4.9.5 Warning and Dissemination System

Phased development of warning and dissemination systems provides the earliest warning to citizens and more accurate information on the magnitude of disaster.

(1) Short-term Plan

a) Seismometer : A warning message is automatically disseminated by the warning center for any earthquake having a magnitude of 6.0 or larger on the Richter scale and the possibility if a tsunami can be generated. Notification of government agencies begins, followed by public announcements by the local media. At this time the public is informed of the ensuring danger by the emergency broadcast system. Evacuation procedures are implemented, and sea going vessels are advised to head out to sea, where in deep waters they will not be affected by the tsunami.

b) Warning siren : As soon as the public announcement issued, the warning sirens, which covers the area of the City of Banda Aceh with a radius of 1 km per siren, disseminate the warning to public.

c) Mobile phone : Mobile phones are in common use in the City of Banda Aceh. As soon as the warning center send a warning message to individuals who are registered in the mailing system maintained by the warning center.

(2) Medium-term Plan

a) Tsunami Watch : Reports on wave activity from the worldwide tide-gauging stations nearest to the earthquake epicenter is requested by the warning center. If the stations report that there is no observed tsunami activity, the Tsunami Watch is canceled. If these stations report that a tsunami has been generated, inspectors stationed at a ferry terminal and the operation room of tidal gate continues “Tsunami Watch” and tsunami warning is issued to the public at the same time for areas that may be impacted in the next hour.

(3) Long-term Plan

a) GPS system : Measurement apparatus for real-time tsunami observation equipped with GPS censor located at a distance of about 20 km offshore is installed (Figure 4.9.28). As soon as sudden and large changes of sea level are recorded by the censor through Ground Positioning System (GPS), the information is sent to warning center about 10 minutes ahead tsunami propagation to shoreline. Lag time of 10 minutes is so valuable for mitigating tsunami disaster that people enables to ran away through escape

road or to go up the stairs of escape building/tower.

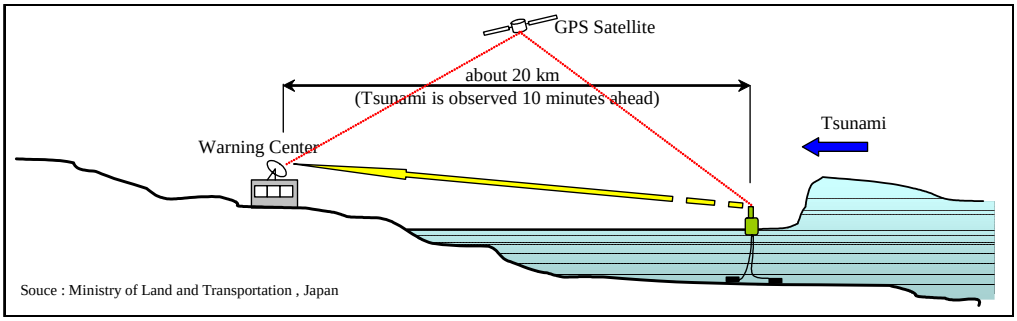


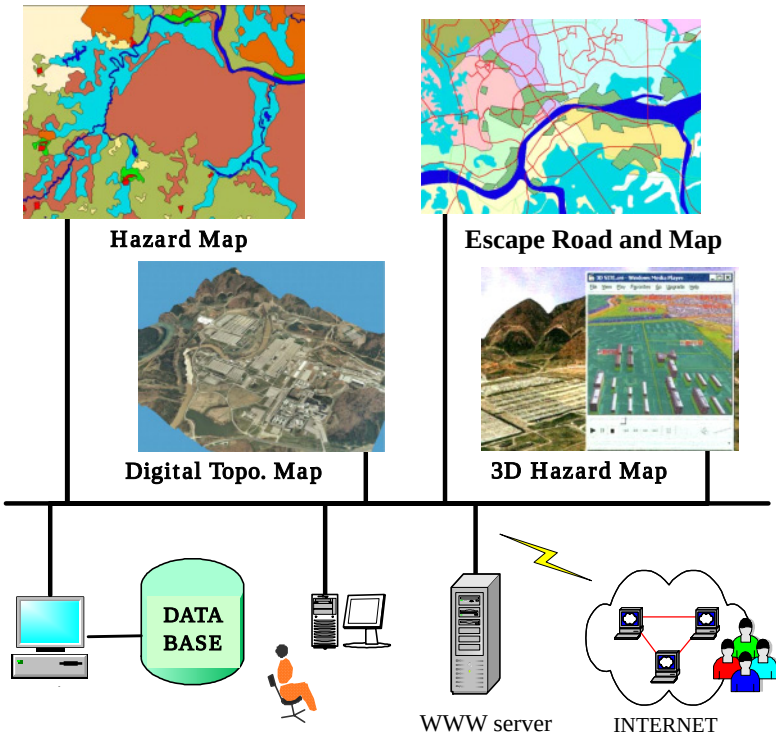
Figure 4.9.28 Schematic Diagram of GPS Real-time Tsunami Observation System

b) Integrated Warning System : The lack of a warning during the 1946 tsunami that devastated coastal area in the City of Banda Aceh. It is crucial for scientists and governmental agencies to establish Disaster Mitigation System as shown in Figure 4.9.29. The main objectives of this system are:

i) To detect and locate the existence all possible tsunami causing earthquakes by the use of properly monitored seismographs;

ii) To ensure that a tsunami actually exists by measuring water level changes and tide-gauging stations located throughout the Indian Ocean; and

iii) To determine the time of arrival of the tsunami and to provide an adequate warning for evacuation procedures.



Source: JICA Study Team

Figure 4.9.29 Configuration of Disaster Mitigation System

4.9.6 Public Education of Disaster Awareness

Various methods are applied for the purpose of public education of disaster awareness. The immediate actions are:

① Cooperation with mass media for public awareness on disaster management;

② Preparation of topographic map for disaster preparedness (Hazard map, etc);

③ Construction of public facilities for Disaster preparedness for tsunami awareness;

④ Installation of monument of tsunami inundation and run-up; and

⑤ Drill for escape from disaster.

The following items are crucial to implement for the achievement of disaster preparedness (Table 4.9.4).

Table 4.9.4 Proposed Methods for Public Education and Disaster Awareness

Item	Contents	Action/Proposal
(1) Mass media	Radio, TV, newspaper, and so on	• The rehabilitation works are on-going. Radio program for interactive dialogue between specialist and citizens will be broadcasted. • After rehabilitation of TV and radio stations, the messages for disaster preparedness are broadcasted periodically. • Basic information such as hazard map and escape plan are opened to the public on newspaper.
(2) GIS	GIS, Website, Brochure etc.	• ARRIS(GIS for disaster preparedness) will be opened to public and be maintained by Syiah Kuala University. The GIS data belong to among government agencies, international donors and NGOs. • Brochure for disaster preparedness and earthquake induced tsunami is prepared by the office of city of Banda Ache. The brochure is distributed to citizens.
(3) Public facilities	Tsunami memorial park, Lessons in school	• Tsunami House is built as part of Tsunami memorial park. Data on tsunami are stored in the house. • Lessons for pupils and students are done in the school.
(4) Monument	Tsunami memorial pole, Tsunami Line	• 「Tsunami Pole」：a stones pole showing the tsunami inundation depth. • 「Tsunami Line」：a board showing tsunami inundated area. • 「Tsunami Park」：Monuments (Big Tree, Big Barge, and so on) are installed.
(5) Drill for escape	Experience in evacuation tents and/or resettlement houses	• Based on the analyses for citizens' behavior when large-scale earthquake occurred on March 2005, site and area of escape road, escape building and emergency base are evaluated and modified • Tsunami Memorial Day on 26 December is established as a Disaster Drill Day. Drills for disaster preparedness are done among citizens.

Note : Underlined Items and/or Activities show the actions being carried out under this Study.

As part of study on public awareness, the escape behavior survey was conducted in the Banda Aceh City as discussed below:

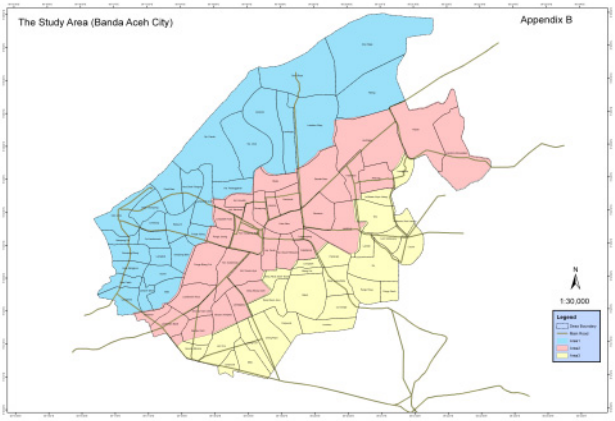
(1) Background

A number of aftershock occurred since 26 December 2004. In the midnight on 28 March 2005, the largest aftershock with a magnitude of M8.7 was recorded as the sixth largest earthquake in the world and the second strongest during the instrumented era in seismology i.e. 1966 to present.

This aftershock was strong enough to be felt in the Band Aceh City causing panic and minor damage. This fact showed that citizens were seriously aware of the occurrence of tsunami due to earthquake.

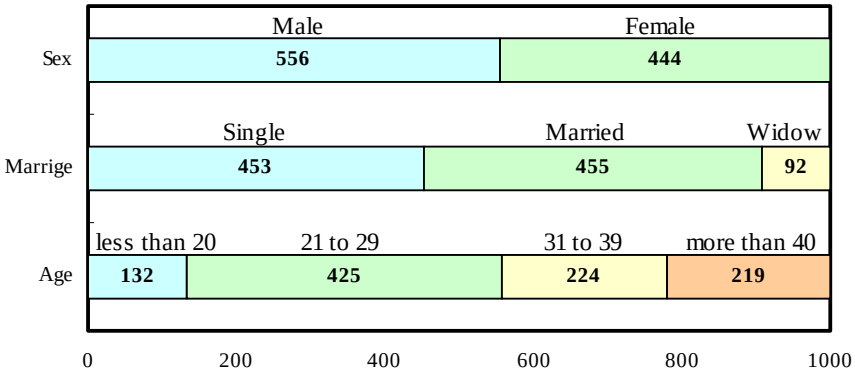
(2) Respondents

Interview survey was carried out which covered 9 sub-districts (87 villages) in the Banda Aceh city was done for the period from 03 to 05 July 2005. The survey conducted to divide the city area into three (3) zones; namely, (i) Zone 1 : along coastal area, (ii) Zone 2 : tsunami inundated area on 26 December 2004, and (iii) Zone 3 : southern city area not affected by tsunami. (Figure 4.3.30). The number of respondents at Zone 2 was more than those in Zones 1 and 3. The number of respondent is 1,000 citizens as shown in the breakdown (Figure 4.9.31).



Source : Escape Behavior Survey (JICA Study Team)

Figure 4.9.30 Survey Area with Three (3) Different Zones



Source : Escape Behavior Survey (JICA Study Team)

Figure 4.9.31 Breakdown of Respondents for Interview Survey

(3) Results of Interview Survey

Most of the respondents (881 citizens) were in their home when the earthquake on 28 March occurred at 11:00 p.m. and went outside quickly. Few respondents (7 persons only) hid themselves underneath table. 62 % respondents left their home quickly, 19 % left within 20 minutes, and the others after 20 minutes. However, most of respondents did not turn on TV or radio for getting more information about earthquake.

Then, they ran away helter-skelter on foot (49 %) or motor car (32 %) to the safer place. The refuge (destination of escaping activity) where they could imagine as a safer place was summarized below (Table 4.9.5).

Table 4.9.5 Destination of Escape Activity

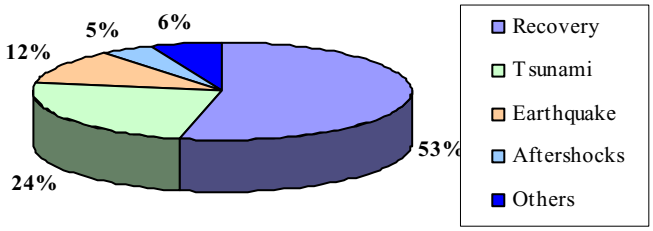
Refuge	Open area	Mosque	High Place	Relatives	Public Bldg.	Others
Nos. of Respondent	424	142	139	113	91	3

Source : Escape Behavior Survey (JICA Study Team)

Many respondents ran away to the nearest mosque and public facilities such as banks, government offices with plural floors of relatively higher elevation. The respondents in Zone 1 (coastal area) mostly ran away to higher and safer places. In Zone 2 the respondents who have their own motorbike or car went to Mataie Hill, Lambaro and airport, while the respondents who ran away on foot mostly went to the nearest mosque and public building. There were traffic accidents on the way to a refuge. About 50 % of the respondents encountered by chance and heard about the accidents. Most of the accidents were happened because of traffic congestions and non-existence of streets lights.

Many respondents (64 %) got the knowledge about tsunami mostly transmitted by word of mouth or from newspaper, not from TV and radio. Public awareness by TV and/or radio broadcasting, namely 23 % from TV and 19 % from radio, should be made more frequently.

In conclusion of interview survey, the questionnaire was that they are willing to get what kind of information. Most of respondents are eager to access information on restoration of the social and environmental pre-tsunami conditions rather than that of natural hazard (Figure 4.9.32). The accurate and timely information on the progress of rehabilitation and reconstruction work is needed.



Source : Escape Behavior Survey (JICA Study Team)

Figure 4.9.32 More Information needed for Respondents

4.9.7 Tentative Implementation Schedule and Cost Estimate

(1) Necessity of Effective Road Network

To ensure the activities for escaping, evacuation and relief is the only effective methods to cope with a huge-scale natural disaster. Also, the structural measures against the other disasters, such as flooding, earthquake and fire spreading, requires the ordinary operation and maintenance works passing through road network. The implementation of disaster mitigation plan depends largely on the accomplishment of rehabilitation of both damaged artery road network and improvement of sub-artery road network. Without the effective road network, the investment to public facilities as a refuge will be of no use since no one can access to those facilities. Thus, the priority for implementation program is given to the implementation of rehabilitation road network for the rehabilitation period (2005-2006).

(2) Necessity of Early Implementation of Non-structural Measure

Public education and disaster awareness is regarded as one of the long-term efforts to achieve disaster preparedness and the people are able to understand well the importance of disaster preparedness immediately after the disaster. It might be high time to start public education and disaster awareness. According to the interview survey to 1,000 citizens in the Banda Aceh City as given in ATTACHMENT 1, almost all of the citizens felt the menace against tsunami when the powerful aftershock occurred on 28 March 2005 and ran away helter-skelter on foot or by motor car to the place or building where they could imagine promptly as a safer place such as open spaces, mosque, higher place, public building and so on. This fact shows that the experiences of huge-scale disaster will be handed down from generation to generation by conducting public education.

The early implementation of non-structural measure is favorable for disaster preparedness taking into account the lesser and long-range acquired of disaster mitigation effects, as well as administrative guidance for the installation of external stairs to existing buildings and newly-built public facilities as escape building.

As for structural measure, coastal forest, which utilizes natural force of vegetation and environmental friendly, will be raised with priority, while the reinforced-concreted structures such as seawall and detached breakwater will be part of reconstruction plan after the completion of effective road network. Detailed studies should be undertaken in the next stage.

(3) Implementation Schedule

Based on the foregoing discussion, the implementation plan and schedule as shown in Table 4.9.6 is formulated. The annual construction cost is also broken down.

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.

a) Physical contingency and price escalation are assumed to be 10 % each of the direct construction cost.

b) Engineering services is assumed to be 10 % of the direct construction cost for detailed study & design and construction supervision.

c) If project is purely program type and/or procurement, only price contingency is considered.

d) VAT is included in the cost, however, import duties are not included in the cost.

e) Land acquisition and compensation costs are not included in the Project cost duet to difficulty of estimation at this time.

(Rp. billion)

	Rehabilitation		Reconstruction			Long-term		TOTAL DIRECT COST	TOTAL PROJECT COST
	2005	2006	2007	2008	2009	2010 and later			
A. STRUCTURAL MEASURE									
A.1 Detached Breakwater (20 @ 4 m wide x 200 m long x 6 m high)					35.84	25.60	40.97	102.41	133.14
A.2 Seawall (4 m high x 4,920 m long)			11.25	11.25	11.25	11.25	11.25	56.23	73.10
A.3 Coastal Forest (200 m wide x 4,800 m long)	2.29	2.29	2.29	2.29	2.29			11.43	14.86
A.4 Tidal Gate (300 m wide for Floodway and 100 m wide for the Aceh River							47.62	47.62	61.90
B. EMERGENCY FACILITIES									
B.1 Emergency Road Network (included in Road Sector)									
B.2 Public Emergency Facilities									
(1) Escape building (Installation of 10 external stairs/year)	1.98	1.98	1.98	1.98	1.98	9.92	9.92	29.76	38.69
(2) Escape towers (2@10 m high)			0.48					0.48	0.62
(3) Emergency Base and Open Spaces			9.92	13.89	3.97	3.97	3.97	35.71	46.43
C. NON-STRUCTURAL MEASURE									
C.1 Warning and Dissemination System									
(1) Seismometer(2 pcs.)/Warning siren (60 pcs.)/ Mobile Phone System	2.38	2.38	4.76	4.76	1.59			15.87	20.63
(2) Tsunami Watch					2.38			2.38	3.10
(3) GPS System/Disaster Mitigation Database						5.95	5.95	11.90	15.48
C.2 Public Education and Disaster Awareness									
(1) Mass Media	0.71	0.71	0.71	0.71	0.71	0.71	0.71	5.00	6.50
(2) GIS	1.62	1.62	1.62	1.62	1.62	1.62	1.62	11.33	14.73
(3) Public Facilities	0.48	0.48	0.48	0.48	0.48	16.35	0.48	19.21	24.97
(4) Monument including City Parks						24.70	24.70	49.40	64.23
(5) Drill for escape	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1.11	1.44
TOTAL DIRECT COST	9.62	9.62	33.64	37.13	62.26	100.23	147.34	399.86	519.81
TOTAL PRJECT COST	12.50	12.50	43.74	48.27	80.94	130.30	191.54	519.81	

Source: JICA Study Team

Table 4.9.6 Tentative Implementation Schedule and Cost Estimate

4.10 GENERAL APPROACH TO VILLAGE PLANNING

4.10.1 General Description

As noted in Section 4.1 of this chapter, village plan is one of the most important elements in the city planning and for the smooth and successful implementation of city development it is prerequisite to incorporate villager's willingness and desires, traditional life style and culture into village planning and then into micro-macro plan procedures.

