CHAPTER 12

ALTERNATIVE STUDY ON FIRST STAGE PROJECT

12 ALTERNATIVE STUDY ON FIRST STAGE PROJECT

12.1 INTRODUCTION

In Chapter 11, the Sewerage/Sanitation Master Plan up to the target year of 2015 was formulated and the Priority Regions are identified as Central Region and South 3 Region. For selecting first stage project, supplementary field investigations were made. They are mainly a) topographic survey b) geotechnic survey and c) environmental survey. Based on the results of these surveys, preliminary engineering design of the sewerage/sanitation system for alternatives are made and it became apparent that the scale of total investment costs makes it difficult to implement both Central and South 3 Regions together in the first stage. Therefore, it became necessary to select either one of the regions for implementation in the first stage. Two Alternatives namely, Alternative 1-Central Region, and Alternative 2-South 3 Region are evaluated to select the first stage project. First Stage Project is selected based on the results of economical and financial evaluation and considering other factors.

12.2 FUNDAMENTALS OF ALTERNATIVES

12.2.1 Staged Implementation

In Section 11.4, Priority Regions namely Central Region and South 3 Region are selected for implementation in three stages. Fig. 12-1 shows the staged implementation program and Fig. 12-2 shows the treatment capacity to be provided in each stage. Table 12-1 shows the capacity of wastewater treatment plants for sewerage and sanitation systems to be provided in each stage.

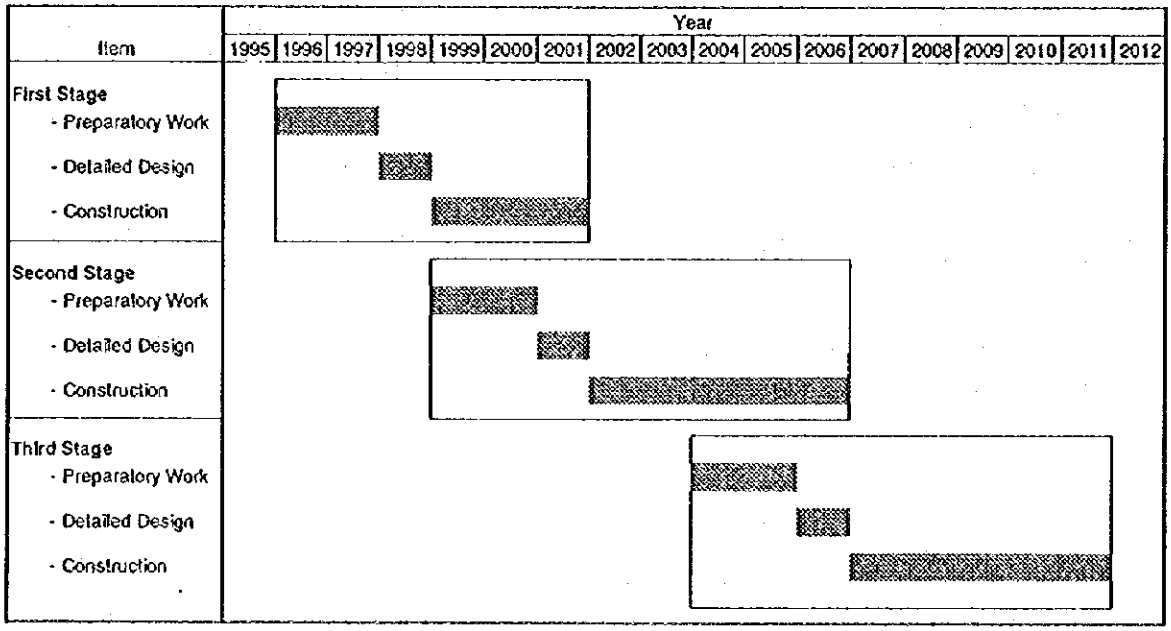
Table 12-1 Treatment Capacity for Sewerage System and Sanitation Systems Planned for Central and South 3 Region

Stage	Construction Period	Wastewater Treatment Plant Capacity, m^3/d			
		Central Region		South 3 Region	
		Sewerage	Sanitation	Sewerage	Sanitation
First	1999-2001	196,000	6,140	36,000	530
Second	2002-2006	235,000	12,640	48,000	-
Third	2007-2011	261,000	19,730	72,000	-

Note: 1 Wastewater treatment plant capacity is expressed in daily maximum flowrate and is independent of treatment level. Treatment level is discussed in Section 12.6.
2 Wastewater treatment capacity provided at a stage is sufficient until the completion of the subsequent stage.

Source : Study Team

Fig. 12 - 1



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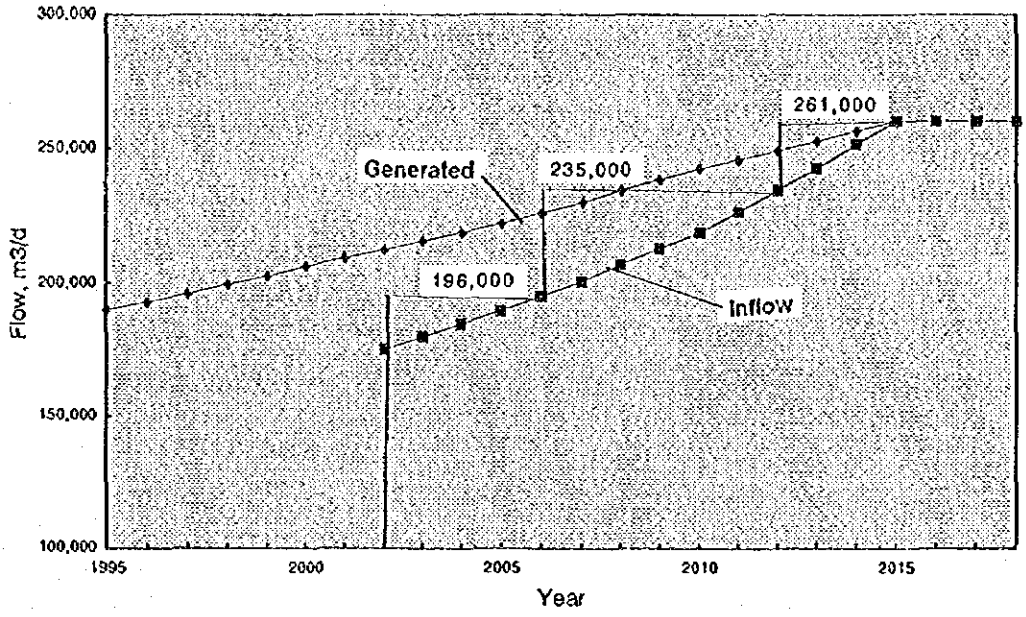
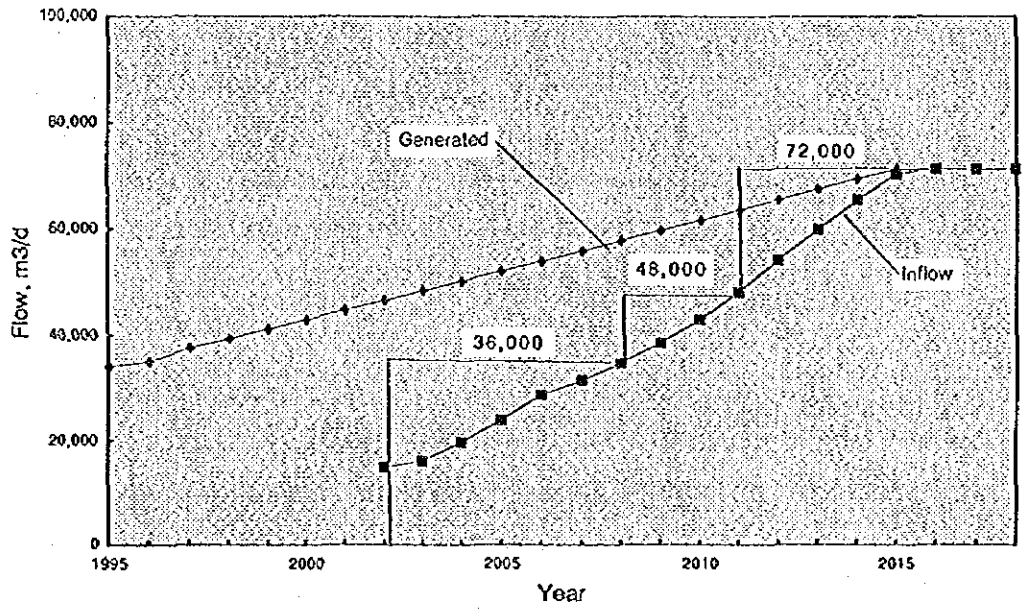
Projected Total Amount of Wastewater Generated and Projected Inflow to Wastewater Treatment Plant - Central Region



Projected Total Amount of Wastewater Generated and Projected Inflow to Wastewater Treatment Plant - South 3 Region



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12.2.2 Area To Be Served

a) Sewerage System

Planned area for sewerage and sanitation in Central and South 3 Regions are 6,460 and 2,360 ha respectively. Fig. 12-3 (a) and Fig. 12-3(b) show sewerage system for each region respectively.

Area to be served in the First Stage in each region is selected considering the following. They are:

- Existing sewered area from which wastewater is discharged without treatment
- Whether the existing small-scale treatment plants could be rehabilitated or not
- Existence of plans for sewering areas, i. e. small-scale plans by municipalities or private developers for sewering but without treatment

For Central Region, wastewater from the existing sewerage system is discharged through Gran Collector North to Las Vacas River at Puente Belice without treatment. Therefore in the First Stage, treatment will be provided to the wastewater by constructing tunnel up to the proposed treatment plant and treatment facilities. Sewered area is estimated to increase to 4,605 ha (71% of the total area to be served by sewerage) at the end of the First Stage.

Unlike Central Region, South 3 Region does not have a large sewerage system. Existing sewered area is 287 ha which is 12 % of the total area to be served by sewerage. The areas are Elgin, La Libertad, and Los Guajitos. There are four existing small-scale treatment plants at Eureka, Elgin Sur, Morse and Aurora II and only Eureka can be rehabilitated. Considering these factors, the area to be served in the First Stage is decided to be 896 ha. Table 12-2 shows the area to be served in the First Stage for each region.

Table 12-2 Area to be Served by Sewerage in First Stage in Central and South 3 Region

Stage	Area to be Served, ha			
	Central Region		South 3 Region	
	Increment	Total	Increment	Total
First Stage	4,605	4,605	896	896
Second Stage	702	5,307	524	1,420
Third Stage	1,153	6,460	940	2,360

Source : Study Team

Fig. 12 - 3(a)

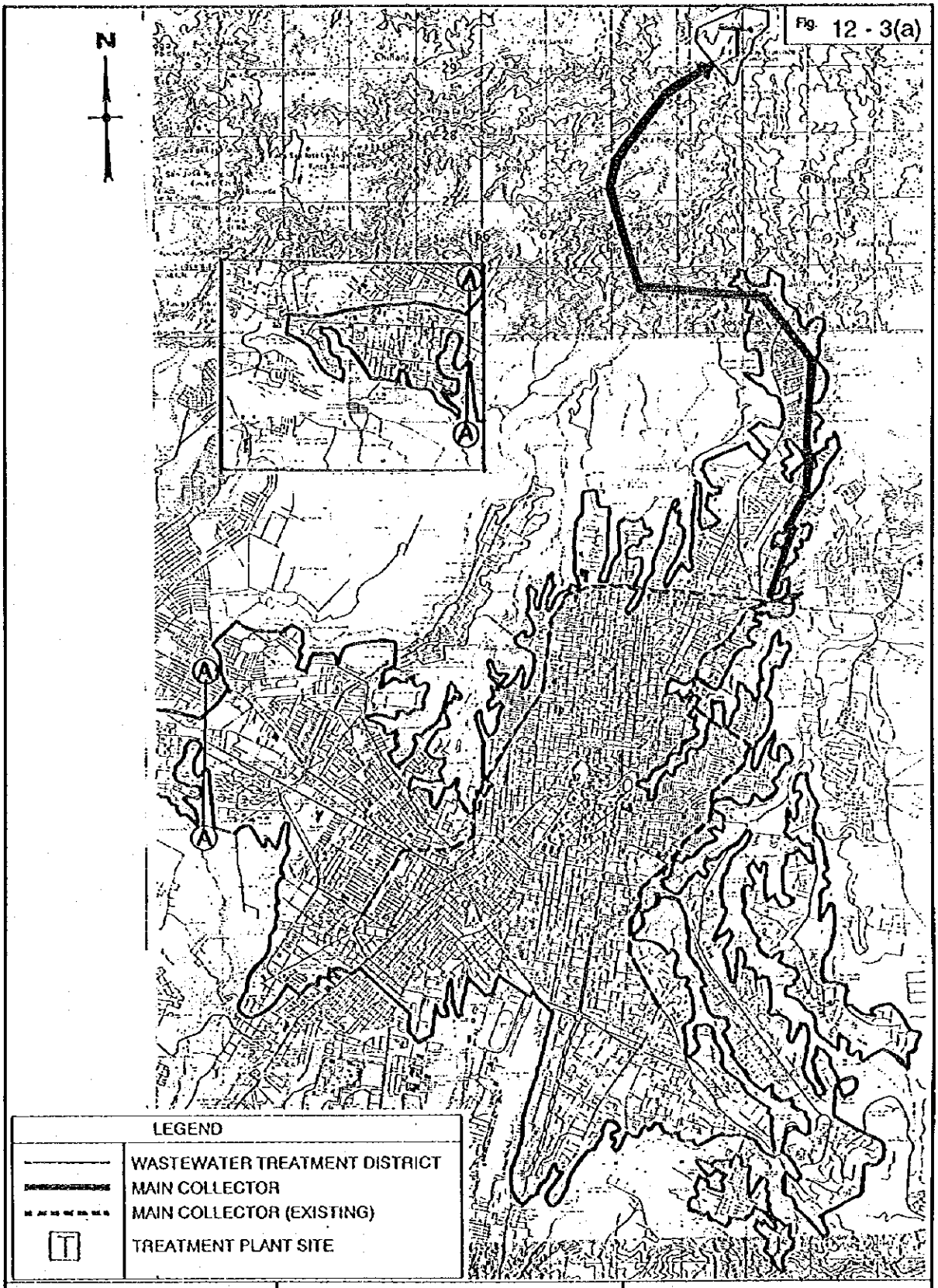

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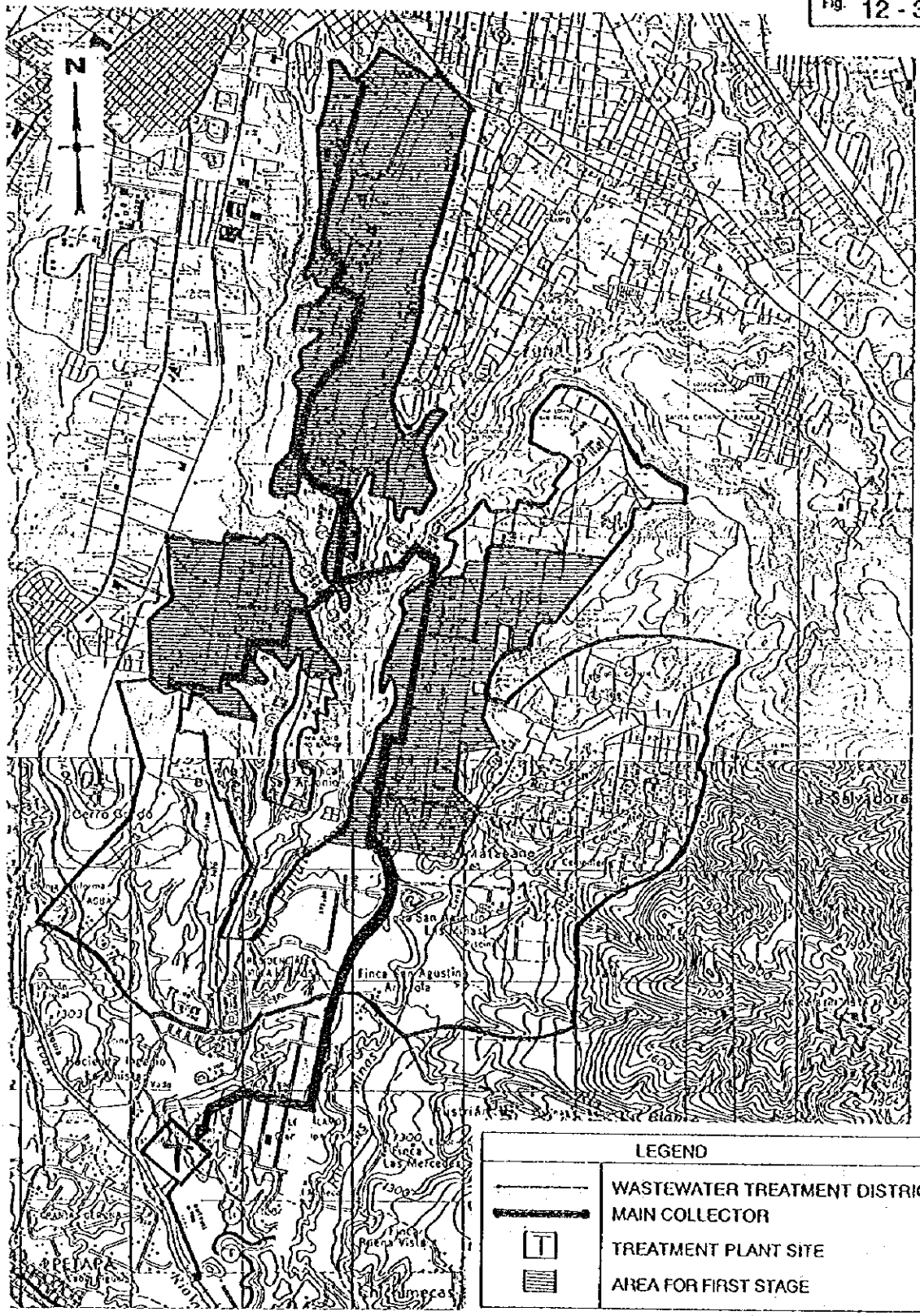
Fig. 12 - 3(b)



LEGEND	
	WASTEWATER TREATMENT DISTRICT
	MAIN COLLECTOR
T	TREATMENT PLANT SITE
	AREA FOR FIRST STAGE

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	JAPAN INTERNATIONAL COOPERATION AGENCY	

b) Sanitation System

In Chapter 10, based on UNICEF survey, "Caracterizacion De Las Areas Precarias En La Ciudad De Guatemala, (1991)", settlements having population of 109,600 and 2,900 population were identified as the settlements to be served by sanitation system in Central and South 3 region respectively.

Further, in Chapter 11 all settlements in South 3 region are identified to be provided with sanitation system in first stage. However in Central region, 35 settlements with population of 33,900 will be selected for the first stage implementation.

Settlements to be implemented in first stage in Central region were selected based on the criteria listed below.

- Priority of EMPAGUA / On going projects
- Pollutant load generation (Population density)
- Reported waterborne diseases cases
- Accessibility to the settlement
- Availability of drawings and other relevant data

Based on the above mentioned criteria the selected settlements for Central and South 3 Regions are described in Table 12-3. The location of these settlements in Central and South 3 region are shown in Fig. 12-4 a) and Fig. 12-4 b) respectively. Further detailed location is shown in Supporting Report N, Volume IV.

Table 12-3 Settlements to be Provided with Sanitation System in the First Stage

S. No.	Name of settlement	Zone	Population[a]	Estimated Area, ha[b]
Central Region				
1	Final	14	500	16
2	El Pilar	14	1,500	48
3	El Cambary	14	300	7
4	Campo Seco	16	1,200	6
5	Finca El Carmen	6	1,000	6
6	Modrno San Antonio	6	1,000	6
7	Jocotales	6	2,600	17
8	Quintanal	6	3,700	24
9	Santa Faz	6	600	4
10	El Tuerto	1	500	4
11	Colinas I y II	1	900	7
12	Bethania Sec I	1	1,400	11
13	Bethania Sec III	7	1,600	11
14	Bethania Sec IV	7	400	3
15	Seis de Octubre	7	1,500	10
16	Joya I	7	2,500	16
17	Joya II	7	2,500	16
18	Joya III	7	2,500	16
19	La Joya IV	7	1,500	10
20	Colonia Argueta	2	2,000	26
21	Incienso	3	4,200	19
	Total		33,900	283
South 3 Region				
1	Loma Blanca I	12	900[c]	9
2	Loma Blanca II	12	1,000[c]	9
3	Plaza de Toros	13	1,000	24
	Total		2,900	42

Note : [a] Adapted from UNICEF Survey "Caracterizacion De Las Areas Precarias En La Ciudad De Guatemala", (1991) and population in the year 2015 is assumed to be same as that present.

[b] Estimated Area = (Population / Population Density of the respective Zone)

[c] Population growth is taken into account for the year 2015.

Area to be served by sanitation system in the first and ultimate satge are shown in Table 12-4.

Table 12-4 Area to be Served by Sanitation in First Stage in Central and South 3 Region

Stage	Area to be Served, ha			
	Central Region		South 3 Region	
	Increment	Total	Increment	Total
First Stage	283	283	42	42
Second Stage	231	514	-	42
Third Stage	253	767	-	42

Source : Study Team

12.2.3 Population to be Served

Table 12-5 and Table 12-6 show the population to be served by sewerage system or sanitation system in the First Stage and subsequent stages, respectively.

Table 12-5 Population to be Served by Sewerage in the First Stage in Central and South 3 Region

Stage	Population to be Served, person			
	Central Region		South 3 Region	
	Increment	Total	Increment	Total
First Stage	520,400	520,400	44,700	44,700
Second Stage	65,700	586,100	64,800	109,500
Third Stage	165,700	751,800	166,600	276,100

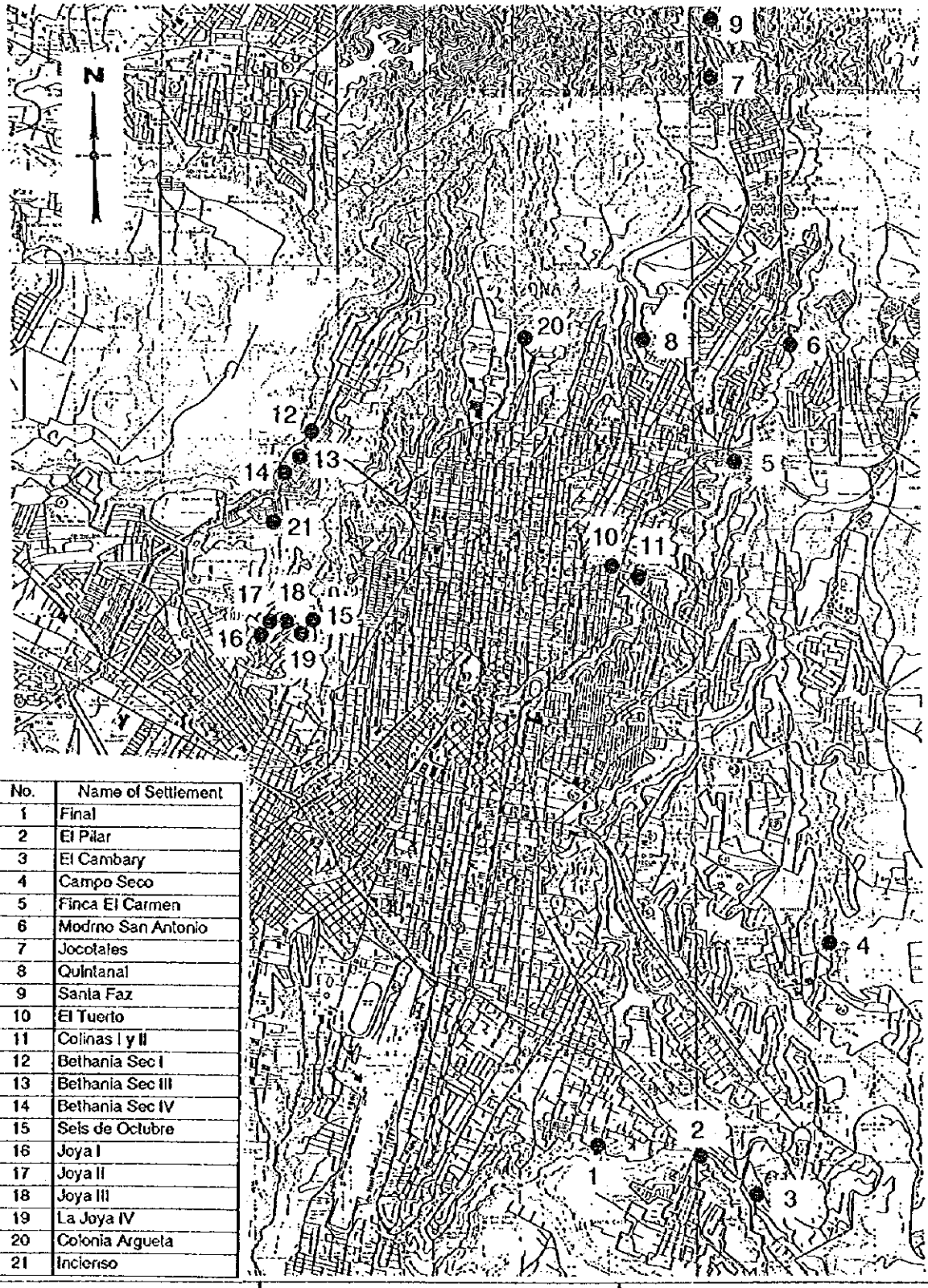
Source : Study Team

Table 12-6 Population to be Served by Sanitation in First Stage in Central and South 3 Region

Stage	Population to be Served, person			
	Central Region		South 3 Region	
	Increment	Total	Increment	Total
First Stage	33,900	33,900	2,900	2,900
Second Stage	36,100	70,000	-	2,900
Third Stage	39,600	109,600	-	2,900

Source : Study Team

Fig. 12 - 4(a)



No.	Name of Settlement
1	Final
2	El Pilar
3	El Cambary
4	Campo Seco
5	Finca El Carmen
6	Modrno San Antonio
7	Jocotales
8	Quintanal
9	Santa Faz
10	El Tuerto
11	Colinas I y II
12	Bethania Sec I
13	Bethania Sec III
14	Bethania Sec IV
15	Seis de Octubre
16	Joya I
17	Joya II
18	Joya III
19	La Joya IV
20	Colonia Argueta
21	Incienso

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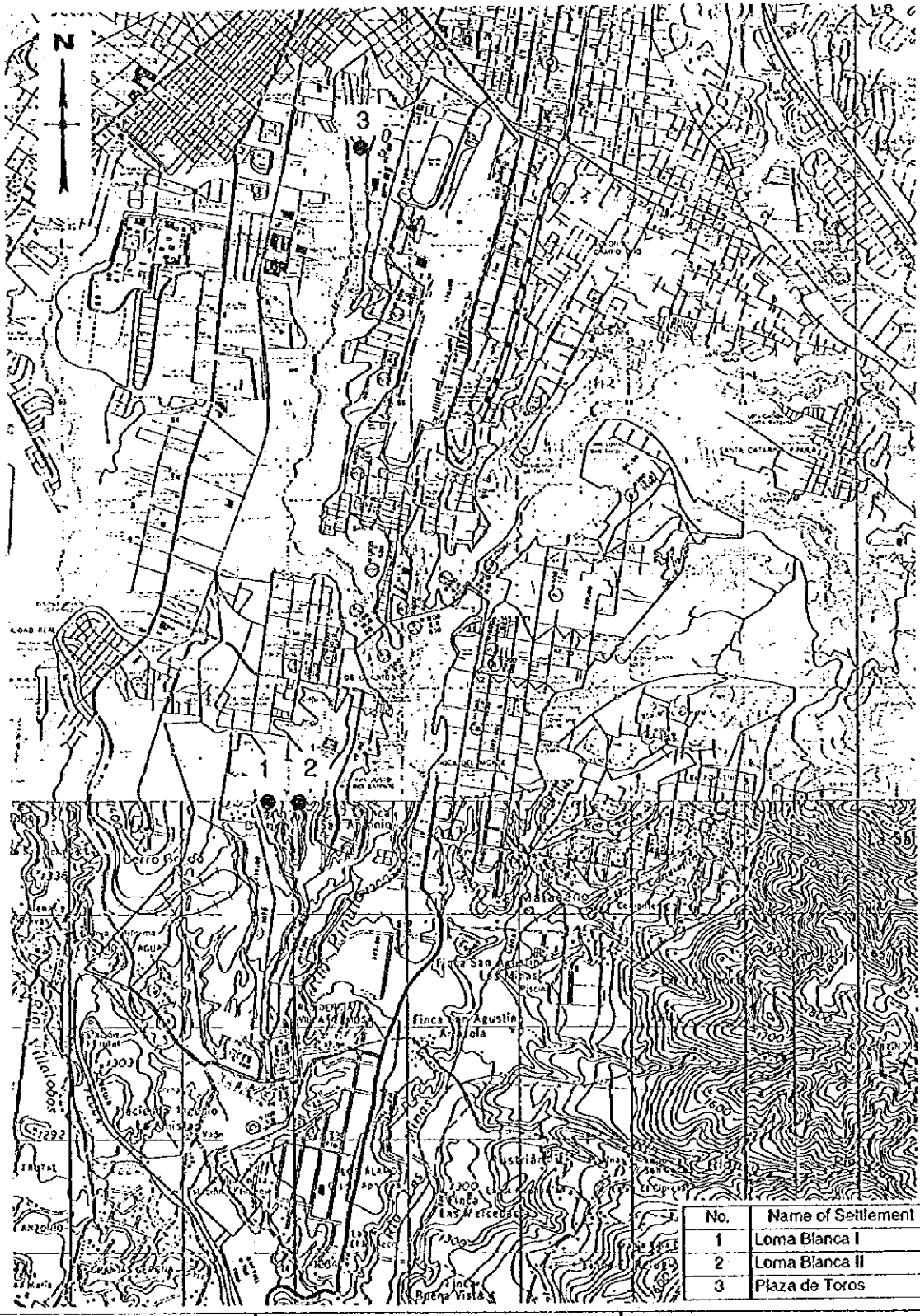
Fig. 12 - 4(b)



No.	Name of Settlement
1	Loma Blanca I
2	Loma Blanca II
3	Plaza de Toros

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12.2.4 Wastewater Generation

Unit wastewater generation for domestic, commercial/institutional and industrial sources is shown in Chapter 7, Section 7.3 for sewerage and sanitation systems. Based on that, wastewater inflow into the wastewater treatment plant is estimated for each region and is shown in Table 12-7.

