

INTEGRATING RECYCLING WITH MSW PROCESSING AND TRANSFER IN A LARGE URBAN AREA

STUART H. RUSSELL
HDR Engineering, Inc.
Chicago, Illinois

ABSTRACT

The additional costs of solid waste recycling programs can be burdensome in large urban areas. Most urban recycling programs have utilized an approach developed for suburban areas with a separate collection and processing system for recyclables operating in parallel with the existing Municipal Solid Waste (MSW) collection, processing and transfer system. Many programs even have a third parallel system for the collection and processing of yard waste. The cost of this approach is high, especially for large urban areas with limited economic resources.

An alternative recycling program approach is needed which reduces the cost impact. An approach which is being implemented in several urban areas integrates the collection and processing of recyclables with MSW collection, processing and transfer utilizing common collection equipment and processing facilities. This paper will focus on one such new approach being implemented in the City of Chicago. The technical features, private contractor issues, and costs of the Chicago program will be examined.

INTRODUCTION

State-mandated recycling programs have required counties and municipalities (urban, suburban and rural) to implement recycling programs resulting in increased costs.

Funding for recycling programs can be a particular problem in large urban areas. The steadily rising costs for solid waste transfer and disposal, especially in urban cities which do not control disposal capacity within their corporate limits, makes funding recycling programs out of existing budgets difficult. The property and sales tax base

in many urban areas is either not growing or shrinking, making increased solid waste management budgets difficult to obtain. Passing on recycling program costs directly to the homeowner can be difficult because many urban areas have traditionally provided refuse disposal service with public employees and equipment, and homeowners have never paid separate charges for such service. Many suburban areas have accommodated the additional cost by requiring private haulers to offer recycling as part of their collection service, and pass on the additional costs directly to the homeowner.

The cost of recycling programs in urban areas is comparable to, and in many cases higher per household or per ton than suburban programs. Most recycling programs in urban areas utilize an approach common to suburban areas in which a separate collection and processing system for recyclables operates in parallel with an existing MSW collection, processing and transfer system. Many even add a third parallel system for yard waste collection and composting. Collection and processing costs for such systems have been reported to range from \$98 to \$138 per ton (\$107.80 to \$151.80 per metric ton) after credit for revenue from recovered material sales (Scarlett, 1993). Costs for large cities such as New York, Philadelphia, Newark, Minneapolis and other have been reported to typically be above \$100 per ton (\$110 per metric ton) and ranging as high as \$266 per ton (\$292.60 per metric ton) (Governmental Advisory Associates, 1991). Costs for yard waste collection and composting are in addition to these recycling costs. Costs can be higher in urban areas due to higher labor costs and lower participation rates. Even after subtracting the savings from avoided disposal cost, the net impact on urban city budgets can be substantial.

Several cities are developing new approaches to reducing recycling costs by analyzing their entire system of solid waste management rather than just the recycling element. Some have opted to co-collect bagged recyclables (so called “Blue Bags”) in the same collection vehicle with separation and processing at a common transfer station and recyclables processing facility (Akron, Ohio; Omaha, Nebraska; Baltimore, Maryland; and High Point, North Carolina). Others have developed facilities which recover recyclables from processing mixed commercial MSW and also process separately collected residential recyclables in a common transfer and processing facility (Babylon, New York; Cleveland (Oakwood), Ohio; Crestwood, Illinois) (Hilts, 1993). These approaches attempt to integrate the collection and/or processing of recyclables with MSW collection, processing and transfer utilizing common equipment and facilities to reduce overall waste management costs.

The City of Chicago has developed a new MSW management program which incorporates many of the approaches used in other cities. This new program will be put into operation over the next two years. It is unique because the Chicago program integrates recyclables collection and processing, yard waste collection and composting, mixed MSW processing, bulky waste and MSW transfer and disposal into one system with common facilities. The purpose of this paper is to discuss the development of the Chicago program, describe its technical and contractual features and examine the program’s costs.

