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# State of Vermont Waste Composition Study

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Final Report  
May, 2013

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State of Vermont, Department of  
Environmental Conservation

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Prepared By:

**DSM ENVIRONMENTAL SERVICES, INC.**

Resource Economists  
Environmental Scientists

**MIDATLANTIC SOLID WASTE CONSULTANTS**



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### APPENDIX A: Waste Category Definitions

## Executive Summary

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### ***Background, Purpose and Scope***

The State of Vermont, Department of Environmental Conservation (VT DEC) commissioned a waste composition study of municipal solid waste (MSW) generated within the State of Vermont. The primary purpose of the State-wide Waste Composition Study (Study) was to estimate the composition of MSW and Construction and Demolition waste (C&D) from residential and Industrial/Commercial/Institutional (ICI) sectors delivered to Vermont transfer stations. The resultant data will help guide VT DEC as it embarks on an effort to implement Act 148.

The Association of Post Consumer Plastics Recyclers (APR) also contributed funds for the study in an effort to gain a better understanding of the types of plastics being disposed in the waste stream.

This Study was carried out by DSM Environmental Services (DSM) and MidAtlantic Solid Waste Consultants (MSW Consultants). The roles of each firm are summarized below.

MSW and C&D sampling was carried out over the course of two seasons (August 20 – 24, 2012 and November 12 - 16, 2012), with waste sampling activities occurring at four permitted solid waste facilities chosen by VT DEC as representative of Vermont’s population. The time periods for sorting were chosen to avoid high yard waste generation seasons which could distort the relative magnitude of the various materials sorted.

Sorting in August occurred at the All-Cycle (Williston, Casella) and Highgate (Casella) transfer stations. Sorting in November occurred at the Triple T transfer station (Brattleboro) and the Sunderland (Casella) transfer station. MSW was sorted into 55 primary categories, with plastics sorted into a total of 46 sub-sort categories. C&D wastes were visually divided into 8 major categories and 40 sub-categories.

Because of the limited budget for this study, sample data by season and for individual sites are not statistically valid, and are therefore not presented in this report. Instead, aggregate, state-wide residential and ICI waste composition is presented, assuming that the four facilities where sorting occurred are representative of the State as a whole.

Data are presented as a percentage of the total material sampled, and on an assumed state-wide tonnage basis. While data on the amount of waste generated in Vermont are not maintained by generator type, a reasonable assumption has been made that 60 percent of the MSW generated in Vermont is residential and 40 percent is ICI waste, with the material percentages applied to these tonnages to estimate total tons of residential and ICI waste by material type.<sup>1</sup>

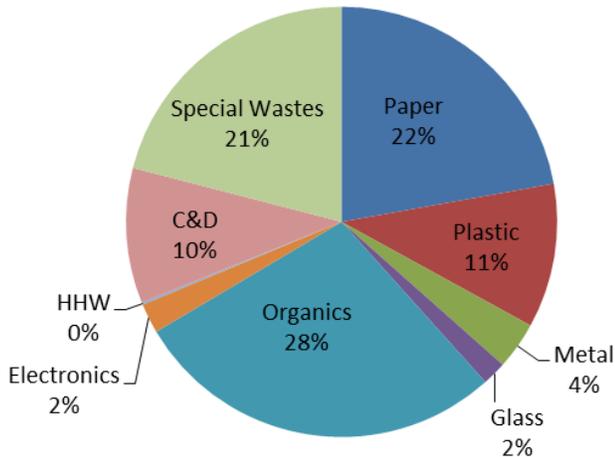
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<sup>1</sup> The Project Team has conducted analyses of the split between residential and ICI waste delivered to facilities in Delaware and Connecticut as part of those state-wide waste characterization studies. DSM has also worked with the Chittenden Solid Waste Management District to allocate tonnage generated in Chittenden County. In all three cases residential waste represented roughly 55 percent of the total MSW and ICI waste 45 percent. However, because of the rural nature of much of VT, and because of the large amount of economic activity on the New Hampshire side of the Connecticut River, it has been assumed that residential waste represents 60 percent and ICI waste 40 percent of the total MSW delivered to transfer stations in Vermont. Note that varying the assumption by 10 percent would make very little difference to the total tonnage estimates in most cases because of the similarities in the composition of the sampled residential and ICI waste.

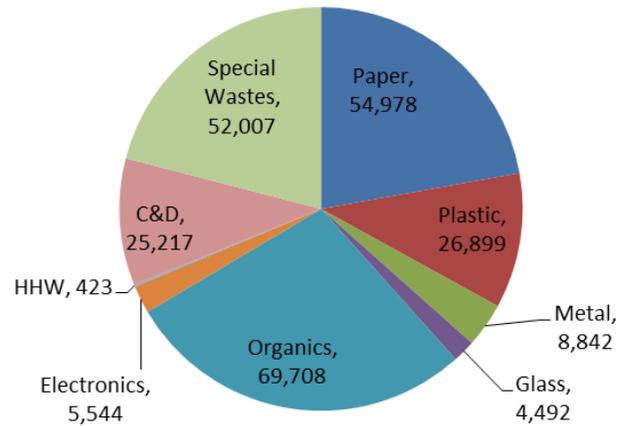
**Results - Residential MSW Composition**

Figures ES 1 and 2 summarize the residential MSW composition by percent and by estimated total tonnage (413,517 tons c. 2012). Note that while the waste composition study was conducted in 2012, final data on waste generation has only been compiled by VT DEC through 2011. Therefore the tonnage data are reported as 2011 tonnages, even though the composition study was carried out in 2012. There is no reason to believe that there would be significant differences between 2011 and 2012.

**FIGURE ES-1:  
COMPOSITION OF VERMONT RESIDENTIAL MSW  
(Percentage, By Weight)**



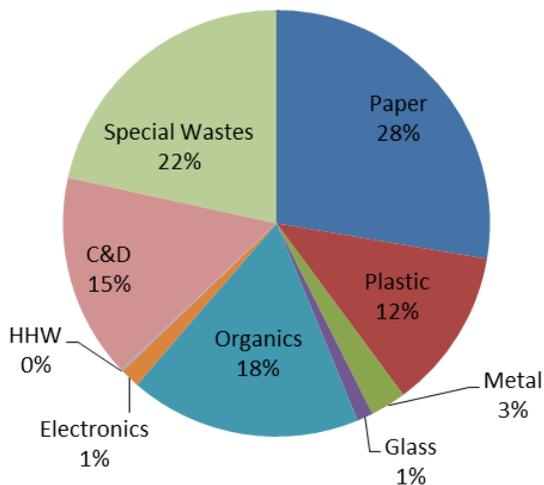
**FIGURE ES-2:  
ESTIMATED 2011 DISPOSAL OF RESIDENTIAL  
MSW BY MATERIAL TYPE (In Tons)**



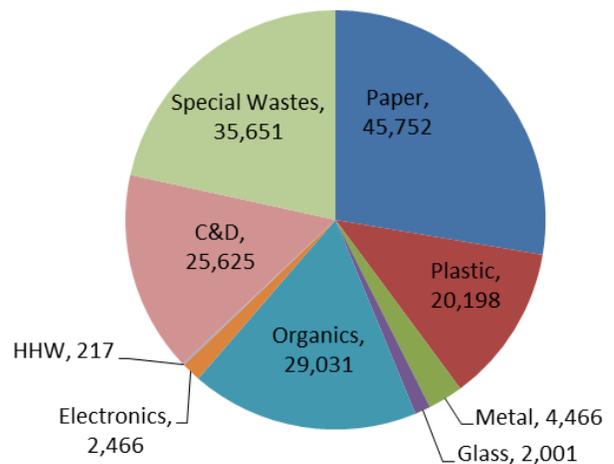
**Results - ICI MSW Composition**

Figures ES 3 and 4 summarize Vermont’s ICI waste by material type and tonnage (Tons, CY 2011).

**FIGURE ES-3:  
COMPOSITION OF VERMONT ICI WASTE  
(Percentage, By Weight)**



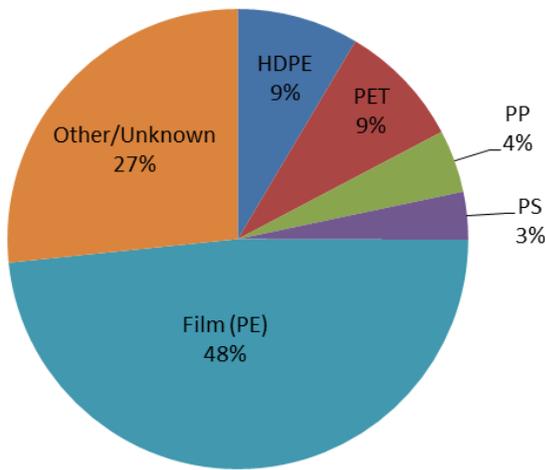
**FIGURE ES-4:  
ESTIMATED 2011 DISPOSAL OF ICI WASTE  
BY MATERIAL TYPE (In Tons)**



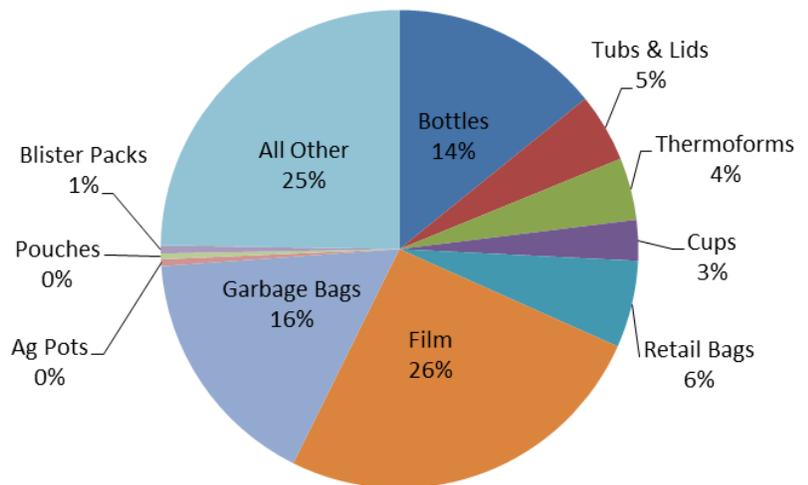
**Results - Plastic Sub-Sort**

Plastic wastes were sorted into 46 categories. The following pie charts summarize the results by resin type and by material type for residential and for ICI wastes. It should be noted that whenever a plastic material could not be identified by either the resin code (because there was no resin code) or by use of the Delta NU resin meter the product was categorized as an “other.” This was especially prevalent for large bulky plastic materials (which are less likely to have a resin identification code) that were black or another dark color and therefore not readily identified by the resin meter. It is the Project Team’s professional judgment that a significant amount of the “other” category was actually PE and PP, but there was no definitive way to determine this in the field.

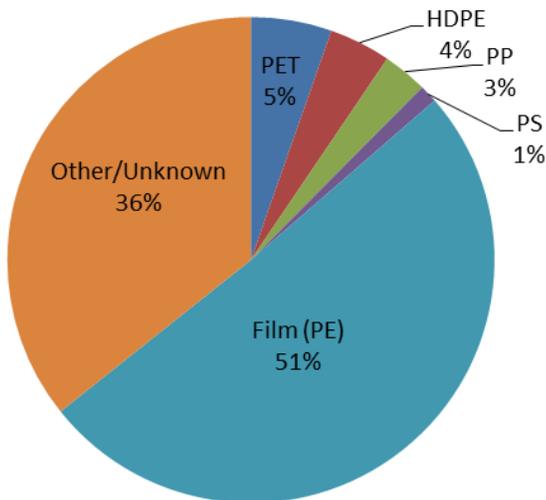
**FIGURE ES-5:  
COMPOSITION OF RESIDENTIAL PLASTIC WASTE  
BY RESIN TYPE (Percentage, By Weight)**



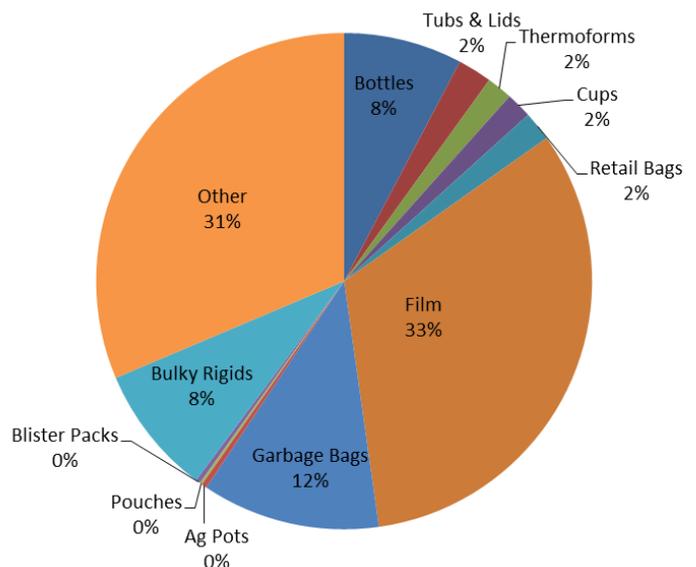
**FIGURE ES-6:  
COMPOSITION OF RESIDENTIAL PLASTIC WASTE  
BY PRODUCT TYPE (Percentage, By Weight)**



