8.2.2 Total Facility Layout

The layout of the total water supply system depends on the components of the system, and their location. Of the system component, particularly the transmission and distribution system should firstly selected. Major facilities to be located are the intake and pumping station, treatment plant, distribution reservoirs, and pipelines. The location of the intake and pumping station are discussed in the previous sub-section. There are some alternatives for the location of the treatment plant, and pipeline system.

(1) Treatment plant location

Two alternatives are proposed for selecting the location of the plant as described below.

(i) Location A (at Ban Mettarang, 7 km north of MWA's intake)

There are some vacant area near this point. However, this point should be considered only in case the raw water intake is located close to this point. If intake point is located near the existing MWA's intake, this alternative will not be considered.

(ii) Location B (close to the existing MWA's intake)

This alternative may be most practical if the raw water will be taken at this point. This location is not so far from the service area and makes the raw water intake operation easier to control from the treatment plant.

(2) Transmission and distribution system

As described in Chapter 7, the zoning method is introduced in the preparation of the water transmission and distribution system. In this method, there are two alternatives for the water transmission and distribution:

(i) Transmission and distribution combined (Combined System)

Water is to be transmitted from the treatment plant to the connected reservoirs and simultaneously distributed from the same pipeline to the consumers located along the pipeline route.

Advantage of this system is that total length of the pipeline is shorter than that for the Separate System. The pipe diameter will, however be larger since the whole length of the pipeline should be designed for the hourly maximum demand.

The pump operation, and pressure and flow control will be more complex so that it needs much more careful observation and experience compared to the Separate System.

(ii) Transmission and distribution separated (Separate System)

Pipelines connecting from the treatment plant to distribution reservoirs are to be used only for conveying the treated water to each reservoir. Water distribution to the consumers is to be made with the pipelines from each reservoir.

This system needs longer pipeline than the Combined System, but the main pipes will have the smaller diameter since they will be

designed for the daily maximum demand.

(3) Proposed Alternatives for the System Layout

Considering the above conditions for the location of the treatment plant and transmission system, the six alternatives are proposed as summarized below.

Table 8-2-1 System Layout Alternatives

Alternative No.	Raw Water Intake Point	Treatment Plant Location	Transmission System
1 - 1	No.1	Location A	Combined System
1 - 2	No.1	Location A	Separate System
2 - 1	No.1	Location B	Combined System
2 - 2	No.1	Location B	Separate System
3 - 1	No.3	Location B	Combined System
3 - 2	No.3	Location B	Separate System

Raw Water Intake Point : No.1 = at Ban Mettarang
No.3 = at upstream of MWA's Intake

Figures 8-2-2 to 8-2-7 show schematic plans and system diagram for the six alternatives.

(4) Land requirement for the distribution reservoirs

Construction of the proposed distribution reservoirs will require the land area. It is desirable to use the existing deep well plants in the service area for this purpose, provided that the plants have usable spaces, and the new construction will not disturb the existing water supply operation. Appendix A-8-2 show the possible location plan of the proposed reservoirs in the existing deep well plants. From these plans, it is anticipated that the existing plants will be able to provide the space for the proposed reservoirs.

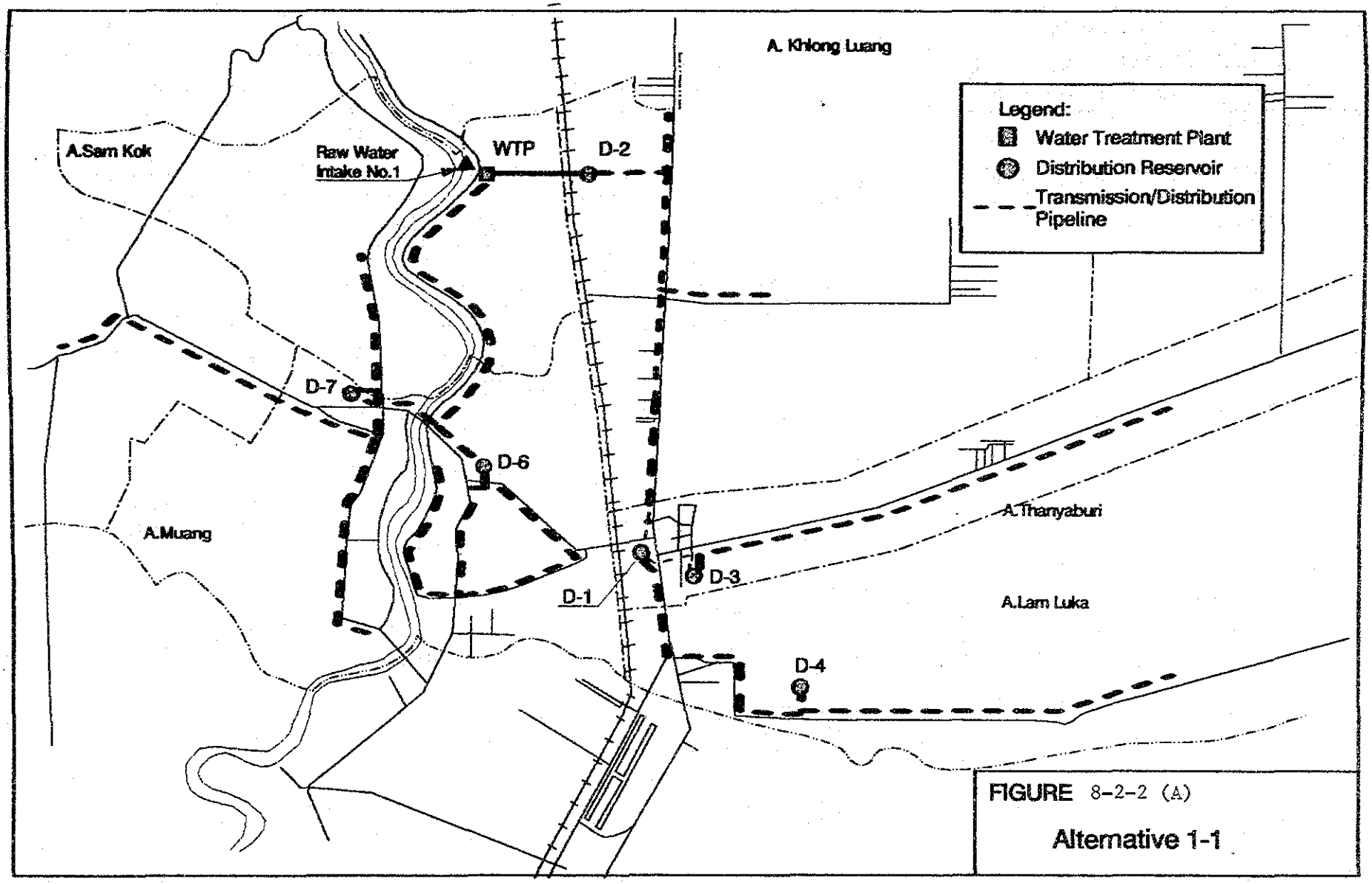


FIGURE 8-2-2 (A)

Alternative 1-1

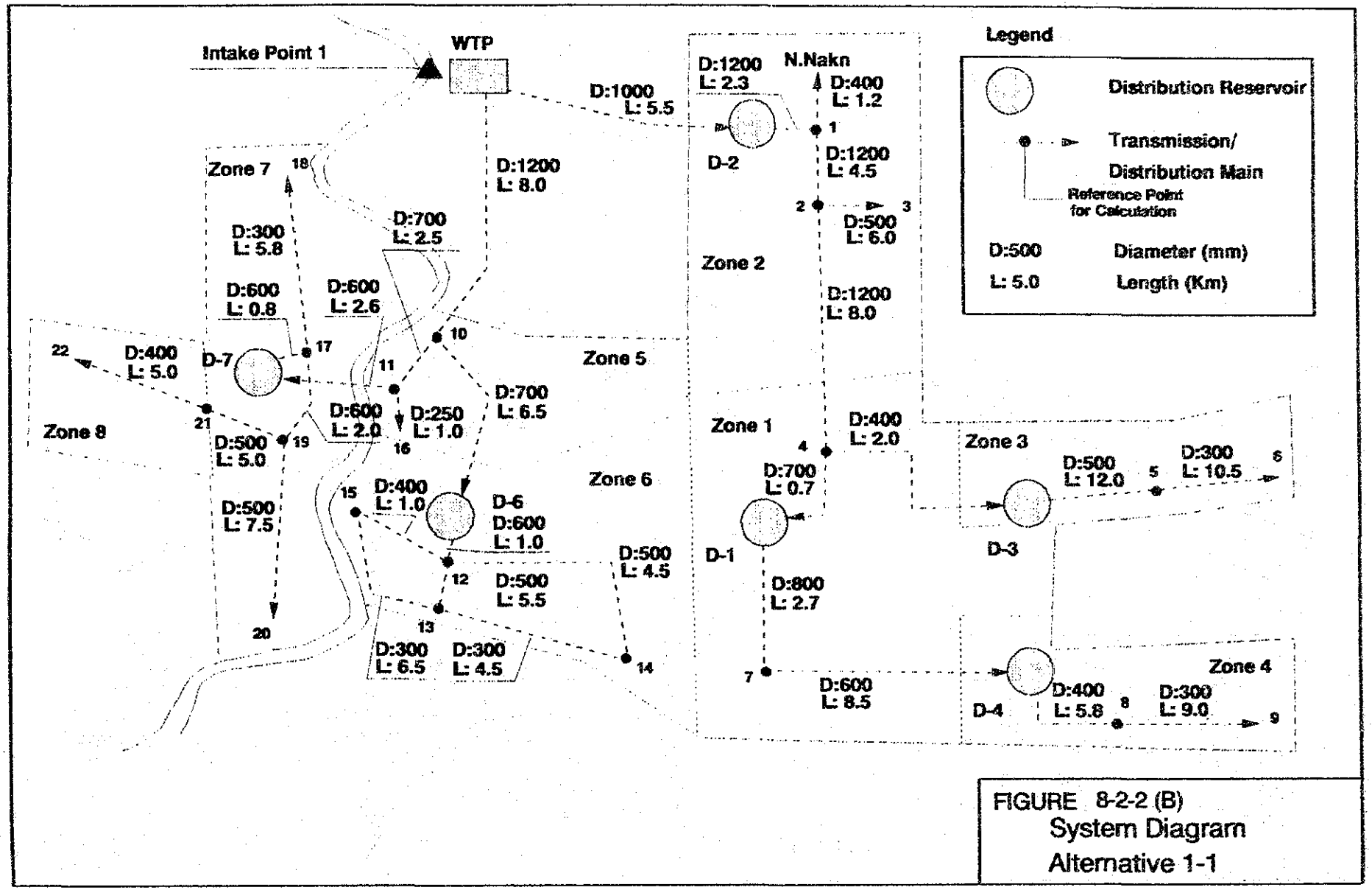


FIGURE 8-2-2 (B)
System Diagram
Alternative 1-1

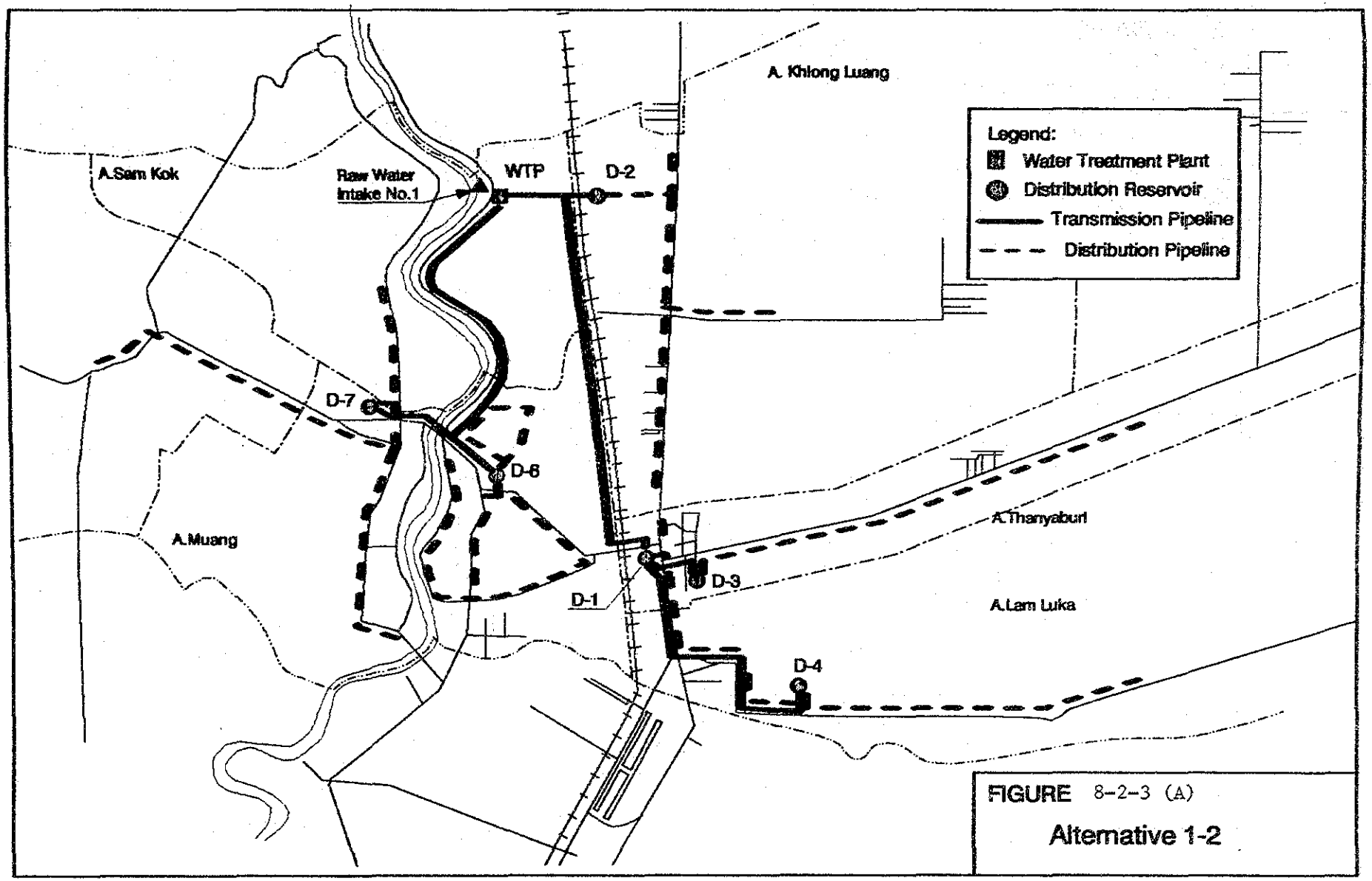


FIGURE 8-2-3 (A)

Alternative 1-2

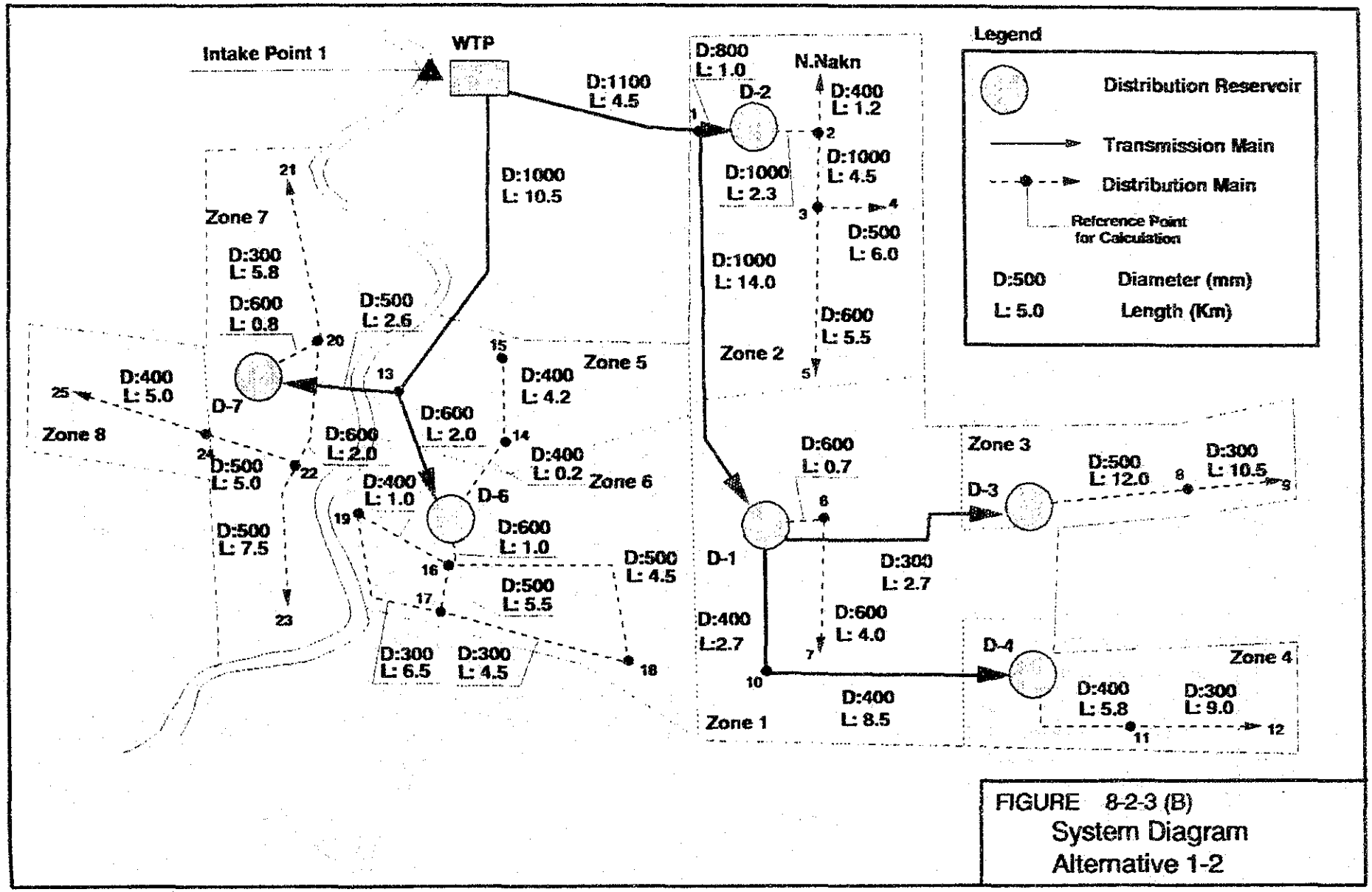


FIGURE 8-2-3 (B)
System Diagram
Alternative 1-2

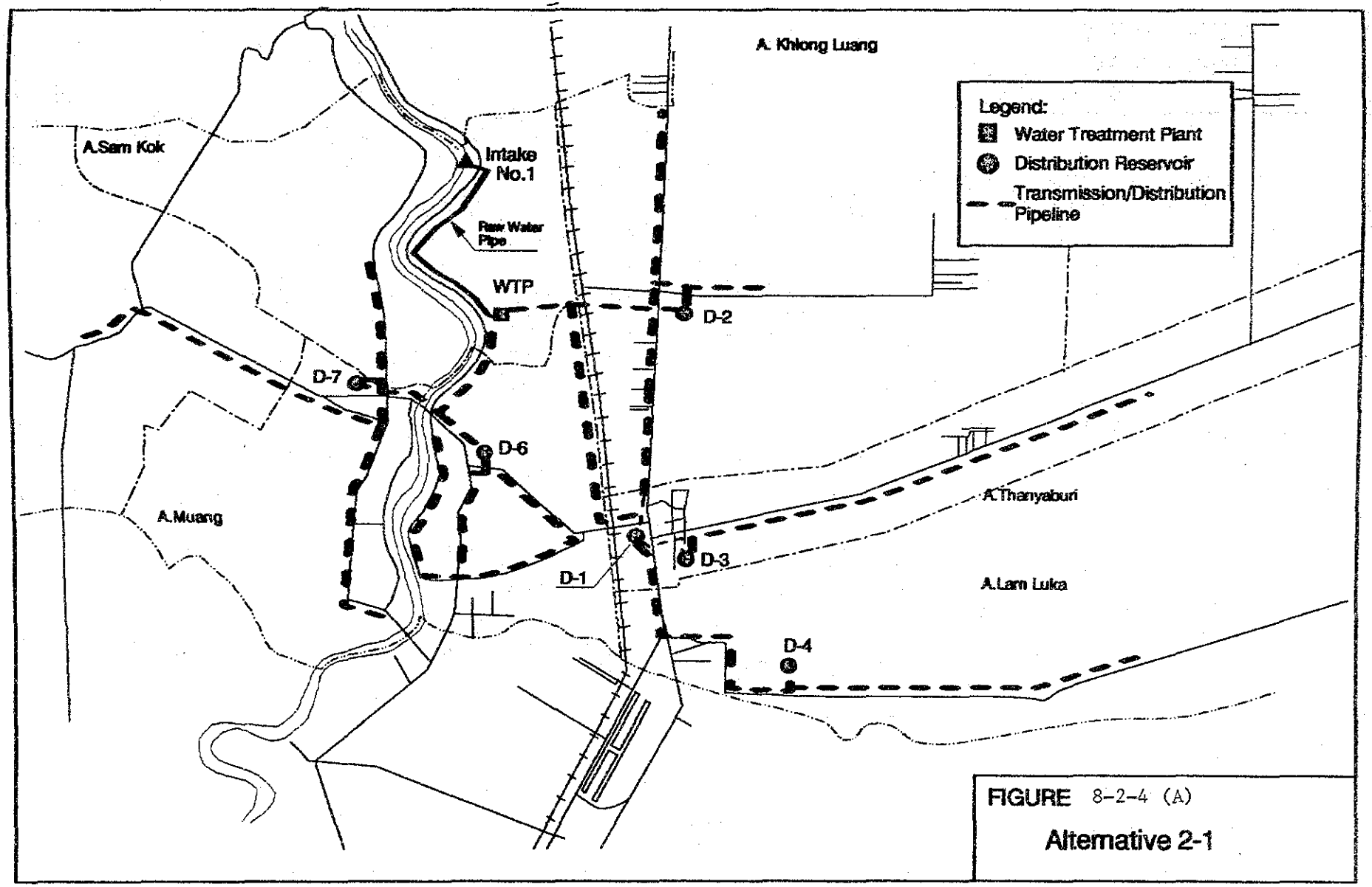


FIGURE 8-2-4 (A)

