CHAPTER 6
PROJECTED RECOVERY RATES

Summary

This section begins by presenting materials-recovery projections for a theoretical, New York City Research and Development Pilot Materials-Recovery and Composting Facility (“pilot MRC facility” or “pilot facility”), as described in Chapter 5. A discussion follows providing the various assumptions that inform these projections, including NYC waste-composition data and interviews with managers of mixed-waste materials-recovery facilities (MRFs). The recovery-rate projections are then combined with the throughput data provided in Chapter 5 to arrive at an estimated, total annual recovery rate for such a pilot facility.

Annual recovery-rate projections for a theoretical, pilot MRC facility allow for a comparison with the recovery rates achieved by the four surveyed MSW-composting facilities (described in Chapter 3), as well as those achieved during the NYC Composting Trials (described in Chapter 1). Such information is useful in understanding how a pilot MRC facility would attempt to meet the dual goals of lower residue and higher recovery rates, presented in Chapter 4. What is not recovered by a pilot facility, conversely, would have to be discarded as residue. Recovery-rate estimates are important therefore in determining residue rates, which in turn are a key component of the estimated, pilot-facility operating costs, presented in Chapter 7.

Projected Materials-Recovery Rates

A pilot MRC facility, as conceptually outlined in Chapter 5, essentially consists of an MSW-composting facility with a mixed-waste MRF on the front end. To estimate how much material such a facility might recover for recycling, and how much material would still require disposal as residue, the Department relied on the following sources:

- NYC waste-characterization data
- Consultants with design experience in either MSW-composting and/or materials-recovery facilities (MRFs)
- Interviews with facility managers at mixed-waste MRFs
- The Department’s own experience conducting the MSW-Composting Research Project

Waste Composition

Before estimating what a pilot facility might recover, the Department needed to know what might be in the waste stream arriving at such a facility. The Department turned to the waste characterization that was performed in conjunction with the NYC Composting Trials. It should be noted that there are some shortcomings associated with using this data, namely that it is not citywide, nor seasonal, nor does it take into account the suspension of glass and plastic recycling that went into effect in July 2002. Therefore, the percentage of yard waste might be low (since the characterization took place in February), as might be the respective percentages of glass and plastic.

That being said, the data itself is representative of the Sanitation District (Staten Island 2) from which it was collected, and is much more recent than the last citywide, multi-season, waste-characterization effort, undertaken in 1989/1990. (For more information about the waste characterization conducted as part of the NYC Composting Trials, see Chapter 1. Appendix A contains the consultant's final report and the actual waste-characterization data.)

The average composition by weight of the various components of the waste stream (the second column listed in Table 6-1 on the next page) comes from the summary of the NYC Composting Trials waste characterization presented in Table 1-1 of this report. However, while Table 1-1 groups materials as "Compostable" and "Non-Compostable," Table 6-1 adds the category, "Recyclable."

Recovery Goals

A pilot MRC facility's pre-composting, materials-recovery process should have three primary goals:

- Send as much paper and paper products to the composting drums as possible
- Prevent as much non-degradable material (especially glass and film plastic) from going to the composting drums as possible
- Recover as many non-degradable recyclable items as possible

Recovery Rates

The projected recovery rate column in Table 6-1 presents the estimated percentage of each material that a pilot MRC facility could potentially recover, and conversely, what percent would require disposal as residue.

To better understand the assumptions underlying these recovery-rate projections, the following sections review how different material fractions of the waste stream will move through a pilot MRC facility, and where and how they will be recovered for recycling. For each material, the section provides the projected recovery rate and the rationale that supports that projection.

Compostable Material

The broad goal for recovering compostable material is to send as much of the paper and other larger-sized, degradable items as possible to the composting drums, as this stream will produce a relatively clean, contaminant-free compost. The majority of the food and yard waste will be dropped out by the first set of screens in the pre-composting, materials-recovery process, along with the rest of the undersized fraction of the incoming waste stream (such as broken glass, bottle caps, etc). The aim is to isolate these small, non-degradable items and handle them separately, so that they do not contaminate the cleaner, mostly paper stream.

Paper

In some senses the entire, pre-drum, materials-recovery component of a pilot MRC facility (described in Chapter 5) can be seen as a positive sort for paper. This means that the various facility sort lines and screens are designed to pick out everything that is *not* paper. Therefore, all types of paper will be left on the conveyors to move to the digester tipping floor for composting.

