In the first step, on the assumption that sewerage/sanitation projects in each Region are implemented independently, a preliminary analysis examined the following parameters for the sewerage/sanitation projects of each Region :

- Level of pollutant load reduction,
- Investment efficiency,
- Willingness to pay,
- Contribution to drinking water source protection,
- Availability of wastewater treatment plant sites.

In the second step, Priority Regions were selected from the alternatives through an overall evaluation which examined the alternatives with respect to the parameters selected in the preliminary analysis and other factors.

4.3.2 Preliminary Analysis

The principal data for sewerage/sanitation projects in each Region is summarized in Table 4-12.

Results of the preliminary analysis are described below and summarized in Table 4-13.

a) Pollutant Loads Reduction

The total BOD_5 load generation in the M/P Area in 2015 is estimated to be 194.6 t/day, of which 143.3 t/day, (or 74%) and 51.3 t/day, (or 26%) will be generated in the Motagua River Basin and the Lake Amatitlan Basin respectively.

Table 4-12 Summary of Principal Data for Project in each Region

Principal Data	Regions of Motagua River Basin					Regions of Lake Amatitlan			Total
	Central	North 1	North 2	East 1	East 2	South 1	South 2	South 3	
1. Population (Capita)									
Present Population (as of 1994)	505,000	180,000	70,000	251,000	31,700	40,000	83,000	139,000	1,299,700
Planned Population (2015)									
Sewerage	751,800	379,100	0	500,800	0	277,500	183,600	276,100	2,368,900
Sanitation	109,600	12,900	150,000	20,200	40,000	2,500	8,000	2,900	346,100
Total	861,400	392,000	150,000	521,000	40,000	280,000	191,600	279,000	2,715,000
2. Planned Area (ha)	7,227	2,232	740	3,935	1,155	1,648	2,293	2,414	21,644
3. Design Wastewater Flow Rate (m3/day)									
Sewerage System									
Daily Average Flow	237,757	88,899	0	120,382	0	63,983	50,969	65,734	627,724
Daily Maximum Flow	260,311	96,481	0	130,398	0	69,533	54,641	71,256	682,620
Hourly Maximum Flow	389,057	143,679	0	195,692	0	102,991	85,414	106,619	1,023,452
Sanitation System									
Daily Average Flow	18,084	2,129	24,750	3,333	6,600	413	1,320	479	57,108
Daily Maximum Flow	19,892	2,341	27,225	3,666	7,260	454	1,452	526	62,816
Hourly Maximum Flow	54,252	6,386	74,250	9,999	19,800	1,238	3,960	1,436	171,321
4. Estimated Pollutant Load Generation (BOD t/day)									
Sewerage	66.57	24.89	0.00	33.71	0.00	17.92	14.27	18.40	175.76
Sanitation	5.97	0.70	8.17	1.10	2.18	0.14	0.44	0.16	18.86
Total	72.54	25.59	8.17	34.81	2.18	18.06	14.71	18.56	194.62
Pollutant Load by Drainage Basin (BOD t/day)									
River Motagua Basin	72.54	25.59	8.17	34.81	2.18				143.29
Lake Amatitlan Basin						18.06	14.71	18.56	51.33
5. Cost Estimates (Million Quetzales)									
Sewerage									
Construction									
Sewers	136.4	172.3	0.0	200.2	0.0	112.5	95.4	183.4	900.2
Treatment Plant Secondary Treatment Level	232.3	93.7	0.0	116.8	0.0	59.1	47.6	70.7	620.2
Sub Total	368.7	266.0	0.0	317.0	0.0	171.6	143.0	254.1	1,520.4
Others	96.8	60.2	0.0	81.1	0.0	44.0	36.5	60.7	379.3
Total	465.5	326.2	0.0	398.1	0.0	215.6	179.5	314.8	1,899.7
Sanitation Facility									
Construction									
Sewers	33.0	1.9	12.0	9.9	56.3	0.4	3.2	1.9	118.6
Septic Tank Facility	41.6	4.9	56.7	7.9	15.1	1.1	3.0	1.1	131.4
Sub Total	74.6	6.8	68.7	17.8	71.4	1.5	6.2	3.0	250.0
Others	20.3	1.9	17.2	5.2	16.9	0.5	1.8	0.8	64.6
Total	94.9	8.7	85.9	23.0	88.3	2.0	8.0	3.8	314.6
Grand Total	560.4	334.9	85.9	421.1	88.3	217.6	187.5	318.6	2,214.3

Source : Study Team

Table 4-13 Preliminary Analysis of Regions

Parameters	Regions of Motagua River Basin					Regions of Lake Amatitlan			Total
	Central	North 1	North 2	East 1	East 2	South 1	South 2	South 3	
Quantitative Parameters									
(a) Projected Pollutant Load Reduction (BOD t/day)									
Sewerage	53.26	19.91	0.00	26.97	0.00	14.34	11.42	14.72	140.58
Sanitation	4.48	0.53	6.13	0.83	1.64	0.11	0.33	0.12	14.18
Total	57.73	20.44	6.13	27.79	1.64	14.44	11.75	14.84	154.76
Pollutant Load Reduction by Drainage Basin (BOD t/day)									
River Motagua Basin	57.73	20.44	6.13	27.79	1.64				113.73
Lake Amatitlan Basin						14.44	11.75	14.84	41.03
(b) Investment Efficiency (in Case of Secondary Treatment)									
per Unit Pollutant Load Reduction (Central Region =100)	100	167	141	156	548	152	163	219	
per Capita Served (Central Region=100)	100	131	88	125	340	120	150	175	
Qualitative Parameters									
(c) Ease of Service Charge Collection									
Average Willingness to Pay (WTP : Quetzales/Household/Month)	11.3	9.8	10.1	13.2	11.2	12.0	17.4	16.0	
(d) Contribution to Drinking Water Source Protection									
Surface Water									
Number of Intake Facilities	-	1	-	1	-	-	-	2	
Intake Flow Rate (m3/day)		6,700		22,400				17,000	
Groundwater									
Number of Wells run by EMPAGUA	21	62	5	15	0	7	1	12	
Total Withdrawal Rate (m3/day)	49,272	45,069	5,156	31,122	-	6,677	1,526	98,658	
(e) Availability of Wastewater Treatment Plant Sites									
Ranking (A : Good, B : Average, C : Difficult)	B	A	B	B	B	B	B	C	

Source : Study Team

All Regions: Fig. 4-4 shows higher pollutant load reduction is expected in Central, East 1, and North 1 Regions, where pollutant load generation is also high. Through implementing schemes in these Regions pollutant load reductions are estimated to be 30%, 14%, and 11% of the total generated pollutant load, and 37%, 18%, and 13% of the overall pollutant load reduction, respectively.

Motagua River Basin: Fig. 4-5 shows pollutant loads removed by implementation in Central and East 1 Regions are high compared with other Regions and are estimated to be 41% and 19% in the Motagua River Basin, and implementation of priority project in these Regions will achieve reductions of 51% and 24% of the overall pollutant load reduction for implementing all schemes in all the basin, respectively.

Lake Amatitlan Basin: Fig. 4-5 shows pollutant load reduction achieved by implementing schemes in South 3 and South 1 Regions are high compared with South 1 Region, and are estimated to contribute 29% and 28% of the total removable pollutant load, and implementation of priority project in these Regions can achieve reductions of 36% and 35% of the total removable pollutant load in the basin, respectively.

b) Investment Efficiency

Two indices expressing investment efficiencies are compared for the sewerage/sanitation project of each Region. The results are shown in Table 4-13. For both indices, a lower value indicates a higher investment efficiency. It should be noted that Central and North 2 Regions, have relatively high investment efficiencies.

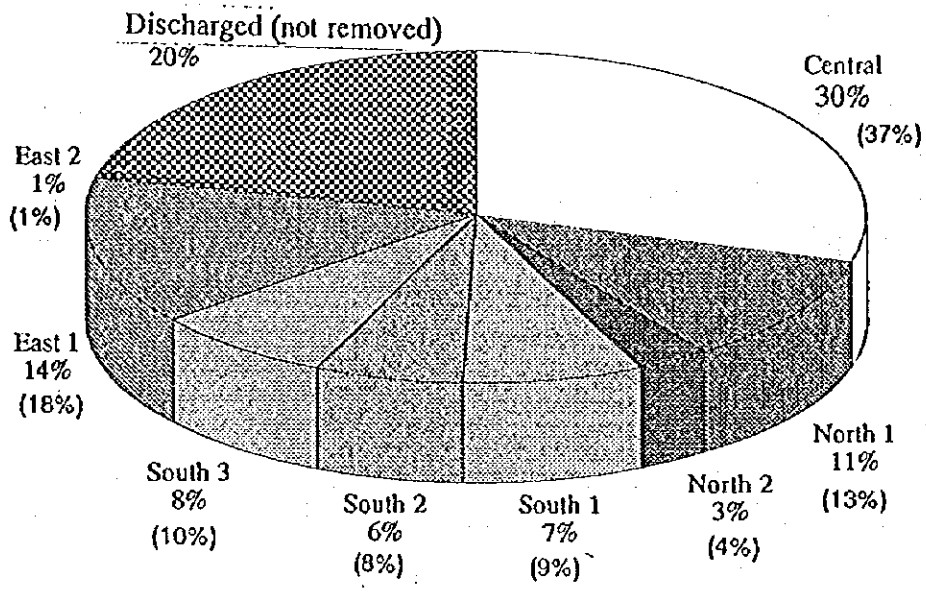
c) Ease of Service Charge Collection

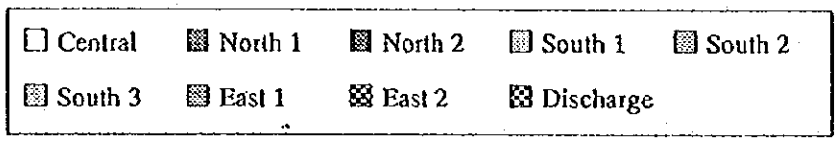
The average level for "Willingness to Pay" for sewerage/sanitation services found from the survey by the JICA Study Team was 13.3 Q/household/month. From a comparison of the estimated average Willingness to Pay in each Region with the overall average, consumers in South 2 and South 3 were willing to pay more for the services.

d) Contribution to Drinking Water Source Protection

In case of surface water, East 1 Region followed by South 3 Region is given high priority. While, in the case of groundwater, South 3 Region is the highest priority followed by Central and North 1 Regions.