Alternative 2-1

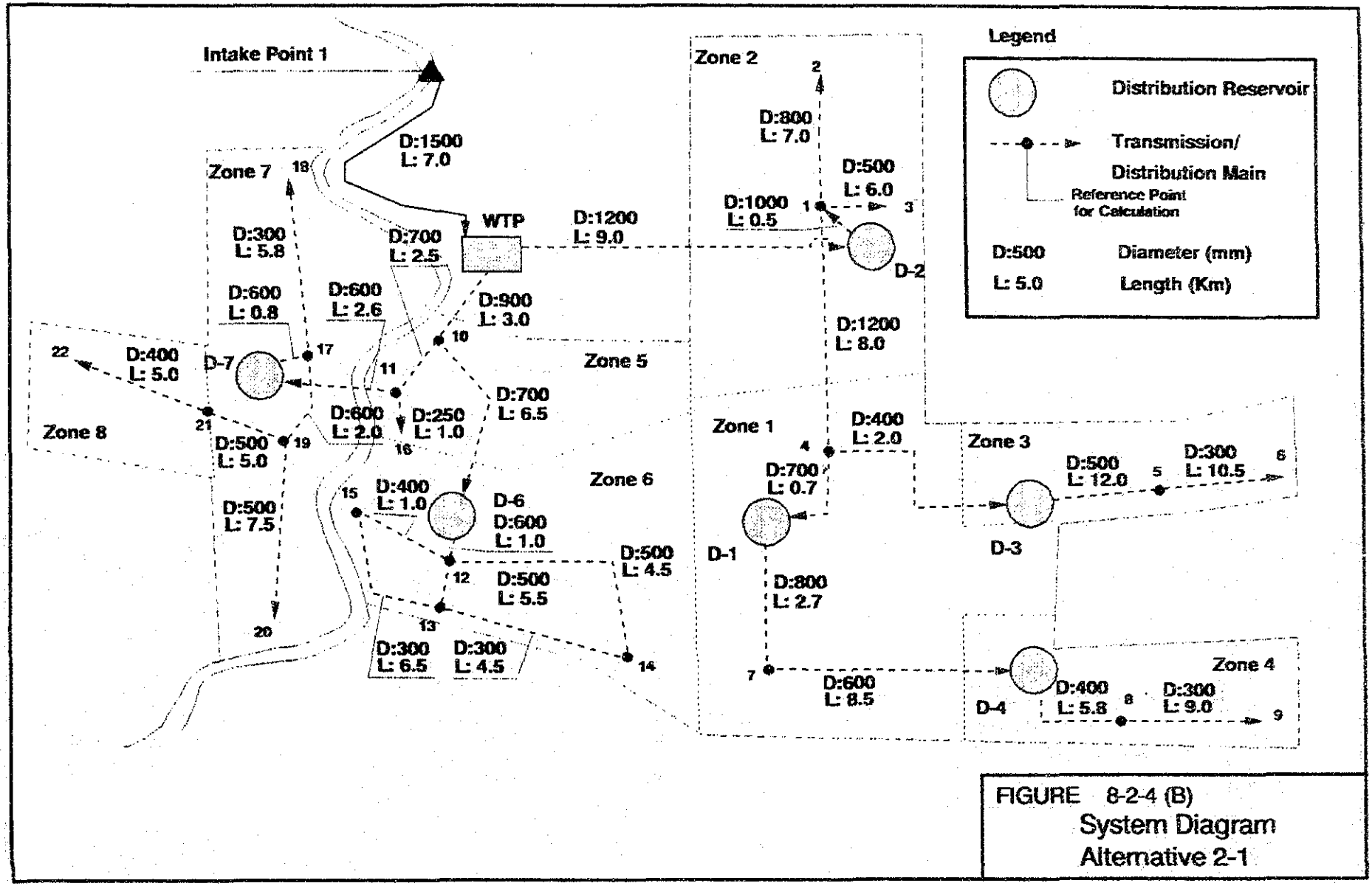


FIGURE 8-2-4 (B)
System Diagram
Alternative 2-1

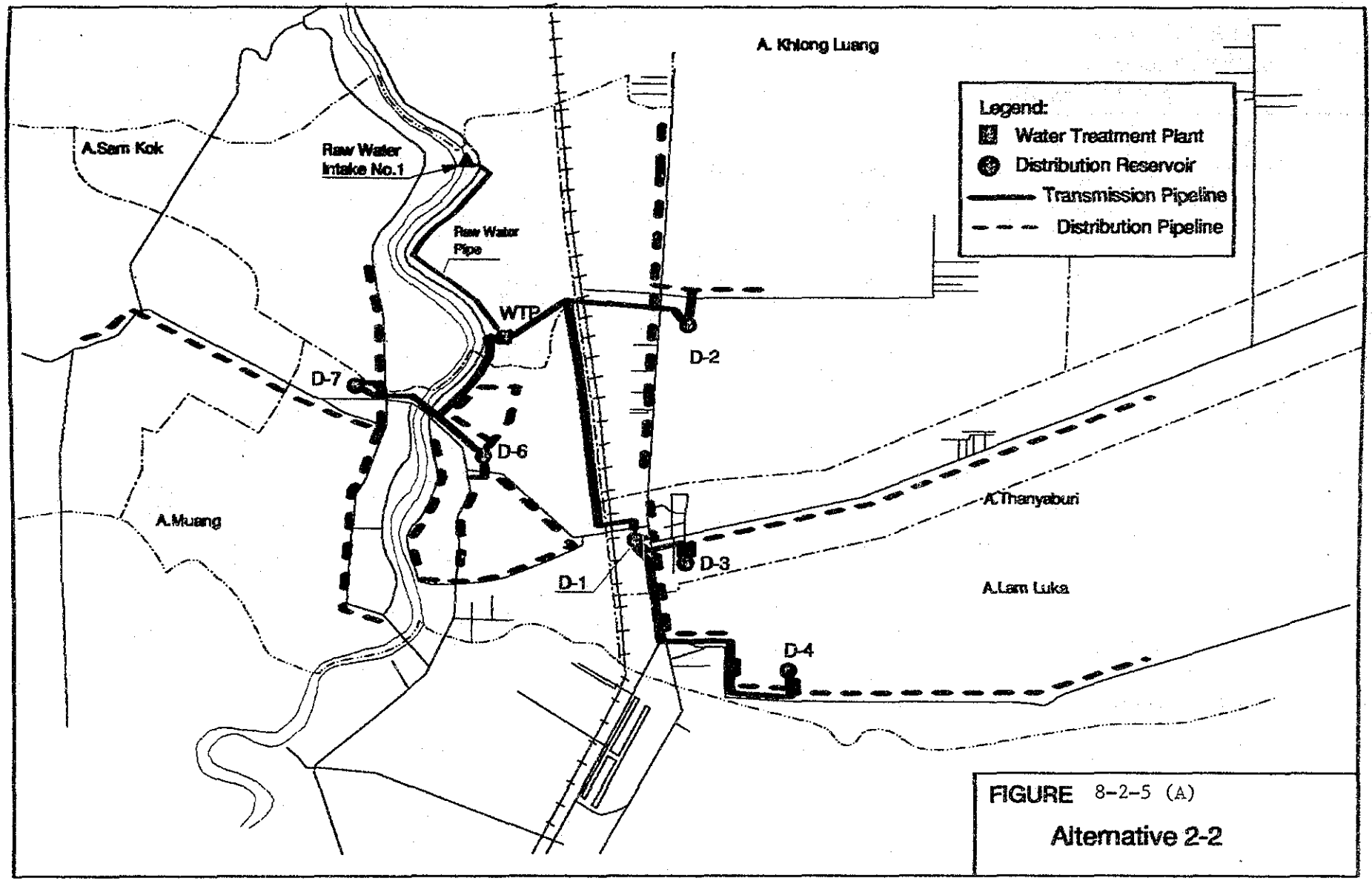


FIGURE 8-2-5 (A)

Alternative 2-2

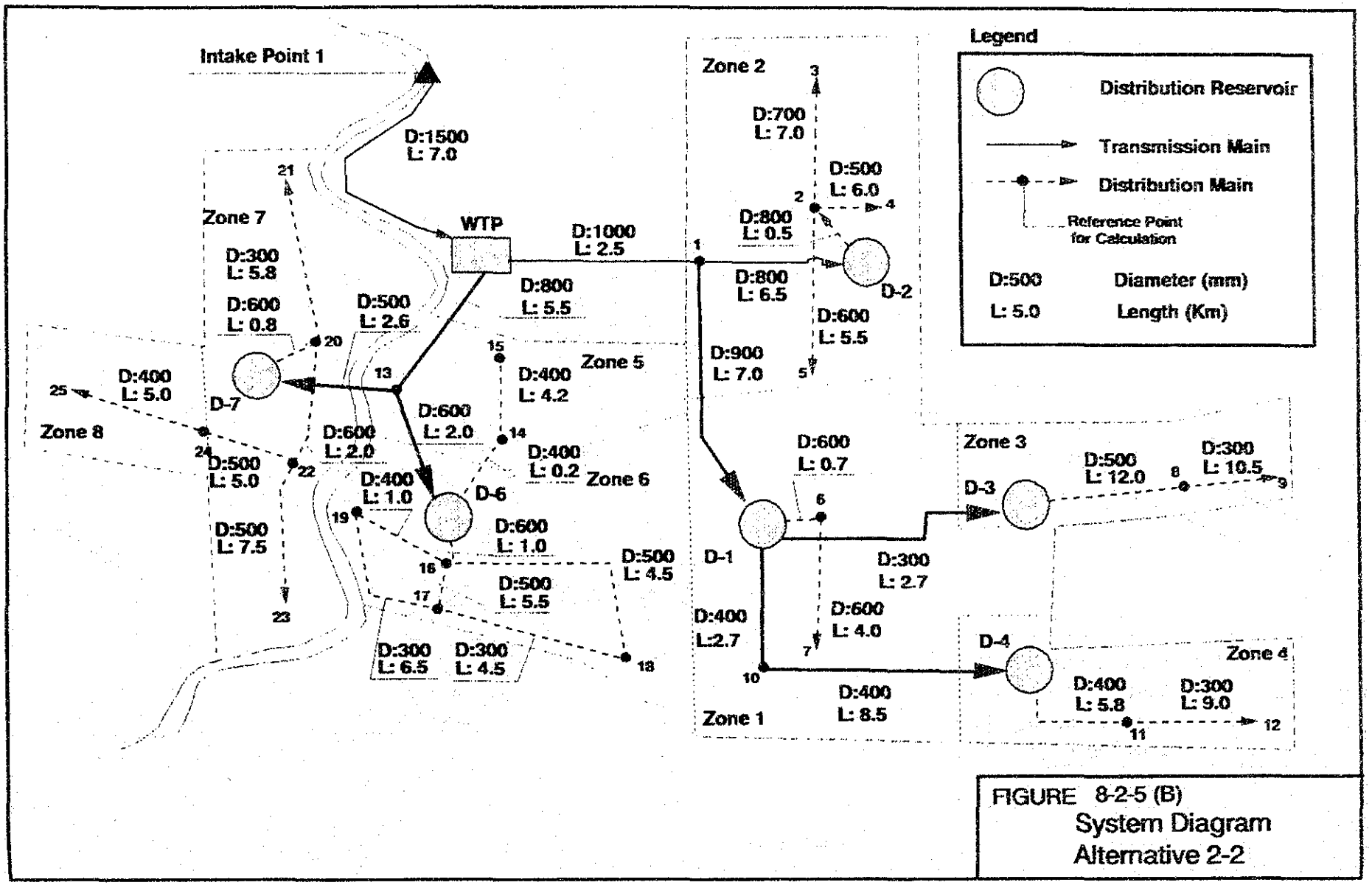


FIGURE 8-2-5 (B)
System Diagram
Alternative 2-2

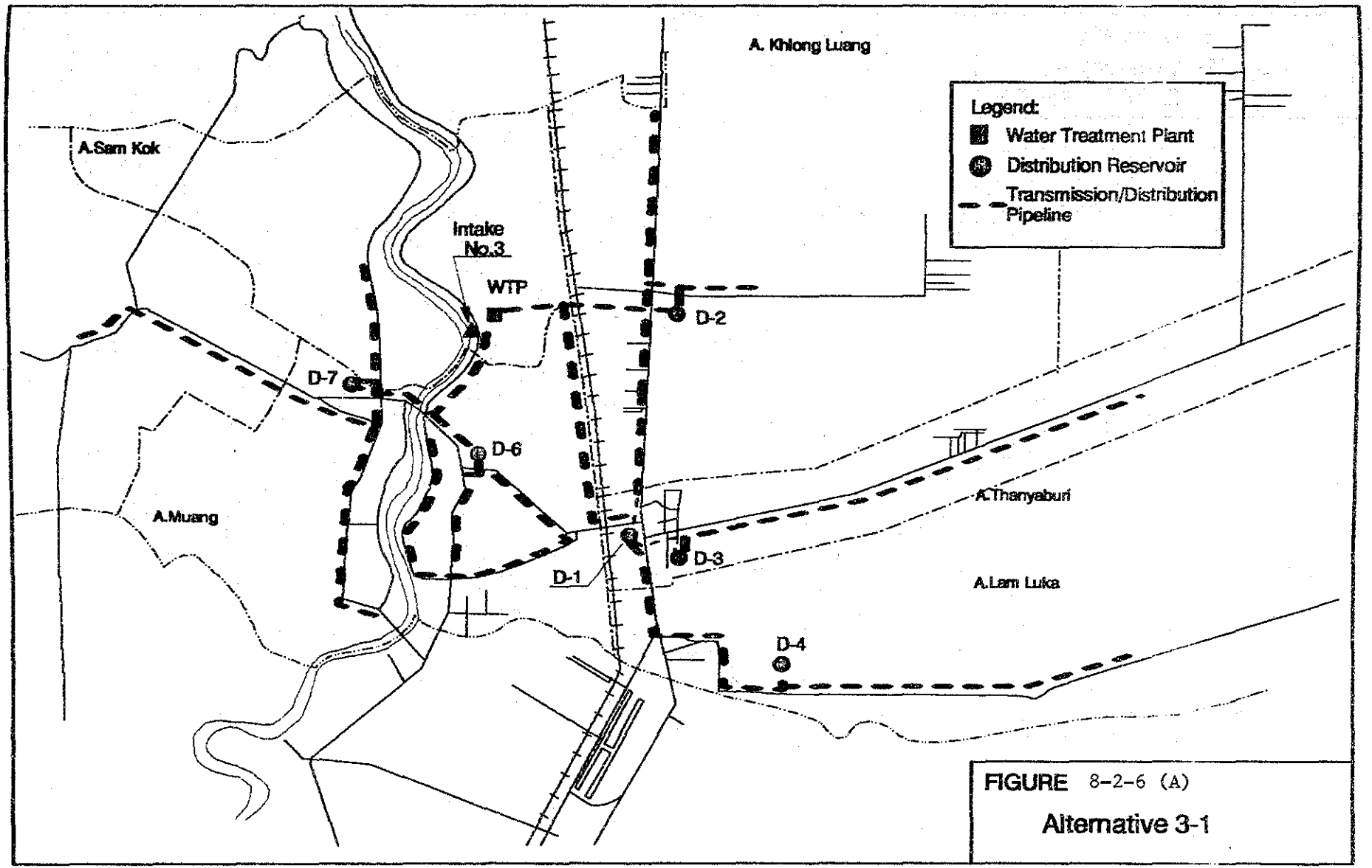


FIGURE 8-2-6 (A)

Alternative 3-1

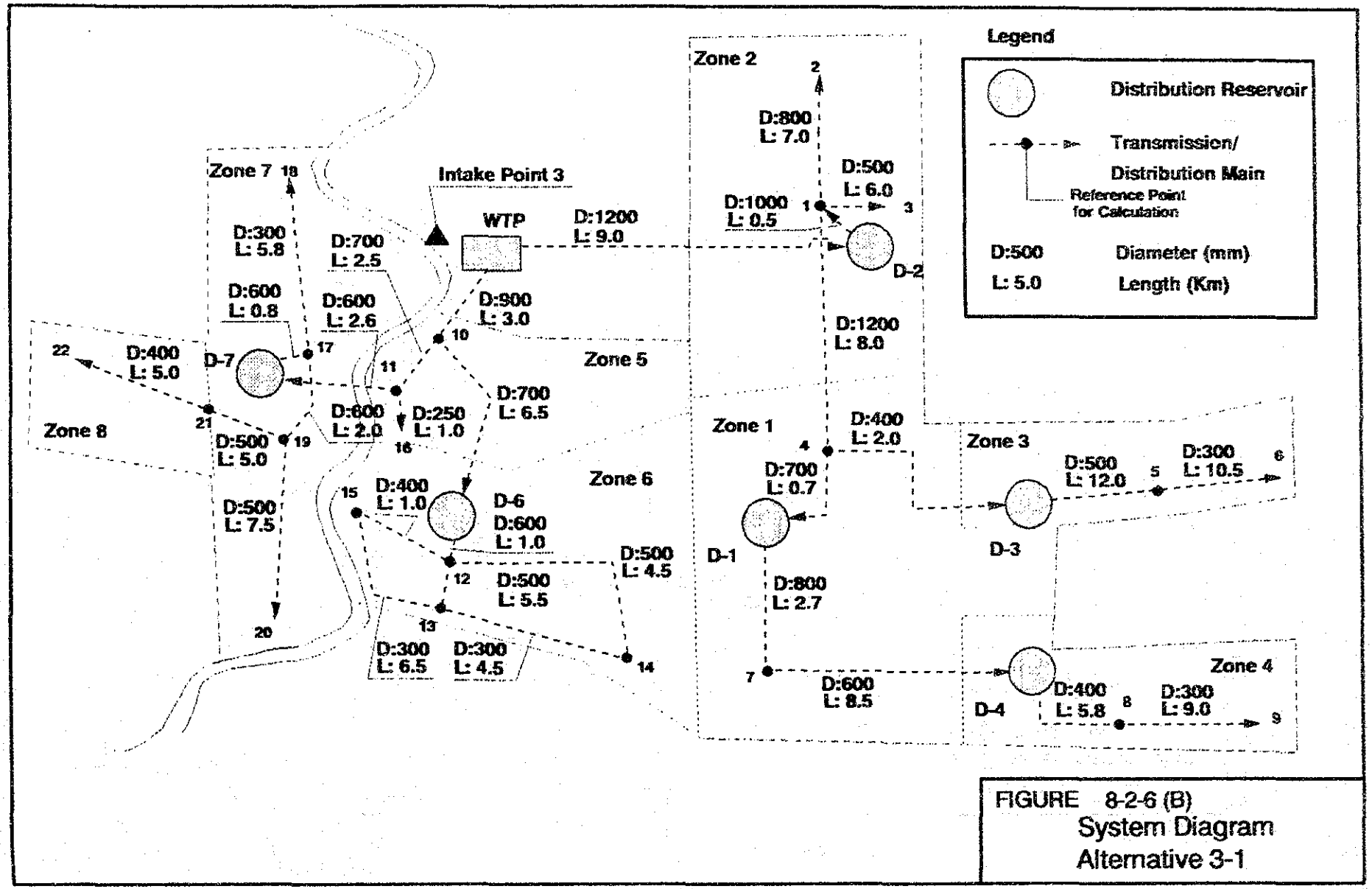


FIGURE 8-2-6 (B)
System Diagram
Alternative 3-1

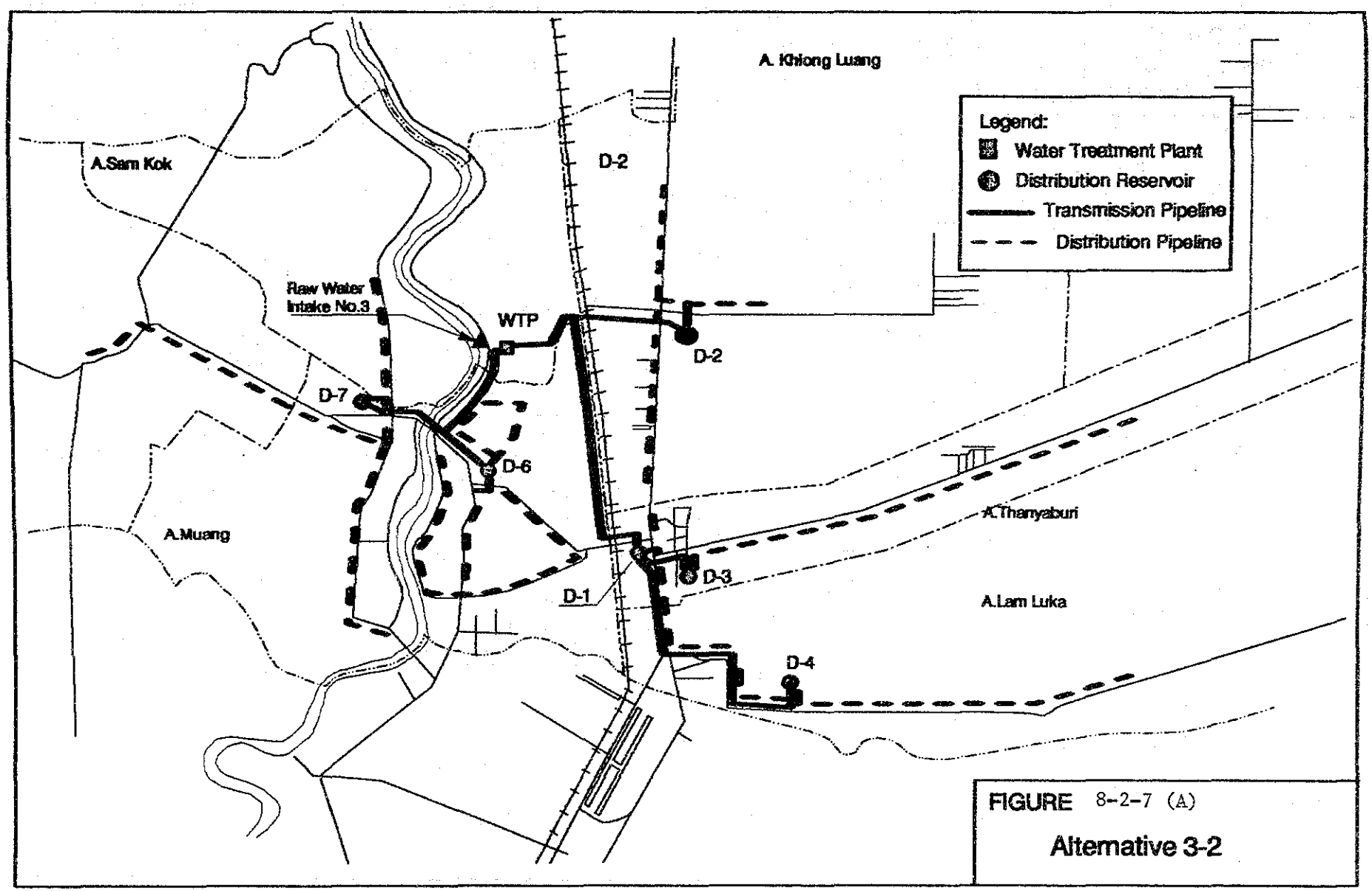


FIGURE 8-2-7 (A)

Alternative 3-2

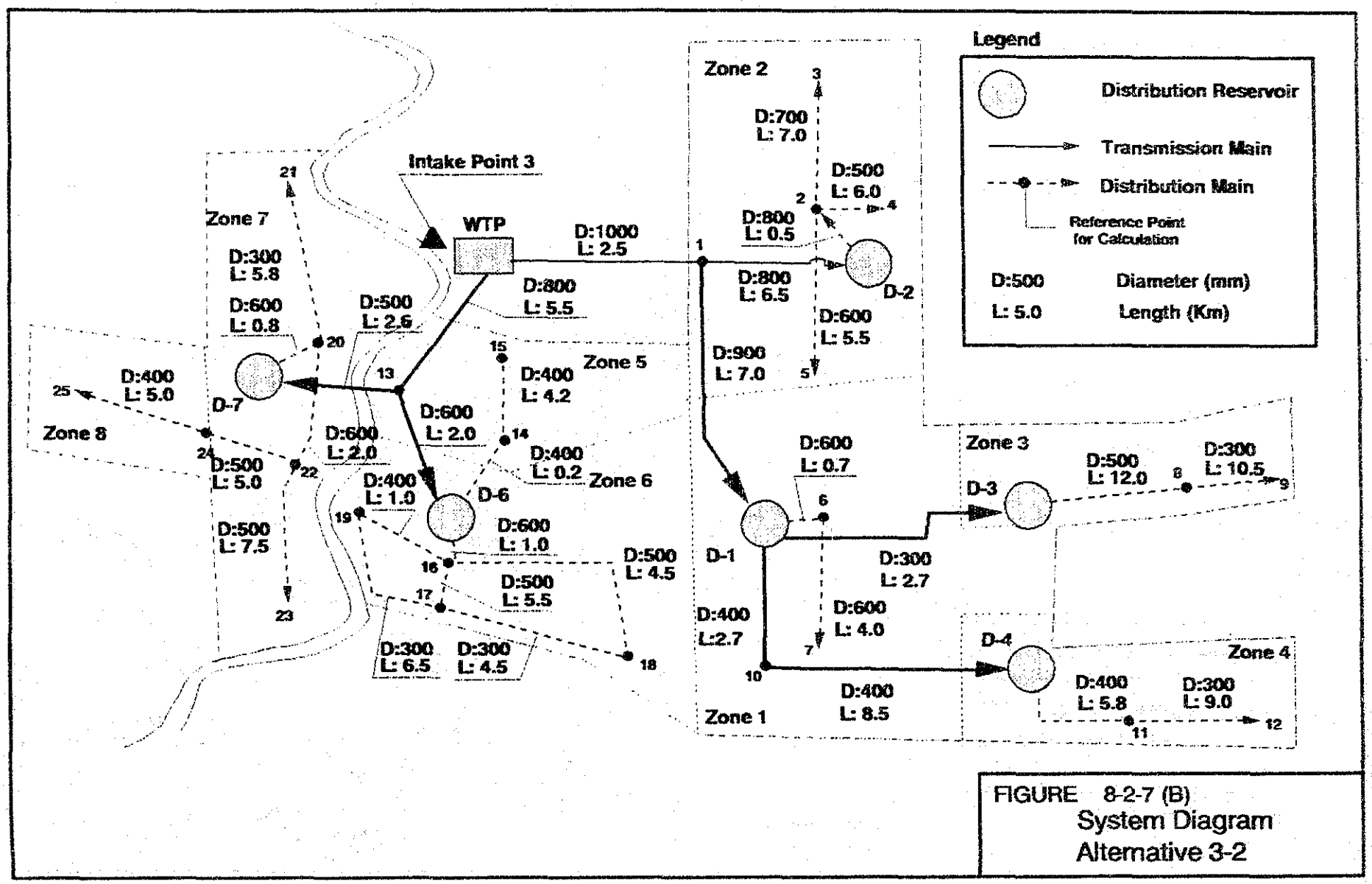


FIGURE 8-2-7 (B)
System Diagram
Alternative 3-2

However, there are some cases that the new land should be purchased for the reservoir construction. These issues are summarized in Table 8-2-2.