The village planning however requires various legal procedures such as land title matter and village mapping, putting in consensus among the villagers and coordination with neighboring villages.

In this section, approach to village planning is described as one of guidelines for implementation of such village planning.

4.10.2 Landownership

(1) Land ownership in Indonesia

Land ownership in Indonesia is stipulated in Basic Land Law enacted in 1960. According to the law, land registry is done by the dual methods; namely, (i) registry by village (village by village) and (ii) land title after colonial era with certificate of Indonesian nationality. Registry by village should be established by land title of BPN in order to establish the right and land clearly.

(2) Land ownership in Banda Aceh City

In the Banda Aceh City, some land registration documents were submerged into tsunami and the others were missed. Although the JICA procured the equipment for refurbishing the registration forms and keeps at Jakarta about 30,000 of the registration forms, refurbishing work will be completed by 2006 to 2007. Thus, the boundary among land lots is still unclear. In order to resolve such a situation and to facilitate quick recovery of housing, the procedure of village mapping and village planning has been introduced[1] by the Indonesian Government.

4.10.3 Village Mapping

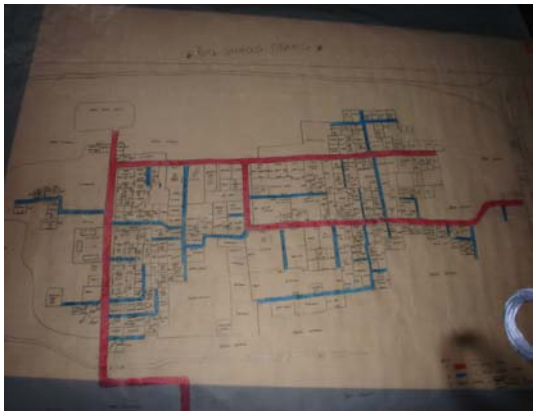
Village mapping is imperative in order to proceed with village planning, and its is being carried out under assistance of a number of NGOs[2]. Unfortunately there is no accurate topographic map at present for this mapping work. Accordingly very laborious efforts and time consuming works are in

1 Guidelines: 1A. Pedoman Pemetaan Tanah Partisipatif, 1B. Tentang Batas-batas Bidang Tanah, Kepemilikan dan Penandaan Bidan-bidan Tanah Dalam Peta, 2. Pedoman Menata dan Membangun Ganpong/Desa, 3. Pedoman Pembangunan dan Perbaikan Rumah, 2005,

2 Main actor is YIPD (Yayasan Inovasi Pemerintahan Daerah).

site. The result is confirmed by the head of village and subsequently BPN issues temporary certificate[3]. The temporary certificate will be entitled as an official land title in the case of no-claim after six (6) months. However, owing to lack of detailed topographic map, village map being developed is not in a definite form and its accuracy is hardly possible to confirm.

Desa Glumpang by YIDP

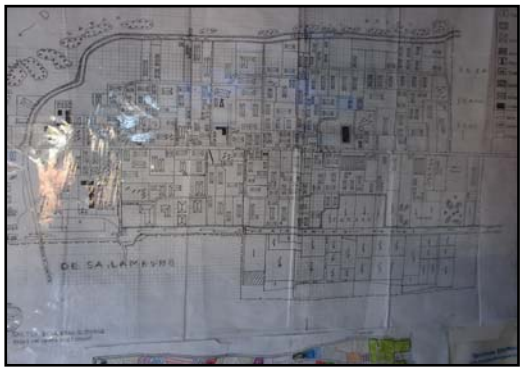


Desa Tibang

Source: JICA Study Team

Figure 4.10.1 Typical Village Mapping

The village maps on left and right sides are produced by YIDO and Tibang respectively. There is a clear difference between two. The later is prepared by village itself.



Hand-writing map

Surveyed Map

Source JICA Study Team

Figure 4.10.2 Quality of Village Map

The identification on site is done by a few stakeholders. When all household members were missed, the confirmation is carried out without any potential inheritor such as relatives. This would be potential problem in future if there is true inheritor and land title documents recovered.

4.10.4 General Approach for Village Planning

3 Decree of Head of BPN No.57-Ⅶ-2005 regarding Kelompok Masyarakat Sadar Tertib Pertanahan in Nanggroe Aceh Darussalam Province, 6 April 2005

4.10.4 General Approach for Village Planning

In the devastated area, the residents who lost their houses have started to discuss and produce village plan with assistance of BPN, NGO and donors. It is however desirous to proceed with such village planning through the following procedures:

(1) In principle actual planning shall be executed by community and facilitated by accompanying team.

(2) The village planning shall include, but not limited to the land use, basic infrastructure, housing and neighborhood facility, escape facility, and environment rehabilitation.

(3) The concept of village plan shall be disclosed to all villagers, prior to open to the neighboring villages.

(4) The community concerned shall hold a meeting with neighboring villages to adjust the inter-village space structuring such as road, drainage and other neighborhood facilities. If there is objection from neighboring village, sub-district apparatus and accompanying team can find a solution through discussion about the role of sub-district apparatus. Finally, the village plan will be agreed by the communities concerned.

(5) Then, the city approves the village plan received from sub-district office and the communal agreement concerning status of land ownership is recorded by BPN. Finally, BPN may conduct new measuring, followed with administration process of land right for proposing land certificate.

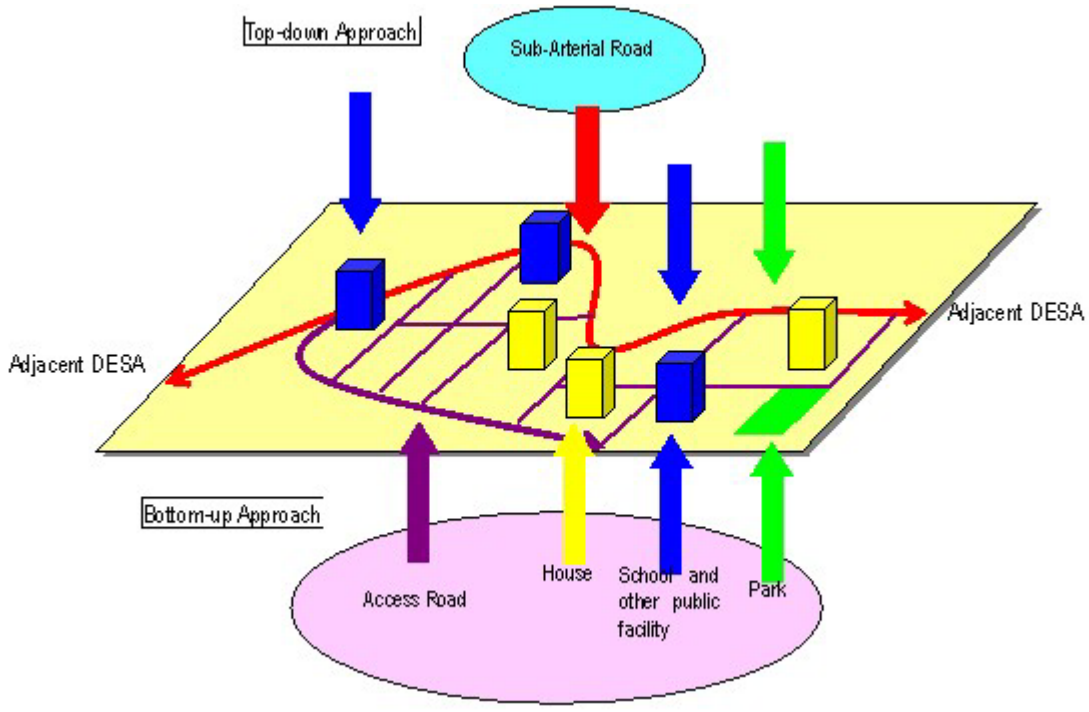
4.11 GENERAL APPROACH TO MICRO PLAN

4.11.1 Needs of Micro Planning

As explained in Section 4.10 of this chapter, procedures of village planning are regarded as people-centered and/or bottom-up approach. Every village, before establishing their definite plan, is required to coordinate and cooperate with the neighboring villages so that village plan could be formulated in an integrated manner. It would apparently be rational and efficient plan and easy for implementation (bottom-up approach).

On the other hand as noted in Section 4.1 of this chapter, the administrative authority formulates an overall city development master plan, in due consideration of various factors as noted in Section 4.5 of this chapter. This overall city development plan will be conveyed gradually to the district office from the city administration (say top-down approach), and subsequently at the district level such top-down concept and bottom-up approach would be assimilated and to form unified city master plan. All the desires and willingness of the communities and the city administration's policy and concept of city development are integrated and absorbed by means of preparation of micro plan.

This integration and assimilation could be depicted schematically as seen in Figure 4.11.1.

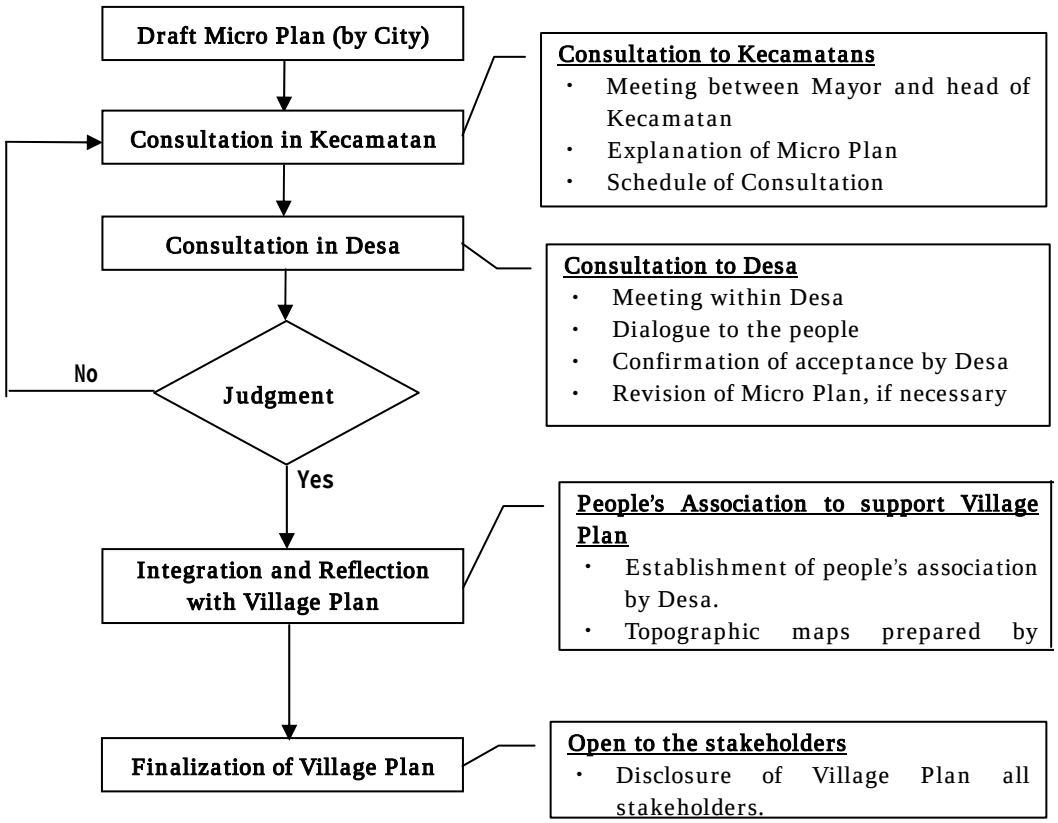


Source : JICA Study Team

Figure 4.11.1 Bottom-up Approach and Top-down Approach in Village

4.11.2 Flow of Micro Planning

It is anticipated that micro plan is absolutely required in the most devastated areas, in particular in the coastal area, since a complete re-development would take place in this area. The process of micro planning would be ideally as illustrated in Figure 4.11.2.



Source : JICA Study Team

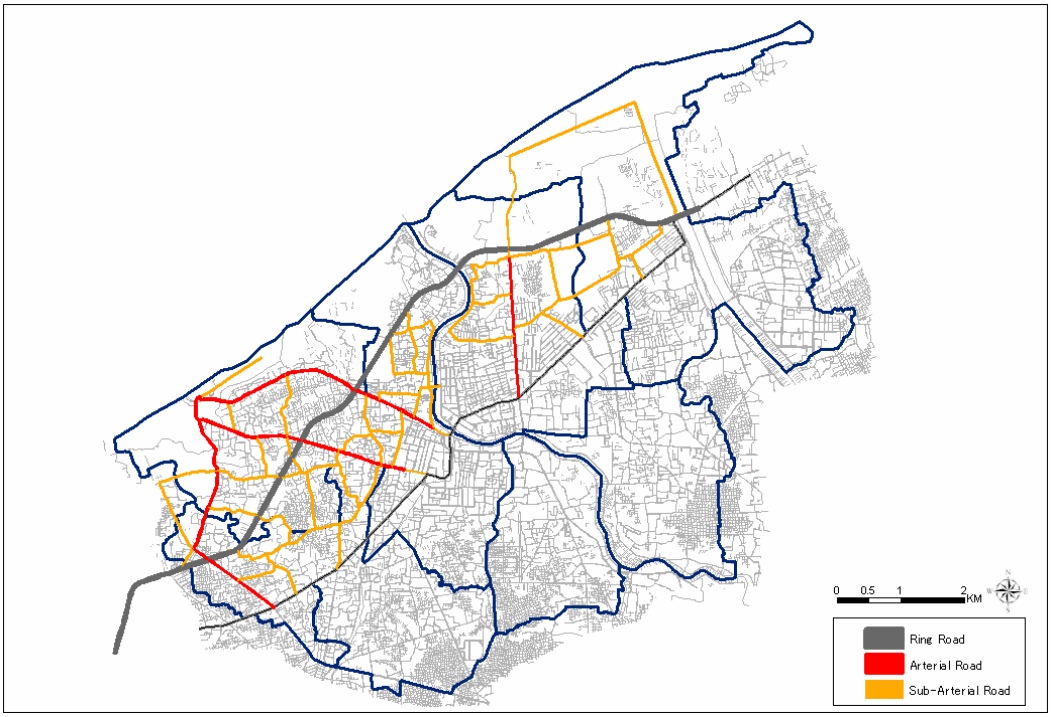
Figure 4.11.2 Flowchart of Micro Planning

4.11.3 Approach to Micro Plan

In extending good guidance to village planning, it is necessary to establish basic framework for Micro Plan by the Local Government Units. The following four (4) plans are considered to be basic frameworks for Micro Plan; namely, road network plan, population allocation plan, land use plan, and new residential area plan.

(1) Framework 1: Artery and Sub-artery Road Network Plan

One of the serious problems of village plans is insufficient information on the updated alignment of artery and sub-artery roads and other roads which traverse through Desa. As one of the example road network would be aligned at an interval of 1,000 m for artery road and at an interval of 500 m for sub-artery road. Typical example is as shown in Figure 4.11.3.



Source : ARRIS (GIS) prepared by JICA Study Team

Figure 4.11.3 Preliminary Road Network for Establishing Village Plan

(2) Framework: Population Distribution Plan

As an example of population distribution plan, three (3) kecamatan (Jaya Baru, Kuta Raja, and Meuraxa) are selected. These kecamatan are most severely damaged area among the entire city area. Table 4.11.1 shows the population distribution plan in those three (3) kecamatan.

Table 4.11.1 Population Distribution Plan

KECAMATAN	DESA/KELURAHAN	Area(dlm angka)	Major Office Statistic(12 April 2005)						future population				
		(m2)	household	poplation	family	missing	dead	save	2005	2006	2007	2008	2009
MEURAXA	Gampong Pie	321000	184	810	4	179	537	94	94	93	93	92	92
	Deah Glumpang	533000	294	1172	4	99	739	334	332	330	328	326	325
	Ulee Lheu	675000	839	4154	5	301	3072	781	784	787	790	793	796
	Lambung	310000	268	1241	5	101	900	240	239	239	238	238	237
	Alue Deah Tengoh	398000	349	1492	4	102	1171	219	219	220	220	220	221
	Deah Baro	448000	258	1010	4	201	607	202	202	202	203	203	203
	Cot Lamkeweuh	348000	374	2005	5	560	1269	176	175	174	173	173	172
	Blang Oi	850000	753	3400	5	235	2595	570	573	576	578	581	584
	Gampong Blang	715000	152	583	4	99	401	83	84	85	86	87	88
	Lamjabat	278000	300	1122	4	99	853	170	169	168	167	166	165
	Asoe Nanggroe	168000	235	1214	5	134	910	170	169	169	168	168	167
	Punge Ujong	210000	368	2013	5	257	1254	502	504	506	508	509	511
	Lampaseh Aceh	590000	438	2400	5	277	1707	416	418	419	421	423	424
	Punge Jurong	422000	1122	5949	5	936	3968	1045	1041	1038	1034	1031	1027
	Surien	412000	282	1268	4	106	851	311	313	316	318	320	323
	Gampong Baro	582000	280	1385	5	151	890	344	345	345	346	347	348
小　計								5657	5662	5667	5672	5677	5682
JAYA BARU	Lampoh Daya	325000	278	1270	5	204	556	510	513	516	519	522	525
	Emperon	277500	367	2070	6	411	785	874	873	872	871	871	870
	Lamjamee	255000	355	1824	5	50	1362	412	413	413	414	415	416
	Bitai	372500	251	1143	5	121	655	367	369	370	372	373	375
	Lamtemen Barat	630000	455	2539	6	70	103	2366	2368	2370	2372	2374	2376
	Lamtemen Timur	505000	709	3793	5	1690	1357	746	745	744	742	741	740
	Ulee Patah	242000	186	978	5	264	557	157	157	158	158	158	159
	Geuceu Menara	370000	469	2716	6	0	14	2702	2702	2702	2702	2702	2702
	Punge Blang Cut	855000	1389	5672	4	377	2081	3214	3222	3230	3238	3246	3254
小　計								11348	11362	11375	11389	11402	11416
KUTA RAJA	Keudah	162500	586	2650	5	201	1866	583	601	622	644	671	701
	Pelanggahan	522500	690	3281	5	279	2050	952	987	1026	1070	1121	1180
	Gp. Pande	2588000	252	1139	5	51	897	191	220	252	289	332	383
	Gp. Jawa	1506000	675	3380	5	70	2174	1136	1247	1370	1511	1674	1867
	Merduati	278000	1039	5029	5	574	3022	1433	1463	1497	1535	1578	1629
	Lampaseh Kota	320000	787	4738	6	213	3698	827	858	892	932	977	1031
小　計								5122	5377	5659	5981	6353	6790

Source : Projected by JICA Study Team based on the census data by the Office of Banda Aceh City on April 12, 2005

(3) Framework 3: Land Use Plan

Housing Frame:

This framework is worked pout for those three (3) kecamatan as those adopted for the population distribution. There is great change in population after disaster in these kecamatan. Land use plan shall be established with due attention to such factors as:

a) Many land registration still remain and an heir exits even if the landowner died.

b) Village mapping is on-going. Thus, population distribution by means of the numeric calculation could not be accepted by people in the area concerned.

