JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DIRECTORATE GENERAL OF HUMAN SETTLEMENTS (CIPTA KARYA)
MINISTRY OF PUBLIC WORKS (PU)
GOVERNMENT OF INDONESIA

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

FINAL REPORT

MAIN REPORT

PART III ALTERNATIVE STUDY FOR WASTEWATER MANAGEMENT

MARCH 1996

PACIFIC CONSULTANTS INTERNATIONAL, TOKYO
YACHIYO ENGINEERING CO., LTD., TOKYO

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DIRECTORATE GENERAL OF HUMAN SETTLEMENTS (CIPTA KARYA)
MINISTRY OF PUBLIC WORKS (PU)
GOVERNMENT OF INDONESIA

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

FINAL REPORT

MAIN REPORT

PART III : ALTERNATIVE STUDY FOR WASTEWATER MANAGEMENT

MARCH 1996

PACIFIC CONSULTANTS INTERNATIONAL, TOKYO

YACHIYO ENGINEERING CO., LTD., TOKYO

In this report project cost is estimated at June 1995 price
and at an exchange rate of 1 US$ = Rp. 2,250 (≈ ¥100)

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a master plan and feasibility study on wastewater and solid waste management for the city of Ujung Pandang and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. Ryuji Yanai of Pacific Consultants International (PCI) five times between June 1994 and February 1996.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

March 1996

Kimio Fujita
President
Japan International Cooperation Agency

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

March 1996

Mr. Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit herewith the final report entitled "MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG". This report has been prepared by the Study Team in accordance with the contract signed on 14 June 1994, 24 April 1995 and 1 November 1995 between the Japan International Cooperation Agency and Pacific Consultants International in association with Yachiyo Engineering Co., Ltd.

The report, based on the results of analysis of existing condition of wastewater and solid waste management in Ujung Pandang, presents a master plan and feasibility study of wastewater and solid waste management, and an alternative study for wastewater management. The report consists of Executive Summary, Main Report and Supporting Report. The Executive Summary briefly illustrates the findings of the entire Study. The Main Report, in three (3) parts, presents the master plan (Part I), feasibility study (Part II) and alternative study (Part III). The Supporting Report describes in details the technical aspects of the master plan and feasibility study. Moreover, the relevant data and drawings are compiled as the Data Book & Drawing.

All members of the Study Team wish to express grateful acknowledgment to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, Ministry of Health and Welfare and Embassy of Japan in Indonesia, and also to officials and individuals of the Government of Indonesia for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of this study will contribute to the socio-economic development and environmental sanitation improvement in Ujung Pandang, the gateway to East Indonesia.

Yours faithfully,

Ryuji Yanai
Team Leader

SUMMARY

1. Introduction

This is a summary of the alternative study for wastewater management conducted targeting the "old town area" and its surroundings of KMUP (Municipality of Ujung Pandang).

The objectives of the entire study and the relevant reports in which they are dealt with are given below.

- To formulate a master plan, until the year 2015, for the improvement of wastewater and solid waste management in KMUP (Part I of Main Report)
- To conduct a feasibility study, until the year 2005, for the priority projects as identified in the master plan (Part II of Main Report)
- To conduct an alternative study for wastewater management (Part III of Main Report - This Report)

2. Objective of the Alternative Study

The objective area of this alternative study is the Priority Area as identified in the Master Plan (ref. *Fig. 1*).

This alternative study was intended at identifying and evaluating essentially simple alternative wastewater management strategies as a stop-gap measure, principally targeting graywater management, in the event the implementation of the proposed sewerage development projects as per the Feasibility Study is delayed due to financial constraints or any other unforeseen circumstances.

Moreover, in order to optimize public sector investment, a social aspect study was conducted to investigate potential active community participation for realizing the simple options of graywater management.

3. Options of Wastewater Management

Wastewater management aspects of this alternative study principally targeted that of graywater management, since the necessary improvement measures for blackwater management have been incorporated as the urgent project component of the Feasibility Study.

Options of graywater management could be selected to target either living environment improvement or water environment improvement, though in general an applied option would result in some form of water environment improvement.

An option principally targeting improvements near residents is for living environment improvement, while an option targeting improvement of a water body is for water environment improvement.

A total of ten (10) strategic options were conceived for wastewater management in the objective area, as follows :

(1) Cleansing of ditches and drains

(2) Provision or improvement of ditches and drains

(3) Installation of screens in ditches and drains

(4) Provision of household based infiltration trench

(5) Graywater collection and infiltration using ditches and drains

(6) Graywater collection and treatment using ditches and drains

(7) Provision of treatment system within canal

(8) Introduction of flushing or dilution water from Jeneberang river

(9) Graywater conveyance and treatment system using canal

(10a) Interceptor for coastal water protection

(10b) Interceptor sewerage system for living environment improvement

The first five (5) options target living environment improvement. They are simple and hence easily amenable for active community participation. While the remaining ones are rather complex and target, other than the last option No. 10b, water environment improvement. Accordingly, these remaining options are not amenable for active community participation. Active community participation implies involvement of community from the initial planning stage to the final operation and maintenance stage of a facility.

The first three (3) options are very simple, where the strategy is essentially the basic maintenance of a drainage ditch. Still they are very important to mitigate the accumulation of graywater in a ditch or drain.

The options No.4 and No.5 target infiltration of graywater into natural soil, respectively, within a household yard (household system) and nearby a road side ditch or drain (communal system). These systems, though simple, are relatively more complex compared to the above three (3) options.

The option No.6 is aimed at the treatment of graywater, using anaerobic filter system, near the outlet of a secondary drain prior to discharge into the primary drainage canal system, the Panampu ~ Jongaya canal.

The options from No.7 to No.9 are aimed at the water quality improvement of Panampu - Jongaya canal. In case of option No.7 installation of aerators in the canal is considered. The option No. 8 envisages introduction of flushing or dilution water into Jongaya canal from the long storage of Jeneberang river. The long storage is provided basically for the potable water supply development by PDAM. The option No.9 is aimed at the conversion of Panampu ~ Jongaya canal into double section, with the inner section conveying the graywater in dry season. The conveyed wastewater will be treated in two (2) separate treatment plants (stabilization pond systems) located at Lembo (to the north) and Maccini Sombala (to the south). These treatment plants would conform to that proposed in the Feasibility Study.

All the above three (3) options assume the provision of three (3) gates, one each at Jongaya, Sinrijala and Panampu canal. The gates while facilitating the separation of wastewater from sea water, would also contribute to mitigation of salinity intrusion.

The option No.10a is aimed at protecting the water quality of Losari beach area, by intercepting the outflows and treating the collected graywater with anaerobic filter system.

The option No.10b envisages the development of interceptor sewer system as the initial step of conventional sewerage development in the central area of the objective area, with the service area being in conformity with the Feasibility Study.

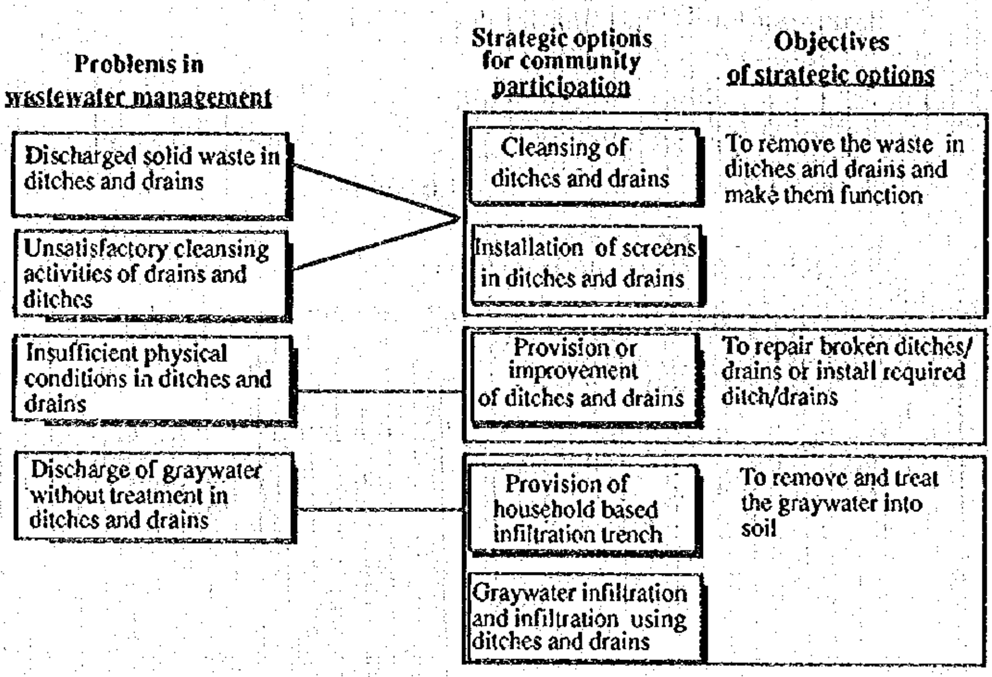
4. Social Study for Wastewater Management

The goal of the community participation is to improve the living environment at community level by enhancing people's awareness of the need for wastewater management and hence engaging communities and individuals in the planning, implementation and operation and maintenance of facilities. Utilization of local resources to the maximum extent possible will be promoted.

