

**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**MINISTRY OF LOCAL ADMINISTRATION  
MINISTRY OF STATE FOR ENVIRONMENTAL AFFAIRES  
LATTAKIA CITY COUNCIL  
HOMS CITY CONCIL  
THE SYRIAN ARAB REPUBLIC**

**THE STUDY ON  
SOLID WASTE MANAGEMENT AT  
LOCAL CITIES IN THE SYRIAN ARAB REPUBLIC**

**FINAL REPORT  
SUMMARY**

**JANUARY 2002**

**YACHIYO ENGINEERING CO., LTD.**

**EXCHANGE RATE**

**US\$1.00 = SP 49.0 (June 2001)**

**US\$1.00 = Yen 121.0 (June 2001)**

## PREFACE

In response to a request from the Government of the Syrian Arab Republic, the Government of Japan decided to conduct a Study on Solid Waste Management at Local Cities and entrusted the study to the Japan International Cooperation Agency (JICA).

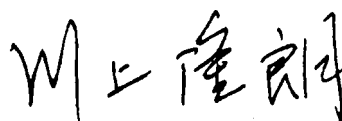
JICA selected and dispatched a study team headed by Mr. Hiroshi Abe of Yachiyo Engineering Co., Ltd. to Syria, three times between January 2001 and December 2001. In addition, JICA set up an advisory committee between January 2001 and December 2001, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of The Syrian Arab Republic and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Syria for their close cooperation extended to the team.

January 2002



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Takao Kawakami  
President  
Japan International Cooperation Agency

January 2002

Mr. Takao Kawakami  
President  
Japan International Cooperation Agency

## **LETTER OF TRANSMITTAL**

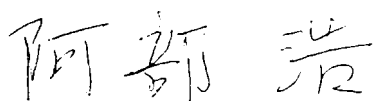
We are pleased to submit to you the final report of the Study on Solid Waste Management at Local Cities in the Syrian Arab Republic. The report includes the advise and suggestions of the authorities concerned of the Government of Japan and your Agency. Also included are comments made by the Ministry of Local Administration, Ministry of State for Environmental Affairs, Lattakia City and Homs City, the Syrian Arab Republic. This report consists of Summary Report, Main Report, Supporting Report and Data Book.

The report deals with the present conditions of solid waste management in Lattakia and three surrounding cities and presents the master plan for solid waste management with the target year of 2010, as well as the results of the feasibility study for the priority projects proposed in the master plan. In Homs city, the report presents the feasibility study for the compost plant.

In accordance with the contract with your Agency, we Yachiyo Engineering Co., Ltd. implemented this study during the period of December 15, 2000 to January 28, 2002. Based on a deep understanding of the existing conditions in Lattakia and three surrounding cities and Homs city in the Syrian Arab Republic we have prepared a plan that is feasible and can be implemented.

Finally we sincerely hope that this report will be effectively used for the realization of the master plan. We wish to express our deep gratitude to your Agency, the Ministry of Local Administration, Ministry of State for Environmental Affairs, Lattakia city, Homs city and other concerned Governmental Agencies for the close cooperation and assistance extended to us during the Study.

Very truly yours,



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Hiroshi Abe  
Team Leader  
The Study on Solid Waste Management at Local Cities  
in the Syrian Arab Republic



# <M/P and F/S for Lattakia (Jableh, Qurdaha, Al-Haffeh) and Surrounding Three Cities>



Location of Proposed SWM Facilities for the M/P (2010)

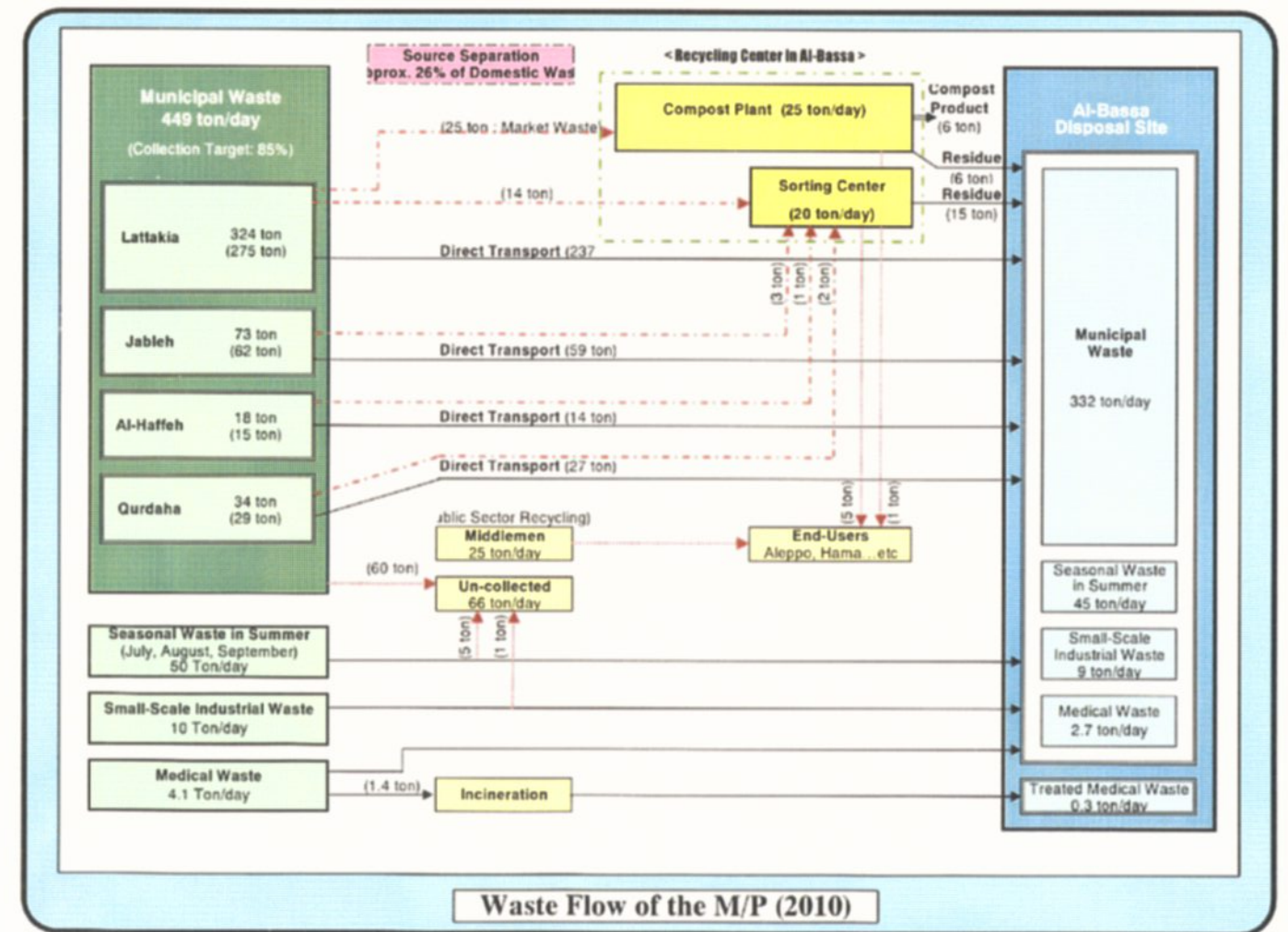
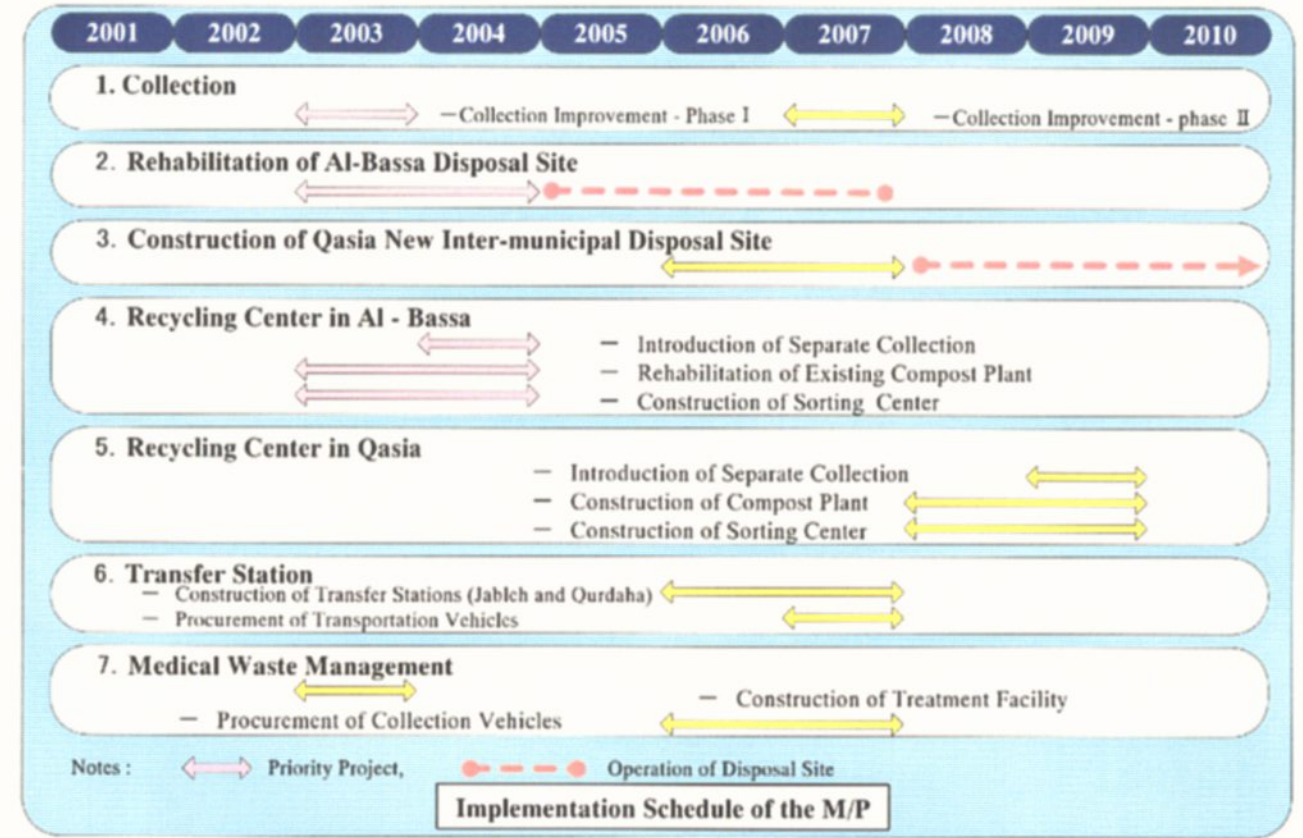
**Planning Conditions**

Target year : 2010 (M/P)  
2006 (F/S)

Population : 687,000 (2010)  
602,000 (2005)

GRDP : 26,117 million SP (2010)  
23,655 million SP (2005)

Waste Amount : 508 ton/day (2010)  
499 ton/day (2006)



① Production of Better Quality Compost



② Public Awareness Campaign on Environment

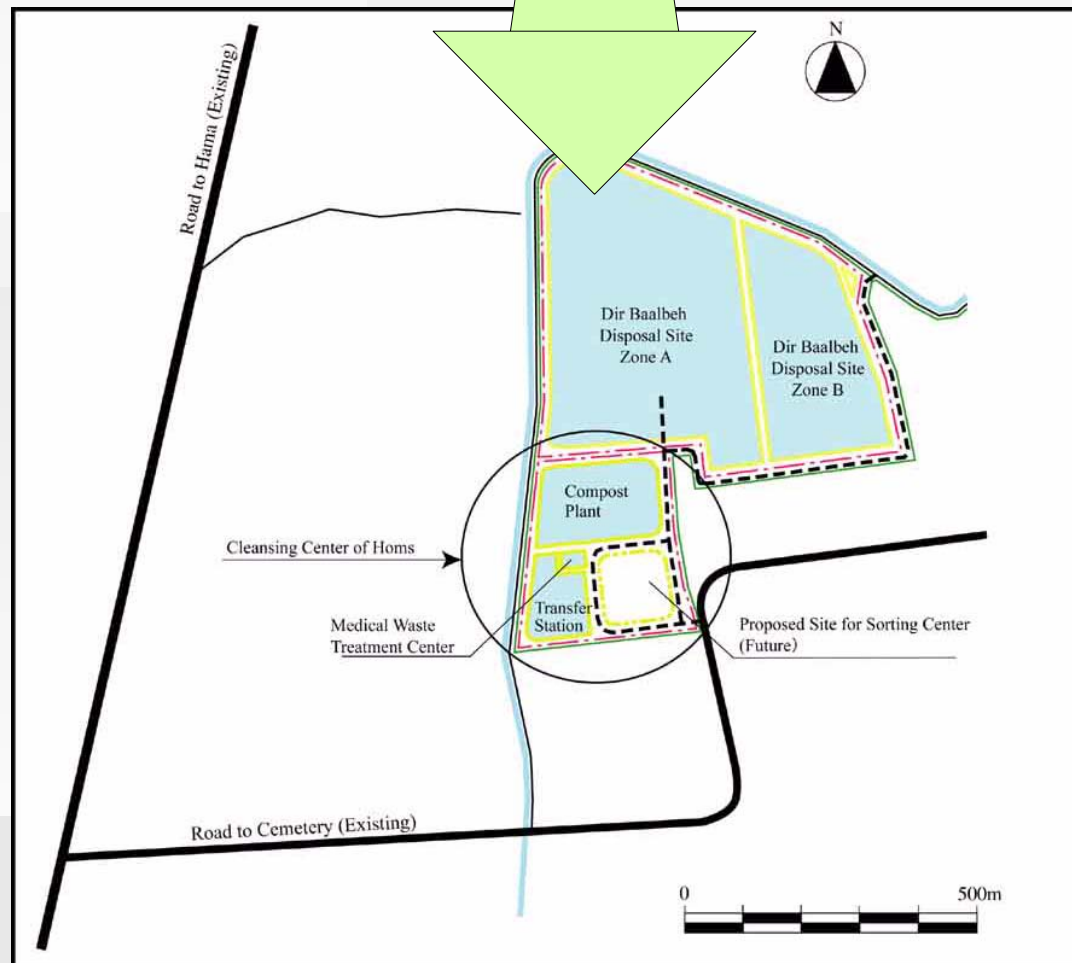
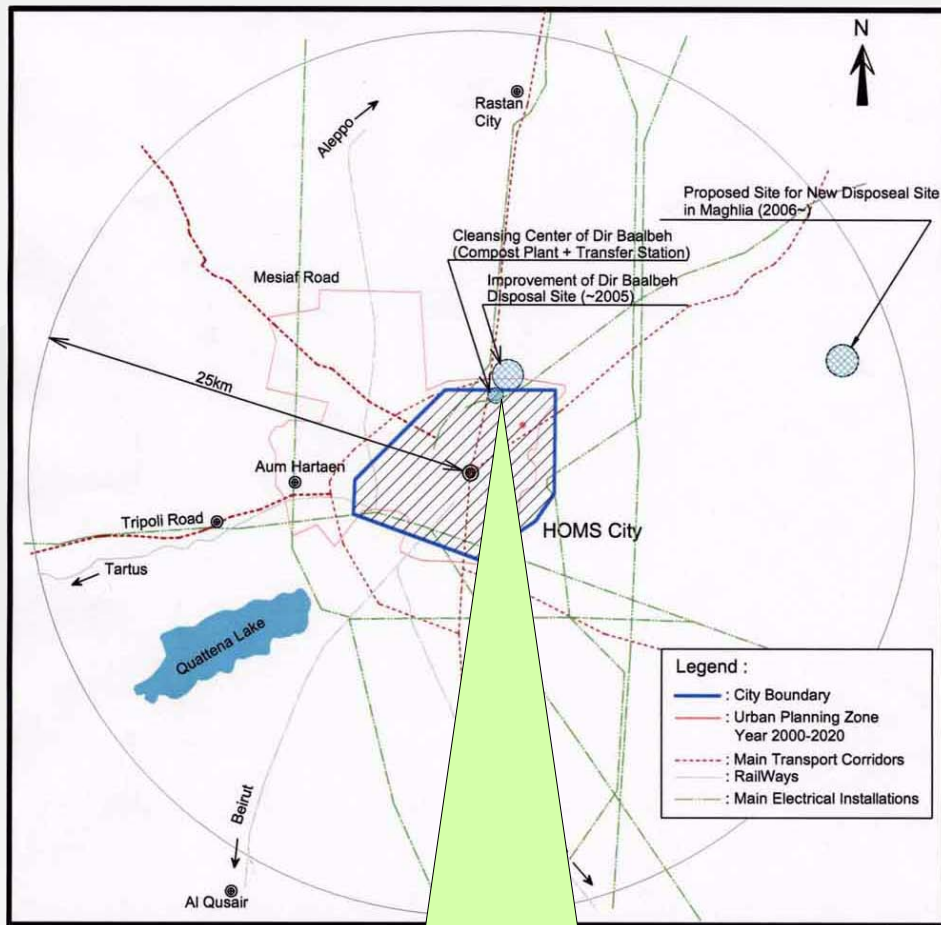
Pilot Study



③ Improvement of Al Bassa Disposal Site

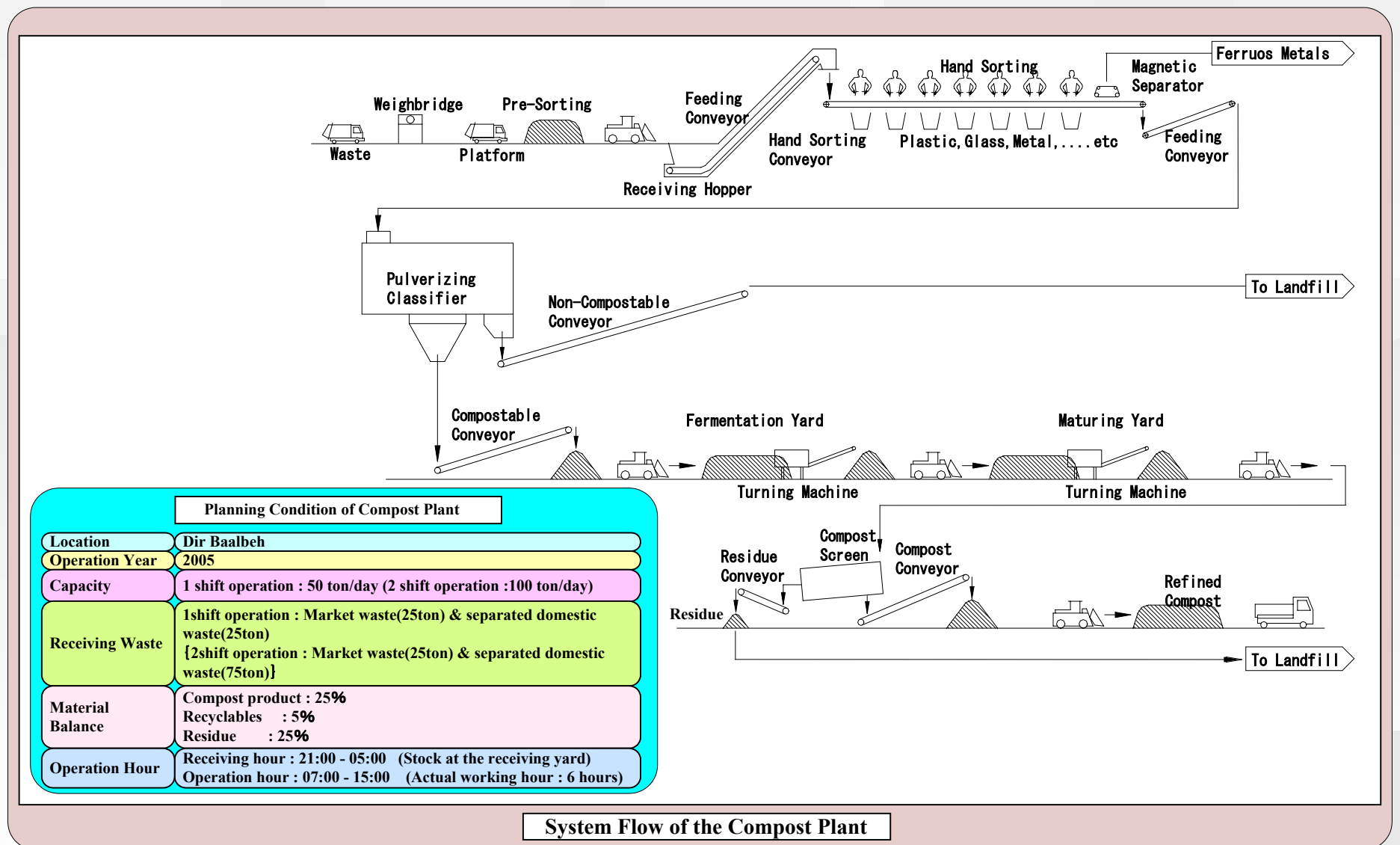
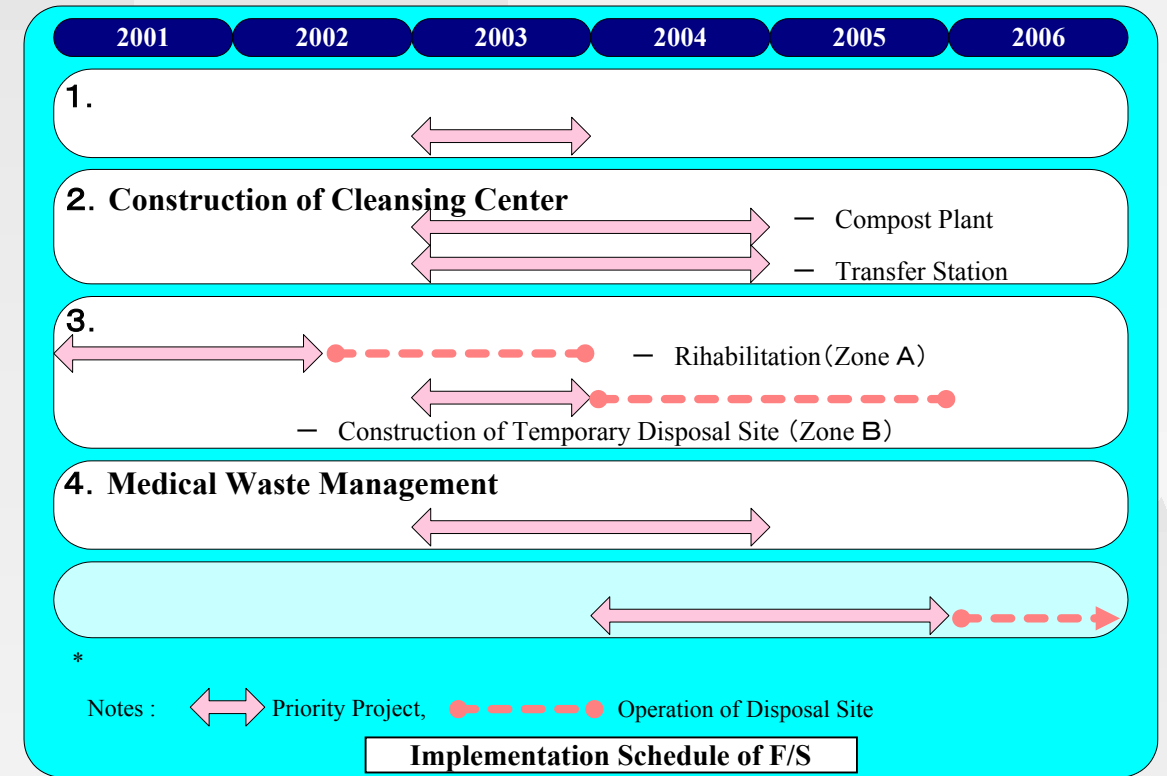


# <Feasibility Study (F/S) on the Compost Plant at Homs>



Location of Proposed SWM Facilities (2006)

Planning Conditions	
Target Year	: 2006
Population	: 1,131,000 (2005)
GRDP	: 33,420 million SP (2005)
Waste Amount	: 809 ton/day (2005)



## **FINAL REPORT COMPOSITION**

The Final Report is composed of the following reports:

1. **SUMMARY REPORT**
2. MAIN REPORT
3. SUPPORTING REPORT
4. DATA BOOK

## **EXECUTIVE SUMMARY**

### **1. Background and Objectives of The Study**

Lattakia City, located on the Mediterranean Coast in the western part of Syria and having a population of 375,000 in 2001, is the fourth largest city in the country. As of 2001, the city generates approximately 280 tons/day of waste and collect approximately 70% of waste. However, the collection situation in outlying areas is very poor and the city has faced a shortage and deterioration of collection vehicle. Collected waste is open dumped at Al-Bassa disposal site without soil covering. As a result, waste become scattered over a wide area and farmland is contaminated. A compost plant was constructed in Lattakia 20 years ago, however, it has closed on March, 2001 because it was only able to produce poor quality compost

The cities of Jableh, Qurdaha and Al-Haffeh are also located in Lattakia Governorate and surround Lattakia City at distances of 20-30 km. The population in these cities is 93,000, 49,000 and 24,000 respectively in 2001. These cities have also faced a shortage and deterioration of collection vehicle. The waste collection rate in Jableh is around 60% and, like in Lattakia City, collection in outlying areas is very poor and the city is confronted with absolute shortages and deterioration of collection equipment. Moreover, collected waste is open dumped at a disposal site

Homs City, located in the center of Syria having a population of 1,000,000 in 2001, is the third largest city in the country. The quantity of waste generated in Homs City is 704 tons/day as of 2000, and approximately 70% of this is collected. Here too, collection in outlying areas is not good enough and Homs City is also confronted with shortages and deterioration of collection equipment. Collected waste is disposed of at Dir Baalbeh disposal site. However, here too open dumping is carried out and the surrounding environment is adversely affected by odor and smoke from spontaneous combustion.