Table 12-7 Estimated Wastewater Inflow into Central and South 3 Wastewater Treatment Plants

Year	Wastewater inflow (daily maximum), m^3/d	
	Central WWTP	South 3 WWTP
2002	175,300	14,890
2003	180,090	16,070
2004	184,790	19,700
2005	189,690	23,830
2006	195,190	28,730
2007	200,800	31,520
2008	207,100	34,750

Source : Study Team

12.2.5 Wastewater Quality

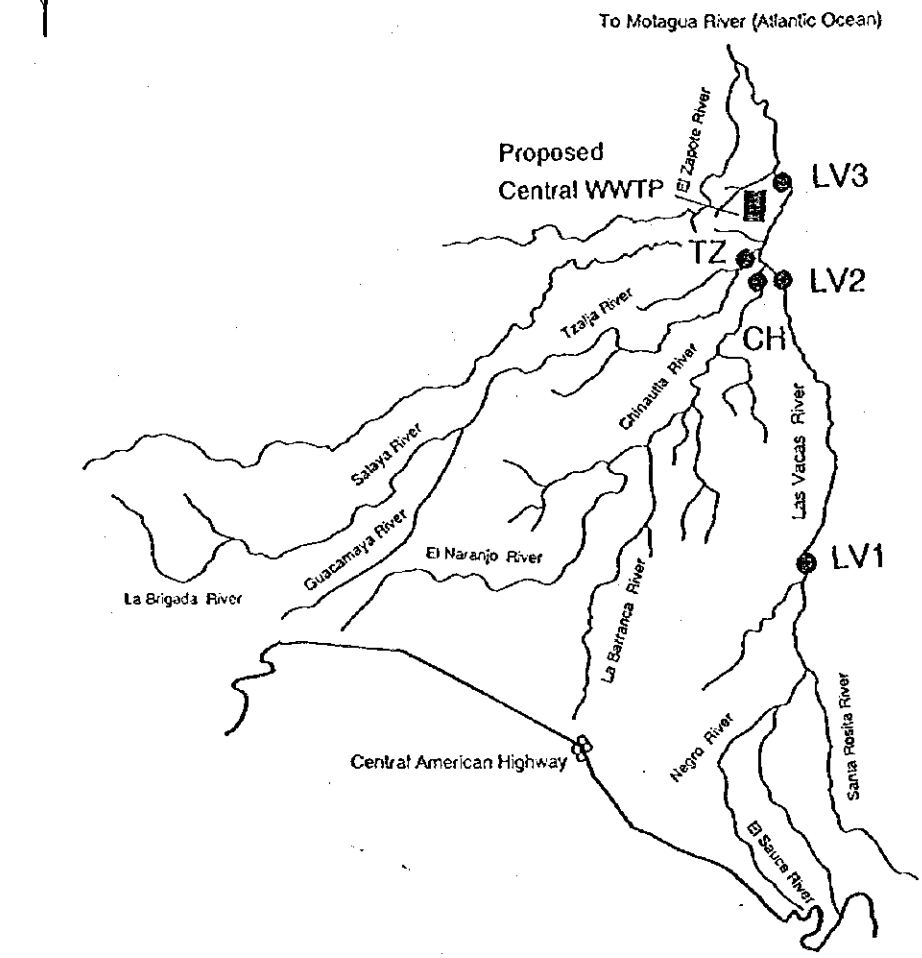
Wastewater quality for the wastewater treatment and sanitation facilities is as described in Chapter 7, Section 7.4.

(1) Sewerage system (both BOD and SS) 280 mg/L
(2) Sanitation system (both BOD and SS) 330 mg/L

12.2.6 Treatment Level

In Section 7.6, it is proposed that secondary treatment level be provided in the wastewater treatment plants. However, in the staged development it is necessary to consider alternatives including that of providing primary treatment in the First Stage. Applicability of this alternative depends on the receiving water where effluent is to be discharged. Table 12-8 shows the receiving water body, existing water quality (December '95~February '96) and effluent quality for primary and secondary treatment. Fig. 12-5 also shows the existing water quality of receiving water bodies.

Fig. 12 - 5(a)



Location	LV1	LV2	LV3	CH	TZ
Flowrate,m3/s	1.80 (1.20~2.87)	2.01 (1.61~2.40)	2.41 (1.40~3.49)	0.65 (0.43~0.89)	0.23 (0.11~0.33)
COD, mg/L	622 (536~709)	487 (398~668)	383 (351~426)	381 (298~409)	323 (202~468)
BOD, mg/L	309 (350~258)	227 (288~180)	178 (150~204)	190 (141~192)	150 (95~216)
TS, mg/L	1048 (800~1500)	945 (700~1200)	2452 (1000~6600)	4728 (3300~8000)	1403 (700~2600)
Sed. S, mL/L	4.4 (2.6~6.2)	5.4 (3.9~8.0)	4.9 (3.8~5.4)	7.4 (3.6~8.0)	3.6 (1.0~8.2)
T-N, mg/L	59.2 (41.0~88.6)	43.4 (20.0~54.3)	47.6 (20.6~89.2)	67.0 (40.7~108.0)	54.8 (25.2~103.0)
T-P, mg/L	9.3 (12.8~7.0)	10.7 (7.0~17.6)	9.6 (5.8~14.2)	9.7 (4.6~16.6)	10.6 (7.2~18.8)
Cl-, mg/L	57.6 (41.1~67.4)	44.0 (32.5~52.5)	46.9 (38.0~59.5)	54.0 (45.4~67.4)	45.4 (41.1~50.3)

LV1 - Las Vacas River (Downstream of Gran Collector North)
LV2 - Las Vacas River (Upstream of Chinautla River)
LV3 - Las Vacas River (Downstream of proposed Central WWTP)
CH - Chinautla River
LV5 - Tzalja River

Average (minimum~ maximum) values are shown.
Flowrates are for two measurements during day time, three days on December 1995 and three days on January/February 1996

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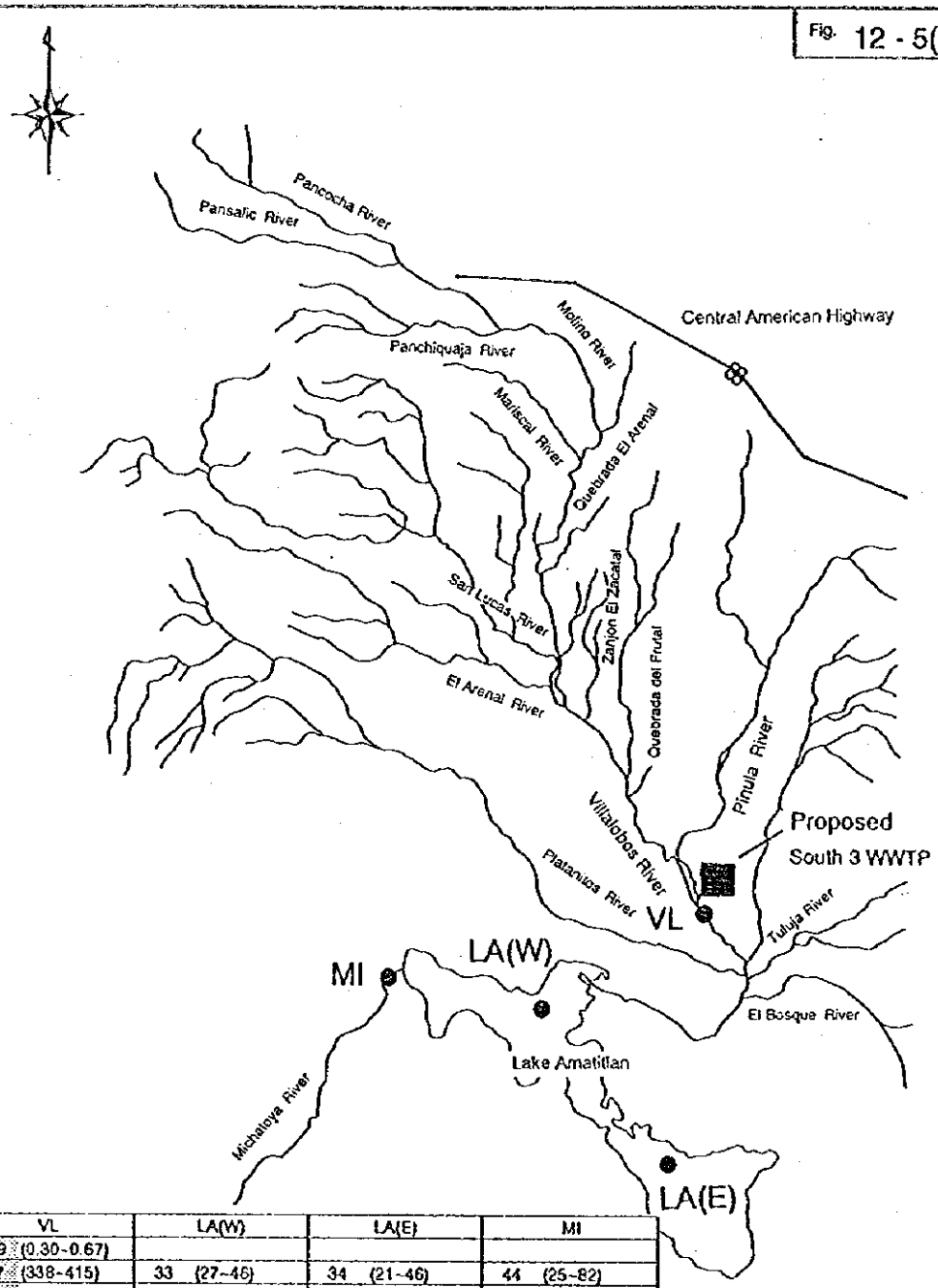
Fig. 12 - 5(b)



Location	VL	LA(W)	LA(E)	MI
Flowrate,m3/s	0.49 (0.30~0.67)			
COD, mg/L	377 (338~415)	33 (27~46)	34 (21~46)	44 (25~82)
BOD, mg/L	188 (120~290)	9.9 (7.5~14.0)	9.0 (5.1~15.0)	11 (4.7~24.0)
TS, mg/L	1252 (1000~1600)	348 (300~500)	400 (200~400)	443 (300~500)
Sed. S, mL/L	4.5 (3.6~5.0)	0.0 (0.0~0.0)	0.0 (0.0~0.0)	0.0 (0.0~0.1)
T-N, mg/L	38.6 (28.8~45.0)	7.7 (2.7~12.7)	6.0 (1.2~13.3)	6.6 (0.6~13.3)
T-P, mg/L	6.9 (5.2~8.6)	3.8 (0.6~7.7)	3.4 (0.1~8.6)	4.5 (0.1~9.2)
Cl-, mg/L	52.0 (29.9~79.6)	150.6 (7.0~17.6)	121.7 (83.2~142.5)	188.2 (105.3~230.6)

VL - Villalobos River (Downstream of proposed South 3 WWTP)
LA(W) - Laka Amatitlan (Playa de Oro)
LA(E) - Lake Amatitlan (Frente punta de Ayala)
MI - Michaloya River (Exit of Lake Amatitlan)

Average (minimum~ maximum) values are shown. Flowrates are for two measurements during day time, three days on December 1995 and three days on January/February 1996

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Table 12-8 Receiving Water Bodies for Central and South 3 WWTP and Their Existing Condition

WWTP	Receiving Water Body	Existing Water Quality of Receiving Water Body (BOD), mg/L	WWTP Effluent Quality (BOD), mg/L	
			Primary	Secondary
Central	Las Vacas River	178 (150 - 204)	182	56
South 3	Villalobos River (Pinula River)	188 (120 - 290)	182	56

Note : Existing water quality were from water quality survey during December, 1995 and February 1996.
Source : Study Team

From Table 12-8, existing quality of receiving water body is similar to the primary treated effluent. If primary treated effluent is discharged, existing conditions will prevail downstream of receiving water body even after the implementation of First Stage. However, water body within the sewered area will be improved. Therefore, providing primary treatment can be considered as an alternative in the First Stage.

One of the important objective of implementing South 3 Region is to reduce the pollutant load to Lake Amatitlan. Since providing only primary treatment will not result in any reduction of pollutant load to Lake Amatitlan, treatment level in the South 3 Wastewater Treatment Plant should be secondary treatment level (i. e. providing primary treatment only shall be excluded as an alternative).

12.2.7 Fundamentals of Alternatives

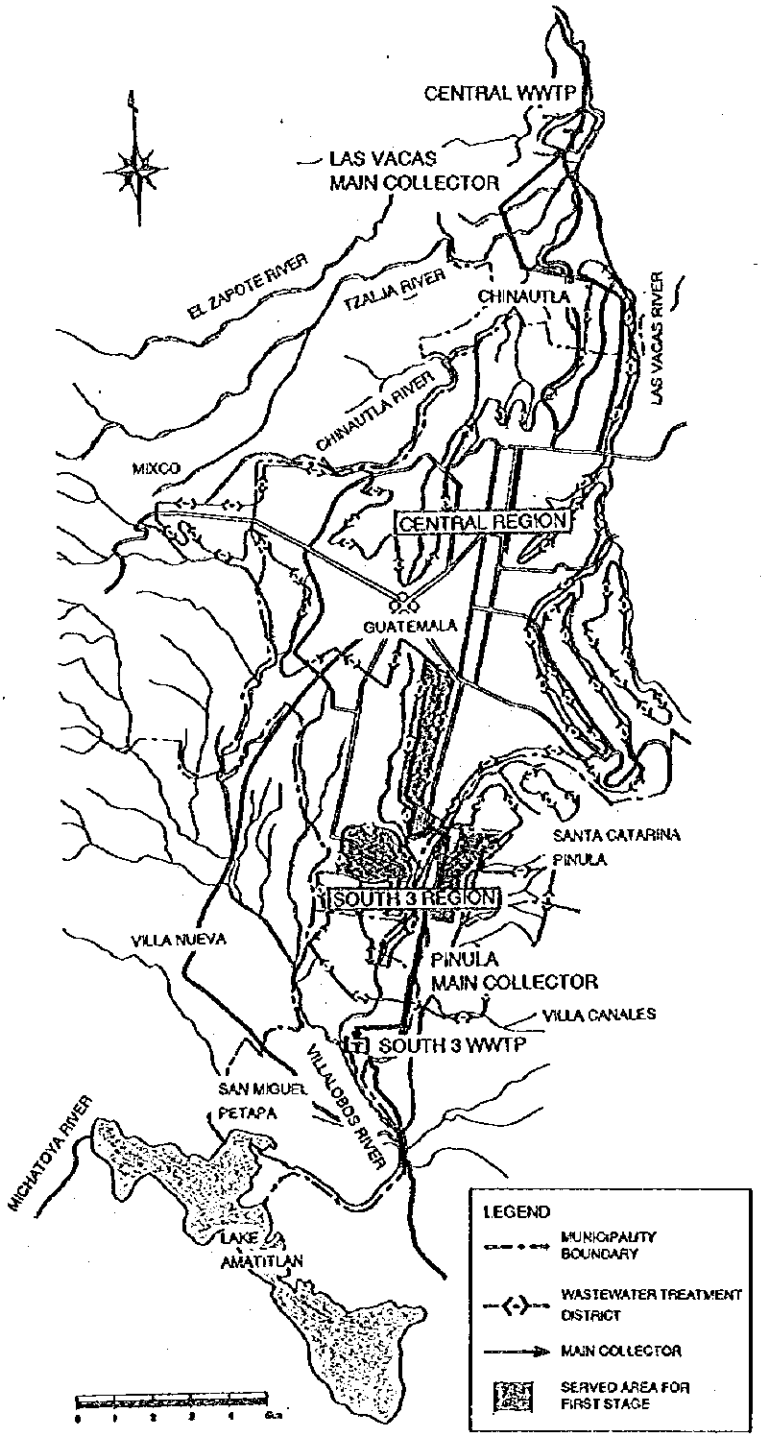
As discussed in Section 12.1 of this Report, Central Region and South 3 Region are considered as alternatives for Feasibility Study. Table 12-9 summarizes basic parameters set out in the preceding sections for each alternative, namely Alternative 1 - Central Region, and Alternative 2 - South 3 Region. Fig. 12-6 shows the outline of each alternative.

Table 12-9 Fundamentals of Alternatives for Feasibility Study

ITEM	CENTRAL REGION	SOUTH 3 REGION
1 FUNDAMENTALS		
1.1 CONSTRUCTION PERIOD	1999 ~ 2001	1999 ~ 2001
1.2 SEWERAGE		
1.2.1 Served Area, ha	4,605	896
1.2.2 Served Population (As of 2002)	533,200	53,200
1.3 SANITATION		
1.3.1 Served Area, ha	283	42
1.3.2 Served Population	33,900	2,900
2 FACILITY DESIGN		
2.1 SEWER		
2.1.1 Collection System	Combined	Separate
2.2 WASTEWATER TREATMENT PLANT		
2.2.1 Treatment Capacity, m3/d (daily maximum)	196,000	36,000
2.2.2 Raw Wastewater Quality		
a) BOD, mg/L	280	280
b) SS, mg/L	280	280
2.2.3 Treatment Level	Primary	Secondary
2.2.4 Treatment Process	Primary Sedimentation	Trickling Filter Process
2.2.5 Final Effluent Quality		
a) BOD, mg/L	182	56
b) SS, mg/L	126	56
2.2.6 Receiving Water Body	Las Vacas River	Villalobos River (Pinula River)
2.3 SANITATION SYSTEM		
2.3.1 Number of Colonies	20	3
2.3.2 Treatment Method	Septic tank with upflow anaerobic filter or with soil absorption well	
2.3.3 Raw Wastewater Quality		
a) BOD, mg/L	330	330
b) SS, mg/L	330	330
2.3.4 Final Effluent Quality		
a) BOD, mg/L	83	83
b) SS, mg/L	83	83

Source : Study Team

Fig. 12 - 6



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12.3 PRELIMINARY DESIGN

12.3.1 Wastewater Collection System

a) Main Collector Design

Main collectors for Central and South 3 Regions, namely Las Vacas Main Collector and Pinula Main Collector, are described in this section. Routes of the collectors are established based on field investigations including longitudinal surveys, and cross-sectional surveys for river-crossings.

River crossings by either pipe-bridge or tunnel under the river-bed were compared and based on the results, main collector route and longitudinal section were established.

Results of topographical surveys is reported in Supporting Report Q, Volume V. Design of main collectors is reported in Supporting Report L, Volume IV.

1) Las Vacas Main Collector (Central Region)

Fig. 12-7 and Fig. 12-8 show the route and longitudinal profile of Las Vacas Main Collector, respectively. It starts just upstream of the existing discharge at Belice Bridge, where it can intercept three times the hourly maximum flowrate during storms. Along it route, it collects wastewater from separate-sewer system of Zone 6 of Guatemala City, and Jocotales sub-district of Chinautla Municipality. Further north, around Santafaz, it turns west and crosses Chinautla River, Tzalja River and its tributary, etc. and reaches proposed site for Central WWTP.

Total length is 11 km, and its diameter is 3,000 mm. Most of the collector will be constructed by tunnelling method except between Santafaz and Chinautla River, where there is a section with about 170 m drop in level. Fig. 12-9 shows the longitudinal profile for that section. River crossings at Chinautla River, Tzalja River, etc. are selected to be pipe-bridge method in order to reach the wastewater treatment plant site at an altitude around 1,220 m above mean sea level.

Design capacity of Las Vacas Main Collector is 14.194m^3/s which is the sum of

a) 3 x hourly maximum flowrate from the combined-sewer area, and
b) hourly maximum flowrate from separate-sewer area.

