

# Practice paper

## Solid municipal waste audit analyses at Denver International Airport

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### Abstract

*In its 2013 Strategic Plan, Denver International Airport (DIA) set a goal of decreasing its amount of waste sent to landfill by 10 per cent over the next five years using DIA's 2012 landfill waste as a baseline. An audit of DIA's solid municipal waste stream was conducted to analyse DIA's current waste streams, to identify how far DIA is from reaching its landfill diversion goal, and to provide recommendations and solutions that would enable DIA to move closer to its strategic waste diversion goal. This paper describes, analyses and draws conclusions from a comprehensive assessment of waste generated at DIA from the following areas: Airport Office Building (AOB)/Main Terminal; Concourses A, B and C; East & West Overflow Parking; Air Cargo; and Maintenance. The assessment, which was conducted from 21<sup>st</sup> to 24<sup>th</sup> June, 2010, sampled 20 loads (totalling 1,464.9 kg) collected from compacted trash delivered from the aforementioned locations. Samples were sorted into 31 material types (organised into seven overarching categories). Weights obtained from the sorts were used to evaluate the effectiveness of DIA's current recycling programmes and to identify areas for improving both the current and future recycling programmes and for identifying potential savings opportunities associated with waste diversion strategies. Based on sample results, the assessment revealed that DIA has an opportunity to decrease the amount of waste sent to landfill by over 62 per cent. The waste audit revealed that up to 3,281.3 metric tons of recyclables (29.8 per cent of the solid waste stream) on an annual basis was sent to landfill instead of being diverted to the existing single-stream recycling programme, as well as 24.5 metric tons (0.2 per cent)*

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of recyclable e-waste and 97.0 metric tons (0.9 per cent) of construction and demolition (C&D) materials. In addition, on an annual basis, DIA has the potential to divert up to 3,187 metric tons (28.9 per cent) of its organics by expanding its current composting programme to include pre-consumer and post-consumer waste throughout the entire airport. Finally, DIA could potentially divert an additional 173.6 metric tons (2.4 per cent) annually by implementing new diversion programmes.

## Keywords

waste assessment, waste management, landfill, DIA, WMSS

## INTRODUCTION

### Overview

In its 2013 Strategic Plan, Denver International Airport (DIA) set a goal of decreasing the amount of waste sent to landfill by 10 per cent over the next five years. As the main provider of waste management services for DIA, Waste Management (WM) retained its Waste Management's Sustainability Services Group (WMSS) to provide recommendations and solutions that would enable DIA to move closer to its waste diversion goal. WMSS's role was to identify opportunities at DIA to minimise waste generation and to maximise recycling and other forms of diversion, as well as providing recommendations that would enable DIA to move closer to its strategic goal while also reducing costs over the long term.

In order to identify where the opportunities exist to minimise waste and increase diversion, WMSS conducted a comprehensive waste assessment for DIA. This assessment evaluated the current solid waste stream from all of the solid waste compactors located on site at DIA, located at 8500 Pena Boulevard, Denver, CO.

The DIA waste assessment was conducted between 21<sup>st</sup> and 24<sup>th</sup> June, 2010. The waste samples were sorted and weighed at WM's transfer station in Commerce City, CO. WMSS arranged for the pick-up and drop-off of materials from DIA to the transfer station and sorted, weighed and recorded all sample information.

The purpose of the waste assessment was to analyse the composition of solid waste generated at DIA by all the locations that WM services. The areas of waste generation evaluated included: the Airport Office Building (AOB) and Main Terminal; Concourses A, B, and C; Maintenance; Air Cargo; and East & West Overflow Parking.

The primary purpose of the waste assessment was to:

- observe the effectiveness of DIA's current recycling and composting programmes;
- identify areas for improvement (ie diverting materials through current programmes more successfully and/or expanding existing programmes);
- inform DIA about how close the facility is to zero waste and provide recommendations to help move DIA closer to this goal.

This report evaluates the components of DIA's solid waste (residuals) that end up in their landfill-bound compactors. For the purposes of this report, waste bound for landfill is designated as 'residual' waste or 'trash'. Waste that could be sent for recycling or material sorting is designated as 'recyclable' or 'divertible'. Waste that can be composted is designated as 'compostable' and material that can be reused is designated as 'reusable'.