CHICAGO PROGRAM DEVELOPMENT

With a population of over 2.8 million and an annual solid waste generation of almost four million tons (4.4 million metric tons), MSW management in Chicago is a significant undertaking. The City’s Department of Streets and Sanitation collects about 1.1 million tons per year principally from over 650,000 households (single family through four-unit multi-family). About 300,000 tons (330,000 metric tons) per year of bulky and demolition waste is also separately collected by City crews. The remaining residential and commercial MSW is collected by private haulers. About 40% of the City-collected residential waste is disposed at the City-owned Northwest Waste-to-Energy Facility, the remainder is tipped at several privately-operated transfer stations for haul to landfill disposal sites. Remaining MSW landfills operating within the City have only limited capacity, and no new landfills will be developed by City ordinance. Contracts for transfer and disposal are bid to private contractors on a relatively short term basis, usually three years.

The City completed a comprehensive solid waste management planning process in 1992 which calls for meeting the State of Illinois mandated planning goal of 25% waste diversion by 1996. In addition, since 1989, the City has undertaken several recycling demonstration programs to

analyze the effectiveness of different recycling systems, including co-collection of bagged recyclables (Robinson, 1992a). The City faced the same problems faced by other large urban areas—how to accommodate the cost of a city-wide recycling and yard waste composting program within a limited solid waste management budget already under pressure from rising disposal costs without long-term control.

In response the City developed a program with the following objectives:

- consolidate transfer operations and upgrade transfer facilities to more stringent aesthetic and environmental standards;
- provide longer-term control over disposal cost;
- minimize recyclables and yard waste collection costs by co-collecting bagged recyclables and bagged yard waste in a common collection vehicle with mixed MSW;
- combine recyclables processing and yard waste separation with MSW and bulky waste transfer operations in common facilities to reduce cost when compared to several single-function facilities; and
- incorporate mixed MSW processing in the same facilities to capture additional recyclables and to provide program flexibility.

The following sections describe how the Chicago program was developed to meet these objectives.

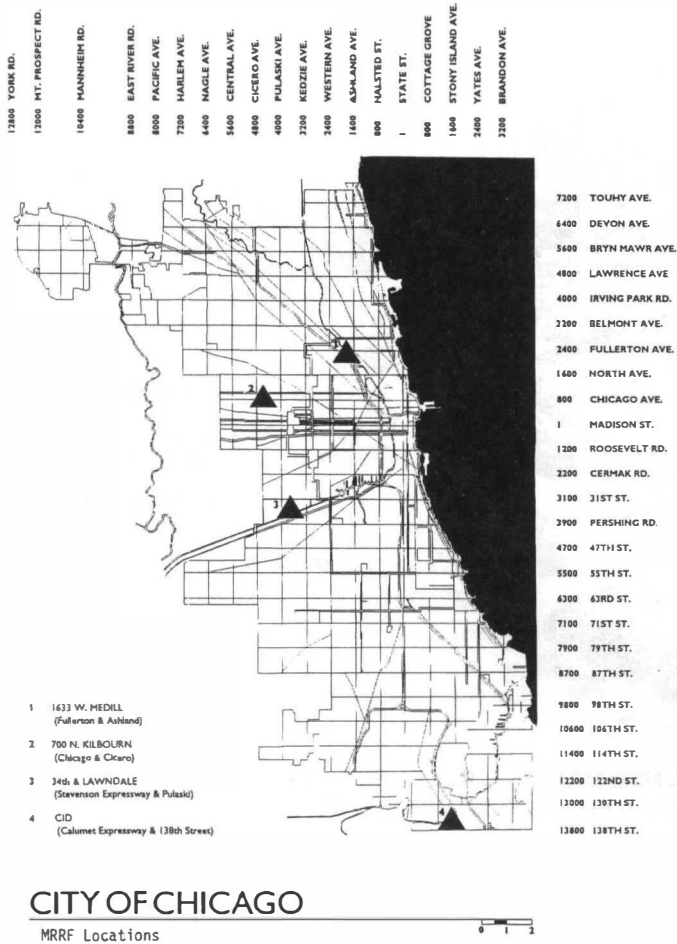
PROGRAM FEATURES

Technical Features

When the program goes into operation in 1995–1996, City residents will be asked to place recyclables (ferrous and aluminum containers, glass containers, plastics, newsprint, other paper, and corrugated) into blue colored plastic bags (newsprint in a separate bag from other recyclables). Residents will also be asked to put yard waste (unless backyard composted) into heavy duty kraft bags. All bags along with mixed MSW are to be placed in the City-provided refuse containers to be collected weekly on regular collection days.