The master plan for solid waste management in Homs City was prepared in the “Homs Solid Waste Management Study (METAP Study)”. In the master plan, it is proposed that a new sanitary landfill disposal site be constructed at Maghlia, which is located some 30 km to the east of Homs City. And it is proposed to introduce recycling systems including compost plant that will also need to be implemented.

Summing up the aforementioned conditions, in order to preserve the living environment and prevent environmental pollution in these cities, it is urgently necessary to establish an appropriate solid waste treatment and management setup via the expansion of waste collection services, promotion of recycling and introduction of sanitary landfilling, etc.

Japan has so far implemented grant aid and produced good results in the area of waste treatment equipment procurement via the Project for Solid Waste Management in Damascus in 1995 and the Project for Solid Waste Management in Aleppo in 1997.

It was against this background that the Government of Syria in 1999 requested the Government of Japan for implementation of the Study. Following this, JICA dispatched the Preliminary Study Team to carry out S/W consultations in August 2000 and started the Study in January 2001.



The purpose of the Study and the Study area are as follows:

- Compiling a master plan and implementing a feasibility study for the priority projects for Lattakia City and the three surrounding cities
- Implementing a feasibility study into construction of a compost plant in Homs City.
- Technical transfer

## **2. Master Plan on Solid Waste Management at Lattakia, Jableh, Quedaha and Al-Haffeh Cities**

### **2.1 BASIC POLICY OF THE MASTER PLAN**

Proper solid waste collection and cleansing service shall be provided in the urban area to maintain living environment. It is also necessary to apply appropriate disposal system to avoid environmental pollution. Reuse and recycle of solid waste shall be promoted to create a society with less burden on environment. Therefore, the solid waste management master plan in Lattakia City and the three surrounding cities was compiled based on the following policy:

- (1) Waste treatment services that respond to demands from society (introduction of recycling, etc.)
- (2) Introduction of sanitary landfilling and inter-municipal treatment and disposal
- (3) Appropriate equipment renewal
- (4) Enhancement of public awareness and cooperation by citizens
- (5) Establishment of a financial base founded on the beneficiaries to pay principle

### **2.2 PLANNING CONDITIONS**

The target year of the master has set on year 2010. Major planning conditions are as follows:

- Design population 687,000 (2.69% rate of increase after 2001)
- Local gross product SP 26,117 million (2% economic growth after 2001)
- Average household income SP 138,600 (average household size 5.3 members)
- Solid waste amount 508 tons/day (187,000 tons/year)

### **2.3 OUTLINE OF THE SWM MASTER PLAN**

In order to improve solid waste collection, collection ratio is planned to expand from 70% at present to 95% in 2010. Separate collection shall be introduced to promote recycling of waste and to produce compost and recycle reusable materials. Al Bassa disposal site shall be rehabilitated and continued to use until Qasia new disposal site will be opened as a sanitary landfill site on 2008. The master plan is outlined in Table 2.3.1.

**Table 2.3.1 Outline of the SWM Master Plan**

Waste collection and street sweeping	Raise the waste collection rate from the present 70% to 95% by 2010. In order to promote recycling, introduce source separate collection (organic waste and inorganic waste) in 50% of districts.	47 collection vehicles will be procured by 2005. In addition, 31 vehicles by 2010
Transport	Construct two transfer stations (Jabla 80 ton/day and Qurdaha 40 ton/day) in line with construction of new disposal sites.	Construction of transfer stations & procurement of 6 container vehicles etc.
Intermediate treatment	Construct recycling centers at Al-Bassa and Al-Qasia, and make compost from organic waste and recover reusable materials from inorganic waste.  <div style="text-align: center;">Compost plant    Sorting center</div> Al-Bassa            50 ton/day,    20 ton/day Al-Qasia            150 ton/day,    20 ton/day	Construction of recycle center at Al-Bassa and Al Qasia
Final disposal	Carry out rehabilitation of Al-Bassa disposal site and controlled landfill until 2007. Construct a final disposal site in Al-Qasia and implement sanitary landfill from 2008.	Rehabilitation of Al Bassa disposal site and procurement of heavy equipment. Construction of Qasia disposal site
Medical waste treatment	Establishment of independent collection system of infectious waste and incineration at existing facility.	Procurement of 3 special collection vehicles
Public awareness	Continuous campaign on solid waste management and environment	Continuous campaign
Organization and institutions	Implement collection and street sweeping in each city, and conduct transport, treatment and disposal under an inter-municipal organization.	Establishment of inter-municipal organization
Finance	Improve fee collection rate from 20% to 80% from household and increase charge step by step from SP 200/year to SP 1,500/year	Raise fee collection rate and cleansing charge.

## 2.4 IMPLEMENTATION SCHEDULE AND PROJECT COST

The investment cost will be SP 1,559 million in total and implementation schedule of the master plan are as indicated in Table 2.3.1.

**Table 2.3.1 Implementation Schedule and Project Cost of SWM Master Plan**

Project Contents	Project Cost (SP1,000)		20 01	20 02	20 03	20 04	20 05	20 06	20 07	20 08	20 09	20 10
	2001-2006	2006-2010										
1. Waste Collection	155,557	110,888										
2. Recycle Center (Al-Bassa)												
(1) Compost Plant	199,000	534,000										
(2) Sorting Center	33,260	33,260										
3. Transfer Station	-	95,420										
4. Final Disposal Site Construction												
(1) Al-Bassa Disposal Site	119,050	-										
(2) Al-Qasia New Disposal Site	-	153,860										
5. Medical Waste Treatment	7,200	-										
6. Enhancement of Citizen Awareness	8,965	6,724										
7. Engineering Service	36,612	65,391										
Subtotal	559,644	999,543										
Total	1,559,187											

## 2.5 FINANCIAL PLAN

The investment cost to procure equipment and facilities required for solid waste management was born by the central government at present while operation and maintenance cost was covered by general budget of local government and revenue of cleansing charge. However, the local government shall be capable in future to finance investment by loan and own funds.

It will be necessary to rely on funds other than those from the municipality own budget in order to fund the investment up until 2006 because local government have no own funds at present.

Operation and maintenance cost excluding depreciation will be SP 107.6 million in 2010. From 2006 onwards, loan repayments will need to be made. The fee levels required in order to cover these costs are as indicated in Table 2.4.1. The domestic waste fee indicated here accounts for roughly 1.1% of income in 2010.

**Table 2.4.1 Fee Level**

(Unit: SP/hh or business entity)

	Now	2006	2010
Domestic Waste	2000/year (100/year)	500/year (200/year)	1,500/year (1,500/year)
Business Waste	250/month (100/month)	250/month (100/month)	500/month (500/month)

## 2.6 EVALUATION OF THE MASTER PLAN

The master plan is formulated to improve solid waste management in Lattakia and the three surrounding cities and will contribute to improve urban environment. It will be effective to promote recycling of waste to reduce environmental deterioration at surrounding area of existing disposal site. And it will be economically and financially viable as described in following:

- a. This master plan aims to introduce source separate collection, construct a recycle center and introduce sanitary landfilling in order to achieve a waste collection rate of 95% and promote recycling of waste. This will make a contribution to preserving the living environment in Lattakia and the three surrounding cities and improving the environment around disposal sites.
- b. Upon examining the value of quantifiable benefits of the project, i.e. 1) benefits resulting from elimination of solid waste from urban areas, 2) benefits of compost production, and 3) benefits of reusable materials recovery, the economic internal rate of return works out to be 6.7%. Also it have the effects of enhancing citizen awareness, reducing final disposal quantities and improving the environment around final disposal sites. The plan can be regarded as a viable undertaking.
- c. In the financial plan of the project, it is necessary to secure funds other than those from the municipality own budget for investment up to 2006 and to raise cleansing service fees by 2010. However, fees will still account for just 1% of household income after the increases and will not represent a major burden. Moreover, if investment up until 2005 can be subsidized, it will be possible for investment from 2006 onwards to be conducted using own funds and loans, thus making it possible to achieve sustained operation of the waste management utility. Therefore, the project is viable in financial terms.
- d. The compost plants and sorting centers can cover operation and maintenance costs except for personnel expenses by means of revenue from the sale of compost and reusable materials.
- e. In addition to widely contributing to improvement of the living environment in urban areas, the plan will help raise citizen awareness of solid waste management through introducing separated collection at the source. Also, the introduction of sanitary landfilling, rehabilitation of existing disposal sites and construction of new disposal sites will help mitigate the environmental pollution that has been growing progressively worse at existing disposal sites. It will be important that the plan have presented a long term solution for final disposal through the development of Qasia new disposal site.

### 3. Feasibility Study on the Priority Project at Lattakia and the Three Surrounding Cities

#### 3.1 PRIORITY PROJECTS

The master plan is scheduled for implementation over two phases up until 2010, and final disposal of solid waste will be continued at Al Bassa disposal site until 2007. Therefore, the priority project has selected to improve solid waste collection, to promote recycling of waste and to improve existing disposal site as shown in Table 3.1.1. Feasibility studies were carried out on these projects.

**Table 3.1.1 Contents of the Priority Project**

Components	Contents
Improvement of waste collection and introduction of source separate collection	Improvement of collection rate from 70% to 85 % at 2006. Introduction of separate collection and renewal of aged equipment. 47 collection vehicle will be procured.
Construction of Al-Bassa recycle center (compost plant: 25 tons/shift, sorting center: 20 tons/shift)	Construction of a compost plant (rehabilitation of existing plant) with capacity 25 ton/shift (Plant will be operated 2 shift in future). Construction of sorting center with capacity 20 ton/day.
Rehabilitation of Al-Bassa disposal site and improvement of landfill work	Rearrangement of existing waste and preparation of tentative disposal area to dispose until 2007. Procurement of heavy equipment to improve disposal operation and to conduct covering soil.
Campaigns for enhancing citizen awareness	Continuous campaign for public awareness on solid waste management and environment.
Establishment of an inter-municipal treatment division	Establishment of Department for operation of Al-bassa disposal site and recycle center.

#### 3.2 IMPLEMENTATION SCHEDULE AND PROJECT COST OF THE PRIORITY PROJECTS

The implementation schedule and project cost of the priority works are as indicated in Table 3.2.1. Moreover, improvement of Al-Bassa disposal site will need to be continued by Lattakia and the three surrounding cities.

**Table 3.2.1 Implementation Schedule of Priority Works in Lattakia and Three Surrounding Cities**

Project Contents		Project Cost (SP1,000)	20 01	20 02	20 03	20 04	20 05	20 06
1	Improvement of Waste Collection, Introduction of Source Separation	155,557						
2	Construction of Recycling Center							
	(1) Compost Plant	199,000						
	(2) Sorting Center	33,260						
3	Rehabilitaiton of Al-Bassa Disposal Site							
	(1) Zone I & II	730						
	(2) Zone III	88,480						
	(3) Disposal Site Equipment	29,840						
4	Enhancement of Citizen Awareness	8,965						
5	Engineering Services	36,108						
	Total	551,940						



### **3.3 FINANCIAL PLAN**

Investment cost based of the priority projects is SP 551.9 million. The financial source of this investment are note yet decided. Since the municipalities do not possess the financial resources to pay for such investment, funds other than those from the municipality budget will be relied on to provide funds.

The operation and maintenance cost of solid waste management in 2006 will be SP 100 million and it is almost same with present expenditure. However, to create own fund for future renewal of equipment, it will be necessary to raise cleansing fees of SP 500/year from households in Lattakia and SP 200/year from households in the three surrounding cities and the fee collection rate to at least 80%. In addition, it will be necessary for each city to outlay costs equivalent at present.

### **3.4 ASSESSMENT OF PRIORITY PROJECTS**

The priority project is formulated to improve solid waste collection, to promote recycling and improve the existing disposal site and it will contribute to improve urban environment in Lattakia and the three surrounding cities. And it will be economically and financially viable as described in following:

- a. This priority project aims to introduce source separate collection, construct a recycle center and carry out rehabilitation of Al-Bassa disposal site in order to achieve a waste collection rate of 85% and promote recycling of waste. This will make a contribution to preserving the living environment in Lattakia and the three surrounding cities and improving the environment around disposal sites.
- b. Upon examining the value of quantifiable benefits of this project, the economic internal rate of return works out to be 9.2%. Also, it has effects on enlightening of citizen awareness, reduction of final disposal quantities and improvement of the environment around final disposal sites, etc. Moreover, since improvement of the environment in Al-Bassa will contribute the tourism development here, the priority project can be regarded as a viable undertaking.
- c. In the financial plan of the project, it is necessary to secure funds other than those from the municipality own budget for the priority projects. Moreover, it is necessary to raise domestic cleansing service fees to SP 500/year in Lattakia and SP 200/year in the three surrounding cities. Also, as is indicated in the master plan, it will be necessary to raise fees further by revising the appropriate law by 2010. However, fees will still account for just 1% of household income after the increases and will not represent a major burden. Moreover, if investment up until 2005 can be subsidized, it will be possible for investment from 2006 onwards to be conducted using own funds and loans, thus making it possible to achieve sustained operation of the waste management utility.
- d. The compost plants and sorting centers can cover operation and maintenance costs except for personnel expenses by means of revenue from the sale of compost and reusable materials.
- e. In addition to widely contributing to improvement of the living environment in urban areas, the project will help raise citizen awareness of solid waste management through introducing separated collection at the source. Also, the ,

rehabilitation of existing disposal sites will help mitigate the environmental pollution that has been growing progressively worse at existing disposal sites.

#### **4. Feasibility Study for Compost Plant Construction in Homs City**

##### **4.1 BASIC POLICY AND PLANNING CONDITIONS OF COMPOST PLANT CONSTRUCTION**

The solid waste management in Homs City is confronted with the issues of deterioration of collection equipment and environmental pollution around the existing disposal site. The master plan of solid waste management in Homs City was compiled in the “Homs Solid Waste Management Study (METAP study) and comprises construction of a new disposal site at Maghlia and introduction of a recycle system including a compost plant. This feasibility study has conducted in line with the master plan policy. Planning conditions of the Project conditions are as indicated below.

- Project target year                      2006
- Design population                      1,614,654 (3% rate of population increase)
- Local gross product                      SP 36,898 million (2% economic growth after 2001)
- Average household income      SP 106,000 (average household size 5.3 members)
- Design waste quantity              809 tons/day (Target collection ratio : 85%)
- Compost plant site                      Land adjoining the existing disposal site

##### **4.2 CONTENTS OF THE COMPOST PLANT CONSTRUCTION WORKS**

Land adjoining the existing disposal site has been selected as the compost plant site. Since it will also be necessary to construct a transfer station on this land, the facility shall be constructed as Homs City Cleansing Center. The components of the project is described in Table 4.2.1.

**Table 4.2.1 Components and Contents of Homs Compost Plant Project**

Component	Content
Improvement of waste collection and introduction of source separate collection	Improvement of collection rate from 70% to 85 % at 2006. Introduction of separate collection and renewal of aged equipment. 59 collection vehicles will be procured.
Construciton of Homs cleansing center Compost plant Transfer station	Construction of the compost plant with capacity 50 ton/shift (Plant will be operated 2 shift in future) and the transfer station with capacity 810 ton/day. (Transportation from the transfer station to the new disposal site will be contract-out)
Rehabilitation of existing disposal site	Rearrangement of existing waste and preparation of tentative disposal area to dispose until 2007. Procurement of heavy equipment to improve disposal operation and to conduct covering soil.
Medical waste management	Establishment of independent collection system and treatment for infectious waste. 3 special collection vehicles and a autoclave will be procured.
Enhancement of citizen awareness	Continuous campaign for public awareness on solid waste management and environment.

### 4.3 IMPLEMENTATION SCHEDULE OF COMPOST PLANT CONSTRUCTION

The project will start in 2002 with facilities construction and equipment procurement taking place in 2003 and 2004. The implementation schedule is as indicated in Table 4.3.1

**Table 4.3.1 Implementation Schedule of Homs City Compost Plant Construction**

Project Contents		Project Cost (SP1,000)	20 01		20 02		20 03		20 04		20 05		20 06	
1	Improvement of Waste Collection, Introduction of Source Separation	201,996												
2	Construction of Cleansing Center													
	(1) Compost Plant	350,000												
	(2) Transfer Station	64,604												
3	Rehabilitaiton of Existing Disposal Site													
	(1) Rehabilitation	30,817												
	(2) Improvement of Disposal	45,960												
4	Medical Waste Treatment	22,280												
5	Enhancement of Citizen Awareness	9,341												
6	Engineering Services	50,750												
	Total	775,748												

### 4.4 FINANCIAL PLAN

Investment cost based of the project is SP 775.7 million. The financial source of this investment is note yet decided. Since the Homs municipalities do not possess the financial resources to pay for such investment, funds other than those from the municipality budget will be relied on to provide funds.

The operation and maintenance cost of solid waste management in 2006 will be SP 142 million and it is 10 % more compare with present expenditure. However, to create own fund for future renewal of equipment, it will be necessary to raise cleansing fees of SP 500/year from households and the fee collection rate to at least 80%. In addition, it will be necessary for to outlay costs equivalent at present.

### 4.5 EVALUATION OF THE PROJECTS

The project has covered an improvement of solid waste collection, promotion of recycling and improvement of the existing disposal site and it will contribute to improve urban environment in Homs. And it will be economically and financially viable as described in following:

- a. This project intends to construct compost plant together with rehabilitation of the existing disposal site and improvement of waste collection in order to acheive collection rate of 85% and promote recycling of waste. This will make a contribution to preserving the living environment in Homs City and improving the environment around disposal sites.
- b. Upon examining the value of quantifiable benefits of this project, the economic internal rate of return works out to be 11.7%. Moreover, since other effects can be considered such as enlightening of citizen awareness, reduction of final disposal quantities and improvement of the environment around final disposal sites, the project can be regarded as a viable undertaking.

- c. In the financial plan of the project, it is necessary to secure funds other than those from the municipality own budget for the priority works. Moreover, it is necessary to raise domestic cleansing service fees to SP 500/year. Also, it will be necessary to raise fees further by revising the appropriate law by 2010. However, fees will still account for just 1% of household income after the increases and will not represent a major burden. Moreover, if investment up until 2005 can be subsidized, it will be possible for investment from 2006 onwards to be conducted using own funds and loans, thus making it possible to achieve sustained operation of the waste management utility.
- d. The compost plants can cover operation and maintenance costs except for personnel expenses by means of revenue from the sale of compost and reusable materials.
- e. In addition to widely contributing to improvement of the living environment in urban areas, the project will help raise citizen awareness of solid waste management through introducing separated collection at the source. Also, rehabilitation of existing disposal sites and implementation of earth covering will help mitigate the environmental pollution that has been growing progressively worse at the existing disposal site.

## **ABBREVIATION**

CDEARE	The Center for Environmental Development for Arab States and Europe
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
FAO	Food and Agricultural Organization of the United Nations
F/S	Feasibility Study
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
JICA	Japan International Cooperation Agency
METAP	Mediterranean Environmental Technical Assistance Programme
MOAAR	Ministry of Agriculture and Agrarian Reform
MOC	Ministry of Culture
MOE	Ministry of Education
MOH	Ministry of Health
MOI	Ministry of Information
MOLA	Ministry of Local Administration
MSEA	Ministry of State for Environmental Affairs
MSW	Municipal Solid Waste
O/M	Operation and Maintenance
PHC	Primary Health Care
PPP	Polluter Pays Principle
SCE	Supreme Council for Environment
SP	Syrian Pound
SPC	State Planning Commission
S/W	Scope of Works
SWM	Solid Waste Management
The Study	The Study on Solid Waste Management at Local Cities in the Syrian Arab Republic
UNDP	United Nation Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children’s Emergency Fund
WHO	World Health Organization



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## **INTRODUCTION**

Local cities in the Syrian Arab Republic represented by Homs City and Lattakia City, the third and the fourth largest cities, and also Jableh, Qurdaha and Al Haffeh Cities are confronted with absolute shortages and deterioration of collection equipment.

In order to preserve the living environment and prevent environmental pollution in these cities, it is urgently necessary to establish an appropriate solid waste treatment and management setup via the expansion of waste collection services, promotion of recycling and introduction of sanitary landfilling, etc.

It was against this background that the Government of Syria in 1999 requested the Government of Japan for implementation of the Study, with the aims of compiling a master plan and implementing a feasibility study for the priority projects for Lattakia City and the three surrounding cities and implementing a feasibility study into construction of a compost plant in Homs City. Following this, JICA dispatched the Preliminary Study Team to carry out S/W consultations in August 2000 and started “The Study on Solid Waste Management at Local Cities in the Syrian Arab Republic” in January 2001.

This is the Summary Report of the Final Report of the Study that was commenced on December, 2000. This Summary Report consists of four Parts and contents of the each Part is as follows:

- Part I: The Master Plan on Solid Waste Management at Lattakia, Jableh, Qurdaha and Al-Haffeh Cities
- Part II: Feasibility Study on the Priority Project at Lattakia, Jableh, Qurdaha and Al-Haffeh Cities
- Part III: Feasibility Study on the Compost Plant at Homs City
- Part IV: Pilot Study in Lattakia

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**PART I**

***MASTER PLAN ON SOLID WASTE MANAGEMENT  
AT LATTAKIA, JABLEH, QURDAHA  
AND AL-HAFFEH CITIES***

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## **PART I MASTER PLAN ON SOLID WASTE MANAGEMENT AT LATTAKIA, JABLEH, QURDAHA AND AL-HAFFEH CITIES**

### **1. Present Conditions on Solid Waste Management**

#### **1.1 REGIONAL CONDITIONS**

Syria, situated on the eastern coast of the Mediterranean Sea and northern part of the Arabian Peninsula, has a population of 17,000,000 and covers an area of 185,000 km<sup>2</sup>. Lattakia Governorate, located in the west of the country on the Mediterranean coast, has a population of 975,000 and contains the four cities of Lattakia, Jableh, Qurdaha and Al-Haffeh. The estimated combined population of Lattakia and these three surrounding cities in 2001 was 541,000 and accounted for approximately 50% of the Governorate population.

