REPORT TO THE

WATER RESEARCH COMMISSION

EVALUATION OF SOLID WASTE PRACTICE IN DEVELOPING URBAN AREAS IN SOUTH AFRICA

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Preface

In January 1994, the Water Research Commission appointed Palmer Development Group to carry out an evaluation of solid waste practice in developing urban areas in South Africa (Project reference K5/629).

The broad objective of this project is: to carry out a strategic evaluation of the present status of domestic solid waste services to developing communities in the urban areas of South Africa with a view to providing relevant and up to date information and analysis upon which rational policy and practice may be based so that the large and increasing demand for solid waste services in developing urban communities may be met in an economically efficient and equitable manner.

The project was conceptually divided into three phases as follows:

Phase 1: Overview

- A review of the current status with domestic solid waste management internationally.
- Execution of a survey of solid waste practice in the urban areas of South Africa, based on questionnaires and interviews, to determine who has access to adequate services, what type of systems are being used, and to obtain as much operating and cost information as possible.

Phase 2: Evaluation using case studies

- Evaluation of solid waste practice to determine: level of access and acceptance by communities; technical options; cost; financial viability; management efficiency; and environmental impact. The method of evaluation is based largely on case studies where the situation in specific areas is investigated.

Phase 3: Key issues and guidelines

- Holding of workshops in different centres around the country to get input from people active in the field, using the findings of the first two phases as a basis.
- Preparation of a summary of the situation with solid waste practice, identifying key areas for action and preparation of draft guidelines for the planning and management of solid waste management systems.

As part of these three phases a series of reports have been prepared, as listed on the following page.

List of documents

1	**Main Report:**	**Evaluation of solid waste practice in developing urban areas in South Africa**
2	Executive Summary	

Provincial profiles: status of solid waste practice in each province:

3	Western Cape
4	Northern Cape
5	Orange Free State
6	Eastern Cape
7	Natal / Kwazulu
8	Eastern Transvaal
9	Northern Transvaal
10	North West

Metropolitan profiles: status of solid waste practice in the three major metropoles:

11	Gauteng
12	Cape Town Metropolitan area
13	Durban Functional Region

Case studies of six urban areas in South Africa

14	Khayelitsha (Cape Town metro)
15	Umlazi (Durban metro)
16	Soweto (Gauteng)
17	Alexandra (Gauteng)
18	Rini (Grahamstown)
19	Winterveld (peri-urban settlement in North West province)

General reports

20	Costing of Domestic Solid Waste Management Systems
21	Draft Guidelines for Domestic Solid Waste Collection

Acknowledgements

The research in this report emanates from a project funded by the Water Research Commission and entitled:

"Evaluation of solid waste practice in developing urban areas in South Africa".

The Steering Committee for this project includes the following people:

HC Chapman	Water Research Commission (Chairman)
DS van der Merwe	Water Research Commission
FS Vivier	Dept of Health
AB Fourie	University of the Witwatersrand
L Bredenhann	Directorate: Water Quality Management
JS Barnard	Transvaal Provincial Administration
J Palm	GFJ Inc
D Joubert	Institute of Waste Management
C Mbande	Van Wyk and Louw

The financing of the project by the Water Research Commission and the contribution of the members of the Steering Committee is gratefully acknowledged.

In carrying out the work for this project an extensive survey was undertaken of organisations involved in the provision of solid waste services throughout South Africa and case studies were done in six specific areas. The success of the survey and case studies has been due largely to the efforts of the numerous people who responded to the survey, gave up time for interviews, and assisted with the case studies. Their assistance and support is sincerely appreciated.

Project team

The Phase 1 and 3 reports, and four of the case studies were written by Robert Macdonald, with assistance from Bee Thompson of Palmer Development Group. Katrina Smith from Durham University in the United States prepared the case study on the Winterveld and assisted with the international review. Justin Descoins of Palmer Development Group prepared the case study on Rini. Trevor Hughes carried out the data analysis and assisted with report preparation. The project was coordinated by Ian Palmer.

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1. OVERVIEW

1.1 INTRODUCTION

This report reviews the main findings of the WRC project entitled "Evaluation of solid waste practice in developing urban areas in South Africa". In addition to this report, nine provincial profiles, three metropolitan profiles, six case studies, a costing document and a draft guidelines document have been prepared. Information from the twelve profiles and the case studies is included in this report. An executive summary is also available, in which recommendations arising from the project are included.

The broad objective of the project was to carry out a strategic evaluation of the present status of domestic solid waste services in developing communities in the urban areas of South Africa. More specifically, the objectives were: to assess the factors that influence effective solid waste management; determine any links between solid waste practice and studies on stormwater runoff; and finally to make recommendations for the improvement of domestic solid waste management.

The research took place in three phases. In phase one a broad overview of solid waste management in South Africa was conducted, phase two involved case studies of domestic waste management in six specific areas, and phase three was an interactive workshop process where the research findings were presented and comment thereon received. This report focusses on phases one and two of the project.

1.2 PHASE ONE

The overarching aim of phase one was to establish a picture of the current state of solid waste practice in South Africa, with specific reference to developing communities and the provision of domestic waste collection services. More specifically, the aims of phase one were to:

- Establish a conceptual framework in which to discuss waste management.
- Review international trends and perspectives in waste management with an emphasis on developing countries.
- Review the current state of solid waste practice in South Africa.
- Identify innovative and alternative systems in use in South Africa.

1.3 DESCRIPTION OF WORK COMPLETED

Three basic research activities were undertaken in the completion of phase one, namely: a literature review, questionnaire surveys and interviews with key people in the field.

a) Literature Review

Both international and domestic literature was reviewed. Literature was sourced from various institutions and a full reference list is annexed.

b) Questionnaire Survey

A questionnaire survey of local authorities was conducted in order to gather detail of the waste management services provided by these authorities, specifically relating to domestic waste collection.

First Questionnaire

A detailed first questionnaire was sent out to 764 local authorities seeking information on collection services, waste details, transport, disposal, problems, cost recovery and alternative waste collection systems. Of these, 493 questionnaires were sent to white local authorities and 271 to black local authorities. Responses to these questionnaires covered a population of 8.5 million people with a 14% response rate from BLAs (39) and 39% from WLAs (191).

Second Questionnaire

Follow-up questionnaires were sent as it was felt that the response was limited, especially in the case of black local authorities. A second questionnaire was sent to 592 local authorities. The detail of the information required in the second questionnaire was less than that required in the first with emphasis on the level of service provided and details of disposal sites used. This was done in light of the poor response received from black local authorities to the first questionnaire. It was decided that the follow-up questionnaires should require as little detailed information as possible, in the hope that local authority personnel would not be put off by the prospect of having to complete a questionnaire. The approach was effective as the number of responses received from BLAs was about double that from the first questionnaire.

The final response rate after both rounds of questionnaires was 54%, with 62% of WLAs responding and 40% of BLAs. Details of the numbers of questionnaires sent out and the responses are provided in Table 1.

Table 1: Questionnaire response

	White Las		Black LAs		Totals	
Q'naire	Sent	Rec	Sent	Rec	Sent	Rec
First	493	191	271	39	764	230
Second	352	137	240	76	592	213
Total LA Response	306		109		415	
LA Response Rate	62%		40%		54%	
Population Covered						
First	6 389 163		2 086 274		8 475 437	
Second	1 760 975		5 963 325		7 724 300	
Totals	8 150 138		8 049 599		16 199 737	

Sole reliance on the local authority questionnaire returns would have led to an unbalanced overview for a number of reasons:

- Uneven response to the survey.
- Inaccuracies in information reported - this was borne out when local authorities returned both the first and second questionnaires and discrepancies between the two were evident.
- The completed questionnaires tended to indicate 100% service coverage which follow up phone calls and the RSC questionnaires contradicted.

It must also be noted that the first set of questionnaires were sent out at the time of the general election which may have impacted upon the response rate. It is also relevant to observe that throughout this research period the local authorities have been in a state of flux preparing for, and awaiting the imminent changes in local government structures. In some instances questionnaire responses reflected that two local authorities had combined resources in a merger of the two bodies as will increasingly be the trend. However, the picture of solid waste management derived in this report must be interpreted as the situation prior to local government transition.

RSC Questionnaires

In an attempt to get more information about waste collection services in black authority areas, questionnaires were sent to 38 Regional Services Councils requesting information on services in black local authorities within the RSC/JSB areas. Twenty responses were received, but not all responses provided information. Consequently information from these responses was used on an ad hoc basis where necessary or appropriate, with no attempt being made to collate the data into any specific format.

Homeland Governments

Attempts to gather information about waste management in the former homelands were made by telephone and fax. Questionnaires were faxed to key personnel in all the former homeland governments. However there was a poor response to these questionnaires with information only being received from three former homelands.

Private Waste Company Questionnaires

Questionnaires were sent out to a random sample of 35 private waste companies. Ten companies sent responses but not all of these responses provided information. This poor response rate has meant that information from these questionnaires could not be included in this report, although input from private sector was received via personal communications.

c) Interviews with Key People

Interviews with key people active in the field of waste management were conducted. People interviewed can be categorised into four groups:

- Local authority cleansing department personnel.
- Waste consultants.
- Private waste contractors.
- Organisations involved or interested in waste management.

The type of information sought in these interviews varied from specific information about waste collection services, to information about waste management in general.

1.4 DEFINITION OF KEY TERMS

There are certain terms used in the report which require clarification.

a) Adequate Level of Service

The key issues to be considered in classifying a domestic waste collection service as adequate or inadequate, are:

- On-site storage facilities.
- Type of collection service.
- Frequency of service.
- Effectiveness of service.
- Education of the community.

On-site storage facilities
An adequate storage facility would be one in which waste is stored hygienically between collections.

Type of collection service
For the purposes of this research, two basic types of collection have been used in the assessment of access to services, namely kerbside/door-to-door collection and communal collection.

- **Kerbside Collection**

A kerbside collection is where the waste collection agency removes waste either from the kerbside outside a dwelling, or from the property itself. Some argue that an adequate collection service is only a kerbside/on-site collection (Neethling, personal communication). However the prevalence of communal collection services, especially in black local authority areas means that this type of collection has been regarded as adequate dependent on the fulfilment of certain criteria.

- **Communal Collection**

Communal collection is where householders take their waste to a collection container where the waste is deposited. The container, usually a skip, is then emptied by the waste collection agency. The adequacy of a communal collection service is determined by the location of the collection point and the frequency of the service.

Factors that influence the location of a communal collection point, and hence its adequacy, include:

- Population density of area.

- Waste generated per household.
- Load capacity of collection point.
- Distance from households to collection point.
- Access to communal point for transfer vehicle - to disposal.
- Whether collection point is manned or unmanned.
- If unmanned, height of collection container.

For the purposes of this research, the key factors were regarded as those factors most important to the receiver of the service, the household. In this regard, the distance to the collection point and the height of the collection container appear to be the major issues. The distance is obviously important in terms of serving as an incentive or disincentive to the householder to make use of the facility. The height is important as in most developing areas children carry the waste to the collection point, and, if the container is too high, they deposit the waste on the ground (Palm, Kapiwa, personal communications). On the basis of these factors, an adequate communal service should meet the following criteria:

- A household has a container in which waste can be stored and which can be used to transfer waste to a communal collection point.

- A household is located within a walking distance of 150m of a communal collection point.[1]

- The size of the communal collection container is such that a child (approximately 10 years of age) could reach over at least one side of the container.

Frequency of Collection Service

Whether it be a kerbside or communal collection service, waste must be removed at least once a week.

Effectiveness of the Service

An effective service is one where the waste is removed completely from designated collection points, be they communal or kerbside, at the scheduled frequency. This is a very subjective criterion to include in the definition of an adequate level of service. However it is a crucial aspect of the definition because the other three criteria could be met, and yet waste may not be completely cleared from the kerbside or communal collection point.

[1] Distance derived from recommendations in the literature, Reilly (1990), as well as practical considerations.

Education of the Community

The community must be aware of the type of service it is receiving and any relevant information such as where storage containers must be placed and when collection is to take place.

Four Levels of Service

Having identified the criteria upon which the adequacy of a service may be determined, four basic levels of service were determined. These levels of service are:

- Level One: No service provided.
- Level Two: Service provided, (either communal or kerbside), but inadequate due one or more factors such as: lack of frequency, poorly located communal collection point, inadequate on-site storage or ineffective service provision.
- Level Three: At least a once weekly communal collection - all criteria of an adequate service being fulfilled.
- Level Four: At least a once weekly kerbside collection - all criteria of an adequate service being fulfilled.

As can be seen, levels one and two could be labelled as "adequate" services, while levels three and four are "inadequate". It must be stressed that these four basic levels of service are identified for the purpose of broad categorization. There are many other permutations which can be derived. For example, in the cases of levels one and two more frequent collections could be regarded as a higher level of service.

The levels of service identified above accord closely with the World Bank's classification of service levels. The World Bank (1993) provided four standards by which to assess a waste removal service. These standards are outlined in Table 2. The key distinction between the World Bank standards and those derived for this study is that the Intermediate level only has the criterion of a "regular" communal collection, whereas the equivalent Level Three requires at least a once weekly communal service. For the purposes of this research, a communal or kerbside service that is rendered less than once weekly is inadequate.

Limitations of Definition

Table 2: Levels of Service, World Bank

STANDARD LEVELS	DESCRIPTION OF SERVICE LEVEL
1. Minimum	No Formal Collection of Refuse
2. Basic	Irregular Collection
3. Intermediate	Regular Collection from Community Collection Points
4. Full	Regular Weekly Collection from Houses

Source: World Bank, Aide Memoire, 1993

Basing the definition of an adequate level of service upon the criteria identified makes it difficult to assess the adequacy of a service based on questionnaire responses and interviews. Experience in certain areas indicates that, in many instances where a communal collection service is provided, it fulfils very few of the criteria listed above, and should be classified as an inadequate service. However an evaluation of whether all communal services provided fulfil the stated criteria was impossible. Consequently the results provided in Chapter Four could in fact provide an overestimate of the extent to which people have access to an adequate waste collection service, as where it has been indicated by the local authority that a communal service is provided, it has been accepted that this service is adequate.

b) Waste

The Environment Conservation Amendment Act No 79 of 1992 defines waste as:

> *"any matter, whether gaseous, liquid or solid, or any combination thereof, which is from time to time designated by the Minister by notice in the Gazette as an undesirable or superfluous by-product, emission, residue or remainder of any process or activity".*

This, however, is not a detailed definition but empowers the Minister to determine what constitutes waste. Litter, which could be regarded as part of the broader concept of waste, is defined in the Act as any object or matter discarded by the person in whose possession or control it was.

The Minister provided a definition of waste in Government Gazette No. 12703 of 24 August 1990:

> *"For the purposes of the definition of "waste" in Section 1 of the Environment Conservation Act [the Minister identifies] as an undesirable or superfluous by-product, omission, residue or remainder of any process or activity, any matter, gaseous, liquid or*

solid or any combination thereof, originating from any residential, commercial or industrial area which:

(a) is discarded by any person; or

(b) is accumulated or stored by any person with the purpose of eventually discarding it, with or without prior treatment connected with the discarding thereof; or

(c) is stored by any person for the purpose of recycling, reusing or extracting a usable product from any such matter, excluding -

(i) water used for industrial purposes...
(ii) any matter discharged into a septic tank or French drain sewerage system...
(iii) building rubble used for filling or levelling purposes...
(iv) any radioactive substances discarded..
(v) any minerals, tailings, waste rock or slimes produced;
(vi) ash produced by or resulting from... the generation of electricity."

The primary focus of this research is on domestic solid waste. Consequently, unless otherwise stated, where the term "waste" is used, it may be interpreted as "solid waste which emanates from an urban residential dwelling".

c) Stand

A stand is a residential property which has been laid out in accordance with a town plan, with its boundaries surveyed. The term "stand" also implies that planned services are provided at least to a "basic" level.

For the purposes of this research, the distinction between formal and informal stands has been made as follows:

Formal Stand
A formal stand is a stand upon which there is at least one permanent formal dwelling structure. There may be other informal dwellings on the stand (typically backyard shacks).

Informal Stand
An informal stand is one upon which only informal dwellings (shacks) are present. This would typically be associated with a "site and service" project.

d) Household

A household is defined as a group of people who are related, typically parents and their minor children but often including adult children, grandchildren and their relatives. It is assumed that the household lives in a single dwelling structure. The sizes of households vary greatly between different residential areas, and between different housing types, be they formal or informal. The national average household size is 5.5 and, for simplicity, this figure is often assumed in this report for purposes of calculation.

e) Urban

In this report the term urban is taken to mean those areas that fall under urban local authorities. This is a comparatively narrow definition and excludes the "dense settlements" which was identified by the Urban Foundation as a separate category. These are "peri-urban" areas, often on the edge of metropolitan areas, which have no local authority. Two exceptions are made in this report:

- All of the population within the Durban Functional Region is taken as urban, even where there are no local authorities.

- The Winterveld, (North West province), is taken as urban although it to does not have a local authority. It is used in this project to demonstrate the differences in waste management approaches between urban and peri-urban areas.

1.5 STRUCTURE OF THE REPORT

The purpose of the report is to review the main findings of the research project. The report is structured accordingly:

- Chapter 2 provides a conceptual framework of waste management, clarifying the parameters of the term.

- Chapter 3 examines the environmental impact of solid waste, looking at both the human and the natural environment.

- Chapter 4 reviews international trends in, and perspectives on, waste management, with an emphasis on developing countries.

- Chapter 5 reviews the current state of waste management in South Africa with emphasis on domestic waste collection in developing communities. As part of this review, the chapter also identifies innovative and alternative forms of waste practice in South Africa.

- Chapter 6 reviews the six case studies that were undertaken in phase two of the project.

- Chapter 7 is the concluding chapter and identifies the major findings of the research and suggests possible areas for action.

2. CONCEPTUAL FRAMEWORK OF WASTE MANAGEMENT

2.1 INTRODUCTION

a) Aim

The aim of this chapter is to provide a conceptual framework of the components which constitute solid waste management. This will be achieved by:

- Defining the term solid waste management.
- Identifying the objectives of solid waste management.
- Examining the various stages of the solid waste management process.
- Considering the optimal approach to solid waste management.

b) Definition of Solid Waste Management

Waste produced by an urban community can be a problem both in terms of aesthetics and community health. Furthermore it is possible for hazardous material to exist in waste. It is thus important that waste is collected efficiently from all sources and disposed of in controlled sites. This process of collection of waste through to disposal can be labelled "solid waste management". The process does however effectively begin with the generation of waste whereafter it includes activities ranging from storage through to reclamation and disposal.

2.2 OBJECTIVES

Hall (1989) states that the "aim of waste management is essentially the responsible re-introduction of waste into the environment". Hall further states that there is a need for a "balance between the lowest costs of actions and their environmental and other implications".

The notions of costs and environmental implications indicate two broad aspects to the objectives of a solid waste management system:

Environmental considerations
The waste management system must provide environmental benefits through clearance of waste and the hygienic disposal thereof. These benefits come in the form of an aesthetically clean environment and the eradication of disease.

Economic considerations

The waste management system must provide economic benefits through the provision of an effective service that is affordable to those who benefit from that service.

Underlying the environmental and economic aspects would be a philosophy that hinges on the objectives of:

- The minimisation of waste generation.
- The optimal re-use or reclamation of waste.
- The minimisation of the need for disposal.

Consolidated objectives

A consolidated hierarchy of waste management objectives would then be:

- Promoting the minimisation of waste generation.
- Promoting the maximum possible reclamation and recycling of waste.
- Ensuring economically efficient and environmentally effective - storage, collection, transport, reclamation, recycling and disposal of waste.

2.3 STAGES OF WASTE MANAGEMENT

The waste management process involves a range of activities which encompass the following:

- Generation
- Storage
- Collection
- Transport
- Recycling
- Reclamation
- Reduction
- Disposal
- Sale of recovered resources

All these activities deal with the flow of waste and can take place at different stages of the waste management process. For example, waste can be recycled at source and sold from that point with the remaining waste being collected and transported directly to disposal. Alternatively, waste could be stored, collected, transported to a disposal site at which point reclamation could take place.

As the emphasis of this research is upon the collection of domestic solid waste, the discussion on the activities of collection and transport in this chapter is more detailed than is the discussion of other activities.

2.4 GENERATION

Waste generation is central to the waste management process as it is the origin of waste which is the focus of this process. The key aspects of waste generation are:

- Source of waste generated.
- Amount of waste generated.
- Characteristics of waste generated.
- Waste reduction or minimisation.

These are important aspects as the type of waste will vary according to the source. This will then impact on characteristics such as waste composition and density which helps the identification of the needs of a waste system. For example, the extent to which resource recovery or recycling can take place. In the same way, the quantity of waste generated is important for establishing the capacity requirements of storage and collection equipment, as well as disposal facilities for example. Not surprisingly then, the features associated with waste generation are central to the waste management process.

a) Source of waste

There are various sources of waste and hence types of waste can be identified according to those sources. The various types of waste include:

- Industrial
- Commercial
- Household
- Institutional
- Construction debris
- Agricultural

This report focuses on waste generated by households, referred to either as household or domestic waste. It is acknowledged that waste generated by other sources such as businesses and institutions is often classified as domestic waste. In this report, an attempt has been made

when and where possible to distinguish between waste generated by households and other sources. It is estimated that household waste constitutes 75% of all waste (Habitat, 1993).

b) Generation Rates

The amount of waste that is generated by households tends to vary according to levels of economic development. Hence higher per capita income countries tend to generate higher per capita quantities of waste. This issue will be explored further in chapter 3.

c) Waste Characteristics

The composition of waste also varies according to levels of economic development. There are other influencing factors such as geographical location and the culture of a society. In addition to the composition of waste, the density of waste is important. This has implications for example, for the potential of compaction both at collection and disposal. Waste characteristic are discussed in detail in chapter 3, with references being made to specific examples.

d) Waste Reduction

It may appear anomalous to include waste reduction as a part of generation, however the link is clear - increased reduction activity should lead to reduced generation. Householders could minimise generation by, for example, a reduction in the consumption of packaged goods. The activity is perhaps best implemented one step back along the generation chain. For example manufacturers can reduce material such as packaging or they can produce goods that can be recycled more easily. Nevertheless householders can have a role in this activity with regard to their discretion in levels of consumption and choice of goods consumed.

2.5 STORAGE

After generating waste, the household is likely to either store or dispose of it immediately. Immediate disposal could take the form of burial or burning. In the event of storage before collection or disposal, two basic storage options can be used: the separate unit storage and the communal storage unit.

Separate Unit Storage

Separate unit storage may be standardized or nonstandardized by the service agency. Nonstandardized containers can include temporary containers such as cardboard cartons,

plastic bags, crates, as well as permanent containers such as plastic or metal bins. Standardized containers tend to be plastic or metal bins as well as plastic bags.

Communal Storage

Communal storage units can be either stationary or portable. Stationary units could include enclosures such as four-sided masonry structures, whilst portable units could include large steel drums or liftable metal containers such as "skips". There is naturally a degree of overlap between the storage options as a household may initially use a separate storage unit on site which is then emptied into a communal storage unit.

2.6 COLLECTION

It has been stated that, "The objective of a waste-collection system is to transport wastes collected from specific locations at regular intervals, to a disposal site at minimal cost" (Habitat, 1993). In light of the economic and environmental considerations impacting upon the objectives of solid waste management, the "minimal cost" referred to here must be interpreted as both economic and environmental. As outlined in the previous chapter, collection of waste from households can take place at four general levels of service.

Service Level One - No Collection/Self disposal

The first level of service can be classified as a "no collection" service. At this level, the authority provides no service but promotes correct practice on site - the service is thus effectively self-provided. This can involve activities such as the separation of the waste into its different constituents such as ash, putrescibles and inorganic material. Each waste type can then be put to different uses eg. ash can be worked into the soil for gardening purposes as can matured compost from putrescible waste. The useful materials can be put to various uses such as containers (cans, boxes) or used as fuel (paper, wood, cardboard).

Service Level Two - Inadequate Collection Service

At the second level, a service is provided, usually communal collection, but is inadequate due to factors such as lack of frequency, poorly located communal collection point, inadequate on-site storage or ineffective service provision.

Service Level Three - Communal Collection

The third level of service is where waste is collected from communal collection points or transfer stations. Waste can be brought to these points by individual householders or by local "entrepreneurs" who conduct house to house collections on a contractual basis and then transport the waste to the collection point.

Service Level Four - Kerbside/On site Collection

At the fourth level of service, collection is conducted on site or at the kerbside by service agencies or contractors using motorized vehicles manned by collection crews. The destination of the waste collected would either be a transfer site or a disposal site.

The four service levels outlined above have a variety of permutations due to variables such as household storage systems, frequency of collection and vehicles used. The extent of the permutations can be gauged from the following discussion of the different types of collection systems.

a) Non-Collection Systems

A non-collection system is a system which does not involve planned and managed removal from the residential site. Such a system essentially involves the disposal of waste on site. In this instance households need to be made aware of methods of disposal as well as recycling options for waste. The system is not suitable for the disposal of hazardous waste which may be toxic eg.batteries.

Non-collection is only viable if there are favourable physical conditions and there is a public awareness of activities such as waste separation and how to make compost. In physical terms, there needs to be space on the site not only to house a compost bin or dump, but for compost to be of use. If the site is too small, the household inevitably will dump waste in the road or in a public area. In order for the public to be aware of how to handle their waste, local authorities would need to conduct extensive educative programmes and possibly provide households with necessary equipment such as compost bins.

b) Communal Collection Systems

Communal Collection

In this option, householders place their wastes at predetermined locations containing a communal storage facility. Refuse vehicles then remove the waste from these sites. Containers, which can be either permanent or portable, may be provided at these sites.

Key features:

- Reduces number of sources from which waste has to be collected.
- Danger that widely spaced sites lead to household disposal of waste on streets.
- High dependence on household co-operation.
- Key that households informed of location of sites.

- A major problem with the system can be a lack of "ownership" of the collection point and thus risk of general disregard for aesthetics and hygiene at the point.

Block Collection

A collection vehicle follows a scheduled route and stops at selected locations. A bell may be rung to alert households. Householders take waste containers to the vehicle and these are emptied into the vehicle and returned to householders.

Key features:

- Success of system dependent on maintenance of schedule.
- High household involvement in system.

Waste Exchange

This system involves the exchange of waste for "goods". Such "goods" can include money, food coupons, transport coupons and even food. Householders bring their waste to a central collection point where the exchange is made. The waste agency then must transport the waste to the disposal site.

Key features:

- Waste is taken to a central collection point.
- High household involvement in system.
- Key that households informed of location of sites.
- Danger that waste generation is encouraged and that waste is "recycled" as waste ie. that previously collected waste is "dug out", either at other communal collection points or at disposal sites.

c) On site/Kerbside Collection

Erf collection can be in the form of on site collection or kerbside collection.

On Site Bin Collection

Each household stores its waste in a plastic or metal bin. The collection crew enters the site, takes the bin to the collection vehicle, empties the waste and then returns the bin to the site.

Key features:

- Lack of householder involvement offset by higher labour costs due to repeated site entry.
- Only productive when collection infrequent ie. maximum once weekly.

On Site Plastic Bag Collection

Household storage may be in bin or bag, but collection involves only removal of the bag. Hence the collection crew only enter the premises once.

Key features:

- As with on site bin collection this is the highest level of service from a user perspective.

Kerbside Collection

The collection crew collects waste in bins, bags, mobile containers, or other containers of refuse which are deposited by the household at the kerbside at fixed intervals, usually once or twice a week.

Key features:

- A high level of service from the point of view of the user.
- Requires regular and well organized collection service - householders must know when to leave out wastes.
- Badly co-ordinated and thus infrequent collection can cause health and odour problems if waste scattered by scavenging neighbourhood pets.

Entrepreneurial Collection

It is worth noting entrepreneurial collection as a separate form of collection, because although it is effectively a kerbside or on-site form of collection, it is unique in the sense that employment is created within a community. In this system, a local "entrepreneur" collects the waste from sites or kerbside and transports the waste to a collection point/transfer station or direct to the disposal site.

Key features:

- Creates employment within a community.
- Reduces dependence on household co-operation.

Table 3 (overleaf) provides a comparison of the service options as discussed above.

2.7 TRANSPORT

The vehicle collection option used will be linked to other aspects of the waste management system, namely: the level of service offered by the waste agency; the household storage method used; the existence of transfer stations and the location and nature of disposal site.

