

Japan International Cooperation Agency (JICA)
Ministry of Environment of the Government of Morocco

The Study on the National Guidelines for
Solid Waste Management for
the Kingdom of Morocco

Final Report

Book 4

Solid Waste Management Plans for Safi and El Jadida

August 1997

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PREFACE

In response to the request from the Government of the Kingdom of Morocco, the Government of Japan decided to conduct the Study on the National Guideline for Solid Waste Management for the Kingdom of Morocco and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA has sent to Morocco a study team headed by Mr. Masato Ohno, Director of Environmental Department, EX Corporation, Ltd., three times between January 1996 to May 1997.

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

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

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

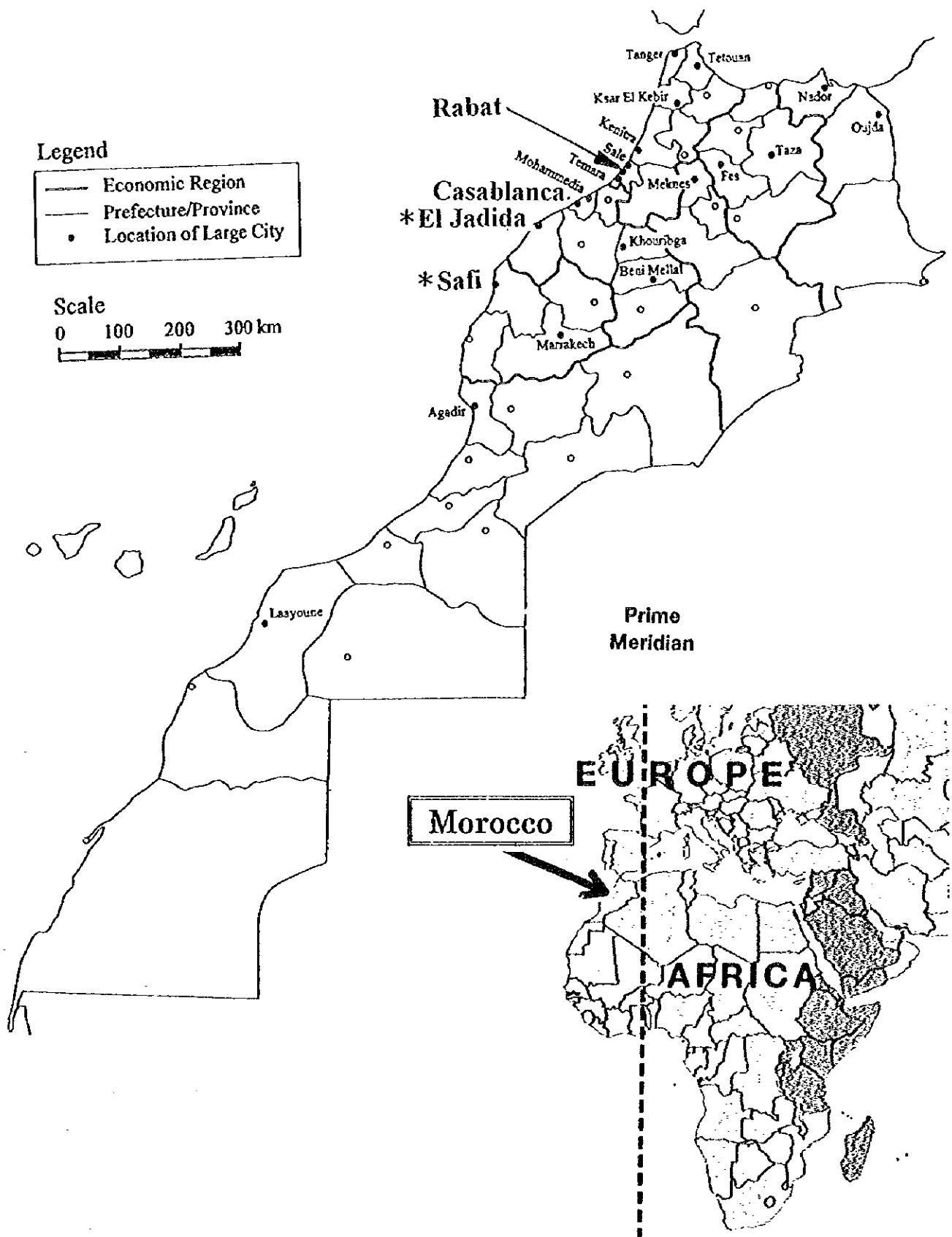
August 1997



Kimio Fujita
President
Japan International Cooperation Agency



Location Map of Morocco



* Safi and El Jadida were selected for the second year study of this project.

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**Solid Waste Management Plans
for Safi and El Jadida**

**Part 1
Solid Waste Management Plan for Safi**

Exchange Rate (as of July 1997)

1 Dirham = 0.115 US dollars = 13 yen

Abbreviation List

BMH	Municipal Health Service
CNE	National Council for Environment (Conseil National de l'Environnement)
CRE	Regional Council for Environment (Conseil Régional de l'Environnement)
DAHIR	Law, Decree, or other legal document signed by the King
DH	Dirham
EU	European Union, E.E.C
FEC	Fond D'Equipement Communal Communal Fund for Equipment
GDLC	General Department of the Local Government, MoI
HCS	Haul Container System
MoA	Ministry of Agriculture
MoC&I	Ministry of Commerce and Industry
MoE	Ministry of Environment
MoEM	Ministry of Energy and Mines
MoH	Ministry of Health
MoI	Ministry of Interior
MoPW	Ministry of Public Works
NP	National Promotion
ONEP	National Office for Drinking Water
SWM	Solid Waste Management
USE	Under Secretariat for Environment, MoI
Veh.	Vehicle

Final Report

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Current Book and Part are marked with “*”.

- Book 1** **Guidelines for National Level Policies and Actions for Solid Waste Management**
- Part 1 National Strategy
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Part 3 Industrial and Hazardous Waste
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- Book 2** **Guidelines for Improvement of Solid Waste Management for Urban Communes and Communities**
- Part 1 Management and Institutions
Part 2 Technical Guidelines
- Book 3** **National Action Programs for Solid Waste Management**
- *Book 4** **Solid Waste Management Plans for Safi and El Jadida**
- *Part 1 Solid Waste Management Plan for Safi
Part 2 Waste Disposal Plan for El Jadida
- Book 5** **Summary**
- Book 6** **Supporting Report**
Current Conditions of Solid Waste Management in Morocco
- Book 7** **Data Book**
Appendices to Solid Waste Management Plan for Safi
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THE STUDY ON THE NATIONAL GUIDELINES FOR SOLID WASTE MANAGEMENT FOR THE KINGDOM OF MOROCCO

INTRODUCTION

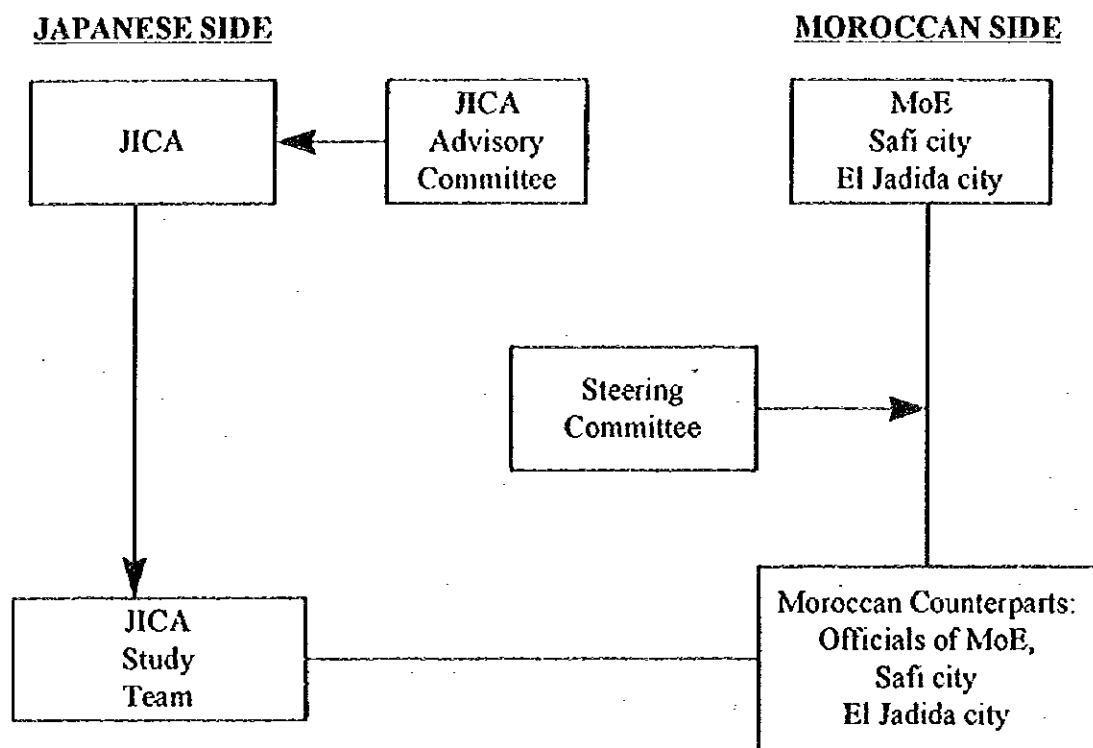
1. Objectives of the Study

The objective of the Study is to strengthen the capacity of solid waste management at both national and local levels. This study has been executed by Japan International Cooperation Agency (JICA) based on the request from the Government of Morocco. JICA commissioned the study to a joint venture comprising EX Corporation and Yachiyo Engineering Co., Ltd. The joint venture has organized a study team comprising of 11 specialists. The Study has been conducted jointly by Japanese consultants and their Moroccan counterparts.

The study period was about 18 months from January 1996 to July 1997. The Study is divided into two phases, the first phase being from the beginning up to September 1996, and the second phase being from October 1996 till the end. The objective of the first phase study is to formulate the guidelines and action plan for solid waste management at both national and local levels. The objective of the second phase is to apply the guidelines formulated and check their applicability. Two cities, i.e. Safi and El Jadida were selected for the second phase. The Study team in collaboration with the counterparts in Safi city have formulated a plan for improvement of solid waste management. In addition, we have implemented a public education campaign (demonstration project) aiming at strengthening citizens' understanding and cooperation concerning city cleansing. We have also formulated a plan for improvement of disposal of solid waste for El Jadida. It is expected that the plans will serve as a model for other local authorities in Morocco.

2. Study Organization

The study organization is shown in the figure below. This study has been conducted jointly by the Study Team led by Mr. Ohno and the Moroccan counterparts, i.e. officials of Ministry of Environment, Safi city and El Jadida city. A key counterpart agency on the Moroccan side is the Ministry of Environment. For the smooth execution of the study, the Moroccan side formed a steering committee comprising of representatives of the Ministry of Environment, Ministry of Interior, Ministry of Health, Ministry of Public Works, and Ministry of Commerce and Industry. Mrs. Layachi, Director, Department of Observation, Study and Coordination, Ministry of Environment served as chairman of the steering committee. On the Japanese side, an advisory committee was formed for the study. Dr. Masaru Tanaka, Director, Department of Waste Management Engineering, the National Institute of Health, served as chairman of the Advisory Committee.



MoE: Ministry of Environment

3. Reports

This study has produced the following reports:

1. Inception report
2. Progress report (1)
3. Interim report
4. Progress report (2)
5. Draft final report
6. Final report

The final report consists of the following Books:

- Book 1** Guidelines for National Level Policies and Actions for Solid Waste Management
 - Part 1 National Strategy
 - Part 2 Laws, Institutions, and Finance
 - Part 3 Industrial and Hazardous Waste
 - Part 4 Infectious Waste
- Book 2** Guidelines for Improvement of Solid Waste Management for Urban Communes and Communities
 - Part 1 Management and Institutions
 - Part 2 Technical Guidelines
- Book 3** National Action Programs for Solid Waste Management
- Book 4** Solid Waste Management Plans for Safi and El Jadida
 - Part 1 Solid Waste Management Plan for Safi
 - Part 2 Waste Disposal Plan for El Jadida
- Book 5** Summary
- Book 6** Supporting Report :
Current Conditions of Solid Waste Management in Morocco
- Book 7** Data Book:
Appendices to Solid Waste Management Plan for Safi
- Book 8** Japanese Summary

All the Book except for Book 8 has been prepared in English and French.