Fig. 4 - 4



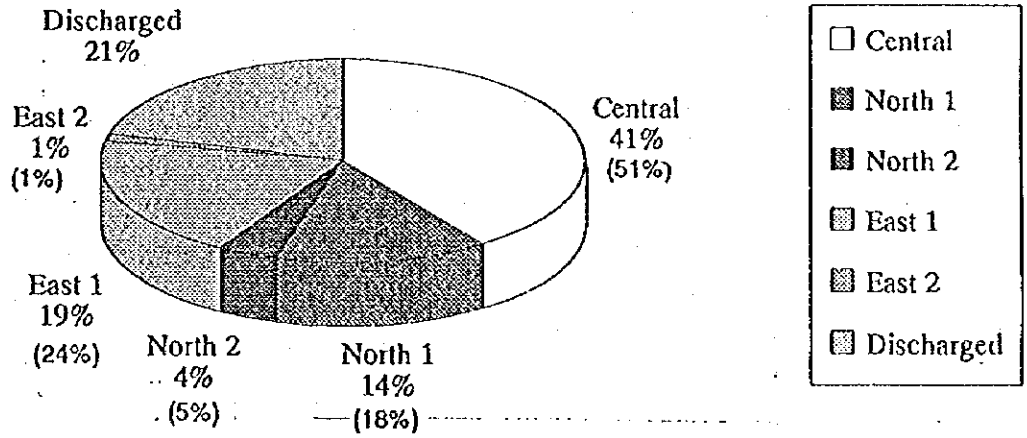


Figures in ( ) is the percentage of overall pollutant load reduction

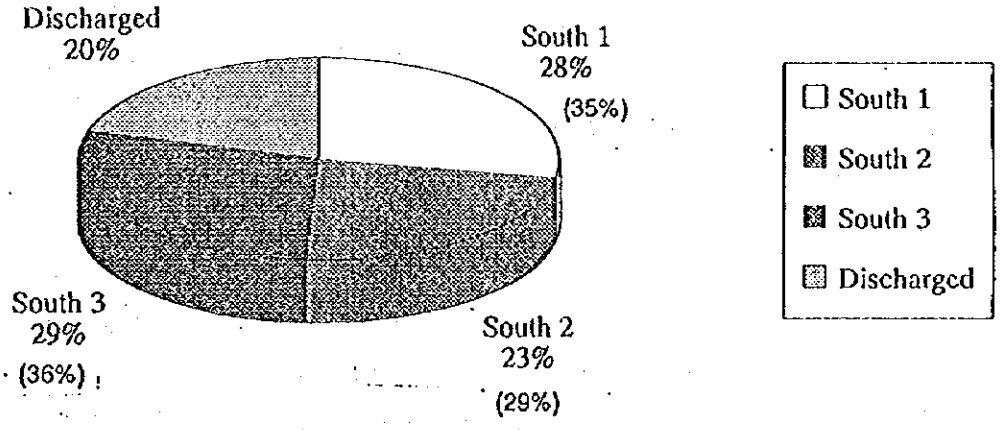
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE ESTIMATED PERCENTAGE BOD LOAD REMOVAL AFTER FULL IMPLEMENTATION (1/2)

Fig. 4 - 5

River Motagua Basin



Lake Amatitlan Basin



Figures in ( ) is the percentage of overall pollutant load reduction

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 ESTIMATED PERCENTAGE BOD LOAD REMOVAL AFTER FULL IMPLEMENTATION (2/2)

e) Availability of Wastewater Treatment Plant Sites

The selected wastewater treatment plant sites were examined and ranked, taking into account required land area, present land use, number of land owners, and level of land acquisition cost.

North 1 Region was ranked A, South 3 Region C, while other Regions were ranked B.

4.3.3 Selection of Alternatives for Priority Regions

From the results of the preceding preliminary analysis the three combinations of Regions shown in Table 4-14 have been selected for further evaluation to select the Priority Regions.

Table 4-14 Selected Alternative Combinations of Regions

Alternative	Regions
B-1	Central + South 1
B-2	Central + South 2
B-3	Central + South 3

Source : Study Team

The reasons for selecting the alternatives are:

- For parameters a), b), and d) in the preliminary analysis Central Region is identified as being the highest priority Region
- Taking into account the importance of Government policy with respect to protection of Lake Amatitlan, the possible Regions to be combined with Central Region should be situated within the Lake Amatitlan (Pacific Drainage) Basin.

4.3.4 Priority Regions

In order to finalize selection of the Priority Regions, each of the three combination of Regions selected from the preliminary study, namely Central Region with South 1, South 2 or South 3, has been further evaluated to assess the investment efficiency, water quality improvement, and other non-quantifiable factors such as the level of likely public profile of the project to promote the government's efforts in environmental protection, impact of implementation of sewerage.

The evaluation led to the following conclusions that Alternative 3 (Central + South 3 Regions) is recommended as the Priority Regions in the Wastewater Management Master Plan.

The reasons are :

a) Alternative 3 would contribute significantly to improving the water quality of Lake Amatitlan and will have high public appeal and demonstrate the governments eagerness for environmental improvement.

b) Alternative 3 covers many municipalities and has a high population thus, the provision of sewerage/sanitation would have a significant impact on the largest number of residents who would as a result better understand and appreciate the public administration's efforts for environmental protection.

4.4 Development Plan of Priority Regions

4.4.1 Implementation Schedule

It is assumed that the construction program to build the sewerage / sanitation system will start in 1999 for the priority Regions of Central and South 3. The whole program period is divided into three consecutive stages; the first stage program being from 1999 to 2001, the second stage from 2002 to 2006, and the third stage from 2007 to 2011. The schedule is summarized in Fig. 4-6. Fig. 4-7 shows the stages for increasing the treatment capacity for plants in Central and South 3 Regions. This phasing, with its inherent flexibility, will permit periodic re-evaluation as required.

4.4.2 Staged Implementation

a) First Stage Construction Program (1999 to 2001)

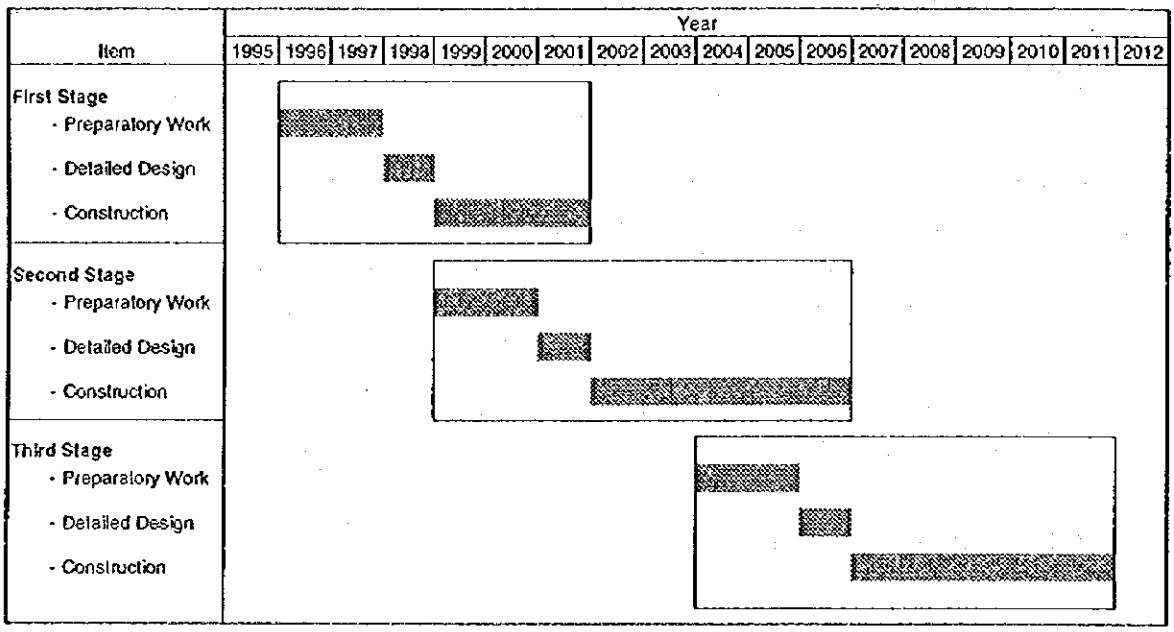
The components of the first stage construction program are summarized in Table 4-15.

Table 4-15 Proposed First Stage Construction Program

Component Facilities	Central Region	South 3 Region
1. Sewerage System		
Main Collector Sewers	3,000 mm dia. x 10.1 km	300 to 1,500 mm dia. x 15.5 km
Branch & Lateral Sewers	—	Reticulations to Main Collector Sewers
Wastewater Treatment Plants	Land Acquisition	Land Acquisition
"	Common Facilities	Common Facilities
"	Primary Treatment, 15 trains	Secondary Treatment, 3 trains
2. Sanitation System		
Branch and Lateral Sewers	Approximately 56 km	Approximately 10km
Community Treatment Plants	Land Acquisition for 35 plants	Land Acquisition for 3 plants
	Construction of 35 plants	Construction of 3 plants

Source : Study Team

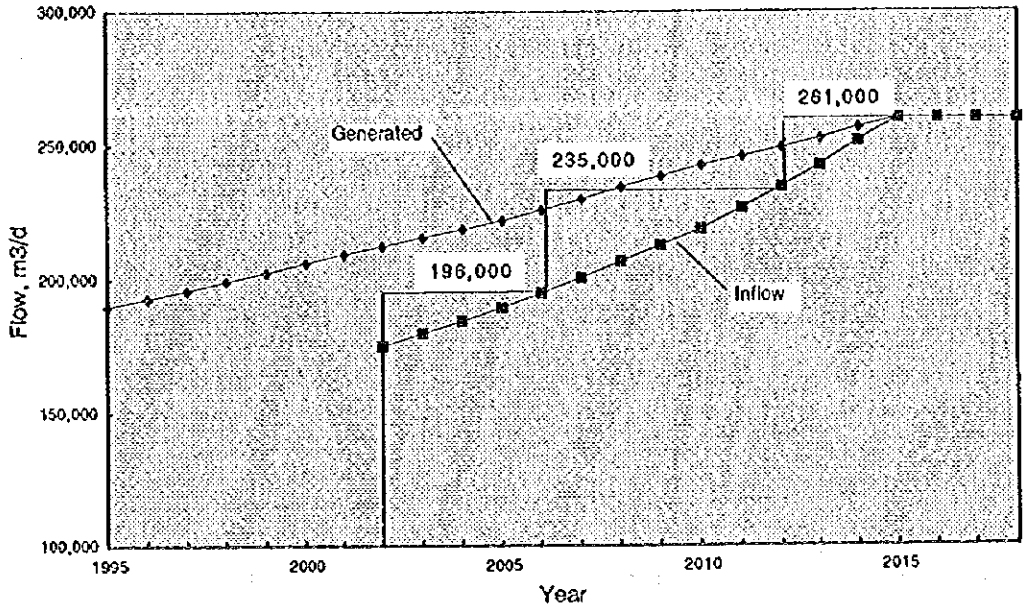
Fig. 4 - 6



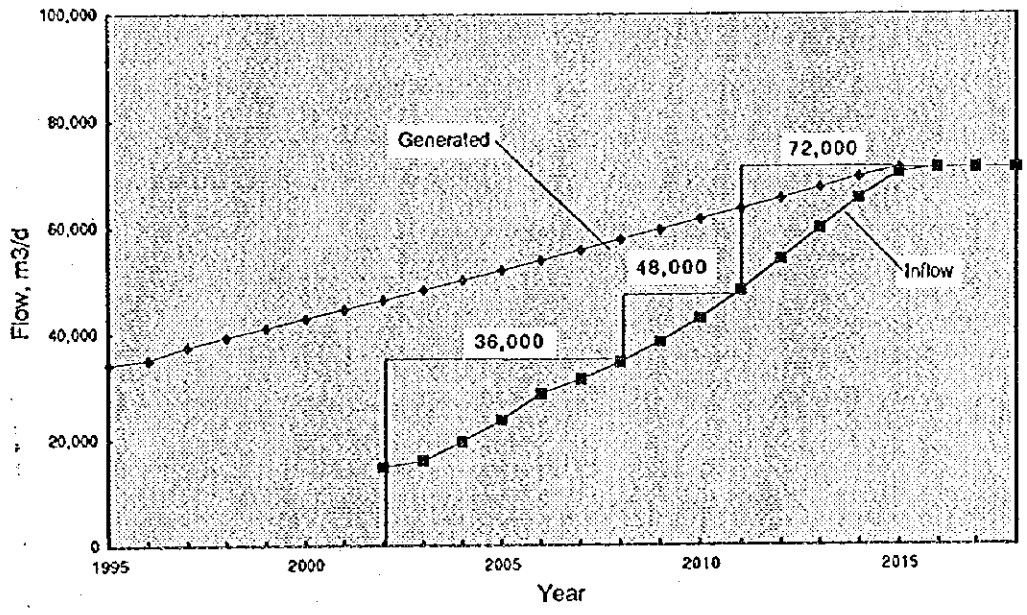
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE STAGED IMPLEMENTATION PROGRAM

Fig. 4 - 7

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



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 STAGES FOR INCREASING TREATMENT CAPACITY IN CENTRAL AND SOUTH 3 REGIONS

b) Second Stage Construction Program (2002 to 2006)

The components to be built are summarized in Table 4-16.