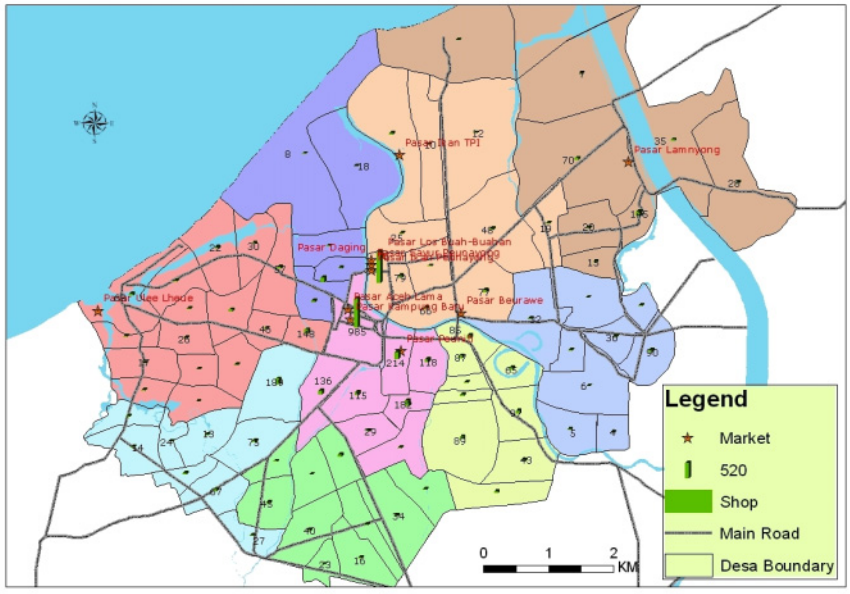
c) Decisive plan with top-down approach is not applied in order to ensure the accomplishment of people-centered Village Pan. However, land area shall absorb the projected population in 2009.

Commercial Activities Frame:

The number of shops is presumed to be proportional per pre-disaster population. The location of commercial building is shown in Figure 4.11.4. Also the number of shops is estimated as shown in Figure 4.11.2.

Table 4.11.2 Numbers of Shops in 2009

Kecamatan	Pre-disaster Population (2002)	Pre-disaster Shops(nos.) (2002)	Post-disaster Population (2009)	Post-disaster Shops (nos.) (2009)
Meuraxa	30,158	622	5,682	117
Jaya Baru	21,133	479	11,416	259
Kuta Raja	18,503	294	6,790	108
Total	69,794	1,395	23,888	484



Source: BPS

Figure 4.11.4 Numbers of Shops (Pre-tsunami, 2002)

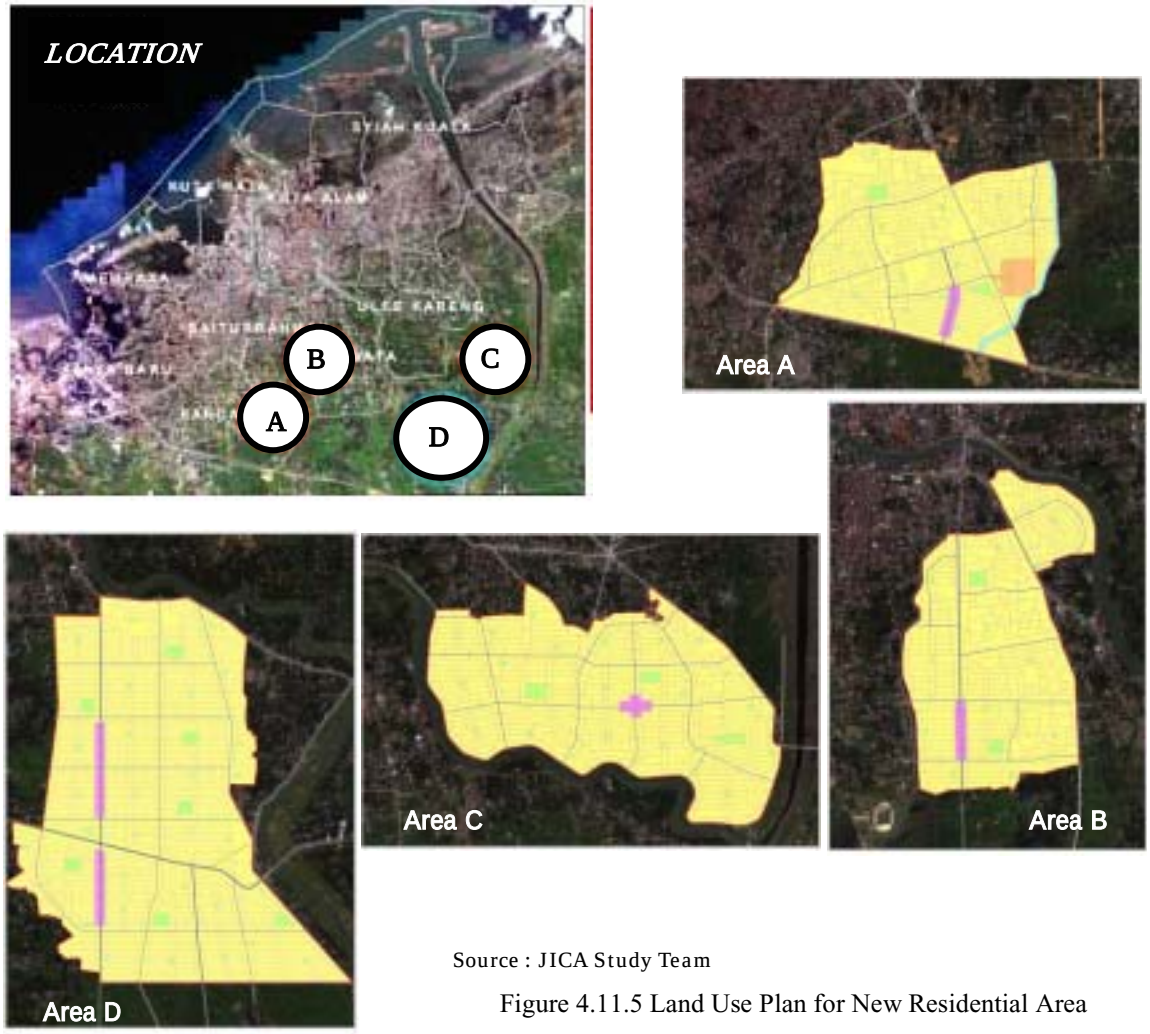
(4) Framework 4: New Residential Area Plan

Urban area would expand further to the south as stated in Section 4.6 of this chapter. The required residential area is estimated assuming that unit residential area of 250 m^2 per household. Required public area is assumed to be 2.5 times of the net residential area[1]. Four (4) model areas are arbitrarily selected within the city area (refer to right top of Figure 4.11.5). Plans A to C show area-wise residential area development, while Plan D is of linear type residential area along the arterial road. The required area for residential purpose is estimated and compared to existing residential area as shown in Table 4.11.3.

Table 4.11.3 New Residential Area required in Southern Part

Area	Required Area (ha)	Existing Resident area (ha)
A	343	110
B	343	110
C	419	140
Sub-total (A+B+C)	1,105	360
D	821	90
Total	1,926	450

[1] Blueprint



Source : JICA Study Team

Figure 4.11.5 Land Use Plan for New Residential Area

4.12 CASE STUDY TO PROCEED WITH VILLAGE PLANNING

4.12.1 Most Conceivable Cases

The JICA Study Team had actually conducted interview survey to catch up directly from inhabitants what is most serious concern to them in order to proceed with their village plan. As a result of the interview survey the JICA Study Team identified three (3) major concerns: the first is Alignment of arterial road, the second location of basic infrastructure and the third land consolidation. It is most likely that these three concerns are common in many countries including Japan when re-development of city is to be implemented after disaster.

Many city administration pays due attention to create the new city to be strong against disaster but it incur cost in various term, whereas the inhabitants tend to protect their asset or loss of their assets due to new city development. Even in case of Banda Aceh City such concerns could not be neglected. The city administration is therefore required to acquaint with itself how such concerns are significant in order to achieve initial objectives and to execute the city development.

Three typical concerns are as summarized below:

Concern 1 Alignment of arterial road: How to negotiate with arterial road alignment

Concern 2 Location of public facilities: How to locate public facilities evenly and consistently for convenience of majority of people.

Concern 3 Land consolidation: How to negotiate with land consolidation requirement.

It is strongly advisable to extend adequate and appropriate advice to the people engaging in village mapping and planning to take into account such concerns and importance of harmonizing village plan and micro plan

4.12.2 Case Study 1: How to Negotiate with Arterial Road Alignment

(1) Sampled Area

Two (2) desa (Lambaro Skep and Tibang) are sampled in kecamatan Syiah Kuala. The population is enumerated in Table 4.12.1. The sample area is situated in the vicinity of administrative boundary between Syiah Kuala and Kuta Alam. In case that the preliminary aligned coastal road is constructed, the road would traverse through the center of the area. At present, none of residence lives in Tibang and only a mosque is reconstructed.

Table 4.12.1 Population Projection (Lambaro Skep and Tibang)

Desa	Pre-disaster (A)	Post-disaster	2009 Projection (B) (A/B)
Lambaro Skep	4,234	2,334	2,700 (63.8 %)
Tibang	1,397	850	1,256 (89.9 %)

Source: JICA Study Team

(2) Land Use Before and After Disaster

The land use situation before and after disaster are made available from satellite image photos for both villages as given in Figures 4.12.1 and 4.12.2.

(a) Pre-tsunami Land Use (b) Post-tsunami Land Use

Figure 4.12.1 Land Use at Desa Lambaro Skep

(a) Pre-tsunami Land Use (b) Post-tsunami Land Use

Figure 4.12.2 Land Use at Desa Tibang

(3) On-going Activities

There was no inhabitant at all in desa Lambaro Skep when the JICA Stud Team conducted interview survey in June 2005. Village mapping and planning are, on the other hand, going on at desa Tibang (refer to Figure 4.10.2), and the village plan so far prepared includes arterial road on the coastal side. The accuracy of village map is however in doubt.

Construction of 10 new houses is in progress in desa Tibang, and the residents are gradually returning to their original lands, which tends to increase day after day.

(4) Public Opinion

The JICA Study Team conducted interview survey and gathered public opinion. According to such interview, the residents are already aware of plan of ring road which will pass through their village. The residents are however not showing any objection for such plan but rather expect such project as it would contribute to their livelihoods and desa's economic encouragement.

(5) Village Plan Case Study

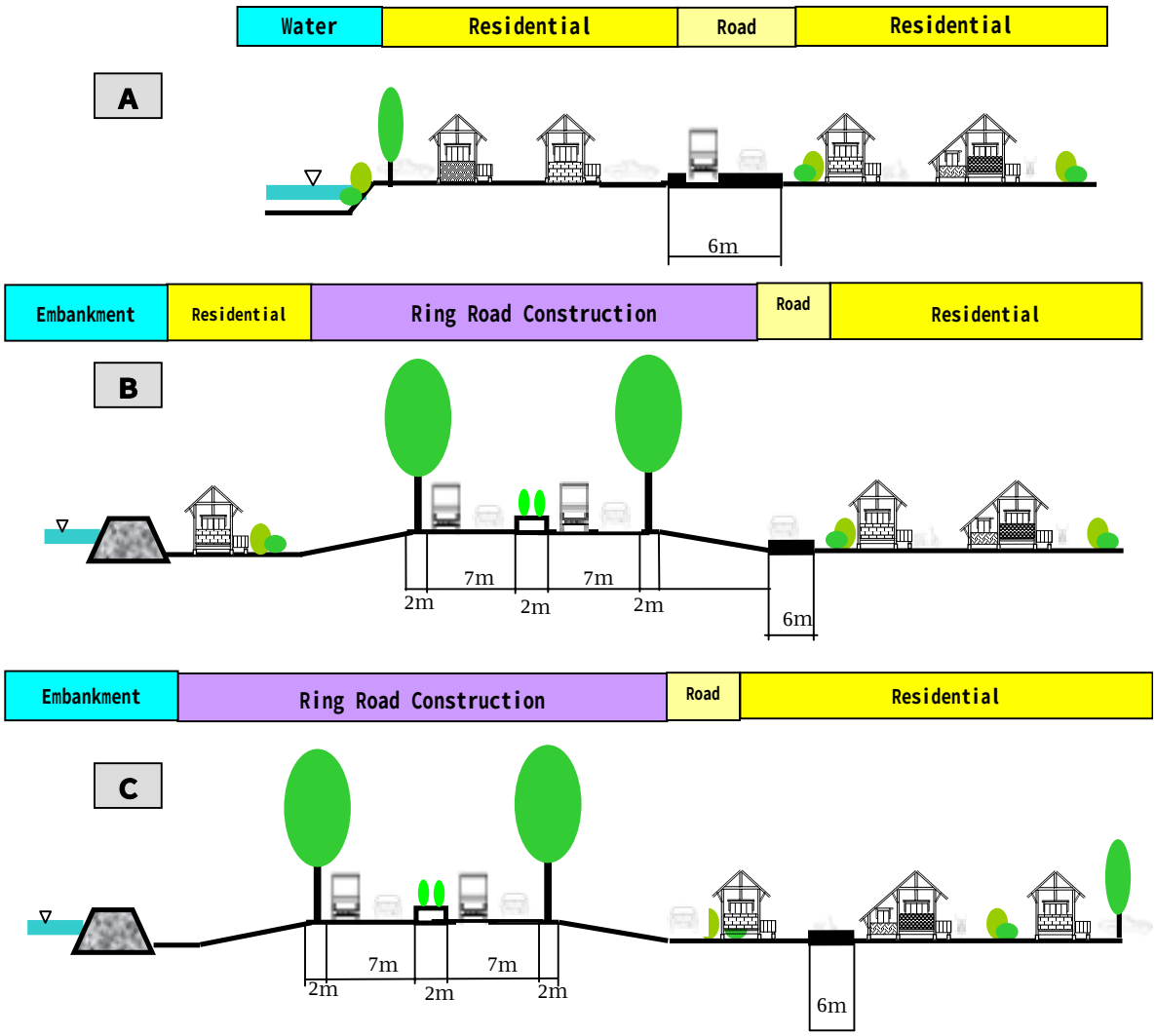
The JICA Study Team has attempted a case study for establishing a village plan for desa Tibang. There would be three (3) different types of village plan conceivable as mentioned below:

Case A: Original state, same pattern as before disaster

Case B: Align the proposed ring road in the center of village

Case C: Align the proposed ring road along the shoreline

The above three (3) cases are schematically shown in Figure 4.12.3.

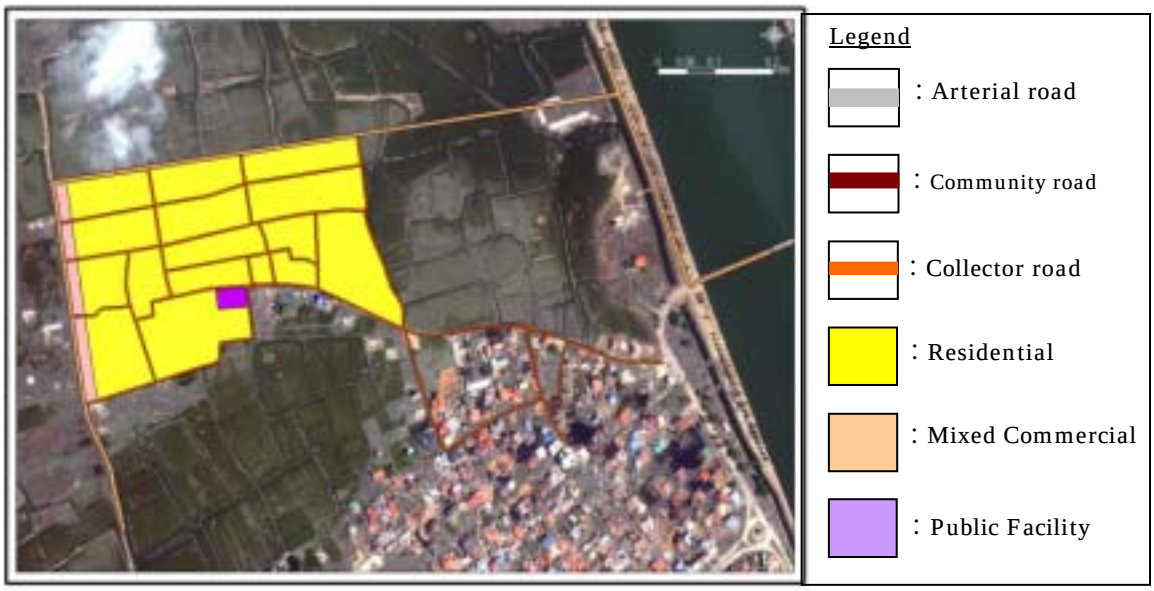


Source: JICA Study Team

Figure 4.12.3 Schematic Section of Village on Planned Ring Road

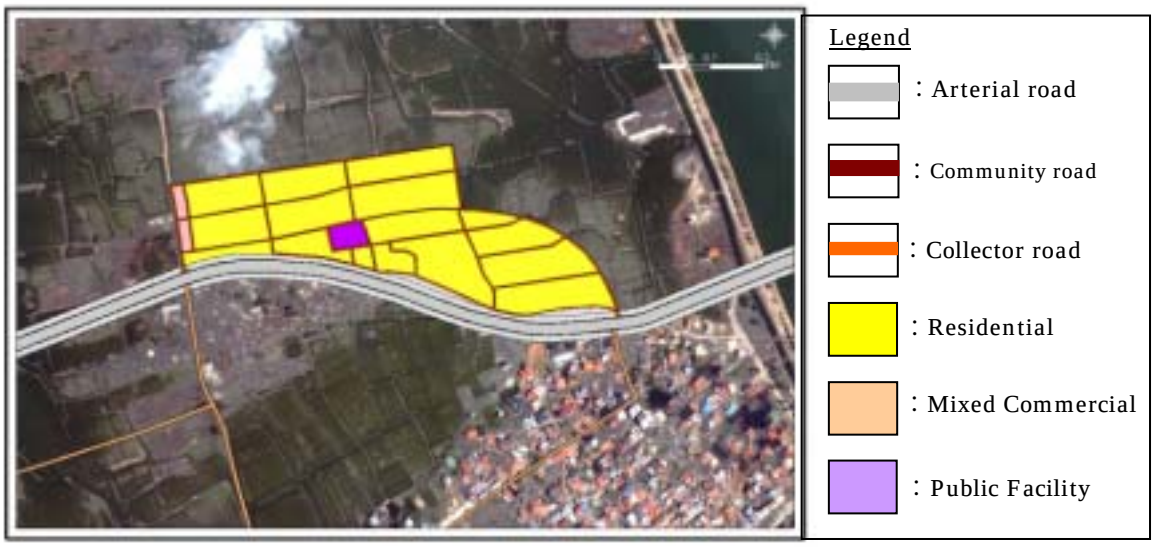
The alignment of the ring road is also one of issues to be solved out at village level paying attention to the villagers' life style and land consolidation matters. Aerial development concept of the village is largely subject to the ring road. Two different cases are conceivable: with and without the ring roads. These are also schematically presented in Figures 4.12.4 and 4.12.5.

