CHAPTER 11
PROJECT EVALUATION

CHAPTER 11 PROJECT EVALUATION

In this chapter, the proposed project is evaluated from points of view of finance, socio-economy as well as environment.

11.1 Technical Viewpoint

The existing inland sewerage system was constructed utilizing the natural topographic condition. Thus, all sewage collected flow by gravity downstream of the inland area without using pumps except one small pump at Morata. The proposed inland sewerage system is planned to follow the above concept. The existing system will be expanded to meet the increased wastewater flow. The newly planned sewerage system for the Bomana zone will follow the same concept.

On the other hand, the sewerage system proposed in coastal area will differ its concept from that of the inland area. Originally, as in many small zones along the coast, the sewage is drained by gravity to the sea to improve the sanitary condition of the inhabitants. However, that system brought the deterioration of the marine environment. Thus, all the coastal sewage was intercepted and diverted to Paga Point, from where sewage is discharged via a long outfall into the ocean using pumps, long-distance trunk mains in addition to conventional gravity pipe.

The Paga Point sewerage system is planned to be expanded to meet the increased wastewater flow. The other catchment in the coastal area is planned similar to the concept of the Paga Point sewerage system. These interception and diversion are required to improve the deteriorated water quality in the coast where fishing and recreational activity are widely practiced.

11.2 Financial Evaluation

The proposed project covers an urbanized area of 15,000 ha. for the target year 2015. It will collect and process wastewater at 240,000 m^3/day generated from a population of 531,000 in 2015. Its capital expenditure is estimated to be 98 million Kina at 1997 price, equivalent to 70 million US$. Financial internal rate of return is only 3.01%. Without contribution either internally from water sale revenue or externally, the project is not viable.

11.3 Socio-Economic Evaluation

Nevertheless, the project is required to be conducted to improve 1) the sanitary condition of the inhabitants themselves and 2) environmental condition of the rivers and oceans. The inhabitant's survey shows that most of the people put sewerage service a high priority. It also shows that they are willing to pay for the service. Coliform levels in beaches from Tatana to Pari exceeded the recommended levels so that bathing is prohibited in December 1997. In order to reduce the coliform levels and sustain invaluable coral lagoons, the project is needed.

11.4 Selection of Priority Project

As discussed previously, the current capacity of the inland sewerage system is not sufficient for the target year 2015 but some surplus capacity can serve for some time. On the contrary, the extent of the sewerage system in the coastal area is limited so that water quality in the coast is bad. Accordingly, the sewerage system in coastal area has a high priority and is selected for a "feasibility study."

CHAPTER 12
FEASIBILITY STUDY-SEWERAGE SYSTEM

CHAPTER 12 SEWERAGE SYSTEM

12.1 Planning Principle

The master plan proposes a reticulated sewerage system for the whole area of NCD. The proposal is based on the assumption that in 2015 PNG will achieve economic development that will warrant a reticulated system sewerage system as one of the basic human needs, both financially and socially.

However, by the year 2005 (target year of the feasibility study), it is unlikely that the above optimistic assumption will be achieved. The feasibility study covers the coastal areas that are highly urbanized, therefore the reticulated sewerage system is justified from the residents' "ability and willingness to pay" the sewerage charges. Moreover, the reticulated sewerage system will help improve the degraded water quality of the coastal waters.

Some less urbanized areas and settlements such as Kaugere, 2 Mile Hill, etc. were included in the feasibility study area because of its proximity to the proposed system. Although these areas may excluded from the implementation of the project because of the financial burden, the use of localized disposal system such as pit/pan latrine and septic tank will continue.

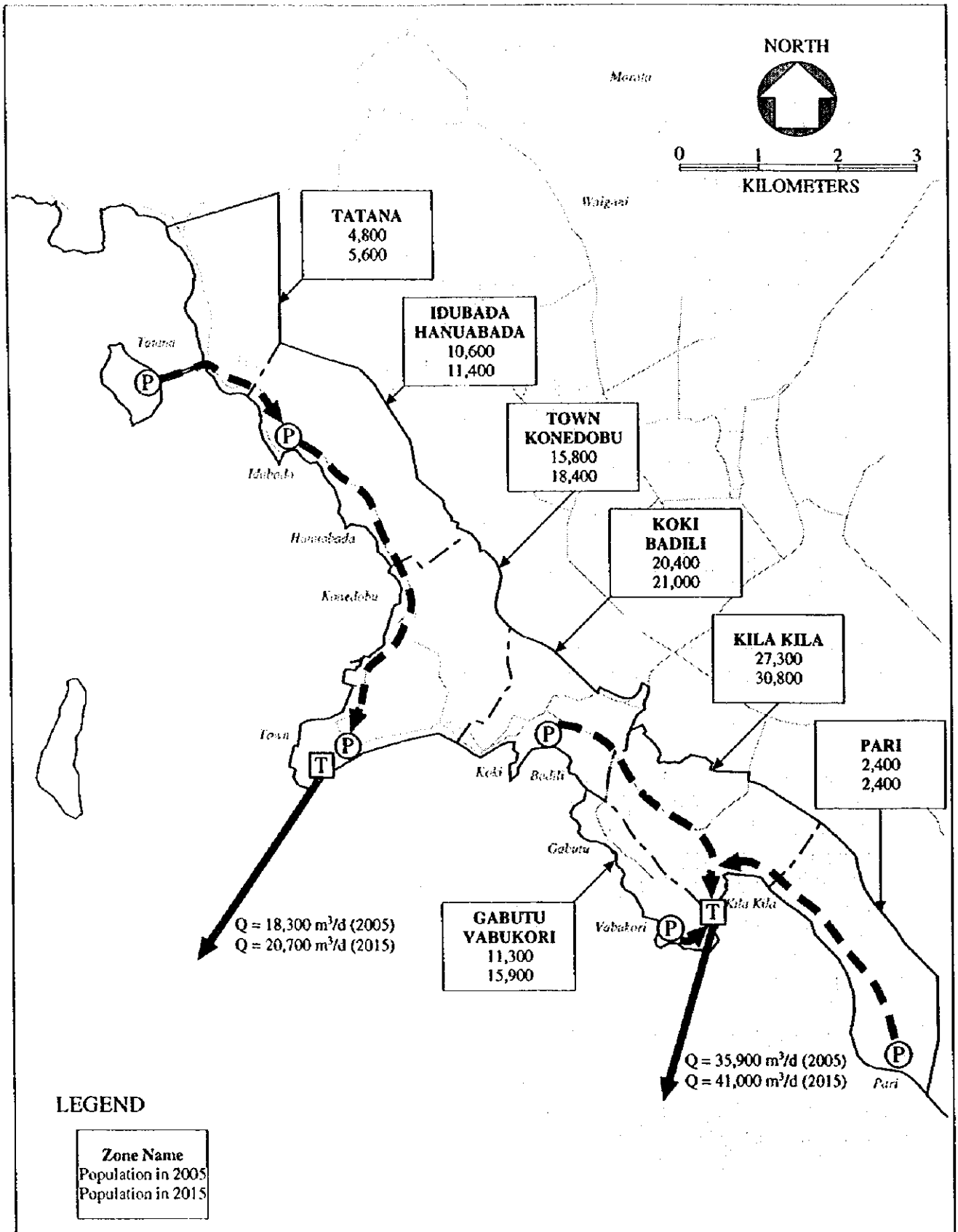
The framework of the study (population and wastewater volume) is shown in Table 12.1. The feasibility study used the same design criteria as the master plan.

12.2 Sewer Layout

The details of the proposed sewer reticulation such as the pipe list and pipe layout are shown in Table 12.5 and Appendix C.1.2, respectively. Points location used in the succeeding discussion are shown in the figures of Appendix C.1. The general philosophy used in designing the sewer layout is to reach a balance between force main and gravity pipeline. The sewage collected from every manhole is successively pumped to the next manhole through a force main or flows by gravity depending on the topography and economic viability. It is a common practice to locate the pumping station at the lowest point of the service area.

12.2.1 Paga Point Zone

The Paga Point zone, which is composed of Tatana/Baruni, Idubada/Hanuabada and Konedobu/Town will have a 2015 total population of 35,400 generating a wastewater volume of 23,900 m^3/day at an area of 332 ha. From the farthest point of Tatana and Baruni, the sewage will be successively pumped or flows by gravity intercepting the sewage along the way until the accumulated volume will reach Paga Point for treatment before it is discharged via the existing 3 km outfall.



Date	Title	Fig.
May 1998	Proposed Sewerage System in F/S Area	12.1

THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI

Table 12.1 Population and Wastewater Quantity

Name	Year	Population (person)	Daily Ave. (m^3/day)	Daily Max. (m^3/day)	Remarks
Kaevaga Poreporena	1995	12,953	5,829	7,578	Tatana, Baruni, Idubada, Hanuabada
	2005	15,386	6,924	9,001	
	2015	16,991	7,646	9,940	
Konedobu North	1995	4,582	2,062	2,680	
	2005	6,611	2,975	3,867	
	2015	8,032	3,614	4,699	
Konedobu South	1995	7,206	3,243	4,216	
	2005	10,062	4,528	5,886	
	2015	10,609	4,774	6,206	
Town/Paga	1995	5,579	2,511	3,264	
	2005	7,664	3,449	4,483	
	2015	8,668	3,901	5,071	
Koki/Badili	1995	8,783	3,952	5,138	
	2005	10,735	4,831	6,280	
	2015	10,881	4,896	6,365	
Murray Barracks	1995	188	85	110	Two Mile Hill
	2005	188	85	110	
	2015	188	85	110	
Senekori	1995	5,922	2,665	3,464	Gabutu, Vabukori
	2005	12,664	5,699	7,408	
	2015	17,834	8,025	10,433	
Kaugere/ Sabama	1995	12,451	5,603	7,284	
	2005	16,318	7,343	9,546	
	2015	17,704	7,967	10,357	
Horse Camp	1995	6,998	3,149	4,094	Kila Kila
	2005	10,167	4,575	5,948	
	2015	11,802	5,311	6,904	
Kila Kila	1995	573	258	335	Kila Kila No. 1 village
	2005	573	258	335	
	2015	573	258	335	
Taurama South	1995	2,230	1,049	1,363	Pari
	2005	2,430	1,094	1,422	
	2015	2,430	1,094	1,422	
Total	1995	67,565	30,404	39,526	
	2005	92,798	41,759	54,287	
	2015	105,712	47,570	61,842	

1) **Tatana/Baruni Sub-Zone: Total Population 5,600 (2015)**

The sewage collected by gravity from Tatana (at Tatana PS No. 2) will be pumped 680 m through a 150 mm dia. pipe to the mainland at Point A3. At this point (Point A3), it will also take the sewage collected by pumping (Tatana PS No. 1) and by gravity from Baruni and flows by gravity 800 mm distance through a 300 mm dia. Pipe to Tatana PS No. 3.

