PART III. EVALUATION OF WASTE-MANAGEMENT ALTERNATIVES.

CHAPTER 7. WASTE PREVENTION ALTERNATIVES.

7.1 Reducing the Generation of Municipal Solid Waste.

"Waste prevention" describes activities that reduce the toxicity or quantity of products and materials requiring management through the solid-waste system. By contrast, recycling is a way to use existing waste once it has already been generated. Waste prevention conserves resources that would otherwise be consumed through waste-management activities or through production of new goods and materials.

Waste prevention strategies fall into three broad sets of activities: reduction, re-use, and diversion from the waste-management system.

Reduction of waste includes production and consumption of fewer products, products using lighter or less voluminous materials ("lightweighting"), and products that last longer because of greater durability or repairability. All categories of waste can be reduced: packages can be made with fewer layers or materials, durable goods can be made to last longer or to be more easily repaired, yard wastes can be produced in smaller quantities through strategies such as careful landscaping, efforts can be made to reduce the amount of toxic metals in sludge, hospital linens can be made out of cloth instead of paper or plastic.

Re-use involves continued use of a material or product for substantially the same purpose. A refillable glass bottle is an example of a re-usable object. Re-use also involves the re-conditioning and repair of durable goods such as appliances for resale.

Finally, some practices that divert goods and materials from the solid-waste-management system also prevent waste even though they may not change production or consumption patterns. Backyard composting of food and yard waste is a form of waste prevention because the wastes never enter the collection and disposal system. The New York State Beverage Container Deposit system removes beer and soda containers from the solid-waste collection and processing system (although these materials are collected and processed by a privately operated collection and processing system).

The goal of these waste-prevention strategies is to create a net reduction in waste. Strategies for waste prevention must be examined closely to ensure that they are not merely creating shifts from one material to another with no net benefit to the environment, or that prevention processes are not worse than the production and management of the material they were designed to replace.

New York State has adopted a solid-waste-management hierarchy which ranks waste prevention above recycling, combustion, and landfilling. The State solid-waste-management policy requires each locality in the state to take every reasonable step to reduce its waste by 8-10% through waste reduction ~~prevention~~ activities by 1997~~8~~.

Even though waste prevention has achieved this priority in solid-waste policy not only in New York, but nationally, in EPA policy and in most states throughout the country, measures to actually reduce waste have not been undertaken on a large scale. A major reason for this is that waste prevention necessarily occurs prior to the waste-management system -- in the design, production and use of goods and materials. It is not necessarily a task that can be achieved by those assigned to manage municipal solid waste. Because changing waste-generating behavior involves changing basic production and consumption patterns in New York City, the U.S., and internationally, the task of preventing waste involves not only those who have traditionally been responsible for waste management, but also industrial planners, product designers, trade officials, marketers and investment managers.

Because waste prevention goes well beyond the bounds of conventional waste management, this chapter, unlike other chapters that deal only with waste-management issues, also focuses on fundamental structural changes needed, throughout City government and in the private sector, to make waste prevention work.

7.1.1 Barriers to Waste Prevention

In order to make prevention work, several kinds of perceived barriers to waste prevention need to be overcome. These include the following:

The United States is oriented toward growth and convenience -- the notion that reduction is inconsistent with a consumption-oriented economy, in which, in order to survive, firms must grow and expand or lose the competition with those that do, and where disposability and convenience are seen as spurring economic growth.

Packaging serves many purposes -- what may be perceived as excess or non-recyclable packaging meets other purposes such as health and safety (e.g. single-use disposable syringes, or tamper-proof drug packaging) or theft prevention (e.g. oversized packages for audio cassettes or compact disks).

Interference with interstate commerce is constitutionally limited -- restrictions on products and packaging in one state or city may provoke trade-policy disputes, and conflict with legal protections for interstate commerce. City- or county-level initiatives can also generate local and regional trade conflict.

Many environmental considerations must be weighed simultaneously -- when products are examined and considered for reduction, there is no assurance that substitutes are less wasteful, less polluting, or less resource-intensive.

Consumer choice is paramount -- the notion that freedom to market and consume are highly prized prerogatives in the U.S. and that actions by manufacturers to make a product or package more appealing are part of the consumer-choice process.

7.1.2 Policy Options to Overcome Barriers to Waste Prevention

Policy measures to counter these barriers to waste prevention fall into four broad categories:

Educational/outreach -- Targeted public education and outreach have been shown to be a potent weapon in many public-policy arenas, such as the prevention of smoking. Environmental consciousness has significantly increased in the past several years and has consumers asking "what can *I* do?" Opportunities for waste prevention can be advanced through appropriately targeted education and public outreach. The City has already embarked on such a campaign with its recent publication of the *Waste Reduction Handbook* (See Appendix 1 in "Waste Prevention for New York City, Analysis and Strategy", Appendix Volume 4.1) and its subway poster campaign for recycling and waste reduction.

Institutional/administrative -- Within a given organizational structure, actions can be taken to prevent waste by establishing internal administrative procedures, sponsoring programs, or creating opportunities for volunteerism.

Legislative/regulatory -- Laws and rules at the local, state, and federal levels influence public policy toward waste prevention in a range of ways, from creating programs, to mandating prevention levels for certain categories of waste (such as packaging), to establishing fiscal policies to encourage prevention by making producers or consumers pay for the disposal and/or environmental costs of making the material, to outright product bans.

Technological innovation -- Obstacles to waste prevention may be overcome by technology improvements that can provide a new type of packaging or material, a new way to convey a good or service that eliminates material transactions (e.g., by computer), or a restructuring of traditional activities.

Entrepreneurial/business enterprise -- By offering goods or services that also advance the goals of waste prevention, businesses can pursue market opportunities that coincide with waste-prevention objectives.

7.1.3 Objectives of the New York City Waste-Prevention Program

The objectives described below are discussed more fully in "Waste Prevention in New York City," in Appendix Volume 4.1. Recommendations for how each of these objectives might be achieved are included in the sections on each waste stream.

1. Make residential and institutional waste generators pay for waste services proportionately and fairly.

Waste collection and disposal is a service delivered by the NYC Sanitation Department to the residential and not-for-profit insitutional sectors. It is supported by the tax dollars paid into New York City's general fund by residents and commercial businesses. There are no specific charges assessed to those who receive this service; consequently, there is no specific financial incentive at the individual residence or institutional level to reduce the amount of solid waste produced. There are now several hundred quantity-based-user-fee (QBUF) systems operating throughout the United States, which have produced waste reduction rates of 18 to 29 percent.

2. Identify and allocate fairly savings from avoided collection and disposal in the commercial sector between generator and hauler.

The financial incentives that prompt businesses to pursue waste prevention fall into two categories: savings on the purchase and use of materials ("front-end" savings) and reductions in the cost of trash collection and disposal ("back-end" savings). Allocating these "back-end" cost savings in a way that gives both the commercial generator and the commercial hauler a financial incentive for waste to be reduced will help to make waste prevention a successful and enduring practice within the commercial sector. Waste audits (see below) may be one way to establish the level of reduction that has been achieved. Cost savings to the waste hauler (after the fixed costs of making the "stop" -- those which are not reduced by picking up less waste -- have been accounted for) which are due, for example, to reduced "tipping" fees, could then be apportioned in a way that appropriately distributes the financial incentives. Obviously such a system, while logical in theory, may be difficult to implement.

3. Have manufacturers incorporate waste prevention in their design and production decisions.

Manufacturers can assist in preventing waste by:

- o using packages that minimize the weight, volume or toxicity of discards;
- o using packages that are re-usable rather than disposable;
- o making goods that are more durable and repairable;
- o making goods with longer product lives; and
- o making goods or providing services that minimize or make unnecessary the use of materials.

4. Integrate waste prevention into management decisionmaking at all levels and in all sectors.

Purchasing decisions and practices, especially those that substitute re-usable goods for disposable products, can prevent waste. To ensure that waste-prevention practices are integrated into the day-to-day operations of workplaces in all commercial, instititutional, and industrial sectors, the professionals responsible for the management of facilities must be given the motivation and opportunity to pursue waste prevention. This can best be achieved by making those professionals accountable for waste-collection and -disposal costs. By including waste prevention in appropriate job descriptions and performance evaluations, waste prevention can be made part of ongoing work activities.

5. Ensure that waste prevention induces beneficial substitution.

Reducing the use of a particular material or item is likely to encourage the use of a substitute resource. That resource is typically another material, as when a durable material is used in place of a disposable one, but the resource can also be water, air, energy or time. The willingness of the waste generator to invest in the use of that substitute is a function of the cost of the substitute, of the legal and economic pressure to reduce generation of the waste in question, and of the likelihood that the generator will have the opportunity to recoup any investments in waste prevention. Substitution can be beneficial or can bring about increased rather than decreased solid-waste-management or environmental burdens. Clearly, the City's aim is to promote beneficial impacts and to minimize the potentially adverse effects of waste-prevention policies.

6. <u>Alter marketing and distribution patterns in favor of waste prevention.</u>

The distribution and marketing of products and packaging present constraints and opportunities for waste prevention that are related to, but distinct from, those that face the design and manufacture of goods and materials. Existing shipping and retail practices, as well as new systems that might be set up specifically to foster waste prevention, can play a key role in determining the success of waste-prevention efforts.

7. <u>Integrate waste prevention with waste-collection, -processing and -disposal practices.</u>

The goal of waste prevention is to minimize the *overall* environmental and economic costs of the solid-waste-management system. It may be preferable to target items for prevention that cannot be recycled easily, rather than to focus on items that can be managed readily further down the chain.

The following recommendations are proposed as the framework for developing a detailed waste-prevention program for New York City. Some recommendations will apply only to City-collected waste, some will apply only to privately collected waste, and many will apply to both. For each recommendation, the policy tool that could be used to implement it, the barrier it is designed to overcome, and the waste-prevention objective that it is meant to achieve are described.

7.1.4 Waste-Prevention Programs/Policies.

Three categories of recommended programs and/or policies are in this section. The first four programs address structural barriers. Because these barriers are part of the City's institutional fabric, these programs or policies will require long-term action if they are to be successful. The next six are immediate, short-term programs that will address targeted waste-stream components. Although their potential impacts are not likely to be as significant as those of the structural proposals, they have the advantage that their implementation can reduce the cost and environmental impacts of municipal solid-waste collection and disposal in the near-term. The final program describes the research that is required in order to develop techniques to measure the impact of waste-prevention programs on the waste stream, to document the relevant costs and savings, and to assess the impact of such programs on the economy of New York, so that more informed waste-prevention policy can be formulated.

7.1.4.1 Programs for Attacking Structural Barriers.

Establish Charges for Waste Services Based on the Amount of Waste Generated.

The City could increase the financial incentives for waste prevention by making waste generators in the residential, institutional and commercial sectors pay for waste collection and disposal according to the quantity of trash they discard. Goals for the program should include:

1. Developing rate structures that offer significant rewards to low-volume generators;
2. Refining cost-accounting structures so that costs can be appropriately allocated to relevant generators; and
3. Devising systems that are fair and explainable to constituents.

Phase 1 -- Institutional Sector. Develop and implement a charge system for municipal and non-municipal institutional customers based on the above goals.

Phase 2 -- Commercial Sector. Revise the existing commercial rate-structures established through the Department of Consumer Affairs to make private carting fees more volume-sensitive and to disaggregate collection and disposal costs. Assign collection-cost savings to the hauler and disposal cost savings to the generator. The Department will continue to support and work with the Department of Consumer Affairs in establishing licensing districts, which will enhance the City's ability to ensure that commercial fees are more volume-sensitive.

Phase 3 -- Residential Sector. Study the feasibility of establishing quantity-based user fees in low-density residential areas and in a multi-tenant area using a system in which users are charged for waste services through the purchase of specially marked refuse bags or on tags that would be affixed to bags. Include in the feasibility analysis means by which these quantity-based fees can be field-tested to gather data on how waste quantities and composition are affected, and on the administrative feasibility of user fees. The feasibility study should also include means for determining whether any residential waste that was collected under the "free" system is "diverted" under the user-fee system through illegal dumping in vacant lots and other such locations.

Develop Administrative Procedures to Integrate Waste Prevention Into Management Decision-Making.

Within the City government, revise administrative directives and budget procedures so that frontline management personnel take on responsibility for the overall cost of solid-waste management. The budget system would include objectives for waste prevention, and expenditure lines for waste services, to reflect the plan for meeting those objectives.

Monitor New Information About the Impacts of Consumer Materials.

Monitor information on which waste components are least harmful to health and the environment so that beneficial materials that lead to net waste reductions can be promoted in lieu of those found to have deleterious effects.

Support State and Federal Taxes to Encourage Waste Prevention.

State and federal taxes could stimulate waste prevention without driving commerce out of the city.

Examine Expansion of Deposit Legislation.

Expand containers covered by the New York State Returnable Container Law to include juice, wine, bottled water and liquor containers.

7.1.4.2 Programmatic Opportunities.

Legislate Waste-Audit Requirements.

A key component of efforts to reduce commercial waste is providing financial incentives for commercial waste generators. This will require that they receive rate reductions that are tied to waste reductions. "Benchmark" waste audits may be the most effective way to establish the level of prevention that is being achieved.

The audit program could be voluntary or mandatory. One way of setting up this program would be to require waste audits to be performed in all businesses that have more than a specified minimum number of employees. Implementation of this program could be organized through relevant trade associations and business groups. The waste plan audit could:

1. Provide time for the trade associations and groups to develop guidelines for how waste prevention could be accomplished in each business sub-sector. It would be expected that some companies could reduce waste generation well in excess of the 10-percent goal.

2. Require waste audits that meet the guidelines for business sub-sectors to be completed by a specified time.

3. Require the trade associations and groups to report on implementation of the strategies generated by the waste audits and the level of reduction being achieved by the affiliated companies at least annually.

This approach to waste auditing could build on the New York City Partnership for Waste Prevention's activities (see Chapter 3). This program could also be linked to the NYC Department of Consumer Affairs' rate-regulation activities, so that businesses could be assured that reductions in waste generation would result in reduced collection and disposal costs.

Fund a Non-Profit Waste Exchange for Shipping Waste and Non-Hazardous Material.

While the concept of a waste exchange is not new, and New York City is served by the non-profit Northeast Waste Exchange in Syracuse, the listings in this service do not focus on local needs within New York City or on low-value items such as packaging materials. Within the City, the value of re-using many inexpensive materials is primarily the avoided cost of collection and disposal. A City-based exchange, initially supported by DOS funding, could serve as broker for a myriad of materials and eventually become a self-sustaining program by charging sufficient transaction fees. (A parallel exchange might serve City agencies, to facilitate the use of "surplus" City equipment and supplies.) City support of such a service should be limited to the value of the avoided cost of collection and disposal.

Support Efforts to Promote Voluntary Efforts to Reduce Packaging.

Efforts such as that of the Coalition of Northeastern Governors, which has issued "preferred packaging guidelines" for corporate packaging producers and users, could be encouraged.

Modify City Procurement Guidelines to Stipulate the Purchase of Re-usable Products and to Minimize Packaging.

The City could revise purchasing policies to support the substitution of durable and re-usable goods in place of semi-durable and disposable goods and the substitution of non-toxic and less-toxic products for their more toxic counterparts.

The City could also develop a program under which vendors selling products to the City would be required to minimize packaging waste associated with their products and to retain possession of shipping waste.

Develop Programs For "Junk Mail."

The City could investigate restructured postal rates and related legislative remedies that would reduce junk mail volumes, and facilitate efforts by the public and by City employees to remove their names from mailing lists. Specifically, the City should monitor whether direct mailers voluntarily implement measures to facilitate removing names from a mailing list. If voluntary efforts prove insufficient, the City should consider local legislation requiring all direct mailers to provide a toll-free number or some other means for requesting to be removed from a mailing list.

Increase Support for Re-Use Centers.

The drop-off and buy-back centers recommended in this plan could be developed into re-use centers, or existing re-use centers such as Salvation Army and Good Will could be hired to pick up re-usable goods delivered to the buy-back or drop-off centers.

Develop "Leave-it-on-the-Lawn" and Backyard Composting Programs.

The Sanitation Commissioner could promulgate regulations forbidding the collection of grass clippings by municipal forces. The Department could also encourage backyard composting in low-density areas.

Monitor the Progress of "Leave-the-Packaging-Behind" Initiatives.

German efforts to expand the responsibility for the disposal of packaging materials to retailers and manufacturers may cause substantial packaging reductions; monitoring the progress of this and related U.S. initiatives would help to determine the applicability of a similar program for New York City.

7.1.4.3 Research Programs.

Develop a Plan for Quantification and Impact Measurement.

A plan for measuring the impacts of waste-prevention strategies as they are implemented, and for tracking costs and savings, would allow the City to improve the effectiveness of its programs. Developing and implementing such a plan will be crucial to the success of waste-prevention efforts.

7.1.5 Waste Stream Impacts.

The impacts of waste-prevention options have been estimated from the categories used in the Sanitation Department's 1990 waste-composition study. A difficulty with using this study for this purpose is that the categories are material-based, rather than product- or use-based, which would make the estimation of potential prevention impacts more precise.[1] For example, an understanding of the occurrence of semi-durable products in the waste-stream is important for an analysis of waste-prevention opportunities because it is this category of disposable goods (disposable diapers, for instance) that could be replaced by re-usable products. The potential *material-specific* impacts of each of the recommended waste-prevention programs and/or policies described in section 7.1.1 are presented in Table 7.1.5-1.