Table 4-16 Proposed Second Stage Construction Program

Component Facilities	Central Region	South 3 Region
1. Sewerage System		
Main Collector Sewers		200 to 1,500 mm dia. x 21.48 km
Branch & Lateral Sewers	Connection to Main Collector Sewers	Reticulations to Main Collector Sewers
Wastewater Treatment Plant	Primary Treatment 3 trains	Primary Treatment 1 train
"	Secondary Treatment 10 trains	Secondary Treatment 1 train
2. Sanitation System		
Branch and Lateral Sewers	Approximately 56 km	—
Community Treatment Plants	Land Acquisition for 35 plants	—
"	Construction of 35 plants	—

Source : Study Team

c) Third Stage Construction Program (From 2007 to 2011)

The wastewater system components to be provided under this stage are summarized in Table 4-17.

Table 4-17 Proposed Third Stage Construction Program

Component Facilities	Central Region	South 3 Region
1. Sewerage System		
Main Collector Sewers	—	—
Branch & Lateral Sewers	Reticulations to Main Collector Sewers	Reticulations to Main Collector Sewers
Wastewater Treatment Plant	Primary Treatment 2 trains	Primary Treatment 2 trains
"	Secondary Treatment 10 trains	Secondary Treatment 2 trains
2. Sanitation System		
Branch and Lateral Sewers	Approximately 65 km	—
Community Treatment Plants	Land Acquisition for 40 plants	—
"	Construction of 40 plants	—

Source : Study Team

4.4.3 Investment Program

Table 4-18 shows the construction cost for each period. Operation and maintenance costs by stage are also summarized in Table 4-19.

Table 4-18 Construction Costs by Stage

(Units: Million Quetzal)

Components	First Stage (1999 - 2001)	Second Stage (2002 - 2006)	Third Stage (2007 - 2011)	Total
1. Sewerage System				
Central Region	162.3	154.0	149.2	465.5
South 3 Region	103.5	97.7	113.6	314.8
Sub-Total	265.8	251.7	262.8	780.3
2. Sanitation System				
Central Region	30.1	30.1	34.7	94.9
South 3 Region	3.8	0.0	0.0	3.8
Sub-total	33.9	30.1	34.7	98.7
3. Grand Total	299.7	281.8	297.5	879.0

Note : Costs are as of September 1995
Source : Study Team

Table 4-19 Annual O/M Costs by Region

(Units: Thousand Quetzal)

Year	Central Region			South 3 Region			Grand Total
	Sewerage	Sanitation	Total	Sewerage	Sanitation	Total	
2002	3,736	151	3,887	996	79	1,075	4,962
2003	3,850	200	4,050	1,113	79	1,192	5,242
2004	3,969	266	4,235	1,241	79	1,320	5,555
2005	4,088	333	4,421	1,372	79	1,451	5,872
2006	4,212	399	4,611	1,506	79	1,585	6,196
2007	5,158	462	5,620	1,749	79	1,828	7,448
2008	5,282	528	5,810	1,909	79	1,988	7,798
2009	5,404	587	5,991	2,104	79	2,183	8,174
2010	5,527	653	6,180	2,270	79	2,349	8,529
2011	5,660	724	6,384	2,441	79	2,520	8,904
2012	6,536	776	7,312	2,728	79	2,807	10,119
2013	6,582	818	7,400	2,782	79	2,861	10,261
2014	6,628	849	7,477	2,806	79	2,885	10,362
2015	6,668	880	7,548	2,856	79	2,935	10,483
2016	6,672	897	7,569	2,859	79	2,938	10,507
2017	6,674	903	7,577	2,859	79	2,938	10,515
2018	6,675	908	7,583	2,859	79	2,938	10,521

Note : Costs are as of September 1995
Source : Study Team

4.5 EVALUATION OF PROJECTS IN PRIORITY REGIONS

4.5.1 Technical Evaluation

The technical soundness of the proposed wastewater management facilities is examined with respect to the following points of view;

- Appropriate technology level,
- Likely ease of project implementation given the local technical level,
- Soundness of operation and maintenance required to run the proposed system.

It can be evaluated that the proposed facilities are technically sound with respect to the points above. The reasons are described in the followings for each of the system components.

a) Wastewater Collection Facilities

The proposed wastewater collection system is a gravity system, which requires no mechanical and electrical equipment and no power supply. The Operation and Maintenance is easy and low cost.

Large collector sewers bigger than 1,500 mm diameter, and manholes (vertical shafts), will be constructed by tunneling.

The existing collectors in the Central Region were constructed by the tunneling method. EMPAGUA has experience and confidence in tunnel construction.

b) Wastewater Treatment Facilities

The proposed wastewater treatment process applied to sewerage and sanitation systems, which are trickling filter and septic tank with adsorption well / anaerobic filter respectively, are easy to construct with locally available materials, and do not require imported mechanical and electrical equipment. The O/M of the proposed systems is easy, and low cost, and there is local practical experience and knowledge accumulated from the existing facilities.

c) Sludge Treatment Facility

The sludge treatment process proposed consists of anaerobic digesters, without covers or heating, and sludge drying beds. This process is being used in existing facilities, and operational experience and knowledge has been accumulated. The O/M of the process is easy and low in cost.

4.5.2 Financial Evaluation

a) Charges for Sewage Services

The rate of sewage service is estimated on the basis of water charge consumed as surcharge. According to the present tariff, the rate is 20% of specific charge portion of potable water consumed. Based on the EMPAGUA's tariff expected to be effective in January 1995, sewage service charge for domestic users is calculated at Q0.16/m^3. For typical business users such as commercial and industrial establishments, sewage service charges were calculated as Q0.40/m^3 and Q0.50/m^3, respectively.

According to the results of the "Public Attitude Survey" conducted by the Study Team, the average monthly price that a household could pay for sewage service is calculated at Q13.3 on average. The unit price that a household could pay for sewage service is calculated at Q0.49/m^3 on average.

Applying this average unit price instead of the charge under the present tariff (Q0.16/m^3), the revenue would be around three (3) times larger than that at present. Under the tariff revised in January 1995, an average sewage service charge is estimated at around Q10 per connection per month, according to the analysis of EMPAGUA's income statements in 1994. Increase of service charges is indispensable for implementation of the proposed project, and the alternatives of service charges are set up as follows (Table 4-20):

Table 4-20 Average Sewerage Service Charges for Financial Evaluation

Average Service Charges with the Project	Regions	Revenue for the Proposed Project, Q/connection/month
Charge I (Q20 / connection/month)	Central	10
	South 3	20
Charge II (Q30 / connection/month)	Central	20
	South 3	30

In Central Region, service charge collected at present (Q10/connection/month) is used for maintenance of the existing sewer system. Therefore, this charge will not contribute to the revenue of the Proposed Project.

b) Financial Evaluation

Financial analysis was conducted to examine the financial viability of the proposed project in the Priority Regions.

Table 4-21 summarizes the results of the analysis for three cases set forth. As shown in the table, the proposed project would be viable if Case 3 could be applied, in which, the sewage service Charge II, based on willingness-to-pay, was applied to the beneficiaries in the service areas and 40% of the investment cost was subsidized by the governments or contributed by beneficiaries.

Table 4-21 Summary of the Results of Financial Analysis

Case	Charge	Contribution	FIRR	Remarks
1	Charge I	nil	-1.1%	
2	Charge II	nil	4.1%	
3	Charge II	40% of Total Investment Cost	8.4%	IBRD (7.2%) IDB(8.1%)

Note : Evaluation Period is 30 years from the completion of construction work.
Source : Study Team

The cash balance of project management was examined for the sound management of proposed project for Case 3 under the following financial conditions.

(1) Long-term foreign loan: interest rate of 8.1% per annum and repayment period of 20 years including grace period of 5 years.
(2) Short-term loan: interest rate of 10% per annum for working fund, in case of covering short-time financial shortage.

It becomes clear that for the undertaker EMPAGUA to accomplish the sound management of the proposed project for Case 3, 66% of the interest of the long-term loan has to be subsidized by the governments.

c) Household Budget of Domestic Users

Table 4-22 shows the level of sewage service charges as a percentage of household income by income class. Those percentages are still small when compared with the referential figure of 3%. However, it can be said that the tariff structure would be more burdensome for low and middle income households than for high income households.

Table 4-22 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	3.68	4.00	6.40
Charges based on Charge II*1	11.04	12.00	19.20
Percentage of Income			
Present Tariff	More than 0.18%	0.08% to 0.20%	Less than 0.13%
Charges based on Charge II*1	More than 0.55%	0.24% to 0.60%	Less than 0.38%
Referential Rate*2	Maximum 3%	Maximum 3%	Maximum 3%

Note: *1 Charge II, i.e., three times of the present tariff.
*2 Low Cost Sanitation, World Bank Economic Development Institute

Source: Study Team

4.5.3 Economic Evaluation

a) Basic Conditions and Assumptions

In estimating economic cost and benefit, economic values are converted or quantified from the financial costs under the following conditions

1) Opportunity cost of capital : 10%
2) Standard conversion factor (SCF) : 90% of financial values
3) No land acquisition costs but negative benefits due to loss of agricultural production in WWTP sites.
4) Economic life of the project : 30 years after the completion of construction works

b) Economic Benefits

The following important and tangible benefits are quantified.

<u>Positive Benefits</u>

1) Decrease of waterborne diseases
   - reduction of number of deaths
   - reduction of number of inpatients
   - reduction of number of outpatients
2) Reduction of future purification cost for water supply

<u>Negative Benefits</u>

3) Loss of agricultural production at WWTP sites

c) Economic Evaluation

Table 4-23 shows net present value (NPV), benefit-cost ratio (B/C) and economic internal rate of return (EIRR). EIRR of 7.9% is lower than the opportunity cost of capital (10%) and B/C was below 1.0. Thus, the proposed project might not be feasible, from the economic point of view.

Table 4-23 Summary of the Results of Economic Analysis

Item	Proposed Project in Priority Regions	Remarks
Net Present Value (NPV)	- 102.1 Million Quetzal	
Benefit Cost Ratio (B/C)	0.79	
Economic Internal Rate of Return (EIRR)	7.9%	Opportunity Cost of Capital is 10%

Source : Study Team

However, EIRR of the sewerage projects scarcely exceed the opportunity cost of capital, in general. The calculated indices seems to be high, as compared with the same kind of projects in other areas. Moreover, this kind of project would rather be considered in terms of fulfilling basic human needs with regard to environmental conditions. From this context, the proposed project would rather be recommendable, even from the economic point of view.

4.6 ORGANIZATIONAL REFORM

4.6.1 Organizational Arrangement

Given that the proposed project will be implemented in phases and that the scale is not sizable compared with the present water supply operation, complete departmentation by product is not recommended from the initiation of the project.

Instead, in order to minimize difficulties of personnel recruitment and administrative expenses, it is desirable to establish the Wastewater Management Project Section at an early stage. Thereby organizational arrangement will aim at mobilization of the existing water supply functions.

At a later stage, the Wastewater Management Project Section should assume responsibility for operation and maintenance of the newly constructed treatment facilities. Also the existing wastewater related units such as Sewerage Construction and Supervision Section, and Sewerage Maintenance Section, should be integrated into the Wastewater Management Division.

Fig. 4-8 illustrates the aforementioned evolution of the wastewater management unit in accordance with the schedule of the proposed project. Number of staff are also shown for each unit.

