5.11 Priority Projects for Feasibility Study

All schemes of the short term plan up to 2005 including software measures are determined based on the urgent demand of environmental sanitation improvement for the Study Area. This short term plan shall be implemented as proposed in the implementation schedule shown in *Fig.* 5.19.

Among all schemes of the short term plan, following components requires direct investment by public sector.

a. Provision of SMS (B) / public toilet

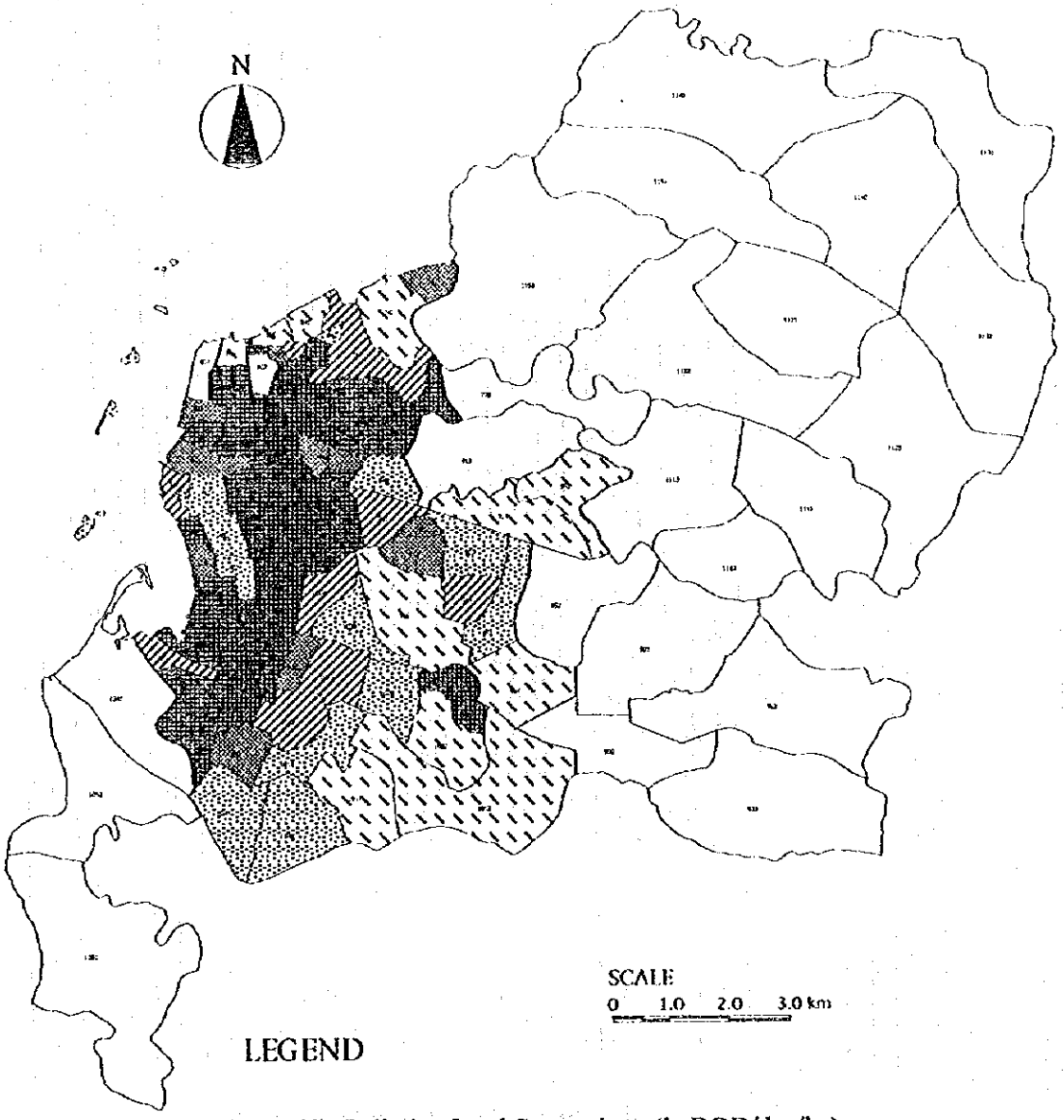
b. Procurement of vacuum trucks

c. Rehabilitation of access road to Antang septage teatment plant

d. Construction of sewerage systems

e. Pilot project for SMS (B/G)

These components of the proposed short term plan are selected as priority projects for Feasibility Study, and dealt with in details in the Part II of Main Report on Feasibility Study.



Source : JICA Study Team

FIG. 5.1 Specific Pollution Load Generation by Kelurahan in 1992

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

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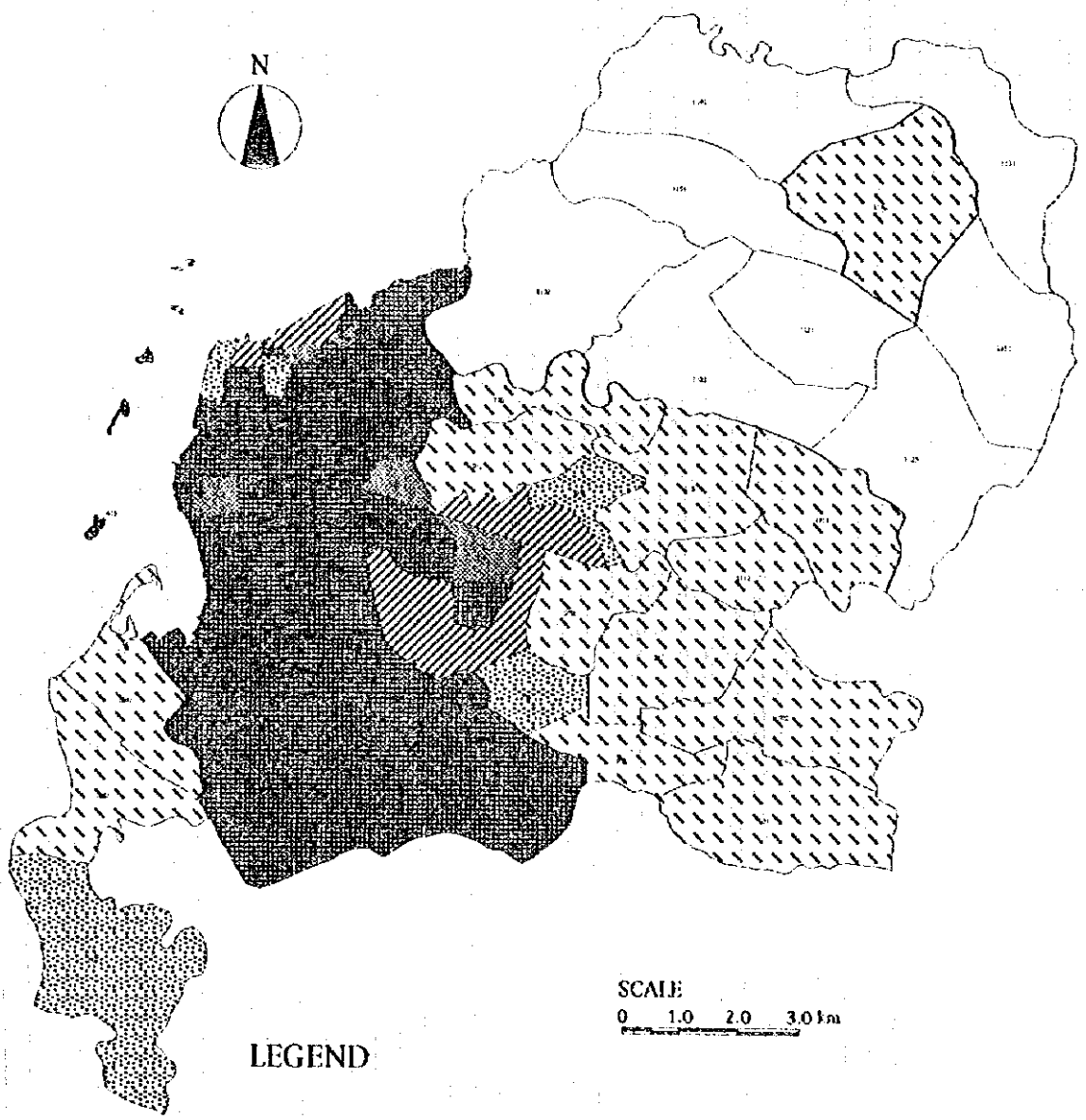
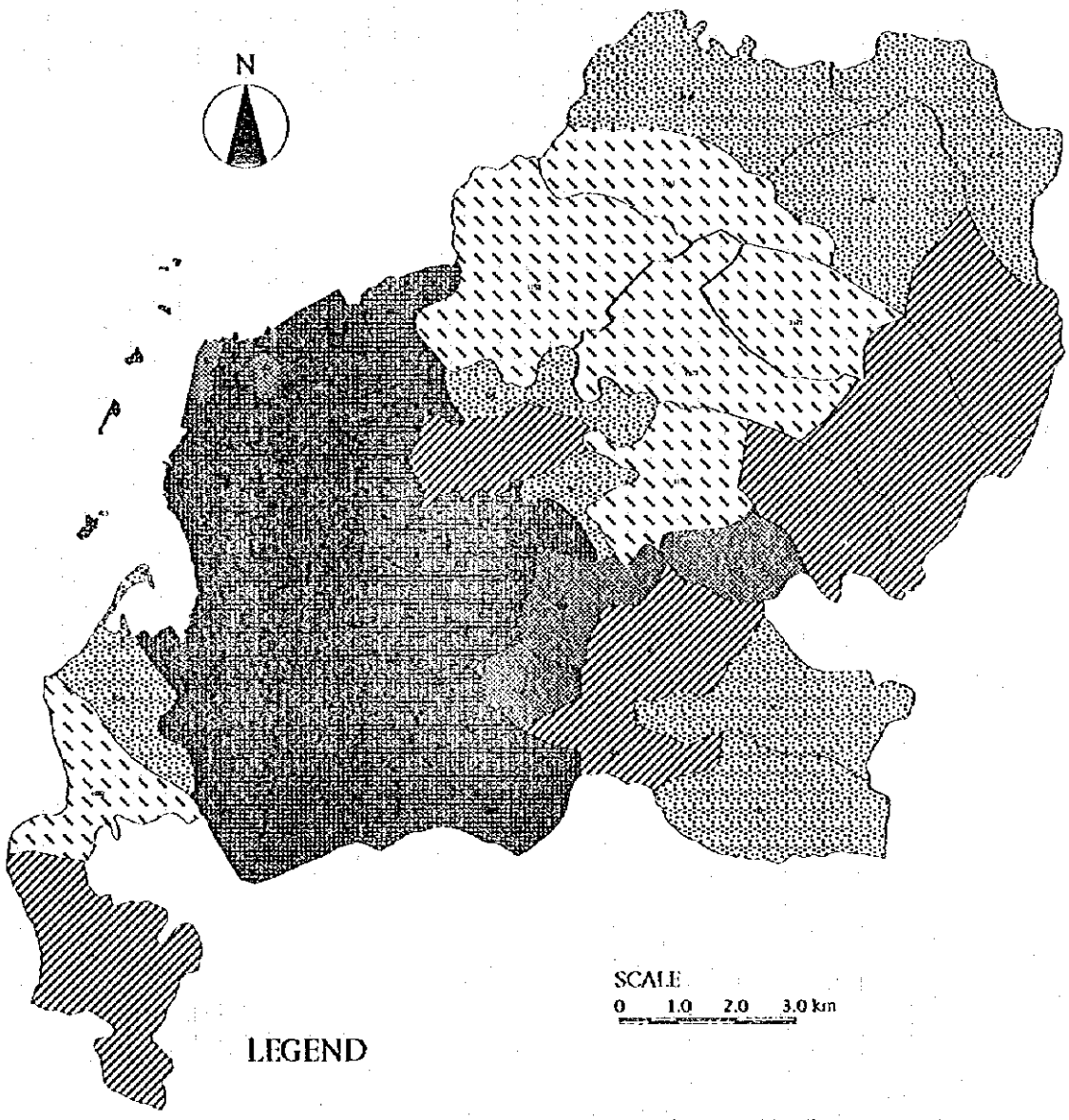


Source : JICA Study Team

FIG. 5.2 Specific Pollution Load Generation by Kelurahan in 2005

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995



Source : JICA Study Team

FIG. 5.3 Specific Pollution Load Generation by Kelurahan in 2015

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

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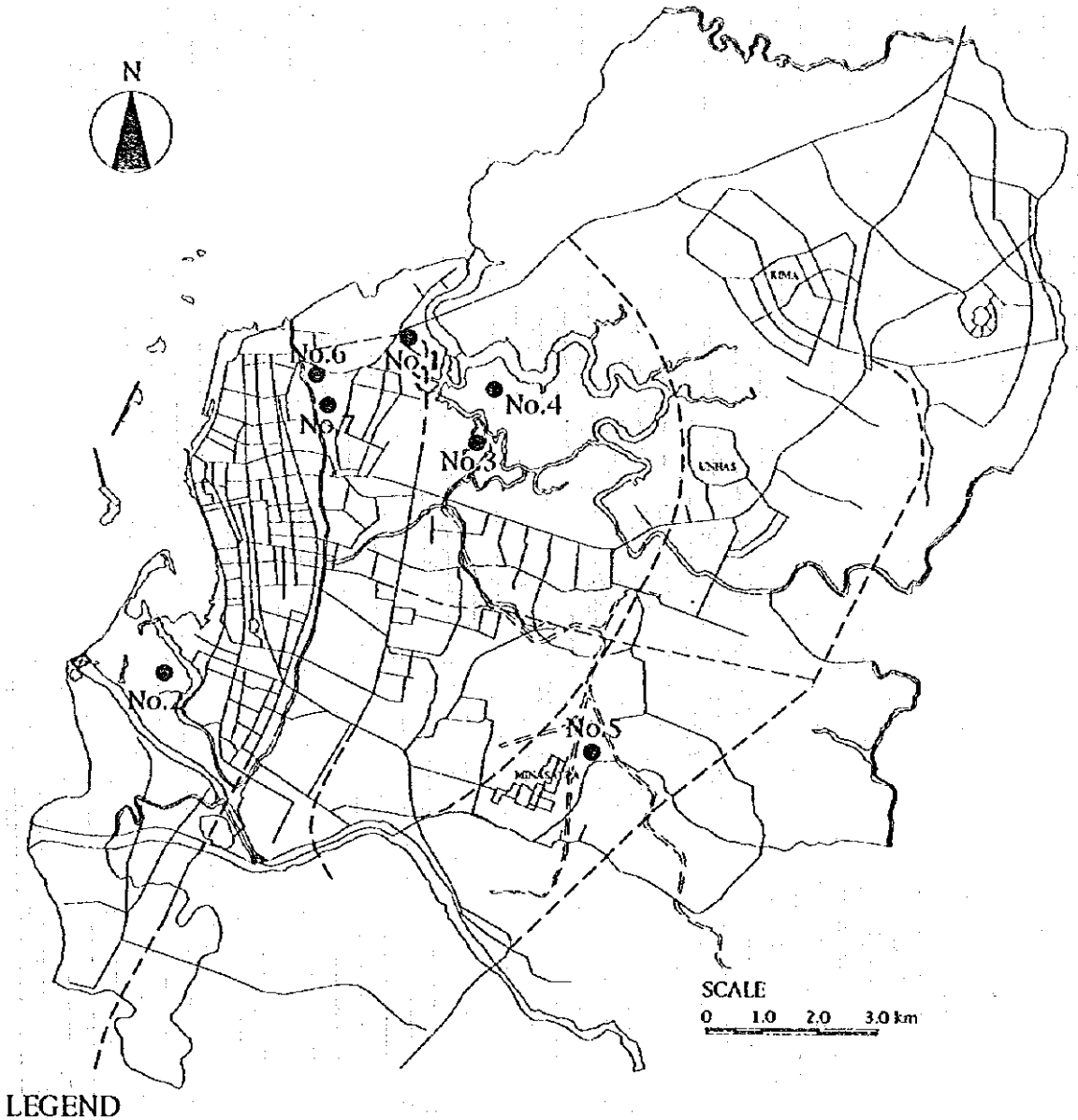


