APPENDIX 4

URBAN SANITATION AND DRAINAGE

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CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION

This report, Appendix 4 is one of 10 appendices for The Study on The Urgent Rehabilitation and Reconstruction Support Program for Aceh Province and Affected Areas in The North Sumatra (the JICA Study). It covers the rehabilitation and reconstruction plan for three infrastructure: (1) wastewater treatment and disposal, (2) solid waste management, and (3) urban drainage system in Banda Aceh City.

The earthquake and tsunami occurred in December 2005 have caused severe damages on infrastructure and also a part of the city administrative area was subsidized. Before the disaster the administrative area of the city was 61 km2 including open water areas, but the land area after disaster is measured at about 41 km2. For the Government of Indonesia it is matter of importance to relief and back people from evacuated area to their original land and stabilize political and security situation. In order to accelerate such national and regional goal it is also important to re-activate the administrative and economic activities to the situation before the disaster so that various institutional support and job opportunities can be extended, resulting in contributing to stabilization of livelihood of people and security in affected areas.

The rehabilitation and reconstruction of infrastructure is also one of the pre-requisite. It sustains the lives of the people as lifeline and economic activities of various sectors. It is however important such rehabilitation and reconstruction plan should be established in harmony with urban development plan.

The planning horizon of the rehabilitation and reconstruction plan is set as follows:

Rehabilitation plan: 2005 to 2006
Reconstruction plan: 2007 to 2009
Further development plan: Beyond 2009

The sector plan presented herein is developed on a basis of urban development plan which is reported in Main Report and in due consideration of the above planning horizons.

1.2 AVALABLE DATA INFORMATION

1.2.1 The Master Plan for Rehabilitation and Reconstruction of Aceh Region and Nias

The Master Plan for Rehabilitation and Reconstruction of Aceh Region and Nias (called as Blueprint) was published in March 2005 to facilitate rehabilitation and reconstruction of disaster affected areas. The plan include spatial plan of Banda Aceh City, though it is of conceptual nature, and strategies for infrastructure. Such strategies are quoted in Table 1.1.

Table 1.1 Strategies in Blueprint

Infrastructure	Strategies
Wastewater treatment and disposal	✓ To adopt best practical approach to communities ✓ To be based on urban development plan including spatial plan and housing development ✓ To limit sewage development only in urban centers ✓ To be sustainable tariff structure
Solid waste management	✓ To be based on urban development plan including spatial plan and housing development ✓ To focus on community oriented approach ✓ To place priority on recycling and separation of solid at generation points
Urban drainage	✓ To restore existing drainage to original design ✓ To reconstruct missing drains ✓ To effectively integrate the urban drainage to rivers

Source: Blueprint

1.2.2 Revised Plan of Regional Spatial Layout, Banda Aceh City, Year 2001-2010

The City Council of Banda Aceh has published “Revised Plan of Regional Spatial Layout, Banda Aceh City, Year 2001-2010” (called as the City Master Plan(2001-2010)) in 2001. This plan associates not only city development but also reinforcement of infrastructure during the planning horizon. Unfortunately this plan is no longer adaptable since geographical situation and fundamentals of the plan have changed substantially, but could be used as one of reference materials.

The City Master Plan (2001-2010) predicts the population of 307,605 at target year 2010. This figure was one of fundamentals for the City Master Plan (2001-2010) and infrastructure. Brief of the infrastructure development are as summarized as follows:

(1) Wastewater treatment and disposal

The wastewater treatment and disposal is a combination of on-site and sewerage system. The sewerage system is planned only in central part of the city as shown in Fig. 1.1 and majority of the wastewater is resorted to be treated by on-site treatment facilities.

It is not clear from the City Master Plan (2001-2010) how much population is planned to be connected to centralized sewerage system. Also target population is planned to be 215,400, corresponding to 70 % of the total population. If this is total population to be covered by septic tanks and centralized sewerage system, is the rest of population disregarded from the urban sanitation service?

(2) Solid waste management

According to the City Master Plan (2001-2010), quantity of solid waste (aggregate of industrial and domestic) will reach 153,848 l/day in 2010, and all solid waste will be disposed of by means of landfill.

The quantity of domestic garbage is based on unit generation volume of 0.5 l/day/capita and total population of 307,695 in 2010. The garbage from industrial and public sectors is assumed to be 40 % of the domestic garbage volume.

It is planned each household will be provided with a garbage bin with a capacity of 40 liter and twice in a week garbage will be collected from collecting stations.

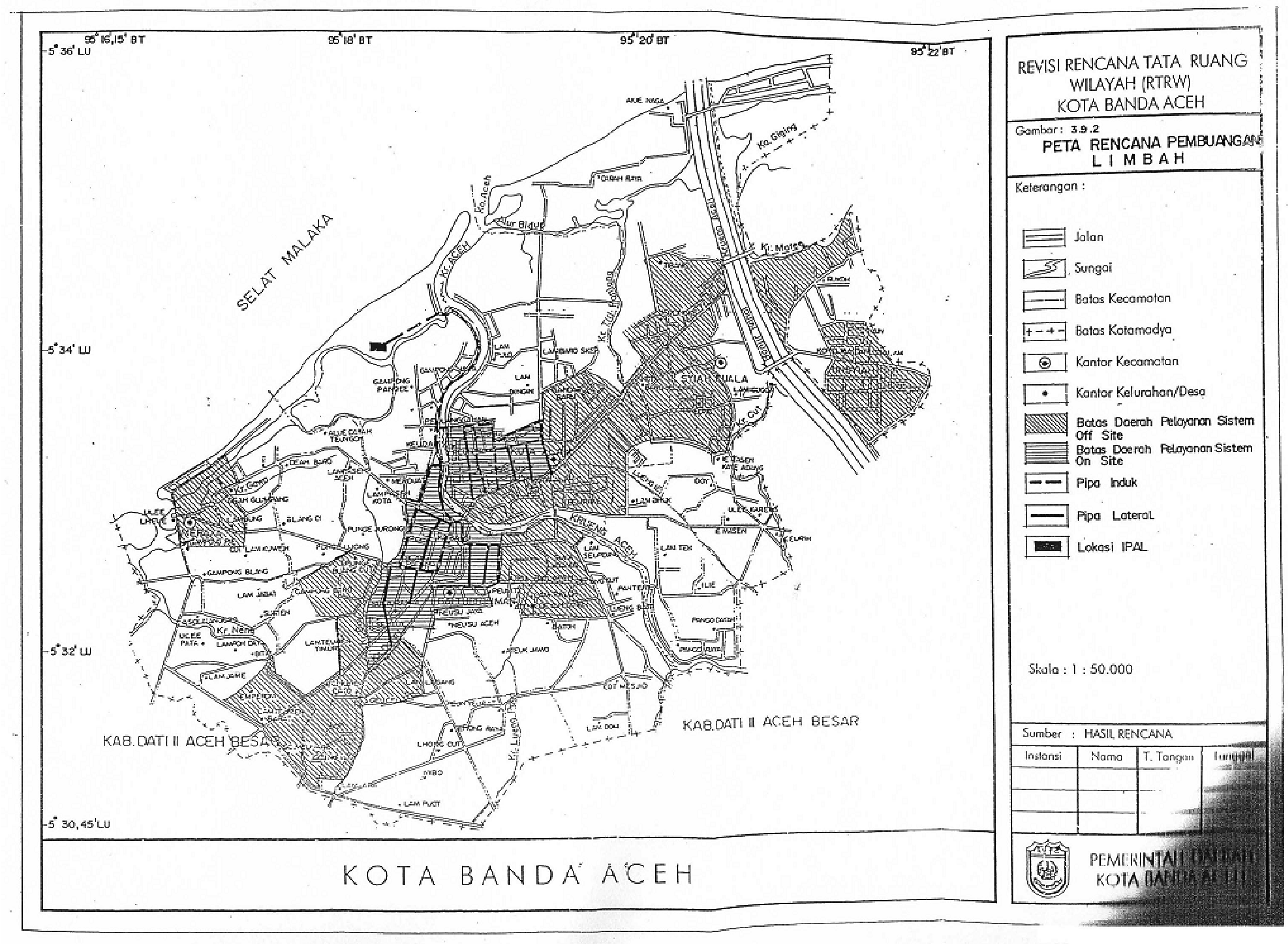
(3) Urban drainage system

Improvement of urban drainage system is vital to secure the life and properties of the people, to ensure smooth transportation during and after storm rainfall, to conserve hygienic urban life. The Urban Development Plan proposes installation of tow additional pumping stations and creation of retardation area to accommodate portion of storm water within the city area.

1.2.3 Aceh Rehabilitation and Reconstruction Information System (ARRIS)

It is one of the important objectives of the current JICA study to build up “Aceh Rehabilitation and Reconstruction and Information System” (ARRIS). There are basically two (2) different systems: one is digital maps in a scale of 1 to 2,000 and the other is Geographical Information System (GIS). It is intended that those two systems will contribute and facilitate the contemplated rehabilitation and reconstruction planning of Kota Banda Aceh and will be used various organizations and agencies to be involved in reconstruction and rehabilitation activities now and in future. It is also very important tools for administration of Kota Banda Aceh.

Practically in this current JICA Study ARRIS was employed in the various sectors such as urban plan, road network planning, land use plan, population distribution, etc. The construction and application of ARRIS to the Study are reported in details in Volume IV Data Book.



Source: Master Plan in Banda Aceh city (2001)

Figure 1.1 Location Map for Introducing Sewer Process Area in Master Plan

CHAPTER 2 URBAN SANITATION AND DRAINAGE BEFORE AND AFTER DISASTER

2.1 WASTEWATER TREATMENT AND DISPOSAL

2.1.1 Situation before Disaster

In Banda Ache City there is no centralized sewerage system including sewage treatment plant, whereas pipe water supply is completed almost entire city administrative area. The pipe water supply is administered by PDAM Banda Ache, while the Sanitation and Park Department of the City Council (DKP) is serving the collection of septage from septic tanks and its treatment and disposal.