Lattakia Governorate is a tourist area along the Mediterranean coast, and coastline in the northern part of Lattakia City is used as a resort area. In this sense, there is a strong need for urban sanitation and environmental protection in this area.

#### **1.2 WASTE AMOUNT AND COMPOSITION**

The estimated amount of waste generated in Lattakia and the three surrounding cities in 2001 is approximately 390 tons/day as indicated in Table 1.2.1. Of this, 290 tons/day (76%) is domestic waste, and 280 tons (72%) is generated in Lattakia City.

**Table 1.2.1 Waste Generation Amount in Lattakia and Surrounding Three Cities (2001)**

Item	Lattakia	Jableh	Qurdaha	Al-Hahheh	Total (t/day)
Domestic waste	203.0	50.1	26.7	12.7	292.5
Commercial waste	65.7	8.9	1.5	1.7	77.8
Park & road waste	10.6	3.2	0.8	0.7	15.2
Total	279.3	62.2	29.0	15.0	385.5

The quality of waste differs according to the generation source. For example, 70% of domestic waste is organic waste (kitchen waste). In the case of commercial waste too, the ratio of organic waste in waste of market, waste restaurants and hotels is high. In carrying out the recycling and treatment of waste, it is necessary to adopt systems that are suited to high ratios of organic waste.

#### **1.3 WASTE COLLECTION AND STREET SWEEPING**

##### **(1) Waste Collection Services and Citizen Satisfaction**

Waste collection, transport, treatment and disposal in Lattakia and the three surrounding cities are carried out based on the Local Autonomy Law. Waste collection rate and level of satisfaction regarding collection services according to citizen awareness surveys are as indicated in Table 1.3.1. In Lattakia City, the waste collection rate is

approximately 70%, but citizen satisfaction is low at 50% or less. In Jableh, only 60% of waste is collected and the level of satisfaction is just 33%. It is necessary to increase collection rates in these two cities. In Al-Haffeh and Qurdaha on the other hand, these are small cities and collection rates are high. However, citizen satisfaction in Al-Haffeh is low and it is necessary to improve waste treatment services.

**Table 1.3.1 Resident’s Satisfaction on Waste Collection**

Item	Lattakia	Jableh	Qurdaha	Al-Haffeh
Collection ratio (%)	68	58	92	88
Resident’s satisfaction (%)	42	32	62	33

Source: Public awareness survey by the JICA Study Team

## (2) Waste Collection and Street Sweeping Equipment

In Lattakia and the three surrounding cities, there are 70 collection vehicles and 13 street sweeping vehicles. However, all these equipments are deteriorated and renewal is urgently needed.

**Table 1.3.2 Waste Collection Equipment in Lattakia and Surrounding Three Cities**

(Unit: nos)

Equipment	Lattakia	Jableh	Qurdaha	Al-Haffeh	Total
Collection					
Compactor (9 ton)	25	2	2		29
Compactor (6 ton)	8	1	1		10
Dump truck	3			1*	4
Tractor	13	3	1	2	19
Shovel loader	2	3	2		7
Wash container	1				1
Sub total	52	9	6	3	70
Sweeping					
Mechanical sweeper	5	2	1		8
Water tank	3		2		5
Sub total	8	2	3		13
Construction debris					
Dump truck	4				4
Tractor	3				3
Loader	5				5
Sub total	12				12
Total	72	11	9	3	95

Note: \* Small dump truck (1m<sup>3</sup>).

## (3) Collection Work Setup

Waste collection in Lattakia is carried out over two shifts in morning and evening. In the morning shift, 202 personnel operate 23 vehicles, while in the evening shift, 285 personnel operate 31 vehicles. In Jableh, two-shift collection is carried out as well, while in Qurdaha and Al-Haffeh, two-shift collection is carried out only in the busy summer season when waste quantities increase. The multi-shift system is also adopted in Homs City as a means of dealing with equipment shortages and breakdown of

deteriorated equipment, and this point will need to be considered when carrying out future examination.

#### **1.4 TREATMENT AND DISPOSAL**

##### **(1) Final Disposal**

In Lattakia, Jableh and Al-Haffeh cities, collected waste is disposed in each city's own disposal site. None of these disposal sites possesses facilities and equipment for sanitary landfill disposal, and the waste is simply dumped without any earth covering and this leads to pollution of the surrounding environment. Conversion from open dumping to sanitary landfilling is one major issue. Incidentally, waste in Qurdaha is transported to and disposed of at the disposal site used by Lattakia City at Al-Bassa.

##### **(2) Al-Bassa Disposal Site**

Al-Bassa disposal site is situated roughly 15 km south of Lattakia City on the coast and covers an area of roughly 100 ha. Waste is open dumped over a wide area here and surrounding farmland is badly polluted as a result.

#### **1.5 COMPOSTING AND RECYCLING**

##### **(1) Composting**

The compost plant in Lattakia City was constructed as a 100-ton/day plant and started operation in 1981. However, equipment deterioration is advanced and treated quantities of waste have fallen dramatically. The conditions at the plant in the year 2000 were as follows:

Treated quantity	4,500 tons/year
Compost production	1,350 tons/year
Compost sales	619 tons/year

The treated quantity is approximately 15% of plant capacity; compost production is 30% of treated quantity; and compost sales are 46% of compost production. The sale price of compost is SP 350/ton. Moreover, this compost plant does not possess any process for recovering reusable materials. When examining compost treatment in future, the first priority should be given to achieve production of good quality compost.

##### **(2) Recycling**

In Lattakia, recovery of reusable materials is not carried out as a formal system. However, around 400 waste-pickers retrieve reusable materials throughout Lattakia City and at Al-Bassa disposal site. Recovered reusable materials are paper, plastic, glass and metals (iron, aluminum, copper) and amount to around 50 tons/day. These reusable materials are transported to Aleppo and Homs City for recycling. In future, it will be necessary to further promote recycling by making use of these recovery routes.

## **1.6 ENVIRONMENTAL CONDITIONS**

The Ministry of State for Environmental Affairs was established in Syria in 1987. Work on establishing an environmental protection legislation that had been continued since 1995 resulted in preparation of a draft bill in September 2000, and this is currently under discussion by the cabinet. The requirement for environmental impact assessment system is included in this bill.

In Syria, waste collection is carried out in central urban areas, however, waste collection in outlying low-income districts is insufficient and this constitutes a major urban environmental issue. Moreover, collected waste is open dumped in almost all cities except for Damascus, and the fact that earth covering is not applied is one factor in environmental pollution.

Al-Bassa disposal site, which is currently being used, has spread randomly along the coastline on the outskirts of Lattakia, and waste is disposed over a wide area here. This coastline is highly regarded as a picturesque tourist location and, due to its proximity to Lattakia City, future plans for construction of a coastal road or development of tourism are being considered. However, not only does the above-mentioned widespread open dumping greatly harm tourism resources, but scattering of waste onto nearby farmland is also a problem. In Jableh too, location of the dumping site on the coast and close to the city center means that odor and smoke caused by spontaneous combustion reach residential land. Therefore, for the sake of improving the urban environment, not only improvement of collection, but also improvement of final disposal is an issue that requires urgent attention.

## **1.7 MEDICAL WASTE AND INDUSTRIAL WASTE TREATMENT**

There are approximately 800 medical facilities including hospitals, health centers and clinics in Lattakia and the three surrounding cities. These facilities generate approximately 3.9 tons of medical waste every day, of which 1.2 tons/day or roughly 30% is estimated to be infectious waste.

In Lattakia Governorate, infectious waste is carried to incinerators in national hospitals, etc. for treatment. The same method is practiced in Lattakia City, however, in Jableh, due to the shortage of collection equipment, infected waste is collected together with urban waste and disposed of in the municipal disposal site. Consequently, there is an urgent need to build a system for collecting and treating infectious medical waste.

In Lattakia City, there are 346 small and medium size factories generating approximately 3,600 tons of industrial waste every year, and this waste is mainly disposed of at Al-Bassa disposal site.

## **1.8 ORGANIZATION AND INSTITUTIONS**

### **(1) Legislation**

Lattakia Governorate is composed of four counties, four cities, 16 towns and 77 villages. Each municipal authority manages solid waste in accordance with the Local Autonomy Law (promulgated on October 10, 1974). The central government agency that supervises each local authority is the Ministry of Local Government, whereas the

Ministry of State for Health and Ministry of State for Environmental Affairs are responsible for public health and environmental protection and have regional branch offices.

## **(2) Lattakia City**

Lattakia City has 15 departments employing a total of 1,888 workers. Departments related to waste management are the Sanitation Department, Engineering Department and Compost Plant Section.

The Cleansing Department belongs to the Sanitation Department and has a work force of 612 employees. The Cleansing Department carries out waste collection (487 workers and 54 drivers also covering manual street sweeping), street sweeping (59 workers and 22 drivers), road encroachment management (23 workers and 3 drivers), and other work (43 workers). Collection of construction waste is carried out together with street sweeping.

The Vehicle Section of the Engineering Department manages waste collection vehicles and mechanical street sweepers. The Vehicle Section is made up of the maintenance section (35 engineers) and work section (220 drivers and engineers). Currently, 52 vehicles carry out waste collection and eight vehicles carry out street sweeping.

The compost plant was closed down in March 2001, however, prior to that 32 engineers and operators were working in two shifts here. Moreover, concerning Al-Bassa disposal site, this is supposed to be managed by the Compost Plant Section, however, there has been absolutely no management until now and there are no responsible staffs at the site. Accordingly, rehabilitation of the final disposal site setup in Lattakia and the three surrounding cities is a highly important issue.

## **(3) Jableh, Qurdaha and Al-Haffeh**

The total number of employees, cleansing department employees and cleansing department drivers in Jableh and Qurdaha are as indicated in Table 1.8.1. As is also true in Lattakia City, disposal sites are totally unmanaged and unmanned.

**Table 1.8.1 Personnel Related to SWM in 2001**

Item	Lattakia	Jableh	Qurdaha	Al-Haffeh	Total
Municipality Personnel (Total)	1,888	NA	56	40	
Cleansing Department	612	65	25	15	717
- Waste Collection		20	8	4	
- Road Sweeping		45	17	11	
Compost Plant	32	-	-	-	32
- Related Drivers	79	12	7	3	101
Total (Cleansing Department)	723	77	32	18	850

## 1.9 ECONOMIC AND FINANCIAL CONDITIONS FOR SWM

### (1) Gross Regional Domestic Product (GRDP) and GRDP Per Capita in Lattakia Governorate

Gross domestic product in Syria in 1998 was SP 790,440 million and the per capita GDP was SP 46,500 (population 17,010,000). Within this, the gross regional domestic product (GRDP) of Lattakia Governorate was SP 39,940 million, accounting for 5% of the national GDP, and per capita GRDP was SP 41,000 (Governorate population 975,000), equivalent to 88% of the national average. The gross regional domestic product of Lattakia and the three surrounding cities is estimated as SP 20,593 million (1998) judging from the ratio of population there.

Whereas it is estimated that population will increase at an annual rate of around 2.7% and estimated population of Lattakia and the three surrounding cities in 2001 is 541,000. Assuming the economic growth rate from 1998 onwards to be 2%, the GRDP of these four cities is estimated as SP 21,853 million and the per capita GRDP is estimated as SP 40,400.

### (2) Household Income and Expenditure

Judging from the findings of citizen awareness surveys, household income per person works out as SP 17,180 per year and expenditure is SP 23,409, which means that income only covers approximately 73% of expenditure. These figures for household income and expenditure are equivalent to approximately 43% and 58% of per capita GRDP respectively. 14.3% of households have income of SP 4,000 or less and account for just 3.4% of total expenditure.

### (3) Financial Situation in Lattakia and Three Surrounding Cities

Financial conditions and waste management costs in Lattakia and the three surrounding cities are as indicated in Table 1.9.1.

**Table 1.9.1 Financial Condition of Lattakia and Three Surrounding Cities in 2000**

(Unit: Million SP)

Item	Lattakia	Jableh	Qurdaha	Al-Haffeh	Total
Population (2000)	365,600	90,300	40,880	22,900	519,680
a. Revenue	445.0	31.8	2.8	1.6	481.2
b. Expenditure	521.0	21.2	6.0	3.4	551.6
c. Revenue on SWM	33.5	0	0	0.1	33.6
d. Expenditure on SWM	93.1	11.2	2.1	0.9	107.3
d/b	17.9%	52.8%	35.0%	26.4%	19.5%

Note: Budget in Al-Haffeh is estimated based on the budget in Qurdaha.

The Expenditure on SWM of Lattakia and the three surrounding cities in SP 107.3 million that shares 19.5% of total expenditure as shown in Table 1.9.1, while the revenue on SWM is SP33.6 million that covers only 31.3% of the expenditure on SWM. An effort shall be paid to increase revenue on SWM.

## **1.10 ENVIRONMENTAL AND SANITARY EDUCATION**

The Environmental Information Department within the Ministry of State for Environmental Affairs is in charge of environmental education. Moreover, the Ministry of State for Health is responsible for sanitary education. Both these ministries have regional branch offices that work in tandem with local authorities and groups in carrying out environmental and sanitary education.

## **2. Major Problems and Issues on Solid Waste Management**

### **2.1 CURRENT PROBLEMS ON SOLID WASTE MANAGEMENT**

#### **(1) Lattakia City**

A solid waste collection service is provided for the major part of Lattakia city and main streets are kept clean by the Cleansing Department. But solid waste collection in low-income areas located in the suburbs of the city is very poor and unsanitary. About 200 tons of waste, which is equivalent to about 70% of total generated waste, is collected daily, and this is transported to Al-Bassa disposal site. According to results of the citizen awareness survey, 68% of citizens receive collection services, but only 42% are satisfied with the services they receive.

Al-Bassa disposal site is located along the seashore and covers an area of approximately 90 ha. The site is on the coast south of Lattakia City and is visible from the city. Solid waste is dumped without application of any earth covering. Scattering of waste and illegal dumping around the disposal site have widely polluted a large area of surrounding agricultural land.

The Cleansing Department of Lattakia City possesses 612 personnel who carry out street sweeping, waste collection and collection and disposal of construction waste. 18% of the municipal budget is allocated to these cleansing activities.

#### **(2) Jableh City**

The Cleansing Department of Jableh city carries out waste collection and street sweeping in the important areas and main roads of the city, and thus the central area is kept in clean condition. However, waste collection services in low-income districts and outlying areas are insufficient and unhygienic. Only 60% of generated waste is collected. According to the findings of the citizen awareness survey, 60% of citizens receive waste collection services, but only 32% are satisfied.

The disposal site in Jableh City is located on the coast in the south of the city and covers an area of approximately 4 ha. Waste here is open dumped and there is no earth covering at all. Since this site is located close to residential areas, there is an endless stream of complaints from citizens.

#### **(3) Qurdaha City**

Qurdaha city has three compactor vehicles and one mechanical sweeper, and waste collection is carried out over almost all of the cities (92%). However, the level of citizen satisfaction is just 62%.

#### **(4) Al-Haffeh City**

Waste collection is carried out over almost the whole city (88%) by two tractors. However, the level of citizen satisfaction is just 33%.



## **(5) Medical Waste**

There is a Lattakia Governorate decree on medical waste. Medical waste is transported to the national hospitals in Lattakia for incineration. Accordingly, Lattakia City Cleansing Department collects and transports medical waste in a separate system. However, medical waste is collected and open dumped in the municipal disposal site together with ordinary waste in Jableh because of the shortage of collection equipment.

## **(6) Construction Waste**

Construction waste can be found illegally dumped all over the urban area. In order to maintain the sanitary environment of the city, it is necessary to manage the disposal of construction waste materials.

## **2.2 MAJOR SOLID WASTE MANAGEMENT ISSUES**

Solid waste that is generated as a result of daily life and industrial activities of human beings not only leads to issues on sanitation but also causes environmental pollution. Therefore, in urban areas of concentrated population, it is extremely necessary to remove solid waste immediately, and then treat it appropriately as well as to keep public sanitation and the living environment of urban areas clean by conducting public cleansing services.

In the central parts and on main roads of Lattakia City and the surrounding three cities, waste collection and street sweeping services are more or less satisfactory. In outlying areas, on the other hand, waste collection services are inadequate and this has led to several issues and problems on sanitation and living environment as well as a lot of discontent among citizens. In addition, collected solid waste is open dumped as it is at the final disposal sites without undergoing any intermediate treatment. A compost plant was constructed 20 years ago, however, the plant has not been in operation recently due to bad quality of compost and deterioration of facilities. The final disposal sites are in very poor condition and cause widespread environmental pollution in surrounding areas because they do not carry out earth covering and are subject to spontaneous combustion. In these conditions, waste-pickers collect valuable waste materials and sheep eat food waste. Additionally, due to the advancing deterioration of collection vehicles and equipment, it will become more and more difficult to maintain collection services even at existing levels. More and more requests from citizens for improving urban environment have increased, and dissatisfaction with and complaints against public services in the area of solid waste management have increased greatly.

Lattakia City and the surrounding three cities assign a lot of staff in solid waste management and allocate approximately 20% of their budgets to this utility, however, as was mentioned above, this is only enough to pay for street sweeping and waste collection in central areas, and the municipalities cannot afford to purchase necessary vehicles and equipment to expand solid waste management and to improve the final disposal sites and renew superannuated equipment. Therefore, it is necessary for Lattakia City and the surrounding three cities to take drastic measures to improve their solid waste management including systems and finances.

It is required in the future to create a society that can reduce consumption of natural resources and the burden on environment as much as possible. In order to attain such a society, the principle of solid waste management has to be based on reducing quantities of solid waste, recycling solid waste as resources as much as possible and treating only non-reusable and recyclable solid waste appropriately. It is necessary for the citizens to keep their city clean first and to not dispose solid waste anywhere illegally in accordance with municipal guidance on solid waste management. In order to get citizens' cooperation, it is important for the municipalities to not only heighten public awareness on environment and solid waste management through as many chances as possible, but also create opportunities for community beautifying and cleaning activities and promote positive citizen participation in such opportunities.

For sound solid waste management, generally, it is pointed out that introduction of the following systems is necessary: 1) to reduce waste generation (generation reduction), 2) to reuse goods and parts that cannot be reduced (reuse), 3) to recycle waste which cannot be reused as resources (recycling), 4) to generate energy from waste that is not reusable and not recyclable (heat recovery), and 5) to appropriately dispose of waste that is not reusable, not recyclable and not heat recoverable (appropriate disposal)

Accordingly, it is necessary to share the cost of solid waste management based on taking appropriate share of responsibility of the central government, local governments, industries and citizens. The central government and local governments have to formulate a policy on solid waste management and enforce the policy in a planned manner. At the same time, industries have to conduct management of solid waste generated by their industrial activities, and this includes generation reduction, reuse, recycling, heat recovery and suitable disposal. Moreover, it is necessary for the citizens to cooperate with these solid waste management activities by the central government and local governments.

The quantity of solid waste generated per capita in Lattakia City and the surrounding three cities is not large at present. Also, the proportion of kitchen waste is very high in the composition of the waste of those cities. Accordingly, it is appropriate to limit the overall amount of generated waste by introducing a cost bearing system that is based on waste discharge quantities.

Because the solid waste of Lattakia City and the surrounding three cities contains a lot of kitchen waste, it is very important to promote recycling of organic waste. Also, it is important to promote recycling of valuable materials such as paper, plastics, metals and glass. In the present circumstances where working opportunities are not sufficiently provided to skilled workers, it is considered realistic to promote waste recycling in cooperation with waste-pickers. Meanwhile, in the long term, it will be necessary to move away from recovery of valuable materials at disposal sites and more towards the separation of such materials at generation sources by means of systematic collection.

The present dumping site at Al-Bassa is located on the coast, but this will need to be moved because construction of a coastal road is planned here. Thus, construction of a new final disposal site is required and selection of the site for this is a major issue.

It is necessary to have a consensus among persons concerned for the selection of the candidate site for the landfill. In order to get such a consensus, the following principles shall be employed: 1) keep transparency in the procedure, 2) have

participation of people concerned in the procedure, 3) fulfill the public responsibility of explanation.

However, it will be difficult for the authorities to obtain such a consensus because citizens living around disposal sites are filled with discontent over the fact that, apart from the case of Damascus, environmental conditions around sites are appalling because solid waste is currently open dumped without undergoing any intermediate treatment, spontaneous combustion occurs at dump sites, and humans and animals scavenge for valuable waste. In order to improve this negative situation, it is essential to eradicate the poor image of final disposal sites by upgrading the present open dumping sites to controlled landfill sites or sanitary landfill sites.

### **3. Policy and Target of the Master Plan**

#### **3.1 BASIC POLICY OF THE MASTER PLAN**

The future final disposal site of Lattakia City and the surrounding three cities has been decided as Qasia located some 18 km east of Lattakia. The necessary procedure for the procurement and construction of the site is set to proceed in due course.

A suitable collection system and public cleansing service are required to maintain a comfortable living environment in urban areas. In addition, appropriate treatment systems and environment protection measures have to be employed to prevent environmental pollution around solid waste treatment facilities and final disposal sites. Moreover, it is important, that such facilities and systems be operated and managed in the appropriate manner.

The minimum-cost method is employed to select appropriate technology on solid waste management. While it is necessary to respond to citizens' demands on solid waste treatment services, it is difficult to predict quantitatively the economic and social benefit. Therefore, it is necessary that appropriate alternative plans be selected among several proposed plans taking account of social and financial factors.

In order to sustain the technology systems, sound institutions and organizations must be established. It is necessary to consider participation by the private sector in solid waste management as at the transfer station in Damascus City in order to create efficient systems. As for the leading facilities, the necessity of inter-municipal management and Governorate participation in the solid waste management shall be considered. Therefore, it is also necessary to consider system contents for inter-municipal management and Governorate participation.

Establishment of a stable financial base is required in order to support the operation and maintenance of technology systems. It is essential for the plan to secure financial resources for the operation of future systems. Therefore, it is necessary to introduce the polluter pays principle (PPP) (burden borne by beneficiaries) to finance solid waste management, while service fees must be adjusted so that costs are covered. It is possible to introduce PPP within the present legal framework. In addition, the cost of solid waste management shall be cleared and the financial systems of the municipalities shall be improved to identify the service cost by each cleansing authority.

The residents are not only waste generators but also beneficiaries of the service. It is extremely important to obtain the cooperation of citizens in order to achieve efficient solid waste management. Cleansing department personnel have more opportunities for coming into contact with citizens than other municipal workers. Accordingly, creation of the mutual trust between citizens and the waste workers is essential. Provision of reliable services will encourage cooperation by citizens and lead to the success of sound solid waste management. Especially, cooperation by citizens concerning waste separation at the source is indispensable.

### **3.2 TARGETS OF THE MASTER PLAN**

In Lattakia, waste collection and street sweeping have been implemented with the goal of sustaining a “clean and beautiful city”. However, due to lack of a clear purpose in the solid waste management, the necessary equipment has become too old for work, collected waste is open dumped at disposal sites, and illegal dumping can be seen all over the place. This situation is a serious issue and citizens understand that drastic improvements need to be made.

To keep the city clean and beautiful, the cleansing service has to be a reasonable system and be accepted by the population. The service cost has to be shared appropriately by the polluters including the citizens since they also generate waste. It is necessary for citizens to understand this and to pay their share of the cost burden.