The social survey has been conducted in order to confirm the commitment of community participation for implementing the simple community oriented strategic options (option No.1 to No.5) in the selected model areas, which represent residential categories in Ujung Pandang as follows:

- Kelurahan Losari, Kecamatan Ujung Pandang: High income residential area
- Kelurahan Parang, Kecamatan Mamajang: Middle income residential area
- Kelurahan Pattunuang, Kecamatan Wajo: High income commercial area
- Kelurahan Maradekaya Selatan and Kelurahan Bara-baraya Selatan, Kecamatan Makassar: Middle and low income residential area

The following figure clarifies the major causes of problems in wasterwater management indicated by the community in the social survey and the objectives of options oriented to the community participation.



5. Evaluation of Alternative Strategies

5.1 Social Aspects

Throughout the social survey, the community's agreements on the improvement for the wastewater management and their willingness to participate in the program have been confirmed. The community participation will be in the form of retribution, manpower as well as mutual help and/or material input depending on their capabilities. Regarding the specified simple strategic options (option No. 1 to No. 5), the respondents in each model area indicated their preferences as shown below:

Model Area / Strategic Options No.	Losari		Parang		Pattunuang		Marsdekaya selatan/ Bara-baraya selatan	
	Household survey	Key informant interview	Household survey	Key informant interview	Household survey	Key informant interview	Household survey	Key informant interview
(1) Cleansing of ditches/drains	50%	80%	34%	40%	50%	100%	57%	58%
(2) Improvement of ditches/drains	20%	0%	22%	20%	10%	0%	25%	33%
(3) Installation of screens	2%	10%	6%	10%	3%	0%	0%	8%
(4) Infiltration trench (household)	16%	0%	0%	0%	3%	0%	12%	0%
(5) Infiltration trench (communal)	2%	10%	38%	0%	25%	0%	7%	0%
Others	10%	0%	0%	30%	10%	0%	0%	0%

Even though technically these five (5) options could be easily implemented by the community with a minimum technical guidance from the local government and the utilization of local resources, still as an incentive to encourage community participation, it would be preferable that the local government provides the sophisticated materials to those communities willing to install the systems. Moreover, public campaign and continuous technical guidance of the local government is essential.

5.2 Technical Aspects

Comparative evaluations of complex strategic options, those from No.7 to No.10, that are essentially projects requiring significant investment, were conducted to identify the possible optimum projects and the relevant constraints, if any.

Based on the results of comparative evaluation, as the canal water improvement program, among the relevant strategic options (Option No.7 to No.9), dilution water introduction from the long storage (option No.8) is identified as the most economical one. Though this could be implemented very quickly, there would be no water available for dilution once the ongoing water supply project is completed.

Between the other two (2) options, double canal section with the required influent pump facilities and treatment plants, one each at Lembo and Maccini Sombala (option No.9), is more economical than the other one (option No.7). Moreover, the option No.9 is more preferred from all other physical, environmental and functional aspects of the canal, as this option does not interfere with the canal.

Box type (covered channel) interceptor system, where the collection system of graywater is combined with that of treatment, insitu anaerobic filter system, is determined as the most economical means of Losari beach protection (option No.10a). However, with the necessary structural modifications this interceptor system could be constructed along the coast line of Losari beach to serve a multipurpose use of coastal beach erosion mitigation cum promenade.

The optimum interceptor sewerage system for the central area (option No.10b) is determined as the one that would limit the maximum length of exposure of graywater in a ditch or drain, prior to interception into the collection sewer network, to 600m. The project cost of this interceptor system would be about 37% of the corresponding cost of conventional sewerage system as per the Feasibility Study.

The direct construction cost of the these options requiring significant investment (option No.7 to No.10b) are given below.

Unit : Rp. million

Option No.	Description of option	Direct construction cost
7*	Aerators within the canal	5,046
8*	Dilution water introduction	515
9*	Canal water conveyance and treatment	4,335
10a-1	Losari beach interceptor (single purpose)	1,700
10a-2	Losari beach interceptor (multipurpose)	7,365
10b	Interceptor sewerage system	13,270

Note : * All these options assume the provision of three (3) gates, one each at Jongaya, Sinrijala and Panampu canals

6. Findings

(1) Community participation (involvement) for realizing the simple means of graywater management shall be promoted under the initiative of the Municipality of Ujung Pandang (KMUP) and those options should be implemented in step by step, starting from the five Kelurahans where the social survey has been carried out.

(2) When the overall environmental improvement of the objective area is targeted on a short term basis, the three (3) project components of option No.8, No.10a-1 and No.10b of above are recommendable as the cost effective (least cost) project package. These projects would contribute to both the improvement of living environment and water environment of the objective area. The total direct construction cost is about 15.5 billion Rp.

However, if the multipurpose interceptor system for overall protection of Losari beach, including that of coastal erosion mitigation, is used instead of the single purpose system (option No.10a-1 is replaced with option No.10a-2) then the total direct construction cost becomes 21.150 billion Rp., an increase of 5.665 billion Rp.