DIA currently has a number of strategies in place for diverting material

from landfill. These strategies include: the implementation of an airport-wide single-stream recycling programme that accepts a variety of materials;<sup>1</sup> a pre-consumer composting programme for concessionaires in the Main Terminal combined with a post-consumer composting programme for the AOB break rooms; e-waste and universal waste recycling programmes; and a C&D recycling programme. Over 200 recycling receptacles are located throughout the airport for travellers and airport employees, and compost receptacles are available in those areas currently accepting compostable materials. Ultimately, janitorial staff, vendors and concessionaires are responsible for delivering both solid waste and recycling from within points of generation at the airport to either trash compactors, recycling gables or roll-offs, or cardboard compactors. A combination of 12 recycling gables and/or roll-offs are co-located with a select number of trash compactors.

There is a significant opportunity to increase the diversion of those materials currently accepted by DIA's single-stream recycling programme (29.8 per cent). Moreover, if the airport were to expand its current composting programme throughout the entire airport to include both pre- and post-consumer waste, a substantial portion of the waste stream could be reduced (28.9 per cent). Some of the ongoing issues in the waste stream include a high volume of currently recyclable materials presently found in the residual waste stream, food waste, and liquids in the load (ie bottles full of liquids, not emptied).

### Facility and assessment information

DIA is the primary airport serving the Denver region. DIA ranks as the fifth busiest airport in the USA and the 13th

busiest in the world. In 2012 passenger traffic (enplanements and deplanements) was 53,156,278. The passenger terminal complex includes a landside terminal (139,350 m<sup>2</sup>) and three airside concourses (371,972 m<sup>2</sup>). The landside terminal accommodates passenger ticketing, baggage claim, concessions and other facilities. Automobile parking facilities are provided in two public parking structures and in surface parking lots. Passengers travel between the landside terminal and three airside concourses (Concourses A, B and C) via an underground automated guideway transit system. In addition, the AOB houses employee offices and additional space. The airside concourses provide 92 full service jet gates for large jet aircraft and up to 64 parking positions for regional/commuter airline aircraft. In January 2010, 26 airlines provided scheduled passenger services at DIA: 11 major/national airlines, 10 regional/commuter airlines and five foreign-flag airlines.

The airport's total cargo operations currently exceed approximately 236,000 metric tons per year. DEN is home to several cargo movers and support facilities, including World Port Cargo Support, DHL, UPS, FedEx and United Airlines cargo. The airport also has a joint-use cargo facility that currently serves nine airline operations.

In addition, DIA is home to approximately 115 stores, restaurants, bars and lounges throughout the terminals. The Denver International site comprises 137.27 km<sup>2</sup> of land.

### WASTE ASSESSMENT DESCRIPTION

WMSS conducted an assessment of waste generated from DIA from 21<sup>st</sup> to 24<sup>th</sup> June, 2010. WM provides hauling service for the 21 trash compactors located at DIA,

which are each serviced at least once every seven days.

Assessment of each DIA compactor load was conducted at WM's solid waste transfer station, located at 6091 Brighton Boulevard, Commerce City, CO. Each compactor load was brought to the transfer station and weighed at the scale house. The total waste stream for all of the compactor loads consisted of 92,315 kg (92.4 metric tons) of residual waste. A representative sample was taken from each compactor load, which was then sorted, weighed and photographed by WMSS. Each load was accurately labelled

by compactor origin. For the study, a sample of 2.65 per cent (2,447.4 kg) was isolated from the entire load (all compactor loads). Table 1 indicates the sample weights of each of the compactor loads that were sorted, weighed and analysed by compactor location.

The waste assessment revealed that there is an opportunity for DIA to improve waste diversion through maximising the utilisation of the existing single-stream and other recycling programmes, expanding the current composting programme, offering new programmes for the diversion of additional materials and enhancing

**Table 1** DIA waste samples (by AOB and concourse location)

<i>DIA sample weights (kg)</i>				
<i>Compactor/roll-off</i>	<i>21<sup>st</sup> June</i>	<i>22<sup>nd</sup> June</i>	<i>23<sup>rd</sup> June</i>	<i>24<sup>th</sup> June</i>
A41			130.90	
A30	140.21			
A46		107.64		
B15 (roll-off)		88.54		
B16 (roll-off)				112.26
B36	108.73			
B39	153.22			
B24		160.25		
B30			176.13	
B44			116.9	
B52	109.1			
B81			145.9	
C38	164.9			
C34				97.4
C39		88.0		
C46		112.1		
AOB	114.2			
Air Cargo				96.7
Maintenance			127.6	
East and West Overflow			95.7	
Total weight of all samples (kg)	2,447.4			

recycling education and communication programmes throughout the airport.