There are various opinions on how to build rational solid waste management systems. Common understanding more or less exists concerning the need to aim for a society that generates as small an environmental load as possible. For this reason, it is necessary to minimize waste discharge quantities and advance reuse and recycling. However, because the benefits of these activities are widely dispersed, recovery within the framework of solid waste management alone is difficult and costs increase as a result. Even so, it is necessary to build the system while aiming to achieve a society that has low environmental load. Moreover, stable sources of finance must be secured for solid waste management. Only when sound finances are secured does it become possible to build a system that is favorably viewed by citizens and maintain a clean and beautiful urban environment.

The objective of solid waste management is to limit generation of solid waste, remove generated solid waste from the urban area in an efficient and economic manner, promote recycling, mitigate environmental load, carry out sanitary treatment and disposal, and as a result preserve the urban living environment. With this objective in mind, the Master Plan aims to build a sustainable and appropriate solid waste management system.

- a. Target year            2010
- b. Master Plan Targets

Establishment of a sustainable and appropriate solid waste management system:

- Provision of waste collection services in urban areas
- Construction and procurement of necessary facilities and equipment
- Promotion of recycling
- Introduction of sanitary landfilling
- Establishment of an inter-municipal treatment and disposal system
- Rehabilitation of existing disposal sites
- Construction of financial base

## 4. Socio-economic Framework

### 4.1 POPULATION PROJECTION

The population of Lattakia and three surrounding cities was estimated based on the census of 1994 and population growth rate of 2.7% issued by the Syrian Department of Statistics. According to this, population in 2001 is estimated as 541,000 and population in 2010 is estimated as 687,000, which represents a 27% increase over 10 years.

**Table 4.1.1 Population Forecast**

City/Year	(Unit: Persons)		
	2001	2005	2010
Lattakia	375,435	428,721	476,747
Jableh	92,729	105,890	117,752
Al-Haffeh	23,516	26,854	29,862
Qurdaha	49,291	56,287	62,593
Total	540,971	617,752	686,954

### 4.2 TOURISTS

The number of tourists visiting Lattakia Governorate is 202,000 per year (1999). This works out as 16,800/month on average, but the number in July is double this at 34,200.

### 4.3 GROSS REGIONAL DOMESTIC PRODUCT

Regional gross domestic product in Syria is reported to grow by around 2% per year. However, since this rate is lower than the rate of population growth, this means that per capita gross regional domestic product will slowly decline from now on. This is a harsh prospect.

**Table 4.3.1 GRDP Forecast**

City/ Year	(Unit: SP million)		
	2001	2005	2010
Lattakia	15,166	16,417	18,125
Jableh	3,746	4,055	4,477
Al-Haffeh	950	1,028	1,135
Qurdaha	1,991	2,155	2,380
Total	21,853	23,655	26,117

Note: Based on GRDP of Lattakia Governorate in 1998, Growth ration is estimated 2% per year

### 4.4 BUDGET

Assuming that the budget in each city increases in line with gross regional domestic product, this will be SP 786.3 million in 2010.

**Table 4.4.1 Budget in Lattakia and Surrounding Three Cities**

(Unit: SP million)

City/ Year	2001	2005	2010
Lattakia	605.0	654.9	723.0
Jableh	45.7	49.5	54.6
Al-Haffeh	2.4*	2.5	2.8
Qurdaha	4.9**	5.2	5.9
Total	658.0	698.2	786.3

Note: \* Budget in Al-Haffeh is estimated based on Qurdaha budget of SP1,100/person  
\*\* Budget in 2000

#### 4.5 ORGANIZATION AND INSTITUTIONS

Based on the Local Government Law, the responsibility for solid waste management lies with each municipality. Each municipality has a cleansing department, however, since the municipalities cannot be relied on to secure equipment and it will be necessary in future to introduce inter-municipal measures (sanitary landfilling, etc.), consideration shall be given to institutional preparation on the Governorate level.

Concerning the cost burden of waste management, since a system of cleansing fee collection is already in place, consideration shall be given to the basic policy of reducing central government subsidies by raising fees and improving fee collection rates based on the polluters to pay principle.

Moreover, since harmful waste products need to undergo special treatment, it is thought that measures on the Governorate level will be difficult. Accordingly, management of such waste types on the central government level will be required.

## 5. Planning Conditions

### 5.1 WASTE AMOUNT AND QUALITY

#### (1) Waste Amount

The generated quantity of solid waste in 2001 was calculated using the unit generation rate obtained from the results of the site survey. The unit generation rate in 2001 is 0.54 kg/cap/day for domestic waste and 0.71 kg/cap/day including commercial waste, etc. Moreover, the quantity of waste increases in the summer with the influx of tourists. The quantity of this waste is estimated as approximately 47 tons/day according to the scale of resort facilities. The quantity of medical waste is estimated as 4 tons/day, and the quantity of waste from small and medium size factories is estimated as 10 tons/day.

The future quantity of waste was calculated assuming annual rate of increase in the unit generation rate of 1% and also taking population increase into account. As a result, the projected amount of generated waste in 2010 is 508 tons/day as shown in Table 5.1.1.

**Table 5.1.1 Waste Generation Amount in 2010**

(Unit: ton/day)

City/ Waste type	Domestic waste	Commercial waste	Road & Part waste	Total
Lattakia	282.0	71.9	11.6	365.5
Jableh	69.7	9.7	3.5	82.9
Al Haffeh	17.7	1.9	0.8	20.3
Qurdaha	37.0	1.6	0.9	39.5
Total	406.4	85.1	16.7	508.2

Note : Beside that, seasonal waste in summer (52 ton/day), medical waste (4 ton/day), and small scale industry (10ton/day) are generated.

#### (2) Waste Composition

The waste composition in Lattakia based on the findings of the site survey is as indicated in Table 5.1.2. This shows a high proportion of food and vegetable (kitchen waste).

**Table 5.1.2 Waste Composition in Lattakia and Surrounding Three Cities  
(Wet base)**

(%)

Composition	Domestic waste			Commercial waste		
	Winter	Summer	Average	Winter	Summer	Average
Food, Vegetable	70.4	74.9	72.7	57.0	52.6	54.8
Paper	10.1	8.4	9.2	20.4	22.4	21.4
Plastic	8.1	8.7	8.4	9.1	13.2	11.2
Rubber & Leather	0.5	0.3	0.4	0.2	0.1	0.2
Wood	0.4	0.2	0.3	1.4	1.2	1.3
Textile	2.4	2.0	2.2	0.8	0.4	0.6
Metal	1.7	1.3	1.5	1.8	1.7	1.7
Glass	1.6	0.8	1.2	3.3	0.9	2.1
Ceramic, Stone & Sand	1.7	1.6	1.7	2.6	3.3	2.9
Others	3.2	1.7	2.4	3.4	4.2	3.8
Total	100.0	100.0	100.0	100.0	100.0	100.0



## 5.2 MINIMUM SERVICE LEVEL

Basic requirements of solid waste management are regular waste collection and appropriate disposal. Moreover, quantity reduction and recycling of waste is required. Table 5.2.1 shows the minimum service levels considered in the plan.

**Table 5.2.1 Minimum Service Levels**

	Lattakia City	Jableh, Al-Haffeh and Qurdaha City
1. Waste collection		
Domestic waste (Central and commercial area)	Daily collection for container system 3 times a week for other system Separate collection for organic and in-organic waste shall be introduced	Daily collection for container system 3 times a week for other system Separate collection for organic and in-organic waste shall be introduced
Domestic waste (Peripheral & low income area)	Daily collection for container system 3 times a week for other system Separate collection for organic and in-organic waste shall be introduced	Daily collection for container system 3 times a week for other system Separate collection for organic and in-organic waste shall be introduced
Reusable material	To be collected separately	To be collected separately
Commercial waste	Daily collection for container system in central area and 3 times a week for other areas	Daily collection for container system in central area and 3 times a week for other areas
Small-scale industry waste	Same as domestic waste excluding hazardous waste	Same as domestic waste excluding hazardous waste
2. Transportation	---	Transfer stations shall be considered in Jableh and Qurdaha
3. Waste reduction and resource recovery	Separate collection and recycling of reusable material	Separate collection and recycling of reusable material
4. Waste treatment and disposal	Sanitary landfill Composting of organic portion of the waste	Sanitary landfill Composting of organic portion of the waste
5. Medical waste	Independent collection and treatment of infectious waste	Independent collection and treatment of infectious waste
6. Street sweeping	Daily sweeping in city center, once a week sweeping in peripheral areas	Daily sweeping in city center, once a week sweeping in peripheral areas
7. Illegal dump sites	Rehabilitation of Al-Bassa disposal site and illegal dump site	Rehabilitation of illegal dump site
8. Service charges	Introduction of "polluter pays" principal.	Introduction of "polluter pays" principal
9. Industrial waste	Generators responsibility (Medium and Large)	Generators responsibility (Medium and Large)
10. Hazardous waste	National level management	National level management

### **5.3 WASTE DISPOSAL SITES**

Waste is currently disposed of at Al-Bassa disposal site, however, construction of a new site is required for the following reasons:

- Part of the sandy coastline is used by the site, which can even be seen from Lattakia inner city. There have been numerous complaints about the environmental pollution that takes place here.
- Ground consists of permeable sandy layers and groundwater is already polluted. It is necessary to prevent further pollution in future.
- There are plans to develop the sandy beach here as a tourist spot and to construct a coastal road in the area.

For the above reasons, a site selection committee was set up and, in its third meeting on August 16, 2001, it decided to adopt Qasia as the location for the new disposal site. Since it is thought that the final acquisition of site land will take more time, waste shall continue to be disposed at Al-Bassa for the immediate future, and sanitary landfilling shall be implemented at the new site in Qasia on 2010.

## **6. Technical Alternatives and Selection of Optimum Alternative**

### **6.1 TECHNICAL ALTERNATIVES FORMULATED**

Since bulldozers and other heavy machinery are required to carry out sanitary landfilling, costs work out to be too high in small disposal sites. Accordingly, one disposal site shall be constructed for Lattakia in 2010 at Qasia. In view of this, the following alternatives are proposed upon giving consideration to efficient transport and promotion of recycling.

- |                 |   |
|-----------------|---|
| Alternative I   | Sanitary landfill and direct transport  |
| Alternative II  | Sanitary landfill and transfer transport  |
| Alternative III | Separate collection, sanitary landfill, organic waste composting/<br>sorting center, and direct transport   |
| Alternative IV  | Separate collection, sanitary landfill, organic waste composting/<br>sorting center, and transfer transport |

Municipal Waste Amount (508 ton/day) / Target Collection Ratio: 95%

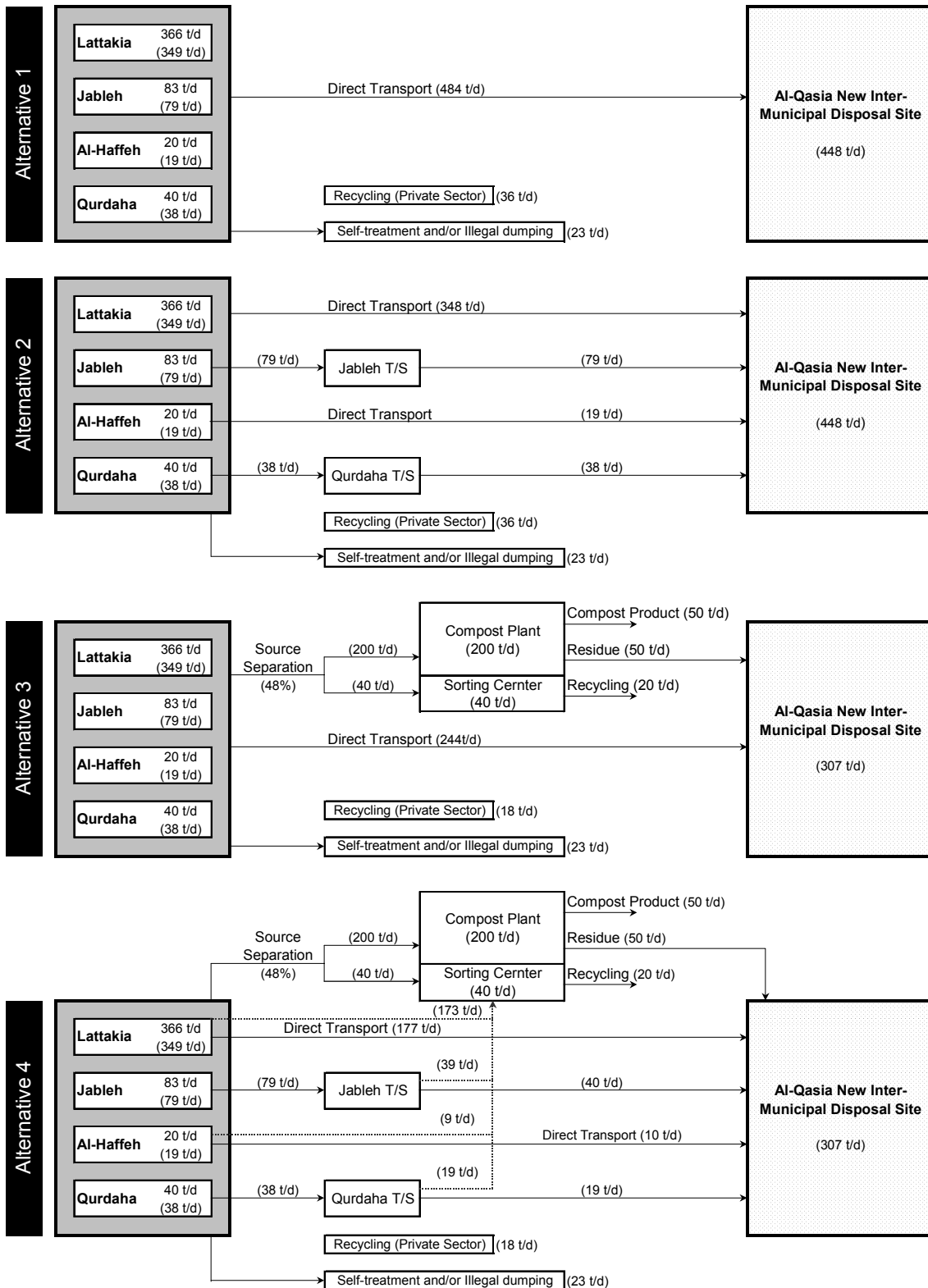


Figure 6.1.1 Waste Flow of Each Alternatives in 2010

## **6.2 COLLECTION AND TRANSPORT**

### **6.2.1 Policy of Collection Improvement**

- a. Many of the existing collection vehicles are deteriorated. Work is carried out over two shifts (daytime and nighttime) in order to deal with breakdowns. It is considered that deteriorated vehicles will be appropriately renewed in future, however, until then it will be necessary to continue the collection work under the present conditions. Accordingly, work over two shifts shall be continued. Moreover, equipment and personnel are assigned separately to each shift, and it is necessary to ensure that work areas do not overlap.
- b. Waste collection is currently mainly carried out by large compactor using container. However, since each city also contains narrow roads, medium and small size vehicles are also necessary. Therefore, medium size vehicles shall be used when using containers, and small size vehicles shall be used when carrying out manual loading. In Al-Haffeh, small size compactor trucks are appropriate because no container is used.
- c. Street sweeping in city centers is carried out mechanically. As for roads in outlying areas, manual street sweeping is carried out together with primary collection up to containers. Mechanical sweeping will continue to be implemented on main roads. Concerning manual street sweeping and primary collection, the basic policy shall be to resolve equipment shortages and secure higher efficiency with the cooperation of citizens.
- d. Since the new inter-municipal disposal site at Qasia is located just 18 km from Lattakia and 8 km from Al-Haffeh, it is not necessary to introduced transfer operations (transfer of waste from smaller trucks to larger trucks). However, transfer operation shall be considered in the cases of Jableh and Qurdaha since these cities are located 35-40 km from the new disposal site.
- e. Judging from the quality of waste in Lattakia, it is practical for recycling to be implemented based around the composting of organic waste and recovery of reusable materials. In order to produce good quality compost and recover reusable materials, it is necessary to introduce source separate collection. The following two alternatives are available for separation. Since waste in Lattakia and the three surrounding cities has a high organic waste (kitchen waste) content, separation of organic waste and inorganic waste shall be conducted with consideration given to the introduction of composting.
  - Organic waste and inorganic waste (when carrying out composting, recovery of reusable materials from inorganic waste is also possible).
  - Reusable materials and others (when only recovering reusable materials)

### **6.2.2 Necessary Collection Equipment in Each Alternative**

#### **(1) Waste collection equipment**

Waste collection equipment for each alternative is as indicated in Table 6.2.1.

**Table 6.2.1 Type of Waste Collection Vehicles in Each Alternative**

City/Alternatives	Alternative-1	Alternative-2	Alternative-3	Alternative-4
Lattakia	A	A	A	A
Jableh	B	A	B	A
Qurdaha	B	A	B	A
Al-Haffeh	C	C	C	C

- A: Medium and small size compactors and dump trucks  
 B: Large, medium and small size compactors and dump trucks  
 C: Small size compactors and dump trucks

## (2) Required quantities of waste collection equipment

The required quantities of equipment in each alternative based on transport distances and waste quantities are as indicated in Table 6.2.2.

**Table 6.2.2 Required Number of Collection Vehicles in Each Alternative**

City/ Alternatives	Alternative-1	Alternative-2	Alternative-3	Alternative-4
Lattakia	53	53	57	57
Jableh	15	13	17	13
Qurdaha	9	5	9	6
Al-Haffeh	5	5	5	5
Total	82	76	88	81

## 6.2.3 Transfer station

Alternative 2 and 4 will have transfer stations at Jableh and Qurdaha cities. The capacity will be 80 ton/day in Jableh and 40 ton/ day in Qurdaha and hauled container system will be suitable.

## 6.3 FINAL DISPOSAL

### (1) Outline

It will be necessary to implement sanitary landfilling at the new disposal site in Qasia in 2010. Until this site is ready, disposal at the present Al-Bassa disposal site will have to be continued. However, the final disposal method here will at least need to undergo improvement such as the implementation of earth covering, etc. Moreover, since waste at Al-Bassa is widely scattered, rehabilitation work is required.

### (2) Basic Policy of Rehabilitation and Operation Improvement at Al-Bassa Disposal Site

Disposal will need to be continued at Al-Bassa disposal site until construction of the new disposal site. Rehabilitation of Al-Bassa disposal site will need to take place at the same time as waste disposal, and methods for achieving this can be considered as follows.

- a. Take out all existing waste and dispose of at a separate site.
- b. Build a temporary disposal site in one corner of Al-Bassa disposal site and dispose the existing waste and new waste.

- c. Collect exiting waste into corner of Al-Bassa disposal site and cover it with earth, and continue to receive new waste with covering soil.

Even if the above methods are used to deal with waste already brought into the site, there will be no meaning to the rehabilitation if open dumping continues to be practiced unchanged. It will at least be necessary to carry out earth covering from now on. Since the city currently does not have any disposal site equipment, it will be necessary for prevention of environmental pollution to implement earth covering using rented machinery.

In consideration of the above, it is necessary to implement rehabilitation using the method that entails the lightest burden, and it is realistic to start from alternative c. indicated above. Concerning the approach to this, since partial rehabilitation and improvement of disposal methods were implemented in the Pilot Study, these activities shall be continued.

Since it is thought that acquisition of land for the new disposal site will take some time, disposal of waste from Lattakia will need to be continued at Al-Bassa for around five more years. In this case, it will be necessary to develop part of Al-Bassa as a temporary disposal site. Concerning the geological conditions at Al-Bassa, consideration shall be given to the prevention of underground percolation of leachate when using the site for temporary disposal.

### **(3) Rehabilitation of Al-Bassa Disposal Site**

Budgetary measures must be taken for implementation of rehabilitation, improvement of disposal site operation and development of the temporary disposal site. Assuming that budgetary measures are taken from now on, it will be roughly three years before the necessary heavy machinery is procured. Accordingly, rehabilitation shall be advanced based on the policy shown in Table 6.3.1.

**Table 6.3.1 Rehabilitation Plan of Al Bassa Disposal Site**

Item	Contents of Rehabilitation
Urgent measures (First three years)	Rehabilitation of Zone I and II Improvement of landfill works (with cover soil) (Implemented by the Municipality by renting landfill equipment)
Medium term measures (After procurement of landfill equipment)	Rehabilitation of Zone III Construction of medium term disposal site in Zone III Waste disposal in Zone III (For about 5 years)

In Zones I and II, as was implemented in the Pilot Study, by building an embankment around the already dumped waste and continuing disposal within, rehabilitation and earth covering shall be implemented. Moreover, in order to improve operation of the disposal site, it is necessary to implement earth covering and the following heavy machinery will be needed for this. For the immediate future, these equipment shall be rented and procured as soon as possible:

- Bulldozers
- Excavators

- Dump trucks

In Zone III, already dumped waste shall be collected into one place and covered with earth, while the remaining area shall be converted into a temporary disposal site, so that waste can continue to be disposed of here.

#### (4) Construction of Qasia New Disposal Site

The new disposal site at Qasia shall be developed as a sanitary landfill. At the same time, necessary intermediate treatment facilities and recycling facilities shall also be constructed. Moreover, by making effective use of the terrain, it should be possible to secure fairly large disposal capacity. In Lattakia Governorate, since it is very difficult to find disposal site land, the site at Qasia shall be developed in phases with the intention of securing use for as long as possible. The major facilities to be prepared are as follows.

**Table 6.3.2 Facilities Plan in Qasia New Disposal Site**

Time for construction	Facilities	Capacity
Phase 1 (about 10 Years)	Fence Waste retaining structure Landfill area: Phase 1 (liner, leachate collection facility, leachate treatment facility, rainwater collection facility, gas removal facility, operation road, etc.) Control building Recycling facility Access road Monitoring facility	Approx. 2 million m <sup>3</sup>
Phase 2 (next 10 Years)	Landfill area: Phase 2	Approx. 2 million m <sup>3</sup>
After Phase 2	After Phase 2	Approx. 6 million m <sup>3</sup>

## 6.4 INTERMEDIATE TREATMENT AND RECYCLE

### (1) Comparison of Intermediate Treatment Methods

Since a large proportion of organic waste characterizes solid waste in Lattakia, it is necessary for the method of intermediate treatment to be suitable to this kind of waste. The following three intermediate treatment alternatives can be considered.

- Incineration
- Composting
- Methanization

**Table 6.4.1 Evaluation of Intermediate Processing System**

Item	Incineration	Composting	Methanization
Reduction of waste disposal amount	+++++	+++	+++
Recovered material	Electricity, steam	Compost	Fuel gas, compost
Marketability of recovered materials	+++++	+++	+++
Necessity of waste separation	+++	++++	++++
Environmental impact	Air pollution	Odor	Odor
Ease of operation and maintenance	+++	+++++	+
Past experience	++++	++++	+
Investment cost	+	+++	+

Note: [+] shows magnitude of plus factors for its introduction



Since the old compost plant in Lattakia was only able to produce poor quality compost, it was not able to deal with latent demand. According to the findings of the compost demand survey, since there appears to be a high potential demand for good quality compost, composting is considered to be appropriate. Moreover, when introducing a new compost plant, in order to ensure that good quality compost is produced, it will be necessary to introduce separate collection and target waste that is suitable for collection.

## **(2) Scale of Composting Plant**

Source separation of domestic waste was carried out at 200 households in the Pilot Study, in which cooperation was obtained from medium and high-income groups. However, introduction of source separation will need to be carried out together with improvement of collection services and will need to be expanded in stages. Concerning low-income groups, current collection services are inadequate and introduction of source separation will not be so easy; therefore, it is realistic to expect that half of all domestic waste will be separated in 2010. Concerning market waste, collection via special routes will be necessary. Therefore the amount of waste suited to composting in 2010 will be as follows:

Source separated domestic waste	$406.4 \text{ tons} \times 0.5 \times 0.78^{*1} = 158.0 \text{ tons}$	*1: Organic waste ratio
Market waste (before separation)	48.2 tons	
<u>Restaurants, hotels (before separation)</u>	<u>5.0 tons</u>	
Total	211.2 tons	

Targeting the above types of waste, approximately 200 tons/day is appropriate as the scale of composting in 2010.

