FINAL REPORT

Statewide Bulky Waste Characterization Study

June 30, 2022

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BULKY WASTE CHARACTERIZATION STUDY

1. INTRODUCTION

With dwindling landfill capacity and fixed capacity for incineration at waste-to-energy (WTE) facilities, sustainable materials management, including aggressive diversion of materials through recycling and reuse, is increasingly important in Massachusetts. The Massachusetts Department of Environmental Protection's (MassDEP) Solid Waste Master Plan seeks to meet this capacity need in large part through setting and achieving aggressive disposal reduction goals. This includes reducing disposal from 5.7 million tons in 2018 to 4.0 million tons in 2030. Solid waste is generally divided into:

- **Municipal solid waste** (MSW), which consists of routinely generated wastes from residential households and commercial businesses, and
- **Construction and demolition (C&D) debris**, which includes a variety of constituents specific to construction, demolition, and renovation activities.

Massachusetts has implemented waste bans as a primary strategy for diverting materials from landfilling or combustion. MassDEP introduced its first bans of easy-to-recycle and toxic materials in 1990, and additional materials have been phased into the waste bans over time. Waste bans span both the MSW and C&D waste streams.

Bulky waste is defined by MassDEP solid waste regulations as "waste items of unusually large size, including but not limited to large appliances, furniture, large auto parts, stumps, trees, branches, brush."

Bulky wastes are largely processed as C&D debris, and, as such, are delivered to C&D handling facilities across the Commonwealth. MassDEP has established a C&D Minimum Performance Standard (MPS) that requires C&D handling facilities to either achieve a Process Separation Rate (PSR) of 15 percent, to transfer all C&D materials to a processor that meets the 15 percent PSR, or to only accept residuals from a processor that meets the 15 percent. All facilities must also demonstrate that all waste ban materials are separated to the greatest extent possible. As these facilities have reported increasing volumes of bulky waste, MassDEP has identified the need to better understand this waste stream.

MassDEP engaged the Center for EcoTechnology, Inc. (CET) in collaboration with MSW Consultants, to characterize bulky wastes delivered to selected processing facilities within the state. This report summarizes the methodology employed for this bulky waste characterization study and presents the results of the research in graphical and tabular format. Specifically, the scope of this study sought to define the composition of bulky waste loads by material category and to determine what percentage of these loads consists of either waste ban materials or other recoverable materials.

2. STUDY DESIGN

This section details critical elements of the study, including:

- Waste Generation,
- Host Facility Selection,
- Material Streams,
- Sampling Plan, and
- Material Categories.

2.1 WASTE GENERATION

At the current time, MassDEP receives tonnage reports annually from 31 large C&D handling facilities across the state. These facilities report the total volume of wastes received, including itemized tonnage of C&D debris, bulky waste, and several other materials. C&D waste and bulky wastes are shown in Table 2-1.

Table 2-1 C&D Handling Facilities Reported Tonnage and Percent of Total Inbound

Reported Tonnage and Percent	2016	2020
C&D Waste	1,140,286 (81%)	1,229,898 (76%)
Bulky Waste	270,906 (19%)	382,579 (24%)
Total Inbound C&D and Bulky Waste	**1,411,192 (100%)**	**1,612,477 (100%)**

As shown, reported bulky waste at these facilities increased from 270,906 tons in 2016 to 382,579 tons in 2020, representing a 41 percent increase. Bulky waste material now represents a substantial portion of materials received at some C&D handling facilities.

2.2 HOST FACILITY SELECTION

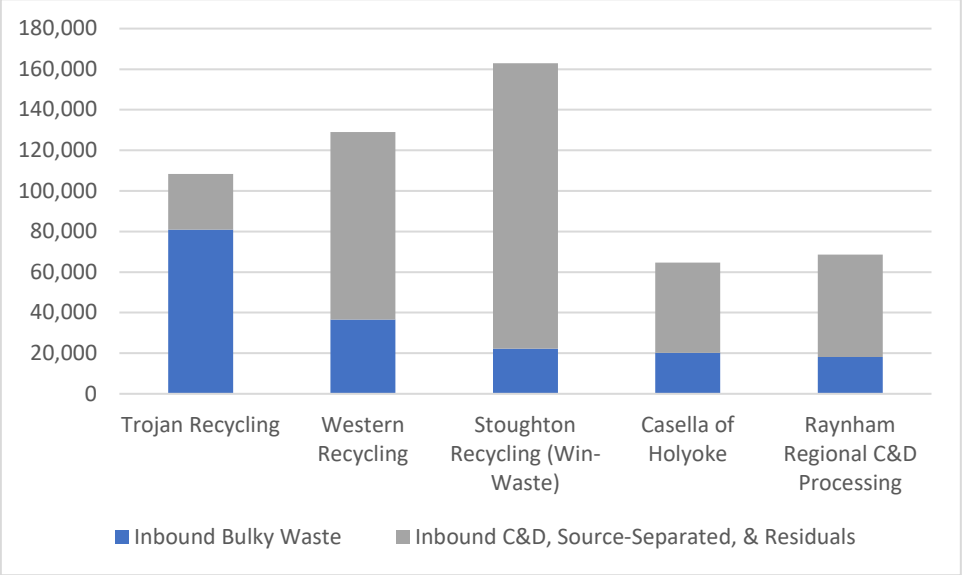
From a list of statewide licensed Construction & Demolition (C&D) handling facilities, MassDEP selected five host facilities with high tonnage of inbound Bulky Waste. The selected facilities and their reported inbound tonnages for 2021 are presented in Table 2-2.

Table 2-2 2021 Host Facility Inbound Bulky Waste Tonnage and Percentages

	Inbound Tons Reported		
Facility Name	Bulky Waste	Total	Bulky Waste Percent
Stoughton Recycling (Win-Waste)	22,246	162,977	14%
Trojan Recycling	80,869	108,425	75%
Casella of Holyoke	20,192	64,665	31%
Western Recycling	36,524	128,985	28%
Raynham Regional C&D Processing	18,155	68,615	26%
Five Facility Totals	**177,986**	**533,667**	**33%**
Statewide	*308,127*	*2,554,078*	*12%*

Figure 2-1 depicts bulky waste tonnage as a portion of the total inbound waste for each host facility in the study. Total Inbound Waste includes Inbound C&D, Source-Separated Materials, Residuals, and Bulky Waste.

Figure 2-1 Bulky Waste Tonnage as a Portion of Total Inbound Waste by Host Facility (2021)



Each participating host facility was visited for this study in May 2022. Table 2-3 provides a list of those facilities along with the dates each facility was visited.

Table 2-3 Bulky Waste Facilities and Study Dates

Facility Name	Location and Region	Dates Visited
Stoughton Recycling (Win-Waste)	Stoughton, Southeast Region	May 16–17, 2022
Trojan Recycling	Brockton, Southeast Region	May 18–20, 2022
Casella of Holyoke	Holyoke, Western Region	May 23–24, 2022
Western Recycling	Wilbraham, Western Region	May 25–26, 2022
Raynham Regional C&D Processing	Raynham, Southeast Region	May 27, 2022

2.3 MATERIAL STREAMS

On the surface, it might seem that identifying bulky wastes contained on inbound trucks at the host facilities would be straightforward. In practice, however, the classification of a load as bulky or C&D is not always so clear. In most cases, the material cannot be assessed until it is tipped on the floor and inspected. Some bulky items are generated in both the MSW and C&D waste streams, so there is some judgement call as to the classification of the material. Furthermore, upon observation of facility operations during this study, C&D handling facilities appear to use the terms "bulky waste" and "C&D" materials as indicators of recyclability. In other words, when loads arrive at C&D handling facilities, the ones that contain significant quantities of recyclable materials are classified as C&D and directed to the recycling/processing area of the facility, while the loads deemed to contain less recyclables are instructed to dump in the bulky waste or MSW areas for disposal.