In cases of A and B, the village area is divided into two (2) because of road, probably causing inconvenience in daily life of the inhabitants. It is important that villagers discuss about such alternative village plans and finally determine best option suitable their life but in harmony with the city development concept which would be conveyed to the villagers by the city administration. From the viewpoint of the city development and village plan, Case C is deemed to be preferable and would be incorporated into Micro Plan.



Source: JICA Study Team

Figure 4.12.4 General Plan without Ring Road



Source: JICA Study Team

Figure 4.12.5 General Plan with Ring Road

4.12.3 Case Study 2: How to Locate Public Facilities

(1) Sample Area

Three (3) desa (Deah Glumpang, Deah Baro and Deah Teungoh) in kecamatan Meuraxa are selected for this case study. As shown in Figure 4.12.6, these villages are geographically located in the same area and severely damaged. The population is enumerated as shown in Table 4.12.2

Table 4.12.2 Population Projection (Deah Glumpang, Deah Baro and Deah Teungoh)

Desa	Pre-disastere (A)	Post-disaster	2009 Projection (B) (A/B)
Deah Glumpang	1,172	334	325 (27.7 %)
Deah Baro	1,010	202	203 (20.1 %)
Deah Teungoh	1,492	219	221 (14.8 %)

Source: JICA Study Team

(2) Land Use Before and After Disaster

Land uses before and after disaster are obtained from satellite image photos as given in Figure 4.12.6.

Pre-tsunami Land Use Post-tsunami Land Use

Figure 4.12.6 Land Use at Meuraxa before and after Disaster

Casualties in the area reached 80 % of pre-disaster population and geographically land area changed greatly as shown in the above figure. Inundation by sea water extends over a wide area and without reclamation it is hardly possible to restore the land resources and eventually construction of houses, infrastructure and public facilities which community requires. Three (3) elementary schools were closed down.

(3) On-going Activities

Preparation of village mapping and plan are going-on in desa Deah Glumpang, whereas no particular action is taken yet at desa Deah Baro and desa Deah Teungoh.
Construction of new houses has started at many locations and people are gradually returning to their original location.

(4) Public Opinion

According to the interview survey of JICA Study Team, the inhabitants are keen to promptly realize construction of seawall along the shoreline to secure their lives and properties. Since these three villages depend on fishing and fish cultivation for their livelihood, the people are unwilling to immigrate into safer inland area even within the city area.
There is a clear different opinion in construction of road network within the area among the three villages. It is therefore advisable to the city administration to consult to the communities as earlier as possible for construction of road network and other public facilities.

(5) Village Plan Case Study

The alignment of road network is required to be determined urgently. Communal public facilities should be arranged effectively through consultative meeting among three desa. Typical case of the road routing through three desa is as follows:

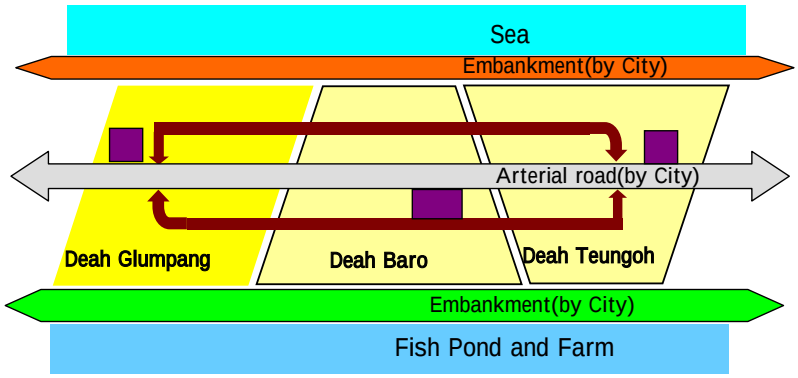
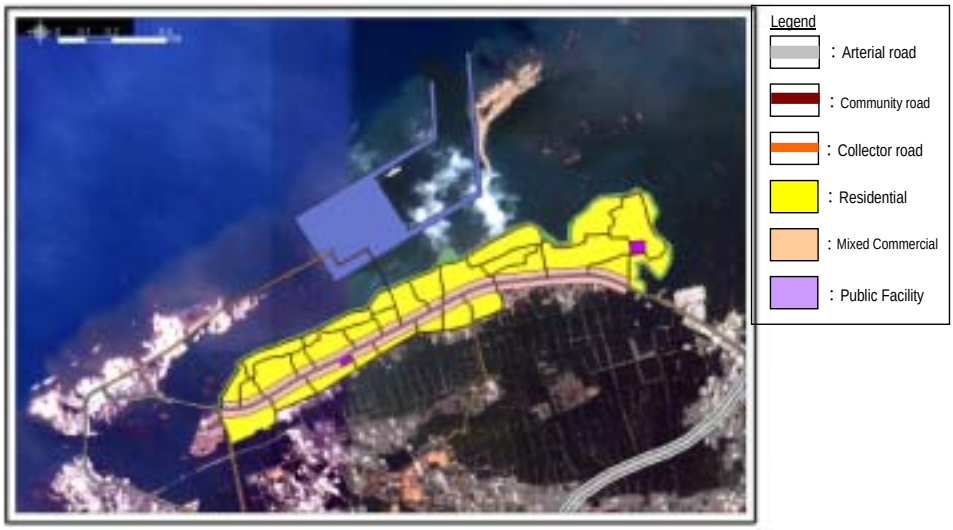


Figure 4.12.7 Schematic Arrangement of Road Network for Village Planning

The proposed road and public facilities shall be aligned effectively and systematically with a view to (i) convenient for three villages, (ii) enhancement of their traditional economic activities, (iii) safety against potential disaster, (iv) access to other part of the city area, (v) inter-village road transport, etc.
In addition micro plan to be developed through coordination and cooperation among three desa, it is essential to take into account the following:

- To secure access Ulee Lheu
- To align sub-artery road to Blang Oi
- To restore agricultural land at southern part of sampled area

- To construct seawall
- To utilize open space of closed-down primary school as communal village office which with function of escape building at emergency
- To allocate space to accommodate shops in a width of 20 to 25 m along the sub-artery road
- To install escape guide board and an external stair for the purpose of escape
- To use major part of land area is used as residential area



Source : JICA Stud Team

Figure 4.12.8 Model Micro Plan in Meuraxa

Figure 4.12.8 presents a sample of Micro Plan for Meuraxa area to be used for reference purpose. It is developed with due attention to alignment of the sub-arterial road and other factors mentioned above.

4.12.4 Case Study 3: How to Negotiate with Land Consolidation Requirement

(1) Sample Area

Two (2) desa, Ulee Lheu and Gampong Pie in Kecamatan Meuraxa are selected for this case study. The population in those desa is forecast as shown in Table 4.12.3.

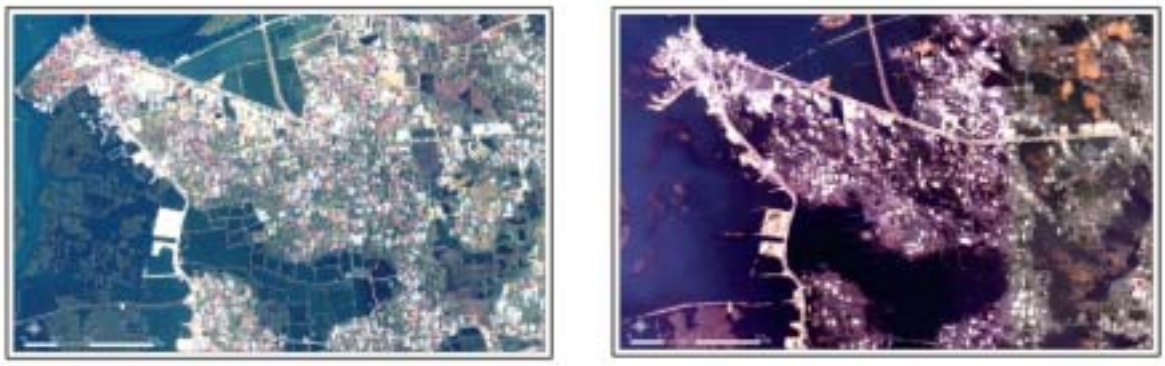
Table 4.12.3 Population Projection (Ulee Lheu and Gampong Pie)

Desa	Pre-(A)	Post-tsunami	2009 Projection (B) (A/B)
Ulee Lheu	4,154	781	796 (19.2 %)
Gampong Pie	810	94	92 (11.4 %)

Source: JICA Study Team

(2) Land Use Before and After Disaster

Land uses before and after disaster are obtained from satellite image photos as given in Figure 4.12.9.



(a) Pre-tsunami Land Use (b) Post-tsunami Land Use

Figure 4.12.9 Land Use before and after Disaster in Desa Ulee Lheu and Desa Gampong Pie

Casualties reached more than 80 % of pre-disaster population and land area reduced remarkably. The road and houses were destroyed completely and land surface looks like a dessert surrounded by sea. The pre-disaster road network is unable to identify because of sand accumulation. The housing area is submerged widely due to land subsidence.

Four (4) elementary schools were closed down, and as consequence integration of primary schools is necessary due to the remarkable reduction in population.

In desa Gampong Pie, two (2) drainage channels are destroyed. High tide causes inundation over a wide area. Inundation depth is 30-40 cm, while it is only 10cm before disaster, meaning subsidence of the land. It is indispensable to carry out reclamation/embankment works to recover/ensure the residential area as required, as substantial portion of the land remains inundated.

Drainage channel at Iskandal Mudah Drainage channel at Kuren Gulamus

Source: JICA Study Team

Figure 4.12.10 Damage on Tidal and Drainage Gates

(3) On-going Activities

Construction works of houses have already started. Thus, the alignment of road network is to be fixed urgently. It appears that preparation of village plan is no taken place yet, though it is one of the important elements for urgent recovery from the disaster.

(4) Public Opinion

People in the area places emphasis on construction of seawall and drainage gates to protect their land from inundation. Some land owners have started at their cost embankment on their own plot.

(5) Village Plan Case Study

For the preparation of Micro Plan covering two desa (Ulee Lheu and Gampong Pie) special attentions are directed to the following:

- To locate coastal forest along shoreline
- To construct primary school and the Office of Village at the same location as before disaster and these building shall be provided with external stairs so that the building can be used as escape building in emergency
- To allow development of shops in a width of 20 to 25 m along the sub-artery road
- To install emergency guide board at adequate location
- To recover the submerged land by means of embankment for housing development
- To locate arterial road in accordance with the city plan which will form part of escape roads and links to the city center

Figure 4.12.11 shows a general plan of those villages for reference.

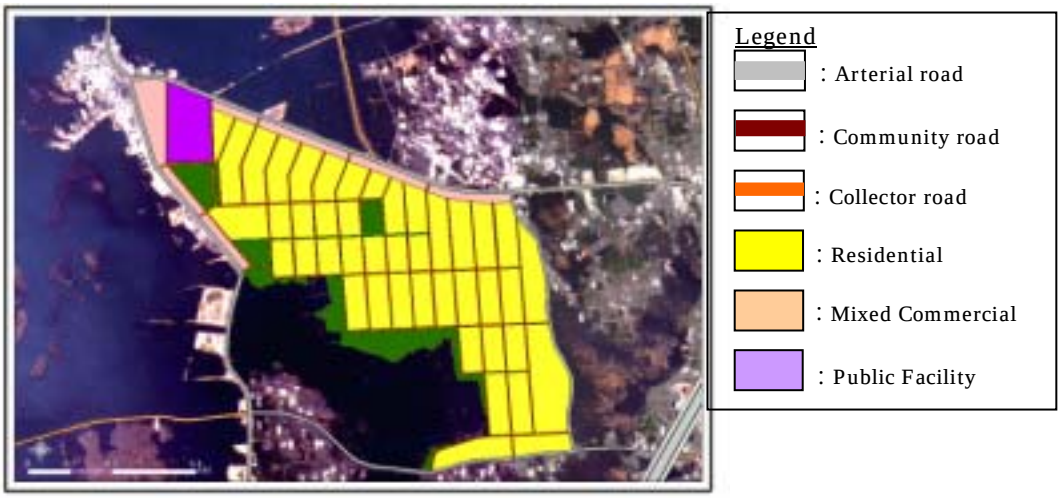
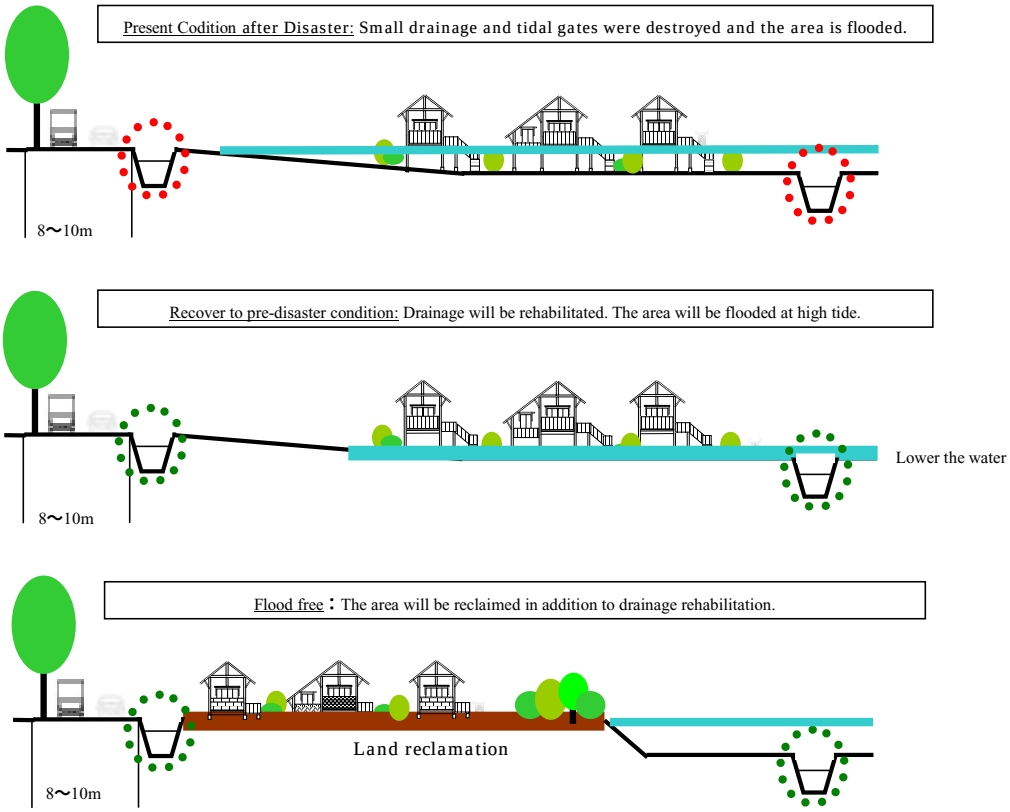


Figure 4.12.11 General Plan of Desa Ulee Lheu and Gampong Pie

For construction of houses in the submerged land there will be required adequate measures. One measure is to adopt traditional house with high column above the ground level, and other alternatives are embankment/reclamation on the present ground level. These typical measures are as illustrated in Figure 4.12.12. From the view point of living environment, the last option is recommendable though it would incur more cost for recovery of land resources. The first measure is not advisable from viewpoint of living environment including risk during flood and occurrence of waterborne decease like malaria. The second measure is to

heighten the land level to the pre-disaster level, but it would still subject to inundation during high tide.



Source : JICA Study Team

Figure 4.12.12 Alternatives for Formation of Residential Area

CHAPTER 5 URGENT SECTORAL REHABILITATION AND RECONSTRUCTION PLAN

5.1 WATER SUPPLY

5.1.1 Situation before and after Disaster

The pipe water supply in Banda Aceh City is served by PDAM Tirta Daroy-Banda Aceh (PDAM Banda Aceh), which treats and distributes the pipe water and collects tariff. Before disaster, there were 24,411 housing connections and 100 public taps. The total population in the Banda Aceh City was 264,000 before disaster, of which approximately 57 % were connected to the pipe water services. The rest of the population was therefore supposed to rely on other sources such as dug wells, deep wells, etc.

The source of pipe water supply is Lambaro and Siron water treatment works, with daily production capacities of 37,584 m^3 and 1,728 m^3 respectively. The Lambaro waterworks had a nominal production capacity of 37,584m^3/day, but its actual production was 31,536m^3/day. There are actually two (2) treatment lines, of which the first line was completed in 19974 and shows deterioration in many components. The distribution network was extended unsystematically over most part of the city administrative area of 61 km^2, but it was reported that un-accounted for water (UFW) was relatively high, about 49 %. According to PDAM Banda Aceh the average water consumption per capita per day was 136 liter. Table 5.1.1 summarizes water supply situation before and after disaster.

