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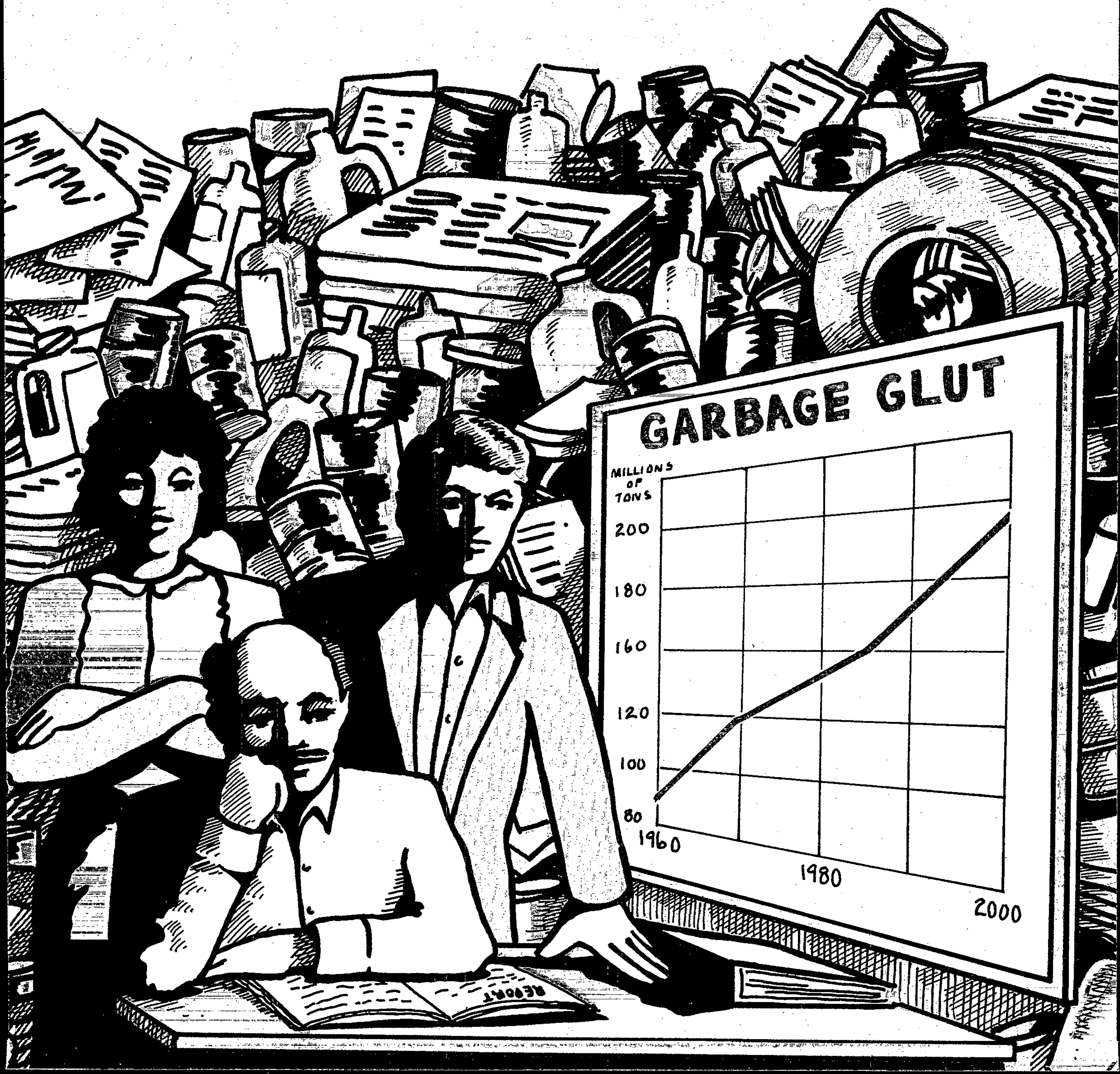
EPA

Decision-Makers Guide To Solid Waste Management



Preface

Solid waste issues are moving to the forefront of public attention. In one city in the Northeast, controversy over a proposed waste-to-energy plant led to delays in developing a response to their solid waste crisis. As options run out, the city faces dramatically rising costs to ship its waste out of state. The daily cost increase for waste management during the period of this controversy now rivals the annual salary of a teacher or police officer. In a city on the West Coast, the costs of closing a substandard landfill are now estimated to approach $50 million; in another West Coast city, the cost of closing a landfill (now a Superfund site) may reach $90 million.

But cities are finding solutions. For instance, one of the towns in Long Island whose waste ended up on the ill-fated garbage barge of 1988 now boasts a curbside recycling program with a high citizen participation rate. The amount of waste destined for disposal has been dramatically cut. The two West Coast cities described above have also implemented aggressive recycling programs, to lessen their future dependance on landfills. A city in the Midwest was able to reach an agreement among its citizens, following extensive public involvement in planning decisions, to build a state-of-the-art waste combustion plant with stringent environmental safeguards. Similarly, a city in the Rocky Mountain West was recently able to work with its citizens to site a modern landfill whose design and operation addressed environmental and other public concerns.

As the examples indicate, management of municipal solid waste is changing dramatically in the United States. Landfills are filling up, new sites for combustion plants and landfills are getting harder and harder to find, and disposal costs are rising significantly. In response to these challenges, more and more communities are adding alternative management techniques that do not rely solely on disposal of the waste. As the management of our nation's waste becomes increasingly complex, decision makers need a more thorough understanding of the options available to them and the interrelationship of these options. To provide local officials with up-to-date information about waste management, the U.S. Environmental Protection Agency's (EPA's) Office of Solid Waste is publishing this new edition of its *Decision Maker's Guide to Solid Waste Management.*

The first edition of the *Decision Maker's Guide to Solid Waste Management* was published in 1976. It successfully aided many communities in the management of their wastes. We are hopeful that this update will be as beneficial to local decision makers as was the early edition. This revised edition provides information on topics covered in the earlier edition as well as new topics applicable to today's waste management needs. Because of the complexity of the issues, this edition will be published in two volumes. This volume, Volume I, is designed to help policy makers understand their present waste management problems, possible techniques for solving them, and how these solutions influence each other. Volume II will contain more technical information for those managers responsible for implementing the chosen management approaches. We plan to issue Volume II next year.

Local decision makers are charged with the task of instituting an overall framework for managing the wastes generated by their community. They must cultivate a dedicated staff and establish a well-defined structure within which the local government can effectively manage municipal solid waste. However, local decision makers cannot be successful by themselves. The responsibility for improving waste management practices, especially source reduction and recycling, ultimately rests with the waste generators. These individuals, businesses, manufacturers, and institutions also comprise the tax base that bears the financial burden for managing their wastes. So that they can better assume responsibility for their wastes, all wastes generators must understand how their wastes are managed, the need for waste management facilities, and, especially, the full costs of managing the wastes they produce.

Integrated waste management may require local governments to take on what for them may be new functions. Some of these include working with the community to plan for waste management, educating the community to participate in specific programs, learning about the markets for recyclable materials, and working with individuals and the commercial sector to reduce the amount of waste generated. The *Decision Maker's Guide* explains these activities and presents many more opportunities that will help you and your community meet these pressing challenges.

Sylvia K. Lowrance, Director
Office of Solid Waste
November, 1989

Integrated Solid Waste Management

In February of 1989, the Office of Solid Waste published the *Solid Waste Dilemma: An Agenda for Action*. The *Agenda* lays out EPA's strategy for dealing with municipal solid waste. It identifies the roles of the many players in solving the waste management problems, and the specific activities EPA is committed to conducting. This *Decision Maker's Guide* is a very important part of the EPA's agenda for solving the nation's garbage problems.

As explained in the *Agenda for Action* and today's *Decision Maker's Guide*, EPA encourages municipalities to use a mix of solutions to handle waste, since there is no single management approach that will serve as a panacea for our waste problems. Within the range of management options, EPA suggests a hierarchy for decision makers to consider when planning and implementing integrated waste management. The first level of the hierarchy is **source reduction**, which is reducing the amount and/or the toxicity of waste we generate. Individuals, government, commercial establishments and industries can all participate in source reduction. Their contributions can be as simple as photocopying on both sides of the page or as complex as modifying manufacturing processes.

Recycling is the second level of the hierarchy. Recycling is collecting, reprocessing, marketing, and using materials that were once considered trash. Many of the components of our waste stream can be recycled -- from metals and plastics to used oil and yard waste. Today we are recycling about 10% of the 160 million tons of municipal solid waste generated every year. EPA has set a goal for the nation to achieve 25% source reduction and recycling by 1992. We are hopeful that this document will help the nation reach this goal.

Finally in EPA's hierarchy comes **waste combustion** and **landfilling**. Combustion can be used to reduce the volume of the waste stream and to recover energy. Landfilling is the only true disposal option. It is a necessary component of waste management, since all management options produce some residue that must be disposed of through landfilling. EPA and State and local governments are working hard to improve the safety of both combustion and landfilling, through new regulatory controls, design and operational practices, training, and careful monitoring.

Acknowledgements

The *Decision Maker's Guide to Solid Waste Management* was developed by ICF Incorporated for EPA's Municipal Solid Waste Program under the direction of Sarah Carney and Terry Grogan of the Office of Solid Waste. In addition, Bruce Weddle, Truett DeGeare, and Bob Dellinger of the Office of Solid Waste were influential in the development of the *Guide*. The *Guide* also benefitted from comments by other EPA Offices, including the Pollution Prevention Office, Office of Research and Development, and the Office of Policy, Planning, and Evaluation.

EPA would like to acknowledge the invaluable assistance of a group of municipal solid waste experts that served as a peer review team during the development of the *Guide*. The team commented extensively on drafts of this document and provided suggestions for improvements at two peer review team meetings. These individuals include:

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Jenny Bagby	Seattle Solid Waste Utility
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Richard Denison	Environmental Defense Fund
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Janet Keller	Rhode Island Department of Environmental Management
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Pete Watson	Browning-Ferris Industries, Boston, Massachusetts
George Winfield	Department of Public Works, Baltimore, Maryland

Draft copies of the *Guide* were sent to several other groups: Aluminum Association, American Federation of State, County, and Municipal Employees, American Paper Institute, American Petroleum Institute, Association of State and Territorial Solid Waste Management Officials, Battery Council International, Council for Solid Waste Solutions (Society of the Plastics Industry), Glass Packaging Institute, Institute of Scrap Recycling Industries, Inc., International City Managers Association, Keep America Beautiful, Inc., National Association of County Officials, National Association of Regional Councils, National Association of Towns and Townships, National Electrical Manufacturers Association, National League of Cities, National Soft Drink Association, Natural Resources Defense Council, Public Technology, Inc., and the U.S. Conference of Mayors. EPA would like to thank the groups that commented on these drafts.

At ICF, acknowledgements go to Frank Arnold, Andrew Barnsdale, Mike Lochhead, Alison Orr, and Jean Tilly, who were responsible for drafting the *Guide*, incorporating various sets of edits, and producing the final document.

EPA would like to emphasize that any of the views or opinions that appear in this *Guide* are those of the Environmental Protection Agency, and do not necessarily reflect the views of the various peer reviewers.

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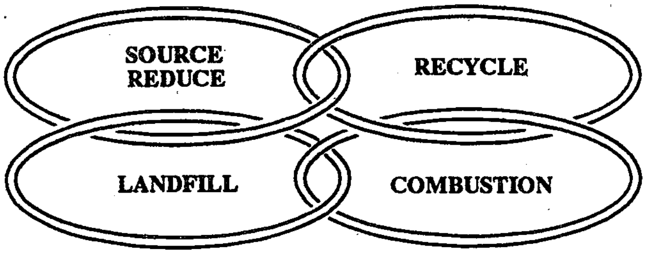
Integrated Waste Management



MAJOR MESSAGES

- The purpose of Volume I of the Decision Makers Guide to Solid Waste Management is to introduce the concept of integrated waste management by providing an overview of major municipal waste management issues while highlighting program options and listing criteria for evaluating alternatives.
- Many parts of the United States are currently facing a municipal solid waste dilemma, for which all elements of society are responsible. Local decision makers must assume the responsibility of managing the local waste stream.
- Integrated waste management combines several techniques to manage distinct elements of the waste stream most effectively.
- Strategic planning by decision makers allows the community to meet short-term needs while building a framework for working towards long-term goals.

MUNICIPAL SOLID WASTE DILEMMA

Over 160 million tons of municipal solid waste will be generated in the United States in 1989. In every year since 1960, we have witnessed a rise in both the total tons of waste generated and pounds generated per person. Adverse environmental and public health impacts have been linked to past disposal practices. State and local officials and private companies are finding it increasingly difficult to site new facilities. And in many parts of the country, existing landfills are reaching or have reached capacity, with the costs associated with municipal waste management skyrocketing. These are a few of the trends and symptoms of what is being called the solid waste dilemma.

Taking Responsibility

The root cause of the solid waste dilemma lies in the fact that all levels of society have underestimated the significance of proper municipal solid waste management. *We are all responsible for the municipal solid waste dilemma*:

- Local, state, and federal governments have all underestimated the importance of providing safe and effective waste management;
- Industry has designed, manufactured, and packaged products with little regard of how they eventually will be disposed;
- Individuals consume products and generate waste (approximately 3.6 pounds per person per day) with little thought of disposal issues; and
- Disposal facility owners and operators have historically considered environmental issues to be of secondary concern.

We are all responsible for the municipal solid waste dilemma. Consequently, we are all part of the solution.

All elements of society are learning that the public good is best served by the organized and controlled management of municipal solid waste. Although we all play a role in solving the dilemma, local governments are in the best position to decide how a community's municipal waste will be managed. Of course, the overall success of a waste management system will also depend on external influences such as state and federal government support, public participation and involvement, and initiatives and cooperation by the private sector. Local government, however, can have an immediate and long-lasting impact by assuming responsibility for the local waste stream.

This is not to say that local governments must deliver all waste management services. Their responsibility lies in determining *how* service is provided, *who* provides the service, and *under what conditions* this takes place. Coordinating the waste management system, while fostering the idea that proper municipal waste management is fundamentally the responsibility of all elements of society, will have the most positive impact on the solid waste dilemma.

Environmental Awareness

The general failure to assume full responsibility for proper municipal waste management has resulted in adverse environmental impacts that have been associated with past disposal practices. Improperly operated landfills have been linked to soil, surface, and ground water contamination. Insufficient pollution control on incinerators has led to air quality problems. Many communities know this all too well, as large chunks of municipal waste management budgets are used to clean up the effects of past disposal practices. Consequently, decision makers must now operate within an atmosphere of increased environmental awareness among citizens, government, and facility operators. Not only are many landfills and incinerators being closed due to environmental concerns, new facilities are becoming increasingly harder to site because of public opposition. In addition, stricter regulations are expected to close many existing facilities, and required environmental controls are making new facilities more costly to build and operate.

Capacity Crisis

Because all landfills have a finite lifetime, and because many are expected to close due to stricter regulation, communities are necessarily faced with the need to site new landfills. But considering the environmental concerns mentioned above, as well as the fact that in more densely populated areas space is not readily available, siting new landfills has become extremely difficult in many parts of the country (in part because of public opposition to proposed sites).

These siting difficulties have resulted in what is being called a landfill "capacity crisis." The capacity crisis is indicated by the sharp rise in tipping fees (the amount charged to dispose of a ton of waste) around the country. In the not-so-distant past, tipping fees were in the ballpark of a few dollars a ton. Now the national average is near $26, and in some areas the average tipping fee is more than six times that amount.

Consequently, decision makers across the country are looking to alternative waste management practices that are environmentally sound, economically viable, and that conserve precious landfill space.

The Necessity of Landfills

Despite the difficulties associated with landfills, they will necessarily be a part of any municipal waste management system because portions of the waste stream cannot be handled in any other way. Landfills should not be considered a "necessary evil." Due to technology improvements and increased regulation, modern landfills are more secure than ever and adverse environmental impacts can be detected and properly addressed.

INTEGRATED SOLID WASTE MANAGEMENT

Integrated solid waste management involves using a *combination* of techniques and programs to manage the municipal waste stream. It is based on the fact that the waste stream is made up of distinct components that can be managed and disposed of separately. An integrated system is designed to address a specific set of local solid waste management problems, and its operation is based on local resources, economics, and environmental impacts.

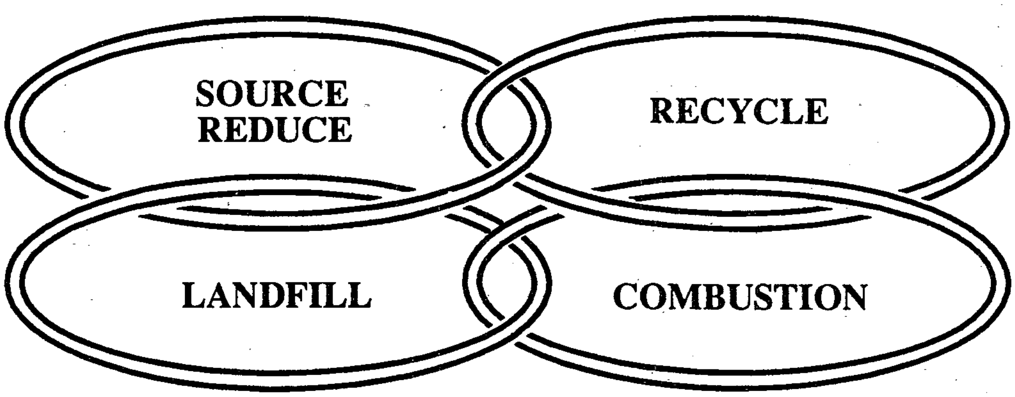
The idea behind integrated solid waste management is that a combination of approaches can be used to handle targeted portions of the waste stream. Instead of immediately driving the development of big, high-technology programs, or setting unrealistic expectations as to what portion of the waste stream can be recycled, decision makers implement a series of programs, each of which is designed to *complement* the others. Source reduction, recycling, combustion, and landfilling can all have a positive impact on the local municipal waste management problem.

This *Decision Makers Guide to Solid Waste Management* is designed to assist in the understanding and development of an integrated solid waste management plan. It shows that a well-designed plan can improve system economics and reduce environmental impacts while fostering public support and involvement in municipal solid waste management.

There is no universal, step-by-step method for selecting and developing integrated waste management components and systems. The success of integrated solid waste management depends largely on the dedication and expertise of local decision makers. The purpose of this *Guide* is not to provide a blueprint of what to do. Instead, the purpose is to provide a list of factors that should be considered in framing municipal solid waste decisions. In addition, the *Guide* also presents information and data helpful in making these difficult decisions.

HIERARCHY OF INTEGRATED WASTE MANAGEMENT

Consistent with the principles described in EPA's *Agenda for Action*, to reduce our waste management problem at the national level most effectively, states, municipalities, and the waste management industry should use the hierarchy described in Figure 1.1 for evaluating the components of integrated waste management against the community's needs. Although each community will choose a mix of alternatives that most effectively meets its needs, the hierarchy is a useful conceptual tool for goal-setting and planning.



The elements of the hierarchy are all interrelated and can be designed to complement each other. For example, a recycling program can have a positive impact on the development of a waste-to-energy facility. One purpose of this *Guide* is to show how municipal waste management alternatives can positively affect each other.

FIGURE 1.1
Hierarchy of Integrated Waste Management

Source reduction is at the top of the hierarchy and is discussed in more detail in Chapter Five. Source reduction programs are designed to reduce both the toxic constituents in products and quantities of waste generated. Source reduction is a front-end waste management approach that may occur through the design and manufacture of products and packaging with minimum volume and toxic content and with longer useful life. It may also be practiced at the corporate or household level through selective buying habits and the reuse of products and materials.

Recycling, including composting, is the second step of the hierarchy. These options can reduce the depletion of landfill space, save energy and natural resources, provide useful products, and prove economically beneficial. These options are discussed in more detail in Chapters Six and Seven.

Below source reduction and recycling are waste combustion and landfilling. EPA does not rank one of these options higher than the other, as both are viable components of an integrated system. Waste combustion, discussed in Chapter Eight, reduces the bulk of municipal waste and can provide the added benefit of energy production. State-of-the-art technologies developed in recent years have greatly reduced the adverse environmental impacts associated with incineration in the past and, although waste combustion is not risk-free, many communities are relying on this waste management alternative.

Landfilling, discussed in Chapter Nine, is necessary to manage non-recyclable and noncombustible wastes, and is the only actual waste "disposal" method. Modern landfills are more secure and have more elaborate pollution control and monitoring devices than in the past. Environmental concerns at properly managed landfills are greatly reduced. Also, many new landfills are utilizing methane recovery technologies to develop a marketable product.

No Miracle Solutions

Decision makers must be realistic in what they expect their waste management system to accomplish. All municipal waste management planning will require the dedication of decision makers; no miracle solutions exist. For example, many people are quick to point out that waste-to-energy is not a complete response to a solid waste problem, citing the need for recycling, source reduction, etc. But just as combustion is not a complete answer, neither is recycling alone going to solve the problem. Even the most successful programs have to dispose of a significant portion of the waste stream. Decision makers must be realistic in their planning. Answers won't come easily.

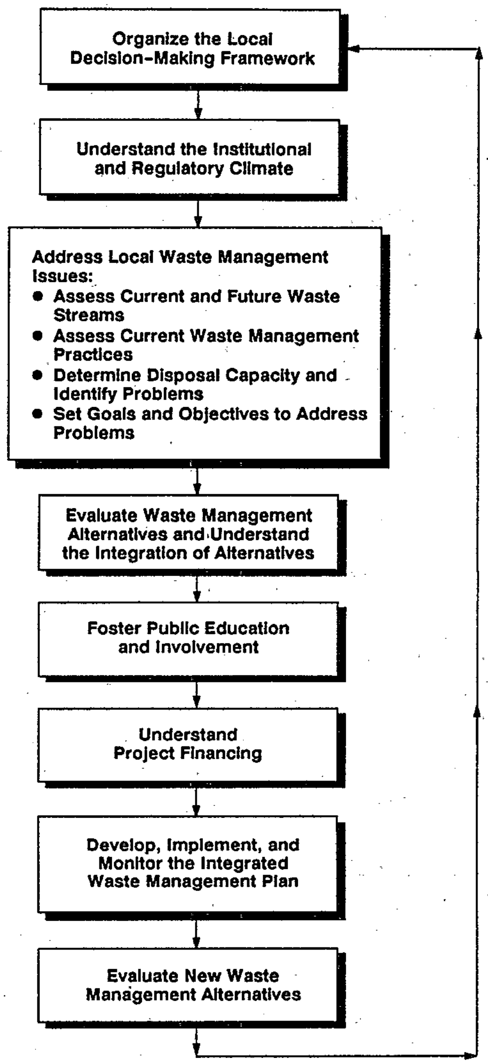
STRATEGIC PLANNING

Strategic planning is a concept that is reiterated throughout this *Guide*. It refers to the concept that decision makers must plan for the long-term, and that the planning process should involve anticipating the changes that are likely to occur in the future. It is crucial to build *flexibility* into all elements of the waste management system. Strategic planning demands a dedicated staff and leadership at the local level that must assume the *responsibility* of managing the community's municipal waste.

The accompanying flowchart (Figure 1.2) provides some structure to the planning process by highlighting key stages. *These steps should be followed only as an outline!* Municipal waste management is an ongoing process that has *no set beginning or conclusion.* Review of new alternatives and evaluation of operations should be performed continually. Although a flowchart is provided here, it should be noted that all stages of the process are interrelated. Decision makers should not put part of the process on hold while developing a particular option or working on a particular activity. Planning, development, monitoring, and evaluation of options take place simultaneously.

FIGURE 1.2

Integrated Solid Waste Management Planning



Municipal Solid Waste Task Force

A part of organizing a local decision-making framework can be the establishment of a municipal solid waste task force. Many decision makers have found this to be helpful in providing a forum for a variety of opinions and for tapping the expertise of the local waste management network. Groups that may be included on such a task force include:

- Local elected officials;
- Community/neighborhood groups;
- Citizens;
- Regulatory agencies;
- Municipal employees;
- Landfill operators;
- Collection system representatives;
- Recycling industry;
- Resource recovery industry; and
- Environmental groups.

Decision makers design the task force and decide what role it plays in the process. It can serve as an advisory committee to local decision makers or a link to key local forces.

Organize the Local Decision Making Framework

By establishing a dedicated staff and framework within the local government, decision making is internalized and local knowledge and experience build with time. *Building local expertise* is a main waste management goal. Many local decision makers are unfamiliar with the details of the various waste management alternatives, even though these issues may not be technical or complex in nature. As a result, local officials often rely on outside experts as sources of information on what are essentially local problems. By investigating and initiating some low-technology waste management options such as source reduction education programs, neighborhood yard waste composting projects, and pilot-scale recycling, local officials can develop their own expertise in areas that may have previously been unfamiliar. For example, a pilot scale curbside recycling program that collects one or two different recyclables will aid in developing an organizational framework for recycling within the entire community, and will familiarize local officials with such issues as public outreach and marketing. Building expertise will better prepare local officials to implement larger programs and will lower the risk of making costly planning mistakes.

Innovative waste management alternatives will be unfamiliar to many people within the community. In many cases, the costs and benefits will not be fully understood. Decision makers must, therefore, serve as advocates for new programs. Once a level of expertise is established, decision makers are in a position to promote programs aggressively to local government and citizens.

Understand the Institutional and Regulatory Climate

This is one of the first activities decision makers should undertake during the planning process. Federal, state, and local opportunities and constraints can all have major impacts on how a system is run. Guidance on these issues is provided in Chapter Two.

Address Local Waste Management Issues

Perhaps the most fundamental planning factor decision makers should understand is the nature of municipal solid waste and solid waste management in the community. This involves understanding what and how much waste is generated now and will be generated in the future, how it is currently managed, and what problems may be anticipated. Once these factors are understood, decision makers must set goals and objectives for addressing local problems. Chapter Three discusses the importance of assessing the waste stream, characterizing local operations, recognizing capacity and management problems, and setting goals and objectives.

Evaluate Waste Management Alternatives

Evaluating alternatives is the most time consuming activity decision makers undertake when developing waste management plans. Dozens of options must be compared and evaluated, and the feasibility of each option within local constraints must be determined. Chapters Four through Ten identify the major waste management options and give criteria for evaluating each option.

Atmosphere of Change

The phrase "undergoing rapid change" could be used to describe nearly every aspect of municipal solid waste management as we head into the 1990's:

- Public Attitudes. With events such as the wandering garbage barge Mobro, individuals are becoming increasingly aware of the significance of effective municipal waste management.
- Waste Stream. Waste generation has been steadily increasing for years, and as management options such as source reduction, recycling, and composting are implemented, waste stream composition can be expected to change in the future.
- Management Techniques. As communities combat local dilemmas, new and more efficient programs and techniques are appearing continuously.
- Technologies. All forms of municipal waste technologies are rapidly changing - from developments in state-of-the-art, mechanized collection vehicles to complex pollution control devices at combustion facilities.
- Economics. Because of increasing demands on municipal waste disposal capacity, costs of disposal have increased sharply in many parts of the country in recent years. Also, as municipal waste management systems become more complex, new economic constraints and benefits are introduced.
- Regulations. Laws and regulations are being implemented at the local, state, and national levels. Pollution control standards, mandated recycling rates, and procurement requirements are just a few examples.

Foster Public Education and Involvement

The involvement of citizens that have been educated in the benefits of proper municipal waste management can be one of the most beneficial aspects of an integrated waste management system. For many municipal waste management options, public participation is one of the main keys to success.

Each public education and public involvement program needs to be specific to the community and its unique solid waste challenge. There are two key elements, however, that can strengthen any program. First, opportunities for communicating with and involving the public should be established early on in the planning process -- the public hearing for an incinerator permit is not the starting point for listening to and addressing public concerns. Second, public education and involvement efforts should be ongoing -- a one-time media blitz announcing a new recycling program will not result in long-term participation.

Public education and public involvement programs provide decision makers with a unique opportunity to establish two-way communication with the community. By building a communication bridge with citizens, special interest groups, and the business community, decision makers can share valuable information while also learning specific concerns and issues. Through public education and involvement, decision makers can create opportunities for community members to be part of the solution to this nation's solid waste dilemma. Chapter Eleven of this Guide addresses these issues in more detail.

Understand Project Financing

Project financing can be performed in a variety of ways within the community, many of which are discussed in Chapter Twelve.

Selecting a financing method is based largely on the degree of risk that the community is willing to take, as the financing method selected can significantly impact the costs incurred by the community.

Develop, Monitor, and Implement an Integrated Waste Management Plan

Developing and implementing the plan is essentially a local activity that involves assimilating all of the issues covered in this *Guide*. Chapter Thirteen highlights some of the major issues that go into plan development, including timing issues, building flexibility into the system, and monitoring programs.

Evaluate New Waste Management Alternatives

By constantly evaluating new waste management alternatives, the decision maker returns to the start of the strategic planning process. Evaluating new alternatives is necessary to ensure that the local system is as successful as possible. Even the most successful and innovative waste management programs experiment with new techniques and technologies. Integrated waste management is an ongoing process that will require continuous attention.

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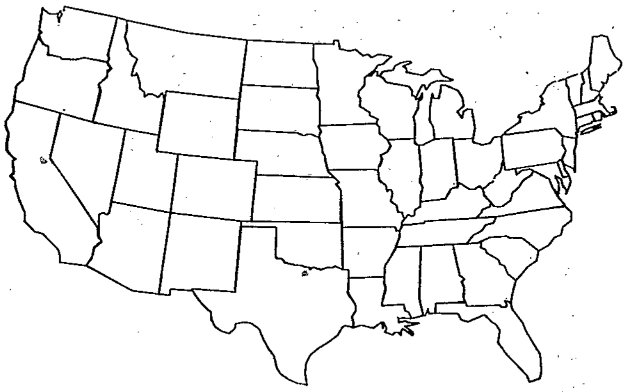
Chapter Two

Factors Affecting Municipal Waste Management Decision Making



MAJOR MESSAGES

- **Decision makers must understand and account for local opportunities and constraints when planning a municipal waste management system.**
- **Multi-jurisdictional factors will affect operation of a municipal waste management system, and opportunities for multi-jurisdictional cooperation should be considered.**
- **State solid waste plans and grant programs constitute a framework for municipal waste management planning.**
- **Decision makers should be aware of the variety of Federal laws and guidelines that affect municipal waste planning.**

LOCAL FACTORS

One of the first steps decision makers should take in developing an integrated system is to frame the planning process according to the political, institutional, and economic realities of both their own community and neighboring political jurisdictions.

Political Setting

The political setting in which decision makers operate can be extremely complicated:

- A number of parties who have an interest in local municipal waste management decisions, including elected officials, the news media, and citizen organizations, have access to the political process. These groups also have the ability to generate community support.
- Business and political interests, as well as community, environmental, and neighborhood groups, will all have particular points of view during the development of a municipal waste plan.
- Entities within the solid waste management industry (e.g., haulers, recyclers, facility vendors) will also play an important role in the municipal waste planning process.
- An extensive agenda of other local issues and programs compete for scarce resources.
- The local electoral cycle may affect waste management priorities.

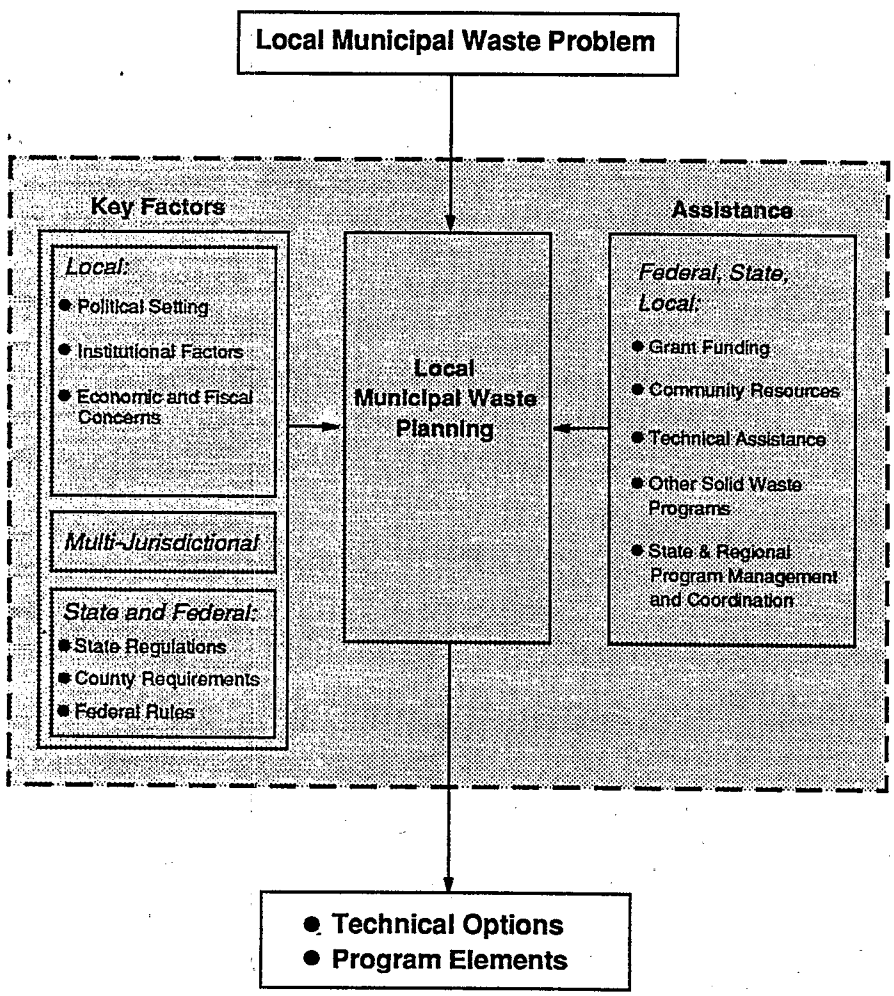
This complicated political setting, however, should not be seen as an insurmountable obstacle. A primary goal of decision makers should be to make the best use of all available community resources. All relevant parties, organizations, interest groups, and individuals need to be enlisted to help, or at least considered, in the municipal waste planning process. To do this, decision makers should take an "inventory" of the possible resources available in the community, whether public or private, and identify groups whose efforts may be assisted, encouraged, used as examples, and whose assistance in planning and implementing an integrated program for the community would be invaluable.

This inventory should also include those groups or factors that may constitute constraints on the system, so as to anticipate problems early. By understanding all of the "players" early in the process, planning can be more efficient and effective. By integrating public concerns into the planning process, long-term success is more likely.

Economic and Fiscal Concerns

Planning for municipal solid waste management will require a careful analysis of budgetary constraints and the potential economic impacts of new alternatives. In addition, the ability to obtain necessary financing for proposed program

Key Factors and Participants in Municipal Solid Waste Decision Making



Considering Community Concerns

Local community and neighborhood groups can be expected to express strong views on issues related to their perceptions of traffic, nuisance factors, public health concerns, lack of perceived benefits, inadequate environmental standards and enforcement, and other issues affecting the value of property and quality of neighborhood life.

Similarly, local businesses, commercial groups, and commercial waste management interests may take strong positions on programs requiring them to recycle office paper, corrugated paper, and other materials.

approaches or technical alternatives will have to be assessed early in the planning process.

To do this, decision makers must first review current outlays for municipal waste management and analyze the sources of current funding. For example, the degree to which user fees, special assessments, and the general fund are used to finance the system should be determined. Later in the planning process, the level and stability of future program funding must be reconciled with estimates of future requirements. These will have to be developed for each mix of program approaches and technical options.

Longer-term initiatives may require new sources of funding. Decision makers will have to review the feasibility of user-charges, tipping fees, and tax assessments to finance the operation and maintenance of future program costs. Depending on the specific mix of waste management practices under consideration, this process may require an analysis of local (or regional) markets for selling recyclables, compost, and energy. In addition, the availability of private waste management services and the potential for private competition or lack of competition in these markets must be considered.

Financing future programs will be affected by factors such as the supply of wastes for fuel, the market for recovered materials and energy, the number of jurisdictions participating in the project, and the way these jurisdictions are organized with respect to ultimate administrative, legal, and financial responsibility. Again, by identifying and integrating these issues into the overall planning process, the likelihood of long-term success is enhanced.

Local Economic and Fiscal Concerns

- The fiscal impact of proposed municipal waste programs and practices must be anticipated.
  - Review current and projected expenditures;
  - Evaluate the stability of current revenues and the potential for new sources of funding.
- Economic and market analyses may be necessary to evaluate the feasibility of potential technical alternatives and program approaches.
- Financing options including state and federal incentives and exemptions must be explored.

Institutional Factors

When developing an integrated waste management plan, decision makers will have to weigh carefully the ability of the current collection/processing/disposal system to accommodate any proposed changes in solid waste management techniques. Examining the existing institutional infrastructure will determine if staff, resources, and technical expertise are available to implement and administer new solid waste programs or adjust to changes in existing programs. Institutional barriers to improved solid waste management exist at both the state and local levels. These barriers can be identified and solutions implemented.

Inter-Governmental Conflicts

It is not uncommon for the administrative tasks associated with waste management (permitting, enforcement, collection, processing, disposal, recycling, contracting, etc.) to be divided among several agencies, such as the Division of Public Works and the Department of Public Health. Indeed, solid waste programs at the local level may be administered by more than one level of government (cities, counties, state, and regional authorities) across several jurisdictions.

In planning for an integrated solid waste management program, communities may discover that they wish to change aspects of the current solid waste management system, including the division of administrative responsibility for the local program. This may be due to perceived problems with the lines of authority or structure of the current system, or it may be due to the types of technologies and programs the community chooses to adopt and the degree to which they differ from the current system. Decision makers may find it worthwhile to incorporate into the solid waste management planning process an assessment of the roles and responsibilities of all concerned public and private agencies to determine whether the management of the solid waste program resides within the appropriate agency or office.

Local solid waste programs are often administered by particular offices or agencies because of fairly rigid legislative, contractual, or cooperative agreements as well as for strictly functional reasons. Nonetheless, the local community may be unrestricted in its ability to change the focus of responsibility for solid waste management. In this circumstance, decision makers should evaluate the current system, determine which aspects of the system, if any, may be feasibly and legally altered, in a manner that best serves the community's current and future needs. This process will identify the possible administrative alternatives for a community-based, integrated solid waste management program.

Local Public Bidding and the Procurement Process

Most states have public bidding laws that constrain local government purchasing. These bidding procedures require that the individual components of a procurement be bid separately. Thus, rather than issuing a procurement using an integrated service approach (e.g., a combination of recycling, waste-to-energy, and landfilling), local governments generally break a procurement into discrete packages. A public works project typically has a design and engineering package, a construction package, and sometimes an operational package for each of the waste management options. Bidders on one package may be excluded from bidding on others. This precludes vendors who are fully capable of integrating waste management techniques from participating on each project.

In the past, many communities have found themselves contracting with a private firm for programs, designs, and technologies that may be beyond the financial means of the community, do not meet the goals and objectives of the community, or cannot accommodate changing circumstances. Decision makers need to draw upon all available expertise and advice before committing the community to any particular technology, program approach, or contractual arrangement. These constraints can present significant hurdles to decision makers in obtaining the optimum services via procurement and consequently can seriously affect the program planning process.

Liability Factors

Financial, legal, and environmental liabilities are concerns that affect all municipal waste collection, processing, and disposal programs. Decision makers must assess the amount of risk they are willing to take in each area and plan accordingly. For example, a municipally owned and operated waste-to-energy facility may be a significant financial risk to the community. If the plant is developed and operated by a full-service, private firm, the financial risk is lowered. But by reducing the risk, the community also sacrifices some control over plant design as well as a portion of the revenues.

Legal and environmental liabilities are also considerations in the planning process. Landfills, for example, have uncertain liabilities attached. For example, ground water and surface water contamination or methane gas migration could remain undetected during site operation or for years after facility closure.

Public/Private Cooperation

State and local governments should work closely with private collectors, haulers, processors, the secondary materials industry, and local utilities in designing integrated waste management approaches. This is especially true for new or expanded recycling programs because of the number of waste management components a recycling program will affect. State and local government planners do not always consider the existing collection, processing, and marketing industries, often because the existing industry has not shown substantial interest in helping to solve local waste management problems. In this respect, successful decision makers often take a broad approach and view all concerned parties (public and private) as part of a comprehensive waste management solution.

MULTI-JURISDICTIONAL FACTORS

Increasingly, many communities are turning to regional approaches to solid waste management to accomplish together what they cannot attain alone. Regionalization offers both large and small communities a number of potential advantages in the areas of procurement, environmental protection, financing, and management.

The regional approach allows communities to achieve economies of scale through better utilization of capital and more efficient management. The approach enables member communities to provide large-scale services not otherwise financially possible, to centralize waste processing and disposal, and to reduce the number of small, inefficient, environmentally suboptimal systems operating in the area.

In the past, local jurisdictions have often had difficulty cooperating on joint waste management projects. One way of insulating integrated waste management projects from the political arena is to establish quasi-governmental authorities or similar agencies with independent bonding authority. Another option is to make a larger regional jurisdiction, such as a county or even a state, responsible for waste disposal. Each state has a unique system of local jurisdictions and powers. Decision makers should review their state laws and solid waste plans and work to adapt these to encourage state, county, municipal, or regional projects, as appropriate.

Multi-jurisdictional issues can be crucial to integrated solid waste management at the local level for two reasons. First, many issues, such as waste-flow control, sales of recovered resources, and permitting of new facilities, are easily derailed if affected parties from outside the community are not included in the planning and implementation process. Second, planning for an integrated approach to waste management may involve technologies and program approaches whose economies of scale, financing, and ease of implementation dictate a broader, or multi-jurisdictional, approach.

The regional approach to municipal solid waste management may be appropriate for a number of local program elements and technical alternatives. For example, the planning and development of a waste-to-energy facility of economical size often requires intergovernmental agreements; regional management of solid waste may be necessary to ensure an adequate supply of waste to the plant and to design the most efficient transportation routes throughout the area.

Because of rising costs, operating environmentally acceptable landfills is another activity that may be better met by regional facilities which can tap the resources of several communities. Multi-jurisdictional approaches also may benefit alternative management programs. For example, composting and recycling programs may require a fairly large waste generation and collection base in order to generate a marketable product. This is especially true of small-scale recycling programs, which can benefit from combining with other programs to develop a larger, more consistent supply of post-consumer materials.

Capital financing for municipal waste disposal facilities usually involves a major expenditure of funds. A larger population and revenue base will generally make financing easier. There are several types of regional organizations created for financing and managing solid waste systems. These are discussed here, and the advantages and disadvantages of each are outlined in Figure 2.2.

Authorities

An authority is usually a corporate body with a charter authorized by the state legislature. It can be established by municipalities and counties to operate outside the regular structure of government; it can finance, construct, and operate revenue-producing public enterprises; and it may have regulatory powers within the scope of its operations.

Special Districts

A special district operates as an agency of government outside of the regular structure, usually performing a single function, and relying primarily on special tax levies for financial support. To be successful, special-purpose districts must respond to local needs and cooperate with local jurisdictions. In some states, special districts can regulate, levy assessments, operate, contract, or do whatever is necessary to perform their single function.

Nonprofit Public Corporations

Similar in many respects to the authority as a means of financing and managing a solid waste system, this corporate entity requires approval or articles of incorporation by member jurisdictions and by the secretary of state or other officials as designated by law. One community or a group of communities create nonprofit corporations to shift financing requirements to an organization outside the immediate municipal bureaucracy, to ease administrative and legal approval of activities, and to capitalize on the presence of a long-term commercial interest in the services rendered. The important feature is that the organization is tax exempt and can issue tax-exempt bonds after satisfying the following Internal Revenue Service criteria:

- The city council must approve the project and accept the assets after bonds are paid;
- The corporation must agree to give its assets to the city after bonds are paid;
- The city must provide all easements to the corporation at no cost;
- The directors of the corporation must be city or State officials; and
- The corporation must provide a public service.