At the outset of data collection, MSW Consultants randomly captured inbound loads for three distinct waste material streams, which were defined based on the origin of where the wastes were generated. The load origin was derived initially from facility operations, as well as a brief interview with the truck driver to confirm the generation type:

- **C&D debris**: As defined by state regulations,
- **Bulky waste**: As defined by state regulations, and
- **Mixed load**: This term was developed by MSW Consultants for this study and refers to loads that contained combinations of Bulky Waste and C&D debris. These loads were identified by the facility as Bulky Waste[1] and, once tipped, were found to contain some meaningful fraction of C&D debris. It did not appear that the facilities were making a concerted effort to change the classification of the load unless it differed significantly from their initial Bulky Waste classification.

2.4 SAMPLING PLAN

The sampling targets for this project specified that between 20 and 25 inbound loads be surveyed each day at each host facility.

At the outset of field data collection, MSW Consultants understood that specific truck types could be included in the sampling, and that in addition to bulky waste deliveries being surveyed, it was possible to survey loads that were ultimately classified as C&D or mixed loads. After several days of visual surveys, MSW Consultants reported on the nature of bulky waste load classification and handling practices at the first two host facilities, and MassDEP clarified that only loads classified as containing bulky waste (whether pure or mixed with C&D or other materials) were to be surveyed. This clarification excluded those loads composed purely of C&D debris.

A total of 219 loads were surveyed at the five host facilities. Table 2-4, Table 2-5, and Table 2-6 summarize the sample distribution by facility, by truck type, and by total tons from each truck type, respectively. MSW Consultants believes that the distribution of surveyed loads was highly representative of the materials delivered on the days that the research took place.

Table 2-4 Load Survey Distribution by Facility

Facility Name	Bulky Loads	Mixed Loads	C&D Loads	Total Loads Surveyed
Stoughton Recycling (Win-Waste)	15	8	18	41
Trojan Recycling	29	17	27	73
Casella of Holyoke	30	13	0	43
Western Recycling	29	13	0	42
Raynham Regional C&D Processing	13	7	0	20
Total Samples	**116**	**58**	**45**	**219**

[1] Three of the host facilities (Western Recycling, Casella Holyoke and Raynham) were also permitted to accept MSW which was segregated from the C&D processing line. Some of the mixed loads identified by MSW Consultants were classified as MSW at these facilities and moved to the MSW pile.

For all facilities, the number of visual samples varied according to truck type. Table 2-5 lists the different truck types and the distribution of visual samples.

Table 2-5 Distribution of Load Surveys by Truck Type

Truck Type	Bulky Load Visuals	Mixed Load Visuals	C&D Load Visuals	Total Visual Samples	Percent of Truck Type
Roll-off Open Top	80	53	34	167	76.3%
Box/Dump Truck	28	2	8	38	17.4%
Pickup Truck/Tow Trailer	7	3	3	13	5.9%
Rear Loader	1	0	0	1	0.5%
Total Samples	**116**	**58**	**45**	**219**	**100%**

Table 2-6 presents the visual sample distribution for all facilities by total tons and truck type.

Table 2-6 Distribution of Visually Surveyed Tons by Truck Type

Truck Type	Bulky Loads	Mixed Loads	C&D Loads	Total Loads	Percent by Tons
Roll-off Open Top	131.3	113.5	103.1	347.9	84.1%
Box/Dump Truck	28.1	1.5	12.5	42.1	10.2%
Pickup Truck/Tow Trailer	4.9	6.0	12.5	23.4	5.7%
Rear Loader	0.5	0.0	0.0	0.5	.1%
Total Tons	**164.8**	**121.0**	**128.1**	**413.5**	**100%**

2.5 MATERIAL CATEGORIES

Table 2-7 lists the material groups and material categories developed for this study. This table indicates which materials are classified as Waste Ban per MassDEP regulations. Additionally, the table identifies whether non-Waste Ban materials have any potential, based on their condition, to be diverted from disposal or if they are non-recoverable. Appendix A contains detailed description for each of the 47 material categories.

Table 2-7 Material Groups and Categories

Material Group	Material Category	Waste Ban	Additional Recoverability Potential			
			Reusable	Recyclable	EfW Fuel	Non-Recoverable
Paper	Uncoated OCC	✓				
	Other Recyclable Paper	✓				
	Non-Recyclable Paper					✓
Plastic	Recyclable Plastic Containers	✓				
	Clean Film Plastic (Commercial/Industrial)			✓		
	5-gal Buckets and Plastic Toters		✓	✓		
	Durable Plastics (Not Furniture)		✓	✓		
	Non-Recyclable Plastics					✓
Metal	Recyclable Metal Containers	✓				
	Large Appliances (white goods)	✓				
	Ferrous/Non Ferrous Scrap	✓				
Glass	Recyclable Glass Containers	✓				
	Non-Recyclable Glass					✓
Organics	Land Clearing (stumps, large branches, etc.)	✓				
	Yard Waste/Green Waste	✓				
	Other Organics					✓
Wood	Untreated Dimensional Lumber	✓				
	Engineered Wood	✓				
	Wood Pallets/Crates/Spools	✓				
	Painted/Stained Wood	✓				
	Treated Wood	✓				
	Cabinetry/Countertops, Moldings, Doors, Windows	✓				
C&D	Asphalt Pavement	✓				
	Brick/Block	✓				
	Concrete	✓				
	Gypsum wallboard - CLEAN	✓				
	Gypsum wallboard - USED			✓		
	Asphalt Shingles			✓		
	Carpet & Carpet Padding			✓		
	Rock/Gravel/Dirt/Sand		✓			
	Porcelain and Other Plumbing Fixtures					✓

Material Group	Material Category	Waste Ban	Additional Recoverability Potential			
			Reusable	Recyclable	EfW Fuel	Non-Recoverable
	Other C&D Materials					✓
Furniture	Predominantly Wood		✓		✓	
	Predominantly Plastic		✓			
	Predominantly Metal (incl filing cabs)	✓				
	Predominantly Upholstered					✓
	Predominantly Mixed					✓
	Mattresses*	✓				
	Box Springs*	✓				
Other Bulky	CRTs (Older televisions & computer monitors)	✓				
	Vehicle Batteries	✓				
	Tires	✓				
	Textiles*	✓				
	E-Waste			✓		
	Other Bulky Materials					✓
Mixed MSW	Bagged and Loose MSW					✓
	HHW/Universal Waste					✓

* Waste Disposal Ban becomes effective on November 1, 2022.

3. FIELD DATA COLLECTION METHODS

This section summarizes the methodology for selecting inbound loads and conducting the visual composition survey.

3.1 INBOUND LOAD SELECTION

Each facility used its own methods for handling and ultimately assigning the material type for inbound loads. At the outset of field data collection at each facility, MSW Consultants interviewed facility personnel to understand the internal load classification and reporting protocols. For this reason, load selection was somewhat reactive to the treatment of the inbound load by each host facility.

Drivers of selected loads were interviewed to confirm the geographic origin and type of waste, as well as any other pertinent data. This information was noted via an app on a handheld tablet computer, along with a unique identifying number associated with that vehicle on that day.

Based on discussions with MassDEP, the following protocol was used to determine if a load should be characterized for this study as a bulky waste load. The bulky waste load characterization protocol was initiated as a mid-course adjustment after having completed site visits at two of the five host facilities:

- The facility scale house classification was considered, as well as where the hauler was directed to tip: C&D recovery area (not assessed) or bulky waste/MSW area.
- The degree to which a facility processes (or does not process) a load was no longer to be the determining factor in whether the load was considered a bulky waste load.

- Other factors considered included type of truck (such as box trucks), and type of hauler (such as junk collection/clean out companies). If the driver could be interviewed and could identify the source of the material, this information was also considered.
- Loads that appeared to be primarily C&D materials on the surface were not characterized as bulky and were therefore excluded from the study.

