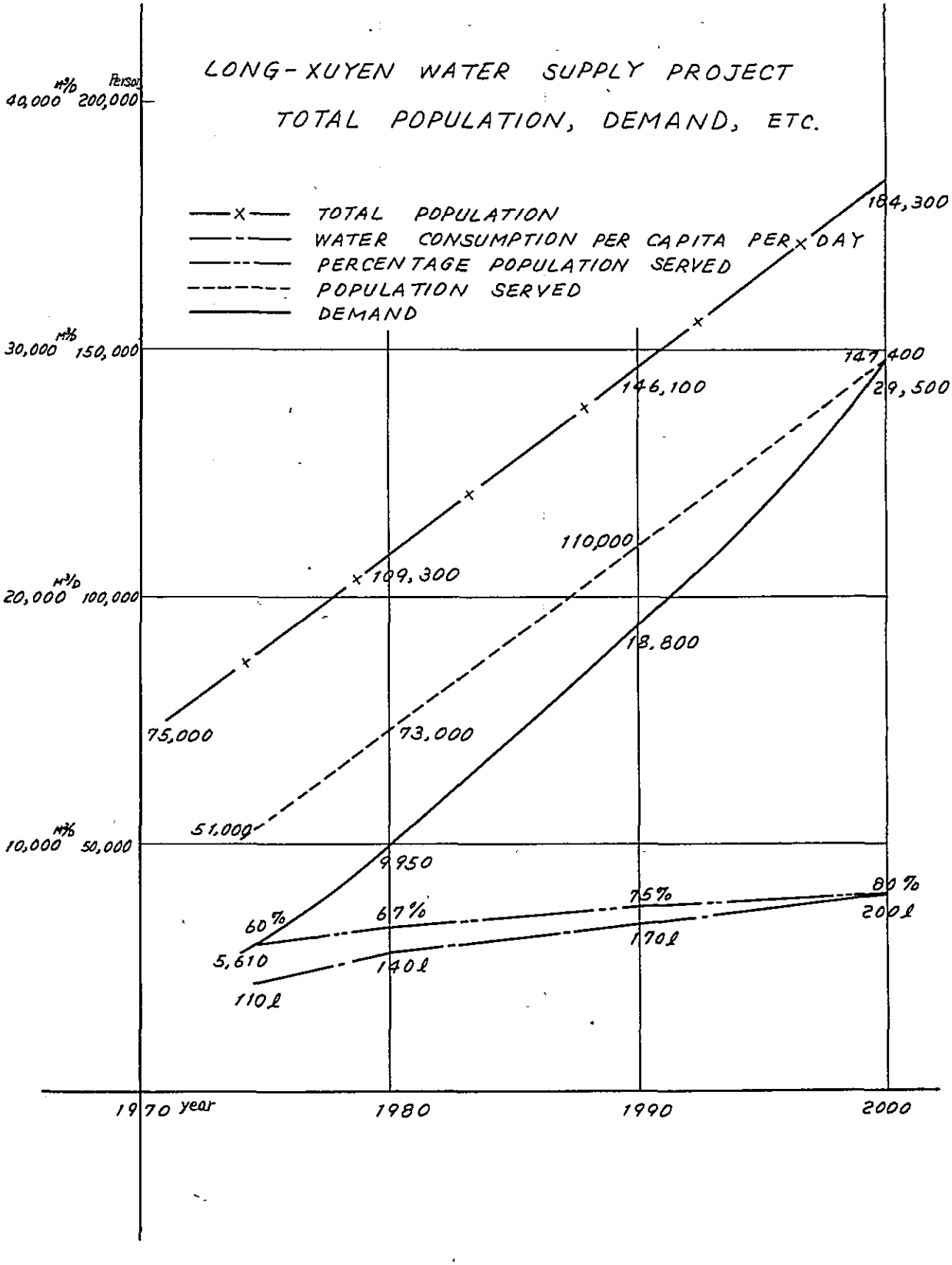
2) Water Supply Program

Under the water supply program, the project period will be divided into three phases. The target year for three phases are 1980, 1990 and 2000 respectively.

Upon the completion of the urgent countermeasure, 60% of the population will be served. The percentage of population served is 67% in 1980, 75% in 1990, and 80% in 2000.

Planned maximum water demand per capita per day upon the completion of the urgent countermeasure is 110 liters (80 ℓ in average), 140 ℓ (100 ℓ in average) in 1980, 170 ℓ (120 ℓ in average) in 1990, and 200 ℓ (145 ℓ in average) in 2000.