Multi-Community Cooperatives

The multi-community cooperative seeks to achieve the same objectives as Authorities, Special Districts, and Nonprofit Public Corporations, without the degree of legal formality and institutional structure. The multi-community cooperative need not have a charter or articles of incorporation, however, its ability to raise funds, determine policy, and execute projects is limited to the powers of the individual member governments acting in congruence. The multi-community approach obviously depends largely on the willingness of independent communities to work together and, in particular, to let one community take a dominant role. The concept of the multi-community cooperative is similar to a network of intergovernmental agreements between several governments actively working toward a

FIGURE 2.2

Multi-Jurisdictional Organizations: Some Advantages and Disadvantages

OPTION	ADVANTAGES	DISADVANTAGES
Authorities	Ability to finance without regard to local debt ceiling and without obtaining voter approval; Service less likely to be hampered by local political activity because board members are usually private citizens; Autonomy and freedom from municipal budgetary and administrative control may mean more efficient delivery of service; and Can generate sufficient income to make service self-supporting, and capital financing is tax-exempt.	Financing can be administratively complex; Can become remote from government or public control; and Can compete with private industry in some areas of operation, reducing the efficiency of both.
Special Districts	The district has a distinct constituency of residents, not merely a group of bondholders living in scattered places; and Governments can be protected by having elected county officials serve as governing body of district.	Powers are limited by State statute; Must rely on special tax levies requiring voter approval; and Creates an additional governmental entity removed from the electorate and thus less responsive to citizens than directly-elected entities.
Nonprofit Public Corporations	Financing is outside government debt limits and can be obtained without voter approval; Corporation gives its assets to cities after bonds are paid; and No real estate or Federal taxes, and capital financing is tax exempt.	Political influence may be exerted and flexibility lost because board members are city, county, and State officials; Difficult to dismantle even if better service becomes available; and Does not have full faith and credit of the taxing power of the communities behind the financing.
Multi-Community Cooperatives	Less restrictive in legal and institutional structure than Authorities, Special Districts, and Public Corporations; and; Enables member communities to provide services not otherwise financially or administratively feasible and provides for more effective contractual agreements.	Member communities lose autonomy in locating waste disposal sites, setting charges for use of system, and other decisions; Increased interest costs when leading community is less creditworthy than other members; and Leader community may require financial assurances through contractual arrangements with member communities.
Inter-Governmental Agreements	The most widely used method of cooperation between governments in the United States; Contracts offer flexibility, while being both predictable and enforceable; Basic governmental structures and organizations are not affected; and Since no reorganization is required, much time can be saved.	It may be difficult to obtain capital financing since each of the communities, rather than a single unit, must borrow money; If agreements are not formalized in detail through a contract or other mechanism, misunderstandings may arise later; and Since there is no single corporate body, all participants must reach agreement each time a new issue arises.

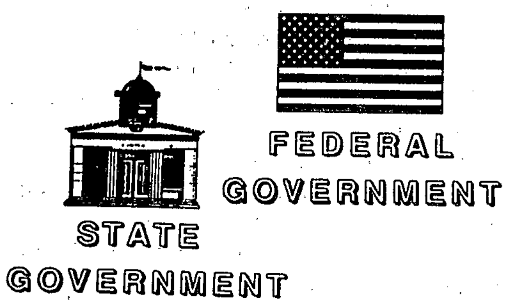
common goal. Tax exempt status is available for financing multi-community cooperatives.

Inter-Governmental Agreements

Local governments can engage in both informal and formal agreements, although formal contracts are usually the only instruments that are predictable, and enforceable. Transfer of function is also a very common arrangement, whereby one level of government delegates responsibility for a function to another level or jurisdiction.

Even though a technical analysis may indicate that a multiple-jurisdiction project is the effective solution to the solid waste problem, this approach can introduce new obstacles to implementation, focusing primarily on equitable sharing of risks, costs, and benefits. For example, if one jurisdiction is the host community for a facility, what constitutes equitable sharing for the other jurisdictions? Can the host community be compensated adequately? Compensation alternatives do exist, including reduced tipping fees for host community residents, cash payments, free electricity if neighbors of a municipal waste combustion facility, or the construction of local improvement projects. However, negotiating these agreements can be difficult.

Nevertheless, once a multi-jurisdictional approach is implemented, the benefits accruing to all parties are usually significant. Regional approaches can be used to focus management resources, to spread unit costs over a larger population base, and to avoid costly duplication of services. Technical alternatives, management practices, and program approaches previously unavailable individually to any of the participants are at once possible, providing a number of environmental, economic, financial, political, and administrative rewards.



STATE AND FEDERAL FACTORS

Solid Waste Plans

Municipal Solid Waste Plans

- Every community generating and disposing wastes should have a solid waste management plan.
- States and counties may regulate and perform a number of activities that will affect the local community.
- State and/or county solid waste plans may require specific actions or programs from communities.
- State and/or county legislation may provide grant or matching funds for a number of activities:
  - Feasibility studies; program design; and construction;
  - Technical assistance and training programs;
  - Program development and implementation;
  - Public education and curriculum materials;
  - Household hazardous and special waste programs;
  - Marketing, service, and information support; and
  - Coordination of local & regional programs.
- Current and pending solid waste legislation and solid waste plans from other levels of government may affect local resources and programs.

Some states have solid waste plans in effect that define the goals and agenda for statewide waste management action. These plans often place requirements on the resources and programs of the local community. Local decision makers must understand and anticipate state requirements and be able to determine what those requirements will imply for the local solid waste program. State solid waste policy or law often defines the limits of local initiatives and suggests appropriate program approaches for communities. States may adopt a variety of different approaches to foster state-wide solid waste management at the local level, including either mandatory or incentive-based approaches. One common mechanism used by states to ensure that these issues receive attention at the local level is to require all levels of government beneath the state level to develop, adopt, and implement a solid waste management plan.

State plans should emphasize integrated solid waste management as a "hierarchy of approaches" yielding an integrated solid waste program based on some combination of reduction, reuse, recycling, composting, energy recovery, incineration, and landfilling.

Congress and many states have endorsed a hierarchy of approaches, including Oregon, Washington, Vermont, Michigan, and Connecticut. Many states also have developed specific plans for each particular program approach (e.g., mandatory yard-waste composting, recycling plans). These plans are usually sub-parts of a broader, comprehensive state solid waste management plan. The State of Connecticut, for example, has adopted a Regional Solid Waste Recycling Plan as a part of its State Solid Waste Management Plan.

State Legislation

Regardless of the type of plan, a state will typically undertake a number of regulatory activities and require actions on the part of the community through legislation. Some state laws require local governments to set up recycling centers or programs that will achieve certain levels of recycling. Other laws impose recycling responsibilities on industries and businesses. States also encourage local waste management approaches by making solid waste grant funding contingent upon indicators of program activity, such as yard-waste and recycling programs. Many states encourage local awareness of waste management efforts through neighborhood groups and support them with public education campaigns. Additionally, states have created various economic incentives to encourage recycling in the private sector. Some states require local governments and waste disposal facilities to recycle (e.g., Connecticut, Oregon, Rhode Island, Washington, and Wisconsin).

State solid waste legislation can provide assistance through state-wide legislative initiatives or grants for local solid waste programs. Legislation may contain provisions for grants or matching funds for feasibility studies, technical assistance, program development and implementation, training programs, public education, educational curriculum materials, household hazardous waste and special waste programs (e.g., used oil, tires, and lead-acid batteries), marketing and service directories, and information networks for both public and private solid waste managers. States also may provide funding for state-wide program support activities, such as state-wide coordination of local and regional programs.

Example State Plan

Connecticut Regional Solid Waste Recycling Plan

- Priority for regional approaches to recycling;
- Grants to establish recycling programs;
- Standards to encourage maximum recycling;
- Financial assistance for processing and marketing recyclables;
- Financial incentives for coordinating recycling programs with energy recovery facility contracts; and
- A hierarchy of techniques including waste reduction, recycling, composting, waste-to-energy, and landfilling to achieve a 20-25% reduction (by weight) of the municipal solid waste stream.

(State of Connecticut, 1986)

State grants can boost capital and staff when programs need to expand; even small grants can help local community-based programs get off the ground. Minnesota, for example, has a statewide grant program to help fund planning and start-up of alternative disposal programs. Many states fund local waste management through outright program or project grants. Connecticut, for example, plans to provide substantial program, technical, and financial assistance to local levels of government. Connecticut also will make a substantial investment in the state-wide recycling effort in terms of program resources, planning, and fixed capital expenditures for plants and equipment.

Potential State Grant Activities

- Improving Sites
- Purchasing recycling, composting, and processing equipment
- Siting and building regional processing, separation, and recycling facilities
- Conducting marketing and feasibility studies, and providing technical assistance
- Providing incentive grants to stimulate the development of community recycling programs
- Providing capital contributions
- Providing operating subsidies for recycling and composting, waste-to-energy, and landfill closure
- Providing matching, program, in-kind, and land and construction grants for funding state programs
- Offering below market rate loans for program development and expansion, including purchases of buildings, land, equipment, machinery, trucks, and engineering and architectural services

Federal Statutes and Regulations

Resource Conservation and Recovery Act (RCRA)

In 1965, the Solid Waste Disposal Act (SDWA) was passed to improve solid waste disposal methods. It was amended in 1970 by the Resource Conservation and Recovery Act (RCRA). The Act is amended by Congress to reflect changing needs. It has been amended twice since 1976; once in 1980 and most recently in November, 1984. The 1984 amendments, called the Hazardous and Solid Waste Amendments (HSWA), significantly expand both the scope and detailed requirements of RCRA. Municipal solid waste is regulated under Subtitle D of RCRA.

RCRA -- Subtitle D

The primary goal of the Subtitle D program is to encourage solid waste management practices that promote environmentally sound disposal methods, maximize the reuse of recoverable resources, and foster resource conservation. To achieve these goals, EPA established both technical standards for solid waste management facilities and a program under which states may develop and implement solid waste management plans.

Technical Standards. RCRA Subtitle D establishes technical standards for the environmentally safe operation of solid waste disposal facilities. In 1984, HSWA made these standards even more stringent. At a minimum, waste disposal facilities must comply with the federal standards, although states may adopt more stringent standards. Commonly called the Subtitle D Criteria, the EPA standards set out mandatory, minimum technical requirements for environmentally acceptable facilities. HSWA requires EPA to revise the Subtitle D landfill criteria.

EPA is expected to finalize the revised landfill standards in early 1990. These revised standards will require, at a minimum, ground-water and gas monitoring, establish criteria on the acceptable location of new or existing facilities, address other landfill design and operating issues, and provide for corrective action, as appropriate. The revised rule also will set performance standards for closure and post-closure care, and also will require financial assurance for closure, post-closure, and corrective action costs for known releases. In addition to revising the standards, HSWA requires that the states establish a permit or prior approval program for facilities receiving small amounts of hazardous waste.

State Plans. The RCRA Subtitle D legislation seeks to encourage state solid waste management plans. Solid waste management plans are an excellent planning and resource management tool; all states, counties, and local governments are strongly encouraged by EPA to adopt them. Although this portion of Subtitle D is voluntary, many states have waste management plans in place and have submitted them for approval to EPA.

EPA's role has been limited to setting the minimum regulatory requirements that states must follow in designing their plans, and approving plans that comply with these requirements. Responsibility for developing and implementing the plan lies with each state, and states continue to develop and implement solid waste management plans that go well beyond the current federal requirements. EPA is now pursuing a renewed federal emphasis on solid waste and Subtitle D programs.

The recent trend has been for states to require local governments to adopt plans of their own to foster better solid waste management at the local level. Moreover, states may require local governments to comply with a variety of waste management practices and develop programs to achieve specific targets. As discussed earlier in this chapter, decision makers should be aware of the wide variety of approaches and requirements these plans can include. Grants also may be available at the state level to help local decision makers develop and implement solid waste plans.

RCRA Subtitle F -- Government Procurement

Subtitle F of RCRA, also known as Section 6002, requires the federal government to participate actively in procurement programs fostering the recovery and use of recycled materials and energy. This not only serves as an example for similar programs at the state and local level, but is, in fact, required of governments and contractors receiving federal funding for a variety of programs. Section 6002 of RCRA requires federal agencies and other applicable groups receiving federal funds to procure items composed of the highest percentage of recovered materials practicable and to delete requirements that products be made from virgin materials or that prohibited the use of recycled materials. Section 6002 also directs EPA to prepare guidelines for procuring products made from recovered materials. EPA issued four guidelines in 1988 and 1989 for paper and paper products, refined lubricating oil, retread tires, and building insulation products. Among other things, these guidelines recommend minimum recovered material content standards.

RCRA Subtitle C -- Hazardous Waste

Subtitle C of RCRA regulates the generation, transportation, and treatment, storage, or disposal of hazardous waste. Wastes designated as hazardous under RCRA Subtitle C are legally excluded from Subtitle D incinerator and landfill facilities and must be disposed of at facilities permitted under the Subtitle C regulations. Subtitle C becomes important to decision makers when planning for the disposal of hazardous elements of the municipal waste stream and when planning for the disposal of hazardous residues, fractions, or wastes generated by processing, or treatment of municipal solid waste.

Clean Air Act (CAA)

Combustion facilities must meet source performance standards that limit emissions of individual pollutants to the air. In addition, facilities must meet these standards by using the best available technology. Although guidance for Best Available Control Technology (BACT) was published in 1986, local decision makers should note that the definition of BACT may be subject to change as EPA evaluates both new control technologies and new information on specific toxics.

Clean Water Act (CWA)

The Clean Water Act affects waste disposal facilities generating ash-quench water, landfill leachate, and surface water discharges. Disposal of ash-quench water and landfill leachate can present problems for solid waste facilities because many wastewater treatment plants cannot accept these discharges. Facilities generating surface water discharges must use the best available technology to control these discharges and obtain a permit to discharge. If a facility discharges to a sewer system rather than directly to surface waters, the facility must meet pre-treatment standards. Furthermore, the 1987 reauthorization of the Clean Water Act, called the Water Quality Act, mandates site-specific requirements for facilities that discharge to streams where the best available technology still fails to meet the standards. One additional element of the Water Quality Act concerns storm water runoff, requiring storm water management plans for facilities whose storm runoff volume exceeds specified limits. Finally, a facility within a wetlands area, needs a Section 404 permit under the Clean Water Act.

1986 Tax Reform

Decision makers should be aware of some of the aspects of the 1986 Tax Reform Act that may affect municipal waste management. On the one hand, the tax reform removed the state caps on private activity bonds for municipally-owned projects. The Tax Reform Act of 1986 has, however, left very few tax incentives for integrated solid waste management. Because of changes to the investment tax credit, the accelerated depreciation schedule, and preferential treatment of capital gains, solid waste management ventures may be less attractive to private investors. The Tax Reform Act has also restricted the use of tax-exempt financing (EPA, Agenda for Action, 1989).

Safe Drinking Water Act (SDWA)

The protection of wellhead areas as defined in the Safe Drinking Water Act may affect municipal waste disposal facilities. Decision makers must consider whether potential sites for future facilities will be located either in a current wellhead area, or in an area that may be designated as a wellhead area in the future. Facilities located in wellhead areas must comply with state and local restrictions on their activities, including design specifications that may add significantly to the cost of the facility.

The CAA, CWA, and SDWA provisions are often delegated to the state level for compliance monitoring and enforcement. State and local application of these statutes are in many cases much more stringent than provided for in the original federal rule.

Public Utilities Regulatory and Policy Act (PURPA)

PURPA was developed as a way of encouraging cogeneration and small power producers in the United States to supplement existing electrical utility capacity. The Act requires investor-owned utilities to purchase electrical power from cogenerators or small producers, (such as municipal waste-to-energy facilities) at "avoided cost" rates (interpreted as the cost of building another power plant or, if the utility has excess capacity, the cost of operating at a higher capacity). Rates are developed under state boards or commissions of public utilities, and overseen by the Federal Energy Regulatory Commission. PURPA has stimulated the construction of alternative energy sources (e.g., resource recovery facilities, cogeneration and hydroelectric plants, and wind farms) by guaranteeing a market and a fair price for the energy produced, and thereby controlling project risk.

Nonetheless, both avoided cost rates and the utilities' willingness to purchase electricity vary from state to state. In some cases, this may present difficulties for local decision makers because the ability to sell electricity wholesale is a key element in the economic feasibility of waste-to-energy projects due to the role revenues play in long-term financing. Although state policies vary, many states set attractive rates for waste-to energy facilities as part of a state policy to encourage municipal solid waste combustion and allow this critical market to remain available.

Decision makers considering waste-to-energy facilities must review Federal and especially state legislation governing resource recovery and cogeneration when determining whether waste-to-energy is a viable option for the community.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA (i.e., Superfund) concerns decision makers for two reasons. First, decision makers must consider the potential for long-term liability under Superfund for current and past waste disposal practices. Careful planning may lead decision-makers to incorporate financial assurance mechanisms into their long-term waste disposal strategy, in addition to more stringent design and operating requirements for their program's facilities. Second, the Act applies to any environmental cleanup, and a substantial number of the sites currently listed as Superfund sites are municipal landfills. Therefore, decision makers may have to assess carefully the overall program impact of Superfund requirements on current landfill activity.

New Rules

Local decision makers also should be aware of new federal and/or state regulations governing the generation, processing, treatment, and disposal of solid waste and processing by-products. EPA is presently developing regulations for new and existing municipal waste combustor air emissions under the Clean Air Act. These are scheduled for proposal in November 1989 and promulgation in December 1990. These EPA guidelines are likely to require regular testing and continuous monitoring of specific operating parameters. In the interim, EPA has issued a set of combustion guidelines termed "good combustion practices," reflecting the advances made in emissions control in facilities worldwide.

Also of note, EPA is using both the Clean Air Act and RCRA to develop its regulatory program for municipal solid waste landfills. Consequently, EPA's Air Office is developing regulations for new and existing landfills under the Clean Air Act. These regulations are scheduled for proposal in the spring of 1990.

Also, legislation is pending in Congress for special RCRA standards under Subtitle D requiring EPA to develop regulations for ash management and reuse. The controversy over the safe handling and disposal of ash has resulted in a number of legislative initiatives at both the federal and state levels. Several states, including Washington and New York, are developing ash testing and management regulations.

Conclusion

Decisions made today will have to provide for safe, cost-effective, and adequate management of solid waste well into the future. Long-term solutions to managing solid waste are often expensive and require extensive program development and community support. Decisions in solid waste management must be made carefully; opportunities, constraints, and alternatives must be developed thoroughly. Communities can ill-afford the costs and long-term effects of unsound decisions and untenable solutions. Prior to expending resources on potentially unnecessary studies, analyses, and technical proposals, decision makers must explore the arena within which solid waste management decisions are made. Decision makers must develop, for the community, the best possible alternatives for local solid waste management by ensuring that all local, institutional, multi-jurisdictional, state, and federal factors are accounted for in the planning process; concerned members of the larger community (decision makers from other jurisdictions) are included in the decision-making process from the beginning; and the broadest possible approach is adopted in pursuing opportunities, resources, incentives, and assistance. This is the first step in developing an integrated solid waste management program.

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Chapter Three

The Local Municipal Waste Management System

MAJOR MESSAGES

- A waste stream assessment provides the basic information needed to make planning, design, contractual, financial, and regulatory decisions.
- Decision makers must carefully analyze the short- and long-term problems within the local municipal waste management system.
- Establishing municipal waste management objectives is an important preliminary step in the planning process.

WASTE STREAM ASSESSMENT

Regardless of the complexity of the community's current waste management plan, some type of assessment of the local waste stream is necessary to provide the basic information for making decisions regarding future waste management. Waste stream assessment is defined in this *Guide* as a procedure designed to determine some basic aspects of the local waste stream: quantity, composition, and sources of waste. *Quantity* refers to the amount of waste generated in the community, both in terms of weight and volume. Waste generation, expressed in tons per year or pounds per capita per year, helps determine landfill capacity and aids in equipment design. *Composition* refers to the relative amounts of different waste stream components, expressed in pounds or tons per year, or as a percentage of the overall waste stream. In addition to quantity and composition, municipal waste stream studies also look at *sources of waste.* This links certain portions of the waste stream to specific generators in the community. This is particularly important for targeting waste management activities and setting goals for different elements of a waste management plan.

Why Assess the Local Waste Stream?

In the past, waste stream assessment was not a fundamental aspect of municipal waste management, as most of the waste stream was disposed of at the local landfill. But because of diminishing landfill space, environmental concerns, and economics, communities are being forced to consider alternative waste management techniques. Many of these alternatives are more complex than the traditional landfilling option, and an unprecedented amount of information on the local waste stream is needed. In an integrated waste management system, program planning, facility design, regulatory development, and financial decision-making all require a knowledge of waste stream quantities and composition. The implications of decisions in these areas can be significant, so the value of an accurate assessment of the waste stream cannot be overemphasized.

Example Applications of Waste Stream Data

- During the selection of collection vehicles, quantity and composition data are required to determine the size and number of trucks; if curbside recycling will take place, the size and number of bins that will be needed; and whether mechanized collection will be more efficient.
- During the development of transfer stations, sizing the facility will depend on waste stream data. History shows that waste volume estimates are often inaccurate, resulting in oversized or undersized facilities faced with operating losses and higher than expected tipping fees.
- Secondary materials brokers will always be interested in a constant and reliable supply of recyclable materials. Waste stream assessments can be designed specifically to determine the amount of certain recyclables in the local waste stream.
- Because fuel values differ for different types of waste, critical aspects of designing and operating a waste-to-energy facility include the quantity, composition, and expected variations of the waste stream. If detailed and accurate information on the waste stream (fuel supply) exists, the facility can be properly designed, and creditors will perceive less risk of facility failure, resulting in lower financing costs.

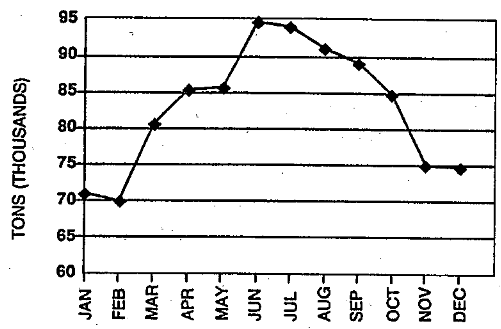
What Does the Municipal Waste Stream Look Like?

Most decision makers probably have some idea of what types of wastes the community generates. In particular, local haulers and facility (e.g., landfill) operators are sources of this information. Decision makers, however, may lack an understanding of *who* generates *what* waste, *how much* is generated, and what *variations* occur in the waste stream. What is important for the local decision makers to understand is that the quantity and composition of the local municipal waste stream is influenced by a number of factors that will be important considerations when developing an integrated solid waste management plan. The following discussion outlines a few of these factors.

Seasonal Variations and Climatic Differences

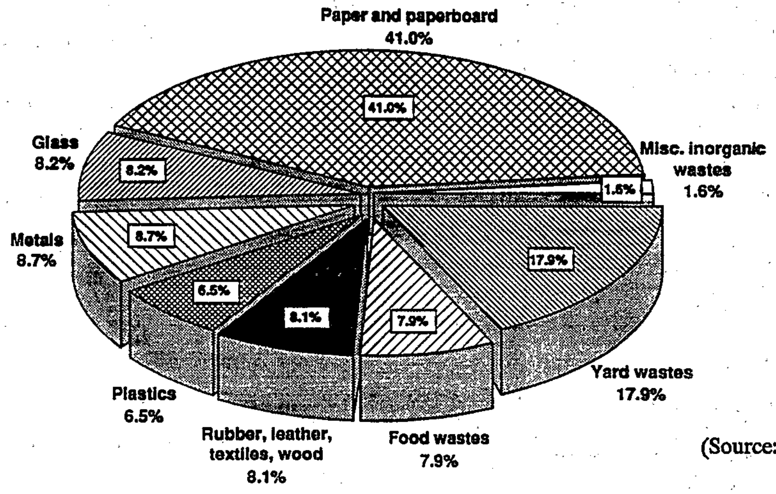
Seasonal variations in waste generation can be very significant in some areas of the country. Figure 3.1 shows the monthly variation in waste flow experienced in the Portland, Oregon Metropolitan Service District in 1987. It should be noted, however, that seasonal variations are unique to the local community. For example, while Portland shows peaks in June and July, Boston's municipal waste generation has peak periods in May-June and October-November. Areas where the climate varies little may show no peaks at all. Climatic differences within a given locale must also be considered. For example, during particularly rainy seasons, wet municipal waste can add significant weight to waste loads. Waste composition can also vary with climate. For example, during warm seasons, the quantity of beverage containers can be expected to rise.

FIGURE 3.1
Monthly Waste Flow
(METRO Region, Portland, Oregon)



Materials Discarded into the Municipal Waste Stream in 1986

(Percent of Total)



(Source: Franklin Associates, 1988)

Residential and Commercial Waste

The distinction between residential and commercial generation can significantly affect the design of a waste management program. The relative amounts of residential and commercial waste will depend on the particular community. Some suburban and rural locales may have little commercial activity generating waste, while in a city like Los Angeles, nearly two thirds of the municipal solid waste comes from commercial sources (City of Los Angeles, 1989). The local residential/commercial distribution plays a significant role in targeting specific waste management programs. In particular, many communities with a large amount of commercial activity are discovering the benefits of developing commercial waste recycling programs, as commercial sources often generate large amounts of easily separated materials.

Demographics

Population variations may also have a significant impact on the municipal waste stream, as demographic data may show certain behavioral patterns affecting waste generation or participation in waste management activities. A study of waste generation in several Milwaukee, Wisconsin neighborhoods showed, among other things, that yard waste constituted approximately 1.5 to 8.2 percent of the waste stream from low income households, while the range was 8.8 to 16.0 percent for middle income households (McCamic, 1985).

Urban/Rural and Industrial/Agricultural Distinctions

The urban/rural and industrial/agricultural components of the local waste stream will also vary from area to area. Because these sources generate very different types of waste, their relative amounts should be determined.

State of the Economy

The economic well-being of a community is a factor that may cause long-term variations in waste generation. For example, the increase in consumption that may be associated with good economic times may be reflected in the waste stream.

Deposit Laws, Recycling Programs, Composting, and Source Reduction

These programs can all significantly affect the local waste stream, depending on public participation, types of materials affected by the programs, and overall success.

Process Residuals

Wastewater treatment sludge, ash from combustion facilities, and processing residuals (e.g., processing at refuse-derived fuel (RDF) and composting facilities) are all items that are disposed of in landfills, and, therefore, can be considered part of the municipal waste stream.

Sources of Municipal Solid Waste

- Residential
  - Single and multiple dwellings
- Commercial
  - Offices
  - Retail stores
  - Entertainment centers
  - Restaurants
  - Hotels/motels
  - Service stations
- Municipal services
  - Demolition and construction
  - Street cleaning
  - Landscaping
  - Catch basin cleaning
  - Parks and beaches
  - Waste treatment residues
- Institutional
  - Schools
  - Hospitals
  - Prisons
- Industrial
- Agricultural

Are All Waste Stream Assessments the Same?

Although there is a certain amount of base information all studies should provide, a waste stream assessment should be seen as a tool used to produce specific information about the local waste stream. Waste stream assessment studies, therefore, will vary from community to community.

Because waste stream assessment can be a relatively expensive process, defining the purpose of the study is one of the most important planning decisions. Both over-specifying the waste stream and not generating the correct information could be costly planning mistakes.

For example, the design of a waste-to-energy facility will require detailed information on the amount and composition (e.g., heating value) of the waste to be handled. The community will thus want a waste stream assessment that provides data on the quantity and relative amounts of combustibles and noncombustibles in the waste stream. Information on the sources of waste could also be used to target areas where separation of materials will benefit facility operation.

WASTE CHARACTERIZATION STUDIES DISTINGUISHED BY PURPOSE

- Provide general data prior to establishing waste management goals or selecting alternatives.
- Provide specific data corresponding to specific waste management options.

Similarly, waste stream assessment to support the development of a major recycling program should also deliver specific information, such as the quantities of recyclable materials and their sources. In this case, a preliminary review of secondary materials markets could be used to target the study.

Waste Stream Assessment Is An Ongoing Process

Identifying the quantity, composition, and sources of the local municipal waste stream is not a one-time activity. As programs are implemented, waste stream assessment will be required to identify successful components as well as areas needing improvement.

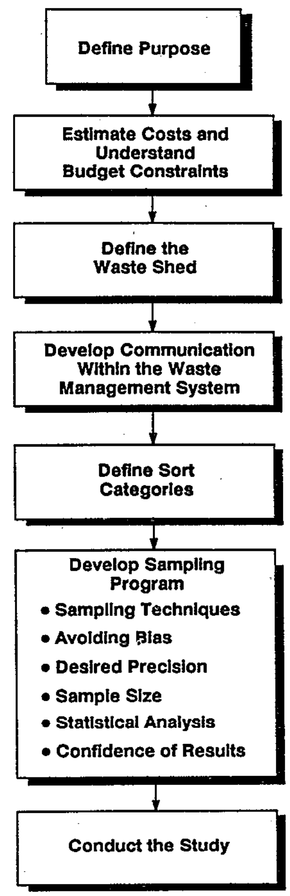
ASSESSING THE CURRENT WASTE STREAM

Two basic methods of current waste stream assessment exist. The first method involves actually performing a local waste characterization study. The second method involves using existing data to characterize the local waste stream.

Performing a Local Waste Stream Assessment Study

Analyzing the local waste stream by actually separating and sampling the waste produced can be the most accurate means of developing data on the local waste stream. Sampling can take place at the landfill, incinerator, or curbside.. During the sampling program waste samples are extracted and the contents separated, identified, and weighed. Samples are taken systematically (usually all day for a week during each season), depending on the precision and accuracy demanded of the results. Provided sufficient samples are taken, this manual separation and assessment method provides the most accurate and reliable information possible, because the data are unique to the waste shed being studied (the waste shed is a defined area in which the local waste stream is generated). This method also involves significant monetary and time commitments. Although the details will be covered in *Volume II* of this *Guide*, Figure 3.2 outlines the methodology used to perform a waste stream study.

FIGURE 3.2
Setting Up A Waste Stream Quantity and Composition Study



Several points in the flowchart may need clarification. The *waste shed* is a defined geographical area serviced by specific disposal facilities or agreements. It is the area within which the decision maker is responsible for waste management operations. *Developing communication within the waste management system* is meant to encourage participation of all those influenced by waste management activities. In particular, facility operators and haulers should be kept informed of study activities, mainly because performing the study will disrupt their normal operations. Decision makers should also respect the fact that these individuals are operating a business, and that some information may be considered confidential. Good relations between participants will also lead to better study results (more access to information). The *sampling program* is discussed in detail in Volume II of the Guide.

Sort Categories

Both waste stream assessment methods also require designating sort categories, which are the specific waste stream components to be identified and quantified. Sort categories should be selected according to the purpose of the study. For example, recycling markets may be used to define sort categories for a study in support of recycling program development. Figure 3.3 provides some example sort categories.

Using Existing Data

This second method of waste stream assessment involves using the information in existing waste stream assessments combined with local knowledge of the waste stream to estimate local municipal waste generation. Information from communities with similar demographic characteristics and waste sources can be extrapolated to fit the local waste shed. Also,

FIGURE 3.3
Example Sort Categories

- Paper
  - Newsprint
  - Office paper
  - Glossy/magazines
  - Computer paper
  - Corrugated cardboard
- Plastic
  - PET (soft drink bottles)
  - HDPE (milk jugs)
  - Mixed Plastics
  - Polystyrene foam
  - Other (LDPE, polypropylene, PVC)
- Metals
  - Ferrous metals (steel, tin, etc.)
  - Aluminum
  - Other non-ferrous
- Glass
  - Clear
  - Amber (brown)
  - Green
  - Other non-container
- Yard Waste
  - Leaf waste
  - Grass clippings
  - Stumps and brush
- Wood (pallets, wood furniture, etc.)
- Tires
- Other rubber
- Leather
- Food wastes
- Diapers
- Other inorganics (ceramics, stones, etc.)
- Fine material (passes through 0.75 inch mesh screen)
- Textiles (clothing, rags, etc.)
- Construction and demolition debris
- Household hazardous wastes (cleaning solvents, pesticides, etc.)
- White (or durable) goods (large appliances, furniture, etc.)
- Residuals (e.g., ash, sewage sludge)

local collection services and facility operators are excellent sources of information on the local waste stream, and in some cases, will have written records. This method is less expensive and less time consuming than the first method, so it may be especially appealing to smaller communities or those with severe financial constraints. There are a variety of factors, however, that affect waste composition, so this method should be used with caution.

Waste stream data represent only a snapshot -- data depend on the particular waste shed and the time at which they are collected. Any extrapolation or reinterpretation of the data may produce misleading results.

Waste stream studies have been conducted primarily for state and county solid waste management planning, resource recovery facility planning, and recycling feasibility studies (EPA's *Bibliography of Municipal Solid Waste Alternatives* provides a list of several existing waste characterization studies; it should be noted, however, that waste stream assessments are being performed fairly frequently and the data pool is expanding).

Reports based on these studies vary both in content and presentation, and are in many respects difficult to compare. When deciding which existing characterization studies might be applicable to the local waste stream, priority should be given to information from studies conducted for communities most similar in size, population, income distribution, urban/rural distribution, and economic base. Although no two communities have exactly the same demographics, some reports address areas whose characteristics mirror the local waste shed more than others. Decision makers should also consider how old the studies are, as waste generation changes with time.

Choosing a Method for Assessing the Waste Stream

Whether communities decide to perform their own study or rely on information provided in existing studies depends on the type of information needed and available resources.

Many communities elect to use existing data to obtain "ballpark" figures on waste stream

Sample Waste Stream Assessment Data

The following data are actual figures developed during waste stream studies at Ingham County, Michigan and Atlantic County, New Jersey. These case studies not only provide examples of the sort categories used, they show how data may vary for different localities. Note, for example, the yard waste percentages. The comparison also shows that categories may have been defined differently, as evidenced by the significant differences in the "other organics" categories.

Percentage of Total Stream

Sort Category	Ingham County	Atlantic County
Newspaper	11.93	9.1
Corrugated	4.74	8.2
Mixed paper	28.74	22.9
Total Paper	45.41	40.2
Ferrous Metals	3.69	5.4
Aluminum	1.32	-
Other non-ferrous	1.43	-
Total non-ferrous	2.75	1.8
Total Metals	6.44	7.2
Total Glass	6.28	10.7
Plastic	6.85	8.5
Yard waste	12.78	4.0
Food waste	8.50	-
Wood	2.87	-
Textiles	6.30	4.2
Other organics	1.47	17.1
Other inorganics	3.07	1.1
Not Classified	-	6.5

(Source: McCamic, 1985)

quantities and composition. This is often done when decision makers are in the early stages of the planning process, when small programs are being implemented, and when more elaborate waste management programs are in the early planning stages. It is often the most economical way of generating information to make preliminary planning decisions. For example, if a community is contemplating a pilot-scale curbside recycling program, then existing waste stream data combined with local knowledge may be sufficient.

Communities that are implementing more comprehensive municipal waste management options tend to use data generated by an actual waste stream assessment performed in the community. Large-scale materials recovery facilities, recycling programs, and waste-to-energy facilities usually demand detailed information to ensure proper design. Although these are all high capital investment options, many decision makers feel that the cost of the waste stream assessment is justified by the resulting risk minimization.

In general, decision makers will have to weigh the costs and benefits of performing an actual waste stream assessment study. One factor to consider is that, as more and more communities perform their own studies, the data pool gets larger, which reduces the probability of large errors in an analysis based on analogous studies. Computer models are also available that compile large amounts of waste stream data. Some of these programs can be adapted to generate data corresponding to the local waste stream.

Costs of Waste Stream Assessment

The cost of performing a waste stream assessment varies from community to community. Costs associated with waste stream assessment studies include:

- One time planning cost
- Field sampling cost
  - -- Labor
  - -- Equipment
- Data analysis cost

The actual costs of performing the study depend on the type and quality of information needed. On one hand, smaller communities looking for general waste stream information may be able to perform a study for $35,000 to $65,000 (refer to *Solid Waste Stream Assessment Guidebook* put out by The Michigan Department of Natural Resources in 1986). On the other hand, larger, full-scale studies can cost as much as $400,000.

Local Sources of Information

Regardless of the type of study conducted, a large amount of local information will be required. Waste generation estimates, sources of waste, demographic information, types of commercial facilities, and employment data are all examples of the types of local information decision makers will need. Specific sources include:

- Waste haulers;
- Landfill and transfer station operators;
- Existing planning documents (e.g., state plans);
- Census bureau;
- Public works office;
- Utilities;
- Retail trade reports; and
- Employment data.

ASSESSING THE FUTURE WASTE STREAM

So far, this chapter has focused on assessing the current waste stream. While this is of fundamental importance, solid waste planning, by definition, is for a *future* waste stream. The quantity, composition, and sources of waste generated in the community will all change with time. Assessing the future waste stream is one of the most important aspects of integrated solid waste management planning. It demands a knowledge of the current waste stream and requires the use of population and economic trends and changing waste generation patterns.

Analysis of the Future Waste Stream

Although future waste stream projections are subject to uncertainty, certain techniques and calculations can make the projections as realistic as possible. These techniques and calculations represent a methodology similar to that used when extrapolating data to the local waste stream, as described in *Volume II* of the *Guide*. The rest of this section focuses on the qualitative issues that should be addressed before any analysis takes place.

Population Changes

Residential growth or decline is one of the first areas to consider when assessing the future waste stream. Local, county, and state planning agencies are excellent sources of this information. Decision makers should obtain as much detailed information as possible.

INFORMATION SOURCES

- Local, county, and state planners
- Local, county, and state legislatures
- Employment offices
- Chamber of Commerce
- Private marketing firms

Population factors such as income distributions, employment information, and other demographic data all have potential impacts on the waste stream. Population density is also important when developing ideas on future logistical concerns of the waste management system. Collection routes and vehicles, recycling feasibility, and facility siting are just a few examples of areas where population density projections will assist in planning.

A change in the local population could influence how waste is collected and disposed of quite significantly. For example, a population rise in what once was a rural area may require a shift from centralized waste drop-off and collection to a more elaborate curbside program. Population growth could also make certain waste management alternatives more economical. A recycling program that may have been logistically difficult to implement in a scattered population area may be easier to implement in a new residential development.

Commercial Growth

Commercial growth can significantly alter the quantity and composition of a community's waste stream, and decision makers should pay particular attention to the trends and opportunities commercial development may create. Commercial sources produce large amounts of specific types of wastes that affect waste stream composition. Office buildings, for example, generate large amounts of various grade paper. One advantage of many commercial wastes is that they are easily separated and recycled. So, aside from the quantity and composition changes that will be experienced, introduction of these new generators into the community will also create new opportunities for commercial recycling and source reduction.

Industrial Growth

Industrial growth will also affect the waste stream, as these facilities produce significant quantities of municipal solid waste in addition to industrial waste. Decision makers must be aware of the quantities and types of wastes these sources produce, as they are likely to affect the community's disposal capacity.

Per Capita Generation

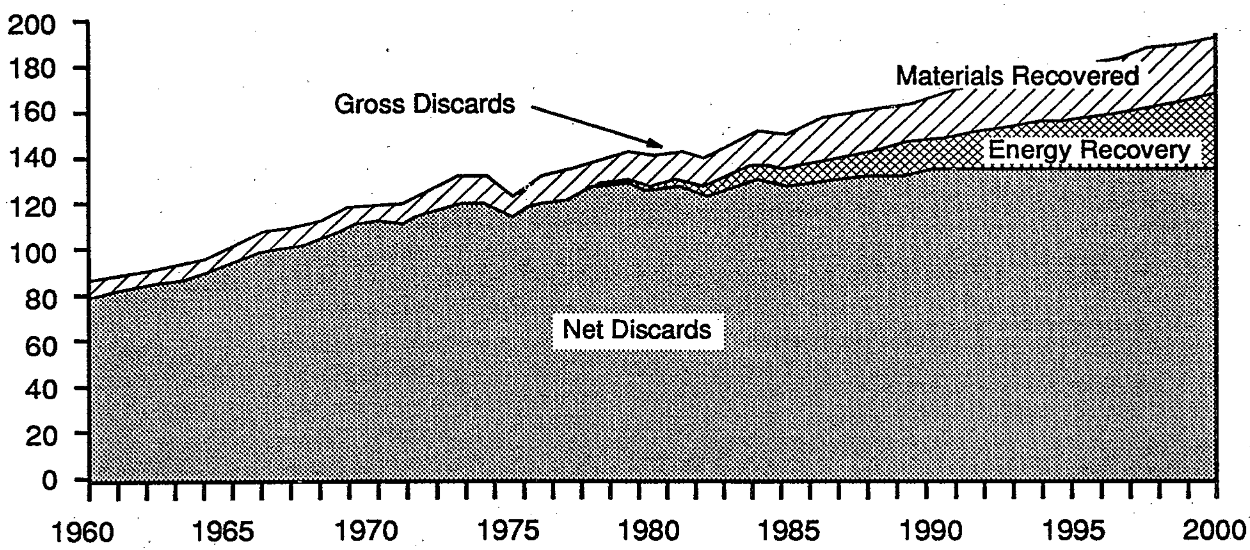
It is generally assumed that the trend of increasing annual waste generation per capita will continue into the future. That is, in the absence of changes to counter these trends, decision makers should anticipate a rise in the pounds of waste produced by an individual or household per year. Education and implementation of source reduction will be helpful in reversing this trend.

A good source of per capita projections is the EPA report entitled *Characterization of Municipal Solid Waste in the United States, 1960-2000* (EPA, 1988), which contains estimates of future waste quantities and composition.

The Effect of Waste Management Practices

Accurate waste stream projections will be difficult to make considering the rapid change in the way waste is handled. It will be difficult to assess the impact that future source reduction, recycling, and composting activities will have on the amount of waste requiring disposal. But this should not discourage decision makers from making projections; rather it should encourage them. An important result of assessing the future waste stream is that areas of concern may become apparent, highlighting areas where future waste management programs can be targeted.

Gross Discards into the Municipal Waste Stream, 1960 - 2000



(Source: Franklin Associates, 1988)

EVALUATING CURRENT WASTE MANAGEMENT IN YOUR COMMUNITY

After assessing the waste stream, it is important to understand how waste is currently being managed in the community. With this information, the decision maker will then be equipped to define problems in solid waste management and set objectives for solving these problems.

This section should assist decision makers in answering two questions:

- How are the major components of the waste stream currently managed?
- If current waste management operations remain unchanged, what problems may arise in five years? Ten years? Twenty years?

Local decision makers, planners, and public works officials know much more about the local system and its operation than this *Guide* can hope to address. Therefore, the purpose of this section is to prompt the decision maker into asking the right questions about the local system, perhaps indicating aspects they may not have previously considered.

Landfill Capacity

One of the first activities the decision maker should undertake in assessing the current waste management system is to evaluate the remaining life of the local landfill(s). In many cases, because of the difficulty in siting a new landfill, this could be the most acute problem a community is facing. It is a problem that could drive all future waste management decisions. Directly linked to the landfill capacity issue is the cost of land disposal. As full capacity is approached and new landfills are not sited, the demand for the remaining landfill space increases, which usually results in increased tipping fees. The decision maker must ask: if disposal in the current landfill is to continue, will the current waste management budget be able to handle the increased costs?

Still another consideration that must be taken seriously is the environmental integrity of the current landfill. A number of landfills have been linked to ground water contamination. In many communities, the costs of cleaning up contamination due to past disposal practices are quite significant. Decision makers should determine the environmental integrity of the local landfill and evaluate whether the landfill should continue to be used. Clean up of an old landfill can significantly limit the resources a community can spend on new waste management technologies.