3.2 VISUAL SURVEYING

Visual surveying of a load of bulky or C&D waste involves detailed volumetric measurements of the truck and load dimensions, followed by the systematic observation of the major material components in the tipped load. The basic steps followed for visual surveying were:

1. The dimensions of the incoming load were measured and recorded prior to tipping and (if possible) the percent fullness of the vehicle/container was estimated.
2. The load was tipped. If it was a large load of non-homogeneous materials, the loader operator was asked to spread out the material so that it was possible to discern dense materials such as block, brick, and dirt that tend to sink to the bottom of the pile.
3. A first pass was made around the load marking the major material groups that were present in the load—wood waste, organics, paper, etc. The percentage of the load made up of these major groups was estimated.
4. A second pass was made around the load, noting the secondary material categories contained within each group – for example, within the Wood material group, secondary categories include wooden pallets, dimensional lumber, painted wood, etc. The percentage of the secondary material category within the primary material groups was then estimated.
5. The app alerted the enumerator if there were any problems with the estimations, for example if the percentages did not sum to 100 percent.
6. Finally, the app compared the volumetrically calculated weight of the load to the actual scale weight of the load. Possible sources of discrepancy could then be identified, and adjustments to volumetric estimates and/or density factors could be made to reduce the degree of difference. This last step is critical to the accuracy of the data.

A tablet-based app for visual estimation of C&D loads was used for this engagement. This app provides professional data collection staff with the density data, mathematical conversion formulae, and QA/QC support needed to convert volumetric composition estimates to weight-based composition estimates. The visual surveying app is a critical tool that provides the calculations in real time to achieve the most accurate estimates. Additionally, MSW Consultants has compiled material densities from various published sources and has also modified certain material densities based on our body of related project work. At each host facility in this study, MSW Consultants field data collection staff worked closely with vehicle drivers and scale house operators to obtain actual weights of each surveyed load. Visual estimates could then be adjusted to accurately solve for the actual load weight.

The volumetric estimation app allows the enumerator to adjust any density factor up or down depending on the observed compactness or saturation of each individual constituent. For example, dimensional lumber that crisscrosses and contains noticeable airspace may have its density factor adjusted downward. Stacked, flattened cardboard boxes or plywood sheets with no noticeable airspace may have their density adjusted upward. Although this feature exists, enumerators do not typically adjust the density factors on a regular basis, as other aspects of the volumetric estimate could also need adjusting.

Appendix B contains representative photographs depicting examples of bulky waste, C&D and mixed loads observed during field data collection.

3.3 DATA ANALYSIS

At the conclusion of field data collection, the data that had been entered into the composition database was statistically analyzed to determine the estimated weight and estimated mean percent associated with each material in the samples. The analysis produced estimates of the pounds and percent associated with each material component present. Consistent with industry standards, the mean composition as well as the confidence intervals were calculated at a 90 percent level of confidence.

Visual volumetric survey data is analyzed through a series of steps. First, volumetric estimates of each surveyed load are converted to weight based on density factors. Once visual sample data were converted to estimated weights, the sample mean composition was determined for each material category by (1) summing the weight of each material in each sample; (2) summing the total weight of all samples, and (3) dividing the first value by the second value to determine the percent-by-weight composition.

The confidence intervals at a 90 percent level are provided for each material category as well as for major material groups (e.g., "paper", "plastic"). Confidence intervals have been calculated at a 90 percent level of confidence, meaning that we can be 90 percent sure that the population mean falls within the upper and lower confidence intervals shown. (The converse is also true: that there is a 10 percent chance that the population mean falls outside of the sample mean.) In general, as the number of samples increases, the width of the confidence intervals decreases, although the more variable the underlying waste stream composition, the less noticeable the improvement for adding incremental samples.

A final point of analysis for this study was to request a complete record of the scale transactions from each facility from the day(s) on which visual surveying occurred, to assess the proportion of C&D to bulky waste loads. Due to the limited number of responses to this request, MSW Consultants was unable to include this perspective in this draft report.

4. RESULTS

4.1 BULKY WASTE COMPOSITION

Figure 4-1 presents an essential finding of this study, which is that there is a significant percentage of Waste Ban materials within the Bulky Waste Stream. At just over 37 percent, Waste Ban materials made up the largest fraction of Bulky Waste. Another 30 percent of Bulky Wastes were found to have at least some potential to divert (albeit in some cases this would have to occur upstream), and the remaining 33 percent were non-recoverable.

Figure 4-1 Bulky Waste Composition by Recoverability Potential

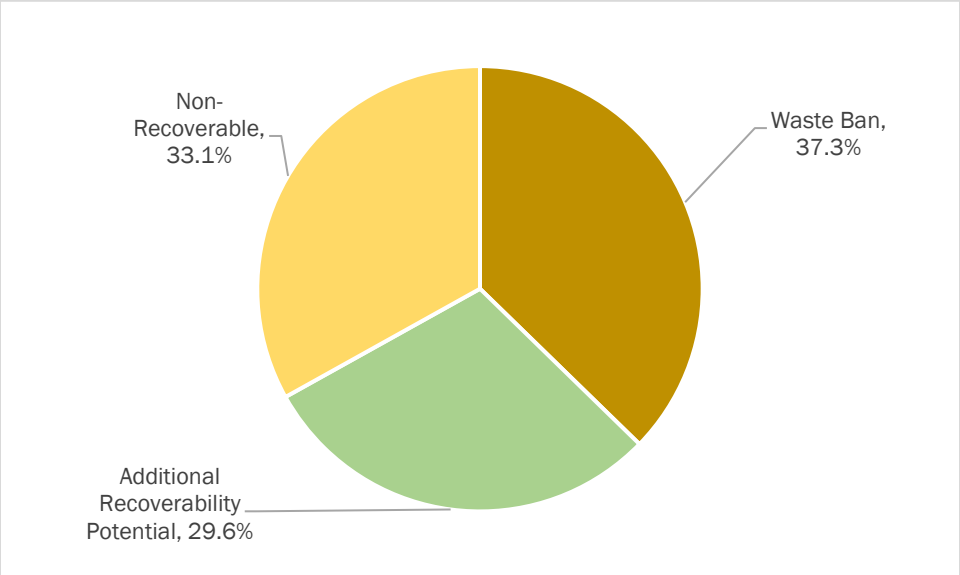


Figure 4-2 illustrates the composition of the bulky waste loads by material group. As shown, Furniture and Wood made up the largest percentages. It is also of interest that so many material groups were represented within the bulky waste stream.

Figure 4-2 Bulky Waste Composition by Material Group

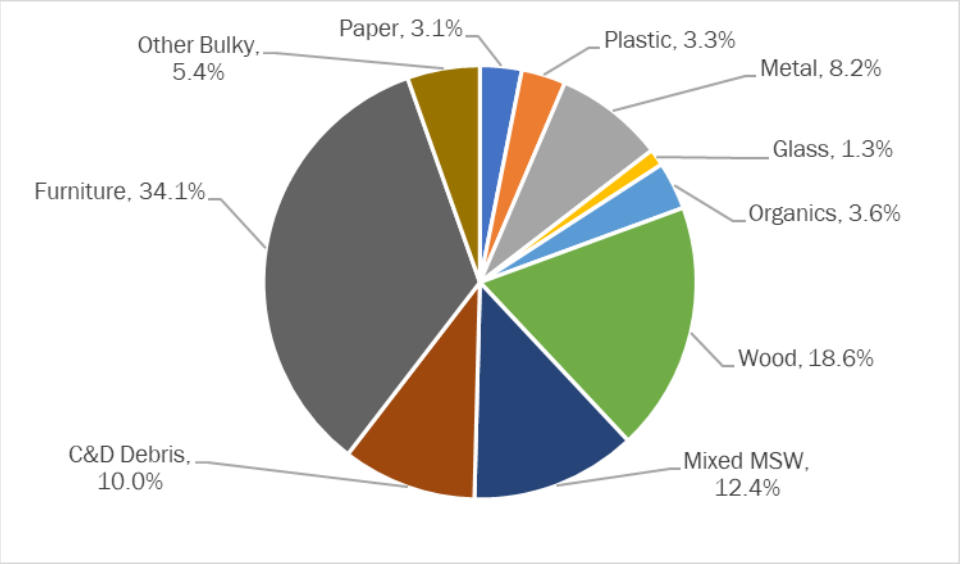


Table 4-1 depicts the top 10 material categories of bulky waste. Wood furniture and bagged/loose MSW comprise almost 30 percent of all bulky waste. The table also provides the subtotal percentage of waste ban materials within this group.

