6.3.3 Outfall

A survey for the planned Joyce Bay ocean outfall effluent pipeline route was conducted to establish the location, design and construction plans of the outfall. The proposed pipeline route will extend beyond the fore-reef slope (about 28 to 30 meters depth range). The main objectives of the survey work included mapping of the sea bed condition and determination of the underlying geological horizons below 3 m from the ocean bed.

The existing outfall at Paga Point is used in the future. However, pumps are also required to meet the increased losses with the outfall, resulted from the increased flow.

1) Outfall length

The basic details of the Kila Kila outfall are as follows:

Planned maximum outfall capacity:

Hourly maximum 41,032 m^3/24h x 60 mm x 60 sec = 0.475 m^3/sec.

Diffusing point and length of pipeline:

Approximately 3,000 m from shoreline of Joyce Bay to the deep ocean at coordinates 009° 31'83"S, 147°11'44"E and depth at datum 30.0 m. The route is presumed that 500 m from shore is shallow consisting of depth 0 to –2 m Datum and further 2,500 m to fall to depth at Datum-28.0 to Datum-30 m.

The soil condition of the pipe route is reported as sand in surface layer. The environmental condition of this area was studied in 1988, and the diffusing point is decided according to the recommendation of the report.

Pipe size and type of material,

Inner diameter: 900 mm
Pipe material: High-density polyethylene (HDP) pipe is selected. Reasons are listed below:

(1) The pipe installation at Datum-30 m is accompanied with risk factors such a high cost and longer duration of installation. In the case of HDP pipe, the installation shall be jointed on shore to a certain length and pulled offshore by joint floating on the ocean surface. After the completion of full length joint, the pipe is towed to the planned location and sunk by water pouring and settled in the final position in a short period. To be able to apply this installation effectively depends greatly on the above item.

(2) HDP pipe is flexible. This character corresponds to the undulation of pipe bed level and especially to the slope variation between shallow to deep ocean level.

(3) The corrosion resistance of the material is a big economic advantage especially in maintenance cost such that no painting is needed.

Pipe covering and anchoring

In the shallow portion and on land, the pipe shall be buried underground or in ocean bottom in order to avoid traffic and sailing obstructions and shall be encased in concrete. In the ocean deep portion, the pipe shall be fixed with concrete anchor at interval of 7.5 m to 10 m according to the anchoring conditions.

2) Diffuser length

According to Item 6.3 in Ocean Disposal of Wastewater published by the Australian Water & Wastewater Association, we can presume the diffuser length as follows:

Simple expression, $I = (Y/6)\,(L/Q)^{0.67}$
where: I : Dilution factor
Y : Water depth in meter assumed at 30.0 m
L : Diffuser length in meter assumed at 45 m and 50 m
Q : Total discharge in m^3/sec
Hourly maximum $Q = 41{,}032\ m^3/24h \times 60\ min \times 60\ sec = 0.475\ m^3/sec$
In case of L = 45.0 m, $I = (30/6)(45/0.547)^{0.67} = 5 \times 19.20 = 96.0 < 100$
L = 50.0 m, $I = (30/6)(50/0.547)^{0.67} = 5 \times 20.60 = 103.0 < 100$

Using the above simple expression, the diffuser length shall be more than 50 m in order to satisfy a dilution factor of less than 100.

3) The existing Paga Point outfall

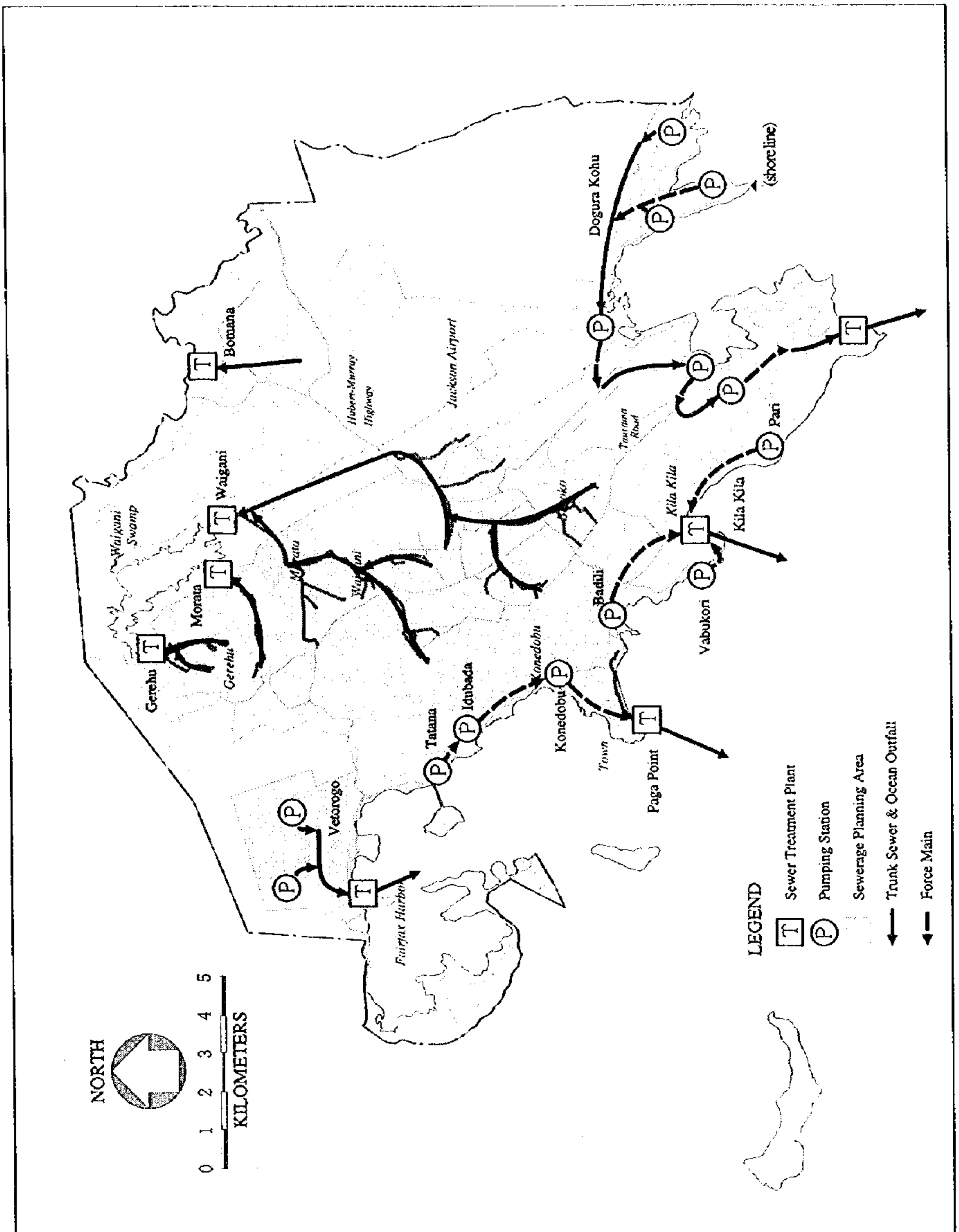
The existing Paga Point Outfall shall be redesigned according to the planned total sewage flow of 20,700 m^3/day, from the existing flow of 15,000 m^3/day. Countermeasures to be considered are as follows:

(1) By increasing the pump capacity to meet the planned sewage flow of 24,000 m^3/day using the existing outfall.

(2) Supplementary or new pipe is not planned.

4) References used in Ocean Outfall Design

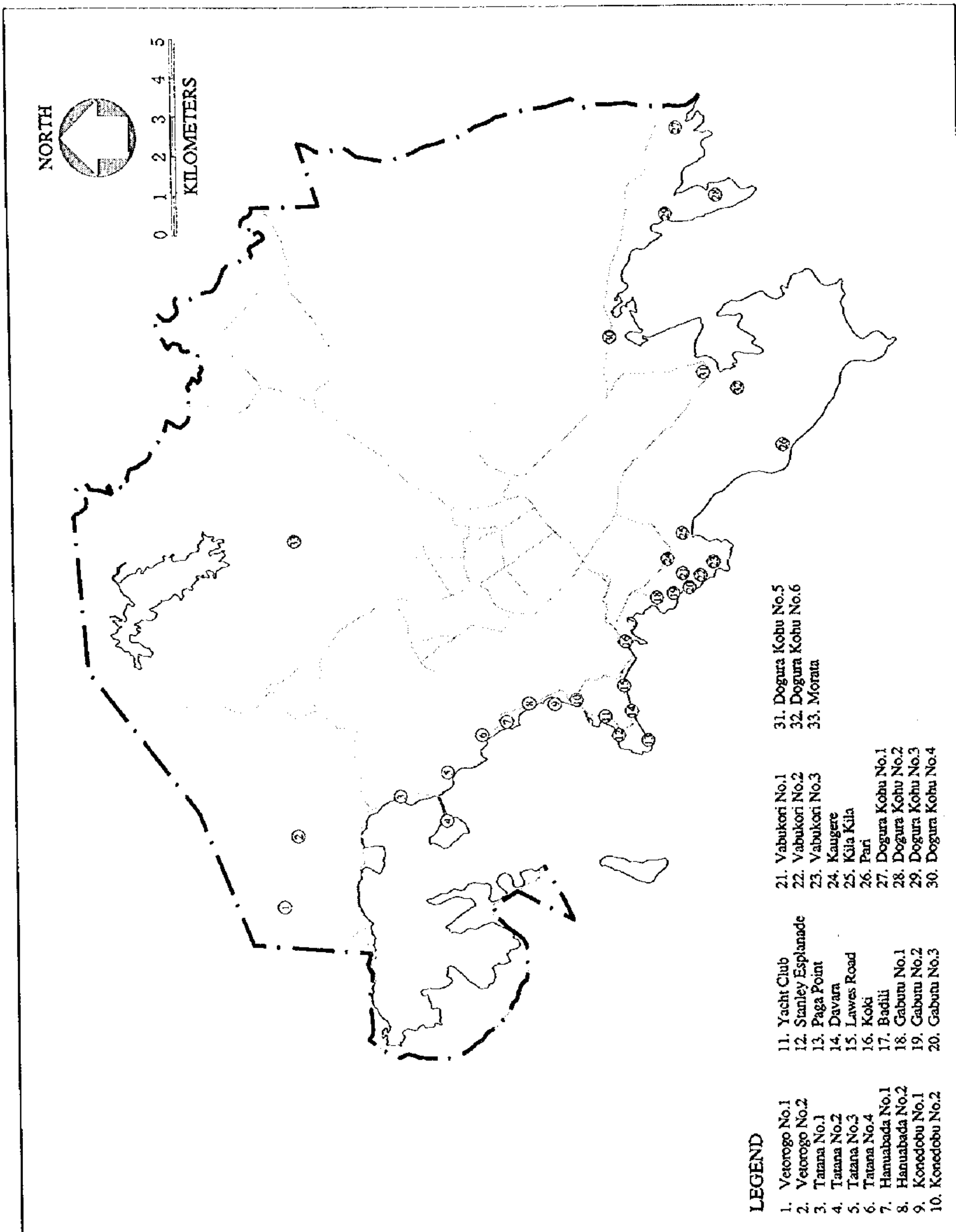
- Design manual "Ocean Disposal of Wastewater" published by Australian Water & Wastewater Association.
- Textbook "Water Science & Technology" Marine Disposal Systems, 1994.
- "Environmental Plan, Joyce Bay Sewage Outfall Study", June 1988, and other reference documents.
- Port Moresby Sewerage, Paga Point Sewage Outfall Drawing.



Date	Title	Fig.
May 1998	Proposed Sewerage System	6.1

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

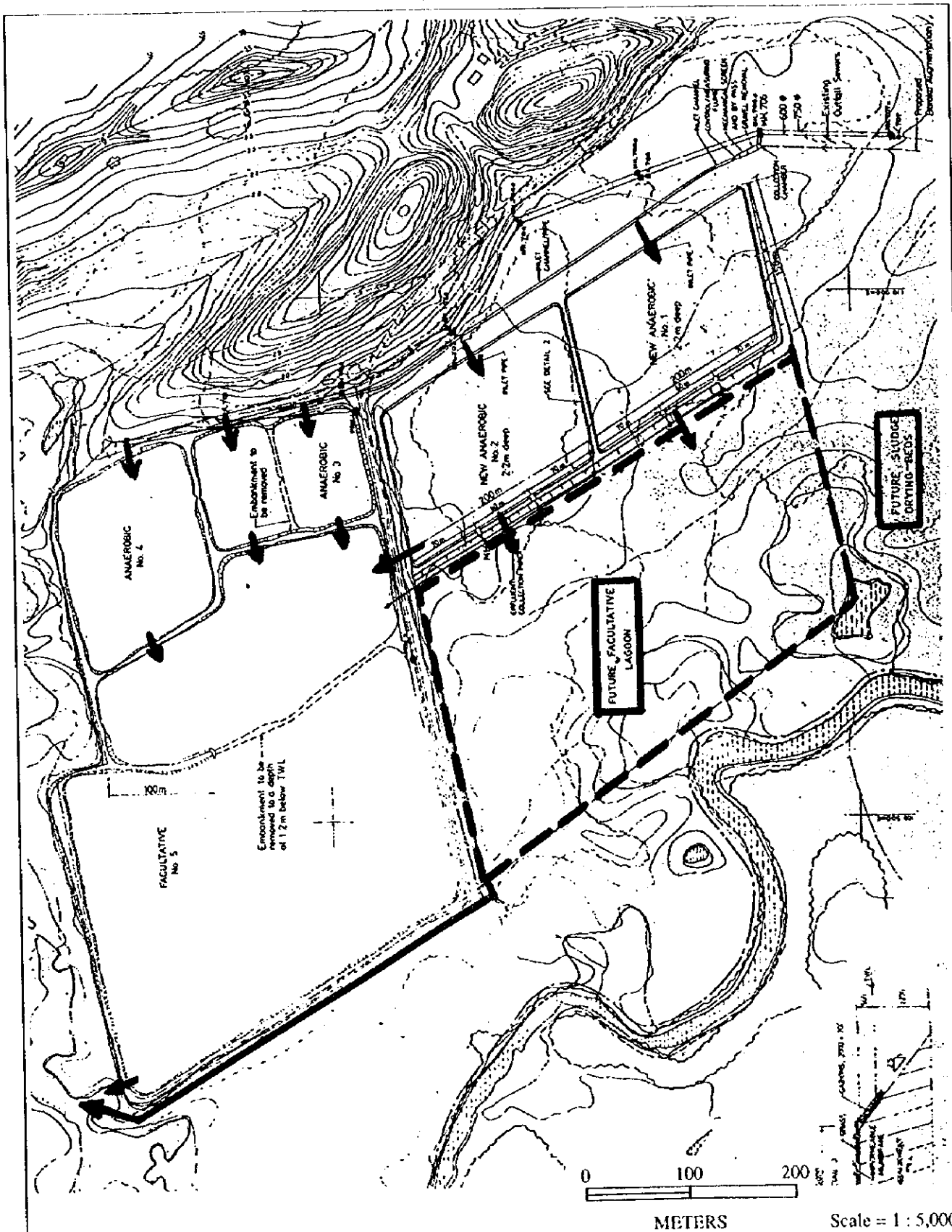
TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI



Date	Title	Fig.
May 1998	Location of Proposed Pumping Station	6.2

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI



Date	Title	Fig.
May 1998	Proposed Waigani STP	6.3

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

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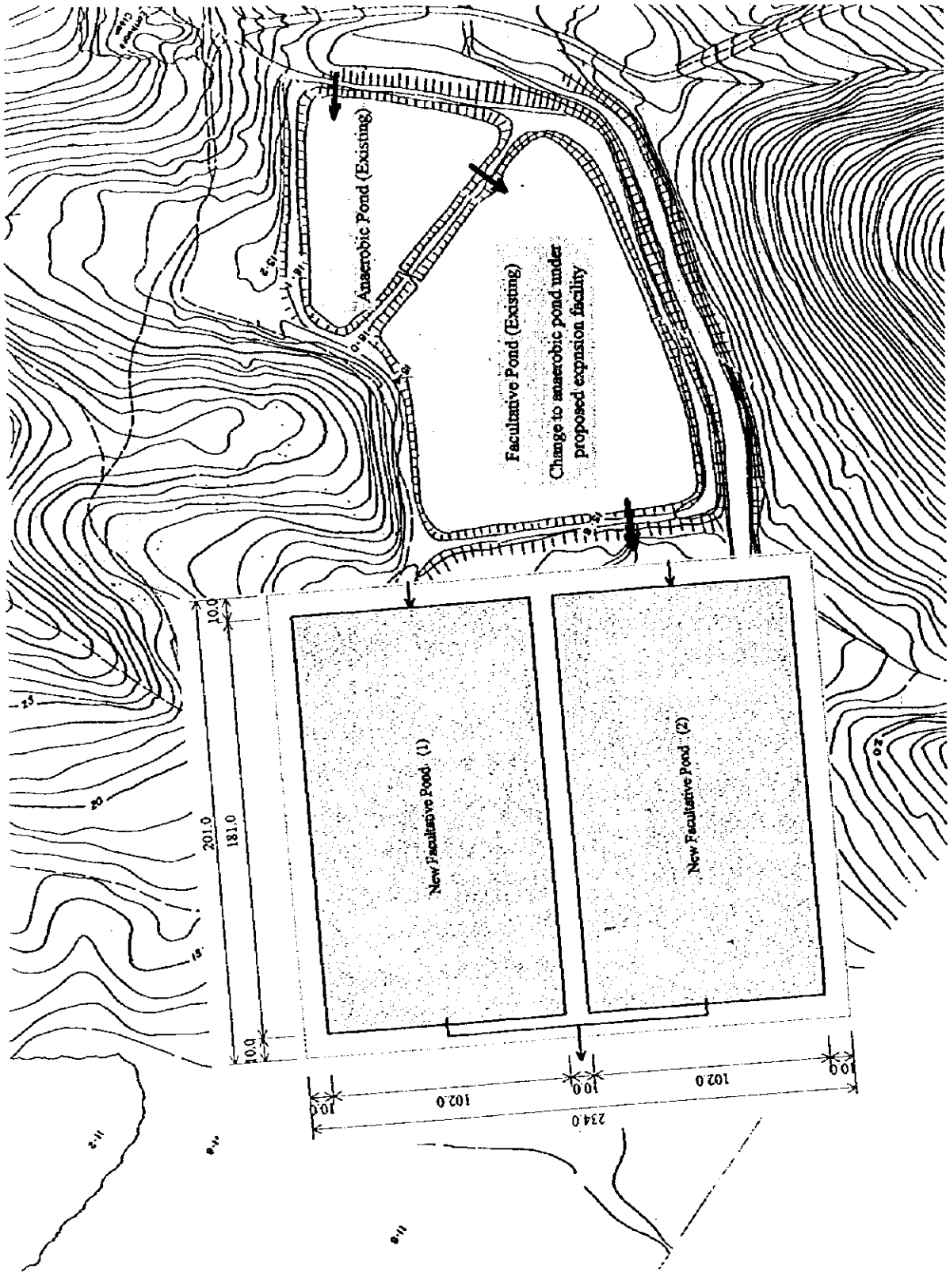
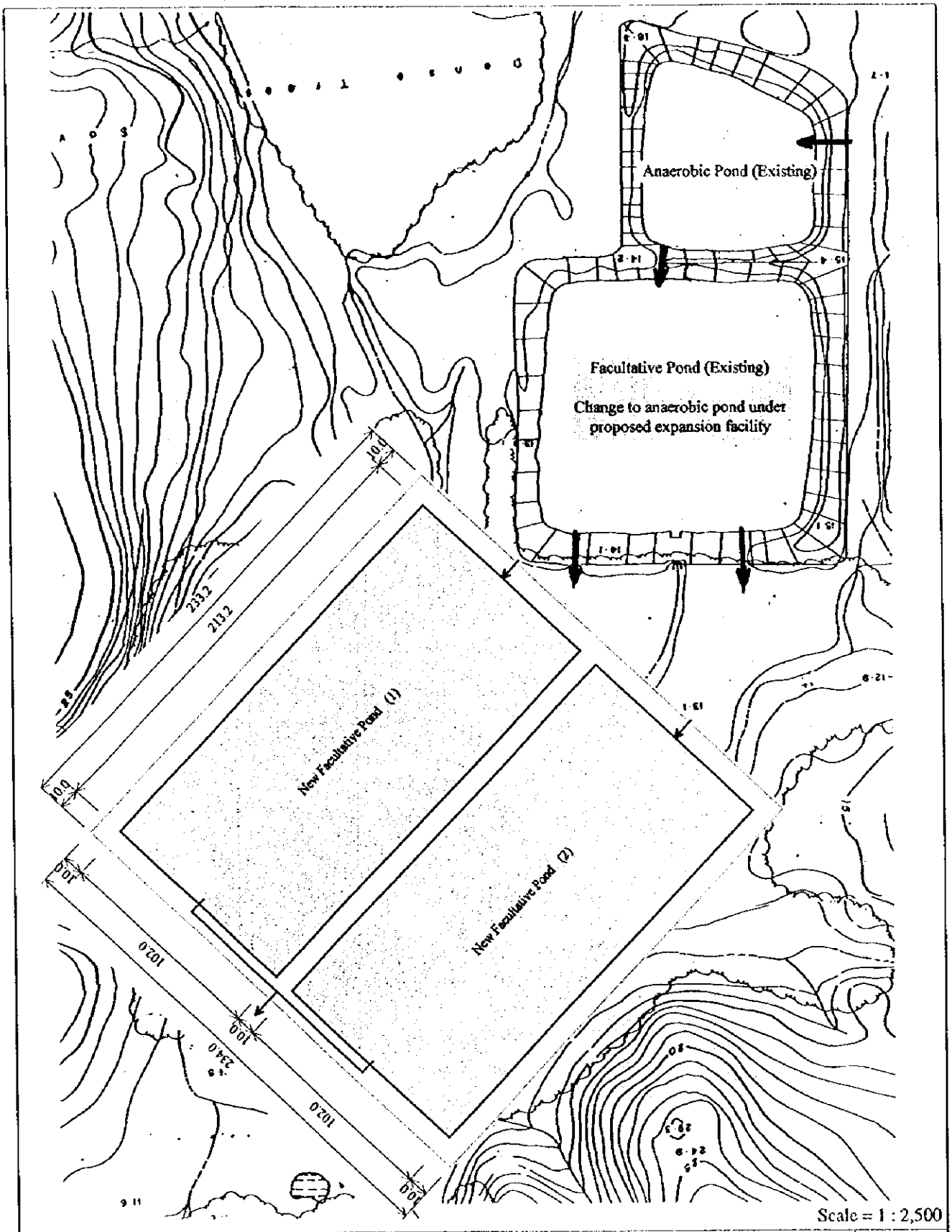


Scale = 1 : 2,500

Date	Title	Fig.
May 1998	Proposed Morata STP(1)	6.4

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

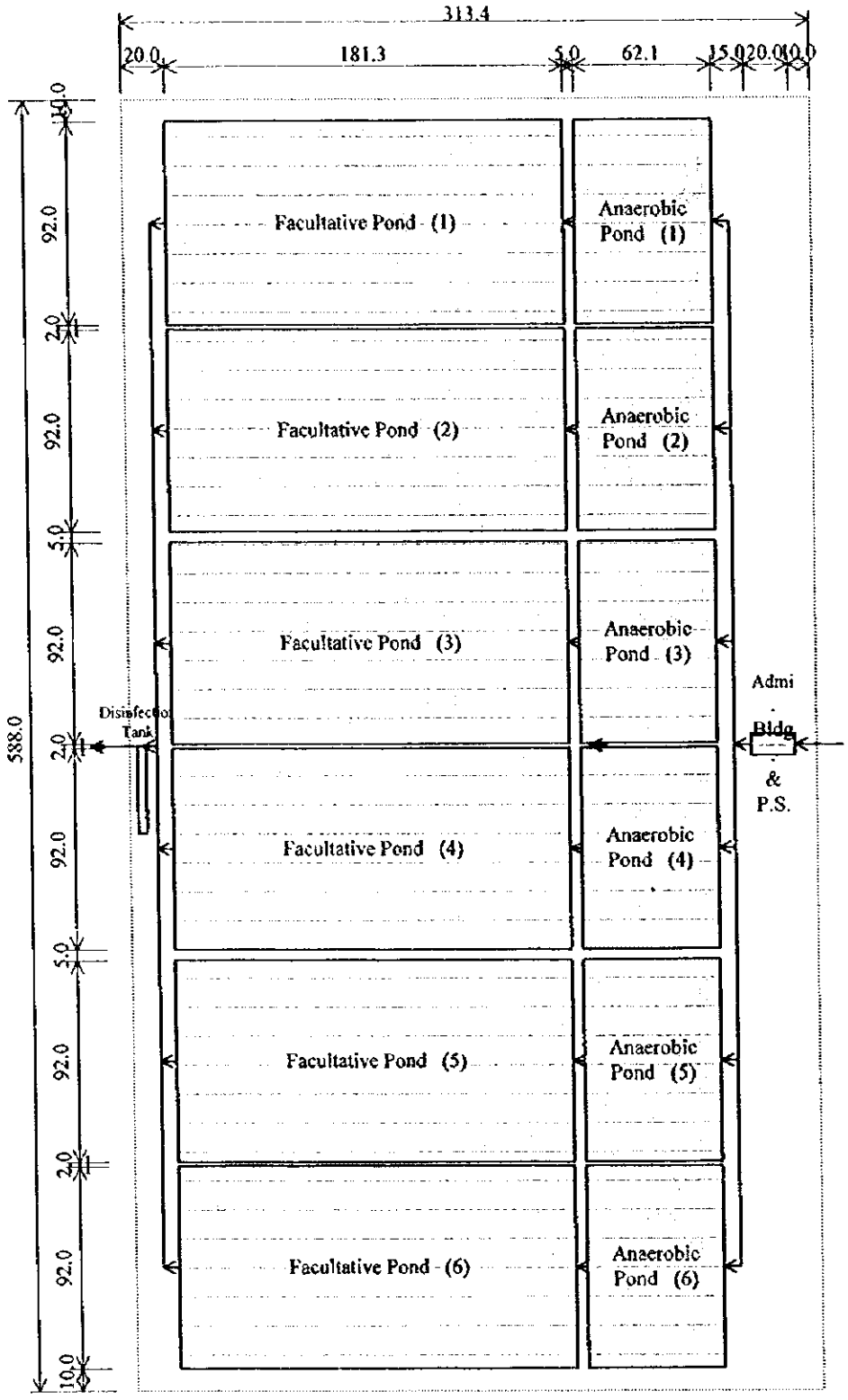
TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI



Date	Title	Fig.
May 1998	Proposed Gerehu STP (1)	6.5

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI

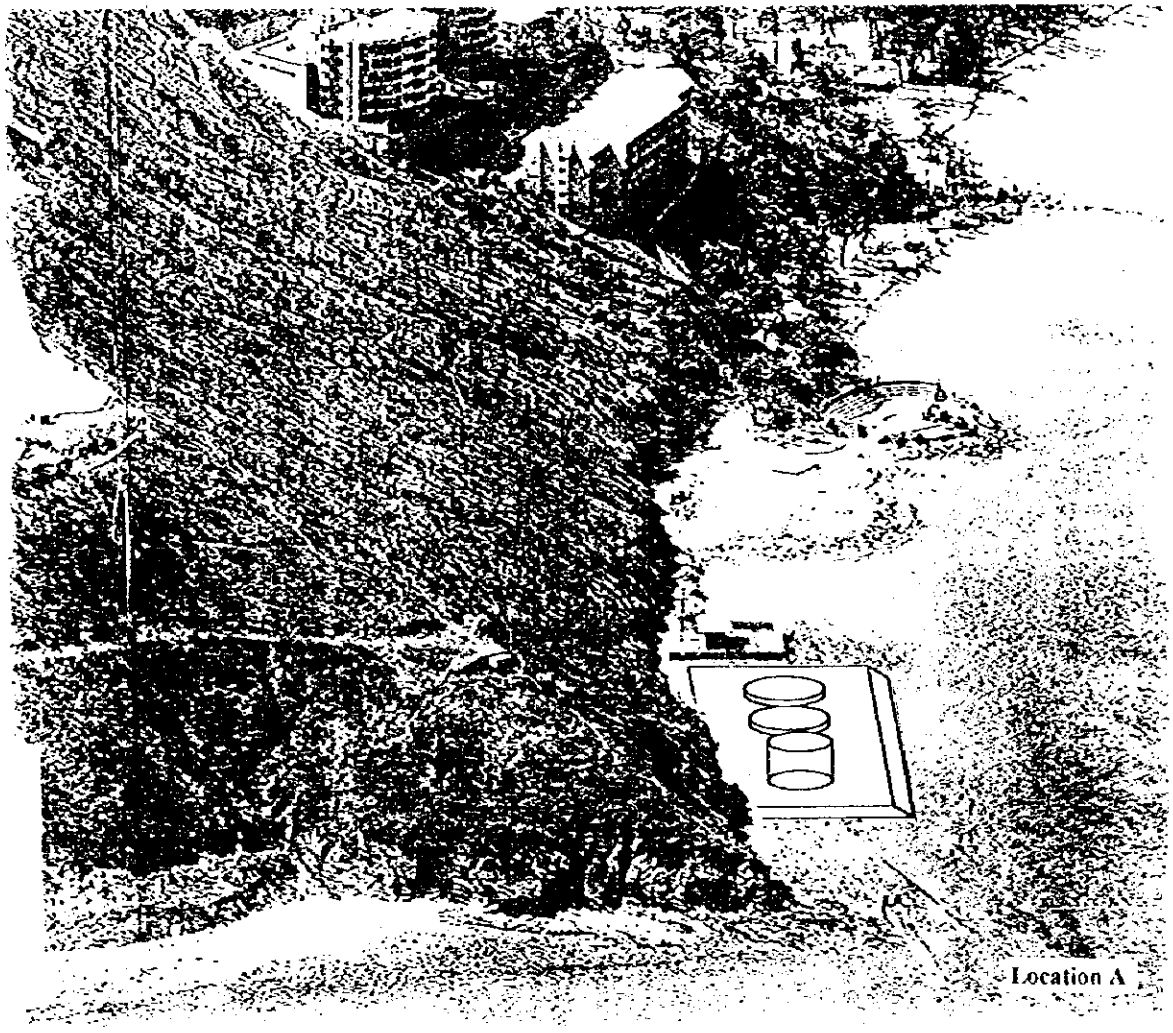


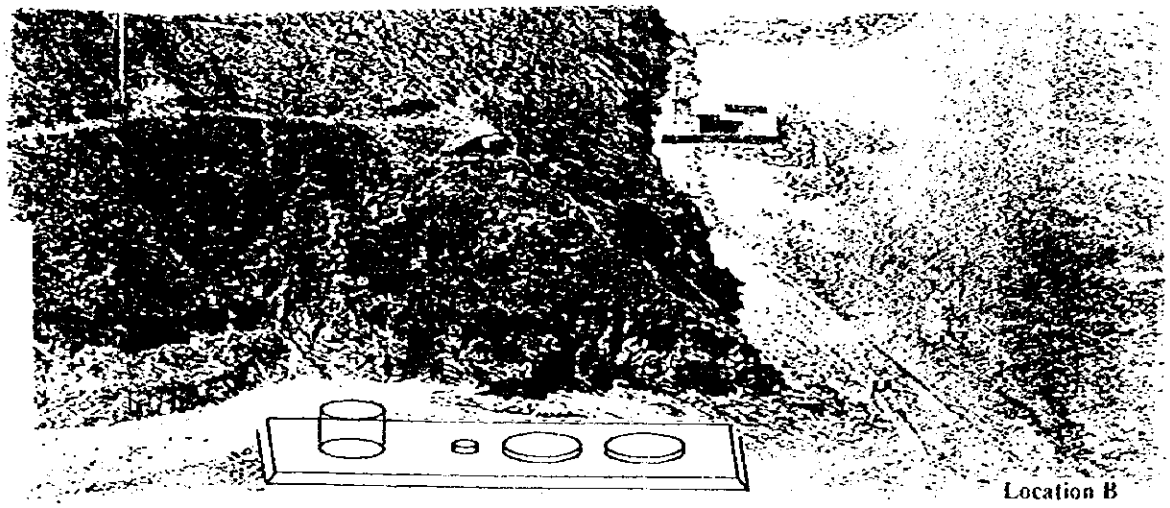
Scale = 1 : 3,000 (Unit : m)