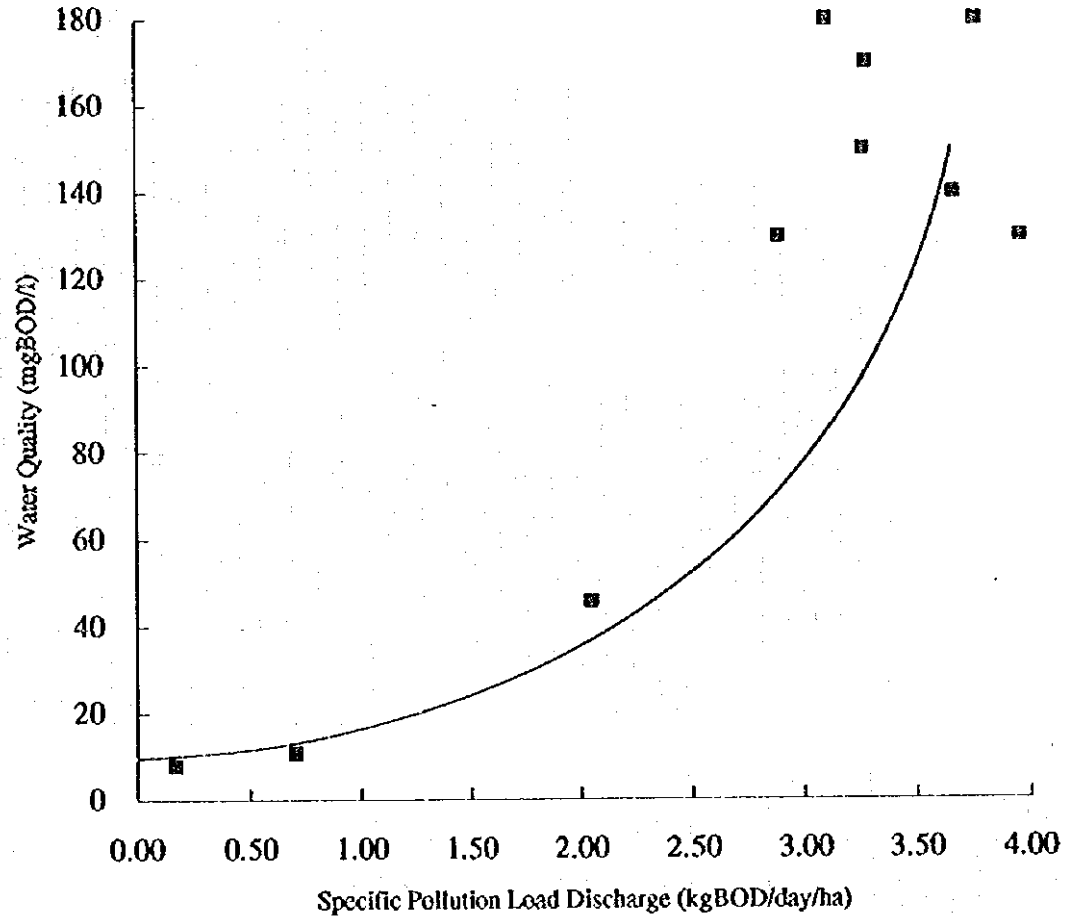
LEGEND

● Potential Sites for Wastewater Treatment Plant

= = = Future Canal

No.1	Kel. Buloa
No.2	Kel. Maccini Sombala
No.3	Kel. Pampang
No.4	Kel. Lakkang/Rappo Kalling
No.5	Kel. Bangkala
No.6	Kel. Panampu
No.7	Kel. Lembo

FIG. 5.4 Location of Potential Sites for Wastewater Treatment Plant



$y = 7.52 \times 2.15^{x}$

y : Water Quality (mgBOD/l)

x : Specific Pollution Load Discharge (kg BOD/day/ha)

r = 0.9603 based on the logarithmic relationship given by ;