Table 6-1
Projected Solid-Waste–Recovery Rate for a Theoretical, NYC Pilot Materials-Recovery and Composting Facility

Material Category	Average % Composition by Weight[1]	Projected Recovery Rate[2] %	Projected Solid-Waste Recovery[3] %	Projected Residue Rate %
Compostable Material				
Paper	32.1	100	32.1	0
Food Waste	15.9	90	14.3	1.6
Yard Waste	1.6	90	1.4	.2
Fines[4]	5.9	85	5.0	.9
Other Compostables	6.0	90	5.4	.6
Total Compostables			**58.2**	**3.3**
Recyclable Material				
Bulk Wood	3.4	95	3.2	.2
Plastic	15.4	25	3.9	11.5
Textiles	5.3	50	2.7	2.6
Glass & Ceramics[4]	5.2	0	0	5.2
Metal	3.1	95	2.9	.2
Total Recyclables			**12.1**	**19.5**
Other				
Large Composite Items	1.0	0	0	1.0
Other Non-Compostables	5.1	0	0	5.1
Total Other			**0**	**6.1**
TOTAL	**100.0**		**70.9**	**29.1**

1. Based on the waste-composition study performed in conjunction with the NYC Composting Trials; see Appendix A for the waste-composition data and final report.
2. Based on the findings of the Department's MSW-Composting Research Project and interviews with mixed-waste MRF managers.
3. Derived by multiplying "Average % Composition by Weight" with "Projected Recovery Rate %."
4. In the waste-characterization final report, fines were divided into non-degradable (3.5%) and unclassifiable (4.3%). According to the report, the non-degradable fines will become part of the compost (see Appendix A, *Waste Characterization for Composting Pilot Study,* p. 15) and therefore are listed under "Compostable material." However, as a portion of the unclassifiable fines was broken glass beverage containers, 45% (conservatively) of the unclassifiable fines have been assigned to the glass and ceramics category.

This includes incorrectly placed, designated paper items from NYC's curbside recycling program (newspapers, magazines, cardboard boxes, office paper, envelopes, etc.), as well as non-designated paper items (such as paper towels and napkins). Given that paper is the largest component of the waste stream, even post-recycling (32.1 percent by weight; see Table 6-1), this overall facility approach makes sense.

However, large sheets of corrugated cardboard would be removed on the first sort line, as these items tend to "blind" materials-recovery screens. "Blinding" in this instance refers to the phenomenon whereby small items ride on top of larger items, such as sheets of cardboard, and therefore fail to pass under the screens designed to remove them. Depending on what proved to be operationally and economically sensible, the facility would either bale this cardboard for recycling or send it through the composting drums.

The Department gained some understanding of the issues involved with composting the paper fraction of the waste stream from its survey of MSW-composting facilities (see Chapter 4 for more information). The Marlborough facility manager reported that without an automated compost-turning system, it was difficult to completely degrade the lignin in paper products (especially corrugated cardboard) in the 21 days that material resides on their air floor. Lignin (the large polymers that cement cellulose fibers together in wood) decomposes slowly because its complex structure makes it highly resistant to enzyme attack.

Even with an automated turning system on its air floor, and material-retention time of 42 days, 38.16 percent of the material passing over the Conporec facility's final screen consisted of paper. On the other hand, after 21 days on its automated air floor, only 2.09 percent of the material passing over the Edmonton final, facility screen was paper (see Table 4-2 for the percent of compost and other degradable material in Edmonton and Conporec final screen overs). It is difficult to know whether Edmonton successfully composts the paper fraction of the waste stream because of its effective air floor, its use of highly nitrogenous biosolids, or because there is less paper coming into the facility. Compared to Marlborough and Conporec, Edmonton may be receiving less paper because it does not process commercial solid waste from supermarkets, which often contains a lot of corrugated cardboard.

Building on this learning, the design for the hypothetical pilot facility allows for retaining composting material on an automated air floor for over 50 days, in order to fully degrade the paper fraction of the waste stream. If paper is still in the final screen overs, then these overs will be sent back through the composting process (as explained in Chapter 5). This, combined with the fact that the entire facility will be geared toward capturing paper, leads to the assumption presented in Table 6-1 that the facility will recover 100 percent, or all paper, available.

