



DENVER[®]
THE MILE HIGH CITY

DENVER PUBLIC WORKS PRESENTS

**A MASTER PLAN FOR MANAGING SOLID WASTE IN THE
MILE HIGH CITY - APPENDICES**

OCTOBER 2010





APPENDICES

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LIST OF ACRONYMS	
C&D	Construction and Demolition
CCTS	Cherry Creek Transfer Station
CPC	Central Platte Campus
CY	Cubic Yard
DADS	Denver Arapahoe Disposal Site
DIA	Denver International Airport
DSWM	Denver Solid Waste Management
EO	Executive Order
E-Waste	Electronic Waste
FTE	Full Time Equivalents
HHs	Households
HHW	Household Hazardous Wastes
ICI	Institutional, Commercial and Industrial Waste
LEED	Leadership in Energy & Environmental Design
LIP	Large Item Pick-up
MFU	Multi-Family Unit
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
NAICS	North American Industry Classification System
PAYT	Pay-As-You-Throw
SFU	Single-Family Unit
SWMP	Denver Solid Waste Master Plan
WCS	Waste Composition Study
USEPA	U.S. Environmental Protection Agency
WMC	Waste Management of Colorado
WMRA	Waste Management Recycle America



APPENDIX B

Denver Legal Summary of Solid Waste Rules and Regulations

The management and collection of solid waste is subject to legal requirements set forth in state law as well as the Home Rule Charter of the City and County of Denver, Denver municipal ordinances, and regulations adopted by the Department of Public Works. The following summary¹ is provided for the convenience of the reader and is not intended to provide legal advice. The reader is cautioned to consult the code itself to learn the specifics of the provisions generally described below.

State Law

A solid waste is defined as follows:

“(a) "Solid waste" means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial or commercial operations or from community activities.

(b) "Solid waste" does not include:

- (I) Any solid or dissolved materials in domestic sewage;
- (II) Agricultural wastes;
- (III) Solid or dissolved materials in irrigation return flows;
- (IV) Industrial discharges which are point sources subject to permits under the provisions of the "Colorado Water Quality Control Act", article 8 of title 25, C.R.S.;
- (V) Materials handled at facilities licensed pursuant to the provisions on radiation control in article 11 of title 25, C.R.S.;
- (VI) Exploration and production wastes, as defined in section 34-60-103 (4.5), C.R.S., except as such wastes may be deposited at a commercial solid waste facility;
- (VII) Excluded scrap metal that is being recycled; or
- (VIII) Shredded circuit boards that are being recycled.” 30-20-101(6), C.R.S. (2009).”

Any person who owns or operates a solid waste disposal site and facility must obtain a certificate of designation from the governing body having jurisdiction over the area in which the site and facility is located. The statute also establishes the process for acquiring a certificate of designation from a county or municipality. The solid and hazardous waste commission is charged with the adoption of rules for the engineering design and operation of solid waste disposal sites and facilities, and the statute lists minimum standards which these rules must contain. State inspection and enforcement authorities, violations, and civil penalties are also prescribed.

Land disposal of certain residentially generated wastes is banned and requirements for their recycling have been established².

County powers to adopt ordinances for control or licensing of matters of purely local concern are enumerated, including the removal of rubbish³, inspection of vehicles involved in the transporting of

¹ This summary is based upon the state statutes and municipal code as of January 31, 2010 and does not include any subsequent enactments or amendments.

² Solid Waste Disposal Limitations, 30-20-1001 et seq., C.R.S. 2009

trash⁴, and regulating the activities of those transporting trash⁵. Home rule counties⁶ have the specifically enumerated power to regulate and prevent the throwing or depositing of ashes, garbage, or any offensive matter in, and to prevent any injury to, any road, street, avenue, alley, or public ground⁷. Home rule cities cannot grant an exclusive territory or regulate rates for the collection and transportation of ashes, trash, waste, rubbish, garbage, or industrial waste products or any other discarded materials^{8, 9}. Notice and other procedural requirements are established for persons and/or governments wishing to start/modify a trash hauling service, or to establish user charges for waste services provided by a governmental body¹⁰.

The general police powers of municipalities include protection of public health, declaring and abating nuisances, and compelling the removal of rubbish from tracts of land, alleys, and sidewalks and to make assessments/liens for such costs¹¹. Municipalities have the power to develop and operate solid waste-to-energy incineration systems¹². These specific grants of power apply to statutory cities and can fill in where our local laws are silent. But, Denver, as a home rule city, has the authority to legislate in matters of local concern.

Home Rule

The Colorado Constitution, Article XX, §1 establishes the powers of home rule cities to operate public utilities local in use and extent, in whole or in part, and everything required therefore for the use of city and county and its inhabitants. The Constitution also provides that a home rule charter supersedes state law in conflict for wholly local and municipal matters, §6; and, that home rule cities have the full right of self government for local and municipal matters, §6.

This means that the state Constitution, statutes, and regulations control matters of statewide concern, as well as matters of mixed state and local concern. The home rule charter, city ordinances, and regulations control matters of purely local concern. If a state law purports to regulate activity, then it is applicable. If a state law merely grants a power to a city, then the home rule city can choose whether to implement that power.

Charter of the City and County of Denver

The Home Rule Charter of the City and County of Denver establishes powers and duties that are exclusively vested in the Department of Public Works, including:

³ 30-15-401(1)(a)(I)(A), C.R.S. (2009)

⁴ 30-15-401(1)(a)(II), C.R.S. (2009)

⁵ 30-15-401(1)(a)(IV) and (VI)

⁶ Denver is a home rule city, but not a home rule county.

⁷ 30-35-201(13)(d), C.R.S. 2009

⁸ 30-15-401(1)(a)(III)

⁹ "... (T)he governing body of a city and county shall not be precluded from adopting ordinances, regulations, codes, or standards or granting permits issued pursuant to home rule authority; except that such governing body shall not grant an exclusive territory or regulate rates for the collection and transportation of ashes, trash, waste, rubbish, garbage, or industrial waste products or any other discarded materials," 30-15-401(5) C.R.S. 2009.

¹⁰ 30-15-401(6) – (7.5), C.R.S. 2009

¹¹ 31-15-401, C.R.S. 2009

¹² 31-15-1001 et seq., C.R.S. 2009

“(E) Collection of sewage, trash, garbage, offal and other offensive substances. Management and control of the collection, removal and disposition of all sewage, trash, garbage, offal and other offensive substances either by the Department or under contracts let by the Department. For the purposes of this Section, and in the manner and pursuant to terms and conditions fixed by the Mayor and the cabinet and subject to ordinance or resolution approval by the Council, the Department may enter into such contracts as in the judgment of the Manager are to the best interests of the City and County.” D.R.M.C. 2.3.3.

Denver Revised Municipal Code, Title 48 Solid Waste

Denver Revised Municipal Code Title 48 sets forth the local law concerning solid waste – garbage, household garbage, commercial garbage, rubbish, litter and refuse. Broadly speaking, title 48 regulates the collection and disposition of trash however denominated.

Article I simply states that it is unlawful to place any garbage into any ash pit or incinerator.

Article II – Household Garbage. Household garbage is the food waste generated in private, household kitchens, and must be placed in a closed, watertight container of not more than forty-gallon capacity. This container needs to be placed where it may be conveniently emptied and removed by the garbage collector.

Article III – Commercial Garbage. Commercial garbage is the food waste generated by places licensed by the City to serve food for human consumption. This does not include canneries, slaughterhouses, packing plants, potato chip processors, or similar industries. Commercial garbage must be stored in covered watertight containers, and must be removed and disposed of at least twice in each week.

Article IV - Rubbish. Rubbish falls into different categories. Ashes are the solid waste products of combustion of any material. Building rubbish is the waste material from construction, remodeling, and repair operations such as stones, bricks, plaster, concrete, roofing, etc. Yard rubbish is waste material from the yard and garden such as tree branches, twigs, grass, leaves, etc. Household rubbish originates from the ordinary household and includes waste other than food waste, ashes, and yard rubbish. Collections of household rubbish, yard rubbish, and cold ashes are to be made in accordance with the rules and regulations of the Manager of Public Works. If the rules allow for collection of household rubbish, yard rubbish, and cold ashes, then the rubbish must be stored in accordance to the rules and regulations. If the rules do not allow for collection, then the person from whose premises the household rubbish, yard rubbish, and cold ashes originates must store the rubbish/cold ashes in a sanitary manner and provide for the private collection and removal of the rubbish/cold ashes.

The Managers of Environmental Health and/or Public Works (or their authorized representatives) may order the owner/occupant/agent of any premises to remove an accumulation of any rubbish, ashes, garbage, or other waste matter within a reasonable time. This order can be made when the accumulation is offensive to sight; generates a propagation of rats, vermin, flies, or other insects; or is in any manner hazardous to the public health. The Managers and their authorized representatives have a right of entry onto property to conduct a reasonable inspection to see if an accumulation of the above

wastes exists. If the owner/occupant/agent does not comply with an order to remove the accumulation of waste within a specified reasonable time, then the City may remove the accumulation after notice to the owner/occupant/agent. The City may bill the owner/occupant/agent of the premises for the cost and expense of removing the waste, and may further initiate a lien against the property if not paid within thirty days of billing.

Except for waste paper that is disposed in City maintained waste disposal containers, it is unlawful to dispose of any rubbish, ashes, or other waste matter on any premises other than those designated as official city dumps. Additionally, except where allowed by rules and regulations, garbage from canneries, slaughter houses, packing houses, or similar industries cannot be disposed at any official city dump.

Non-residents of the City and commercial users are not allowed to deposit any rubbish or other waste material in city-owned trash containers. Additionally, it is unlawful for City residents to deposit any rubbish or other waste matter in city-owned trash containers in violation of rules and regulations of the Manager of Public Works.

The Manager of Public Works is empowered to enforce these provisions.

Article V – Rubbish Haulers. Persons who transport any rubbish or garbage within the City in or on any motor vehicle must register the vehicle with the Department of Public Works and receive a rubbish hauler registration number. Additionally, vehicles transporting rubbish within the City must have the name and telephone number of the rubbish hauler, and the rubbish hauler's registration number painted on both sides of the vehicle. Exception: Vehicles equipped with a mechanical compactor or roll-off rubbish container unit do not need to register or have the markings listed above.

Rubbish haulers must also obtain a receipt from any solid waste disposal site and facility in which they deposit and must maintain copies of all receipts obtained for one year from the date of deposit.

Article VI – Littering of Watercourses. It is unlawful to dump or deposit any refuse (putrid or offensive substances like dung, carrion, dead animals, etc.) upon any embankment or into any lake, pond, reservoir, stream, or watercourse; or any place where the natural flow of drainage would lead to the above areas. It is also unlawful to dump or deposit any garbage or rubbish upon any embankment or into any lake, pond, stream, or watercourse, unless the City designates the area for the purpose of dumping; the garbage or rubbish is placed in an appropriate receptacle on such property; the person depositing owns such property or has obtained written consent from the owner; or the depositing is done under the direction of the owner in lawful possession of such property. Anytime refuse, garbage, or rubbish is deposited from a motor vehicle, the driver will be presumed to have caused the waste material to be deposited from the motor vehicle.

Article VII – Certificate of Designation. Any person who operates a solid waste disposal site and facility within the City and County of Denver is required to obtain a certificate of designation from the city council acting by ordinance following a public hearing held at a regular council meeting. The city council must take into account the effect on the surrounding property, the convenience of the site, the ability of

the site to comply with state law and state rules and regulations concerning health, and consistency of the site with the comprehensive plan of the City and County of Denver. City council shall not issue the certificate if the state or Manager of Environmental Health recommend disapproval, and city council can revoke or suspend the certificate after reasonable notice and a public hearing if the site fails to comply with all applicable laws, resolutions, and ordinances.

Article VIII – Disposal Fees. This article deals with radioactive waste and radium contaminated material. Radioactive waste and radium contaminated materials are defined terms. The City will charge \$5.10/cubic foot of radioactive waste or radium contaminated material to any person disposing or implementing a remedial control of the above material, unless the disposal is incidental to installation, maintenance, repair, improvement, or replacement of utilities, streets, sidewalks, and alleys in public rights-of-way. Permanent disposal and control of radioactive waste and radium contaminated material are not permitted uses of property. Money collected from the radioactive waste disposal fee shall be used to fund city costs associated with regulation, oversight, management, control and disposal of radioactive waste. Any person who disposes or implements a remedial action to control radioactive waste or radium contaminated material that results in the waste or material remaining on property within the City and County of Denver must record in the real property records of the City's Clerk and Recorder a document stating the volume of waste or material remaining in the City and County of Denver.

Rules and Regulations

The Manager of Public Works has the authority to issue rules and regulations regarding the collection, removal and disposition of household garbage and commercial garbage; the categories of dwelling units from which collection of household rubbish, yard rubbish, and cold ashes are made and the storage of these wastes; registration of rubbish haulers.

Public Works Rules and Regulations – Governing the Preparation, Storage, and Collection of Household and Yard Rubbish

The Manager has adopted rules and regulation pertaining to household and yard rubbish, dated October 15, 1993.

Section II of the Rules and Regulations lists terms and definitions. The rules and regulations define authorized residences, prescribed containers, collection types, acceptable waste, and the hours of collection.

Section III deals with the collection of rubbish, for which a schedule and other requirements are established.

Section IV of the Rules and Regulations presents the Department's enforcement policy: agency representatives are directed to attempt to gain voluntary compliance, with the Manager deciding disputes. Repeated or gross violations may result in the issuance of a notice of violation up to and including a court summons.

Section V deals with disposal of rubbish. The Manager determines the place for disposal of rubbish, using route efficiency and costs in this determination. However, this regulation is superseded by Executive Order 115, the City’s Landfill Agreement, and the City’s Solid Waste Agreement which require the City to direct all non-hazardous waste that the city collects or generates to the Denver Arapahoe Disposal Site (“DADS”). DADS is owned by the city. Non-hazardous waste, for this purpose, includes all municipal, residential and commercial solid waste including construction debris, soil and asbestos.

Section VI states that situations involving day-to-day operations that are not listed in the rules and regulations should be resolved by an authorized representative of the department, and retains ultimate decision authority in the Manager.

Other Code provisions

The Municipal Code ordinances pertaining to Solid Waste are largely found in Title 48 and are summarized, above. The Code also contains various provisions related to other requirements for waste management which are not directly pertinent to this discussion, such as the following:

Chapter 19 – Excavation	Section 19-16(6) (no garbage for backfill of clay/sand/ gravel pits)
Chapter 27 – Housing	Section 27-23 (every occupant shall dispose of rubbish ...)
Chapter 35 – Mobile Homes and Trailers	Sections 35-19 (rubbish containers); 35-21 (garbage disposal, incineration); 35-38 (garbage storage and removal)
Chapter 37 – Nuisances	Section 37-53 (trash removal as condition of suspended sentence)
Chapter 39 – Parks and Recreation	Section 39-18 (littering prohibited including rubbish, waste, garbage, refuse, other trash)
Chapter 40 – Pest Control	Section 40-50 (unlawful to accumulate garbage, trash to remain in building, land, or waterway)
Chapter 49 – Streets, Sidewalks, and Other Public Ways	Sections 49-512 (trash-free news racks); 49-550.20 (trash-free express mail drop boxes); 49-552 (containerized or covered garbage/trash transportation); 49-553 (unlawful to deposit/litter any street, alley, public place with rubbish, waste, garbage)
Chapter 54 – Traffic Regulations	Section 54-130 (unlawful to deposit or throw upon any highway, street, alley, public place with rubbish, waste paper, garbage from any moving or standing motor vehicle)
Chapter 56 – Utilities	Sections 56-56 (unlawful to place garbage in sewers); 56-102 (unlawful to deposit garbage or other waste on public property); 56-203 (no disposal of garbage, sludge or waste materials in floodplain)



APPENDIX C

Denver Solid Waste Management – Public Involvement Report (July 2009)



DENVER SOLID WASTE MANAGEMENT
PUBLIC INVOLVEMENT REPORT



JULY 2009

HDR Engineering, Inc.



In Association with:
LBA Associates
The Keystone Center

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APPENDICES

Please note: in order to keep the size of this submittal minimal, the following appendices to the Public Involvement Report are not provided here, but have previously been provided to DSWM and are available upon request.

APPENDIX A — PowerPoint Presentation

APPENDIX B — Meeting Agenda

APPENDIX C — Meeting Sign-in Sheets

APPENDIX D — Polling Questions and Data

1.0 Introduction

Denver Solid Waste Management (DSWM) is currently working to develop a Solid Waste Management Master Planning. A Solid Waste Master Plan is typically a 20-year plan that foresees a city's long range plans. Midterm (typically 5- and 10-year) goals are established as implementation check points, which provide the opportunity to make adjustments or revisions, if necessary. As part of the Master Planning process, DSWM conducted a *Spring Waste Composition Study*, a *Fall Waste Composition Study* (WCS) and a *Policy Survey of Comparable Cities* in 2008 to provide data to both guide and inform the planning process. This Public Involvement Report describes the next phase of the process which included informing the public about what had been gleaned from these two reports and also solicited input from the public regarding Denver's solid waste program now and into the future.

1.1 Background

As part of its Master Planning process, in April 2008, DSWM conducted a survey to determine how solid waste policies and programs are implemented in ten comparable cities in the U.S. The primary topics studied were:

- User fees
- Yard waste and Organics programs
- Trash overages – bulky collections (i.e., Large-item pick-up [LIP]) – illegal dumping
- Recycling programs
- Commercial and C&D recycling

The purpose of the spring and fall WCSs was to analyze:

- Data to determine the effectiveness of the existing recycling program and the recycling rates of residents: low, medium and high
- Information to support adding new materials to the recycling program
- Information to support the feasibility of a future Food and Yard waste diversion program (composting)

The report recommended that DSWM evaluate the feasibility of implementing an organics recovery program (i.e. composting) as a primary component of both the Solid Waste Master Plan and in response to the Greenprint Denver goal of 30% diversion by 2011. The results of this study indicate that diversion of yard and food wastes, which constituted 48% of the residential waste stream sampled, have the greatest potential for decreasing landfilled materials. The study also provided recommendations to expand or enhance the existing recycling program and increase public outreach and education efforts.

1.2 Purpose and Need for Public Involvement

To assess public opinion, DSWM solicited input to determine the public's satisfaction with the current solid waste collection, recycling and disposal program, and interest in changing aspects of the collection

and disposal program to reduce reliance on landfill disposal. DSWM developed a public involvement program which included a PowerPoint presentation to inform the public of DSWM's current collection, recycling and disposal processes (provided in Appendix A); interactive participation with citizens in a public forum; polling of citizens attending the forums; and polling of citizens accessing the presentation and polling questions online. Because of the current economic situation, if the public continues to express interest in expanding the diversion/reuse/recycling program, some current services may need to be reduced in order to offset the cost. Current budgetary constraints preclude both continuing the level of service currently offered by DSWM and expanding the recycling program.

Information provided by the public is presented within this report, and will be used to draft the 20-year Solid Waste Master Plan, which will guide DSWM programs into the future.

1.3 Greenprint Denver

In 2004, Greenprint Denver, a division of the Mayor's Office, used a public process to establish several goals for decreasing the City's carbon footprint. Among the goals, Greenprint Denver articulated the importance of decreasing reliance on landfill disposal, and increasing reuse and recycling. The Greenprint Denver goal for solid waste management clearly stated 30% diversion from the landfill by 2011 (using 2004 as a basis), which is in line with the average diversion rate of 35% in the U.S. Facing a drastically changed economic picture, the Mayor's Office included two questions in its Annual Citizens' Survey (fall 2008) related to diversion and recycling. In this survey, 88% of citizens endorsed increased diversion/increased recycling and reuse.

In 2004, 265,000 tons of refuse was disposed of at the landfill (see Table 1). Despite an increase in population, the volume of landfilled trash decreased to 220,000 in 2008 while diversion increased. In order to meet the Greenprint Denver goal, landfilled tons would need to be reduced to 185,500 by 2011. Taking the steps necessary to achieve this goal would affect all City agencies.

Table 1. Tonnage Landfilled by Year.

YEAR	2004	2008	2011*
LANDFILL (TONS)	265,000	220,000	185,500
RECYCLED (TONS)	15,700	28,550	62,700

*The tonnage landfilled and recycled needed to meet the GreenPrint Denver goal.

2.0 Denver Solid Waste Management Services

DSWM currently offers the following services to 166,000 households:

- Trash collection and disposal (including unlimited out-of-container pick up)
- Recyclable collection and processing
- Large item pick-up (LIP) and disposal (10 times per year)
- Graffiti abatement

- Keep Denver Beautiful
- Fall leaves and Christmas tree composting; mulch giveaway

Of the 166,000 households served, 140,000 are single family units (SFUs) and the remaining 26,000 are multi-family units (MFUs). DSWM only serves multi-family units that contain seven units or less.

DSWM has a \$24M annual operating budget. Although the tipping fee is low compared to other comparable cities, \$15M is spent on refuse collection and disposal.

Refuse is collected via three methods: manual collection in which residents provide their own bags or containers (this constitutes 19% of waste collected by weight). The second method is automated barrels, which are provided by the City and comprise 33% of waste collected by weight. Dumpsters are provided for multiple households to use. Dumpsters generate more tonnage than manual or barrel areas—constituting 48% of waste collected by weight. Dumpster areas also generated more waste per household as discussed below.

2.1 How Denver Differs From Comparable Cities

The following information is provided in the *Denver Solid Waste Strategic Master Plan Policy Survey of Comparable Cities* (April 2008).

Unlimited Overflow

DSWM collects an unlimited amount of refuse weekly. This is to say that if residents fill their waste container, any overflow waste can be bagged and placed next to the container and will be collected. There is no additional charge for overflow (please see fee structure, next section).

Funding Structure

The monthly cost of waste collection and disposal is about \$14 per household. Unlike other cities of comparable size, customers are not assessed a direct monthly fee; rather, DSWM receives funds from the City's General Fund which is made up of sales and property taxes. Given this fee structure, the cost is "invisible" to many residents. The volume of waste collected per household is not tied to the monthly cost (a practice known as "pay as you throw") that is commonly used in other cities. Although DSWM pays a tipping fee at the landfill which is tied to volume, there is no subsequent increase in fees assessed to residents based upon volume of waste collected. Other cities charge customers based upon the volume of waste generated and collected above the allotted amount (container). In the 2008 Denver survey on general services, 62% of residents surveyed supported the use of variable (pay-as-you-throw) funding for Denver solid waste services. This would involve tying the fee to the volume of refuse discarded.

Dumpsters

Denver is unique in that dumpsters are provided for some SFUs and MFUs. Illegal dumping frequently occurs when residents dump their overflow trash into a dumpster that is not theirs alone. As previously noted, dumpsters produce more tons per household than individual cans (dumpsters account for 48% of

waste by weight). None of the other cities surveyed used dumpsters for SFUs. The cities that formerly used dumpsters have phased them out in favor of containers.

LIP

DSWM provides Large-Item Pickup (LIP) 10 times per year for every household. Each household is given a schedule of pick-up times whereby they can place an unlimited amount of large items such as mattresses, appliances and furniture at the curb and it will all be collected. As is the case with overflow waste, there is no additional fee assessed for the quantity or frequency of LIP. According to the results of DSWM's 10-city SWM survey, this schedule of 10 pick-ups per year is much more frequent than other cities surveyed. LIP requires separate equipment and extra routes are required. No distinction is made between refuse and recyclable items. After refuse collection and disposal (which account for \$15M of the \$24M annual budget), LIP/overflow costs are the second largest budgetary item (\$3.4M annually).

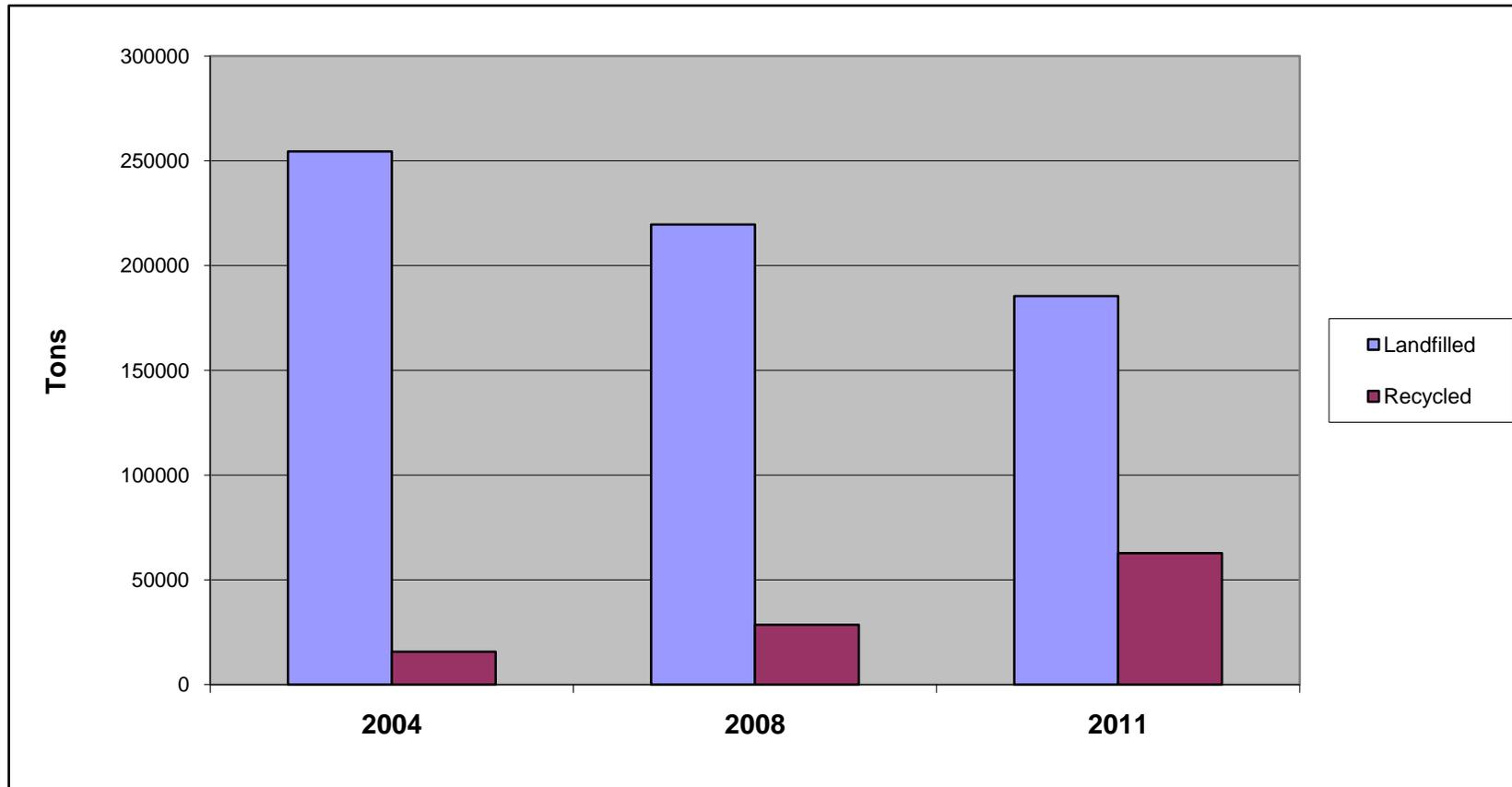
2.2 DSWM Recycling Program

Based upon the Mayor's Office Annual Survey conducted in fall 2008, 88% of residents said that recycling is very important or essential. DSWM's recycling program is voluntary—only 40% of potentially recyclable items are actually being recycled by residents and roughly half of all residents actually recycle. Although expanding the recycling program may decrease the volume of waste that is landfilled, the potential exists that the quality of recyclable items (which is currently very good) could also decrease.

2.3 Composting Collection Pilot Program

The Composting Collection Pilot Program will end in 2010. 3,300 households spread throughout the city participated. Yard and food debris and soiled paper were collected in carts provided to residents. This pilot program has been extremely popular with the public (which was also indicated in the public meetings, as discussed below). Data are currently being collected for analysis; however, the initial results are good.

Figure 1. Landfilled vs. Recycled Waste: 2004, 2008 and 2011 (projected to meet Greenprint Denver goal).



2.4 Master Plan Activities to Date

In late 2007/early 2008, DSWM hired a consultant (HDR Engineering, Inc.) and conducted a waste sort to characterize the waste stream. In 2008, a survey of 10 cities similar to Denver was conducted to assess DSWM's level of services provided with respect to comparable cities. In 2009, the public involvement phase was conducted (this report is the result of that process). In June 2009, the Compost Collection Pilot Program Phase 1 ended and analyses of results began.

3.0 Public Meetings

A series of five public meetings were held at various locations around the Denver Metropolitan area (see Meeting Agenda, Appendix B). A total of 66 people attended the five meetings; the meetings on June 9th and June 16th meeting had the highest attendance (21) and the lowest attendance was at the June 10th meeting at Barnum Recreation Center (6) (see Table 2 and Sign-In Sheets, Appendix C).

Table 2. Public Meeting Attendees and Locations.

DATE	REGION	LOCATION	ATTENDANCE
June 9, 2009	southeast Denver	District 3 Police Station	21
June 10, 2009	south/central west Denver	Barnum Recreation Center	5
June 16, 2009	north/central Denver	National Jewish Hospital	21
June 17, 2009	northeast Denver	Montbello Recreation Center	7
June 18, 2009	northwest Denver	District 1 Police Station	14
TOTAL			67

The following Agenda was used for all five public meetings:

- 6:30 p.m. – Visit Information Stations – Questions and Answers
- 6:45 p.m. – Welcome and DSWM PowerPoint Presentation
- 7:10 p.m. – Visit Information Stations – Questions and Answers
- 7:25 p.m. – Polling
- 7:45 p.m. – Conclusion

4.0 Polling Procedures

Immediately following the PowerPoint presentation and a give-and-take discussion period, meeting attendees (and the online respondents) were given a series of polling questions to determine preferences on DSWM current services, the importance of expanding the recycling program, priorities and funding preferences. Polling questions are provided in Table 3 and Appendix D.

To provide real-time response data, attendees were provided response cards (i.e. clickers made by Turning Point Technology). This allowed respondents to answer each question simultaneously and to see the data in real time, which provided an interactive audience experience.

The same PowerPoint was presented at the public meetings and on the Internet prior to polling; likewise, the questions asked following the presentation were identical for both meeting attendees and online respondents. The complete polling results are provided in Appendix E; what follows is a summary of the data collected and questions asked by meeting attendees. Only the response to each question that generated the highest percentage is provided in Table 3.

5.0 Results

5.1 Polling Results

The number of meeting attendees (66) did not provide adequate data to draw any definitive conclusions. However, the combined feedback from both the public meetings and the online polling did yield some interesting data. Following the online presentation, which was the same presentation provided to meeting attendees, a series of 17 questions were posed to online participants. When asked which of the current DSWM services constitute their top priority, 78% indicated that recyclables collection was their top priority and approximately 84% responded that MFUs with seven or greater units should have mandatory recycling. Approximately 72% of responders indicated that recycling for all households served by DSWM should have mandatory recycling and the same percentage responded that it is very important for Denver to reduce citizen's impact on the environment.

Please see Appendix D for the complete results.

6.0 Conclusion

The purpose of the public involvement phase was to assess the public's opinion on the importance of DSWM services above and beyond trash collection. To that end, it was revealed that 78% of respondents said that recycling is their priority after trash collection; this is consistent with the Mayor's Office Survey during the fall of 2008. The other purpose of soliciting input from the public was to determine the degree of public support for the GreenPrint Denver goal of diverting 30% of landfill waste by 2011. Approximately 72% of respondents believe it is very important for Denver to reduce its citizens' impact on the environment and 73% believe recycling should be mandatory (84% responded that it should be mandatory for multi-family units greater than 7 units). When asked which services currently provided by DSWM they would be willing to reduce or forego, there was a tie between removing/reducing LIP from 10 times per year to 4 times per year and adding a city-wide composting program (approximately 31% for each).

The input received from the public will inform the next phase, which entails developing the Solid Waste Master Plan, which will guide and inform future DSWM programs.

APPENDICES

Please note: in order to keep the size of this submittal minimal, the following appendices to the Public Involvement Report are not provided here, but have previously been provided to DSWM and are available upon request.

APPENDIX A

PowerPoint Presentation

APPENDIX B

Meeting Agenda

APPENDIX C

Meeting Sign-in Sheets

APPENDIX D

Polling Questions and Data



APPENDIX D

Increasing Residential and Commercial Organics Waste Diversion in the City and County of Denver (August 2009)



**Increasing
Residential &
Commercial
Organics Waste
Diversion
in the City & County of
Denver**

**FINAL REPORT SUBMITTED TO:
COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT**

FROM

**CITY AND COUNTY OF DENVER'S
SOLID WASTE MANAGEMENT DIVISION AND DENVER INTERNATIONAL AIRPORT**

WITH

**HDR ENGINEERING'S TEAM OF
HDR ENGINEERING
LBA ASSOCIATES, INC.
GRACESTONE, INC.**

with in-kind donations and services from

A1 ORGANICS
REHRIG PACIFIC
ISS
AECOMM

August 28, 2009

**Final Report to CDPHE on RREO Grant
Denver-DIA Organic Waste Diversion Project**

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Appendix 1

Maps of Residential Collection routes – attached as PDF files.

Appendix 2

Residential Program Collection Data (attached as an excel spread sheet)

DIA Collection Data

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Appendix 3

Data from Sample Weights showing neighborhoods

Appendix 4

Residential Program Educational Materials

DIA Educational Materials

Appendix 5

Residential Photographs

DIA Photographs

Appendix 6

Waste Composition Study Final Report – attached as a PDF

Appendix 7

Survey summary and data



DENVER
THE MILE HIGH CITY

July 30, 2009

ORGANIZATION INFORMATION

- 1. Agency Name: City & County of Denver**
- 2. Project Title: Increasing Residential & Commercial Organics Waste Diversion in the City & County of Denver**
- 3. Name of Project Manager: Charlotte Pitt**
- 4. Project Manager e-mail address and phone number:
charlotte.pitt@denvergov.org, 720-865-6816**
- 5. Name of person(s) completing this report:
Charlotte Pitt and Anne Peters**
- 6. E-mail address and phone number of person(s) completing this report:
Charlotte Pitt: charlotte.pitt@denvergov.org , 720-865-6816
Anne Peters: annep@indra.com , 303-494-4934**

**Final Report to CDPHE on RREO Grant
Denver-DIA Organic Waste Diversion Project**

**Final Report:
“Increasing Residential and Commercial Organics Waste Diversion
in the City and County of Denver”**

II. WORK PLAN

Deliverable	Completion Date	Comments (if deliverable <u>was not completed</u>, please explain why or progress made)
Research and Plan Pilot Logistics and Outreach/Education (SWM pilot planning)	11/08	
Waste Composition Study for Denver residential pilot	11/08	Report not completed until March 2009
Research and Plan Pilot Logistics and Outreach/Education (DIA Pilot Planning)	1/09	
Implement Pilot Program (DIA)	4/09	Pilot was launched in Jan. 09 and ran through April 09
Implement Pilot Program (SWM)	10/08	Pilot program was started 10/08 but took two months to ramp up to full participation

III. GRANT PROJECT INFORMATION

1. Executive Summary

The City and County of Denver’s Solid Waste Management (SWM) Division and Denver International Airport (DIA) received a grant from the Colorado Department of Public Health and the Environment’s (CDPHE) Recycling Resources Economic Opportunity (RREO) fund in July 2008. The grant funded a project from July 1, 2008 through June 30, 2009 entitled “*Increasing Residential and Commercial Organics Waste Diversion in the City and County of Denver.*” The purpose of this grant was to conduct a one-year pilot program to increase the diversion of organic waste in both the residential and commercial settings.

Denver designed the program to be a dual, concurrent pilot to collect and compost organics waste from (a) Denver residences (discarded yard, food and soiled paper) and (b) commercial operations at DIA (discarded food and soiled paper). The pilot program has provided data and useful observations regarding: waste composition, expected diversion rates, public acceptance, DIA vendor acceptance, staffing needs, operational needs (including number of trucks, food vendor needs, residential carts and vendor containers, education, contamination limits, etc.), and a baseline for generating some cost estimates for full implementation. The residential composting pilot program illustrated that the City might expect higher pounds per set out than initially expected (31 pounds per week per cart during the growing season, and 12 pounds per week per cart during the winter months). This is a significant number when considering that in 2008 Denver households averaged about 52 lbs of trash per household per week. The pilot also allowed the City to verify many of its other assumptions for this program. DIA, through this project, was able to learn some valuable lessons about program logistics. The pilot’s diversion of

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approximately 31-38 tons of organic waste from DIA, over an 11 week period, will help DIA meet its goal of decreasing disposal to .45 lbs/passenger in 2009” This data will enable both Denver SWM and DIA to make informed decisions about fully developing and implementing permanent programs in both settings.

Immediate environmental and economic benefits from the grant program itself included waste diversion, job creation, participant education, reduced greenhouse gas emissions, and new data on organics diversion that will be used for program planning at DIA and Denver SWM. A key data point that the City discovered through the waste composition study was the high volume of organic material found in the residential waste stream. Considering Colorado has a semi-arid/arid climate, the City expected to be below or right at national average (38.5% as reported by the EPA in 2007); instead results showed our organic materials (about 57% of the total) is significantly higher than the average. This data can also be extrapolated to develop programs or analyze waste streams throughout Colorado.

Should there be final implementation of a citywide residential compost service and/or a food waste collection program at DIA, it benefits will include job creation, waste diversion, greenhouse gas emissions reductions, and create compost for use in and around the Denver metro area (along with the resulting benefits of its uses). For example, composting food discards yields a net reduction of 0.05 MTCE/ton¹, while landfilling increases greenhouse gas emissions by 0.20 MTCE/ton.

The City and County of Denver, Denver International Airport, and other parties to the project all wish to thank the Colorado Department of Public Health and Environment (CDPHE’s Pollution Prevention Advisory Board and its Assistance Committee) for the opportunity to carry out this pilot project. It would not have been possible without grant funds. We believe the comments from Denver residents will help us further expressing out gratitude:

- “Thanks for starting this program. It's nice to feel that maybe we will be part of the solution (i.e., helping reduce our environmental damage) instead of the problem”
- “I really like that I can minimize my landfill garbage exponentially now.”
- “We are a family of 6 and we can't begin to tell you how easy you have made this for us to do our part. We love the program and will use it all year long”

(comments taken from a survey of participants in December 2008)

NOTE TO READER: *In order avoid confusion, we have divided the two projects into two separate reports. First you will find a full report on the residential composting collection pilot program, followed by a full report of the DIA composting collection pilot program. We will end the report with a joint conclusion for both projects. We hope this will provide readers with the format that is easiest to follow and understand.*

¹ MTCE = Metric tons of carbon equivalent per short ton of material. From Exhibit ES-4 “Net GHG Emissions from Source Reduction and MSW Management Options,” in *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* 3rd Edition, September 2006, US EPA, available at <http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html>

RESIDENTIAL COMPOSTING COLLECTION PILOT PROGRAM REPORT

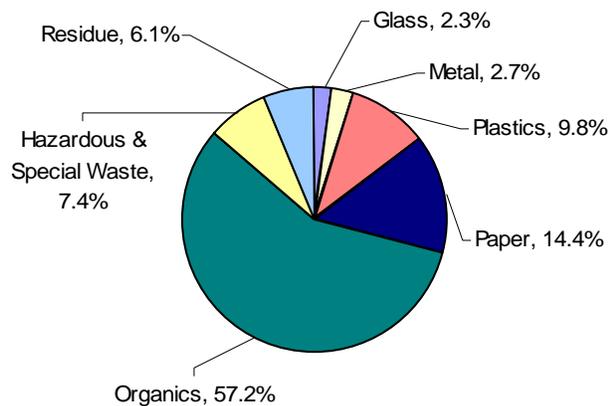
R.1.0 Project Description and Overview of Work Completed

The Denver Residential Composting Collection Pilot Program has long been a desire of Solid Waste Management for the belief that, despite Denver's semi-arid climate, organic materials made up a significant portion of the waste stream and that Denver residents would embrace the ability to divert this material from the landfill. Anecdotally, SWM seasonally adds personnel to staff trash collection crews during the growing season to handle the additional organic materials in the waste stream. In order to verify this and determine the feasibility of a citywide composting collection program, Solid Waste Management submitted an application for funding to CDPHE under the RREO grant program. The grant provided partial funding of a two-season Waste Composition Study (WCS) and the establishment of a composting collection pilot program for 3,300 Denver homes.

R1.1 Related Research

Waste Composition Study. A two-season waste composition study (WCS) was conducted on Denver's residential trash during the spring and fall of 2008². The WCS was conducted on trash generated from Denver's residential waste collection routes. It was designed to evaluate the composition of the residential trash stream and to provide data to help guide the City in making decisions about how to increase waste diversion. The aggregated WCS results indicated an organics content of over 57% by weight, with two major sub-categories: (a) yard waste, and (b) food waste.

Figure __. Average Aggregate Composition (percent by weight)



² This work was completed and funded as part of two projects: By the City of Denver (Spring 2008 WCS) as part of its Strategic Master Plan effort, and by grant funding from the Recycling Resources Economic Opportunity Fund of CDPHE (Fall 2008 WCS).

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The organics category was comprised of (provided as percent by weight):

- 38% yard waste – including mostly grass clippings, sod, branches and leaves which can be managed in a curbside cart collection program
- 10% food waste – including food-contaminated paper and packaging
- 2% textiles – clothing, shoes, rags, bedding, insulation and carpeting
- 8% mixed, other organics – diapers, animal feces and cat litter

Although soiled paper was not a sort category for the WCS, it has been an acceptable item in the actual composting collection pilot program. Estimates are that waxy paper, milk cartons and tissue paper constitutes another 3% of readily compostable materials. These “non-recyclable” papers were not counted as organic in the WCS, but rather in the paper fraction. Therefore we believe there is a potential to capture about 51% of the waste stream through the yard, food and soiled paper waste fraction targeted by the pilot study.

The WCS results were subsequently used to project annual potential waste diversion from food and yard waste recovery, based on an assumed recovery rate ranging from 40% to 60% of total organics generated. This projection indicated that between 37,300 and 56,000 tons/year of food and yard waste could be diverted through an established citywide program. This pilot project has been conducted to evaluate the feasibility of both implementing such a program and of the program’s actual potential for success³.

Public Input on the City’s Solid Waste Master Plan, June 2009. In addition to the WCS, and relevant to the RREO grant project, Denver has just completed a series of public meetings and a survey on community values related to waste management (not funded by this grant). 30.4% of respondents indicated that adding a composting collection program would be the first thing they would change to increase waste diversion in the City. This was just 0.3% below first-highest response which was to eliminate or reduce bulky item collection to offset the cost of increased diversion. There were six possible answers that respondents could have chosen.

R1.2. Pilot Scope and Basic Program Design

Based on its groundwork from 2008 and earlier, Denver wished to conduct a pilot study to explore the feasibility of collecting organic waste (yard, food and soiled paper) from a cross-section of Denver’s residential neighborhoods. SWM’s goal was to test:

- Interest in participating in the program.
- Barriers to participation.
- Routing and collection efficiencies.
- Participation in various neighborhoods in Denver.
- Program costs.
- Ability to divert materials.
- Quantities that could be diverted, both by volume and weight.

³ The “Final Report - Spring/Fall 2008 Waste Composition Analysis” was submitted to Denver Solid Waste Management” by HDR Engineering, Inc. in association with LBA Associates and Gracestone in March 2009. It is included as Appendix 6.

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Pilot Project Team. In addition to the RREO grant funds, the program relied on a number of program partners with distinct roles and responsibilities. They were:

- Denver Solid Waste Management/Denver Recycles – grant management, composting collection, residential education and outreach, data collection.
- A1 Organics – receiving and composting organic materials. Providing services at half price.
- HDR team members (including Gracestone and LBA Associates) – gathering data, including weighing selected samples of curbside organic waste; compiling and analyzing data, and drafting final report.
- Rehrig Pacific – manufactured carts, providing half the needed quantity at no cost to the City.

Pilot Design. The pilot was designed to collect organic waste from Denver residences in a manner that was easy and convenient for Denver resident in order to encourage participation.

a. Material Collected: Organic materials targeted to be collected included:

- Food waste (e.g. table scraps such as baked goods, left over pizza; food preparation waste including meat, bones and dairy and fruit/vegetable scraps).
- Compostable paper products (e.g. non-recyclable fiber including food-contaminated paper, waxed cardboard, waxed paper, paper towels and napkins, tissues and paper milk cartons).
- Yard debris such as grass, weeds and branches.
- Other compostable organics such as flowers, houseplants, dryer lint, etc.

Additional acceptable items can be viewed in the attached residential education resources. Due to the extensive nature of the acceptable items, Denver Recycles provided a detailed list to guide residents and then encouraged them to e-mail or call with specific questions.

b. Neighborhood Selection:

Participating areas were selected based on a number of varying factors:

- Service was selected for Monday, Thursday and Friday, the days that SWM had additional trucks available for use. Areas that already had recycling collection on those days were chosen so that participating households could conveniently put both their recycling and compost cart out on the same day for collection.
- Areas of high, medium and low recycling participation.
- Areas with dumpsters, barrels and manual trash collection.
- Pilot neighborhoods crossed every City Council district.
- Anecdotally, not scientifically, staff also considered the yard size and maturity of landscaping for the different areas.

c. Program Operations Basics:

The program worked as follows:

- Residents in the pilot areas were invited to subscribe to service at no charge to them.
- Subscriptions were cut off when the maximum number of households SWM could serve was reached.
- SWM provided subscribed residents with one, 65-gallon green cart; one, 2-gallon kitchen pail for collecting food waste in their home; and educational materials (including a list of acceptable materials and a service calendar).
- The customers on Friday's routes were also given 2 boxes of BioBags (50 bags; biodegradable corn resin bags) for their kitchen pails in the initial round of delivery.

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- Composting was collected on the same day of service as trash and recycling (except dumpster routes, where it mirrored only recycling collection). Organics were collected weekly during the growing season and every-other-week during the winter.
- Organic materials from the residences was consolidated at the Cherry Creek Transfer Station (CCTS) and then delivered to A1 Organics' Keenesburg, CO facility on a weekly basis⁴.
- A1 Organics was responsible for composting the material and marketing the finished product.

d. Project Timeline. The main events in the Denver pilot project occurred as follows. This list also provides an overview of the program operations highlights:

- August 2008: Specify and order collection carts, kitchen pails and BioBags.
- August 2008: Begin design on announcement postcard, educational brochures, web site, service calendars etc.
- August/September 2008: Choose and finalize participation areas.
- September 2008: Send announcement to eligible residents and allow residents to sign up.
- October 2008: Begin cart delivery the first two weekends of the month.
- October 2008: Expanded routes to allow more eligible residents to participate, in order to reach maximum sign-up of 3,300 homes quickly.
- November 2008: Sign up complete with maximum participants.
- November 2008: First survey of participants.
- December 2008: Participant education and switch to every-other-week collection.
- January 2009: Second survey of participants.
- April 2009: Participant education and switch to weekly collection.
- June 2009: Notified of award for 2009/2010 grant to test additional transportation and program parameters.

R2.0 Summary of Findings and Results

R2.1 Results

Quantities. Overall, more than 811 tons of organic wastes were collected from approximately 3,260 Denver households during the 8.5-month study. During 18 weeks of this period (December through March), collections were every-other-week (EOW), the remainder of the time (October, November and April through June) they were weekly. Collection was conducted Monday (approximately 48% of subscribing households), Thursday (9%) and Friday (43%). Figures A and B show the weekly total tons collected and pounds per household, respectively - the vertical separations in the data indicate the separation between weekly and EOW collection periods.

⁴ This practice was modified in May, 2009 as a result of reduced operational resources at the Cherry Creek Transfer Station. Starting in May, materials were delivered to A1 Organics Stapleton Facility where they were consolidated and transported to A1 Organics Keenesburg facility. This consolidation was provided by A1 Organics.

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Figure A - Weekly tons of Organic Waste Collected

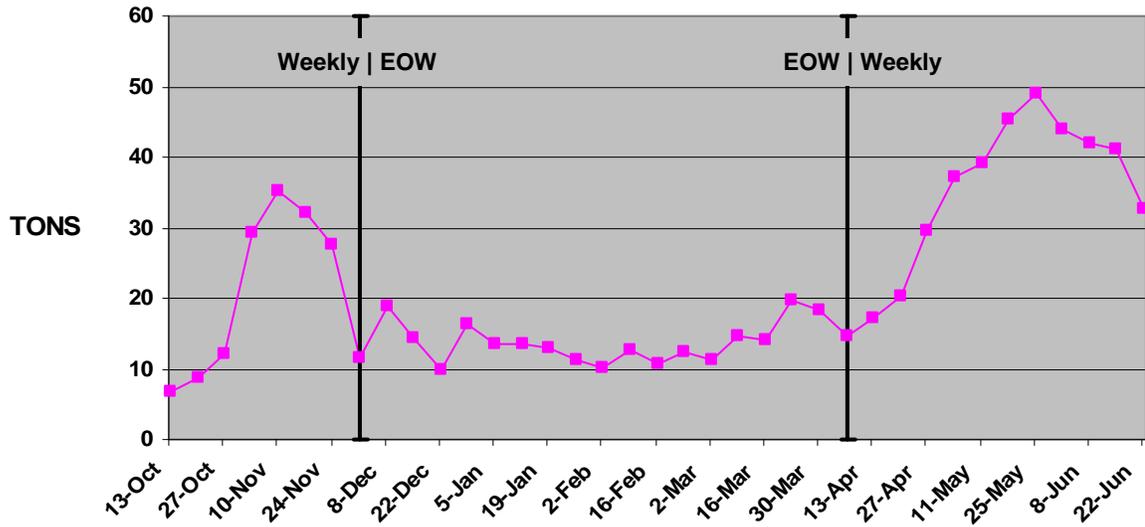
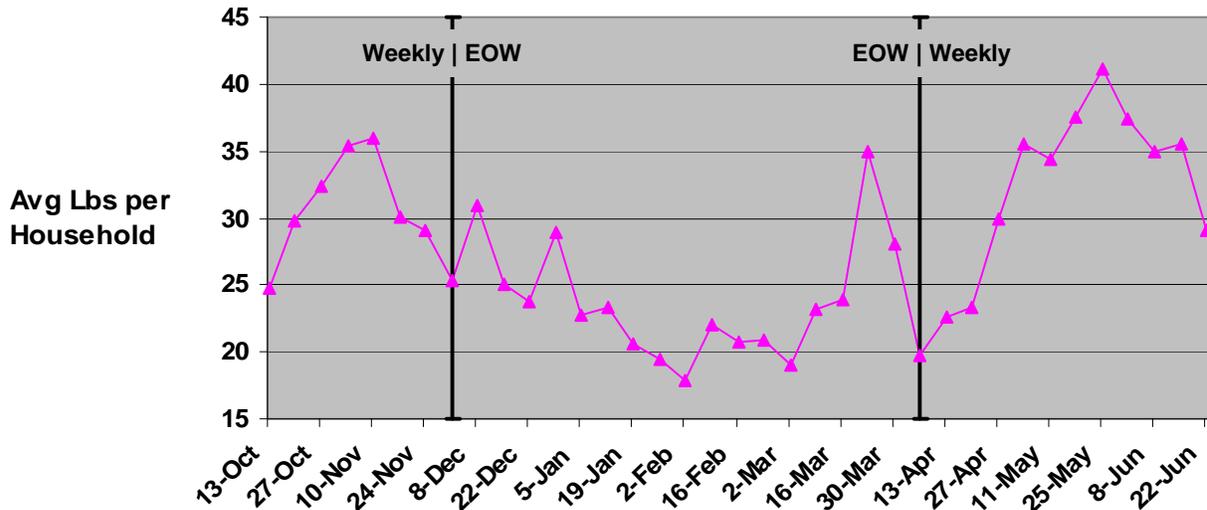


Figure B - Household Collections of Organic Waste



Tonnages were obtained using truck scales at the CCTS and A1 Organics' Stapleton facility. Average household weights were calculated from tonnages and the number of subscriber set-outs on each collection day. Table 1 provides a summary of results as a function of the collection frequency (note that the high growing season is typically April through November, which corresponds to weekly collection during the pilot study).