Septic tank is the most common means of sewage treatment in the city and nearly 80 % of houses and buildings have relied on such on-site treatment facilities. The rest is dependent on pit latrines and other means. Septic tanks are normally connected to storm water drainages which are eventually linked to the main rivers/floodway within the city area. On the other hand domestic wastewater is directly drained to the urban drainages without any treatment. This mode of wastewater treatment and disposal is widely seen in many urban areas in Indonesia.

Unfortunately there is no data available showing quality of the river water which is receptacle of the effluent from the septic tanks and the domestic wastewater. Judging from the color the river water might have been contaminated to certain extent.

DKP was serving to collect the septage from septic tanks and pit latrines and treat them at septage treatment plant (Instalasi Pengelolann Lumpur Tangki, IPLT), which still exists nearby river-mouth of the Ache River as shown in Fig. 2.1. It was constructed in 1995 and comprises two lines of imhoff tank, anaerobic tank, facultative tank and maturation tank as show in Fig. 2.2. The features of main components are as summarized in Table 2.1.

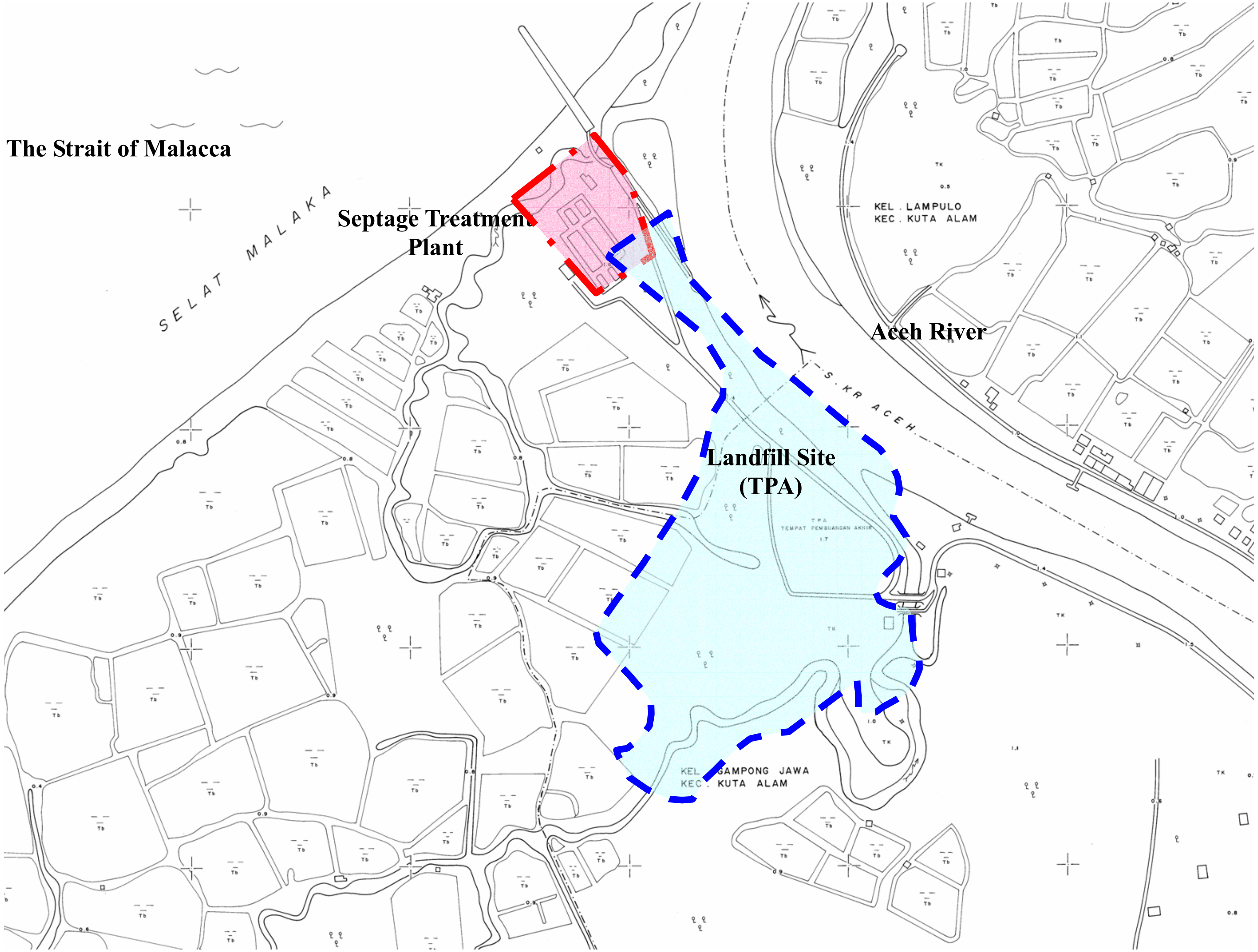
Table 2.1 Features of Main Components of IPLT

Description/ Components		Structural Features	Dimension (m)			Capacity (m3)
1	Imhoff Tank	RC structure, shape: ship-bottom	Bottom Length	Bottom Width	Depth	
2	Anaerobic Tank	Cross-sectional shape: trapezoidal with a slope 1 to 1.12, slope protection: concrete lining, leakage protection: impervious soil material (clay)	10.8	3.0	3.5	392
3	Facultative Tank	Same as above	48.0	13.9	1.35	1,078
4	Maturation Tank	Same as above	15.8	7.0	1.35	221
5	Sludge Drying Bed	Cross-sectional shape: rectangular	8.0	4.0	1.2	38
6	Office building	One unit				

(Source: Outline Plan of Pembuangan Air Limbah Domestic Kota Banda Ache, DPU)

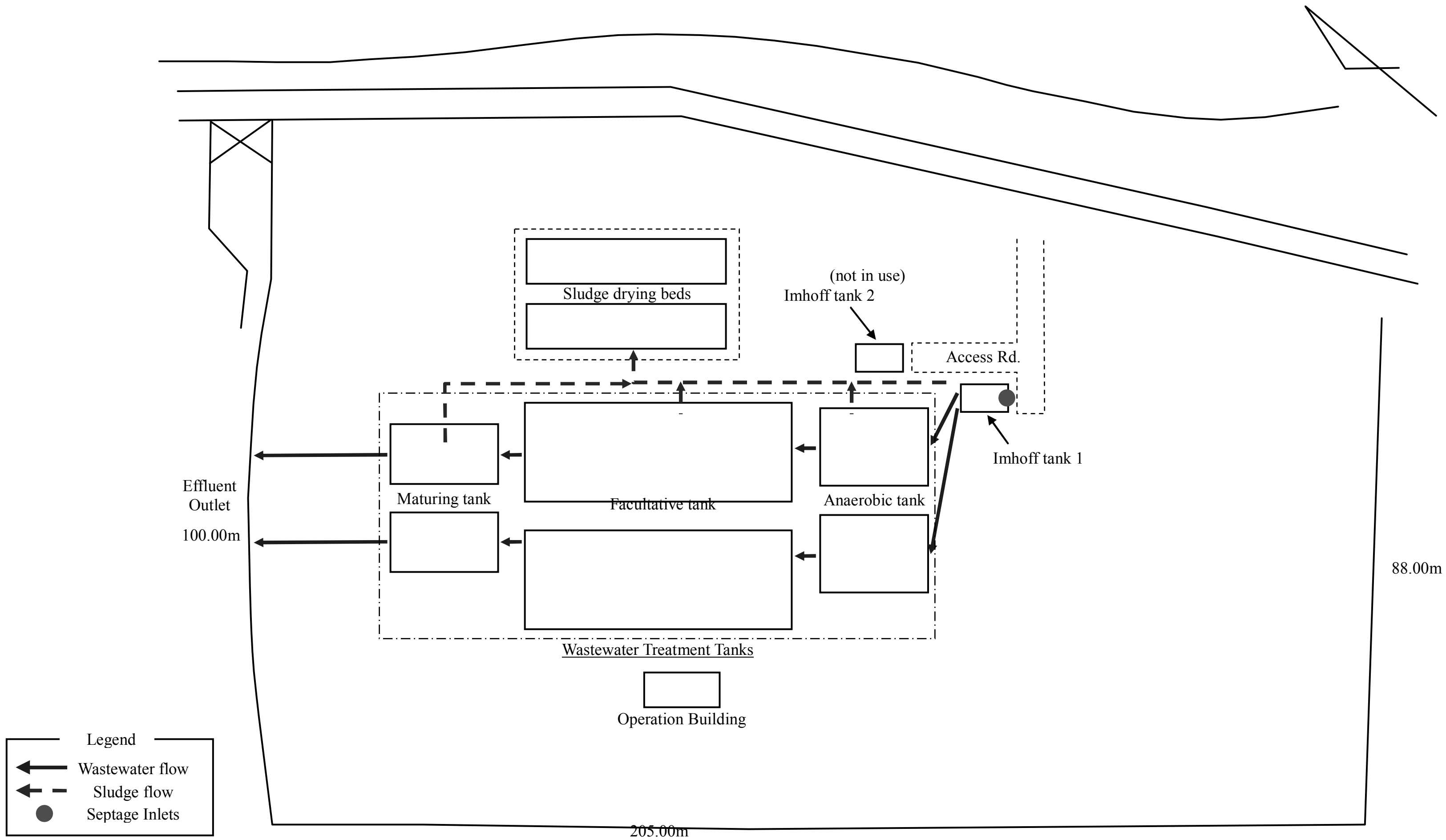
In addition to the above treatment facilities, the plant was provided with operation office. Before the disaster it is reported that DKP had operated three (3) vacuum cars and the private operators also had same numbers of the vacuum cars.