Table 4-1 Top 10 Bulky Waste Categories

No.	Material Category	Mean	Waste Ban
1	Predominantly Wood Furniture	17.2%	
2	Bagged and Loose MSW	12.4%	
3	Predominantly Mixed Furniture	9.4%	
4	Ferrous/Non-Ferrous Scrap	7.8%	✓
5	Engineered Wood	6.3%	✓
6	Textiles	3.7%	✓
7	Carpet & Carpet Padding	3.6%	
8	Predominantly Metal Furniture	3.5%	✓
9	Treated Wood	3.1%	✓
10	Painted/Stained Wood	2.8%	✓
	Subtotal Waste Ban Materials	**27.2%**	

Table 4-2 provides the detailed composition profile for bulky waste. The resulting composition has been applied to the reported 2021 tonnage of bulky wastes. The margin of error (MOE) has been calculated at a 90 percent level of confidence.

Table 4-2 Detailed Bulky Waste Composition

Material Category	Mean Percent	Margin of Error	Est. Annual Tons	Material Category	Mean Percent	Margin of Error	Est. Annual Tons
Paper	**3.1%**	**0.5%**	**9,608**	**C&D Debris**	**10.0%**	**3.0%**	**30,943**
Uncoated OCC	1.4%	0.2%	4,328	Asphalt Pavement		Not Found	0
Other Recyclable Paper	0.8%	0.2%	2,374	Brick/Block	0.1%	0.2%	336
Non-Recoverable Paper	0.9%	0.2%	2,905	Concrete		Not Found	0
Plastic	**3.3%**	**0.4%**	**10,182**	Gypsum wallboard - CLEAN	0.1%	0.1%	205
Recyclable Plastic Containers	0.2%	0.0%	571	Gypsum wallboard - USED	1.1%	0.7%	3,431
Clean Film Plastic	0.0%	0.0%	152	Asphalt Shingles	0.6%	0.6%	1,880
5-gal Buckets and Plastic Toters	0.3%	0.1%	815	Carpet & Carpet Padding	3.6%	1.0%	11,134
Durable Plastics (Not Furniture)	1.2%	0.2%	3,671	Rock/Gravel/Dirt/Sand	1.0%	1.6%	2,961
Non-Recoverable Plastics	1.6%	0.2%	4,973	Porcelain/Plumbing Fixtures	1.5%	1.0%	4,501
Metal	**8.2%**	**1.5%**	**25,144**	Other C&D Materials	2.1%	1.2%	6,495
Recyclable Metal Containers	0.0%	0.0%	140	**Furniture**	**34.1%**	**5.3%**	**105,131**
Large Appliances (white goods)	0.3%	0.2%	876	Predominantly Wood	17.2%	3.3%	53,050
Ferrous/Non Ferrous Scrap	7.8%	1.4%	24,127	Predominantly Plastic	0.7%	0.2%	2,133
Glass	**1.3%**	**0.5%**	**3,908**	Predominantly Metal	3.5%	1.6%	10,732
Recyclable Glass Containers	0.1%	0.1%	214	Predominantly Upholstered	1.3%	0.4%	4,029
Non-Recoverable Glass	1.2%	0.5%	3,694	Predominantly Mixed	9.4%	4.0%	28,877
Organics	**3.6%**	**2.7%**	**10,974**	Mattresses	1.2%	0.3%	3,555
Land Clearing	0.0%	0.0%	75	Box Springs	0.9%	0.3%	2,755
Yard Waste/Green Waste	1.6%	1.4%	4,951	**Other Bulky**	**5.4%**	**1.3%**	**16,731**
Other Organics	1.9%	1.9%	5,948	CRTs	0.3%	0.3%	920
Wood	**18.6%**	**2.4%**	**57,308**	Vehicle Batteries		Not Found	0
Untreated Dimensional Lumber	1.8%	0.3%	5,667	Tires	0.3%	0.2%	803
Engineered Wood	6.3%	1.3%	19,344	Textiles	3.7%	1.1%	11,366
Wood Pallets/Crates/Spools	1.7%	0.7%	5,346	E-Waste	0.4%	0.4%	1,334
Painted/Stained Wood	2.8%	0.7%	8,756	Other Bulky Materials	0.7%	0.3%	2,308
Treated Wood	3.1%	0.6%	9,610	**Mixed MSW**	**12.4%**	**1.9%**	**38,198**
Cabinetry/Countertops/Doors	2.8%	0.7%	8,585	Bagged and Loose MSW	12.4%	1.9%	38,152
				HHW/Universal Waste	0.0%	0.0%	46
				Grand Total	**100%**		**308,127**
				No. of Samples	***116***		

4.2 C&D COMPOSITION

Visual sampling of C&D waste was conducted at two of the host facilities. Similar to the Bulky Waste composition, Figure 4-3 also reveals a significant percentage of Waste Ban materials in the C&D Waste Stream. At just over 43 percent, Waste Ban materials made up the largest fraction of C&D Waste. Almost 23 percent of C&D Wastes were found to have at least some potential for diversion, and the remaining 34 percent were non-recoverable.

Figure 4-3 C&D Waste Composition by Recoverability Potential

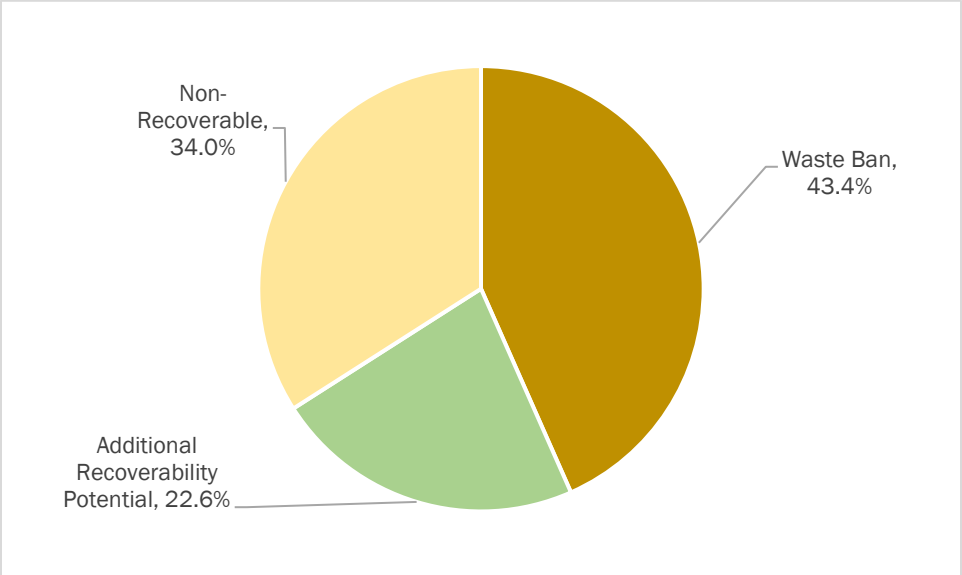


Figure 4-4 displays the composition of C&D loads by material group. As shown, C&D loads contained sharply higher fractions of wood and C&D debris compared to the bulky waste loads.

Figure 4-4 C&D Waste by Material Group Composition

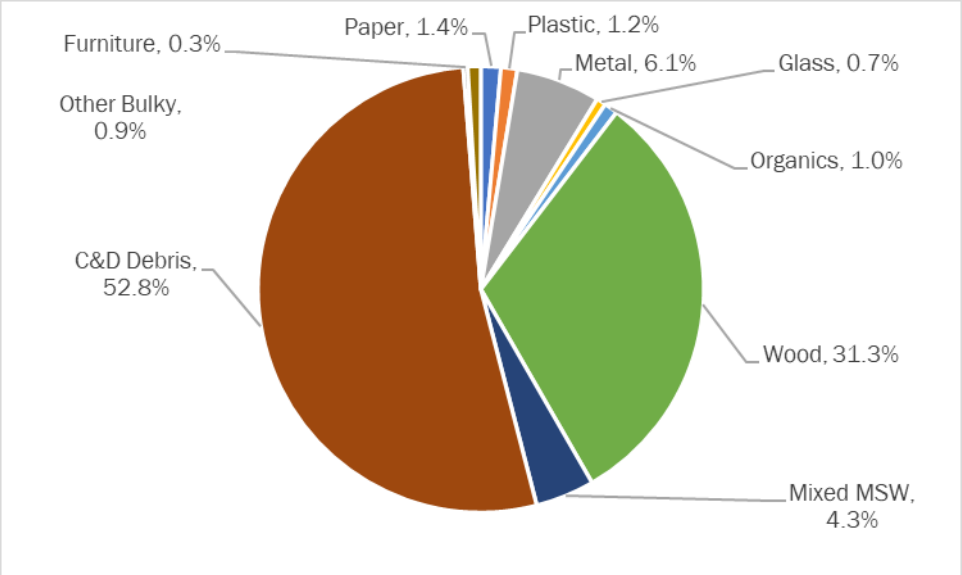


Table 4-3 lists the ten most prevalent material categories in C&D Waste. These items are consistent with construction, demolition, and renovation-related activities, and are further described in the definitions in Appendix A. The table also provides the subtotal percentage of waste ban materials within this group.