Table 8-2-2 Land Requirement for the Proposed Distribution Reservoirs

Reservoir: No.	Alternatives 1 - 1	1 - 2	2 - 1	2 - 2	3 - 1	3 - 2
D-1 (Zone1)	A	A	A	A	A	A
D-2 (Zone2)	New	New	(*) New	(*) New	(*) New	(*) New
D-3 (Zone3)	A	A	A	A	A	A
D-4 (Zone4)	A	A	A	A	A	A
D-6 (Zone6)	New	New	New	New	New	New
D-7 (Zone7)	A	A	A	A	A	A

Note : A = Land available in the existing PWA's plant
New = Land to be purchased newly
(*)New = 2 rais (3,200 sq m) of PWA's purchased land should be expanded.

(5) Cost Comparison

Table 8-2-3 shows a summary of the cost comparison for the six alternatives which are including the construction, operation, and land costs. The details of the costs are shown in Appendix A-8-3.

In this comparison, costs for the distribution branch pipeline is not included since they are common for all alternatives.

Table 8-2-3 Cost Comparison of Alternatives

(Unit : Baht 1000)

Item	Alternative 1 - 1	1 - 2	2 - 1	2 - 2	3 - 1	3 - 2
Construction Cost						
1. Raw Water Intake	66.9	66.9	66.9	66.9	66.9	66.9
2. Raw Water Pipe	5.3	5.3	184.8	184.8	5.3	5.3
3.Treatment Plant	656.0	656.0	656.0	656.0	656.0	656.0
4. Distribution Reservoirs	345.7	367.5	345.7	367.5	345.7	367.5
5. Transmission / Distribution Main	953.8	977.3	845.6	734.4	845.6	734.4
Construction Cost Total	2,027.7 (110.80)	2,073.0 (113.27)	2,099.0 (114.69)	2,009.6 (109.81)	1,919.5 (104.88)	1,830.1 (100.00)
Land Cost	177.0	177.0	177.0	177.0	177.0	177.0
Operation Cost (1995-2011)						
Raw Water Intake/ Transmission Cost	85.9	85.9	197.7	197.7	85.9	85.9
Transmission/Distrib. Cost	715.0	678.2	747.0	677.9	747.0	677.9
Total	3,005.6 (108.47)	3,014.1 (108.78)	3,220.7 (116.23)	3,062.2 (110.51)	2,929.4 (105.72)	2,770.9 (100.00)
Raw Water Inspection/ Control	Easy	Easy	Difficult	Difficult	Easy	Easy
Water Transmission Control	Difficult	Easy	Difficult	Easy	Difficult	Easy

Note : Cost of Transmission/Distribution Main is for comparison only.
Operation cost not including Chemical, Manning, and Repair costs which are common.

Result of the cost comparison shows that the Alternative 3-2 is the lowest choice in both the construction and the operation cost. This is derived from the economical water transmission on this alternative.

Alternative 3-2 also has the advantages in the ease of operation and raw water intake control; therefore, this system is recommended.

8.2.3 Facility Planning

On the basis of the system layout selected in the previous subsection, the detailed planning is prepared for the facilities as follows:

(i) Treatment plant

(ii) Distribution Reservoir

(iii) Transmission and Distribution Pipelines

(1) Treatment plant

To treat the raw water taken from Chaophraya River, treatment process should consist of chemical coagulation, sedimentation, and rapid sand filtration. This is a process normally applied for treating surface water with high turbidity. There is no alternative to be considered for the treatment process in this respect.

The followings are the proposed facilities as the major treatment plant components.

a. Receiving well
b. Mixing basin
c. Flocculator
d. Sedimentation basin
e. Rapid sand filter
f. Clear water reservoir (with pumping station)
g. Sludge lagoon
h. Sludge drying bed

Some buildings and housings, such as administration building, chemical storage, staff houses, warehouses will be incorporated in the facility planning of the treatment plant.

There are some alternatives for selecting the sedimentation basin type which will affect the construction cost and land requirement. Generally, three types of sedimentation should be compared: (i) conventional rectangular basin, (ii) inclining-plate sedimentation basin, and (iii) clarifier. The first type consist of the flocculation channel and rectangular sedimentation basin. The second type has an inclining plate in the sedimentation basin so that the surface loading are extensively increased, and therefore the surface area can be reduced. The clarifier type is a combination of the flocculator and sedimentation basin. Table 8-2-4 shows the comparison of three sedimentation types.

Table 8-2-4 Comparison of Sedimentation Type

Parameter	Conventional Type	Inclining Plate	Clarifier
General			
Surface area	largest	smallest	medium
Operation	easy	easy	floc likely to carry over if overloaded. need more experience than other types
Maintenance	easy	need to clean inclining plate	easy
Drained Sludge	normal	normal	less condensed
Planned Q (day max)	= 283,000 cu m/day = 11,792 cu m/hour = 196.5 cu m/min		
Shape	Rectangular	Rectangular	Circular
Retention Time	3 - 5 hours	20-40 min or more	1.5-2.0 hours
Velocity	40 cm/min >	60 cm/min >	30-50 mm/min > (upward)
Restriction	L=(3 - 5)W D= 3 - 4 m		turbidity < 1,000
Design			
No.of Basin	16	8	8
Dimension	w l d 12 x 50 x 4.5 m	w l d 18 x 18 x 4.5 m	Dia. d 29 x 4.5 m
Surface Area	600 sq m/basin	324 sq m/basin	661 sq m/basin
Retention time	3.7 hours	59 min	2.0 hours
Velocity	0.23 m/min	0.30 m/min	40 mm/min (upward)

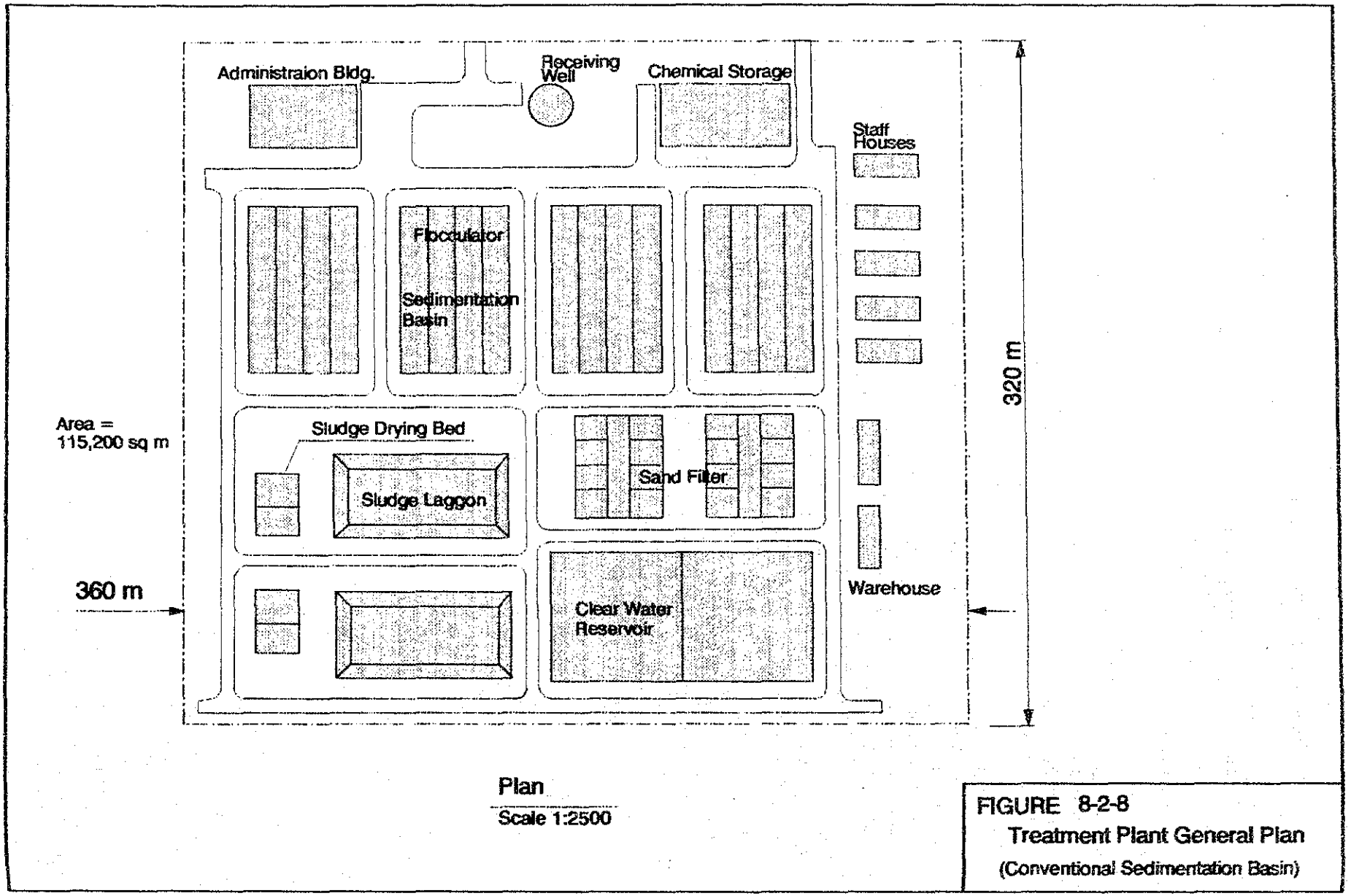
The general layout plan is prepared to determine the land requirement for the alternatives as shown in Figures 8-2-8 to 8-2-10. The each facility is designed on the design criteria presented in Chapter 5 in this report. The capacity calculation is shown in Appendix A-8-4. The comparison of three alternatives is made considering the construction cost, land cost, and technical view for the operation and maintenance. Table 8-2-5 shows the comparison in costs.

Table 8-2-5 Cost Comparison of Three Sedimentation Types

(unit : ฿1000)

Items	Conventional Type	Inclining Plate	Clarifier
Construction Cost			
Structures			
Flocculator	27,400	27,400	-
Sediment-ation Basin	89,800	136,500	72,500
Equipment			
Flocculator	28,800	28,800	-
Sediment-ation Basin	60,000	20,000	100,000
Sub-Total	206,000	213,500	172,500
Land Cost (add.to Incl-ining Plate)	12,500	0	12,500
Total	218,500	213,500	185,000

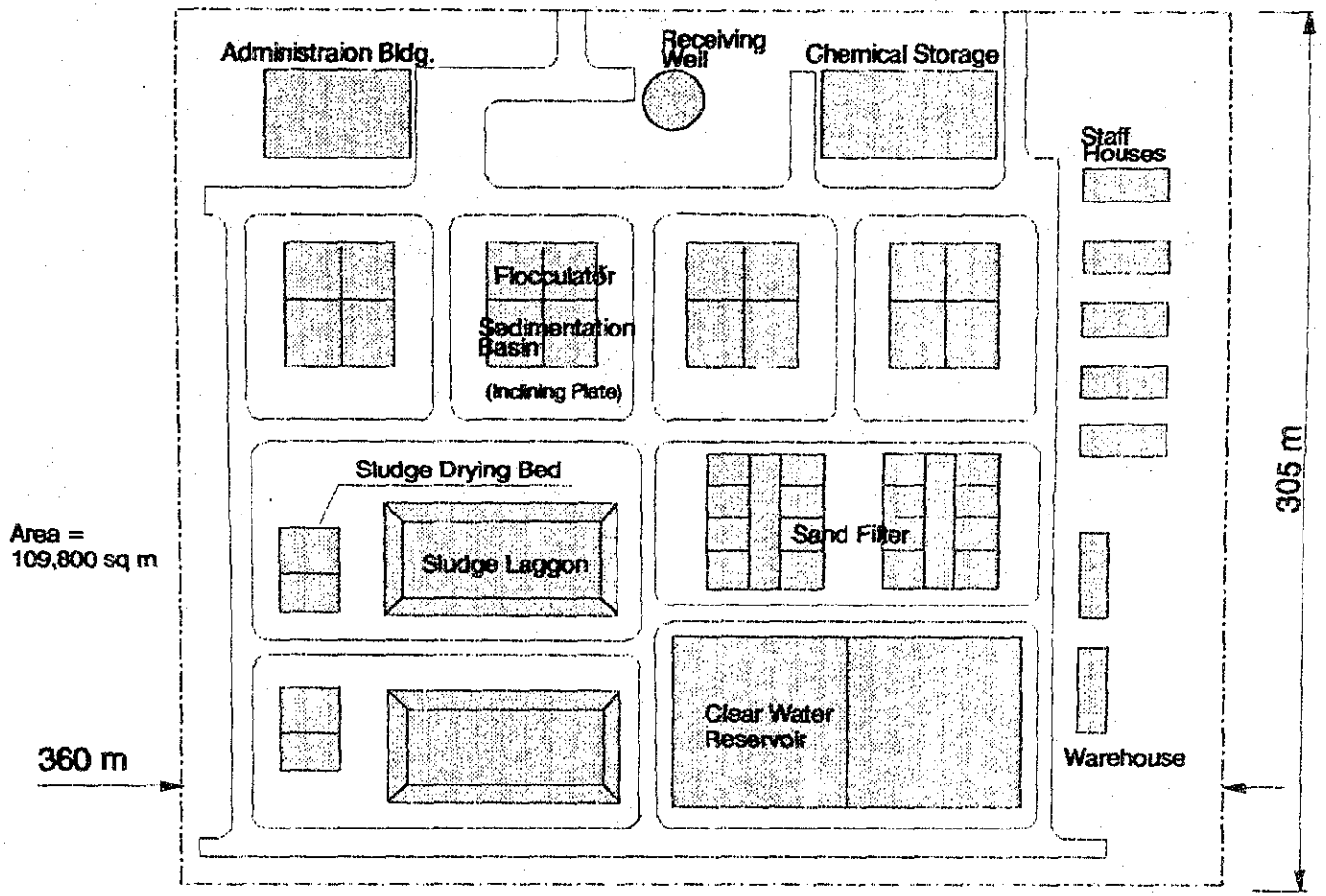
Note: (1) Operation cost is not counted in the comparison since it is considered to be same.
(2) Unit land cost = Baht 2 million per rai, or
Baht 12.5 million per hectare



Plan

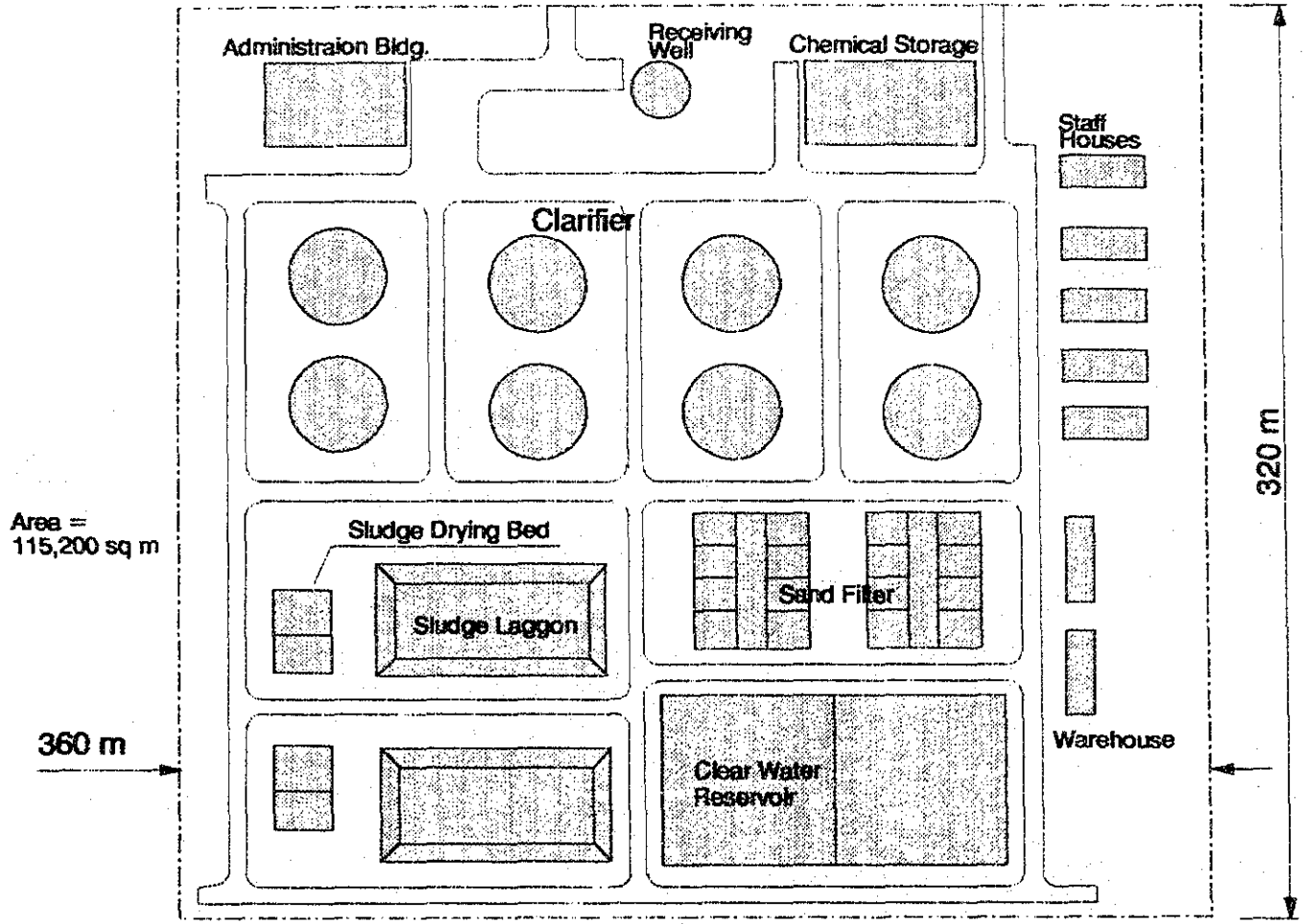
Scale 1:2500

FIGURE 8-2-8
Treatment Plant General Plan
(Conventional Sedimentation Basin)



Plan
Scale 1:2500

FIGURE 8-2-9
Treatment Plant General Plan
(Sedimentation Basin with Inclining Plate)



Plan

Scale 1:2500

FIGURE 8-2-10
Treatment Plant General Plan
(Clarifier)

From this comparison, alternative of clarifier is obviously cheapest. However, from the technical point of view, clarifier is regarded as a more difficult process to operate and less reliable in treatability than other alternatives. In particular, because of its process principle, clarifier is unable to remove turbidity if it is hydraulically overloaded.

The cost difference between the clarifier and the inclining plate type is about 30 million Baht which is less than 5 percent of the total construction and land cost for the treatment plant. Further, the inclining plate type alternative requires smallest land so that the land acquisition problem is expected to be less.

On the other hand, the costs of the conventional type and inclining plate type is nearly same.

From the view point of the operation, the conventional type is most suitable since it is easy to operate and maintain.

The inclining plate type is recommended in this study since it is still unknown if enough land is available. However, the conventional type should be taken into consideration in the detailed design stage if the enough land has been purchased.

The characteristics of the major facilities of the treatment plant are summarized as follows:

a. Receiving Well
   - Type : Circular
   - Dimension : Dia. 9.0 m x D 5.0 m
   - No. : 1

b. Mixing Basin
   - Type : Square
   - Dimension : L 4.0 m x W 4.0 m x D 3.0 m
   - No. : 4

c. Flocculator
   - Type : Mechanical flocculation
   - Dimension : L 3.6 m x W 10.0 m x D 3.6 m x 3 stages
   - No. : 16

d. Sedimentation Basin
   - Type : Rectangular with Inclining Plate
   - Dimension : L 18.0 m x W 18.0 m x D 4.5 m
   - No. : 8

e. Sand Filter
   - Type : Rapid Sand Filter, Inter-filter backwashing type
   - Dimension : L 15.0 m x W 10.0 m
   - No. : 16

f. Clear Water Reservoir
   - Type : Rectangular
   - Dimension : L 60.0 m x W 60.0 m x D 5.0 m
   - No. : 2

g. Sludge Lagoon
   - Type : Open Cut, Rectangulr
   - Dimension : L 68.0 m x W 33.0 m x D 3.0 m
   - No. : 2

h. Sludge Drying Bed
Type : Concrete Bed, Rectangular
Dimension : L 30.0 m x W 20.0 m x D 1.0 m
No. : 4

Appendix A-8-5 shows plans of each facility of the treatment plant.

(2) Distribution Reservoirs

A total of six units of the distribution reservoir will be constructed as presented in Chapter 8.2.1. Out of six, four units are proposed to be located in the existing deep well plants; therefore, they have a restriction from the land space at each plant. General principle for the new construction of the reservoirs is that they should be of reinforced concrete (RC) because of its lower construction cost. However, in case that sufficient area of land is not available, prestressed concrete (PC) reservoir is recommended.

For the reservoirs to be constructed at newly purchased land, prestressed concrete reservoir is also considered so that the land requirement could be minimized. The selection between PC and RC structures should be depending on the availability of the land area. The comparison study for these structures, including land cost, are presented in Appendix A-8-6. The result of the comparison is summarized as shown in Table 8-3-6.

Table 8-3-7 Summary of the Comparison for the Distribution Reservoirs

Zone	R C - Alternatives				P C - Alternatives			
	Volume (m3)	Cost (฿1000)	Land Area (m2)	Cost (฿1000)	Volume (m3)	Cost (฿1000)	Land Area (m2)	Cost (฿1000)
Zone 1								
Exis.New	2,000	5,000	-	0	5,000	49,300	-	0
Exis.Pld	3,000	8,000	-	0	13,000	68,400	-	0
New Land	13,000	45,800	10,800	33,600	-	-	-	0
Total		58,800		33,600		117,700	-	0
Total of Construction and Land Costs =				92,400	Total of Construction and Land Costs =			117,700
Zone 2								
New Land	19,100	65,400	13,000	40,500	19,100	118,600	6,000	18,750
Total		65,400		40,500		118,600	-	18,750
Total of Construction and Land Costs =				105,900	Total of Construction and Land Costs =			137,350
Zone 5 & 6								
New Land	13,000	45,800	10,800	33,600	13,000	74,400	6,000	18,800
Total		45,800		33,600		74,400		18,800
Total of Construction and Land Costs =				79,400	Total of Construction and Land Costs =			93,200

As shown in Table 8-3-6, the RC alternatives are lower in the total cost for all of three Zones. The difference between PC and RC is largest in Zone 2 case.

From the economical reason, it is recommended to purchase the land large enough to accomodate the RC made reservoirs for these Zones. However, it is predicted that the land acquisition for large area may not be easy in the Patum Thani area, and need considerable time for the arrangement and negotiation with land owners. Since this project is quite urgent to cope with the rapid development in this area, and to prevent the land subsidence caused by ground water use, the immediate commencement of the project is inevitable.

Considering the urgency of the project and the possible difficulty of the land acquisition, the PC alternatives are adopted in this report for the facility plan and cost study to cope with the worst case of land acquisition. This recommendation does, however not mean to reject the RC alternative, but to remain it a possible way to reduce the total cost if land acquisition have been achieved in time.

The Table 8-2-7 summarizes the characteristics of the proposed reservoirs.

Table 8-2-7 Characteristics of the Proposed Distribution Reservoir

Reservoir No.	Zone No.	Location	Volume (cu m)	Structure	Land Requirement
D-1-1	1	Exis.(New)	5,000	PC	-
D-1-2		Exis.(Old)	13,000	PC	-
D-2	2	New	19,100	PC	6,500 sq m
D-3	3	Exis.	2,000	RC	-
D-4	4	Exis.	2,200	RC	-
D-6	6	New	13,000	PC	6,000 sq m
D-7	7	Exis.(New)	9,000	RC	-

Figure 8-2-11 shows the plan of the proposed distribution reservoirs for Zone 2 and 6.