The program will also include four new Materials Recycling and Recovery Facilities (MRRFs) to process and transfer the collected MSW and bags. The MRRFs are to be located around the City as described in the following paragraphs (see Figure 1):

- *Northern: 1633 W. Medill Avenue.* This MRRF is to be located at the site of an existing City-owned incinerator which has been out of service since the mid 1970s. The site is currently used as a transfer station. The old incinerator building will be demolished as part of the project.



- **Northwestern: 700 N. Kilbourn (Northwest WTE Facility).** This MRRF will be located on the site of the existing City-owned Waste-to Energy (WTE) facility in an area currently occupied by a fleet maintenance garage (to be demolished) and a truck parking lot (to be relocated). The MRRF will share a common wall with the tipping hall of the WTE facility and MSW will be conveyed directly to the storage pit of the WTE facility after processing for removal of recyclables and yard waste.
- **Southwestern: 34th and Lawndale.** An existing structure which originally housed the City-owned Southwest Supplemental Fuel Plant will be renovated and expanded for this MRRF. The old processing equipment, almost 20 years old, will be removed and replaced with new equipment. The existing tipping building and administration building will be reused, and additional building area will be added to expand facility capacity.
- **Southern: 138th Street (CID).** This MRRF will be constructed on a currently empty, privately-owned site ad-

acent to the CID Landfill on the southern edge of the City.

All four MRRFs will be designed with a throughput capacity of 1,600 tons (1,760 metric tons) per day (two-shift per day basis) and will receive all of the City collected residential waste (no City-collected waste will go directly to any other transfer or disposal facility). All MRRFs utilize a common design concept with differences to accommodate different site features and constraints (see Figure 2).

The MSW containing co-collected bagged recyclables and bagged yard waste will be deposited by City packer trucks on a tipping floor where any bulky waste will be separated prior to processing and moved to the transfer area. The waste will be stored on the tipping floor until being moved onto the infeed conveyors of two separate processing lines by front-end loaders. Each processing line will have an infeed design capacity of 75 tons (82.5 metric tons) per hour. Plastic bags containing recyclables and kraft bags containing yard waste will be hand picked at the initial picking stations. Yard waste bags will be conveyed to roll-off containers for transfer to offsite processing and composting. The bagged recyclables will be conveyed onto a separate processing line which will open the bags (and separate them for recycling) and sort the recyclables into marketable categories using hand-picking and mechanical sorting. Glass will be color-sorted and crushed for shipment. Other materials will be baled. The remaining mixed MSW will be further processed through a multi-stage trommel screen, hand-picking and other mechanical sorting stages to remove additional recyclable material. The remaining MSW ("End-Waste") will be deposited in a floor storage area (except in the case of the Northwest MRRF) for loading into open-top transfer trailers for hauling to landfill disposal (or at the City's option to the Northwest WTE facility for combustion). The minus 2-inch (50.8-mm) fraction from the trommel screens will be conveyed to the transfer area or to a roll-off container for separate disposal.

The MRRFs will be designed, constructed and tested on a schedule of about 20 months beginning with a notice to proceed with design in early December, 1993.