Table 4-3 Top 10 Material Categories, C&D Waste

No.	Material Category	Mean	Waste Ban
1	Other C&D Materials	20.7%	
2	Asphalt Shingles	13.4%	
3	Engineered Wood	9.3%	✓
4	Treated Wood	7.5%	✓
5	Gypsum wallboard - USED	6.6%	
6	Ferrous/Non-Ferrous Scrap	6.1%	✓
7	Porcelain and Other Plumbing Fixtures	5.8%	
8	Painted/Stained Wood	5.0%	✓
9	Untreated Dimensional Lumber	4.9%	✓
10	Bagged and Loose MSW	4.2%	
	Subtotal Waste Ban Materials	**32.8%**	

Table 4-4 provides the composition of these C&D loads.

Table 4-4 Detailed C&D Composition

Material Category	Mean Percent	Margin of Error	Material Category	Mean Percent	Margin of Error
Paper	**1.4%**	**0.7%**	**C&D Debris**	**52.8%**	**6.8%**
Uncoated OCC	0.5%	0.2%	Asphalt Pavement	0.0%	0.0%
Other Recyclable Paper	0.3%	0.2%	Brick/Block	2.6%	2.3%
Non-Recoverable Paper	0.6%	0.4%	Concrete	0.6%	1.0%
Plastic	**1.2%**	**0.3%**	Gypsum wallboard - CLEAN	1.0%	1.2%
Recyclable Plastic Containers	0.0%	0.0%	Gypsum wallboard - USED	6.6%	3.0%
Clean Film Plastic	0.1%	0.0%	Asphalt Shingles	13.4%	8.1%
5-gal Buckets and Plastic Toters	0.2%	0.1%	Carpet & Carpet Padding	1.6%	1.6%
Durable Plastics (Not Furniture)	0.1%	0.1%	Rock/Gravel/Dirt/Sand	0.4%	0.6%
Non-Recoverable Plastics	0.7%	0.3%	Porcelain/Plumbing Fixtures	5.8%	3.4%
Metal	**6.1%**	**2.4%**	Other C&D Materials	20.7%	5.0%
Recyclable Metal Containers	0.0%	0.0%	**Furniture**	**0.3%**	**0.3%**
Large Appliances (white goods)	0.0%	0.0%	Predominantly Wood	0.1%	0.2%
Ferrous/Non Ferrous Scrap	6.1%	2.4%	Predominantly Plastic	0.0%	0.0%
Glass	**0.7%**	**0.5%**	Predominantly Metal	0.0%	0.0%
Recyclable Glass Containers	0.0%	0.1%	Predominantly Upholstered	0.0%	0.0%
Non-Recoverable Glass	0.6%	0.4%	Predominantly Mixed	0.2%	0.2%
Organics	**1.0%**	**1.3%**	Mattresses	0.0%	0.0%
Land Clearing	0.0%	0.0%	Box Springs	0.0%	0.0%
Yard Waste/Green Waste	0.6%	0.7%	**Other Bulky**	**0.9%**	**0.6%**
Other Organics	0.4%	0.7%	CRTs	0.0%	0.0%
Wood	**31.3%**	**5.1%**	Vehicle Batteries	0.0%	0.0%
Untreated Dimensional Lumber	4.9%	1.9%	Tires	0.0%	0.0%
Engineered Wood	9.3%	2.1%	Textiles	0.3%	0.2%
Wood Pallets/Crates/Spools	2.4%	1.3%	E-Waste	0.0%	0.1%
Painted/Stained Wood	5.0%	1.2%	Other Bulky Materials	0.6%	0.5%
Treated Wood	7.5%	3.0%	**Mixed MSW**	**4.3%**	**2.1%**
Cabinetry/Countertops/Doors	2.2%	1.1%	Bagged and Loose MSW	4.2%	2.0%
			HHW/Universal Waste	0.1%	0.1%
			Grand Total	**100%**	
			No. of Samples	***45***	

4.3 MIXED COMPOSITION

Similar to the Bulky Waste and C&D Waste composition data, Figure 4-5 also reveals a significant percentage of Waste Ban materials in the Mixed Composition waste stream. At 41 percent, Waste Ban materials made up the largest fraction of Mixed Waste. Almost 30 percent of Mixed wastes were found to have at least some potential for diversion (similar to Bulky Waste), and the remaining 29 percent were non-recoverable.

Figure 4-5 Mixed Load Composition by Recoverability Potential

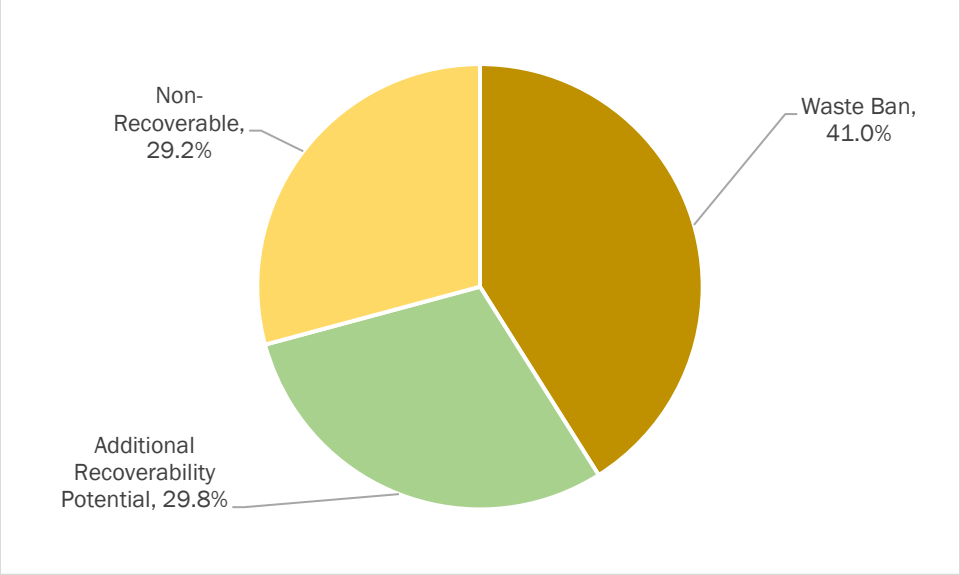


Figure 4-6 shows the composition of the mixed loads. These loads were generally found to have characteristics of both C&D waste (C&D Debris) and Bulky Waste (Furniture and Mixed MSW).