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Table 1 – Summary of Results By Collection Frequency

	WEEKLY October 13 - November 29, 2008	EVERY OTHER WEEK December, 1 2008 - April 3, 2009	WEEKLY April 6 - June 22, 2009
Average tons/Week	21.8	13.7	34.4
Average Pounds/ Household	31.0	23.9 (or approx 12 lbs/week)	31.8
Average Set-Out %	61.2%	64.6%	61.6%

A number of observations can be drawn from the previous figures and table:

- A relatively low number of tons were collected during the early weeks of the pilot, as subscribers were still being added and participants were becoming familiar with the new service.⁵
- Elevated tons per week associated with fall yard debris (peaked the week of November 10, 2008) were notably less than those associated with spring yard debris (which peaked the week of May 25, 2009).
- Unseasonably warm weather in March followed by a cool down, most likely resulted in the March spike and subsequent fall in April.
- Households maintained their participation (set-out percent) during the low season (EOW) collection period.
- The slightly lower participation during the 2009 weekly collection period may be indicative of the beginning of a “leveling off” that is common for maturing programs (i.e., relatively high participation rate typically occurs with new programs, but stabilizes at a lower rate after several months). Participation can also be affected by weather conditions on the collection day.⁶
- When pro-rated over 12 months and 165,000 households, the 811 tons collected during the pilot project equates to approximately 58,000 tons/year⁷ and compares favorably with the waste composition study analysis which correlated a 60% organics recovery rate to about 56,000 tons/year. In 2008, Denver’s 165,000 homes disposed of 219,000 tons of trash.

Subscriber Set-Out Rates. Figure C shows the number of subscribers who set out organics to be collected at the curb each week, as a function of the total number of subscribers in the pilot study at that time (Table 1 shows average set-out rates as a function of the collection frequency).

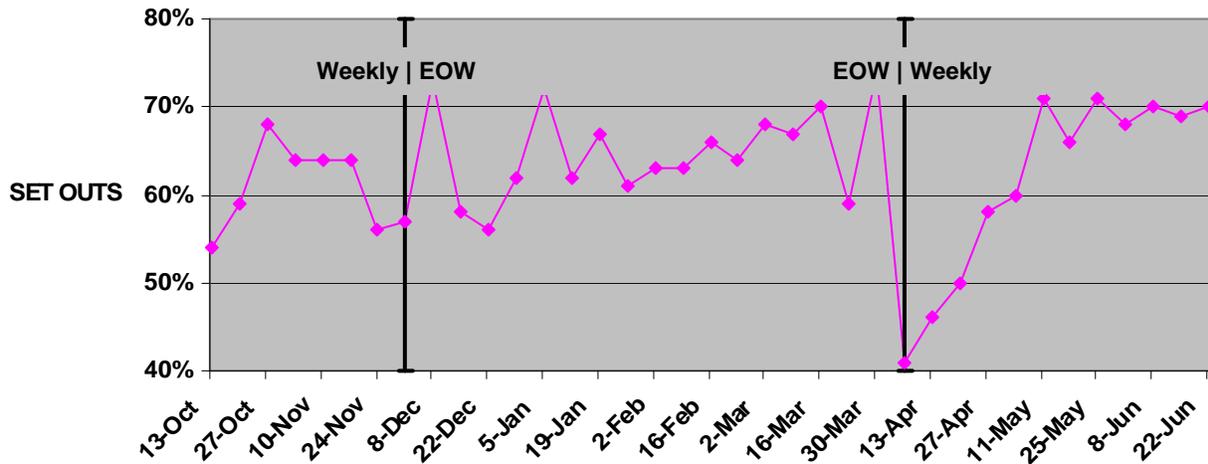
⁵ In October, there were only about 1,000 household subscribers, but this number increased to 3,260 by the end of November. Note that the number of subscribers was dynamic throughout the study as new households joined and others moved out of the area (total subscribers peaked at about 3,270). The highest subscriber number – compared to total households in the targeted areas – reflects an approximate 19% participation rate.

⁶ Note that a participation rate in the 60% range is good for any diversion program (in the King County, WA 2007 study of its organics collection, a 38% subscriber set-out rate was measured). Denver Recycles recorded a 78% participation rate in 2008 for its curbside residential recycling program, which is a high level for a voluntary program (especially when not supported by a pay-as-you-throw (PAYT) fee structure).

⁷ If only single-family homes are considered (141,600), the pro-rated estimate is approximately 50,000 tons/year (approximately 23,400 multi-family homes up to 7 units are also served by SWM).

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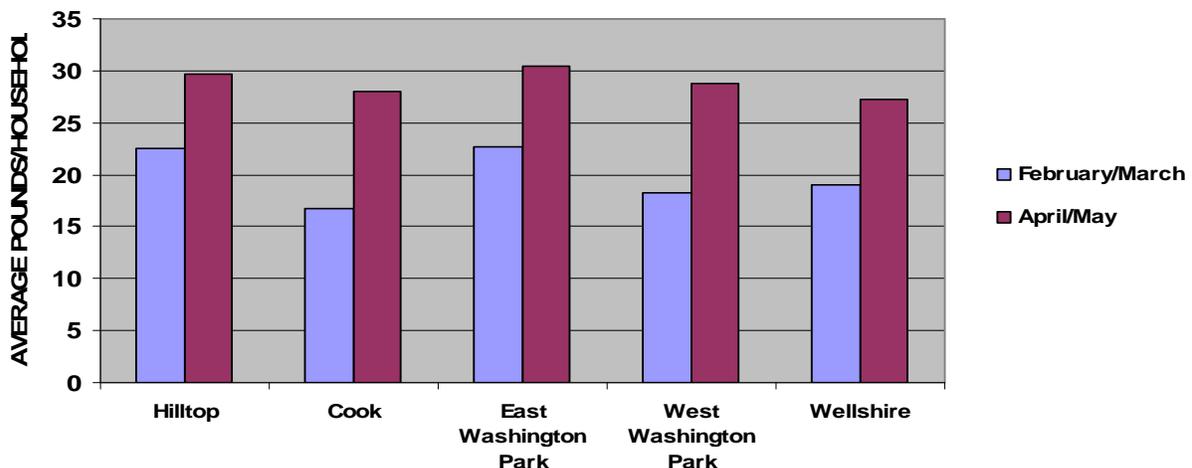
Figure C – Average Set-Out Rates



This data indicates some variability in mid-December, early January and late March that are unexplained but could be related to weather, increased food waste and contaminated paper quantities generated around the holidays (December and January) and elevated early spring yard debris levels (March). Of particular note is the sharp drop in set-out rates in early April when the pilot returned to weekly collection. This drop probably maps the lag time for residents to adjust to a new collection frequency, but may also indicate Denver’s ability to continue EOW collection through April (at least in a spring as cool and wet as experienced in 2009).

Individual Neighborhood Measurements. In addition to measuring quantities and set-out rates, individual subscriber carts were monitored in five different neighborhoods during one week each in the winter and spring seasons. The winter 2009 measurements were conducted in late February/early March, during the EOW collection period. The spring 2009 measurements were conducted in late April/early May, during the spring weekly collection.

Figure D – Neighborhood Weight Measurements



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The spring 2009 data indicates notably higher weights than winter, corresponding to increasing yard waste generation during spring months. Although the East Washington Park and Hilltop neighborhoods had the highest average weights per set-out in both seasons, there is not a striking difference between neighborhoods.

A visual observation of how full the individual carts were was also made during the neighborhood measurements. During the winter 2009 (EOW collection), these neighborhoods averaged 49% full, while during the spring 2009 (weekly collection), the neighborhoods average 51% full. These numbers support the possibility of Denver extending the EOW collections (i.e., reducing the weekly collections) such that the individual carts are used more efficiently. However, the neighborhood data did not represent the full pilot and other periods during the study may have yielded greater fill levels (i.e., mid-November and late May through June). Public input suggests that cart size is adequate to allow for year round fluctuations due to seasonality.

Organic Waste Composition. Although a composition analysis was not conducted on the collected organic waste, notably higher levels of yard debris than food waste were seen during visual observation overall, and particularly during the growing season. This is consistent with observations made by A1 Organics, who noted that organic waste streams similar to Denver's may be as high as 90% yard waste on an annual average – hence the term “dirty yard waste” for these materials. A predominance of yard waste is also consistent with measurements made by King County, WA (including Seattle), which found that 97% of its organic stream consisted of yard waste in a fall 2007 waste composition study, and that only 19% of subscriber carts included food scraps.

Of significance is the fact that the Denver organics waste contained only minimal contamination, as observed both during the neighborhood measurements and by A1 Organics. Contaminants included Styrofoam products, contaminated wood, and foil-lined packaging⁸. While the Compostable BioBags used by some subscribers in the pilot are compostable, they can still be a nuisance at the compost facility as blowing litter. Plastics in general are the primary source of contamination and litter-related nuisance at a processing facility.

R2.2. Operational Observations and Results

A. Collection Operations

- i. Denver Solid Waste Management used anywhere from 1 to 3 trucks to complete the composting collection routes. There were three collection routes on Mondays and Fridays and one route on Thursdays. Route maps are provided in Appendix 1.
- ii. Denver crews averaged about 69 miles per route.
- iii. Observations from route operators indicate that there were no major collection issues during the pilot program. The materials did not prove to be easier or more difficult than the collection of traditional recyclables or trash. For the most part, route operators observed that residents followed guidelines for material preparation and set out. This is especially useful information as it was anticipated that branches might create some significant collection challenges and that did not hold true.

B. The use of the Cherry Creek Transfer Station worked well to increase the efficiency of transporting the organic materials to A1 Organics. In May 2009, SWM did experience some

⁸ Some recyclable paper (cardboard, Kraft bags and newspaper) was observed.

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transfer trailer shortages, which required us to shift the consolidation of materials to A1 Organics' Stapleton site. This switch did not impact the program or its results. The additional cost of having A1 Organics consolidate was absorbed by Solid Waste Management.

C. Density: Through this pilot program we have learned that the density of the material collected was much lower than expected, which means there is a lot of air in the material. To maximize transportation efficiencies SWM believes volume reduction of the organic materials could be beneficial (note phase 2 of the pilot program will allow the City and its partners to test this). The primary reason for this is likely the large percentage of yard debris being collected and the difficulty of compacting it in collection vehicles.

D. Contamination: A1 Organics reported minimal contamination of the Denver stream. The most problematic material received was plastics.

E. Other: Due to our need to test a variety of parameters as part of this pilot, the collection routes created were not designed to maximize efficiency.

R2.3 Public Education and Input

Education and outreach is a critical component of any waste diversion program, but is especially important for a new service. The goal of the education efforts for the composting program was to provide valuable information about composting and instructions for correct participation, in the program in a manner that was appealing and eye-catching. The subscription based pilot program proved to be beneficial to City staff, because we were able to request an e-mail address from each subscriber. About two-thirds of participants provided their e-mails allowing staff to distribute much of the messaging electronically.

a. Educational Strategies:

- Introductory brochure direct mailed to eligible home inviting participation.
- Direct mail postcard to remind residents about the opportunity to participate.
- Program overview brochure and calendar of collection days, delivered with the composting cart.
- Cart sticker on lid of cart to remind participants what is acceptable in program.
- Survey of participants – while questions were designed to solicit feedback, many were worded to provide educational value.
- Quarterly Newsletter – email and mailed to those without address.
- Direct e-mails to participants as early questions and issues arose.

See Appendix 4 for samples of all the educational pieces developed.

Educational Accomplishments: The data around program participation, tonnages collected and low levels of contamination indicated that the education and outreach program was successful. The ability to transmit information electronically was a big part of staff's ability to quickly respond to concerns. For example, a participant noted that they had placed their kitchen pail on the bottom shelf of their dishwasher and it melted. We quickly sent an e-mail reminder to residents letting them know the pail was top rack dishwasher safe only. Survey results from participants indicate that educational materials and messages were effective.

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b. Survey Summary

Two surveys were conducted during the program to obtain input from the 3,270 participating households about several matters:

- Adequacy of information at startup.
- Motivation to participate.
- Adequacy of cart size.
- Materials going into the carts.
- Seasonal and weekly vs. every-other-week use and participation variability.
- Perception of reduction of trash.
- Interest in the pilot from participants friends and neighbors.

These surveys were conducted via email notifications to participants, inviting them to answer up to 7 questions on a web-based survey (using Survey Monkey). Initiated on November 17, 2008 (“Round 1”) and on January 14, 2009 (“Round 2”), both surveys were open for three weeks. Participation was excellent:

Round 1 – 1,108 total responses (34% response rate)

Round 2 – 761 total responses (23% response rate)

The survey obtained many comments as well as quantifiable responses. Analysis of the data yielded the following key findings about the pilot.

- Participants were well informed at the pilot start-up:
 - 99% of Round 1 respondents said the information received with the green cart adequately prepared them to use the service and to understand what is accepted in the cart. (This question was not asked in Round 2.)
 - 14% provided useful comments such as the need to clarify accepted materials and collection scheduling, appreciation for the BioBags, etc.
- Participants were motivated to participate by two primary factors:
 - Wanting to make less garbage
 - Because it was the “right thing to do”
 - Of the 14% of respondents who provided comments, many expressed that they...
 - “Could have selected all of the above;”
 - “Wanted to be part of this pilot program to help Denver;”
 - Liked city organics collection better than backyard composting; or
 - “To help reduce my family’s footprint on the planet.”
 - Appreciated the program, using words like ‘thrilled,’ ‘awesome,’ ‘gleeful,’ and ‘wonderful;’ many said things like “I don’t just like this service, I LOVE IT.”
- Residents were asked if the green cart was too big, too small, or just right, in both surveys.
 - Satisfaction with cart size was very high, and went up slightly from November to January,
- In November, Round 1 respondents reported that leaves were the majority of materials being placed in green carts, with food scraps as the second-highest item.
- Also in November, 99% said they planned to continue to use the green carts to set out food scraps and soiled paper.

c. Public Interest: Staff made efforts to track program queries but has struggled keeping this accurate due to the number of avenues that we receive inquiries. Inquiries come to Denver

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Recycles via 3-1-1, SWM administrative phone line, e-mail, City Council Offices, the Mayor's Office, Community meetings, neighborhood associations and more. Denver Recycles staff directly responds to multiple requests to participate each week. While anecdotal, the City has seen an immense amount of interest around this program, as can be supported by the response received from the Solid Waste Master Plan public input survey.

R3.0 Summary of Unanticipated Outcomes or Roadblocks

The City was fortunate that the residential portion of this project resulted in very few unexpected outcomes and the two listed below were very minor for the City to overcome.

- Sign ups. The City was initially very conservative in the number of residents that were invited to participate out of concern that there would be too many interested participants. The reality is that people are often a bit slower to respond to services than expected and generally the delivery of a cart to a neighbor will spur a request. Therefore, in order to ensure full participation by November, the number of residents invited to participate was increased.
- In May, the City saw a shortage in Transfer truck trailers and could no longer dedicate a trailer to the composting program. The City worked with A1 Organics to take over the consolidation and transfer of the materials, and paid for this service.

R4.0 Communication of Project

Interest in the composting collection pilot program remains high. To date staff has:

- Presented at the CAFR Annual Summit for Recycling in May 2009.
- Worked with the media on a number of TV news stories and print articles. Staff will continue to seek opportunities to promote the program. Sample print articles can be found in Appendix 4.
- Communicates the program through the Denver Recycles website (currently doing so and will continue to do so).
- Received numerous calls from City's around the country about the program.

R5.0 Future Impact of Project

Solid Waste Management believes that the pilot composting collection program has been a huge success in regards to proving the potential for diversion, customer satisfaction and community support. There is a significant amount of demand to expand and continue the service. Should the City be successful at implementing a citywide composting collection program the future impacts would be:

1. The potential to divert significant amounts of waste, estimated between 50,000 to 58,000 tons per year for an established program. In 2008, Denver homes disposed of about 219,000 tons of trash.
2. Avoid trash collection and transportation costs. Conservative estimates suggest that for every five compost collection trucks, one garbage truck could be removed from the streets.
3. Ensure that the GreenPrint Denver goal is met, and likely exceeded.
4. Closing the Loop – ensuring Denver's compost from its organics are made available to residents, purchased by the City, etc.
5. Ability to establish a system/infrastructure that could aid other communities and private vendors establish similar programs and services.

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The challenges for providing a citywide service remain the upfront investment in equipment to provide the service and the ability to minimize transportation costs. There is also a significant amount of education needed to around the costs of composting. There remains much confusion around the economics of the composting process and how it impacts overall service costs.

R5.1. Future Organics Diversion Program Considerations

The following is a list of thoughts of things to consider while planning a citywide implementation or to consider as tools to aid in justifying a Citywide composting collection program.

A. Management of Large Yard Waste Debris.

During the growing seasons, homeowners frequently generate brush and limbs that are too large to be placed in a 65-gallon organics container. These materials end up usually end up in the trash. One alternative for managing this material includes adding drop site capability to Denver's CCTS in southeast Denver and/or another location(s) in the north/west part of the city to provide reasonable access. Ideally this site would be controlled in terms of some staff oversight and limited hours, and access, in order to minimize collection of unacceptable items such as trash. The addition of one or more drop sites at an existing city facility with a limited hauling distance to A1 Organics' Stapleton transfer site would add minimal costs to the existing SWM program.

Another option is the addition of a separate large yard waste collection route similar to Denver's large item pick-up collection. Unless implemented on a by-appointment basis, this option could require up to a full rear-load or manual truck route with a driver and laborer that would canvas the residential areas of the city over the course of a number of weeks. While it would provide residents with expanded yard waste collection service, it would add inefficiencies and cost to an already capital-intensive solid waste program.

B. Alternative Hauling Options.

In May Denver switched from weighing and aggregating pilot study organics at the City's CCTS to doing the same at A1 Organics' Stapleton site. Stapleton is located north of CCTS, about 20 miles from A1's Keenesburg composting facility. This switch addressed an equipment shortage at the transfer station and allowed A1 to make the long haul to Keenesburg instead of the City. Use of the Stapleton site will continue to make sense for the next several years (especially once A1 obtains its new State grant-funded grinder in the summer of 2009). The use of this site will generate data that could be transferable to any number of transfer sites in Denver, including the Cherry Creek Transfer Station.

One alternative to be considered at that time is to outsource the transfer and transport of Denver's organics stream to a third-party hauler. The City could conduct a procurement process (hopefully obtaining multiple bids) for the provision of a local transfer facility and hauling to whichever compost facility Denver may be contracting with at the time⁹. This procurement

⁹ It should be noted that the city contracted with Waste Management to haul organics from DIA to Keenesburg at a rate of \$211/roll-off haul, which sometimes included less than 15 cy. This contrasts with the \$240 A1 Organics charged Denver during the same project to haul 100 cy of organics.

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could also include public drop-off of large-item yard waste (and processing as needed to maximize payload between Denver and the compost facility location). The cost of this service would need to be considered in overall funding obtained for a new citywide composting collection program.

C. Increased Organics Stream Density.

In the organics stream, yard waste especially is likely to have high voids and lower density, resulting in the need to “haul a lot of air” which decreases hauling efficiency. While density measurements were not made on Denver organics, A1 Organics observed and the City’s set out data confirmed, the density to be 200-300 lbs/cy, noting that yard waste was the predominant component of this stream¹⁰. This value is lower than expected by A1 Organics who anticipated seeing about 400 to 600 lbs/cy, considering the addition of food waste¹¹ and the high density of summer yard debris.

The ability to reduce the volume of this material and increase density before a long haul by grinding or similar processing will increase payload and decrease transportation costs. Downsides to grinding, such as making contaminant removal difficult and shredding plastic BioBags (increasing wind-blown litter), can be addressed by selecting a coarse grinder suitable for yard waste, providing quality control, and removing (or prohibiting) bags in advance of screening. Using a 2009/2010 State grant, A1 Organics and Denver will be obtaining a new yard waste grinder to test the feasibility and effectiveness of this. This method has been used in other parts of the country, especially in cities where the haul to a compost site is greater than ours. The addition of a pre-haul processing step should be carefully estimated against the cost of hauling, before a long-term commitment is made by either Denver or its contractor, and the 2009/2010 grant project will allow that to happen.

D. Alternative Compost Facility.

To increase the long-term sustainability of organics collection and composting, it would be ideal if Denver could tip its waste at a compost facility located in or near the city. However, the permitting, siting, and operation of a new facility would be challenging given the proximity and density of residents and businesses combined with the high likelihood of odor, noise and litter. In fact, although Boulder has a privately-operated compost facility located in its immediate vicinity, this is an exception – most facilities that serve U.S. communities are located well outside city limits and far from residentially-zoned areas.

Despite Denver’s strong partnership with A1 Organics (for the pilot study and on other projects), it would improve the procurement process if the City had multiple facilities to choose from when procuring new processing services¹². It is possible that other private sector operators will develop regional compost facilities in the future as the demand for organics recovery grows.

¹⁰ National sources indicate that trimmings/prunings can range from 40-170 lbs/cy; leaves 250lbs/cy; grass 400 lbs/cy; leaves/grass about 350 lbs/cy; and branches/stumps 460 to 1,100 lbs/cy (USEPA, Cascadia Consulting Group, Tellus Institute and the National Recycling Coalition).

¹¹ Food waste can have densities ranging up to 2,000 lbs/cy according to the USEPA.

¹² Denver does not anticipate owning or operating its own composting facility in the foreseeable future.

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E. Collections Expanded Beyond Single-Family Homes.

Given the popularity and success of the pilot project, it is reasonable to look beyond a citywide roll-out serving all voluntary single-family homes. Expansion of a Denver organics recovery program to eventually include food, paper and yard waste from municipal buildings, schools, and maybe even multi-family homes might realistically be a good 5- or 10-year goal.

The addition of food, paper, and yard waste from municipal buildings and schools would be the easiest first step in this phase of an extended program – primarily because of existing city control over these wastes (Denver currently collects trash and recyclables from municipal buildings and is just about to roll out service to Denver Public schools). However, the separation, containerization and collection of kitchen/cafeteria, office/classroom and yard waste from these generators would be needed. In some cases, 65-gallon carts may be sufficient, but other generators will require larger containers, which can be sealed and locked to minimize leaks from food waste and scavenging¹³.

Expanded service to multi-family residential units has different challenges, including an existing ordinance that keeps Denver from serving these generators and a lack of space at most of these locations to separate and containerize organics. This expansion would require:

- Ordinance changes:
 - Requiring or providing incentives for organics diversion by generators, landlords and haulers.
 - Who would collect from these generators (city, private sector or both).
- Change to Denver’s Managers Rules if SWM pursues collection from these generators.
- Procurement for collection, transfer/long-haul and composting services (may be bundled into one request for proposals/contract step depending on the services needed).

Any expansion of the service area will require extensive education efforts, ranging from early notification to workshops and continuous follow-up.

F. Coordination with DIA in a Future Program.

Should DIA implement a permanent organics recovery program, it may cover only pre-consumer food waste from the Main Terminal and Airport Office Building included in the pilot project or it may expand to ultimately include pre-consumer food waste from these areas plus the existing (and future) concourses¹⁴. Despite the differences in their respective organics streams, there are definite synergies between a permanent DIA and a citywide Denver organics recovery program that could reduce overall costs including:

- Piggy-backing on Denver contract services for local transfer, long-haul and compost operation services; ideally, increased tons would reduce unit costs for each service.
- Using a combination of SWM staff and DIA Environmental Services staff to consult on opportunities for compacting DIA food waste on-site, on utilizing compacting collection vehicles, or on other options for reducing haul costs from DIA.
- Educating the public – messages, media and products could be replicated, reducing staff time (this was accomplished effectively during the pilot program when SWM staff provided vendor training and outreach materials with a “similar-look” for both DIA and Denver).

¹³ Use of dumpsters in institutional and commercial applications would require DSWM to acquire front-load collection capacity (or modified rear-load for small dumpsters) – or to contract the collection with another hauler.

¹⁴ The addition of post-consumer food waste and even airport landscaping and yard waste is a less likely possibility.

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G. New Policies and Practices to Increase Diversion.

Mandatory organics recovery – If Denver’s future citywide organics program was implemented as mandatory, then every single-family home would be provided with a green cart. If actual enforcement occurred (i.e., keeping organics out of trash), then increased organic tons diverted would undoubtedly increase. However, these actions would have other ramifications such as:

- Elevated funding needs to purchase carts and trucks to service the about 165,000 single-family households.
- Funding needed for an aggressive enforcement function.
- Diluted organics generation per household may decrease collection efficiency. (i.e., in a voluntary program, such as the pilot study, the “best of the best” residents want to participate, whereas when forced, some residents do not embrace the concept of diversion and may divert only nominal quantities (low weights per set-out would increase the unit cost of collection).¹⁵
- Organics quality may suffer (e.g., increased contamination).

Yard waste disposal ban - It would be difficult for Denver to implement a true disposal ban as the Denver Arapahoe Disposal Site (DADS) is operated by a private contractor. The DADS operator accepts a significant quantity of waste from other generators who may not support a ban (although nothing would preclude Denver from working with its contractor and other users to make this a regional or even statewide initiative in the future). Denver could, however, implement policy to prohibit the collection of yard waste as trash¹⁶ (similar to mandatory enforcement of yard waste diversion discussed above). This would require concerted education and enforcement measures, and could only be implemented once full yard waste collection services (including large-item yard waste collection options) are in place. Denver could also support statewide yard waste disposal bans, should some ever be introduced.

Meeting Denver Greenprint’s Landfill Reduction Goal.

This goal calls for a reduction in landfill tons generated by Denver’s residential collections to 185,000 tons by 2011 (from 2004 baseline). Denver’s recent WCS analysis of 2008 tons illustrated that this goal would be achieved if 40% of each of the total potential quantity of recyclables and organics are successfully diverted. If this were accomplished, the resulting overall diversion rate would be approximately 27%, which compares much more favorably with the 2007 national average recycling/composting diversion rate of 33.4% than the current program achieves.

Based on the estimations made from the pilot project results, it appears that a citywide organics recovery program could exceed a 40% organics diversion rate and significantly contribute to meeting the Denver Greenprint goal.

¹⁵ Note that Denver Recycles program is voluntary and 53% of eligible single-family homes currently participate. These homes generated an average 34 pounds of recyclables per set-out in 2008 (a relatively high number compared to available data for other U.S. programs).

¹⁶ Other communities without the ability to enforce an actual disposal ban implement this type of mandatory diversion. One example is Fort Collins’ ban on the collection of electronics by residents (i.e., imposed on private trash haulers).

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R6.0. Financial Summary

Table 2 – Budget Overview

Spending tracking			
Residential Pilot Only			
	Amount Invoiced to Gr	Donated Amount	Total Budget
Equipment over \$5000			
65-gallon wheeled carts	\$ 76,849.00	\$ 68,000.00	\$ 144,849.00
3-gallon kitchen pails	\$ 13,741.61	\$ -	\$ 13,741.61
Bio-bags	\$ 5,373.17	\$ -	\$ 5,373.17
Equipment under \$5000			
Waste sort supplies	\$ 318.01	\$ -	\$ 318.01
Operations			
EOS drivers	\$ 25,920.00	\$ 30,230.00	\$ 56,150.00
Supervisor	\$ 21,065.00	\$ 19,992.50	\$ 41,057.50
Truck cost (14680 miles at \$2.84)	\$ -	\$ 41,691.20	\$ 41,691.20
Administrative Personnel- SWM			
	\$ -	\$ 30,418.00	\$ 30,418.00
Consultants			
HDR	\$ 23,737.55	\$ 2,324.00	\$ 26,061.55
Contractors/Sub-contractors			
A1 Organics (processing fees)	\$ 12,037.78	\$ 12,037.78	\$ 24,075.56
		\$ -	\$ -
Education Expenses			
graphic design		\$ 3,166.90	\$ 3,166.90
printing and mailing		\$ 5,839.00	\$ 5,839.00
Total	\$ 179,042.12	\$ 204,693.48	\$ 383,735.60

A summary of grant dollars spent and in-kind donations are attached. It should be noted that many of the expenses incurred were start-up costs, necessary for the program’s success but if this were not a pilot they would have been spread over a larger number of participants. Of specific note:

- The carts and kitchen pails are a one time start up cost. Rehrig Pacific warranties its carts for 10 years and we expect to see an average of 15 years of life. This cost should be amortized.
- Supplying BioBags to participants would not be part of a citywide program. The City tested them to determine their effectiveness at encouraging the composting of more food waste. The City would work with the BioBag vendors to ensure more opportunities for residents to purchase them in retail outlets for future service.
- Through the pilot program, staff has developed all the education resources needed for the service. Moving forward the City would only incur printing costs.
- Routes were not designed to maximize efficiency.

DENVER INTERNATIONAL AIRPORT COMPOSTING COLLECTION PILOT PROGRAM

A.1.0 Project Description and Overview of Work Completed

DIA Food Waste Composting Pilot Project Report

A1.1 About the Project

History. The DIA Food Waste Composting Pilot Project's history actually goes back to 2005 when DIA Environmental Services (ES) prepared its first Integrated Waste Management Program (IWMP). The IWMP established a baseline solid waste disposal rate of 0.51 lbs of total disposed solid waste per year per passenger, and set goals for further waste reduction (*Integrated Waste Management Program: Final Report for DIA*, November 1, 2005, Gracestone, Inc.). The IWMP identified best management practices for a number of waste streams, including DIA's organics waste, and recommended that a pilot project be conducted on organics composting.

In Spring 2008, a Waste Composition Study was conducted on trash generated at DIA (funded in part by a Denver Department of Environmental Health Seed Capital Fund grant as well as by DIA). This study found that approximately 29% of DIA's overall waste stream was organic waste, with three major sub-categories: (a) food waste including bones and rinds, food-contaminated paper towels and napkins (18%); (b) paper towels and tissues from lavatories (8%); and (c) other organics, such as waxed cardboard (3%). Further, this study found that 18% of the waste, by weight, generated in only the Main Terminal and Airport Office Building (AOB) areas alone was also food waste. The Main Terminal and the AOB comprise the core DIA facility that supports three concourses and numerous support facilities.

A1.2 Pilot Scope and Basic Program Design

Based on this groundwork, DIA ES wanted to conduct a pilot study to explore the feasibility of diverting food waste from the Main Terminal and the Airport Office Building (AOB) to evaluate if diversion of organic waste could viably help meet its ongoing goals of reducing disposed solid waste. The RREO grant made the pilot project possible.

Pilot Project Participants. The DIA grant was carried out with assistance from several parties, including 16 food vendors in the Main Terminal. The project required coordination between many different parties, which include:

- DIA Environmental Services (ES) – oversight and coordination; backup on physical collection.
- DIA ES and Denver Solid Waste Management (SWM) staff – purchase and delivery of slim containers¹⁷ and countertop pails to vendors, compostable liners; design and printing of educational materials; vendor training.
- Denver SWM staff – coordinating hauling.
- Staff at all the food vendors – sort and separate correct materials into slim containers and pails, and keep the slim containers clean and functional for their needs.

¹⁷ These tall, slim cans are often referred to as 'slim jims' – this is actually a trademarked name (Slim Jim by Rubbermaid). The pilot used a different brand (Busch Systems); hence they are referred to here as slim containers.

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- Volunteers from two different companies at DIA – ISS (janitorial, formerly BG) and AECOM (formerly DMJM), both of whom donated time to actually haul the full BioBags of food waste from the food vendors to the roll-off at the loading dock.
- Waste Management, Inc. – hauling roll-off to A1 Organics composting facility in Keenesburg.
- A1 Organics – receiving and composting food waste.
- HDR team members, which included Gracestone, Inc and LBA Associates – gathering data, including weighing selected samples of food waste; compiling and analyzing data, and drafting final report.

Pilot Design. The pilot program was designed to collect organic waste from:

- Volunteer vendors in the Main Terminal with pre-consumer food or plant waste.
- Employee break rooms in the AOB and Main Terminal.

Organic waste targeted to be collected from these areas included:

- Food preparation (e.g. fruit and vegetable trimmings, meat trimmings, etc.).
- Food waste (e.g. stale bread, unusable pretzel dough, coffee grounds, unsold food, expired meat, plate scrapings, etc.).
- Compostable paper products (e.g. non-recyclable fiber including food-contaminated paper, waxed cardboard, wax paper, paper towels and napkins).
- Other compostable organics such as unsold flowers, register receipts, straw wrappers, milk cartons, etc.
- From the AOB and Terminal break areas, employee lunchroom-type waste (e.g. banana peels, coffee grinds, paper cups, towels and napkins; greasy fast food bags and papers; uneaten food).

Briefly, the pilot program was planned to work as follows:

- For vendors in the Main Terminal
 - Kitchen staff separated compostable material from other solid waste in preparation areas, and placed the compostable organic waste in either 23-gallon Busch System tall, slim containers or Norseman 2-gallon countertop kitchen pails.
 - Slim containers and pails were lined with BioBags – organically-based bags that biodegrade in the compost process and enable clean tipping of collected organics.
 - Pails were also placed by registers at front counters to capture register receipts, etc.
 - On a pre-planned route through the Main Terminal, several times a day, janitorial or other staff removed the BioBags from the slim containers/pails and placed them into either a 65-gallon cart or a tilt cart, then putting a clean BioBag into the slim container or pail.
 - Each vendor's containers were emptied from one to five times per day, depending on the volume of organic waste generated.
 - Janitorial or other staff took the full cart to a 30-cubic yard open-top roll-off in the AOB loading dock area for tipping.
- For the break rooms in the Airport Office Building (AOB) and Main Terminal
 - Pails were placed with appropriate signage.
 - Designated "Environmental Focal Point" (EFP) staff volunteered to empty the pails at the loading dock; they did so about two to three times/week, as needed to avoid overflow.

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- From the loading dock, the roll-off was hauled by Waste Management (WM) once per week to A1 Organics (A1) facility in Keenesburg, CO.
- WM tipped the organic loads at A1, where A1 composted the material.
 - WM and A1 billed Denver SWM, who then paid bills out of the RREO grant funds.
- DIA ES staff coordinated collection and provided trouble-shooting and fine-tuning of the program for all aspects on-site at DIA.
- Denver SWM managed the purchase of necessary equipment, design and implementation of signage.
- Both ES and SWM planned and delivered necessary training to vendors' staff and EFPs.
- The HDR team provided planning, training, weighing/sampling to obtain detailed data, coordination, data gathering, and report writing.

Chronology. The main events in the DIA pilot project occurred as follows. This list also provides an overview of the management process:

- July 11, 2008: Kick-off meeting for both DIA and Denver programs.
- July 18, 2008: DIA-specific kick-off meeting.
- August 2008: Site tours for key players.
- September 4, 2008: Meeting for all program participants, including concessionaires (vendors), janitorial (ISS, formerly BG Janitorial Services); DIA staff including Environmental Services (ES), Contract Managers, Engineering; Denver SWM; volunteers (AECOM); and HDR team. Explain program to vendors, find out needs, review what can/cannot be composted, and encourage participation.
- September 2008: Survey concessionaires to better understand what is generated and other needs.
- End of September, 2008: Confirm concessionaire participation.
- October 2008: Specify and order collection bins and bags (slim containers, pails, BioBags).
- Fall 2008: Design posters, labels, and table-top tents displays and get printed.
- November 2008: Tour A1 Organics composting facility to understand its operational needs.
- November – December 2008: Plan pilot rollout, including
 - Planning for deploying containers.
 - Setting collection schedule.
 - Coordinating collection between ISS, ES, AECOM.
 - Designing training for vendor staff.
 - Planning roll-off placement at DIA loading dock.
 - Making haul arrangements from DIA to A1.
 - Confirming A1's needs and contamination limits.
 - Identifying data needs.
- Week of January 6, 2009: Training for participating vendors' staff conducted by ES, SWM, and HDR staff.
- January 26, 2009: Pilot kick-off (collections begin from all participants).
- January – April 2009 Pilot program operations
 - 16 vendors in the Main Terminal participating.
 - Janitorial and other staff emptying an average of about 15 containers per shift, carting the organic waste to the loading dock.
 - Fine-tuning collection schedule to meet vendors' and staff's needs (ES managed).

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- Random weight measurements by HDR team to get data-points on weight by day, vendor, and shift; visual fill observations (February - April 2009).
- EFPs emptying AOB break room waste.
- April 15, 2009: Pilot ends (no further collection).

A2.0. Summary of Findings and Results

A2.1 Weight/volume findings

Overall, it is estimated that 31-38 tons (approximately 151 cubic yards) of organic waste was collected and composted from DIA during the 11.4 weeks that the pilot ran.¹⁸ This equaled approximately 2.8 - 3.4 tons/week. Total tonnage was derived based on weight measurements of slim containers and pails taken during the pilot. Weight and volume information is critical in evaluating future program viability, as it helps predict costs and sizing for capital equipment, collection receptacle numbers, hauling costs, and labor costs.

- For the **Main Terminal** the following metrics and program parameters yielded data about weight and volume: 16 vendors participated, including 9 restaurants, 2 coffee shops, 2 quick snack shops, 2 food preparation areas (not at same spot as the restaurants), and 1 general market area (coffee, wrapped snacks, and flowers).
- 30 slim containers and 6 pails were placed at these vendors' sites.
- Slim containers and pails were emptied each day from vendors' kitchens in the Main Terminal, for a total of about 820 tips of the slim container and pail containers per week (or 9,394 total). Appendix 2 shows the schedule and number of containers emptied, by vendor, during the pilot.
- During February through April weight measurements, the HDR pilot team observed:
 - Containers averaged about 30% full (based on a visual assessment).
 - Slim containers contained an average of 8.1 lbs. of organic waste.
 - Pails contained an average of about 1.4 lbs of organic waste.
- The data from measuring vendors' organic wastes showed that weights and fill varied by vendor type as shown in Table 3 below (full detail can be found in Appendix 2). (Note that this data is based on sampling a total of about 300 weights taken of individual containers, across 18 separate shifts on each day of the week – or about 3% of all containers emptied during the pilot period).

¹⁸ This number was derived from averaged weight of all containers of 6.6 - 8.1 lbs./containers (slims and pails). The overall weight and the lbs/container are expressed as a range because only 3% of the pilot's collected organic waste was sampled and actually weighed. Scales were not available to weigh the total material coming from the pilot, so material was measured by volume. A1 Organics estimated the weight of pilot organics received at its facility based on assumptions about density that did not match the actual density found in weights and fill-level observations taken by the pilot team.

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Table 3 – Average Weight and Visual Percent Full, by Vendor, Based on Sampling

	Average lbs./ container by vendor type	Average visual percent full per container ^[1]	
		Low	High
Restaurants	6.7	24%	34%
Coffee Shops	7.2	24%	34%
Food Prep Facilities	18.1	32%	40%
Quick Snack Shops	12.2	35%	45%
General Store	5.3	19%	29%
Grand Total (all sites)	7.3	25%	35%

[1] Expressed as range - volume varied as some slims had boxes in bottom so bags wouldn't break

- Clearly, food preparation facilities (2 kitchens doing all the food preparation for 3 restaurants serving plated, cooked food) generated the heaviest waste per slim container of all vendor types (food preparation facilities didn't use pails). Restaurants' weights are low as food waste related to their service is generated primarily at the food preparation facilities. The general market area, which had coffee grounds, wrapped snacks and flower waste, generated the least weight per slim container.
- Fill volume did not correlate with weight. This is due to following variables:
 - How much actual food prep is done on-site by the vendor vs. how much food is brought to the site "pre-prepared" – e.g., Domino's brings in its food ready to serve.
 - How heavy the food waste is – e.g., the pretzel vendor in the Quick Snack category threw out unused, uncooked dough before closing, notably raising the weight in that category. Coffee shops' waste is heavy, wet grounds in contrast to restaurants (e.g., fast-food pizza or burger service) that toss large amounts of compostable paper (waxed cardboard and paper packing) which can fill a slim container without much weight.
 - How well staff participated in sorting food waste as directed.

For the **Airport Office Building** and Main Terminal break rooms, the following observations were made about weight and volume:

- 12 to 15 pails were placed in AOB break rooms, and were emptied two to three times per week.
- Pails from the AOB were note weighed, but the weight of waste from this location was assumed to range from 270 - 1,500 lbs. during the pilot period. This range is based on the carrying weight of a pail full of kitchen waste – from one to three pounds.
- Foot-activated pails (to avoid hand contact) were recommended by the people collecting the break room organics.

A3.0 Summary of Unanticipated Outcomes or Roadblocks

The DIA project encountered two unexpected roadblocks. The first was the need to switch from DSWM providing the hauling to a private contractor (Waste Management, Inc.) after initial site checks of the loading dock area. It was determined that Waste Management was better equipment with commercial collection equipment than DSWM and would have the ability to adjust service levels if needed. The second unanticipated outcome was the odor that came from having the food waste roll off stored inside. This problem was controlled through

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regular collections of the roll off, however this meant the roll off was emptied even if it was not full.

A4.0 Communication of Project

DIA has communicated this project through marketing internally to vendors, a press release about the program on February 26, 2009, and article in the GreenPrint Denver February 2009 Newsletter, and has plans to present the program at the Colorado SWANA Annual Meeting in October 2009.

A5.0 Future Impact of the Pilot

A5.1. Discussion and Summary

This section analyzes the costs and resources used for the project in order to project the costs for a full-scale, permanent program in the Main Terminal. It also provides observations and anecdotes that will be relevant to future planning.

A. Lessons Learned – relevant to future implementation

A variety of lessons were learned in the course of implementing the pilot project:

Quality of feedstock (contamination issues). Organics waste as collected is a feedstock for an industrial process (the making of compost), not a waste going to landfill with no future use. Therefore it is important to meet the quality standards set by the receiving party (A1 Organics). A1 reported that it had little problem with contamination in the material received from DIA and its operator said “for the most part the material seemed cleaner than typical food waste we receive.” It rated DIA’s material contamination levels as acceptable to good.

The collection of the organics from vendors’ kitchens was performed by a more-or-less dedicated staff (as opposed to the vendors’ own staff); this meant that collectors communicated with kitchen staff daily, providing immediate corrective feedback when contaminants were found in slim containers or pails. Contaminants included mostly plastics (box and food wrapping, plates, utensils), aseptic packaging (chai tea), foil, glass, metals, and as well as some paper materials that were not contaminated and could have been recycled. This regular communication may have yielded a cleaner stream than would result from having vendor kitchen staff fill and empty organics containers on their own, with no regular (daily) corrective feedback from a janitor to kitchen staff. The ISS supervisors requested that posters be pasted on each slim container to educate kitchen staff about acceptable items.

It was observed that some restaurants (e.g. Boulder Beer, Red Rocks, Aviator’s Club) were adding post-consumer waste (plate scrapings) into the slim container accessible to the wait staff. Contamination in the form of newspapers, cigarette butts (from the Smoking Lounge), plastic coffee cups was observed, though was not pervasive.

Some contamination was observed in the open-top roll-off in the loading dock; it appears trash was dumped in the roll-off as many employees have access to the area, goods come in for distribution to restaurants, and there is little oversight. Contamination in the roll-off included secondary packaging boxes, plastic film, strapping and buckets, and trash. ES staff made a “hook” to fish out and remove contamination from the roll-off. Signage was set up and access restricted with a cloth rope, but some contamination did continue.

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Lessons Learned: Ensure mechanism for regular corrective feedback to kitchen and wait staff, including appropriate training, signage, rewards, etc. Control access to collection receptacle to avoid contamination from staff working in the loading dock. How this is done will depend on the type of container used (compactors and other receptacles have options such as locking lids to prevent unwanted tipping).

Biodegradable Liner Use. The schedule for emptying slim containers and pails in the Main Terminal called for about 9,400 separate “emptyings” during the pilot period. Over 14,600 BioBags were used during the pilot. Practices with regard to use of BioBags varied depending on who was doing the collecting. Generally, when ES and AECOM did the collection route, they would tend to consolidate waste materials, and not replace the BioBag if it was not wet, contaminated with food waste, or wasn’t full. However, ISS staff (trained janitors) would sometimes place the whole BioBag into the collection cart even if it was barely full and not dirty, and replace a new one into the slim container. Janitorial staff would also double-line the slim containers for vendors with particularly heavy or wet food waste (coffee shops, food prep facilities), sometimes tipping both bags into the collection cart. Double lining did however, keep the slim containers cleaner.

Lessons Learned: Ensure mechanism to keep costs related to BioBag use down. If vendors are buying and replacing them out of their own budgets (as they do with trash bags) they may use them more sparingly. As well, vendors did find that the BioBags are not as sturdy as a trash bag when carrying, say, 20-30 lb. of wet coffee grounds all the way to the loading dock. This could be an obstacle to program success. If janitorial staff does rounds to collect organics, they will need additional training to avoid over-use of BioBags. See following discussion for additional recommendations.

Biodegradable Liner Types. BioBags are currently the most popular biodegradable bag on the market. A1 Organics’ Keenesburg facility manager did note that A1 must pay to dispose of shredded biodegradable liners that blow off the windrows and collect on perimeter fences. Recognizing the value of BioBags to participation, A1 Organics has indicated they are working on better process to handle shredded bags.

Another observation is that vendors managing their own organics disposal might forget to use biodegradable bags, forget to re-order, melt/break the bag through incorrect use, or object to the cost and thus make unacceptable substitutions.

The BioBags purchased for the pilot (20 gallons) were not deep enough for the 23-gallon Busch Systems containers. It was hard to secure them around the top of the container, resulting in the bags often slipping down into the slim container when it was heavy and full. Staff devised a temporary solution – placing a box in the bottom of the slim container to make the slim’s overall volume smaller. Larger bags might also solve this issue.

Finally, the BioBags were not always strong enough for vendors who generated really heavy waste such as pretzel dough or coffee grounds. Double-bagging solved this (at added expense).

Lessons Learned: Research other biodegradable bag types that might cost less and offer a better sizing match to the containers, better ability to be secured to the container and better strength for the coffee ground generators, etc.). Train staff emptying containers carefully on when BioBags do and don’t need to be replaced, and how to manage double-bagging to ensure cleanliness but minimize expense. While this was difficult to achieve during the pilot, growing organics recovery in restaurants and similar waste generation sites may expand future liner and

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container options and also decrease prices. If vendors are managing their own compost separation and disposal at the loading dock, ES managers should monitor types of bags being used and provide corrective feedback if needed.

On-Site Collection Containers. (Busch System slim containers and Norseman kitchen pails). On the whole, these worked very well, though they did get dirty and vendors complained about this occasionally. The loading dock area has hot/cold water spigots and the ES and ISS staff provided cleaning of slim containers as needed. One slim container broke during the pilot; ES was able to replace it. Some vendor staff expressed concerns about people touching the lids of the compost pails or rims of the slim containers and thus being exposed to germs and bacteria.

Lessons Learned: At the beginning of a program of this type, some adjustment is needed while vendors “right-size” their receptacles. A strong program coordinator who is responsive and can bring or remove the receptacles right away aids program success (which ES did very well). Regular cleaning of slim containers will be needed, and a plan for both swapping out slim containers while being cleaned and for replacing broken ones should be included. Other receptacle options should be explored, such as a floor pail with a lid that opens with a foot-activated pedal. This may alleviate concerns about germs. Additional education around the fact that composting and trash are very similar may also alleviate these concerns.

Setting Collection Schedules. It took two to three weeks for ES to work with vendors to establish a schedule that worked well for all parties. This should be considered during planning for a full-scale diversion program. There are many particulars in establishing a workable schedule that can maximize organics capture – e.g., one vendor closed at 10:30 pm (after last pick-up of day at 9:30 p.m.) and did not want to store organics waste overnight in its kitchen because of sanitary concerns. A 65-gallon cart was placed in the hallway outside of this vendor’s kitchen where it could toss its filled BioBags before closing. The cart needed to be added to the collection route.

The percent full (or fill) level of slim containers was observed visually during sampling activity, and averaged 25-35% full. As shown in Appendix 2, vendors’ containers were emptied from two to five times per day. It is likely that the number of collections at some vendor locations could be reduced, raising the average fill level, and reducing labor costs without compromising on sanitary or odor issues for the vendors. This would be especially true for the restaurants, coffee shops, and the general market (see Table 3).

If janitorial staff is used to empty receptacles, a schedule must be set that respects shift changes.

Lessons Learned: If DIA is in charge of scheduling a route to empty the slim containers and pails, consider reducing service somewhat to lessen overall labor requirements (and to have a greater organics material-to-BioBag ratio). Vendors with light organic waste but high fill volumes might be targeted first, and encouraged to break down milk cartons, pizza boxes and other dirty or waxed cardboard or other items contributing to high volume/low weights. If janitorial staff is used to empty receptacles, a schedule must be set that respects shift changes. Data on average weights per container (Table 3), while based on random sampling, can be used to project weights when expanding the program throughout DIA.

Collection Carts and Systems. The janitorial staff observed that the 65-gallon carts were difficult to move through the collection route, and preferred the large, gray, tilt carts normally used on DIA internal trash collection routes. The larger tilt carts also enable better collection of

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waxed cardboard (it’s bulky to break down and hard to fit in a slim container). It was also easier to empty the tilt carts into the roll-off than the 65-gallon carts.

Lessons Learned: If DIA is in charge of scheduling a route to empty the slim containers and pails, use of the self-dumping tilt carts may enable more efficient “routing” and better capture of entire stream. In the access corridors to vendors’ work areas, where possible, staging areas could be set up with 65-gallon carts where vendors would bring their BioBags. This would create an incentive to use fewer BioBags, would add convenience for vendors, and reduce routing frequency. Locations suggested include Carnation hallway behind the Food Court, Pour La France, and possible locations on the fifth floor.

B. Costs and Needs for Full-Scale Implementation in Main Terminal

This section addresses what would be needed for full-scale implementation of an organics pilot in the Main Terminal and AOB.

To calculate costs of a year-round Main Terminal organics collection program versus “business as usual,” it is necessary to compare against DIA’s current waste disposal practices and costs. Table 4 shows the major steps involved in waste management in the Main Terminal in order to compare the pilot program to ‘business as usual’ (trash disposal).

Table 4 – Considerations: Business-as-Usual Waste Disposal vs. Composting Pilot

Activity	Business as Usual - TRASH		Composting Pilot - ORGANICS		Considerations for Full Implementation
	Who does it?	Who pays and how?	Who does it?	Who pays and how?	
Generate and manage waste on site	Vendor	No charge	Vendor	No charge	Behavioral change required of staff to sort organics from solid waste. Ongoing training and feedback required to get best results
Take waste to load dock and tip	Vendor staff	Vendor pays staff to do this	Pilot crew (ISS, ES, AECOM)	Donated for grant	This task could be done by dedicated janitorial staff (less cost to vendors, helps reduce contamination, avoid build-up, cost could be passed through in lease fees) or by vendor staff (as waste is hauled now)
Haul roll-off to where it’s tipped	WM to DADS landfill in compactors	DIA. Cost to vendor is in lease fees, not broken out.	WM to A1 Organics at Keenesburg in roll-offs (covered for transport)	SWM paid from grant \$\$	Food waste could be compacted at DIA to reduce volume (discussed below), rental cost, and space requirements. Discussed under “Loading Dock Containers” below, in this section.)
Receive and manage the discarded material	WM operates DADS landfill	DIA via contract w/ WM. Cost to vendor is in lease fees and not visible.	A1 at Keenesburg	SWM paid A1 from grant \$\$	If City of Denver (DIA and residential organics) became large customer of A1 we might be able to negotiate reduced tip fees. Consider buying compost from A1 as part of deal for airport and other city projects.

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Labor. The pilot was conducted with staff (ES, ISS, AECOM) providing pick-up in the kitchens of vendors. As such, it is the highest level of service possible – about 70 hours/week were used to collect from Main Terminal vendors across five shifts, seven days/week (the schedule is shown in Appendix A). Annualized, this would equal 1.8 FTEs¹⁹. Paid at ISS janitorial rates (\$22.00/hour, burdened), this would cost about \$81,800.00 (2009 dollars). Options to reduce labor cost, in order of decreasing the direct janitorial cost to DIA (but increasing the risk of contamination) – with pros and cons discussed – include:

- Provide consolidation points in hallways for organic waste collection, where feasible
 - Pros: enables tipping for kitchen staff as needed, fewer stops needed to collect en route.
 - Cons: access and egress issues with carts in the hallway.
- Reduce number of shifts collected or number of pick-ups per shift (coffee shops received the most pick-ups per week (82) and the general store the least (19)); this could be fine-tuned to ensure higher fill volumes per tip of slim container or 65-gallon cart.
 - Pros: reduces labor costs.
 - Cons: requires thoughtful observation by supervisor or ES staff.
- Increase rent to tenants to cover the costs of trained, dedicated janitorial staff collecting organic waste from tenants' kitchens/operations.
 - Pros: ensures clean stream and smooth operations from kitchen to compost facility, creates jobs, reduces labor needs for tenant (fewer trips emptying trash).
 - Cons: may require more training than janitors usually get, so they can give corrective feedback to kitchen staff on contamination, increased costs to tenants.
- Simply have tenants do all hauling of organic waste (as they do presently with solid waste) to loading dock area.
 - Pros: least cost to DIA directly.
 - Cons: increased training and training costs due to employee turnover; likely to continue to have contamination issues.