**FIGURE ES-7:  
COMPOSITION OF ICI PLASTIC WASTE BY  
RESIN TYPE (Percentage, By Weight)**



**FIGURE ES-8:  
COMPOSITION OF ICI PLASTIC WASTE  
BY PRODUCT TYPE (Percentage, By Weight)**



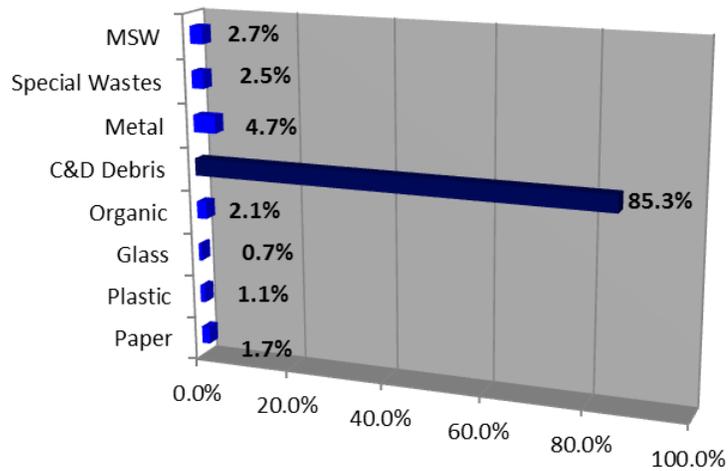
**Results - Construction and Demolition Waste**

While C&D wastes were disposed as MSW, some portion of the waste delivered to Vermont transfer stations is categorized by at the scale house as C&D waste, as opposed to mixed solid waste. Truck loads of C&D waste were visually sampled to estimate the composition of this material, and the results are summarized below.

Figures ES-9 and ES-10 below present the total composition of C&D waste (Figure ES-9), and then the composition of the material classified as C&D debris (Figure ES-10).

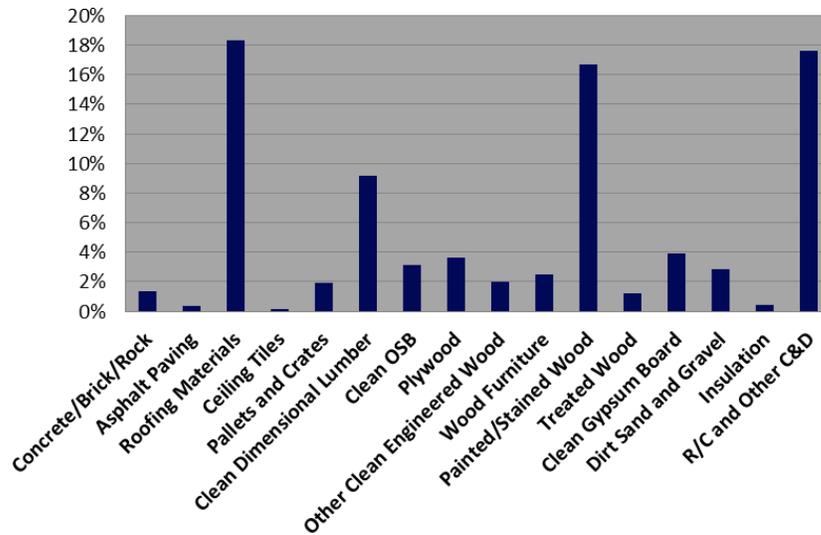
**FIGURE ES-9**

**Composition of C&D Waste, By Major Material Type (By Weight)**



**FIGURE ES-10**

**Composition of the "C&D Debris" Fraction**



## Introduction

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### ***Background, Purpose and Scope***

The State of Vermont, Department of Environmental Conservation (VT DEC) commissioned a waste composition study of municipal solid waste (MSW) generated within the State of Vermont. The primary purpose of the State-wide Waste Composition Study (Study) was to estimate the composition of MSW and Construction and Demolition waste (C&D) from residential and Industrial/Commercial/Institutional (ICI) sectors delivered to Vermont transfer stations. The resultant data will help guide VT DEC as it embarks on an effort to implement Act 148.

The Association of Post Consumer Plastics Recyclers (APR) also contributed funds for the study in an effort to gain a better understanding of the types of plastics being disposed in the waste stream.

This Study was carried out by DSM Environmental Services (DSM) and MidAtlantic Solid Waste Consultants (MSW Consultants). The roles of each firm are summarized below.

**DSM Environmental Services, Inc.** coordinated the Project Team in all activities and had primary responsibility for:

- Project Management
- Logistics
- Sample Site Selection
- Plastic Sub-Sorting
- Visual C&D sampling
- Problem Resolution
- Preparation of the Draft and Final Report

**MSW Consultants** was responsible for:

- Field Supervision
- On-site Logistics
- MSW Sampling and Sorting
- Sort Crew Training
- Sorting QA/QC
- Compilation of Sorting Data
- Statistical Analysis
- Report Tables Preparation
- Report Review

MSW and C&D sampling was carried out over the course of two seasons (August 20 – 24, 2012 and November 12 - 16, 2012), with waste sampling activities occurring at four permitted solid waste transfer stations chosen by VT DEC as representative of Vermont's population. Sorting in August occurred at the All-Cycle (Williston, Casella) and Highgate (Casella) transfer stations. Sorting in November occurred at

the Triple T transfer station (Brattleboro) and the Sunderland (Casella) transfer station. This final report presents the results of the study.

Because of the limited budget for this study, sample data by season and for individual sites are not statistically valid, and are therefore not presented in this report. Instead, aggregate, state-wide residential and ICI waste composition is presented, assuming that the four facilities where sorting occurred are representative of the State as a whole.

Data are presented as a percentage of the total material sampled. Data on the amount of waste disposed at Vermont facilities are not maintained by generator type, and therefore there is no way to accurately allocate the residential and ICI waste by total tons. However, because it is useful to not only report materials by percent, but to report materials by tonnage, an assumption has been made that 60 percent of the MSW delivered to transfer stations in Vermont is residential and 40 percent is ICI waste, with the material percentages applied to these tonnages to estimate total tons of residential and ICI waste by material type.<sup>2</sup>

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<sup>2</sup> The Project Team has conducted analyses of the split between residential and ICI waste delivered to facilities in Delaware and Connecticut as part of those state-wide waste characterization studies. DSM has also worked with the Chittenden Solid Waste Management District to allocate tonnage generated in Chittenden County. In all three cases residential waste represented roughly 55 percent of the total MSW and ICI waste 45 percent. However, because of the rural nature of much of VT, and because of the large amount of economic activity on the New Hampshire side of the Connecticut River, it has been assumed that residential waste represents 60 percent and ICI waste 40 percent of the total MSW delivered to transfer stations in Vermont. Note that varying the assumption by 10 percent would make very little difference to the total tonnage estimates in most cases because of the similarities in the composition of the sampled residential and ICI waste.

## Study Design

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### *Site Coordination and Communication*

#### **LOGISTICS**

The first task of the Study was to identify MSW transfer sites around Vermont that: (1) would be representative of state-wide waste composition; and, (2) had sufficient throughput to support continuous sampling and sorting throughout the day. Ultimately four sites were selected to represent: urban and rural populations; geographic diversity; and, areas with expected high recycling rates (due primarily to parallel access to recycling and waste collection) and areas with the potential for lower recycling rates. The four sites selected were:

- All-Cycle Transfer Station in Williston owned and operated by Casella;
- Highgate Transfer Station in Highgate owned and operated by Casella;
- Triple T Trucking Transfer Station in Brattleboro owned and operated by Triple T Trucking; and,
- Sunderland Transfer Station owned and operated by Casella.

Before the field work commenced, DSM worked with the selected facilities to collect facility-specific logistical information necessary to develop the sampling plan. The following information was collected:

- The facility's contact information;
- The facility's days and hours of operation;
- The vehicle traffic expected for each sector (residential and ICI) on each day of the week, and the estimated peak time of day for each type of load;
- Location of the sorting area;
- Coordination between the scale house and the Field Supervisor to determine the net weight of each sampled vehicle;
- Facility-specific health and safety procedures and emergency contact numbers; and,
- The facility's ability to provide assistance (e.g. front loader, sorting space, vehicle selection, etc.) to ensure safe and accurate sampling and sorting.

#### **TRAINING AND SUPERVISION**

At the outset of both sampling seasons the Field Supervisor led a detailed training session on the morning of the first day of the sort. The training covered all aspects of the safety and health requirements, as well as sorting and weighing procedures. Training included:

- General facility overview;
- Learning and reviewing the material categories and definitions;
- Facility-specific health and safety requirements;
- Personal protective equipment (PPE) requirements;

- Waste handling techniques; and
- Productivity strategies and daily sorting quotas.

## ***Sampling Plan***

### **DEFINITIONS OF WASTE SECTORS**

Sectors of the waste stream analyzed in the study were defined as follows:

- **Residential** – MSW generated in Vermont and brought to VT DEC permitted facilities by commercially or municipally operated vehicles, in which 80 percent or more of the waste is from single-family and/or multifamily residential sources. Loads from transfer trailers entering the facility were not sampled because the generator types could not be determined. Several residential samples were also obtained from the residential drop boxes at the Sunderland Transfer Station to assure a steady supply of material to sort and because these boxes contained primarily residential waste.
- **Institutional/Commercial/Industrial (ICI)** – MSW generated in Vermont and brought to VT DEC permitted facilities by commercially operated vehicles, in which 80% or more of the waste was from institutional, commercial, or industrial sources. This sector excluded Construction and Demolition debris as well as Bulky Waste. Vehicles chosen for sampling in the ICI sector included **Compacted Drop Boxes** where the generator could be identified and **Packer Trucks**. Commercial self-haulers using several other truck types were also accepted in this category.
- **Unacceptable Loads** – Loads that contain less than 80% of either residential or ICI waste, and loads originating from outside of Vermont were omitted from the sampling. However, in some cases where the majority of loads entering a facility were mixed residential and commercial and it was not possible to obtain a sufficient number of samples of residential or ICI loads from trucks with over 80% of the designated sector, a decision was made by the Field Supervisor, after discussions with the truck driver, to sample from the portion of the load which the driver indicated was primarily residential or ICI waste.
- **C&D Loads** – Loads that contained 80 percent or more of material generated from construction and demolition activities in Vermont. Note that “dry waste” or bulky waste loads were not analyzed, even though they are often characterized as C&D waste by facilities in Vermont. Loads of C&D waste were visually sampled from both commercial roll-offs and from contractors delivering C&D waste in pickups and trailers.

### **ALLOCATION OF SAMPLES BY SITE, SECTOR, AND SEASON**

The study design called for hand-sorting 100 samples of residential and ICI waste, each weighing 200 to 250 pounds. The overall quota of 100 samples was split evenly over two seasons.

As shown in Table 1 below, greater numbers of samples were allocated to the ICI waste sector. The waste found in the ICI stream tends to be more variable from load to load than that found in the residential stream. Higher variability means that additional samples of ICI waste are required to provide precision levels comparable to the residential waste sector.

**TABLE 1:**

**Estimated Allocation of Samples by Sector**

<b>Sector</b>	<b>Number of Samples</b>
Residential	40
ICI	60
<b>Total</b>	<b>100</b>

In addition to hand sorting of MSW samples, 66 loads of C&D waste were visually characterized over the course of the two seasons. The exact number of loads was dependent on sufficient quantities of C&D waste delivered to the facilities during the course of the MSW sampling at each facility and the ability to safely survey the loads within the facility after they had been dumped.

***Acquisition of Samples***

**MSW VEHICLE SELECTION**

The Field Supervisor attempted to follow a systematic selection procedure to identify residential and ICI waste vehicles for sampling by establishing a sampling interval at each facility. The sampling interval was determined by dividing the total expected number of loads for each sector arriving at the facility on the scheduled day – based on questions asked of each facility in the planning phase of the study -- by the number of samples needed each day. The resulting number is the sampling frequency, which determines whether every third vehicle, every sixth vehicle, or every 20<sup>th</sup> vehicle is selected for sampling. This strategy is referred to as “selecting every n<sup>th</sup> vehicle” within a waste sector.

Vehicles entering the facility that met the definition of the n<sup>th</sup> vehicle were surveyed by the Field Supervisor to determine if they were eligible for sampling. In order for a vehicle to be eligible for sampling, the load had to fit within the residential or ICI definitions. If the load was selected for sampling then the Field Supervisor collected data regarding the vehicle type and waste type, and identifying information for use in obtaining a net weight from each selected vehicle from the scale house.