2) **Idubada/Hanuabada Sub-Zone: Total Population 11,400 (2015)**

At Tatana PS No. 3, the sewage collected from Kanudi is intercepted and then pumped southward along the road to reach the high Point B5. At this point (Point B5) the accumulated sewage flows by gravity along the shoreline until it reaches Point C1 at Idubada. The accumulated sewage including that volume intercepted from Idubada flows again by gravity to Tatana PS No. 4, where it is pumped towards Point C2 at Gabi Village. At this point (C2), the accumulated sewage including those collected from the schools and small villages then flows by gravity towards Hanuabada PS No. 1 where it is pumped towards C3 from Point C3 the pipe is increased to 400 mm dia. until it reaches Point C4. At Point C4, it also collects the sewage from the houses over the water then flows further by gravity through a 450 mm dia. pipe towards C41 and then to Hanuabada Ps No. 2. At Hanuabada P.S. No. 2 all the accumulated sewage including the large volume collected from the Hanuabada village are pumped via 450 mm dia. 850 mm pipeline to the existing Konedobu PS.

3) **Konedobu/Town Sub-Zone: Total Population 18,400 (2015)**

The existing onshore outfalls are intercepted at the lowest point before all the accumulated sewage is pumped to the existing Konedobu PS.

At MH 101, the sewage collected from the Konedobu area is intercepted and than pumped (new PS 101) through a 350 mm dia., 120 m pressure pipe to the existing Konedobu PS. The existing Konedobu PS corresponding and pressure pipeworks will then be upgraded to cater for the increased volume of wastewater generated by a total population of 28,786.

All the accumulated sewage pumped from the Konedobu PS will finally be pumped to Paga Point through the existing Stanley Esplanade PS in a 500 mm dia. pressure pipe. At some point the sewage will gravitationally flow before finally reaching Paga Point PS and intercepting the sewage coming from Ela Beach through the MH.

12.2.2 Kila Kila Zone

The Kila Kila zone, which is composed of Koki/Badili, Kila Kila, Gabutu/Vabukori and Pari, will have a 2015 total population of 70,100 generating a wastewater volume of 41,000 m^3/day. The sewage collected from the sub-zone will be pumped or flows by gravity to the Kila Kila STP for treatment before it is discharged to Joyce Bay via offshore outfall.

1) **Koki/Badili Sub-Zone: Total Population 21,000 (2015)**

The sewage collected by gravity at the Koki catchment is pumped over the hill via the 300 mm, 336 m pressure pipe and then flows by gravity to Badili PS. The existing outfall at Badili will be abandoned. All the collected sewage will then be pumped through a 450 mm, 1160 m long pressure pipe to Kaugere (MH D13) where it will flow by gravity to the existing Kaugere PS.

2) Kaugere/Sabama/Kila Kila Sub-Zone: Total Population 30,800 (2015)

The sewage accumulated at Kaugere PS will be pumped via 600 mm x 230 m pressure pipe to a higher point (MH) where it will be allowed to flow by gravity southward to Kila Kila PS and intercept the wastewater along the way. At the Kila Kila PS all the accumulated sewage will be pumped through the 800 mm dia. pressure pipe at a distance of 360 m until it reaches the Kila Kila STP.

3) Gabutu/Vabukori Sub-Zone: Total Population 15,900 (2015)

There are a total of six pumping stations required to transmit the accumulate sewage starting from the Gabutu catchment down towards Vabukori village, where it is finally pumped to the Kila Kila STP. At the final pumping, (Vabukori PS No. 3), the sewage is transmitted in a 300 mm dia. pressure pipe along the shoreline at a distance of 1,400 m until it reaches the Kila Kila STP.

4) Pari Sub-Zone: Total Population 2,430 (2015)

The sewage collected from Pari is pumped via 200 mm diameter pressure pipe to reach the Kila Kila STP at a distance of 3.2 km.

12.3 Pumping Station

Specifications of the pumps are shown in Table C.12.2 while their locations are shown in Fig.6.2 of Chapter 6.

12.3.1 Paga Point Zone

Tatana PS No. 2 is located at the end of the causeway in order to pump the sewage from the island to the mainland at Point A3. The pipe length between Point A3 and Hanuabada rather long and would require a deep excavation, therefore, Tatana PS No. 3 is installed at Point B3 between them. Tatana PS No.4 is planned to pass over the 15 m hill.

Hanuabada PS No. 1 is installed to collect the sewage from the northern half of the Hanuabada village.

Konedobu PS No. 2 is to be constructed next to the existing Konedobu PS to cater for the increased flow. The existing civil structure at the Yacht Club PS will be utilized but pumps and motors will be replaced.

The existing Stanley Esplanade PS will be rebuilt. The existing civil structures of both the Lawes Road and the Davara P/S will be utilized but the pumps and motors will be replaced.

12.3.2 Kila Kila Zone

There will be a total of 11 PS in this zone. The existing civil structures at Koki PS will be utilized but the pumps and motors will be replaced. The existing pumping stations at Badili and Kaugere will be replaced with new ones.

The remaining 8 PS is to be newly built with new pumps and motors.

The remaining 8 PS are newly installed.

Table 12.2 Type of New Pumping Station

Zone	Pumping Station Name		No. in Fig.6.2	Site W × L	Flow Qhmax	Type	Well Diameter Diameter φ or W×L	Well Diameter Depth : H	Pump Specification Nos.*	Pump Specification Q	Pump Specification Dia	Pump Specification Hl	Pump Specification out put STD	Remark
				m	m³/min		m	m	-	m³/min	mm	m	kw	
Vetorogo	Vetorogo	No.1	1	10 × 10	3.38	III	φ 4.0	5.50	2(+1)	1.69	100	10.22	5.5	New
		No.2	2	10 × 10	5.00	III	φ 4.0	4.20	2(+1)	2.50	150	9.66	7.5	New
Paga Point	Tatana	No.1	3	10 × 10	1.72	III	φ 4.0	3.00	2(+1)	0.86	100	17.65	5.5	New
		No.2	4	10 × 10	1.77	III	φ 4.0	5.10	2(+1)	0.88	100	23.57	7.5	New
		No.3	5	10 × 10	3.12	III	φ 4.0	4.70	2(+1)	1.56	100	17.93	11.0	New
		No.4	6	10 × 10	3.63	III	φ 4.0	8.50	2(+1)	1.81	100	12.67	7.5	New
	Hanuabada	No.1	7	10 × 10	4.65	III	φ 4.0	5.20	2(+1)	2.32	150	8.42	7.5	New
		No.2	8	17 × 17	8.73	IV	7 × 7	5.20	3(+1)	2.91	150	18.65	18.5	New
	Konedobu	No.1	9	10 × 10	4.86	III	φ 4.0	5.40	2(+1)	2.43	150	2.52	0.0	New
		No.2	10	17 × 17	12.81	IV	7 × 7	4.20	3(+1)	4.27	200	17.51	22.0	Rebuild
	Yacht Club		11		0.34				1(+1)	0.34	100	16.73	2.2	Rehabilitate
	Stanley		12	17 × 24	15.08	V	7 × 14	3.90	3(+1)	5.03	200	19.63	30.0	Rebuild
	Paga		13	17 × 24	16.59	V	7 × 14	4.40	3(+1)	5.53	200	9.12	15.0	Rebuild
	Davara		14		1.62				2(+1)	0.81	100	5.85	1.5	Rehabilitate
	Lawes		15		1.07				1(+1)	1.07	100	3.03	1.5	Rehabilitate
Kila Kila	Koki		16		2.90				2(+1)	1.45	100	12.37	5.5	Rehabilitate
	Badili		17	17 × 17	9.54	IV	7 × 7	5.30	3(+1)	3.18	150	31.67	30.0	Rebuild
	Gabutu	No.1	18	5 × 5	0.62	I	φ 1.5	5.10	1(+1)	0.62	100	20.95	5.5	New
		No.2	19	5 × 5	1.67	II	φ 1.8	8.10	2(+1)	0.83	100	27.91	7.5	New
		No.3	20	5 × 5	0.39	I	φ 1.5	8.00	1(+1)	0.39	100	27.27	5.5	New
	Vabukori	No.1	21	10 × 10	2.89	III	φ 4.0	3.80	2(+1)	1.44	100	32.97	15.0	New
		No.2	22	5 × 5	1.14	II	φ 1.8	6.00	1(+1)	1.14	100	23.30	11.0	New
		No.3	23	17 × 17	8.26	IV	7 × 7	5.50	3(+1)	2.75	150	32.91	30.0	New
	Kaugere		24	17 × 17	13.33	IV	7 × 7	5.70	3(+1)	4.44	200	11.71	15.0	Rebuild
	Kila kila		25	17 × 24	25.14	V	7 × 14	5.50	3(+1)	8.38	250	9.48	22.0	New
	Pari		26	10 × 10	1.52	III	φ 4.0	2.80	2(+1)	0.76	100	26.90	7.5	New
Dograkohu	Dograkohu	No.1	27	10 × 10	1.88	III	φ 4.0	3.00	2(+1)	0.94	100	20.21	5.5	New
		No.2	28	10 × 10	1.88	III	φ 4.0	3.00	2(+1)	0.94	100	23.41	7.5	New
		No.3	29	10 × 10	3.38	III	φ 4.0	4.30	2(+1)	1.69	100	20.09	11.0	New
		No.4	30	17 × 17	6.05	IV	7 × 7	2.90	3(+1)	2.02	100	32.00	22.0	New
		No.5	31	17 × 17	9.47	IV	7 × 7	3.50	3(+1)	3.16	150	9.94	11.0	New
		No.6	32	17 × 24	17.91	V	7 × 14	3.40	3(+1)	5.97	200	11.08	22.0	New
Morata	Morata		33	5 × 5	3.78	II	φ 4.0	4.50	2(+1)	1.89	100	11.08	7.5	Rebuild

Note; * Duty (+Stand-by)

12.4 Sewage Treatment Plant (STP)

The (2) STPs located at Paga Point at Kila Kila are proposed for the coastal area. Locations are shown in Figs 6.7 and 6.9.