Food and Yard Waste

The projected recovery rate for these items is more difficult to predict than paper. This is because few mixed-waste facilities attempt to segregate food and yard waste up-front. MSW-composting facilities do not segregate this material, but leave it in garbage bags, mixed with other fractions of the solid-waste stream. Mixed-waste MRFs, on the other hand, do not generally attempt to recover food and yard waste for recycling. Rather, they leave these materials for disposal, as sort line workers can concentrate on recovering conventional recyclables, such as metal, plastic, and paper. The experience of both types of facilities informs the projected recovery rate for food and yard waste at the pilot MRC facility.

The pilot MRC facility is designed to separate out the majority of food and yard waste at the first set of screens in the materials-recovery building (see Illustrations 5-5 and 5-6 in Chapter 5). Material arrives at these screens after going through the bag openers and moving past sort line workers, who will tip the contents of these bags onto the conveyor belt (and remove the film-plastic bags).

The screens are vibrating finger screens, which are commonly used in mixed-waste MRFs to remove the small-sized fraction of the waste stream. Depending on the size setting, these MRFs will employ such screens to generate, for example, a “four-inch-under” (<4") stream or a “three-inch-under” (<3") stream. Based on the experience of other MRFs that accept mixed waste, the vibrating finger screens remove the majority of the food and yard waste, along with broken glass and other small, non-degradable items. Pilot facility operators would remove incoming brush and other large, woody waste off of the tip floor, or the elevated, primary, pre-drum sort line (see *Bulk Wood,* which follows). Some fraction of the food and yard-waste stream that is larger than the vibrating finger screen setting, such as bones, twigs, and smaller pieces of brush, would pass over this screen, but the majority would pass under.

As noted in Chapter 5, the City of Industry mixed-waste MRF in Los Angeles sends its incoming material to a bag breaker and then to a vibrating finger screen with a three-inch setting. They report that 10 percent of the incoming material passes under these screens, with the unders largely comprised of food and yard waste and broken glass. The City of Industry’s facility disposes of these unders. However, a mixed-waste MRF in Medina County, Ohio (population 50,000), currently processing 550 tons of mixed waste a day, composts these unders. After sending incoming MSW through a bag-breaking trommel, this MRF takes the unders and composts them in outdoor windrows. While the actual screen-size setting is proprietary, the owner reports that similar to the L.A. MRF, unders comprise approximately 10 percent of the incoming material.

Again, the pilot MRC facility (as described in Chapter 5) is designed to drop out the majority of food and yard waste at the first set of materials-recovery (vibrating finger) screens, which would be located after the secondary sort line (film plastic picking station). This glass-laden organics stream would move under a magnet to remove any small ferrous items, and then continue to a designated digester drum, separate from the the clean paper stream. Upon discharge, facility operators would screen this material and/or de-stone it to separate the glass and other small non-degradable items (such as bottle caps, etc.) from the immature compost. The compost could be sent back through one of the two general materials digester drums, or moved directly to the First-Phase Composting building (see Illustration 5-1 for location).

What is known from MRFs handling mixed waste is that debagging incoming waste and sending it to a vibrating screen will drop out most of the food and yard waste (along with most broken glass, bottle caps, and other small, non-degradable items). What is also known is that due to the presence of food and yard waste, this unders stream is compostable. What is known from MSW-composting facilities is that it is possible to separate compost from small pieces of glass and other non-degradable items through de-stoning. This is especially true when the material is dry and run through the de-stoner slowly, in relatively small batches. However, as no facility to the Department’s knowledge has documented experience with this procedure as a whole, this would be a research component of any pilot facility.

The assumption is that a pilot MRC facility would recover a significant fraction of food and yard waste (90 percent), but that a portion (10 percent) would still be lost to overs during the post-drum screening and de-stoning process. It should be noted that the facility could also process loose (unbagged) yard waste from commercial landscapers. Based on the Department’s experience, this material is generally free of non-degradable contaminants and could therefore by-pass the materials-recovery and digester-drum components of the pilot facility, moving instead directly to the First-Phase Composting building. However, the facility recovery rate projections and cost estimates do not take this type of material, or potential revenue stream, into account.