Date	Title	Fig.
May 1998	Proposed Bomana STP	6.6

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI

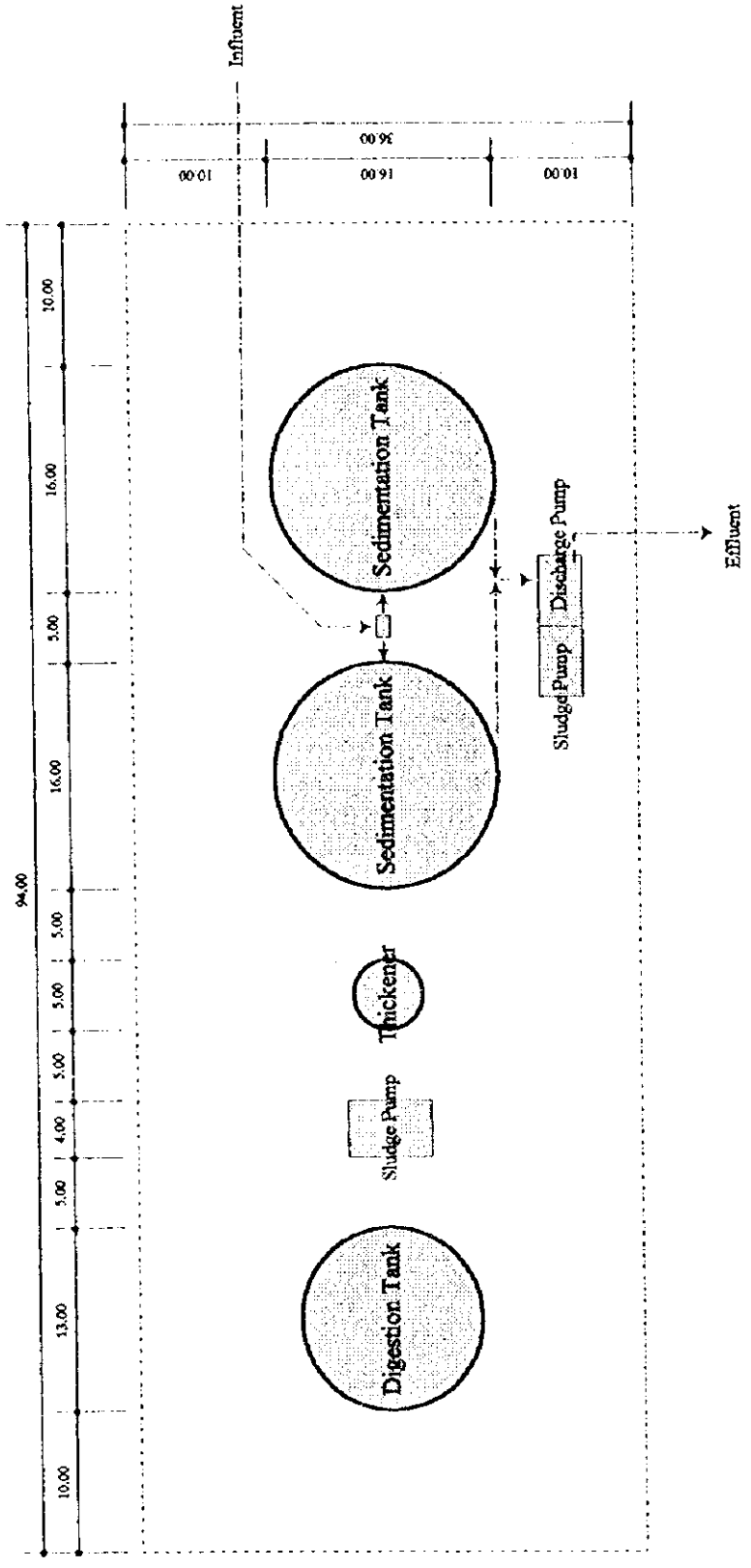




Date	Title	Fig.
May 1998	Proposed Paga Point STP Site	6.7

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI



(Unit : m)

Date	Title	Fig.
May 1998	Proposed Paga Point STP	6.8

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI

Scale = 1 : 6,750

Date	Title	Fig.
May 1998	Proposed Kila Kila STP Site	6.9

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

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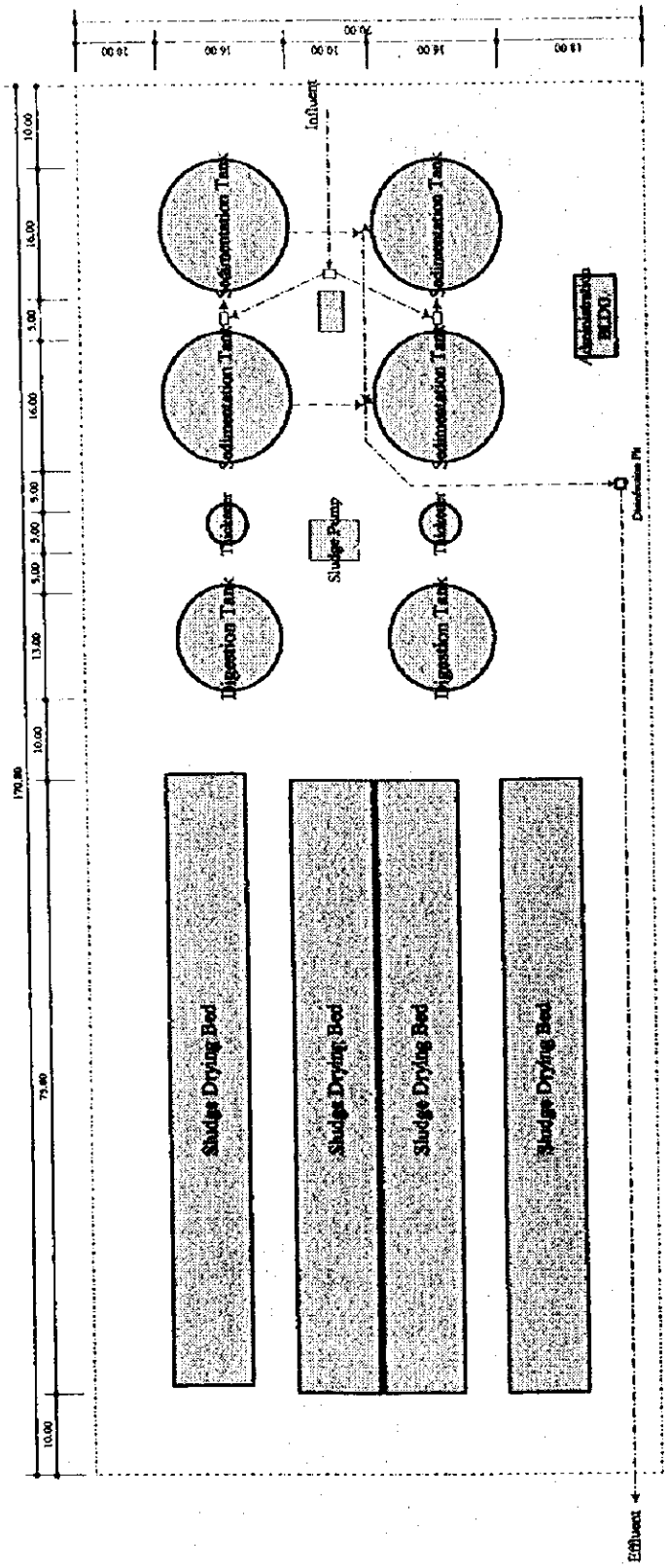
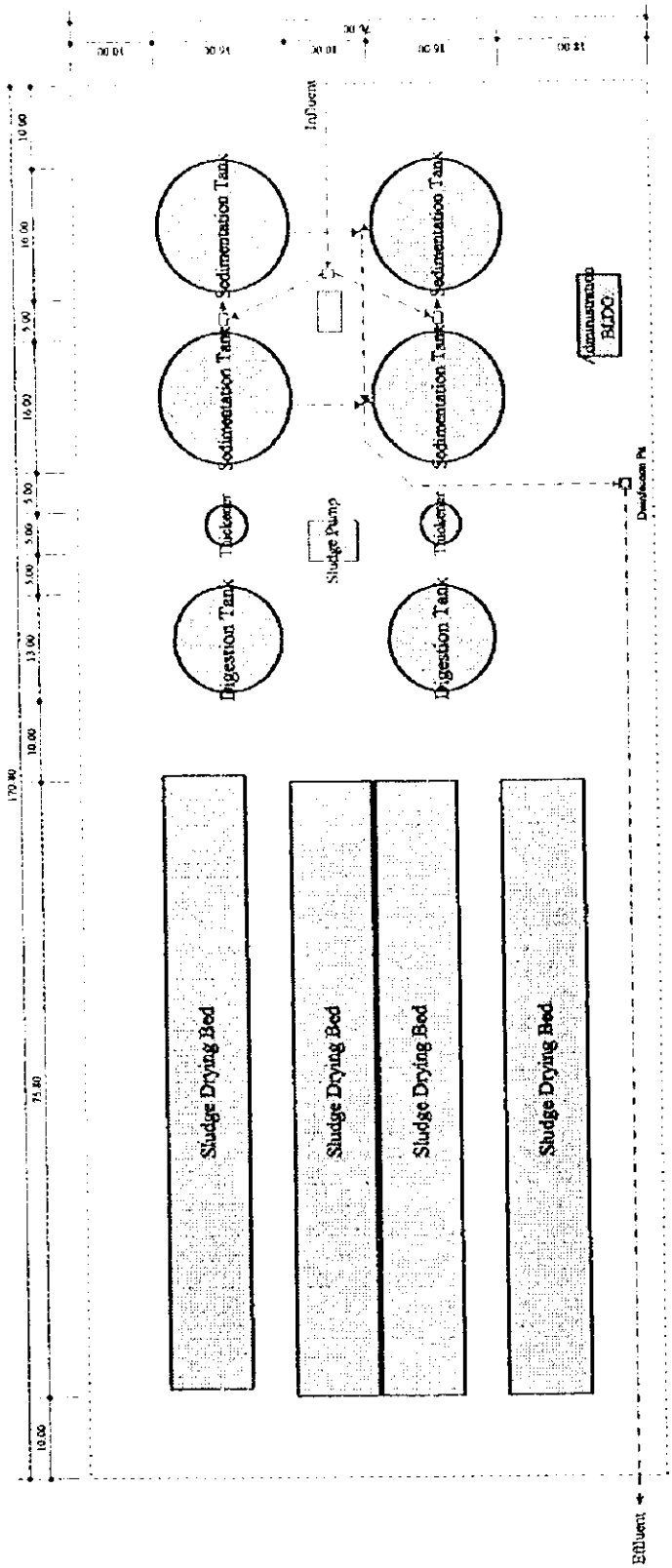


(Unit : m)

Date	Title	Fig.
May 1998	Proposed Kila Kila STP	6.10

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI

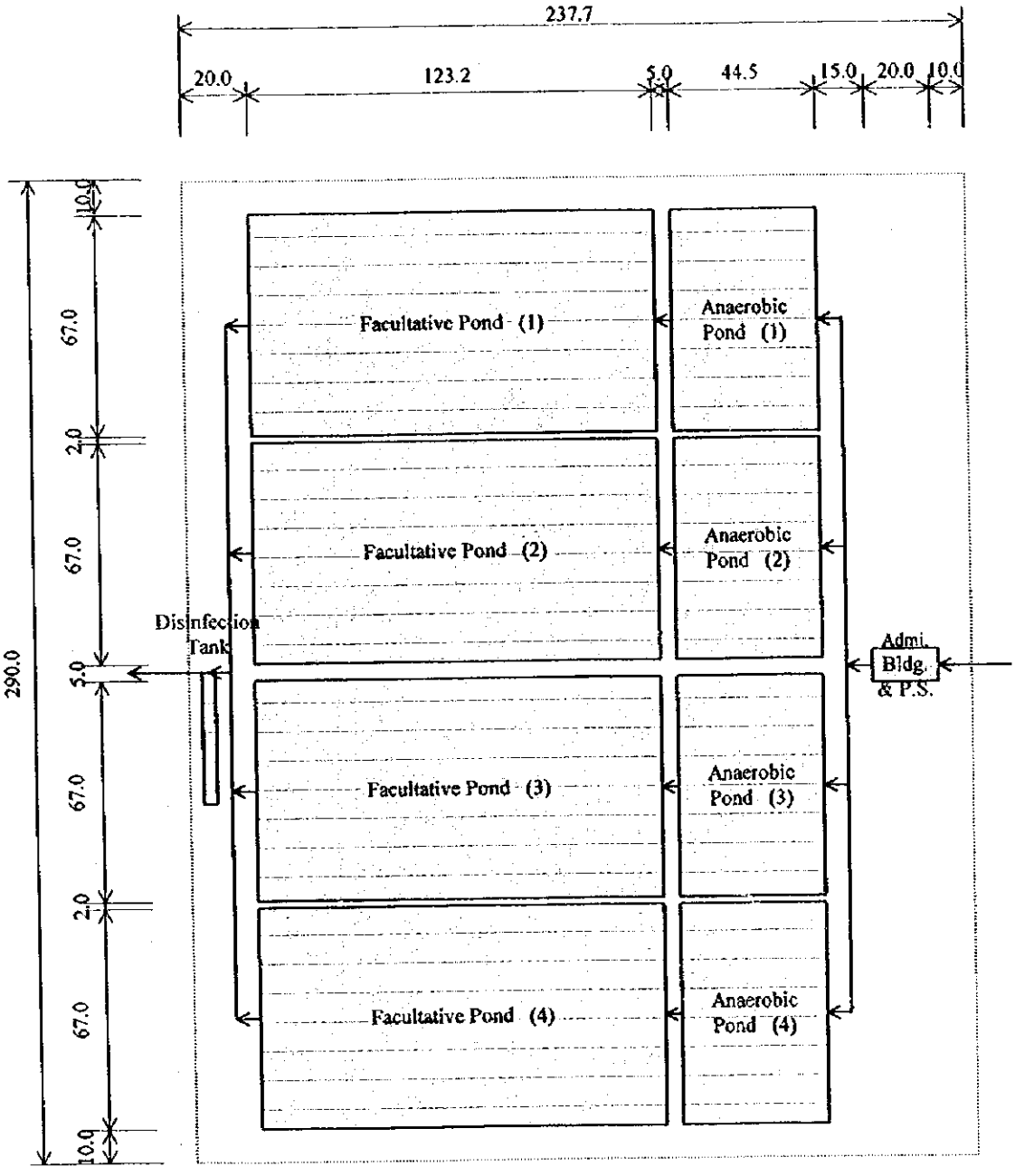


(Unit : m)