Fig. 12 - 7

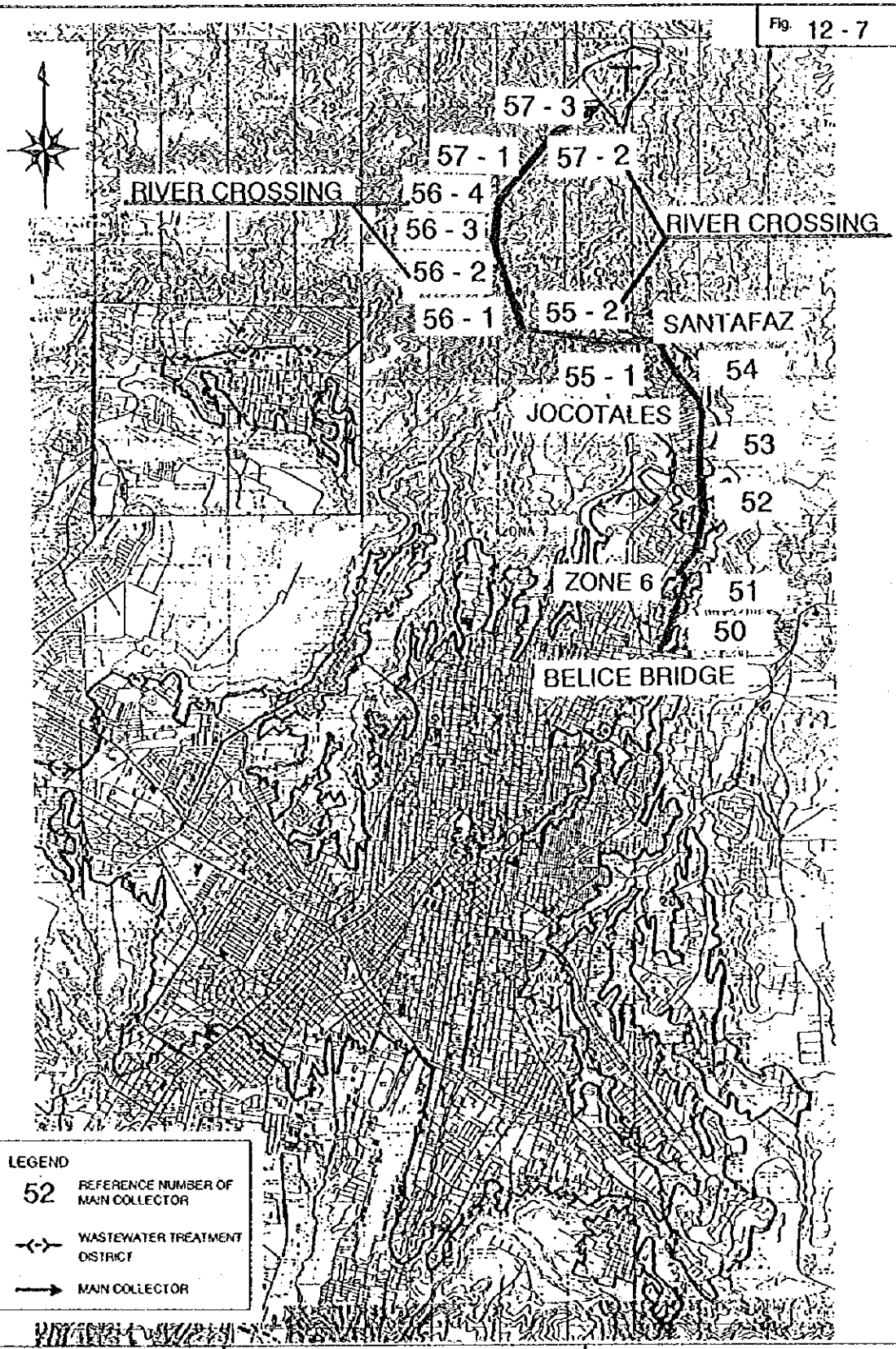

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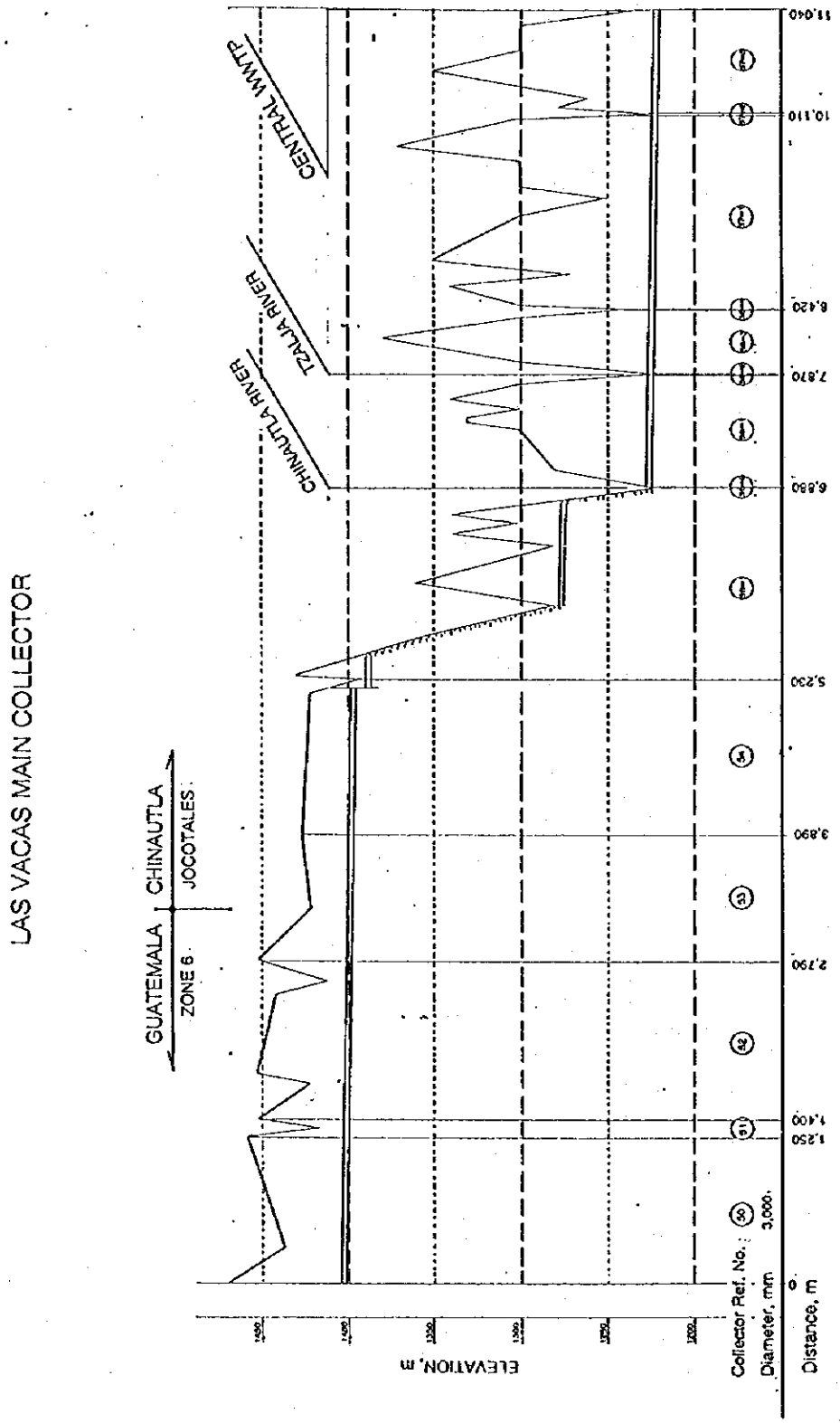
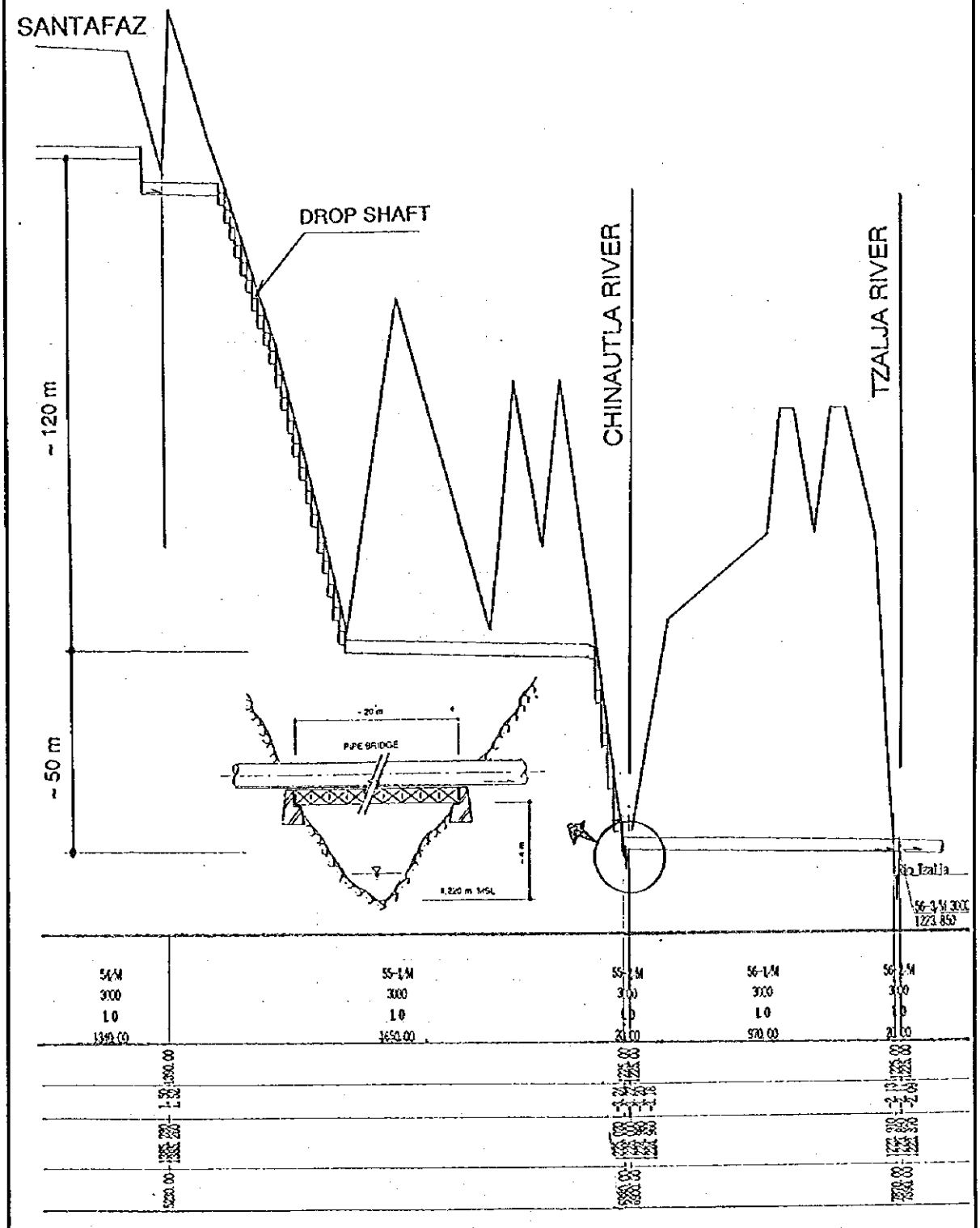
Fig. 12 - 8



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LONGITUDINAL PROFILE OF LAS VACAS MAIN COLLECTOR

Fig. 12 - 9



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LONGITUDINAL PROFILE OF LAS VACAS MAIN COLLECTOR (SANTA FAZ-TZALJA RIVER SECTION)

Since the cost of pipe-bridge is high, locations of river crossing were selected (based on field investigations and cross-sectorial survey) such that the span of the bridge is small as possible (maximum span is 20m). This resulted in an increase of one kilometer (1 km) compared to that proposed in Section 9.1.1.

2) Pinula Main Collector (South 3 Region)

Fig. 12-10 and Fig. 12-11 show the route and longitudinal profile of Pinula Main Collector respectively. Pinula Main Collector starts from the northernmost part zone13 of South 3 Wastewater Treatment District where it collects wastewater from public offices in the west of Aurora International Airport and runs about 5.3km south up to Colonia La Libertad sub-district, where it receives wastewater from Los Guajitos sub-district (Colonia Letran sub-district in zone22) through a pipe-brdige over Guadron River. From there it runs back north-east for about 800 m along the national highway "CA1" to cross over Pinula River (where the old bridge stands at Hincapie). After the river crossing, it runs further south along "CA1", receives wastewater from Boca del Monte sub-district of Villa Canales Municipality and El Porvenir sub-district of San Miguel Petapa Municipality and reaches Los Alamos sub-district. Construction will be by tunneling up to this point with a diameter of 1,500 mm and length of about 5.5 km. From there open-cut method (1,200 mm diameter) will be used for about 1,150 m, to reach the proposed South 3 Wastewater Treatment Plant site at an altitude of 1,270m above mean sea level.

b) Construction Method for Collectors

1) Excavation Method

Mainly three methods of construction are selected for construction of collectors, namely a) open-cut method, b) tunnelling method, and, c) pipe-bridge method. Excavation method will be different for tunnelling method, due to hard rock in some parts of collector, resulting in much different excavation costs.

Field investigations were conducted along the collector routes for Central and South 3 Region including geotechnical surveys. Results of geotechnical surveys are reported in Supporting Report R, Volume V. It was found that there are medium-hard rock in the section from Chinautla River crossing up to the Central Region Wastewater Treatment Plant. Soil investigations near the four river crossings showed rock having unconfined compression strengths of 94kg/cm^2 (Borehole B-9, tributary of Tzaja River) and 110kg/cm^2 (Borehole B-10, Quebrada El Juez).

Fig. 12 - 10

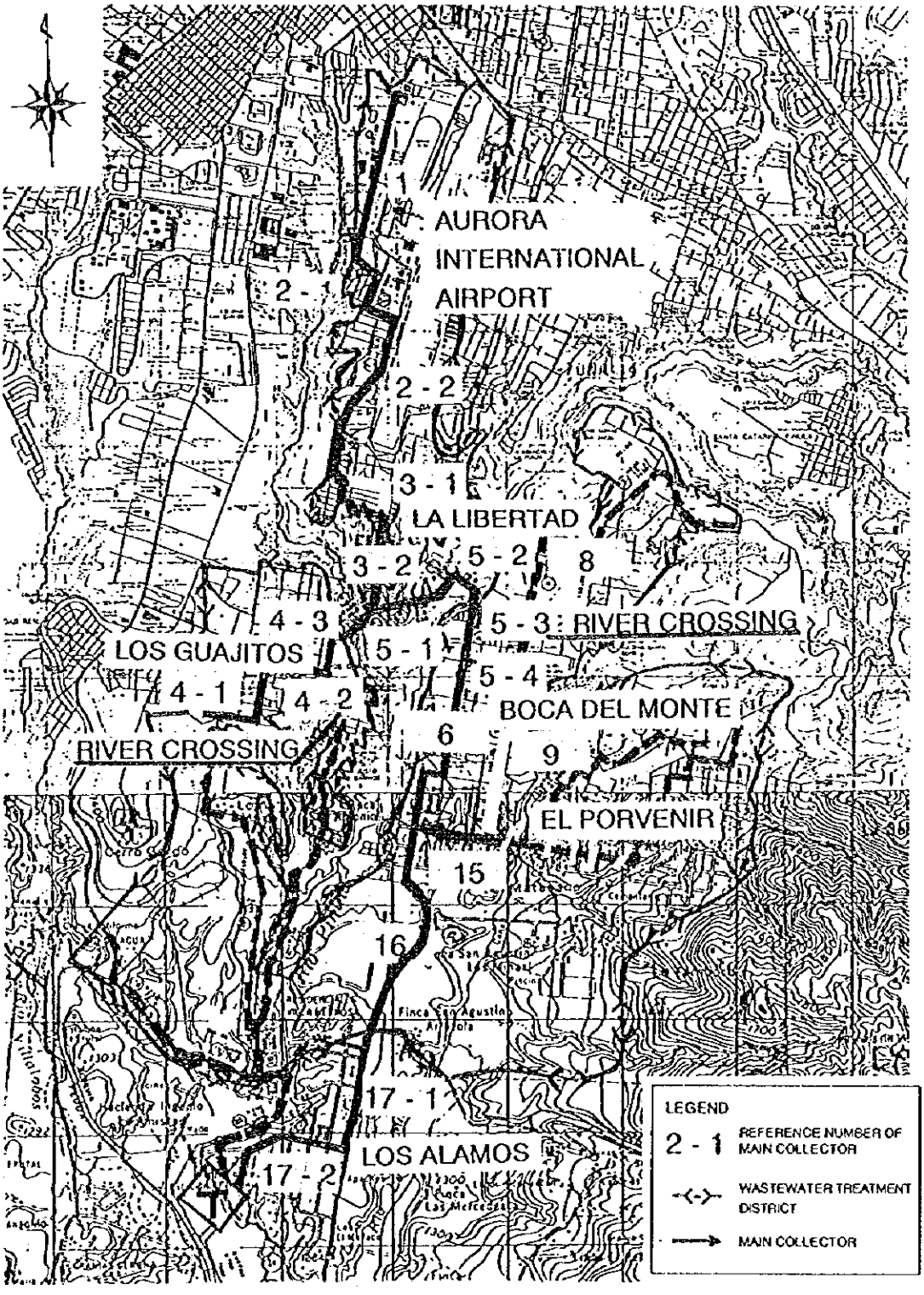


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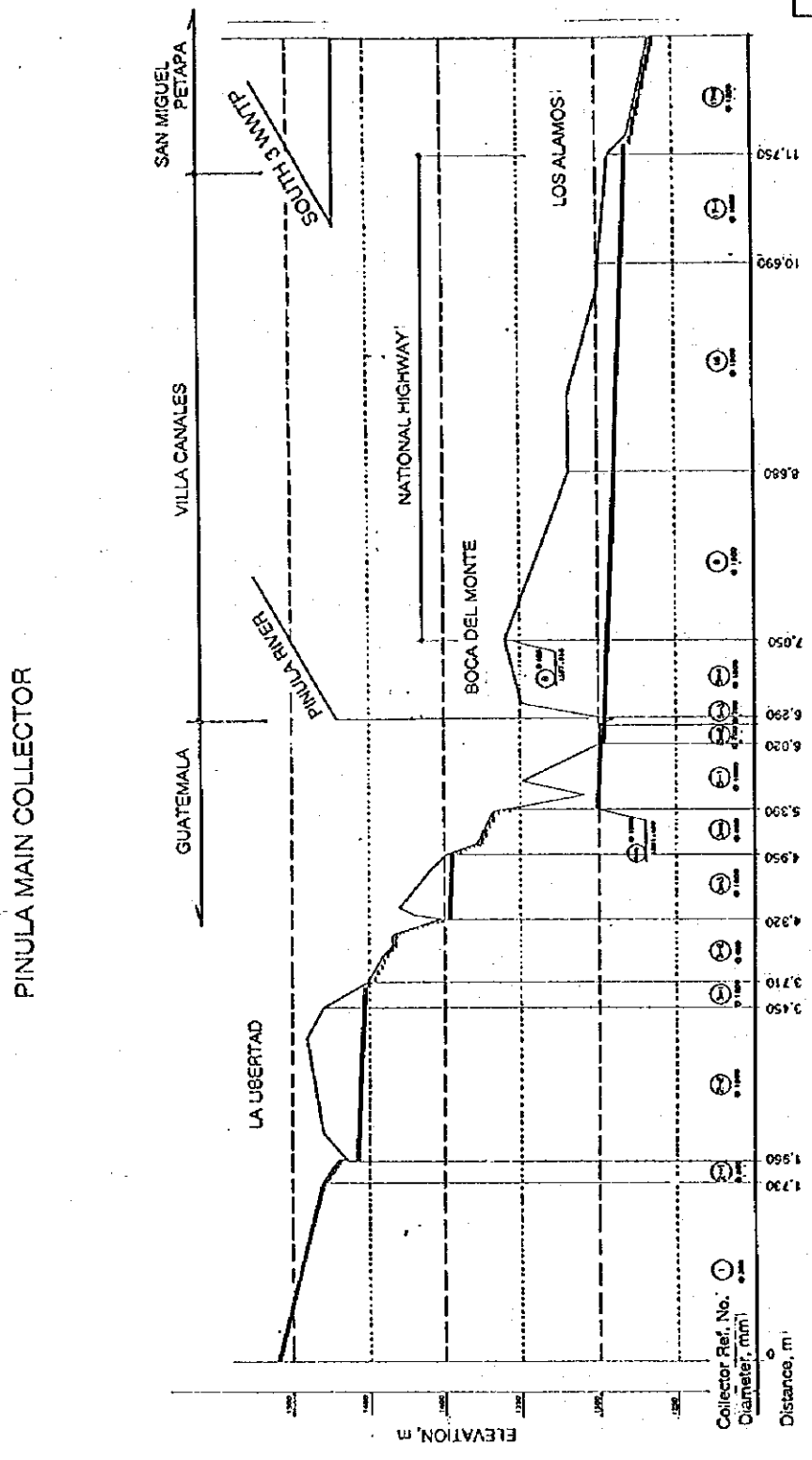
Fig. 12 - 11



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Blasting method is selected for this section for excavation based on consultation with EMPAGUA, which had previous experience with this kind of method in the Xaya-Pixcaya Raw Water Transmission Tunnel for Lo De Coy Water Treatment Plant.

For other sections, manual excavation method will be used for tunnelling.

2) Spacing for Vertical Shafts

When excavating tunnels, it is necessary to have access to the working face of the tunnel for workmen, soil disposal, equipment, etc. Generally, vertical shafts are provided at regular intervals along the tunnels. EMPAGUA has a wealth of experience in the construction of tunnels and from this experience spacing of vertical shafts for excavation in soft is set to be around 50-100 m.

However, for the excavation in hard between Chinautla River crossing to Central Wastewater Treatment Plant, it will be uneconomical to have vertical shaft at similar intervals. There are four river crossings in that section of collector and using both ends of the tunnel for working access will be an economical solution. No vertical shafts for construction will be necessary, in this section.

3) Depth of Manholes

In the existing sewerage system of Guatemala City, manholes around 40 to 50 m depth are not uncommon and there is an existing manhole of 96 m depth in Los Guajitos. Main collectors planned in this Study has ground cover more than 100 m in several sections along the mountains. However, considering the existing manhole, maximum depth of manhole should be around 100 m.

c) Summary of Main Collector Design

Table 12-10 and 12-11 show the summary of main collectors for Central and South 3 Regions. Location of the collectors are shown on Fig. 12-7 and Fig. 12-10 according to their reference numbers shown on Tables 12-10 and 12-11.

d) Collectors

Length of collectors to be provided in the First Stage Project in South 3 Region is estimated at 86.1 km based on length of collectors required per unit area (270 m/ha) and area (319 ha) to be newly sewered.

Table 12-10 Summary of Main Collectors for Central Region

Ref. No.	Diameter, mm	Length, m	Construction Method	Remarks
50	3,000	1,250	Tunnel	Soft
51	3,000	150	Tunnel	Soft
52	3,000	1,390	Tunnel	Soft
53	3,000	1,100	Tunnel	Soft
54	3,000	1,340	Tunnel	Soft
55-1	3,000	1,650	Tunnel	Soft
55-2	3,000	20	Pipe Bridge	
56-1	3,000	970	Tunnel	Hard
56-2	3,000	20	Pipe Bridge	
56-3	3,000	530	Tunnel	Hard
56-4	3,000	20	Pipe Bridge	
57-1	3,000	1,670	Tunnel	Hard
57-2	3,000	20	Pipe Bridge	
57-3	3,000	910	Tunnel	Hard
Total		11,040		

Note : Total length of main collectors are based on the results of longitudinal surveys conducted in this Study. Note that the lengths reported in Table 9-1 and 9-2 are based on topographical map of scale 1 : 15,000 and enlarged map of scale 1 : 50,000. Therefore, the lengths are different.

Source : Study Team

Table 12-11 Summary of Main Collectors for South 3 Region

Ref. No.	Diameter, mm	Length, m	Construction Method	Remarks
1	300	1,730	Open-cut	
2-1	500	230	Open-cut	
2-2	1,500	1,490	Tunnel	Soft
3-1	1,500	260	Tunnel	Soft
3-2	600	610	Open-cut	
3-3	1,500	630	Tunnel	
3-4	600	440	Open-cut	
5-1	1,500	630	Tunnel	Soft
5-2	700	200	Open-cut	
5-3	700	70	Pipe bridge	
5-4	1,500	760	Tunnel	Soft
15	1,500	660	Tunnel	Soft
16	1,500	2,010	Tunnel	Soft
17-1	1,500	1,060	Tunnel	Soft
17-2	1,200	1,150	Open-cut	
4-1	400	1,510	Open-cut	
4-2	1,500	760	Tunnel	Soft
4-3	400	50	Pipe-Bridge	
4-4	1,500	130	Tunnel	Soft
7	400	500	Open cut	
8	500	810	Open-cut	
9	1,500	1,630	Tunnel	Soft
Total		17,320		

Note : Total length of main collectors are based on the results of longitudinal surveys conducted in this Study. Note that the lengths reported in Table 9-1 and 9-2 are based on topographical map of scale 1 : 15,000 and enlarged map of scale 1 : 50,000. Therefore, the lengths are different.

Source : Study Team

12.3.2 WASTEWATER TREATMENT PLANT

a) Basic Conditions and Proposed Treatment Process

1) Design Flowrate

Design flowrate for the Master Plan is estimated in Chapter 8, Section 8.2.1. Design flowrate for the First Stage is set based on the factors discussed in Section 12.2.1. Table 12-12 shows the design flowrate.

Table 12-12 Design Flowrates for Wastewater Treatment Plants

Flowrate	Design Wastewater Flowrate, m^3/d			
	Central Region		South 3 Region	
	Ultimate	First Stage	Ultimate	First Stage
Daily Average	238,000	178,000	66,000	33,000
Daily Maximum	261,000	196,000	72,000	36,000
Maximum Hourly	390,000	291,000	107,000	53,500
Wet Weather	1,087,000	873,000	-	-

Source : Study Team

2) Proposed Treatment Process Flow

For the Feasibility Study of First Stage Project, it is necessary to modify the treatment process flow proposed in Master Plan considering the factors shown in Table 12-13.

Table 12-13 Factors Affecting the Treatment Process Flow for the First Stage

Factor	Central Region	South 3 Region
Liquid Treatment Level	Primary	Secondary
Sludge Treatment	Omission of digestion process	

Source : Study Team

Reasons for the selection of liquid treatment level is discussed in Section 12.2.6. Regarding sludge treatment process, digestion process will be excluded in the First Stage for the following reasons. They are:

- Proposed sewage treatment plants will be the largest in Guatemala and are comparatively large for First Stage as well. Operation and management of large treatment plant will require much effort compared to the existing small-scale plants.

Therefore, by eliminating those processes at the beginning, facilities required for operation and management will be reduced.

- Drying of raw sludge (without digestion) requires more land than that for digested sludge and is generally practiced in developing countries where it is possible to secure large land area. In the First Stage, enough land will be available for drying of raw sludge because the land area required for the ultimate capacity is acquired at the beginning.

It is necessary to increase the number of sludge drying beds (i.e. capacity) in the First Stage because the volume reduction expected in the digesters cannot be obtained.

During the sludge treatment processes supernatant liquid from sludge digetser and drained liquid from sludge drying bed will be generated and their treatment is discussed in the following.

Liquid waste generated from the sludge treatment facilities are of very high concentration (much greater than the raw wastewater) and therefore cannot be discharged directly to the receiving water. Generally, this liquid is mixed with the raw water and treated in the wastewater treatment facilities.

To treat the supernatant by conventional method, pumping of the supernatant to the inlet of the sewage treatment plant would be necessary and this would conflict with gravity flow principle adopted in the design of treatment facilities and "not to use mechanical and electrical equipment". Therefore, supernatant will be treated by separate treatment facilities which will located at a lower level of sludge treatment facilities so that supernatant can flow by gravity through those facilities.

Stabilization Pond method will be used for treatment of supernatant, for the following reasons:

- construction cost is very low even though the required area is higher compared to other treatment processes
- total area required is also low because the volume of supernatant generated is low
- volume of sludge generated would be extremely low (drying or desludging once in few years would be sufficient)
- stabilization pond treatment is applied widely in developing countries for low volume wastewater

Treatment process flows for Central and South 3 Regions for the First Stage are as shown in Fig. 12-12 and Fig. 12-13.

3) Water Quality

Based on the process flow selected for each Region, and wastewater qualities and removal rates discussed in Section 8.2.1 (Tables 8-7 and 8-8), and treatment level is discussed in Section 12.2.6. Table 12-14 shows the effluent qualities expected in each Region.

Table 12-14 Treated Water Quality in the First Stage

Region	Treatment Level	Parameter	Concentration, (mg/L)	
			Influent	Effluent
Central Region	Primary	BOD_5	280	182
		SS	280	126
South 3 Region	Secondary	BOD_5	280	56
		SS	280	56

Source : Study Team

4) Septage

It is planned to treat septage collected from newly constructed sanitation facilities (septic tanks), in each Region, at the respective wastewater treatment plant of that Region. Table 12-15 shows the septage quantity to be treated in each wastewater treatment plant.

Table 12-15 Quantity of Septage from Sanitation Facility in Central and South 3 Region

Flowrate	Central Region		South 3 Region	
	Ultimate	First Stage	Ultimate	First Stage
Annual, m3/year	4,384	1,356	144	116
Daily (average), m3/d	12.0	3.7	0.4	0.3
Dried Sludge, ton/d	0.84	0.26	0.03	0.02

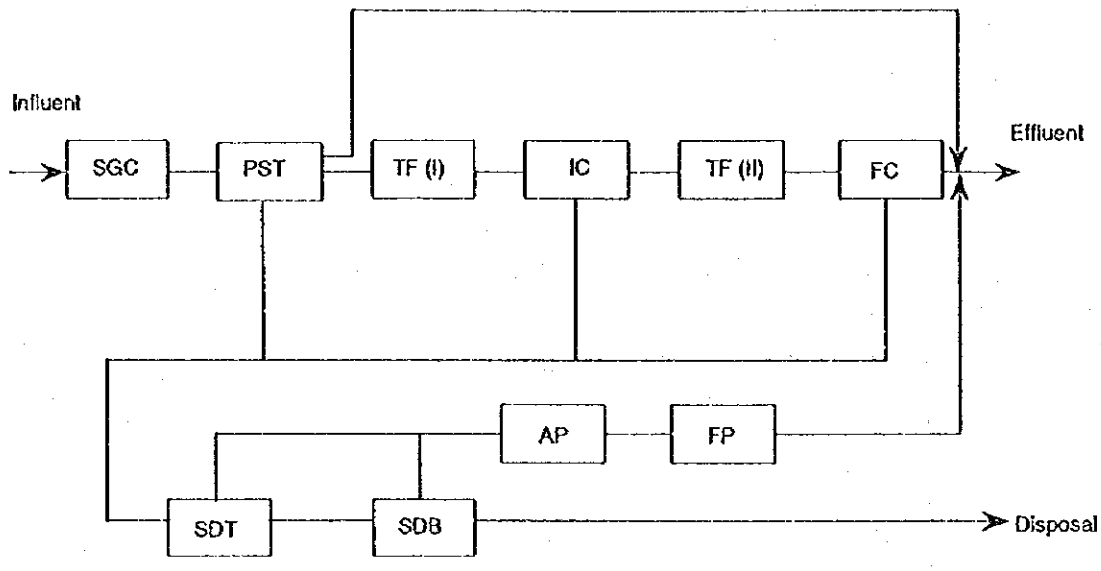
Source : Study Team

b) Design Criteria

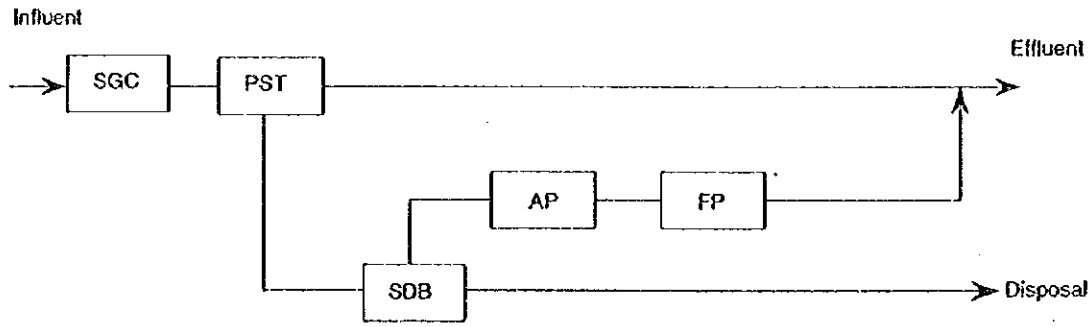
Design criteria for each facility are as shown in Table 8-11 in Section 8.2.3.