Fines and Other Compostables
Fines are very small pieces of material, such as sand, dirt, ashes, cat litter, etc. Some fines are so small that they cannot be categorized. The consultant conducting the waste characterization divided fines into "non-degradable fines" (3.5 percent) and "unclassifiable fines" (4.3 percent). (See Table 1-1.) In the final report (attached as Appendix A), the consultant notes that (despite the "non-degradable" designation) most of the non-degradable fines will become part of the compost. Therefore, Table 6-1 combines these two types of fines into one and places them under the compostable material category. However, as explained in the *Glass* section later, broken glass was categorized with "unclassifiable fines." Assuming that just under half of the fines (45 percent) consisted of broken glass, 45 percent of the "unclassifiable fines" category in Table 1-1 was added back to the "glass and ceramics" category in Table 6-1. (In other words, glass and ceramics increase from 3.3 percent in Table 1-1 to 5.2 percent in Table 6-1.)

These fines would drop out with the food and yard waste (along with most broken glass, bottle caps, and other small, non-degradable items), passing under the first set of materials-recovery screens. These are the vibrating finger screens described in the *Food and Yard Waste* section above. The fines would travel with these unders to the designated digester drum and through the post-drum trommel screen and/or de-stoning equipment. The recovery-rate projection for fines is based on the assumption that the majority of what the waste characterization classified as non-degradable fines would become part of the compost, as would a portion of the unclassifiable fines (that are not broken glass). However, some fraction of the unclassifiable fines would be non-degradable. Given the New York State Department of Conservation (DEC) requirement that a final compost contain particles no larger than ten millimeters (three-eighths of an inch), these non-degradable items will pass over the final screen for disposal as residue. Therefore, the projected recovery rate is lower for fines (85 percent) than for food and yard waste (90 percent).

The waste-characterization final report describes the category "Other Degradables" (labeled "other compostables " in Table 6-1) as including all small, readily degradable items that did not fit the definition of paper, food waste, or yard waste. This included such things as disposable diapers and their contents, sanitary napkins, animal feces, cut flowers, and dryer lint. At six percent, these items do not comprise an insignificant amount of the total waste stream.

Given the small size of most of these items, they would generally pass under the first set of vibrating finger screens (along with food waste, yard waste, fines, and small, non-degradable items), and move to the designated digester for composting. The exception to this would be disposable diapers. The vibrating nature of the screens might shake out the contents of the diapers, while the diapers themselves passed over the screens to be removed on the next set of sort lines. Due to the "compostability" of this material, the recovery-rate assumption for the items within the "other compostables" category is the same as that for food and yard waste (85 percent).

Recyclable Material

A pilot facility's broad goals for recovering potentially recyclable items in the waste stream are to remove textiles early in the process, before they become wet and soiled, and to capture as much wood, metal, and designated plastics as possible. If it proved possible to separate clean, dry textiles, these would be diverted for disposal to avoid the heavy residue problem described in Chapter 4. Metal and certain plastics have known value as recyclables, while wood will be easy for a facility to grind and incorporate into the composting process. With regard to glass and other plastics (that a facility did not designate for recovery), the recovery goals are aimed first at diverting these problematic materials from the composting process, and then second, determining if it is worth recovering them for recycling. Film-plastic bags and broken glass are especially pernicious in the composting process and the materials-recovery component of the pilot facility will make every effort to divert these items before they go to the composting drums.

Bulk Wood

Bulk wood items (such as plywood, lumber, uprooted shrubs, and tree branches) are easy to identify and remove. As is currently the case at MSW-composting facilities and mixed-material MRFs, the grapple crane operators at the proposed pilot facility can pick this material out and move it into containers on the facility tipping floor. Workers on the elevated, primary, pre-drum sort line would intercept any bulk wood that the crane operators miss (see Illustration 5-2). A tub grinder at the facility would shred this material along with brush into chips, which facility operators could load directly into either the first- or second-phase composting process. Wood chips are an ideal bulking agent for compost, as their structure provides porosity and therefore air space in dense, decomposing material.

Wood chips that do not break down by the end of the second-phase composting process would pass over the final facility screen. Facility operators could run these woody overs back through the composting drums, or through either the first- or second-phase composting process. Therefore, it is assumed that the pilot MRC facility would recover 95 percent of woody materials.