4.6.2 Required Functions

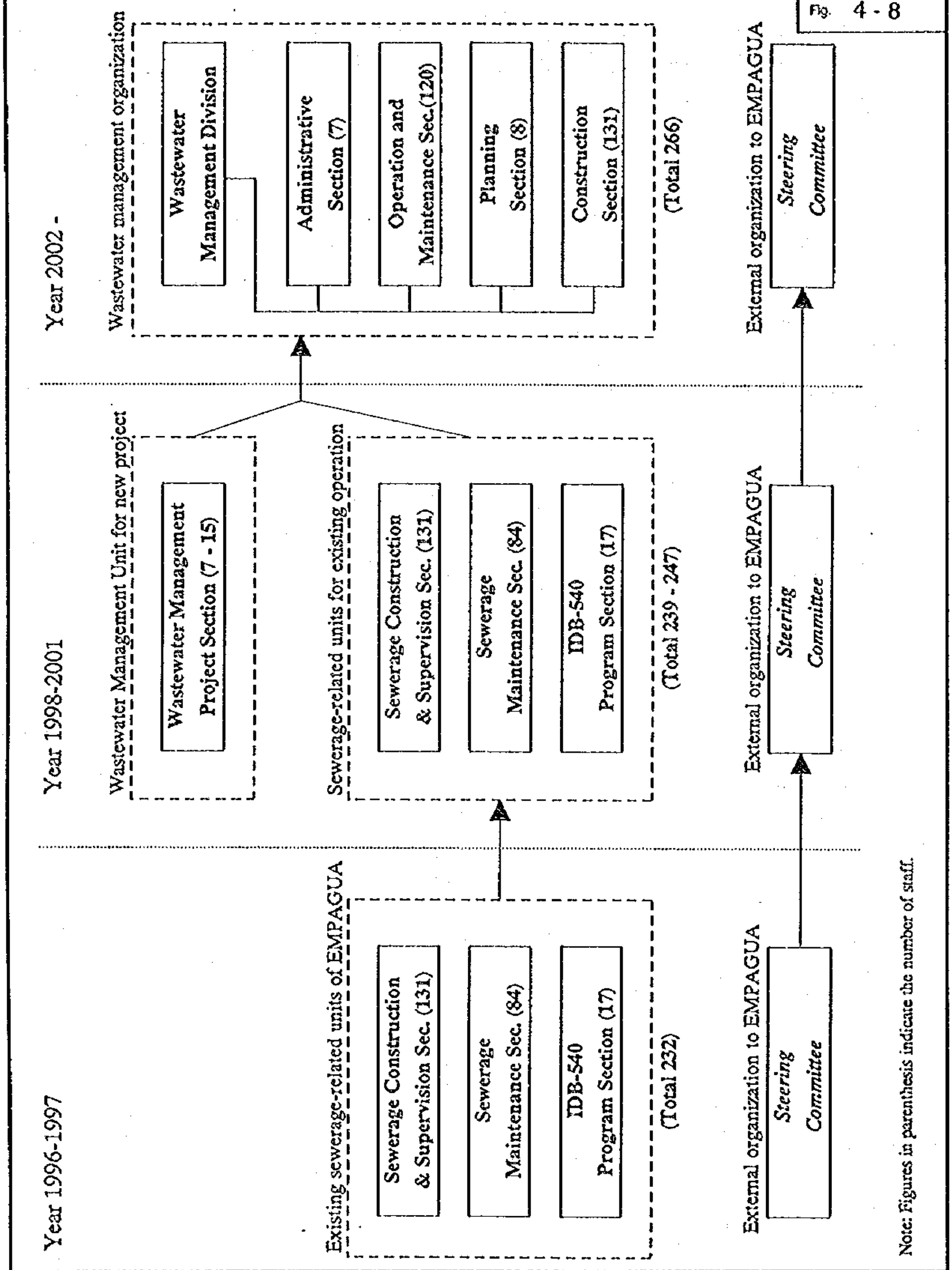
The functions considered necessary for the proposed wastewater management project can be either (i) performed by the proposed wastewater management unit, (ii) entrusted to existing water supply related units or (iii) contracted out to external suppliers. Fig. 4-8 shows the Proposed Wastewater Management Unit during construction (1998~2001) and afterwards (from 2002). Table 4-24 summarizes an alternative allocation of these functions to each section from the year 2002. The wastewater management units shown in Fig. 4-8, and Table 4-24 are defined to cover the smallest number of these dissimilar functions.

Table 4-24 Functions of Wastewater Management Division

Section	Funtion (Area to Be Covered)
Administrative Section	• finance and accounting • procurement and inventory control • community participation • coordination and public relations
O/M Section	• operation and maintenance • monitoring
Planning Section	• planning and design
Construction Section	• construction management
Other units of EMPAGUA or outsourcing	• legal administration • loan administration • recruitment and evaluation • training • customer services

Source : Study Team

Fig. 4 - 8



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5 FIRST STAGE PROJECT

5.1 TOPOGRAPHIC, GEOTECHNIC AND ENVIRONMENT SURVEYS

To supplement the information available for the Priority Regions, namely Central Region and South 3 Region, topographic, geotechnical and environment surveys were conducted. Based on the results of these surveys, preliminary engineering design of the sewerage/sanitation system for Central and South 3 Region were made and it become apparent that the scale of total investment costs makes it difficult to implement both Central and South 3 Regions 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.

5.2 FUNDAMENTALS OF ALTERNATIVES

Table 5-1 summarizes basic parameters for each alternative, namely Alternative 1 - Central Region, and Alternative 2 - South 3 Region.

Table 5-1 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

5.3 PRELIMINARY DESIGN

5.3.1 Wastewater Collection System

a) Main Collector Design

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

1) Las Vacas Main Collector (Central Region)

Fig. 5-1 and Fig. 5-2 show the route and longitudinal profile of Las Vacas Main Collector, respectively. Total length is 11 km, and its diameter is 3,000 mm. Most of the collector will be constructed by tunneling method except between Santafaz and Chinautla River, where there is a section with about 170 m drop in level. River crossings at Chinautla River, Tzalja River, etc. are selected to be pipe-bridge method in order to reach the wastewater treatment plant site by gravity at an altitude around 1,220 m above mean sea level.

The summary of main collectors for Central Region is shown in Table 5-2.

2) Pinula Main Collector (South 3 Region)

Fig. 5-3 and Fig. 5-4 show the route and longitudinal profile of Pinula Main Collector respectively. Construction will be by tunneling with a diameter of 1,500 mm and length of about 5.5 km. 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.

The summary of main collectors for South 3 Region is shown in Table 5-3.