The project components delineated above are illustrated in *Fig. 2.*

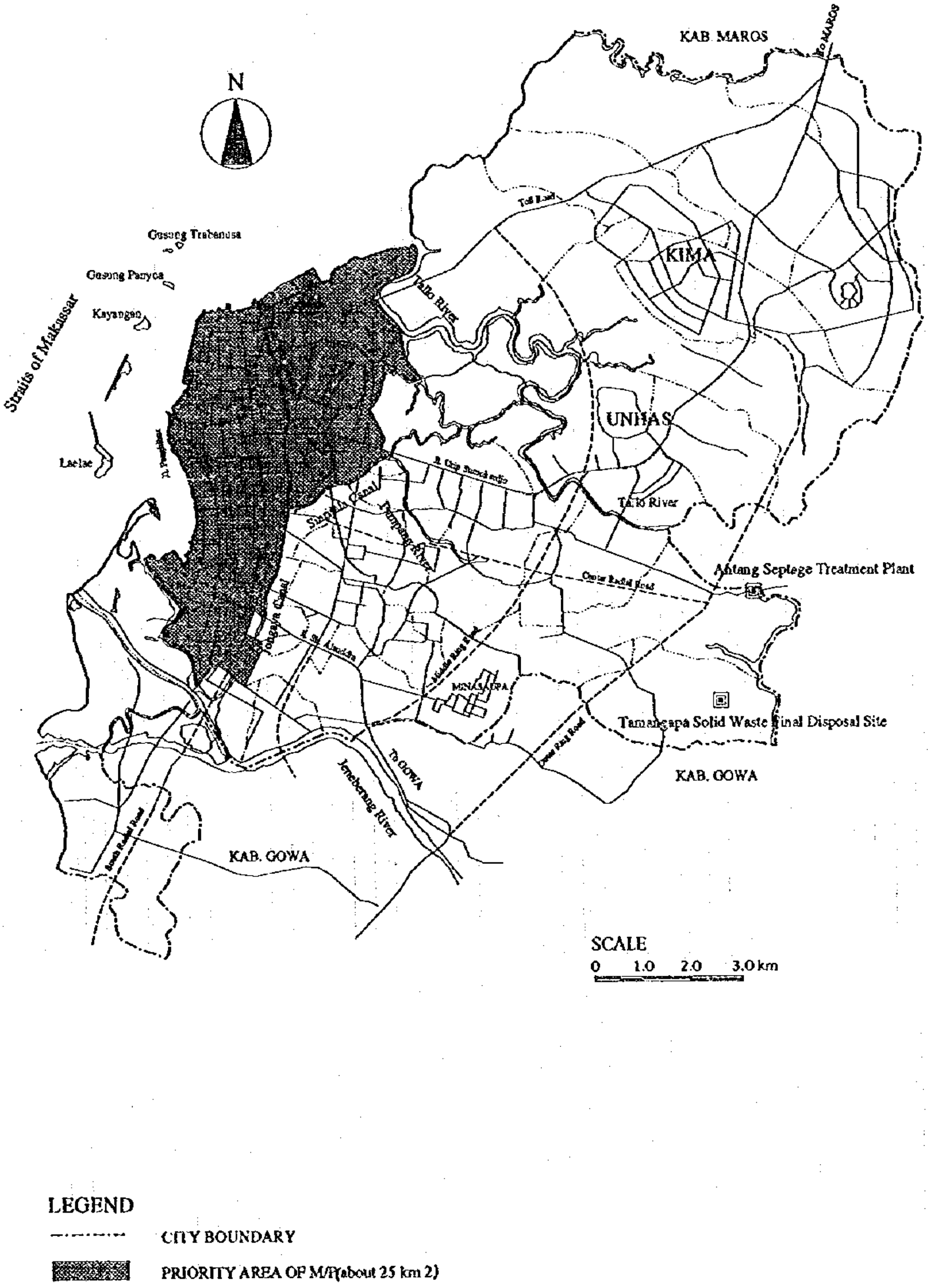


FIG. 1 Objective Area for Alternative Study

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

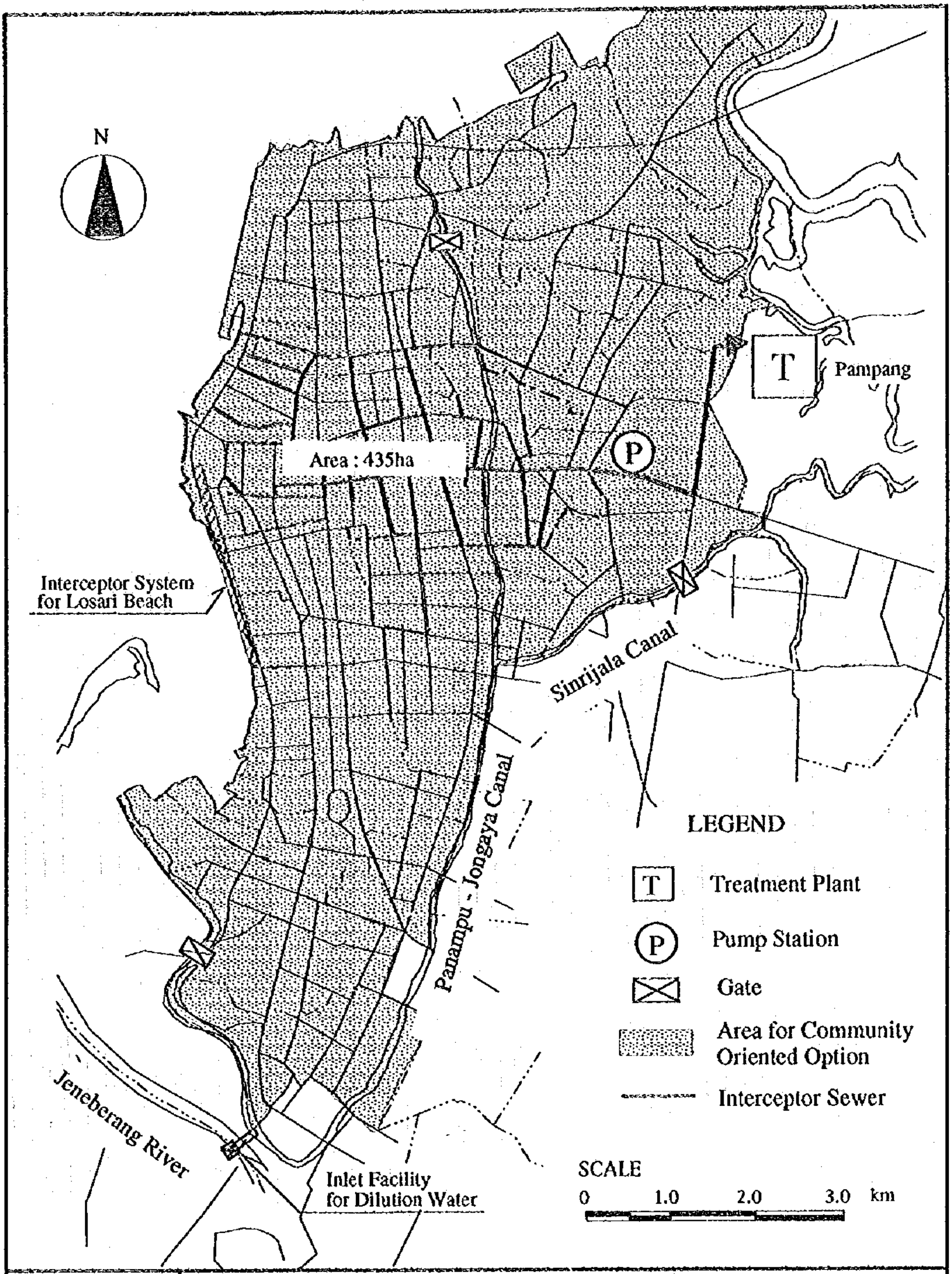


FIG. 2 Recommended Project Components

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

TABLE OF CONTENTS

List of Tables

Page

List of Figures

ABBREVIATIONS AND ACRONYMS

(in alphabetical order)

1. ADIPURA : Evaluation system of the city cleanliness
2. AMDAL : Environmental impact assessment process
3. ANDAL : Environmental impact assessment study
4. APBD : Annual local government development budget
5. APBN : Annual central government development budget
6. BANDES : Village aid plan
7. BAPEDAL : Environmental impact control agency
8. BAPPEDA : Local development planning agency
9. BAPPENAS : National development planning agency
10. DIP : Budget proposal for project
11. DK : Dinas Kebersihan (Cleansing department)
12. IUIDP : Integrated Urban Infrastructure Development Program
13. KANWIL : Provincial branch of department of central government
14. KIP : Kampung Improvement Program
15. KMUP : The Municipality (city) of Ujung Pandang
16. LKMD : Village social activity group
17. MINASAMAUPA : Ujung Pandang, Maros and Gowa metropolitan area
18. PERUMNAS : Public housing authority
19. PD : Regional enterprise
20. PDAM : Local government water supply enterprise
21. PKK : Woman's education plan

22. PLN : State electricity enterprise

23. PLP : Environmental sanitation division

24. PU : (Ministry of) Public works

25. PUSKESMAS : Public Health Center

26. RDTRK : Land arrangement plan

27. REPELITA : Five-year development plan

28. SLA : Subsidiary Loan Agreement

29. SOP : Standard Operation Procedure

30. SWM : Solid Waste Management

31. TPA : Final disposal site

32. TPS : Temporary disposal site

34. UNHAS : Hasanuddin University

35. WWM : Wastewater Management

DEFINITION OF TECHNICAL TERMS

A. Wastewater Management

1. On-site System	: The system treating wastewater within each building lot.
2. Off-site System	: The system collecting and treating wastewater from multiple number of building lots.
3. Package Wastewater Treatment Plant (PWTP)	: The compact blackwater and graywater treatment system which can obtain high BOD removal efficiency. The popular treatment processes of this system are an anaerobic filter-contact aeration process and separate contact aeration process.
4. Small Modular System (B)	: The system consisting of collection system, septic tank and leaching bed to collect and treat black water from about 20 households.
5. Small Modular System (B/G)	: The off-site system that serves about 1 RT (250 people) with collection and treatment system for both blackwater and graywater. The treatment system will be abandoned after integration into conventional sewerage system.
6. Large Modular System	: The off-site system that serves about 10,000 ~ 50,000 people with collection and treatment system for both blackwater and graywater. The treatment system will be abandoned after integration into conventional sewerage system.

7. Developer Modular System	:	The off-site system with collection and treatment system for both blackwater and graywater covering a housing complex constructed by developer.
8. Small Scale Sewer	:	The separate collection system from each household to main sewer constructed under foot path or housing lot at a shallow depth less than 1.0 m.
9. Interceptor Sewer	:	The collection system that receives gray water from road side ditch during dry weather.

B. Solid Waste Management

1. Primary Collection	:	Solid waste collection from houses and transport to communal stations or TPS using hand cart or small satellite vehicle.
2. Secondary Collection	:	Solid waste collection from communal stations and generator premises and transport to final disposal site or intermediate treatment facilities.
3. Semi-sanitary Landfill	:	The solid waste disposal system which requires leachate collection, re-circulation and pre-treatment (aeration) facility and gas removal facility in addition to the necessary facilities of control landfill.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Objective of the Study

The objective area of this alternative study for wastewater management is the Priority Area, the same area targeted for Feasibility Study, as identified in the Master Plan (ref. *Fig.* 1.1).

This priority area covers the highly urbanized "old town area" and its surroundings of KMUP (Municipality of Ujung Pandang).

This alternative study was intended at identifying and evaluating alternative wastewater management strategies as a stop-gap measure, principally targeting graywater management, in the event the implementation of the proposed sewerage development projects as per the Feasibility Study is delayed due to financial constraints or any other unforeseen circumstances.

The strategic options of graywater management studied are essentially simple and of low cost so that they could be implemented with a modest budget allocation and in a short time frame.

Moreover, in order to optimize public sector (government) investment, active community participation (involvement) for realizing the simple options of graywater management was studied in details, as social aspects.

This social aspect study was conducted with direct contribution from national experts on community participation, by forming an expert committee. The expert committee comprised of personnel from both CIPTA KARYA and KMUP.

1.2 Community Participation

1.2.1 National policy of community participation

The community participation is one of the important aspects in the national development in Indonesia. In the Repelita VI, it has been set that the involvement of community as well as that of private sector, is an urgent need, in the sanitation sector projects such as water supply, solid waste management and wastewater management, particularly in the cities and other vast-growing areas.

Purposes of community participation are:

1) To motivate active community involvement in basic infrastructure and facility development in order to improve and sustain environmental sanitation for community welfare.

2) To encourage the community to identify and implement practicable and sustainable self-support program with regard to sanitation improvement by means of community participation.

1.2.2 Basic concept of community participation in sanitation program

The Community Based Development (CBD) approach is the principle of CIPTA KARYA in the sanitation programs. In the sanitation programs including wastewater management, it is the government's effort to ensure the community's involvement, where the community determines its priority, system and kinds of activities that are most possible to be implemented starting from program identification, implementation, to monitoring and evaluation. The CBD entails the following three approaches for achieving adequate participation by community:

(1) Social approach

The approach of community participation depends on the social condition of the community. CIPTA KARYA categorizes the following four kinds of approaches from the view point of the social conditions of the community:

1) Socio-charity approach: The target group of this approach is poor, suffers from poverty, and unable to solve their own problem, because they can not afford to help themselves. Most of these people have uncertain income and are not well educated. A community in such a condition, needs to be given full support by continuous guidance of the government.