Note that there were five instances where the n<sup>th</sup> vehicle approach for selecting a vehicle for sampling was modified:

- On the day of sampling and sorting, if the number of loads expected to arrive at the facility was less than previously anticipated, the sampling frequency was shortened and a new “n<sup>th</sup> vehicle” selection strategy calculated and followed;
- If the n<sup>th</sup> residential vehicle selected was found to contain over 20% of ICI waste, the next load of residential waste (n<sup>th</sup> + 1) was taken as a replacement;
- If the n<sup>th</sup> commercial vehicle selected was found to contain over 20% residential waste, the next load (n<sup>th</sup> + 1) of ICI waste was taken as a replacement;

- If the sort crew had completed sorting of all available stored samples and was set up and ready for the next sort, the Field Supervisor was allowed to take the next available residential or ICI load in place of the n<sup>th</sup> vehicle if necessary to keep the sort crew busy; and,
- In the event that the waste was not from Vermont.

The Field Supervisor obtained and recorded the following information on the *Vehicle Selection Form* for each vehicle that was selected for sampling:

- Waste sector – Residential or ICI;
- Vehicle type --Compactor, Transfer Vehicle, Packer Truck or Other Type;
- Date and Time of Day;
- Truck Identification information (Hauler License or Plate Number); and,
- Net weight of the load (obtained from the scale house using the truck identification information).

The Crew Chief then recorded the date and time, sample number, and facility location, and noted on the *Field Data Sheet* any unusual circumstances associated with the load or the sample.

### **C&D VEHICLE SELECTION**

The selection of C&D loads for visual surveying was not subjected to the same degree of rigorousness as the MSW sample selection. This is because it was not clear how much C&D waste would be received at each host facility; and, the data collection team committed to conducting the visual C&D analysis was not devoting 100% of the time to monitoring and capturing C&D loads as they were also conducting the plastic sub-sorting. C&D loads were therefore taken as they arrived, within the constraints established by the Facility Manager, and recorded on the *C&D Visual Survey Form*.

### **MSW SAMPLE SELECTION**

In most cases, one sample of waste was selected from each load based on systematic “grabs” from the perimeter of the load. For example, if the tipped load is viewed from the top as a clock face with 12:00 being the part of the load closest to the front of the truck, the first sample of the day would be taken from 3 o’clock, followed by the next sample of the day at 6 o’clock, then 9 o’clock and 12 o’clock, followed by 1, 4, 7, and 10 o’clock, and so-on. Following a random sample selection process from the dumped loads is designed to minimize “cherry picking” waste that would be easy to grab and/or sort. However, the Field Supervisor was allowed to deviate from the sample selection process in the event that the load was dumped immediately adjacent to another load or the main waste pile making it impossible to take the sample from the prescribed location. In that case the sample was taken from the first area potentially available for sampling.

Once the area of the load was identified for sampling, the facility loader operator would grab a sample of the waste using a skid steer loader or front loader. The Field Supervisor would then pull waste out of the bucket and place it in garbage cans, weighing the waste until a sample weighing roughly 225 pounds was obtained. Each sample was then labeled by its identifying number using reusable white boards and

set aside until it was ready to be sorted. If material larger than a garbage can was part of the sample, it was separately labeled and placed next to the garbage cans that made up that sample.

### C&D SAMPLE SELECTION

In the case of C&D loads the *entire load* was visually surveyed by a trained professional based on estimates of the volume of each material type.

The professional first observed the load being tipped, in order to note material(s) that might be covered from view. Then observations were made from all angles to attempt to summarize major categories of C&D waste. Finally, the detailed C&D waste characterization form was completed with the professional noting all types of waste present and estimating their approximate volume in the load. Volumes were later converted to weight using standard conversion factors developed from other waste characterization studies in the United States.

This procedure is described in more detail in the results section.

### *Characterization of Samples*

#### HAND SORTING PROCEDURE FOR MSW

The photograph below (Figure 1) presents the idealized layout of the sorting table and bins into which each targeted material was sorted.

**FIGURE 1:**  
**Layout of Hand-Sorting Table and Bins**

Once the sample was acquired and placed on the sorting table, the material was sorted by hand into 55 categories (Table 2). Plastic 20-gallon bins with sealed bottoms were used to contain the separated components. The sorting crew members typically specialize in groups of materials, such as papers or plastics, and assigned to those materials for the day, or the duration of the sort.



The following picture (Figure 2) shows the actual sort table, bin placement, and crew in Vermont. While the idealized picture illustrates bin placement with less than 35 bins, the 55 primary sort categories required stacking to accommodate all of the categories while still allowing the sort crew to easily access all the bins from the sorting table.

**FIGURE 2:**  
**Vermont Sorting Crew**



The Crew Chief was responsible for monitoring the component bins as they accumulated, re-classifying materials that were improperly classified and providing guidance to the sorting crew as to proper classifications of materials. Open bins allowed the Crew Chief to see the material at all times and verify the purity of each component as it is weighed, before recording the weight on the form. The sample was sorted to a particle size of 2 inches or less by hand, until no more than a small amount of homogeneous fine material (“mixed residue”) remained. The layer of material ranging from 2-inch down to ½ inch was allocated to the appropriate categories based on the best judgment of the Crew Chief — most often a combination of Other Paper, Other Organics, or Food Waste. The screen size on the custom sorting table was ½ inch, which allowed small particles to pass through to a tray under the screen. These particles were swept into the Fines category.

The weigh-out and data recording process is the most critical of process of the sort. The Crew Chief was responsible for overseeing all weighing and data recording of each sample. Once each sample had been sorted, and fines swept from the table, the weigh-out was performed. Each bin containing sorted materials from the just-completed sample was carried over to the scale and the sort category type and number called out to Crew Chief, with the Crew Chief recording all data and reading weights off the scale.

The Crew Chief recorded the data on a *Waste Composition Data Form*. Each data sheet containing the sorted weights of each sample was then matched up against the Field Supervisor’s sample sheet to assure accurate tracking of the samples each day.

**TABLE 2:  
Final List of  
Material Categories**

*Note: BB = Bottle Bill  
EBB = Expanded Bottle Bill*

	No.	CATEGORY
PAPER	1	Newsprint
	2	High Grade Office Paper
	3	OCC (Old Corrugated Cardboard)
	4	Magazines/Catalogs
	5	Mixed Recyclable Paper
	6	Boxboard (chipboard)
	7	Books
	8	Polycoated / Aseptic Containers
	9	Compostable Paper
	10	Non-Recyclable R/C Paper
PLASTIC	11	#1 PET Bottles - BB
	12	#1 PET Bottles - EBB
	13	#1PET Food, Dairy & Other Bottles and Jars
	14	#2 HDPE bottles - BB
	15	#2 HDPE bottles - EBB
	16	HDPE Food, Dairy & Other Non-BB
	17	# 3 - 7 Bottles - BB
	18	# 3 - 7 Bottles - EBB
	19	# 3 - 7 Bottles, Non BB
	20	Bulky Rigids >1 Gallons
	21	Thermoforms
	22	Film,Retail Bags
	23	Film, Other Bags
	24	Film, Garbage
	25	Film, Other
	26	Pouches - BB
	27	Other Plastic
METAL	28	Aluminum Cans - BB
	29	Aluminum Cans - EBB
	30	Aluminum Foil and Cooking Pans & Non-BB
	31	Ferrous Containers
	32	Other Ferrous
	33	Other Non-Ferrous
GLASS	34	Glass Beverage Bottles - BB
	35	Glass Beverage Bottles - EBB
	36	Plate Glass & Non-BB
ORGANIC	37	Food Waste
	38	Mixed Yard Waste Leaves, Branches, & Stumps
	39	Fines / Dirt /Mixed Residue
	40	Other Organics
ELECTRONICS	41	Electronics (Plug-in)
	42	Small Electronics (Rechargeable)
	43	Small Appliances
HHW	44	Mercury Containing Products
	45	Other HHW
C&D	46	C&D Materials (Except Clean Wood)
	47	Clean Wood
SPECIAL WASTE	48	Textiles/Leather
	49	Diapers / Sanitary Products
	50	Carpet/Padding
	51	Batteries
	52	Rubber
	53	Tires
	54	Furniture/Bulky Items
	55	All Other Waste

### ***Plastic Sub-Sort***

DSM's contract with VT DEC specified that MSW be sorted into 50 categories. Subsequent to entering into the contract with VT DEC, DSM entered into a contract (with approval from VT DEC) with the Association of Post Consumer Plastics Recyclers (APR) to carry out a much more detailed sort of plastic wastes. The Project Team agreed that logistically, the most efficient way to conduct the expanded plastic sort was for the MSW sorting crew to sort into 17 plastic sort categories, with DSM then conducting sub-sorts of these categories. This resulted in 55 MSW sort categories (Table 2, above), with DSM then sub-sorting the plastics to the 46 category level (Table 3).

The plastic sub-sort was carried out using a combination of manually identifying the resin type by reading the resin identification code on the package or, if a resin ID number could not be located then a resin ID meter was used to attempt to identify the resin. The meter could not read all materials – especially black and dark green materials – so any material which could not be positively identified was placed in the “other plastic” category.

**FIGURE 3:**  
**Delta Nu, V2 Plastic Resin**  
**Identification Meter**



**TABLE 3:  
Plastic Sub-Sort Categories**

Plastic Sub-Sort Categories	
#1 PET Bottles EBB	Thermoforms PET
#1 PET Bottles BB	Thermoforms PS
#1PET Food and Dairy Bottles and Jars	Thermoforms PVC
#2 HDPE Beverage Bottles EBB	Thermoforms PP
#2 HDPE Beverage Bottles BB	Thermoforms PLA
HDPE Food and Dairy and Detergent	Thermoforms Other
# 3 - 7 Bottles EBB	Film, Retail Bags
# 3 - 7 Bottles BB	Film, Other Bags
# 3 - 7 Bottles Non	Film, Wrap
# 3 - 7 Bottles PP	Film, Garbage
Plastic Cups PET	Film, Other
Plastic Cups PP	Film, Other Metalized
Plastic Cups PS	Ag Pots PE
Plastic Cups Keurig	Ag Pots PP
Plastic Cups Other	Ag Pots PS
Tubs and Lids PE	Ag Pots Other
Tubs and Lids PP	Pouches New
Tubs and Lids PS	Pouches Old
Tubs and Lids Other	Pouches Other
Bulky Rigid >1 Gallons PE	Other Plastic Blister
Bulky Rigid >1 Gallons PP	Other Plastic All Other
Bulky Rigid >1 Gallons Other	Bottles PLA
Bulky Rigid >1 Gallons PE Buckets	Tubs and Lids PLA

**Table Notes:**

BB = Current Bottle Bill material; EBB = Expanded Bottle Bill material assuming same beverages covered as in Maine.

PLA = Poly Lactic Acid – plastics made from plant based sources and compostable under certain conditions.

Thermoforms = plastic “clamshell” packaging made from plastic sheet heated and then formed in a mold.

PET = resin code #1, HDPE = #2, PVC = #3, LDPE = #4, PP = #5, PS = #6, All Other Plastic = #7

***Sorting Wet and Organics Contaminated Waste***

It is common to encounter materials during the sorting event that have been contaminated or combined with organics or liquids. In this event, an attempt was made to remove the contaminating material to the best of the Project Team’s ability with the removed material placed in the food waste bin for weighing. Note that this procedure increases the amount of potentially recyclable packaging because in

reality, some of these containers would have been thrown out and never recycled, while others (primarily beverage containers) could have been recycled even though there was some liquid in them.<sup>3</sup>

### ***Data QA/QC Procedure***

From the moment a vehicle is selected for sampling to the time the final report is presented to VT DEC, the data collection process follows a well-established set of QA/QC strategies to ensure data accuracy and integrity. The quality assurance/quality control process involves:

- Assigning a unique combination sample number, date and time to each sample, and applying the sample number to all subsequent tally sheets that are used to record material weights for the sample.
- Using the *Vehicle Selection Form* to track the numbers of each type of load obtained and sampled.
- Verifying that data forms were obtained for each day the data collection crew was in the field.
- Designing the data entry spreadsheets to prevent out-of-range values for vehicle and sample characteristics such as vehicle type, net weight, etc.
- Performing random checks of computer-entered data against the paper forms, to verify that all numbers are being entered correctly, and to look for any systematic or random errors in the database, and the resulting data analysis.

Following each season of fieldwork, all field forms were transported back to MSW Consultants' office and entered into the firm's waste composition database. In the case of data collected by DSM, the field data were transferred to Excel-based data sheets, proofed to assure all data were entered correctly, and then sent electronically to MSW Consultants.