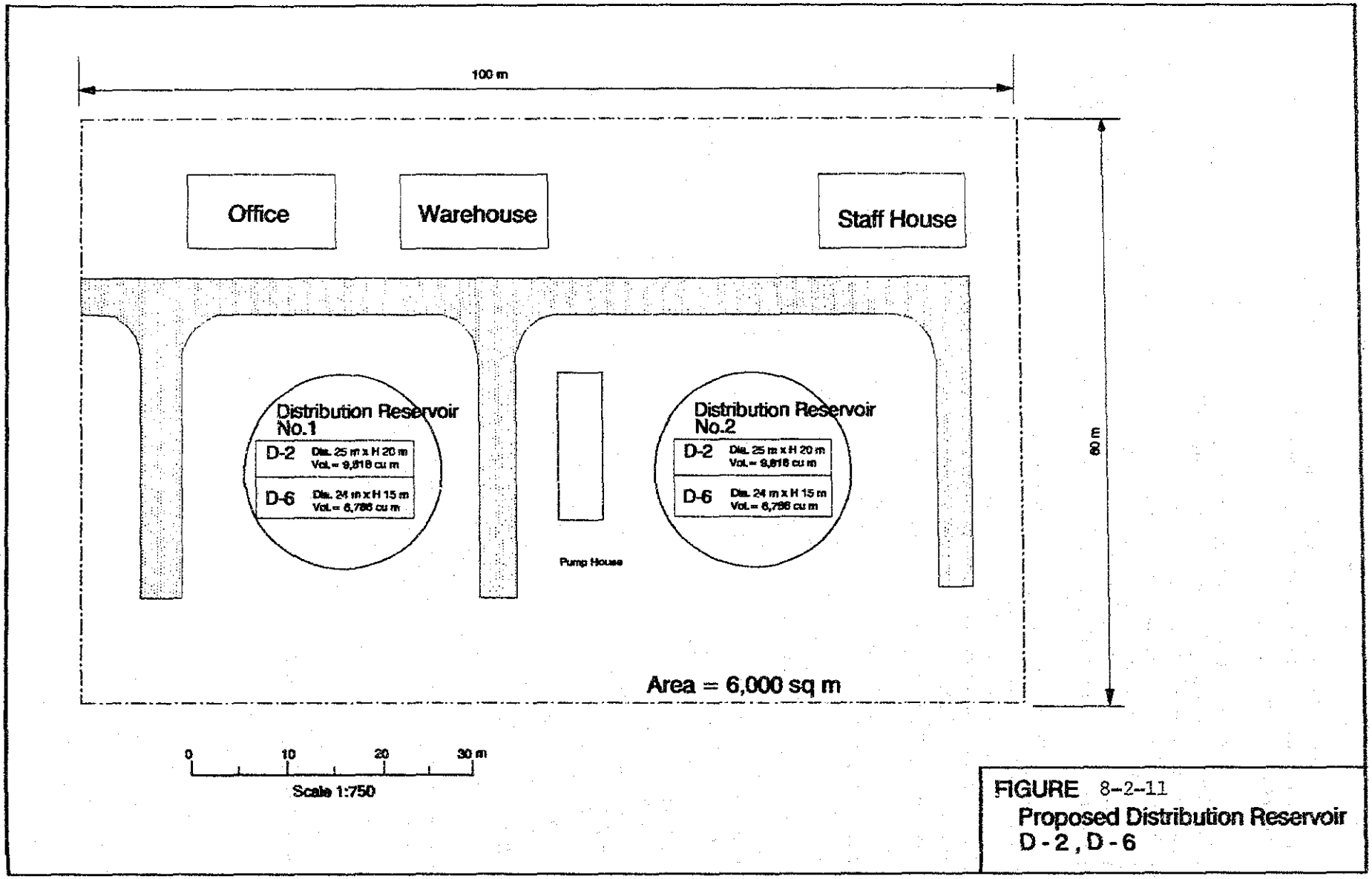


FIGURE 8-2-11
Proposed Distribution Reservoir
D-2, D-6

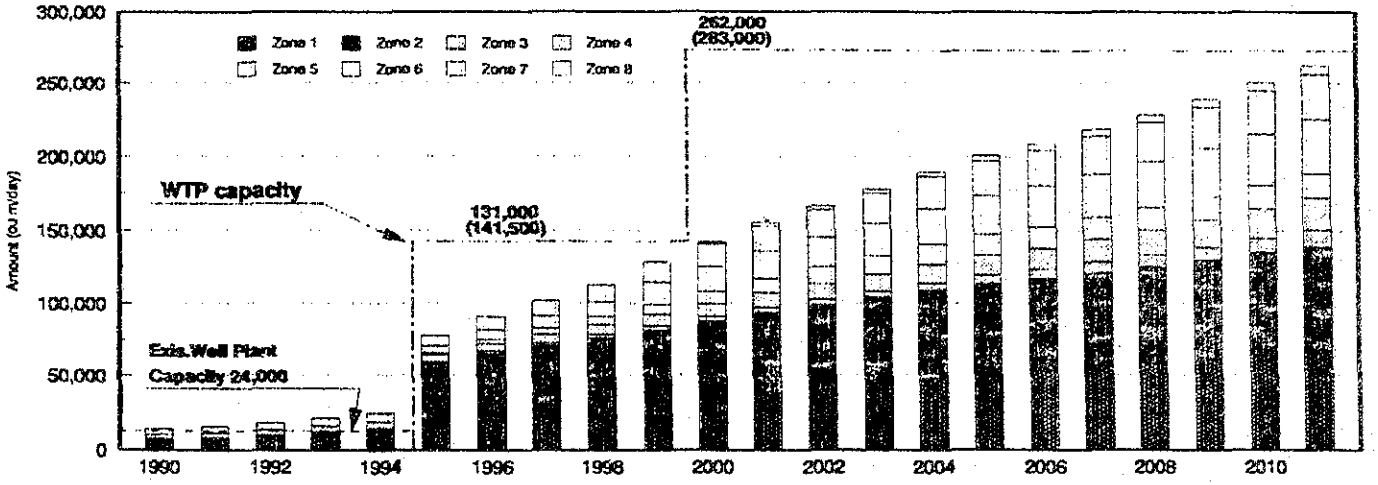
(3) Transmission and Distribution Pipelines

Design of the pipes should follow the design criteria described in Chapter 5.2. Route and location of the pipelines are determined from the location of the treatment plant and the distribution reservoirs. Sizes of pipes are calculated from the water demand by zone and distribution of the water demand in each zone depending on demand by Tambon.

Appendix A-8-7 shows diagrams and calculation of network analysis of the proposed distribution pipes.

9. IMPLEMENTATION PLAN

The implementation plan of the total project is proposed as shown in Figure 9-1. In this program, the facility construction is prepared following the water demand prediction. The construction of the treatment plant will be carried out in two phases. It is assumed that the distribution pipelines will be constructed within two years in each phase.



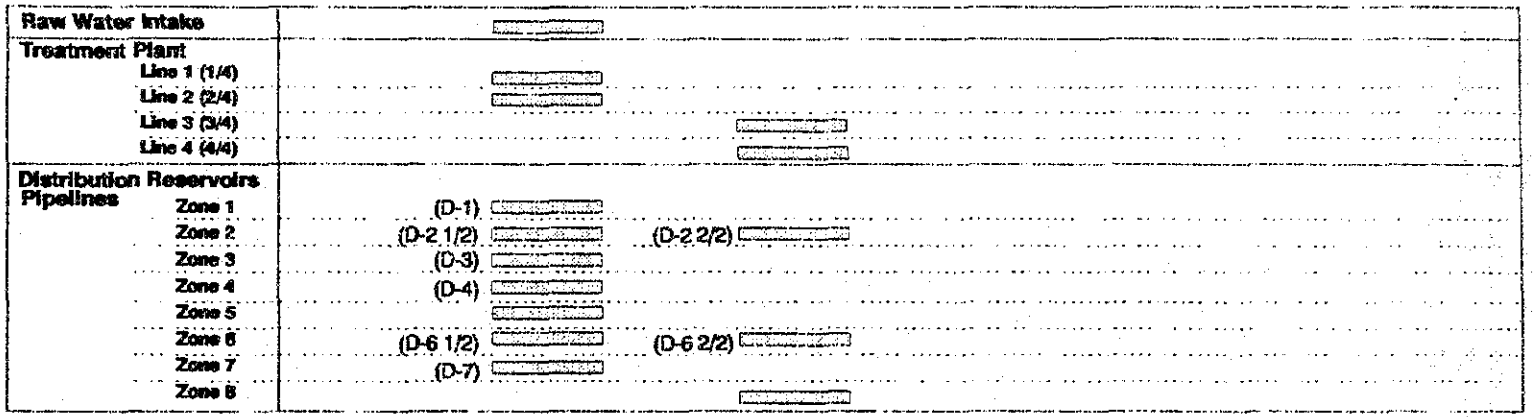


FIGURE 9 - 1

Implementation Plan

10. ORGANIZATION OF WATERWORKS

The organization of the waterworks is proposed with consideration on the components and size of the proposed water supply system. The construction of the sections is based on the existing organization of the waterworks. Some additional sections are proposed for the operation of the proposed water treatment plant and distribution reservoirs. The proposed organization consists of the administration, water production, operation of the distribution reservoirs, and service sections as shown in Figure 10-1.

The major tasks of each section are described as follows:

(1) Administration Section

This section will be responsible for the administrative and financial issues of the waterworks. The works to be done will include the preparation of the general administration for the waterworks' staff, meter reading and preparation of bills, collectin of water charge, and management of the documents and records.

(2) Water Production Section

This section will be responsible for the operation and maintenance of the water treatment plant and raw water intake. Inspection of the transmission pipelines will be performed by this section.

(3) Distribution Reservoir Section

This section will be responsible for the operation and maintenance of the distribution reservoirs and distribution pipelines under the extent of each reservoir. One subsection will be formed for one reservoir.

(4) Service Section

This section will be responsible for setting and repair of house connection.

Numbers of staff of each section are decided from the water demand in each year. Ratios of present number of staff and the water demand in 1987 are used in calculating the future number of staff.

Table 10-1 shows numbers of staff.

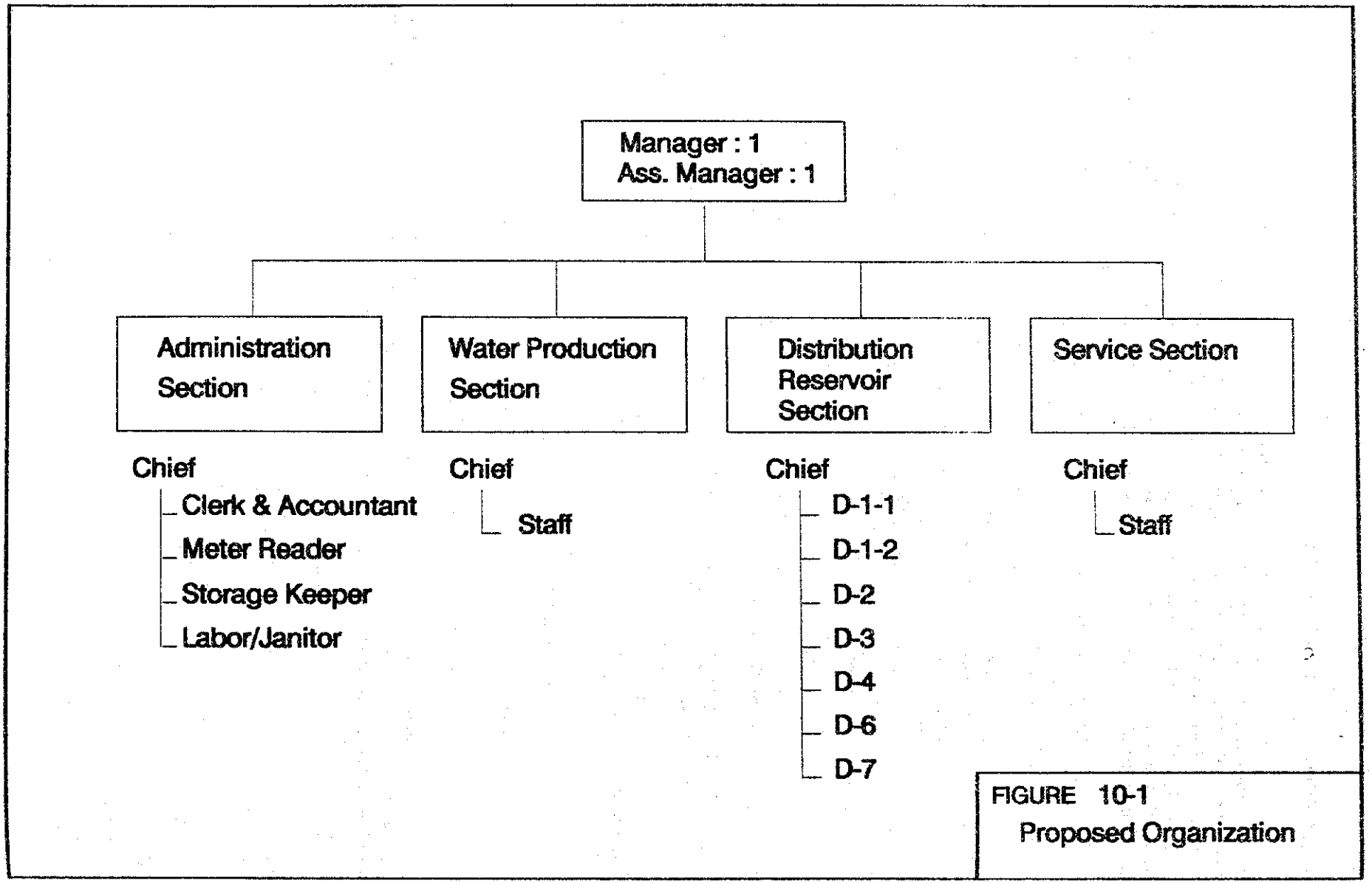


FIGURE 10-1
Proposed Organization

Table 10-1 Proposed Number of Staff of Patum Thani and Prachatipat Waterworks

Year	No. of Staff Total	Manager	Ass. Manager	Administrative: Chief	Clerk	Account Keeper	Storage Meter Reader	Labor etc.	Water Production: Chief	Staff	Distribution Reservoir: D1-1 (New)	D1-2 (Old)	D2	D3	D4	D6	D7	Service Section: Chief	Staff
1990	55	2	2	7	2	6	1		1	5	5	1	0	5	5	0	5	2	6
1991	60	2	2	7	2	8	1		1	5	5	1	0	5	5	0	5	2	8
1992	64	2	2	7	2	11	1		1	5	5	1	0	5	5	0	5	2	11
1993	68	2	2	7	2	13	1		1	5	5	1	0	5	5	0	5	2	13
1994	73	2	2	7	2	15	1		1	5	5	1	0	5	5	0	5	2	15
1995	83	2	1	7	3	17	4		1	5	5	1	1	5	5	1	5	3	17
1996	106	2	1	7	3	19	5		1	10	5	5	5	5	5	5	5	3	19
1997	115	2	1	7	3	24	6		1	10	5	5	5	5	5	5	5	3	24
1998	125	2	1	7	3	28	7		1	10	5	5	5	5	5	5	5	3	28
1999	135	2	1	7	3	32	8		1	10	5	5	5	5	5	5	5	3	32
2000	150	2	1	7	3	37	9		1	15	5	5	5	5	5	5	5	4	37
2001	160	2	1	7	3	41	10		1	15	5	5	5	5	5	5	5	4	41
2002	173	2	1	8	4	46	11		1	15	5	5	5	5	5	5	5	4	46
2003	183	2	1	8	4	51	12		1	15	5	5	5	5	5	5	5	4	51
2004	194	2	1	8	4	55	13		1	15	5	5	5	5	5	5	5	4	55
2005	212	2	1	8	4	60	14		1	20	5	5	5	5	5	5	5	6	60
2006	222	2	1	8	4	65	15		1	20	5	5	5	5	5	5	5	6	65
2007	239	2	1	10	5	71	16		1	20	5	5	5	5	5	5	5	6	71
2008	252	2	1	10	5	77	17		1	20	5	5	5	5	5	5	5	6	77
2009	265	2	1	10	5	84	18		1	20	5	5	5	5	5	5	5	6	84
2010	279	2	1	10	5	90	19		1	20	5	5	5	5	5	5	5	6	90
2011	292	2	1	10	5	96	20		1	20	5	5	5	5	5	5	5	6	96

11. Project Cost Estimates

11.1 Construction Cost

The construction cost of the water supply system was calculated for each component of facility. Table 11-1 shows a summary of the construction cost based on the 1989 price.

Table 11-1 Summary of the Construction Cost

(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
1.Raw Water Intake	72,195	50,549	21,646
2.Treatment Plant	656,017	305,705	350,312
3.Distribution Reservoirs	367,487	147,426	220,061
4.Transmission Pipeline	287,027	227,610	59,417
5.Distribution Pipeline	600,223	424,969	175,254
Sub Total	1,982,949	1,156,259	826,690
6.Land Cost	177,000	0	177,000
Total	2,159,949	1,156,259	1,003,690

The breakdown of the cost estimates are shown in Tables 11-2 to 7.

Table 11-2 Cost Breakdown of the Raw Water Intake Facility

(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
A. Civil/Architectural Works	14,415	4,325	10,090
B.Mechanical Works	35,000	28,000	7,000
C.Electrical Works	17,500	14,000	3,500
D.Raw Water Pipe	5,280	4,224	1,056
Total	72,195	50,549	21,646

Table 11-3 Cost Breakdown of the Treatment Plant
(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
A.Civil/Architectural Works			
1.Receiving Well	1,498	449	1,049
2.Mixing Basin	2,559	768	1,791
3.Flocculation Basin	27,384	8,215	19,169
4.Sedimentation Basin	136,503	40,951	95,552
5.Rapid Sand Filter	83,782	25,135	58,647
6.Clear Water Reservoir	68,542	20,563	47,979
7.Sludge Lagoon	3,367	1,010	2,357
8.Sludge Drying Bed	7,364	2,209	5,155
9.Pumping Station			
-1.Clear Water Pumping Station	1,800	540	1,260
-2.Sludge Lagoon Drain Pumping Station	270	81	189
10.Chlorination House	1,140	342	798
11.Chemical Storage House	1,140	342	798
12.Site Fill	36,000	10,800	25,200
13.In-Plant Road	6,750	2,025	4,725
14.In-Plant Piping	18,000	5,400	12,600
15.Administration Bldg.	2,280	684	1,596
Sub-Total of A.	398,379	119,514	278,865
B.Mechanical Works			
1.Clear Water Pump			
600 mm, 560kw, 4 units	24,000	19,200	4,800
400 mm, 360kw, 4 units	12,000	9,600	2,400
2.Sludge Lagoon Drain Pump			
300 mm, 30kw, 3 units	2,400	1,920	480
3.Flush Mixer	6,000	4,800	1,200
4.Flocculator	28,800	23,040	5,760
5.Sludge Collector	20,800	16,640	4,160
6.Chemical Equipment	6,000	4,800	1,200
7.Chlorination Equipment	10,000	8,000	2,000
8.Others (20% of above)	22,000	17,600	4,400
Sub-Total of B.	132,000	105,600	26,400
(50 % of Mechanical)	66,000	52,800	13,200
D.Miscellaneous			
(10 % of A.B.C.)	59,638	27,791	31,847
Total	656,017	305,705	350,312

Table 11-4 Cost Breakdown of the Distribution Reservoirs

(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
Reservoir D-1-1 (PC, 5,000 cu m, in the Exis.Plant (New))			
A.Civil/Archit. Works	29,178	8,753	20,425
B.Mechanical Works	12,000	9,600	2,400
C.Electrical Works	3,600	2,880	720
D.Miscellaneous	4,478	2,123	2,354
Total of D-1-1	49,256	23,357	25,899
Reservoir D-1-2 (PC, 13,000 cu m, in the Exis.Plant (Old))			
A.Civil/Archit. Works	51,740	15,522	36,218
B.Mechanical Works	8,000	6,400	1,600
C.Electrical Works	2,400	1,920	480
D.Miscellaneous	6,214	2,384	3,830
Total of D-1-2	68,354	26,226	42,128
Reservoir D-2 (PC, 19,100 cu m)			
A.Civil/Archit. Works	92,214	27,664	64,550
B.Mechanical Works	12,000	9,600	2,400
C.Electrical Works	3,600	2,880	720
D.Miscellaneous	10,781	4,014	6,767
Total of D-2	118,595	44,159	74,437
Reservoir D-3 (RC, 2,000 cu m)			
A.Civil/Archit. Works	6,340	1,902	4,438
B.Mechanical Works	3,000	2,400	600
C.Electrical Works	900	720	180
D.Miscellaneous	1,024	502	522
Total of D-3	11,264	5,524	5,740
Reservoir D-4 (RC, 3,200 cu m)			
A.Civil/Archit. Works	6,890	2,067	4,823
B.Mechanical Works	3,000	2,400	600
C.Electrical Works	900	720	180
D.Miscellaneous	1,079	519	560
Total of D-4	11,869	5,706	6,163
Reservoir D-6 (PC, 13,000 cu m)			
A.Civil/Archit. Works	57,237	17,171	40,066
B.Mechanical Works	8,000	6,400	1,600
C.Electrical Works	2,400	1,920	480
D.Miscellaneous	6,764	2,549	4,215
Total of D-6	74,401	28,040	46,360

Table 11-4 Cost Breakdown of the Distribution Reservoirs (Cont'd)
(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
Reservoir D-7 (RC, 9,000 cu m)			
A.Civil/Archit. Works	22,879	6,864	16,016
B.Mechanical Works	6,000	4,800	1,200
C.Electrical Works	1,800	1,440	360
D.Miscellaneous	3,068	1,310	1,758
Total of D-7	33,747	14,414	19,333
Total of D-1 to D-7	367,487	147,426	220,061

Table 11-5 Cost Breakdown of the Transmission Pipeline
(unit : Baht 1000)

PIpeline				Total Value	Foreign Currency Portion	Local Currency Portion
From	To	Dia(mm)	L (km)			
WTP	D1	1,000	2.5	34,550	27,640	6,910
		900	7.0	73,570	58,856	14,714
	D2	800	6.5	60,125	48,100	12,025
D1	D3	300	2.7	4,023	1,207	2,816
	D4	400	11.2	40,880	32,704	8,176
WTP	D6	800	5.5	50,875	40,700	10,175
		600	2.0	11,200	8,960	2,240
WTP	D7	500	2.6	11,804	9,443	2,361
Total				287,027	227,610	59,417

Table 11-6 Cost Breakdown of the Distribution Pipeline

(unit : Baht 1000)

Pipe Dia(mm)	L (m)	Material	Total Value	Foreign Currency Portion	Local Currency Portion
Zone-1					
600	1,450	S	9,179	7,343	1,836
500	7,590	S	39,013	31,210	7,803
400	3,650	S	15,148	12,118	3,030
300	4,480	AC	7,258	2,117	5,080
250	1,000	AC	1,180	354	826
Total	18,170		71,776	53,202	18,574
Zone-2					
1,000	200	S	3,126	2,501	625
900	3,190	S	37,865	30,292	7,573
800	4,540	S	47,443	37,954	9,489
700	1,000	S	7,460	5,968	1,492
600	2,640	S	16,711	13,369	3,342
500	640	S	3,290	2,632	658
400	4,100	S	17,015	13,612	3,403
300	1200.0	AC	1,944	583	1,361
250	2,200	AC	2,596	779	1,817
200	3,000	AC	2,670	801	1,869
150	1,550	AC	946	284	662
Total	24,260		141,066	108,775	32,291
Zone-3					
600	10,380	S	65,705	52,564	13,141
500	4,000	S	20,560	16,448	4,112
400	5,000	S	20,750	16,600	4,150
300	1,000	AC	1,620	486	1,134
250	1,000	AC	1,180	354	826
200	2,000	AC	1,780	534	1,246
Total	23,380		111,595	86,986	24,609
Zone-4					
500	4,830	S	24,826	19,861	4,965
400	4,000	S	16,600	13,280	3,320
300	6,000	AC	9,720	2,916	6,804
250	2,845	AC	3,357	1,007	2,350
200	1,000	AC	890	267	623
Total	18,675		55,393	37,331	18,062

Table 11-6 Cost Breakdown of the Distribution Pipeline (Cont'd)
(unit : Baht 1000)

Dia(mm)	Pipe L (m)	Material	Total Value	Foreign Currency Portion	Local Currency Portion
Zone- 5					
500	680	S	3,495	2,796	699
400	1,480	S	6,142	4,914	1,228
250	3,950	AC	4,661	1,398	3,263
150	1,720	AC	1,049	315	734
Total	7,830		15,347	9,423	5,925
Zone- 6					
700	200	S	1,492	1,194	298
600	250	S	1,583	1,266	317
500	9,470	S	48,676	38,941	9,735
400	930	S	3,860	3,088	772
300	15,800	AC	25,596	7,679	17,917
250	5,810	AC	6,856	2,057	4,799
200	1,700	AC	1,513	454	1,059
Total	34,160		89,575	54,677	34,897
Zone- 7					
500	3,500	S	17,990	14,392	3,598
400	11,010	S	45,692	36,553	9,138
300	11,000	AC	17,820	5,346	12,474
250	2,450	AC	2,891	867	2,024
200	5,600	AC	4,984	1,495	3,489
150	8,050	AC	3,542	1,063	2,479
Total	41,610		92,919	59,716	33,202
Zone- 8					
400	3,900	S	16,185	12,948	3,237
300	1,750	AC	2,835	851	1,985
250	1,000	AC	1,180	354	826
200	2,300	AC	2,047	614	1,433
150	500	AC	305	92	214
Total	9,450		22,552	14,858	7,694

Table 11-6 Cost Breakdown of the Distribution Pipeline (Cont'd)
(unit : Baht 1000)

Pipe Dia(mm)	Pipe L (m)	Pipe Material	Total Value	Foreign Currency Portion	Local Currency Portion
Grand Total					
1,000	200	S	3,126	2,501	625
900	3,190	S	37,865	30,292	7,573
800	4,540	S	47,443	37,954	9,489
700	1,200	S	8,952	7,162	1,790
600	14,720	S	93,178	74,542	18,636
500	30,710	S	157,849	126,280	31,570
400	34,070	S	141,391	113,112	28,278
300	41,230	AC	66,793	20,038	46,755
250	20,255	AC	23,901	7,170	16,731
200	15,600	AC	13,884	4,165	9,719
150	3,770	AC	2,300	690	1,610
100	8,050	AC	3,542	1,063	2,479
Total	177,535		600,223	424,969	175,254

Table 11-7 Cost Breakdown of the Land Cost
(unit : Baht 1000)

Item	Land Area (sq m)	Total Value	Foreign Currency Portion	Local Currency Portion
Intake Facility	1,600	2,000	0	2,000
Treatment Plant	110,000	137,500	0	137,500
Distribution Reservoirs	12,000	37,500	0	37,500
Total	123,600	177,000	0	177,000

Appendix A-11-1 shows more details of the cost estimates.