Table 7.1.5-1: Potential for Waste Prevention (Year 2000)

	Total Tonnage (000s)	Tons Reduced (000s) Resid'l Sector	Inst'l Sector	Comm'l Sector	% Reduction of: Waste Material	Waste Stream
Paper	3700	100	79	304	13%	6%
Plastics	710	(6)	(5)	(15)	(4%)	(.3%)
Organics	2700	85	13	36	5%	2%
Glass	320	21	2	4	9%	.3%
Aluminum	70	.1	.1	.6	1%	.01%
Other Metal	280	5	.9	4	4%	.1%
Inorganics	80	2	.3	.05	3%	.03%
Hazardous	20	.6	.09	.2	4%	.01%
Bulk	370	39	1	0	11%	.5%
TOTAL TONNAGES	8300	3400	930	3900		
TOTAL PREVENTED	670	250	90	330		
PERCENT PREVENTED	8%	7%	10%	9%		

Based on the recommended programs described above, and the assumptions contained in the waste prevention section of Appendix Volume 4.1, the total prevented waste stream would be nearly 700,000 tons per year in the year 2000. 250,000 tons (about seven percent) are from the residential waste stream, 90,000 (about ten percent) are from the institutional waste stream, and 350,000 (about nine percent) are from the commercial and industrial waste streams, for an overall prevention rate of just over eight percent.

7.2 Programs to Reduce Pollutant Concentrations in Sludge.

There are no feasible sludge-prevention programs. Industrial pre-treatment programs to reduce pollutant levels are already in place or in development. No other types of programs are considered feasible.

7.3 Reducing the Generation of Medical Wastes.

Cost-effective techniques were identified which have the potential for reducing the generation of medical wastes by 12 percent. Some of the 11 techniques that were evaluated involve operational and behavioral changes that could be achieved through planning and public education initiatives; the others involve the substitution of re-usable objects for disposable objects. As noted in the general discussion of medical wastes in Chapter 2 (section 2.4), the distinctions between the two types of medical waste, "regulated" and "non-regulated," are blurry, and depend less on technical definitions than on operational and behavioral practices, which generally involve some degree of inappropriate waste-stream segregation. More to the point, in terms of prevention techniques, is the fact that in many instances it is not the type of object itself, but where and how it is used (i.e., whether the material eventually comes into contact with blood or other infectious agents) that ultimately will determine whether the used object should be treated as regulated or non-regulated. Accordingly, prevention techniques for both types of medical waste are treated together. Each of these 11 options is discussed below, and in greater detail in Appendix Volume 8. (Note that the cost numbers reflecting net savings for the programs described below must be understood in the context of the total cost of purchasing and using disposable materials; this context is provided in Appendix Volume 8.)

A separate consideration, not included in the specific techniques listed below, is improving the segregation of regulated and non-regulated medical wastes. Since New York City regulated waste in 1990 cost an average of 43 cents a pound to dispose of, versus 28 cents a pound for non-regulated waste,[2] every pound of non-regulated waste that is improperly entrained with regulated waste costs an additional 15 cents to dispose of. Efforts to reduce the amount of wastes handled as regulated wastes (simply by keeping non-regulated wastes out of red-bag containers) have been the primary focus thus far of "waste reduction" efforts by New York City hospitals -- and have succeeded in some cases in reducing the regulated waste stream by up to 50 percent.

In general, the measures outlined below would require additional labor (much of it relatively unskilled), additional transportation, and additional energy and water use. For purposes of this analysis, it was assumed that replacing certain throw-away linens with re-usable ones would entail laundering in off-site commercial laundries, which use re-circulated water. When re-circulated water is used for children's diapers, the life-cycle water demand is almost five times higher than for the use of disposable diapers; if typical once-through on-site laundries were used, hot water requirements would be many times greater. On the other hand, to the extent that any of these programs result in less waste entering the regulated stream (which requires incineration and/or autoclaving prior to landfilling), there are reductions in air emissions. To the extent that non-regulated wastes are incinerated or autoclaved, there would be corresponding reductions in air emissions there as well. Most particularly, reductions in the amount of i.v. bags and tubing incinerated would directly affect the amount of chlorine in exhaust gases. Reducing the number of plastic bags used would contribute to lower cadmium emissions.

- Improved Control on the Discard of Unused Products.

Data from a number of sources, including the waste-composition study performed for this plan at HHC hospitals, suggest that unused products (which have never been opened) are discarded at significant rates in hospitals. The reasons for this include the fact that hospital staff often store significant amounts of material in patient rooms, hoard supplies, or use improper ordering methods. Another reason is that inefficient purchasing procedures result in over-ordering of perishable products that become outdated and therefore must be discarded. Reducing the rate at which these materials are discarded involves developing improved monitoring of supply usage to ensure that supplies are always available (which should reduce hoarding) and to minimize improper discards. This would require additional staff time, but these costs would be more than offset by the savings produced. If there were a 10 percent reduction in the amount of unused products discarded in a 1,000-bed hospital, there would be a net annual savings on the order of $100,000.

- Instituting Departmental Accountability for Waste-Generation Costs.

Just as fully-loaded accounting systems have been used in local hospitals to cut utility costs for telephone and electrical services through sampling and monitoring programs, waste costs can also be assigned to the department that generates the waste. Such programs could reduce waste generation by up to 20 percent, with modest staff costs that would be offset easily even at a one-percent-reduction level, while producing overall savings of nearly $500,000 annually at a 20 percent level.

- Product-Purchasing Evaluation Criteria.

If an assessment of the cost of disposal were part of the purchasing decision, the significant, but currently unrecognized costs of waste disposal might change purchasing decisions in a way that would reduce waste generation by reducing the number of single-use products purchased. Paper towels are an example: if the costs for additional labor and disposal fees were factored in, the per-case cost of paper towels would rise by $5 -- a figure that puts the offsetting savings that would be achieved by electric hand-dryers (which are treated below as a separate option) in clearer perspective. Again, for modest incremental staff costs, significant savings could be expected.

- Replacing Paper Towels with Air Dryers.

Replacing paper towels in public rest rooms and staff locker rooms with automatic-eye electric dryers would reduce a 1,000-bed hospital's waste by one hundred tons a year, for a net savings of $45,000.

- Replacing Disposal Utensils Used for Food Services.

Almost half of the material disposed by food services (or about five percent of the waste generated by a typical NYC hospital) is disposable utensils, dishes, and trays. Replacing these with re-usable items would require the use of additional space for dishwashing equipment, as well as the capital and operating costs for using this equipment and for purchasing re-usable dinnerware. It would also require additional staff, water and energy use, and the discharge of detergent chemicals, but would reduce a 1,000-bed hospital's wastes by almost 200 tons a year, at a net savings (including the avoided cost of purchasing disposable materials) of almost $500,000.

- Reducing the Use of Plastic Bags in Administrative Areas.

Replacing the plastic waste-basket liners used for office waste with sturdy plastic waste baskets would prevent close to seven tons of waste a year in a 1,000-bed hospital, at an overall savings of about $20,000.

- Replacing Disposable Linens with Re-usable Linens.

About a third of the disposable linens currently used, those which are not directly related to patient-care and infection-control issues (certain gowns, scrub clothes, and diapers), may be relatively easy to replace with re-usable linens. Since it may not be feasible at any given hospital to establish an on-site laundry, use of an off-site laundry service was assumed for purposes of this analysis. This measure could, at a 1,000-bed hospital, reduce waste volumes by 150 tons a year (half regulated medical waste, half unregulated), at a savings of about $200,000.

- Replacing Disposable Admission Kits and Components with Re-Usable Items.

Switching to re-usable "admission kit" items (such as water pitchers, glasses, and bed pans) would require the development of collection, transportation, disinfection, and storage systems within the hospital's central sterile supply areas. This would entail the use of more labor, more energy, and more disinfectants, but would prevent over 20 tons of waste at a 1,000-bed hospital a year, at a savings of $150,000.

o Use of Re-Usable Sharps Containers.

Instead of using throw-away containers for sharp instruments, using re-usable containers mounted on wall brackets would reduce the amount of regulated medical waste in a 1,000-bed hospital by 17 tons a year, at a net cost of $18,000, if done by an outside service, or at a net savings, if done by an in-house service, of $175,000.

7.4 Reducing the Generation of Harbor Debris.

The Department of Environmental Protection's plans to develop storage systems to prevent the untreated release of combined-sewer overflows is probably the single-most effective measure that can be taken to reduce the amount of harbor debris that will be generated in the long-term future. Near-term programs that would reduce the amount of floatable materials that enter the waterways through the sewer system would include improved street-sweeping by the Department of Sanitation, more public education about and more stringent enforcement of anti-littering laws, decreasing the use of toilets as a disposal method for certain items that should be discarded in the trash, and reducing certain components of the waste stream, such as plastic straws, wrappers, styrofoam cups, and certain other containers.

The Corps of Engineers' ongoing program to remove decrepit pier structures, which will have an even more dramatic effect in reducing the overall amount of material that enters the rivers and harbor surrounding New York City, will reduce the generation of harbor debris from 31,000 tons a year to 6,000 tons by 2010. A program to use "plastic lumber" -- a material made from recycled plastic, which is more durable than wood -- for the construction of future pier structures would reduce the long-term generation of pier-maintenance material in the future (as well as helping to develop markets for recycled plastics.)

The Sanitation Department's recent improvements in its marine transfer system (such as the introduction of netting to cover barges, improved cranes, and the use of skimmer boats and booms) have reduced the amount of waste that enters the rivers and harbor; a covered unloading facility at Fresh Kills -- a project that is under consideration -- could reduce this source of litter even further. Beyond that, reducing the amount of raw waste transported by barge for landfilling at Fresh Kills, as the implementation of any of the non-landfill measures in this plan would do, would further reduce the potential for waste to enter waterways due to the Sanitation Department's activities. Restricting the future use of the marine system, or completely eliminating it, might reduce this potential even further, but at the cost of increased truck miles traveled. Given the relative environmental and cost effects of highway versus barge transport, reducing barge transport in order to further reduce a source of waste that, even under present conditions is estimated to be less than one-and-a-half tons a year, would not be not an environmentally desirable option.

7.5 Environmental and Cost Impacts of Prevention Options.

Specific environmental impacts and costs of the proposed prevention programs are identified in Chapter 17. Another way of looking at these impacts is to attempt to assign an economic value to particular pollutant emissions, so that the overall "externality costs" that are avoided by not disposing of solid waste can be considered. This approach requires that the cumulative costs created by particular types of pollutants in particular environmental media be summed. At the present time, this is a far-from-exact science. Nonetheless, there may be some heuristic value in such an analysis, even with admittedly-imperfect input data, if only because it may offer a way of putting the relative impacts of particular pollutants (and, by extension, the choices inherent in solid-waste management system decisions) in a larger perspective. The pollutant "costs" in the table below were developed by the Tellus Institute as part of a broader study of packaging issues. They are used to illustrate the magnitude of avoided externality costs that might be associated with a New York City waste-prevention program. The conclusion provided by this table is that a six percent reduction in the waste stream would produce pollutant reductions worth three percent.[3] These direct disposal-reduction impacts, however, are dwarfed by the avoided costs of not producing products in the first place, which are generally an order-of-magnitude higher.[4]

Table 7.6-1: Summary of Prevention Program Impact on Facility Group Pollutant Costs*

Facility Group Pollutant Costs WITHOUT Prevention	Waste TPY (000s)	Mercury ($000s)	Nitrogen Oxides ($000s)	Sulphur Dioxide ($000s)	Lead ($000s)	Volatile Org Compounds ($000s)	All Others ($000s)	Total ($000s)
System A (HQ/R)								
Recycling	2,400	$10	$12	$0	$12	$44	$240	$320
Compost	580	$0	$22	$0	$0	$310	$270	$600
Transfer	3,300	$14	$14	$0	$28	$66	$220	$350
WTE	3,900	$130,000	$28,000	$12,000	$10,000	$11,000	$35,000	$230,000
Landfill	810	$0	$51	$0	$4	$48	$4,700	$4,800
Ashfill	630	$210	$8	$0	$0	$0	$8	$220
TOTAL SYSTEM A	**11,600**	**$130,000**	**$28,000**	**$12,000**	**$10,000**	**$11,000**	**$36,000**	**$235,000**
System B (HQ/O/R)								
Recycling	2,400	$10	$12	$0	$12	$44	$240	$320
Compost	1,200	$0	$34	$0	$0	$660	$490	$1,200
Transfer	3,600	$15	$15	$0	$31	$72	$240	$380
WTE	3,500	$130,000	$26,000	$11,000	$9,000	$11,000	$30,000	$220,000
Landfill	650	$0	$41	$0	$3	$39	$3,800	$3,800
Ashfill	610	$200	$8	$0	$0	$0	$8	$210
TOTAL SYSTEM B	**11,900**	**$130,000**	**$26,000**	**$11,000**	**$9,000**	**$12,000**	**$35,000**	**$225,000**
Cost/lb of Pollutant		$7,467	$4	$6	$1,600	$3		

Facility Group Pollutant Costs PREVENTED	Waste TPY (000s)	Mercury ($000s)	Nitrogen Oxides ($000s)	Sulphur Dioxide ($000s)	Lead ($000s)	Volatile Org Compounds ($000s)	All Others ($000s)	Total ($000s)
A: HQ/R:RDF								
Recycling	220	$1	$1	$0	$2	$4	$15	$23
Compost	5	$0	$0	$0	$0	$2	$2	$4
Transfer	140	$1	$1	$0	$1	$3	$10	$15
WTE	240	$200	$1,300	$1,200	$490	$81	$2,500	$5,800
Landfill	140	$0	$9	$0	$1	$0	$29	$39
TOTAL SYSTEM A	**750**	**$200**	**$1,300**	**$1,200**	**$500**	**$91**	**$2,600**	**$5,800**
B: HQ/O/R:RDF								
Recycling	200	$1	$1	$0	$2	$4	$15	$23
Compost	7	$0	$0	$0	$0	$4	$3	$6
Transfer	140	$1	$1	$0	$1	$3	$10	$15
WTE	240	$200	$1,300	$1,200	$490	$81	$2,500	$5,700
Landfill	145	$0	$9	$0	$1	$0	$29	$39
TOTAL SYSTEM B	**760**	**$31,000**	**$1,300**	**$1,200**	**$500**	**$92**	**$2,600**	**$5,800**

Prevented Costs as % of Total Costs	Prevented TPY/Total	Total Cost ($000s)
TOTAL SYSTEM A	6%	3%
TOTAL SYSTEM B	6%	3%

*Due to rounding, numbers may not appear to sum.

Endnotes

1. Examples of useful prevention-based categories would include:
   - packaging and containers, with subcategories such as cardboard boxes, glass bottles, or plastic film wrap;
   - semi-durables (goods with product lives of three years or less), with subcategories such as toys, clothing, small household furnishinings, etc.;
   - durables (goods with product lives of more than three years), with subcategories such as furniture, televisions, stoves, refrigerators, etc.; and
   - organic wastes, with subcategories such as food, food-contaminated mixed paper, leaves, brush, grass, etc.

   These categories were suggested by Marjorie Clarke, "Categories for NYC DOS Waste Compostion Sort for Source Reduction," 1990.

2. Appendix Volume 8, "The New York City Medical-Waste-Management Plan, Appendix A, p.33.

3. The percentage of pollutants reduced is not proportional to the percentage of tons reduced due to the allocation of the prevented tons among different types of facilities that have different per-ton emission factors.

4. Tellus Institute, "Impacts of Production and Disposal of Packaging Materials: Methods and Case Studies," prepared for the Council of State Governments, November, 1991.

CHAPTER 8. ALTERNATIVE RECYCLING OPTIONS.

8.1 Decision Factors in Developing a Recycling Program for Municipal Solid Wastes.

There is a certain logic in beginning an evaluation of alternative recycling program options with a discussion of markets, because market assumptions affect program decisions at every level of recycling-system design, and because the validity of these assumptions will have an important effect on the system's overall cost. This is not to say that an analysis of existing markets should drive decisions in the design of recycling programs, but simply that an understanding of the dynamics of ends (recyclables' "end-uses") may best inform the design of means.

There are two paradigms to explain the relationship between potentially available supplies of recyclable materials and market demand for them. In one paradigm, markets are seen as the primary constraint on recycling programs, since the collection of materials that cannot be sold to be manufactured into new products may end up in landfills or incinerators anyway (as has happened here in decades past, and more recently elsewhere). This is no doubt the most commonly accepted view, at least among governmental officials throughout the country. At a recent meeting of the U.S. Conference of Mayors, for example, the co-chairman of the Solid Waste Disposal Task Force, Sharpe James, of Newark, NJ, said "The consensus among the mayors was simply that recycling will not work unless there is a market and we need help on this..." And according to Sylvia K. Lowrance, director of the U.S EPA's Office of Solid Waste, the lack of markets for recycled goods is the most pressing problem facing solid-waste-management today.[1]

In the other paradigm, these priorities are up-ended. Instead of according "demand" legitimacy as the proper agent for determining the amount of recyclable materials that should be collected (to become "supply"), supply is seen as the factor that will eventually create demand, as industries, technologies, and markets evolve to take advantage of new and less-expensive sources of raw materials. This view is more akin to neoclassical economic theory, and to long-term historical patterns such as the shifts from wood to coal to oil over the past 300 years (or to the recently predicted shift from virgin wood fibers to recycled fibers).[2] The assured long-term availability of reliable material supplies, some economists argue, will be a sufficiently powerful stimulus to the development of sufficient market capacity.