(Fig 4 - 1)


LONG-XUYEN WATER SUPPLY PROJECT
TOTAL POPULATION, DEMAND, ETC.
TOTAL POPULATION
WATER CONSUMPTION PER CAPITA PER DAY
PERCENTAGE POPULATION SERVED
POPULATION SERVED
DEMAND
40,000 m³/D
200,000 Person
30,000 m³/D
150,000
20,000 m³/D
100,000
10,000 m³/D
50,000
184,300
146,100
109,300
75,000
147,400
129,500
110,000
73,000
51,000
18,800
9,950
5,610
60%
67%
75%
80%
200ℓ
170ℓ
140ℓ
110ℓ
1970 year
1980
1990
2000

The project outlines are as follows:

1st phase project (target year - 1980)

Total population	109,300
Percentage of the population served	67%
Planned population served	73,000
Planned maximum water demand per day	10,000 m^3/D
Planned maximum water demand per capita per day	140 ℓ
Total length of distribution pipes	48 km (70 km)*
Number of water meters	10,000

Note: *Parentheized figure represents the total legth including the existing lines.

2nd phase project (target year - 1990)

Total population	146,100
Percentage population served	75%
Planned population served	110,000
Planned maximum water demand	20,000 m^3/D (Expansion - 10,000 m^3/D)
Planned maximum water demand per capita per day	170 ℓ

3rd phase project (target year - 2000)

Total population	184,300
Percentage population served	80%
Planned population served	147,400
Planned maximum water demand	30,000 m^3/D (Expansion - 10,000 m^3/D)
Planned maximum water demand per capita per day	200 ℓ

The future program outline will now be given. As stated in section 4-2-1, the urgent countermeasure calls for 1) the construction of a water purification plant at a site 6 km east of Longxuyen City.

The expansion and 2) of 23 km of distribution pipes. The only remaining work contemplated under the 1st phase project is the extension of distribution pipes by 25 km and the installation of 3,000 water meters.

For both the 1st and 2nd phase projects, the location of the intake site and water purification plant may be the same as that under the urgent countermeasure.

The estimated project cost of the future program is shown below.

	Foreign currency US$	Local currency VN$	Total US$
1st phase project (1971 - 1979)	1,955,000	202,125,000	2,690,000
Urgent counter-measure (1971 - 1974)	1,420,000	137,775,000	1,921,000
After completion of urgent counter-measure (1975 - 1979)	535,000	64,350,000	769,000
2nd phase project (1977 - 1989)	1,955,000	202,125,000	2,690,000
3rd phase project (1987 - 1999)	1,955,000	202,125,000	2,690,000

4-2-3 Advantages of the proposed site

The proposed site for the construction of a new water treatment plant was recommended by the Angiang Provincial Government. The site is located on the bank of the Bassac River, downstream from Longxuyen City. As the city area is expanding in a southeast direction, construction of a water purification plant at the proposed site is considered to contribute greatly to the reduction of the water distribution cost. The discharge of the Bassac River situated near the purification plant is considered sufficient to remove any fear of pollution of the water by city sewage. Since the Bassic River at this point is under the influence of backwater, it does not matter very much whether the intake point is located up or down - stream from Longxuyen City.

Since the land of the proposed site is owned by the central government, the acquisition of the land space will not present any difficulty. This is great advantage for Longxuyen City, where land prices are relatively high.

4-3 Conclusions and Recommendations

The present water supply system does not adequately serve the population of Longxuyen City, and as the population continues to increase, the demand for water will rise sharply. Furthermore, the present sanitary conditions are unsatisfactory, and must be immediately improved.

In view of these critical needs, a new purification plant having a maximum capacity of 10,000 m^3/D should be constructed as quickly as possible and the distribution pipes should be extended by 23 km.

The new water purification plant should be constructed on the bank of the Bassac River, at a site 6 km east of Longxuyen City. Once the new water purification plant is completed, the existing plant should be closed down as soon as possible. These measures will all be

accomplished under the urgent countermeasure.

After the completion of the urgent countermeasure, the distribution pipe network will be further expanded, and additional water meters will be installed.

Also, it is essential that close observation be maintained on changes in the population movement, and that a study is initiated on the timing for the implementation of the future program.

The urgent countermeasure is outlined below and the estimated project cost and project disbursement is shown on Table 4-2.