$\ln y = x \times \ln 2.15 + \ln 7.52$

Source : JICA Study Team

FIG. 5.5 Correlation between Water Quality and Specific Pollution Load Discharge

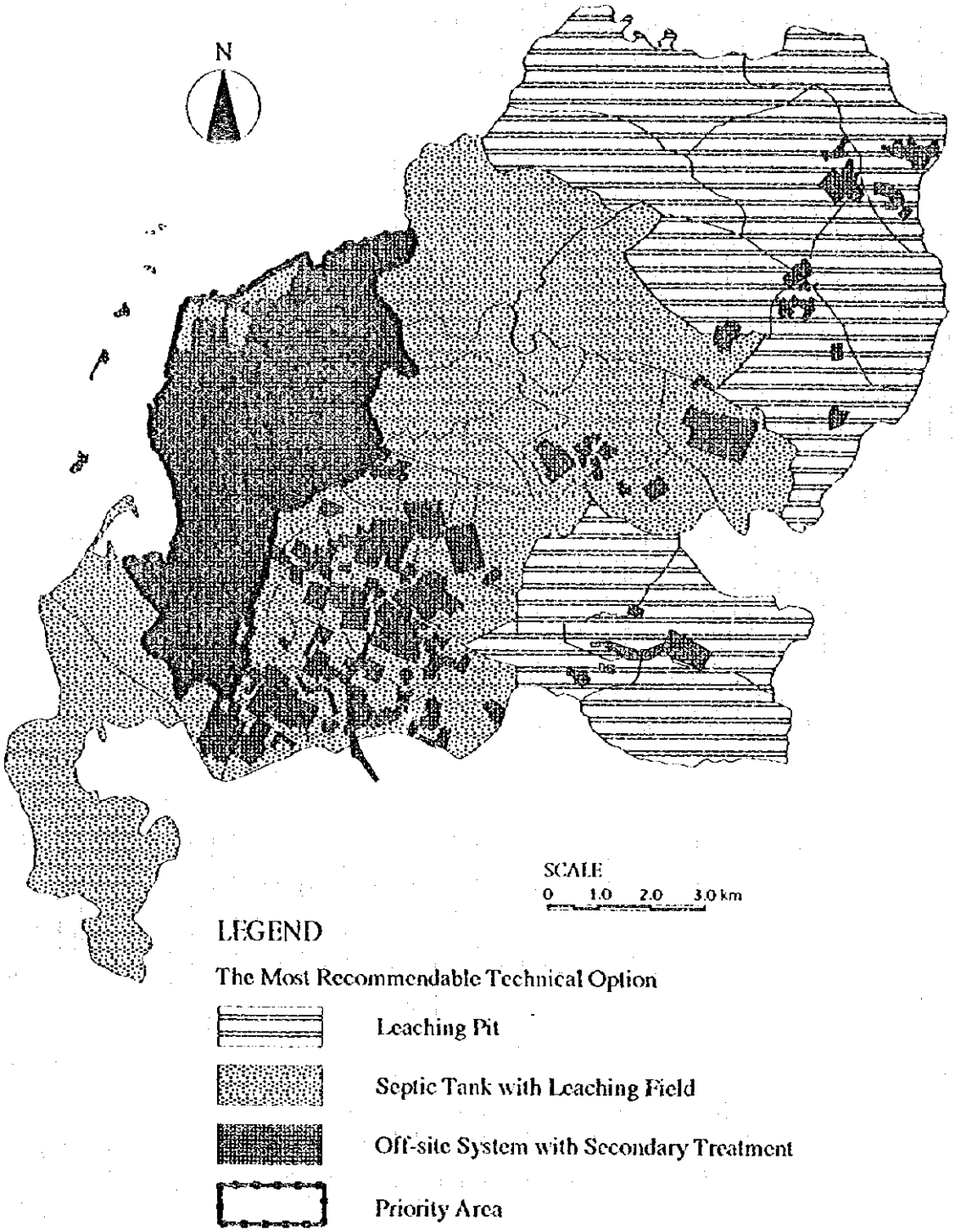


FIG. 5.6 Result of Demarcation for the Short Term Plan

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

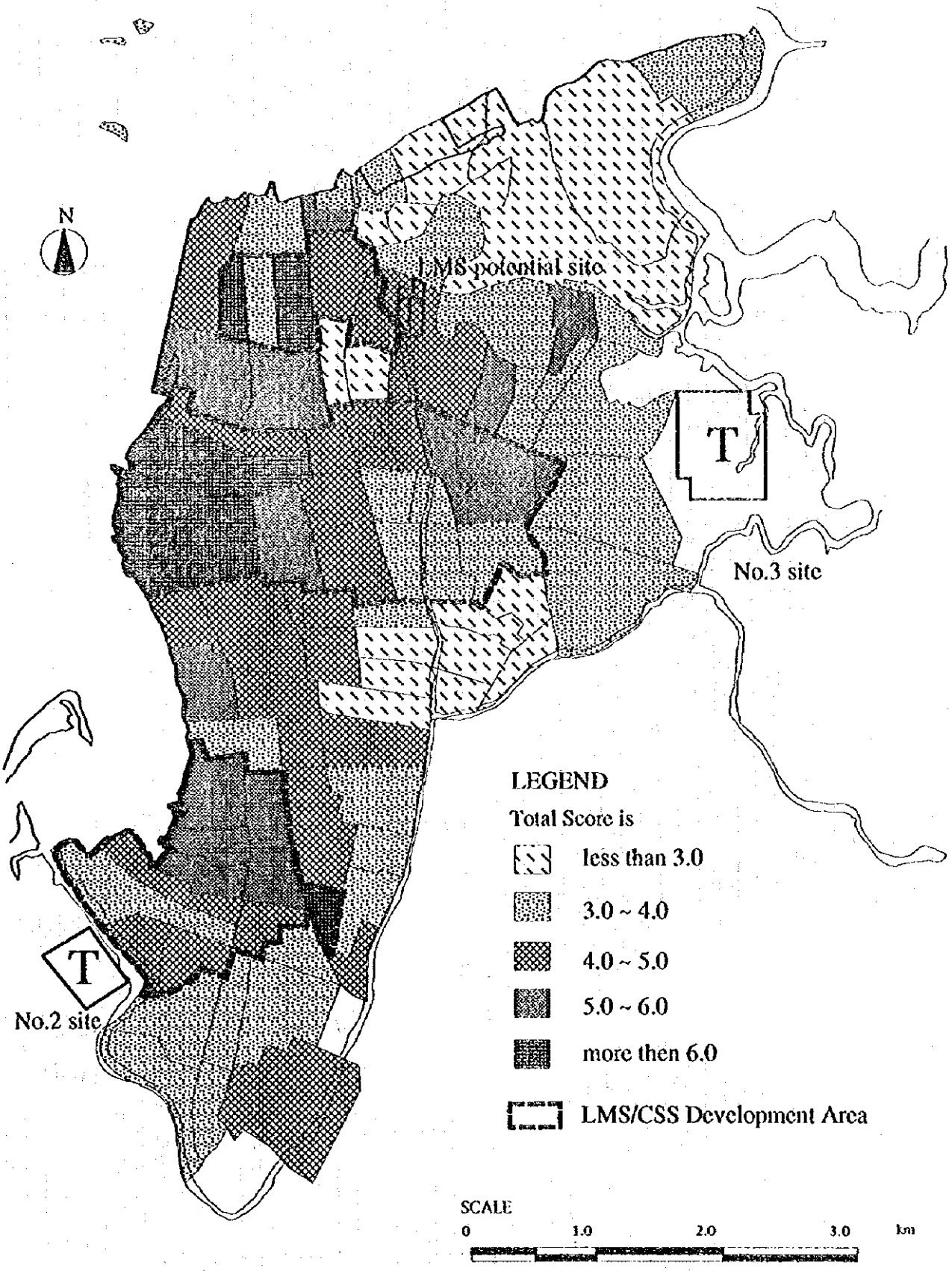


FIG. 5.7 Selection of LMS/CSS Development Area

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

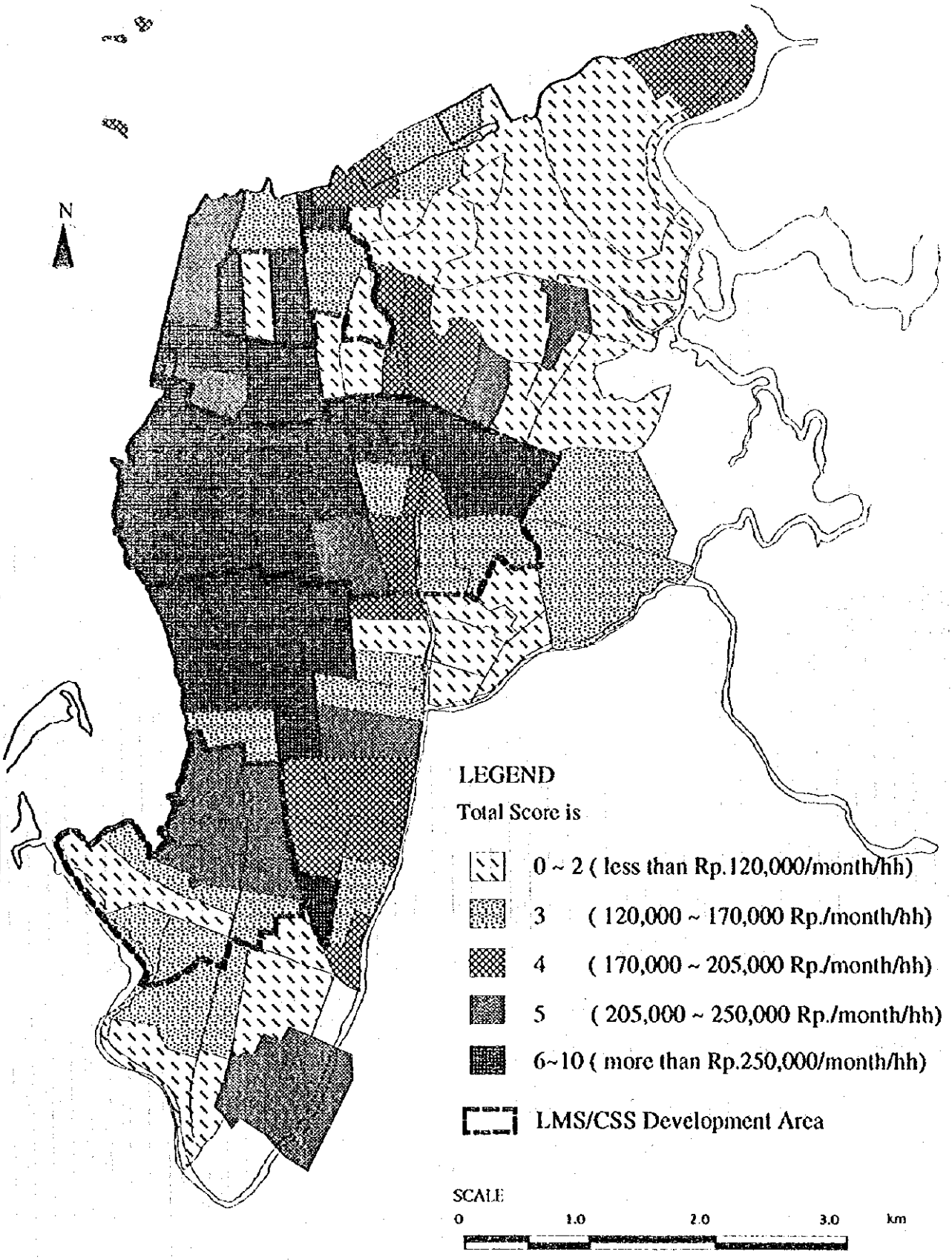


FIG. 5.8 Average Income Level by Kelurahan

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

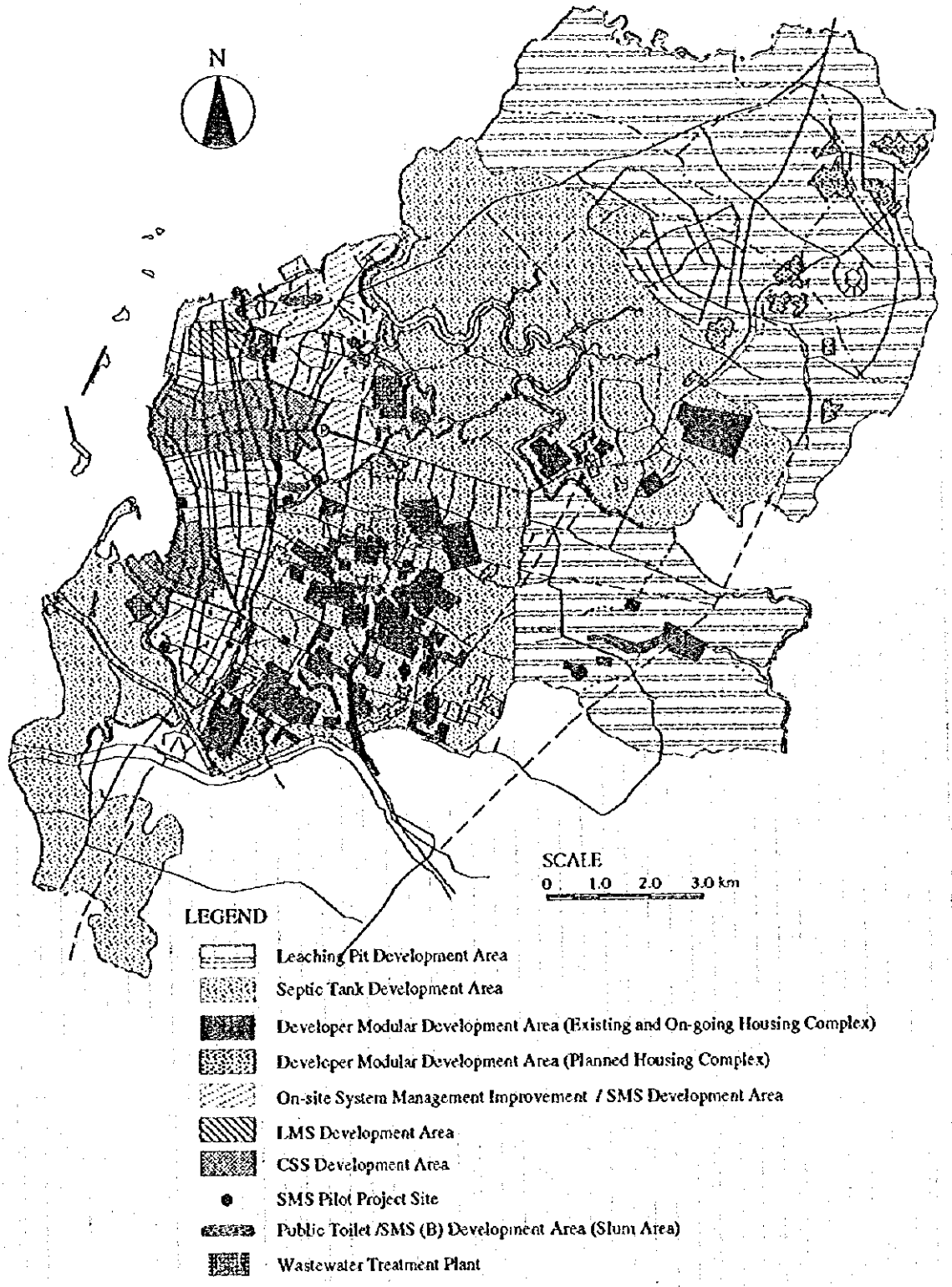


FIG. 5.9 Short Term Wastewater Management Plan in 2005

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

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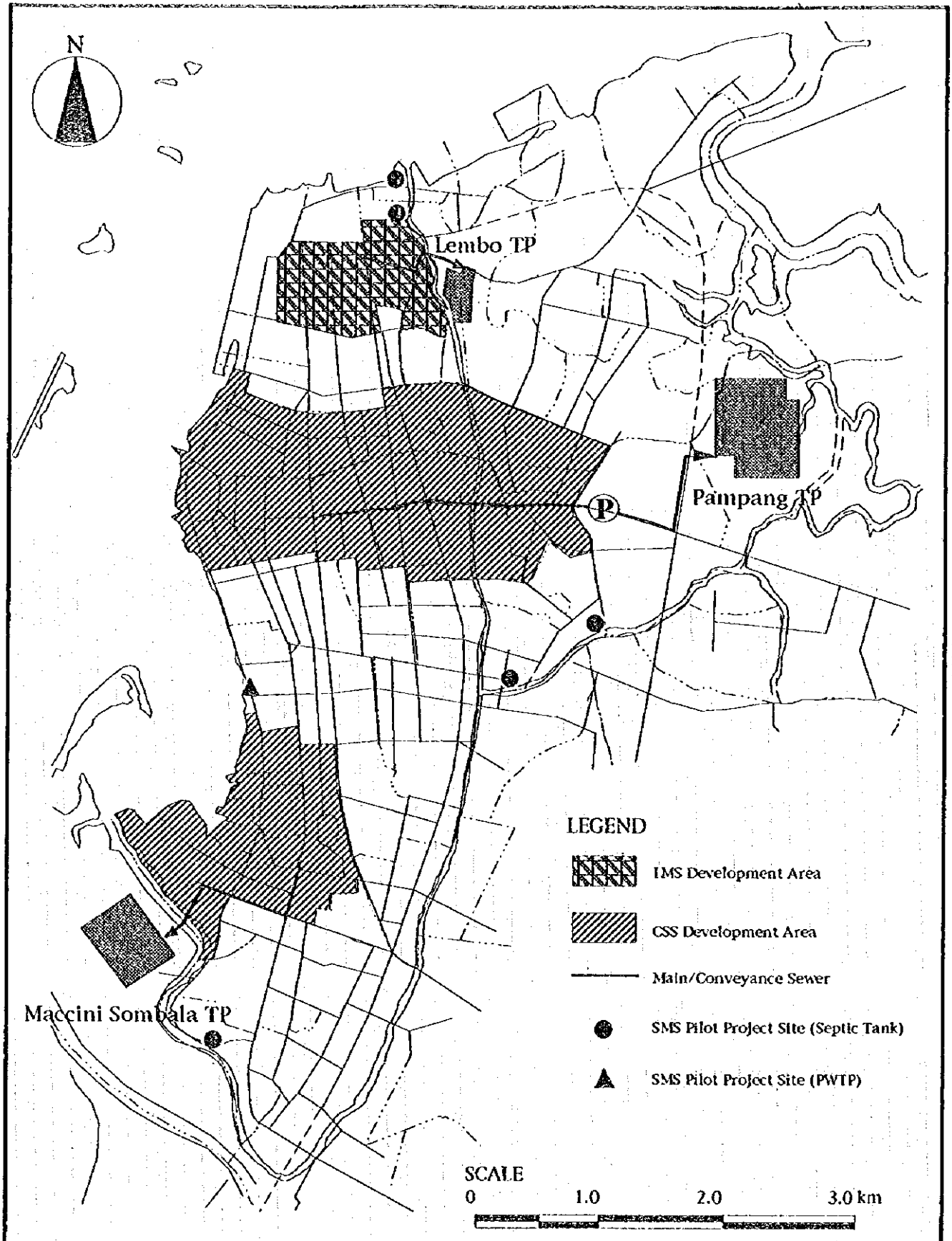

FIG. 5.10 LMS/CSS Deveiopment Plan until 2005 and SMS Pilot Project Sites

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

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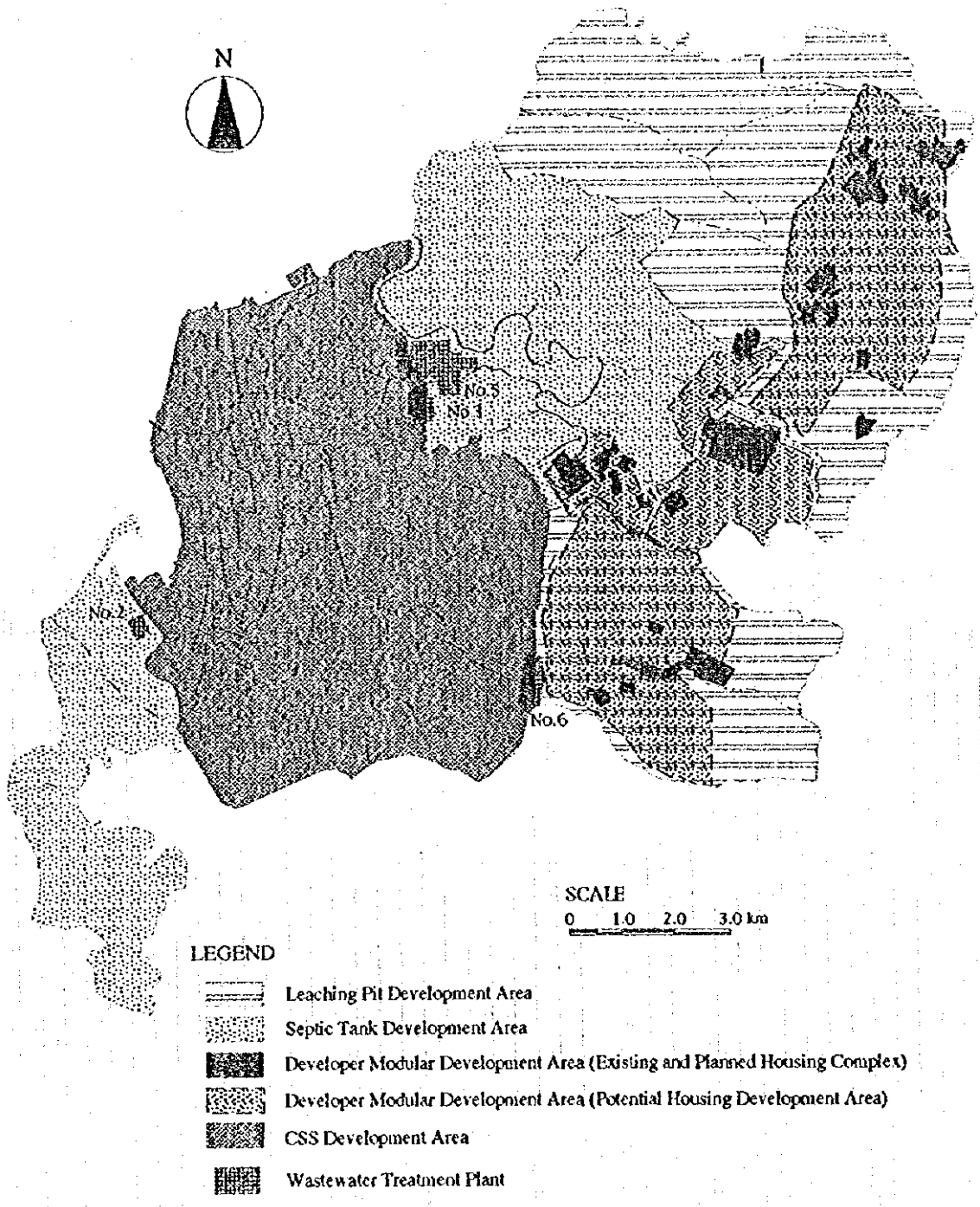