4. Solid Waste Management Improvement Plans for Safi and El Jadida (Book 4)

This book contains the following two reports:

- Part 1 Solid Waste Management Plan for Safi
- Part 2 Waste Disposal Plan for El Jadida

The two reports were prepared as the result of the second phase study.

An objective of the second phase study is to improve solid waste management in the cities of Safi and El Jadida. In addition, the second phase study has the following important objectives: 1) to examine the applicability of the Guidelines, 2) to reflect findings obtained through these activities in the Guidelines.

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**PART A SOLID WASTE MANAGEMENT
IMPROVEMENT PLAN FOR SAFI**

PART A

SOLID WASTE MANAGEMENT IMPROVEMENT PLAN FOR SAFI

CHAPTER 1

INTRODUCTION

1.1 Objectives

The objectives of the Safi study is to improve solid waste management of Safi city through 1) formulating a solid waste management improvement plan and 2) executing public waste education demonstration project. Accordingly, the Safi study report consists of the following two parts.

Part A Solid Waste Management Improvement Plan for Safi

Part B Public Waste Education Demonstration Project in Safi

1.2 Study Method and Aspects

This study includes field surveys and questionnaire surveys listed below as well as collection of written information, hearing from relevant organizations, observation and discussion with the counterparts.

1. Household waste generation survey
2. Waste collection quantity survey by using truck scale
3. Industrial waste survey
4. Waste composition analysis
5. Household (opinion) survey
6. Time and motion study
7. Financial questionnaire survey (expenditure and revenue)

The three urban communes of Boudheb, Zaouia, and Biada, as well as the Urban Community of Safi and the Province of Safi contributed greatly to the implementation of the above surveys.

This study covers technical, operational, managerial, institutional, financial, and legal aspects as well as public awareness.

The public awareness campaign consisted of several different programs and activities. Materials produced for the campaign include posters of various sizes, leaflets, notebooks, and post cards. Designs used in the materials were selected through competition organized within schools (7th grade students) as well as for artists.

Target groups for the campaign include not only the general public but also school children and city officials.

1.3 Study Organization

The second phase study has been carried out by the JICA Study Team and the counterparts from the cities of Safi and El Jadida with the support of the Ministry of Environment.

In Safi, the following organizations participated in the execution of the campaign:

1. Province of Safi
2. Urban Community of Safi
3. Urban Commune of Boudheb
4. Urban Commune of Zaouia
5. Urban Commune of Biada
6. Delegation of Minister of National Education
7. Delegation of Public Health
8. Delegation of Minister of Youth and Sports
9. Delegation of Cultural Affairs
10. Delegation of Minister of National Mutual Aid
11. Association of Culture and Leisure
12. Association for Environment and Development

This campaign serves as a demonstration project of this kind for other Moroccan cities.

CHAPTER 2 CHARACTERISTICS OF THE STUDY AREA

2.1 Outline of Safi

Safi city is the seat of the provincial government. The province of Safi is located in the northwestern part of the economic region of Tensift which consists of 8 provinces and prefectures. The province of Safi consists of 7 urban communes and 30 rural communes. The area of the province is 7,285 km² (1.0% of the kingdom's territory) and the population was 822,564 (3.2% of the kingdom's population) in 1994.

Facing the Atlantic ocean, the urban area of Safi city (Safi urban community) is formed around the mouth of the Chabab river, approximately 250 km distant from Casablanca. Safi city consists of 3 urban communes; Asfi Biada, Asfi Boudheb, and Asfi Zaouia. The city had a population of 262,276 in 1994, which is estimated at 32% of the total population of the province. Major industries are the phosphoric industry and fishery.

The phosphoric industry dominates the economy of the city. A volume of raw phosphate rock and fertilizers (the latter produced in chemical plants of the south) passes through the port that is located on the north of the urban area.

Fishing is also a principal industry in Safi city. The haul in 1994 was estimated at 13,983 tons (88.2 million DH), approximately half of the catch being sardines. However, the canning industry declined from the peak it reached under the French protectorate; the number of processing units decreased from 80 in 1950 to 30 in 1975. At present, only 19 of those processing units are actually active, and these operate at about 50% of capacity, due to the irregular supply of raw materials.

As a unique feature, Safi city is well known for its traditional potteries which are a principal tourism attraction as well as historic sites such as the Portuguese fortress which was restored in 1963.

2.2 Climate

The climate of Safi city is relatively moderate due to the influence of the sea and is characterized as semiarid, hot and dry during summer and rigorously humid and temperate in the winter. The minimum average temperature is 12.8 in January and the maximum average temperature is 32.1 in July. The average annual rainfall is estimated at 405.4 mm based on observation over the past 21 years (1955-75). Table 2.1 shows the climatic condition of Safi in 1995. Rainfall in 1996 was 1018.2 mm, which was unusually high. Wind directions in Safi city are mainly north-east and north-west.

Table 2.1 Temperature and Rainfall in Safi (1995)

		Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Temp.	min	2.8	4.8	3.6	8.0	12.4	13.0	15.7	15.5	13.5	13.0	7.4	5.0	-
	max	23.8	26.4	30.2	32.0	36.5	32.2	38.3	37.6	32.4	33.2	28.8	26.7	-
Rainfall (mm)		N/S	30.3	41.3	20.2	-	-	-	-	N/S	11.6	33.6	159.4	296.4

Source: Safi Province

2.3 Socio-economic Conditions

2.3.1 Population

As shown in Table 2.2, the annual growth rate of the kingdom's population has declined in recent years. Annual growth rates of both the province and urban community of Safi are lower than the national level; the annual growth rate of Safi urban community for the period of 1971-82 was 3.93%, while the rate for the kingdom's urban population is at 4.46%. Similarly, for the period of 1982-94, the former was 2.40% and the latter was 3.64%.

Table 2.2 Annual Growth Rate of Population

Item	Population			Annual Growth Rate (%)	
	1971	1982	1994	1971-82	1982-94
Province of Safi	554,545	706,618	822,564	2.23	1.27
Urban Community of Safi	129,113	197,309	262,276	3.93	2.40
Kingdom's Population	15,379,259	20,419,555	26,073,717	2.61	2.06
Urban Population in Kingdom	5,401,971	8,730,399	13,415,659	4.46	3.64

Source: Direction de la Statistique

Since the first chemical plant of Maroc-Chimie was established in Safi in 1965, the chemical industry has rapidly expanded.

The urban community of Safi is administratively comprised of three communes; Asfi Biada, Asfi Boudheb and Asfi Zaouia of which the administrative areas are 27.0 km², 11.0 km² and 33.0 km² respectively. Table 2.3 shows the population and the numbers of households in each commune, based on the population census implemented by the Ministry of Population in 1994. Asfi Boudheb, in which most of the administrative and commercial facilities are concentrated, has the largest population and density, followed by Asfi Zaouia and Asfi Biada. Regarding household size, Asfi Biada of which the built-up area is mostly used for residential purposes, has the largest average family size at 5.7, followed by Asfi Zaouia where the phosphate processing factories are operated, at 5.2. Boudheb, known for its canning factories, shows an average family size of 4.9.

Table 2.3 Population and Households of Safi in 1994

Commune	Area (sq.km)	Population	Density (per./sq.km)	Household	
				No. of Household	Av. Family Size
Asfi Biada	27.0	65,917	2,441.4	11,665	5.7
Asfi Boudheb	11.0	100,757	9,159.7	20,709	4.9
Asfi Zaouia	33.0	95,602	2,897.0	18,539	5.2
Total	71.0	262,276	3,694.0	50,913	5.2

Source: Direction de la Statistique and JICA Study Questionnaire Survey

The future population of each commune is projected by the Ministry of Population, as shown in Table 2.4. The total population of Safi urban community in 2010 is estimated at 379,293, increasing by nearly 120 thousand persons from the 1994 population. The annual growth rate for each commune is projected on the basis of past trends. Asfi Zaouia has the highest annual growth rate among 3 urban communes, this being estimated at 3.26% for 1994-2010. Asfi Biada and Asfi Boudheb have relatively lower annual growth rates. Projected population growth rates between 1994 and 2010 are shown below based on "Service Regionale de la Population de Safi." provided by the Ministry of Population.

Table 2.4 Population Projections

Commune	Actual	Projected Population			Annual Growth Rate 1994-2010 (%)
	Year 1994	Year 2000	Year 2005	Year 2010	
Asfi Biada	65,917	72,105	77,704	83,737	1.51
Asfi Boudheb	100,757	112,676	123,679	135,756	1.88
Asfi Zaouia	95,602	115,913	136,099	159,800	3.26
Total	262,276	300,694	337,482	379,293	2.33

Source: Service Regional de la Population de Safi

2.3.2 Economic Conditions

The economic activities of Safi city are briefly listed under four sectors; manufacture, fishery, pottery, and tourism. Among them, the manufacturing sector dominates the city's economy, the production of this sector being estimated at 6,306 million DH in 1992. The chemical industry accounts for 78% of the total production of the four major manufacturing sectors, this resulting from the activities of the OCP.

Agribusiness, which consists mainly of canning industries, is concentrated in Boudheb commune and is located on the southern side of the commune. The key industry of Safi city is the phosphate processing of OCP which is located in the southern part of Zaouia, and distant from the urbanized area. All potteries, the unique industry of Safi city, are located in the Biada commune, along the valley of the Chabah river. Table 2.5 shows the distribution of manufacturing industries in Safi.

Tableau 2.5 Distribution of Manufacturing Industries in Safi

Items	No. Manufacturing Industries			Total
	Biada	Boudheb	Zaouia	
Agro-industry	4	27	-	31
Textile and leather	-	2	-	2
Pottery	135	-	-	135
Chemistry and parachemistry	27	-	1	28
Total	166	29	1	196

Source: JICA Study Team

2.3.3 Sanitation Conditions

1) Water Supply

ONEP (Office National de l'Eau Potable) produces water for Safi city. The source of water supply is mostly from the Imfout dam of the Oum Errabia river, approximately 150 km distant from Safi city, which accounts for about at 83% of the total. The rest of the resource, which is mostly supplied to Biada commune, is from groundwater.

The water demand of the city is estimated at 30,000 m³/day. According to the study of "The Master Plan for Water Supply in Safi City" implemented by RADES in 1993, 56.5% of the households of the city are connected to the public water supply. The rates of connection to the public water supply by communes are not available; however, the rates by the zones which are divided for the purpose of the service and the management of the network are available from the study, as shown in Figure 2.1. The city's residential area is divided into 18 zones. The zone of Kaouki which belongs to Zaouia commune has the highest rate at 92.4%, followed by Plateau which is the administrative center of Safi city, and Sidi Bouzid in Biada commune. The zones of Courses and Medina have lower rates, estimated at 16.0% and 27.7% respectively.

2) Wastewater

It was estimated that 88% of the population of Safi city was connected to the sewer system in 1988. However, Safi city still does not have a sewage treatment plant, thus the whole wastewater including industrial effluents discharged untreated to the sea. It seems that effluent from OCP's chemical complex is the most critical environmental problem in SAFI.

2.3.4 Land Use

Figure 2.2 shows the present land use in Safi city, excluding agricultural and vacant land. Major administrative and commercial facilities are located in a hilly area of Boudheb commune. The original city is centered on the Medina, which is located on the low land area along the coast. The canning and textile industries are also situated along the coast, on the south fringe of Boudheb commune. Land use in Biada commune is however mainly for residential purposes. The vast area of OCP's chemical complex is located on the south of Zaouia commune, distant from the residential area. The stretch from Medina to the Safi railway station is the most densely populated, as shown in Figure 2.1.

The built-up area of each commune is estimated as shown in Table 2.6. Boudheb commune is the most developed, estimated at 83.3% of the territory. Urban expansion is primarily north and south. Multi-story housing has been constructed mainly for the Zaouia commune and mixed housing (multi-story housing, villas and so on) is to be found in Biada commune.

Table 2.6 Built-up Area of Each Commune

Commune	Territory (ha)	Built-up Area (ha)	Rate (%)
Biada	3,300	1,527	46.3
Boudheb	1,100	916	83.3
Zaouia	2,700	900	33.3
Total	7,100	3,343	47.1

Source: Province of Safi

The master plan of Safi city was authorized in 1983. It is now out of date, and revision is in progress. Information regarding the revised plans is not available.