There was no data made available for septage treatment capacity of the plant. An attempt was made based on a couple of assumptions. In due consideration of climatologic condition of the Banda Aceh, a retention time is assumed to be 60 days for a proper treatment of septage, and two (2) lines are in operation at the same time. Given total storage capacity of 3,382 m^3 by two lines and retention time of 60 days, treatment capacity is assessed to be 50m^3/day.



Source: JICA Study Team

Figure 2.1 Location Map of Existing IPLT



Source: JICA Study Team (based on drawing provided by DPU)

Figure 2.2 Layout Map for Existing Septage Treatment Plant

According to DKP one of Imhoff tank remains out of operation even before disaster, mainly because of sedimentation at the bottom of the tank. According to DKP, the septage contains plastic products, garbage, soils and other material, and DKP had to engage a lot of manpower in desludging work. Outflow from the maturation tanks was discharged to the sea and dried sludge was disposed to the landfill site in the vicinity of the plant.

2.1.2 Situation after Disaster

The earthquakes and following tsunami destroyed/damaged the houses, building and other facilities including septage treatment plant, in a large part of Banda Aceh City. Especially houses and buildings in the coastal area were completely destroyed, and the area is flattened after removal of all debris by laborious efforts by the Government and international cooperation. It is supposed that all septic tanks in the area had been collapsed and/or undermined, and they are no longer usable even still remaining.

However there is continuous and urgent need of disposal of septage every days and its quantity is increasing day after day as evacuates gradually move in again to the affected area and various activities tend to back the situation before the disaster.

Appropriate collection, treatment and disposal of the septage are matter of importance and urgent. Fleet of vacuum cars has been provided through one of immediate relief program by international donors and has been active since commencement of the relief and restoration works. Since the septage treatment plant was severely damaged, collected septage are directly disposed to the sea near the mouth of the Aceh River. There is therefore urgent need of rehabilitation of the plant for conservation of aqua-ecology and securing adequate hygienic condition.

According to the initial investigation by DKP and assessment by the JICA Study Team, the plant is no longer usable under the present condition, since the main components were completely washed away/collapsed/destroyed. For instance there are a number of cracks in the anaerobic, facultative and maturation ponds, resulting in leakage of wastewater, sludge drying bed is no longer in place. In addition DKP’s three (3) vacuum cars were washed away. Photos (1) and (2) in Figure 2.3 show the present situation of the plant.

	(1) General view of the plant All main components were severely damaged to the extent that they are no longer usable without proper rehabilitation/reconstruction
	(2) Imhoff Tank I, view from outlet Outlet pipes were lost.
	(3) Part of anaerobic and facultative tanks Slope protection works (concrete slab) were cracked and broken at many places. Impervious material is exposed and supposed that might have been damaged to certain extent.
	(4) Typical septic tank
	(5) Direct disposal of septage

Figure 2.3　Present Condition of Human Excrement Treatment Plant

2.2 SOLID WASTE MANAGEMENT

2.2.1 Situation before Disaster

In Banda Aceh city, solid waste management is administered also by DKP. According to DKP, garbage, solid waste and other waste are collected all together at designated collection sites scattering in the city at appropriate intervals (normally once in 2 to 3 days) by garbage trucks of DKP, and them transported to the landfill site (called TPA: Tempat Pembuangan Akhir). They were dumped at the site and spread with adequate thickness and then covered by soil (controlled landfill).

The land fill site extends on the left bank of the Aceh River as seen in Fig. 2.1 and has the area of 12 ha. It was developed in 1995 by DPU. It was initially divided into three (3) sub-dumping sites and provided with a leachate pond almost at center of the 3 sub-areas to retain leachate. The controlled landfill was exercised by using 3 bulldozers, 6 armroll trucks, 17 dump trucks and 16 pick ups, according to DKP.

2.2.2 Situation after Disaster

DKP has suffered from serious damages, not only for structures and equipment but also for human resources.

According to DKP, out of 353 staff, 40 lives were lost. Among the equipment, 3 bulldozers, 14 dump trucks, and all armroll trucks were seriously damaged, and all pick ups were lost. Thus, immediately after disaster, DKP was unable to collect garbage and solid waste from unaffected area and still it is hardly difficult to extend adequate services to the people without help and assistance from international societies.

The landfill site was also damaged, especially in leachate pond. Disaster left in the city a great amount of debris and it is one of the important matters to remove such debris to re-build Banda Aceh and expedite the affected people to their original homeland. The landfill site has been receiving such debris in addition to the garbage and solid waste from the unaffected area continuously resulting in reduction of remaining capacity very rapidly. According to DKP, it is estimated that the remaining life of the landfill site is estimated to be only two (2) years now. (See Figure 2.4). It is absolutely necessary to develop new solid waste management practice including development of new landfill site at appropriate location.

2.3 URBAN DRAINAGE SYSTEM

2.3.1 Situation before Disaster

The urban drainage system in the city accommodates not only storm water but also effluent from the septic tanks and domestic water from houses and food services, industrial wastewater from factories, since there installed no separate sewerage system. Along the trunk roads, network of drainage conduits was extended almost over the entire city area.

The urban drainage in the city is under control of DPU. According to DPU, the existing drainage area covered the area of 35 km^2, and is divided into 3 zones and further sub-divided into 17 sub-areas. Mainly owing to topographic conditions combined with tidal effect, it is not possible to drain the entire areas in gravity flow and therefore there were pumping stations at outlet of trunk drainage channels and temporary retardation areas of the stormwater as shown in Fig. 2.5. The trunk drainage channels are connected to the Ache River and its tributaries and floodway. The principal features of drainage system before disaster was as follows.

Table 2.2 Principal Features of Drainage System before Disaster

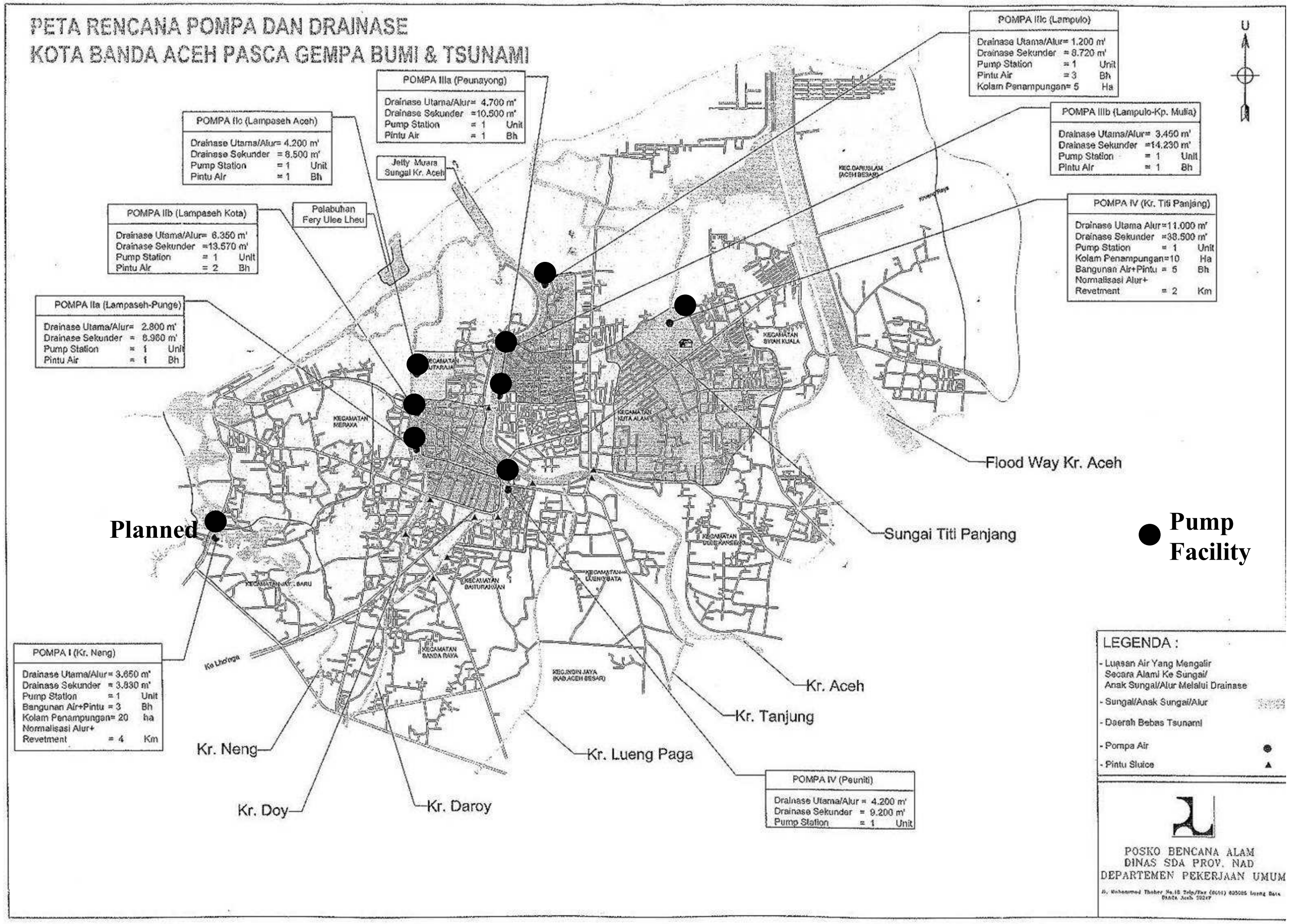
Description	Unit	Drainage Zone I	Drainage Zone II	Drainage Zone III	Total
Drainage area	ha	957	992	1,550	3,499
Nos. of sub-drain area	nos.	6	5	6	17
Nos. of pumping stations	Nos.	4	1	3	8
Length of primary drains	m	22,735	12,937	15,690	51,362
Water gates	Nos.	25	30	43	98

(Source: Master Plan for Urban Development 2004, DPU)

It is supposed that drainage conduits might have reduced its conveyance capacity owing to deposit of sediment, debris, garbage, etc. at many locations. Combined with topographic characteristics, some areas of the city are thus prone to inundation when there was heavy down pour, according to DPU.