Costs discussed above do not include the cost of training janitorial staff, and having management and oversight involvement from ES and DIA's contract services. Those costs – after program startup – are estimated to be about 2 hours/week (at \$41.00/hour burdened) or \$4,300.00/year (2009 dollars).

Decision Questions: (1) Should vendors be asked to purchase BioBags, and sort and haul food waste in those bags to a dedicated roll-off in the loading dock (as they do now with trash) or should DIA offer collection of food waste via janitorial staff? (2) Who should carry cost of biodegradable bags – DIA or vendors? (3) Depending on decision, modification of vendor contracts?

Costs and Contractor Service. As noted in Table 5, direct costs related to signage, BioBags, receptacles, hauling, and tipping fees over the pilot period totaled about \$10,300 (labor is excluded). The direct cost for the pilot of hauling organics to A1 plus A1's tipping fee equaled \$103/ton (based on assumed total of 34.4 tons, the midpoint between the estimated range of 31 - 38 Ts collected); this equaled \$23/cubic yard. This cost represents an actual cost of \$63/ton

¹⁹ Actual numbers, based on pilot: 71.5 hrs/week = 3,719 hrs/year; when staffed with full-time, 40-hr/week employees = 1.8 jobs. These are direct jobs as distinct from indirect jobs which are a result of the employed person's spending and economic activity.

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when the avoided cost of hauling plus landfilling of \$40.25/ton is subtracted. As noted, A1 charged half its normal tip rate for the pilot.

When weights and costs are annualized and adjusted to actual charges, collecting the estimated 156 Ts (about 3 Ts/week, or 687 cy at 4.4 cy/T) of organic waste (that would be generated in the Main Terminal plus the AOB) would directly cost \$11,600 based on:

- 35 pulls/year at \$211/pull (assumes 30-yd roll-off pulled no less than 2/3 full).
- \$4.20/load County Road Maintenance Fee charged at A1's Keenseburg facility.
- \$26.50/ton tip and process fee charged by A1 Organics.
- 2009 charges are used here.

Subtracting \$6,300 in avoided haul and landfill tip fees (based on 2009's cost of \$40.25/ton for waste disposal), derives a total actual annual cost to DIA of \$5,300 or \$34/ton (based on 2009 dollars). There are a number of variables that likely will lower this \$/ton fee:

- New disposal service costs; if the \$40.25/T figure rises, the actual \$/T cost for composting will go down.
- Landfill tip fees may go up.
- Pull fees could perhaps be negotiated to be lower.
- These calculations are based on current density of the waste as collected in the pilot (4.4 cy/T). If a compactor were installed, the organic waste density could increase, resulting in fewer pulls and a lower cost (see discussion on compaction below).
- Increased rents from tenants to cover costs on the labor side could also possibly be adjusted to recoup some of the haul and tip fee costs.
- A1 has indicated it would negotiate its tip fees for a permanent program, particularly with known, clean streams from both the City and DIA.
- Ability for A1 to accept food waste at a location closer to DIA than Keenesburg may result in lower tip fees.
- As the program expands and matures, collection of more compostables and greater vendor participation will yield efficiencies, lowering per-ton costs.
- Vendors with organic waste off-site but near to DIA (grocery stores, restaurants, even homeowner associations with organic wastes) could participate in establishing an organics collection route in the area that would increase efficiencies and lower costs.

Without these cost reductions, the cost of composting may seem high as compared to landfilling. Note however, that some of the value of composting is difficult to quantify in economic terms but of value to DIA and the City and County of Denver nonetheless:

- Reduced greenhouse gas impacts (composting food discards yields a net reduction of 0.05 MTCE/ton while landfilling increases greenhouse gas emissions by 0.20 MTCE/T²⁰).
- Creates more jobs than landfilling (an ILSR study found composting creates 4 jobs per 10,000 Ts of waste composted, while landfilling only creates 1 job/10,000 Ts²¹).

²⁰ MTCE = Metric tons of carbon equivalent per short ton of material. From Exhibit ES-4 "Net GHG Emissions from Source Reduction and MSW Management Options," in *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* 3rd Edition, September 2006, US EPA, available at <http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html>

²¹ "Recycling Means Business," from the Institute for Local Self-Reliance, available at www.ilsr.org/recycling/recyclingmeansbusiness.html

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- Passengers value green efforts and have expressed appreciation to vendors with table tents touting the program – adds to Denver’s image as a green city and builds on City and State goals of growing green, clean tech jobs.
- Supports DIA in meeting its environmental goals, and maintaining its position as an environmental leader in both the City and County of Denver and the airport community.
- Life cycle costs of diversion vs. disposal are lower.

Loading Dock Containers. The ability to increase efficiency and decrease haul costs was evaluated for a permanent organics recovery program. It is not reasonable to haul food waste from the AOB loading dock to a composting facility less frequently than weekly due to potential nuisances (especially during the summer). However, smaller containers and denser food waste could be considered to decrease container rental cost, hauling cost (if based on container size), and reduce the loading dock space requirement. Discussion of these options follows.

1. Smaller roll-off:
 - The 30-CY roll-off used for the pilot study never appeared to be filled more than 50% between pulls and some weeks was as low as 30% full (by visual observation).
 - Depending upon the number of new Main Terminal vendors added to a permanent program, DIA could reduce the roll-off size to 20 CY, which would give an approximate peaking factor of 1.3 over the maximum fill level observed during the pilot.
 - It must be noted that volumetric measurements for the pilot are very approximate, however, and adjustments would be expected during implementation of a permanent program.
2. Volume reduction on site at DIA’s loading dock using a dedicated food grinder:
 - On-site grinding of collected food waste at the AOB loading dock could reduce the waste to be hauled and tipped at a processing facility but would:
 - Increase labor and utility requirements for DIA staff and/or contractors, and more oversight would be required than the trash/cardboard compaction process already in place at DIA.
 - Typically processing plus storage tanks will be required – hauling may be by vacuum truck instead of compaction vehicle or roll-off hoist.
 - Most importantly, grinding reduces the ability to remove contaminants prior to processing and would degrade the high quality of organics DIA generated during the pilot study (A1 Organics has expressed its concern about accepting pre-ground food waste due to contaminant concerns).
 - Therefore, organic waste grinding is not considered a viable option for DIA.
3. Volume reduction on site at DIA’s loading dock using a compactor:
 - Front-load self-contained compactors.
 - The units are available in the 6-CY range with the ability for a volume reduction of up to 4:1 (results vary based on specific waste composition).
 - DIA could experiment with quantities generated during permanent operation and actual volume reduction achieved; it could use two compacting dumpsters for redundancy.
 - Front-load collection vehicles would be required.
 - Full-size self-contained compactors
 - Similar to those used on-site for trash and cardboard.

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- These units can be as small as 17 CYs.
- Compaction ratio is typically 4:1.
- These units were evaluated in DIA's "Integrated Waste Management Program" (Gracestone, 2005).

DIA could investigate the collection of compostables with a front-load vehicle at once or twice per week intervals as part of a regular organics collection route.

Decision Questions: (1) Evaluate container size and features for best "fit" in terms of loading dock space, need to reduce haul frequency and costs, contamination issues with size reduction technologies, operational resources, etc.

Future Compost Processing Possibilities. Should the pilot prove feasible for permanent program development, then DIA will be adding a new method of managing a portion of its solid waste stream to its repertoire of waste management strategies. As such, it is may be valuable to consider other options for converting the organic waste stream to compost, in a way that could reduce haul and tip fees. One such alternative would be for DIA to process food waste and use the compost product on-site. Processing would require an in-vessel system (containerized bio-reactor) to control space requirements, odors and vectors. In-vessel technologies include vertical flow reactors, horizontal or inclined flow reactors and batch reactors. In general, these systems are highly mechanized and have high capital and operating costs. While these technologies would typically reduce collected food waste volume by 50% or more and avoid the cost of hauling and tip fees at a private compost facility, an on-site system would require DIA to:

- Dedicate indoor space for the active in-vessel composting operation (package systems can be relatively small while aerated windrow systems can be several acres) and space for curing.
- Train and dedicate staff to operate and monitor.
- Purchase and store bulking agents (such as wood chips, shavings, etc. to achieve required moisture levels).
- Provide mechanical and electrical support (especially for the aeration system needed to maintain aerobic conditions and control odors).
- Provide equipment to move product.
- Provide aeration and bio-filtration.
- Manage leachate.
- Screen feedstock and finished product for contaminants.
- Utilize finished product (if used on-site, some Colorado testing, labeling and revenue regulations would not be triggered and compliance requirements would be reduced).

It should be noted that there are small self-contained, package in-vessel system options available that require minimal space, minimal operation, and include the aeration system within the unit. One example is the Earth Tub by Green Mountain Technologies (90" diameter and 68" height), which was specifically designed to process institutional food waste on-site. These tubs could ideally be located at the loading dock or other convenient location (such as in the concourse area if composting is expanded airport-wide) close to collection aggregation points (although it is not likely that DIA would have the space near the terminal/concourses for even small composting units). Alternatively, these units could be placed in an outbuilding elsewhere on DIA's campus. With a maximum capacity of only 30 to 40 tpy per tub, DIA would require several tubs.

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Additionally, organics sourced from residential and commercial generators in the area could contribute to feedstock and sizing options, suggesting consideration of other composting technologies and processes, based on economies of scale.

Such an option would not necessarily put DIA in to the wholesale/retail business if it used all compost on site in its own operations. Or, it could contract with a business specializing in marketing and sales of finished compost. This might be an arrangement not unlike DIA’s hosting of photovoltaic collectors with a third-party managing the distribution and sale of electricity generated onsite.

Hauling Considerations. A final note considers the ability to haul large loads of food waste within Colorado legal vehicle weight limits. This can come into play with dense food waste (in the 500 to 1,000 lbs/CY range²²). However, this is not likely to be a consideration for DIA organics, based on the pilot study’s estimation of an average of up to 300-450 lbs./CY density²³.

Any change to container size or addition of on-site processing of DIA’s food waste should be carefully considered based on future quantity projections, equipment selection and compost facility parameters.

Decision Questions: (1) Use density calculations as a negotiation point to secure lower tip fees?

A6.0 Financial Summary

A6.1. Cost data

Most direct project costs were covered by the RREO grant funds. This included the following:

- Equipment to get organic waste from kitchens and break rooms to loading dock:

Table 5 – Cost of Equipment for Collecting and Disposing Organic Waste

	Unit	Number	Cost	Total Bags Used	Cost/ Bag
BioBags: Super Slim Liners	cases	27	\$3,860.16	7,620	\$0.38
BioBags: 2.5 gal. Pail Liners	cases	27	\$633.60	7,000	\$0.09
Slim Jims	each	30	\$1,149.69		
Pails	each	45	\$280.35		
65-gallon Carts	each	4	\$198.32		
Total			\$6,122.12	14,620	

- This included nearly 8,000 individual slim liner bags and about 7,000 pail liners.
- The cost of gloves was carried by the janitorial service or other collectors.
- 65-gallon carts used on the Main Terminal collection routes were provided by the grant; when the janitorial staff used the tilt carts, it was from its own fleet of carts.
- Hauling costs totaled \$2,532.00, representing 12 pulls of the partially-filled 30-CY roll-off by WM, over a 11.4-week period, based on submitted invoices.
- Tipping fees at A1 Organics totaled \$998.79, based on submitted invoices
 - Note that A1 provided DIA with tipping services at half its normal rate (i.e., \$13.25 instead of \$26.50).

²² EcoCycle’s food waste collection program has observed food waste density of about 500 lbs/CY and A1 Organics uses an average food waste density of 950 lbs/CY at its Keenesburg facility.

²³ The limit for a 3-axle roll-off hoist unit is 54,000 lbs and chassis/hoist/container can weigh 31,000 lbs empty (based on Kenworth truck chassis and Wastequip hoist). A fully-loaded 30-CY container with dense food waste could exceed the total weight limit.

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A6.2 In-kind (not paid by the RREO grant) project costs were:

- Denver SWM spent \$1,063.75 on design services for the DIA print materials and DIA spent \$652.00 for printing of table tents and posters, based on submitted invoices.
- HDR/Gracestone/LBA Associates donated 50 hours (approximately \$5,800 in labor) in general support of this project.
- Gracestone/LBA Associates donated over 30 hours (approximately \$3,500) to the collection of vendor food waste weights at DIA.

Labor hours and costs directly related to emptying containers, taking carts to the roll-off in the loading dock area, and tipping the carts are shown below in Table 6. These costs were not reimbursed by the grant and were donated by volunteer “Environmental Focal Points” (EFP) staff in the AOB and by a combination of janitorial (ISS), ES, volunteer staff (AECOM), and EFPs in the Main Terminal. Wages include fringe benefits (fully burdened). Note that the actual number of hours is the more relevant data point; this number is used in Section 3 below to discuss costs for a potential future project.

Table 6 – Labor Costs

Labor Provider	HOURS	Wages/ Hour	Cost	Average Hourly Cost
Main Terminal				
ISS	386	\$22.00	\$8,483.64	
ES	225	\$41.00	\$9,221.31	
AECOM	207	\$44.00	\$9,100.96	
Subtotal	817		\$26,805.91	\$32.80
Airport Office Building				
Volunteer EFPs	42	\$41.50	\$1,722.25	\$41.50
Entire DIA project				
TOTAL Value	859		\$28,528.16	\$33.22

The direct costs incurred to carry out the pilot are shown in Table 7, below.

Table 7 – Actual Costs for DIA Food Waste Composting Pilot

Category	Cost	Notes	Grant Paid?
Equipment	\$6,122.12	BioBags, Slim Jims, pails	Yes
Printing fees	\$652.00	Done at DIA	No, donated by DIA
Labor	\$28,528.16	See Table 3 for detail	No, donated by all
Hauling	\$2,544.00	12 pulls over 11.4 weeks	Yes
Tip Fees	\$998.79	For 151 CY ^[1]	Yes
Total	\$38,845.07		

[1] A-1 charged for 72 Tons @ \$13.25/T (half its normal rate), based on its volume to weight conversion rate, not based on actual weights. A-1 has indicated it can adjust this based on the pilot's sampled weights.

Additional resources were used to start the pilot that are not quantified here because they reflect grant implementation costs and are not reflective of non-grant, permanent program implementation: labor from Denver SWM, ES and HDR to plan the pilot, order equipment, conduct training, manage billing and payment, and gather data.

The direct cost for the pilot of hauling organics to A1 plus A1’s tipping fee equaled \$103/ton (based on assumed total of 34.4 tons, the midpoint between the estimated range of 31 - 38 Ts

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collected); this equaled \$23/cubic yard). Cost notes:

- Haul costs were \$74/ton (\$17/CY).
- 2008-2009 tip fees normally are \$26.50/ton (plus County Road fee of \$4.20/load) at A1.

This cost represents an actual cost to DIA of \$63/ton when the avoided 2009 cost of hauling plus landfilling of \$40.25/ton is subtracted. Put another way, DIA saved about \$1,400 in solid waste haul/disposal costs during the pilot.

2. Next Steps for Residential and Airport Programs:

Residential: Conduct additional seasonal analysis of the organics stream and test alternative hauling options through a 2009/2010 State grant.

Airport: DIA is currently renegotiating its waste services contract. DIA's next steps are contingent on the both the costs associated with the new contract, evaluation of how the costs from the pilot extrapolate to not only the Terminal, but to the concourses over a full year, the overall economy, and the overall composting scope.

Considerations for both projects: There would be value for the City to quantify the value of composting outside of the respective agencies budgets to quantify the benefits of:

- Reduced greenhouse gas impacts (composting food discards yields a net reduction of 0.05 MTCE/ton while landfilling increases greenhouse gas emissions by 0.20 MTCE/T²⁴)
- Ability to create more jobs than landfilling (an ILSR study found composting creates 4 jobs per 10,000 Ts of waste composted, while landfilling only creates 1 job/10,000 Ts²⁵)
- The value the community and DIA passengers place on green efforts and how this impacts Denver's image as a green city and builds on City and State goals of growing green, clean tech jobs, etc.
- Supporting the City and DIA in meeting its environmental goals, and maintaining its position as an environmental leader in both the State, Country and for DIA in the community of airports.
- The environmental and financial impact of the finished compost being used locally through reduced water and fertilizer use (commercially and residentially), reduced surface run off, effects on local food production, etc.

²⁴ MTCE = Metric tons of carbon equivalent per short ton of material. From Exhibit ES-4 "Net GHG Emissions from Source Reduction and MSW Management Options," in *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* 3rd Edition, September 2006, US EPA, available at <http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html>

²⁵ "Recycling Means Business," from the Institute for Local Self-Reliance, available at www.ilsr.org/recycling/recyclingmeansbusiness.html

**Final Report to CDPHE on RREO Grant
Denver-DIA Organic Waste Diversion Project**

3. Appendices

Appendix 1

Maps of Residential Collection routes – attached as PDF files.

Appendix 2

Residential Program Collection Data (attached excel spread sheet)

DIA Collection Data (attached excel spreadsheet)

Appendix 3 (attached as a PDF)

Data from Neighborhood weighing and visuals

**Final Report to CDPHE on RREO Grant
Denver-DIA Organic Waste Diversion Project**

Appendix 4

Residential Program Educational Materials (attached as a PDF)

DIA Educational Materials (attached as a PDF)

Appendix 4

Residential Program Educational Materials

1. Mailer inviting residents to participate



Final Report to CDPHE on RREO Grant Denver-DIA Organic Waste Diversion Project

Welcome to the next generation of recycling

Denver residents have proven they are great recyclers. So now we're ready to take recycling to the next level in Denver by testing composting collection through a new pilot program. **Organic material, like food, soiled paper and yard debris,** is the single largest item we throw away in our landfill and its 100% compostable.



We need you to help us make this project successful by joining Denver Recycles' new composting pilot program. **We'll provide you with a 65-gallon green cart and a small kitchen pail for collecting food and soiled paper within your home to get you started.** Then you just need to set your green cart out as instructed and we'll collect all of your organic material and turn it into nutrient rich compost.

Why Compost?

- ✓ Organic material makes up about 58% of what Denver residents send to the landfill.
- ✓ Methane is generated in landfills as organic material decays under anaerobic (without oxygen) conditions.
- ✓ Methane is a greenhouse gas 21 times more potent than carbon dioxide.
- ✓ Composting is a way to divert organic material from landfills, thereby reducing climate warming gases generated from landfills.
- ✓ Composting is nature's way of recycling and returning valuable organic matter and nutrients to the soil to be used again.



Sign up Today.

1. Call 3-1-1 or sign up at DenverGov.org/DenverRecycles
2. Sign up by Sept. 12, 2008
3. Space in the pilot program is limited, so carts will be provided on a first-come, first-served basis for each eligible neighborhood. Only 3,000 homes will be participating in this pilot.
4. Participants will receive their green cart in early October 2008 and will be able to use it through June 2009.

Concerned about odor or have other questions?

It's not a problem. Come to a Denver Recycles neighborhood meeting and we'll answer all your questions.

Meetings to be held on:

Sept. 3, 2008 7 PM – 7:45 PM Ross-Barnum Library 3570 W. First Ave. @ Lowell Blvd	Sept. 10, 2008 7 PM – 8 PM Mitchell Hall Denver Botanic Gardens 1005 York St.
---	--



(Para la información en Español llame al 3-1-1 o visite DenverGov.org/DenverRecycles)

2. Composting Guide provided with cart delivery

How the Composting Collection Program Works



ONE: You sort, seal, pack and place items in your green cart for Denver Recycles to collect. (After collection, the waste is sorted and composted into a nutrient-rich soil product.)

TWO: Denver Recycles delivers your green cart to your home. The compost is ready to use in your garden. (The compost is ready to use in your garden.)



Alley Collection

Place your green cart on the right side of the alley. Place it on the curb or sidewalk.

Make sure the front face of the cart is facing the street. Do not place any items on top of the cart. Do not place any items in the cart. Do not place any items in the cart.



Curb Collection

Place your green cart on the curb. Place it on the curb. Place it on the curb.

Make sure the front face of the cart is facing the street. Do not place any items on top of the cart. Do not place any items in the cart. Do not place any items in the cart.

Service Instructions

Call your green cart delivery. (Call your green cart delivery.)

Place your green cart on the curb. (Place your green cart on the curb.)

Make sure the front face of the cart is facing the street. (Make sure the front face of the cart is facing the street.)

Do not place any items on top of the cart. (Do not place any items on top of the cart.)

Do not place any items in the cart. (Do not place any items in the cart.)

Denver Composts!

¡Compostaje en Denver!



Denver Recycles compost is available for purchase at various locations. (Denver Recycles compost is available for purchase at various locations.)

Final Report to CDPHE on RREO Grant Denver-DIA Organic Waste Diversion Project

What You CAN Put in Your Green Cart
(As permitted by a contractor only)

- ✓ Food scraps (fruit, vegetable, meat, dairy, bones, etc.)
- ✓ Paper products (paper, cardboard, paper bags, etc.)
- ✓ Yard debris (grass, leaves, twigs, etc.)
- ✓ Small appliances (toasters, blenders, etc.)
- ✓ Small electronics (cell phones, MP3 players, etc.)
- ✓ Small tools (hand saws, etc.)
- ✓ Small appliances (toasters, blenders, etc.)
- ✓ Small electronics (cell phones, MP3 players, etc.)
- ✓ Small tools (hand saws, etc.)

What You Can't Put in Your Green Cart
(As permitted by a contractor only)

- ✗ Plastics (bags, bottles, containers, etc.)
- ✗ Metals (cans, lids, etc.)
- ✗ Glass (jars, bottles, etc.)
- ✗ Appliances (stoves, washers, etc.)
- ✗ Large electronics (TVs, computers, etc.)
- ✗ Large tools (chainsaws, etc.)
- ✗ Hazardous materials (oil, paint, etc.)
- ✗ Flammable liquids (gasoline, etc.)
- ✗ Flammable solids (kerosene, etc.)
- ✗ Flammable gases (propane, etc.)
- ✗ Flammable dusts (sawdust, etc.)
- ✗ Flammable solids (kerosene, etc.)
- ✗ Flammable gases (propane, etc.)
- ✗ Flammable dusts (sawdust, etc.)

Using a kitchen pail makes food scrap and soiled paper collection neat and easy!
(Use only clean, empty, leak-proof pails)

Tips for Using Your Kitchen Pail
(As permitted by a contractor only)

- ✓ Store your kitchen pail under or in the sink, on the counter or anywhere that makes it easy to empty into your green cart when you're ready.
- ✓ Empty your kitchen pail into your green cart when you're ready.
- ✓ Don't overfill your kitchen pail. It should be no more than 3/4 full.
- ✓ Don't use your kitchen pail for anything other than food scraps and soiled paper.
- ✓ Don't use your kitchen pail for anything other than food scraps and soiled paper.

Maintaining Your Green Cart
(As permitted by a contractor only)

- ✓ Don't use your green cart for anything other than food scraps and soiled paper.
- ✓ Don't use your green cart for anything other than food scraps and soiled paper.
- ✓ Don't use your green cart for anything other than food scraps and soiled paper.

Please do not set out your kitchen pail for collection!
(As permitted by a contractor only)

3. Calendars provided with cart delivery

Composting Collection Calendar (Friday/A Week)
Please note every other week collection December through March

October 2008	November 2008	December 2008
Su Mo Tu We Th Fr Sa	Su Mo Tu We Th Fr Sa	Su Mo Tu We Th Fr Sa
1 2 3 4	1	1 2 3 4 5 6
5 6 7 8 9 10 11	2 3 4 5 6 7 8	7 8 9 10 11 12 13
12 13 14 15 16 17 18	9 10 11 12 13 14 15	14 15 16 17 18 19 20
19 20 21 22 23 24 25	16 17 18 19 20 21 22	21 22 23 24 25 26 27
26 27 28 29 30 31	23 24 25 26 27 28 29	28 29 30 31
	30	

January 2009	February 2009	March 2009
Su Mo Tu We Th Fr Sa	Su Mo Tu We Th Fr Sa	Su Mo Tu We Th Fr Sa
H 2 3	1 2 3 4 5 6 7	1 2 3 4 5 6 7
4 5 6 7 8 9 10	8 9 10 11 12 13 14	8 9 10 11 12 13 14
11 12 13 14 15 16 17	15 16 17 18 19 20 21	15 16 17 18 19 20 21
18 19 20 21 22 23 24	22 23 24 25 26 27 28	22 23 24 25 26 27 28
25 26 27 28 29 30 31		29 30 31

April 2009	May 2009	June 2009
Su Mo Tu We Th Fr Sa	Su Mo Tu We Th Fr Sa	Su Mo Tu We Th Fr Sa
1 2 3 4	1 2	1 2 3 4 5 6
5 6 7 8 9 10 11	3 4 5 6 7 8 9	7 8 9 10 11 12 13
12 13 14 15 16 17 18	10 11 12 13 14 15 16	14 15 16 17 18 19 20
19 20 21 22 23 24 25	17 18 19 20 21 22 23	21 22 23 24 25 26 27
26 27 28 29 30	24 25 26 27 28 29 30	28 29 30
	31	

H = City Holidays

Remember to set out your green cart in the same location where you set out your purple cart.

YES

- Flowers
- Grass clippings
- Houseplants
- Leaves
- Plant trimmings
- Small branches
- Weeds
- Coffee filters
- Facial tissue
- Greasy pizza boxes
- Paper coffee cups
- Paper ice cream cartons
- Paper milk cartons
- Paper napkins
- Paper plates
- Paper towels
- Tea bags
- Wax paper
- Baked goods
- Bones
- Bread
- Cereal
- Cheese
- Coffee grounds
- Dairy products
- Eggs and eggshells
- Fish
- Fruits
- Gravy and sauces
- Meat
- Nuts
- Pasta
- Peanut butter
- Pizza
- Processed foods
- Rice
- Salads
- Vegetables



Please remember:

Branches should be no larger than 4 feet long and no more than 4 inches in diameter.

Store your green cart on your property out of public view on non-collection days.

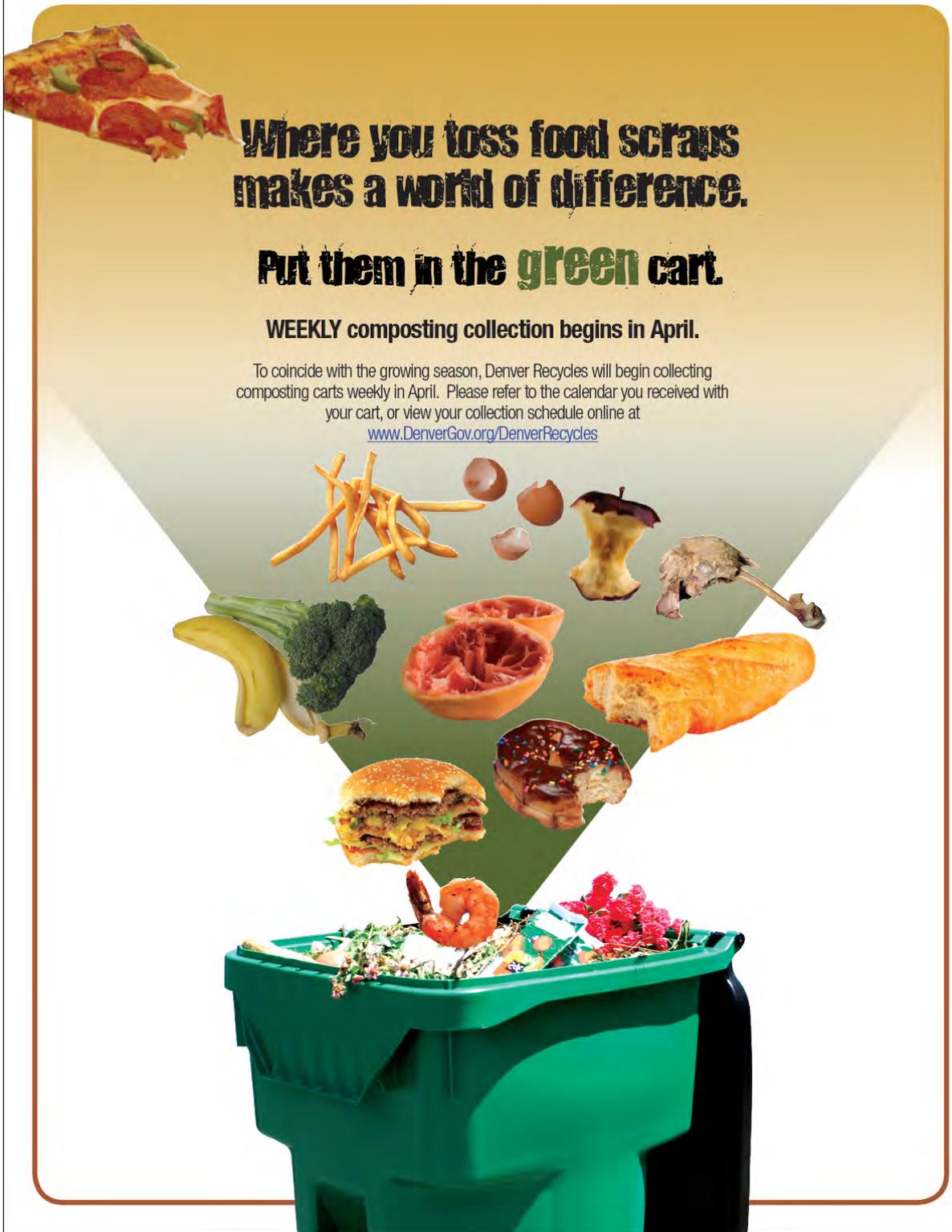
NO

- No Glass
- No Grease
- No Liquids
- No Metal
- No Styrofoam
- No Diapers
- No Cooking oil
- No Construction debris
- No Foil lined cartons
- No Plastics of any kind
- No Treated or coated wood
- No Used toilet paper
- No Pet waste
- No Rocks
- No Sand
- No Sod
- No Dirt



Printed on 100% recycled paper

4. Seasonal education flyers e-mailed to participants



Final Report to CDPHE on RREO Grant Denver-DIA Organic Waste Diversion Project

FAQ'S

1. Why can the Denver Composts program accept meat and dairy?

The material collected through the Denver Composts program is taken to A1 Organics commercial composting site in Keenesburg, Colorado. This site is permitted to accept mixed food waste which includes meat and dairy products. The commercial composting process is closely managed, and achieves and maintains higher compost pile temperatures that break meat and dairy down quickly, and kill pathogens. In fact, A1 Organics maintains its compost windrows at temperatures of 131°F to 150°F for a minimum of 30 to 60 days.

Backyard compost piles are not able to achieve and maintain such high temperatures. If meat and dairy are added to small backyard compost piles, it takes so long to break down that they can often attract rodents.



2. Why should I put my food waste in the Denver Composts cart? It's much easier to use the garbage disposal in my sink.

Placing food waste in the garbage disposal may seem like the best way to handle your leftovers, but it is not as eco-friendly as composting. Garbage disposals use more fresh water per pound of food than composting, and putting food waste through the sewer system adds stress to the sewer infrastructure. So make sure you are putting your food waste in your green cart.

3. My kitchen pail broke. What are my options for replacing it?

Due to the limited funding for the composting collection pilot program, Denver Recycles is unable to issue replacement kitchen pails. If yours is broken, we recommend:

Reusing an old Tupperware or plastic food container. Large ice cream buckets make great kitchen collectors (and you get to eat the ice cream, yum!), or large yogurt or cottage cheese tubs work well too. You can always use an empty paper milk carton or paper ice cream container to collect wet food and then drop it in your green cart.

You can purchase new kitchen collectors from:

- All Things Renewable in Stapleton's Northfield;
- Smith and Hawken in Cherry Creek; or
- Online at www.Amazon.com ,

www.composters.com or www.gardeners.com



4. What is soiled paper?

Soiled paper is low-grade paper that is primarily used for food or personal care. It includes items like paper towel, used facial tissues, paper plates, paper coffee cups, wax paper that food (like hamburgers and deli sandwiches) comes wrapped in, and French fry holders and soda fountain cups from fast food restaurants. Soiled paper is **NOT** the paper that can be placed in your purple Denver Recycles cart (newspaper, brown paper bags, phone books, office paper, junk mail, magazines, cardboard or paperboard). Although some of these items are compostable in small amounts (like wrapping your food scraps in sheets of newspaper), it is more environmentally beneficial to recycle paper items in your purple cart.

We recognize that this can be confusing so if you have questions about specific items, don't hesitate to ask us:

DenverRecycles@denvergov.org

- ✓ Coffee filters
- ✓ Facial tissue (even used facial tissue)
- ✓ Greasy pizza boxes
- ✓ Microwave popcorn bags
- ✓ Paper coffee cups
- ✓ Paper ice cream cartons
- ✓ Paper milk and juice cartons
- ✓ Paper napkins
- ✓ Paper plates
- ✓ Paper take-out cartons
- ✓ Paper towels
- ✓ Tea bags
- ✓ Tissue paper
- ✓ Waxed cardboard (ex: produce boxes)
- ✓ Wax Paper



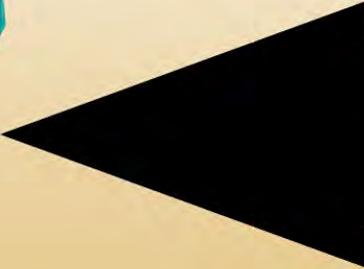
5. Where can I buy compostable Biobags for my kitchen collector?

Unlike traditional plastic bags made from petroleum, BioBags are made from plants and have been certified by the Biodegradable Products Institute, which makes them completely compostable and acceptable in your green cart. Remember, traditional plastic bags and all other plastic items are not acceptable. Whole Food Markets and All Things Renewable (in Stapleton's Northfield) both carry BioBags that are acceptable in the Denver Composts program.



If no one else wants your fruit cake, we'll take it.

Did you know that Americans generate 25% more food waste between Thanksgiving and the New Year? This year, we'll take what you can't eat. Use your green cart to compost your turkey carcass, eggnog cartons, sweet potato peels, corn cobs and leftover pumpkin pie.



Compostable Bags

To make composting your food scraps easier and cleaner, try using a compostable bag in your kitchen pail. Bags made from plants like corn, wheat and potatoes are compostable. Please make sure that the compostable bags you buy are the color GREEN and are labeled as COMPOSTABLE by the Biodegradable Products Institute (BPI), so the composting facility can easily identify them as acceptable. Compostable bags may be purchased online and at some Whole Foods stores. (Of course, newspaper and paper bags are still an easy and much cheaper way to keep composting cleaner.)

× NO PLASTIC BAGS

Winter Composting Service Schedule:

Please note that your composting collection day will switch from every week to every-other-week starting the first week of December and through the rest of the winter. Please consult your composting collection service calendar for your collection dates. To make it easy to remember, your composting collection will be on the same day as your recycling collection.

Recycle Your Holiday Tree!

Treecycle 2009 runs January 5 through January 16. To learn how you can recycle your holiday tree, call 3-1-1 or visit DenverGov.org/DenverRecycles. Trees are not accepted in the green cart.



What You CAN Put in Your Green Cart

- ✓ Baked goods
- ✓ Bones
- ✓ Bread
- ✓ Butter and margarine
- ✓ Candy
- ✓ Cereal
- ✓ Cheese
- ✓ Coffee grounds
- ✓ Dairy products
- ✓ Eggs and eggshells
- ✓ Fish and shellfish
- ✓ Fruits
- ✓ Grains
- ✓ Gravy and sauces
- ✓ Jams and jellies
- ✓ Meat
- ✓ Nuts and nut shells
- ✓ Pasta
- ✓ Peanut butter
- ✓ Pizza
- ✓ Poultry
- ✓ Processed foods
- ✓ Rice
- ✓ Salads
- ✓ Vegetables
- ✓ Coffee filters
- ✓ Facial tissue (even used facial tissue)
- ✓ Greasy pizza boxes
- ✓ Microwave popcorn bags
- ✓ Paper coffee cups
- ✓ Paper ice cream cartons
- ✓ Paper milk and juice cartons
- ✓ Paper napkins
- ✓ Paper plates
- ✓ Paper take-out cartons
- ✓ Paper towels
- ✓ Tea bags
- ✓ Tissue paper
- ✓ Waxed cardboard (ex: produce boxes)
- ✓ Wax paper
- ✓ Cotton balls
- ✓ Dryer lint
- ✓ Feathers
- ✓ Hair (pet and human)
- ✓ Wooden chopsticks
- ✓ Wooden popsicle sticks
- ✓ Wooden toothpicks
- ✓ Flowers
- ✓ Grass clippings
- ✓ Houseplants
- ✓ Leaves
- ✓ Plant trimmings
- ✓ Small branches
- ✓ Weeds

What You CAN'T Put in Your Green Cart

- ✗ **NO** Construction debris
- ✗ **NO** Kitty litter
- ✗ **NO** Sand
- ✗ **NO** Cooking oil
- ✗ **NO** Liquids
- ✗ **NO** Sod
- ✗ **NO** Diapers
- ✗ **NO** Metal
- ✗ **NO** Styrofoam
- ✗ **NO** Dirt
- ✗ **NO** Plastics of any kind
- ✗ **NO** Treated or coated wood
- ✗ **NO** Glass
- ✗ **NO** Pet waste
- ✗ **NO** Used toilet paper
- ✗ **NO** Grease
- ✗ **NO** Rocks

✗ **NO** Foil lined cartons (Typically these are broth cartons and juice boxes for kids. But you should tear the carton to determine if it is foil lined for sure.)

✗ **NO PLASTIC BAGS**

****Please do not put paper items that are accepted in your purple recycling cart in your green composting cart. Although some of these items are compostable in small amounts (like wrapping your food scraps in sheets of newspaper), it is more environmentally beneficial to recycle paper items in your purple cart. Recycling paper allows old paper to be turned back into new paper, which saves natural resources like trees and water and generates significant energy savings. The following paper items should still be recycled in your purple cart: office paper, cardboard boxes, paperboard boxes (cereal, pasta, crackers, soap, etc.), envelopes, junk mail, magazines and newspaper.**

Questions about what can go in your green cart? Email us at DenverRecycles@ci.denver.co.us or call 3-1-1.
(Para la información en Español llame al 3-1-1 or visite DenverGov.org/DenverRecycles)

**Final Report to CDPHE on RREO Grant
Denver-DIA Organic Waste Diversion Project**

1. Marketing Flyer

DIA Composts!

Denver International Airport's Newest Green Initiative

By choosing to patronize this business, you are helping to support Denver International Airport's Composting Collection Pilot Program.

Participating businesses sort and collect their pre-consumer food scraps and soiled paper products, and send them to a composting facility where they are turned into nutrient-rich compost. This helps to minimize trash and reduce greenhouse gases.

The program is voluntary, and the City and County of Denver would like to recognize the following businesses for their participation:

amore fiori, BURGER KING, CARIBOU COFFEE, PANDA EXPRESS, AYALA'S, GANTINA, RED ROCKS BAR, Four in Four, BOULDER BEER, Domino's PIZZA, TACO BELL Express, FRESH MILK MARKET, TCBY, Auntie Anne's

Visuals: A row of food items (flowers, milk, carrot, banana, broccoli, shrimp, coffee) with an arrow pointing to a circular image of hands holding a seedling in soil.

Logos: DENVER INTERNATIONAL AIRPORT, DENVER THE GOLDEN CITY, 311 For City Services Denver gets it done!, DENVER RECYCLES CITY AND COUNTY OF DENVER, A program of Solid Waste Management Denver Public Works

Funding for this pilot program is provided by a grant from the Colorado Department of Public Health and Environment and contributions from Denver Solid Waste Management, DIA Environmental Services, Rehrig Pacific Company, A1 Organics, AECOM Transportation and ISS.

2. Table tent used by participating vendors

Final Report to CDPHE on RREO Grant Denver-DIA Organic Waste Diversion Project

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**Final Report to CDPHE on RREO Grant
Denver-DIA Organic Waste Diversion Project**

3. Training Flyer

DIA Composts!

Clean & Green at Denver International Airport

All Food

Fruits, vegetables, meat, poultry, seafood, shellfish, bones, rice, pasta, bread, baked goods, cheese, coffee grounds, sauces, pizza and processed foods

Toda La Comida

Frutas, verduras, carne, pollería, pescado, mariscos, huesos, arroz, pasta, pan, productos homeados, queso, asientos o posos del café, salsas, pizza y alimentos procesados

Soiled Paper

Coffee filters, tea bags, paper milk and juice cartons, waxed cardboard, napkins, paper towels, tissue paper, paper cups, paper plates, wax paper, paper take-out boxes, greasy pizza boxes, wooden chopsticks and wooden toothpicks

Papel Sucio

Filtros de café, bolsitas de té, cajas de cartón de la leche y del jugo, cartón encochado, recipientes de cartón de la comida para llevar, servilletas, toallas de papel, papel de seda, tazas de papel, platos de papel, papel encochado, cajas de pizza grasientas, palitos chinos de madera y escarbadientes de madera

Plants

Flowers, houseplants, plant trimmings and small branches

Plantas

Flores, plantas del hogar, recortes de plantas y ramas pequeñas

NO

NO

Funding for this pilot program is provided by a grant from the Colorado Department of Public Health and Environment and contributions from Denver Solid Waste Management, DIA Environmental Services, Rehrig Pacific Company, A1 Organics, AECOM Transportation and ISS.

Questions? Call DIA Environmental Services at (303) 342-2087

What You **CAN** Put in Your Green Bin

- ✓ Baked goods
- ✓ Bones
- ✓ Bread
- ✓ Butter and margarine
- ✓ Candy
- ✓ Cereal
- ✓ Cheese
- ✓ Coffee grounds
- ✓ Dairy products
- ✓ Eggs and eggshells
- ✓ Fish and shellfish
- ✓ Fruits
- ✓ Grains
- ✓ Gravy and sauces
- ✓ Jams and jellies
- ✓ Meat
- ✓ Nuts and nut shells
- ✓ Pasta
- ✓ Peanut butter
- ✓ Pizza
- ✓ Poultry
- ✓ Processed foods
- ✓ Rice
- ✓ Salads
- ✓ Vegetables
- ✓ Coffee filters
- ✓ Facial tissue (even used facial tissue)
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- ✓ Microwave popcorn bags
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- ✓ Hair (pet and human)
- ✓ Wooden chopsticks
- ✓ Wooden popsicle sticks
- ✓ Wooden toothpicks
- ✓ Flowers
- ✓ Grass clippings
- ✓ Houseplants
- ✓ Leaves
- ✓ Plant trimmings
- ✓ Small branches
- ✓ Weeds

What You **CAN'T** Put in Your Green Bin

- ✗ **NO** Plastics of any kind
- ✗ **NO** Styrofoam
- ✗ **NO** Metal
- ✗ **NO** Glass
- ✗ **NO** Cooking oil
- ✗ **NO** Grease
- ✗ **NO** Liquids
- ✗ **NO** Foil lined cartons (Typically these are broth cartons and soy milk cartons. But you should tear the carton to determine if it is foil lined for sure.)
- ✗ **NO PLASTIC BAGS**

Compostable Bags

To make composting clean and easy, your business has been given compostable bags that are made from plants like corn, wheat and potatoes.

Please only line your green composting bins with the GREEN bags that are labeled COMPOSTABLE and provided to you by DIA Environmental Services. Other bags are not acceptable.

**Final Report to CDPHE on RREO Grant
Denver-DIA Organic Waste Diversion Project**

4. Training Poster

DIA Composts!

Clean & Green at Denver International Airport

All Food

Fruits, vegetables, meat, poultry, seafood, shellfish, bones, rice, pasta, bread, baked goods, cheese, coffee grounds, sauces, pizza and processed foods

Toda La Comida

Frutas, verduras, carne, pollería, pescado, mariscos, huesos, arroz, pasta, pan, productos horneados, queso, asientos o posos del café, salsas, pizza y alimentos procesados

Soiled Paper

Coffee filters, tea bags, paper milk and juice cartons, waxed cardboard, napkins, paper towels, tissue paper, paper cups, paper plates, wax paper, paper take-out boxes, greasy pizza boxes, wooden chopsticks and wooden toothpicks

Papel Sucio

Filtros de café, bolsitas de té, cajas de cartón de la leche y del jugo, cartón encerado, recipientes de cartón de la comida para llevar, servilletas, toallas de papel, papel de seda, tazas de papel, platos de papel, papel encerado, cajas de pizza grasientas, palillos chinos de madera y escarbadientes de madera

Plants

Flowers, houseplants, plant trimmings and small branches

Plantas

Flores, plantas del hogar, recortes de plantas y ramas pequeñas

NO

NO

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Questions? Call DIA Environmental Services at (303) 342-2087

**Final Report to CDPHE on RREO Grant
Denver-DIA Organic Waste Diversion Project**

**Appendix 5
Photographs (attached as PDF files)
Residential
DIA**

**Appendix 6
Waste Composition Study Final Report (attached as a PDF)**

**Appendix 7
Residential Survey Summary and Data**

Two surveys were conducted during the organics pilot, to obtain input from the 3,270 participating households about several matters:

- adequacy of information at startup
- motivation to participate
- adequacy of cart size
- materials going into the carts
- seasonal and weekly vs. every-other-week use and participation variability
- perception of reduction of trash
- interest in the pilot from participant's friends and neighbors

These surveys were conducted via email notifications to participants, inviting them to answer up to 7 questions on a web-based survey (using Survey Monkey). Initiated on November 17, 2008 ("Round 1") and on January 14, 2009 ("Round 2"), both surveys were open for three weeks. Participation was excellent:

Round 1 – 1,108 total responses (34% response rate)

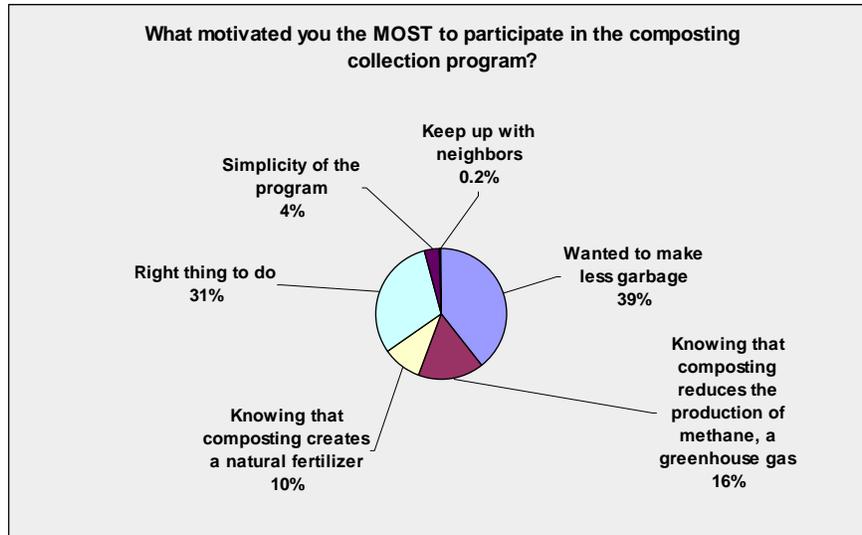
Round 2 – 761 total responses (23% response rate)

The survey obtained many comments as well as quantifiable responses. Analysis of the data yielded the following key findings about the pilot.

- Participants were well informed at the pilot start-up:
 - 99% of Round 1 respondents said the information received with the green cart adequately prepared them to use the service and to understand what is accepted in the cart. (This question was not asked in Round 2.)
 - 14% provided useful comments such as the need to clarify accepted materials and collection scheduling, appreciation for the BioBags, etc.
- Participants were motivated to participate by two primary factors:
 - Wanting to make less garbage
 - Because it was the "right thing to do"
 - Figure *a* below shows what motivated residents to choose to participate in the pilot.

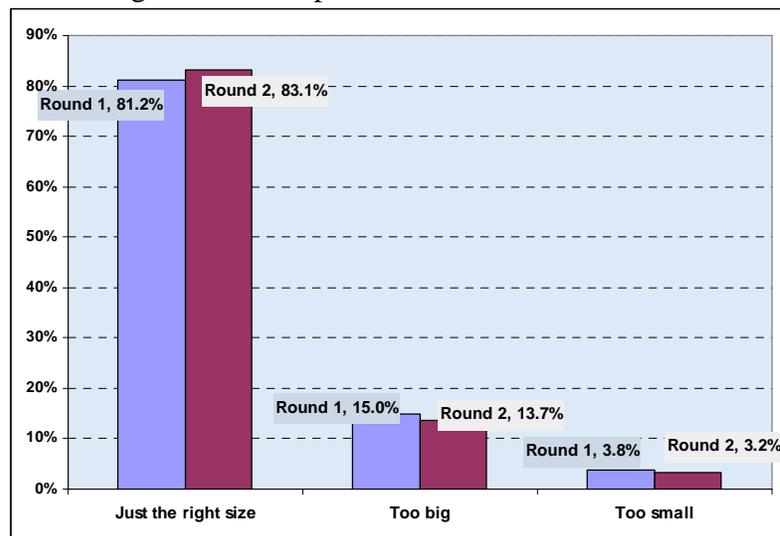
Figure *a* – Reason for Participation in the Pilot

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- Of the 14% of respondents who provided comments, many expressed that they...
 - “Could have selected all of the above;”
 - “Wanted to be part of this pilot program to help Denver;”
 - Liked city organics collection better than backyard composting; or
 - “To help reduce my families footprint on the planet.”
 - Appreciated the program, using words like ‘thrilled,’ ‘awesome,’ ‘gleeful,’ and ‘wonderful;’ many said things like “I don’t just like this service, I LOVE IT.”
- Residents were asked if the green cart was too big, too small, or just right, in both surveys.
 - Satisfaction with cart size was very high, and went up slightly from November to January, as shown in Figure *b*.