11.2 Operation and Maintenance Cost

It is proposed that two lines out of four lines of the new treatment plant will be constructed in 1993 to 1995, and start operation in the end of 1995. The third and fourth lines will start operation in 2000. The water distribution will be carried out in accordance with the proposed water demand prediction and staging implementation program as shown in the Feasibility Study in this Report.

Operation and maintenance cost is, therefore calculated from the water demand in each year, and consists of energy, chemical, manning, repair, and replacement costs.

The energy cost consist of the raw water intake and transmission, treatment, and transmission and distribution of the clear water.

The chemical cost is calculated from the daily average water demand and the proposed dosage rates as presented in Appendix A-11-2.

Manning cost is based on the prediction of the staff number of waterworks as shown in the Chapter 10.

Replacement of the mechanical and electrical equipment is considered to be made 20 years after the installation so that they are not included in the period of the development plan.

The administrative cost for the regional and the head offices are considered as an indirect cost, and calculated and later added as shown in the Chapter 17.

Total operation and maintenance cost is tabulated in Table 11-9.

Table 11-8 Summary of Operation and Maintenance Cost

(unit : Baht 1000)

Year	Energy Cost	Chemical Cost	Manning Cost	Repair Cost	Total
1990 :	0	132	4,566		4,698
1991 :	0	145	5,178		5,324
1992 :	0	169	5,840		6,009
1993 :	0	196	6,555		6,751
1994 :	0	228	7,327		7,555
1995 :	21,740	3,204	8,793		33,737
1996 :	24,015	3,725	11,718	921	40,379
1997 :	27,170	4,166	13,433	921	45,689
1998 :	29,289	4,625	15,290	921	50,124
1999 :	33,954	5,275	17,298	921	57,449
2000 :	36,457	5,833	20,279	921	63,490
2001 :	40,169	6,369	22,665	921	70,124
2002 :	42,667	6,832	25,668	921	76,088
2003 :	46,364	7,304	28,603	1,365	83,636
2004 :	49,584	7,785	31,767	1,365	90,502
2005 :	52,511	8,249	36,381	1,365	98,506
2006 :	54,731	8,561	40,112	1,769	105,172
2007 :	56,689	8,956	45,232	1,769	112,646
2008 :	58,752	9,372	50,167	1,769	120,061
2009 :	60,925	9,810	55,482	1,769	127,986
2010 :	63,211	10,269	61,204	1,769	136,452
2011 :	65,612	10,750	67,359	1,769	145,490

12. ANNUAL DISBURSEMENT SCHEDULE

The annual disbursement schedule is prepared on the basis of the construction schedule and the cost estimates as shown in the Chapter 9, and 10, respectively.

Table 12-1 shows an annual disbursement by item.

Table 12-1 Annual Disbursement Schedule

(Unit : Baht 1000)

Year	CONSTRUCTION COST								Sub-Total	Engineering Cost		Sub-Total	Direct Operation Cost Total	Land Cost: Total	Grand Total
	Intake	WTP (Line 1&2)	WTP (Line 3)	WTP (Line 4)	Distrib. Reservoir	Trans. Pipe	Distrib. Pipe	Contin-gency		Design	Super-vision				
Total	72,195	354,507	213,321	88,190	367,487	287,027	600,223	198,295	2,181,245	87,250	43,625	130,875	1,487,869	177,000	3,976,989
1990	0	0	0	0	0	0	0	0	0	0	0	0	4,698	177,000	181,698
1991	0	0	0	0	0	0	0	0	0	0	0	0	5,324	0	5,324
1992	0	0	0	0	0	0	0	0	0	43,625	0	43,625	6,009	0	49,634
1993	0	35,451	0	0	0	28,703	57,767	12,192	134,113	34,900	2,617	37,517	6,751	0	178,381
1994	27,348	177,254	0	0	123,928	143,514	288,836	76,088	836,966	0	13,087	13,087	7,555	0	857,608
1995	21,878	141,803	0	0	147,061	114,811	231,068	65,662	722,283	0	10,470	10,470	33,737	0	772,506
1996	0	0	0	0	0	0	0	0	0	0	0	0	40,379	0	40,379
1997	0	0	0	0	0	0	0	0	0	8,725	0	8,725	45,689	0	54,414
1998	0	0	106,661	44,095	48,249	0	0	19,900	218,905	0	6,980	6,980	50,124	0	276,009
1999	17,500	0	106,661	44,095	48,249	0	22,552	23,306	262,962	0	10,470	10,470	57,449	0	330,882
2000	0	0	0	0	0	0	0	0	0	0	0	0	63,490	0	63,490
2001	0	0	0	0	0	0	0	0	0	0	0	0	70,124	0	70,124
2002	0	0	0	0	0	0	0	0	0	0	0	0	76,088	0	76,088
2003	0	0	0	0	0	0	0	0	0	0	0	0	83,636	0	83,636
2004	0	0	0	0	0	0	0	0	0	0	0	0	90,502	0	90,502
2005	0	0	0	0	0	0	0	0	0	0	0	0	98,506	0	98,506
2006	0	0	0	0	0	0	0	0	0	0	0	0	105,172	0	105,172
2007	0	0	0	0	0	0	0	0	0	0	0	0	112,646	0	112,646
2008	0	0	0	0	0	0	0	0	0	0	0	0	120,061	0	120,061
2009	0	0	0	0	0	0	0	0	0	0	0	0	127,986	0	127,986
2010	0	0	0	0	0	0	0	0	0	0	0	0	136,452	0	136,452
2011	0	0	0	0	0	0	0	0	0	0	0	0	145,490	0	145,490

Note: 1. Contingency = 10 % of the total of gross construction cost
2. Engineering Cost (Design) = 4 % of the total construction cost
3. Engineering Cost (Supervision) = 2 % of the total construction cost
4. Repair cost = 0.3 % of (Mechanical and Electrical Works Cost)
5. Manning Cost = (Average Salary :Baht 6,895 (in 1990)/cap/month)x(No. of Staff) : with increase of 5 %/year

Part 3
FEASIBILITY STUDY

Part 3. FEASIBILITY STUDY

13. FUNDAMENTALS FOR FEASIBILITY STUDY

It is obvious that the future water demand will be extremely larger than the capacity of the existing deep well plants so that only the rehabilitation or modification of the existing plants will hardly be able to fill the gap between the demand and supply capacity. To meet the requirement, it is inevitable to immediately build a water treatment plant, and transmission and distribution systems as proposed and assumed to start operation in 1995.

Therefore, the existing water supply system should be working until the new system start the operation. The following comparison shows the capacity of the existing deep well plants and daily maximum water demand in 1995:

Deep Well Plant Capacity			Water Demand
(for Zones 1, 2, 3 and 4)			16,155 cu m/day
Prachatipat (new)	:	240 cu m/h or 5,760 cu m/day	
Prachatipat (old)	:	120 cu m/h or 2,880 cu m/day	
Thanyaburi	:	120 cu m/h or 2,880 cu m/day	
Lam Luka	:	240 cu m/h or 5,760 cu m/day	
(Total)		17,280 cu m/day	
(for Zone 7 & 8)			5,453 cu m/day
Patum Thani (new)	:	240 cu m/h or 5,760 cu m/day	
Patum Thani (old)	:	40 cu m/h or 960 cu m/day	
(Total)		6,720 cu m/day	

From the comparison above, the existing plants may be able to supply water to these zones until 1995 except for Zone 1. On the other hand, there are many private deep wells in the Zones 1 and 2 so that these wells will serve as supplementary sources of water. Temporary measures to secure the water source are therefore not required if the new treatment plant will start operation in 1995.

In the determination of the priority of implementation of each zone, it is anticipated to include as many zones as possible in the first phase considering the urgency of the area development and demand for water supply. From this point of view, Zones 1 to 7 are to be covered by the proposed water supply system from the first phase of the project while Zone 8, which is currently less developed area, is included in the next stage of expansion.

The capacity of the future water supply system will depend on the capacity of the new water treatment plant. The plant will consist of four lines so that the expansion work will be well planned with a consideration on the water demand increment. Each line has a maximum treatment capacity of 70,750 cu m/day and consists of mixing tank, flocculator, and sedimentation basin. The rapid sand filter and clear water reservoir have two lines each.

The capacity of the treatment plant is shown by line as follows:

Table 13.1 Treatment Plant Capacity by Line

Plant Facility	Treatment Capacity	Supply Capacity
1st line	70,750 cu m/day	65,509 cu m/day
to 2nd line	141,500	131,018
to 3rd line	212,250	196,528
to 4th line	283,000	262,040 cu m/day

Note : Supply capacity = Treatment capacity / 1.08

The water demand prediction shows that the water demand in 2000 will be 142,116 cu m/day which is more than 50 percent of that in 2011. Therefore, it is recommended to divide a construction plan of the treatment plant into two phases. A half of the treatment plant should be constructed in the earliest time; and the another half of the treatment facilities will be started not later than in 2000. This condition is rather practical to reduce the total cost and physically facilitate the stage construction.

Figure 13.1 shows a schematic plan of the area and facilities to be implemented as the First Phase. Preliminary design plans of the treatment plant facilities are shown in Appendix A-8-5.

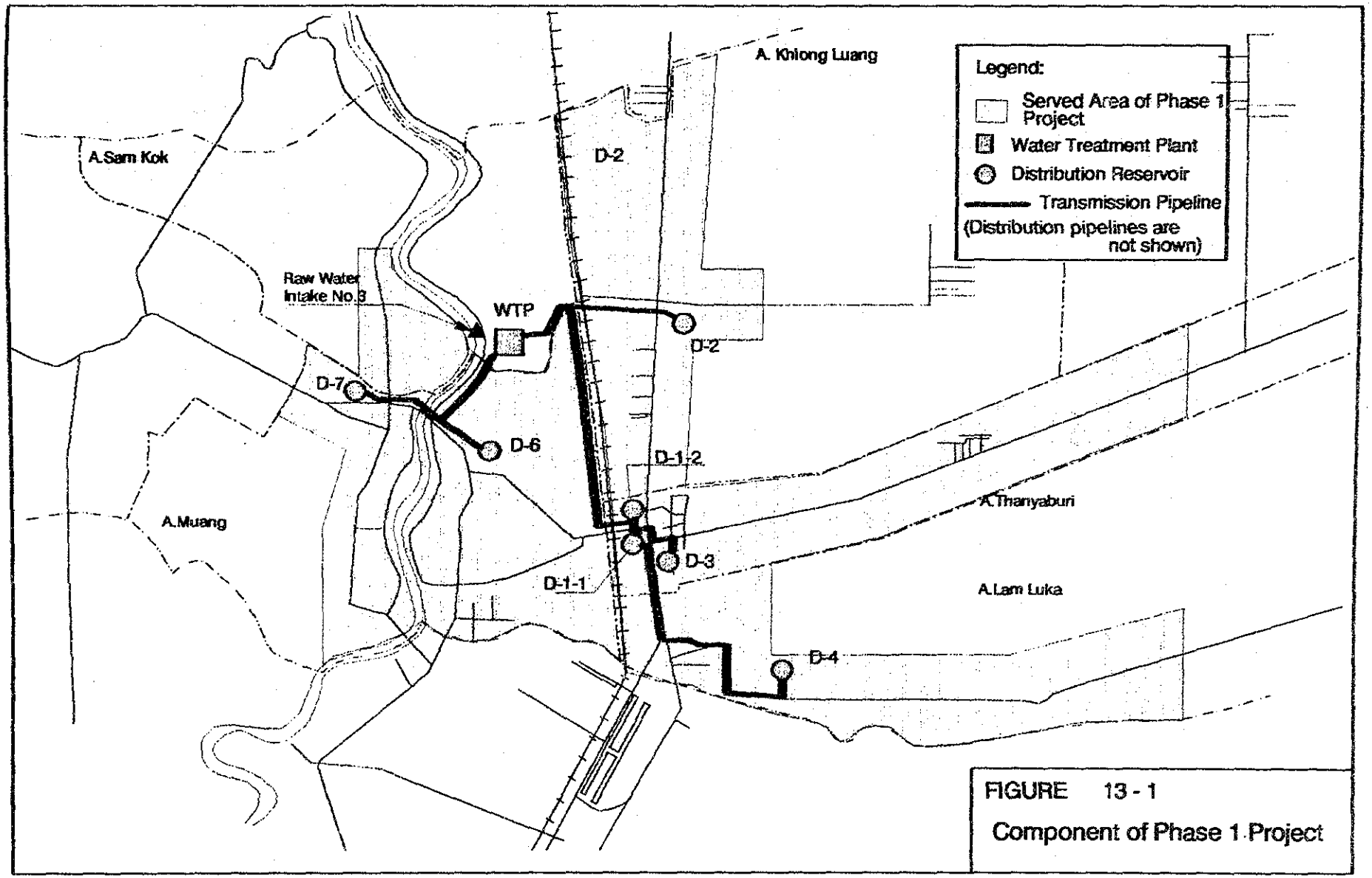


FIGURE 13 - 1

Component of Phase 1 Project

14. Preliminary Design

14.1 Rehabilitation/Modification Plan

As described in the previous chapter, the existing deep well plants may have a capacity for the water demand until the year 1995. Therefore, the construction of new deep well plants is not recommended provided that the new system will start operation in 1995.

However, it may occur that the implementation of the proposed system is delayed by any reasons. Even in such a case, a considerable amount of the investment will be required if the temporary facilities, such as a deep well or a pipeline to convey water from the MWA's treatment plant, is to be constructed. Such facilities will be used as the temporary facilities only for several years until the new treatment plant is started. Such investment should be regarded to be uneconomical.

Therefore, it is anticipated that the investment for such temporary facilities should be avoided to save funds for the implementation of the new system.

14.2 Expansion Works

14.1 Facility Construction Plan

Implementation of the proposed water supply system is scheduled in accordance with the predicted water demand by year. The construction of the treatment plant will be splitted in two stages to effectively use the investment. It is assumed that the first part of the treatment plant will start operation in 1995 considering the time for the detailed design and the construction works.

The distribution reservoirs and the transmission pipelines will be constructed to supply water to the zones included in the service area for each phase. The construction periods of the various facilities were assumed as follows:

a. Water Treatment Plant : 2 years
b. Distribution Reservoirs : 1 year each
c. Transmission Pipelines : 1 year
d. Distribution Pipelines : 2 years

14.2 Phasing for the Implementation

The project components of each phase are summarized as shown in Table 14.1.

Table 14.1 Project Component in Two Phases

Facility	Phase 1	Phase 2
Raw Water Intake		
	Intake Channel	
	Pumping Station	
	Pump : 3 units	Pump : 1 unit
	Raw water pipe	
Treatment Plant		
	Capacity : 141,500 cu m/day	Capacity : 141,500 cu m/day
	Receiving well	
	Mixing tank : 2 units	Mixing tank : 2 untis
	Flocculator : 2 lines	Flocculator : 2 lines
	Sedimentation basin: 8 basins	Sedimentation basins: 8 basins
	Sand filter : 8 units	Sand filter : 8 units
	Cleat water reservoir: 1 unit	Clear water reservoir: 1 unit
	Sludge lagoon : 2 units	
	Sludge drying bed : 2 units	Sludge drying bed : 2 units
	Clear water pump: 6 units	Clear water pump : 2 units
Distribution Reservoir		
	D-1-1 : V = 5,000 cu m	
	D-1-2 : V = 13,000 cu m	
	D-2 : V = 9,550 cu m	D-2 : V = 9,550 cu m
	D-3 : V = 2,000 cu m	
	D-4 : V = 2,200 cu m	
	D-6 : V = 6,500 cu m	D-6 : V = 6,500 cu m
	D-7 : V = 9,000 cu m	
Transmission Pipelines		
	Steel pipes	
	1,000 mm, L = 2,500 m	
	900 mm, L = 7,000 m	
	800 mm, L = 12,000 m	
	600 mm, L = 3,800 m	
	400 mm, L = 11,200 m	
	AC Pipe	
	300 mm, L = 2,700 m	
Distribution Pipelines		
	(for Zones 1 to 7)	(for Zone 8)
	Steel Pipes	Steel Pipes
	1,000 mm, L = 200 m	400 mm, L = 3,900 m
	900 mm, L = 3,190 m	
	800 mm, L = 4,540 m	A/C Pipes
	700 mm, L = 1,200 m	300 mm, L = 1,750 m
	600 mm, L = 14,720 m	250 mm, L = 1,000 m
	500 mm, L = 30,710 m	200 mm, L = 2,300 m
	400 mm, L = 30,170 m	150 mm, L = 500 m
	A/C Pipes	
	300 mm, L = 39,480 m	
	250 mm, L = 19,255 m	
	200 mm, L = 13,300 m	
	150 mm, L = 3,270 m	
	100 mm, L = 8,050 m	

15. IMPLEMENTATION PLAN

The implementation plan is established for the three stages of the process: (i) the pre-construction stage, (ii) the construction stage, and (iii) the operation stage. The necessary processes for each stage are summarized as follows:

(i) Pre-construction stage:

a. Land acquisition
b. Preparation of the PWA's own budget
c. Loan application
d. Selection of the consultants for the detailed design
e. Preparation of the detailed design
f. Pre-qualification of the contractors
g. Tendering
h. Contract award

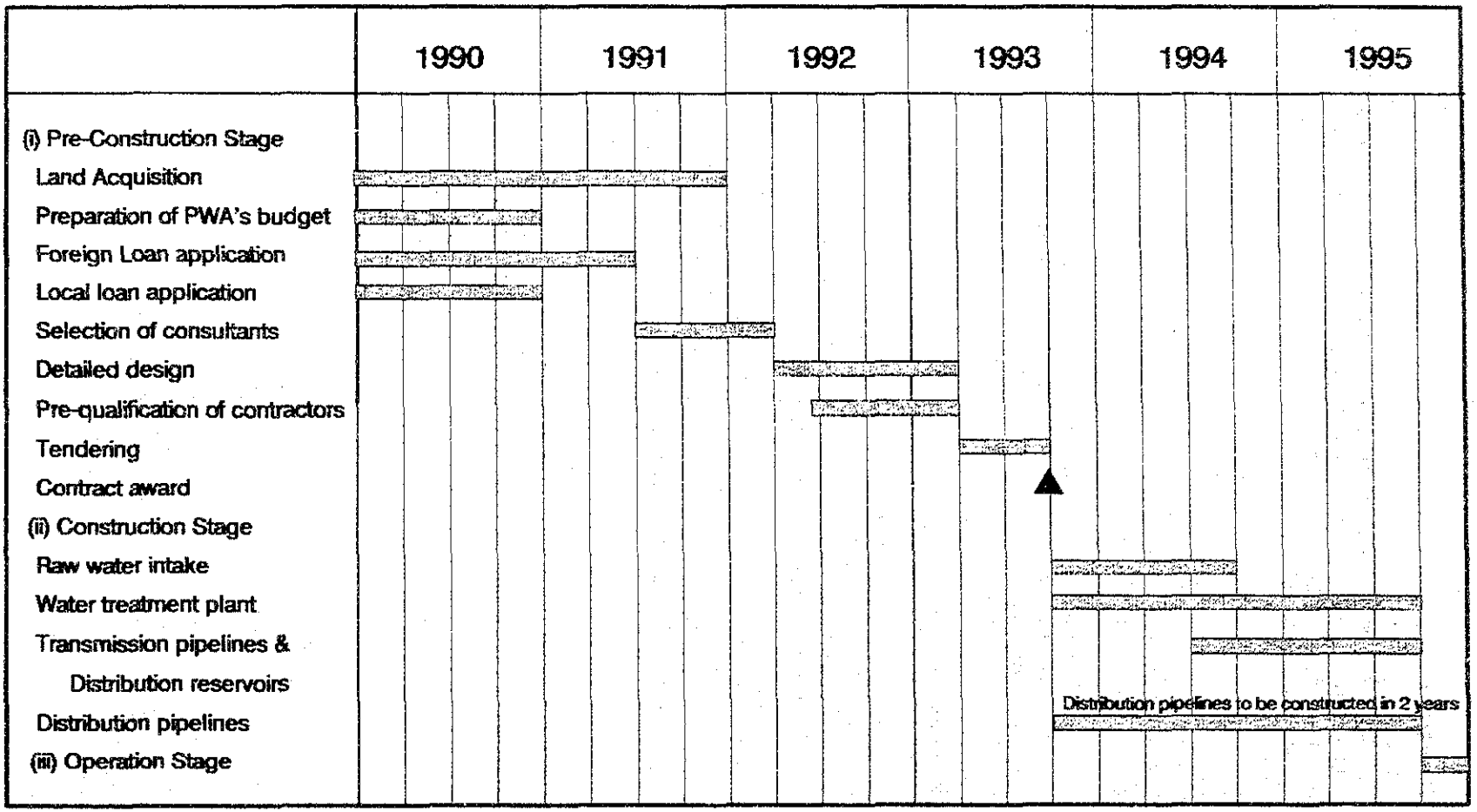
(ii) Construction stage

a. Raw water intake
b. Water treatment plant
c. Transmission pipelines and distribution reservoirs
d. Distribution pipelines

(iii) Operation

The total implementation schedule is as shown in Figure 15-1.

Figure 15 - 1 Implementing Schedule for Phase 1



16. Project Cost Estimates

The project cost is estimated and allocated for each phase on the basis of the cost estimates of each component of the project as shown in Table 16-1.