Nestled in the interstices between these competing visions are other factors and considerations that directly affect the assessment of markets for New York City's potentially enormous supply of recyclable materials. Some of these involve the trade-offs between simpler, cheaper collection systems, concomitantly more complex processing systems, and lower-grade specifications for higher volumes of processed recyclable materials. Depending on the costs of alternative collection, processing, and marketing systems, the resultant relatively low-grade specifications for recyclable materials might provide the most advantageous bottom-line for the City, but this analysis is highly dependent on what assumptions are made about the effects of competition for recyclable markets between such "low-spec" New York City recyclables versus "higher-spec" (i.e., less-contaminated, "purer") materials from more-source-segregated suburban and/or commercial recycling programs. Here the scale of New York City's potential pool of recyclable materials may come into play, giving New York City the opportunity to capitalize on "dedicated" end-user markets, such as, for example, a newsprint mill devoted to absorbing only New York City-collected newspapers, which may be more contaminated and of lower grade than newspapers collected in more "pristine" programs.

Another such issue is the different characteristics of manufacturing processes for different types of material, which make certain materials inherently easier to recycle than others. Some recyclable materials, for example, can be used in the same mills that use virgin materials, without the use of any specialized equipment or processing, while other secondary materials require extra processing steps; standard glass and steel mills, for example, can accept either raw materials or secondary glass and steel. New mills, therefore, do not need to be built to absorb secondary materials; instead, secondary materials can directly displace virgin materials as feed stock in existing mills. Special de-inking capacity needs to be built, on the other hand, in order for newsprint mills to absorb recycled newspaper, so one type of mill handles virgin fibers, while another can handle a combination of new and old. Glass and steel are also capable of being recycled repeatedly, using various proportions of virgin and secondary materials, without diminishing the quality of the finished goods; newsprint fibers, on the other hand, become shorter and shorter as they are re-used, so that new newsprint can only contain a fixed proportion of secondary fibers. However, depending on the different material specifications for various end-products, lower-grade uses may be available for the same recycled material.

Another issue is the importance of positive cash-flows for the sale of recyclable materials. Given the magnitude of New York City's collection costs vis-a-vis those in smaller cities, the magnitude of the City's waste-disposal-capacity needs, and the magnitude of the pool of recyclable materials, the receipt of revenues for the sale of secondary materials may be relatively less important to the overall economics of the system. Displaced disposal costs (for landfilling and/or incinerator capacity and operations) and reduced collection and processing costs may make a product like "glassphalt" (which uses mixed colors of glass in asphalt for street-paving), even if the revenue derived from the sale of the material is neglible or negative, a net gain for the City. Compost "markets" may be liberally defined as well to encompass low- or non-paying uses such as landfill cover and forest flooring.

New York City's potential strengths in competing for developing markets are: the volume of materials that can be used to develop dedicated end-user markets; the possibility of using long-term, large-volume contracts; the fact that City streets can absorb a large volume of mixed-color glass as glassphalt, and that there are other large-volume low-grade local uses (such as landfill cover and compost markets) that could absorb significant volumes. The potential problems are that large volumes of materials for sale can be a liability as well as a potential benefit, and that material-quality control may be more difficult to achieve, given New York City's generation, collection, and processing logistics, than they are in smaller, less-densely populated areas.

A detailed discussion of general market factors is presented in Appendix Volume 3 and market surveys for specific materials are described in section 8.4.

8.1.1 Alternative Recycling Programs for Materials Collected from Non-Commercial Waste Generators.

8.1.1.1 Decision Factors in Developing Residential Recycling Programs.

The first step in designing a residential recycling program is to decide what materials should be targeted for recovery. This decision hinges largely on the interrelationship between the quantities of various recyclable components in the waste stream and the potential "value" of those materials in the secondary-materials marketplace. Between those two ends of the recycling spectrum lie decisions about how best to segregate and collect the targeted materials, which in turn drive decisions about the appropriate intermediate processing steps that are required to prepare the materials for their respective end-users.

Most residential recycling programs in this country involve varying degrees of source separation: waste generators are required to sort certain designated materials in their households and to place them out for collection separated from other waste. Source-separation programs are intended to preserve the value of recyclable materials by minimizing their "contamination" by other wastes. Although they may require the use of dedicated trucks and thus additional collection costs, source-separated recyclables can be readily and cost-effectively prepared for market at intermediate processing centers, and generally yield high-grade materials and proportionately high revenues.

Another alternative, though not yet widely tested with residential waste, is to mechanically and manually separate recyclable materials from mixed waste. In the absence of much empirical data, such "post-collection" recycling raises questions about the relative amounts of marketable materials that can be recovered, the costs of processing, and the grades and market-acceptability of the processed materials. Though mixed-waste processing would allow savings on collection costs, these may be offset by higher processing costs, lower recovery rates, and less revenue for lower grades of materials. Post-collection recycling is widely used in the commercial sector in New York City, but that waste stream is generally more homogeneous than residential waste.

A variation on these two extremes is a system that involves source separation of "wet" wastes from "dry" wastes, with post-collection processing to recover recyclables from the mixed dry materials. While material contamination problems may be reduced by this approach, the recyclables-recovery potential of this type of system is basically unproven. It is likely, however, that there would be a greater potential for inadvertent material contamination with a wet/dry system than with a conventional source-separation system: in a conventional program the generator is instructed to keep designated materials separate from other refuse, and "mistakes" would be more likely to mean recyclables improperly thrown into the refuse container. With only the choice of depositing wastes in either a "wet" or a "dry" container, however, it might be more likely that wet discards would mistakenly be placed in the "dry" container, which could degrade the quality of these recyclable materials.

In source-separation programs, the number of "separations" in the household is one of the most basic program decisions. It affects the choice of collection systems, the level of required intermediate processing, and the likely rates of public participation and material diversion. High participation rates are a function of citizens' willingness and ability to separate effectively the designated materials. Fewer separations require less effort by the household, are easier to communicate to the public, and demand less space for separate receptacles. Since storage space is severely limited in many New York City households, the fewer separations that are required, the higher the likely degree of compliance would be.

A single separation of all recyclable materials from other waste poses a risk of contamination, particularly of paper (the largest recyclable component of the residential waste stream) by glass, which may break when being loaded into a collection truck. Sorting mixed recyclables at a processing facility is also less efficient than processing source-separated materials. Requiring multiple separations of individual recyclable components in the home, on the other hand, presents participation and collection difficulties. A two-separation system, in which paper (and textiles) is kept separate from other recyclable materials, offers an optimal balance between preserving material quality, maximizing processing efficiency, and ease of public participation.

Until recently, most source-separation programs in this country have used specialized rigid plastic containers (various types and sizes of boxes and/or bins) as the preferred receptacle for curbside set-out of recyclables. They offer the advantages of being reusable and of being readily identifiable by collection workers. When set out at the curb, they also serve as a visible reminder of the recycling collection day.

The City's curbside program was initially designed around the use of blue plastic set-out bins for non-paper recyclables. They were were distributed to each participating household free of charge. Although these containers serve as a useful educational "tool," the experience with them to date has been problematic. The cost to the City of purchasing and distributing the containers is substantial, and theft has been widespread. The requirement that residents bear the cost of replacing lost or damaged containers has engendered some public resentment, as has the necessity of retrieving, cleaning, and storing these containers. In terms of collection-labor efficiency, emptying containers into a truck and replacing them on the curb has been less efficient than tossing bags into a truck would be.

Some source-separation programs, particularly in larger cities, are now beginning to experiment with curbside collection of recyclables in plastic bags. There are a number of advantages to using bags instead of rigid bins: they avoid the problem of container theft, they can protect recyclables (particularly paper) from the elements (and potentially from contamination if co-collected in one truck), they eliminate the need to bundle paper (as now required in New York City's program), they can minimize litter problems, and they can be loaded into collection trucks more efficiently. The marketing of specially designated "recycling bags" also can offer useful educational opportunities. A bag system, on the other hand, requires householders to maintain adequate supplies of the designated type of bag, entails a continuing cost to residents, and imposes an additional processing step to open and remove the bags at the materials-processing facilities. While the plastic bags themselves could be marketed, the current demand for film plastics is weak.

Collection costs represent the single largest expense in a recycling system. The number of collection trucks in the system also affects traffic congestion, air quality, energy consumption, and noise impacts. From a cost and environmental perspective, therefore, the most viable alternatives are those that minimize the number of required collection trucks.

Because of New York City's density and the large volumes of recyclables to be collected at curbside, it is necessary to use large-capacity, compactor trucks for collection. The City's experience during the initial pilot phase of its curbside program demonstrated that the smaller, multi-bin, non-compacting trucks commonly used in suburban recycling programs are not feasible. A study of the feasibility of using trailers hitched to the back of existing collection trucks for recyclables demonstrated the operational and safety problems of this approach in New York City.

The City's current curbside recycling program uses two trucks for separate collection of paper and non-paper recyclables. (A third truck collects all other waste.) Alternatives for reducing this number of collection trucks include: co-collection of all recyclables in one standard compactor truck; co-collection of all recyclables in the same truck with other waste; and co-collection of all recyclables in a single two-compartment compactor truck. In any of these alternatives, using bags rather than bins would limit material contamination.

Since none of these alternative source-separation collection systems has been widely tested, each poses varying degrees of uncertainty and risk. A more promising approach, however, appears to be the use of a two-compartment-truck, which -- if it works -- would assist in preserving the benefits of keeping paper and non-paper recyclables separate. However, only three companies now offer these vehicles in the U.S. Recent demonstration tests by the Sanitation Department of one such vehicle found that the off-the-shelf design failed to fully meet the City's needs. Nevertheless, the concept seems promising, and the Department plans to buy and test 10 redesigned prototype versions (under a contract with an option to buy 20 more) of a two-compartment truck.

An alternative to the curbside system involves collecting recyclables in large, mechanically hoisted containers in the same way regular waste is now collected from some locations in the

City. This system is suitable only for certain types of large multi-family buildings, however, where space is available for storing additional containers for source-separated recyclables.

In addition to these systems, recycling programs elsewhere have relied to varying degrees on two additional mechanisms fordiverting recyclables from the residential waste stream. Buy-back and drop-off centers offer residents another way to recycle by voluntarily bringing materials to these types of facilities. In one case, a cash incentive is offered for materials. Drop-off facilities can range from neighborhood recycling centers, to the type of self-help drop-off locations operated by the Sanitation Department, to the "igloo"-type "bottle banks" widely dispersed on streets and in other public spaces in many European cities.

Although these types of recycling centers are found most often in locations that are not served by curbside collection programs, they offer potential supplementary benefits to a curbside recycling program. Buy-back centers may be most suitable and effective as a means of diverting certain additional materials that are not targeted for curbside collection. Drop-off centers too can be used for collecting specialized materials such as bulky items, batteries and household hazardous wastes. In prominent public locations, such as parks and transportation centers, they also can serve as a convenient way to divert recyclables that do not "originate" at home, such as newspapers and non-deposit beverage containers.

The conceptual ranges of alternatives that have been described in this section, which, together, affect the design of a recycling program, are summarized in Table 8.1.1-1.

8.1.1.2 Alternative Institutional Recycling Programs.

The range of options for designating the materials to be collected, for the degree of separation, and for the collection mechanism, is the same for institutional recycling programs as it is for residential ones. Depending on the type and size of institution, however, there may be different internal waste-management systems that would affect how materials are separated and set out for collection. These site-specific differences also apply to large residential buildings. In both cases, effective compliance with source-separation requirements may be as much a function of the efforts made by custodial and building-management staff as it is of the participation of individual waste-generators in the building.

There also may be institution-specific opportunities to enhance the overall efficiency of a recycling program. Such

Table 8.1.1-1: Conceptual Ranges of Alternatives for Recycling Program Design

		NUMBER OF SORT CATEGORIES (FOR GENERATORS)		
Many	———	———	———	None
>4	4	3	2	1
		MATERIALS DESIGNATION		
Expansive	———	———	———	Restrictive
"Wet/Dry"	———	"High Quality Recyclables"	———	"High-Market-Value Recyclables"
		CONTAINER TYPE		
Rigid/ Dedicated	———	Plastic/ Paper Bags	———	No Separate Container
		NUMBER OF TRUCKS/COLLECTION ROUNDS		
>4	4	3	2	1
		TYPE OF COLLECTION TRUCK		
Non-Compacting	———	———	———	Compacting
Multi Compartments	———	———	———	Single Compartment
Automated Loading	———	Semi-Automated	———	Manual Loading
		TYPE OF COLLECTION SYSTEM		
Curbside	Containerized	———	Buy-back	Drop-off (Staffed or Not Staffed)
		TYPE OF PROCESSING FACILITY		
Materials Recovery Facility to Handle Multiple Segregated Waste Streams	———	Materials Recovery Facility to Handle a Single Co-Mingled Waste Stream	———	Mixed-Waste Recovery Facility for Mixed Refuse

site-specific factors may, for instance, make the use of a baler for corrugated material a cost-effective option at a particular location, or use of designated automated-collection containers for particular types of material (e.g., office paper). Also, depending on differences in the composition and generation of wastes at given institutions, site-specific programs may be feasible for diverting additional materials. The Rikers Island Correctional Facility, for example, is a large generator of household batteries and, therefore, might be a prime candidate location for a special battery-recovery program.

8.1.2 Alternative Recycling Programs for Materials Collected from Commercial Establishments.

In addition to the same alternatives that are available for residential and institutional collections, Local Law 19 provides commercial waste generators with the option of "post-collection separation" for recyclable materials. Post-collection separation may be appropriate for generators who have particular space or operational constraints, for small haulers who have constraints on the number or types of collection routes that they can service, or in any other cases the use of mixed-waste processing techniques at a transfer station or recycling facility proves to be more efficient and cost-effective. It is the Department of Sanitation's position, however, that certain materials, such as high-grade office paper, should be source-separated in order to avoid contamination problems that may affect the marketability of the recovered material.

The New York City Department of Consumer Affairs is preparing legislation to authorize the establishment of exclusive licensing districts for commercial refuse collection. One stated purpose of the legislation is to further the City's recycling goals. The Department of Sanitation is working closely with Consumer Affairs to draft an RFP that will encourage proposers to develop collection systems that will maximize recycling. Possibilities for achieving this include the use of binned trucks, financial incentives to businesses to source-separate materials, and structuring routes to minimize contamination and/or processing costs.

Commercial mixed-waste processing facilities (as well as a variety of mixed-waste processing facilities for residential and institutional wastes) were among the universe of reference facilities evaluated in this planning process. Their design, cost, and environmental characteristics are presented in Appendix Volume 5.

8.2 Alternative Collection Systems.

8.2.1 Collection System Options for Non-Commercial Waste-Generators.

8.2.1.1 Alternative Collection Systems for Residences.

There are a wide range of alternative systems for collecting residential recyclables. Depending on the type of material set-out program and whether the material is in bags, bins, or large stationary containers, different numbers and types of trucks are required, with varying costs and environmental impacts. Local community-based collection programs that involve buy-back and drop-off facilities depend on the public to voluntarily bring materials to the collection location.

Set-out options fall into three basic categories: source-separated recyclables (either sorted or commingled), "wet/dry" separation, and unsorted mixed waste. A variety of different types of collection trucks can be used: single-compartment or multi-compartment, compacting or non-compacting, and fully automated, semi-automated or fully manual. Drop-off recycling facilities can be attended (as are local neigborhood recycling centers staffed by volunteers) or unattended (as in the case of "igloos" or "bottle banks"). A detailed description of these alternatives is contained in Appendix Volume 4.1.

In the most common form of recycling collection system, a dedicated truck collects source-separated materials at curbside. All other waste is collected in a second truck, sometimes on a reduced frequency due to the amounts of material diverted in the recycling collections. Many different types and sizes of trucks are marketed and used for recyclables collection. Non-compacting trucks, often with multiple bins or compartments, have been the vehicle of choice for most suburban curbside recycling programs. Packer trucks are sometimes used for collecting paper only, but are beginning to be used more widely for commingled recyclables as curbside programs are being introduced in larger cities.

In New York City, the use of large-capacity trucks with compacting capability is essential for an efficient citywide recyclables collection system. Although these trucks might tend to create more glass breakage, which complicates glass sorting by color (an essential pre-requisite for marketing used glass), the collection cost-savings far outweigh any added processing costs or lost material revenues. The City also has the benefit of a large, local "market-of-last-resort" for mixed, broken glass -- glassphalt. The City has experienced some difficulties in processing and marketing other commingled non-paper recyclables (glass and plastic containers) that are now collected in its compactor trucks.

For curbside collection of paper and non-paper recyclables, it is common practice to keep the two categories of material separate so as to avoid possible contamination of the paper with broken glass, which can render the material difficult to market. The definitions of "contamination," however, are generally subjective, based on the preferences of individual used-paper recyclers. Nevertheless, the risk and costs of having paper loads rejected by an end-user make the co-collection of paper and non-paper recyclables an option that can be approached only with considerable caution.

