WYOMING INTEGRATED SOLID WASTE MANAGEMENT HANDBOOK

A DECISION MAKERS' GUIDE FOR RESPONSIBLE FISCAL AND ENVIRONMENTAL SOLID WASTE PLANNING FOR WYOMING LOCAL GOVERNMENTS

1996/1997

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Wyoming Integrated Solid Waste Management Handbook

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TOOL 1. HOW TO CONDUCT THE SOLID WASTE PLANNING PROCESS

INTRODUCTION

Tool 1 has been developed to help those responsible for solid waste management (SWM) to plan and implement effective SWM programs in their communities. It is designed primarily for governmental officials but may also be helpful to waste management firms, consultants and others with an interest in this area. The intent of Tool 1 is to provide the reader with an overview of the elements that should be addressed in developing a SWM plan and the information that should be included in the plan. A suggested step-by-step process for developing a SWM plan is presented. The steps are presented in a suggested planning order.

- **A SWM manual for small to medium size Wyoming communities.**

It is anticipated that this manual will be of most value to those from small and medium size Wyoming communities that do not have the resources to hire staff dedicated solely to SWM activities. As such, the material presented in Tool 1 is oriented toward planning in these communities. Except for Cheyenne and Casper, all of the cities in Wyoming have less than 30,000 population.

Solid waste management planning in these smaller (more rural) communities may vary from that in larger communities. Solid waste quantities and characteristics may be different and waste disposition costs may be higher due to smaller facilities. These differences should be considered in the planning process. Tool 1 and the other Tools in this manual were developed in consideration of the solid waste management needs of Wyoming communities of less than 30,000 population.

STEP 1. ESTABLISHING WASTE MANAGEMENT OBJECTIVES/GOALS

Introduction

An important step in the SWM planning process is choosing the plan objectives. The following factors may affect these choices:

- current SWM problems
- identified future SWM needs
- legislative requirements
- economic condition of the community
- community SWM goals.

A SWM planner must establish clear, attainable waste management objectives or goals to which the plan will be dedicated. The process of determining the SWM objectives/goals, based on the above factors, is discussed below.

- **Attainable waste management objectives or goals must be determined.**

Preliminary Goal Setting

Preliminary goal setting, may result from an economical, political, or legislative need, and may initiate the planning process. SWM services are usually available in a community whether or not a SWM plan is being followed. Either the public or private sector will provide collection and disposition of waste when the need exists. However, these services may be quite limited in scope and may not be the most desirable from an environmental or economical standpoint. For example, the community may be receiving service below the level required to protect health and safety, therefore, providing an obvious need for changes in the SWM system.

- **Preliminary goal setting, may result from an economical, political, or legislative need.**

Preliminary goal setting may often be initiated by the public. For example, public desire for recycling options may initiate the need for SWM planning by public officials.

Review Current SWM Practices

Problems with current SWM practices can often be identified through a review of the existing system. All aspects of the existing system should be characterized to the extent that data is available. For example, information that should be obtained on management of residential MSW includes:

- types and quantities of waste collected
- who provides for collection—for disposal, for recycling/composting, curbside/backyard, etc.
- public or private collection crews and equipment
- collection services available—for disposal, for recycling/composting, curbside/backyard, etc.
- collection frequency
- geographical coverage of collection service
- waste storage when collected—cans, bags, etc.
- collection equipment used
- collection charges/costs
- methods of paying collection charges
- destination of collected waste (transfer station, mixed waste processing facility, materials recovery facility, recyclables processing facility, compost facility, combustion facility, landfill, or other land disposal facility).

• All aspects of the existing system should be characterized to the extent possible.

Similar information will be needed for non-residential municipal and other solid wastes. General patterns of collection service will emerge and can be used to identify places where improvements are needed. For example, unusually high collection charges in an area may be traced to a lack of competition or more than one collector operating in the same neighborhood —perhaps even on the same streets. These problems are not uncommon in residential areas when individual households must contract for service.

• General patterns of collection service will emerge.

A review of facilities used to manage solid waste generated from the planning area should also be conducted. Of particular importance is the ability of these facilities to handle the types and quantities of solid wastes projected to be generated in the future. Since the need for landfill capacity will exist regardless of the use of other management options (a residue which must be landfilled will always exist no matter which SWM practice is chosen), the availability of future landfill capacity is a first priority. If future landfill capacity in the area is limited, this presents a potential problem that should be addressed in the planning process.

- **Facilities need to be able to handle the types and quantities of SW projected to be generated in the future.**

Detailed solid waste generation estimates should be part of the existing system review. Waste stream projections will be needed to project facility capacity needs in the future. In addition to total quantities of MSW and other solid wastes, estimates of recyclable components in the waste stream will be important in planning for recovery versus disposal. Quantities currently recovered for recycling (including composting) should be determined for planning purposes, as well.

Alleviating current or potential problems identified through reviewing existing SWM practices in the planning area will become an objective in the planning effort.

Review Legislative Requirements

Legislation will have an impact on SWM objectives to be addressed in the planning process. SWM legislation has been promulgated at both the federal and state levels. The federal legislation is directed primarily at controlling damage to human health and the environment from air pollution, surface water and ground water contamination, and control of explosive gases at disposal facilities. Legislation in many states includes requirements for diverting waste from disposal through source reduction and recycling.

- **Federal legislation is directed primarily at controlling damage to human health and the environment.**

The Resource Conservation and Recovery Act (RCRA), first enacted in 1976, has been the most significant SWM legislation at the federal level. Subtitle D of RCRA has resulted in new standards for MSW landfills. These more stringent requirements have led to higher landfilling costs and the closure of many smaller landfills. In some instances, states have issued landfill standards even more stringent than those imposed by Subtitle D. Many communities not only pay more to landfill their solid waste than in the past but also have to haul it farther. For example, waste in Teton County is hauled more than 90 miles to the landfill in Marbleton and LaBarge solid waste is trucked 50 miles to the Kemmerer landfill.

- **More stringent requirements have led to higher landfilling costs and the closure of many smaller landfills.**

The efforts by state legislatures to divert solid waste from disposal and preserve landfill space is a major factor leading local communities to develop SWM plans. Even where local plans are not required, the need to plan for recycling/reduction goals and landfill bans may exist. In addition, the changing availability and cost of landfills meeting the more stringent standards is another factor requiring SWM planning at the local level.