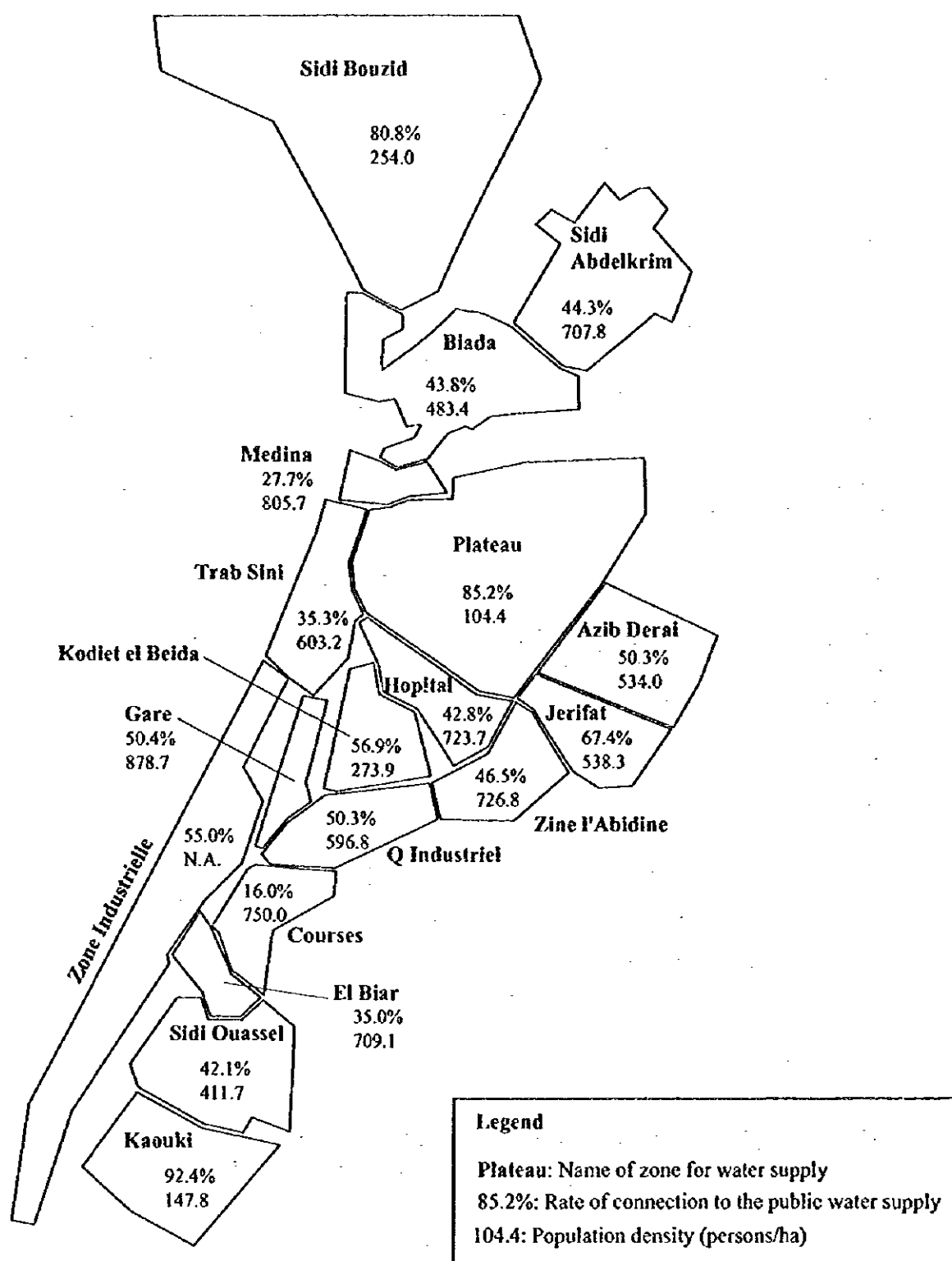
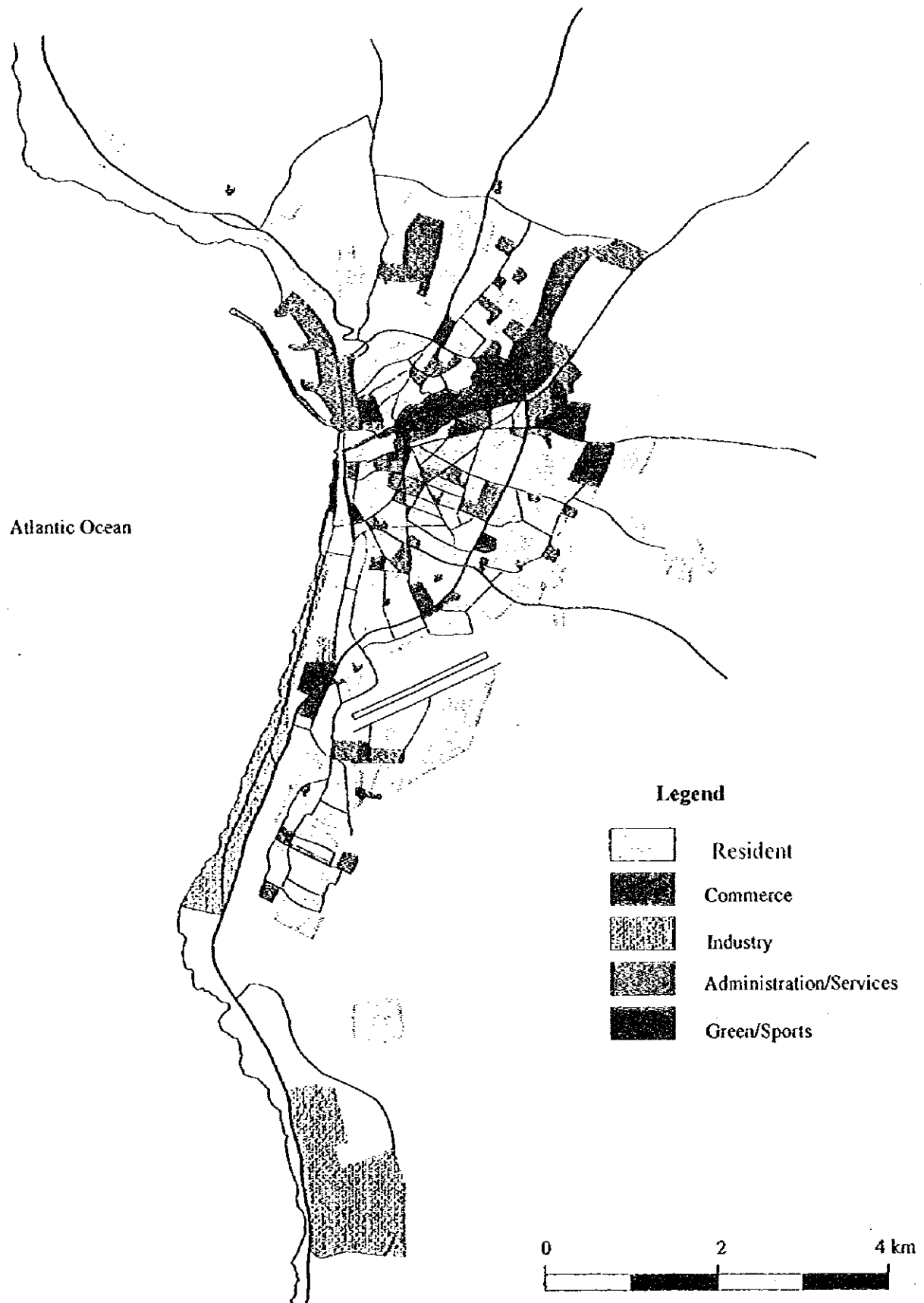


Figure 2.1 Rates of Connection to the Public Water Supply

Source: The Master Plan for Water Supply in Safi City, RADES 1993

Figure 2.2 Present Land Use in Safi City





CHAPTER 3 WASTE GENERATION - CURRENT AND FUTURE

3.1 Municipal Waste

3.1.1 Current Municipal Waste Generation

1) Municipal Waste Amount

a. Methodology

Municipal solid waste comprises the following waste types;

- Household waste
- Commercial wastes (includes shops, markets, hotels, restaurants, office buildings, packing and household wastes from factories, institutions, etc.)
- Street waste

The survey to determine the unit generation rate for municipal household solid waste was done by collecting the waste generated in a number of households daily for eight days, discarding the first days waste. The households surveyed were as follows;

3 urban communes x 20 households/income level x 3 income levels = 180 households

The waste collected from each household was weighed daily and, knowing the number of people in each household, it was possible to determine the daily unit generation rate (gram/cap/day). The counterparts in each urban commune selected the households to represent each of the three income levels and also provided the Study Team with Information In each Income group for each commune.

The amount of other municipal waste generated was surveyed through questionnaire survey of major enterprises representing roughly half of the total in the city, selected by the counterparts from the list provided by the local chamber of commerce and industry. An understanding of street and market wastes was obtained through the truck scale survey where the wastes hauled in were measured and the type recorded of waste.

b. Municipal Household Waste Amount

The results of the survey are provided in Appendix 1 and summarized in the following table;

Table 3.1-1 Municipal Household Waste Unit Generation (unit: kg/cap/d)

Urban Commune Income level	Boudheb	Zaouia	Biada	Tot. Safi avg. (*1)
Low income	0.383	0.223	0.336	0.313
Middle income	0.511	0.340	0.508	0.446
High income	0.520	0.412	0.677	0.513

Note (*1) Estimated based on population data issued by Ministry of Population

The expected tendency of the unit generation rate increasing with the increase in wealth is clear for all three urban communes. The low values for Zaouia urban commune in all three income levels compared to the other two communes is significant. The low values may be partially explained by the nature of the residents in that commune, many of which are migrants drawn towards work opportunities in the city.

Based on the surveyed rates and using the population distribution provided by each urban commune the municipal household waste amount in 1996 and average unit generation rates were estimated as shown in the following table.

Table 3.1-2 Generated Municipal Household Waste Amounts in 1996

	Boudheb	Zaouia	Biada	Tot. Safi
A. Population (total)	104,581	101,937	67,923	274,443
- Low income	23,264	19,848	5,912	49,024
- Middle income	71,265	80,088	61,182	212,535
- High income	10,053	2,002	829	12,884
B. Waste amount (t/d)	50.48	32.48	33.56	116.53
C. Ave. Unit generation rate (kg/cap/d)	0.483	0.319	0.494	0.425

Notes:

- ① 1996 population projected based on 1994 population data using assumptions shown in Section 3.1.2
- ② Population distribution by income levels based on number of housing units by type

c. Other Municipal Waste Amount

It is always difficult to survey the unit generation rate by type of commercial activity or street length when overall data on number or floor areas of commercial and business establishments and street lengths are not available. Such is the case in Safi city. Therefore based on interviews conducted with 23 commercial and industrial establishments, analysis of the results of the waste types surveyed at the truck scale during one week, existing land use, and discussions with the counterparts the municipal other waste amounts generated by each urban commune were estimated as shown in the following table.

Table 3.1-3 Municipal Other Waste Generation Amounts (unit: t/d)

Municipal Other Waste Type	Urban Commune	Boudheb	Zaouia	Biada
1. Commercial/industrial waste		9.63	4.33	1.94
2. Street sweeping		1.1	0.9	0.5
3. Tot. Municipal Other Waste Amount		10.73	5.23	2.44

d. Municipal Waste Amount

Based on the analysis presented above the municipal waste unit generation rate and amount in 1996 can be estimated as shown in the following table.

Table 3.1-4 Municipal Waste Amount

	Boudheb	Zaouia	Biada	Tot. Safi
1. Municipal waste amount (t/d)	61.21	37.71	36.00	134.92
- Municipal Household waste amount	50.48	32.48	33.56	116.53
- Municipal other waste amount (t/d)	10.73	5.23	2.44	18.39
2. Unit generation rate (kg/cap/d)	0.585	0.370	0.530	0.492

In addition to the above estimated waste quantity, the truck scale survey showed that 4 t/d are hauled to the disposal site daily directly by the generators as follows:

- Port waste: 3.2 t/d
- Other non-industrial: 0.8 t/d

These figures will be considered separately in the following section, where the waste amounts are projected and in the collection plan. In the disposal plan they will be added to the waste to be disposed of at the disposal site.

e. Seasonal Fluctuation of Waste Amount

The JICA Study Team survey was conducted during the month of November 1996, which is the winter season in Safi city. Unfortunately this Study period did not include the summer period. While types of food produce by season and even religious seasons (such as Ramadan) will effect the waste unit generation rate it is expected that lack of some factors in one season will be compensated by existence of other factors unique to that season. Therefore the above estimated unit generation rates may be adopted as the annual average.