The City has conducted a limited experiment to determine the potential marketability of used paper co-collected with glass in a compactor truck. Sample loads of the paper were processed in a trommel before being shipped to paper mills for inspection. The results of this test suggested that under these conditions the quality of the paper might be acceptable, but further research is planned in order to reduce the still-high level of uncertainty surrounding this issue. Due to concern about paper marketability, the City currently collects designated recyclable paper (bundled newspaper, magazines and corrugated) in a separate compactor truck. This two-truck recyclables-collection system, however, is one of the factors contributing to the high costs of the City's current curbside program.

Co-collection of loose mixed recyclables (paper and non-paper materials set out in bins) in a single compactor truck, would present a significant risk of material contamination. An alternative in which the paper and non-paper recyclables are set out in separate plastic bags might reduce the contamination risk, but a pilot study conducted by the City in collaboration with a plastic-bag manufacturer found that high proportions of the tested bags ruptured in the compactor truck. While significant bag breakage alone is not a definitive indicator of material contamination, it does raise reasonable concerns about the viability of this type of co-collection system.

The high potential for bag breakage raises an even greater concern about the viability of a co-collection system in which bagged recyclables would be collected in the same single-chamber compactor truck with other waste. Further study of this approach would need to be conducted before it could be considered as a viable alternative for the City's recycling collection system.

Moreover, the apparent cost advantage of collecting all material (recyclables and other waste) in a single truck may be obviated by the additional processing and transportation costs such a system would entail. The processing facilities that would receive such mixed loads would need to be considerably larger than a conventional materials recovery facility in order to provide sufficient tipping-floor space for the separation of bags of recyclables from bags of waste. Additional labor also would be required for this "front-end" processing step, which might be made even more difficult if a substantial proportion of the bags had been ruptured in the truck. Furthermore, the separated wastes would then need to be transported a second time to a disposal site unless the processing facility were co-located with a disposal facility (i.e., at the same site as an incinerator or landfill). While the City's existing marine transfer stations or incinerators might appear to be suitable locations for these types of facilities, none of them has sufficient adjacent land area to accommodate a sizable processing facility.

Collection trucks with two separate compacting chambers have recently become available, in very limited quantity, in this country. Although there are limited data on the costs and performance of these types of trucks, they are likely to be more expensive than conventional packer trucks. In addition, collection efficiency may be reduced if one of the compartments fills before the other and the truck has to leave the collection route to make its dump with less than a full load.

Nonetheless significant overall savings are likely from using a single two-compartment truck for collecting recyclables, instead of two separate trucks. A comparative analysis that assumed reduced collection efficiency (only 75 percent of the available capacity of the split-body truck being filled) and a 20 percent higher per-truck capital cost, and 50 percent higher maintenance costs, showed overall savings on the order of $120 per ton for a two-compartment truck over two conventional trucks for collecting recyclables. An analysis of an assumed citywide source-separation program that targets about 47 percent of the residential waste stream, with assumed participation rates about 50 percent higher than in the City's current program, shows that up to 44 percent fewer trucks might be needed (see "Scenario Modeling Results" in Appendix Volume 7.1).

Drop-off facilities may be the most effective means of collecting certain types of materials which would be too costly to collect in a regular curbside program. Another advantage is that materials so collected (such as color-separated bottles in igloos) may not require significant processing before being shipped to market.

Voluntary community-based recycling efforts have played an important role in neighborhoods that do not yet have curbside recycling collections. The Sanitation Department has subsidized a number of these programs in the past, and has experimented with its own mobile drop-off service (a regularly stationed truck in certain communities to which residents could bring recyclables). Both of these types of programs provide opportunities to recycle, but divert only small quantities of material. There is no precedent anywhere to suggest that a citywide network of these small-scale recycling programs could be a feasible, comparable <u>alternative</u> to a curbside collection system.

A variant on community-based recycling systems is when individual buildings organize recycling programs, and contract with private "jockeys" to pay for and pick up their recyclables. The Environmental Action Coalition, with a subsidy from the Department of Sanitation, conducted an education program designed to encourage such building-wide recycling efforts. A major draw-back of such a system is its unpredictability in the face of fluctuations in the markets for recyclable materials; private collectors under the EAC-sponsored program, for instance, stopped collecting newspapers when the paper market collapsed.

An important factor to consider when designing subsidized drop-off or buy-back systems is the need to avoid paying twice for attempts to recycle the same materials. Since there are fixed costs associated with municipal recycling collection efforts, any subsidized drop-off or buy-back programs should enhance the effectiveness of these programs by diverting more and/or additional materials from the waste stream, rather than simply competing with municipal collections for the same pool of materials. It may be appropriate initially to target buy-back facilities in areas where residential curbside collection participation rates are below acceptable levels. Buy-back program success can then be monitored in terms of cost-effectiveness and diversion rates before citywide expansion.

A detailed discussion of recycling collection alternatives is contained in Appendix Volume 4.1.

8.2.1.2 Alternative Collection Systems for Institutions.

There are two major differences between potential institutional and residential collection systems. One is that there may be greater opportunities for automated/containerized collection of institutional waste, due to the scale of institutional generators and to the higher volumes of particular types of recyclable materials that they may produce. The second is that it may be relatively easier to implement and administer a system for quantity-based user fees.

8.2.2 Alternative Collection Programs for Commercial Establishments.

The same basic collection alternatives for residential and institutional recyclables apply to the commercial sector as well. Some recyclables that are generated in large quantities by certain commercial generators lend themselves most readily to dedicated source-separation collections, such as office white paper from large office buildings and corrugate cardboard from food retail businesses. These types of materials have been recycled consistently (although not universally) in the past. Even when they are not collected in separate trucks, their predominance in certain commercial routes makes them relatively easy to segregate at transfer stations or commercial processing facilities.

The size and variability of New York City's commercial sector, the fact that it is serviced by several hundred predominantly small-to-mid-sized private carting companies, and the unique distinctions in waste characteristics across the range of different commercial generators, make uniform citywide source-separation requirements a less viable option for commercial waste than they are for the residential sector. For some generators, particularly generators of small quantitities of solid waste, the option of post-collection separation may be the most efficient and effective means to divert materials for recycling. When commercial generators and carters are capable of handling wet/dry separations, this option may improve the effectiveness of post-collection separation by minimizing material contamination. Finally, as noted above, source separation programs for high-grade paper are appropriate for businesses that generate these materials in large quantities.

8.3 Alternative Processing Facilities for Recyclable Materials.

Material processing facilities form the link between the collection system and the marketing of secondary materials to end-users. Existing materials-processing systems are designed to perform two basic functions: to separate and sort recyclable materials, and to prepare them to meet end-user specifications and shipping requirements (e.g., baled, crushed, etc.). Most types of processing systems consist of some combination of standard mechanical equipment (e.g., conveyors, trommels or other screening devices, magnetic separators) and manual-sorting techniques. Other types of processing equipment, such as plastic-bag-opening devices, are relatively innovative and are being used at only a few facilities.[3] Different systems vary primarily in the degree to which they rely on manual versus mechanical sorting.

The available processing facility alternatives correspond to the types of materials targeted for recycling and to the collection system used. Even the most mechanized processing systems have relatively low capital costs in relation to most other types of waste-management facilities. The labor costs of different types of processing facilities (which depend on the marketable grades of material that are produced), however, can vary more significantly. Adding or subtracting workers is also a means of maintaining flexibility in terms of throughput capacity. For example, a facility that is physically sized to process 250 tons of material in an eight-hour work shift can double its throughput by adding a second shift.

Materials recovery facilities (MRFs), also known as intermediate processing centers (IPCs), are the most common form of processing facility. They are generally designed to receive and process source-separated materials in two streams: paper and co-mingled non-paper recyclables. Depending on market conditions and marketing strategy, materials can be sorted "positively" (by selectively sorting HDPE plastic containers, for example) or "negatively" (by sorting out all other materials and leaving all plastics to be marketed as "mixed plastics"). MRFs usually produce only small amounts of residue (contaminated or otherwise unmarketable material) that requires disposal.

There are very few facilities in this country that are designed to process recyclables from mixed residential waste or from "dry" bags. While the equipment and manual sorting techniques needed for these types of facilities would not be markedly different from those of a standard MRF, performance data in terms of material-recovery rates, material quality, and costs, are lacking. Performance data are especially uncertain for the sorting of commingled paper grades and textiles into marketable product categories. It is probable, however, that somewhat less material would be recovered and more residue would be left, and that per-ton costs would be higher.

Recyclable materials can also be recovered from mixed refuse at the "front-end" of a waste-to-energy or composting facility. Refuse-derived-fuel (RDF) waste-to-energy systems are designed to remove non-combustible materials from the incoming waste stream by using automated processing equipment (such as trommels and magnets). Such highly automated systems, while less costly to operate than operations that include more manual sorting ("hand-picking"), cannot recover as much material as can more labor-intensive systems, nor is the recovered material likely to be of the same quality. Pre-processing equipment that involves greater or lesser degrees of manual sorting can be used in front of mass-burn incinerators, and is generally used in front of mixed-waste-composting facilities. (In the latter case, post-processing equipment is also used, but recyclables that are screened from compost at this stage do not have much market value; analagously, magnetic separation of ferrous metals from waste-to-energy ash can also be done, but such material is much less marketable than are metals that have not been incinerated.)

The operating and cost characteristics of these various types of facilities are discussed in Chapters 9 (composting systems) and 10 (waste-to-energy systems), and in more detail in Appendix 4. Appendix Volumes 4 and 5 also contain detailed design, operating, and cost data on various forms of recycling facilities, including conceptual "front-end" facilities for mass-burn or composting plants which are designed to maximize the recovery of recyclables.

Since the incremental capital cost of facilities capable of processing additional materials is relatively modest compared with the cost of a standard MRF, one conclusion of the analysis of processing options is that facilities should be designed with the capacity to process the maximum pool of potential recyclables. Then, depending on the collection strategy selected and on market conditions, the choice becomes one based primarily on the relative costs of additional labor versus anticipated market capacity and revenues.

The differential costs and environmental impacts of different types of facilities for processing recyclable materials are presented in the appendix on reference facilities (Appendix 5). The individual differences between facility types (which for the most part are relatively trivial) are not very informative because they consist primarily in the degree of admixture of the wastes to be processed, the degree of manual versus automated processing, and the degree of processing that is achieved.

These differences, in turn, can only be understood within the context of an overall generation/collection/processing/ marketing/disposal system. In simplistic terms, the higher the degree of source separation, the lower the level of public participation/diversion, the higher the collection costs, the lower the processing costs, and the higher the market revenues: in other words, there are offsetting costs and benefits that tend to cancel each other out. This characterization is too simplistic, however, since: collection systems can be streamlined to be more or less efficient (for instance, through the use of two-compartment compacting trucks, or through a variety of labor-related efficiencies); processing facilities can be operated at varying degrees of cost-efficiency, the overall cost-effectiveness of which will in part be determined by residue disposal costs (and residue can be disposed of in a variety of ways -- composting, waste-to-energy, landfilling, each of which entails a different cost structure) and market revenues; and the ability of the market to absorb the proferred volume of material at a given specification can significantly affect overall system economics.

These differences between alternative waste-management systems are presented in the analysis of scenario-modeling results in Chapter 17.

8.4 Markets.

8.4.1 Market Surveys.

8.4.1.1 Newspaper Markets.

subcomponents of these materials are not specifically identified in these appendices. However, the categories they represent are incorporated in the more general categories that are presented. For example, high-grade paper, non-corrugated paper, and telephone books are included in the general discussion of mixed-paper markets section, and are clearly considered to be potentially recyclable and/or compostable. The recyclability issues pertaining to car batteries, dry cell batteries, and used oil are well established in the literature: the major components of car batteries (i.e., lead) are readily recyclable, and used oil is most beneficially recycled through established re-refining techniques, while recycling of dry cell batteries on a significant scale has not yet been implemented in this country. The recyclablity of household hazardous waste components, as experienced by the City thus far, is discussed on page 3-15 and in more detail in Appendix 4.2. Many components of construction and demolition waste are potentially recyclable (see Table 16.2.5-2 for a projection of the tonnages of particular materials that are expected to be recycled). A general presentation of existing and potential markets for the major material categories is provided below.

8.4.1 Market Surveys.

8.4.1.1 Newspaper Markets.

The market for old newsprint (ONP) is growing: domestic and export markets are expected to absorb available supplies by 1995.[4] In order to develop a stable market for the newspaper (and corrugated cardboard and magazines) that it collects, the Department of Sanitation is soliciting proposals from qualified firms and organizations to enter into 10-to-20-year marketing agreements.

The largest markets for ONP are the recycled paperboard and tissue-paper mills, which account for about half of the ONP consumption in the Northeast. The demand for ONP from these mills is not predicted to increase significantly in the next five years.

Recycled newsprint mills account for about a fifth of total consumption in the Northeast. The majority of this consumption is due to one large newsprint mill in New Jersey. However, many other mills are considering investing in de-inking machines, due to recent advances in de-inking technology and to the expectation of increased supplies of ONP. The long-term outlook for ONP demand is favorable, provided that newspaper publishers commit to buying newsprint made from ONP and that the mills can be assured of receiving a steady and reliable fiber supply that meets quality standards.

Export markets absorb about a quarter of the ONP sold in the Northeast. The overseas demand for ONP has grown rapidly in the late 1980's, and is projected to continue to expand in the next five years. Given its proximity to the port, New York City should remain in a strategic position to supply this market. The export market, however, is extremely volatile due to the changing availability of sea containers, freight-rate changes, currency exchange rate fluctuations, and political disturbances.

Other markets for ONP, which include cellulose insulation, animal bedding, hydromulch, and packaging materials, currently absorb less than a tenth of the ONP used in the Northeast. These markets are not projected to increase significantly over the next five years.[5]

A more detailed survey of newspaper markets and a discussion of de-inking technologies are presented in Appendix Volume 3.1.

8.4.1.2 Corrugated Cardboard Markets.

The market for old corrugated cardboard (OCC) was the strongest of any paper market in the late 1980's, but market demand has leveled off and may not be large enough to absorb increasing supplies in the near-term.

The largest domestic market for OCC is the recycled paperboard industry, which accounts for almost half of all OCC demand; other paperboard manufacturing (unbleached kraft linerboard and semi-chemical corrugated medium) and overseas export are the second and third largest markets respectively. The Northeast has nearly a quarter of the national capacity for recycled paperboard, and new mills planned in Connecticut and Massachusetts are expected to create additional capacity to meet projected increase in linerboard demand.

OCC exports from the Northeast increased three-fold during the 1980s and are projected to continue to grow.

A more detailed survey of markets for old corrugated cardboard is presented in Appendix Volume 3.1.

8.4.1.3 Mixed Paper Markets.

The market for mixed paper is the weakest of all paper markets. At present, and for the next five years or so, New York City would be unable to market the amount of mixed paper it could collect. The greater the degree of separation of paper types, either at the source or in post-collection processing, the greater the degree to which the City could find markets for these papers. The gradual development of supply capacity by New York City might help to spur the long-term development of markets for these materials without overwhelming the available markets.

New technologies for removing contaminants from mixed-paper feedstocks and improved deinking techniques could overcome major barriers to expanded demand for mixed paper. Research and development activities are being undertaken in these areas. Uncertainty on the part of mill operators about the effects of mixed paper on the quality of their products, regulations limiting or prohibiting the use of mixed paper in the manufacture of certain products, and the presence of coatings, additives and other impurities in some mixed-paper types pose significant problems for mixed-paper recycling. The market for mixed paper is also restricted by the availability of cost-competitive alternative secondary fiber grades from pre-consumer and commercial waste-paper sources.

Consumer demand for high-grade writing papers with recycled content is growing. The American Paper Institute projects a 3.5 to 4 percent annual increase in the use of recycled-content high-grade paper.

New federal procurement guidelines are being considered that would require specified recycled content in government printing and writing-paper purchases, with a mimimum percentage composed of post-consumer recycled paper. If adopted, these requirements could provide an important stimulus for expanded recycled-paper production.

A more detailed survey of markets for used mixed paper is presented in Appendix Volume 3.2.

8.4.1.4 Markets for Used Tires and Rubber Products.

Of the about five million tires disposed of annually in New York City,[6] about three million are currently exported out of the City for re-treading, recycling, or disposal. The remaining volume of tires -- and more -- could be absorbed through any of a number of market uses. More re-treading, particularly of tires from City-agency fleets (some of which, including the Sanitation Department's, are already re-treaded), could absorb up to 30 percent of the overall number of tires generated in the City. Use of shredded tires as landfill cover at Fresh Kills could absorb over half of the overall generation. A number of potential facilities in the region, including the Oxford Energy tire-combustion facility under construction in Sterling, CT,[7] various cement kilns, and several other facilities, could together absorb up to half of the overall amount of tires generated.

There are many other uses for tires, many of which are currently constrained, however, by limited demand for the finished products, by unresolved technical difficulties, and/or by the high costs of producing them. These include the use of whole, sliced, shredded and/or crumbed tires: as an ingredient in asphalt (which use could absorb a large quantity of tires if this technique becomes cost-competitive);[8] compression-molded goods such as mats, traffic cones, carpet backing, and trash containers; cut and stamped products such as playground equipment, toys, boat and truck bumpers; artificial reefs, breakwaters, and crash barriers; soil-erosion-control devices and various construction applications; and as a bulking agent for composting.

