# PLANNING FOR SUSTAINABLE MUNICIPAL SOLID WASTE MANAGEMENT

PRACTICAL ACTION
Technology challenging poverty

technical brief

## Introduction

As towns and cities around the world expand and populations grow, volumes of waste produced increase and the challenges of solid waste management change.

This technical brief presents some important considerations for planning solid waste systems. It begins by outlining solid waste management (SWM) concepts and goes on to describe the process of planning for sustainable municipal SWM. Some aspects, such as planning secondary collection, selecting vehicles and designing landfills are quite complex. Although this brief does not provide in-depth guidance on each of these issues, the final sections do highlight some of the important questions to consider and suggests possible solutions. The brief also provides sources of further information.

Responsibility for managing waste usually falls on municipalities, although NGOs, the private sector and the informal sector often play important roles. This technical brief would be particularly useful for municipalities, NGOs or businesses involved in planning and managing solid waste management programmes

### Solid waste

Solid waste is defined as material which no longer has any value to its original owner, and which is discarded. The main constituents of solid waste in urban areas are organic waste (including kitchen waste and garden trimmings), paper, glass, metals and plastics. Ash, dust and street sweepings can also form a significant portion of the waste.

Waste is generated by a range of stakeholders including: pedestrians, households, businesses, markets, industries and healthcare facilities. Therefore solid waste can also include toxic waste (e.g. chemicals from industry), biological waste (e.g. dressings from hospitals) and occasionally faeces (e.g. from nappies). These hazardous wastes require specialised treatment and disposal, not discussed in this technical brief. The source of waste often determines its quantities and characteristics. In developing countries waste generated from various sources is often combined at collection and disposal, so due care must always be taken to ensure the health and safety of those involved in waste management.

Photo 1: Door-to-door solid waste collector in Delhi (Jonathan Rouse)

Practical Action, The Schumacher Centre for Technology and Development, Bourton on Dunsmore, Rugby, Warwickshire, CV23 9QZ, UK
**T** +44 (0)1926 634400 | **F** +44 (0)1926 634401 | **E** infoserv@practicalaction.org.uk | **W** www.practicalaction.org

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## Solid waste management: the basics

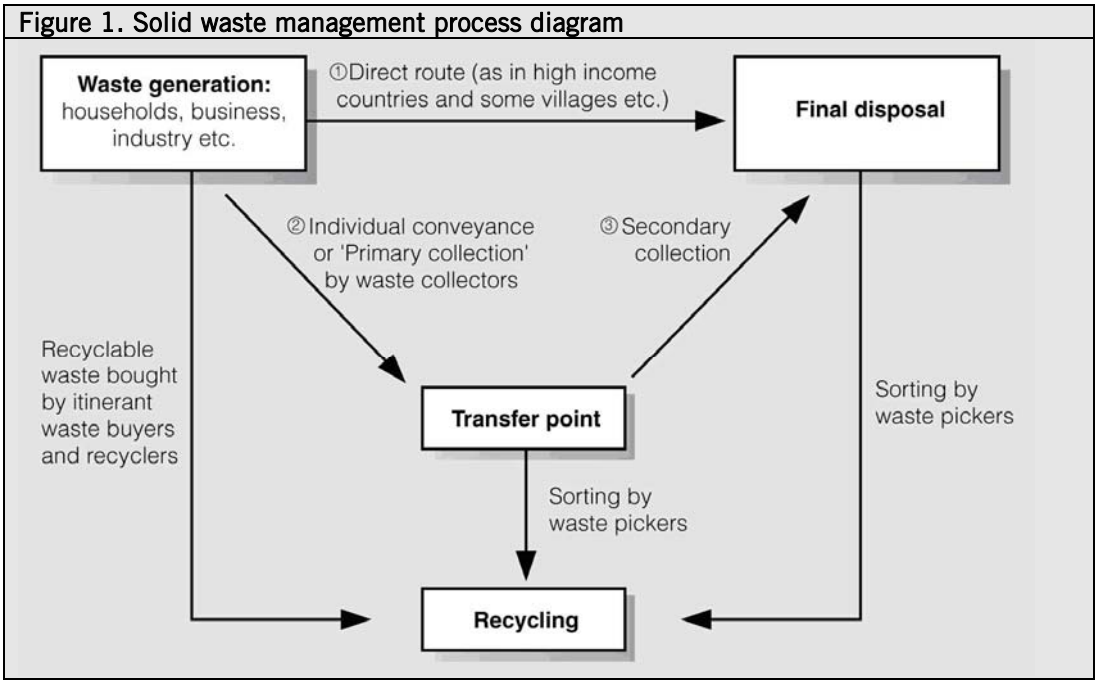
Solid waste management (SWM) involves the collection, storage, transportation, processing, treatment, recycling and final disposal of waste. Systems need to be simple, affordable, sustainable (financially, environmentally and socially) and should be equitable, providing collection services to poor as well as wealthy households. SWM should aim to improve the environment, provide direct health benefits, support economic productivity, and provide safe, dignified and secure employment. Figure 1 illustrates typical SWM processes.