Figure 4-6 Mixed Loads Material Group Composition

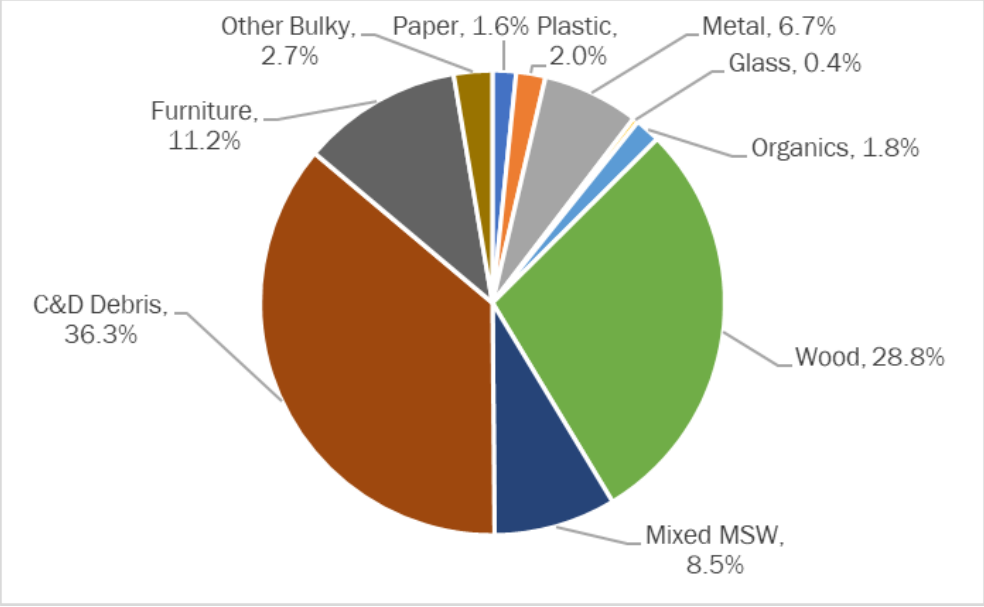


Table 4-5 lists the top 10 material categories appearing in mixed loads. The table also provides the subtotal percentage of waste ban materials within this group.

Table 4-5 Top 10 Material Categories, Mixed Loads

No.	Material Category	Mean	Waste Ban
1	Other C&D Materials	11.0%	
2	Asphalt Shingles	10.4%	
3	Bagged and Loose MSW	8.5%	
4	Engineered Wood	7.6%	✓
5	Ferrous/Non-Ferrous Scrap	6.5%	✓
6	Treated Wood	5.8%	✓
7	Gypsum wallboard - USED	5.6%	
8	Predominantly Wood Furniture	5.1%	
9	Painted/Stained Wood	4.3%	✓
10	Cabinetry/Countertops, Moldings, Doors, Windows	4.3%	✓
	Subtotal Waste Ban Materials	**28.4%**	

Table 4-6 provides the composition of mixed loads. C&D debris made up the largest percent of mixed loads, with asphalt shingles accounting for the majority of the C&D group. As expected, Bulky Waste materials are also present, with Furniture and Bagged/Loose MSW increasing in percentage from C&D Waste.

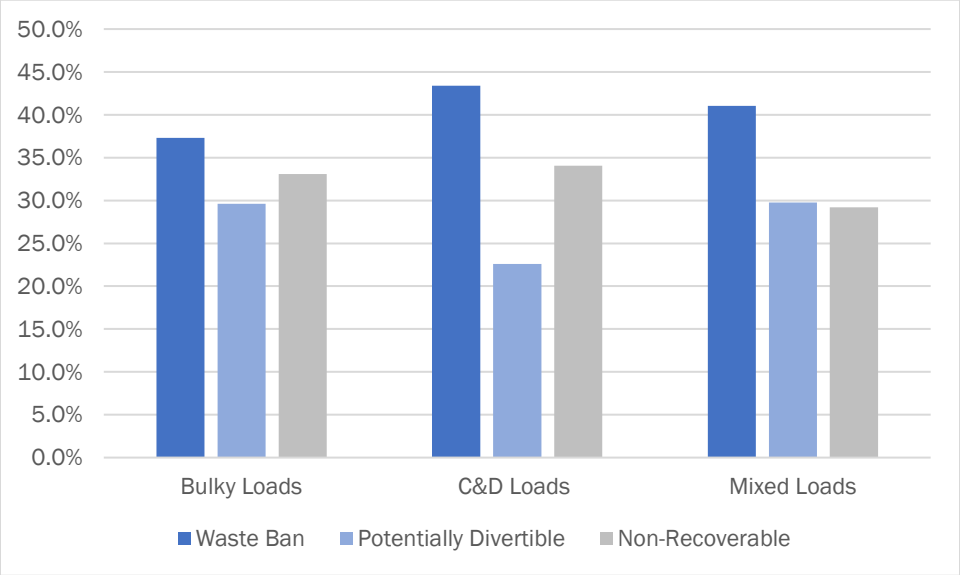
Table 4-6 Detailed Mixed Loads Composition

Material Category	Mean Percent	Margin of Error	Material Category	Mean Percent	Margin of Error
Paper	**1.6%**	**0.4%**	**C&D Debris**	**36.3%**	**5.9%**
Uncoated OCC	0.9%	0.2%	Asphalt Pavement	0.0%	0.0%
Other Recyclable Paper	0.3%	0.1%	Brick/Block	0.1%	0.1%
Non-Recoverable Paper	0.5%	0.2%	Concrete	0.0%	0.0%
Plastic	**2.0%**	**0.3%**	Gypsum wallboard - CLEAN	0.0%	0.0%
Recyclable Plastic Containers	0.1%	0.0%	Gypsum wallboard - USED	5.6%	2.4%
Clean Film Plastic	0.1%	0.0%	Asphalt Shingles	10.4%	5.6%
5-gal Buckets and Plastic Toters	0.2%	0.0%	Carpet & Carpet Padding	2.6%	0.9%
Durable Plastics (Not Furniture)	0.6%	0.1%	Rock/Gravel/Dirt/Sand	3.9%	4.0%
Non-Recoverable Plastics	1.2%	0.2%	Porcelain/Plumbing Fixtures	2.7%	1.8%
Metal	**6.7%**	**1.0%**	Other C&D Materials	11.0%	2.7%
Recyclable Metal Containers	0.0%	0.0%	**Furniture**	**11.2%**	**2.6%**
Large Appliances (white goods)	0.2%	0.2%	Predominantly Wood	5.1%	1.6%
Ferrous/Non Ferrous Scrap	6.5%	1.0%	Predominantly Plastic	0.2%	0.1%
Glass	**0.4%**	**0.3%**	Predominantly Metal	1.1%	0.6%
Recyclable Glass Containers	0.0%	0.0%	Predominantly Upholstered	0.4%	0.3%
Non-Recoverable Glass	0.4%	0.3%	Predominantly Mixed	3.3%	1.3%
Organics	**1.8%**	**1.5%**	Mattresses	0.6%	0.4%
Land Clearing	0.7%	0.7%	Box Springs	0.4%	0.2%
Yard Waste/Green Waste	1.0%	1.0%	**Other Bulky**	**2.7%**	**0.8%**
Other Organics	0.1%	0.1%	CRTs	0.0%	0.0%
Wood	**28.8%**	**3.8%**	Vehicle Batteries	0.0%	0.0%
Untreated Dimensional Lumber	3.9%	0.8%	Tires	0.2%	0.2%
Engineered Wood	7.6%	1.7%	Textiles	1.4%	0.6%
Wood Pallets/Crates/Spools	2.9%	1.4%	E-Waste	0.1%	0.1%
Painted/Stained Wood	4.3%	1.0%	Other Bulky Materials	1.1%	0.5%
Treated Wood	5.8%	1.5%	**Mixed MSW**	**8.5%**	**1.5%**
Cabinetry/Countertops/Doors	4.3%	1.1%	Bagged and Loose MSW	8.5%	1.5%
			HHW/Universal Waste	0.0%	0.0%
			Grand Total	**100%**	
			No. of Samples	***58***	

4.4 COMPARISONS

Figure 4-7 compares the potential divertibility of bulky waste, C&D, and mixed waste loads in bar chart format. This chart highlights the persistence of waste ban materials in all loads, while also highlighting the potential divertibility of almost a quarter or a third of materials present in all loads.

Figure 4-7 Comparison of Composition by Waste Type



4.5 MATERIAL REUSABILITY

At the outset of the study, it was agreed by MassDEP, CET and MSW Consultants that materials observed at the facilities would not actually be reusable at the point of disposal. Rather, the intention was to note what, if any, materials could have been reused if captured upstream and in usable condition, prior to inclusion in a load destined for the C&D processing facility. It is acknowledged that only a portion of these items were likely in any condition to be reused even if captured upstream; however, the exercise was performed to highlight this potential.