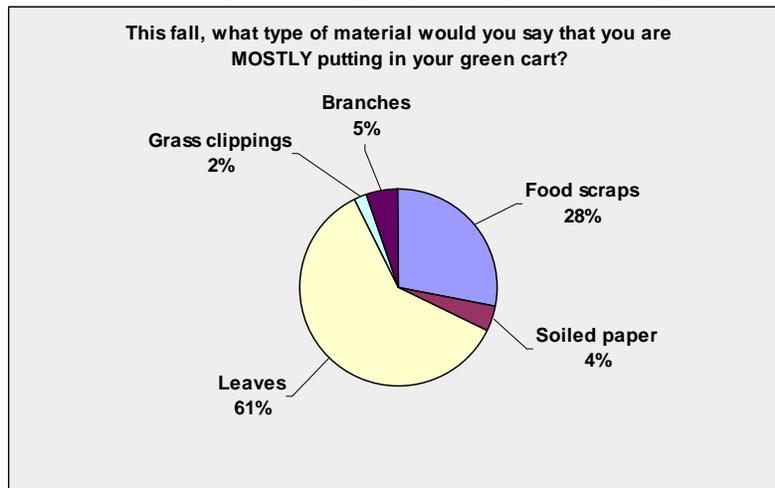
Figure *b* – Perceptions About Green Cart Size



- Residents who received the kitchen pails commented how much they appreciated it and how effective it was in the kitchen.
- In November, Round 1 respondents reported that leaves were the majority of materials being placed in green carts, with food scraps as the second-highest item, as shown in Figure *c*:

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Figure c – Residents Report of Majority of Organics Going Into Green Cart

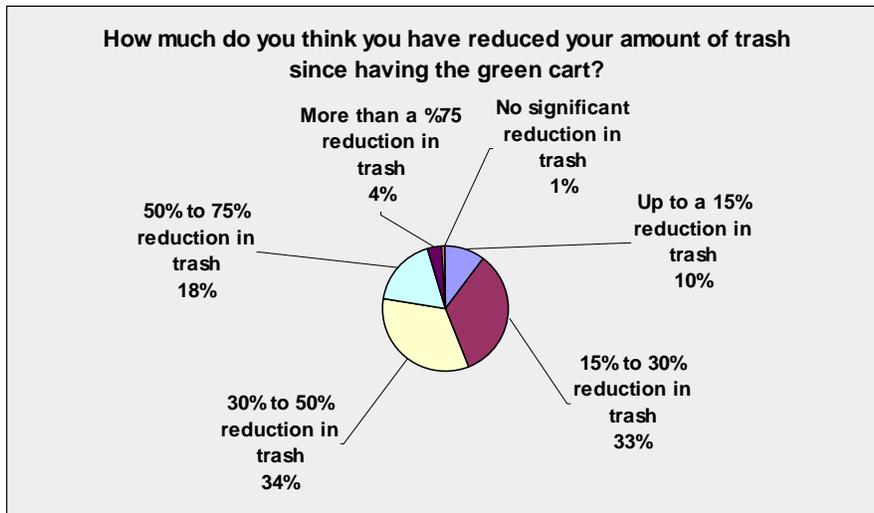


- Also in November, 99% said they planned to continue to use the green carts to set out food scraps and soiled paper.
 - 11% provided thoughtful comments to this question, such as//we can cut the anecdotal comments here and going forward, if you think this section gets too long. They could go in an Appendix. It was so inspiring to read these comments! We could consider using some quotes as callouts in the Ex. Summ or elsewhere. - AHP//:
 - “... it’s a learning curve, and we’re just starting to mine other bins in the house (besides kitchen) for compostable stuff.”
 - “We are saving some leaves to "layer" between food scraps”
- The pilot sought to determine frequency of collection needed during different seasons. Weekly pickups were conducted until the week of December 8, when they moved to every other week.
 - Three-quarters of Round 1 respondents seemed to welcome fall weekly pickups, saying:
 - 41% - in the fall, they had more each week than the cart could hold
 - 34% - liked the weekly pickup
 - 25% - every other week collection would have been adequate
 - Nearly all Round 2 respondents, in January, found every-other-week collection adequate:
 - 57% - once every other week was just right
 - 41% - could have gone to once a month
 - 2% - could have used every week collection
- Overall, comments from Round 1 respondents showed fantastic enthusiasm, as well as some unintended benefits for the City:
 - Increased neighborliness, as residents discuss the ‘ins’ and ‘outs’ of what’s accepted, and share as needed (“We share with our neighbors, if their bin is full they use ours and vice versa,” or letting those who didn’t get in the program put organics in a cart)
 - Generous-spirited participants: “Please know that I will donate \$20 to the program, keep up the good work”
 - “Having the compost bin also makes me more motivated to spruce up my yard more than I might otherwise, which probably benefits the appearance of the neighborhood,” or “Instead of procrastinating on raking leaves and pruning back, we got after it!”
 - Many said the green carts inspired them to start or resume backyard composting as well as curbside, further reducing trash for Denver to haul.

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- Some stopped backyard composting: “In the past I have composted in my own back yard but this is a lot more convenient and does not draw mice and foxes, the cats are disappointed but they will get over it. Thanks.”
- Gratitude to Denver
 - “Thanks for starting this program. It's nice to feel that maybe we will be part of the solution (i.e., helping reduce our environmental damage) instead of the problem”
 - “I really like that I can minimize my landfill garbage exponentially now.”
 - “We are a family of 6 and we can't begin to tell you how easy you have made this for us to do our part. We love the program and will use it all year long”
- Some comments exposed problems or issues, or offered suggestions to better the program:
 - Each week I have had to clean out the alley to remove the stench left behind by the liquids leaking from the truck.
 - Squirrels are chewing through the lid (several people had trouble with this)
 - Would like biodegradable leaf bags in the fall “so it would not be necessary to use the green cart for leaves. We actually had too many leaves for the green cart.”
 - “Denver should sell big paper bags for consumers to put additional lawn and fall scraps in” for organics overflow, this would “pay for the additional pick up.”
- By January, participants had had time to notice changes in household trash levels. Round 2 survey respondents reported reductions in amount of trash, as shown in Figure *d*, below:
 - 22% saw a reduction in disposed trash of greater than 50%
 - 34% found a 30 - 50% reduction in trash
 - 11% saw trash reduced by up to 15% or not at all

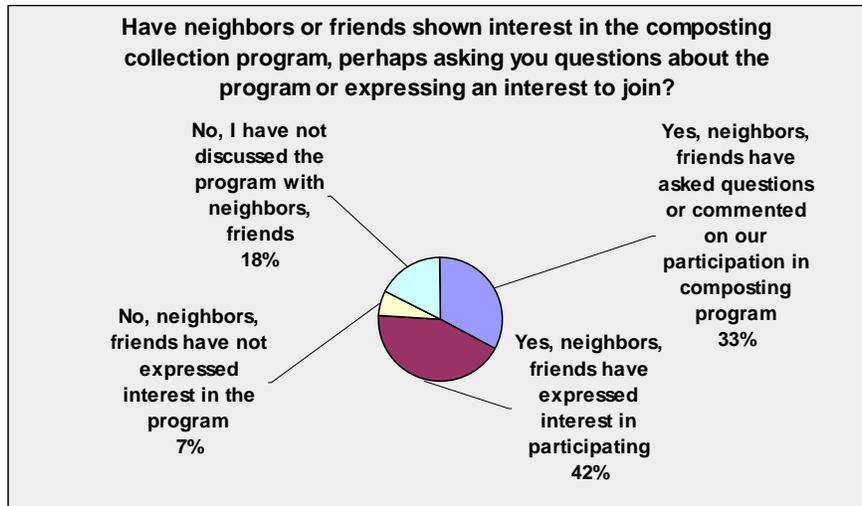
Figure *d* – Perceived Reduction of Trash, by Percent of Respondents



- Participation in the organics pilot seems to have engendered some old-fashioned neighborhood envy. Round 1 respondents were asked if they'd gotten questions or comments from neighbors and friends; results are shown in Figure *e*. About three-quarters of participants' neighbors and friends expressed interest in or asked questions about the program:

Figure *e* – Interest in the Program From Neighbors and Friends of Participants

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- By January, little yard debris was being generated. The Round 2 survey asked if participants were still using the green carts:
 - 93.5% - putting both food scraps and soiled papers in the green carts
 - 2.4% - only occasionally putting food scraps and soiled paper in green cart
 - 1.7% - only putting food scraps in green cart
 - 1.2% - only putting soiled paper in green cart
 - 1.2% - not putting food or soiled paper in
- Round 2 respondents were asked one open-ended question: *“Please share with us some comments about the things that have most surprised you about participating in the composting collection pilot program.”* 65% of those surveyed provided a total of nearly 500 comments. These comments were thoughtful and wide-ranging. Sample comments included:
 - Overall, tremendous enthusiasm and gratitude for the program.
 - Much pleasant surprise, especially pleased with:
 - The significant reduction in overall household trash
 - Number of materials accepted (meat and bones, pizza boxes, milk cartons, dryer lint, tissues);
 - Surprisingly little smell problems
 - Ease of handling the cart (several seniors mentioned this)
 - Reduced use of garbage disposal and lessened burden on the wastewater system (“this must be reducing water usage by the City” one astute person said)
 - Getting a stolen cart replaced very quickly
 - Compost envy from those in Denver and beyond who do not have this service
 - Denver for doing this (“am really proud of our city”)
 - Good problem-solving by participants:
 - Working out where to store carts, especially for those with smaller lots
 - Using milk cartons to put kitchen scraps in
 - Freezing food scraps til set-out day
 - Further reducing waste (“We are starting to buy products from the bulk section and ones with less and/or recyclable packaging so we have even less for the landfill bin.”)
 - Closing the loop: many asked if they could get some of this compost for their yards

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- Bringing out the obsessive composters: “I find myself thinking about it everywhere I go. I am bringing paper cups, plates and napkins plus banana peels home from work for the bin. I even bring some co-worker’s compostable items home.” A surprising number of people mentioned this.
- Some concerns:
 - Cart size too big or small
 - Odor and bugs when it gets warmer
 - In neighborhoods where residents don’t do own gardening, getting the commercial landscaper to use the compost bin
- Needing more information – where to buy biobags, specific material questions
- Finally, Round 2 respondents were asked if they would like to get additional information from Denver Recycles about other diversion opportunities; 85% replied “Yes.”

Appendix 8 Grant Metrics

Appendix 9. Community Leaders



APPENDIX E

Policy Survey of Comparable Cities (April 2008)
and
Ten-City Resurvey (November 2009)



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DENVER
THE MILE HIGH CITY



Denver Solid Waste Strategic Master Plan

Policy Survey of Comparable Cities

City and County of Denver
Solid Waste Management Division

April 2008



LBA ASSOCIATES



kessler consulting inc.
innovative waste solutions

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Appendix A	List of Abbreviations
Appendix B	Blank Survey Instrument
Appendix C	City Organization Charts
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I. INTRODUCTION & METHODOLOGY

As part of its work to create the 2008/09 Solid Waste Master Plan, Denver asked its consultant, HDR Engineering, Inc. to survey comparable cities to learn about how policies and programs were implemented elsewhere, and to learn from other cities' experiences. Denver's chief topical areas of interest in this survey pertain to policy and program areas of great near-term interest to the Division of Solid Waste and the City's environmental practices. These policy and program areas are:

- A. User Fees
- B. Yard Waste Program
- C. Trash Overages - Bulky Collections - Illegal Dumping
- D. Recycling Program
- E. Commercial and C&D recycling

The communities which HDR interviewed were selected on the basis of comparable demographics, services and policy positions that would be the most relevant in assisting Denver to evaluate the feasibility of making policy and program changes in its current solid waste system. Ten communities were researched:

<i>Austin, Texas</i>	<i>Milwaukee, Wisconsin</i>
<i>Charlotte, North Carolina</i>	<i>Salt Lake City, Utah</i>
<i>Chicago, Illinois</i>	<i>Salt Lake County, Utah</i>
<i>Houston, Texas</i>	<i>San Diego, California</i>
<i>Louisville, Kentucky</i>	<i>Thornton, Colorado</i>

Senior solid waste/recycling staff professionals from each of these cities generously gave between one and three hours of their valuable time for these in-depth interviews (as well as responding to follow-up questions).

A survey instrument was designed to ask interviewees details about each of the five topical areas: what current services are, how the policies were put in place for those services, if changes had been recently implemented or are planned, how customers are educated about services, costs, operational details, and other measures. We also obtained general contextual information such as relevant state and local policies, departmental budgets, number of employees, and other descriptive information. Data has been analyzed using both quantitative and qualitative methods in this report.

Eight tables summarizing findings are at the end of this report (see Appendix E).

Secondary policy and program issues were also researched, including general collection approaches, delineating limits on size of multi-family units (MFUs) served, use of drop sites, service changes and privatization.

Appendix A is list of acronyms used in this report and its tables. Appendix B includes a copy of the survey instrument.

II. GENERAL FINDINGS

Tables 1, 2 and 3 summarize key background information to the policy questions at issue in this survey.

- ◆ Table 1 – Background Information (population, department, number employees)
- ◆ Table 2 – Policy, Services, Budget Summary
- ◆ Table 3 – Collection Summary

General Statistics

Since the primary focus of the survey was to provide guidance on key policy topics, population was not the principal determinant for community survey selection. Therefore, the cities surveyed have a broad range in sizes, with the cities having:

- ◆ Populations ranging from 115,000 to 2,800,000 (Thornton is the smallest city surveyed, and Chicago the largest, with Denver's population at 580,000)
- ◆ Customer bases ranging from 25,000 to 660,000 households (Denver serves 165,000 households)

Appendix C includes copies of organization charts as available from communities surveyed.

State Laws & Local Policies for Solid Waste Management

Table 2 provides a program summary including overarching state or local laws and policies that impact solid waste management at the local level. It includes tip fees, for purposes of comparison, as well.

The most notable state laws in Table 2, in generally decreasing order of impact on local governments, include:

- ◆ Requirement for local governments to provide residential trash collection – Utah and Texas (governments can provide directly or via contract with private sector)
- ◆ Requirement for 50% waste diversion – California
- ◆ Bans on disposing recyclables, yard waste, white goods, universal/special wastes in landfills – Illinois, Kentucky, Wisconsin, and California also Charlotte-Mecklenburg County, but not all of statewide North Carolina)
- ◆ Mandatory alcoholic beverage container recycling – North Carolina
- ◆ Non-mandatory goal for reduced waste generation (North Carolina) and encouragement of PAYT pricing (Texas)

Local ordinances that also have significant impact on community programs include:

- ◆ Prohibition on charging customers for trash collection – Houston (up to 90 gallons per week) and San Diego (in place since 1919)
- ◆ Requirement for citizens to use public solid waste service – Salt Lake City, Louisville, Milwaukee, and Austin
- ◆ Mandatory yard waste diversion – Louisville
- ◆ Mandatory residential & commercial recycling – Mecklenburg County/Charlotte (commercial only), Chicago, Milwaukee (residential), and San Diego; several have exemption options
- ◆ Prohibition of container overages – Austin, Salt Lake City and Chicago
- ◆ Structure for franchising or hauler licensing (and fee collection) – Austin, Charlotte, Chicago, Houston, Louisville and San Diego

Colorado and Denver, respectively, have none of these requirements or policies. This current lack of regulatory drivers is expected to make establishing some of the policy-driven programs that have been successfully implemented in other communities more challenging for Denver.

Landfill Tip Fees (Table 2)

It is worth noting that four of the ten communities surveyed pay landfill tip fees with ranges that have mid-points from \$35 to \$55/ton. Four other communities pay fees ranging from \$23 to \$26/ton. This rate is more than twice what Thornton and Denver pay (\$10 to \$11/ton), and likely reflects the state and local mandates and policies outside of Colorado. At least one state (Texas) has a tip fee surcharge (\$1.25) that

generates revenues split between the state Department of Environmental Quality and local Council of Governments to cover administrative costs.

General Services (Table 2)

The communities surveyed have a number of common elements:

- ◆ Most all serve multi-family unit dwellings (MFUs) with between two and eight units for waste collection (Charlotte serves MFUs up to 29 units by rollout cart and 30 units or greater by City-contracted bulk container service; San Diego has no limit on number of units per MFU)
- ◆ All provide collection of trash and recyclables
- ◆ All provide collection of bulky materials except Chicago
- ◆ All provide collection of yard waste on some level except Thornton
- ◆ Half the communities contract for some level of these residential curbside services – all rely on open-subscription for customers not serviced by the city/county (except San Diego which implements a non-exclusive franchise)
- ◆ Most communities augment curbside recycling with drop-off sites to take extra materials or to serve generators without recycling service
- ◆ Every community provides drop-off collection for household hazardous waste (HHW) and special/universal wastes
- ◆ Most communities offer “back door” service for the disabled and elderly (also called “back yard” and “carry out” service by some communities)

Collection (Table 3)

- ◆ All communities have semi- or fully-automated trash collection – two-thirds are fully automated
- ◆ Six of the programs have automated recyclables collection (Milwaukee has a split-body system to accommodate dual-stream materials); four have manual systems for recyclable collection
- ◆ Of the six communities that provide regular curbside yard waste collection, two are automated and four are manual (Milwaukee and Salt Lake County also have irregular, seasonal collections)
- ◆ Every community that provides bulky materials service utilizes special collection equipment
- ◆ Five of the communities conduct at least of 95% of residential collection curbside instead of in alleys; five have significant alley collection (Austin, Chicago, Milwaukee and Louisville are more than half alley service)

In terms of general programs and services, Denver’s automated system with its mix of alley and curbside collection, is well bracketed by these communities.

Cost Observations

In order to estimate ballpark unit costs of the solid waste systems surveyed, three estimations were made for each city surveyed below – calculated to provide Denver with a general feel for system-wide costs only. Data should be compared judiciously as each system includes different services and service areas, different levels of regulation, and different program and financing constraints. The estimates include:

- (1) Annual Cost Per Household: based on the total city/county solid waste budget divided by the total of single-family units (SFUs) and MFUs served (calculation will be falsely high as budgets typically cover non-residential services which were not quantified)
- (2) Annual Cost Per Ton: based on the total city/county solid waste budget divided by the total tons of trash, recyclables and yard waste managed by

the city/county (this will also be falsely high as tons of special waste streams are not included)

- (3) Annual Tons Per Household: based on the total tons of trash, recyclables and yard waste managed divided by the total of SFUs and MFUs serviced (the numerator and denominator do not include non-quantified special wastes and non-residential customers, respectively)

Observations from this approximation include:

- ◆ Salt Lake City’s and Thornton’s low costs appear to be related to their lack of yard waste management and aren’t as comparable to the other communities
- ◆ Austin’s and Charlotte’s low cost/household reflects a low per-customer tonnage even with yard waste included
- ◆ Milwaukee’s high unit costs may be caused in part by the provision of significant “back door” service that is extended to regular trash and recyclables customers (Milwaukee noted that its program saved \$700,000/year when curbside rather than “back door” collection for garbage was instituted in 1993 for eight months per year)
- ◆ High costs for Chicago, Louisville, and Milwaukee include significant additional services such as rodent control, servicing many special events, neighborhood clean-ups, street sweeping, leaf collection, multiple drop-off centers, weed abatement and dead animal collection
- ◆ Chicago, Houston, and Louisville collect recyclables and yard waste collection manually, which may also lead to higher program costs

COMMUNITY	ANNUAL COST PER HOUSEHOLD ^{1,3}	ANNUAL COST PER TON ^{2,3}	ANNUAL TONS PER HOUSEHOLD ^{2,3}
Warmest Climates⁴			
Austin, TX	\$150	\$140	1.1
Charlotte, NC	\$140	\$110	1.3
Houston, TX	\$160	\$85	1.9
Louisville, KY	\$240	\$130	1.8
San Diego, CA	\$180	\$110	1.6
Moderate to Cold Climates			
Thornton, CO	\$140	\$85	1.6 (no yard waste program)
Denver, CO	\$140	\$90	1.6
Coldest Climates			
Chicago, IL	\$250	\$110	2.2
Milwaukee, WI	\$200	\$120	1.7 (yard waste not included)
Salt Lake City, UT	\$140	\$80	1.8 (yard waste program starts March 2008)
Salt Lake County, UT	\$160	\$90	1.9

¹ Excludes non-residential customers

² Excludes HHW, special and universal wastes

³ Rounded to nearest \$10 or nearest 0.1 tons; includes trash, recyclables, and yard waste unless noted otherwise

⁴ Climate impacts quantity of yard waste – warmer climates have longer growing seasons

Note that Denver’s 2008 budget is \$23M and is expected to manage approximately 265,000 tons (235,000 trash and 30,000 recyclables). Denver’s base services – in addition to residential trash, recyclables and bulky material collections – include graffiti control and Keep Denver Beautiful. Ancillary services include seasonal yard waste

programs, backyard composting education, alley cleanup and other miscellaneous cleanup activities. The City of Denver's costs are at the low end relative to programs surveyed, and are generally consistent with those communities that do not manage yard waste (especially Salt Lake City and Thornton).

III. PRIORITY POLICY FINDINGS

A. Implementation of User Fees (Table 4)

The Denver solid waste program is paid for from the City's General Fund and currently collects no user fees for regular services. Although the cost of services is passed on to customers through their property tax bill, there is no separate or visible line item that customers see through the course of the year that delineates solid waste costs. It should also be noted, that the largest contributions to Denver's General Fund (which supports the city's solid waste program) does not come from property tax revenues, but instead from sales tax revenues – a source that does not give price signals to solid waste users either. As a result, most Denver residents perceive trash (including bulky materials collection) and recycling collection as a "free" service. In an effort to generate revenues to support existing programs as well as additional services, Denver intends to explore the implementation of some level of user fees that are visible to the customer and that provide an incentive for preferred behavior (i.e., decreased waste generation and increased diversion).

Residential Programs

As shown in Table 4, six of the community programs surveyed are funded by general funds, and have no user fee tied to specific solid waste services for at least the first trash cart and recycling services (most do have purchase fees for additional trash carts). Of these, both Charlotte and Milwaukee assess visible, flat fees:

- ◆ Charlotte includes a flat "Solid Waste Disposal Fee" as a line item on its annual City-County property tax bill - SFUs are assessed \$57/year and MFUs \$39/year (approximately 70% of these fees go to the city's general fund and the rest goes to Mecklenburg County)
- ◆ Milwaukee assesses a Solid Waste Fee on its quarterly water bills of \$33/quarter-SFU; MFUs up to 4 units pay \$33/quarter/dwelling unit. It also serves some larger apartment buildings with dumpsters (billed quarterly)

Four cities' programs are operated as enterprise funds and collect user fees from residential customers, using a variable rate pricing structure for trash collection:

- ◆ Salt Lake City (its new rate structure is being implemented in March 2008) uses three cart sizes (40, 60- and 90-gallons) with fees linked to size
- ◆ Thornton uses one 95-gallon cart size with additional fees for more carts (up to four)
- ◆ Salt Lake County also uses only one 95-gallon cart, with varying fees for additional carts (no cart limit)
- ◆ Austin has several monthly, per-household fees it uses for residential customers; there are comparable, slightly higher fees for small businesses in residential neighborhoods (Loveland, CO has a very similar rate structure):
 - (1) Base fee: \$7.00
 - (2) Cart fees: Three sizes (30-, 60- and 90-gallons) with fees linked to size
 - (3) Anti-Litter Fee: \$2.60 anti-litter fee (pays for street sweeping, dead animal collection, HHW facility, & code enforcement)

The range of per-household monthly fees for weekly collection of 90-95-gallons cart is \$11 to \$13.50, although rates can be as low as \$4.75 (30-gallon cart, Austin) or \$8.25 (40-gallon cart, Salt Lake City). These fees cover trash and recycling collection – and Austin includes yard waste management as well.

Other residential program funding sources include charges for:

- ◆ Additional services – such as for containers beyond base service, larger carts, or pre-paid fees for extra bag stickers (Austin, Charlotte, Houston, Louisville, Salt Lake County, and Thornton)
- ◆ Curbside yard waste – Salt Lake City and Salt Lake County
- ◆ Services outside customer base (Houston and Salt Lake City)
- ◆ Special services – such as for dead animal collection (Houston)
- ◆ Penalties for delinquent overage fees (Austin, Houston, and Milwaukee)
- ◆ Penalties for illegal dumping (Chicago, Houston, Milwaukee, and San Diego)
- ◆ New service – new customers pay to set up account (Austin)

Note that Salt Lake County has observed that for every \$1 million increase in annual budget, its user fees need to increase by \$1/household-month (this covers 80,100 SFUs and MFUs up to 3 units).

Mixed Residential & Commercial Program

San Diego's solid waste program is also generally funded, and its residents are not assessed service-specific user fees. Like many California cities, it has a complex set of funding sources for its waste/recycle operations, which demonstrates creativity in structuring a waste/recycling budget:

- (1) General Fund: In 1919, the "People's Ordinance" was passed and mandated free trash collection (it was put in place by pig farmers who needed garbage to feed their pigs). This ordinance is still in place and would take a vote of the people to change it.
- (2) Revenue from private sector: Two sources include a Recycling Fee paid to the city by private haulers of \$7/ton, and materials recovery facility (MRF) revenue sharing (expected range from \$5M to \$6M in 2008).
- (3) AB939 funds from state: These funds help cover costs of meeting diversion goals.
- (4) At the City-owned landfill the \$8/ton Refuse Collection Business Tax (RCBT) is levied on all commercial and non-residential MSW, regardless of weight (residential self-haul is charged if greater than 2 tons). The RCBT revenue goes to the General Fund for broader city operation needs (e.g., police, fire, library, streets, etc.).
- (5) Hauler licensing fees: \$11 to \$12/ton for haulers collecting over 40,000 tpy.

San Diego is also considering a new flat recycling fee which could generate \$8M/yr and thus enable the city to go to weekly collection.

Commercial Program & Other Funding Sources

- ◆ Commercial service fees:
 - Per ton fees – such as San Diego's RCBT assessed on haulers of non-residential materials
 - Hauler licensing fees (Louisville and San Diego)
- ◆ Revenue sharing from facility operations – such as between Salt Lake City and County, and both Milwaukee and San Diego the and processing/disposal facilities they use

- ◆ Revenue sharing from sale of designated recyclables – such as between Charlotte and Mecklenburg County
- ◆ State or other funding – such as that provided to California communities through AB939 legislation that mandates diversion
- ◆ Interest income, sales of equipment, permit fees and other miscellaneous – also unclaimed deposits such as those expected from the construction and demolition (C&D) recycling program in San Diego starting summer 2008

Billing Mechanisms & Delinquency Management

The four enterprise fund programs bill customers on the local utility bill, with the exception of Salt Lake County, which includes the cost of solid waste services as a separate line item on customers' property tax bill. Milwaukee (a generally-funded program that assesses a flat fee), bills on quarterly water bills with a line item for garbage services; recycling collection is paid through the general fund levy.

To handle delinquent accounts, those that use utility billing will turn off water service and/or remove trash/recycling carts. In Salt Lake County, delinquent customers' outstanding fees are listed in the county's tax notice, service is stopped, and the county's carts are removed.

Fee Changes Pursued

Several of the communities have pursued changing the rate structures, but have found inadequate "political will" to:

- ◆ Make user fees "visible" to customers by itemizing on property tax bills or use other billing mechanisms (Chicago, Louisville and San Diego)
- ◆ Implement new flat or variable rates (Houston and Milwaukee)
- ◆ Franchise or contract private haulers (Chicago)
- ◆ Regularly and systematically increase fees to fully cover program costs (Milwaukee initially assessed a Solid Waste Fee that only recouped about 50% of its costs but has slowly been raising rates to capture the true service costs)
- ◆ Raise rates (Austin has not had a rate increase since 1997, though through the use of modest fees for various services has been effective in recouping many costs)

B. Implementation of Yard Waste/Organics Collection (Table 5)

Denver currently provides no yard waste or organic waste collection services, other than its fall leaf drop-off option, which collected about 200 tons in 2007. The US EPA estimates that combined, yard trimming and food waste comprise about 25% of all waste nationally (*Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2006*, EPA-530-F-07-030, November 2007). As well, recent regional data on waste composition matches this, showing compostable organic waste may comprise 24% of the waste stream overall, and at least 25.8% of the residential waste stream. This data shows yard waste alone is 6.6% of the entire waste stream and 8% of the residential stream (*Larimer County Two-Season Waste Composition Study*, May 2007).

Denver is considering adding yard waste and/or other compostable waste (food, compostable paper) collection to its services to meet diversion goals outlined in Greenprint Denver. Overall findings, by city, are in Table 5.

Yard Waste Diversion

All the cities surveyed, except Thornton, have yard waste diversion programs of some sort. None are diverting food or other compostable organic waste. Cities' annual diversion of yard waste ranges widely:

- ◆ Southern, wetter cities with long growing season – from 430 lbs/household-year in Louisville to 750 lbs in Houston
- ◆ Dryer, colder climates – from 50 lbs/household-year in Salt Lake County to 230 lbs in Milwaukee

These are well-established programs (all have been in place for 10-20 years), with the exception of Salt Lake City which is starting March, 2008. Most serve all residences (including multi-family dwellings) with year-round service, except in Milwaukee and Salt Lake City, which cease collection in the winter. Austin distinguishes between yard trimmings and brush – the former is picked up weekly and latter during specially scheduled brush collection days twice a year. Salt Lake County has an unusual service – it rents out its yard waste trailer to residents for \$24/pull; this likely explains the low diversion as well. Operationally, most cities use rear load trucks with two- or three-person crews to collect yard waste. All have been successful in finding nearby processing options, whether private or public – and many offer mulch to residents for free.

A majority of the communities surveyed use bags or cans to collect yard waste. These may be provided by the customer or city. Chicago, also a bag-based yard waste system, is also piloting cart collection in “leafier” neighborhoods with good success. However, the city contact believes that yard waste “complicates everything and is expensive” – and, preferably, should be directed to a backyard composting program.

Note that Salt Lake City's new yard waste program requires a minimum one-year subscription from residents. Despite restrictions, the program is already popular, with more than 10% of eligible households subscribed early in 2008.

Austin makes its green waste into the very popular “Dillo Dirt” compost product, sold in area nurseries; the compost facility operator would like to be taking more green waste from the city.

The survey respondents did not provide costs specifically broken out for yard waste services, such as cost per ton or cost per household. Perhaps because these are mature services integrated into existing waste and recycle collection, the cities have not needed to allocate distinct costing to yard waste.

Food Waste Diversion

Only Chicago has seriously considered adding food waste, but budget limitations or lack of access to appropriately permitted processing facility have hindered implementation. Austin is beginning to look at food waste diversion.

C. Reduction of Overages, Bulky Collections, Residential Dumpsters and Illegal Dumping (Table 6)

Denver currently does not have a policy to limit or control overages (overflowing waste receptacles). While overages are less problematic in neighborhoods served by dumpsters for trash, these areas (as well as some public locations) suffer from illegal dumping. Denver provides bulky materials collection at each household every fifth week through its Large Item Pickup service. Denver would like to find ways to reduce costs

associated with overages, bulky waste pickup, and illegal dumping – without reducing overall services to residents.

Overages & Illegal Dumping

As noted in Table 6, none of the communities reported currently having significant problems with overages or illegal dumping – nor are their observations consistent with Denver's. Those with dumping problems (particularly the larger cities) have well-tested mechanisms for resolving overages and illegal dumping. Several noted that these issues occur more often in lower economic and vacant areas. Several communities rely on city agencies outside the solid waste department for handling residents that fail to comply after warnings (e.g., Charlotte's Code Enforcement Division within its Neighborhood Development Department, Milwaukee's Department of Neighborhood Services, the Houston Police Department's Neighborhood Protection Division, and the Salt Lake County Health Department).

None of the communities have fees or penalties originating from the waste division for failure to comply, with the exception of Milwaukee. Residents can place neat piles outside their cart up to 4 cy in size with no fee associated; fees of \$50 apply when the pile exceeds 4 cy. Milwaukee noted that it has good support for the resources needed for enforcement (staffing, back-up by courts) but that the \$50 does not recoup all its costs. San Diego says "we hold the line and make people buy an additional cart" if customers keep overflowing waste.

Most have a system in place to address overages, typically consisting of a multi-tiered warning system that ultimately leads to refusal by the city or county to collect trash. Other cities (such as Charlotte) will turn offenders over to code enforcement officers who take ticketed offenders through the court system, with fees coming from the courts, not a solid waste division. Fees vary: Houston's charges (\$50-\$2,000 for first violation and \$250-\$2,000 for second) is not atypical.

Houston and Austin both require any additional bags or overages to be labeled with a pre-paid tag or sticker – from \$1-\$2 each; Austin customers are charged \$4 on the next bill for each bag collected without a sticker. For multi-family units that continued to have overages after repeated education and enforcement attempts, Austin put these households on dumpsters, which are serviced by a private hauler under contract with the city; it bills them to recoup all its costs.

San Diego handled 20,000 illegal dumping abatements in 2007, including weed abatement and dead animal collection. It has 3 crews and trucks (packer, flatbed, crane truck – depending on need) working on just this. Eleven code enforcement officers work full-time on illegal dumping. San Diego also reports success partnering with local non-profits (using homeless or juveniles for labor) working year-round on mini-cleanups.

Overage waste from non-city customers can result in cost and expense to a city as well. Chicago's Streets & Sanitation crews routinely clean up loose trash in alleys, regardless of whose customer generated it. To address this cost, an ordinance requires all dumpsters to be labeled with the name and number of the contracting party right on the dumpster. Chicago actively tickets overflowing dumpsters. As well, all haulers are required to have a broom and a shovel on trucks at all times to cleanup overages. Finally, Chicago and Salt Lake City also enforce the requirement that lids must be closed on all trash containers, with notices and tickets. Chicago's aggressive enforcement of these requirements stems from its ongoing need for citywide rodent control.

Austin's Public Assembly Code Enforcement (PACE) multi-agency team addresses litter and illegal dumping associated with special events (e.g., music festivals or university move-in/move-out). The PACE team includes solid waste, EMS, fire, and police who meet and educate event organizers and participants on public safety – including litter and trash. This has reduced post-event cleanup costs and increased overall safety.

Unlike Denver, none of the communities tie illegal dumping occurrences directly to dumpster areas. Only half of the communities utilize dumpsters for city/county trash collection.

As a budget-tightening measure, Charlotte ceased litter pickup on state highways, telling the state it must bear the cost of that. Charlotte prides itself on being a clean and beautiful city; the state hasn't provided litter pick-up at the City's preferred service level and this remains an issue of concern.

Several solid waste directors remarked how important it is to have City Council understand the health and environmental issues associated with overflowing waste – so when citizens call and complain that their overages are not picked up, the solid waste division is supported by Council, and Council officials actually educate their constituents about waste-related responsibilities.

Residential Dumpster Collection

Denver's service where single-family units share dumpsters appears to be unique – none of the cities surveyed had a comparable service. We noted that dumpsters are not used for any residential collection excepting horse properties in rural Salt Lake County. Milwaukee will provide dumpsters to MFUs, but only with repeated problems with overages - and then the City's contractor services the dumpsters and the City bills the MFU to recover full costs. Illegal dumping disposal of unacceptable materials in commercial dumpsters appears to be relatively easily controlled in surveyed cities through contracts or ordinances for private sector hauling (e.g., Chicago, Austin) or through issuing permits with space and fencing requirements to businesses (Houston).

Bulky Materials Collection

Every community except Chicago includes some frequency of separate bulky material collection in its basic residential service (only Thornton contracts for bulky waste collection). Three provide annual curbside collection, one twice a year (Austin), one monthly (Houston) and one quarterly (Louisville). The others offer this collection on an irregular ("as needed") schedule or with scheduled collection – Charlotte and Milwaukee take bulky items at the curb with regular waste collection (which depending on demand could amount to a weekly service). Four out of the ten surveyed communities had no quantity limits for bulky materials; Milwaukee tells residents "up to two couches worth of bulky items at a time," and readily gets this material on its regular trash collection trucks.

Costs available from Houston and Thornton indicate that this service component constitutes 34% and approximately 10% of their annual budgets, respectively. We note that Denver expects to spend 7% of its 2008 solid waste budget on its large-item pick-up service.

Commonly excluded materials are hazardous wastes, Freon-containing units, building materials, yard wastes, and items covered by disposal bans. With the exception of programs that separate out wood waste destined for mulching or composting (Austin, Houston, Louisville, San Diego, and Salt Lake City), all materials are disposed.

Chicago discontinued bulky item pickup when its blue bag recycling program started in the early 1990s as a way to be able to afford recycling. Residents kept putting bulky

items in alleys – and Chicago saw a thriving cottage industry emerge of folks with pickups who simply drive around and take appliances and other large items. The city reports it can easily collect remaining bulky items on its regular routes, and does not report a problem with costs or dumping.

Louisville, San Diego and Houston's solid waste divisions all sponsor community cleanup events on an as-requested basis. San Diego does 75 events a year and bears the cost of printing language-appropriate door-hangers but expects local contacts to promote the neighborhood cleanup. If the local contacts fail to get the word out, and residents don't turn up with material for collection, San Diego simply won't come back to that neighborhood again.

As well, Houston and Louisville have ongoing, staffed drop-off sites that take bulky items and junk.

Denver's Large Item Pickup program is generally consistent with these programs, although the current collection cycle of once every five weeks is among the more frequent of those surveyed.

D. Increased Voluntary Recycling (Table 7)

Denver operates a voluntary recycling program. The program provides 65-gallon carts for weekly collection of single-stream materials and is fully automated. Approximately 45% of eligible households participated in 2006, generating an average 38 pounds per set out. Denver collected about 25,900 tons of recyclables from its residents in 2007. Denver would like to:

- ◆ Increase total tons diverted through its program
- ◆ Maintain participation by residents who want to recycle (and who recycle at fairly high levels)
- ◆ Encourage residents not currently recycling to do so
- ◆ Keep very low contamination rates (curbside contamination rate was only 2% as recently as November, 2007)

Programs

Table 7 provides a summary of programs surveyed. Only Chicago, Milwaukee, and San Diego have mandatory residential recycling programs, though Chicago's and Milwaukee's are not heavily enforced (see Appendix D for information on ordinances). Chicago's mandate applies to MFUs with more than 4 units, but is not enforced. San Diego just passed mandatory residential recycling requirements, which are being phased in over the next two years. All other programs are voluntary, with participation varying from mid-forty percent (Houston and Thornton) to nearly 100% in Salt Lake County, where recycling carts are provided to all residents.

Six programs are single-stream and four are dual-stream (with Austin migrating to single stream by the end of 2008). Neither of the Salt Lake communities collects glass curbside, which is consistent with recycling trends in Utah and reflects the lack of local markets.

Five programs (two single- and three dual-stream) are collected weekly, and four (also evenly split) are every-other-week collection. Milwaukee's dual-stream recyclables are collected via "back door" service roughly every 20 work days or every 28 calendar days; it is running a pilot for "set" scheduled collection (and its garbage collection schedule is only "set" from April through November). Only Salt Lake City and San Diego (25% of residents) rely on contract collection.

Chicago's recycling budget (\$15M) is about 9% of the Streets & Sanitation Department's total solid waste budget, while Milwaukee allocated about 26% (\$4M for yard waste and \$6M for recycling) of its Sanitation Department budget to diversion programs. Denver expects to spend approximately \$2.5M (11% of its 2008 budget) on recycling.

Several of the recycling programs have undertaken significant changes recently:

- ◆ Chicago is currently piloting single-stream, weekly cart service
- ◆ Milwaukee will pilot twice per month collection this summer (Setout of carts required for those in the routes that have curb rather than alley collection.)
- ◆ Salt Lake City made curbside yard waste collection available to residents for an additional fee as well as smaller trash carts for lower fees (March, 2008)
- ◆ Salt Lake County provided recycle carts to every resident, removed recycling fees but increased trash fees (June, 2007)
- ◆ San Diego made residential and business recycling mandatory and added recycling requirements for C&D and special event recycling (January, 2008 through 2010)
- ◆ Thornton changed from dual to single-stream recycling (January, 2007) and from monthly to every other week collection (January, 2008)
- ◆ Austin is just about to go citywide to single stream (by end of 2008)

All communities reported that these programs were relatively easy to implement at both the public and council/commission level (though it took San Diego many years to garner needed support from all community sectors). Salt Lake County acknowledges that delays in rolling out its program did frustrate some residents and that its outreach message wasn't precisely on target (see Section V), but that virtually no social or political obstacles were encountered. Austin's single-stream pilot effort was so successful, residents refused to give carts back and return to recycling bins at end of pilot; this more than convinced the city council of the value of the program.

Finally, as well as pay-as-you-throw billing for trash collection, Austin uses other price signals to encourage diversion. Customers pay a \$15 fee for a larger or additional cart there is – but there is no fee to switch to a smaller cart.

Education and Outreach

Educating and reaching out to citizens is vital to keeping diversion rates high and contamination low. Most communities emphasized that public education is the key to increased recycling (especially without mandates or other strong incentives) and low levels of contamination.

Effective efforts toward these ends include:

- ◆ Providing recycling programs in schools and educating schoolchildren yields a measurable increase in residential diversion as children bring recycling behavior home and encourage families to participate (most cities reported this)
- ◆ Miami/Dade solid waste requires senior solid waste staff to give talks on recycling and waste reduction to schools and community groups – it deepens commitment and understanding of their solid waste staff of the importance of ongoing outreach, and helps keep diversion up
- ◆ Do outreach in the language people speak and use social communication channels they use (e.g., many don't read city newspaper and can't read flyers in English) – in Chicago's pilot blue cart program Sanitation staff goes to neighborhood events and uses block captains who lend credibility to the program by being from the neighborhoods

- ◆ Competition between neighborhoods for greatest recycling increase with \$5,000 reward to be used for neighborhood improvement programs (Houston’s “Go Green” program)
- ◆ A Milwaukee pilot program uses high school students to go door to door in lower participation area and distribute (correct language) educational materials and chat about recycling – early results show increased set-out rates, lowered contamination rates, lowered rates of empty carts, and increased diversion
- ◆ Quality inspectors tagging set-outs with incorrect materials – Salt Lake County observes this has provided strong one-on-one public relations and education that’s been very effective
- ◆ Being sensitive to the fact that recycling is simply not in the vocabulary of some groups and adjusting service and expectations accordingly – one large city manager observed that “For about a third of our customers, we’re just happy if they put garbage IN the can. If we gave them recycle carts, they’d be filled with water & kids using them as swimming pools, and folks would store clothes in them inside”
- ◆ Back-yard composting programs which yield modest source reduction yet are popular with the interested public – Austin, Louisville, and Milwaukee

Success Rates

Reported diversion rates vary from “guesstimates” to measured results and range from single digit numbers (Houston and Thornton) to 55% in San Diego (driven by state regulation). While Milwaukee’s 12% recycle diversion rate seems relatively low for a city with mandatory recycling, its monthly collection service and no enforcement of requirements are probable causes; note that it diverts another 12% via yard waste collection.

Chicago earns the highest recyclables revenues (in this survey and beyond) of \$65/ton. The range of curbside contamination levels were from 5% to 10% in Salt Lake County and Salt Lake City, respectively (both are single-stream programs). Contamination in Charlotte’s and Milwaukee’s dual-stream programs ranged from 7% to 9%.

E. Implementation of Policy for Commercial and C&D Recycling (Table 8)

Waste and recycle customers not served by Denver use an open subscription system for hauling services from the private sector. There is no hauler registration, licensing or data reporting requirement. Private haulers are not required to offer recycling service to their trash customers, and non-residential customers are not required to recycle.

Denver also has no requirement to recycle construction and demolition (C&D) debris by contractors. C&D debris includes paper/cardboard, yard/land clearing debris, wood, and building materials (drywall, block/brick/stone, carpet, insulation, asphalt roofing, plastic, and miscellaneous junk). The regionally relevant May, 2007 *Larimer County Two-Season Waste Composition Study* estimated C&D debris to be upwards of 26% of the waste stream. The US EPA does not break out C&D materials as a separate category in its national municipal solid waste composition analyses; however, it did find that the following materials found in the C&D waste stream comprise as follows: wood - 13%, metals – 19%, and other materials – 5%.

Denver is interested in assessing the pros and cons of policies to encourage waste diversion in non-residential sectors, which would provide the City some level of control and information on these activities, as well as increase waste diversion levels.

Commercial and Institutional Recycling

As shown in Table 8, many communities require licensing of private sector haulers (who collect primarily from non-residential areas in the communities surveyed). Both Charlotte (exclusive) and San Diego (non-exclusive) franchise some portion of their residential sector. Only San Diego and Louisville require reporting of trash or recycling data. Charlotte and San Diego require businesses to recycle.

It notable that most public trash (and some recycling) programs do serve city or county buildings (Salt Lake County buildings are required to recycle), as well as smaller facilities such as libraries, fire stations and other city departments – those that do not need compactors or dumpsters.

Austin manages a waste and recycling collection contract serving its central business district and City buildings. Thus it has some measure of control over hauler services provided to all its core downtown businesses – e.g., the hauler must provide recycling services.

Several cities provide recycling services to public schools. In some communities, such as San Diego, Charlotte and Salt Lake County, large MFUs can receive public service upon request. Austin, Charlotte, Houston, Louisville, and San Diego also provide various levels of trash service to small businesses.

Construction and Demolition Recycling

Both Chicago and San Diego have C&D recycling requirements for building construction and demolition activities within city limits. Chicago's ordinance requires reporting of quantities diverted and establishes penalties if less than 50% of construction/deconstruction materials are not recycled. It was put in place primarily for job site cleanliness and safety; while site cleanliness is enforced, the reporting requirement is not generally enforced. San Diego's new C&D recycling ordinance requires a deposit (as high as \$50,000 depending on project size) that is refundable only if the contractor can document that at least 50% of all debris generated was recycled. Milwaukee is conducting a pilot project to recycle C&D from its city building projects (or those using city funds); this data will help decide if an ordinance should be passed requiring C&D recycling on all city-owned or -funded C&D projects.

Appendix D includes a copy of the Chicago and San Diego C&D ordinances. San Diego reported that staff and citizen advocates worked for nearly 15 years to get the mandatory recycling ordinances for all sectors passed in late 2007 approved by Council and the public.

IV. OTHER FINDINGS

Our survey respondents also generously shared information on a number of issues that, while not policy priority areas for Denver, are relevant to its upcoming Solid Waste Management Plan. These topics are discussed briefly below.

Multi-Family Units (MFU)

Many cities provide both recycle and waste service to MFUs. Of interest to Denver is the number of MFUs served. This survey observed that the surveyed communities' residential trash and recycling services include:

- ◆ Duplexes and vertical town homes in Thornton
- ◆ Up to 4 or 5 units in Austin, Chicago, Milwaukee, Salt Lake City/County and San Diego

- ◆ Up to eight units in Houston and Louisville
- ◆ Up to 29 units in Charlotte by City crews; greater than 29 units by City's contractor
- ◆ No limit on MFU size in San Diego – if the property manager can place a cart in the right-of-way, the city will service it

Drop Sites

All cities reported using drop sites to collect recyclables from customers not served by regular collection, and/or to take additional materials not collected curbside. Table 7 includes full details; highlights include:

- ◆ Cities have from one (Thornton) to over 40 (San Diego)
- ◆ All report their drop sites are popular with citizens and well used
- ◆ Some have a mixture of staffed and unstaffed sites (Houston and Louisville)
- ◆ Many of these sites also take other materials such as HHW, bulky items, appliances, etc.
- ◆ Several cities augment permanent collection facilities with periodic collection events for materials including recyclables, bulky materials, large brush, batteries/oil/paint/anti-freeze, e-waste, HHW/CESQG, and even trash
- ◆ One of Houston's drop site distributes small, used industrial and consumer items for art projects, and has a book and magazine swap area
- ◆ All are free (some require proof of residency) except Louisville's Waste Reduction Center that takes bulky items.

Service Changes (also see Increased Voluntary Recycling above). Highlights include:

- ◆ Thornton increased rates and added variable fees for additional carts in 2003 – at same time it moved bulky collection from the city's general fund to Environmental Services enterprise fund and was able to tell public that the trade of increased fees was the ability to free up \$250k (2003 dollars) for parks and recreational improvements
- ◆ Salt Lake City made curbside yard waste collection available to residents for an additional fee at the same time it added two smaller trash carts available for lower fees (March, 2008)
- ◆ Salt Lake County provided recycle carts to every resident at the same time it removed recycling fees but increased trash fees (June, 2007)
- ◆ When Chicago started its blue bag recycle program in the early 1990s, it discontinued bulky item collection, using that cost savings to pay for recycling (see Section III. C, above on bulky items)

Privatization

Many cities have privatized (contracted for) various aspects of waste services to achieve cost reductions or to meet other goals. Some examples include:

- ◆ Charlotte and San Diego franchise/contract 25% and 75%, respectively, of waste and recycle collection services
- ◆ Louisville and Salt Lake City contract recyclables collection
- ◆ Thornton contracts bulky collection
- ◆ Austin contracts for waste and recyclables collection in its central business district
- ◆ Most use contract MRFs
- ◆ San Diego is considering contracting for collection from its drop-off centers located in city parks

V. RECOMMENDATIONS

Recommendations from Communities Surveyed

We asked an open-ended question of interviewees: “What recommendations might you have for Denver?” People responded with thoughtful observations, provided here without screening or prioritization:

General

- ◆ Don’t be rushed into implementing changes or new programs too quickly – explore with pilot programs and phase in new efforts
- ◆ Get rates right the first time; use unit-based pricing
- ◆ Keep exemptions to a minimum
- ◆ Include employees in decisions and make them accountable,
- ◆ Educate employees on what keeps costs down but also on what keeps customers happy
- ◆ Make customer service #1 priority (even though it may conflict with operational cost efficiencies)
- ◆ Do find new service to add when deleting an existing one or increasing prices (“service exchange”)
- ◆ “Need public services to be better and more cost effective than private sector services or what’s the point?”
- ◆ Do litter abatement program – work to get state funds to help on major roadways
- ◆ Use “optimized” or other incentives to maintain costs (if Charlotte’s actual costs are under budget, up to one-third of difference is shared with employees) instead of “managed competition” which public and private sectors compete (if city wins and has costs less than budget, up to one-half difference shared with employees)

Cost Efficiencies

- ◆ Implement unit-based user fees that provide incentives for recycling (recommended by all of those with enterprise funds, plus Milwaukee)
- ◆ Charge for everything except first recycling cart (recommended by both enterprise and general fund programs)
- ◆ Make all collections semi- or fully automated
- ◆ Switching from same-day collection to varied routes saved money through staffing and vehicle efficiencies (Austin)
- ◆ Standardize carts and collection (Chicago)
- ◆ Turning over fleet every three years leads to decreased down time/overtime and increased employee morale
- ◆ Know exactly how much each service costs
- ◆ Provide incentives to employees to keep costs down (Charlotte has bonuses for employees if efficiency goals are met)
- ◆ Negotiate for revenue sharing from MRFs with clear floor/ceilings on pricing
- ◆ Shifting from weekly to every-other-week recycle collection can decrease costs without decreasing diversion (however, Salt Lake County argues for establishing weekly collection at the beginning of the program)

Diversion

- ◆ Implement/increase yard waste collection to really increase diversion
- ◆ Strong MRF contracts – require minimum processing metrics (residue), monthly reporting, and access by local government for spot checks
- ◆ Give new customers a smaller cart to begin with along with the recycle and yard waste carts; charge for larger carts but not for downsizing cart size

- ◆ Have multiple drop sites for wide range of materials – staff those with more critical items (recyclables, special/universal wastes)
- ◆ Have direct, well-targeted and honest public outreach/education program

Public Outreach

- ◆ Keep messages honest – for example, claiming that recycling is “free” is not honest
- ◆ Do explain cost increases with real reasons like increased fuel
- ◆ Don’t begin outreach for new program too far in advance - public can become frustrated with delay
- ◆ Do use relationship building and “carrot versus stick” approach (such as Salt Lake County uses with its Quality Assurance inspectors)
- ◆ Include stakeholders early and often (haulers, HOAs, construction contractors, member communities and neighborhood groups)

Sustainability Programs

The six largest cities we interviewed all have sustainability programs, which have programs or other efforts at the mayor’s or comparable level within the city structure. Other cities have a sustainability focus (usually in an environmental services division, as distinct from sanitation/solid waste divisions); only one has no sustainability focus at present.

Recommendations from HDR

The following are HDR’s recommendations for continued evaluation in Denver’s Strategic Master Plan. These recommendations are based in part upon the survey results reported in this document. However, most of the cities surveyed had regulatory, policy and/or fiscal drivers not available to Denver. The survey also did not provide comprehensive information on one or two aspects of the priority policies researched. As a result, these recommendations are based on both the survey findings and our understanding of the specific needs of Denver’s SWM program. We understand that future discussions amongst SWM staff and city leadership will provide substantive input to sociopolitical feasibility of these recommendations.

- ◆ Residential user fees (ideally including an incentive for diversion)
- ◆ Residential curbside collection of yard waste
- ◆ Increase in residential recycling – including adding drop-off sites, adding service to larger MFUs, and increasing public education
- ◆ Commercial recycling – including a private hauler ordinance that generates fees and promotes recycling
- ◆ Construction and demolition (C&D) debris recycling ordinance
- ◆ Service controls – use fees, enforcements, changes in service levels, and other mechanisms to collect full costs associated with problems such as trash overages, bulky wastes, and overflowing dumpster trash

Specific programs and policies will be evaluated in detail in the SMWP. The evaluation will consider necessary outcomes (increased diversion/decreased disposal, decreased costs, sustained customer satisfaction, etc.), planning and implementation needs, capital costs, and annual operations/maintenance costs.