After the *Field Data Sheets* were checked by the Field Supervisor, the data manager verified that all required data had been recorded properly and supervised the data entry process. As an additional step in quality control, an inspection of randomly selected records was carried out to monitor the accuracy of the data entry process.

During the analysis of the data the following statistical measures were calculated to determine the overall composition of each waste generator sector:

- **Sample Mean:** The sample mean, or average, composition is considered the "most likely" fraction for each material category in the waste stream. The sample mean is determined by (i) summing the weight of each material in each sample; (ii) summing the total weight of all samples, and (iii) dividing the first value by the second value to determine the percent-by-weight composition. Note that the sample mean, while a good estimate, is unlikely to be identical to the population mean value.

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<sup>3</sup> There is no consistent methodology for addressing this issue because a number of containers sorted out of the waste typically contain some amount of food or beverage residue. While emptying the contents increases the quantity of packaging assumed to be recyclable, not emptying smaller quantities of food or beverages and instead throwing the container into another waste category reduces the quantity of packaging assumed to be recycled.

The significance of the sample mean is enhanced by the following statistical measures:

- **Standard Deviation:** The standard deviation measures how widely values within the data set are dispersed from the sample mean. A higher standard deviation denotes higher variation in the underlying samples for each material, while a lower standard deviation reflects lower variation among the individual samples. The standard deviation is stated in the same unit as the sample mean, which in this case is percent by weight.
  
- **Confidence Intervals:** When a sample of data is obtained, it is analyzed in an attempt to determine certain values that describe the entire population of data under analysis. For example, in a poll of likely voters, the intent of the poll is to determine the percentage of all voters who support a given candidate, not simply the percentage of voters in the poll who support that candidate. The percentage of voters who support a given candidate in the poll can easily vary from sample to sample; but the percentage of all voters who support that candidate is a fixed value. In our sample of incoming loads of waste, we are not primarily interested in the percentage composition of the sampled loads, but rather in trying to determine what the composition of the sampled loads tells us about the composition of all waste generated. A confidence interval is a statistical concept that attempts to indicate the likely range within which the true value lies. The confidence intervals reflect the upper and lower range within which the population mean can be expected to fall. Determining the confidence intervals require the following “inputs”:
  - The “level of confidence,” or how sure one wants to be that the interval being constructed will actually encompass the population mean;
  - The sample mean, around which the confidence interval will be constructed;
  - The sample standard deviation, which is used as a measure of the variability of the population from which the sample was obtained; and,
  - The number of sampling units that comprised the sample (i.e. sample size).

Consistent with industry standards, confidence intervals were calculated at a 90 percent level of confidence, meaning that one can be 90 percent sure that the mean falls within the upper and lower confidence intervals shown. (The converse is also true: that there is a 10 percent chance that the mean falls outside of the confidence interval.) In general, as the number of samples increase, the width of the confidence intervals decrease, although the more variable the underlying waste stream composition, the less noticeable the improvement for adding incremental samples.

## Results

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The results of the aggregated MSW sorting data are presented below in a series of tables for the following categories:

- Residential MSW;
- Residential Plastics by Sub-Sort Category;
- ICI MSW;
- ICI Plastics by Sub-Sort Category; and,
- Aggregated C&D.

When reviewing the tables the following points should be kept in mind.

First, in each case the average of the percent of all material is presented by material followed by the range at a 90 percent confidence interval. As discussed above, the budget for this statewide analysis was relatively small resulting in an attempt to explain statewide residential waste from 40 samples and statewide ICI waste from 60 samples. While this sample size is sufficient to provide defensible insight into the state's waste composition, it is small enough that outlier samples may be more influential in the overall results than had the study sample size been larger.

The correct way to interpret each results table is to understand that we are 90 percent confident that the actual composition falls between the lower and upper confidence intervals. For example, Paper represents between 20.0 and 24.3 percent of total residential waste in Vermont and the average composition of 22.2% reflects the "best" estimate based on the statistical analysis.

Second, residential and ICI MSW is presented first as a percent of the total, and then in tons by material type assuming that 60 percent of the waste disposed at transfer stations in Vermont is residential and 40 percent is ICI MSW,

Third, the residential and ICI MSW tables carry only the total plastic composition row for plastics. That is because the Project Team sorted plastics into 46 sub-categories as part of our Sub-Contract with the Association of Post-Consumer Plastics Recyclers. Fitting these 46 sub-categories into the main table would require that the MSW tables fall on two pages rather than one which would make it more difficult for the reader to see the whole picture of composition.

Instead, the plastic sub-categories are presented immediately after the relevant MSW table, and contain three columns. The first column presents the plastic sub-categories the same way as the sub-categories are presented for all other material types – as part of the total composition. However because of the light-weight nature of plastics, many of these sub-categories contain very small numbers when compared to all waste materials. As such, a second column has been included which presents the plastic sub-categories *as a percent of the total plastic category* rather than a percent of the total waste. Thus, for example, one can see that HDPE food, dairy, and detergent bottles represent 0.45 percent of the total residential waste stream but represent 4.5 percent of all plastics found in the residential waste stream. The third column then presents the estimated tonnage of plastic by material type.

Fourth, for all glass, aluminum and plastic containers subject to Vermont’s current bottle bill, there are two sub-categories – “Deposit” (or “BB”), and “New (or EBB)”. The “EBB” sub-category refers to all containers that would be subject to the deposit if Vermont’s bottle bill were expanded to include the same containers as are included in Maine’s expanded bottle bill<sup>4</sup>.

**TABLE 4:  
Vermont Residential Waste Composition Results  
(Percentage, by weight)<sup>5</sup>**

Material Category	Average	90% Conf. Interval		Material Category	Average	90% Conf. Interval	
		Lower	Upper			Lower	Upper
<b>Paper</b>	<b>22.2%</b>	<b>20.0%</b>	<b>24.3%</b>	<b>Plastic</b>	<b>10.8%</b>	<b>9.7%</b>	<b>12.0%</b>
Newsprint	1.4%	1.0%	1.8%	<b>Glass</b>	<b>1.8%</b>	<b>1.2%</b>	<b>2.4%</b>
High Grade Office Paper	0.6%	0.2%	1.0%	Glass Beverage - BB	0.3%	0.1%	0.4%
OCC (Old Corrugated Cardboard)	5.7%	4.0%	7.4%	Glass Beverage - EBB	0.4%	0.2%	0.5%
Magazines/Catalogs	1.6%	0.8%	2.3%	Food and Dairy Glass	0.6%	0.4%	0.8%
Mixed Recyclable Paper	2.3%	1.8%	2.8%	Other Glass	0.6%	0.3%	0.9%
Boxboard (chipboard)	2.1%	1.7%	2.5%	<b>Organic</b>	<b>28.1%</b>	<b>24.4%</b>	<b>31.8%</b>
Books	0.8%	0.2%	1.4%	Food Waste	16.7%	14.0%	19.4%
Polycoated/Aseptic Containers	0.2%	0.1%	0.2%	Yard Waste/Leaves/Branches	3.2%	1.4%	4.9%
Polycoated/Aseptic, Dairy	0.3%	0.2%	0.3%	Fines / Dirt	2.8%	2.2%	3.4%
Compostable Paper	6.2%	5.3%	7.2%	Other Organics	5.4%	3.8%	7.0%
Non-Recyclable R/C Paper	1.0%	0.7%	1.3%	<b>C&amp;D</b>	<b>10.2%</b>	<b>7.4%</b>	<b>13.0%</b>
<b>Metal</b>	<b>3.56%</b>	<b>2.59%</b>	<b>4.54%</b>	All C&D except Clean Wood	8.4%	5.7%	11.1%
Aluminum Beverage Cans - BB	0.157%	0.093%	0.221%	Clean Wood	1.8%	0.9%	2.6%
Aluminum Beverage Cans - EBB	0.014%	0.004%	0.024%	<b>Special Waste</b>	<b>21.0%</b>	<b>17.9%</b>	<b>24.0%</b>
Aluminum Cans, Non-Beverage	0.052%	0.028%	0.076%	Textiles/Leather	6.8%	5.2%	8.4%
Aluminum Foil and Cooking Pans	0.276%	0.209%	0.344%	Diapers / Sanitary Products	2.3%	1.6%	3.0%
Ferrous Containers	0.896%	0.702%	1.089%	Carpet/Padding	5.0%	3.0%	7.1%
Other Ferrous	1.558%	0.668%	2.447%	Batteries	0.1%	0.1%	0.2%
Other Non-Ferrous	0.610%	0.283%	0.937%	Rubber	1.1%	0.6%	1.6%
<b>Electronics</b>	<b>2.23%</b>	<b>1.01%</b>	<b>3.46%</b>	Tires	0.0%	0.0%	0.0%
Electronics (Plug-in)	1.446%	0.446%	2.446%	Furniture/Bulky Items	3.4%	1.2%	5.6%
Small Electronics (Rechargeable)	0.227%	0.024%	0.431%	All Other Waste	2.2%	1.6%	2.9%
Small Appliances	0.561%	0.035%	1.088%	<b>Total</b>	<b>100%</b>		
<b>HHW</b>	<b>0.17%</b>	<b>0.06%</b>	<b>0.28%</b>				
Mercury Containing Products	0.015%	0.001%	0.03%				
Other HHW	0.156%	0.043%	0.27%	<b>Total Samples</b>	<b>40</b>		

<sup>4</sup> See <http://www.maine.gov/agriculture/gar/bottlebill/guidetoselling.html> for information concerning beverages covered under Maine’s deposit legislation.

<sup>5</sup> It was necessary to increase the detail for Metals, Electronics and HHW to show non-zero numbers, however the reader is cautioned that this represents a higher level of accuracy than is probably warranted.

**TABLE 5:**  
**Estimated Residential**  
**Tonnage by Material,**  
**CY 2011<sup>6</sup>**

Class	Mat. #	Material Category	Average (%)	Total (tons)
PAPER	1	Newsprint	1.4%	3,472
	2	High Grade Office Paper	0.6%	1,483
	3	OCC (Old Corrugated Cardboard)	5.7%	14,177
	4	Magazines/Catalogs	1.6%	3,896
	5	Mixed Recyclable Paper	2.3%	5,739
	6	Boxboard (chipboard)	2.1%	5,265
	7	Books	0.8%	1,884
	8	Polycoated / Aseptic Containers	0.2%	402
	9	Polycoated / Aseptic Containers, Dairy	0.3%	629
	10	Compostable Paper	6.2%	15,506
	11	Non-Recyclable R/C Paper	1.0%	2,525
		<b>Subtotal Paper</b>	<b>22.2%</b>	<b>54,978</b>
<b>PLASTIC</b>		<b>Subtotal Plastic</b>	<b>10.8%</b>	<b>26,899</b>
METAL	29	Aluminum Beverage Cans - BB	0.2%	390
	30a	Aluminum Beverage Cans - EBB	0.0%	35
	30b	Aluminum Cans, Non-Beverage	0.1%	129
	31	Aluminum Foil and Cooking Pans	0.3%	686
	32	Ferrous Containers	0.9%	2,222
	33	Other Ferrous	1.6%	3,865
	34	Other Non-Ferrous	0.6%	1,513
		<b>Subtotal Metal</b>	<b>3.6%</b>	<b>8,842</b>
GLASS	35	Glass Beverage - BB	0.3%	665
	36	Glass Beverage - EBB	0.4%	870
	37	Food and Dairy Glass	0.6%	1,435
	38	Other Glass	0.6%	1,521
		<b>Subtotal Glass</b>	<b>1.8%</b>	<b>4,492</b>
ORGANIC	39	Food Waste	16.7%	41,486
	40	Mixed Yard Waste Leaves, Branches, & Stumps	3.2%	7,913
	41	Fines / Dirt	2.8%	6,960
	42	Other Organics	5.4%	13,349
		<b>Organic Subtotal</b>	<b>28.1%</b>	<b>69,708</b>
ELECTRONIC	43	Electronics (Plug-in)	1.4%	3,588
	44	Small Electronics (Rechargeable)	0.2%	564
	45	Small Appliances	0.6%	1,392
		<b>Subtotal Electronic</b>	<b>2.2%</b>	<b>5,544</b>
HHW	46	Mercury Containing Products	0.0%	37
	47	Other HHW	0.2%	386
		<b>Subtotal HHW</b>	<b>0.2%</b>	<b>423</b>
C&D	48	C&D Materials (Except Clean Wood)	8.4%	20,863
	49	Clean Wood	1.8%	4,354
		<b>Subtotal C&amp;D</b>	<b>10.2%</b>	<b>25,217</b>
SPECIAL WASTE	50	Textiles/Leather	6.8%	16,759
	51	Diapers / Sanitary Products	2.3%	5,788
	52	Carpet/Padding	5.0%	12,516
	53	Batteries	0.1%	302
	54	Rubber	1.1%	2,661
	55	Tires	0.0%	0
	56	Furniture/Bulky Items	3.4%	8,431
	57	All Other Waste	2.2%	5,551
		<b>Subtotal Special Waste</b>	<b>21.0%</b>	<b>52,007</b>
		<b>Total</b>	<b>100.0%</b>	<b>248,110</b>

<sup>6</sup> Assumes that *residential waste is 60 percent* of total Vermont Municipal Solid Waste Disposal.