Fig. 5 - 1

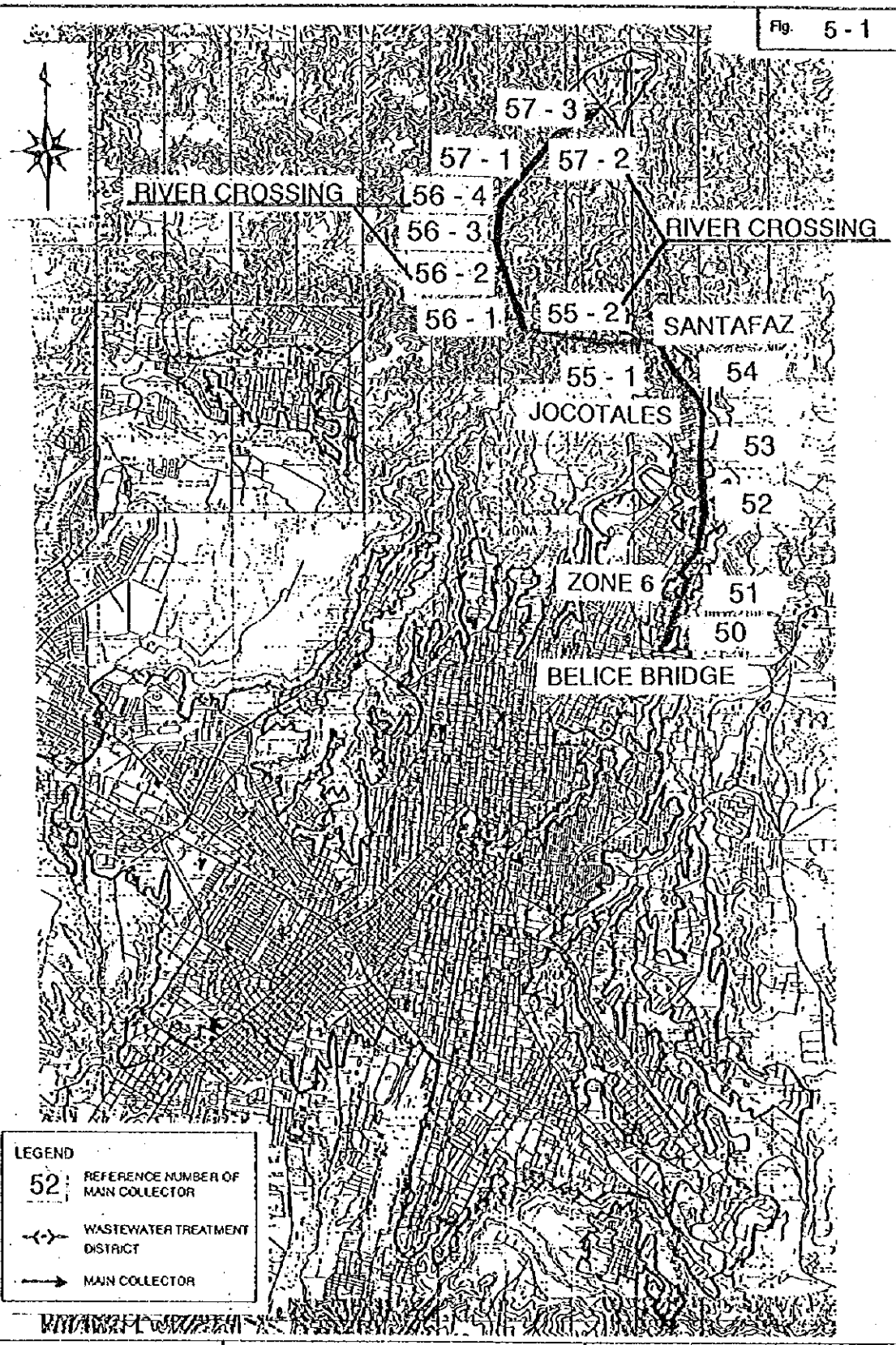

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Fig. 5 - 2

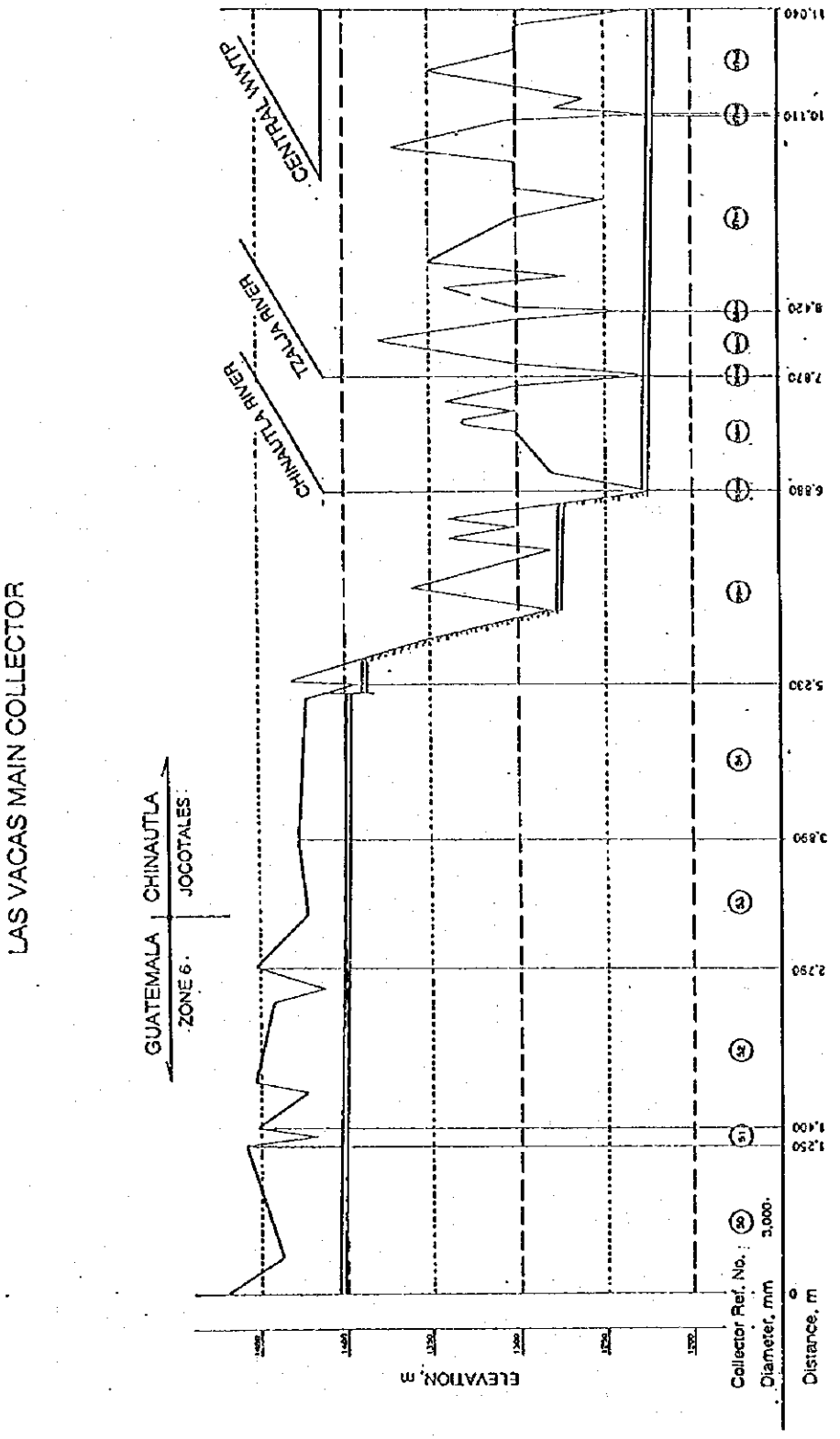

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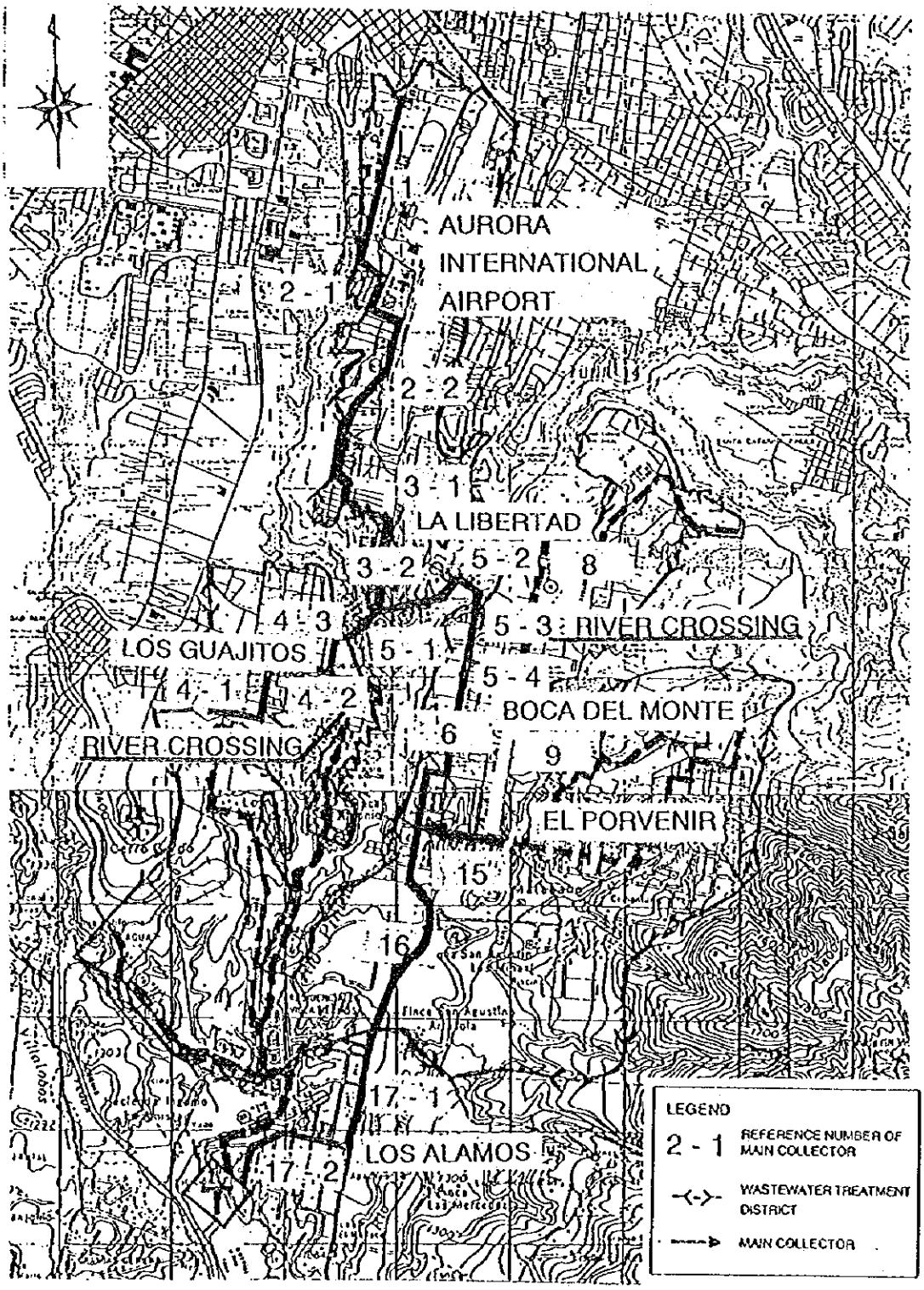
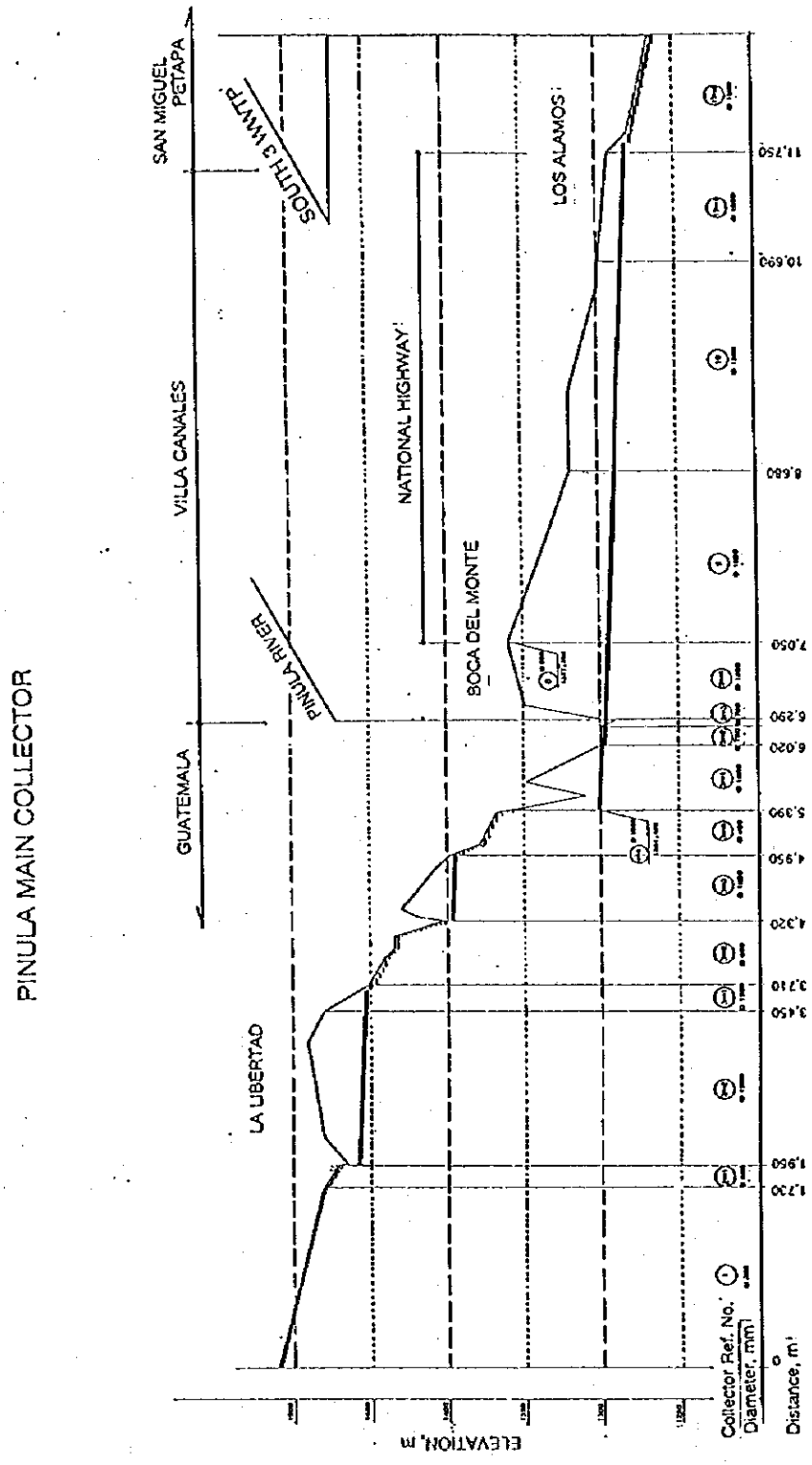
Fig. 5 - 3



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 PINULA MAIN COLLECTOR ROUTE (SOUTH 3 REGION)

Fig. 5 - 4



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 PINULA MAIN COLLECTOR

Table 5-2 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 4-1 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 5-3 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 4-1 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

5.3.2 Wastewater Treatment Plant

a) Proposed Treatment Process Flow

The treatment process flows for Central and South 3 Regions for the First Stage are as shown in Fig. 5-5 and Fig. 5-6. The treatment process flow proposed in Master Plan was modified, for the Feasibility Study of First Stage Project.

b) Water Quality

Table 5-4 shows the effluent qualities expected in each Region.