Construction of an intake facility and a water purification plant

Both facilities constructed on the Bassac River

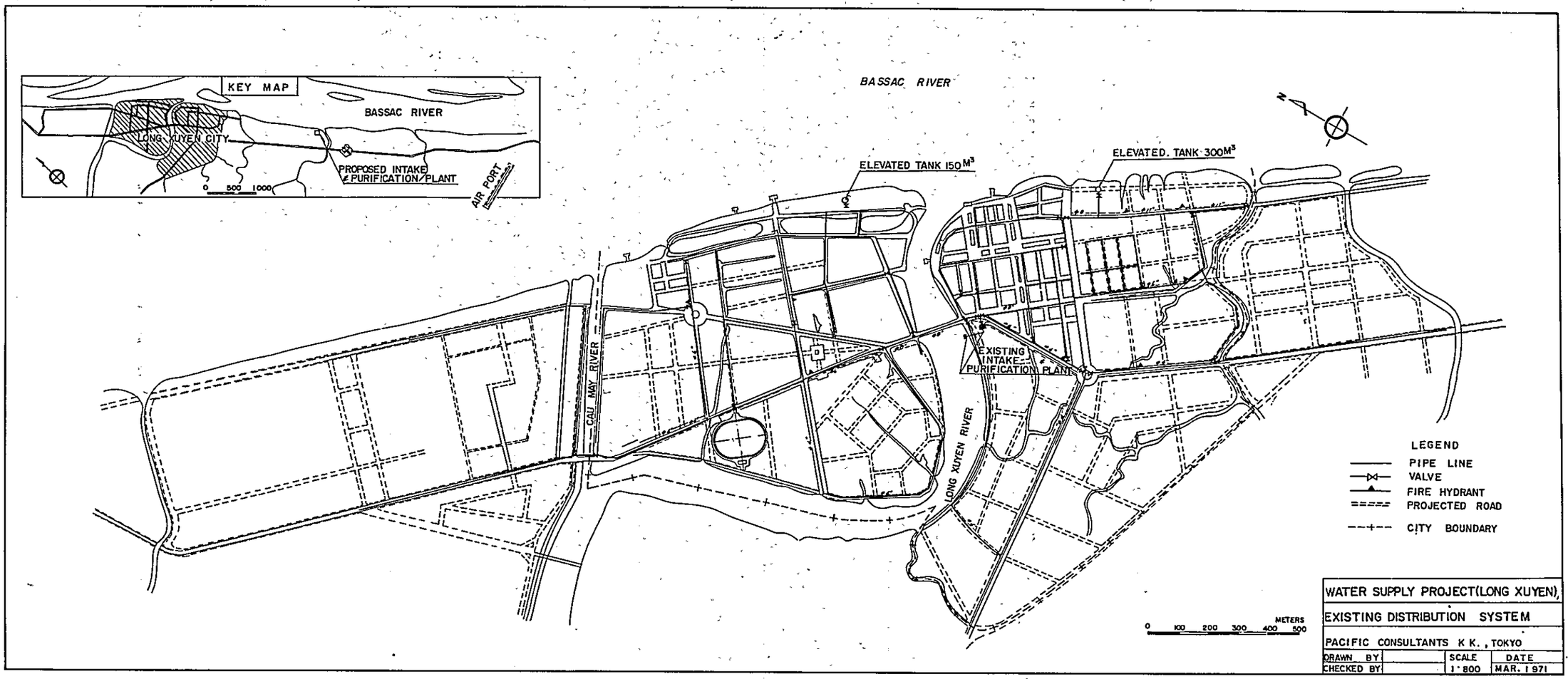
Extension of distribution pipes by 23 km