Table 3: Service Option Matrix

SERVICE LEVEL	SERVICE OPTION	ADVANTAGES	DISADVANTAGES
FIRST	Non-collection (On-site disposal)	• Cheap, no service required • Waste recycled	•Cost for necessary comprehensive education programme •Awareness and co-operation of community crucial •Hazardous wastes eg. batteries still need disposal elsewhere
SECOND	Inadequate Collection	•Collection does occur	•Collection is irregular
THIRD	Communal Collection	•Reduces number of collection points •Service provided close to household	•Widely spaced sites lead to disposal on streets •High dependence on household co-operation •Households need to be informed of site location •Problem of lack of ownership of site
	Block Collection	•Service provided close to household	•Success of system depends on maintenance of schedule •High household involvement in system
	Waste Exchange	•Waste collection encouraged by reward	•High household involvement •Need for informed households •Danger that waste generation encouraged
FOURTH	Kerbside Collection	•No site entry	•Householder must know when to leave out waste •Non-collection can lead to scattering of wastes
	On Site Bin Collection	•Lack of householder involvement	•High labour involvement •Potentially intrusive to householder •Productive for infrequent collection
	On Site Bag Collection	•Lack of householder involvement •Less labour as only one site entry	•High labour involvement •Potentially intrusive to householder •Productive for infrequent collection

The suitability of a collection service and the transport used can depend on factors such as:

- Size and layout of an area.
- Population density.
- Road quality and traffic congestion.
- Quantity and nature of waste to be removed.
- Haul distance to disposal.

These factors will impact upon the characteristics of the vehicle used in collection and consequently on labour requirements. As in the case of the service options, there are a number of permutations of vehicle collection options.[2]

a) Non-motorized collection

Non-motorized collection tends to occur in conjunction with labour based collection systems. A house to house collection service can still be provided with the vehicles taking the form of handcarts, animal carts and even tricycles.

Handcarts

These are used widely in developing countries for collecting road sweepings but are increasingly being used as primary refuse-collection vehicles in areas inaccessible to motor vehicles, such as low-income, high-density settlements with narrow roads.

Animal-drawn carts

Whilst low in capital and operating costs, these vehicles have limited speed which confines their operational radius, and they can cause obstructions to traffic. Nevertheless, they can be used in low-income settlements where traffic densities are limited, although they are essentially primary collection vehicles that need to discharge wastes into large secondary containers or vehicles.

Pedal tricycles

Although little used in South Africa, these are used for transporting goods in many developing countries and can also be used as primary refuse-collection vehicles.

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[2] The discussion of the transport options is taken largely from Habitat (1993) **Refuse Collection Vehicles for Developing Countries.**

b) Motorized Collection

The type of motorized vehicles used for collection can vary according to the type of collection service. For example vehicles needed for a communal collection service can differ from those used in kerbside collection.

Communal Service

In communal collection each collection point can be regarded as a "transfer station" with the waste agency transporting the waste from this point to a disposal site in vehicles which can carry large collection containers. Alternatively waste from collection points can be transferred by smaller vehicles to more formal transfer stations, and then on to a disposal site.

Collection containers and transfer stations can take on various forms making collection vehicle requirements varied. Collection containers at communal collection points can vary between fixed masonry structures to portable containers such as skips. Transfer stations can take the form of collection vehicles which remain located at a certain point till full, to permanent compaction-transfer stations where a fixed hydraulic compacting unit is used to compress the waste into large containers.

Vehicles that are often used for communal collection services include:

- *Container-hoist vehicles* which are equipped with hydraulically-operated hoisting arms to move detachable containers (or skips) between the floor of the vehicle and the ground. Such vechicles are characterised by quick turnaround times, with the same amount of time required to pick up a load as to tip a load.

- *Tractor and trailed-container systems* which are usually slower in operation but cheaper to purchase and operate than a container-hoist vehicle.

- *Truck-mounted front-loading container-handling vehicles* pick up waste containers with forks located at the front of the truck and tipped into the front of the compactor body. The key advantage of this is that compaction takes place on collection.

- *Truck-mounted rear-loading container-handling vehicles* differ from the front-loaders in that they have an electric or hydraulically operated winch which discharges a container into the rear-loading hydraulic-compactor truck.

Table 4 outlines the advantages and disadvantages of the container handling systems as discussed.

Table 4: Motorized Collection - Communal Storage: Container Handling Systems

SYSTEM	ADVANTAGES	DISADVANTAGES
Truck-mounted front-loading		•Complex machinery •Moving parts exposed
Truck-mounted rear-loading		•Complex machinery •Moving parts exposed
Tractor and trailed container-system	•Vehicle availability	•Low speed •Wear and tear at speed •Poor braking system
Container-hoist vehicles	•Detachable containers have fast turnaround time	•More costly than tractor and trailer

c) Motorized Collection

Kerbside/On Site Collection

Kerbside collection often takes place without the need for a transfer station. The collection vehicle usually takes the waste direct to the disposal site. Motorized vehicles can largely be categorized as non-compactor, semi-compactor or compactor vehicles.

- **Non-compactor vehicles**

Non-compaction vehicle bodies require a larger load space than a compactor body to enable the vehicle to achieve its payload. The bodies are however light and therefore can permit greater payloads than compactors, especially when waste densities are high.

Typical non-compactor vehicles include:

- *High-sided open-top vehicles* where the waste is passed up from ground level to a worker inside the truck who packs the load. Loading operations can be unhygienic and depending on the height of the vehicle, the loading speed can be slow.

- *Side loading "roll-top" vehicles* have semi-circular tops on the bodies which can be loaded from each side through semi-circular sliding doors. Vehicle productivity is maximised when standardized containers, liftable by collection crew members,

are used. Vehicle productivity is drastically reduced when waste-storage facilities are such as to require the waste to be dumped on the ground before loading.

- A *tractor and open trailer system* has key advantages such as low cost, good maintenance prospects and advantages for use on poorly surfaced roads. However the vehicle has limited use for waste collection on good quality roads due to both slow speeds and limited carrying capacity. Nevertheless it is often suitable in inaccessible areas.

- *Front-loading high-sided enclosed vehicles* have a step up to a platform behind the driver's cab with an opening in the front of the body through which waste is loaded. Waste is passed up to a worker on the platform who fills the front of the body, and when the front section is full, the body is tipped back with the rear door closed, and the operation is repeated until the vehicle is full.

Other types of non-compactor vehicles include the *three-wheeler auto-rickshaw* with either an open or closed body, the *dumper-based tipper* and the *fore-and-aft tipping vehicle* - where the body is tipped forwards or backwards. In general the fore-and-aft tipper is suitable for handling wastes with densities above 250kg/m^3 and although it is rarely used in developing countries, it is regarded by the UNCHS as one of the most suitable and cost-effective of all vehicles for handling the type and nature of wastes found in developing countries. (Habitat, 1993, p.29)

- **Semi-compactor vehicles**

Semi-compactor vehicles achieve some reduction in waste volume but not as much as hydraulic compaction vehicles. Nevertheless there are arguments that these vehicles are more appropriate for developing country wastes which vary from medium to high density. (Coffey, 1989)

Semi-compaction vehicles include, *side-loading, moving-barrier vehicles* which have openings at the side of the body, high up near the front and a packing plate which compacts the loaded waste towards the back door; the *fore-and-aft vehicle* which is a variation of the simple fore-and-aft tipping vehicle and includes a hinged packer plate operated hydraulically and can be applied usefully where a proportion of the wastes is contained either in plastic bags or cardboard boxes; and *side-loading-hopper vehicles* in which one side of the body drops down to form a large hopper which is raised hydraulically to tip the load into the body and compress the waste against the opposite side. The need for wide streets and loading from

only one side means that the side-loading hopper has limited application in developing countries.

- **Compactor vehicles**

Compactor vehicles are designed specifically for purposes of compacting low-density compressible wastes, usually common in higher income areas. The vehicle is also appropriate in areas where labour costs are high as only a small crew is required.

The major types of compactor vehicles include:

- *Rear-Loading Hydraulic Compactors* which use rear-mounted compaction systems with large hoppers and compaction plates that sweep the refuse from the hopper into the truck body. It is then compressed against a movable barrier which is pushed forward along the body by the waste. This barrier is subsequently used to discharge the collected waste by pushing it rearwards, after initially lifting the compaction mechanism clear of the back of the body. This is the most commonly used compactor in South Africa.

- A *Screw Compactor* truck is characterised by its capability to tip conventionally for purposes of discharging waste, hence the vehicle is light and simple and has few wearing parts.

- *Side-Loading Hydraulic Compactors* have waste loaded through an aperture near the cabin which is pushed into the body by a packing plate. The load is discharged by means of a hydraulically operated discharging plate, through the rear of the truck.

- *Rotating Drum Compactors* have waste loaded at the rear of the machine into a large rotating drum which is then forced forward by helical blades inside the drum as it rotates. The vehicle is more suitable for handling small items and dense wastes than hydraulic-compaction vehicles. The reduction in the volume of the wastes is achieved both by the pulverizing effect of the wastes rolling around inside the body as by compaction. The vehicle however can have excessive wear problems with abrasive wastes.

- A *Paddle Compactor* has a paddle which sweeps backwards and forwards in a semicircular motion, thereby the refuse is alternately swept into each side of the body. Loading can be either at the rear of the vehicle or behind the driver's cab.

Table 5 summarises advantages and disadvantages of the transport collection options discussed above.

2.8 RECYCLING

Recycling occurs when material from the waste stream is recovered and serves as a "raw material" input for the manufacture of a new product. Hence recycling is not merely the separation of materials from the solid waste stream but in fact only occurs when such materials are incorporated into products that enter the market place. The recycling process has two basic approaches. One is that recyclable materials are separated at the point of generation by the waste generator, and these materials are collected separately and transported to recycling markets. The second approach is to collect mixed wastes or co-mingled recyclable materials and separate them at a central processing facility. Consequently recycling activity can take place at various stages, ranging from at source - in this instance the household through to pre-disposal, be it landfill or incineration. Recycling programmes can be ongoing or they can be sporadic.

a) Source Recycling

This involves the separation of recyclable materials by the waste generator and separately collecting and transporting these materials to recycling markets. This system has the advantage that materials are not contaminated by other wastes. However there is a great need for household co-operation as the waste generator is required to separate the wastes correctly and store them in separated form. Furthermore, either the householder must take the separated material to recycling centres, or specially designed compartmentalised collection vehicles need to be used. Key factors in the success of source recycling are thus household co-operation and potential added collection and transport costs.

b) Mixed waste recycling

Mixed solid waste can be separated for recycling at local processing centres or materials recovery facilities. Some plants process segregated recyclables; others separate mixtures of glass bottles, aluminium cans and steel cans; whilst others process mixed residential or commercial wastes, separating the recyclable materials. The success of these plants depends on the processing costs and the quality of the recyclable material produced.

Table 5: Collection Option Matrix

VEHICLE TYPE	ADVANTAGES	DISADVANTAGES
NON-MOTORIZED		
Handcarts	•Accessible to all areas	•Limited operation radius
Pedal tricycles	•Reduced travel time •Operate on any surface	•Limited operation radius •Limited capacity
Animal-drawn carts	•Useful in low traffic density areas	•Limited speeds and operating radius •Can cause traffic obstruction
MOTORIZED COMPACTOR		
Rear-Loading Hydraulic Compactor	•Handles large bulky items •Low loading height	•Excess wear from abrasive waste •Weight distribution problems can strain rear axle
Side-Loading Hydraulic Compactor	•Better weight distribution than rear loaders	•High loading height •Small loading apertures •Excess wear from abrasive waste
Screw Compactor	•Lighter than hydraulic compactor •Screw only moving part contact with waste •Truck can be tipped to discharge •Continuous loading system	
Rotating Drum Compactor	•Suitable for small items and dense wastes •Continuous loading system	•Excessive wear from abrasive wastes
Paddle Compactor	•Side or rear loading •Suitable for narrow streets or heavy traffic •Continuous loading system	
MOTORIZED NON-COMPACTOR		
High sided open top		•Loading operations unhygienic due to fallback •Slow loading speed
Side loading "roll-top"	•Suitable for heavy materials	•Unsuitable for light materials such as refuse
Tractor and open trailer	•Low cost •Easily maintained •Usable on poor surfaces	•Poor vehicle productivity
Front-loading high-sided enclosed vehicle	•Body has large capacity •Body producible locally •Body enclosed	•Slow to load •Only accommodate 1 or 2 workers
Fore-and-aft tipping vehicles	•Body can be tipped two ways •Suitable for developing countries	
MOTORIZED SEMI-COMPACTOR		
Side-loading, moving-barrier		•High loading height •Small loading doors •Reduced load speed •Abrasive wastes wear
Fore-and-aft	•Ideal for medium-density wastes •Useful if storage in plastic bags and boxes	
Side-loading-hopper		•Need for wide streets •Loading from one side

c) Composting

Composting is a form of recycling organic waste. As with other forms of recycling, this can take place at source, on the land of the householder, or in a composting plant prior to disposal. Co-composting with sewerage can also occur.

d) Recycling vs. Disposal

A major factor influencing recycling economics is the difference in cost between disposal and recycling. Increased disposal costs can make recycling a more viable option.

e) Gas Extraction

Methane gas is a by-product of the waste decomposition process and this gas can be extracted for use as an energy source. The extraction of gas from landfill sites also has two further advantages. First, it helps to extend the life of landfills by creating more space. Second, the burning of methane gas gives off carbon dioxide and water vapour, by-products which are less harmful to the ozone layer than methane gas itself. It has been estimated that methane gas is considerably more harmful to the ozone layer than carbon dioxide (Dorkin, personal communication).

f) Availability of Markets

Another factor influencing the viability of recycling is the availability of secondary materials markets. The acceptance of recyclable material by manufacturers or other agents is central to the continuance of recycling. If markets for certain recycled materials are not found, and the materials subsequently disposed of, then the costs of recycling obviously have not been recovered. Furthermore, if legislation is introduced that requires inputs of separated waste materials in products, then such a measure will only facilitate recycling if the products can compete in the market on price and quality.

2.9 RECLAMATION

Reclamation of wastes can be distinguished from recycling in that materials which are reclaimed from the waste stream can have use or value without undergoing a process of recycling. Reclamation can take place at source or just prior to disposal. Pickers on landfills are traditional examples of agents who reclaim waste prior to disposal.

2.10 REDUCTION

Waste reduction activities help to minimise the rate of waste generation. Waste reduction has various aspects.

a) Toxicity reduction

For example, the nature of waste is changed by reducing a manufacturer's use of toxic materials in consumer goods.

b) Volume reduction

This involves the use of less material initially. For example, reduced packaging in consumer goods.

c) Production changes

Other methods of reducing waste include the production of goods that can be recycled more easily, such as changing from multi-material to one-material packaging; redesign of products; restrictions on specific product types.

d) Behavioural changes

A number of economic actors can contribute to the reduction of waste: industries in the production of goods; individuals and commercial enterprises can use their purchasing power to create a demand for low waste products or items produced from recycled materials; governments can influence producers through economic or other incentive, and can influence consumers through education and information dissemination (Skinner, 1994).

2.11 DISPOSAL

Disposal of waste can take place in a controlled or uncontrolled manner. Uncontrolled disposal could take the form of dumping of waste or open burning of waste. Controlled disposal of waste usually takes place by means of sanitary landfilling or incineration.
Incineration tends to be used in the disposal of hazardous wastes such as medical waste, although countries with limited land space do use incineration for the disposal of domestic waste eg. Japan.

2.12 SALE OF RECOVERED GOODS

Whilst this activity might seem out of place as an activity in the waste management process, its importance is worth noting in light of the discussion on recycling. Without markets for recovered or recycled goods, the activities of recycling and reclamation become redundant.

2.13 COST RECOVERY

The issue of cost recovery in solid waste management revolves around whether the service provided is regarded as a public or private good. Public goods, such as national defence, are consumed jointly and are nonexclusive, while private goods, such as retail department store goods, are consumed jointly and are nonexclusive. Private goods are consumed individually and the producer can deny the good to the consumer until payment has been made. If a good is a public good, than there is an argument that costs should be covered by public funds ie. from the general revenues of local government. The extent to which the various activities within the solid waste management framework are public goods varies according to factors such as the *type of service* offered eg. street cleaning as opposed to household collection; and the *level of service* provided eg. kerbside vs communal collection.

The manner in which costs are recovered, either by user charges or subsidy/transfer payments, depends on issues such as the efficiency of the service provided, attitudes of the users to the service, as well as their *affordability to pay* and *willingness to pay*. The expression of a desire for a service does not necessarily indicate a willingness to pay, while users are likely to demonstrate a willingness to pay only if they are confident that the service provided meets their expectations of that service. The existence of private alternatives to the service offered can affect willingess to pay for example, the dumping of household refuse in open spaces or water courses might be viewed by some as an attractive alternative. The amount that people are willing to pay depends on a variety of factors, the most important of which are income status; the priority afforded to an improved service; the level of understanding about the service to be provided; the extent to which waste removal is seen to be a government rather than a private responsibility; and existing tarrif levels.

More detailed discussion of cost recovery and related issues takes place in the separate costing report prepared for this project.

2.14 WASTE MANAGEMENT APPROACH

The framework of waste management as discussed here indicates that there is no single route for the waste stream. This means that any approach to waste management cannot be undertaken by means of a normative application of certain principles. As Flintoff (1984) pointed out, there is no universal solution, applicable to all cities for waste managers planning efficient collection operations and the most appropriate combination of treatment and disposal facilities. Waste management for any area needs to be adapted to prevailing physical, cultural and economic circumstances. Rushbrook (1988) outlined the circumstances that need to be taken into account when establishing a waste management systems in developing countries, but these circumstances would also be applicable to developed countries:

- Climate and seasonal variations.
- Budget and foreign exchange limitations.
- Economic structure of the region.
- Physical characteristics of cities.
- Social and religious customs.
- Level of public health knowledge among the general public.
- Quality of management and available technical skills.
- Setting and enforcement of appropriate environmental standards.

As Lombard (1988) points out, the merits of waste management systems need to be considered in relation to the communities served. Hence a conceptual framework of solid waste management can only serve as a point of reference, with circumstantial factors as outlined above being the key influences upon how a solid waste management system is designed, and what aspects of the conceptual framework are implemented.

3. THE ENVIRONMENTAL IMPLICATIONS OF SOLID WASTE

3.1 INTRODUCTION

a) Aim

The aim of this chapter is to examine the impact of solid waste on the environment, in light of the environmental considerations of the waste management process as noted in the previous chapter.

b) Background

The generation of substantial quantities of waste is an inevitable consequence of modern-day urban living. This waste impacts on the human and natural environment, with the nature and extent of the impact depending on a number of factors, including the quantity and composition of waste; the adequacy of collection services and the methods of disposal. The extent of recycling and re-use is also significant, as this affects both the quantity and the composition of the matter that needs to be absorbed into the environment.

On the national level issues such as toxic build-up in soil and water from inadequately managed landfill sites are important, and will eventually affect the population and the economy as a whole. But in inadequately serviced and generally overcrowded low-income urban areas there are far more immediate concerns. Here the major problems are those that result from uncollected waste and informal dumping sites. These problems are the main focus of this chapter, with reference to both the human and natural environments, both within neighbourhoods and further afield. Other issues briefly discussed are the problems caused firstly by certain methods of collecting waste, and secondly by landfill sites in South Africa. Finally, the potential environmental advantages of recycling, reclamation and reduction are mentioned.

3.2 PROBLEMS FOR THE HUMAN ENVIRONMENT CAUSED BY INADEQUATE WASTE COLLECTION SERVICES

a) Health Problems

For people living in areas where waste collection services are either inadequate or totally absent, uncollected household waste makes life not only unpleasant, but also more hazardous.

Such waste poses a health risk both directly and via its effects on water supplies and drainage systems. This risk is related to the following factors:

Local surface water

Possibly the most serious risk to health posed by uncollected garbage relates to its effects on the stormwater system. Waste matter, together with loose soil, can lead to blockages in the stormwater drainage system. This means that standing water cannot drain away, and this standing water becomes contaminated with pathogens from decaying waste and human and animal excreta. The level of contamination will be particularly high if, as is often the case, sanitation is inadequate. Contaminated standing water exposes residents to the risk of many "faecal-oral" diseases, including not only the more dramatic ones such as cholera and typhoid fever but also more common ones such as intestinal parasites and diarrhoeal diseases. Although less severe the latter can nevertheless be debilitating, and even fatal among undernourished children and the elderly in particular. People may become infected if the standing water contaminates their hands, eating utensils or water supplies. Children who play in the water are at particular risk (WHO 1991).

Standing water also encourages mosquitoes to breed, and in this way diseases such as malaria and yellow fever can be spread. Bilharzia (Schistosomiasis) in vulnerable areas is a further potential hazard, if standing water allows snails that host the parasite to breed. All that is required is for the faeces of one infected person to contaminate the water for large numbers of people to be placed at risk (WHO 1991).

Rivers and streams

The problems associated with standing water transfer into water quality problems in stormwater channels, streams and rivers. A study of the quality of the water flowing into the Jukskei River from Alexandra, for example, revealed very high levels of pollution. The major source was identified as human and animal excreta, with uncollected waste a secondary source (Wimberley 1992). Another study conducted in Khayelitsha revealed that the entire stormwater system was highly microbiologically polluted, for the purposes of both ingestion and direct contact (Wright et al 1992). While this cannot be related solely to solid waste it is probable that uncollected waste contributes to the pollution load. Furthermore, it was found during the case studies for this report that the dumping of uncollected garbage into stormwater canals, rivers and streams is a common practice. This certainly adds to the contamination problem in the areas concerned.

Contaminated water can thus pose a health risk to people both within the immediate area and further afield. For instance, people coming into contact with the water in the stormwater

canals in Khayelitsha, such as children swimming, are at serious risk of contracting diseases (Wright et al 1992). Quick (1993) draws attention to the fact that people using the sea in False Bay for recreational purposes near stormwater outlets can be at risk if the water is highly polluted.

Groundwater

Where household waste is not collected, in addition to being dumped in water courses and stormwater drains it is also dumped on open ground. These informal dumping sites can lead to pollution of the groundwater locally. This can pose a threat to health if the water is accessed for domestic or agricultural use. It may also add to the contamination load of rivers and streams. Relatively little is however known about the problem in South Africa, and the issue is currently being investigated by Wright et al (publication forthcoming).

Pests

Concentrations of organic waste attract pests such as flies, rats and cockroaches. These pests, besides being a nuisance, can be carriers of diseases such as hepatitis A, trachoma and diarrhoeal diseases (Hardoy et al 1992).

Injury

Children playing in and around uncollected garbage are at risk of injury from, for instance, broken glass and rusty tins. The chances of contracting pest-related diseases are also that much greater among children due to their greater exposure and the unlikelihood of their practising good hygiene. For similar reasons the chances of infestation by intestinal parasites are greater among children, where waste is contaminated by human and/or animal faeces. Children (and adults) are further exposed to risk if they eat discarded scraps of food that might be contaminated.

Air pollution

Uncollected waste is often burned and this can give rise air pollution. Burning can lead to the release into the air of both toxins (eg from certain plastics) and suspended particles (eg ash). These, in turn, may cause or at least aggravate respiratory problems and skin and eye irritations, for instance (Hardoy et al 1992). The extent of the health hazard posed by burning will of course depend on factors such as how much burning occurs, the amount of air pollution that exists from other sources, prevailing weather conditions (eg whether winds regularly clear the air or not), where the burning occurs and the nature of the matter burned. But to those exposed to the smoke and fumes burning certainly can be a problem. This method of waste disposal is fairly common practice in South Africa. For instance in Alexandra and Soweto it was established during the case studies that a large proportion of

uncollected waste is burned. In Rini the burning of uncollected waste was found to be officially encouraged, and its effects on air quality, in the form of noxious fumes and flying ash, were clearly evident.

Land Use

Dumping in informal sites on open ground means that the land thus occupied becomes unavailable for other uses such as recreation, community services or housing. This often occurs in areas that are overcrowded anyway, thereby worsening the quality of life. And as previously noted, when children play in such areas they expose themselves to the risk of injury and disease.

b) Flooding

Where litter, ash and loose soil block stormwater drains, flooding after a storm is a frequent occurrence. This is not only inconvenient, but can cause economic hardship due to the loss of, or damage to, homes and possessions. Health problems may also result for those whose homes are destroyed or left cold and damp.

c) Aesthetic effects

Uncollected waste is aesthetically objectionable, both visually and due to the smell from rotting waste. This affects both the resident population and the wider community. According to Hardoy et al (1992), many "psychosocial disorders" are associated with poor living conditions, with such disorders including depression, drug and alcohol abuse, suicide and violence of many kinds. While inadequate solid waste collection is only one among a number of perhaps more serious environmental problems, it nevertheless remains a significant, and certainly very visible, factor in the creation of a stressful environment. As one Soweto resident put it, noting that the streets of Johannesburg are regularly cleaned,

> *"Why not our places? Do we deserve to be treated like pigs or are we human as well?"* (Sowetan, March 26 1993).

And another resident, referring to the problems of informal dumping close to residential areas, reports that residents nearby

> *"...can't study, eat or sleep during the day without the interference of flies. They also breathe air which has a pungent odour..."* (Sowetan, March 26 1993).

On the wider front, uncollected waste is unsightly and offensive to both residents and visitors. Much of this finds its way into rivers, dams and the sea, causing aesthetic problems in these areas as well. This litter problem can have an economic spin-off, as it may reduce the viability of the affected areas as tourist/recreational destinations. For instance, there have been reports of visitors threatening not to return to Cape Town due to the litter problem (Cape Times, 11 August 1993).

3.3 PROBLEMS FOR THE NATURAL ENVIRONMENT CAUSED BY INADEQUATE WASTE COLLECTION SERVICES

As discussed above, large proportions of uncollected waste end up in water courses and eventually the sea, and this has a detrimental effect on the ecology of the areas concerned.

In the first place, decaying organic matter and bacteriological activity use oxygen, thereby reducing the amount available for aquatic life. Thus the Jukskei River, for instance, was found to contain very low levels of oxygen near Alexandra, with adverse effects on river life (Wimberley 1992).

Secondly, the presence of nutrients in the water, as a result of the process of decay, leads to the undesirable growth of aquatic weeds, algae and macrophytes. This in turn affects water quality, is unsightly, can interfere with recreation and poses a potential health hazard (Wimberley 1992, CSIR 1991).

Thirdly, plastics can be a particular problem for river and marine life (CSIR 1991). According to Stander and Benade (1990), large numbers of marine and freshwater birds, fish and animals die every year after ingesting or becoming entangled in plastic. Plastics can pose a similar problem for animal and bird life on land.

3.4 ENVIRONMENTAL PROBLEMS CAUSED BY COLLECTED SOLID WASTE

a) Collection Practices

Collection practices can have damaging effects on the urban environment. For instance, large, heavy vehicles can cause damage to roads thereby both increasing road maintenance costs and detracting from the quality of the urban environment.

A collection practice that is common in the poorer urban areas of South Africa deserves particular mention, namely that of collecting dumped garbage from kerbsides and open places by means of front-end loaders. The first problem, as pointed out in the case studies, is that not all the waste matter is picked up. Secondly, this method removes quantities of soil and vegetation. This in turn creates loose soil which then may find its way into the stormwater drainage system and add to the problem of blockages. The removal of soil also means diminished future potential for cultivation, which is a problem in itself and because of the implications of this for further soil erosion. Thirdly, this practice can cause damage to infrastructure, such as underground telephone and electricity cables that are regularly exposed in Soweto. Finally, the ditches created - up to one metre deep in some places in Soweto - are aesthetically unpleasing, collect water and can be dangerous to people and animals who are at risk of falling into them.

b) Landfill sites

Collected household solid waste in South Africa is deposited in landfills, and these too can cause environmental problems. Although landfills are not specifically dealt with in this report and are well documented elsewhere, their environmental implications are mentioned briefly for the sake of completeness.

The first problem with landfills is the space they occupy. This can be a problem particularly in expanding urban areas, where space for residential and commercial use is at a premium. Secondly, decay can give rise to heavy metals and poisonous chemical substances, which leach into the surrounding soil and contaminate ground water, rivers and streams. Thirdly, the process of decay gives rise to gases which can be harmful or malodorous. The methane and carbon dioxide produced have been linked to the"greenhouse effect" and the depletion of the ozone layer, while methane has the additional problem of being explosive (Jarmain et al 1994). Fourthly, where landfills are close to residential areas flies, rats and other pests bring health hazards. Ash and noxious fumes from burning can also be a problem. Residents of Belhar (Cape Town), for instance, complained of bad smells from a refuse dump sited only 100 metres away from some homes, and flying ash from occasional burning (Cape Times, 5 March 1993).