	(1) General View of Landfill site Garbage, solid waste and wreckages are disposed disorderly.
	(2) Garbage collection trucks donated by international partner after disaster
	(3) Garbage collection with assistance by UNDP and NGOs
	(4) On-Site Separating Activity at landfill site People affected by the disaster are hired to separate recyclable materials from garbage.
	(5) Piles of separated timbers

Figure 2.4 Solid Waste Management after Disaster



Source: Dept. of Public Works (PU)

Figure 2.5 Layout Map for Existing Urban Drainage

2.3.2 Situation after Disaster

More than 90% of drainage channels were filled with mud and debris. 7 pumping stations out of 8 have been washed away according to DPU. Table 2.3 presents degree of damages on the drainage system.

Table 2.3 Damages on Drainage Structures

Structures	Description	Unit	Zone I	Zone II	Zone III	Total
Pumping stations	Existing	Nos.	4	1	3	8
	Damaged	Nos.	4	0	3	7
	Damage ratio	%	100	0	100	88
Primary drains	Existing	m	22,735	12,937	15,690	51,362
	Damaged	m	6,177	3,490	1,927	11,594
	Damage ratio	%	27	27	12	23
Water gates	Existing	Nos.	25	30	43	98
	Damaged	Nos.	15	7	8	30
	Damage ration	Nos.	60	23	19	31

(Source: DPU)

The most of drainage facilities in the area along the coast was seriously damaged and/or collapsed mainly due to tsunami. In addition dykes and flood walls along the major rivers/floodways were also washed away and/or collapsed in many locations, resulting in inundating vast lands along the rivers/floodways. It is challenge for DPU how to tackles the problem of marching rainy season in 2005, high tide and their combination. Urgent measures are indispensable not only normalization of drainage channels in residential areas but also urgent repairs of collapsed dykes/flood walls, otherwise inundation would happen over the substantial portion of the city area.

Figure 2.6 presents typical damages on various drainage structures.

	(1) Location: Primary Channel in Meuraxa Region Caption: Inundation is observed due to damaged drainage channel.
	(2) Pumping Station and gate at Titi Panjan River were washed away and seriously damaged respectively
	(3) Break of the Doy river dyke and subsequent inundation
	(4) Recovery Work for Digging Channels (Kuta Raja Region
	(5) Sedimentation in drainage conduit by debris and garbage.

Figure 2.6 Damages on Drainage Structures

CHAPTER 3 URGENT REHABILITATION AND RECONSTRUCTION PLAN FOR WASTEWATER TREATMENT AND DISPOSAL FACILITIES

3.1 INTRODUCTION

3.1.1 Mission, Strategy and Goal

Although there was no sewerage system in the city, situation of wastewater treatment and disposal is facing serious problems. There was no way to collect and treat septage from the septic tanks since vacuum cars were lost and septage treatment plant was damaged to great extent. The wastewater and night soils in refugee camps have been accumulated. There was fear of outbreak of waterborne deceases and deterioration of living environment even in the areas unaffected by disaster.

In order to cope with such situation, a number of vacuum cars were provided by donors and it was committed by the Government of Japan to rehabilitate the damaged septage treatment plan as one of urgent measures.

The wastewater treatment and disposal in Banda Aceh city in future will be planned and implemented along with urban development plan which is being discussed in the other chapter of the report. Mission, goal and strategies of the wastewater treatment and disposal will be, but not limited to the following;

Table 3.1 Mission, Strategy and Goals for Urgent Rehabilitation and Reconstruction Plan for Wastewater Treatment and Disposal Facilities

Mission	To secure health of whole population of 254,000 from waterborne deceases To create attractive and hygienic urban environment To improve aqua-ecology in open water within city
Strategies	To guide people to adopt improved type of septic tank To apply technically and financially feasible and sustainable technology To properly treat the whole volume of septage to be generated by 2009 to reduce pollution loads to the sea and open water within the city To strength DKP so that all population receives equitable services
Goals	To restore existing septage treatment plant within year 2005 To reinforce septage collection and treatment capacity up to the year 2007 To develop sewerage system at adequate time

3.1.2 Planning Criteria

The total population of the city is forecasted at 254,000 in 2009 and is distributed over 9 Kecamatan as also predicted by the city master plan. These essentials are reported in section of Urban Development in details.

In accordance with the strategies and goals of the wastewater treatment and disposal, the planning criteria are set forth as follows:

(1) Planning criteria before introduction of sewerage system

Wastewater treatment method	:	On-site treatment only
Population load in septage treatment plant in 2009	:	254,000
Average size of family	:	5 persons
Numbers of household in 2009	:	50,800
Assumed value of BOD 5 of septage	:	2,000 mg/l for raw, less than 50 mg/l for treated wastewater
Assumed value of COD	:	6,000mg/l for raw, less than 100mg/l for treated wastewater
Suspended solid	:	Less than 200 mg/l for treated wastewater
Assumed type of on-site treatment facility	:	Septic tank, 1.0m in dia., 1.2 m in depth
Frequency of desludging	:	Once a year
Septage from industry and others	:	15% of the domestic septage

(2) Planning criteria after installation of sewerage system

Wastewater treatment method	:	Combination of sewerage and on-site treatment
Kecamatan to be connected to sewerage	:	Bitrraham and Kuta Alam
Total population in sewer planned area	:	35,900
Planned sewer connection ratio	:	100 %
Assumed per capita wastewater generation	:	150 l/day/capita
Assumed rate of wastewater from commercial activity	:	30 % of domestic wastewater
Assumed value of BOD_5	:	200 mg/l for raw wastewater, less than 50 mg/l for treated wastewater
Assumed COD	:	200 mg/l for raw wastewater, less than 100mg/l for treated wastewater
Suspended solid	:	200 mg/l for raw wastewater, less than 200 mg/l for treated wastewater

The qualities of wastewater was set forth making reference to the Standards of BAPEDALDA (Regional Environmental Impact Management Agency).

3.2 PRELIMINARY DESIGN OF SEPTAGE TREATMENT FACILITIES AND SEWERAGE SYSTEM

3.2.1 Quantity of Septage

The septage generation in Banda Aceh City is estimated as given in Table 3.2, based on the above planning criteria.

Table 3.2 Septage Generation

	Description	Unit	Quantity/Value
1	Population	Nos.	254,000
2	Assumed number of households	houses	50,800
3	Volume of septage	m^3	0.9m3
	Septage generation from households	m^3	45,720
	Septage from industry and other	m^3	6,860
	Total septage per year	m^3	52,580
	Total septage per day	m^3	144

(Source: The JICA Study Team)

By the year 2009, total volume of septage is estimated to amount to 52,580m^3/year assuming that there are no sewerage system and sludge extraction from septic tank takes place once a year. This volume is equivalent to 144$m^{3/}$day.

There exists IPLT having septage treatment capacity of 50m^3/day as reported in Section 2.1 of this report, and its rehabilitation is expected to be completed within 2005. Accordingly it is necessary to construct additional septage treatment facilities with a daily treatment capacity of 94m^3/day.

3.2.2 Urgent Rehabilitation of Existing Septage Treatment

As noted in this report existing septage treatment plant (IPLT) with estimated treatment capacity of 50 m3/day has already in the process of rehabilitation at the time of preparation of this report with a grant aid assistance of the Government of Japan.

3.2.3 Preliminary Design of Additional Septage Facilities

The septage treatment facilities which were already proposed by UNCEF are determined to be adopted. It is composed of two (2) lines of treatment, each line consisting of grit chamber, bio-digester, sludge stabilization and stripping unit, anaerobic baffled reactor, anaerobic filter, maturation pond, sludge drying bed, etc. Layout design of the plant is as shown in Fig. 3.1.

It is deemed that this type of treatment facilities is relatively easy in operation and not much expensive in terms of initial cost. It is however required to train the DKP's operating staff.

Salient features of the facilities are as follows.

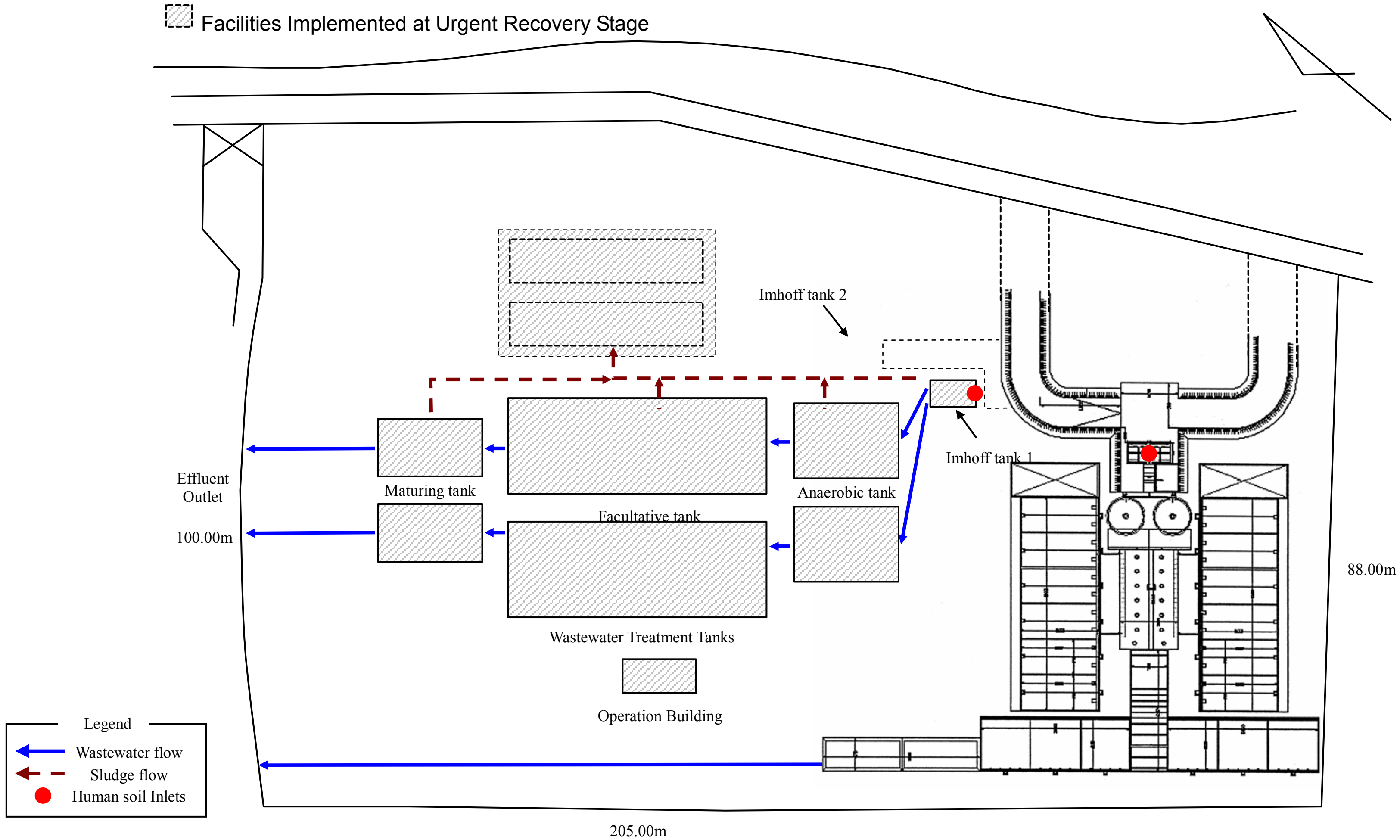
Table 3.3 Principal Features Additional Septage Treatment Plant

