CHAPTER 2 RANG SIT AREA

2.1 Study Area for First Stage Sewerage Program

As detailed in the Master Plan, the priority area for the first stage of the sewerage project was chosen to meet the needs of current land use practices, with an emphasis on those areas affected by population pressures. Identified for priority work was the 1,288 ha area which consists of the Prachatipat and Khu Khot S.D.s, which are located in the western and southern parts, respectively, in the master plan area. The design area is about 70% of the two administrative areas.

Further, in the Rang Sit area there are 14 housing estates which have been developed by the private sector. Nine (9) of these estates are located in the design area. The total population at present is some 8,200 people, with a projected population of about 13,000.

2.2 Existing Sanitation/Sewerage Facilities

The present sewerage system in the study area consists of on-site nightsoil treatment, channels, and klongs. Wastewater treatment in the housing complexes is rather sparse and inadequate. The klongs are generally shallow, with an average depth of about 1.0 - 2.0 m, and many suffer from solid deposits (garbage), as well as stagnant water. There are many small discharge pipes in the klongs that are covered with grass and do not seem to be maintained.

2.3 Population

The population of the preliminary design area at present was 41,000, while for the year 2001 62,830 was estimated.

2.4 Quantity and Quality of Wastewater

The quantity of wastewater to be treated for the preliminary design area was calculated covering domestic, business, and groundwater infiltration. Domestic and business wastewater uses a per capita basis. The design quantity and quality of the wastewater in the area is summarized below:

WASTEWATER SOURCE	QUANTITY (m^3/d)	BOD LOAD (kg/d)
Domestic	9,097	2,500
Business	4,525	540
Industrial	4,174	1,457
Groundwater	3,559	-----
TOTAL	21,355	4,497

2.5 Design Criteria

Design criteria is detailed in Section 3.9, Chapter 2, Part II of the Master Plan.

2.6 Wastewater Collection System

The wastewater collection system utilized is the combined collection method. The target year for the interceptors and pump stations is 2011.

There are no plans for road expansion and improving/expanding the klongs. The existing public roads are to be utilized for the installation of the interceptors and that routes along the klongs are to be avoided due to the difficulty of obtaining proper construction and maintenance support. Further, available land will determine the location of the pump stations. Designs of six (6) pump stations and four (4) inverted siphons are presented. Plan of the sewerage system is shown in Figure 2.6.1.

2.7 Wastewater Treatment and Sludge Disposal System

The proposed wastewater treatment plant site (3ha) is located in Tambol Klong Nung, Klong Luang S.D.. The site is about 2 km north of Klong Rang Sit and is on open land that is currently privately owned. Adjacent to this area is land owned by the S.D. and used for a garbage dump.

The wastewater quantity and quality of the area is noted in the previous section. The conventional activated sludge treatment method is employed. Figure 2.7.1 shows the flow treatment process.

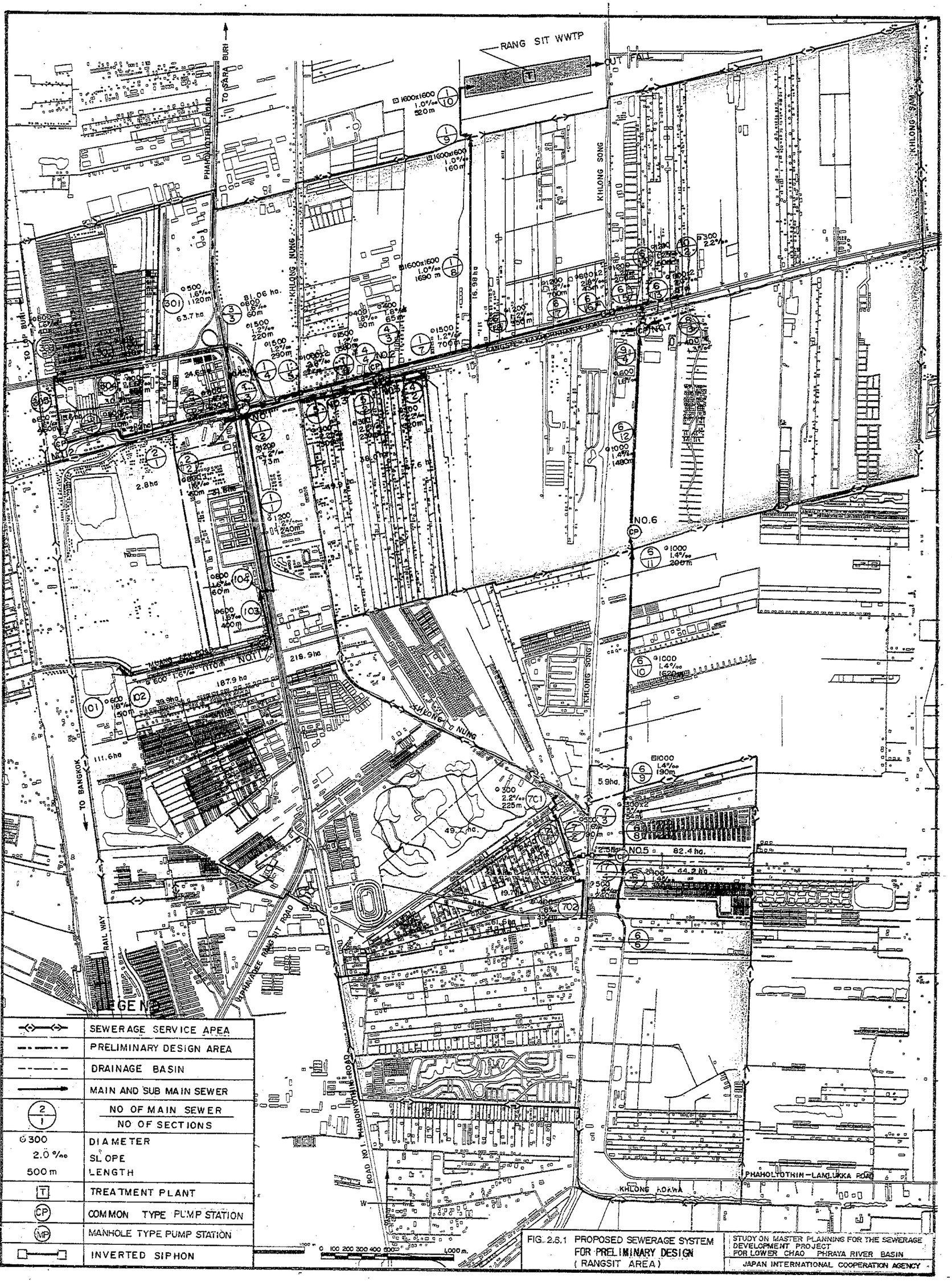
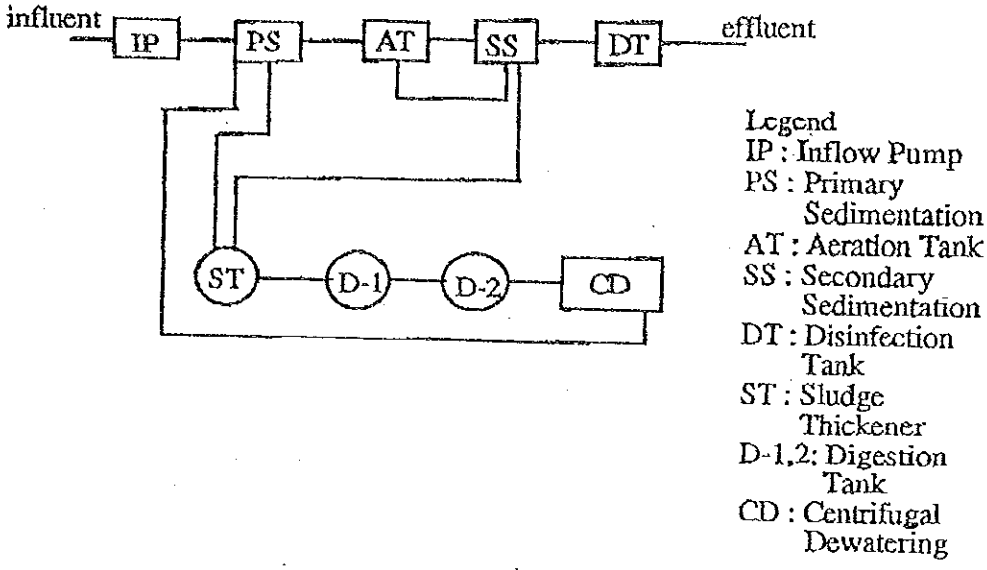


FIG. 2.8.1 PROPOSED SEWERAGE SYSTEM FOR PRELIMINARY DESIGN (RANGSIT AREA)

STUDY ON MASTER PLANNING FOR THE SEWERAGE DEVELOPMENT PROJECT FOR LOWER CHAO PHRAYA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 2.7.1 Wastewater Treatment Process



The design quality of the influent is assumed to be 175 mg/l for BOD and 150 mg/l for SS. The design wastewater plan includes that from the nine (9) housing areas, as the consolidated treatment plant can economically treat the combined discharged wastewater in the service area. A summary of the design quantity of wastewater for the preliminary design is shown below:

WASTEWATER	Year 2001 (m^3/d)	Year 2011 (m^3/d)
Daily Avg.	21,350	62,500
Daily Max.	25,700	75,000
Hourly Max.	33,300	97,500
Wet Weather Flow	100,000	292,500

Removed ratios by the major facilities are:

	Primary Sed. Tank	Final Sed. Tank
BOD	30.0%	83.7%
SS	35.0%	69.2%

The final effluent quality is 20 mg/l for BOD and 30 mg/l for SS.