As mentioned elsewhere in the report, a particular problem in South Africa has been the poor management of landfills. Legislation has historically been inadequate, responsibility divided among numerous government departments, provincial and local bodies, and supervision lacking. A large proportion of landfills do not have permits,and practices at these "illegal" sites are even less likely to be controlled than at the "legal" ones. In a report produced by

the President's Council in 1991 it was stated that of the sites surveyed, 62 percent caused water pollution, 65 percent caused air pollution and 71 percent posed a problem for nearby communities. They also established that most of the sites were inadequately designed, supervised and monitored and very little attempt was made to rehabilitate full or abandoned sites. Ongoing pollution problems at these sites were left unattended to (President's Council 1991). Steps to improve the situation will hopefully now be initiated, following the recent publication of the Minimum Requirements for Waste Management by the Minister of Water Affairs and Forestry.

3.5 REDUCTION, RECLAMATION AND RECYCLING

Reduction, reclamation and recycling are extensively dealt with elsewhere in this report. Clearly the more waste that can be recycled and re-used, the less there will be to dispose of, and the less of a problem to the environment such waste will therefore pose. Similarly, the less that is produced, for example due to the use of less packaging material, and the lower the toxity of discarded matter, the smaller the impact on the environment. Recycling, reclamation and reduction also mean lower levels of demand for new resources, such as minerals and wood, thus reducing the possibility of future resource depletion. Composting for example can be particularly advantageous to the environment, as properly composted matter enhances soil fertility (Smit and Nasr, 1992).

The processes of recycling and reclamation can create their own environmental problems, since the procedures use water, energy and other materials and produce by-products that may act as pollutants. Many forms are at present not economically viable, while some make little environmental sense. For example, the Australian Government's permanent Industry Commission found that the energy and water used to wash glass bottles for re-use could be up to 15 times higher than the amount used to manufacture new ones (Warmer Bulletin No. 31. November 1991). But in the long term waste reduction, pollution control and resource depletion are critical environmental issues, and here recycling, reclamation and reduction are important factors (Brown 1993).

3.6 CONCLUSION

In the developing urban areas of South Africa uncollected household waste poses the most immediate problem. It adversely affects the human environment due to the health hazards posed, the wasteful use of open space and the increased potential for flooding due to blocked stormwater drains. Uncollected waste is also aesthetically unpleasing to both residents and visitors, and adds to the general level of stress in under-serviced areas while reducing the

tourist and recreational potential of adjacent areas. Uncollected waste also poses a problem for the natural environment, and in particular aquatic eco-systems since large quantities of the waste find their way into water courses.

Waste in landfills and collection methods can also pose environmental problems. Environmental issues relating to landfills are of major importance, but this is a fairly specialised area and not dealt with at any length in the report. With regard to collection, the particular practice of collecting dumped garbage by means of front-end loaders is raised, as this adversely affects the urban environment.

4. INTERNATIONAL TRENDS

4.1 INTRODUCTION

a) Aim

The aim of this chapter is to identify and briefly examine the trends which are emerging in waste management in both developed and developing countries. Discussion of the trends will be conducted within the framework of waste management established in the previous chapter. Within this framework, distinction will be drawn as far as possible between the experience of developing and developed countries with greater emphasis placed on the experience of developing countries. Once trends and examples thereof have been discussed, possible lessons for South Africa will be outlined.

b) Trends

Developed Countries
Waste management in developed countries is characterised generally by four major trends:

- Increasing use of sophisticated technology.
- Emphasis on waste minimisation and recycling.
- Greater responsibility and participation of householders in the waste management process.
- Ever more stringent legislation on all aspects of the waste management process.

The increasing sophistication of waste management in developed countries reflects a high level of basic service provision - generally households in developed countries enjoy a regular and efficient domestic waste collection service.

Developing Countries
In developing countries the emphasis is upon improving service coverage and thereby meeting the basic needs of households more effectively. The major features of waste management are:

- Increasing need for community participation in the waste management process.
- Extensive recovery, re-use and recycling of wastes.
- The achievement of economic empowerment through involvement with wastes.

4.2 INSTITUTIONAL ARRANGEMENTS

Institutional arrangements in both developed and developing countries are similar in that the responsibility for the actual provision of waste services tends to rest at the local authority level. However, policy development and legislative decisions tend to be taken at regional and national levels.

The Netherlands, consisting of 12 provinces, each with their own administration, provides a clear example of this approach. Waste policies are set at national level but it is the responsibility of the local municipalities within the provinces to implement and pay for the implementation of these policies, and to collect and to dispose of waste. Many small communities have joined to form co-operative associations for waste management to achieve economies of scale. The provinces are responsible for drawing up plans for the collection and handling of wastes, and also have the responsibility of approving and licencing facilities such as landfills, compost plants and incinerators (Warmer Bulletin No 37, May 1993).

The agencies responsible for the carrying out of waste collection and disposal services can either be from the public or the private sector.

a) Public Sector

According to Bartone et al (1990a), in large systems the optimum scheme is to have all waste managment delegated to one agency within the local government hierarchy. The agency should be positioned at a level that relates to the financial importance and operational difficulties of the service, and have a top level administrator, mid-level technical staffing and its own budget. The designation of such an agency however, does not preclude some operational functions being delegated to other public agencies at local level or to the private sector. Nevertheless Bartone (1990a) believes that one agency should be assigned the principal responsibility for strategic planning, co-ordinating solid waste management operations, contracting services, and overseeing contract performance.

It is of interest that in a review of municipal solid waste projects, Bartone (1990a) noted that there was a low level of borrowing for municipal solid waste management projects. One of the factors to which this was attributed is that borrowers do not recognize solid waste management as a major consumer of scarce municipal resources with the true cost of solid waste management services often being hidden due to deficient municipal accounting practices and reliance on central government transfers. Consequently the relative importance of achieving greater efficiency in service provision tends not to be properly appreciated.

Bartone (1990a) notes that this management information problem is more deeply rooted in overall municipal management capacity.

b) Private Sector

Amos (1993) points out that waste management should not automatically be regarded as the responsibility of a local authority. Cointreau (1992) points out that solid waste services are among the easiest of municipal services to privatize, and competition can be introduced there much more easily than in water and sanitation services. The fact that the task of waste management can be precisely defined and the performance can be measured without serious difficulties means that the local authority can delegate the operation to other entities. There are two forms of delegation, both of which are used in developing and developed countries. One form of delegation is using a private contractor to do the work, and this can be useful in terms of being able to assess the efficiency and cost-effectiveness of the operation. There is however the risk that cost cutting may lower standards (Amos, 1993). The other is to delegate responsibility to the community.

Private Contractors

There is much use of private contractors in both developed and developing countries and there are various possible institutional arrangements when the public and private sector are both involved. In West Africa there have been examples of the leasing of government-owned vehicles to private firms who assume responsibility for collection operations and maintenance. In several Latin American cities there are several public-private sector arrangements where the public agency authorizes a contract or grants a franchise to a private firm which provides the service using its own assets.

With regard to solid waste collection in developed countries, the private sector has been shown to be significantly more efficient than the municipal collection service. According to Savas (1987), nationwide studies in the United States, Canada, Switzerland, Japan, as well as regional studies undertaken in Connecticut, California and the midwestern United States have shown that contract collection is about 15% less costly than municipal collection for comparable collection services.

Savas (1987) points out that if taxes paid by the private supplier are taken into account, the fact that these support various local services indicates that the true cost to the resident for a contract service can be as much as 58% lower than that for a municipal service. Furthermore, a study in 20 cities with similar urban conditions revealed that the cost of

contract street sweeping, with the same frequency and quality of service in each city, was 43% less per curb mile than the cost of municipal sweeping (Savas, 1987).

There is limited information available on the performance of private sector solid waste services in developing countries. However, experience in Brazil and Turkey supports the findings in developed countries (Bartone, 1990c). According to Leite (1989), for a comparable level of service, taxpayers in Rio de Janeiro pay at least twice the amount per metric ton of refuse collected as taxpayers in Sao Paulo, where private firms are contracted to perform solid waste services. The higher productivity and efficiency of the Sao Paulo contractors was attributed largely to the higher labour and vehicle use efficiency of the private firms. Contributing factors were the high cost of maintaining the old collection fleet in Rio de Janeiro and the difficulty in replacing vehicles due to a government policy restricting access to credit for parastatals seeking to renew equipment (Bartone, 1990c).

The three firms that operate the street sweeping and refuse collection service in Sao Paulo report to the Regional Administrations which are bodies that administer the city's districts. These bodies are responsible for authorizing payments and monitoring contract performance in accordance with measurable variables. The city's waste management department is responsible for overseeing competing bidding, hiring contractors, and supervising the private services. The waste management department's ability to negotiate contract conditions with private firms on the basis of its broad knowledge of unit costs and performance standards is a key factor in the success of the arrangement (Bartone 1990c).

In Adana, Turkey, the municipality hires two private contractors to collect 75 percent of the city's wastes in one area of the city, and the municipality works in another part. The private sector costs for cleansing services are almost three times lower than the costs of the service provided by the municipality, while the productivity of labour in the private firms is up to four times higher than that of the municipal service (Bartone, 1990c).

Community approach

The second form of delegation which Amos (1993) mentioned, is where communities assume responsibility for their own waste collection and disposal. In such instances, the community self-help can reduce costs and community self-interest can result in high standards. However these benefits can only be achieved where there is high community motivation combined with adequate levels of education, awareness and skills within the community. The potential for variability in standards from area to area would be high due to the voluntary nature of these arrangements. Consequently the local authority could have difficulty in enforcing minimum standards in some areas.

An example of community involvement on this basis was in Jakarta and Surabaya in Indonesia where the responsibility for solid waste management was split between the Local Authority cleansing department and a number of neighbourhood organisations. The neighbourhood organisations were responsible for organizing household collection of wastes to central collection points while the responsibility of the cleansing department was the transfer, transport and disposal from local collection points and the cleansing of main streets. However problems arose with this system as there was poor coordination between the neighbourhood collection and the cleansing department, consequently wastes were not collected timely and this caused substantial over-spilling of storage facilities (World Bank, 1993).

There are also urban centres where the local authority plays no active part in waste management because semi-formal scavenging has made the operation into a profitable commercial activity (Amos, 1993). This aspect of waste management is discussed further in the section on recycling.

The World Bank (1993) points out that most developing countries have little or no expertise in environmental/sanitary engineering and municipal waste management. Furthermore the solid waste service in most developing country cities lacks planning, human resource development, financial management and budget control functions. This despite the fact that in most cities in developing countries, the solid waste service is the largest employer of municipal labour and transport, and spends the largest portions of the city's revenues for operations. Consequently the Bank recommends that efforts to improve municipal solid waste management should include appropriate levels of technical assistance and training in the operational, financial, and managerial aspects of solid waste management.

4.3 WASTE CHARACTERISTICS

a) Distinctive Features

Developed Countries

The distinctive features of waste in developed countries are:

- per capita waste generation rates usually exceed 1 kg per day;
- waste density is usually no greater than 150 kg per cubic metre;
- in contrast to developing countries, the waste is composed of relatively large amounts of paper, metals, glass and plastics, and less putrescibles.

Developing Countries

The distinctive features of waste in developing countries are:

- per capita generation rates generally are below .60 kg per day;
- waste density is usually greater than 400kg per cubic metre;
- in contrast to developed countries, the waste is composed of relatively large quantities of putrescibles, dust and ash, and comparatively little paper, metals, glass, and plastic.

b) Comparison of Waste Characteristics

Table 6, Table 7 and Table 8 compare the central features of the waste characteristics identified above.

The comparisons are made between categories identified as:

- Developed Countries
- Developing Countries
- Middle Income Country

Table 6 provides a comparison of international waste generation rates. As can be seen, generation rates range from 0.3 kg per person per day in Nepal, to 1.8 kg per person per day in the USA. This range accords with Kalbermatten's (1992) figures with the range for developing countries being 0.4 to 0.6 kg per capita per day, and 0.7kg to 1.8kg for developed countries.

Table 7 shows a comparison of waste densities with range being 100 kg per cubic metre for the USA, to 430 kg per cubic metre for Nepal. Again this compares with Kalbermatten's ranges of 100 to 200 kg/m^3 for developed countries and 250 to 500 kg/m^3 for developing countries.

Table 8 shows a comparison of waste composition in specific countries. Again this compares with Kalbermatten's (1992) comparison between developing and developed countries as shown in Table 9.

Table 6 International Waste Generation Rates

	Country	kg/day/person
Developed Countries	USA (1)	1.8
	USA (2)	1.49
	Japan	1.38
	France	1.10
Middle Income Country	Singapore	0.87
Developing Countries	Pakistan	0.60
	Phillipines	0.50
	Nigeria	0.46
	Delhi, India	0.375
	Kathmandu, Nepal	0.3

Source: Kersey (1994) and Rushbrook (1988)

Table 7 *Comparison of waste densities*

Waste	Developed Countries		Middle Income	Developing Countries	
Density	USA	UK	Singapore	Delhi, India	Kathmandu, Nepal
kg/m^3	100	147	175	422	430

Source: Rushbrook et al (1988)

4.4 THE WASTE MANAGEMENT PROCESS

a) Storage

Developed Countries

Storage of household waste generally takes place in standardized containers, usually plastic bags or bins. Traditionally, during the collection process the bags are removed and the bins emptied. Technological developments have led to a shift to automation which enables bins to be mechanically emptied into collection vehicles. Further technological advances are taking place with the introduction of identity chips implanted in bins. These chips allow for more detailed information to be processed about the householder and the waste load. This enables the waste agency to have more accurate records about waste generation rates and variability according to location. It also makes billing easier and more accurate as householders can be charged according to weight of waste generated.

Table 8 Comparison of waste composition

Waste	Developed Countries		Middle Income country	Developing Countries		
Composition	USA	UK	Singapore	Delhi, India	Kathmandu, Nepal	Wuhan, PRC.
Vegetable	22	25	5	47	67.5	16.35
Paper	34	29	43	6.3	6.5	2.12
Metals	13	8	3	1.2	4.9	0.55
Glass	9	10	1	0.6	1.3	0.61
Textiles	4	3	9	na	6.5	0.62
Plastic/ Leather/ Rubber	10	7	6	0.9	0.3	0.5
Wood	4	na	na	na	2.7	1.76
Dust/ash/ other material	4	18	32	36	10.2	77.61
Moisture content (%)	22	20-30	40	15-40	na	30

Source: Rushbrook et al (1988)

The implanted chips have details of the owner recorded. The automatic truck lifter contains load cells that continuously weigh the bin both while it is being raised to dump into the truck, and also on the way back to the ground. The load cell is wired to a computer located on board the vehicle. The computer takes the difference between the full and empty masses to generate a net weight. An antenna built into the lift device "reads" a unique identification signal emitted by a tag on the container. The customer and address are thus identified. This data is stored in a computer on the vehicle and then downloaded at the end of the day into a computer at the depot. The data is then used for billing purposes.

A mass-based pilot project has been operating in Farmington, Minnesota for three years. Weight based schemes are also being used in East Germany and Australia (von Schoenberg, 1994). One issue to arise is the determination of who actually benefits from the weight based system and whether these benefits are of any significance. Potential savings to the household are relatively insignificant when the cost of disposal is two to three cents per pound, as is the case in Farmington, Minnesota. (McMahon, 1994)

The move to a variable fee rate is not new, with volume-driven rates being the basis for such rates until now. The volume driven system can work with rates varying according to different

Table 9: Waste components, Developing and Developed countries

Key Components	Developed Countries (% of wet weight)	Developing Countries (% of wet weight)
Paper	15-50	1-10
Glass, Ceramics	4-12	1-10
Metals	3-13	1-5
Plastics	2-10	1-5
Textiles	2-10	1-5
Vegetable Matter	20-50	40-85
Moisture Content (%)	20-40	40-80

Source: Kalbermatten, 1992

sized containers or with specific disposal bags where the charge is according to the number of bags used. Such a system also has its flaws. For example, in Switzerland, during 1993, a payment system was introduced which required householders to place their waste only in special bags, called Bebbi-bags, for which they had to pay. Problems however arose when householders, seeking to avoid higher disposal costs, devised innovative disposal methods such as dumping unsuitable waste material in compost containers which affected the quality of compost as well as overloading compost areas; waste was also dumped around bottle banks, in roadside litter bins and in public parks (Warmer Bulletin No.40, February 1994).

Developing Countries

In developing countries household storage of waste is often non-standardized. Non-standardized containers range from temporary items such as cardboard cartons, plastic bags and crates, to permanent containers such as plastic or metal bins. Cointreau (1982) points out that standardized plastic bags are generally inappropriate for developing countries because they are expensive, they are prone to bursting in hot climates, and they can be subject to interference such as that from scavenging animals. Standardized bins have disadvantages in that they can have more attractive uses such as food and water storage.

Communal storage units are also common in developing countries. These can take the form of a permanent structure, such as three-side masonry building, or take the form of mobile containers such as steel drums, skips or trailers. Inevitably the communal storage does not preclude the need for some form of temporary household storage such as a plastic bag or cardboard box, before the waste is transferred to the communal collection point.

b) Collection

Developed Countries

The minimum standard of service available to households in developed countries is a once weekly kerbside collection, usually by compactor vehicles. This level of service is compatible with the better infrastructure (eg. better roads) and effective management arrangements which are typical of developed countries.

Developing Countries

Developing countries have less standardized methods of collection and levels of service than developed countries. House to house services for example are not necessarily operated with motorized vehicles but are characterized by low technology methods. In Ouagadougou, Burkina Fasa, the local waste management committee of a residential area known as Wogodogo initated the use of indigenously designed and produced donkey carts for door to door collection. In Alladjan, Ivory Coast, the primary collection system consists of two-wheeled pushcarts which make daily rounds.

Communal collection systems also make use of low technology methods. For example in Adjoufou II, a region of Abidjan in the Ivory Coast, two-wheeled barrows are used to transport communal drums (which are placed less than 30m from each house) to skips at collection points. The skips are then emptied periodically by a private municipal collection company (Meyer, 1993).

A "waste exchange" collection system has been introduced in Curitiba, Brazil where a "purchase of garbage" programme is run in the favelas (squatter settlements). In the past, residents dumped their household refuse in open air pits or vacant lots as there was no service to collect this waste. Residents of favelas can now "sell" their bags of waste for bus fares and agricultural and dairy produce. The programme has led to a considerable decrease in city litter and has helped to improve the quality of life of the urban poor. The payment to the communities through bus fares and food for garbage is equivalent to the municipaliy paying a private company to collect the waste. The programme involves more than 22 000 families in 52 communities (Rabinovitch,1992).

c) Transport

Developed Countries

With a comparatively low density waste, which can be compacted up to a quarter of its original volume, the use of compactor vehicles is appropriate and is used widely in developed

countries. Technological advances of the vehicles are reflected in semi-automated bin lifters which require labourers purely to wheel containers to the vehicle, and can be complemented by mass based charging systems.

Developments in collection vehicles are epitomized in the recently developed German "shuttle" which is a futuristic front loading waste collection vehicle that looks like a tour coach (Warmer Bulletin No.40, February 1994). The vehicle has bin grabbers designed to lift wheeled bins and containers from 120 litres to 1.1 cubic metres. The grabbers emerge from behind a roll screen above the driver cabin and empty the bins into a delivery area behind the cabin. The waste is compacted in this area and pressed into removable tanks with a load capacity of ten tons. The advantage of the system is that tanks are easy to uncouple so that long transportation distances to disposal sites in expensive collection vehicles can be avoided. Effectively the parked waste tanks or containers can act as mobile transfer stations.

Rail transport is another method of transport used in the disposal process, but not for primary collection. Rail transport tends to be used to transfer waste from transfer stations to landfills or incinerators. The waste is usually compacted into bales at the transfer site and then transported on rail cars to disposal.

Developing Countries

An indication of the type of low technology transport used in developing countries was given by the discussion on collection methods. Vehicles ranging from pushcarts to compactor trucks are used for primary collection whilst compactor trucks, standard open trucks as well as container vehicles are all used as transfer vehicles. Developing countries, however, do experience problems when making use of technology that is designed primarily for use in developed countries. For example, in a World Bank project in Jakarta, Indonesia it was found that the use of compactor trucks was not feasible as the waste had a very high water content (40 to 50 percent) while baling machines were found to be ineffectual as scavengers pulled apart the waste (Bartone, 1990a).

d) Recycling

Recycling activities in developed countries tend to be more formalised than in developing countries, with for example scavenger activities in developing country cities often being officially discouraged. A key issue in recycling is the need for markets for the recyclables with the formal sector often reluctant to accept products for recycling. This issue can only be adequately addressed when there are linkages - be they institutional, financial or

economic, between the industries producing the waste and those recycling, hence providing incentives to economy (Kalbermatten, 1992).

Developed Countries

Recycling activity is on the increase in developed countries, whether it be of industrial, commercial or household waste. For example in the US the percentage of the municipal solid waste steam recovered for recycling or composting increased from 13 percent in 1988 to 17 percent in 1990.

There are two central features of recycling in developed countries: the need for household co-operation, especially at source recycling, and legislative coercion.

- **Household Co-operation**

Central to gaining household co-operation with recycling programmes is awareness creation and education. The responsibility for this generally falls upon the authorities. New York City has applied this process with some success. Here a source recycling "curbside programme" was begun in 1990. Districts are selected for recycling after which residents are "alerted" and "educated" to the imminent recycling drive. Flyers explaining recycling procedures, posters and meetings are all methods to create an awareness within a community. This "curbside program" was scheduled to be implemented in all 59 districts of New York by 1992. In 1990, more than a 1000 tons of newspaper, metal cans and glass bottles were diverted from New York's waste stream per week through the program. At the time, less than a third of the 59 community districts were online (Lofaso, 1990).

- **Legislation**

There is a need for recycling to be facilitated through legislation because producers often find raw materials cheaper than recyclables in the production process. An example of the type of legislation which can be enacted comes from Germany where a packaging ordinance aims to ensure that the producers of packaged products take responsibility for the disposal of the packaging. Consequently recycling depots are prevalent outside supermarkets. In the same way Germany passed a Draft Used Paper Ordinance in July 1993. The ordinance essentially states that paper manufacturers, publishers, printers, distributors and retailers will be obliged to take back used graphic paper free of charge to the consumer. Industry, distributors and retailers must accept waste paper returned by consumers in the immediate vicinity of points-of-sale or by post (eg. junk mail items) (Warmer Bulletin No. 36, February 1993).

It may be noted that whilst there is a widespread awareness of recycling throughout the developed world, not all countries have achieved significant levels of resource recovery

through recycling. In the Republic of Ireland for example, less than 1% of the 1.22 million tons of household waste is recycled, according to a survey commissioned by the Irish Department of the Environment (Warmer Bulletin No. 38, August 1993, p.7). Legislation is again seen as the tool to address this situation, with a recommendation from the Ministry of the Environment that all organic wastes be composted from the beginning of 1994 and not landfilled.

Developing Countries

Hardoy et al (1992) note that cities in developing countries are characterised by the scale and complexity of waste minimisation, recovery of materials from wastes for re-use or recycling and use of minimal resources. Waste materials are used by low-income households for the construction of their shelters and by small-scale industries and workshops as raw material in their production. Such activity keeps waste levels down and reduces consumption levels for non-renewable natural resources.

In developing countries it could be argued that two factors have served as catalysts for a widespread recycling ethic. First environmental considerations due to less effective collection systems, and second, the economic opportunities created through the "waste industry". It would appear however, that the economic benefits of recycling are the key factor. For, according to Furedy (1991), whether or not there is a formal system of waste collection, there is a highly developed network for resource recovery.

The recycling network may consist of door to door collectors and/or "scavengers" who separate reusable materials at dumps and collection sites. In the Federal District of Mexico City, around 10 000 people are involved in informal scavenging at the landfill sites. Each day they recover some 600 tons of materials (quoted in Kalbermatten, 1992). However these recyclers can come into conflict with municipal waste management systems as, for example, many municipalities see scavengers as a menace and try to prevent them from working at dump sites. However, experience in many countries has shown it to be beneficial for waste collection services to include existing collectors, rather than to launch new programs for resource recovery (Furedy, 1991). According to Ohnesorgen (1993), "scavengers are, in a sense, a resource, because they recycle solid waste, and cities have to learn to work with them and train them, not work against them."

There is much evidence of economic benefits arising from recycling activity. For example, in Asia several million urban dwellers depend on wastes for their livelihoods, including workers in small industries which use plastics, tin can, bottles, bones, feathers, intestines, hair, leather and textile scraps (Furedy, 1990). The waste economy can include bodies such

as: itinerant buyers who collect or purchase certain kinds of wastes direct from the streets to sell, dump pickers, small waste shops, second-hand markets, dealers, transporters and the various recycling industries (Furedy, 1992).

In Calcutta, it is estimated that 40 000 people make a living from recovering and using or selling resources picked from wastes. Thousands more make a living from intensive farming using composted household wastes, and fish-rearing in ponds fertilized by city sewage (Furedy, 1990b). In Bogota (Columbia), an estimated 30 000 to 50 000 earn a living as cart drivers, small-scale waste dealers, workers reclaiming materials from street waste and the employees of the municipal waste disposal and street-cleaning department (Pacheco, 1992).

Furedy (1990a) has documented the ways and means by which the recovery, recycling or re-use of materials from city wastes provides livelihoods for poorer people, whether as individuals, households or informal groups. Furedy asserts that city and municipal governments can make such activities a central part of their waste management programme with cost advantages to themselves, better returns and working conditions for those who make a living from the waste and the retention by the city of the environmental advantages.

Furedy has shown that alternative approaches to waste management can include social goals since the process of resource utilization and waste recovery in Third World cities is usually driven by poverty. She has observed that in Asian cities the poorer or less equal the society, the greater the range and volume of wastes which have value and are re-used or recycled. This argument may well have validity internationally (Furedy, 1990a). The individuals or households who use or collect resources rarely obtain an adequate return relative to the number of hours worked. They undertake this work as in the absence of a better alternative and it provides a livelihood, usually for the poorer groups in society.

There are problems with resource recovery. Injuries can be incurred from broken glass and other sharp objects and there can be exposure to excreta-related diseases from excreta-contaminated wastes. Additional risks come from exposure to disease vectors and the occurence of toxic wastes mixed with household waste. As Hardoy (1992) points out, a critical consideration is how great the environmental advantages of informal resource recovery and utilization can be kept (and enhanced) while income levels and working conditions are improved and health risks reduced for individuals, households and enterprises engaged in the process.

Below are some further examples of recycling activity in developing countries.

Cairo, Egypt

In Cairo, the city government failed in an attempt to introduce first world municipal collection - trucks broke down, compactors failed, the streets were too narrow, and the system was too expensive (Jensen, 1991). The municipal authority then began to work with private waste collection contractors and with the Zabbaleen, the community of scavengers who traditionally have collected reusable wastes. This approach enabled the city to introduce some mechanization and to improve the solid waste collection service while maintaining the Zabbaleen's livelihood and the flow of recyclables (paper, metal, glass, bone etc.) to small workshops throughout the city.

Harare, Zimbabwe

According to Keeling (1991), there is an extensive recycling industry in Harare. The system is supported by collectors who pick up scraps from industries and scavengers who sort waste from tip sites and sell materials to contractors' representatives at the site. Co-operation between the contractors and the municipality has allowed scavengers to operate at city dump sites and ensured the continued operation of the system.

Olinda, Brazil

In 1983, the municipality of Olinda selected a favela with 450 low-income families covering an area of 3.5 hectares known as "Triangulo de Peixinhos" for a pilot project in upgrading. The origins of the favela date back to 1945, but in 1983 only a few of the occupants held legal title to the land they occupied. The settlement had no sanitation facilities, and provision for drainage was inadequate or non-existent. There was no municipal refuse collection service and none of the roads were paved. Most dwellings were connected to the electricity network but water supply was inadequate.

In order to overcome these problems, the project team identified the need for a solution which would involve the local community and provide a simple but effective basic infrastructure. Prior to the project, only a portion of the household refuse was placed in a nearby skip set aside for waste collection. The rest would usually be left in the streets to rot or would be dispersed by the wind and rain. A municipal engineer designed a small composting and recycling plant which was built with the help of the inhabitants. This offered obvious advantages over a centralised system of rubbish collection for the whole city. For example, a large number of unskilled labourers were given employment during construction, and running costs were kept comparatively low partly because the community was involved in the everyday running of the plant.