The table 12.3 and 12.4 show the main features and the main facilities of the proposed STPs.

Table 12.3 Main Features of the Proposed STPs

Item		Paga Point STP		Kila Kila STP	
Planned population (person)		32,300/36,000		61,400/70,100	
Planned sewage flow (m^3/day)	Daily average	14,500/15,900		27,700/31,600	
	Daily maximum	18,900/20,700		35,900/41,000	
	Hourly maximum	21,800/23,900		41,400/47,300	
Planned water quality (mg/L)	Item	BOD	SS	BOD	SS
	Influent	170	200	170	200
	Effluent	102	120	102	120
Site area (m^2)		36 m × 94 m=3,400 m^2		70 m × 171 m = 12,000 m^2	

Note: Planned population and planned sewage flow are for target year 2005 and 2015.

Table 12.4 Main Facilities of the Proposed STPs

Facility	Paga Point STP	Kila Kila STP
1. Sedimentation tank	16.0 mD × 3.5 mH × 2 tanks	16.0 m D × 3.5 mH × 4tanks
2. Disinfection facility	Chlorine weight: 159.2 kg/day (10 mg/L)	Chlorine weight: 315.6 kg/day (10 mg/L)
3. Offshore discharge pump	250 mm × 8.30 m^3/min. × 7.6 mH × 18.5 Kw × 2 nos. (+1 stand-by)	-
4. Offshore discharge pipe	HDPE, Dia. 560 mm × 2,920 m (Existing)	HDPE, Dia. 900 mm × 3,000 m
5. Thickener	5.0 mD × 3.5mH × 1tank	5.0 mD × 3.5mH × 2 tanks
6. Digestion tank	13.0 mD × (6.5H1 × 2.2mH2) × 1tank	13.0mD × (6.5mH1 × 2.2mH2) × 2 tanks
7. Sludge drying bed	-	15.0mW × 10.0mL × 0.4mH × 20 beds
8.Administration BLDG.	5.0 mW × 5.0 mL	5.0mW × 10.0 mL

Figures C.3.1 to C.3.8 in Appendix C shows the general layout plan and hydraulic profile of the proposed STPs.

The capacity calculations are shown in Table C.3.2 in Appendix C.

12.5 Ocean Outfall

The existing outfall (diameter 560 mm, length 3,000 m) at Paga Point will be utilized. In order to cope with the increased flow, pumps are supplemented. Their specifications are shown in the previous section.

For the Kila Kila zone, a new outfall is to be installed towards the center of the Papuan Lagoon at Joyce Bay. The length and pipe diameter is 3,650 m and 900 mm respectively. In this case, pumps are not planned utilizing head difference between effluent point and discharge point.

Table 12.5 Proposed Sewage Facilities

Zone / Item	Paga			Kila Kila				Total
	Baruni/Tatana	Idubada/Hanuabada	Konedobu/Town	Koki/Badili	Gabutu/Vabukori	Kila Kila	Pari	
1.Sewer Network (m)	70ha	168ha	94ha	134ha	14ha	160ha	9ha	649ha
	9,800	23,520	-	18,760	1,960	22,400	1,260	77,700
2.Sub-Trunk Sewer (m)								
200mm	550	2,460	160	3,049	0	2,302	520	9,041
250mm	0	130	116	57	0	0	0	303
300mm	0	0	0	0	0	430	0	430
400mm	0	0	0	0	0	200	0	200
S-Total	550	2,590	276	3,106	0	2,932	520	9,974
3.Trunk Sewer (m)								
200mm	760	0	0	0	360	0	0	1,120
250mm	0	0	0	0	0	0	0	0
300mm	2,580	0	0	0	480	0	0	3,060
350mm	0	270	0	0	0	0	0	270
400mm	0	110	0	0	0	0	0	110
450mm	0	640	0	0	0	0	0	640
500mm	0	0	1,181	0	0	52	0	1,233
600mm	0	0	0	373	0	1,843	0	2,216
S-Total	3,340	1,020	1,181	373	840	1,895	0	8,649
4.Force Main (m)								
150mm	960	0	0	0	1,160	0	0	2,120
200mm	0	0	0	0	300	0	3,200	3,500
250mm	0	0	0	0	0	0	0	0
300mm	220	130	0	336	1,400	0	0	2,086
350mm	0	0	220	0	0	0	0	220
400mm	0	0	0	0	0	0	0	0
450mm	0	1,480	1,000	1,160	0	0	0	3,640
500mm	0	0	303	0	0	0	0	303
600mm	0	0	0	0	0	0	0	0
700mm	0	0	0	0	0	0	0	0
800mm	0	0	0	0	0	360	0	360
S-Total	1,180	1,610	1,523	1,496	2,860	360	3,200	12,229
5.Pumping Station	Tatana-1	Hanuabada-1	Konedobu-1, 2	Koki	Gabutu-1, 2, 3	Kila Kila	Pari	
	Tatana-2	Hanuabada-2	Yacht	Badili	Vabukori-1, 2, 3			
	Tatana-3		Stanley	Kaugere				
	Tatana-4		Paga					
			Lawes, Davara					
6.Treatment Plant			Paga			Kila Kila		
7.Ocean Outfall (m)			Diameter :-560 mm			Diameter : 900 mm		
			Length : 3,000m			Length : 3,650		
			(Existing)					

CHAPTER 13
PROJECT COST AND CONSTRUCTION PROGRAM

CHAPTER 13 PROJECT COST AND CONSTRUCTION PROGRAM

13.1 Project Cost

1) Basis for Cost Estimation

The project components and their estimation are as follows:

- Direct Construction Cost: Based on the preliminary design of each facility
- Land Acquisition Cost: Land area and unit land price (25 Kina/m^2)
- Engineering Cost: 10% of direct construction cost
- Government Administration Cost: 1.5% of direct construction cost.
- Physical Contingency: 10% of direct construction cost
- Cost is based on December, 1997 price level.

2) Direct Construction Cost

Direct construction costs for the facilities are shown in Table 13.1 and 13.3.

Table 13.1 Construction Cost

Facility	Construction Cost (1,000 Kina)
1. Sub-Trunk Sewer	2,421
2. Trunk Sewer	3,709
3. Force Main	4,015
4. Pumping Station	4,386
5. Treatment Plant	7,745
6. Ocean Outfall	4,893
Total	27,169

3) Project Cost

The total project cost is 34.07 million Kina with the breakdown shown in Table 13.2 and more details in Table 13.4. Of the total project cost, 21.541 million Kina or 63% is the local currency component, and the remaining 12.529 million Kina or 37% is the foreign currency component as shown below.

Table 13.2 Project Cost (1,000 Kina)

Item	Total	Local Currency	Foreign Currency
1. Direct Construction Cost	27,169	17,229	9,940
2. Procurement of Equipment	687	-	687
3. Land Acquisition	374	374	-
4. Government Administration	407	407	-
5. Engineering Service	2,717	815	1,902
6. Physical Contingency	2,717	2,717	-
Total	34,070	21,541	12,529

4) Operation and Maintenance Cost

The annual operation and maintenance cost for the sewage facilities proposed for the study area in 2005 is estimated at 0.793 M Kina for the pumping facilities and sewage treatment plants.

13.2 Priority for Implementation

The project in the Kila Kila basin should be implemented first to improve the deteriorated sea water quality. The construction will start with the trunk sewer in the Kila Kila basin, situated near the sewage treatment plant, following gradually upstream. All facilities in this basin will be completed by 2002.

Secondly, the facilities in the Paga Point basin will start in 2003 by initially constructing the trunk sewer in the Town area and all the facilities in the basin will be completed by 2005 (refer to Table 13.5).

13.3 Implementation Schedule

Under Phase 1, the project will start in 1999 with the detailed design and land acquisition for the Kila Kila STP. The following year (2000) the trunk sewer construction in the Kila Kila basin, and land acquisition for the pumping stations will occur. From the later half of 2001, the construction work of the treatment plant and collection facilities will start. Finally, the construction of the ocean outfall will start from early 2002 to be completed all with the facilities at the end of the year.

Under Phase 2, the project will start in 2003 with trunk sewer construction in the Town area and land acquisition for the pumping stations. The project progresses gradually upstream until the completion of Paga Point STP in 2005.

On the other hand, the Kila Kila STP starts operation in 2002, such that the operation and maintenance costs start from 2003. The Paga Point STP starts operation in 2006. With the two treatment plants in operation, the equipment for water analysis and sewer cleaning should be procured in 2005 for the smooth operation and maintenance of the sewerage system (refer to Table 13.6).