Date	Title	Fig.
May 1998	Proposed Kila Kila STP	6.10

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI

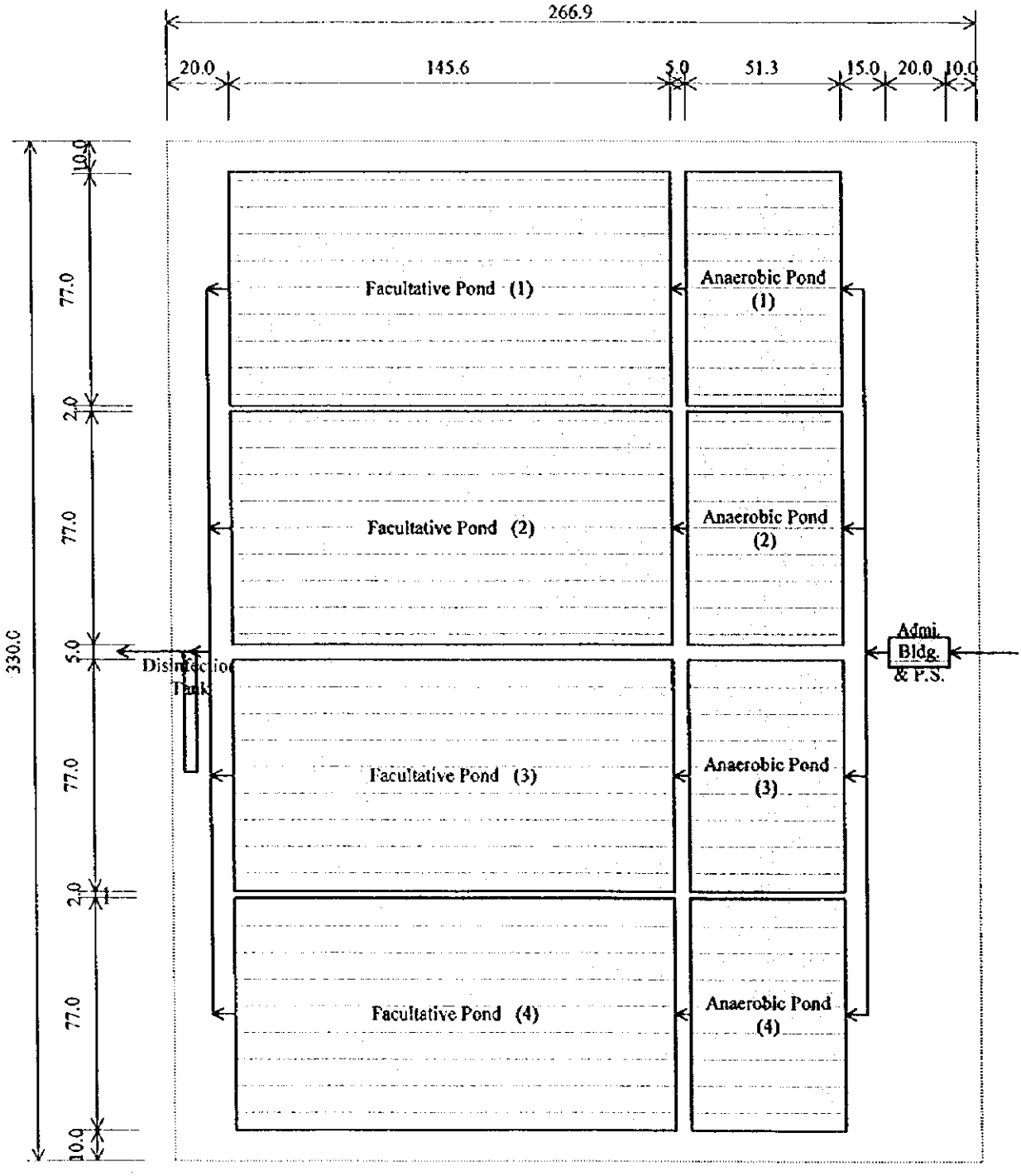


Scale = 1 : 2,000 (Unit : m)

Date	Title	Fig.
May 1998	Proposed Vetorogo STP	6.11

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI



Scale = 1 : 2,000 (Unit : m)

Date	Title	Fig.
May 1998	Proposed Dogura Kohu STP	6.12

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

TOKYO ENGINEERING CONSULTANTS in association with NIPPON JOGESUIDO SEKKEI

CHAPTER 7
PROJECT COST AND IMPLEMENTATION SCHEDULE

CHAPTER 7 PROJECT COST AND IMPLEMENTATION SCHEDULE

7.1 Project Cost

The project cost components are as given below.

1. Direct construction cost
2. Land acquisition cost
3. Engineering cost
4. Administration cost
5. Physical contingency

The project cost estimated is based on December, 1997 price level. The exchange rate of 1 Kina was JP¥81.3.

Direct construction cost was estimated for each sewerage facility as described later in this section. Details are shown in Appendix E. Land acquisition cost was estimated based on the land areas necessary for the construction of facilities and unit land price. Unit land price is minimum 25 K/m^2 for an area of 1,000 m^2 or less. The rate decreases when the area increases. Sizable land areas are necessary for construction of large pumping stations and treatment plants.

Two indirect cost components, namely engineering cost and administration cost, were estimated as ratios of the direct construction cost. 10% and 1.5% of the direct construction cost were used as the engineering and administration costs, respectively.

The physical contingency cost was also estimated as a ratio of direct construction cost. A commonly used ratio of 10% of the direct construction cost was used.

1) Sewer Network

NCDC has provided the sewer network based on the principle that the development cost including sewer network provision is borne by the developer. Subsequently, NCDC has carried out maintenance and upkeep of the sewer network. In view of the above, the cost* has not been included in the overall project cost in this study, and is merely used as a reference value.

For arriving at the density of pipeline per unit area, several locations were sampled from model areas (one ha.) of Waigani, Morata, Gerehu and Town, which are presently served by sewer networks, and the average value was used. The average value worked out to 140 m/hectare. According to the Land Use Plan for 2015, the total new development area is 13,649 ha. The working expenses for provision of facilities for this area are shown in Table 7.1. The size of pipeline for the sewer network has been taken as 150 mm.

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* Reticulation is normally the responsibility of the land developer, and individual toilets and connection to reticulation is the responsibility of the property owner. Because of the high cost of these elements, it is recommended that the government as well as EDA RANU should seek funding methods.

2) Trunk Sewer

Construction costs for trunk sewers and force mains were estimated, based on the preliminary design. Construction of pipes is to be carried out by the open-cut method.

Centrifugal reinforced concrete pipes are recommended. All force mains are to be constructed by the open-cut method. Pipe material recommended is PVC. Representative unit construction costs for trunk sewers and force mains are shown in Table 7.1.

3) Pumping Station

Construction costs for the new and improved pumping stations were estimated based on the preliminary design shown in Table 7.1.

4) Treatment Plant

Construction costs for treatment plants were estimated based on the preliminary design. Primary sedimentation method is proposed for Paga Point and Kila Kila STP. Stabilization ponds are proposed for the other three new treatment plants. Construction costs for each treatment plants are shown in Table 7.1.

5) Operation and Maintenance

Operation and maintenance costs required for all sewerage facilities to be completed by 2015 was estimated based on the extents and numbers of the facilities.

Additional annual operation and maintenance costs which are required for the operation and maintenance of the sewerage facilities proposed under the Master Plan are 2.3 million Kina per annum (PS: 0.9, STP: 1.4) and its breakdown is shown in Tables C.3.4 and C.3.7 in Appendix C.

Table 7.1 Project Cost for Seven Planning Sewerage Zone

(Unit: 1000 Kina)

	Inland Area				Coastal Area				
	Waigani	Morata	Gerehu	Bomana	Paga Point	Kila Kila	Vetorogo	Dogura Kohu	Total
1.Sewer Network	4,900ha	720ha	810ha	3,680ha	332ha	317ha	1,210ha	1,680ha	13,649ha
	(3,379)	(16,895)	(15,018)	(138,166)	(8,936)	(11,902)	(63,076)	(45,430)	(302,802)
2.Trunk Sewer									
200mm	0	0	0	0	915	1,452	0	0	2,367
250mm	0	0	0	0	70	16	0	0	86
300mm	162	0	332	3,080	903	319	1,750	1,015	7,561
350mm	865	0	0	2,872	101	0	1,641	970	6,449
400mm	860	666	530	1,128	43	78	622	389	4,317
450mm	0	412	0	859	289	0	542	316	2,419
500mm	1,735	370	0	2,340	614	27	0	832	5,918
600mm	0	0	0	529	0	1,303	0	0	1,832
S-Total	3,623	1,448	862	10,808	2,935	3,195	4,556	3,522	30,951
3.Force Main									
150mm	0	0	0	0	187	226	0	0	413
200mm	0	0	0	0	0	781	0	379	1,160
250mm	0	0	0	0	0	0	127	0	127
300mm	0	0	0	0	102	503	145	435	1,185
350mm	0	0	0	0	80	0	0	730	810
400mm	0	0	0	0	0	0	0	0	0
450mm	0	0	0	0	1,108	519	0	536	2,163
500mm	0	0	0	0	153	0	0	0	153
600mm	0	0	0	0	0	0	0	1,226	1,226
700mm	0	0	0	0	0	0	0	0	0
800mm	0	0	0	0	0	356	0	0	356
S-Total	0	0	0	0	1,630	2,385	272	3,307	7,595
4.Pumping Station									
Newly	0	125	0	0	2,080	1,934	250	1,291	5,680
Improvement	0	0	0	0	249	123	0	0	372
S-Total	0	125	0	0	2,329	2,057	250	1,291	6,052
5.Treatment Plant									
Newly				5,375	2,636	5,109	2,921	3,315	19,356
Improvement	1,363	1,074	1,187						3,624
S-Total	1,363	1,074	1,187	5,375	2,636	5,109	2,921	3,315	22,980
6.Ocean Outfall									
						4,893			4,893
S-Total	0	0	0	0	0	4,893	0	0	4,893
Direct Construction Cost - Total	4,986	2,647	2,049	16,183	9,530	17,639	7,999	11,435	72,470
Land Acquisition	0	0	0	4,192	50	324	1,629	2,128	8,323
Administration	74	39	31	243	142	264	120	172	1,086
Procurement Equipment				0	0	687	0	0	687
Engineering Service	498	265	205	1,618	953	1,764	800	1,143	7,247
Physical Contingency	498	265	205	1,618	953	1,764	800	1,143	7,247
Project Cost	6,056	3,216	2,490	23,854	11,628	22,442	11,348	16,021	97,061

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

7.2 Priority of Implementation

Project implementation program was formulated taking into account the following conditions.

a) Environmental impact of the effluent discharge to water body.
b) Degree of urban development.
c) Inadequacy of existing sewerage system.
d) Availability of piped water supply.

Table 7.2 Implementation Priority

Area/Zone	a. Impact	b. Development	c. Sewerage	d. Water	Overall
Inland					
Waigani	B	A	B	A	B
Morata	B	B	B	A	B
Gerehu	B	A	B	A	B
Bomana	C	B	-	A	C
Coastal					
Vetorogo	A	C	-	C	C
Baruni/Tatana	A	B	A	C	B
Idubada/Hanuabada	A	A	A	B	A
Town/Konedobu	A	A	B	B	A
Koki/Badili	A	A	B	A	A
Gabutu/Vabukori	B	B	A	B	B
Kila Kila	A	B	A	B	A
Pari	B	B	A	B	B
Dogura Kohu	B	C	-	C	C
Note	A; heavy B; moderate C; light	A; heavy B; moderate C; light	A; inadequate B; adequate	A; available B; intermittent C; not available	A; high B; medium C; low

From the above, the priority of the implementation program is in the following order.

(1) Kila Kila: Joyce Bay is completely contaminated with untreated sewage because the discharge point is located at the center of a very shallow bay.
(2) Koki/Badili, Idubada/Hanuabad, Town/Konedobu: Onshore of the populated areas of Koki/Badili and Idubada/Hanuabada are also heavily contaminated.
(3) Tatana and Pari: Some coastal villages have no sewerage system, but no significant sea water contamination is observed at present. In the future, as population increases, pollution will be significant.
(4) Waigani, Morata and Gerehu: At present, sewage is properly collected and treated in the Inland Area. However, with the increase in population and continued development of the area, expansion of the sewerage facilities to include the STP is required.
(5) Bomana, Vetorogo and Dogura Kohu: The sparsely populated areas of Bomana, Vetorogo and Dogura Kohu are planned for future development.

7.3 Implementation Schedule

The implementation program is divided into four phases as described below. Works to be done in each phase are mainly for the construction of trunk sewer and force main, pumping stations, treatment plants, and procurement of maintenance equipment.

Phase 1 (1999 - 2002)

Collection System	Coastal Area
- Trunk Sewer	Kila Kila Zone(Kila Kila, Koki, Gabutu Vabukori and Pari)
- Force Main	Same as above
- Pumping Station	11 PS in above areas
- Sewage Treatment Plant	1 STP at Kila Kila
- Ocean Outfall	1 Outfall at Joyce Bay

Phase 2 (2003 - 2005)

Collection System	Coastal Area
- Trunk Sewer	Paga Point Zone(Town, Konedobu, Hanuabada, Idubada and Tatana)
- Force Main	Same as above
- Pumping Station	9 PS (new) and 4 PS (improvement)
- Sewage Treatment Plant	1 STP at Paga Point

Phase 3 (2006 -2010)

Collection System	Inland Area
- Trunk Sewer	Waigani, Morata and Gerehu Zones
- Pumping Station	1 PS at Morata (improvement)
- Sewage Treatment Plant	3 STPs at Waigani, Morata, Gerehu (improvement)

Phase 4 (2011 - 2015)

Collection System	Inland and Coastal Area
- Trunk System	Bomana, Vetorogo and Dogura Kohu
- Force Main	Same as above
- Pumping Station	8 PS in above areas
- Sewage Treatment Plant	3 STP in above areas

Phase 1 and 2 are priority projects expected to be completed by the end of 2005, while Phase 3 and 4 are to be completed by the end of 2010 and 2015, respectively.

The procedures of project are described in Table 7.3.

Table 7.3 Procedures of Projects

	Phase I (1999 to 2002)	Phase 2 (2003 to 2005)	Phase 3 (2006 to 2010)	Phase 4 (2011 to 2015)
Preparation of project	1999	2002	2006	2011
Detailed design, bidding	1999	2002	2006	2011
Construction	2000 to 2002	2003 to 2005	2007 to 2010	2012 to 2015
Commencement of operation	2003	2006	2011	2016

The project implementation and disbursement schedule with estimated annual disbursement of project cost including O&M is presented in Table 7.4.

Table 7.4 Project Implementation and Disbursement Schedule

(Unit: 1000 Kina)

		Phase-1				Phase-2			Phase-3					Phase-4				
		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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	**8,360**	297	27			50								7,986				
2. Administration	**1,086**		14	60	190	5	37	101		22	40	40	42		114	114	153	153
3. Construction Work	**72,470**		938	4,012	12,688	342	2,437	6,752		1,483	2,691	2,691	2,817		7,623	7,623	10,183	10,190
4. Procurement Equipment	**1,247**							687					560					
5. Engineering Service	**7,247**		94	401	1,269	34	244	675		148	269	269	282		762	762	1,018	1,019
6. Physical Contingency	**7,247**		94	401	1,269	34	244	675		148	269	269	282		762	762	1,018	1,019
Sub-Total of Annual Disbursement	**97,657**	297	1,167	4,875	15,416	466	2,961	8,889		1,802	3,270	3,270	3,983	7,986	9,262	9,262	12,372	12,381
7. O/M Cost	**17,544**					793	793	793	1,490	1,490	1,490	1,490	1,490	1,543	1,543	1,543	1,543	1,543
Total of Annual Disbursement	**115,201**	297	1,167	4,875	15,416	1,259	3,754	9,682	1,490	3,292	4,760	4,760	5,473	9,529	10,805	10,805	13,915	13,924

CHAPTER 8
ORGANIZATION AND MANAGEMENT

CHAPTER 8 ORGANIZATION AND MANAGEMENT

8.1 Important Organizational/Institutional Issues

For as long as the operation and maintenance of the existing sewerage facilities, such as cleaning and replacement of old and broken sewers, cleaning of manholes, routine maintenance of pumping stations and treatment plants, are carried out efficiently the system will function effectively. Furthermore EDA RANU's management and administrative capacity as an autonomous company has to be strengthened in order to carry out not only the daily operations and maintenance, but also facility planning, development and rehabilitation of the sewerage system.

The following are some key factors to be considered in order to overcome the transition period and to strengthen its management capacity.

1) EDA RANU Status

Issue: At present, EDA RANU is 100% owned by the government. However, certain essential works, such as water sources, water treatment plant operation and billing and collection of water/sewerage charges are being contracted out to the private sector. EDA RANU seems satisfied on the infusion of private power in this area, but is unclear on the direction of management style to be taken in the future; whether management power/ownership will be held entirely by the government or a portion will be shared to the public.

Recommendation: Unlike a commodity sold in a competitive market, the water supply and sewerage services cannot be replaced by other services. Both water supply and sewerage utilities are high priority public services.

The private sector seeks profit as its first priority. From a business point of view, if majority of the shares is held by the private sector, the risk of not providing an efficient sewerage services to non-profit low income and sparsely populated areas will arise. Therefore, a public authority should own EDA RANU in order to provide equal sewerage services to the populace.

Regardless of whether the shares of EDA RANU are partly sold to the general public/private sector, the government, who will have the decisive control of EDA RANU's operation, should hold majority.

2) Management Policy and Corporate Planning

Issue: Though the National Capital Water and Sewerage Act defines the obligation and power of EDA RANU in carrying out its operations, management policy and/or company objectives have yet to be established. Furthermore, EDA RANU does not have a corporate plan, i.e., investment plan, financial plan, etc., and it is still unclear as to how it intends to improve the sewerage services (and water supply services too) particularly managing its operations.

Recommendation: There should be a stated management policy/objectives of EDA RANU. Company policy and objectives should be understood by all employees that will lead them the direction in prioritizing values which makes the operation effective and efficient. To assist employees and the public in understanding the company's policy and objectives, it is helpful that related issues be disseminated from time to time in public notices.

