

## Volume to Weight Conversion Ratios for Commercial Office Waste in New York City

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### Abstract

*This paper establishes volume to weight conversions for waste streams specific to large commercial office buildings. This sector-specific study can be used by commercial properties 1) to better measure and calculate waste generation, and 2) as a model to establish more accurate conversion standards.*

*Waste is typically reported in weight (tons). However waste is typically collected and measured by volume (cubic yards). When actual weights are not available, it is necessary to convert data from cubic yards to tons. Depending on the specific material stream composition, commonly used conversion rates may not be accurate, thus creating unreliable waste data.*

*This paper focuses on defining material streams specific to large commercial properties (500,000 sq. ft – 1m sq. ft) in the New York metropolitan area: mixed office waste, mixed paper, and comingled Glass/Metal/Plastic); and establishing volume to weight conversion ratios for these material streams. Great Forest staff weighed 2,684 bags of waste across 18 buildings and calculated the average bags per cubic yard. With an open explanation of the waste audit methodology involved, the conversion ratios arrived at are expected to contribute to increased accuracy and transparency in waste reporting in the United States.*

*On average, we found volume to weight conversions as follows:*

<i>Dry office waste</i>	<i>73 pounds per cubic yard</i>
<i>Mixed sorted paper</i>	<i>172 pounds per cubic yard</i>
<i>Commingled glass/metal/plastic containers</i>	<i>113 pounds per cubic yard</i>

## Introduction

The purpose of this paper is to establish a more accurate volume to weight conversion ratio for waste generated in commercial office buildings. Waste is typically reported in weight (tons), while it is frequently collected and measured by volume (cubic yards). There are readily available volume to weight conversions for various waste material streams, however, there are none that reflect the material streams specific to commercial office buildings. Without accurate volume to weight conversions, waste reporting can be over or under reported.

There are several waste studies that look specifically at commercial waste streams. These primarily serve to determine the material make-up of commercial waste streams, but do not include any volume to weight conversions.

The New York City Department of Sanitation commissioned a commercial waste study, which looked at composition of commercial waste and various generators. They break commercial waste down into three categories: putrescible, non-putrescible and fill.

*Putrescible waste – Solid waste generated daily by the City’s business establishments that is principally office and retail waste with small quantities of putrescible material and also includes restaurant and other waste.<sup>1</sup>*

The Solid Waste Authority of Palm Beach County conducted a commercial waste study in 1995, which laid out multiple commercial generator categories in an attempt to determine average total amount generated and pounds per square foot.

The California Environmental Protection Agency Integrated Waste Management Board indicated findings for large office buildings including total pounds of waste per 1000 sq foot and make-up of waste stream. These large office buildings “may also contain retail space or restaurants.”<sup>2</sup> No volume to weight conversions were included.

A Commercial Waste Disposal Assessment Report from the Massachusetts Department of Environmental Protection<sup>3</sup> included breakouts for various commercial sectors, but was not specific in commercial generator definitions.

These studies do contribute to information pertaining to specific material categories generated from various commercial waste sectors, and how much is typically diverted. However, volume to weight conversions were not included in these studies.

Volume to weight conversions are commonly found in table form listing a multitude of very specific material categories, most of which are recyclable and/or divertible materials including paper, plastics, metals, glass, organics, and a several types of materials found in construction debris.

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<sup>1</sup> Henningson, Durham & Richardson, “Commercial Waste Management Study Volume II,” New York City Department of Sanitation, March 2004, p1.

<sup>2</sup> California Environmental Protection Agency, Integrated Waste Management Board, “Waste Disposal and Diversion Findings for Selected Industry Groups,” June 2006, p 101.

<sup>3</sup> Massachusetts Department of Environmental Protection, “Commercial Waste Disposal Assessment Report,” November 2002.



The most commonly cited volume to weight conversions for waste are published by the United States Environmental Protection Agency. We also found a few other agencies or organizations with similar volume to weight conversion tables. There were at least three separate publications from the U.S. EPA that had slight variations. All cited similar or identical sources.

While these volume to weight conversion tables are readily accessible, determining which material categories apply to commercial office buildings is not as straight forward.