- **Setting goals for diverting SW from disposal will frequently be part of the local planning process.**

Some states require planning areas to reach specified waste diversion levels whereas other states may require that a planning area propose its own diversion goal in its plan, in either case, planning areas are usually obliged to plan for increased levels of recycling and source reduction. This is further emphasized by the number of landfilling bans placed on certain wastes. For more detail on setting local diversion rate goals see Tool 3.

Setting goals for diverting solid waste from disposal will frequently be part of the local planning process. These goals will often result from and/or will be influenced by state legislation. See Tool 3 for a discussion of Wyoming's voluntary diversion rate goal. Both federal and state requirements affecting landfills and other facilities may indirectly affect SWM objectives, as well. The more stringent landfill requirements resulting from Subtitle D of RCRA, for instance, affects both the cost and availability of landfills in many areas. Each community must evaluate their legislative requirements. These requirements will define what is required in a successful SWM plan. A SWM planner needs to understand why legislation was developed, what is the expected outcome of the legislation, and what is required of them to meet the obligations of that legislation.

- **Each community must evaluate their legislative requirements.**

Obtain Public and Political Input

The importance of input from the public and public officials in developing a SWM plan is often underestimated. Leaving the public and their elected officials out of the process is perhaps the surest road to failure. Even if a viable plan has been developed, it may well be viewed with suspicion if the public has not been involved.

Public involvement should occur early in the planning process (U.S. EPA, August 1995). This is mutually beneficial in that the public becomes better educated as to the realities of managing their wastes and planners become better attuned to the public's concerns and desires. This should result in a better determination of plan objectives and lead to a plan with the needed public and political support for implementation.

- **Public involvement should occur early in the planning process.**

Obtaining representative public input is sometimes difficult—particularly in a planning region that may include several counties. Establishing groups of citizen representatives to act as liaison between the SWM planners and the remaining citizenry is usually advisable. These representatives should be carefully selected to represent the wide range of public interests. Meetings with the citizens groups should be supplemented with meetings open to the general public to obtain added public input.

Clearly, the public input process can be an important element in determining the SWM needs and goals of the planning area. In addition, public input is usually critical to acquiring the support needed to implement a SWM plan.

- **Public input is usually critical to acquiring the support needed to implement a SWM plan.**

Establish SWM Goals/Objectives

Performing the above tasks, as described, will allow those developing a SWM plan to determine the needs and goals that should be addressed. The plan will be directed toward meeting these needs and goals.

STEP 2. INITIAL PLANNING

Introduction

If the existing system of SWM in a planning area does not meet the SWM objectives of the area, new waste management alternatives should be considered. Selecting SWM alternatives to review for potential use in a planning area is directly related to the plan objectives. If reducing waste quantities disposed is an objective, a number of alternatives may be considered, including source reduction and increased recycling options. If waste management costs are judged as too high, waste collection alternativesmay need to be changed or modified. Another option to reduce costs might be the use of regional facilities which, due to their size, are often more cost effective than facilities serving only one community. For example, Fremont County has replaced several of the small landfills with transfer stations. The solid waste is then transported to larger more cost effective landfills in the region. Different objectives may require different alternatives.

- **The plan will be directed toward meeting a community's needs and goals.**

Since each part of a SWM system is integrally related, it is important to consider the entire system when comparing waste management alternatives. Changing or adding a SWM option will often affect other system elements. For instance, establishing a recycling program that

- **Each part of a SWM system is integrally related.**

diverts waste from disposal will impact the waste collection and disposal elements of the existing system. Thus, all elements of SWM including initial waste storage, collection and transport, processing, and final disposition should be included when comparing waste management alternatives.

- **It is important to consider the entire system when comparing waste management alternatives.**

Initial planning considerations are reviewed in this section. System alternatives that may be considered in SWM planning are described first. The potential role and benefits of regional SWM are presented as well. Public and political input in the initial planning stage are also discussed.

System Alternatives for Consideration

Collection and Transfer

Collection of Household MSW. Collecting and transporting municipal solid waste (MSW) is an important element in a solid waste management system. For MSW—particularly household MSW—it is the most costly element. Household MSW to be disposed (i.e., refuse) is generally collected in "packer" trucks that compact the refuse to reduce the number of loads. Packer trucks used in neighborhoods with single-family households may typically range between 15 to 30 cubic yards in load volume capacity. substantially for similar truck volumes, however, because of different compaction capabilities on the trucks.

- **For household MSW—collection and transport are the most costly elements.**

Some choices to consider in household refuse collection include:

- Manual versus automated loading trucks
- Collection frequency (once or twice weekly)
- Curbside versus household collection
- Refuse storage in bags or cans.

These choices will be made in view of services desired and associated costs.

Collection of source separated household recyclables is occurring in many communities in the U.S. Options for source separated household recyclables collection include resident sort, collection crew curbside sort, and commingled. In most cases, these recyclables are collected in non-compaction vehicles. In curbside recycling programs, household recyclables are placed at the curb in separate containers or bags. They are typically collected in trucks containing two or more compartments.

- **Collection of source separated household recyclables is occurring in many U.S. communities.**

In some instances, household recyclables are co-collected with refuse in the same vehicle. Separately bagged recyclables can be placed in the same compaction compartment as refuse and then pulled from the refuse when unloaded. Another option is to place refuse and recyclables in separate compartments of the same vehicle.

In addition to separate collection of traditional household recyclables, yard trimmings may be collected separately for composting. Yard trimmings are usually placed in paper or plastic bags and manually loaded in a packer truck like that used for refuse collection. In some instances, trucks that vacuum leaves from the curb or from the side of the street are used.

- **Yard trimmings may be collected separately for composting**

Household refuse and recyclables collection alternatives are listed in Table 1-1. Collection frequencies, points of collection and storage options that are compatible with different collection vehicles are shown. The choice of collection vehicle can dictate the use of other collection elements, as shown, to achieve a compatible system.

Collection of Commercial MSW. MSW from commercial and institutional sources is collected in much larger quantities per stop. Waste is usually stored in "dumpsters" or roll-off containers. Dumpster containers vary, typically, between two and eight cubic yards in capacity and are emptied into packer trucks. Either front or

- **Roll-off containers are frequently used at business establishments that generate large quantities of waste.**

rear loading packers may be used, but they must be equipped with automated lifting capability.