Structures	Nos.	Dimensions of Respective Structure (m)		
		Width	Length	Depth
Receiving area	1	4.5	9.0	1.1
Grease and Grit chamber	1	2.5	5.0	1.7
Bio-digester (circular shape	2	7.0 (dia)		
Sludge stabilization and stripping unit	2	6.0	21.0	2.9
Anaerobic baffled reactor, anaerobic filter	1	7.6	25.0	3.4
Sludge drying bed	12	7.0	15.0	1.5
Tunnel dryer	2	7.0	16.0	1.0
Horizontal gravel filter	2	12.0	30.6	1.0
Maturation pond	2	6.8	30.5	1.2

Source: UNICEF

Dried sludge is possible to be used as compost for agricultural and gardening purpose, if it is not containing harmful materials. It is necessary to conduct laboratory test to confirm its quality.

It is estimated that total amount of pollution loads is 308 kg/day in terms of BOD_5 without septage treatment. With the rehabilitation and construction of additional facilities this quantity is estimated to be reduced to 77kg/day, resulting in greatly to aqua-ecology of the rivers and sea.



Source: UNICEF Proposal

Figure 3.1 Layout Plan of Additional Septage Treatment Plant

3.2.4 Septage Collection and Transportation

As same as the present septage will be collected from septic tanks and transported directly to the septage treatment plants by vacuum cars. Based on the planning criteria and a couple of assumptions the required numbers of vacuum car are estimated as given in Table 3.4.

Table 3.4 Estimate of Vacuum Cars

Description	Unit	Quantities	Notes
Quantity of septage to be collected	m3/day	175	300 working days in a year
Assumed working hour	Hrs/day	8.0	
Assumed loading capacity of vacuum cars	m3/car	3	
Assumed numbers of trip of vacuum car	trip/day	3	
Required numbers of vacuum car	units	20	Without stand-by

Source: JICA Study Team

3.3 PRELIMINARY DESIGN OF SEWERAGE SYSTEM

3.3.1 Quantity of Wastewater

The sewerage system is proposed to be extended over the central business district of the Banda Aceh City. According to the population distribution plan and planning criteria, rate of domestic wastewater is estimated as follows.

Table 3.5 Quantity of Domestic Wastewater

Sewered Area		Population in 2009	Connection ratio	Connected population	Wastewater generation per capita (l/day/capita)	Quantity of wastewater (m3/day)
Kecamatan	Desa					
Baiturrahman	Sukaramai	4,753	100	4,753	150	713
	Neusu Jaya	3,616	100	3,616	150	542
	Peniti	7,901	100	7,901	150	1,185
	Kampong Baro	2,720	100	2,720	150	408
Kuta Alam	Peunayong	2,919	100	2,919	150	438
	Laksana	6,729	100	6,729	150	1,009
	Keuramat	6,258	100	6,258	150	938
	Mulia	3,386	30	1,016	150	152
Total		38,282		35,912		5,385

Source: JICA Study Team

As set forth in the planning criteria, the wastewater generation from commercial entities is assumed to be 30 % of the domestic wastewater. Its amount is therefore estimated at 1,615m^3/day. The total quantity is 7,000m^3/day in terms of dry weather flow. Further rate of infiltration and rainwater is assumed to be 20 % of the total wastewater, resulting in 1,400m^3/day. Thus design daily mean wastewater is assessed at 8,400m$^{3/}$day.

Daily maximum and hourly maximum will be 9,250 and 12,600m^3/day respectively, assuming daily max and hourly max factors at 1.25 and 1.50 respectively.

3.3.2 Preliminary Design of Sewerage System

The sewerage system is preliminarily designed as described below.

(1) Sewers

Sewer system will be separated from the storm water drainage system, and designed in gravity flow as much as possible. Alignment of sewer network is based on the existing City Development Plan and is seen in Fig. 1.1.

(2) Wastewater treatment plant

Wastewater treatment plant will be located in the vicinity of existing septage treatment plant. The selected wastewater treatment process is of Oxidation Ditch type. This type of treatment process is still widely used in many countries. Construction cost and annual operation and maintenance cost are considered to be lower than other types of treatment process. It is also considered that the DKP's technical staff would easily familiarize operation and maintenance practice.

The plant is provided with sludge thickener, dehydrator, composting yard for proper treatment of sludge deriving from process of wastewater treatment. It is expected that compost would be old to the farmers for agricultural purposes. The preliminary design and principal features of wastewater treatment plant area are shown in Fig. 3.2 and Table 3.6.

Table 3.6 Outline of Sewerage System

	Components	Nos. of Unit	Width (m)	Length (m)	Depth (m)	Capacity (m3/sec)	Note:
Sewer	Trunk line		Dia. 0.2	3,500	-	-	Pressure flow
	Lateral lines		Dia. 0.2	52,400	-	-	Gravity flow
	Booster pump station	1	-	-	-	0.18	On trunk line
Wastewater treatment plant	Grit Chamber	2	1.0	5.0	0.5	-	
	Oxidation ditch	6	8.0	60.0	2.9	-	
	Final sedimentation tank	3	Dia.21.5	-	3.0		
	Chlorine mixing chamber	1	6.0	50.0	1.2	-	
	Sludge thickener	3	Dia.4.0	-	3.0		
	Sludge dehydrator	3	-	-	-	-	
	Composting yard	1	-	-	-	-	

Source: JICA Study Team

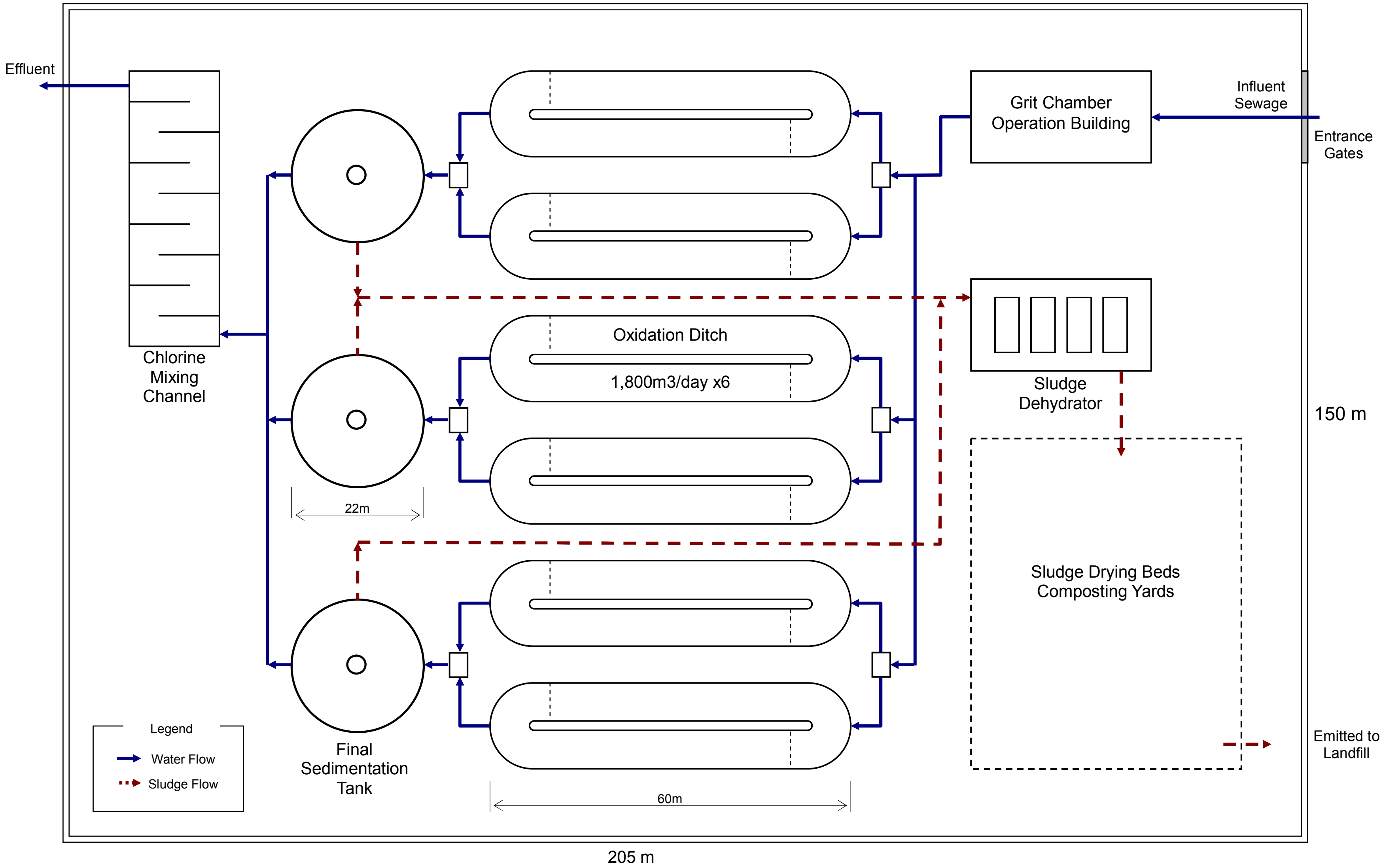
3.4 PRELIMINARY PROJECT COST ESTIMATE

The project cost for sewerage system development is estimated preliminarily based on actual costs of similar types of the project and at price level of mid 2005 and is shown in Table 3.7.