The sludge treatment is designed for use of the thickener, anaerobic digestion tank and mechanical dewatering process. A total of six (6) treatment unit systems are planned for the final arrangement in the year 2011 and these unit systems will have a capacity of 75,000 m3/d. Two (2) unit systems with a capacity each of 12,500 m3/d are used for the first stage program. The layout plan and hydraulic profile of the facilities are shown in Figures 2.7.2 and 2.7.3.

Recommendations on the countermeasures to cope with the differences of influent quality and quantity between design and operation stages. These are as follows:

- Low concentration of influent quality :
  A provision of by-pass between inflow pump chamber and aeration tank without treatment at primary sedimentation Tank.

- Dissolved oxygen : Prior to primary sedimentation basin, aeration of wastewater for 30-60 minutes

- Low BOD concentration and small volume of influent :
  Modified use of aeration tank as extended aeration tank after by-pass of primary sedimentation.

2.8 Construction Plan & Operation and Maintenance of the Facilities

1. Construction

The manner of the construction of the sewerage facilities is detailed in the Master Plan. Description of the interceptor, overflow chamber, and inverted siphon are summarized below.

Interceptor - open trench method with sheet piling if deeper than 2.0 m.

Overflow Chamber - built under public roads, strategically located to accommodate housing estate sewage using consolidated inflow drainage.

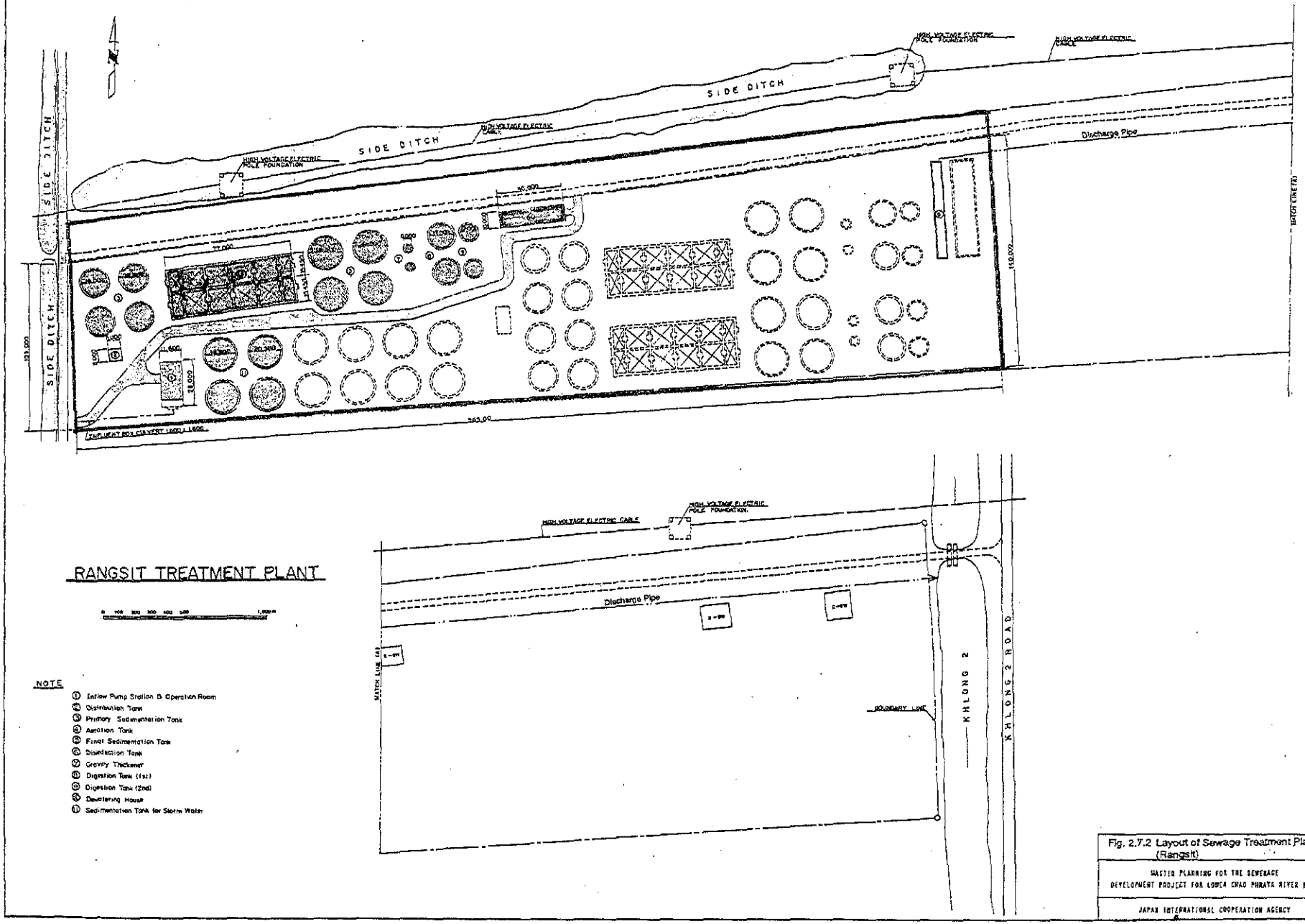


Fig. 2.7.2 Layout of Sewage Treatment Plant (Rangsit)