Many communities ship their municipal waste out of the local waste shed for disposal at a distant facility. It may be more difficult to obtain information on these facilities, but it is important to determine the same information (e.g., projected capacity, costs, environmental risks) if these facilities are expected to be used into the future. Also, decision makers should note that growing concerns about cross boundary shipments in receiving states and communities could limit this option in the future.

Collection and Transfer Activities

Decision makers should have an accurate inventory of all collection vehicles and equipment under the municipality's control. They should also account for private collection services and the types and quantities of wastes they handle. Furthermore, they should understand collection factors such as the labor force, frequency of collection, point of collection, etc. (see Chapter Four).

Most decision makers already have a clear idea of how collection operates. Future waste management scenarios, however, will probably involve very different collection demands (e.g., curbside collection of recyclables, mechanized collection vehicles, etc.). When evaluating waste management alternatives, decision makers must determine if waste management options are compatible with existing equipment and personnel skills to determine whether new equipment, employee skill mix, or programs will be needed.

Existing transfer stations should also be evaluated in terms of future changes in the waste stream and waste management system. The same capacity questions that applied to landfills apply to transfer stations. Decision makers should also account for any recycling activities that take place at local transfer stations, and begin developing ideas on how new programs may be implemented at transfer stations in the future.

Combustion Facilities

Approximately 10 percent of the nation's municipal solid waste is currently handled at combustion facilities (i.e., incinerators or waste-to-energy). These facilities may be in the community or operated at a regional level. Again, the main question to consider is capacity. How much of the future waste stream can be handled at the facility?

In addition to the capacity question, decision makers should also look at the potential for materials recovery and how future recycling or materials recovery programs may affect facility operation. Combustion facilities are designed to handle a certain composition and quantity of waste. Some may even require that a certain portion of the community's waste stream be handled at the facility (flow control ordinances). Decision makers should evaluate what constraints current facility operation may place on future waste management decisions, and how they can be reconciled.

Another factor to consider with these facilities is environmental compliance. Regulations on air emissions and ash disposal are expected to change significantly in the coming years. Decision makers should determine whether the facility is currently in compliance, and whether it will be in compliance if regulations become stricter (i.e., can the facility be upgraded or retrofitted with pollution control equipment). Decision makers will also want to assess the costs of future compliance.

Recycling Activities

Existing recycling and composting programs should be evaluated in terms of who operates them, what materials are involved, the status of materials markets, the degree of public participation, and the percentage of materials recovered. By doing this, decision makers will identify areas where more comprehensive programs can be developed.

Source Reduction

Programs promoting source reduction by individuals, businesses, and industry are becoming more and more common. These programs assist in decreasing the amount and toxicity of material that is discarded. Effects of these programs may be difficult to quantify, but do have an impact on the waste stream.

ESTABLISHING WASTE MANAGEMENT OBJECTIVES

Municipal solid waste management and planning will involve long-term, expensive choices. Prior to expending resources on potentially unnecessary studies, analyses, and technical proposals, it is important to develop a comprehensive plan including goals and objectives based upon external constraints, local and multi-jurisdictional issues, waste characteristics and waste management systems, and future waste patterns. Chapters One, Two, and Three of this *Guide* have provided information that should assist decision makers in identifying long-term goals and developing planning objectives to meet these goals.

One of the decision maker's key functions is to serve as the focal point for the decision-making process. A number of people will be involved in the decision-making process, including members of community groups, public officials, technical staff, solid waste managers, and private groups, including business and commercial interests. Decision makers must ensure that, despite the number of groups or individuals involved in the complexities of the decision-making process, each issue is addressed, every major approach is examined, and that a broad perspective is maintained throughout the process.

Figure 3.4 provides a few sample planning objectives. Note, they are not intended to serve as models for any particular community; rather, their purpose is to serve as examples of how a decision maker might integrate the concepts discussed thus far in the *Guide*, and come up with objectives that give direction to the decision-making process.

FIGURE 3.4

Sample Planning Objectives

Some example objectives for meeting these goals are provided here. Note, they are not intended to serve as models for any particular community; rather, their purpose is to serve as examples of how a decision maker might integrate the concepts discussed thus far in this *Guide*, and come up with objectives that give direction to the decision making process.

- Local plans will include provisions for compliance of new and existing facilities with federal and state standards.
- The community will develop a strong community involvement program to enhance reduction, separation, recycling, composting, and facility siting programs, in an effort to meet EPA's goal of 25% waste reduction and recycling by 1992.
- The community will apply for grant funding for program development, feasibility and design studies, and technical assistance, in return for maintaining detailed records of waste characteristics and waste management system performance measures and providing these records to the state on a quarterly basis.
- Public participation will be strongly encouraged throughout the planning and decision making process. Regularly scheduled public meetings will be well-publicized and held.
- The community will join in regional approaches for technical assistance to local programs, public education and information campaigns, and to assist in developing stable markets for recycled materials and products. Regional cooperation in sharing technical and managerial expertise and in technology transfer will be sought from neighboring communities.
- New programs for source reduction, separation, and drop-off of compostable organics and recyclables will be pursued.
- An analysis of the impact of transfer stations with larger vehicles en-route to final disposal and smaller vehicles for pre-transfer collection will be conducted.
- The community will maintain the current waste disposal system, taking advantage of the county waste-to-energy facility. The community will join with a state-run regional recycling program and contribute to the public education components of that program in return for processing recyclables at the regional recycling facility.

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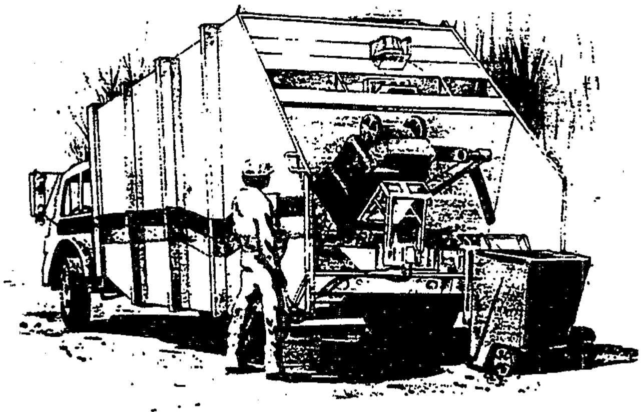
Chapter Four

Collection and Transfer



COLLECTION OF MUNICIPAL SOLID WASTE

In most communities, collecting municipal solid waste is not a new activity. Like the other areas of municipal solid waste management, however, it is a field that is undergoing rapid changes. Reevaluation and even redesign of the local collection system may be a necessary component of integrated solid waste planning.

Collection System Management

One of the main planning decisions is whether the collection system should be operated publicly or through contract or private collection services. In a public system, the municipality owns and operates all equipment, manages personnel, and determines user fees and revenue sources. The advantages and disadvantages of a public collection system are outlined in Figure 4.1.

Communities may choose not to provide all collection services directly, instead turning to some type of privately operated system. Many

MAJOR MESSAGES

- Collection programs are often the most costly component of the local waste management system; proper collection system design and management can result in significant cost savings.
- Siting difficulties in populated areas are pushing disposal facilities away from waste sources and increasing the costs of transporting wastes. Transfer stations can potentially reduce these costs by increasing overall collection system efficiency.

Recycling Program Collection is Discussed in Chapter Six of this Guide

The collection of source separated materials as part of a recycling program creates a number of new collection issues decision makers must consider, such as dedicated recycling vehicles, provision of storage containers, and collection scheduling.

Because these issues are so interrelated with recycling program implementation, their discussion has been reserved for the "Recycling" Chapter (Six) of this Guide. Chapter Four concentrates mainly on overall collection issues as they relate to the entire waste management system, rather than to a particular program.

communities find this type of system more efficient and less costly than a public system. Privatized collection can take several forms, depending on the needs of the community. *Contract* and *franchise* are terms often used to describe types of privatized systems. The definitions of these terms vary from community to community. *Contracts* often refer to agreements (resulting from a public bidding process) between the community and a vendor in which the private firm agrees to collect refuse for a pre-specified amount of money. The local government or waste management authority is usually responsible for setting fees and billing customers in such a system. *Franchises* involve a specified area of the community for which the private firm is responsible. Again, these agreements usually result from a public bidding process. With a franchise, the private firm often directly bills the customer at rates that are set by the local government. Variations and combinations of these systems are used throughout the country.

Another collection option is the completely privatized, or *private subscription* system, in which residents choose between competing collection companies and subscribe to their service. Refuse is collected for a fee set by the private company, and local governments exercise little control. The advantages and disadvantages of privatized collection are also outlined in Figure 4.1.

In 1988 private collection systems handled 60 percent of the household waste and 90 percent of the commercial waste generated in the United States (Wingerter, 1988).

FIGURE 4.1
Public Vs. Private Collection

Public Collection

Advantages

- Non-profit, so no additional revenues have to be raised for profits;
- Government operation results in purchasing advantage;
- Centralized operation allows for standardization of procedures;
- System flexibility is more easily designed.

Disadvantages

- Susceptible to political interferences;
- Short-term politics may favor cheapness instead of long-term economics;
- Capital expenditures take longer to process;
- Personnel efficiency may be lower than that of private firms.

Private or Contract Collection

- May be less susceptible to political interference;
- Competition can increase system efficiency and improve service;
- More flexibility in establishing management structure;
- Can involve less strain on municipal budget (e.g., capital expenditures internal to private firm);
- Fiscal and administrative consistency.

- Profit structure and taxation costs may be passed on to customers;
- Community dependence on one contractor may occur minimizing advantages accruing from competition;
- Third party administration (requires municipal oversight);
- Accountability (e.g., financial difficulties and contract problems can hinder service).

(Derived from: OSCAR, March 1989)

When planning the local waste management system, decision makers should consider both the public and private collection approaches. The final decision will ultimately depend on local conditions and the opinions of local decision makers. Both approaches have advantages and disadvantages. It is up to the decision maker to determine which system best fits the community's needs.

> **Providing a Public Service**
>
> When evaluating municipal solid waste collection alternatives, decision makers must keep in mind the idea of customer service. In particular, decision makers must evaluate services in terms of each of the following areas:
>
> - *Efficiency*: minimize the cost per household;
> - *Effectiveness*: satisfy the community's needs;
> - *Equity*: provide service equally to all social and demographic groups;
> - *Reliability*: ensure consistency; and
> - *Safety and Environmental Impact*: ensure worker safety and the protection of public health and the environment.

Standardizing Procedures

The standardization of collection procedures within the community's decision-making framework can provide substantial benefits to the entire municipal waste management system. Standardization of procedures does not necessarily imply that the local government delivers all collection services. Privatization of portions of the system is still a viable alternative. What it does imply is that local government takes responsibility for the delivery of services, and ensures that it is done in an equitable, efficient, and cost-effective way.

Some of the advantages of collection system standardization are listed here:

- *Economies of scale*; financing, purchase of equipment, and development of recycling markets can all benefit from a large, standardized system;
- *Flexibility*; in case of breakdown or other problems, standardized control over the system will allow alternative procedures to be implemented;
- *Ability to experiment*; new technologies and programs can be tested in a system where all other factors can be held constant.

Decision makers should continually explore and consider methods of standardization that will benefit the delivery of services.

The remainder of this Chapter examines the more specific elements of a municipal waste collection system.

Point of Collection

The point of collection affects collection system elements such as crew size and storage, and ultimately controls the cost of collection.

Residential Collection Point Alternatives

Residential collection point alternatives include:

- Curbside/Alley;
- Backyard/On-property; and
- Drop-off Centers.

Curbside and alley collection requires the resident to place the waste containers at the curb or alley for collection. The resident must then retrieve the containers from the curb.

Backyard collection can take several forms, but basically involves retrieving containers from in, at, or behind the home.

Drop-off centers are used in areas where individual collection is impractical and in communities where cost savings are more important than service provision. These usually involve regularly-emptied dumpsters or other containers where residents drop off their waste.

Evaluating Residential Collection Point Alternatives

Curbside or alley collection is generally more economical than the backyard system, which is more time consuming. Backyard collection involves more truck idling time and more wasted driver time.

The point of collection, however, may depend largely on historical precedent in many communities. Residents may demand specific services. In some cases, communities provide a choice of curbside or backyard service and charge a different price for each.

Commercial Collection Points

Commercial waste collection usually takes place at dumpsters located at the establishment. Commercial generators often hire a collection company to handle their waste, but some municipalities take this responsibility. If the municipality is responsible for commercial waste collection, some type of standardized containers will be most efficient, as dumpsters or other containers must be compatible with the various collection vehicles.

> Decision makers are encouraged to refer to EPA's 1976 *Decision Makers' Guide in Solid Waste Management* and the forthcoming Volume II of this *Guide*, which cover collection system design in more detail.

Frequency of Collection

Collection frequency is based on cost factors as well as customer service. More frequent collection is generally more costly. A collection frequency of at least once a week is usually required for aesthetic and health reasons, as residential wastes usually contain food wastes and other putrescible material. In more densely populated areas, more frequent collection may be required because of limited storage space in households and at businesses.

Evaluating Frequency Alternatives

Collection frequency largely depends on the demographics of the area where collection takes place and the service demanded by residents. Factors to consider include:

- *Costs.* Fewer trucks, employees, and total route miles result from less frequent collection.
- *Storage Space.* Less frequent collection may require more storage space at the household.
- *Sanitation.* More frequent collection reduces health, safety, and nuisance concerns associated with stored refuse.

Storage Containers

Proper container selection can save collectors' energy, increase the speed of collection, and reduce crew size. In general, the types of containers used should be defined by ordinance or regulation, and citizens should be informed of what is expected of them and why. The various containers currently used for the storage of household waste are described in Figure 4.2.

Evaluating Container Alternatives

When evaluating residential waste containers, the following factors should be considered:

- *Efficiency.* Containers should help maximize overall collection efficiency.
- *Convenience.* Containers must be manageable for both residents and collection crews -- some communities set maximum weight limitations.
- *Compatibility.* Containers must be compatible with collection equipment.
- *Public Health and Safety.* Containers should be securely closed and stored.
- *Ownership.* Municipal ownership can guarantee compatibility with collection equipment, as well as symbolize a service to residents.

FIGURE 4.2
Residential Waste Storage Containers

Containers for mechanized collection. Mechanized collection from bulk containers is becoming a popular and efficient collection practice. This system usually involves 80 or 90 gallon plastic roll-out containers that are tipped into the collection vehicle automatically by an arm attached to the vehicle. These containers are often provided by the municipality to ensure compatibility with collection equipment.

Metal or plastic cans. These common containers are designed with tight-fitting lids and made from galvanized metal or plastic. Sizes vary from 20 to 32 gallons. Residents usually own this type of container.

Paper and plastic bags. Bags are lightweight, efficient methods of storing certain types of refuse. Disadvantages include bag failure and their susceptibility to damage by foraging animals. Paper bags are often used to store newspaper and yard wastes in conjunction with recycling and composting programs.

55 gallon drums. Size and weight make these drums difficult and even dangerous to handle. They usually have no lids, which allows precipitation to enter, making them even heavier. Rusting of the drums can result in sharp edges. The use of drums is becoming less and less common.

Bulky Items

Bulky items such as appliances, stumps, and furniture often demand unique collection practices. Several options exist for collecting this type of waste:

- Collect with other refuse;
- Pickup at homeowners request;
- Periodic or seasonal pickup along defined routes; and
- Pickup after report from collection crew.

Because bulky wastes create unusual collection problems, decision makers should plan procedures that will work most efficiently and cost-effectively with the overall collection system.

Collection Revenues

Fees for collection services take a variety of forms. A straight user fee distributes equal shares of the cost of collection to all residences serviced. Variable user fees involve billing residences according to the amount of waste they produce in an effort to correlate costs with services. This system may involve charging on a per-container basis, or setting a minimum fee for a certain number of containers with an extra charge for additional containers.

In addition to the basic user fee methods, a variety of progressive taxes or fees can be used to generate waste management revenues. These are discussed in more detail in Chapter Twelve of this Guide.

Collection Crew Size and Personnel Management

Municipal solid waste collection is a labor-intensive activity, and labor is usually one of the most costly aspects of a municipal collection system. Labor, however, is often overlooked as a powerful means of improving system efficiency. Decision makers can influence the productivity of the collection system by using an effective collection crew size and proper personnel management.

Collection Crew Size

Selecting the proper collection crew size depends on the point of collection and the demographic breakdown of the collection route (e.g., urban vs. suburban). In general, a one person crew is the most productive option in terms of homes served and tons collected per hour.

Not all collection systems, however, can operate with only one person crews. Factors such as existing equipment, distance between collection points, types of wastes collected, and union contracts also come into play. Decision makers should carefully analyze the existing collection system in an effort to optimize collection crew size. This may involve examining the feasibility of instituting mechanized collection vehicles, which are more cost-efficient.

Personnel Management

Because of the repetitive nature and perceived lack of opportunities for advancement, job satisfaction is often low among municipal waste collection crews. Crew productivity, therefore, depends directly on management effort. This may involve creative worker incentive systems or innovative approaches to routing, collection frequency, etc. Municipal managers can help facilitate change by working cooperatively with employees and any unions, through such policies as advanced notice of proposed changes, meaningful consultation and joint planning, and trial periods followed by mutual consideration of initial results and new implementation proposals.

Training is also an important aspect of any personnel management program. It will help collectors, drivers, equipment operators, mechanics, and other employees to understand both their jobs and the system better. Training in basic public relations, work rules, unit operations, safety, and equipment use and care should be scheduled at regular intervals.

Safety is another important consideration. Solid waste collection workers have an extremely high injury rate and injury severity rate. This injury problem results in both direct and indirect human and financial costs. Dramatic cost savings can be realized by implementing safety training programs and providing safety equipment such as gloves, safety glasses, respirators, and special footwear. In addition, personnel managers may find it beneficial to provide vaccinations to workers, especially for exposure to hepatitis and other transmittable diseases.

Collection Routes

Proper routing can have major impacts on collection system efficiency. Not only can person-hours and vehicle mileage be minimized, energy can be conserved and collection crew safety can be maximized. As new programs such as recycling and composting are implemented, the waste stream may decrease. The collection program must take this into consideration to make collection for disposal more efficient (Schuster and Schur, 1974).

Residential Collection Vehicles

Vehicle selection is critical to the productivity and cost-effectiveness of waste management. Collection vehicles come in a variety of sizes and shapes, and are selected based on specific local needs. A trend that has emerged in recent years is the move towards automated collection vehicles. Mechanized tipping equipment is rapidly gaining popularity. Instead of hand-loading the refuse, workers use mechanized "arms" to lift and tilt the containers. Mechanized collection increases worker safety and productivity.

A number of truck types are currently used:

- Rear loaders;
- Side loaders;
- Front loaders;
- Roll-off and tilt-frames;
- Transfer trailers; and
- Vehicles designed for recyclables.

Collection vehicle bodies are usually sold as units that are mounted on a chassis (the frame and working parts of the vehicle, as opposed to the body). Vendors will quote prices of the vehicles either as "mounted" (including the chassis) or "unmounted." In many cases, the municipality or private collector will purchase the chassis separately. Figure 4.3 outlines some of the trends, options, and prices associated with collection vehicles.

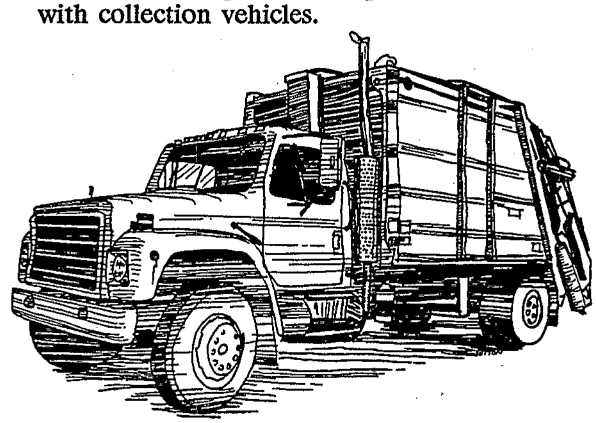


FIGURE 4.3
Collection Vehicles: Trends, Options, and Prices

Collection Vehicle Trends

Trends in solid waste management affect all aspects of future systems, including collection. Some of the trends in truck design and performance are outlined here.

- Recycling could extend the capacity of regular refuse collection, but will demand additional or modified vehicles.
- Federal air pollution regulations (expected in 1991 and 1994) could affect the entire trucking industry, as increased pollution control will increase vehicle costs. Noncompliance fines associated with older vehicles could also affect overall collection costs.
- Industry indicators (including the Federal Highway Administration) suggest that a shortage of skilled truck drivers has begun in the United States. Labor forecasters are anticipating up to a 25 percent shortage in qualified operators of large (greater than 26,000 lb) trucks. In addition, national driver's licensing and testing standards are being considered. The driver shortfall could impact collection system personnel across the country. Not only may salaries rise (increasing collection costs), filling positions could also become difficult, as in some cases, drivers also serve as part of the collection crew.
- A national plan to overhaul truck weight laws and enforcement is under consideration. Because of the high weights and short wheel base associated with collection vehicles, these laws could have a major impact on collection, as many existing trucks may not meet future requirements.
- Another trend in truck design coincides with anticipated standards from the National Highway Traffic Safety Administration. Safety equipment could add over $29,000 to the cost of a state-of-the-art truck.

(Source: Waste Age, August 1988)

Options and Prices (1989)

When purchasing refuse collection vehicles, buyers look at body, hydraulic, and chassis specifications. In particular, bodies should meet all American National Standards Institute (ANSI) safety standards with standard equipment.

- Chassis. Chassis prices vary greatly, depending on the body design desired. The ballpark for chassis prices is in the range of $74,000 to $82,000. Mounting charges are in the range of $3,000 to $5,000.
- Rear Loaders. These units can be loaded by hand or automatically. The trucks are usually grouped into categories based on the rated compaction pressure of the truck. The different categories are heavy-duty, medium-duty, and light-duty. Unmounted heavy-duty (20-31 yd.) rear loaders range from $45,000 to $48,000. Medium-duty (16-25 yd.) prices are $35,000 to $40,000.
- Side Loaders. These units also come in hand loading and automatic loading versions (some of the automatic loading vehicles can be operated from inside the cab). Unmounted, hand loading units (10-32 yd.) range from $40,000 to $45,000. Mounted, the hand-loading units are $70,000 to $90,000, and the mechanized systems are $110,000 to $120,000.
- Front Loaders. Front loaders are used to pick up dumpster-type containers. One person usually both drives and operates the collection device. Front loading vehicle prices range from $50,000 to $55,000.
- Roll-Off Containers. The price of cable systems range from $15,000 to $20,000, while hydraulic systems are in the $24,000 to $56,000 range.
- Transfer Trailer. Transfer trailers come in two basic varieties: open-top and enclosed. Standard open-top trailers (45 ft., 115 cu. yd.) cost from $45,000 to $50,000. 6 axle trailer: $50,000 to $70,000. 8 axle trailer: $60,000 to $80,000. Enclosed: $40,000 to $50,000. Multi-axle units: $25,000 to $75,000.
- Vehicles for the Collection of Recyclables. These vehicles are discussed in Chapter Six of this Guide.

(Prices based on contacts with vendors and industry representatives)

Evaluating Collection Vehicle Alternatives

Decision makers will want to consider several factors when selecting collection vehicles. In terms of personnel, the ease of entry and exit and the materials loading efficiency should be considered. In terms of the vehicle, storage capacity and fuel efficiency are important considerations. Capital, operating, and maintenance costs should also be part of the evaluation.

Factors related to the local system will also play a role in vehicle selection. Housing density and the number and configuration of one-way and dead end streets place constraints of vehicle maneuverability, as do traffic conditions and topography. Road and bridge conditions and vehicle weight limits are also important factors. The distance from the route to the unloading point is also important.

One additional consideration is the flexibility of equipment to adapt to changing collection demands. Long-term goals, plans, and anticipated changes should be part of the evaluation process.

Planned Preventive Maintenance

A standardized, planned preventative maintenance program can provide long-term benefits to the collection system. Fewer emergency failures and road calls will occur when vehicles are well maintained. Also, maintenance costs can be reduced, as problems are detected early in a system that regularly checks equipment. In addition, when deciding on new vehicles and equipment, decision makers and local collection staff can rely on the increased experience and knowledge when making decisions (Hickman, 1986).

Rural Collection

Although many of the collection factors that apply to municipal collection also apply to rural collection, sparse population creates some unique planning considerations. For example, in large areas with low population density, the benefits of cooperative, regional approaches can be substantial. This is true for financing the system, purchasing equipment, and hiring personnel. Also, when planning a rural collection system, decision makers should allow the flexibility to accommodate growth and expansion. Another planning consideration is the ability to integrate the town's system with collection systems currently existing throughout the region;

Rural Collection Alternatives

A traditional method of rural waste management has been disposal on one's own property. Although this method can be convenient for homeowners, local officials may find the need to exercise more control over waste disposal in order to avoid adverse environmental impacts.

Aside from disposal on one's own property, four basic rural collection alternatives are used:

- Direct haul by residents to disposal site;
- Centrally located bulk containers ("Green Box" containers);
- Roll-off containers; and
- "Mail Box" collection of solid waste.

The options are outlined in more detail in Figure 4.4.

FIGURE 4.4
Rural Collection Options

Direct haul by residents to a disposal facility is generally used in sparsely populated areas where a collection system is impractical. This method does involve inconvenience to the resident, and may also be difficult to control.

Green box refers to the use of 8 to 12 cubic yard steel containers that are placed strategically throughout the region. A front loading compactor is used to collect the waste from the containers. Although residents are still responsible for delivery to the container, careful placement throughout the region can minimize travel distances. This system requires constructing a pad (cement, gravel, asphalt) on which the container is stored. The pad is also designed for vehicle access purposes.

Roll-off containers are placed throughout the region in the same manner as the strategic bulk containers. These containers, however, have a greater capacity (20 cubic yards) and are sometimes equipped with a compactor. The roll-off containers are loaded onto a truck and transported to the disposal facility. This method also requires the construction of a pad.

Mail box collection systems require residents to leave their waste near their mail box for scheduled collection, in a manner similar to curbside collection in residential areas. This system assumes that a collection vehicle can travel the same routes as a mail delivery vehicle.

When rural collection systems involve un-staffed drop-off centers, provisions must be made to provide for customer safety; for example, the container should be easily loaded by residents. Procedures should also be taken to minimize animal scavenging, and prevent illegal dumping.

TRANSFER STATIONS

Transfer stations are centralized facilities where waste is unloaded from several small collection vehicles and loaded into a larger vehicle for hauling. This tends to increase the efficiency of the system, as collection vehicles and crews remain closer to routes, while larger vehicles, designed for transfer, make the trip to the disposal facility.

Because of siting problems and the lack of available space, landfills and other disposal facilities are being sited in more remote areas, away from municipal waste sources or generation points. Consequently, the costs associated with transporting the waste from the collection route to the disposal facility are increasing. Transfer stations are becoming a more attractive alternative for controlling these rising costs. In addition, transfer station operation may be integrated with other waste management options, such as recycling programs and waste-to-energy facility operation, which further enhances the attractiveness of transfer stations.

Despite the benefits associated with transfer stations, significant capital and operating costs may remove them as feasible options for many communities. Decision makers must perform careful cost and benefit analyses when evaluating transfer stations. This section should assist in this process.

Transfer Station Planning

As with other municipal waste management facilities and programs, there exists a need for public responsibility at transfer stations, whether they are municipally or privately operated. The primary reason for this is to ensure that the waste is managed according to local goals and objectives. This may involve keeping waste streams segregated in conjunction with disposal or recovery programs. For example:

- In-state and out-of-state waste may be accepted at the facility. Accounting for the flows of these waste streams requires monitoring to ensure that all waste received is identified.

- Hazardous and non-hazardous waste must be segregated. Most municipal waste transfer stations will not accept hazardous waste unless designated handling areas exist.

- Commercial and residential waste may be kept separate for the purpose of recovering material. Many commercial waste loads contain large amounts of recyclable materials, such as office paper.

Transfer Station Design

Transfer station categories are briefly outlined in Figure 4.5 and some of the associated advantages and disadvantages are included.

Transfer Vehicles

Transfer vehicles come in two basic varieties:

- Open-top trailers, and
- Enclosed trailers.

Open-top, noncompaction trailers are lighter than their compactor counterparts and, consequently, a larger payload can usually be loaded in these vehicles before weight limits are reached, unless the waste has been previously compacted. There are difficulties, however, associated with covering the trailer (usually requires more than one person to pull the canvas tarp over).

Compaction trailers are enclosed vehicles that are loaded by some type of stationary compactor. This type of trailer is easy to unload (they are usually equipped with some type of hydraulic blade) and problems associated with canvas tops are avoided. The compaction or ejection equipment, however, constitutes "dead-weight" in the vehicle so waste payloads are smaller due to legal weight limitations.

Transfer trailer options and prices were presented in Figure 4.4.

Factors Affecting Transfer Vehicle Selection

Decision makers should consider:

- Capital costs;
- Capacity of the trailers;
- Type of station;
- Length of haul to disposal site;
- Hours of haul/day;
- Quantity of waste; and
- Weight limits.

Transfer Station Costs and Benefits

Developing and operating transfer stations involves significant capital costs, including land acquisition, buildings, equipment, and haul vehicles. Costs of design, site preparation, and construction are also significant.

Substantial benefits, however, can also be realized. Cost savings resulting from transfer station implementation may include:

- Reduced nonproductive time of collection crews;
- Reduced truck mileage;
- Reduced maintenance costs (smaller collection vehicles stay on paved roads, limiting the suspension and drivetrain problems associated with driving at landfills); and
- Increased use of lighter duty collection vehicles.

FIGURE 4.5
Transfer Station Design Alternatives

Design Option	Advantages	Disadvantages
<u>Tipping floor, open-top trailer</u> • Large tipping floor where collection vehicles unload • Dozers organize and push waste into open-top trailers	• Requires little site work • Involves relatively low building costs • Can separate recyclables	• Not as efficient as other systems for large volumes of waste
<u>Pit, Open-Top Trailer</u> • Collection vehicles unload directly into a large pit • Tractor with dozer or landfill-type blade organizes the waste and pushes loads into open-top transfer trailers	• Collection vehicles unload while loading and transfer operations are still going on, reducing transfer time. • Pit serves as storage area • Efficient system for high volumes of waste • Can separate recyclables	• Requires three-level facility (considerable amount of site work and capital investment)
<u>Direct dump, open-top trailer</u> • Collection vehicles dump loads directly into open-top trailers via large hoppers • Stationary or mobile clamshell equipment can be used to distribute the waste in trailer	• No intermediate handling of the waste involved, increasing efficiency • Facility shutdown rare because no complicated equipment involved	• If large amounts of uncompacted wastes received, difficult to attain maximum payloads (operation may require separate trailer-packing machines) • Collection vehicle unloading not independent of transfer vehicle loading (additional tipping floor/storage space may be required)
<u>Hopper-type compaction</u> • Waste is gravity-fed via hopper into a stationary compactor that compacts the waste before or while entering the trailer.	• Efficient for small capacity demands	• If compactor fails, no alternative method of loading • Trucks may line up waiting to unload because of limited hopper size.
<u>Push-pit compaction</u> • Collection vehicles dump their loads into large steel or concrete pits • Large hydraulic blade moves the waste to compactor charging box • Compactor packs the waste into the trailer	• Large compactor can usually handle all types of wastes, including large and bulky wastes • Pit acts as storage area during peak arrival	• Large capital investment • Facility operation depends on operation of the compactor
<u>Stationary compactor, roll-off container</u> • Low-volume operations such as rural drop-off centers • Refuse unloaded directly into container	• Container may be equipped with compactor to handle lighter materials	• Bulky and large materials may create problems with small compactor • Operation depends on functioning compactor
<u>Track and top-load</u> • Tracked compactor followed by loading in open-top trailers	• Efficient for larger facilities (over 300 tons per day)	

Evaluating Transfer Station Options

In addition to costs, decision makers should also address these important questions when investigating the feasibility or appropriateness of transfer stations:

- Will a short haul to the existing landfill remain so in the future (i.e., is a new, more remote landfill expected to open)?
- Is the current collection system large enough to make a transfer station economically feasible?
- Is less traffic to the landfill desired?
- How strong is public opposition to siting a new facility?
- Can an existing landfill site be used as the transfer station site?

Another factor to consider in transfer station planning is the demands of the local disposal facility. For example, waste-to-energy facilities will not usually accept baled wastes. Prior to designing the transfer station, it is necessary to identify all specification demands that are in place at these facilities.

Sizing Transfer Stations

A fundamental transfer station design factor is the community's waste volume estimate. History shows that estimates are often inaccurate, resulting in oversized or undersized facilities faced with operating losses and high tipping fees. Accurate waste stream assessment data and estimating the changes in the waste stream due to recycling or other programs (discussed in Chapter Three) are the only way to avoid this problem.

Other Transfer Station Design Elements

Modern transfer stations are usually equipped with the following:

- Scales;
- Office space;
- Employee facilities;
- Fuel depot;
- Fences;
- Landscaping and berms;
- Utilities; and
- Maintenance shop.

Siting Issues

Several criteria determine where a transfer station should be located. Some of these are more obvious than others. First of all, the transfer station should be near the collection area, since minimization of travel distances is the whole purpose of the transfer station. In addition to proximity to the collection routes, access to major haul routes is also important in optimizing transfer vehicle productivity. Access roads must be able to handle heavy truck traffic, and truck routes should be designed to minimize the impact of the vehicles on neighborhoods. Aside from the routing issues, the land on which the facility is built needs to be zoned for industrial purposes, and the area used should provide adequate isolation. Siting the facility will also involve garnering neighborhood and community acceptance, which in many cases is the most difficult task. Some communities have had success using closed landfill sites as sites for new transfer stations.

Integration With Other Waste Management Options

Operating a transfer station can have significant impacts on other elements of an integrated solid waste management system and, if properly planned, these impacts can be extremely positive.

Recycling

Recovering materials for recycling at transfer stations is not a new activity. Private facilities receiving loads with large quantities of recyclables (i.e., corrugated cardboard) have taken advantage of selling these easily separated materials for years. This practice of recovering recyclables at transfer stations is becoming more widespread. Corrugated cardboard, paper, wood, metals, plastics, waste oil, glass, and household hazardous wastes are all currently collected. Not only are portions of the incoming waste stream marketable, recycling removes materials that would otherwise be disposed of. This creates transport and disposal cost savings.

Developing a more comprehensive recycling program at a transfer station may involve significant planning on the part of the decision maker. For example, equipment and employees to separate the materials are likely to be required, as may be processing equipment. Incoming vehicles will have to be monitored, as some contain large amounts of recyclables which may become useless if mixed with other refuse. The benefits of recycling programs often outweigh these planning, monitoring, and cost concerns.

Transfer stations can easily serve as drop-off centers for recyclables, as long as containers or specific areas are designated for this purpose. Aluminum, glass, and newspaper are often delivered by residents to specific areas at transfer stations.

Landfill Operations

Transfer stations will also have a positive impact on landfill operation, as less traffic in and out of the facility and less on-site congestion can be expected to result.

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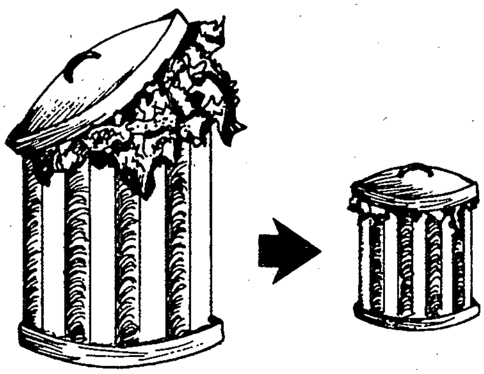
Chapter Five

Source Reduction



MAJOR MESSAGES

- Source reduction is an approach that precedes waste management and addresses how products are manufactured, purchased, and used.
- Source reduction technical options include product reuse, reduced material volume, reduced toxicity, increased product lifetime, and decreased consumption.
- Source reduction programs and approaches can be implemented through education, research, financial incentives and disincentives, regulation, as well as technological developments.

WHAT IS SOURCE REDUCTION?

EPA's *Solid Waste Dilemma: An Agenda for Action*, defines source reduction as "the design, manufacture, and use of products so as to reduce the quantity and toxicity of waste produced when the products reach the end of their useful lives." Source reduction is not a waste management tool, although it can have a positive impact on waste management systems. It involves considering the ultimate destiny of products when making decisions on how the products are made and which products or materials are used.

Source reduction may occur through the design, manufacture, and packaging of products with minimum toxic content, minimum volume of material, and/or a longer useful life. Source reduction may also be practiced at the corporate or household level through selective buying patterns and reuse of products and materials.

Implementing a source reduction program involves changes in the way products are made and used. It is an ethic that is applied throughout a product's life cycle (design, manufacture, sale, purchase, and use). It is a non-traditional approach to the municipal solid waste management dilemma in that it addresses the waste problem prior to generation. Historically, waste management has been an "end-of-pipe" (after the product becomes waste) activity.

Source reduction as waste reduction is not currently a widely applied concept, so it is difficult to estimate the actual impact that source reduction programs have had (or will have) on the waste stream. Although the exact benefits of source reduction are difficult to quantify, the benefits are conceptually clear. For example, through the implementation of source reduction activities, landfill capacity and natural resources are conserved, less energy is used during product manufacture, and air, water, and land pollution are reduced.

SOURCE REDUCTION PROGRAMS

Source reduction activities fall into some basic categories. Examples are provided here to clarify the categories.

Product reuse

An example of product reuse is the reusable shopping bag. Rather than taking a bag from the store after each trip, a reusable bag could be used several times. Using reusable products instead of their disposable equivalents reduces the amount of materials that must be managed as waste.

Reduced material volume

Larger food containers can reduce the amount of packaging used (provided the larger size does not lead to food spoilage). For example, a single 16-ounce can uses 68 grams of metal, or 40 percent less than the 95.4 grams used in two 8-ounce cans (Keep America Beautiful, Inc. 1989). Lighter aluminum cans and glass, buying in bulk, and using concentrates are other examples.

> **Elements of Source Reduction Programs**
>
> Source reduction activities fall into some basic categories:
>
> - Product reuse;
> - Reduced material volume;
> - Reduced toxicity of products;
> - Increased product lifetime; and
> - Decreased consumption.

Reduced toxicity

In an effort to reduce adverse environmental impacts from recycling and other waste management alternatives, source reduction programs encourage reducing the amount of toxic constituents in products entering the waste stream. Less problematic substitutes for the toxic constituents need to be developed and used. For example, substitution for lead and cadmium in inks and paints is a source reduction activity.

Increased product lifetime

Products with longer lifetimes can be used over short-lived alternatives that are designed to be discarded at the end of their useful lives. Technical gains, as in the manufacture of longer lasting tires, is a good example of where this has been successfully applied. Source reduction policies also encourage a design that allows for repairs and continued use rather than disposal.

Decreased consumption

Consumers can be educated on what materials are difficult to dispose of or are harmful to the environment. Buying practices can be altered (e.g., buying in bulk) to reflect this environmental consciousness. Retail purchasers should also be given the opportunity to alter buying practices with respect to source reduction.

IMPLEMENTING A SOURCE REDUCTION PROGRAM

A national policy of source reduction requires the cooperation of business, industry, consumers, and federal, state, and local government. Because the goals and actions of a local waste management system are specific to local conditions, decision makers may wonder how they can affect the actual generation of waste.

There are some specific actions that can take place at the local level to encourage source reduction. In fact, a source reduction program should be part of a community's integrated waste management plan. Several options that are often suggested are:

Citizen-Based Activities to Encourage Source Reduction

Everyday activities can encourage source reduction and citizens can be taught to become "environmental shoppers." Consumer activities that encourage source reduction can include:

- Buying in bulk;
- Avoiding disposable items such as razors and batteries when reusable alternatives are available;
- Reusing common products, such as plastic sandwich bags and paper lunch bags;
- Repairing all kinds of items, from clothes to appliances, rather than disposing;
- Buying concentrates and powdered drinks; and
- Using long-life, energy-efficient light bulbs.

- Education and research;
- Financial incentives and disincentives; and
- Regulation.

Care must be taken when choosing an option for a particular community. While some source reduction activities may work well at the municipal level, others are best done on a larger scale, such as at the State or Federal level.

Education and Research

Education and research programs can be implemented at the local level. Decision makers should target consumers, businesses, industry, government, and other institutions, such as schools. The aim of education and research programs is to provide and develop information about source reduction needs, goals, and methods and to elicit voluntary efforts by the public and private sectors to help bring about specific changes. The activities should address the need for source reduction, consequences, available choices, benefits and costs, and good will. These activities can include:

- Forming a council from industry and government to develop a source reduction "message" for the general public and to develop and carry out educational and research activities.
- Exploring and developing funding sources, such as government grants, industry financial support, in-kind support (donation of staff, offices, supplies), private foundation grants and contributions, and direct taxes and solid waste surcharges.
- Providing a clearinghouse so industry can share source reduction techniques with each other and with government.
- Developing media campaigns for public outreach, including posters in grocery and other stores, and conferences and forums concerning source reduction.
- Developing curricula for schools and universities as well as organizing a group of professionals with knowledge of source reduction and solid waste management.

Since some of these activities may be underway at the State, regional, or national level, local decision makers should pursue ways to build upon and use similar efforts.

Financial Incentives and Disincentives

Financial incentives are designed to encourage source reduction by linking an economic benefit to the implementation of source reduction activities. Financial disincentives are designed to add cost to waste-producing activities that could be avoided through source reduction activities. These incentives and disincentives can be targeted at consumers and industry. If a financial option is chosen, it is important to evaluate its impact:

- Will market conditions need to be considered?
- Will consumer and industry actions be appropriately influenced?
- Will the option be socially equitable and fair?
- Will it address the root problem?

Examples of financial incentives and disincentives include:

Tax Credits/Exemptions. These may be given to companies and institutions that follow specific source reduction procedures for manufacturing or consuming.

Variable Waste Disposal Charges for Garbage Collection. A number of localities have instituted variable waste disposal charges (also known as per-container rates, local user fees, and volume-based pricing). These charges are variable fees, rather than a flat fee, for collection or disposal of post-consumer solid wastes. The fee can be based on the number of garbage cans used, the number of bags collected, or the frequency of collection. This is the same type of charge system that is used for other utilities, such as water and electricity. With this system, disposers are directly affected by disposal costs and have the opportunity to do something about reducing costs.

Product Disposal Charges. These charges are either assessed on product or packaging producers at the time of manufacture, or on the consumer at the time of purchase. These charges differ from deposits, because they are non-refundable; instead the cost of the product's eventual disposal is incorporated into the charge. Although these charges can encourage source reduction on economic grounds and the funds generated from the charges can be used to correct and reduce impacts of product disposal, it is difficult to assess such charges effectively and efficiently. Different product disposal charges include:

- *Per-Unit Taxes* establish different rates according to category, material composition, or product size. Taxes on products that use excessive packaging are an example. These taxes affect manufacturer and consumer behavior by influencing choices of packaging materials produced, utilized, and purchased.

- A *Product Value Tax*, based on the cost of the product, encourages both reduction in materials used to manufacture products and their substitution by less expensive materials. It can also discourage expensive, excessive packaging used solely for marketing (e.g., packaging for cosmetics and toiletries).

Regulation

Although most regulation occurs at the state and federal level, local authorities can participate in legislative activities, including:

- Declaring source reduction to be a top priority in solid waste management.

- Establishing a program to inform consumers about a product's environmental impacts, durability, reusability, and recyclability.

- Participating in the development of regulations that affect municipal solid waste management.

Regulatory options for source control include:

Quantity Control Regulations. These include restrictions and bans to encourage substitution of products that have the same function, but that pose less threat to human health and the environment. This is an area that must be considered cautiously; bans can unintentionally shift production to even less desirable substitutes; they might also require manufacturers and regulators to commit extensive resources to changing a product or to administration and enforcement, with limited effect on source reduction. The idea is for environmental results, not just transferring a problem between environmental media or taking action to satisfy a perception rather than a fact.