Many developed countries have formal door-to-door collection systems (① in Figure 1). However, in low-income countries waste generators (e.g. householders), domestic helpers or private waste collectors carry waste to transfer points (see photograph 1).

This stage is indicated by ②, and is referred to as *'primary collection'*. A transfer point is an intermediate place at which waste is deposited and stored before being transported to the final disposal site.
Local authorities then collect waste from the transfer point and convey it to the final disposal site. This stage is indicated by ③ and is referred to as *'secondary collection'.* Finally, waste is disposed of to a variety of standards according to available resources and knowledge. This stage is called final disposal.

Recyclable materials may be extracted from the waste stream from the points of generation, transfer or disposal. In reality there are many variations on Figure 1: for example, sometimes large private sector companies manage everything.

**Figure 1. Solid waste management process diagram**




Source: Rouse and Ali 2002.

Stakeholders in SWM are many and varied. Table 1 presents the common roles and responsibilities of various actors. Understanding existing roles is an extremely important first step in planning.

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Table 1: Who does what in solid waste management?

| | Generation | Primary collection | Secondary transportati | Recycling | Sweeping | Disposal | Awareness raising | Monitoring | Policy/ Planning |
|---|---|---|---|---|---|---|---|---|---|
| Householders and other generators | ■ | ■ | | ▒ | | | | | |
| Informal sector | | ■ | ▒ | ■ | ▒ | ▒ | | | |
| Private sector | | ▒ | ■ | | ▒ | | | | |
| NGOs | | ■ | | ▒ | | | ■ | ■ | ▒ |
| Municipalities | | | ■ | | ■ | ■ | ▒ | ■ | ■ |
| Government bodies | | | | | | | | | ■ |

■ Common roles ▒ Occasional roles

**Informal-sector and solid waste management**

In many developing countries, the informal sector makes a significant contribution to solid waste management. Their work includes:

- door-to-door waste collection (often contracted informally by householders) and depositing waste in transfer points;
- purchasing valuable recyclable items from householders and small businesses, thus reducing the overall burden of waste management and recovering resources; and,
- 'waste picking' - searching for recyclable materials from waste on streets and at disposal grounds.

## Planning for improved solid waste management

Many municipalities struggle with achieving acceptable quality and coverage of SWM services due to budget constraints, lack of cooperation of generators, conflicts between different stakeholders, and the difficulty of managing transport fleets and identifying and managing disposal sites. Better solid waste management is important because uncollected waste is an eyesore, blocks drains and is a public health risk. Planning sustainable solid waste management can be complex, but a logical approach and carefully considering the various stakeholders and options will increase the chances of developing an efficient, effective and successful system. Planning SWM must include a consideration of each of the stages in Figure 1, and all the actors.

**Strategic planning**

Strategic planning (SP) is a logical approach to developing appropriate, achievable action plans for improving the quality, coverage and efficiency of SWM services. It can be summarised by the following three questions:

- What is happening at present? (Situation analysis)
- What do you want to happen? (Goals)
- How can you make this happen? (Strategic plan)

SP is a planning tool designed for long-term planning, particularly at town, city or even national level rather than neighbourhoods or projects. It is geared towards developing a vision and long-term roadmap with wide ownership following detailed consultations. This technical brief draws on many of the principles of SP, but focuses more on the practical planning issues of improved SWM.

See Wilson 2004 for more information.

## Situation analysis

Planning begins with a study of the existing situation and systems. Planners should develop a broad understanding of actors, opportunities, constraints, possible partners and so on. Key questions include:

- What existing information exists on waste streams, quantities and characteristics (see next section)?
- How does SWM work at present? What are its strengths and inefficiencies?