Preliminary project cost for the urgent rehabilitation and reconstruction works proposed in this study is estimated based on the following conditions and assumptions, however, these are subject to change due to finalization on the Indonesian authorities.

Conditions and Assumptions for Preliminary Cost Estimate

(1) Physical contingency and price escalation are assumed to be 10% each of the direct construction cost.
(2) Engineering services is assumed to be 10% of the direct construction cost for detailed study & design and construction supervision.
(3) If project is purely program type and/or procurement, only price contingency is considered.
(4) VAT is included in the cost, however, import duties are not included in the cost.
(5) Land acquisition and compensation costs are not included in the Project cost duet to difficulty of estimation at this time.



Source: JICA Study Team

Figure 3.2 Layout Plan of Wastewater Treatment Plan

Table 3.7 Preliminary Cost Estimate for Wastewater Treatment and Disposal

Works	Cost Items	Description	Amount (Rp. million)
Rehabilitation of Existing Septage Plant	Direct Construction cost	Cleansing works	1,753
		Rehabilitation of plant	2,393
		Access road	1,989
	Physical contingency		614
	Price escalation		614
	Engineering services		614
		Sub-total	7,977
Additional Septage Treatment Plant	Direct construction cost	Main component	3,528
		Pipe works	202
		Miscellaneous	1,608
	Physical contingency		534
	Price escalation		534
	Engineering services		534
		Sub-total	6,940
Procurement of Vacuum Cars	Procurement cost		4,600
	Price escalation		460
		Sub-total	5,060
Sewerage Development	Direct construction cost	Primary sewers	5,250
		Lateral sewers	7,860
		Preparatory works	705
		Wastewater treatment plant	109,140
		Booster pumping station	13,000
	Physical contingency		13,595
	Price escalation		13,595
	Engineering services		13,595
		Sub-total	176,740
Total			196,717

Source: JICA Study Team

As explained in Section 3.5 of this report, the sewerage development is proposed to be deferred beyond 2009. Accordingly the required investment in the sector amounts to Rp. 19,977 only. Further it is most probable that there exist and/or would be a number of assistance by donors and NGOs in this sector. Such assistance is not taken into consideration in the above-estimate.

3.5 TENTATIVE IMPLEMENTATION PLAN

The implementation plan takes into account the goals of the sector and based on the following assumption:

(1) The urgent rehabilitation work of existing septage treatment work will be completed within 2005.

(2) Additional septage treatment work shall be commissioned into service by 2007, as existing plant is already over-loaded.

(3) The development sewerage system is set after 2009.

Fig. 3.3 shows implementation schedule of the wastewater treatment disposal sector.

Source: JICA Study Team

Figure 3.3 Implementation Schedule of Wastewater Treatment and Disposal Sector

As aforesaid the City Master Plan (2001-2010) includes development of sewerage system in the central part of the city, but there is no master plan how sewerage system would be expanded in a long-term. The proposed plan just covers only about 12 % of the whole population in 2009 and requires a huge amount of initial cost and annual operation and maintenance cost. It is deemed that such small scale sewerage system development would cause overburden to financial situation of DKP, and also willingness and financial capability of beneficiaries are not clear enough. It is therefore advisable to defer the implementation of sewerage system project after 2009 and establishment of the master plan.

The procurement of vacuums cars is planned to be made over a-3yeat period, in due consideration of increase of septage generation and minimization of financial burden on DKP. Construction of additional plant will have to be commissioned into service by 2008.

3.6 ANNUAL FUND REQUIREMENT

The annual fund requirement during the planning horizon is estimated as shown in Table 3.6.1. based on the project implementation schedule.

Table 3.8 Annual Fund Requirement in Wastewater and Disposal Sector

(Unit Rp, million)

Components	2005	2006	2007	2008	2009
Rehabilitation of existing septage plant	7,977	-	-	-	-
Additional septage treatment plant	-	2,776	4,164	-	-
Procurement of Vacuum cars	-	1,686	1,687	1,687	-
Total	7,977	4,462	5,851	1,687	-

Source: JICA Study Team

CHAPTER 4 URGENT REHABILITATION AND RECONSTRUCTION PLAN FOR SOLID WASTE MANAGEMENT

4.1 INTRODUCTION

4.1.1 Mission, Strategy and Goal

As reported the existing landfill site has a residual life of only 2 years because of dumping of great amount of debris from the devastated areas. It is urgent need to develop new landfill site to accommodate garbage and solid waste to be generated from the city in future.

Paying attention to the present situation, missions, strategies and goals of solid waste management are set forth as follows.

Table 4.1 Mission, Strategy and Goals for Urgent Rehabilitation and Reconstruction Plan for Solid Waste Management

Mission	To create clean urban environment To minimize generation of solid waste and garbage
Strategies	To introduce separation and recycling of solid waste with education and cooperation of people To strength DPPK so that all population receives equitable services
Goals	To develop promptly as possible new landfill site before 2009 To reinforce garbage collection vehicle and landfill equipment

4.1.2 Planning Criteria

In accordance with the strategies and goals of the wastewater treatment and disposal, the planning criteria are set forth as follows:

(1) General criteria

Planning criteria	:	Rehabilitation; 2006, Reconstruction; 2009
Target year	:	Banda Aceh City with administrative area of 61 km2
Population in 2009	:	254,000 as projected under this study
Population distribution	:	As per studied as a part of urban development plan of this study
Urban development	:	As per spatial and urban development plans of this study

(2) Criteria for landfill site planning

Garbage generation by domestic	:	2.5 l/day/household
Garbage generation from others	:	40% of the domestic

Useful life of landfill site : 20 years for new development

4.2 PRELIMINARY DESIGN OF LANDFILL SITE

4.2.1 Estimate of Garbage and Solid waste

Based on the planning criteria annual volume of garbage and solid waste is estimated as shown in Table 4.2. The quantity of garbage and solid waste generation is estimated at 64,970m^3/year.

Table 4.2 Estimate of Quantity of Garbage and Solid Waste

Description	Details	Unit	Amount
Fundamentals	Population in 2009	people	254,000
	Average family size	People/household	5.0
	Nos. of household	households	50,800
Domestic garbage	Unit production rate	l/day/household	2.5
	Domestic garbage generation	m3/day	127
Industrial solid waste	Assumed rate	40% of garbage	51
Total of garbage and solid waste		m3/day	178
		m3/year	64,970

Source: JICA Study Team

4.2.2 Preliminary Design of New Landfill Sites

According to DKP it is most desirous to design the new landfill site with a life capacity of 20 years. The total dumping volume is estimated at approximately 1.3 million m^3 for 20 years. Assuming average filling thickness of 5m, approximately 25 ha of land are required. As the same as existing landfill site, leachate pond will have to be provided to properly treat the water derived from the dumped materials. Such land can be identified in the vicinity of existing landfill site.

4.2.3 Required Numbers of Collection and Disposal Vehicles

Collection and disposal of garbage will be done by a combination of packer vans and dump truck. The industrial waste will be collected by dump trucks and domestic garbage by packer ban. Required numbers of dump truck (8 m^3) and packer van (2m^3) will be 5 and 25 respectively, including stand-by. Details of estimate are as given in Table 4.3.

Table 4.3 Estimate of Garbage Collection and Transportation Vehicles

Description	Details	Unit	Quantity
Quantity of garbage		m3/year	64,970
Assumed working days		Days/year	300
Quantity to be collected	Domestic garbage	m3/day	155
	Industrial waste	m3/day	62
	Total	m3/day	217
Capacity	Dump truck	m3	8.0
	Packer van	m3	2.0
Assumed numbers of trip between city area and dumping site	Dump truck	Nos./day	6
	Packer van	Nos./day	6
Required number of vehicle	Dump truck	Nos.	15
	Packer van	Nos.	3

Source: JICA Study Team

The required number of packer vans and dump trucks include stand-by.

4.3 PRELIMINARY PROJECT COST ESTIMATE

The construction cost of new landfill site and procurement cost of garbage collection and disposal vehicles are estimated as presented in Table 4.4 based actual costs of similar types of the project and at price level of mid 2005. Preliminary project cost for the urgent rehabilitation and reconstruction works proposed in this study is estimated based on the following conditions and assumptions, however, these are subject to change due to finalization on the Indonesian authorities.

Conditions and Assumptions for Preliminary Cost Estimate

(1) Physical contingency and price escalation are assumed to be 10% each of the direct construction cost.
(2) Engineering services is assumed to be 10% of the direct construction cost for detailed study & design and construction supervision.
(3) If project is purely program type and/or procurement, only price contingency is considered.
(4) VAT is included in the cost, however, import duties are not included in the cost.
(5) Land acquisition and compensation costs are not included in the Project cost duet to difficulty of estimation at this time.