Table 16.1 Project Cost Estimates by Phase

(Unit :Baht 1000)

Item	Phase 1 Foreign Currency	Phase 1 Local Currency	Phase 1 Total	Phase 2 Foreign Currency	Phase 2 Local Currency	Phase 2 Total
1.Raw Water Intake						
Structural/Pump House	4,325	10,091	14,415			
Pump & Electrical	31,500	7,875	39,375	10,500	2,625	13,125
Raw Water Pipe	4,224	1,056	5,280			
Sub-Total of 1.	40,049	19,022	59,070	10,500	2,625	13,125
2.New Treatment Plant						
A Civil/Architectural Works						
1. Receiving Well	449	1,049	1,498	0	0	0
2. Mixing Basin	384	896	1,280	384	896	1,280
3. Flocculation Basin	4,108	9,584	13,692	4,108	9,584	13,692
4. Sedimentation Basin	20,475	47,776	68,252	20,475	47,776	68,252
5. Rapid Sand Filter	12,567	29,324	41,891	12,567	29,324	41,891
6. Clear Water Reservoir	10,281	23,990	34,271	10,281	23,990	34,271
7. Sludge Lagoon	505	1,178	1,684	505	1,178	1,684
8. Sludge Drying Bed	1,105	2,577	3,682	1,105	2,577	3,682
9. Pumping Station						
-1. Clear Water Pumping Station	270	630	900	270	630	900
-2. Sludge Lagoon Drain Pump	41	95	135	41	95	135
10. Chlorination House	171	399	570	171	399	570
11. Chemical Storage House	171	399	570	171	399	570
12. Site Fill	7,200	16,800	24,000	3,600	8,400	12,000
13. In-Plant Road	1,013	2,363	3,375	1,013	2,363	3,375
14. In Plant Piping	2,700	6,300	9,000	2,700	6,300	9,000
15. Administratio Bldg.	684	1,596	2,280	0	0	0
Sub-total of A.	62,124	144,955	207,079	57,390	133,910	191,301
B. Mechanical Works						
1. Clear Water Pump	21,600	5,400	27,000	10,600	1,800	9,000
2. Sludge Lagoon Pump	960	240	1,200	960	240	1,200
3. Flush Mixer	2,400	600	3,000	2,400	600	3,000
4. Flocculator	11,520	2,880	14,400	11,520	2,880	14,400
5. Sludge Collector	8,320	2,080	10,400	8,320	2,080	10,400
6. Chemical Equipment	2,400	600	3,000	2,400	600	3,000
7. Chlorination Equip	4,000	1,000	5,000	4,000	1,000	5,000
8. Others (20% of above)	10,240	2,560	12,800	7,360	1,840	9,200
C. Electrical Works	30,720	7,680	38,400	22,080	5,520	27,600
D. Miscellaneous	15,428	16,799	32,228	12,363	15,047	27,410
Sub-Total of 2.	169,712	184,794	354,506	135,993	165,517	301,511

Table 16.1 Project Cost Estimates by Phase (Cont'd)
(Unit :Baht 1000)

Item	Phase 1 Foreign Currency	Phase 1 Local Currency	Phase 1 Total	Phase 2 Foreign Currency	Phase 2 Local Currency	Phase 2 Total
3.Distribution Reservoirs						
D-1-1						
A.Civil/Archit. Works	8,753	20,425	29,178			
B.Mechanical Works	9,600	2,400	12,000			
C.Electrical Works	2,880	720	3,600			
D.Miscellaneous	2,123	2,354	4,478			
D-1-2						
A.Civil/Archit. Works	15,522	36,218	51,740			
B.Mechanical Works	6,400	1,600	8,000			
C.Electrical Works	1,920	480	2,400			
D.Miscellaneous	2,384	3,830	6,214			
D-2						
A.Civil/Archit. Works	13,832	32,275	46,107	13,832	32,275	46,107
B.Mechanical Works	7,200	1,800	9,000	2,400	600	3,000
C.Electrical Works	2,160	540	2,700	720	180	900
D.Miscellaneous	2,319	3,462	5,391	1,695	3,306	5,391
D-3						
A.Civil/Archit. Works	1,902	4,438	6,340			
B.Mechanical Works	2,400	600	3,000			
C.Electrical Works	720	180	900			
D.Miscellaneous	502	522	1,024			
D-4						
A.Civil/Archit. Works	2,067	4,823	6,890			
B.Mechanical Works	2,400	600	3,000			
C.Electrical Works	720	180	900			
D.Miscellaneous	519	560	1,079			
D-6						
A.Civil/Archit. Works	8,586	20,033	28,618	8,586	20,033	28,618
B.Mechanical Works	4,800	1,200	6,000	1,600	400	2,000
C.Electrical Works	1,440	360	1,800	480	120	600
D.Miscellaneous	1,483	2,159	3,382	1,067	2,055	3,382
D-7						
A.Civil/Archit. Works	6,864	16,016	22,879			
B.Mechanical Works	4,800	1,200	6,000			
C.Electrical Works	1,440	360	1,800			
D.Miscellaneous	1,310	1,758	3,068			
Sub-Total of 3.	117,047	161,092	277,489	30,379	58,969	89,998

Table 16.1 Project Cost Estimates by Phase (Cont'd)
(Unit :Baht 1000)

Item			Phase 1 Foreign Currency	Phase 1 Local Currency	Phase 1 Total	Phase 2 Foreign Currency	Phase 2 Local Currency	Phase 2 Total
4.Transmission Pipeline								
Steel	1,000 mm	2,500 m	27,640	6,910	34,550			
	900 mm	7,000 m	58,856	14,714	73,570			
	800 mm	12,000 m	88,800	22,200	111,000			
	600 mm	2,000 m	8,960	2,240	11,200			
	500 mm	2,600 m	9,443	2,361	11,804			
	400 mm	11,200 m	32,704	8,176	40,880			
AC	300 mm	2,700 m	1,207	2,816	4,023			
Sub-Total of 4.			227,610	59,417	287,027			
5.Distribution Pipeline								
Steel	1,000 mm	200 m	2,501	625	3,126			
	900 mm	3,190 m	30,292	7,573	37,865			
	800 mm	4,540 m	37,954	9,489	47,443			
	700 mm	1,200 m	7,162	1,790	8,952			
	600 mm	14,720 m	74,542	18,636	93,178			
	500 mm	30,710 m	126,279	31,570	157,849			
	400 mm	30,170 m	100,165	25,041	125,206			
AC	300 mm	39,480 m	19,187	44,771	63,958			
	250 mm	19,255 m	6,816	15,905	22,721			
	200 mm	13,300 m	3,551	8,286	11,837			
	150 mm	3,270 m	598	1,396	1,995			
	100 mm	8,050 m	1,063	2,479	3,542			
Steel	400 mm	3,900 m				12,948	3,237	16,185
AC	300 mm	1,750 m				851	1,985	2,835
	250 mm	1,000 m				354	826	1,180
	200 mm	2,300 m				614	1,433	2,047
	150 mm	500 m				92	214	305
Sub-Total 5.			410,111	167,561	577,672	14,858	7,694	22,552
Total			964,528	591,886	1,555,764	191,731	234,805	427,186

17. FINANCIAL AND ECONOMIC STUDY

17.1 Financial Study

The financial plan for the proposed water supply system is studied to enable the waterworks to take necessary steps for the viable implementation of the project with due consideration on the existing financial practices, potential finding sources to meet the estimated capital costs for the construction and recurrent costs for the operation.

17.1.1 Funding Arrangements

The funds are required largely in two categories for the construction capital and recurrent costs for yearly operating and maintenance of the systems, including debt service, depreciation and other miscellaneous expenses.

1) Cost Estimates

The required costs break down and the implementation-disbursement schedule into annual disbursement for the construction stage are presented in Table 17-1-1. The implementation plan of this program is separated into two stages. Phase I is constructed from 1990 to 1997 and Phase II is planned to be implemented from 1998 to 2004.

The capital disbursement for the construction is graphically indicated in Figure 17-1-1.

2) Funds for Construction Costs

Out of the total capital costs, the foreign currency portion is financed by the international lending agency which the local currency portion is financed by the government subsidies, PWA's own equity or loan.

Such international loans are normally provided to finance the foreign currency portion of the project costs; however, in certain cases, a part of local currency portion is also financed by international loan when such is desirable.

If the funding capability of the executing agency is not sufficient, the subsidy from the central government to the possible extent may be desirable and more soft loans with low interest and longer period of repayment should be sought.

a. Loan from the international lending agencies

The international loans are broadly grouped in two categories such as multilateral and bilateral loans. The multilateral loans are regarded as loans from the World Bank and Asian Development Bank. The interest of such loans are presently ranging from 6-8 percent per annum and repayment period is normally 20 years with a grace period of 5 years. The bilateral loans are exemplified by the loan from West Germany, U.S.A. or Japan with very concessionaire terms, for example, low interest rates of 2-3 percent per annum and long maturity periods (up to 30 years) including an extended grace period up to 10 years.

b. Government Subsidy

Table 17-1-1 Implementation/Disbursement Schedule at 1989 Price

(Unit : Baht x 1000)

Year	Construction Cost			Enginaering Cost						Land Cost	Sub-Total			Contingency			Grand Total		
				Design			Supervision												
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	L.C.	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
Total	1,300,752	682,200	1,982,952	55,974	31,276	87,250	28,505	15,926	44,431	177,000	1,385,231	906,402	2,291,633	130,074	68,221	198,295	1,515,305	974,623	2,489,928
1990	0	0	0	0	0	0	0	0	0	177,000	0	177,000	177,000	0	0	0	0	177,000	177,000
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	27,987	15,638	43,625	0	0	0	0	27,987	15,638	43,625	0	0	0	27,987	15,638	43,625
1993	89,102	32,819	121,921	22,390	12,510	34,900	1,731	967	2,698	0	113,223	46,296	159,519	8,910	3,282	12,192	122,133	49,578	171,711
1994	509,602	251,278	760,880	0	0	0	8,655	4,836	13,491	0	518,257	256,114	774,371	50,960	25,128	76,088	569,217	281,242	850,459
1995	433,522	228,567	662,089	0	0	0	6,924	3,868	10,792	0	440,446	232,435	672,881	43,352	22,857	66,209	483,798	255,292	739,090
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	5,597	3,128	8,725	0	0	0	0	5,597	3,128	8,725	0	0	0	5,597	3,128	8,725
1998	120,153	78,852	199,005	0	0	0	4,478	2,502	6,980	0	124,631	81,354	205,985	12,015	7,886	19,901	136,646	89,240	225,886
1999	148,373	90,684	239,057	0	0	0	6,717	3,753	10,470	0	155,090	94,437	249,527	14,837	9,069	23,906	169,927	103,506	273,433
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: 1.Contingency = 10 % of the total of gross construction cost
2.Engineering Cost (Design) = 4 % of the total construction cost
3.Engineering Cost (Supervision) = 2 % of the total construction cost
4.F.C.: Foreign Currency
5.L.C.: Local Currency

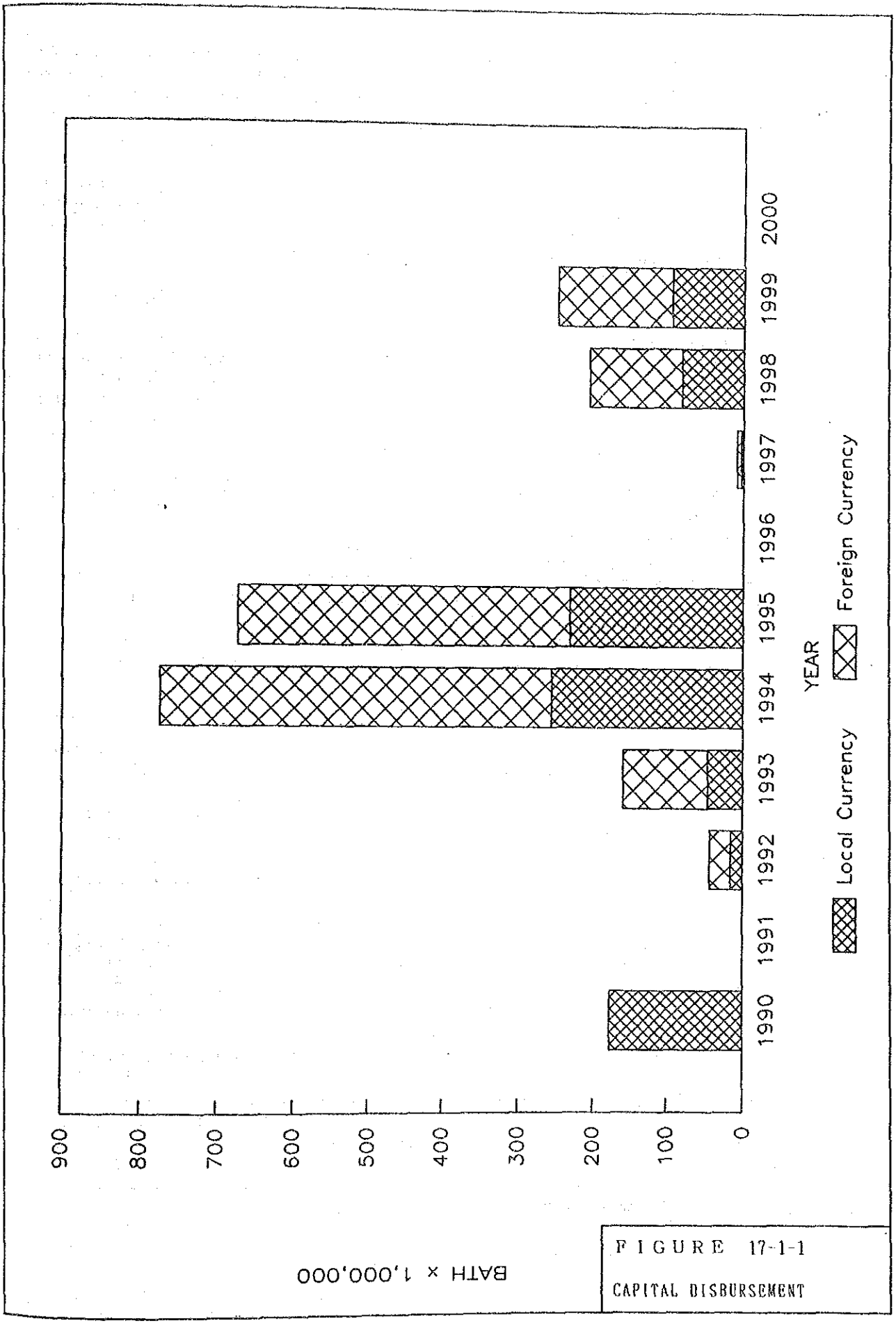


FIGURE 17-1-1

CAPITAL DISBURSEMENT

The subsidy from the central government is allocated to the local municipalities in Thailand for the construction project to develop public utilities such as irrigation and drainage system, sewerage system, feeder roads and other infrastructure development projects.

The water supply development project as proposed to enhance community benefits such as public health and economic development is necessary to be encouraged by the government initiative with allocation of meaningful amount of subsidy.

c. Loan from domestic banks

The local currency portion of the capital costs are normally financed by domestic banks, wholly or partly depending on availability of other sources of capital as subsidy. PWA presently borrows the fund from the Krung Thai Bank. In amortization period, PWA pays only interest part and capital repayments are in charge of national government.

Table 17-1-2 shows loan conditions of international lending agencies.

Table 17-1-2 Loan Conditions

Agency	Interest Rate	Duration (Grace Period) Year	Charge
IBRD	7.74%	15-20 (3-5)	Front-end Fee: ——— Commitment Charge: 0.75%
IDA	0%	40 (10) or 35 (10)	Service Charge: 0.75% Commitment charge: ———
IDB	8.1%	15-25 (4-6)	Commitment Charge: 0.75% Inspection Fee 1% of loan amount
ADB	6.37%	10-30 (2-7)	Commitment Charge: 0.75%
OECF *	2.74%	28.8 (9.6)	———

* Average condition of 1988.

3) Funds for the recurrent costs

The funds are normally required after the construction of the system to meet the annual costs including operation and maintenance costs, and debt service payment if any loan is provided. There are established practices in the developed counties that such recurrent costs are met by the users of the system who receive the benefits through the collection of water tariff.

17.1.2 Alternative Financing Plan

The financial plans are developed based on the capital disbursement schedule and funding arrangements. The funding arrangements are considered among others one of the most decisive factor for the financial viability of the project. The funding arrangement which will not impose unbearable burden upon the waterworks is the most desirable subject, however, to the availability of sufficient fund or the loan of lenient condition.

The following five alternatives for the funding arrangement are considered to assess the financial impact on the waterworks as well as individual consumer and thereby to select adequate funding arrangement.

Alternative 1 : Total project costs is financed by the international lending agencies (ADB or IBRD).

Alternative 2 : The foreign currency portion equivalent to 1,385,231 thousand Baht is financed by bilateral loan and local currency portion of 906,402 thousand Baht is financed by the international lending agencies.

Alternative 3 : The foreign currency portion equivalent to 1,385,231 thousand Baht is financed by bilateral loan and local currency portion of 906,402 thousand Baht is financed by equal contribution of local loan and PWA's own equity allocation.

Alternative 4 : The total of foreign currency portion and a part of local currency portion equivalent to 593,670 thousand Baht (approximately 86 percent of the total project cost) is financed by bilateral loan and 312,732 thousand Baht is financed by equal contribution of local loan and PWA's own equity allocation.

Alternative 5 : The total of foreign currency portion and a part of local currency portion equivalent to 593,670 thousand Baht (approximately 86 percent of the total project cost) is financed by bilateral loan and remaining portion of 312,732 thousand Baht is financed by local loan.

In the alternative plans above, the conditions of the loan are assumed as follows.

IBRD or ADB: 20 year repayment period including 5 year grace period with 7 percent interest per annum.

Bilateral Loan: 30 year repayment period including 10 year grace period with 2.7 percent interest per annum.

Local Loan: 13 year repayment period including 3 year grace period with 11 percent interest per annum and in amortization period, PWA pays only interest part and principal repayments are depended on national government contribution.

Such government funding contribution can also be justified by the prospective increase of socio-economic benefits to be derived from the proposed project as manifested in economic project analysis.

Summarized fund arrangements for each alternative plan are shown in Table 17-1-3.

Table 17-1-3 Funds Arrangements
Unit : Baht x 1,000

Funds Plan	Source of Fund			
	International Loan	Bilateral Loan	Local Loan	PWA's own Equity
Alternative 1	2,291,633			
Alternative 2	906,402	1,385,231		
Alternative 3		1,385,231	453,201	453,201
Alternative 4		1,978,901	156,366	156,366
Alternative 5		1,978,901	312,732	

The sources of capital costs and subsequent recurrent costs including debt services and operation and maintenance costs are indicated in alternative funding plans in Table 17-1-4 and the funding burden to be imposed on PWA in each alternative is highlighted in Figure 17-1-2.

As clearly shown in this figure, the Alternatives 3 and 4 appear more agreeable since required funds from PWA in successive years are less than other alternatives. Although there is no significant difference in graphic indication between Alternatives 3 and 4, Alternative 4 imposes less initial funding burden on PWA during construction stage.

Alternative 4 is, therefore assumed as a recommendable funding arrangement. The further financing analysis are made based on this alternative to identify the various factors needed to make the project financially viable.

Tables 17-1-5 to 17-1-7 show the detail debt service for Alternative 4 Financing Plan and Table 17-4 shows summarized project cost and funding allocation of Alternative 4.

Appendix A17-1-1 to A17-1-5 shows details of debt services for each alternative plans.

Table 17-1-4 Capital and Annual Costs Cash Outlay Patum Thani & Prachatipat

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Alternative 1															
Capital Costs															
PWA's Equity															
Subsidy															
Foreign loan	177,000	0	43,625	159,519	774,371	672,881	0	8,725	205,985	249,527	0	0	0	0	0
Local loan															
Recurrent Costs															
O/M costs	4,698	5,324	6,009	6,751	7,555	33,737	40,379	45,689	50,124	57,449	63,490	70,124	76,088	83,636	90,502
Debt Service	12,390	12,390	15,444	26,610	80,816	173,861	173,861	174,472	188,891	206,358	251,609	251,609	251,609	251,509	251,609
TOTAL	17,088	17,714	21,453	33,361	88,371	207,598	214,240	220,161	239,015	263,807	315,099	321,733	327,697	335,245	342,111
Alternative 2															
Capital Costs															
PWA's Equity															
Subsidy															
Foreign loan(1)	0	0	27,987	113,223	518,257	440,446	0	5,597	124,631	155,090	0	0	0	0	0
Foreign loan(2)	177,000	0	15,638	46,296	256,114	232,435	0	3,128	81,354	94,437	0	0	0	0	0
Recurrent Costs															
O/M costs	4,698	5,324	6,009	6,751	7,555	33,737	40,379	45,689	50,124	57,449	63,490	70,124	76,088	83,636	90,502
Debt Service	12,390	12,390	14,240	20,538	52,459	100,322	100,322	100,692	109,752	120,550	136,919	136,919	179,118	179,118	179,118
TOTAL	17,088	17,714	20,249	27,289	60,014	134,059	140,701	146,381	159,876	177,999	200,409	207,043	255,206	262,754	269,620
Alternative 3															
Capital Costs															
PWA's Equity	88,500	0	7,819	23,148	128,057	116,218	0	1,564	40,677	47,219	0	0	0	0	0
Subsidy	0	0	0	5,760	6,394	7,097	23,870	26,496	29,410	32,645	41,586	46,160	51,238	40,519	44,976
Foreign loan	0	0	27,987	113,223	518,257	440,446	0	5,597	124,631	155,090	0	0	0	0	0
Local loan	88,500	0	7,819	23,148	128,057	116,218	0	1,564	40,677	47,219	0	0	0	0	0
Recurrent Costs															
O/M costs	4,698	5,324	6,009	6,751	7,555	33,737	40,379	45,689	50,124	57,449	63,490	70,124	76,088	83,636	90,502
Debt Service	9,735	9,735	11,351	22,714	50,793	75,469	91,461	91,785	99,624	109,006	114,355	114,355	156,554	140,199	140,199
TOTAL	102,933	15,059	25,179	52,613	186,405	225,424	131,840	139,038	190,425	213,674	177,845	184,479	232,642	223,835	230,701
Alternative 4															
Capital Costs															
PWA's Equity	88,500	0	708	0	17,002	21,836	0	365	13,971	13,985	0	0	0	0	0
Subsidy	0	0	0	5,335	5,922	6,573	9,619	10,677	11,851	13,155	16,295	18,088	20,077	7,138	7,923
Foreign loan	0	42,209	159,519	740,367	629,209	0	7,996	178,044	221,557	0	0	0	0	0	0
Local loan	88,500	0	708	0	17,002	21,836	0	365	13,971	13,985	0	0	0	0	0
Recurrent Costs															
O/M costs	4,698	5,324	6,009	6,751	7,555	33,737	40,379	45,689	50,124	57,449	63,490	70,124	76,088	83,636	90,502
Debt Service	9,735	9,735	10,953	20,594	42,454	61,845	64,168	64,424	70,768	78,288	79,981	79,981	140,265	125,117	125,117
TOTAL	102,933	15,059	17,670	27,345	67,011	117,418	104,547	110,478	134,863	149,722	143,471	150,105	216,353	208,753	215,619
Alternative 5															
Capital Costs															
PWA's Equity															
Subsidy	0	0	0	10,670	11,843	13,146	19,237	21,353	23,702	26,309	32,590	36,175	40,155	14,276	15,847
Foreign loan	0	42,209	159,519	740,367	629,209	0	7,996	178,044	221,557	0	0	0	0	0	0
Local loan	177,000	0	1,416	0	34,004	43,672	0	729	27,941	27,970	0	0	0	0	0
Recurrent Costs															
O/M costs	4,698	5,324	6,009	6,751	7,555	33,737	40,379	45,689	50,124	57,449	63,490	70,124	76,088	83,636	90,502
Debt Service	19,470	19,470	20,765	35,742	59,472	81,265	85,910	86,206	94,087	103,146	106,533	106,533	166,816	136,521	136,521
TOTAL	24,168	24,794	26,774	42,493	67,027	115,002	126,289	131,895	144,211	160,595	170,023	176,657	242,904	220,157	227,023

Table 17-1-4 Capital and Annual Costs Cash Outlay (Cont'd)

Unit: Baht x 1000

YEAR	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Alternative 1																
Capital Costs																
PWA's Equity																
Subsidy																
Foreign loan																
Local loan																
Recurrent Costs																
O/M costs	98,506	105,172	112,646	120,061	127,986	136,452	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490
Debt Service	251,609	251,609	251,609	251,609	251,609	124,849	124,849	124,849	124,849	141,658	0	0	0	0	0	0
TOTAL	350,115	356,781	364,255	371,670	379,595	261,301	270,339	270,339	270,339	287,148	145,490	145,490	145,490	145,490	145,490	145,490
Alternative 2																
Capital Costs																
PWA's Equity																
Subsidy																
Foreign loan(1)																
Foreign loan(2)																
Recurrent Costs																
O/M costs	98,506	105,172	112,646	120,061	127,986	136,452	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490
Debt Service	179,118	179,118	190,064	190,064	190,064	135,710	135,710	135,710	135,710	135,710	90,546	90,546	90,546	90,546	90,546	90,546
TOTAL	277,624	284,290	302,710	310,125	318,050	272,162	281,200	281,200	281,200	281,200	236,036	236,036	236,036	236,036	236,036	236,036
Alternative 3																
Capital Costs																
PWA's Equity																
Subsidy	49,923	10,006	11,107	12,329	13,685	0	0	0	0	0	0	0				
Foreign loan																
Local loan																
Recurrent Costs																
O/M costs	98,506	105,172	112,646	120,061	127,986	136,452	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490
Debt Service	140,199	94,790	105,736	105,736	105,736	90,546	90,546	90,546	90,546	90,546	90,546	90,546	90,546	90,546	90,546	90,546
TOTAL	238,705	199,962	218,382	225,797	233,722	226,998	236,036	236,036	236,036	236,036	236,036	236,036	236,036	236,036	236,036	236,036
Alternative 4																
Capital Costs																
PWA's Equity																
Subsidy	8,795	3,168	3,516	3,903	4,332	0	0	0	0	0	0	0				
Foreign loan																
Local loan																
Recurrent Costs																
O/M costs	98,506	105,172	112,646	120,061	127,986	136,452	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490
Debt Service	125,117	118,523	134,160	134,160	134,150	129,351	129,351	129,351	129,351	129,351	129,351	129,351	129,351	129,351	129,351	129,351
TOTAL	223,623	223,695	246,806	254,221	262,136	265,803	274,841	274,841	274,841	274,841	274,841	274,841	274,841	274,841	274,841	274,841
Alternative 5																
Capital Costs																
PWA's Equity																
Subsidy	17,590	6,335	7,032	7,806	8,664	0	0	0	0	0	0	0				
Foreign loan																
Local loan	0															
Recurrent Costs																
O/M costs	98,506	105,172	112,646	120,061	127,986	136,452	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490
Debt Service	136,521	123,331	138,969	138,969	138,969	129,351	129,351	129,351	129,351	129,351	129,351	129,351	129,351	129,351	129,351	129,351
TOTAL	235,027	228,503	251,615	259,030	266,955	265,803	274,841	274,841	274,841	274,841	274,841	274,841	274,841	274,841	274,841	274,841