Roll-off containers are frequently used at business establishments that generate large quantities of waste. They may be open-topped or enclosed and typically range in size between 20 and 40 cubic yards. Some roll-offs are designed for waste compaction to achieve greater load capacity. Roll-off containers are loaded/rolled on to a truck chassis from where they are hauled to a landfill or other location where the waste is unloaded.

Recyclables collected from businesses are primarily corrugated boxes or office paper. Grocery stores and discount stores commonly recover corrugated boxes. The corrugated boxes are generally baled prior to collection and placed in flat-bed trucks when collected. Loose collection of corrugated boxes has been reported in Wyoming with delivery to a recycling facility for baling. Office paper may be collected in various types of vehicles.

- **Recyclables collected from businesses are primarily corrugated boxes or office paper.**

Similar choices are made in deciding between collection options for commercial MSW as household MSW. However, these choices are more specific to each business from which waste is collected and, therefore, less subject to SWM planning.

Transfer of Household MSW. Sometimes, municipalities find it more efficient or convenient to transfer waste from collection vehicles to larger vehicles (or, in some instances, rail cars) before transporting it to the disposal site (U.S. EPA, 1994). If the disposal site is a substantial distance from where the waste is generated (e.g., at least 10 to 15 miles), a savings in waste hauling costs may be realized with waste transfer. In addition to the potential cost savings, a transfer station can offer increased flexibility in selection of disposal facilities and the opportunity to shred or bale wastes to reduce volume prior to disposal.

- **If the disposal site is a substantial distance from where the waste is generated a savings in waste hauling costs may be realized with waste transfer.**

A transfer station may also be expanded into a facility to process recyclables or to perform composting. Where co-collection of recyclables and refuse in the same truck compartment is practiced, a transfer station is necessary to separate the bagged, commingled recyclables from the refuse.

Table 1-1
HOUSEHOLD REFUSE AND RECYCLABLES COLLECTION ALTERNATIVES

	Refuse Collection		
Collection Vehicles for Refuse	**Collection Frequency (times per week)**	**Point of Collection**	**Refuse Storage Container When Collected**
Manual Loading Compaction	once/twice	curbside/houseside	bags/cans
Semi-automated Loading Compaction	once/twice	curbside/houseside	cans
Fully Automated Loading Compaction	once/twice	curbside	cans
	Recyclables Collection		
Collection Vehicles for Recyclables	**Collection Frequency (times per week)**	**Point of Collection**	**Recyclables Storage Container When Collected**
Manual Loading Non-compaction with Multiple Compartments	weekly/biweekly	curbside/houseside	open containers/bags
Semi-automated Loading Non-compaction with Multiple Compartments	weekly/biweekly	curbside/houseside	open containers/bags
Co-collection Vehicle with Separate Compartments for Refuse and Recyclables	same as for refuse	same as for refuse	open containers/bags
Co-collection Vehicle with One Compaction Compartment for Refuse and Recyclables	same as for refuse	same as for refuse	bags

Franklin Associates, Ltd.

Source Reduction

Source reduction refers to reducing the quantity or toxicity of waste at its source. Other terms often used to mean the same thing include waste prevention, waste reduction, waste minimization, pollution prevention, and precycling (U.S. EPA, 1994). Source reduction is considered the most preferable method of managing solid waste in the U.S. (U.S. EPA, 1989). It reduces the amount of materials that must be produced and the harmful effects associated with producing and disposing of them.

- **Source reduction refers to reducing the quantity or toxicity of waste at its source.**

The Congressional Office of Technology Assessment (OTA) has estimated that appropriate technology and adequate economic conditions already exist to reduce solid waste generation by 50 percent in the next few years. Some basic source reduction measures include the following:

- Reducing the amount of material used in products
- Increasing the useful life of products
- Reusing products/materials
- Reducing consumer use of products/materials
- Reducing production (e.g., manufacturing) waste
- Decreasing toxicity.

Approaches by local governments/SWM planners to effect source reduction at households include providing education and promotion programs and economic incentives. Perhaps the most effective approach is unit-based pricing on waste collection. A fee is placed on each bag/can of refuse and yard trimmings set out for collection. As opposed to the flat based fee system, unit-based pricing provides an economic incentive to produce less waste. It is particularly effective in reducing quantities of yard trimmings. Households will often choose to manage their grass clippings and leaves at home rather than pay extra to have them collected. Since yard trimmings are the largest single material in

- **Approaches to effect source reduction at households include providing education and promotion programs and economic incentives.**

residential waste, substantial source reduction occurs when they are not collected. Other measures that households can take to reduce their waste include buying in bulk or buying concentrates to reduce packaging, purchasing durable and reusable products, and borrowing or renting items that are seldom used.

Recycling

Recycling refers to the activities that result in a recovered material being used in a new product. Thus, recycling involves any and all of the following steps: separating, collecting, processing, market or free distribution, remanufacturing (if done), and purchase/use by a consumer (Franklin Associates, Ltd., September, 1994). Ultimately, a material must have become at least a part of a new product to have been recycled.

- **Recycling refers to the activities that result in a recovered material being used in a new product.**

Recycling is exceeded only by source reduction as a preferred method of managing solid waste. As with source reduction, recycling reduces the quantity of wastes requiring disposal (including landfilling). In addition, recycling preserves natural resources and saves energy. Energy requirements when using secondary (i.e., recovered) materials in manufacturing new products is generally less than when using virgin materials (Franklin Associates, Ltd., 1993).

- **Recycling reduces the quantity of wastes requiring disposal.**

Both households and businesses generate wastes that can be recycled. The types of waste materials that are recycled are largely market driven. If markets do not exist for a recyclable material, recycling will not occur. The availability of markets for a material depends upon its suitability for use in a new product and the resulting demand for that product. Old corrugated paperboard containers and high-grade office paper from businesses have been recycled in the U.S. for many years. Several household waste materials are recycled including newspapers, magazines, glass containers, steel and aluminum cans, and HDPE and PET plastic containers. Other materials, including mixed grades of paper may

- **If markets do not exist for a recyclable material, recycling will not occur.**

also be recycled when markets are available. Yard trimmings and other biodegradable household wastes are sometimes composted, which also qualifies as recycling. However, composting is different from traditional recycling and will be discussed separately in this manual.