Table 5-4 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

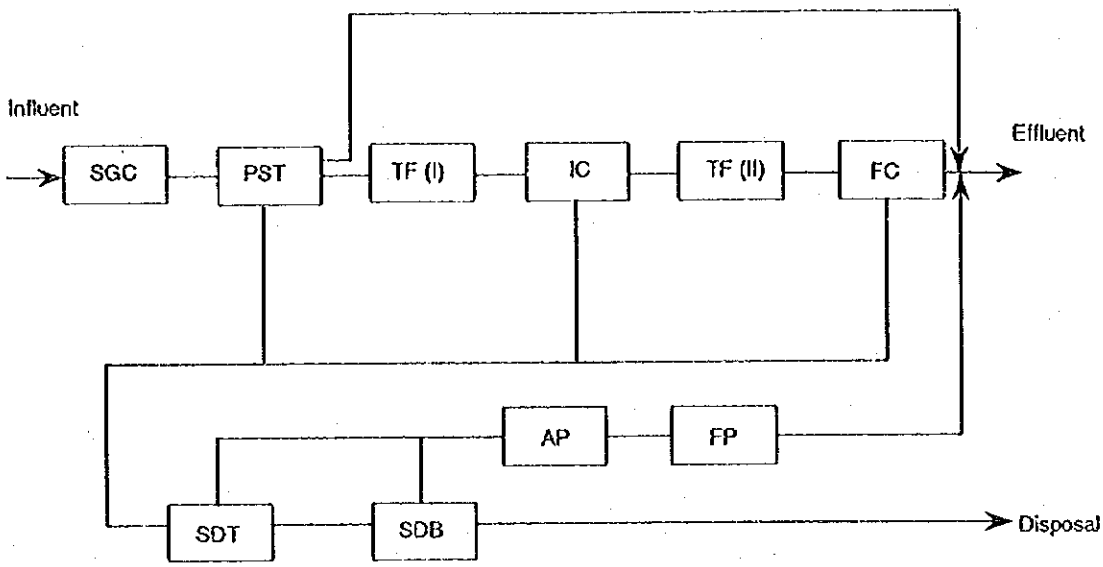
Source : Study Team

c) Outline of Treatment Facilities

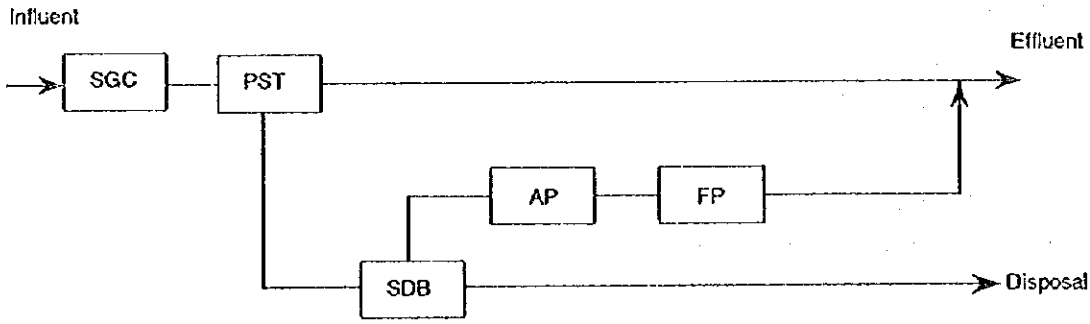
Table 5-5 shows the outline of facilities.

Fig. 5 - 5

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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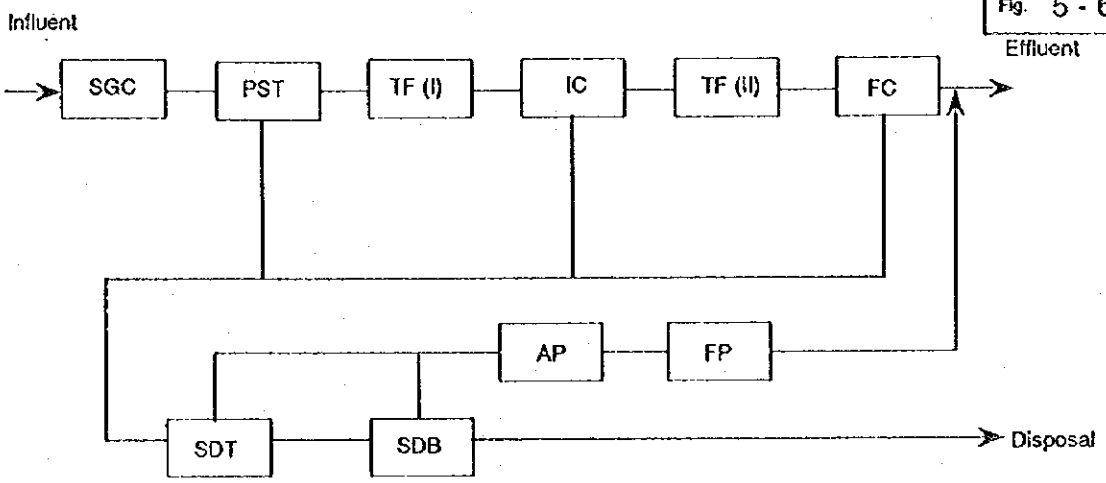
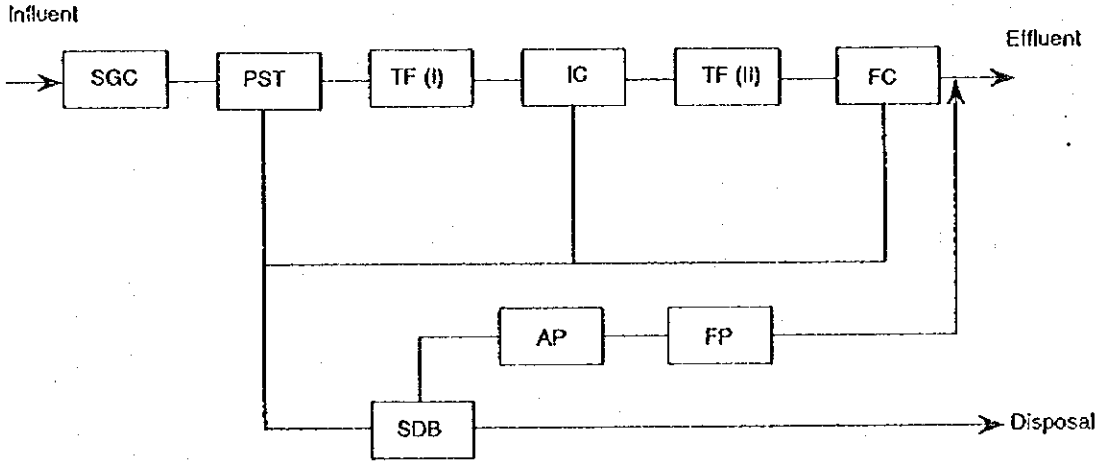
Fig. 5 - 6



a) Ultimate



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—— - Sludge Line

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Table 5-5 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

5.3.3 Sanitation System

a) Collection System

A Conventional Gravity system is proposed for collecting and transporting the wastewater to the community sanitation treatment facility. The total length of sewer required in each settlement to be covered in first stage is 65.2 km and 9.2 km for Central Region and South 3 Region, respectively.

b) Sanitation Treatment System

The sanitation treatment system consist of treatment and effluent disposal system.

Community treatment plants for various settlements in Central Region and South 3 Region are described in Table 5-6. According to the soil percolation test conducted at five locations showed that soil is predominantly clay/clayey silt. 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.

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 total annual quantity of septage to be desludged from each settlement is 1,356 and 116m^3/year in Central Region and South 3 Region respectively.

Table 5-6 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

5.4 COST ESTIMATION

5.4.1 Total Investment Cost

The total investment cost of sewerage and sanitation system were updated as of February 1996.

Summary of total investment cost for Central region and South 3 region is shown in Table 5-7. Direct construction cost of each system, sewerage and sanitation systems are shown in Table 5-8.

Table 5-7 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

Note : Cost is as of February 1996
Source : Study Team

Table 5-8 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

Note : Cost is as of February 1996
Source : Study Team

5.4.2 Operation and Maintenance Costs

The summary of required annual O/M costs for sewerage and sanitation system are shown in the Table 5-9 and 5-10 respectively.

Table 5-9 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 : Cost is as of February 1996
Source : Study Team

Table 5-10 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 : Cost is as of February 1996
Source : Study Team

5.5 EVALUATION OF ALTERNATIVES

To select the most feasible alternative, financial and economic evaluation are made and factors which are not quantifiable are compared. Table 5-11 shows the summary of the results of these evaluations.

5.5.1 Financial Evaluation

As shown in Table 5-11 , FIRRs of the alternative 1 (the project in Central Region) are calculated at -1.7%, 3.5% and 7.1% for three sewage service charge options; Charge I (Q20/connection/month), Charge II (Q30/connection/month), and Charge III (Q40/connection/month), 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 financially sound, because FIRR is less than the interest rates of the financial sources.

FIRRs of the alternative 2 (the project in South 3 Region) 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 government financial support.

Therefore, an appropriate financial conditions for sound management of the alternatives are studied under the following integrated cases set forth, taking into account of loan sources, sewage service charges, and financial sources.

a) **Loan Sources**

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 of 10 years.

b) **Charge Options**

Sewage service charge options are set out at Q20, 30 and 40/connection/month as described above. However, it should be noted that some portion of service charges collected from Central Region; Q10/connection/month, will be used not for the proposed project but for the maintenance of existing sewer pipe networks.

Table 5-11 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

c) **Financial Sources**

i) 100% capital covered by loans
ii) 90% by loans and 10% by grant
iii) 80% by loans and 20% by grant
iv) 70% by loans and 30% by grant

The following financial conditions are indispensable to manage the project soundly in Central and South 3 Regions, respectively.

For Central Region (alternative 1)

(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

For South 3 Region (alternative 2)

(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 III

5.5.2 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 Table 5-11.

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. The economic efficiency for the project in South 3 is further examined by a sensitivity test.

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 project in South 3 Region. The results are shown in the following Table 5-12.

Table 5-12 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%

Source : Study Team

The results 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 in South 3 Region could be viable from the economic view, considering the EIRR values for sewage projects.

5.5.3 Other Factors

Unquantifiable factors, are also considered for selection of First Stage Project.

The factors are:

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

Based on the discussion shown in Item 3 of Table 5-11, as a first stage project South 3 Region is favored in all aspects.

5.6 SELECTED ALTERNATIVE FOR THE FIRST STAGE PROJECT

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).

Table 5 -13 shows the facilities for the First Stage Project. Layout Plan of Wastewater Treatment Plant for the First Stage Project is as shown in Fig. 5-7.

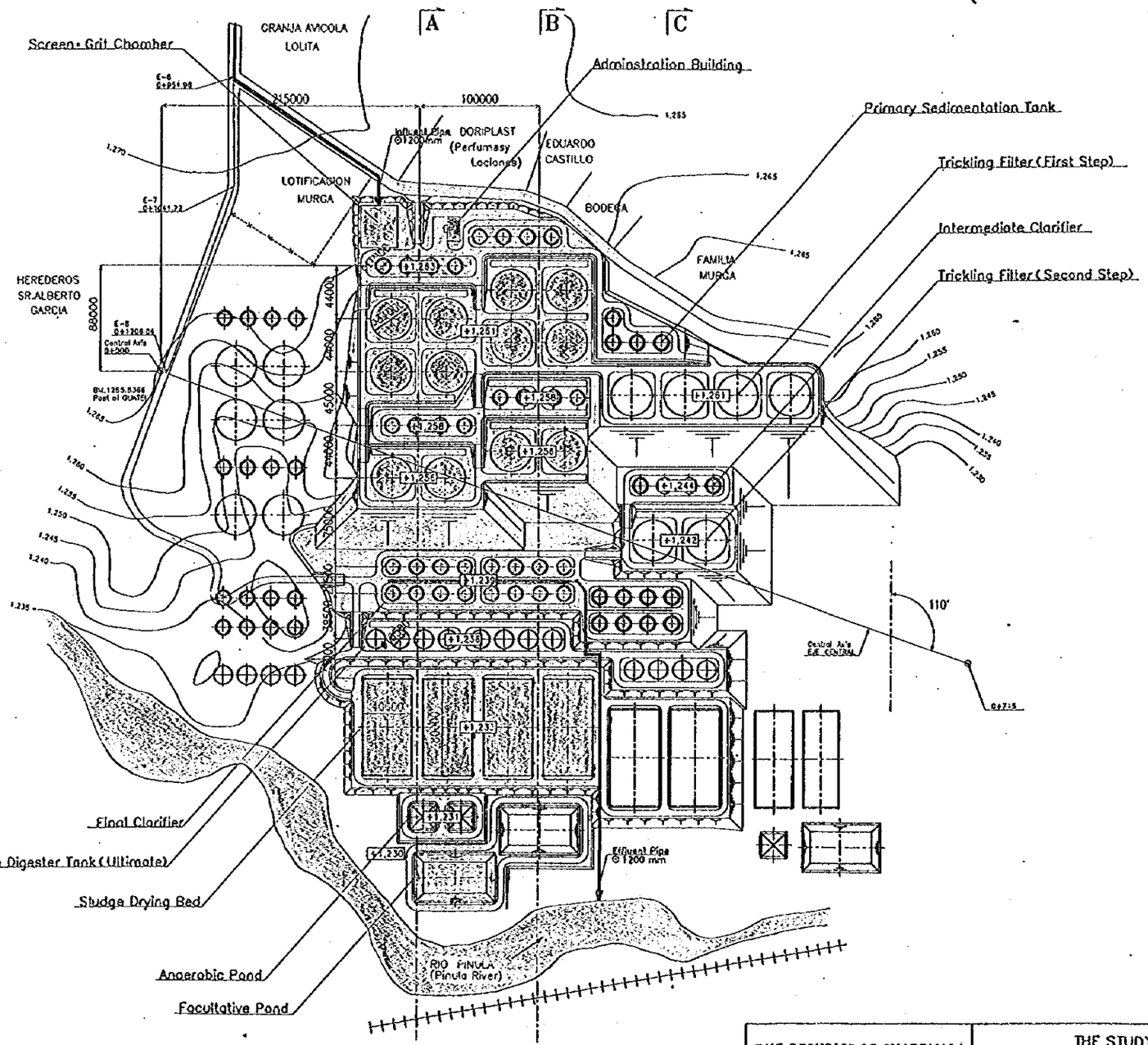
It is necessary to devise a feasible financial plan. It should be noted that the evaluations are made on the condition that each alternative are paid by the users in the respective region. In other words, it is based on 'Polluters Pay Principle'. Water supply resources of South 3 Region is being used 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 summarized in Section 5.7.1.