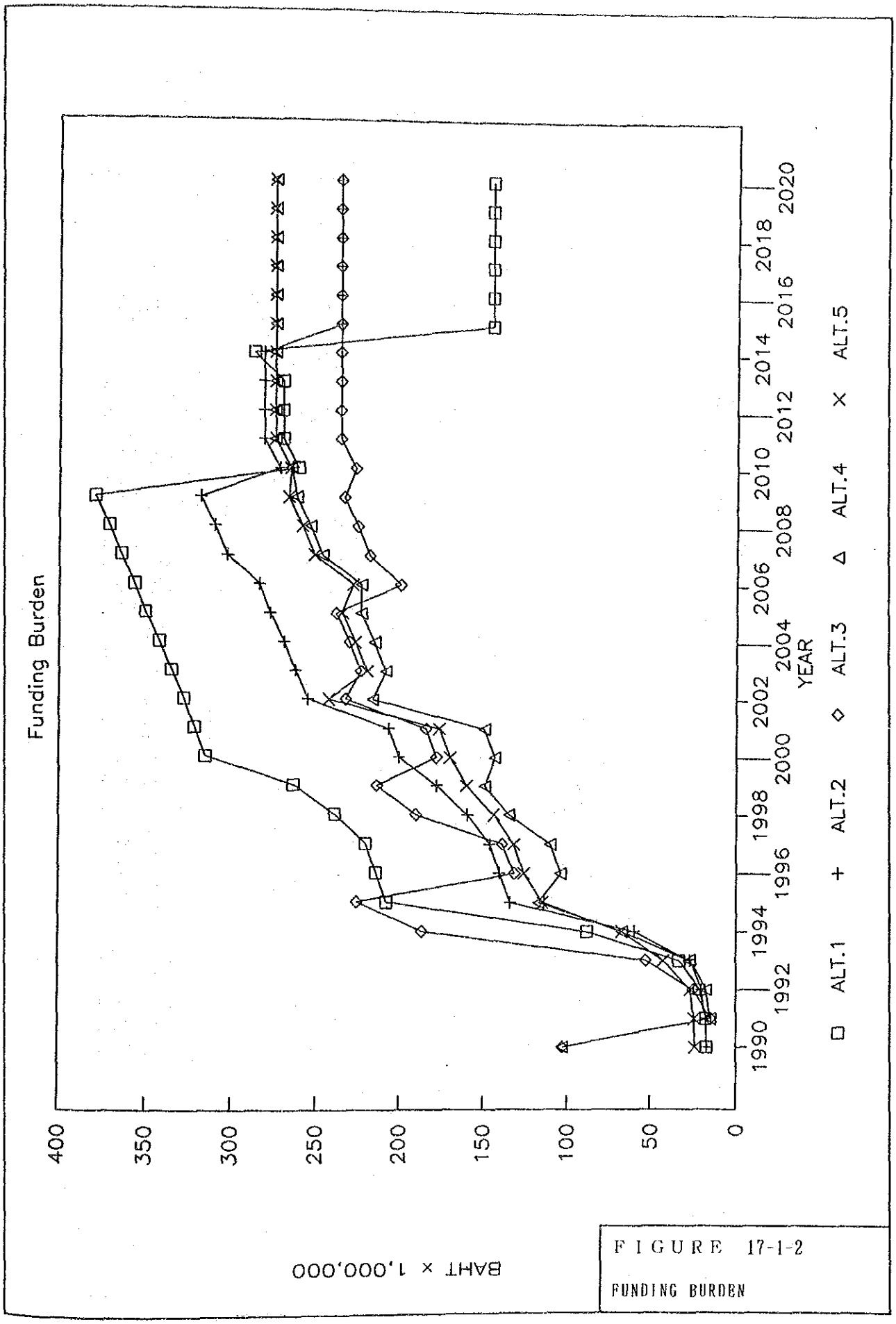


FIGURE 17-1-2

FUNDING BURDEN

Table 17-1-5 Debt Services (Alternative 4) for Foreign Portion

(UNIT: Baht x 1000)

Year	Capital	Interest	Total annual repayment	Balance of Capital
1990	0	0	0	0
1991	0	0	0	0
1992	0	1,140	1,140	42,209
1993	0	5,447	5,447	201,728
1994	0	25,437	25,437	942,095
1995	0	42,425	42,425	1,571,304
1996	0	42,425	42,425	1,571,304
1997	0	42,641	42,641	1,579,300
1998	0	47,448	47,448	1,757,344
1999	0	53,430	53,430	1,978,901
2000	0	53,430	53,430	1,978,901
2001	0	53,430	53,430	1,978,901
2002	60,283	53,430	113,714	1,978,901
2003	61,911	51,803	113,714	1,918,618
2004	63,583	50,131	113,714	1,856,706
2005	65,299	48,414	113,714	1,793,124
2006	67,063	46,651	113,714	1,727,824
2007	84,511	44,841	129,351	1,660,762
2008	86,793	42,559	129,351	1,576,251
2009	89,136	40,215	129,351	1,489,458
2010	91,543	37,809	129,351	1,400,322
2011	94,014	35,337	129,351	1,308,780
2012	96,553	32,799	129,351	1,214,765
2013	99,160	30,192	129,351	1,118,213
2014	101,837	27,514	129,351	1,019,053
2015	104,587	24,765	129,351	917,216
2016	107,410	21,941	129,351	812,629
2017	110,310	19,041	129,351	705,219
2018	113,289	16,063	129,351	594,909
2019	116,348	13,004	129,351	481,620
2020	119,489	9,862	129,351	365,272
2021	122,715	6,636	129,351	245,783
2022	23,320	3,323	26,643	123,068
2023	23,949	2,693	26,643	99,748
2024	24,596	2,047	26,643	75,799
2025	25,260	1,382	26,643	51,202
2026	25,942	700	26,643	25,942
Total	1,978,901	1,030,406	3,009,307	

Table 17-1-6 Debt Services (Alternative 4) for Local Portion

(UNIT: Baht x 1000)

Year	Capital	Interest	Total annual repayment	Balance of Capital
1990	0	9,735	9,735	88,500
1991	0	9,735	9,735	88,500
1992	0	9,813	9,813	89,208
1993	5,335	9,813	15,148	89,208
1994	5,922	11,096	17,018	100,875
1995	6,573	12,847	19,420	116,790
1996	9,619	12,124	21,742	110,217
1997	10,677	11,106	21,782	100,963
1998	11,851	11,468	23,319	104,257
1999	13,155	11,703	24,858	106,390
2000	16,295	10,256	26,551	93,236
2001	18,088	8,463	26,551	76,941
2002	20,077	6,474	26,551	58,853
2003	7,138	4,265	11,404	38,776
2004	7,923	3,480	11,404	31,637
2005	8,795	2,609	11,404	23,714
2006	3,168	1,641	4,809	14,919
2007	3,516	1,293	4,809	11,751
2008	3,903	906	4,809	8,235
2009	4,332	477	4,809	4,332
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
Total	156,366	149,303	305,669	

Table 17-1-7 Debt Services (Alternative 4)

(Unit: Baht x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	9,735	9,735	88,500
1991	0	9,735	9,735	88,500
1992	0	10,953	10,953	131,417
1993	5,335	15,260	20,594	290,936
1994	5,922	36,533	42,454	1,042,970
1995	6,573	55,272	61,845	1,688,094
1996	9,619	54,549	64,168	1,681,521
1997	10,677	53,747	64,424	1,680,263
1998	11,851	58,917	70,768	1,861,601
1999	13,155	65,133	78,288	2,085,291
2000	16,295	63,686	79,981	2,072,137
2001	18,088	61,894	79,981	2,055,842
2002	80,361	59,904	140,265	2,037,754
2003	69,049	56,068	125,117	1,957,393
2004	71,506	53,611	125,117	1,888,344
2005	74,094	51,023	125,117	1,816,838
2006	70,230	48,292	118,523	1,742,743
2007	88,027	46,133	134,160	1,672,513
2008	90,696	43,465	134,160	1,584,486
2009	93,468	40,692	134,160	1,493,790
2010	91,543	37,809	129,351	1,400,322
2011	94,014	35,337	129,351	1,308,780
2012	96,553	32,799	129,351	1,214,765
2013	99,160	30,192	129,351	1,118,213
2014	101,837	27,514	129,351	1,019,053
2015	104,587	24,765	129,351	917,216
2016	107,410	21,941	129,351	812,629
2017	110,310	19,041	129,351	705,219
2018	113,289	16,063	129,351	594,909
2019	116,348	13,004	129,351	481,620
2020	119,489	9,862	129,351	365,272
2021	122,715	6,636	129,351	245,783
2022	23,320	3,323	26,643	123,068
2023	23,949	2,693	26,643	99,748
2024	24,596	2,047	26,643	75,799
2025	25,260	1,382	26,643	51,202
2026	25,942	700	26,643	25,942
Total	2,135,267	1,179,709	3,314,976	

Table 17-1-8 Project Cost, Disbursement Schedule and Funding Allocation of Alternative 4

a. Project Cost and Disbursement Schedule (Unit : Baht x 1,000)

Year	Foreign Portion	Local Portion	Total
1990	0	177,000	177,000
1991	0	0	0
1992	27,987	15,638	43,625
1993	113,223	46,296	159,519
1994	518,257	256,114	774,371
1995	440,446	232,435	672,881
1996	0	0	0
1997	5,597	3,128	8,725
1998	124,631	81,354	205,985
1999	155,090	94,437	249,527
Total	1,385,231	906,402	2,291,633

b. Funding allocation

Unit : (Baht x 1,000)

Year	Bilateral Loan	Local Loan	PWA's Equity	Total
1990	0	88,500	88,500	177,000
1991	0	0	0	0
1992	42,209	708	708	43,625
1993	159,519	0	0	159,519
1994	740,367	17,002	17,002	774,371
1995	629,209	21,836	21,836	672,881
1996	0	0	0	0
1997	7,996	364.5	364.5	8,725
1998	178,044	13,970.5	13,970.5	205,985
1999	221,557	13,985	13,985	249,527
Total	1,978,901	312,732	312,732	2,291,633

17.1.3 Revenue Plan

1) Water Sales

The revenue is required to be raised by waterworks to meet the annual cash requirement after the construction of the systems. Such annual cash requirements normally include the operation and maintenance costs as well as debt service if a certain loan is made to finance the capital costs.

a. PWA Water Tariff Schedule

Water tariffs are collected based on reading water meters with the exception of negligible direct sale fees. PWA has three major sources of tariff revenue: namely, water sales, service charges and connection fees. Revenue from these tariffs contribute 95 percent to the total revenue of PWA. All the waterworkes have the same income structure as this. PWA also applies the same water tariff structure to all waterworks. Table 17-1-9 shows the current levels of water tariff structure.

Table 17-1-9 Present Water Tariff Structure

Consumption (cu m / mo)	Tariff (Baht / cu m)
0 - 10	3.75
11 - 20	4.50
21 - 30	6.50
31 - 50	7.50
51 - 80	8.00
81 - 100	8.50
101 - 300	9.00
300 - 1,000	9.25
1,100 - 2,000	9.50
2,001 - 3,000	9.75
3,001 and above	10.00

Connection Fees and Service Charges:

These fees and charges are of the nature which cover actual expenses to be borne by the consumers for connection work. PWA accounts these fees and charges as revenue sources as they actually form a significant part of its revenue.

Present Connection Fees:

The minimum connection fee is set at 2,050 Baht for 1/2" diameter pipe with a length of 10 meters. The additional fee can be added substantially to the total cost of a connection - for example a new 1/2" connection with a length of 30 meters from the main pipe which could cost over double that for an equivalent connection 10 meters from the main. The additional fees are not charged according to a fixed scale, but instead are levied by PWA on an ad hoc basis charges for the labor and material costs.

Present connection charge and estimated connection fees are shown in Tables 17-1-10 and 17-1-11 respectively.

Table 17-1-10 Present Connection Charge

Size of Connection	Basis Connection Fee (Baht / conn.)
1/2"	2,050
3/4"	2,750
1"	3,750
1-1/2"	6,690
2"	9,575
2-1/2"	13,075
3"	15,495
4"	21,455
6"	30,025

Note : Basic connection fee is applied to the connection less than 10m from the main pipe

Table 17-1-11 Connection Fee

(Unit :Baht x 1000)

Size of Conn. (inch)	0.5	0.75	1	1.5	2	2.5	3	4	6	
Conn. charge (Bath/conn.)	2,050	2,750	3,750	6,690	9,575	13,075	15,495	21,455	30,025	Total (Baht x1000)
					No. of Connection					
1990	0	0	0	0	0	0	0	0	0	0
1991	649	15	0	5	13	0	0	0	0	1,530
1992	1,198	34	0	10	5	0	0	0	0	2,664
1993	1,607	34	0	10	5	0	0	0	0	3,503
1994	2,017	34	0	10	5	0	0	0	0	4,343
1995	2,951	97	0	10	5	0	210	0	0	9,685
1996	3,406	39	0	12	6	0	2	0	0	7,258
1997	2,580	41	0	27	25	0	107	0	0	7,480
1998	2,892	40	0	27	25	0	107	0	0	8,117
1999	3,204	41	0	27	25	0	107	0	0	8,759
2000	3,666	41	0	27	25	0	107	0	0	9,706
2001	4,053	41	0	26	24	0	106	0	0	10,468
2002	3,135	18	0	28	7	0	3	0	0	6,777
2003	3,251	18	0	28	7	0	3	0	0	7,015
2004	3,367	17	0	28	7	0	3	0	0	7,250
2005	3,482	18	0	28	7	0	3	0	0	7,488
2006	3,598	19	0	30	8	0	1	0	0	7,721
2007	4,151	18	0	36	7	0	0	0	0	8,867
2008	4,288	19	0	36	7	0	0	0	0	9,151
2009	4,423	18	0	36	7	0	0	0	0	9,425
2010	4,559	18	0	36	7	0	0	0	0	9,703
2011	4,694	17	0	38	7	0	0	0	0	9,991

Note : 0.5 inch ;$Domestic
0.75inch ;$Commercial
1.5 inch ;$Others
2 inch ;$Governmental
3 inch ;$Industrial

Present Service Charges:

Service charges are levied on consumers according to the size of their connection,and increase rapidly for larger connections. The service charge is levied monthly and is fixed, regardless of the level of water consumption during a given month. Present service charges are shown in Table 17-1-12 below.

Table 17-1-12 Present Service Charge

Size of connection	Monthly Service Charge (Baht)
1/2"	10
3/4"	15
1"	30
1-1/2"	60
2"	100
2-1/2"	120
3"	160
4" and above	200

Service charges are estimated by multiplying the number of connections by the service charge per connection as shown in Table 17-1-13.

Table 17-1-13 Service Charge

Size of Conn. (inch)	0.5	0.75	1	1.5	2	2.5	3	4 & above	
Conn. charge (Bath/conn.)	10	15	30	60	100	120	160	200	Total (Baht x1000)
					No. of Connection				
1990	8,083	163	0	45	78	0	0	0	1,125
1991	8,732	178	0	50	91	0	0	0	1,225
1992	9,930	212	0	60	96	0	0	0	1,388
1993	11,537	246	0	70	101	0	0	0	1,600
1994	13,554	280	0	80	106	0	0	0	1,862
1995	16,505	377	0	90	111	0	210	0	2,650
1996	19,911	416	0	102	117	0	212	0	3,085
1997	22,491	457	0	129	142	0	319	0	3,657
1998	25,383	497	0	156	167	0	426	0	4,266
1999	28,507	538	0	183	192	0	533	0	4,913
2000	32,253	579	0	210	217	0	640	0	5,615
2001	36,306	620	0	236	241	0	746	0	6,360
2002	39,441	638	0	264	248	0	749	0	6,774
2003	42,692	656	0	292	255	0	752	0	7,201
2004	46,059	673	0	320	262	0	755	0	7,643
2005	49,541	691	0	348	269	0	758	0	8,098
2006	53,139	710	0	378	277	0	759	0	8,566
2007	57,290	728	0	414	284	0	759	0	9,102
2008	61,578	747	0	450	291	0	759	0	9,654
2009	66,001	765	0	486	298	0	759	0	10,223
2010	70,560	783	0	522	305	0	759	0	10,807
2011	75,254	800	0	560	312	0	759	0	11,409

b. Project Water Sales Revenue

Water Sales of the waterworks are estimated as tabulated in Table

17-1-14 with the following conditions adopted in the forecasting.

i) Water tariffs will remain unchanged until 2020.

ii) Water sales are estimated by use for domestic, commercial, institutional, industrial and other use as predicted in each year.

iii) Water sales are calculated from the monthly average water consumption multiplied by water tariff.

In the PWA's water tariff system, water charge is levied on consumers according to metered water consumption after every month. Charging method is to levey a progressive method for the amount metered. Prior to the increases, charges were levied on a sliding scale. Thus, for example, a consumer using 25 cu m of water in a month would pay 3.75 Baht per cu m for the first 10 cu m, 4.50 Baht per cu m for the next 10 cu m and 6.50 Baht per cu m only for the last 5 cu m above 20 cu m, so that a total payment will be 115 Baht.

17.1.4 Cash Flow Statement

1) Cash Flow

Table 17-1-15 shows the projected cash flow from 1990 to 2020. Estimate condition of each items to be counted in cash flow are as follows.

a. CASH INFLOW

- Government contribution

  capital contribution for interest payment of domestic loan.

- Loan

  Local and foreign loan disbursement is estimated based on the Alternative 4 financing plan.

- Water sales, connection charge and service charge.

  Detailed estimation is shown in Table 17-1-11, 17-1-13 and 17-1-14.

- Other income

  This income is including sales of materials, fine penalties and other, and estimated 2 percent of total water sales of each year.

b. CASH OUTFLOW

- Project expenditure

  It is according to capital disbursement schedule for implementation plan.

Table 17-1-14 WATER SALES (Patum Thani & Prachatipat)

(1)Domestic

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Water Sales (cu.m/d)	5,600	6,319	7,295	8,539	10,075	11,926	14,205	16,155	18,350	20,801	23,523
(cu.m/month)	168,000	189,570	218,850	256,170	302,250	357,780	426,150	484,650	550,500	624,030	705,690
No.of Connections	7,741	8,710	9,896	11,481	13,465	15,848	18,776	20,933	23,332	25,968	28,843
Water Cons./Conn.	21.70	21.76	22.11	22.31	22.45	22.58	22.70	23.15	23.59	24.03	24.47
Water Sales(x1,000Baht)	724	818	952	1,120	1,325	1,573	1,879	2,156	2,469	2,823	3,218

(2)Governmental/Institutional

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Water Sales (cu.m/d)	1,492	1,578	1,891	2,203	2,515	6,228	6,688	7,126	7,565	8,002	8,442
(cu.m/month)	44,760	47,340	56,730	66,090	75,450	186,840	200,640	213,780	226,950	240,060	253,260
No.of Connections	78	91	96	101	106	111	117	142	167	192	217
Water Cons./Conn.											
Water Sales(x1,000Baht)	394	413	500	585	673	1,718	1,846	1,958	2,069	2,182	2,294

(3)Commercial

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Water Sales (cu.m/d)	1,117	1,182	1,416	1,651	1,885	2,119	2,353	2,570	2,787	3,005	3,222
(cu.m/month)	33,510	35,460	42,480	49,530	56,550	63,570	70,590	77,100	83,610	90,150	96,660
No.of Connections	162	169	202	235	269	302	336	367	398	429	460
Water Cons./Conn.	206.85	209.82	210.30	210.77	210.22	210.50	210.09	210.08	210.08	210.14	210.13
Water Sales(x1,000Baht)	270	287	343	401	457	514	571	623	676	729	781

(4)Industrial

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Water Sales (cu.m/d)	0	0	0	0	0	24,814	28,100	30,451	32,801	35,151	37,501
(cu.m/month)	0	0	0	0	0	744,420	843,000	913,530	984,030	1,054,530	1,125,030
No.of Connections	154	202	204	206	208	210	212	319	426	533	640
Water Cons./Conn.	0.00	0.00	0.00	0.00	0.00	3,544.86	3,976.42	2,863.73	2,309.93	1,978.48	1,757.86
Water Sales(x1,000Baht)	0	0	0	0	0	7,073	8,055	8,582	9,183	9,742	10,357

(5)Others

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Water Sales (cu.m/d)	326	363	423	494	579	679	798	901	1,015	1,141	1,280
(cu.m/month)	9,780	10,890	12,690	14,820	17,370	20,370	23,940	27,030	30,450	34,230	38,400
No.of Connections	45	50	60	70	80	90	102	129	156	183	210
Water Cons./Conn.	217.33	217.80	211.50	211.71	217.13	226.33	234.71	209.53	195.19	187.05	182.86
Water Sales(x1,000Baht)	79	88	103	120	141	166	196	218	244	273	305

Total	1,467	1,606	1,898	2,226	2,596	11,044	12,547	13,537	14,641	15,749	16,955

Table 17-1-14 (Cont'd)

(1)Domestic

Item/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	26,529	30,019	33,854	38,050	42,620	47,595	52,242	57,164	62,369	67,864	73,657
(cu.m/month)	795,870	900,570	1,015,620	1,141,500	1,278,600	1,427,850	1,567,260	1,714,920	1,871,070	2,035,920	2,209,710
No.of Connections	31,957	35,646	39,607	43,839	48,343	53,139	57,290	61,578	66,001	70,560	75,254
Water Cons./Conn.	24.90	25.26	25.64	26.04	26.45	26.87	27.36	27.85	28.35	28.85	29.36
Water Sales(x1,000Baht)	3,654	4,160	4,720	5,338	6,015	6,757	7,467	8,223	9,028	9,881	10,787

(2)Governmental/Institu

Item/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	8,879	12,526	13,210	13,894	14,577	15,261	15,704	16,146	16,589	17,031	17,474
(cu.m/month)	266,370	375,780	396,300	416,820	437,310	457,830	471,120	484,380	497,670	510,930	524,220
No.of Connections	241	248	255	262	269	277	284	291	298	305	312
Water Cons./Conn.											
Water Sales(x1,000Baht)	2,407	3,442	3,633	3,825	4,017	4,207	4,331	4,452	4,575	4,698	4,820

(3)Commercial

Item/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	3,439	3,745	4,051	4,358	4,664	4,970	5,096	5,222	5,347	5,473	5,599
(cu.m/month)	103,170	112,350	121,530	130,740	139,920	149,100	152,880	156,660	160,410	164,190	167,970
No.of Connections	491	535	578	622	665	710	728	747	765	783	800
Water Cons./Conn.	210.12	210.00	210.26	210.19	210.41	210.00	210.00	209.72	209.69	209.69	209.96
Water Sales(x1,000Baht)	834	908	983	1,057	1,131	1,205	1,236	1,266	1,296	1,327	1,358

(4)Industrial

Item/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	39,851	57,542	61,451	65,376	68,877	69,753	70,628	71,504	72,379	73,255	74,130
(cu.m/month)	1,195,530	1,726,260	1,843,530	1,961,280	2,066,310	2,092,590	2,118,840	2,145,120	2,171,370	2,197,650	2,223,900
No.of Connections	746	749	752	755	758	759	759	759	759	759	759
Water Cons./Conn.	1,602.59	2,304.75	2,451.50	2,597.72	2,726.00	2,757.04	2,791.62	2,826.25	2,860.83	2,895.45	2,930.04
Water Sales(x1,000Baht)	10,972	16,069	17,209	18,354	19,375	19,631	19,886	20,143	20,399	20,655	20,911

(5)Others

Item/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	1,431	1,611	1,806	2,018	2,247	2,495	2,716	2,950	3,197	3,458	3,732
(cu.m/month)	42,930	48,330	54,180	60,540	67,410	74,850	81,480	88,500	95,910	103,740	111,960
No.of Connections	236	264	292	320	348	378	414	450	486	522	560
Water Cons./Conn.	181.91	183.07	185.55	189.19	193.71	198.02	196.81	196.67	197.35	198.74	199.93
Water Sales(x1,000Baht)	341	384	431	483	540	601	654	710	770	833	900

Total	18,208	24,963	26,976	29,057	31,078	32,401	33,574	34,794	36,068	37,394	38,776