Markets for tire-derived products could be dramatically expanded by City, State, and federal procurement policies, ranging from expanded requirements for the use of re-treaded tires, to increased procurement of the range of other materials listed above, many of which are used primarily by government agencies. (Of these uses, asphalt uses may be the most significant in terms of quantities, and perhaps, eventually, in terms of economic and environmental benefits; expanding the use of tires in asphalt will require action by all three levels of government, since the Federal Highway Administration has not yet approved "rubberized asphalt" as a paving material that qualifies for federal funds, except on an experimental basis.)[9] As with market-development options for other materials, use of City economic-development incentives for firms that work with tire-derived materials (since many of these involve relatively low capital-equipment requirements, and require largely-untrained labor), may be particularly advantageous.

A more detailed survey of markets for used tires and rubber is presented in Appendix Volume 3.2.

8.4.1.5 Markets for Used Wood and Construction Waste.

Most wood generated in the New York city area is kiln-dried lumber and scrap from new construction, building renovations, and freight handling. Some of this wood is marketed to seven major wood processors in the New York City metropolitan area. These wood processors produce approximately 300,000 tons per year of marketable wood chips. At present, the demand for used wood materials in New York City is not sufficient, forcing haulers to export used wood materials out-of-state.[10]

All of the materials recovered from the Sanitation Department's Fresh Kills screening plant are used at the landfill as road aggregate and daily cover material.

All asphalt waste generated from City streets is recycled into new asphalt at City-run asphalt plants.

A more detailed survey of markets for used wood and construction waste is presented in Appendix Volume 3.2.

8.4.1.6 Markets for Used Plastics.

Markets for used plastics are at present relatively limited. While there have been significant technological constraints on processing plastics for re-use in new materials, the limited supply of post-consumer material also has been a major limiting factor. As more reliable supplies of used plastic are collected, it is likely that market capacity will readily expand.[11] The key issue for plastics recycling will be the degree to which separation of plastics by resin will be necessary to secure adequate market demand.

Current post-consumer plastics recycling is dominated by PET and HDPE containers, for which demand is strong and expected to grow. Projected recycling capacity for these plastics in the Northeast is likely to exceed New York City's supply.

Demand for mixed plastics is limited. The primary product from recycled mixed plastics is plastic lumber, which can be used for piers and bulkheads, erosion barriers, tables and benches, and fencing and other landscaping purposes. While the current purchase price of plastic lumber is approximately double that of treated wood, the longer service life of plastic lumber in certain applications may offset some of this cost difference. Future growth in market demand for plastic lumber remains uncertain.

Plastics-industry representatives generally predict that market conditions will be more favorable for separated plastic resins than for mixed post-consumer plastics. While there are well-defined markets for used PET and HDPE containers, markets for other plastics such as film plastic, polypropylene, polystyrene and polyvinyl chloride, are not yet fully developed. A major marketing constraint is the ability to segregate these different plastics types.

Products manufactured with post-consumer film plastics include grocery sacks and various molded items. Existing U.S. demand for film plastics, however, will not be nearly enough to accommodate the City's anticipated supply. Export markets for film have not been consistently available, and the future export market is uncertain. A major barrier to film-plastic marketing is that six different resins are used for film production. The City may be able to overcome this problem with specific content requirements for bags that could be used to collect recyclables in its curbside program.

The other plastics resins individually do not comprise a large portion of the plastics waste stream. The present capacity for reprocessing post-consumer PVC, polystyrene and polypropylene containers is very limited. Increased demand is possible if consistent supplies are made available.

More detailed surveys of markets for used plastics are presented in Appendix Volume 3.2.

8.4.1.7 Markets for Used Glass.

The container-glass industry is the leading market for glass recycling. There are, however, virtually no domestic uses for green glass, so the primary productive capacity available in the U.S. is for clear and brown glass. Post-consumer cullet can be directly substituted for up to 70 percent of the virgin materials used in glass-container manufacturing. The economic incentive to use recycled glass cullet is strong since the lower furnace temperatures required for its use produce substantial energy savings.

Glass-container manufacturers demand color-sorted, "furnace-ready" cullet. Green and mixed-colored cullet is suitable only as an admixture to road-paving material ("glassphalt"). The demand for glassphalt in New York City is sufficient to consume all of the City's recycled mixed-color glass.

Other uses for post-consumer glass containers include glass-bead manufacture, fiberglass insulation, and specialty glass products, but none of these markets is as well developed as is glass-container remanufacturing.

A more detailed survey of markets for used glass is presented in Appendix Volume 3.1.

8.4.1.8 Markets for Used Ferrous and Non-Ferrous Metals.

The economics of aluminum manufacturing overwhelmingly favor the use of recycled aluminum in place of raw materials: about 20 times more energy is consumed in producing aluminum from refined bauxite rather than from aluminum scrap, and additional cost savings accrue from not having to mine or refine bauxite. Consequently, although prices fluctuate with supply, the market for used aluminum is very strong.

The aluminum market has expanded steadily over the past decade and has shown no difficulty in keeping pace with the increasing supply of used beverage cans that are being recovered by municipal recycling programs and through the beverage industry (over 90 percent of which are made from aluminum). This trend is expected to continue, ensuring that the City can readily market all of its recovered aluminum.

The market for steel and bi-metal cans is generally good, although regional processing capacity may need to be expanded to meet the increasing supply of tin cans and used ferrous scrap. The export market for steel scrap is strong and is expected to grow.

A more detailed survey of markets for used ferrous and non-ferrous metals is presented in Appendix Volume 3.1.

8.4.1.9 Markets for Used Textiles.

A strong market exists for used textiles in the form of used clothes for domestic and export consumption, wiping and polishing cloths, reprocessed textiles for carpeting and other materials, and various types of rag-content papers. There is a shortfall in the supply of used textiles to meet current market demands, which are generally stable or increasing. There is a current unmet demand for uncontaminated textiles of all sorts in the New York region of 120,000 tons a year, although it is not known if the available capacity reflects the composition and condition of textiles which may be recycled via expanded curbside or drop-off collection. Nevertheless, since only 141,000 tons are in the City's waste stream currently (some fraction of which inevitably will be contaminated), the City should be able to find markets for a good portion of the uncontaminated textiles that it can recover.

More detailed analyses of markets for used textiles are presented in Appendix Volume 3.2.

8.4.1.10 Markets for Harbor Debris.

Since this salt- and chemical-soaked material cannot be used for compost, and is loaded with metal hardware which make it difficult to be sawn for re-use, the only markets are for shredded harbor debris to be used as fuel. This material from New York Harbor has been used in a Proctor and Gamble facility on Staten Island, and shipped to Pakistan for use in a desalinization plant.

8.4.2 Projected Market Shortfalls Based on Regional Supplies of Recyclable Materials.

The potential magnitude of recyclables that might be diverted by the City's recycling program in the future could very well exceed or seriously stress existing regional markets for a number of materials. Overseas export markets may be available for some materials, but they are limited, unreliable, and subject to economic and other influences that are beyond local or even U.S. domestic control. The materials that are most likely to suffer market constraints due to oversupply are mixed paper and plastics.

Figures 8.4.2-1 and 8.4.2-2 show: (a) estimated regional demand for secondary materials, (b) the City's potential supply of these materials (assuming an overall 60 percent recovery rate), (c) the supply that could be become available if per-capita recycling rates in the nine-state northeast region were to be the same as those projected for City, and (d) the resulting excess market demand or shortfall.[12] These graphics illustrate potential market strengths and weaknesses that should guide the City's market-development strategies.

The materials generally considered "recyclable" can be grouped into three "marketability" categories. The first category, which includes the various types and grades of glass and metal, can be characterized as materials with sufficient market demand. In general, these materials form "closed-loop" recycling systems in which the secondary material can be re-used in its original production process. Aluminum cans and glass containers, for example, can be re-used to make new aluminum cans and new glass containers. While only a small percentage of steel cans go back into making new steel cans, secondary steel can be substituted for virgin steel in a large number of steel applications. In addition, producers of this category of materials generally prefer secondary materials over their virgin counterparts since they can be used to make a technically equivalent product more cheaply. (There is no quality difference, for example, between a glass jar made from cullet and a glass jar made from virgin materials, but cullet costs less to use.)

The second category of recyclable materials, which includes most types and grades of paper, is characterized by "moderately" sufficient demand. In general, paper grades can be re-used in closed-loop recycling systems, but often they are not. Both for technical reasons (recycled fibers are generally shorter than their virgin counterparts) and for quality reasons, manufacturers often prefer virgin fibers. The marketing goal for this material is to increase the amount of new paper production that uses secondary fibers by both increasing the number of secondary mills and by increasing the amount of secondary content that is used in "primarily virgin" mills. The technology for making closed-loop products exist, but its use needs to be expanded.

The third category of recyclable materials, which includes most types and grades of plastics and and some types of textiles, is characterized by insufficient demand. This category involves materials that to date generally have not been used in closed-loop recycling systems. Significant research-and-development efforts will be required before these secondary materials can be absorbed into manufacturing processes on a scale equal to the amounts of material that could be recovered by this region's recycling programs.

8.4.3 Steps That Could Be Taken by the City, State and Federal Governments to Expand Markets.

There are four major forces that influence market demand for secondary materials: demand for end products made with recycled materials, the availability of plant capacity to manufacture such products, the degree to which different manufacturing processes are amenable to using recycled materials as a substitute for virgin materials, and the relative cost of recycled versus virgin raw materials. Weaknesses in one or more of these factors can affect the availability of markets for the City's recyclables.

Although some of the conditions that influence these market forces are outside direct governmental control, a number of the same "tools" used for other economic-development purposes can be applied to secondary materials markets as well. Actions by the federal government have the broadest impact, but State and City strategies can be effectively focused on market impediments specific to local program needs. The range of potential market-development strategies includes regulatory actions, procurement activities, financial incentives, and technical assistance and other direct services. Factors that affect the choice of appropriate market-development alternatives include their cost, the likelihood that they will be effective, the probable scale of their impact, their compatability with other programs, and their ability to be implemented.

Potential strategies to address weak end-product demand include recycled-content legislation, product-labelling requirements, product-use bans, preferential procurement policies, public outreach and information programs, and research and development activities.

To address the problem of limited manufacturing capacity, the City could promote the development of new plants through guaranteed long-term supply agreements, or through other direct (financial, technical, permitting) or indirect (infrastructure improvements such as roads, utilities and transportation facilities) efforts. In some cases, the City could develop new plants on its own (such as for glassphalt production) or in joint-ventures with private-sector entities.

Among the techniques available to encourage substitution of recycled materials for virgin-material feedstock are information and technical-assistance programs (such as waste audits, industry outreach, waste exchanges, and clearinghouses), procurement "set-asides" for businesses that use recycled materials as feedstock, and pilot programs to test and demonstrate the use of recycled materials in manufacturing processes.

A variety of economic incentives and disincentives can be used to "level the playing field" in terms of the relative cost of recycled versus virgin materials through tax policies, direct grants or loans, loan guarantees, financing assistance, and other forms of subsidies.

A detailed assessment of market-development strategies is contained in Appendix Volume 3.

8.5 Differential Waste-Stream Impacts From Alternative Recycling Programs.

Figure 8.4.2-1: Regional Demand and Supply Relationships for Secondary Recyclable Fiber Materials

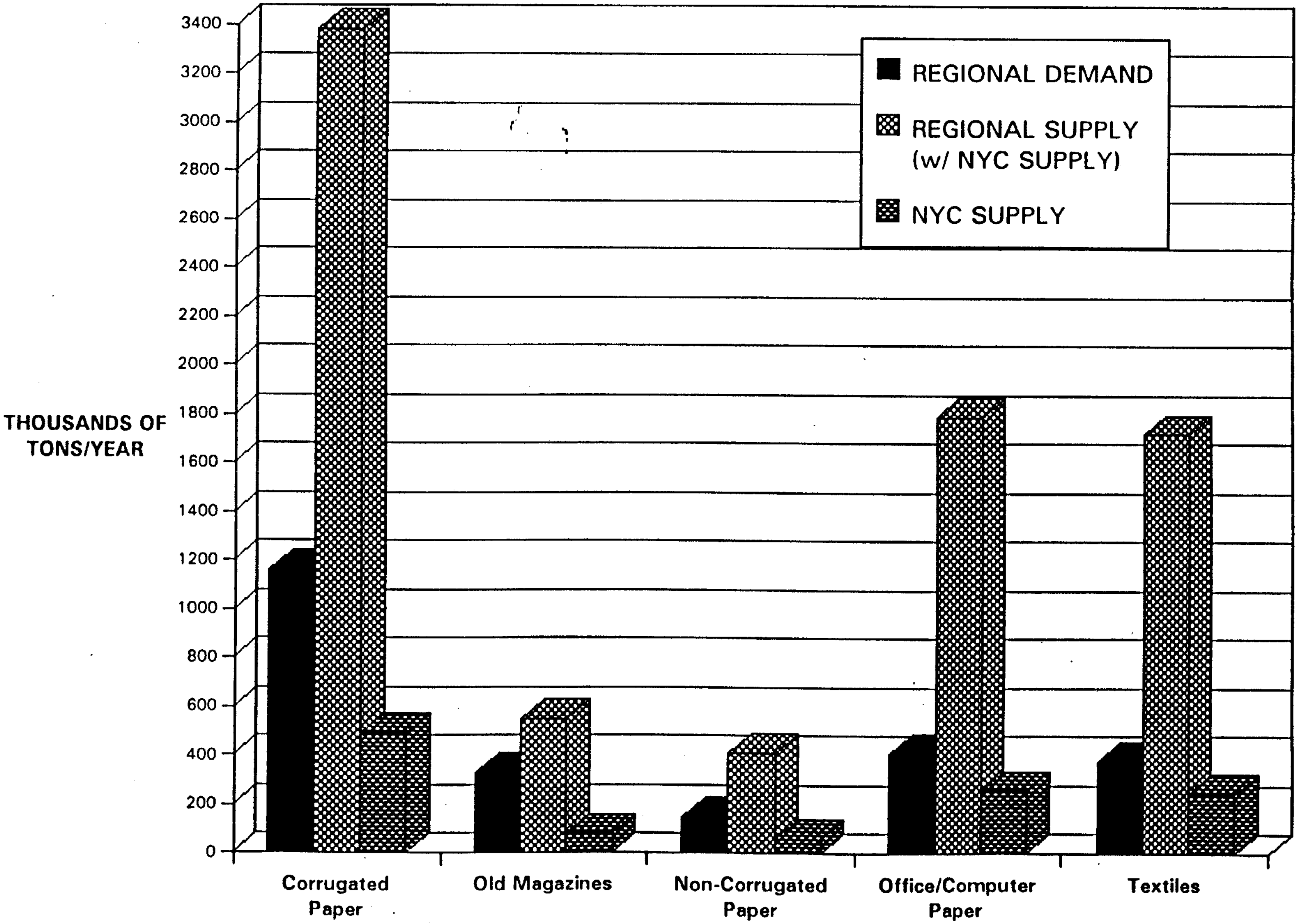
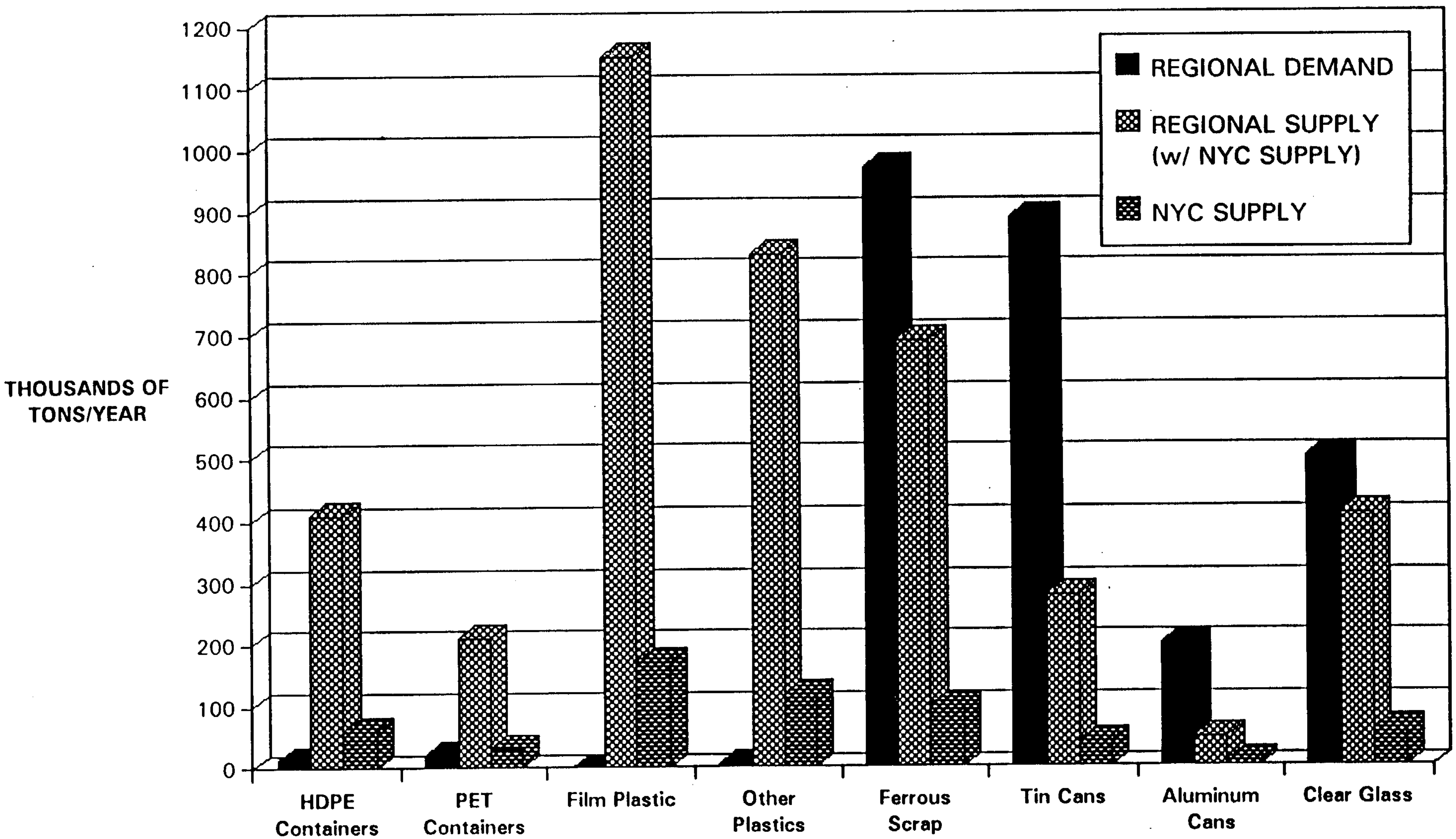


Figure 8.4.2-2: Regional Demand and Supply Relationships for Selected Recyclable Materials



A range of alternative recycling programs was analyzed in the initial phases of this planning process. One basic program type, which was labelled "high quality," involves separate collection of the universe of materials (defined as expansively as possible) that are generally considered to have the highest likelihood of being marketable. In this program, paper and textiles would be collected in one compartment of a two-compartment compactor truck, and metals, glass, and plastic in the other. In a variation on this high-quality program, the remaining (non-source-separated) refuse was assumed to be processed in "mixed-waste-processing facilities" (see Appendix Volumes 5 and 7.1 for further details on the assumptions behind these facilities) to recover potentially recyclable materials that remained in the refuse stream.