Product Design Regulations. Products that do not meet certain design criteria (some examples of which are outlined in Figure 5.1) could be subject to quality control by sales taxes or restrictions.

Evaluating Source Reduction Options

Before source reduction policies can be adopted, decision makers must first develop a framework for evaluating policy options, using criteria such as:

- Social and economic equity;

- Economic and administrative feasibility, efficiency, and cost;

FIGURE 5.1
Designing Products for Source Reduction

Product Durability: Requiring certain technologies and warranties to increase the life of a product;

Product Design: Changing design to limit hazardous constituents and products in packaging.

Mandatory Disclosure of Environmental Impact: Requiring industry to provide consumers with information on the environmental impact of products; and

Purchasing Requirements for Government Agencies: Mandating source reduction procurement procedures to serve as a good example and expression of government policy.

- Volume requirement and scarcity of materials and natural resources used in a product's manufacture;
- Volume of a product and its manufacturing by-products that eventually must be disposed;
- Useful life, reusability, or recyclability of the product; and
- Priority of source reduction of products, from products more hazardous to those less hazardous to human health and the environment.

Economic and Environmental Effects of Source Reduction

Source reduction activities vary widely, and thus create many factors to consider when evaluating economic and environmental effects. Some factors require careful analysis, while others may only need a good dose of common sense. Source reduction practices can save disposal costs, as a smaller waste stream means there is less waste to transport and manage. Reduction of the waste stream may reduce the less quantifiable costs of pollution (e.g., less landfill leachate, less ash to dispose of, fewer ecological impacts, fewer aesthetic problems, etc.).

Procurement Procedures to Encourage Source Reduction

Local governments and businesses can have a positive impact on the local waste stream by adopting procurement procedures that encourage source reduction. Some examples include:

- Using two-sided copiers;
- Using longer-life tires on vehicles;
- Using longer-life, energy efficient light bulbs; and
- Buying in bulk.

Before source reduction programs are implemented, the decision maker should research the potential environmental impacts of the program to ensure that source reduction measures address the environmental problem at hand and do not have side effects more harmful than the current practice. The program should not simply transfer an environmental problem from one medium to another. The decision maker will also want to evaluate how a source reduction program will affect the economics of the local waste management system, mainly because some programs may involve new costs to local industry, businesses, and residents.

OVERCOMING OBSTACLES TO SOURCE REDUCTION

Source reduction programs have been difficult to establish for a variety of reasons, some of which are listed here. Decision makers should not be intimidated by this list. Creativity and commitment at local, state, and national levels will produce positive results.

- Current social and cultural values seem to favor convenience, time savings, and newness in consumer products. However, the development of a new environmental ethic, which is already taking place, can displace these old values.

- A change in attitude and behavior is required to reduce waste before it is produced. Many source reduction activities, such as buying reusable goods or goods in bulk, require both a conscious decision to reduce waste and a pre-purchase comparison of the waste implications of each product considered. An environmentally conscious public will assume these tasks if offered opportunities to do so.

- Measuring source reduction effects is extremely difficult; without short-term evidence of the benefits of source reduction, gaining government and public support and funding is often difficult. As the costs of municipal solid waste management continue to rise, however, local governments will be forced into investigating alternative approaches to waste management.

- For industry, there may be high initial costs for planning and capital investments to minimize raw material and energy use in order to achieve source reduction goals. The implementation of a national source reduction program, however, will require the commitment of industry, which will involve considering disposal costs.

- For a number of reasons (e.g., less disruptive of manufacturing process), industries tend to concentrate on treatment technologies in response to pollution abatement regulations rather than to work on source reduction. As the environmental and economic benefits of source reduction become more quantifiable, however, this trend may be changed.

The United States will witness more source reduction activity in the next few years and into the future. Local decision makers can participate in these activities while developing positive impacts on the local waste management system.

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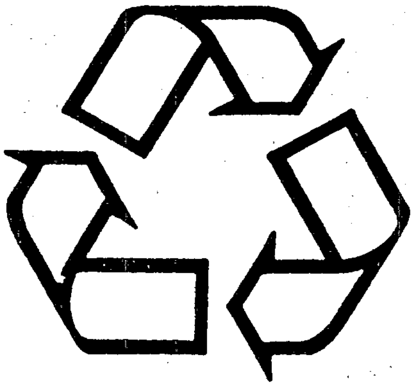
Chapter Six

Recycling



MAJOR MESSAGES

- Planning for recycling involves understanding materials markets, building local expertise, setting realistic goals, and fostering public participation.
- Elements of a recycling program could include source separation, curbside collection, materials recovery facilities, and full stream processing.
- Recycling will have a positive impact on other municipal waste management programs.

Although it is not a new technique, recycling is becoming increasingly important in municipal solid waste management, as communities, businesses, and industry battle the rising costs and environmental impacts of waste disposal.

Recycling is more than the separation and collection of post-consumer materials. These are only the first steps; post-consumer materials must also be reprocessed or remanufactured, and only when the materials are reused is the recycling loop complete.

Recycling will be a fundamental part of any integrated waste management plan. Recycling alone cannot solve a community's municipal solid waste management problem, but it can divert a significant portion of the waste stream from disposal in landfills or combustion facilities. EPA has set a national goal of 25 percent reduction of the waste stream through source reduction and recycling by 1992 (EPA, *Agenda for Action*). Currently, only 10 percent of products discarded are recycled, so significant progress needs to be made. Some existing programs, however, have already achieved or, in fact, exceeded this 25 percent goal. As new post-consumer materials markets, programs, and processing equipment develop, the nation will move towards this and higher goals.

PLANNING FOR RECYCLING

Dozens of different recycling options are available, and recycling program development will require strategic planning. When properly implemented, a recycling program can become a popular municipal waste management activity among citizens.

Start Small and Build Local Expertise

For many decision makers, recycling is a new waste management option and, as with any new program, mistakes are bound to be made. An important factor to understand during the planning process is that many of the most successful recycling programs across the country began as small or even pilot-scale programs in neighborhoods or specific areas of the community. By starting small, decision makers can build local expertise in recycling while minimizing the problems caused by planning mistakes. With small-scale programs, decision makers are able to compare and evaluate which programs and techniques are most successful within the community. When the time comes to develop large-scale programs, decision makers will have practical experience and an established decision-making framework which will enhance the likelihood of program success.

Understand and Develop Recycling Markets

One of the most difficult yet fundamentally important tasks decision makers must deal with is finding an outlet for the recyclable materials collected. Identifying markets, securing agreements with materials brokers and end-users, and meeting buyer specifications are all part of this task. Recycling programs must be designed with the flexibility to handle fluctuating markets and uncertain outlets for materials. Consequently, market analysis will be both a planning and ongoing activity, as even the most successful recycling programs can be severely affected by market oscillations.

Decision makers can also play an important role in recycling by working to build local markets for recyclables in the community. This can be done by encouraging businesses and industries that use recycled materials to come to your community or by expanding the local use of recyclables that is already taking place. These businesses will provide a reliable market for recyclables and increase jobs.

Foster Public Education and Involvement

Public participation in recycling programs is one of the most important factors deciding a program's success. A well-planned public education and involvement program will foster participation in recycling. See Chapter Eleven for more information.

Assess the Local Waste Stream

Planning any waste management program requires a knowledge of the local waste stream. This is true of recycling. Choosing which materials to recycle and designing the logistics of the program are important parts of the planning process that require local waste stream information. Waste stream assessments in support of recycling programs can be targeted by analyzing post-consumer materials markets to determine which materials have potential outlets.

Augment Existing Programs

Many recycling programs have been operated for years by private entities such as manufacturing facilities, waste haulers, scrap dealers, transfer station operators, and landfill operators. In most cases, these groups recognized the revenues that could be generated by selling secondary materials. Other programs are run by local volunteer organizations as a community service and to raise funds. These programs are important planning considerations; the community's recycling program should augment the success that has been attained by these other groups.

Local Government as an Advocate

Decision makers must play an advocacy role in promoting recycling. In many communities, recycling represents a new waste management option that is unfamiliar to many people. Recycling, however, can be a popular activity. Decision makers should tap into the desire among citizens and businesses to "do the right thing," should design programs that make it easy to recycle, and then should aggressively promote plans and programs to all members of the community.

Set Realistic Goals and Objectives

Part of the planning process involves setting goals and objectives. For example, after evaluating remaining landfill capacity and performing a preliminary assessment of the local waste stream, decision makers may find it helpful to set long-term goals for the community. For example, a community may set a goal of recycling 30 percent of the residential waste stream within the next five years. Specific planning objectives in support of this goal will also be helpful. Planning objectives may include determining which waste stream components should be part of the program (based on market analysis and the make up of the local waste stream), investigating the feasibility of a comprehensive curbside collection program, developing a pilot-scale curbside program, investigating public outreach avenues, etc. When a plan is decided and a program is being implemented, new, more specific objectives should be set. An example could be working towards 90 percent participation.

Decision makers should be as realistic as possible when setting goals and objectives. Recycling is not a "miracle solution" any more than waste-to-energy or landfilling. The community will benefit from carefully developed, achievable goals and objectives and an integrated approach to waste management.

Program Evaluation

Planning for recycling is never actually completed; it is an ongoing process. Because new programs and technologies are developing continuously, decision makers should experiment with and evaluate new options. Even the best recycling programs experiment with new techniques to improve on their current efforts.

RECYCLING PROGRAM MANAGEMENT

Several aspects of recycling program management should be fully understood during the planning process.

Municipal Coordination

As discussed in Chapter One, it is important that decision makers assume the responsibility for managing the local waste stream. Again, this is not to say that the local government must provide all services; its role is to assure that all services are provided properly.

Many communities choose to operate recycling systems as another public service. For example, programs are operated in conjunction with the regular refuse collection system, including financing programs and raising revenues. An advantage of municipally-operated systems is that the benefits of recycling (e.g., revenues from the sale of materials) are internalized within the waste management system.

Providing a Public Service

A recycling program should be seen as a public service, and customer service should be a normal evaluation criterion. Like any public service, recycling programs should be:

- Consistent;
- Predictable;
- Equitable; and
- Efficient.

Municipal Corporations or Utilities

An alternative to direct local government operation is the creation of a municipal corporation to operate the recycling center or program. This allows financing from the tax base while separating recycling from normal municipal functions. In such a system, the recycling program has independent budgeting and money-raising powers.

Regional Approaches

Regional approaches to recycling program development are particularly important in areas with sparse populations. Regional systems allow collected materials to be pooled, creating a larger, more marketable supply for buyers. In addition, large scale options such as materials recovery facilities (MRFs, explained later in this chapter) may be more economical at the regional level, where economies of scale can be significant. Economies of scale may also be realized when purchasing collection vehicles and equipment and financing programs.

Private Recycling Programs

Until recently, the majority of recycling was done through private entities such as industry, waste management firms, and non-profit organizations. For example, the aluminum industry recognized the benefit of recovering post-consumer aluminum, and set up a network of aluminum collection and processing centers. Similarly, many transfer station operators recognized that particular waste loads contain large amounts of recyclable materials. By separating and selling these materials, transfer station operators generate income from the sale of goods while also creating an avoided disposal cost savings.

In addition to these larger-scale operations, most communities are familiar with the recycling drives of volunteer organizations, which are often run as fundraising or public service activities. Newspaper collection and aluminum can programs associated with elementary schools or scouting groups are examples. These programs are often operated in conjunction with the local government, which may supply buildings, equipment, and staff.

In many cases, private recycling programs are well-organized and have a history of successful operation. A municipally-run recycling program should augment the success of existing private programs. Decision makers may find it beneficial to tap into this experienced recycling network.

When planning a municipal recycling program in conjunction with existing private operations, decision makers should be aware that most private programs tend to focus on the high-revenue, steady market materials such as aluminum and glass. Because recycling is essentially a money-making operation in many of these cases, low-value materials (such as mixed paper and mixed plastics) are usually avoided. This is an important consideration when determining the economic feasibility of the local program.

COMMONLY RECYCLED MATERIALS

This section briefly addresses some commonly recycled materials and their markets.

Paper

Waste paper recycling has several advantages: it provides mills with a valuable fiber source, it provides income to recyclers, and it reduces municipal disposal costs. According to the American Paper Institute, in 1986, 200 of the nation's 600 pulp, paper, paperboard, and building products mills relied almost exclusively on waste paper for raw material, and another 300 used at least some waste paper in their operations (API, 1986; note: a large amount of this waste paper used was industrial scrap rather than post-consumer paper). As more recycling programs come on line and the supply of scrap paper increases, the paper industry is expected to respond by developing more facilities that handle secondary fiber. The following discussion looks more specifically at the issues associated with recycling paper, including market status and program considerations.

Old Newspaper (ONP). Most recycling programs have provisions for the collection of old newspaper, which is not only one of the most prevalent materials in the municipal solid waste stream, it has historically been one of the most commonly recycled materials. Many volunteer and private programs started as single material programs, collecting only newspapers for resale.

It should be noted that old newspaper and mixed paper markets can fluctuate greatly, and that the market is currently down in parts of the country (summer 1989). One of the main reasons for this down market is that waste paper recovery has exceeded domestic mill capacity. This is especially true as more states pass mandatory recycling laws. With the domestic oversupply, many ONP brokers have turned to foreign markets, especially in Pacific Rim countries such as Korea. Although the demand is currently stronger in these countries, many foreign brokers are also holding out because of oversupply. Foreign markets can also present significant transport costs.

Corrugated Cardboard. According to the American Paper Institute, corrugated cardboard is the largest single source of waste paper for recycling (API, 1985). Many commercial generators, such as supermarkets and retail stores, have in-house balers for preparing corrugated for mills. Markets for good quality, baled cardboard have historically been steady.

High-Grade Paper. High-grade papers include computer paper, white ledger paper, key punch cards, and trim cuttings from industrial paper manufacturers. The market for this material has historically remained steady, as good quality product (e.g., few colored paper mixtures, binders, plastics, etc.) can be used as a direct substitute for wood pulp.

Mixed Paper. Mixed paper is usually collected from office buildings and industrial plants, but can also be collected in municipal programs. Segregation is a key to successful paper recycling programs. Mixed paper often contains significant quantities of high quality paper, which can be valuable if separated. Also, "contaminant" materials, such as rubber bands, inks, and coatings decrease mixed paper value, as they must be removed during intermediate processing.

Like the newspaper market, the mixed paper market is currently soft, and the revenues may not outweigh the cost to collect, process, and transport mixed paper. However, this does not consider the benefit of avoided disposal costs.

Baled Corrugated Cardboard, Portland, Oregon

Aluminum

42.5 billion of the 77.9 billion aluminum cans produced in 1988 were recycled (Salimando, 1989). The demand for recycled aluminum is high, as it is estimated that it takes 95 percent less energy to produce an aluminum can from an existing can than from ore (Keep American Beautiful, Inc., 1989). Consequently, aluminum is a high-value product that is the greatest revenue generator of many recycling programs.

In addition to aluminum cans, window frames, storm doors, siding, and gutters are all sources of recyclable aluminum. Because these material are of different grades, recycling programs should check with the buyer to determine specific separation requirements.

Glass

Glass is also one of the most commonly recycled materials and the market for post-consumer glass has historically been steady. Glass if often separated by color to be reprocessed, and three categories are used: clear, green, and brown. Separation can take place in the household, at the drop-off center, or by hand-pickers or optical separators at materials recovery facilities. After collection (or drop-off) and separation, glass recycling involves crushing used bottles and jars into small pieces, forming a material called cullet that is sold to end-users who mix the cullet with sand, soda ash, and limestone to form new glass containers. Glass crushing can take place at recycling centers, intermediate processing centers, or material recovery facilities. Most glass brokers require that the glass be clean and free of contaminants such as metal caps, ceramics, rocks, and dirt.

Ferrous Metals (Iron and Steel)

According to the Steel Can Recycling Institute, steel is the number-one recycled material in the world, as over 55 million tons of iron and steel were recycled in the U.S. and Canada alone in 1987 (Steel Can Recycling Institute). The largest amount of recycled steel has traditionally come from large items such as cars and appliances. Many communities have large scrap metal piles at the local landfill or transfer station. In many cases, the piles are unorganized and different metals are mixed together, making them unattractive to scrap metal buyers. Recycling programs will benefit from procedures keeping scrap metal piles orderly and free of contaminants.

Steel can recycling is also becoming more popular. Steel cans are used as juice and food containers, and are easily separated from mixed recyclables or municipal solid waste using large magnets (which also separate other ferrous metals).

The overall market for ferrous metals is well established, and the demand for scrap metal is expected to remain steady or increase as processing technologies develop.

Plastics

Plastics recycling is a relatively young industry, and only one percent of plastics are currently recycled. But as processing technologies are developed, plastics recycling is expected to expand. The availability of materials has spawned the search for new processing techniques and product uses, and new markets are expected to develop in the near future. Although plastics recycling is not an established money-maker in many areas, the plastics recycling industry is in a stage of rapid growth.

Transporting Plastics

Plastics are essentially lightweight, high-volume materials. Because of the large volume, they tend to fill collection vehicles rather quickly, and more trips between the route and the processing facility may be necessary. If this distance is significant, the cost of collection for plastics could be high, although solutions such as on-truck compaction are being implemented.

PET (polyethylene teraphthalate). Most plastic soft drink bottles are made of this material, which is the most commonly recycled plastic. The Plastic Bottle Institute reports a 20 percent rise in the number of plastic bottle recycling companies between 1987 and 1988. 150 million pounds of plastic soft drink bottles were recycled in 1987 (PBI, 1988). End-uses for recycled PET include: plastic fibers (for sleeping bags, vests, etc.) injection molding, non-food grade containers, structural foam molding, and chemicals.

HDPE (high-density polyethylene). Milk jugs and detergent bottles are the easily identified HDPE products in the waste stream. Like PET bottles, this type of plastic is currently recycled and the HDPE market is growing as processing technologies are developed. End-uses for reclaimed HDPE include non-food bottles, drums, pails, toys, pipe, sheet plastic, crates, and plastic pallets.

Mixed Plastics. Mixed, or commingled, plastics are unsorted materials including combinations of several plastic resins and "contaminants" such as paper, wood, metals, and glass. Mixed plastics processing is a developing technology, and markets for the material are expected to increase. Mixed plastic is being used to make "wooden" park benches, trash containers, car stops, etc.

Other Plastics. Other plastics that could be recycled in greater quantities in the future include: polystyrene (styrofoam), polyvinyl chloride (PVC), polypropylene (PP), and low-density polyethylene (LDPE).

Because plastics recycling is such a new field, the recycling loop is not yet complete in many parts of the country. Significant progress must still be made in the collection, separation, and processing of plastics.

Batteries

Battery recycling is not only a response to market conditions (i.e., the price of lead), it is also attractive due to concern over the toxic components found in many batteries, including lead, cadmium, and mercury. These metals are contaminants in incinerator air emissions and ash, and can cause ground water contamination through leaching at landfills and composting facilities. Pressure to remove them from the waste stream is becoming more intense. Collection of batteries, however, does not constitute recycling -- it is only the first step. Like other materials, battery recycling depends largely on market conditions, and requires consistent collection and processing. It can be argued, however, that even when markets are down, batteries should be separated and collected, because disposal as hazardous waste is more environmentally sound than landfilling as municipal solid waste.

Lead-Acid Batteries. Automobiles use lead-acid batteries, each of which contain approximately 18 pounds of lead and a gallon of sulfuric acid, both hazardous materials. Automotive batteries are the largest source of lead in the municipal solid waste stream. Battery reprocessing involves breaking open the batteries, neutralizing the acid, chipping the polypropylene containers for recycling, and smelting the lead and lead oxides, to produce reusable lead. Recycled lead must compete with virgin lead suppliers and markets, which can fluctuate greatly. When virgin lead prices are low, less recycling takes place. Another consideration in lead-acid battery recycling is potential liability associated with the storage and processing of hazardous materials.

Household batteries. Household batteries come in a variety of types, including: alkaline, carbon zinc, mercury, silver, zinc, and nickel cadmium. Not all household batteries are recyclable and, in fact, only those containing mercury and silver are usually marketed to end users who extract the metals. Most batteries are handled as hazardous wastes once they are segregated from the waste stream. The metals found in household batteries can contaminate incinerator air emissions and ash and cause ground water contamination through leachate, so removal from the waste stream is environmentally sound, regardless of the market value.

Used oil and **tires** are also recyclable materials. These are discussed in more detail in the Special Wastes chapter of this *Guide* (Chapter Ten).

Recycling Program Options that Increase Participation

The following program options have been shown to increase participation in recycling:

- Mandatory participation
- Curbside collection (rather than drop-off)
- Provision of special containers
- Collection of recyclables on the same day as regular trash pick-up
- Comprehensive and integrated public education

RECYCLING PROGRAM ELEMENTS

Recycling programs are designed according to the needs and priorities of communities. They may include a mix of strategies, ranging from simple, single material drop-off centers to large-scale, centralized processing facilities.

Source Separation

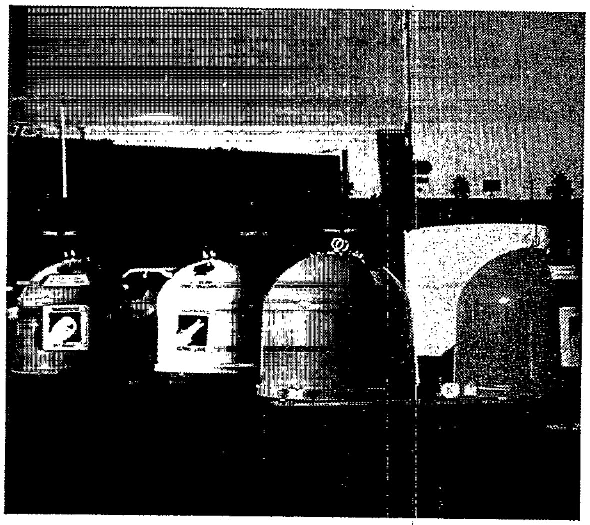
Source separation refers to the segregation of recyclable materials at the point of generation (e.g., the household, business, or apartment building). Some source separation programs require that several designated materials (e.g., glass, aluminum, and newspapers) be segregated into their own specific containers. Other programs use only two or three containers, one or two for the storage of mixed recyclables (called commingled recyclables), the other for regular trash. Source separation may be voluntary or mandated, and is performed in conjunction with several recycling program alternatives.

Drop-Off / Buy Back

A drop-off program requires residents or businesses to source separate recyclable materials and bring them to a specified drop-off or collection center. Drop-off centers range from single material collection points (e.g., easy-access "igloo" containers) to staffed, multi-material collection centers. Because residents and businesses are responsible for separating their recyclable materials and taking them to a drop-off center, low participation can be a problem with these programs. Drop-off centers also require residents and businesses to store the materials in their homes until sufficient material is collected to warrant a trip to the drop-off center. This is a problem in densely populated areas where residences do not have much storage space available.

To encourage participation, most successful programs have made drop-off centers as convenient to use as possible. For example, drop-offs at shopping centers or other convenient locations are common. Mobile collection centers, which can be moved to new locations periodically, also increase convenience. Other incentives, such as donating portions of proceeds to a local charity, can also foster greater participation.

Buy-back refers to a drop-off program that provides a monetary incentive to participate. In this type of program, the residents are paid for their recyclables either directly (e.g., price per pound) or indirectly through a reduction in monthly collection and disposal fees. Other incentive systems include contests or lotteries.



"Igloo" Drop-Off Containers, San Jose, California

Curbside Programs

In a curbside system, source separated recyclables are collected separately from regular refuse at the curbside, alley, or commercial facility. Because residents and businesses do not have to transport the recyclables any further than the curb, participation in curbside programs is typically much higher than for drop-off programs.

Curbside programs vary greatly from community to community. Some programs require residents to separate several different materials (e.g., glass, plastic, metals, and newspaper) that are stored in their own containers and collected separately. Other programs use only one container to store commingled recyclables or two containers, one for paper and the other for "heavy" recyclables, such as glass, aluminum, etc. Commingled recyclables are separated by the collection crew or at some type of processing center. Collection and processing of recyclables are discussed later in this chapter.

Same Day vs. Different Day Collection of Recyclables

Studies have shown that when the collection of recyclables is on the same day as regular garbage collection, participation rates are higher, because residents do not have to learn new collection schedules.

Commercial Recycling

Many communities and businesses are just beginning to realize the benefits of commercial recycling, while others have been enjoying the benefits of recycling such items as corrugated cardboard and office paper for years. Commercial recycling is responsible waste management, not necessarily a profit-making venture. Businesses do, however, realize avoided disposal costs, a benefit that is becoming more significant as the costs of waste management rise.

Materials recovered in commercial recycling programs include office paper, corrugated cardboard, sorted ledger paper, newspaper, aluminum cans, glass, steel containers, and plastic. Commercial recycling programs can target office buildings, restaurants, schools, supermarkets, and hospitals.

Community decision makers should encourage commercial recycling aggressively, especially if commercial sources contribute significantly to the local waste stream. Figure 6.1 outlines the basic elements of a commercial recycling program.

Multi-Family Dwellings

Apartment buildings and condominium complexes generate large amounts of recyclable materials. Because of the large quantity of

FIGURE 6.1
Recycling at Commercial Facilities

(1) Obtain approval and support for the recycling program from the chief executive, owner, or business manager.

(2) Select a recycling coordinator.

(3) Determine the types and quantities of recyclable materials in the waste stream.

(4) Determine space, container, and equipment needs:

- In-house containers
- Central storage containers
- Auxiliary equipment

(5) Find a market for the recyclables.

(6) Contact a hauler or representative of the municipal collection system.

(7) Promote and publicize the recycling program to your employees.

(8) Recycle - segregate and market your recyclables.

(9) Monitor recovery rates, revenues, and costs.

(Source: OSCAR, Handbook for Reduction and Recycling of Commercial Solid Wastes, RI Dept. of Environmental Management, 1988)

materials concentrated in a small area, recycling can be an attractive option at these dwellings. The actual programs could be implemented in the same manner as a curbside program. Storage space (especially in apartment buildings) is more of a problem in multi-family dwellings than in residential neighborhoods. An option is to have residents bring their recyclables to a centralized storage area within the complex, perhaps in the basement of an apartment building or at an outside storage area. In addition to promoting recycling to the residents and the managers of multi-family residents, decision makers may also wish to promote changes in city building codes to require new buildings to provide storage space for separated materials.

Apartment building recycling may require agreements with private waste haulers if the program cannot be integrated with the municipal collection program.

STORAGE AND COLLECTION OF RECYCLABLES

Collection of source separated materials is a necessary component of curbside recycling programs and most yard waste composting programs (discussed in Chapter Seven). This may raise new collection issues for decision makers to understand.

Establishing a collection system for source separated materials will require more careful planning than for regular trash collection, due to the fact that more containers will probably be involved and, in some cases, collection crews will be responsible for organizing or even separating materials.

Sound Storage and Collection Principles

Some principles of sound recyclables storage and collection should be understood when developing the program:

- *Resident convenience*. The easier it is for residents to separate materials, the higher participation and recovery rates will be.

- *Collection crew convenience*. The system should be convenient for collection crews as well. For example, loading and sorting activities should be as simple as possible.

- *Cost effectiveness*. Trash (or recyclables) collection is one of the most expensive municipal activities, and within the collection system, labor is usually one of the most costly aspects. Equipment and procedures must be designed to maximize collection crew and vehicle productivity.

- *Integrity of materials*. The storage and collection system should keep recyclables in the best shape possible. The potential for mixing materials should be minimized and equipment should be designed to keep materials as dry and as contaminant free as possible. Also, collection crews should be trained in proper handling.

Storage in the Household

How residents store recyclables in the household and at the curb has a direct impact on the success of a recycling program. In the past, storage was primarily the responsibility of each residence. But in an effort to increase convenience (and encourage participation), most successful recycling programs have turned to providing households with special, standardized containers for storing materials. This has directly increased participation rates.

Providing containers allows residents to feel that they are "getting something back" from the municipal government (or private recycling firm), which can foster positive attitudes toward program organizers. In addition, the containers serve as a constant reminder to recycle.

Some dedicated recycling vehicles have automatic container-tipping devices. With such systems, compatible containers are usually required. In this case, providing residents with the appropriate containers standardizes the collection system.

Household Storage Containers

Storage containers and special recycling markers serve several important functions:

- Providing a handy way to store materials until collected;
- Serving as a constant reminder to recycle; and
- Making it easy for the collector to distinguish recyclables from garbage.

A wide variety of special recycling containers are available. Some common options include:

- Baskets,
- Sacks,
- Buckets or boxes, and
- Stacking pan carts.

Studies show that the use of a single (i.e., commingled recyclables) special container significantly increases participation.

Recycling Collection Vehicles

The dramatic increase in the number of comprehensive curbside recycling programs that has been witnessed in the last few years has brought with it a new generation of collection vehicles designed specifically for collecting recyclables. These vehicles have several storage bins, are easily loaded, and are often equipped with automatic container-tipping devices.

Before this line of vehicles became available, recycling programs usually relied on modified or additional collection vehicles. These included racks attached to compactor trucks, trailers, and perhaps the use of pick up trucks or dump trucks.

Although these modified vehicles may still be considered options, a dedicated, closed-body recycling collection vehicle with sufficient capacity offers significant advantages that can warrant the initial investment:

- Easy loading and unloading;
- Flexible compartments; and
- Protection from weather.

Vehicles designed specifically for the collection of recyclables come in a variety of shapes and sizes. Both side-loading and rear-loading closed body trucks are used, as are compartmentalized trailers and flat-bed trucks.

Decision makers are encouraged to refer to current trade journals (e.g., *Waste Age*, *Resource Recycling*, *Recycling Today*), which publish equipment guides regularly. Volume II of this *Decision Maker's Guide* addresses collection vehicles and equipment in more detail.

Processing Equipment

Recycling involves a variety of processing techniques, some of which require special equipment:

- Balers. Newspapers, cardboard, and plastics are often baled to achieve larger transport payloads, reducing transportation costs.
- Can densifiers. Can crushers are used to densify aluminum and steel cans prior to transport.
- Glass crushers. Used to process glass fraction separated by color, crushers break glass into small pieces. The material is then called cullet and can be reprocessed into new glass products.
- Magnetic separators. These are used to remove ferrous metals from a mixture of materials.
- Wood grinders. Wood grinders are chippers used to shred large pieces of wood (e.g., pallets, branches) into chips that can be used as mulch or as fuel (see "Wood Wastes" in Chapter 10);
- Scales. Scales are used to measure the quantity of materials recovered and sold.

Most trade journals publish equipment guides that decision makers should consult for more information on processing equipment.

MATERIALS RECOVERY FACILITIES (MRFs)

MRFs are centralized facilities that receive, separate, process, and market recyclable materials. MRFs can be operated in conjunction with both drop-off and curbside programs, and can be designed to process separated materials or commingled recyclables.

Why a MRF?

The primary advantage of MRFs is that they allow recyclable materials from a municipality or region to be pooled and processed uniformly. This is important considering buyer specification demands. Not all communities, however, need a MRF. Whether to incorporate a MRF into the municipal waste management system will depend on a variety of factors:

- *Market Demands.* Buyers may have specifications for certain materials. For example, corrugated cardboard and plastics are usually baled before transport. When additional processing is required, a MRF may be attractive.
- *Commingled vs. Separate Collection.* In systems where residents commingle their recyclables, intermediate separation and processing are required.
- *Number of Different Recyclables.* In general, a MRF will be more beneficial when a large number of different recyclables are collected.
- *Quantities of Materials.* Because MRFs involve significant capital and operating costs (e.g., buildings, equipment, labor), a significant amount of materials must be handled to justify its operation. For example, a regional MRF handling 100 to 200 tons per day of recyclables will serve a population of approximately 250,000 to 400,000 (Chertow, 1989).

MRF Operations

MRFs may be designed to handle all types of recyclables or certain categories of recyclables. For example, some programs require residents to separate the paper fraction of the recyclable stream from heavier materials such as glass, steel, and aluminum.

At the MRF, both hand classifying and mechanical separation technologies may be used. For example, steel and other ferrous metals are separated by large magnet systems. Air classifiers may be used to separate lighter fractions such as paper and plastics. Hand sorting is often used to separate different colored glass, but optical separation systems may be available as well.

MRF Costs

Although the sale of recyclables can generate considerable revenues at large processing facilities, the sale of recyclables alone has not been shown to support the full cost of siting, building, and operating a new MRF. Revenues from materials sales vary greatly from area to area, depending on market conditions and transportation costs. Again, the avoided cost of landfilling must be taken into account when evaluating the integrated waste management system.

Capital Costs

Existing MRFs have had total capital costs of $10,000 to $22,000 per daily ton of input (Chertow, 1989). A 100 tpd facility, therefore, would have capital costs ranging from $1 to $2.2 million. Capital costs for equipment alone can range from $4,000 to $8,000 per design ton.

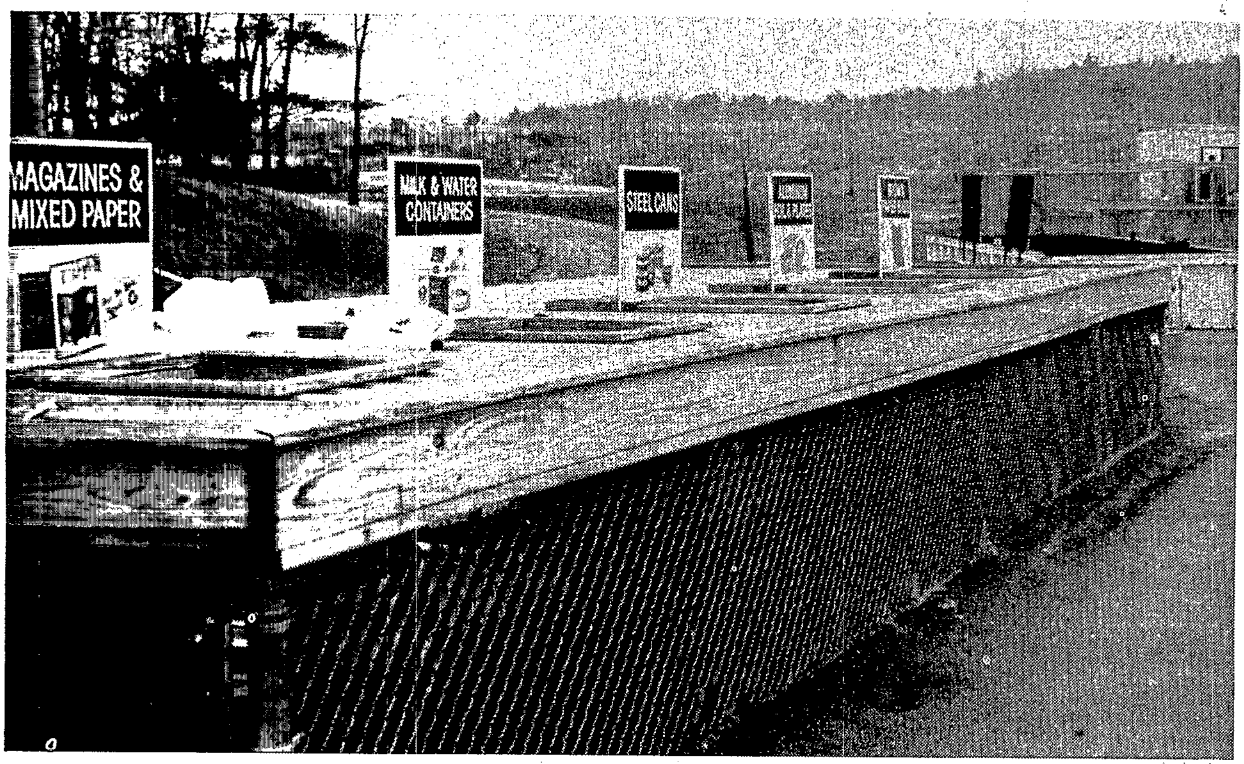
Operating Costs

Primary operating costs include labor, equipment operation and maintenance, and the cost of disposing residuals (approximately 25 percent of the incoming material at a MRF will eventually be disposed of as residual). Operating costs will vary from facility to facility, but have been estimated to range from $20 to $60 per incoming ton, prior to the sale of materials and capital cost considerations (Chertow, 1989).

Transfer Station Recycling Programs

One of the simplest types of recycling programs involves designating areas or containers at transfer stations where recyclable materials can be dropped off. Methods range from using several dedicated bins to constructing simple concrete slabs where materials are piled. These separated materials are taken directly to processing facilities.

At unstaffed facilities, product quality may be difficult to control. Materials specifications must be made clear to the participants.



Drop-Off Containers at Wellesley, Massachusetts Transfer Station

FULL STREAM PROCESSING

Full stream processing technologies have developed largely in Europe and are just beginning to be used more frequently in the United States. Initially developed to prepare refuse-derived fuel, these technologies are now also considered materials recovery operations. Unlike MRFs, which accept mixed *recyclables*, full stream processing units accept mixed *municipal solid waste* (i.e., the full waste stream).

These systems produce a combustible fraction, a compostable fraction, recovered materials, and residuals. In general, the materials recovered from this process are of lower quality than the materials that are source separated or separated at MRFs, mainly because they have been mixed with other types of refuse. To achieve higher quality, materials must be cleaned, which can be costly. As full steam processing technologies develop, however, product quality of recovered materials is expected to increase.

> **Full Stream Processing**
>
> *Full stream processing* is a high-technology separation technique that processes all components of municipal waste (not just recyclables). Full stream processing operations are used in several applications:
>
> - *RDF preparation*; full stream processing is used to extract the combustible portion of municipal waste in the preparation of refuse-derived fuels.
> - *Municipal waste composting*; used to concentrate the compostable portion of municipal solid waste; sometimes performed as part of RDF preparation.
> - *Materials recovery*; certain materials can be recovered and resold, making this a recycling technology as well.

Full stream processing is attractive because no source separation of materials is required. Participation could effectively be 100 percent.

Materials are separated at full stream processing facilities both mechanically and by hand. Depending on the facility design, different amounts of hand and mechanical technologies would be used.

Size and weight are the main characteristics used to separate materials:

- When the material is first dumped, oversized materials such as white goods and furniture are removed;
- Rotating screens called trommels are used to create two waste fractions: a large-sized materials fraction that includes combustibles and metals, and a small-sized materials (e.g., pass through three inch screen) fraction, which is comprised largely of compostable materials;
- Ferrous metals are extracted from the large materials fraction using magnet systems;
- Air classification can be used to separate the lighter materials in the large materials fraction from the heavies:
- Light materials include plastic and paper, and can be further processed into RDF;
- The heavy fraction can be mechanically or hand sorted further to recover salable materials such as corrugated cardboard; and
- Disposal of residuals is required.

DEVELOPING A RECYCLING PROGRAM

There is no "boiler plate" methodology for developing recycling programs. A variety of different approaches have been used successfully. Local recycling programs must be crafted to the needs of the community. The following discussion highlights some of the program development issues decision makers should consider when developing a local recycling program.

Materials Markets

Understanding post-consumer materials markets is one of the most important responsibilities municipal solid waste decision makers have.

Assess Materials Markets and Select Materials to be Recycled

A preliminary market analysis will show decision makers what markets are currently available or may be available in the future. National and some regional market information is available in the trade publications (e.g., *Recycling Times* includes a markets page with current prices for post-consumer materials). Decision makers should also directly identify local, national, and international buyers with which the community will actually deal. With this information, materials to be recycled can be targeted within the local waste stream.

Locating and Choosing a Buyer

Three general "outlets" for secondary materials exist: brokers (or dealers), end-users, and internal markets.

Brokers purchase particular materials and sell them to end-users. Brokers accumulate an amount of material, guarantee that it meets certain specifications, and then provide it to end-users as a "raw" material feedstock. Most end-users prefer secondary materials obtained through brokers because a large quantity of uniform quality product can be guaranteed. Brokers are reliable buyers, as they often purchase materials even when the market is down, stockpiling in anticipation of higher prices. Many transport materials and also require little processing (usually, a clean product is all that is demanded).

End-users are the facilities that actually reprocess or remanufacture the post-consumer materials. For example, a paper mill accepting post-consumer scrap paper is an end-user. Selling directly to the end-user may result in a better price, but could also include meeting more stringent product specifications (e.g., the waste may have to be baled). Many end-users also require the supplier (i.e., the recycling program) to deliver the materials, which adds transportation costs.

Internal markets such as municipal government agencies not only provide an outlet for some materials, they promote a recycling "awareness" within the government. Examples might include using tires to build playground equipment or using newspapers for animal bedding.

Contract vs. Open Market

Secondary materials are usually sold either on the open or "spot" market or through some type of contract arrangement. On the open market, decision makers must locate a buyer each time enough material has been accumulated to be sold. By selling materials in this manner, the community can get the best price for the materials at the time. When the markets are down, however, the community may be faced with low prices or no buyers at all. With a contract, a deal is made between the community and a broker or end-user involving the delivery of a certain amount of material at a certain price for a specified amount of time. A contract helps protect the community from market fluctuations and ensures an outlet for materials. The agreed price, however, may end up below the actual market price for the material.

When possible, many decision makers choose to develop contracts with buyers, mainly because it reduces the risk of having no outlet for materials. Post-consumer materials markets fluctuate greatly, and many programs are not equipped to handle flat markets (for example, material may have to be stored sent to a landfill if no buyers are available). A contract will guarantee a buyer for a specific amount of time.

Stockpiling

Because post-consumer materials markets fluctuate so greatly, recycling programs may be faced with no outlet for materials during down markets. In anticipation of this, many successful recycling programs are prepared to stockpile materials until markets become available (or for as long as it is practical).

Programs designed with no stockpiling capacity may have to dispose of the collected materials.

Cooperative Marketing: An Option for Small Communities and Generators

Cooperative marketing involves combining materials and resources from different groups into a larger pool that may be more marketable. Small communities and businesses have traditionally had little success in establishing lasting relationships with secondary materials brokers and end-users, mainly because smaller communities neither have the resources to perform market research nor a significant enough amount of materials to garner the attention of brokers. Combining materials and using a cooperative marketing strategy can bring materials from these communities into the marketplace.

Cooperative marketing can be developed within existing management structures. For example, a county or state government or regional council of governments may do market research and make arrangements for the collection and delivery of recyclables to a broker. Another option would be for an independent organization to serve as the link between small towns and brokers or end-users. An excellent example of such a group is the New Hampshire Resource Recovery Association, a non-profit organization that serves as a link to secondary materials markets for many of New Hampshire municipalities.

Aside from regional arrangements, cooperative marketing can take several other forms, including:

- Drop-off centers using a centralized recycling center for marketing;
- Different recycling centers combining materials; and
- Recycling centers or communities exchanging marketing ideas and information.

Local Recycling Legislation and Guidelines

Several types of legislation and guidelines to support recycling programs have been enacted in different locations across the country.

State Incentives

States may provide financial or technical assistance to local programs in need of resources and stable markets, including grant money for equipment and publicity. States may even undertake construction of recycling and/or processing facilities. Technical assistance and support at the State level may include identifying local markets, attracting "end-user" industries to the state, or developing a statewide marketing cooperative. The State may also be a good source of information on recycling methods and implementation strategies.

Mandatory Source Separation

Legally requiring residents and businesses to separate recyclable materials from their waste has proven to be an effective way of increasing public participation in recycling programs. Mandatory source separation can be enforced in several ways, including the use of citations, fines, or refusal to collect unseparated garbage.

Disposal Bans

Disposal bans are applied to certain recyclable materials. Yard wastes, newspapers, glass bottles, lead-acid batteries, used oil, and household hazardous wastes are examples of materials that are sometimes banned from landfills or incinerators.

Variable Disposal Rates

Adjusting disposal fees at landfills, composting facilities, or combustion facilities provides an economic incentive to recycle. For example, landfills may charge higher tipping fees for loads containing large amounts of recyclables. This would encourage the generator or the collection firm to keep these materials separate.