Table 13.3 Direct Construction Cost

(Unit: 1000 Kina)

	Paga			Kila Kila				Total
	Baruni/ Tatana	Idubada/ Hanuabada	Konedobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	
1.Sewer Network	70ha	168ha	94ha	134ha	14ha	160ha	9ha	649ha
	(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)	(20,838)
2.Sub-Trunk Sewer								
200mm	128	573	37	710	0	536	121	2,107
250mm	0	37	33	16	0	0	0	86
300mm	0	0	0	0	0	151	0	151
400mm	0	0	0	0	0	78	0	78
S-Total	128	610	70	727	0	765	121	2,421
3.Trunk Sewer								
200mm	177	0	0	0	84	0	0	261
250mm	0	0	0	0	0	0	0	0
300mm	903	0	0	0	168	0	0	1,071
350mm	0	101	0	0	0	0	0	101
400mm	0	43	0	0	0	0	0	43
450mm	0	289	0	0	0	0	0	289
500mm	0	0	614	0	0	27	0	641
600mm	0	0	0	219	0	1,084	0	1,303
S-Total	1,080	433	614	219	252	1,111	0	3,709
4.Force Main								
150mm	187	0	0	0	226	0	0	413
200mm	0	0	0	0	67	0	714	781
250mm	0	0	0	0	0	0	0	0
300mm	64	38	0	97	406	0	0	605
350mm	0	0	80	0	0	0	0	80
400mm	0	0	0	0	0	0	0	0
450mm	0	662	447	519	0	0	0	1,627
500mm	0	0	153	0	0	0	0	153
600mm	0	0	0	0	0	0	0	0
700mm	0	0	0	0	0	0	0	0
800mm	0	0	0	0	0	356	0	356
S-Total	251	699	680	616	699	356	714	4,015
5.Pumping Station								
Newly	494	394	1,192	592	818	399	125	4,014
Improvement			249	123				372
S-Total	494	394	1,441	715	818	399	125	4,386
6.Treatment Plant								
			2,636			5,109		7,745
S-Total	0	0	2636	0	0	5,109	0	7,745
7.Ocean Outfall								
						4,893		4,893
S-Total	0	0	0	0	0	4,893	0	4,893
Direct Construction Cost - Total	1,953	2,135	5,441	2,276	1,769	12,633	960	27,169

Note : Cost for sewer network is not included in the total cost.

Table 13.4 Disbursement Schedule

(Unit: 1000 Kina)

Zone	Cost	Phase-1				Phase-2			Total
		1999	2000	2001	2002	2003	2004	2005	
I.Direct Construction Cost									
Koki/Badili	L/C			511	916				1,427
	F/C			270	579				849
	Total			781	1,495				2,276
Gabutu/Vabukori	L/C			152	858				1,010
	F/C			81	678				759
	Total			233	1,536				1,769
Kila Kila	L/C		632	1,827	5,812				8,271
	F/C		306	814	3,242				4,362
	Total		938	2,641	9,054				12,633
Pari	L/C			324	320				644
	F/C			33	283				316
	Total			357	603				960
Zone-Total	L/C		632	2,814	7,906				11,352
	F/C		306	1,198	4,782				6,286
	Total		938	4,012	12,688				17,638
Baruni/Tatana	L/C						250	957	1,207
	F/C						153	593	746
	Total						403	1,550	1,953
Idubada/Hanuabada	L/C						620	857	1,477
	F/C						252	407	659
	Total						872	1,264	2,136
Konedobu/Town	L/C					233	783	2,176	3,192
	F/C					109	379	1,761	2,249
	Total					342	1,162	3,937	5,441
Zone-Total	L/C					233	1,653	3,991	5,877
	F/C					109	784	2,761	3,654
	Total					342	2,437	6,752	9,531
G-Total	L/C		632	2,814	7,906	233	1,653	3,991	17,229
	F/C		306	1,198	4,782	109	784	2,761	9,940
	Total		938	4,012	12,688	342	2,437	6,752	27,169
II.Procurement Equipment								687	687
III.Land Acquisition		297	27			50			374
IV.Administration			14	60	190	5	37	101	408
V.Engineering Service	L/C		28	120	381	10	73	203	815
	F/C		66	281	888	24	171	473	1,902
	Total		94	401	1,269	34	244	675	2,717
VI.Contingency			94	401	1,269	34	244	675	2,717
VII.O/M Cost						793	793	793	2,379
VIII.Total Project Cost	L/C	297	795	3,396	9,746	1,126	2,799	6,450	24,609
	F/C	0	372	1,479	5,670	133	955	3,232	11,840
	Total	297	1,167	4,875	15,416	1,259	3,754	9,682	36,449

Table 13.5 Project Implementation and Disbursement Schedule

(Unit: 1000 Kina)

		Phase-1				Phase-2		
		1999	2000	2001	2002	2003	2004	2005
Implementation Schedule								
1. Preparation of Project								
2. Pre-Construction Stage								
2-1. Detailed Design								
2-2. Bidding								
3. Construction								
3-1. Collection System								
Trunk Sewer								
Force Main								
3-2. Pumping Station								
3-3. Sewage Treatment Plant								
3-4. Ocean Outfall								
4. Procurement Equipment								
Disbursement Schedule	**Total Cost**							
1. Land Acquisition	**374**	297	27			50		
2. Administration	**407**		14	60	190	5	37	101
3. Construction Work	**27,169**		938	4,012	12,688	342	2,437	6,752
4. Procurement Equipment	**687**							687
5. Engineering Service	**2,717**		94	401	1,269	34	244	675
6. Physical Contingency	**2,717**		94	401	1,269	34	244	675
Sub-Total of Annual Disbursement	**34,070**	297	1,167	4,875	15,416	466	2,961	8,889
7. O/M Cost	**2,379**					793	793	793
Total of Annual Disbursement	**36,449**	297	1,167	4,875	15,416	1,259	3,754	9,682

Table 13.6 Implementation Schedule

(Unit: 1000 Kina)

Zone	Cost	Phase-1				Phase-2		
		1999	2000	2001	2002	2003	2004	2005
Koki/Badili								
1.Trunk Sewer	946			473	473			
2.Force Main	616			308	308			
3.Pumping Station	714				714			
S-Total	2,276		0	781	1,495			
Gabutu/Vabukori								
1.Trunk Sewer	252				252			
2.Force Main	699			233	466			
3.Pumping Station	818				818			
S-Total	1,769		0	233	1,536			
Kila Kila								
1.Trunk Sewer	1,876		938	938				
2.Force Main	356				356			
3.Pumping Station	399				399			
4.Treatment Plant	5,109			1703	3,406			
5.Ocean Outfall	4,893				4,893			
S-Total	12,633		938	2,641	9,054			
Pari								
1.Trunk Sewer	121				121			
2.Force Main	714			357	357			
3.Pumping Station	125				125			
S-Total	960		0	357	603			
Total	17,638		938	4,012	12,688			
Baruni/Tatana								
1.Trunk Sewer	1,208						403	805
2.Force Main	251							251
3.Pumping Station	494							494
S-Total	1,953					0	403	1,550
Idubada/Hamuabada								
1.Trunk Sewer	1,043						522	522
2.Force Main	699						350	350
3.Pumping Station	393							393
S-Total	2,135					0	871	1,264
Konedobu/Town								
1.Trunk Sewer (m)	684					342	342	
2.Force Main (m)	680						340	340
3.Pumping Station	1,441						480	961
4.Treatment Plant	2,636							2,636
S-Total	5,441					342	1,162	3,937
Total	9,529					342	2,437	6,752
G-Total	27,169		938	4,012	12,688	342	2,437	6,752

CHAPTER 14
ORGANIZATION AND OPERATIONS

CHAPTER 14 ORGANIZATION AND OPERATIONS

The present organizational structure seems appropriate for works currently executed. However, this structure should be slightly restructured and strengthened in order to cope with the additional tasks and bigger work volume. The Study Team also proposes construction of new STPs and PSs, sewer pipe extensions to areas not serviced by the sewerage systems, which complies to the environmental protection requirements, such as control of treated and non-treated sewage effluent into water bodies.

14.1 Organizational Structure

The following is the proposed organizational structure of the Sewerage Operations after the completion of the project. Duties to be carried out by each section and the required manpower are presented for the years 2005 and 2015. The Planning & Works Section and the Technical Services should be set up to support both Sewerage and Water Operations since work volume is expected to increase.

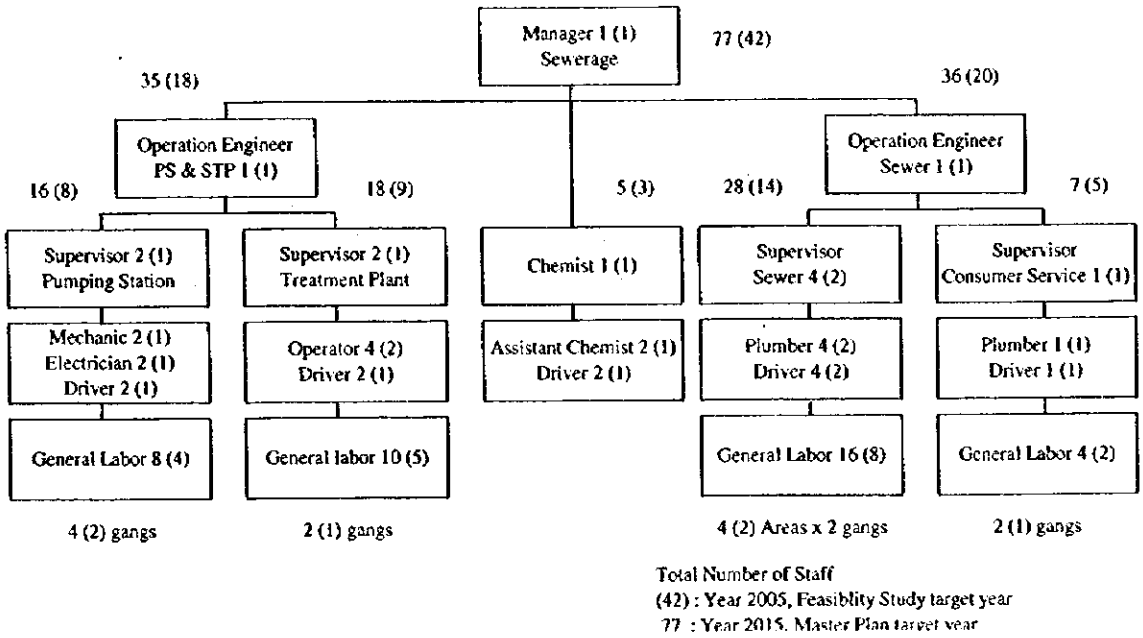


Fig. 14.1 Organization Chart of the Sewerage Operations Division

14.2 Manpower and Duties of the Sewerage Operations Division

The following are the manpower and duties of each individual unit in the Sewerage Operations Division. The number of staff is estimated separately for the years 2005 and 2015 that will coincide with implementation schedule of the project.