Appendices

- A List of Acronyms
- B Blank Survey Instrument
- C City Organization Charts
- D Example Ordinances
- E Tables

APPENDIX A – LIST OF ACRONYMS

Al	Aluminum
BOPA	Batteries, oil, paint, anti-freeze (HHW/special waste collection)
CESQG	Conditionally-exempt small quantity generators
C&D	Construction and demolition debris
CY	Cubic yards
DOC	Drop-off site (drop site)
EPA	Environmental Protection Agency
E-Waste	Electronic waste
FTE	Full-time equivalent
Gal	Gallons
HDR	HDR Engineering, Inc.
Hg	Mercury
HH	Household
HHW	Household hazardous waste
HOA	Homeowners association
K	One thousand
LBS	Pounds
LF	Landfill
M	One million
MFU	Multi-family units
MRF	Materials recovery facility
MO	Month
MSW	Municipal solid waste
OCC	Old corrugated cardboard
ONP	Old newspaper
OMG	Old magazines
PAYT	Pay-as-you-throw (trash unit pricing)
PB	Lead
PD	Police department
SFU	Single-family units
SS	Single-stream
SWMP	Solid waste management plan
TPY	Tons per year
YR	Year
YW	Yard waste
WK	Week

Appendix B - Blank Survey Instrument

I Organization Profile

1 Solid Waste Programs

Overarching issues: (policy, ops context, state bans or mandates req'g local public sector SW svc.)

a City Budget = \$ _____ Million/yr

b Service Providers 1 = Public 2 = Contract 3 = Franchise 4 = Private

<input type="checkbox"/>	Residential	<input type="checkbox"/>	Trash	<input type="checkbox"/>	Yard Waste	<input type="checkbox"/>	Recyclables	<input type="checkbox"/>	Bulky Waste
<input type="checkbox"/>	Multi-family	<input type="checkbox"/>	Trash	<input type="checkbox"/>	Yard Waste	<input type="checkbox"/>	Recyclables	<input type="checkbox"/>	Bulky Waste
<input type="checkbox"/>	Institutional	<input type="checkbox"/>	Trash	<input type="checkbox"/>	Yard Waste	<input type="checkbox"/>	Recyclables	<input type="checkbox"/>	Bulky Waste
<input type="checkbox"/>	Commercial	<input type="checkbox"/>	Trash	<input type="checkbox"/>	Yard Waste	<input type="checkbox"/>	Recyclables	<input type="checkbox"/>	

c Municipal Collection (define service limits)

Multi-family # of Units	Single-family # of Units
Institutional Types	
Commercial Types	
Airport Services	
Special events?	

d Processing/Disposal

<input type="checkbox"/>	Transfer Station
<input type="checkbox"/>	Landfill
<input type="checkbox"/>	MRF
<input type="checkbox"/>	HHW
<input type="checkbox"/>	Oil/Antifreeze
<input type="checkbox"/>	EWaste
<input type="checkbox"/>	Other

2 Tonnages Handled by City Forces (2007)

<input type="checkbox"/>	Trash	_____ tpy
<input type="checkbox"/>	Recyclables	_____ tpy
<input type="checkbox"/>	Yard Waste	_____ tpy
<input type="checkbox"/>	Bulky Waste	_____ tpy

3 Collection Methods R = Rear S = Side-Load F = Front-Load

<input type="checkbox"/>	Curbside	<input type="checkbox"/>	Manual	<input type="checkbox"/>	Automated	<input type="checkbox"/>	Semi-automated
<input type="checkbox"/>	Alley	<input type="checkbox"/>	Manual	<input type="checkbox"/>	Automated	<input type="checkbox"/>	Semi-automated
<input type="checkbox"/>	Carryout	Notes on collection:					

Container Sizes: _____ Residential
 Container Sizes: _____ Multi-family
 Container Sizes: _____ Commercial

4 Private Hauler Control Mechanisms

a	Contracts	
	Franchises	
	Ordinances	
	Hauler Licensing	
b	Service Restrictions	
	Other	

c Is there a city code/ordinance requiring any sector to use municipal SW/Recycle/YW service?

5 About the operations:

Number employees:
Service restrictions?
Mandates driving service?
Other services? (e.g., graffiti?)
Organization chart?

Appendix B - Blank Survey Instrument

II Municipal Funding Mechanisms

6 General Fund User Fees Enterprise Fund

a Describe how program expansions/improvements were impacted by this funding mechanism?

7 User Fee Structure

a Flat Rate Customer Type
 Variable Rate Container Size Customer type

b Is there a different Price structure for single vs multi-family units; commercial? (Y,N)

c Are fees adequate to cover all costs? (Y,N)

d Billing: how done? Admin. costs? (how deadbeats, delinquencies handled, etc.?)

8 How was system implemented?

a Politics addressed?

b Public Education Methods Used

c Service Level Changes Implemented

- Change Containers
- Service Frequency
- Reduced Services
- Other

d Customer Reactions

Illegal Dumping? _____
 Other _____

Appendix B - Blank Survey Instrument

III Collection System Issues

9 Container Overflows/Quantity Problem Areas

- a Container Sizes _____
 Service Sectors _____
 Extra Containers _____
 Other _____

b Overflow Handling Method

- | | | | |
|---|----------------|------------|-------|
| <input type="checkbox"/> Collected | Extra Fees? | Fee Method | _____ |
| <input type="checkbox"/> Not-Collected | Warning Tag | | _____ |
| <input type="checkbox"/> Customer Options | Virtually none | | |

c What policy changes have been considered or implemented?

10 Bulky Waste Collection Methods/Options

- a Periodic Collection Frequency _____
 Appointments _____
 Roll-off/Dumpster _____
 Drop-off Locations _____

b Bulky Material Restrictions

- Quantity Restrictions _____
 Material Restrictions _____

c Penalties/Enforcement Mechanisms

d What policy changes have been considered or implemented?

11 Multi-family Dumpsters Issues

- | | | |
|--|---------------|-------|
| <input type="checkbox"/> Illegal Use | Solution Used | _____ |
| <input type="checkbox"/> Higher Waste/HH | Solution Used | _____ |

12 Are waste drop sites used? Waste Recyclables Other
 a _____

Appendix B - Blank Survey Instrument

IV Residential Recycling Policies	
13	Recycling Mandate Diversion Goal
	LF Disposal Bans _____
	Enforcement Mechanisms _____
14	City Residential Recycling Program
a	Diversion Rate = _____ (excluding yard waste)
b	Commingling
	<input type="checkbox"/> Single Stream <input type="checkbox"/> Dual Stream <input type="checkbox"/> Dirty MRF <input type="checkbox"/> Other _____
c	Collection Frequency
	<input type="checkbox"/> Weekly <input type="checkbox"/> Bi-weekly <input type="checkbox"/> Drop-off <input type="checkbox"/> Other _____
d	Material Processing
	<input type="checkbox"/> City MRF <input type="checkbox"/> Multi-City MRF <input type="checkbox"/> Private MRF
	Contamination Rate <input type="checkbox"/> %
15	Recycling Participation
a	<input type="checkbox"/> Subscription <input type="checkbox"/> All Residential <input type="checkbox"/> Mandatory <input type="checkbox"/> All Sectors?
b	Participation Rate _____ % Set-out Rate _____ %
c	Methodology _____
16	How has participation been expanded?
a	<input type="checkbox"/> Mandates <input type="checkbox"/> Variable Rates <input type="checkbox"/> Service Options <input type="checkbox"/> Other _____
	Was a waste sort conducted to assess quantities/diversion? <input type="checkbox"/> (Y,N)
b	Did the program expansion change participations rates? _____
	Impact on contamination rates? _____
17	How are multi-family different from single-family participation? _____
18	What education efforts have been most cost-effective for maximizing recycle diversion?

Appendix B - Blank Survey Instrument

V Residential Organic Waste Policies - describe

19 Yard Waste Bans Enforcement State Local

20 **Yard Waste Programs**

a,b Start of Program _____ Year-round Seasonal # weeks

c Diversion Rate = _____

d **Materials Accepted**

Grass, Leaves, etc. Gardening Brush Kitchen _____

e **Processing**

City Multi-City Private _____

21 **Yard Waste Participation**

a Subscription All Residential Multi-Family _____

b Participation Rate _____ % Set-out Rate _____ %
Methodology _____

c Was a waste sort conducted to assess quantities/diversion? (yes or no)

22 **Has a food waste program been successful? (define success)** _____

Processing

City Multi-City Private _____

23 **What education programs have been most cost-effective for maximizing organics diversion?** _____

VI Institutional & Commercial Service Policies

24 **Service Segments**

a,b Schools City Buildings Federal Buildings Other _____

Materials Handled

c Trash Recyclables Yard Waste Other _____

25 **Commercial Recycling Ordinances (Obtain copy)**

a Business Regs Mandate Data Hauler Regs Mandate Data Licensing

b Enforcement Mechanism _____

c Program Startup _____

26 **Were private haulers involved in developing the requirements & implementation?** _____

27 **What education/outreach strategies have been most cost-effective for maximizing C/I diversion?** _____

28 **Impact on city infrastructure?** _____

29 **What is the level of participation?** _____

30 **C&D Recycling Requirements**

a Ordinance Fees Req'd? \$ _____ Mandate De-minmus % Plans Req'd Data Submit

b Enforcement Mechanism _____

c Program Startup _____

d **Were contractors involved in developing the requirements & implementation?** _____

e **What assistance programs have been most cost-effective for maximizing C&D diversion?** _____

f Diversion Impact = _____

Appendix B - Blank Survey Instrument

VI Closing Questions

- 31 How would you rank department pro-activeness? (1-10)
- 32 What is the single most effective action the city has taken to improve diversion?
- 33 What is the single most effective action the city has taken to control program costs?
- 34 By the way, is there a city sustainability proram? Does it address waste/diversion/etc.?
- 35 Any recommendations for Denver?

Any other notes of interest:

Interview Date:
Persons present, titles, contact info:
Interviewer:

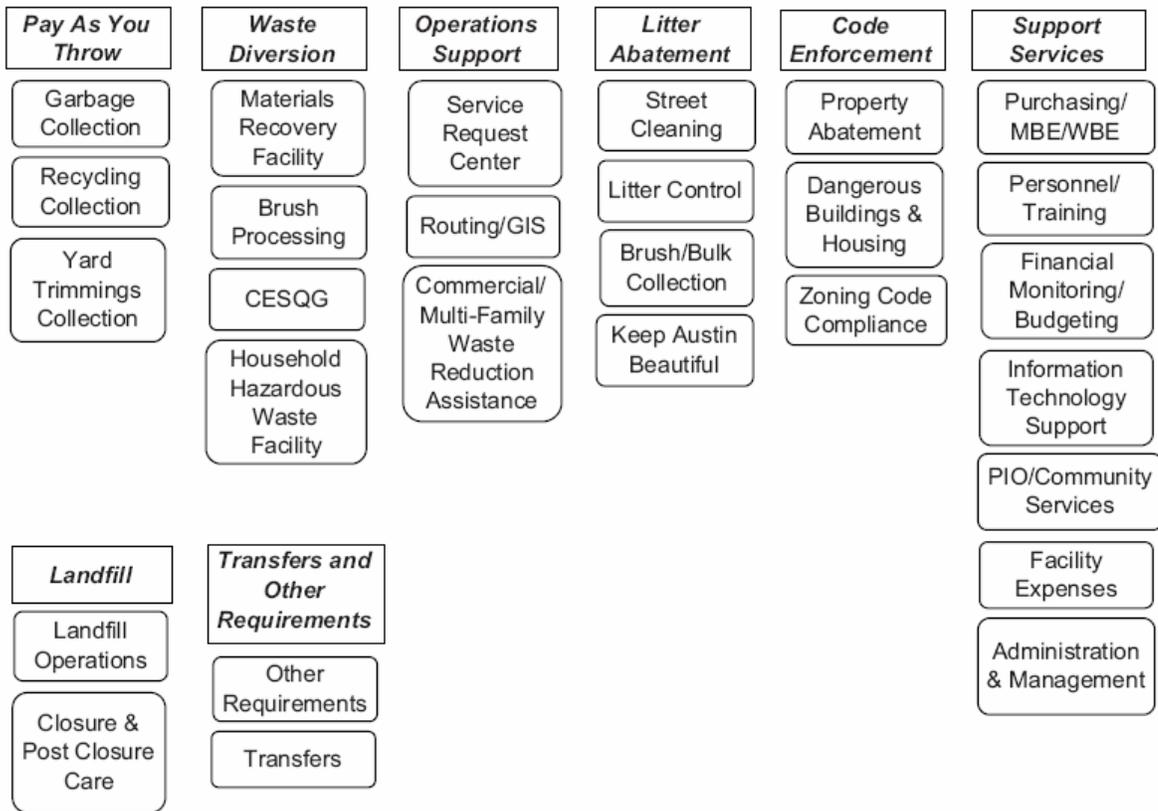
APPENDIX C – CITY ORGANIZATION CHARTS

Organization charts were provided by several of the surveyed cities:

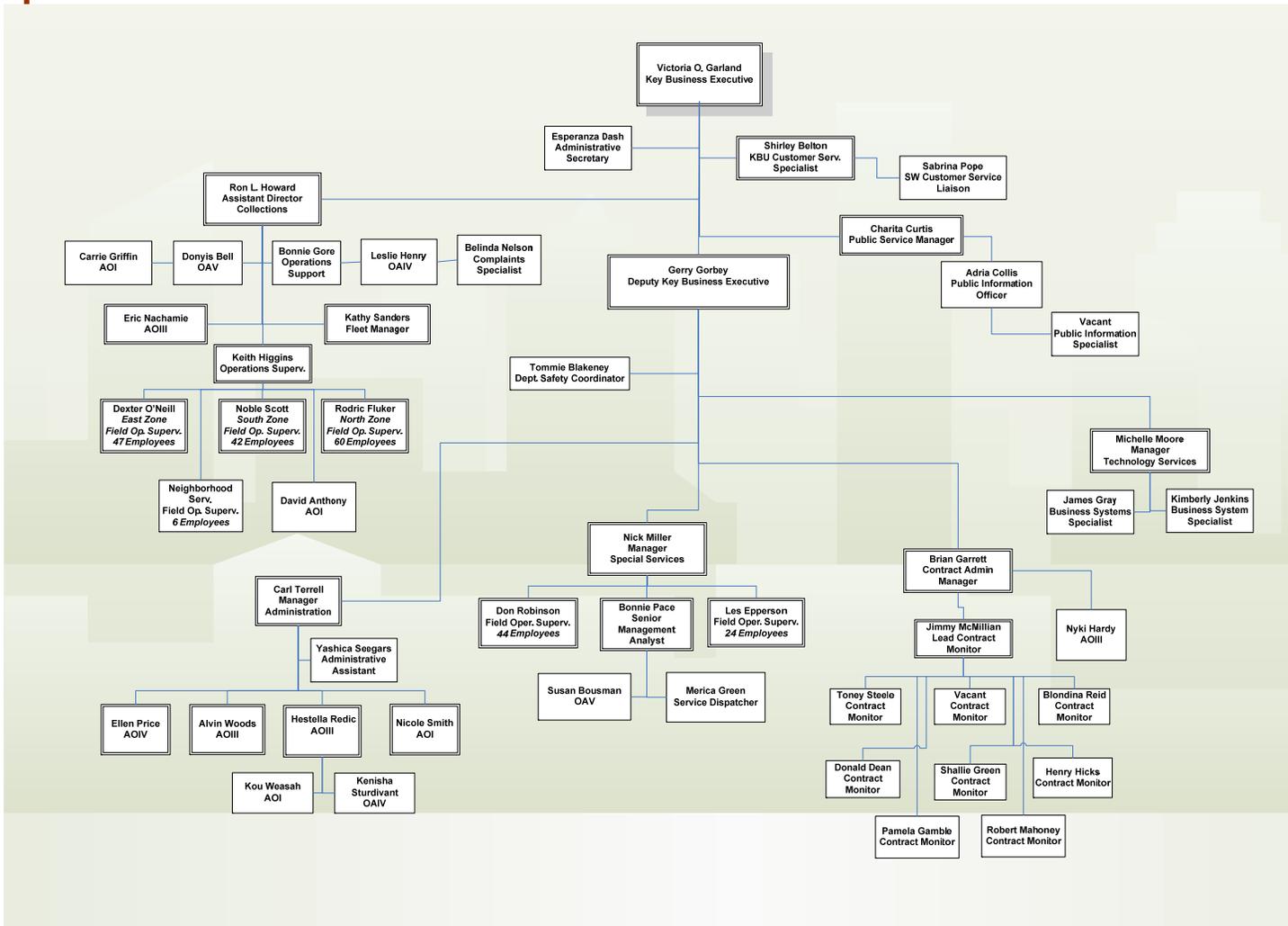
- ◆ Austin, Texas
- ◆ Charlotte, North Carolina
- ◆ Salt Lake County, Utah
- ◆ Thornton, Colorado

Austin, TX Functional Organization Chart

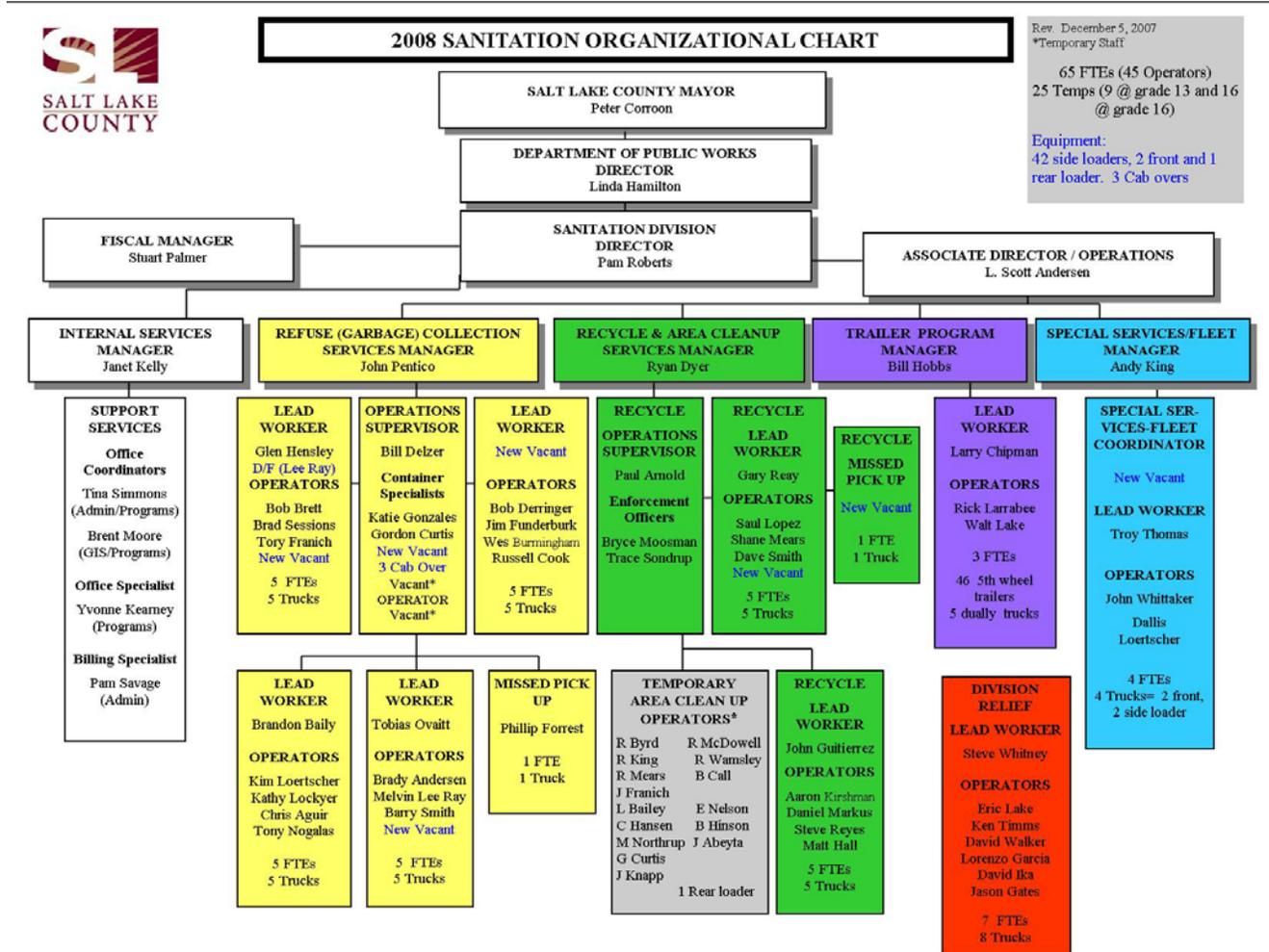
Solid Waste Services — 2007-08



Charlotte, NC Organization Chart

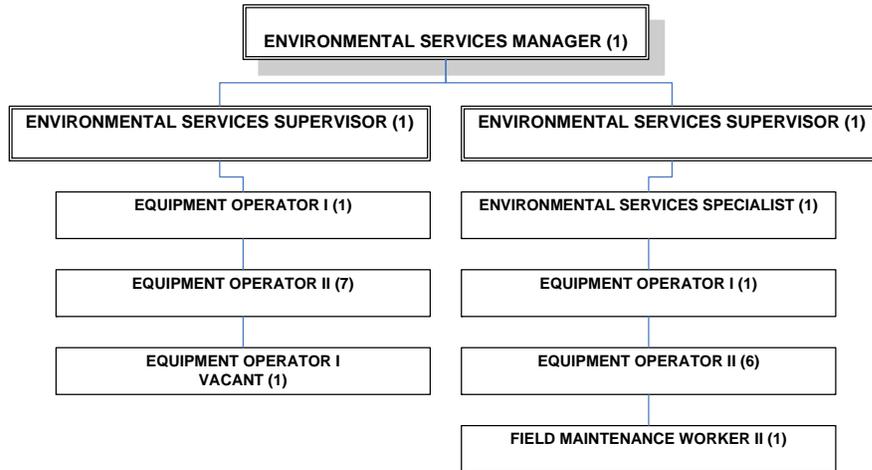


Salt Lake County, UT Organization Chart



Thornton, CO Organization Chart

Environmental Services – March 07, 2008



21 Employees

APPENDIX D – EXAMPLE ORDINANCES**Chicago**

- ◆ Construction or demolition site waste recycling ordinance – attached.
- ◆ contact HDR for a copy of Chicago's *High Density Residential & Commercial Source Reduction and Recycling Ordinance* (20 pages)

Louisville – contact HDR for a copy of its solid waste ordinance (70 pages)

Milwaukee's solid waste ordinance is online: <http://cctv25.milwaukee.gov/code/volume1/ch79.pdf>. The recycling subchapter begins on the 13th page of the 22-page pdf. Recycling is required for single family through 4-unit households. Recycling language: "79-31. Residences, Except Multiple-Family Dwellings. Occupants of single family residences, 2- to 4-unit residences and condominium complexes shall provide for the preparation and collection of separated standard recyclable materials in accordance with the rules of the commissioner. This ("in accordance with the rules...") means through the Department of Public Works recycling program.

San Diego

- ◆ New recycling ordinance – contact HDR for a copy (20 pages) or read it online at www.sandiego.gov/environmental-services/recycling/ro
- ◆ Construction or demolition site waste recycling ordinance – contact HDR for a copy (10 pages) or read it online at www.sandiego.gov/environmental-services/recycling/cdrecycling.shtml

APPENDIX E – TABLES

**TABLE 1
BACKGROUND INFORMATION**

CITY	POPULATION	DEPARTMENT	NUMBER OF EMPLOYEES	CONTACT
Austin, TX	710,000	Solid Waste Services	446	Willie Rhodes, Director of SW Services willie.rhodes@ci.austin.tx 512-974-1970
Charlotte, NC	610,000	Solid Waste Services	290	Victoria Garland, Director vgarland@ci.charlotte.nc.us 704-432-4223
Chicago, IL	2,800,00	Streets & Sanitation	1,770 (entire Bureau of Sanitation)	Jim Conlon, Asst Commissioner jconlon@cityofchicago.gov 312-744-0789
Houston, TX	2,150,000	Solid Waste Management	~ 200	Harry Hayes, Director harry.hayes@cityofhouston.net 713-837-9103
Louisville, KY	230,000	Metro Solid Waste	245	Keith Hackett, Director keith.hackett@louisvilleky.gov 502-574-2522
Milwaukee, WI	590,000	Sanitation	467	Rick Meyers, Recycling Prgm Mgr rick.meyers@milwaukee.gov 414-286-2334
Salt Lake City, UT	180,000	Streets & Sanitation	25 full-time; 25 seasonal	David Lust david.lust@slcgov.com 801-535-6928
Salt Lake County, UT	1,000,000	Sanitation Services	65 full-time; 25 temps	Pam Roberts, Director proberts@slco.org 801-562-6428
San Diego, CA	1,300,000	Environmental Services	~ 235	Stephen Grealy, Waste Reduction Program Manager sgrealy@sandiego.gov 858-492-5010
Thornton, CO	115,000	Environmental Services	21	Adam Lovato, Manager adam.lovato@cityofthornton.net 720-977-6310

**TABLE 2
POLICY, SERVICES and BUDGET SUMMARY**

CITY	KEY POLICIES	CUSTOMER BASE	ANNUAL BUDGET (accounting)	TONS MANAGED per YEAR	LANDFILL TIP FEES	FACILITIES OWNED (exclude DOCs)	CITY'S CUSTOMER SERVICES		PRIVATE SERVICES
Austin, TX	State no LF bans (may be future ban on computers & TVs); \$1.25/T surcharge at LF City requires residents to use trash service (can use another service but must still pay city); working on a zero waste plan (over next 32 years, reduce to zero waste to LF)	177,000 customers (don't break out MFUs separately)	\$27M	137k trash+ bulky; 29k recycle; 21k YW + brush	~\$30-40/ton	MRF Landfill (in closure process)	Trash, recycling, yard waste & bulky (twice/yr)	HHW, e-waste, BOPA, recyclables	Manage contract for dumpster MSW & recycle collection in central business district & special events
Charlotte, NC	State disposal bans for tires, automotive fluids, Pb-acid batteries, Hg-containing devices, free liquids, Al cans, white goods, yard waste, oyster shells; goal to reduce waste generation per capita by 1%; mandate SWMPs; requires recycling of alcoholic beverage containers Mecklenburg County yard waste disposal ban & mandatory business recycling for > 15 cy OCC/wk City allows private sector to	City crews collect 202,000 SFUs & MFUs in complexes up to 29 units, and 4,000 small businesses; City-contractor collects 97,000 MFUs in large complexes & city buildings	\$42M	285K trash; 33K recyclables; 46K yard waste	\$26/ton residential waste; clean wood \$16.50/ton; concrete, brick & block \$5/ton; C&D \$35/ton	None	Trash, recycling, yard waste & bulky (by appt)	HHW, recyclables	Contract for non-city customers (managed competition) in half of service area; open subscription for commercial
Chicago, IL	State disposal bans for yard waste, Pb-acid batteries, white goods, whole tires, used oil City recycling for MFUs > 4 & commercial areas (not enforced); requires all trash lids to be closed; contracting parties to be identified	660,000 SFUs and MFUs up to 4 units; some businesses; plus school, city buildings & departments (cart	\$163M	1.16M trash; up to 200K recyclables; 114K yard waste	\$40/ton	None	Trash, recycling & yard waste (no regular schedule)	HHW, e-waste, recyclables	Open subscription for all non-city customers
Houston, TX	State "encourages" PAYT; \$1.25/T surcharge at LF City prohibits fees for customers w/ < 90 gal trash/wk; HOAs can use private hauler w/ city reimbursement	460,000 SFUs & MFUs up to 8 units	\$73M	860K all materials	Ranges from \$26-\$42/ton depending on LF used, bulky waste at \$4-7/ton	None	Trash, recycling, yard waste & bulky (monthly)	HHW, BOPA, e-waste & recyclables	Open subscription for all non-city customers

**TABLE 2
POLICY, SERVICES and BUDGET SUMMARY**

CITY	KEY POLICIES	CUSTOMER BASE	ANNUAL BUDGET (accounting)	TONS MANAGED per YEAR	LANDFILL TIP FEES	FACILITIES OWNED (exclude DOCs)	CITY'S CUSTOMER SERVICES		PRIVATE SERVICES
Louisville, KY	State disposal bans for yard waste, tires, automotive fluids, Pb-acid batteries, Hg-containing devices, free liquids; City mandates yard waste collection for customers. Also required hauler licensing	93,000 SFUs & MFUs (Urban Service District only); small businesses with cart service only licensing	\$22M	128K trash; 21K recyclables; 20K yard waste	NA	None	Trash, recyclables, yard waste & bulky (quarterly)	HHW, BOPA, yard waste, e-waste & bulky	Contract recyclables collection; open subscription for all non-city customers
Milwaukee, WI	State disposal bans for Pb-acid batteries, yard waste, major appliances, oil, tires, ONP, glass/plastic/aluminum/steel containers, OCC, OMGs - also requires govts to prove local enforcement of bans City mandates trash & recycle collection for SFUs & MFUs up to 4 units, plus condominiums	190,000 SFUs & MFUs up to 4 units; city bldgs/department s schools, libraries	\$38M	Trash ~ 185,000 T from 1-4 unit curbside collection. 55K recyclables	~ \$45-65/ton	City MRF	Trash, recycling, bulky (~ weekly) & yard waste (regular schedule in fall only)	Yard waste, appliances bulky, BOPA, trash, e-waste, recyclables, scrap metal	Open subscription for all non-city customers
Salt Lake City, UT	State requires govts to provide residential trash collection & mandates school recycling City requires residents to use public service & close all trash lids	50,000 SFUs & MFUs up to 3 units; govt bldgs	\$7M	75K trash & bulky; 14K recyclables	\$23/ton	Co-own LF/compost/transfer station with Salt Lake County	Trash, recycling & bulky (annual); yard waste started March 2008	Seasonal yard waste & HHW	Contract recyclables collection; open subscription for all non-city customers
Salt Lake County, UT	State requires govts to provide residential trash collection & mandates school recycling	80,100 SFUs & MFUs up to 3 units; govt bldgs, some large MFU, schools & businesses	\$13M	134K trash & bulky; 15K recyclables; 2K yard waste	\$23/ton	Co-own LF/compost/transfer station with Salt Lake City	Trash, recycling & bulky (annual)	Rental trailer & seasonal yard waste; BOPA; HHW & CESQG	Open subscription for all non-city customers

**TABLE 2
POLICY, SERVICES and BUDGET SUMMARY**

CITY	KEY POLICIES	CUSTOMER BASE	ANNUAL BUDGET (accounting)	TONS MANAGED per YEAR	LANDFILL TIP FEES	FACILITIES OWNED (exclude DOCs)	CITY'S CUSTOMER SERVICES		PRIVATE SERVICES
San Diego, CA	State requires SWMPs & mandates 50% diversion with penalties City ordinance provides free residential service; mandates residential & commercial recycling (also requirements for C&D and special event recycling); mandates non-exclusive franchise license by private haulers for all waste	303,000 SFUs & MFUs (no limit on MFU size - carts only); small businesses cart service only	\$17.8M recyc + YW \$37M trash = \$54.8M	380k trash; 80k recyclables; 30k yard waste	MSW - from \$35 to \$49/ton (res/non-res, city/non-city); clean YW free for residents and \$22-25/ton from business	City LF	Trash, recycling, yard waste & bulky (periodic)	Trash, recyclables; HHW, BOPA & e-waste	Franchise collection for all non-city customers (~75% of city - by weight of trash collected)
Thornton, CO	No local requirement for residents to use City services	25,000 SFUs, duplexes, vertical town houses; govt bldgs	\$3.4M	37K trash & bulky; 3K recyclables	\$10.34/ton includes taxes	None	Trash, recycling & bulky (annual)	BOPA, recyclables & trash	Open subscription for all non-city customers; contract for bulky collections

**TABLE 3
COLLECTION SUMMARY**

CITY	RESIDENTIAL CURBSIDE				OTHER	COMMENTS: Alley v. Curbside
	Trash	Recyclables	Yard Waste	Bulky		
Austin, TX	40/60/90-gal carts; semi-automated collection (side loader)	Has been split body side loaders; when whole city goes single stream later in 2008 will be automated side loader	Automated collection (side loader)	Rear loader & trailers for bulky & clean ups	Contracted dumpster service for MFUs in problem areas, city buildings, central business district, and special events	Roughly 35% alley collection (feels alley collection best if vehicles designed correctly; recommends automated side loaders with carts if size permits)
Charlotte, NC	95/96-gal carts; automated collection (side loader)	16-gal bins; manual collection (rear loader)	Manual (rear loader) - bags	Manual (rear loader) collection	Rear loader collection for backyard service to disabled/elderly	New communities being built requiring alley collection
Chicago, IL	95-gal carts; semi-automated (rear loader with tipper)	Bags collected in trash vehicles, sorted at dirty MRF (except for current cart pilot - side loaders)	Manual (rear loader) - sorted at dirty MRF	Manual (rear loader) (no set collection)	Cart service only; have split-body for co-collecting trash & recyclables at events	Nearly all alley collection
Houston, TX	40/60/90-gal carts; automated collection (side loader)	18-gal bins; manual collection (rear loader)	Plastic bags; manual (rear loader)	60-cy trailers & bucket loader	Contracted collection - dumpster service for MFUs	1% alley collections (city req'ts for physical limitations)
Louisville, KY	95-gal carts; semi-automated (rear loader with tipper)	18-gal bins; manual collection (rear loader) - MFUs > 8 units can have 90-gallon cart service upon request	Customer bags or cans; manual (rear loader)	Collected with regular trash	95-gal carts for business yard waste	Majority alley collection (have short-axle trucks for tight areas)
Milwaukee, WI	95-gal carts; semi-automated (rear loader with tipper) - customer can also select dumpster service	95-gal split carts (semi-automated rear loader with tipper) - some neighborhoods still have 18-gal bins (manual)	Rear loader for unscheduled yard waste collection	Collected with regular trash, unless over 4 cy, in which case a skid crew is sent.	MFU & commercial dumpsters are responsibility of property owner	57% alley collection; union workers cannot work if temp < 10 degrees Fahrenheit at 6 am; curbside customers get "carryout" service in winter
Salt Lake City, UT	40/60/90-gal carts; automated collection (side loader)	Contracted collection - 60-gal carts; automated collection (side loader)	Starting March 2008 - 90-gal carts; automated collection (side loader)	Rear loader & trailers for bulky & clean ups	90-gal cart or 300-gal dumpsters for city bldg trash	5% alley collection
Salt Lake County, UT	95-gal carts; automated collection (side loader)	65-gal carts; automated collection (side loader)	Via trailer rental by residents only (5-wheel trailers)	Rear-load collection; also roll-offs & 6-wheel trucks	Rear-load collection for overages, cardboard box collection (new homeowners)	1% alley collection (mostly commercial)

**TABLE 3
COLLECTION SUMMARY**

CITY	RESIDENTIAL CURBSIDE				OTHER	COMMENTS: Alley v. Curbside
	Trash	Recyclables	Yard Waste	Bulky		
San Diego, CA	96-gal carts; automated ("mini" side loader)	Automated (side loader) collection for single-stream from carts; front loaders for dumpster collection	32/45-gal carts; mostly manual (rear loader) - 3 communities automated	Flat bed crane & rear loader	96-gal carts; automated (side loader)	Nearly all alley collection
Thornton, CO	95-gal carts; automated collection (side loader)	95-gal carts; automated collection (side loader)	NA	Lightening loader with grapple	DOC - rear loader with cart tipper (wrench box)	Less than 5% alley collection (side loader)

**TABLE 4
FUNDING SUMMARY**

CITY	ACCOUNT- ING	USER FEES (trash)		OTHER FUNDING SOURCES	BILLING MECHANISM	DELINQUENT ACCOUNTS
		Residential (per HH-mo)	Other Fees			
Austin, TX	Enterprise	Base fee \$7; 30/60/90-gal cart - \$4.75/\$7.50/\$10.25 per hh-mo; anti-litter fee \$2.60	\$2 extra garbage sticker OR charged \$4 per bag if no sticker; new service fee = \$15 to start	One-time \$15 fee to bet bigger or extra cart but no fee if getting smaller car; fee waived if within 60 days of starting service	On monthly city-owned utility bills (also bills for electric & water)	Utility Dept. has cost recovery procedure
Charlotte, NC	General	No user fees (until 2nd trash cart, a one-time purchase)	Annual Solid Waste Disposal Fee (line item on property tax bill) of \$57/yr SFU (\$45 to city), \$39 MFU (\$27 to city)	\$44.86 purchase price for 2nd 95-gal residential cart (no monthly fee); planned revenue share from Mecklenburg County facilities to support single stream recycling (\$1M/yr)	Property tax bill (no separate line item)	NA
Chicago, IL	General	No user fees	No	No charge for extra carts	Property tax bill (no separate line item)	NA
Houston, TX	General	No user fees (until > 90 gallons trash)	\$13.50/mo for non-residential customers	\$7.50/HH/mo for trash carts after 1st 90-gal (2 cart limit); overflows (\$1/extra container); \$25 dead animal collection	NA	NA
Louisville, KY	General	No user fees (until 2nd trash cart, a one-time purchase)	No	\$65/hh-yr for 2nd 95-gal cart of \$60 for add'l 65-gallon cart; fees for bulky materials collected at drop site (first 2 visits free)	Property tax bill (no separate line item)	NA
Milwaukee, WI	General	No user fees up to 4-units; city serves some MFUs >4 units with dumpsters, which it bills at cost quarterly	Flat fee on quarterly water bill: \$33/dwelling unit (e.g., SFU=\$33, duplex=\$66 per quarter. Adjusted annually - based on 96-gal service/unit with up to 4-CY overage)	Overages that exceed 4 cy charged \$50; No charge for extra carts	Water bill	Unpaid charges are added on to the property tax bill
Salt Lake City, UT	Enterprise	40/60/90-gal trash cart - \$8.25/\$9.25/\$11.25 per hh-mo		\$3.50/hh-mo for voluntary yard waste; cart replacement/delivery fees; \$3.75/hh-mo non-customer recycling fee	Utility bill	Water turned off & remove carts
Salt Lake County, UT	Enterprise	1st 95-gal trash cart - \$1/hh-mth; add'l 95-gal carts - add'l \$15 (no limit)	Trash service from \$40/mo (4 CY once/wk) to \$410 (8cy five times/wk); all recycling dumpster service available (\$30 to \$140/mo)	Trailer rentals (\$25/\$80 per pull for yard waste/bulky); interest income; sales of equipment	Property tax bill as separate line item	Tax notice; stop service & remove carts

**TABLE 4
FUNDING SUMMARY**

CITY	ACCOUNT- ING	USER FEES (trash)		OTHER FUNDING SOURCES	BILLING MECHANISM	DELINQUENT ACCOUNTS
		Residential (per HH-mo)	Other Fees			
San Diego, CA	General Fund	No user fees up to 4 or 5 units for city-served residences	Refuse Collector Business Tax (\$8/ton) assessed at landfill on non-residential loads - supports non-solid waste services.	Recycling fees (\$7/ton) paid by private haulers; franchise/hauler fee of \$11-\$12/ton if > 40K tpy (goes to general fund); MRF revenue sharing (\$5-6M in 2008); state funding (AB939 funds); permit fees; C&D recycling deposits	NA	NA
Thornton, CO	Enterprise	1st 95-gal trash cart - \$13.50/hh-mo; add'l 95-gal cart - add'l \$9.20 (max of 4 carts)	NA	NA	Utility bill	Water turned off; \$30 service & full pymt to turn back on

**TABLE 5
YARD WASTE SUMMARY**

CITY	HAS PROGRAM? FREQUENCY of SERVICE	WHEN STARTED	SERVES?	DIVERTED per Household-YR (pounds)	MATERIALS ACCEPTED	TRUCKS USED; PROCESSING	ADD FOOD WASTE?	COMMENTS
Austin, TX	Yes Weekly curbside collection Year-round (brush collected twice/yr)	Over 20 years ago	All residential	240	Grass, leaves, garden, waste, brush (size reduced); bag in up to 50 lb. bundles	YW in side loaders; brush in rear loader with skids	Beginning to think about it	Compostable material is made into the popular "Dillo Dirt" sold widely at nurseries etc in area; compost ops wants more green waste
Charlotte, NC	Yes Weekly curbside collection Year-round	Over 20 years ago	Single family houses; MFU less than 30 units	470	Grass, leaves, garden, waste, brush (size reduced)	City collects using manual rear loader; Mecklenburg County processes	No plans	County landfill bans yard waste
Chicago, IL	Yes Weekly collection Year-round	Early 1990s	All residential	350	Grass, leaves, garden, waste, brush (size reduced)	Rear-load collection w/ MSW; sorted at dirty MRF and directed to compost facility	Might take food but no permitted facilities nearby	State LF ban on YW; having success in small pilot giving "leafier" neighborhoods a black trash cart with Yard Waste sticker; promotion of backyard composting
Houston, TX	Yes Weekly collection Year round	1993	All residential	750	Grass, leaves, garden, waste, brush (size reduced); bag in up to 50 lb. bundles	Manual, rear loader; private processor	No plans	High diversion due to nearly year-round growth; may do yard waste ban in future
Louisville, KY	Yes Weekly (same day as recycle) Year-round	Early 1990s	All residential	430	Grass, leaves, brush, Christmas trees, straw, pine needles, wood ash, sawdust.	Rear-load collection	No plans	State landfill ban for yard waste. Mandatory YW collection; backyard composting has been successful - some Council members have taken leadership on this; also offer "lawn Care Rebate" program promoting old mower trade-in with regional air pollution & schools - includes leaving grass on lawn

**TABLE 5
YARD WASTE SUMMARY**

CITY	HAS PROGRAM? FREQUENCY of SERVICE	WHEN STARTED	SERVES?	DIVERTED per Household-YR (pounds)	MATERIALS ACCEPTED	TRUCKS USED; PROCESSING	ADD FOOD WASTE?	COMMENTS
Milwaukee, WI	Yes; brush only Mar-Nov. residents call for pickup & city sets up routes based on requests (no winter service)	Early 1990s	All residential	230	Mar-Nov - brush only. During Oct-Nov leaf collection, also take garden debris w/ leavesraked to the street.	Rear-load collection skid crew; Tipped at TS before haul to nearby compost facility	Would like to but not enough funds	State landfill ban for yard waste; if resident puts yard waste in cart, crews leave whole cart uncollected and tag for resident to remove; extensive waste reduction education (in cooperation w/ statewide effort) for leaving grass on lawn, backyard composting
Salt Lake City, UT	Program just started (March - November)	March 2008	Residential (10% households signed up)	Too early for data	Grass, leaves, garden, waste, brush (size reduced)	Compost facility at city/county LF	Not done.	Residents will pay \$3.50/hh-mo over entire year; have provided Christmas tree collection previously
Salt Lake County, UT	Residents can rent YW trailer at \$24/pull	1998	All county residents	50	Grass, leaves, garden, waste, brush (size reduced)	Compost facility at city/county LF	Not done	Low diversion rate partly due to very dry climate
San Diego, CA	Yes; weekly collection (year-round)	1987	All residential	320	Grass, leaves, garden, waste, brush (up to 40 lbs & size reduced)	Side-load collection; processed at city-owned facility "the Greenery" at LF	No plans	Did waste comp study; acceptable YW includes plywood and particle board, invasive plants, clean lumber (no nails); do not accept other plans, sawdust or ashes, tree stumps > 4', or any one piece > 6" in diameter, shingles, chemically treated or painted wood; bags (plastic or paper), C&D debris, pet waste & other materials
Thornton, CO	No	NA	NA	NA	NA	NA	NA	May evaluate in 2008

**TABLE 6
OVERAGES, BULKY and ILLEGAL DUMPING SUMMARY**

CITY	OVERAGES		BULKY MATERIALS		DUMPSTERS	ILLEGAL DUMPING
	Violations	Issues	Current Collection	Issues		
Austin, TX	1st - educate re diverting more; next must buy larger cart	Previously had similar problems as Denver - no education message worked; no issues now	Twice/yr; ~ 36 FTEs required	Purposely don't advertise bulky collection dates to avoid scavenging; instead send postcard 3-4 wks ahead & flyer 1 wk ahead	Use dumpsters in chronic MFU overflow areas (city has contract hauler) & charges to cover all costs (~ 1,100 dumpster customers); education in English & Spanish	Violators ticketed; Litter Abatement Dept provides street cleaning, litter control, brush/bulk collection & Keep Austin Beautiful (~100 FTE & \$8M budget)
Charlotte, NC	1st & 2nd time - warning; 3rd time no collection & turn over to Code Enforcement	Biggest issue in lower economic areas	Scheduled collection by citizen ("as needed") - plus drop site collection	All materials except hazardous, C&D materials (no quantity limit)	None by city	City ceased litter clean up on state highways to reduce costs.
Chicago, IL	Not specifically addressed for residential (crews "just do it"); ticket dumpster overages (commercial)	Yes - but don't quantify	Not a separate collection program (customers put in alleys & drivers pick up as time/room allow) - plus drop site collection	Not significant problem	None by city	NA
Houston, TX	\$1 tag req'd for all overflows; not collected if not tagged	Created Neighborhood Protection Division in Houston Police Dept to ticket offenders (both overflow & bulky materials)	Monthly residential plus drop site collection (34% of SWMD budget - approx \$28M/yr) - plus drop site collection	All materials except hazardous & Freon-containing units; residents asked to separate out wood waste; max 8 cy per pick-up total & max 4 cy bldg materials	Used for community clean-up & commercial trash (permit req'd)	Problem mostly limited to vacant & low economic areas (PD's Neighborhood Protection Division) investigates & tickets offenders
Louisville, KY	NA	No significant problem except over Christmas & during Kentucky Derby	Quarterly collection - plus drop site collection	No quantity or material limit	None by city	Problem in alleys; city does all clean up
Milwaukee, WI	Warning tags & \$50 fee for > 4 cy (use Sanitation inspectors)	Not significant problem	Customers place at alley or curb. If over 4 CY, then scheduled for skid crew to pick up (& \$50 fee). Plus drop site collection	Size limits on tree limbs; They tell customers to visualize "2 couches worth of 'stuff'" for th 4 CY limit and that is limit on quantity.	None by city. Will issue 20 cy roll-off containers for neighborhood cleanups for about 7 months of yr.	Not significant problem

**TABLE 6
OVERAGES, BULKY and ILLEGAL DUMPING SUMMARY**

CITY	OVERAGES		BULKY MATERIALS		DUMPSTERS	ILLEGAL DUMPING
	Violations	Issues	Current Collection	Issues		
Salt Lake City, UT	1st time - warning; 2nd time no collection (no fees)	Not significant problem	Once/yr residential; residents pile materials street-side	All materials except hazardous, rock, dirt, concrete, bldg materials; residents asked to separate out wood waste (no quantity limit)	Used for city bldg trash only	Not significant problem
Salt Lake County, UT	Residents encouraged to purchase add'l trash (fee) or recycling (free) carts	Not significant problem	Once/yr residential; large trailers & roll-offs placed in neighborhoods	All materials except hazardous (no limit except 2 tons on small trailers)	Used for homes with stables, commercial, schools, govt bldgs	Issue managed by County Health Dept - not significant per Sanitation Dept
San Diego, CA	Don't collect; encourage residents to buy add'l cart	Not significant problem	Periodic/requested city clean-up by community (~ 125 per year)	All materials except hazardous, green waste & materials with state disposal bans (e-waste, appliances, motor oil)	None by city	Have rec'd as many as 20K trash dumping incident reports (includes weed abatement)
Thornton, CO	2nd time courtesy notice; 3rd time no collection & supervisor contacts resident (no fees)	Not significant problem	Private contractor collection (cost ~ \$250k) - once/yr residential collection; add'l collection by appointment	All materials except hazardous & Freon-containing units (no quantity limit)	NA	Not significant problem

**TABLE 7
RESIDENTIAL RECYCLING SUMMARY**

CITY	BANS OR MANDATES	CURRENT CURBSIDE PROGRAM	RECENT CHANGES	RECYCLING DIVERSION (by weight)	PUBLIC EDUCATION	RECYCLE DROP SITES	OTHER
Austin, TX	No; voluntary residential participation	Source-separated bins and bags weekly; going to single-stream carts by end of 2008	Planned move to single-stream in 2008	28% (includes yard waste, which is slightly less than half of diversion)	In schools starting in 3rd grade and go all the way up to math classes at the University of Texas	2 (north & downtown) run by Ecology Action; in south there is drop site at LF for recyclables & other items	Single-stream pilot was so successful residents refused to give carts back & return to bins at end of pilot
Charlotte, NC	No; voluntary residential participation	Dual-stream (bins) every week; hauled by city (75%) & contractors (25%) to county MRF	Planned move to single-stream recycling in FY2010	10-12% diversion. 45% average set out rate (MFU 25% lower than SFU)	County SWMP & City public education focused on SFU & MFU recycling; also school program	Provided by Mecklenburg County but city residents use; have 40 sites - 4 full-service, 9 self-service; 27 business locations (OCC & paper)	If move to single-stream, county MRF ok's <10% contamination but City must cost share contamination > 10%
Chicago, IL	Mandatory recycling for MFUs > 4 units & other commercial generators (not enforced)	Single-stream (bag excepting pilot areas) weekly; hauled by city to contract dirty MRF (also takes yard waste)	On-going pilot study to switch to carts	8% bag program; 18% in cart pilot areas	Strong for current pilot - flyers, letters, libraries, schools, brochures, magnets, block captains	20 drop sites; very popular as many residents live in high-rises and don't get recycling services	MFU recycling requirement is not enforced
Houston, TX	No; voluntary residential participation	Dual-stream (bins) collected every other week; hauled by city to contract MRF (includes used oil in separate container)	No	2-10% diversion (conflicting data); 43% of residents in service area participate	Dedicated outreach staff, "Go Green" neighborhood competition to increase recycling, good website	4 neighborhood depositories (soon to be six - half are staffed); 3 Consumer Recycling Centers	
Louisville, KY	No; 25% recycling & 20% yard waste diversion goals (not actively pursued)	Single-stream (18-gal bins for SFU) collected weekly; hauled by contractor to contract MRF	No	22% (hauler contract based on 85% participation by eligible residents)	"Green City" schools, OP recycling program for businesses, strong business outreach/technical assistance	5 staffed drop site & 12 unstaffed (located at regional firehouses, other public buildings; also has Metro Waste Reduction Center for junk	

**TABLE 7
RESIDENTIAL RECYCLING SUMMARY**

CITY	BANS OR MANDATES	CURRENT CURBSIDE PROGRAM	RECENT CHANGES	RECYCLING DIVERSION (by weight)	PUBLIC EDUCATION	RECYCLE DROP SITES	OTHER
Milwaukee, WI	Mandatory recycling for SFUs & MFUs up to 4 units (not strictly enforced); ONP, OCC, OMG & all containers are banned from disposal	Dual-stream (95-gal split carts) collected monthly but schedule is not regular; hauled by city to city MRF	On-going pilot to switch to twice/month curbside collection	12-13% (yard waste diversion 11-12%)	Door-to door, use students, packets, focus on high contamination areas, give MRF tours; Sanitation newsletter sent each fall to all 190,000 HH prior to start of leaf collection	2 "Self-Help Centers" take recycle plus YW, metals, auto wastes, C&D (only recycle concrete), appliances, e-scrap; wood chips given out to public there. HHW only at one site (run by Milwk. Metro Sewerage Dist., not City)	"Back door" service. Crews collect monthly in summer & as time permits in winter - from snow plowing duties
San Diego, CA	State reqt for 50% diversion, LF bans on appliances, certain metals, HHW, all batteries, & e-waste; new city ordinances require residential, commercial;& C&D recycling with recycling reqts for special events	Single-stream collected every other week; hauled by city/franchise hauler to private MRF (includes aerosol cans)	Mandatory residential & commercial recycling; recycling reqts for C&D and special event	55% diversion	Program is brand new - just implementing new public education (don't know effectiveness yet)	44 parks in City have drop sites; city shares revenue from this particular recycle stream back to Parks & Rec based on participation (which gets their buy-in on maintaining the drop sites)	Mandatory residential & commercial recycling to be phased in over next 2 yrs, by # of units per dwelling; exemptions for MFUs, commercial, & mixed use with < 6 CY trash; city is considering managed competition for drop sites
Salt Lake City, UT	No; voluntary residential participation (approximately 82% of residents have carts)	Single-stream collected weekly; hauled by contractor to contract MRF (excludes glass)	Add yard waste curbside collection & variable trash cart sizes/rates in March 2008	Approx 18% diversion (estimated by hauler)	Hauler req'd to do public education by contract	Yes - for glass (not collected curbside) + other recyclables	10% curbside contamination (plus 26% of recyclables contaminated by trash); city helps contract hauler reduce curbside contamination
Salt Lake County, UT	Mandatory school & govt building recycling; voluntary residential participation (97% of residents have carts);	Single-stream collected every other week; hauled by county to 2 contract MRFs (excludes glass)	Provided carts to all customers, removed recycling fee & increased trash fee in June w007	11% diversion	Two full-time quality assurance inspectors monitor contamination & interact directly with residents (carrot v stick approach)	Drop sites in neighborhoods, with seasonal drop sites used for leaves, Xmas trees; drop sites take glass (not taken curbside)	5% curbside contamination; public wants weekly recycling