Contract Features

The City has elected to contract with a private contractor to design, construct, test and operate the MRRFs. The City will be responsible for filing permit applications for construction on the three City-owned sites (Medill, 34th and Lawndale, and Northwest). A single contractor will build and operate all four MRRFs under separate contracts. Each of the four contracts is slightly different due to differences in financing, ownership and technical features. Generally, the contracts have the following features:

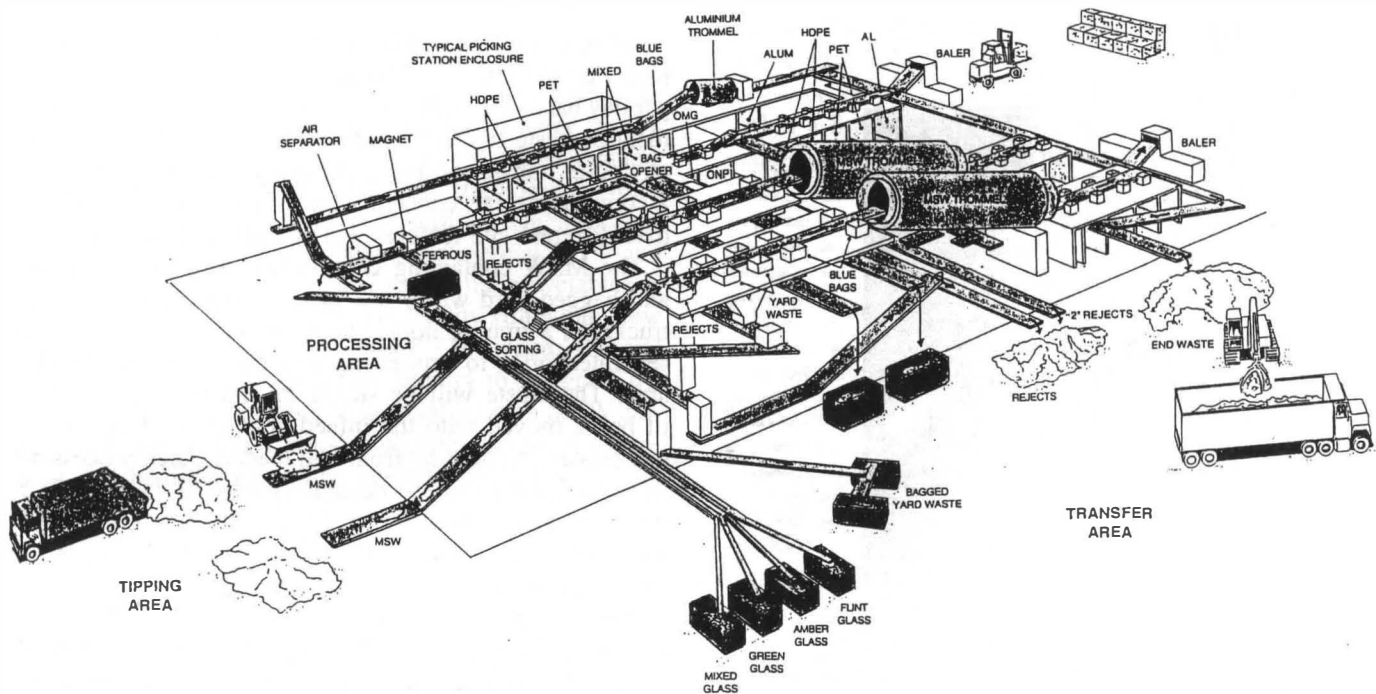


FIG. 2 CITY OF CHICAGO/MEDILL AVENUE MATERIAL RECOVERY AND RECYCLING FACILITY CONCEPTUAL VIEW OF PROCESSING SYSTEM

- Design.** The contracts establish a design concept with performance requirements. The detailed design is to be established by the contractor consistent with the design concept and performance specifications. The City will review and comment on the design at specified milestones and approve final design prior to construction start.
- Construction.** The contracts establish a fixed facility price for publically financed MRRFs (Medill and Northwest) and fixed annual capital burden fees for privately financed MRRFs (34th and Lawndale, and 138th Street). Increases in facility price or capital burden fees can only be made via a change order approved by the City. The fixed facility prices are between \$15 and \$16 million depending on the site. Construction must be complete by a date certain (with extensions only via approved change orders) and the MRRF must be tested and approved in accordance with an acceptance test procedure established in the contract. The acceptance test will run for five consecutive days and will test throughput, various recovery efficiencies and environmental compliance in accordance with the acceptance guarantees. In the event of test failure, the contract establishes the opportunity for a retest, and a “buydown”
- by the contractor if performance is above a minimum level.
- Operation.** After acceptance, the operating provisions of the contracts take effect. The initial term of operation is seven years with one-year extensions by mutual agreement up to twenty years. The City pays a processing fee for recyclables processing, yard waste transport and composting, and mixed waste processing (\$14 to \$17 per ton [\$15.40 to \$18.70 per metric ton] depending on the MRRF site applied to all tons processed, not to bulky waste); a disposal fee for hauling and disposal of End Waste (\$32 to \$35 per ton [\$35.20 to \$38.50 per metric ton] depending on the MRRF site applied to those amounts of waste hauled to landfills up to a maximum of 75% of the amount of waste processed); and a hauling fee for transfer of end waste to the Northwest WTE Facility to the extent directed by the City (\$10 to \$18 per ton [\$11 to \$19.80 per metric ton] depending on the site applied to actual tons transferred). The processing fee is fixed for the first two operating years, then escalates with an inflation adjustor. The disposal fee is fixed until acceptance (1995), then escalates with a landfill disposal market escalator capped at 5% per year for the first three years and 8% per year for the