Plastic

Plastic is a more complicated material category for which to project a recovery rate for two reasons. First, it is difficult to predict to what degree sorters will be able to pick out different types of plastics, and to what degree it will be worth the effort. Second, the waste characterization associated with the NYC Composting Trials grouped all plastics together and did not distinguish recyclable from non-recyclable items. For example, the 15.4 percent of the waste stream characterized as plastic in Table 6-1 includes both plastic garbage bags (non-recyclable) as well as PET and HDPE bottles (recyclable plastics). "Recyclable" in this instance means plastics with well-established, secondary-use markets.

The pilot MRC facility is designed to recover large plastic items that arrive at the facility loose (not in bags), on the primary, pre-drum sort line (see Illustration 5-2). Sort line workers will remove both large, recyclable, plastic items, such as five-gallon plastic buckets, as well as large, non-recyclable, plastic items, such as plastic furniture and laundry baskets.

After the material that arrives at the pilot facility in bags has gone through the bag openers and workers on the secondary sort line have emptied the bags (and separated the film plastic for disposal), the material passes over the first set of vibrating finger screens (see Illustrations 5-5 and 5-6). Very small pieces of plastic, such as bottle caps, broken toys, etc. would pass under these screens and move with the other undersized items (such as food waste, yard waste, and broken glass) to the designated digester for composting as described in the *Food and Yard Waste* section above. After composting, these small, hard plastic items would ultimately be separated from the immature compost through screening and de-stoning, and would be disposed of as residue.

Small, plastic items that are larger than the vibrating screen setting (greater than 2.5 inches), both recyclable (such as bottles and jugs) and non-recyclable (such as plastic deli containers) would pass over this screen and on to the final sort line (see Illustration 5-8). Workers would sort the recyclable from the non-recyclable, removing as much plastic as possible. A mixed-waste MRF manager in Oakland, California, interviewed by the Department's consultant, reports that the vibrating finger screens not only serve to drop out the undersized fraction of the waste stream, but also spread the remaining materials out on the conveyor belts so that sorters have a good visual presentation of what is moving past them.

Given the emphasis on removing both film plastic (primarily in the form of plastic garbage bags), as well as other types of plastic (both recyclable and non-recyclable), a pilot MRC facility would most likely divert the majority of plastic items before they reach the composting process. However, how much of this material would be recyclable is harder to predict.

The projected recovery rate for plastic assumes that film plastics, and other non-recyclable plastics that would require disposal as residue, would comprise 50 percent of the total incoming plastics stream. Of the remaining 50 percent, it is assumed that sort line workers would capture only half for recycling, with the other half also requiring disposal. Therefore, the projected recovery rate for the plastic materials category is 25 percent.

Textiles

Textiles comprised 5.3 percent of the waste stream that the Department sent to Marlborough for the New York City Composting Trials. This is the second-largest, non-degradable category of material after plastics. As a waste category, textiles includes such items as rugs, carpeting, towels, cloth napkins and place mats, curtains, pillows, bedding, and all types of clothing, including coats.

Visual inspection of the New York City MSW arriving at the Marlborough facility revealed that these textiles primarily took the form of carpets, as well as whole bags full of clean, discarded clothes, blankets, and curtains. That generators tend to separate these items from other parts of the waste stream makes sense, as people will set bags of old clothing or bedding aside when cleaning out their closets, basements, or attics. The Marlborough facility was not designed to sort for textiles before they went to the digester drums for composting. However, it seemed that if workers were sorting for these items, it might be possible to segregate these materials from others in the waste stream.

The pilot MRC facility design seeks to recover textiles as soon as material is de-bagged. To review, incoming, bagged MSW would pass over the bag breakers, which serve to slash bags (see Illustration 5-3 and 5-4). A conveyor leading from the bag breakers deposits the slashed bags into a surge pile, from where they are loaded by a grapple crane onto another conveyor, leading to the second elevated sort line (see Illustration 5-5). Workers on this sort line pick up the slashed bags, empty their contents onto the conveyor, and throw the film plastic bag into a cage below for baling and disposal. Another set of workers picks out garbage bags that the bag breaker missed, as well as any smaller, sealed bags that were inside the larger garbage bags, and drops these into containers below for re-processing through the bag breakers. A final set of workers positioned in between these two stations would assist in both tasks, but would also pick out all clean, dry textiles and drop them into separate containers below, before they became contaminated with other fractions of the waste stream.