Table 5.1.1 Water Supply Situation before and after Disaster

Description	Details	Unit	Situation before Disaster	Situation after Disaster
Source of water supply	Lambaro	m^3/day	37,584	31,536
	Siron	m^3/day	1,728	1,728
Distribution and reticulation	Nos. of housing connection	Nos.	24,411	14,656
	Public taps	Nos.	100	46
UFW		%	48.7	-
Average consumption per capita		l/day/capita	136	-
Average tariff		Rp./m^3	1,400	-
PDAM Operation	Staff	people	173	144
	O&M vehicle	Nos.	3	1
	Distribution tanker	Nos.	5	6

Source: PDAM Tirta Daroy – Banda Aceh

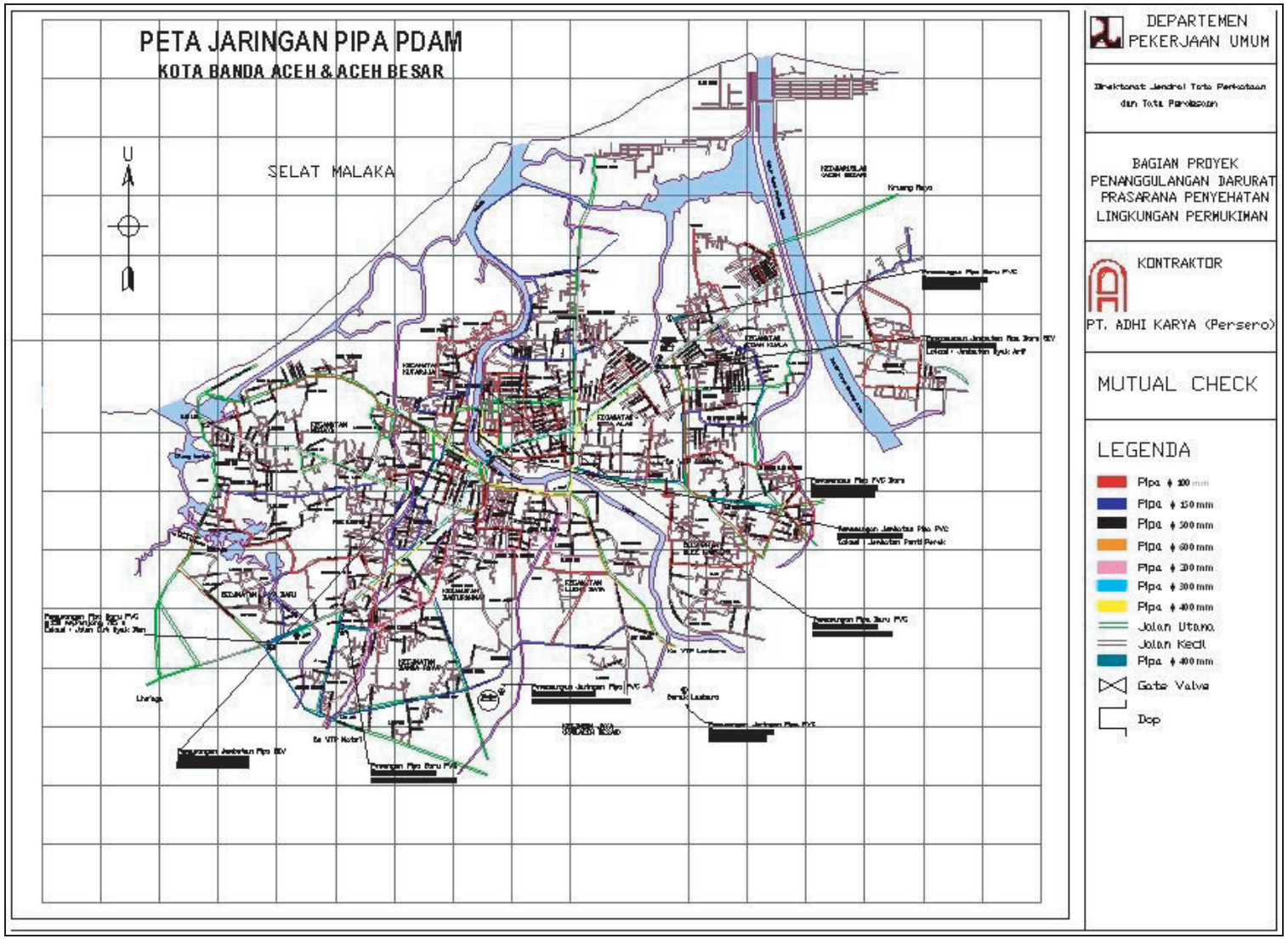
PDAM Banda Aceh suffered severe damages from disaster, not only in terms of their facilities but also their skilled staff. The distribution network was destroyed almost completely in the area along the coast. Currently Lambaro waterworks is the only the source of pipe water supply, though a number of portable water treatment equipment was provided through international and local assistance immediately after disaster. The international and local donors including NGOs

quickly moved to ensure safe water supply as it is one of important lifelines for people. Also DPU engaged in reinstallation of distribution and reticulation pipes in many locations of the city area. Table 5.1.2 and Figure 5.1.1 present such assistance and pipe re-installation respectively.

Table 5.1.2 Summary of Emergency Relief for Water Supply

Aid Item	Donors	Aid Contents /Capacity	Notes
Mobile Water Treatment Equipment	Australia	480 m^3/day	
	LAPI-ITB&Kodam III	199.2 m^3/day	
Chemicals for water treatment	Ministry of Public Works	48 ton	Aluminium-sulphate
	UNICEF	200 ton	Aluminium-sulphate, etc.
	ICRC	52 ton	Various kinds
Installation of public tap	DPU	46 units	Grant
Re-installation of pipes	DPU		
Water tankers	DPU	6 units	
	PDAM-Medan	2 units	
	PALYJA	2 units	
	PT Nidya Karya	4 units	
	NGOs	12 units	
Human assistance	PDAM-Medan	operators	
	PDAM-Kabupaten Bogor	engineers	
	IATPI	engineers	
	PALYJA	operators mechanics engineers	
	PDAM-Padang	engineers	
Cash fund	Dana Pensiun PERPAMSI	Rp.45million	
Vehicle	Swis Red Cross	One pick-up	

Source: PDAM Banda Aceh



Source: JICA Study Team

Figure 5.1.1 Location Map for Replaced Pipeline

5.1.2 Mission, Strategies and Goals

Mission:

- To provide the safe and sufficient water to as many people as possible
- To strengthen institutional and financial capability of PDAM Banda Aceh
- To develop the water supply system strong against disaster

Strategies:

- To expand water distribution and reticulation networks in conformity with the new urban development plan
- To reduce un-accounted for water
- To conduct corporate development planning
- To re-train PDAM staff

Goals:

- To re-install the distribution and reticulation network until 2006
- To rehabilitate Lambaro and Siron waterworks until 2006
- To achieve connection ratio of 80 % by 2009
- To reduce UFW to 30 % by 2009

5.1.3 Planning Criteria

Through a number of discussions with relevant government organizations and PDAM Banda Aceh, planning criteria for rehabilitation and reconstruction of water supply system are set forth as described below.

(1) General Criteria

Target Year	: 2006 for rehabilitation, 2009 for reconstruction
Population	: 254,000 by 2009, as projected by this study
Population distribution	: As projected by this study (see Figure 5.1.2)

(2) Water Supply Criteria

In order to achieve the missions and goals, the planning criteria are set forth as shown in Table 5.1.3 below

Table 5.1.3 Water Supply Planning Criteria

Description		unit	2005	2006	2007	2008	2009	PU guideline
Connection	Served population	%	58	60	65	70	80	
	Average family size		1:5					1:(5-6)
	House connection	%	90					80-90
	Public tap	%	10					10-20
Unit consumption	House connection	lpcd	150					150
	Public tap	lpcd	40					30-50
	Non-Domestic	%	20					15-30
UFW		%	50	45	40	35	30	30-50
Maximum Daily Demand Factor			1.1					1.1-1.25
Peak Hourly Demand Factor			1.5					1.5-2.0

note: PU guideline for house connection per capita consumption applied figure for the city with 100,000-500,000 population.

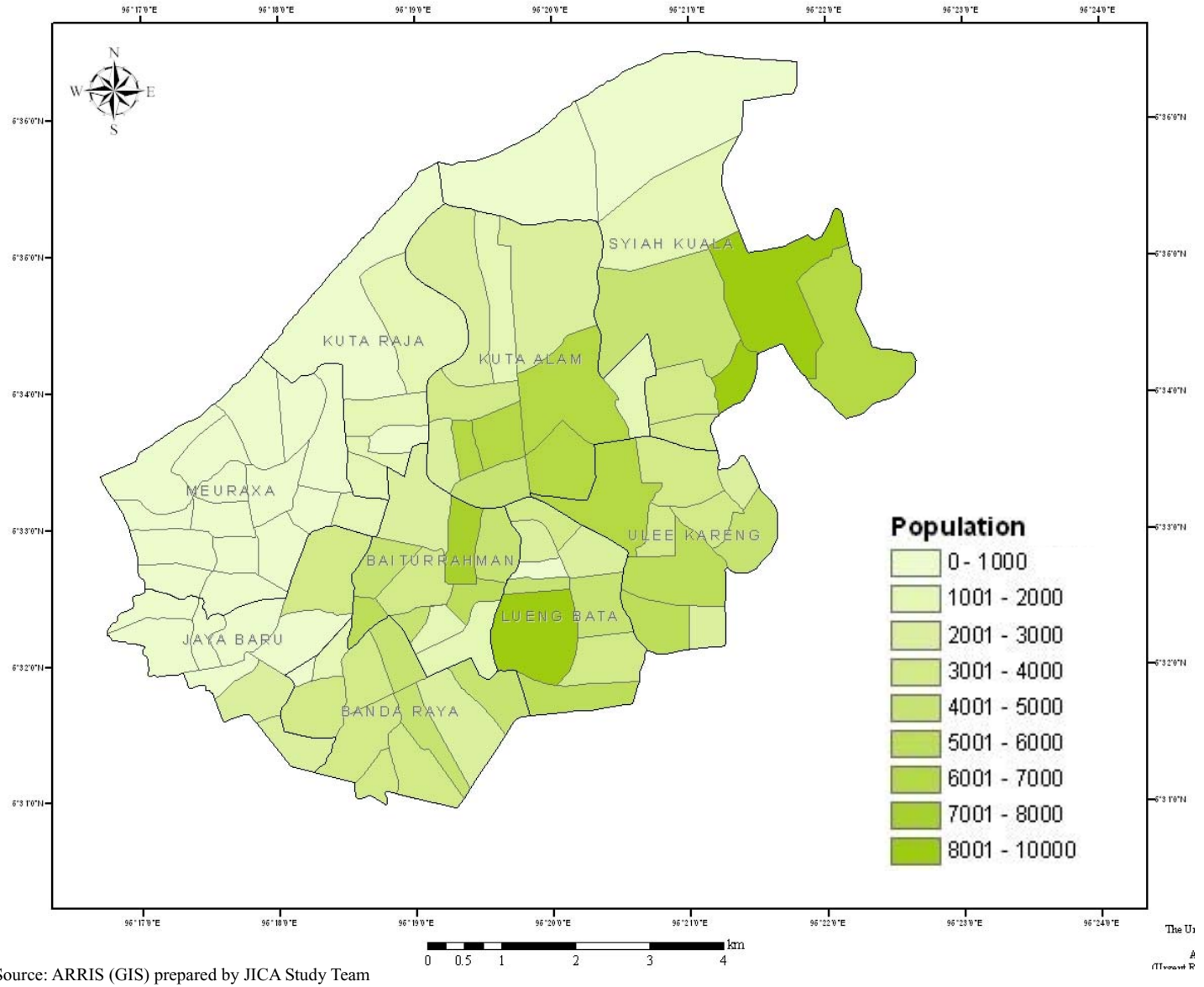
5.1.4 Approach to Rehabilitation and Reconstruction Planning

It is very urgent matter to rehabilitate and reconstruct the water supply system in order to sustain and secure the livelihood of the people and enhance administrative and economic activities as soon as possible. The rehabilitation and reconstruction plan is proceeded in due consideration of the following international assistance in this particular sector, as of June 2005.

Table 5.1.4 Ongoing Projects and Donor Intentions

Assistance	Donor	Notes
Lambaro Water Treatment Plant	France	Not know yet.
	Switzerland	Rehabilitating pumps, buildings and office equipment.
Distribution Pipeline	Japan	Prepare Corporate Plan and urgent rehabilitation of distribution network.
PDAM Office Building	Switzerland	Building rehabilitation and office equipment supply.
Capacity Development	USA	Program continues to 2009.
Others	The Netherlands	Under consideration.

Source: PDAM Banda Aceh



Source: ARRIS (GIS) prepared by JICA Study Team

Figure 5.1.2 Population Projection for 2009

5.1.5 Water Supply Rehabilitation and Reconstruction Plan

(1) Water Demand

Water demand during the planning horizon is forecasted based on the planning criteria as given in Table 5.1.5.

Table 5.1.5 Forecast of Water Demand

Description		unit	2005	2006	2007	2008	2009	2015
Population		people	200,843	212,893	225,767	239,206	254,000	360,304
Served Population	Total	people	116,489	127,736	146,749	167,444	203,200	288,243
	House Conn.	people	104,840	114,962	132,074	150,700	182,880	259,419
	Public Tap	people	11,649	12,774	14,675	16,744	20,320	28,824
Net Demand	House Conn.	m^3/day	15,726	17,244	19,811	22,605	27,432	38,913
	Public Tap	m^3/day	466	511	587	670	813	1,153
	Non-Domestic	m^3/day	3,238	3,551	4,080	4,655	5,649	8,013
	TOTAL	m^3/day	19,430	21,306	24,478	27,930	33,894	48,079
UFW	Rate	%	50	45	40	35	30	30
	Amount	m^3/day	9,715	9,588	9,791	9,775	10,168	14,424
Gross Demand		m^3/day	29,146	30,894	34,269	37,705	44,062	62,503
Supply Capacity	Lambaro	m^3/day	37,584	37,584	37,584	37,584	37,584	37,584
	Siron	m^3/day	1,728	1,728	1,728	1,728	1,728	1,728
	Total	m^3/day	39,312	39,312	39,312	39,312	39,312	39,312
Balance		m^3/day	10,166	8,418	5,043	1,607	-4,750	-23,191

source: JICA Study Team

As shown in table above, the water demand amounts to 44,062 m^3/day in 2009, whereas aggregate production capacity of the Lambaro and Siron water treatment plants are 39,312m^3/day only. It is evident that there is a shortage of water in 2009, amounting to 4,750 m^3/day. On the other hand, water demand in 2015 is preliminarily estimated at 62,503 m^3/day, which is almost 140 % of the water demand in 2009. It is advisable to conduct the feasibility study as soon as possible, so that expanded water supply system could be commission into service by 2010 at latest.

(2) Preliminary Design

Urgent Rehabilitation of Lambaro Water Treatment Plant

The Lambaro water treatment plant has suffered minor damages as noted in Section 5.1.1 above, and is resumed its production already. However, as also reported in Section 5.1.4, it is reported by PDAM that the French and Swiss Governments have offered rehabilitation of this treatment plant for better operation and production of higher quality of treated water. At the time of preparation of this report, details of the proposed rehabilitation works are not known.

Water Supply Distribution Network

The distribution and reticulation networks in the devastated area will be restored and newly installed in conjunction with the development of the new urban area. As noted in Section 5.1.4 of this report, the Government of Japan has committed to rehabilitate distribution network as one of 13 "Quick Impact Projects" and its design is in progress at the time of preparation of this report. The alignment of new distribution networks is as shown in Figure 5.1.3.

Table 5.1.6 Project Feature of Quick Impact Project for Distribution Network

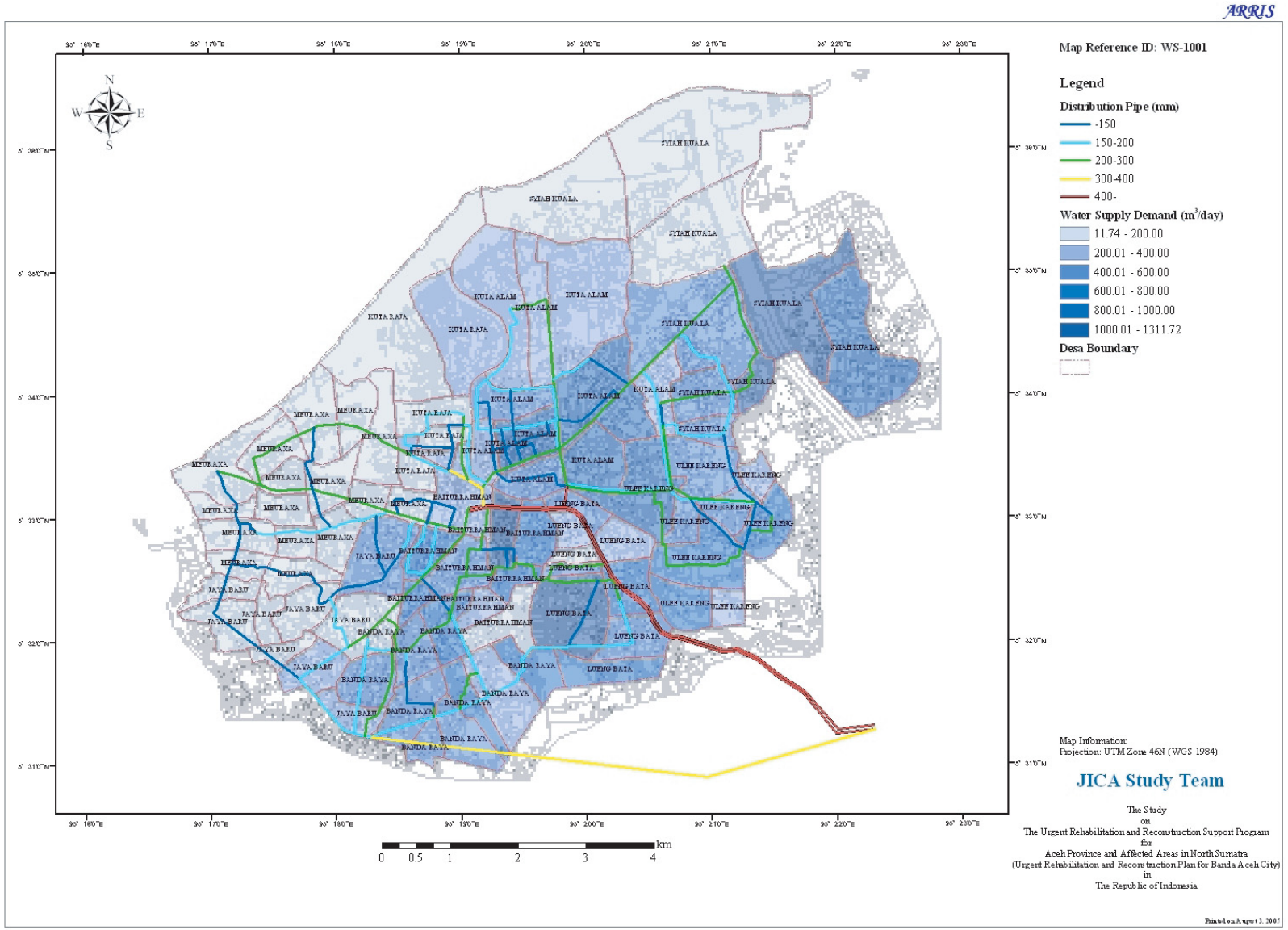
Components	Pipe Material	Diameter	Quantity
1. Replacement Works			
Primary pipe	DIP	600 mm	378 m
Primary pipe	DIP	500 mm	303 m
Primary pipe	PE	400 mm	73 m
Primary pipe	PE	300 mm	250 m
Secondary pipe	PE	250 mm	319 m
Secondary pipe	PE	200 mm	3,660 m
Secondary pipe	PE	150 mm	6,116 m
Tertiary pipe	PE	100 mm	1,463 m
Tertiary pipe	PE	75 mm	1,200 m
Tertiary pipe	PE	50 mm	150,000 m
Tertiary pipe	PE	< 50 mm	109,200 m
Water pipe bridge	-	-	9 units
Public tap	-	-	20 units
Fire hydrant	-	-	10 units
House connection recovery	-	-	13,000 units
2. Extension Works			
Distribution pipe	PE	300 mm	6,500 m

source: JICA Study Team

Preliminary Proposal for Expansion of Water Supply System

It is necessary to implement an expansion of water supply system as assessed in Section 5.1.5 herein. Otherwise, Banda Aceh City would face a shortage of water supply from 2009 onward. The water demand in 2015 is forecasted on a basis of rough population projection. The required additional supply is estimated at 23,191 m^3/day to meet the whole demand in 2015.