next 7 years. The contractor guarantees to process all delivered waste up to a daily maximum, and the City guarantees to "put or pay" a daily minimum. In addition the contractor guarantees to recover, in aggregate (including recyclable materials and yard waste) 25% of the processed tonnage on an average annual basis (10% in the first operating year). To the extent actual recovery is greater than 25%, an additional recovery fee is paid by the City according to a formula which has the effect of sharing the City's benefit from avoided disposal fee payments. To the extent that actual recovery is less than 25% annually, the contractor bears the additional disposal cost unless a re-test of the MRRF demonstrates compliance with the acceptance guarantees. The contracts also give the contractor 100% of the revenue from the sale of recovered materials. In return, the City bears no market risk for the value of recovered materials.

- **Public Education.** The contractor is required to contribute \$2 million for each MRRF (\$8 million total) to the City towards the cost of a comprehensive public education effort to promote participation in the recycling program. These contributions are to be paid to the City on a schedule established by the contracts over the initial seven-year term.

PROGRAM COSTS

In order to demonstrate whether the program selected by the City of Chicago results in cost savings when compared to a more traditional separate curbside bin and yard waste collection and processing system, an analysis of the costs of both systems was prepared. The analysis compared the costs of all system elements to provide a comprehensive comparison.

The analysis indicates that a traditional curbside bin recycling system with separate collection and processing, combined with separate collection and processing of yard waste applied City-wide, would be significantly more costly than the Chicago program. The curbside bin program would cost between \$1.5 million and \$3.7 million more in each of the first two operating years. Further, the cost over the initial seven-year operating period for the traditional program would be about \$17 million higher than the Chicago program over the same period. Table 1 illustrates the cost comparison in the 1996 operating year.

The principle reasons for these cost differences are;

(1) A curbside bin program would require separate fleets of recyclables collection vehicles and yard waste collection vehicles. These costs would be particularly high in Chicago due to the City's residential alley system, where most MSW and recyclables are collected. Large capacity recyclables collection vehicles cannot make the required alley maneuvers resulting in a larger fleet of smaller collection vehicles. There are no additional collection costs

**TABLE 1 SYSTEM COST COMPARISON
CHICAGO PROGRAM VS. CURBSIDE BIN PROGRAM**

| System Cost Category | Curbside Bin Program | Chicago Program |
|---|----------------------------|-----------------|
| MRRF Processing Fee | n.a. | \$17,356,000 |
| Curbside Bin Collection & Processing | \$9,972,000 ⁽¹⁾ | (1) |
| Yard Waste Collection | 6,648,000 ⁽²⁾ | (1) |
| Yard Waste Composting | 8,426,000 ⁽³⁾ | (4) |
| Public Education | 1,500,000 | (4) |
| Refuse Disposal ⁽⁴⁾ | 18,325,000 | 15,157,000 |
| Additional Transportation Cost ⁽⁵⁾ | 0 | 1,285,000 |
| Debt Service ⁽⁶⁾ | 0 | 7,366,000 |
| | \$44,871,000 | \$41,164,000 |
| Difference | \$3,707,000 | |