## **(3) Volume Reduction and Recycling of Waste**

In order to reduce the volume of waste, it is necessary to develop lifestyles that generate as little waste as possible and also to promote recycling. However, base units of domestic waste generation are not large in Syria. Moreover, it is hoped that introducing source separate collection will raise awareness of citizens and lead to the recycling and volume reduction of waste. Following discharge of waste, it is necessary to promote recycling, and composting is an effective means of achieving this. Moreover, since inorganic waste contains valuable materials such as paper, plastic, iron and glass, etc., it is necessary to promote recycling by establishing a sorting center and recovering valuable materials. The sorting center should target shop waste, which contains little organic waste, and also separated domestic waste. Targeted waste is generally as follows.

Separated domestic waste	$406.4 \times 0.5 \times 0.22^{*2} = 44.7 \text{ tons}$	*2: Ratio of inorganic waste
<u>Shop waste, etc.</u>	<u>31.9 tons</u>	
Total	76.6 tons	

Therefore, the maximum capacity of the sorting center will be around 70 tons. Since valuable materials are collected in an informal manner at the moment, a sorting center with around 40 tons capacity shall be constructed.

## 6.5 MEDICAL WASTE AND INDUSTRIAL WASTE TREATMENT

### (1) Medical Waste

In Lattakia Governorate, approximately 3.9 tons of medical waste is generated, and around 30% of this is infectious waste. Concerning infectious waste, careful handling and treatment are required. Currently in Lattakia Governorate, infectious medical waste is incinerated at national hospitals, however, in Jableh City, due to the shortage of collection equipment, medical waste is collected and disposed of at the city disposal site together with general waste. Accordingly, it is necessary to build a setup for carrying out the appropriate treatment of medical waste.

Treatment of medical waste is implemented both inside hospitals and outside hospitals. The features of both methods are as shown in Table 6.5.1. The method for treating infectious waste shall be selected from either incineration or sterilization by autoclave.

**Table 6.5.1 Medical Waste Treatment**

	In-hospital Treatment (Separate Treatment)	External Treatment (Integrated Treatment)
System outline	At each hospital, infectious waste is separated, or treatment facilities are installed and it is discharged after being treated. After treatment, it is collected and disposed together with general waste. Other medical waste is collected with general waste. Treatment facilities are installed at some large hospitals.	At each hospital, infectious waste is separately discharged. The waste is collected separately and carried to treatment facilities for treatment. Other medical waste is collected with general waste. This method is adopted in Damascus.
Merits	Infectious medical waste is treated inside hospitals.	Treatment facilities can be concentrated in a few places, enabling easy management
Demerits	Since facilities are needed in each hospital, the burden on small hospitals is large. Numerous facilities make management difficult.	Thorough separation inside hospitals is necessary. Independent collection is necessary.

In Lattakia Governorate, since incinerators are installed at three hospitals, these shall be utilized, while a system for collecting infectious waste from other hospitals shall be constructed.

Special care is required when collecting infectious waste and it is necessary to implement thorough separation inside hospitals. Also, countermeasures for preventing infection during collection and treatment are necessary. When collecting infectious waste, it is necessary to distribute special containers to each hospital and to carry out collection that is suited to these.

As for non-infectious medical waste, this shall be collected together with general waste as done so far.

## (2) Non-hazardous Industrial Waste

Since industrial waste also includes hazardous products, it is first necessary to separate the hazardous items. Since hazardous waste requires special treatment according to the waste composition, handling in each Governorate and city is difficult. Therefore, it is necessary for hazardous waste treatment facilities to be constructed on the national level.

Concerning non-hazardous industrial waste, it is desirable for large factories to treat their own waste. As for waste discharged by small and medium factories, this shall be collected and disposed of together with general waste. In either case, it is important to separate waste at the source to ensure that hazardous waste does not get mixed in.

## 6.6 COMPARISON AND SELECTION OF OPTIMUM ALTERNATIVES

### (1) Comparison of Alternatives

Table 6.6.1 shows comparison of the four technical alternatives that were introduced in Section 6.1. The costs of each alternative are shown in Table 6.6.2.

**Table 6.6.1 Evaluation of Each Alternative**

Item	Alternative-1	Alternative-2	Alternative-3	Alternative-4
Facilities provided	Disposal site Collection equipment	Disposal site Collection equipment Transfer stations	Disposal site Collection equipment Separate collection Compost plant & Sorting center	Disposal site Collection equipment Separate collection Transfer stations Compost plant & Sorting center
Institutions build-up	Inter-municipal disposal	Inter-municipal disposal Waste transfer	Inter-municipal disposal Compost plant & Sorting center	Inter-municipal disposal Waste transfer Compost plant & Sorting center
1. Environmental impact	+++	+++	++++	++++
2. Burden to disposal site	+++++	+++++	++	++
3. Collection efficiency	++	++++	++	++++
4. Waste minimization	+	+	++++	++++
5. Recycling	+	+	+++++	+++++
6. Citizens awareness	+	+	++++	++++
7. Contribution to agriculture	+	+	+++++	+++++
8. Cost	++	++	++++	++++

Note: O: better than other alternatives    -: average    x: worse than other alternatives

**Table 6.6.2 Cost of Each Alternative**

(Unit: Million SP)

Item	Alternative-1	Alternative-2	Alternative-3	Alternative-4
Investment cost (2001 - 2010)	586.3	638.8	1,388.9	1,441.5
O/M cost (2001 - 2010)*	1,113.5	1,107.5	1,156.7	1,143.6

Note: \* Depreciation is not included

## **(2) Selection of Optimum Alternatives**

Alternatives 1 and 2 are basic systems, while Alternatives 3 and 4 also include introduction of recycling. Therefore, Alternative 3 and 4 have advantages on reduction of solid waste, promotion of recycling of waste and enhancement of public awareness.

Investment cost is smaller in Alternatives 1 and 2 than in 3 and 4, and Alternative 1 has the lowest. However, operation and maintenance costs excluding depreciation of four alternatives are almost same although Alternative 2 is lowest.

Alternatives 3 and 4 include introduction of source separate collection and recycling facilities for the promotion of recycling. As a result, investment costs are higher than in Alternatives 1 and 2. However, operation and maintenance costs are almost same as Alternative 1 and 2. In future, since society will demand the volume reduction and recycling of waste, the utmost effort should be made to select Alternatives 3 or 4.

Alternative 4 entails introduction of transfer stations. As is indicated in Table 6.6.2, investment cost of Alternative 4 is higher than Alternative 3 that have no transfer station but operation and maintenance cost is lower. Also, it should be considered that these facilities relieve the burden placed on cities located far from disposal sites and they can be utilized by surrounding municipalities. Therefore, Alternative 4 will be desirable than Alternative 3.

Moreover, cost in Alternatives 4 is less than 1% of the gross regional domestic product in Lattakia and the three surrounding cities and is a permissible level for the society. Therefore, it is desirable that Alternatives 4 will be selected.

Incidentally, Alternative 4 entails the introduction of separate collection, recycling facilities and transfer stations to the solid waste management by 2010. Careful investigation of facilities will be required in future, however, Alternative 4 is desirable as the master plan for waste management.

## 7. SWM Master Plan

### 7.1 WASTE FLOW

In 2010, solid waste collection rate shall be increased to 95% to improve collection service at suburban area and 500 ton/day of waste will be collected. To promote solid waste reduction and recycling, separate collection will be introduced in the middle and high income area and mixed collection will be continued in remaining area. Also, solid waste will be transported to Qasia new disposal site directly from Lattakia and Al Haffeh cities while transported through transfer stations from Jableh and Qurdaha cities.

Separated organic waste is treated to produce compost and inorganic waste is processed to recover reusable materials at the recycle centers to be constructed at Al Bassa (old compost plant site) and Qasia new disposal site. Solid waste will be disposed at Qasia new disposal site constructed 2008 and at Al Bassa existing disposal site until that time. Infections medical waste will be collected independently and incinerated. The waste management flow in 2010 is as indicated in Figure 7.1.1. Also, locations of the waste management facilities proposed in the Master Plan are shown in Figure 7.1.2.

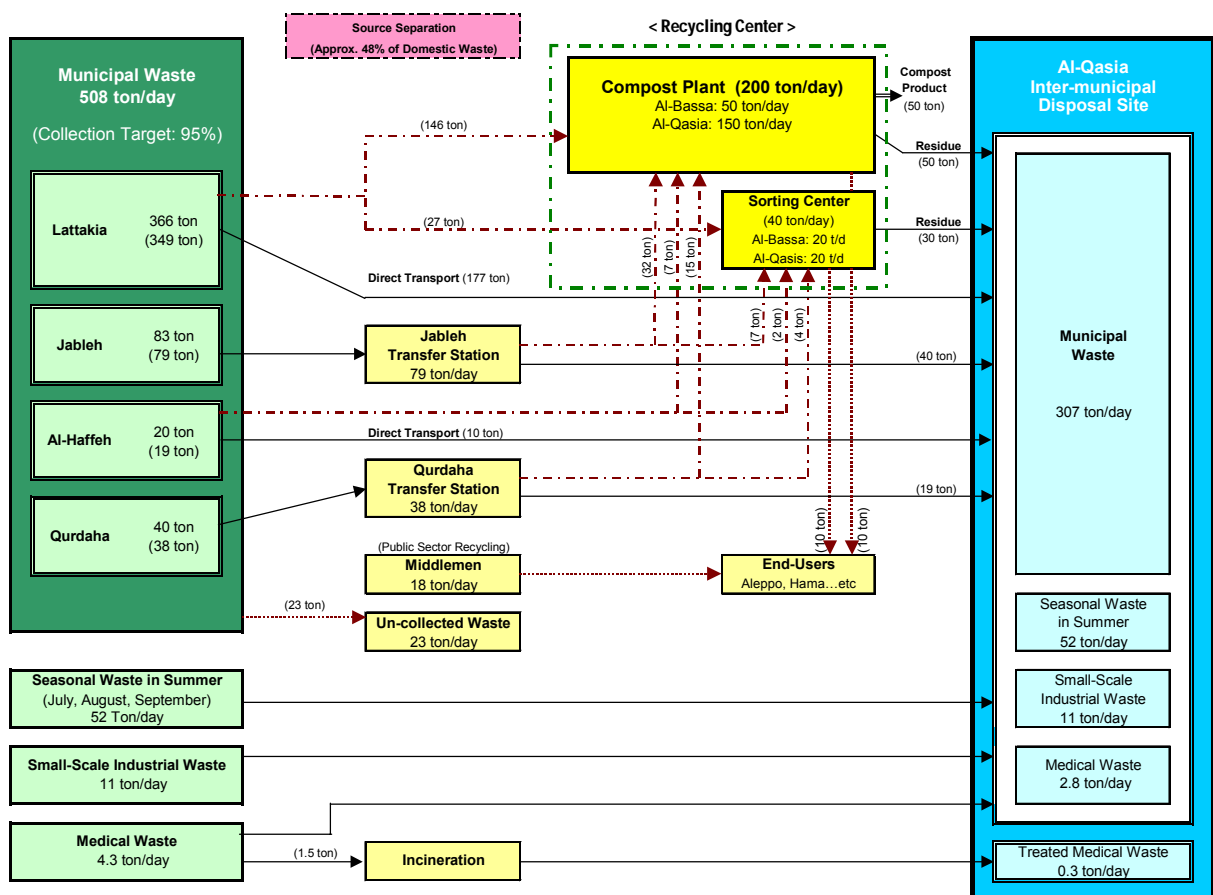


Figure 7.1.1 Solid Waste Flow in the Year 2010

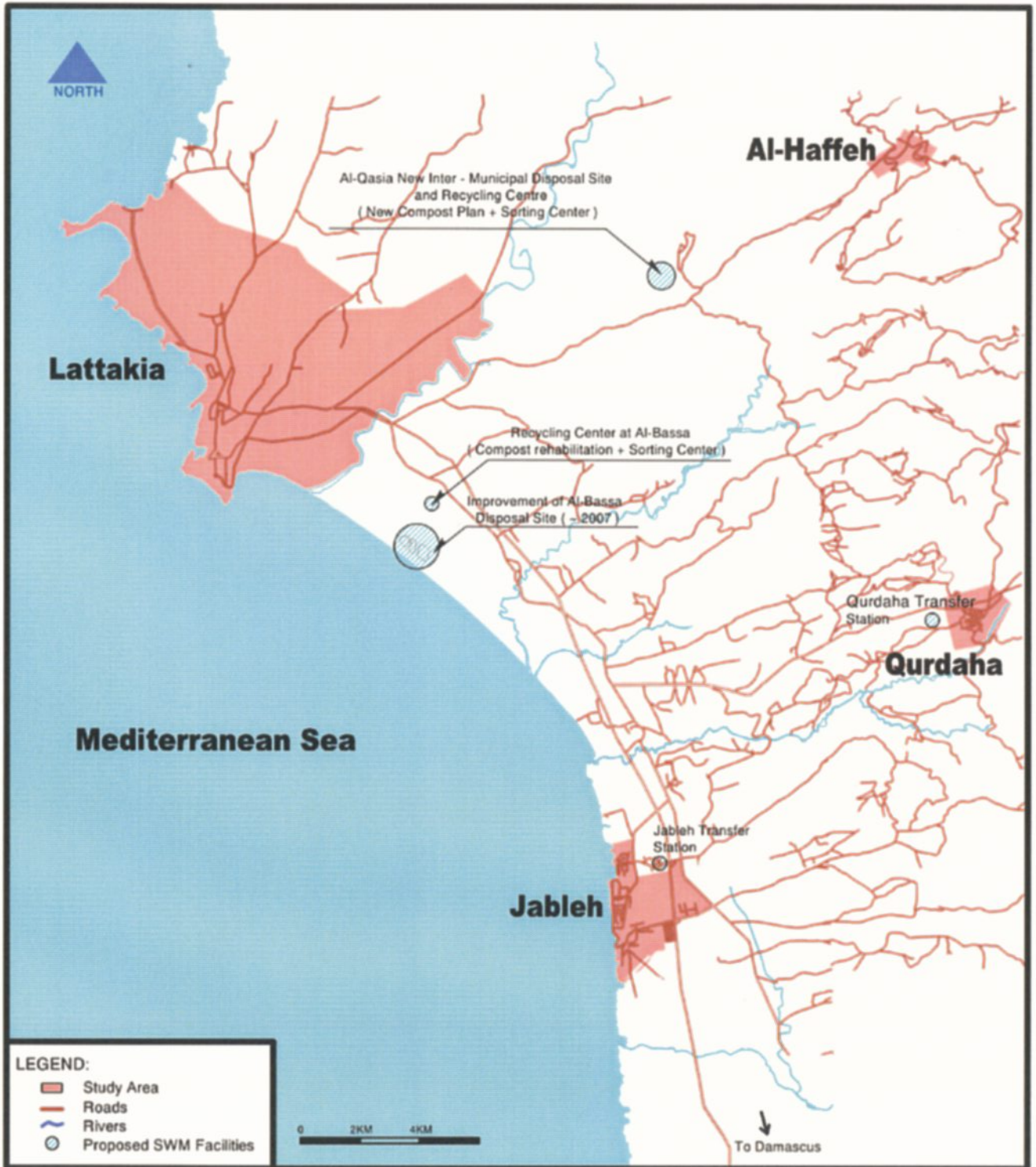


Figure 7.1.2 Location of Proposed SWM Facilities for the M/P in 2010

## 7.2 COLLECTION, STREET SWEEPING AND TRANSPORT

### (1) Outline

To improve waste collection and transportation, the preparation of a well-organized system for the procurement and renewal of the required collection vehicles will be necessary. Then expansion of the collection service to the surrounding areas is especially an urgent matter for the cities of Lattakia and Jableh.

On the other hand, the current trend is to construct a society that generates the least environmental pollution as possible. The introduction of source separation as well as the promotion of recycling waste are necessary. In consideration of these facts, by the year of 2010 the source separation of the waste should be introduced high and middle-income residential districts.

Additionally, by the year of 2010, waste disposal at a new final disposal site, Qasia, shall be started. The distance from Qurdaha and Jableh to the said disposal site is estimated to be about 35 to 40 km and for the improvement of transportation efficiency, transfer stations shall be constructed in line with the opening of Qasia new final disposal site.

### (2) Collection Target and Planning Condition

- a. The target waste collection rate shall be 85 % in 2006 and 95 % in 2010, and domestic waste, commercial waste (including market waste), park and street waste, non-infectious medical waste and small-scale factory waste shall be collected.
- b. By the year of 2010, the source separate collection in high and middle-income residential regions shall be adopted. Under this program, the separation shall be done for organic and inorganic waste. Market waste shall be collected as organic waste. In the rest of cities, mixed collection shall be continued as it is currently being done.
- c. The forecast for waste collection amount, as shown in Table 7.2.1 will be 390 ton/day by 2006 and 499 ton/day by 2010.

**Table 7.2.1 Waste Collection Amount in 2006 and 2010**

(Unit: ton/day)

Item	2006		2010	
	Generation amount	Collection amount	Generation amount	Collection amount
Domestic waste	351.2	298.5	406.4	386.1
Separated organic waste	-	71.2	-	152.1
Separated in-organic waste	-	20.1	-	42.9
Mixed waste	-	207.2	-	191.9
Commercial waste	81.8	69.6	85.1	83.3
Market waste (organic waste)	-	25.0	-	48.2
Others (mixed collection)	-	44.6	-	35.1
Road & park waste	16.1	15.3	16.7	15.9
Medical waste (non-infectious)	2.8	2.8	2.8	2.8
Industrial waste (small scale)	10.4	9.3	10.8	10.8
Total	462.3	395.5	521.8	499.0

Note: All figures showing the total waste in Lattakia and surrounding three cities

The forecast collection amount for each city is shown in Table 7.2.2.

**Table 7.2.2 Waste Collection Amount by City**

(Unit: ton/day)

Year	Item	Lattakia	Jableh	Qurdaha	Al Haffeh	Total
2006	Mixed collection waste	201.3	45.3	21.3	11.2	279.1
	Separated organic waste	74.4	12.2	6.5	3.1	96.2
	Separated in-organic waste	14.0	3.4	1.8	0.9	20.1
	Total	289.7	60.9	29.6	15.2	395.4
2010	Mixed collection waste	183.3	42.0	19.9	10.6	255.8
	Separated organic waste	145.7	32.0	15.1	7.5	200.3
	Separated in-organic waste	29.8	7.3	3.9	1.9	42.9
	Total	358.8	81.3	38.9	20.0	499.0

### (3) Collection System

#### a. Separate collection

By the year 2010, the separate collection should be introduced at high and middle income residential area. This introduction shall be required in Lattakia and the three surrounding cities because:

- In case the source separation practice is introduced only in Lattakia, an unfair feeling among the people of the urban area will result because of the increased service fee burden, and on the other hand, the complaints from other cities concerning non-introduction of the same separation practice will occur. Maintaining fairness among the people of the cities becomes very important.
- The source separation practice is easily introduced in small cities and moreover, introduction in small cities will become a model case for large cities.

As for the collection of organic waste, the current system of using containers and daily collection shall be continued at Lattakia, Jableh and Qurdaha. At Al-Haffeh, collection shall be done using plastic bags. As for inorganic waste collection, plastic bag collection shall be done twice per week because small waste amounts are generated and there are no storage problems at the household level.

#### b. Mixed collection

Mixed waste collection will be continued in remaining area. As for mixed collection the current container collection shall be continued and daily collection shall be implemented, except at Al-Haffeh where plastic bag collection shall be continued. In addition, large compactor trucks are currently used for container collection. However, in consideration of the existing conditions in the collection area, medium size compactor trucks may be more suitable.



#### (4) Street Sweeping

At Lattakia, Jableh and Qurdaha, street sweeping is mainly being carried out with mechanical equipment, and in future the same sweeping practice shall also be continued. For other streets, manual sweeping in combination with waste collection shall be carried out as it is currently being done. Furthermore, at the smallest city of Al-Haffeh, all street sweeping shall be performed manually. The total length of streets to be swept is shown in Table 7.2.3.

**Table 7.2.3 Length of Street Sweeping**

(Unit: km)

Item	Lattakia	Jableh	Qurdaha	Al Haffeh
Main street	76.7	54.0	NA	NA
Other street	229.1	52.0	NA	NA
Total	305.8	106.0	14.8	NA

#### (5) Renewal of Equipment

The equipment introduced into service before 1990 shall be renewed promptly after being used over 10 years. The equipment procured before 1995 shall also be renewed by the year of 2010. The necessary collection vehicles are shown in Table 7.2.4.

**Table 7.2.4 Required Equipment for Collection and Street Sweeping in 2010**

(Unit: nos)

Equipment	Lattakia			Jableh			Qurdaha			Al Haffeh			Total		
	Ex	New	Total	Ex	New	Total	Ex	New	Total	Ex	New	Total	Ex	New	Total
2010 Collection															
Compactor (9ton)	-	-	-	1	-	1	3	-	3	-	-	-	4	-	4
Compactor (8m <sup>3</sup> )	-	41	41	-	7	7	-	-	-	-	-	-	-	28	28
Compactor (4m <sup>3</sup> )	-	12	12	-	3	3	-	1	1	-	3	3	-	19	19
Dump truck (6m <sup>3</sup> )	-	2	2	-	2	2	-	1	1	-	1	1	-	6	6
Tractor	2	-	2	-	-	-	1	-	1	1	-	1	4	-	4
Wheel loader	-	1	-	-	1	1	-	-	-	-	-	-	-	2	2
Wash container	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1
Sub total	2	57	59	1	13	14	4	2	6	1	4	5	8	76	84
2010 Sweeping															
Mechanical sweeper	3	-	3	1	-	1	1	-	1	-	-	-	5	-	5
Water tank	-	-	2	-	-	-	1	-	1	-	-	-	1	2	3
Sub total	3	2	5	1	-	1	2	-	2	-	-	-	6	2	8

Note: ( ) Existing Vehicle

#### (6) Operation Plan

Waste collection and street sweeping work shall be implemented as shown in Table 7.2.5.

**Table 7.2.5 Waste Collection and Street Sweeping Work**

Item	Contents
1.	Collection system In Lattakia, two (2) shifts operation, day and night, and necessary vehicles and personnel for each shift shall be arranged (8 operation hours). In other cities, one (1) shift operation, daytime, and operation hour shall be 8 hours. Further, in summer time the operation hours shall be extended to cope with increased waste amount.
2.	Organization of waste collection crew One operator for a collection vehicle with 2 workers. One supervisor for every 5 vehicles. One supervisor, one operator and one worker for a wheel loader.
3.	Organization of street sweeping crew One operator with one sweeper. For manual sweeping, one handcart for each worker. One team consists of one manager and ten workers.
4.	Method of discharge Daily discharging of mixed collection and separated organic waste to containers. In Al-Haffeh, discharging of waste by use of plastic bags to collection points. Discharging of separated inorganic waste in plastic bags to collection points twice a week.
5.	Maintenance of equipment Daily maintenance shall be carried out by operator and periodical inspection and repairing shall be contracted out to a specialized private company.

The numbers of personnel required for waste collection and street sweeping are as shown in Table 7.2.6. At present, a total of 818 personnel are engaged in waste collection and street sweeping in the four (4) cities. Except for Lattakia City, the numbers of personnel in the other three (3) cities must be increased. However, in Lattakia it is necessary to decrease the number of people doing manual sweeping in accordance with the upgrading of the equipment and improvement of residents' cooperation in waste issues. It is also necessary to switch over those surplus people to the waste treatment and disposal divisions, for the purpose of cost reduction in waste disposal.