It is presumed that the Aceh River has enough unregulated discharge to meet such increased water demand and there is an ample land available in the vicinity of existing Lambaro water treatment plant. This is one of feasible alternatives for consideration of PDAM.



Source: ARRIS (GIS) prepared by JICA Study Team

Figure 5.1.3 Alignment of New Distribution Network

5.1.6 Preliminary Cost Estimate and Implementation Schedule

(1) Preliminary Project Cost Estimate

As shown in Table 5.1.7, the estimated project cost is of indicative natures and subject to change when more in-depth study is completed. The preliminary project cost is estimated at Rp. 145.7 billion, of which Rp. 21.7 billion is attributable to expansion of water supply system after 2009.

Table 5.1.7 Preliminary Project Cost Estimate

(Rp. billion)

Proposed Project/Program	Works	Amount
A. Projects	(1) PDAM Administrative Facilities	12.80
	(2) Rehabilitation of Lambaro Water Treatment Plant	14.42
	(3) Rehabilitation of Water Distribution System	87.65
	(4) Expansion of Lambaro Water Treatment Plant	21.67
	Sub-total for Projects	136.54
B. Programs	(1) Banda Aceh Water Supply Master Plan 2007-2020	3.14
	(2) PDAM Corporate Plan 2005-2009	0.33
	(3) Capacity Building Program	5.70
	Sub-total for Programs	9.17
	Total	145.71

Source: JICA Study Team

The cost estimate is based on actual contract price of the similar works with the following conditions and assumptions:

a) Land acquisition and compensation cost is not included.

b) The direct construction cost is assumed to include the amount of VAT but not to include import duties.

c) The physical and price contingencies are assumed to be 10 % of the direct construction cost, respectively.

d) The engineering service for design and construction supervision is assumed also to be 10 % of the direct construction cost.

(2) Tentative Implementation Schedule

The rehabilitation and reconstruction works are planned to be implemented with the following schedule:

Table 5.1.8 Tentative Implementation Schedule

Projects/Programs	Implementation Schedule				
	Rehabilitation Stage		Reconstruction Stage		
	2005	2006	2007	2008	2009
A. Projects					
(1) PDAM Administrative Facilities					
(2) Rehabilitation of LambaroWater Treatment Plant					
(3) Rehabilitation of Water Distribution System					
(4) Expansion of Lambaro Water Treatment Plant	Beyond 2009				
B. Programs					
(1) Banda Aceh Water Supply Master Plan 2007-2020					
(2) PDAM Corporate Plan 2005-2009					
(3) Capacity Building Program					

Source: JICA Study Team

(3) Annual Fund Requirement

In accordance with the preliminary project cost estimate and tentative implementation schedule presented above, annual fund requirement for the water sector is set as follows.

Table 5.1.9 Annual Fund Requirement

(Rp. billion)

Projects/Programs	Rehabilitation		Reconstruction			Long-term	Total
	2005	2006	2007	2008	2009	2010/15	
Project							
(1) PDAM Administrative Facilities	7.87	0.25	4.68				12.80
(2) Rehabilitation of Lambaro Water Treatment Plant	4.15	10.27					14.42
(3) Rehabilitation of Water Distribution System	14.32	72.29	1.04				87.65
(4) Expansion of Lambaro Water Treatment Plant						21.67	21.67
							Program
(1) Banda Aceh Water Supply Master Plan 2007-2020		3.14					3.14
(2) PDAM Corporate Plan 2005-2009	0.33						0.33
(3) Capacity Building Program	1.33	1.93	0.92	0.76	0.76		5.70
Total	28.00	87.88	6.64	0.76	0.76	21.67	145.71

Source: JICA Study Team

5.2 URBAN SANITATION AND DRAINAGE

5.2.1 Situations before and after Disaster

It is important to assess realistically the urban sanitation and drainage situation before and after disaster to set forth the most feasible rehabilitation and reconstruction plan for the target year 2009 and thereafter.

(1) Wastewater Treatment and Disposal

Even before the disaster there was no sewerage system in Banda Aceh City. The wastewater treatment was wholly resorted to on-site treatment facilities, most predominantly septic tank. Septage accumulated in the septic tank was extracted normally once a year by the Department of Sanitary and Park (DPK) and a private firm, and effluent from the septic tank is flown into the rivers through the urban drainage. Septage was to some extent treated at septage treatment plant which is still located on the left bank and in the vanity of the Aceh River mouth. It consists of two lines of an Imhoff tank, an anaerobic tank, a facultative tank and a maturation tank. Its treatment capacity is estimated at 50m^3/day on a basis of volume of the tanks. It is however informed that the Imhoff tanks were not properly functioning even before the disaster. Since the septage generation is far bigger than the treatment capacity, it is likely that the plant was operated in over-load or portion of sludge was discharged to the sea without any treatment. Figure 5.2.1 and Table 5.2.1 show a general layout and principal features of the existing septage treatment plant before the disaster.

Table 5.2.1 Features of Main Components of Septage Treatment Plant

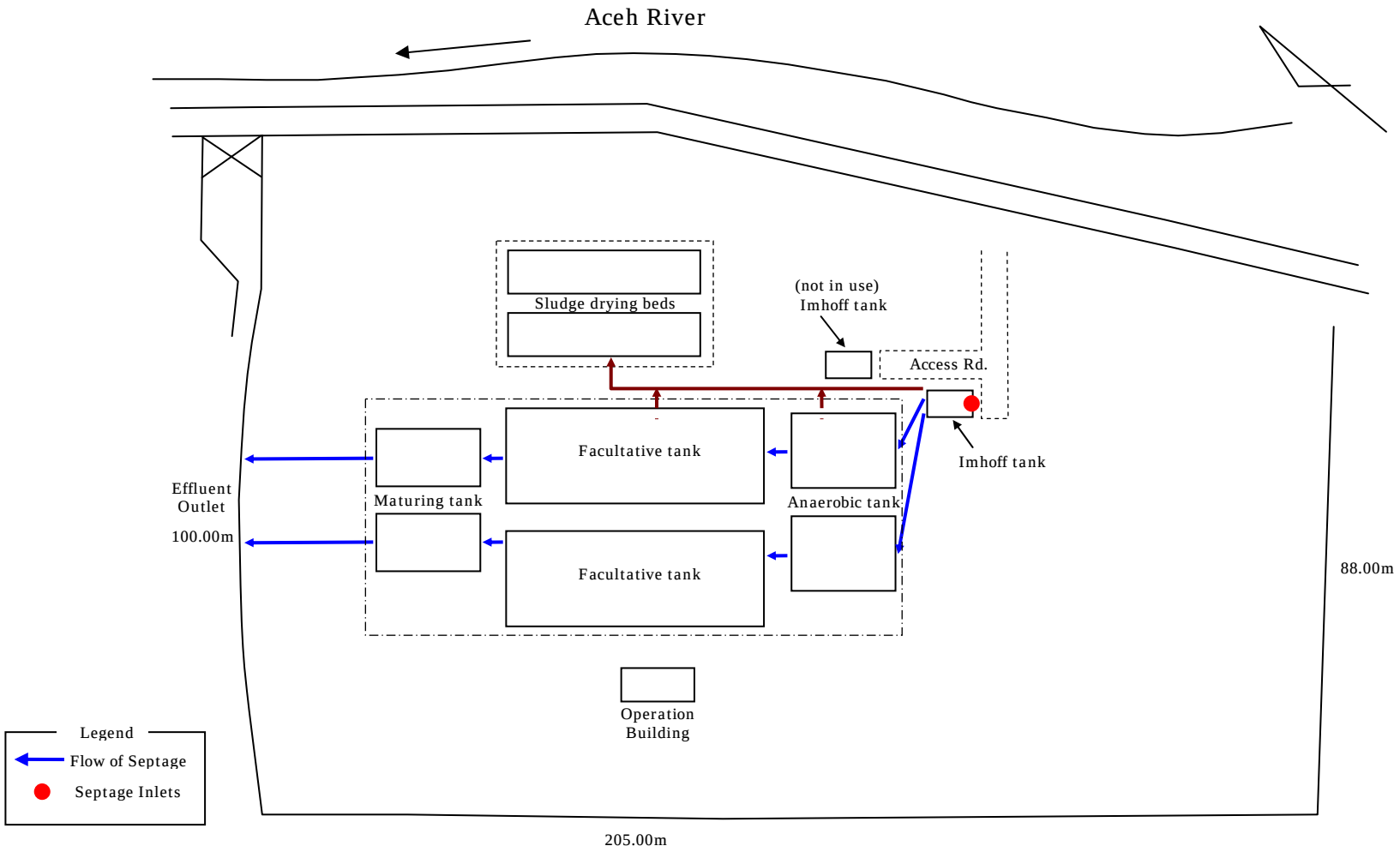
Components		Dimension (m)			Storage capacity
1	Imhoff Tank	Bottom Length	Bottom Width	Depth	(m^3)
2	Anaerobic Tank	10.8	3.0	3.5	392
3	Facultative Tank	48.0	13.9	1.35	1,078
4	Maturation Tank	15.8	7.0	1.35	221
5	Sludge Drying Bed	8.0	4.0	1.2	38

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

The houses and buildings in the area along the coast were completely collapsed, mainly due to Tsunami. After removal of great amount of debris the area is almost flattened. Conditions of the septic tanks in this area are not known exactly. Also the disaster has deteriorated completely not only the septage treatment plant but also washed away septage collection vehicles and skilled technical staff of DKP. Also compound area of the plant was subsidized, resulting in hampering discharge of the treated wastewater from the plant. Table 5.2.2 presents the structural conditions of the plant after the disaster.

As one of the emergency measures to ensure hygienic environment immediately after the

disaster, international communities donated not only septage collection vehicles but are actually engaging in septage collection at their own finance. The septage is being collected from the residential areas and also from the IDP camps. Unfortunately it is inevitable to dispose the septage directly into the sea in the vicinity of the existing septage treatment plant, probably resulting in deteriorating aqua-ecology.



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

Figure 5.2.1 Layout Map of Existing Septage Treatment Plant

Table 5.2.2 Septage Treatment Plant after Disaster and Sludge Disposal

	General view of the plant. All main components were severely damaged to the extent that they are no longer usable without proper rehabilitation/reconstruction.
	Disposal of septage at present.

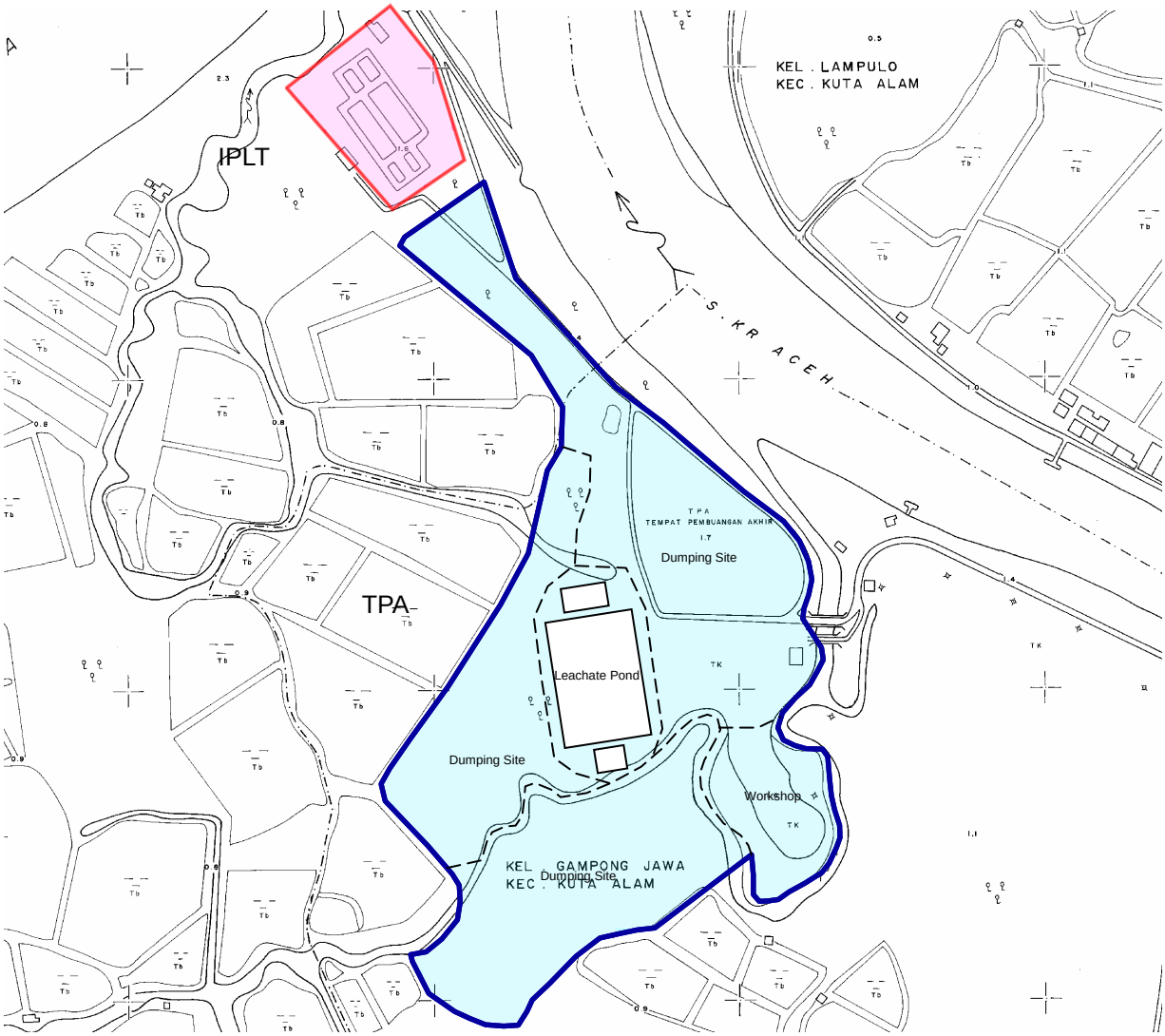
(2) Solid Waste Management

DKP is also responsible for the collection and disposal of garbage and solid waste. There is a landfill site of 12 ha almost at the same location as the septage treatment plant mentioned above. Normally DKP collected the garbage and solid waste from the designated collection stations within the city at an interval of 2-3 days by collection cars. The location of existing landfill site is shown in Figure 5.2.2.

The disaster has caused severe damages for the services. Out of 353 service staffs, 40 people were lost/missing and various equipments were also washed away and/or seriously damaged. The disaster has also caused other unexpected problem. That is a large reduction in residual life of existing landfill site. A huge amount of debris has occurred in devastated areas, and they are dumped there. It is reported by DKP that the residual life is only two (2) years. Damages to solid waste service facilities are seen in Table 5.2.3.

Table 5.2.3 Solid Waste Management after Disaster

	General View of Landfill site Garbage, solid waste and wreckages are disposed disorderly.

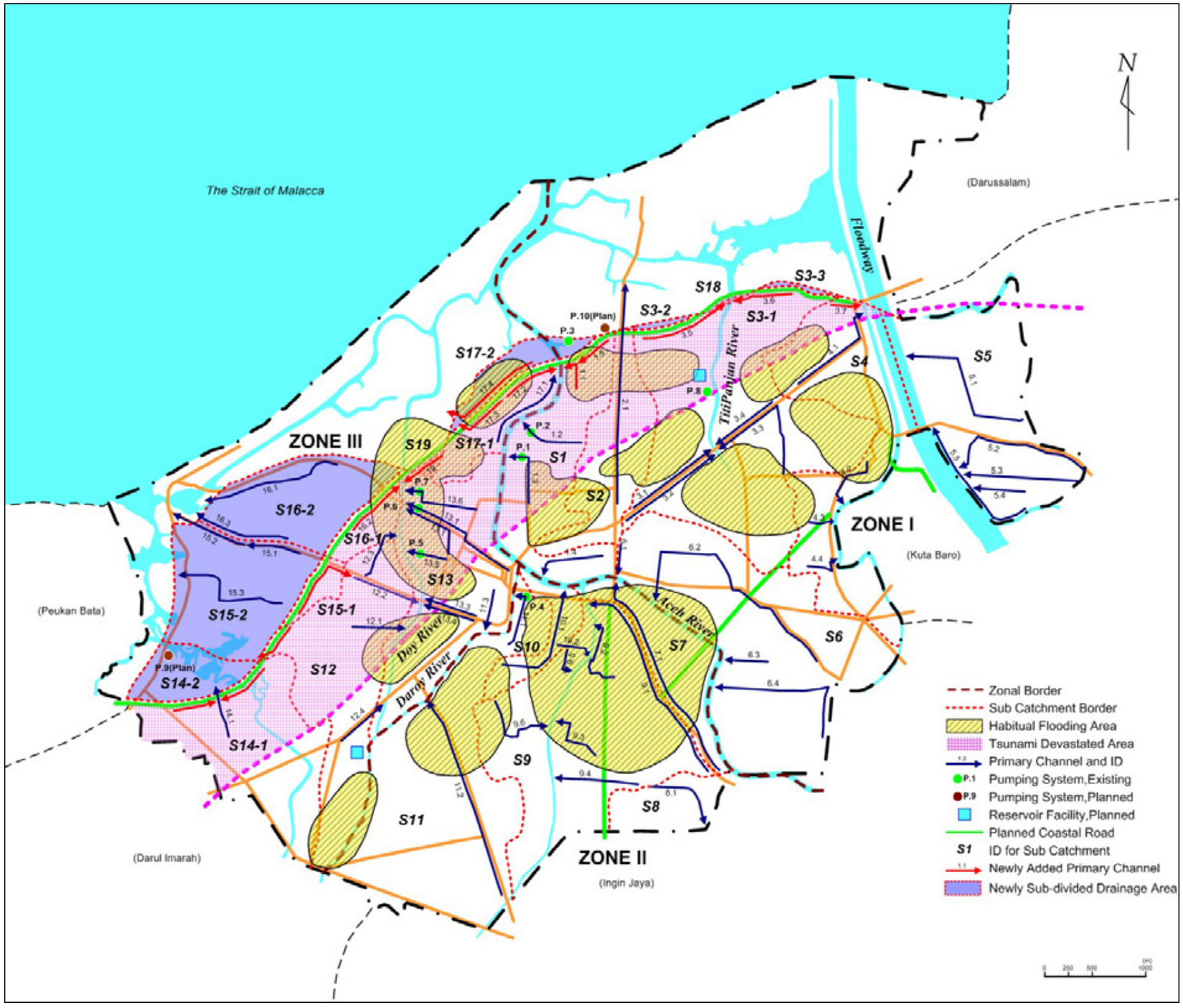


Source: JICA Study Team

Figure 5.2.2 Location Map of Existing Septage Treatment Plant and Landfill Site

(3) Urban Drainage System

According to DPU, existing drainages covers the area of 35 km^2, where is divided into three (3) drainage zones as shown in Figure 5.2.3. Each zone was provided with a network of covered drainage conduits, mostly aligned along the roads, and there were 8 pumping stations in total, owing to topographic characteristics. Table 5.2.4 presents the drainage area and facilities before and after the disaster.