In accordance with the corporate policy/objectives, a corporate plan should be carefully discussed and developed. The major merit of developing and providing a corporate plan is to facilitate discussion and development regarding matters related to the sewerage system. It is also important to the company's operations, including sewerage facility development/rehabilitation, routine operation and services to the public, financing, organization, human resources, out-sourcing, etc., and to prioritize matters to be carried out. Further, it will help reflect aspects of corporate priorities not only in the managerial level but also in the operational level thereby improving performance.

3) Long-term Development Policy and Plan

Issue: A committee developing mid-long term operational plans has been established by EDA RANU to include development plans of the existing sewerage systems. However, efforts have to be exhausted to put forward the policy or concrete plan for sewerage facilities development.

Since 1974, five study reports related to sewerage facilities development has been made as discussed in the earlier section of this report.

Recommendation: The most efficient and effective method to developed/improved the sewerage facilities is to coordinate and refer to other development plans. Since the sewerage facilities are vital to social infrastructure and require massive investment, any development plan must be made from a long-term point of view. However, prior to this, a fundamental policy must first be formulated in order to determine the extent and capacity of these facilities. Without such a policy, it may prove difficult to adhere to any plan developed, and will also be likely difficult to gain a consensus between the institutions involved and the populace. Moreover, without such a policy and plan, any facility built will be insufficient or will serve for a limited period.

The following measures are necessary in the preparation of development plans.

- Urban Development Plans should include basic plans for the construction of sewerage facilities.
- Funds are secured at the planning stage.
- Unsewered areas should be carefully studied.

4) Contracting out jobs

Issue: Due to the shortage of manpower and equipment, certain operational and maintenance works of the sewerage facilities are contracted out to private sector. However, there is no clear guidance or policy being followed regarding this matter.

Recommendation: The quantity and type of work to be contracted out to the private sector will affect the organizational capacity and structure of EDA RANU. There must be a policy on how to utilize the private sector at this period of transition and in the future. Along with the establishment of such policy it is necessary to develop a selection procedure and control measures to maintain the standard of workmanship. These works must be such that it requires special techniques, experience and knowledge, specialized machinery/equipment, works not done on daily basis and lower in cost if done by EDA RANU. Works performed better if contracted out include large-scale construction, detailed examination of water quality, major repair of machines and facilities.

5) Job Description of Divisions and Sections

Issue: Duty statements have been developed by EDA RANU for the workforce. However, delineation of functions for respective divisions/units are still to be clarified since in some cases overlapping of function is imminent.

Recommendation: It is necessary to specify not only individual work responsibilities but also to define the function of each respective individual unit, whereby delegation of powers and authority will be clearly followed. Job descriptions should be compiled in a database for convenience.

6) Billing of Sewerage Together with Water Charges

Issue: Charges for sewerage services are billed annually to consumers. To pay charges on an annual basis create a heavy burden to consumer thereby creating a low percentage in collection rate.

Recommendation: Quarterly and/or monthly billing of sewerage rates is recommended. Charges billed quarterly and/or monthly are lighter in the purse of the consumer. Such a system should make payment easier for consumers and thus help improve the collection rate. Furthermore, billing and collecting sewerage rates together with the water bill will simplify the procedure and will enhance control.

7) Sewerage Tariff Determined by Water Consumption

Issue: At present, sewerage services are charged based on the number of toilets, and the land value of the premises as previously determined by NCDC.

Recommendation: It is reasonable to correlate sewerage and water charges, simply because wastewater discharged into the sewer is almost equivalent to the water consumed. If this scheme were implemented, it would motivate consumers to save water. It would then not be necessary to count toilets when calculating charges. It is therefore recommended that such a scheme be implemented for sewerage billing. However, it is necessary to take into consideration two points. Firstly, there are exceptional cases to which this scheme may not be applied, i.e., if consumers and/or establishments have their own wells and/or other water sources from which they obtain water. The other is the difficulty in measuring wastewater of consumers and establishments who do not have water meters. For such consumers and establishments, the present tariff system may be employed.

8) Sewerage Tariff on Trade Wastewater

Issue: At present, premise characteristics and the number of toilets determine sewerage tariffs, as in the case of large discharge. However, no tariff for trade wastewater is indicated in the tariff system. As a result, factories discharging a large volume of wastewater are charged based on the current tariff system, regardless of the heavy burden the intercepting sewers could carry and the treatment plants could treat.

Recommendation: Because commercial establishments discharge large volume of wastewater into the system, it is quite reasonable to charge them with a special tariff. A clear way to quantify the volume of wastewater discharged from their premises is to install a meter at the point of discharge. However, rather than introducing discharged water metering, volume of water consumed could be used to measure the discharged volume of wastewater. For establishments not supplied by EDA RANU's water supply, the present tariff system maybe employed.

9) Human Resource Development

Issue: Water Operations staff training is virtually being conducted through programs stated in the Management Improvement Agreement with JC-KRTA. This arises from complacency within EDA RANU and that most works requiring any skill/knowledge of sewerage system development, maintenance/operation and management be contracted to the private sector. Only existing routine sewerage system operations are carried out internally.

Recommendation: All works should be achieved efficiently and effectively which highly depends on personnel capacity. Advanced sewerage system technology and techniques can help promote efficient and effective sewerage system operations. Engineers and technicians of EDA RANU should familiarise themselves with such technology. Such knowledge can contribute towards the general improvement of engineering/technical capacity and support in evaluating the capacity of constructors undertaking facility constructions, cost-estimations prepared by them as well as controlling their work.

Therefore, it is recommended that education and training programs be introduced and implemented, in order to enhance performance and improve employee capacity in executing sewerage system development, maintenance and operation and to strengthen their work.

10) Quality Standards of Discharging Wastewater

Issue: The Public Health Act regulates that all residents, business establishments and public organizations should discharge wastewater into the sewerage system in a regulated manner, if situated within the sewerage system service area. There are penalty provisions within the laws for persons and/or establishments who break this and are liable to be charged for penalties. The Environmental Contamination Act and laws and regulations related to the sewerage system have been established in order to conserve environmental conditions and maintain hygiene, however, no quality standards are enforced. As a result, no provision has been established to observe the quality of discharged wastewater.

Recommendation: Without such standards, it is difficulty to regulate and control the quality of wastewater discharged from on-site-sewage treatment plants and to impose penalty on violators. There must be a wastewater quality standard for discharge into the sewerage system and receiving water body, and a provision to force the discharger to maintain these standards at any time and place. It is necessary to establish a wastewater quality standard in order that the water quality examination capacity of EDA RANU will be strengthened to a certain level, even though an external laboratory carries out detailed quality examination.

11) Right to Enter Premises

Issue: Under the National District Water and Sewerage Act, established in November 1996, EDA RANU's right to enter any place for construction, inspection and maintenance of sewerage facilities has been established. However, there are provisions in other Acts, which give authorities the right to refuse any organization or individual entry into its premises. There seems to have some conflicts in the provisions of the Acts that would give difficulty to Sewerage Operations personnel to pursue necessary works for sewerage system development and maintenance if laws and regulations remain as they are. Such conflicts are typical experiences of the sewerage operations personnel in the past.

Recommendation: To avoid such conflicts, provisions on entry with prior notice should be clearly stated in the National District Water and Sewerage Act. These provisions should have the power to override any other laws and acts giving certain authorities the right to refuse entry into their land/premises.

8.2 Operation and Maintenance

1) Facility Construction

The facility operation and maintenance sections can be divided into two categories based on work frequency and scale. One is large- scale, seldom occurring works, such as new, expansion, and upgrading and the other for small and routine works, such as cleaning facilities and small repair works. Large-scale construction requires huge investment for special (high priced) machinery and a substantial workforce, which seldom occurs. Consequently, maintaining these machines and workforce by EDA RANU will certainly bring down the company's operations and efficiency due to low utilization. Although the sewerage facilities are to be expanded, it is rational, as in the scheme employed presently, that EDA RANU carries out routine and rather small-scale works, and other rather large- scale, rarely occurring works is contracted out.

2) Sewer Operation and Maintenance

The sewerage system service area can be divided into coastal and inland areas for a convenient operation and maintenance. It seems natural and rational from the view of area segregation and geographical characteristics. This divisional approach to operation and maintenance if continued will result to responsible and efficient performance even though sewerage facility expansions will be made. An increase in the operational and maintenance works volume due to expansion will require additional work force. It is advisable to organize

more groups with small number of workers than increasing the number of workers in a group assigned to large areas or bigger responsibility.

The Organizational structure and functions of the Sewer Operation Division are discussed in the Feasibility Study.

3) Pumping Stations & Treatment Plant

A separate working group should be assigned in the operation and maintenance of pumping stations and sewage treatment plants. For efficiency in operation and maintenance, the current system employed by EDA RANU is reasonable because of the nature and volume of work. However, both working groups shall concentrate on routine and non-engineering works, while the high level technical and engineering aspect such as pump overhauls are to be contracted out to qualified companies. Additional information on the staff and duties are discussed in the Feasibility Study section.

4) Wastewater Quality Control

EDA RANU should perform both inspection and examination of wastewater quality discharged into the system and the effluent discharged into the environment; to include the pollution levels of treated wastewater. However, less priority has been given to wastewater quality control, such that wastewater examination is seldom performed, and the workforce is insufficient. Routine examination of wastewater quality is vital to require the wastewater influent into sewers and effluent from sewerage treatment plants under the regulated pollution levels. The quality control section shall enforce this responsibility. Detail works to be performed by this section are discussed in the Feasibility Study.

5) Planning and Inspection of New Facilities

The sewerage facility is to be divided into three general categories, namely; sewer reticulation, pumping stations and sewage treatment plants, requiring each category, proficient engineering and operational knowledge. Ideally, EDA RANU requires specialised engineers of each facility in order to attain total effective and efficient engineering works. Currently there are few engineers specializing in sewer reticulation, planning and related engineering works, and less necessity exists in engineering work for pumping stations and sewage treatment plants.

However, in the near future, expected expansion of sewerage services will cause an increase in the capacity and number of sewerage facilities. Consequently, the services for a specialized engineering knowledge will be necessary. In PNG, however, there is a shortage of such engineers (specializing in pumping stations, sewage treatment plants and general facility planning) and difficulty in hiring qualified persons. Consideration has to be taken in strengthening the capability of staff through training programs and facilitating usage of engineering tools.

6) Purchasing and Stock control

There seems to be no major issues currently made within the Technical Service Section that is responsible for purchasing and stock of control materials and tools necessary for operation

and maintenance of water supply and sewerage facilities. More discussions on the duties and staffing of this section are stated in the Feasibility Study.

7) Consumer Service

The installation of sewer connections, referred to, as 'house-connection' is the responsibility of the Sewerage Operation Division, while private contractors carry out pipe installations from consumers' premises to the connection point of the sewer main. The duties and staff of the Consumer Services are discussed in the Feasibility Study.

CHAPTER 9
FINANCIAL ANALYSIS

CHAPTER 9 FINANCIAL ANALYSIS

9.1 General

The objective of this chapter is to assess the financial feasibility of the sewerage development master plan from 1999 to 2015 for the city of Port Moresby, which we propose, and to recommend a feasible financial plan for the sewerage development.

This study is comprehensive and its effects will cover various areas in the long period. Therefore the fundamental position for the financial analysis should be clarified at first.

1) To support and establish current EDA RANU system, on 1 November 1996 the water supply and sewerage operation in NCD was privatized and transferred to EDA RANU. At the same time, a substantial portion of the operation including fee collection has been outsource to JC-KRTA.

2) The privatization of government business is becoming a worldwide trend and the establishment of EDA RANU was decided at the highest level of PNG government. Therefore, a financial plan must follow with the worldwide trends and the governmental policy.

3) At first, the financial soundness is crucial for a new organization. EDA RANU has to be operated as a private enterprise and its financial position shall be carefully watched. The operating and maintenance expenses must be fully covered by fee collection and should not rely on outside assistance. The fee collection has been outsource to JC-KRTA and the substantial improvement of fee collection from less than 70% level in NCDC period is expected.

4) On the contrary to water supply, the profitability of the sewerage service is rather poor. Therefore, in most countries, the development of sewerage service goes behind water supply. The BOT schemes for sewerage service or the success cases of privatization are almost rare. The objectives of sewerage development are multifaceted. Not only the business aspect but also the environmental improvement and sanitary aspect should be considered.

5) As to long term investment, on the contrary to operation and maintenance, the introduction of long term and of low interest loan from international aid institutions should be considered. Grant from donor countries should be given high priority because of the low profitability and environmental effect of sewerage systems.

6) The area of financial analysis should cover the whole sewerage operation. That is, not only additional investment but also existing systems will be included.

7) Because of the existence of low income residents as shown in Table 9.1, we recommend a progressive fee structure based on the volume of wastewater discharged and quarterly billing.

8) According to the philosophy of privatization, the financial analysis, which deals with actual money flow, is getting more importance than economic analysis. Economic analysis deals not only with real money flow but also indirect money flow that does not have any real purchasing power. Sometimes economic analysis computes a shadow price. But nobody can buy any goods at a shadow price. These concepts mainly come from a planned economy idea and are out of date with the prevalence of the market economy, which follows market price as the sole signal for resources allocation.

9.2 Proposed Scale and Schedule of Investment

Table 9.2 gives an overall investment schedule for the rehabilitation and expansion of the system. The breakdown of the construction costs is given in chapter 7 of this report.

As to the estimation of the O&M expenditure during the master planning period, we do not adopt the traditional way of accumulating various kinds of cost items (general administrative expense, operation expense etc.). Although such a method has been very popular in public sector accounting, the problem of this method is the difficulty to hold down the overrun of expenditure.

In private company, costs must be restrained within the limit of the income, which is predicted. If an income decreases from the level of prediction, costs will be cut immediately. The expenditure should not be admitted right away just because it is a necessary cost. Because EDA RANU was corporatized, the cost must be controlled within the limit of the income.

A starting point of O&M cost estimation is the budget of EDA RANU in the fiscal year 1997. This budget is the one in the first fiscal year and to adopt this as a standard budget might be dangerous because it lacks adequate ground of estimation. But except for this budget, there is not a proper standard for EDA RANU's operation. While in 1997 the actual expenditures are far exceeding budget provisions in most cost categories as we have examined in Chapter 3, from 1998 the budget limit should be observed strictly when additional funds other than the revenue are not available.

However, the actual O&M cost in 1997 exceeded the original budget considerably. The original budget estimate was unrealistically low, although there are many categories of one time disbursement. A too low budget estimate might have been prepared due to little income estimate.

As described later, EDA RANU has a plan to revise sewerage charge in June 1998 and as a whole sewerage service charge income will be twice the present income level. The new fee system needs to be realized by all means. Under the new fee system, the expense over the current budget level become possible but the growth of expenditure should be strictly limited below the increase of income. Although it is expected that the sewerage service income becomes 2 times, we assume the growth rate of an expense as 90 percent from current fee structure to be conservative.

At present, there is no exact method that divides the whole budget of EDA RANU into separate section of water supply and sewerage. The cost accounting system that divides the

whole cost into water supply and sewerage sections has not been introduced yet. We distributed operational expenses in proportion to direct working staff number (water supply 57 and sewerage section 31), while indirect expenses other than operation expenses are distributed in the proportion of the revenue from Nov. 1996 to Oct. 1997 in each division.

However, we see the personnel expense of the sewerage division is over the income ratio. Therefore this method of cost estimation is assuming implicitly an internal subsidy from water supply to sewerage collection. The growth of the costs in 1998 is only allowed within the limit proportionate to the growth of the income.

9.3 Fund Sources

9.3.1 Financial Source of Initial Cost

We suggest a long term and a low interest loan from an international aid agency. For example, OECF to Japan offers thirty-year loan (with 10-year grace period) at about 2.1% level or even less (a loan for environmental improvement etc.).

Grant from donor country should be considered strongly. Although this master plan is feasible with a long term and low interest loan from an international aid agency, this assumes the improvement of collection rate and there might be cost overrun due to unexpected causes. Therefore, especially at the first stage of the master plan, an official grant from overseas sources is strongly recommended if available. This will fortify the financial basis of this Master Plan and will contribute to the materialization of this Master Plan.

Investment with private funds at market levels interest rates is not recommended. A high interest rate and short term loan gives financial burden on the project and the Master Plan will become absolutely unfeasible as shown in Table 9.6.