Before construction of the composting plant, there had been clean-up of the whole settlement, with all rubbish which had accumulated in different parts of the favela collected, along with any other wastes that households wanted to get rid of; altogether about 50 tons of waste were collected. A daily collection of refuse was then begun using a simple hand-pushed cart designed and constructed by a local firm, with the support of the municipality. The cart could be operated by one person - and it was narrow enough to fit throught the narrowest alleys and thus reach all houses.

The operational capacity of the composting plant was one ton per day. As the waste arrived, the recyclable matter was separated and sold. Most of the remaining waste was compostable — and the composting process typically reduced the volume to a quarter of that of the waste volume prior to processing. The municipal authorities in Olinda have also developed other composting plants, and also seek to design and implement rubbish collection and street cleaning systems which match local conditions and possibilities (Hardoy, 1990).

Curitiba, Brazil

A system has been introduced in Curitiba known as the "garbage that is not garbage" recycling programme which encourages city residents to separate organic and inorganic refuse. Once a week, a "garbage that is not garbage" lorry collects the materials which households have sorted. Over 70 per cent of the community now participates in the programme and its success is largly due to a city-wide environmental education programme which highlights the benefits of recycling. Approximately 150 tons of recyclable material are collected daily - 30 tons a day by the municipality and the rest by entrepreneurs (150 tons represents a volume of 3 000 cubic metres a day which is not being dumped on the landfill). Since its inception, some 13 000 tons of refuse have been recycled. The paper recycling alone saves the equivalent of 1 200 trees a day. Apart from the environmental benefits, this recycling programme has generated other positive side effects, including support for social programmes, since the income earned through the sale of the recyclable garbage is reinvested in local social programmes (Muller, 1992).

Shanghai, China

Since 1957 the Shanghai Municipal Environmental Sanitation Administration[3] has developed into a complex entity involved in the retrieval and marketing of reclaimed products, and now has some 29 000 full-time and many more part-time employees. A network of 502 purchasing stations and 1 500 purchasing agents in rural areas acquires material for reclamation or recycling. The agents are paid on commission. Twenty-six integrated recycling centres

[3] The administration serves a 150 square kilometre city (Shanghai) plus 6035 square kilometres of peripheral suburbs and rural areas with a total population of 12 million. (Gunnerson, 1987)

reclaim or recycle material from industrial and consumer wastes and a network of sales departments and retail shops sell reclaimed products. Over 3 600 people are employed to work directly with factories - for instance advising them on setting up containers for wastes and establishing systems by which the company can collect them (Gunnerson,1987).

Jayanagar IV Block, Bangalore

In 1990, the Waste Wise project was launched with the general goal of exploring alternatives to the conventional solid waste system. The new approach was based on waste reduction, separation of compostable, recyclable and other wastes, and decentralization. The project also has specific social, economic, environmental and educational goals. Amongst other things, the project hopes to raise the status of pickers and create an awareness that wastes are resources eg. by composting in public parks people see the process of recycling and the negative effects where synthetics are not being separated from organics.

The selected area for the project, Jayanagar IV Block, is an affluent to middle-class residential area. Prior to the start of the project, householders and local authorities were consulted, and local waste pickers were brought on board. Project households were given bamboo baskets to hold dry wastes and they were told to segregate compostable and insanitary waste (for disposal by city collection). Former waste pickers, operating in pairs, pick up the separated wastes from the project households. They are equipped with handcarts and baskets and trained by a supervisor paid by Waste Wise. Collectors visit each house daily, take the organics to the compost site, sell the dry recyclables and dispose of residues in communal bins. Households pay a small fee per month for the service. The project supervisor meets weekly with the collectors for a training session and to discuss problems.

The collectors are all children as adults were not interested because the earnings were below what they could make by independent street-picking throughout the day. The house to house collecting is done in "prime time" for street-picking, so the two jobs could not be effectively combined. A number of problems face the project; it has been said that Waste Wise is a "shoe string" operation; separation is done by servants; householders are suspicious of the collectors; the collectors do not always stick to their schedule. Nevertheless, the Waste Wise group hopes to transform approaches to solid waste management in Bangalore by building upon social and environmental motivations. Apart from making the work of young street pickers cleaner, more productive and respectable, it is possible that keeping waste resources separate could enhance their value for recycling as well as make it part of an environmental ethic in the city (Furedy, 1992).

e) Disposal

The key factor distinguishing disposal in developed countries from that in developing ones is control. Developed countries tend to have greater legislative controls over the disposal process be it landfilling or incineration.

Developed Countries

Disposal of household waste generally takes two forms in developed countries, sanitary landfilling or incineration. In most European countries, space shortage is central to the disposal problem. A lack of space means that landfill sites are becoming scarce. In larger countries there may be sufficient sites, but disposal becomes more expensive because, although there may be space for new landfill sites, these sites tend to be further away from the collection areas.

The central role of legislation is once again illustrated with an example from Germany. In February 1993, the German parliament passed a law requiring that, prior to landfilling, domestic waste must be treated to ensure that groundwater contamination and air pollution are avoided. This will mean that those wastes which are not recycled or composted will probably have to be incinerated before landfilling. Predictions are that at least 36 new incinerators will need to be built to achieve this objective within 12 years. However there are acute disposal problems in some of the lander (provinces) which would mean that alternative short-term solutions would need to be found (Warmer Bulletin No 37, May 1993).

The lack of landfill space confronted by Germany is inevitably worse in a densely populated country such as Japan. Incineration is regarded by the Japanese as the most sanitary method to treat wastes. By 1988 Japan had constructed 1 915 waste incinerators in sizes up to 1 980 tons/day. The facilites processed 68% of post-recycling waste. This represents the greatest commitment to waste incineration of any country, complementing Japan's significant recycling efforts which appear to be the most comprehensive and successful in the world (Hershkowitz, 1988).

All incinerators in Japan are municipally owned, although one-third are operated by private companies under contract. Many facilities are not just incinerators but are community centres as well, often equipped with heated swimmming pools and other recreational facilities. These amenities are negotiated by the community in exchange for allowing an incinerator to be sited in their area, and on how well a specific technology is known to perform. This usually results in emissions much lower than the levels that the Japanese government substantiates as safe (Hershkowitz, 1988).

Developing Countries

Developing countries lack control over disposal due to limited resources such as appropriate technology and adequately skilled management and staff. The main problem arising from a lack of control is that disposal takes place randomly without safeguards against possible environmental degradation. For example, in East Germany, in 1990, only about 120 of 11 000 sites could be described as controlled, safe dumps approaching western standards. Approximately 10 000 were so-called "wild dumps" often close to road sides. The majority of landfills were not sealed to prevent leachate seepage and compacting equipment is largely outdated and primitive. Additionally the tipping fees which averaged 1.83 East German Marks per cubic metre were excessively low (Von Schoenberg, 1990). These minimal financial costs for disposal are widespread in developing countries and even with such low charges, in many cases it is easier to "dump" waste free of charge, a common occurence.

An example of the dumping problem can be found in Accra, Ghana, where the metropolitan authority has limited capacity for waste collection. A study in 1989 found that only 10 per cent of refuse was collected with 81 per cent being dumped and 9 per cent being burned. Despite the existence of 130 official communal refuse dumps, some 100 unauthorised dumping sites have been created along with widespread dumping of refuse along water courses, channels, on waste ground and roadside verges (Songsore, 1992 and Tahal, 1981). Various problems can arise from such dumps, with scavengers and animals scattering wastes. Also leachates from decomposing and putrifying rubbish can contaminate food, water and soil and thus transmit diseases, while open drains can become blocked by waste. In 1980, in Ibadan City, Nigeria, following a flood-event, the devastation of lives and property that was experienced was attributed to solid wastes which blocked sewers and gutters (Sangodoyin, 1993).

Although there is a close link between dumping and lack of collection, it was found that in Bangkok, Thailand, with 80% of the population being served by a refuse service, 24 percent of solid wastes were still dumped, mostly onto vacant land or in canals and rivers (Sivaramakrishnan and Green, 1986; Phantumvanit and Liengcharernsit, 1989; and United Nations, 1987).

4.5 PROBLEMS

The nature of problems experienced by developed countries differ significantly from those experienced by developing countries. This is not surprising for, as can be seen, developed countries are dealing with established systems which require ongoing "fine-tuning", whereas developing countries are still confronted with the difficulties of setting up systems that work.

Developed Countries

The major problems with waste management in developed countries are related to the disposal of waste rather than collection. This may be attributable to factors such as:

- The existence of efficient collection services and; hence the majority of waste generated is being collected for formal disposal.

- The high generation of waste in the consumer-oriented societies of the developed world.

- Waste increases as on-site storage capacity is increased. Research has shown that the amount of waste generated increases when householders are provided with larger containers such as wheeled bins (Warmer Bulletin No. 41, May 1994).

Developing Countries

Ten major problems with waste management in developing countries have been identified and are discussed briefly below. It is important to note that traditionally the focus of attention in projects in developing countries has been upon the technical aspects of collection and disposal (Flintoff, 1976). For example, 66 of 71 waste related World Bank loans during 1974 to 1988 went primarily to obtain waste collection vehicles (Bartone and Olivera, 1990b). More recently, the focus has shifted to improving institutional arrangements — especially privatization — for such services (Bartone, Liete, Treiche, Schertenlieb, 1990c).

a) Institutional inadequacies

Institutional inaequacies are experienced at all levels in developing countries, ranging from policy-making down to actual delivery of the service. These inadequacies have been highlighted in a number of World Bank projects in developing areas.

- Jakarta, Indonesia
  Institutional deficiencies presented constraints to the implementation of a solid waste programme. The deficiencies included: lack of adequate project management and supervision; insufficient staff resources - employees involved in solid waste services held concurrent jobs in other agencies; and the need to replace a technical supervisor three times.

- Calcutta, India
  The Calcutta Municipal Corporation changed its solid waste methodologies more frequently than could be readily absorbed by staff who were poorly prepared to deal with increasing levels of technology; there was a lack of continuity among middle management solid waste staff; and there were problems with sustaining the momentum of solid waste improvements among competing urban service needs.

- Lagos, Nigeria
  In 1977 the Lagos State Refuse Disposal Board was established to deal with the mounting accumulation of garbage and abandoned vehicles on the streets. It was given broad powers to plan and operate a citywide refuse collection system. It procured new vehicles and engaged expatriate technical assistance to manage the board's operations. By 1981 the Board had expanded its sphere of operation to include commercial and industrial waste management; stormdrain cleaning; collection and disposal of abandoned vehicles. In 1984, however, the contract with the foreign expert assistance was not renewed and Nigerians took over the full management of the Board. However they had limited civil engineering capacity and furthermore there were few engineers in Nigeria who had any expertise in designing and managing solid waste facilities. Due to limited funding, staffing and equipment, the Board's operations consisted largely of crisis management on a day-to-day basis; there was no long-term planning for development, improvement or expansion of their operations.

b) Inappropriate technology

The use of inappropriate technology is reflected in situations such as those outlined below.

- Houses are too small to accommodate standard refuse bins (Niyirenda, undated).

- Standard bins used as containers for alternative purposes (Niyirenda, undated).

- Compactor vehicles designed for high compaction ratios when developing country waste is already highly dense (Habitat, 1993).

- Poor road infrastructure with uneven surfaces unsuitable for sophisticated vehicles.

- Large numbers of people live in slum and squatter areas where the road access is poor or non-existent.

- Sub-optimum balance between mechanization and labour inputs with labour being cheap and fuel expensive (Habitat, 1993). A comparison between a basic collection system using 3-wheel cycles as primary collectors (feeding to a roll-off container-handling vehicle) and conventional compactor trucks suggested that the latter were 2.6 times more expensive in financial terms, but 3.4 times more expensive in economic terms. Furthermore this study did not include the likelihood of imported equipment being unserviceable for a large proportion of the time due to lack of spare parts and expertise (quoted in Kalbermatten, 1992).

- Continued use of vehicles beyond their economic life eg. in Peshawar, Pakistan - 85% of the local municipal council's fleet is made up of vehicles older than 10 years (Habitat, 1993).

c) Inadequate income

Municipal authorities tend to be underfunded largely due to inadequate refuse collection techniques. There is also a particular problem with squatter communities as people living in such situations are assumed to be less likely to pay rates and taxes, hence municipalities argue that they cannot be served. This assumption that squatter communities are not prepared to pay is often unfounded, as reflected in Brazil, Indonesia and Sri Lanka where communities consider the payment of municipal taxes and service charges as a positive means of obtaining governmental recognition of the existence of illegitimate plots and a way of being integrated into the urban economy (Habitat, 1993).

This perspective is reinforced by survey results from Gujranwala, Pakistan where only 20% of households considered free service to be a government responsibility; 80% were willing to pay for improved service.

d) Over-reliance on imported equipment

Despite lower municipal income bases and the high cost of importing equipment and vehicles, importation of equipment is widespread. This places a strain on foreign exchange requirements because the initial capital outlay is followed up by replacement and maintenance costs (Habitat, 1993). Furthermore access to spare parts can be made difficult. For example in Antananarivo, Madagascar, a World Bank project was undermined due to differences between the government and the overseas supplier of collection vehicles. The government unexpectedly charged duties and taxes on the import of the collection vehicles. In resopnse the supplier refused to supply spare parts for truck maintenance until it was reimbursed for

the taxes and duties. 23 trucks were delivered in 1984 and in 1987 it was reported that 11 out of the 23 trucks financed under the project were out of service due to a lack of spare parts (Bartone, 1990a).

Another example of a similar problem comes from Lagos where, as part of a World Bank project, 600 collection vehicles were to be purchased. Difficulties such as the technical aspects of equipment specifications and complicated local procurement procedures impeded the purchase process to the extent that, when the contracts were finally approved, the actual local currency cost of the vehicles was eight to nine times higher than originally estimated due to devaluation in the currency (Bartone, 1990a).

e) Inappropriate methods of finance

Waste collection equipment has a relatively short life; vehicles usually last no more than 5 to 7 years. Developing countries often tie themselves into loans over longer periods without considering the revenue raising capability of the vehicle and its time frame. This is exacerbated by companies from industrialised countries who attempt to make the terms of payment as attractive as possible to the purchasing country (UNCHS).

f) Inequity in service provision

Levels of service can be inconsistent within areas. For example:

- In Onitsha, Nigeria, only 10 per cent of the waste generated in poor neighbourhoods was collected as compared to 80 per cent in upper-income residential areas (Cointreau, 1980).

- A squatter community in Karachi where 20 per cent of the population was observed to have only 5 per cent of its waste collected by the municipality while the average for the whole city was 33 per cent (Sinnatamby, 1984).

- In Cairo, Egypt, prior to the implementation a World Bank project, small contractors called "Zabbaleen" conducted house to house collection. However it was more profitable for the Zabbaleen to collect refuse from the wealthy neighbourhoods with poor neighbourhoods being neglected. Most of the waste from the high and middle-income areas, about half of the waste from lower middle income areas, and none from low-income areas was collected (Bartone, 1990a).

g) Unsustainable technology and lack of organisational capacity

Technology has proved to be unsustainable due to a combination of technical and human resource issues. In terms of human resources, there has been a lack of skilled personnel with limited technical capacity and poor management. With regard to technology, problems that arise include the following:

- High equipment set up costs.
- Difficulties in getting spares.
- Insufficient operating budgets.
- Climatic and seasonal variations.
- Foreign exchange limitations on imported equipment.
- Ignoring economic realities - developing countries tend to have abundant labour and little capital (Kalbermatten, 1992 ; Niyirenda, undated).

h) Insufficient emphasis on privatization

Schertenleib (1989) asserts that externally-funded improvements tend to focus on upgrading public sector agencies' capabilities, rather than that of the private sector. However as noted earlier, studies in industrialized countries suggest that for cities of greater than 50 000 people, collection services delivered by the municipality are on average more than 40 per cent more expensive than those delivered by private contractors.

Davey (1993) points out, however, that the advocacy of contracting out requires caution, and that it is only preferable if:

- Private enterprise or community organization is sufficiently mature to offer genuine competition for supply.
- There is adequate social control of urban government to ensure that the award and supervision of contracts are not governed by nepotism or corruption.

- The tasks to be performed can be clearly specified in terms of geographical coverage, frequency and performance standards, and achievement measured.

- Urban government has the capacity to enforce contract fulfillment and to substitute services when contractors fail completely.

Davey (1993) also points out that these conditions are far from universal, especially in rapidly urbanizing countries.

i) Urbanization

Increasing rates of urbanization in developing countries have been accompanied by problems which impact on solid waste management. Such problems include:

- Increasing density of population.

- Increasing per capita production of solid waste.

- Non-availability of land conveniently situated for waste diposal.

The above problems place demands on solid waste management which are only likely to increase as cities' residential, commercial and industrial sectors expand and economies develop. (Habitat, 1993)

j) Lack of collection

It is estimated that less than half the waste generated in urban areas is collected by municipal authorities entrusted with their disposal. In China for example, it is estimated that 10 million tons of refuse is left on the streets each year (Kalbermatten, 1992). In a survey of 34 municipalities in India, more than 60 per cent of the municipalities were observed to collect less than 40 per cent of the waste generated daily (Nath, 1983). Other examples of this lack of coverage by collection authorities can be seen in Table 10. It is also estimated that in developing countries the population served per collection vehicle could be as high as 30 000 (Habitat, 1993).

The types of problems arising from a lack of collection, and the prevalence of the problem are illustrated by the examples cited below.

Table 10 Municipal Waste Collection Coverage

Location	Collection Coverage	Source
Karachi, Pakistan	33 %	Sinnatamby, 1984
Rangoon, Burma	40 %	Gromiec, 1985
Arusha, Tanzania	13 %	Ngainayo, 1986
Cairo, Egypt	50 %	Flintoff, 1978

Bogota (Colombia)
An estimated 1.5 million tons of refuse is generated every year. Only half of this is collected and disposed of by local authorities. Every day approximately 2 500 tons is left uncollected with a small portion of this being informally recycled while the rest rots in small tips, canals, sewers, or on the streets (Castaneda, 1989.).

Dar es Salaam (Tanzania)
About two thirds of all solid wastes from both residential areas and from commercial enterprises remains uncollected (Kulaba, 1989 and Yhdego, 1991).

Guatamala City
An estimated 1 100 tons of refuse is generated per day, of which approximately 750 tons are collected by private and municipal companies; the rest is thrown onto informal dumps or left to rot in the ravines around the city (Di Pace et al, 1992).

Jakarta (Indonesia)
About 40 per cent of the solid waste produced in Jakarta remains uncollected. The waste ends up in canals, rivers and on roadsides where drainage facilities are blocked and as a result extensive flooding occurs in the rainy season (Sivaramakrishnan and Green, 1986 and Clarke, Hadiwinoto and Leitmann, 1991).

Karachi (Pakistan)
Approximately one third of the solid waste generated by households in the city is collected and transported to dump sites (Hasan, 1990; Beg et al, 1985; and United Nations, 1988).

Kampala (Uganda)
Less than 20 per cent of the solid wastes generated within the city are collected and less than 10 per cent of the city's population have a regular collection of household wastes. A household survey in one district of Kampala found that 90 per cent of households had no proper place to dispose of household wastes. Large volumes of organic wastes are evident

in public spaces, backyards, lanes, pathways and vacant lots, while City Council collection bins are usually overflowing (UNEP, 1988).

Kinshasa (Zaire)

The collection of household waste is only undertaken in a few residential areas. Elsewhere in the city household waste is put out on the road, on illegal dumps, in storm-water drains or buried on open sites (Mbuyi, 1989).

Manila (Phillipines)

It is estimated that less than half the solid waste generated in metropolitan Manila is collected and transported to solid waste sites (Douglass, 1992).

Nairobi (Kenya)

Newly developed residential estates and the informal settlements where a high proportion of the total population live, are not served by the city's refuse collection service (Bubba and Lamba, 1991).

Sao Paulo (Brazil)

One third of the population are living in areas where there is no refuse collection service (Faria, 1988). The poorer areas of the city generally have little or no refuse collection service. Most poor households also have limited space, be it in tenements or high-density informal settlements. This makes waste storage and/or transporting refuse to a formal dump site difficult. Many poor settlements are also on sites to which access by motor vehicles is difficult if not impossible.

Abeokuta (Nigeria)

Sangodoyin (1993) identified a number of management problems with the waste system in the area. These included: inadequate finance and personnel, acute shortage of refuse collection vehicles, the unplanned nature of roads and residential areas (particularly traditional areas) as well as laxity in enforcing sanitation bylaws. Sangodoyin also observed waste alongside waste depots which residents claimed was due to the fact that depots were not cleared frequently.

4.6 LESSONS FROM INTERNATIONAL EXPERIENCE

a) Holistic Approach

When waste management systems are being developed, local climate, physical, economic and social factors must be taken into account (Niyirenda, undated; Hardoy, 1992). Rushbrook et al (1988) also stress that waste management is not only a technical problem but is strongly influenced by cultural, social and economic circumstances. The need for a **holistic approach** thus should be the central principle upon which any waste management system is based. A holistic approach to waste management is relevant to both developed and developing countries. However the emphasis in the lessons identified below is on developing countries.

b) Institutional Arrangements

- A thoroughly considered waste policy, legislative framework and management plan are essential (Rushbrook et al, 1988).

- A balance is needed between incentives for private sector involvement and the authorities' responsibility to the public for a universal and reliable service (Meyer, 1993).

- While locally designed and contractor operated systems seem to be the most successful in developing countries, appropriate incentives and overall control must be sustained by the authorities - coordination is thus the key (Smith, 1993).

c) Appropriate systems

- Technology must be physically sustainable in local conditions - physical and climatic.

- Technology must be appropriate to the capacity of local human resources - from labour to management.

- Labour intensive systems tend to offer the most opportunity for important social, environmental and economic benefits to the community (Kalbermatten, 1992).

- Financial analyses must not underestimate the comparative advantage of locally-fabricated vehicles and labour-intensive systems (Kalbermatten, 1992).

- The least cost system is one that minimizes imported vehicles and maximises system productivity through using high labour inputs (Kalbermatten, 1992).

d) Finance

- Direct incentives can play a crucial role in cost recovery (Meyer, 1993).

e) Community Involvement

- Community involvement in planning waste programmes and systems is key (Meyer, 1993).

- District or neighbourhood-level refuse collection schemes devised and managed in collaboration with the residents are often the cheapest and most effective solutions (Habitat, 1993).

- Authorities should provide services which support informal activity within systems eg. the provision of health services to scavengers (Habitat, 1993).

- Improvements in refuse collection can complement and be complemented by improvements in infrastructure and services (Habitat, 1993).

- Primary collection systems not managed directly by the authorities can be prone to difficulties in linking with secondary collection services (Meyer, 1993).

- Public education and the creation of awareness within communities are both crucial. In Bangkok for example, the "Magic Eyes are Watching You" campaign, a private initiative aimed at children aged 10-16, is credited with reducing litter on the streets by 90 percent (Sopchokchai, 1990).

f) Resource recovery

- There are significant economic benefits from recycling and resource recovery for low income groups, but these can be undermined by health risks facing people involved in these activities and authorities should take responsibility for minimising such risks.

5. OVERVIEW OF SOLID WASTE PRACTICE IN SOUTH AFRICA

5.1 INTRODUCTION

a) Aim

The aim of this chapter is to provide an overview of domestic solid waste management in South Africa. Much of the discussion draws on information that can be found in more detail in the nine provincial profiles and the three metropolitan profiles written as part of this research.

b) Focus

The overarching focus of the chapter is on domestic (or household) waste management rather than on industrial and commercial waste. Also, special attention is given to domestic waste collection with less emphasis on disposal of the collected waste.

5.2 DEMOGRAPHICS

a) Model Used

The demographic model used as a basis for this research is based on figures from the Development Bank of South Africa's (DBSA) 1993 publication, *Nine Provincial Profiles*. The Urban Foundation Model (1991) was used for cross-reference purposes. Growth rates provided by the DBSA for each of the provinces were applied to the DBSA's 1993 population estimates to derive the 1994 figures used in this research.

b) Population Estimates

The population estimates used in the research are shown by province in Table 11. As can be seen, the total urban population estimate is 21.7 million people.

Table 11: Summary of the DBSA population model

Province	Urban Population	Total Population
Western Cape	3 297 000	3 682 000
Northern Cape	563 000	770 000
Orange Free State	1 836 000	2 847 000
Eastern Cape	2 507 000	6 839 000
KwaZulu/Natal	4 458 000	5 158 000
Eastern Transvaal	932 000	2 924 000
Northern Transvaal	475 000	5 323 000
Gauteng	6 655 000	6 935 000
North-West	1 018 000	3 615 000
Total	21 742 000	38 093 000

5.3 INSTITUTIONAL ARRANGEMENTS

a) Regulation

National Policy

There is no national policy on waste management. The President's Council Report of 1991 and a 1992 Draft White Paper on a National Environmental Management System for South Africa both recommend that the responsibility for waste management should fall under the auspices of the Department of Environment Affairs. Furthermore, the CSIR (1991) assert that a national policy could by declared by the Minister of Environment Affairs under a provision in the Environment Conservation Act (73 of 1989). The relevant section of the Act which would facilitate this makes provision for the Minister of Environment Affairs to declare a statutory policy in respect of certain matters, amongst others: "the protection of the environment against disturbance, deterioration, defacement, poisoning or destruction as a result of man-made structures, installations, processes or products or human activities" (s2(1)c).

A White Paper in 1993 entitled "Policy on a National Environmental Management System" for South Africa does reflect an intention to finally address the need for a national waste

management policy. The white paper states that the government would be obliged to "deploy a national strategy for waste management and develop integrated pollution control in which the elements of responsibility, accountability, prevention, treatment and re-use should enjoy priority. Disposal in the atmosphere, land and water environments should be considered as a last option only." A similar intent was expressed in a 1980 White Paper on a National Policy Regarding Environmental Conservation. This intent did not materialise into anything substantive, and it remains to be seen if the 1993 White Paper has any greater impact upon the development of a national waste management policy.

b) National Legislation

South Africa does not have an all embracing national statute dealing with waste. The CSIR (1991) identified 37 key national statutes, and 16 provincial ordinances which cover land-based waste and pollution control law. There are certain aspects of waste management which are regulated by national legislation, namely:

- Wastes on roads.
- Wastes in protected areas.
- Mine waste.
- Health-related wastes.
- Littering.
- Waste-disposal sites.
- Waste management regulations.
- Hazardous waste.
- Pesticides.
- Radioactive waste.
- Tax deductions for recycling plant.

Myburgh (1991) identifies four principal acts which are applicable to waste management in South Africa, namely:

- The Environment Conservation Act, No. 73 of 1989.
  The Act prohibits the disposal of waste other than on a disposal site and provides that no person shall establish, provide, or operate, any such site without a permit issued by the Minister of Water Affairs.

- The Water Act No. 54 of 1956.
  The Act's relevance to waste management is in its provisions for the prevention of pollution of water, a key provision being that: "Any person who wilfully or negligently does any act which could pollute public or private water, including underground water ... shall be guilty of an offence" (Section 23).

- The Hazardous Substances Act No. 15 of 1973.
  The relevant provision of the Act is that it empowers the Minister to regulate the manner in which hazardous substances are disposed.

- The Health Act No. 63 of 1977.
  The Act has a bearing on the disposal of waste in that the improper disposal of waste constitutes a health hazard (Myburgh, 1991) and one of the objects of the Health Act is "to provide for measures for the promotion of the health of the inhabitants of the Republic". Most significantly the Act imposes an obligation on local authorities to maintain hygienic conditions within their areas of jurisdiction and to take steps to combat any condition which may constitute a health hazard to the health of its inhabitants and provides for the appointment of officials whose task it is to ensure that object is achieved. The Act obliges every local authority to take:

  - "all lawful, necessary and reasonable practical measures:

    (a) to maintain its district at all times in a hygienic and clean condition;

    (b) to prevent the occurrence within its district of:
    i) any nuisance;
    ii) any unhygienic condition;
    iii) any offensive condition; or
    iv) any other condition which will or could be harmful or dangerous to the health of any person within its district or the district of any other local authority." (Section 20)

c) Provincial Legislation

The control of solid waste at provincial level has in the past been exercised mainly in respect of solid waste pollution along roads. The various Road Ordinances prohibit the depositing or leaving of waste on roads, while the Road Traffic Act, which is administered at provincial level, prohibits anyone driving or having a vehicle on a public road from negligently or

wilfully depositing, as well as causing or permitting the deposit of, waste alongside the road. The various nature conservation ordinances regulate litter and waste in protected areas under provincial control. The powers of the Minister of Environment Affairs to make solid waste control regulations in terms of the Sea-Shore Act have been delegated in terms of the Act to the executive committees of the Cape and Natal. The Environment Conservation Act (1989) may also assign functions to provincial administrations through regulations that may be issued in terms of the Act with respect to waste management.