**TABLE 7
RESIDENTIAL RECYCLING SUMMARY**

CITY	BANS OR MANDATES	CURRENT CURBSIDE PROGRAM	RECENT CHANGES	RECYCLING DIVERSION (by weight)	PUBLIC EDUCATION	RECYCLE DROP SITES	OTHER
Thornton, CO	No; voluntary residential participation	Single-stream collected every other week; hauled by city to private MRF	Was dual-stream collected monthly until Jan 2007; then single-stream monthly until Jan '08	9% diversion; 45% average weekly set out rate (ranges from 15-70%)	Has education line item in budget (\$20k) for first time in 2008; have good website, annual mailing	Drop site at Recreation Center takes auto waste (Pb-acid batteries, oil, antifreeze, tires) & SS recyclables (serves MFUs that don't have city service); for residential only	Feel "ardent recyclers" participate at high level with minimal contamination (per MRF)

**TABLE 8
COMMERCIAL AND CONSTRUCTION/DEMOLITION DEBRIS RECYCLING**

CITY	COMMERCIAL RECYCLING			C&D RECYCLING	
	City Accounts	Ordinances for Public Haulers	Comments	Ordinance for C&D Contractors	Comments
Austin, TX	Only collects from small businesses in residential neighborhoods; manages dumpster contract serving all downtown biz district, city bldgs, & some MFUs	No ordinance but haulers pay fees; these fees cover waste reduction assistance program	Has strong program for commercial waste reduction assistance	No	Interested in this; SWS manages Code Enforcement and plans to use this division to encourage C&D recycling
Charlotte, NC	City buildings (MFUs < 30 units)	Mecklenburg County requires larger businesses generating > 15cy OCC/wk to recycle	NA	No	City will pick up only tenant setout C&D as part of bulky program (not recycled)
Chicago, IL	Only cart service - city bldgs/department, airports, MFUs up 4 units	Hauler licensing; mandatory recycling for MFUs > 4 units & other commercial	Req'ts of ordinance were not strict & was never enforced. Under consideration for change	Yes	Done by permit (small sites exempt), penalty if <50% materials not recycled (not enforced), generally supported by builders but space issues
Houston, TX	MFUs up to 8 units	Franchise fee for haulers operating within city limits	Commercial dumpsters must be permitted by city	No	City will pick up bldg materials as part of bulky program (not recycled)
Louisville, KY	Cart service only - small businesses	Hauler licensing (\$100/yr plus \$10/truck); require private solid waste facilities to be licensed & submit quarterly reports	Strong business outreach/technical assistance program	No	
Milwaukee, WI	City bldgs/departments, libraries & MFUs up to 4 units	No	Outreach is weak	Pilot for recycling at city bldg projects at present	Ordinance requiring C&D recycling at city projects under consideration; infrastructure for C&D recycling is not developed yet
Salt Lake City, UT	City buildings, any MFU & commercial (can only provide trash to MFUs up to 3-plex)	No	NA	No	NA

**TABLE 8
COMMERCIAL AND CONSTRUCTION/DEMOLITION DEBRIS RECYCLING**

Salt Lake County, UT	County buildings, can also service commercial/school/large MFUs if requested	No	NA	No	Private C&D LF located adjacent to city/county LF with lower tip fees & some processing
San Diego, CA	MFUs up to 29 units, large MFUs not franchised	Mandatory business/MFU recycling; franchise/hauler licensing (\$11-12/ton) for haulers with > 40K tpy	Mandatory recycling ordinance new in 2008	Yes (beginning July 2008); surcharge at LF for C&D fees	Builders must put deposit (\$200-\$50,000) down when getting bldg permit & must recycle 50% of waste; also reporting requirements
Thornton, CO	City buildings (working to expand to schools & libraries)	No	NA	No	NA

RE-SURVEY FINDINGS - DENVER SWMP

	AUSTIN, TX 783,000 pop SA=177,267 hhs/2,160 commercial	CHARLOTTE, NC 700,000 pop SA=240,000 hhs	CHICAGO, IL 2.8M pop SA=600,000 HHS	HOUSTON, TX 2.2M pop SA=360,000 hhs	LOUISVILLE, KY 230k city pop SA=700,000 hhs (metro area) SA = 93,000 HHS (all data from 2008 survey)	MILWAUKEE, WI pop 604,407 (08) SA=190,000 hhs	SALT LAKE CITY, UT 180,000 pop SA=45,000 hhs	SALT LAKE COUNTY, UT 1M pop SA=80,000 hhs incl 4 cities	SAN DIEGO, CA 1.3M pop SA=304,000 hhs T, 280,000 hhs R, 191,000 hhs O	THORNTON, CO 120,000 pop SA=25,134 hhs
Mandates	City requires MF>100 & businesses>100 employees to recycled 2-4 materials; working on YW/FW disposal ban	State disposal ban on YW, plastic & aluminum containers; state requires bars/restaurants to recycle alcohol bottles; county mandates businesses>15 cy OCC/week to recycle	State YW, other disposal bans		State YW disposal ban; city requires customers to divert YW	State disposal ban on YW, ONP, OCC, OMG, containers, etc.	State mandate for school recycling; city considering mandatory diversion of recyclables & organics for all customers	State mandate for school recycling	State mandates 50% diversion at city level; city mandates recycling for residential & commercial customers	
Service Area	Residential (SF, MF<5), some commercial - T,R,B,O	Residential (SF, MF<5) - T, R, O	Residential (SF, MF<4) - T,R,B,O	Residential (SF, MF<9) - T,R,B,O	Residential (SF, MF<4) - T, R, B, O	Residential (SF, MF<4) - T,R,B, Leaves	Residential - (SF, MF<4) - T, R, B, O	Residential (SF, MF<4) - T,R, B	Residential (SF, MFs incl some high-rises)	Residential (SF, duplex, some townhomes) - T, R, B
Landfill Tons 2007/2008-09	05 - 121k tons 06 - 132k; 07 - 139k; 08 - 144k; 09 154k est	Down 1.5% over past two yrs; pop growing too	Been dropping since 06	Down 5.5% 07/08; down 2% 08/09	na	Down 5.4% since '06	Down 4% each of last 2 yrs	Down 2-3%/yr since 07	Down 2.7 - 3.4%/yr since 06	Dropped 8% 07/08; 2% 08/09 (projected)
Trends/ Reasons		Recession; possibly reductions in packaging	Increased recyclables routes; recession		na	Recession	Recession	New SS, recession	Economy; new C&D ordinance/facility; mandatory commercial MF recycling	Recession
Recycling Program/Frequency	Transitioned from DS wkly to SS EOW 10/08	DS wkly - transitioning to SS wkly 7/2010	Blue bag program - transitioning to SS carts (35% of routes have SS now)	DS/SS EOW	SS wkly	SS monthly (small part of city wkly DS bins) - not that half year curbside, half year "at the door" collection	SS w/o glass Wkly	SS w/o glass EOW	SS EOW	SS EOW
Age	Curbside since 1986	> 2 year	Bag 20 yrs; SS rollout for 2-3 years	1992 DS - started SS 3/09 (today 150k hhs DS, 22k SS)	> 2 year	~1994	2001	2007	2001 started SS	Started SS Feb-08 (previously DS)
Participation	100% - all SA gets carts	100% - all SA gets cart	na - R tons are 14.5% of total tons on SS routes	46% (41% DS, 6% SS)	Approximately 85%	100% - all SA gets cart ("mandatory")	84% subscribe (free)	10% 07; 30% 08; 98% 09	>80% (measured 1 time)	85% subscribe (free)
Set-Out	Approx 90% when education is strong	na (guesstimate 45%)	na	na	na	85% based on 1-time phone survey/field check	na (guesstimate <100%)	na (guesstimate as high as 90%)	na	About 47% (ranges from ~ 40-50%)
Lbs/HH-Collection	Back-calculates based on full SA - has increased to 11.5 #/hh-wk since SS (up to ~13# at 90% set-out)	na (new pgm will have RFID tags)	na	Was 15# DS - now 33# SS - saw decrease when 2nd local major newspaper failed	na	Back-calculates based on full SA (varies from 4-40#); '06 22.05 lbs/hh/mo; '07 21.22 lbs/hh/mo; '09 19.49 lbs/hh/mo (up to ~23# at 85% set-out)	Back-calculates based on full SA 13# up slightly from 07/08 - incl 20-30% contamination (up to 15# at 84% subscription w/o glass)	Back-calculates based on full SA 18.5# (1600 tpm 09) (up to 21# at 90% set-out w/o glass)	Back-calculates based on full SA; 9 lbs/hh/wk (65k tons/yr) - flat-lined for 3 yrs but dropped 10% last year (up to 11# at 80% participation)	Back-calculates based on full SA 12-13# for ALL hhs in SA (up to 31# at 85% subscription, 47% set-out)
Trends/ Reasons	45% increase in tons since SS & began accepting al plastics	Recycle tons "stagnant" - attribute to recession	Rolling out SS slower than planned due to budget limits	Subscriptions not increasing wo funding - saw DS decrease wo outreach + 1-mth suspension Hurricane Rita (but doubling of participation as SS implemented)	na	Recession; decreasing newspaper subscriptions (less ONP in SS); began big R promo 10/08 - # down but set-out higher			Economy; R has decreased LESS than T	Tons doubled since SS (2/08) but leveling off (recession)

RE-SURVEY FINDINGS - DENVER SWMP

	AUSTIN, TX 783,000 pop SA=177,267 hhs/2,160 commercial	CHARLOTTE, NC 700,000 pop SA=240,000 hhs	CHICAGO, IL 2.8M pop SA=600,000 HHS	HOUSTON, TX 2.2M pop SA=360,000 hhs	LOUISVILLE, KY 230k city pop SA=700,000 hhs (metro area) SA = 93,000 HHS (all data from 2008 survey)	MILWAUKEE, WI pop 604,407 (08) SA=190,000 hhs	SALT LAKE CITY, UT 180,000 pop SA=45,000 hhs	SALT LAKE COUNTY, UT 1M pop SA=80,000 hhs incl 4 cities	SAN DIEGO, CA 1.3M pop SA=304,000 hhs T, 280,000 hhs R, 191,000 hhs O	THORNTON, CO 120,000 pop SA=25,134 hhs
Organics Program/Frequency	Yr round	Wkly yr-round	Wkly Apr-Nov	Wkly yr-round	Wkly yr-round	Apr-Nov on demand service for brush	Wkly seasonal	Trailer pgm	Wkly yr-round	na
Age	> 2 yrs	> 2 yrs	> 2 yrs	11 mths (January 2010)	since early 90s	> 2 yrs	Since 3/08	1997	1989	na
YW - FW?	YW	YW	YW	YW - grass/leaves weekly; brush every-other month	YW + straw, pine needles, wood ash, sawdust	YW-brush only; on demand (routes are compiled daily based on demand is); leaves collected citywide all fall (SA rakes to curb & city picks up)	Woody, YW	YW	YW - just started taking FW from commercial (there is a wait list)	na
Container	Kraft bags, tied bundles, individual containers	Bags	Bags set next to T carts	Biodegradable bags for grass, leaves	na	Bundles, piles of leaves	90-gal auto	Rental trailers	Bags - transitioning to carts (10% of HHS have carts now)	na
Participation Set-Out	na	na	na	Provided to 100% hhs	na	Leaves collected from entire city (beyond SA)	18% and increasing (pay extra for)	As needed	89% of 191k SA	na
Lbs/HH	06/07 - 4.8 #/hh-wk; 07/08 - 5.2#; 08/09 - 4.3 #	na	na	50k tons brush for 360k hhs	na	Brush ranges from 15.6 in 07 to 22.7 lbs/hh-yr in 08	Back-calculates based on 100% set-out ~27# (8 months only)	na	Lower than San Jose (same number of hhs); YW tons down 25% over last 5 years	na
Trends/ Reasons	08/09 YW quantities down due to 2-yr drought	Quantity generally flat unless drought or other weather variation	Quantity flat	na	na	Quantity dependent on weather (early snow, rainy autumns)	na	na	No reminders or education (vs. R which gets lots of reminders)	na
DOC Materials	Operated by NPOs & private	Run by County - R, O, B, scrap metal, tires	R, O, HHW, e-scrap	B, R, scrap metal, tires	B, R, C&D, scrap metal, tree limbs & stumps	MSW, B, R, O, scrap metal, tires, C&D, WGS, (not FW, motor oil/other car waste)	R (glass + OCC)	Leaf bag collection only	R, YW/FW, C&D, cooking oil (Goodwill has drop box)	R, branches/limbs
No/City Coverage	Varies	Many around city/county - 4 staffed, 9 self-serve, 27 for business (OCC & paper)	35 locations, none staffed, all areas of City	4 all materials (staffed) w/ 2 more in progress, 4 R only (unstaffed)	1 serves whole city; 2 times/yr DSWM provides free junk & B DOC at same facility	2, serving whole city	3 locations	10 locations	1 central location at LF (in center of City)	4 locations
Users/Year	na	na	na	6,000 users/mo (at staffed DOC)	na	300,000 vehicles/yr	na	na	120k customers/year	700 vehicles w branches
Quantities/Year (/Generator)	na	na	4,200 tpy	15,000 tpy	na	51,880 MSW/yr in 2008	~1,020 glass + 120 tons OCC annually	200 tpy-DOC (leaves) + 150 tons Xmas curbside	20k TPY R	600 tpy SS (est 2009) 50 tpy branches (est 2009)
Charge?	na	No	No	No	Yes except free DOC days 2 times/year	No but will start small fee for C&D in 2010	No	No	No	No - subsidized
Restricted Use?	na	Residents, small businesses	No	City residents have unlimited use of unstaffed sites; 4 visits/month limit at staffed sites	na	Residents, no commercial	Residents (but any)	Residents (but any)	Residents only	Open to all
MFU/Commercial Diversion	Voluntary glass recycling	MF>30 city manages contract w/ private hauler for T, R	na	na	Take T,R daily from business district	na	None but exploring for residential/ commercial	na	Serve many MFUs	na

RE-SURVEY FINDINGS - DENVER SWMP

	AUSTIN, TX 783,000 pop SA=177,267 hhs/2,160 commercial	CHARLOTTE, NC 700,000 pop SA=240,000 hhs	CHICAGO, IL 2.8M pop SA=600,000 HHs	HOUSTON, TX 2.2M pop SA=360,000 hhs	LOUISVILLE, KY 230k city pop SA=700,000 hhs (metro area) SA = 93,000 HHs <i>(all data from 2008 survey)</i>	MILWAUKEE, WI pop 604,407 (08) SA=190,000 hhs	SALT LAKE CITY, UT 180,000 pop SA=45,000 hhs	SALT LAKE COUNTY, UT 1M pop SA=80,000 hhs incl 4 cities	SAN DIEGO, CA 1.3M pop SA=304,000 hhs T, 280,000 hhs R, 191,000 hhs O	THORNTON, CO 120,000 pop SA=25,134 hhs
Enforcement	Minimal	State bans not enforced - w SS city will add education more than enforcement for contamination	na	na	na	na		na	na	na

- | | | | |
|--|---|---|---|
| B = bulky
C&D = construction/demolition debris
CY = cubic yards
DOC = drop-off collection
DS = dual-stream recyclables collection
EOW = every other week
EST = estimated
FW = food waste
K = 1,000 | HH = household
HHW = household hazardous waste
LF = landfill
MF = multi-family
MO = month
NA = not available or not applicable
NPO = non-profit organization
O = organics
OCC = cardboard | OMG = magazines
ONP = newspaper
POP = population
RFID = radio frequency identification display
R = recycling
SA = service area
SF = single-family
SS = single-stream recyclables collection
T = trash | TPM = tons per month
TPY = tons per year
W = with
WG = white goods (appliances)
WK = week
WKLY = weekly
W/O = without
YR = year
YW = yard waste |
|--|---|---|---|

Back-calculations for pounds of materials set-out on collection days: Unless these calculation consider both the specific program's subscription and set-out rate (i.e., when these are not available), the actual set-out weight is expected to be higher than that shown.



APPENDIX F

Denver Solid Waste Master Plan Projections Memorandum (November 2009)



The purpose of projecting Denver MSW tons is to establish a basis for estimating short-term (2015) and long-term (2030) quantities that will be used to identify potential diversion as well as implementation costs in the Denver SWMP. While it is likely that these quantities will be adjusted slightly during the analyses, the HDR Team’s intent is to generally establish an agreed upon basis at this time that supports future work.

1.0 Background

MSW generation projections are often tied to population increases. However, these correlations do not always exist. Figure 1 shows that MSW generation (US) and landfill disposal (CO) have increased faster than population based on historical data (see trend line projections). The Colorado State Demography Office predicts that the state population will increase nearly 40% between 2010 and 2030¹.

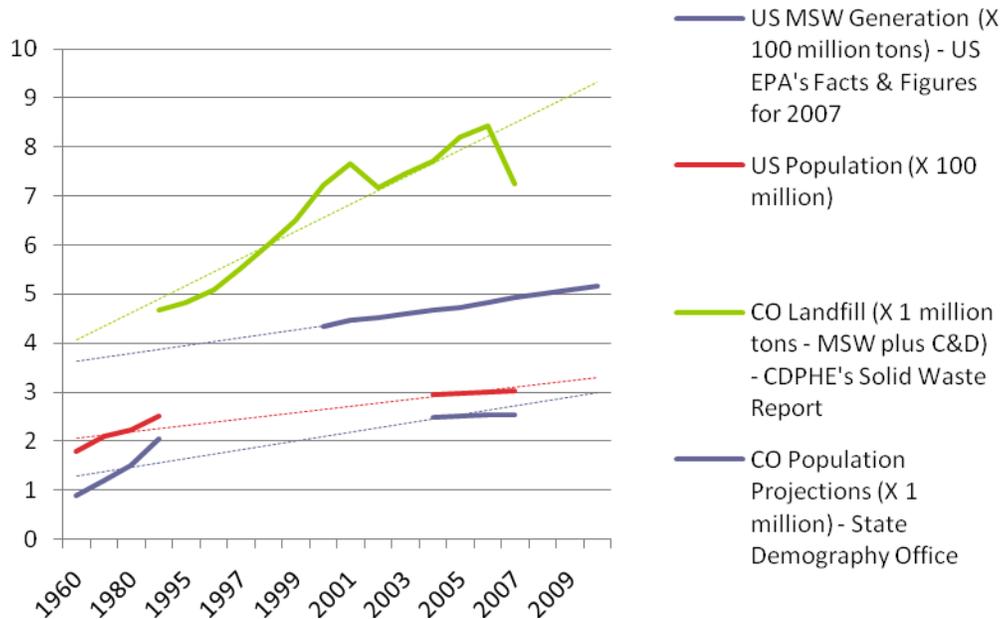


Figure 1 National & State Waste Trends (including linear trend lines)

Conversely, quantities observed in recent years indicate that more current trends in national and state MSW generation and disposal are increasing at a slower rate:

¹ Colorado State Demography Office predicts that Denver’s population will increase by 18% between 2010 and 2030.



- US MSW generation rates fell for the first time in 2007 despite a growing population and economy – this trend continued in 2008²
- In a recent national survey, 75% of respondents observed lower than average landfill quantities during the 2nd and 3rd quarter 2009 – 72% expect flat to more than 4% quantity declines over the next 12 months³
- The 10 cities re-surveyed in October/November 2009 observed MSW landfill tonnages have decreased by 2% to 8% per year since 2007⁴
- Various other US landfill observations range from no impact to a 26% decrease over the last one to two years⁵
- The DADS landfills tonnages fell 21% between 2007 and 2008, 25% between 2008 and 2009
- CDPHE’s database shows a 6.2% decrease between 2001 and 2002 and a 14.2% decrease between 2007 and 2008

These recent quantity trends are attributed to economic recessions (2001 and 2008/2009), non-recession events (such as the September 11, 2001 terrorist attacks), increased source reduction and waste diversion, and the global move towards on-line media and paperless communication (less newspaper, office paper and commercial printing). A summary of economic indicators include:

- The US Gross Domestic Product is projected to level off/begin increasing between the 4th quarter 2009 and the 2nd quarter 2010⁶
- The US civilian unemployment rate is projected to increase nearly every month into the 2nd quarter 2010⁷
- Housing inventory is expected to delay real growth in Colorado residential construction for one to two years
- Colorado manufacturing growth is down 8% and mimics the decrease seen following the previous recession in 2002-2003⁸
- While employment numbers are down close to 2001 recession levels, other indicators showed improvement in September (the state unemployment rate, mortgage rates, home re-sales, housing inventory and the Denver/Boulder inflation) - that have caused some to state that the recession is “moderating” statewide⁹

² USEPA’s Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008.

³ First Analysis Cooperation, October 2009 – survey included both MSW and C&D landfills.

⁴ HDR/LBA Draft Re-Survey Findings, November 2009.

⁵ For example: McPherson Area Solid Waste Authority, KS no impact in 2008; Lancaster County, PA – 4% decline in 2008; State of South Carolina – 6% decline in 2008; State of North Carolina – 5% decline in 2008; Winston-Salem/Forsythe County, NC – 4.4% decline in 2009; Orange County, CA – 11.7% decline in 2009 (MSW and recycling tons); City of Grand Island Landfill, NE – 12.2% decline in 2009; and Los Angeles County, CA – declines of 7% (Chiquita Canyon Landfill), 21% (Calabasas Landfill), 27% (Puente Hills Landfill).

⁶ forecasts.org/economic-indicator/gdp.htm (updated September 2009) and PNC National Economic Outlook (October 2009).

⁷ forecasts.org/economic-indicator/gdp.htm (updated September 2009).

⁸ University of Colorado at Boulder LEEDS School of Business, Colorado Business Review, Volume 7, Number 3, 2009.

⁹ www.coloradoeconomy.com/coind/html (September 2009).



2.0 Projecting Denver's Future Tons

The MSW tons collected by Denver Solid Waste and disposed at the DADs landfill (Figure 2) have fallen since 2001 – on the heels of both the 2001 recession, the multi-year drought during the implementation of the city's recycling program. While disposal tons collected by Denver increased by 1.4% to 4.3% per year from 1996 to 2000, they decreased from 0.6% to 5.8% per year from 2001 to 2008. These historical landfill tons have no clear relationship with the population projections for the city (i.e., growth rate of just over 0.8%/year between 2010 and 2030).

Denver Solid Waste collects residential waste from single-family and multi-family homes up to 7 units, as well as from city government buildings and Denver Public Schools. Waste generated by multi-family homes greater than 8 units, commercial businesses, non-DPS institutions and industries is collected by private haulers. The quantity of this waste is unknown.

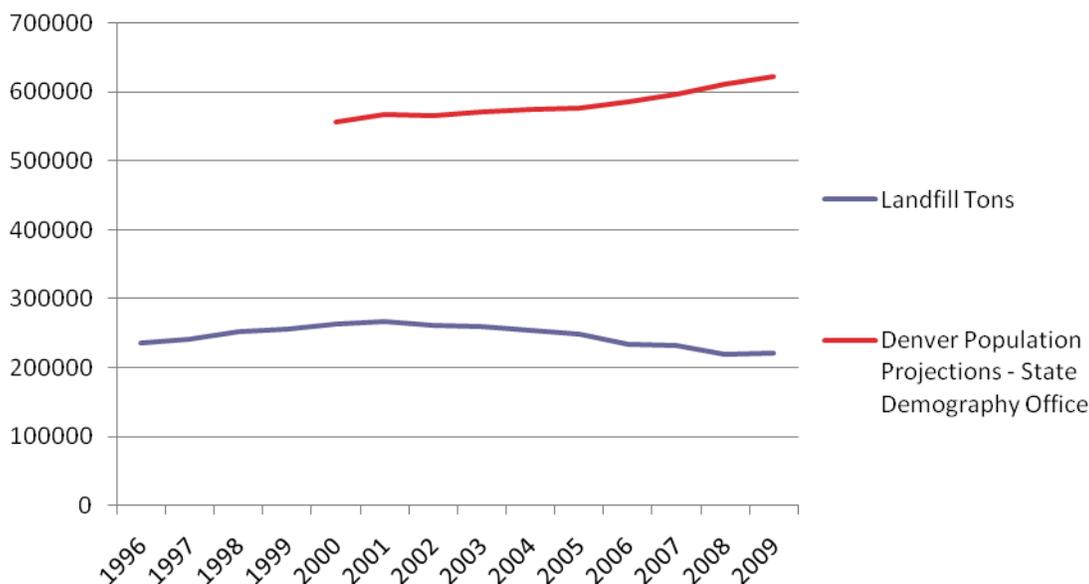


Figure 2 Denver Solid Waste Landfill Tons and Population

2.1 Total Tons

As landfill tons are only one component of MSW generation, it is important to evaluate Denver's total MSW tons. Figure 3 shows how recycling, organic and other material quantities (e-waste, appliances, HHW, leaves and trees) were combined with landfill quantity data to determine the total MSW tons. A linear trend line through the resulting total tonnage data from 1996 to 2008 shows a decrease over



time (nearly 400 tons/year)¹⁰. This quantity reflects historical landfill and recycling tonnages, as well as organics and miscellaneous (e-waste, appliance, HHW, Christmas tree and leaf) tonnages tracked since 2008.

Using current estimates from the Colorado Demography Office, it appears that as many as 197,000 households could exist by 2030. Given apparent limitations on residential building growth observed by Denver Solid Waste staff, however, these projections were modified for the SWMP planning periods noted in Tables 2 and 3.

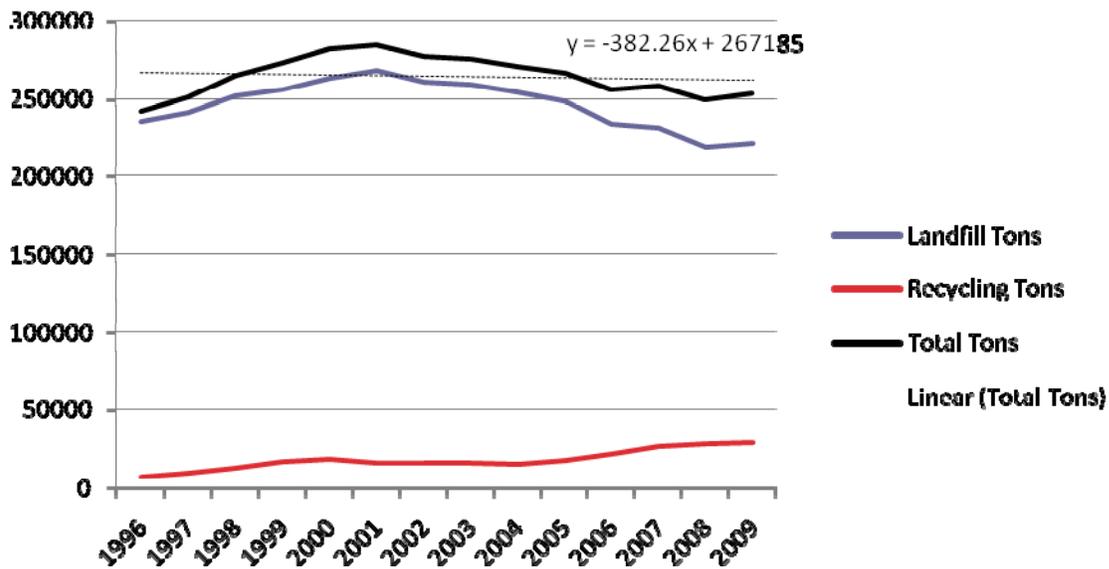


Figure 3 Denver Solid Waste MSW Tons

2.2 Recyclables

The SWMP evaluates expanding DSWM’s current household collection service. This program provides every-other-week collection of single-stream materials. Table 1 includes available performance data for this program to date.

¹⁰ Linear trend line equation $y = -382.26x + 267,185$ tons.

Table 1 Historical Denver Recycles Program Data

YEAR ^a	Year-End Subscribers	Average Subscriber (% of Eligible HHs)	Average Pounds/Set-Out	Average % Set-Out
2004	80,987	not available	35.58	42.86%
2005	80,555	not available	34.13	48.42%
2006	66,298	not available	38.07	57.35%
2007	76,841	44.5%	39.69	71.29%
2008	87,227	49.8%	34.36	77.90%
2009 (through mid-October)	95,317	54.9%	30.04	79.15%

^a Phasing in of Denver’s single-stream recycling program began mid-2005
 HHS = households

A projection of future recycling tons was based on continued growth of the existing program. Using Table 1 data, 2009 Re-Survey findings¹¹ and other available information, assumptions were made for the expanded program’s future performance metrics. Specifically:

- The rapid increase in the recycling subscription rate between 2007 and 2008 (about 5% per year) is typical of new programs like Denver Recycle’s single-stream collection – this growth is expected to slow in the short-term as the program matures (2% was observed between 2008 and 2009)
- A similar trend in the percent of set-outs (number of subscribed households that set out recyclables on their collection day) occurred as single-stream collection was fully implemented (as much as a 14-percentage-point growth was observed between 2006 and 2007) – this rate is also expected to slow and stabilize at about 78% in the short-term as household compost collection service is implemented (see Section 2.3)
- The set-out weight (pounds of recyclables set out on each collection day) is expected to have similar trend during the short-term with a slight decrease as the compost program is implemented (assumed to stabilize around 29 pounds/set-out in the short-term)
- The subscription, pounds/set-out and set-out rate are each expected to grow over the long-term planning period, however, as the city continues to emphasize waste diversion through both program and policy changes

Quantities generated from the collection of additional materials, more frequent collection, or the addition of drop-site collections are not considered here. The assumptions used in Table 2 may be adjusted slightly during the SWMP analyses.

¹¹ Note that the cities surveyed generally do not measure set-out rates or weight/set-out. Instead, most “guesstimate” a set-out rate, and back-calculate set-out weight by dividing annual tonnage by households (usually eligible - not subscribing - households). Therefore these findings must be used very carefully. Note that 4 cities achieved recycling program set-out rates of 80% or greater for mature programs – Louisville, KY; Salt Lake City, UT; San Diego, CA (has residential/commercial recycling mandate); and Thornton, CO.



During the two-season 2008 Waste Composition Study (WCS), it was noted that as much as 21.3% of landfill waste was recyclable paper and containers. This represented nearly 47,000 tons in 2008 (which was in addition to the 28,550 tons diverted through household collection service). It is expected that expanded household collection service would reduce the quantity of these materials in landfill waste in the future.

Table 2 Projected Recyclable Tons (rounded to nearest 100 tons)

	Current Program (2009)	Future Program Assumptions ^a					
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	2030
Subscriber (% of Eligible Households)^b	55%	57%	59%	61%	63%	65%	80%
Eligible Households^c	167,662	172,900	175,400	178,000	180,300	181,800	190,000
Pounds/Set-Out	30	30	29	29	29	29	30
% Set-Out	79%	78%	78%	78%	78%	78%	80%
Total Tons	29,116	30,000	30,400	31,900	33,400	34,700	47,400

^a Assumptions for subscriber and set-out rates based on observations from the existing program and knowledge of other U.S. household recycling collection programs

^b Subscription rate increase corresponds to 20%/20%/20%/20%/20% implementation during short-term

^c Based on current service area (only 98.6% of Denver’s service area is eligible for recycling services) and Colorado State Demography office population projections (October 2009); 2030 households were capped given known property constraints

2.3 Organics

The SWMP evaluates adding permanent household collection of yard and food waste organics to voluntary, subscribing households similar to the recycling program. It is expected that organics would be collected weekly April through November, and every other week December through March. Using data obtained from Denver’s 2008/09 pilot study and 2009 Re-Survey findings¹², assumptions were made for the new program’s future performance metrics. Specifically:

- Table 3 shows that the 2008/09 pilot study was successful in terms of both set-out rate and weight
- The escalation of these factors and the subscription rate through Phase 5 were assumed to mimic the short-term implementation of Denver Recycles single-stream program – assumptions for the new program therefore included assumptions for a steady increase to 55%, 80% set-out and moderate pounds/set-out were assumed

¹² Again, surveyed cities have little performance data (set-out weight is back-calculated) – most programs collect yard waste only.



- The subscription, pounds/set-out and set-out rate are each expected to grow over the long-term planning period as the city continues to emphasize waste diversion through both program and policy changes

The projected organic tons shown in Table 3 are based on quantities generated through an expansion of the existing pilot program. Yard waste quantities generated from future drop-site collections are not considered here. The assumptions used in this table may be adjusted slightly during the SWMP analyses.

The 2008 WCS identified that as much as 42.4% of City-collected landfill wastes were food (13.7%) and yard waste (28.7%) organics during the spring and fall seasons. This represented over 93,000 tons of Denver’s landfilled waste in 2008.

Table 3 Project Organic Tons (rounded to nearest 100 tons)

		Future Program Assumptions ^a						
		2009 Pilot Program	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	2030
Subscribers (% of Eligible Households) ^b		2%	11%	33%	41%	50%	55%	68%
Eligible Households ^c			172,900	175,400	178,000	180,300	181,800	190,000
Pounds/ Set-Out	Weekly Collection (April-Nov)	31	20	20	20	20	20	30
	Every-Other-Week Collection (Dec-March)	13	9	9	9	9	9	13
% Set-Out	Weekly Collection (April-Nov)	61%	40%	50%	60%	70%	80%	80%
	Every-Other-Week Collection (Dec-March)	65%	40%	50%	60%	80%	80%	80%
Total Tons		1,400	2,900	11,200	16,900	24,300	30,900	59,600

^a Assumptions for subscriber and set-out rates based on observations from the pilot program, the existing recycling program, and knowledge of other U.S. household collection programs

^b Subscription rate increase corresponds to 20%/40%/15%/15%/10% implementation during short-term

^c Based on current service area (only 98.6% of Denver’s service area is eligible for recycling services) and Colorado State Demography office population projections (October 2009); 2030 households were capped given known property constraints
HHS = households



2.4 Other Diverted Materials

These materials - including e-waste, appliances, HHW, Christmas trees and leaves – totaled approximately 760 tons in 2008/09. It is assumed that generation of these materials may increase by 3% annually.

2.5 Landfill Tons

By subtracting recyclable, organic and other tons from total MSW generation projections, potential landfill tonnage can be estimated as shown in Table 4. However, when the historical trend of total tonnage (described by the linear regression equation $y = -382.26x + 267,185$ tons in Section 2.1) is applied to projections for 2010 and the planning period, the total tonnage does not match DSWM expectations (i.e., projected landfill tons would be nearly 261,800 – notably more than the actual 253,100 tons in 2009). In order to address significant changes to tonnages in the last decade, the projection analysis was modified on the basis of annual total ton change described by historical data (382-ton decrease per year), and current tons (253,100 total tons in 2009). This modification is reflected in Table 4.

Year 2004 data is provided as 2004 is the baseline year used by Greenprint Denver to establish its goal of a 30% reduction in landfill tons managed by Denver Solid Waste. Thirty-percent reduction of 2004 landfill tons requires a landfill quantity of 178,100 tons. Table 4 indicates that this reduction is not expected to be reached during the short-term planning period through implementation of voluntary diversion programs alone. If the city is successful in growing the diversion programs at a faster rate than estimated in this analysis – and/or if additional programs are implemented which support additional diversion - the goal may be achieved more quickly.

Based on assumed growth of the household recycling and compost collection programs, the short-term diversion rate may reach as high as 27% (Phase 5), with significant potential growth in later years. The long-term landfill ton projections indicate an average annual decrease **between 2011 and 2030** of about 2.4% compared to a decrease in total MSW generation of about 0.2% per year.



Table 4 MSW Quantity Projections^a (rounded to nearest 100 tons)

	Actual	Projections							
			Short-Term					Long-Term	
	2004	2010	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	2030	Phase 1-2030 %
Total MSW Tons	270,194	252,700	252,300	251,900	251,600	251,200	250,800	245,100	-0.2%
Recycling Tons	15,705	29,600	30,000	30,400	31,900	33,400	34,700	47,400	2.4%
Organic Tons	0	1,400	2,900	11,200	16,900	24,300	30,900	59,600	17.3%
Other Tons	0	800	800	900	900	900	900	1,500	3.4%
Landfill Tons	254,489	220,900	218,600	209,400	201,900	192,600	184,300	136,600	-2.4%
% Diversion	6%	13%	13%	17%	20%	23%	27%	44%	6.6%

^a Summations may not appear to total exactly due to rounding errors



APPENDIX G

Denver Solid Waste Management Plan Final Report Spring/Fall 2008 Waste Composition Analysis (March 2009)



Final Report

Spring/Fall 2008 Waste Composition Analysis

Denver Solid Waste Management

March 2009

HDR HDR Engineering, Inc.

In Association with
LBA Associates



Denver Solid Waste Management and HDR Engineering would like to thank Kessler Consulting for their assistance with the Spring WCS and CDPHE's Recycling Resource Economic Opportunity Fund for its support of the Fall WCS.

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Executive Summary

As part of its on-going Solid Waste Strategic Master Plan, Denver Solid Waste Management conducted a two-season spring/fall waste composition analysis in 2008, which included a Spring Waste Composition Study (WCS) during the week of June 9th and a Fall WCS during the week of November 3rd. These sorts were scheduled to target yard wastes in the waste stream, and to provide information that supplements the city's 2008/09 organics collection pilot program. The results of this analysis provided insight into both residential yard waste generation and other disposal practices.

The purpose of the WCS was to analyze:

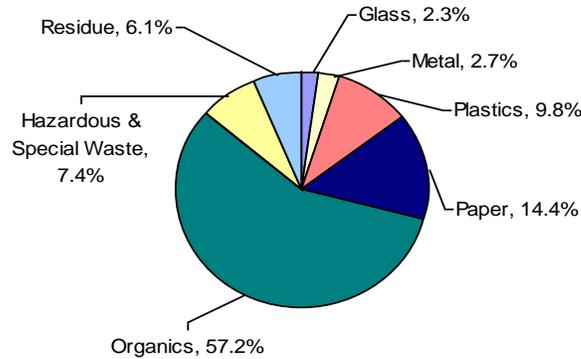
- ◆ The effectiveness of the existing Denver recycling program, including the relative impact of both the three collection systems used by DSWM for residential waste (characterized by dumpster, barrel/cart and resident-provided or manual containers) and the varying recycling subscription rates (low, medium and high) of Denver's residents.
- ◆ Information to support adding new materials to the existing recycling program.
- ◆ Information to support the feasibility of a future food and yard waste diversion program (this WCS was scheduled to coincide with spring/early summer and fall yard waste generation).
- ◆ Information to provide material focus to a Denver Solid Waste Master Plan.

An aggregate of the spring and fall 2008 WCS results, while not reflective of Denver's annual average waste stream, illustrates peak yard waste management needs. The figure below illustrates the combined composition of residential spring/fall waste. The Organics category included the greatest quantity of materials at 57.2% by weight.

Key observations included:

- ◆ In the Organics category, spring Yard Waste was primarily grass clippings, sod and branches and fall Yard Waste was primarily leaves - these materials could easily be managed by curbside or alley collection (i.e., would fit in a 65- or 95-gallon cart).

Average Aggregate Composition Spring & Fall Sorts by Material Category (percent by weight)



- ◆ It was noted that dumpster routes generate the greatest amount of Organics (i.e., Yard and Food Waste) during the spring season, followed by barrel routes.
- ◆ Within the Paper category, Single-Stream Paper included primarily Cardboard (mostly not broken down) and Newspaper (heavily contaminated with Food Waste and Other Organics).
- ◆ In the Hazardous & Special Waste category, C&D debris included primarily construction waste from home improvement projects such as treated wood, shingles, bricks and ceramics.
- ◆ Large quantities of small, easily mixed materials (such as grass clippings, leaves and dirt) plus high winds (which caused paper and plastics to blow throughout the sort area) resulted in elevated levels of contamination and Residue weights for some samples.

An evaluation of probable average annual results indicates slightly lower Organics percentages and slightly higher percentages for other materials, as shown below. These results indicate that at least 67,000 tons/year of material could be diverted from disposal (based on 2008 quantities) if the current recycling program is maintained and city-wide organics collection (Yard and Food Waste) is added such that both systems recover 40% of the targeted recyclables and organics.

Assessment of Annual Average Waste Composition

	AVERAGE DENVER Spring & Fall 2008	ASSESSMENT OF AVERAGE ANNUAL COMPOSITION
Glass	2.4%	2.9%
Metal	2.7%	3.7%
Plastics	9.9%	10.2%
Paper	14.5%	18.0%
Organics	57.1%	52.7%
Hazardous & Special Waste	7.4%	7.1%
Residue	6.3%	5.0%
	100%	100%

The primary recommendations from the spring/fall 2008 waste composition analysis are:

1. Evaluate the feasibility of adding permanent organics recovery program - the WCS results strongly support the potential for significant diversion through the recovery of Yard and Food Waste (the primary components of the largest material category observed).
2. Increase public outreach to capture existing recyclables and launch new diversion programs effectively.

The spring/fall 2008 waste composition analysis was conducted as part of an on-going Solid Waste Master Plan that DSWM will use to comply with Greenprint Denver. It also satisfied the second task in an organics pilot project, partially funded by a grant from the Recycling Resources Economic Opportunity Fund of the Colorado Department of Public Health and Environment. Denver is conducting the organics collection pilot program under this grant for 3,300 residences from October 2008 through June 2009. Data from the WCS will be an instrumental part of analyzing the viability of the pilot for full-scale implementation.

1.0 Introduction

Denver Solid Waste Management (DSWM) conducted a spring/fall 2008 waste composition analysis of its residential waste in 2008, including a Spring Waste Composition Study (WCS) during the week of June 9th and a Fall WCS during the week of November 3rd. Both sorts were conducted at Denver's Cherry Creek Transfer Station (CCTS) in southeast Denver. The WCS was coordinated for DSWM by the HDR Engineering Team. DSWM staff conducted the actual sorting.

These studies were scheduled to target yard wastes in the waste stream, and to provide information that supplements the city's 2008/09 organics collection pilot program. The results of this analysis provide excellent insight into both residential yard waste generation and other disposal practices, but because of the seasonal focus is not necessarily reflective of average annual waste generation.

The over-arching purpose of the WCS was to analyze the composition of waste generated by Denver residents. DSWM collects residential waste using a combination of dumpster, barrel and manual systems. The study was designed to identify:

- ◆ The effectiveness of the existing Denver recycling program, including relative impact of the three collection systems.
- ◆ Information to support adding new materials to the recycling program.
- ◆ Information to support the feasibility of a future food and yard waste diversion program.

Both sorts were conducted by DSWM as part of a larger, on-going strategic master planning effort that will evaluate new and/or revised solid waste programs and policies over the next year. The Fall WCS was also completed by DSWM as part of an organics recovery grant project funded in part by the Colorado Department of Public Health & Environment (CDPHE). The combined results from both studies, covering two waste generation seasons, will provide critical information to DSWM's short- and long-term planning work.

1.1 Background

DSWM's residential waste collections were the target of both seasonal sorts. The City's residential program serves approximately 141,600 single-family and about 23,400 multi-family (two to seven units each) homes. Regular service includes weekly waste collection plus bulky materials (also known as large item pick-up). Weekly waste collection is broken into three systems, classified by type of waste receptacle and the corresponding truck needed to empty those receptacles, which vary by areas of the city:

- ◆ Dumpster Collection (in all parts of the City excepting southwest area) - small groups of residents are provided with dumpsters; DSWM collects with automated side-load vehicles.
- ◆ Barrel Collection (in all parts of the City excepting northwest area) - each resident is provided with 95-gallon carts; DSWM collects with automated side-load vehicles (overflows are allowed).
- ◆ Manual Collection (predominately in northern half of the City) - residents provide their own bags or containers; DSWM collects with rear-load vehicles.

Large-item pickup (LIP) collection is provided to every resident ten times each year on a pre-set schedule. LIP waste was not specifically included in the WCS, although some routine collections include these bulky materials as daily schedules allow.

DSWM's residential recycling program is voluntary and approximately 80,000 residents (or one-half of Denver residents) currently subscribe. These homes are provided with a 65-gallon cart, which DSWM collects every other week with automated side-loaders. Acceptable materials include most paper, plus glass, plastic and metal containers and are fully commingled in a single-stream system.

Denver currently does not have permanent organics collection, although DSWM operates seasonal yard waste programs (i.e., Fall Leaf Drop and Christmas Tree recycling). Beginning in early October, however, Denver initiated a pilot program for the curbside collection of Yard and Food Waste from nearly 3,300-homes under the same CDPHE organics recovery grant project described above. Materials - including such items as food-contaminated paper and paper milk and juice cartons - will be collected through June 2009. Collection is weekly through mid-December and every other week for the duration of the program. Sixty-five-gallon automated carts are being used by targeted households, which are spread throughout the City.

In 2007, DSWM disposed of 226,000 tons of waste at the Denver Arapahoe Disposal Site (DADS) landfill and recycled nearly 27,000 tons. In accordance with Greenprint Denver, the City's 2006 sustainability agenda, the disposal tons need to be reduced to 185,000 tons by 2011. Therefore, DSWM is focusing current research and planning efforts on waste diversion.

1.2 Report Organization

This report presents the background, methodology and results for the two waste composition studies. The document is divided into the following sections:

- ◆ Methodology (Section 2.0) - based on the Denver Waste Composition Study: Sampling & Sorting Guidelines (Appendix A), this section includes observations on the sorting procedure as well as the list of materials sorted for.
- ◆ Sample Selection & Aggregation (Section 3.0) - describes which of the City's collection routes were selected for sampling and explains how the results were weighted to develop an aggregate composition.
- ◆ Results (Section 4.0) - an analysis of waste composition in terms of aggregate composition as well as type of collection and current recycling participation is summarized in this section.
- ◆ Projection of Potential Future Diversion (Section 5.0) - evaluates existing and future materials in the residential waste stream with diversion potential.
- ◆ Recommendations (Section 6.0) - this section includes suggestions for conducting the Fall 2008 study and focusing the City's Strategic Solid Waste Master Plan.
- ◆ Appendices - Appendix A is the Sampling-Sorting Guidelines used for both sorts; Appendix B includes sort photographs; Appendices C and D include summary results; and Appendices E and F include the field data logs.

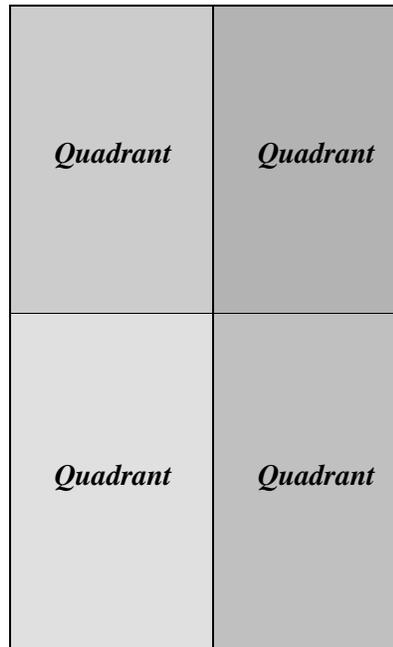
2.0 Methodology

The Denver Waste Composition Study: Sampling & Sorting Guidelines, or “Guidelines,” (Appendix A), was completed prior to each WCS and approved by DSWM (the Fall WCS was adjusted slightly to include improvements over the Spring WCS). The Guidelines identified sorting logistics, equipment needs, sample selection, targeted materials and the sorting protocol. The Guidelines were developed in accordance with ASTM’s “Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste” (D 5231-92).

2.1 Sort Observations

Denver’s 2008 WCS generally followed the Guidelines. Several general observations related to procedure were made during the two sorts:

1. The City provided its own supervisory-level staff (part-time in the spring, nearly full-time in the fall) to oversee the crew of five sort laborers.
2. Safety glasses were used by sorters rather than goggles, based on a hazard assessment by the City’s safety supervisor.
3. Due to typical routing frequencies, multiple loads from targeted routes often arrived at the CCTS at the same time. In those cases, sort supervisors and drivers occasionally struggled to identify loads (vehicle numbers and weight tickets did not necessarily correlate to targets). This problem was improved during the Fall WCS when loads were tipped directly on the transfer station floor. This modification also avoided both tipping in open space during windy weather and the City’s need to double-handle sample material.
4. A “virtual” grid (see Figure 1) was imposed on the windrow-shaped loads once they were unloaded at the designated tipping area of the transfer station tip floor. One quadrant was assigned to each sort day and was sampled from, unless physical constraints from an adjacent load required a modification.
5. It was originally anticipated that sample loads would be tipped on the day of sampling and sorting. However, it was necessary to tip and sample some loads late in the day, but conduct the sort on the following day. These samples were covered with a second tarp overnight to minimize blowing litter and moisture contamination and evaporation.
6. The CCTS truck scale was not operating properly during either sort and could not be used to approximate 200-pound samples. Sort supervisors instead approximated load size visually.
7. Windy days compromised sample integrity prior to sorting (this was especially problematic during the Spring WCS). Materials that escaped the tarps and sorting tables were collected at the end of each day, weighed as Residue and allocated between all the samples sorted that day.
8. Rather than disposing of sorted waste in dumpsters after sorting, automated carts were provided part way through the Spring WCS to divert recyclables and for both recyclables and organics during the Fall WCS.

Figure 1. Sampling Grid

2.2 Materials Sorted

Seven over-arching materials categories were identified to sort for, with several material types within each category also sampled. In the Spring WCS, 18 material types were sampled (excluding residue). Because of interest in additional materials, three more material types were added in the Fall sort. Table 1, below, shows a full description of materials. Samples with unusual materials or a predominance of one material were noted in the Field Data Logs (Appendices E and F) and in Section 4.0 as appropriate.

Table 1. Material Categories and Description

MATERIAL CATEGORIES	DESCRIPTION (include each material in sorting unless noted)
GLASS	
Glass Food & Beverage Containers	All colors of food & beverage bottles & jars
All Other Glass	Non-fluorescent light bulbs, glassware, window glass, ceramic dishware
METAL	
Aluminum/Steel/Tin Food/Beverage Containers, Foil & Pie Tins	Aluminum, tin, steel & bi-metal beverage & food cans, <u>empty</u> aerosol cans, foil, food trays and pie tins
All Other Metal	Non-food containers, all scrap metal & items that are primarily metal, container lids/caps - excluding aerosols still containing product (move to Hazardous/Special Waste)
PLASTICS	
Plastic Bottles	Any bottles with necks/openings narrower than body including beverage containers and cleaning containers (<u>any</u> resin)
Rigid Plastic Food Containers	Plastic cups, tubs, clamshells, etc.
All Other Plastic	Film, Styrofoam, other extruded polystyrene, other rigid packaging, foil-lined chip bags, foam products
PAPER	
Single-Stream Paper	Unwaxed/uncoated corrugated cardboard, Kraft paper/bags, newspaper, office paper, shredded paper, magazines/catalogues, telephone books
Waxy/Coated Paper	Waxed or coated milk cartons, food packaging, etc. excluding any foil-lined paper (move to Other Paper)
All Other Paper	Any foil-lined paper, carbon paper, photographs
ORGANICS	
Food Waste	All food/beverage waste (out of containers where active emptying not required) including bones & rinds, including food-contaminated paper towels & napkins
Yard Waste & Untreated Wood (excludes sod)	Grass, leaves, weeds, pruning, stumps trees (excludes sod) Unpainted or untreated wood, wood that is not heavily mixed with other materials (such as dimensional lumber, pallets, crates, etc.)
Sod¹	Sod clumps and associated dirt
Textiles¹	Clothing, bedding, sleeping bags, etc.
Pumpkins¹	Whole or partial pumpkins (leftover from Halloween)
All Other Organics	Carpet & padding, diapers, rubber products, upholstery, leather products, animal foods & waste, combustibles including wax, soap, cigarettes, briquettes, ash

MATERIAL CATEGORIES	DESCRIPTION (include each material in sorting unless noted)
HAZARDOUS/SPECIAL WASTES	
Electronics	Electronics with circuit boards (computer monitors, televisions, VCR or DVD players, portable music devices, cell/wireless phones, answering machines, digital cameras, electric razors, newer small household appliances) but excluding toasters, toaster ovens, older small household appliances (move to Other Metal)
Other Consumer Products	Furniture (unless primarily textiles or leather, plastic, metal - move to other categories as appropriate), mattresses & box springs, electronics or similar devices without circuit boards (such as head sets)
Motor Vehicle Waste	Automobile batteries, used oil, used filters, tires
C&D Debris¹	Construction, demolition and rehabilitation debris including concrete, asphalt, painted or treated wood, drywall, fiberglass, rock/brick, ceramics (other than glassware), sawdust, scrap debris, etc.
Other Hazardous/Special Waste	Antifreeze Non-auto batteries Pesticides, herbicides, cleaners, adhesives, glues, explosives, asbestos Latex & oil paint, aerosol containers with product Medicines, cosmetics & other household chemicals Gasoline, kerosene, fuels Medical/biohazard waste Other hazardous materials or difficult to manage (requires special handling)
RESIDUE	
Residue	Sand, soil, dirt (but <u>not</u> sod) Inorganic materials not classified elsewhere Mixed MSW fines

¹ Added in Fall WCS - not included in Spring WCS

3.0 Sample Selection and Aggregation

3.1 Sample Selection

The Sampling and Sorting Guidelines included a plan for targeting DSWM's residential routes to obtain 40 samples of approximately 200 lbs. each, to represent the dumpster, barrel and manual collection systems, and to represent the City's four collection quadrants.