FIG. 5.11	Master Plan of Wastewater Management in 2015

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

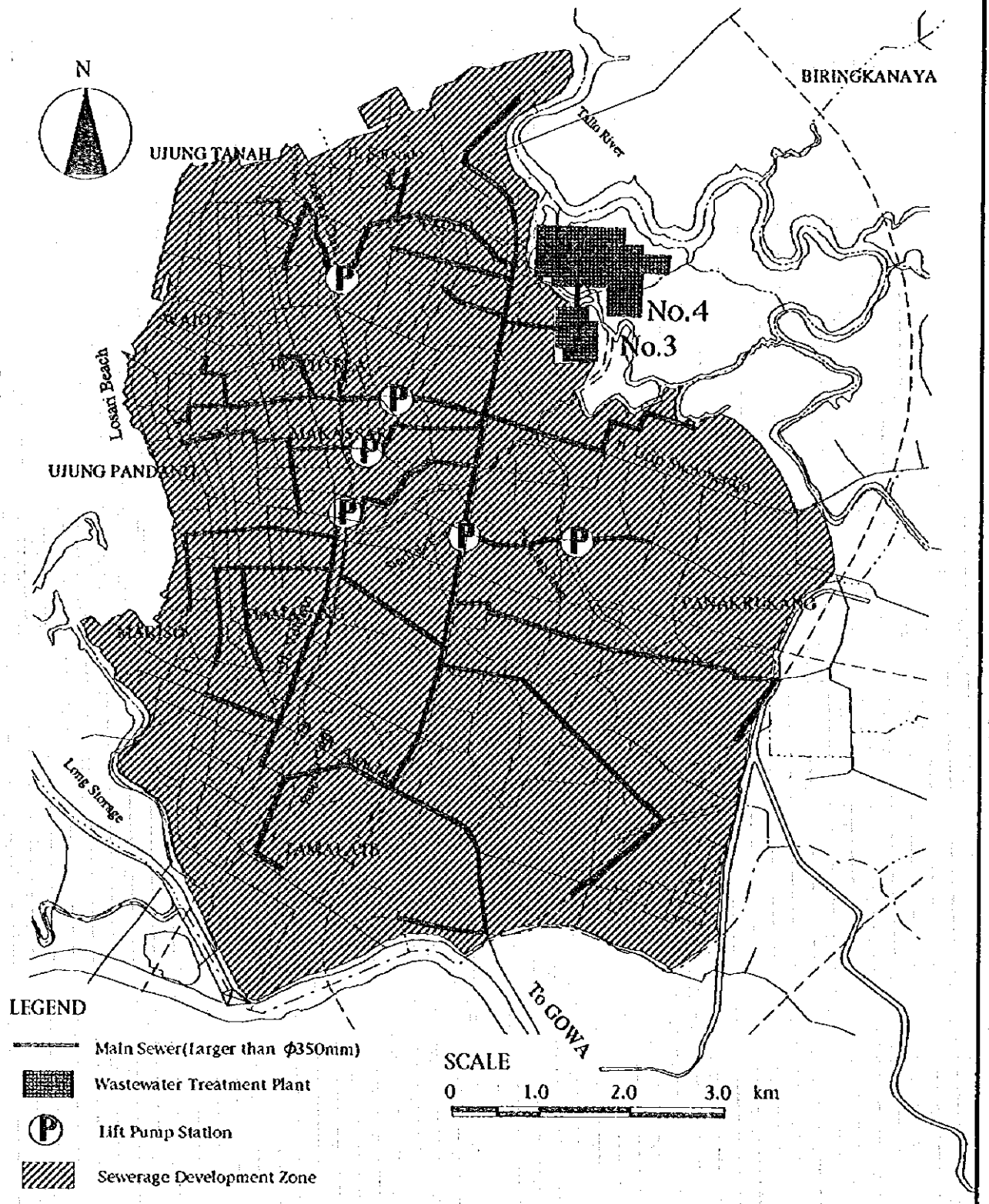

FIG. 5.12 Facility Plan of Alternative 1

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

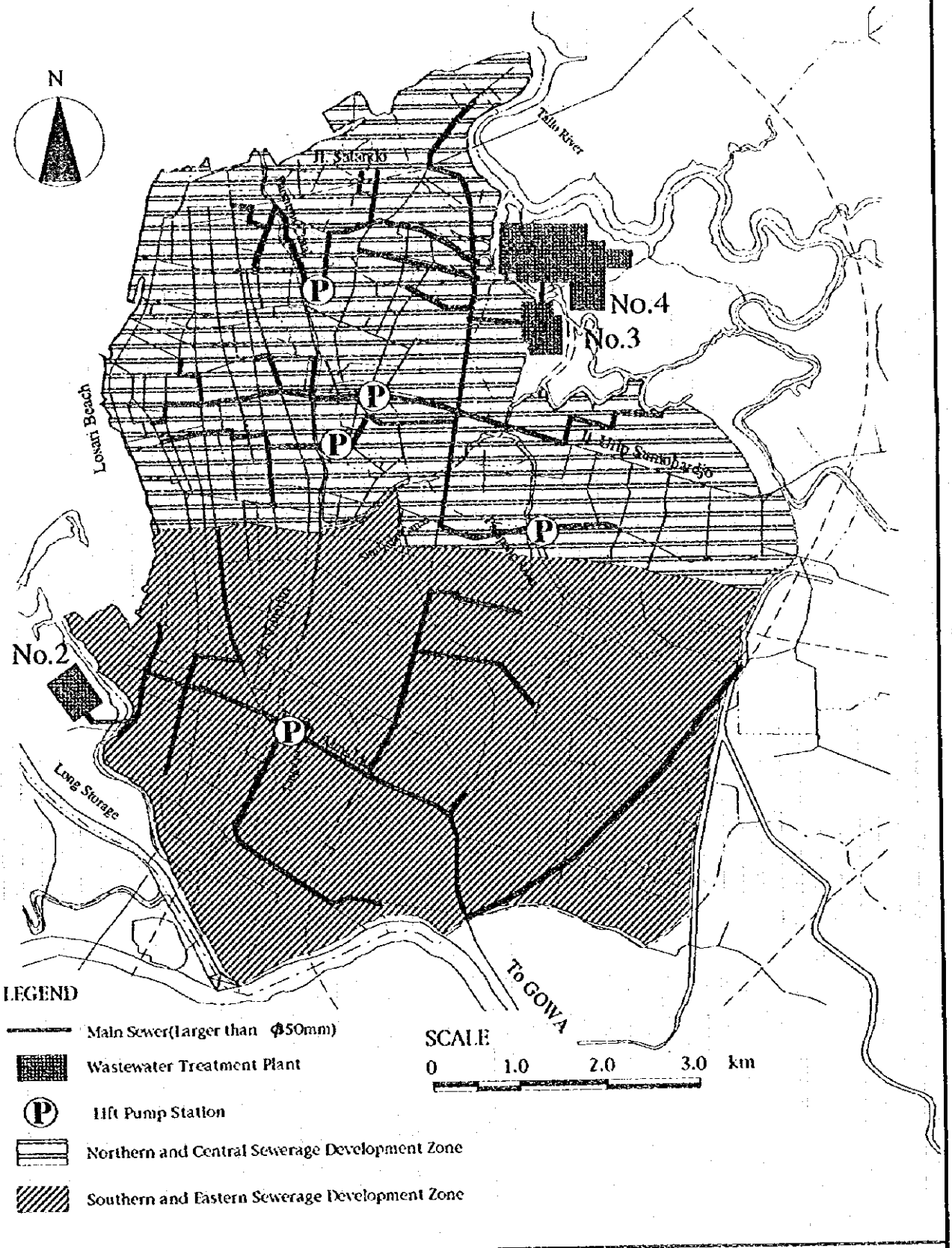

FIG. 5.13 Facility Plan of Alternative 2

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

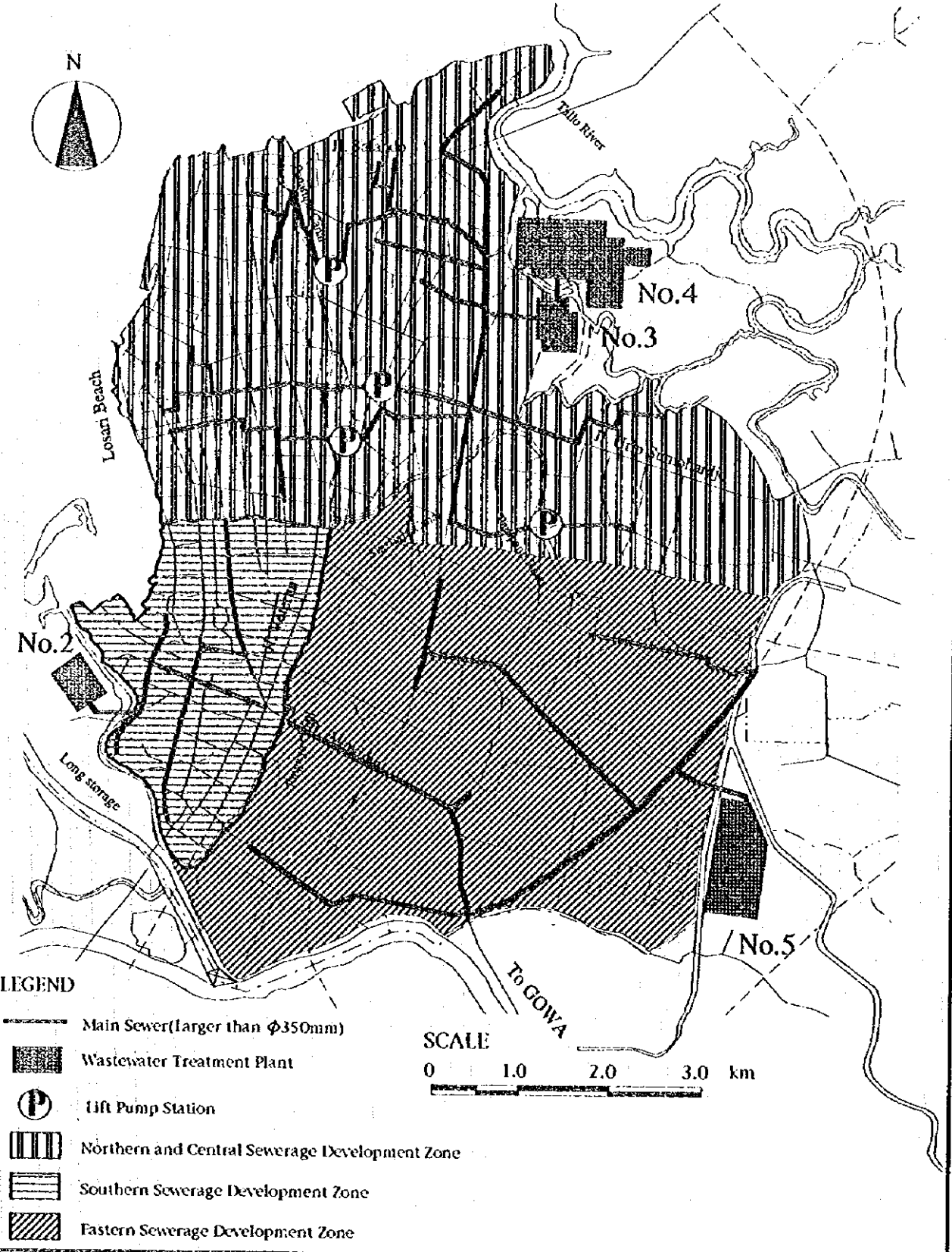

FIG. 5.14 Facility Plan of Alternative 3

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

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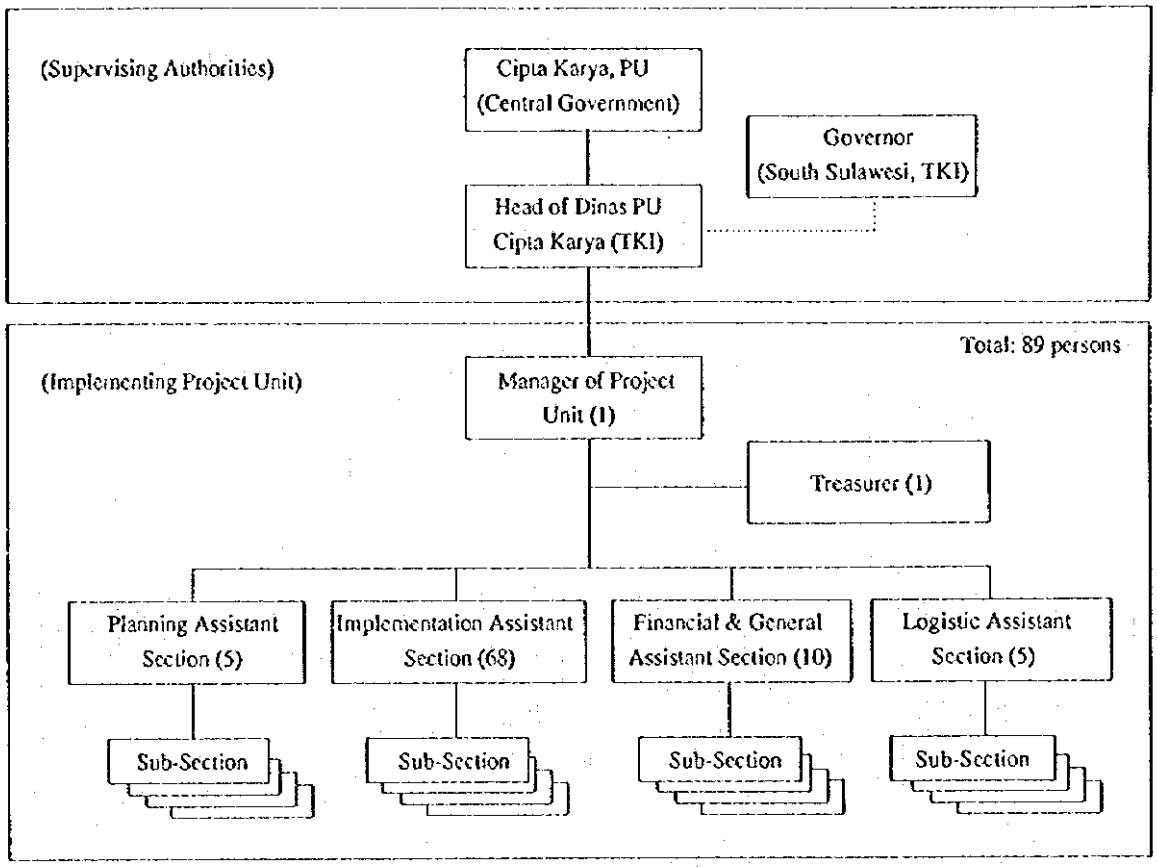
Organization of Project Unit in 1996



Source: JICA Study Team (Hearing from Sub-Director of Eastern Region II, Directorate of Eastern Regional Development, Cipta Karya, the PU)

Remarks: _____ Command line & ----- Coordination line

Concerning the size/scale and structure of the project unit, it is needed to consult with the authorities concerned on account of the case that the PT PAL JAYA Jakarta started merely with the head, the administration & financial section, maintenance section and control section.

FIG. 5.15 Organization Chart of Project Unit in 1996

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

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Organization Chart of BPAL by ／ in 2005

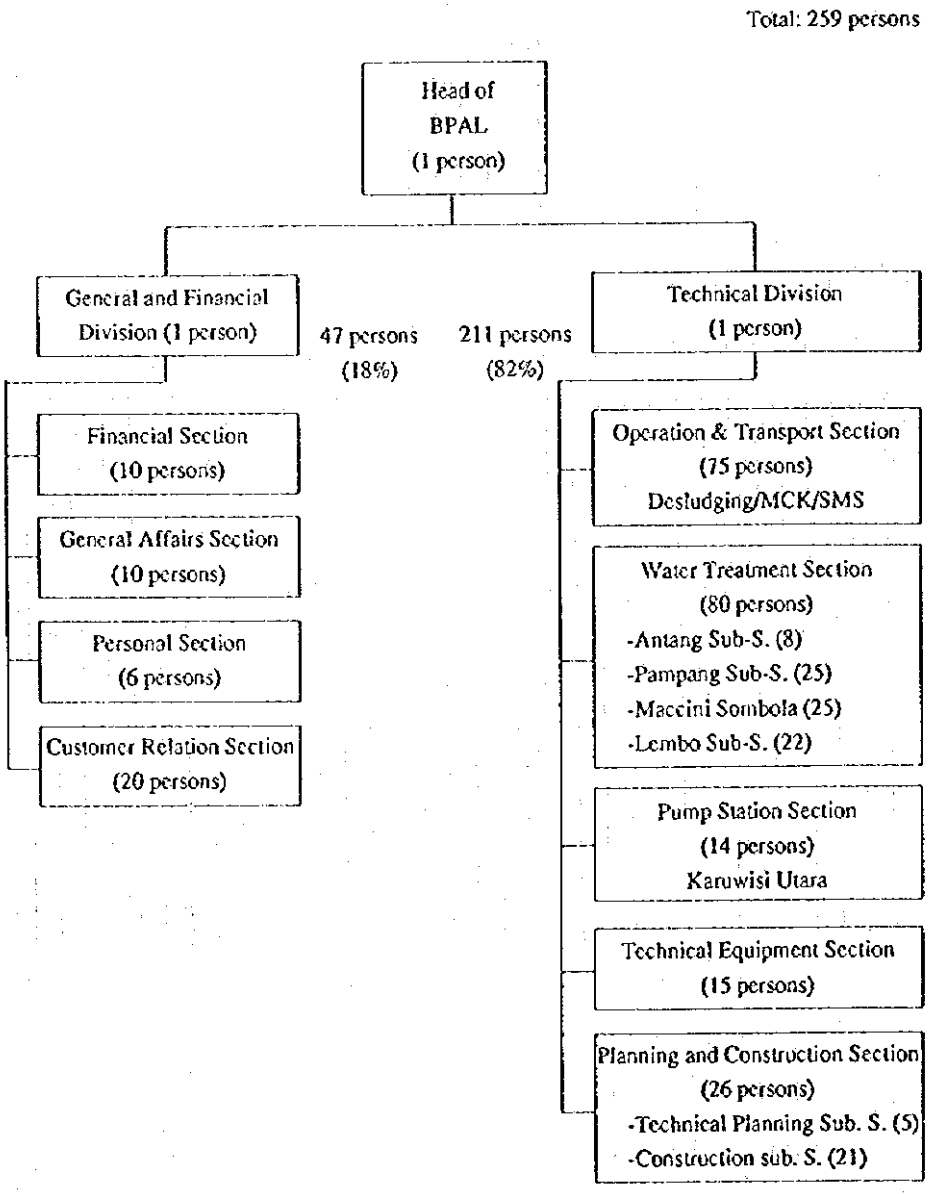

FIG. 5.16 Organization Chart of BPAL by ／ in 2005

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

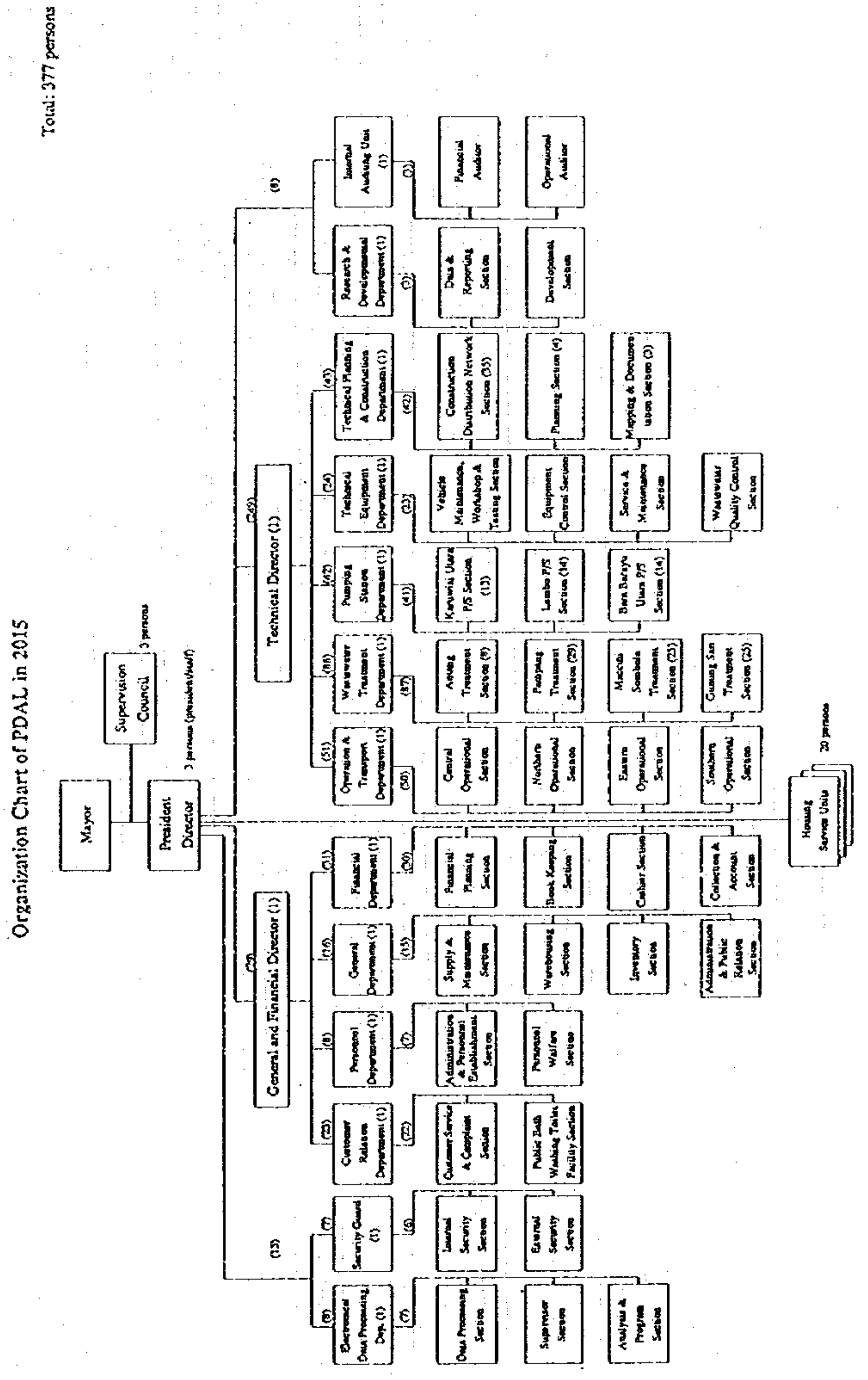

FIG. 5.17 | Organization Chart of PDAL in 2015

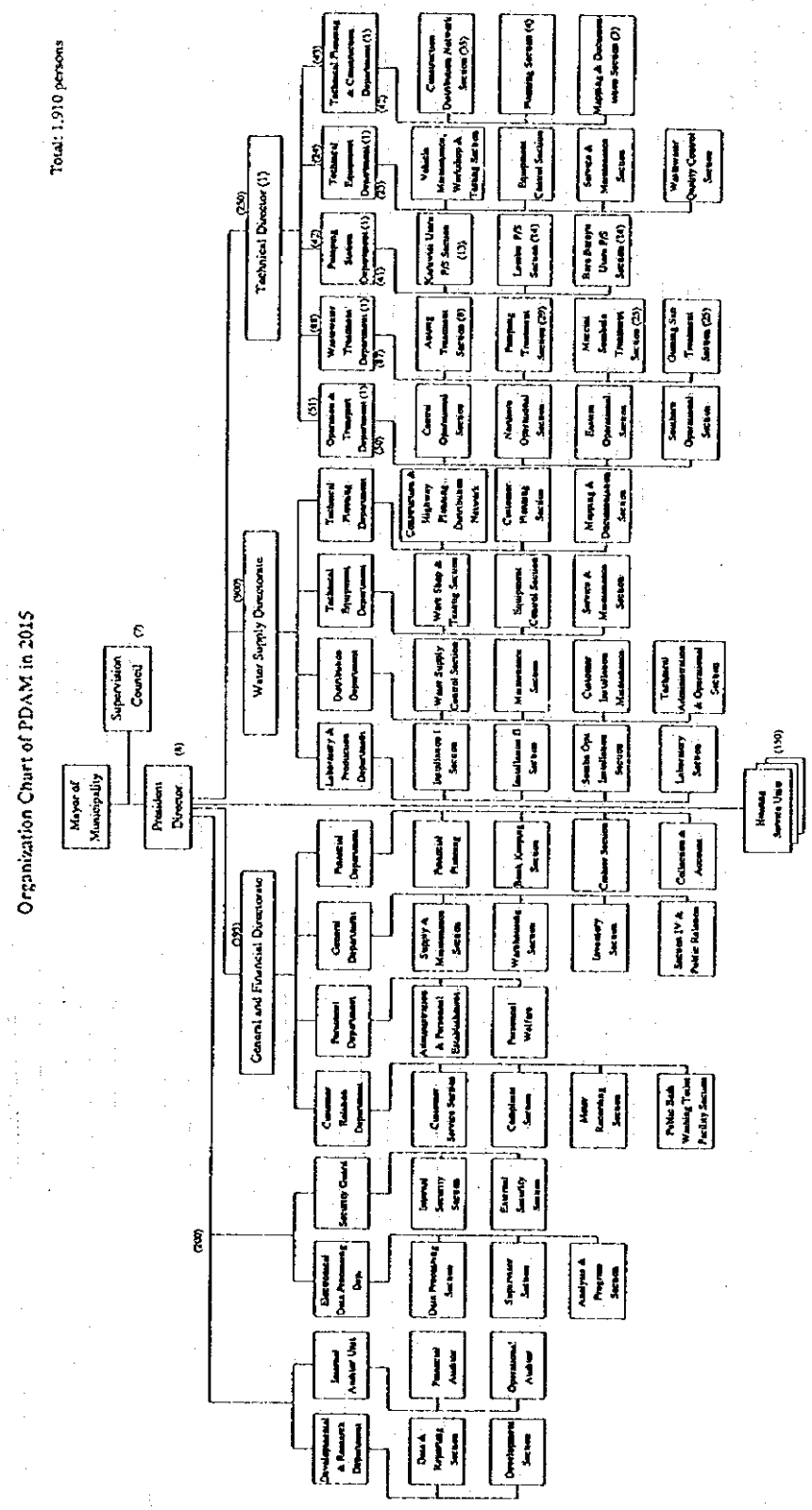

FIG. 5.18 Organization Chart of PDAM in 2015

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

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F/S Public Project (million Rp)