The Financial Relations Act 65 of 1976 extends the powers of provincial councils to enable them to legislate for the control of environmental pollution, particularly of littering. Two provinces, the Orange Free State and Natal, have passed ordinances in this regard.

The Orange Free State was the first province to exercise this authority through Prohibition of the Dumping of Rubbish Ordinance 8 of 1976 which provides amongst other things that no person may without authority throw, dump or leave any rubbish on public land or water, except in a container or at a place specially adapted and set apart for such purpose. An authorized officer is also able to order the removal of rubbish that may have accumulated in sight of a public road or place.

The Natal Prevention of Environmental Pollution Ordinance 21 of 1981 renders it an offence for any person in any manner whatsoever and whether wilfully or negligently to perform any act of littering or pollution on, in or into any land, whether public or private or the sea or inland waters.

d) Local Legislation

The main functions of local authorities in connection with solid waste are in their obligations to provide sanitary services for the collection and disposal of waste under Section 20 of the Health Act 63 of 1977.

The most common control of solid waste by local authorities is exercised through empowering provincial local government ordinances over the littering of public places, streets, private premises, streams, dams etc. The provisions are generally enforced through a criminal sanction. Other methods of control include:

- the abatement notice procedure prescribed for dealing with nuisances (Section 27 of the Health Act 63 of 1977; and,

- prescriptions relating to the keeping of animals, the disposal of dead animals and the regulation of offensive trades.

The Sea Shore Act empowers the Minister of Environment Affairs and the executive committees of the Cape and Natal to authorize local authorities to make regulations for the prevention or the regulation of the depositing or the discharging upon sea-shore and in the sea, of waste, offal or any other likely impediment to health.

Functions may also be assigned to the local authority by the Environment Conservation Act (1989), but any regulations which may affect the activities of a local authority may be promulgated only with the concurrence of such local authority (Sections, 24, 28 (a) and 28 (i)(iii)).

e) Legislation Review

The 37 statutes identified by the CSIR (1991) justifies Myburgh's statement that there are a "plethora of laws which seek to regulate waste management" (Myburgh, 1991, p.23). Myburgh also expresses the opinion that the law is "in a mess", because there are so many laws and they often fail to address the issues raised by the activities which they seek to regulate. Furthermore, at the level of local government where most of the control of waste appears to lie, there is no uniform set of by-laws for waste management. Lombard et al point out that the penalties which are provided in the legislation for transgressions are often not appropriate or stringent enough, they are not uniformly applied, and interest among and support from justice officials in the enforcement of the provisions of the legislation is poor.

The CSIR (1991) makes a number of recommendations on the law:

- Legislation should be holistic in approach.
- A single comprehensive waste control act should be passed.
- Such an Act - would supplement and coordinate all relevant legislation.
- Such an Act - should at least contain a national policy for the reduction of waste.
- Such an Act - should contain separate sections dealing with liquid, solid and hazardous waste.

- Planning legislation should ensure that land use planning aspects are considered and make adequate provision for landfill sites.

- The Deeds Registry Act should provide for the registration of land sites to be used as landfills.

Lombard et al also make a number of additional recommendations:

- Legislation should be comprehensive in that it deals with all facets of waste; generation, avoidance, re-use, recycling, collection, disposal.

- Confer powers on regional and local authorities to regulate aspects that require a particular regional or local approach.

- Be the vehicle for the publication of a model set of regulations relating to waste management.

- Standardize waste terminology.

- Standardize approaches to the various aspects of waste management.

- Provide for the education of the public regarding environmental issues affected by the management of waste from generation to disposal.

- Provide for the acquisition of data in respect of waste.

- Incorporate effective incentives and sanctions, emphasising appropriate economic instruments to stimulate the reduction of waste streams and the re-use and recycling of waste.

f) Administration

Central Government

The plethora of laws inevitably means that there is an abundance of central government departments with some involvement in the regulation of waste management. In fact the CSIR (1991) states that "virtually every government department has a piece of legislation under its control which affects waste management directly or indirectly" (p.158).

Furthermore, those departments tasked directly with the administration of key environmental legislation appear neither to have the means nor the manpower to fulfil the tasks assigned to them. The CSIR (1991) refers to the Department of Environment Affairs as "virtually powerless" with, for example, no staff to administer the provisions of the Environment Conservation Act (1989) prohibiting litter. This problem is not unique to the Department of Environment Affairs. By the same Act, the Department of Water Affairs is tasked with administering the provisions for the disposal of waste. However it has been stated that the only action taken by the Department of Water Affairs regarding waste disposal is in reaction to problems that develop (Race Relations, 1993). The capacity for proactive initiatives is thus limited.

Apart from the limited capabilities of departments directly involved in regulating waste management, Myburgh (1991) points out that the multiple overlaps in jurisdiction coupled with the absence of a hierarchy of authority, means that no Department or individual is in charge, which in turn has the result that no one is accountable for the management of the environment as a whole. The net result is what Myburgh (1991) terms, "bureaucratic paralysis".

Provincial government

As noted in the previous section, the control of solid waste at provincial level has largely been in respect of solid waste pollution along roads. This control has been exercised in terms of the various roads ordinances and the Road Traffic Act. Control has also come from the nature conservation ordinances as well as empowerment from national legislation.

Local government

The administration of waste disposal laws has been left largely to the local authorities (CSIR, 1991). The law enforcement authorities in the municipal area of Cape Town for example, have powers to issue fines for littering. The local authorities administer both the legislation as well as their own bye-laws. As noted earlier, the main functions of local authorities in connection with solid waste are their obligations in the course of providing sanitary services for the collection and disposal of refuse.

g) Service Provision

Waste services are provided by both the public and private sectors. Both sectors provide the whole range of waste services from collection to disposal.

Public Sector

Local authorities, as required by the Health Act of 1977, are the most active public agents in the provision of collection and disposal services. There is a trend towards a regionalisation of landfill sites, particularly in metropolitan areas, and as this continues, responsibility for disposal will be taken away from those local authorities who currently operate disposal sites and given to regional bodies such as metropolitan authorities. The responsibility for collection is however likely to remain at the local level, as reflected in the Durban metropolitan area, where refuse removal has been designated as a function of the sub-structure in the future metropolitan structure (Rabelly, personal communication).

Regional Services Councils, Joint Services Boards and Provincial administrations also have involvement with waste management. RSCs/JSBs can be designated a waste management function, the parameters of which can range from pure administration through to the actual provision of collection services. The most common responsibility for RSCs/JSBs is that of establishing, funding and monitoring of regional landfill sites. This is the case with RSCs such as East Rand, Pretoria and Port Natal-Ebhodwe. The Western Cape RSC is unusual in that it is actively involved in the provision of waste collection services but this is due to the body's origins in the old Divisional Council. Provincial administrations have also been involved with waste management in different ways. The NPA for example is responsible for the operation of certain disposal sites in the Durban metropolitan area; the TPA was in the past responsible for the provision of services to informal settlements, achieved through the employment of contractors and consultants, now the responsibility of the Johannesburg City Council; and the CPA provides funding for waste collection services in certain areas such as Khayelitsha.

Private Sector

The private sector is involved in waste management in respect of both collection and disposal services. This involvement tends to be greater in the metropolitan areas than in smaller towns. The extent of private sector involvement in each of the metropolitan areas varies, for example:

- Durban Metropolitan Area
  In the Durban City area it is estimated that about 20% of the total waste stream is collected by private contractors (World Bank, 1993). However the Durban City Council is the sole collector of domestic and street waste. The largest private operator in the Durban metropolitan area does not provide domestic waste collection services as other services such as industrial and medical are more lucrative. Of 22 disposal sites identified in the Durban metropole, four are operated privately.

- Cape Metropolitan Area
  It is estimated that 9% of all households in the Cape metropolitan area have their waste collected by private waste companies. Although an attempt to gauge the extent of private sector involvement in other types of waste collection was not made, it can be accepted that there will be greater private sector involvement with non-domestic waste services.

- Gauteng Metropolitan Area
  The involvement of the private sector in waste collection in Gauteng varies between the five RSC regions in the area. In Pretoria it is estimated that 35% of the stands are serviced by private operators. In the East Rand, out of 11 black local authorities 7 are serviced fully by private contractors, with a further 2 having partial private sector involvement. In the Central Wits area, Soweto and Alexandra have private contractors operating in the area while the Johannesburg City Council has private sector involvement through the hiring of collection vehicles. It can thus be estimated that up to 40% of the population in the Central Wits area are served by private contractors. The West Rand does not appear to have any private sector involvement while the extent of private sector involvement in the Vaal Triangle is uncertain.

5.4 ACCESS TO WASTE SERVICES

An estimate of the different levels of service provided to the population has been derived from the results of the questionnaires, and information from interviews and other documented surveys.

a) Survey Results Adjusted

In order to derive an estimate of access to services for the urban population as a whole, adjustments were made to the survey data. The adjustments were made to address the following issues:

- Information from the survey about access in certain areas, for example in former homeland territories, was limited.

- Local authority questionnaires tended to indicate 100% service coverage but information from other sources such as RSCs indicated that this was not necessarily the case.

- The information about the three major metropolitan areas was more accurate than the for other areas because more interviews were conducted and there were more published sources which could be accessed.

b) Total Access (Adjusted)

The estimate for access to household waste collection services after adjustments of the results for the total urban population in South Africa is provided in Table 12. As can be seen, it is estimated that about 21% of the urban population, approximately 4.5 million people, do not have access to an adequate waste collection service. About 35% of the population living in Black Local Authority and urban areas of the former homelands do not have access to an adequate waste collection service, but it is possible that this figure could be as high as 50%.

Table 12: Access to waste services

Level of service	WLA	%	BLA	%	Total	%
Adequate						
Kerbside	8 760 000	99	6 962 000	54	15 722 000	72
Communal	33 000	0	1 467 000	11	1 500 000	7
Inadequate						
Other	12 000	0	2 067 000	16	2 079 000	10
None	0	0	2 446 000	19	2 446 000	11
Total	8 805 000	100	12 942 000	100	21 747 000	100

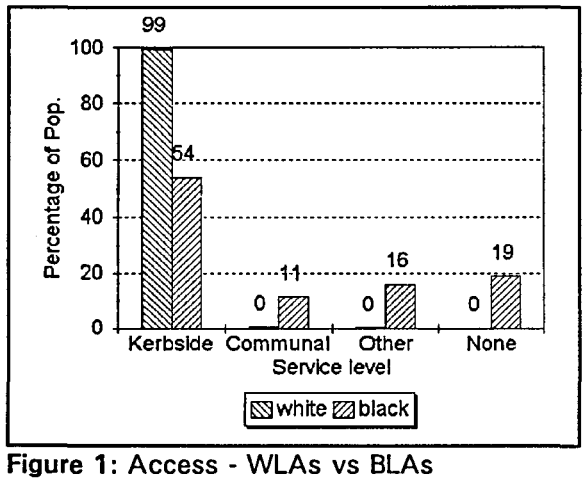

Figure 1: Access - WLAs vs BLAs

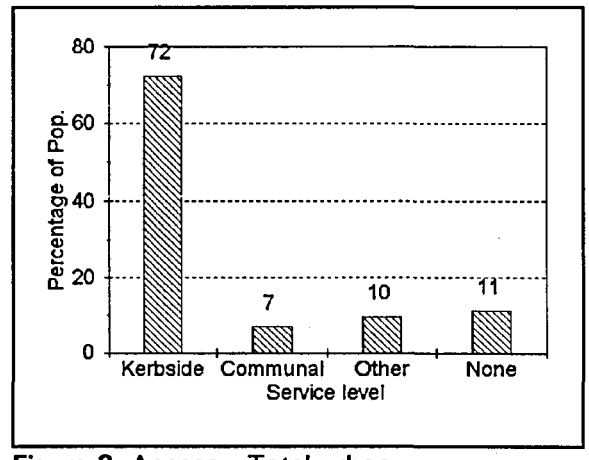

Figure 2: Access - Total urban

5.5 WASTE DETAILS

a) Waste generation rates

National Overview

According to the CSIR (1991), the total solid waste stream amounts to between 340 and 480 million tonnes annually. The major sources of solid waste according to this study are shown in Table 13.

Table 13: Sources of Waste Generation in South Africa

SOURCE OF WASTE	ANNUAL PRODUCTION (millions of tons)
Mining	238.5
Fly Ash	22.2
Municipal Waste	15.0
Chemical Waste	12.2
Metallurgical Waste	5.4
Agriculture	20.0
Sewage Sludge	12.0
Unclassified	4.8

Source: CSIR, 1991

Domestic Solid Waste

Estimates of the generation rates of domestic solid waste for this study were determined in two ways: from questionnaire responses and calculations.

- **Questionnaire Responses**

Estimates of weekly household generation rates were received in both volume and mass measures. A total of 76 local authorities provided estimates in volume, while 104 authorities provided estimates by mass. The weighted averages of these estimates are outlined in Table 15. However these estimates need to be treated cautiously. Firstly, as can be seen the limited response from BLAs means that the figures are weighted to WLAs. Secondly, the volumetric estimates are included without clarification of compaction ratios, hence the mass

estimates may be regarded as the more accurate figures. Finally it is important to note that the manner in which records are kept by local authorities vary greatly.

Mayet (1994) points out the variety of methods used by local authorities to record waste information and explains why there is little consistency in the unit of measurement. The methods used by local authorities include:

- *Weighbridge records of truckloads.* A weighbridge at the waste disposal site is used to log the mass of each truckload of waste that arrives. In a study of fifty five local authorities in the Durban Functional Region it was found that only two local authorities, namely Durban and Pinetown, used weighbridges (Mayet, 1994).

- *Volume estimates from mobile compaction units.* Some local authorities estimate waste generation data from the volume collected by mobile compaction trucks. The figure is usually based on a total daily, weekly or monthly compactor volume. This figure must then be multiplied by a conversion factor to obtain an equivalent "loose volume" estimate. The conversion factor, usually about 3, is itself also an estimate. Additionally assumptions are made about the extent of the capacity of the truck that is being used for each load.

- *Volume estimates of non-compacting vehicles.* These vehicles include tipper trucks, skip trucks and tractor and trailer combinations, the carrying capacity of which is usually calculated from measurement of key dimensions of the container section. These estimates are usually obtained from calculating the total number of trips made by each vehicle to the disposal site.

- *Estimates from number of bags delivered/collected.* Some local authorities keep records of waste generation in terms of the number of 80 litre plastic refuse bags issued or collected. This measure is very rough as it is difficult to determine whether all bags delivered are collected, as well as the fact that it is very difficult to establish the "average" amount of waste per bag.

Mayet (1994) identified a number of trends associated with waste generation. The most significant finding overall was that there is a strong relationship between the amount of waste generated by a community and its demographic characteristics, particularly income. Three major findings in connection with this relationship were that:

- The highest per capita generation tends to emerge from high income level zones with a primarily white residential population.

- The lowest per capita generation rates tend to arise from low income level zones, with a predominant african residential population.

- There appears to be no distinct pattern between type of dwelling and population density on the one hand, and waste generation per capita on the other.

Other factors which Mayet (1994) postulated could impact upon waste generation rates are qualitative or generic factors. These include the state of infrastructural development in a residential area, lifestyle and value systems, aspirations and attitudes, migratory patterns, level of education, ethical standards, and willingness to recycle or reduce waste output. The qualitative nature of these factors makes it difficult to assess their impact on waste generation.

- **Calculations**

Calculations of waste generated require certain assumptions. For this research Lombard's (1993) waste generation classification, shown in Table 14 was used where calculations were made. As can be seen the estimates of a daily generation rate range from 0.2kg per capita per day, to 0.8kg per capita per day. Although this range may be considered low, it was nevertheless useful for determining an overview of the features in certain areas. For example, calculations based on Lombard's classification allow for the following observations on the situation in the three major metropolitan areas:

Table 14: Waste Generation Classifications

CLASS	CHARACTERISTICS	DENSITY (kg/cu m)	GENERATION RATE (kg/cap/day)
A	High Income, Low Density Housing	144	0.8
B	Middle Income, Low Density Housing	170	0.5
C	Middle Income, Medium Density Housing	200	0.3
D	Low Income, High Density Housing	330	0.2

Source: Lombard, 1993

- In the Cape Metropolitan area, black local authorities generate less than 20 per cent (by volume) and less than 30% (by mass) of the total domestic waste stream while constituting over 40% of the population.

- In the Gauteng metropolitan area, black local authorities generate an estimated 25% (by volume) and 40% (by mass) of the total domestic waste stream, while constituting nearly 70% of the metro population.

- In the Durban metropolitan area, black local authority areas generate about 34% (by volume) and 50% (by mass) of the total domestic waste stream, while constituting about 73% of the total metro population.

Table 15: Household waste generation (per week)

Province	WLA		BLA		Total	
	Volume m3	Weight kg	Volume m3	Weight kg	Volume m3	Weight kg
Western Cape	0.15 (15)	23.28 (20)	0.28 (2)	12.00 (1)	0.18 (17)	19.02 (21)
Northern Cape	0.81 (6)	18.11 (10)	0.11 (1)	15.00 (1)	0.70 (7)	17.62 (11)
Orange Free State	0.46 (9)	18.49 (14)	0.91 (3)	25.41 (4)	0.61 (12)	20.92 (18)
Eastern Cape	0.97 (3)	12.50 (6)	0.53 (2)	14.58 (4)	0.91 (5)	13.19 (10)
KwaZulu/Natal	0.25 (13)	8.48 (7)	0.00 (0)	0.00 (0)	0.25 (13)	8.48 (7)
Eastern Transvaal	0.25 (8)	23.72 (10)	0.78 (2)	24.42 (3)	0.29 (10)	24.00 (13)
Northern Transvaal	1.00 (1)	11.27 (4)	0.00 (0)	0.00 (0)	1.00 (1)	11.27 (4)
Gauteng	0.27 (4)	27.70 (11)	0.00 (0)	0.00 (0)	0.60 (5)	31.95 (12)
North-West	0.65 (5)	24.62 (7)	0.50 (1)	20.00 (1)	0.57 (6)	22.04 (8)
Average	0.31 (66)	23.41 (93)	0.53 (11)	17.67 (14)	0.45 (76)	24.67 (104)

Source: Questionnaire

Notes: 1 All figures have been weighted by population
2 The figure in parentheses is the sample size
3 As volume and mass figures are from different responses, they cannot be used to calculate density.

Based on the figures in Table 15, the total mass of domestic solid waste generated in the urban areas of South Africa is 81 000 tons per week (11 500 tons per day). Annually, this is 4,2 million tons which can be compared with the CSIR estimate for municipal waste of 15

million tons (see Table 13). The difference could relate to the inclusion by the CSIR of commercial and other non-domestic waste, and that from rural areas.

b) Waste Composition

It appears that domestic waste composition characteristics in South Africa are influenced by four major factors:

- Geographical location.
- Income level of the community.
- Seasonal conditions.

Income level

The waste composition shows characteristics of both developed and developing countries, as identified in the previous chapter. The waste content from higher income areas reflects that of developed countries, and that from lower income areas is similar to developing countries. This can be seen in Table 16.

Geographical influence

In contrast to the data in Table 16, a study by Reddy (1992) compared waste composition in a low income area, Phoenix, with that of a higher income area, Durban North. It was found that the domestic waste from Phoenix comprised mainly of remains from fresh chicken, fresh vegetables, fish and organic waste, and that from Durban North consisted mainly of packaging material. This finding contrasts with the low percentage organics (4.6%) in developing communities as opposed to 32% in developed communities, in Table 16.

Mayet (1994) explains the high vegetable content in the lower income area by the greater use of more affordable fresh produce in food preparation. This is also reflected in the fact that there is a higher moisture content in those waste streams. In contrast, higher income areas tend to buy more pre-cooked or prepacked food which has a relatively high disposable packaging component. However a significant proportion of their vegetable waste can come from garden waste: in Pietermaritzburg, for example, garden waste constitutes more than half the waste stream from higher income areas (Scanes, personal communication). Reddy's findings could in part be explained as being unique to the location or community. Certainly waste content in South Africa does vary geographically, hence low income areas in Gauteng

province have higher ash content in their waste than Cape Town areas, because more coal is used as an energy source in Gauteng than in the Cape (Palm, personal communication).

Table 16: Waste Content Comparison: Developing and Developed Communities in SA

Waste Type	Developed *	Developing **
Paper	37%	3.4%
Plastic	17%	2.4%
Glass	4%	2%
Metal	6%	1.6%
Ash/Soil	0%	82%
Organic/Food Waste	32%	4.6%
Other	6%	2.4%

Source: Gibbons et al, 1992

* Figures are from Spruitville, an affluent area of Katlehong, which was considered typical of "developed areas"

** Average from data gathered in five developing communities in the East Rand

Seasonal Differences

Despite the apparent contradiction of Reddy's (1992) observations, the expected differences between higher income areas and lower income areas in South Africa as a result of international experience are reflected in Table 17 which compares the typical waste streams from three communities around Johannesburg (Lombard, 1989, unpublished). The two different sets of figures for Soweto reflect seasonal differences, as reflected in the high ash content for winter, 47.3%, and the high glass content for summer, 21.3%. The figures compare generally with Theron (1994) except in respect of metals, with Lombard's figures indicating a low metal and aluminium content for Soweto but Theron indicating that a typical township will have up to 10% metal content.

Theron (1994) notes that although the composition of "township" wastes is variable, it contains a "surprisingly large proportion of soil" sometimes as high as 12%. This is not necessarily surprising as the use of front end loaders in the collection of waste inevitably results in the collection of soil as well as waste. This has caused severe problems in Soweto where underground cables have been damaged through front end loaders digging up earth in the process of collecting waste. According to Theron (1994), other contents of "township" waste include metal at about 10%, glass 6%, and paper and paper products seldom exceeding 15%. The remainder of the waste stream consists of organics, rags, plastics and unclassified material.

Table 17: Comparison of Waste Compositions

Waste Content	Johannesburg	Soweto A	Soweto B	Bedfordview
Putrescibles	17.0	14.7	3.8	23.0
Kraft Paper	9.8	3.3	1.2	8.0
Newsprint	13.9	7.1	0.7	14.0
Common Paper	14.0	4.1	1.8	12.7
Plastics	8.5	4.9	1.3	6.0
Glass	14.1	21.3	2.3	7.0
Ferrous Metals	8.9	4.3	1.9	7.0
Aluminium	1.1	0.4	0.2	2.0
Other metals	0.1	0.0	0.0	0.8
Rags, rubber, leather	2.1	1.0	2.0	0.7
Unclassified	8.8	22.5	37.4	8.0
Fines (ash)	1.7	16.6	47.3	0.8

Source: Mayet, 1994 (From Lombard, 1989, unpublished)

Survey Response

A total of 60 local authorities provided details of waste composition and typically the responses reflected the international trend regarding variability between developed and developing countries. However, with a few exceptions, the responses were not very detailed and some appeared to be inaccurate. Consequently inclusion of this data in this report did not seem warranted. Nevertheless the actual responses provided by local authorities are detailed in the provincial profiles. Table 18 shows by provincial breakdown, the number of authorities that gave details on the composition of their waste.

c) Waste Density

Waste density is linked closely to income level: the lower the income, the denser the waste. Palmer Development Group (1993) found in a study of the low-income Klippan area of the Winterveld (Bophuthatswana), that waste density was 220 kg/cu m. The relationship between income level and density of waste may be seen in Lombard's (1993) classification which indicates a range from 330 kg/cu m for low income, high density areas, to 144 kg/cu m for high income low density areas.

Table 18: Number of authorities that gave details of waste composition.

Province	White LAs	Black LAs	Total
Western Cape	6	2	8
Northern Cape	5	1	6
Orange Free State	10	6	16
Eastern Cape	6	4	10
KwaZulu/Natal	3	0	3
Eastern Transvaal	4	4	8
Northern Transvaal	1	0	1
Gauteng	3	0	3
North-West	4	1	5
Total	42	18	60

5.6 STORAGE

There are three basic standard containers used for on-site storage of domestic waste in South Africa:

- Plastic Bag - 85 litre capacity.
- Steel or Plastic Bin - 85 litre capacity.
- Plastic wheeled bin - 240 litre capacity.

In addition to these standard containers, residents of informal settlements make use of containers such as boxes to store waste. The use of the containers varies according to residential area.

In white local authority areas, all three standard containers are in use, with the wheeled 240 litre bin being introduced increasingly to replace the other two traditional containers. The wheeled bin is used on specially adapted compactor vehicles which lift and empty the bins automatically. The bins are generally only used in formal areas where compactor vehicles have access and the bins can be wheeled to the vehicle. One impact that the use of this bin appears to have had is to increase the amount of waste collected. In Bellville, since the introduction of the bin, waste loads collected have increased by 25% (Fourie, personal communication).

In black local authority areas the 85 litre bins or plastic bags tend to be used. However the prevalence of ash restricts the use of plastic bags and bins, and if metal bins are not available, the ash is dumped. A questionnaire response from Vredefort registers the complaint that the difference in waste material between white and non-white households makes waste removal difficult. The example is cited that in african areas hot ash can't be collected in standard containers. It is also relevant to note that bins also get used as containers for other purposes such as washing clothes and storing food.

The efficient distribution of storage containers to householders is crucial for the waste collection system to operate, whether a communal or a kerbside service is offered. In both instances an adequate storage container is crucial. The sorts of problems which arise in this regard include:

- Failure to distribute enough plastic bags as appears to happen in Alexandra.

- Residents issued with a bin at one residential stand move with the bin to another stand requiring a new bin to be issued for the stand. This happens in areas such as Alexandra and Khayelitsha where there is ongoing movement of people into the area and between sites within the area.

- In some instances local authorities don't issue the storage containers and difficulties arise with householders purchasing bins. This problem was identified in Lehoi, where the questionnaire return has the comment, "residents don't want to buy bins for storage".

5.7 TRANSPORT

The type of vehicles used for the collection and transport of domestic waste in South Africa is varied. In white local authorities, compactor vehicles are the most common vehicles used for waste collection. In black local authority areas, collection vehicles vary between tractor and trailers, open topped tipper trucks and standard compactors. Black local authority areas are also characterised by the use of front end loaders for the removal of piles of waste from pavements and streets.

Vehicles transporting waste from transfer stations tend to be roll-on-roll-off-vehicles and waste from communal sites tend to be transported by skip luggers. In the Cape Metropolitan area, there is a move to the establishment of fewer regional landfill sites. As a result

transport of waste by rail is being planned. This will involve the baling of waste at a transfer station which is then placed on rail trucks and railed to the disposal site.

It must be noted that apart from the use of specially designed bicycles in the collection of recyclables in Soweto (by the Green Team), little evidence of non-motorized collection vehicles was found.

Certain general transport indicators were extracted from the survey of local authorities. For South Africa as a whole, it was calculated that on average 14 000 people are served by one collection vehicle. The average daily distance travelled per vehicle is estimated at 84km and the average loads per vehicle per day are estimated as $36m^3$ by volume, and 8.3 tons by mass. There is however a marked difference in these indicators between BLA areas and WLA areas: in BLAs it is estimated that there are over 24 000 people per collection vehicle, compared with about 11 400 in WLAs.

In order to allow some interpretation of these figures, the number of people per vehicle can be compared with experience with newly planned solid waste collection systems. For a properly run system it could typically be expected that a 19 m^3 compactor vehicle could serve 5 000 stands (about 30 000 people). A figure of 11 400 people per vehicle would thus indicate inefficiency in the use of such vehicles.

In BLA areas the survey result of 24 000 people per vehicle indicates greater efficiency of use of vehicles, particularly considering the trend for smaller capacity vehicles to be used in these areas. However, it needs to be kept in mind that the waste quantity per person is substantially lower and the service has often not been provided properly. Therefore the indication of efficiency is false to an extent.

Estimates of daily loads carried were also calculated. In BLAs the average daily load carried by a collection vehicle is estimated to be in the region of $21m^3$ by volume and 3.4 tons by mass. In WLAs, the average daily load estimate by volume is approximately $38m^3$ by volume and 7 tons by mass. These estimates need to be treated with caution as the format and quality of information received about vehicle capacities and loads carried was not consistent.

The statistics were derived from a consolidation of information that included different types of vehicles carrying different loads for varying distances, within each local authority. Consequently the figures provided here must be regarded only as general indicators contributing to an overview picture.