Pay-Per-Container Charges

In order to encourage recycling at the residential level, communities may charge for services on a pay-per-container basis. For example, a flat rate could be charged for the first two containers, with an extra charge for each additional container.

Flow Control Ordinances

Flow control ordinances can be designed to encourage recycling and to ensure a steady flow of materials to municipal solid waste combustion facilities. Municipalities can direct certain materials to recycling or energy recovery facilities to ensure proper operation.

Anti-Scavenging Ordinances

These ordinances deter individuals from removing recyclable materials before they are picked up by the selected hauler, which is important when haulers, recycling facilities, or residents depend on recycling revenues to operate programs.

Public Education and Involvement

The entire recycling program must be designed to maximize participation. This involves making participation as convenient as possible for residents and businesses. An integrated, comprehensive public outreach program will be one of the keys to a recycling program's success. The public must know the importance of recycling, the nature of the local waste problem, and how they can get involved.
Procedures for curbside and drop-off programs will have to be publicized, and participation and materials recovery rates will have to be monitored. Chapter Eleven of this *Guide* covers public education and involvement in more detail.

COSTS AND BENEFITS OF RECYCLING

Costs

The costs of recycling programs vary greatly because the economics are specific for each local area and a wide variety of program structures are used.

Start up costs are one-time costs to initiate the program. These include:

- Planning costs for activities such as market assessments, waste stream assessments, re-routing collection vehicles, planning any new facilities, and negotiating contracts;
- Publicity costs to develop, print, and distribute information (this will also be an ongoing cost); and
- Capital costs if additional collection and/or processing equipment is needed.

Operating costs are usually addressed in normal accounting procedures. These include:

- Annual costs for labor;
- Equipment operation and maintenance;
- Fuel;
- Supplies;
- Debt service;
- Administrative and overhead costs; and
- Marketing costs.

Benefits

Economic analysis should also include potential revenues and benefits of recycling. The most obvious source of revenues is from the sale of recovered materials. These revenues are often less than the costs of operating the program.

Disposal cost savings, which are increasingly important, are equivalent to how much it would have cost to dispose of the recyclables at the local disposal facility. Disposal cost savings may be calculated by estimating the total tipping fee avoided through diverting waste from disposal. In some communities, the funds saved through avoided costs are returned to the specific recycling programs. These "refunds" are called cost-avoidance credits or diversion credits.

Recycling programs can also be a source of local economic stimulus, especially if there is growth in local business handling or processing collected materials.

ENVIRONMENTAL EFFECTS OF RECYCLING

Recycling is not a "risk free" option in terms of environmental impacts. Recycling involves reprocessing or remanufacturing materials, which may have environmental impacts.

Processing and Remanufacturing Recyclables

Many people do not realize that recycling is not necessarily environmentally benign. From an environmental standpoint, the recycling loop is complete only when proper pollution control and waste management practices are employed at remanufacturing facilities. In addition to proper facility operation, Federal and State regulations are designed to protect the environment and public health from potentially adverse impacts. When these standards of operation are followed, public health and the environment are protected.

An example of how recycling carries potential environmental impacts is the de-inking of waste paper. Colored inks used in magazines and color inserts in newspapers may contain hazardous heavy metals such as lead and cadmium. After the de-inking process, these constituents may be found in high concentrations in de-inking wastewater treatment sludge. If improperly disposed of, these metals could eventually leach from the sludge into ground water. De-inking facilities must follow all mandated management procedures to ensure protection of the environment.

In addition, municipal and commercial employees engaged in collecting and sorting recyclables may be subject to repetitive motion injuries, a phenomenon of growing concern in the workplace.

Increased Traffic

Collection of recyclables usually involves additional collection vehicles that could potentially affect air quality, especially in urban areas. The proposed Los Angeles recycling system had to take into consideration the addition of two collection vehicles to each route. Since, in Los Angeles, air quality is a significant consideration, the environmental impact was assessed during the planning process. Because the new vehicles would be automated (requiring less time per stop) and because not every residence would require pick-up by all three collection trucks each collection day, the city concluded that truck congestion and air pollution would not be significantly different from the previous system. State-of-the-art collection vehicles are also more fuel efficient and may use alternative fuels or have more elaborate pollution control systems.

Storing and Cleaning Recyclables

Since some recycling centers may handle hazardous materials (e.g., household hazardous wastes, batteries, waste oil), there is the potential for harmful water runoff from stockpiles. Procedures and facilities should be designed to minimize this risk. For example, storing materials in closed containers (or inside) and moving materials quickly to final processing centers quickly can minimize this risk. Also, water used during materials processing must be disposed of properly.

INTEGRATION WITH OTHER WASTE MANAGEMENT OPTIONS

Recycling programs vary greatly, as can the amount of materials removed from the waste stream. In the more comprehensive recycling programs, significant quantities of waste can be diverted from ultimate disposal. Recycling is, therefore, one of the first options selected by communities faced with an impending landfill capacity shortfall.

Recycling impacts on waste-to-energy facilities can be equally beneficial, despite the historical tension that exists between the supporters of the two options. Decision makers should recognize the benefits associated with combining recycling with energy recovery. The two alternatives can, in fact, complement each other:

- Recycling programs can reduce the overall waste stream, which means a smaller capacity municipal waste combustion facility. Capital and operating costs are directly linked to the capacity of the facility.

- Recycling can have a direct effect on the environmental impact of municipal waste combustion (MWC). Air emissions and MWC ash are the main environmental concerns at these facilities. Many of these possible problems can be removed from the MWC feed stream by recycling programs. For example, lead is of major concern in air emissions and ash. Lead in the waste stream can be found in automotive batteries and steel cans and electronics equipment that use lead solder. By recycling these non-combustible materials, lead problems can be reduced.

- A more positive public reaction can result from combining an extensive recycling program with a municipal waste combustion facility. New MWC facilities have met public opposition; decision makers may find that a facility that is developed after a recycling plan has been implemented may be more acceptable to the public.

- Recycling diverts non-combustibles (e.g., glass, aluminum, and ferrous metals), reducing wear and tear on MWC facilities.

Recycling can also have a positive impact on composting operations. Like combustion facilities, recycling can remove harmful constituents (e.g., metals) from the material to be composted. In fact, many commonly recycled materials are non-compostable (e.g., glass, aluminum, ferrous metals), and are actually contaminants in the compost product.

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Chapter Seven

Composting

MAJOR MESSAGES

- Composting is becoming an increasingly popular municipal waste management alternative, as communities look for ways to divert significant amounts of organic wastes away from rapidly filling landfills.
- Yard waste composting is a low-technology, low cost operation that can handle large portions of the municipal solid waste stream.
- Municipal solid waste (MSW) composting is a developing technology that is expected to see increased use in the future. MSW composting can be developed simultaneously with recycling and refuse-derived fuel operations.
- Composting programs can significantly benefit other waste management operations, both environmentally and economically.

Composting is becoming an increasingly popular waste management option, as communities look for ways to divert portions of the local waste stream away from rapidly filling landfills. Composting is an aerobic (oxygen-dependent) degradation process by which plant and other organic wastes decompose under controlled conditions. As a result of the composting process, the compostable waste volume can be reduced 50 to 85 percent (Taylor and Kashmanian, 1988). The finished product is a dark-brown substance referred to as humus or compost.

Composting programs can be designed to handle yard wastes (e.g., leaves and grass clippings) or the compostable portion of a municipal solid waste stream (e.g., yard wastes, food wastes, or other degradable organics). Composting programs have also been designed for agricultural wastes, wastewater treatment sludge, or mixtures of all of the above.

The Composting Process

The composting process involves the action of microorganisms on biodegradable organic material. Organic materials are placed in a pile or windrow (elongated pile), where decomposition takes place, depending on the amount of oxygen, moisture, and nutrients in the material. The decomposition is caused by microorganisms such as bacteria and fungi, which use the organic material as a food source. The metabolic activity of these organisms changes the chemical composition (including volume reduction) of the pile and generates heat. When the biodegradable food supply is depleted, heat generation slows and the pile cools.

Although certain controlled conditions must be maintained to ensure a productive compost pile, most of the actual process occurs naturally.

Factors Affecting the Compost Process

Moisture. Improper moisture content (too much or too little) slows down the composting process, especially in the early stages of operation. Proper moisture levels optimize decomposition. Most yard wastes contain sufficient amounts of moisture, but moisture addition may be beneficial with certain composting approaches.

Oxygen. Composting is an oxygen-dependent process. Turning or forced aeration aid the composting process.

Nutrients. Nutrient levels can be defined in terms of the nitrogen to carbon ratio. The higher the ratio, the faster the decomposition. Grass clippings contain higher amounts of nitrogen than leaves, so grass clippings tend to decompose more rapidly. Nitrogen is sometimes added to compost piles to foster decomposition. In general, nitrogen occurs in sufficient quantities within the material to be composted.

Other naturally occurring nutrients, such as potassium and phosphorus, will also encourage decomposition.

Temperature. Temperatures within compost piles naturally rise due to the metabolic activity of the microorganisms. This has the positive impact of killing a large amount of harmful pathogens that may be present in the material to be composted, but too much heat can be detrimental to the composting process. As with moisture, proper pile temperatures will optimize the decomposition process, and temperature control is a part of high-technology composting approaches.

BACKYARD COMPOSTING

Backyard composting involves individual homeowners installing the "traditional" compost pile on their own property, where yard wastes and degradable household wastes (especially food wastes) are composted.

Backyard composting is a source reduction activity in that materials composted in backyard operations do not have to be managed as municipal waste. Collection costs and the cost of disposal are therefore eliminated for all materials that are composted in a backyard. Consequently, decision makers should encourage backyard composting as a source reduction activity and may choose to provide residents with guidance and technical assistance on proper backyard composting methods.

The number of backyard systems available is limited only by the imagination of individual homeowners. Some commonly used methods include:

- *Windrows.* Windrows are elongated piles 2 to 5 feet high constructed by layering the raw materials. Windrows are turned periodically to expose more of the material to the air. To protect the material from excessive moisture during rainy seasons, piles are sometimes covered with a tarp.

- *Cylindrical pen.* The cylindrical pen method of composting involves building a compost pile within a disconnectable cylindrical pen of woven wire (e.g., chicken wire). This type of system is easily moved and the wire allows for increased air circulation.

- *Perforated steel drum.* The perforated steel drum is a large, 55-gallon drum punctured with holes and partially filled with compostable material. To turn the material for aeration, the drum is simply rolled (METRO).

Mulching Grass Clippings

Leaving grass clippings on a freshly mown lawn (instead of bagging) is a source reduction activity. If grass clippings are short enough, they will fall through the grass to the ground where they will be assimilated into the soil. Decision makers should encourage grass mulching as a source reduction activity.

CENTRALIZED YARD WASTE COMPOSTING

Over 650 yard waste composting facilities are currently in operation in the United States (Glenn and Riggle, 1989). Composting is likely to become a more widely used waste management alternative, as yard waste comprised approximately 20 percent of the total discards into the municipal waste stream (national average) in 1986 (EPA, 1988). During peak seasons, this percentage can rise up to 35 percent and higher in differing climates.

Commonly Composted Yard Wastes

Leaves, collected in the fall and spring, are the easiest material to compost and are the most common materials handled at yard waste facilities.

Grass clippings are also compostable, but require more attention than leaves alone. Grass clippings are higher in nitrogen and moisture than leaves and, when left in bags or large piles, they can become odorous. Daily (or even more frequent) and thorough mixing of incoming grass with existing leaf piles can limit these problems.

Brush, stumps and wood are compostable only if they are chipped, but the costs of chipping for compost are usually high, and the time needed to decompose is longer than for other yard wastes. These materials are often chipped and sold as bark mulch, or may even be used as firewood without chipping.

YARD WASTE COMPOSTING TECHNOLOGIES

Centralized yard waste composting facilities operated by municipalities or private companies are becoming a more common response to local municipal waste management problems. Strom and Finstein (1986) have developed categories of yard waste composting that decision makers may find useful. Figure 7.1 outlines several compost facility site factors that apply to the various approaches discussed here.

Minimal Technology

The minimal technology approach involves forming large windrows (12 feet high by 24 feet wide) that are turned only once a year with a front-end loader. Because of infrequent turning, decomposition will take longer in the minimal technology approach than in the other, more advanced approaches. The material is usually

FIGURE 7.1
Composting Site Factors

Several site-specific factors must be considered when looking at the various centralized yard waste composting approaches.

Buffer zone. A buffer zone refers to the area between the composting facility and neighboring residences and businesses which serves to minimize the impacts of composting operations on neighbors (odor, noise, dust, and visual impacts). Buffer zone requirements vary for the different composting technology approaches.

Environmental considerations.

- Stream encroachment -- composting facilities should not be sited in a flood plain;
- Slope and grading -- steep slopes are difficult to access and drainage has to be carefully designed;
- Percolation -- high soil percolation rates are desirable for limiting water and leachate run-off;
- Water table -- a high water table is generally undesirable at a composting site;
- Water supply -- operation of the pile may require occasional wetting of the leaves, so some supply of water (i.e., fire hydrant, pumping station) is desirable.

Security and safety. Security and safety are also important factors in facility design. Measures should be taken at the site to prohibit illegal dumping and vandalism. In general, public access should be restricted. Fencing, gates, berms and existing natural barriers can help secure the facility.

suitable for use as compost after one to three years, depending on the region of the country.

The obvious advantage of this approach is that it is relatively inexpensive and requires little attention. The space required to actually compost the material is also relatively small, because the windrows are so large (a single windrow 60 yards long would contain 3000 cubic yards of leaves.

The compost facility, however, will have to be relatively large, because a large buffer zone between the facility and neighboring residences is needed. This is due to the considerable odor problems that result from infrequent turning. In areas where a facility can easily be sited away from residences, this is an attractive option.

Low-Level Technology

To limit odor problems, smaller windrows and more frequent turning are required. Piles 6 feet high and 12 to 14 feet wide are a moderate enough size to allow sufficient composting while limiting overheating and odors. In addition, two piles can be combined after the first "burst" of microbial activity (approximately one month). After 10 to 11 months and additional windrow turning, the piles can be formed into "curing" piles around the perimeter of the site, where the final stage of the composting process (stabilization) takes place. This frees area for the formation of new piles. The composting process with the low-level technology approach is approximately 16 to 18 months.

The low-level technology approach is still relatively inexpensive, because only a few operations are involved: forming the piles, combining the piles, turning, and curing pile formation. Although more actual composting space is required (smaller windrows), the facility itself is smaller because of reduced buffer zone requirements.

Intermediate-Level Technology

The intermediate-level technology approach is similar to the low-level technology approach except that windrow turning machines are used weekly. With this approach, the compost product is ready in 4 to 6 months.

Windrows at a Composting Facility in Sumter County, Florida

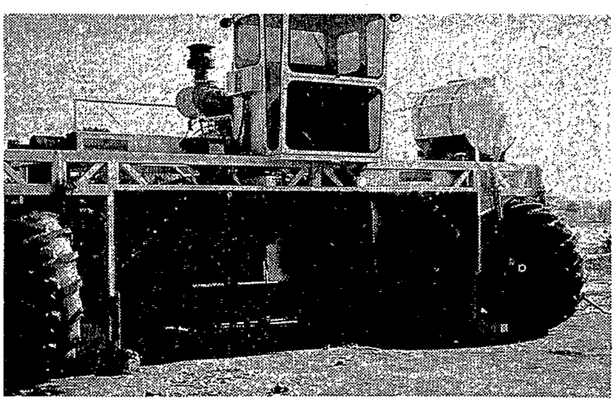
Capital and operating costs for the intermediate-level approach are higher because of the more frequent operations and the higher capital costs associated with the windrow turning machines, which are more expensive than front-end loaders. Windrow turning machines also limit the size of the piles, which may increase composting area requirements (more, smaller piles may be required).

The advantage of this approach is that greater volume reductions are achieved and the composting process takes place more rapidly. This may be more attractive for large facilities.

High-Level Technology

The high-technology approach involves using forced aeration to optimize composting conditions with the piles. This is done using a blower controlled by a temperature feedback system. When the temperature within the pile reaches some pre-determined value, the blower turns on, cooling the pile and removing water vapor. This method aerates the pile while optimizing temperatures.

Forced aeration usually takes place for 2 to 10 weeks, at which time the blowers are removed and the piles are turned periodically. The composting process can be completed within one year using the high-level technology approach.



Windrow Turning Machine

Area Requirements

A generally accepted rule of thumb is that one acre of land is required for every 3,000 to 3,500 cubic yards of leaves collected in operations using front-end loaders to pile and turn the compost in windrows (Strom and Finstein, 1986). A community collecting 15,000 to 20,000 cubic yards of leaves in a season, therefore, would require five to seven acres of land for the compost windrows.

Another advantage of this approach is that larger windrows can be formed (reducing area requirements) without creating anaerobic conditions and odor problems. The disadvantages of the high-level technology approach are the increased capital and operating costs associated with the aeration equipment and increased site activities.

DEVELOPING A CENTRALIZED YARD WASTE COMPOSTING PROGRAM

A variety of factors affect the development of a centralized yard waste composting program, and decision makers (both government and private) must carefully plan operations.

Compost Product Markets

Like recycling, the availability of and access to outlets for the compost product are fundamental in determining composting program success. Typical markets include agriculture, nurseries, greenhouses, and individual gardens. The compost product may also be used as a fill material in municipal operations (parks, landscaping, and construction). Marketing the compost product is discussed in more detail later in this chapter.

Like municipal waste combustion, composting is also a volume reduction activity. Even if the composting product is landfilled, composting conserves landfill space (although composting used purely for volume reduction may be economically prohibitive).

Facility Ownership and Financing

Facility ownership is a concern with any waste management facility. Chapter Four of this Guide (Collection and Transfer) outlined some of the advantages and disadvantages of private versus public operation. In general, commercial operations may be more attractive at the larger facilities, primarily due to the larger capital costs involved. Municipal operations, however, also offer distinct advantages.

Decision makers must evaluate local conditions and needs to determine which approach is most attractive.

Choosing a Level of Technology

The selection of a particular composting technology depends on a variety of local factors. In general, the higher technology options are used in more densely populated areas where the availability of space is limited. Strom and Finstein (1986) recommend the low-level technology approach where it is feasible because of the lower costs. Other factors, such as distance from collection routes, available resources, quantity of compostables in the local waste stream, and relevant regulations also affect technology selection.

Costs of Centralized Yard Waste Composting

A primary consideration when selecting a composting technology will be the cost of each option. Costs related to the development of a centralized yard waste composting facility include:

- Land acquisition;
- Land improvements;
- Labor;
- Initial windrow formation;
- Combining windrows;
- Water (and other possible additives);
- Turning and turning equipment;
- Storage (curing) pile formation;
- Separation/shredding/screening;
- Disposal of noncompostable and unacceptable materials;
- Insurance;
- Contingencies (unusual costs due to bad weather, equipment breakdown, etc.); and
- Overhead.

Costs at medium-sized facilities (20,000 to 30,000 cubic yards of leaves) at which Strom and Finstein's low-level technology approach is employed have been estimated at $4 per cubic yard for 1989. These costs will be higher if:

- The site operates at less than design capacity;
- Extensive downtime occurs at the site; or
- Small quantities of materials are separated or shredded at a time.

Costs at larger facilities (80,000 cubic yards or more) using the medium or high-level technology approach will be higher due to increased capital costs (equipment, buildings), increased labor costs, and more administrative costs. These costs have been estimated at $6 per cubic yard for 1989 (all above costs: Derr and Dhillon, 1989).

Additional Costs

The above costs do not include the cost of collecting and transporting the yard wastes. Collection costs will be similar for the various approaches, but transportation costs could vary significantly depending on the distance between the composting facility and the collection route.

Economies of Scale

The above cost analysis violates traditional economies of scale, which imply that larger facilities should be less expensive to operate on a dollar per ton basis. Economies of scale, however, do not necessarily apply to these approaches, mainly because the larger facilities require increased capital expenditures for equipment and labor. Decision makers must, therefore, evaluate options on other criteria (e.g., facility size limitations) in addition to cost.

Composting Equipment and Approximate 1988 Prices

Vacuum leaf collectors

Trailer mounted:	$14,000 - $21,500
Truck:	$50,000 - $60,000

Front end loaders:

Purchased:	$75,000 - $150,000
Leased:	$2,600 - $4,600 per month

Water Tank Truck:	$50,000 - $65,000
Specialized aerating and turning equipment:	$30,000 - $160,000
Separating and shredding equipment:	$17,000 - $150,000
Tub Grinder:	$110,000

(Source: University of Connecticut Cooperative Extension Service, 1989; Illinois DENR, 1989)

MARKETING THE YARD WASTE COMPOST PRODUCT

Decision makers must investigate end-uses for the compost product as part of the program planning process. Unlike recyclable items such as aluminum and glass, no national markets for compost product are available. Compost product outlets, however, do exist in many locations throughout the country.

Marketing Costs

Marketing the compost product may involve additional costs:

- Laboratory analysis;
- Packaging equipment;
- Packaging materials;
- Advertising;
- Distribution;
- Transportation;
- Labor; and
- Energy.

Although the compost product can generate revenues, these revenues may not outweigh the cost of collecting, processing, and distributing compost. Decision makers, however, must also account for avoided disposal costs and the environmental benefits of the composting program when evaluating feasibility.

Obstacles to Compost Marketing

The Illinois Department of Energy and Natural Resources (1989) has outlined some of the obstacles decision makers must consider when evaluating markets for yard waste compost.

Costs

Costs of composting operations will vary depending on the approach selected. Regardless of the technology, the compost product must have the proper purity, appearance, porosity, texture, consistency, and chemical balance. Consequently, maintaining a quality product will include certain monitoring and control costs.

Supply of Materials

The composting facility must provide potential buyers with a consistent supply of product. Assurance of a consistent supply of materials is one of the key elements of developing new markets.

Soil Quality

Because one of the main uses for the compost product is as a soil amendment, decision makers should assess the need for quality soil amendment within the local region.

Contamination

Perhaps the most important factor in marketing the compost product is assurance of a contaminant-free product. Various lawn and tree chemicals and auto exhaust could potentially contaminate incoming yard wastes. Decision makers should monitor incoming yard wastes as well as product quality to assure a high-value product. (Note: the composting process will degrade many commonly used pesticides that may be present in the material being composted, limiting their impact on the final product).

Consumer Reluctance to Change

In developing compost product markets, decision makers will have to develop strategies to overcome a natural reluctance to change among potential end-users. Assuring a quality product is the first step in this process, which can be supplemented by public education programs outlining the value of the compost product as well as the role composting plays in addressing local municipal waste management problems.

Marketing Strategies

Figure 7.2 outlines some of the typical compost markets used in regions across the country. A general approach for marketing the yard waste composting product may involve:

- Requiring compost use by government entities and specifying its use by private contractors performing land maintenance activities for those entities.
- Direct-retail sale or free distribution of bulk compost by truck-load or in small quantities on-site.
- Direct sale or free distribution of bagged compost on site or at special distribution centers.
- Direct sale or free distribution to wholesalers for processing in bulk or bags to retailers (Illinois DENR, 1989).

These are general marketing procedures that can be adapted to local markets and conditions.

Compost Product

FIGURE 7.2
Typical Compost Markets

Residential

- Food Garden Application
- Lawn and Flower Garden Application

Commercial

- Greenhouses
- Nurseries
- Golf Courses
- Landscape Contractors
- Turfgrass Farmers
- Industrial Park Grounds
- Cemeteries
- Agriculture
- Topsoil Suppliers

Public Agencies

- Public Parks
- Playgrounds
- Roadside and Median Strips
- Military Installations

Land Reclamation

- Landfill Cover
- Strip Mined Lands
- Sand and Gravel Pits
- Derelict Urban Land

(Source: Illinois Department of Energy and Natural Resources, 1989)

MUNICIPAL SOLID WASTE COMPOSTING

Municipal solid waste (MSW) composting is a developing waste management technology in the United States. Unlike yard waste composting, a large amount of pre-processing of incoming materials is required prior to composting. Pre-processing is performed to isolate the compostable portion of the municipal solid waste stream (yard wastes, food wastes, and organic fractions such as paper). These materials can constitute anywhere from 30 to 60 percent of the municipal waste stream (Chertow, 1989).

Processing MSW for Composting

Pre-processing municipal solid waste prior to composting is largely a separation task. Both manual and mechanical separation techniques are available to remove bulky items (e.g., white goods, furniture), metals, glass, plastic, and other non-compostables. These technologies are addressed in Chapter Six (Recycling) of this *Guide* where they are referred to as "Full Stream Processing." As discussed in that section, full stream processing can take place as part of composting operations, recycling programs, and the preparation of refuse-derived fuel. In fact, all of these operations can take place simultaneously, as each demands a different portion of the waste stream: the smaller-sized fraction (yard waste, food waste, some paper) are generally sent to the composting facility, materials such as ferrous metals and aluminum can be recovered for recycling, and the remainder can be processed into RDF.

Separation of the compostable portion of MSW is usually performed using a rotating screen called a trommel. Once separated, these materials are usually shredded to reduce the particle size and moisture may be added to aid the composting process.

Composting MSW

The compostable fraction of MSW is usually composted in a manner similar to the high-level technology approach for yard wastes. Forced aeration and frequent turning are used to foster optimum composting conditions.

In-Vessel Systems

Sometimes called "digesters," in-vessel systems use forced aeration and turning in large, enclosed chambers to produce the compost product. These systems claim to provide a more consistent product and have fewer odor problems than the windrow or static pile variety. In-vessel composting is sometimes followed by a windrow step to further compost the materials. In-vessel systems are more expensive than windrow operations, due to the facility and technology requirements. Operating costs for these facilities range from $100 to $380 per dry ton in 1988 (Johnston, 1989).

Preparation of the MSW Compost Product

After the initial composting process is complete, the materials are stored in piles for stabilization (curing). In windrow MSW composting operations, initial composting takes approximately six weeks, and curing takes an additional two weeks. In vessel systems digest material for two days to four weeks, and curing usually takes another four weeks (Chertow, 1989).

Marketing the MSW Compost Product

The major obstacle to marketing the MSW compost product is that of product quality. Because of the processing technologies used and the variety of materials composted, MSW compost is likely to contain larger amounts of contaminants (e.g., glass, plastic, metals) than the yard waste compost product. For this reason, MSW composting operations must have well-established procedures for removing contaminants from the incoming waste stream, as well as for assuring product quality. Post-processing may be required to remove contaminants after the composting operation is complete.

One advantage of MSW compost is that it is expected to be produced in large quantities at MSW composting facilities. The large quantities available may make the product more attractive to potential buyers.

OTHER TYPES OF COMPOSTING

Sludge Composting

Sludge composting is also becoming an increasingly popular waste management practice. The process involves mixing sludge with some bulking agent (e.g., sawdust, wood chips, leaves or recycled compost) to increase airflow and absorb moisture. Sludge composting facilities may be static piles, windrows, or in-vessel. In the static piles, the material is aerated using perforated pipes and blowers. For environmental and public health reasons, sludge piles are often built on some type of pad (e.g., concrete) and, ideally, should be enclosed. In-vessel operations are similar to those described in the MSW composting section above. These facilities are usually easier to site because of reduced area requirements and odor problems.

The sludge compost product is high in nutrients (especially nitrogen) and is a valuable product when sufficient quality is assured.

Co-Composting

Co-composting refers to the simultaneous composting of two or more diverse waste streams with sludge or some other nitrogen-rich material. Sludge provides moisture and nutrients to the compost, while municipal solid waste acts as a bulking agent, adding porosity and absorbing water. Combining sludge composting with municipal solid waste composting is planned at some facilities in an effort to generate a more valuable product and to combine operations. Again, the success of these operations will depend on the quality of the final product. Because several waste streams are involved in co-composting, testing the compost product for contaminants will be necessary.

Agricultural/Animal Waste Composting

This process involves mixing animal manures with bulking agents (i.e., hay, bedding, leaves, brush, food waste, or shredded paper) and then composting it in windrows or static piles. This is usually undertaken by small, private entities such as farms or nurseries. In some cases, the composting product is sold as a high quality soil amendment. Some large zoos collect and compost animal wastes and market the product as "zoo doo."

ENVIRONMENTAL EFFECTS OF COMPOSTING

Because the compost product is often used as a soil amendment in a variety of applications, the quality of the product must be monitored before being used. In particular, MSW composting facilities and facilities co-composting municipal solid waste with manure, septage, sewage sludge, fish wastes, or residuals from RDF processing create some significant environmental considerations.

Odors are one of the most frequent problems at composting facilities. Frequent turning of compost piles has proven to be effective in limiting odor problems. When in-vessel systems are used, odor control devices (e.g., air scrubbers) can minimize these problems.

Pathogens (found in manure, sewage sludge, or municipal waste), are usually destroyed by the high temperatures achieved during normal composting operations. Nevertheless, the compost product should be tested for the presence of pathogens.

Monitoring the Compost Process

Monitoring both the material to be composted and the compost product are important aspects of the overall composting process. Because the end product is used for a variety of purposes, contamination could have detrimental environmental effects. This is especially true when one considers that the environmental threats are easily minimized through simple procedures (waste segregation, proper turning, and sufficient composting time).

Water Impacts

Water runoff from yard waste composting facilities could contain large concentrations of nutrients (i.e., nitrates and phosphorus) that could cause algal blooms in nearby surface waters. Retention basins or berms may be used at facilities to limit water runoff. Facilities constructed on highly permeable soils may require liners or pads. Water impacts are not generally expected to be serious at yard waste composting facilities.

Because municipal waste composting, sludge composting, and co-composting involve a large amount of potential contaminants, water impacts could be greater at these facilities. Leachate from MSW compost facilities can contain high concentrations of nutrients (such as nitrates and phosphorus) and perhaps volatile organics and metals. Leachate could affect both surface and ground water. Retention basins to capture storm water runoff are good practice, as are liners or pads. Enclosing the composting operation will also minimize leachate formation.

Land Impacts

At yard waste composting facilities, soil may become more acidic because of the presence of certain leaves and pine needles in the compost pile. Nitrogen depletion may also occur. Proper turning of compost piles can limit these effects.

MSW and co-composting facilities carry the potentially harmful impacts of acid, organic, and metal contamination. Again, careful pre-processing to divert as much of the potentially hazardous materials from the compost facility is an important quality control procedure.

Health Impacts

The primary public health concerns associated with composting operations result from:

- Drinking water contamination;
- Toxics in the finished product (applied on land); and
- Pathogens.

Nitrate contamination of drinking water can affect the oxygen-carrying capacity of blood in infants and in the elderly, but again, under proper composting conditions, this risk is minimal. Pathogens can be spread by insects and vermin. Worker risks include respiratory problem aggravation. Worker training and health monitoring can minimize these risks, as can proper apparel and equipment.

INTEGRATING COMPOSTING WITH OTHER WASTE MANAGEMENT OPTIONS

Composting programs can be designed to complement or augment most other waste management activities. Preserving landfill space is the most obvious example, and this factor is often the driving force behind a composting operation.

Composting can also complement the operation of a municipal waste combustion facility. Because yard wastes have high moisture content, they do not burn as well as some of the other waste stream components. Also, yard wastes have high seasonal fluctuations which could lead to an oversized combustion facility. Diverting yard wastes to a composting facility can increase the heating value of the waste entering the combustion facility and reduce extreme volume fluctuations (improving combustion).

In addition, nitrogen oxides (NOx) are air pollutants at municipal waste combustion facilities. NOx result primarily from the combustion of nitrogen-rich grass clippings. By removing grass clippings from the stream entering the combustion facility, overall environmental benefits can be realized.

As discussed earlier, municipal solid waste composting operations can effectively be combined with recycling programs and/or the preparation of refuse-derived fuels. The processing technologies used separate a compostable fraction, a fraction of materials suitable for recycling, and a stream that can be processed further into RDF. As these technologies develop, the benefit of combining all three operations is expected to become even more attractive.

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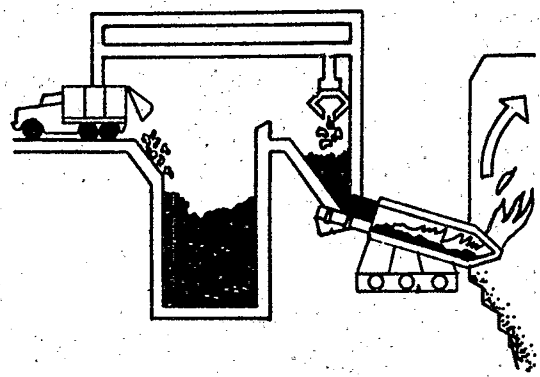
Chapter Eight

Municipal Waste Combustion



State-of-the-art municipal waste combustion (MWC) has two functions: reduction in the quantity of waste subject to final disposal and recovery of energy. Modern combustion facilities are no longer simple "garbage burners." Instead, waste-to-energy units are designed to produce steam and electricity, and can be used in conjunction with (or as a complement to) source reduction, recycling, and composting programs.

Combustion of solid waste is becoming an increasingly important aspect of integrated solid waste management, as communities look for alternatives to rapidly filling landfills. It is estimated that nearly 75 percent (by weight) of the municipal solid waste stream is combustible, and that combustion of solid waste can reduce its volume by 70 to 90 percent (Hershkowitz, 1986).

PLANNING A COMBUSTION FACILITY

Strategic, long-term planning is essential for developing a successful municipal waste combustion facility. Decision makers must develop an understanding of a variety of issues in the planning process:

- Facility ownership and risk;
- Engineering and legal decisions;
- Contractor selection and coordination;
- Marketing a product (steam or electricity); and
- Generation of capital.

Long-term planning within local government is the key to successful facility design and operation. By understanding all issues and developing a dedicated staff, municipal waste

MAJOR MESSAGES

- Long-term planning is the key to municipal waste combustion facility success.
- Major combustion technologies include mass burn, modular, and RDF-fired systems.
- Proper pollution control for emissions and ash management are important aspects of combustion facility planning and operation.
- Proper ash management is necessary to protect human health and the environment.

combustion can become a positive component of the local waste management system.

Facility Ownership and Operation

One of the first planning decisions faced by local officials is what entity will actually own the facility and who will oversee its operation. This decision will be based largely on the amount of financial risk the community is willing to assume and the time and resources available. Several procurement options are available:

Full Service Approach

This is the most common approach. In this system, the community hires a single firm to design, construct, and operate the plant. The community specifies only the process type and performance requirements. In this case, the facility may be owned by the vendor, owned by the community, or a shared equity.

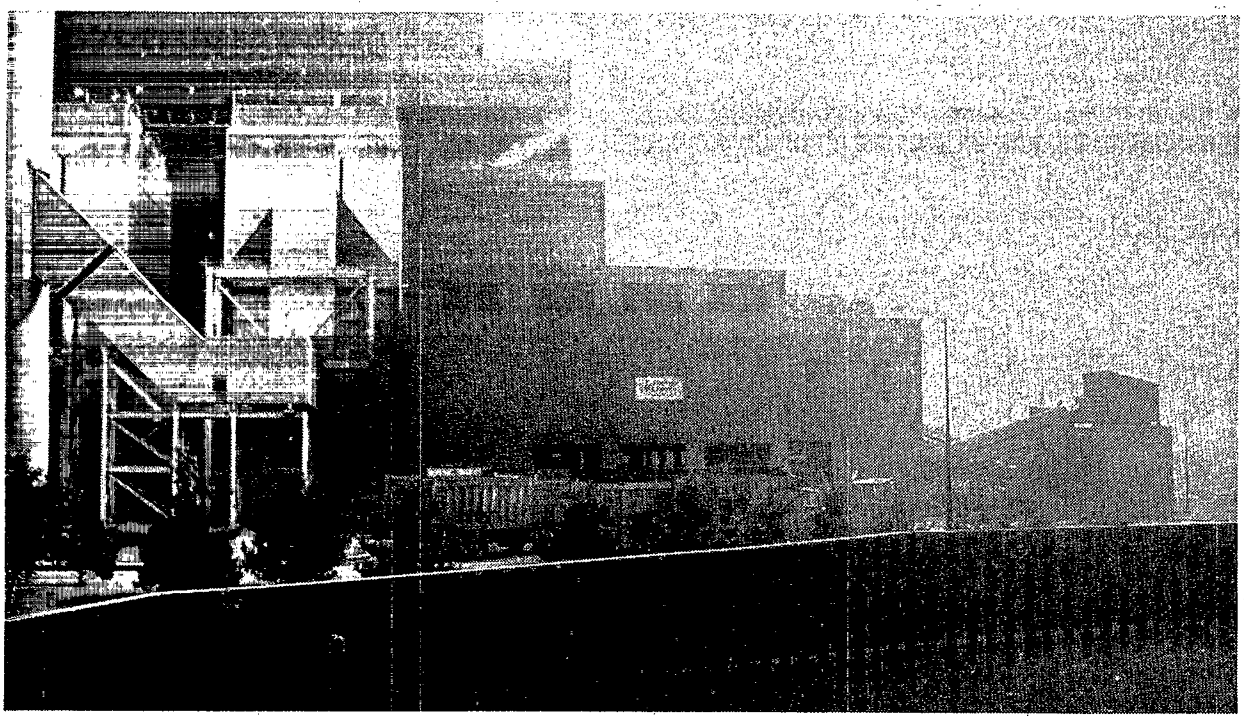
Merchant Plants

With these facilities, all implementation decisions are left to the private sector. A private firm designs, construct, owns, and operates the facility. Waste is accepted on a dollars per ton basis, and agreements may be made to give tipping fee discounts to the "host" community or the communities that commit to long-term contracts.

Besides Full Service and Merchant Plants Other procurement approaches are available, but are less widely used. These include:

Architectural and Engineering (A/E) Approach. In this system the community first contracts an A/E firm to design the facility and then enlists a construction firm (usually through a bidding process) to build the facility. The community owns and operates the plant or contracts its operation.

Turnkey Approach. With turnkey, a single company designs and builds the plant according to the community's specifications. More of the development authority is delegated to the contractor than in the A/E approach. The community or a different contractor owns and operates the plant.



Waste-to-Energy Facility, Baltimore, Maryland

Energy Markets

Municipal waste combustion facilities differ from most government services in that they generate a product, energy, that is sold for revenue. Decision makers must, therefore, be prepared to market the product and secure buyers.

Steam or electricity are the energy products at combustion facilities, depending on the particular design.

Marketing Steam

The primary end uses for steam from municipal waste combustion facilities are industrial and institutional heating and cooling systems, many of which use forced steam in their process.

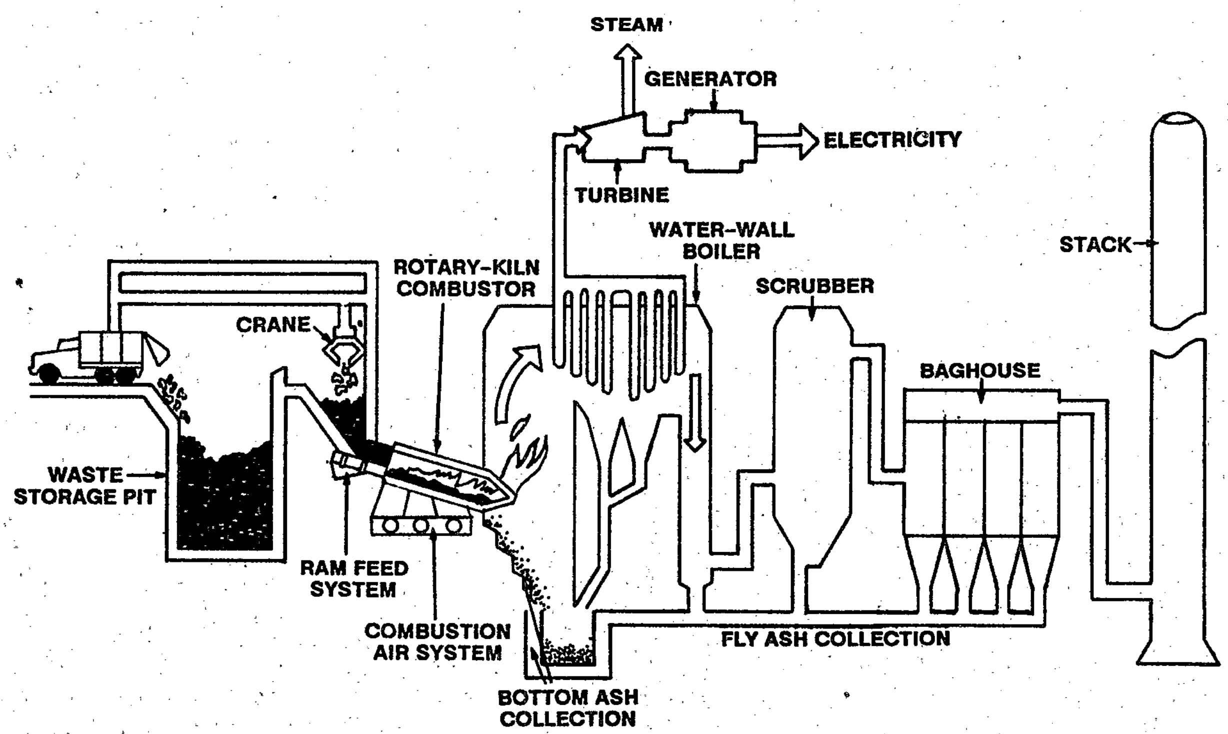
Marketing the steam product will involve identifying these industries and institutions within the region. Once identified, agreements on prices, steam delivery, and product specifications will have to be made.

Industrial steam users that should be explored include: textile, lumber, paper and pulp, food processing, rubber, leather, and chemical producers. Institutional heating and cooling systems using steam are located at: hospitals, colleges, and public buildings and services. Many cities also have commercial steam distribution utilities.

Marketing steam as a product involves some important considerations:

- *Consistent supply.* Energy users do not usually accept disruptions in service. For this reason, municipal waste combustion facilities may have to be equipped with a back-up boiler to guarantee a consistent supply.

- *Consistent demand.* Municipal waste combustion facility operators must be prepared for steam demand variations (often caused by changing seasons). Under these conditions, the combustion facility may have to be equipped with a boiler by-pass flue that allows the steam generating process to be halted temporarily.



Typical Mass Burn Municipal Waste Combustion Facility Schematic

Marketing Electricity

Municipal waste combustion facilities generating electricity are referred to as "cogenerators," as they provide electricity in addition to that generated by the local electric utility. In addition to possibly using electricity generated by combustion internally to operate the plant, customers for electricity from municipal waste combustion facilities include nearby industries and public and private utilities.

When marketing electricity, some important factors must be considered:

- *Consistent supply.* As with steam users, electricity users do not accept disruptions in service. Again, municipal waste combustion facilities may have to be equipped with a back-up boiler to guarantee a consistent supply.

- *Competitive price.* The municipal waste combustion facility will be competing with other cogenerators in selling energy.

PURPA. The Public Utilities Regulatory and Policy Act was developed as a way of encouraging cogeneration to supplement existing electrical utility capacity. The Act basically requires investor-owned utilities to purchase electricity from cogenerators at "avoided cost" rates (interpreted as the cost of building another power plant or the cost of operating at a higher capacity). Rates are developed under state boards or commissions of public utilities, and overseen by the Federal Energy Regulatory Commission.

Avoided cost rates and the utility's willingness to purchase electricity vary from state to state. Some states set attractive rates for waste-to-energy facilities as part of a policy to encourage municipal solid waste combustion. Decision makers must review Federal and State legislation governing cogeneration when determining whether municipal waste combustion will be economically viable.

Sizing the Facility

Proper plant sizing results from carefully evaluating a wide variety of criteria:

Waste Supply

Waste supply is the most fundamental sizing factor. Not only will the facility's capacity reflect the expected amount and heat-value of the waste, a steady stream of waste close to the design capacity is the only assurance of proper facility operation.