9.3.2. Financial Source of Operation and Maintenance Cost

The O&M costs should be covered with the fee income completely. The link between cost and revenue must be clarified introducing an adequate management accounting system in order to control cost within income. According to our analysis, these cost controls will be attained if a low interest loan is available.

9.4 Fee System for Sewerage Collection

1) At present, the sewerage service charge for residences is divided into 2 levels according to the market value of the residence, either 90 Kina or 180 Kina annually collected once a year.

2) We propose that the sewerage service charges should be linked with the volume of the water supply consumed and incorporate a progressive fee structure according to the volume of the wastewater discharged. As the income discrepancy of the residents here is extremely high, such fee structure will facilitate the income transfer from the rich to the poor and will improve the collection rate for low-income users.

3) We also recommend collecting the sewerage fee every 3 months for residential use and to collect every month for commercial users like water supply charges, because the present collection system of once a year will be a burden for payers.

4) If environment improvement and effects are considered, aid from the Government or an overseas aid agency should be sought in addition to relying on the fee revenue. But we have to consider the increase of fee revenue, following the general principle that is very popular in advanced countries including Japan. Some of these measures will be considered in the following feasibility study.
   - Adequate sewerage service charges are generally considered at the level of 30 to 40 percents of water supply charges.
   - Internal subsidy from water supply to sewerage collection is common.
   - Combining water supply charge and sewerage collection charge, a handbook written by Japanese sewerage experts suggests a 2 to 5 percent of the resident's income.

5) Recently, EDA RANU has developed a new sewerage charge system, which will become effective on June 1998 upon governmental approval. The new fee system adopts following major characters, which we have suggested during this study as follows:
   - The sewerage charge should be based on the water volume consumed. That is, the metering system for water supply become critical for sewerage fees assessment.
   - To increase the frequency of fee collection for residential users from once a year to quarterly and for commercial users from quarterly to monthly.
   - To increase the sewerage charge for commercial users who have the ability to pay.

Based on the proposed plan, the total annual income will become 6,782,000 Kina divided into 1,979,000 Kina and 4,803,000 Kina for residential and commercial users respectively. This new fee structure is vital for the EDA RANU's sustainability. The total billing amount in June 1997 was 2,774,000 Kina, broken down into 2,034,990 Kina for residential users (12,518 accounts), and 738,720 Kina for commercial and industrial users (837 accounts). Residential users were charged either 90 Kina or 80 Kina annually depending on the size of their dwelling unit whilst commercial users were charged on the number of water closets installed. The new plan shows a drastic fee structure change resulting to an income increase from commercial users.

9.5 Income Forecasting

As mentioned above, fee income is critically important for EDA RANU's sewerage operation. The World Bank had already made forecasting for sewerage fee income until year 2005. It is not applicable because of the privatization and management change. Our fee income forecasting is as follows:

1) Our forecast formula for fee income is new fee income level times population increase times per capita GDP growth.

2) As to current coverage of the sewerage service in NCD, we have the following two numbers available. The first number is 127,684. It is available by multiplying the residential accounts, 12,518 with the estimated average household size of 10.2 (including

temporary member, 2.0, on average taken from question 3 of the Inhabitant's Behaviour Survey. The second estimated number is 140,031. It is computed by multiplying the estimated population 274,570 (population in 1997 as per Table 9.3) by 51 percent (a sewerage collection availability from question 9 of the Inhabitant's Behaviour Survey). Therefore the estimate for the coverage of sewerage service will be around 130,000 to 140,000.

3) As for population increase, we adopt the lowest case among the three cases of the World Banks UDSS. The decrease in birth rate will be gradually attained by the improvement in women's education and other reasons. Therefore, the annual growth rate in NCD, assume 4.60 percent until year 2000, 3.92 percent from year 2001 to year 2005 and 3.39 percent after year 2006.

4) As to the annual GDP per capita increase, we adopt 0.6% from the 1995 World Development Report.

5) The critical issue for income forecasting is the collection rate. During the NCDC era, it was estimated at less than 70 percent level. After privatization, JC-KRTA has been trying to increase the collection rate. Substantial improvement has already been realized in the first year of privatization. Therefore, we assume an 80 percent collection rate during the first five years of the Master Plan and 85 percent collection rate thereafter. The improvement of the collection rate is one of the major purposes of privatization. Above average level of collection rate must be attained. These information and assumption are given in Table 9.3.

6) There is a significant portion of poor residents in NCD, which would impede increase of collection rate.

7) A group of Japanese expert suggests 2 to 5 percent of the resident's income is allocated for water supply and sewerage fee. But, if the current income differences and absolute income level is considered (as revealed in the Inhabitant's Behaviour Survey), this fee level seems unfeasible. The "Willingness to pay" amount revealed in the Inhabitant's Behaviour Survey is 107 Kina annual average for water supply and 91 Kina for sewerage service. A drastic fee increase for residential users is absolutely unrealistic and, therefore, not recommendable. JC-KRTA is trying hard to collect the fees at the current rate.

9.6 Financial Projections

9.6.1 Projection of Financial Statements

Case A of Table 9.4 (Base case) is based on a long term and low interest rate (2.7 percent) loan from international aid organizations and fee income at our estimated level. Financially, the third and fourth phase investments give the largest burden to EDA RANU. While the OECF of Japan offers a loan at 2.1 per cent or less interest rate, the loan may not cover the whole investment. Therefore, we assume an interest rate at 2.7 percent level.

As to the period of financial projection, analysis was made until year 2045, which is 30 years after year 2015 (the end of this Master Plan). Thirty years correspond to the assumed loan period by the international aid agency.

Depreciation is computed by the straight-line method with no salvage value. The economic life for civil works and machinery is assumed at 50 years, respectively.

The output of this projection are income statement, balance sheet and cash flow table. These financial statements are hypothetical and carrying the financial situation of the sewerage operation of EDA RANU. The balance sheet of EDA RANU has not been finalized as of the end of November 1997. Therefore, our analysis can not start from the current balance sheet. The financial analysis covers both the existing portion and additional portion that is added by this Master Plan.

Case B of Table 9.5 is based on 3.2 percent interest rate. This is a sensitivity analysis for Case A. The result is almost the same as Case A of Table 9.4.

Case C of Table 9.6 is based on the present rate in financial market. For conservative interest rate of 8.5 percent is assumed. The fixed assets are depreciated using the straight-line method (20 years with no salvage value). Loan term is 17 years with five-year grace period. Both assumptions are conservative than to the real market condition. The estimated financial statements show the accumulated debt at an eventual financial disaster. It also shows that this option is absolutely unrealistic.

Moreover, the terms of the loan used in Case C are more generous than to the actual financial market conditions. The analysis of alternatives using financial from commercial sources is presented in the Feasibility Study.

9.6.2 Estimation of Financial Internal Rates of Return (FIRR)

The FIRR is estimated at 3.01 percent for Case A (Base case) as shown in Table 9.7.

Table 9.8 and Table 9.9 show significant FIRR improvement with a gradual introduction of grant from overseas donors for the Phase I investment.

9.6.3 Alternative Proposal

The combination of a long-term loan with low interest rate from an international aid agency and an improved fee collection system are recommended. In addition, a grant from an overseas donor will facilitate the implementation of the Master Plan especially for Phase 1.

It is not feasible and not recommendable to rely mainly on a loan from financial sources having a high interest rate and a short recovery period. This option will cause a financial disaster as discussed earlier in Section 9.6.1.

Table 9.1 The Income Distribution in NCD

(1995 Kina)

Household income	Frequency(%)	Cumulative(%)
K2,000	0.5	0.5
K4,000	2.2	2.7
K6,000	5.0	7.7
K8,000	6.8	14.5
K10,000	9.0	23.5
K12,000	12.0	35.5
K14,000	11.4	46.9
K16,000	8.4	55.3
K18,000	5.7	61.0
K20,000	8.3	69.3
K22,000	5.2	74.5
K24,000	6.8	81.3
K26,000	3.6	84.9
K28,000	3.2	88.1
K30,000	11.9	100.0

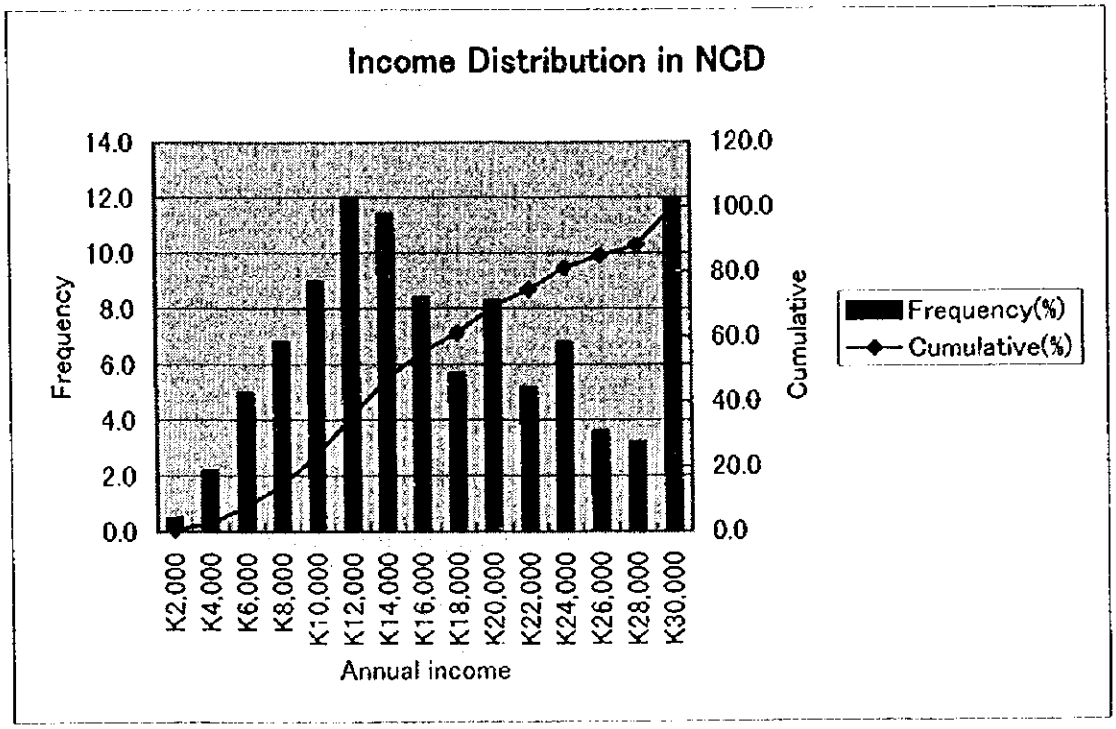

Table 9.2 The Investment Plan (1999 - 2015)

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	Total
1. Construction		938	4,012	12,688	342	2,438	6,751	0	1,483	2,691	2,691	2,817	0	7,623	7,623	10,183	10,190	72,470
2. Procurement of Equipment							687					560						1,247
3. Land Acquisition	297	27			50								7,986					8,360
4. Administration		14	60	190	5	37	101	0	22	40	40	42	0	114	114	153	153	1,085
5. Engineering Service		94	401	1,269	34	244	675	0	148	269	269	282	0	762	762	1,018	1,019	7,246
6. Contingency		94	401	1,269	34	244	675	0	148	269	269	282	0	762	762	1,018	1,019	7,246
Sub Total (All Investment)	297	1,167	4,874	15,416	465	2,963	8,889	0	1,801	3,269	3,269	3,983	7,986	9,261	9,261	12,372	12,381	97,654
Sub Total (Investment Except Land)	0	1,140	4,874	15,416	415	2,963	8,889	0	1,801	3,269	3,269	3,983	0	9,261	9,261	12,372	12,381	89,294
7. O&M Cost	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,288	5,501	5,721	5,949	6,188	6,437	6,694	6,964	7,245	89,905
Total Project Cost	3,799	4,851	8,725	19,442	4,674	7,639	13,776	5,084	7,089	8,770	8,990	9,932	14,174	15,698	15,955	19,336	19,626	187,559

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

Table 9.3 The Bill Collection Forecasting of EDA RANU Sewerage Service Operation

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

No.	9	10	11	12	13	14	15	16	17		
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007-2015	1999-2015
NCD Population	407,099	420,900	435,168	449,920	465,173	480,942	497,246	514,103	531,711		
Bill. Flat GDP	9,191	9,502	9,824	10,157	10,502	10,858	11,226	11,606	12,004	94,869	157,499
Bill. GDP Growth	9,641	10,028	10,430	10,848	11,283	11,736	12,206	12,696	13,209	102,077	166,116
Collection (70 %)	6,749	7,019	7,301	7,594	7,898	8,215	8,544	8,887	9,247	71,454	116,281
Collection (80 %)	7,713	8,022	8,344	8,679	9,027	9,389	9,765	10,157	10,568	81,662	132,893
Collection (85 %)	8,195	8,524	8,865	9,221	9,591	9,975	10,375	10,791	11,228	86,766	141,198

Table 9.4 The Financial Statements of Sewerage Division of EDA RANU : M/P

(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	8,195	8,254	8,865	9,221	9,591	9,975	10,375	10,791	11,228
Loan (2.7%)	297	1,167	4,874	15,416	465	2,963	8,889	0	1,801	3,269	3,269	3,983	7,986	9,261	9,261	12,372	12,381
Investment	297	1,167	4,874	15,416	465	2,963	8,889	0	1,801	3,269	3,269	3,983	7,986	9,261	9,261	12,372	12,381
Interest Payment (2.7%)	8	40	171	587	600	680	920	920	969	1,057	1,145	1,250	1,457	1,678	1,898	2,198	2,486
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	5,288	5,501	5,721	5,949	6,188	6,437	6,694	6,964	7,249
Net Cash Inflow	1,916	1,985	1,947	1,627	1,714	1,890	1,768	1,875	1,939	1,697	1,984	1,949	1,628	772	672	370	-211
Income Statement																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	8,195	8,254	8,865	9,221	9,591	9,975	10,375	10,791	11,228
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,288	5,501	5,721	5,949	6,188	6,437	6,694	6,964	7,249
Depreciation	0	23	164	606	614	684	1,003	1,003	1,039	1,106	1,174	1,284	1,284	1,476	1,669	1,940	2,211
Interest Payment (2.7%)	8	40	171	587	600	680	920	920	969	1,057	1,145	1,250	1,457	1,678	1,898	2,198	2,486
Balance	1,916	1,962	1,783	1,021	1,100	1,206	765	872	900	591	825	738	661	384	114	-311	-718
Balance sheet																	
Cash	1,916	3,902	5,848	7,475	9,189	11,079	12,847	14,722	16,661	18,357	20,342	22,291	23,919	24,691	25,363	25,734	25,523
Investment	0	1,140	6,014	21,430	21,845	24,808	33,697	33,697	35,498	38,767	42,036	46,019	46,019	55,280	64,541	76,913	89,294
Less Accum.Depreciation	0	23	187	793	1,407	2,091	3,094	4,097	5,203	6,377	7,661	8,945	10,421	12,090	14,030	16,241	16,241
Land	297	324	324	324	374	374	374	374	374	374	374	374	8,360	8,360	8,360	8,360	8,360
Total Assets	2,213	5,343	11,999	28,436	30,001	34,170	43,824	44,696	47,330	51,121	55,091	59,739	67,877	76,241	84,234	94,766	106,936
Loan (balance)	297	1,464	6,338	21,754	22,219	25,182	34,071	34,071	35,872	39,141	42,395	46,305	53,974	62,147	70,297	81,410	92,087
Reserved Fund	1,916	3,879	5,661	6,682	7,782	8,988	9,753	10,625	11,458	11,980	12,696	13,434	13,903	14,094	13,937	13,356	14,849
Total Liabil.&Capital	2,213	5,343	11,999	28,436	30,001	34,170	43,824	44,696	47,330	51,121	55,091	59,739	67,877	76,241	84,234	94,766	106,936