### **Waste assessment procedures**

To analyse a normal collection cycle for DIA, an assessment of each WM-serviced compactor load located throughout the airport was conducted. All other waste collection practices (front-end loaders, recycling and composting containers) taking place at DIA were not included as part of the assessment.

According to WM staff, each compactor is collected at least once a week. Each compactor load was delivered to WMSS for sorting on its regularly scheduled pickup date. This ensured that the volume collected for this waste assessment was typical for the facility. The assessment included waste from AOB/Main Terminal, Concourses A, B and C, Maintenance, East & West Overflow Parking and Air Cargo (see Table 1 above for the complete list of compactor locations).

All waste samples collected from DIA were sorted into 31 material types, listed in Table 2. These 31 material types fall into the overarching categories of Glass, Plastic, Metal, Fibre, Organics, Miscellaneous and Residual waste. A full description of the types of waste that were sorted into each category is also listed in Table 2. Unusual materials — or a predominance of one type of material — were observed and are noted in this report. Observations were made, photos were taken and measurements were made to the nearest 0.1 kg. Please reference Table 2 for information related to the material types included within each category throughout the remaining document. Table 2 also indicates how each material listed in the assessment was designated (ie ‘recyclable’, ‘compostable’, etc.) for the analysis.

In order to calculate annual values, extrapolations were made using data provided from WM’s billing department. WM provided a 12-month summary covering June 2009–May 2010, indicating how many loads were picked up from each compactor and the associated tonnages. This information was used to generate annual weight values for each material category based on the corresponding percentages found in the sampled residual waste stream.

### **WASTE STREAM ANALYSIS**

#### **Waste assessment summary**

The residual waste stream was assessed using the general material categories of Glass, Plastics, Metal, Fibre, Organics, Miscellaneous and Residual waste. The assessment did not include an analysis of DIA’s current recycling or composting practices.

During the waste assessment, 20 waste samples were sorted from each of the compactors on site at DIA (Table 3), totalling 2,447.4 kg. These samples were collected from full compactor and roll-off loads which represented 92,315 kg (92.35 metric tons) of DIA waste according to the scale tickets provided.

Table 3 breaks down the estimated yearly waste generation attributed to each area examined for this assessment. Analysis revealed that a significant portion of the sampled waste stream could be recycled, composted or reused. The analysis revealed that: 29.8 per cent can be recycled using the current single-stream recycling programme; 0.8 per cent could potentially be recycled if a plastic film collection programme were implemented for the Air Cargo area; 28.9 per cent could potentially be composted if a pre- and post-consumer organics collection programme were to be implemented throughout the entire airport area; 0.2 per cent consisted of e-waste that can be recycled using the

**Table 2** Material description by category and diversion opportunity

<b>Materials</b>	<b>Categories and description</b>	<b>Diversion opportunity</b>
<i>Glass</i>		
Glass food & beverage containers	All colours of food & beverage containers	<i>Recyclable in single-stream programme</i>
All other glass	Non-fluorescent light bulbs, glassware, window glass	<i>Recyclable outside of single-stream programme</i>
<i>Plastics</i>		
#1 Plastic bottles	PETE (polyethylene terephthalate) (any bottles with necks/openings narrower than body, including beverage containers, cleaning containers)	<i>Recyclable in single-stream programme</i>
#1 Plastic (non-bottle)	PETE (polyethylene terephthalate) (cups, cup lids, plates, food packages)	<i>Recyclable in single-stream programme</i>
#2 Plastic bottles	HDPE (high-density polyethylene) (any bottles with necks/openings narrower than body, including beverage containers, cleaning containers)	<i>Recyclable in single-stream programme</i>
#2 Plastic (non-bottle)	HDPE (high-density polyethylene) (cleaning containers, pails, motor oil bottles)	<i>Recyclable in single-stream programme</i>
#3 Plastic	PVC (polyvinyl chloride) (all #3 plastics, including plastic piping, toys, furnishings)	<i>Recyclable in single-stream programme</i>
#4 Plastic	LDPE (low-density polyethylene) (all #4 plastics, including plastic film, wrap, grocery bags, sandwich bags from large & small packaging, including clear garbage bags/liners)	<i>Non-recyclable in single-stream programme except for film plastic found in Air Cargo area</i>
#5 Plastic	PP (polypropylene) (all #5 plastics, including drinking cups, food containers)	<i>Recyclable in single-stream programme</i>
Styrofoam	PS (polystyrene) (#6 plastics made of styrofoam, including cups, food containers, peanut packing)	<i>Non-recyclable — trash</i>
#6 Plastics — excluding styrofoam	#6 plastics excluding styrofoam, including cups, food packaging, cup lids	<i>Recyclable in single-stream programme</i>
#7 Plastic	Plastics labelled #7 Other, including biodegradable cups, bottles, food containers	<i>Recyclable in single-stream programme</i>
All other plastic	Foams, mixed plastics, unidentifiable plastics, etc.	<i>Non-recyclable — trash</i>
<i>Metal</i>		
Steel/tin	Steel/tin	<i>Recyclable in single-stream programme</i>
Aluminium	Aluminium cans/foil	<i>Recyclable in single-stream programme</i>