2) Socio-transformation approach: An approach that considers community improvement and development so as to transform the attitude, manner, cultural view of the community to be self-help and self reliance oriented in identifying their problems, planning the required solutions and monitoring of the implemented solutions.

In sanitation, the role of government will be to provide continuous guidance in the form of technical guidance, training and motivation, so that the community can identify and solve sanitation problems with self-help.

3) Socio-economic approach : An approach that is based on community improvement and development where the problem can be overcome with appropriate solution, because of sufficient economic affordability of the community.

In sanitation, generally the community have sufficient capability to pay some expenses for the service to both private and government enterprises.

4) Socio-reformation approach : An approach that is more specific, due to the condition which requires a reformation.

(2) Organization approach

The organization approach of the CBD consists of :

1) Unorganized development: wastewater management that is carried out by self-support of community/individual, which can motivate and facilitate the community to prepare wastewater facility for the sake of fulfillment of community's requirement.

2) Organized development: is development of wastewater facility that are conducted by a community group in cooperation with government or private sector.

(3) Technological approach

A technology adopted in the CBD is adequate and effective for community participation, technically and economically, namely:

1) It can be operated easily by community members, including those who still have low technical skill.

2) It is achievable by community's affordability and can encourage the improvement of community's technical skill easily.

3) It is easy to obtain materials and also simple and easy to maintain.

4) It is required by community and can be adjusted/adaptable to a certain environment, culture and social condition.

1.2.3 Community participation for wastewater management in the city of Ujung Pandang

The community participation for wastewater management has been regarded as a significant and urgent measure for living environment improvement in Ujung Pandang.

The goal of community participation is to improve living environment at community level by undertaking the following :

(1) Improving people's awareness of the need for wastewater management

(2) Involving communities and individuals in the planning, implementation and operation and maintenance periods including evaluation and monitoring

(3) Utilizing local resources to the maximum extent possible for wastewater management

1.3 Study Reports

This is the Part III of the Main Report that elaborates the alternative study for wastewater management.

The composition of the entire reports of the Study is as follows:

(1) Main Report (English version)

Part I : Master plan of wastewater and solid waste management
Part II : Feasibility study of wastewater and solid waste management
Part III : Alternative study for wastewater management (This Report)

(2) Executive Summary Report (English and Indonesian version)

Presents the summary of the entire study

(3) Supporting Report (English version)

Describes in details the technical aspects of the Master Plan and Feasibility Study on a sectored basis

(4) Data Book (English version)

Compiles the basic data/information used in the study and the relevant drawings

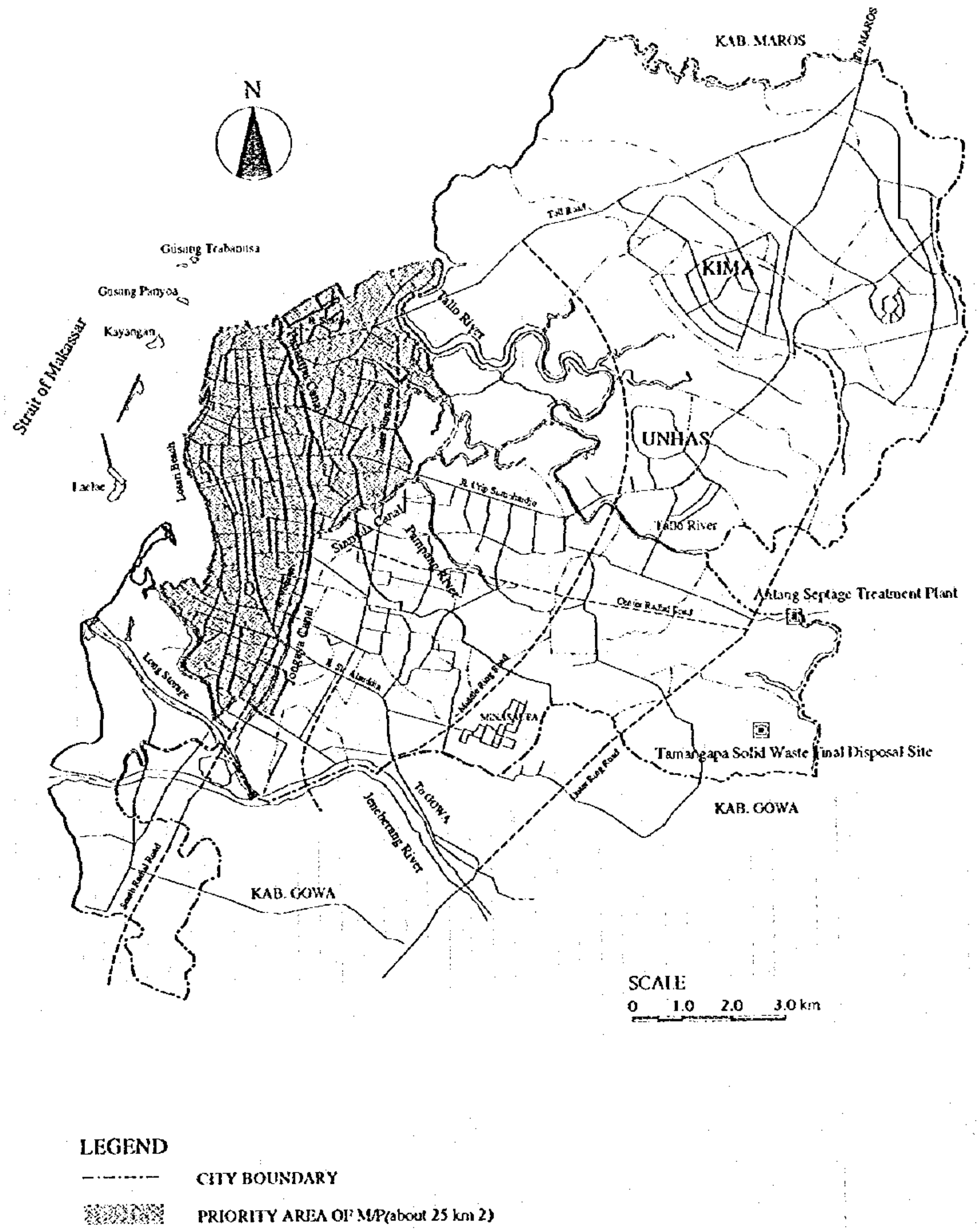


FIG. 1.1	Objective Area for Alternative Study

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

CHAPTER 2

STRATEGIC OPTIONS OF WASTEWATER MANAGEMENT

CHAPTER 2 STRATEGIC OPTIONS OF WASTEWATER MANAGEMENT

2.1 Basic Concept

This alternative study is intended at identifying and evaluating the available strategic options of graywater management. This is in consideration to the fact that the blackwater management in the priority area is accomplished basically by individual household based septic tank/leaching pit.

Though, this blackwater management requires further improvement principally in the slum areas, that lack the basic sanitation facilities of toilet with treatment (septic tank/leaching pit), the required improvement of such blackwater management has been incorporated as urgent projects in the Feasibility Study.

In the Priority Area, in fact in Indonesia in general, the graywater that arises from the miscellaneous activities of washing, bathing and cooking is disposed to nearby ditches and drains with no treatment. Such untreated discharge of graywater has become the principal source of surface water quality deterioration of not only the ditches and drains but also the major canals (Panampu ~ Jongaya canal) in the Priority Area.

Accordingly, all alternative strategic options of graywater management studied would target, in general, the improvement of surface water quality.

Still, depending on the effectiveness of the utilized option of water quality improvement, the benefits realized to surface water quality could differ.

When the strategic option used targets the collection/treatment (removal) or any other improvement of graywater near the location of wastewater generation it would contribute principally to the improvement of living environment, in addition to a possible subsequent surface water quality improvement at further downstream in major drains and canals.

Such a strategic option would target the management of graywater at most from the yard of a household or at least from ditches/drains nearby household. A relevant system meeting this requirement is referred to as "living environmental improvement method."

On the other hand a strategic option that collects and treats or simply treats or utilizes any other method to improve the surface water quality of water body (like drains and canals) due to graywater pollution, while contributing to environmental water quality improvement of surface waters, would not contribute significantly to living environmental improvement of residential households. A system of such characteristics is referred to as "water environmental improvement method."

It is noted that there could be a strategic option that is flexible enough to be applied, or to be interpreted, either as a living environmental improvement method or water environmental improvement method. Accordingly the above environmental effect based classification does not necessarily distinguish clearly the available strategic options conforming to the desired environmental effect.

One such flexible strategic option that could be applied to realize either effect of living environment improvement or water environment improvement is the interceptor system, in which the collection system could be designed according to the desired effect.

The available/suitable strategic options to realize each of the targets of living environmental improvement and water environmental improvements could be categorized as shown below. It is to be noted that the beneficial effect realized would vary according to the utilized strategic option.

(1) Living environmental improvement (strategic options)

1) Provision/improvement of ditches and drains (micro drains)
2) Installation of screens in drains (also a solid waste management option)
3) Cleansing of ditches and drains (also a solid waste management option)
4) Provision of graywater infiltration trench (within a household and/or adjacent to ditches/drains of public roads)
5) Provision of interceptor in ditches and drains (intercepting from micro drains) and the subsequent treatment/disposal of collected wastewater

(2) Water environmental improvement (strategic options)

1) Introduction of flushing/dilution water into drainage system
2) Provision of treatment within the drainage system or within bypass adjacent to drainage system
3) Provision of interceptor prior to drains and other final discharge water body and the subsequent treatment/disposal of collected wastewater

It is emphasized that the strategic options of water environment improvement including that of interceptors are rather complex in general and hence require appropriate planning and implementation including that of operation and maintenance. Accordingly the responsible agency shall be a governmental institution. Still, community involvement could be possible in the form of assistance in operation and maintenance of the constructed facilities.