Fig. 12 - 12

Primary Treated ExcessWet weather Flow
(3 x Maximum Hourly Flow - 1 x Maximum Hourly Flow)



a) Ultimate



b) First Stage

Legend
SGC - Screen Grit Chamber
PST - Primary Sedimentation Tank
TF - Trickling Filter
IC - Intermediate Clarifier
FC - Final Clarifier
SDT - Sludge Digester Tank
SDB - Sludge Drying Bed
AP - Anaerobic Pond
FP - Facultative Pond
—— - Liquid Line
—— - Sludge Line

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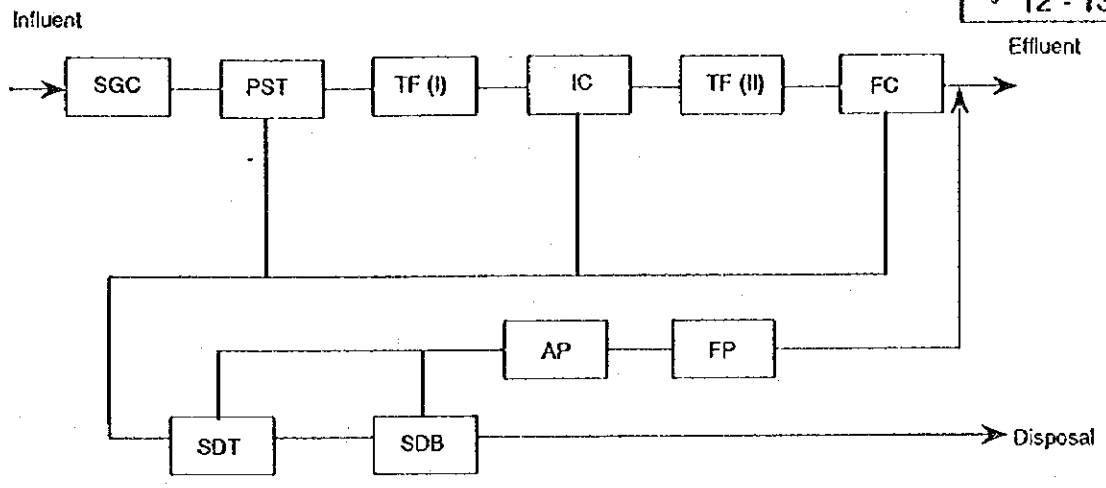
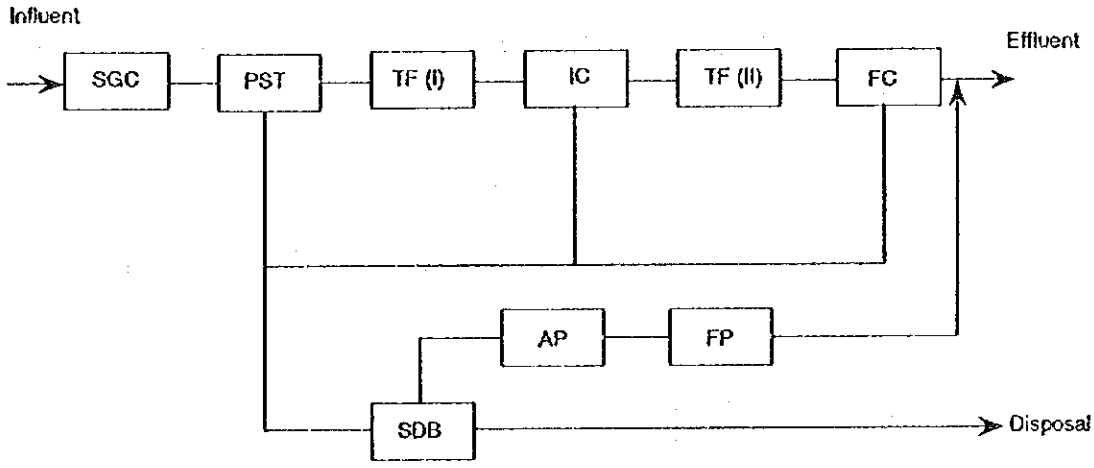
Fig. 12 - 13



a) Ultimate



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SGC - Screen Grit Chamber
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SDB - Sludge Drying Bed
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FP - Facultative Pond
—— - Liquid Line
—— - Sludge Line

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c) **Others**

1) Basic Concept for the Facility Layout

- Layout of each treatment facility should be such that it is connected to the preceding and subsequent facilities and all flows shall be under gravity. Connection pipes between consequent facilities should have valves and piping for by-passing each and every facility.
- Each treatment facility will be constructed in stages namely first, second and third. Facilities in each stage shall be in a compact manner so that there is greater flexibility even if changes in plans are made in the future.
- Amount of cut and fill is large and the layout shall be such that cut and fill are nearly balanced.

2) Slope for cut and fill

Slopes for cut and fill are based on local experience and the results of geotechnical survey (Refer to Supporting Report R, Volume V for details). They are as follows :

Slope for cut	-	1 : 1	(vertical : horizontal)
Slope for fill	-	1 : 2	(vertical : horizontal)

3) Items of Civil Engineering Construction which need to be Studied in the Detailed Design Stage

- Installation of drainage for terraces in cuts of large heights and for fills.
- To enhance the stability of slopes, growing grass etc. is necessary and application of dried sludge shall also be considered.
- Protection measures against erosion along the Pinula River, especially in the vicinity of final effluent outfall site.
- Measures for improving aesthetic environment of WWTP (landscaping), for effecting odor control by growing green-belt around the WWTP site, and for protecting against erosion / gullying within WWTP.

d) **Outline of Treatment Facilities**

Table 12-16 shows the outline of facilities designed based on the design conditions and criteria set out in the previous sections and Fig. 12-14 and 12-15 show the layout of treatment facilities for Central and South 3 WWTP.

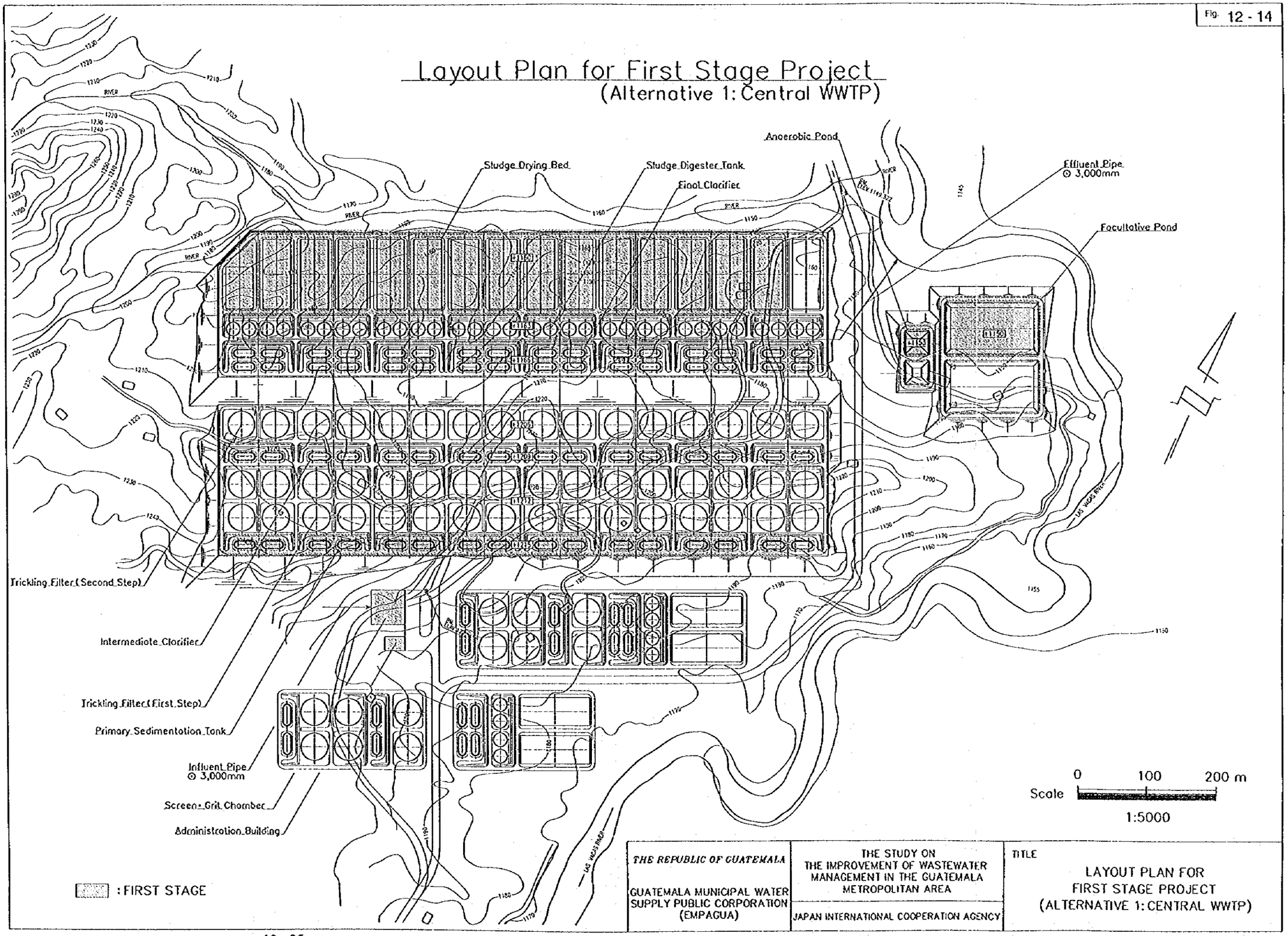
Table 12-16 Outline of Treatment Facilities for Central Region and South 3 Region

FACILITY	CENTRAL			SOUTH 3 (PINULA COLLECTOR)			SOUTH 3 (HERMOSA COLLECTOR)		
	Dimensions	No.		Dimensions	No.		Dimensions	No.	
		Ultimate	First Stage		Ultimate	First Stage		Ultimate	First Stage
Primary Sedimentation Tank	B10.0m x L30.0m x h10.0m	20	15	ϕ11.0 m x h 10.0 m	12	8	ϕ9.5 m x h 9.0 m	4	-
Trickling Filter (First Step)	ϕ39.0 m x h 2.0 m	40	-	ϕ34.0 mx h 2.0 m	12	8	ϕ29.0 m x h 2.0 m	4	-
Intermediate Clarifier	B10.0 m x L30.0 m x h10.0 m	20	-	ϕ11.0 m x h 10.0 m	12	8	ϕ9.5 m x h9.0 m	4	-
Trickling Filter (Second Step)	ϕ39.0 m x h 2.0 m	20	-	ϕ34.0 m x h 2.0 m	6	4	ϕ29.0 mx h 2.0 m	2	-
Final Clarifier	B10.0 m x L30.0 m x h 1.0 m	40	-	ϕ11.0 m x h 1.0 m	24	16	ϕ9.5 m x h 9.0 m	8	-
Sludge Digester Tank	ϕ17.5 m x h10.0 m	40	-	ϕ15.5 m x h 9.0 m	12	-	ϕ14.0 m x h 8.0 m	4	-
Sludge Drying Bed	W 40.0 m x L 100.0 m	20	15	W 40.0 mx L 80.0m	6	5	W 30.0 m x L 80.0 m	2	-
Anaerobic Pond (h = 3.0 m)	BA 13.0 m x 13.0 m SA 31.0 m x 31.0 m	2	1	BA 1.0 m x 1.0 m SA 19.0 m x 19.0 m	2	1	BA 1.0 m x 1.0 m SA 19.0 m x 19.0 m	1	-
Facultative Ponds (h = 2.0 m)	BA 120.0 m x 60.0 m SA 132.0 m x 72.0 m	2	1	BA 52.0 m x 26.0 m SA 64.0 m x 38.0 m	2	1	BA 20.0 m x 40.0 m SA 32.0 m x 52.0 m	1	-
DESIGN BASIS Design Flowrate	Ultimate	First Stage		Ultimate	First Stage		Ultimate	First Stage	
Daily Average, m3/d	238,000	179,000		52,700	33,000		13,300	-	
Daily Maximum, m3/d	261,000	196,000		57,500	36,000		14,500	-	
Hourly Maximum, m3/d	390,000	293,000		85,500	53,500		21,500	-	
Hourly Maximum Wet weather, m3/d	1,087,000	879,000		-	-		-	-	
Sludge Generation, t/d	90	71		20	19		5	-	

Note : BA....Bottom Area, SA....Surface Area
Source: Study Team

Fig. 12 - 14

Layout Plan for First Stage Project
(Alternative 1: Central WWTP)



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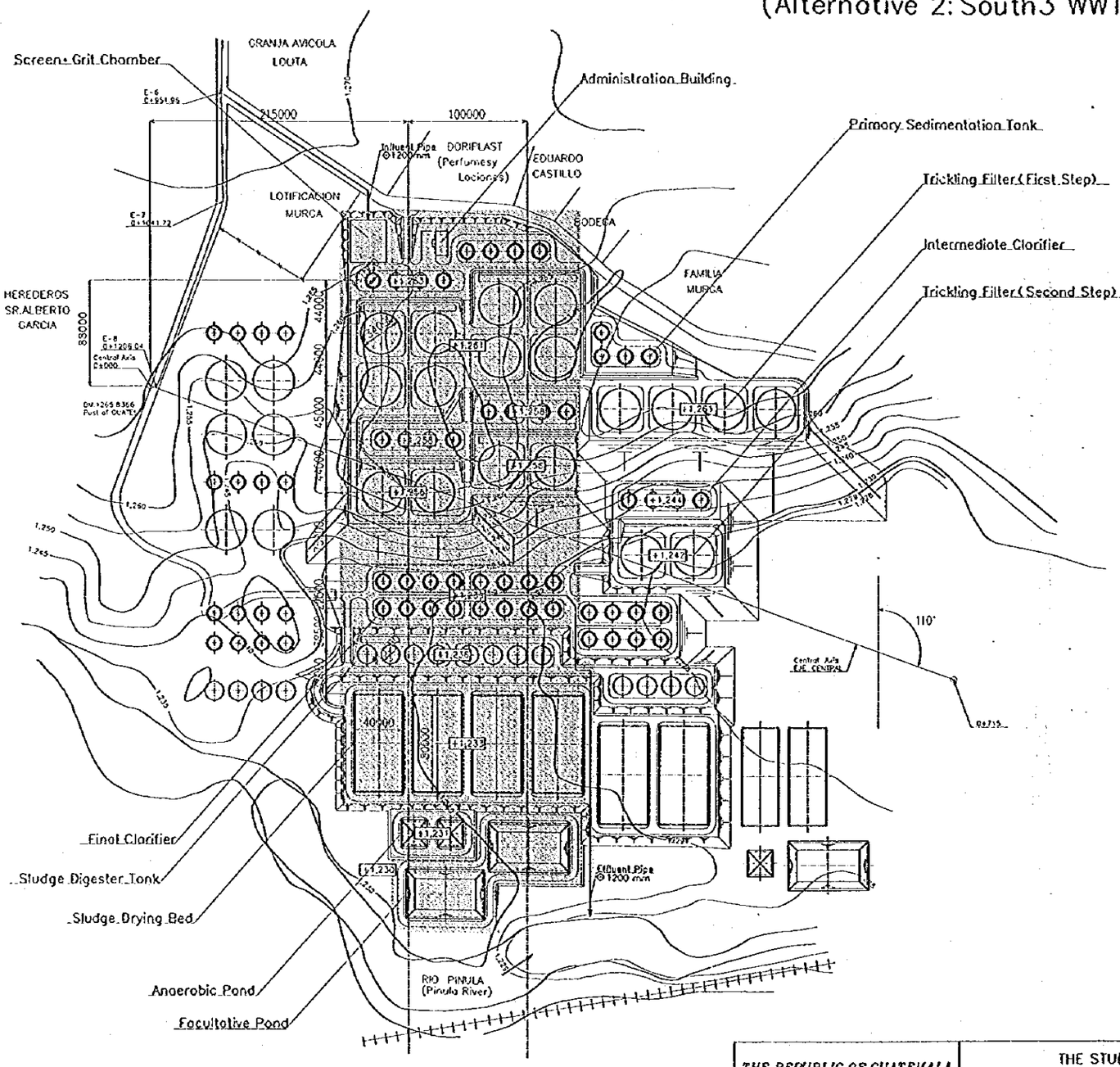
Layout Plan of Wastewater Treatment Plant
(Alternotive 2: South3 WWTP)



EST.	P.O.	RUMBO	DIST.
6	7	S 47° 17' 00" W	89.76
7	8	S 68° 35' 20" W	164.32
8	BM	S 89° 54' 00" W	13.90

EST.	P.O.	RUMBO	DIST.
E-8	Control Axis 0+000	N 21° 42' 00" W	5.94
Control Axis 0+000	Control Axis 0+715	S 21° 42' 00" E	715.00

0 100 200 m

Scale 1:4000

: FIRST STAGE

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12.3.3 Sanitation System

a) Design Flowrate

Basis of design flowrate for the Sanitation System has been described in Section 8.3.1 and population to be covered in first stage has been discussed in Section 12.2.3. Table 12-17 shows design flowrate for community plants of Sanitation System.

Table 12-17 Design Flowrates for Community Plants (Sanitation System)

Flow rate	Design Wastewater Flowrate, m^3/d			
	Central Region		South 3 Region	
	Ultimate	First Stage	Ultimate	First Stage
Daily Average	18,090	5,600	480	480
Daily Maximum	19,730	6,140	530	530
Maximum Hourly	54,260	16,790	1,440	1,440

Source : Study Team

b) Collection System

A Conventional Gravity sewerage system is proposed for collecting and transporting the wastewater to the community sanitation treatment facility. The design criteria have been already described in Section 8.3.3 and are also summarized in Supporting Report N, Volume IV.

Tables 12-18 describes length of sewer required in each settlement to be covered in first stage for Central Region and South 3 Region. Longitudinal survey for main sewer route of five sanitation settlements was conducted (Refer Supporting Report N, Volume IV) and drawings are attached in Drawings, Volume VI. Based on this information sewer network plan and vertical profile of main sewer for the typical settlements have been drawn and are shown in Supporting N, Volume IV.

Table 12-18 Length of Sewers Required for Each Settlement

S. No.	Name of Settlement	Zone	Diameter (mm)	Length (Km)
Central Region				
1	Final	14	200	3.7
2	El Pilar	14	200	11.1
3	El Cambary	14	200	1.7
4	Campo Seco	16	200	1.4
5	Finca El Carmen	6	200	1.5
6	Modrno San Antonio	6	200	1.5
7	Jocotales	6	200~250	3.8
8	Quintanal	6	200~300	5.5
9	Santa Faz	6	200	0.9
10	El Tuerto	1	200	0.9
11	Colinas I y II	1	200	1.6
12	Bethania Sec I	1	200	2.5
13	Bethania Sec II	7	200~250	3.0
14	Seis de Octubre	7	200	2.2
15	Joya I	7	200~250	3.8
16	Joya II	7	200~250	3.8
17	Joya III	7	200~250	3.8
18	La Joya IV	7	200	2.3
19	Colonia Argueta	2	200~250	5.9
20	Incienso	3	200~400	4.3
	Total			65.2
South 3 Region				
1	Loma Blanca I	12	200	2.0
2	Loma Blanca II	12	200	2.0
3	Plaza de Toros	13	200	5.6
	Total			9.6

Note : Bethania III and IV are considered as one community and is mentioned as Bethania II.

Source : Study Team

c) Sanitation Treatment System

The wastewater collected from the settlement is proposed to be treated at community plant. The sanitation treatment system consist of treatment and effluent disposal system.

Settlements to be covered by sanitation system are located on the steep slope and are closer to the valley. Limited area is available for the treatment site in these settlements. Most of the settlements have river nearby.

Further soil percolation test conducted at five locations showed that soil is predominantly clay/clayey silt. And as the proposed septic tank system is closed to the valley, possibility of underground channel of porous materials can not be ruled out as found in Bethania II (Refer Supporting Report N, Volume IV for more details)

Based on the above site conditions, treatment system consisting of septic tank with upflow anaerobic filter and effluent discharged to the river is preferred. By treating septic tank effluent through upflow anaerobic filter and then discharging into the river, possibility of contamination of ground water can be avoided. However for settlement Final and El Pilar, where Pinula river is used for water supply intake downstream, septic tank effluent is proposed to be disposed by means of soil absorption system.

Design details of community treatment plant for various settlements in Central Region and South 3 Region are described in Table 12-19. Further detailed design for typical settlements are shown in Supporting Report N, Volume IV.

Table 12-19 Details of Community Treatment Plant

S. No.	Name of Settlement	Zone	Daily Maximum Flowrate m^3/d	Septic Tank (LxWxD) m	Upflow Filter (LxWxD) m
Central Region					
1	Final	14	90	17.0x8.5x2.0	-
2	El Pilar	14	270	28.0x14.5x2.0	-
3	El Cambary	14	60	13.0x7.0x2.0	5.5x7.0x1.2
4	Campo Seco	16	220	25.5x13.0x2.0	10.5x13.0x1.2
5	Finca El Carmen	6	180	23.5x11.5x2.0	10.0x11.5x1.2
6	Modrno San Antonio	6	180	23.5x11.5x2.0	10.0x11.5x1.2
7	Jocotales	6	470	37.5x19.0x2.0	15.5x19.0x1.2
8	Quintanal	6	670	45.0x22.5x2.0	18.5x22.5x1.2
9	Santa Faz	6	110	18.5x9.0x2.0	7.5x9.0x1.2
10	El Tuerto	1	90	17.0x8.5x2.0	6.5x8.5x1.2
11	Colinas I y II	1	170	22.0x11.5x2.0	9.5x11.5x1.2
12	Bethania Sec I	1	260	28.0x14.0x2.0	11.5x14.0x1.2
13	Bethania Sec II	7	360	33.0x16.5x2.0	13.5x16.5x1.2
14	Seis de Octubre	7	270	28.0x14.5x2.0	11.5x14.5x1.2
15	Joya I	7	450	36.5x18.5x2.0	15.0x18.5x1.2
16	Joya II	7	450	36.5x18.5x2.0	15.0x18.5x1.2
17	Joya III	7	450	36.5x18.5x2.0	15.0x18.5x1.2
18	La Joya IV	7	270	28.0x14.5x2.0	11.5x14.5x1.2
19	Colonia Argueta	2	360	33.0x16.5x2.0	13.5x16.5x1.2
20	Incienso	3	760	47.5x24.0x2.0	20.0x24.0x1.2
South 3 Region					
1	Loma Blanca I	12	170	22.0x11.5x2.0	9.5x11.5x1.2
2	Loma Blanca II	12	180	23.5x11.5x2.0	10.0x11.5x1.2
3	Plaza de Toros	13	180	23.5x11.5x2.0	10.0x11.5x1.2

Note 1. Bethania III and IV are considered as one community and is mentioned as Bethania II.

Note 2. Dimensions of septic tank and upflow filter are effective dimensions.

Note 3. LxWxD = Length x Width x Depth

Source : Study Team

Septage desludged from these community plants is proposed to be treated at the sludge treatment facility of the wastewater treatment plant to be constructed in the respective region. The quantity of septage is calculated based on a sludge accumulation rate of 0.04m^3/capita/year. The quantity of septage to be desludged from each settlement in Central Region are described below in the Table 12-20.

Table 12-20 Quantity of Septage to be Desludged in the First Stage

S. No.	Name of Settlement	Zone	Septage to be desludged (m^3/year)
Central Region			
1	Final	14	20
2	El Pilar	14	60
3	El Cambary	14	12
4	Campo Seco	16	48
5	Finca El Carmen	6	40
6	Modrno San Antonio	6	40
7	Jocotales	6	104
8	Quintanal	6	148
9	Santa Faz	6	24
10	El Tuerto	1	20
11	Colinas I y II	1	36
12	Bethania Sec I	1	56
13	Bethania Sec II	7	80
14	Seis de Octubre	7	60
15	Joya I	7	100
16	Joya II	7	100
17	Joya III	7	100
18	La Joya IV	7	60
19	Colonia. Argueta	2	80
20	Incienso	3	168
	Total		1,356
South 3 Region			
1	Loma Blanca I	12	36
2	Loma Blanca II	12	40
3	Plaza de Toros	13	40
	Total		116

Source : Study Team

12.4 COST ESTIMATION

12.4.1 Total Investment Cost

The major components involved in cost estimation and method used are same as described in Section 9.3.

However, the total investment cost of sewerage and sanitation system are updated as of February 1996. Further to account for the difference in the scale of project, engineering fee for Central and South 3 Regions are assumed to be six (6) and eight (8) percent of the direct construction cost respectively.

Summary of total investment cost for Central region and South 3 region is summarized below in Table 12-21. Direct construction cost of each system, sewerage and sanitation systems are shown in Table 12-22. Details of direct construction cost and land acquisition cost are further broken down in Table O2-4 to Table O2-9 in the Supporting Report O.

Table 12-21 Summary of Total Investment Cost (Unit: Million Quetzal)

Item	Central	South 3	Total
1 Direct Construction	379.5	173.8	553.3
2 Land Acquisition	29.2	18.1	47.3
3 Engineering Fee	22.8	13.9	36.7
4 Administration Fee	11.4	5.2	16.6
5 Physical Contingency	38.0	17.4	55.4
Total	480.9	228.4	709.3

Source : Study Team

Table 12-22 Summary of Direct Construction Cost (Unit: Million Quetzal)

Item	Central	South 3	Total
1 Sewerage System	331.5	168.0	499.5
(1) Sewer Pipeline	221.1	78.2	299.3
(2) WWTP	110.4	89.8	200.2
2 Sanitation System	48.0	5.8	53.8
(1) Sewer Pipeline	33.3	4.5	37.8
(2) Community Plant	14.7	1.3	16.0
Total	379.5	173.8	553.3

Source : Study Team

12.4.2 Operation and Maintenance Costs

The operation and maintenance (O/M) costs of sewerage and sanitation system consists of annual O/M costs required for wastewater treatment plant (WWTP), community treatment plant and sewer pipeline.

The O/M costs of the former are composed of personnel expenses, disposal/transportation cost of sludge generated and repairing costs. And that of sewer pipeline is composed of personnel expenses and repairing costs. These O/M cost are estimated as of February 1996.

The conditions of O/M cost estimation, such as number of required staff, disposal/transportation cost of sludge generated and repair works of sewerage system and sanitation system, are same as described in Section 9.3.3 and 10.4.3 respectively.

The summary of required annual O/M costs for sewerage and sanitation system are mentioned below in the Table 12-23, 24. Details of O/M cost are further broken down in Table O2-10 to O2-15, in the Supporting Report O.

The basic cost data, which has been used for the cost estimation are mentioned below (see Supporting Report O).

(1) Unit Construction Cost of Sewer Pipeline Laying Works.
[Refer to Table O3-1]
(2) Other Unit Construction and Materials Costs.
[Refer to Table O3-2]
(3) Unit Land Acquisition Cost.
[Refer to Table O3-3]
(4) Unit Costs for Operation and Maintenance.
[Refer to Table O3-4]

These data were investigated by EMPAGUA and JICA Study Team from June 1995 to February 1996.

Table 12-23 Summary of Required Annual O/M Cost for Sewerage System

(Unit : Thousand Quetzal/year)

	Item	Central	South 3
1	Wastewater Treatment Plant		
-1	Personnel Cost	740	377
-2	Transportation Cost of sludge	735 ~ 871	64 ~ 150
-3	Repair Costs (0.5% of C/C)	552	449
	Sub-Total	2,027 ~ 2,163	890 ~ 976
2	Sewer Pipeline		
-1	Personnel Cost	132	346
-2	Repair Costs (0.5% of C/C)	1,106	391
	Sub-Total	1,238	737
	Total O/M Cost	3,265 ~ 3,401	1,627 ~ 1,713

Note : Refer Table O2-11,12, Supporting Report O, Volume V.

Source : Study Team

Table 12-24 Summary of Required Annual O/M Cost for Sanitation System

(Unit : Thousand Quetzal/year)

	Item	Central	South 3
1	Wastewater Treatment Plant		
-1	Personnel Cost	66	33
-2	Transportation Cost of sludge	9 ~ 43	1 ~ 4
-3	Repair Costs (0.5% of C/C)	73	6
	Sub-Total	148 ~ 182	40 ~ 43
2	Sewer Pipeline		
-1	Personnel Cost	66	33
-2	Repair Costs (0.5% of C/C)	167	23
	Sub-Total	233	56
	Total O/M Cost	381 ~ 415	96 ~ 99

Note : Refer Table O2-13, Supporting Report O, Volume V.

Source : Study Team

12.5 EVALUATION OF ALTERNATIVES

12.5.1 Summary of Alternatives

In the preceding sections, preliminary engineering designs are made for the alternatives and Table 12-25 shows the summary of the alternatives. Financial and economical evaluations are described in the following sections.

Table 12-25 Summary of Alternatives For Feasibility Study (First Stage Project)

ITEM	CENTRAL REGION	SOUTH 3 REGION
1 FACILITY DESIGN		
1.1 SEWER		
1.1.1 Collection System	Combined	Separate
1.1.2 Main Collector		
a) diameter and Length	3,000 mm x 6.9 km (Tunnel, soft) 3,000 mm x 4.1 km (Tunnel, hard) 3,000 mm x 0.08 km (Pipe Bridge, 4 locations)	1,500 mm x 10.0 km (Tunnel, soft) 1,200 mm x 1.2 km (Open Cut, soft) 300~700mm x 6.0 km (Open Cut, soft) 400~700mm x 0.12 km (Pipe Bridge, 2 Locations)
b) Total Length	11.08 km	17.32 km
1.1.3 Collector		
a) diameter and Length	-	200mm x 86.1 km (Open cut, soft)
1.2 WASTEWATER TREATMENT PLANT		
1.2.1 Treatment Capacity, m^3/d (daily maximum)**	196,000	36,000
1.2.3 Treatment Level	Primary	Secondary
1.2.4 Treatment Process	Primary Sedimentation	Trickling Filter Process
1.3 SANITATION SYSTEM		
1.3.1 Number of Colonies	20	3
1.3.2 Collector (diameter and length)	200~400mm x 65.2 km	200mm x 9.6 km
1.3.3 Treatment Capacity, m3/d (daily maximum)	6,140	530
1.3.4 Treatment Method	Septic tank with either upflow anaerobic filter or absorption well	
2 COST ESTIMATION		
2.1 Total Investment Cost, million Quetzal	480.9	228.4
2.2 Total O/M Cost, million Quetzal/year (for the year 2002)	3.65	1.73
a) sewerage, million Quetzal/year	3.27	1.63
b) sanitation, million Quetzal/year	0.38	0.10

Note : All costs are in 1996 Prices (February 1996)
** Wastewater treatment capacity provided at this stage is sufficient until the completion of the second stage.
Source : Study Team

12.5.2 Financial Evaluation

a) Charges for Sewage Services

The charge for sewage service is estimated on the basis of water service charge as surcharge, as discussed in Chapter 11. According to the present tariff, the sewage service charge is 20% of specific charge portion of potable water consumed. The typical users and the planned figures are also applied in this feasibility study. The details of these conditions are explained in Section 11.5.2.