1) Manpower and Duties of the Sewer Operation and Maintenance Section

This section is responsible for the two major operations, namely; sewer maintenance and consumer services. The sewer maintenance section is responsible for all sewer maintenance

works, while the large scale maintenance work such as new sewer pipe installations is to be contracted to the private sector. The consumer services group is to handle Y-junction installations and manhole connections, while the house connections discharge pipe installation from consumer premises to sewer main/sub-mains are to be carried out by the client themselves. Below are the works this section is responsible for.

- Daily inspection of sewer main/sub-mains.
- Frequent investigations of unexpected water influx into sewers and taking measures to prevent it.
- Fixing of broken pipes and superannuated pipes.
- Frequent investigations of severely polluted water discharged into sewers, and preparation of reports on preventive measures.
- Weekly inspection on the conditions of sewer main/sub-mains and sewage effluent facilities.
- Monthly cleaning of sewers and manholes, and as necessary.
- Installation of new sewer pipes and replacement of old/damaged sewer pipes with new ones (to be contracted out, when necessary).
- Installation of service connections: Y-Junction or manhole connection. (House connections up to sewer main/sub-mains are to be installed by client).
- Daily recording of operation and maintenance activities.

For an effective and efficient execution of responsibilities it is recommended that maintenance gangs be formed. It is suggested that two gangs, one for the North (inland) area and the other for the South (coastal) area of NCD, be formed by the year 2005. However, from 2015, eight (8) gangs will be necessary for the Northeast, Northwest, Southeast and Southwest areas.

Table 14.1 Gang Teaming

Gangs	Responsible area	
	Year 2005	Year 2015
Two gangs	North	Northeast
Two gangs	N/A	Northwest
Two gangs	South	Southeast
Two gangs	N/A	Southwest

2) Manpower and Duties of Pumping Stations & Treatment Plant Section

Under the control of the Operation Engineer for PS & STP, two staff gangs are to be organized, one for operation and maintenance of pumping stations, and the other for sewage treatment plant operation and maintenance. The works listed below are to be carried out by the EDA RANU staff for the pumping station operation and maintenance such as small scale and daily work. The work that requires special knowledge and skills are to be contracted out to private engineering companies. The following works are to be carried out by this section.

- Daily inspection of pumping stations.
- Weekly cleaning of screens at pumping stations.
- Weekly inspection of pump station machinery.

- Small scale maintenance of machines at stations, when necessary.
- Large scale maintenance of machinery is to be contracted out to engineering companies, when necessary.

The number of staff required to carry out the above works is listed in Table 14.2.

Similar to the pumping station operation and maintenance, the works to be carried out by the EDA RANU staff for the STP are as follows:

- Daily inspection of the STP's condition.
- Daily recording of influent sewage volume for each STP.
- Weekly scrubbing of mud from the plants (Paga and Kila Kila).
- Daily removal of mud from Paga Point and Kila Kila STP.
- Weekly accumulation of mud and levelling of dry bed.
- Weekly delivery of dry mud from Kila Kila plant to firm land.
- Regular maintenance of sewage treatment plants, such as mowing, etc., are to be contracted out.

The number of staff required for operation and maintenance of the STP are listed in Table 14.2.

3) Manpower and Duties of the Water Quality Control

EDA RANU shall perform both inspection and examination of the quality of wastewater discharged into sewer main/sub-mains and the effluent quality discharge into water bodies. This section is to control the inspection and examination of water pollution levels in areas where treated water is discharged from the treatment plants. However, it seems impractical for EDA RANU to maintain a water examination laboratory, since the tests are only conducted periodically and require special knowledge/experience, as well as special equipment to examine water quality. It is thus recommended that detailed examination of water quality be contracted out to established laboratory which has the capability, as presently done by the National Agriculture Chemistry Laboratory and/or Central Provincial Laboratory. The following are the major works to be carried out by this section:

- Weekly inspection/examination of the quality of STP's influent/effluent.
- Monthly detailed examination of water quality (to be contracted out to a laboratory).
- Weekly observation of trade waste discharge into sewer main/sub-mains.
- Examination of the quality of trade waste discharges on all occasions.
- Detection of polluted material and finding origin on all occasions.
- Annual preparation of recommendations for the improvement of treatment plant capacity.
- Recording water quality inspection, observation and examination results.

The number of staff that is indicated in Table 14.2 is necessary for this section to carry out wastewater quality control, while a separate manpower will have to be assigned for water supply operations.

14.3 Engineering Divisions

In addition to the sewerage operation and maintenance organisational units, support groups such as the Planning & Works, and Technical Services sections are necessary. As stated earlier, these sections will be supporting sewerage and water supply, but their positions and number of staff specified below will only carry out work related to the sewerage system.

1) Planning & Works

Drafting of plans for the sewerage system and water supply, and supervising facility developments/construction by developers/private constructors are the main responsibility of the Planning & Works. These two main work areas should be achieved in accordance with the Urban Services Development Plan, such that this section carries out its activities in close coordination with the Physical Planning Board. The annual sewerage system development and rehabilitation plan shall basically follow the long-term facility development plan supported by the annual financial plan. The following are the duties to be carried out by this section.

- Maintaining the sewerage ledger, as a daily procedure.
- Regular discussions with developers/contractors regarding new projects/development's connection of service into the existing system, making sure that plans and workmanship follows the standards.
- Developing EDA RANU's annual plan for sewerage system construction and renovation for the proceeding year.
- Preparation of basic design and cost estimates of sewer construction, sewer rehabilitation, etc., after the annual construction and rehabilitation plan has been developed.
- Supervision of works contracted out.

The number of staff listed in Table 14.2 are required to carry out the works of this section discussed earlier.

2) Technical Services Section

This section is responsible for the procurement, safekeeping and stores of materials; tools and machinery required for both water and sewerage operations. A separate clerk should be assigned to handle matters for each operation (sewerage and water supply). The following are the main duties of the Technical Services.

- Procurement of materials, machines, equipment, tools, etc., necessary for operations.
- Administrative support when contracting out jobs.
- Daily inspection of the condition of incoming stock materials, machines, equipment, tools, vehicles, etc.
- Organize for the repair of machines, equipment, tools, vehicles, etc., when necessary.
- Daily control of stock material, machines, equipment, tools, vehicles, etc.

Table 14.2 (1/2) Staff required in Sewerage Division by year 2005 and 2015

Position	Number of staffs 2005	2015	Remarks
Sewerage Operation			
Sewerage Operation Manager	1	1	
Sewer Section			
Operation Engineer	1	1	
Sewer Main			
Supervisors	2	4	
Plumbers	2	4	
Drivers	2	4	
General Labourers	8	16	
Total	14	28	
Consumer Service			
Supervisors	1	1	
Plumbers	1	1	
Drivers	1	1	
General Labourers	2	4	
Total	5	7	
Total of Sewer Section	20	36	
Pumping Station & Treatment Plant Operation and Maintenance Section			
Operation Engineer	1	1	
Pumping Station			
Supervisors	1	2	
Mechanics	1	2	
Electricians	1	2	
Drivers	1	2	
General Labourers	4	8	
Total	8	16	
Sewage Treatment Plant Operation and Maintenance			
Supervisors	1	2	
Operators	2	4	
Drivers	1	2	
General Labourers	5	10	
Total	9	18	
Total of PS & STP	18	35	
Quality Control Section			
Chemists	1	1	for Sewerage only
Assistant chemists	1	2	for Sewerage only
Drivers	1	2	for Sewerage only
Total	3	5	
Sewerage Operation Total	42	77	

Table 14.2 (2/2) Staff required in Engineering Sections for Sewerage by year 2005 and 2015

Engineering				
Planning and Works --- responsible for both water and sewerage				
	Manager	1	1	Responsible for Water & Sewerage
	Engineers	1	2	for Sewerage only
	Draftsman	1	2	for Sewerage only
	Total	3	5	
Technical Services --- responsible for both water and sewerage				
	Manager	1	1	Responsible for Water & Sewerage
	Clerk	1	2	for Sewerage only
	Mechanics	1	2	for Sewerage only
	Storekeepers	1	1	for Sewerage only
	Total	4	6	

14.4 Considerations for Operation and Maintenance

1) Keeping Records

It is difficult to study how much construction work has been contracted out and how often emergency cleaning has been carried out. Nevertheless, works contracted out to the private sectors can be accounted for by counting individual order forms and invoices.

Maintaining work records will help strengthen control over all works accomplished. It is also useful for review purposes and in identifying past problems and solutions, serving as reference should similar situations occur in the future. It is useful to file important information for future reference. Important records to be kept include the following:

- Sewer pipe, manhole inspection and maintenance records including sewer replacement works.
- House-connection.
- Treatment plant inspection, operation and maintenance. (No records exist currently).
- Pump station inspection, operation and maintenance. (Current records to be improved).
- Water quality inspection and examination. (No historical records exist).
- Stock in-out records. In addition to the semi-annual stock records, annual inventory should also be taken.
- Maintenance records of vehicles, machines, equipment, tools, etc. (Current records to be updated and improved).