- **Solid waste planners generally have more influence on residential recycling than recycling from businesses.**

Solid waste planners generally have more influence on residential recycling than recycling from businesses. The primary techniques used for residential recycling are drop-off/buy-back centers and curbside collection. These are discussed below.

Drop-Off and Buy-back Centers. Locations where citizens can deliver recyclables are either drop-off or buy-back centers. At drop-off centers, the recyclables are donated whereas, at buy-back centers, at least some of the materials are purchased depending on market conditions. Recyclables at drop-off and buy-back centers are generally sorted into component materials by the resident before delivery to the centers. Some of these centers are mobile and serve different areas at regularly scheduled times. The materials collected are transported to a processing facility to prepare them to be marketed. In some cases, a drop-off or buy-back center will be located at a processing facility.

- **Participation levels are usually lower in drop-off and buy-back programs then in curbside collection programs.**

This form of recycling is less convenient for residents than curbside pickup. As a result, participation levels are usually lower in drop-off and buy-back programs. However, if the drop-off locations are convenient to residents and a thorough educational and promotional effort is made, much higher participation rates will be achieved than otherwise.

Curbside Collection. Many communities in the U.S. provide curbside collection of source separated recyclables at households with individual waste collection service—i.e., primarily single-family households. The household recyclables may be stored in bins, buckets, or bags depending upon the curbside program. The recyclables may be collected commingled or they may be at least partially sorted when placed in the collection vehicle. The blue bag sytem in Gillette, WY is an example of commingled collection. In most programs, newspapers and other paper grades that may be collected are usually kept separate from other materials. Containers (including glass, steel, aluminum, and plastic) may be either commingled or in separate compartments of the collection vehicle. Sorting recyclables prior to collection may be accomplished by the household resident or by the collector. Typically, a resident may keep newspapers and other paper separate from recyclable containers and any further sorting prior to collection is done at the curb by the collector.

- **Sorting recyclables prior to collection may be accomplished by the household resident or by the collector.**

In most curbside recycling programs, the recyclables are placed in non-compaction vehicles with enclosed truck bodies that may be partitioned into several compartments for the collected materials. This allows flexibility in determining the level to which the materials will be sorted when collected. In some curbside programs, however, recyclables in separate bags are collected along with refuse in compaction trucks. These co-collection programs eliminate the need to separately collect recyclables but, instead, separation of the bags of recyclables from refuse at a transfer station will be required. In addition, compacting the recyclables—and, in particular, compacting them with the refuse—may lead to contamination problems. Other co-collection programs use trucks with separate compartments for refuse and recyclables. This approach prevents the concern about potential contamination, but co-collection costs will be higher.

- **Recyclables are usually taken to a processing center prior to being sent to an end user.**

Recyclables Processing. Recyclables from MSW are usually taken to a processing center prior to being sent to an end market. Two examples of processing facilities in Wyoming include the facilities in Jackson and Laramie. MSW recyclables that require little or no sorting may be taken to a recyclables processing facility (RPF). At an RPF, old newspapers, OCC, and other grades of paper are usually baled prior to shipment to an end user. Glass containers are usually crushed, whereas, steel and aluminum cans are typically flattened or baled. Plastics may be baled or granulated. The main functions of RPFs are densifying recyclables to reduce hauling costs and removing contaminants to assure quality (Franklin Associates, Ltd., September 1994). Recyclables are received from businesses as well as from drop-off and buy-back centers that accept residential recyclables. Materials from curbside recycling programs may also be taken to RPFs if they are sorted when collected.

The advent of commingled curbside recycling brought another type of processing facility into prominence—the materials recovery facility (MRF). A MRF is different from a RPF in that it has the capability to sort recyclables that are mixed together (i.e., commingled). A MRF is in the process of being constructed in Gillette for Campbell County. Many large curbside recycling programs collect source-separated household recyclables in a commingled form. At minimum, the glass, metal, and plastic containers are commingled and must be sorted at the MRF. A MRF may also take sorted materials, which simply bypass the sorting area and are directed to the densifying equipment to prepare them for shipment to market.

- **A MRF has the capability to sort recyclables that are commingled.**

Composting

Composting is a method of solid waste management where the organic portion of the solid waste stream is biologically decomposed under controlled conditions. Composting results in a waste weight reduction of approximately 50%. The finished products is humus, a dark-brown material referred to as compost.

- **Composting is where the organic portion of the solid waste stream is biologically decomposed under controlled conditions.**

Composting as a solid waste management alternative, has recently become more popular. Communities have realized the importance of composting in reaching mandated solid waste disposal reduction goals (U.S. EPA, 1989b). Mixed municipal solid waste, source separated organics, such as yard trimmings (municipal and non-municipal), and wastewater treatment plant biosolids are the three main compost feedstocks. Agricultural waste is a source of compostable organics generated in rural communities. The mixing of two feedstocks (co-composting) is also an option.

Mixed MSW Composting. A mixed MSW composting program requires the least amount of effort from the waste generator. Both residential and non-residential waste streams are collected for mixed waste composting. Mixed waste is transported to a mixed waste processing center where recyclables and non-degradable materials are generally removed to the extent possible before composting the mixture. However, contaminants in compost from mixed MSW usually make this compost difficult to market.

- **A mixed MSW composting program requires the least amount of effort from the waste generator.**

Source Separated Organics Composting. A source separated composting program requires separation of the organic portion of the waste stream by the generator. The segments of the community that can separate organic materials from their waste stream and the types of materials separated are shown in the table below.

- **A source separated composting program requires separation of the organic portion of the waste stream by the generator.**

Table 1-2

Residential single-family households and multi-family living units	Food waste, pet waste, yard trimmings, non-recyclable paper products, and non-recoverable recyclable paper products
Businesses and institutions	Cafeteria waste, room waste, yard trimmings, grocery store and restaurant food waste
Industrial	Cafeteria waste, food industry process waste, agricultural waste.

Residential households participate in composting through backyard composting programs or centralized municipal composting programs. Backyard composting is considered a source reduction activity since the materials composted are being managed by the resident. The need to collect, process, or dispose of the material by a municipality is no longer necessary. A municipality may want to encourage this activity by providing educational kits, technical assistance, and possibly the composting bins to be used by the individual households.

Backyard composting is usually not an option for residences of multi-family dwellings. Any on-site management of waste would be coordinated through the building manager. The yard trimmings generated from multi-family buildings would be easier to capture than food, pet, or contaminated paper wastes.