A second basic program type was labelled "wet/dry." In this program, waste generators would sort all of their refuse into two plastic bags: one that contained primarily wet, kitchen-type waste, and one that contained all dry materials. In one variation of this program, the two bags would be co-collected in the same (one-compartment compactor) truck; in a second variation, the truck would have a separate compacting compartment for each type of bag. A third variation, a blend of the two basic types of programs, would include one two-compartment truck for high-quality recylables, and a second two-compartment truck to collect the remaining refuse, partitioned in wet and dry fractions.

In addition to these two basic program types, a number of auxilliary recycling programs -- drop-off and buy-back centers, and separate collection and processing for bulk materials --were considered.

The amounts of material projected to be actually <u>recycled</u> in these various programs (differently configured programs would produce varying quantities of post-processing residue -- contaminated or otherwise unsaleable material that would have to be composted, incinerated, or landfilled) are presented in Table 8.5-1. The assumptions used in modelling these programs are described in Appendix Volume 7.1. The relative costs of these alternative types of recycling programs cannot be compared directly, since they are integrally related to the overall collection costs of the entire MSW system; the collection costs of integrated system alternatives are presented in Chapter 15 and Appendix Volume 7.1.

8.6 Most Viable Recycling Program Options.

Because of the remaining uncertainties associated with large-scale urban recycling programs, the most viable options for the City to pursue are those that embody maximum flexibility but encompass all reasonably anticipatable developments.

First, to maximize material diversion, the City's recycling program should define the pool of targeted recyclable materials as expansively as possible. This makes participation simpler and increases the possibilities for market developments that respond to large, steady supplies of material. Targeted "high quality" materials, therefore, would include all dry residential paper, all plastics, metal, glass and textiles. Source separation, at least in the residential and institutional sectors, is superior to "wet/dry" separation since it increases the likelihood of high recovery rates for marketable materials and minimal residue requiring disposal.

Table 8.5-1: Residential Waste-Stream Recycling Rates in Alternative Recycling Programs (Year 2000)

Recycling System	Tons Recycled Through Source-Separation Programs		Tons Recycled from Mixed Waste Stream		Total Tons Recycled	Percent Recycled
High Quality/Refuse	High Quality: Bulk: Buy-back:	563,000 198,000 57,000			818,000	24%
High Quality/Refuse with Mixed Waste Processing	High Quality: Bulk: Buy-back:	563,000 198,000 57,000	MWP:	313,000	1,131,000	33%
Wet/Dry: 1 Truck, 1 Compartment	Bulk: Buy-back:	198,000 57,000	Dry Bag:	324,000	579,000	17%
Wet/Dry: 1 Truck, 2 Compartments	Bulk: Buyback:	198,000 57,000	Dry Bag:	482,000	737,000	21%
High Quality/Wet/Dry	High Quality: Bulk: Buy-back:	563,000 198,000 57,000	Dry Bag:	282,000	1,100,000	32%

Collection in plastic bags offers many advantages over the use of rigid containers. Using one dual-compartment, compactor truck to collect source-separated residential recyclables is more cost-effective than either two separate trucks or a single truck with one compartment.

Processing facilities should be designed and equipped to handle all of the collected materials. Decisions about the types and grades of materials that are sorted then become a function of the relative costs of additional labor versus material revenues. Having this flexibility at the processing end of the system is more efficient and less risky than changing source-separation requirements in response to market fluctuations and developments.

Endnotes

1. Solid Waste Report, 2-11-91, p. 55.

2. On the economics of the predicted transition from virgin to recycled wood fibers, see Arthur C. Veverka, "Economics Favor Increased Use of Recycled Fiber in Most Furnishes," Pulp and Paper, September, 1990, pp. 97-103.

3. A status report and engineering evaluation of alternative bag-opening systems is presented in Appendix Volume 4.1. In addition, Biocycle magazine presented a review of this technology in its March, 1992 issue (Peg Ballister-Howells, "Debag Systems: Getting It Out of the Bag," pp. 50-4.)

4. Franklin Associates, Generation, Supply and Demand for Old Newspapers in New York City and the Northeast, Final Report, October 1990, as summarized in Recyclables Market Assessment for New York City, Appendix Volume III, p. 17.

5. Recyclables Market Assessment, Appendix Volume 3.1, pp. 17-24.

6. The figure of approximately five million tires represents "passenger-tire equivalents," that is, the estimated 3,800,000 automobile tires plus 214,000 truck tires, each of which is equivalent in weight to 5 automobile tires.

7. This facility is sized to burn nine million tires annually; Oxford Energy has also proposed a plant in Erie County, NY that would burn 11.8 million tons annually. The NYS Legislative Commission on Solid Waste Management, The Road to Less Waste: Recycling New York State's Scrap Tires Into Asphalt Paving Material, January, 1991, p. 25.

8. Ibid, p.1.

9. Ibid., p. 5.

10. Appendix Volume 3.1, "Sources and Disposition of New York City Wood Waste", p. 2.

11. A.D. Little, Marketing Development Strategies for Recyclable Materials, prepared for the New Jersey Department of Environmental Protection, Division of Solid Waste Management, Office of Recycling, July, 1989, pp.3-95 to 3-97, and passim.

12. This assumption is consistent with the Regional Plan Association/Tellus Institute study of the 31-county metropolitan New York region, which found that in the year 2000 New York City will constitute 38% of the region's population, and generate 37% of its garbage and 40% of its recyclables.

CHAPTER 9. ALTERNATIVE COMPOSTING OPTIONS.

Composting is the process through which organic material is decomposed by the action of bacteria or other organisms under optimal conditions of temperature and moisture. The final product of this decomposition process -- compost, or humus -- is a dark, crumbly material with a non-offensive odor that resembles soil. The term "composting" is usually reserved for the digestive processes of oxygen-breathing ("aerobic") bacteria, and excludes the digestive processes of the non-oxygen-breathing ("anaerobic") bacteria.

The process is accelerated and controlled by the characteristics of the compostable wastes: oxygen content, moisture content, particle size, porosity, and carbon/nitrogen ratio. The techniques for managing these characteristics range from the simple (use of an open wire-mesh enclosure in the backyard) to the complex (such as a steel silo equipped with sophisticated equipment and computerized controls), but they all involve some degree of control over temperature (aerobic micro-organisms produce heat), air supply (the bacteria require oxygen), and some degree of mixing. The finished product, depending on the source of the raw material and the consequent degree to which it is contaminated with heavy metals or other types of pollutants, can be used as a soil conditioner or amendment for purposes that range from potting soil to forest lands and landfill cover.

All forms of composting have the potential to become odorous if not managed properly. The decomposition process must be kept aerobic in order to prevent the formation of odorous intermediary metabolic molecules. This is done by keeping the mass aerated by moving it, blowing air through it, and mixing. If these relatively labor- or cost-intensive processes are not carried out properly, the composting process can rapidly degrade to an anaerobic, odorous state. A commitment to composting implies a commitment to good design, operation, and maintenance.

Despite its apparent simplicity and the logical attractions of "returning to the soil that which came from it," composting has not been a technique in widespread use in the United States in this century. (In former centuries, primitive and pestilential "manure heap" compost piles were widespread in New York City and elsewhere.) In Europe, it has been a different story: France and Germany each compost more than a million tons a year, and a quarter of Sweden's waste is composted.[1] Until very recently, the cost of compost systems had limited their use in the U.S., but with the rising costs of alternative waste-management techniques the number of U.S. composting facilities is rapidly increasing.

Another factor that has constrained the development of U.S. compost facilities has been the perceived lack of markets within a feasible transport distance from major cities, particularly for compost products that are contaminated with undesirable materials. However, if "markets" for compost materials are loosely defined to include such low-level uses as landfill cover, mine reclamation, and soil conditioner for forestry uses -- and if the overall cost-effectiveness of compost systems relative to other waste-management options does not depend on positive revenues from the sale of this material -- market capacity is not a significant limitation.

9.1 Composting Municipal Solid Waste.

9.1.1 Program Options for MSW Compost.

Organic materials in the residential, institutional, and commercial waste streams that might be suitable for composting are leaves and yard waste, food waste, mixed and/or contaminated paper, and non-recyclable paper.

One way to compost some of this material is called "backyard composting," the technique of placing certain food and yard wastes into a simple outdoor enclosure to allow natural decomposition to take place. (An even simpler option for one kind of material, grass clippings, is simply to leave them on the lawn, where they can harmlessly decompose to become a nutrient for the soil).[2] Although backyard compost bins are simple to improvise or construct at home, over 50 companies are making backyard-composting equipment,[3] and some municipalities are providing compost kits and information to encourage this practice. A more-entertaining variation on the standard procedure is to use worms to decompose the garbage more rapidly; mail-order worms sold for this purpose can also be kept indoors, even closer to the kitchen-waste source.[4]

Composting systems can vary tremendously in size, from a system for an individual residence, to a system for an individual institution, to a 1500-ton-per-day system. New York City has recently been awarded a $200,000 grant from the New York State Energy Research and Development Authority to develop a small-scale organic-waste-composting system for the prison on Riker's Island. This will allow the City to test the viability of institution-based small-scale composting systems. (Several types of small-scale composting systems are described in Appendix Volume 4.1.)

Slightly more than a third of New York City households are in buildings that have fewer than five units. Of the 160,000 tons of leaves and grass in the residential waste stream, over 60 percent (roughly 100,000 tons) are generated by these households. These households also generated 180,000 tons of foodwaste and 120,000 tons of "miscellaneous organics" (a category in the City's waste-composition analysis which is composed of pieces of yard waste and food waste that are too small to recognize). If ten percent of these households were to participate in a backyard composting program (assuming that 90 percent were either unwilling or unable to due to lack of space or for other logistical reasons), composting on average, 40 percent of their leaves, grass, and foodwaste, approximately 17,000 tons of material would be diverted from the City's disposal system.

The costs of backyard composting have been estimated based on a program in Seattle. Compost bins cost approximately $36-$40 per household. Public-education expenses (for brochures, demonstration pilots in backyards across the City, and neighborhood workshops) would be roughly $12-$16 for each participating household. These costs, annualized over five years, would amount to approximately $5 per household for all the households in low-density buildings across the City.

Any compost options other than backyard composting obviously require some form of collection system. Collection systems vary by the type(s) of material they are designed to collect, by the type of source that generates the material, and by the type of composting system to which the material will be delivered, as well as by factors that pertain to the collection system itself. Compost processing systems, in turn, vary by the type(s) of material they are designed to handle, the types of sites for which they will be suitable, the speed of the composting process, and the quality of the compost product.

One type of compost program is for leaf-and-yard waste only. The advantages of collecting only leaves and yard waste are that these types of materials are easy to segregate from the rest of the waste stream, are generated in quantity during relatively brief periods of the year, can be composted without creating environmental nuisances in simple, unenclosed, low-cost facilities, and produce a relatively uncontaminated end-product that can be used in a wide variety of market applications. Alternatively, leaves can be used as a "bulking agent" to be used in more sophisticated types of facilities with less-easily-manageable materials such as dewatered sewage sludge or food wastes. Yard wastes can be collected loose or in paper or plastic bags. Although they can be used in any type of processing facility, most leaf-and-yard-waste-only programs use simple "windrow" or "static-pile" outdoor facilities, which either use specialized turning equipment to turn over rows of composting material, or rely on aeration and venting systems to control the composting of material within a covered pile.

New York City generates about 200,000 tons of leaf-and-yard waste a year, half of it during a six-week period in the fall. Of this total, approximately 160,000 tons are from residential waste and 40,000 are from commercial waste. Commercial landscapers may be collecting an additional 100,000 tons of leaves, brush and grass. Extrapolating from the experience of mandatory programs for separate collection of leaf-and-yard waste elsewhere,[5] and from the experience with a pilot leaf-collection program in Queens in the fall of 1989 (which captured 80 percent of the leaves from one third of the target households), it seems reasonable to assume, in a mandatory program, after an intensive public-education program, that a 75-percent participation level and 80-percent capture rate might be reached. This would divert about 50,000 tons of leaves[6] from the low-density sections of the City through a six-week collection period in the fall. If 60 percent of the leaves generated by institutions, commercial establishments, and private landscapers were also collected, this would amount to an additional 42,000 tons of diverted leaves.

A special subset of leaf-and-yard-waste programs is the once-a-year collection of Christmas trees, which can be chipped and used directly for mulch, or used as an ingredient in compost production. An estimated 2,600 tons of Christmas trees are thrown away in New York City every year.[7]

Food-waste programs[8] require more stringent collection and processing systems. Since food waste contains a high degree of moisture, attracts animals and insects, decomposes quickly, and is a source of odor, it must be kept in sealed containers (either tightly closed re-usable bins or plastic bags) and collected frequently. In-vessel systems include both warehouse-like facilities in which composting material is moved or turned within long bays or drums, and silos in which composting material moves vertically by means of augers. In-vessel systems are naturally more capital-intensive than unenclosed systems, but they have the potential advantage of being able to reduce operating costs and to better control emissions such as odor.

A third type of program handles a less "pure" organic waste stream. Originally developed in Western Europe, this program is based on a basic division of wastes into "wet" and "dry" fractions. The wet fraction would contain food wastes, yard wastes, contaminated paper, and other compostable materials, as well as, in most cases, some amount of "contaminants," that is, materials such as glass, plastic, and cans which would have to be screened out of the compost, before or after processing. "Wet" waste-stream compost programs may offer advantages in terms of lowering collection costs (because more material is collected at one time), but they require more complex processing equipment, and might produce a lower-grade compost, which could have more limited (and less remunerative) market applications.

The last major type of compost program for municipal solid waste involves composting organic materials collected in a mixed-waste system. In this type of program, organic materials are collected along with other types of waste, and delivered to a processing facility that is capable of separating organics from non-organics prior to composting the organic waste. The trade-offs with this type of system are lower collection costs and higher participation, capture, and diversion rates, but higher processing costs and lower market revenues.

The various compost program components -- collection, processing, and markets -- are treated separately below for greater analytical clarity, and in more detail in Appendix Volume 4.1.

9.1.2 Collection Alternatives for Municipal-Solid-Waste Compost Systems.

The range of alternatives for collecting municipal solid waste from residential, institutional, and commercial generators is discussed below; more detailed presentations of these options are presented in Appendix Volume 4.1.

9.1.2.1 Collection Alternatives for Compostable Residential Waste.

9.1.2.1.1 Generator Set-Out Alternatives for Collecting Residential Organic Wastes.

There are four basic choices for the way organic wastes may be stored in residences and brought to the curb for pick-up: bins (including wheeled containers and small dumpsters for single-family households or multi-family buildings), bags (paper or plastic), loose (for leaves and yard waste), or commingled with other wastes. The type of set-out system, and thus the type of container, will largely depend on the materials targeted for collection by the organics-collection program, along with other factors such as the design and frequency of the collection program, the spatial characteristics of the generators' residences, the configuration of processing equipment in the compost facility, and the collection system.

Individual sealed bins for each household comply with New York City health codes, and are relatively effective in preventing the escape of odors and in keeping out animals and insects, and avoid the need for special de-bagging equipment at the processing facility, but they are inconvenient for the generator insofar as the empty bins must be picked up at the curb and taken back into the residence (where they require several cubic feet of storage space), and they must be washed out after use (which would use City-supplied water and generate waste-water discharge to the sewage system). While practical for single-family households, they are not well-suited to apartment-dwelling households. Communal bins -- large covered "dumpster"-type containers -- offer an efficient way of collecting organic wastes from apartment complexes that have the space for storing such containers, and offer the advantage to householders of not having to store putrescible material in the household any longer than may be desired. 60- and 90-gallon wheeled carts can also be used as the central storage receptacle for source-separated organics in multi-family buildings. Use of such wheeled carts requires hoists fitted on the rear of the collection vehicle to empty the contents of the cart into the vehicle.