Applying the present tariff of EMPAGUA, the expected annual revenue for the alternative plans were estimated as Table 12-26:

Table 12-26 Basic Information of Sewage Service Revenue of Alternative Plans under Present Tariff

User Category	Average Discharge (m3/Connection/ .month)	Unit Charge*1 (Q/m3)	In-flow Volume (10^6 m3/year) 2002	In-flow Volume (10^6 m3/year) 2015	Consumption Revenue (Q million/year) 2002	Consumption Revenue (Q million/year) 2015
Central Region						
Domestic*2	32	0.16	36.5	41.8	5.9	6.7
Commerce	70	0.40	17.4	19.9	6.9	7.9
Industry	200	0.50	1.7	1.7	0.9	0.9
Total	-	-	55.6	63.6	13.7	15.5
South 3 Region						
Domestic*2	32	0.16	3.6	9.5	0.6	1.5
Commerce	70	0.40	0.4	1.0	0.1	0.4
Industry	200	0.50	0.8	0.8	0.4	0.4
Total			4.8	11.3	1.1	2.3

Note: *1 Applying the present tariff of EMPAGUA
*2 Covered by sewerage system only
*3 Wastewater discharges balance between domestic and commercial establishments was assumed to be the same as the present one.

Source : Study Team

As discussed in Chapter 11, the increase of sewage service charge is indispensable for implementation of the alternatives. The range of the increase in sewage service charges would be arranged on the basis of the present tariff. The options of sewage service charges are set up in this feasibility study as follows:

1) Charge I: The sewage service charge is set up two (2) times of the present average charge, i.e., around Q20 per connection per month. This is the same option as Charge I in Chapter 11. In Central Region, a half of the charge share the maintenance work of existing sewer network conducted by EMPAGUA, and the rest half of the charges is applied for the management of the proposed project.

Then, an average monthly charge for the alternatives is as follows: Q10/connection for Central Region and Q20/connection for South 3 Region.

2) Charge II: The sewage service charge is set up as three (3) times of the present average charge, i.e., around Q30 per connection per month. This is the same option as Charge II in Chapter 11. Then, an average monthly charge for the alternatives is as follows: Q20/connection for Central Region and Q30/connection for South 3 Region.
3) Charge III: The sewage service charges is set up as four (4) times of the present average charge, i.e., around Q40 per connection per month. Then, an average monthly charge for the alternatives is as follows: Q30/connection for Central Region and Q40/connection for South 3 Region.

b) Financial Viability

The financial viability for the proposed projects are carefully examined by means of financial internal rate of return (FIRR) of gross capital. It also suggests a key issue of financial sources and some necessary measures for implementation.

Financial construction and O/M costs were estimated in Section 12.4 of this Chapter. Financial revenue was estimated as a product of wastewater volume collected and sewage service charge options. The charge options were discussed in the previous section.

Comparing the revenues with the costs, FIRRs of the respective alternatives for charge options were calculated in Table 12-27. The financial stream of revenue and expenditure for Charge II was tabulated in Table 12-28 for Central Region scheme and 12-29 for South 3 Region scheme. The streams for other charge options are listed in Supporting Report P.

Table 12-27 Financial Internal Rate of Return for Gross Capital

Region	Charge I	Charge II	Charge III
Central	-1.7%	3.5% *1	7.1%
South 3	-5.5%	-2.7% *2	-0.8%

Note: *1 Refer to Table 12-28
*2 Refer to Table 12-29
*3 Financial streams of other cases are tabulated in Supporting Report P.
Source : Study Team

FIRRs of Central Region project are calculated at -1.7%, 3.5% and 7.1% for the three charge options, respectively. Only FIRR 7.1% under Charge III is close to the rates of IBRD (7.72%) and IDB (8.1%) which were applied in the foregoing projects of EMPAGUA. In the case of Charge II, some supporting countermeasures such as grant

would be necessary for EMPAGUA to manage the project with financially sound, because FIRR is less than the interest rates of the financial sources.

FIRRs of South 3 Region project are negative for all sewage service charge options. Therefore, even if a low interest foreign loan was applied to the proposed project, it could be difficult to manage the project financially sound without any financial support from the government.

Table 12-28 Financial Expenditure and Revenue Stream: Central Region

In Case of Charge II

(Unit:Q million)

Serial No.	Year	Expenditure			Revenue			Balance
		Construction	O/M	Total	Domestic	Industry	Total	
1	1998	9.1	0.0	9.1	0.0	0.0	0.0	-9.1
2	1999	172.1	0.0	172.1	0.0	0.0	0.0	-172.1
3	2000	149.8	0.0	149.8	0.0	0.0	0.0	-149.8
4	2001	149.8	0.0	149.8	0.0	0.0	0.0	-149.8
5	2002		3.6	3.6	25.7	1.7	27.5	23.8
6	2003		3.7	3.7	26.6	1.7	28.3	24.6
7	2004		3.7	3.7	27.5	1.7	29.2	25.5
8	2005		3.8	3.8	28.4	1.7	30.1	26.3
9	2006		3.8	3.8	28.7	1.7	30.5	26.7
10	2007		3.8	3.8	28.9	1.7	30.6	26.9
11	2008		3.8	3.8	29.1	1.7	30.9	27.1
12	2009		3.8	3.8	29.3	1.7	31.0	27.3
13	2010		3.8	3.8	29.5	1.7	31.3	27.5
14	2011		3.8	3.8	29.6	1.7	31.3	27.5
15	2012		3.8	3.8	29.7	1.7	31.4	27.6
16	2013		2.7	2.7	29.8	1.7	31.5	28.8
17	2014		3.8	3.8	30.0	1.7	31.7	27.9
18	2015		3.8	3.8	30.0	1.7	31.7	27.9
19	2016		3.8	3.8	30.0	1.7	31.7	27.9
20	2017		3.8	3.8	30.0	1.7	31.7	27.9
21	2018		3.8	3.8	30.0	1.7	31.7	27.9
22	2019		3.8	3.8	30.0	1.7	31.7	27.9
23	2020		3.8	3.8	30.0	1.7	31.7	27.9
24	2021		3.8	3.8	30.0	1.7	31.7	27.9
25	2022		3.8	3.8	30.0	1.7	31.7	27.9
26	2023		3.8	3.8	30.0	1.7	31.7	27.9
27	2024		3.8	3.8	30.0	1.7	31.7	27.9
28	2025		3.8	3.8	30.0	1.7	31.7	27.9
29	2026		3.8	3.8	30.0	1.7	31.7	27.9
30	2027		3.8	3.8	30.0	1.7	31.7	27.9
31	2028		3.8	3.8	30.0	1.7	31.7	27.9
32	2029		3.8	3.8	30.0	1.7	31.7	27.9
33	2030		3.8	3.8	30.0	1.7	31.7	27.9
34	2031		3.8	3.8	30.0	1.7	31.7	27.9

FIRR: 3.5%

Table 12-29 Financial Expenditure and Revenue Stream: South 3 Region

In Case of Charge II

(Unit:Q million)

Serial No.	Year	Expenditure			Revenue			Balance
		Construction	O/M	Total	Domestic	Industry	Total	
1	1998	5.6	0.0	5.6	0.0	0.0	0.0	-5.6
2	1999	86.3	0.0	86.3	0.0	0.0	0.0	-86.3
3	2000	68.2	0.0	68.2	0.0	0.0	0.0	-68.2
4	2001	68.2	0.0	68.2	0.0	0.0	0.0	-68.2
5	2002		1.7	1.7	2.2	1.2	3.4	1.7
6	2003		1.7	1.7	2.4	1.2	3.6	1.9
7	2004		1.7	1.7	2.9	1.2	4.2	2.4
8	2005		1.8	1.8	3.5	1.2	4.7	3.0
9	2006		1.8	1.8	4.1	1.2	5.3	3.6
10	2007		1.8	1.8	4.3	1.2	5.5	3.7
11	2008		1.8	1.8	4.4	1.2	5.6	3.8
12	2009		1.8	1.8	4.6	1.2	5.8	4.0
13	2010		1.8	1.8	4.7	1.2	6.0	4.2
14	2011		1.8	1.8	4.9	1.2	6.1	4.4
15	2012		1.8	1.8	5.1	1.2	6.3	4.6
16	2013		1.8	1.8	5.3	1.2	6.6	4.8
17	2014		1.8	1.8	5.6	1.2	6.8	5.0
18	2015		1.8	1.8	5.8	1.2	7.0	5.2
19	2016		1.8	1.8	5.8	1.2	7.0	5.2
20	2017		1.8	1.8	5.8	1.2	7.0	5.2
21	2018		1.8	1.8	5.8	1.2	7.0	5.2
22	2019		1.8	1.8	5.8	1.2	7.0	5.2
23	2020		1.8	1.8	5.8	1.2	7.0	5.2
24	2021		1.8	1.8	5.8	1.2	7.0	5.2
25	2022		1.8	1.8	5.8	1.2	7.0	5.2
26	2023		1.8	1.8	5.8	1.2	7.0	5.2
27	2024		1.8	1.8	5.8	1.2	7.0	5.2
28	2025		1.8	1.8	5.8	1.2	7.0	5.2
29	2026		1.8	1.8	5.8	1.2	7.0	5.2
30	2027		1.8	1.8	5.8	1.2	7.0	5.2
31	2028		1.8	1.8	5.8	1.2	7.0	5.2
32	2029		1.8	1.8	5.8	1.2	7.0	5.2
33	2030		1.8	1.8	5.8	1.2	7.0	5.2
34	2031		1.8	1.8	5.8	1.2	7.0	5.2

FIRR: -2.7%

c) Financial Analysis

1) Financial Source for Capital Investment

Referring to the past experience, the following financial sources were expected for implementation of the projects. Although the terms of loans are not always steady the followings are assumed.

(1) Loan 1: interest rate of 8.1% per annum and repayment period of 20 years including grace period of 5 years.
(2) Loan 2: interest rate of 2.5% per annum and repayment period of 30 years including grace period 10 years.

2) Financial Analysis of Alternatives

Before analyzing financial balance, integrated cases are set up on the basis of key factors such as financial sources, charges and their combination.

(1) There are two financial source options mentioned above.
(2) There are three charge options: (i) Charge I; (ii) Charge II; and (iii) Charge III.
(3) There are four options of financial source combination: (i) 100% capital covered by loans, named as "combination a"; (ii) 90% by loans and 10% by grant, "combination b"; (iii) 80% by loans and 20% by grant, "combination c"; and (iv) 70% by loans and 30% by grant, "combination d".
(4) Finally, "Integrated cases 1 and 2" are represented for Central Region project procuring the respective basic financial sources of Loan 1 and 2. "Integrated cases 3 and 4" are represented for South 3 Region project procuring the basic financial sources of Loan 1 and 2, respectively.

For instance, Case 3-IIc means that the first digit indicates the integrated case 3, i.e., for South 3 Region procuring the financial source of loan 1; the second character "II" indicates the charge II; and the final "c" indicates "combination c" of financial sources.

FIRRs of net capital were calculated to examine financial viability of financial source combination. Hence, net capital which is invested by an undertaker is identified as total investment costs minus grant. Table 12-30 shows FIRRs of Central Region project for the respective financial source combination. According to the table, FIRR of Case IId (Charge II and 70% of the initial cost as net capital) is calculated at 6.3%, which is smaller than the interest rates of IBRD and IDB. Thus, even if the undertaker gets a grant amounting to 30% of the investment cost, the project might not be feasible under the financial procurement of the loan 1, from the financial point of view.

Table 12-30 FIRRs for Net Capital: Central Region

Financial Combination			Charge Option		
	Loan	Grant	Charge I	Charge II	Charge III
Combination a	100%	0%	-1.7%	3.5%	7.1%
Combination b	90%	10%	-1.1%	4.3%	8.1%
Combination c	80%	20%	-0.5%	5.2%	9.2%
Combination d	70%	30%	0.3%	6.3%	10.6%

Cash Balance Accumulated by End of Economic Life: Central Region

(Unit: Q million)

	Financial Combination		Charge I	Charge II	Charge III
	Loan	Grant			
Integrated Case 1					
Loan 1			**Case 1-I**	**Case 1-II**	**Case 1-III**
Combination a	100%	0%	-519	-51*1	416
Combination b	90%	10%	-480	-12*1	455
Combination c	80%	20%	-440	27*1	495
Combination d	70%	30%	-401	66*1	534
Integrated Case 2					
Loan 2			**Case 2-I**	**Case 2-II**	**Case 2-III**
Combination a	100%	0%	-350	118	585
Combination b	90%	10%	-279	188	656
Combination c	80%	20%	-209	259	726
Combination d	70%	30%	-138	329	797

Note: *1 Financial streams of these cases are tabulated in Table P-13 to 16 of Supporting Report P.
Source : Study Team

Needless to say, if the loan 2 was procured instead of the loan 1, the project would be feasible because the FIRR value is higher than the interest rate of loan 2.

The lower part in Table 12-30 shows the financial balance accumulated by the end of economic life for the respective cases. For instance, an accumulated balance of Case 1-IId and Case 2-IId is estimated at Q66 million and Q329 million, respectively. This means the project would get a surplus expected at the end of project life, in case that the project is managed without any problems on working funds.

Table 12-31 shows FIRRs of South 3 Region project. As seen in the table, FIRR of Case IId is negative, -0.9% and FIRR of Case IIId is calculated at 1.2%, which are lower than the interest rate of the loan 2. Thus, even if the undertaker gets a grant amounting to 30% of the investment cost and the loan 2, the project might not be feasible from the financial point of view. Therefore, drastic countermeasures should be taken in order to implement the

project. For instance, some parts of current expenditure and interest of loans must be subsidized by the governments and the beneficiaries.

The lower part in Table 12-31 also shows accumulated financial balance at the end of project life for respective cases. For instance, an accumulated balance of Case 4-IId and Case 4-IIId is estimated at -Q99 million and -Q35 million, respectively. This means that the project still gets a deficit at the end of project life even if the project is managed properly. As mentioned above, unless drastic financial countermeasures are applied for management of the proposed project, the implementation of the project be difficult from the financial view point.

Table 12-31 FIRR for Net Capital: South 3 Region

	Financial Combination		Charge I	Charge II	Charge III
	Loan	Grant			
Combination a	100%	0%	-5.5%	-2.7%	-0.8%
Combination b	90%	10%	-5.1%	-2.2%	-0.2%
Combination c	80%	20%	-4.6%	-1.6%	0.5%
Combination d	70%	30%	-3.9%	-0.9%	1.2%

Accumulated Cash Balance at End of Economic Life: South 3 Region

(Unit: Q million)

	Financial Combination		Charge I	Charge II	Charge III
	Loan	Grant			
Integrated Case 3					
Loan 1			**Case 3-I**	**Case 3-II**	**Case 3-III**
Combination a	100%	0%	-344	-281	-217
Combination b	90%	10%	-325	-262	-199
Combination c	80%	20%	-306	-243	-180
Combination d	70%	30%	-288	-224	-161
Integrated Case 4					
Loan 2			**Case 4-I**	**Case 4-II**	**Case 4-III**
Combination a	100%	0%	-263	-200*2	-136
Combination b	90%	10%	-229	-166*2	-103
Combination c	80%	20%	-196	-133*2	-69
Combination d	70%	30%	-162	-99*2	-36

Note: *1 Financial streams of these cases are tabulated in Table P-17 to 20 of Supporting Report P.
Source : Study Team

d) Financial Evaluation

In Central Region, FIRR of net capital was 6.3% in the case of the Charge II and the source combination d, as mentioned before. In the case that the financial source of loan 1 is applied for implementation, the project could not be feasible without some countermeasures for improvement of management circumstances. Table 12-32 shows the financial stream of this case. As a countermeasure, 100% of interest subsidy for long-term loan is applied for current revenue. In spite of that, a financial deficit of -Q89 million is expected at the end of

project life. During the period of loan repayment, the revenue balance is smaller than the capital balance. To get rid of the red cash balance, the undertaker has to procure a working fund. An interest rate of this fund is assumed at 10% per annum in this study, although the rate is lower than the actual market rate of 25% to 30%. This procurement activity bears interest of working fund in current expenditure. The accumulation of this interest seems to become heavy burden for the management. Finally, the undertaker results in having the financial deficit.

Yet, once the loan 2 was applied instead of the loan 1, the project would be viable from the financial view point. Table 12-33 shows the financial stream of this case. However, even in this case, the undertaker has to procure a working fund. The accumulation of this fund's interest seems to become heavy burden for the management. Then to mitigate this burden, 20% of interest subsidy for long-term loan must be applied for current revenue. Finally, the undertaker results in having the financial small surplus of Q7.8 million at the end of project life.

In summary, the key issues for sound management of the Central Region project is whether or not the following supposition is available: (i) loan for 70% of the total investment cost from the loan 2; (ii) grant for 30% of the total investment cost; (iii) subsidy to cover 20% of the loan interest; and (iv) application of Charge II.

Table 12-32 Financial Stream of Income and Expenditure: Central Region

Case 1-IId: Charge II with Financial Sources of both 70% of Loan 1 and 30% of Donantion

(Unit: Q Million)

Serial No.	Year	Capital Balance: Revenue: Foreign Loan*4	Capital Balance: Revenue: Donation (30%)	Capital Balance: Revenue: Total	Capital Balance: Expenditure: Construction Cost	Capital Balance: Expenditure: Repayment of Principal	Capital Balance: Expenditure: Total	Capital Balance: Balance	Revenue Balance: Revenue: Domestic Sewage	Revenue: Industry Sewage	Revenue: Subsidy	Revenue: Total	Expenditure: O/M Expenses	Expenditure: Depreciation*2	Expenditure: Interest of Loan	Expenditure: Interest of W/F	Expenditure: Total	Balance	Working Fund (W/F)*3: Procurement	Working Fund (W/F)*3: Repayment	Cash Balance *1	Balance Carried Forward
1	1998	6.4	2.7	9.1	9.1	0.0	9.1	0.0	0.0	0.0	1.9	1.9	0.0	0.0	1.9	0.0	1.9	0.0	0.0	0.0	0.0	0.0
2	1999	120.5	51.6	172.1	172.1	0.0	172.1	0.0	0.0	0.0	11.7	11.7	0.0	0.0	11.7	0.0	11.7	0.0	0.0	0.0	0.0	0.0
3	2000	104.9	45.0	149.8	149.8	0.0	149.8	0.0	0.0	0.0	43.1	43.1	0.0	0.0	43.1	0.0	43.1	0.0	0.0	0.0	0.0	0.0
4	2001	104.9	45.0	149.8	149.8	0.0	149.8	0.0	0.0	0.0	74.6	74.6	0.0	0.0	74.6	0.0	74.6	0.0	0.0	0.0	0.0	0.0
5	2002					0.0	0.0	0.0	25.7	1.7	74.6	102.1	3.6	10.1	74.6	0.0	88.3	13.7	0.0	0.0	13.7	13.7
6	2003					22.4	22.4	-22.4	26.6	1.7	25.4	53.8	3.7	10.1	25.4	0.0	39.2	14.5	0.0	0.0	-7.9	5.8
7	2004					22.4	22.4	-22.4	27.5	1.7	23.6	52.8	3.7	10.1	23.6	0.1	37.6	15.3	1.4	0.0	-5.8	0.0
8	2005					22.4	22.4	-22.4	28.4	1.7	21.8	51.9	3.8	10.1	21.8	0.8	36.5	15.4	8.4	1.4	0.0	0.0
9	2006					22.4	22.4	-22.4	28.7	1.7	20.0	50.5	3.8	10.1	20.0	1.6	35.5	15.0	15.9	8.4	0.0	0.0
10	2007					22.4	22.4	-22.4	28.9	1.7	18.2	48.8	3.8	10.1	18.2	2.4	34.5	14.4	23.9	15.9	-0.1	0.0
11	2008					22.4	22.4	-22.4	29.1	1.7	16.4	47.2	3.8	10.1	16.4	3.3	33.5	13.7	32.7	23.9	0.1	0.0
12	2009					22.4	22.4	-22.4	29.3	1.7	14.5	45.6	3.8	10.1	14.5	4.2	32.7	12.9	42.2	32.7	0.0	0.0
13	2010					22.4	22.4	-22.4	29.5	1.7	12.7	44.0	3.8	10.1	12.7	5.3	31.9	12.1	52.5	42.2	0.0	0.0
14	2011					22.4	22.4	-22.4	29.6	1.7	10.9	42.2	3.8	10.1	10.9	6.4	31.2	11.0	63.9	52.5	0.0	0.0
15	2012					22.4	22.4	-22.4	29.7	1.7	9.1	40.5	3.8	10.1	9.1	7.7	30.6	9.9	76.5	63.9	0.0	0.0
16	2013					22.4	22.4	-22.4	29.8	1.7	7.3	38.8	2.7	10.1	7.3	8.9	29.0	9.8	89.1	76.5	0.0	0.0
17	2014					22.4	22.4	-22.4	30.0	1.7	5.5	37.2	3.8	10.1	5.5	10.4	29.8	7.4	104.1	89.1	0.0	0.0
18	2015					22.4	22.4	-22.4	30.0	1.7	3.6	35.4	3.8	10.1	3.6	12.1	29.6	5.7	120.8	104.1	0.0	0.0
19	2016					22.4	22.4	-22.4	30.0	1.7	1.8	33.6	3.8	10.1	1.8	13.9	29.7	3.9	139.3	120.8	0.0	0.0
20	2017					22.4	22.4	-22.4	30.0	1.7	0.0	31.7	3.8	10.1	0.0	16.0	29.9	1.8	160.0	139.3	0.1	0.0
21	2018					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	15.8	29.7	2.0	157.9	160.0	-0.1	0.0
22	2019					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	15.6	29.5	2.3	155.7	157.9	0.1	0.0
23	2020					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	15.3	29.2	2.5	153.1	155.7	-0.1	0.0
24	2021					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	15.0	29.0	2.8	150.4	153.1	0.1	0.0
25	2022					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	14.7	28.6	3.1	147.3	150.4	0.0	0.0
26	2023					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	14.4	28.3	3.4	143.8	147.3	-0.1	0.0
27	2024					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	14.0	27.9	3.8	140.0	143.8	0.0	0.0
28	2025					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	13.6	27.5	4.2	135.8	140.0	0.0	0.0
29	2026					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	13.1	27.0	4.7	131.0	135.8	-0.1	0.0
30	2027					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	12.6	26.5	5.2	125.8	131.0	0.0	0.0
31	2028					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	12.0	25.9	5.8	120.0	125.8	0.0	0.0
32	2029					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	11.4	25.3	6.5	113.5	120.0	0.0	0.0
33	2030					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	10.6	24.5	7.2	106.3	113.5	0.0	0.0
34	2031					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	0.0	13.9	17.8	0.0	106.3	-88.5	-88.5
	Total	336.6	144.3	480.9	480.9	336.6	817.5		883.5	51.5	396.8	1,331.8	112.8	302.9	396.8	271.1	1,083.6					

Note: *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 30 years depreciation

*3 Interest rate of working fund: 10% p.a.

*4 Terms of Source Alternative 1 Interest: 8.1% p.a.

Repayment Period: 20 years (including 5 years of grace period)

Table 12-33 Financial Stream of Income and Expenditure: Central Region

Case 2-IId: Charge II with Financial Sources of both 70% of Loan 2 and 30% of Donantion

(Unit: Q Million)

Serial No.	Year	Capital Balance							Revenue Balance										Working Fund (W/F)*3		Cash Balance *1	Balance Carried Forward
		Revenue			Expenditure			Balance	Revenue				Expenditure					Balance	Procure-ment	Repay-ment		
		Foreign Loan*4	Donation (30%)	Total	Construc-tion Cost	Repayment of Principal	Total		Domestic Sewage	Industry Sewage	Subsidy	Total	O/M Expenses	Depreci-ation*2	Interest of Loan	Interest of W/F	Total					
1	1998	6.4	2.7	9.1	9.1	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	-0.1	0.1	0.0	0.0	0.0
2	1999	120.5	51.6	172.1	172.1	0.0	172.1	0.0	0.0	0.0	0.6	0.6	0.0	0.0	3.2	0.3	3.5	-2.8	3.0	0.1	0.0	0.0
3	2000	104.9	45.0	149.8	149.8	0.0	149.8	0.0	0.0	0.0	1.2	1.2	0.0	0.0	5.8	0.9	6.6	-5.5	8.5	3.0	0.0	0.0
4	2001	104.9	45.0	149.8	149.8	0.0	149.8	0.0	0.0	0.0	1.7	1.7	0.0	0.0	8.4	1.7	10.1	-8.4	16.9	8.5	0.0	0.0
5	2002					0.0	0.0	0.0	25.7	1.7	1.7	29.1	3.6	10.1	8.4	1.1	23.3	5.9	11.0	16.9	0.0	0.0
6	2003					0.0	0.0	0.0	26.6	1.7	1.7	30.0	3.7	10.1	8.4	0.4	22.6	7.4	3.6	11.0	0.0	0.0
7	2004					0.0	0.0	0.0	27.5	1.7	1.7	30.9	3.7	10.1	8.4	0.0	22.2	8.7	0.0	3.6	5.1	5.1
8	2005					0.0	0.0	0.0	28.4	1.7	1.7	31.8	3.8	10.1	8.4	0.0	22.3	9.5	0.0	0.0	9.5	14.6
9	2006					0.0	0.0	0.0	28.7	1.7	1.7	32.1	3.8	10.1	8.4	0.0	22.3	9.8	0.0	0.0	9.8	24.5
10	2007					0.0	0.0	0.0	28.9	1.7	1.7	32.3	3.8	10.1	8.4	0.0	22.3	10.0	0.0	0.0	10.0	34.5
11	2008					16.8	16.8	-16.8	29.1	1.7	1.7	32.5	3.8	10.1	8.4	0.0	22.3	10.2	0.0	0.0	-6.6	27.9
12	2009					16.8	16.8	-16.8	29.3	1.7	1.6	32.6	3.8	10.1	8.0	0.0	21.9	10.8	0.0	0.0	-6.1	21.8
13	2010					16.8	16.8	-16.8	29.5	1.7	1.5	32.8	3.8	10.1	7.6	0.0	21.5	11.3	0.0	0.0	-5.5	16.3
14	2011					16.8	16.8	-16.8	29.6	1.7	1.4	32.8	3.8	10.1	7.2	0.0	21.1	11.7	0.0	0.0	-5.1	11.2
15	2012					16.8	16.8	-16.8	29.7	1.7	1.3	32.8	3.8	10.1	6.7	0.0	20.6	12.2	0.0	0.0	-4.7	6.5
16	2013					16.8	16.8	-16.8	29.8	1.7	1.3	32.8	2.7	10.1	6.3	0.0	19.1	13.7	0.0	0.0	-3.1	3.4
17	2014					16.8	16.8	-16.8	30.0	1.7	1.2	32.9	3.8	10.1	5.9	0.0	19.8	13.1	0.4	0.0	-3.4	0.0
18	2015					16.8	16.8	-16.8	30.0	1.7	1.1	32.8	3.8	10.1	5.5	0.4	19.8	13.0	4.2	0.4	0.0	0.0
19	2016					16.8	16.8	-16.8	30.0	1.7	1.0	32.7	3.8	10.1	5.0	0.8	19.8	13.0	8.0	4.2	0.0	0.0
20	2017					16.8	16.8	-16.8	30.0	1.7	0.9	32.7	3.8	10.1	4.6	1.2	19.7	12.9	12.0	8.0	0.1	0.0
21	2018					16.8	16.8	-16.8	30.0	1.7	0.8	32.6	3.8	10.1	4.2	1.6	19.7	12.9	15.9	12.0	-0.1	0.0
22	2019					16.8	16.8	-16.8	30.0	1.7	0.8	32.5	3.8	10.1	3.8	2.0	19.7	12.8	19.9	15.9	0.0	0.0
23	2020					16.8	16.8	-16.8	30.0	1.7	0.7	32.4	3.8	10.1	3.4	2.4	19.7	12.7	24.0	19.9	0.0	0.0
24	2021					16.8	16.8	-16.8	30.0	1.7	0.6	32.3	3.8	10.1	2.9	2.8	19.7	12.6	28.2	24.0	0.0	0.0
25	2022					16.8	16.8	-16.8	30.0	1.7	0.5	32.2	3.8	10.1	2.5	3.3	19.7	12.6	32.5	28.2	0.0	0.0
26	2023					16.8	16.8	-16.8	30.0	1.7	0.4	32.2	3.8	10.1	2.1	3.7	19.7	12.5	36.9	32.5	0.0	0.0
27	2024					16.8	16.8	-16.8	30.0	1.7	0.3	32.1	3.8	10.1	1.7	4.1	19.7	12.3	41.4	36.9	0.0	0.0
28	2025					16.8	16.8	-16.8	30.0	1.7	0.3	32.0	3.8	10.1	1.3	4.6	19.8	12.2	46.0	41.4	0.0	0.0
29	2026					16.8	16.8	-16.8	30.0	1.7	0.2	31.9	3.8	10.1	0.8	5.1	19.8	12.1	50.7	46.0	0.0	0.0
30	2027					16.8	16.8	-16.8	30.0	1.7	0.1	31.8	3.8	10.1	0.4	5.6	19.9	11.9	55.6	50.7	0.0	0.0
31	2028					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	4.2	18.1	13.6	42.0	55.6	0.0	0.0
32	2029					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	2.7	16.6	15.1	26.9	42.0	0.0	0.0
33	2030					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	1.0	14.9	16.8	10.0	26.9	-0.1	0.0
34	2031					0.0	0.0	0.0	30.0	1.7	0.0	31.7	3.8	10.1	0.0	0.0	13.9	17.8	0.0	10.0	7.8	7.8
	Total	336.6	144.3	480.9	480.9	336.6	817.5		883.5	51.5	31.3	966.3	112.8	302.9	156.4	49.8	621.9					

Note: *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 30 years depreciation

*3 Interest rate of working fund: 10% p.a.