Nevertheless, it is recommended that at a later time when the results of this survey are updated, that Safi city conduct the survey during both seasons to estimate seasonal fluctuations.

2) Municipal Household Waste Composition

a. Methodology

Samples from the household waste unit generation rate survey were used to implement this survey, which comprised the following components;

- bulk density
- waste composition (wet base)
- waste composition (dry base)
- water content by waste component

The survey was implemented at the regional laboratory of the Ministry of Public Works.

The survey covered only the household waste portion of the municipal waste, which represents 86% of total municipal solid waste.

b. Municipal Household Waste Composition

The results of the survey are shown in Table 3.1-5. Detailed results by income level are given in the Appendix.

Table 3.1-5 Municipal Household Waste Composition (wet base)

Survey Item	Boudheb	Zaouia	Biada	Tot. Safi
1. Bulk density (kg/m ³)	0.383	0.344	0.348	0.360
2. Composition on wet base (%)				
- Kitchen waste	76.1	77.6	77.2	76.9
- Paper	7.3	10.9	7.2	8.6
- Wood	0.4	0.5	0.2	0.4
- Plastic	4.4	5.8	7.6	5.7
- Metal	0.6	1.9	1.9	1.4
- Glass	2.2	0.5	3.2	1.8
- Leather, textiles	1.0	1.6	1.7	1.4
- Others	7.6	1.4	1.1	3.7

The results show that there is not much variation between the three urban communes in terms of waste composition. Kitchen waste is significantly high. Produced amounts of paper, plastic and glass wastes, which are targets for recycling are estimated as 10, 7 and 2 t/d respectively (these figures do not include the Municipal Other Waste which may increase the paper and plastic waste amounts by 3-5 tons each).

Municipal household waste samples obtained from Boudheb were oven dried for about 5 days and the results of the survey are shown in Table 3.1-6.

Table 3.1-6 Waste Composition Analysis on Dry Base (unit: %)

Waste components	Composition	Moisture content
- Kitchen waste	49.2	78.4
- Paper	10.5	51.7
- Wood	3.7	19.5
- Plastic	8.1	42.5
- Metal	1.8	7.6
- Glass	6.7	1.4
- Leather, textiles	1.1	33.7
- Other combustible wastes	1.3	11.3
- Other non-combustible waste	17.8	4.1
- Total/average	100.1	66.2

The overall moisture content, at 66% is quite high and indicates the unsuitability of burning waste, and the need to take this into consideration when introducing compactor trucks for waste collection and transport. The high moisture content in both paper and plastic wastes indicates the need to separate these waste types at source in order to improve their recycling potential.

Table 3.1-7 Projection of Municipal Solid Waste Generation

Table 3.1-7 Projection of Municipal Solid Waste Generation in Safi																				
Population (Persons)					Per Capita Generation (gram/capita/day)					Waste Generation (ton/day)					Annual Generation (ton/year)					
Year	Boudheb	Zaouia	Biada	Total	Boudheb	Zaouia	Biada	Weighted Average		Boudheb	Zaouia	Biada	Total	Quantity of Large Generators	Grand Total	Boudheb	Zaouia	Biada	Total	
1994	100757	95602	65917	262276																
1995	102651	98719	66912	268282																
1996	104581	101937	67923	274441	585	370	530	492	61	38	36	135	4	139	22331	13767	13140	49237	1460	
1997	106547	105260	68948	280755	591	373	536	496	63	39	37	139	4	143	22978	14317	13481	50777	1518	
1998	108550	108691	69989	287230	597	375	541	499	65	41	38	143	4	148	23645	14890	13832	52366	1579	
1999	110591	112235	71046	293872	603	378	547	504	67	42	39	148	4	152	24330	15486	14191	54007	1642	
2000	112670	115894	72119	300683	609	381	553	508	69	44	40	153	5	157	25036	16105	14560	55701	1708	
2001	114788	118672	73208	307668	615	383	559	512	71	46	41	157	5	162	25762	16749	14919	57450	1776	
2002	116946	123573	74314	314833	621	386	565	516	73	48	42	162	5	167	26509	17419	15327	59256	1847	
2003	119145	127602	75436	322183	627	389	571	520	75	50	43	167	5	173	27278	18116	15756	61120	1921	
2004	121385	131761	76575	329721	634	392	577	524	77	52	44	173	5	178	28069	18841	16135	63044	1998	
2005	123667	136057	77731	337455	640	395	583	528	79	54	45	178	6	184	28883	19594	16554	65031	2078	
2006	125992	140492	78905	345389	646	397	590	532	81	56	47	184	6	190	29720	20378	16985	67083	2161	
2007	128360	145072	80096	353528	653	400	596	536	84	58	48	190	6	196	30632	21193	17426	69202	2248	
2008	130774	149802	81306	361882	659	403	602	540	86	60	49	196	6	202	31469	22041	17879	71389	2338	
2009	133232	154685	82533	370450	666	406	609	545	89	63	50	202	7	208	32382	22922	18344	73648	2431	
2010	135737	159728	83780	379245	673	409	615	549	91	65	52	208	7	215	33321	23839	18821	75981	2528	
Total																412598	273656	237342	925293	29234
																			954527	

3.1.2 Projection of Waste Generation

1) Generation Quantity

It is projected that waste generation in the city of Safi will increase from 139 ton/day in 1996 to 216 ton/day in 2010, an increase of 1.5 times. The average rate of increase during the period is 3.1 %/year. Rates of increase differ by communes; Zaouia 4.0 %, Boudheb 2.9 %/year, and Biada 2.6 %. Projected waste generation is shown in Table 3.1-7.

Remark: Of the 139 ton/day of waste generated, 4 ton/day is generated by large enterprises which transport waste by themselves to the municipal landfill site. Such enterprises include the port authority (ODEP) and CCT. The remaining 135 ton/day is comprised of household waste (116.5 ton/day) and other municipal waste (18.5 ton/day) as shown in Table 3.1-4. Of the 135 ton/day of waste, about 101 ton/day is collected by the 3 urban communes and the urban community as shown in Table 4.1-1.

2) Assumptions Used

Major assumptions are shown in the following table.

Table 3.1-8 Assumptions on Annual Growth of Population, Economy and Waste Generation during 1996 - 2010

	Boudheb	Zaouia	Biada
1. Population Growth	1.88 %	3.26 %	1.51 %
2. Per Capita Economic Growth	2 %	2 %	2 %
3. Economic Growth	3.9 %	5.3 %	3.5 %
4. Waste Generation Growth (75 % of economic growth)	2.9 %	4.0 %	2.6 %

Sources:

1. Population growth rates: Ministry of Population
2. Per capita economic growth: JICA Study Team's assumption
3. Economic growth rates are calculated on the basis of population growth and per capita economic growth.

Japanese experience between 1965 and 1985 shows that the annual average municipal waste generation growth was 3 %/year, which is about 70 % of the annual average economic growth (4.3 %/year). In general, this coefficient would be larger when the income levels are lower. For this study, the coefficient of 0.75 is assumed.

It is assumed that the municipal waste generation by large quantity generators (transported by generators) is 4 %/year.

3.2 Waste Generated by Industrial Enterprises

3.2.1 Current Generation

1) Methods

To understand the types and quantities of waste generated by industrial enterprises, an industrial waste inventory survey was carried out. Out of 107 industrial enterprises registered at the Chamber of Commerce and Industry of Safi, 33 major enterprises were selected for the inventory survey. Actually, 23 enterprises responded to the questionnaire delivered. Of the 23 enterprises, 18 are in Boudheb, 4 in Biada, and 1 in Zaouia. Appendix 5 shows copies of the answers given by the enterprises. Appendix 12 contains the terms of reference for the survey and formats used. Table 3.2-4 shows a summary of the survey.

In view of the fact that surveyed enterprises are major ones in Safi, it is assumed that the quantity of non-recycled waste reported by the surveyed enterprises represents one half of the total quantity of Safi, and the quantity of recycled waste represents 35 % of the total recycled waste of Safi.

Results of the truck scale survey and interview surveys were also used for estimating the quantity of a part of industrial waste.

2) Type and Quantity of Waste Generated from Industrial Enterprises

It is estimated that about 60 tons/day of waste (including recyclable materials) are generated from industrial enterprises in Safi, of which 8 ton/day is reused or recycled. Of the remaining 52 ton/day, non recycled industrial waste is 37 ton/day and 15 ton/day is municipal (non industrial) waste.

Of the 52 ton/day of non-recycled waste generated from industrial enterprises, 14.4 ton/day is disposed of at the municipal dump site, 36 ton/day of waste (most is demolition waste) is disposed of at unofficial dump sites. The remaining 1.6 ton/day remains uncollected.

An important finding of the survey is that the majority of waste discharged by industrial enterprises (excluding demolition waste, pottery waste and expired fish cans) is municipal waste such as package materials (cardboard, paper and plastics), and food waste. Most enterprises have such waste collected by the communes.

The total quantity of non-municipal waste generated from industry is 15 ton/day. Most (9.4 ton/day) of this type of waste is collected by the communes. There are only a few enterprises such as the port authority, and CCT (plastic products manufacturer) who transport their waste to the municipal dump site. They transport about 4 ton/day of waste to the municipal dump site.

Demolition waste and pottery waste are disposed of at unofficial dump sites. There are 3 major sites of this kind, and some other small sites in Safi. The quantity of demolition waste and pottery waste dumped at these sites is estimated to be about 34 ton/day.

These types of waste are actually used as filling materials. Some houses have been built on former dumping places of this kind

Industrial waste other than demolition waste and pottery waste is not disposed of as waste but mostly reused or sold to other companies for recycling. The quantity of reused or recycled waste is estimated to be about 8 ton/day.

The only hazardous waste disposed of at the municipal dump site is medical waste generated from Mohammed V Hospital. This waste is transported by the Urban Commune of Boudheb. Its quantity is estimated to be 1 ton/day. (2 ton/day including household waste of the hospital.)

Table 3.2-1 Summary of Waste Generated by Industrial Enterprises in Safi in 1996

Type of Waste	Disposal Method/ Location	Generation Quantity (including 1.6 tons of non-collected waste)	Collected by the Communes	Collected or Recycled or Disposed by Generators
1. Municipal (non-industrial) waste	Disposed of at the municipal dump site	15 ton/day (Uncollected waste is 1.6 ton/day)	9.4 ton/day (Note 1)	4 ton/day (Note 2)
2. Non-recycled Industrial Waste		1 ton/day (medical waste)	1 ton/day (Note 3)	0
	Disposed of at unofficial dump sites	36 ton/day demolition waste & some pottery waste) or burnt at quarry (expired fish cans)	0	36 ton/day (Notes 4 - 7)
Sub total		37 ton/day	1 ton/day	36
Total (1 + 2)		52 ton/day	10.4 ton/day	40 ton/day
3. Reused/ Recycled Industrial Waste (Materials)	Reused or sold for recycling	8 ton/day	0	8 (Notes 8 - 10)
Total (1 + 2 + 3)		60 ton/day	10.4 ton/day	48 ton/day

Notes:

1. 9.4 ton/day transported by the communes to the municipal dump site is estimated assuming that the corresponding quantity (4.7 ton/day shown in Table 3.2-2) of the surveyed enterprises represents 50 % of the total in Safi.
2. 4 ton/day of non municipal waste transported by enterprises is estimated on the basis of the result of the truck scale survey conducted in November 1996.
3. According to the Industrial Waste Inventory Survey, Mohammed V Hospital generates 2 ton/day of waste. It is assumed that a half (1 ton/day) of this waste is medical waste.

4. 36 ton/day of waste dumped at unofficial dump sites consists of the following waste:
- | | |
|------------------------------------|--------------|
| a. Pottery waste | 2.5 ton/day |
| b. Demolition waste | 31.7 ton/day |
| Sub total | 34.2 ton/day |
| c. Expired fish cans and bad meat: | 1.8 ton/day |
| Total: | 36.0 ton/day |
5. The quantity of pottery waste (2.5 ton/day) discharged to unofficial dump sites was estimated based on information obtained from a pottery workshop owner. The waste is transported by privately-hired trucks to the dump sites where demolition waste is dumped.