MASTER PLANNING FOR THE SEWERAGE DEVELOPMENT PROJECT FOR GREATER CHAO PHRAYA RIVER BASIN

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HYDRAULIC PROFILE

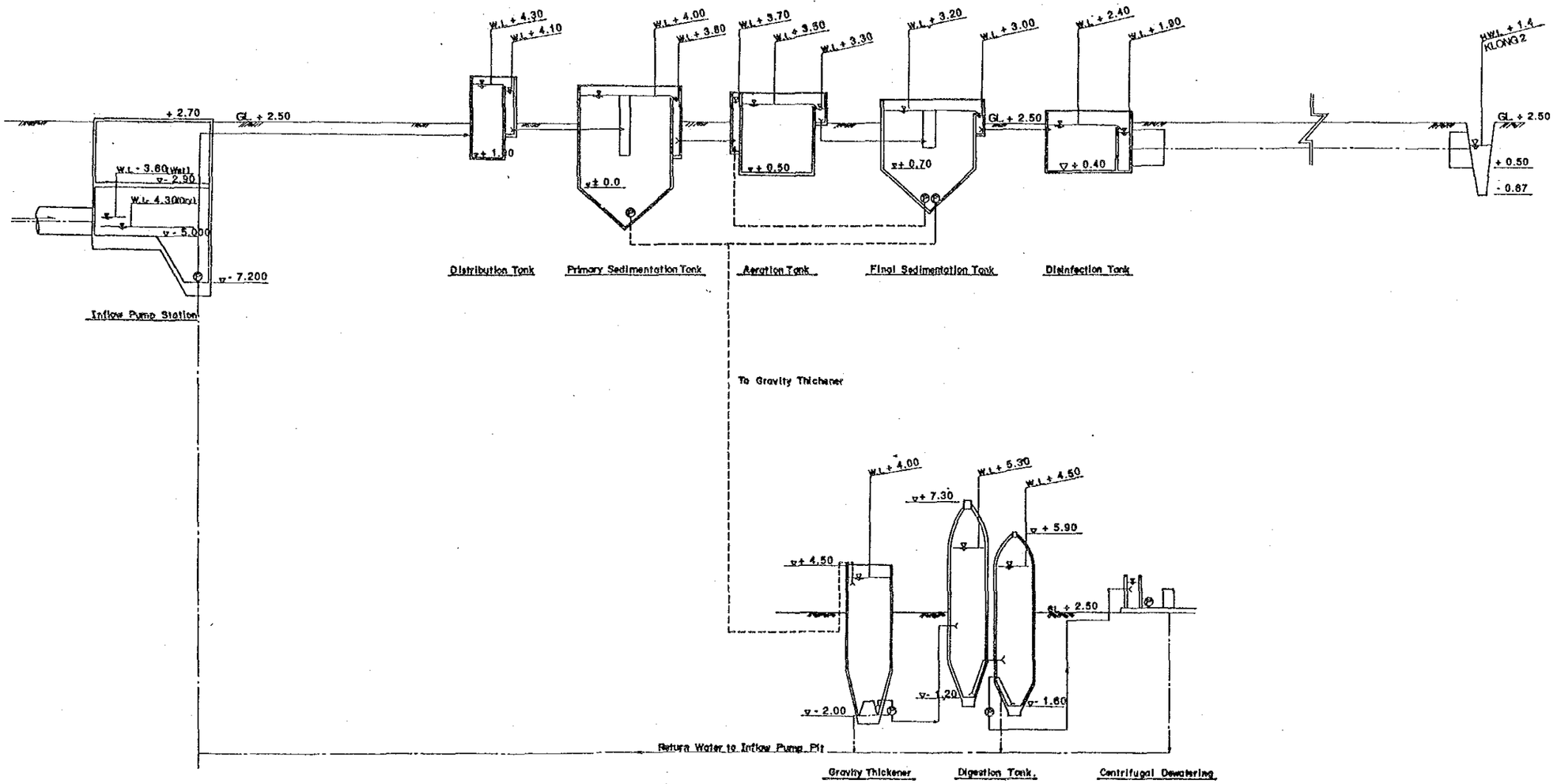


Fig. 2.7.3 Hydraulic Profile of Sewage Treatment Plant (Rangsit)

MASTER PLANNING FOR THE SEWERAGE DEVELOPMENT PROJECT FOR LOWER CHAO PHRAYA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Inverted Siphon - parallel pipes using the open cut method crossing a klong provided with chambers at both ends. Drain pumps if chamber depth is more than 5.0 m. Pressure releasing cover on chamber upstream of siphon.

Pump Station - located relative to surrounding elevations. Piling used with bearing strata at about 15 m below ground surface if necessary. At least more than two (2) units of pump facility will be utilized. Four (4) submersible pumps (for large pump stations) with 75 mm mesh bar screen. Central monitoring installed. No generator.

To minimize potential environmental problems caused by this project during construction, measures will be taken using careful construction methods and by securing cooperation from the local inhabitants. Every effort will be made to keep any interference with roads, klongs, and housing areas to a minimum. Road and klongs work will be done to allow partial traffic flow. Construction will be done as much as feasible only during the daytime to minimize disturbance to the people who live in the area.

(2) Operation and Maintenance

1) Interceptors and Pump Stations - routine inspections will be done along sewer routes. Careful maintenance of inverted siphon and discharge pipes. Periodic cleaning of overflow chamber. Periodic inspection for illegal connections. Public education about proper waste disposal in the sewer system.

2) Wastewater Treatment Plant - odor and noise minimized through careful operation and by monitoring. Effluent control done in consideration of current conditions and plant capacities. Routine investigations conducted to collect data and to optimize sewerage charge collection.

2.9 Cost Estimates and Capital Investment Program

The construction costs will consist of direct cost, indirect cost, contingency fee (20% of direct cost), and engineering fee (17% of total construction cost including contingency fee).

The direct cost, including tax, covers the costs of the interceptors with accessories, pump stations and treatment facilities. Most of the construction materials are available in Thailand except for certain mechanical and electrical equipment. Unit prices of basic materials and equipment are noted in the Master Plan. Current exchange rate will be used. The total construction cost is shown in Table 2.9.1.

Table 2.9.1 Project Cost on 1993 Price Level
(Unit : Million Baht)

Description	Domestic Portion	Foreign Portion	Total
1. Direct Cost			
1.1 Collection System			
(1)Interceptor	229.0	-	229.0
(2)Manhole	6.0	-	6.0
(3)Overflow Chamber	0.4	-	0.4
(4)Inverted Siphon	9.2	0.9	10.1
(5)Pump Station	42.2	60.2	102.4
Sub-Total	286.8	61.7	347.9
1.2 Treatment Plant			
(1)Civil & Architec. Facilities	61.5	-	61.5
(2)Mechanical Facility, (3)Electrical Facility	-	187.6	187.6
Sub-Total	61.5	187.6	249.1
Total of item 1	348.3	248.7	597.0
2. Contingency	69.7	49.7	119.4
3. Total of Construction Cost (1 + 2)	418.0	298.4	716.4
4. Engineering Cost	121.8	-	121.8
5. Land Acquisition Cost	76.9	-	76.9
Grand Total	616.7	298.4	915.1

Note : 1.1(1) includes maintenance equipment / car
1.2(2) includes P.S monitoring facility

Operation and maintenance annual cost estimates for the year 2001 are summarized below:

Item	Cost (x 1000 Baht)
1. Interceptor & accessories	847
2. Pump Stations	
(1) Labor	116
(2) O & M	6,062
3. Wastewater T.P.	
(1) Labor	736
(2) O & M	14,724
TOTAL COST:	22,485

The capital investment of the project will follow the Figure 2.9.1 schedule and will entail the currency amounts in Table 2.9.2.

Figure 2.9.1 Implementation Program for the First Stage Project

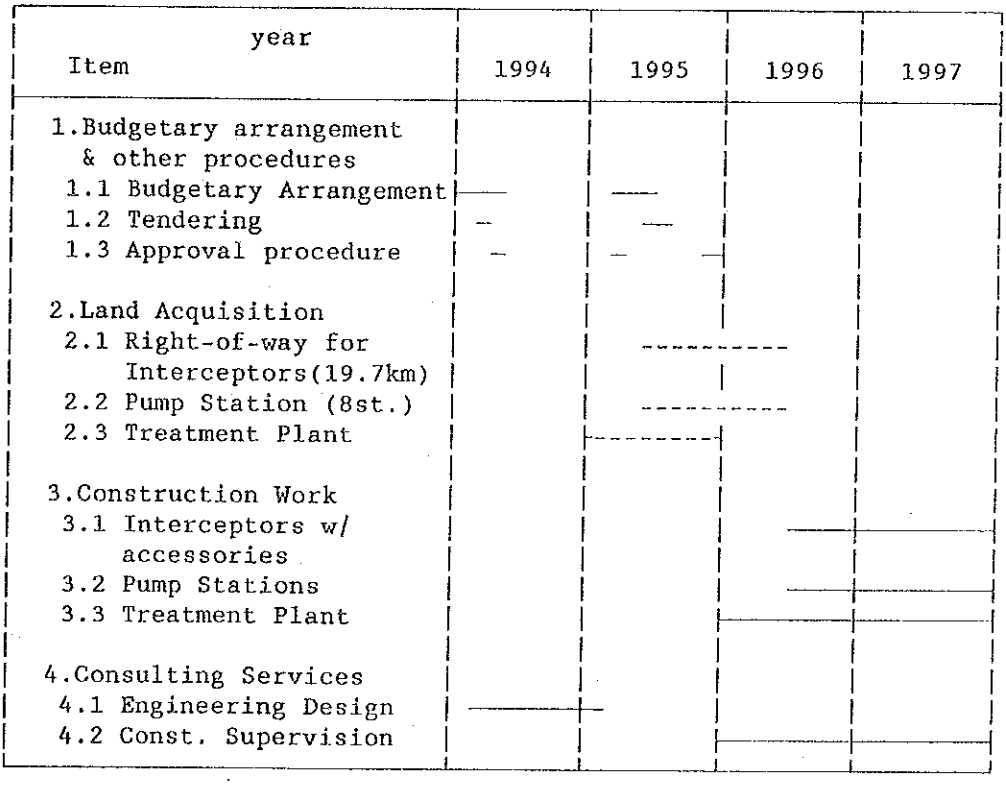


Table 2.9.2 Capital Investment Program for First Stage Project

Unit : Million Baht

Year / Item	1994			1995			1996			1997			Total		
	Dom.	Foreign	Total	Dom.	Foreign	Total	Dom.	Foreign	Total	Dom.	Foreign	Total	Dom.	Foreign	Total
1. Interceptors W/Accessories							73.4	0.3	73.7	171.2	0.6	171.8	244.6	0.9	245.5
2. Pump Stations							12.7	18.1	30.8	29.5	42.1	71.6	42.2	60.2	102.4
3. Treatment Plant							30.8	93.8	124.6	30.7	93.8	124.5	61.5	187.6	249.1
Sub-Total (item 1-3)							116.9	112.2	229.1	231.4	136.5	367.9	348.3	248.7	597.0
4. Contingency							23.4	22.4	45.8	46.2	27.3	73.5	69.7	49.7	119.4
5. Consulting Fee															
(1) Detailed Design	82.3		82.3	9.1		9.1							91.4		91.4
(2) Supervision							15.2		15.2	15.2		15.2	30.4		30.4
6. Land Acquisition				75.9		75.9	1.0		1.0				76.9		76.9
Sub-Total (item 4-6)	82.3		82.3	85.0		85.0	39.6	22.4	62.0	61.4	27.3	88.7	268.4	49.7	318.1
Total	82.3		82.3	85.0		85.0	156.5	134.6	291.1	292.8	163.8	456.6	616.7	298.4	915.1

Note : Dom.; Domestic portion
Foreign; Foreign portion
Procurement of maintenance car is included in item 1.
Laboratory equipment is considered in item 3.