	1996-2000	2001-2005	2006-2015
Public toilet / SMS (B)	360 /360		
Procurement of vacuum trucks	1,540 / 1540		
Improvement of Antang STP	540 / 540		
Pilot Project of SMS (B/G)	2,268 / 2,268		
Sewerage System	71,638 / 71,638		

value: term cost/accumulation cost

M/P Public Project (million Rp)

	1996-2000	2001-2005	2006-2015
Public toilet / SMS (B)	360 /360		
Procurement of vacuum trucks	1,540 / 1540		4,774 / 6,314
Improvement of Antang STP	540 / 540		
Pilot Project of SMS (B/G)	2,268 / 2,268		
Sewerage System	71,638 / 71,638		470,166 / 541,804

value: term cost/accumulation cost

FIG. 5.19 Implementation Schedule of Wastewater Management

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

CHAPTER 6

MASTER PLAN FOR SOLID WASTE MANAGEMENT

CHAPTER 6 MASTER PLAN FOR SOLID WASTE MANAGEMENT

6.1 Solid Waste Amount and Composition

6.1.1 Prediction of solid waste amount

(1) Waste amount in KMUP

Since all the waste generated in KMUP is not collected and transported at present, the generated solid waste amount is estimated using the unit generation rate obtained through the field survey conducted in this JICA study. The future solid waste amount is estimated in the same way based on the future framework of socioeconomic conditions including future population and future land-use and considering the general tendency in many countries that an improved standard of living will be accompanied by an increase in unit generation rate especially for commercial waste.

The total waste amount will be as follows.

Future Solid Waste Amount ton/day average

	1993	1995	2000	2005	2010	2015
Domestic waste	367	400	490	617	797	985
Commercial waste	66	84	128	187	266	370
Institution	15	16	19	23	28	35
Street sweeping	13	14	17	20	23	28
Ditch cleansing	10	10	10	10	10	10
Total	471	525	666	861	1,132	1,438
Industry	58	73	101	131	165	201
Grand total	529	598	767	992	1,296	1,640

(2) Waste amount by Kecamatan

Waste amount generated in each Kecamatan is estimated as follows, based on the population distribution and land use characteristics of each.

Waste Amount Generated Daily by Kecamatan ton/day

No.	Kecamatan	1995	2005	2015
1	MARISO	28	38	45
2	MAMAJANG	33	41	48
3	MAKASSAR	46	62	74
4	U.PANDANG	25	29	38
5	WAJO	43	52	68
6	BONTOALA	35	46	54
7	TALLO	49	79	99
8	U.TANAH	29	39	64
9	PANAKKUKANG	82	146	287
10	TAMALATE	105	209	301
11	BIRINGKANAYA	48	122	362
Total KMUP		525	862	1,439

(3) Waste amount in MINASAMAUPA

As it is difficult to secure a site for final disposal in KMUP in the future, future disposal sites will be located outside KMUP. In this case, the final disposal site will be operated as an inter-municipal disposal site based on the MINASAMAUPA (KMUP & Maros and Gowa) concept.

To develop a final disposal plan in MINASAMAUPA area, the future solid waste amount in the area has been estimated based on MINASAMAUPA concept report. Service population in Maros and Gowa in year 1993 were provided as 17,000 and 40,000, and service ratio of total population were 8% and 18% respectively (service ratio of urban population were 34% and 68%). As the priority will be to provide solid waste collection service in the urban area and the predicted population density is less than 50 persons/ha, the population to be served shall be set based on the following principals.

a. Until the year 2005, collection service is provided to all the urban population.

b. By the year 2015, collection service will be provided to all the urban population and surrounding villages. Service ratio is set at 40% of total population (almost 1.5 times the urban population).

The future solid waste amount is predicted using a unit generation rate that is assumed to be 1.2 times, the unit generation rate of domestic waste used in KMUP. The solid waste amount in Maros and Gowa is shown in the following table.

Solid Waste Amount in Maros and Gowa

	1993	1995	2000	2005	2010	2015
Unit generation rate	0.43	0.44	0.46	0.49	0.51	0.54
Maros & Batang Ase	7.3	11.3	21.7	33.4	56.5	82.3
Sungguminasa	17.2	20.5	29.2	38.9	60.8	85.5

6.1.2 Solid waste composition

The future prediction of solid waste composition was prepared based on the field survey results. Characteristics of solid waste in KMUP are summarized as follows.

a. High content of putrescible matter
b. Low non-combustible content such as metal and glass
c. High moisture content specially in the wet season
d. Low lower calorific value specially in the wet season

Solid waste characteristics are sensitive to changes in life style. Experience in many countries shows the following tendencies:

a. Paper, plastic and metal will increase
b. Putrescible content, cinder, stone will decrease
c. Moisture content will decrease and organic content increase
d. Lower calorific value will increase
e. Bulk density will decrease

In line with the above mentioned assumptions, the future composition of KMUP domestic waste is estimated as shown in the following table based on solid waste characteristics in the dry season. The result shows that lower calorific value will exceed 1,200 kcal/kg after the year 2005. As mentioned above, also in the future, moisture content will be high and lower calorific value will be low during the wet season.

Future Solid Waste Composition of Domestic Waste

Wet base composition(%)	1994	1995	2000	2005	2010	2015
Combustible						
Paper	10.31	10.71	12.71	14.71	16.71	18.71
Textile	0.81	0.81	0.81	0.81	0.81	0.81
Plastic	7.94	8.24	9.74	11.24	12.74	14.24
Rubber & Leather	0.07	0.07	0.07	0.07	0.07	0.07
Wood	0.96	0.96	0.96	0.96	0.96	0.96
Putrescible matter	66.76	65.96	61.96	57.96	53.96	49.96
Other (over 5mm)	4.74	4.74	4.74	4.74	4.74	4.74
Other (under 5mm)	3.24	3.24	3.24	3.24	3.24	3.24
Sub-total	94.83	94.73	94.23	93.73	93.23	92.73
Non combustible						
Metal	1.39	1.49	1.99	2.49	2.99	3.49
Glass	2.14	2.14	2.14	2.14	2.14	2.14
Ceramic	0.84	0.84	0.84	0.84	0.84	0.84
Stone	0.80	0.80	0.80	0.80	0.80	0.80
Sub-total	5.17	5.27	5.77	6.27	6.77	7.27
Total	100.00	100.00	100.00	100.00	100.0	100.00
Moisture content (%)	58.32	58.02	56.52	55.02	53.52	52.02
Ash content (%)	13.52	13.42	12.92	12.42	11.92	11.42
Organic (%)	28.2	28.56	30.56	32.56	34.56	36.56
Lower calorific value (Kcal/kg)	917	937	1,036	1,135	1,234	1,333
Bulk Density (ton/m^3)	0.265	0.26	0.247	0.232	0.217	0.202

6.2 Target and Strategy

6.2.1 Target of SWM

The targets of SWM are to provide speedy, efficient and economical service to collect solid waste from areas where it is generated and dispose of it in a sanitary manner, in order to provide the citizens with a sound sanitary environment. The need for environmental conservation has pushed countries in the developed world to exert efforts to transform from heavy waste generation societies to ones where less waste is generated, however in the case of Ujung Pandang the important issues at present are to expand the limited collection service and to provide the much needed sanitary disposal of solid waste.

In REPLITA VI (1994/95-1998/99), a target is set to provide solid waste collection service to 80% of the population including commercial areas, industrial areas, tourism areas, residential areas (more that 50 person/ha) and slum areas. According to this target, KMUP should provide collection service at least 88% in 2005 and 92% in 2015.

The targets may be broken down into short, middle and long term as follows:

(1) Short and middle term targets

a. Expand collection service to 90% by 2005 using an efficient collection system
b. Implement sanitary landfill disposal
c. Provide a SWM financial base based on new fee collection system
d. Strengthening of Institutional set-up
e. Strengthen public sanitary education and citizens participation
f. Introduction of private sector participation

(2) Long term targets

a. Expand collection service to 95% by 2015 using an efficient collection system
b. Implement sanitary landfill disposal
c. Promotion of waste volume reduction
d. Provide a SWM financial base

e. Strengthen public sanitary education and citizens participation
f. Expansion of private sector participation

6.2.2 Basic strategy

(1) Expanded and more efficient collection service

At present collection service is extended to the old Kecamatan and their immediate vicinities. It is necessary to extend collection service to the slum areas and suburban Kecamatan. Expansion of service to the new residential areas in suburban Kecamatan and areas bordering the old Kecamatan where the forecast of high population growth is anticipated is particularly important.

Collection service expansion will be realized through procurement of equipment and encouragement of private sector participation. More rational discharge and collection systems will be introduced in order to improve equipment utilization efficiency. Means to expand housing developers involvement in solid waste collection and transport, similar to the Future City in Panakkukang, will be considered.

(2) Disposal by sanitary landfill method

Tamangapa disposal site will be expanded as a sanitary landfill site. It is necessary to eliminate illegal dumping of solid waste through the long term planning of disposal sites under a regional plan (inter-municipal cooperation between KMUP and its neighboring two Kapubaten under the MINASAMAUPA concept). In that context a candidate site will be identified to serve as a long term sanitary landfill site. It may also be necessary to introduce intermediate treatment facilities if economically feasible.

(3) Promotion of solid waste volume reduction

At present most of the reusable materials in the waste are recycled through already established informal routes and by scavengers. It is considered that at present no new recycling system is required. However these routes are unstable and subject to changes in prices of the materials, so from the long term perspective more formal and stable recycling systems should be promoted.

It is noted that solid waste management shall incorporate some incentive system for volume reduction. A fee system based on solid waste amount will contribute to reduce the amount of solid waste.

(4) Sustain a SWM financial base

In Indonesia, waste collection fees are expected to at least cover the operating costs. In KMUP a new system has been introduced to collect waste retribution fees at the PLN windows where electricity consumption fees are paid. Under this system the estimated collected retribution amount is expected to cover the 65% of SWM operating cost in the years 1995/96.

(5) Strengthen public sanitary education and citizens participation

In order to improve and conserve the sanitary environment of the city the citizens cooperation and active participation is necessary. Therefore enriching the citizens knowledge and education in sanitary environment is important. Collection work in particular is a labor intensive activity and the positive cooperation of the citizens will contribute to implementing a cost effective system. Environmentally conscious citizens are also expected to conserve, as well as demand to live in a sanitary environment.

(6) Responsibility for solid waste management

Dinas Kebersihan would be changed to PD Kebersihan to strengthen management capability according to the national policy for metropolis cities. One important target of PD. Kebersihan is to collect fees to cover operation and maintenance cost and depreciation cost of collection equipment. The new inter-municipal disposal site will accept non-hazardous industrial waste in return for payment of a tipping fee that will cover all costs of final disposal. The following table shows the responsible organizations in principle.

Responsible Organizations

Type of solid waste	Responsible organization	
	Collection	Treatment and disposal
Domestic waste	Collected by DK	Disposal at Municipal disposal site
Commercial waste	Collected by DK (Private collection)	Disposal at Municipal disposal site
Street waste	Swept by DK	Disposal by DK
Ditch cleansing	Swept by DK	Disposal by DK
Non-hazardous industry waste	Generator responsibility	Disposal at municipal disposal site or at KIMA
Hazardous waste	Generator responsibility	Generator responsibility

(7) Policy for privatization

KMUP shall consider introduction of privatization in the future, following the example of DKI Jakarta which contracts out solid waste collection and street sweeping to private companies in several areas of the city. Introduction of privatization will contribute to reducing KMUP's workload and support efficient performance of solid waste management.

a. The master plan shall be flexible to introduction of the contracting out system on solid waste collection and street sweeping.

b. Private collection service for large dischargers against a special collection charge shall be promoted considering adjustment of retribution system.

c. Non-hazardous industrial waste shall be transported by the generators themselves. The municipal disposal site will accept disposal of non-hazardous industrial waste in return for payment of a tipping charge.

6.3 Technical Options

6.3.1 Collection and transport

The collection and transport component of SWM in general accounts for anywhere between 60 to 90% of the total SWM costs. In 1994 DK reported that collection and transport costs accounted for 78% of the total operation and maintenance costs. Final disposal site had a share of 15%, and street sweeping was 7%. It is therefore necessary to consider a technical system that is cost efficient as well as technically sound.

Collection and transport component of SWM covers;

a. discharge system for solid waste by the generators,
b. primary collection and transport of waste to collecting stations (TPS),
c. collection of waste from the collecting stations and transport to the disposal site, and
d. in case of introduction of intermediate treatment facility, transport of the residual waste from the facility (such as ash from incineration plant) to the disposal site.

For each of the above four items there are a number of technical options that may be adopted as shall be described hereinafter.

(1) Discharge of solid waste

Options for discharge, including present practice are as follows;

1) Permanent concrete/brick bins

Permanent concrete or brick bins are constructed in front of many single or semi-detached dwellings. Sizes range from $0.3m^3$ to $0.5m^3$. KMUP proposes terminating usage of such bins in favor of non-permanent bins.

Mostly unpacked waste is discharged into these bins and removing the waste takes a long time. Survey results show that on average it takes over 80 minutes to collect one ton from such bins. Therefore KMUP's decision to suspend use of the permanent bin shall be followed by the master plan.

2) Individual bins

These bins are made of plastic, metal or wood. As permanent bins usage decreases, these bins are expected to increase in number. KMUP encourages the use of individual bins. Even though it may be necessary to empty such bins for a collection crew into a vehicle, emptying time is much shorter than that required for emptying of permanent bins. Therefore the master plan will consider that a portion of households and small commercial businesses served will discharge their waste into individual bins.

3) Unpacked waste

This is the worst discharge practice in terms of the time required to load the waste into collection vehicles, and for the aesthetics of the neighborhood. It will therefore be avoided in the master plan except in the case of hauled containers.

4) Plastic bag

Although the present use of plastic bags is limited, KMUP is promoting their usage. These bags are locally produced. It is not realistic to assume that the bags will be affordable to all residents and the master plan shall not consider this option as a global solution. Gradual introduction of plastic bags shall be considered.

(2) Primary collection

1) Comparison of manual and mechanized primary collection

Primary collection may be required in areas where roads are narrow and collection vehicle access is difficult or communal pick up stations are located at long walking distances (say over 200 meters). However as primary collection increases the SWM cost, this should be limited as much as possible to places where it is necessary.

Two options for primary collection are use of hand cart and small satellite vehicles. Presently hand carts only are used. A three wheel motorized vehicle equipped with a 2 m^3 container which can be hydraulically lifted

for unloading is one potential system. Such vehicles are used in the United States.

Costs of both manual and mechanized primary collection systems were compared. As the mechanized system shows only a slight advantage in cost in high density populated areas (over 400 person/ha), it is recommended to continue use of manual hand carts.