**TABLE 6:  
Absolute and Relative  
Composition of Residential  
Plastic Waste**

	Category/Composition	Absolute	Relative	Tons
12a	#1 PET Bottles EBB	0.37%	3.4%	908.1
12b	#1 PET Bottles BB	0.06%	0.5%	137.6
12c	#1 PET Bottles PLA	0.00%	0.0%	0.0
13	#1PET Food and Dairy Bottles and Jars	0.26%	2.4%	642.2
14a	#2 HDPE Beverage Bottles EBB	0.06%	0.6%	157.9
14b	#2 HDPE Beverage Bottles BB	0.00%	0.0%	0.0
15	HDPE Food and Dairy and Detergent	0.45%	4.2%	1,122.5
16a	# 3 - 7 Bottles EBB	0.12%	1.1%	296.4
16b	# 3 - 7 Bottles BB	0.01%	0.1%	15.3
16c	# 3 - 7 Bottles Non	0.04%	0.3%	90.7
16d	# 3 - 7 Bottles PP	0.02%	0.2%	40.9
17a	Plastic Cups PET	0.02%	0.1%	39.6
17b	Plastic Cups PP	0.06%	0.6%	156.1
17c	Plastic Cups PS	0.14%	1.3%	346.2
17d	Plastic Cups Keurig	0.17%	1.5%	410.7
17e	Plastic Cups Other	0.05%	0.4%	118.0
18a	Tubs and Lids PE	0.03%	0.2%	63.0
18b	Tubs and Lids PP	0.24%	2.2%	583.2
18c	Tubs and Lids PS	0.11%	1.0%	267.1
18d	Tubs and Lids PLA	0.00%	0.0%	0.0
18e	Tubs and Lids Other	0.08%	0.8%	204.4
19a	Bulky Rigid >1 Gallons PE	0.12%	1.1%	307.5
19b	Bulky Rigid >1 Gallons PP	0.00%	0.0%	0.0
19c	Bulky Rigid >1 Gallons Other	0.62%	5.7%	1,532.8
19d	Bulky Rigid >1 Gallons PE Buckets	0.17%	1.6%	421.2
20a	Thermoforms PET	0.16%	1.5%	398.9
20b	Thermoforms PS	0.08%	0.7%	199.7
20c	Thermoforms PVC	0.00%	0.0%	7.2
20d	Thermoforms PP	0.10%	0.9%	249.8
20e	Thermoforms PLA	0.00%	0.0%	0.0
20f	Thermoforms Other	0.06%	0.6%	156.5
21	Film, Retail Bags	0.57%	5.3%	1,417.0
22	Film, Other Bags	1.13%	10.4%	2,803.5
23	Film, Wrap	0.70%	6.5%	1,743.8
24	Film, Garbage	1.60%	14.8%	3,974.7
25a	Film, Other	0.65%	6.0%	1,625.1
25b	Film, Other Metalized	0.07%	0.6%	174.5
26a	Ag Pots PE	0.00%	0.0%	0.0
26b	Ag Pots PP	0.03%	0.3%	81.5
26c	Ag Pots PS	0.00%	0.0%	2.0
26d	Ag Pots Other	0.01%	0.1%	26.2
27a	Pouches EBB	0.04%	0.4%	94.3
27b	Pouches BB	0.00%	0.0%	0.0
27c	Pouches Other	0.00%	0.0%	0.0
28a	Other Plastic Blister	0.05%	0.5%	129.0
28b	Other Plastic All Other	2.40%	22.1%	5,954.3
<b>Total Plastics</b>		<b>10.84%</b>	<b>100.0%</b>	<b>26,899</b>

**TABLE 7:  
Vermont ICI Waste Composition Results  
(Percentage by weight)**

Material Category	Average	90% Conf. Interval		Material Category	Average	90% Conf. Interval	
		Lower	Upper			Lower	Upper
<b>Paper</b>	<b>27.7%</b>	<b>22.9%</b>	<b>32.5%</b>	<b>Plastic</b>	<b>12.2%</b>	<b>9.3%</b>	<b>15.1%</b>
Newsprint	2.1%	0.8%	3.4%	<b>Glass</b>	<b>1.2%</b>	<b>0.9%</b>	<b>1.6%</b>
High Grade Office Paper	1.8%	0.5%	3.1%	Glass Beverage - BB	0.2%	0.1%	0.3%
OCC (Old Corrugated Cardboard)	12.4%	8.3%	16.6%	Glass Beverage - EBB	0.2%	0.1%	0.3%
Magazines/Catalogs	0.4%	0.3%	0.5%	Food and Dairy Glass	0.3%	0.2%	0.5%
Mixed Recyclable Paper	2.8%	0.3%	5.3%	Other Glass	0.4%	0.2%	0.7%
Boxboard (chipboard)	2.1%	1.1%	3.0%	<b>Organic</b>	<b>17.6%</b>	<b>14.0%</b>	<b>21.1%</b>
Books	0.2%	0.1%	0.3%	Food Waste	11.2%	8.2%	14.2%
Polycoated/Aseptic Containers	0.0%	0.0%	0.1%	Yard Waste/Leaves/Branches	2.9%	1.6%	4.2%
Polycoated/Aseptic, Dairy	0.1%	0.1%	0.2%	Fines / Dirt	2.5%	1.6%	3.4%
Compostable Paper	3.8%	3.0%	4.7%	Other Organics	0.9%	0.6%	1.2%
Non-Recyclable R/C Paper	1.9%	0.4%	3.4%	<b>C&amp;D</b>	<b>15.5%</b>	<b>11.9%</b>	<b>19.1%</b>
<b>Metal</b>	<b>2.70%</b>	<b>1.67%</b>	<b>3.73%</b>	All C&D except Clean Wood	8.7%	6.2%	11.1%
Aluminum Beverage Cans - BB	0.137%	0.094%	0.180%	Clean Wood	6.8%	4.3%	9.4%
Aluminum Beverage Cans - EBB	0.013%	0.005%	0.021%	<b>Special Waste</b>	<b>21.6%</b>	<b>16.8%</b>	<b>26.3%</b>
Aluminum Cans, Non-Beverage	0.027%	0.016%	0.038%	Textiles/Leather	6.6%	4.3%	8.9%
Aluminum Foil and Cooking Pans	0.143%	0.090%	0.196%	Diapers / Sanitary Products	1.1%	0.3%	1.8%
Ferrous Containers	0.389%	0.296%	0.483%	Carpet/Padding	3.3%	0.9%	5.7%
Other Ferrous	1.424%	0.434%	2.415%	Batteries	0.0%	0.0%	0.1%
Other Non-Ferrous	0.566%	0.162%	0.970%	Rubber	0.6%	0.3%	0.9%
<b>Electronics</b>	<b>1.49%</b>	<b>0.64%</b>	<b>2.34%</b>	Tires	0.0%	0.0%	0.0%
Electronics (Plug-in)	0.653%	0.094%	1.212%	Furniture/Bulky Items	7.8%	4.1%	11.6%
Small Electronics (Rechargeable)	0.018%	0.004%	0.033%	All Other Waste	2.1%	0.1%	4.0%
Small Appliances	0.819%	0.165%	1.473%	<b>Total</b>	<b>100%</b>		
<b>HHW</b>	<b>0.13%</b>	<b>0.01%</b>	<b>0.25%</b>				
Mercury Containing Products	0.061%	0.000%	0.137%				
Other HHW	0.071%	0.000%	0.160%	<b>Total Samples</b>	<b>60</b>		

**TABLE 8:**  
**Estimated ICI Tonnage**  
**by Material, CY 2011<sup>7</sup>**

Class	Mat. #	Material Category	Average (%)	Total (tons)
PAPER	1	Newsprint	2.1%	3,498
	2	High Grade Office Paper	1.8%	2,962
	3	OCC (Old Corrugated Cardboard)	12.4%	20,577
	4	Magazines/Catalogs	0.4%	657
	5	Mixed Recyclable Paper	2.8%	4,618
	6	Boxboard (chipboard)	2.1%	3,400
	7	Books	0.2%	310
	8	Polycoated / Aseptic Containers	0.0%	71
	9	Polycoated / Aseptic Containers, Dairy	0.1%	204
	10	Compostable Paper	3.8%	6,345
	11	Non-Recyclable R/C Paper	1.9%	3,111
		<b>Subtotal Paper</b>	<b>27.7%</b>	<b>45,752</b>
<b>PLASTIC</b>		<b>Subtotal Plastic</b>	<b>12.2%</b>	<b>20,198</b>
METAL	29	Aluminum Beverage Cans - BB	0.1%	227
	30a	Aluminum Beverage Cans - EBB	0.0%	22
	30b	Aluminum Cans, Non-Beverage	0.0%	45
	31	Aluminum Foil and Cooking Pans	0.1%	237
	32	Ferrous Containers	0.4%	644
	33	Other Ferrous	1.4%	2,356
	34	Other Non-Ferrous	0.6%	936
		<b>Subtotal Metal</b>	<b>2.7%</b>	<b>4,466</b>
GLASS	35	Glass Beverage - BB	0.2%	333
	36	Glass Beverage - EBB	0.2%	379
	37	Food and Dairy Glass	0.3%	562
	38	Other Glass	0.4%	728
		<b>Subtotal Glass</b>	<b>1.2%</b>	<b>2,001</b>
ORGANIC	39	Food Waste	11.2%	18,592
	40	Mixed Yard Waste Leaves, Branches, & Stum	2.9%	4,818
	41	Fines / Dirt	2.5%	4,135
	42	Other Organics	0.9%	1,486
		<b>Subtotal Organic</b>	<b>17.6%</b>	<b>29,031</b>
ELECTRONIC	43	Electronics (Plug-in)	0.7%	1,080
	44	Small Electronics (Rechargeable)	0.0%	30
	45	Small Appliances	0.8%	1,355
		<b>Subtotal Electronic</b>	<b>1.5%</b>	<b>2,466</b>
HHW	46	Mercury Containing Products	0.1%	100
	47	Other HHW	0.1%	117
		<b>Subtotal HHW</b>	<b>0.1%</b>	<b>217</b>
C&D	48	C&D Materials (Except Clean Wood)	8.7%	14,336
	49	Clean Wood	6.8%	11,289
		<b>Subtotal C&amp;D</b>	<b>15.5%</b>	<b>25,625</b>
SPECIAL WASTE	50	Textiles/Leather	6.6%	10,899
	51	Diapers / Sanitary Products	1.1%	1,790
	52	Carpet/Padding	3.3%	5,465
	53	Batteries	0.0%	75
	54	Rubber	0.6%	1,047
	55	Tires	0.0%	0
	56	Furniture/Bulky Items	7.8%	12,974
	57	All Other Waste	2.1%	3,400
		<b>Subtotal Special Waste</b>	<b>21.6%</b>	<b>35,651</b>
		<b>Total</b>	<b>100.0%</b>	<b>165,407</b>

<sup>7</sup> Assume that ICI tonnage is 40% of Total Vermont Municipal Solid Waste.