Municipal source-separated composting programs require the generator to do part or all of the separation before collection. Homeowners have historically handled yard trimmings separately from the other wastes generated in the home. This separation has made educating the public about the yard trimmings collection process easier than with other residential source-separated collection programs. Composting of separately collected yard trimmings is the most common composting program because of its comparative simplicity.

- **Yard trimmings composting is the most common composting program.**

Municipal Biosolids (Sludge) Composting. Biosolids from municipal wastewater treatment facilities can be land applied after digestion or stabilized further by composting before being returned to the soil. The biosolids are mixed with a bulking agent such as wood chips, leaves, or immature compost from the same facility before putting in compost piles. Biosolids are commonly co-composted with other organic waste streams such as municipal solid waste. Co-composting is successful when the two waste streams compliment each other in the composting

- **Municipal wastewater treatment biosolids can be returned to the soil after treatment.**

process. The high moisture content of the sludge is a good match for MSW, which has a lower density and acts as the bulking agent.

Combustion of Mixed MSW

Municipal waste combustion facilities include those that produce an energy product and those that incinerate waste simply for volume reduction. Combustion of MSW in the U.S. increased rapidly between 1980 and 1990, with numerous new facilities coming into operation. However, the amount of MSW combusted since 1990 has increased very little to approximately 33 million tons. This estimation represents about 16 percent of national MSW generation in 1994 (Franklin Associates, Ltd., March 1996).

- **The amount of MSW combusted in the U.S. since 1990 has increased very little.**

MSW combusted without energy recovery (incineration) has dropped steadily for over 30 years. An estimated 27 million tons or approximately 31 percent of national MSW generation was incinerated in 1960. As the technology for energy recovery from combustion advanced, incineration of MSW without energy recovery became less popular and less cost effective. Approximately 1.3 million tons or less than 1 percent of MSW generation was incinerated in 1994 (Franklin Associates, Ltd., March 1996).

- **About 16 percent of national MSW generation was combusted in the U.S. in 1994.**

About 31 million tons of MSW were combusted with energy recovery in 1994. The technology for waste-to-energy includes mass burn and refuse derived fuel (RDF). Mass burn plants burn unprocessed MSW, with removal of some recyclables either before or after combustion (from the ash). The MSW is typically mixed to distribute combustible materials and moisture before being moved to the burning chamber. Large bulky items may not be acceptable because of their size.

RDF plants burn a homogeneous prepared fuel. This fuel is MSW which has had most of the noncombustibles and some recyclables removed prior to processing. The remaining combustibles are processed into RDF. The prepared fuel can be in either a shredded form, or it can be compacted into pellets, cubes, or briquettes (ICF, 1992). RDF may be burned by itself in a dedicated boiler, or it may be burned with another fuel, such as coal.

In addition to combustion of mixed MSW, a small but growing quantity of source-separated MSW is being burned for fuel. Such items as tires, paper, and plastics are sometimes separated and burned in existing or dedicated boilers.

Combustion of MSW is often considered where maximum diversion of MSW from landfilling is a goal (Franklin Associates, Ltd., September 1994). Some components of MSW that can be burned are not compostable or practical to recycle—for example, certain plastic resins. Conversely, certain MSW recyclables, such as glass and metal containers, cannot be burned. Thus, the greatest saving in landfill space can be achieved with a combination of waste combustion and recycling.

- **Combustion of MSW is often considered where maximum diversion of MSW from landfilling is a goal**

Municipal waste combustion facilities must comply with stringent environmental regulations. Federal and state regulations have impacted the technology and economics of MSW combustion. Air emission standards, solid waste residue disposal regulations, and wastewater treatment and disposal regulations are still evolving. The costs and complexities of burning mixed MSW has, in general, made this alternative less suitable in smaller communities.

Land Disposal

Landfilling. While other SWM management alternatives can divert significant portions of solid waste from landfilling, this final disposal method will still be required for much of the waste stream. Approximately 61 percent of MSW in the U.S. was landfilled in 1994 (Franklin Associates, Ltd., March 1996). This, however, understates the reliance on landfilling resulting from MSW because of residues from recycling and

- **Approximately 61 percent of MSW in the U.S. was landfilled in 1994** combustion. For example, some of the fibers in recovered newspapers are too short to be used in new paper products and must be disposed—probably by landfilling or combustion. For MSW that is combusted, not all will be emitted as a gaseous end product; 20 to 30 percent or more of the incoming weight of the MSW may be left as a residue to be landfilled. Thus, the waste that must ultimately be landfilled is more than the quantity of MSW taken directly from the resident to landfill.

Other solid wastes will be landfilled, as well, including certain industrial process wastes, C&D debris, municipal wastewater treatment sludges, street sweepings, etc. The degree to which these wastes are landfilled depends on the level of recycling/composting and the use of other disposal techniques including combustion and land application (discussed later). Nonhazardous process wastes from industrial/manufacturing operations may be landfilled on site or in off-site MSW landfills. An industrial waste landfill is typically located on the site of the waste generator and permitted to accept only the waste created on site. The number of active industrial waste landfills in Wyoming is reported to be 25. Municipal wastewater treatment sludges are sometimes taken to landfills, whereas C&D debris may often go to landfills with less stringent requirements. In Wyoming, most C&D debris is disposed of in MSW landfills. Street sweepings are virtually all landfilled and may sometimes be permitted in less stringently regulated landfills, as well. Residue/ash from coal-fired power plants and from MSW combustion is often landfilled as a single material in an on-site "monofill."

- **Landfilling is used to dispose of a wide variety of solid wastes.**

MSW landfills of today use much more sophisticated technologies than in the past. Preparing a landfill site to accept MSW requires the installation of liner systems (usually a clay and synthetic composite), leachate collection systems and, sometimes, leachate treatment facilities. Provisions must also be made for controlling landfill gas and monitoring for both

- **MSW landfills use more sophisticated technologies than in the past.**

leachate and landfill gas that might escape the landfill boundaries. Leachate is polluted water that has been in contact with the refuse and could potentially pollute groundwater or surface water. Methane is a major constituent of landfill gas, which results from biological decomposition of the organic waste, and is potentially explosive if mixed in a 5 to 15 percent concentration with air. Controlling leachate and methane from MSW permitted landfills is a major part of landfill design.