2) Extent of hand cart primary service

The following table covers the three discharge practices presently applied in KMUP. In principle, case 3 shall be applied, as much as possible. Land use and population forecasts for the three suburban Kecamatan are forecast to increase by 2.4 and 2.9 times the present figures respectively by the year 2015. In 2015 the population in these areas will reach 67% of the total, as compared to 45% in 1992. In such areas, where development is expected to progress at a planned pace and solid waste collection and transport needs to be considered, wide introduction of hand cart service shall be avoided. Hand cart service will nevertheless continue in parts of the city's older districts, where vehicle accessibility is difficult. Taking the population forecast into consideration, the master plan will consider offering hand cart service to not more than 30% of the population in 2015.

Case 1	Case 2	Case 3
Door-to-Door by DK	Hand cart collection by LKMD to pick-up point/TPS	Discharger brings waste to pick-up point/communal container by own means
1) Advantage Eliminates need for primary collection	Brings waste to a common point which is served by collection vehicle, thereby reducing vehicle stops, and increasing potential of extra trips/shift	(1) Accumulates waste at a common point, as Case 2 (2) Eliminates need for door-to-door or hand cart collection
2) Disadvantage (1) Collection vehicle makes too many stops on collection route thereby decreasing possible trip number/shift (2) Burden on collection workers increases	Burden of added costs of workers and hand carts for primary collection, and their management	(1) Walking distances must be considered and therefore more pick up points than those under Case 2 will be required (2) Citizens cooperation is important in applying this system
3) Application (1) Commercial and high income areas located along wide roads (2) Block buildings (3) Large dischargers	(1) Areas inaccessible to collection vehicles (2) Medium to low density populated areas	(1) New development areas with suitable sites for open stations or hauled containers

(4) Secondary collection

The title of secondary collection is misleading because it may imply an effort inferior to primary collection. Of course this is not the case and secondary collection; collection from communal stations and generator premises and transport to final disposal site or intermediate treatment facilities, is the most cost consuming element in the SWM.

Unit costs were estimated for following seven (7) vehicle types.

Pick-up (3 m^3 capacity)
Tipper Large (10 m^3) Tipper Medium (6 m^3)
Armroll Large (10 m^3) Armroll Medium (6 m^3)
Compactor Large (15 m^3) Compactor Medium (10 m^3)

The results show that compactor vehicles have the highest haul potential in one shift, followed by armroll and tippers. For all vehicle types, the larger of the two examined under each type had the higher haul potential. Pick-up vehicles had the lowest.

Unit cost comparison shows that a combination of compactor vehicles and containers will result in the highest unit costs. This may be explained by the high investment costs of the vehicle and containers and the resulting high depreciation cost. If compactor vehicles are operated without containers, although the trip numbers will decrease, unit costs will also go down. Use of compactor vehicles, especially medium sized ones with plastic bag discharge after a certain period of time may be considered. This period is necessary to strengthen plastic bag discharge.

Pick-up vehicles are also costly to operate. This is due to the low haulage capacity and difficulty to operate a substantial number of trips per shift to offset the low capacity. Although trip number may be improved if a transfer station is used, the overall cost of collection and transport will increase with the additional expenses of the transfer station. Therefore pick-up vehicles will not be included in the master plan.

The armroll vehicle types provided the lowest operating costs. However the large armroll has not yet been introduced and the problem of space limitation for large containers is worth noting. In the Master Plan, the medium armroll shall be used.

The medium tipper unit cost was almost the same as the respective cost of the medium armroll, and it should also be considered.

In summary, the vehicle types subject of the M/P alternatives study are;

	Vehicle Type	Capacity (m^3)	Collection Frequency	Discharge Type
A)	Armroll Medium	6	Daily	Haul container
B)	Tipper Medium	6	3 d/week	Plastic bag at designated place
C)	Compactor Medium	10	3 d/week	Plastic bag at designated place

(5) Direct haul and transfer station

As the distance from the collection zone to the disposal site increases, the number of trips that can be made by the collection vehicle decreases. At a certain distance it becomes more cost effective to construct a transfer station near the collection zone where the waste is transferred to larger vehicles and

the collection vehicles are therefore spared the need to travel all the way to the disposal site.

Fig. 6.1 shows that the break-even point for armroll medium and tipper medium is between 20-25 kilometers, and compactor medium 35-40 kilometers. In the case of KMUP it will probably not be necessary to utilize a transfer station if the new disposal site does not exceed an average distance of 20 kilometers from the collection zone.

The figure also shows that at distances of more than 22 kilometers it is more cost efficient to operate tipper compared with armroll, and that compactor operation is more cost efficient over the other two vehicle types at distances of more than 15 kilometers.

(6) Examination of two-shift operation

Presently solid waste collection and transport is implemented daily by Dinas Kebersihan in one 7 hour-shift. A comparative study under different working conditions of seven and six days/week, and shift duration's of 7, 11 and 14 hours was prepared.

Increased operating days and hours will contribute to a decrease in the number of vehicle required, but staff will be required to work overtime hours or additional staff will be employed to work a second shift. Rapid vehicle depreciation will be reflected in the decreased number of operable years and increased maintenance costs.

Unit cost for operation and maintenance of tipper and compactor vehicles will decrease as working days and hours are increased. Armroll vehicles, on the other hand will show an increased unit rate cost due to the rapid increase in depreciation costs because of the added number of containers needed to accommodate the increased trip numbers.

Based on the analysis, the master plan proposed one shift per vehicle crew, in the daytime. The night shift will offer advantages of lighter traffic conditions and maintaining a clean city during the day time. However it may be difficult to operate all shifts at night because of the change in working conditions of crew members concerned.

Presently DK is operating two-thirds of its vehicles during the day time and 1/3 at night. DK has plans to increase its night shift activity. As a decision of operating at night involves social as well as security considerations, the M/P will leave the door open to both possibilities. While the night shift is expected to improve vehicle running speeds, the M/P will consider running speeds applicable to the daytime shift. Related SWM intermediate treatment facilities and disposal sites will operate two shifts to accommodate both day time and night time collection.

(7) Summation

The elements that will form the master plan for waste collection and transport are summarized as follows;

a) Discharge	(1) Plastic Bags; Gradual introduction (2) Individual Bins
b) Primary Collection	(1) Discharger directly brings waste to communal station (2) Hand cart service within a radius of 200 meters
c) Secondary Collection Vehicle Type	Up to Year 2005: (1) Armroll ($6m^3$) with daily collection of hauled container (2) Tipper ($6m^3$) with 3 d/wk collection of plastic bags at communal station Year 2006 to 2015: The above vehicle types, in addition to: (3) Compactor ($10m^3$) with 3 d/wk collection of plastic bags at communal station
d) Direct Transport to TPA	Direct transport for haul distances less than 20 kilometers and examination of overall effect of transfer station on collection and transport cost for areas with distances longer than 20 kilometers.
e) Operating hours days	7 hours/day, 6 days/week

6.3.2 Intermediate treatment and disposal

(1) Final disposal

As open dumping is prohibited and its enforcement shall be improved in Indonesia, options for final disposal will be controlled land fill and sanitary landfill. However, sanitary landfill shall be employed by KMUP to prevent environmental pollution of the surroundings.

1) Control landfill site

Open dumping sites shall be transformed into controlled landfill sites, based on the following operational concept.

a. Control of disposed waste
b. Periodical soil covering

Under this operational concept, the controlled landfill site shall have a fence, control room with weigh-bridge, and a dike to prevent outward flow of waste. It shall also have heavy equipment for periodically spreading layers of covering soil. It is desirable to provide cover daily, and not less than twice a week. Further more, only suitable sites shall be selected for controlled landfill sites to prevent adverse environmental impact. The operation will require the following conditions.

a. Facilities	-	Surrounding dike
	-	Gate and fence
	-	Control house and weighbridge
b. Equipment	-	Bulldozer, dump truck and excavator
c. Landfill method	-	Controlled landfill with periodical soil covering
d. Manpower	-	Administrator and operator

2) Sanitary landfill site

Sanitary landfill sites shall be provided with a leachate treatment plant with the capability to meet effluent standards and liner to prevent groundwater pollution. Treatment of leachate is difficult, in particular to satisfy the COD standard, since leachate is highly contaminated. Therefore, a sophisticated leachate treatment plant will be required. Operation of the sanitary landfill sites will require the following conditions.

a. Facilities	-	Surrounding dike
	-	Gate and fence
	-	Liner system
	-	Leachate collection system
	-	Leachate treatment system

- Gas removal system
- Weigh bridge and control room
- Storm water drainage system

b. Equipment - Bulldozer, landfill compactor, dump truck and excavator

c. Landfill method - Sanitary landfill with daily soil covering

d. Manpower - Administrator and operator

3) Semi-sanitary landfill site

The concept of a semi-sanitary landfill site takes into consideration the gap between the legal requirements on the one hand and actual environmental conditions and limited financial resources on the other. Semi-sanitary landfill sites shall be provided with a leachate collection system, leachate re-circulation system, pre-treatment (aeration) system and gas removal system (refer to *Fig.* 6.2). Suitable sites shall be selected to prevent groundwater pollution. Since there is little rainfall in the dry season, there will be no leachate discharge through the re-circulation system at that time. But in the wet season, especially in January with an average rainfall of 700 mm/month, the leachate volume will be substantial requiring a large pre-treatment plant. Since there is little data on leachate amounts in Indonesia, the capacity of the pre-treatment plant will be set at around half the estimated leachate amount. To reduce the leachate amount during the wet season, soil covering shall be carried out every day. The operation will require the following conditions.

a. Facilities
- Surrounding dike
- Gate and fence
- Leachate collection system
- Leachate circulation system (pond and pump-up system)
- Gas removal system
- Weigh bridge and control room
- Storm water drainage system

b. Equipment - Bulldozer, dump truck and excavator

c. Landfill method - Semi-sanitary landfill with periodical soil covering

d. Manpower - Administrator and operator

(2) Transfer station

A disposal site in Maros will be located at an average distance of about 30 km from the city center of KMUP. In this case, a transfer station will be required for transportation of solid waste collected in the southern and central parts of KMUP. Outline of transfer station in shown in *Fig.* 6.3 and described as follows:

a. Waste amount to be transferred
   - 965 ton/day on average
     (1,126 ton/day, 313 working days per year)

b. Plant capacity
   - 1,200 ton per working day
   - Peak hour capacity 180 ton/peak hour (peak ratio 15%)

c. Incoming vehicles
   - Around 700 vehicles
   - Average loading weight 1.8 ton/trip

d. Type of system
   - Stationary compactor type

e. Facilities and equipment
   - Access road and on-site road
   - Container yard
   - Transfer station building
   - Entrance building
   - Weigh-bridge capacity 20 ton 2 units
   - Compactor and associated equipment including hopper, hydraulic unit, run-up support 3 units
   - Electrical work and instrumentation 1 lot
   - Trailer-container $40m^3$ 15 units
   - Tractor 10 units
   - Prime-mover 2 units

- Leachate treatment plant 1 unit
- Maintenance tools and spare parts 1 lot

f. Environmental protection plan

- Odor	Storage in closed container Chemical spray unit attached to hopper
- Waste water	Discharge to sewerage (or leachate treatment plant)
- Noise	Dumping of waste inside transfer station building

g. Operation (16 hour operation): Total 51 persons

(3) Incineration plant

Incineration is a method used for volume reduction of the amount of waste to be disposed of in many cities. A schematic flow diagram of an incineration plant is given in *Fig.* 6.4. Advantages of incineration are summarized as follows.

a. Large volume reduction: Ash will be 15% of treated solid waste in weight and 5% in volume at disposal site
b. In general, less adverse environmental impact from ash than from raw solid waste.
c. Stabilization of disposal site
d. Energy recovery
e. Cost reduction of solid waste collection and transportation
f. Stable collection work due to shorter transportation distance

As mentioned in section 6.1.2 of this report, solid waste generated in KMUP is not suitable for incineration because of its low calorific value. However, the calorific value will increase in the future and self-combustion will be possible after 2005. The incineration plant, introduction of which shall be examined in the master plan, will have a capacity of 600 ton/day for the following reasons:

a. To treat all collected waste in 2015, the total capacity required will be 1610 ton/day. However, providing such an incineration capacity may be

difficult because of the financial constraints of KMUP. Therefore, phased introduction of incineration shall be considered.

b. As the incineration plant shall recover energy by generating electricity, minimum furnace capacity will be 200 ton/day. Considering operation during the maintenance period, three (3) furnaces will be required for one plant.

Outline of incineration plant is as follows.

a. Waste amount to be accepted
   - 570 ton/day on average
     (570 ton/day, 313 working day per year)

b. Plant capacity
   - 600 ton per working day (continuous operation)

c. Incoming vehicles
   - Around 450 vehicle trips daily
   - Average loading weight 1.8 ton/trip

d. Type of system
   - Stoker type

e. Facilities and equipment

- Foundation and infrastructure including stack	
- Incineration building including waste storage	
- Weigh-bridge capacity 20 ton	2 units
- Receiving and feeding equipment	1 lot
- Stoker and furnace 200 ton/day	3 units
- Boiler and associated equipment	
- Ash draught equipment and discharger	1 lot
- Generator and steam condenser	3,000 kwh
- Anti air and water pollution equipment	
- Piping and miscellaneous	
- Electrical equipment and instrumentation	1 lot
- Maintenance tools and spare parts	1 lot

f. Environmental protection
   - Anti-air pollution

Dust collector	Dust emission less than 0.1 g/Nm^3
HCl gas eliminator	HCl less than 400mg/Nm^3

- Waste water Discharge to sewerage (or treatment plant)

g. Operation (24 hour operation): Total 60 persons

(4) Disposal site up to 2005

Although the final disposal site is the most important facility in solid waste management, it is difficult to obtain the huge land area required for it. Among six potential sites for final disposal which were identified during the first field study period in Indonesia, only two sites, Tamangapa (KMUP) and Bonto Mate'ne (Maros), are promising in terms of land acquisition. Meanwhile, as Bonto Mate'ne site is close to the airport, it is not suitable for use as an inter- municipal disposal site. Therefore to use the existing Tamangapa site and extend it, is the only most suitable way to provide a final disposal site for solid waste up to 2005. *Table* 6.1 describes the main characteristics of the candidate disposal sites for the Master Plan.

Tamangapa is located in the south-east part of the city at a distance of 14 km from the city center. Recently an area of five (5) hectares is being used as a final disposal site. It is possible to extend this area up to 32 hectares by buying the rice fields located east of Tamangapa site.

(5) Disposal site after 2005

It is difficult to find a large enough area for a final disposal site inside Ujung Pandang City after 2005. Therefore selection of a potential site will be done taking into consideration the MINASAMAUPA integrated urban use concept. As the amount and density of population of Kab. Maros and Gowa is low, a final disposal site shall be selected in these areas in cooperation with KMUP. Within the MINASAMAUPA area, and considering waste transport, at least two site, one north (Maros) and the other south (Gowa) of KMUP, shall be selected.

During the first field work in Indonesia, two potential sites were suggested in Maros (Bonto Mate'ne and Palisi), but neither site were suitable as an inter-municipal disposal site because of the proximity of the airport to both. Therefore a definite potential site could not yet be selected in Maros. Therefore a site was assumed ten kilometers north of KMUP boundary, and examined in the master plan as a potential disposal site in Maros for waste

collected in Maros, and that from KMUP under the MINASAMAUPA concept. This approach has been taken because the potential to find suitable site for disposal in Kab. Maros is considered high.

Therefore potential sites considered in this study shall be the following:

- Samata (Gowa)
- Maros
- Bulurokeng (KMUP)

1) Samata (Gowa)

Samata is located about 17 km south-east of the city center of KMUP and lies in the basin of the Tallo river as does the Tamangapa site. This area is approx. 2.5 - 3.5 meters above mean sea level. The area is partly flooded in the rainy season, therefore a surrounding dike is required for the final disposal site. Geological conditions are described in F/S report.

2) Maros

As already mentioned in section (1), the exact location of potential site has not yet been identified. But for purposes of examination an assumed site ten kilometers from the boundary of KMUP is considered.

3) Bulurokeng (KMUP)

Bulurokeng is located in the northern part of KMUP at a distance of 17 km from the city center. This area was recommended as a candidate disposal site by IUIDP in 1991. The site consists of fish ponds and rice fields, and it is difficult to obtain covering soil from the surrounding areas. The site is also adjacent to a boy scout camp. For these reasons the IUIDP study selected Tamangapa over Bulurokeng as the final disposal site.

(6) Site of other facilities (Intermediate treatment and others)

Introduction of a transfer station shall be examined in the master plan taking into consideration the long distance from KMUP city to the disposal site in the future. Also, to reduce the amount of waste which must be disposed of at the final disposal site, an incineration plant will also be examined. Kelurahan

Borong, Kecamatan Panakkukang, in the central part of Ujung Pandang city area, was selected as a potential site for an intermediate treatment plant, considering its ideal location within the road network and near planned new roads and therefore easy accessibility to all parts of KMUP and the final disposal site. The area is about 4 hectares.