Large, sturdy paper bags are manufactured specifically for the purpose of collecting leaf-and-yard waste in an organic container that can itself be composted, thus avoiding the need for the capital and operating expense of a de-bagging operation at the processing facility. Because they are harder to seal tightly, they are not well suited to food wastes, and they are considerably more expensive than plastic bags; their expense, however, can be borne by the householder rather than by the municipality, while saving the municipality operating costs. Another disadvantage of paper bags is in ensuring public compliance in using them: if enough householders refuse to use paper bags, and use plastic ones instead, the processing facility cannot avoid the need for de-bagging. Plastic bags are relatively inexpensive and can be sealed relatively effectively, but they require de-bagging at the processing end, and shreds of plastic film are a contaminant in the finished compost.

Leaves and yard waste can be left piled loose at the curb to be picked up by vacuum trucks, street sweepers, or by vehicles fitted with front-end equipment such as plow blades and front-end loaders. (Christmas trees -- and similarly bulky brush and wood waste that can be picked up directly -- are most easily left at the curb to be picked up by hand.) This method may be easiest for the householder, but cannot be used effectively on streets where cars are parked; piles of leaves on the street can also be a traffic hazard for children.

Participation and capture rates for source-separated organics-collection programs will vary widely depending upon the type of program designed, the materials targeted, and the collection system employed. For just a leaf-and-yardwaste program operated in the fall and spring in low-density, yard-waste-generating neighborhoods, participation rates could be relatively high -- in the range of 70 to 85 percent -- with an effective public education program. If all organic materials generated by residences are targeted for collection, participation and capture rates may be significantly lower, particularly if household organics were collected less frequently than regular solid waste, since this would create an incentive for residents to get rid of their putrescible, organic wastes as frequently as their solid waste. If source-separated organic wastes are collected at the same time and as frequently as regular solid waste, participation rates might be expected, under mid-case assumptions, to be in the 65 percent range, with capture rates in the 80 percent range. (For a more detailed discussion of the relationship between targeted materials, program design, collection system and diversion rates see Appendix Volume 4.1, "Source-Separated Compost Collection," Chapter 7.)

Table 9.1.2-1 presents the different types of set-out containers that could be used in a New York City source-separated organics program, along with their costs.[9]

Table 9.1.2-1: Containers Used in Organics Collection Programs

Material	Plastic Bag Collection ($/hhld/yr)	Paper Bag Collection ($/hhld/yr)	Rigid Container (one-time cost)
Leaves only	2	3	30
Leaves and grass	3	6	30
Leaves, grass, foodwaste, misc organics, mixed paper and diapers	10	30	40

9.1.2.1.2 Collection Systems for Residential Organic Waste.

To some extent, the form of set-out containers identified above will determine the type of collection vehicle that can be used, but this decision will also depend on broader collection-system choices related to the degree of co-collection or commingling of distinct source-separated waste-streams and to the type of facility at which loads are dumped or transferred.

Leaf-and-yard waste that is piled loose at the curb must be collected by a truck that offers a mechanical means for loading the material. Vacuum trucks are one means of collecting loose leaves. A typical vacuum-collection crew consists of a truck driver who tows the vacuum, a laborer who operates the vacuum machine, and one or two rakers. The capital costs of a vacuum unit (truck and vacuum) are the least expensive of all leaf collection options (@$85,000) although their operating costs are the highest, due to the large crew and lower collection efficiencies (vacuum-truck systems, in effect, substitute paid municipal labor for the bagging labor of individual households). The benefit of a vacuum system, or of any system that only requires leaves to be raked to the curb, is that participation rates are generally higher, as the experience of Montgomery County, MD, Stamford, CT, and Newton, MA, among other locales, shows.

Street sweepers offer the advantage that the Sanitation Department already owns them, and that they can be used year-round for general applications. They could be used for this purpose, however, only in areas of the City where on-street parking is the exception rather than the rule. Street sweepers also have a relatively limited container capacity, which means that they must be driven to dumping locations frequently, and they cannot be dumped directly into other vehicles for transport to composting facilities. The use of front-end equipment to push and load leaves into an open-topped truck offers all of the disadvantages noted for the other loose-leaf systems, with the additional disadvantages that they create more noise, more disruption of traffic, and more wear on the streets.

Material set out in individual bins or bags is manually loaded into any kind of collection vehicle. Compacting vehicles are clearly desirable for this purpose, since they offer collection efficiencies that are up to four times greater than those for non-compacting trucks, and organic materials are easily compacted without degrading the material to be composted or adversely affecting the unloading or processing operation. The decision as to what type of compactor truck, and whether the material is collected in a dedicated truck, a dedicated compartment, or commingled with other wastes can therefore be made on the basis of other collection and transfer/processing decisions.

Material set out in large, communal containers must be collected with an automated collection vehicle. Such systems offer clear cost and operational efficiencies, as well as "pure" loads that can be taken directly to a transfer or processing facility without the need to empty multiple compartments or separate commingled refuse. They are therefore likely to be the optimum choice whenever set-out circumstances permit.

Table 9.1.2-2 compares collection efficiencies for different types of source-separated organic collection systems. The collection efficiencies reported in this table are based on published data which are adjusted to correspond to New York City conditions.[10]

For New York City circumstances, a bagged set-out system, using a rear-loading packer truck for collection, is likely to be the most cost efficient, and will have the least adverse impact on traffic flow during collection operations.

Table 9.1.2-2: Collection Efficiencies for Organic Waste

Collection System	Collection Vehicle	Collection Efficiency	Capital Cost	Crew Size
Automated Single Family Set-out Bin (mixed organics)	Semi-automated rear loading packer	180 hhlds/hr	$120,000	2
Multi-family Set-out Bin (mixed organics)	Semi-automated rear loading packer	10 bldgs/hr	$120,000	2
Paper or Plastic Bag (leaves)	Rear loading packer	130 hhlds/hr	$108,000	2
Loose leaves at curb	Truck/vacuum unit	100 hhlds/hr	$85,000	4
Loose leaves at curb	Street sweeper	120 hhlds/hr	$200,000	3
Loose leaves at curb	Front end loader w/ claw	150 hhlds/hr	$260,000	4

For references, see Source Separation Compost Report, Appendix Volume 4.1

9.1.2.2 Collection Alternatives for Compostable Institutional Waste.

All of the set-out and collection-vehicle options discussed above are potentially available for institutional organic waste as well, but the particular characteristics of specific institutional waste generators offer distinct advantages in relation to specific set-out and collection systems. Institutions generate both major types of compostable wastes -- leaf-and-yard waste and food waste -- in large, easily segregable amounts, in ways that are particularly amenable to "pre-processed" and/or containerized collection. "Pre-processing" of organic wastes can involve chipping/mulching-type operations for yard waste, pulping/de-watering-type operations for food waste, and compacting operations for either kind of waste, or for wet/dry sorted waste or mixed waste. Bulk-loading systems (vacuum trucks, front-end loaders) may also be relatively advantageous given the high volumes of material that may be involved, and the space available for storing and loading the material.

Because nearly 40 percent of foodwaste is liquid, foodwaste pulpers are ideal for large generators of foodwaste. The commercial/institutional sector generates over 500,000 tons of foodwaste, which is more than six percent of the total New York City MSW stream. A large percentage of this waste comes from major food-waste generators, such as schools, cafeterias in office buildings, and restaurants. A typical foodwaste pulping system consists of a pulper, an excess-water extractor, piping and controls. Kitchen workers feed waste, including foodwaste, napkins, wrappers, and milk and juice cartons into the pulper via a tray or water trough, often in the dishwashing area. The waste is forced through a filter screen by a pressurized spray of water, then is ground into a slurry and piped any distance to the extractor, where excess water is removed. The leftover pulp, which has an oatmeal-like consistency, is discharged into a container or dumpster, and the excess water is recirculated to the pulping tank for reuse. At the pulper at Rutgers University, the food pulp is stored in 55-gallon drums, stored in refrigerators and used by cattle and pig farmers for feed. Pulping systems that can handle 600-1000 pounds per hour range in cost from $18,000 to $36,000. Extractors that can handle 1,400 to 4,000 pounds per hour cost between $17,000 and $40,000.

Other on-site storage containers for wet organic waste from commercial and institutional establishments include dedicated dumpsters and rolloff containers that have been sealed to prevent leaking. They range in size, depending on the volume of organics handled, from one to 40 cubic yards.

9.1.2.3 Collection Alternatives for Commercial Organic Waste.

Some of the same dynamics identified above for institutional waste streams also apply to the collection of organic wastes from commercial establishments. In particular, given the volumes of easily segregable, relatively homogenous food wastes that they produce, restaurants and hotels may be good candidates for automated source-separated food-waste collection programs in dumpsters or roll-out carts.

9.1.3 Processing Technologies for Composting Municipal Solid Waste.

The composting of solid wastes is divided into three distinct operations: pre-processing, composting, and post-processing.

9.1.3.1 Pre-Processing.

Pre-processing involves activities necessary to prepare the waste materials for composting and production of a marketable product: removal of undesirable materials, particle-size reduction, and mixing and addition of moisture. The selection and design of pre-processing systems is determined by the type(s) and quantity waste to be composted, by how much preparation is needed to prepare the waste for optimal composting conditions (described at the beginning of this Chapter), and by the need to ensure that a marketable compost is produced. The amount of pre-processing required increases as the complexity and potential level of contamination of the waste materials increase.

Undesirable materials such as metals, glass, plastics, and other recyclables as well as bulky, hazardous, flammable, and nondegradable materials which have not been removed by source-separation are removed using screens, manual labor, air classifiers, and magnetic separators. For yard-waste-composting programs, this may entail removal of plastic bags, oversized woody materials, and other contaminants using a mechanical debagging machine, manual debagging, and/or a rotary trommel screen. Composting separated organic wastes will require front-end removal systems to ensure that contaminants are removed before composting. Source-separation collection systems that ensure high levels of participation may require people to use plastic bags, which would need to be removed at a composting facility.

The primary reason for particle-size reduction is to make the waste material more readily compostable. In general, when wastes are ground up or shredded, they compost more quickly. Some yard-waste-composting operations use a tub mill grinder or low-speed shear shredder to reduce particle size. All composting systems for source-separated organic waste, wet-fraction waste, and mixed solid waste require size reduction.

Before composting, waste materials may need to be mixed and to have their moisture content adjusted. For yard-waste-composting systems, this process may be as simple as spraying the yard waste with a fire hose while it is formed into windrows by a front-end loader. Other composting systems can require more complex mixing and water-adding systems, such as stationary pugmills or paddle mixers that produce an homogenous mix of waste ready for composting.

9.1.3.2 Composting.

There are three basic types of systems for composting MSW: windrow, static pile, and in-vessel. The evaluation of the appropriate technologies for the compostable waste streams in New York City was based on the types and characteristics of the waste to be composted, the quantity of waste, the amount of land available, the amount of money required, and the needs for environmental and odor control.

Windrow composting is probably the most widely used composting system in the world for yard wastes and MSW because of its ability to handle various mixes of waste and to provide excellent mixing, shredding, and chopping of wastes. Capital costs for windrow composting facilities are quite variable, depending on how much of the facility is enclosed, but are generally lower than in-vessel systems. The major drawback of windrow composting systems is the comparatively large land area needed.

Static-pile systems require less land than do windrow systems, and they tend to have better odor control. They have relatively low capital and operating costs. As with windrow systems, capital costs can become comparatively high if the compost piles need to be enclosed within a building. The major disadvantages with static-pile systems are that the waste materials are not agitated or shredded, and that it is difficult to add more moisture during composting. These problems make static-pile systems inappropriate for MSW.

In-vessel systems, which are generally proprietary, come in many shapes and forms, including agitated horizontal bed, rotary drum, multiple hearth, silo, and tunnel reactor. In-vessel systems frequently require less land, and can have better environmental and odor controls than windrow and static-pile systems have. They also tend to require less labor than the other types of composting systems. The disadvantages of these systems are their higher capital costs, their higher maintenance costs (due to specialized mechanical equipment), and that they are less flexibile in handling varying waste materials and waste characteristics.

Yard waste is typically composted in windrows because the higher capital and operating costs of in-vessel and static-pile systems are not justified for this application. Yard-waste compost systems are typically not enclosed, again for economic reasons. Odors from yard-waste composts can be controlled, without an enclosure and process-air control systems, through proper site drainage, and through operations to maintain optimal temperature, moisture, and mixing.

All three types of composting systems -- windrow, static pile, and in-vessel -- are used for source-separated organic wastes, "wet" waste, MSW, and MSW and sludge mixed together. Windrow systems are typically modified to include forced aeration systems for these types of wastes because of the need to have greater process control. Composting systems for these wastes generally need to be enclosed, especially when they are located in urban or suburban environments. The additional expenditures for buildings, aeration systems, and process-air control are needed to maintain optimal composting conditions and to control odors and other potential adverse environmental impacts.

The composition of mixed MSW affects the rate of composting. There are two phases in the production of compost: the initial active-composting phase, and the curing phase. The active phase for MSW typically lasts 30 to 45 days, and the curing phase, during which final stabilization occurs, may require up to an additional 45 days. New York State requires that compost be processed for a minimum of 51 days (for the two stages combined).

9.1.3.3 Post-Processing.

The objective of post-processing is to ensure that the compost produced is marketable. This means that it must be stable and have acceptable physical characteristics, i.e. particle size and absence of contaminants.

After active composting is completed, the raw compost needs to be kept for a period in large curing piles to ensure that organic materials are fully decomposed and that the compost is stable. An unstable compost presents two major liabilities. If the waste material is not fully decomposed, it can produce malodors as decomposition continues in uncontrolled and anaerobic conditions. An unstable compost can also threaten the health of plants to which it is applied, because continued decomposition can keep key nutrients from being used by the plants.

Finished compost may also be screened to remove contaminants and to produce a uniform product. Rotary trommel screens and shredders may be used for this. The amount of screening and the particle size of the product are determined by the requirements of the intended users.

9.1.3.4 Controlling the Composting Process.

Three process parameters are most important to successful composting: aeration, moisture, and carbon/nitrogen ratio. Since composting is an aerobic decomposition process, an adequate supply of air must be available. Air circulation is also used to control temperatures and to remove any excess moisture; controlling these factors also helps to control odors, since compost odors are largely due to hydrogen sulfide and ammonia, compounds which are produced under anaerobic conditions. Oxygen concentrations should be kept between five and 15 percent. In windrow systems, this is accomplished by periodically turning or agitating the rows to expose new surfaces and renew the entrained air supply. In aerated piles, air is drawn or pushed through the pile by low-pressure, high-volume blowers and an immersed piping system. Proprietary in-vessel systems use one or the other of these techniques. The second important parameter is the moisture level in the pile. Moisture levels below 40 percent restrict the microbial activity; if the moisture level exceeds 60 percent, however, the pile becomes too dense for oxygen to reach its center. The third parameter is the carbon-to-nitrogen ratio. Ideally, there should be 25 to 30 parts of carbon for every part of nitrogen: more carbon slows the decomposition process and decreases the temperature; less carbon can result in the release of excessive amounts of ammonia.

9.1.3.5 Comparative Economics of Composting Technologies.

The costs of composting are related to a number of factors, including: the degree of pre-treatment required; the environmental controls (e.g. odor scrubbers, enclosures) required; the desired relationship between capital and operating costs; the quality requirements for the final product; and other site-related issues. In general, the capital costs of constructing of unenclosed systems will be significantly lower than those for enclosed systems; these costs, however, will be offset by increased acreage requirements (both for the facility itself and for buffer space). The majority of operating and maintenance costs are for pre-processing systems; the O&M costs for the composting operation itself are substantially lower.

Static-pile compost systems require less land area than do windrow systems, and they can provide better odor control, but they have not proven as successful as windrow systems in composting mixed municipal solid waste. They have, however, proven to be quite successful at composting segregated materials, such as food wastes.

Three MSW-composting systems in the United States have operated at a scale similiar to that which would be required if composting of source-separated organic waste were to become a major component of New York City's solid-waste-management system. One is a 1,350-ton-per-day (1,000 TPD MSW and 350 TPD sewage sludge) facility in Wilmington, DE, which has been operating for eight years and is considered the oldest operating MSW/sludge composting facility in the United States. This facility produces approximately 250 tons per day of compost. In addition to compost products, the facility produces a waste-derived fuel that is incinerated on-site to produce electricity, as well as recovered metals and glass.

Agripost, Inc. owned and operated a 1,000-ton-per-day composting facility in Pompano Beach, FL, which operated for over two years before ceasing operation late in 1991 due to odor complaints. The facility produced 280 tons per day of compost. The Riedel Oregon Compost Company owns and operated a 600-ton-per-day facility in Portland, OR, which started up in April, 1991, and suspended operations at the end of January, 1992, due to a combination of odor-control and financing problems.[11]

There are roughly a dozen smaller-sized MSW compost facilities in the United States, as well as several under construction or in start-up operations, including a 600-ton-per-day facility in the Fort Lauderdale, Florida area. In addition, there are several dozen large-scale MSW-composting facilities operating throughout the world. For a listing of the major facilities in the U.S., see Appendix Volume 4.1, "Compost Technologies," Section 4.3.2.