Measures are usually taken to guarantee a waste supply for the facility. Waste flow control ordinances are often used to ensure a certain quantity of waste. In some cases creditors may require such ordinances before a facility can be financed. Waste flow control ordinances usually require that all or a defined portion of the local waste stream be delivered to the combustion facility. One type of waste supply agreement is known as "put-or-pay," which guarantees the facility operator a certain amount of waste. If the community does not supply this amount, it is responsible for reimbursing the facility.

Waste flow control will have to be carefully planned within the community. Many recycling program coordinators see waste flow control as a hindrance to their operations because it reduces their supply of materials. Any current or future source reduction, recycling, or composting programs, therefore will have to be accounted for in the waste flow agreement. When properly planned, waste flow control can benefit both the combustion facility and the alternative waste management programs by diverting the relevant portions of the waste stream to each (e.g., recyclables to the recycling program and combustibles to the MWC facility).

Alternative Waste Management Programs

In addition to waste flow control agreements, future source reduction, recycling, and composting programs are directly related to facility design. When sizing the combustion facility, decision makers will have to account for the types and amounts of materials that will be diverted from the facility, as these programs will affect the quantity and heating value of the combustor feed stream.

Many decision makers feel that source reduction, recycling, and composting programs should be developed before or while a combustion facility is planned. They generally take less time and resources to implement. They also will give decision makers a better idea of the future waste stream and the resulting waste stream reduction will allow for a smaller capacity and, therefore, less expensive facility.

Waste Stream Characteristics

Good combustion depends on the accuracy of waste stream data. Most communities planning a combustion facility, therefore, perform their own waste stream assessment to develop an accurate picture of the quantity and composition of the local waste stream. Resources committed at this stage can prevent costly mistakes later in the project.

From a technical standpoint, the waste stream data will be used to ascertain the heating value of the waste (technical details regarding the heat-value of specific components will be discussed in Volume II of this *Guide*). Information on amounts of materials to be recycled will also assist in planning for heating values. Waste stream heating values may actually be higher or lower than anticipated, both of which could be detrimental to plant operation.

Planning for Facility Disruptions

Accounting for down-time is also an important facility planning criterion. Most combustion facilities are designed to operate continuously (i.e., 24 hours a day), but both scheduled (e.g., maintenance) and unscheduled (e.g., equipment failure) down-time are likely to occur. Storage space must be available for the waste that continues to arrive during down-time, and the unit must have the capacity to "catch-up" to normal levels. If these capabilities are not built into the system, provisions must be made to send waste to a landfill or alternative facility.

Facility Financing

Depending on the procurement approach selected, municipal waste combustion facilities will require extensive financing agreements. Chapter Twelve of this *Guide* discusses financing waste management alternatives in detail.

Time Frame

The time required to plan, develop, and construct a facility will vary, but at least 5 to 8 years are required to bring a new facility from the earliest planning stages to in-service.

Facility Siting

Siting the facility will be one of the most difficult tasks decision makers will undertake. A variety of social and technical hurdles will have to be negotiated for a successful siting:

- Effect on residents. Residents will be concerned with health effects associated with the plant, decreased property values, and increased traffic. Not-in-my-backyard (NIMBY) syndrome must be overcome.
- Environmental impact. Combustion has the potential to create a variety of environmental concerns, which are discussed later in this section.
- Development plans. Decision makers will have to evaluate future land use plans at a possible site.
- Proximity to waste source. Transportation cost are among the most significant expenditures in a waste management system.
- Proximity to energy markets. The energy product will have to be delivered to buyers. The location of power lines must be considered.
- Logistical concerns. Area zoning and access routes must also be considered.
- Residual ash disposal. Access to a secure landfill or ash monofill is a necessity.

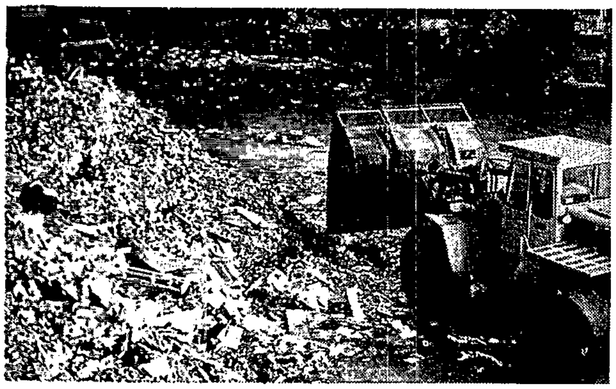
Decision makers are encouraged to refer to EPA's Sites for Our Solid Waste, referenced in the Chapter Eight Bibliography.

TYPES OF MUNICIPAL WASTE COMBUSTION FACILITIES

Municipal waste combustion facilities are designed to meet specific local needs, so there are variations in actual designs. There are, however, some basic categories.

Mass Burn Facilities

Mass burn systems combust municipal waste without any preprocessing other than removal of items too large to be fed into the unit. Mass burn facilities usually have two or three combustor units, which can range in capacity from 50 to 1,000 tons per day (tpd). Plant capacities, therefore, range from 100 to 3,000 tpd. These facilities are erected at the site, and all new systems have waterwall combustion chambers designed for energy recovery. Older facilities may have refractory-lined combustion chambers with no energy recovery.



MWC Facility Tipping Floor

Modular Combustors

Modular combustors are small mass burn units (i.e., no preprocessing of the waste) with capacities of 5 to 120 tpd. Modular combustion plants usually have one to four combustor units, so plant capacity is 15 to 400 tpd. These units are usually fabricated at a plant and transported to the facility site.

Waterwall Boilers

Most new municipal waste combustion facilities are designed with "waterwall" combustion chambers. Unlike refractory-lined furnaces, waterwall units are lined with steel tubes filled with circulating water. Heat from the combustion gases is transferred to the water. The resultant steam is either sold or used to drive turbines for the generation of electricity.

Most modular units operate with a two stage process:

(1) *Partial combustion.* Waste is initially combusted under starved-air conditions; the lack of sufficient air leads to the formation of combustible gases and ash.

(2) *Secondary combustion.* The partially combusted gases produced in the first chamber are fired with an auxiliary fuel and excess air in what is called the thermal reactor (or afterburner). The auxiliary fuel is often used only during start-up to insure proper combustion temperatures. The hot gases are first directed to a heat recovery boiler, then cleaned and discharged.

All new modular combustion facilities for municipal waste combustion are expected to have energy recovery.

Refuse-Derived Fuel-Fired Facilities

Refuse-derived fuel (RDF) refers to a wide range of pre-processed municipal solid waste. A variety of RDF-fired combustors are used, depending on the degree of pre-processing:

- *Dedicated RDF boilers*: burn RDF only;
- *Co-fired boilers*: highly processed RDF co-fired with coal in coal burners; and
- *Mixed waste firing*: RDF fired with other wastes such as wood or coal.

Individual RDF combustors range from 300 to 1,000 tpd capacity. Plants typically have two to four combustion units, so plant capacities range from 600 to 4,000 tpd.

Types of RDF

Several different types of RDF exist. Definitions of the types vary, but can generally be classified as:

- Coarse;
- Prepared;
- Recovery Prepared;
- Fluff; and
- Densified;

RDF also comes in powdered, liquified, gaseous, and wet-dry forms, but few municipal solid waste boilers use these technologies and they are generally considered unavailable.

Coarse RDF. Coarse RDF results from minimal processing (i.e., shredding); materials that pass through a six-inch screen are considered coarse RDF. No materials separation by type occurs. Coarse RDF is used in dedicated RDF boilers.

Prepared RDF. This type of RDF refers to coarse RDF that has been processed further by removing ferrous metals, fine materials, glass, ceramics, sand, and grit. This reduces wear and clogging of the moving equipment in the unit and increase heating values of the RDF. Prepared RDF is used in dedicated RDF boilers.

Recovery Prepared RDF. This material is similar to the prepared RDF except that a larger portion of the metallic constituents are removed (i.e., aluminum, zinc, copper, brass, and ferrous metals) as are greater glass fractions. Recovery prepared RDF has less ash per pound and more Btu's per pound. Recovery prepared RDF is used in a dedicated RDF boiler.

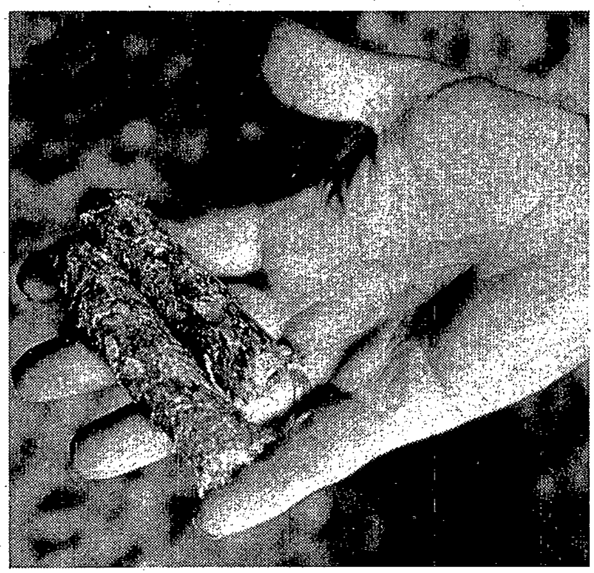
Fluff RDF. Fluff RDF is a shredded material, 95 percent by weight of which passes through a 2-inch square mesh screen. Several processing units are used to produce fluff. Primary shredding is used for homogenization and size reduction of the waste; air classification is used to separate light from heavy materials (most combustibles are light, most non-combustibles are heavy); magnetic separation is used to remove the ferrous metal (which can be resold); a screening process is performed on the light (combustible) fraction of the stream to remove dirt, glass, grit; and finally, secondary shredding is used to further reduce the combustion fraction. Fluff can be co-fired with coal in suspension-fired or fluidized bed boilers, as well as dedicated boilers.

Densified (Pellet) RDF (d-RDF). Densified RDF is produced through the compaction of fluff material into cubes, pellets, briquettes, buttons, or similar forms. Densified RDF is less costly to transport over long distances, and can be fired in stoker-fired industrial boilers designed for coal (Blue).

Each of the RDF categories have different amounts of residuals, with d-RDF producing the most. Full stream processing technologies that may be used at RDF plants were described in Chapter Six of this *Guide.*

Fluidized-Bed Combustion Facilities

This is largely a developing technology that burns processed municipal solid waste in a heated bed of non-combustible material (such as sand). Existing and planned fluidized bed combustors have capacities ranging from 200 to 500 tpd. Plant capacity is estimated to be 300 to 1,000 tpd.



Densified RDF Pellets

AIR EMISSIONS: REGULATION AND CONTROL

Emissions from municipal waste combustion facilities are a mixture of pollutants with health-related risks. Of particular concern are:

- Particulates;
- Acid gases (sulfur oxides, hydrogen chloride, hydrogen fluoride);
- Nitrogen oxides;
- Trace metals (lead, cadmium, mercury, etc.);
- Dioxins and furans.

Most siting difficulties for municipal waste combustion result from concerns over the environmental impact of air emissions. Regulations will soon be in place to address these concerns. Decision makers must fully understand these regulations and plan pollution control accordingly.

Regulation of Air Emissions

In 1986, EPA issued operational guidance on control technology for new and modified municipal waste combustors (MWC). This guidance was issued to make best available control technology (BACT) determinations consistent and to reduce delay and confusion in the permitting process. EPA also issued an advanced notice of proposed rulemaking in 1986 which explains EPA's intent to regulate MWC emissions for new or modified MWC under 111(b) of the Clean Air Act (CAA) and EPA's intent to regulate existing facilities under 111(d) of the CAA. New and modified MWC are built with the prescribed pollution control devices and existing facilities are being retrofitted to also meet the guidance for BACT.

The regulations under 111(b) for new and modified MWC will set limits for MWC emissions and NOx. These emissions are composed of:

- Particulate matter containing various metals;
- Acid gases; and
- Organic emissions.

In addition, these regulations will contain requirements for some form of source separation of recyclables before the waste is burned.

The proposed regulations are expected in November of 1989 and the final regulations are expected to be issued in December of 1990. These regulations will contain guidelines for new, modified, and existing sources.

Air Pollution Control

State-of-the-art combustion facilities are equipped with pollution control equipment that greatly reduce air emissions and any adverse environmental and public health impacts. Emission controls can take several forms:

Combustion Control

The proper design, construction, operation, and maintenance ("good combustion practices") are a fundamental aspect of controlling air emissions. In particular, proper combustion conditions can limit the formation of dioxins and furans. Continuous monitoring and control, both computerized and manual, are key "good combustion practices." Operator training can thus be considered basic to preventing pollution.

Dioxins and furans also form after discharge from the combustion chamber. Exhaust gas cooling is the control method which successfully limits this secondary formation.

Particulate Matter Control

Fabric filters (referred to as the "baghouse" in the facility) and electrostatic precipitators (ESPs) control particulate emissions.

Baghouses are designed with long, heat resistant fabric bags that capture fine particles (referred to as "flyash"). The dust and particles are collected and disposed.

Electrostatic precipitators (ESPs) treat emissions by applying a voltage to incoming particles to give them a negative charge. The particles are then removed on positively charged plates. ESPs use multiple electrostatic fields to achieve maximum particulate collection.

Acid Gas Control

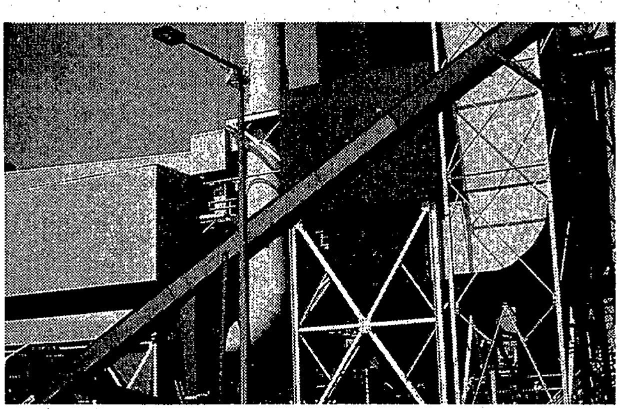
Acid gas control units are sometimes referred to as scrubbers. Lime spray scrubbers followed by

Monitoring and Automatic Control

Two recent developments that have had a great impact on combustion facility operation are monitoring technologies and automatic control. Nearly all aspects of the combustion process can now be monitored continuously, from combustion chamber temperature to stack gas composition. Expanding on this, computer-operated control devices can respond to instantaneous changes in operation and introduce corrective action. These instruments have had a major impact on increasing facility safety and reducing environmental risk.

fabric filters are considered the best acid gas control technology. In this system, a lime slurry which reacts with acid gases is sprayed into the scrubber. The water in the slurry evaporates, cooling the flue gas. The remaining flyash and reacted sorbents are removed by the fabric filter. This type of system is used to control the emission of sulfur dioxide (SO_2) hydrogen chloride (HCl), particulates, metals, and dioxins and furans.

Another acid gas control system is dry sorbent injection (DSI) followed by flue gas cooling and an ESP. Two DSI systems exist. One involves injecting dry alkali sorbents such as hydrated lime into the flue gas downstream from the combustion chamber. The other method injects the sorbent directly into the combustor.



Baghouse and Scrubber

In addition to these pollution control devices, materials separation prior to combustion can also reduce emissions. In particular, metals emissions can be reduced if materials separation is used. Although few data exist on how the separation of other materials will affect emissions, several specific effects are suspected. Materials that may contribute to harmful emissions include:

- Lead soldered items, such as steel cans;
- Household batteries, which contain heavy metals, such as mercury and cadmium;
- Lead-acid (automotive) batteries, a major source of lead in municipal solid waste;
- Certain plastics, such as polyvinyl chloride (PVC), which may be precursors to dioxin formation; and
- Yard wastes, which lead to inconsistent combustion performance because of their variable moisture content.

This list contains many recyclable or compostable materials, which supports the idea raised earlier in this *Guide* that development of recycling and composting programs can have positive impacts on the operation of combustion facilities.

ASH MANAGEMENT

Residual ash is produced during normal municipal waste combustion operations. The inorganic, noncombustible portion of the waste stream (e.g., cans, bottles, dirt, etc.) and uncombusted organic matter (i.e., soot) are the constituents in the ash.

Two types of ash are produced during combustion: bottom ash and fly ash. Bottom ash is comprised of the unburnable material that passes out of the combustion chamber. The bottom ash is usually collected by conveyor and is cooled by some type of water quench. This ash constitutes 75 to 90 percent of all ash produced, depending on the technology employed. Fly ash is a lighter material that is suspended in the flue gas and collected in the air pollution control equipment.

MWC Ash

Bottom ash is comprised of the noncombustible material that passes through the combustion chamber. The bottom ash is usually cooled by some type of water quench and collected by conveyor.

Fly ash is a lighter material that is suspended in the flue gas and collected in the air pollution control equipment. The concern associated with fly ash comes from the metal and organic compound components that are sometimes attached to the particles. It is important to note that as pollution control devices become more efficient, larger amounts of flyash, including its harmful constituents, will be removed.

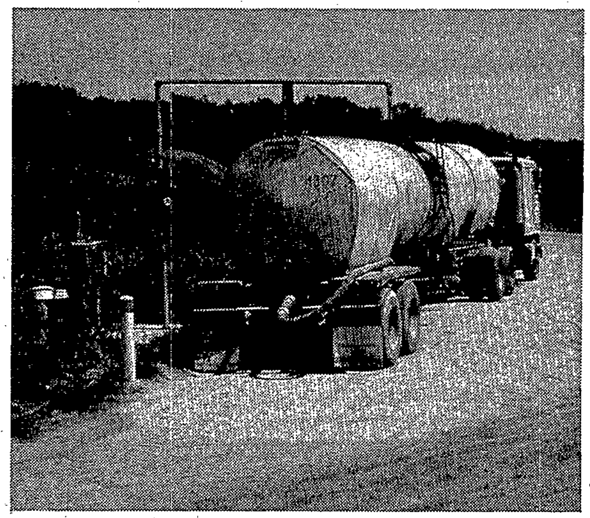
Of particular concern in MWC ash is the presence of heavy metals, especially lead and cadmium, which are present in such materials as lead-acid batteries, electronic equipment, and some plastics. Because of the potentially harmful effects of ash disposal, decision makers must address ash disposal early in the decision-making process. Leaching at landfills is the main concern, as soluble metals may contaminate ground water. Dioxins associated with the flyash can largely be controlled through good combustion practices. If present, however, they are not mobile in a land disposal unit. Fugitive dust emissions should also be controlled through proper handling. In addition to proper handling and disposal, decision makers will also have liability concerns associated with potential contamination.

There has been considerable controversy over whether MWC ash is subject to RCRA Subtitle C regulations, which govern the management of hazardous waste. The EPA stated, in the July 15, 1985 Federal Register (50 FR 28725-26), that ash generated from the combustion of non-hazardous waste that exhibits a characteristic of a hazardous waste needs to be managed accordingly. The U.S. Congress, however, is considering legislation that would create a special waste category for ash and require EPA to develop special management standards for ash as a non-hazardous waste.

Proper Ash Management

Proper ash management involves properly handling the ash from its generation in the combustion process to its ultimate disposal. Because of the potential harmful effects of contacting or breathing MWC ash or ash dust, worker safety must be ensured when loading vehicles or transporting the ash within the facility. If the MWC ash is to be transported to an off-site disposal facility, closed body vehicles should be used and unloading procedures should be established to minimize fugitive dust and protect workers.

Appropriate MWC ash testing should take place to determine its regulatory status. Disposal of non-hazardous MWC ash may take place at a municipal solid waste landfill, ash monofill (facility that accepts only ash; may be located at the combustion facility), or co-fill (facility that accepts several diverse waste streams). Because of the potentially hazardous nature of the ash, the landfill used should be equipped with a liner/leachate collection system, and ground water monitoring should take place. Not only is this type of landfill more protective of the environment, it will also reduce the liability risks associated with Superfund.



Leachate Collection at an MWC Ash Monofill

Liquid Wastes

Small quantities of industrial liquid wastes may be generated at municipal waste combustion facilities, resulting from:

- Boiler blow-down;
- Floor cleaning;
- Equipment cleaning; and
- Ash quenching.

In the past, large amounts of water were used at incinerator facilities during the flue gas cleaning and ash quenching processes. State-of-the-art facilities now utilize water treatment systems and water recycle, greatly minimizing the amount of water discharged. Modern facility designers are currently striving for "zero discharge" of process waters.

COMBUSTION FACILITY COSTS AND REVENUES

Cost factors vary considerably from facility to facility, so specific cost estimates are difficult to determine. Variable factors include:

- Size (tons per day);
- Technology;
- Location (labor and construction costs can vary significantly);
- Type of financing;
- Ownership;
- Pollution control technology; and
- Cost of ash disposal.

Capital Costs

Some ballpark figures have been developed (National League of Cities, 1988) to assist in making preliminary estimates of facility costs. Modular incinerators (less than 400 tons per day) have capital costs in the range of $80,000 to $90,000 per ton of rated capacity (economies of scale are reflected in the smaller figure). Larger, field erected facilities will cost in the ballpark of $90,000 to $100,000 per ton of capacity. Capital costs for RDF-burning facilities will generally be lower than for mass burn facilities because of the more homogeneous fuel source. These costs, however, may be offset by the capital costs of the RDF processing facility. These figures are based on national averages. Actual costs will vary considerably depending on site specific conditions.

Operating Costs

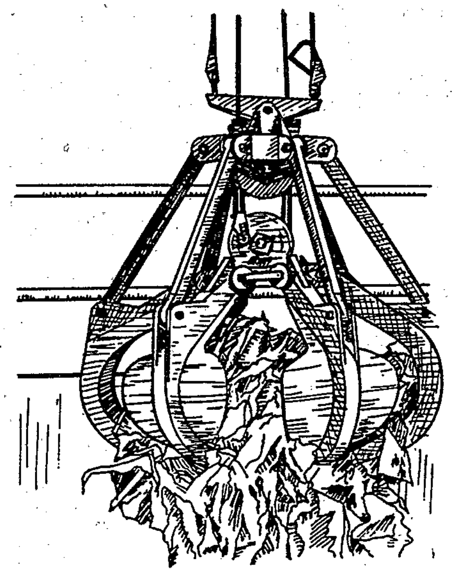
Operation and maintenance (O&M) costs will also vary considerably, based on the size, location, and technologies used. Labor costs are among the largest operating costs, and depend on the local economy. Total operating and maintenance costs for a 2,000 tpd facility have been estimated at $20 per ton on an annual basis (National League of Cities, 1988). O&M costs increase slowly as the size of the facility decreases.

Revenues

Combustion facility revenues result from:

- Sale of energy;
- Interest from reserve funds required with revenue bonds; and
- Tipping fees at the facility.
- Sales of ferrous metals recovered from the ash and other materials recovered at the RDF preparation facility.

According to a sample facility survey performed by the National Solid Wastes Management Association, the average municipal waste combustion facility tip fee in 1988 was $39.86 (Pettit, 1989). In some areas of the country, the MWC facility tip fee was as high as $65.



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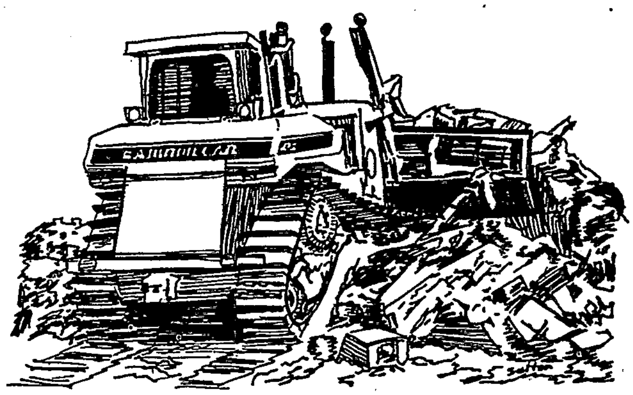
Chapter Nine

Land Disposal



MAJOR MESSAGES

- Landfills are a necessary component of any municipal solid waste management system.
- A variety of State and Federal requirements set performance standards for new and existing municipal solid waste landfills.
- Leachate and methane gas control will be important aspects of any new land disposal facilities.

Landfills are the most widely used waste management method in the United States, as approximately 80 percent of the nation's municipal waste stream is landfilled (EPA, 1988). Many communities, however, are having difficulties siting new landfills, and as old facilities reach the end of their useful life, a "capacity crisis" may result. The capacity crisis has resulted from the increasing quantities of waste generated coupled with decreasing disposal capacity. The difficulty in siting new landfills has resulted largely from an increased concern among citizens and government of the adverse environmental impacts associated with improperly located, designed, or operated landfills. Many communities are in the unfortunate situation of having to commit considerable resources to the cleanup of past disposal practices.

Modern municipal solid waste landfills are coming under increased regulatory scrutiny, and as a result, will be more protective of the environment in the future. The technologies used at modern landfills are more sophisticated than the open dump methods of the past. A

Necessity of Landfills

Despite the capacity and environmental concerns associated with landfill operation, every waste management system must still have access to a landfill. Source reduction and recycling, including composting, can divert significant portions of the waste stream from final disposal, but not all materials are recyclable. Combustion of solid waste significantly reduces waste volumes, but even the most advanced facilities must dispose of residuals (i.e., bottom ash and fly ash), and wastes may have to be disposed of during plant shut-down. With this in mind, decision makers must work to conserve existing landfill space or develop and site a new landfill, both of which could force a redefinition of the local waste management system.

variety of specific technologies are associated with a state-of-the-art landfill:

- Liner systems (clay and/or synthetic);
- Leachate collection systems;
- Leachate treatment;
- Landfill gas control and recovery;
- Improved closure techniques;
- Provisions for post closure care and maintenance;
- Monitoring systems; and
- Control of materials entering the site.

Sanitary Landfills

The American Society of Civil Engineers defines a sanitary landfill as "a method of disposing of refuse on land without creating nuisances or hazards to public health or safety, by utilizing the principles of engineering to confine the refuse to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with a layer of earth at the conclusion of each day's operation or at such more frequent intervals as may be necessary."

Landfill Design

Cells are the basic building blocks of sanitary landfills. During daily operations, solid waste is confined to defined areas where it is spread and compacted throughout the day. At the end of the day (or more often), the waste is covered by a thin layer of soil, which is also compacted. This unit of compacted and covered waste is called the cell. Several adjacent cells (all the same height) are referred to as a lift. The landfill is a series of lifts.

REGULATORY APPROVAL AND COMPLIANCE

State Regulations

State or other local or regional regulatory agencies will have specific requirements for the design, operation, and closure of municipal solid waste landfills. These requirements vary from state to state, so decision makers should consult with the appropriate regulatory agency to determine relevant standards. State requirements are likely to cover:

- Siting;
- Design;
- Operation;
- Monitoring;
- Closure and post-closure care; and
- Financial assurance.

Federal Regulations

In September 1979, EPA issued criteria providing general environmental performance standards that apply to all solid waste disposal facilities with certain limited exceptions. In the 1984 Hazardous and Solid Waste Amendments (HSWA), Congress mandated revisions to these criteria.

In August 1988, EPA proposed revised criteria for new and existing municipal solid waste landfills (including those that receive sewage sludge and combustion ash). The following is a brief summary of the proposal. EPA is currently evaluating extensive public comments and developing the final rule, which is expected to be issued in early 1990.

Location Restrictions

The proposed regulations contained specific restrictions on locating landfills at, on, or near:

- Airports,
- Floodplains,
- Wetlands,
- Fault areas,
- Seismic impact zones, and
- Unstable areas.

Operating Criteria

Landfill operating requirements were proposed in each of the following areas:

- Procedures for excluding hazardous waste,
- Daily cover,
- Disease vector control,
- Explosive gases,
- Air criteria,
- Access control,
- Run-on and run-off control,
- Surface water requirements,
- Liquids management, and
- Recordkeeping.

Design Criteria

The proposed criteria established a risk-based performance standard based on lifetime cancer risks. New units would be required to be designed with liners, leachate collection systems, and final cover systems as necessary to meet this standard, while existing units would be required to use final covers. Retrofitting of existing units with liners and leachate collection systems would not be required. The proposed point of compliance would be at the waste management unit boundary or a State-established alternative boundary.

Ground Water Monitoring

The proposed municipal solid waste landfill regulations specified ground-water monitoring to detect releases at landfills and determine if corrective action is needed. New landfills would be required to comply with the ground-water monitoring regulations prior to accepting wastes. Existing landfill units would need to comply with a State established schedule or a Federal fall-back schedule.

The proposed rule specified that the ground-water monitoring system must:

- Be approved by the State;
- Be installed at unit boundary or alternative boundary;
- Yield representative samples of the uppermost aquifer;
- Have well casings; and
- Perform throughout the life of the monitoring program.

The ground water monitoring program is performed in two phases under the proposed rule:

- Phase I: detect changes in ground water chemistry (performed semiannually on a limited number of parameters); and

- Phase II: identify hazardous constituents released and to monitor hazardous constituents detected (State establishes monitoring frequency).

Corrective Action Program

The proposed rule establishes specific corrective action plans, including assessment of corrective measures, remedy selection, and corrective action program implementation.

Closure and Post-Closure Care

The proposed rule required that closure must occur in a manner that:

- Minimizes post-closure release of leachate and explosive gases;
- Minimizes the need for further maintenance; and
- Ensures protection of human health and the environment.

The proposed requirements include post-closure care:

- Maintenance of the final cover and containment system;
- Leachate collection (when a leachate system exists);
- Ground water monitoring; and
- Gas monitoring.

Post-closure care must continue for a minimum of 30 years. Additional time periods may be added by the State as necessary to protect human health and the environment.

Financial Assurance

Financial assurance was proposed for closure, post-closure care, and corrective action for known releases.

LEACHATE FORMATION AND CONTROL

The term "leachate" refers to liquids that migrate from the waste carrying dissolved or suspended contaminants. Leachate results from precipitation entering the landfill and from moisture that exists in the waste when it is disposed. Contaminants in the buried refuse may result from the disposal of industrial wastes, ash, waste treatment sludge, household hazardous wastes, or from normal waste decomposition. If uncontrolled, landfill leachate can be responsible for contaminating ground water and surface water.

The composition of leachate varies greatly from site to site, and can vary within a particular site. Some of the factors affecting composition include:

- Age of landfill;
- Types of waste;
- Degree of decomposition that has taken place; and
- Physical modification of the waste (e.g., shredding).

Once ground water is contaminated, it is very costly to clean up. Today's landfills, therefore, undergo rigorous siting, design, and construction procedures that provide many safeguards for the control of leachate migration.

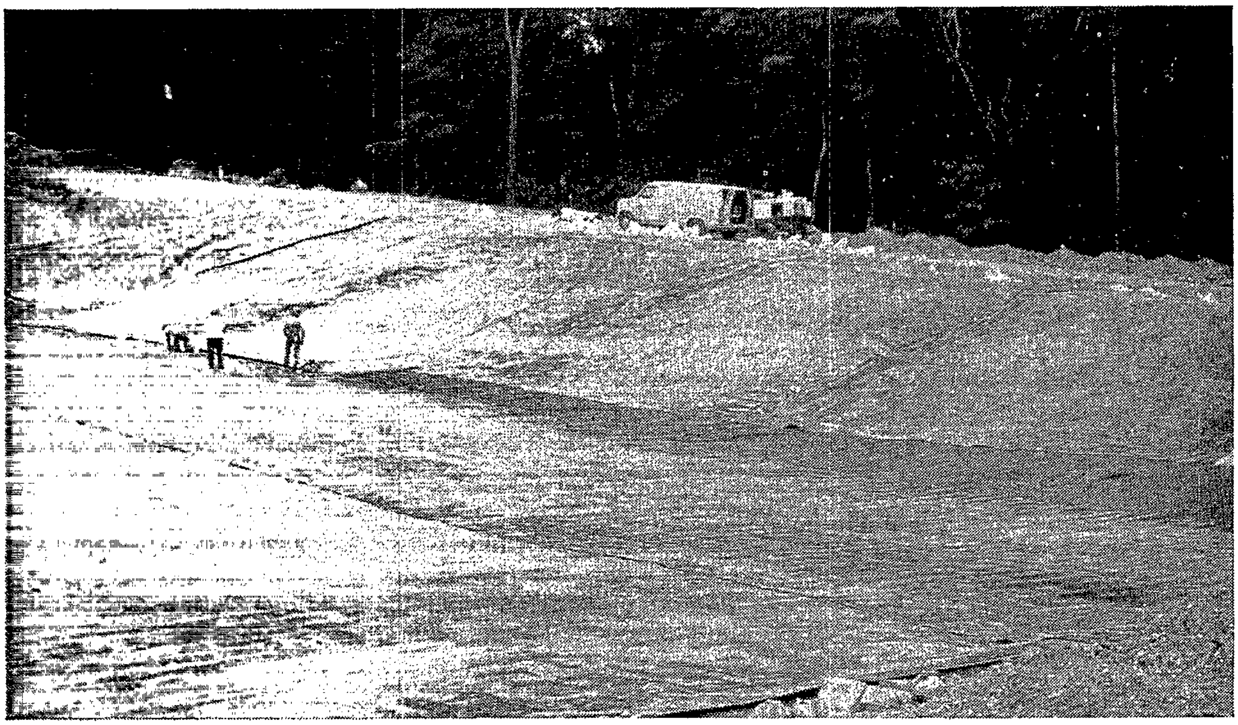
Liners

Liners are low-permeability membranes designed to limit leachate movement into ground water. Liners are made of low-permeability soils (typically clays) or synthetic materials (e.g., plastic). Landfills can be designed with more than one liner, and a mix of liner types may be used.

Leachate collection systems are installed above the liner and usually consist of a piping system sloped to drain to a central collection point where a pump is located.

Leachate Treatment or Disposal

Once the leachate has been collected and removed from the landfill, it must undergo some type of treatment and disposal. The most common methods of management are:



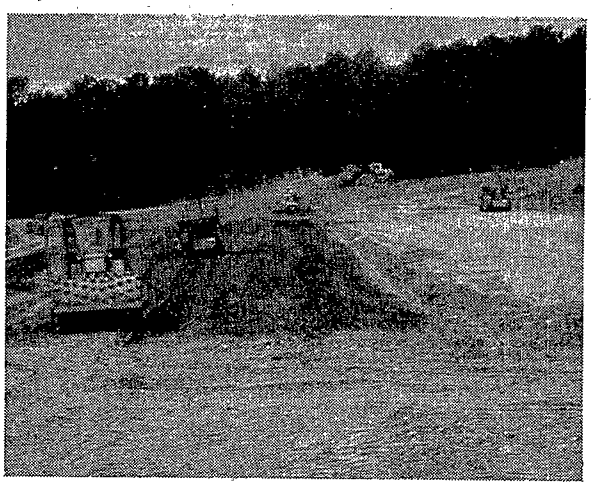
Installation of Synthetic Liner

- Discharge to publicly-owned treatment works (POTWs);
- On-site treatment followed by discharge; and
- Recirculation back into the landfill.

Treatment in a POTW. In some cases, landfill leachate can be added into incoming wastewater stream at a POTW, where it is biologically, physically, and/or chemically treated. Discharge to a POTW, however, is not an option in all cases. Care must be taken not to interfere with operations at the POTW. The contaminants in leachate can sometimes upset POTW operations.

On-Site Treatment. When discharge to a POTW is not feasible, constructing wastewater treatment facilities on-site with the sole purpose of treating leachate may be necessary. These facilities will add to the cost of a new facility, but may be required to meet environmental regulations.

Recirculation. Recirculation is another management technique for leachate. When leachate is recirculated through the waste pile, the decomposition process in the landfill speeds up, resulting in a shorter time for the landfill to stabilize. The technique, however, does not eliminate the leachate. Ultimately, the leachate will have to be treated by one of the above methods. Certain restrictions on recirculation, however, will probably be imposed by the new landfill rules.



Clay Liner Installation and Compaction

Other leachate management options have been used in the past, but are not very common, primarily due to economic factors. These include deep well injection, natural evaporation, and mechanical evaporation.

Ground Water Monitoring

To ensure that all of these technologies are performing their designed function, and that compliance with all applicable regulations and permits is being maintained, surface water and ground water monitoring should be included at all new landfills. By sampling from ground water wells located near the solid waste disposal facility, the presence, degree, and migration of any leachate can be detected.

Proposed ground water monitoring requirements were discussed under the "Federal Regulations" section of this Chapter.

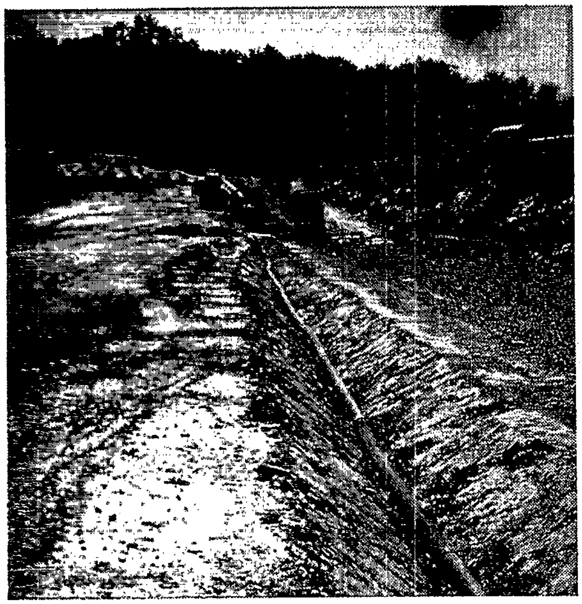
Surface Water Pollution and Control

Surface water can also become contaminated at or near a landfill, especially if ground water contamination is present (ground water often migrates towards, and may be the source of, surface water). Runoff from the landfill can contaminate surface waters at or near the site.

Berms and grading both are used to control runoff and surface water contamination. Surface water monitoring should also take place to detect any contamination as quickly as possible.

METHANE FORMATION AND CONTROL

Methane gas is a product of the anaerobic (absence of air) decomposition of organic refuse. At and around municipal solid waste landfills, methane can migrate through soil and accumulate in closed areas (e.g., building basements) where it can present significant explosion dangers if not properly controlled. (methane is explosive in confined spaces when found in concentrations between 5 and 15 percent).



Pipes for Leachate Collection

Landfill gas emissions are comprised of a mixture of carbon dioxide and methane, of which methane comprises 50 to 60 percent. A normal landfill will generate methane at these concentrations for 10 to 20 years as waste decomposition takes place, although methane generation can continue for over 100 years.

Methane Control

Due to the inherent danger, methods of controlling landfill gas have been developed. Once methane is collected, it is usually vented into the atmosphere, flared (burned), or recovered as an energy source.

Both passive and active methane control systems can be used at landfill sites. In *passive* systems, trenches are dug around the perimeter of the landfill and are filled with gravel and perforated piping. As methane is formed in the landfill, it migrates to the perimeter trenches where it travels up the piping system and is eventually vented or flared. In some instances, a membrane liner is added to the outside walls of the trenches to further inhibit gas migration beyond the site.

Active systems use blowers to extract landfill gas from the landfill.

Methane Recovery

In addition to controlling methane to reduce explosion risks, recovering methane for fuel may also be a viable option at landfills generating sufficient quantities of gas. Methane can be cleaned (remove impurities) and sold as a low-grade fuel or it can be purified and upgraded to pipeline-quality methane. The economics of these options depend largely on current natural gas prices.

The gas-to-energy industry is growing, as 155 landfills in the United States recover or plan to recover methane gas (Berenyi, 1989). Approximately 50 percent of these are currently operational. Methane recovery is expected to become an important aspect of municipal solid waste landfill operation in the future.

Volatile Organic Compound (VOC) Emissions

In addition to methane and carbon dioxide, landfill gas usually contains small quantities of volatile organic compounds. VOCs are often toxic and sometimes carcinogenic, and may present an environmental risk at landfills. VOCs have also been linked to low-level ozone (smog) formation. EPA's Office of Air Programs is currently developing rules for landfill VOC emissions.

CLOSURE AND POST-CLOSURE CARE

Once a landfill reaches its capacity, it must be managed to limit any potential adverse environmental effects. *Closure* involves capping the landfill with a low-permeability material (usually clay or a synthetic membrane) to minimize moisture infiltration. The top layer of soil must support vegetation. Closure also involves maintaining the function of methane and leachate collection and monitoring equipment.

Post-Closure Care usually involves inspections of the site, land surface care, leachate hauling and transport, and methane control (i.e., venting or collection). Monitoring is a post closure activity designed to detect any adverse environmental impacts. Post-closure costs are also discussed in the next section.

Potential new Federal requirements for closure and post-closure care were discussed earlier in this chapter.

SITING A NEW LANDFILL

Siting a new landfill involves analyzing the scientific, logistical, and societal factors associated with location alternatives.

Design Factors

Because of strict legal and environmental regulations, careful scientific and engineering analysis must take place during potential site evaluation. Surface and subsurface geology, hydrogeology, and the environmental nature of surrounding areas must be evaluated for potential impacts. Ground-water resources and flow must be protected, and the integrity of soils must be preserved. A substantial hydrogeological investigation and the prediction of leachate quantities are usually performed early in the planning stages.

Logistical Factors

Because of siting difficulties, new landfills are being built further and further from waste generation points. This has a significant impact on collection and transport operations. When siting a new facility, decision makers will have to consider logistical factors such as access roads, travel distance, and travel time.

Community Factors

Community residents have very real concerns regarding potential health and environmental impacts, decreased property values, and increased traffic. Decision makers will benefit from addressing these concerns as early in the planning stages as possible. EPA is currently preparing a facility siting guide entitled *Sites for Our Solid Waste: A Guidebook for Effective Public Involvement.*

LANDFILL COSTS

Diminished capacities and increased environmental concerns have directly led to increased landfill costs and tipping fees. According to a survey by the National Solid Wastes Management Association, average landfill tipping fees (for a national sample) increased over 30 percent between 1987 and 1988 (Pettit, 1989). Tipping fees vary significantly from region to region.

Tip Fees

(Average for national sample)

Year	Tip Fee
1982	$10.80
1983	$10.80
1984	$10.59
1985	$11.93
1986	$13.43
1987	$20.36
1988	$28.93

(Source: Pettit, 1989)

Factors contributing to the rising landfill costs include:

- Stricter, more comprehensive environmental regulations;
- Increased public awareness and demand for environmental protection;
- Time delays in obtaining permits;
- Compensation to local parties (those who are affected by a new site); and
- State fee assessments for recycling, refuse-to-energy, environmental restoration, ground water protection, etc. (Glebs, 1988).

Pre-Development Costs

Pre-development costs are usually associated with site selection, investigation, and permitting costs. Land prices are directly linked to local economics, and can vary greatly from place to place. Landfills located in remote areas generally have lower land costs but higher transportation costs. As environmental and legal requirements become more stringent, permitting and licensing also become more complex. The cost of obtaining a permit or license (and the cost of the engineering or legal support associated with permitting) depend on the requirements of the particular state.

Construction Costs

Several factors contribute to the overall cost of landfill construction:

- General excavation;
- Liner construction;
- Leachate collection/extraction system design;
- Leachate treatment system;
- Ground water monitoring system;
- Surface water drainage controls; and
- Other facilities and equipment (scales, maintenance building, access roads, fencing).

The impact of these factors can vary considerably from site to site. The liner and leachate collection/treatment system is generally the most expensive component of the landfill. Figure 9.3 provides some general construction cost information. These costs are only examples, actual costs could be very different.

FIGURE 9.3
Construction Costs
(1986 Dollars)

Construction costs for a State-of-the-art landfill.

Total:	$5,690,000
$/ton:	$4.00
Percent of Total Landfill Costs	35.5%

(Source: Glebs, August 1987)

Operating Costs

Operating costs include:

- Personnel;
- Equipment;
- Maintenance;
- Utilities;
- Administration costs; and
- Fuel.

These factors vary from location to location, so operating costs are site-specific. Some example operating costs are outlined in Figure 9.4. Note that these are in 1986 dollars.