Kelurahan Borong is located in the south-east part of Ujung Pandang City and the distance from the city center is approx. 10 km. Present land use of this area is for rice fields and little housing. Swamp surround the area. Recently a drainage project is under construction to prevent flooding.

6.3.3 Waste recycling and volume reduction

(1) Composting

As putrescible matter is a major factor in composting, the high content of putrescible matter in solid waste generated in KMUP makes the waste suitable for composting, even though the C/N ratio (carbon/nitrogen) is high. Cipta Karya is implementing a pilot project for manual composting in KMUP. Manual composting, can be used in future although working conditions are not desirable and the scale will be small.

Small scale compost devices are used in many houses with small gardens in Japan to produce compost for the garden, and at the same time reduce the amount of waste. Some cities in Japan promote the use of this device by providing a certain subsidy.

(2) Separate collection and recycling of reusable material

Although the amount of reusable material included in the solid waste is small at present, this amount is forecast to grow, so an effective recycling system will be necessary in future. The most important recycling item will be used paper, specially newspapers, carton boxes and old magazines. These are recycled by scavengers at present. Scavengers' activity will be maintained and strengthened as necessary in the future.

Metal and glass are also important recyclable items. Although, percentages of metal and glass in KMUP solid waste are presently small, they are also forecast to increase. Therefore, a recycling system for these items may be

required in the future. A recycling system for reusable material shall include separate collection of reusable material which relies heavily on citizens' cooperation. In Japan, Yokohama city is implementing the separate collection of tin cans and glass jars. *Fig.* 6.5 shows composting device for household and the system flow of the recycling plant in Yokohama city.

6.3.4 Street sweeping

(1) General

Street sweeping is governed by the local government regulation no. 3/1990. Accordingly DK have explained that their objective is to sweep Class I streets twice a day, Class II streets once a day, and Class III streets once every two days. Street lengths by this classification are (based on Dinas PU 1993 survey);

Class I	121 km
Class II	112 km
Class III	87 km

Presently this activity is carried out manually in KMUP. The Master Plan shall look into the need to introduce mechanical sweepers. A comparison of both manual and mechanical sweeping methods shall be outlined hereafter.

(2) Manual sweeping

Under this method a large number of sweepers may be anticipated although the costs may be less.

In order to determine the required number of sweepers in KMUP, in the absence of any heavy equipment and plans to procure them, three options have been developed as follows;

	Class I Streets	Class II Streets	Class III Streets
Option 1	OK; twice/day NK; once/day	OK; once/2 days NK; once/2 days	OK; once/2 days NK; none
Option 2	OK; twice/day NK; once/day	OK; once/day NK; once/2 days	OK; once/2 days NK; once/2 days
Option 3	OK; twice/day NK; twice/day	OK; once/day NK; once/day	OK; once/2 days NK; once/2 days

Notes: OK = Old Kecamatan, NK = New Kecamatan

Option 3 follows DK objectives, but would obviously require a large number of street sweepers. Option 1 is more realistic and basically calls for more efforts on the part of residents in new Kecamatan to take responsibility for street sweeping. Option 2 lies in between these options. The following table shows the manpower requirements by Kecamatan for each option calculated on the basis of present sweeper manual performance of 500m/day (both sides of the street).

Obviously it would be difficult and costly to hire 5 times the present staff (815 persons) and provide the budget (Rp.1.1 billion/year) to implement Option 3. Option 1 would be more realistic to attempt to achieve, although even with the lowest manpower requirement, it is still over 3 times the present staff number.

Therefore the unit cost will be Rp. 8,335/swept Km/day.

(3) Mechanical sweeping method

To sweep the same road length of option 3 by mechanical sweepers, the number of sweepers required shall be 9 vehicles, based on the following assumptions;

Vehicle daily sweeping length = 50 km
Vehicle capacity = 3.8 m^3
Sweeping length/trip = 10 km

Therefore unit cost of mechanical sweeping will be Rp. 3,636/swept km/day that is much cheaper than manual seeping. This indicates that mechanical sweeping is less costly to operate in this example. However investment costs for purchase of mechanical vehicles is too high to be borne by KMUP at one time. Therefore the master plan shall consider including both mechanical and manual sweeping, with gradual introduction of mechanical sweepers and modification of work extent closer to options 1 and 2.

6.3.5 Ditch cleansing

It is evident that discharge of solid waste into open drains in KMUP is a significant problem that creates unsanitary conditions in the city and disturbs the functioning of the drainage network.

The reasons for pollution of the drains by solid waste are summarized as follows;

a. Low collection service ratio in the city encourages illegal waste dumping in open spaces and ditches.

b. Placing of many of the TPS structures on or near to ditches and improper disposal of waste inside the TPS, or when waste is not regularly collected from TPS, it overflows into the ditch.

c. Lack of citizens' awareness and strict enforcement by punishment.

In principle there are two methods to carry out ditch cleansing; the manual method which is labor intensive, and mechanical method relying heavily on equipment. A combination of both methods may also be considered.

The manual method presently employed results in difficult and unsanitary working conditions for the workers involved. Although it is preferable to continue the present method, as this activity is not expected to expand in future with the improvement of the solid waste collection service, it is recommended to include one or two mechanical excavators to assist in the operation.

6.3.6 Public participation and private sector participation

(1) Public participation

An efficient solid waste collection system cannot be realized without the cooperation of the citizens. Many aspects of solid waste collection such as waste storage and discharge are directly related to the activities of the citizens and for the collection plan to succeed it must meet the citizens' aspirations and have their positive support. The M/P for SWM shall be developed on the basis of public participation in its execution. This section describes some aspects of public participation in the M/P.

(2) Private sector participation

1) Type of privatization

As privatization is a national policy of Indonesia and is deeply related to the technical system of solid waste management, major issues of privatization in solid waste management are discussed hereafter.

KMUP shall consider introduction of privatization in the future. This will contribute to reducing KMUP's work load and support efficient performance of solid waste collection.

Taking into consideration that the activities of a private company are initiated to make profit, three forms of privatization for solid waste collection may be considered.

- Contracting out
- Private collection in open competition
- Private collection under franchises

a. Contracting out

Contracting out is the system whereby a private company carries out collection service based on a contract with the government. The government is responsible for payment. The fee for solid waste collection will be collected from the waste generator by the government.

b. Private collection in open competition

This is the system whereby the private company will collect not only solid waste but also the fee for solid waste collection from the waste generator directly. The company will also set the fee at a level to make a profit in open competition. In this case, the private company will not be interested to provide service to low income areas where residents will be unable to pay the required fee. Therefore service in low income areas will need to be provided by the government.

c. Private collection under franchises

This is another system of private collection. The government gives an exclusive franchise license to a company to operate alone in a given area to avoid excessive competition. The company having the franchise will have the right to set fees at levels allowing for cross subsidy between different income levels.

2) Applicable type in KMUP

Since the new fee collection system has been introduced in KMUP and the fee is already collected by the municipality, the form of contracting out may be more suitable, especially for residential areas. Contracting out will also ensure that private sector activity may be extended to low income areas.

The second form, private collection in open competition, can be introduced only for large waste generators such as hotels, etc. if tariffs can be mutually agreed.

3) Area to be contracted out concerning solid waste collection

Some thought has been given to introducing a contracting out for solid waste collection as follows.

a. Contracting out of collection up to year 2005

The area to be contracted out will at first be the old city up to year 2005, if there are some private companies interested. The area will comprise the old Kechamatan for the following reasons.

- Work load and operation costs can be clearly defined.
- Primary collection provided by LKMD has been largely discontinued because all the money collected goes directly to DK under the new fee collection system. Privatization of this area may be the only way to solve this problem.
- If all of the old city area (6 Kecamatan) is to be contracted out, the ratio of citizens served by private collection will be 30% of the total population in the year 2005. This figure is very acceptable.

b. Contracting out of collection after the year 2005

It is necessary to expand contracting out after the year 2005. To expand contracting out, the collection service shall be extended to the newly developed housing areas in the suburbs, because major expansion of population will occur there. When all of the newly

developed area will be contracted out, the above ratio will rise to 50% of the total population.

3) Privatization of final disposal

Concerning final disposal, there are two options

- Contracting out of the operation
- Private disposal site

a. Contracting out of the operation

It is noted that the key point of operation of the final disposal site is making effective use of the heavy equipment. Efficient operation and maintenance of equipment is indispensable to avoid frequent breakdowns and interruption of work. Contracting out will result in the efficient use of equipment reducing unit costs and pollution due to accumulation of waste during down time.

b. Private disposal site

Selection and obtaining of suitable land for final disposal sites is a very critical issue in solid waste management. Therefore private ownership and operation of disposal sites may provide a good solution but it seems difficult to realize the sufficient level of tipping fees to attract the private sector. And the government will be requested to assist the private sector to secure the necessary land.

In the near future, KMUP is urged to attract and introduce private disposal sites based on the Government's and residents' environmental requirements. However, Government shall continue to provide disposal sites until a private company is able to secure them.

c. Contracting out of other activities

The area to be contracted out will not be restricted to the collection service, but can be extended to other activities, such as street sweeping, ditch cleansing, operation of final disposal site and maintenance work. It is recommended to contract out these activities

as much as possible and to promote the interest of private companies in undertaking this kind of work.

6.4 Technical Alternatives

6.4.1 Basic consideration to formulate alternatives

(1) Up to 2005

The most important facility for solid waste management is the final disposal site. An effective collection and transportation plan, and intermediate treatment plan cannot be prepared until the location and area of the final disposal site is clearly confirmed.

As mentioned before, the only possible location for the final disposal site up to 2005 is the extension of the present Tamangapa site. As sanitary landfill is acceptable from the environmental and economical viewpoints, sanitary landfill shall be adopted even though up to 2005.

The most important issue up to 2005 is to improve waste collection and transportation to achieve the target set out in REPLITA IV (1994-1998). Therefore it is necessary to upgrade the collection service ratio to 90% by the year 2005.

As for intermediate treatment, implementation of a pilot project shall be implemented for the following reasons:

a. To construct large scale facilities, such as an intermediate treatment plant, is difficult because of the financial burden involved
b. As for the waste quality, the lower calorific value of the waste of KMUP makes it unsuitable for incineration
c. Recyclable/reusable material content is very low
d. Small scale incineration and compost facilities are being carried out by Cipta Karya as pilot projects

Institutional improvement shall also be considered for the efficient collection of waste.

(2) After 2005

The final disposal site in the future shall be planned in consideration of the MINASAMAUPA concept, because it is difficult to find such a large area as

is required for a final disposal site inside Ujung Pandang. Sanitary landfill system shall also be adopted. In consideration of the efficient and economical waste collection and transportation system in the MINASAMAUPA area, at least two sites for final disposal shall be required. Therefore, the following alternatives regarding solid waste management of KMUP are proposed and shall be examined in their technical and financial aspects.

Alt-1. All collected waste of KMUP shall be disposed of in Gowa
Alt-2. All collected waste of KMUP shall be disposed of in Maros
Alt-3. All collected waste of KMUP shall be disposed of in Gowa and Maros
Alt-4. Transfer Station shall be constructed and all collected waste of KMUP shall be disposed of in Maros
Alt-5. The waste collected from the central area of KMUP shall be incinerated and ash and other waste of KMUP shall be disposed of in Gowa and Maros
Alt-6. All collected waste of KMUP shall be disposed within KMUP

(3) Other activities

1) Recycling and volume reduction

An effective recycling system and volume reduction of solid waste will be necessary in future. The period up to 2005 will be the preparation period for introduction of an efficient system in future. Several pilot projects will be tried to obtain necessary information, technology and experience. Promotion of recycling and volume reduction shall be included in the Master Plan after the year 2005.

2) Strengthening of organization

Up to year 2005, KMUP shall establish a more suitable organization for solid waste management. The future direction will be establishment of Persan Daerah (PD) Kebersihan. Also it will be necessary to provide a branch office and field office considering the expansion of the collection service area. When an inter-municipal disposal site is introduced, an adequate organization shall be established to manage it.

3) Fee collection

To establish a concrete financial base and to cover the cost of solid waste management, proper tariff system shall be established based on the new fee collection system introduced in KMUP in 1994.

4) Private sector participation

Private sector shall be involved in solid waste management in future as describedin section 6.3.6. However technical alternatives are formulated based on direct operation by government because:

a. No specified firms are interested in solid waste management at present.

b. Service cost by private firms will be less than direct operation by DK

6.4.2 Alternatives up to 2005

(1) Discharge

Solid waste discharge is the first step towards introducing a more efficient collection service. While citizens participation in the following waste discharge rules is essential, these rules should be made within the context of a collection and transport plan strictly adhered to by the authority concerned.

In most areas of the city, waste discharge shall be three times per week and door-to-door service will be minimized. The M/P will not propose alternatives for discharge and the new discharge system shall be as follows;

a. Door-to-door service shall not be increased and be maintained at the present level.

b. Jali-Jali system will be introduced on a limited scale in specific land use areas.

c. Unpacked waste brought to open spaces shall be strictly prohibited.

d. No new fix bins and TPS (RC containers) shall be added to the approximately 400 presently serving the city. Discharge system by using packed waste will be promoted, and the packed waste shall be brought to

the designated TPS according to discharge schedule. TPS will be gradually replaced by haul containers. By 2005 use of TPS in the city will be greatly reduced.

e. The number of haul containers ($6m^3$) shall be gradually increased from the present 80 to 700 by the year 2015. Containers shall be located in densely populated areas of more than 170 persons/hectare, to maintain walking distances less than 200m as much as possible.

f. Open Stations collection point for packed waste shall replace door-to-door and open space discharge. Designated suitable locations shall serve as compactor and tipper vehicles pick-up points. Packed waste shall be brought to these stations at fixed times.

Packed waste may be discharged either in plastic bags or individual bins. The bins shall be of suitable size and material to facilitate handling by the collection crew.

(2) Primary collection

At present approximately 400 to 450 persons are employed in this activity (one hand cart/worker) and 35 to 40% of waste collected by DK is brought to the pick-up points by primary collection. If this service is allowed to grow, at the present rate 800 to 900 employees will be required by the year 2015, with a similar number of hand carts. Needless to say this is not a cost that can be justified, and primary collection service must be streamlined.

The M/P will not promote this system and the present level will be maintained. Service will be provided only where vehicle accessibility is very difficult and at places where pick-up points are located too far from dischargers. This system will not be introduced in newly developed areas in the suburbs where the bulk of the population will be residing in the future.

Information shall be collected to determine the areas where this service is needed. Workers and hand cart operation will be attached to the local authorities, but supervision and subsidization of this system will be borne by the SWM authority.

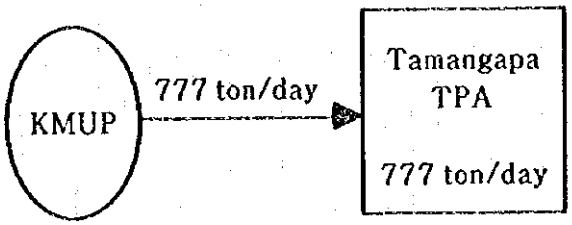
The approximate percent of collected waste transported by primary collection service in the M/P shall be as follows;

Year 2005 about 30%
Year 2015 about 20%.

All waste collected by primary collection shall be discharged in plastic bags so as not to delay off and on loading from cart to pick up point to collection vehicle.

(3) Collection and transport

During the first half of the master plan (M/P) period KMUP will continue to utilize the present Tamangapa disposal site for sanitary landfill disposal. The amount of waste to be collected and transported to Tamangapa site is shown in the following figure. The amount in 2005 will be just less than 3 times the presently collected amount.



Alternative up to the year 2005

This will require much improvement in the operational aspects of collection and transport to improve efficiency and avoid incurring enormous costs. The work will be expanded to new areas in the suburbs where the population balance is forecast to shift and hardly any present service is available.

Conditions for estimation of requirements and improvement/expansion of collection and transport service during this period are as follows;

a. No introduction of new vehicle types, such as compactor, are considered in order to avoid costly investment and introduction of a new system at an early stage.

b. Of the existing fleet, trucks and armroll vehicles with 6 m^3 haul capacities will continue to be used for the duration of their useful life. As required the new vehicles to be introduced shall be tipper of 6m^3 capacity and armroll vehicles.

c. KMUP was divided into 15 collection zones (9 old Kecamatan plus division of the suburban 3 Kecamatan into 6 zones). Traveling speeds from each zone to Tamangapa disposal site were taken as 30 km/hour, and the new road projects were taken into consideration to estimate distances to the disposal site.

d. Based on operation costs, the share of residential and street waste to be handled by each vehicle type was calculated for each collection zone. The share of each type was about half. For commercial and institutional waste, under the assumption of large discharge amounts, armroll's share was taken at 70% and tipper at 30%. Overall in 2005, 63% of the collected waste shall be by armrolls.

e. Collection shall be 313 days/year (6 d/week) in principle.

f. Collection frequency shall be;

Daily	For commercial and institutional activity and 30-40% of total residential waste (mainly in Kecamatan U. Pandang, Wajo, Bontoala, and Makassar)
3 d/week	For all other areas

As the distance to Tamangapa disposal site is 14 km from the city center, from the economic viewpoint there is no need to introduce a transfer station and direct haul shall be employed.