Local Authority Comparisons

In BLAs it is estimated that over 24 000 people are served by a collection vehicle, while in WLAs about 11 400 people are served by a collection vehicle. In terms of average distance travelled, in BLAs it is 64km per day and in WLAs it is 87km per day. This difference may be attributable to on the one hand the legacy of apartheid whereby landfill sites tended to be located nearer african areas. On the other hand it also reflects the denser living conditions found in BLAs. In terms of the average daily loads per vehicle, as might be expected from estimated waste generation rates, vehicles in BLAs carry lower average daily loads than in WLAs. In BLAs the average load by volume is 21m^3 and by mass it is about 3.4 tons. In WLAs, the average daily load by volume is 38m^3 and 7 tons by mass.

Provincial Comparisons

In terms of provincial comparisons, the highest ratios in each category are as follows:

- Population per vehicle - in Eastern Cape BLAs the average is over 36 000 people per vehicle.

- Distance per day - in Orange Free State BLAs where the average distance travelled per day is 132 km.

- Volume carried - in Gauteng WLAs where the average daily volume carried is 53m^3.

- Mass carried - in Eastern Transvaal WLAs where the daily mass carried is 15.8 tons. However this estimate is only based on a sample of two local authorities, hence a more accurate estimate is likely to be Gauteng, where 9.9 tons of waste are carried per vehicle per day.

A comprehensive summary of the ratios discussed here is shown in Table 19.

5.8 STREET CLEANING

Although the focus of this report is on household waste collection, it is relevant to comment on street cleaning for two reasons. First, the type of waste placed on streets and in street bins tends to be largely domestic waste. Second, the cleanliness of the streets can impact upon blockages in the stormwater drainage system and associated pollution.

Table 19: Transport details

Province	White				Black				Total			
	Pop per Vehicle	Dist per day	Daily load		Pop per Vehicle	Dist per day	Daily load		Pop per Vehicle	Dist per day	Daily load	
			Volume m3	Weight kg			Volume m3	Weight kg			Volume m3	Weight kg
Western Cape	9 105 (34)	87 (27)	35 (22)	8 306 (7)	9 479 (2)	60 (2)	3 (1)	0 (0)	9 210 (36)	80 (29)	34 (23)	8306 (7)
Northern Cape	10 (208) (14)	45 (12)	15 (9)	2 875 (3)	18 (385) (1)	0 (0)	15 (1)	0 (0)	11 (092) 15	45 (12)	15 (10)	2875 (3)
Orange Free State	5 629 (21)	69 (20)	38 (15)	5 500 (4)	14 (616) (8)	132 (6)	7 (3)	3 491 (4)	9 392 (29)	82 (26)	34 (18)	4395 (8)
Eastern Cape	12 661 (14)	101 (10)	40 (9)	6 107 (3)	36 259 (8)	47 (7)	2 (2)	1 270 (2)	20 524 (22)	93 (17)	37 (11)	5814 (5)
Kwazulu /Natal	14 884 (22)	71 (19)	23 (17)	9 473 (3)	30 000 (1)	0 (0)	0 (0)	0 (0)	15 663 (23)	71 (19)	23 (17)	9473 (3)
Eastern Transvaal	5 891 (14)	50 (15)	26 (13)	15 833 (2)	19 825 (6)	23 (4)	18 (1)	3 000 (2)	12 289 (20)	46 (19)	25 (14)	14000 (4)
Northern Transvaal	3 531 (5)	40 (5)	17 (4)	3 341 (2)	7 500 (1)	20 (1)	2 (1)	0 (0)	4 654 (6)	37 (6)	14 (5)	3341 (2)
Gauteng	11 900 (16)	119 (16)	53 (14)	9 974 (6)	34 869 (3)	58 (2)	75 (1)	4 100 (1)	15 851 (19)	116 (18)	54 (15)	9484 (7)
North-West	8 308 (13)	66 (13)	22 (12)	2 400 (1)	16 071 (2)	35 (2)	21 (2)	0 (0)	11 969 (15)	58 (15)	21 (14)	2400 (1)
RSA	11 408 (153)	87 (137)	38 (115)	8 721 (31)	24 398 (32)	64 (24)	21 (12)	3 438 (9)	14 431 (185)	84 (161)	36 (127)	8269 (40)

Source: Questionnaire

Notes:
1 Population by vehicle weighted by population.
2 Distance per day and daily load weighted by the number of vehicles in daily use.
3 Figure in parentheses is the sample size.

Information on street cleaning was received in 214 questionnaire responses. The main observation to be made about this information is the contrast in resources between white local authorities and black local authorities. Three key ratios were extracted from the information, namely:

- Ratio of street bins to head of population.
- Ratio of collection vehicles to head of population.
- Number of labourers per head of population.

National Overview

Detail of these aspects on a national scale are reflected in Table 20. For the country as a whole, on average, one bin serves 410 people; one labourer serves 3 600 people; and one vehicle serves 32 000 people. As can be seen however, the situation differs somewhat when contrasting the statistics between WLAs and BLAs.

Local Authority Comparison

In the case of BLAs, one labourer serves over 6 300 people, there are just under 900 people per bin and each vehicle serves over 46 000 head of population. For WLAs, the ratios are practically halved in each instance, with one labourer serving 2 800 people; there being one bin per 350 people, and each vehicle serves about 27 000 people.

Table 20: Street cleaning

Area	People per Labourer		People per Vehicle		People per Bin	
White LAs	2 800	(170)	27 000	(119)	350	(157)
Black LAs	6 300	(34)	46 000	(27)	890	(10)
Total SA	3 600	(204)	32 000	(146)	410	(167)

5.9 RECYCLING

a) Overview of recycling in South Africa

Lombard (1994) states that the "low technology recycling industry in South Africa is alive and well." He does however point out that there are no incentives or subsidies to encourage the movement of recovered material from the sources to the converters. In general it appears

that transport costs of recycled material are of the same order as new material costs, thus recycled material is often more expensive. In 1993 the then Minister of Environment Affairs, Japie van Wyk, stated that there had been a 73% increase in the volume of material recycled over the previous five years. Although the figures are from 1992, the extent of recycling in South Africa can be gauged from Table 21.

Table 21: Recycling in South Africa, 1992

PRODUCT	TONNAGE RECYCLED	% OF TOTAL PRODUCED
Paper & Board	570 000	28.4
Plastics	100 000	14.8
Tinplate	75 000	26.3
Aluminium	37 000	29.6
Glass	89 000	22.4
Total	871 000	25.0

Source: Lombard, 1994

In questionnaire responses, 25% of the 230 local authorities who returned the first questionnaire, indicated some form of recycling activity in their areas. The breakdown of these local authorities according to province can be seen in Table 22.

Table 22: Authorities reporting recycling activity

Province	Number of Authorities
Western Cape	9
Northern Cape	0
Orange Free State	5
Eastern Cape	4
KwaZulu/Natal	13
Eastern Transvaal	8
Northern Transvaal	2
Gauteng	11
North-West	6
Total	58

b) Incentives

In response to a question in Parliament in March 1993, the then Minister of Environment Affairs, Mr Japie van Wyk, said that the government of the day was not planning to introduce legislation to promote recycling. Van Wyk claimed that international and national experience had shown legislation in this area had not been effective. The government of the day advocated regulation by market forces and van Wyk stressed at the time that direct incentives to promote recycling could also not be considered due to the economic climate of the time (Race Relations, 1993).

c) Markets

The executive president of the Packaging Association of South Africa, Mr Piet Neethling, said in January 1993 that, despite environmental, employment and economic advantages to be obtained from recycling, local and overseas experience showed that factors such as cost constraints in the production of recycled material and limited uses for recycled products mitigated against obtaining optimum recycling rates. It has been argued that legislative measures to encourage recycling could raise the inflation rate by compelling expensive changes such as the replacement of conventional plastics by biodegradable plastics (Race Relations, 1993).

Markets in South Africa for recyclable materials are dominated by a few big players.

- Sappi, Mondi and Nampak purchase paper and cardboard material:
  It was reported in March 1993 that between 12% and 14% of South African newspapers used recycled paper. About 25% of paper used in newspapers was made up of recycled matter, which came from the Mondi recycling plant in Durban, and 75% comprised timber pulp. The Mondi plant had been commissioned in 1991 at a cost of R102m. It has the capacity to process 85 000 tons of used paper a year. It was estimated that this saved chopping down as many as 4 million pine trees each year. During 1993 Mondi introduced a free national newspaper collection service in order to capitalise on domestic waste paper.

- Consol purchases glass.

- Collect-a-Can purchases aluminium and tin cans:
  Collect-a-Can was formed by a joint venture between Iscor, Metal Box of South Africa and Crown Cork. The company was launched in 1993 to recover and recycle

tin cans. The aim of the company to increase beverage can recovery from 20% of all beverage output in 1993 to 50% in 1996. Currently the company accounts for 80% of all cans recovered in South Africa.

d) Problems

Recycling in South Africa is characterised by some significant failed ventures.

- A recycling plant built at the Kya Sands Disposal Site as a joint venture between Randburg Municipality and the private sector with an investment of over R9 million was forced to close down. The plant was not financially viable essentially due to the lack of a sustainable market.

- A recycling plant of the same scale as the Randburg plant was built at the Robinson Deep Disposal Site. It closed down for similar reasons, as was another in Durban.

- A Soweto community based recycling company known as the Green Team has been forced to change the focus of activities to conventional waste collection as it has not been able to find a sustainable market for its recyclables.

- A recycling venture in the Durban Metropole known as "Greensavers" was stopped stopped at the end of 1994 as Durban Solid Waste found that the waste stream was only being reduced by between 1% and 2%, and Mondi was finding the venture economically unviable.

e) Successes

Private Sector

There appear to be few successful recycling ventures in South Africa. One successful venture has been established in Alexandra where a company called the SA National Can Recycling Movement employs 28 people on a permanent basis and 20 on a casual basis. The success of this venture is largely attributable to two key factors: one, low wage rates paid to workers and two, external support in terms of resources eg. Collect-a-Can donated an 8 ton truck to assist in the collection and delivery of recyclables.

Institutional

Schools around the country in both black and white local authority areas have become involved in recycling activity. This activity is usually co-ordinated by the regional affiliates

of Keep South Africa Beautiful. These ventures are successful because wage costs are minimal and they are generally conducted for educational and fund raising purposes.

f) Composting

A few local authorities have composting operations which have been developed largely as a result of diminishing landfill space. Local authorities who undertake composting include, Cape Town, Paarl, Bellville and Parow but the activity tends not to be economically viable but is rather undertaken to prolong the life of landfills.

g) Gas extraction

Gas extraction from landfills is a relatively new technology and currently only takes place at a few disposal sites, including the Robinson Deep landfill in Johannesburg, while extraction at the Bisasar Road Landfill in Durban is due to begin in early 1995. The gas from Robinson Deep is piped 17km to an AECI factory for use in cyanide production. In Durban, it is anticipated that the tapping of gas will extend the life of the landfill. (Dorkin, personal communication).

h) Informal recovery

Recycling failures which are referred to above are largely in the formal, capital-intensive arena where returns on investment in plant and equipment have not been adequate. However, "informal" recovery also takes place on a widespread but difficult to quantify scale. The two general forms of informal recovery may be identified, namely: individual shopping trolley "entrepreneurs" and scavengers on landfill sites.

Individual Entrepreneurs
The shopping trolley entrepreneurs collect waste on foot usually with shopping trolleys, from any accessible source and sells the waste to more "formal" collectors of recyclable materials.

Scavengers
The term "scavengers" is used here to describe people who collect recyclables from landfills throughout the country with varying degrees of acceptance by the authorities, for example:

- Bisasar Road Landfill, Durban
  Scavengers from the nearby Kennedy Road and Canaan settlements are allowed onto the site after 4pm. The scavengers previously caused chaos by being on the landfill

when vehicles were dumping loads. A special area on the landfill has also been set aside for the dumping of waste food products to limit the risk of contamination from other waste products.

- New England Road Landfill, Pietermaritzburg
  Scavengers for many years had reasonably free access to the site, however the recent construction of a security fence around the site and the installation of a 24 hour security guard system has effectively ended scavenging activity on the site.

- Frankdale Disposal Site, Cape Town
  The Frankdale squatter community use this site as their primary source of income, but they have had to resist moves over the past two years by the Western Cape RSC to move them off the site to a site and service settlement located at Du Noon, about 5km away.

The high rate of unemployment in the country means that scavenging has to be seen as a real option for promoting recycling and creating employment. At the moment there appear to be no guidelines for local authorities on how to deal with what is perceived by many as a problem. It seems sensible to recognize the advantages of scavenging and to deal with the problems such as safety and health risks in an innovative way.

5.10 DISPOSAL

The major formal method of disposal in South Africa is through controlled sanitary landfilling. However uncontrolled disposal of waste appears widespread. Incineration of waste tends to be limited to hazardous waste such as medical waste.

a) Landfilling

It was estimated that, in 1989, 12 million tons of waste were disposed of in South Africa's landfills (Jarmain et al, 1994). However in most areas of South Africa, the Best Practical Means principle as opposed to Best Practical Environmental Option (BPEO) is still applied when it comes to landfilling. This is changing with a shift in government policy towards more environmentally acceptable standards, as evidenced by the Department of Water Affairs & Forestry's recently published Minimum Requirements for: Waste Disposal by Landfill; Monitoring at Waste Management Facilities; and the Handling and Disposal of Hazardous Wastes. These Minimum Requirements provide frameworks for undertaking each of the

respective activities and they advocate the BPEO approach. It would not be appropriate to review these requirements here, but it is appropriate to comment on one aspect of waste disposal in South Africa, that of permit requirements.

Although there is much legislation related to waste disposal, there is little legislation in South Africa that relates directly to the environmentally acceptable development, operation and closure of landfills. However, Section 20(1) of the Environment Conservation Act (Act No 73 of 1989) makes provision for the permitting of landfills. The Act states that any person who operates or who intends to operate a waste disposal site must apply to the Department for a permit. A permit is thus a Minimum Requirement for all operating waste disposal sites and for all sites closed after August 1990. The Minimum Requirements do state, though, that the detail required for a permit application will vary for different classes of landfill, with increasing size requiring greater detail.

It would seem that in the three major metropolitan areas regulation and control of major disposal sites does take place to a reasonable level. For example the Chloorkop waste disposal site in the Gauteng metropole has been prevented from opening as a Class 1 landfill. High levels of control and regulation are also reflected in the fact that there is only one Class 1 site operational in the Cape Town metropole, and no Class 1 sites operational in either the Durban metropole or the Gauteng metropole. There is a downside to this type of control as pointed out by Graham Noble of the CSIR who stated that the underlying difficulty of regulating the waste industry is that if there is too much regulation, people could be compelled to dump in the veld and rivers, which would obviously be counterproductive (Race Relations, 1993). This reality inevitably the question of where all hazardous waste goes if there is only one class 1 site operational in the three major metropolitan areas.

It is estimated only one in ten disposal sites in South Africa is properly controlled and audited (Race Relations, 1993). In 1993, of the 1 200 formal waste disposal sites in South Africa, only 60 had been issued with permits (Race Relations, 1993). This estimate accords with the responses received from questionnaires regarding the use of disposal sites. Of 342 local authorities indicating that they use landfills for disposal, only 67 of these (20%) indicated that they make use of a classified or permitted landfill.

Hence, while Lombard (1994) asserts that the Environment Conservation Act forces organisations to allocate more resources to the development of higher standards of waste disposal, and the Minimum Requirements are intended to do the same, it appears that much is to be done for there to be significant regulation and control of waste disposal.

Other statistics to emerge from the questionnaire responses are that:

- Only about 20% of the sites identified have charges for disposal.
- The average distance travelled to landfill sites from collection areas is 6.95km.

Table 23: Disposal sites reported used by local authorities

Province	Number of Local Authorities that report using				Average distance to site
	Sites	Classified Sites	Unclassified Sites	Sites that Charge	
Western Cape	61	15	46	15	9.09
Northern Cape	26	3	23	1	5.12
Orange Free State	65	12	53	7	5.41
Eastern Cape	43	6	37	7	5.96
KwaZulu/Natal	43	5	38	12	5.56
Eastern Transvaal	42	3	39	7	5.75
Northern Transvaal	9	3	6	2	4.14
Gauteng	30	17	13	14	10.68
North-West	23	3	20	2	7.72
Total	342	67	275	67	6.95

A consolidated picture of statistics from questionnaire responses for each of the provinces and on a national scale is shown in Table 23.

b) Incineration

Incineration of medical waste takes place in Durban, Cape Town and Johannesburg and the service is provided by both the public and private sector in each of these areas.

5.11 FINANCE

The financial arrangements for the provision of domestic waste collection services are considered in terms of Local Authority Waste Budgets and Cost Recovery.

Table 24: Waste Collection - Costs and Charges

Authority	Type	Cost R/household/month	Charge R/household/month
Weighted Ave	WLA	12.13	13.66
Sample	228	105	183
Weighted Ave	BLA	13.28	8.05
Sample	75	23	52
Weighted Ave	RSA	12.57	11.49
Sample	303	128	235

a) Costs and charges

Information about costs and charges was received from 303 local authorities representing just under 5 million people. In the case of costs, the authority was asked to estimate cost for *household* waste collection per stand. The weighted average cost per household for the provision of services in WLA areas was calculated to be R12.13 per month, while in BLA areas it was R13.28.

In the case of charges, the authority was asked to give the charge levied to households for waste collection, where this was identifiable as a separate charge. The weighted average charge in WLAs was R13.66 and in BLA areas, R8.05. It must noted however, that although there are charges in BLAs, the payment boycotts in BLAs has meant that a very small percentage of people living in these areas make any payments.

A summary of costs and charges information is shown in Table 24. It should be noted that there is uncertainty regarding the way cost per household per month has been calculated by local authorities, as discussed in the next section on household budgets. However it is concluded then that the local authority estimates of costs for collection of household waste are fairly reliable.

The figures in Table 24 thus lead to the following conclusions:

- WLAs are generally recovering actual costs with charges but only for household waste collection.

- The issue of cost recovery for cleansing of streets and public spaces is uncertain. The intention may be to recover these costs through a general rates account or through

household charges. If the latter is the case, with authorities generally wishing to recover public space cleansing costs from household charges, then these need to be higher.

- BLAs are not setting charges high enough to recover costs.

b) Local Authority Budgets

A total of 283 local authorities covering a population of just over 4.6 million provided information about local authority budgets.

White local authority areas

The per capita weighted average total annual budget expenditure on waste collection services in WLAs was calculated to be R40.41 and the per capita household budget in WLAs was calculated to be R23.24. For the sample of 70 WLAs that gave details of both household and total budgets, on average the household budget made up 47% of the total budget.

Black local authority areas

In BLAs the weighted average per capita total budget was calculated as R8.85 and the per capita household budget as R9.86. This apparent discrepancy in the figures can be explained by the fact that black local authorities tended to report only one budget figure, either a total budget or a household budget.

Only 9 BLAs gave details of both budgets, with the household budget making up on average, 81% of the total budget. Although this figure is for a small sample, it is a good indicator of the fact that in BLAs the waste budget largely covers domestic waste services as there is limited commercial and industrial activity in BLA areas. This also indicates lack of attention paid to cleansing of public spaces (including streets) in BLA areas.

A summary of the local authority budgetary information is provided in Table 25, with figure per stand per month estimated on the basis of estimated number of people per stand.

There is a substantial difference between the figures which local authorities estimate as costs per stand per month in Table 24, and those calculated from the budget in Table 25. This can be seen as follows:

Table 25: Local authority solid waste budgets.

Description	"White" Local Authorities		Black Local Authorities	
	per capita per year	per stand per month[1]	per capita per year[4]	per stand per month[2]
Household waste budget	R23.20	R8.70	R9.90	R5.70
Total solid waste budget	R40.40	R15.20	R8.80	R5.10
Ratio household/total[3]	0.47		0.81	
Sample size	228		75	

1. Based on a stand occupancy rate of 4.5.
2. Based on stand occupancy rate of 7.0.
3. Based only on those responses where both total and household budgets were reported for the same authority.
4. The fact that the average is smaller for total waste budget is due to a situation where sample for total budget was different to sample for household waste budget.

	WLA	BLA
Authority estimate	R12.13	R13.28
Calculated from budget	R8.70	R5.10

This difference is likely to relate to three main factors:

- Authorities are estimating costs with a full, properly operating service to all stands.
- The is less tendency to hide costs, particularly vehicle costs when estimating.
- The calculated figure is based on the number of people authorities say they serve. In fact many people, particularly in BLA areas, are not provided with an adequate service. Hence it is not strictly speaking correct to allocate an equal proportion of the budget to them.

The authority estimates in Table 24 can thus be taken to be fairly reliable.

c) Cost Recovery

The cost recovery aspect of waste management in South Africa has not been specifically addressed in this report, with the exception of the Winterveld case study in Phase Two where residents were questioned on their willingness to pay. This study found that residents did indeed express a willingness, but the area is atypical in that, as a peri-urban area, it has no local authority and therefore no municipal services. In the urban areas, willingness to pay

is a complex and rather sensitive issue, due to the rent (and service charges) boycott initiated in the mid-1980s to discredit the then Black Local Authorities.

Future willingness to pay will depend in no small measure on the success of the Masakhane Campaign to restore rental, service and bond repayments. It will also be important to gain the confidence of the affected communities in the ability of the chosen agents to provide effective services. An accurate assessment of willingness to pay would however require require fairly extensive investigation, which is beyond the scope of this report. Nevertheless further discussion on cost recovery and willingness to pay may be found in the separate report on costing prepared for this project.

5.12 INNOVATIVE/ALTERNATE COLLECTION SYSTEMS IN USE

For the purposes of this discussion, the definition of innovative or alternative collection systems is any system that differs from the traditional local authority administered and operated domestic waste collection system.

a) Food for Waste

The principle of the food for waste system is that bags of waste are exchanged for food parcels or food coupons. This system has been tried in three areas: Doornkop, Wallacedene and Khayelitsha.

Doornkop

A grant of R3 million from the Department of Health and Population Development provided funding for a food for waste scheme aimed at families with no fixed income. Each family was issued with a set of stamp forms and each form had a place for forty stamps. One stamp was issued for each bag of waste collected. Forty stamps qualified for a month's food. The scheme required families to register for the scheme showing proof of residence. The system was not a success. Typical problems experienced were: duplication of residential permits; lies about employment status; and the import of refuse from other areas. However the scheme's greatest problem was that it was grant financed as no rates were raised in the area and, once the funding was cut, the scheme collapsed.

Wallacedene

Wallacedene is located in the Cape metropolitan area. Also sponsored by the Department of Health and Population Development, this system operates on a direct exchange, with five bags of waste being exchanged for a R10 food parcel. The scheme only operates once

fortnightly when 550 food parcels are distributed. It is currently in operation but relies on the donation of food parcels.

Khayelitsha

A food for waste system operated for a short time but it failed largely due to abuses of the system as well as administrative incapacity. Typical problems were linked to waste content. For example, if handing in a minimum number of bags was a criterion to receive food, then it was found that bags would be filled with cardboard boxes. It weight was the criterion, bags were often filled with stones.

b) Money for waste

A money for waste programme was instituted in Marconi Beam squatter camp in Milnerton. In this system, community members would purchase a refuse bag for 20 cents and return a full bag for payment of 70 cents. Largely due to lack of community co-operation this system failed.

Entrepreneurial Systems

The entrepreneurial system may be defined as a system which facilitates the employment of community based entrepreneurs in the collection of domestic waste. This system is being used increasingly as emphasis on community based systems is encouraged so that money is put back into communities.

One Man Contract - labour based

- **Stswetla, Alexandra**

A one man contract system has been started in a squatter camp, Stswetla, in Alexandra. The system, launched by Keep South Africa Beautiful, is sponsored by United Bank to the tune of R50 000. The system operates with 14 individual "contractors" clearing waste from designated areas of responsibility. The waste, put into plastic bags by residents, is collected on foot by the "contractors" and taken to skips. The skips are then cleared by a larger contractor from Alexandra who transports the waste to the disposal site.

- **Marconi Beam, Milnerton**

The previously mentioned money for waste system was replaced by a form of one man contract system. The squatter camp was divided into ten separate sectors with a "contractor" (a member of the community) being contracted to clean up a particular sector. Contractors

bought bags for 20 cents and distributed them in their areas. They then collected the full bags and ensured the cleanliness of that area. The contractors were then paid 60 cents for the return of each full bag, with a bonus of 10 cents being paid to the contractor if the area was regarded as adequately clean by the local authority liaison officer.

Combined labour/vehicle community based systems

Community based systems where both vehicles and labour are employed by community contractors have been identified in a number of areas in KwaZulu/Natal, the Eastern Cape, Gauteng and the North West. Characterising these community based systems in South Africa is the use of the outside consultants in the administration of the systems with two basic contracting permutations:

- A consultant contracts with a local authority to operate a collection system, and then the consultant contracts with community based entrepreneurs eg. Umlazi, KwaMashu.

- The local authority contracts community based entrepreneurs and then employs a consultant to administer the contract eg. Kwandebele, Alexandra

5.13 PROBLEMS

An overview of the problems experienced in domestic waste management in South Africa was achieved by means of surveying local authorities directly through the questionnaires as well as determining an overall perspective from personal communications and the literature. The problems considered assessed directly by local authorities were essentially operational ones, while the problems reviewed from other sources were more general in nature.

a) Survey responses

In the first questionnaire that was sent out, local authorities were asked to indicate the degree to which they experienced certain specified problems. The response required grading of problems according to four levels of seriousness: none, minimal, moderate and severe.

Areas where potential problems could occur were identified as follows:

- Vehicles
- Labour

- Supervision/Management
- Access
- Public interference
- Disposal
- Inadequate finance
- Water pollution

The results of the survey indicate that the most severe problem identified by local authorities is that of inadequate finance. On a national scale, 31% of respondents indicated this as a "severe" problem. The next most significant problems identified as "severe" on a national scale were vehicles and disposal. In terms of "moderate" classifications of problems, these three problems were again identified as the most significant.

White local authorities

In white local authorities, the ranking of problems replicates the national situation, with inadequate finance, vehicles and disposal identified as the three major problems.

Table 26: Problems - White Local Authorities

Category	None	Minimal	Moderate	Severe
	Percentage			
Vehicles	10	47	35	9
Labour	20	58	20	2
Supervision	43	45	11	1
Access	49	41	8	2
Interference	28	51	17	3
Disposal	30	34	29	7
Finance	25	23	28	24
H_2O Pollution	72	22	5	1
Sample Size	174			

Black local authority areas

The most serious problem identified in BLA areas is that of inadequate finance, with 69% of respondents classifying the problem as "severe". This is double the percentage of respondents on a national scale. Disposal is the problem identified by the fewest number of black local authorities as "severe". This contrasts greatly with white local authority areas.

In BLAs vehicles are identified as the second most "severe" area, indicated by 25% of respondents, followed by water pollution, 19% of respondents. However by classifying serious problems as those areas where responses indicate "moderate" or "severe" experience, then the ranking of problems would be - first: inadequate finance; second: vehicles; third: labour and fourth: supervision.

The high ranking of disposal as a problem in white local authority areas, and its low rating in BLAs reflects different priorities and possibly different levels of service between WLAs and BLAs. Although inadequate finance is a universal problem, the BLA difficulties with vehicles, labour and supervision indicate that the provision of collection services is hampered by problems. The problem of disposal amongst WLAs indicates that collection problems are not a priority in WLAs.

Table 27: Problems - Black Local Authorities

Category	None	Minimal	Moderate	Severe
	Percentage			
Vehicles	14	31	31	25
Labour	19	31	31	19
Supervision	39	28	14	19
Access	47	31	14	8
Interference	36	28	25	11
Disposal	58	22	14	6
Finance	11	6	14	69
H_2O Pollution	58	22	0	19
Sample Size	36			

b) General Problems

A report on cleansing by the Central Wits Metropolitan Chamber, and a Department of Environment Affairs forum on refuse and litter both identified broadly, the scope and nature of problems confronted in waste management. The key issues identified by these two bodies are outlined briefly below.

Socio-political environment

- Some officials not part of the community they serve.
- Misuse of the service and physical resources by members of the community.
- Political unrest, intolerance, violence and intimidation of workers.
- Non-payment of services as a political tool.
- Psychological effects of living in a dirty environment unknown.
- Lack of communication within communities, and between communities and their leaders.

Socio-economic environment

- High unemployment reducing the ability of users to pay for the service.
- Public indifference to casual littering exacerbated by informal traders and non-resident commuters.
- Growth of informal settlements accompanied by a lack of land ownership.
- Many families living on one stand.