Table 2 continued

<b>Materials</b>	<b>Categories and description</b>	<b>Diversion opportunity</b>
Aerosol cans	Aerosol cans	<i>Recyclable in single-stream programme</i>
All other metal	Non-food containers, all scrap metal, items that are primarily metal, container lids/caps	<i>Recyclable in single-stream programme</i>
<i>Paper</i>		
OCC corrugated cardboard	Unwaxed/uncoated corrugated containers and boxes	<i>Recyclable in single-stream programme</i>
Newspaper	All newspaper, including inserts (glossy and otherwise)	<i>Recyclable in single-stream programme</i>
Mixed paper	Office paper (except fluorescent), envelopes, junk mail, telephone directories, paperboard	<i>Recyclable in single-stream programme</i>
Magazines & catalogues	All magazines & catalogues	<i>Recyclable in single-stream programme</i>
Waxed cups	All wax-coated drinking cups	<i>Compostable</i>
<i>Organics</i>		
Food waste	All food/beverage waste (out of containers where possible), including bones & rinds, food-contaminated paper towels & napkins, compostable wrappers	<i>Compostable</i>
Lavatory waste	Primarily paper towels & tissues	<i>Compostable</i>
Liquid waste	All liquid emptied from bottles and drinking containers	<i>Compostable</i>
All other organics	Textiles, including cloth napkins, blankets, clothing, hats, safety vests, rubber, broken wood, etc.	<i>Reusable depending on nature of item</i>
<i>Miscellaneous wastes</i>		
Hazardous waste	Any material that requires special treatment and handling	<i>Special treatment</i>
E-waste	Electronics, including headphones, cell phones, other devices with electronic components	<i>Recyclable in e-waste programme</i>
Universal waste	Bulbs, batteries, items that cannot be disposed of in a landfill but are not e-waste or hazardous waste	<i>Special treatment</i>
Construction and demolition waste	Construction materials, including concrete, wood and steel that can be recycled	<i>Recyclable in C&amp;D recycling programme</i>
<i>Residual waste (trash)</i>		
Trash/residual waste	All materials not classified elsewhere, materials that are not recyclable and/or were too soiled or contaminated to be repurposed (includes soiled food containers, nitrile gloves, wax and plastic food wrappers, cigarette butts, dark trash bags, etc.)	<i>Trash</i>

**Table 3** Material description by category and type

	<i>Annual waste (metric tons)</i>	<i>Percentage contribution</i>
AOB/Main Terminal	1,517	15%
Concourse A	1,714	17%
Concourse B	3,461	35%
Concourse C	1,912	19%
Maintenance	954	10%
East & West Overflow	216	2%
Air Cargo	68	1%
Total	9,842	100%

airport's existing e-waste recycling programme; 0.9 per cent could be recycled using DIA's existing C&D recycling programme; 1.6 per cent consisted of organic material that could be repurposed or reused if a textiles collection programme were to be implemented but would not be acceptable in the current composting programme; and the remaining 37.8 per cent was residual waste or trash which, in its current form, could not be recycled, composted or reused.