TABLE 17-1-15 Project Cash Flow at 1989 Price Patum Thani & Prachatipat

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CASH INFLOW																
Government contribution																
Capital contribution	0	0	0	5,335	5,922	6,573	9,619	10,677	11,851	13,155	16,295	18,088	20,077	7,138	7,923	8,795
Laon	88,500	0	42,917	159,519	757,369	651,045	0	8,361	192,015	235,542	0	0	0	0	0	
Local loan	88,500	0	708	0	17,002	21,836	0	365	13,971	13,985	0	0	0	0	0	
Foreign loan	0	0	42,209	159,519	740,367	629,209	0	7,996	178,044	221,557	0	0	0	0	0	
Operating Revenue	19,387	22,939	27,810	32,949	38,641	165,347	188,056	207,454	228,529	260,051	286,266	310,478	328,694	351,244	374,125	395,981
Water Sales	17,904	19,788	23,292	27,300	31,800	150,012	174,228	192,468	211,908	241,548	265,632	287,892	308,964	330,420	352,188	372,936
Connection Fee	0	1,530	2,664	3,503	4,343	9,685	7,258	7,480	8,117	8,759	9,706	10,468	6,777	7,015	7,250	7,488
Service Charge	1,125	1,225	1,388	1,600	1,862	2,650	3,085	3,657	4,266	4,913	5,615	6,360	6,774	7,201	7,643	8,098
Ohter Income	358	396	466	546	636	3,000	3,485	3,849	4,238	4,831	5,313	5,758	6,179	6,608	7,044	7,459
Total Inflow	107,887	22,939	70,727	197,803	801,932	822,965	197,675	226,492	432,395	508,748	302,561	328,566	348,771	358,382	382,048	404,776
CASH OUTFLOW																
Project expenditures																
Local portion	177,000	0	15,638	46,296	256,114	232,435	0	3,128	81,354	94,437	0	0	0	0	0	
Foreign portion	0	0	27,987	113,223	518,257	440,446	0	5,597	124,631	155,090	0	0	0	0	0	
Amortization																
Principal	0	0	0	5,335	5,922	6,573	9,619	10,677	11,851	13,155	16,295	18,088	80,361	69,049	71,506	74,094
Interest	9,735	9,735	10,953	15,260	36,533	55,272	54,549	53,747	58,917	65,133	63,686	61,894	59,904	56,068	53,611	51,023
Operating Expenses	9,912	11,701	13,692	15,698	17,871	71,642	82,175	91,441	100,292	114,186	125,777	137,484	146,044	158,234	169,806	182,303
O & M Cost	4,698	5,324	6,009	6,751	7,555	33,737	40,379	45,689	50,124	57,449	63,490	70,124	76,088	83,636	90,502	98,506
Connection Expenses	0	765	1,332	1,752	2,172	4,843	3,629	3,740	4,059	4,380	4,853	5,234	3,389	3,508	3,625	3,744
Share of Head Office	5,214	5,612	6,351	7,196	8,144	33,062	38,167	42,012	46,109	52,357	57,434	62,126	66,568	71,091	75,679	80,053
Total Outflow	196,647	21,436	68,270	195,812	834,697	806,368	146,343	164,590	377,045	442,001	205,758	217,466	286,309	283,351	294,923	307,420
Net Cash flow	-88,760	1,503	2,457	1,991	-32,765	16,598	51,332	61,902	55,350	66,747	96,803	111,100	62,462	75,031	87,125	97,356
Accumulated	-88,760	-87,257	-84,800	-82,809	-115,574	-98,976	-47,644	14,258	69,608	136,355	233,158	344,258	406,720	481,751	568,876	666,232

TABLE 17-1-15 Project Cash Flow at 1989 Price Patum Thani & Prachatipat (Cont'd) Unit: Baht x 1000

YEAR	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
CASH INFLOW															
Government contribution															
Capital contribution	3,168	3,516	3,903	4,332											
Laon															
Local loan															
Foreign loan															
Operating Revenue	408,787	425,377	441,807	458,574	477,135	496,018	496,018	496,018	496,018	496,018	496,018	496,018	496,018	496,018	496,018
Water Sales	384,804	399,420	414,708	430,320	447,672	465,312	465,312	465,312	465,312	465,312	465,312	465,312	465,312	465,312	465,312
Connection Fee	7,721	8,867	9,151	9,425	9,703	9,991	9,991	9,991	9,991	9,991	9,991	9,991	9,991	9,991	9,991
Service Charge	8,566	9,102	9,654	10,223	10,807	11,409	11,409	11,409	11,409	11,409	11,409	11,409	11,409	11,409	11,409
Obter Income	7,696	7,988	8,294	8,606	8,953	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306
Total Inflow	411,955	428,893	445,710	462,906	477,135	496,018	496,018	496,018	496,018	496,018	496,018	496,018	496,018	496,018	496,018
CASH OUTFLOW															
Project expenditures															
Local portion															
Foreign portion															
Amortization															
Principal	70,230	88,027	90,696	93,468	91,543	94,014	96,553	99,160	101,837	104,587	107,410	110,310	113,289	116,348	119,489
Interest	48,292	46,133	43,465	40,692	37,809	35,337	32,799	30,192	27,514	24,765	21,941	19,041	16,063	13,004	9,862
Operating Expenses	191,587	202,715	213,494	224,847	237,110	250,010	250,010	250,010	250,010	250,010	250,010	250,010	250,010	250,010	250,010
O & M Cost	105,172	112,646	120,061	127,986	136,452	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490	145,490
Connection Expenses	3,861	4,434	4,576	4,713	4,852	4,996	4,996	4,996	4,996	4,996	4,996	4,996	4,996	4,996	4,996
Share of Head Office	82,554	85,635	88,858	92,149	95,806	99,525	99,525	99,525	99,525	99,525	99,525	99,525	99,525	99,525	99,525
Total Outflow	310,109	336,875	347,655	359,007	366,462	379,361	379,362	379,362	379,361	379,362	379,361	379,361	379,362	379,362	379,361
Net Cash flow	101,846	92,019	98,055	103,899	110,674	116,657	116,656	116,656	116,657	116,656	116,657	116,657	116,656	116,656	116,657
Accumulated	768,079	860,097	958,152	1,062,052	1,172,725	1,289,383	1,406,039	1,522,695	1,639,352	1,756,008	1,872,666	1,989,323	2,105,979	2,222,635	2,339,293

- Amortization

  Alternative 4 financing plan is adopted in the debt service calculation.

- Operation & maintenance

  Details are shown in chapter 11.

- Connection expenses

  50 percent of Connection Fee.

- Share of Head Office

As clearly shown in this table, in 1990 and 1994, the net cash flow ended in a defect.

It seems clear from "Alternative 4 financing plan" that these deficits are covered with PWA's own equity finance.

After 1994, net annual revenue surpluses are forecasted large enough to cover throughout the phase II construction period and operation and expenditures in the maintenance period, amortization cost and operating expenses.

The result of this cash flow statement reveals that the annual net cash flow will continuously raise profit surpluses throughout after 1994, with cumulative surplus increasing to 1,289,383 thousand Baht in 2011 and 2,339,293 thousand Baht in 2020. This accumulated surplus is almost three times as large as the gross operating revenue of the year 2011.

This result may demonstrate the simple financial feasibility of this project.

As a sensitivity analysis, cash flow statement are also made on the assumption that the water tariff including connection and service charges will be increased every three years at the rate of five percent per annum adjusting for inflation of five percent per year. The result of this study reveals, as shown in Appendix, A 17-1-6, that the annual net cash flow will continuously raise profit surpluses throughout after 1994 except year of 2000 and 2001.

The cumulative surplus amount will be 3,640,552 thousand Baht in 2011 and 9,494,667 thousand Baht in 2020, respectively.

2) Share of Head and Regional Office Overhead Expenses

PWA is administratively, technically, economically and financially independent from the central government. Therefore, in order that total financial independence can be achieved by the PWA in the future, administrative expenses of its head and regional office, such as inventories, personal expenses and consignment fee shall be charged to the revenue of each waterworks.

In view of the above, it is recommended that the share allocation of administrative expenses shall be calculated based on number of waterworks

and gross revenue of each waterworks.

Table 17-1-16 shows share of Head and Regional Office Overhead Expenses in 1986 and 1987.

Table 17-1-16 Share of Head and Regional Office Overhead Expenses
Patum Thani & Prachatipat (Regional Office No. 3)

YEAR 1986	
1. HEAD Office Expenses	
a) Per Waterworks Portion (1/3)	Baht 937,376
b) WW/PWA-Total Consumption Portion (2/3)	Baht 1,092,965
2. Regional Office Expenses	
a) Per Wateworks Portion (1/3)	Baht 320,735
b) WW/Region-Total Consumption Portion (2/3)	Baht 441,218
TOTAL SHARE OF HEAD AND REGIONAL OFFICE OVERHEAD EXPESES	Baht 2,792,294
YEAR 1987	
1. Head Office Expenses	
a) Per Waterworks Portion (1/3)	Baht 1,034,996
b) WW/PWA-Total Consumption Portion (2/3)	Baht 1,222,010
2. Regional Office Expenses	
a) Per Waterworks Portion (1/3)	Baht 405,565
b) WW/Region-Total Consumption Portion (2/3)	Baht 591,667
TOTAL SHARE OF HEAD AND REGIONAL OFFICE OVERHEAD EXPESES	Baht 3,254,238

3) Unit Cost of Water

As shown in Table 17-1-17, the unit cost before depreciation which will register 3.92 Baht per cu m in 2011 or equal to 22% of the average unit water cost from year 1990 to 2011 and almost minimum level of present water tariff structure of PWA, and average units cost of water from 1990 to 2020 is projected to stand at 5.75 Baht or third level of present water tariff.

Table 17-1-17 Unit Cost of Water

(Unit:Baht x 1000)

year	Water Consumption (cu.m/day)	Capital Invest.	Operating Expenses	H.R.O Expenses Allocation	Total Expenses	Unit Water Cost (Baht/cu.m)
1990	8,535	177,000	4,698	5,214	186,912	60.00
1991	9,443	0	6,089	5,611	11,700	3.39
1992	11,024	43,625	7,341	6,350	57,316	14.24
1993	12,887	159,519	8,503	7,195	175,217	37.25
1994	15,054	774,371	9,727	8,143	792,241	144.18
1995	45,767	672,881	38,580	33,059	744,520	44.57
1996	52,144	0	44,008	38,163	82,171	4.32
1997	57,203	8,725	49,429	42,007	100,161	4.80
1998	62,518	205,985	54,183	46,105	306,273	13.42
1999	68,100	249,527	61,829	52,352	363,708	14.63
2000	73,966	0	68,343	57,428	125,771	4.66
2001	80,129	0	75,358	62,120	137,478	4.70
2002	105,443	0	79,477	66,561	146,038	3.79
2003	114,380	0	87,144	71,084	158,228	3.79
2004	123,694	0	94,127	75,672	169,799	3.76
2005	132,985	0	102,250	80,045	182,295	3.76
2006	140,073	0	109,033	82,546	191,579	3.75
2007	146,385	0	117,080	85,627	202,707	3.79
2008	152,985	0	124,637	88,849	213,486	3.82
2009	159,881	0	132,699	92,140	224,839	3.85
2010	167,080	0	141,304	95,797	237,101	3.89
2011	174,592	0	150,486	99,515	250,001	3.92
2012	174,592	0	150,486	99,515	250,001	3.92
2013	174,592	0	150,486	99,515	250,001	3.92
2014	174,592	0	150,486	99,515	250,001	3.92
2015	174,592	0	150,486	99,515	250,001	3.92
2016	174,592	0	150,486	99,515	250,001	3.92
2017	174,592	0	150,486	99,515	250,001	3.92
2018	174,592	0	150,486	99,515	250,001	3.92
2019	174,592	0	150,486	99,515	250,001	3.92
2020	174,592	0	150,486	99,515	250,001	3.92
Average Unit Water Cost (1990-2020) :						5.75

Note : H.R.O. Expenses Allocation is Head and Regional Office Expenses Allocation

4) Average Water Rate

In view of revenue aspects, average water tariff is calculated based on water sales and is shown in Table 17-1-18.

5) Depreciation

At the end of the project, it may reasonably be expected to exist some residual (or terminal) value. That is, the capital asset will not have been used up in the course of the project period, and there will be a "residual asset". In this financial study, project period is established for 31 years from 1990 to 2020. The residual value is, therefor added to the benefit stream in the last year 2020.

Table 17-1-19 shows the depreciation of the project fixed assets of water supply system, such as intake facility, treatment plant and mechanical & electrical equipment.

For calculating, following conditions are adopted.

Depreciation method : Straight - line method
Final Salvage value : 10 percent of investment Cost

Durable years :

1. Raw Water Intake	:	27 years
2. Treatment Plant	:	30 years
3. Distribution Reservoirs	:	39 years
4. Transmission Pipeline	:	30 years
5. Distribution Pipeline	:	28 years

Durable years of facilities was calculated by weighted average of each component. As shown in the Table, total salvage value in the year 2011 and 2020 are 1,078,705 thousand Baht and 552,462 thousand Baht, respectively.

Table 17-1-18 Average Water Tariff

Year	Water Consumption (cu.m/d)	Water Sales (1000 Baht /year)	Average Water Tariff (Baht/cu.m)
1990	8,726	17,904	5.62
1991	9,609	19,788	5.64
1992	11,206	23,292	5.69
1993	13,090	27,300	5.71
1994	15,287	31,800	5.70
1995	51,049	150,012	8.05
1996	59,350	174,228	8.04
1997	66,413	192,468	7.94
1998	73,795	211,908	7.87
1999	84,322	241,548	7.85
2000	93,380	265,632	7.79
2001	102,110	287,892	7.72
2002	109,697	308,964	7.72
2003	117,461	330,420	7.71
2004	125,405	352,188	7.69
2005	133,119	372,936	7.68
2006	138,397	384,804	7.62
2007	144,925	399,420	7.55
2008	151,798	414,708	7.48
2009	159,026	430,320	7.41
2010	166,621	447,672	7.36
2011	174,592	465,312	7.30
2012	174,592	465,312	7.30
2013	174,592	465,312	7.30
2014	174,592	465,312	7.30
2015	174,592	465,312	7.30
2016	174,592	465,312	7.30
2017	174,592	465,312	7.30
2018	174,592	465,312	7.30
2019	174,592	465,312	7.30
2020	174,592	465,312	7.30

Table 17-1-19 Depreciation

Unit : Baht x 1000

	Facilities							
	Raw Water Intake	Treatment Plant	Distri. Reservoir	Trans. Pipeline	Distri. Pipeline	Yearly Total	Accumulated Total	Salvage Value
Asset Price	72,195	656,020	367,487	287,027	600,223			
Year								
1990	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0
1994	0	0	0	861	1,857	2,718	2,718	119,203
1995	0	0	0	5,167	11,141	16,307	19,025	863,776
1996	1,823	10,635	6,254	8,611	18,568	45,891	64,916	1,479,974
1997	1,823	10,635	6,254	8,611	18,568	45,891	110,807	1,434,083
1998	1,823	10,635	6,254	8,611	18,568	45,891	156,698	1,388,192
1999	1,823	10,635	6,254	8,611	18,568	45,891	202,588	1,541,307
2000	2,407	19,681	8,481	8,611	19,293	58,472	261,060	1,721,892
2001	2,407	19,681	8,481	8,611	19,293	58,472	319,531	1,663,421
2002	2,407	19,681	8,481	8,611	19,293	58,472	378,003	1,604,949
2003	2,407	19,681	8,481	8,611	19,293	58,472	436,474	1,546,478
2004	2,407	19,681	8,481	8,611	19,293	58,472	494,946	1,488,006
2005	2,407	19,681	8,481	8,611	19,293	58,472	553,418	1,429,534
2006	2,407	19,681	8,481	8,611	19,293	58,472	611,889	1,371,063
2007	2,407	19,681	8,481	8,611	19,293	58,472	670,361	1,312,591
2008	2,407	19,681	8,481	8,611	19,293	58,472	728,832	1,254,120
2009	2,407	19,681	8,481	8,611	19,293	58,472	787,304	1,195,648
2010	2,407	19,681	8,481	8,611	19,293	58,472	845,775	1,137,177
2011	2,407	19,681	8,481	8,611	19,293	58,472	904,247	1,078,705
2012	2,407	19,681	8,481	8,611	19,293	58,472	962,718	1,020,234
2013	2,407	19,681	8,481	8,611	19,293	58,472	1,021,190	961,762
2014	2,407	19,681	8,481	8,611	19,293	58,472	1,079,661	903,291
2015	2,407	19,681	8,481	8,611	19,293	58,472	1,138,133	844,819
2016	2,407	19,681	8,481	8,611	19,293	58,472	1,196,604	786,348
2017	2,407	19,681	8,481	8,611	19,293	58,472	1,255,076	727,876
2018	2,407	19,681	8,481	8,611	19,293	58,472	1,313,547	669,405
2019	2,407	19,681	8,481	8,611	19,293	58,472	1,372,019	610,933
2020	2,407	19,681	8,481	8,611	19,293	58,472	1,430,490	552,462
2021	2,407	19,681	8,481	8,611	19,293	58,472	1,488,962	493,990
2022	2,407	19,681	8,481	8,611	17,436	56,615	1,545,577	437,375
2023	583	19,681	8,481	8,611	8,152	45,508	1,591,084	391,868
2024	583	19,681	8,481	7,750	725	37,219	1,628,303	354,649
2025	583	19,681	8,481	3,444	725	32,914	1,661,217	321,735
2026	583	9,045	8,481	0	725	18,834	1,680,052	302,900
2027	0	9,045	8,481	0	725	18,251	1,698,303	284,649
2028	0	9,045	8,481	0	0	17,526	1,715,829	267,123
2029	0	9,045	8,481	0	0	17,526	1,733,355	249,597
2030	0	0	8,481	0	0	8,481	1,741,835	241,117
2031	0	0	8,481	0	0	8,481	1,750,316	232,636
2032	0	0	8,481	0	0	8,481	1,758,797	224,155
2033	0	0	8,481	0	0	8,481	1,767,278	215,674
2034	0	0	8,481	0	0	8,481	1,775,758	207,194
2035	0	0	2,227	0	0	2,227	1,777,985	204,967
2036	0	0	2,227	0	0	2,227	1,780,212	202,740
2037	0	0	2,227	0	0	2,227	1,782,439	200,513
2038	0	0	2,227	0	0	2,227	1,784,666	198,286

17.1.5 Financial Internal Rate of Return (FIRR)

In the calculation of the Financial Internal Rate of Return (FIRR), the following two indicators are normally used to evaluate the financial profitability of the project.

(1) Internal Rate of Return on Investment (IRROI)

The term, IRROI, indicates the internal rate of return on total capital investment, and assesses the profitability of the project as a whole and the ability to recover funds invested in the project.

The IRROI is calculated based on the assumption that the total capital investment is covered by its own capital. Therefore, the financial conditions such as the loan conditions on borrowed capital, changes on the ratio of equity to total capital requirement and others have no effect on the IRROI. Accordingly, the IRROI indicates the profitability of the project itself.

(2) Internal Rate of Return of Equity (IRROE)

The term, IRROE, indicates the internal rate of return on equity, and assesses the profitability only with respect to equity and the ability to recover funds invested in the project as equity. Here, the IRROE is calculated on the basis of such financial conditions proper to the project as the loan conditions on borrowed capital and amount of capital owned.

In this study, the FIRR was calculated using both method.

The rate of return was computed based on the present value of cash inflow and outflows. Tables 17-1-20 and 17-1-21 represent the tabulation and calculation of each Financial Internal Rate of Return for the project. As clear in these tables, the FIRR on equity is estimated to be 17.0 percent, and the FIRR on investment is 6.6 percent respectively.

Since this rate exceeds the opportunity cost of capital of 9 percent and interest rate of international lending agencies, the project is considered financially feasible. The undertaking of the project is therefore suggested itself to proceed positively on condition to repay the interest for borrowed capital.

Table 17-1-20 Financial Internal Rate of Return (on equity)

(Unit:Baht x 1000)

year	Loan	Government Subsidy	Operating Income	Total Income	Capital Investement	Operating Expenses	Debt Service	Total Expenses	NET INCOME	Present Value Discounted at (20 %)	(30 %)
1990	88,500	0	0	88,500	177,000	0	9,735	186,735	-98,235	-98,235	-98,235
1991	0	0	0	0	0	0	9,735	9,735	-9,735	-8,113	-7,488
1992	42,917	0	0	42,917	43,625	0	10,953	54,578	-11,661	-8,098	-6,900
1993	159,519	5,335	0	164,854	159,519	0	20,594	180,113	-15,259	-8,830	-6,945
1994	757,369	5,922	0	763,291	774,371	0	42,454	816,825	-53,534	-25,817	-18,744
1995	651,045	6,573	126,706	784,324	672,881	53,772	61,845	788,498	-4,174	-1,677	-1,124
1996	0	9,619	149,415	159,034	0	64,305	64,168	128,473	30,561	10,235	6,332
1997	8,361	10,677	168,813	187,851	8,725	73,571	64,424	146,720	41,131	11,479	6,555
1998	192,015	11,851	189,888	393,754	205,985	82,422	70,768	359,175	34,579	8,042	4,239
1999	235,542	13,155	221,410	470,107	249,527	96,316	78,288	424,131	45,976	8,910	4,336
2000	0	16,295	247,625	263,920	0	107,907	79,981	187,888	76,032	12,280	5,515
2001	0	18,088	271,837	289,925	0	119,614	79,981	199,595	90,330	12,157	5,040
2002	0	20,077	290,053	310,130	0	128,175	140,265	268,440	41,690	4,676	1,789
2003	0	7,138	312,603	319,741	0	140,365	125,117	265,482	54,259	5,071	1,791
2004	0	7,923	335,484	343,407	0	151,936	125,117	277,053	66,354	5,168	1,685
2005	0	8,795	357,340	366,135	0	164,433	125,117	289,550	76,585	4,971	1,496
2006	0	3,168	370,146	373,314	0	173,717	118,523	292,240	81,074	4,385	1,218
2007	0	3,516	386,736	390,252	0	184,845	134,160	319,005	71,247	3,211	824
2008	0	3,903	403,166	407,069	0	195,625	134,160	329,785	77,284	2,903	687
2009	0	4,332	419,933	424,265	0	206,978	134,160	341,138	83,127	2,602	569
2010	0	0	438,494	438,494	0	219,240	129,351	348,591	89,903	2,345	473
2011	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	2,084	388
2012	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	1,737	299
2013	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	1,447	230
2014	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	1,206	177
2015	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	1,005	136
2016	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	838	105
2017	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	698	80
2018	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	582	62
2019	0	0	457,377	457,377	0	232,141	129,351	361,492	95,885	485	48
2020	0	0	457,377	457,377	0	232,141	129,351	361,492	648,347	2,731	247
Salvag								-552,462			
								Total Present Value		-39,522	-95,116

FIRR is 17.0%

Table 17-1-21 Financial Internal Rate of Return (on investment)

(Unit:Baht x 1000)

year	Operating Income	Government Subsidy	Total Income	Capital Invest.	Operating Expenses	Head & Regional Expenses	Total Expenses	NET INCOME	Present Value Discounted at (10 %)	(5 %)
1990	0	0	0	177,000	0	0	177,000	-177,000	-177,000	-177,000
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	43,625	0	0	43,625	-43,625	-36,054	-39,569
1993	0	5,335	5,335	159,519	0	0	159,519	-154,184	-115,841	-133,190
1994	0	5,922	5,922	774,371	0	0	774,371	-768,449	-524,861	-632,205
1995	126,706	6,573	133,279	672,881	28,853	24,919	726,653	-593,374	-368,439	-464,924
1996	149,415	9,619	159,034	0	34,281	30,024	64,305	94,729	53,472	70,688
1997	168,813	10,677	179,490	8,725	39,702	33,869	82,296	97,194	49,876	69,074
1998	189,888	11,851	201,739	205,985	44,456	37,966	288,407	-86,668	-40,431	-58,660
1999	221,410	13,155	234,565	249,527	52,102	44,214	345,843	-111,278	-47,193	-71,731
2000	247,625	16,295	263,920	0	58,616	49,291	107,907	156,013	60,150	95,778
2001	271,837	18,088	289,925	0	65,631	53,983	119,614	170,311	59,693	99,577
2002	290,053	20,077	310,130	0	69,750	58,425	128,175	181,955	57,976	101,319
2003	312,603	7,138	319,741	0	77,417	62,948	140,365	179,376	51,959	95,127
2004	335,484	7,923	343,407	0	84,400	67,536	151,936	191,471	50,420	96,706
2005	357,340	8,795	366,135	0	92,523	71,910	164,433	201,702	48,286	97,022
2006	370,146	3,168	373,314	0	99,306	74,411	173,717	199,597	43,438	91,438
2007	386,736	3,516	390,252	0	107,353	77,492	184,845	205,407	40,639	89,618
2008	403,166	3,903	407,069	0	114,910	80,715	195,625	211,444	38,030	87,859
2009	419,933	4,332	424,265	0	122,972	84,006	206,978	217,287	35,528	85,988
2010	438,494	0	438,494	0	131,577	87,663	219,240	219,254	32,591	82,635
2011	457,377	0	457,377	0	140,759	91,382	232,141	225,236	30,436	80,847
2012	457,377	0	457,377	0	140,759	91,382	232,141	225,236	27,669	76,997
2013	457,377	0	457,377	0	140,759	91,382	232,141	225,236	25,154	73,330
2014	457,377	0	457,377	0	140,759	91,382	232,141	225,236	22,867	69,838
2015	457,377	0	457,377	0	140,759	91,382	232,141	225,236	20,788	66,513
2016	457,377	0	457,377	0	140,759	91,382	232,141	225,236	18,899	63,346
2017	457,377	0	457,377	0	140,759	91,382	232,141	225,236	17,180	60,329
2018	457,377	0	457,377	0	140,759	91,382	232,141	225,236	15,619	57,456
2019	457,377	0	457,377	0	140,759	91,382	232,141	225,236	14,199	54,720
2020	457,377	0	457,377	0	140,759	91,382	232,141	777,698	44,569	179,942
Salvage Value							-552,462			
							Total Present Value		-450,380	368,869

FIRR is 6.6%