Many commercial office buildings in NYC are comprised of multiple tenants who are the generators of waste. Source separation efforts vary between tenants and between buildings, but there are four basic material categories<sup>4</sup>:

- **Dry Office Waste (trash):** Non-recyclable materials such as food packaging (waxed sandwich wrappers, snack wrappers, soiled plastic food and beverage containers, coffee cups, soiled paper plates and utensils, Styrofoam cups and containers), plastic packaging, bubble wrap, Styrofoam packaging and peanuts, soiled tissues, napkins and paper towels. Some food remnants also appear.
- **Mixed Paper:** White paper, color paper, file folders, envelopes, magazines, newspapers, paper bags, paper packaging, and paperboard (soft cardboard boxes and cafeteria trays).
- **Glass/Metal/Plastic:** Aluminum cans, plastic and glass bottles, tin cans, and aluminum foil.
- **Cardboard**<sup>5</sup>: Cardboard boxes, whole or flat.

The specific material categories listed in published volume to weight conversion tables are not reflective of the make-up of commercial office waste and how it is bagged and removed from NYC commercial office locations.

**Table 1 – Lbs/CY**

	Mixed MSW (uncompacted)	Residential Waste (Uncompacted at Curb)	Mixed Ledger (uncompacted, crumpled)	Glass (whole bottles)	Aluminum Cans Whole	Plastic (PET whole bottles)	Mixed PET, daily & other rigid, whole loose	Mixed PET and HDPE, whole, loose	Comingled plastic, glass, and metal containers
1 EPA (communities, various sources cited)	200 lbs/cu yd								
2 Rosenthal			110-205 lbs/cu yd	500-700 lbs/cu yd	50-75 lbs/cu yd	30-40 lbs/cu yd			
3 EPA (various sources cited)			42.35 lbs/ 55 gallon	1000 lbs/cu yd	65 lbs/cu yd	35 lbs/cu yd	40 lbs/cu yd	50 lbs/cu yd	177 lbs/cu yd
4 CIMP (various sources cited)			42.35 lbs/ 55 gallon		65 lbs/cu yd			32 lbs/cu yd	
5 EPA (appendix B, various sources cited)		150-300 lbs/cu yd	110-205 lbs/cu yd	500-700 lbs/cu yd	50-75 lbs/cu yd	30-40 lbs/cu yd		32 lbs/cu yd	

1 EPA - Waste Prevention, Recycling, and Composting Options: Lessons from 30 Communities

2 Rosenthal Group: Recyclable Material Conversion Table Volume to Weight

3 EPA - Standard Volume-to-Weight Conversion Factors

4 California Integrated Waste Management Board, Appendix I, Weight Conversion Sources and Table

5 EPA - Standard Volume-to-Weight Conversion Factors, Appendix B p.59-62

<sup>4</sup> Hazardous, universal, electronic, bulk and construction waste was not included as these materials require separate storage and handling. Additionally, any waste from tenant cafeterias or retail establishments present in the buildings audited were excluded from this study.

<sup>5</sup> Cardboard is typically not bagged, and is usually handled and transported within commercial office buildings separately from other bagged office waste.



## Method

Great Forest conducts waste audits at large commercial office buildings. For the purpose of this study, we gathered information from waste audits conducted at 18 locations ranging in size from 500,000 sq. ft. to 1.5m sq. ft. Each office building was comprised of multiple tenants. Tenant types ranged from law firms, financial firms, administrative offices and other similar businesses. We excluded tenant cafeteria waste and any retail waste (restaurants or other non-food and beverage establishments) from this study.

In New York City, typical source-separated waste streams fall into the following four categories: Trash, Mixed Paper, GMP, Cardboard. Cardboard is typically handled and stored separately within commercial office buildings, and as such, we did not include that stream in this study.

For each location we confirmed that the audit was conducted on a day of typical building operations to ensure the materials we were auditing were representative of typical generation. Since a majority of commercial office building tenants conduct business Monday through Friday, all audits were conducted on weekdays. We coordinated with janitorial staff on-site to ensure that normal collection procedures occurred, and to ensure that all bagged materials intended as trash by tenants, all materials intended as mixed paper by tenants, and all materials intended as GMP by tenants were kept separate in order for our auditors to identify the intended material streams. At each location bags were identified as to their intended material designation, then weighed and recorded. Bag size was consistent across locations as janitorial staff primarily uses 55-gallon brute barrels for collection of waste.

In order to determine number of bags per cubic yard, we placed average sized bags of average fullness of each material stream into a 1-cubic yard container. Janitorial staff primarily use Rubbermaid 1-cubic yard plastic tilt trucks for transport of waste.