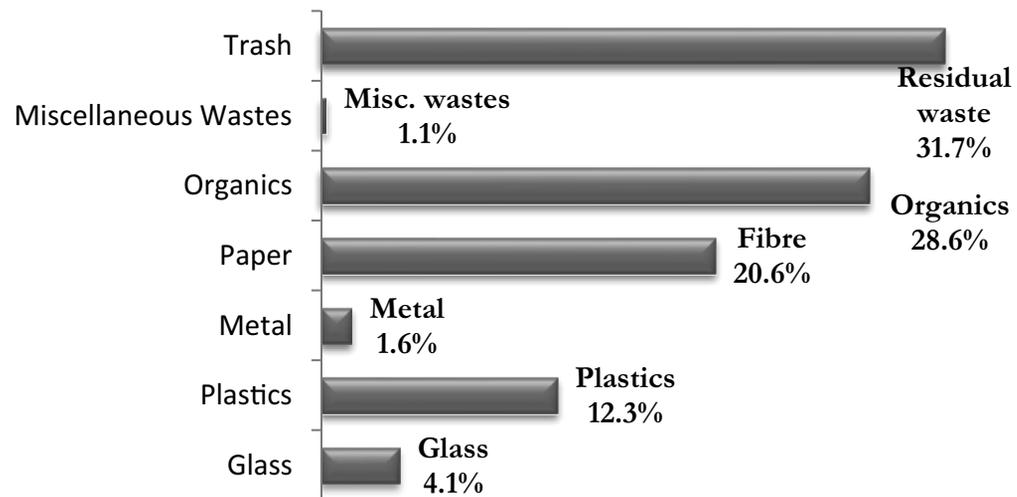
Within the total residual waste stream the weights per material found were: Glass (4.1 per cent), Plastics (12.3 per cent), Metal (1.6 per cent), Fibre (20.6 per cent),

Organics (28.6 per cent), Miscellaneous waste (1.1 per cent) and Residual waste (31.7 per cent).

Figure 1 illustrates the overall composition of DIA waste by material category. As shown, the Residual Waste, Organics, Fibre and Plastic categories represent the majority of wastes observed (totalling more than 93 per cent of all sample waste by weight).

**CONCLUSIONS**

DIA has the potential to divert an additional 62 per cent of its residual waste stream from landfill (Tables 4 and 5). By taking full advantage of its existing



**Figure 1** Overall waste composition by material category

**Table 4** Diversion potential

<i>Item</i>	<i>Waste reduction potential (%)</i>
Divert recyclables to existing single-stream programme	29.8%
Implement pre- and post-consumer composting collection programme for food waste	28.9%
Bale and recycle film plastic	0.8%
Recycle e-waste from airlines	0.2%
Implement airlines textile collection programme for reuse through donation	1.6%
Recycle C&D debris	0.9%
<b>Total landfill diversion potential</b>	<b>62.2%</b>
Residual material	37.8%
Total	100%

**Table 5** Total diversion potential

<i>Item</i>	<i>Waste reduction potential (%)</i>	<i>Waste reduction potential (metric tons)</i>
Divert recyclables to existing single-stream programme	29.8%	2,929.5
Implement pre- and post-consumer composting collection programme for food waste and wax cups	15.77%	1,551.7
Eliminate paper towel waste from solid waste stream — compost	8.5%	832
Eliminate liquids from load by composting	4.7%	461.9
Recycle construction and demolition debris	0.9%	86.6
Implement airlines textile collection programme for reuse through donation	1.6%	155
Recycle e-waste from airlines	0.2%	21.9
Bale and recycle film plastic	0.8%	81
<b>Total potential diversion</b>	<b>62.2%</b>	<b>6,119.9</b>

single stream, expanding its organics collection programme to include pre- and post-consumer food waste and implementing new programmes to capture additional reusable materials, DIA can move substantially closer to its strategic waste goal.

Using the waste audit results, DIA expanded its composting collection to include used paper towels from the public restrooms in the terminal and diverted more than 15.4 tonnes of compostable material from landfill in 2012.

Based on the waste audit, DIA was awarded an RREO (Recycling Resources Economic Opportunity) grant from the

state of Colorado to purchase a plastic film baler which was installed in December 2011. During 2012 DIA collected more than 3.5 tonnes of plastic film, which was sold as a commodity instead of being sent to landfill.

In 2013, DIA diverted 13.39 per cent of material from landfill (Table 6).

**Table 6** 2013 Diversion metrics (metric tons)

Single-stream recycle	1,534.48
Wood pallets, recycled	67.78
Composting captured	59.29
Plastic film wrap baled	5.26

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