Table 3.2-2 Waste Amount Discharged to Unofficial Dumping Sites

Size	No of Sites	Waste Amount ton/month	Total Waste Amount ton/month
Small Workshop	129	0.6	77.4
Medium Workshop	3	2	6
Large Industry	3	(Recycled)	(Recycled)
Total	135	77.4 ton/month	
		928.8 ton/year	
		2.5 ton/day	

6. 31.7 ton/day of demolition waste was estimated on the basis of the observation of the 3 large dump sites in Safi where this type of waste is dumped. From the observation, it is estimated that the total quantity of waste dumped in the 3 dump sites is approximately 250,000 ton. Assuming that this is a cumulative quantity of the past 20 years, average dumping quantity is 12,500 ton/year or 34.2 ton/day. Main types of waste dumped in the 3 dump sites are demolition waste and pottery waste. The quantity of pottery waste dumped at these sites is estimated to be about 2.5 ton/day from the industrial waste inventory survey. Therefore, the demolition waste quantity is estimated to be 31.7 ton/year. ($34.2 - 2.5 = 31.7$).
7. 1.8 ton/day of expired fish cans and bad meat burnt in a quarry is estimated based on the following information provided by the Hygiene Office of Safi.

Table 3.2-3 Annual Quantity of Cans Disposed of under the Supervision of Hygiene Office in 1996

Products Disposed of	Annual Quantity of Cans Disposed of under the Supervision of Hygiene Office in 1996 (Source: Hygiene Office)	
a. Expired cans filled with fish	4,741,263 cans/year	592.7 tons/year (Note 1)
b. Bad cans/containers without filling	2,584,684 cans/year	64.6 ton/year (Note 2)
c. Sub-total of cans (a + b)		657.3 ton/year = 1.8 ton/day
d. Meat and fish		5.2 ton/year = 0.014 ton/day
Total (c + d)		662.5 ton/year = 1.814 ton/day (Note 3)

Note 1: 125 gram/can x 4,741,263 cans/year = 592.7 ton/year

Note 2: 25 gram/can x 2,584,684 cans/year = 64.6 ton/year

Note 3: Details are as follows:

meat 753 kg + offal (inside stomach) 1567 kg + fish 2,864 kg = 5184 kg

8. 8 ton/day of reused/recycled waste consists of 4 ton/day of recycled pottery waste and the remaining 4 ton/day of other recycled waste.
9. 4 ton/day of pottery waste reused is estimated on the basis of information from the pottery industry. There are 3 pottery factories which have equipment to crush waste for reuse. Total pottery waste reused is 1460 ton/year or 4 ton/day.
10. According to the Industrial Waste Inventory Survey of selected factories, the total quantity of reused/recycled industrial waste excluding pottery waste is 496 ton/year. Assuming this quantity represents about one third of the total, the total is estimated to be 1488 ton/year or 4 ton/day.
11. Commercial waste generation (not included in the above table) is estimated to be 3.9 ton/day.

Table 3.2-4 Summary of Results of the Safi Industrial Waste Inventory Survey (Selected 23 Enterprises)

Unit: ton/year

Type of Waste	Disposed of at Municipal Disposal Site	Sold, Recycled, or Disposed of at Non-Municipal Disposal Sites	Company Name	Remarks
1. Cardboard, paper, plastic	594		ABDA (Leather/Tanning)	cardboard, plastic
	180		CMC (Canning Industry)	cardboard, plastic, partly to the sea
	84		Les Grands Moulins (Mills)	plastic
	18.0		Photo-Taibi	paper
	9.6		Comunivers (Retail Detergent)	cardboard, plastic
	8		La Bouée company (Paint, Maritime, Electric)	paper, cardboard, plastic
	0	7.2	PIC Maillf (Clothing)	cardboard, wool, sold
	6.5		Safi Pullmode (Clothing)	partly sold
	6		MBH Printing Company	paper, cardboard
	4		Pharmacy ALFARABI	cardboard
	3.6		Pharmacy la liberte	cardboard, plastic
	3		shell station	
	2.4		Moroccan company (Construction Materials)	transported by enterprise

	0	0.5	SOCARBA (Mineral and Quarry)	sold
- Sub total	919.1	7.7		
2. Waste generated from hospital	720		Mohammed V Hospital	
3. Reformed bins		300	CE Shell	recycled
4. Expired Cans		144	CMC (Canning Industry)	burnt at quarry, supervised by the Health Office (BMH)
		18	Haj Abid (Canning Industry)	180,000 cans/year (Average weight of one can is 0.1 kg.)
- Sub total		162		
5. Food waste	2.5		La Bouée company (Paint, Maritime, Electric)	
	2		CE Shell	
	2		Shell station	
	30		SOMOS Mill	wheat
	28.6		Haj Abid (Canning Industry)	partly to the sea
- Sub total	65.1			
6. Polyethylene waste		20	CCT (Plastic products)	sold
7. Oil waste		1	Shell Station	recycled
		1.3	CCT (Plastic products))	burnt inside factory
		1	SOCARBA (Mineral and Quarry)	sold
- Sub total		3.3		
8. Tire waste		3	SOCARBA (Mineral and Quarry)	sold
9. Felt	3		CCT (Chemical/Plastic)	transported by enterprise
10. Broken pottery		32.4	Maitre Ceramiste Serghini (pottery)	transported by private trucks to disposal (not municipal disposal)
		3	Ziouani Jilali (Pottery)	transported by private trucks to disposal (not municipal disposal)
		500	BRIMAK (Pottery)	100% recycled
- Sub total		535.4		
11. Wood and ash	2		Ziouani Jilali (Pottery)	transported to disposal site by truck
Grand Total	1709.20	1025.10		
Daily Average	4.7 t/day	2.8 t/day		

Remark 1: OCP (National phosphate company) generates 7.5 million tons of phosphated gypsum (liquid waste) annually (20,548 ton/day). OCP discharges it to the sea after washing and filtering process.

Remark 2: All above-listed companies except for SOCARBA and OCP are located in Boudheb; SOCARBA is in Biada and OCP is in Zaouia.

3.2.2 Future Projections

Table 3.2-4 shows projections of generation and collection quantities of waste produced by industrial enterprises.

Industrial enterprises produce both non industrial (municipal) waste and industrial waste. It is assumed that municipal waste will increase by 3.3 %/year, and industrial waste will increase by 4 %/year. On this assumption, in 2010, the total quantity of waste generated from industrial enterprises will be 102 ton/day, of which 14 ton/day will be recycled. No waste will remain uncollected.

Table 3.2-3 Projection of Waste Generated by Industry and Quantity Collected

Unit: ton/day except for the bottom row													
Type of Waste	Municipal Waste (Non Industrial Waste)	Target collection Rate	Medical Waste (Municipal)	Non Recycled Industrial Waste Generation & Collection Quantity	Fish Cans & Bad Meat	Sub total (c+d+e)	Pottery Waste	Industrial Waste	Other Industrial Waste	Sub total (g+h)	Industrial Waste Recycled or Recycled Quantity	Total Waste Generated	Total Waste Collected or Recycled
Collected or Recycled by	Communes & Generators	Commune	Generators	Generators	Generators	Generators	Generators	Generators	Generators	Generators	Generators	Generators	Generators
	a	b	c	d	e	f	g	h	i	j	k	l	m
1996	15	80%	1	34	2	37	4	4	8	60	58	2	
1997	15	90%	1	36	2	38	4	4	8	62	61	1	
1998	16	91%	1	37	2	40	4	4	9	65	63	1	
1999	17	92%	1	38	2	42	4	4	9	67	66	1	
2000	17	93%	1	40	2	43	5	5	9	70	68	1	
2001	18	93%	1	42	2	45	5	5	10	72	71	1	
2002	18	94%	1	43	2	47	5	5	10	75	74	1	
2003	19	95%	1	45	2	49	5	5	11	78	77	1	
2004	19	96%	1	47	2	51	5	5	11	81	80	1	
2005	20	96%	1	49	3	53	6	6	11	84	83	1	
2006	21	97%	1	51	3	55	6	6	12	87	87	1	
2007	21	98%	2	53	3	57	6	6	12	91	90	0	
2008	22	99%	2	55	3	59	6	6	13	94	94	0	
2009	23	99%	2	57	3	62	7	7	13	98	98	0	
2010	24	100%	2	59	3	64	7	7	14	102	102	0	
Cumulative Total during 1996 - 2010	104098		7309	24954	13155	270419	29234	29234	58469	432985	428062	4923	
Assumption and Note:													
1. Quantity of industrial waste generated is identical to quantity collected.													
2. Municipal waste generation quantity will increase by 3.3 %/year, which is the average growth rate used for estimating municipal waste generation quantity.													
3. Industrial waste (both non recycled and recycled) will increase by 4 %/year.													
4. Commercial waste is not included in the above table. Quantity of commercial waste generated is estimated to be 3.9 ton/day in 1996.													



CHAPTER 4 EXISTING SWM

4.1 Collection and Transport

4.1.1 Collection Service

1) Collection Service Coverage

Safi city is comprised of three urban communes; Boudheb, Zaouia and Biada, and each urban commune is responsible for the collection and transport of solid waste and street sweeping within its respective area. Safi Urban Community is responsible for sweeping of the streets bordering two communes and for collection and transport of special waste such as slaughter house waste.

In addition to the dominant household waste, each urban commune also collects commercial waste, medical waste and packing and household waste generated at industrial plants. The Port authority, ODEP, collects and transports the waste generated at the port by its own truck.

Some enterprises transport their own waste, but this was found to be very low (less than 1% of total waste entering the disposal site).

The waste amounts collected and transported in November - December 1996 are shown in Table 4.1-1.

Table 4.1-1 Solid Waste Collection Amounts

Organization	Amount (t/d)	Share of total (%)
A. Public Authorities	100.70	96.1
- Urban Community	0.75	0.7
- Boudheb Urban Commune	54.99	52.5
- Zaouia Urban Commune	29.12	27.8
- Biada Urban Commune	15.84	15.1
B. Generators	4.09	3.9
- ODEP Port Waste	3.15	3.0
- Other companies	0.94	0.9
C. Total Regular Waste Collected	104.79	100.0

Motivated by a Royal Letter concerning the cleansing situation, a campaign was undertaken by a number of organizations to eliminate illegal dumping sites in Safi city. This took place at the same time as the JICA study team survey was being conducted. The amount of waste collected during that campaign and excluded from the above figures was as follows;

- OCP collected waste: 47.10 t/d
- Zaouia collected waste: 17.68 t/d

Collection service coverage is measured by;

- area served, and
- population served

Concerning area coverage, the urban communes reported the following;

- In Boudheb and Zaouia all the urban commune area is covered
- In Biada the villages in the northern outskirts are not covered

In terms of population served, based on the survey results and knowing the waste amount generated in Safi city, as explained in Chapter 3.1, the collection service coverage provided in each urban commune per week, is estimated as shown in Table 4.1-2.

Table 4.1-2 Collection Service Coverage

	Boudheb	Zaouia	Biada	Tot. Safi
Collection Service Coverage	90	77	44	75

(unit: %)

The results speak for themselves.

- Boudheb, the city's administrative and commercial center enjoys a high service coverage rate.
- In Zaouia, the second largest commune in terms of population, more effort is required to ensure that collection service is extended to all the residents.
- In Biada, where new development is spreading over a wide area there is an urgent need to increase the collection service. However as that commune generates only 29% of the total waste the overall collection service rate for the city does not fall below 75%.

The contradiction in area coverage and population coverage for Boudheb and Zaouia shows that in some areas the waste discharged by the inhabitants is not collected by the collection trucks that are serving these areas. This may be the result of negligence on the part of the residents to bring down their wastes at the designated collection time or in in the designated pick up place, or lack of communication between the communes and the residents regarding collection discharge and collection hours.

The objectives of the collection improvement plan, presented in Chapter 6, are derived from these figures.

2) Manpower and Equipment

The manpower and collection trucks provided for the street sweeping, collection and transport service by each public organization are shown in the following table.