The basic building blocks of MSW landfills are called cells (U.S. EPA, 1989b). A cell refers to the defined area volume of solid waste landfilled in a day plus the layer of soil cover over the waste. During daily operations, the waste is spread and compacted in thin layers in the cell. A total refuse depth of 8 to 10 feet is usually reached before covering with soil. Adjacent cells are constructed to approximately the same height and, together, are referred to as a lift. A landfill is a series of lifts—one on top of the other. The daily cells usually have at least 6 inches of compacted soil cover. At least 12 inches of compacted soil usually exists at the top of each lift.

• A landfill cell is a defined daily area volume of SW landfilled plus the layer of soil cover.

Once the landfill is closed, it will be graded and topped with at least two feet of final cover. There may also be a need for an impermeable cover to prevent precipitation from entering the buried waste. Thus, another liner may underlay the soil cover.

Post-closure care of landfills operating today must usually continue for a minimum of 30 years. Post-closure care requirements include:

• Post-closure care of landfills usually continues for a minimum of 30 years.

- Maintenance of the final cover and containment systems
- Collection and management of leachate
- Monitoring for groundwater contamination and landfill gases.

Landfill Regulations. Federal regulations governing MSW landfills were developed in accordance with the requirements of Subtitle D of RCRA. In general, the regulations apply to all MSW landfills that received wastes on or after October 9, 1993. They cover the following six basic areas (U.S. EPA 1993):

- Location
- Operation
- Design
- Groundwater monitoring and corrective action
- Closure and post-closure care
- Financial assurance.

The federal regulations have revolutionized MSW landfilling in the U.S. because of requirements that are much more stringent than generally practiced before.

• Very small landfills may be exempted from the Subtitle D landfill regulations.

Variances from the Subtitle D landfill regulations are available only in states and tribal areas that have an EPA-approved program. In these areas, waivers of some of the requirements may be allowed if circumstances warrant such changes. For example, the composite clay and synthetic liner requirement may be waived in some areas where groundwater contamination is not a concern or can be adequately controlled with a different design. Wyoming has been approved by the EPA to administer their own landfill program.

Type II landfills are currently subject to the Wyoming standards and the permitting process which includes restrictions on location, design and construction, operation, monitoring, closure and post-closure requirements. Wyoming standards also establish daily cover and financial assurance requirements beginning in October 1997.

• Land application/ landspreading of municipal wastewater treatment sludges is a common practice.

Land Application. In addition to landfilling, land application is another form of land disposal. Land application/landspreading is commonly practiced to dispose of municipal wastewater treatment sludges. The sludge is either spread over the ground or injected just below the surface. Nutrients in the sludge can be beneficial to crops. Care must be taken to be sure that land applied sludge does not contain prohibitive levels of heavy metals that may occur if the treatment plant accepts certain industrial wastes.

Yard trimmings (e.g., grass clippings and shredded leaves) are also sometimes spread on farm land and later incorporated into the soil. These materials decompose over time and improve soil properties. Sludges from certain industrial/ manufacturing operations may also be land applied if they are biodegradable and comparatively free of contaminants such as heavy metals. Sludges from the food processing industry have sometimes been disposed in this manner.

- **Yard trimmings are sometimes land applied.**

MSW Management Summary

The flow of MSW under different management options is depicted in Figure 1-1. A variety of approaches that can be used to recycle, compost, combust, and landfill MSW is illustrated. Final disposition of the waste stream under each approach is shown.