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- What are the existing resources for SWM including personnel, skills, equipment, land etc?
- What are the financial issues (including budget, cost recovery, forecasting)?
- What policies, legislation and regulations apply? What level of political ownership/vision exists?
- Who are the actors? What level of investment and interest is there from the private sector?
- What are the potential hazards from handling waste?
- What are the key constraining factors (e.g. lack of co-operation of generators, lack of vehicles, no disposal site etc.)?
- What are the long-term trends and future needs (e.g. population growth, waste type)?
- What are the socio-cultural issues and expectations (e.g. attitudes and level of cooperation)?

Much of this information may be secured from secondary sources, though it may be necessary to undertake some primary research. The situation analysis should also involve detailed consultations with a range of stakeholders, as outlined in Table 1 above. The consultation process should also be an opportunity to build co-operation and support and ensure solutions are inclusive and geared towards demand. Such activities must use simple concepts and encourage genuine participation.

### Waste characterisation

The cornerstone of successful planning for a waste management program is reliable baseline information about the quantity and type of waste being generated. This enables informed decisions to be made about equipment, vehicles, storage facilities, specialised handling requirements and personnel. The information can also enable targets to be formulated for reduction and recycling programs, and provide baseline data for assessing whether goals and targets have been achieved.

Issues to investigate may include:

- What waste is produced (constituent elements, density)?
- Generation rates (i.e. how much waste is produced (volume and mass))
- Where is it produced?
- When is it produced (e.g. seasonal variation)?
- What are the trends in all of the above (e.g. amount of packaging in waste may be increasing)?
- What are the potential hazards (e.g. sharps, toxic chemicals)?

There are a number of methods for quantifying and characterising waste, but care is required to ensure accurate and representative data. For example, weighing and examining the waste from a sample of households could give an estimate of total household waste produced in a city (multiply by the total number of households), as well as an indication of the types of waste present in domestic waste. However, the sample needs to be carefully selected in order to account for the considerable variation found in some cities, for example between wealthy and poor neighbourhoods. Additionally, it is important to recognize that the characteristics of waste can change as it progresses towards disposal, processing or recycling. For example, where waste is placed in a transfer point, recyclable materials may be removed and commercial waste added, thus significantly changing its composition, volume, density and mass. Waste characterisation studies may be undertaken at different points in the solid waste management process according to the intended use of the data. For example, household generation rate data could be useful for planning primary collection, but not necessarily so for secondary. Finally, waste generation and composition may vary seasonally.

Table 2 contrasts typical waste characteristics in low- and high-income countries.

| | Low-income country | High-income country |
|---|---|---|
| Generation per household | 0.5 kg | 2 kg |
| Density | 500 kg per cubic metre | 100 kg per cubic metre |
| Composition: | | |
| *Organic* | Up to 80% | 30% |
| *Paper* | 5% | 40% |
| *Metals* | Less than 1% | 10% |
| *Plastic* | Less than 1% | 2% |



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| | | |
|---|---|---|
| *Glass* | Less than 1% | 10% |
| Moisture content | High | Low |

Before embarking on waste characterisation studies, check for existing survey data.

## Developing action plans

Sustainable SWM cannot be achieved through isolated approaches, for example by a number of isolated projects, or applying technology or awareness raising alone. Action plans ideally contain a range of activities: some which are easy and simple to undertake in the short-term, as well as activities which contribute to longer-term goals and which require considerable time, effort and investment. Short and long-term activities should complement one another.

**Goals and indicators**

Achieving 'perfect' solid waste management is a challenging goal, and achieved by few - if any - municipalities around the world. It is often more helpful to develop a 'roadmap' consisting of incremental goals and indicators (i.e. ways of measuring performance) to achieve long-term improvements to SWM. Positive change relies not only on hardware investments and systems design, but also mindsets and behaviour. These can take time to change.

Practically, this means you may choose to define a series of goals. For example:

- Short-term goals: to achieve minimum standards, i.e. collect all waste from streets and make minor improvements to disposal facilities (6 months);
- Medium-term: improve resource recovery and recycling, and improve the quality of the disposal facilities with basic leachate treatment and compaction (2 years);
- Long-term: achieve 100% source separation of waste, and develop sanitary landfill (5 years).