Table 4.1-3 Current Manpower and Equipment

Item	Boudheb	Zaouia	Biada	Urban Community
A. Manpower	147	88	52	11
(1) Engineer (part time)	1+(1)	(2)		(1)
(2) Technician	1	1	2	
(3) Driver	14	13	7	
(4) Collection worker	30	35	17	
(5) Street sweeper	100	36	25	10
(6) Clerical staff	1	0	1	
(7) Gate keeper	0	1	0	
B. Equipment				
(1) Compactor (8 - 12m ³)	3	0	1	0
(2) Dump trucks (3 - 4m ³)	5	10	2	0
(3) Dump trucks (5 - 6m ³)	0	0	2	0
(4) Multi-loader	1	0	0	1
(5) Pick-up (1.7 m ³)	1	0	1	0
(6) Dumper (1.0 m ³)	1	0	1	0
(7) Communal containers (0.36 & 0.76 m ³)	200	0	0	0
(8) Multi-loader containers (3 m ³)	3	0	0	5
(9) Hand carts	95	(??)	9	(??)
C. Manpower and Equipment sufficiency				
C.1 Manpower				
(1) SWM staff/10,000 residents	14	9	8	NA
(2) SWM staff share of total staff	30%	33%	41%	NA
C.2 Equipment				
(1) Truck fleet capacity (t) (one trip/day)	33.6	28.9	16.1	2.3
(2) Capacity/generated waste	0.55	0.77	0.44	3.01
(3) Average truck age (years)	9	4	12	12

The manpower in the above table does not include the workshop staff which will be discussed in a later section in this chapter.

- Boudheb has the highest staff in terms of population and this is due to the large number of street sweepers employed in that commune to maintain the cleanliness of the city's commercial and administrative center.
- Biada falls behind the other two communes in terms of both manpower per population and truck capacity. An additional complication is the high average truck age in that commune which exceeds 12 years.
- The procurement of new trucks to both Boudheb and Zaouia fleets has decreased the average age and increased the fleet capacity. These new trucks can easily operate two trips per shift, and therefore the capacity can meet the demand to transport the generated waste.
- On the other hand the aged trucks in Biada make it difficult to operate an average 2.3 trips/shift required to collect all the waste and consequently there is an urgent need to renew and reinforce the Biada fleet.

3) Collection System

The collection system operated in the three urban communes can be broadly classified as follows;

- Dump truck collection, door-to-door being the predominant system
- Compactor truck, using communal containers have been used in Boudheb since 1996
- Compactor truck collection, door-to-door
- Multi-loader truck using communal containers
- Dumper and donkey cart collection, using transfer station in the Medina

The extent of each system used by urban commune is shown in Table 4.1-4 and each system is described as follows.

Table 4.1-4 Collection System applied by each Urban Commune

(unit: %)

Collection system	Boudheb	Zaouia	Biada
1) Dump truck, door-to-door	42	100	78
2) Compactor, door-to-door	7	NA	22
3) Compactor, communal container	26	NA	NA
4) Multi-loader, communal container	25	NA	NA
5) Dumper/donkey cart with transfer station, door-to-door	(6)	NA	NA

Under the door-to-door system, two collection truck crew members empty the individual bins discharged in front of the houses as the truck passes. In the early morning the bins are discharged before the truck arrives, but in many areas, as the truck arrival time becomes late (say after 10:30 am) it is necessary for the driver to honk his horn to alert the residents. The low sides of the dump trucks help the collection crews to swing the bins into the box where one crew member empties the bins and returns it. Where truck access is difficult, the residents bring their individual bins to the main road, or the crew members go to each door and empty the bins into a larger sack which they bring back to the waiting truck, with the latter being more dominant.

In Boudheb, compactors with mechanical loading of communal containers have been in operation since the summer of 1996. Plastic communal containers are placed at walking distances of up to 100 meters from residents, and emptied daily.

The multi-loader truck serves large generators such as markets, inaccessible areas and the transfer station near the Medina, in Boudheb. The narrow alleys of the Medina make the use of donkey carts, and recently small dumpers more suitable. These vehicles access the narrow alleys and collect the waste from each house. Where access is not possible the collection workers collect the waste using large sacks and bring it to the waiting vehicle. In a similar area in Biada, said to be the oldest part of Safi city a pick-up and door-to-door collection system is used. The busy traffic on the narrow streets there make it difficult to use the more efficient dumper system.

Dump truck and door-to-door collection system is also used in villages in Boudheb. The unpaved narrow streets in such areas make the collection work under this system time consuming.

Table 4.1-5 describes some of the advantages and disadvantages of the main systems as observed in Safi city.

Table 4.1-5 Characteristics of each Collection System

Collection system	Advantage	Disadvantage
1) Door-to-door, dump truck	<ul style="list-style-type: none"> • Comfort for residents • Eliminates need for waste open stations where sanitary problems easily occur if waste is not promptly collected 	<ul style="list-style-type: none"> • Long time spent on collection route • At long distances from the disposal site (Biada and to a lesser degree Zaouia) dump truck is not cost effective • Poor working conditions for collection crews
2) Compactor, door-to-door	<ul style="list-style-type: none"> • Comfort for residents • Eliminates need for waste open stations where sanitary problems easily occur if waste is not promptly collected • Compactor more cost effective at long distances to disposal site • Better working conditions 	<ul style="list-style-type: none"> • Long time spent on collection route • Excessive water content in waste produces much leachate during compacting
3) Compactor, communal container	<ul style="list-style-type: none"> • Shortens time spent on collection route and increases cost efficiency • Compactor more cost effective at long distances to disposal site • Better working conditions • Increases residents awareness of SWM by having them walk to the containers, and may to an extent help in waste volume reduction 	<ul style="list-style-type: none"> • Containers may become source of bad odor • Residents cooperation in bringing waste to containers and putting containers in front of their properties is necessary • Excessive water content in waste produces much leachate during compacting
4) Dumper/ donkey cart with transfer station, door-to-door	<ul style="list-style-type: none"> • Transfer station allows for a large number of trips • Dumper more suitable than donkey cart because of sanitary condition • Provides high quality service to the residents 	<ul style="list-style-type: none"> • Door-to-door collection in narrow alleys causes time delays and traffic circulation problems

In addition to the regular collection service, collection campaigns are implemented on a periodic basis to eliminate so-called black points. These points are illegal dump sites in open spaces or near construction sites where uncollected construction waste encourages the dumping of household waste alongside it. During these campaigns commune trucks are assisted by loaders and other needed heavy equipment from enterprises to clear the points during the afternoons or on holidays.

4) Street Sweeping

Street sweeping is carried out in each of the three urban communes as follows.

a. Boudheb

- Sweepers are allocated hand carts, baskets and brooms
- Main streets are swept twice times daily, and sweepers are permanently stationed at the major squares
- Street sweeping wastes are collected separately in the evenings by dump truck
- Street sweepers are assigned within six sectors and supervised by 6 foremen

b. Zaouia

- Sweepers are allocated hand carts, baskets and brooms
- Main streets are swept once daily in the mornings
- Streets where illegal dumping is common are swept in the evenings
- Street sweeping wastes are collected separately in the evenings by a dump truck

c. Biada

- Sweepers are allocated hand carts, baskets and brooms
- Main streets are swept once daily in the mornings
- Street sweeping wastes are collected separately in the evenings by a dump truck every 2-3 days

5) Maintenance and Repairs

Presently the urban community and each of the three urban communes operate their own workshops. However in terms of area, all four workshops are rather small, with that of Biada being the smallest. Biada is scheduled to construct a new workshop in the near future, for which land has already been allocated. At present Biada trucks are mostly repaired at the community workshop. All the four workshops also serve depots for the trucks, and they are not exclusively used for collection equipment.

In interviews with the workshop personnel it was understood that there are no major problems concerning maintenance and repairs, and most repairs can be handled at the workshops. Spare parts for the older trucks are sometimes a problem to obtain, but the downtime for such vehicles does not exceed 2-3 days per month. Private workshops in Safi city are sometimes used for the larger repairs.

Repair records are kept for each truck and the type of repair, money spent in purchase of spare parts and number of man-hours are recorded.

The manpower for the workshops is shown in the following table.

Table 4.1-6 Workshop Manpower

	Community	Boudheb	Zaouia	Biada
A. Workshop staff	14	29	32	17
- Workshop Chief	1	1	1	1
- Mechanics	2	5	10	3
- Electrician	1	3	1	1
- Body works	5	6	8	5
- Tires	1	2	--	1
- Fuel pump operator	1	2	2	2
- Truck washer/ oil change	--	4	--	1
- Store keeper	1	2	1	1
- Administrators	1	2	5	0
- Guardsman	2	2	4	2
B. Total vehicles	NA	13	14	7
- Collection equipment	1	10	10	6

According to the interviews, and based on the total number of vehicles, collection truck repairs and maintenance account for 70 - 80% of the total workshop activity in each commune.

6) Evaluation of Collection Service

The objective of the evaluation is to improve the collection service where possible, both in terms of coverage and cost efficiency. It is clear from the collection service coverage rates that coverage improvement is desirable. The efficient utilization of the trucks will be examined later on.

Surveys were implemented to assist in the evaluation. Both the truck scale and time and motion surveys provided data for analyzing truck utilization. The household opinion survey gathered data on residents' perception of the collection service.

a. Technical Evaluation

The technical evaluation poses the following two main questions;

- Has the right truck type been selected?
- Are trucks being used to its optimum effectiveness?

And the most important evaluator is the cost in terms of Dirham per ton of waste collected from the generation areas and transported to the disposal site.

(1) Truck Type

Factors affecting performance by truck type are;

- distance to the disposal site
- accessibility of the area served
- land use of the area

Distances to the presently used disposal site from Boudheb, Zaouia and Biada are on average 5, 9 and 10 kilometers respectively. These distances do not warrant

construction of a transfer station to convey the waste from smaller trucks to larger trucks. However as the distance increases it becomes more cost effective to use a truck capable of hauling more waste in order to compensate for the reduction in number of trips that may be accomplished during one shift. Compactors of 10 and 12 m³ capacities with communal containers (SCS; stationary collection system) are most effective under these conditions, with minimum trips of 2/shift. Multi-loader trucks (HCS; haul container system) are very effective on short distances because they can make many trips (6 - 8 trips) although the amount of waste hauled may be limited. Dump trucks, presently used in the city (capacities 3-4 m³) are effective over short distances of 5 - 7 km, provided they make 2 trips/day. Table 4-1.7 shows trips and haul shares by truck types for the three Urban Communes based on the truck scale survey. Only Boudheb operated its trucks on Sunday, although with a limited number of trips.

Table 4-1.7 Collection Truck Types used by Urban Communes

Item	Boudheb	Zaouia	Biada
1) Collection share by truck type (%)			
- Compactors	33	--	22
- Dump trucks	42	100	78
- Multi-loader	25	--	--
2) Average trips/shift			
- Compactors	1.3 (1.4)	--	1.0 (1.2)
- Dump trucks (excluding pick-up)	1.7 (1.8)	1.0 (1.2)	1.1 (1.3)
- Multi-loader	8.1 (8.2)	--	--

Note; trip numbers between brackets consider only six days operation, 1 shift/day

The above table indicates the following;

- The compactors used in Boudheb (2 of which are new; 1996 purchase) are not making sufficient trips. The performance of dump trucks and multi-loaders there is satisfactory.
- In 1996 Zaouia purchased 6 dump trucks, a seventh being purchased two years earlier. The number of trips operated there, at 1 trip/shift, is low and results in poor cost efficiency.
- Biada's operated trip numbers must be considered in relation to the age of their vehicles and the huge area of that urban commune. At an average age of 12 years, these trucks are not expected to make more than 1.5 trips on average.

From the viewpoint of land use and accessibility, the types of trucks and the extent of their future service coverage can be evaluated as follows.

- In Boudheb, introduction of compactors, with communal containers of 0.3 and 0.7 m³ capacities is quite suitable and can be expanded to cover roughly 60-70% of the commune.
- While the population in Zaouia is comparatively less wealthy than that of Boudheb, and there may be fears that citizens there will not cooperate with the compactor and communal container system, this system should nevertheless be introduced gradually. The long distances to the disposal site warrant this system, and land use there is not considered an obstacle. Effort must be made to gain the residents cooperation.

- The topography of Biada is hilly in many places and large truck access may be hindered. However this represents only about 30% of the area. For the remainder the dominant new development with wide streets allows for large truck access. Compactors coupled with smaller communal containers are more suited for this commune.

(2) Truck Operation

The service is ultimately evaluated in terms of cost efficiency; how much money it costs to collect and transport one ton of waste. Therefore total costs incurred must be divided by total waste collected and transported. It is obviously very important to increase that waste amount. This is achieved by ensuring that the weight hauled per trip is consistent with the truck capacity, and that as many trips as possible are made within one shift.

What is happening in Safi city?

In principle all three urban communes operate one shift, 6 days per week (Boudheb sometimes operates on Sunday as was the case during the November surveys). Each collection truck is assigned a specific collection sector, and the sectors are prepared based on experience. There are no population data for the sectors.