Table 9.5 The Financial Statements of Sewerage Division of EDA RANU : M/P

(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	8,195	8,254	8,865	9,221	9,591	9,975	10,375	10,791	11,228
Loan (3.2%)	297	1,167	4,874	15,416	465	2,963	8,889	0	1,801	3,269	3,269	3,983	7,986	9,261	9,261	12,372	12,381
Investment	297	1,167	4,874	15,416	465	2,963	8,889	0	1,801	3,269	3,269	3,983	7,986	9,261	9,261	12,372	12,381
Interest Payment (3.2%)	10	47	203	696	711	806	1,090	1,090	1,148	1,253	1,357	1,482	1,727	1,989	2,250	2,605	2,947
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	5,288	5,501	5,721	5,949	6,188	6,437	6,694	6,964	7,249
Net Cash Inflow	1,914	1,978	1,915	1,518	1,603	1,764	1,598	1,705	1,759	1,501	1,772	1,717	1,359	461	320	-37	-672
Income Statement																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	8,195	8,254	8,865	9,221	9,591	9,975	10,375	10,791	11,228
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,288	5,501	5,721	5,949	6,188	6,437	6,694	6,964	7,249
Depreciation	0	23	164	606	614	684	1,003	1,003	1,039	1,106	1,174	1,284	1,284	1,476	1,669	1,940	2,211
Interest Payment (3.2%)	10	47	203	696	711	806	1,090	1,090	1,148	1,253	1,357	1,482	1,727	1,989	2,250	2,605	2,947
Balance	1,914	1,955	1,751	912	989	1,080	595	702	720	395	613	506	392	73	-238	-718	-1,179
Balance sheet																	
Cash	1,914	3,892	5,807	7,325	8,928	10,692	12,290	13,995	15,754	17,255	19,027	20,744	22,102	22,563	22,884	22,847	22,176
Investment	0	1,140	6,014	21,430	21,845	24,808	33,697	33,697	35,498	38,767	42,036	46,019	46,019	55,280	64,541	76,913	89,294
Less Accum.Depreciation	0	23	187	793	1,407	2,091	3,094	4,097	5,203	6,377	7,661	8,945	10,421	12,090	14,030	16,241	16,241
Land	297	324	324	324	374	374	374	374	374	374	374	374	8,360	8,360	8,360	8,360	8,360
Total Assets	2,211	5,333	11,958	28,286	29,740	33,783	43,267	43,969	46,423	50,019	53,776	58,192	66,060	74,113	81,755	91,879	103,589
Loan (balance)	297	1,464	6,338	21,754	22,219	25,182	34,071	34,071	35,872	39,141	42,395	46,305	53,974	62,147	70,297	81,410	92,087
Reserved Fund	1,914	3,869	5,620	6,532	7,521	8,601	9,196	9,898	10,551	10,878	11,381	11,887	12,086	11,966	11,458	10,469	11,502
Total Liabil.&Capital	2,211	5,333	11,958	28,286	29,740	33,783	43,267	43,969	46,423	50,019	53,776	58,192	66,060	74,113	81,755	91,879	103,589

Table 9.6 The Financial Statements of Sewerage Division of EDA RANU : M/P

(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	8,195	8,254	8,865	9,221	9,591	9,975	10,375	10,791	11,228
Loan (8.5%)	297	1,167	4,874	15,416	465	2,963	8,889	0	1,801	3,269	3,269	3,983	7,986	9,261	9,261	12,372	12,381
Investment	297	1,167	4,874	15,416	465	2,963	8,889	0	1,801	3,269	3,269	3,983	7,986	9,261	9,261	12,372	12,381
Interest Payment (8.5%)	25	124	539	1,849	1,889	2,138	2,884	2,839	2,838	2,958	3,058	3,155	3,592	4,125	4,635	5,387	6,110
Loan Repayment	0	0	0	0	0	25	122	528	1,813	1,852	2,099	2,839	2,839	2,989	3,262	3,534	3,866
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,288	5,501	5,721	5,949	6,188	6,437	6,694	6,964	7,249
Net Cash Inflow	1,899	1,901	1,579	365	425	407	-318	-572	-1,744	-2,057	-2,013	-2,722	-3,028	-3,576	-4,216	-5,094	-5,997
Income Statement																	
Cash Collection 80%-85%	5,426	5,709	5,969	6,240	6,523	7,246	7,575	7,879	8,195	8,254	8,865	9,221	9,591	9,975	10,375	10,791	11,228
O/M	3,502	3,684	3,851	4,026	4,209	4,676	4,887	5,084	5,288	5,501	5,721	5,949	6,188	6,437	6,694	6,964	7,249
Depreciation	0	57	301	1,072	1,092	1,240	1,685	1,685	1,775	1,938	2,102	2,301	2,301	2,764	3,199	3,817	4,436
Interest Payment (8.5%)	25	124	539	1,849	1,889	2,138	2,884	2,839	2,838	2,958	3,058	3,155	3,592	4,125	4,635	5,387	6,110
Balance	1,899	1,844	1,278	-707	-667	-808	-1,881	-1,729	-1,706	-2,143	-2,016	-2,184	-2,490	-3,351	-4,153	-5,377	-6,567
Balance sheet																	
Cash	1,899	3,800	5,379	5,744	6,169	6,576	6,258	5,686	3,942	1,886	-127	-2,849	-5,878	-9,454	-13,670	-18,763	-24,760
Investment	0	1,140	6,014	21,430	21,845	24,808	33,697	33,697	35,498	38,767	42,036	46,019	46,019	55,280	64,541	76,913	89,294
Less Accum.Depreciation	0	57	358	1,430	2,522	3,762	5,447	7,132	8,907	10,845	12,947	15,248	17,549	20,313	23,512	27,329	31,765
Land	297	324	324	324	374	374	374	374	374	374	374	374	8,360	8,360	8,360	8,360	8,360
Total Assets	2,196	5,207	11,359	26,068	25,866	27,996	34,882	32,625	30,907	30,182	29,336	28,296	30,952	33,873	35,720	39,181	41,130
Loan (balance)	297	1,464	6,338	21,754	22,219	25,157	33,924	33,396	33,384	34,801	35,971	37,115	42,262	48,534	54,533	63,371	71,886
Reserved Fund	1,899	3,743	5,021	4,314	3,647	2,839	958	-771	-2,477	-4,620	-6,635	-8,819	-11,310	-14,661	-18,814	-24,190	-30,757
Total Liabil.&Capital	2,196	5,207	11,359	26,068	25,866	27,996	34,882	32,625	30,907	30,182	29,336	28,296	30,952	33,873	35,720	39,181	41,130

Table 9.7 FIRR of EDA RANU Sewerage Service (Master Plan)

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	8,195	1,801	5,288	7,089	1,106	
2008	8,254	3,269	5,501	8,770	-516	
2009	8,865	3,269	5,721	8,990	-125	
2010	9,221	3,983	5,949	9,932	-711	
2011	9,591	7,986	6,188	14,174	-4,583	
2012	9,975	9,261	6,437	15,698	-5,723	
2013	10,375	9,261	6,694	15,955	-5,580	
2014	10,791	12,372	6,964	19,336	-8,545	
2015	11,228	12,381	7,245	19,626	-8,398	
2016	11,228	931	7,245	8,176	3,052	
2017	11,228	2,861	7,245	10,106	1,122	
2018	11,228	0	7,245	7,245	3,983	
2019	11,228	233	7,245	7,478	3,750	
2020	11,228	3,026	7,245	10,271	957	
2021	11,228	0	7,245	7,245	3,983	
2022	11,228	0	7,245	7,245	3,983	
2023	11,228	40	7,245	7,285	3,943	
2024	11,228	40	7,245	7,285	3,943	
2025	11,228	668	7,245	7,913	3,315	
2026	11,228	0	7,245	7,245	3,983	
2027	11,228	148	7,245	7,393	3,835	
2028	11,228	148	7,245	7,393	3,835	
2029	11,228	505	7,245	7,750	3,478	
2030	11,228	514	7,245	7,759	3,469	
2031	11,228	931	7,245	8,176	3,052	
2032	11,228	2,861	7,245	10,106	1,122	
2033	11,228	0	7,245	7,245	3,983	
2034	11,228	233	7,245	7,478	3,750	
2035	11,228	3,026	7,245	10,271	957	
2036	11,228	0	7,245	7,245	3,983	
2037	11,228	0	7,245	7,245	3,983	
2038	11,228	40	7,245	7,285	3,943	
2039	11,228	40	7,245	7,285	3,943	
2040	11,228	668	7,245	7,913	3,315	***3.01%***
2041	11,228	0	7,245	7,245	3,983	3.19%
2042	11,228	148	7,245	7,393	3,835	3.35%
2043	11,228	148	7,245	7,393	3,835	3.49%
2044	11,228	505	7,245	7,750	3,478	3.61%
2045	11,228	514	7,245	7,759	3,469	3.72%

Table 9.8 FIRR of EDA RANU Sewerage Service (Master Plan)

(50 Percent Grant for Phase 1)

Unit: 1000 Kina (1997 Price)

Year	Cash Collection	Investment (All)	O&M	Total Cash Outflow	Net Cash Flow	FIRR
1999	5,426	149	3,502	3,651	1,775	
2000	5,709	584	3,684	4,268	1,441	
2001	5,969	2,437	3,851	6,288	-319	
2002	6,240	7,708	4,026	11,734	-5,494	
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	8,195	1,801	5,288	7,089	1,106	
2008	8,254	3,269	5,501	8,770	-516	
2009	8,865	3,269	5,721	8,990	-125	
2010	9,221	3,983	5,949	9,932	-711	
2011	9,591	7,986	6,188	14,174	-4,583	
2012	9,975	9,261	6,437	15,698	-5,723	
2013	10,375	9,261	6,694	15,955	-5,580	
2014	10,791	12,372	6,964	19,336	-8,545	
2015	11,228	12,381	7,245	19,626	-8,398	
2016	11,228	931	7,245	8,176	3,052	
2017	11,228	2,861	7,245	10,106	1,122	
2018	11,228	0	7,245	7,245	3,983	
2019	11,228	233	7,245	7,478	3,750	
2020	11,228	3,026	7,245	10,271	957	
2021	11,228	0	7,245	7,245	3,983	
2022	11,228	0	7,245	7,245	3,983	
2023	11,228	40	7,245	7,285	3,943	
2024	11,228	40	7,245	7,285	3,943	
2025	11,228	668	7,245	7,913	3,315	
2026	11,228	0	7,245	7,245	3,983	
2027	11,228	148	7,245	7,393	3,835	
2028	11,228	148	7,245	7,393	3,835	
2029	11,228	505	7,245	7,750	3,478	
2030	11,228	514	7,245	7,759	3,469	
2031	11,228	931	7,245	8,176	3,052	
2032	11,228	2,861	7,245	10,106	1,122	
2033	11,228	0	7,245	7,245	3,983	
2034	11,228	233	7,245	7,478	3,750	
2035	11,228	3,026	7,245	10,271	957	
2036	11,228	0	7,245	7,245	3,983	
2037	11,228	0	7,245	7,245	3,983	
2038	11,228	40	7,245	7,285	3,943	
2039	11,228	40	7,245	7,285	3,943	
2040	11,228	668	7,245	7,913	3,315	*5.47%*
2041	11,228	0	7,245	7,245	3,983	5.64%
2042	11,228	148	7,245	7,393	3,835	5.78%
2043	11,228	148	7,245	7,393	3,835	5.91%
2044	11,228	505	7,245	7,750	3,478	6.02%
2045	11,228	514	7,245	7,759	3,469	6.12%

Table 9.9 FIRR of EDA RANU Sewerage Service (Master Plan)

(60 Percent Grant for Phase 1)

Unit: 1000 Kina (1997 Price)

Year	Cash Collection	Investment (All)	O&M	Total Cash Outflow	Net Cash Flow	FIRR
1999	5,426	119	3,502	3,621	1,805	
2000	5,709	467	3,684	4,151	1,558	
2001	5,969	1,950	3,851	5,801	168	
2002	6,240	6,166	4,026	10,192	-3,952	
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	8,195	1,801	5,288	7,089	1,106	
2008	8,254	3,269	5,501	8,770	-516	
2009	8,865	3,269	5,721	8,990	-125	
2010	9,221	3,983	5,949	9,932	-711	
2011	9,591	7,986	6,188	14,174	-4,583	
2012	9,975	9,261	6,437	15,698	-5,723	
2013	10,375	9,261	6,694	15,955	-5,580	
2014	10,791	12,372	6,964	19,336	-8,545	
2015	11,228	12,381	7,245	19,626	-8,398	
2016	11,228	931	7,245	8,176	3,052	
2017	11,228	2,861	7,245	10,106	1,122	
2018	11,228	0	7,245	7,245	3,983	
2019	11,228	233	7,245	7,478	3,750	
2020	11,228	3,026	7,245	10,271	957	
2021	11,228	0	7,245	7,245	3,983	
2022	11,228	0	7,245	7,245	3,983	
2023	11,228	40	7,245	7,285	3,943	
2024	11,228	40	7,245	7,285	3,943	
2025	11,228	668	7,245	7,913	3,315	
2026	11,228	0	7,245	7,245	3,983	
2027	11,228	148	7,245	7,393	3,835	
2028	11,228	148	7,245	7,393	3,835	
2029	11,228	505	7,245	7,750	3,478	
2030	11,228	514	7,245	7,759	3,469	
2031	11,228	931	7,245	8,176	3,052	
2032	11,228	2,861	7,245	10,106	1,122	
2033	11,228	0	7,245	7,245	3,983	
2034	11,228	233	7,245	7,478	3,750	
2035	11,228	3,026	7,245	10,271	957	
2036	11,228	0	7,245	7,245	3,983	
2037	11,228	0	7,245	7,245	3,983	
2038	11,228	40	7,245	7,285	3,943	
2039	11,228	40	7,245	7,285	3,943	
2040	11,228	668	7,245	7,913	3,315	*6.39%*
2041	11,228	0	7,245	7,245	3,983	6.56%
2042	11,228	148	7,245	7,393	3,835	6.71%
2043	11,228	148	7,245	7,393	3,835	6.84%
2044	11,228	505	7,245	7,750	3,478	6.95%
2045	11,228	514	7,245	7,759	3,469	7.04%

CHAPTER 10

INITIAL ENVIRONMENTAL EXAMINATION

CHAPTER 10 INITIAL ENVIRONMENTAL EXAMINATION

10.1 Environmental Condition

Environmental aspects were considered in this master plan that support an immediate program and a long range plan to create improvements in the sanitation, public health, and quality of life of the people of Port Moresby. With this concern, an affordable solution to the problems of sewage collection, treatment, disposal including improvements to the quality of the coastal waters, the Waigani Swamp, and the tributary rivers and streams must be drawn-up. An immediate program to be implemented using a cost-effective method must first be fulfilled. This program will lessen to the greatest extent possible, further environmental degradation and will eventually promote environmental enhancement of the area must first be fulfilled.

The environmental evaluation begins with a review of existing wastewater and sanitation conditions of Port Moresby. This review included detailed evaluations of previous reports and existing reports including environmental criteria and standards, as well as laws, rules and regulations. On-site inspections were conducted to all relevant aspects of the study. The JICA Study Team heavily relied on interviews with the officers and staff of the different institutions involved in environmental protection and conservation for additional information. Table 10.1 outlines the environmental condition of the study area.

10.2 General Areas of Environmental Concern

There are three critical concerns that must be thoroughly addressed and evaluated, namely; sanitation and wastewater condition, receiving waters, and regulatory framework of environmental/water sector management.

10.2.1 Sanitation and Wastewater Conditions

Existing sanitation conditions vary widely throughout the area. These conspicuously vary with the social, cultural, and economic features of the area. The general level of sanitation in Port Moresby leaves much to be desired especially in coastal settlements and villages where there is no proper sewerage service. Sewage is often deposited using a combination of septic, pit, and directly on the beach or in the sea. The present sewage disposal practices in these areas are then a threat to the environment and to public health.

Areas covered by the present Port Moresby sewerage system are the well-differentiated residential areas and most of the commercial and industrial areas. The coverage area is delineated into two (2) catchment areas: i) the coastal catchment area where the untreated sewage is directly discharged into the sea through a number of very short outfalls along the shoreline, except for the Paga Point outfall, which has about a 3 km marine outfall, and ii) the inland catchment area where the sewage flows into the three treatment pond systems and the treated effluent into the Waigani Swamp.