CET's role in the visual Bulky Waste Characterization study was to assist in preparing the list of material categories and definitions and to flag possible reusability of items observed in the waste loads. CET attended the bulky waste visual field inspections over two days in the field (at the Stoughton and Trojan Recycling facilities) to observe loads and to advise MSW Consultants on identifying reusable materials.

Of the materials categorized, Furniture, as a broad category, and Cabinetry/Countertops/Doors (within the wood category) have the most potential for reuse if they could be captured at the point of generation. It is assumed that some percentage of those materials would likely have been too badly damaged, moldy, or otherwise not reusable. However, as suggested in Figure 4-1, a significant fraction could conceivably have been reused. Even if only a portion of these constituents were of a quality and condition in which they could be reused, this potentially represents a significant portion of bulky waste that could be source-reduced, with the proper intervention at the point of generation, to prevent its disposal at a C&D handling facility.

5. CONCLUSION

The Bulky Waste Characterization Survey established the following findings:

- Waste Ban material percentages were 37.3% of Bulky Waste; 43.4% of C&D Waste; and 41.0% of Mixed Wastes.
- Percentages of materials with Additional Recoverability Potential were 29.6% of Bulky Waste; 22.6% of C&D Waste; and 29.8% of Mixed Waste.
- Non-Recoverable material percentages were 33.1% of Bulky Waste; 34.0% of C&D Waste; and 29.2% of Mixed Waste.

This effort represents a first attempt at better understanding the proportion of various constituents that are being delivered to large C&D handling facilities and categorized as Bulky Wastes. The results of this effort are intended to spur dialog between MassDEP and these C&D processors to optimize the management of this waste type.

APPENDIX A

MATERIAL CATEGORIES & DEFINITIONS

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APPENDIX A – MATERIAL CATEGORIES & DEFINITIONS

Material Group	Material Category	Material Definition	Waste Ban
Paper			
	Uncoated OCC	Uncoated Corrugated Cardboard	✓
		All other Recyclable Paper including low and high-grade paper, magazines, newspapers, boxboard, chipboard, cartons, kraft paper, etc.	
	Other Recyclable Paper	Paper combined with other products (plastics, metals, glues) that cannot be recycled. Includes waxed OCC, food-soiled paper, paper towels, napkins, etc.	✓
Plastic			
	Recyclable Plastic Containers	Bottles, Jars, Tubs, and Jugs: Non-bulky recyclable plastic containers of any resin type, and regardless of deposit designation	✓
	Clean Film Plastic (Commercial/Industrial)	Clean, industrial, or commercial film or packaging used in the transport of goods from the manufacturer/distributor. Examples include pallet shrink wrap, mattress bags, etc.	
	5-Gal. Buckets and Plastic Toters	Rigid, (mostly) HDPE 5-gallon buckets with or without lids or handles, and plastic waste toters (with or without lids) of any size.	
	Durable Plastics	Plastic items other than containers or film that are intended for more than one use. Examples include plastic crates, totes, barrels, large storage tubs/bins, large plastic toys, toolboxes housewares, and novelty items. Does not include 5-gallon buckets or furniture	
	Non-Recyclable Plastics	Other plastic items that do not fit the above categories. Includes items made mostly of plastic but combined with other materials. Includes auto parts made of plastic but combined with metals or electronics, as well as foam packaging, plastic twine, netting/rope, and strapping, etc.	
Metal			
	Recyclable Metal Containers	Non-bulky recyclable metal containers (tin, steel, aluminum, etc.) regardless of deposit designation.	✓
	Large Appliances (white goods)	Large, bulky appliances for commercial or residential use. Examples include refrigerators, washers/dryers, ranges, water heaters, freezers, and similar items. Does not include microwaves.	✓
	Ferrous/Non-Ferrous Scrap	All other metal items including empty paint cans, steel beams, metal bed frames, metal toolboxes and tools, nails, metal clothes hangers, along with items made of stainless steel, brass, and copper.	✓
Glass			
	Recyclable Glass Containers	Non-bulky recyclable glass bottles and jars regardless of deposit designation.	✓
	Non-Recyclable Glass	All items containing mostly glass and including mirrors, decorative glass light fixtures, windows, safety glass, etc.	

APPENDIX A – MATERIAL CATEGORIES & DEFINITIONS

Material Group	Material Category	Material Definition	Waste Ban
Organics			
	Land Clearing Debris (stumps, large branches, etc.)	Primarily land clearing debris consisting of stumps and tree limbs greater than 1" in diameter.	
	Yard Waste/Green Waste	Leaves and grass. Also includes brush less than 1" in diameter.	✓
	Other Organics	Animal by-products and wastes, including manure and animal bedding. Also includes large quantities of sawdust, organic rope and netting, and wax materials.	
Wood			
	Untreated Dimensional Lumber	Clean, unpainted dimensional lumber from new construction, remodeling, or demolition, including wood shingles if uncontaminated by paint, stain, or preservative treatment. Includes easily separable wood other durable products. Excludes preservative treated wood or particleboard, chipboard, Masonite, or wood from furniture.	✓
	Engineered Wood	Wood products made from sawdust or shavings mixed with an adhesive binder. Includes laminated wood products, oriented strand board (OSB), and fiberboard.	✓
	Wood Pallets/Crates/Stools	Wood staging and storage materials for commercial and industrial products.	✓
	Painted/Stained Wood	Any painted or stained dimensional lumber or engineered wood.	✓
	Treated Wood	Wood products that have been treated with chemical preservatives, such as those that prevent insect infestation or fungal growth. May be identified by end tags or indentations/slits.	✓
	Cabinetry/Countertops/ Moldings/Doors/Windows	Wood construction components, fixtures, or finishes. May have originated from residential or commercial use.	✓
C&D Debris			
	Asphalt Pavement	Petroleum-based tar material mixed with gravel aggregate for use as a paving material. Can be in hardened or soft form.	✓
	Brick/Block	Clay brick or concrete block building materials	✓
	Concrete	Concrete building material in slab or powdered (unmixed) form.	✓
	Gypsum Wallboard - Clean	Gypsum sheet wallboard building material that is free from paint and other indications that it has been used in construction.	✓
	Gypsum Wallboard - Used	Gypsum sheet wallboard building material that has been used in construction. May be damaged by demolition, or may have wood, glue, wallpaper, or other construction materials attached.	
	Asphalt Shingles	Roofing material composed of fiberglass or organic felts saturated with asphalt and covered with inert aggregates as well as attached roofing tar and tar paper.	

APPENDIX A — MATERIAL CATEGORIES & DEFINITIONS

Material Group	Material Category	Material Definition	Waste Ban
	Carpet and Carpet Padding:	Flooring application consisting of various natural or synthetic fibers which may be bonded to some type of backing material. Includes the plastic, foam, felt, or other material used under the carpet to provide insulation and padding.	
	Rock/Gravel/Dirt/Sand	ROCK/GRAVEL/DIRT/SAND: Aggregates of stone, gravel, dirt, and sand. Can be homogeneous or mixed together.	
	Porcelain & Other Plumbing Fixtures	Sinks, toilets, and other fixtures (can be porcelain, ceramic, or metal).	
	Other C&D Materials	Construction and demolition material that cannot be put in any other type or subtype. This type may include items from different types combined, which would be very hard to separate. Includes various wall and flooring materials with backings, fiberglass insulation, and other miscellaneous C&D Materials not mentioned above.	
Furniture			
	Predominantly Wood	Furniture comprised entirely of wood or comprised mostly of wood framing with lesser amounts of other materials.	
	Predominantly Plastic	Furniture comprised entirely of plastic, or consists mostly of plastic, with lesser amounts of other materials.	
	Predominantly Metal	Furniture comprised mostly of metal. Includes filing cabinets.	✓
	Predominantly Upholstered	Furniture that is mostly upholstery, such as cushion sofas or chairs.	
	Predominantly Mixed	Furniture that contains multiple components.	
	Mattresses	Mattresses of any size (not including futon mattresses).	✓
	Box Springs	Box spring bedding of any size.	✓
Other Bulky Material			
	CRTs	Video screen in which a high vacuum (glass) tube emits cathode rays to produce a luminous image on a fluorescent screen. Includes older televisions and computer monitors.	✓
	Vehicle Batteries	Wet-cell rechargeable battery used to start automotive vehicles or boats.	✓
	Tires	Waste tires (intact or shredded form).	✓
	Textiles	Cloth or woven fabric used as clothing or upholstery.	✓
	E-Waste	Discarded electronic products, typically with circuit board components, such as cell phones, computers, and similar devices. Also includes smaller electrical devices and appliances with digital controls such as microwaves, VCRs, stereos, copiers, etc.	
	Other Bulky Materials	Bulky items not elsewhere described. May include miscellaneous or unidentifiable items. Examples include trade show displays, futon mattresses, conveyor belts, maritime buoys, ship bumpers, netting, or other equipment, etc.	