**TABLE 9:  
Absolute and Relative  
Composition of  
ICI Plastic Waste**

	Category/Composition	Absolute	Relative	Tons
12a	#1 PET Bottles EBB	0.32%	2.6%	525.8
12b	#1 PET Bottles BB	0.06%	0.5%	97.6
12c	#1 PET Bottles PLA	0.00%	0.0%	0.0
13	#1PET Food and Dairy Bottles and Jars	0.12%	1.0%	193.4
14a	#2 HDPE Beverage Bottles EBB	0.02%	0.1%	24.8
14b	#2 HDPE Beverage Bottles BB	0.00%	0.0%	0.0
15	HDPE Food and Dairy and Detergent	0.35%	2.9%	584.3
16a	# 3 - 7 Bottles EBB	0.03%	0.2%	45.2
16b	# 3 - 7 Bottles BB	0.00%	0.0%	0.0
16c	# 3 - 7 Bottles Non	0.05%	0.4%	75.7
16d	# 3 - 7 Bottles PP	0.01%	0.1%	12.9
17a	Plastic Cups PET	0.01%	0.1%	20.3
17b	Plastic Cups PP	0.05%	0.4%	80.6
17c	Plastic Cups PS	0.05%	0.4%	85.8
17d	Plastic Cups Keurig	0.04%	0.3%	62.6
17e	Plastic Cups Other	0.05%	0.4%	88.9
18a	Tubs and Lids PE	0.02%	0.2%	40.8
18b	Tubs and Lids PP	0.15%	1.3%	255.4
18c	Tubs and Lids PS	0.03%	0.3%	57.5
18d	Tubs and Lids PLA	0.00%	0.0%	0.1
18e	Tubs and Lids Other	0.06%	0.5%	94.2
19a	Bulky Rigid >1 Gallons PE	0.04%	0.3%	67.7
19b	Bulky Rigid >1 Gallons PP	0.07%	0.5%	109.7
19c	Bulky Rigid >1 Gallons Other	0.90%	7.4%	1,496.6
19d	Bulky Rigid >1 Gallons PE Buckets	0.02%	0.1%	29.2
20a	Thermoforms PET	0.09%	0.7%	146.3
20b	Thermoforms PS	0.03%	0.3%	56.3
20c	Thermoforms PVC	0.00%	0.0%	0.0
20d	Thermoforms PP	0.03%	0.2%	48.8
20e	Thermoforms PLA	0.00%	0.0%	0.0
20f	Thermoforms Other	0.05%	0.4%	86.4
21	Film, Retail Bags	0.23%	1.9%	384.7
22	Film, Other Bags	0.75%	6.1%	1,234.4
23	Film, Wrap [1]	2.80%	22.9%	4,624.5
24	Film, Garbage	1.42%	11.6%	2,345.2
25a	Film, Other	0.36%	3.0%	602.8
25b	Film, Other Metalized	0.06%	0.5%	100.9
26a	Ag Pots PE	0.00%	0.0%	3.3
26b	Ag Pots PP	0.02%	0.2%	36.4
26c	Ag Pots PS	0.01%	0.1%	17.6
26d	Ag Pots Other	0.03%	0.2%	42.5
27a	Pouches New	0.01%	0.1%	10.1
27b	Pouches Old	0.00%	0.0%	0.0
27c	Pouches Other	0.01%	0.1%	22.4
28a	Other Plastic Blister	0.04%	0.3%	58.8
28b	Other Plastic All Other	3.83%	31.3%	6,327.7
	<b>Total Plastics</b>	<b>12.21%</b>	<b>100.0%</b>	<b>20,198</b>

**TABLE NOTES:**

[1] The percentage shown here is most likely overstated. The high percentage shown is driven by one sample that contained almost all film wrap. This sample was a statistical outlier; however, it has been retained in the analysis because it was obtained through random selection methods.

## ***Construction and Demolition Wastes (C&D)***

There is a general consensus that it is impossible to take grab samples of C&D waste from loads to characterize the C&D waste stream. This is because each load is different, and a sample taken from one part of a load will not necessarily be representative of the remainder of the load. In addition, this is because many materials found in C&D loads tend to be large and unusually shaped, making removal of a representative grab sample extremely difficult.

As a consequence, a technique for conducting visual samples of C&D loads has been developed and used that provides relatively accurate information on the composition of C&D loads. Under this methodology an enumerator (trained in the identification of different C&D materials) walks around the entire load after it has been dumped and estimates the percent of each major material type by *volume*. The enumerator then goes back around the load, and estimates the percent of each sub-category within each of the major categories. For each load, the container (roll-off, pickup bed, trailer) volume, percent full, and estimated fraction of each C&D material category is estimated and recorded. This methodology was used for this analysis.

While the methodology used for visual surveying was performed consistently and accurately, in practice there is potential for error to be introduced because certain steps of visual characterization are, by nature, qualitative. For example, two well trained solid waste professionals with field experience may observe a fraction of drywall in the same sample, yet their estimate of the percent of that drywall will vary. Human judgment is a necessary obstacle of precise visual surveying.

Fortunately, for all loads surveyed, it was also possible to obtain a copy of the weigh ticket from the scale house at each host facility. Because landfill scales must be calibrated on a regular basis to assure accurate reporting of incoming waste flows, the measured weight of each load from the scale house are highly defensible data points. The first step toward tabulating the results was therefore to convert volumetric estimates for each sample into weight-based estimates.

Doing so required the following process:

1. Researching and compiling the raw density factors for all of the material categories defined for the study. Raw density factors were compiled based on available literature (primarily other C&D characterization studies and various recycled material manuals) as well as on the Project Team's experience in conducting prior waste characterization studies;
2. Converting volumetric estimates to weight-based estimates by applying the raw density factors;
3. Comparing the sum of the weights of the raw volume-to-weight conversions against the actual weight of each load as shown on the weigh tickets;
4. Applying targeted statistical analysis to identify the density factors that contribute to the variance between the calculated (item 2) and the actual (item 3) weights; and
5. Developing adjusted density factors that, when applied to the volumetric estimates observed in the field, yield calculated weights that are, in the aggregate, within acceptable tolerances of the actual weights.

As with MSW sampling, the larger the number of samples, the less that errors in visual estimation impact the overall results. For example the Project Team completed 633 visual samples of C&D waste as part of the 2007 Delaware solid waste characterization study. For this study virtually all loads of C&D entering each transfer station where sampling was occurring were visually characterized, yet a total of only 66 loads were observed. This relatively small sample size results in large standard deviations and wide confidence intervals, but is still useful for planning purposes.

**TABLE 10:  
Vermont C&D Waste  
Composition Results  
(Percent, by weight)**

Group	Category	Average	Std Dev	90% Conf. Intervals	
				Lower	Upper
PAPER	1 OCC/Kraft	1.1%	2.6%	0.6%	1.7%
	2 R/C and Other Paper	0.5%	1.7%	0.2%	0.9%
	<b>Subtotal Paper</b>	<b>1.7%</b>			
PLASTIC	3 HDPE Buckets	0.1%	0.3%	0.0%	0.2%
	4 Clean Recoverable Film	0.3%	0.6%	0.1%	0.4%
	5 RC and Other Plastic	0.7%	1.6%	0.4%	1.0%
	<b>Subtotal Plastic</b>	<b>1.1%</b>			
GLASS	6 <b>Subtotal Glass</b>	<b>0.7%</b>	3.0%	0.1%	1.3%
ORGANIC	7 Yard Waste	0.2%	1.2%	0.0%	0.4%
	8 Carpet	1.0%	3.4%	0.4%	1.7%
	9 Carpet Padding	0.2%	0.6%	0.0%	0.3%
	10 R/C and Other Organics	0.0%	0.2%	0.0%	0.0%
	<b>Subtotal Organic</b>	<b>2.1%</b>			
C&D	11 Concrete/Brick/Rock	1.3%	7.9%	0.0%	2.9%
	12 Asphalt Paving	0.4%	2.9%	0.0%	0.9%
	13 Roofing Materials	18.3%	43.5%	9.5%	27.1%
	14 Ceiling Tiles	0.2%	0.9%	0.0%	0.3%
	15 Pallets and Crates	1.9%	7.4%	0.4%	3.4%
	16 Clean Dimensional Lumber	9.2%	16.3%	5.9%	12.5%
	17 Clean OSB	3.1%	11.4%	0.8%	5.4%
	18 Plywood	3.7%	7.3%	2.2%	5.1%
	19 Other Clean Engineered Wood	2.0%	8.0%	0.4%	3.6%
	20 Wood Furniture	2.5%	8.6%	0.7%	4.2%
	21 Painted/Stained Wood	16.7%	30.2%	10.6%	22.8%
	22 Treated Wood	1.2%	5.1%	0.2%	2.2%
	23 Clean Gypsum Board	3.9%	14.5%	1.0%	6.9%
	24 Dirt Sand and Gravel	2.9%	19.0%	0.0%	6.7%
	25 Insulation	0.5%	0.9%	0.3%	0.6%
	26 R/C and Other C&D	17.6%	27.8%	12.0%	23.2%
<b>Subtotal C&amp;D</b>	<b>85.3%</b>				
METAL	27 HVAC Ducting	0.1%	0.2%	0.0%	0.1%
	28 Other Ferrous	2.1%	5.7%	1.0%	3.3%
	29 Non-Ferrous	2.5%	6.7%	1.1%	3.8%
	<b>Subtotal Metal</b>	<b>4.7%</b>			
SPECIAL	30 Appliances	0.1%	0.4%	0.0%	0.2%
	31 Electronics	0.0%	0.0%	0.0%	0.0%
	32 Items with CRTs	0.0%	0.0%	0.0%	0.0%
	33 Bulky Items	2.4%	9.1%	0.5%	4.2%
	34 Tires	0.0%	0.0%	0.0%	0.0%
	35 Lead Acid Batteries	0.0%	0.0%	0.0%	0.0%
	36 Vehicle and Equipment Fluids	0.0%	0.0%	0.0%	0.0%
	37 Paint Other Hazardous Waste	0.0%	0.0%	0.0%	0.0%
	38 Other Hazardous Waste	0.0%	0.0%	0.0%	0.0%
	39 Fines/Mixed Residue	0.0%	0.1%	0.0%	0.0%
<b>Subtotal Special</b>	<b>2.5%</b>				
MSW	40 <b>Subtotal Mixed MSW</b>	<b>2.7%</b>	8.5%	0.9%	4.4%
<b>Total</b>		<b>100.0%</b>			

## Findings and Observations

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Typically waste composition studies are used for two primary purposes. First, to determine if policies concerning waste diversion have had measurable success since the last waste composition study was conducted, and second to develop new policies based on the current composition.

The Project Team has chosen to use four other studies as comparison to this study to inform the results. These are:

- *Municipal Solid Waste Generation, Recycling, and Disposal in the United States, Tables and Figures for 2010, US EPA, December 2011;*
- *Vermont Waste Composition Study, Vermont Agency of Natural Resources, June 2002;*
- *Connecticut State-wide Solid Waste Composition and Characterization Study, CT DEEP, May 2010; and,*
- *Delaware Solid Waste Authority Statewide Waste Characterization Study, 2006 – 2007, DSWA, October 2007*

The US EPA study, while based on a different methodology is the only comprehensive analysis of materials discarded throughout the US, and therefore represents a national baseline against which to compare the Vermont results. However, it must be emphasized that the US EPA methodology does not involve waste sampling, and reflects national averages which mask large variations in disposal based both on differences in consumption among states, and differences in materials diversion. For these reasons the US EPA data cannot be compared directly with waste composition data from individual states.

The 2002 Vermont study was the last waste composition study conducted in Vermont, and therefore serves as the basis for comparison against the current analysis.

The 2010 Connecticut study was performed by the Project Team and therefore reflects the same methodology and represents another New England state with a bottle bill.

The 2007 Delaware study was also conducted by the Project Team using a similar methodology. Although somewhat dated, it was, at the time of the study, a bottle bill state (except for aluminum). More importantly, it represents large sample sizes as well as the visual analysis of a large number of C&D loads conducted by the same enumerators performing the visual characterizations in Vermont.

Five important cautions are necessary when reviewing the data presented in this report and attempting to compare Vermont's 2012 waste composition with the 2002 report, or with other states.

- **Change in relative composition** - All materials are reported as a percent of the total. A significant change in the relative concentration of one material can therefore impact the relative percentages of all other materials. For example, the 2002 Vermont Waste Composition Study reported that C&D wastes averaged 4.6 percent of total residential waste. The current residential waste composition reflects C&D waste at 10.2 percent of total waste. If one were to hold the mean C&D percent for 2012 constant at the 4.6 percent reported in 2002, that would increase the mean organics by 1.7 percentage points to 29.8 percent, paper by 1.3 percent to 23.5 percent and plastics by 0.7 percent to 11.5 percent. This does not mean that either the

2002 or 2012 analysis is somehow “wrong”, only that increasing the weight of one category changes the percentages of the other categories.

- **Small sample size** – The available budget resulted in a small sample size for a state-wide composition effort. This is reflected in relatively large confidence intervals for some material categories. Readers interested in a detailed analysis of the results should not only compare the mean for each material but the accompanying confidence intervals.
- **Comparison with Vermont’s 2002 Waste Composition Study** - The 2002 Waste Composition Study only included 14 samples of mixed ICI waste. This sample size was too small to provide statistically valid data for the composition of mixed ICI waste. As such there is no way to compare the 2002 and 2012 ICI waste compositions.
- **Comparison among sampling locations** - The samples from all four transfer stations were combined to conduct the analysis. The goal was to provide a rough snap shot of all Vermont waste in 2012, recognizing that there may be significant differences in waste diversion programs served by these four transfer stations. However, the sample size is not large enough across the individual transfer stations to make reasonable comparisons of individual transfer station data.
- **Impact of bulky waste** - The Project Team did not sample bulky waste loads. These loads may make up a significant fraction of the total waste disposed based on our observations during data collection and sampling. Ignoring this potentially important waste stream skews the sampled results up because some percent of the waste going into Vermont landfills has not been accounted for. For example, if bulky wastes were to make up 10 to 20 percent of the waste going into Vermont landfills, then the percent of recyclables and organics is overestimated by that amount based on the percentages reported in this study. That means that programs designed to divert additional recyclable or compostable waste will over-estimate the potential impact. However, the lack of inclusion of bulky waste also can balance out the higher than anticipated C&D wastes discussed above.<sup>8</sup>

With these caveats in mind the following observations are discussed below.