*4 Terms of Source Alternative 2 Interest: 2.5% p.a.

Repayment Period: 30 years (including 10 years of grace period)

The project proposed for South 3 Region is more difficult than that for Central Region, from the financial point of view. The total investment cost of the project amounted to Q228 million. The O/M cost for the project life is aggregated to Q54 million. Then, the total cost is accumulated to Q282 million. On the other hand, in the case that Charge II is applied to the revenue of the undertaker, the total revenue is aggregated to Q189 million for the project life consisting of Q152 million of domestic services and Q37 million of industrial services. Thus, the total revenue is Q93 million smaller than the total investment cost. This Q93 million was almost equal to 40% of the initial investment cost. Moreover, to cover the interests of not only long-term loan but also short-term debt subsidy should be applied for current revenue. However, even if the project was implemented under this conditions, i.e., Case 4-IId with subsidy covering interests, the undertaker would result in having heavy deficit of Q25 million at the end of project life as shown in Table 12-34.

Table 12-35 shows the financial stream of Case 4-IIId, that is, Charge III with financial sources of both 70% by loan 2, 30% by grant, and subsidy to cover 20% of the loan interest was applied to mitigate the financial burden. In this case, the undertaker would result in having small deficit of Q1 million at the end of project life as shown in the table. It could be feasible from the financial point of view.

In summary, the following countermeasures are indispensable to implement the project in South 3 Region.

(1) loan for 70% of the total investment cost from the loan 2.
(2) grant for 30% of the total investment cost.
(3) subsidy to cover 20% of the loan interest.
(4) application of Charge III.

Table 12-34 Financial Stream of Income and Expenditure: South 3 Region

Case 4-IId: Charge II with Financial Sources of both 70% of Loan 2 and 30% of Donation

(Unit: ¥ Million)

Serial No.	Year	Capital Balance: Revenue: Foreign Loan*4	Capital Balance: Revenue: Donation (30%)	Capital Balance: Revenue: Total	Capital Balance: Expenditure: Construction Cost	Capital Balance: Expenditure: Repayment of Principal	Capital Balance: Expenditure: Total	Capital Balance: Balance	Revenue Balance: Revenue: Domestic Sewage	Revenue: Industry Sewage	Revenue: Subsidy for Loan	Revenue: Subsidy for W/F	Revenue: Total	Expenditure: O/M Expenses	Expenditure: Depreciation*2	Expenditure: Interest of Loan	Expenditure: Interest of W/F	Expenditure: Total	Revenue Balance: Balance	Working Fund (W/F)*3: Procurement	Working Fund (W/F)*3: Repayment	Cash Balance *1	Balance Carried Forward
1	1998	3.9	1.7	5.6	5.6	0.0	5.6	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2	1999	60.4	25.9	86.3	86.3	0.0	86.3	0.0	0.0	0.0	1.6	0.0	1.6	0.0	0.0	1.6	0.0	1.6	0.0	0.0	0.0	0.0	0.0
3	2000	47.8	20.5	68.2	68.2	0.0	68.2	0.0	0.0	0.0	2.8	0.0	2.8	0.0	0.0	2.8	0.0	2.8	0.0	0.0	0.0	0.0	0.0
4	2001	47.8	20.5	68.2	68.2	0.0	68.2	0.0	0.0	0.0	4.0	0.0	4.0	0.0	0.0	4.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0
5	2002					0.0	0.0	0.0	2.2	1.2	4.0	0.0	7.4	1.7	4.8	4.0	0.0	10.5	-3.1	0.0	0.0	1.7	1.7
6	2003					0.0	0.0	0.0	2.4	1.2	4.0	0.0	7.6	1.7	4.8	4.0	0.0	10.5	-2.9	0.0	0.0	1.9	3.6
7	2004					0.0	0.0	0.0	2.9	1.2	4.0	0.0	8.2	1.7	4.8	4.0	0.0	10.5	-2.4	0.0	0.0	2.4	6.0
8	2005					0.0	0.0	0.0	3.5	1.2	4.0	0.0	8.7	1.8	4.8	4.0	0.0	10.6	-1.8	0.0	0.0	3.0	9.0
9	2006					0.0	0.0	0.0	4.1	1.2	4.0	0.0	9.3	1.8	4.8	4.0	0.0	10.6	-1.2	0.0	0.0	3.6	12.5
10	2007					0.0	0.0	0.0	4.3	1.2	4.0	0.0	9.5	1.8	4.8	4.0	0.0	10.6	-1.1	0.0	0.0	3.7	16.2
11	2008					8.0	8.0	-8.0	4.4	1.2	4.0	0.0	9.6	1.8	4.8	4.0	0.0	10.6	-1.0	0.0	0.0	-4.1	12.1
12	2009					8.0	8.0	-8.0	4.6	1.2	3.8	0.0	9.6	1.8	4.8	3.8	0.0	10.4	-0.8	0.0	0.0	-4.0	8.1
13	2010					8.0	8.0	-8.0	4.7	1.2	3.6	0.0	9.6	1.8	4.8	3.6	0.0	10.2	-0.6	0.0	0.0	-3.8	4.3
14	2011					8.0	8.0	-8.0	4.9	1.2	3.4	0.0	9.5	1.8	4.8	3.4	0.0	10.0	-0.4	0.0	0.0	-3.6	0.6
15	2012					8.0	8.0	-8.0	5.1	1.2	3.2	0.3	9.8	1.8	4.8	3.2	0.3	10.1	-0.2	2.8	0.0	-0.6	0.0
16	2013					8.0	8.0	-8.0	5.3	1.2	3.0	0.6	10.2	1.8	4.8	3.0	0.6	10.2	0.0	6.1	2.8	0.1	0.0
17	2014					8.0	8.0	-8.0	5.6	1.2	2.8	0.9	10.5	1.8	4.8	2.8	0.9	10.3	0.2	9.1	6.1	0.0	0.0
18	2015					8.0	8.0	-8.0	5.8	1.2	2.6	1.2	10.8	1.8	4.8	2.6	1.2	10.4	0.4	11.9	9.1	0.0	0.0
19	2016					8.0	8.0	-8.0	5.8	1.2	2.4	1.5	10.9	1.8	4.8	2.4	1.5	10.5	0.4	14.7	11.9	0.0	0.0
20	2017					8.0	8.0	-8.0	5.8	1.2	2.2	1.8	11.0	1.8	4.8	2.2	1.8	10.6	0.4	17.5	14.7	0.0	0.0
21	2018					8.0	8.0	-8.0	5.8	1.2	2.0	2.0	11.0	1.8	4.8	2.0	2.0	10.6	0.4	20.3	17.5	0.0	0.0
22	2019					8.0	8.0	-8.0	5.8	1.2	1.8	2.3	11.1	1.8	4.8	1.8	2.3	10.7	0.4	23.1	20.3	0.0	0.0
23	2020					8.0	8.0	-8.0	5.8	1.2	1.6	2.6	11.2	1.8	4.8	1.6	2.6	10.8	0.4	25.9	23.1	0.0	0.0
24	2021					8.0	8.0	-8.0	5.8	1.2	1.4	2.9	11.3	1.8	4.8	1.4	2.9	10.9	0.4	28.7	25.9	0.0	0.0
25	2022					8.0	8.0	-8.0	5.8	1.2	1.2	3.2	11.4	1.8	4.8	1.2	3.2	11.0	0.4	31.5	28.7	0.0	0.0
26	2023					8.0	8.0	-8.0	5.8	1.2	1.0	3.4	11.4	1.8	4.8	1.0	3.4	11.0	0.4	34.3	31.5	0.0	0.0
27	2024					8.0	8.0	-8.0	5.8	1.2	0.8	3.7	11.5	1.8	4.8	0.8	3.7	11.1	0.4	37.1	34.3	0.0	0.0
28	2025					8.0	8.0	-8.0	5.8	1.2	0.6	4.0	11.6	1.8	4.8	0.6	4.0	11.2	0.4	39.9	37.1	0.0	0.0
29	2026					8.0	8.0	-8.0	5.8	1.2	0.4	4.3	11.7	1.8	4.8	0.4	4.3	11.3	0.4	42.7	39.9	0.0	0.0
30	2027					8.0	8.0	-8.0	5.8	1.2	0.2	4.6	11.8	1.8	4.8	0.2	4.6	11.4	0.4	45.5	42.7	0.0	0.0
31	2028					0.0	0.0	0.0	5.8	1.2	0.0	4.0	11.0	1.8	4.8	0.0	4.0	10.6	0.4	40.3	45.5	0.0	0.0
32	2029					0.0	0.0	0.0	5.8	1.2	0.0	3.5	10.5	1.8	4.8	0.0	3.5	10.1	0.4	35.1	40.3	0.0	0.0
33	2030					0.0	0.0	0.0	5.8	1.2	0.0	3.0	10.0	1.8	4.8	0.0	3.0	9.6	0.4	29.9	35.1	0.0	0.0
34	2031					0.0	0.0	0.0	5.8	1.2	0.0	0.0	7.0	1.8	4.8	0.0	0.0	6.6	0.4	0.0	29.9	-24.7	-24.7
	Total	159.9	68.5	228.4	228.4	159.9	388.3		152.4	36.6	74.5	49.6	313.1	53.8	143.9	74.5	49.6	321.8					

Note *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 30 years depreciation

*3 Terms of working fund loan: 10% p.a.

*4 Terms of Source Alternative 2 Interest: 2.5% p.a.

Repayment Period: 30 years (including 10 years of grace period)

Table 12-35 Financial Stream of Income and Expenditure: South 3 Region

Case 4-IIId: Charge III with Financial Sources of both 70% of Loan 2 and 30% of Donation

(Unit: Q Million)

Serial		Capital Balance							Revenue Balance										Working Fund (W/F)*3		Cash Balance *1	Balance Carried Forward
		Revenue			Expenditure			Balance	Revenue				Expenditure					Balance				
No.	Year	Foreign Loan*4	Donation (30%)	Total	Construc-tion Cost	Repayment of Principal	Total		Domestic Sewage	Industry Sewage	Subsidy	Total	O/M Expenses	Depreci-ation*2	Interest of Loan	Interest of W/F	Total		Procure-ment	Repay-ment		
1	1998	3.9	1.7	5.6	5.6	0.0	5.6	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2	1999	60.4	25.9	86.3	86.3	0.0	86.3	0.0	0.0	0.0	1.2	1.2	0.0	0.0	1.6	0.1	1.7	-0.5	0.5	0.0	0.0	0.0
3	2000	47.8	20.5	68.2	68.2	0.0	68.2	0.0	0.0	0.0	2.1	2.1	0.0	0.0	2.8	0.1	2.9	-0.8	1.3	0.5	0.0	0.0
4	2001	47.8	20.5	68.2	68.2	0.0	68.2	0.0	0.0	0.0	3.0	3.0	0.0	0.0	4.0	0.3	4.3	-1.3	2.6	1.3	0.0	0.0
5	2002					0.0	0.0	0.0	3.0	1.6	3.0	7.6	1.7	4.8	4.0	0.1	10.6	-3.0	0.9	2.6	0.1	0.1
6	2003					0.0	0.0	0.0	3.2	1.6	3.0	7.8	1.7	4.8	4.0	0.0	10.5	-2.7	0.0	0.9	1.2	1.3
7	2004					0.0	0.0	0.0	3.9	1.6	3.0	8.5	1.7	4.8	4.0	0.0	10.5	-2.0	0.0	0.0	2.8	4.1
8	2005					0.0	0.0	0.0	4.7	1.6	3.0	9.3	1.8	4.8	4.0	0.0	10.6	-1.3	0.0	0.0	3.5	7.7
9	2006					0.0	0.0	0.0	5.5	1.6	3.0	10.1	1.8	4.8	4.0	0.0	10.6	-0.5	0.0	0.0	4.3	12.0
10	2007					0.0	0.0	0.0	5.7	1.6	3.0	10.3	1.8	4.8	4.0	0.0	10.6	-0.3	0.0	0.0	4.5	16.5
11	2008					8.0	8.0	-8.0	5.9	1.6	3.0	10.5	1.8	4.8	4.0	0.0	10.6	-0.1	0.0	0.0	-3.3	13.3
12	2009					8.0	8.0	-8.0	6.1	1.6	2.8	10.6	1.8	4.8	3.8	0.0	10.4	0.2	0.0	0.0	-3.0	10.3
13	2010					8.0	8.0	-8.0	6.3	1.6	2.7	10.6	1.8	4.8	3.6	0.0	10.2	0.5	0.0	0.0	-2.7	7.5
14	2011					8.0	8.0	-8.0	6.6	1.6	2.5	10.7	1.8	4.8	3.4	0.0	10.0	0.8	0.0	0.0	-2.4	5.1
15	2012					8.0	8.0	-8.0	6.8	1.6	2.4	10.9	1.8	4.8	3.2	0.0	9.8	1.1	0.0	0.0	-2.1	3.0
16	2013					8.0	8.0	-8.0	7.1	1.6	2.2	11.0	1.8	4.8	3.0	0.0	9.6	1.4	0.0	0.0	-1.8	1.2
17	2014					8.0	8.0	-8.0	7.4	1.6	2.1	11.2	1.8	4.8	2.8	0.0	9.4	1.7	0.3	0.0	-1.2	0.0
18	2015					8.0	8.0	-8.0	7.7	1.6	1.9	11.3	1.8	4.8	2.6	0.2	9.4	1.9	1.5	0.3	-0.1	0.0
19	2016					8.0	8.0	-8.0	7.7	1.6	1.8	11.2	1.8	4.8	2.4	0.3	9.3	1.9	2.8	1.5	0.0	0.0
20	2017					8.0	8.0	-8.0	7.7	1.6	1.6	11.0	1.8	4.8	2.2	0.4	9.2	1.8	4.3	2.8	0.1	0.0
21	2018					8.0	8.0	-8.0	7.7	1.6	1.5	10.9	1.8	4.8	2.0	0.6	9.2	1.7	5.8	4.3	0.0	0.0
22	2019					8.0	8.0	-8.0	7.7	1.6	1.3	10.7	1.8	4.8	1.8	0.8	9.2	1.5	7.5	5.8	0.0	0.0
23	2020					8.0	8.0	-8.0	7.7	1.6	1.2	10.6	1.8	4.8	1.6	0.9	9.1	1.4	9.2	7.5	-0.1	0.0
24	2021					8.0	8.0	-8.0	7.7	1.6	1.0	10.4	1.8	4.8	1.4	1.1	9.1	1.3	11.2	9.2	0.1	0.0
25	2022					8.0	8.0	-8.0	7.7	1.6	0.9	10.3	1.8	4.8	1.2	1.3	9.1	1.1	13.2	11.2	-0.1	0.0
26	2023					8.0	8.0	-8.0	7.7	1.6	0.7	10.1	1.8	4.8	1.0	1.6	9.2	0.9	15.5	13.2	0.0	0.0
27	2024					8.0	8.0	-8.0	7.7	1.6	0.6	10.0	1.8	4.8	0.8	1.8	9.2	0.8	17.9	15.5	0.0	0.0
28	2025					8.0	8.0	-8.0	7.7	1.6	0.4	9.8	1.8	4.8	0.6	2.1	9.3	0.5	20.6	17.9	0.0	0.0
29	2026					8.0	8.0	-8.0	7.7	1.6	0.3	9.7	1.8	4.8	0.4	2.4	9.4	0.3	23.5	20.6	0.0	0.0
30	2027					8.0	8.0	-8.0	7.7	1.6	0.1	9.5	1.8	4.8	0.2	2.7	9.5	0.0	26.7	23.5	0.0	0.0
31	2028					0.0	0.0	0.0	7.7	1.6	0.0	9.4	1.8	4.8	0.0	2.1	8.7	0.6	21.3	26.7	0.0	0.0
32	2029					0.0	0.0	0.0	7.7	1.6	0.0	9.4	1.8	4.8	0.0	1.5	8.1	1.2	15.2	21.3	-0.1	0.0
33	2030					0.0	0.0	0.0	7.7	1.6	0.0	9.4	1.8	4.8	0.0	0.9	7.5	1.9	8.5	15.2	0.0	0.0
34	2031					0.0	0.0	0.0	7.7	1.6	0.0	9.4	1.8	4.8	0.0	0.0	6.6	2.7	0.0	8.5	-1.0	-1.0
	Total	159.9	68.5	228.4	228.4	159.9	388.3		203.5	48.8	55.8	308.2	53.8	143.9	74.5	21.0	293.2					

Note *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 30 years depreciation

*3 Terms of working fund loan: 10% p.a.

*4 Terms of Source Alternative 2 Interest: 2.5% p.a.

Repayment Period: 30 years (including 10 years of grace period)

12.5.3 Economic Evaluation

a) Basic Conditions and Assumptions

The economic evaluation is conducted under the figures re-evaluated into economic terms regarding both costs and benefits for each alternative. The evaluation methodology was already described in Section 11.5.3. In this section, the same conditions and assumptions are applied to get economic values of costs and benefits.

b) Quantification of Economic Benefits

In this feasibility study as well, the following tangible benefits are quantified for each alternative by the same procedure which was used in the master plan study: (i) decrease of water-borne diseases, (ii) reduction of future purification cost for water supply, and (iii) negative benefit of eliminating crop production at the wastewater treatment plant sites.

1) Decrease of Water Borne Diseases

Project benefit regarding decrease of water-borne diseases consists of three components: (i) reduction of deaths due to water-borne diseases, (ii) reduction of inpatients and (iii) reduction of outpatients.

Table 12-36 shows the accumulated number of avoidable medical losses owing to development of sewerage and sanitation systems in the project areas for each region until the target year 2015. The reason why the numbers in the table are different from those in Table 11-18 is that the proposed projects cover only the first stage project areas, so the number of the project beneficiaries is smaller than that of the fully developed cases. Therefore, the number of avoidable medical losses is estimated in proportion to the number of the project beneficiaries in each stage.

The number of death due to water-borne diseases under "without project" conditions was estimated applying the past mortality. Once the project is introduced in the project areas, the mortality rate would be reduced to 2.16 for 1000 population at the first year and finally to 0.48 for 1000 population in the target year, which was the same assumption as mentioned in Section 11.5.3. As a result, 12,385 and 2,051 people could avoid death from water-borne diseases in Central Region and South 3 Region, respectively.

Table 12-36 Number of Medical Losses Avoidable by Implementation of Sewerage and Sanitation System during 1999 to 2015

Region	Deaths	Inpatients	Outpatients
Central Region	12,385	29,343	51,304
South 3 Region	2,051	4,888	8,547

Source : Study Team

In the same manner, the number of patients suffering from water-borne diseases was estimated and shown in the above table. According to the estimates, the number of inpatients due to water-borne diseases would be reduced by 29,343 in Central Region and 4,888 in South 3 Region respectively. The number of outpatients would be reduced by 51,304 in Central Region and 8,547 in South 3 Region respectively.

The medical care period for inpatients in hospitals was recorded as 12.7 days on average. A national hospital expensed Q8.00 per day for a inpatient on average in 1976. This value is re-evaluated as around Q92.00 per day for a patient in 1996, applying a price index of 1,150 to 100 in the base year 1976. Furthermore, an inpatient has to suspend his business during medical care period. An average income was estimated at Q1,500 per month. This loss could also be avoided and appropriated as economic benefit.

The medical care for outpatient in hospital costs Q4.25 per outpatient on average in 1976. This value was re-evaluated as around Q48.88 per day for a patient in 1996. An outpatient also has to suspend his business during medical care, although its period might be short as compared with inpatient case.

Deaths due to water-borne diseases is evaluated based on the annual income expected by the casualties. The benefit is estimated as a product of the number of deaths, an average annual income which is assumed at Q18,000, and a labor participation rate which is estimated at 36% of the total population in the project areas.

Yet, people in existing sewered areas have already enjoy some environmental effects of public health, even if no wastewater treatment plant is constructed in the areas, as discussed in Section 11.5.3. In this feasibility study as well, the medical losses in the existing sewered areas are assumed to be a half of those in non-sewered areas. Thus, the medical losses in the existing sewered areas such as Central Region are assumed to be a half of those expected in no sewered areas in the current study. On the other hand, South 3 Region has very few existing sewerage systems, so it is assumed to be able to enjoy the full reduction benefit of water-borne diseases.

2) Reduction of Future Purification Cost for Water Supply

Reduction of purification cost of water supply sources is quantified as done in the master plan study. Under "without project" conditions, it is assumed that the water supply sources in the project areas need to be purified by means of upgrading and strengthening water treatment processing because of water contamination beyond the year 2001, the completion year of the first stage.

The reduction of unit purification cost for water supply is estimated at about Q0.5 per m^3 in 1996, as explained in Section 11.5.3. Contribution of wastewater in the respective regions to water resources contamination was assumed at 50% of entire contamination. After 2002, the ground water for supply in both Central and South 3 Regions will be extracted by 662 L/s and 1,240 L/s respectively, as shown in Table 11-19. Consequently, the annual reduction of purification cost with project is estimated at Q5.22 million in Central Region and Q9.78 million in South 3 Region in financial terms. In economic terms, they are converted to Q4.70 million and Q8.80 million, respectively. These costs could be eliminated under the "with-project" conditions in the respective regions.

3) Negative Benefit

This negative benefits are already discussed and summarized in Table 11-20. The economic losses of crop cultivation are estimated at Q47,000 per annum at the plant site of Central Region and Q25,000 per annum at the plant site of South 3 Region.

c) Central Region

1) Economic Costs

Applying SCF, the economic costs of construction and O&M for the project in Central Region were converted from the financial costs in Table 12-37.

Table 12-37 Financial Costs and Economic Costs: Central Region

(Unit: Q Million, 1996 Prices)

	Local Portion	Foreign Portion	Total
I. Financial Costs			
Construction Cost	463.79	17.08	480.87
• Construction Works	441.55	17.08	458.63
• Land Acquisition	22.24	0.00	22.24
Annual O&M Cost*1	3.82	0.00	3.82
II. Economic costs			
Construction Cost	397.40	17.08	414.48
• Construction Works	397.40	17.08	414.48
• Land Acquisition	0.00	0.00	0.00
Annual O&M Cost*1	3.43	0.00	3.43

Note: Annual cost in the target year of 2015
Source : Study Team

2) Economic Benefits

As mentioned in the previous section, the tangible economic benefits consist of (i) decrease of water-borne diseases, (ii) reduction of future purification cost for water supply, and (iii) negative benefit of eliminating crop production at the wastewater treatment plant site. Table 12-38 shows the benefit stream which was quantified on the basis of the above discussion.

Table 12-38 Economic Cost and Benefit Stream: Central Region

(Unit:Q1000)

Serial No.	Year	Cost			Benefit						Balance
		Const-ruction	O/M	Total	Decrease of Diseases			Purification for W/S	Negative Benefit	Total	
					Death	Inpatient	Outpatient				
1	1998	8,881	0	8,881	0	0	0	0	0	0	-8,881
2	1999	135,199	0	135,199	0	0	0	0	47	-47	-135,246
3	2000	135,199	0	135,199	0	0	0	0	47	-47	-135,246
4	2001	135,199	0	135,199	0	0	0	0	47	-47	-135,246
5	2002		3,281	3,281	733	104	7	4,697	47	5,494	2,213
6	2003		3,315	3,315	1,369	139	10	4,697	47	6,169	2,854
7	2004		3,349	3,349	2,191	175	13	4,697	47	7,028	3,680
8	2005		3,383	3,383	3,200	212	15	4,697	47	8,077	4,694
9	2006		3,403	3,403	4,306	244	17	4,697	47	9,218	5,815
10	2007		3,407	3,407	5,492	273	20	4,697	47	10,435	7,028
11	2008		3,413	3,413	6,786	300	21	4,697	47	11,757	8,345
12	2009		3,417	3,417	8,178	326	23	4,697	47	13,178	9,761
13	2010		3,423	3,423	9,663	351	25	4,697	47	14,689	11,266
14	2011		3,425	3,425	11,233	375	27	4,697	47	16,285	12,860
15	2012		3,427	3,427	12,882	398	28	4,697	47	17,958	14,531
16	2013		2,430	2,430	14,605	420	30	4,697	47	19,705	17,275
17	2014		3,434	3,434	16,398	440	32	4,697	47	21,520	18,086
18	2015		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
19	2016		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
20	2017		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
21	2018		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
22	2019		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
23	2020		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
24	2021		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
25	2022		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
26	2023		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
27	2024		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
28	2025		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
29	2026		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
30	2027		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
31	2028		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
32	2029		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
33	2030		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963
34	2031		3,435	3,435	18,255	461	33	4,697	47	23,399	19,963

Present Value (Discounted at 10%)

Cost (Q1000) :	335,349	NPV (Q1000):	-246,412
Benefit(Q1000):	88,937	B/C :	0.27
		EIRR :	0.5%

d) South 3 Region

1) Economic Costs

In the same manner, the economic costs of construction and O&M for the project of South 3 Region were calculated as shown in Table 12-39.

Table 12-39 Financial Costs and Economic Costs: South 3 Region

(Unit: Q Million, 1996 Prices)

	Local Portion	Foreign Portion	Total
I. Financial Costs			
Construction Cost	217.98	10.42	228.40
•Construction Works	199.88	10.42	210.30
•Land Acquisition	18.10	0.00	18.10
Annual O&M Cost*1	1.81	0.00	1.81
II. Economic costs			
Construction Cost	179.89	10.42	190.31
•Construction Works	179.89	10.42	190.31
•Land Acquisition	0.00	0.00	0.00
Annual O&M Cost*1	1.63		1.63

Note: Annual cost in the target year of 2015
Source : Study Team

2) Economic Benefits

In South 3 Region as well, the benefits comprise (i) decrease of water-borne diseases, (ii) reduction of future purification cost for water supply, and (iii) negative benefit of crop production at the plant site. Table 12-40 shows the stream of these benefits.

e) Economic Evaluation

The economic evaluation for respective projects is examined in economic efficiency through factors of net present value (NPV), benefit-cost ratio (B/C) and economic internal rate of return (EIRR). The results of these factors are shown in Tables 12-38 and 12-40, in addition to the annual stream of economic costs and benefits.