2) Job Procedure Manual

EDA RANU is in the process of developing the job procedure manual that is useful not only to the present workforce but would also be helpful to new recruits and transferees (internal). The job manuals should contain work schedules, procedures/steps on how to execute jobs, teamwork, etc. The job procedure manual to be developed include the following:

- House-connection.
- Sewer maintenance.
- Pump station operation and maintenance.
- Treatment plant operation and maintenance.
- Waste-water-quality monitoring.
- Procurement and inventory control.

3) Training

The EDA RANU workforce should have basic knowledge on the job assigned to them. To uplift their capability and knowledge, training courses and orientation seminar should be given periodically. To implement the training programs the following are to be considered:

- Basic knowledge on sewerage system.
- Basic and practical knowledge sewerage facility planning and designing.
- Construction control and supervision.
- Operation and maintenance of sewer.
- Waste water quality monitoring.

The current workforce, new recruits and internal transferees should undergo periodic training in order to achieve proficiency. It is also essential to get the services of trainers/lecturers having sufficient background in their respective fields. It is suggested to initially invite eligible foreign consultants to carry out these courses, and trained EDA RANU's staff may conduct subsequent training program in order to save costs.

For effective implementation of the training program, the following should first be considered.

- EDA RANU to provide training program budget. It is estimated at approximately 100,000 Kina for years 1998 and 1999 (including cost for foreign consultants).
- EDA RANU to set up procedural standards of the training program beforehand or at least during the first training session.
- EDA RANU to develop necessary manuals and the respective tasks beforehand, or at least during the first training session.
- EDA RANU to take advantage of the training programs provided by foreign aid agencies instead of inviting foreign consultants, which are costly. JICA provides free training courses including those for the sewerage systems in Japan, and also dispatch specialist (such as sewerage engineers) to requesting countries.

CHAPTER 15
FINANCIAL PLAN

CHAPTER 15 FINANCIAL PLAN

15.1 General

The feasibility study covers the Phase 1 (1999 - 2001) and the Phase 2 (2002 - 2006) of the master plan. The year 2006 is the year for the preparation of the Phase 3. Therefore, the assumptions used in this study such as population growth and fee collection forecasting are in line with those of the master plan, taking into account the investments relating to the feasibility study.

15.2 Financial Plan

1) Investment Plan

The investment plan as shown in Table 15.1 is entirely identical with the first eight years investment plan of the master plan. The investment of 34 M Kina is planned for 2005. The O&M costs cover the whole Sewerage Operations Division including the proposed investments. The estimation of the O&M costs was explained in Chapter 9 of the master plan.

2) Income Prediction

The prediction of income as shown in Table 15.2, is based on the 1997 billing for sewerage service at 2,774,000 Kina. The new charge system, which is currently in a planning phase, will have a total billing of 6,782,000 Kina annually. This revised plan is very close to the contents of the proposal and will be realized by a healthy financial management of EDA RANU. The financial analysis made in this study is using the new charge system as the premise. The collection rate for this first 5 years is expecting at 80 percent of the billing and 85 percent thereafter. An income increase is expected substantially more that what the World Bank has predicted that shows the positive effect of the privatization.

3) Financial Statements

The financial statements (funds flow, income statement and balance sheet) are shown in Table 15.3 to Table 15.5. Case A (Table 15.3) is taken as the base case. Investment fund is assumed available at an interest rate of 2.7 percent annually payable in thirty years (with ten years grace period). The depreciation is calculated using the straight-line method (no salvage value). The life of machine and electric equipment are assumed at fifteen years whilst the civil works are assumed at fifty years.

The plant and equipment are assumed to be maintained during the F/S period and that there is no investment in plant and equipment thereafter. Under this assumption, the forecasting of financial statements until 2015 is prepared. The financial situation will be healthy until 2015 if the conditions such as that of the loan, fee collection, etc., will be meet: Case B (Table 15.4) is the sensitivity analysis of Case A with the annual interest rate increased to 3.2 percent. The other assumptions remain the same.

Case C (Table 15.5) is the case where a commercial financing is secured having an interest rate of 8.5 percent, annually. The term is assumed at seventeen years with five years grace

period. All investments will be depreciated in twenty years period. All investments will be depreciated in twenty years using the straight-line method (no salvage value). This case disclosed a financially not viable scenario with a negative cash position in 2010, although the conditions used are fairly more generous than in the real financial market. Besides, investment funding from commercial financing will be tough for a sewerage service that is not profitable. Therefore, EDA RANU need to request financing and/or grant from international aid organizations.

4) FIRR

The FIRR of the investment plan for the FS period is shown in Table 15.6. The FIRR is 6.21% for the period until 2015 and eventually improves thereafter. The cause of the improved FIRR is the change of the sewerage charge systems based on water consumption and control of O&M cost within affordable level.

15.3 Conclusion

If the conditions mentioned earlier are meet, the proposed investment of the feasibility study will be financially feasible and desirable.

Table 15.1 The Investment Plan (1999 - 2006)
(Feasibility Study)

Unit: 1000 Kina (1997 Price)

Phase	1	1	1	1	2	2	2	2	
Year	1999	2000	2001	2002	2003	2004	2005	2006	Total
1. Construction		938	4,012	12,688	342	2,438	6,751	0	27,169
2. Procurement of Equipment							687		687
3. Land Acquisition	297	27			50				374
4. Administration		14	60	190	5	37	101	0	407
5. Engineering Service		94	401	1,269	34	244	675	0	2,717
6. Contingency		94	401	1,269	34	244	675	0	2,717
Sub Total (All Investment)	297	1,167	4,874	15,416	465	2,963	8,889	0	34,071
Sub Total (Investment Except Land)	0	1,140	4,874	15,416	415	2,963	8,889	0	33,697
7. O&M Cost	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	33,919
Total Project Cost	3,799	4,851	8,725	19,442	4,674	7,639	13,776	5,084	67,990

Note: O&M Costs cover the whole sewerage division including the existing operation. They are estimated by the formula described in chapter 9 of the master plan.

Table 15.2 The Bill Collection Forecasting of EDA RANU Sewerage Service Operation
(Feasibility Study)

Unit: 1000 Kina (1997 price)

No.		1	2	3	4	5	6	7	8	
Year	1997	1999	2000	2001	2002	2003	2004	2005	2006	1997-2006
NCD Population	274,570	300,411	314,230	326,548	339,348	352,651	366,472	380,812	393,751	
Bill, Flat GDP	2,774	6,782	7,094	7,372	7,661	7,961	8,273	8,597	8,889	62,630
Bill, GDP Growth	2,774	6,782	7,137	7,461	7,800	8,154	8,525	8,911	9,269	64,038
Collection (70 %)	1,942	4,747	4,996	5,223	5,460	5,708	5,967	6,238	6,489	44,827
Collection (80 %)	2,219	5,426	5,709	5,969	6,240	6,523	6,820	7,129	7,415	51,231
Collection (85 %)	2,358	5,765	6,066	6,342	6,630	6,931	7,246	7,575	7,879	54,433
World Bank Forecast	2,100	2,271	2,362	2,457	2,555	2,657	2,763	2,874	NA	17,939

Table 15.3 The Financial Statements of Sewerage Division of EDA RANU : CASE A
(Collection Rate 80 %(first five years), 85 % (after that), Interest Rate 2.7 %)

Unit: 1000 Kina (1997 Price)

Phase	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fund Flow Table																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879
Loan (2.7%)	297	1,167	4,874	15,416	465	2,963	8,889	0	0	0	0	0	0	0	0	0	0
Investment	297	1,167	4,874	15,416	465	2,963	8,889	0	0	0	0	0	0	0	0	0	0
Interest Payment (2.7%)	8	40	171	587	600	680	920	920	920	920	920	918	909	880	850	816	770
Loan Repayment	0	0	0	0	0	0	0	0	0	0	0	15	73	317	1,088	1,111	1,259
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084
Net Cash Inflow	1,916	1,985	1,947	1,627	1,714	1,890	1,768	1,875	1,875	1,875	1,860	1,804	1,569	827	834	720	321
Income Statement																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084
Depreciation	0	23	164	606	614	684	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003
Interest Payment (2.7%)	8	40	171	587	600	680	920	920	920	920	920	918	909	880	850	816	770
Balance	1,916	1,962	1,783	1,021	1,100	1,206	765	872	872	872	872	874	883	912	942	976	1,022
Balance sheet																	
Cash	1,916	3,902	5,848	7,475	9,189	11,079	12,847	14,722	16,597	18,471	20,331	22,136	23,704	24,531	25,365	26,085	26,406
Investment	0	1,140	6,014	21,430	21,845	24,808	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697
Less Accum.Depreciation	0	23	187	793	1,407	2,091	3,094	4,097	5,100	6,103	7,106	8,109	9,112	10,115	11,118	12,121	12,121
Land	297	324	324	324	374	374	374	374	374	374	374	374	374	374	374	374	374
Total Assets	2,213	5,343	11,999	28,436	30,001	34,170	43,824	44,696	45,568	46,439	47,296	48,098	48,663	48,487	48,318	48,035	48,356
Loan (balance)	297	1,464	6,338	21,754	22,219	25,182	34,071	34,071	34,071	34,071	34,056	33,983	33,666	32,578	31,467	30,208	28,504
Reserved Fund	1,916	3,879	5,661	6,682	7,782	8,988	9,753	10,625	11,497	12,368	13,240	14,115	14,997	15,909	16,851	17,827	19,852
Total Liabil.&Capital	2,213	5,343	11,999	28,436	30,001	34,170	43,824	44,696	45,568	46,439	47,296	48,098	48,663	48,487	48,318	48,035	48,356

Table 15.4 The Financial Statements of Sewerage Division of EDA RANU : CASE B
(Collection Rate 80 %(first five years), 85 % (after that), Interest Rate 3.2 %)

Unit: 1000 Kina (1997 Price)