9.2 Sludge Composting.

Sludge composting is the rapid decomposition process in which the volatile organic constituents (such as sugars and some cellulosic products) in dewatered sewage sludge are broken down microbially under controlled aerobic conditions into stable organic compounds. The micro-organisms decompose organic matter into a stabilized organic residue with a release of carbon dioxide and water. Heat generated during this process reduces the number of pathogens in the sludge and promotes the evaporation of water. The compost system requires air to keep the system aerobic so that odors are minimized, so that excess water can be removed, and so that the temperature of the pile can be maintained in a sufficient range to ensure pathogen kill but also encourage optimal microbial activity.

The experience with sludge composting in this country is slightly longer than that for MSW composting (eight to ten years for sludge, versus only a couple of years for MSW), and over 200 sludge-composting plants are currently operating in the U.S. (as opposed to only about 10 for MSW).

One of the major differences between composting sludge and municipal solid wastes is that, since dewatered sludge is a semi-solid material, it requires the addition of a dry, granular "bulking agent" to reduce the overall moisture level and to increase porosity to allow for better air circulation. Such bulking agents may be chipped wood, brush, leaves, or chipped tires. A second major difference between sludge and MSW is the amount of nitrogen in sludge compared to that in mixed MSW. The additional nitrogen is in the compost composition, and may enhance its value relative to leaf or mixed-waste compost. Since sludge has a relatively low carbon-to-nitrogen ratio, the addition of carbonaceous bulking agents may also enhance the value of the finished compost as a soil conditioner.

A third major difference between sludge composting and MSW composting is the time it takes to stabilize the material. Sludge composters frequently have a 15- to 21-day active compost period followed by a 30 to 36-day curing period. A final difference is that there is much more experience in handling sludge in in-vessel systems than in handling mixed MSW.

Wood chips are used most commonly as the bulking agent for static-pile facilities, and sometimes are used for windrow facilities. These chips can be provided by land developers, by commercial brokers, or by landscapers. A survey indicated that over 11,500 tons per week of wood chips are available locally -- much more than would be required for all of the City's sludge-composting needs -- at an average price of $30 per ton. Alternatively, ground wood wastes or brush chips can be used in the static-pile process, provided they are not contaminated with heavy metals, such as lead. A compost demonstration study at Ward's Island showed high lead levels in several samples of supposedly-clean ground demolition wastes. A number of grinders in the New York City area have expressed an interest in providing chips at the cost of transportation. Sawdust or finely ground wood wastes are used most commonly as bulking agents for in-vessel systems. Approximately 2,000 tons per week of sawdust is currently available to the City at a cost of $30 per ton.

There are eight in-vessel compost vendors that have operating systems in the United States. These vendors have up to six years in the American market and have each experienced some successes, as well as some failures. The most significant failures have involved odor control and materials-handling problems.

9.3 Composting Mixed Waste Streams.

The composting of mixed waste streams is often called co-composting. The wastes most commonly combined are sludge and either yard wastes or mixed MSW. When yard waste is used, it generally replaces the bulking agent in the sludge mix. In order to do this, the yard waste needs to be pre-processed by grinding or shredding, and mixed with the sludge to obtain a starting mix which is at least 40 percent solids. Wet yard waste and grass do not make good bulking agents.

If mixed municipal waste and sludge are co-composted, the sludge tends to serve as a moisture source for the process, and the sludge is mixed with the processed municipal wastes in place of water. The compost process remains unchanged from straight solid-waste composting. The sludge provides nitrogen and other nutrients to the compost.

If sludge is used in any compost, the regulations covering sludge composting will take precedence. Thus, when the new U.S. EPA 503 regulations are in place, they will cover use of co-composted materials. The current NYS Part 360 rules cover all forms of co-composting.

9.4 Markets/End Uses.

The compost products that result from the most feasible composting options are sewage-sludge compost, municipal-solid-waste compost, food-waste compost, and yard-waste compost. In addition, a variety of co-composts may be produced. The marketability of a compost product is largely dependent on the quality or overall physical and chemical characteristics of the product. Table 9.4-1 compares nutrient content, carbon-to-nitrogen ratio, salinity, total contaminants, foreign material, and particle size of the five compost products that could be produced from New York City wastes. Food-waste compost has the most desirable characteristics, followed by sewage-sludge compost, yard-waste compost, co-compost (sludge and other), and municipal-solid-waste compost.

Table 9.4-1: Rating of Various Compost Products According to Key Characteristics

Compost Type	Nutrient Content	C:N Ratio	Salinity	Total Contaminants	Foreign Material	Particle Size
Sewage Sludge	1	1	1	3	1	1
MSW	3	3	3	3	3	3
Co-Compost	2	2	3	3	2	2
Yard Waste	3	3	1	1	3	3
Food Waste	1	1	2	1	2	1

RATING SYSTEM:
1. Desirable level.
2. Acceptable level.
3. Undesirable level.

9.4.1 Existing Markets/End Uses.

Public and private-sector markets for compost products were identified in the New York City area. These potential market sectors have been further subdivided into specific agency and end-user categories. A potential compost market is defined as a private or public group that uses materials that may be substituted for, in part or whole, by a compost product. These materials typically include topsoil, peat, compost, and other organic soil amendments.

The range of compost usage for potential compost markets in the New York City area is 1,625,300 to 3,898,500 cubic yards per year. This was determined by applying substitution rates based on the specific requirements of each user group to the amounts of materials currently used that can be replaced readily or augmented by compost products. Table 9.4.2-1 summarizes the size of potential compost markets by individual user groups.

9.4.1.1 Public-Sector Markets.

1.1 to 2.4 million cubic yards per year of compost could be used as daily cover for the Fresh Kills landfill or for final-closure operations at the City's closed landfills; this represents over 50 percent of the potential markets identified.

The requirements for daily cover operations are generally well matched with the characteristics of all Class II composts with particle sizes up to 25mm that are blended with traditional fill dirt at a 1:4 ratio. Final-closure functional requirements are similarly well matched with Class II composts applied at aggregate 1:8 ratios. The most significant barrier to realizing this market is the case-by-case approval of NYS DEC regulatory staff. Composts have not been used as daily cover on a large scale in New York State.

Other New York City agencies create a potential market demand for compost products in the range of 108,000 to 288,000 cubic yards per year. Public agencies have numerous potential on-going uses for compost, including creating and maintaining parks, lawns, ballfields, golf courses, road embankments, and median strips. Effective communication of health risks and benefits to affected parties will be necessary in order to realize this market potential.

Airports owned and operated by the New York/New Jersey Port Authority represent a significant potential market that could be on the order of 110,000 and 147,000 cubic yards per year. The three major airports in the New York Metropolitan area have large grass-covered areas adjacent to runways and buildings. In general, airports have minimum maintenance programs and are unlikely to incur additional expenses to receive, store, and apply composts. In order to realize this market potential, it is

Table 9.4.2-1: Potential Compost Markets in the New York City Area

Market	Low Range (cy per year)	High Range (cy per year)
Public Sector		
NYC Parks and Recreation	69,150	207,500
NYC Housing Authority	36,500	73,250
NYC Shade Tree Commission	2,800	7,000
NY/NJ Port Authority	110,250	147,000
NYC Department of Transportation	2,250	5,600
NYC Department of Sanitation and other NYC Area Landfills	1,180,700	2,450,000
Private Sector		
Landscapers	49,300	355,800
Nurseries	56,600	214,000
Golf Courses	7,300	42,800
Soil Dealers	75,000	265,200
Sod Farms	97,500	390,000
Cemeteries	11,250	52,500
Mine Reclamation	14,000	42,000
TOTAL MARKET FOR COMPOST PRODUCTS[1]	1,712,600	4,252,650
Adjustment for Double Counting of Soil Amendment Markets		
Soil Dealers	(75,000)	(265,200)
Landscapers	(12,300)	(88,950)
TOTAL MARKET FOR COMPOST PRODUCTS[2]	1,625,300	3,898,500

NOTES:
1. Markets may not be totally additive.
2. Total accounts for repetitive use of products.

likely that the City would be required to finance the transport and application of composts at area airports.

9.4.1.2 Private-Sector Markets.

Soil dealers, sod farms, nurseries, and landscape contractors are the primary private-sector users of soil products, and thus represent the lionshare of potential markets for compost products. Sod farms, although they are the largest single private-sector user group, are not considered an easily accessible market, because of their distances from the City.

Soil dealers traditionally have been the primary distribution network for most soil products. They are the link between the source of material and the consumer, and often provide the service of product delivery. Soil dealers are in general quite knowledgeable about the benefits of using compost in their operations, and are quite supportive of this concept. Price and consistent quality are the factors that will most significantly influence their use of compost products.

Nurseries represent a major potential compost market, especially for sludge compost which is higher in nutrients. However, nursery operations are generally sensitive to variations in product quality, and operators are reluctant to experiment with unknown soil products. High-value plant products grown at nurseries may be lost if poor quality soil amendments are used. For this reason, demonstrations, independent growth trials, consistent compost quality, and careful follow-up by market agents is necessary to gain a significant share of the potential nursery market.

Landscape contractors show a high level of interest in using compost products. They tend to be more willing to try a different material than are the managers of nurseries and golf courses. Price and availability are the primary factors affecting use by landscape contractors.

Golf courses, cemeteries, and mined-land reclamation projects represent a smaller market potential in the New York City area.

9.4.1.3 Regulatory Quality Standards.

All the major markets identified in the New York City area can be largely satisfied with a compost that meets the New York State Class II classification (see section 9.5.2). There may be a small need for compost products that meet New York State Class I requirements. The greatest, and perhaps only need for a Class I compost is as a soil amendment for vegetable gardens. The potential Class I market accounts for approximately one percent of the total New York City-area potential market. Class I compost can be produced from either yard waste or source-separated food-waste compost. It is unlikely that New York City sludge or mixed MSW could produce a Class I compost consistently.

9.4.2 Market Potential By Compost Type.

The characteristics or quality of a compost dictate the potential end-uses of the product. The application of compost products varies in each potential market; consequently, each market has different priorities in regards to compost characteristics. Table 9.4.2-2 shows the types of composts preferred by the various user groups.

Table 9.4.2-2: Preferred Use of Compost Products by Potential Compost Markets, Based on Quality.

USER	USE	PREFERRED USE OF POTENTIAL COMPOST PRODUCTS
COMMERCIAL		
Landscape contractor	soil amendment	GC > SS = CO > MSW = YD
	mulch substitute	GC > YD > SS = CO-MSW
Sod farmers	soil amendment	GC > SS = CO > MSW = YD
	fertilizer substitute	GC > SS
Nurseries	potting mix component	GC > YD > SS = CO = MSW
Golf courses	soil amendment	GC > SS > YD > CO = MSW
	topdressing	SS
Groundskeeping	soil amendment	GC > SS > YD > CO = MSW
	mulch substitute	YD
	topdressing	SS > CO
Cemeteries	soil amendment	GC > SS > YD > CO = MSW
	topdressing	SS > CO
GOVERNMENT/PUBLIC AGENCIES		
Public Parks	soil amendment	GC > SS > YD > CO = MSW
	topdressing	SS > CO
Roadsides	soil amendment	GC > SS > YD > CO = MSW
	topdressing	SS > CO
Groundskeeping	soil amendment	GC > SS > YD > CO = MSW
	topdressing	SS > CO
LAND RECLAMATION		
Landfill cover	cover material	GC > YD > SS = CO = MSW
Strip-mined lands	soil amendment	GC = YD > SS = CO = MSW
Sand and gravel pits	soil amendment	GC > YD > SS > CO = MSW
RESIDENTIAL	soil amendment	GC > YD > SS = CO = MSW

KEY:
GC: Green Compost (i.e., source-separated organics)
SS: Sewage Sludge Compost
MSW: Municipal Solid Waste Compost
CO: Co-Compost
YD: Yard Waste Compost

9.4.3 Market-Development Program.

The amount of compost that is marketed will depend on the quality and intensity of the marketing program. The low and high market estimates presented in this study are intended to reflect the result of two different marketing programs after a three-to-five-year period. The achievement of either market estimate will require an intensive marketing program that features a quality-control/testing program, product demonstrations, education programs, delivery systems, and application services. New York City can aid in the market plan by ensuring that all specifications and bid documents require the use of compost on City-sponsored projects. The City can also make a policy of using compost to re-vegetate park lands.

The State of New York can likewise specify the use of compost products on any State-funded programs.

The City should work with the private sector to develop a good distribution network to ensure that the compost is available to all potential users on a timely basis. The City should also work with various universities and trade groups to develop research-and-demonstration projects.

Finally, the City and State should work to ensure that the compost product can be used in landfills as a daily-cover material, and in all landfill closures.

9.5 Regulatory Requirements.

9.5.1 Operational Regulations.

The siting of compost facilities and their operational requirements are currently covered by 40 CFR 257 at the Federal level and by 6 NYCRR Part 360 at the New York State level. The Part 257 regulations cover siting of any solid-waste facility, and define several siting criteria to protect the environment. These criteria include flood plains, endangered species, surface water, groundwater, air, safety, and disease. For the disease criteria, Part 257 defines operational criteria to achieve two defined levels of "pathogen kill." "Processes to significantly reduce pathogens" (PSRP) require that the composting mass maintain a minimum operating temperature of 40°C for five days, and achieve a temperature of 55°C for at least four hours during this time. A higher level of pathogen kill is achieved by meeting the "process-to-further-reduce-pathogen" (PFRP) criteria. These criteria require that the compost reach 55°C or greater for three days, with the static pile or in-vessel composting methods, or 55°C or greater for 15 days, with at least five turnings, by the windrow method. If the PFRP criteria are met, there are minimal constraints on use of the compost from a pathogen-kill perspective.

6 NYCRR Part 360 covers all aspects of siting and permitting for a solid-waste compost facility. This regulation establishes record-keeping requirements, sampling protocols, and incorporates the Part 257 pathogen-kill requirements.

9.5.2 Use Regulations.

The 40 CFR 257 and 6 NYCRR Part 360 regulations are the only regulations that currently set standards for the end product. The U.S. EPA is in the process of finalizing the Part 503 sludge regulations, which will supplant the Part 257 regulations and serve as the basis for modifications to the Part 360 regulations. All of these regulations set maximum loadings for cadmium, chromium, lead, copper, zinc, mercury, nickel, and PCBs. These limits control the methods in which the compost can be used. The regulations also limit the use of the product in most cases to non-agricultural areas.

The Part 360 regulations create two classes of compost. Class I compost, which has more stringent pollutant limits than does Class II compost, is considered a "beneficial use product" rather than a "solid waste." The respective standards for these two classes of compost are presented in Table 9.5.2-1.

Table 9.5.2-1: Class I and II Compost Comparitive Standards

Parameter	Class I (ppm dry weight)	Class II (ppm dry weight)
Mercury	10	10
Cadmium	10	25
Nickel	200	200
Lead	250	1000
Chromium - total	1000	1000
Copper	1000	1000
Zinc	2500	2500
PCBs	1	10

9.6 Compost-System Impacts.

The differential cost and environmental impacts, as well as the differential impacts of alternative compost systems in terms of reducing the waste stream, as with the case with recycling facilities, are not primarily a function of the type of composting system or facility per se, but of the way that a particular composting program is integrated into an overall waste-management system. These compost-specific factors are addressed in the evaluation of alternative waste-management scenarios in Chapter 17.

9.7 Viable Program Options.

Composting of various waste streams is a proven technology around the world. However, due to constraints on markets for the final material, regulatory constraints, and the relatively large land-area requirements, some materials are more viable for composting than are others. The most viable options at this time are to compost the City's sewage sludge with yard waste and clean ground demolition wastes in either a static-pile or agitated-bed in-vessel compost system, to compost source-separated food wastes in either agitated-bed in-vessel systems or smaller, specially designed composters, depending on the volume of materials collected at a given point, and to consider developing an MSW compost facility to produce landfill cover-material, initially, while broader markets are developed. This compost can be mixed with dredge spoils and other materials to produce artificial topsoil mixes.

Endnotes

1. See Appendix Volume 4.1 for a complete description of composting systems.

2. This is clearly the most preferable option from an environmental and cost standpoint. The obvious attractions of leave-it-on-the-lawn systems are reflected in the number of lawn-care companies that are catering to the demand for finer-cutting mowers (although specialized equipment is not necessary), new slower-growing grass species (see, e.g., Biocycle, March, 1991, p.4), and by the number of states refusing to accept grass clippings (and in some cases other yard waste) in landfills or waste-to-energy facilities.

3. Biocycle, loc. cit.

4. A useful book on the subject is Worms Eat My Garbage by Mary Appelhof, Kalamazoo, MI, Flower Press, 1982.

5. See Appendix Volume 4.1, "Source-Separated Compost Collection," p.158.

6. (Assuming that leaves make up about half the total amount of leaf-and-yard waste.)

7. Appendix Volume 4.1, "Source-Separated Compost Collection," Appendix 3-3, p.33.

8. ("Food-waste" compost programs may also include some amount of contaminated paper.)

9. An extensive table describing containers for both single and multi-family buildings is found in Appendix Volume 4.1, "Source-Separated Compost Collection," pp. 95-96.

10. Appendix Volume 4.1, "Source-Separated Compost Collection," pp.130, 138.

11. Biocycle, February 1992, p. 6.