APPENDIX A – MATERIAL CATEGORIES & DEFINITIONS

Material Group	Material Category	Material Definition	Waste Ban
Mixed MSW			
	Bagged and Loose MSW	Mixed bagged and loose MSW contained in the bulky waste load.	
	HHW/Universal Waste	Household Hazardous Waste, and Universal Waste (fluorescent bulbs, non-vehicle batteries, oil-based finishes, and paints).	

APPENDIX B

BULKY WASTE STUDY REPRESENTATIVE PHOTOS

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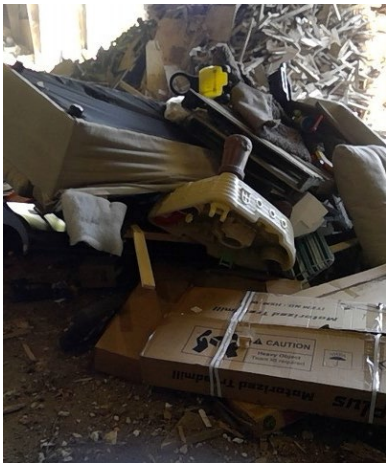
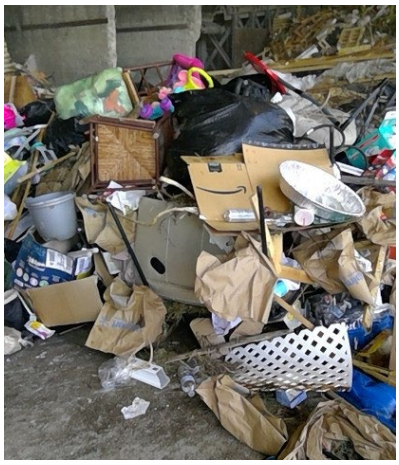
APPENDIX B – BULKY WASTE STUDY REPRESENTATIVE PHOTOS

B 1. BULKY WASTE


Household items such as furniture, file boxes, and tires are visible in these bulky waste loads.



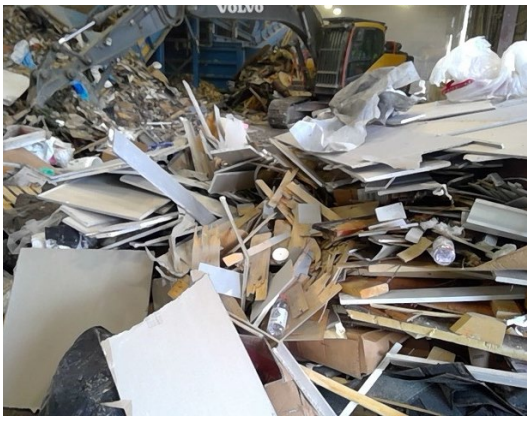
Household items such as furniture, bed frames, and file boxes are visible in these bulky waste loads.



Household items such as furniture, file boxes, and bulky plastic items are visible in these bulky waste loads.

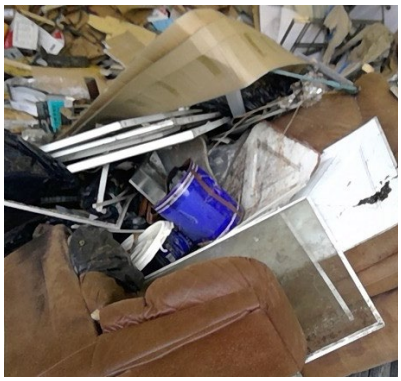
APPENDIX B – BULKY WASTE STUDY REPRESENTATIVE PHOTOS

B 2. C&D WASTE

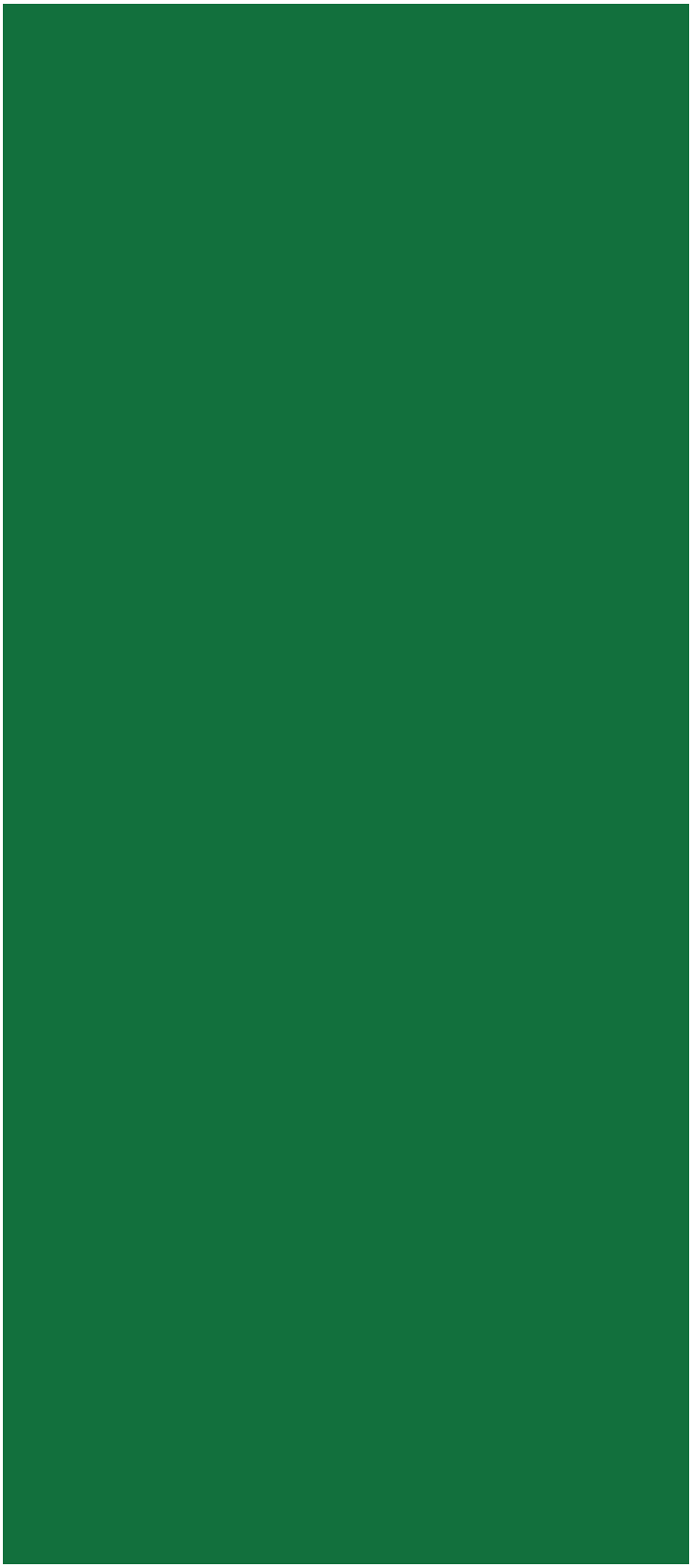


Typical C&D materials such as wood scrap, drywall scrap, and engineered wood are visible.

B 3. MIXED WASTE (C&D AND BULKY MIX)



Mixed loads are comprised of elements from both C&D and Bulky Waste loads. These photos show combinations of scrap wood material (fencing and wood fixtures) as well as bulky waste (furniture).



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