Of all of the projected materials-recovery rates, the estimate for textiles is the most speculative. It is unclear to what extent the bags of clothing, curtains, bedding, and other items will remain relatively uncontaminated with other material fractions of the waste stream as they pass over the bag openers and move to the surge piles. None of the mixed-waste MRFs interviewed by the Department's consultant attempt to recover textiles through their respective processes, so there is no precedent to confirm the recovery-rate estimate, as there are for other projections presented here.

The post-consumer textile industry generally accepts any used clothing item and household textile article such as pants, dresses, hats, shirts, drapes, curtains, blankets, towels, sheets, handbags, belts, and paired shoes. However, they must be dry and in clean condition (meaning free from any contamination by water, chemicals, etc.). Textile recycling companies will then sort the material and sell it, depending on its quality, as usable clothing (for export or wholesale markets), or as wiping products, or to the fiber market. (Many products made from recycled fiber are used in the automotive industry, such as soundproofing for auto engines and carpet padding.)

Again, it is unclear if workers will be able to pull textiles off the passing conveyor belt before they become wet, soiled or otherwise unacceptable to the post-consumer textile industry. The facility recovery estimates assume that 50 percent of the incoming textiles will be unrecoverable. Conversely, the facility recovery-rate projection for textiles is 50 percent, which given textiles susceptibility to contamination may be optimistic.

Glass

Capturing glass would be as important an objective for a pilot MRC facility as capturing paper. However, whereas all paper would be directed to the composting drums, as much glass as possible would be diverted before it reached this stage.

Glass in the municipal waste stream is primarily found in various food and beverage containers. The waste characterization placed glass mirrors and ceramic items in the glass category, but did not include light bulbs, placing these in "Other Non-Compostables" instead. Two things are important to note about this data. First, as with plastic containers, the waste characterization was performed before the suspension of glass and plastic recycling in July 2002. Therefore, the amount of glass in the waste stream will be higher after this date (until such a time that source-separated glass recycling is restored). Second, because broken glass beverage containers were too dangerous for the waste-characterization workers to handle, the consultant notes that the broken glass tended to end up in the "unclassified fines" category. As explained in the *Fines and Other Compostables* section earlier, 45 percent of the "unclassified fines" total was therefore subtracted from this category and added back to "glass and ceramics." Glass then represents a total of 5.2 percent of the waste stream.

Glass would arrive at the pilot facility in two forms: intact (or largely intact) and broken. As described previously, the first screen in the materials-recovery process is a vibrating finger screen, which is designed to drop out the small fraction of the waste stream. By testing different screen sizes at this point, facility operators would attempt to drop out as much of the smaller broken pieces of glass as possible. Many mixed-waste (as well as single-stream) MRFs attempt to screen out all of the broken glass early in the process, as broken glass is extremely abrasive and can damage conveyor belts and other equipment.

As explained in the *Food and Yard Waste* section earlier, a significant portion of the food and yard waste would also drop out at this stage. Therefore, this glass-laden–organics stream would be sent to a separate, designated composting drum and composted separately from the clean paper stream. Post-drum, pilot-facility screens and de-stoning equipment would separate and remove pieces of glass from this resulting compost.

The Ohio mixed-waste MRF (described in the *Food and Yard Waste* section earlier), which currently composts their primary screen unders, reports that this compost is obviously full of glass. Therefore, they now use this material as landfill cover. They are experimenting, however, with drying these composted unders and sending the material through a de-stoner in order to remove the glass and produce a more useful compost. At the time of this writing, trials with de-stoning at the Ohio MRF had yielded positive results, but a full-scale operation had not yet begun.

The whole bottles and containers and larger pieces of glass would move over the vibrating finger screen and on to the secondary, pre-drum elevated sort lines where workers would manually pick them out. In order for recycled glass to be valuable as an input for container manufacturers, it generally needs to be separated by color. The materials-recovery facilities (MRFs) that processed the City's metal, glass, and plastic routinely complained that crushed, mixed-color glass had very little value and no market outlets (other than as fill material in road and construction projects, or alternative daily landfill cover). These MRFs were able to market the larger pieces of intact glass containers that workers would manually segregate by color, although this accounted for very little of the total glass stream that they received.