Table 5-13 Selected Alternative for the First Stage Project

ITEM	SOUTH 3 REGION
1 FUNDAMENTALS	
1.1 CONSTRUCTION PERIOD	1999 ~ 2001
1.2 SEWERAGE	
1.2.1 Served Area, ha	896
1.2.2 Served Population (As of 2002)	53,200
2 FACILITY DESIGN	
2.1 SEWER	
2.1.1 Collection system	Separate
2.1.2 Main Collector	
a) diameter and Length	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	17.32 km
2.1.3 Collector	
a) diameter and Length	200mm x 86.1 km (Open cut, soft)
2.2 WASTEWATER TREATMENT PLANT	
2.2.1 Treatment Capacity, m3/d (daily maximum)	36,000
2.2.2 Raw Wastewater Quality	
a) BOD, mg/L	280
b) SS, mg/L	280
2.2.3 Treatment Level	Secondary
2.2.4 Treatment Process	Trickling Filter Process
2.2.5 Final Effluent Quality	
a) BOD, mg/L	56
b) SS, mg/L	56
2.2.6 Receiving Water Body	Villalobos River (Pinula River)
3 COSTS	
3.1 Total Investment Cost, million Quetzal	221.3
3.2 Total O/M Cost, million Quetzal/year (for the year 2002)	1.63

Note : All costs are in 1996 Prices (February 1996)
Source : Study Team

Layout Plan of Wastewater Treatment Plant
(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	Central Axis 0+000	N 21° 42' 00" W	5.94
Central Axis 0+000	Central Axis 0+715	S 21° 42' 00" E	715.00

Scale 0 100 200 m

1:4000

Note: Colored Facilities are for First Stage

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 Layout Plan for the First Stage Project (South 3 WWTP)

5.7 IMPLEMENTATION PROGRAM

5.7.1 Financial Plan

a) Finance and Sewage Service Charge

The financial evaluation of the project in South 3 Region conducted in the previous section as an individual and independent management scheme indicated that the project can not 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. Thus, the following financial sources are considered, to prepare a financial plan to implement the project ; (i) loans from foreign financial sources and (ii) self fund which is saved through surcharge on other EMPAGUA's service territory.

The latter financial sources for the project in South 3 Region could be provided from other EMPAGUA's service territory, such as Central Region, as discussed in Section 5.6 of this 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). A 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%. A 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 financial shortage on operation, 10% of interest rate loan limited within one-year is also applied as working fund.

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 account of 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.

Derivative Plan 1: This is a Derivative of Plan 1, in which construction of sub-main and lateral sewer system is extended for two more years, such that net mark-up of sewage service charge could be reduced to Q7/connection/month.

The financially practicable conditions for each plan are enumerated in Table 5-14. The nominal FIRRs of the financial alternative plans were calculated at 8.0%, 3.2% and 5.8% respectively.

Table 5-14 Financially Feasible Conditions for Proposed Project

(Unit: Million Quetzal)

Item		Plan 1	Plan 2	Derivative of Plan 1
Financial Sources	Financial Source A	173.5	173.5	173.5
	Financial Source B	-	26.5	-
	Fund Saved by EMPAGUA*1	52.0	25.5	52.0
Total Revenue *2	Revenue of Sewage Services	131.0	93.6	106.2
	• Domestic	105.4	75.3	84.0
	• Industrial	25.6	18.3	22.2
	Transfer from General Account	611.7	276.1	371.0
Average Service Charge (Q/connection/Month)		21.0	15.0	17.0
Nominal FIRR *3		8.0%	3.2%	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.

The average sewage service charge (Q21/connection/month) of Plan 1 looks high compared to the present average charge of Q10/connection/month. On the other hand, the average sewage service 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.

Sewage service charge is calculated at Q17/connection/month for Derivative Plan 1. This is 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 could promote the implementation without intricate procedures. The nominal FIRR of the financial alternative plans is calculated at 5.8%.

Table 5-15 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 5-15 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 based on Derivative of Plan 1*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 based on Derivative of Plan 1*2	More than 0.31%	0.14% to 0.34%	Less than 0.22%
Referential Rate *3	Maximum 3%	Maximum 3%	Maximum 3%

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.

*3 Low Cost Sanitation, World Bank Economic Development Institute

When the charges based on the derivative financial plan of 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.

The mark-up of the average sewage service charge from Q10 to Q17 is considered to have the same effect that the present 20% surcharge rate is raised to 34%. 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.

b) Economic Efficiency

As described in Section 5.6, implementation of sanitation system is not included in the proposed First Stage Project, thus, EIRR of the First Stage Project (only sewerage) in South 3 Region was re-calculated at 5.7% (increased from 5.4%).

5.7.2 Construction Program

a) Implementation Schedule

The development plan of the project is scheduled as follows based on Derivative Plan 1.

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 5-16.

Table 5-16 Implementation Ratio/Volume of Construction Works

Serial No	Year	Sewer Pipeline			WWTP
		Trunk Sewer		Branch Sewer	
		dia 1500 mm	dia 300 ~1200	dia 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	----

Source : Study Team

c) Disbursement Schedule

The proposed disbursement schedule of the project cost in the first stage is shown in Table 5-17. Payments for Land acquirement of WWTP will be in year 1999 and 2000.

5.7.3 Organizational Plan

Table 5-18 shows the staff separation of Wastewater Management Division by person-year concept. The staff of Administrative Section and Division Head are divided pro rata 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, such as existing sewerage /sanitation works and preparation for other works in later stages.

Table 5 - 17 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

Costs are as of February 1996

Source : Study Team

Table 5-18 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

Source : Study Team

5.8 ENVIRONMENTAL IMPACT ASSESSMENT

5.8.1 Legal Framework

Environmental Impact Assessment is carried out to satisfy the requirements of the Law for the Protection and Improvement of the Environment ('Ley 68-86') since EIA must be approved prior to project implementation by National Environment Commission (CONAMA). At the Master Plan stage, an IEE was carried out and the TOR for EIA was approved by CONAMA. The Municipal Water Supply Public Corporation (EMPAGUA) will be the implementing organization for the First Stage Project.

5.8.2 Proposed Project Versus No Action

Table 5-19 shows the Project Summary. The existing environmental conditions are worsening and action on systematic management of wastewater disposal is long overdue. The Proposed Project is part of the sustainable solution to the worsening problems due to indiscriminate disposal of wastewater in the Guatemala Metropolitan Area. Table 5-20 shows the comparison of the benefits of the Proposed Project versus if no action is taken. From the table, it is clear that the advantages outweigh the disadvantages.

Table 5-19 Project Summary

Item	Content
Name of Project	First Stage Project on the Improvement of Wastewater Management in the Guatemala Metropolitan Area
Background	Most of the wastewater from Guatemala Metropolitan Area is being discharged without treatment to valleys/rivers and Lake Amatitlan, thus polluting water supply sources (surface water and groundwater) and living environment. To improve the wastewater management a Master Plan has been prepared to the year 2015. Feasibility Study is conducted to select the First Stage Project.
Objective	To construct and operate a) sewage collection facilities (main collectors and manholes), and b) wastewater treatment plant for the South 3 Region with a treatment capacity sufficient until the year 2008
Location	Areas in the Municipalities of Guatemala, Santa Catarina Pinula, Villa Canales and San Miguel Petapa (Fig. 5-8)
Implementing Organization	Guatemala Water Supply Public Corporation (EMPAGUA)
Beneficial Population	Direct beneficiaries are the 53,200 people who will be connected to the WWTP at the commencement of WWTP (2002). Improvement of living environment and reduction of water-borne diseases in the sewer served area is expected. Indirect beneficiaries are ; a) population depending on the groundwater resources of Ojo de Agua and surrounding area b) population using Pinula River water for washing and irrigation c) population downstream of Michatoya River
Type of Plan	Feasibility Study
Target Area	a) Collectors - 1,500mm x 10.0km (tunnel in soft) - 1,200mm x 1.2km (open-cut in soft) - 300~700mm x 6.0km (open-cut in soft) - 400~700mm x 0.12km (pipe-bridge, 2 locations) Total length - 17.32km b) Area of WWTP about 30ha c) Served Population year 2002 -53,200 persons, commercial establishments and industries year 2008 - 133,300 persons, commercial establishments and industries d) Area of treatment district year 2001 - 896ha e) Quantity of Wastewater year 2002 - 5,890m^3/d (daily maximum) year 2008 - 34,750m^3/d (daily maximum)
Sewage Collection Method	Separate-sewer System
Wastewater Treatment Plant (WWTP)	a) Treatment Process High-rate trickling filter with intermediate clarifier b) Treatment Capacity 36,000m^3/d (daily maximum)
Wastewater Sludge Treatment and Disposal Method	a) Treatment Process Drying-bed b) Disposal Method Sanitary landfill of the Municipality of Guatemala
Receiving Water	Treated effluent will be discharged to Pinula River which confluence with Villalobos River about 1 km downstream. Villalobos River discharges to Lake Amatitlan at about 7.7 km downstream. Michatoya River, which is the only exit of Lake Amatitlan, confluences with many rivers and finally discharges to Pacific Ocean 81 km downstream. Effluent quality : BOD - 56 mg/L and SS - 56 mg/L

Source : Study Team

Table 5-20 Comparison of Proposed Project Versus No Action

Item	With Project	No Action
1. Sewerage service with treatment	- Improvement of living environment of 896 ha and for 53,200 persons, commercial establishments and industries - Reductions of water-borne diseases - Pollutant load reduction to rivers and groundwater of 3,010 kg BOD/d and 3,010 kg SS/d.	- Indiscriminate disposal of wastewater without treatment and worsening living environment - Increase in water-borne diseases - Additional pollutant load to rivers and groundwater, thus accelerating the pollution of existing water supply sources.
2. Construction of Collector and WWTP	- Employment opportunities in construction sector	- No opportunity. - Strain on existing infrastructure.
3. Operation and Management of WWTP	- New employment opportunities and acquiring of WWTP operation skills, which are essential for sewerage development in Guatemala - Slight impairment of living environment around WWTP	- No opportunity and no skills. - No impairment.