Notes:

- (1) No additional collections costs for recyclables or yard waste due to co-collection with MSW.
- (2) Estimated at \$1.17 per household per month (1992) escalated at 3% per year. Applied 9 months per year for Yard waste.
- (3) Actual 1992 cost of \$67 per ton of yard waste applied to 15% of the total MSW, escalated at 3% per year.
- (4) Included in Processing Fee.
- (5) It is assumed that both programs recover 25% of the total MSW. Difference is due to lower per ton disposal costs negotiated under Chicago Program in 1996.
- (6) Additional cost due to consolidation of transfer operations into fewer sites.
- (7) Sum of Bond debt service for Publically-financed sites and capital burden fees for privately financed sites. Debt service for curbside bin program included in collection and processing cost.

under the Chicago program because bagged recyclables, bagged yard waste and mixed MSW are collected in the same packer truck.

(2) The MRRF processing fee is fixed by contract until MRRF acceptance (1995), and for the first two operating years. Curbside bin and yard waste collection and processing costs are likely to escalate with inflation over this same period.

(3) The cost for yard waste composting at an off-site location is included in the MRRF fees, but is a separate additional cost in the curbside bin example.

(4) The negotiated disposal fee in the MRRF contracts is fixed through 1995. Beyond 1995, escalation of the disposal fee is limited to the caps negotiated in the contracts. Without the MRRF contracts, disposal costs would be subject to escalation with inflation each year as under the status quo, with no escalation caps. While it may be possible for the City to negotiate disposal cost controls similar to the MRRF contracts with the several available private transfer station operators, the City's negotiating position would be weaker with these shorter-term contracts for smaller portions of the total waste stream. Even if it is assumed that the disposal costs are the same in 1996 for the two programs, the Chicago program would still be less cost to the City because of savings in other cost categories.

(5) Public education costs (\$1.5 million in 1996) will be contributed by the MRRF contractor. Under a curbside bin program, these costs would need to be funded from the City's operating budget.

Some of the assumptions used in this analysis are:

- Both the Curbside Bin and Chicago programs assume recovery of 25% of the waste stream (recyclables and yard waste).
- Costs are escalated at 3% per year from a 1992 base,
- Actual contract fees for the MRRFs were applied to projected tonnages and adjusted for inflation in accordance with the contracts.

- A collection and processing cost of \$1.17 per household per month (1992\$) was assumed for a curbside recycling program based upon the lowest bid for such service received by the City in 1992. This cost is at the low end of the range of costs for similar services in other large cities.
- A yard waste collection cost of \$1.17 per household per month (applied over 9 months per year) plus \$47 per ton (\$51.7 per metric ton) for composting was assumed for the separate yard waste collection program (1992\$). These costs are based upon the City's actual costs and are within the range of costs for similar services in the region.
- For the Curbside Bin program, disposal costs were projected from actual average costs for hauling and disposal in 1992 (assuming no changes in the current system). For the Chicago program, the disposal fee established in the contracts was used. Disposal costs under both programs were escalated at 3% per year. Costs under both programs reflect reduced tonnage disposed due to amounts recycled.
- Debt service costs under the Chicago program include costs to service the bond debt for the two publically financed MRRFs and the costs to pay the annual capital burden fees to the contractor for the two privately financed MRRFs. No additional debt service is assumed for the Curbside Bin program because it is assumed that the collection and processing cost includes a debt service component.