Each truck is served by a crew of three and collection is mainly implemented door-to-door. Collection routes are basically decided by the drivers, under the supervision of the foremen. Route maps are not available in Zaouia and Biada, but Boudheb reported that maps exist. In the case of dump trucks, one collection worker stands in the truck box and empties the bins swung on to the top by the other two workers. He arranges the waste on the truck and also indulges in some separation of recyclable elements from the waste, such as plastic and paper/cardboard. Working conditions are poor and the workers do not have complete uniforms.

Operation indices, based on the time and motion surveys are as follows.

Table 4-1.8 Collection Time on Collection Route

Operation Indicator	Boudheb	Zaouia	Biada
A) Collection time (min/ton)			
- Compactor	26	NA	not surveyed
- Dump truck	75	63	75
B) Waste collected/crew member (t/person/shift)			
- Compactor	2.34	NA	not surveyed
- Dump truck	0.77	0.99	0.73

The compactor is clearly superior in terms of time saving, and thereby increasing the number of trips possible in one shift. However the waste amount transported during the second trip on the surveyed day was less than 40% that of the first trip, and thus the efficiency in terms of collected waste per crew member could be higher. Adjusting the route in order to collect a larger amount of waste on the second trip is required. The dump trucks all performed only one trip, and therefore the collected waste per crew

member is low. Although the required time to collect one ton is almost three times that of the compactor, a second trip by the surveyed trucks could have theoretically been accomplished if the complete 8 hours shift had been respected. In practical terms, the old age of the trucks and the poor working conditions make it difficult to operate 2 trips over full 8 or 9 hour shifts.

Table 4-1.9 shows the trip numbers and haulage amounts by truck for each urban commune during one week in November 1996.

Table 4-1.9 Operation Indicators by Truck

Truck	Age (year)	trip/ work days	Ave. ton/ trip	Ave. household served/d	Max t/trip	trips> av. (%)	Standard deviation
A. Boudheb							
1) Compactor 63959	15	1.3	2.86	1,282	4.3	54	0.84
2) Compactor 117202	1	1.7	5.09	3,044	8.1	43	2.28
3) Compactor 117203	1	1.0	5.18	1,807	6.0	55	0.48
4) Dump truck 63955	15	1.7	1.62	971	3.8	77	0.73
5) Dump truck 63957	15	1.9	3.09	2,002	4.4	31	0.98
6) Dump truck 63958	15	1.7	2.38	1,422	3.2	61	0.47
7) Dump truck 73912	11	1.9	2.46	1,597	4.5	45	1.18
8) Dump truck 90384	8	1.3	1.27	569	2.2	52	0.56
9) Pick-up 97814	7	2.9	1.03	1,027	1.4	74	0.19
10) Multi-loader 117204	1	8.1	1.67	4,749	2.9	55	0.59
B. Zaouia							
1) Dump truck 73911	11	1.3	2.19	594	3.5	34	0.72
2) Dump truck 73914	11	1.2	1.90	520	4.4	26	1.19
3) Dump truck 90381	8	1.2	3.57	520	5.3	51	0.88
4) Dump truck 110233	3	1.0	2.63	446	3.1	75	0.67
5) Dump truck 117050	1	1.2	3.39	520	5.8	52	1.21
6) Dump truck 117051	1	1.3	3.62	594	5.0	55	0.92
7) Dump truck 117052	1	1.2	3.05	520	5.2	28	1.01
8) Dump truck 117053	1	1.2	2.68	520	4.4	43	1.19
9) Dump truck 117054	1	1.2	3.59	520	5.0	34	0.68
10) Dump truck 117055	1	1.0	2.40	446	4.4	60	1.29
C. Biada							
1) Compactor 51655	17	1.2	3.45	331	4.0	57	0.33
2) Dump truck 49735	19	1.0	2.67	284	4.3	33	0.83
3) Dump truck 63956	15	1.0	2.99	284	4.5	50	0.90
4) Dump truck 90380	8	1.0	2.90	284	4.6	33	0.89
5) Dump truck 107430	4	2.0	2.04	567	3.3	33	0.58
6) Pick-up 97815	7	2.0	0.91	567	1.3	50	0.22

The shaded areas in the table indicate operational issues. As explained earlier each truck is allocated a collection sector. Due to lack of population data by sector it is difficult at the outset to estimate the amount of waste generated in each (the number of households in each sector can be estimated based on the total waste amount collected per week

divided by the waste generated per household). These sectors should be adjusted based on operating results. The fluctuation in collected waste amounts by trips and number of trips with waste amounts below the average are indicators of the need for sector modification, either in terms of area or collection frequency. The results are evaluated by urban commune as follows.

Boudheb Urban Commune

- Boudheb is reported to be setting the routing of the newly introduced compactors on a trial basis. That may be the reason why one compactor number 117203 operates only one trip per day, and there is a wide margin within the figures for the waste amount hauled per trip (standard deviation of 2.28), especially during the second trip. These compactors operate in conjunction with the communal containers. The available 200 containers, with a total volume of 90 m³, multiplied by the density of Boudheb waste (0.38 t/m³) and assuming 80% filling, can accommodate up to 27 tons of waste daily. At an average of 5 ton/trip 4 trips can be easily operated daily by both compactors. Of course placing the containers in correct locations is important and Boudheb's monitoring of the conditions is the best way to achieve this. It is hoped that these figures will assist them in planning the routes.
- It is necessary to consider modifying the three sectors served by truck numbers 117202, 63957 and 73912 because of the large number of trips with waste amounts below the average (column before last), and the significant fluctuation in collected waste amounts by trips (standard deviation). The sector sizes should be adjusted in order that each of the three trucks collects a number of tons as close as possible to the average haul per trip while setting a target for the standard deviation not to exceed 1.0 ton.
- The sector served by truck number 90384 is too small, when considering the haul capacity of that truck, as indicated by the average number of households served. Truck numbers 63955 and 73912, of similar capacities and older in age, are allocated sectors roughly three times larger in terms of population.

Zaouia Urban Commune

- The new collection trucks, numbers 110233 to 117054 should on average make 2 trips/shift. This can improve the collection service coverage and retire some of the older trucks which are expensive to operate in terms of maintenance costs and create noise and odor problems.
- It is easily possible to implement a second trip with the new dump truck, based on the following simple estimation;

$$3.0 \text{ ton/trip} \times 60 \text{ min/ton} \times 2 \text{ trips} = 390 \text{ minutes, i.e. 6.0 hours}$$
 Working 8.0 hour shifts there will be still time left over for the journey to the disposal site twice. However reduction of the time spent on the route, through improving the route traveled by the truck and eliminating unnecessary maneuvers and other issues, which will be discussed in the improvement plan, will provide a more comfortable margin, for other time-consuming "difficult to eliminate" practices such as long coffee breaks and waste separation by the collection crew.
- Collection sectors are well balanced in terms of residents per sector.
- The weekly waste amounts hauled for all the trucks are similar. Therefore the high standard deviations in terms of waste amount hauled per day for the three trucks;

73914, 117050 and 117053 shows that many of the residents served by these trucks discharge their waste every 2 or 3 days. This is an interesting point when considering adoption of 3 day per week collection system.

Biada Urban Commune

- It is difficult to recommend much improvement in the operation of Biada's truck fleet because of the aging fleet. However for a commune where collection coverage is less than 50% (in terms of population) making only one trip per truck shift is a luxury that cannot be afforded.
- The comparatively low standard deviations and differences between average haul per trip and maximum haul per trip for all the trucks, when compared to the other two communes indicate the low fleet haulage capacity. No matter what day of the week, or where there is always waste to be collected.

b. Public Perception of the Service

Under this Study 100 households were interviewed in each urban commune on issues related to SWM (as reported on in the appendices). Asked about their degree of satisfaction with the service, Zaouia residents were the most satisfied (92% satisfied), followed by Biada (78%) and lastly Boudheb with 61%. These results are surprising when considering the high service coverage rate of Boudheb and the lowest of Biada.

On the other hand all the residents interviewed in Boudheb responded affirmatively when asked if the city's cleanliness had improved. Affirmative responses of Zaouia and Biada residents were 95 and 82% respectively.

Amongst their concerns about the most serious infrastructure problems facing the city, 96% of Biada's respondents included SWM, a high figure compared to only 15 and 7% in each of Zaouia and Biada respectively.

While it is not possible to expand these results and state that they represent the total population in each commune because of the low sample rate, nevertheless they show that residents are responding positively to efforts exerted by the communes in SWM, and that residents of Biada have a keen awareness of the SWM problem in their commune. Although 78% of the Biada respondents were satisfied with the collection service provided directly to them, their high concern over SWM may be due to the overall low collection service coverage in the commune at large.

4.1.2 Current Costs

Both activities of collection and transport and street sweeping result in large costs, the first from the extensive use of trucks and the second because of the large amount of manpower involved. The costs are analyzed in terms of operation and maintenance and investments.

Operation and maintenance costs are normally broken down into;

- salaries
- fuel and lubricants
- maintenance and repairs

- depreciation of the equipment
- a percentage of the above as indirect costs

The investment costs cover the purchase of new equipment.

In order to understand the present costs incurred, data were collected from the three urban communes and the urban community, and interviews were held with the counterparts. Unfortunately the collection and transport and street sweeping costs are not treated independently by the communes but are included in other cost items. Breakdowns were provided as much as possible and estimates were made when these were not available. These costs were for 1995.

In addition during the truck scale survey conducted for one week in November - December 1996, the amount of waste transported, number of trips conducted by each truck and crew members were surveyed. Using certain assumptions, the costs were estimated for each truck. Table 4.1-10 shows the costs estimated during the truck scale survey and Table 4.1-11 shows the data obtained from the questionnaire survey (for 1995) and cost estimates for 1996 based on the truck scale survey.

The results of the analysis by urban commune are as follows;

Boudheb Urban Commune

- As the Boudheb trucks make more trips in a day, the overall unit cost for that commune is significantly lower than the other two communes.
- The low unit price of 206 DH/ton was achieved by the Boudheb compactor truck, using communal containers. This reflects the cost effectiveness of that type of truck. However it is necessary to better operate the second compactor of that commune (320 DH/t) in order to get similar costs.
- The multi-loader produced the lowest unit cost of 126 DH/ton because during the survey week the multi-loader operated by the urban community was out of order and the urban community containers were hauled by Boudheb's multi-loader.
- The introduction of more efficient collection system in 1996 helped reduce the unit cost from 300 DH/ton in 1995 to about 250 DH/ton in 1996.

Zaouia Urban Commune

- Currently Zaouia operates 10 trucks, with an average of 1 trip per truck shift. However it is possible to collect the same amount of waste operating only the seven newer trucks, with more trips per truck shift.
- A comparative cost analysis for the operation of the seven trucks is as follows (figures in Table 4-1.10 used as base)

Salaries	= 7 trucks x 3,188 DH =	22,313
Fuel and oil	= total fuel costs =	7,000
Maintenance	= 7 trucks x 519 DH =	3,635
Depreciation	= 7 trucks x 1,298 DH =	9,087
Indirect costs	= 20% of the above =	8,407
Unit cost (DH/t)	= above total cost/204 tons =	247

The unit cost of operating the seven trucks is less than that of the 10 trucks combined.

- 1995 cost figures obtained concerning Zaouia are rather doubtful, especially since they show that a very small number of truck trips were made in 1995, as estimated from the low fuel costs. This amplifies the need to set up an accurate accounting system to monitor SWM operating expenses.
- Street sweeping is done manually and so a large number of sweepers are required. The low value reported for sweeping salaries in Zaouia may be explained by the large number of sweepers employed under the national promotion system (reported as 52 for 1995). The fall of this number to 36 in 1996 has probably weakened this activity.