Phase	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fund Flow Table																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879
Loan (3.2%)	297	1,167	4,874	15,416	465	2,963	8,889	0	0	0	0	0	0	0	0	0	0
Investment	297	1,167	4,874	15,416	465	2,963	8,889	0	0	0	0	0	0	0	0	0	0
Interest Payment (3.2%)	10	47	203	696	711	806	1,090	1,090	1,090	1,090	1,090	1,087	1,077	1,042	1,007	967	912
Loan Repayment	0	0	0	0	0	0	0	0	0	0	15	73	317	1,088	1,111	1,259	1,704
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084
Net Cash Inflow	1,915	1,978	1,915	1,518	1,603	1,764	1,598	1,704	1,704	1,704	1,690	1,634	1,400	664	677	569	178
Income Statement																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084
Depreciation	0	23	164	606	614	684	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003
Interest Payment (3.2%)	10	47	203	696	711	806	1,090	1,090	1,090	1,090	1,090	1,087	1,077	1,042	1,007	967	912
Balance	1,915	1,955	1,751	912	989	1,080	595	701	701	701	702	704	714	749	785	825	879
Balance sheet																	
Cash	1,915	3,893	5,808	7,326	8,928	10,693	12,291	13,995	15,699	17,404	19,093	20,728	22,128	22,792	23,469	24,038	24,216
Investment	0	1,140	6,014	21,430	21,845	24,808	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697
Less Accum.Depreciation	0	23	187	793	1,407	2,091	3,094	4,097	5,100	6,103	7,106	8,109	9,112	10,115	11,118	12,121	12,121
Land	297	324	324	324	374	374	374	374	374	374	374	374	374	374	374	374	374
Total Assets	2,212	5,334	11,959	28,287	29,740	33,784	43,268	43,969	44,670	45,372	46,058	46,690	47,087	46,748	46,422	45,988	46,166
Loan (balance)	297	1,464	6,338	21,754	22,219	25,182	34,071	34,071	34,071	34,071	34,056	33,983	33,666	32,578	31,467	30,208	28,504
Reserved Fund	1,915	3,870	5,621	6,533	7,521	8,602	9,197	9,898	10,599	11,301	12,002	12,707	13,421	14,170	14,955	15,780	17,662
Total Liabil.&Capital	2,212	5,334	11,959	28,287	29,740	33,784	43,268	43,969	44,670	45,372	46,058	46,690	47,087	46,748	46,422	45,988	46,166

Table 15.5 The Financial Statements of Sewerage Division of EDA RANU : CASE C
(Collection Rate 80 %(first five years), 85 % (after that), Interest Rate 8.5 %)

Unit: 1000 Kina (1997 Price)

Phase	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fund Flow Table																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879
Loan (8.5%)	297	1,167	4,874	15,416	465	2,963	8,889	0	0	0	0	0	0	0	0	0	0
Investment	297	1,167	4,874	15,416	465	2,963	8,889	0	0	0	0	0	0	0	0	0	0
Interest Payment (8.5%)	25	124	539	1,849	1,889	2,138	2,884	2,839	2,685	2,527	2,349	2,107	1,866	1,625	1,383	1,142	901
Loan Repayment	0	0	0	0	0	25	122	528	1,813	1,852	2,099	2,839	2,839	2,839	2,839	2,839	2,839
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084
Net Cash Inflow	1,899	1,900	1,579	365	425	407	-317	-572	-1,703	-1,585	-1,653	-2,152	-1,910	-1,669	-1,428	-1,187	-945
Income Statement																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879	7,879
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084	5,084
Depreciation	0	57	301	1,072	1,092	1,240	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,656	1,656	1,656
Interest Payment (8.5%)	25	124	539	1,849	1,889	2,138	2,884	2,839	2,685	2,527	2,349	2,107	1,866	1,625	1,383	1,142	901
Balance	1,899	1,843	1,278	-707	-667	-808	-1,880	-1,729	-1,575	-1,418	-1,239	-998	-756	-515	-245	-4	238
Balance sheet																	
Cash	1,899	3,800	5,378	5,743	6,169	6,575	6,258	5,686	3,983	2,399	745	-1,406	-3,317	-4,986	-6,414	-7,600	-8,546
Investment	0	1,140	6,014	21,430	21,845	24,808	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697	33,697
Less Accum.Depreciation	0	57	358	1,430	2,522	3,762	5,447	7,132	8,817	10,502	12,187	13,872	15,557	17,213	18,869	20,525	20,525
Land	297	324	324	324	374	374	374	374	374	374	374	374	374	374	374	374	374
Total Assets	2,196	5,207	11,358	26,067	25,866	27,995	34,882	32,625	29,237	25,968	22,629	18,793	15,197	11,872	8,788	5,946	5,000
Loan (balance)	297	1,464	6,338	21,754	22,219	25,157	33,924	33,396	31,583	29,731	27,632	24,793	21,954	19,115	16,276	13,437	10,598
Reserved Fund	1,899	3,743	5,020	4,313	3,647	2,838	958	-771	-2,346	-3,763	-5,003	-6,000	-6,757	-7,243	-7,488	-7,491	-5,598
Total Liabil.&Capital	2,196	5,207	11,358	26,067	25,866	27,995	34,882	32,625	29,237	25,968	22,629	18,793	15,197	11,872	8,788	5,946	5,000

Table 15.6 FIRR of EDA RANU Sewerage Service (F/S)

Unit: 1000 Kina (1997 Price)

Year	Cash Collection	Investment (All)	O&M	Total Cash Outflow	Net Cash Flow	FIRR
1999	5,426	297	3,502	3,799	1,627	
2000	5,709	1,167	3,684	4,851	858	
2001	5,969	4,874	3,851	8,725	-2,756	
2002	6,240	15,416	4,026	19,442	-13,202	
2003	6,523	465	4,209	4,674	1,849	
2004	7,246	2,963	4,676	7,639	-393	
2005	7,575	8,889	4,887	13,776	-6,201	
2006	7,879	0	5,084	5,084	2,795	
2007	7,879	0	5,084	5,084	2,795	
2008	7,879	0	5,084	5,084	2,795	
2009	7,879	0	5,084	5,084	2,795	
2010	7,879	0	5,084	5,084	2,795	
2011	7,879	0	5,084	5,084	2,795	
2012	7,879	0	5,084	5,084	2,795	
2013	7,879	0	5,084	5,084	2,795	
2014	7,879	0	5,084	5,084	2,795	
2015	7,879	0	5,084	5,084	2,795	*6.21%*
2016	7,879	931	5,084	6,015	1,864	6.90%
2017	7,879	2,861	5,084	7,945	-66	6.88%
2018	7,879	0	5,084	5,084	2,795	7.68%
2019	7,879	233	5,084	5,317	2,562	8.28%
2020	7,879	3,026	5,084	8,110	-231	8.23%
2021	7,879	0	5,084	5,084	2,795	8.73%
2022	7,879	0	5,084	5,084	2,795	9.14%
2023	7,879	0	5,084	5,084	2,795	9.48%
2024	7,879	0	5,084	5,084	2,795	9.77%
2025	7,879	0	5,084	5,084	2,795	10.02%
2026	7,879	0	5,084	5,084	2,795	10.23%
2027	7,879	0	5,084	5,084	2,795	10.40%
2028	7,879	0	5,084	5,084	2,795	10.56%
2029	7,879	0	5,084	5,084	2,795	10.69%
2030	7,879	0	5,084	5,084	2,795	10.80%
2031	7,879	931	5,084	6,015	1,864	10.87%
2032	7,879	2,861	5,084	7,945	-66	10.87%
2033	7,879	0	5,084	5,084	2,795	10.95%
2034	7,879	233	5,084	5,317	2,562	11.01%
2035	7,879	3,026	5,084	8,110	-231	11.01%
2036	7,879	0	5,084	5,084	2,795	11.06%
2037	7,879	0	5,084	5,084	2,795	11.11%
2038	7,879	0	5,084	5,084	2,795	11.15%
2039	7,879	0	5,084	5,084	2,795	11.19%
2040	7,879	0	5,084	5,084	2,795	11.22%
2041	7,879	0	5,084	5,084	2,795	11.25%
2042	7,879	0	5,084	5,084	2,795	11.28%
2043	7,879	0	5,084	5,084	2,795	11.30%
2044	7,879	0	5,084	5,084	2,795	11.32%
2045	7,879	0	5,084	5,084	2,795	11.34%

CHAPTER 16
PROJECT EVALUATION AND RECOMMENDATION

CHAPTER 16 PROJECT EVALUATION AND RECOMMENDATION

The coastal area, which has been selected as a priority project area, has old and outmoded facilities, but the sewerage collection system is accessible to nearly 50% of the population. However, in most locations, the sewage collected is discharged into the sea, and this has become the prime cause of marine pollution. In this section, the effects of implementing this project and the evaluations considering future developments are mentioned, as below.

The outline of facilities required for the project are as follows:

- **Installation of sub-trunk sewer pipelines:** Pipelines connected to the ends of existing sewer system and connecting new trunk sewers
- **Installation of trunk sewers:** Pipelines that connect sub-trunk sewer pipes and reach up to the treatment plant via pumping stations
- **Pumping stations:** Based on geographical and terrain conditions, new pumping stations are required at 16 locations along the trunk sewer route. The capacity of eight existing pumping stations is to be enhanced by extensive improvements in order to cope with the increase in capacity in the future.
- **Treatment plants:** Installation of primary sedimentation facilities and sludge thickening facilities at the treatment plants at two locations - Paga and Kila Kila
- **Ocean outfall pipeline:** Existing facilities at Paga shall be used; installation of new outfall pipeline with diameter 900 mm and length 3,650 m at Kila Kila

16.1 Water quality conservation effect for receiving water bodies

Results of simple pollution analysis show that COD and coliform levels are below the strict standard levels of Japan. It was also found that accumulation of T-N and T-P, which are difficult to decompose, will not be a problem in the year 2015. From the above, the following secondary effects are anticipated to accompany the purification of receiving water bodies:

- The natural environment will be conserved by protecting animal and plant species in and surrounding the water.
- Aquatic resources will be protected.
- Environment around water will be conserved through allocation of areas for recreation activities.
- Scenic spots around water bodies in cities will create a cool, pleasant and peaceful feeling.