Source : Study Team

5.8.3 Significant Environmental Impacts and Mitigation Measures

Table 5-21 shows the summary of significant environmental impacts and mitigation measures required . Fig. 5-8 shows the major environmental changes due to the proposed project.

Table 5-22 shows the mitigation measures to be taken at each stage showing the organization responsible for it.

5.8.4 Monitoring and Contingency Plans

In addition to the water and sludge quality monitoring of WWTP to be conducted by EMPAGUA for operation of WWTP, monitoring the effects of the Project is necessary for planning in the future. They are :

a) South 3 wastewater treatment plant effluent
b) Dried sludge from South 3 WWTP
c) Pinula River and Villalobos River near the confluence of those rivers.
d) Lake Amatitlan and Michatoya River

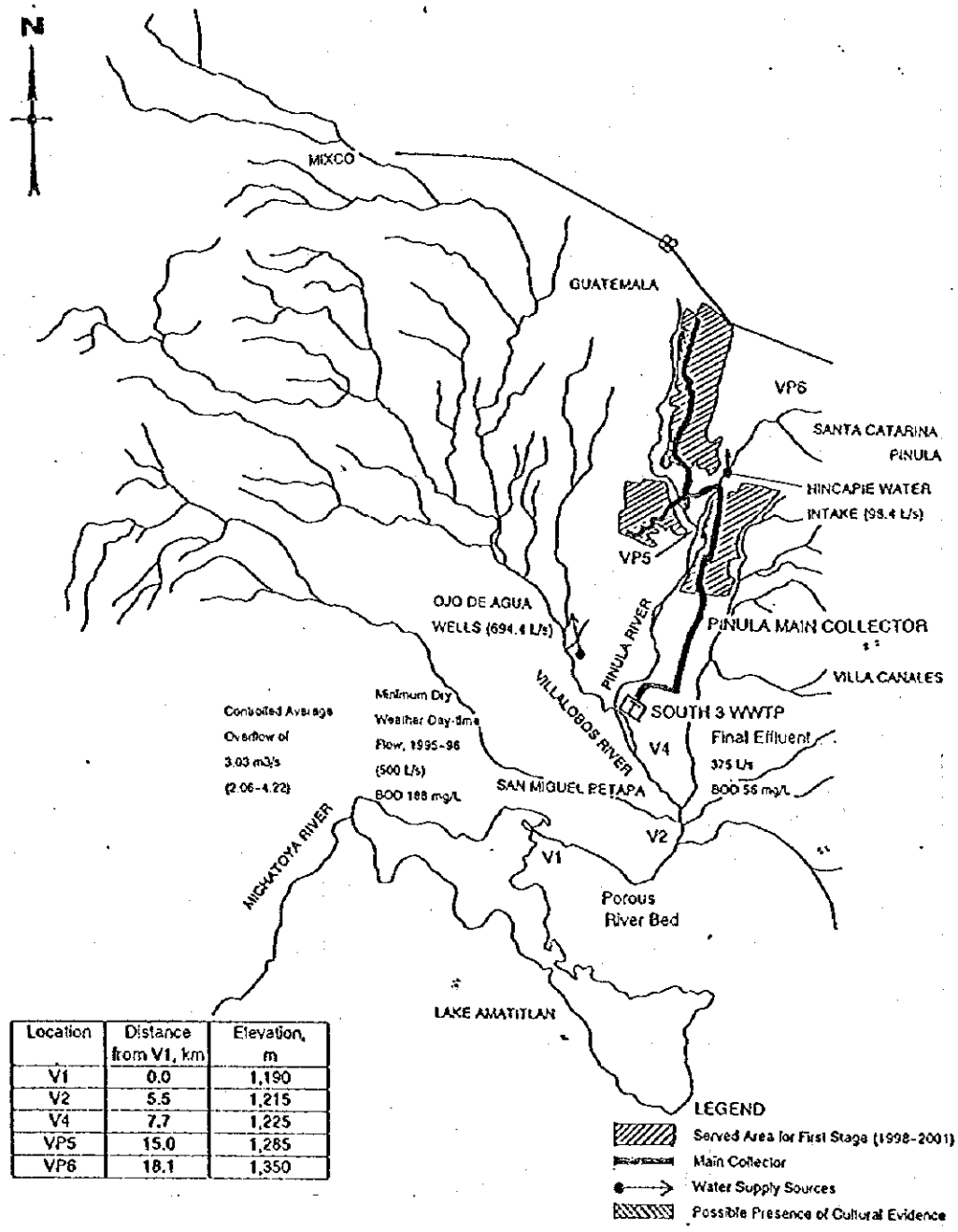
Table 5-21 Summary of Significant Environmental Impacts

Project Activity	Description of Impact	Category	Impact	Action
a) Pre-construction Stage (immediate impacts)				
1-1 Land Procurement for WWTP	1-1.1 Failure in procurement	Social	Serious	Ensure procurement.
1-2 Public Relations	1-1.2 Public opposition	Social	Moderate	Implement public education on the role of sewerage
b) Construction Stage (immediate or short-term impacts)				
2-1 Excavation of Tunnels	2-1.1 Wash-away of excavated soil	Physical	Moderate	Provide adequate drainage and retention pond for soil stock-piles.
	2-1.2 Possibility of finding historical evidences underground	Social	Positive	Inform Department of Monuments for rescue of those items
	2-1.3 Noise, dust and accidents during transportation	Social	Moderate	Take proper construction procedures to reduce them. Request public understanding with short-term disturbances.
2-2 Cut and Fill Operation for WWTP Construction	2-2.1 Muddy water and silting of Pinula River	Physical	Moderate	Take proper construction procedures to avoid wash-away of material.
	2-2.2 Disturbance to vegetation	Physical	Minor	Landscape WWTP site.
2-3 Construction Activity	2-3.1 Strain on infrastructure due to labor influx.	Physical	Minor	Provide waste disposal facilities for temporary shelters for labor.
c) Operation Stage (long-term impact)				
3-1 Elimination of Raw Wastewater Discharges (connection to sewerage system)	3-1.1 Legal authority is necessary for implementation	Physical	Serious	Revise laws and regulations
3-2 WWTP Discharge to Receiving Water	3-2.1 New point source from WWTP	Physical	Minor	Implement monitoring
	3-2.2 Erosion of river bed	Physical	Moderate	Build suitable outfall
3-3 WWTP Operation	3-3.1 Fly and odor problem	Social	Moderate	Plant trees and plants. Follow good house-keeping
3-4 Disposal of sludge	3-4.1 Contamination of soil and water.	Physical	Serious	Accept only non-toxic wastewater. Monitor wastewater and sludge.
3-5 Stability of Cut and Fill Slopes	3-5.1 Failure of slopes	Physical	Serious	Provide stable slope and maintain.
3-6 Ability to withstand earthquake	3-6.1 Failure of sewerage system due to earthquake	Physical	Serious	Design structures to withstand earthquakes
3-7 Public Relations	3-7.1 Public opposition or indifference to sewerage	Social	Serious	Public education and conduct public / children visits to WWTP

Note : Impact are classified as Serious, Moderate and Minor of which only serious impact will endanger the Project implementation or its sustainability.

Source : Study Team

Fig. 5 - 8



Location	Distance from V1, km	Elevation, m
V1	0.0	1,190
V2	5.5	1,215
V4	7.7	1,225
VP5	15.0	1,285
VP6	18.1	1,350

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 MAJOR ENVIRONMENTAL CHANGES DUE TO THE PROPOSED PROJECT

It is desirable that these kind of monitoring be conducted by CONAMA. Frequency of monitoring may be three to four times a year. Analytical and measurement parameters shall include flowrate, organic matter, nutrients and heavy metals.

At this stage, it is not convenient, nor necessary, to prepare detailed contingency plans. These have to be done during the final design stage and can be focused in the following aspects:

1) Plan in case of accidents during tunneling.
2) Plan in case the tunnels fail / during maintenance
3) Plan in case the wastewater treatment plant stops operation.

Table 5-22 Mitigation Management

Mitigation Measure	Responsible Organization(s)
a) Before Detailed Design	
- Arrangements for land procurement	EMPAGUA
- Publicity and public education campaigns	EMPAGUA and INFOM
- Revision of laws and regulations for EMPAGUA to provide sewerage service	Government of Guatemala (INFOM / EMPAGUA)
b) During Detailed Design	
- Construction methods	EMPAGUA
- Design criteria for structures	(approved by CONAMA)
- Design criteria for slopes (cut/fill)	
- WWTP O/M Manual	
- Landscape Design	
c) During Construction	
- Construction method	EMPAGUA (supervision)
- Provision of shelters/facilities	EMPAGUA/Municipalities
d) During Operation	
- WWTP Operation	EMPAGUA
- Public liaison/children Education	EMPAGUA, Municipalities and Ministry of Education
- Monitoring	CONAMA

Source : Study Team

6 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The Project in South 3 Region is identified and is proposed as the First Stage Project through the Study on the Improvement of Wastewater Management in Guatemala Metropolitan Area.

Discussion in the preceding sections showed that the First Stage Project in the South 3 Region is financially feasible provided that a Wastewater Management Fund is established to cover the local portion required for implementation.

Generally, sewerage projects are implemented with subsidies from the Central Government or local government because initial investment required is high. However, in this case the possibility of obtaining subsidy is rather limited and the only way of generating capital for investment will be to obtain foreign with a low interest rate and good terms loan and to establish the Wastewater Management Fund from the mark-up of sewerage service charges in the existing sewer-served areas in Central Region.

It is concluded that the proposed First Stage Project in South 3 Region is the most feasible alternative in the process of improving the wastewater management in the Guatemala Metropolitan Area. The proposed mitigation management and monitoring plan described in EIA should be carefully examined and implemented.

6.2 RECOMMENDATIONS

To implement the proposed First Stage Project and Wastewater Management Master Plan smoothly the following measures are recommended.

a) First Stage Project

1) Establishment of Wastewater Management Fund

- Take necessary actions to establish Wastewater Management Fund for implementation of First Stage Project, such as to obtain approval from municipalities for increasing sewerage service charge.
- A suitable tariff structure shall be introduced and the billing and collection system shall be improved to ensure the accumulation of Wastewater Management Fund

2) **Procurement of Land for WWTP**

- Take necessary actions to procure land for the proposed South 3 WWTP site. Alternative sites for WWTP are very limited due to mountainous topography and utmost importance should be given for this.

3) **Strengthening of Legal Powers of EMPAGUA**

- Entrust EMPAGUA with wastewater management in the First Stage Project Area and in the long-term to the entire Study Area (not only within the municipality of Guatemala),
- Set standards for accepting or refusing industrial wastewater
- Require that all desludging be controlled by EMPAGUA. Private desludging operators shall report to EMPAGUA and the sludge shall be brought to the wastewater treatment plants.

b) Wastewater Management Master Plan

1) **Sanitation Facility Management**

- New facilities to be constructed by EMPAGUA will be managed by it,
- Bring the management of existing small-scale sewage treatment plants under EMPAGUA's management as a prerequisite for their rehabilitation,
- Disposal of septage from private desludging shall be at the wastewater treatment plants and shall be applied over the entire Area in order to appeal to the public.

2) **Sewerage Facility Management**

- Information and Records of the existing sewer network are in disorder. Confirmation and arrangement of this data is urgently required. Systematic record keeping for all sewerage facilities should be established.

3) **Effluent Standards**

- Current effluent standards shall be improved and enforced. In the long-term effluent standards shall be set based on water quality standards for public water bodies.

4) **Ground Water Protection**

- Currently there are no laws governing the disposal of wastewater underground. Underground disposal of wastewater is practiced extensively including the disposal of industrial wastewater. Regulations concerning the underground disposal of wastewater shall be prepared and implemented to protect ground water sources.

JICA