EIRR and B/C of the project in Central Region is calculated at 0.5% and 0.27, respectively. The values indicate that the project is not feasible from the economic point of view.

EIRR and B/C of the project in South 3 Region is calculated at 5.4% and 0.58, respectively. The project in South 3 Region has higher economic efficiency than that in Central Region,

as far as judging from the economic point of view. In other words, the former project would have a higher priority than the latter one.

In any case, implementation of the project should be decided not only from the economic point of view but also from the point of environmental views and basic human needs for the people in the project areas. In fact the project areas of the South 3 Region plays an important role to supply drinking water in the Guatemala Metropolitan area. Thus, the proposed project is quite important to protect water supply sources. From this point of view, the project in South 3 Region is recommended to be implemented to prevent contamination of water supply sources.

f) Sensitivity Test

The economic efficiency of the project in South 3 Region is further examined by sensitivity test, considering the reliability of input data.

The sensitivity test is carried out only on the variation of the total costs and benefits, without any examination on the variation of the major input. The test is made for variation of 5% and 10% of the cost and benefit with regard to EIRR of the proposed projects. The results are given in the following Table 12-41.

Table 12-40 Economic Cost and Benefit Stream: South 3 Region

(Unit:Q1000)

Serial No.	Year	Cost			Benefit						Balance
		Const-ruction	O/M	Total	Decrease of Diseases			Purification for W/S	Negative Benefit	Total	
					Death	Inpatient	Outpatient				
1	1998	5,421	0	5,421	0	0	0	0	0	0	-5,421
2	1999	61,631	0	61,631	0	0	0	0	25	-25	-61,655
3	2000	61,631	0	61,631	0	0	0	0	25	-25	-61,655
4	2001	61,631	0	61,631	0	0	0	0	25	-25	-61,655
5	2002		1,551	1,551	179	32	2	8,799	25	8,986	7,435
6	2003		1,555	1,555	352	46	3	8,799	25	9,173	7,618
7	2004		1,569	1,569	676	70	4	8,799	25	9,523	7,954
8	2005		1,581	1,581	1,148	99	6	8,799	25	10,026	8,444
9	2006		1,595	1,595	1,814	134	8	8,799	25	10,730	9,135
10	2007		1,598	1,598	2,419	158	9	8,799	25	11,360	9,761
11	2008		1,601	1,601	3,123	158	9	8,799	25	12,064	10,463
12	2009		1,605	1,605	3,936	158	9	8,799	25	12,877	11,272
13	2010		1,608	1,608	4,861	158	9	8,799	25	13,801	12,193
14	2011		1,612	1,612	5,924	158	9	8,799	25	14,864	13,252
15	2012		1,616	1,616	7,129	158	9	8,799	25	16,069	14,453
16	2013		1,621	1,621	8,481	158	9	8,799	25	17,422	15,801
17	2014		1,626	1,626	10,000	158	9	8,799	25	18,940	17,314
18	2015		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
19	2016		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
20	2017		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
21	2018		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
22	2019		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
23	2020		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
24	2021		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
25	2022		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
26	2023		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
27	2024		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
28	2025		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
29	2026		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
30	2027		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
31	2028		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
32	2029		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
33	2030		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999
34	2031		1,631	1,631	11,689	158	9	8,799	25	20,629	18,999

Present Value (Discounted at 10%)

Cost (Q1000) :	154,549	NPV (Q1000):	-64,986
Benefit(Q1000):	89,563	B/C :	0.58
		EIRR :	5.4%

Table 12-41 Results of Sensitivity Test on EIRR for South 3 Region Project

Cost Increase	Benefit Decrease		
	0%	5%	10%
0%	5.4%	5.0%	4.6%
5%	5.0%	4.7%	4.3%
10%	4.7%	4.3%	3.9%

The results of the sensitivity test indicate that EIRRs of the project in South 3 Region keeps more than 4% except the case of 10% increase of cost and 10% decrease of benefit. Although, EIRRs are lower than the opportunity cost of capital of 10%, the project might be feasible, considering the EIRR values for sewage projects.

12.5.4 Other Factors

In the preceding sections , financial and economic evaluations of the alternatives were made based on quantifiable parameters. However, there are unquantifiable factors, which are necessary to be considered for project selection.

The factors are:

- Contribution to the protection of potential water resources
- Benefit to the downstream population
- Public appeal
- Ease of implementation

a) Contribution to the Protection of Potential Water Resources

In the economic analysis, tangible benefits for the alleviation of future water purification costs of existing water supply sources are evaluated. However, there are potential water resources which can be exploited in the future due to urban growth around southern part of Guatemala Metropolitan Area.

Water supply sources for Guatemala Metropolitan Area are limited and Lake Amatitlan, is one of the potential water resource. Wastewater discharges from South 3 Region is polluting the lake. Steps taken to protect this water resource are beneficial for the sustainable urban growth of Guatemala Metropolitan Area.

Implementation of wastewater management project in South 3 Region will be a positive step towards the protection of water resource potential of Lake Amatitlan.

b) Benefit to the Downstream Population

Beneficiaries of wastewater management project are those within the sewered area and those along the downstream of water bodies, which receive wastewater discharges. Las Vacas River receives wastewater discharges from Central Region while Villalobos River-Lake Amatitlan - Michatoya River receives wastewater from South 3 Region. People along the Lake Amatitlan and Michatoya river use this water for bathing and washing of clothes and thereby come into direct contact with water. Compared to this, there is only a little population along Las Vacas River which have direct contact with river water. Though improvement of water quality along these water bodies due to implementation of South 3 Region alone will be intangible, it will be a first step towards the improvement of water quality downstream.

c) Public Appeal

Lake Amatitlan is a well known location to the Guatemalan population. Continuing discharge of wastewater into the lake is causing public concern recently, especially in the national newspapers.

Therefore, implementation of wastewater management project in South 3 Region will have a strong public appeal compared to that of Central Region.

d) Ease of Implementation

To ensure smooth construction and operation of first stage project, the following needs to be considered. They are :

- Ease of construction.
- Ease of operation and management.

First stage projects will be the first ever full-scale sewerage facilities to be constructed and operated by EMPAGUA. Compared to Central Region which requires massive construction of tunnels and other facilities, South 3 Region is desirable. Increasing the operation and management capacity of EMPAGUA will be smoother for South 3 Region compared to Central Region.

Based on the discussion above, as a first stage project South 3 Region is recommended since there are no existing full-scale wastewater management facilities in Guatemala.

12.6 SELECTED ALTERNATIVE

Results of financial and economic evaluations, and other factors are summarized in Table 12-42. **Alternative 2 : South 3 Region** is selected as First Stage Project because it is economically superior and other factors are also favorable. The only drawback of Alternative 2 is financial.

Considering the financial limitations, Sanitation System in the Alternative 2 is transferred to the subsequent stage for the following reasons:

- investment efficiency,
- priority of EMPAGUA / on-going projects, and
- existing density of houses (shows potential growth).

It is necessary to devise a feasible financial plan . It should be noted that the evaluations are made on the condition that each alternative are paid by the users in the respective region. In other words, it is based on 'Polluters Pay Principle'. Water supply resources of South 3 Region is being used by the population in Central and other Regions. Therefore, water supply users in Central Region are also the beneficiaries of the First Stage Project in South 3 Region and it is justifiable that part of the financial burden be borne by the water supply users in Central Region. Complementing the 'Polluters Pay Principle' with 'Beneficiaries Pay Principle' , feasible financial plan is prepared and is described in Chapter 13.

Table 12-42 Results of the Evaluation of Alternatives for First Stage Project

Item	Central Region	South 3 Region	Remarks
1 **Financial Evaluation**			
1.1 Financial Viability (FIRR)			
a. Charge I (Q20/CONNECTION/M)	-1.7 %	- 5.5 %	
b. Charge II (Q30/CONNECTION/M)	3.5%	-2.7%	
c. Charge III (Q40/CONNECTION/M)	7.1%	-0.8%	
1.2 Financial Evaluation Required Conditions for sound management of the project	(1) Loan for 70% of total investment cost from Loan Source 2 (2) Grant for 20% of total investment cost (3) Subsidy to cover 20% of loan interest (4) Application of Charge II	(1) Loan for 70% of total investment cost from Loan Source 2 (2) Grant for 30% of total investment cost (3) Subsidy to cover 20% of loan interest (4) Application of Charge III	Loan 1 (8.1% p.a., 20years, 5years) Loan 2 (2.5% p.a., 30years, 10years) Working Fund: Commercial Bank 10%
2 **Economic Evaluation**			Discount Rate : 10%
2.1 Evaluation Parameters			
a. Net Present Value (NPV:Q1000)	-246,412	-64,986	Tangible Benefits
b. Benefit-Cost Ratio (B/C)	0.27	0.58	- Decrease of Water Borne Diseases
c. Economic Internal Rate of Return (EIRR)	0.5%	5.4%	- Reduction of Future Purification Cost for Water Supply
2.2 Economic Evaluation			- Negative Benefit
	The Project is not feasible from economic point of view. Main reasons for unfeasible are the increase in total construction costs based on findings of soil survey and consequent method of collector main.	Although the EIRR of 5.4% is smaller than the opportunity cost of capital as a discount rate of 10%, the project is recommended for implementation has a high priority to protect potable water sources from pollution.	
3 **Other Factors**			
a. Contribution to the protection of potential water resources	-	- Lake Amatitlan is one of potential water sources for the sustainable urban growth of Guatemala Metropolitan Area - A positive step towards the protection of water resource potential of Lake Amatitlan	
b. Benefit to the downstream population	- There is little population along the Las Vacas River which have direct contact with the river water	- People along the Lake Amatitlan and Michatoya river use the water for bathing and washing clothes and thereby come into direct contact with water	
c. Public Appeal	- The implementation of wastewater management project will not have a strong public appeal compared to that of South 3 Region	- Continuing discharge of wastewater into Lake Amatitlan is causing public concern recently - The implementation of wastewater management project will have a strong public appeal compared to that of Central Region	
d. Ease of Implementation	- It will be difficult for EMPAGUA to construct, operate and manage medium capacity facilities	- It will be difficult for EMPAGUA to construct, operate and manage medium capacity facilities	
4 **Recommendation**		As the First Stage Project, South 3 Region is recommended because it is economically attractive and other factors favor it.	

Source : Study Team

CHAPTER 13

IMPLEMENTATION PROGRAM OF THE FIRST STAGE PROJECT

13 IMPLEMENTATION PROGRAM OF THE FIRST STAGE PROJECT

13.1 FINANCIAL PLAN

a) Finance and Sewage Service Charge

In the previous chapter, the financial and economic evaluation of the projects were conducted as an individual and independent management scheme. The evaluation showed that the First Stage Project in South 3 Region has higher economic efficiency, but cannot be managed soundly without any government support.

However, as it is advised by the Steering Committee, the governments of both the central and local autonomous can not afford to offer subsidy for the project. Donation from the people in the served areas is available legitimately, but its expected amount might be too small to implement the project as far as judging from the past experience of EMPAGUA. Thus, the following financial sources are considered; (i) loans from foreign financial sources and (ii) self fund which is saved through surcharge on other EMPAGUA's service territory.

The latter financial source for the project in South 3 could be provided from other EMPAGUA's service territory, such as Central Region, as discussed in Section 12.6 of the Main Report.

Following terms of loans are set up to prepare financial plans:

1) Financial Source A (Long-term Loan)

   The credit ceiling is 75% of the total investment cost and an interest during construction period can be added on the ceiling. Interest rate is 2.5%.(2.1% applied to consultant fee). Repayment period is 30 years including 10 years of grace period.

2) Financial Source B (Long-term Loan)

   The credit ceiling is 90% of the total investment cost, which can include a local portion as well as a foreign portion. Interest rate is 8.1%. Repayment period is 20 years including 5 years of grace period.

3) Financial Source C (Short-term Loan)

   In addition to the above long-term loan to cover the deficit of cash-flow, a loan limited to one-year time limit as working fund with 10% interest rate is also applied.

The following financial plans are provided for the implementation of the proposed project, in which the financial source A is considered as the main source, taking into account of the difficulty of financial viability.

Plan 1: Seventy five percent (75%) of the total investment cost is financed by the financial source A and the rest (25%) is raised by EMPAGUA's fund saved through surcharge on Central Region.

The average sewage service charge will be increased from the current average charge of Q10/connection/month to Q21/connection/month. The net mark-up charge of Q11/connection/month will be contributed to implement the First Stage Project in South 3 Region through saving as a Fund during four years from 1998 to 2001 before the implementation of the project.

After starting the operation as well, some amount of supposition fund is transferred through surcharge on beneficiary in Central Region. The surcharge rate is kept at the same level continuously even after starting the operation.

Plan 2: Seventy five percent (75%) of the total investment cost is financed by the financial source A. The rest of 25% is raised by both the financial source B and EMPAGUA's fund saved through surcharge on Central Region. In this case, the fund saved by EMPAGUA through the mark-up of charge of Q5/connection/month during 1998 to 2001 is not sufficient to cover the rest of 25%. The remainder will be financed by the financial source B.

The financial stream of revenue and expenditure for the respective financial plans are presented in Tables 13-1 and 13-2. Based on this analysis, the financially practicable conditions for the project in South 3 Region are enumerated in Table 13-3. The nominal FIRRs of the financial alternative plans are calculated at 8.0% and 3.2%, respectively. Hence, the nominal FIRRs are defined as internal rate of return of total revenue from sewage services including transfer from EMPAGUA's general accounts against the total costs of initial construction and O/M.

Table 13-1 Financial Stream of Revenue and Expenditure: South 3 Region

Plan-1: Under 2.1 Times' Charge with Transfer from Central Region's Surplus Portion after 1998

(Unit: Q Million)

Serial No.	Year	Capital Balance							Revenue Balance										Working Fund (W/F)*3		Cash Balance *1	Balance Carried Forward
		Revenue			Expenditure			Balance	Revenue				Expenditure					Balance				
		Financial Source 1	Transfer fm Central	Total	Construc-tion Cost	F.Source 1 Repayment	Total		Domestic Sewage	Industry Sewage	Transfer fm Central	Total	O/M Expenses	Depreci-ation*2	Interest of F.Source 1	Interest of W/F	Total		Procure-ment	Repay-ment		
1	1998	5.5	9.3	14.7	5.4	0.0	5.4	9.4	0.0	0.0	4.2	4.2	0.0	0.0	0.1	0.0	0.1	4.1	0.0	0.0	13.5	13.5
2	1999	58.3	13.9	72.2	75.0	0.0	75.0	-2.8	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	1.6	-1.6	0.0	0.0	-4.4	9.1
3	2000	58.3	14.2	72.5	75.0	0.0	75.0	-2.4	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	3.0	-3.0	0.0	0.0	-5.4	3.7
4	2001	51.4	14.6	66.0	66.0	0.0	66.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	4.3	-4.3	0.6	0.0	-3.7	0.0
5	2002					0.0	0.0	0.0	1.5	0.9	15.0	17.4	1.6	6.6	4.3	0.0	12.5	4.9	0.0	0.6	10.9	10.9
6	2003					0.0	0.0	0.0	1.7	0.9	15.4	17.9	1.6	6.6	4.3	0.0	12.6	5.4	0.0	0.0	12.0	22.9
7	2004					0.0	0.0	0.0	2.0	0.9	15.8	18.7	1.6	6.6	4.3	0.0	12.6	6.1	0.0	0.0	12.8	35.7
8	2005					0.0	0.0	0.0	2.4	0.9	16.2	19.5	1.7	6.6	4.3	0.0	12.6	6.9	0.0	0.0	13.5	49.2
9	2006					0.0	0.0	0.0	2.8	0.9	16.7	20.4	1.7	6.6	4.3	0.0	12.6	7.8	0.0	0.0	14.4	63.6
10	2007					0.0	0.0	0.0	2.9	0.9	17.2	21.0	1.7	6.6	4.3	0.0	12.6	8.4	0.0	0.0	15.0	78.6
11	2008					8.5	8.5	-8.5	3.0	0.9	17.7	21.6	1.7	6.6	4.1	0.0	12.4	9.2	0.0	0.0	7.3	86.0
12	2009					8.5	8.5	-8.5	3.1	0.9	18.2	22.2	1.7	6.6	3.9	0.0	12.2	10.0	0.0	0.0	8.2	94.1
13	2010					8.5	8.5	-8.5	3.3	0.9	18.7	22.8	1.7	6.6	3.6	0.0	12.0	10.8	0.0	0.0	9.0	103.1
14	2011					8.5	8.5	-8.5	3.4	0.9	19.3	23.6	1.7	6.6	3.4	0.0	11.8	11.8	0.0	0.0	10.0	113.1
15	2012					8.5	8.5	-8.5	3.5	0.9	20.0	24.4	1.7	6.6	3.2	0.0	11.5	12.8	0.0	0.0	11.0	124.1
16	2013					8.5	8.5	-8.5	3.7	0.9	20.7	25.2	1.7	6.6	3.0	0.0	11.3	13.9	0.0	0.0	12.1	136.2
17	2014					8.5	8.5	-8.5	3.9	0.9	21.4	26.1	1.7	6.6	2.8	0.0	11.1	15.0	0.0	0.0	13.2	149.4
18	2015					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	2.6	0.0	10.9	16.0	0.0	0.0	14.2	163.5
19	2016					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	2.4	0.0	10.7	16.2	0.0	0.0	14.4	177.9
20	2017					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	2.1	0.0	10.5	16.4	0.0	0.0	14.6	192.6
21	2018					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	1.9	0.0	10.3	16.7	0.0	0.0	14.8	207.4
22	2019					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	1.7	0.0	10.1	16.9	0.0	0.0	15.0	222.4
23	2020					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	1.5	0.0	9.9	17.1	0.0	0.0	15.3	237.7
24	2021					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	1.3	0.0	9.6	17.3	0.0	0.0	15.5	253.1
25	2022					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	1.1	0.0	9.4	17.5	0.0	0.0	15.7	268.8
26	2023					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	0.9	0.0	9.2	17.7	0.0	0.0	15.9	284.7
27	2024					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	0.6	0.0	9.0	17.9	0.0	0.0	16.1	300.8
28	2025					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	0.4	0.0	8.8	18.2	0.0	0.0	16.3	317.2
29	2026					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	0.2	0.0	8.6	18.4	0.0	0.0	16.5	333.7
30	2027					8.5	8.5	-8.5	4.0	0.9	22.1	26.9	1.7	6.6	0.0	0.0	8.4	18.6	0.0	0.0	16.8	350.5
31	2028					0.0	0.0	0.0	4.0	0.9	22.1	26.9	1.7	6.6	0.0	0.0	8.4	18.6	0.0	0.0	25.2	375.7
32	2029					0.0	0.0	0.0	4.0	0.9	22.1	26.9	1.7	6.6	0.0	0.0	8.4	18.6	0.0	0.0	25.2	400.9
33	2030					0.0	0.0	0.0	4.0	0.9	22.1	26.9	1.7	6.6	0.0	0.0	8.4	18.6	0.0	0.0	25.2	426.1
34	2031					0.0	0.0	0.0	4.0	0.9	22.1	26.9	1.7	6.6	0.0	0.0	8.4	18.6	0.0	0.0	25.2	451.3
	Total	173.5	52.0	225.5	221.3	169.3	390.6		105.4	25.6	611.7	742.8	50.9	199.2	75.4	0.0	325.4					

Note: *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 30 years depreciation

*3 Transfer amount from Central Region was assumed at Q11.00/Connection/Month on average in the served area.

*4 Terms of Source Alternative 1

Item	Financial Source 1
Interest Rate:	2.5% p.a. (2.1% for Consultant fee)
Repayment Period:	30 Years
Grace Period:	10 Years

Table 13-2 Financial Stream of Revenue and Expenditure: South 3 Region

Plan-2: Under 1.5 Times' Charge with Transfer from Central Region's Surplus Portion after 1998

(Unit: Q Million)

Serial No.	Year	Capital Balance: Revenue: Financial Source 1	Financial Source 2	Transfer fm Central	Total	Expenditure: Construction Cost	Repayment: Source 1	Source 2	Total	Balance	Revenue Balance: Revenue: Domestic Sewage	Industry Sewage	Transfer fm Central	Total	Expenditure: O/M Expenses	Depreciation*2	Interest of Loan: Source 1	Source 2	Interest of W/F	Total	Balance	Working Fund (W/F)*3: Procurement	Repayment	Cash Balance Carried Forward*1	
1	1998	5.5	0.0	6.1	11.6	5.4	0.0	0.0	5.4	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	-0.1	0.0	0.0	6.1	6.1
2	1999	58.3	4.3	6.3	68.9	75.0	0.0	0.0	75.0	-6.1	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.3	0.0	2.0	-2.0	1.9	0.0	-6.1	0.0
3	2000	58.3	12.3	6.5	77.1	75.0	0.0	0.0	75.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	3.0	1.3	0.1	4.4	-4.4	4.2	1.9	-0.1	0.0
4	2001	51.4	9.8	6.6	67.9	66.0	0.0	0.0	66.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	4.3	2.1	0.2	6.6	-6.6	8.9	4.2	0.0	0.0
5	2002						0.0	0.0	0.0	0.0	1.1	0.6	6.8	8.5	1.6	6.6	4.3	2.1	0.2	14.9	-6.3	8.6	8.9	0.0	0.0
6	2003						0.0	1.8	1.8	-1.8	1.2	0.6	7.0	8.8	1.6	6.6	4.3	2.0	0.2	14.8	-6.0	9.7	8.6	0.0	0.0
7	2004						0.0	1.8	1.8	-1.8	1.4	0.6	7.2	9.2	1.6	6.6	4.3	1.9	0.2	14.6	-5.4	10.2	9.7	0.0	0.0
8	2005						0.0	1.8	1.8	-1.8	1.7	0.6	7.4	9.7	1.7	6.6	4.3	1.7	0.2	14.5	-4.8	10.2	10.2	0.1	0.0
9	2006						0.0	1.8	1.8	-1.8	2.0	0.6	7.6	10.2	1.7	6.6	4.3	1.6	0.2	14.4	-4.1	9.4	10.2	-0.1	0.0
10	2007						0.0	1.8	1.8	-1.8	2.1	0.6	7.8	10.5	1.7	6.6	4.3	1.4	0.2	14.2	-3.7	8.2	9.4	0.0	0.0
11	2008						8.5	1.8	10.2	-10.2	2.2	0.6	8.0	10.8	1.7	6.6	4.1	1.3	0.3	14.0	-3.2	15.0	8.2	0.0	0.0
12	2009						8.5	1.8	10.2	-10.2	2.2	0.6	8.3	11.1	1.7	6.6	3.9	1.1	0.4	13.8	-2.7	21.2	15.0	0.0	0.0
13	2010						8.5	1.8	10.2	-10.2	2.3	0.6	8.5	11.4	1.7	6.6	3.6	1.0	0.6	13.5	-2.1	26.9	21.2	0.0	0.0
14	2011						8.5	1.8	10.2	-10.2	2.4	0.6	8.8	11.8	1.7	6.6	3.4	0.9	0.7	13.3	-1.5	32.0	26.9	0.0	0.0
15	2012						8.5	1.8	10.2	-10.2	2.5	0.6	9.1	12.2	1.7	6.6	3.2	0.7	0.8	13.0	-0.8	36.4	32.0	0.0	0.0
16	2013						8.5	1.8	10.2	-10.2	2.6	0.6	9.4	12.6	1.7	6.6	3.0	0.6	0.8	12.8	-0.1	40.1	36.4	0.0	0.0
17	2014						8.5	1.8	10.2	-10.2	2.8	0.6	9.7	13.1	1.7	6.6	2.8	0.4	0.9	12.5	0.6	43.0	40.1	0.0	0.0
18	2015						8.5	1.8	10.2	-10.2	2.9	0.6	10.0	13.5	1.7	6.6	2.6	0.3	1.0	12.2	1.3	45.3	43.0	0.1	0.0
19	2016						8.5	1.8	10.2	-10.2	2.9	0.6	10.0	13.5	1.7	6.6	2.4	0.1	1.0	11.8	1.7	47.2	45.3	0.0	0.0
20	2017						8.5	1.8	10.2	-10.2	2.9	0.6	10.0	13.5	1.7	6.6	2.1	0.0	1.0	11.5	2.0	48.8	47.2	0.0	0.0
21	2018						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	1.9	0.0	1.0	11.3	2.2	48.4	48.8	0.0	0.0
22	2019						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	1.7	0.0	1.0	11.1	2.4	47.8	48.4	0.0	0.0
23	2020						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	1.5	0.0	1.0	10.8	2.7	47.0	47.8	0.0	0.0
24	2021						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	1.3	0.0	1.0	10.6	2.9	45.9	47.0	0.0	0.0
25	2022						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	1.1	0.0	0.9	10.4	3.1	44.6	45.9	0.0	0.0
26	2023						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	0.9	0.0	0.9	10.1	3.4	43.0	44.6	0.0	0.0
27	2024						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	0.6	0.0	0.9	9.9	3.6	41.2	43.0	0.0	0.0
28	2025						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	0.4	0.0	0.8	9.6	3.9	39.1	41.2	0.0	0.0
29	2026						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	0.2	0.0	0.8	9.3	4.2	36.8	39.1	0.0	0.0
30	2027						8.5	0.0	8.5	-8.5	2.9	0.6	10.0	13.5	1.7	6.6	0.0	0.0	0.7	9.1	4.4	34.2	36.8	0.0	0.0
31	2028						0.0	0.0	0.0	0.0	2.9	0.6	10.0	13.5	1.7	6.6	0.0	0.0	0.5	8.8	4.7	22.9	34.2	0.0	0.0
32	2029						0.0	0.0	0.0	0.0	2.9	0.6	10.0	13.5	1.7	6.6	0.0	0.0	0.2	8.6	4.9	11.3	22.9	0.0	0.0
33	2030						0.0	0.0	0.0	0.0	2.9	0.6	10.0	13.5	1.7	6.6	0.0	0.0	0.0	8.4	5.2	0.0	11.3	0.5	0.5
34	2031						0.0	0.0	0.0	0.0	2.9	0.6	10.0	13.5	1.7	6.6	0.0	0.0	0.0	8.4	5.2	0.0	0.0	11.8	12.3
	Total	173.5	26.4	25.5	225.5	221.3	169.3	26.4	417.0		75.3	18.3	276.1	369.7	50.9	199.2	75.4	20.9	18.7	365.0					

Note: *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 30 years depreciation

*3 Transfer amount from Central Region was assumed at Q5.00/Connection/Month on average in the served area.

*4 Terms of Source Alternatives

Item	Financial Source 1	Financial Source 2
Interest Rate:	2.5% p.a. (2.1% for Consultant fee)	8.1% p.a.
Repayment Period:	30 Years	20 Years
Grace Period:	10 Years	5 Years

Table 13-3 Financially Feasible Conditions for Proposed Project

(Unit: Million Quetzal)

Item		Plan 1	Plan 2
Financial Sources	Financial Source A	173.5	173.5
	Financial Source B	-	26.5
	Fund Saved by EMPAGUA*1	52.0	25.5
Total Revenue *2	Revenue of Sewage Services	131.0	93.6
	• Domestic	105.4	75.3
	• Industrial	25.6	18.3
	Transfer from General Account	611.7	276.1
Average Service Charge (Q/connection/Month)		21.0	15.0
Nominal FIRR *3		8.0%	3.0%

Note: *1 Average service charge in this table has to be applied to Central Region area after the year 1998.
*2 Accumulation for the economic life of the sewerage facilities.
*3 An internal rate of return of total revenue from sewage treatment services including transfer from EMPAGUA's general accounts against the total amount from loans.

Source : Study Team

The average sewage service charge (Q21/connection/month) of Plan 1 looks high compared to the present average sewage service charge of Q10/connection/month. On the other hand, the average charge (Q15/connection/month) of Plan 2 looks reasonable when compared to that of Plan 1. In Plan 2, however, the undertaker has to get loans from two foreign financial sources. It might often be intricate for a debtor because of complicate procedures and communication among agencies concerned.

Higher mark-up of sewage service charge of Plan 1 is caused by short period available for accumulating the fund. Fund for investment has to be raised within a short period of four (4) years from 1998 to 2001. But when the construction period of sub-main and lateral sewer systems is extended two more years, it could mitigate the burden on beneficiaries due to lower mark-up of sewage service charges. Table 13-4 and Fig 13-1 show the financial stream of Derivative Plan 1, which is a variation of the financial plan 1.