**Table 7.2.6 Number of Personnel for Waste Collection and Street Sweeping in 2010**

(Unit: Person)

Year	Person	Lattakia	Jableh	Qurdaha	Al Haffeh	Total
2010	Collection					
	Supervisor	14	4	2	2	22
	Driver	64	16	6	6	92
	Worker	128	30	11	11	180
	Sub total	206	50	19	19	294
	Sweeping					
	Supervisor	27	5	2	1	35
	Driver	6	2	3		11
	Worker	6	2	3		11
	Manual sweeper	250	31	9	6	296
	Sub total	289	40	17	7	353
	Total	495	90	36	26	647

**(7) Transfer Station**

**a. Waste Transportation Volume**

In line with the construction of a new landfill disposal site at Qasia, all of the waste generated in Jableh and Qurdaha shall be transported through transfer stations to the

final disposal site. Under the system of the transfer stations, waste shall be separated into the mixed and separated organic waste and the separated inorganic waste. The waste volume of both cities, Jableh and Qurdaha in the year of 2010 is estimated as 120 ton/day as shown in Table 7.2.7.

**Table 7.2.7 Waste Volume to be Transported in 2010**

Item	Jableh	Qurdaha	Total
Mixed waste	41.8	20.0	61.8
Separated organic waste	32.1	15.1	47.2
Separated in-organic waste	8.6	4.6	13.2
Total	81.2	39.0	120.2

(Unit: ton/day)

**b. Transfer System**

In consideration of the small amount of waste, 120 ton/day in total, and also of necessity of waste separated transportation, the roll-on type container truck shall be adopted. The capacity of containers is 20 m<sup>3</sup>, a large type container for this type, and the collected waste is directly dumped onto the container from the collection vehicle.

**c. Transfer Equipment and Personnel**

At each transfer station, one manager shall be stationed; and for each container truck, one driver and worker are needed. Working hours shall be eight (8) per day and the work shifts shall match the regulations of each city. Transfer equipment and personnel are shown in Table 7.2.8.

**Table 7.2.8 List of Transportation Equipment and Required Personnel**

Item	Unit	Jableh	Qurdaha	Total
<b>Equipment</b>				
Container truck	Nos.	4	2	6
Container	Nos.	7	5	12
Container booth	Nos.	4	4	8
<b>Personnel</b>				
Manager	Person	1	1	2
Driver	Person	4	2	6
Worker	Person	4	2	6
Total		9	5	14

**7.3 FINAL DISPOSAL**

**7.3.1 Basic Policy of Final Disposal**

Inter-municipal final disposal of waste targeting Lattakia, Jableh, Al-Haffeh and Qurdaha shall be introduced. Until 2007, this shall be carried out at Al-Bassa final disposal site, and from 2008 onwards this shall be implemented at the new disposal site in Qasia.

The existing disposal site at Al-Bassa causes environmental pollution because waste here is scattered over a wide area. In the master plan, Al-Bassa disposal site shall be treated as an intermediate disposal site and accumulated waste shall be rearranged and organized in the same way as adopted in the Pilot Study. Next, in order to carry out final disposal of waste until the new disposal site at Qasia is commissioned, facilities for implementing sanitary landfilling shall be prepared. At Qasia disposal site, facilities shall be constructed and sanitary landfilling introduced in view of this experience.

Concerning operation and maintenance, Lattakia City shall continue to be responsible for Al-Bassa disposal site, while a newly established inter-municipal waste management department setup within Lattakia Governorate shall be responsible for Qasia disposal site.

The amount of waste treated in 2010 is 373 tons/day, and the quantity of waste that will be treated between 2001 and 2010 will be approximately 1,250,000 tons. The disposal sites will accept the following kinds of waste:

- Mixed collection waste (domestic waste)
- Commercial waste
- Street sweeping waste
- Summer tourist waste (July, August, September)
- Recycling center residue
- Waste from small and medium factories
- Non-infectious medical waste
- Residue from treatment of infectious medical waste

### **7.3.2 Rehabilitation Plan of Al-Bassa Disposal Site**

Concerning Zones I and II, by employing the same methods as adopted in the Pilot Study, existing waste shall be used to build a perimeter embankment, and landfilling with earth covering shall be carried out within until 2003.

In Zone III, already dumped waste shall be collected into one place and covered with earth, while the remaining land shall be used as a controlled disposal site for implementation of landfilling and earth covering until 2007.

The rehabilitation plan for Al-Bassa disposal site is illustrated in Figure 7.3.1.

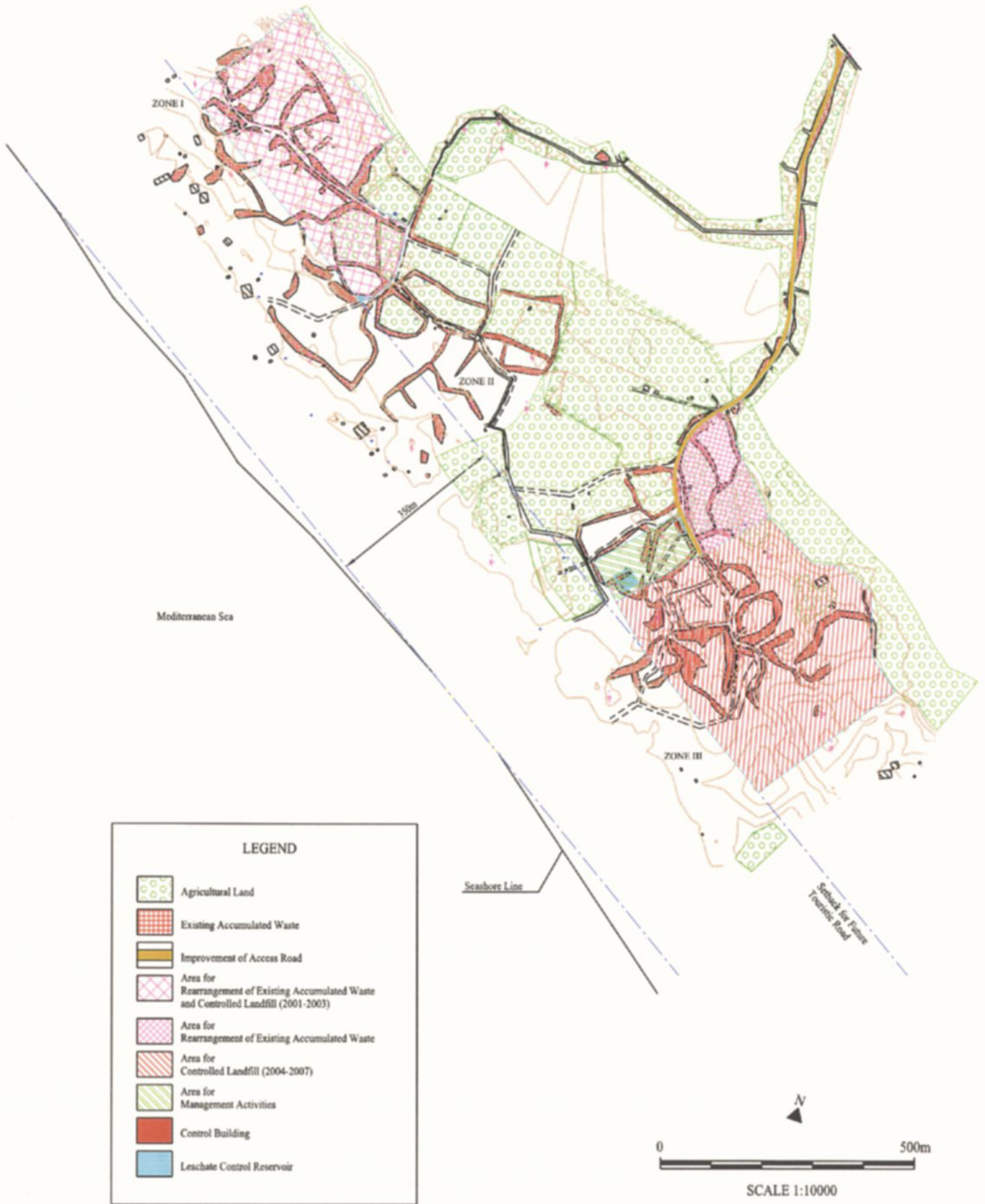


Figure 7.3.1 Overall Rehabilitation Plan of Al-Bassa Disposal Site

The major facilities and equipment required for rehabilitation of Al-Bassa disposal site are as indicated in the section 5.2 of Part II. The number of personnel required for site operation and maintenance will be 15.

### **7.3.3 Plan for Qasia Disposal Site**

Since it is extremely difficult to secure land for final disposal sites in Lattakia Governorate, it is important that Qasia disposal site be used over the long term. Since Qasia disposal site covers an area of approximately 62 ha and is situated in a valley portion of hilly ground, it is possible to secure large capacity (approximately 10 million m<sup>3</sup>) here.

In the master plan, it is set to commence operations at Qasia disposal site from 2008 and to implement development over the subsequent 10 years as Phase I works (2008-2017). Phase I targets land on the upstream side of the disposal site having approximately 2,000,000 m<sup>3</sup> capacity. Incidentally, the volume of waste disposed between 2008 and 2010 will be approximately 470,000 m<sup>3</sup>. The plan of Qasia disposal site is shown in Figure 7.3.2.

At Qasia disposal site, sanitary landfilling shall be introduced and the major facilities and equipment required are as shown in Table 7.3.1. Moreover, 19 personnel will be required for operation and management of the site.

**Table 7.3.1 Major Facilities and Equipment in Qasia Disposal Site**

Item	Facility/Equipment
Facility	Embankment, enclosed fence, groundwater collection facility, rainwater collection facility, flood control reservoir, liner, leachate collection facility, leachate control reservoir, gas removal facility, gate & guard house, control building, truck scale, car washing facility, access road, operation road, groundwater monitoring well
Equipment	Bulldozer: 1 unit, Excavator: 1 unit, Dump truck: 1 unit

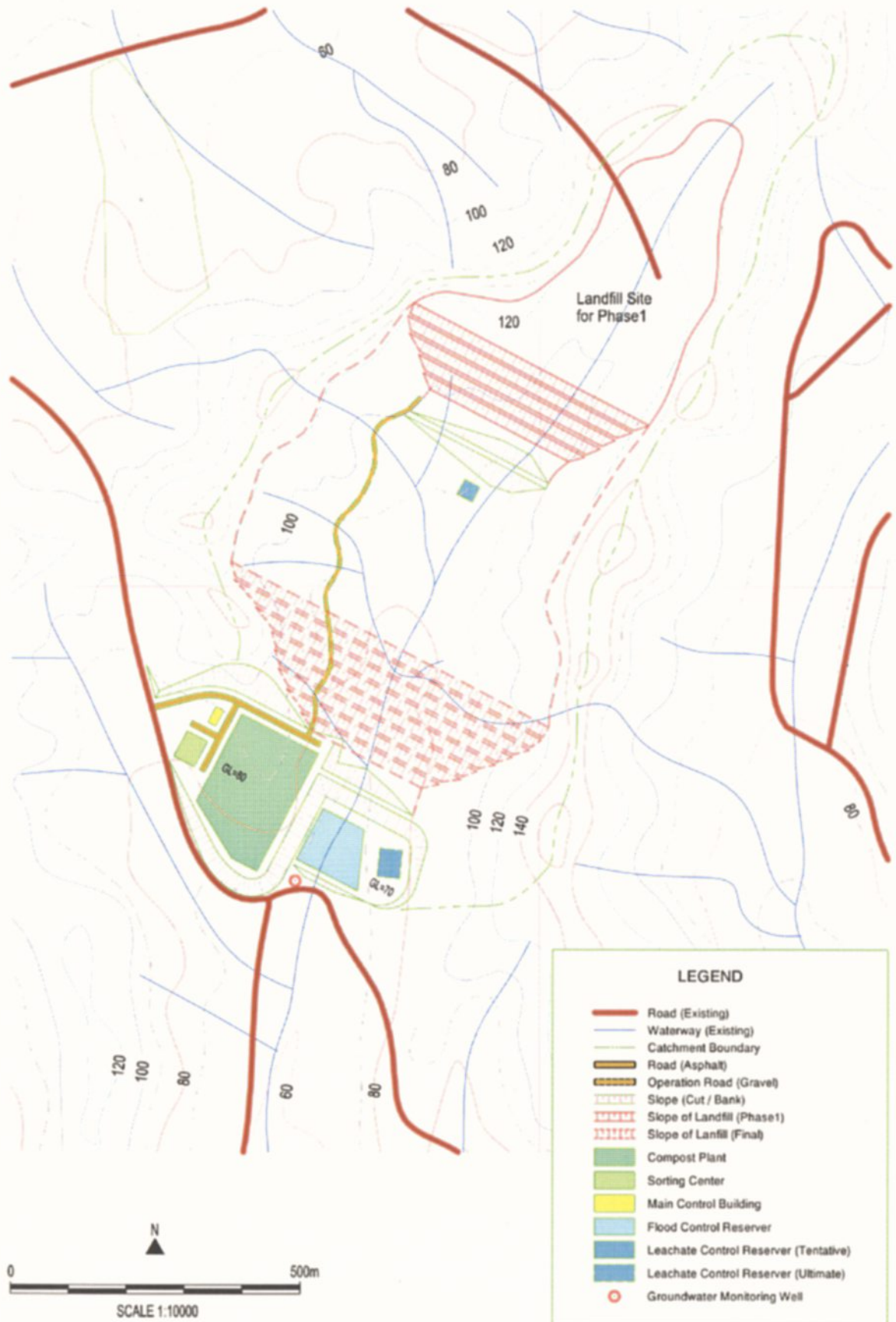


Figure 7.3.2 Layout Plan of Qasia Inter-municipal Disposal Site

## 7.4 INTERMEDIATE TREATMENT AND RECYCLING

### 7.4.1 Composting

Two recycle centers consisting compost plant and sorting center shall be constructed at the site of old compost plant in AL Bassa and Qasia New Disposal site to reduce solid waste amount to be disposed and to promote recycling.

#### (1) Basic Policy on Composting

From the viewpoints of reducing the volume of waste and introducing recycling, composting of 200 tons/day of organic waste (market waste and separated organic domestic waste) shall be carried out.

Two potential sites for composting facilities are the old compost plant site (Al-Bassa) and the new disposal site at Qasia, however, it is forecast that a few years will be required before land at Qasia is acquired. Accordingly, in the master plan, composting facilities shall be developed over the following two phases:

- Phase 1 development: rehabilitation of the old compost plant (Al-Bassa)
- Phase 2 development: construction of new compost plant (inside Qasia disposal site)

Moreover, concerning rehabilitation of the old compost plant to be conducted in the Phase I development, since questions remain concerning the demand for compost, the site shall be developed as a Pilot Plant with emphasis placed on the production of good quality compost. Therefore, the plant shall be operated over one shift with capacity of 25 tons/day, and capacity shall be raised to 50 tons/day after it has been confirmed that compost quality that is capable of satisfying the demand has been secured.

#### (2) Design Conditions

The design conditions for composting facilities are as shown in Table 7.4.1.

**Table 7.4.1 Planning Condition of Compost Plant**

Item	1 <sup>st</sup> stage implementation (Rehabilitation of existing compost plant)	2 <sup>nd</sup> stage implementation (Construction of new compost plant)
Location	Al-Bassa	Qasia
Operation year	2005	2010
Capacity	25 ton/day (50ton/day) <sup>*</sup>	150 ton/day
Receiving waste	Market waste: 25ton, Separated domestic waste (organic): 25ton	Market waste: 48 ton, Separated domestic waste (organic): 102 ton
Material balance	Compost product : 25% Recyclables : 5% Residue : 25%	Compost product : 25% Recyclables : 5% Residue : 25%
Operation hour	1sift (2sifts)	2 sifts

Note <sup>\*</sup> 1 sift operation: receiving waste is market waste (25ton)

2 sift operation: receiving waste is market waste (25ton) + separated domestic waste (25ton) = total 50ton

Based on data obtained in the separate collection experiment (Pilot Study), the design quality of waste accepted by the composting facilities is indicated in Table 7.4.2.



**Table 7.4.2 Waste Quality for the Plan**

(Unit: % wet base)

Waste type	Food, vegetable	Paper	Plastic	Metal	Glass	Others	Total
Market	83.3	3.6	7.1	0.6	0.5	4.9	100
Domestic	83.6	5.8	5.4	1.0	0.8	3.8	100
Design	83.5	5.3	5.8	0.9	0.7	4.1	100

Note: Design waste quality is calculated as a weighted average between market and domestic waste.

### (3) Treatment Flow

The treatment flow of composting facilities is composed of the following six stages.

- Waste receiving
- Removal of unsuitable items and recovery of valuable materials by hand sorting
- Crushing by classifier
- Primary fermentation (turning by wheel loader)
- Secondary fermentation (turning by wheel loader)
- Screening

### (4) Facilities Development Plan and Personnel

The main facilities and equipment required for developing the project composting facilities are as indicated in Table 7.4.3. The necessary operation and maintenance personnel on both shifts are 92 in total.

**Table 7.4.3 Major Facilities and Equipment for the Compost Plant**

Item	Facility and Equipment		1 <sup>st</sup> stage implementation (Rehabilitation of existing Plant)	2 <sup>nd</sup> stage implementation (Construction of new plant)
Facility	Reception	Truck scale	50 ton	50 ton
		Receiving yard	270m <sup>2</sup> (Repair existing bldg.)	750 m <sup>2</sup>
	Pre-treatment	Hand sorting conveyor	5.0 t/h, 0.75 m width	12.5 t/h, 1.3 m width
		Pulverizer	5.0 t/h, 110 kw	12.5 t/h, 240 kw
	Primary fermentation	Primary fermentation yard	1,280 m <sup>2</sup> (Repair existing bldg.)	8,000 m <sup>2</sup> (with roof)
		Turning method	Wheel loader	Turning machine
	Secondary fermentation	Secondary fermentation yard	1,040 m <sup>2</sup> (Repair existing bldg.)	8,000 m <sup>2</sup> (without roof)
		Turning method	Wheel loader	Turning machine
	Refining	Screen	1.3 t/h, trommel type	3.5 t/h, trommel type
	Building		Repair existing bldg.	Control bldg., parking lot, guard house
Equipment	Wheel loader		1.2 m <sup>3</sup> : 3 nos, 3.1 m <sup>3</sup> : 1 nos	1.2 m <sup>3</sup> : 3 nos, 3.1 m <sup>3</sup> : 1 nos
	Turning machine		--	630 m <sup>3</sup> /h: 1 nos
	Dump truck		8 ton: 1 nos	8 ton: 1 nos

## 7.4.2 Recycling

### (1) Recycling Target

The target for recycling shall be to recover 8% (approximately 49 tons/day) of generated waste (domestic waste and commercial waste). Recyclable materials shall consist of paper, fibers, plastics, metals and glass.

### (2) Recycling Plan

#### 1) Introduction of Source Separation

The target for source separate collection in 2010 shall be 48% (approximately 195 tons/day) of generated domestic waste. When introducing source separate collection, since it is essential to enhance the cooperation, independent action and awareness of citizens, based on the public awareness enhancement campaign conducted during the Pilot Study, similar campaigns shall be implemented in future while introducing source separate collection.

#### 2) Sorting Centers

The sorting centers shall be provided in order to receive inorganic domestic waste and recover valuable materials from this. The sorting centers shall be constructed in stages at Al-Bassa and Qasia, in tandem with the two-stage development of composting facilities. Design conditions and contents of the sorting centers are shown in Table 7.4.4. Moreover, the system flow and layout plan of the sorting centers are indicated in Figure 7.4.1. Moreover, the number of operation and maintenance personnel required at each sorting center will be 19.

**Table 7.4.4 Planning Conditions of Sorting Center**

Item	1 <sup>st</sup> stage implementation	2 <sup>nd</sup> stage implementation
Location	Al-Bassa	Qasia
Operation year	2005	2010
Capacity	20 ton/day	20 ton/day
Receiving waste	Separated domestic waste (in-organic)	Separated domestic waste (in-organic)
Material balance	Sorted recyclables : 25% (5 ton/day) Residue: 75% (15 ton/day)	Sorted recyclables: 25% (5 ton/day) Residue: 75% (15 ton/day)
System	Manual sorting	Manual sorting
Sorted recyclables	Paper, textile, plastic, metal, glass	
Facilities	Receiving pit/ hopper, feeding conveyor, hand-sorting conveyor, control office, container, etc.	
Equipment	Wheel loader : 1 nos.	Wheel loader : 1 nos.

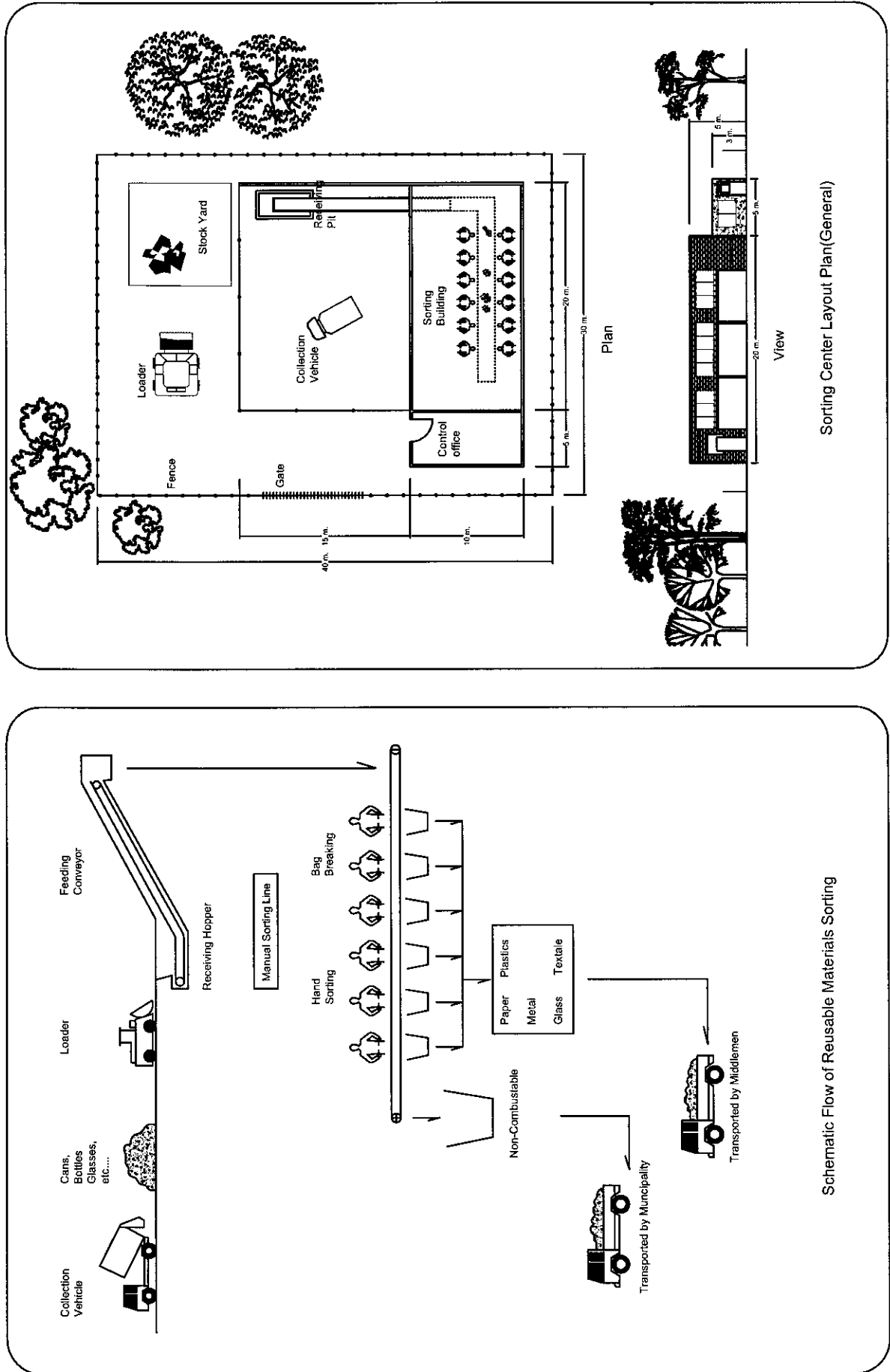


Figure 7.4.1 System Flow and General Plan of Sorting Center

## **7.5 MEDICAL WASTE TREATMENT**

3.9 tons of medical waste is discharged every day, and it is estimated that infectious medical waste accounts for roughly 30% or 1.2 tons of this. The appropriate treatment of infectious medical waste is extremely important and it must be separated from non-infectious waste at the source (hospitals) and be collected separately. Moreover, the collected infectious medical waste needs to undergo appropriate treatment.