Table 10.1 Environmental Conditions of the Study Area

Item		Description
PHYSICAL	Meteorology and Climate (Temperature, rainfall/types and levels of existing air pollutants/ ambient noise levels, nuisance and odor/health hazards/standards)	Climate is tropical with temperature ranging from 22 to 31℃. Average annual rainfall is 1,000 mm. There is no significant air pollutant source. Odor can be a nuisance in some areas where sanitation level is low. Standards not available for air quality and noise levels.
	Topography/Geology/Soils (Steep slope/erosion/loose foundation)	Steep rocky areas with very narrow plain coastal strip. Indicates widespread calcareous and siliceous mudstone and chert, mostly hard and strong on hillside areas. Flatter areas have soil that is generally firm plastic clay with some gravel.
	Oceanography (Tides/currents, shoreline characteristics/water quality/ pollution problems/standards)	Dominant current directions are WNW (towards Manubada Is.) and ESE (towards reef opening) with speeds from 40 to 140 cm/sec and show flood dominance in Joyce Bay. Habitats include tidal flat, inner lagoon, fringing reef, reef edge, fore-reef edge, and Papuan Lagoon. Inadequate sewage disposal and presence of littered garbage along shoreline. Standards are still under review.
	Land and Resource Use (Land uses, plans and patterns/ unique sensitivity or special status as scenic spots, areas of religious, historic and cultural significance)	Rapid expansion of urban area with corresponding increases in population. Non-conforming land use development in some areas. Most coastal settlements have no proper sewerage service. Seven traditional villages located within close proximity to the coast. Villages are provided with different levels of services and infrastructure.
BIOLOGICAL	Vegetation-Terrestrial and Aquatic (Plant species/habitat/endangered, unique species)	Patches of small areas of mangrove swamps occur along the shoreline of Joyce Bay and Tatana areas. Mudflats support sea grasses and provide shelter and nursery grounds to various marine organisms.
	Fauna-Terrestrial and Aquatic (Animal species/habitat/ endangered, unique species)	Intertidal zone supports mollusks and sea cucumber, shrimps, crabs, gobies, damselfish, grasses, etc., mostly for sustenance fishing. Extensive reef system is shelter to coral reef and open coastal sea fish, crabs, clams and oysters mostly for cash income.
	Microbiological (Bacteriological content/presence, levels/sources)	Direct discharge of untreated sewage through short outfalls is observed along the coastal area. Coastal settlements with over-hung latrines or discharge directly to the sea/beach significantly contribute to the organic and microbial pollution.
SOCIO-ECONOMIC	Demography (Population size, distribution/effect on the area's service sector through migration of workers and dependents to project site)	Estimated population of NCD in 1995 is 251,000. Population of the present sewerage service area is about 150,000. Migrants usually come from villages/rural areas.
	Infrastructure (Water supply/sewerage/ports/ hospitals/ schools/transportation/ communication)	Water supply and sewerage services are provided by EDA RANU. Transport network consists of a paved road network that serves road, public transport and pedestrian traffic, an international airport and port facilities. Telecommunication service is provided by a government corporation.
	Economic Activities (Employment, availability of workforce/ activities)	Services sector constitutes the major employment group. Economically active population was 82,401 in 1990 of which 31% was unemployed.
	Historical, Archaeological, Ethnographic Sites (Location/preservation/cultural practices, changes due to project)	Final location of the proposed facilities has to be determined and an inventory of the sites is needed. Public consultation has to be conducted if such sites can be relocated. Effects on cultural communities near or within study area have to be identified.

The untreated wastewater discharged into the sea is major contributors to the pollutant load of the coastal water, while problem of eutrophication due to high levels of nutrient output from the treated wastewater has been extensively documented in Waigani Swamp by the University of Papua New Guinea (UPNG) Biology Department.

10.2.2 Receiving Waters

The significant receiving waters of the existing sewerage systems include the coastal waters of Port Moresby, and the Waigani Swamp and its tributaries.

1) The Coastal Waters of Port Moresby

The coastal waters of Port Moresby are presently the major receiving waters for untreated wastewater from the Paga Point Outfall, Badili Outfall, Konedobu Outfall and other outfalls in the Harbour Area.

The pollutant loads of the short sewage outfalls mostly located in mudflats significantly affect the water quality of this marine ecosystem. In general, the water quality in these areas is the poorest during low tide. The quality improves during high tide when the highly concentrated effluent is diluted and is flushed away from the shoreline. The level of improvement however, varies according to the current flow and direction of the area.

Public exposure to the contaminated waters such as swimming, fishing, and shellfishing has created serious health problems. The polluted waters are contributory factors to the high incidence of water borne diseases such as diarrhea and other ill-defined intestinal infections, typhoid and skin diseases as reported in the National Capital District Health Statistics for the years 1990 to 1994. It was observed that there was possible contact with raw sewage by fishermen and the swimming public along Joyce Bay making the area a significant health hazard.

At present, there is no monitoring on the development of water quality and predicting the wastewater assimilative capacity of the marine waters along the foreshore of Port Moresby, especially in areas directly affected by the wastewater discharges is done.

2) The Waigani Swamp

The Waigani Swamp receives the wastewater from the sewage treatment lagoon facilities of Waigani, Gerehu I (Morata), and Gerehu II. Its present functions are for sustenance fishing (mainly talapia and carp species), as habitat for native fauna and act as tertiary treatment system before the water drains into the Laloki River.

According to a series of studies of Dr. Osborne et al. Of UPNG, the dominant primary productivity is the phytoplankton. Further, the nutrients in the sewage effluents provide stimulus to phytoplankton growth. The macrophytes (water hyacinths) are confined to the peripheral area of the lake. There is no reported massive fish kills in the lake due to the problem of deoxygenation of the water column. This wetland is important for breeding of birds and as a refuge for crocodiles.

Presently, the Waigani Swamp has no designation as to its protected environmental value. The surrounding area of the Waigani Swamp however, has been designated as preserved land based on the recommended urban development plan (2015) of the 1996 Urban Development and Services Study.

10.2.3 Regulatory Framework of Environmental/Water Sector Management

A strong legal and regulatory framework and the establishment of standards and criteria are necessary to achieve the desired environmental outcomes that will affect environmental protection.

The following Acts summarize the current arrangements that have impact on the proposed sewerage facilities and the receiving waters.

1) Environmental Planning Act (1978)

The Environmental Planning Act provides government control on projects likely to have significant impact to the environment. An Environmental Plan may be required by the Minister of the Department of Environment and Conservation (DEC) or voluntarily prepared by the developer. An Environmental Impact Statement (EIS) is the primary framework for this Plan. A developer, either government or private cannot implement a project if the required EIS or Plan is submitted and accepted. Section 4(3) of the Act states that "The Minister may allow an environmental plan to be a submitted as a series of parts during the planning feasibility study, construction or operational phase of any project, each part of which shall be dealt with as an environmental plan in the manner provided by this Act."

2) Environmental Contaminants Act (1978)

This Act relates to the prevention, abatement and control of environmental contamination. The Act covers the licensing of the discharge of environmental contaminants, the issuance of permits for the importation, sale, manufacture, and/or distribution of hazardous environmental contaminants, and the control of noise. Environmental Contaminants Advisory Council provides advise to the Minister.

3) Public Health Act (1983)

Chapter 226 of this Act deals on Public Health (Sewerage) Regulation and is administered by the Minister of Health. This Regulation provides for government controls of sewerage development including connection, plumbing, drainage, and discharges of domestic and trade wastes. Permit to connect to a sewerage system or to do plumbing work connected with the connection is required under this Regulation. Penalties are imposed to owners or occupiers found guilty of an offence. This Act applies to all sewerage districts.

4) Water Resources Act (1982)

The Water Resources Act provides for the management and protection of all national water resources, both surface and groundwater. Water use is managed through a system of permits that are effective for a 25-year period as stipulated in Section 40(7). The Act does not affect

customary rights to the use of water, but allows for small-scale domestic use. The abstraction of raw water by water service agencies and the contamination of water Section 19 (1) and Section 42 (f) come under this Act.

5) National Capital District Water Supply and Sewerage Act (1996)

This Act defines the responsibilities of the NCD Water Supply and Sewerage Pty. Limited (EDA RANU) for providing, constructing and maintaining catchment areas, reservoirs and other works to secure and provide adequate supply of water, and for providing, designing, constructing and maintaining sewerage facilities, in and for the National Capital District.

10.3 Environmental Quality Standards/Criteria with Reference to Water Quality and Classification of Waterbodies as to their Beneficial/Intended Uses

Currently, the country is still in the process of finalizing a comprehensive water quality standards/criteria for the protection of the water resources and their environmental values. This includes standards for raw water used for drinking, standards for protection of aquatic ecosystem in fresh water, standards for protection of aquatic ecosystem in marine waters, and standards for recreation and aesthetic values.

Because of this lack of standards or criteria, all the waterbodies in the country have not been classified as to their most beneficial or intended use. There is no basis therefore to evaluate if a certain waterbody has already exceeded its acceptable limits for its intended use.

These regulatory instruments are essential in maintaining water quality of waterbodies and in pollution control. These tools will be extensively used for an effective monitoring.

10.4 Monitoring the Ecosystem and Water Quality of the Receiving Water Bodies for Both Coastal and Inland Sewerage Catchment Areas

At present, there is no systematic measurement of pollution in all receiving water bodies of the sewerage system that would establish order of priority for remedial work. It should be emphasized that only by systematic monitoring of chemical, physical, and biological parameters, together with flow metering, that the assessment of the extent of pollution will be possible. This monitoring is for control purposes and will determine the best, most economical strategy, in the management of a water resource.

10.5 Specific Environmental issues and Problems with Reference to Wastewater Management

In general, the establishment of a proper system considered as an environmental infrastructure project contributes to the improvement of sanitation and water pollution of the served area. It is expected to prevent or alleviate the effects of the pollutants on the natural and human environments. When properly carried out, the overall environmental effects are positive. These effects can either be direct or indirect.

10.5.1 Potential Environmental Effects

Direct effects include:

- mitigating nuisances and public health hazards,
- improve the quality of receiving water bodies, and
- increases the beneficial uses of receiving water bodies

Indirect effects include

- increased fishery productivity,
- increased tourists and recreational activities,
- increased agricultural activity through water re-use, and
- reduced chemical fertilizer requirements if treated effluent and sludge are reused.

There are however, some potential negative effects during and after project construction. The following items should be taken into account in the detailed evaluation of alternative plans for the sewerage improvement of Port Moresby.

1) The pollutants of the combined domestic and industrial wastewater of Port Moresby are suspended and dissolved solids consisting of inorganic matter, nutrients, oil and grease, and pathogenic microorganisms. Human wastes that are not properly treated and disposed pose parasitic infections through direct contact with fecal material and various gastrointestinal deceases and hepatitis through contamination of water supplies and food.

   Another pollutant that should be seriously looked into is toxic waste from industrial discharges. Currently, the threat is not present due to the type of industrial activities existing in the city, however, to prevent future possibility, industrial discharge standards must be set up before its acceptance to the sewerage system. The prevailing practices of most of the industries are direct discharge to the system without any treatment at all.

2) When wastewater is collected without proper treatment as in the case of the existing system in the coastal area, the same public health hazards happen. If the discharge point is a receiving water body, additional harmful effects will occur such as destruction of the habitat for aquatic marine and lacustrine organisms through accumulation of both suspended and dissolved solids, deoxygenation, and biological magnification in food chains of the lacustrine and marine organisms.

3) Discharge to confined waters such as in the Waigani Swamp may hasten eutrophication due to increased nutrient from additional sewage flows. Solid waste generated in wastewater treatment plants can pollute soil and groundwater if not properly handled.

4) Construction related activities associated with the proposed project such as excavation, pipe installation, etc., are expected to result in temporary adverse impact. These effects can, however be mitigated through awareness of environmental concerns during the design and construction of the sewerage facilities.

5) Silt generated during the construction period will be prevented from entering the waterbodies through the construction of ditches in the sites, which will direct the storm water from the construction site to the nearest silt containment area.

6) Pipelaying of the proposed sewage marine outfall may result in drastic damage to aquatic ecology if this is not taken into account. Of particular concern are the inner and fringing lagoons.

7) Air pollution, aesthetics, noise and vibration effects are expected to be minimal and mainly temporary while construction is on going. An example is generated dust during earth moving operations in the construction site, which can be minimized by water sprinkling during dry and windy periods.

10.5.2 Issues

1) The location of effluent discharge and the level of treatment are important in planning for the improvement of the Port Moresby Sewerage System. The projected wastewater volume and the quality are essential to establish the magnitude of the possible effects to the receiving water bodies.

2) The level of treatment depends on the magnitude of pollutant removal of the treatment process that in turn depends on the performance standards applicable to the system. Since national standards for effluent reuse have not yet been established, the World Health Organization guidelines or standards from other countries may be adopted.

3) As stated earlier, PNG has yet to establish the water quality standards. The process of setting standards for these discharges to surface waters begins with classification of receiving water bodies based on the intended or beneficial uses. Classification of water bodies should be done with consideration for what is economically and technically realistic, for instance, the designated use of the Waigani Swamp.

4) Ideally, effluent limitations for wastewater discharges should be determined by a mathematical modelling process that takes into account the existing quality and flow characteristics of the receiving waterbody. It calculates the maximum load of each pollutant that can be assimilated in each zone under a specified statistical condition of dry-season streamflow without violation the standards and allocates that load among all dischargers. Such models require seasonal data on the quality of the receiving water body volume and concentration of all discharges and the long record of hydrologic data showing seasonal flow averages and permit calculations of a dry season flow. Such comprehensive information is not readily available for the receiving inland waterbodies. Therefore, it is recommended that the concerned agency responsible should start data collection.

5) As a starting point, previous Waigani Swamp studies (1994, 1996) conducted by Dr. Osborne and R. Totome of UPNG indicated that the swamp was significantly reducing loads on suspended solid and concentrations of dissolved nitrogen and phosphorous. The swamp acts as a "physical sieve" with the uptake of nutrients by microorganisms present on it. However, the same studies also implied that dilution of water draining from the

catchment area is negligible during the long dry season, and therefore the capacity of the swamp for water purification becomes limited during this period. Thus, further study was recommended to determine the carrying capacity/capability of the swamp in improving the quality of the water passing through it.

6) Limitations and discharges to marine waters are usually simpler because they focus on preventing discoloration of the water and pollution caused by floating debris and bacteria in shellfish harvesting and recreational waters. The major planning tasks is to identify an acceptable location for the submerged outfall, where the effluent will not degrade significant water areas or contaminate shellfish beds and beaches. The mathematical models for this purpose will simulate the processes of dilution, dispersion, diffusion, stratification and pollutant decay or die-off. The models will require data on current, temperature, salinity, and water quality collected over a full 12 months cycle, along with detailed bathymetric and ecological information. Again, there is a dearth of information along this line; hence it is recommended that an extensive data collection should be undertaken.

7) In the absence of these information, data generated from the existing Paga Point outfall will be utilized for the proposed Joyce Bay outfall. Based on the 1988 Environmental Plan - Joyce Bay Sewage Outfall Study of the Water, the current regime of both areas is similar, with Paga Point's current speeds even slightly lower. Analysis of the said study with appropriate modifications based on updated data, will be extensively used in the evaluation of the impact. Although, it is expected that there will be a significant improvement of the water quality because the new plan provides for a sedimentation basin and disinfection tank.

8) Phasing wastewater investment maybe the only realistic way to make progress towards ultimate water quality objectives in densely populated, highly polluted areas, where a single project would exhaust all resources available for public works. The level of treatment can be phased in a single project or as part of sector strategy. This approach that is helpful when environmental improvement is urgently needed but local financial resources are limited and the data needed to determine the extent of pollutant removal required has not been collected.

9) Sludge management should be part of wastewater treatment planning. Wastewater treatment generates sludge and other solid wastes. This portion of the pollutants removed from the wastewater must not become pollutant of the land.

10) Treatment facilities require land. Sites should be chosen to avoid resettlement. Also, case should be taken to site treatment and disposal facilities where odors or noise will not disturb residents or other users of the area, and to include in the project mitigation plan provisions to mitigate or offset adverse effect on the human environment.

10.5.3 Monitoring

1) An operational monitoring program should be developed. The program should include:
   - Observation trends and effluent volume and strength.
   - Detection of hazardous substances entering treatment works.

- Strictly enforcing industrial pre-treatment regulations that are currently lacking.
- Controlling the treatment process, assessing and managing the treatment plant performance.
- Monitoring environmental quality at disposal location (swamp, coastal waters, and river).
- Ensuring sludge products and reclaimed wastewater meet re-use standards.

2) Parallel to the monitoring activities is the putting up of a laboratory facility with corresponding equipment and technicians. At present, water quality laboratory facility for wastewater in Port Moresby is very limited.