There are a number of uncertainties about the Chicago Program which could influence the results of this cost comparison. Most of these uncertainties have been controlled by the City via its contracts with the MRRF contractor, and by the design of the MRRFs. For example, there is uncertainty about recovery rates due to evidence from "Blue-Bag" type programs in other cities that recovery rates may be significantly lower than 25% due to low participation rates and loss of recyclables to bag breakage. The City has reduced this uncertainty by selecting a bag thickness (1.75mm) which has demonstrated minimal breakage (less than 10%) in the 10-week test program. Also, the City has selected a MRRF design which includes not only the recovery of bagged recyclables, but also mixed MSW processing to recover additional amounts of recyclables from the mixed waste. In this way, the Chicago program does not rely entirely upon separation of recyclables by the household, or 100% bag survival. The contracts also give strong incentives for the contractor to recover the maximum amount possible;

- The contractor will pay for the disposal of any amounts short of the 25% aggregate recovery guarantee;
- The contractor will be paid an additional recovery fee

for any amounts recovered in excess of the 25% aggregate recovery guarantee; and

- The contractor will lose 100% of the revenue for any recyclables not recovered.

Further, the City has assured adequate public education funding, which is essential to achieve participation in any recycling program, by requiring in the contracts substantial public education contributions by the contractor. With a well-designed and adequately funded public education program, the City expects household participation to be comparable to a traditional curbside bin program. Indeed, results of the City's survey on general responses to the demonstration program indicate that people may find the Chicago program an easier way to recycle, and thus may potentially participate at a higher rate than a curbside bin program (Robinson, 1992b). The combination of public education, contractor incentives and mixed MSW processing for recyclables recovery is likely to produce a recovery rate in excess of 25%, and a rate comparable to a curbside bin program.

Another uncertainty in any recycling program is the market value of the recovered recyclables. This uncertainty is perhaps greater for the Chicago program due to evidence from other programs which utilize bagged recyclables that certain materials become contaminated (particularly newsprint) from broken glass, dirt, and liquids. The City has reduced this uncertainty by program design and by shifting market value risk to the contractor. To control contamination, the City will require residents to place newsprint in a separate bag from other recyclables. This technique has reportedly worked very well to minimize contamination in the Omaha program (Aquino, 1993). Further, the contracts give the contractor 100% of the revenue from recovered materials sales. In return, the contractor must arrange for the sale of all recovered materials (or pay for materials to be taken). The fees paid by the City will not change with changes in market value or marketability of the recovered materials. Therefore, the cost comparison between the two programs will not change even if the market value or marketability of the materials recovered in the Chicago program are lower than for a curbside bin program.

CONCLUSIONS

The City of Chicago has developed a solid waste management program which will cap the escalation of the City's disposal cost over ten years; will consolidate and upgrade transfer operations; minimize recyclables and yard waste collection costs by co-collection with MSW in common collection vehicles; and control recyclables and yard waste processing costs by integrating these process-

ing functions with transfer station operations in common facilities. It has been estimated that the additional capital cost (and associated annual debt service) and processing cost for this program will be more than offset by savings in collection cost and disposal cost when compared to a more traditional separate curbside collection of recyclables and yard waste combined with separate processing facilities.

While this program has been developed to meet the specific goals of the City of Chicago, the program's concept may have applications in other cities where:

- Limited landfilling capacity exists within corporate boundaries, and there is a need to control long-term disposal cost;
- Transfer stations are required for long-distance hauling; and where
- It is not practical or politically feasible to pass on the costs of separate collection and processing of recyclables and yard waste to individual households.

ACKNOWLEDGMENTS

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REFERENCES

- Aquino, John T. and White, Kathleen M., 1993, "Am I Blue: A Report on Blue Bag Recycling Programs," *Waste Age*, July, 1993, pp. 29-36.
- Governmental Advisory Associates, 1991, "Materials Recovery and Recycling Yearbook 1990-91," New York.
- Hiltz, Michael E., 1993, "Putting Mixed-Waste MRFs to the Test," *Solid Waste & Power*, March/April, 1993, pp. 18-25.
- Robinson, David B.; Eubanks, David M.; and Traeger, David J., "Bagged Recyclable Co-Collection: An Effective Method for Urban Solid Waste Planning," *Public Works*, May, 1992, pp. 56-61.
- Scarlett, Lynn, 1993, "Recycling Costs: Clearing Away Some Smoke," *Solid Waste & Power*, July/August, 1993, pp. 12-17.