There are a number of ways of developing action plans. One is to draw up a table listing the various functions (e.g. primary collection, recycling, transportation, disposal etc.) and for each function outline the present situation and the goals (including intermediate goals), and then devise a plan for achieving this. At this point you should also identify opportunities, threats, budget requirements and set target dates. Table 2 shows the possible column headings for this process.

**Table 2: example strategic plan development**

| Function | Goals | Action plan | Opportunities | Threats | Budget | Target date |
|---|---|---|---|---|---|---|
| Disposal | 1. Meet minimum standards | 1. Compact and cover waste<br>2. Stop all waste burning<br>3. etc. | - Vehicles available from other municipal department | - Waste pickers<br>- Unco-operative workforce | $##.## | + 6 months |
| | 2. Medium term goal | | | | | +1 year |
| | 3. Long-term goal | | | | | +3 years |

## Sustainable solid waste management options

### Generation and primary storage

*Why is planning this important? Waste generators are important stakeholders in SWM. The success of SWM systems depend on the crucial support and co-operation of householders, businesses and markets etc. Planning can ensure systems meet their needs.*

Understanding and gaining the support of waste generators, including households, shops and businesses, is vital but frequently overlooked. Key planning questions include:

- What are the present behaviours, perceptions and attitudes?
- Are waste generators willing to segregate waste or participate in door-to-door collection?
- What is used for waste storage in homes at present?

Information gathered at this stage can also be useful for planning other aspects of SWM (e.g.



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primary collection).

Waste needs to be stored in homes before being collected. Households generally prefer the storage period to be as short as possible because - particularly in warmer climates - waste begins to decompose and smell quickly. Household waste storage containers should have lids to protect the waste from the rain, to control odour and keep rodents, birds, cats and dogs away.

**Attitudes and behaviour**

The attitudes and behaviour of waste generators can have significant impacts on solid waste management. For example they may cooperate and segregate waste, or they may dump mixed waste indiscriminately on the streets. Awareness raising campaigns using messages such as 'Reduce -- Reuse -- Recycle' can be used to change attitudes and modify behaviour amongst householders and businesses. These can be an important aspect of solid waste management. Successful campaigns could result in reduced wastage in homes, encourage reuse (for example of plastic bags), promote separation of recyclable materials for giving/selling to waste collectors, and even lead to home composting of organic waste (see 'Organic waste composting' technical brief). Each of these reduces the burden on the solid waste management system, and can result in environmental improvements.

Engaging waste generators may lead to community-led SWM initiatives. These can be effective vehicles for improving the cleanliness of neighbourhoods, gaining widespread support and increasing rates of resource recovery.

### Primary collection

*Why is planning this important? Primary collection is what helps ensure waste enters the waste management process without ending up on streets or blocking drains. Careful planning is required to ensure solutions address a range of stakeholder needs.*

Primary collection may be undertaken by waste generators themselves, domestic helpers or paid waste collectors. Key planning questions include:

- Are householders and other generators using any collection service at present? If so are they happy with this, and if not is there a demand for it? Are people willing to pay for this service?
- How can the coverage of existing waste collection activities be increased and/or new initiatives be started?
- How can waste collection from poor as well as richer areas be ensured?

Often primary collection (as indicated by ② on Figure 1) is undertaken by informal-sector entrepreneurs who charge a fee for periodic removal of waste. NGOs and small businesses occasionally also fill this role, and on rare occasions, it is undertaken by municipalities. Because it is suited to labour-intensive approaches, this SWM function is particularly appropriate for providing employment to the poor. Primary collection can result in higher rates of resource-recovery from businesses and households, particularly where generators are segregating recyclable and organic waste.

The vehicles used for primary collection are often small and low-cost, such as wheelbarrows, handcarts or tricycles carts (see 'Human and animal powered waste collection vehicles' technical brief for more detail). These enable access to small sidestreets and can be used on uneven surfaces.

**Embracing the informal sector**

Informal sector workers are important stakeholders in solid waste management. They are an existing skilled and motivated workforce, which can sometimes be utilised as part of a sustainable and equitable solid waste management initiative. In some instances conflicts of interest may arise as SWM systems are improved and formalised. It is important to be able to make informed decisions about how to address and resolve them if necessary. Understanding the informal sector should be part of any baseline assessment.