### **Residential Waste**

Considering the limitations above, the following observations are made about Vermont’s residential waste:

- The amount of paper in the waste stream has declined by roughly 5 to 6 percentage points since the 2002 study. A significant part of this decline is in newsprint which is a result of both declining newspaper circulation and size, and potentially increased recovery of newspaper. Interestingly, the amount of corrugated containers remaining in the residential waste stream appears to have increased, perhaps because e-commerce has grown relative to traditional retail commerce, with the household receiving the product in a corrugated container instead of the retail store emptying the corrugated container and recycling it; indicating that there is a need to more aggressively target corrugated containers for recycling in residential programs.

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<sup>8</sup> Adjusting the C&D waste down closer to the 2002 results would increase the percent of recyclables. However, adding bulky waste would reduce the percent of recyclables.

- Despite the declines in paper in the Vermont waste stream, there is still significantly more paper in the waste stream (at 22.2 – 27.7 percent for residential and ICI wastes, respectively) than the US EPA estimate of 16.2 percent discards nation-wide. However, Vermont’s paper discards are similar to Connecticut in 2010 and lower than Delaware in 2007.
- The amount of electronics found in the waste stream remains essentially the same as it was ten years ago. This is probably the result of lighter-weight electronics and much more aggressive e-waste recycling programs.
- Plastic has increased as a percent of the total when compared to 2002 – from 9 percent to 10.8 percent. This is less than the increase that the Project Team has observed in other states. For example, plastic represented 12.9 percent of Connecticut’s residential waste in 2010 and 11.4 percent of Delaware’s waste in 2007. However, the Connecticut and Delaware results fall within the 90 percent confidence interval for plastic in Vermont’s residential waste stream.
- Organics (food and yard residuals) represent the largest single component of the residential waste stream in Vermont at 28.1 percent. This is slightly lower than Connecticut at 32.1 percent and Delaware at 30.6 percent, although as with plastics, the CT and DE organics composition falls roughly within the 90 percent confidence interval for Vermont’s 2012 composition.
- The largest difference between 2002 and 2012 is in the quantities of C&D waste sorted as MSW at 10.2 percent. This compares to 4.6 percent in 2002. However, the 2012 results are consistent with Connecticut, at 10.6 percent and Delaware at 8 percent, and is comparable to the US EPA estimate of 8 percent wood waste.
- The percent of the residential waste stream comprised of beverage containers subject to the current bottle bill has remained relatively consistent over the past ten years, with glass and aluminum up 0.1 percent over 2002 (within the same confidence interval range) and plastic down 0.04 percent. When compared to Connecticut, Vermont’s residential waste stream had about twice as much PET subject to the deposit as Connecticut (before CT’s expanded bottle bill), the same amount of glass, and about twice as much aluminum.
- Interestingly, the amount of plastic tubs and thermoforms (called “clamshells” in 2002) has remained about the same which is somewhat surprising given the increase in plastic packaging. This is probably a result of lighter weight packaging now when compared to ten years ago, and more recycling programs for this material.

### ***ICI Waste***

As discussed above it is not possible to compare mixed ICI waste results from this study with the 2002 study. However, some general observations can be made.

- In general Vermont’s ICI waste stream composition is similar to both Connecticut’s and Delaware’s.
- Organic waste represents 17.6 percent of total ICI waste in Vermont when compared to 19.9 in Connecticut and 17.8 in Delaware. From a policy perspective, the relatively lower quantities of

organics, and especially food waste in the overall ICI waste stream means that programs focusing on organics removal from ICI wastes will not have as great a state-wide impact as programs focusing on residential waste. However, because certain ICI generators such as restaurants and supermarkets are very large generators of organic waste, programs focusing on these large generators are likely to be the most successful in reducing organic wastes disposed to landfills despite a lower impact on overall ICI wastes.

- Paper represents 27.7 percent of Vermont’s ICI waste compared to an average of 26.8 percent of Connecticut’s and 35.3 percent of Delaware’s ICI waste, respectively. However, it is important to recognize that, like organics, different ICI generators have significantly different waste compositions. For example, while corrugated containers represented, on average 12.4 percent of total ICI waste, three ICI samples were over 80 percent corrugated, and another four samples contained over 25 percent corrugated. Figure 4, below is a picture of a randomly selected ICI load that was predominantly compacted corrugated cardboard.

**FIGURE 4:**  
Photograph of ICI Load Sampled With  
High Corrugated Content



- As with other states, despite the wide availability of corrugated recycling programs corrugated still represents a significant percent of total ICI (and residential) waste in Vermont.
- As with residential plastics, ICI plastic waste in Vermont appears to be below what the Project Team has observed in other states. For example, plastic represents 16.9 percent of Connecticut’s ICI waste stream and 16.3 percent of Delaware’s ICI waste stream, while only 12.2 percent of Vermont’s ICI waste stream.
- Textiles, at 6.8 percent of ICI (and residential) waste are another potential area for new recovery programs going forward. The State of Massachusetts has recently begun to emphasize diversion of textiles, and it may be that Vermont can learn from Massachusetts as to what programs for textiles diversion makes sense going forward.

## ***Deposit Containers***

One objective of this study was to examine the percent of beverage containers in Vermont's waste stream that either are, or could be included under an expanded bottle bill (EBB). It is somewhat hard to compare Vermont's results against non-bottle bill states because for all three main container materials (aluminum, glass, and PET) there are containers that would be subject to a deposit and those with food or dairy that would not under most proposals for expanded bottle bills. Recognizing these limitations the following observations can be made.

- Connecticut and Vermont had relatively the same percent deposit containers in the residential and ICI waste stream (especially if one looks at the 90 percent confidence intervals). It should be noted that Connecticut's waste composition study was conducted before the deposit was expanded to include water bottles.
- The US EPA estimates that total glass packaging (assumed to be primarily bottles) represents 3.8 percent of total MSW discards. This compares to Vermont at 1.1 to 1.7 percent for ICI and residential discards, respectively; and Connecticut at 1.5 to 1.8 percent, respectively. This implies that the deposit on glass beverage containers has a significant impact on the amount of glass packaging remaining in the waste stream in Vermont when compared to the national average, and that glass recycling programs irrespective of the bottle bill are also successful.
- The same cannot be said for aluminum where the US EPA estimates that aluminum cans represent only 0.4 percent of total US MSW discards, while in Vermont aluminum cans represent 0.6 to 1.0 percent of ICI and residential discards, respectively. Connecticut aluminum can discards are essentially the same as the US, at 0.5 to 0.3 percent for ICI and residential, respectively.
- Because of the light weight nature of plastic bottles, the comparison between US statistics and Vermont and Connecticut are not as dramatic as for glass. The US EPA estimates that plastic bottles represent 2.4 percent of total MSW discards, while they represented 1.6 to 1.5 percent for ICI and residential discards, respectively in Vermont, and 1 to 1.6 percent in Connecticut.
- Table 11, on the next page, presents the estimate of how much bottle bill (BB) and expanded bottle bill (EBB) material is being disposed under current conditions. Note that Table 11 is based on the mean for each material and that there are relatively large confidence intervals under which these materials might fall.

**TABLE 11:**  
**Estimated Disposal of Bottle Bill and Expanded Bottle Bill Materials**

Material	Residential		ICI		Total	
	BB (tons)	EBB (tons)	BB (tons)	EBB (tons)	BB (tons)	EBB (tons)
Aluminum	390	35	227	22	617	57
Glass	665	870	333	379	998	1,249
PET	138	908	98	526	235	1,434
HDPE	0	158	0	25	0	183
3-7	15	296	0	45	15	342
<b>Total</b>	<b>1,209</b>	<b>2,265</b>	<b>657</b>	<b>996</b>	<b>1,866</b>	<b>3,261</b>

***Plastic Sub-Sort***

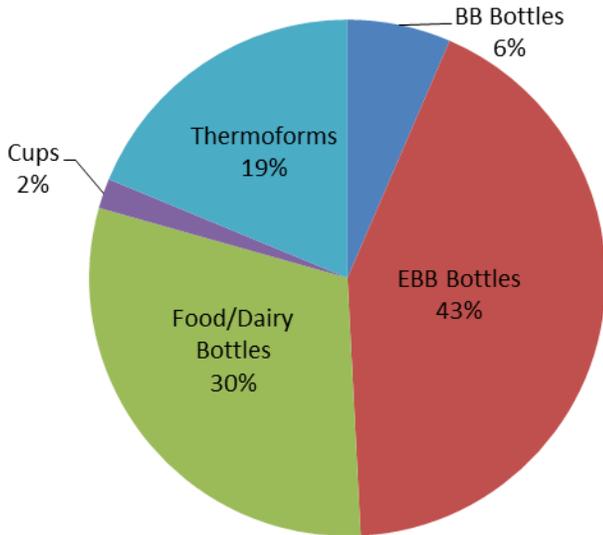
Table 12 below presents the results of the plastic sub-sort by product type. As illustrated by Table 12, plastic film is the largest single component of plastic waste representing 43 to 45.5 percent of residential and ICI plastic waste respectively. It should be cautioned that film plastics are among the most affected by moisture, dirt and food contaminants during waste composition studies, and that the weights shown for films should be considered to overestimate the actual amount of plastic being disposed because of contamination.

**TABLE 12:**  
**Composition of Plastic Waste by Product Type**

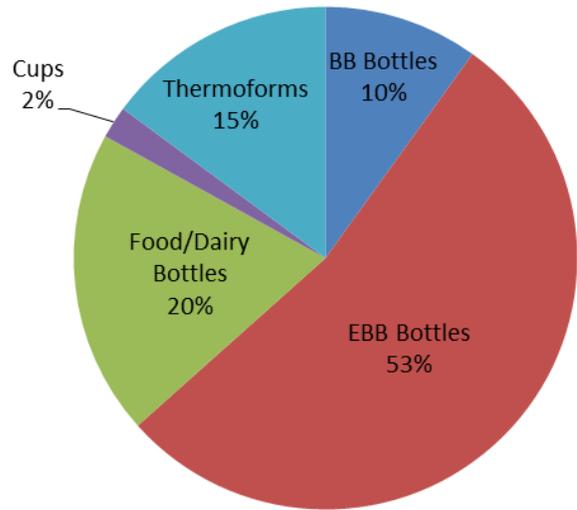
Product Type	ICI Plastic Waste		Residential Plastic Waste	
	(%)	(tons)	(%)	(tons)
Bottles	7.7%	1,560	12.7%	3,412
Tubs & Lids	2.2%	448	4.2%	1,118
Thermoforms	1.7%	338	3.8%	1,012
Cups	1.7%	338	4.0%	1,071
Retail Bags	1.9%	385	5.3%	1,417
Film	32.5%	6,563	23.6%	6,347
Garbage Bags	11.6%	2,345	14.8%	3,975
Ag Pots	0.3%	100	0.4%	110
Pouches	0.2%	33	0.4%	94
Blister Packs	0.3%	59	0.5%	129
Bulky Rigids	8.4%	1,703	8.4%	2,261
Other	31.3%	6,328	22.1%	5,954
<b>Total</b>	<b>99.9%</b>	<b>20,198</b>	<b>100.0%</b>	<b>26,899</b>

Figures 5 through 7, on the next two pages, present the breakdown of rigid plastic containers for PET (#1), HDPE (#2) and PP (#3) packaging in the residential (Table 6) and ICI (Table 9) waste stream.