On the other hand most simple strategic options of living environmental improvement, other than interceptor, are amenable for active community involvement, with respect to both the construction and operation and maintenance of the facilities.

The concept of graywater management is shown in *Fig. 2.1*.

2.2 Description of Alternative Strategies

The conceived strategic options for wastewater management in the objective area (priority area) are grouped into the following ten (10) categories.

(1) Cleansing of ditches and drains

(2) Provision or improvement of ditches and drains

(3) Installation of screens in ditches and drains

(4) Provision of household based infiltration trench

(5) Graywater collection and infiltration using ditches and drains

(6) Graywater collection and treatment using ditches and drains

(7) Provision of treatment system within canal

(8) Introduction of flushing or dilution water from Jeneberang river

(9) Graywater conveyance and treatment system using canal

(10) Installation of interceptor system
- Interceptor for coastal water protection
- Interceptor sewerage system for living environment improvement

Each of the above alternative strategies, in reference to the objective area (ref. *Fig. 1.1*) are delineated in the subsequent sections.

It is noted that of the above ten (10) options, initial of five (5) options are simple and essentially target living environment improvement, and hence considered to be easily amenable for community participation. The remaining strategic options are rather complex and target water environment improvement, other than the interceptor for living environment improvement, and hence considered to be not amenable for significant community participation.

2.2.1 Cleansing of ditches and drains

This strategic option targets basic living environmental improvement, as the prime objective.

The cleansing of ditches and drains is the most basic, simple but an important aspect of not only graywater management but also solid waste management.

Without the implementation of this basic strategy, consideration on implementing any other strategy would not produce the desired effect. In other words, regular cleansing of ditches /drains and other major canals (rivers) is prerequisite to ensure effectiveness of other alternative strategic options of higher order.

The strategy is regular cleansing of micro drains (drains/ditches), including those major canals and drains (rivers) to facilitate the uninterrupted flow of graywater.

In fact based on the field survey results, conducted by the Study Team during November 1995, there was a vast number on areas where the existing ditches and drains malfunctioned.

Those locations of malfunctioned ditches and drains in the objective area are shown in *Fig. 2.2*.

Moreover, based on the above survey results it became evident that the major cause for ditch malfunctioning, at 80% of the cases, was accumulation of solid waste. This clearly demonstrates both the inadequacy of existing ditch cleansing works and the importance of ditch cleansing to ensure proper functioning of ditches.

The number of locations of malfunctioned ditches and drains along with the causes, as per the above field survey results, are summarized in *Table 2.1*.

The ditch cleansing could be organized and carried out on a regular basis (for example, once in two weeks) with active community participation on a volunteer basis.

In this regard, it is recommended that a particular day in every other weeks in a month (eg. first and third Friday of every month) shall be promoted as the cleansing day for volunteer community cleansing works of ditches and drains.

Still, the cleansing of major drains and canals (rivers) need to be carried out by the relevant municipal agency, Dinas Kebersihan.

2.2.2 Provision or improvement of ditches and drains

This strategic option also principally targets living environmental improvement as the prime objective.

This is also a basic activity of repairing a broken drain and/or provision of a required drainage ditch, where necessary.

Implementation of this basic strategic option is also to facilitate uninterrupted flow of graywater in ditches/drains. In fact, for ditch cleansing to be effective, the ditch itself should be functioning properly.

In this regard, provision or improvement of damaged ditch is the most basic aspect to ensure a smooth flow of graywater in a ditch.

The technical skill required for the basic provision or improvement of a micro drain (ditch/drain) is only a minimum. Still, alignment and base elevation of a ditch shall be properly determined, to ensure gravity drainage, by the government/municipal institution (Dinas Kebersihan).

The basic improvement and/or repair of ditches/drains (micro drains) could be carried out on a community basis, with active community participation.

However, as pointed out above, proper technical guidance concerning to alignment and base elevation of a ditch may be required to be provided by the government/municipal sector.

Finally, ditch cleansing work, as described in the foregone section, is the requirement of operation and maintenance.

2.2.3 Installation of screens in ditches and drains

This strategic option principally targets living environment improvement. It also could be considered as a solid waste management option in addition to that of graywater management.

The screens are to trap floating debris and other solid waste, hence would be coarse metal screens.

The size of a screen would conform to the dimension of the ditch/drain concerned.

This is also a very simple strategic option, specially with respect to installation. However, though simple, regular removal of trapped debris need to be conducted to ensure the intended purpose of a screen.

All aspects of a screen installation and its subsequent maintenance with periodic removal of trapped (accumulated) debris are amenable to active community participation.

Still the installation of screen may require contribution from the relevant governmental/municipal agency, Dinas Kebersihan, while maintenance with periodic removal of trapped debris be relegated to the neighborhood community.

A typical screen is shown in *Fig. 2.3.* Installation of screen is recommended in a ditch or drain at an interval of about every ten (10) to fifteen (15) houses. The responsibility of proper maintenance of a screen could be shared equally among the houses located in the neighborhood of the screen.

2.2.4 Provision of household infiltration trench

This strategic option targets living environment improvement, by removing graywater with infiltration into natural soil, on an individual household basis. This is also a simple system, in which the available open space/yard of a household is utilized for possible removal of graywater and its subsequent treatment by soil microorganisms followed with infiltration into natural soil.

Any remaining wastewater (graywater) that could not be infiltrated is discharged into nearby ditch/drain.

Accordingly, the available infiltration capacity would depend both on the quantity of graywater discharge as well as the available space of open yard of a household up to the drainage ditch.

The long term infiltration rate of wastewater into natural soil is found to be independent of soil type in general and principally governed by the biomat formed on the infiltrative surfaces with the soil microorganisms that treat the infiltrated wastewater.

Functionally the biomat serves as biological treatment unit as well as a mechanical and biological filter. Although the biomat penetrates into the soil surface, the major portion of the biomat is located on the surface of the soil. Since the biomat serves as a mechanical and biological filter, the passage of infiltrated wastewater into surrounding soil is essentially controlled by the hydraulic characteristics of the biomat, rather than that of the natural soil.

The long term infiltration rate of biomat is experimentally determined to be in the range of 12 - 20 liter/sq. meter/day (Metcalf and Eddy Inc.).

Accordingly assuming a long term infiltration rate of 20 liter/m^2/day, the required ideal length of an infiltration trench for a typical household to facilitate total (100%) infiltration of graywater, with no discharge to surface drain/ditch, is estimated as shown below.

Graywater discharge	:	100 liter/person/day
Number of average inhabitants	:	5.5 person
Effective depth of infiltration trench	:	1 m

The required ideal length of infiltration trench under the above conditions becomes 13.75 m (about 14 m).

Since this required ideal length is very long, the aim of providing a household infiltration trench, would be to reduce the discharge of graywater to drain/ditch, rather than to remove the entire generated graywater within the house yard.

Accordingly, wherever possible a resident shall be encouraged to provide infiltration trench, as a conduit to facilitate infiltration of graywater to the permissible extent prior to its discharge into surface ditch/drain (public water course).

Since the infiltration trench is an individual household based system, no community participation is involved. It is necessary to institute the necessary legal, educational and promotional campaign and other means to encourage a resident to provide ones own graywater infiltration trench.

In the priority area (objective area) most areas, other than the wetland areas and fish ponds, are suited for the provision of infiltration trench. Those areas not suited for the provision of infiltration trench are shown in *Fig. 2.2* . Moreover, a typical infiltration trench for a household is shown in *Fig. 2.4*.

2.2.5 Graywater collection and infiltration using ditches and drains

This system uses ditches and drains that convey graywater as the collection system with subsequent infiltration of the collected graywater.

The system, depending on the location of installation, could target either living environment improvement or water environment improvement. Still practically the system could be interpreted as a living environment improvement system.

The wastewater (graywater) conveyed and collected by using the ditches/drains could be infiltrated into natural soil, with the provision of infiltration trench by the side of a ditch/drain, as required. Accordingly, this is a highly flexible system, provided sufficient space could be found in between the ditch/drain and road to provide the infiltration trench, with no significant interference to the entrance of many properties (houses) and underground facilities.

The trench shall be designed so that any wastewater (graywater) that cannot be infiltrated could still continuously flow in the drain or ditch. Such a provision to bypass any flow that can not be infiltrated to the drain is very important to ensure no interference with the flood control function of the drain during rainy season.

The long term infiltration capacity of the trench could be determined as illustrated in the case of an infiltration trench for a household (in the foregone section), by assuming a long term infiltration rate of 20 liter/m^2/day.

As long as the objective is to reduce the graywater flow in drains with infiltration, the rate of infiltration itself need not be considered as a critical parameter.

Instead, the availability of space for an infiltration trench at a suitable location, where significant quantity of graywater could be collected using drains, would be of much significance.

A typical infiltration trench for graywater collection and infiltration using ditches and drains is shown in *Fig. 2.5*.