2.10 Organization and Management Aspect

(1) National Level

1) Strengthening of PWD and OSW

A new office was created in PWD in 1993 to implement sewage works throughout the country. It is called as Office of Sewage Works (OSW). The Sanitary Engineering Division (SED) staff have been dealing with wide duties from solid waste management, nightsoil disposal, drainage and sewerage. The staff number of SED was 119, of which only 7 staff were in charge with drainage and wastewater treatment.

OSW has been just created and is in process of staffing. The staff number of OSW is recommended to be at least 50, including documentation, survey and drafting teams. It is recommended that OSW staff be involved with more policy-oriented direction and coordination among national and local governments.

The organization of OSW shall be strengthened immediately by replacing and recruiting expertise from in and out of the government. But if impossible, the key staff shall be assigned immediately and the other staff shall be increased gradually within 2 years.

2) Creation of NSWA

It is predicted that the demands for sewerage system will continue to increase through the future. But sanitary engineers who can work for sewerage system are rather limited, in Thailand, because of the historical and social background. One of the solutions for this is to create a new organization out of the central government, but with close relationship of PWD (OSW). This is to ensure efficient use of limited human resources.

This new organization can be National Sewage Works Authority (NSWA) as temporally named, in analogy with Metropolitan or Provincial Water Authority for water supply. NSWA shall be mainly concentrated with

sewerage planner and engineers, supported with other expertise (mechanical, electrical, chemical, biological and others).

It is recommended that NSWA be created within 3 years form now. By its creation OSW is expected to play the key role in implementing sewerage systems.

3) Legal arrangement

The laws and standards for environmental pollution control have been well developed for air, water and others in Thailand. However the problem is how to enforce these laws and standards in order to realize the people's welfare and amenity. If there is no capacity to monitor a pollution despite of the standard, the regulations is almost useless. This is why a real mechanism of legal enforcement should be developed. Fore the purpose effective trainings are one tool, and public education is also useful.

The Study Team recommends to implement two laws in 1994 : Sewage Works Law and Law of National and Local Sewage Works Authorities.

(2) Design Area

1) Creation of Local Sewage Works Authority (LSWA)

The Study Team recommends that a local sewage works authority be created in Rangiest after comparative study of two options. LSWA is expected to work better than an attached division to the municipality, because it can be to some degree free from regulations of Ministry of Interior. LSWA shall have a highly qualified manager and maintain contact with the municipality through liaison to Sewerage subsection under Health division of the municipality.

The 1st stage (1994-1997) is a period to prepare the management. The staff number of 15. After completion of the System the organization shall be expanded to operation shifting, for the second stage (1998-2001). The staff number is estimated to be 33.

2) Training

At national level National Sewage Works Authority (NSWA) shall be established. It shall be responsible for the trainings required for the municipality level. The number of training participants is small at municipal level. It is better to concentrate training courses in the center of the country. NSWA is expected to organize different training courses by its department.

The following training courses shall organized:

a) Management courses

i) Financial management
ii) System management
iii) Record management

b) Technical course

i) Training for TP operators
ii) Training for PS operators
iii) Training for pipe maintenance

The first group of NSWA and LSWA as staff shall be given respective trainings on time by end of 1997.

2.11 Financing the Project Cost

2.11.1 Central Government

The construction cost required under the responsibility of central government is not collected from beneficiaries directly. However, required payment was estimated in assumption of beneficiaries burden. The study was conducted in combination of the two study areas, Rang Sit and Bang Bua Thong. The Rangsit project cost was estimated at 915.1 million Baht in 1993 prices. The cost was divided into the local (616.7) and possible foreign (298.4) portion. The Bang Bua Thong project was also estimated at 459.5 million Baht in 1993 prices. The cost was derived form the local (338.1) and the foreign (121.4) portion.

(1) Option 1: 30% Project Cost by Foreign Loan and 70% by Self Financing

According to the arrangements by the central government through the future, the Central Government assumes 75% of the land acquisition cost (170.55) while the remaining 25% is borne by local municipalities.

There is no definite figure to be maintained, but in view of the capital opportunity cost of, say, 10 to 12%, the FIRR should be closer to the opportunity cost and be higher than the capital cost used in this example. The FIRR turned out to be 11.8%, reflecting the capital opportunity cost.

In assumption of beneficiaries responsibility, the loan cost per household user becomes 893 Baht in 1999 and decreased to 510 Baht toward the year 2024.

(2) Option 2: 30% Project Cost by Foreign loan and 70% by Local Loan

On the basis of 143,556 Baht as the low household income in 2011, 4,135 Baht would be equivalent of 2.8% of household income, much too high to bear. Should the entire project cost be financed, the financial burden on the part of household users would be too high and the household users would not be able to pay that amount.

2.11.2 Cash Flow and Household Burden of O&M and Local Land Acquisition Cost

Should the entire land acquisition cost be financed by the 50% foreign land and 50% local loan with the weighted average capital cost of 7% for 25 years with the grace period of 5 years, the break even cost per household user becomes 109 Baht per year in 1999 and drops to 63 Baht in 2024. However, the real burden on the household user become 437 Baht in 1999 and decreases to 254 in 2024. This is because the FIRR should be maintained in such a level that the local financial project be feasible. The FIRR should be somewhere greater than 7%, but less than the prevailing capital market cost of, say, 12%. The FIRR turned to be 7.4% in Rangsit. The above figure would indicate the maximum burden on the household user should Rangsit be financed entirely by the combination of foreign and local loans. Should Rangsit obtain through official procedures, subsidy and grant, the real burden on the household user would be smaller.

2.11.3 Affordability

In the Master Plan, it was estimated that the household income in highly industrialized Municipality of Rangsit would reach 430,670 Baht in 2011. This is the average figure and the low household income in Rangsit would be much less, say, less than one third. Using the figure of one third of 430,670 give 143,556 Baht. In the case of Rangsit, the relative cost of household user would become 437 Baht in 1999, 0.3% of household income of 143,556 Baht. Should the project loan cost by the Central Government be added to Rangsit household users, this figure would increase to 1,300 in 1999 and 764 Baht in 2024, respectively.

2.11.4 Recommendations

It is generally agreed upon that the burden on the household user be 1% or less. Should the household income in Rangsit in the neighborhood of 150,000 Baht in 2011, the relative burden on household users would not a be problem.

2.11.5 Financial Sensitivity Analysis

When the loan amount is fixed, the cash flow depends upon the revenue generated from the expected household user. As in most cases, the revenue collection efficiency, defined as the ration of the expected revenues to the actual revenues collected. When the collection efficiency drops to, say 80%, the expected FIRR also drops accordingly.

Three scenarios are assumed: The first is 80% revenue collection efficiency (FIRR=5.5%) and the second, (FIRR=4.4%), and the third, 60% (FIRR=3.2%), respectively.

2.12 Benefits of the Project

2.12.1 Economic Benefits

Significant economic benefits to public health of the community can be derived from installation of an adequate sewerage system. The benefits to be derived from the sewerage systems as recommended in this Master Plan can be classified into three categories, (1) water quality improvement, (2) health and sanitation improvement, and (3) economic benefits attributable to the increase of land value, tax income, and of business activities, and (4) upgrading of living standard.

Water Quality Improvement of Chao Phraya river

The sewerage projects in the study area will contribute enormously for improvement of the water quality of the River, although water quality at R4 would be critical comparing with the environmental standard.

Health Benefits

The benefits can be measured by the reduction of private health costs attributable to the incidence of the water-borne diseases.