According to this analysis, the sewage service charge is calculated at Q17/connection/month. This was only Q2 higher than that of Plan 2. This rate sounds reasonable. Moreover, the undertaker could rely on a single foreign financial source, so it can promote the implementation without intricate procedures. The financial conditions under the derivative financial plan from Plan 1 were tabulated in Table 13-5. The nominal FIRR of the Derivative Plan 1 is calculated at 5.8%.

Table 13-4 Financial Stream of Revenue and Expenditure for 5 Year Construction Schedule Plan: South 3 Region

Under 1.7 Times' Tariff with Transfer from Central Region's Surplus Portion After 1998

(Unit: Q Million)

Serial No.	Year	Capital Balance							Revenue Balance										Working Fund (W/F)*3		Cash Balance *1	Balance Carried Forward
		Revenue			Expenditure			Balance	Revenue				Expenditure					Balance				
		Financial Source 1	Transfer fm Central	Total	Construction Cost	F.Source 1 Repayment	Total		Domestic Sewage	Industry Sewage	Transfer fm Central	Total	O/M Expenses	Depreciation*2	Interest of F.Source 1	Interest of W/F	Total		Procurement	Repayment		
1	1998	5.5	6.8	12.3	5.4	0.0	5.4	6.9	0.0	0.0	1.9	1.9	0.0	0.0	0.1	0.0	0.1	1.8	0.0	0.0	8.7	8.7
2	1999	58.3	9.0	67.3	69.1	0.0	69.1	-1.9	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	1.6	-1.6	0.0	0.0	-3.4	5.3
3	2000	58.3	9.2	67.5	69.1	0.0	69.1	-1.6	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	3.0	-3.0	0.0	0.0	-4.6	0.7
4	2001	51.4	9.5	60.9	60.1	0.0	60.1	0.7	0.0	1.4	0.0	1.4	0.0	0.0	4.3	0.0	4.3	-2.9	1.5	0.0	-0.7	0.0
5	2002		8.7	8.7	8.7	0.0	8.7	0.0	1.2	0.7	0.8	2.7	1.5	6.1	4.3	0.1	12.0	-9.3	4.7	1.5	0.0	0.0
6	2003		8.7	8.7	8.7	0.0	8.7	0.0	1.2	0.7	1.1	3.0	1.6	6.4	4.3	0.2	12.4	-9.4	7.7	4.7	0.0	0.0
7	2004					0.0	0.0	0.0	1.5	0.7	10.1	12.3	1.6	6.6	4.3	0.0	12.6	-0.3	1.4	7.7	0.0	0.0
8	2005					0.0	0.0	0.0	1.8	0.7	10.3	12.8	1.7	6.6	4.3	0.0	12.6	0.3	0.0	1.4	5.5	5.5
9	2006					0.0	0.0	0.0	2.2	0.7	10.6	13.5	1.7	6.6	4.3	0.0	12.6	0.9	0.0	0.0	7.5	13.1
10	2007					0.0	0.0	0.0	2.3	0.7	10.9	13.9	1.7	6.6	4.3	0.0	12.6	1.3	0.0	0.0	8.0	21.1
11	2008					8.5	8.5	-8.5	2.4	0.7	11.2	14.4	1.7	6.6	4.1	0.0	12.4	2.0	0.0	0.0	0.1	21.2
12	2009					8.5	8.5	-8.5	2.5	0.7	11.6	14.8	1.7	6.6	3.9	0.0	12.2	2.6	0.0	0.0	0.8	22.0
13	2010					8.5	8.5	-8.5	2.6	0.7	11.9	15.2	1.7	6.6	3.6	0.0	12.0	3.2	0.0	0.0	1.4	23.4
14	2011					8.5	8.5	-8.5	2.7	0.7	12.3	15.7	1.7	6.6	3.4	0.0	11.8	4.0	0.0	0.0	2.1	25.5
15	2012					8.5	8.5	-8.5	2.8	0.7	12.7	16.2	1.7	6.6	3.2	0.0	11.5	4.7	0.0	0.0	2.9	28.4
16	2013					8.5	8.5	-8.5	3.0	0.7	13.2	16.8	1.7	6.6	3.0	0.0	11.3	5.5	0.0	0.0	3.6	32.0
17	2014					8.5	8.5	-8.5	3.1	0.7	13.6	17.4	1.7	6.6	2.8	0.0	11.1	6.3	0.0	0.0	4.5	36.5
18	2015					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	2.6	0.0	10.9	7.0	0.0	0.0	5.2	41.7
19	2016					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	2.4	0.0	10.7	7.2	0.0	0.0	5.4	47.1
20	2017					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	2.1	0.0	10.5	7.5	0.0	0.0	5.6	52.7
21	2018					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	1.9	0.0	10.3	7.7	0.0	0.0	5.8	58.5
22	2019					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	1.7	0.0	10.1	7.9	0.0	0.0	6.1	64.6
23	2020					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	1.5	0.0	9.9	8.1	0.0	0.0	6.3	70.8
24	2021					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	1.3	0.0	9.6	8.3	0.0	0.0	6.5	77.3
25	2022					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	1.1	0.0	9.4	8.5	0.0	0.0	6.7	84.0
26	2023					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	0.9	0.0	9.2	8.7	0.0	0.0	6.9	90.9
27	2024					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	0.6	0.0	9.0	9.0	0.0	0.0	7.1	98.1
28	2025					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	0.4	0.0	8.8	9.2	0.0	0.0	7.3	105.4
29	2026					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	0.2	0.0	8.6	9.4	0.0	0.0	7.6	112.9
30	2027					8.5	8.5	-8.5	3.2	0.7	14.0	17.9	1.7	6.6	0.0	0.0	8.4	9.6	0.0	0.0	7.8	120.7
31	2028					0.0	0.0	0.0	3.2	0.7	14.0	17.9	1.7	6.6	0.0	0.0	8.4	9.6	0.0	0.0	16.2	136.9
32	2029					0.0	0.0	0.0	3.2	0.7	14.0	17.9	1.7	6.6	0.0	0.0	8.4	9.6	0.0	0.0	16.2	153.2
33	2030					0.0	0.0	0.0	3.2	0.7	14.0	17.9	1.7	6.6	0.0	0.0	8.4	9.6	0.0	0.0	16.2	169.4
34	2031					0.0	0.0	0.0	3.2	0.7	14.0	17.9	1.7	6.6	0.0	0.0	8.4	9.6	0.0	0.0	16.2	185.6
	Total	173.5	52.0	225.5	221.3	169.3	390.6		84.0	22.2	371.0	477.1	50.6	198.4	75.4	0.3	324.7					

Note: *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

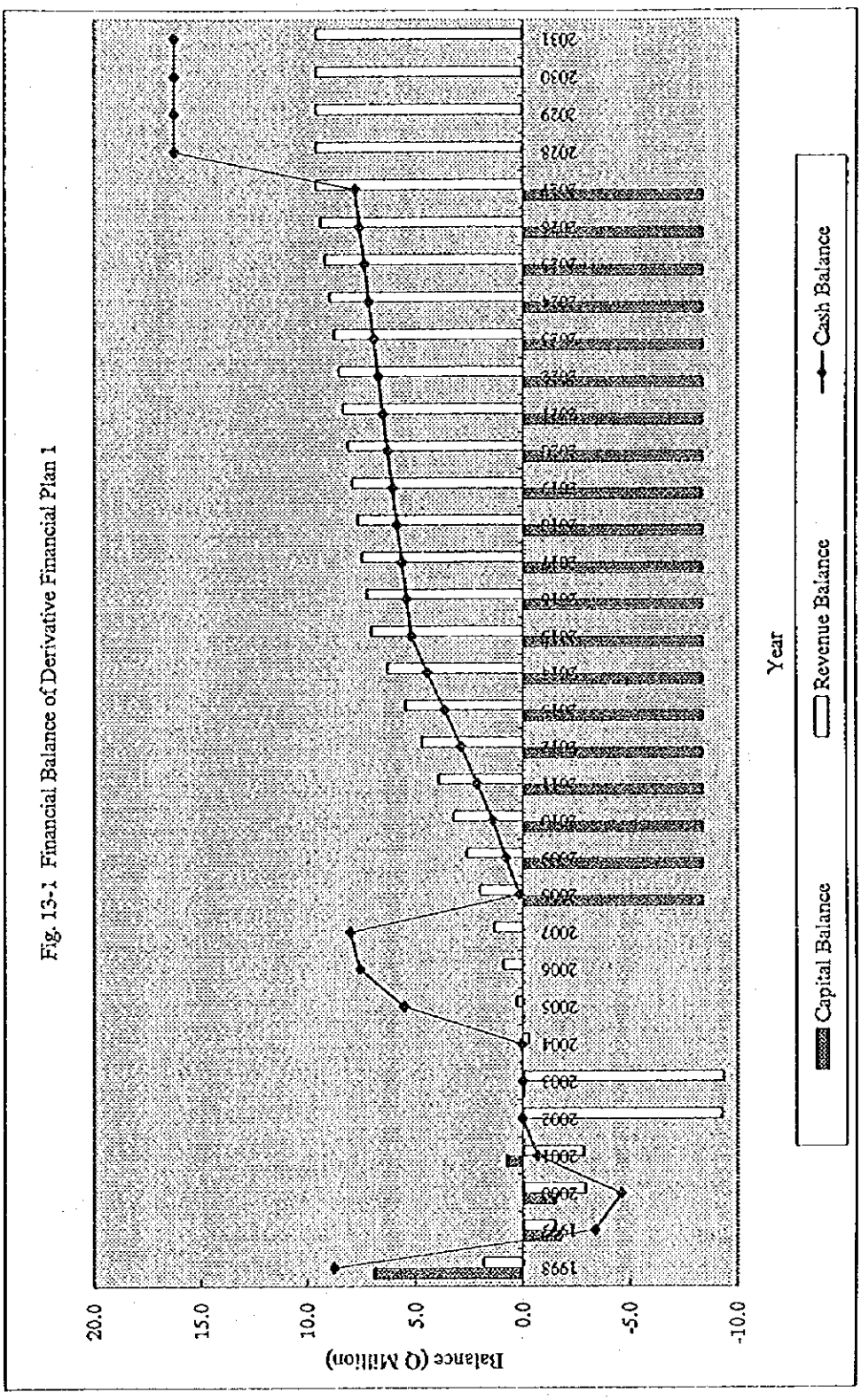
*2 30 years depreciation

*3 Transfer amount from Central Region was assumed at Q7.00/Connection/Month on average in the served area.

*4 Terms of Source Alternative 1

Item	Financial Source 1
Interest Rate:	2.5% p.a. (2.1% for Consultant fee)
Repayment Period:	30 Years
Grace Period:	10 Years

Fig. 13 - 1



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE FINANCIAL BALANCE OF DERIVATIVE FINANCIAL PLAN 1

Table 13-5 Financial Conditions of Derivative Plan 1

(Unit: Million Quetzal)

Item		Derivative Plan 1
Financial Sources	Financial Source A	173.5
	Fund Saved by EMPAGUA*1	52.0
Total Revenue *2	Revenue of Sewage Services	106.2
	• Domestic	84.0
	• Industrial	22.2
	Transfer from General Account	371.0
Average Service Charge (Q/connection/Month)		17.0
Nominal FIRR *3		5.8%

Note: *1 Average service charge in this table has to be applied to Central Region area after the year 1998.
*2 Accumulation for the economic life of the sewerage facilities.
*3 An internal rate of return of total revenue from sewage treatment services including transfer from EMPAGUA's general accounts against the total amount from loans.

b) Household Budget of Domestic Users

In the "Public Attitude Survey", the monthly income of households were classified into the following three levels: high income class, (of more than Q5,000); middle income class, (of between Q2,001 and Q5,000); and low income class, (of less than Q2,000), as mentioned in Chapter 11. The average volume of water consumption was analyzed as follows: 43 m^3/month for high income class; 25 m^3/month for middle income class; and 23 m^3/month for low income class. Table 13-6 shows the level of sewage service charges as a percentage of household income by income class. Hence, each family is assumed to consume the aforesaid volume of water.

Table 13-6 Level of Sewage Service Charge as Percentage of Household Income

Item	Low Income	Middle Income	High Income
Monthly Income (Quetzal)	Less than 2,000	2,001 to 5,000	More than 5,001
Water Consumption (m^3/month)	23	25	43
Sewage Service Charge			
Present Tariff*1	3.68	4.00	6.40
Charges Proposed*2	6.26	6.80	10.88
Percentage of Income			
Present Tariff *1	More than 0.18%	0.08% to 0.20%	Less than 0.13%
Charges Proposed*2	More than 0.31%	0.14% to 0.34%	Less than 0.22%

Note: *1 The present tariff, revised in January 1995.
*2 Charge based on the derivative financial plan of Plan 1, i.e., Q17/connection/month on average. This average charge corresponds to Q0.27/m^3, which is 1.7 times of present unit charge of Q0.16/m^3.

At present the sewage service charge accounts for less than 0.13% of household income for high income class; 0.08% to 0.20% for middle income class; and more than 0.18% for low income class. When the charges based on the Derivative Plan 1, i.e., Q17/connection/month on average, were reflected in the sewage service tariff, the charges will increase to less than 0.22% of household income for high income class; 0.14% to 0.34% for middle income class; and more than 0.31% for low income class. For low income households, the tariff structure still seems to be more burdensome. However, those percentages as a whole look reasonably small, as already compared to the proposal in Table 11-16.

Furthermore, this mark-up of tariff can be also compared with the surcharge rates used in other cities. The mark-up of the tariff from Q10 to Q17 is considered to have the same effect that the present 20% surcharge rate is raised to 34%. As can be seen in Table 13-7, the surcharge rates of other cities range from 14% to 178%. The 34% does not stands out among those rates. Moreover, once the incremental charge is examined from the total increase of the water and sewage services, the increase rate results in only 12%. This would look not so heavy for the beneficiaries in the service areas.

Table 13-7 World Sewerage Surcharge Practice

City, Country	Surcharge rate
Bandung, Indonesia	30%
Bombay, India	50%
Madras, India	20%
Hanoi, Vietnam	14.2%
Karachi, Pakistan	50%
Suva, Fiji	Over 70%
Beijing, China	40%
Seoul, Korea	40%
Tokyo, Japan	76%
Berlin, Germany	144%
Hamburg, Germany	178%
Paris, France	42%
London, UK	95%
New York, USA	158%

Source: Water Utilities Data Book. Asia Development Bank
Survey by Ministry of Construction of Japan
Japanese Assistance of Sewerage Project. Tokyo Metropolitan Government

c) Economic Efficiency

As described in Section 12.6 of Main Report, implementation of sanitation system is not included in the proposed First Stage Project, thus, EIRR of the project in South 3 Region is calculated at 5.7% (increased from 5.4%).

Table 13-8 Economic Cost and Benefit Stream: Sewerage Scheme of South 3 Region

(Unit:Q1000)

Serial		Cost			Benefit						Balance
No.	Year	Const-	O/M	Total	Decrease of Diseases			Purification	Negative	Total	
		ruction			Death	Inpatient	Outpatient	for W/S	Benefit		
1	1998	5,242	0	5,242	0	0	0	0	0	0	-5,242
2	1999	54,328	0	54,328	0	0	0	0	25	-25	-54,353
3	2000	54,328	0	54,328	0	0	0	0	25	-25	-54,353
4	2001	54,328	0	54,328	0	0	0	0	25	-25	-54,353
5	2002	7,872	1,340	9,212	176	31	2	8,799	25	8,983	-230
6	2003	7,872	1,402	9,275	343	44	3	8,799	25	9,164	-111
7	2004		1,474	1,474	656	68	4	8,799	25	9,501	8,027
8	2005		1,486	1,486	1,114	96	5	8,799	25	9,989	8,503
9	2006		1,499	1,499	1,761	130	7	8,799	25	10,672	9,173
10	2007		1,505	1,505	2,350	154	9	8,799	25	11,286	9,781
11	2008		1,508	1,508	3,037	154	9	8,799	25	11,973	10,464
12	2009		1,512	1,512	3,830	154	9	8,799	25	12,766	11,254
13	2010		1,516	1,516	4,734	154	9	8,799	25	13,670	12,155
14	2011		1,520	1,520	5,775	154	9	8,799	25	14,710	13,190
15	2012		1,524	1,524	6,956	154	9	8,799	25	15,892	14,368
16	2013		1,528	1,528	8,283	154	9	8,799	25	17,219	15,691
17	2014		1,534	1,534	9,774	154	9	8,799	25	18,710	17,177
18	2015		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
19	2016		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
20	2017		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
21	2018		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
22	2019		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
23	2020		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
24	2021		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
25	2022		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
26	2023		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
27	2024		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
28	2025		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
29	2026		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
30	2027		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
31	2028		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
32	2029		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
33	2030		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833
34	2031		1,538	1,538	11,435	154	9	8,799	25	20,371	18,833

Present Value (Discounted at 10%)

Cost (Q1000) :	146,501	NPV (Q1000):	-57,715
Benefit(Q1000):	88,786	B/C :	0.61
		EIRR :	5.7%

13.2 CONSTRUCTION PROGRAM

13.2.1 Outline of Facilities to be Constructed

An outline of the facilities to be constructed in first stage are described below.

Sewer Pipeline (collectors) : Trunk sewer as the collector and branch sewers are proposed to be constructed by open cut and tunneling methods (diameter : 1.5 m, length : about 10 km). The diameter of the trunk sewer varies from 300 to 1,500 mm and diameter of branch sewer is 200 mm.

WWTP : Treatment plant up to secondary treatment level is proposed to be built in the first stage. The sludge generated in the WWTP will be transferred after drying process to landfill site of Guatemala Municipality for final disposal.

13.2.2 Construction Methods

Sewer Pipeline : Sewer pipelines will be constructed mainly three (3) different methods. The sewer of 1,500 mm diameter as the main collector will be constructed by tunneling methods which is usually adopted in Guatemala and the sewers of 1,200 mm diameter and below are considered to be constructed by open cut method.

The sewer pipeline needs to cross Pinula and Guadron river each at one point. Pinula River crossing will be 70 m length and that of the Guadron River will be 40 m.

WWTP : The main construction works of WWTP is composed of civil works, building works and the pipe laying works. The civil works are carried out for land preparation, construction of the access road, the primary and secondary treatment facilities and other facilities. The building works are considered for administration building, warehouses and guardhouse. The pipe laying works include inflow pipe of the sewer, discharge pipe of the treated wastewater from WWTP to Pinula River and various pipeline within the WWTP.

13.2.3 Planning of Construction Works

a) Implementation Schedule

The development plan of the project is scheduled as follows.
Detailed design and construction periods for the first stage is estimated to be six (6) years from 1998 to 2003.

[First Stage]	1998	:	Detailed Design Period
	1999 ~ 2003	:	Construction Period
	2002	:	Commissioning

b) Construction Works for Each Year

Facilities to be constructed from the year 1998 to 2003 are shown in Table 13-9.

Table 13-9 Implementation Ratio/Volume of Construction Works

Serial No	Year	Sewer Pipeline			WWTP
		Trunk Sewer		Branch Sewer	
		Ø 1500 mm	Ø 300 ~1200	Ø 200 mm	
1	1998	----	----	----	----
2	1999	3,340 m	one-third	20,000 m	one-third
3	2000	3,340 m	one-third	20,000 m	one-third
4	2001	3,340 m	one-third	20,000 m	one-third
5	2002	----	----	13,000 m	----
6	2003	----	----	13,000 m	----

c) Disbursement Schedule

The proposed disbursement schedule of the project cost in the first stage is shown in Table 13-10. Land required for WWTP has been assumed to be acquired in year 1999 and 2000.

Table 13-10 Disbursement Schedule of First Stage for South 3 Region

(Construction Work Period : 5 years)

(Unit : Million Quetzal)

No	Costs Item	1998			1999			2000			2001			2002			2003			Total		
		L/C	F/C	Sub-Total	L/C	F/C	Sub-Total	L/C	F/C	Sub-Total	L/C	F/C	Sub-Total	L/C	F/C	Sub-Total	L/C	F/C	Sub-Total	L/C	F/C	Grand Total
1	Direct Construction	0	0	0	50.7	0	50.7	50.8	0	50.8	51.0	0	51.0	7.7	0	7.7	7.8	0	7.8	168.0	0	168.0
-1	Sewer Pipeline	0	0	0	20.8	0	20.8	20.9	0	20.9	21.0	0	21.0	7.7	0	7.7	7.8	0	7.8	78.2	0	78.2
	(1) Trunk Sewer	0	0	0	9.5	0	9.5	9.6	0	9.6	9.6	0	9.6	0	0	0	0	0	0	28.7	0	28.7
	(2) Brunch Sewer	0	0	0	11.3	0	11.3	11.3	0	11.3	11.4	0	11.4	7.7	0	7.7	7.8	0	7.8	49.5	0	49.5
	Brunch Sewer (1/2)	0	0	0	11.3	0	11.3	11.3	0	11.3	11.4	0	11.4	0	0	0	0	0	0	34.0	0	34.0
	Brunch Sewer (2/2)	0	0	0	0	0	0	0.0	0	0.0	0.0	0	0.0	7.7	0	7.7	7.8	0	7.8	15.5	0	15.5
-2	WWTP	0	0	0	29.9	0	29.9	29.9	0	29.9	30.0	0	30.0	0	0	0	0	0	0	89.8	0	89.8
2	Land Acquisition	0	0	0	9.0	0	9.0	9.0	0	9.0	0.0	0	0.0	0	0	0	0	0	0	18.0	0	18.0
3	Engineering Fee	1.3	4.1	5.4	0.7	2.0	2.7	0.7	2.0	2.7	0.7	2.0	2.7	0	0	0	0	0	0	3.4	10.1	13.5
4	Administration Fee	0	0	0	1.5	0	1.5	1.5	0	1.5	1.6	0	1.6	0.2	0	0.2	0.2	0	0.2	5.0	0	5.0
5	Physical Contingency	0	0	0	5.0	0	5.0	5.1	0	5.1	5.1	0	5.1	0.8	0	0.8	0.8	0	0.8	16.8	0	16.8
	Total	1.3	4.1	5.4	66.9	2.0	68.9	67.1	2.0	69.1	58.4	2.0	60.4	8.7	0	8.7	8.8	0	8.8	211.2	10.1	221.3

Note : L/C : Local Currency, F/C : Foreign Currency

13.3 ORGANIZATION PLAN

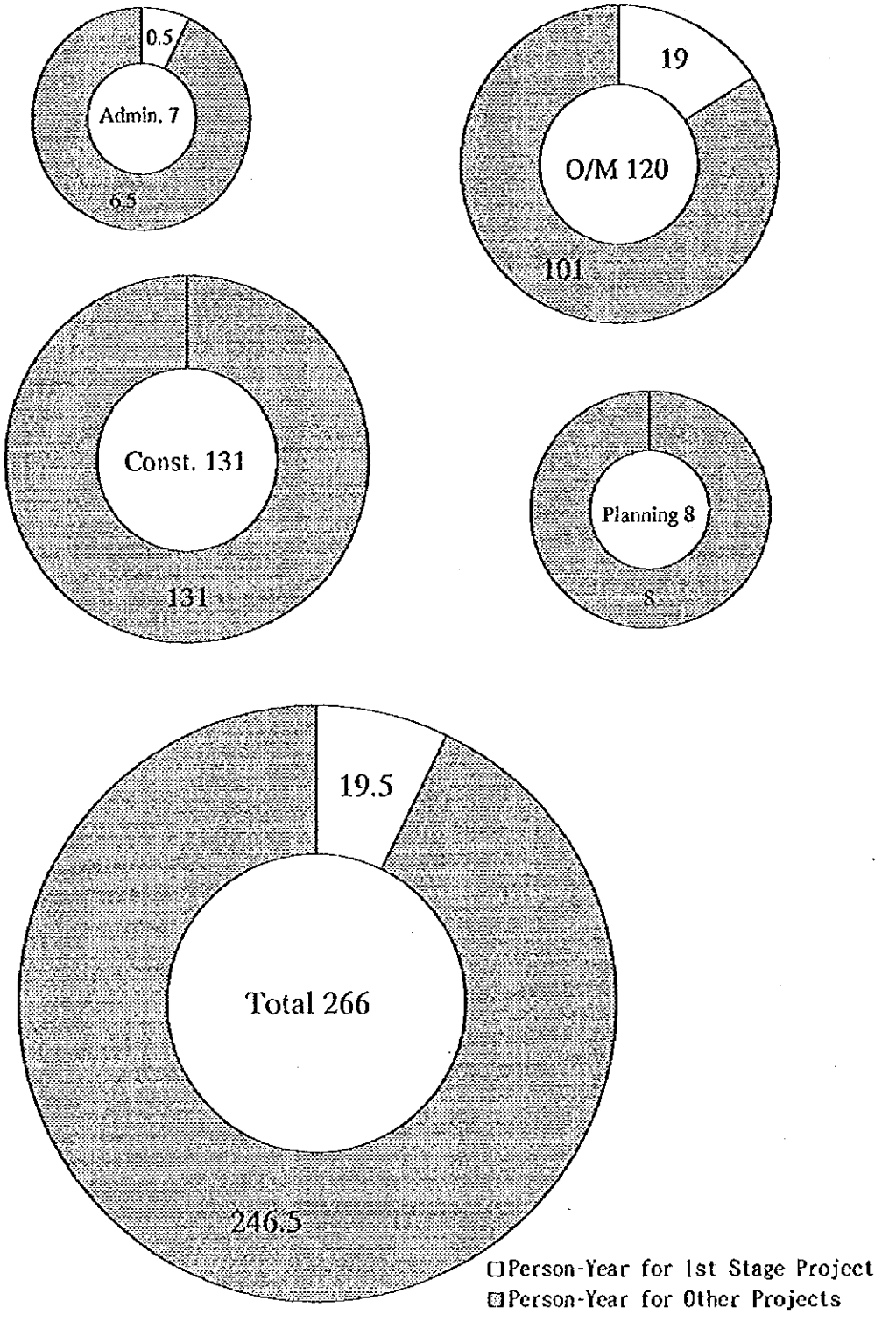
As described in Table 11-23, the Wastewater Management Division at the beginning of 2002 will have 266 staff due to the reorganization of sewerage-related units. This staff is further divided by project type. Since one physical person can work for plural projects, the concept of "person-year" is applied. If a staff exclusively works for a particular project during a year, his or her work volume is regarded as one person-year; if he works for two projects equally, he will be supposed to dedicate half person-year of working time for each project.

Table 13-11 shows the staff separation of Wastewater Management Division by this concept. The staff of Administrative Section and Division Head are divided prorata to the number of non administrative staff working for various sewerage projects. "Other projects" include all other projects than the First Stage Project of the Proposed Project. No personnel relocation and dismissals in old sewerage-related units are considered here. Therefore, 246.5 staff for other projects may shrink depending on EMPAGUA's personnel strategy. Fig. 13-2 visualizes the distribution of staff between the First Stage Project and other projects.

Table 13-11 Person-Year Required for First Stage Project in 2002

	Required for First Stage Project	Required for Other Projects	Total Staff Required
Division Head	0.07	0.93	1
Administrative Section			
Section head	0.07	0.93	1
Assistant section head	0.07	0.93	1
Secretary	0.14	1.86	2
Unskilled worker	0.14	1.86	2
Total	0.43	5.57	6
O/M Section			
Section head	0	1	1
Assistant section head	0	1	1
Clerk	0	2	2
Civil or sanitary engineer	1	0	1
Technical Staff	2	11	13
Secretary	1	1	2
Unskilled worker	15	85	100
Total	19	101	120
Planning Section			
Section head	0	1	1
Civil or sanitary engineer	0	1	1
Assistant engineer	0	2	2
Drafts person (Assist.engineer)	0	1	1
Secretary	0	1	1
Unskilled worker	0	2	2
Total	0	8	8
Construction Section			
Section head	0	1	1
Assistant Section Head	0	1	1
General affair staff	0	3	3
Clerk	0	4	4
Secretary	0	1	1
Technician	0	4	4
Specialized worker	0	5	5
Chief worker	0	10	10
Operative worker	0	102	102
Total	0	131	131
Grand Total	19.5	246.5	266

Fig. 13 - 2



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE PERSON - YEAR DISTRIBUTION IN WASTEWATER MANAGEMENT DIVISION IN 2002