The two WCS each targeted for sampling:

- ◆ 16 dumpster routes from three of the four City areas served by dumpster collection;
- ◆ 13 barrel routes (including overflow) from the three areas served by this system; and
- ◆ 11 manual routes from throughout the City

Targeted loads are summarized in Table 2, below. Loads ultimately sampled during each sort deviated slightly from the Guidelines to accommodate City routing schedules in each of the sort weeks, and are noted in the table.

Due to the normal vagaries of a collection schedule, a total of 41 loads were sampled in the Spring sort (from 40 routes) and 39 were sampled in the Fall sort (from 38 routes); meeting the overall target of a total of 80 samples for 2008. These differences in the sample selection were due to the following reasons:

- ◆ Most of the City's waste collection routes generate multiple loads of waste on any given day – the load from each targeted route tipped for the WCS was chosen primarily at the discretion of the route driver and may not fully represent the overall route.
- ◆ Routes with the same designation collect from different households on different days of the week in the same sector (e.g., ANW #1 on Mondays is a different route from ANW #1 on Tuesdays).
- ◆ An “overflow” load was included in the barrel loads sampled - while this collection is made manually with a rear-loader, the wastes collected are from a barrel route where the materials do not fit in the automated cart provided the resident.

For data comparison purposes, the samples averaged approximately 275 pounds in the Spring WCS and approximately 210 pounds in the Fall WCS, for a total of 19,465 pounds sorted (i.e., 9.7 tons).

Table 2. Targeted Routes by Area and Actual Routes Sampled

Targeted Route	Route Day	Recycling Participation	Spring WCS	Fall WCS
Dumpster Collections				
ANE#1	Tues	Low	ANE#1	ANE#1
ANE#3	Wed	Low	ANE#3	ANE#3
ANE#5	Thurs	Medium	ANE#5	ANE#5
ANE#7	Fri	Medium	ANE#7	ANE#7
ANE#9	Fri	Low	ANE#9	ANE#9
	Fri			ANE#2
ASE#2	Tues	Low	ASE#2	ASE#2
ASE#3	Tues	Medium	ASE#3	ASE#3
ASE#4	Wed	Medium	ASE#4	ASE#4
ASE#5	Wed	High	ASE#5	ASE#5
ASE#6	Thurs	High	ASE#6	ASE#6
ASE#7	Thurs	Medium	ASE#7	ASE#7
ANW#1	Mon	Low	ANW#1	ANW#1
ANW#2	Tues	Medium	ANW#2	ANW#2
ANW#4	Wed	Low	ANW#4	ANW#4
ANW#5	Thurs	Medium	ANW#5	ANW#5
ANW#7	Thurs	Low	ANW#7	
Barrel Collections				
BNE#2 (1 st load)	Mon	Low	BNE#2 (1 st load)	BNE#2
BNE#2 (2 nd load)	Mon	Low	BNE#2 (2 nd load)	
BNE#3	Tues	Low	BNE#3	BNE#3
BNE#4	Wed	Low	BNE#4	BNE#4
BNE#5	Thurs	Low	BNE#5	
BSE#1	Tues	High	BSE#1	BSE#1
BSE#1	Wed	High	BSE#1	BSE#1
BSEO#2	Fri	High	BSEO#2	BSEO#2
BSE#4	Wed	High	BSE#4	BSE#4
BSE#5	Tues	High	BSE#5	BSE#5
BSE#6	Fri	High	BSE#6	BSE#6
BSW#2	Mon	Low	BSW#2	BSW#2
BSW#3	Thurs	Medium	BSW#3	BSW#3
BSW#4	Tues	Low	BSW#4	BSW#4
BSW#6	Wed	Medium	BSW#6	BSW#6
BSW#6	Thurs	Medium	BSW#6	BSW#6
Manual Collections				
MNE#1	Mon	Low	MNE#1	MNE#1
MNE#3	Tues	Low	MNE#3	MNE#3
MNE#5	Wed	High	MNE#5	MNE#5
MNE#6	Fri	High	MNE#6	MNE#6
MNE#7	Thurs	Low	MNE#7	
MNW#1	Mon	Medium	MNW#1	MNW#1
MNW#2	Tues	Low	MNW#2	MNW#2
MNW#3	Wed	Low	MNW#3	MNW#3
MNW#4 (1 st load)	Thurs	Low	MNW#4	MNW#4 (1 st load)
MNW#4 (2 nd load)	Thurs	Low	not targeted	MNW#4 (2 nd load)

A = Dumpster

M = manual

NE = northeast

NW = northwest

B = Barrel

O = overflow

SE = southeast

SW = southwest

3.2 Sample Aggregation

The majority of the tonnage collected by the City is collected under the dumpster system. Table 3 shows the breakdown of the relative service area size (by number of households served) and tonnages collected by each of Denver's collection systems. The waste tonnage percentages in the far right column of Table 3 were used as weighting factors in order to estimate the aggregate composition of the residential waste collected by DSWM.

Table 3. Households Served and Waste Quantities from Each Collection System

Collection System	Single-Family Households Served	Multi-Family Households Served	2007 Tons Collected (to nearest 1,000 tons)	Percent of Total Tons
Dumpster	50,000	14,000	109,000	48.2%
Barrel (includes barrel overflow)	54,200	800	74,000	32.8%
Manual	37,400	8,600	43,000	19.0%
Total	141,600	23,400	226,000	100%

4.0 Results

4.1 Statistical Analysis

The following statistical measures were used to indicate how well the samples represent the residential waste managed by DSWM. The ASTM D 5231-92 procedures call for a four-season waste composition analysis to generate data that is fully representative of average waste generated for disposal over the course of a year. Typically, a statistical analysis run on a full data set would be used to assess correlation between sort samples and actual Denver waste composition. Given the availability of only two sorts, however, individual statistical analyses of each sort have been run, but should be considered independently of one another, and reflective only of the season being studied.

The analysis included a calculation of:

- ◆ Sample Mean - or average weight for each material type and category.
- ◆ Standard Deviation - measures how widely the values for each material varied around the mean (or average).
- ◆ Confidence Interval - the range of values expected to encompass the mean of the overall population (i.e., the full quantity of compactor loads from which the WCS samples were collected); the Denver confidence interval was calculated at a 90% level of confidence (a typical interval used by ASTM for MSW waste study work).

Tables 4 and 5 include summaries of raw (not yet weighted by Table 3 calculations) data with the 90% confidence intervals for each material. Appendices C and D include the statistical analysis on the raw data for each material type for the spring and fall sorts respectively (see the “Results Summary & Statistics” tables).

A higher standard deviation indicates greater variation in the samples than a lower standard deviation. And typically, the width of the confidence intervals decreases as the sample size increases. For example, the Spring WCS results in Table 4 show that the range between lower and upper confidence limits (high minus low confidence interval values) for Food Waste in manual samples only (9 samples) was 19.4 pounds. However, the same range for Food Waste in dumpster samples (16 samples) was only 9.8 pounds.

Table 4. Spring WCS - Raw Data Including 90% Confidence Intervals for Each Material Type (not weighted)

Material Category	Material Type	Dumpsters			Barrel			Manual		
		90% Confidence Limit	Confidence Interval		90% Confidence Limit	Confidence Interval		90% Confidence Limit	Confidence Interval	
			Low	High		Low	High		Low	High
Glass	Glass Containers	2.3%	4.1	7.9	1.8%	3.4	6.8	1.8%	2.8	7.5
	Other Glass	0.4%	0.4	1.6	0.1%	-0.1	0.8	0.0%	-0.1	0.4
Metals	Alum/Steel/Tin Food & Beverage	0.9%	1.7	3.2	1.4%	2.9	4.7	0.8%	1.3	3.4
	Other Metal	1.2%	0.2	6.2	1.0%	1.4	4.4	1.1%	1.6	4.7
Plastics	Plastic Bottles	1.8%	2.8	6.6	2.1%	4.0	7.6	1.4%	2.5	5.7
	Rigid Plastic Food Containers	0.6%	1.2	2.1	1.3%	2.0	5.4	0.7%	1.1	3.1
	Other Plastic	7.0%	14.9	22.2	7.0%	13.4	25.5	9.2%	20.2	33.6
Paper	Single-Stream Paper	10.7%	22.7	33.5	12.1%	26.0	41.6	13.1%	30.0	46.3
	Waxy-Coated Paper	1.1%	1.6	4.1	1.2%	2.1	4.5	2.8%	1.9	14.6
	Other Paper	0.5%	0.6	1.9	0.9%	0.2	4.8	0.4%	0.3	1.9
Organics	Food Waste	6.9%	13.1	23.0	11.8%	24.0	41.8	9.1%	16.7	36.1
	Yard Waste	45.2%	88.6	149.4	34.2%	58.8	131.8	31.6%	58.0	126.2
	Other Organics	9.4%	17.3	31.9	10.1%	18.5	38.2	11.3%	21.1	44.7
Hazardous & Special Waste	Electronics	0.2%	-0.1	1.0	0.2%	0.0	1.1	0.2%	-0.3	1.5
	Other Consumer Products	0.5%	-0.4	3.0	0.0%	0.0	0.2	0.2%	0.0	1.2
	Motor Vehicle Waste	1.6%	-2.7	10.9	0.0%	NA	NA	0.0%	NA	NA
	Other Haz & Special Waste	3.4%	3.0	14.7	7.6%	8.5	33.9	3.3%	-0.1	19.1
Residue	Residue	6.4%	8.5	25.4	7.1%	13.7	26.1	13.0%	19.5	56.0

Table 5. Fall WCS - Raw Data Including 90% Confidence Intervals for Each Material Type (not weighted)

Material Category	Material Type	Dumpsters			Barrel			Manual		
		90% Confidence Limit	Confidence Interval		90% Confidence Limit	Confidence Interval		90% Confidence Limit	Confidence Interval	
			Low	High		Low	High		Low	High
Glass	Glass Containers	2.2%	1.7	5.7	2.3%	3.3	7.4	2.5%	2.1	10.0
	Other Glass	0.1%	0.0	0.4	0.1%	0.0	0.3	0.1%	-0.1	0.5
Metals	Alum/Steel/Tin Food & Beverage	1.0%	1.2	2.3	1.9%	2.6	6.3	1.8%	2.7	6.1
	Other Metal	2.7%	1.6	7.5	1.4%	1.6	4.8	0.0%	0.0	0.1
Plastics	Plastic Bottles	1.1%	1.3	2.4	2.6%	2.2	10.2	1.5%	2.3	4.9
	Rigid Plastic Food Containers	1.2%	1.2	3.0	1.0%	1.7	3.0	0.8%	0.8	2.8
	Other Plastic	5.9%	7.3	12.6	6.9%	11.0	21.3	8.9%	13.9	29.0
Paper	Single-Stream Paper	14.5%	19.8	29.3	12.0%	22.8	33.5	12.3%	14.9	44.5
	Waxy-Coated Paper	0.1%	0.1	0.3	0.6%	0.5	2.4	0.4%	0.3	1.7
	Other Paper	2.3%	0.9	7.1	0.6%	0.1	2.6	2.3%	1.8	9.3
Organics	Food Waste	10.4%	12.3	23.1	12.3%	18.7	39.1	10.7%	12.9	38.7
	Yard Waste	34.4%	40.4	76.6	33.9%	55.7	103.4	36.0%	41.7	131.7
	Pumpkins	2.4%	0.7	7.4	2.2%	1.3	8.9	2.1%	0.4	9.9
	Sod	0.0%	NA	NA	0.0%	NA	NA	0.0%	NA	NA
	Textiles	3.6%	3.5	8.7	2.5%	2.4	9.2	3.3%	4.2	11.6
	Other Organics	5.5%	6.6	12.2	4.4%	4.8	15.9	5.2%	3.1	21.9
Hazardous & Special Waste	Electronics	1.5%	0.1	4.9	0.7%	0.3	3.0	0.1%	0.0	0.5
	Other Consumer Products	0.0%	0.0	0.1	0.0%	NA	NA	0.1%	-0.1	0.3
	C&D Debris	0.7%	-0.3	2.7	0.0%	NA	NA	1.7%	NA	NA
	Motor Vehicle Waste	6.2%	3.0	17.9	8.1%	-2.9	40.9	5.0%	-2.5	26.6
	Other Haz & Special Waste	0.3%	0.0	1.1	0.8%	-0.3	4.0	0.3%	0.1	1.5
Residue	Residue	3.8%	2.2	10.6	6.0%	5.5	22.5	4.9%	2.6	20.9

4.2 Composition of Seasonal Waste

4.2.1. Spring 2008 Composition

Figure 2 illustrates the Spring WCS aggregated waste composition for the 7 over-arching material categories observed in the 41 residential waste samples. Figure 3 shows the aggregate composition by the 18 specific materials types (plus residue).

Note that the Organics category included the greatest weight of observed waste (58.3%), while Yard Waste was the single most prevalent material type (39.5%). The top five material types by weight were Yard Waste, Single-Stream Paper, Other Organics, Food Waste and Residue.

These materials types represent 77.3% of the total residential waste stream sampled. Three of these (Yard Waste, Single-Stream Paper and Food Waste) could potentially be diverted in the future (see Section 5.0).

Figure 2. Spring WCS - Aggregate Composition by Material Category (percent by weight)

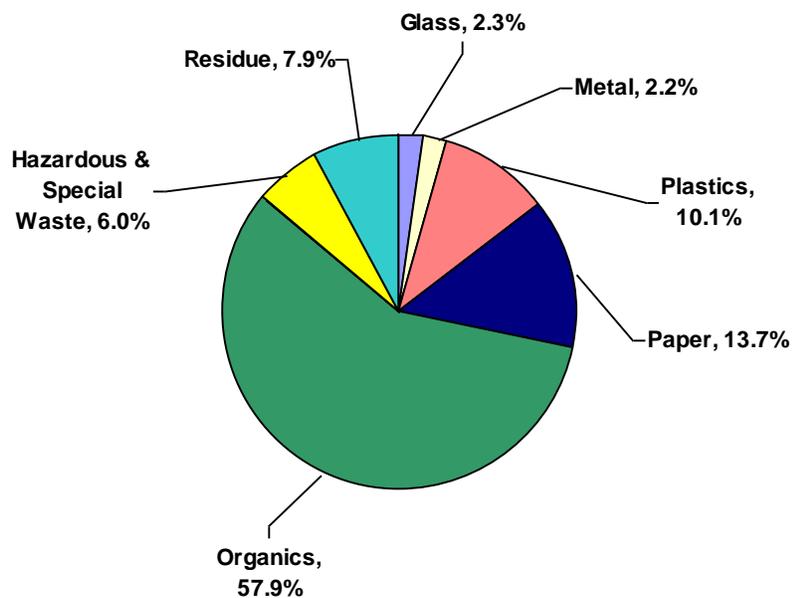
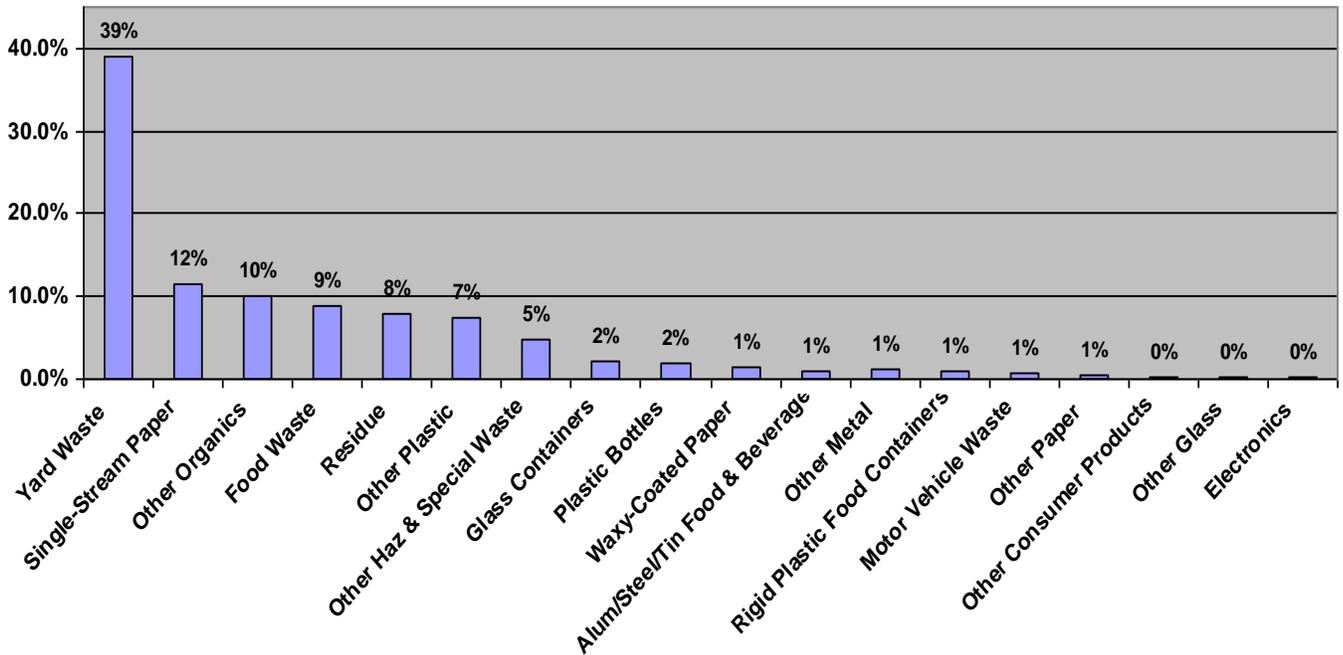


Figure 3. Spring WCS - Aggregate Composition by Material Types (percent by weight)



4.2.2. Fall 2008 Composition

Similarly, Figures 4 and 5 illustrate the composition of the Fall WCS samples in terms of the overarching categories and specific material types, respectively (the Fall WCS had 21 material types plus residue). The aggregated results for the Fall WCS indicate that that Organics was the largest category (56.2%) by weight. The largest material types of Yard Waste, Single-Stream Paper, Food Waste, Other Plastics and C&D Debris were the largest material types, comprising 72.2% of all samples. Of these, the three largest categories provide opportunity for more diversion in the future.

Figure 4. Fall WCS - Aggregate Composition by Material Category (percent by weight)

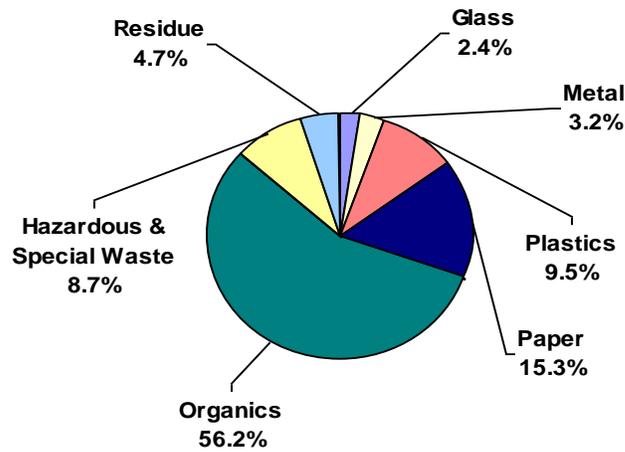
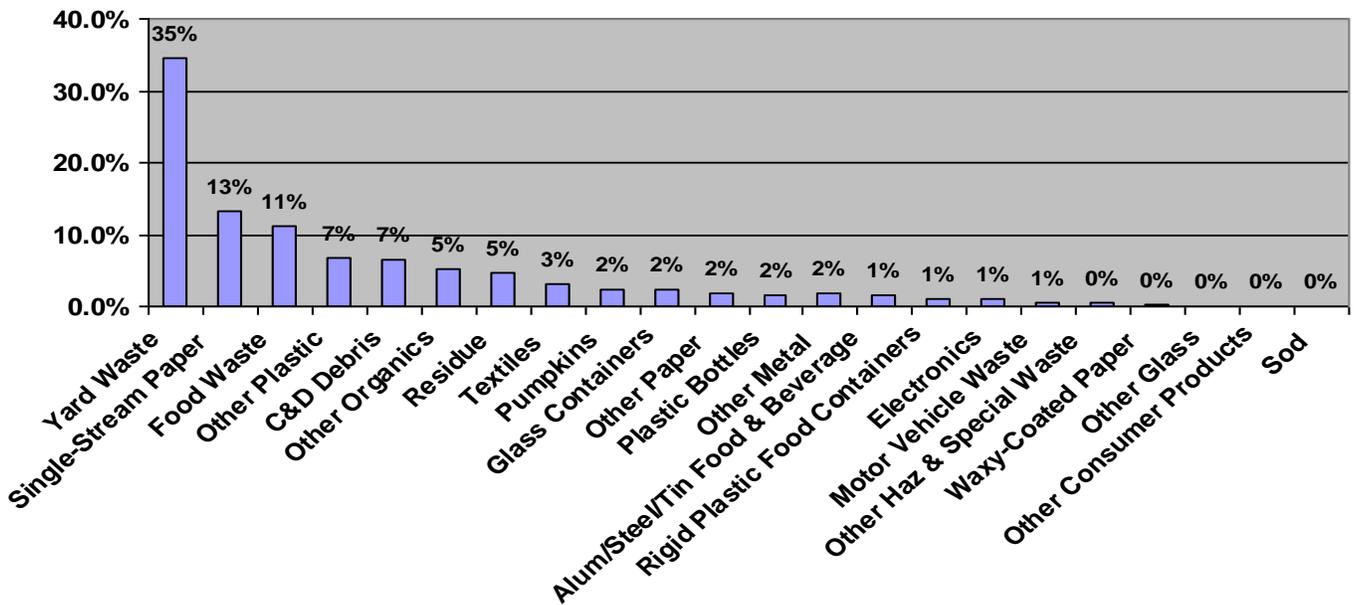


Figure 5. Fall WCS - Aggregate Composition by Material Types (percent by weight)



4.2.3. Aggregated Spring and Fall 2008 Composition

Although the spring and fall 2008 sort results are two distinct snapshots of the Denver waste stream, their aggregated results provide reasonable insight into the yard waste management needs during peak generation periods. It is noted that the aggregated results do not necessarily represent the average annual composition of Denver waste.

Table 6 and Figure 6 compare the aggregated results of the two seasonal sorts. Overall, the results are very comparable, but two key differences should be noted:

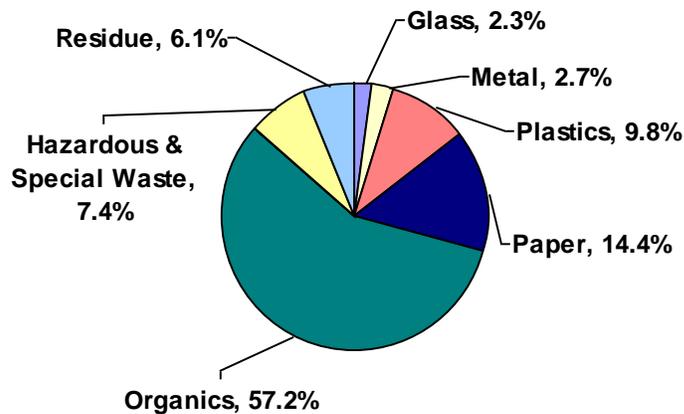
- ◆ Three material types were added to the Fall WCS. Thus, the Fall weights were spread out over more materials, making some categories look smaller in the second sort - most notable is Other Organics (which included sod and textiles during the Spring WCS) and Other Hazardous and Special Waste (which included C&D Debris during the Spring WCS).
- ◆ Residue was higher during the spring (7.5% versus 4.7% in the fall) as a result of higher winds during the week of June 9th.

Table 6. Comparison of Spring & Fall Sort Results (aggregated, percent by weight)

		Spring WCS	Fall WCS	Average WCS Results
Glass	Glass Containers	2.1%	2.3%	2.2%
	Other Glass	0.2%	0.1%	0.1%
Metals	Alum/Steel/Tin Food & Beverage	1.1%	1.5%	1.3%
	Other Metal	1.1%	1.7%	1.4%
Plastics	Plastic Bottles	1.9%	1.7%	1.8%
	Rigid Plastic Food Containers	0.9%	1.1%	1.0%
	Other Plastic	7.3%	6.8%	7.0%
Paper	Single-Stream Paper	11.5%	13.2%	12.4%
	Waxy-Coated Paper	1.3%	0.3%	0.8%
	Other Paper	0.6%	1.8%	1.2%
Organics	Food Waste	8.9%	11.1%	10.0%
	Yard Waste	39.5%	34.5%	37.0%
	Pumpkins		2.3%	1.1%
	Sod		0.0%	0.0%
	Textiles		3.2%	1.6%
	Other Organics	9.9%	5.1%	7.5%
Hazardous & Special Waste	Electronics	0.2%	1.0%	0.6%
	Other Consumer Products	0.3%	0.0%	0.2%
	Motor Vehicle Waste	0.8%	0.6%	0.7%
	C&D Debris		6.6%	3.3%
	Other Haz & Special Waste	4.9%	0.5%	2.7%
Residue	Residue	7.5%	4.7%	6.1%
TOTALS		100.0%	100.0%	100.0%

The top five material types observed on the basis of averaged results from the two seasonal sorts include Yard Waste (37.0%), Single-Stream Paper (12.4%), Food Waste (10.0%), Other Organics (7.5%) and Other Plastics (7.0%).

Figure 6. Aggregate of Composition Spring and Fall Sorts by Material Category (percent by weight)



4.2.4. Comparison with 1992 WCS Data

RW Beck completed a “Limited Waste Composition Study” for Denver during the summer of 1992. As shown in Table 7, that study evaluated fewer materials than the 2008 WCSs. This comparison looks at composition only (percent by weight) - it does not compare the amount of waste generated by a growing population over the 16-year period.

Three observations between 1992 (when there was no city-wide recycling program) and 2008 (when more than half of Denver’s 165,000 households currently have curbside/alley recyclables collection) waste compositions are noted below.

1. It appears that the relatively same proportion of Paper was disposed during both time frames, however:
 - ◆ The 1992 study counted only Newspaper and Cardboard while the 2008 study counted a much larger number of paper types.
 - ◆ EPA data estimates the national average for Newspaper/Cardboard at less than half of the total Paper category (based on national waste characterization data).
 - ◆ The difference in materials sorting between the two studies likely masks a notable decrease in the disposal (increase in diversion) of these Newspaper and Cardboard fractions in 2008, as a result of the Denver Recycles program.

- ◆ The 2008 studies were conducted during seasons when the Yard Waste percentage was at its highest for the year, causing the relative percentages of all other materials (including recyclables such as paper) to be reduced below their likely average annual level (see Table 10).
2. The container composition (especially the ratio of Glass to Plastic Bottles) has changed slightly:
 - ◆ This reflects the national change in food and beverage packaging over the last several years, trending toward more plastic.
 - ◆ The 1992 study only counted PETE and HDPE Plastic Bottles (resins #1 and #2) and only Aluminum/Tin cans - while the 2008 sort counted 7 types of Plastic Bottles as well as several additional types of food and beverage container metals.
 - ◆ It is likely that these differences also hide a notable increase in container recycling.
 - ◆ The high Yard Waste percentage in the 2008 studies caused the relative percentages of containers to be reduced below their average annual rate (see Table 10).
 3. There are two reasons for the notable difference between the 1992 and 2008 Yard Waste component. The 1992 sort was conducted in August and missed the late spring peak of yard waste, and Beck admitted that the 1992 Yard Waste measurement was low as much of the grass clippings during that sort were counted as Other Material. The Spring WCS captured the peak (or near peak spring yard waste generation), while the Fall WCS captured the peak (or near peak) of leaf generation.

**Table 7. Comparison with 1992 Waste Composition Study
(percent by weight)**

Material	1992 Summer WCS (RW Beck)	2008 Spring WCS (HDR)	2008 Fall WCS (HDR)
Paper	10.3% newspaper & cardboard only	11.6% newspaper, cardboard, Kraft paper/bags, office paper, shredded paper, paperboard, magazines/catalogues, telephone books	13.2% newspaper, cardboard, Kraft paper/bags, office paper, shredded paper, paperboard, magazines/catalogues, telephone books
Plastic Containers	0.8% resin #1 and #2 only	2.0% resins #1-#7	1.7% resins #1-#7
Glass Containers	4.2%	2.0%	2.3%
Metal Containers	1.4% alum/tin only	1.0% alum/tin/steel/bimetal cans; foil, food trays & pie tins	1.5% alum/tin/steel/bimetal cans; foil, food trays & pie tins
Yard Waste	17.6%	39.0%	34.5%
Other Materials	65.7%	56.2% Other Paper, Plastics, Glass, Metal, Organics; Food Waste; Hazardous/Special Waste; Residue	46.8% Other Paper, Plastics, Glass, Metal, Organics; Food Waste; Hazardous/Special Waste; Residue
Total	100%	100%	100%

4.2.5. Waste Material Composition

ORGANICS - The Organics category represents an average of 57.2% of all residential waste samples between the two sorts, and included two of the heaviest material types observed during the sort (Yard and Food Waste). Key observations about these material types include the following:

- ◆ Yard Waste (average of 37.0%) was primarily grass clippings during the Spring WCS with some sod, small- to medium-sized stumps and branches (especially from juniper bushes), untreated wood and sawdust; the Fall WCS samples were predominately leaves.
- ◆ Food Waste (average of 10.0%) included notable quantities of food-contaminated paper towels, napkins, paper packaging and coffee grounds.
- ◆ Pumpkins (average of 1.2% but measured for the Fall WCS only) - were observed in about 40% of the fall samples (the fall sort was held the week of November 3rd and included Halloween-related waste); note that this material is typically only generated during fall months and is not typical of the average annual waste stream.
- ◆ Textiles (average of 1.6% but measured for the Fall WCS only) - included clothing, shoes, rags, bedding, insulation and carpeting.
- ◆ Other Organics (average of 7.5%) included high quantities of diapers with lesser quantities of animal feces and cat litter.

The high quantity of grass clippings, sod and leaves (easily mixed with other materials) often made sorting these materials into individual types difficult. In a small number of samples there were also portions of waste with high organics content too foul for sorting (animal fecal material, highly degraded food, etc.). In each of these cases, the waste was sorted to the extent feasible - remaining materials were then weighed and counted as the type of organics visually observed in the greatest quantity. Notes about mixed materials and contamination were subsequently made on the log sheets in Appendices E and F.

PAPER - The Paper category represented an average 14.4% between the two sorts, and included the second highest material observed during the sort (Single-Stream Paper). Key observations about these materials included:

- ◆ Single-Stream Paper (average of 12.4%) included more cardboard and newspaper than Kraft paper, office paper, shredded paper, magazines, paperboard and telephone directories - much of the cardboard was not broken down and much of the newspaper was heavily contaminated with Food Waste and Other Organics.
- ◆ Waxy-Coated Paper (average of less than 1%) included mostly paper cups, plates (often from take-out food) and milk cartons.
- ◆ Other Paper (average of 1.2%) included freezer food packaging and other foil-lined packaging.

Windy weather during the Spring WCS caused paper and plastics (along with other light-weight materials) to be blown away from the sorting areas. These materials were collected at the end of sorting and allocated to the Residue category for all samples sorted that day. As a result, some paper materials were counted in the Residue versus Paper category.

PLASTICS - The Plastics category represented an average of 9.9% for the two sorts. Key observations about these materials included:

- ◆ Plastic Bottles (average of 1.8%) included mostly empty water/juice/soda bottles and milk jugs.
- ◆ Rigid Plastic Food Containers (average of 1.0%) included cups, clamshells, yogurt containers and other mixed packaging.
- ◆ Other Plastic (average of 7.1%) included primarily film - with notably less quantities of foam, Styrofoam, mixed packaging, hoses and several 5-gallon plastic buckets.

The mixed plastic packaging during the Fall WCS included observable quantities of candy wrappers, which was consistent with timing of Halloween. Some Other Plastic materials (primarily packaging) were counted in the Residue versus Other Plastic category due to contamination (especially during windy weather during the Spring WCS) as noted above.

GLASS & METAL - The Glass (average of 2.4% between the two sorts) and Metal (average of 2.7%) categories included the lowest quantity of materials sorted. It was noted that most containers were empty, and that non-container materials were minimal.

HAZARDOUS & SPECIAL WASTE - The Hazardous & Special Waste category represented an average of 7.5% for the two sorts. Electronics, Other Consumer Products and Motor Vehicle Waste each represented less than 1% and included such items as bits of circuit boards, small motors, parts of household electronics, and cell phones; small appliances; furniture; and tires. No whole computers, televisions, CRT monitors, or laptops were observed, though parts of these items were observed.

C&D Debris was measured for the Fall WCS only (average of 3.3%) and included notable quantities of treated wood, asphalt shingles, bricks and ceramics (rolls of carpet were also observed in waste loads, but not weighed). Other Hazardous & Special Waste averaged 2.7%, and included C&D Debris in the spring but not the fall. Non-C&D materials observed included syringes, batteries, partially filled aerosol cans, paint and filters.

RESIDUE - Residue includes inorganic materials not included in the other material types, as well as contamination that cannot reasonably be separated from other materials. Grass clippings and leaves were especially hard to separate, as were small pieces of paper and plastic packaging. The Residue total represented an average 6.1% between the two sorts.

4.3 Comparison of Composition by Collection System

DSWM has documented that households served by dumpsters generate more waste (1.7 tons/household-year excluding Large Item Pick-Up) than those served by carts in the barrel system (1.4 tons/household-year) or those who provide their own containers in the manual system (1.1 tons/household-year). However, the relative quantities of material types from each collection system were unknown. An evaluation was therefore conducted on unweighted results (i.e., not adjusted by Table 3 calculations) to identify any waste patterns that might be helpful in Denver's future program changes or improvements. Table 8 compares findings for the Spring and Fall 2008 WCSs.

Table 8. Comparison of Waste Composition (Unweighted) by Collection System (percent by weight)

Material	SPRING 2008			FALL 2008		
	Dumpster	Barrel	Manual	Dumpster	Barrel	Manual
Glass Containers	2.3%	1.8%	1.8%	2.2%	2.3%	2.5%
Other Glass	0.4%	0.1%	0.0%	0.1%	0.1%	0.1%
Alum/Steel/Tin Food & Beverage	0.9%	1.4%	0.8%	1.0%	1.9%	1.8%
Other Metal	1.2%	1.0%	1.1%	2.7%	1.4%	0.0%
Plastic Bottles	1.8%	2.1%	1.4%	1.1%	2.6%	1.5%
Rigid Plastic Food Containers	0.6%	1.3%	0.7%	1.2%	1.0%	0.8%
Other Plastic	7.0%	7.0%	9.2%	5.9%	6.9%	8.9%
Single-Stream Paper	10.7%	12.1%	13.1%	14.5%	12.0%	12.3%
Waxy-Coated Paper	1.1%	1.2%	2.8%	0.1%	0.6%	0.4%
Other Paper	0.5%	0.9%	0.4%	2.3%	0.6%	2.3%
Food Waste	6.9%	11.8%	9.1%	10.4%	12.3%	10.7%
Yard Waste	45.2%	34.2%	31.6%	34.4%	33.9%	36.0%
Pumpkins	0.0%	0.0%	0.0%	2.4%	2.2%	2.1%
Sod	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Textiles	0.0%	0.0%	0.0%	3.6%	2.5%	3.3%
Other Organics	9.4%	10.1%	11.3%	5.5%	4.4%	5.2%
Electronics	0.2%	0.2%	0.2%	1.5%	0.7%	0.1%
Other Consumer Products	0.5%	0.0%	0.2%	0.0%	0.0%	0.1%
Motor Vehicle Waste	1.6%	0.0%	0.0%	0.7%	0.0%	1.7%
C&D Debris	0.0%	0.0%	0.0%	6.2%	8.1%	5.0%
Other Haz/Special Waste	3.4%	7.6%	3.3%	0.3%	0.8%	0.3%
Residue	6.4%	7.1%	13.0%	3.8%	6.0%	4.9%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

On a collection system basis, the most notable observation is that more Yard Waste, percent by weight, was collected in the dumpsters during the spring (45.2%) than in the other containers. However, the barrel system included slightly more Food Waste than the other systems. The combined percentage of Yard and Food Waste was most diverse in the spring, when dumpster, barrel and manual results were 52.1%, 46.0% and 40.7%, respectively.

This supports a recommendation to add organics collection in dumpster areas first, followed by barrel areas, if implementation occurs in phases.

Other Organics were observed in greater quantities during the spring sort and are likely a result of spring clean-up activities by residents. Less Other Paper was observed during the spring sorts of dumpster and manual loads - these materials probably ended up in the Residue fraction due to windy conditions during the May sort.

4.4 Comparison of Composition by Recycling Participation

During the Spring WCS, DSWM conducted an evaluation of waste composition as a function of recycling participation. DSWM tracks recycling participation on a per route basis in terms of the percent of households that have subscribed for recycling (Table 2 identified participation levels for the targeted sampling routes). This tracking data has been organized into three categories for the purpose of the Spring WCS:

- ◆ Low recycling participation = <31% average subscribers per route
- ◆ Medium recycling participation = 31% to 55% subscribers
- ◆ High recycling participation = >55% subscribers

During the spring 2008 WCS, 20 samples were taken from low participation routes (<31% households subscribed to the Denver Recycles' program); 11 from medium participation routes (31% to 55% subscribed); and 10 from high participation routes (>55% subscribed). Figure 7 graphically compares the material categories collected in these samples. Table 10 provides numerical data for both material types and categories, as a function of recycling participation.

Note that this analysis considered dumpster, barrel and manual collections for each level of participation, and that samples associated with each collection type were weighted based on Table 3 calculations.

Figure 7 indicates that - from a broad category perspective - there was little difference in waste composition between routes with households that recycle at low, medium or high rates for materials in the Glass, Metal, Plastics and Paper categories (the range between recycling areas for these materials is 2.2% or less). More notable variation occurred in the last two categories, with high-participating samples containing less than one-half to one-third of the Hazardous and Special Waste (primarily construction debris) of the others.

Table 9 provides more only slightly more insight on a material-specific level. With respect to materials that can be recycled in Denver Recycles' existing program, it was noted that:

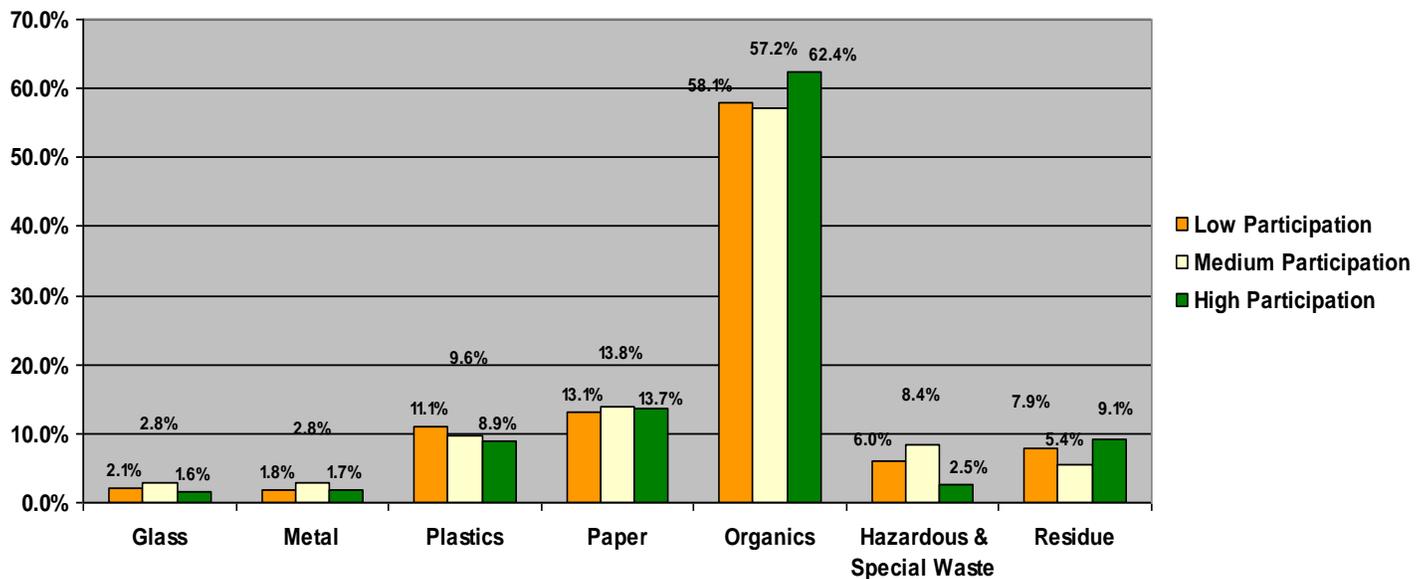
- ◆ With respect to recyclable containers, the results do not indicate that low-participating areas had the most Glass Containers, Alum/Steel/Tin Containers and Plastic Bottles in their waste as expected - or that high-participating areas had the least (these results were mixed although the results were all within only 1% of each other and too close for clear differentiation).

- ◆ Single-Stream Paper results were also not expected - low-participating areas had less of this material than the other areas (although results were also very close - within 0.8% of one another).

Observations for other materials included:

- ◆ Low-participating areas had more Other Plastic, primarily plastic film (the results were within only 2.5%).
- ◆ High-participating areas had more Organics (the results for material types within this category were within 5.2%).

Figure 7. Comparison of Material Categories by Recycling Participation Level (not weighted)



These results do not present clear differentiation between participation (or subscription) levels. One possible reason for these results may be that WCS samples were not collected from every load on each route. It is possible that samples were not specifically collected from those portions of the routes that best represent the households whose participation levels drive DSWM’s metrics of low, medium and high recycling.

Another explanation for these results could be that actual recycling levels are not tied to average subscription rates in any given route. In other words, if the recycling households on low-participating routes recycled more aggressively than those in high-participating areas, the resulting waste composition might have the same general lack of differentiation as noted in Table 10.

Note that, due to the inconclusive results obtained during the Spring WCS, this analysis was not repeated for the Fall WCS.

Table 9. Comparison of Waste Composition by Recycling Participation (Subscription) Levels (percent by weight)

Material Category	Material Type	Participation					
		Low		Medium		High	
		Type %	Category %	Type %	Category %	Type %	Category %
Glass	Glass Containers	2.0%		2.4%		1.4%	
	Other Glass	0.1%	2.1%	0.4%	2.8%	0.2%	1.6%
Metals	Alum/Steel/Tin Food & Beverage	1.1%		1.3%		0.5%	
	Other Metal	0.7%	1.8%	1.5%	2.8%	1.2%	1.7%
Plastics	Plastic Bottles	2.1%		1.7%		1.5%	
	Rigid Plastic Food Containers	0.5%		1.2%		1.6%	
	Other Plastic	8.4%	11.1%	6.8%	9.6%	5.9%	8.9%
Paper	Single-Stream Paper	11.1%		11.9%		11.8%	
	Waxy-Coated Paper	1.4%		1.6%		1.3%	
	Other Paper	0.6%	13.1%	0.3%	13.8%	0.6%	13.7%
Organics	Food Waste	9.1%		8.8%		9.4%	
	Yard Waste	39.3%		37.5%		43.1%	
	Other Organics	9.7%	58.1%	10.8%	57.2%	9.8%	62.4%
Hazardous & Special Waste	Electronics	0.1%		0.6%		0.0%	
	Other Consumer Products	0.1%		0.5%		0.0%	
	Motor Vehicle Waste	0.0%		1.9%		0.0%	
	Other Haz/Special Waste	5.7%	6.0%	5.3%	8.4%	2.5%	2.5%
Residue	Residue	7.9%	7.9%	5.4%	5.4%	9.1%	9.1%
Totals		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

5.0 Assessment of Annual Average Waste Composition and Projection of Potential Future Diversion

Due to the targeted seasonal nature of the 2008 waste composition analysis, it was necessary to consider other information to assess the average annual composition. DSWM evaluated composition results obtained from waste characterization studies on waste samples at the Larimer County Landfill. Larimer County's work was based on two seasonal sorts (summer and winter) and was completed in 2006. Table 10 includes a summary of Denver and Larimer County results, and an assessment of annual Denver waste composition based on the combined data sets.

Table 10. Assessment of Annual Average Waste Composition

Material Category	Material Type	DENVER 2008 WCS RESIDENTIAL			LARIMER 2006 WCS RESIDENTIAL	Denver Annual Composition
		Spring WCS	Fall WCS	Avg Denver	Average Summer/Winter	
Glass	Glass Containers	2.0%	2.3%	2.2%	3.1%	2.6%
	Other Glass	0.2%	0.1%	0.2%	0.4%	0.3%
Metals	Alum/Steel/Tin Food & Beverage	1.1%	1.5%	1.3%	2.1%	1.7%
	Other Metal	1.1%	1.7%	1.4%	2.5%	2.0%
Plastics	Plastic Bottles	1.8%	1.7%	1.8%	2.3%	2.0%
	Rigid Plastic Food Containers	0.9%	1.1%	1.0%	3.2%	2.1%
	Other Plastic	7.4%	6.8%	7.1%	5.1%	6.1%
Paper	Single-Stream Paper	11.6%	13.2%	12.4%	23.5%	15.0%
	Waxy-Coated Paper	1.4%	0.3%	0.9%	0.2%	0.5%
	Other Paper	0.6%	1.8%	1.2%	7.7%	2.5%
Organics	Food Waste	8.9%	11.1%	10.0%	17.4%	13.7%
	Yard Waste/Pumpkins	39.0%	36.8%	37.9%	9.9%	28.7%
	Sod	0.0%	0.0%	0.0%	0.0%	0.0%
	Textiles	0.0%	3.2%	1.6%	2.4%	2.0%
	Other Organics	10.0%	5.1%	7.6%	9.0%	8.3%
Hazardous & Special Waste	Electronics	0.2%	1.0%	0.6%	2.2%	1.4%
	Other Consumer Products	0.3%	0.0%	0.2%	0.4%	0.3%
	Motor Vehicle Waste	0.8%	0.6%	0.7%	0.0%	0.4%
	C&D Debris	0.0%	6.6%	3.3%	4.1%	3.7%
	Other Haz & Special Waste	4.7%	0.5%	2.6%	0.8%	1.7%
Residue	Residue	7.9%	4.7%	6.3%	3.7%	5.0%
		99.9%	100.1%	100.0%	100.0%	100.0%

In an effort to identify potential diversion of recyclables and yard waste based on the waste composition in Table 10, material quantities have been estimated based on percent by weight and the 2008 landfill tonnage (220,000 tons). This estimation is shown in Table 11.

Table 11. Future Potential Diversion (based on 100% recovery)

Material Category	Material Type	Avg Type %	Tons	Potential Tons Diverted	
Glass	Glass Containers	2.6%	5,720	5,720	
	Other Glass	0.3%	660		
Metals	Alum/Steel/Tin Food & Beverage	1.7%	3,740	3,740	
	Other Metal	2.0%	4,400		
Plastics	Plastic Bottles	2.0%	4,400	4,400	
	Rigid Plastic Food Containers	2.1%	4,620	4,620	
	Other Plastic	6.1%	13,420		
Paper	Single-Stream Paper	15.0%	33,000	33,000	Existing Recyclables 46,860
	Waxy-Coated Paper	0.5%	1,100	1,100	Future Recyclables 5,720
	Other Paper	2.5%	5,500		
Organics	Food Waste	13.7%	30,140	30,140	Future Organics 97,680
	Yard Waste/Pumpkins	28.7%	63,140	63,140	
	Sod	0.0%	0	0	
	Textiles	2.0%	4,400	4,400	
	Other Organics	8.3%	18,260		
Hazardous & Special Waste	Electronics	1.4%	3,080		
	Other Consumer Products	0.3%	660		
	Motor Vehicle Waste	0.4%	880		
	C&D Debris	3.7%	8,140		
	Other Haz & Special Waste	1.7%	3,740		
Residue	Residue	5.0%	11,000		
TOTALS		100%	220,000	150,260	Total Potential 150,260

Note that 100% recovery is unreasonable and consideration of lower recovery rates is needed

As shown, if DSWM recovered 100% of these materials, Denver has the maximum potential to divert as much as 150,260 tons in 2008, which represents 68.3% of the 220,000 tons landfilled. These materials include:

- ◆ Existing recyclables (21.3%) - containers and fiber that are not being captured by the current Denver Recycling program.
- ◆ Future recyclables (2.6%) - Rigid Plastic Food containers and Way-Coated Paper that may be accepted by DSWM's recycling and organics vendors in the future.

- ◆ Future organics (42.4%) - Yard and Food Waste that may be part of a permanent organics collection program implemented by DSWM in the future.

However, it is not reasonable that any program achieve 100% recovery of its potentially diverted materials. To estimate more reasonable levels, a range of 40% to 60% diversion for both recyclables and organics was evaluated.

**Table 12. Total Tons Diverted if Recyclables/Organics Recovered at 40%-60% Level
(tons unless otherwise indicated)**

	Actual	Assume 40% Diverted Recyclables/40% Diverted Organics	Assume 50% Diverted Recyclables/50% Diverted Organics	Assume 60% Diverted Recyclables/60% Diverted Organics
Existing Recyclables				
2008 Diversion	28,600	30,180	37,730	45,280
Recyclables in Waste	46,860	45,280	37,730	30,180
Total Recyclables	75,460	75,460	75,460	75,460
Recyclables Diversion Rate	37.9%	40.0%	50.0%	60.0%
Organics				
2008 Diversion	0	37,310	46,640	55,970
Recyclables in Waste	93,280	55,970	46,640	37,310
Total Recyclables	93,280	93,280	93,280	93,280
Organics Diversion Rate	0.0%	40.0%	50.0%	60.0%
Diverted Tons (Recyc + Org)	28,600	67,490	84,370	101,250
Landfilled Tons	220,000	181,110	164,230	147,350
Total (Recyc + Org + LF)	248,600	248,600	248,600	248,600
Overall Diversion Rate	11.5%	27.1%	33.9%	40.7%

Table 12 indicates that DSWM's current program recovers 37.9% of its recyclables and 0% organics, and achieves an overall landfill diversion rate of 11.5%. The table also shows that if DSWM is able to develop and maintain mature recyclables and organics diversion programs that consistently divert between 40% and 60% of the materials in each category, overall diversion of materials from landfill disposal can range from 27% to 41%. This estimate does not consider diversion benefits achieved through DSWM's handling of electronic, household hazardous or other wastes.

It is clear that Denver has significant opportunities for additional diversion. Notably, Table 12 also demonstrates that the Denver Greenprint goal of reducing landfilled quantities to at least 185,000 tons can be met by generally maintaining the current recycling program and adding an organics recovery program that diverts 40% of the total yard and food waste generated by residents. In the 40% diversion scenario, approximately 67,000 tons of recyclables and organics would be diverted.

6.0 Recommendations

A number of recommendations are made for Denver's future waste diversion activities based on the two-season waste sort and evaluation of annual waste composition. These recommendations should be a primary component of both DSWM's Solid Waste Master Plan and its response to the Greenprint Denver goals.

DEVELOP A CITY-WIDE ORGANICS RECOVERY PROGRAM - diversion of yard and food wastes holds the biggest diversion potential for Denver.