The economic advantage to the community due to the reduction of the water-borne diseases is estimated. Quantification of health cost is determined through the direct relationship between the water-borne diseased and the cost of for treatment and care. For the purpose of this study, health cost is quantified, taking three factors into consideration; cost of medical treatment and care, income lost due to hospitalization, and out-patient consultation, it is expressed as the sum of these three factors:

The three factors are listed below:

a) medical cost of treatment and care per person at a hospital
b) medical cost of treatment and care per person per consultation
c) illness cost per person

Medical cost of a) and b) was 232.6 Baht in 1001, compared with illness cost of 99.4 Baht in 1991.

Then annual cost was estimated at 3.7 million in 1994 and 5.3 million Baht in 2024 in this study area of Rangsit sewerage project.

Land Value

A quantitative attempt to measure property value attributable to the sewerage factor:
An attempt to quantify economic benefits attributable to the increase in land price. Average Land price in the project service area is indicated as 46,605 million Baht in 1993.

It is assumed that the land price will increase at 5% per year from 1993 to 2000. The sewerage service area is assumed to contribute to 5% of the value of land increase. Net benefit of the increase of land value attributable to the sewerage project.

2.12.2 Economic Justifications

Socio-economic benefits derived from sewerage project are qualitatively discussed in the Master Plan.

Nevertheless, a quantitative trial measurement on health benefits and land value is attempted as an index of economic benefits.

An attempt to quantify economic benefits on the basis of the increase of land value and of the reduction of private health costs attributable to the sewerage project indicate that EIRR become 31%. This figure appears reasonable to justify the project on economic grounds. However, as will be indicated in 12.3 sensitivity analysis, this figure of EIRR should be interpreted with caution. Underlying assumptions and conditions may be subject to change and are sometimes difficult to foresee some fundamental changes of the socio-economic environment.

In view of qualitative improvement and quantitative measurement, the realization of sewerage project will bring about substantial advantages. Further deterioration of water quality in the public water body is indispensable without provision of sewerage project. The future opportunity cost is bound to increase should the project be delayed any further.

2.12.3 Economic Sensitivity Analysis

The EIRR of 30.8% appear high enough to justify the project on economic grounds. However, the major contributing factor to the value of EIRR is the assumptions made under land value and land value increase. Should the assumptions indicated may change, the value of EIRR will also be altered. Thus the value of EIRR should be interpreted with caution.

When the volume of land transactions decreases by 50%, then the EIRR drastically drops from 31% to 6.8%. Similarly when the volume of transactions decreased to one third, then EIRR will become 6.7%. The worst scenario that one fourth of land transactions is generated, then the EIRR becomes a negative of 2.2%.

CHAPTER 3 BANG BUA THONG MUNICIPALITY

3.1 Study Area for First Stage Sewerage Program

Of the two (2) service areas in the sewerage Master Plan, the Bang Bua Thong North area, covering some 438 ha, was selected as the priority area for the first stage program because of its higher population density. Administratively the area comprises two villages, Pimol Ratch 3 and 5, and part of Sano Loy and Bang Bua Thong 2 in Nonthaburi province. There are seven (7) housing estates in the master planning area, four of which are in the first stage plan area. The current population of the design area is estimated at 13,973 not including the housing estates.

3.2 Existing Sanitation/Sewerage Facilities in the Study Area

There are drainage facilities connected to the klong Pro Pimol in the urbanized area. On-site nightsoil disposal is practiced in the area. Some of the housing estates have wastewater treatment facilities, but rather few are in comparatively good condition.

The major klongs in the area are klong Phra Phimon and klong Ban Klual, which are connected to klong Bang Bua Thong. These klongs were observed to be shallow, stagnant, and filled with debris, indicating a lack of maintenance.

3.3 Population

The current registered population of the area is 14,802 for the administrative area and 13, 973 for the design area (excluding housing estates). The population for the housing estates increases the population in the design area to 18,643. Design population for the year 2001 is estimated by interpolating those in 1992 and 2011. The design population was determined to be 32,110 people.

3.4 Quantity and Quality of Wastewater

Wastewater quantity and quality (BOD load) to be collected and treated for the preliminary design area was calculated covering domestic, business and

groundwater infiltration. Domestic and business wastewater uses a per capita basis. The quantity and quality of the wastewater in the design area is summarized below:

WASTEWATER SOURCE	QUANTITY (M3/d)	BOD LOAD (kg/d)
Domestic	5,009	1,278
Business	2,517	302
Groundwater	1,505	-----
TOTAL	9,031	1,580

3.5 Design Criteria

Design criteria for the design of the sewerage facilities are summarized in Section 3.9 Chapter 2, Part II of the Master Plan.

3.6 Wastewater Collection System

The wastewater collection system utilized is the combined collection method. The target year for the main interceptors and pump stations is 2011.

As there are no plans to expand/improve the roads, channels, or klongs, the existing public roads are to be utilized for the installation of the interceptors and that routes along the klongs are to be avoided due to the difficulty of obtaining proper construction and maintenance support. Further, the land available will determine the location of the pump stations. The details of the collection facilities are shown in Table 6.1 in the Main Report. The designs of two (2) pump stations and one (1) inverted siphon are presented. The plan of the sewerage system is shown in Figure 2.6.1.

3.7 Wastewater Treatment and Sludge Disposal System

The proposed site for the wastewater treatment plant (1.8 ha) is located in Pimol Ratcha 5 village, behind the Chol Lada housing estate. The site is currently a paddy field.

The design quantity and quality of the wastewater for this area was studied in the previous section. The conventional activated sludge process is used. Figure 3.7.1 shows the flow treatment process.

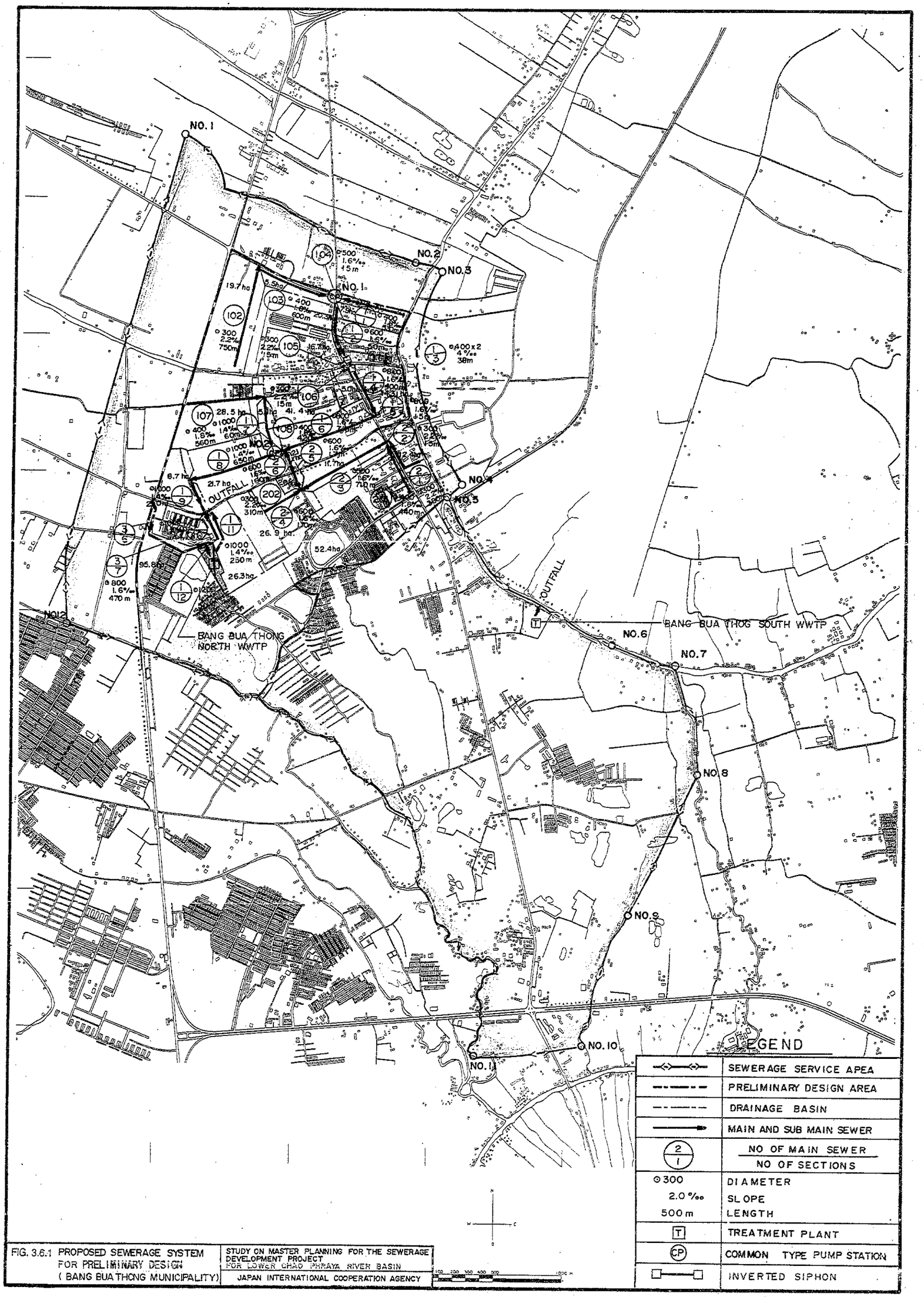
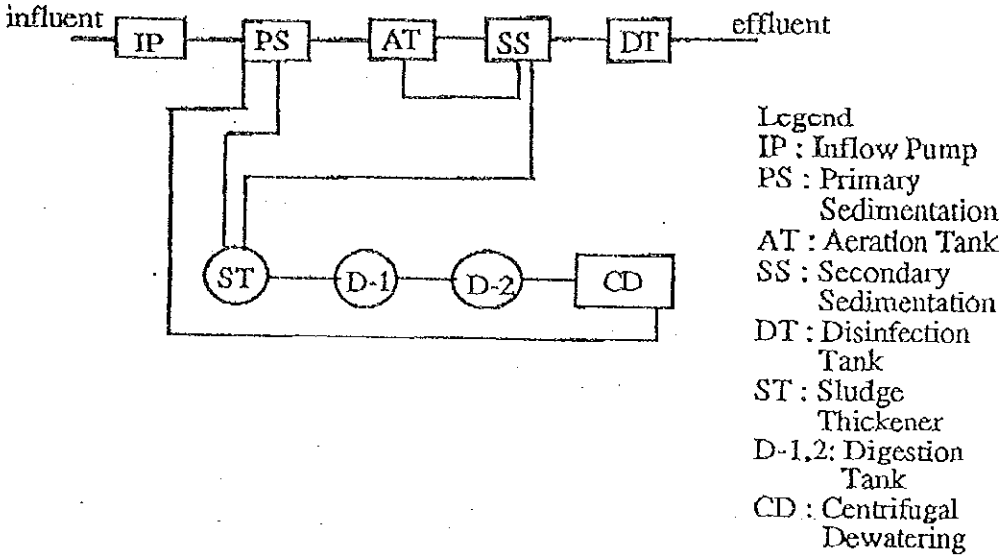