Table 4.4 Cost Estimate for Solid Waste Management

Works	Cost Items	Description	Amount (Rp, million)
Landfill site	Direct construction cost	Construction of landfill site	158,376
		Leachate	484
	Physical contingency		15,886
	Price escalation		15,886
	Engineering services		15,886
		Sub-total	206,518
Collection and transportation vehicles	Procurement cost	Pucker van	1,575
		Dump truck	1,125
	Price escalation		270
		Sub-total	2,970
Total			209,488

Source: JICA Study Team

4.4 TENTATIVE IMPLEMENTATION PLAN

In view of the residual life of existing landfill site, it is proposed that the new landfill site is strongly required to be completed by 2007 or operational from 2008. The implementation period would extend over a period of two (2) years. The procurement of packer vans and dump truck is assumed to extend over a period of three years from 2006 to 2008 in due consideration of construction schedule of new landfill sites and increase of garbage and solid waste.

The landfill method requires a huge extent of valuable land and/or space. In order to create better urban environment and conserve land resource around coastal area, it will be necessary to reduce the quantity of garbage and industrial waste. With gradual increase of institutional capacity of DKP, DKP is advised to move an introduction of selective and recycle/re-use system of garbage and solid waste by means of acquaint with citizen importance of recycle and re-use system for conservation of land and natural resources.

4.5 ANNUAL FUND REQUIREMENT

The annual fund requirement is estimated on the basis of the implementation schedule and estimated project cost and is as shown in Table 4.5.

Table 4.5 Annual Fund Requirement for Solid Waste Management

(Unit Rp, million)

Components	2005	2006	2007	2008	2009
New Landfill Site	-	103,259	103,259	-	-
Pucker vans and Dump truck	-	990	990	990	-
Total	-	104,249	104,249	990	-

Source: JICA Study Team

CHAPTER 5 URGENT REHABILITATION AND RECONSTRUCTION PLAN FOR URBAN DRAINAGE

5.1 INTRODUCTION

5.1.1 Missions, Strategies and Goals

As noted in Chapter 2 of this report, substantial portion of existing drainage facilities were damaged completely. In addition, dykes and floodwalls along main rivers/ floodway were broken out and/or washed away at many locations and in length. It is very serious matter how quickly such damaged/washed out/destroyed facilities could be restored in order to save people and properties against coming rainy season and high tide. In addition urban drainage system will be required to be re-organized in conformity with a new rod network and urban development plan.

Table 5.1 Mission, Strategy and Goals for Urgent Rehabilitation and Reconstruction Plan for Urban Drainage

Mission	To ensure safety of human lives and properties To contribute to enhancement of economic development activities without any interruption even during high tide and rainy season To complete systematic urban drainage network over the entire city area
Strategies	To minimize habitual inundation areas with reinforcement of drainage facilities To layout drainage network in conjunction with urban road development plan To remove sediment, debris and garbage deposits in conduits To reinforce O& M capability of DPU
Goals	To reinstall systematic drainage in devastated area by 2009 To reinstall and reinforce drainage pump stations by 2009 To rehabilitate broken and destroyed dyke and flood wall urgently

5.1.2 Planning Criteria

For the sector under consideration, existing design criteria are widely deployed. It is however deemed necessary to conduct in-depth study before realization of actual rehabilitation and reconstruction works.

(1) General criteria

Target year	:	Rehabilitation; 2006, Reconstruction; 2009
Target area	:	Banda Aceh City with administrative area of 61 km2
Population in 2009	:	254,000 as projected under this study
Population distribution	:	As per studied as a part of urban development plan of this study
Urban development	:	As per spatial and urban development plans of this study

(2) Criteria for drainage system design

Design storm rainfall	:	165 mm with a return period of 5 years
Runoff calculation	:	Rational formula
Runoff coefficient	:	Variable, characterized by drainage area
Drainage conduit	:	Rectangular shape

5.2 PRELIMINARY DESIGN OF URBAN DRAIANGE SYSTEM

5.2.1 Delineation of Drainage Zones

The urban drainage development plan is basically followed to the master plan established by DPU, which was prepared before disaster but it is judged that this master plan still adaptable with slight modification to newly proposed urban plan under the current study.

In principle, the whole city area is divided into three (3) zones, the same as existing, but characterized by the new urban development plan. Four (4) sub-drainage areas are proposed to be newly created. The proposed new drainage areas are as shown in Fig. 5.1.

5.2.2 Storm Run-off

Given the catchments area of each sub-drainage area and planning criteria, storm run-off is calculated for the respective primary drains as shown in Table 5.2. In calculation, run-off coefficient is derived from that used by DPU in their master plan.

5.2.3 Assessment of Discharge Capacity of Existing Drains and Pumping Stations

The discharge capacity of existing primary drains and pumping stations was calculated under conditions before disaster and based on features of drains and pumping facilities which were made available from DPU. The resultants were compared to the storm run-off calculated so that improvement needs are clarified quantitatively. This comparison is presented in Table 5.2.

Table 5.2 Capacities of Existing Drainage Facilities vs. Run-off

Sub-drainage areas	Name	Drain to:	Run-off (m3/s)	Discharge Capacity of Drain (m3/s)	Pumping Capacity (m3/s)
1.3	P.1	Aceh R.	1.205	1.082	0.245
1.2	P.2	Aceh R.	0.268	0.470	0.200
1.1	P.3	Aceh R.	1.254	0.357	0.270
11.1	P.4	Daroy R.	1.480	1.099	0.745
13.5	P.5	Doy R.	0.539	0.51	0.824
13.1	P.6	Doy R.	2.628	0.512	0.225
13.6	P.7	Doy R.	2.552	4.022	0.200
3	P.8	Titi Panjan	11.080	0.686	0.225
1	P.9	Aceh R.	-	-	-
14	P.10	Neng R.	-	-	-

Source: JICA Study Team

It is revealed that of the existing 8 pumping stations, 7 stations have less capacity than the required drainage quantity. Also it is assessed that existing drains are not capable of conveying storm run-off. Thus excess water stagnates at many locations resulting in disturbing traffic flow, inundation of properties ad hampering daily life of people.

5.2.4 Preliminary Design of Drainage System

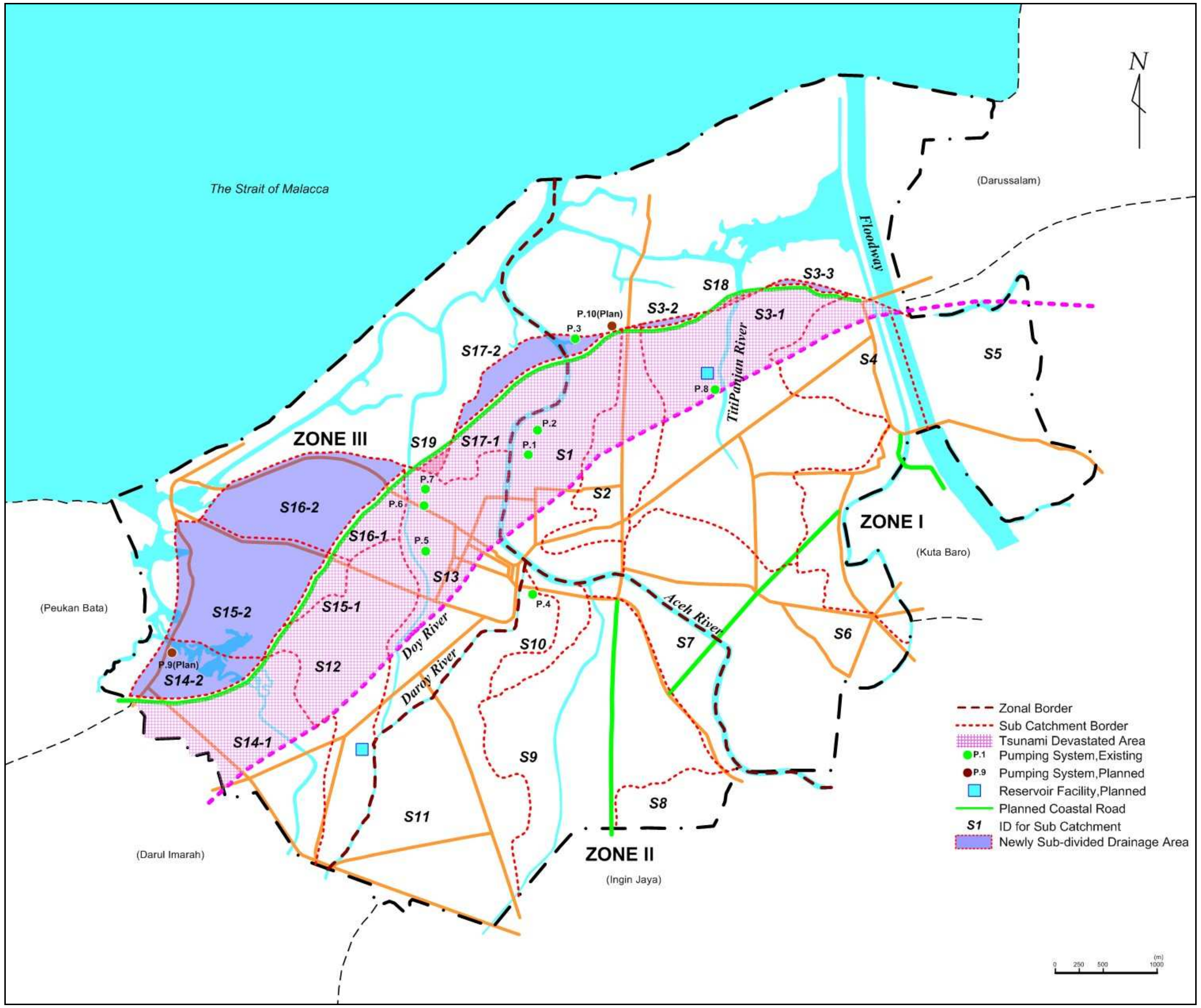
In view of geographical situation and as already planned by DPU before disaster, it is considered rational to plan drainage system with a combination of drainage conduits, pumping station and retardation ponds. Proposed layout of drainage plan is as shown in Fig. 5.2 and proposed rehabilitation and reconstruction plan is presented in Table 5.3.