FIGURE 9.4
Typical Operating Costs
(1986 Dollars)

Operation Costs **$600,000-$750,000/yr**
(For a 606-750 TPD site, including personnel, machines, facilities/maintenance)

Leachate collection, treatment
by truck: 10 mile haul:
$0.02-$0.03/gal. $65,700-$219,000/yr.
by sewer: sewer charge
$0.01-$0.03/gal. $21,900-$65,700/yr.
(Assuming a 40-acre site with an efficient liner and collection system with good drainage, a typical rate of generation is 6,000-10,000 gallons per day during operations and about 10,000 gallons per day after closure)

Environmental monitoring varies with site setting and time:
$8,000-$40,000/yr.

Ongoing engineering, staff time, etc.
(Costs will vary depending on operations, design, etc.)
$0-$20,000/yr.

(Source: Glebs, March 1988)

Closure and Post-Closure Care Costs

A major portion of closure costs is in maintaining the environmental monitoring systems. Figures 9.5 and 9.6 outline some of the costs associated with closure and post closure care. These costs are only examples. Actual costs may be very different.

Additional Costs

In addition to these costs, other costs that are not normally associated with site operations could affect overall site costs. Some examples include state assessments for funding recycling programs, ground water protection, and repair of old sites. Local site factors also constitute a category of unanticipated costs. These include costs to upgrade local roads, to protect/guarantee property values, and replace wells.

FIGURE 9.5

Typical Closure Costs

(1986 Dollars)

Item	Range of Unit Prices
Final Cover	$2.20 to $2.50 per cu. yd.
Topsoil	$2.00 to $2.80 per cu. yd.
Seed, Fertilizer, and Mulch	$750 to $850 per acre
Gas Control (passive trench in final cover)	$4.00 to $6.00 per linear foot

(Source: Glebs, 1988)

FIGURE 9.6

Typical Post-Closure Care Costs

(1986 Dollars)

Annual Inspections:	$1,000 to $9,000 per year
Land Surface Care:	$500 to $1,000 per year
Leachate Hauling and Treatment:	$36,000 per year (10,000 gallons/day, sewer discharge cost of $0.01 per gallon)
Environmental monitoring:	$8,000 to $40,000 per quarter
Gas:	$10 per point
Groundwater:	$250 to $500 per sample location
Leachate:	$500 to $2,000 per sample

(Source: Glebs, 1988)

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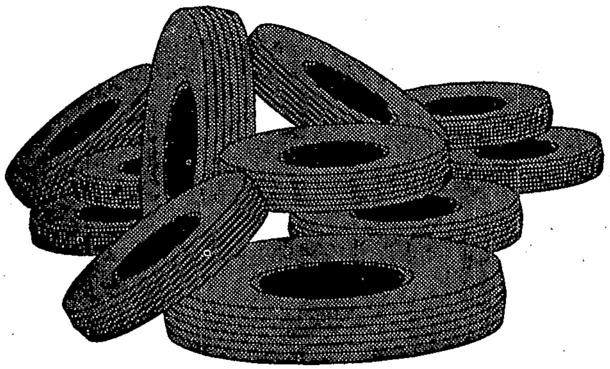
Chapter Ten

Special Wastes



MAJOR MESSAGES

- Proper management of household hazardous wastes will have positive environmental effects and will improve waste management facility operation.
- Used oil should be seen as a valuable resource rather than a waste. Used oil recycling can have significant environmental and economic benefits.
- Tires cause problems in landfills and stockpiles. New uses for used tires are being explored.
- Construction and demolition debris, wood wastes, and white goods all have recyclable elements.

Special wastes, such as household hazardous wastes, used oil, and tires are not normally collected with other municipal solid waste and require special handling practices. These wastes present unique problems and opportunities for decision makers.

HOUSEHOLD HAZARDOUS WASTE (HHW)

Many products used for everyday household cleaning and upkeep contain substances that can threaten human health and the environment if they are disposed of improperly. Common detergents, cleaners, and furniture polishes, as well as pesticides, paints, thinners, solvents, and do-it-yourself automotive materials are just a few examples of these "household hazardous wastes."

The disposal of household hazardous waste is unregulated in most states. Therefore, people typically dispose of it by pouring it down drains or storm sewers, burning or burying it in the backyard, or mixing it in with non-hazardous household waste that is collected by the city or a waste management company. Unfortunately, many people either do not realize that household hazardous waste should be disposed of in a special manner, or they find it too inconvenient or costly to do so. Decision makers must be aware of this problem and seek to educate citizens about household hazardous waste as well as provide them with opportunities to dispose of it properly.

Improper Disposal of HHW

Although improperly disposed of household hazardous waste makes up only a very small percentage (less than one percent) of the municipal solid waste stream, it can pose serious problems for any type of waste management effort. Even small amounts of some substances can cause fires and explosions, release toxic fumes, contaminate soil and ground water, and harm those who handle them unknowingly.

Quantifying the precise risks and effects of improper household hazardous waste disposal is difficult for several reasons. First, it is almost impossible to determine how much of the waste stream household hazardous wastes make up. The composition of this fraction is also very difficult to determine. In addition, many common methods of household hazardous waste disposal (pouring down the drain, backyard burning, etc.) are very difficult to track. Researchers have also had difficulty distinguishing the damage resulting from household hazardous waste from the damage attributable to illegally deposited hazardous waste from other sources.

Improper Disposal of Household Hazardous Wastes

Improper disposal of household hazardous wastes can lead to a variety of problems:

- Drain/Sewer Disposal: Corrosion of plumbing materials, toxic fumes, problems in septic systems and at wastewater treatment plants, ground and surface water pollution, toxic accumulation in food chains.
- Incineration: Fires and explosions, toxic emissions, concentrated toxic ash.
- Burial: Soil and ground water contamination, fires and explosions, toxic fumes.
- Mixing with non-hazardous waste: Harm to workers during handling.

Special HHW Collection Programs

In the past, efforts to minimize improper household hazardous waste disposal have included public education programs, toll-free information "hot-lines", special collection days, recycling of certain wastes, and permanent waste collection sites.

Collection Days

One of the most common approaches to household hazardous waste management is to hold a community waste collection day. On collection days, community members are invited to bring their household hazardous wastes, at little or no charge, to a specified location for recycling, treatment, or disposal by professional waste handlers. Promotion and education for these events are very important.

A great deal of advanced planning and coordination is required to make these events successful and cost-effective. Persons familiar with HHW must be on hand to direct people to the proper storage area or container. Chemists may also be required, especially if any mixing ("bulking") of materials will take place.

Participation in collection days is usually less than one percent, which makes the cost per person quite high. The cost of collection day programs can range from $30 to $300 per participant (Conn, 1989). It is important to remember, however, that even if households do not participate directly in a collection day, the publicity surrounding the event will raise awareness about the household hazardous waste problems. This will encourage people to use proper disposal methods in the future and participate in the next collection day.

Permanent Collection Sites

To increase the convenience of the program and, therefore, increase participation, more and more communities are establishing permanent collection sites (e.g. fire stations, landfill, county property) to collect HHW. Programs involving permanent collection facilities allow citizens to drop off wastes at their own convenience. Thus, permanent collection sites can be more effective for collecting HHW than one day collections.

HHW Exchanges

Waste exchanges are programs that allow community members to "recycle" household products, such as cleaners, paints, batteries, and some kinds of pesticides, that have been brought to a waste collection site by others. Household hazardous waste exchanges are not common activities, however, mainly due to the risk of distributing incorrectly labeled or contaminated products. Sponsors could be held liable for injury or damage resulting from the use of the "recycled" HHW.

HHW Management and Disposal

EPA suggests that program sponsors follow the waste management hierarchy for managing collected HHW. This means reusing and recycling as much as possible, then treating waste in a hazardous waste treatment facility and finally, disposing of the remaining waste in a hazardous waste landfill.

Household hazardous waste is exempt by definition from the Federal hazardous waste regulations of RCRA. All household wastes are exempt, including HHW that has been accumulated in HHW collection programs. State and local requirements may differ, so decision makers should review both.

Although HHW is exempt from RCRA Subtitle C hazardous waste regulations, EPA recommends that sponsors of HHW collection programs manage the collected HHW as a hazardous waste. When a community has already gone to the effort and expense of collecting these materials, Subtitle C controls provide a greater level of human health and environmental protection and reduce potential CERCLA liability (CERCLA does not exempt household hazardous waste from liability).

Benefits of Removing HHW From the Municipal Waste Stream

It is important to keep in mind that the chief goal of any program that addresses household hazardous waste is to reduce the amount of this waste that is being added to the everyday municipal solid waste stream. The benefits from diverting HHW from the waste stream are immediate. In addition to potential damage to drainpipes and water supplies, HHW can lead to ground water contamination at landfills and composting facilities, and hazardous air emissions and contaminated ash at municipal waste combustion facilities. Decision makers should carefully balance the costs and benefits of any special household hazardous waste program. A well planned HHW program can create significant environmental benefits.

USED OIL

Used oil is a valuable resource that should be recycled for several reasons. One of the main concerns associated with used oil is that it can contain a number of materials that can cause harm to human health and the environment if disposed of improperly. For instance, pouring oil down storm drains, onto the ground, or into the trash, can contaminate ground water, surface water, and soils. It only takes one gallon of oil to ruin one million gallons of water.

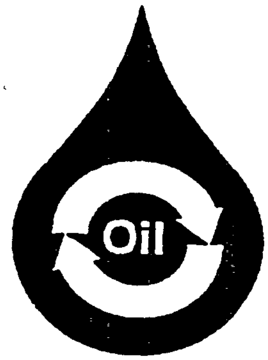
Recycling used oil saves energy and natural resources. Used oil can be rerefined into lubricating oil and used again as motor oil or reprocessed and used as fuel in industrial burners and boilers.

EPA estimates that do-it-yourselfers (DIY), those who change their own oil, generate 200 million gallons of used oil per year. Of this, it is estimated that only 10 percent is recycled. That means 180 million gallons per year are poured onto the ground, down sewers, or into the trash, contaminating surface and ground water as well as soil. Clearly, greater efforts should be made by decision makers to increase the level of used oil recycling in communities throughout the country.

Used oil is not currently a federally listed hazardous waste. As with household hazardous waste, DIY used oil collected in local recycling programs is not exempt from CERCLA liability. For this reason, it is important that the program sponsor be sure the DIY used oil is

Benefits of Used Oil Recycling

- It takes only one gallon of used oil to make the 2.5 quarts of lubricating oil that it takes 42 gallons of crude oil to make.
- Re-refining oil takes only about one-third the energy required to refine crude oil to lubricant quality.
- If all of the used oil in the U.S. were recycled, it would save the U.S. 1.3 million barrels of oil per day.
- One gallon of used oil used as fuel contains about 140,000 Btu of energy.



being recycled by a reputable company. It is also important that individuals who contribute oil for recycling, do not mix the used oil with any other substances, (e.g., gasoline, paint thinner). Mixing can contaminate the oil and make it unfit for recycling.

Decision makers should also investigate State and local regulations for used oil, since these are often more stringent than the Federal regulations.

Used Oil Collection Programs

In the past few years, efforts to initiate used oil recycling programs have been successful. As of 1988, over half of the States either had or were planning to start used oil recycling programs. Many of these programs are joint efforts between local governments and private or semi-private sponsors. Local sponsors often design, organize, and promote the program, while local governments collect the used oil at central collection centers or by means of curbside pickups. As with any type of recycling program, it is important to provide convenient collection service and maintain high levels of education and promotion of the program.

Curbside Collection Programs

In a curbside collection program, used oil is picked up at a designated time along with regular trash or other recyclables. Normally, the used oil is then transferred to a holding tank where it is picked up by a used oil hauler. If this kind of collection program is implemented, it is very important to coordinate closely with the local waste haulers and recycling collection crews so that collection trucks are equipped with temporary holding tanks or storage space for the used oil.

A variation on this type of program is periodic curbside collection. Ideally, periodic collections occur during peak oil-changing seasons, in the late spring and early fall. Continual public promotion is crucial to the success of both regular and periodic curbside collection programs.

Designated Collection Sites

Designated collection sites are drums or tanks set up in established private or public locations for the collection of used oil. It is very important that the location of such a site be both convenient and accessible. Locations that are frequently chosen include stores selling discount oil, fire stations, service stations, and landfills. These sites must be well marked and frequently maintained in order to minimize the risk of contamination. In addition, they should be serviced regularly to make sure that there is always sufficient room in the collection containers for more oil.

Businesses With Established Oil Collection Tanks

Many businesses that regularly use oil themselves, such as service stations, car dealerships, and taxi or rental car garages, already have tanks installed for used oil collection. When the price of virgin oil was high, many of these groups accepted used oil from DIYers. Today, fewer will take the oil because of increased costs and confusion over the regulatory status of used oil. Decision makers should encourage these businesses to accept used oil and should make their services known to the community.

Special Drop-off Days

Used oil can also be collected on special drop-off days such as community household hazardous waste collection days. It is important to publicize these special collection days throughout the community in order to ensure high rates of participation. (These programs are similar to the HHW collection days described above.)

TIRES

Over 200 million tires are disposed of annually, primarily in landfills or tire piles. Landfilling or stockpiling tires, however, are not the "best" management options. Tires are large volume wastes that take up a significant amount of space at landfills. As landfill space becomes more scarce, this becomes an increasingly expensive option.

Besides the valuable space they use, tires placed in landfills pose other "burial" problems. Not only do they cause uneven settling, they tend to rise in landfills and can break landfill covers.

Stockpiling of tires also presents problems. Large tire piles are a potential source of large, difficult-to-extinguish fires which emit noxious fumes. The stockpiles also provide an ideal habitat for breeding mosquitos and vermin that can spread disease.

Tire manufacturers have worked hard to make their products more durable. Today's passenger car tire has an average life of 40,000 miles, while tires during the World War II era lasted only 10,000 miles. Unfortunately, the availability of inexpensive natural and synthetic rubber has decreased the number of tires which are retreaded. In addition, the durability and the complex mixture of ingredients in radial tires make them a challenge to recycle.

Tire Recycling

Despite the disposal problems associated with tires, they are only beginning to be recognized as a valuable resource. For several reasons, used tires are well-suited to recycling or reuse. Because used tires are often stored in stockpiles, or are disposed of in large quantities by retailers who haul them by the truckload, used tires are a particularly accessible material for recycling or reuse. Also, tire components are fairly standard making them particularly suitable for recycling. Tire recycling options include:

- Retreading or recapping decent-quality used tires for reuse;
- Using whole tires for playground equipment or in reef construction;
- Chopping, shredding, or grinding used tires and reusing the rubber in smaller rubber parts such as rubber mats and molded rubber objects; and
- Mixing ground rubber from tires with asphalt to produce rubberized paving materials.

Tire-Derived Fuel

The energy value of tires is high (comparable to high grade coal) so reuse as fuel may be an option. Tire-derived fuel (TDF) refers to tires that have been shredded into small rubber chips that are burned in dedicated TDF boilers or used as a replacement for high grade bituminous coal. Facilities that may use TDF as a fuel include cement kilns, pulp and paper facilities, and electric power plants.

CONSTRUCTION / DEMOLITION WASTE

Construction and demolition (C&D) debris is made up of a variety of waste materials from building and demolition sites. These materials include: steel, asphalt, concrete, brick, plaster, wallboard, and piping.

Most construction/demolition debris is currently disposed of in landfills. It is usually separated from other solid waste since its contents are relatively inert and the requirements for the disposal of such wastes are not as stringent as the requirements for the disposal of standard municipal solid waste.

However, some construction/demolition debris contains toxic substances such as asbestos, an insulating material that has been determined to be a carcinogen associated with lung cancer. Other hazardous materials that may be found in this waste include lead pipes, PCBs in transformers and capacitors, and toxics in paints and treated lumber. If hazardous materials are found in construction/demolition debris, they must be removed and handled separately.

Recyclable Materials in C&D waste

Much construction/demolition debris contains recyclable materials. For instance, asphalt can be reused in road repair, and bricks and cinderblocks make good fill material. Unfortunately, these materials are often difficult to recycle because they are combined in the construction process and are not easy to separate. Economical ways to separate these materials must be found before their full recycling potential will be realized.

WOOD WASTES

About four percent of what EPA defines as the solid waste stream (excluding construction/ demolition wastes) consists of wood (EPA, 1988). Nearly half of this wood is wood packaging such as shipping pallets and boxes.

Processing Wood Wastes

Ideally, wood wastes are processed at materials recovery facilities (MRFs) or transfer stations rather than being sent to landfills. Wood waste can then be separated for recycling. Removing wood from the waste stream conserves landfill space and saves energy and natural resources.

When wood is sent to a MRF or a transfer station, it is hand inspected and processed until an acceptable level of purity is reached. It is then sent through large chippers, magnetic separators to remove metal debris such as nails and staples, and screens to remove undersize chips and residue. The final product consists of wood chips 1/2 to 3 inches in size.

Uses of Processed Wood

Where markets are available, use as an industrial fuel constitutes the best outlet for processed wood, mainly because it can currently be sold at higher prices. Processed wood is also sold as mulch or used for landfill cover.

Waste wood is turning into a business, as recycling facilities that accept only wood are generating fair amounts of revenue. Tipping fees at these facilities are lower than those at general waste disposal sites when the wood has already been separated from the waste stream. Both the recycling facility, which gets its raw material, and the generator, who saves money through lower disposal costs, benefit from this arrangement. Like all recycling operations, however, waste wood recycling will be economically feasible only if a steady supply and a steady market are available.

WHITE GOODS

White goods are large, worn-out or broken household and industrial appliances such as stoves, refrigerators, and clothes dryers. These wastes are usually handled by scrap processors who use shredders to recover the metal components of the appliances for reuse in mills and foundries to produce new steel. There is some concern over the presence of polychlorinated biphenyls (PCBs) in the electrical components used in some white goods. Many scrap metal dealers and brokers require that PCB-containing components be removed before the appliances are processed. Most municipalities currently pay to have their white goods disposed.

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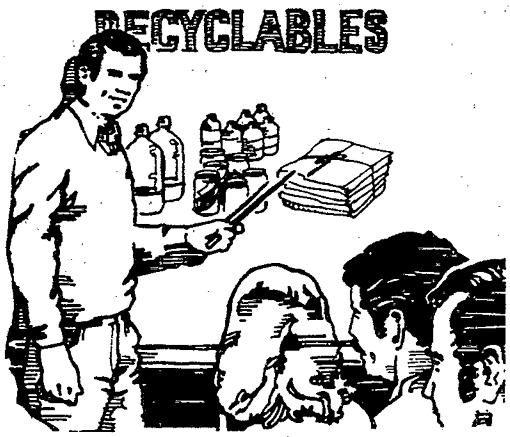
Chapter Eleven

Public Education and Involvement



MAJOR MESSAGES

- Decision makers should involve the public early in the waste management planning process.
- Promotion and education programs should be tailored to the needs of each community and maintained throughout the year.
- Planning for public education and involvement requires that decision makers understand their audience, prepare a formal plan, and establish a method for evaluating programs.
- Delivering educational messages, maintaining program participation, and funding activities are challenges that face decision makers who implement education and involvement programs.
- The public has a right and a responsibility to understand the full costs and liabilities of managing the wastes they produce.

Whether decision makers are considering mandatory recycling, organizing a household hazardous waste collection program, or developing a source reduction campaign for industries, public education and involvement will play a significant role before a program is chosen as well as after. Public recognition and concern regarding solid waste management issues has increased tremendously in the last several years and will continue to increase into the 1990s. Public education efforts result in a more informed citizenry that can actively participate in solving its community's solid waste problems.

The terms public education and public involvement encompass a broad scope of activities and techniques designed to help citizens participate in decisions, convey information, solicit citizen concerns, heighten public awareness, and motivate participation in programs. A comprehensive solid waste management education and involvement program makes use of civic groups, businesses, schools, churches, and the media to participate in decision making and to promote a positive solid waste ethic through meetings, special events, lectures, promotional materials, newsletters, displays, contests, and collection activities.

Public Involvement in Decision Making

Decision makers should strive to involve the public in decision making throughout the solid waste management planning process. It is particularly important for decision makers to work with the community in the initial planning process. An advisory council or task force can be established to provide an organizational framework for citizen participation. This group could include citizens, business people, members of local environmental groups, community neighborhood groups, and church organizations.

The advisory group can be educated about the local waste management situation, the full costs and liabilities associated with managing the waste, and the management and disposal options which are available. The community group can identify concerns and assist the decision makers in integrating solutions into the plan for the management of waste. This type of input can build community support for the chosen management scenario and can increase its success.

Management of municipal waste requires flexibility in program design; for this reason, it is helpful to maintain the citizen advisory group even after initial planning. The advisory group can provide feedback on chosen options and make recommendations about changes and additions to the program.

Key to Effective Public Education and Participation

Implementing new waste management programs requires education of the public, especially for programs where citizen participation is needed. Education information for the public should answer the questions of "where?, when?, why?, and how?". The education program should be positive, and provide simple instructions on how to participate. Opportunities for communicating with and involving the public should be established early in the planning process. For example, if a neighborhood drop-off site for recyclables is going to be established, the decision maker should promote it to build citizen interest and support, even before it is in place. Communication with the public and promotion of the program should be ongoing. Media events, posters, newsletters, are all good tools to use in a continuing education program.

An effective education and promotion program should be planned with the community's needs in mind. But it is not necessary to "reinvent the wheel." A significant amount of time and energy can be saved by examining the public education activities that other communities have initiated -- borrowing from their successes and learning from their failures. Decision makers can review activities and educational materials used in other public awareness programs, such as seat belt safety campaigns. Techniques used in these campaigns to promote an idea or suggest a new behavior can be modified to express a municipal solid waste management theme.

Building a successful public participation program will be assisted by explaining to the public how the parts of the integrated plan were decided upon, who participated in the decision making and what was taken into consideration. Also, the public has a right and responsibility to understand the full costs and liabilities associated with management of the waste they generate. This information will help the public understand the importance of the municipal waste management issues, assist in gaining community support and help individuals take responsibility for the waste they generate.

PLANNING A PUBLIC EDUCATION PROGRAM

Successful public education programs are the result of careful planning. By developing a realistic education and involvement plan, decision makers can assess the situation and know where best to direct their efforts and resources.

Decision makers will benefit from taking advantage of all opportunities to work with the community. The process of developing an education and involvement plan provides an opportunity to involve the community in the planning process at an early point. The previously described citizens advisory council or other groups like environmental education subcommittees of local organizations can provide valuable input and assistance in developing the plan.

Understanding Your Audiences

The first step in public education planning is to understand the different audiences that exist within the community and determine how these diverse groups receive information. What are some of the sub-groups within the community? Should public awareness materials be bilingual? What are citizens concerned about? What local radio news programs and talk shows do residents listen to? Do citizens respond well to public notices included in their county or city bills? Are posters at local stores an effective method of getting across a message? Are civic groups already conducting recycling or litter education campaigns? Answering these kinds of questions will ensure that the appropriate messages, activities, and media are used in the plan. Decision makers can conduct interviews with community leaders, administer public opinion surveys, and work with existing citizen advisory groups to gather this information.

Preparing A Plan

The second step in public education planning is to prepare a formal plan. The program should be broken down into one-year increments so that its goals are manageable. Decision makers should include the following in their plans:

- Main issues or challenges to be addressed;
- Goals to be reached;
- Activities and events to accomplish each goal;
- Resources (funding, volunteers, and community support) available for each activity and event; and
- Timeline that coordinates public education efforts with program implementation and takes into account seasonal activities and events.

There is a broad range of possible activities or events that can be included in a public education plan. The activities chosen should promote and complement the specific waste management options being considered or implemented as part of the community's solid waste management program. For example, if a community's first priority is to reduce wastes from businesses and industries, then education programs targeted toward business associations need to be emphasized.

Proposed activities should also satisfy the information needs of the community and be within a community's budget and resource limits. In some instances, decision makers should consider conducting smaller-scale pilot public education projects. Such efforts can provide a perfect testing ground for new ideas. Lessons learned from these projects can be incorporated into larger, more visible projects as the program gains public support.

Facility Siting

As a result of developing a new waste management plan, decision makers may find themselves in the position of having to site new waste management facilities (e.g. landfills, incinerators, recycling, and compost facilities), an activity that is often met with great community opposition. Without a comprehensive process for identifying community concerns and integrating them into the decision-making process, decision makers can be faced with costly project delays and even cancellations.

EPA has prepared a comprehensive guide for decision makers to assist them in communicating with and involving the public during the siting of waste management facilities. This document is entitled *Sites for Our Solid Waste: A Guidebook for Effective Public Involvement*. In addition to discussing risk communication, mitigating impacts, and building credibility for technical information, the guidebook describes a variety of public involvement activities that can be used to improve community relations at a new waste management site. Decision makers will benefit from reading this guide regardless of whether or not they are involved in a siting effort. The public participation techniques described can be used during all phases of solid waste management planning.

Evaluating Activities

The final step in public education planning is to establish a method for evaluating each of the program activities. Evaluating each activity will provide decision makers with the information needed to refine and modify the plan over time. For example, if a community has a goal of reducing the amount of household hazardous waste going to its landfill, its public education plan could include periodic household hazardous waste collection events. Decision makers could set participation and collection goals for each event. Tallies of the number of actual participants and the amount and types of household hazardous wastes collected could be kept to determine if goals were achieved. In addition, a simple survey form could be passed out to participants to solicit comments on the event's logistics, advertising, and overall effectiveness.

The data gathered to evaluate an activity, such as the number of participants, should be communicated to the community. Feedback on the accomplishments of the program will serve as positive reinforcement for the community.

MEETING PUBLIC EDUCATION AND PUBLIC INVOLVEMENT CHALLENGES

Many public education and involvement efforts that address waste management issues face similar challenges. Three of the more common challenges include successfully delivering educational messages, maintaining program participation, and funding activities or a program.

Successfully Delivering Educational Messages

Budget constraints all too often restrain decision makers from hiring solid waste public education specialists. Some states, such as Ohio and Virginia, have established county grants for litter control and recycling programs that have enabled local communities to hire education personnel. However, one or two people cannot effectively visit every classroom, or talk at every civic organization meeting. As a result, decision makers need to be resourceful when deciding upon the best approach for delivering their education programs.

Educating Young People

Teaching young people about solid waste management -- about the value of recycling and reducing litter and household hazardous wastes and the need for properly operated waste management facilities -- is essential for developing a responsible solid waste ethic among a community's future residents. In addition to future benefits, youth-oriented programs can have an immediate pay-off by bringing recycling and other waste management messages home to parents. It is important to remember that schools and educators are already overwhelmed by "Fire Prevention Week," "Dental Care Week," and a variety of other important issues such as drug abuse that take time away from required studies. Therefore, when developing in-school education programs, decision makers should use interdisciplinary activities that can be integrated into teacher's lesson plans throughout the year. For example, math problems that use recycling statistics, short stories or plays about conservation issues, science experiments that deal with waste disposal, or word puzzles that use solid waste management terms, can be part of a waste awareness curriculum.

Many states, communities, and non-profit organizations have already developed effective curricula covering recycling, litter control, and waste management. (EPA has a national solid waste curriculum entitled *Let's Recycle: Curriculum for Solid Waste Awareness*). By using these materials, decision makers can minimize high development costs. Interdisciplinary curricula, complemented by special events, such as recycling drives or waste management science fair projects, allow for maximum teacher and student participation, flexibility, and creativity.

In-school education programs are not the only avenue through which children can be reached. Decision makers should consider developing programs that can be integrated with activities that are already organized at the local level such as reading programs at libraries and after-school programs at boys and girls clubs. Other youth-oriented organizations, such as church youth groups, 4-H clubs, and Junior Achievement clubs, should also be explored. For example, Girl Scouts and Boy Scouts have merit badges that focus on ecology, recycling, litter clean-up, and civic pride. One way to educate Scouts about solid waste management is to conduct workshops for their Troop Leaders. At a workshop, Troop Leaders can learn about local solid waste management operations, potential field trip opportunities, and specific projects that their Scouts can undertake to earn related badges. This type of "targeted" approach to public education is cost-effective since the Troop Leaders will end up sharing their new knowledge with hundreds of youngsters year after year.

Encouraging Program Participation

Establishing and maintaining participation in a solid waste program can be a perpetual challenge for any decision maker. This challenge is complicated by the addition of new program elements, such as source reduction and recycling, which require a change in citizen attitude and action. For example, attention to the separation and non-contamination of certain wastes may be required. One key to this challenge is to implement activities that promote a sense of community pride and ownership. Neighborhood recycling drop-off centers are an excellent example of an activity that can foster a sense of community pride. People develop a sense of pride by playing an active role in the development of a recycling drop-off center and in participating in collection. Decision makers can solicit youth groups or civic organizations to paint the center's collection bins or landscape the surrounding grounds. A contest to name the local drop-off center will enable neighbors to develop a sense of ownership for the facility. Neighborhood drop-off centers can also become social places where people see their neighbors and can enjoy participation together. If several drop-off centers exist in a community, contests measuring the amount of recyclables collected during a certain period of time can be held between neighboring centers. This type of activity builds a sense of friendly rivalry and a spirit of competition that attracts new participants and increases existing involvement.

The citizen advisory group and community in general need to be encouraged, reinforced, and recognized for their efforts. For example, newspaper articles about members or activities of the citizen advisory group can be featured. Articles about recyclers in the community and awards for residents or groups that regularly volunteer for household hazardous waste collections can also encourage active citizens to continue their efforts as well as motivate other members of the community to take part in waste management activities. A personalized thank you note or a letter to the editor goes a long way toward building positive community spirit and encouraging continued participation.

Funding Activities or a Program

Public education and public involvement programs for municipal solid waste management do not have to be extremely costly. They do, however, require a definite commitment from decision makers for the funds as well as staff time necessary to plan and coordinate a successful program. This cost is small when one considers the benefits that a community will receive from public input on decisions and public education programs that promote integrated solid waste management -- averted disposal costs, a cleaner environment, and longer landfill life, as well as the prospect of better community relations.

While the competition for cash contributions is steep, whenever possible, decision makers should look to the community for assistance. With innovative ideas and strategic planning, a little money and a lot of in-kind services can go a long way. For example, printing grocery bags with a civic message such as an announcement for a household hazardous waste collection day is a community service frequently provided by local grocery stores. A high school or local college class can take on the challenge of producing a video that shows residents how to source separate their household waste. This same video could be shown to civic groups by members of a volunteer speakers bureau. Many clubs and organizations have newsletters and welcome noteworthy information on community events such as source reduction or recycling programs in schools. Businesses with marquees and reader boards are often willing to announce special events and display promotional messages.

Media coverage, such as newspaper articles, radio interviews, and public service announcements, are low-cost ways to communicate with hundreds to thousands of community members about planning special collection events and project milestones. Advertising space can also be purchased. Although this is a more expensive route, carefully designed and well-placed advertisements can be well worth the cost. In some cases, local businesses will underwrite advertising costs, if appropriate credit is given.

SUCCESSFUL PUBLIC EDUCATION AND INVOLVEMENT PROGRAMS

Decision makers should keep in mind that each community's municipal solid waste plan is different, and what constitutes a successful public education and involvement program in one case may not be what is needed in another. It is critical that decision makers involve citizens in the waste management planning process and that they educate the citizenry of the full costs and liabilities of managing the waste they produce. This, combined with broad and ongoing education on how to participate, will lead to public support of and participation in waste management programs.

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Chapter Twelve

Financing and Revenues

MAJOR MESSAGES

- **Sound financial management of the proposed waste management system will require decision makers to know the operating and capital costs and projected revenues of each waste management alternative.**
- **Waste generators, both corporate and individual, need to understand the full costs and liabilities associated with the management of their wastes, so that they can understand the current waste management system and how waste reduction and recycling can be beneficial to them.**
- **Operating revenues may be generated by a number of options, including taxes, user fees, and revenues from recovered materials.**
- **Capital financing may be accomplished using a number of alternatives, including borrowing, current revenues, and private financing.**

Once a number of alternatives for managing the community's solid waste have been identified, the financial impact of each of these alternatives must be carefully considered. The costs of collecting and disposing of solid waste have increased substantially for most communities over the past ten years. In many cases the operating cost of solid waste collection and disposal has been the fastest growing budget item. This trend can be attributed to a number of factors, including rising wages, equipment costs, waste volume, and increasingly stringent environmental standards. Similarly, the capital cost of financing solid waste programs and systems also has become a problem for many communities due to the need to construct new facilities or maintain and upgrade existing ones at a time when other community programs are competing for scarce resources.

Partly responsible for this trend is the need to conform to new federal and state regulations, the development of highly capital-intensive waste management systems, and the need to respond to public demands for safe and clean waste management. Additionally, many communities are finding their financing decisions constrained by the need to pay for past disposal practices, including corrective action costs at older landfills.

UNDERSTANDING THE FULL COSTS OF WASTE MANAGEMENT

It is very important for decision makers and waste generators to understand the full cost of municipal solid waste management. Commonly, waste generators, both individual and corporate, aren't aware of the full costs and liabilities associated with the management of their wastes because the fees they pay are subsidized by general revenue or other funds. Individuals, businesses, etc. never receive a bill reflecting the full costs of their waste production practices including closure, any cleanup, or replacement of waste management facilities. This makes it impossible for them to understand the operation of the current waste management system and how waste reduction and recycling can be financially beneficial to them on an individual or corporate basis. Waste management accounting and billing systems need to be revised to provide this information on the full cost of management.

OPERATING REVENUE

Constraints on the budgets of many local governments have increased dramatically in recent years. This trend has been compounded by the rising cost of solid waste collection and disposal, including the costs of current systems and the added costs of closure, post-closure, and remediation. Many communities, therefore, are looking for new sources of funding through a variety of taxes and revenues.

Tax Financing

Traditionally, funding for community solid waste systems comes from a general fund, whose primary source of revenue is the property tax. A growing trend toward tax reform in recent years, however, often coupled with falling revenues due to regional economic problems, has led many communities to seek alternative taxes to fund solid waste programs.

Property Tax

Many communities have successfully used a portion of the property tax to support the solid waste management system. This tax is easy to administer since no separate billing or collection system is needed and payment is virtually guaranteed (many citizens prefer this method of financing since the tax is deductible on federal and state income tax returns). The primary disadvantage is that solid waste is often considered a low-priority item and must compete with other municipal budget items. Second, since solid waste operating costs often are not broken out from other costs, there is less incentive for efficient operation of the system. If cost savings are instituted, the savings usually accrue to the general fund rather than the solid waste system.

Sales Tax

The sales tax appears particularly attractive in regions with high recreational and tourist trade. The revenue stream is usually seasonal and often inadequate, however, and voter approval may need to be obtained before implementation. Sales taxes are often considered regressive in their relatively larger impact on low-income people.

Municipal Utility Tax

This tax may be levied on some or all of the utilities in a community, whether municipally or privately owned. Utilities commonly subject to a municipal tax are the telephone, electricity, gas, water, and cable television franchises. This tax eliminates individual billing problems, and usually can be set by ordinance without referendum. The revenue stream may be too limited and variable, however, and commercial establishments who must contract with private haulers still may pay the tax, although they do not receive the service.

Special Tax Levies

Some state statutes give communities or counties authority to levy special taxes other than those already mentioned. Usually, the amount is limited by statute and is based on the assessed valuation of property. A referendum of the citizens is usually not required. It is often the case, however, that many special tax levy statutes already have been instituted to cover non-budgeted items such as hospitals, parks, playgrounds, and museums, and the solid waste system has to compete with these projects for funds.

User Fees

User fees can be an equitable means of funding solid waste management services if properly administered. The community can establish fees on the basis of actual costs of collection and disposal. The user fee can be assessed at a uniform or variable rate, depending on the amount and kind of services provided.

Uniform Fees

A straight user charge allocates an equal share of the costs to all users within a service-level group. A user receiving backyard collection may pay more than a user receiving curbside service, but all backyard users are charged the same fee, regardless of the amount of waste they generate. This type of user charge can be collected by adding a separate solid waste charge to a periodic utility bill or the yearly property tax bill, or through a separate billing system. To avoid added overhead costs and to facilitate collection of bills, it is usually preferable to attach the charge to an already existing billing system. This type of user charge is efficient and the least costly to administer.

Variable Fees

A progressive user charge represents an attempt to correlate costs and service by charging the resident according to the amount of waste generated. The assessment can be calculated in two ways: 1) a charge for each container collected, or 2) a minimum charge that would cover collection of a certain number of containers plus an extra charge for each additional container.

Controlling variable user fees so that customers are billed only for the containers they are using and collectors know how many containers are supposed to be collected from each customer can be difficult. An increasing number of communities are turning to this kind of system, however, and a variety of methods for identifying, collecting, and charging for waste container pickup are being used throughout the country. These include using specially marked containers or providing, for a fee, either special bags or special container stickers and tags.

Some communities are combining user fee systems, which provide an incentive to reduce waste, with free pickup of recyclables, which encourages recycling because it saves households waste removal charges. The City of Seattle has successfully incorporated both variable user fees and free collection of recyclables into its waste collection and disposal system. The City offers both backyard and curb/alley collection, with a 40% rate incentive for customers choosing the curb/alley system. Seattle also uses a variable rate structure for collecting containers ranging from a 1/2 can to 3 cans. Since 1981, the average waste services subscription for residential ratepayers has dropped from 3.5 cans to 1.4 cans per household.

One problem that is often raised concerning user fees is that residents charged on a volume or container basis might have a tendency to overfill their containers or engage in illegal dumping when they have more trash than will fit in the can. This could result in loose litter, higher street cleaning costs, and public dissatisfaction. Seattle has approached this problem by providing standardized containers to households and selling pre-paid trash tags (available from local grocery and convenience stores) for bulky waste items. Waste that is either not in a container or not tagged for pickup is clearly identifiable as being in violation.

Traditionally, user charges have seldom covered the total cost of operating a municipal solid waste system. Solid waste services usually are paid for partially out of funds raised from property taxes. As a result, the public often becomes accustomed to a nominal service charge and some city officials feel the public would raise strong objections to a service charge that actually reflects total operating costs. Decision makers can take advantage of the planning process in this instance by using public education and involvement programs to discuss increased waste generation, shrinking disposal capacity, and rising system costs. The public's increased awareness of solid waste issues coupled with a sense of their own role in the decision making process, may provide the opportunity to adjust user fees to reflect the real cost of providing solid waste services.

User fees foster citizen awareness of waste collection, processing, and disposal costs and provide an impetus for more efficient consumer behavior. User fees are an excellent means of placing explicit costs on each household's contribution to the waste stream and are an incentive to reduce waste generation and encourage recycling. Primary problems with user charges are billing, difficulties in administration, and the fact that if they truly reflect costs, they may be too high for low-income or fixed-income persons.

Disposal Site Fees

Disposal costs historically have not been the most expensive component of solid waste systems. Although disposal costs are rising rapidly in some communities, collection is generally the most costly component of the waste management system. This is the case because often tipping fees at MWC or landfills do not accurately reflect true operating costs, especially the costs of environmental controls, closure, post-closure maintenance, and liability. All haulers, large trucks, and industrial users should be charged a tipping fee that takes into consideration total system costs, scaled according to the amount of waste dumped. Fees can also depend on the type of refuse received. For example, fees may be charged for stumps, tires, and building and demolition refuse, because these materials are more difficult to compact and cover.

Decision makers must consider three factors when determining tipping fees at facilities: 1) total disposal costs, including ash disposal for combustion facilities and closure and post-closure costs for landfills, 2) the need for resources to plan, site, and operate replacement facilities in the future, and 3) using part of the tipping fee as a source of funds for other components of the solid waste program such as recycling, composting, and source reduction programs.

Tipping fees should reflect the full cost of facilities, including compliance with more stringent environmental controls than in the past. Also, some jurisdictions (such as New Jersey) have added surcharge to landfills, as a way of discouraging disposal and thus encouraging waste management alternatives and preserving landfill capacity.

Decision makers should note that because of the many factors affecting solid waste management costs, none of the methods described above can be precisely equitable nor would some communities desire them to be. In many cases, one sector of the population subsidizes service to another sector by paying a price higher than the actual cost of the service.

Revenues From Recovery Programs

Financial planning for a waste management system should account for the operating revenues that may be generated by recycling, composting, waste-to-energy, and methane gas recovery programs. Decision makers should carefully consider the impact of all of these program revenues and expenses on the balance sheet of the overall solid waste system. These programs can provide tangible financial benefits associated with recovered materials and conserved energy. While markets for recovered materials can be volatile and regionally underdeveloped, revenues can be gained nonetheless from the sale of recycled materials. The long-term presence of a concerted local and/or regional recycling program, combined with the efforts of community groups and public officials, can serve to stabilize and broaden the local market for these recycled materials. The provision of a constant supply of quality materials to the market is important in establishing revenues for the community's recovery programs.

Additionally, the cost savings realized by not landfilling wastes that are reduced at the source, recycled, or composted also can be partially captured by the community solid waste system. These savings, either as direct pay-backs or as avoided costs, can be realized through contractual arrangements with private waste haulers, processors, and recyclers or with the disposal facilities themselves. For example, incentives for recycling can be provided to these parties by apportioning the cost-savings through avoided tipping fees between the community solid waste system and the private waste management firms. Many communities use such a system both to increase the capture rate for recycled materials and to provide additional revenues to the community recycling program. Finally, cost savings also may be realized from the decreased volume of waste by the redesign of waste collection systems, with the savings captured through new rate structures and modified collection contracts.

CAPITAL FINANCING

There are three basic sources of capital: borrowed funds, current revenues, and private financing.

Borrowing

General Obligation Bonds

Among all public borrowing mechanisms available, general obligation (GO) bonds are usually the most flexible and least costly alternative. The issuing municipality guarantees a (GO) bond with its full faith and credit based on its ability to levy on all taxable real property such ad valorem taxes as may be necessary to pay the principal and interest on the bonds. Because general obligation bonds are considered to be the safest of all municipal securities, they tend to carry lower interest rates than other forms of municipal debt having similar maturity. Most states require voter approval before state or local general obligation bonds can be issued.

A GO bond issuance may not require direct technical or economic analysis of particular projects to be funded. Small projects may be grouped to obtain capital, making GO bonds an ideal funding mechanism for solid waste facilities in small and medium-sized communities. The transaction costs for issuing GO bonds impose a benchmark minimum on debt issuance below which the "effective interest rate" increases prohibitively. The minimum issuance will probably fall within the range of $500,000 to $1 million.

If total capital requirements of a small or medium-sized community are less than $500,000, the community might adopt an alternative financing mechanism, such as borrowing from a bank, leasing equipment and facilities, or contracting for the service from the private sector.

Municipal Revenue Bonds

One mechanism that is often used to circumvent the constraints associated with GO bond issuance is the municipal revenue bond. Revenue bonds do not require voter approval and do not affect a city's legal debt limits. A revenue bond is issued to finance a single project with revenue-producing services. Revenue bonds do not have the full faith and credit of the community; rather, they pledge the net revenue generated by the project to guarantee payment. The increased risk associated with revenue bonds yields a correspondingly higher interest rate. The coupon rates on revenue bonds depend strictly on the revenue-generating capacity of the project being financed.

Revenue bonds require extensive bond circulars describing the economics of the project, and there may be limitations on the volume of the bonds which can be sold or outstanding at any one time.

Bank Loans

A municipal bank loan is not a viable alternative to long-term bond financing. Relatively small-scale capital requirements, however, may be met in the short run (five years or less) at a low cost by securing a bank loan. Typical use of bank loans in the solid waste field has been to supply short-term funding for rolling stock (vehicles, trailers, etc.). Since interest on a loan to a municipality is tax free to the bank, the corresponding interest will compare favorably with the coupon on a GO bond.

Municipalities often use bank loans to stabilize cash flow, and occasionally large cities use bank notes in anticipation of a bond issue. The notes, often substantial if arranged with a large bank, are refinanced as they expire. A medium-term loan source of funding is thus provided.