Service issues

- Inadequate response to the increase in the density of accommodation and resulting change in service needs.
- Inadequate access to points of generation.
- Insufficient funding for necessary resources in certain areas.
- Inadequate and inappropriate institutional structures.
- Inability of many local authorities to repair and maintain essential plant and equipment.
- A tendency of non-reporting of service problems partly due to local authorities' inability to respond.
- Inadequate road surfaces and breakdowns in other services eg. sewers disrupting street cleaning.
- Lack of service flexibility eg. not catering for large events such as funerals and weddings.
- Inadequate separate collection of different wastes eg. builders rubble and commercial and industrial waste.

User issues

- User needs not always identified by local authorities.
- Absence of user participation in the planning process and the provision of services.
- Inexperience or lack of knowledge by some users of the service offered.
- Abuse and misuse of waste receptacles.
- Lack of environmental education and awareness.

- Overloading of services in areas with informal houses and backyard shacks.
- Illegal dumping of waste.
- In certain areas, cross-boundary use of "garden refuse sites" leading to passing on of disposal costs.

Management Issues

- Fragmented services leads to parochial planning and unequal service levels.
- Fragmented management arising from questions over legitimacy of existing structures and a general uncertainty regarding areas of responsibility.
- Low priority of waste management as an activity within local authorities.
- Inadequate data availability.
- Lack of managers' influence on planning and funding of services regionally and locally.
- Staff and resources in smaller local authorities being used for functional responsibilities outside solid waste.
- Absence of management in some cases, and excessive spans of control in others.
- Lack of skills upgrading and development programmes with unclear professional career paths.
- Absence of performance management systems.
- Absence of the implementation of regulations and by-laws.
- Weak policing, low penalties and difficulty of obtaining court convictions.
- Inadequate systems eg. no two-way communication with public.

Funding

- Financial constraints imposed by external authorities.
- Uncertainty of funding in most local authorities.
- Non-payment for services.
- Cross-subsidy from industrial and commercial tariffs to domestic users being concentrated in white local authorities.
- Complex and non-uniform tariff structures for services.
- Competition with other service departments within the local authorities for funding.
- Lack of access to capital funding.

Environmental considerations

- Absence of a policy with regard to materials recovery and waste minimisation.
- A limited number of disposal sites classified for the disposal of toxic and hazardous waste.

- Absence of an accessible and well defined management and control system for dealing with toxic and hazardous waste.
- Absence of a co-ordinated educational and promotional awareness programme to advise the public about environmental issues.
- Fragmentation of the responsibility for enforcement of by-laws resulting in the absence of satisfactory measures to prevent illegal dumping.
- Lack of knowledge and awareness of the health impacts of poor waste management.

6. CASE STUDIES

6.1 INTRODUCTION

The second phase of the research involved undertaking six case studies which reviewed solid waste management in selected areas. The areas studied, and special features of each area are as follows:

- Umlazi has a community based waste[4] collection system which operates effectively.
- Alexandra has a largely community based waste collection system which has interesting features but currently does not provide an adequate service.
- Soweto has a privatized waste collection system which has problems which appear to stem largely from the nature of the contracting system.
- Khayelitsha has a local authority operated system which reflects the potential difficulties that can arise when the interests of the service provider and the community diverge.
- Rini reflects the problems that the transition in local government can have on the provision of waste collection services.
- Winterveld provides an example of how communities handle their waste when no formal waste collection system is provided.

The aim of this chapter is to review the case studies, and highlight the key issues arising from each study.

6.2 CASE STUDY ONE: UMLAZI

a) Background

Umlazi is an area south of Durban with an estimated 300 000 people living in formal households and up to 100 000 people in informal settlements. An infill programme aimed at providing freestanding informal settlements with basic water and sanitation services, and improved roads and stormwater drainage is in progress. It is intended that 15 000 sites will be formalised through the infill programme (World Bank, 1993).

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[4] "Community based waste collection system" is defined here as a system that is operated by members of the community which is served by the system.

b) Domestic Waste Management

All services in Umlazi are administered and managed by private consultants who are contracted by the KwaZulu government. In waste collection, the private consultant is Munitech, who administer and inspect the work of seven community based operators who are contracted directly to the KwaZulu Department of Works.

Levels of Service

The waste collection services provided differ between formal housing units and informal settlements. The service currently provided to formal household units includes the following:

- One refuse bag delivered to each residential unit per week.
- Refuse collected from the street verge once per week on scheduled days.
- Drums placed at community centres and other points of major litter generation (such as shopping centres, bus ranks and schools) and cleared twice weekly.
- Streets and street verges cleaned (both CBD and residential areas) on a weekly cycle.
- Skips placed at points of significant waste generation (such as boarding establishments) and cleared as and when required.

Services to informal settlements are of a lower standard. Currently if plastic bags are placed by "informal" residents on the verges of roads, the intention is that these are picked up by the contractors. However, with a less-than-adequate service, much of their waste gets dumped on verges or into rivers. The informal settlers are therefore the main (but not the only) contributors to illegal dumps and rubbish in rivers. In order to deal with this, the Port Natal Ebhodwe Joint Services Board has supplied a number of skips for placement at strategic points so that the waste from informal areas can be collected and removed. The clearing of the skips has been put out to tender, hence an eighth contract will be awarded to a contractor from the community.

Resources of the Contractors

The quality of the resources of the contractors varies greatly. For example, some have fenced-in depots for their vehicles while others only have open public ground on which to

park. With regard to vehicles, tractors and trailers are most widely used. They have a number of advantages, the first of which is their long lifespan; anything up to 20 years. Secondly, a tractor breaking down while on a round causes minimal disruption as a replacement tractor can be sent to take the trailer. Thirdly, compared to trucks, tractors suffer less driver abuse because they travel slowly. Finally, the theft of trucks is more common than that of tractors.

Workers employed by contractors mainly live in informal settlements and usually come from outside of Umlazi as it is apparently not acceptable for people within the community to be seen cleaning up their own areas.

Monitoring of the Contractors

Munitech monitors the performance of the contractors who are remunerated on the basis of the cleanliness of the areas for which they are responsible. The cleanliness of each area being assessed by an inspector. Penalties, usually 50% of the fee for the area, are invoked if the area is not cleaned properly or only partially cleaned. Munitech not only monitors and pays the contractors, but they also provide training and assistance with resources when required.

Key factors in the success of the monitoring role appear to be: a good relationship between the inspector and the contractors, and especially with the contractors' managers and employees; a good relationship between the inspector and the community; resistance to corruption by, and general diligence of, the inspector.

Recycling

There is limited recycling activity in Umlazi, being restricted largely to schools. In 1993 about 500 tons of waste was collected for recycling, raising about R35 000 for the schools.

Disposal

Waste is disposed of at the Umlazi landfill site which is on the perimeter of Umlazi. The site is privately operated and is located near a group of hostels which made the establishment of the site easier as the hostel dwellers do not see the area as their permanent home. Unpleasant odours emanating from the site have led to complaints from residents in the area and an active lobby group has been set up to have the site closed. However, the operators of the site are investigating the possibility of extending the life of the site.

Cost Recovery

A fundamental aspect of a successful community based contracting system is that of cost recovery. The primary problem with the waste management system at Umlazi is that it is almost entirely subsidized. Residents do not pay for the service which has been funded by the Kwazulu government. The contractors are thus assured of their remuneration at present. However any local service which is reliant on transfers for its operating costs is unlikely to be sustainable in the long term.

c) Problems with Waste Management

Operational problems mainly stem from a lack of knowledge about the proper handling of waste. Residents from both formal and informal areas throw refuse into rivers and drains. Waste thrown into watercourses results in buildups of waste, blockages and flooding. A lack of equipment and manpower makes it difficult to clear the waste from the watercourses.

Petty crime is a major operational problem. Grills from stormwater catchpits are removed, contractors' vehicles are hijacked, and grass cutters are stolen from workers who are held up when they are cutting verges. Problems have also arisen from the dumping of medical waste from clinics into the domestic waste stream.

d) Conclusion

The overall impression of relative cleanliness in Umlazi indicates that the community based contractor system can work. The key success factors to such a system appear to be:

- The basis of remuneration is performance ie. the contract areas are assessed in terms of their cleanliness.
- Contractors need to be assisted with planning and scheduling and with tendering techniques.
- Contracts need to be intensely inspected and strictly administered.
- The collection programme/level of service must be appropriately selected and must be capable of dealing with the quantity of waste generated at the source.

- Contractors must receive remuneration that provides a reasonable return on the cost of effectively providing the service.

- The community must be informed about the proper handling of waste.

Nothwithstanding these success factors, it is important to reiterate the likely unsustainability of such a system if it is totally dependent on grant funding.

6.3 CASE STUDY TWO: ALEXANDRA

a) Background

Alexandra has a population of over 320 000 people and covers an area of about 460ha. It is divided by the Jukskei River into areas known as the East and West Banks which slope gradually towards the river. There are over 50 000 residential units in Alexandra, of which over 30 000 are shacks. In addition there are a further 9 000 hostel beds.

b) Domestic Waste Management

Waste is collected in Alexandra by three contractors, two of whom are community based. Alexandra City Council is responsible for the monitoring of the collection system and two inspectors are employed by the council to this end. The area has been divided into 5 cleansing zones with the clearing of skips providing a sixth "zone". Each contractor has two zones of responsibility.

Level of Service

A once weekly door to door service is provided to formal residential units. Skips are also meant to be cleared on a once weekly basis but the contractor responsible for this has vehicle ownership difficulties and consequently this arrangement does not appear to work well with the clearing of skips only carried out on an irregular, ad hoc basis.

The contractors are paid according to the fulfilment of five specific criteria:

- Number of units served.

- Provision of a plastic bag to the household and the collection of a plastic bag. (Accurate records are kept of the number of plastic bags issued, however it is difficult to assess the number of bags collected.)

- The length of street cleaned - per km.

- The number of catch pits and swivel bins cleared. (Many of the swivel bins that were placed in Alexandra have been vandalised and/or removed. However the contractors still get paid for these bins being cleared because they argue that it is not their fault that the bins have been removed.)

- Per cubic metre of rubble removed.

Resources

Alexandra is typical of an under-resourced black local authority as reflected in the following key ratio estimates:

- There is only one cleansing worker for every 2 740 residents, which is significantly different from neighbouring Sandton where there are 628 residents per worker.

- 93kg of waste per capita is collected per annum in Alexandra, while 499kg is collected in Sandton.

- Alexandra spends R23 per capita per annum on waste services, in contrast to Sandton where expenditure is estimated at R94 per capita per annum (Central Wits Task Team, 1994).

It is therefore not surprising that the collection service provided in Alexandra does not adequately serve the needs of the community.

"One Man Contract"

An innovative collection system, the "one man contract", has been introduced into Stswetla, a squatter camp on the outskirts of Alexandra. The system is the first to be launched by Keep South Africa Beautiful and is a Tidy Town Project of the Alexandra Tidy Town Association. Stswetla consists of about 1000 shacks, and has previously had no waste management system

in place. The system operates with 14 individuals clearing waste from designated areas of responsibility. The waste is placed into skips and the skips are then cleared by one of the Alexandra contractors.

The one man contract system is being sponsored for the first six months by the United Bank, who have put up R50 000 to cover operating costs, and the bank will consider extending the period if the pilot project proves successful. The Alexandra City Council has undertaken to provide additional refuse removal skips in Stswetla to ensure that there is adequate container space for the domestic waste and litter that is collected. Plastomark, in association with East Rand Plastics have sponsored 100 000 plastic refuse liners to service the waste and litter removal.

The contractors, one of whom has been appointed as a supervisor, were selected by the community of Stswetla. Originally the plan was to appoint 7 contractors, but the community decided that it would be better for 14 people to gain employment with the salaries of the contractors accordingly being halved from the original amount. All the contractors were put through two workshops by the KSAB to train them in waste collection methods and litter removal. Strict monitoring procedures have been implemented to ensure that the plastic bin liners are not used for other purposes, with virtually each liner being accounted for by the supervisor.

The system appears to be effective in keeping clean what is now dubbed by some as the "cleanest squatter camp in South Africa". However, once again the service is dependent on grant finance and the sustainability of the operation is thus uncertain.

Recycling

A recycling operation is conducted in Alexandra by a company called SA National Can Recycling Movement. The company was started by an Alexandra resident, Mr Mike Beea in July 1993. The aims of the company go beyond recycling, with objectives that include:

- To create jobs.
- To educate the community not to "throw away".
- To encourage environmental protection and pollution control.
- To foster community awareness and interest in horticulture.

- To lobby government support for recycling.

The company employs 28 people full-time and 20 casual workers. Apart from the employed workers, schools in Alexandra also collect recyclables and these are purchased by the SA National Can Recycling Movement. The company sells its recyclables to Sappi, Consol and Collect-a-Can.

Disposal

Disposal of the waste collected from Alexandra takes place at the Linbro Park tip site located about three kilometres from Alexandra. However much waste is disposed of in open spaces, especially along the banks of the Jukskei river. Waste that is dumped in an open space usually ends up being burnt, as does the waste that is not cleared from skips or which is placed around the skips.

An observation on the disposal of waste in Alexandra made in 1992 is still relevant today:

> *"The disposal of solid waste in the Alexandra township is not completely and effectively undertaken. This results in large piles of litter strewn throughout the township. Solid waste is also thrown into the Jukskei River. Regular clean-ups organised by concerned residents in the areas downstream of Alexandra are helpful in alleviating this problem. However this problem will only be effectively solved by improving the overloaded waste disposal facilities within Alexandra"* (Wimberley, 1992).

Cost Recovery

Waste management services in Alexandra prior to the change in local authority structures was funded by the Central Wits RSC. The "One Man Contract" in Stswetla is being funded by United Bank. Payments from the community are negligible. This once again highlights the problem of funding through transfer payments and the inevitable unsustainability of such a system.

Problems with Waste Management

Alexandra has major problems with the adequate collection and disposal of waste. More specific problems which contribute to this overall difficulty include:

- A lack of land. Shacks are being built in every conceivable place, and there is concern that Alexandra is increasingly being turned into a transit camp as immigrants come to the area because of the easy access to central Johannesburg, as well as to nearby factories. Furthermore the multiple occupations of single properties is resulting in damage to water, electricity and sanitation infrastructure.

- The density of shack structures. Shacks are so close to one another that it is difficult to move in between them, especially if a bag or bin of waste is being carried. In many parts a bin will not fit between shacks.

- Illegal dumping. Dumping of waste and rubble not only from within Alexandra but also from white areas. Waste contractors from outside Alexandra try to avoid the payment of tip fees at Linbro Park by dumping.

- Poor roads. The roads in Alexandra are in a very bad state, with about only half the roads being adequately surfaced.

- Service frequency. The density and numbers of population, as well as the lack of waste storage facilities means that no matter how efficiently a once weekly service is operated, it is unlikely to alleviate problems such as dumping because the waste generation rate far exceeds the collection rate.

- Management. There appears to be a great deal of uncertainty about the management arrangements. Randburg City Council seems to have ultimate administrative responsibility for Alexandra, which means that the administration is inevitably detached from its area of administration. Furthermore there are difficulties within the Alexandra City Council administrative structure due to problems of legitimacy and lack of capacity. In addition, there is little interaction between the community and the authorities and a lack of communication between workers and the authorities.

- Contract Administration. Certain aspects are not covered adequately in the contract document. For example, random dumps of rubble and refuse are expected to be cleared by the contractors without extra payment. A specific clause dealing with this issue was not put into the contract document. Responsibility for the administration of the contract is also unclear.

Conclusion

The current state of domestic waste management in Alexandra is inadequate. This can be attributed to a number of key issues:

- Poor management at all levels. Monitoring on the ground is hampered by a lack of resources while the council administration is in turmoil.

- The density and size of the population indicates that a more frequent service is needed, because even the areas where a service is provided have the appearance of being unserviced not long thereafter.

- The effectiveness of the basis for remuneration of the contractors is uncertain as actual performance is not the only criterion.

A positive feature of waste management in Alexandra is the introduction of the "one man contract" in Stswetla, although, as previously mentioned, its dependency on grant funding makes the system's sustainability uncertain.

6.4 CASE STUDY THREE: SOWETO

a) Background

Soweto, situated to the south-west of Johannesburg, is the country's largest african residential area, covering an area of about 7000 hectares. Population estimates vary but for this study a population of 1.1 million was assumed, reflecting a population density of about 158 residents per hectare. There are about 95 000 formal houses in Soweto, a further 50 000 backyard shacks and about 20 000 households living in informal settlements or "transit camps". It is estimated that there are also over 30 000 people living in hostels.

b) Domestic Waste Management

Two private companies provide domestic and commercial waste collection services in Soweto, with building rubble being collected by the council. The decision to privatize the waste services arose after a strike of council waste workers in 1988. Although the private operators are contracted to provide a total cleansing service, the contract is undermined by the basis of remuneration - tonnage collected. Such a system means that the contractors have

no incentive to keep the area as a whole clean, or to have the interests of the community (their clients), as their primary concern.

Level of Service

All formal households are provided with a door to door twice weekly collection service. The service provided is in effect an "on-site" service with bins being removed from the property of householders. Complementing the house to house collection are skip containers which are placed at appropriate places, usually in open spaces. Waste from backyard shacks which does not get into the formal household's waste stream can be placed in these skips, as can waste from the transit camps. No formal collection service is provided to backyard shack dwellers or to transit camps.

The council is responsible for monitoring the performance of the private companies. However the council is significantly under-resourced and it is questionable how effectively this monitoring role is performed. Exacerbating this is an apparent lack of commitment from senior management. When contractors are reported to be underperforming they are not penalized.

Despite the provision of a collection service to formal households, there is much evidence of informal dumping taking place within Soweto itself. There are a number of causes of such dumping:

- Householders miss their refuse collection round but want their bins emptied.
- Informal householders do not have their waste collected.
- Overcrowding causes bins to become full quickly and the overflow is dumped.

The problem of dumping has been exacerbated by inadequate service provision in transit camps. For example, where land invasions occur, there is no access for vehicles and thus bulk containers such as skips are the only viable storage items. Often dumps develop around skips which have been positioned as communal collection points. In some instances skips are filled to capacity and surplus waste is then placed around them. In other instances, the skips are not actually filled, but waste is nevertheless placed around the skips. This is in part due to the fact that children often take the waste to the skips and are not tall enough to put the waste inside them. Dumped waste as well as waste in skips is often burned.

Front-end loaders are used by the contractors to scoop up waste that has been dumped on the ground, be it at a skip or on open ground. These loaders however pick up a lot of soil and grass when they scoop up the waste which leads to "impure" waste loads as well as causing damage to underground telephone and electric cables.

Recycling

A recycling initiative begun by the Green Team towards the end of 1993 has failed due to high costs, lack of environmental awareness within the community, and lack of a market for the recyclables that were collected. The Green Team is a company which was formed in 1993 to provide job opportunities for youth through waste recycling. The company was formed by the Blue Crane Trust, the ANC Youth League and other independent youth organisations.

Although the company was "born for recycling", the Green Team learnt that it is very difficult to instill a recycling culture when the basic collection service provided to residents is unsatisfactory and the market for recyclables is unsustainable. Consequently the Green Team has undergone some restructuring as well as redirecting its focus of attention to the provision of waste collection and environmental services. The Green Team is now hoping to win the tender for a community based collection system to be implemented in four suburbs of Soweto: Endeni; Zola; Jabulani; and Naledi, in early 1995. The strength of the Green Team is its roots in the community, but it faces problems such as limited finance and a lack of technical capacity.

Furthermore, in this instance, the tendering process has also proved to be an obstacle. In the tender document released by the Soweto City Council, any organisations wishing to tender for the contract in Endeni, Zola, Jabulani and Naledi had to put down a guarantee deposit of R250 000. This amount of money is naturally prohibitive to community based organisations and the Green Team management were able to have the tender document withdrawn on the grounds that it was prejudicing true community based contractors who wished to tender for the contract.

Disposal

Until recently waste was disposed of at 6 disposal sites within the Soweto boundary. These sites were uncontrolled and scavengers were prevalent on them. The sites have now been closed down and waste is disposed of at the Goudkoppies and Marie Louise disposal sites. Council workers/supervisors, are positioned at these disposal sites to monitor the contractor

vehicles bringing in waste and problems have been experienced with private contractors dumping "impure" loads.

c) Conclusion

The experience of Soweto highlights four major issues when dealing with domestic waste management.

- The drawbacks of a tonnage based system of remuneration for waste collection are evident as it can lead to incomplete waste collection as there is no incentive to keep the area clean.

- The difficulties faced by community based organisations such as: limited finance, lack of technical capacity and tendering procedures that are prejudicial to small concerns.

- The lack of service provided to informal areas.

- Another example of a formal recycling initiative failing for reasons which hinge chiefly on a limited market for recyclable material, but also undermined by a lack of community support.

6.5 CASE STUDY FOUR: KHAYELITSHA

a) Background

Khayelitsha, situated along the northern shoreline of False Bay about 25km southeast of Cape Town, covers an area of about 3 190 ha. The site is characterized by high, vegetated dunes with a large central low-lying area. Population estimates vary between 300 000 and 500 000. There are an estimated 52 000 families living on serviced land and over 12 000 families living on unserviced land.

b) Domestic Waste Management

The domestic waste collection service in Khayelitsha is provided by the Lingelethu West City Council (LWCC). No part of the service is contracted out and disposal takes place at the nearby Swartklip disposal site which is operated by the Cape Town City Council.

Level of Service

Collection from formal households takes place once weekly. Tractors and trailers, compactor trucks and standard tipper trucks are used. The waste is then taken to one of two transfer stations where it is compacted into containers and then transported on roll-on-roll-off vehicles, to the Swartklip Disposal Site which is about 5km from each transfer station. Open topped tipper trucks and front-end loaders are used to clear heaps of waste found on the sides of roads and in open spaces. Informal disposal of waste is widespread with dumps in most open spaces and on kerbsides.

About 120 skips are also located throughout Khayelitsha to complement the kerbside collection service and to provide a service to those living in informal housing where access is difficult for collection gangs. According to the Council the skips are serviced once every two days, or otherwise when residents phone to request them to be cleared. The reality however appears to be that the skips are not cleared regularly.

In one part of Khayelitsha, Site C, residents in formal sites actually do not want skips placed in certain places as infrequent collection is exacerbated by unhygienic waste, such as dead dogs, being placed in the skips. Skips have been relocated from certain places in Site C, but dumping now occurs in places where skips were previously located. Furthermore, residents from the formal serviced sites also make use of informal dumps. sites.

The Western Cape Regional Services Council Health Inspector's report for the quarter ending March 1994 reported that there were no refuse removal services for informal shacks in two parts of Khayelitsha, Site B and Site C. In Site C this was the case for just under 10 000 shacks, and in Site B for about 9 200 shacks. In these two informal settlements alone, it is estimated that there are up to 100 000 people without an adequate refuse removal system.

Recycling

There are no formal recycling initiatives currently operational in Khayelitsha. The Fairest Cape Association is involved in attempts to establish a recycling operation, while the Khayelitsha Environmental Action Group (KEAG) has identified recycling as a tool for educating people, making people aware of the use of waste and aware of the problems that can arise from waste that is poorly handled. KEAG is trying to overcome the community's acceptance of waste as a normal part of everyday life rather than as a health and aesthetic problem. The organisation is also attempting to start a recycling depot but is faced with a major shortage of funds.

c) Problems with Waste Management in Khayelitsha

A major problem in Khayelitsha is the different perspectives on waste management held by the local authority service provider and various community groups. The local authority sees its task as a "job" while there are some groups within the community eg. health workers and interest groups, such as KEAG, who are concerned about the impact upon the community of the inadequate service.

The difference in perspective has led to conflict between the two groups over future developments in the waste management system. The LWCC recently proposed to buy a further six compactor vehicles to boost current capacity. A community based organisation, the Khayelitsha Negotiating Forum (KNF), however, criticised this proposal as it involves the use of capital intensive technology in an area of extreme unemployment, with perhaps between 40% and 65% of the economically active population underemployed.

Consultants employed by the KNF argue that the council proposal is also technically flawed as the compactor vehicles are not suitable for local conditions. These vehicles are designed for the purpose of compacting low-density compressible wastes which are not overly abrasive and corrosive. Consequently compactors are suitable for use in high income areas where waste densities tend to be low and the wastes are relatively non-organic, non-acidic and non-abrasive. Wastes in Khayelitsha, in contrast, have a relatively high degree of organic, acidic and abrasive content - given low incomes, high levels of ambient sand and cooking methods. These factors combined with the fact that Khayelitsha already has two transfer stations with compaction facilities indicates that additional compactor vehicles would be technologically inappropriate.

In terms of the capital vs labour debate, the consultants argue that the proposal has a number of flaws including:

- a disregard for the need to keep as much income as possible within the community;
- no creativity in utilising the people of Khayelitsha;
- ignoring the international lessons of capital intensive development strategies.

An analysis based upon comparative economic shadow costing[5] carried out by the consultants found that: four times more capital than labour is employed per compactor; at least 41 potential jobs are sacrificed per compactor; and 80% of the payments per compactor leave the community in the form of debt repayment, finance charges, petrol costs and imported parts. In fact the consultants argue that up to 70% of the compactor expenditures ultimately will leave South Africa (Liles et al, 1994).

Other problems in Khayelitsha include the following:

- Labour is regarded by the local authority as unreliable, with absenteeism a problem, especially after pay day when there is usually an average of 25 workers absent without leave or excuse. This problem no doubt influences the local authority in its wish to acquire more compactors, rather than go a labour-based route in improving the service provided.

- Waste containers are not issued to "unregistered" residents, which contributes significantly to dumping and littering practices.

- Community co-operation is criticised by LWCC who complain that people often do not have their bins positioned on the kerbside when collection rounds take place. If residents don't get their bins emptied on the collection round, then they empty the bins in open spaces.

- Alternative use (eg. washing of clothes) is made of bins as they are good water containers. The council has attempted to address this problem by drilling holes in the bottom of the bins.

d) Links between waste management and water pollution

As part of the case study, the findings of Wright's (1992) hydrological investigation of the stormwater runoff from the Khayelitsha urban catchment was reviewed. The purpose of this review was to determine the link, between domestic waste management and stormwater runoff quality. There were a number of areas identified by Wright (1992) where this link is apparent, including the following:

[5] Shadow costing is a tool used to adjust market costs to reflect the overall economic costs of a project.

- Wright found that uncollected waste, along with faecal contamination, is the major pollutant of stormwater runoff from the Khayelitsha catchment.

- Wright's study found a direct link between the run-off from different housing types and the quality of stormwater runoff. Undoubtedly the house to house waste collection enjoyed by formal houses contributes significantly to the better quality runoff from these sub-catchments. In the same way the inefficient skip system in informal settlements and the random dumping in open spaces contributes to the increased pollution in runoff from these areas. Furthermore the observations of the detrimental effects of dense living on the runoff quality can also be related to the difficulties of carrying out efficient waste collection in such areas where access for collection vehicles is poor, and space for on-site storage is limited.

- The importance of service provision was observed by Wright (1992) when it was seen that during periods of unrest and strikes, the resultant breakdown in services had a negative impact on the runoff quality.

e) Conclusion

The major issues raised by the Khayelitsha case study are the following:

- The difficulties of different perspectives and a lack of communication which can arise if the local authority does not have a community constituency.

- The danger that a "living with rubbish" ethic which can be sustained through lack of environmental and health awareness.

- The very real impact that an inadequate waste collection service has on water quality and the accompanying dangers for health and the wider environment.

6.6 CASE STUDY FIVE: RINI

a) Background

Rini, situated to the north-east of, and adjoining, the town centre of Grahamstown, has a population of about 80 000 people. The area is administered by the Rini City Council whose jurisdiction extends over about 750ha, of which about 320ha are occupied.

b) Domestic Waste Management

The system of waste collection has changed since the government reduced "bridging finance" to the Rini City Council. Previously the system operated using six tractor/trailer systems to collect household waste which was then transported to the Grahamstown municipal landfill site. The same system applied to commercial and industrial sites.

Various problems existed with the system. The use of old tractors meant breakdowns occurred regularly and absenteeism among the workforce was commonplace. The household occupants had problems with providing their own bins and, as no bin liners were used, odour and fly problems existed.

A new system was thus introduced which operates on the basis of serviced areas of the community being divided into sectors and household refuse from each sector being cleared on a rotational basis. Three tractor/trailer systems now collect the household refuse bags and transport them to the Grahamstown municipal landfill site. This system has been an improvement on the former, with no reduction in the level of service provided but the average hours worked are less, and the incidence of absenteeism has been drastically reduced.