1. Evaluate and utilize pilot study results:

- ◆ Preliminary results from the still-ongoing study indicate positive results (i.e., approximately 55% of participating households place organics out each collection day; nearly 32 pounds/set out were observed during the weekly collection and 20-26 pounds/set out were observed during the every-other-week collection).
- ◆ Contamination of captured organics appears to be very low.
- ◆ Final pilot study results should be used to project the cost and logistics of a city-wide program - additional grant or sponsorship funding should be pursued for container purchase and public outreach.

2. Consider permanent program design:

- ◆ Carts - the Spring WCS yard waste included primarily grass waste as well as other yard debris that would, with few exceptions, be small enough to fit into 65- or 95-gallon carts collected weekly or every-other-week; the same was true of the leaves and miscellaneous yard debris in the Fall WCS.
- ◆ Collection frequency - every-other-week collection may be too frequent for many residents during the winter months (may require education about handling food waste and not placing organics out on collection day unless cart is at least 50% full).

3. Evaluate phased implementation - the combination of Yard and Food Waste (percent by weight) was generated in greatest quantities from dumpster routes in the spring (the greatest amount of Organics are generated during this season), followed by barrel routes. Phased implementation should consider adding organics collection to dumpster areas first and barrel areas second.

Note that adding organics recovery as a new service could be "exchanged" with existing service DSWM would like to reduce, change or remove, such as replacing dumpsters with carts, reducing Large Item Pick-Up collections or other. An "exchange" of services is one way to minimize customer concern over changed service, as well as encourage diversion.

4. Evaluate long-term options for compost processing:

- ◆ The cost of transfer/hauling/tipping associated with A1 Organics' Keenesburg facility may not be cost-effective over the life this program - a cost/benefit analysis will be necessary to fully develop costs.

- ◆ The city should explore - either on its own or in partnership with a private sector processor - the ability of developing a compost facility closer to Denver.
- ◆ Other organics sources should be considered when evaluating future processing options - such as DIA's food waste (currently a pilot study), drop-site and seasonal yard waste from residents and commercial generators and potentially other sources.

EXPANDED PUBLIC OUTREACH - additional focus in the following areas is recommended to encourage residents to:

1. Leave grass clippings on lawns and practice backyard composting.
2. Use the fall leaf drop program.
3. More effectively recycle paper (especially newspaper and cardboard);
 - ◆ Encourage residents to break down cardboard boxes (they may not understand that cardboard is fully recyclable in the current program, that cardboard left outside recycling carts is treated as overflow and landfilled - or they may not be willing to break down boxes for recycling).
 - ◆ Consider replacing one of the Large Item Pick-Up routes with a cardboard collection route and/or drop site collection.
 - ◆ Encourage residents to wrap dirty diapers, food scraps and animal feces in plastic bags that aren't recyclable (yet) instead of high-valued newspaper (largely contaminated by Food Waste and Other Organics) - implementation of permanent organics collection with kitchen pails and biobags is likely to reduce this practice.

RE-EVALUATION OF RECYCLING PARTICIPATION - DSWM should reconsider the use of "number of recycling subscriptions" as an indicator of actual recycling levels. If information on how waste composition varies between routes with differing levels of recycling data is still needed by DSWM, an alternate sampling methodology should be evaluated. As well, set-out data from recycling routes should be linked to waste collection routes to better correlate recycling and waste practices.

ADDITIONAL WASTE COMPOSITION STUDIES - DSWM obtained good waste composition data from the sorts conducted in 2008. They yielded detailed information about Yard and Food Waste, and also provided reasonable data on recyclables still being disposed. While additional WCSs (especially to evaluate summer and winter waste characteristics) would be beneficial, they are probably not critical. And if additional studies are conducted after 2009/10, their relativity to 2008 results will probably be limited as well.



APPENDIX H

Refuse, Recycling and Organics Compost Cost Analysis

APPENDIX H - ORGANICS COLLECTION COST OPINION

Project:	Denver Solid Waste Management Plan
Technology:	Organics Collection - Automated and Semi-Automated
Date:	3/8/2010 Updated
Cost Estimate Basis:	2010\$ - Cost assumptions from Denver, costing manuals & other projects
Location:	Denver, Colorado

ORGANICS COLLECTION EXPANSION COSTS

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	
Automated Organics Collection						
No. of Carts/Yr	20,000	40,000	15,000	15,000	10,000	
New Households in Program	20,000	60,000	75,000	90,000	100,000	
No. of Routes/Day (April - November)	6	16	20	24	27	
No. of Routes/Day (Dec - March)	3	8	10	12	14	
No. Automated Vehicles Purchase/Yr	6	10	4	4	3	
Automated Spares - Assume existing vehicles at end of replacement schedule used as spares						
Automated Vehicle Capital Cost	\$1,440,000	\$2,400,000	\$960,000	\$960,000	\$720,000	
Annual O&M						
Amortized Vehicle	\$283,700	\$756,500	\$945,600	\$1,134,700	\$1,276,600	
Organics Cart Costs	\$835,000	\$2,000,000	\$750,000	\$750,000	\$500,000	less 3300 carts existing: one time
Collection Labor	\$267,600	\$713,700	\$892,100	\$1,070,500	\$1,213,200	Weekly (Apr-Nov); EOW (Dec-Mar)
Fleet Maintenance	\$282,900	\$754,400	\$943,000	\$1,131,600	\$1,282,200	Weekly (Apr-Nov); EOW (Dec-Mar)
Misc. Cart Delivery	\$2,300	\$4,500	\$1,700	\$1,700	\$1,100	one time
Organics Collection Subtotal	\$1,671,500	\$4,229,100	\$3,532,400	\$4,088,500	\$4,273,100	
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	
Organics Composting Tip Fee						
Organics Diversion Quantities (tons)	1,500	9,800	15,500	22,900	29,500	
Composting Tip Fees (1)	\$40,500	\$264,600	\$418,500	\$618,300	\$796,500	
Organics Composting Subtotal	\$40,500	\$264,600	\$418,500	\$618,300	\$796,500	

Notes:

1. Projected tip fee at Stapleton location; **\$27** per ton
Includes transfer operations from Stapleton, haul and composting fee at A1 Organics facility in Keenesburg.



APPENDIX I

Projected Recyclables Revenues



APPENDIX J

LIP, Overflow and Litter Collection Cost Analysis

APPENDIX J - LIP, OVERFLOW LITTER COST OPINION

Project:	Denver Solid Waste Management Plan
Technology:	Large Item Pickup and Overflow
Date:	3/8/2010 Updated
Cost Estimate Basis:	2010\$ - Cost assumptions from Denver, costing manuals & other projects
Location:	Denver, Colorado

LARGE ITEM PICKUP (LIP)

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
General LIP Frequency	6	6	4	4	4
Estimated Quantities (tons)	4,800	4,200	3,900	3,400	3,100
Collection Routes	4	4	3	3	3
Rearloader Capital Cost - Use existing rear loaders					
Annual O&M					
Fixed Charges	\$145,200	\$145,200	\$145,200	\$145,200	\$145,200
Variable Charges	\$1,104,000	\$1,104,000	\$736,000	\$736,000	\$736,000
Waste Disposal	\$76,800	\$67,200	\$62,400	\$54,400	\$49,600
General LIP Subtotal	\$1,326,000	\$1,316,400	\$943,600	\$935,600	\$930,800

Currently 5 rearloaders are dedicated to routes and 3 spares.
 At least 3 rearloaders currently in the fleet do not need to be replaced.

Savings of \$86,800 per year in amortized rearloader capital

No change to Night LIP and Special Districts LIP (not included). These costs remain the same.

OVERFLOW

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Overflow Collection Frequency	17	4	4	4	0
Est. Refuse Quantities* (tons)	12,000	10,800	10,100	9,200	8,500
Rearloader Capital Cost - Use existing rear loaders					
Annual O&M					
Overflow Labor	\$567,200	\$377,100	\$377,100	\$377,100	\$0
Fleet Maintenance	\$157,700	\$114,200	\$114,200	\$114,200	\$0
Waste Disposal	\$192,000	\$172,800	\$161,600	\$147,200	\$0
Overflow Total	\$916,900	\$664,100	\$652,900	\$638,500	\$0

*Refuse in 2015 managed through curbside collection, litter management, and drop sites.

LITTER MANAGEMENT

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Estimated Quantities (tons)	2,400	2,100	2,000	1,800	1,600
Rearloader Capital Cost - Use existing rear loaders from LIP and Overflow programs					
Enforcement Hours: Personnel FTE	0.5	0.6	0.6	0.5	0.3
Annual O&M					
Enforcement Labor	\$31,200	\$37,400	\$37,400	\$31,200	\$18,700
Collection Labor	\$191,600	\$191,600	\$191,600	\$191,600	\$191,600
Fleet Maintenance	\$88,400	\$88,400	\$88,400	\$88,400	\$88,400
Waste Disposal	\$38,400	\$33,600	\$32,000	\$28,800	\$25,600
Litter Management Total	\$349,600	\$351,000	\$349,400	\$340,000	\$324,300

APPENDIX J - LARGE ITEM PICKUP, OVERFLOW, LITTER COST ASSUMPTIONS

Project:	Denver Solid Waste Management Plan
Technology:	Large Item Pickup and Overflow
Date:	3/8/2010 Updated
Cost Estimate Basis:	2010\$ - Cost assumptions from costing manuals & other projects
Location:	Denver, Colorado

INPUT ASSUMPTIONS

Interest Rate	5%
Annual Escalation Rate	3% (from year 2009 to 2010)
Average Disposal Cost (2010\$)	\$16 per ton

Large Item Pickup (LIP)

Manual collection with up to 2 workers

Driver (Equip. Operator) =	\$35,491	Step 5 of EO	(2009\$ escalated at 3%)
Laborer (Sr. Utility Worker) =	\$33,943	Step 5 of SUW	(2009\$ escalated at 3%)
		38% benefits	

Fleet Maintenance

Rear loader	\$3.86	per mile	(Rearloaders - LIP, 2009\$ escalated at 3%)
Dump truck with plow	\$2.77	per mile	(Dump truck, 2009\$ escalated at 3%)
Pick-up	\$8,800	per pick-up	(based on 10-month 2009\$ & # pickups)
Rear Loader Capital	\$187,000	per vehicle	(2009\$ purchase escalated)
Vehicle Replacement Schedule		8 years	

Year 2010 Budget	Total LIP	Night LIP (est.)	Special District LIP (est.)	General LIP	
Labor	\$1,087,687			\$776,687	
Fixed Labor (estimate)		\$96,000	\$96,000	\$119,000	supervisor & on-call
Other Services	\$25,500			\$25,500	excludes disposal
Fleet Maint Straight Charge	\$730			\$730	
Fleet Maintenance	\$382,343	\$34,000	\$23,000	\$325,343	estimated Night & SD
	\$1,496,260	\$130,000	\$119,000	\$1,247,260	
General LIP (Fixed Charges)	\$145,200				
General LIP (Variable Charges)	\$1,102,030				
		\$184,000			per LIP frequency

Overflow

Manual collection with 2 workers

Driver (Equip. Operator)	\$35,491	Step 5 of EO	(2009\$ escalated at 3%)
Laborer (Sr. Utility Worker)	\$33,943	Step 5 of SUW	(2009\$ escalated at 3%)
On-Call (Utility Worker)	\$31,046	Step 5 of UW	(2009\$ escalated at 3%)
		38% benefits	

Fleet Maintenance - Rearloader

Rearloader	\$3.86	per mile	(Rearloaders, 2009\$ escalated at 3%)
	\$35,400	per vehicle	(based on 2009\$ annual fleet maintenance per route)

	2010 & 2011	2012	2015	
Barrel HHs	55900	99200	179500	
Driveby/HH/year	17	4	0	
Collection Routes (year-round)	4	3	0	44 miles/day/route
Add'l Collection Routes(summer)	2	1	0	4 days/week
No. of Route Rearloaders	9	4	0	
No. of Spare Rearloaders	1	1	0	
Labor				
Equipment Operator	3	3	0	
Senior Utility Worker	5	3	0	
Senior Utility Worker - rotation	1	1	0	
Oncall Utility Worker	3.25	1	0	

Barrel routes only; # barrel routes increasing through short-term period

APPENDIX J - LARGE ITEM PICKUP, OVERFLOW, LITTER COST ASSUMPTIONS

2009\$ Fleet Maint. Budget	\$392,000
2009\$ Labor Budget	\$867,000 (3 EO; 9 SUW; 3 SUW-rotation; 4.6 OUW)

Litter Collection

Litter increase due to reduced LIP and conversion to barrels

Assume # routes 2 rotated through all collection areas
55 miles/day/route
4 days/week

Assume 2-worker crew:

Driver (Equip. Operator)	\$35,491	Step 5 of EO	(2009\$ escalated at 3%)
Laborer (Sr. Utility Worker)	\$33,943	Step 5 of SUW	(2009\$ escalated at 3%)
		38% benefits	

Fleet Maintenance - Rearloader	\$3.86	per mile	(Rearloaders, 2009\$ escalated at 3%)
Rearloader	\$35,400	per vehicle	(based on 2009\$ annual fleet maintenance per route)

Enforcement applies to LIP, overflow and litter management.

Enforcement included under ongoing litter management since LIP and Overflow reduced.

Enforcement (Assoc City Insp)	\$45,204	Step 5 plus 3% escalation to 2010
		38% benefits

Hours estimated from # barrel households and approximate time/complaint



APPENDIX K

Short-Term Drop-Site Collection Cost Analysis

APPENDIX K - DROP-OFF SITES CAPITAL IMPROVEMENT COSTS

Project:	Denver Solid Waste Management Plan
Technology:	Drop-Off Site Collection Standard Location
Date:	3/8/2010 Updated
Cost Estimate Basis:	2010\$ - Cost assumptions from costing manuals & other projects
Location:	Denver, Colorado

CAPITAL COST PER DROP-SITE

Item	Quantity	Units	Unit Cost	Total
Land Purchase (1)	0.5	Acres	\$0	\$0
Final Grading (1)	2420	SY	\$3	\$7,300
Concrete Pad (2)	45	CY	\$350	\$15,750
Steel Rails (3)	3	sets	\$1,000	\$3,000
Crushed Rock/Gravel (4)	2220	SY	\$10	\$22,200
Access Stairs/Platform	3	EA	\$2,000	\$6,000
Drop-Site Signage	2	EA	\$500	\$1,000
Security Fencing (5)	590	LF	\$24	\$14,200
Personnel Convenience Building (6)	1	EA	\$10,000	\$10,000
Subtotal Site Improvements				\$79,450
Contingency (10%)				\$7,950
Drop-Site Improvements				\$87,400
Covered Recycling Roll-Off	1	EA	\$6,000	\$6,000
Organics Roll-Off	1	EA	\$5,000	\$5,000
Large Items Roll-Off	1	EA	\$5,000	\$5,000
Subtotal Mobile Equipment				\$16,000
Contingency (10%)				\$1,600
Mobile Equipment				\$17,600
Total Drop-Site Capital Cost Per Location				\$105,000

Assumptions:

- 1 Land assumed to be existing city property or donated use.
Area estimated for 4 roll-offs (3 plus spare) plus maneuvering & expansion.
- 2 Concrete slab on grade under roll-offs and tractor approach (10' x 60' x 8" thick).
- 3 Steel rails to be placed under each roll-off container - 2 rails per set.
- 4 Crushed rock/gravel cover over remaining area.
- 5 Perimeter 6-ft chain link fence and gate.
- 6 Pre-fabricated convenience building (8' x8') installed. Electricity assumed available at site(s) selected.
If drop sites co-located with other facilities or functions, this can be eliminated.

DROP-SITE PROGRAM SHARED EQUIPMENT

Item	Quantity	Units	Unit Cost	Total
Covered Recycling Roll-Off	1	EA	\$6,000	\$6,000
Organic/Large Item Roll-Off	1	EA	\$5,000	\$5,000
Roll-off Truck	1	EA	\$125,000	\$125,000
Subtotal				\$136,000
Contingency (10%)				\$13,600
Total Drop-Site Shared Capital Costs				\$149,600

APPENDIX K - DROP-OFF SITE HAULING COSTS

Project:	Denver Solid Waste Management Plan
Technology:	Drop-Off Site Collection Standard Location
Date:	3/8/2010 Updated
Cost Estimate Basis:	2010\$ - Cost assumptions from costing manuals & other projects
Location:	Denver, Colorado

DROP SITES	CCTS Drop-Site			CVPC Drop-Site			Comments
	MRF	Organics	LIP	MRF	Organics	LIP	
No 40-CY Containers:	2	1	1	2	1	1	
Container Payload (tons):	3.7	6.0	3.4	3.7	6.0	3.4	<i>Avg Product Density: 85% full</i>
Tonnages (tpy): 2015	1,700	1,100	300	800	500	200	
Hook-Up/Unload Time (min):	30	20	30	30	20	30	
One-Way Distance (miles)	15	12	14	8	12	25	
Average Speed (mph):	40	50	30	40	50	45	
Average Trips/Year:	460	184	89	217	84	59	
Average Trips/Month:	38.4	15.4	7.5	18.1	7.0	5.0	
Average Trips/Week:	8.9	3.6	1.8	4.2	1.7	1.2	
Hours Per Trip	1.3	0.8	1.4	0.9	0.8	1.6	
Weekly Freight Hours:	11.1	2.9	2.6	3.8	1.4	1.9	
Wkly Veh Inspect/Breaks:	2.1	0.5	0.5	0.7	0.3	0.4	<i>Ratio to freight hours</i>
Annual Freight Hours:	578.5	152.3	134.2	196.6	71.9	100.5	<i>Freight hours for vehicle operations</i>
Total Miles/Yr	13,800	4,416	2,492	3,472	2,016	2,950	

Annual Costs Assumptions:

Maintenance, Repairs, Tires & Fuel

Denver Fleet Maintenance (based on miles)	\$2.74	\$2.74	\$2.74	\$2.74	\$2.74	\$2.74	<i>Uses Transfer Tractor fleet maint. at \$2.66/mile (Rollof had only 2138 miles per 10 month period)</i>
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Driver Labor

Driver % (based on freight time)	34%	9%	8%	12%	5%	6%	
Driver annual salary	\$35,491	\$35,491	\$35,491	\$35,491	\$35,491	\$35,491	<i>DSWM Equipment Operator</i>
Fringe benefits (% of salary)	38%	38%	38%	38%	38%	38%	

Truck Amortization - Included with Drop Sites Capital Cost

Recycling Roll-Off Container Purchase - Included with Drop Sites Capital Cost

Insurance (per yr/RO truck)@ 3% \$ - Included with Fleet Maintenance

Estimate % of capital cost

License&Taxes (per yr/RO truck)@1.5% \$ - Included with Fleet Maintenance

Estimate % of capital cost

Annual Recycling Haul Costs:	SE Quadrant Drop-Site			NW Quadrant Drop-Site			Avg. Total	Comments
	MRF	Organics	LIP	MRF	Organics	LIP		
Maintenance, Repairs, Tires & Fuel	\$37,800	\$12,100	\$6,800	\$9,500	\$5,500	\$8,100		Mileage Based
Driver Labor	\$16,700	\$4,400	\$3,900	\$5,900	\$2,400	\$2,900		Time Based
Truck Replacement	\$0	\$0	\$0	\$0	\$0	\$0		In Capital Costs
Roll-Off Container Amortization	\$0	\$0	\$0	\$0	\$0	\$0		In Capital Costs
Insurance	\$0	\$0	\$0	\$0	\$0	\$0		In Fleet Maintenance
Licensing & Taxes	\$0	\$0	\$0	\$0	\$0	\$0		In Fleet Maintenance
Haul Cost	\$54,500	\$16,500	\$10,700	\$15,400	\$7,900	\$11,000	\$116,000	
Haul Cost/Ton	\$32.10	\$15.00	\$35.70	\$19.30	\$15.80	\$55.00	\$25.20	
Total Haul Cost/Pull	\$118	\$90	\$120	\$71	\$94	\$186	\$106	

APPENDIX K - DROP-OFF SITE ANNUAL COSTS

Project:	Denver Solid Waste Management Plan
Technology:	Drop-Off Site Collection Standard Location
Date:	1/21/2010
Cost Estimate Basis:	2010\$ - Cost assumptions from costing manuals & other projects
Location:	Denver, Colorado

Item Description	Quantity	Units	Unit Cost	Total
LABOR				
Job Classification	Qty	Labor Rate	Hrs/Yr	Total
Senior Utility Worker	1	\$22.50	2080 hrs	\$ 46,800
Subtotal				\$ 46,800
Notes:				
Labor rate assumes fringe benefits	38%			
SUW annual rate (step 5) =	\$33,943	(without benefits; escalate 3% to year 2010)		
SITE MAINTENANCE & UTILITIES				
Item	Quantity	Unit Price	Total	
Site Maintenance	1.50%	\$87,400	\$	1,300
Building Repair & Depreciation	3.33%	\$10,000	\$	300
Electricity	1,500 kwh	\$0.10	\$	200
Heating (Space Heater)	2,100 kwh	\$0.10	\$	200
Sanitary Service	1 port-a-let service/month	\$200 /month	\$	2,400
Water	0 No on-site water; minimal bottled water		\$	-
Mobile Phone	1 phone	\$60 /month	\$	700
Subtotal				\$ 5,100
Notes:				
Building lighting based on	1.66 watts/sf	2080 hours/year		
Site Lighting	2 1000W Lights	620 hours/year		
ANNUAL TOTAL				\$ 51,900



APPENDIX L

Public Education Cost Analysis

APPENDIX L - PUBLIC EDUCATION COST OPTIONS

General Menu of Education Options and Cost Estimates

	per household under 10,000	Per household over 10,000	All residents
1 Direct mail			
a Direct mail 1 page brochure	\$ 0.57	\$ 0.50	\$ 0.35
b multiple page brochure	\$ 0.98	\$ 0.78	\$ 0.49
2 Flyers/Posters/audit tags	\$ 0.25	\$ 0.22	\$ 0.18
	Total Campaign Cost		
3 Print Advertising - local	\$ 3,500.00 per round approx. one ad in 8-10 neighborhood publications		
4 Print Advertising - daily	need to get updated pricing but don't envision using this option much		
5 Radio Advertising	\$ 5,000.00 for about 200 runs in one month - varies per station		
6 TV/Cable Advertising	\$ 15,000.00 minimum buy - give minimal coverage		
7 Web	\$ 10,000.00 investment in more interactive technology		
8 Social networking sites/blog	minimal cost/staff time		
9 Staff Time - 1 new program coordinators	\$ 76,180.00	Labor	Category = Prog Admin 2009 Step #5, escalated 3% to 2010, plus 38% benefits
10 Required Public Notices	\$ 2,000.00		
11 Truck signs	\$ 1,200.00		per round of messages = minimum of 5
12 Professional Services - Design	\$ 25,000.00		Annually

Note costs are average based on low and high range and are based on best current knowledge.

Split on across-the-board options - these are all in the per-household costs

	7 options 2011	10 options 2012	11 options 2013	11 options 2014	12 options 2015
2011	\$ 15,882.86	\$ 11,118.00	\$ 10,107.27	\$ 10,107.27	\$ 9,265.00

APPENDIX L - ANNUAL PUBLIC EDUCATION COSTS

SHORT-TERM OPTION EVALUATION	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
7.0 Standardize Automated Collection & Provide Recyclable/Organics Diversion to Full Service Area (0-7 units)					
Automate 70.7% current manual customers (~34.3k hhs)	10%	25%	20%	25%	20%
<i>number of homes to reach</i>	3700	9300	7400	9300	7400
<i>Options recommended</i>	1a, 2	1a, 2	1a, 2	1a, 2	1a, 2
<i>Estimated cost per household</i>	\$ 0.82	\$ 0.82	\$ 0.82	\$ 0.72	\$ 0.72
<i>Total estimated cost</i>	\$ 18,916.86	\$ 18,744.00	\$ 16,175.27	\$ 16,803.27	\$ 14,593.00
Automate 87.5% current dumpster customers (~ 57.1k hhs)	10%	25%	20%	25%	20%
<i>number of homes to reach</i>	6200	15600	12500	15600	12500
<i>Options recommended</i>	1a, 2	1a,2	1a, 2	1a, 2	1a, 2
<i>Estimated cost per household</i>	\$ 0.82	\$ 0.82	\$ 0.82	\$ 0.82	\$ 0.82
<i>Total estimated cost</i>	\$ 20,966.86	\$ 23,910.00	\$ 20,357.27	\$ 22,899.27	\$ 19,515.00
Semi-automate "narrow alley" manual (14.2k hhs) & dumpster (8.1k hhs) (total homes 22,300)	Match needs as automation implemented for manual				
<i>number of homes to reach</i>	2400	6100	4900	6100	4900
<i>Options recommended</i>	1a, 2	1a, 2	1a, 2	1a, 2	1a, 2
<i>Estimated cost per household</i>	\$ 0.82	\$ 0.82	\$ 0.82	\$ 0.82	\$ 0.82
<i>Total estimated cost</i>	\$ 17,850.86	\$ 16,120.00	\$ 14,125.27	\$ 15,109.27	\$ 13,283.00
<i>Total # homes to reach each year</i>	12,300	31,000	24,800	31,000	24,800
<i>Total estimated cost per year</i>	\$ 57,734.57	\$ 58,774.00	\$ 50,657.82	\$ 54,811.82	\$ 47,391.00
Recycling carts to growing number of voluntary subscribers - overlap w/ switch to automation where possible (approx 19,700 hhs added 2010-2015)	20%	20%	20%	20%	20%
<i>number of homes to reach</i>	4600	4600	4600	4600	4600
<i>Options recommended</i>	1a, 2, 3, 5	1a, 2, 3, 5	1a, 2, 3, 5	1a, 2, 3, 5	1a, 2, 3, 5
<i>Estimated cost per household</i>	\$ 2.67	\$ 2.67	\$ 2.67	\$ 2.67	\$ 2.67
<i>Total estimated cost</i>	\$ 28,154.86	\$ 23,390.00	\$ 22,379.27	\$ 22,379.27	\$ 21,537.00
Organics carts to voluntary subscribers - overlap w/ switch to automation where possible (approx 97,700 hhs added 2010-2015)	20%	40%	15%	15%	10%
<i>number of homes to reach</i>	20000	40000	15000	15000	10000
<i>Options recommended</i>	1a,2,3,5,6,11	1a,2,3,5,6,11	1a,2,3,5	1a,2,3,5	1a,2,3
<i>Estimated cost per household</i>	\$ 2.87	\$ 2.10	\$ 1.54	\$ 1.54	\$ 1.18
<i>Total estimated cost</i>	\$ 73,373.95	\$ 95,291.59	\$ 33,189.77	\$ 33,189.77	\$ 21,047.40

APPENDIX L - ANNUAL PUBLIC EDUCATION COSTS

SHORT-TERM OPTION EVALUATION	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
8.0 Evaluate Policy for LIP, Overflows & Late Set-Outs					
Policy to reduce free service to 1/quarter (1/9 weeks as of Jan 2010)	None	None	Reduce to 1/quarter	Maintain	Maintain
<i>number of homes to reach</i>	0	0	168000		
<i>Options recommended</i>	0	0	1b	Wastewise	Wastewise
<i>Estimated cost per household</i>	0	0	\$ 0.51		
<i>Total estimated cost</i>	0	0	\$ 85,820.00		
Policy to eliminate free overflow collections (1 OF every 3 wks Jan 2010) - move to fee-, appointment-based 60K home?	None	Reduce to 1 OF every 3 mths	None	None	Eliminate free OF
<i>number of homes to reach</i>	0	60000	0	0	60000
<i>Options recommended</i>	0	1 a, 2	0	0	1a,2
<i>Estimated cost per household</i>	0	\$ 0.89	0	0	\$ 0.87
<i>Total estimated cost</i>	0	\$ 53,307.27	0	0	\$ 52,465.00
Identify needs for enforcement	10%	50%	10%	Maintain	30%
<i>Options recommended</i>	Use Wastewise to inform residents about changes?				
Identify needs for clean alleys (57% of trash hhs served in alleys)	10%	50%	10%	Maintain	30%

APPENDIX L - ANNUAL PUBLIC EDUCATION COSTS

SHORT-TERM OPTION EVALUATION	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
9.0 Implement Two Drop-Site Collection for Large Items, Recyclables & Organics (0-7 units) at CCTS & Central Platte Valley Campus					
Add two drop sites	None	First DOC	None	Second DOC	None
<i>number of homes to reach</i>		0 Promote Citywide	continued promotion of First site		ongoing
<i>Options recommended</i>	0	3, 5 6	3, 5	3,5,6	3,5
<i>Estimated cost per household</i>	0	N/a	n/a	n/a	n/a
<i>Total estimated cost</i>	0	\$ 34,618.00	\$ 18,607.27	\$ 33,607.27	\$ 17,765.00
10.0 Implement Private Hauler Requirements (applies only to all MFUs>7 units except as noted)					
Licensing for all "rubbish" haulers (see Chapter 48 SOLID WASTE) = registration with fee (fee may not be determined in SWMP)	None	None	Implement fully	None	None
Reporting requirements for all haulers	None	None	Implement fully	None	None
Policy for all haulers to offer recyclables & organics collection from voluntary customers plus restaurants	None	None	Implement fully	None	None
Policy for restaurants w/ certain criteria to divert organics (includes coordination with haulers)	None	None	None	Implement fully (0.5 FTE trainer)	None (0.5 FTE trainer)
Identify needs for enforcement	None	None	50%	50%	Maintain
Identify needs for tracking data (assume annual requirement w/ 1-yr delay before data is submitted)	None	None	60%	40%	Maintain
<i>Total estimated cost (Pgm Coor step #4, 3% esc, 38% benefits)</i>	0	\$ -	\$ -	\$33,335	\$33,335
12.0 Implement Capacity Assessment for >7 Unit Residential Trash/LIP Generators					
Policy for generators to provide proof of storage capacity & collection service - coordinate w/ hauler requirement to collection recyclables/organics from non-residential generators	None	None	None	None	100%
Identify needs for verification & enforcement	None	None	None	None	100%



APPENDIX M

Long-Term Drop-Site Analysis

APPENDIX M - DROP-OFF SITES CAPITAL IMPROVEMENT COSTS

Project:	Denver Solid Waste Management Plan
Technology:	Drop-Off Site Collection Standard Location
Date:	3/8/2010 Updated
Cost Estimate Basis:	2010\$ - Cost assumptions from costing manuals & other projects
Location:	Denver, Colorado

CAPITAL COST PER DROP-SITE

Item	Quantity	Units	Unit Cost	Total
Land Purchase (1)	0.5	Acres	\$0	\$0
Final Grading (1)	2420	SY	\$3	\$7,300
Concrete Pad (2)	45	CY	\$350	\$15,750
Steel Rails (3)	3	sets	\$1,000	\$3,000
Crushed Rock/Gravel (4)	2220	SY	\$10	\$22,200
Access Stairs/Platform	3	EA	\$2,000	\$6,000
Drop-Site Signage	2	EA	\$500	\$1,000
Security Fencing (5)	590	LF	\$24	\$14,200
Personnel Convenience Building (6)	1	EA	\$10,000	\$10,000
Subtotal Site Improvements				\$79,450
Contingency (10%)				\$7,950
Drop-Site Improvements				\$87,400
Covered Recycling Roll-Off	1	EA	\$6,000	\$6,000
Organics Roll-Off	1	EA	\$5,000	\$5,000
Large Items Roll-Off	1	EA	\$5,000	\$5,000
Subtotal Mobile Equipment				\$16,000
Contingency (10%)				\$1,600
Mobile Equipment				\$17,600
Total Drop-Site Capital Cost Per Location				\$105,000

Assumptions:

- 1 Land assumed to be existing city property or donated use.
Area estimated for 4 roll-offs (3 plus spare) plus maneuvering & expansion.
- 2 Concrete slab on grade under roll-offs and tractor approach (10' x 60' x 8" thick).
- 3 Steel rails to be placed under each roll-off container - 2 rails per set.
- 4 Crushed rock/gravel cover over remaining area.
- 5 Perimeter 6-ft chain link fence and gate.
- 6 Pre-fabricated convenience building (8' x8') installed. Electricity assumed available at site(s) selected.
If drop sites co-located with other facilities or functions, this can be eliminated.

ADDITIONAL THIRD DROP-SITE EQUIPMENT

Item	Quantity	Units	Unit Cost	Total
Covered Recycling Roll-Off	1	EA	\$6,000	\$6,000
Organic/Large Item Roll-Off	1	EA	\$5,000	\$5,000
Roll-off Truck	1	EA	\$125,000	\$125,000
Subtotal				\$136,000
Contingency (10%)				\$13,600
Total 3rd Drop-Site Equipment Capital Costs				\$149,600

APPENDIX M - DROP-OFF SITE HAULING COSTS

Project:	Denver Solid Waste Management Plan
Technology:	Drop-Off Site Collection Standard Location
Date:	3/8/2010 Updated
Cost Estimate Basis:	2010\$ - Cost assumptions from costing manuals & other
Location:	Denver, Colorado

DROP SITES	Northeast Drop-Site		
	MRF	Organics	LIP
No 40-CY Containers:	1	1	1
Container Payload (tons):	3.7	6.0	3.4
Tonnages (tpy): 2030	2,400	1,500	500
Hook-Up/Unload Time (min):	30	20	30
One-Way Distance (miles)	8	5	17
Average Speed (mph):	40	40	45
Average Trips/Year:	649	250	148
Average Trips/Month:	54.1	20.9	12.4
Average Trips/Week:	12.5	4.9	2.9
Hours Per Trip	0.9	0.6	1.3
Weekly Freight Hours:	11.3	2.9	3.6
Wkly Veh Inspect/Breaks:	2.1	0.5	0.7
Annual Freight Hours:	585.0	148.6	189.3
Total Miles/Yr	10,384	2,500	5,032

Annual Costs Assumptions:

Maintenance, Repairs, Tires & Fuel

Denver Fleet Maintenance (based on miles)	\$2.74	\$2.74	\$2.74
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Driver Labor

Driver % (based on freight time)	34%	9%	11%
Driver annual salary	\$35,491	\$35,491	\$35,491
Fringe benefits (% of salary)	38%	38%	38%

Truck Amortization - Included with Drop Sites Capital Cost

Recycling Roll-Off Container Purchase - Included with Drop Sites Capital Cost

Insurance (per yr/RO truck)@ 3% \$ - Included with Fleet Maintenance

License&Taxes (per yr/RO truck)@1.5% \$ - Included with Fleet Maintenance

Annual Recycling Haul Costs:	Northeast Drop-Site			Avg. Total
	MRF	Organics	LIP	
Maintenance, Repairs, Tires & Fuel	\$28,500	\$6,800	\$13,800	
Driver Labor	\$16,700	\$4,400	\$5,400	
Truck Replacement	\$0	\$0	\$0	
Roll-Off Container Amortization	\$0	\$0	\$0	
Insurance	\$0	\$0	\$0	
Licensing & Taxes	\$0	\$0	\$0	
Haul Cost	\$45,200	\$11,200	\$19,200	\$204,000
Haul Cost/Ton	\$18.80	\$7.50	\$38.40	\$21.50
Total Haul Cost/Pull	\$70	\$45	\$130	\$90



APPENDIX N

Transfer Station Cost Analysis

APPENDIX N - TRANSFER STATION WASTE TONNAGE PROJECTIONS

Project:	Denver Solid Waste Management Plan		
Technology:	Top-Load Transfer Station		
Date:	3/30/2010		
Cost Estimate Basis:	2010\$ - Cost assumptions from costing manuals & other projects		
Location:	Denver, Colorado	NE Service Area Location	

WASTE & TRAFFIC QUANTITIES

ASSUMPTIONS:

- Packer Truck** Traffic (as % total)= **100%**
- Packer Waste (as % of total) = **100%**
- Packer Payload = **6.0 tons/load** from City 2009 data
- Roll-Offs** Traffic (as % total) = **0%**
- Roll-Off Waste (as % of total)= **0%**
- Roll-Off Payload = **3.0 tons/load**

- Days of Operation = **5 days/week** 12 months
- Hours of Operation = **8 hours/day**
- Monthly Peak Factor = **1.25** Estimate
- Daily Peak Factor = **1.35** Estimate
- Hourly Peak Factor = **1.5** Estimate
- Annual Waste Generation Growth= **1.0%**

DSWM SERVICE AREA QUANTITIES TO NEW TRANSFER STATION					
Service Area	Waste Quantities			Traffic Quantities	
	2015		2030	2015	2030
Northwest*	49,900		45,700	8,300	7,600
Northeast**	35,600		32,600	5,900	5,400
Totals	85,500		78,300	14,200	13,000

* Assume 100% of Northwest Service Area refuse tons directed to new transfer station.
Equivalent to **24%** of total refuse

** Assume approximately one-half of Northeast Service Area refuse tons directed to new transfer station.
Equivalent to **16%** of total refuse

PEAK DESIGN YEAR 2015				
Waste Stream	Tons		Vehicles	
	Ave TPD	Peak TPD	Avg VPD	Peak VPH
Packer Trucks	330	560	55	17
Roll-Offs	-	-	-	-
Totals	330	560	55	17
	Avg VPD in Peak Month		68	

APPENDIX N - TRANSFER STATION WASTE TONNAGE PROJECTIONS

Project: Denver Solid Waste Management Plan
 Technology: Top-Load Transfer Station
 Date: 3/30/2010
 Sizing Basis: Solid Waste Projections and Northwest and Northeast Service Areas Tonnages
 Location: Denver, Colorado **NE Service Area Location**

TRANSFER STATION BUILDING SIZE CALCULATIONS

Summary	Length	Width
DESIGN SIZE (Peak Day) = 560 TPD		
FACILITY SIZE = 8,800 SF	80	110
Tipping Floor Size = 7,500 SF	80	94
Loadout Area Size = 1,300 SF	80	16
Outside Maneuvering Area Size = 6,400 SF	80	80
Average Bldg Footing Depth = 6 FT		
Push Wall Height = 12 FT		
TRANSFER TYPE = TOP LOAD		

I. ESTIMATE INTERIOR VEHICLE UNLOADING SPACE REQUIRED

- Assumptions: 1. Unloading distance required approx. **30** feet. (Utilized in LENGTH)
 2. Assume outside maneuvering space (> Storage or Unloading dist.)
 at width of stalls required by **80** feet. Minimum of 60 feet.

UNLOADING AREA FOR DESIGN YEAR						
Waste Stream	PEAK VPH	UNLOAD TIME	STALLS REQ'D.	WIDTH/STALL	WIDTH REQ'D. FT	SQ. FT. REQ'D.
Packer Trucks	17	6	1.7	16		
Roll-Offs	0	10	0.0	0		
Columns, Door Framing, & Person Door					12	
Totals	17	NA	2	NA	28	840

II. ESTIMATE TIPPING FLOOR WASTE STORAGE SIZE

STORAGE AREA FOR DESIGN YEAR						
Waste Stream	Average TPD	Storage TPD	DENSITY LB/CU.FT.	CU. FT. STORAGE	SQ. FT. REQ'D.	LENGTH REQ'D. FT (7)
Packer Trucks	330	330	15	44,000		
Roll-Offs	0	0	13	-		
Totals	330	330	NA	44,000	5,490	70

- Assumptions: 1. Size to store average tons in 2015 at **1** day avg waste.
 2. Effective average pile height at **10** feet.
 Assume push wall height of 12 feet.
 Side Slopes are 1:1 (horizontal to vertical)
 3. Width required (hoppers versus tipping) = **65** feet **VERSUS** **28** feet
 4. Aisle width required for loader **12** feet

ADD AISLE WIDTH REQUIRED FOR LOADER TO LENGTH REQUIRED.

WIDTH = 80 FT (Unloading Bays)
 LENGTH = 94 FT (Max of Unloading or Storage Distance)

Tipping Floor Area = 7,500 square feet

Outside Maneuvering Area = 6,400 square feet

APPENDIX N - TRANSFER STATION WASTE TONNAGE PROJECTIONS

**III. LOWER LEVEL LOADOUT AREA
OPEN TOP TRANSFER OPTION**

- Assumptions:
- 1. Open-top load-out
 - 2. Typical # of Trailer Loads per hour = 3.0 loads/hour/hopper
 - 3. Trailer payload estimated to be avg. 20 tons/container load.
 - 4. Hours of transfer operation = 8 hours.

LOADOUT DATA FOR YEAR 2015			
Waste Stream	AVERAGE	PEAK	
	TPD	OUT TPD	OUT TPH
Packer Trucks	330	560	
Roll-Offs	0	-	
Total	330	560	60
Peak Trailer Loads/Day	28		
No. Loadout Hoppers	1		

- Size Loadout Area:
- 1. Number of traffic lanes required. 1
 - 2. Total tunnel width = 16 feet wide.
12 feet per lane 2 feet clearance each side lane
 - 3. Width for Tamping Cranes 0 feet.
 - 4. Required Loadout Length = 65 feet for trailer single lane
45 feet trailer length
 - 5. Total Loadout Length = 65 feet.

Loadout Area =	1,300 square feet
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APPENDIX N - TRANSFER STATION WASTE TONNAGE PROJECTIONS

**PRELIMINARY ENGINEERING OPINION OF PROBABLE CONSTRUCTION COST (2010\$)
DENVER, COLORADO - TRANSFER STATION**

ITEM DESCRIPTION	QUANTITY	UNIT	ESTIMATED COST	
			UNIT PRICE	TOTAL PRICE
Site Acquisition				
Land - Assume City Owned	4	acre	\$0	\$0
Site Work				
Bonds, Mobilization and Insurance	4%	of WORK	\$2,054,000	\$82,000
Demolition	1	LS	\$50,000	\$50,000
Clearing and Grubbing	4	acre	\$2,000	\$8,000
Site Grading - General (1 FT across site)	6,500	CY	\$3	\$19,500
Earthwork/Structural Fill (Building Area)	1,300	CY	\$10	\$13,000
Earthwork/Structural Fill (Man'vg Area)	900	CY	\$10	\$9,000
Excavation - Loadout Tunnel (Grade Diff.)	2,300	CY	\$5	\$11,500
Site Retaining Walls (at Loadout)	280	CY	\$450	\$126,000
Roadways - Paved	2,800	SY	\$23	\$64,400
Erosion Control/Stormwater Management	1	LS	\$50,000	\$50,000
Landscape and Planting	1	Allowance	\$20,000	\$20,000
Misc Site (Signage, Sidewalks, etc.)	1	LS	\$5,000	\$5,000
Surveying	1	LS	\$25,000	\$25,000
Site Utilities				
Water Supply & Fire Protection	1	LS	\$75,000	\$75,000
Sanitary Sewer	1	LS	\$50,000	\$50,000
Natural Gas System	1	LS	\$10,000	\$10,000
Electrical	1	LS	\$100,000	\$100,000
Site Lighting	5	EA	\$3,000	\$15,000
Chain Link Security Fence (6' high)	1,700	LF	\$22	\$37,400
Chain Link Gate (cantilever, automatic)	1	EA	\$9,500	\$9,500
Concrete & Foundations				
Foundation Excavation/Structural Fill	600	CY	\$10	\$6,000
Maneuvering Area Paving - Concrete	710	SY	\$55	\$39,100
TS Loadout Approaches - Concrete	200	SY	\$55	\$11,000
Building Foundations	70	CY	\$350	\$24,500
Concrete Aprons @ Roll-Up Doors	70	CY	\$350	\$24,500
Building Retaining Walls - Lower Level	140	CY	\$450	\$63,000
Concrete Floor Pits/Drains-Lower Level Scales	3	EA	\$500	\$1,500
Steel Grating at Scales-Lower Level Scales	6	EA	\$3,000	\$18,000
Elevated Floor Slab at Hoppers	50	CY	\$700	\$35,000
Tipping Floor	830	SY	\$75	\$62,300
Interior Push Walls (12' high)	100	CY	\$450	\$45,000
Interior Push Walls (3' high) @ Loadout	20	CY	\$450	\$9,000
Transfer Station Building				
Pre-Engineered Building	8,800	SF	\$40	\$352,000
Misc. Building Steel, Panels, Etc.	8,800	SF	\$10	\$88,000
Building Electrical	8,800	SF	\$9	\$79,200
Building Mechanical (fire protect'n, venting, etc.)	8,800	SF	\$13	\$114,400
Roll-Up Doors	6	EA	\$7,500	\$45,000
Load-out Scales (1 set per load-out hopper)	1	EA	\$50,000	\$50,000
Load-Out Hopper Framing & Metals	1	EA	\$36,000	\$36,000
Truck Scale				
Motor Truck Scale (10'x70')	1	EA	\$65,000	\$65,000
Scale Approaches	23	CY	\$55	\$1,300
Automated Reader & Software	1	EA	\$30,000	\$30,000
Misc. Scale Protection (bollards, curbs, etc.)	1	EA	\$5,000	\$5,000

APPENDIX N - TRANSFER STATION WASTE TONNAGE PROJECTIONS

**PRELIMINARY ENGINEERING OPINON OF PROBABLE CONSTRUCTION COST (2010\$)
DENVER, COLORADO - TRANSFER STATION**

ITEM DESCRIPTION	QUANTITY	UNIT	ESTIMATED COST	
			UNIT PRICE	TOTAL PRICE
Office Building				
Pre-Engineered Metal Building - One Story	900	SF	\$65	\$58,500
Concrete Slabwork	17	CY	\$300	\$5,100
Concrete Footings	18	CY	\$300	\$5,400
HVAC	900	SF	\$16	\$14,400
Plumbing	900	SF	\$7	\$6,300
Electrical	900	SF	\$23	\$20,700
Interior Treatments	900	SF	\$45	\$40,500
SUBTOTAL				\$2,136,000
General Contractor Fees (10% of Sitework, Bldg Elec/Mech, Utilities)				\$107,000
Design/Engineering (8%)				\$179,000
Permitting (3%)				\$67,000
Construction Management/Observation (8%)				\$179,000
Contingency (25%)				\$561,000
TOTAL SITEWORK & FACILITY				\$3,229,000

Annual Capital Debt Payment (5% interest rate over 20 years) =	\$259,000
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Does not include potential costs of financing.

	QUANTITY	UNIT	ESTIMATED COST	
			UNIT PRICE	TOTAL PRICE
Rolling Stock & Equipment				
Front Loader	1	EA	\$350,000	\$350,000
SUBTOTAL EQUIPMENT				\$350,000
Contingency (10%)				\$35,000
TOTAL ROLLING STOCK				\$385,000

Annual Equipment Debt Payment (5% interest rate over 10 years) =	\$50,000
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APPENDIX N - TRANSFER STATION WASTE TONNAGE PROJECTIONS

Project:	Denver Solid Waste Management Plan
Technology:	Top-Load Transfer Station
Date:	3/11/2010
Cost Estimate Basis:	2010\$ - Cost assumptions from City, costing manuals & other projects
Location:	Denver, Colorado NE Service Area Location

Transfer Station	Northeast TS	Comments
Tonnages (tpy):	78,300	
Daily TPD:	330	
Trailer Payload (tons):	20	<i>based on average loads out of CCTS</i>
Days Operation/Week:	5	
Load/Unload Time (min):	40	
One-Way Distance (miles)	17	
Average Speed (mph):	40	
Average Trips/Year:	3,915	
Average Trips/Month:	326	
Average Trips/Week:	75	
Hours Per Trip	1.5	
Weekly Freight Hours:	114	
Wkly Veh Inspect/Breaks:	21	<i>Ratio to freight hours</i>
Annual Freight Hours:	5,939	<i>Freight hours for vehicle operations</i>
Total Miles/Yr	133,110	

Annual Costs Assumptions:

Maintenance, Repairs, Tires & Fuel

Denver Fleet Maintenance (per miles)	\$2.74	<i>Transfer Tractor fleet maintenance at \$2.66/mile (2009\$)</i>
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Driver Labor

Driver % (based on freight time)	340%	
# of Drivers	4	
Driver annual salary	\$39,366	<i>DSWM transfer operator (STTO)</i>
Fringe benefits (% of salary)	38%	

Transfer Truck Purchase/Amortization

# of Trucks	5	<i>includes one spare</i>
Capital Cost - per Tractor	\$150,000	<i>Other projects and vendor data</i>
Resale Value (% of truck \$)	20%	
Replacement Schedule (years)	10	
Interest Rate	5%	
Capital Recovery Factor (A/P,i,n)	0.1295	

Trailer Purchase/Amortization

# of Trailers	5	<i>includes one spare</i>
Capital Cost -- per Trailer	\$95,000	<i>Other projects and vendor data</i>
Replacement Schedule (years)	10	
Interest Rate	5%	
Capital Recovery Factor (A/P,i,n)	0.1295	

Insurance (per yr/truck)@ 3% \$ - Included with Fleet Maintenance

License&Taxes (per yr/truck)@1.5% \$ - Included with Fleet Maintenance

Annual Haul Costs:	Northeast TS		Comments
Maintenance, Repairs, Tires & Fuel	\$364,700		Mileage Based
Driver Labor	\$217,300		# of Drivers
Transfer Truck Amortization	\$77,700		# Trucks
Trailer Amortization	\$61,510		# Trailers
Insurance	\$0		In Fleet Maintenance

APPENDIX N - TRANSFER STATION WASTE TONNAGE PROJECTIONS

Project:	Denver Solid Waste Management Plan
Technology:	Top-Load Transfer Station
Date:	3/11/2010
Cost Estimate Basis:	2010\$ - Cost assumptions from City, costing manuals & other projects
Location:	Denver, Colorado <i>NE Service Area Location</i>

<i>Licensing & Taxes</i>	\$0		In Fleet Maintenance
Haul Cost	\$721,210		
Haul Cost/Ton	\$9.21		

APPENDIX N - TRANSFER STATION WASTE TONNAGE PROJECTIONS

**PRELIMINARY ENGINEERING OPINON OF PROBABLE OPERATING COST (2010\$)
DENVER, COLORADO - TRANSFER STATION**

				ESTIMATED COST	
ITEM DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
LABOR					
Job Classification	FTE	Labor Rate	Hrs/Yr		Total
Operations Supervisor	1	\$33.60	2080 hrs	\$	69,890
Heavy Equipment Operator	1	\$28.10	2080 hrs	\$	58,450
Utility Worker	1	\$20.60	2080 hrs	\$	42,850
Oncall Utility Worker	1	\$20.60	2080 hrs	\$	42,850
STTO - Rotation	1	\$26.90	2080 hrs	\$	55,950
				Subtotal	\$ 269,990
Notes/Assumptions:					
Labor rate assumes fringe benefits	38%				
STTO = Semi-Tractor Trailer Operator					
INSURANCE					
Item		Quantity		Unit Price	Total
General, Liability, Fire, Etc.	1%	\$1,600,300	bldgs/equipment	\$	16,000
FACILITY MAINTENANCE					
Item		Quantity		Unit Price	Total
Site Maintenance	1.50%	\$737,400		\$	11,060
Building Repair & Depreciation	3.33%	\$1,215,300		\$	40,470
Scale Maintenance	1.50%	\$101,300		\$	1,520
Electricity		35,000 kwh		\$0.10	\$ 3,500
Electricity Demand - Peak Est.		20 kw		\$50	\$ 1,000
Heating - Natural gas		1,800 DTH		\$5 /DTH	\$ 9,000
Sanitary Service	90%	214,500 gpy		\$5 /1000 gal	\$ 970
Water		214,500 gpy		\$8 /1000 gal	\$ 1,720
Mobile Phone	2	phone		\$50 /month	\$ 1,200
				Subtotal	\$ 70,440
Notes/Assumptions:					
Building lighting based on	0.5 watts/sf		2600 hours/year		(50 hrs/week)
Site Lighting	5 1000W Lights		4380 hours/year		(night)
Assume natural gas use	2 therm/sf/season		(DTH = decatherm)		
Assume water use at	15 gals/day/person		0.1 gpd/SF		tipping floor washdown
EQUIPMENT O&M					
Item	Qty	Rate	Hrs/Yr	Unit Price	Total
Front Loader Fuel	1	3.0 gal/hr	2080 hrs	\$3.00	\$ 18,720
Front Loader O&M	1		2080 hrs	\$12	\$ 24,960
Supervisor Pick-Up	1	LS		\$650	\$ 650
				Subtotal	\$ 44,330
Notes/Assumptions:					
CCTS Loader fleet maintenance cost in 2008 was \$42,169 (including fuel).					
ANNUAL TOTAL					\$ 400,760

**Note: Excludes Transfer Station Facility and mobile equipment capital debt amortization.
Also excludes haul costs. See Summary table for total.**