(4) Intermediate treatment and disposal

Considering the financial situation of KMUP, no intermediate treatment system will be introduced up to 2005. All collected solid waste will be disposed of at Tamangapa disposal site. As the distance to Tamangapa is 14 km from the city center, direct haulage shall be employed because it is more economical than haulage through a transfer station.

Although Tamangapa disposal site shall be operated under the sanitary landfill system as required by the regulations in Indonesia, there are several problems that must be overcome before a full sanitary landfill system can be realized such as operation of leachate treatment plant and construction of liner system. Therefore, Tamangapa disposal site will be expanded based on the concept of semi-sanitary landfill described in section 6.3.2 of this report.

Outline of Tamangapa final disposal site is as follows.

a. Waste to be disposed of: Domestic waste and commercial waste
b. Daily waste amount in 2005 — 777 ton/day
c. Total waste amount from 1995 to 2005 — 2.6 million tons
d. Total area of Tamangapa disposal site — 32 ha

Operation equipments are as follows.

a. Heavy equipment

Track type tractor	3 units	Removal, spreading and compacting
Excavator	1 unit	Covering soil, excavation and others

b. Vehicles

Dump truck	2 unit	Covering soil transportation
Water tank truck	1 unit	Dust removal
Pick up truck	2 unit	Communication, miscellaneous work

Standard of work consists of ;

a. Working hour — 16 hours (day shift and night shift)
b. Covering soil — periodical covering (minimum twice a week)
c. Entrance control — Solid waste amount, type of waste

Required number of personnel is 29 persons in total.

(5) Street sweeping

The M/P shall propose daily sweeping of Class I and II streets and every other day sweeping of Class III streets (Option 3 described in Section 6.3.4). More street sweeping by the citizens themselves through public participation will be promoted.

Furthermore it is considered that introduction of mechanical street sweepers will contribute to the cleaning of the streets and allow a decrease in the number of street sweepers required.

During this phase of the M/P, mechanical sweepers will be used to sweep Class I streets only. The street sweeping plan was formulated under the following considerations;

a. Mechanical sweeper will have a daily sweeping length of 50 km.
b. Average distance to the disposal site covered by the mechanical sweeper is 20 km in one direction
c. Present efficiency of sweeper will be improved to achieve 1,500 meters per day, up from 1,000 meters at present by striker supervision and proper distribution of the work
d. Number of street sweepers will be maintained within the present levels
e. For every 20 sweepers one supervisor is required
f. Manual sweepers will bring the swept waste in hand carts to pick up points designated for collection vehicles collecting other waste types, and no specialized vehicles will be provided for street sweeping.

(6) Ditch cleansing

The master plan for ditch cleansing shall continue the present work method under the following conditions/assumptions:

a. The total waste collected from ditch cleansing shall be maintained at 10 t/d in the future because expanded and improved waste collection service is expected to contribute to decreasing waste discharge into ditches.

b. Although working conditions are difficult under manual cleansing, introduction of mechanical equipment in large numbers may be difficult because of non-uniformity of ditch cross sections.

c. The labor force shall be set at 130 workers and 10 supervisors. Three (3) drivers shall also be assigned to this activity.

d. Two tippers ($6m^3$ capacity) shall be assigned to this duty.

However it is recommended that an accurate inventory of the ditch network be undertaken and if enough uniformity in drain widths and depths is found, then introduction of one or two mechanical excavators to facilitate the work should be considered. It is further recommended that intensive educational campaigns be held on a regular basis to discourage solid waste discharge in the ditches and promote citizens' participation in actual ditch cleansing. The labor force should not be allowed to exceed the proposed 140 personnel.

6.4.3 Alternatives after 2005 and up to 2015

(1) Collection and transport

1) Equipment and manpower for each alternative

From the year 2006, a new disposal site shall be required. Candidate disposal sites as well as intermediate treatment facilities have been proposed and six (6) alternatives formulated as described in section 6.4.1. Flows of collected waste amount under each alternative are shown in *Fig.* 6.6.

Collection service ratio will continue to be expanded during this period to reach 95% of the total population of KMUP in 2015 (approximately 98% if island population is excluded).

Discharge methods, primary collection extent and collection frequencies will remain the same as those introduced at the start of the M/P. In two out of three of the proposed candidate disposal sites, in Gowa and Maros, traveling distances to the disposal sites from the city center will exceed the respective distance to Tamangapa disposal site and therefore the compactor vehicle (10 m^3 capacity) which is more cost efficient than the tipper and armroll at distances greater than 15 kilometers will be considered.

Conditions for estimation of manpower and equipment requirements for each alternative for all the SWM elements and improvement/expansion of collection and transport service during this period are as follows;

⇒ In principle, selection of vehicle type used to transport waste based on distance from collection zone to disposal site as follows;

Waste Type	Distance> 15 km		Distance<15 km	
Residential	Compactor: Armroll:	80% 20%	Tipper: Armroll:	50% 50%
Commercial and Institutional	Armroll: Tipper:	70% 30%	Armroll: Tipper:	70% 30%

⇒ In Alt. 3, collected waste shall be disposed of at the closer of the two disposal sites proposed to the collection zone. All Biringkanaya waste, 25% of the total, will be transported to Maros.

⇒ In Alt. 4 all waste collected at Biringkanaya and Ujung Tanah will be directly hauled to Maros (30% of total), while the remaining amount will be transported through the transfer station.

⇒ In Alt. 5 collected waste will have the following destination:

Incineration plant	41% (ash produced at plant will be disposed at Gowa)
Gowa disposal site	34%
Maros disposal site	25%

2) Comparative analysis of the alternatives

For the purpose of comparative analysis, a "No-Improvement Option" was also set up under the following assumptions;

⇒ The M/P waste collection service targets shall be maintained

⇒ Primary collection will be maintained as at present

⇒ Vehicle types will be three (3) types, tipper ($6m^3$), armroll ($6m^3$) and compactor ($10m^3$)

⇒ There will be no improvement in collection operation present indices, and these will continue, as follows, in the future.

Tipper:	2.5 trips/day,	1.2 ton/trip
Armroll:	5.5 trips/day,	1.5 ton/trip

The results of the comparative analysis are shown in the following table.

Comparative Analysis of the Alternatives

Indices	1994	2005	2006 - 2015						
			Gowa Alt. 1	Maros Alt. 2	Gowa + Maros Alt. 3	T/S + Maros Alt. 4	Ic + Gowa + Maros Alt. 5	Bulur Alt. 6	Without Improv-ement
1) Vehicle number	95	110	203	260	208	191	195	215	357
2) Trip number/day	1.9	6.6	5.3	3.1	4.9	4.1	4.0	5.2	4.1
3) Loading Time (Min/Ton)	163	52	54	69	55	51	52	57	95
4) Haul/veh/day (t)	2.6	8.1	7.8	6.1	7.6	8.3	8.1	7.4	4.4
5) Ton/person/day (t)	0.7	1.02	1.30	1.11	1.28	1.35	1.34	1.27	0.9
6) Unit cost (Rp./ton)	17,830	15,559	15,296	18,649	15,442	14,401	15,150	16,193	19,885

Alternatives 1 through 6 show a marked improvement on the present operation indices. While Alternatives 4 and 5 provide the least unit cost, it should be noted that the cost of transport of waste from the transfer station to disposal site (Alt. 4) and transport of ash from incineration plant to disposal site (Alt. 5) are not included. Alternative 1, therefore offers the most promising alternative.

The "No-Improvement" alternative will actually provide some improvement compared to the present system. This is due to limiting vehicle types to armroll and tipper and discarding the more costly and inefficient types presently in use, such as pick-up, large tippers, flat trucks and covered dump trucks.

(2) Intermediate treatment and final disposal

1) Waste amount to be disposed of in each alternative

As mentioned in 6.4.1, six (6) alternatives were formulated based on the differences in transportation, intermediate treatment and final disposal. Solid waste amount to be disposed at the disposal sites designated in each alternative during the period 2005 to 2015 are estimated as follows:

Considering the difficulty in land acquisition in KMUP in the future, Alternatives 1 to 5 introduce an inter-municipal disposal system under MINASAMAUPA concept using two (2) disposal sites, in the northern and southern MINASAMAUPA region. KMUP and the regional authorities concerned will search for an appropriate location in the

northern part of the region, in Kab. Maros, around 10 km from KMUP's northern border. The southern disposal site will be at Samata, Kab. Gowa, around 17 km from KMUP city center. Alternative 6 is the only alternative using an independent disposal system for KMUP at Bulurokeng.

Alternatives of Intermediate Treatment and Final Disposal (unit : million ton)

		North Disposal Site (Maros)	South Disposal Site (Gowa)	Bulurokeng (KMUP)	Remarks
Alt-1	Inter-municipal disposal system Sanitary landfill at Gowa	0.3	4.4	-	-
Alt-2	Inter-municipal disposal system Sanitary landfill at Maros	4.3	0.4	-	-
Alt-3	Inter-municipal disposal system Sanitary landfill at Maros and Gowa	1.2	3.5	-	-
Alt-4	Inter-municipal disposal system with transfer station Sanitary landfill at Maros	4.3	0.4	-	Transfer station (1,200 ton/day)
Alt-5	Inter-municipal disposal site with incineration Sanitary landfill at Maros and Gowa	1.2	2.0	-	Incineration plant (600 t/day)
Alt-6	Independent disposal system Sanitary landfill at Balurokeng	0.3	0.4	4.0	-

To examine the cost effectiveness of transfer haulage, Alternative 4 has been formulated considering use of a northern disposal site with a distance of about 30 km from KMUP city center. In this alternative, solid waste collected in the central and southern parts of KMUP will be hauled to the transfer station planned at Borong, Kecamatan Panakkukang, while waste from the northern part will be directly hauled to the final disposal site. Considering the importance of the reduction of the volume of solid waste be disposed of, Alternative 5 has been formulated to introduce an incineration plant facility at Borong, Kecamatan Panakkukang. In this case, waste collected from KMUP's central area will be treated at the incineration plant and the ash will be disposed of at Samata together with solid waste hauled from the southern

part of KMUP. Waste collected from KMUP's northern areas will be directly hauled to the northern disposal site.

2) Working standard and personnel in each alternative

Working hours at the disposal sits will differ by alternative as follows.

Working Hour and Personnel of Disposal Site

	Working hour	Daily waste amount	Personnel
Alternative 1			
Maros	Daytime	82 ton	11 person
Gowa	Daytime and night	1,451 ton	37 person
Alternative 2			
Maros	Daytime and night	1,448 ton	37 person
Gowa	Daytime	85 ton	11 person
Alternative 3			
Maros	Daytime	426 ton	20 person
Gowa	Daytime and night	1,107 ton	34 person
Alternative 4			
Maros	Daytime and night	1,448 ton	37 person
Gowa	Daytime	85 ton	11 person
Transfer station	Daytime and night shift	965 ton	51 person
Alternative 5			
Maros	Daytime	426 ton	20 person
Gowa	Daytime and night shift	695 ton	28 person
Incineration plant	24 hours	570 ton	65 person
Alternative 6			
Maros	Daytime	82 ton	11 person
Gowa	Daytime	85 ton	11 person
Bulurokeng	Daytime	1,366 ton	41 person

(3) Street sweeping

The basic conditions for preparing the plan for street sweeping beyond the year 2005 are the same as for the first period of the M/P. However to avoid increasing the number of manual sweepers, a part of the Class II streets will also be mechanically swept.

(4) Ditch cleansing

The same conditions for preparing the ditch cleansing during the first period of the master plan shall apply to the period 2006 to 2015.

In other words, 10 supervisors, 3 drivers and 130 workers shall be employed in this activity and 10 tons of solid waste are assumed to be removed from the

ditch and taken to the disposal site daily. Two tippers will be employed and it is recommended to introduce one or two excavators to facilitate the work.

6.4.4 Cost estimation for each alternative

Cost estimation is made for each of the alternatives. During the period 1995 to 2005 one alternative is proposed, while for the 2006 to 2015 period six alternatives are considered.

Each alternative is composed of primary collection, secondary collection, ditch cleansing, sanitary landfill, and street sweeping. In addition for two alternatives intermediate treatment facilities of incineration plant and transfer station are proposed. Each of these items has been costed.

For alternatives during 2006 to 2015, the cost estimation considered operation of final disposal sites as inter-municipal within the MINASAMAUPA concept. Therefore all alternatives included costs of the Gowa and Maros disposal sites regardless of whether the KMUP waste was disposed of at the site or not.

(1) Investment costs

Investment costs are calculated based on the following conditions;

a. Price levels are these of August 1994
b. Exchange rate applied is US$ 1.00 = Rp. 2,150 (August 1994)
c. Land acquisition costs based on counterpart team/site information
d. Estimates of administration, engineering and contingency costs are;

- Administration costs are 2% of investment costs
- Engineering costs are 12% of investment costs
- Physical contingency costs are 10% of investment costs

For landfill sites investment costs in 2015 were calculated based on the amount of waste entering the site which gave the required area. Accordingly investment costs were calculated for constructing a disposal site of that required area.

(2) Operation and maintenance costs

Calculated operation and maintenance costs for all the alternatives are estimated based on unit costs as follows.

a. Personnel	-	Supervisor	Rp.4,500/day
	-	Driver	Rp.3,500/day
	-	Worker	Rp.3,000/day
b. Fuel	-	Diesel	Rp. 380/liter
	-	Petrol	Rp. 700/liter
c. Utilities	-	Electricity	Rp. 300/Kwh
	-	Water	Rp. 2,500/m^3
d. Electricity Sales	-		Rp. 200/Kwh

For the calculation of depreciation costs the following operable years were assumed;

a. Civil works	30 years
b. Machinery	20 years
c. Heavy equipment	8 years
d. Collection vehicles	8 years
e. Containers	5 years

For landfill site operation and maintenance costs in 2015, the share of KMUP was calculated for each of the alternatives applying KMUP's waste share (1,366 t/d) of the total waste under the MINASAMAUPA concept (1,533 t/d). Depreciation costs of the disposal sites were calculated using unit cost per m^3 because some of the alternatives will have remaining capacities.

6.4.5 Selection of suitable alternative

(1) Technical Aspect

As waste volume reduction is expected to be an important issue in the future, Alternative 5 is the most preferable alternative from the technical viewpoint. Also this alternative will contribute to a more efficient collection service.

(2) Economic aspect

In comparison with the "without improvement case", Alternative 1 provides the most cost saving at Rp. 2.7 billion in year 2015, followed by Alternative 3. On the other hand, Alternatives 4 and 5 result in negative cost savings when compared with the "without improvement case". However the cost of Alternative 5 will decrease if the electricity produced at the incineration plant proposed in that alternative can be sold at a high price.

(3) Financial aspect

Alternative 1 is the least cost alternative, while Alternative 5 is the highest. Investment cost for Alternative 5 is 3.7 times that of Alternative 1 while operation cost in Alternative 5 is 1.9 times. However, operation cost excluding depreciation is only 1.2 times. *Table* 6.2 shows the financial comparison of each alternatives.

Considering economic growth in the future, investment cost up to 2005 will be 1.30% of GRDP in that year. Operation cost in 2005 will be 0.28% of GRDP, which is less than the present ratio calculated at 0.43% if annual growth rate is assumed to be 6%. In the same way, investment cost of Alternative 1 will be 2.02% of GRDP in 2015 and operation cost of Alternative 1 will be 0.33% of GRDP. It is emphasized that this percentage of Alternative 1 is less than the corresponding present figure if economic growth will continue at 6% annually. Investment and operation costs of Alternative 5 will be 7.52% and 0.54% of GRDP in 2015 respectively. Should economic growth achieve 8% annually, investment and operation costs of Alternative 5 will be 4.99% and 0.36% of GRDP.

As mentioned above, Alternative 1 is the most preferable alternative. But Alternative 5 may also be selected if economical growth achieves 8% annually.

(4) Social and Institutional Aspects

All alternatives except for alternative 6 will introduce an inter-municipal disposal system, which can be realized based on the MINASAMAUPA concept and guided by experience in the Jabotabek area in Indonesia.

(5) Environmental aspects

Concerning environmental aspects, Alternative 5 may be the alternative most effective in reducing environmental impacts generated from the disposal site, although it should be noted that operation of the proposed incineration plant will have some environmental impact.

(6) Overall aspects

As mentioned above, Alternative 1 will be the most preferable alternative considering the economical and financial constraints in KMUP. Therefore, first priority shall be given to alternative 1. However, Alternative 5 is also considered suitable if rapid economic growth will be realized.