As for non-infectious medical waste, this shall continue to be collected together with other urban waste. Therefore, in order to prevent mixing in by infectious medical waste, the importance of separation by medical institutions at the source is great.

In Lattakia Governorate, infectious medical waste is burned in incinerators installed at national hospitals, and these facilities shall also be used in 2010. However, since source separation and collection setups at hospitals are not properly in place, their establishment is urgently required. For this reason three special collection vehicles shall be procured and a management setup shall be established.

## **7.6 INDUSTRIAL WASTE TREATMENT**

Industrial waste generated by large-scale factories shall be treated and disposed of by producers. As for industrial waste from small and medium factories, non-hazardous waste shall continue to be collected together with general urban waste.

However, all factories must take responsibility for separating hazardous waste and only discharging non-hazardous waste. Since hazardous waste needs to undergo special treatment according to its properties and it is difficult to do this on the municipal or Governorate levels, management by the national government is required. It is necessary to construct facilities for receiving and disposing of hazardous waste on the national level.

## **7.7 ORGANIZATION**

### **(1) Establish of New Institution on the Governorate Level**

Up to the year 2010, new inter-municipal disposal site (sanitary landfill) and recycling center (compost plant and sorting center) will be introduced in Qasia and the waste generated in Lattakia, Jableh, Al-Haffeh, and Qurdaha will be treated and/or disposed of here. Accordingly, it will be necessary to construct an inter-municipal treatment institutional system to deal with this situation. Moreover, concerning the transfer stations that are required in the cases of Jableh and Qurdaha, it is desirable that management and operation of these be carried out at the inter-municipal level. Meanwhile, it is recommended that infectious waste contained in medical waste be collected and treated at the Governorate level.

Based on the above understandings, a new institution on the Governorate level shall be established. The responsibilities of the new institution shall be as described below.

- Inter-municipal transport, treatment and disposal of the waste
- Inter-municipal transport, treatment and disposal of infectious waste

Financially, this new institution shall be managed by subsidies from the Governorate and each city and also fees from users (such as medical entities, etc.). First, the new institution shall be established as a provisional organization under the jurisdiction of Lattakia City up until the start of operation at the inter-municipal disposal site in Qasia in the year 2008. Then, the management body of the new institution shall be transferred to Lattakia Governorate. Organization chart of the new institution is shown in Figure 7.7.1.

**(2) Organization in Each City**

Waste collection and street sweeping will continue to be implemented by the existing organizations in each city. Concerning financing of street sweeping, this shall be covered by subsidies from general revenue and waste fee collection. Meanwhile, each municipality shall be responsible for financing transport, treatment and disposal carried out at the inter-municipal level.

**Table 7.7.1 Required Personnel on SWM in 2010**

Item	Lattakia	Jableh	Qurdaha	Al Haffeh	Total
Manager	1	1	1	1	4
Administration	3	1	1	1	6
Collection	206	50	19	19	294
Road sweeping	289	40	17	7	353
Others	59	1	1	1	62
Total	558	93	39	29	719
Present personnel	723	77	32	18	850

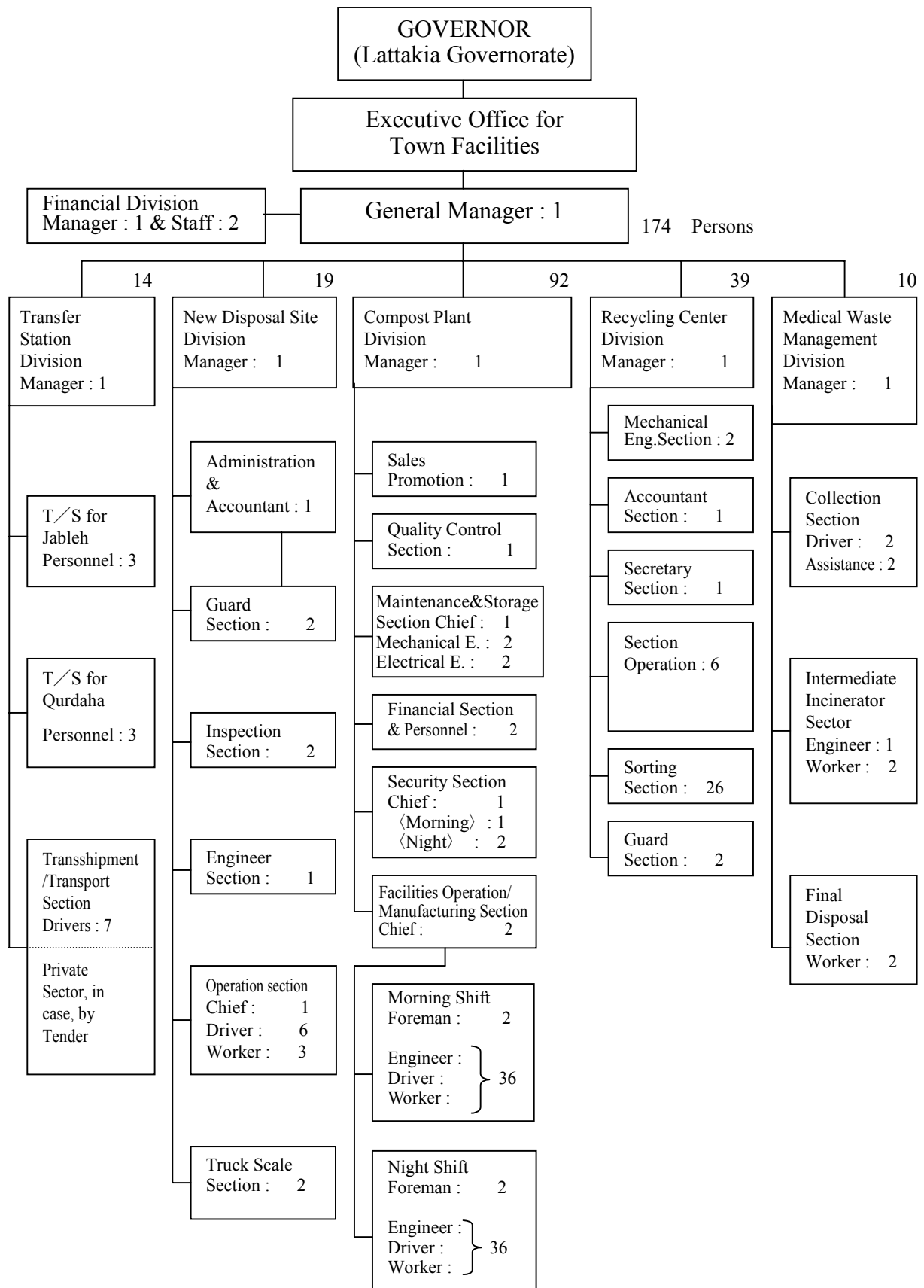


Figure 7.7.1 Organization Chart of New Institution on the Governorate Level

## **7.8 PUBLIC AWARENESS ON ENVIRONMENT AND SWM**

The Proper discharge will be essential to create an efficient system of solid waste management. As the separate collection will be introduced in the high and middle income residential area to promote recycling, source separation into organic and non-organic waste shall be conducted at source through residents cooperation. Therefore, residents cooperation and participation will be essential for successful introduction of the separate collection providing necessary guidance and information. To enhance public awareness on solid waste management, a section for public awareness shall be established and various campaigns shall be conducted.

### **7.8.1 Public Awareness Section**

It is necessary to set-up a public awareness section in the cleansing division of Lattakia and the three surrounding cities. The public awareness section shall be responsible on enhancement of public awareness on solid waste management through publicity of problems and future direction, and coordination of various campaigns. Required staff will be three (3) persons in Lattakia city and one person for each surrounding cities.

### **7.8.2 Public Awareness Campaigns**

#### **(1) Campaigns Activities and Timing**

Yearly campaign shall be conducted to advertise future action of solid waste management to the population and specific campaigns shall be conducted when an improvement projects will be implemented and a new system will be introduced. The campaigns shall be conducted using community participatory approach.

#### **(2) Specific Campaigns**

Specific campaigns on the events of solid waste management shall be implemented according to the schedule of the master plan. The specific campaign will include a publicity of actions through the mass media and other media and a demonstration of new equipment and facilities.

##### **1) Opening of the public awareness section**

The new public awareness section and its role will be advertised and informed.

##### **2) Procurement of new equipment**

The new equipment will be demonstrated and shall be requested proper discharge.

##### **3) Construction of the recycle**

Publicity and demonstration of new facilities when the recycle centers and disposal sites will be constructed.

#### 4) Introduction of separate collection

The campaign shall implement at the same time including a guidance of proper discharge and separation, supervision and guidance of discharge manner, public opinion survey. It is important that woman's cooperation is extremely required for the campaigns.

#### (3) Yearly Campaigns and Activities

Yearly campaigns shall be conducted to explain present problems and future plan of solid waste management. Also, Cleansing Day and Cleansing Week shall be set and conduct cleansing activity in communities and schools including environmental education on that day and week.

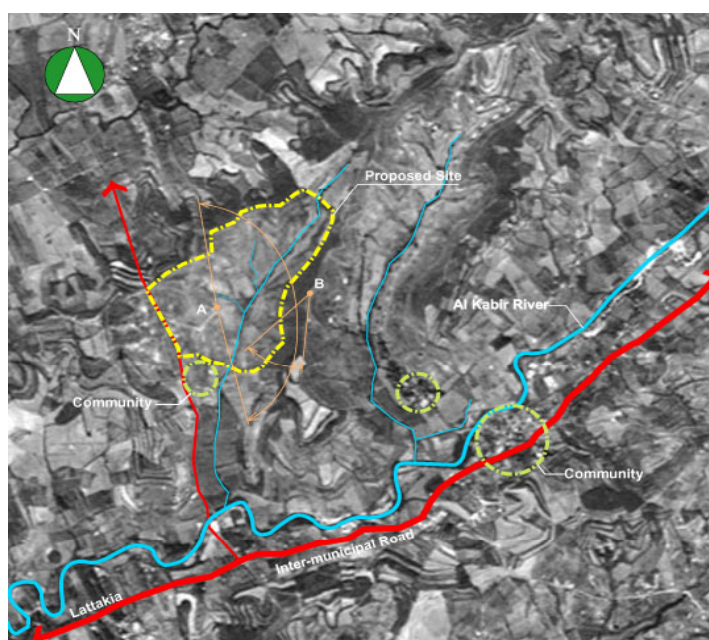
#### 7.8.3 Other Activities

It will be necessary to organize scavengers and discipline on safety works considering better cooperation between scavengers and local government.

### 7.9 ENVIRONMENTAL CONSIDERATION

Although, solid waste management is conducted aiming to maintain sanitation and living environment in urban area, it is necessary to avoid adverse environmental impact caused by major facilities such as final disposal sites and recycling centers.

According to the plan, Al Bassa existing disposal site which is proposed for rehabilitation and restore is used till year 2007 and a new inter-municipal landfill site in Qasia is opened after year 2008. The recycle centers are planned to be constructed at Al Bassa (the old compost plant site) and Qasia new disposal site. Thus, the Al Bassa disposal site and recycle center are improved expectedly and the new landfill site including recycling center is subject to environmental evaluation on this study.



**Figure 7.9.1 Location of the Site (Qasia)**



### (1) Initial Environmental Study

Quasia new disposal site is located at upper stream of Al Kabir river and there are few houses in surrounding area as shown in Figure 7.9.1. Screening and Scoping were carried out in order to identify significant environmental impacts caused by the project implementation using qualitative method such as matrix and ripple effect flow based on available secondary information. Environmental factors to be considered and items to be examined in detail in consideration of the project cycle were clarified as summarised below and the result of the scoping classified by project cycle is shown below.

**Table 7.9.1 Matrix for Scoping Result Classified by the Project Cycle**

Major facilities, activities Which may cause impacts		Project Activities					
		Overall Evaluation	Before Operation		Operation		
			Reclamation and spatial occupancy	Operation of construction equipment	Occupancy of land	Operation of vehicle	Operation of facilities
Social Environment	1. Resettlement						
	2. Economic Activities	✓			✓		
	3. Traffic and Public Facilities	✓			✓		
	4. Split of Communities						
	5. Cultural Property						
	6. Water Rights and Rights of Common	✓	✓				
	7. Public Health Condition	✓				✓	
	8. Waste						
	9. Hazards (Risk)	✓					
Natural Environment	10. Topography and Geology	✓	✓				
	11. Soil Erosion	✓					
	12. Ground Water	✓✓	✓✓			✓✓	
	13. Hydrological Situation	✓✓	✓✓			✓✓	
	14. Coastal Zone						
	15. Flora and Fauna	✓	✓				
	16. Meteorology						
	17. Landscape	✓	✓		✓		
Pollution	18. Air Pollution	✓					
	19. Water Pollution	✓✓	✓			✓✓	
	20. Soil Contamination	✓				✓	
	21. Noise and Vibration	✓		✓		✓	
	22. Land Subsidence						
	23. Offensive Odour	✓✓					✓

Note:

- ✓✓: The environmental items to which special attention has to be paid. They might be serious impacts that may affect the project formulation depending on the magnitude of the impacts and the possibility of the measures.
- ✓: The environmental items that may have a significant impact depending on the scale of the project and site condition
- No mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

As the result of evaluation, environmental factors that special attention has to be paid are following subjects.

- Topography and Geology
- Ground Water
- Hydrological Situation

- Landscape
- Water Pollution

In conclusion, it is anticipated that implementation of the master plan will contribute to mitigating environmental impacts compared to current disposal management. However, further environmental study shall be carried out for detail evaluation and formulation of countermeasures.

## **(2) Environmental Consideration**

### **1) From Al-Bassa to Qasia Inter-municipal disposal site**

It is proposed that existing Al-Bassa disposal site will be closed in 1997, and then a new inter-municipal disposal site in Qasia will be opened. Viewpoint from environmental burden in the areas, environmental impacts will be decelerated. The location of Al-Bassa is located in fragile coastal area while the inter-municipal disposal site is located in isolated inland where is 17km from Lattakia centre. In addition to this, sanitary landfill is proposed there while Al-Bassa site is presently dumping the waste with soil cover method partially.

### **2) Groundwater and hydrological condition in Qasia**

The site forms a small valley and there is a small seasonable river. Construction of disposal site in upper basin, groundwater quality and flow may be affected. It is necessary to have detail survey on this matter in design phase.

### **3) Water Rights in Qasia Site**

Wells are seen in the community and adjacent farms. When the plan changes topographical and geological conditions there, the ground water condition may be affected. It is necessary to survey these conditions in design stage.

### **4) Resettlement may cause in Inter-municipal Disposal Site**

Depend on the scale and works of the plan, resettlement may cause in adjacent community. Based on observation of the site, some farmers' housings are seen and they have used ground water for their farms. Once topographical condition changes, the ground waster condition might be affected so that they discontinue to work there.

### **5) Al-Bassa Site**

As it is explained in previous section, existing dumping site is proposed as master plan site especially up to third quarter of the Plan duration. The plan contains rehabilitation of existing SWM facilities such as disposal site and composting plant. In general there is no significant impact on the plan however miner impacts are identified as follows:

#### **a. Proper treatment of leachate from the disposal site**

The leachate from the site may cause ground water pollution and may affect on ecosystem. So far this relation is unknown, though it is necessary to have detail survey further.

**b. Haulage of waste from cities**

The site will be used till third quarter of the planning period. Current road condition there is insufficient and heavy compactors transport municipal waste every day. The degraded access roads condition may cause spreading wastes on the routes.

In addition, surrounding area of collection bins in the city is insufficient management and this condition generates offensive odour and attracts vectors and pests. Promotion and prevalence of the proper management should also be introduced on the public awareness activities in the plan.

Many of existing collection vehicles have insufficient maintenance in terms of safety driving. It is seen that some collection vehicles that tail lamps had gone at night and one of headlight also had gone. Proper maintenance of these vehicles should be considered.

**c. Improving visual amenity in Al-Bassa Site**

The site is located in one of the most scenery dune along the Mediterranean Sea coast in the region. While the scene of dumping site including coastal area is terrible; for example, scattering of the waste, dispersion of the smoke, awful offensive odour, disordered dumping and spreading the waste in the area, etc. The proposed rehabilitation includes countermeasures against to such negative aspect of the site, though visual amenity and ecosystem there should be considered on the rehabilitation plan.

**7.10 IMPLEMENTATION SCHEDULE**

Project component necessary to achieve the master plan target is divided into two phases, taking into account the priority of each component. One is the project to be carried out until the year 2006, and the other is until the master plan target of 2010. The implementation schedule of the master plan is shown in Table 7.10.1.

**Table 7.10.1 Implementation Schedule of the Master Plan**

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1 Collection										
(1) Collection Improvement - Phase I										
(2) Collection Improvement - Phase II										
2 Rehabilitation of Al-Bassa Disposal Site										
3 Construction of Qasia New Inter-municipal Disposal Site										
4 Recycling Center in Al-Bassa										
(1) Introduction of Separate Collection										
(2) Rehabilitation of Existing Compost Plant										
(3) Construction of Sorting Center										
5 Recycling Center in Qasia										
(1) Introduction of Separate Collection										
(2) Construction of Compost Plant										
(3) Construction of Sorting Center										
6 Transfer Station										
(1) Construction of Transfer Stations (Jableh and Qurdaha)										
(2) Procurement of Transportation Vehicles										
7 Medical Waste Management										
(1) Procurement of Collection Vehicles										
(2) Construction of Treatment Facility										

## 7.11 COST OF THE MASTER PLAN

### (1) Condition of Cost Estimation

Master plan cost has been calculated based on the following exchange rate.

Exchange rate: US\$1.00 = SP 49 (as of June 2001)  
US\$1.00 = Yen 121 (as of June 2001)

Price: Price of June 2001

### (2) Investment Cost

Investment cost of the master plan is shown in Table 7.11.1.

**Table 7.11.1 Master Plan Investment Cost**

(Unit: Thousand SP)

Item	2001—2006	2006—2010	Total
1. Collection Improvement	155,557	110,888	266,445
2. Construction of Recycling Center			
(1) Compost Plant	199,000	534,000	733,000
(2) Sorting Center	33,260	33,260	66,520
3. Construction of Transfer Station	—	95,420	95,420
4. Improvement of Disposal Site			
(1) Al-Bassa Disposal Site	119,050		119,050
(2) Qasia Inter-municipal Disposal Site		153,860	153,860
5. Improvement of Medical Waste Management	7,200	—	7,200
6. Improvement of Public Awareness	8,965	6,724	15,689
Sub-total	523,032	934,152	1,457,184
7. Engineering Service	36,612	65,391	102,003
Total	560,230	999,782	1,559,187

### (3) Operation and Maintenance Cost

Operation and maintenance cost of the master plan (year 2006 and 2010) is shown in Table 7.11.2.

**Table 7.11.2 Operation and Maintenance Cost**

Item	2006	2010
1. Collection Improvement	88,172	84,260
2. Construction of Recycling Center		
(1) Compost Plant	3,553	13,415
(2) Sorting Center	2,955	5,911
3. Construction of Transfer Station	—	7,387
4. Improvement of Disposal Site		
(1) Al-Bassa Disposal Site	8,966	—
(2) Qasia Inter-municipal Disposal Site	—	12,490
5. Improvement of Medical Waste Management	1,924	1,924
6. Others	1,097	1,097
Sub-total	106,667	126,484
7. Income by selling compost & recyclables	-4,771	-18,848
Total	101,896	107,636

Note: Depreciation is not included.

## 7.12 FINANCIAL PLAN

### (1) Policy of the Financial Plan

In order to ensure the appropriate operation of the solid waste management, it is necessary to secure investment funds for purchasing and renewing the necessary equipment and facilities and a source of revenue for covering operation and maintenance costs. Currently, subsidies from the central government are relied on in order to carry out equipment and facilities renewal. However, it will be necessary in future to invest and to make repayment using own fund and loans.

Meanwhile, collected service fees and the general budget of municipalities cover operation and maintenance costs. Revenue from fees currently covers no more than 30% of overall operation and maintenance cost (however, depreciation of equipment is not taken into account here). Taking into consideration the tight financial situation in each municipality, in order to secure sound finances in the solid waste management, revenue from service fees should be regarded as the main component of revenue that covers all costs including depreciation expenses as well as the current operation and maintenance costs.

### (2) Sources of Finance

There is no definite funding source for the investment proposed in the master plan. Considering the present financial state of municipalities, there is no choice but to rely on funds other than those from the municipality own budget in order to finance investment up to 2005. However, concerning investment after that, a funding plan for covering costs by autonomous sources and borrowing in each municipality shall be compiled.

Two sources of revenue to cover operation and maintenance costs are municipal subsidies and cleansing fees. Considering that costs in future will increase in line with the repayment of loans and disposal site improvement, it will be necessary to expand

fund sources. For this purpose, it will be necessary to expand either subsidies or revenue from fees. However, since it is difficult to expand subsidies, it will be necessary to examine the second alternative of expanding revenue from fees.

### **(3) Cleansing Fees**

Cleansing fees are collected in Lattakia, Jableh and Al-Haffeh. Total revenue from fees in 2000 was SP 3.6 million from households and SP 30 million from business establishments. Uniform cleansing fees are prescribed throughout the whole country in Syria (Finance Act No. 1, 1994) and these ranges from SP 75-500/hh/year in Lattakia and SP 75-200/hh/year in other cities. In Lattakia, cleansing fees of SP 200/year for households and SP 250/month for business establishments are established. Fee collection rate in total is about 50%, however, the rate from households is extremely low (around 20%).

The potential revenue from cleansing charge will be as follows:

- a. Assuming the current level of fees, if the collection rate can be raised to 80%, it will be possible to raise SP 17.6 million from households and SP 36.4 million from business establishments in 2010.
- b. If household fees are set at the upper legal limit and the collection rate is 80%, it will be possible to collect revenue of SP 42.3 million in 2010.
- c. If even higher revenue is to be sought via service fees, it will be necessary to carry out revision of national legislation. The upper limit of service fees for households is generally put at 1-2% of household income. Judging from the results of citizens' awareness surveys, average household income is SP 140,000/year (5.3 household members). If the service fee is set at SP 1,500/year and the collection rate is raised to 80%, revenue of SP 155.5 million can be obtained. In this case, in consideration of fairly spreading the burden, it will be necessary to raise the fee for business establishments to SP 500/month. The revenue from business establishment will be SP 79.4 million.

### **(4) Case Studies**

In 2010, it will be necessary to carry the burden of operation and maintenance costs also taking the depreciation cost of facilities and equipment into account, and this comes to a total of approximately SP 230 million. The only available sources of funds for this are municipal government subsidies and revenue from fees. The results of examining different combinations for covering this burden are as indicated in Table 7.12.1.