Concerned to active community participation during construction, the excavation works of an infiltration trench is considered as easily amenable. Moreover once the facility is constructed, the periodic cleansing work of the inlet screen of the infiltration trench, to remove any trapped debris/solid waste, could be relegated to neighborhood community.

2.2.6 Graywater collection and treatment using ditches and drains

The collection system, that uses existing ditches and drains, is essentially the same as that for an infiltration trench delineated in the foregone section.

Still, since a treatment plant would be provided to treat the collected graywater (wastewater), the location of treatment plant would be governed by the treatment method as well the disposal requirement of treated effluent.

Accordingly, the criteria of site selection for an infiltration trench mentioned in foregone subsection and that of treatment plant could differ, even though both are theoretically similar systems with their difference being distinguished based on the final disposal method of collected wastewater (infiltration or treatment and disposal). Practically, this system could be categorized as a water environment improvement system rather than that of living environment improvement.

The technical feasibility of graywater collection and treatment system, will be mostly governed by the availability of suitable location for treatment plant, as well as the available alternative technical options of treatment system.

Concerned to treatment system, theoretically, there exist vast alternative options. However, considering the simplicity of the collection system, that uses existing ditches and drains, it is rational to have a simple treatment system as well.

Moreover, the treatment system needs to be flexible to cope with the inherent daily variation with respect to both quantity and quality of graywater, which is relatively of low strength. In addition, shock loading due to a sudden rainfall run-off and the potential wash-out of microbial mass due to such rainfall events shall be tolerable, along with the resting of treatment plant itself during rainy season.

It is evident from the above considerations, that the proposed treatment system shall be highly flexible. However, there are not many alternative treatment systems that are flexible enough to meet the above requirements.

Anaerobic filter with rock (crushed stone) media is considered to be the most suited treatment method due to both its simplicity and flexibility. Since this in an attached microbial growth process, it could be expected to be tolerant to shock loading as well as variation in loading including the potential washout of microbial mass from the treatment system.

Also the system could be easily rested during the rainy season and retrieved gradually with the beginning of the dry season.

In the objective area, it is considered to be most effective to use the secondary canals, that discharge into the primary canal system (Panampu-Jongaya-Sinrijala canal), as the final conduit of graywater collection system for treatment of graywater.

This is due to the fact that, these secondary canals carry significant quantity of graywater, thereby justifying the provision of treatment system (anaerobic filter), prior to the disposal of wastewater into the primary canal (Panampu ~ Jongaya canal).

Physically such an anaerobic filter treatment system for collected graywater could be provided beneath the maintenance road of the primary canal concerned.

A typical anaerobic filter treatment system of this nature is shown in *Fig. 2.6.*

It is noted that hydraulic requirement to ensue the gravity flow of treated effluent from the treatment plant may constrain the provision of the treatment plant, even when such provision of treatment plant is physically possible (under the maintenance road).

In other words, the bed elevation of the secondary canal should be sufficiently higher than that of the primary canal concerned so that the head loss within the treatment system could be accommodated.

It is noted that in the objective area, the difference in bed elevation between most secondary canals and the primary canal is not very much. Accordingly, the provision of such anaerobic filter system is essentially impossible, hydraulically.

Still it may be possible to provide such a treatment system, both hydraulically and physically, near the outlet of a micro-drain/ditch. However, due to a small catchment area no significant quantity of graywater could be collected for treatment. Accordingly, the provision of treatment system can not be justified.

2.2.7 Provision of treatment system within canal

This option involves provision of treatment within major canals and drains to improve the water quality in the form of mechanical aeration.

Accordingly, this strategic option targets water environment improvement and not living environment improvement.

In drains and canals, while graywater flows through, wastewater treatment occurs by means of the natural self-purification process. Such self-purification is accomplished by microorganisms attached to the bed of canal/drain. It is the attached micro organisms to the bed, in addition settled sludge/solids, that imparts the appearance of dirtiness to the canal/drain, due to the black/gray color of the biofilm that blankets the bed of canal/drain. This attached biofilm that purifies the graywater comprised of anaerobic/facultative microorganisms. In case of micro drains, due to the low quantity of flow and hence the low organic loading, a high degree of purification of the graywater could result. Still, the drain itself would appear to be dirty and black in color due to the color of microorganisms (biofilm) attached to the bed of the drain.

On the other hand, in the case of a large canal with high flow and high organic loading, no significant purification due to the biofilm attached to the bed could be expected. In fact significant treatment to the flowing water (wastewater) would be due to deposition of sludge/solids to the canal bed. Accordingly, the water quality of the flowing wastewater itself would remain deteriorated resulting in foul odor and black color of the flowing water.

In order to significantly improve the water quality as the target of water environmental improvement, significantly polluted water bodies with significant quantity of flow like major canals/rivers need to be targeted.

In the priority area, the Panampu canal, Jongaya canal (Panampu - Jongaya canal) and Sinrijala canal are the major canals that carry the pollution load run-off of the city.

They have a significant wastewater discharge of about 10,000 m^3/day in combination with a significant pollution load, with their BOD levels in the range of 100 - 200 mg/l.

In these canals, due to the significant flow, natural self-purification by anaerobic/facultative microorganisms attached to the bed of canal is insignificant, for the flowing wastewater (though the settled sludge would undergo anaerobic digestion).

Accordingly, a high rate of treatment in the form of mechanical aeration with the provision of aerators within the Panampu-Jongaya canal need be used to expedite the wastewater treatment in canal.

Consequently it is noted that this strategic option, as well as the proceeding two (2) options, would deal with the water quality improvement of the Panampu-Jongaya canal.

As the prerequisite for effectiveness of these options, installation of three (3) gates, one each near the sea outlets of Panampu canal and Jongaya canal and one at Sinrijala canal, to separate the canal from Pampang river, is necessary. Installation of these three (3) gates is for the separation of wastewater from sea water thereby mitigating salinity intrusion into the inland canal system (Panampu-Jongaya canal).

Assuming the provision of these three (3) gates as above, the other significant issues associated with the provision of aerators within the canal, including that of aerated treatment process, are itemized below.

1) Aerator installation in the canal would interfere with free flow of flood run-off in rainy season, the season during which the operation of aerators is not a critical requirement. In other words, during the rainy season aerators in a canal may be a nuisance.

2) A minimum effective span width of about 10m in combination with a minimum water depth of 2 m is required for effective operation of a typical aerator. Such a water depth is a very significant requirement, especially during dry season, when the operation of aerator is a must. Even the requirement of effective span width of 10m for a canal would be a significant constraint.

3) Aerated treatment processes, results in high quantity of sludge generation. Without the removal of the generated sludge aerated treatment process is a very inefficient use of aeration energy, as the treatment efficiency would decrease from more than 90 % with sludge removal to less than 50 % (40 - 50 %) without sludge removal (sedimentation following aeration would remove the sludge generated). In other words, sludge removal accounts for about 50% of the total efficiency of the aerated treatment system.

   Since the provision of sedimentation facility for sludge removal in the canal, following aeration, in practically impossible, it implies provision of aerators within the canal is a very inefficient means of aerator operation.

   Based on the above considerations alone, it may be concluded that the strategic option of provision of treatment system within canal, is not justifiable both economically and physically, for water environment improvement.

Nevertheless, installation of aerators within the Panampu-Jongaya canal, is studied assuming that three (3) gates, one each at Panampu, Jongaya and Sinrijala canals, could be provided.

Based on the study results, the cost of the project and the resultant benefit as water quality improvement are assessed.

The aerator installation is determined under the following conditions:

1) A water level of 1m in the canals could be maintained with appropriate gate operation of the three (3) gates.

2) An effective water depth of 3m can be achieved, with a 2m excavation of the canal, at the location of aerator installation.

3) Aerator installation is possible only at locations where the base width of the canal is at least 10m. Moreover a width of excavation of 9m is assumed at the location of aerator installation.

The location of Panampu-Jongaya canal is illustrated in *Fig. 2.7.* In the canal, there exist five (5) canal types as shown in *Fig. 2.8.* Moreover, typical gate for the Jongaya canal, at Maccini Sombala, is shown in *Fig. 2.9.*

The base width of each canal types are as follows :

Type A :	Base width ; 10.5 m
Type B :	Base width ; 5.0 m (very narrow)
Type C :	Base width ; 12.5 m
Type D :	Base width ; 4.0 m (very narrow)
Type E :	Base width ; 14.0 m

It is evident from the above figures that the central reaches of the Panampu-Jongaya canal, where the channel types are Type B and Type D, though receive high pollution load run-off, are not amenable for mechanical aeration due to their narrow base width. Since these reaches are expected to be highly deteriorated due to a high pollution load input, the physical constraint of aerator installation in these reaches itself demonstrates the limitation of mechanical aeration as the means of surface water quality improvement in the Panampu-Jongaya canal.

With due consideration to the above limitation, and on the assumption that the flow direction would be from South to North, so that the discharge to coastal waters would be through the operation of Panampu gate only, installation of aerators is considered at two (2) locations, one each in Jongaya canal and Panampu canal, as shown in *Fig. 2.7*.

This south to north flow direction in the canal system is considered as the means of protecting the Losari beach area, which is near the proposed southern gate at Jongaya canal (ref. *Fig. 2.7*).