16.2 Recommendation for conserving water quality of receiving water bodies over a very long term

The levels of COD, T-N, T-P and total coliform in receiving water bodies up to the year 2015 are as mentioned above. However, the purifying functions of nature cannot bring about decomposition of T-N and T-P, which gradually accumulate in the Papuan Lagoon, bring about an increase in the nutritive salts due to eutrophication, and reduce the dissolved oxygen. There are apprehensions that the above-mentioned factors may lead to extinction of fish and destruction of coral reefs.

As a part of this Study, a baseline study was implemented for constructing a monitoring system over the long term in order to study the effects of implementation of this project on coral reefs found at a large number of locations surrounding sea areas. It is felt that the discharge outlet into the sea should be extended to the outer reef, and direct discharge offshore should also be considered.

For this case, the two instances mentioned below for the two locations at Paga Point and Kila Kila were visualized, and the approximate project costs for installing treatment plants were compared.

1) For Paga Point

- The existing ocean outfall pipe (diameter 600 mm) is extended to the outer reef over a distance of 4.5 km.
- Total Extension: 7.5 km
- Extension of the existing pipe: 3.0 km
- Additional extension: 4.5 km
- Extension of inner reef excavation: None
- Extension of outer reef excavation: 2.0 km
- Construction cost: Approximately 5.418 million kina.

Table 16.1 Comparison of Ocean Outfall Option (1)

(Unit : Thousand Kina)

	STP Installation Plan	Outfall Pipe Extension (No Treatment)
1. Land Acquisition	50	-
2. Administration	143	185
3. Construction Work	9,531	(9,531-2,636)+5,418=12,313
4. Procurement Equipment	687	687
5. Engineering Service	953	1,231
6. Contingency	953	1,231
Total	12,217(1.00)	15,647(1.28)

2) For Kila Kila

The following three cases may be contemplated considering the effects of pipe excavations on coral reefs:

Case A: Extension of the pipeline in the present plan to the outer reef (no treatment plant)
- Total Extension: 7.65 km
- Extension of the planning: 3.65 km
- Additional extension: 4.0 km
- Extension of inner reef excavation: 1.5 km
- Extension of outer reef excavation: 1.0 km
- Construction cost: Approximately 10.560 million kina

Case B: Shift of pipeline under present plan to the tip of the peninsula and extension to the outer reef (no treatment plant)

- Total Extension: 9.15 km
- Extension over land: 1.65 km
- Extension of the sea floor: 7.5 km
- Extension of inner reef excavation: None
- Extension of outer reef excavation: 1.5 km
- Construction cost: Approximately 12.260 million kina

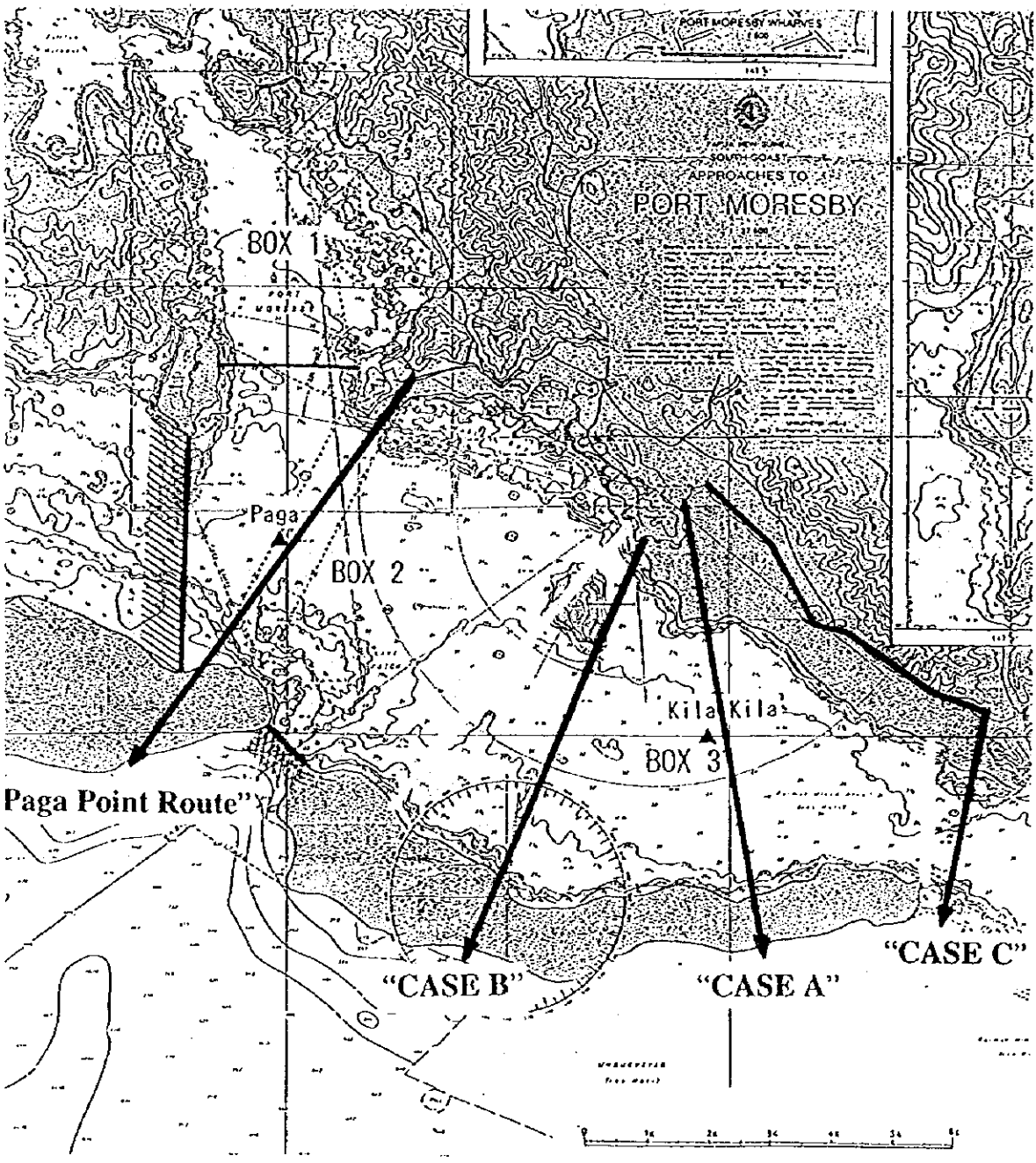
Case C: Over land up to Taurama Beach and extension to the outer reef (no treatment plant)

- Total Extension: 10.0 km
- Extension over land: 6.5 km
- Extension of the sea floor: 3.5 km
- Extension of inner reef excavation: None
- Extension of outer reef excavation: 1.0 km
- Construction cost: Approximately 14.270 million kina

Table 16.2 Comparison of Ocean Outfall Option (2)

(Unit : Thousand Kina)

	STP	Ocean outfall Pipe Extension (No Treatment)		
	Installation Plan	Case A	Case B	Case C
1. Land Acquisition	324	-	-	-
2. Administration	264	346	372	402
3. Construction Work	17,638	23,089	24,780	26,799
4. Procurement Equipment	-	-	-	-
5. Engineering Service	1764	2,309	2,479	2,680
6. Contingency	1,764	2,309	2,479	2,680
Total	21,754(1.00)	28,053(1.29)	30,119(1.38)	32,561(1.50)



Date	Title	Fig.
May 1998	**The Concept of Ocean Outfall Route**	**16.1**

THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI

16.3 Recommendation for management of sewerage project

1) Views on financial status in the future

The FIRR for this project considering the period until 2015 is 6.21%. The key to success of this investment plan lies in implementing a new tariff system and establishing the tariff collection system based on the water tariff. If the O&M costs are restricted to fall within the range proportional to the income, this investment plan is feasible and may be said to be desirable.

2) Review of organization to cope with the expansion of sewerage facilities

The construction and scale of organization of the departments responsible for sewerage work of EDA RANU is considered to be generally adequate for maintaining and operating the existing sewerage facilities. However, with the expansion of sewerage facilities and reinforcement of maintenance and operations to be proposed by the Study Team, a review of the organization and business plans is necessary so that the ability to implement operation and maintenance plans of sewerage facilities to be expanded in the future, can be enhanced.

Given below are the construction of organization and duties of every responsible department for operation and maintenance of sewerage facilities in the future. The planning and design departments, material procurement and work subcontracting departments, and workshop (stores, machinery repairs) departments are not organized separately for the water supply system and the sewerage system, but integrated. Persons responsible for sewerage and persons responsible for water supply shall be stationed in each department.

Organization	Charged Tasks
Sewage Operation and Maintenance Section	Periodic inspection and cleaning of sewers and manholes. Fixing broken pipes and superannuated pipes. Connecting to households. And yet, the work groups are divided into Coastal Area and Inland Area
Pumping Station Operation and Maintenance Section	Periodic inspection. Fixing troubles and cleaning. And yet, the outside charges except simple repairs.
Treatment Plant Operation and Maintenance Section	Inspection of STP. Removal of sludge. Accumulated sludge moving to the farming land. The external charges except daily routine works such as grass mowing within the premises.
Water Analysis Control	Water quality analysis for influent and effluent of STP. Monitoring and analyzing of industrial wastewater and toxic substances. The external charges for detailed water analysis asking to the reliable laboratory and institute.

<Below listed sections hold the charges in common with the water supply section>

Planning and Design Section	Maintaining and keeping the sewerage ledger. Negotiating with and instructing developers. Developing an annual plan. Basic design and cost estimation. Supervising works.
Procurement Section	Materials and equipment procurement. Construction ordering.
Workshop Section	Periodic inspection and repair for materials and equipment. Stock management. Maintenance of machine-tool and tools