- Case 1: Improvement of fee collection rate and provision of subsidies
- Case 2: Revision of fees (raising of upper legal limit) and provision of subsidies
- Case 3: Maintenance of existing subsidies and revision of fees
- Case 4: Zero subsidies and revision of fees

**Table 7.12.1 Financial Plan Alternatives**

Item	Unit	Case 1	Case 2	Case 3	Case 4
Fee on domestic waste	SP/year	200 (100)	500 (200)	1,000 (400)	1,500 (1500)
Fee on commercial waste	SP/month	250 (100)	250 (100)	500 (500)	500 (500)
Subsidy (from municipality)	--	Apply a shortage	Twice of current	Same w/current	No subsidy
Income: Households	Million SP/year	17.6	42.3	84.6	155.6
Income: Commercial entities	Million SP/year	36.4	36.4	79.5	79.5
Income: Subsidy	Million SP/year	Approx. 180	Approx. 150	72.8	0.0
Total	Million SP/year	234.0	228.7	236.9	235.1

Note: ( ) shows the collection fee of surrounding three cities.

As is indicated in Table 7.12.1, even in Case 2 where the upper legal limit of fees is revised, subsidies from the municipal government equivalent to roughly two times the present level are necessary. Therefore, over the long term, as is indicated in Case 3 and Case 4, it is necessary to lighten the burden placed on the municipal government by revising the law and raising fees. Since service fees only account for around 1% of income even in Case 4, this burden can be handled by citizens. Fees in Case 4 are higher than in Case 2 and Case 3, however, in accordance with the principle of polluters must pay, and Case 4 should be aimed for.

#### **(5) Financial Plan**

The financial plan for the period up until 2010 based on the above examination is indicated in Table 7.12.2. The following measures need to be implemented in order to realize this plan.

- a. Concerning investment up until 2005, utilize funds other than those from the municipality own budget.
- b. Immediately embark on improving the service fee collection rate based on the present law; also establish service fee collection ordinances in each city and revise fees in line with project implementation (upper legal limit).
- c. Prior to construction of Qasia disposal site, carry out revision of Syrian law and fees in each city so that the level of fees is SP1,500/year for households and SP 500/month for business establishments.
- d. Continue to provide general municipal budget until realization of the new fee system.
- e. Concerning project works from 2006 onwards, establish a system whereby investment funds that cannot be covered by autonomous sources are procured via loans. Concerning the borrowing conditions, loan period of 10 years and interest rate of 8% are envisaged.

Table 7.12.2 Annual Investment Cost and Financial Plan

Items	(1) Investment and O/M Cost																	Total			
	2,001	2,002	2,003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017		2,018	2,019	2,020
1. Construction																					
Disposal site	0	730	81,505	36,815		76,490	77,370	0	0	0			29,840			76,490	77,370				456,610
Transfer station						23,360	72,060										48,700				144,120
Compost plant			116,500	82,500	0	0	347,000	187,000						21,776				187,412			942,188
Sortin center			14,000	19,260			14,000	19,260						5,260				21,110			92,890
Collection			155,557				110,888	0				49,096	155,557			0	110,888				581,986
Medical			7,200									7,200									14,400
Public awareness			1,494	2,241		1,868	1,494	1,868	1,494												15,689
Engineering	0	156	26,364	9,857	131	7,094	18,353	25,375	14,599	105											102,003
Sub total	0	2,380	402,994	150,673	1,999	1,08,438	280,539	387,869	222,697	1,599	0	49,096	192,597	27,036	0	76,490	236,958	0	209,522	0	2,349,886
2. Operation																					
Disposal site	8,195	16,390	16,390	8,310	8,946	8,966	8,996	12,620	12,640	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	238,843
Transfer station								7,387	7,387	7,387	7,387	7,387	7,387	7,387	7,387	7,387	7,387	7,387	7,387	7,387	96,031
Compost plant						3,553	3,553	3,553	5,517	13,415	13,415	13,415	13,415	13,415	13,415	13,415	13,415	13,415	13,415	13,415	167,284
Sortin center	110,981	110,981	88,172	88,172	88,172	88,172	84,260	84,260	84,260	84,260	84,260	84,260	84,260	84,260	84,260	84,260	84,260	84,260	84,260	84,260	79,796
Collection				1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,924	1,754,290
Medical																					32,708
other	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	20,843
Sub total	119,176	128,468	105,659	99,503	106,847	106,667	102,785	113,796	115,780	126,484	126,484	126,484	126,484	126,484	126,484	126,484	126,484	126,484	126,484	126,484	2,389,805
Total	119,176	130,848	508,653	250,176	1,08,646	1,215,105	383,324	501,665	338,477	1,28,083	1,26,484	1,75,580	319,081	153,520	1,26,484	202,974	369,442	1,26,484	335,006	1,26,484	4,739,691

Items	(2) Cash Flow																	Total			
	2,001	2,002	2,003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017		2,018	2,019	2,020
1. Revenue																					
Remaining	7,600	14,205	14,587	36,095	37,066	38,063	143,631	147,495	151,462	155,537	155,537	155,537	155,537	155,537	155,537	155,537	155,537	155,537	155,537	155,537	0
Fee from HH	30,000	36,426	36,426	36,426	36,426	36,426	79,466	79,466	79,466	79,466	79,466	79,466	79,466	79,466	79,466	79,466	79,466	79,466	79,466	79,466	1,324,654
Sub sidy	89,461	77,837	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	72,800	458,498
Sales of compost					678	678	678	678	678	678	678	678	678	678	678	678	678	678	678	678	63,743
Sales of reusable					4,093	4,093	4,093	4,093	5,007	13,423	13,423	13,423	13,423	13,423	13,423	13,423	13,423	13,423	13,423	13,423	169,032
Sub total	127,061	128,468	123,813	145,321	151,063	152,060	227,868	231,792	237,291	253,851	253,851	253,851	253,851	253,851	253,851	253,851	253,851	253,851	253,851	253,851	4,317,033
Grant (100%)	0	2,380	402,994	150,673																	556,047
Loan (70%)					1,399	75,907	196,377	271,508	155,888	1,119	0	34,367	134,818	18,925	0	65,017	201,414	0	177,244	0	1,339,983
Total	127,061	130,847	526,807	295,994	152,462	227,967	424,245	503,240	393,179	254,970	253,851	288,218	388,669	272,776	263,851	318,867	455,265	253,851	431,094	253,851	6,207,063
2. Expense																					
Capital Invest	7,885	2,380	402,994	150,673	1,999	1,08,438	280,539	387,869	222,697	1,599	0	49,096	192,597	27,036	0	76,490	236,958	0	209,522	0	2,357,771
Operation	119,176	128,468	105,659	99,503	106,647	106,667	102,785	113,796	115,780	126,484	126,484	126,484	126,484	126,484	126,484	126,484	126,484	126,484	126,484	126,484	2,389,805
Loan repayment					0	140	7,731	27,368	54,519	70,108	70,220	70,220	73,657	87,138	89,031	88,891	87,802	88,306	61,155	63,290	939,575
Loan interest(%)					0	112	61,73	21,255	40,796	48,906	43,387	37,789	34,901	39,794	34,337	27,214	25,304	34,393	27,329	36,616	458,295
Total	127,061	130,848	508,653	250,176	1,08,646	215,357	397,228	550,298	433,792	247,096	240,090	283,569	427,638	280,452	249,851	319,079	479,548	249,183	423,490	226,390	6,145,446
Balance	0	-0	18,154	45,818	43,816	12,610	27,017	-47,058	-40,613	7,873	13,760	4,649	-38,970	-7,676	3,999	-212	-21,283	4,668	7,605	27,460	61,618
Accumulation	0	-0	18,153	63,971	107,768	120,997	147,415	100,357	59,743	67,617	81,377	86,026	47,057	39,390	43,380	43,168	21,884	26,552	34,157	61,618	
Remaining loan	0	0	0	0	1,399	77,166	265,813	509,952	611,321	542,332	472,112	436,260	497,421	429,208	340,177	316,303	429,915	341,610	457,699	394,408	
Total debt	0	-0	18,153	63,971	106,388	43,231	-118,398	-409,596	-551,578	-474,715	-390,735	-350,233	-450,365	-389,828	-296,798	-273,135	-408,031	-315,057	-423,541	-332,791	
Debt ratio	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	6.1%	21.0%	40.2%	44.8%	46.9%	42.5%	42.9%	50.0%	48.6%	45.7%	44.6%	48.3%	34.9%	39.4%	



## **8. Effectiveness of the Master Plan**

### **8.1 TECHNICAL ASPECT**

#### **(1) Improvement of Collection**

The collection system employed in the master plan is mainly compactor container system and it is same as present. When introducing new collection equipment, considering topographical conditions in the collection districts, vehicles shall basically consist of medium size compactors rather than the present large size vehicles. Implementation of these measures will make possible to raise the collection rate to 95% (2010) and is judged to be very feasible.

#### **(2) Source Separation**

Source separate collection will be introduced in middle and high income area in phases in line with the commissioning timing of related facilities (composting facilities and sorting centers). The target amount of source separate collection as a ratio of generated domestic waste shall be 26% in 2006 and 48% in 2010. Source separate collection was carried out in the Pilot Study, and active participation of citizens was obtained at this time. Therefore, it is judged that source separate collection is possible if carried out in tandem with campaigns to enhance citizen awareness.

#### **(3) Transfer System**

The Master Plan proposes a transfer station transport system for the cities of Jableh and Qurdaha, which are located between 35-40 km away from the new disposal site. Direct reloading has been set as the reloading method at transfer stations since this is a simple method in technical terms and also from the viewpoint of operation and management.

#### **(4) Composting**

The compost plant that was constructed in Lattakia some 20 years ago was closed on March 2001 because it produce pad quality compost. In the Master Plan, composting of separated domestic organic waste and market waste is proposed, and it has already been proven in the Pilot Study that good quality compost can be produced using this method. Also, capacity of the compost plant will be expanded step by step considering actual demand of compost. Therefore, composting is judged to be technically feasible.

#### **(5) Sorting of Reusable Materials**

The Master Plan proposes construction of a reusable materials sorting center for handling inorganic waste that is separated at the source. Simple and sure manual sorting is assumed for the reusable materials recovery process, and this proposal is judged to be very feasible in technical terms.

#### **(6) Sanitary Landfill**

The existing dumping site conducts open dumping that entails no special treatment. The Master Plan proposes introduction of a sanitary landfill and minimizing of impact

on the surrounding environment. By installing control facilities such as leachate collection and drainage pipes, leachate treatment ponds (circulation treatment facilities) and monitoring wells, etc., and also by introducing the landfill techniques (pushing up/cell method, earth covering) adopted in the Pilot Study and using appropriate landfill equipment (bulldozers, excavators and dump trucks), disposal that entails low environmental load is proposed. Therefore, sanitary landfill disposal is judged to be technically appropriate.

## **8.2 ECONOMIC AND FINANCIAL ASPECT**

### **8.2.1 Economic Aspect**

In the economic assessment, economic cost and benefit estimation and cost-benefit analysis are conducted, and the economic internal rate of return is computed. Also, a qualitative evaluation is conducted.

#### **(1) Economic Cost**

In carrying out economic assessment, financial costs are directly converted into economic costs.

#### **(2) Economic Benefits**

Generally speaking, improving the solid waste management utility has the effects indicated in Table 8.2.1.

**Table 8.2.1 Benefits of Solid Waste Management**

Item	Benefit	Contents
Preservation of living environment	Reduction of solid waste	Removal of waste from inner cities
Improvement of public sanitation	Reduction of odor and harmful pests Prevention of epidemics Mitigation of human health harms	Removal of waste from inner cities Earth covering at final disposal sites
Environmental preservation effect	Reduction of environmental pollutants Reduction of final disposal quantities Conservation of energy and resources Reduction of global warming-related substances	Environmental preservation around existing disposal sites (leachate treatment, prevention of waste scattering and spontaneous combustion) Reduction of final disposal quantities by composting Reduction of global warming gases
Utility revenue effect	Resource recycling by composting Recovery of reusable materials	Reduction of chemical fertilizer, increase agriculture production, improvement of agriculture production quality, reduction of water consumption, reduction of disposal costs, recovery of reusable materials Recovery of reusable materials
Other effects	Enhancement of citizen awareness Vacant site utilization Promotion of tourism and recreation sectors Other effects	Utilization of vacated site at Al-Bassa Promotion of coastal road construction

Benefits resulting from implementation of the project can be considered as follows.

**Table 8.2.2 Benefits of Solid Waste Management**

Type	Benefit
Qualification benefit	Elimination of solid waste: protection of the urban living environment, improvement of public sanitation.
	Compost production : reduction of chemical fertilizer , increase in production , reduction of irrigation water consumption.
	Recovery of reusable materials : recovery of reusable materials.
Non-quantifiable benefit	Environmental protection: reduction of pollutant , reduction of disposal quantities, reduction of global warming gases.
	Compost production : improvement of quality of agriculture.
	Other benefit: increase of public awareness, promotion of tourism development.

### **(3) Quantifiable evaluation**

Quantifiable benefits are: 1) benefits resulting from removal of solid waste, 2) benefits of compost production, and 3) benefits of reusable materials recovery. The economic value of these benefits is as follows.

- Concerning the solid waste elimination effect, the amount beneficiaries are willing to pay shall be the benefit. Judging from the findings of the citizen awareness survey, the average amount beneficiaries are willing to pay is SP 132/month in Lattakia. It is assumed that stores have similar willingness to pay according to the amount of waste. Taking this willingness to pay, the number of households and the waste collection rate into account, the estimated benefit will be SP 196.2 million in 2006 and SP 243.8 million in 2010. Incidentally, this amount beneficiaries are willing to pay roughly works out at 1% of income and is a fair level.
- Effect of compost production: The project intends to introduce a 200-tons/day compost plant by 2010 which produce 50 tons of compost per day. The effects of composting can be divided into the fertilizer reduction effect, agricultural production increased income effect, and water consumption reduction effect. In economic terms, these effects work out as SP 580, SP 1,500 and SP 500 per ton of compost respectively. It is estimated that this benefit will be SP 40.0 million in 2010.
- Reusable materials recovery effect: In the project, it is planned to recover 10 tons/day of reusable materials at both the compost plant and the sorting center. It is estimated that this benefit will be SP 13.4 million in 2010.

Calculating from the above estimates of cost and benefit, the economic internal rate of return works out as 6.7% as indicated in Table 8.2.3.

### **(4) Qualitative evaluation**

- Rehabilitation and covering soil will improve environmental condition of existing disposal site and reduce air pollution, order and waste scattering.
- 75 ton/day of final disposal amount will decrease through composing process and global warming gases will be decreased.
- The quality of agriculture production will be improved through usage of compost.
- Rehabilitation of AL Bassa disposal site will promote to tourism development such as coastal road.

### **(5) Conclusion**

The economic internal rate of return will be 6.7%. However, in addition to the above quantifiable effects, when non-quantifiable effects such as reduction of final disposal quantities (150 tons/day in compost treatment, 10 tons/day at sorting facilities), environmental improvement of disposal sites, utilization of the vacated site at Al-Bassa, and promotion of tourism, etc. are taken into account, it is possible to view the project as a viable undertaking. Moreover, the fact that project implementation will enable waste disposal to be carried out over the long term at Qasia in Lattakia Governorate is extremely important.

**Table 8.2.3 Economic Analysis on the Master Plan**

(Unit: SP million)

Year	Balance	Coat			Benefit			
		Total	Invest	Operation	Total	Willingness	Compost	Reusable
2001	0.0	0.0	0.0		0.0			
2002	-2.4	2.4	2.4		0.0			
2003	-327.6	508.8	403.1	105.7	181.2	181.2		
2004	-64.2	250.2	150.7	99.5	186.0	186.0		
2005	91.5	108.6	2.0	106.6	200.1	191.0	5.0	4.1
2006	-9.9	215.2	108.5	106.7	205.3	196.2	5.0	4.1
2007	-149.3	383.5	280.7	102.8	234.2	225.1	5.0	4.1
2008	-261.4	501.7	387.9	113.8	240.3	231.2	5.0	4.1
2009	-91.2	338.6	222.8	115.8	247.4	237.4	5.0	5.0
2010	169.1	128.1	1.6	126.5	297.2	243.8	40.0	13.4
2011	170.7	126.5	0.0	126.5	297.2	243.8	40.0	13.4
2012	121.6	175.6	49.1	126.5	297.2	243.8	40.0	13.4
2013	-21.9	319.1	192.6	126.5	297.2	243.8	40.0	13.4
2014	143.6	153.6	27.1	126.5	297.2	243.8	40.0	13.4
2015	170.7	126.5	0.0	126.5	297.2	243.8	40.0	13.4
2016	94.2	203.0	76.5	126.5	297.2	243.8	40.0	13.4
2017	-66.3	363.5	237.0	126.5	297.2	243.8	40.0	13.4
2018	170.7	126.5	0.0	126.5	297.2	243.8	40.0	13.4
2019	-37.8	335.0	208.5	126.5	297.2	243.8	40.0	13.4
2020	181.2	126.5	0.0	126.5	307.7	254.3	40.0	13.4
2021	471.5	-471.5	-471.5					
Total	752.7	4,021.5	1,879.1	2,142.4	4,774.2	4,140.5	464.9	168.8
EIRR	6.7%							

## **8.2.2 Financial Aspect**

The results of the economic analysis indicate that the project is a viable undertaking. In the financial plan of the project, it is necessary to raise central government subsidies for investment made up until 2005 and to raise cleansing fees until 2010. However, since the ratio of cleansing fees following the price increases will still only be around 1% of household income, this will not prove to be a major burden. Moreover, if investment until 2005 can be subsidized, it will be possible to sustain the solid waste management utility by financing investment from 2006 onwards using 30% own funds and 70% loans. It can thus be concluded that the project is financially viable.

Furthermore, the compost plant and sorting center can cover operation and maintenance costs except for personnel expenses by means of revenue from the sale of compost and reusable materials.

## **8.3 ENVIRONMENTAL ASPECT**

Environmental Effectiveness is defined as the positive environmental aspects by the implementation of the proposed Master Plan when compared to current waste disposal management. Consistent implementation of the plan and its proper operation will contribute to a variety of environmental practices and the environmental effectiveness on this plan is summarized by four points 1) global environment, 2) regional environmental effectiveness, 3) improvement of the existing disposal site and 4) recycling effectiveness as described as follows:

### **1) Global Environmental Issues:**

- **Promotes environmentally sound practices, such as reduced methane generation**

The emission of landfill gases produced by the anaerobic and aerobic decomposition of organic matters is major source of green house gases, which is responsible for global warming and ozone depletion. It is assumed that one million tones of unsorted municipal waste contain approximately 0.3 ton of carbon in various forms. Experimental research and process modeling demonstrate that about 0.2 ton would be converted to landfill gases consisting of 0.09 ton carbon dioxide and 0.09 ton methane. Landfill gases from landfills account nearly half of the anthropogenic source of methane. Landfills have proven to be only partially successful since up to 60% of the methane generated escapes through leakage. It is clear to prevent land filling of organic waste is a measure and composting is one of the simplest ways to prevent emission of methane because the organic fraction of the waste stream is diverted from landfill<sup>1</sup>.

### **2) Regional Environmental Issues:**

- **Creation of Environmentally Sound Cities**

The solid waste management proposed in the master plan brings wide range of environmental effectiveness in the cities. Waste separation at source will increase

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<sup>1</sup> Composting and Its Applicability in Developing Countries, World Bank

enlightenment of municipal waste disposal manner, and improvements of collection and haulage system with sufficient collection vehicles and equipments will be sufficient for keeping clean the cities. In addition, recycling activity may effect reducing the waste amount. Rehabilitation and rearrangement of Al-Bassa Disposal site and construction of Recycling Centre are the other hand of the management body. Sufficient capacity and appropriate operation will be essential, then, as results, the plan will contribute to create sound cities in terms of hygiene and living environment.

### **3) Environmental Issues on the site:**

- **Minimize environmental damage from indiscriminate dumping at existing disposal site**

Presently waste disposal management is under insufficient management condition and lack of equipment and inappropriate engineered measures are frequently seen. Proposed the rehabilitation and introduction of sanitary landfill method are suitable for maintaining the environment and the project will contribute to enhance positive aspects.

- **Improve coastal landscape and environmental conditions along the Mediterranean Sea Coast which is one of the most scenery area in this area**

The existing disposal site is located on dune area, which is one of the most attractive scenes in this area. The proposed rehabilitation and the arrangement of the site are in order and effective for recovering coastal landscape and environment, which are presently degraded by the existing disposal activity.

- **Improve the quality of landfill leachate**

Landfill leachate is created when water percolates through the waste and biological and chemical constituents from the waste are brought in to solution. Depending on the landfill design and prevailing weather condition, composting may not significantly reduce the quantity of landfill leachate, however it will improve quality of the leachate.

### **4) Recycling Issues:**

- **Improves recycling by removing organic matter from the waste stream**

Recycling organic matter from the waste in the study area is suitable idea that 78% of the total collected municipal waste is organic and almost of all market waste is also dominated by organics. In addition to this, climate condition helps to introduce composting system as recycle of the waste.

The composting process reduces the waste amount, and enhances recycling the waste. 5% of the total waste amount is sorted and 20 % will be fine compost, 25% will be residue and 16% will be recycle compost. As a result, total amount of the organic waste will be 63.5%. In addition, another recyclable wastes such as plastics, glasses and metals are sorted and are used as supplement materials for new productions. Moreover the activity is also effective for enlightenment of waste disposal management at source.

- **Produces a valuable soil additive – integral to sustainable agriculture**

Utilization of compost product is an essential for agriculture in order for intergrading physiochemical soil structure. An organic component will introduce well-balanced nourishment in addition to the chemical fertilizers.

- **Enhances the effectiveness of fertilizer application**

Organic manure namely the compost will improve nourishment of the soil and will enhance applicability of fertilizer. Chemical fertilizers are generally preferred over compost because they are easy to handle, store and apply, and a synergistic relationship exists between compost and chemical fertilizers, and greater fertilizer efficiency can be established through the use of compost in conjunction with chemical fertilizers (World Bank 1997a).

- **Can integrate existing informal sectors involved in collection, separation and recycling**

There is an opportunity to involve informal sectors working on waste separation into integrated system. Presently waste-pickers are sorting valuable wastes, which are sellable metals, plastics and glasses. In order for proceed recycling and keeping safety on the site, waste-pickers can be involved in the system. It is therefore social impact may be minimized.



## **9. Priority Projects**

The Master Plan aims to preserve cleanness and promote recycling in Lattakia and the three surrounding cities, and the major project components that need to be implemented by 2010 for achieving these goals are as follows.

- Improvement of waste collection and street sweeping, and introduction of source separate collection
- Construction of recycle centers (Al-Bassa and Qasia)
- Rehabilitation of Al-Bassa disposal site and improvement of disposal work
- Construction of transfer stations
- Construction of Qasia new disposal site
- Medical waste treatment
- Establishment of the inter-municipal treatment setup
- Campaigns for raising citizens' awareness
- Securing of sources of funds for solid waste management

Out of the above, since construction of Qasia disposal site requires consensus of related officials and acquisition of site land, it was decided to continue using Al-Bassa disposal site for the immediate future. Accordingly, out of the above project components, priority projects requiring implementation by 2005 in Lattakia and the three surrounding cities shall be as follows. (Treatment of medical waste is excluded from this list because issues remain concerning separation of infectious medical waste, etc.) :

- Improvement of waste collection and street sweeping, and introduction of source separate collection
- Construction of recycle center (Al-Bassa)
- Rehabilitation of Al-Bassa disposal site and improvement of disposal work
- Establishment of the inter-municipal treatment setup
- Campaigns for raising citizens' awareness
- Securing of sources of funds for solid waste management