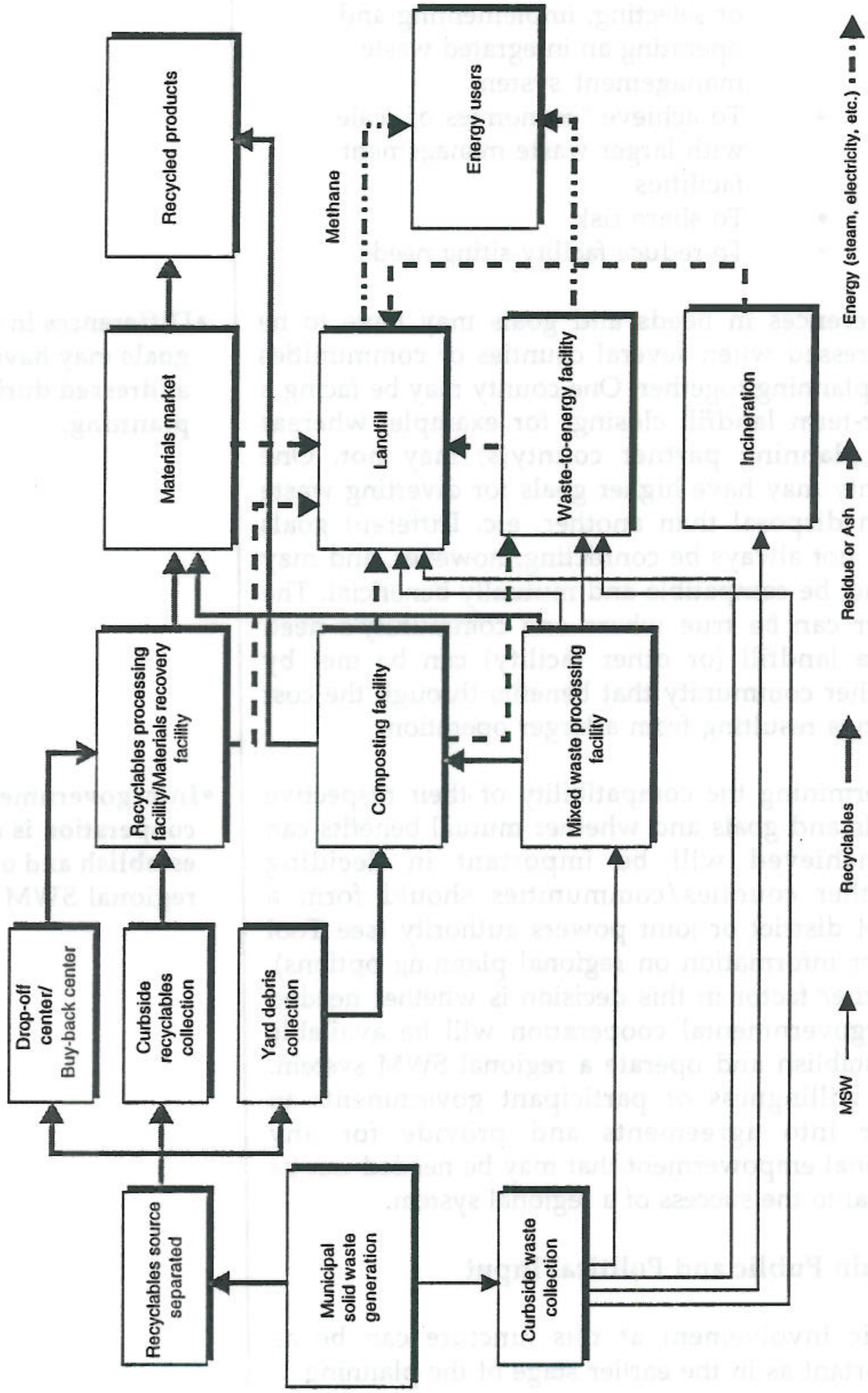
Determine Regional SWM Potential

The increased complexities and costs of SWM today are leading to the use of regional solutions. For example, it is often less expensive for two or more communities to share the use of a landfill rather than have a landfill for each community. Although waste hauling distances are greater with fewer landfills, small landfills that must meet RCRA Subtitle D requirements are often found to be cost prohibitive.

- **It is often less expensive for two or more communities to share the use of a landfill rather than have a landfill for each community.**

Many counties and communities, particularly those in less than major metropolitan areas, are joining together to develop regional SWM plans.

Figure 1-1
INFRASTRUCTURE FLOW DIAGRAM FOR MUNICIPAL SOLID WASTE



Source: Franklin Associates, Ltd.

Regional approaches are being used for the following reasons (Artz, 1990):

- To better manage the complexities of selecting, implementing and operating an integrated waste management system
- To achieve "economies of scale" with larger waste management facilities
- To share risk
- To reduce facility siting needs.

Differences in needs and goals may have to be addressed when several counties or communities are planning together. One county may be facing a near-term landfill closing, for example, whereas the planning partner county(s) may not. One county may have higher goals for diverting waste from disposal than another, etc. Different goals may not always be conflicting, however, and may in fact be compatible and mutually beneficial. The latter can be true where one community's need for a landfill (or other facility) can be met by another community that benefits through the cost savings resulting from a larger operation.

- **Differences in needs and goals may have to be addressed during regional planning.**

Determining the compatibility of their respective needs and goals and whether mutual benefits can be achieved will be important in deciding whether counties/communities should form a SWM district or joint powers authority (see Tool 12 for information on regional planning options). Another factor in this decision is whether needed intergovernmental cooperation will be available to establish and operate a regional SWM system. The willingness of participant governments to enter into agreements and provide for any regional empowerment that may be needed can be crucial to the success of a regional system.

- **Intergovernmental cooperation is necessary to establish and operate a regional SWM system.**

Obtain Public and Political Input

Public involvement at this juncture can be as important as in the earlier stage of the planning process. Meetings with designated citizens representatives and/or the general public may be necessary to select the SWM scenarios to be reviewed in the more detailed technical and economical analyses. The meetings should be used to discuss alternatives that could be implemented to meet previously selected goals/objectives. Public input at this point in the planning process may well establish public preferences and eliminate selection of alternatives that would not have the public support necessary for implementation.

•Public input meetings are necessary to select the SWM scenarios to be reviewed in the planning process.

Select Alternatives/Scenarios for Detailed Analysis

Selection of a few SWM alternatives/scenarios for detailed review should be made at the end of the initial planning stage. The selections will be made after a preliminary review of available SWM alternatives, the potential for regional benefits, and published political input. The new alternatives/scenarios will be chosen for review because of their potential to meet SWM objectives. However, they will need to be compared with respect to several criteria before a decision is made as to whether they should be implemented. For example, different alternatives to increase diversion of wastes from landfilling may vary in costs, facility siting requirements, diversion levels achieved, and other factors relevant to choosing between them.

•Selection of a few SWM scenarios for detailed review should be made at the end of the initial planning stage.

As noted previously, it is important to consider the entire SWM system when comparing waste management alternatives because of the effect a change in one element of the system has on the other elements. Scenarios are developed combining different alternatives. Table 1-3 shows examples of scenarios that may be considered. Criteria for use in comparing SWM scenarios that have different waste management alternatives are identified and discussed in Step 3 below.

•It is important to consider the entire SWM system when comparing waste management options.

Table 1-3

EXAMPLES OF SOLID WASTE MANAGEMENT SYSTEMS SCENARIOS*

Alternative	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
MSW Collection	curbside	curbside	curbside	curbside	curbside
Recyclables Collection	none	drop-off	none	drop-off	curbside
Yard Debris Collection	none	none	drop-off	curbside	curbside
Hazardous Waste Collection	none	drop-off	none	drop-off	drop-off
Composting	none	none	√	√	√
Combustion	none	none	none	none	none
Landfill	√	√	√	√	√

*The above scenarios are examples—scenarios should be community specific.
**Scenario 1 is typically the existing system.

STEP 3. DETAILED ANALYSIS & COMPARISON OF ALTERNATIVES

Introduction

After identifying the SWM alternatives that can help to meet the community's SWM objectives, planners must evaluate and compare the alternatives. This comparison will allow for the selection of SWM alternatives that are most appropriate for the planning region. Criteria for use in comparing SWM systems that have different waste management alternatives are divided into technical criteria and economic/cost criteria. Detailed descriptions of the technical and economic/cost criteria can be found in Tool 4.

- **A comparison of a community's SWM objectives will allow for the selection of SWM alternatives that are most appropriate for the planning region.**

Technical Criteria

The evaluation of solid waste management system scenarios by various technical criteria is essential to a comparative analysis of the options. The following are among technical issues that should be considered in choosing between solid waste management scenarios:

- Effectiveness in achieving objectives
- System compatibility
- Environmental effects
- Land use requirements
- Resource conservation
- System reliability/longevity
- Facility siting
- Regulatory compliance
- Implementation timing.

- **Technical and economic/cost criteria are used in comparing SWM systems selected for detailed review.**

Economic/Cost Criteria

Choosing between waste management alternatives almost always involves cost considerations. In some cases, costs are the only criteria used in making these choices. The net cost of a solid waste management system is determined by three basic cost elements:

- Capital costs
- Operating and maintenance costs
- Revenues.