Level of Service

All formal households, approximately 5 000, are provided with a door to door twice weekly collection service. The households are issued with black refuse bags free of charge. The bags are filled and placed on the kerbside in front of the houses by the occupants on their removal days. Commercial and industrial sites receive the same level of service.

About 2000 informal households, which is roughly half of the total number of informal households, are provided with a refuse removal service. These households are provided with a door to door once monthly collection service. Black bags are also provided free of charge and the occupants place the bags on the kerbside. Access routes to other informal household areas, however, are impassable for the tractor/trailer systems and therefore no service is provided. As a large number of informal households are not provided with any service, there is a prevalence of waste dumped in open spaces, stormwater channels and natural watercourses. The Council encourages these households to burn their refuse to reduce these problems, but this in turn creates its own problems of noxious smoking piles of refuse burning for long periods and wind blown ashes.

Garden refuse is dumped in random piles along the kerbsides. Large piles of garden refuse mixed with rubble and household refuse along the roads create a visual impact. Presently, the Council road maintenance team scrapes these piles off the kerbside using a front-end loader and tipper truck at an average of three monthly (previously once monthly) intervals and dumps the refuse at the Grahamstown landfill site or at an informal dump site in an open area near to the Rini City Council works department. The front-end loader also picks up soil and grass in the process, therefore accounting for "impure" waste loads being dumped at the landfill. Kerbsides are also stripped of grass by this process, creating dust problems and kerbside levels are being eroded and in places are well below the adjacent road levels.

During rainy periods, the piles of refuse get washed into properties and roadways blocking stormwater drains and precipitating flooding. The informal dumping site is also used by members of the community to dump rubble and uncollected household refuse.

Recycling

A research based project led to the development of a forced aeration nightsoil/domestic refuse co-composting plant in Rini. By a unique method of mixing nightsoil and household refuse and placing the mixture in windrows aerated by air extraction pumps, both nightsoil and biodegradable household refuse were fully composted in approximately 40 days. The compost produced was an ideal pathogenic free compost, suitable for use on public parks, playing fields, trees and even domestic vegetable gardens.

The system was regarded as an economically feasible, low cost, environmentally friendly method of treating nightsoil and household refuse (La Trobe,1994). The fact that the site chosen for the operation was the Rini waste treatment plant, meant that there was a big reduction in transport costs for refuse removal. The added advantage was the potential increase in the life of the Grahamstown landfill site and the corresponding reduction of leachate from this site. The system facilitated the separation of the non biodegradable recyclable elements of the refuse from the biodegradable therefore reducing recycling costs. Glass, plastic and metal were sieved from the composted material and separated ready for recycling. The process is also labour intensive with signicant job creation potential.

The project, funded by the Algoa Regional Services Council, was implemented in May 1992 after a successful pilot study had been conducted in 1990. The plant was the first of its kind in the world and operated successfully until management and staff problems forced its closure in 1993.

Problems with Waste Management in Rini

There are a number of operational difficulties experienced by the Rini City Council with its solid waste removal system. The general problem of a lack of finance for the provision of services to Rini recently led to late payment of salaries to staff and therefore caused the total suspension of the refuse removal service for a few days. A management crisis appears to exist in the Rini City Council as the impending change in local government has cast uncertainty over the future of the current management. This appears to have led to a careless attitude to the management of solid waste in Rini.

The inadequate solid waste removal system results in domestic refuse being dumped into watercourses and stormwater drains. The refuse is transported during rainfall into water systems. Domestic refuse in Rini typically contains high percentages of organic material and when washed into these systems, increased organic loads result in contamination of the water. Unbiodegradable elements further contaminate watercourses. Stormwater drains can also become easily blocked resulting in flooding. Flooded areas eventually drain into watercourses with runoff carrying high sediment loads, increasing turbidity in the natural watercourses.

c) Conclusion

The experience of Rini once again demonstrates the difficulties that can arise when a local authority does not have a community constituency, the main problem appearing to be apathy of the local authority towards the changes in local government.

Rini also confronts the universal problems of high unemployment, a lack of finance and the environmental problems arising from uncollected waste such as water contamination, flooding and noxious fumes from waste burning.

The positive feature to arise from the Rini experience is the fact that when bridging finance was cut, the local authority was able to adapt the waste collection system such that with only half the resources, the level of service remained unchanged.

6.7 CASE STUDY SIX: WINTERVELD

a) Background

Klippan is a densely populated section of the Winterveld, an informal urban settlement and smallholding area of approximately 9 500ha, North of Mabopane and Soshanguve in what

was previously Bophutatswana. The Winterveld is unique in that it has a system of land tenure for black South Africans which has survived since before the "apartheid era". The population of the area is estimated at 180 000.

b) Domestic Waste Management

There is currently no solid waste collection system in Klippan resulting in an accumulation of rubbish in streets, in drainage ditches and on open land. The case study was thus largely based on a household survey and a waste stream composition study. The findings of the study provide insight into the characteristics of the waste stream, current disposal practices, and residents' attitudes toward solid waste collection.

Waste Stream

The waste stream study was conducted by collecting refuse from 19 households over a one-week period in a summer month. The overall density of the waste collected was high (220kg/m^3) with ash a significant contributor to the density. According to the household survey of 117 residents, 85% of the households use coal for either cooking or heating, whereas 48% use coal for cooking only. Hence waste densities are expected to increase significantly during the winter months.

Other than the low paper content, Klippan's waste steam is fairly typical of a "middle income" area, being rich in glass, metals, and plastics. Nearly 40% of the waste is organic material (excluding ash) - this is also more typical of a middle income area than a low income area. If the ash and organic waste is combined, then 70% of the waste stream is compostable.

There are possible sources of error in the results reported. Firstly, the sample was too small and the duration of the study too short to get an accurate picture of the average waste stream. Secondly, as there is no collection service, people may have taken advantage of the opportunity to dispose of accumulated waste. Old bottles, shoes and clothing in several of the bags indicated that a "spring cleaning" may have taken place. Nevertheless, the data do give an indication of where Klippan falls in the spectrum of waste stream compositions.

Current disposal practices

The household survey results indicate that diverse methods of waste disposal have been developed by individuals in Klippan. One question asked of households was where their

waste was dumped. Just over half the respondents dispose of their waste in their own yards. Another significant percentage throw their refuse in piles, streets or drainage ditches within three minutes walk of their homes. A very small number bring their waste to sites farther from their houses, usually after storing the waste in a bin or pile in their yard for a week or more. This pattern of waste disposal is possible because, despite the population density, most households have yards or access to numerous open spaces scattered throughout the area.

There is actually a landfill in the Winterveld, the Mabopane dump, which receives waste from Winterveld and Mabopane. However due to the lack of a collection system, little, if any, of the waste produced in Klippan ends up in this dump. Extensive resource recovery takes place at the Mabopane landfill by a community of scavengers who work there. The number of tin cans and other recyclables visible in piles of rubbish throughout Klippan however indicates that scavengers are not very active within Klippan.

Another series of questions determined whether different types of waste are treated differently. Most of the respondents dispose of their ash with the rest of the refuse, although about 15% indicated that they spread their ash around the yard or leave it in a pile. Under 10% of the respondents reported that they give tins to collectors. Although several people set aside tins for these collectors, there does not seem to be a formal or regular pattern to this collection. No one reported receiving money from tin collectors. About 15% of those surveyed feed their food waste to animals - either their own or someone else's. Glass is seldom separated but is sometimes thrown in the toilet (pit latrine) so that children do not step on it. Just over 10% of respondents burn their paper and sometimes plastic before disposing of them. The majority of those who keep animals report that they throw the animals' faeces away with the rest of the rubbish. A few respondents, however, reported using or even selling animal waste as manure.

Although some separation of wastes takes place, the fact that most respondents (69%) reported no separation of wastes, and the relatively high percentage of recyclable materials in the waste stream indicate that recycling and composting could be substantially increased in Klippan.

Residents' attitudes toward solid waste collection

Respondents generally agreed that rubbish is a problem in Klippan. The most common reasons given were that it is a health hazard, smells bad, and is aesthetically unpleasant. Several people also mentioned the hazards posed by broken glass to car tyres and children's feet. 79% of respondents ranked water as the most important service to them. In comparison

only 3% of the respondents ranked rubbish as their top priority. However an additional 72% did mention it among the services that they would like to have. When asked how much they would be willing to pay per week for their preferred level of waste collection service, the amount ranged from R2.33 for a once a week service to R3.49 for a four times per week service. The key issue is not the amounts that the residents were willing to pay, but rather the fact that they expressed a willingness, and sometimes even an enthusiasm to pay, if this would mean an effective service.

c) Conclusion

The household survey indicated that residents of Klippan are dissatisfied with the current methods of waste disposal and they display a fairly high level of awareness of problems associated with a lack of removal. While not as important as electricity or water, most residents did indicate that they place a high priority on receiving a rubbish collection service. The survey results also indicate a strong willingness to pay for waste collection services in Klippan.

6.8 OVERALL CONCLUSIONS

A number of key issues emerge from the case studies which are highlighted briefly:

a) Management

The effectiveness of the management, at all levels, can have a major impact on waste collection systems. The studies suggest that good management involves:

- Consultation and communication between the local authority and the community, no matter whether the authority or a contractor is providing the service.
- Appropriate contract specifications when a service is contracted out, with the focus on the cleanliness of the area and not on tonnage based remuneration.
- Effective supervision and monitoring on the ground.
- The use of appropriate technology which ideally meets the needs of both the service provider and the community.

b) Community based contracting

The experience of Umlazi shows that community based contracting can work effectively if the system is properly designed and implemented, and the management criteria outlined above are met.

c) Finance

The two major issues here are availability and source of finance. Inadequate finance is a common problem and it can lead to problems. The system in Umlazi shows what can be done with a secure flow of funds, and the experience of Rini shows that it is possible to adapt a system despite limited finance. The source of funds is however perhaps the most crucial aspect of finance. The dependence on subsidy or grant finance in all the case study areas means the sustainability of the systems is questionable. However it would appear that domestic waste collection systems will only be sustainable, and in places such as the Winterveld, available, if the user pays.

d) Resident's attitudes

From the case studies it seems that attitudes to waste range from a high level of concern and awareness of the problems associated with uncollected waste, as in the Winterveld, to a general apathy amongst the larger community, as in Khayelitsha. These attitudes can have important implications for issues such as willingness to pay, recycling efforts and the types of service that would be found acceptable. It might be that apathy is limited to a belief that waste collection is a government function and in this regard awareness campaigns and direct community involvement in planning could be very important.

e) Recycling

Recycling has been found to be a limited activity in all the case study areas. The major problem with recycling appears to be the limited markets for recyclables. Exacerbating this is a general lack of environmental awareness within communities as well as managerial and financial difficulties within recycling establishments.

7. CONCLUSION

7.1 INTRODUCTION

Each chapter in this report has highlighted a number of important issues on different topics. It is thus appropriate to conclude this report with a review of the major issues raised in each topic and then provide a final conclusion drawing on the most important implications of these issues for South Africa.

7.2 OVERVIEW

Chapter One outlined the methodology of the research as well as the parameters for Phases One and Two of the project. It also provided certain key definitions for the research. Both these areas are important in assessing the validity of the information gathered in the research process.

a) Methodology

The key methodology issue was the questionnaire process where it was found that:

- There was an uneven response to the survey - significantly more white local authorities than black local authorities responded to the first questionnaire which was the more detailed one.

- The accuracy of some of the information provided in questionnaires was found at times to be wanting.

b) Definitions

The interpretation of data was influenced by the definition of levels of service. The World Bank levels of service were found to be too general and vague for interpretation. The more detailed definitions derived for this research found that there are certain criteria which need to be assessed when determining whether or not a service is adequate or not, namely:

- Households must have a hygienic storage facility.

- The service, whether kerbside or communal, must be provided at least once a week.

- The service must be effective, ie. the waste must be removed from the designated collection point at the scheduled frequency.

- The community must be educated in how the service operates and what is expected of them.

Although these criteria provide a convenient framework within which to assess a service, short of visiting every local authority, information about all criteria was never gathered. Hence the assessment of levels of service provided was done very subjectively, usually with the local authority getting the benefit of any doubt. In other words, the national picture of access to services as outlined in Chapter Four is possibly optimistic.

7.3 CONCEPTUAL FRAMEWORK OF WASTE MANAGEMENT

The conceptual framework outlined in Chapter Two raised three key issues, dealing with: objectives of waste management; the integrated nature of waste management, as well as its situation specific character.

a) Objectives

The objective of waste management is not only to provide an environmental service in removing waste, but it has the crucial aspect of being economically sustainable for the community which is served.

b) Integrated Waste Management

Integrated waste management is often interpreted as referring to the co-ordination of managing different types of waste. In this context the importance of the term is that effective waste management involves integrating appropriate technology with adequate levels of service to meet both the needs and means of the community.

c) Situation Specific

It is essential that waste management for any area must be designed to fit the physical, cultural, and economic circumstances of the area.

Hence it was determined that any approach to waste management cannot be undertaken according to a universal solution but rather that a conceptual framework of waste management is helpful as a point of reference when dealing with specific circumstantial factors.

7.4 THE ENVIRONMENTAL IMPLICATIONS OF SOLID WASTE

Chapter Three outlined the environmental threats from uncollected solid waste and indicated why environmental considerations are a key parameter in the objectives of solid waste management. Uncollected solid waste causes problems for both the human environment and the natural environment, while collected solid waste can also cause environmental problems.

a) The Human Environment

The key risk of uncollected solid waste is the impact on health both directly and via effects on water supplies and drainage systems. Possibly the most serious risk to health posed by uncollected waste relates to its effects on the stormwater system. Blockages of the stormwater drainage system result in standing water which may be contaminated and which also encourages the breeding of mosquitoes and flies with the resultant threat of diseases such as malaria and diarrhoea. The problems associated with standing water transfer into water quality problems in stormwater channels, streams and rivers. Informal dumping can also impact on local groundwater quality while uncollected waste can also lead to pest breeding, physical injury to children; air pollution; general flooding; land damage and aesthetic problems relating to sight and smell.

b) The Natural Environment

Uncollected waste that ends up in water courses and eventually the sea impacts detrimentally on the ecology of such areas. Decaying organic matter and bacteriological activity use oxygen, thereby reducing the amount available for aquatic life. The process of decay leads to the undesirable growth of aquatic weeds, algae and macrophytes, affecting water quality and aesthetics. Finally plastics have been identified as a particular problem for river and marine life.

c) The Impact of Collected Waste

The environment can be harmed both through collection practices and disposal practices. Collection can damage the environment through, for example, the use of heavy vehicles. The practice of using front end loaders for loading waste also creates problems as soil and vegetation is removed and hollows created where water accumulates. Landfill sites can be environmentally damaging through the leaching of heavy metals and other hazardous substances into soil and groundwater. Also, the production of methane gas can be dangerous and there are obvious aesthetic impacts where landfills are located near to residential areas.

7.5 INTERNATIONAL TRENDS

The examination of international trends in Chapter Four highlighted the characteristics of major aspects of waste management in both developing and developed countries. These features may be reviewed briefly according to Chapter Two's conceptual framework as follows:

a) Institutional aspects

It was seen that in developed countries there has been a shift to privatizing the provision of waste collection services. Research has shown that private contractors are more efficient than the public sector, but that moves in this direction in developing countries are less advanced. It was also seen that waste services can be a very big employer of labour in developing countries.

b) Waste characteristics

There is generally a contrast between waste from developed and developing countries in terms of both generation rates and density. The waste tends to be less dense in developed countries, usually ranging between 100 kg and 150 kg per cubic metre, as opposed to over 400 kg per cubic metre in developing countries. The per capita waste generation rate tends to be higher in developed countries ranges betwee 1kg and 1.8kg per day, as opposed to the range in developing countries of between 0.3kg and 0.5kg per capita per day.

c) Storage containers

In developed countries storage containers are becoming highly sophisticated to the extent that in some countries technological developments have facilitated the installation of identity chips in containers so that variable collection fees can be charged according to the weight of the container. In developing countries containers are often non-standardized, with boxes and drums being used.

d) Levels of service

Developed countries tend to have consistent service levels with at least a once weekly kerbside collection being the norm. Developing countries are characterized more by large degrees of non-collection and, when a service is provided, it is often a communal collection system. Furthermore scavengers are often involved in providing an informal collection service.

e) Transport

Compactor vehicles, and increasingly rail transport, are used widely in developed countries while low technology characterizes developing countries, with anything from pushcarts, bicycles and animal carts being used for transport. Trucks and compactor vehicles are also used in these countries but maintenance problems usually undermine their effectiveness.

f) Resource Recovery and Recycling

Resource recovery and recycling tend to be seen in developing countries largely as economic activities generating income and employment, while in developed countries it is legislation which drives the activities, largely due to environmental considerations, especially in view of decreasing landfill space.

g) Disposal

The key distinction between developing and developed countries is that of control. Sanitary landfilling and incineration take place in developed countries under strict controls. In Germany for example there is now legislation requiring that waste be treated before disposal. The lack of control of disposal in developing countries is due largely to shortages of skills and inadequate technology.

h) Problems

The problems experienced differ widely as the infrastructure of developed countries is so much more advanced than that of developing countries. Hence while developed countries are dealing with issues such as legislative controls for disposal, developing countries are addressing problems at the other end of the spectrum, namely a lack of collection. Other problems which were seen to be confronting developing countries included: institutional inadequacies; inappropriate technology; inadequate income; over-reliance on imported equipment; inappropriate methods of finance; inequity in service provision; insufficient emphasis on privatization and broader issues related to increased urbanization.

7.6 OVERVIEW OF SOLID WASTE PRACTICE IN SOUTH AFRICA

Chapter Five provided an overview of domestic solid waste practice in South Africa, and the discussion highlighted a number of key issues.

a) Institutional Arrangements

The institutional arrangements appear to be undermined by a lack of co-ordination and cohesion. There is no national policy on waste management and no single government department that deals with waste management issues. A large number of national statutes and provincial ordinances together with the involvement of various government departments mean that responsibilities and controls suffer from what has been described as "bureacratic paralysis".

The private sector is becoming increasingly involved in waste management, although this involvement currently appears to be more active in the industrial sector.

b) Access to Services

In urban areas it was seen that approximately 4.5 million people, representing about 21% of the urban population, do not have access to an adequate waste collection service. It was also determined that about 35% of the population living in Black Local Authority and urban areas of the former homelands do not have access to an adequate waste collection service. Bearing in mind the previously mentioned problems with the data gathered, this figure could be as high as 50% of the black urban population.

c) Waste details

The data on waste received from local authorities revealed that the authorities do not have very accurate records about waste content or waste generation rates. Nevertheless from existing research and basic calculations it was established that South Africa has features representative of both developed and developing countries. In white local authority areas generation rates are in the region of 1kg per person per day, while in black local authority areas, the generation rate can be as low as 0.2kg per person per day. Waste density differs between these areas with WLA densities being low at about 150 kg per cubic metre and BLA densities generally being over 300 kg per cubic metre. The composition of waste is affected by factors such as geographical location, income level, seasonal conditions, and the size of the urban settlement.

d) Storage and Transport

Storage containers in WLAs tend to be standardized - bags or bins, with a move to the new 240l bin taking place in certain areas. In contrast BLAs tend to have standard containers in

formal areas but the informal areas make use of both standard containers and less standardized containers, such as boxes.

In transport terms, compactor vehicles are commonly used in WLAs, while in BLAs a variety of vehicles are used, ranging from tractors and trailers, open topped tipper trucks and standard compactors. A key difference between WLAs and BLAs is that there are significantly more vehicles available per head of population in WLAs - one for every 11 400 people than in BLAs - one for every 24 000 people. This mismatch in terms of resources is also evident when looking at street cleaning, with for example there being one labourer per 2 800 in WLAs, and one labourer per 6 300 people in BLAs.

e) Resource Recovery and Recycling

Although it is estimated that up to 25% of domestic waste tonnage produced is recycled, there are a number of examples in South Africa of failed recycling initiatives. These failures have tended to be due to losses on investments in large capital intensive recycling plants. Such failures have highlighted the need in South Africa for greater attention to be paid to the issue of incentives to encourage recycling as well as broadening markets for recovered as well as recycled goods. Informal resource recovery and recycling are widespread activities but it is difficult to quantify either the numbers of people involved, or the volume of waste that is recycled in this way.

Composting activity as well as gas extraction from landfills both occur in South Africa, but not on a very wide scale. The diminishing landfill space in metropolitan areas is making these activities increasingly attractive options for local authorities.

f) Disposal

The most common form of disposal in South Africa is landfilling, with incineration being used for more hazardous waste types such as medical waste. The major issue surrounding disposal is that of control, with only one in ten disposal sites (of about 1200 formal sites) estimated to be properly controlled and audited. Furthermore the questionnaire responses indicated that only about 20% of sites have a charge for disposal. A recent development has been the tabling, by the Department of Water Affairs & Forestry, of draft Minimum Requirements for Waste Disposal by Landfill. These Minimum Requirements provide frameworks for undertaking landfilling activities and they advocate the Best Practical Environmental Option approach. An issue arising from the requirements is the anticipated

impact on cost that they will have, although a process of public consultation is still in progress and the Requirements are not expected to be legislated for some time.

g) Finance

The financial arrangements for the provision of domestic waste collection services are characterized by two major features. One is the disparity in expenditure between WLAs and BLAs. The survey revealed that in WLAs the expenditure per capita for household waste services averaged at about R23.00 per annum, while the same figure for BLAs was under R10.00. The second issue is that of non-payment for services in BLAs with the result that costs in BLAs tend to be covered by subsidy payments.

h) Innovative systems in use

Innovative waste collection systems tend to develop in BLA areas as part of attempts to improve services. The most successful innovations have been in the area of community based contracting, where members of communities have been contracted by local authorities to provide services. These systems tend to be characterised by vehicle collection using low technology options such as tractors and trailers. Only one example of a labour intensive collection system was found, the One Man Contract system in Stswetla (Alexandra), where the primary collection is conducted on foot. The scope for large-scale use of unskilled labour, together with the re-injection of money into the community makes community-based contracting a potentially important developmental tool for use in developing communities in South Africa.

i) Problems

The survey indicated that the three major operational problem areas identified by WLAs are inadequate finance, vehicles and disposal sites. Reflecting the differences between WLA levels of service and those in BLAs, disposal was not identified by BLAs as a major problem, but rather issues of finance, vehicles, labour and supervision were of major concern. This is unsurprising as lack of collection (rather than formal disposal) is the priority issue in BLAs.

Apart from these problems, other concerns identified include the lack of involvement of communities in the planning of waste services, inadequate organisational structures of service providers, and growing urbanisation.

7.7 CASE STUDIES

The case studies revealed a number of issues specific to certain situations, but also allowed for a number of common issues to be identified, namely: the importance of management, community based contracting, finance, resident's attitudes and recycling.

a) Management

The studies revealed that there is a direct link between good management and the provision of an effective service. Good management involves ongoing consultation and communication between the service provider and the community; appropriate contract specifications when a service is contracted out, and effective supervision and monitoring on the ground.

b) Community based contracting

The case studies revealed that community based contracting can work effectively if there is good management - both by the contractor and of the contractor.

c) Finance

The case studies revealed two important aspects of finance, one the availability of finance and the other, the source of finance. Invariably a shortage of funds limits the effectiveness of a service although the Rini case study showed that this is not necessarily the case. In terms of source, the dependence on subsidy or grant finance in all the case study areas raises questions about the sustainability of the systems that were examined. The Masakhane campaign for service payments will have a key role in determining whether sustainable waste collection systems are to be established.

d) Residents' Attitudes

The case studies indicated that the concern of residents to waste management issues ranges from a high level of concern to one of apathy. The existence of apathy may be attributable to a history of poor service levels and will need to be addressed through education. It is thus likely that education be recognised as an important part of any service provider's responsibilities.

e) Resource Recovery & Recycling

Recycling was found to be a limited formal activity with a lack of viable markets for recyclables. Resource recovery is undertaken on an informal basis, but it is apparent that this activity as a generator of income has not yet reached the level of some developing countries discussed in Chapter Four. This may be attributable to various factors but perhaps most importantly there is a lack of acknowledgement from formal service providers of the potential benefits to be derived from this "industry" and hence inclusion of these agents in the waste management process.

7.8 FINAL CONCLUSIONS

This chapter has reviewed the major issues raised by each part of the project. The consolidation of such issues is important in order to identify, inter alia, priority areas for action and factors to consider when undertaking such action. The findings of the research appear to indicate the following key areas for action and factors for consideration:

a) Access to Services

It has been seen that up to 50% of the urban population do not have access to an adequate waste collection service. The extension of services to currently underserviced areas needs to be undertaken urgently.

b) Institutional Overhaul

A lack of institutional responsibility and capability has been identified. The current situation of various national government departments having involvement in waste management needs to be examined with a view to the establishment of either a national waste management department/board, or the allocation of all waste management responsibilities to one existing department. Complementing this structure would be a provincial level waste management department/board in each of the provinces. Although the focus of this project has been on solid waste, such departments/boards would need to have jurisdiction over all forms of waste. The purpose of these structures would be to co-ordinate and monitor the handling of waste by third tier agencies.

Accompanying the institutional overhaul would be a legislative overhaul which would provide standard guidelines for service providers. Along the same lines as the Minimumum

Requirements for disposal, there is a need for standard minimum requirements for the collection and transport of waste.

c) Management Arrangements

The changes in local authority structures will enforce changes in the management arrangements for the provision of waste management services. These changes will need to ensure that the imbalance in resource allocations between different areas, identified in this research, are corrected. Not only will it be necessary to ensure the universal provision of adequate services, but also that this is in accordance with situation specific factors such as the local economy, culture, physical aspects and community needs. Hence an integral part of managing waste services will need to be interaction and communication with communities to ensure that the services provided are appropriate to community needs. A key component of this interaction will also be education of the community.

An emphasis on using community based contractors should also become a priority in order to contribute to address employment problems and enhance community economies. In the use of contractors, the conditions of the contract are critical in determining the effectiveness of the operation.

d) Finance

The dependence on grant finance for the provision of services needs to be addressed. This can be addressed not only through the Masakhane Campaign, but also through the approaching of providing services not only appropriate to the needs of communities, but also their means. An adequate service can still be provided using low technology options accompanied by low costs.

e) Waste generation

Waste generation is a key issue in light of diminishing landfill space in certain metropolitan areas, and the increasing sensitizing of the public to the issue of landfill location. Previously landfills tended to be located near BLA areas without much consideration for impacts on surrounding communities. The increased political power of these communities now makes the location of landfills a more negotiable issue. The recent experience of the Philadelphia community in the Cape and the Chloorkop waste site in Gauteng provide evidence of the fact that community support is an essential requirement for landfill location.

One way of addressing the landfill issue is by reducing the amount of waste that enters landfills. This highlights the need for strategies to reduce waste generation to become an integral part of the waste management process. The fact that local authorities are introducing 240l bins for domestic waste suggests that not much consideration has been given to the issue of waste reduction. Unsurprisingly it has been shown that where bigger storage containers are used, increased waste generation rates have resulted.

f) Resource Recovery and Recycling

One way of addressing the issue of reduced waste generation is through encouragement of resource recovery and recycling. Attention should be given to the lack of incentives for resource recovery, and the lack of markets for recycled goods. Furthermore the integration into the formal waste management process of informal agents such as scavengers needs to be addressed.

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Mr Jan Palm, Geustyn Forsyth & Joubert Inc, Stellenbosch. 17/3/94

Ms Morag Peden, Institute of Natural Resources, University of Natal, Maritzburg. 18/4/94

Mr Hilton Petters, Munitech Pty Ltd., Durban. 19/4/94

Mrs Martha Pretorius, CSIR Information Services, Pretoria. 22/4/94.

Dr John Raimondo, Environmental Evaluation Unit, University of Cape Town. 4/5/94 (Telephone)

Mr Robert Scanes, Cleansing Department, Pietermaritzburg Municipality.

Ms Cherise Schaerer, Keep South Africa Beautiful, Johannesburg. 21/4/94

Prof Eric Senior, Waste Technology Unit, University of Natal, Maritzburg. 18/4/94

Mr J. (Koos) Stander, Dept. of Environmental Affairs, Pretoria. 21/4/94 (Telephone)

Dr Andre van der Westhuizen, Foundation for Research and Development. 4/5/94. (Telephone)

Mr Dirk van Dyk, Lingelethu West Town Council. (Telephone)

Mr Conrad van Heerden, Parow Municipality, Cape. 30/3/94

Ms Di White, Environmental Services Mgr, Waste-tech, Cape Town. 6/5/94