Leasing

In lease agreements, the leasing company (the lessor) usually purchases and holds title to the asset and the municipality (the lessee) pays rent for using it during the lease term, generally not more than five years for equipment. Longer leases are often executed for land. Occasionally the municipality will hold title from the outset to avoid sales taxes incurred during the eventual title transfer. Lease agreements in the solid waste area are usually arranged by local equipment representatives, who place the financing with either a bank or leasing company. Often, stipulations are included in the contract agreement which allow the community to purchase the equipment at "fair market value" at the end of the lease.

The use of leasing by private solid waste companies is quite prevalent. Small private collection companies that are trying to expand their business often encounter cash flow limitations and turn to this type of financing. Leasing is often worthwhile because the cost of leasing can be deducted as a business expense for tax purposes.

Other Debt Instruments

Within the broad categories of general obligation and revenue bonds, there are a wide variety of individual debt instruments.

- Tax Increment and Tax Allocation Bonds. These bonds are secured by the "additional" or "incremental" tax revenues which new capital projects financed by the bonds generate. They are often issued by local governments to finance redevelopment projects.

- Lease-Purchase Bonds. These bonds, which are also referred to as lease-revenue or lease-rental bonds, usually are issued by public, private, or nonprofit leaseback corporations which use the bond proceeds to construct facilities that are then leased to governmental entities. The lessee makes payments to the lessor sufficient to pay for debt servicing and corporate operating expenses. At the end of the lease period, the title covering the facility is transferred to the lessee government.

State and local governments also issue a variety of short-term tax-exempt financial instruments which, although not technically bonds, are a form of municipal debt (State of California, 1982).

- Tax Anticipation Notes (TANs) and Revenue Anticipation Notes (RANs). these notes are issued in anticipation of receiving tax revenues or other income in the future.

- Bond Anticipation Notes (BANs). These notes are issued with the expectation that financial market conditions will permit the issuance of long-term debt at lower interest costs in the future. Thus, BANs provide temporary financing for capital projects until long-term bonds are marketed.

- Tax-Exempt Commercial Paper. Municipal commercial paper is an extremely short-term, unsecured debt obligation issued by a state or local government, similar in principle to the short-term, unsecured taxable commercial paper issued by corporations. Municipal commercial paper is a far more flexible financial instrument than conventional municipal notes or bonds, partly because issues can be easily structured to mature on the exact day that an investor requests. Most tax-exempt municipal paper is purchased by tax-exempt money market funds, and municipalities frequently must show evidence of some sort of bank agreement in order to ensure that their unsecured issues will be liquid in the financial marketplace.

Current Revenue Capital Financing

The most common method for obtaining capital equipment for a municipal solid waste program has been to buy it as needed. The principal advantage is simplicity: no institutional, informational, analytical, or legal arrangements are required. This method, however, depends on the ability of the community to generate surplus capital.

In the solid waste area, current revenue financing has been used mainly for collection vehicles and selected landfill disposal systems. Municipalities that dispose of solid waste using landfills are usually able to maintain the system with current revenue. Equipment replacement is not likely to be a major expense and can be addressed periodically through reserve funds dedicated for that purpose. Land can be leased or purchased as an investment. On the other hand, municipalities requiring either extensive upgrading of their systems in the short run or a capital-intensive solution to their solid waste problem will have to raise capital by borrowing or contracting with a private firm.

Private Financing

A third alternative is to contract with a private firm for waste management services and thereby transfer to it the process of raising capital.

Generally, the private firm will then raise the capital, purchase the equipment, and operate the system. There are a range of options for implementing private financing alternatives. The differences between these options concern the procurement, management, and degree of ownership and control of the facilities and systems, as well as alternatives in the design, construction, and performance of the facilities. These options are "packaged" using a variety of terms including full service, merchant plant, architectural engineering, and turnkey approaches, and are discussed in more detail in Chapter 8 under the section on Combustion, although they apply to all facilities. These approaches relieve the municipality from having to devote capital funds to solid waste management and presumably provide the most long-term flexibility, although the effective financing rate will be higher.

Industrial Revenue Bonds and Pollution Control Revenue Bonds

Industrial revenue bonds (IRBs) and pollution control revenue bonds (PCRBs) are issued by a municipality for, or on behalf of, a private enterprise. The municipality technically owns the facility and equipment, which it leases to the private firm. The lease payments are specified to meet the scheduled payments of debt and interest on the bond. The municipality thus acts as a vehicle through which a corporation may obtain low-cost financing. If payment arrangements between the corporation and the municipality are structured as an installment sale, the corporation may claim ownership for tax purposes. This gives the corporation a tax benefit in the form of depreciation, which should be reflected in lower service fees charged to the municipality.

There are two major distinctions between the IRBs and PCRBs. First, IRBs are limited to $5 million in the amount of capital that they can raise, while PCRBs have no such limit (although volume limits on debt per capita and/or on the total tax-exempt allowable debt in a state were included in the 1986 Tax Reform Act). Second, capital raised through IRBs must be for industrial development while PCRBs must finance pollution control equipment.

In the solid waste field, PCRBs have seldom been used. In addition to the administrative complexities, broadly defined tax guidelines frequently require IRS rulings which can delay financing by up to six months. Solid waste disposal and resource recovery facilities generally qualify as pollution control projects under section 103c of the IRS regulations, but at this time it is not clear whether entire systems of certain types will qualify. This ambiguity may discourage the broadest application of PCRBs to finance resource recovery systems.

Another major stumbling block for PCRBs concerns a community's ability to sign long-term contracts with corporations, guaranteeing a minimum supply of solid waste. Additionally, while the security of these issues requires long-term agreements, many states prohibit communities from entering into long-term service contracts.

Leveraged Leasing

Leveraged leasing is technically not a financial instrument. Rather it is a financial package that combines several financial options. The concept is based upon the benefits (lower long-term capital and interest costs) that accrue to a city if a financial intermediary, a corporation or individual, is interposed between a long-term source of capital and the municipality.

Leveraged leasing is a complex mechanism to initiate. It involves two major participants, a financial intermediary (lessor) and a city (lessee). It differs from traditional leasing in that both the lessor and the city provide capital funds to purchase the asset. Usually, the lessor puts up 20 to 30 percent of the cost of the asset, and the city finances the remaining portion through a typical borrowing method.

The financial intermediary acquires the tax advantages of ownership, and therefore can pass on to the city a very low interest rate because it is the owner of the entire facility from a tax standpoint and can therefore depreciate the investment. Essentially, the depreciation and tax credit act to shelter the financial intermediary's other income, allowing the intermediary to receive an adequate after-tax return on its initial investment in the asset.

Private financing can be an attractive alternative for a community because a private firm essentially conducts the entire operation, saving the community both staff time and direct outlays of resources. Obviously, the community will be charged for all services rendered and these charges may be higher than if the community had undertaken the task in-house. Nonetheless, private financing may be an option if the firm can provide services at a lower cost than the community could provide on its own and/or if the administrative savings in staff time and resources are important to the community.

Regardless of the choice of financing options, technologies, and management and service delivery systems chosen for the community, decision makers must constantly remain aware of their role in the solid waste management process. Decision makers and other public leaders are always ultimately responsible for the choices they make in selecting waste management alternatives and for the performance of the system once it is in place. Decision makers always must remain ultimately in control of the waste management system serving the community.

Issuing And Marketing A Bond

This section briefly outlines the major issues associated with "floating" a bond. The information provided here applies to both the general obligation bonds and the municipal revenue bonds discussed in the previous sections.

Bond ratings

To provide reliable information on the quality of different investments, a municipal bond rating system has been developed. Since 1950, two private rating agencies -- Moody's Investors Services, Inc. and Standard and Poor's Corporation -- have issued municipal bond ratings on a nationwide scale.

There are four general categories of variables used in determining a community's bond rating: 1) economic base; 2) financial factors; 3) debt factors; and 4) administrative factors. Measures of economic base reflect the community's ability to pay. Important factors are the size of the population, income levels and income growth, the employment mix and the number of leading employers, and measures of the age and composition of the community's housing stock. Financial factors are the revenue structure, the balance among different types of taxes, and the relationship between expenditures and revenues. Debt factors include the nature of the debt issue and measures of total debt burden relative to budgetary resources and the community's tax base. Both the community's debt history and the plans for the retirement of the current debt are examined.

Variables in the administrative category relate to the form of government and the degree of professionalism shown in carrying out ordinary governmental functions (obtained to a large extent subjectively through meetings between rating agency analysts and local officials). With respect to bond ratings, many communities will find themselves falling into the pattern shown for a survey of cities in Minnesota (see Figure 12.1). While not all communities will qualify for a rating by either agency, the majority of smaller communities will find themselves with bond ratings on the lower end of the spectrum while the medium to large communities will achieve the higher ratings.

Rating Fees

Standard and Poor's generally bases its rating fee on the time and expense involved in determining and monitoring the rating. The fees for domestic long-term bond issues occupy a fairly wide range from $2,500 to $50,000 (S&P Credit Week, July 17, 1989). For municipalities, Moody's fees for rating general obligation bonds generally are based on the latest officially recorded population of the issuer under consideration. The fees of the two agencies are, however, generally comparable in dollar terms (State of California, 1982). Decision makers should note that it is not always necessary to obtain a rating prior to raising capital through a debt issue. Hence, the community should weigh the reduced interest costs derived from obtaining a rating against the rating fee.

Municipal Bond Insurance

Government officials increasingly are taking advantage of credit enhancement provided by services such as letters of credit and municipal bond insurance to lower borrowing costs and increase the marketability of their bond issues. Insured bonds carry a Triple-A rating from Moody's and Standard & Poor's. This generally results in a lower interest cost over the life of the bonds and can reduce an issuer's borrowing costs by as much as 50 basis points or more. Investors who buy insured bonds benefit from knowing that interest and principal will be paid on time until the bonds mature.

Significant cost savings can be realized from insuring a bond issue, although the savings will depend on many factors, including the size of

SPRINGFIELD, MASSACHUSETTS GENERAL OBLIGATION BONDS $20,000,000 (18 year issue)

Insured	Uninsured	
Rating	A/A	Aaa/AAA
Interest Rate	7.27	7.14
Net Int. Cost	10,848,345	10,524,750
Cost of Ins.	-	131,000
Total Cost	10,848,345	10,655,750
Net Savings	-	192,595

(Source: Municipal Bond Investors Assurance Corporation)

the issue, geographic location, and the issuer's underlying credit worthiness. While market conditions and interest rates can and will change, normally there will be a spread between insured and uninsured interest rates that will determine the net savings if insurance is used.

- Qualifying for Insurance. Eligibility for insurance depends on the issuer's financial history, legal status, economic condition, demographics, debt load, and ability to pay. The information needed to review a potential issuer's eligibility varies according to the type of issue, but is generally similar to that required by the credit rating agencies, including basic financial, economic, and demographic information.

- Paying the Premium. Premiums for bond insurance generally range from approximately four-tenths of one percent to nine-tenths of one percent of the total debt service due over the life of the bonds.

Generally the best course for an issuer of bonds is to secure a commitment from an insurer in advance in order to advertise the bond sale as Triple-A insured. This requires the issuing community to pay the premium directly and allows it to select the insurer. Normally this step produces the greatest interest cost savings, because all parties know in advance that the bonds will be insured.

When the community cannot pay the premium directly, other alternatives are available which can shift both the cost and the selection of the insurer to the underwriter of the bonds.

- Selling Insured Bonds. The market for insured issues is currently very strong for several reasons. First, after the Tax Reform Act of 1986, municipal bonds have become one of the few investments left for investors offering tax-free income. Second, because of the fiscal difficulties experienced by many municipal issuers in the mid-1970's, the combination of Federal cutbacks in revenue sharing and economic recession in the early 1980's, and the number of recent defaults, investor demand for municipal bond insurance has grown dramatically over the past few years. Third, the volatility of the stock market has made many investors much more concerned about the safety of their investments. This makes insured bonds particularly attractive because of the safety of principal and interest payments.

Issuing, Marketing, and Trading Municipal Bonds

The primary marketing advantage to issuers of municipal bonds is that the interest earned on the bonds is exempt from federal income taxation. For this reason, municipal bonds are commonly referred to as tax-exempt bonds. The interest on municipal bonds is also exempt from income taxation in most states, at least in the state where the bond was issued. The immediate practical effect of the tax exemption is that state and local governments can sell bonds that provide a lower interest yield when borrowing to finance capital outlays (State of California, 1982).

State and local governments must follow numerous steps when issuing and marketing municipal bonds:

- Securing specialized bond-related services, such as fiscal advisors, bond counsel, auditors, and paying agents;

- Obtaining public approval if the bonds are to be sold as a general obligation issue;

- Designing the bond issue's features, such as its maturity schedule, the denominations of individual bonds, the coupon interest rates for bonds of differing maturities, and call privileges or options and the premiums which must be paid to exercise them;

- Drafting a bond security agreement if the bond issue is a revenue or limited liability (as opposed to general obligation) bond issue;

A COMPARISON OF MUNICIPAL BOND RATINGS AND CITY SIZE IN MINNESOTA

Bond Rating vs. Population

Population	<2,500	2,500 - 10,000	10,000 - 20,000	20,000 100,000	>100,000	Total # of Cities
Bond Rating						
Aaa				1	1	2
Aa1				4		4
Aa		2	1	6	1	10
A1		4	7	10		21
A	12	28	21	9	1	71
Baa1	34	43	1	1		79
Baa	56	20				76
Ba	1					1
NR	572	18	1			591
Total # of Cities	675	115	31	31	3	855

(Source: State of California, 1982)

FIGURE 12.1

- Marketing the bonds, either by public or private sale. In the case of public marketing, this includes preparing certain documents necessary to sell the bonds, obtaining a bond rating, selecting a sales date, advertising the bonds and accepting bids, awarding winning bids, printing and delivering bonds, and closing the bond sale, including issuance of debt records; and

- Administering outstanding debt, including maintaining debt-related accounting records.

Financial Issues Concerning Expected Landfill Requirements

EPA's proposed rules for landfill closure include specific requirements for financial assurance for the maximum cost of closing a landfill based on site-specific factors. The purpose of financial assurance is to ensure that the owner or operator adequately plans for the future costs of closure, post-closure care, and corrective action for known releases, and to ensure that adequate funds will be available when needed to cover these costs if the owner or operator is unable or unwilling to do so. One of the benefits of the proposed financial assurance requirements is that local governments may use it as a tool to induce advanced planning for future environmental costs. Moreover, demonstrating financial assurance may help the community to raise funds for costs that will ultimately have to be covered. To demonstrate that it has planned for future costs, the owner or operator must prepare written cost estimates according to specific guidelines.

The proposed rule parallels the closure and financial assurance requirements for hazardous waste/Subtitle C facilities, which allows the use of a trust fund, letter of credit, surety bond, insurance, financial test, corporate guarantee, state-required mechanism, state assumption of responsibility, or a combination or certain mechanisms to demonstrate financial assurance for closure and post-closure. Additionally, the Agency will be exploring a financial test that can be used by municipal governments to demonstrate adequate financial assurance. EPA is not proposing the types of mechanisms that may be used to demonstrate financial assurance. Rather, EPA proposes to establish performance standards that specifies a set of criteria that must be satisfied by any mechanism that is used. Regardless of the mechanism chosen, it must ensure that adequate funds are available in a timely manner whenever they are needed.

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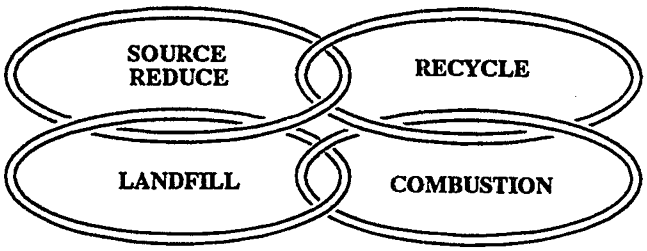
Chapter Thirteen

Conclusions on Integrated Waste Management



MAJOR MESSAGES

- **Integrated municipal waste management programs use a mix of alternatives to manage specific components of the waste stream. These alternatives can be combined and designed to complement each other.**
- **Integrated waste management systems must be designed with the flexibility to handle future changes in the local waste management system.**
- **Program monitoring and evaluation are important, ongoing activities.**

As discussed throughout the Guide, integrated solid waste management is the use of specific management and disposal programs and techniques to handle distinct components of the waste stream. Programs are designed to complement each other, both environmentally and economically.

PLANNING AN INTEGRATED SYSTEM

Selecting waste management alternatives is essentially a local activity performed in response to local waste management needs. No "boiler plate" exists for indicating which alternatives should be used when and where -- it varies from community to community.

In the past, many local officials have looked for easy answers, only to find themselves locked into an expensive and perhaps unpopular program.

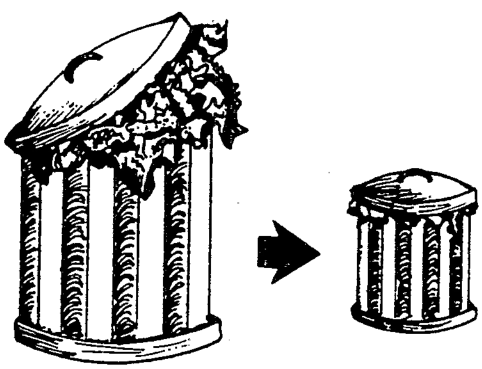
Modern landfills and combustion facilities are high-technology, and consequently high capital investment waste management options. Because of the time frame and technical demands involved, these options are the most difficult to implement. Further complications arise when considering siting and public opposition.

This is not to say that these so called "large" facilities are not necessary. Every waste management system must have access to a landfill, and a properly operated energy recovery facility can be extremely beneficial to handle large amounts of waste and produce steam or electricity. Many decision makers, however, are only beginning to comprehend the benefits that can be realized when other waste management techniques (e.g. source reduction, recycling, composting) are integrated into the local waste management system. Not only are these options beneficial from an environmental and a public perception standpoint, when implemented properly they can improve overall system economics.

Decision makers must be realistic in planning their waste management system. Just as waste-to-energy is not a "miracle solution," neither is recycling. There will be difficulties, trade-offs, and hard decisions associated with all waste management options. By recognizing the uncertainties and limitations inherent in solid waste management, the decision maker will be better prepared to develop a sound integrated waste management plan.

INTERACTION OF WASTE MANAGEMENT ALTERNATIVES

If designed properly, waste management alternatives can be designed to complement each other environmentally and economically.

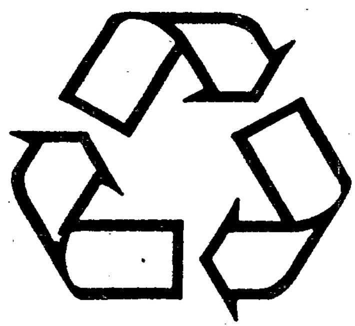


Source Reduction

Source reduction programs are designed to reduce the quantity and toxicity of materials entering the municipal waste stream. Both goals, if reached, could have significant impacts on the operation of other waste management alternatives.

Reducing the quantities of materials in the waste stream can result in a reduced number of waste handling vehicles and equipment and smaller management and disposal facilities. Collection costs, for example, can be reduced if there is less waste to be collected. Also, the costs of constructing and operating facilities such as transfer stations, material recovery facilities, and waste-to-energy plants will be lower with a smaller waste stream. In addition, landfill capacity is preserved through effective quantity reduction programs.

The removal or reduction of products with toxic components will also improve the operation and environmental impacts of waste management facilities. For example, heavy metals such as lead and cadmium can be found in printing inks and household batteries. When these materials are buried at a landfill or burned at a combustion facility, these constituents require control of leachate at the landfill and air emissions at the combustion facility. A source reduction program that minimizes the use of these materials can reduce environmental risks.



Recycling

Recycling programs vary in degrees of aggressiveness; some may be simple, low-technology drop-off centers, while others may involve comprehensive source separation and curbside collection or complex separation technologies at material recovery facilities. Because recycling can divert significant quantities of materials from ultimate disposal, it is usually one of the first options selected by communities faced with an impending landfill capacity shortfall.

The impact of recycling on combustion facility operation can also be beneficial:

- Recycling programs divert materials from combustion facilities. As a result, smaller facilities can be designed.

- Recycling can remove materials that may be noncombustible, like glass or metal, or sources of contamination in the ash (e.g., lead and cadmium in inks and batteries).

- More positive public attitudes can result from combining a recycling program with an energy recovery facility. Although energy recovery facilities are generally met with public opposition, one that is developed along with or after a recycling plan has been implemented may be more acceptable.

Despite the obvious benefits that can be realized through the combination of recycling and combustion programs, a historical tension exists between the supporters of each. Much of the tension results from flow control ordinances that are designed to guarantee that a certain quantity of waste is sent to the energy recovery facility (these facilities are designed to a specific capacity that is sensitive to the amount of waste that enters). Flow control, however, can be designed to provide materials both for recycling programs and energy recovery facilities. Planning and evaluation during program design can simplify the task of deciding where wastes should go.

In addition to landfills and combustion facilities, recycling programs can also have a positive impact on composting operations. Many commonly recycled materials (e.g., glass, aluminum, plastic) are not easily composted, and are generally considered contaminants in the compost product. Similarly, the removal of toxic constituents (e.g., lead and cadmium from inks and batteries) in the waste stream will also result in a higher quality product.

Composting

A variety of composting programs exist, ranging from simple backyard systems to in-vessel digesters handling municipal solid waste. Composting can divert significant quantities of

materials from disposal. Composting programs, therefore, can play a fundamental role in the conservation of landfill space.

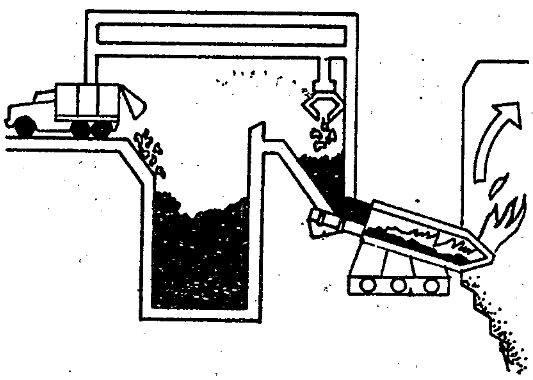
Backyard composting is often considered a source reduction activity, as materials handled in this manner never actually appear in the municipal waste stream. The benefits of waste stream reduction have been discussed throughout this section.

Centralized yard waste composting facilities are becoming more popular as a waste management tool, and their operation can directly benefit other alternatives. First, composting can divert a significant amount of material from the stream entering combustion facilities or landfills. A smaller waste stream means a smaller facility (which is less expensive to build and operate). Second, because yard wastes do not burn as well as some of the other waste stream components, diversion of yard wastes from a combustion facility to a composting facility can increase the heating value of the remaining waste stream entering the combustion facility. A higher heating value means that more steam or electricity can be produced per pound of waste burned.

Municipal waste composting is a developing technology. Composting possesses great potential for reducing the amount of material that must be otherwise managed or landfilled.

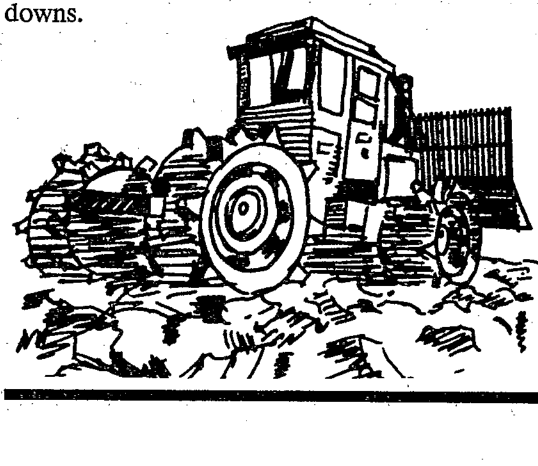
Combustion of Solid Waste

The impacts of alternative management options on combustion facility design and operation have been described above. To summarize, the reduction in the size, non-combustibility, and toxicity of the waste stream that results from source reduction, recycling, and composting programs can significantly lower costs and improve the operation of future combustion facilities. Combustion plays an important role in waste management because it not only reduces the volume of material requiring disposal, it also produces a revenue-generating product.



Land Disposal

Landfills are necessary components of waste management systems, and complement the other waste management alternatives by providing disposal capacity for the various residuals. For example, processing recyclables generates residuals that cannot be sold, reprocessed or reused. Similarly, non-compostable and non-combustible (i.e., ash) materials require disposal. In addition, disposal capacity is often needed during planned or unanticipated facility shut-downs.



Timing Issues

A good integrated solid waste management plan should focus not only on what specific programs will be undertaken, but also on when and how they will be implemented.

This Guide has tried to show the advantages of implementing low-technology, perhaps pilot-scale programs. Among the advantages associated with these programs is the fact that most take relatively little time to implement. For example, a waste-to-energy facility will take literally years to design, site, and construct, while a pilot-scale, neighborhood drop-off recycling program will take much less time. The point made in comparing these time frames is that decision makers should realize that all planning and management does not have to be put on hold while a certain program or facility is being developed. Integrated waste management is an ongoing process.

FLEXIBILITY OF WASTE MANAGEMENT SYSTEMS

The flexibility of the set of options is also an important consideration that must be built into the local waste management system. The ability to adapt waste management practices to changing conditions is important for a variety of reasons:

- Projections of waste quantities and characteristics are not always exact, and decision makers may be faced with a future waste stream that is different from what was predicted;

- Markets for recycled materials can rise and fall for reasons beyond the control of the locality (some recycling programs have been forced to store or landfill recyclables, or even terminate operations because of unexpected declines in materials markets; others have quickly added new materials as the local market expanded); and

- Opportunities and problems cannot always be anticipated; the field is simply changing too quickly.

Because of potential changes, it is best to examine the economics of investments under a number of possible outcomes and conditions. For example, mechanical separation facilities may be economically justified investments under one set of prices for separated secondary materials, but may not be under alternative scenarios. Waste management components that are more flexible serve to insulate the locality from unexpected changes in local and larger-scale conditions.

Flexibility to expand is also beneficial. Many large-scale capital projects (such as energy recovery facilities) have inherent maximum capacities. Should the community reach these limits earlier than anticipated, the solutions may be very expensive. Thus, ease of expansion of waste management components, individually and in concert, is a significant consideration in the planning and implementation process.

MONITORING AND EVALUATING PROGRAMS

Integrated solid waste decision making is an ongoing process. Monitoring and evaluating program performance allows decision makers to determine whether objectives are being met and whether goals will be reached. Areas that may not have been considered potential trouble spots during the planning process may be identified, and monitoring and evaluation can also provide insight into possible ways of improving the system.

CONCLUSION

There is no universal, step-by-step method for selecting and developing integrated waste management components and systems. The success of integrated solid waste management depends largely on the expertise and dedication of local decision makers. As the Foreword of the *Guide* indicated, the purpose of Volume I was not to provide a blueprint of what to do. Instead, the *Guide's* purpose is to provide a discussion of factors that should be considered in framing local decisions. The *Guide* also presents information and data helpful in making the decisions.

It is hoped that the information presented in this *Guide* will be helpful to solid waste decision makers at the local level. To that end, feedback from reviewers and users of this document will be useful in the continuing process of updating this material. Users are encouraged to send comments and suggestions to Decision Maker's Guide, Municipal Solid Waste Program, OS-301, United States Environmental Protection Agency, 401 M St., S.W., Washington, D.C. 20460.

Glossary

[Several of the definitions included here are drawn from *Garbage Solutions: A Public Official's Guide to Recycling and Alternative Solid Waste Management Technologies*, by Marian Chertow (1989)]

Aeration - The process of exposing bulk material, such as compost, to air. *Forced aeration* refers to the use of blowers in compost piles.

Aerobic - A biochemical process or condition occurring in the presence of oxygen.

Air Classification - A process in which a stream of air is used to separate mixed material according to the size, density, and aerodynamic drag of the pieces.

Algal Bloom - Population explosion of algae (simple one-celled or many-celled, usually aquatic, plants) in surface waters. Algal blooms are associated with nutrient-rich run-off from composting facilities or landfills.

Anaerobic - A biochemical process or condition occurring in the absence of oxygen.

Baghouse - An municipal waste combustion facility air emission control device consisting of a series of fabric filters through which MWC flue gases are passed to remove particulates prior to atmospheric dispersion.

Baler - A machine used to compress recyclables into bundles to reduce volume. Balers are often used on newspaper, plastics, and corrugated cardboard.

Biodegradable Material - Waste material which is capable of being broken down by microorganisms into simple, stable compounds such as carbon dioxide and water. Most organic wastes, such as food wastes and paper, are biodegradable.

Bottle Bill - A law requiring deposits on beverage containers (see Container Deposit Legislation).

Broker - An individual or group of individuals that act as an agent or intermediary between the sellers and buyers of recyclable materials.

Btu (British Thermal Unit) - Used as a unit of measure for the amount of energy a given material contains (e.g., energy released as heat during combustion is measured in Btu's. Technically, one Btu is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Buffer Zone - Neutral area which acts as a protective barrier separating two conflicting forces. An area which acts to minimize the impact of pollutants on the environment or public welfare. For example, a buffer zone is established between a composting facility and neighboring residents to minimize odor problems.

Bulking Agent - A material used to add volume to another material to make it more porous to air flow. For example, municipal solid waste may act as a bulking agent when mixed with water treatment sludge.

Bulky Waste - Large items of refuse including, but not limited to, appliances, furniture, large auto parts, non-hazardous construction and demolition materials, trees, branches and stumps which cannot be handled by normal solid waste processing, collection and disposal methods.

Buy-Back Center - A facility where individuals bring recyclables in exchange for payment.

Centralized Yard Waste Composting - System utilizing a central facility within a politically defined area with the purpose of composting yard wastes.

Clean Air Act - Act passed by Congress to have the air "safe enough to protect the public's health" by May 31, 1975. Required the setting of National Ambient Air Quality Standards (NAAQS) for major primary air pollutants.

Clean Water Act - Act passed by congress to protect the nation's water resources. Requires EPA to establish a system of national effluent standards for major water pollutants, requires all municipalities to use secondary sewage treatment by 1988, sets interim goals of making all U.S. waters safe for fishing and swimming, allows point source discharges of pollutants into waterways only with a permit from EPA, requires all industries to use the best practicable technology (BPT) for control of conventional and non-conventional pollutants and to use the best available technology (BAT) that is reasonable or affordable.

Co-composting - Simultaneous composting of two or more diverse waste streams.

Commercial Waste - Waste materials originating in wholesale, retail, institutional, or service establishments such as office buildings, stores, markets, theaters, hotels and warehouses.

Commingled Recyclables - A mixture of several recyclable materials into one containers.

Compactor - Power-driven device used to compress materials to a smaller volume.

Compost - The relatively stable decomposed organic material resulting from the composting process. Also referred to as humus.

Composting - The controlled biological decomposition of organic solid waste under aerobic conditions.

Construction and Demolition Waste - Materials resulting from the construction, remodeling, repair or demolition of buildings, bridges, pavements and other structures.

Container Deposit Legislation - Laws that require monetary deposits to be levied on beverage containers. The money is returned to the consumer when the containers are returned to the retailer. Also called "Bottle Bills."

Corrugated Paper - Paper or cardboard manufactured in a series of wrinkles or folds, or into alternating ridges and grooves.

Cullet - Clean, generally color-sorted, crushed glass used to make new glass products.

Curbside Collection - Programs where recyclable materials are collected at the curb, often from special containers, to be brought to various processing facilities.

Decomposition - Breaking down into component parts or basic elements.

Densified Refuse-Derived Fuel (d-RDF) - A refuse-derived fuel that has been processed to produce briquettes, pellets, or cubes.

Detinning - Recovering tin from "tin" cans by a chemical process which makes the remaining steel more easily recycled.

Dioxins - Heterocyclic hydrocarbons that occur as toxic impurities, especially in herbicides.

Diversion Rate - A measure of the amount of waste material being diverted for recycling compared with the total amount that was previously thrown away.

Drop-off Center - A method of collecting recyclable or compostible materials in which the materials are taken by individuals to collection sites and deposited into designated containers.

Electrostatic Precipitator - Device for removing particulate matter from MWC facility air emissions. It works by causing the particles to become electrostatically charged and then attracting them to an oppositely charged plate, where they are precipitated out of the air.

Emission - Discharge of a gas into atmospheric circulation.

Energy Recovery - Conversion of waste energy, generally through the combustion of processed or raw refuse to produce steam. See also "Municipal Waste Combustion," and Incineration.

Enterprise Fund - A fund for a specific purpose that is self-supporting from the revenue it generates.

Ferrous Metals - Metals that are derived from iron. They can be removed using large magnets at separation facilities.

Fly Ash (flyash) - Small, solid particles of ash and soot generated when coal, oil, or waste materials are burned. Fly ash is suspended in the flue gas after combustion and is removed by the pollution control equipment.

Flow Control - A legal or economic means by which waste is directed to particular destinations. For example, an ordinance requiring that certain wastes be sent to a combustion facility is waste flow control.

Garbage - Spoiled or waste food that is thrown away, generally defined as wet food waste. It is used as a general term for all products discarded.

Ground water - Water beneath the earth's surface that fills underground pockets (known as aquifers) and moves between soil particles and rock, supplying wells and springs.

Hammermill - A type of crusher or shredder used to break up waste materials into smaller pieces.

Hazardous Waste - Waste material that may pose a threat to human health or the environment, the disposal and handling of which is regulated by federal law.

Heavy Metals - Hazardous elements including cadmium, mercury, and lead which may be found in the waste stream as part of discarded items such as batteries, lighting fixtures, colorants and inks.

High Grade Paper - Relatively valuable types of paper such as computer printout, white ledger, and tab cards. Also used to refer to industrial trimmings at paper mills that are recycled.

Humus - Organic materials resulting from decay of plant or animal matter. Also referred to as compost.

Hydrogeology - The study of surface and subsurface water.

Incinerator - Facility in which the combustion of solid waste takes place.

Incinerator Ash - The remnants of solid waste after combustion, including non-combustibles (e.g., metals) and soot.

Industrial Waste - Materials discarded from industrial operations or derived from manufacturing processes.

Inorganic waste - Waste composed of matter other than plant or animal (i.e., contains no carbon).

Institutional Waste - Waste materials originating in schools, hospitals, prisons, research institutions and other public buildings.

Integrated Solid Waste Management - A practice of using several alternative waste management techniques to manage and dispose of specific components of the municipal solid waste stream. Waste management alternatives include source reduction, recycling, composting, energy recovery and landfilling.

In-Vessel Composting - A composting method in which the compost is continuously and mechanically mixed and aerated in a large, contained area.

IPC - Intermediate Processing Center - usually refers to the type of materials recovery facility (MRF) that processes residentially collected mixed recyclables into new products available for market; often used interchangeably with MRF.

Leachate - Liquid that has percolated through solid waste or another medium and has extracted, dissolved, or suspended materials from it, which may include potentially harmful materials. Leachate collection and treatment is of primary concern at municipal waste landfills.

Magnetic Separation - A system to remove ferrous metals from other materials in a mixed municipal waste stream. Magnets are used to attract the ferrous metals.

Mandatory Recycling - Programs which by law require consumers to separate trash so that some or all recyclable materials are not burned or dumped in landfills.

Manual Separation - The separation of recyclable or compostible materials from waste by hand sorting.

Mass Burn - A municipal waste combustion technology in which solid waste is burned in a controlled system without prior sorting or processing .

Mechanical Separation - The separation of waste into various components using mechanical means, such as cyclones, trommels, and screens.

Methane - An odorless, colorless, flammable, and explosive gas produced by municipal solid waste undergoing anaerobic decomposition. Methane is emitted from municipal solid waste landfills.

Microorganisms - Microscopically small living organisms that digest decomposable materials through metabolic activity. Microorganisms are active in the composting process.

Modular Incinerator - Smaller-scale waste combustion units prefabricated at a manufacturing facility and transported to the MWC facility site.

MSW Composting - Municipal Solid Waste Composting - The controlled degradation of municipal solid waste including after some form of preprocessing to remove non-compostible inorganic materials.

Mulch - Ground or mixed yard wastes placed around plants to prevent evaporation of moisture and freezing of roots and to nourish the soil.

Municipal Solid Waste (MSW) - Includes non-hazardous waste generated in households, commercial and business establishments, institutions, and light industrial process wastes, agricultural wastes, mining waste and sewage sludge. In practice, specific definitions vary across jurisdictions.

NIMBY - Acronym for "Not In My Back Yard" - expression of resident opposition to the siting of a solid waste facility based on the particular location proposed.

Organic Waste - Waste material containing carbon. The organic fraction of municipal solid waste includes paper, wood, food wastes, plastics, and yard wastes.

Particulate Matter (PM) - Tiny pieces of matter resulting from the combustion process that can have harmful health effects on those who breath them. Pollution control at MWC facilities is designed to limit particulate emissions.

Participation Rate - A measure of the number of people participating in a recycling program compared to the total number that could be participating.

Pathogen - An organism capable of causing disease.

Percolate - To ooze or trickle through a permeable substance. Ground water may percolate into the bottom of an unlined landfill.

Permeable - Having pores or openings that permit liquids or gasses to pass through.

Post-Consumer Recycling - The reuse of materials generated from residential and commercial waste, excluding recycling of material from industrial processes that has not reached the consumer, such as glass broken in the manufacturing process.

Recyclables - Materials that still have useful physical or chemical properties after serving their original purpose and that can, therefore, be reused or remanufactured into additional products.

Recycling - The process by which materials otherwise destined for disposal are collected, reprocessed or remanufactured, and reused.

Refractory - A material that can withstand dramatic heat variations. Used to construct conventional combustion chambers in incinerators. Currently, waterwall systems are becoming more common.

Refuse-Derived Fuel (RDF) - Product of a mixed waste processing system in which certain recyclable and non-combustible materials are removed, and the remaining combustible material is converted for use as a fuel to create energy.

Residential Waste - Waste materials generated in single and multiple-family homes.

Residue - Materials remaining after processing, incineration, composting, or recycling have been completed. Residues are usually disposed of in landfills..

Resource Recovery - A term describing the extraction and utilization of materials and energy from the waste stream. The term is sometimes used synonymously with energy recovery.

Retention Basin - An area designed to retain runoff and prevent erosion and pollution.

Reuse - The use of a product more than once in its same form for the same purpose; e.g., a soft-drink bottle is reused when it is refined to the bottling company for refilling.

Roll-off Container - A large waste container that fits onto a tractor trailer that can be dropped off and picked up hydraulically.

Sanitary Landfill - Land waste disposal site that is located to minimize water pollution from runoff and leaching. Waste is spread in thin layers, compacted, and covered with a fresh layer of soil each day to minimize pest, aesthetic, disease, air pollution, and water pollution problems.

Scavenger - One who illegally removes materials at any point in the solid waste management system.

Scrap - Discarded or rejected industrial waste material often suitable for recycling.

Scrubber - Common anti-pollution device that uses a liquid or slurry spray to remove acid gases and particulates from municipal waste combustion facility flue gases.

Secondary Material - A material that is used in place of a primary or raw material in manufacturing a product.

Sludge - A semi-liquid residue remaining from the treatment of municipal and industrial water and wastewater.

Soil Liner - Landfill liner composed of compacted soil used for the containment of leachate.

Source Reduction - The design, manufacture, acquisition, and reuse of materials so as to minimize the quantity and/or toxicity of waste produced. Source reduction prevents waste either by redesigning products or by otherwise changing societal patterns of consumption, use, and waste generation.

Source Separation - The segregation of specific materials at the point of generation for separate collection. Residences source separate recyclables as part of a curbside recycling program.

Special Waste - Refers to items that require special or separate handling, such as household hazardous wastes, bulky wastes, tires, and used oil.

Stack Emissions - Air emissions from a combustion facility stacks.

Subtitle C - The hazardous waste section of the Resource Conservation and Recovery Act (RCRA).

Subtitle D - The solid, non-hazardous waste section of the Resource Conservation and Recovery Act (RCRA).

Subtitle F - Section of the Resource Conservation and Recovery Act (RCRA) requiring the federal government to actively participate in procurement programs fostering the recovery and use of recycled materials and energy.

Superfund - Common name for the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) to clean up abandoned or inactive hazardous waste dump sites.

Tipping Fee - A fee, usually dollars per ton, for the unloading or dumping of waste at a landfill, transfer station, recycling center, or waste-to-energy facility, usually stated in dollars per ton; also called a disposal or service fee.

Tipping Floor - Unloading area for vehicles that are delivering municipal solid waste to a transfer station or municipal waste combustion facility.

Transfer Station - A permanent where waste materials are taken from smaller collection vehicles and placed in larger vehicles for transport, including truck trailers, railroad cars, or barges. Recycling and some processing may also take place at transfer stations.

Trash - Material considered worthless, unnecessary or offensive that is usually thrown away. Generally defined as dry waste material, but in common usage it is a synonym for garbage, rubbish, or refuse.

Tub Grinder - Machine to grind or chip wood wastes for mulching, composting or size reduction.

Variable Container Rate - A charge for solid waste services based on the volume of waste generated measured by the number of containers set out for collection.

Volume Reduction - The processing of waste materials so as to decrease the amount of space the materials occupy, usually by compacting or shredding (mechanical), incineration (thermal), or composting (biological).

Waste Exchange - A computer and catalog network that redirects waste materials back into the manufacturing or reuse process by matching companies generating specific wastes with companies that use those wastes as manufacturing inputs.

Waste Reduction - Reducing the amount or type of waste generated. Sometimes used synonymously with Source Reduction.

Waste Stream - A term describing the total flow of solid waste from homes, businesses, institutions and manufacturing plants that must be recycled, burned, or disposed of in landfills; or any segment thereof, such as the "residential waste stream" or the "recyclable waste stream."

Water Table - Level below the earth's surface at which the ground becomes saturated with water. Landfills and composting facilities are designed with respect to the water table in order to minimize potential contamination.

Waterwall Incinerator - Waste combustion facility utilizing lined steel tubes filled with circulating water to cool the combustion chamber. Heat from the combustion gases is transferred to the water. The resultant steam is sold or used to generate electricity.

Wetland - Area that is regularly wet or flooded and has a water table that stands at or above the land surface for at least part of the year. Coastal wetlands extend back from estuaries and include salt marshes, tidal basins, marshes, and mangrove swamps. Inland freshwater wetlands consist of swamps, marshes, and bogs. Federal regulations apply to landfills sited at or near wetlands.

Wet Scrubber - Anti-pollution device in which a lime slurry (dry lime mixed with water) is injected into the flue gas stream to remove acid gases and particulates.

White Goods - Large household appliances such as refrigerators, stoves, air conditioners, and washing machines.

Windrow - A large, elongated pile of composting material.

Yard Waste - Leaves, grass clippings, prunings, and other natural organic matter discarded from yards and gardens. Yard wastes may also include stumps and brush, but these materials are not normally handled at composting facilities.

Acronyms

ANSI	American National Standards Institute
BAN	Bond Anticipation Note
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSWMP	County Solid Waste Management Plan
EIS	Environmental Impact Statement
EPA	(United States) Environmental Protection Agency
ESP	Electrostatic Precipitator
GO bond	General Obligation Bond
HDPE	High Density Polyethylene
HHW	Household Hazardous Waste
HSWA	Hazardous and Solid Waste Amendments
IRB	Industrial Revenue Bond
IPC	Intermediate Processing Center
LDPE	Low-Density Polyethylene
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
MWC	Municipal Waste Combustor
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIMBY	Not In My Back Yard
NSPS	New Source Performance Standards
NSWMA	National Solid Wastes Management Association
ONP	Old Newspaper
PCB	Polychlorinated Biphenyl
PCRB	Pollution Control Revenue Bond
PET	Polyethylene Terephthalate
PP	Polypropylene
PSD	Prevention of Significant Deterioration
PVC	Polyvinyl Chloride
RAN	Revenue Anticipation Note
RCRA	Resource Conservation and Recovery Act
RDF	Refused-Derived Fuels
SQG	Small Quantity Generator
SWDA	Solid Waste Disposal Act
TAN	Tax Anticipation Note
VOC	Volatile Organic Compound

* U.S. G.P.O.:1991-524-858:40575