Both assumed locations of aerator installation are of canal Type A (base width : 10.5m). These locations are determined where the canal discharge due to graywater run-off, under existing condition, would be 5,000 m^3/d (Location 1 in Jongaya canal) and 20,000 m^3/d (Location 2 in Panampu canal).

The relevant design considerations for the of determination of the two (2) aerated treatment systems in canal are as follows :

(1) Location 1 (Jongaya canal)

Quantity of wastewater to be treated	:	5,000 m^3/day
Detention time in the system	:	2 day
Effective width of treatment system	:	9 m
Effective water depth	:	3 m
Required depth of excavation of canal	:	2 m
Power requirement of aerator for mixing	:	5watt/m^3

Based on the above considerations, the required canal length of aerator installation becomes 370m, where 2m excavation of the canal is necessary (within an effective width of 9m).

Design aerator configuration	:	3.7 kw x 14 No.

(2) Location 2 (Panampu canal)

Quantity of wastewater to be treated	:	20,000 m^3/day

In Panampu canal a similar system as Location 1 is provided, with the reduction of detention time to 12 hrs (0.5 day).

The overall treatment efficiency of the whole system, as BOD removal, is determined to be about 60%.

A comparative evaluation of this option with those of similar ones described in the following two (2) sections (Section 2.2.8 and Section 2.2.9), is presented in Section 3.2 of Chapter 3.

2.2.8 Introduction of flushing or dilution water from Jeneberang River

(1) Introduction

The priority area has two (2) major river sources, the Jeneberang river toward the south and the Tallo River to the north. The Tallo river is much affected by tidal intrusion, hence has high salinity even at far inland. This is also due to the low elevation of the Tallo river basin.

On the other hand, Jeneberang river, the basin of which virtually does not comprise KMUP area but the areas at upstream, the Kab. Gowa, lies in a relatively higher elevation and does not suffer from significant salinity intrusion as well as pollution load run-off from the KMUP.

Jeneberang river is being exploited for many beneficial uses, including irrigation, power generation and water supply with the development of Bili-Bili Dam in Kab. Gowa (Bili-Bili).

Moreover, a bypass rubber dam is constructed nearby the sea outlet of the river, as a long storage of fresh water for water supply development (Somba Opu water supply project). This long storage of Jeneberang river is located just beyond the southern boundary of the priority area.

Assuming the provision of three (3) gates, similar to the option dealt with in the foregone section (ref. *Fig. 2.7*), water from the "long storage of Jeneberang river" could be easily introduced into Jongaya canal, either for flushing or dilution, provided sufficient excess quantity of water is available for such use in dry season (ref. *Fig. 2.10*).

In this regard it is noted that the minimum distance between the long storage of Jeneberang river and Jongaya canal is only about 40m. Still, the requirement of fresh water during dry season to dilute wastewater in canal may be a serious constraint of this method.

Moreover, introduction of dilution water does not result in any significant treatment of wastewater in the canal. In other words, no significant reduction in the pollution discharge to the sea would be accomplished.

Still, an apparent water quality improvement in combination with the mitigation of salinity intrusion could be achieved. The mitigation of salinity intrusion is in fact the major benefit of installing the three (3) gates (ref. *Fig. 2.10*), rather than anything else.

It is noted that the availability of water from the long storage of Jeneberang river for flushing or dilution, would depend on the raw water demand of the ongoing water supply development project by PDAM. In this regard, once the water supply development is fully accomplished there would be no excess water available for any other use, including flushing or dilution.

However, at present, the water supply development project is behind schedule. As long as this project is delayed it may be possible to extract water from the long storage for the purpose of flushing or dilution.

Assuming sufficient water could be extracted from the long storage of Jeneberang River, the method of water introduction, between intermittent flushing and continuous dilution, is compared as follows :

1) Introduction of intermittent flushing water would seriously affect the existing uses of the Panampu ~ Jongaya canal. Such existing uses include, usage of the most downstream reaches of the Panampu canal as a boat terminal. Moreover, the canal is easily accessible to nearby residents, including children. Accordingly, flushing the canal is not recommendable from the view point of safety of its users.

2) No significant difference with respect to canal water quality improvement is expected between both of these methods of flushing and dilution.

Based on the above considerations, the dilution water introduction method is recommendable in comparison to flushing water introduction.

(2) Dilution water introduction

The required optimum quantity of dilution water, from the view point of water quality improvement of Panampu ~ Jongaya canal, is determined based on the relationship between the quantity of introduced dilution water and the resultant water quality improvement. The result is shown in *Fig. 2.11.*

Based on the above figure, the effective quantity of dilution water requirement is in the range of 0.2 ~ 0.4 m^3/sec, with an average of 0.3 m^3/sec.

The required structural facilities for the introduction of dilution water from the long storage of Jeneberang river are as follows :

1) Three (3) gates, one each at Jongaya canal, Panampu canal and Sinrijala canal, similar to the foregone option (ref. Section 2.2.7 and *Fig. 2.7*).

2) The necessary inlet facility to introduce the dilution water through gravity, at the nearest location between the long storage of Jeneberang river and Jongaya canal. The proposed location of dilution water introduction is also shown in *Fig. 2.10*.

The details of the proposed inlet facility is shown in *Fig. 2.12*.

A comparative evaluation of this option, with those similar ones described in the preceding and following sections (Section 2.2.7 and Section 2.2.9) is dealt with in Section 3.2 of subsequent Chapter 3.

2.2.9 Graywater conveyance and treatment system using canal

This is a strategic option for water environment improvement of Panampu-Jangaya canal, which could be considered as an improvement or modification to the strategic option, namely, provision of treatment system within canal (ref. Section 2.2.7). This option also basically requires the three (3) gates, one each at Jongaya canal, Panampu canal and Sinrijala canal, as per the foregone two (2) options.

This option basically eliminates the economical and physical impediments to the provision of treatment system within the canal. However, pump facility is required to convey the collected wastewater to the treatment plant.

The basic strategy is to utilize a canal as the wastewater collection system, with the provision of the necessary means to have a speedy flow of wastewater.

Wastewater thus collected will be directed and treated in a treatment plant (or treatment plants, if more than one plant is used) located adjacent to the canal.

In this regard, the sites of two (2) treatment plants proposed as the components of sewerage development project in the Feasibility Study, namely, the ones in Lembo and Maccini Sombala are strategically located adjacent to, respectively, the Panampu canal and Jongaya canal at their downstream reaches.

Still, as the means to ensure speedy flow of wastewater (graywater) in canal under the dry weather flow conditions in dry season, double channel section is proposed.

The graywater conveyance and treatment system proposed is shown in *Fig. 2.13*. The treatment system proposed both at Lembo and Maccini Sombala is stabilization pond (similar to the treatment system of the Feasibility Study). The flow of graywater is divided between both the treatment plants, due to the topographic condition.

The required treatment capacities at Lembo and Maccini Sombala to treat the conveyed graywater through the canal (Panampu-Jongaya canal) is compared with that of the projects of Feasibility Study (ref. Chapter 2 of Part II, Main Report).

The quantity of discharge available for treatment to the Lembo treatment plant is about 15,000 m^3/day, while the treatment capacity as per the project of Feasibility Study is 5,500 m^3/day. The corresponding values for the Maccini Sombala treatment plant are, respectively, 12,000 m^3/day and 11,000 m^3/day.

Allowing for about 30% of reduction in influent BOD loading, by considering the difference in quality between the graywater conveyed from canal as per this strategy and the entire wastewater (blackwater and graywater) conveyed through pipe network as per the project of Feasibility Study, the treatment capacities of Lembo and Maccini Sombala, as per the project of Feasibility Study would be expanded respectively to 7,000 m^3/day and 14,000 m^3/day.

Accordingly a treatment plant at Maccini Sombala with the treatment capacity as per the project of Feasibility Study could treat the entire graywater of 12,000m^3/day. However the Lembo treatment as per the Feasibility Study can accommodate only about 50% of the available flow in the Panampu canal (7,000 m^3/day against the available flow of 15,000 m^3/day).

Still, in an overall sense, the combined Lembo and Maccini Sombala treatment systems can treat about 70% of the graywater discharged in the Panampu-Jongaya canal system, which is satisfactory as a stop-gap measure of canal water quality improvement.

Accordingly, this strategy assumes the provision of Lembo and Maccini Sombala treatment plants, conforming to that of the Feasibility Study.

However, the required pump facilities at Lembo and Maccini Sombala would not be in conformity with that proposed in the Feasibility Study.

The required pump head for both the treatment plants is about 4m, while the pump capacity would be to meet the entire graywater flows of 15,000 m^3/day for Lembo and 12,000 m^3/day for Maccini Sombala.

The requirement of pump capacity to meet the entire flow of 15,000m^3/day, even though the available treatment capacity (stabilization pond system) is about 7,000 m^3/day, at Lembo, is to ensure the effectiveness of the double canal section, where the wastewater flow in dry season will be confined to the inner section of canal, and the gate system, the Panampu gate, to mitigate both the graywater accumulation in canal and the saline water intrusion inland.

It is noted that the proposed method of gate operation with this option is the closure of all three (3) gates in dry season and to pump the entire canal water for treatment and disposal, beyond the respective gates, using both the pump facilities of Lembo and Maccini Sombala (ref. *Fig. 2.13*).

A comparative evaluation of this option of graywater conveyance and treatment system using canal with those similar ones dealt with in the foregone two (2) sections (Section 2.2.7 and Section 2.2.8) is illustrated in Section 3.2 of following Chapter 3.