Table 4-1.10 Operating Costs by Truck

License	Truck	waste (t/wk)	Salaries (DH)	Fuel & oil (DH)	Maint- enance (DH)	Depric- ation (DH)	Indirect cost (DH)	unit cost (DH/t)
A. Boudheb								
63955	Dump	19	3,188	1,200	519	1,298	1,241	382
63957	Dump	40	3,188	1,300	519	1,298	1,261	188
63958	Dump	29	3,188	1,200	519	1,298	1,241	261
63959	Compactor	26	3,188	900	817	2,043	1,390	324
73912	Dump	32	3,188	1,300	519	1,298	1,261	236
90384	Dump	11	3,188	900	519	1,298	1,181	621
97814	Pick-up	21	3,188	2,000	212	529	1,186	345
117202	Compactor	61	3,188	1,200	1,571	4,503	2,092	206
117203	Compactor	36	3,188	700	1,288	4,503	1,936	320
117204	Multi-loader	95	2,475	5,700	502	1,306	1,996	126
	Dumper	13	3,188	600	192	481	892	424
	Total	371	34,350	17,000	7,178	19,855	15,677	254
B. Zaouia								
73911	Dump	18	3,188	800	519	1,298	1,161	397
73914	Dump	13	3,188	700	519	1,298	1,141	515
90381	Dump	25	3,188	700	519	1,298	1,141	274
110233	Dump	16	3,188	600	519	1,298	1,121	426
117050	Dump	24	3,188	700	519	1,298	1,141	289
117051	Dump	29	3,188	800	519	1,298	1,161	240
117052	Dump	21	3,188	700	519	1,298	1,141	321
117053	Dump	19	3,188	700	519	1,298	1,141	365
117054	Dump	25	3,188	700	519	1,298	1,141	273
117055	Dump	14	3,188	600	519	1,298	1,121	467
	Total	204	31,875	7,000	5,192	12,981	11,410	336
C. Biada								
49735	Dump	16	3,188	600	519	1,298	1,121	420
51655	Compactor	24	3,188	700	817	2,043	1,350	335
63956	Dump	18	3,188	600	519	1,298	1,121	374
90380	Dump	17	3,188	600	519	1,298	1,121	387
97815	Pick-up	11	3,188	1,200	212	529	1,026	564
107430	Dump	24	3,188	1,200	519	1,298	1,241	305
	Total	111	19,125	4,900	3,106	7,764	6,979	378

Notes;

1. Salaries = Driver, 2200 DH/month, worker, 1900 DH/month, multiplied by factor for insurance, etc.
2. Fuel costs = number of trips x 10 liters x 10 DH
3. Maintenance = (0.4 x truck cost)/8 years
4. Depreciation = truck cost/8 years, and container cost/3 years
5. Indirect costs = 20% of above costs
6. Unit cost = total costs/total hauled waste tons

Table 4.1-11 Total Current Collection and Transport Costs

	unit	1995	1996
A) Boudheb (includes urban community)			
- Salaries	DH	1,564,032	1,786,200
- Fuel and lubricants	DH	1,283,417	884,000
- Maintenance and repair	DH	201,686	373,247
- Depreciation	DH	1,103,983	1,032,483
- Indirect and misc. costs	DH	830,624	815,186
- Total	DH	4,983,742	4,891,116
- Unit cost	DH/ton	300	254
- Collection service coverage	(%)	85	90
- Salaries for street sweeping	DH	1,695,026	NA
B) Zaouia			
- Salaries	DH	684,033	1,657,500
- Fuel and lubricants	DH	91,049	364,000
- Maintenance and repair	DH	262,134	270,000
- Depreciation	DH	675,000	675,000
- Indirect and misc. costs	DH	342,443	593,300
- Total	DH	2,054,659	3,559,800
- Unit cost (DH/ton)	DH/ton	400	336
- Collection service coverage (%)	(%)	40%	77
- Salaries for street sweeping	DH	129,105	NA
C) Biada			
- Salaries	DH	705,157	994,500
- Fuel and lubricants	DH	236,808	254,800
- Maintenance and repair	DH	158,036	161,500
- Depreciation	DH	403,750	403,750
- Indirect and misc. costs	DH	300,950	362,910
- Total	DH	1,805,701	2,177,460
- Unit cost (DH/ton)	DH/ton	356	377
- Collection service coverage (%)	(%)	40	44
- Salaries for street sweeping	DH	349,803	NA
D) Total Safi city			
- Salaries	DH	2,954,222	4,438,200
- Fuel and lubricants	DH	1,611,274	1,502,800
- Maintenance and repair	DH	621,856	804,747
- Depreciation	DH	2,182,733	2,111,233
- Indirect and misc. costs	DH	1,474,017	1,771,396
- Total	DH	8,844,102	10,628,376
- Unit cost (DH/ton)	DH/ton	328	298
- Collection service coverage (%)	(%)	54	75
- Salaries for street sweeping	DH	2,173,934	NA

Notes;

1. 1995 figures based on questionnaire survey and truck depreciation based on 1996 truck fleet
2. 1996 figures based on truck scale survey
3. Boudheb 1995 figures include urban community collection and transport costs
4. Zaouia 1995 collected waste amount estimated by multiplying trip number x 4.0 t/trip. Trip number estimated by dividing fuel costs by fuel cost/trip (14 lit/trip at present)
5. 1996 estimates do not include use of national promotion workers (i.e. salaries are all borne by communes)

Biada Urban Commune

- Overall Biada had the highest unit rate, which is due to the low amount of waste collected.
- The pick up operated in the old area of the city produces a very high cost. While pick up operation there appears to be the only viable alternative more trips are required by the pick up in order to improve its cost efficiency.
- Unlike the other two urban communes, unit cost in 1996 increased compared to that of 1995. This indicates that collection service operation in this commune shows no improvement.

4.1.3 Recycling Activity

On an official basis the urban communes do not have any recycling activity. The Urban community on the other hand, leases the right to separate recyclable items from the waste arriving at the disposal site to a private contractor.

On the unofficial side, separation of valuable items by collection crew members, scavengers at the disposal site (about 20 in number) and scavengers in the city (number unknown) exists.

Two large recycling operators were interviewed by the Study team. One has a stockyard and some processing equipment at a facility near the disposal site. Most of the collection crews sell their sorted waste items to this recycler. The second has a storage area near the main market. Both sell their sorted waste items outside the city, with the first recycler using his own truck to transport the sorted waste. The daily average waste items sorted and processed by both are as follows.

Table 4.1-12 Amounts of Waste Items Sorted

	(unit: kg/day)	
	Disposal site recycler	Main market recycler
1. Cardboard	510	200
2. Plastic	530	50
3. Glass	110	10
4. Bones	50	--
5. Aluminum	20	--
sub-total	1,220	260
Total of both		1,480
Total incl. Other recycling activity (5%)		1,550

The above estimate shows that about 1.1% of the waste generated in the city is recycled through this informal sector.

4.1.4 Collection and Transport Issues

The purpose of analyzing the current waste collection and transport conditions is to identify the outstanding issues that need to be resolved and set the objectives and targets for the improvement plan. These issues can be briefly summarized in the following table.

Table 4.1-13 Solid Waste Collection and Transport Issues

Issue	Boudheb	Zaouia	Biada
1. Collection service coverage rate	C	B	A
2. Cost efficiency	C	A	B
3. Time consuming operation (excessive door-to-door)	B	A	A
4. Poor truck routing design	B	B	B
5. Illegal dumping/ black points	C	B	B
6. Aged collection trucks	C	O	A
7. Truck fleet capacity	C	O	A
8. Poor working conditions	C	B	B
9. Communication with the general public	C	A	B
10. Overall evaluation	C	B	A

Notes: A: Very serious, B: Serious, C: Moderately serious, O: Not serious

Boudheb Urban Commune

With the introduction of the compactor and communal container system, Boudheb seems to be headed in the right direction to provide complete and rational collection coverage. The urban commune has plans to expand this system. However some areas of the commune will continue to be served by dump truck and their share of the service needs to be identified. The routes of the compactors introduced over 6 months ago need to be fixed more accurately based on the experience gained during that period. A system for the cleaning and maintenance of the communal containers should be setup, so as to avoid attracting criticism from the residents.

Zaouia Urban Commune

Zaouia has opted for dump trucks and its recent purchase of 7 trucks has voided for the time being the need to discuss the issue of most optimum truck type in that commune. However the insufficient utilization of these new trucks and the deficit in the collection service coverage clearly indicate the need to improve the collection system. More communication with the residents to reduce door-to-door collection and increase collection points and thereby reduce time spent on the collection routes is an issue.

Biada Urban Commune

Biada seems to be the urban commune everybody has chosen to forget. The main issue here is the urgent need to renew the truck fleet. Within the next two years seven trucks should be retired. The selection of the suitable truck type will be important, but of more concern will be the resolution of the financial source to back the renewal plan.

These issues will be dealt with in Chapter 6 Collection and Transport Improvement Plan.

4.2 Disposal

4.2.1 Conditions and Issues of Existing Municipal Disposal Site

1) Site Condition and Surroundings

The current municipal disposal site is located on the gently sloping hill-side along the Sebt Gxoula Road (secondary road No. 120), at a distance of approx. 4 km east of the city center. Agricultural land for wheat, barley, etc. surrounds the site while a residential area, which is expanding from the city center to the east is located 1.2 km west of the site. Three wells exist within 400 m radius of the site and are used for drinking, irrigation and a sardine canning factory.

The total area of the disposal site is 11.345 hectares; 6.08 hectares of it is owned by Safi Urban Community and the remaining is privately owned. Almost no disposal facilities, such as enclosed fencing, inspection gates, proper operation roads, storm-water drainage, signboards indicating site usage, site office, water or electricity supply are equipped at the site.

A large amount of waste has been hauled and accumulated outside of the municipal disposal site boundary, south of the site, on an area of approx. 7 hectares. It is estimated that 390,000 m³ of waste has been deposited inside the municipal disposal site and in the surrounding area.

Several disposal sites restricted to demolition waste exist within the territory of Safi Urban Community, and three of them have been visited by the JICA Team. These sites are located in a natural depression, a small valley and in low land, respectively, and have been used for land reclamation purposes. Their average heights are approx. 3m, 12m and 8m, respectively, and the total amount of demolition waste accumulated at the three sites is estimated at 210,000 m³.

2) Site Operation

Operation of Safi municipal disposal site commenced in 1983. The responsible organization for site management and operation is Safi Urban Community. Current operational conditions of the site are described as follows;

- Hauled waste has not been controlled in any proper manner such as soil covering, waste compacting, etc. However, one bulldozer (D600D) is operating at the site to maintain minimum site operation.
- All types of waste; that is municipal, industrial and hospital waste (which may contain toxic/infectious waste), are accepted/hauled to the site in mixed form.
- No staff from the Urban Community are present for site inspection, recording incoming vehicles and waste, or for site access control.
- The operation road is in poor condition and inaccessible in case of heavy rains.
- Scavengers are active and animals are grazing at the site without any control.

3) Issues

In light of the location, facilities and operational conditions of the existing municipal disposal site, the following issues have been identified and should be taken into consideration for the future disposal plan of Safi.

- i. Sanitary/environmental conditions of the current municipal disposal site are very poor, because of lack of landfill operation control. Scattering of waste, diffusion of offensive odor, self-burning of the waste, breeding of vectors and insects, free discharge of the leachate, and so on, are observed at the site.
- ii. No records of incoming collection vehicles, waste amount and waste types have been kept, because of the lack of a SWM control plan and site facilities. For the same reason, unlimited access to scavengers and animal grazing puts them in dangerous contact with potential hazardous wastes mixed with domestic waste.
- iii. The current municipal disposal site is located at one of the main gates to Safi city. The site is regarded as representative of black points of Safi, because of its unsuitable siting and poor sanitary conditions. Existing wastes, accumulated outside the municipal disposal site boundary, should be conveyed inside the current disposal site, to restore the private land to its owners in its original condition. The remaining life time of the current municipal disposal site is assumed to be approx. 3.5 years. It is therefore urgent to select a new disposal site.

4.2.2 Current Costs

Current expenditure for operation and maintenance of the municipal disposal site in Safi is shown in the following Table 4.2-1.

Table 4.2-1 Current Operation and Maintenance Cost

	Items	Unit cost	Cost per year (DH)
1	Salary of operators		48,600
2	Fuel and oil	DH10/litre, 60 liter/day	180,000
3	Sub total (1+2)		228,600
4	Indirect cost (3)x 10%		22,860
5	Equipment maintenance & repair cost		20,000
6	Depreciation		328,600
	G. total (3+4+5+6)		600,060

The Urban Community of Safi does not take into consideration the depreciation of heavy equipment; one bulldozer (D600D), which is currently operating at the disposal site. If its depreciation is estimated based on current prices, it would be DH 328,600/year.

Meanwhile, as a revenue, Urban Community of Safi contracts out scavenging activity to one contractor, every year. Its contract amount in 1995 was DH 106,700/year.

The amount of waste hauled at the municipal disposal site in 1996 was assumed to be approx. 37,700 ton. Therefore, unit cost to handle/dispose of one ton of waste is calculated at DH 13.1/ton.