## Results

Across 18 locations a total of 2,083 bags of trash were weighed; 485 bags of mixed paper; and 116 bags of GMP. Average bag of 'dry waste' or trash weighed 10 pounds. Average bag of 'mixed paper' weighed 16 pounds. Average bag of GMP weighed 9 pounds.

Our pounds per cubic yard results for Mixed Paper were in-line with published conversions by the EPA, falling within the 110-205 lb/cu yd range. The comingled GMP pounds per cubic yard was lower than the 177 lbs/cu yd information from the EPA. There is currently not a comparable conversion for 'dry waste'.

**Table 2 – Lbs/CY Study Results Summary**

	<u>Dry Waste</u>	<u>Mixed Paper</u>	<u>GMP</u>
Total Weight	20,763	7,767	1,093
Total Bags	2,083	485	116
Average Bag Weight	10	16	9
Bags per CY	<u>7.4</u>	<u>10.7</u>	<u>12.0</u>
<b>Pounds per CY</b>	<b>73</b>	<b>172</b>	<b>113</b>

**Table 3 – Lbs/CY Study Results - Detail**

POUNDS PER CUBIC YARD

site	Dry Waste					Paper					GMP				
	lbs	bags	lbs/bag	bags/cy	lbs/cy	lbs	bags	lbs/bag	bags/cy	lbs/cy	lbs	bags	lbs/bag	bags/cy	lbs/cy
1	1,850	143	13	7.4	95	359	18	20	10.7	214	21	2	10	12.0	125
2	1,957	175	11	7.4	82	291	15	19	10.7	208	-	-	-	-	-
3	262	24	11	7.4	81	237	15	16	10.7	170	30	3	10	12.0	118
4	3,312	238	14	7.4	103	2,196	92	24	10.7	256	-	-	-	-	-
5	3,408	311	11	7.4	81	1,636	95	17	10.7	185	116	9	13	12.0	154
6	901	68	13	7.4	98	388	21	18	10.7	198	-	-	-	-	-
7	1,816	189	10	7.4	71	360	28	13	10.7	138	25	4	6	12.0	76
8	465	37	13	7.4	92	206	12	17	10.7	184	10	1	10	12.0	120
9	769	127	6	7.4	45	327	45	7	10.7	78	58	17	3	12.0	41
10	827	136	6	7.4	45	193	31	6	10.7	67	12	8	2	12.0	18
11	1,816	189	10	7.4	71	399	28	14	10.7	153	196	21	9	12.0	112
12	228	21	11	7.4	80	-	-	-	-	-	-	-	-	-	-
13	297	22	14	7.4	99	242	22	11	10.7	118	319	26	12	12.0	147
14	1,303	147	9	7.4	65	601	36	17	10.7	179	285	22	13	12.0	156
16	1,552	256	6	7.4	45	68	14	5	10.7	52	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	21	3	7	12.0	85
18	-	-	-	-	-	263	13	20	10.72	149	-	-	-	-	-
subtotal	20,763	2,083	10			7,767	485	16			1,093	116	9		
			lbs Dry Waste/cy		<b>73</b>			lbs Paper/cy		<b>172</b>			lbs GMP/cy		<b>113.11</b>



## Discussion

There were significantly fewer bags of mixed paper and GMP weighed, which is attributed to varying source separation efforts at each location. Additionally, source-separating GMP is not required of non-food businesses in NYC. There could also be the possibility of janitorial staff not maintaining tenant source-separation efforts.

It is also a possibility that local law and capability of local processing facilities could contribute to 'allowable contamination' in the trash or recyclable stream. In many waste audits Great Forest has conducted, we find that 25% of dry waste generated from commercial office buildings is comprised of recyclables (mixed paper, GMP). Many private carters in NYC recognize this and take dry waste from commercial office buildings to Material Recovery Facilities to try and recover the recyclables discarded within the dry waste stream<sup>6</sup>.

Whereas, in San Francisco, where recycling laws vary greatly from NYC, bagged dry office waste may in fact weigh less due to single stream recycling, and the diversion of food remnants through compost requirements, and greater use of recyclable and/or compostable disposable food packaging.

We encourage additional studies in this area to further confirm volume to weight conversions of combined material streams that are better represented of various generator types. As more and more municipalities across the United States require businesses to report waste information, not all businesses will have the resources or capabilities to conduct in-depth waste audits and will need volume to weight conversions that match up with key material categories they generate.

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<sup>6</sup> NYC law stipulates that all commercial businesses must have their waste removed by private carters.