In order to be conservative, the assumption behind the facility cost estimates and the recovery rates is that the facility would *capture* all glass, however, none of it would be recovered for recycling, and would therefore require disposal as residue. Recycling outlets would actively be sought for this material, but realistically it would not be prudent to assign any value to this material in advance. Another option besides traditional recycling of glass would be to use pulverizing equipment to crush all of the glass into sand. The sand could be used in the composting process. The preliminary pilot facility design and budget does not specify this procedure, but it is an interesting option that could be explored.

Metal
The waste characterization associated with the NYC Composting Trials revealed that 3.1 percent of the post-recycling waste stream was metal. Since DSNY wanted to know what if any metal items in the waste stream might contribute to the heavy metals content in the ultimate compost, the consultant performed a sub-sort to further characterize metals as aluminum, brass, copper, lead, pot metal, and ferrous metal. Of the 3.1 percent of the waste stream that was metal, ferrous items were present at the highest levels (1.4 percent), followed by aluminum (.75 percent). From a compost-quality perspective, the compost made in the NYC Composting Trials met all the DEC limits for heavy metals. From the perspective of recycling, almost all metal, especially ferrous and aluminum, have established, secondary-use markets.

A grapple crane would remove bulk metal items from the tip floor of the pilot MRC facility and place them into containers, which would move via truck to the Materials-Recovery Staging Area and ultimately to scrap metal processors. Workers on the first sort line would remove large metal items not in bags and missed by the grapple crane and drop them into containers below for recycling. An overhead magnet would pull out very small ferrous items that fall under the primary set of vibrating finger screens (see Illustration 5-7). After the incoming, bagged MSW moves through the bag openers and the secondary sort lines, it moves to a final set of sort lines, where workers would remove any small, metal items that passed over the vibrating finger screens, such as metal cans. Finally, as the material moves to the last set of (debris roll) screens before the composting process, a set of magnets would remove any ferrous metal items, missed by the sort line workers.

Given the many opportunities to remove metal, including two sets of overhead magnets, the theoretical pilot facility recovery-rate projection assumes that 95 percent of the incoming metal items in the waste stream would be recovered for recycling.

Other Material

Large, Composite Items
Large, composite items include such things as mattresses, furniture, large cushions, home renovation debris, and other items consisting of material from more than one waste category. The pilot facility is designed to remove these items on the tip floor via grapple crane, as well as on the first elevated sort line. While some of these items might be reusable by the goodwill industry, the projected recovery rate assumes that none of these items will be recovered for recycling or reuse, and that all of them would require disposal.

Other Non-Compostables
Non-compostable items (referred to as “non-degradables” in the waste-characterization final report) include all items that are not readily biodegradable and do not fit in any other waste category. These include, among other things, wood that does not fit the definition of bulk wood, concrete, asphalt, stones, medium-sized composite items, all footwear, lightbulbs, electronics, wiring, and cables. In the conceptual pilot facility design, the final sets of workers on both the first and final elevated sort lines remove these medium-sized, miscellaneous, non-compostable, non-recyclable items and drop them into containers below for disposal. Inevitably, workers will

Table 6-2
Projected Annual Inputs and Outputs for a Theoretical, NYC Pilot Materials-Recovery and Composting Facility

Material	Tons	Percent of Input Material
INPUTS:		
MSW Input[1]	90,600	60
Biosolids Input[2]	60,400	40
Total Inputs	**151,000**	**100**
OUTPUTS:		
Compost Output[3]	38,354	25
Loss of Mass[4]	73,506	49
Recyclables[5]	12,775	8
Residue Output[6]	26,365	17
RECOVERY		
Total Facility Recovery[7]	**124,635**	**83**
Recovery of Solid-Waste Fraction	**64,235[8]**	**71[9]**

Note: Assumes 302 operating days per year.
1. From Table 5-3 in Chapter 5.
2. From Table 5-4 in Chapter 5.
3. From Table 5-5 in Chapter 5.
4. Calculated by subtracting compost output, recyclables, and residue from total inputs. Loss of mass is attributed to loss of moisture and CO_2.
5. Using recyclable-material–recovery projections from Table 6-1 (14.1% of total MSW input).
6. Using residue-rate projections from Table 6-1 (29.1% of total MSW input).
7. Includes compost output, loss of mass, and recyclables.
8. Calculated by subtracting liquid input (biosolids) from “Total Facility Recovery.”
9. Based upon solid-waste input.

miss some of these items and they will pass over the materials-recovery screens and be loaded into the composting drums with the clean paper stream. As is the case at other MSW-composting facilities, these items will be screened out in the post-drum trommel screens for disposal.