There is evidence that ignoring the needs and activities of the informal sector can compromise the effectiveness of any improvements to solid waste management. In some instances there is scope for involving (as opposed to displacing) informal sector workers into more sanitary and



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efficient systems of waste management. In doing so, there is also an opportunity to improve the welfare, conditions, safety, dignity and livelihood-security of these workers, which can make a positive contribution to achieving some of the millennium development goals.

### Recycling

*Why is planning this important? Recycling initiatives can have a beneficial environmental impact, reduce the volume of waste to be managed, and support important livelihoods for poor men and women in cities. It is vital to fully understand the priorities of existing recyclers in order to ensure sustainability both of recycling and other SWM activities.*

Many cities have active recycling sectors. This is predominantly an informal-sector activity, and can provide employment for tens of thousands of urban poor in a single city (photograph 2). Where the sector is particularly well developed, influential businessmen may have vested interests in retaining control. Efforts of SWM planners may be best directed at regulation and support: for example ensuring recycling workers are properly protected from health and safety risks, and that businesses access recyclable materials *as close to the point of generation as possible* (e.g. collected from households, not picked from a disposal site).

Photo 2: Recyclable materials dealer in Pakistan (Jonathan Rouse).

Organic waste (e.g. vegetable peelings, garden clippings etc.) is one of the most significant components of solid waste. This can be composted: a form of recycling which produces a useful soil conditioner (see 'Organic waste composting' technical brief).

### Transfer points

*Why is planning this important? With good planning, transfer points can be relatively attractive, clean and efficient facilities. Careful consultation can ensure their location and function is well suited to the local environment and users.*

One of the most visible aspects of SWM is the transfer point, providing an interface between primary and secondary collection. These are often poorly designed, involving double handling of waste (once to unload tricycles, again to reload trucks) and unsanitary conditions where transfer points are not properly cleaned and used as public toilets.

Key planning questions for improving transfer include:

- How much space is available? How is waste deposited at present (e.g. by hand, tipped from a tricycle)?
- What is acceptable to householders in terms of location, visual impact, method of disposing of waste?
- How far are waste generators willing to walk to deposit waste?
- Do waste pickers access waste from transfer points? If so, should they be discouraged from picking, or can their activities be adapted to improve the management of the



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transfer point as well as their livelihoods?

Also consult waste characterisation data:

- in view of the quantity and density of waste generated, the number of householders a single transfer point will serve, and the frequency of emptying, how large does the transfer point need to be?

Where waste generators carry their own waste, transfer points need to be located within easy walking distance (a good guide is ~ 50m) to discourage indiscriminate dumping. All transfer points and areas should be cleared daily and cleaned as necessary to prevent odours and keep rats and other disease vectors under control. All transfer points should also be designed to ensure minimum double handling. There are a number of approaches to achieving this, including 'ramp transfer points' which raise primary collection vehicles up to the loading level of demountable containers (photograph 3). Sometimes, however, space does not allow this. Another innovative solution is to use carts which carry a series of small containers that can be easily and safely lifted and emptied into containers (photograph 1).

Photo 3: Ramped transfer point in Bangladesh (Jonathan Rouse)

### Secondary collection

*Why is planning this important? Well-planned transportation can make optimal use of vehicles and staff and ensure all waste is collected and reaches its designated disposal or processing point.*

Secondary collection entails the removal and transportation of waste from transfer points to processing and disposal facilities. This is often one of the most costly elements of SWM systems. Waste characterisation study data will play an important part in planning secondary collection as it informs us how much waste requires collection, its weight and volume (affecting payloads), where it is located (affecting collection routes) and so on. Key planning questions for secondary collection include:

- What resources (including staff and hardware) exist at present and how efficiently/inefficiently are they being used?
- What percentage of total waste generated is being collected?
- Are the collection routes as efficient as possible?

Basic improvements to secondary collection include ensuring collection routes are as efficient as possible, putting measures in place to ensure waste is dumped as intended (e.g. staff incentives), and covering waste during transportation. Increasingly, municipalities are choosing to contract secondary collection to private sector operators. This can ease over-stretched municipal budgets, remove the headache of managing transport fleets, and result in a more efficient and accountable service (see Coad 2005 for more information).