2.2.10 Installation of interceptor system

An interceptor system could be developed either for living environment improvement or water environment improvement.

In the priority area, interceptor for water environment improvement was considered as a strategic option for coastal water quality improvement, specifically for the protection of Losari beach.

On the other hand, interceptor system for living environment improvement, that would collect the wastewater (graywater) from ditches and drains near residents, could be developed as the initial (first) step of the conventional sewerage development, as per the sewerage component of the feasibility project delineated in the Part II of Main Report.

Each of these two (2) systems are delineated below.

(1) Interceptor for coastal water protection

The coastal reaches of the objective area facing the Makassar Strait (western coastal area) is targeted for intercepting the wastewater (graywater) run-off that is discharged into coastal waters.

The drainage basin of the objective area that discharges directly into the coastal waters is divided into three (3) sub-basins.

These sub-basins and their direct outlets to the coastal waters are shown in *Fig. 2.14*.

The areas and the number of outlets of each sub-basins are as follows :

Sub-basin	Area (km^2)	No. of outlets
Northern basin	4.1	8
Central basin	2.8	13
Southern basin	2.5	4
Total	9.4	25

Division of the basin into the three (3) sub-basins is made in consideration to the following aspects.

a. The sea outlets of the Northern Basin pass through the area belonging to the Port Authority of Ujung Pandang.

b. The outlets of the Central Basin discharge directly into the Losari Beach area, the tourism area.

c. The outlets of the Southern Basin would be subject to modification with the proposed reclamation as per the development plan for this southern part of the Priority Area.

The means of the provision of interceptors along the coastal reaches (outlets), and any other possible alternatives to interceptor, are studied separately for each of the above three (3) sub-basins. They are delineated below.

1) Northern basin

The northern basin has a total of eight (8) sea outlets, mostly through the area belonging to Port Authority.

As an alternative to interceptor along the sea coast, a portion of the basin could be diverted to the inland. In fact 30% of the basin could be diverted so that it discharges into Muhammadiyah secondary canal. The wastewater (graywater) diverted in this manner would be finally discharged into the Panampu canal.

Diversion of this 30% of the northern basin is very simple and hence recommended as the primary option.

Concerning the remaining areas (70%), interceptor along or near the sea coast, to intercept most of the relevant outlets, is proposed.

Possible alternative interceptor systems for this purpose are as follows:

a. Provision of interceptor pipes along the north to south direction, to collect the wastewater (graywater) and the treatment of collected wastewater at the vacant area near the Ferry Terminal to Kayangan island. Anaerobic filter is considered as the most suited treatment method (ref. Section 2.2.6).

b. Provision of box type (ditch with cover) interceptor in combination with anaerobic filter, through the Port Authority area, and the disposal of treated wastewater, thereby eliminating the requirement of separate treatment plant.

   From the cost point of view, Alternative b is more economical than Alternative a. However, coordination with Port Authority is required.

2) Central basin

Provision of interceptor along Losari beach is determined as the only means of coastal water protection.

There exist three (3) alternative means for the provision of interceptors as shown in *Fig. 2.15*. They are as follows:

a. Provision of interceptor pipes, from centre to north and centre to south (in opposite directions), to collect and treat the wastewater at two (2) separate treatment plants (anaerobic filter systems) along with the influent pump facilities, located respectively near the Ferry

Terminal to Kayangan island (centre to northern collection system) and Taman Safari Park (centre to southern collection system).

b. Instead of the pipe interceptor as above, provide box type (ditch with cover) interceptor. In every other aspect, the system is the same as above.

c. Provision of the above box type interceptor in combination with anaerobic filter, thereby eliminating the requirement of separate treatment plants.

From the view point of cost, the Alternative c is the most economical one. An evaluation of these alternatives is presented in Section 3.3 of Chapter 3.

3) Southern basin

Since the outlets of this basin would be modified as the consequence of the proposed reclamation project, the possible means of interceptor system to collect and treat the wastewater is recommended to be studied as an integral component of the reclamation plan.

(2) Interceptor sewerage system for living environment improvement

1) Introduction

Three (3) sewerage development projects, namely, northern sewerage system, central sewerage system and southern sewerage system are proposed as the components of sewerage development project of Feasibility Study (ref. Chapter 2 on Facility Plan of Wastewater Management, Part II of Main Report).

The service area and present population of these three (3) sewerage systems are as follows :

Sewerage System	Service Area (ha)	Present Population
Northern sewerage system	73	21,000
Central sewerage system	435	107,000
Southern sewerage system	162	58,000
Total	670	186,000

It is evident from the above table, the central sewerage system is the largest both in terms of service area and present population.

Accordingly, the central sewerage system is selected to conduct the case study, for the development of interceptor sewerage system not only as the first step toward conventional sewerage development, but also as the means of living environment improvement. It is noted that an interceptor system, in principle, would not collect blackwater, since it has no house connections.

2) Case study

The service level of an interceptor system is expressed in terms of length of exposure of graywater (wastewater) in ditches and drains prior to its collection into the interceptor sewer network. Accordingly, higher the length of exposure, lower the service level of the interceptor system.

Three (3) alternatives, with varying length of exposure of wastewater (graywater) and the respective cost of project are studied, as the Case Study, to identify the most cost-benefit effective interceptor system for the central sewerage area.

The length of exposure of graywater is approximated as the number of square meshes, each with a dimension of 50m x 50m.

The significant features of these alternatives are summarized below.

System	Maximum exposure length (km)	Total pipe length (km)
Alternative - 1	2.9	2.5
Alternative - 2	1.2	11.9
Alternative - 3	0.6	19.0

The project cost of each alternatives and other relevant details are shown in *Table 2.2*.

The two (2) alternatives with significant total pipe length, Alternative-2 and Alternative-3, are shown, respectively, in *Fig. 2.16* and *Fig.2.17*.

The relationship between the service level of each alternative, expressed as the maximum length of exposure, and the respective project cost, expressed as the share of the cost of conventional sewerage system (including that of house connection) as per the feasibility study project, is shown in *Fig. 2.18*.

It is evident from the above figure, that Alternative-3 is the most cost-benefit effective. The project cost of this alternative is 37% of the conventional sewerage development cost, in which the maximum length of exposure is limited to 600m.

This optimum Alternative-3 and Alternative-2 are subjected to detailed financial evaluation in Section 3.4 of the subsequent Chapter 3.

2.3 Social Study for Wastewater Management

2.3.1 Social survey for community participation in wastewater management

The social survey has been conducted in the selected model areas in order to confirm the commitment of community participation for implementing the strategic options (1) to (5) (ref. Section 2.2.1 to 2.2.5) in particular and strategic options (6) to (10) (ref. Section 2.2.6 to 2.2.10) in general as dealt with in foregone section. *Fig. 2.19* shows the work flowchart of the social survey.

(1) Selection of model survey area

The natural and socio-economic characteristics such as groundwater level, landuse (ref. Chapter 2 of Part I, Master Plan), population density (ref. Chapter 3 of Part I, Master Plan) and income level (ref. Chapter 5 of Part I, Master Plan) have been reviewed in order to select the model areas for the social survey which represent residential categories in Ujung Pandang. Physical, topographic and other natural conditions related to the provision of each of the ten (10) strategic options have been illustrated in the foregone section.

The following Kelurahans are the model areas selected:

1) Kelurahan Losari, Kecamatan Ujung Pandang: High income residential area

2) Kelurahan Parang, Kecamatan Mamajang: Middle income residential area

3) Kelurahan Pattunuang, Kecamatan Wajo: High income commercial area

4) Kelurahan Maradekaya Selatan and Bara-baraya Selatan, Kecamatan Makassar: Middle and low income residential area

Moreover, from each Kelurahan one or two RWs was selected which properly revealed the residential criteria for each area. The socio-economic characteristics of selected model areas, shown in *Fig. 2.20*, are summarized below.

Kelurahan	Losari	Parang	Pattunuang	Maradekaya Selatan	Bara-baraya Selatan	Ujung Pandang
Population in 1993 (persons) *1	3,483	6,790	6,611	4,333	8,601	1,019,948
Area (ha)	23	14	53	13	13	17,577
Population density (persons/ha)	151	485	125	333	662	58 225*2 (Central part)
Income level	High	Middle	High	Middle, Low	Middle, Low	
Monthly average *3 income (Rp. 1,000)	417	275	525	258	194	272
Land use	Residential	Residential	Commercial	Residential	Residential	
Major ethnic groups	Bugis	Makassar Bugis	Chinese	Makassar Bugis	Makassar Bugis	Makassar Bugis

Note 1: Results of Kelurahan Office interview
Note 2: In the central parts of Ujung Pandang (7 Kecamatans)
Note 3: Results of RW interview survey

(2) Interview survey in selected model areas

The survey was conducted during November 1995. The information for the social survey was obtained from three types of interview survey as follows:

- Interview to local leaders (Key Informant Survey) consisting of formal and infomal leaders of the community, teachers and religious groups in the area
- Interview to households: surveyors visited and interviewed 200 households in the selected model areas with interview sheets
- Group interview survey of residents in the selected model areas by adopting "Participatory Approach" Method.

Besides the above interview surveys, the results of the related surveys conducted during the Master Plan and Feasibility Study have also been referred for the study on community participation.