FIG. 3.6.1 PROPOSED SEWERAGE SYSTEM FOR PRELIMINARY DESIGN (BANG BUA THONG MUNICIPALITY)

STUDY ON MASTER PLANNING FOR THE SEWERAGE DEVELOPMENT PROJECT FOR LOWER CHAO PHRAYA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.7.1 Wastewater Treatment Process



The design influent quality is assumed to be 180 mg/l for BOD and 150 mg/l for SS. The design influent quantity is summarized below:

QUANTITY	Year 2001 (m^3/d)	Year 2011 (m^3/d)
Daily Avg.	9,100	19,700
Daily Max.	10,900	23,600
Hourly Max.	14,200	30,700
Wet Weather Flow	42,600	92,100

Removed ratios by the major facilities are:

	Primary Sed. Tank	Final Sed. Tank
BOD	30.0%	81.0%
SS	35.0%	69.2%

The final effluent quality is 20 mg/l for BOD and 30 mg/l for SS.

The sludge treatment is designed for use of the thickener, anaerobic digestion

The sludge treatment is designed for use of the thickener, anaerobic digestion tank and mechanical dewatering process. A total of four (4) treatment unit systems are planned for the final arrangement in the year 2011 and these unit systems will have a capacity of 23,600 m3/d. The two (2) unit systems with a capacity each of 5,900 m3/d are used for the first stage program. The layout plan and hydraulic profile of the facilities are shown in Figures 3.7.2 and 3.7.3.

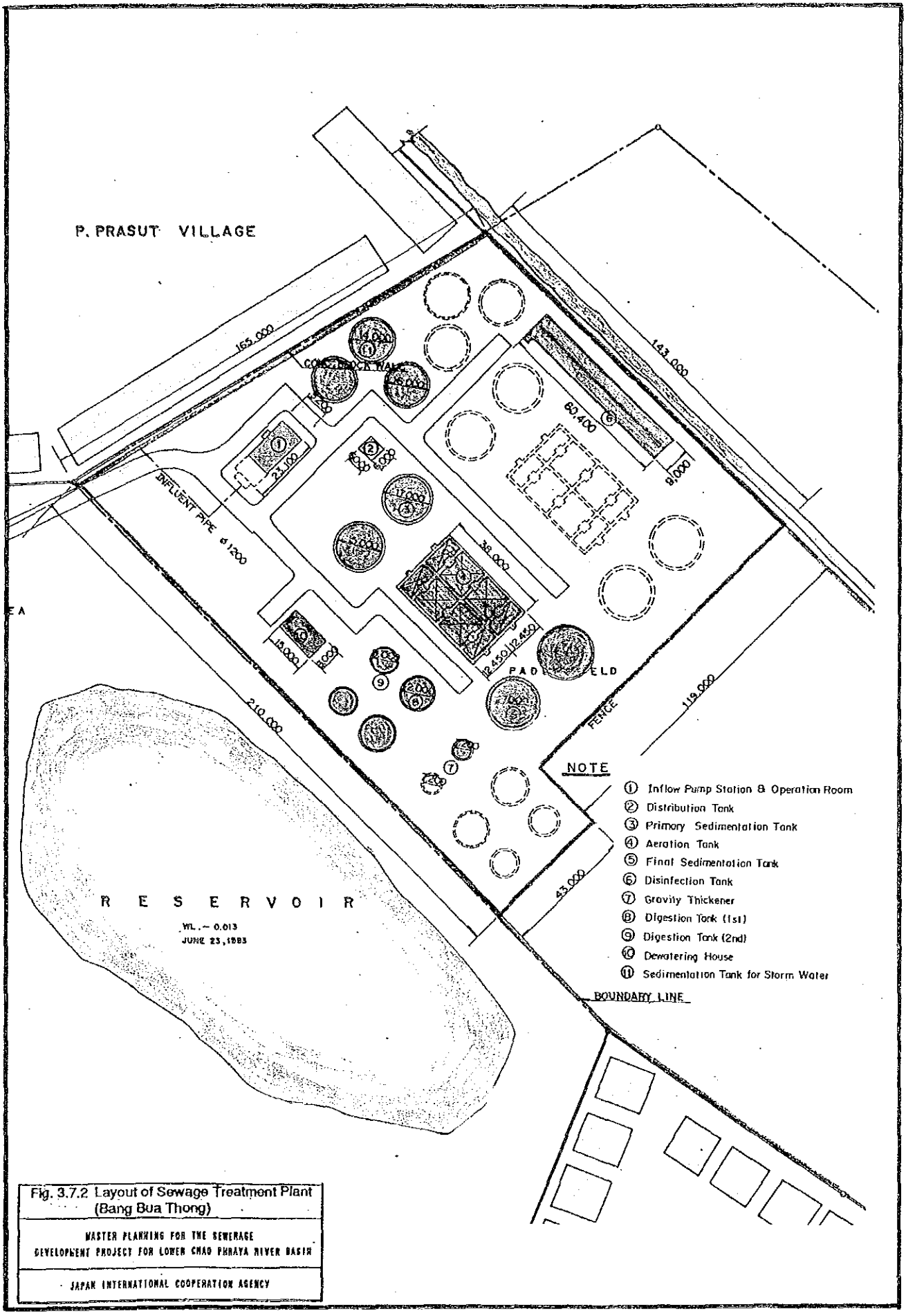


Fig. 3.7.2 Layout of Sewage Treatment Plant (Bang Bua Thong)