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## Landfill and incineration

*Why is planning this important? Waste which is not carefully disposed of or processed can present a serious threat to public health and the environment. Planning involves many stakeholders as well as climatic, economic and even geological considerations. Getting all this right is important and can make improved disposal and treatment a realistic prospect.*

Disposal is one of the most problematic aspects of solid waste management in low-income countries. Waste characterisation data will prove useful in planning disposal options. The quantities of waste generated will help you decide what volume of landfill site is required and, according to trends in waste production, enable you to project its lifespan. Waste composition data will also help guide your decisions about suitable options: for example the presence of toxic waste will indicate the need for particular care in disposal, and a high organic/moisture content could make incineration very difficult. Key planning issues include:

- Identifying and understanding practices at present, including issues (e.g. corruption) which may impact performance now and in the future;
- For landfilling, where could a disposal site be situated, what are the pervading geological conditions, where does the water table lie, and what regulations must be adhered to (e.g. environment agency)?
- For incineration, is the waste composition suitable (often drier waste with a high proportion of plastics is particularly suitable), is safe technology affordable and would it be possible to maintain and operate it to sufficiently high standards?

Fully engineered sanitary landfill is the safest disposal option in terms of human health and the environment, and methane can be recovered for electricity generation. Engineered landfill sites are usually very expensive to construct and operate so may be a more suitable long-term objective. Incineration, involving high-temperature complete combustion of organic material, can be used to reduce volume and in some situations energy can be recovered. Open burning of waste is *not* incineration and is not recommended because it releases toxic smoke. Controlled incinerators can be developed relatively cheaply, but the high moisture content of waste in many low-income countries can cause problems. Most waste incinerators are costly to develop and operate.

In many cases a carefully managed basic landfill site will be more achievable in the short run, involving the following practices:

- Preventing all burning (spontaneous or intentional) at the site;
- Locating the site at least 500 m downwind from housing and water sources on a geologically suitable site;
- Daily compacting and covering with soil, to increase stability and discourage vermin;
- Basic monitoring of dumping, ideally using a weigh-station if available;
- Fencing to prevent waste blowing outside the site; and,
- Basic leachate control.

Leachate is liquid runoff, and is a particular problem in rainy conditions. It has a high 'biological oxygen demand' and can damage ecosystems in water bodies. It may also contain toxins such as heavy metals, which can pollute groundwater sources.

A local authority wants to design a basic landfill site to serve a town of population 10,000 to operate for 5 years. Based on generation rates of 0.5kg/ person, total waste generated each day equals 5000 tonnes. With a density of 500Kg/$m^3$, total volume per day is [Total waste/density] = 10 $m^3$/ day. Each year the total volume will be [10 $m^3$ x 365 days] = 3650$m^3$, and for 5 years [3650*5] = 18250 $m^3$. This is equivalent to a site approximately 50m x 50m wide x 8m deep.

In fact, the estimate above may be inaccurate for a number of reasons:

- Over time waste will compact and its density increase. In addition, some of the liquid in waste will evaporate or be removed for treatment. These factors will tend to prolong the life of the disposal site.
- Waste generation rates, as well as the size of the town, may drastically increase in a five year period. Additionally, daily covering of waste with soil will tend to increase the rate at which it is filled, but this is still an important activity. These factors will tend to

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shorten the life of the site.
Recycling and composting could have a very significant impact on the lifetime of a disposal site: if organic waste was composted and all paper, glass plastics and metal were recycled, your landfill site could last many decades!

## Conclusion

Just as the cells of a body need to work together to thrive, so too do the elements of a SWM system. There are many 'interfaces' and interdependencies between aspects of SWM, such as the reliance of the recycling industry on waste generators segregating waste. These need to be well understood and addressed in planning.

Solid waste management in cities is a challenge, and many local authorities face limited budgets and growing volumes of waste. Whether municipality, NGO or business, making carefully planned incremental improvements is key to finding solutions. A detailed understanding of the context, and developing a plan in consultation with a range of stakeholders, can help ensure success and sustainability.

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- Waste Netherlands (www.waste.nl) is also a useful online resource.


This technical brief was prepared by Jonathan Rouse in consultation with Mansoor Ali, April 2008.

Practical Action
The Schumacher Centre for Technology and Development
Bourton-on-Dunsmore
Rugby, Warwickshire, CV23 9QZ
United Kingdom
Tel: +44 (0)1926 634400
Fax: +44 (0)1926 634401
E-mail: inforserv@practicalaction.org.uk
Website: http://practicalaction.org/practicalanswers/

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