Source: JICA Study Team

Figure 5.2.3 Outline of Rehabilitation and Reconstruction Plan for Urban Drainage

Table 5.2.4 Status of Drainage Facilities before and after Disaster

Structures	Description	Unit	Zone I	Zone II	Zone III	Total
	Drainage area	ha	957	992	1,550	3,499
	Number of sub-zones	Nos.	6	5	6	17
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 ratio	Nos.	60	23	19	31

Source: Dept. of Public Works (DPU)

Primary drains are connected to such river as Krueng Aceh, Krueng Doy, floodway, etc. It should be noted that drainage conduit receives effluent from septic tanks and discharges to the rivers and there exist habitual inundation areas in many locations within the city area as also shown in Figure 5.2.3.

After the disaster, the network of drainage conduits was seriously damaged, eroded and deteriorated at many places, especially in the area along the coast. Also dykes and floodwalls along the major rivers were broken and destroyed at many locations, causing inundation in surrounding areas. Such damages to the drainage system and dykes are shown in Table 5.2.5.

Table 5.2.5 Damages on Drainage Structures

	Pumping Station and gate at Titi Panjang River were washed away and seriously damaged respectively
	Break of the Doy river dyke and subsequent inundation

	Recovery Work for Digging Channels, Kuta Raja Region

5.2.2 Mission, Strategies and Goals

Mission, strategies and goals for urban sanitary services and drainage are set forth as stated below:

	Wastewater Treatment and Disposal	Solid Waste Management	Drainage
Mission	To secure health of whole population of 254,000 from waterborne deceases To create amenity and hygienic urban environment To conserve aqua-ecology in open water within city	To create clean urban environment To minimize generation of solid waste and garbage	To ensure safety of human lives and properties To enhance economic activities without any interruption throughout the year To complete systematic urban drainage network over the entire city area
Strategies	To guide people to adopt improved type of septic tank To apply technically and financially feasible and sustainable technology To strengthen DPK so that all population receives equitable services	To introduce separation, re-use and recycling of solid waste with education and cooperation of people To strengthen DPK so that all population receives equitable services	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 in conduits To reinforce O& M capability of DPU
Goals	To bring existing septage treatment plant back into operation within 2005 To reinforce septage collection and treatment capacity To treat the whole volume of septage to be generated by 2009 To develop sewerage system at adequate time	To develop promptly as possible new landfill site before 2009 To reinforce garbage collection vehicle and landfill equipment	To re-install systematic drainage in devastated area by 2009 To re-install and reinforce drainage pump stations urgently To rehabilitate broken and destroyed dyke and flood wall in two years period

5.2.3 Rehabilitation and Reconstruction Planning for Wastewater Treatment and Disposal

It should be noted that the present planning is of preliminary level and prepared based on the limited data and information and in a very short time. It is therefore necessary to conduct in-depth study before realization of actual rehabilitation and reconstruction works.

(1) Planning Criteria

For the purpose of rehabilitation and reconstruction plan the following planning criteria are set forth:

a) General criteria

Target year	: Rehabilitation by 2006, Reconstruction by 2009
Target area	: Banda Aceh City with administrative area of 61 km^2
Population in 2009	: 254,000 as projected under this study
Population distribution	: As per studied as a part of city development plan of this study
Urban development	: As per spatial and city development plans of this study

b) Planning criteria for wastewater treatment and disposal

(b.1) Numbers of household

Average family size	: 5 people
Nos. of household	: 50,800 in 2009

(b.2) Septage treatment

Assumed quality of wastewater	:BOD_5; 2,000mg/l, COD; 6,000mg/l,
Target quality of treated wastewater	:BOD_5; 50mg/l, COD; 100mg/l, SS; less than 200mg/l
Type of on-site treatment	:Septic tank, 0.9m in diameter, 1.2m in depth
Interval of desludging	:Once in a year
Septage generation from others	:15 % of the domestic septage

(b.3) Sewerage treatment

Connection ratio	: 100 % in proposed sewered area
Domestic wastewater generation	: 150l/day/capita
Wastewater from others	: 30 % of the domestic
Assumed quality of wastewater	: BOD_5; 200mg/l, COD; 200mg/l, SS; 200mg/l

Target quality of treated wastewater: BOD_5; 50mg/l, COD; 100mg/l, SS; 100mg/l

(2) Approach to Wastewater Treatment

The rehabilitation of the existing septage treatment plant is the must and must be completed in the shortest time possible. Fortunately the Government of Japan through JICA has committed to its rehabilitation and actual construction has taken place with a completion target within 2005.

There are two development scenarios to address the wastewater treatment in the future as described below:

Scenario (A): To continuously depend entirely on the on-site treatment method

Scenario (B): To combine the on- and off-sites treatment method

In case of Scenario (A) it is necessary to expand the existing septage treatment plant, since it is not possible to properly treat the whole quantity of septage by 2009. In 2001, the City Administration has established its 10-year physical development plan which includes development of sewerage system in center of the city, in particular 8 desas in kecamatan Baiturrahman and kecamatan Kuta Alam.

In this report preliminary layout design and construction cost estimate are made for the above two (2) scenarios.

(3) Estimate of Septage and Wastewater Generation

For planning of additional septage treatment plant and sewerage system, quantity of septage and wastewater from the planned sewer area are estimated based on the planning criteria mentioned above. Details of the calculation are presented in Appendix 4 Urban Sanitation and Drainage.

The septage volume is estimated to amount 144m^3/day in 2009, exceeding the treatment capacity of the existing plant by 94m^3/day.

The sewerage system development is basically referred to the physical development of the city. The sewered area includes the population of 38,282 in 2009 according to the latest forecast, all of which is planned to be connected with sewer, except part of desa Mulia (connection rate: 30 %). The quantity of wastewater is estimated to be 7,000m^3/day in terms of dry weather flow. With allowance to storm water and groundwater penetration, gross quantity of wastewater reached 8,400m^3/day in terms of daily mean. The daily maximum and hourly maximum quantity are estimated at 9,250m^3/day and 12,600m^3/day, respectively.

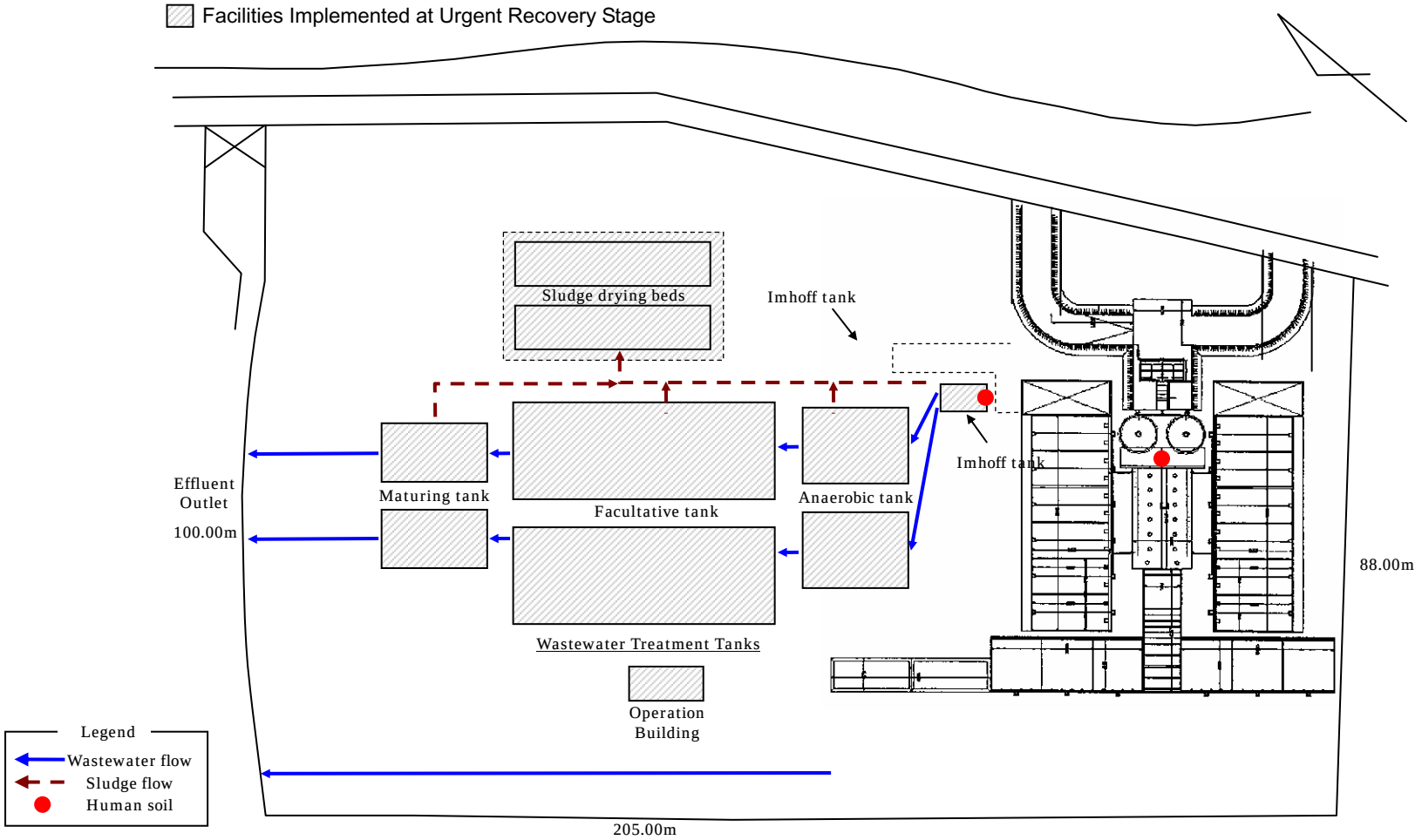
(4) Preliminary Design

The preliminary layout design is prepared for both the septage treatment plant and sewerage system as briefly described below:

Septage Treatment Plant

The required treatment capacity is 94m^3/day. It is proposed to locate the additional plant

adjacent to the existing plant to minimize land acquisition and, ease operation and maintenance. The design prepared by UNICEF is assumed to be adaptable. The layout of the plant is shown in Figure 5.2.4 and principal features in Table 5.2.6.



Source: UNICEF Proposal

Figure 5.2.4 Layout Plan of Additional Septage Treatment Plant

Table 5.2.6 Principal Features of 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

The septage is one of pollution source to the rivers. The amount of pollutant is estimated to be 288kg/day in terms of BOD_5 in 2005. With proper operation of existing and additional septage treatment plants pollution load would be reduced to 72kg/day.

Sewerage System

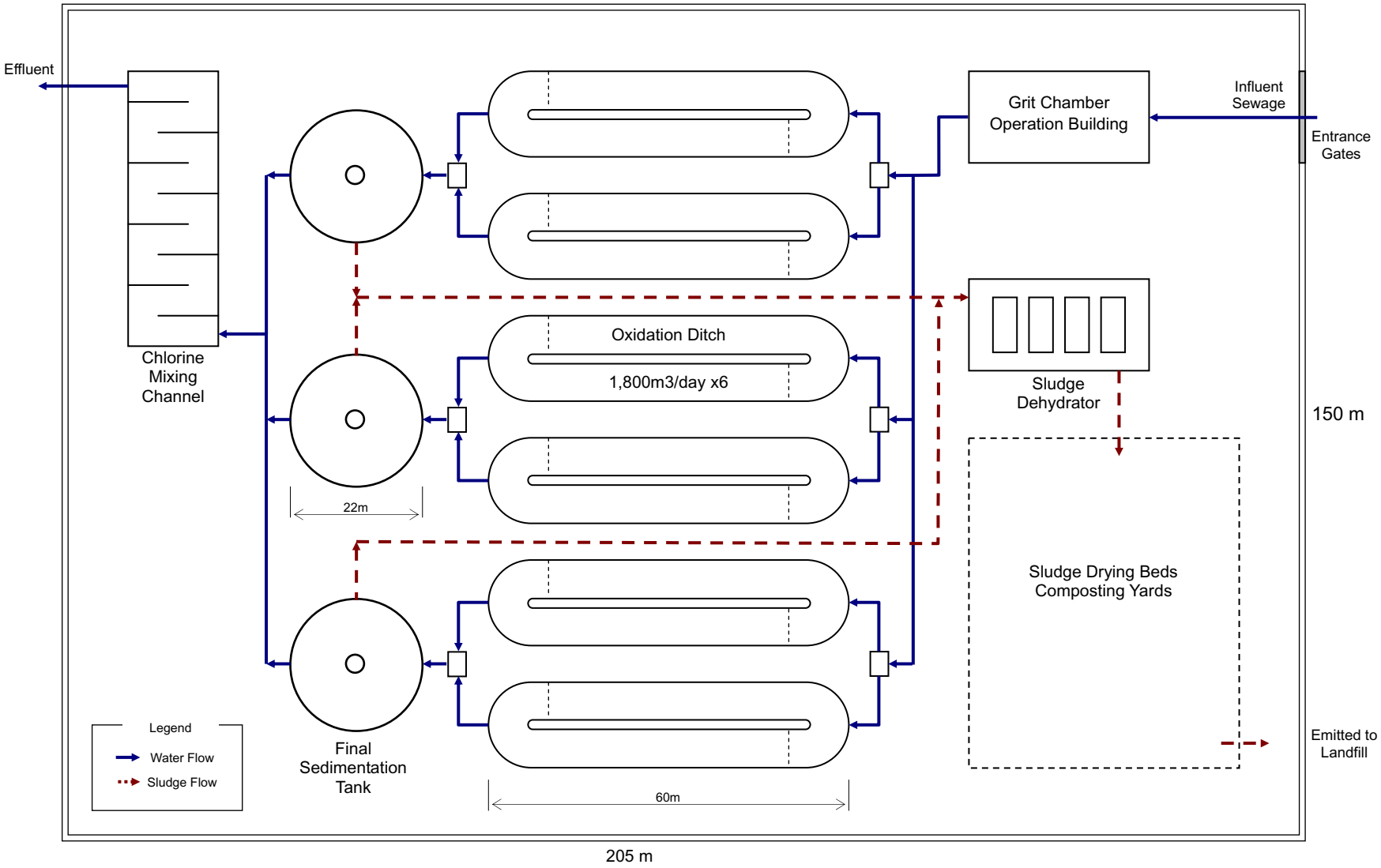
The sewerage system will have a daily treatment capacity of 8,400m^3/day and comprise sewer network, wastewater treatment plant and sludge treatment and disposal facilities. Its overall layout is as given in Figure 5.2.5.

The sewer network will be separated from storm water drainage system and designed in gravity flow. The length of the sewer is estimated at 3,500m for trunk lines and 52,400m for lateral. At the down stream end of the trunk sewer it will be necessary to install a booster pumping station owing to topographic reason. The wastewater treatment plant will be located in the vicinity of the existing septage treatment plant and of oxidation ditch treatment type. Sludge will be processed by dehydrator and sludge thickener. A salient feature of the wastewater treatment plant is as presented in Table 5.2.7.

Table 5.2.7 Principal Features of Wastewater Treatment Plant

Main Component	Nos. of Unit	Width (m)	Length (m)	Depth (m)	Notes;
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	-	-	Circular shape
Chlorine mixing chamber	1	6.0	50.0	1.2	
Sludge thickener	3	4.0	-	3.0	
Sludge dehydrator	3	-	-	-	
Composted yard	1	-	-	-	

Source: JICA Study Team



Source: JICA Study Team

Figure 5.2.5 Layout Plan of Wastewater Treatment Plant

Reinforcement of Septage Collection Capacity

DKP had lost substantially its septage collection and transport fleet. As of July 2005, the septage collection is handled by the international assistance. An attempt is made to estimate the number of septage collection cars required to collect the whole volume of septage in 2009. It is assessed that 20 numbers of collection vehicles, each with a capacity of 3 tons, would be required by the year 2009. Detail of this assessment is presented in Appendix 4.

(5) Preliminary Cost Estimate

Construction cost was estimated for the additional septage treatment plant and the sewerage system, on the basis of costs of the similar scale and type of the facilities as shown in Table 5.2.8.

Table 5.2.8 Preliminary Cost Estimate

(Rp. billion)

Proposed Project/Program	Works	Amount
A. Projects	(1) Rehabilitation of Existing Septage Plant	7.98
	(2) Additional Septage Treatment Plant	6.94
	(3) Procurement of Vacuum Cars	5.06
	(4) Sewerage Development	176.74
	Total	196.72

Source: JICA Study Team

The cost estimate is based on the following conditions and assumptions:

a) Land acquisition and compensation cost is not included.

b) The direct construction cost is assumed to include the amount of VAT but not to include import duties.

c) The physical and price contingencies are assumed to be 10 % of the direct construction cost, respectively.

d) The engineering service for design and construction supervision is assumed also to be 10 % of the direct construction cost.