MASTER PLANNING FOR THE SEWERAGE DEVELOPMENT PROJECT FOR LOWER CHAO PHRAYA RIVER BASIN

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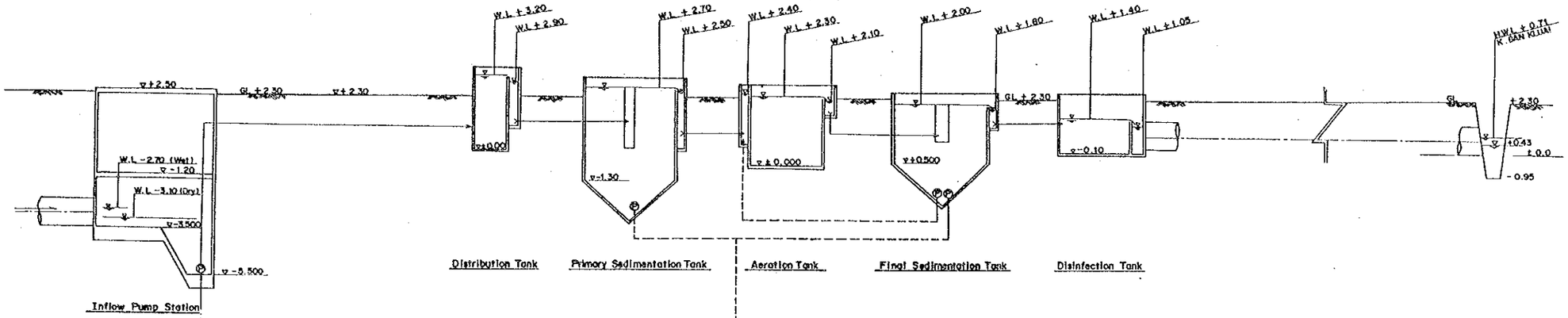
HYDRAULIC PROFILE



To Gravity Thickener

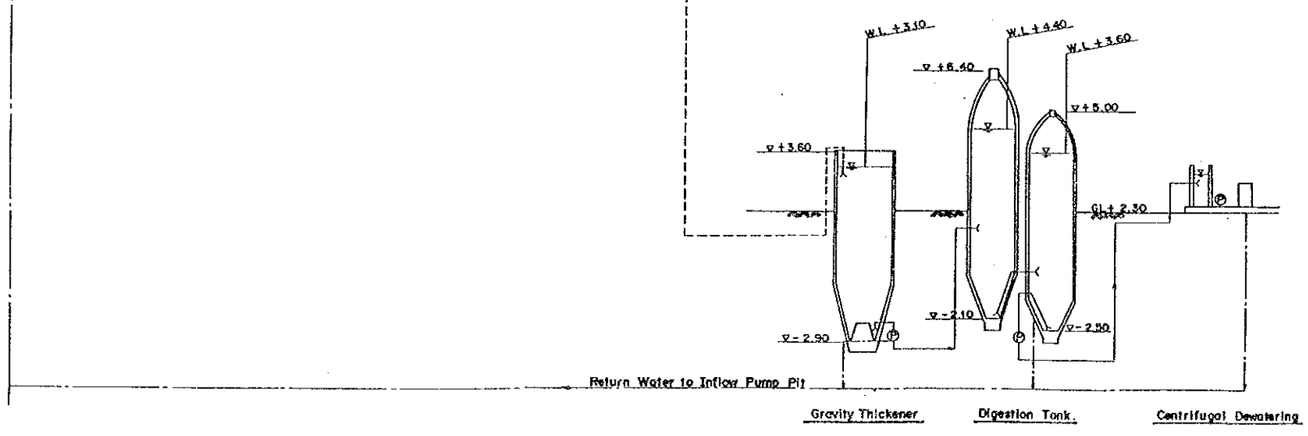


Fig. 3.7.3 Hydraulic Profile of Sewage Treatment Plant (Bang Bua Thong)

MASTER PLANNING FOR THE SEWERAGE DEVELOPMENT PROJECT FOR LOWER CHAO PHRAYA RIVER BASIN

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3.8 Construction Plan & Operation and Maintenance of the Facilities

The manner of construction of the sewerage facilities is detailed in the Master Plan. Description of the interceptor, overflow chamber, and inverted siphon are summarized below:

Interceptor - open trench method with sheet piling if deeper than 2.0 m.

Overflow Chamber - built under public roads, strategically located to accommodate housing estate sewerage using consolidated inflow drainage.

Inverted Siphon - parallel pipes using the open cut method crossing a klong provided with chambers at both ends. Drain pumps if chamber depth is more than 5.0 m. Pressure releasing cover on chamber upstream of siphon.

Pump Station - located relative to surrounding elevations. Piling used with bearing strata at about 15 m below ground level if necessary. At least two (2) units of pump facility will be utilized. Four (4) submersible pumps (for large pump stations) with 75 mm mesh bar screen. Central monitoring installed. No generator.

To minimize potential problems, the same procedures will be followed as those stated in Chapter 2 Rangsit Area, Section 2.8.

For operation and maintenance, methods identical to those outlined in Chapter 2 Rangsit Area, Section 2.8.

3.9 Cost Estimates and Capital Investment Plan

The same arrangements as outlined in Chapter 2 Rang Sit Area, Section 2.9 will apply. Most of the construction materials are available in Thailand except for certain mechanical and electrical equipment. Table 3.9.1 shows the 1993 project cost.

Table 3.9.1 Project Cost on 1993 Price Level

(Unit : Million Baht)

Description	Domestic Portion	Foreign Portion	Total
1. Direct Cost			
1.1 Collection System			
(1)Interceptor	74.3	-	74.3
(2)Manhole	2.8	-	2.8
(3)Overflow Chamber	0.4	-	0.4
(4)Inverted Siphon	1.1	0.2	1.3
(5)Pump Station	9.4	11.4	20.8
Sub-Total	88.0	11.6	99.6
1.2 Treatment Plant			
(1)Civil & Architec. Facilities	30.9	-	30.9
(2)Mechanical Facility, (3)Electrical Facility	-	89.6	89.6
Sub-Total	30.9	89.6	120.5
Total of item 1	118.9	101.2	220.1
2. Contingency	23.8	20.2	44.0
3. Total of Construction Cost (1 + 2)	142.7	121.4	264.1
4. Engineering Cost	44.9	-	44.9
5. Land Acquisition Cost	150.5	-	150.5
Grand Total	338.1	121.4	459.5

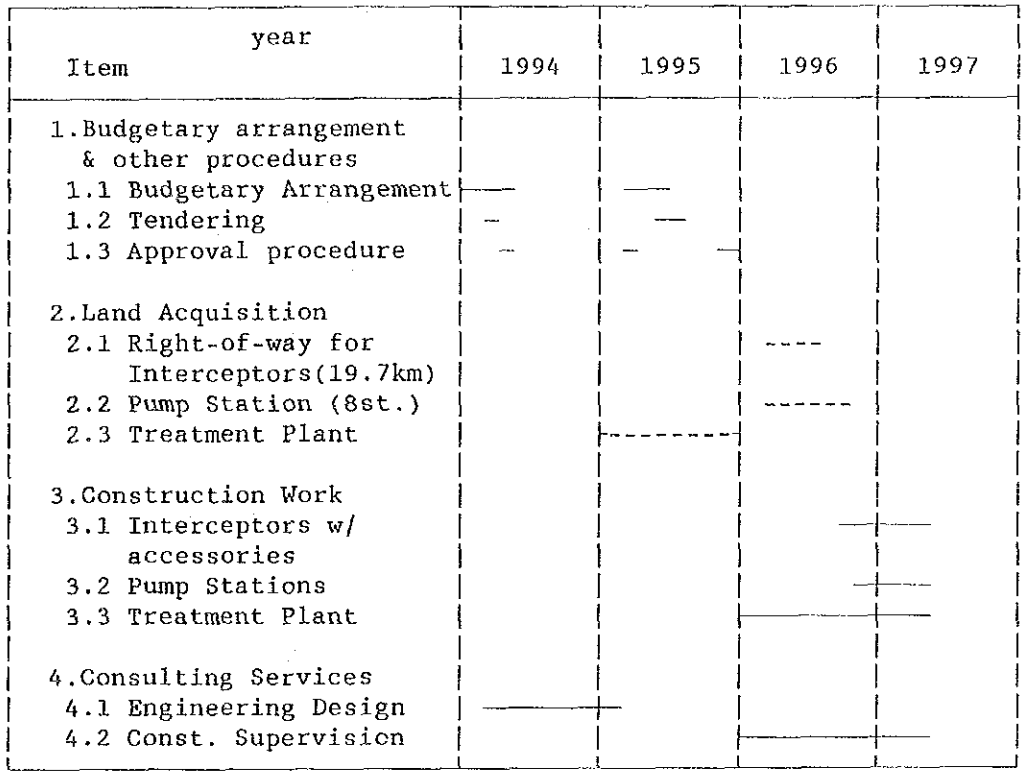
Note : 1.1(1) includes maintenance equipment / car
1.2(2) includes P.S monitoring facility

Annual operation and maintenance costs are summarized below:

Item	Cost (x 1000 Baht)
1. Interceptor & accessories	366
2. Pump Stations	
(1) Labor	116
(2) O & M	1,289
3. Wastewater T.P.	
(1) Labor	737
(2) O & M	7,192
TOTAL COST:	9,700

The capital investment of the project will follow the Figure 3.9.1 schedule and will entail the currency amounts in Table 3.9.2.