Survey and design for the above work

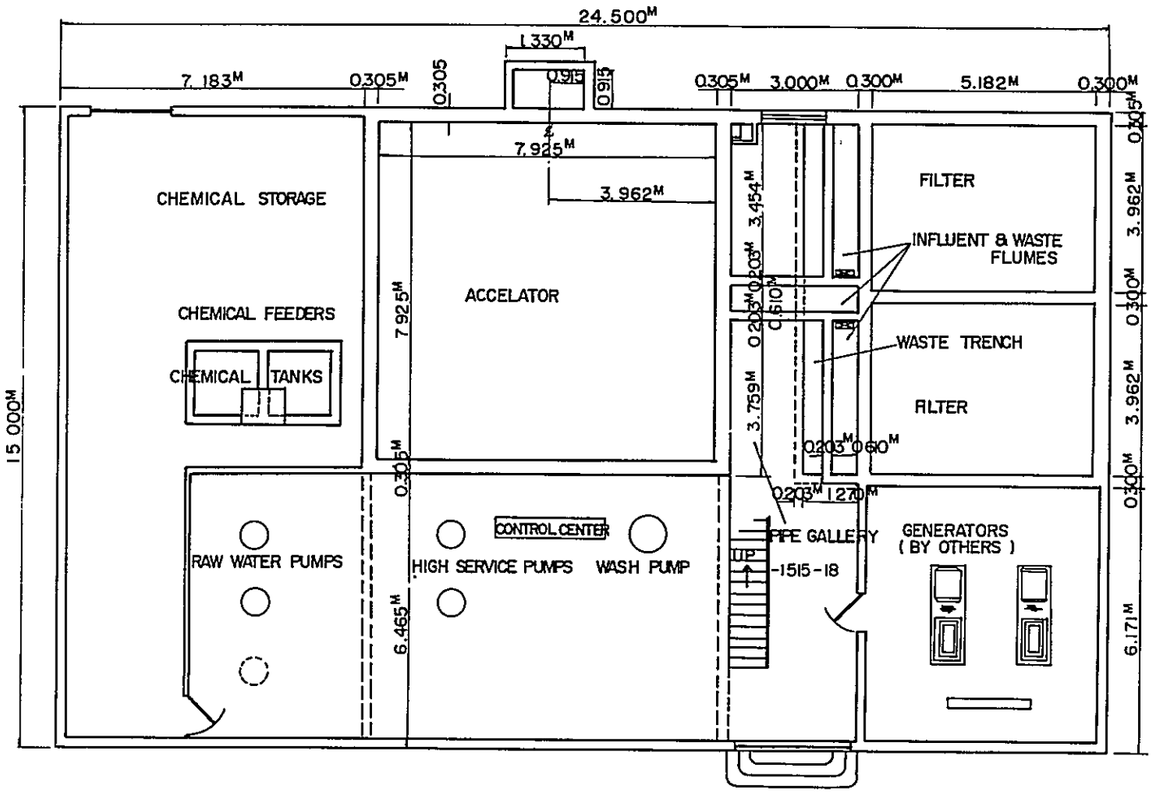
Extimated project cost and project disbursement

Project year		Construction Cost	Engineering Fee	Total
1st year	Foreign currency (US$)	——	115,000	115,000
	Local currency (VN$)	——	4,125,000	4,125,000
2nd year	Foreign currency (US$)	930,000	150,000	1,080,000
	Local currency (VN$)	89,900,000	8,600,000	98,500,000
3rd year	Foreign currency (US$)	135,000	90,000	225,000
	Local currency (VN$)	30,000,000	5,150,000	35,150,000
Total	Foreign currency (US$)	1,065,000	355,000	1,420,000
	Local currency (VN$)	119,900,000	17,875,000	137,775,000

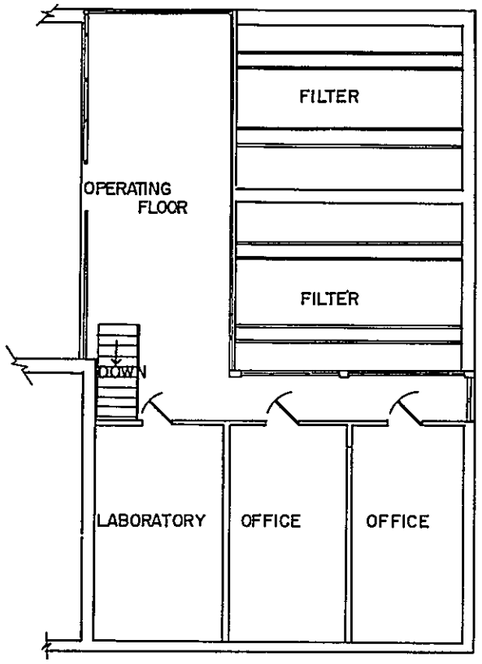
Exchange rate: VN$275 = US$1.00


KEY MAP
BASSAC RIVER
LONG XUYEN CITY
PROPOSED INTAKE & PURIFICATION PLANT
AIR PORT
0 500 1000
BASSAC RIVER
ELEVATED TANK 150M3
ELEVATED. TANK 300M3
EXISTING INTAKE PURIFICATION PLANT
CAU MAY RIVER
LONG XUYEN RIVER
LEGEND
PIPE LINE
VALVE
FIRE HYDRANT
PROJECTED ROAD
CITY BOUNDARY
0 100 200 300 400 500 METERS
WATER SUPPLY PROJECT(LONG XUYEN),
EXISTING DISTRIBUTION SYSTEM
PACIFIC CONSULTANTS K K., TOKYO
DRAWN BY
CHECKED BY
SCALE 1:800
DATE MAR. 1971

PLAN



PLAN - 2ND FLOOR



WATER SUPPLY PROJECT (LONG XUYEN)			
PLAN OF EXISTING PURIFICATION PLANT			
PACIFIC CONSULTANT K.K., TOKYO			
DRAWN BY		SCALE	DATE
CHECKED BY		1:100	MAR. 1971