(1) Primary drains

The total length of primary drains extends over a distance of 51,362m of which 11,595m were damaged and/or destroyed. They will all be rehabilitated and/or reconstructed. In addition new primary drains will be installed in Zones I and III: 2,360m in Zone I and 5,748m in Zone III. New drains will be in trapezoidal section and lined with masonry as is most typically seen in the city.

(2) Pumping stations

8 pumping station will be reconstructed, of which 7 pumping station will have more discharge capacity than the original.



Source: JICA Study Team

Figure 5.1 Drainage Areas

(3) Retarding ponds

Two retarding ponds will be required to be newly created to absorb excess run-off. One will be located in Zone I with a storage capacity of 54,000m^3 and the other in Zone III with a storage capacity of 75,000m^3.

5.3 PRELIMINARY PROJECT COST ESTIMATE

The rehabilitation and reconstruction cost was estimated on a basis of data and information made available from DPU. Preliminary project cost for the urgent rehabilitation and reconstruction works proposed in this study is estimated based on the following conditions and assumptions, however, these are subject to change due to finalization on the Indonesian authorities.

Conditions and Assumptions for Preliminary Cost Estimate

(1) Physical contingency and price escalation are assumed to be 10% each of the direct construction cost.
(2) Engineering services is assumed to be 10% of the direct construction cost for detailed study & design and construction supervision.
(3) If project is purely program type and/or procurement, only price contingency is considered.
(4) VAT is included in the cost, however, import duties are not included in the cost.
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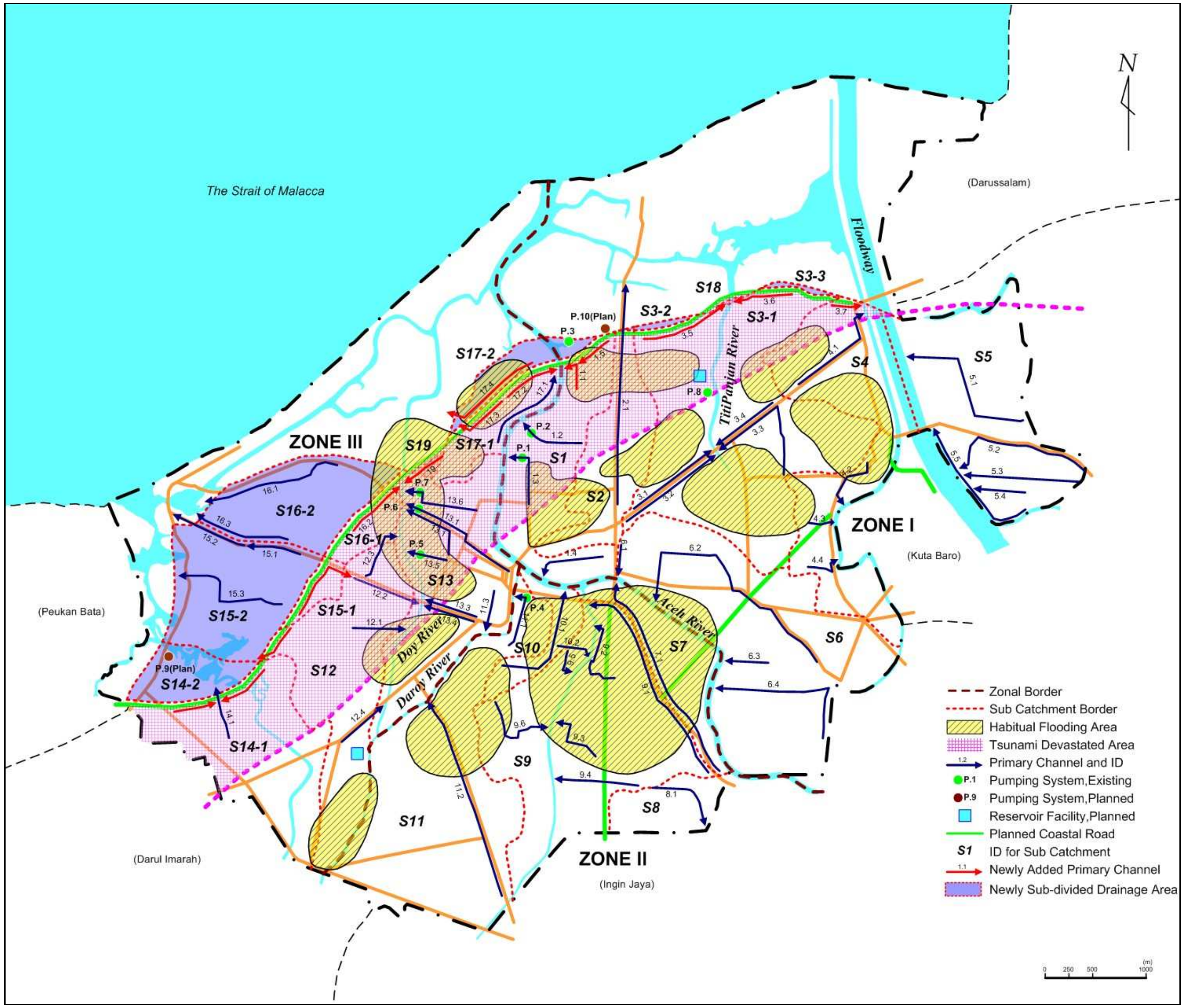

Source: JICA Study Team

Figure 5.2 Outline of Rehabilitation and Reconstruction Plan for Urban Drainage

Also the project cost is estimated for each of implementation packages which are determined in accordance with in order of priority for implementation as described in the succeeding section 5.4. The estimated project cost is shown in Table 5.3.

Table 5.3 Preliminary Cost Estimate for Rehabilitation and Reconstruction of Drainage System

Category	Cost Items	Works	Amount (Rp, million)
Urgent Recover (Priority 1 and 2)	Direct construction cost	Pumping facilities	83,070
		Primary drains	2,693
		Water gates	140
		Retardation ponds	14,310
	Physical contingency		10,021
	Price escalation		10,021
	Engineering services		10,021
		Sub-total	130,276
Rehabilitation (Priority 3 and 4)	Direct construction cost	Pumping facilities	36,050
		Primary drains	1,870
		Water gates	80
	Physical contingency		3,800
	Price escalation		3,800
	Engineering services		3,800
		Sub-total	49,400
Reconstruction (Priority 5)	Direct construction cost	Pump facilities	96,780
		Primary drains	17,450
		Water gates	80
		Retardation pond	22,590
	Physical contingency		13,690
	Price escalation		13,690
	Engineering services		13,690
		Sub-total	177,970
Rehabilitation and reconstruction of dykes and floodwall along major rivers			95,000
Total			452,646

Source: JICA Study Team

The cost for rehabilitation and reconstruction of dykes and flood wall is based on Concept Note submitted by the Embassy of Japan to BRR.

5.4 TENTAIVE IMPLEMENTATION PLAN

As noted in the above rehabilitation of drainage system is matter of urgency because of marching rainy season and high tide. There is however many so many works need to be undertaken. It is therefore considered to execute such works in order of priority as follows:

Priority 1 : Urgent recovery of drainage pump stations Nos. 1, 8, 4, 6 and primary drains for a length of 766m (Drain IDs 1.3, 11.1)

Priority 2 : Normalization of primary drains of approximately 4,620 m (Drain IDs 2.1, 4.1-2, 6.2, 7.1, 9.1-3, 9.5-6, 11.2, 12.1-3)

Priority 3 : Rehabilitation of pumping stations Nos. 2, 3. 5 and 7 and rehabilitation of primary drains for a length of 1,896m (Drain IDs 1.1-2, 13.5-6)

Priority 4 : Rehabilitation of primary drains for a length of 3,691m (Drain IDs 4.1.1, 4.3-4, 6.1, 6.3-4, 8.1)

Priority 5 : Reconstruction of primary drain for a length of 622m (Drain IDs 17.1-4, 19) and new drains for a length of 8,108m (Drain IDs 1.1, 1.5, 3.5-3.7, 12.5, 14.1-3, 15.1-4, 16.1-2, 17.1-4, 19)

The implementation schedule of the rehabilitation and reconstruction plan is set up as shown in Figure 5.3 taking into account of the above priority.

Source: JICA Study Team

Figure 5.3 Tentative Implementation Schedule for Urban Drainage Sector

In addition to the above, it is urgently required to implement the rehabilitation and reconstruction works of dykes and floodwalls of the major rivers/floodway in order to prevent inundation of the city land due to flow of river flow through destroyed/broken portion during coming rainy season. Fortunately it is reported that such urgent rehabilitation/reconstruction works has been committed to be executed by the Government of Japan at the time of preparation of this report and are scheduled to complete within a year.

5.5 ANNUAL FUND REQUIREMENT

The annual fund requirement is estimated based on the project cost estimate and implementation schedule as shown below:

Table 5.4 Annual Fund Requirement for Drainage System

(Unit Rp, million)

Components	2005	2006	2007	2008	2009
Urgent Recovery (Priority 1 and 2)	32,569	65,138	32,569	-	-
Rehabilitation Works (Priority 3 and 4)	-	14,820	34,580	-	-
Reconstruction (Priority 5)			35,594	71,188	71,188
Rehabilitation and reconstruction of dykes and floodwall along major rivers/floodway	28,500	66,500			
Total	61,069	146,458	102,743	71,188	71,188

Source: JICA Study Team