Figure 3.9.1 Implementation Program for the First Stage Project



3.10 Organization and Management Aspects

(1) Creation of Local Sewage works Authority (LSWA)

The study Team recommends that local sewage works authority be created in Bang Bua Thong, because it is expected to work better than the attached sewerage division in the municipality. However a new organization for sewerage should be managed with close liaison with the municipality.

This is the same recommendation made for Rangsit Area, because the both municipalities have almost the same structure from management point of view for sewerage system.

Table 3.9.2 Capital Investment Program for First Stage Project

Unit : Million Baht

Year / Item	1994			1995			1996			1997			Total		
	Dom.	Foreign	Total	Dom.	Foreign	Total	Dom.	Foreign	Total	Dom.	Foreign	Total	Dom.	Foreign	Total
1. Interceptors W/Accessories							31.4	0.1	31.5	47.2	0.1	47.3	78.6	0.2	78.8
2. Pump Stations							2.8	3.4	6.2	6.6	8.0	14.6	9.4	11.4	20.8
3. Treatment Plant							21.6	62.7	84.3	9.3	26.9	36.2	30.9	89.6	120.5
Sub-Total (item 1-3)							55.8	66.2	122.0	63.1	35.0	98.1	118.9	101.2	220.1
4. Contingency							11.2	13.2	24.4	12.6	7.0	19.6	23.8	20.2	44.0
5. Consulting Fee															
(1) Detailed Design	30.3		30.3	3.4		3.4							33.7		33.7
(2) Supervision							7.8		7.8	3.4		3.4	11.2		11.2
6. Land Acquisition				150.0		150.0	0.5		0.5				150.5		150.5
Sub-Total (item 4-6)	30.3		30.3	153.4		153.4	19.5	13.2	32.7	16.0	7.0	23.0	219.2	20.2	239.4
Total	30.3		30.3	153.4		153.4	75.3	79.4	154.7	79.1	42.0	121.1	338.1	121.4	459.5

Note : Dom.; Domestic portion
Foreign; Foreign portion
Procurement of maintenance car is included in item 1.
Laboratory equipment is considered in item 3.

(2) Training

It is recommended that most of trainings be given to managers and operators at national level. NSWA shall organize the different training courses which are the same as Rangsit Area.

The sewerage system is scheduled to go into operation in 1998. The first group of LSWA staff shall have the training by the end of 1997.

3.11 Financing the Project Cost

Optional study on budgetary arrangements was made covering Rangsit and Bang Bua Thong areas as described for Rangsit area.

3.11.1 Cash Flow and Household Burden of O&M and Local Land Acquisition Cost

Should the entire land acquisition cost be financed by the 50% foreign land and 50% local loan with the weighted average capital cost of 7% for 25 years with the grace period of 5 years. The break even cost per household user becomes 236 Baht in 1999 and drops to 131 in 2024. The real burden on the household user, however, becomes 482 Baht in 1999 and decreases to 267 Baht in 2024. This is because the FIRR should be maintained in such a level that the local financial project be feasible. The FIRR should be somewhere greater than 7%, but less than the prevailing capital market cost of, say, 12%. The FIRR turned to be 8.7% in Bang Bua Thong.

The above figure would indicate the maximum burden on the household user should Bang Bua thong be financed entirely by the combination of foreign and local loans. Should Bang Bua Thong obtain through official procedures, subsidy and grant, the real burden on the household user would be smaller.

3.11.2 Affordability

In the Master Plan, it was estimated that the household income in highly industrialized Municipality in Bang Bua Thong would be 430,670 Baht in 2011. But the low income household would be much less, say, less than one third. Using the figure of one third of 430,670 give 143,556 Baht.

In the case of Bang Bua Thong, the relative cost of household user would become 482 Baht in 1999, 0.3% of household income of 143,556 Baht. Should the project loan cost by the Central Government be added to Bang Bua Thong household users, this figure would increase to 1,375 in 1999 and 777 Baht in 2024, respectively.

3.11.3 Recommendations

It is generally agreed upon that the burden on the household user be 1% or less. Should the household income in Bang Bua Thong be in the neighborhood of 150,000 Baht in 2011, the relative burden on household users would not a be problem.

However, in the first five years between 1994 and 1999, some form of subsidy and grant will be much to be desired in Bang Bua Thong where the relative burden on household users is substantially high.

With respect to local financing, the municipality will be advised to utilized a combination of foreign and local loans to the extent that their local financial resources will not be too much burdened. This study has provided one practical and feasible solution as 50% foreign loan 50% local loan. There are other combinations of foreign and local loans also.

3.11.4 Financial Sensitivity Analysis

When the loan amount is fixed the cash low depends upon the revenue generated from the expected household user. As in most cases, the revenue collection efficiency, defined as the ration of the expected revenues to the actual revenues collected. Then the collection efficiency drops to, say 80%, the expected FIRR also drops accordingly.

Three scenarios are assumed: The first is 80% revenue collection efficiency (FIRR=6.7%) and the second, 70% (FIRR=5.5%), and the third, 60% (FIRR=4.3%), respectively.

3.12 Benefits of the Project

3.12.1 Economic Benefits

Significant economic benefits to public health of the community can be derived from installation of an adequate sewerage system. The benefits to be derived from the sewerage systems as recommended in this Master Plan can be classified into three categories. (1) water quality improvement, (2) health and sanitation improvement, (3) economic benefits attributable to the increase in land value and (4) upgrading of living standard.

Water Quality Improvement of Chao Phraya river

The sewerage projects in the study area will contribute enormously for improvement of the water quality of the River, although water quality at R4 would be critical comparing with the environmental standard. The benefits can be measured by the reduction of private health costs attributable to the incidence of the water-borne diseases.

Health the Sanitation Benefits

The economic advantage to the community due to the reduction of the water-borne diseases is estimated. Quantification of health cost is determined through the direct relationship between the water-borne diseases and the cost of for treatment and care. For the purpose of this study, health cost is quantified, taking three factors into consideration; cost of medical treatment and care, income lost due to hospitalization, and out-patient consultation, it is expressed as the sum of these three factors:

The three factors are listed below:

a) medical cost of treatment and care per person at a hospital
b) medical cost of treatment and care per person per consultation
c) illness cost per person

Medical cost of a) and b) was 232.6 Baht in 1991, compared with illness cost of 99.4 Baht in 1991.

Then annual health cost was estimated at 1.7 million in 1994 and 2.5 million Baht in 2024 in this study area of Bang Bua Thong sewerage project.

Increases of Land Value

A quantitative attempt to measure property value attributable to the sewerage factor:

An attempt to quantify economic benefits attributable to the increase in land price. Average Land price in the project service area is indicated as 27,585 million Baht in 1993.

It is assumed that the land price will increase at 5% per year from 1993 to 2000. The sewerage service area is assumed to contribute to 5% of the value of land increase. Net benefit of the increase of land value attributable to the sewerage project.

3.12.2 Economic Justifications

Socio-economic benefits derived from sewerage project are qualitatively discussed in the Master Plan.

Nevertheless, a quantitative trial measurement on health and sanitation benefits and increase of land value is attempted as an index of economic benefits.

An attempt to quantify economic benefits on the basis of the increases of land value and of the reduction of private health costs attributable to the sewerage project indicate that EIRR become 48%. This figure appears reasonable to justify the project on economic grounds. However, as will be indicated in 12.3 sensitivity analysis, this figure of EIRR should be interpreted with caution. Underlying assumptions and conditions may be subject to change and are sometimes difficult to foresee some fundamental changes of the socio-economic environment.

In view of qualitative improvement and quantitative measurement, the realization of sewerage project will bring about substantial advantages. Further deterioration of water quality in the public water body is indispens-

able without provision of sewerage project. The future opportunity cost is bound to increase should the project be delayed any further.

3.12.3 Economic Sensitivity Analysis

The EIRR of 48.1% appear high enough to justify the project on economic grounds. However, the major contributing factor to the value of EIRR is the assumptions made under land value and land value increase. Should the assumptions indicated may change, the value of EIRR will also be altered. Thus the value of EIRR should be interpreted with caution.

When the volume of land transactions decreases by 50%, then the EIRR drastically drops from 48.1% to 12.5%. Similarly when the volume of transactions decreases to one third, then EIRR will become 4.9%. The worst scenario that one fourth of land transactions is generated, then the EIRR becomes 1.3%.