Projected Annual Facility Recovery Rate

Table 6-2 contains the projected annual inputs and outputs for the theoretical, New York City Research and Development Pilot Materials-Recovery and Composting Facility described in Chapter 5. The pilot MRC facility would recover 83 percent of the total incoming material (MSW and biosolids), or 71 percent of the incoming MSW (exclusive of biosolids). The information in this table integrates the projected facility throughput rates presented in Chapter 5 with the materials-recovery and residue-rate information summarized in Table 6-1, and discussed above.

The data in Table 6-3 allows for a direct comparison of the proposed pilot facility with both the four, surveyed MSW-composting facilities, as well as the performance of the New York City material during the Composting Trials at Marlborough. While the actual number of annual operating days will vary slightly between facilities (and, of course, the NYC Trials was a limited pilot project), Table 6-3 compares the annual summary data from the proposed NYC pilot facility and the MSW-Composting Research Project.

The proposed pilot MRC facility is designed with the goal of achieving low-residue and high-recovery rates. As explained in Chapter 4, these attributes are the hallmarks of a successful facility. The following section briefly reviews the “desirable” and the “undesirable” outputs presented in Chapter 4 and summarized in Table 6-3, and describes how the pilot facility will meet its goal.

Table 6-3
Summary Data: Theoretical, NYC Pilot Materials-Recovery and Composting Facility and MSW-Composting Research Project

Parameter (% of total facility input)	NYC Pilot MRC Facility	Conporec	Edmonton	Marlborough	Rapid City	NYC Trials
Recovery Total Facility	**83**	75	61	64	64	65
Recovery Solid Waste	**71**	72	50	48	60	50
Compost Output	**25**	45	29	48	33	37
Recyclables	**8**	3	0	0	1	0
Loss of Mass	**49**	28	32	16	29	24
Residue	**17**	25	39	36	36	39

For source information, see the following tables: Table 6-2 (Proposed NYC Pilot Facility), Table 3-3 (Conporec), Table 3-5 (Edmonton), Table 3-7 (Marlborough), Table 3-9 (Rapid City), and Table 1-12 (NYC Trials).

Quality Compost Output and High Loss of Mass

As explained in Chapter 4, a successful facility will focus on making a quality compost product both from a regulatory and end-use perspective. A successful facility does not strive to make as much compost as possible, but rather seeks to actively manage the decomposing material in order to shed as much moisture and mass as possible.

The pilot facility will actively manage the composting material for over 50 days using highly automated air-floor processes, with the goal of maximizing loss of mass and creating a mature compost product. The pilot facility will actively manage the compost for longer than any of the surveyed facilities currently creating a finished product. This extended material-detention time will also allow facility operators to drop moisture levels towards the end of the composting process, in order to facilitate better screening and inerts removal. Conporec currently employs such practices and achieves positive results.

Recyclables

In order to maximize recovery rates, facilities need to capture non-degradable, recyclable materials, as well as degradable materials for composting. Recyclable material, such as certain plastic and metal containers, lose value as commodities after they go through the composting process, as is currently the case at most MSW-composting facilities. A pilot MRC facility should be equipped to systematically remove non-degradable materials before they go to the composting drum. The facility should attempt to recover as many of these non-degradable items as is economically practical and technically possible.

Residue

Residue is an “undesirable” facility output. As facilities must pay to dispose of all residue, keeping residue rates low represents an important way to reduce operating costs. A pilot MRC facility should reduce residue by recovering designated, non-degradable items for recycling, as well as running final screen overs back through the composting process. A pilot facility should also minimize the compost lost to overs, as well as the weight of those overs, by removing non-degradable items before they go to the composting drum. As explained in Chapter 4, immature compost becomes entrained in the non-degradable material while tumbling through the drum at MSW-composting facilities. For example, compost packs empty containers, sticks to plastic bags, and fills pockets in clothing, and is then disposed of with these items as residue. The compost and moisture also adds weight to these non-degradable items, making them more expensive to dispose.

The next chapter presents cost estimates for building and operating a theoretical, New York City Research and Development Pilot Materials-Recovery and Composting Facility (MRC), using the equipment and labor requirements outlined in Chapter 5, and the recovery, residue, and throughput estimates summarized here.