(6) Implementation Schedule

There are two scenarios for implementation of the wastewater treatment and disposal as noted hereinabove. It is however recommendable to implement the rehabilitation and reconstruction plan along with the Scenario (A) as follows:

Table 5.2.9 Tentative Implementation Schedule

Projects/Programs	Implementation Schedule				
	Rehabilitation Stage		Reconstruction Stage		
	2005	2006	2007	2008	2009
A. Projects					
(1) Rehabilitation of Existing Septage Plant					
(2) Additional Septage Treatment Plant					
(3) Procurement of Vacuum Cars					
(4) Sewerage Development	Beyond 2009				

Source: JICA Study Team

It is very important to realize the additional septage treatment plant in order to accomplish the mission and goals of this sector. It is however advisable to defer the implementation of the sewerage system beyond 2009. The proposed sewer area planned in the physical development plan encompasses only about 36,000 population or 14 % of total population of 254,000 in 2009. Its financial viability is questionable and it is practically hardly possible to complete the construction works before 2009. It is also advisable to carry out a master plan study to identify the most appropriate and adaptable wastewater treatment system within the city.

(7) Annual Fund Requirement

In accordance with the preliminary project cost estimate and tentative implementation schedule presented above, annual fund requirement for wastewater treatment is set as follows.

Table 5.2.10 Annual Fund Requirement

(Rp. billion)

Projects/Programs	Rehabilitation		Reconstruction			Long-term	Total
	2005	2006	2007	2008	2009	2010/15	
Project							
(1) Rehabilitation of Existing Septage Plant	7.98						7.98
(2) Additional Septage Treatment Plant		2.78	4.16				6.94
(3) Procurement of Vacuum Cars		1.69	1.69	1.69			5.06
(4) Sewerage Development						176.74	176.74
Total	7.98	4.47	5.85	1.69		176.74	196.72

Source: JICA Study Team

5.2.4 Rehabilitation and Reconstruction Planning for Solid Waste Management

As reported in the preceding section 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 therefore urgent need to develop new landfill site to accommodate garbage and solid waste to be generated from the city in future.

(1) Planning Criteria

a) General criteria

Target year	: Rehabilitation; 2006, Reconstruction; 2009
Target area	: Banda Aceh City with administrative area of 61 km^2
Population in 2009	: 254,000 as projected under this study
Population distribution	: As per studied as a part of city development plan of this study
Urban development	: As per spatial and city development plans of this study

b) 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

(2) Estimate of Garbage and Solid Waste

Based on the planning criteria annual volume of garbage and solid waste is estimated at 64,970m^3, equivalent to 178m^3/day.

(3) Preliminary Design

According to DKP it is most desirous to design the new landfill site with a life of 20 years. Assuming average filling thickness of 5m, approximately 25 ha of land are required. A leachate pond will be provided to properly absorb and treat the water derived from the dumped materials. The new landfill site can be identified in the vicinity of existing landfill site.

Collection of garbage will be done by a combination of packer vans and dump truck. The solid waste other than domestic garbage will be collected by dump trucks and domestic garbage by packer van. Required numbers of dump truck (8 m^3) and packer van (3m^3) will be 5 and 25 respectively, including stand-by. Details of estimate are presented in Appendix 4.

(4) Preliminary Cost Estimate

The construction cost of new landfill site and the procurement cost of garbage collection and transportation vehicles are estimated as presented in Table 5.2.11.

Table 5.2.11 Preliminary Cost Estimate

(Rp. billion)

Proposed Project/Program	Works	Amount
A. Projects	(1) Construction of new Landfill Site (TPA)	206.52
	(2) Procurement of Packer and Dump Trucks	2.97
	Total	209.49

Source: JICA Study Team

The cost estimate is based on actual contract price of similar works with the following conditions and assumptions:

a) Land acquisition and compensation cost is not included.

b) The direct construction cost is assumed to include the amount of VAT but not to include import duties.

c) The physical and price contingencies are assumed to be 10 % of the direct construction cost, respectively.

d) The engineering service for design and construction supervision is assumed also to be 10 % of the direct construction cost.

(5) Implementation Plan

In view of the residual life of existing landfill site, it is proposed that the new landfill site be completed by 2007 or operational from 2008. Tentative implementation schedule is set as follows.

Table 5.2.12 Tentative Implementation Schedule

Projects/Programs	Implementation Schedule				
	Rehabilitation Stage		Reconstruction Stage		
	2005	2006	2007	2008	2009
A. Projects					
(1) Construction of new Landfill Site (TPA)		[redacted]	[redacted]		
(2) Procurement of Packer and Dump Trucks		[redacted]	[redacted]	[redacted]	

Source: JICA Study Team

(6) Annual Fund Requirement

In accordance with the preliminary project cost estimate and tentative implementation schedule presented above, annual fund requirement for solid waste management is set as follows.

Table 5.2.13 Annual Fund Requirement

(Rp. billion)

Projects/Programs	Rehabilitation		Reconstruction			Long-term	Total
	2005	2006	2007	2008	2009	2010/15	
Project							
(1) Construction of new Landfill Site		103.26	103.26				206.52
(2) Procurement of Packer Van and Dump Trucks		0.99	0.99	0.99			2.97
Total		104.25	104.25	0.99			209.49

Source: JICA Study Team

5.2.5 Rehabilitation and Reconstruction Planning for Urban Drainage System

One of the most urgent issues is to implement urgent rehabilitation works on drainage system and dykes and floodwalls of major rivers in the city, since the city would be attacked by high tide and storm water in the later part of 2005. Although the preliminary planning of rehabilitation and reconstruction of drainage system is attempted in this report, it is important to conduct more detailed study before actual implementation of the works in framework of long-term drainage system improvement.

(1) Planning Criteria

a) General criteria

Target year : Rehabilitation; 2006, Reconstruction; 2009
Target area : Banda Aceh City with administrative area of 61 km^2
Population in 2009 : 254,000 as projected under this study
Population distribution : As per studied as a part of city development plan of this study
Urban development : As per spatial and city development plans of this study

b) Criteria for drainage system design

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

(2) Approach to Planning

The rehabilitation and reconstruction plan basically follows drainage pattern and system before the disaster. However, it is necessary to slightly modify in conformity to the proposed city development plan.

Also in order to cope with the immediate problems such as marching of high tide and rainy season, it is absolutely necessary to execute countermeasures as soon as possible. The rehabilitation and reconstruction works are therefore proposed to be carried out in the priority order mentioned below.

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)

As reported in the preceding section of this report, there are a number of habitual inundation areas and some parts of the city area are lower than high water level of the Ache River. It is considered to be rational that drainage system is designed with a combination of drainage channels, retardation areas and pumping stations to efficiently and safely drain storm water from the land area of the city.

(3) Drainage Zones

Drainage zones remain the almost same as those before disaster. The entire drainage area is divided into three (3) zones. However the new sub-drainage areas are created, characterized by the city development plan under the current study. Those new sub-drainage areas are S14-2, S15-2, S16-2 and S17-2. The new zoning map is as shown in Figure 5.2.3.

(4) Run-off

The run-off from each sub-drainage area is computed on a basis of the Rational formula and design storm rainfall as given in Table 5.2.14.

Table 5.2.14 Run-off Calculation from Each Drainage Areas

Zone	Sub	Primary	Pump	Run-Off			
	Drainage	Drain	Station	Drainage Area	Furthest Distance	Coefficient Discharge	Run-off
				(ha)	(m)	-	(m^3/s)
Zone I	1	1.1	P.3	58.00	150	0.5170	1.254
Zone I	1	1.2	P.2	53.00	200	0.5175	0.268
Zone I	1	1.3	P.1	65.50	200	0.5585	1.205
Zone I	1	1.4		29.50	150	0.5755	0.481
Zone I	2	2.1		130.00	400	0.5095	1.571

Zone	Sub	Primary	Pump	Run-Off			
	Drainage	Drain	Station	Drainage Area	Furthest Distance	Coefficient Discharge	Run-off
				(ha)	(m)	-	(m^3/s)
Zone I	3	3.1		41.00	1,300	0.5085	0.576
Zone I	3	3.2		75.50	600	0.5335	2.613
Zone I	3	3.3.		223.00	650	0.5190	6.484
Zone I	3	3.4		58.00	280	0.5410	1.406
Zone I	3	3.5	P.8	0.00			
Zone I	4	4.1		47.00	325	0.5075	1.832
Zone I	4	4.1.1		35.00	275	0.4930	
Zone I	4	4.2		39.50	250	0.4745	1.291
Zone I	4	4.3		29.00	250	0.4850	0.787
Zone I	4	4.4		44.00	275	0.4890	1.410
Zone I	5	5.1		77.50	200	0.4335	2.110
Zone I	5	5.2		30.00	275	0.5059	1.000
Zone I	5	5.3		56.00	400	0.4990	0.500
Zone I	5	5.4		50.50	350	0.5150	0.240
Zone I	5	5.5		110.00	150	0.5365	2.130
Zone I	6	6.1		40.50	200	0.5100	4.680
Zone I	6	6.2		125.50	550	0.5070	1.621
Zone I	6	6.3		57.00	370	0.4895	0.940
Zone I	6	6.4		75.00	350	0.4850	1.490
Zone II	7	7.1		65.00	275	0.4475	0.945
Zone II	8	8.1		90.00	200	0.4700	1.340
Zone II	9	9.1		127.00	2	0.4610	1.223
Zone II	9	9.2		45.00	500	0.4745	1.128
Zone II	9	9.3		60.00	200	0.4685	0.854
Zone II	9	9.4		53.00	200	0.4700	0.920
Zone II	9	9.5		19.00	250	0.4700	0.552
Zone II	9	9.6		50.00	420	0.4640	1.015
Zone II	10	10.1		41.00	2	0.5035	1.138
Zone II	11	11.0		54.00	300	0.5155	0.840
Zone II	11	11.1	P.4	34.00	300	0.5100	1.480
Zone II	11	11.2		335.00	700	0.4850	6.116
Zone II	11	11.3		19.00	220	0.4025	0.551

Zone	Sub	Primary	Pump	Run-Off			
	Drainage	Drain	Station	Drainage Area	Furthest Distance	Coefficient Discharge	Run-off
				(ha)	(m)	-	(m^3/s)
Zone III	12	12.0		58.00	450	0.5120	2.351
Zone III	12	12.1		150.00	50	0.5125	0.593
Zone III	12	12.2		24.00	100	0.5060	1.578
Zone III	12	12.3		38.50	175	0.4930	1.880
Zone III	12	12.4		33.00	250	0.5035	1.581
Zone III	13	13.1	P.6	45.00	100	0.5540	2.628
Zone III	13	13.2		16.00	100	0.5660	1.118
Zone III	13	13.3		26.50	400	0.3835	0.129
Zone III	13	13.4		28.50	350	0.5165	0.684
Zone III	13	13.5	P.5	43.00	500	0.5215	0.539
Zone III	13	13.6	P.7	50.00	150	0.5245	2.552
Zone III	14	14.1		45.50	300	0.5105	3.200
Zone III	15	15.1		45.00	100	0.4934	1.780
Zone III	15	15.2		27.00	150	0.5070	0.841
Zone III	15	15.3		85.00	425	0.4975	1.880
Zone III	16	16.1		180.00	200	0.3810	3.251
Zone III	17	17.1		41.50	200	0.4250	0.710
Zone III	17	17.2		20.50	100	0.5170	1.058
Total	-	-	-	3,499.00	-	-	82.34

(5) Preliminary Design

Primary Drains and Pumping Stations

The discharge capacity of existing primary drains and pumping stations was firstly assessed whether they are capable of draining the discharge of their drainage area. Table 5.2.15 summarizes the comparison of the computed discharge and drainage capacities of pumps and drains.

Table 5.2.15 Capacities of Existing Drainage Facilities vs Run-off

Sub-drainage areas	Name	Drain to:	Run-off (m^3/s)	Discharge Capacity of Drain (m^3/s)	Pumping Capacity (m^3/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

Source: JICA Study Team

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 so that excess water should be absorbed in retardation basins. Table 5.2.16 summarizes drainage facilities proposed for rehabilitation and reconstruction plan.

Table 5.2.16 Summary of Rehabilitation and Reconstruction Plan for Urban Drainage

Term	Rehabili-tation Stage	Zone	Sub Drainage	Primary Channel	Pump No.	Run-Off		Pumping Facilities	Primary Channels				Water Gates			Retarding Ponds	
						Drainage Area	Run-off		Total Length	Damaged Length	Damaged Ratio	New Channels	Total Gates	Damaged Gates	Damaged Ratio	Dimension	Volume
						(ha)	(m3/s)	(m3/s)	(m)	(m)	(%)	(m)	-	-	(%)	(m)	(m3)
Urgent Recovery	1	Zone I	1	1.3	P.1	65.50	1.205	1.205	950	500	53	0	4	4	100	-	0
		Zone I	3	3.5	P.8	0.00	0.000	11.079	250	0	0	0	0	0		240x120x3.5	540,000
		Zone II	11	11.1	P.4	34.00	1.480	1.480	700	266	38	0	2	0	0	-	0
		Zone III	13	13.1	P.6	45.00	2.628	2.628	225	0	0	0	1	0	0	-	0
	2	Zone I	2	2.1	-	130.00	1.571	-	1,225	490	40	0	2	2	100	-	0
		Zone I	3	3.1-4	-	397.50	11.079	-	5,025	0	0	0	3	2	67	-	0
		Zone I	4	4.1-2	-	86.50	3.123	-	1,475	265	37	0	2	0	0	-	0
		Zone I	6	6.2	-	125.50	1.621	-	1,725	1,670	97	0	2	0	0	-	0
		Zone II	7	7.1	-	65.00	0.945	-	1,363	1,363	100	0	6	0	0	-	0
		Zone II	9	9.1-3,5-6	-	301.00	4.772	-	3,575	293	24	0	12	2	17	-	0
		Zone II	10	10.1	-	41.00	1.138	-	1,500	0	0	0	1	0	0	-	0
		Zone II	11	11.2	-	335.00	6.116	-	1,750	280	16	0	2	4	200	-	0
		Zone III	12	12.1-3	-	212.50	4.051	-	2,075	259	35	0	3	0	0	500x50x3	75,000
		Zone III	13	13.2-4	-	71.00	1.931	-	1,887	0	0	0	5	0	0	-	0
Rehabili-tation	3	Zone I	1	1.1-2	P.2,3	111.00	1.522	1.522	950	850	177	0	4	4	100	-	0
		Zone III	13	13.5-6	P.5,7	93.00	3.091	3.091	1,348	1,046	142	0	9	0	0	-	0
	4	Zone I	1	1.4	-	29.50	0.481	-	575	0	0	0	5	3	60	-	0
		Zone I	4	4.1.1,3-4	-	108.00	2.197	-	1,285	454	70	0	0	0		-	0
		Zone I	5	5.1-5	-	324.00	5.980	-	5,270	0	0	0	0	0		-	0
		Zone I	6	6.1,3-4	-	172.50	7.110	-	4,005	1,948	171	0	3	0	0	-	0
		Zone II	8	8.1	-	90.00	1.340	-	1,289	1,289	100	0	0	0		-	0
		Zone II	9	9.4	-	53.00	0.920	-	1,000	0	0	0	1	1	100	-	0
		Zone II	11	11.0,3	-	73.00	1.391	-	1,760	0	0	0	6	0	0	-	0
		Zone III	12	12.0,4	-	91.00	3.932	-	2,365	0	0	0	0	0		-	0
Reconst-ruction	5	Zone I	1	1.1,1.5	-	0.00	0.000	-	0	0	0	440	0	0		-	0
		Zone I	3	3.5-7	-	0.00	0.000	-	0	0	0	1,920	0	0		-	0
		Zone III	12	12.5	-	0.00	0.000	-	0	0	0	500	0	0		-	0
		Zone III	14	14.1-3	-	45.50	3.200	-	840	0	0	1,020	12	4	33	-	0
		Zone III	15	15.1-4	-	157.00	0.000	-	4,150	0	0	820	5	0	0	-	0
		Zone III	16	16.1-2	-	180.00	3.251	-	975	0	0	680	4	4	100	-	0
		Zone III	17	17.1-4,19	-	62.00	1.768	-	1,825	622	62	2,728	4	0	0	-	0
Total	-	-	-	-	-	3,499.00	77.843	21.005	51,362	11,595	23	8,108	98	30	31	-	615,000

Source: JICA Study Team

Retardation Areas

It is proposed to create the retardation ponds at two (2) locations: one is at Pump Station No.8 with a storage capacity of 540,000m^3 and the other is in Sub-drainage 12 with a storage capacity of 75,000m^3.

(6) Preliminary Cost Estimate

The rehabilitation and reconstruction cost is roughly estimated as shown in Table 5.2.17, on the basis of experiences of the similar works.

Table 5.2.17 Preliminary Cost Estimate

(Rp. billion)

Proposed Project/Program	Works	Amount
A. Projects	(1) Urgent Recover (Priority 1 and 2)	130.28
	(2) Rehabilitation Works (Priority 3 and 4)	49.40
	(3) Reconstruction Works (Priority 4)	177.97
	(4) Rehabilitation and reconstruction of dykes and floodwall along major rivers	95.00
	Total	452.65

Source: JICA Study Team

The cost estimated is also based on the following conditions and assumptions:

a) Land acquisition and compensation cost is not included.

b) The direct construction cost is assumed to include the amount of VAT but not to include import duties.

c) The physical and price contingencies are assumed to be 10 % of the direct construction cost, respectively.

d) The engineering service for design and construction supervision is assumed also to be 10 % of the direct construction.

(7) Implementation Schedule

It is proposed the proposed plan will be implemented along with the following schedule:

Table 5.2.18 Tentative Implementation Schedule

Projects/Programs	Implementation Schedule				
	Rehabilitation Stage		Reconstruction Stage		
	2005	2006	2007	2008	2009
A. Projects					
(1) Urgent Recover (Priority 1 and 2)					
(2) Rehabilitation Works (Priority 3 and 4)					
(3) Reconstruction Works (Priority 5)					
(4) Rehabilitation and reconstruction of dykes and					

Source: JICA Study Team

(8) Annual Fund Requirement

In accordance with the preliminary project cost estimate and tentative implementation schedule presented above, annual fund requirement for Drainage System is set as follows.

Table 5.2.19 Annual Fund Requirement for Drainage System

(Rp. billion)

Projects/Programs	Rehabilitation		Reconstruction			Long-term	Total
	2005	2006	2007	2008	2009	2010/15	
Project							
(1) Urgent Recover (Priority 1 and 2)	32.57	65.14	32.57				130.28
(2) Rehabilitation Works (Priority 3 and 4)		14.82	34.58				49.40
(3) Reconstruction Works (Priority 5)			35.59	71.19	71.19		177.97
(4) Rehabilitation and reconstruction of dykes and floodwall along major rivers	28.50	66.50					95.00
Total	61.07	146.46	102.74	71.19	71.19		452.65

Source: JICA Study Team