Capital costs may be considered as long-term investment costs required to pay for facilities and equipment. Operating and maintenance costs (O&M) are on-going expenditures necessary to keep a SWM system operating.

Adding annualized capital investment costs to annual O&M costs provides total annual costs for a SWM system. Subtracting any revenues from the sale of recovered materials or energy results in a net cost for the system. The net cost may be converted into a cost per ton or, in the case of residential waste management, a cost per household, as well.

• Adding annualized capital investment costs to annual O&M costs and subtracting any revenues results in a net cost for the system.

Total System Costs

The importance of considering total system costs when comparing waste management alternatives is demonstrated by the impact of adding curbside recycling to an existing SWM system. At first glance, it might be assumed that the reduction in waste quantity disposed would result in a proportionate reduction in waste collection and disposal costs. Unfortunately, the avoided collection and disposal costs are usually not proportional to the quantity of recyclables removed. Thus, the net cost impact of curbside recycling may be higher than expected. Separate recyclables collection and processing have been added to system costs whereas the corresponding savings in refuse collection and disposal may be less than expected.

• Avoided collection and disposal costs are usually not proportional to the quantity of recyclables removed from the waste stream.

Life Cycle Costs

Cost estimates are often developed over the projected life of a proposed SWM system. This allows comparison in both the early years and later years of the system. In some cases, one alternative may be more cost effective in the early years and another in the later years. This is sometimes found when comparing waste management alternatives with quite different initial capital costs. A high capital cost alternative—e.g., combustion—will usually have a large part of its annual costs in debt service payments, which remain levelized (or the same) over the debt repayment period. As a result, the annual cost of this alternative may not rise as much as those for alternatives more subject to inflation.

• **A "present value" analysis is frequently used to compare costs over a period of time.**

A "present value" analysis is frequently used to compare costs over a period of time. This form of comparison attempts to equate future year costs to first year costs. Present value costs reflect the time value of money and are developed by discounting future year costs at an annual discount rate reflecting the cost of capital. The discount rate used to develop present value costs may sometimes be the same as the interest rate on tax-exempt project revenue bonds, which are often used to finance SWM alternatives/systems (Kreith, 1994). Summing discounted annual costs (i.e., present valued costs) allows a better comparison of the life cycle costs of SWM alternatives.

• **Summing present valued costs allows a better comparison of the life cycle costs of SWM alternatives.**

STEP 4. SELECTION AND IMPLEMENTATION OF SWM SYSTEM

Introduction

Once scenarios to meet waste management objectives have been evaluated, selecting a SWM system for future use in the planning area is the next step in the planning process. If the selected system includes new waste management facilities/operations, options for implementing these must be considered, as well. Issues that must be addressed in selecting and implementing a new SWM system are discussed below. Decision on these issues should be part of the SWM plan.

• **Selecting a SWM system for future use is the next step in the planning process.**

Selection of SWM System for Future Use

Several things must be considered in selecting a SWM system for future use over a 10 to 20-year period. These include the size of the geographical area to be covered, the waste management sectors that should be addressed, and the waste management alternatives that should be chosen. In addition, it will be important that public participation be a part of the selection process.

- **Public participation must be part of the selection process.**

Regional/Local System

As noted previously, regional SWM systems sometimes offer advantages in dealing with the increasing complexities and costs of managing solid wastes. Smaller communities and counties, in particular, may find that joining together to develop larger regional facilities can save costs and lessen other concerns (such as facility siting) as well. However, deciding on a regional approach will also depend upon compatibility of needs and goals and the willingness of participant governments to enter into cooperative agreements.

- **A regional approach will depend upon compatibility of needs and goals and the presence of intergovernmental cooperation.**

Residential & Nonresidential Coverage

SWM planning frequently addresses all aspects of managing residential MSW including waste storage, collection, transportation, processing (including recycling) and disposal. This may not be true for solid wastes from other sources. SWM plans may affect these wastes only with respect to the availability of disposal options. In particular, storage and collection of nonresidential solid wastes are often not considered in SWM planning unless they pose an obvious problem. This may reflect the fact that collection of these wastes has typically not been provided through the municipal sector. However, in locations where diverting wastes from disposal is a concern, measures to increase recovery of nonresidential MSW and other solid wastes is receiving more attention. Thus, the level (or degree) to which management of solid wastes from various sources

- **SWM planning frequently addresses all aspects of managing residential MSW.**

will be addressed is a factor in planning and selecting a SWM system.

Collection & Disposition Alternatives Selected

Once decisions have been made regarding the geographical area and waste management sectors to address in the SWM system, waste management alternatives can be selected for future use. The selected alternatives may address waste collection, transportation, processing and disposal. They should be selected on the basis of their effectiveness in meeting SWM objectives and other technical and economic criteria (discussed previously). The selected alternatives should reflect an integrated SWM approach that has considered source reduction, recycling (including composting), combustion and land disposal.

- **Selected waste management alternatives should be effective in meeting SWM objectives and other technical and economic criteria.**

Public Input in Selection Process

Meetings with designated citizens representatives and/or the general public may be necessary to select a SWM system that will have the support needed for implementation. These meetings will follow earlier ones in the planning process designed to help establish SWM objectives and planning direction as well as selection of SWM scenarios for detailed review. They should be used by the SWM planners to present recommendations and receive public input in response. The end result should be the selection of a SWM system that is best suited for the planning area.

- **Meetings with the public may be necessary to select a SWM system that will have the support needed for implementation.**

Public participation techniques that may be used in the selection process include:

- Citizens advisory groups/task forces
- Interviews with individuals from key community groups
- Workshops
- Hotline
- Public meetings
- Public hearings prior to final decision making
- Polls
- Public votes.

• Implementation options must be considered if the selected system includes new waste management facilities/operations.

Implementation of Selected System

When establishing new waste management systems, choices must be made in several areas necessary for system implementation. Decisions may be needed on the following:

- Implementing entity(s)
- Ownership
- Procurement and operation
- Financing
- Public risk
- Method of payment for services
- Implementation scheduling
- Public education and participation.

• Options for implementing are often inter-related and must be considered in terms of compatibility.

Choices in these areas are often inter-related and must be considered in terms of compatibility as well as other factors. A detailed discussion of options for implementing waste management systems is presented in Tool 5.