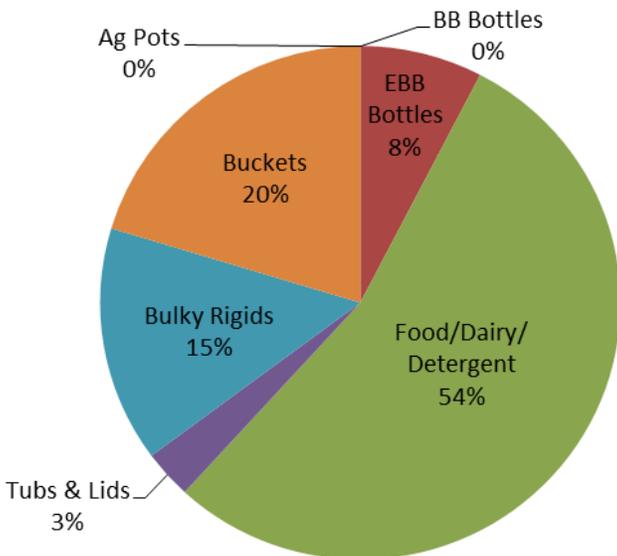
**FIGURE 5A:**  
**Residential Waste Composition,**  
**PET Rigid Plastic Containers**  
 (Percentage, By Weight)



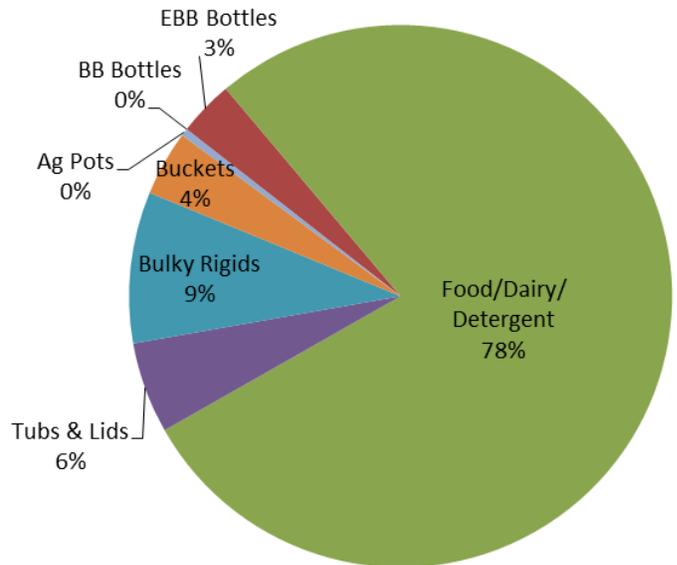
**FIGURE 5B:**  
**Commercial Waste Composition,**  
**PET Rigid Plastic Containers**  
 (Percentage, By Weight)



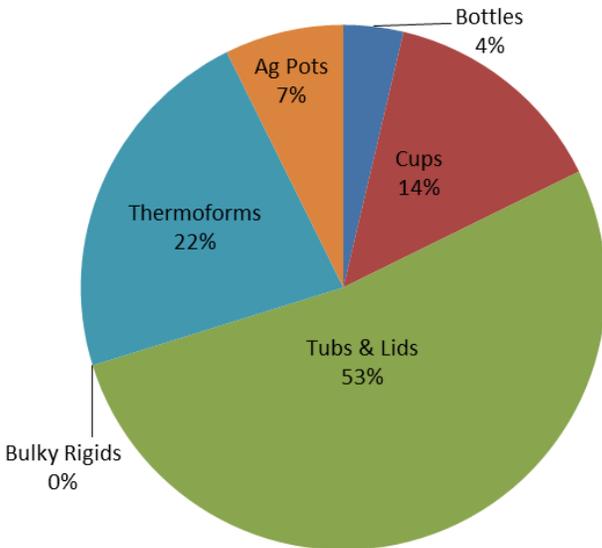
**FIGURE 6A:**  
**Residential Waste Composition,**  
**HDPE Rigid Plastic Containers**  
 (Percentage, By Weight)



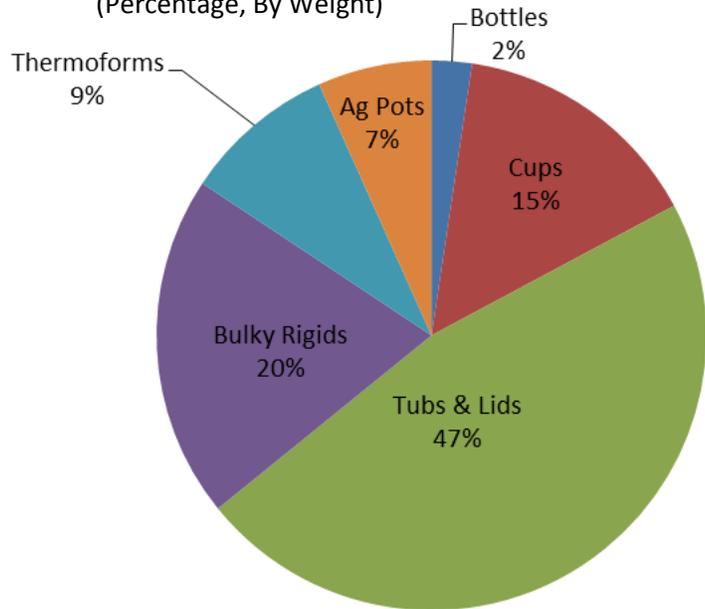
**FIGURE 6B:**  
**Commercial Waste Composition,**  
**HDPE Rigid Plastic Containers**  
 (Percentage, By Weight)



**FIGURE 7A:**  
**Residential Waste Composition,**  
**PP Rigid Plastic Containers**  
 (Percentage, By Weight)



**FIGURE 7B:**  
**Commercial Waste Composition,**  
**PP Rigid Plastic Containers**  
 (Percentage, By Weight)



**Construction and Demolition Wastes**

Table 13 presents a breakdown of where the C&D loads that were observed were generated. As illustrated by Table 13, the vast majority of C&D loads observed were residential renovations, with very few new construction projects.

**TABLE 13:**  
**Source of C&D Loads by Job Type<sup>9</sup>**

Type of Construction	Residential	Commercial
New Construction	0	2
Demolition	7	0
Renovation	42	8
Clean Out	4	1
<b>Total</b>	<b>53</b>	<b>11</b>

Despite the small number of samples observed in Vermont (66) when compared to Delaware (633), and the fact that there was very little new construction when compared to Delaware (impacted by a different economy), the mean percentages by material type are remarkably similar across all categories.

<sup>9</sup>Table 13 presents data from 64 of the 66 loads that were surveyed. The type of load was not reported by the driver for two additional loads.

- Paper, primarily corrugated containers (OCC) and Kraft (brown paper), was 1.7 percent in Vermont when compared to 2.1 percent in Delaware.
- Plastic was 1.1 percent in Vermont compared to 1.6 percent in Delaware.
- In both states, C&D debris was in the 84 to 85 percent range, and in both states clean wood (the only really valuable component of C&D) represented just over 9 percent.
- Roofing materials were the largest single C&D material observed. Asphalt roofing materials can potentially be diverted to road paving, and therefore represent an area for further work by VT DEC.
- Painted and stained wood represents the second largest type of C&D debris. This is consistent with the data DSM collected for the State of Massachusetts. Because painted and stained wood cannot be diverted to clean wood uses, there are limited outlets for this material other than combustion or delivery to particle board manufacturers.
- Finally, clean gypsum, often a target for up-front separation represented 3.9 percent in Vermont and 9.8 percent in Delaware – but this was a time of very high new construction in Delaware.

## Recommendations for Future Waste Composition Studies

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The following recommendations should be considered by VT DEC in preparation for the next State-wide waste composition study.

- Both the 2002 and the 2012 studies have been under-funded when compared to what other states have expended on state-wide studies. This has resulted in relatively small sample sizes and larger uncertainty with respect to the relative importance of some materials. It is recommended that VT DEC consider, at a minimum, doubling the budget for the next study. This would allow for an increased sample size, and the possibility of sampling at more locations throughout the State.
- More emphasis should be placed on determining the composition of roll-off wastes delivering material to transfer stations and/or disposal facilities. This study concentrated on packer truck loads and loads that were defined by the driver as primarily residential or commercial. While some roll-off waste was sampled when it was known to have come from a single generator (e.g., a 40 cubic yard closed roll-off from a supermarket), a significant amount of waste in Vermont is brought to drop-offs and transfer stations by individuals and small businesses. This waste was not sampled because the resulting roll-offs were known to contain a mix of residential and commercial waste and therefore could not be categorized as either “residential” or “ICI” waste. One solution to this problem would be to sample individual loads being delivered to these transfer stations – called “self-haul” loads in the Delaware study.
- Bulky waste loads should also be sampled and an attempt made to quantify how much of the waste coming to the sampling locations is bulky waste. Visual sampling, similar to that carried out for C&D waste could be performed on these loads, and a tonnage count kept on the days of sampling at each facility to quantify what percent of deliveries were represented by these loads.
- The plastic sub-sort carried out for this study is one of the first in the country. The data are useful because of the growing amount of plastics in the waste stream, and the increasing complexity of plastic wastes. It would be very helpful for future research to duplicate this sub-sort over the next several waste composition studies so that changes in the composition and relative quantities of plastic waste could be determined off of the 2012 baseline.
- An attempt should be made by VT DEC to compile data on residential versus ICI disposal, either on an annual basis, or at the time of the next waste composition study so that more accurate tonnage estimates by material type can be made.

## Appendix A: Waste Category Definitions

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### Paper

1. **Newsprint** means the class or kind of paper chiefly used for printing newspapers – i.e. uncoated ground wood paper, including inserts.
2. **High Grade Office Paper** means the type of paper that is free of ground wood fibers; usually sulfite or sulphate paper; includes office printing and writing papers such as white ledger, color ledger, envelopes, and computer printout paper, bond, rag, or stationary grade paper. This subtype does not include fluorescent dyed paper or deep-tone dyed paper such a goldenrod colored paper.
3. **Uncoated Corrugated Cardboard/Kraft Paper** means corrugated boxes or paper bags made from Kraft paper. Uncoated Corrugated Cardboard has a wavy center layer and is sandwiched between the two outer layers and does not have any wax coating on the inside or outside. Examples include entire cardboard containers, such as shipping and moving boxes, computer packaging cartons, and sheets and pieces of boxes and cartons. This type does not include chipboard. Examples of Kraft paper include paper grocery bags, un-soiled fast food bags, department store bags, and heavyweight sheets of Kraft packing paper.
4. **Magazines/Catalogs** means items made of glossy coated paper. This paper is usually slick, smooth to the touch, and reflects light. Examples include glossy magazines, catalogs, brochures, and pamphlets.
5. **Mixed Recyclable Paper** means paper, other than the paper mentioned above, which can be recycled. Examples include manila folders, manila envelopes, index cards, white envelopes, white window envelopes, notebook paper, phone books carbonless forms, junk mail, groundwood paper, and deep-toned or fluorescent dyed paper.
6. **Boxboard** means chipboard and uncoated paperboard. Examples include cereal boxes and other dry food boxes.
7. **Books** means softcover and hardcover books.
8. **Polycoated/Aseptic Beverage Containers, New** means laminated high quality paper cartons used to store drinks without refrigeration. Only cartons that would be included in an expanded bottle bill (juice, teas) are included in this category. Excluded drink cartons contain rice milk, soy milk, milk and dairy products.
9. **Polycoated/Aseptic Containers, Dairy** means laminated high quality paper cartons used to store rice milk, soy milk, milk and dairy drinks or other food products without refrigeration.
10. **Compostable Paper** means low grade paper that is not capable of being recycled, as well as food contaminated paper. Examples include paper towels, paper plates, waxed papers and waxed cardboard, and tissues.

11. **Remainder/Composite Paper** means items made mostly of paper but combined with large amounts of other materials such as plastic, metal, glues, foil, and moisture. Examples include plastic coated corrugated cardboard, cellulose insulation, blueprints, sepia, onion skin, foiled lined fast food wrappers, frozen juice containers, carbon paper, self-adhesive notes, and photographs.

## Plastics

12. **PET Bottles** means clear or colored PET bottles, including “VT” deposit containers. When marked for identification, it bears the number “1” in the center of the triangular recycling symbol and may also bear the letters “PETE” or “PET”. The color is usually transparent green or clear. A PET container usually has a small dot left from the manufacturing process, not a seam. It does not turn white when bent. This category is to be set aside for sub-sorting by DSM.
13. **PET Food and Dairy Bottles and Jars (which originally contained non-hazardous material)** means food and rice milk, soy milk, milk and dairy bottles and jars (e.g., peanut butter, mayonnaise) but excluding PET tubs and lids – see below.
14. **HDPE Beverage Bottles** means natural and colored HDPE containers that contained beverages, excluding rice milk, soy milk, milk and dairy. When marked for identification, it bears the number “2” in the triangular recycling symbol and may also bear the letters “HDPE. This category is to be set aside for sub-sorting by DSM.
15. **HDPE Food, Dairy and Detergent Bottles**, means all HDPE bottles that would not be subject to either the current VT deposit or an expanded deposit, including food bottles, rice milk, soy milk, milk and dairy and laundry detergent bottles.
16. **Plastic Bottles #3-#7 (which originally contained non-hazardous material)** means plastic bottles made of types of plastic other than HDPE or PET. Items may be made of PVC, PP, or PS. When marked for identification, these items may bear the number 3, 4, 5, 6, or 7 in the triangular recycling symbol. This subtype also includes unmarked plastic bottles. This category is to be set aside for sub-sorting by DSM.
17. **Plastic Cups** means all plastic cups, no matter what resin used for drinking beverages including iced coffee, solo cups, etc. This category also includes Keurig cups used to brew cups of coffee. This category is to be set aside for sub-sorting by DSM.
18. **Tubs and Lids** means all plastic containers used for food items that are not a bottle or a jar. Examples include yogurt and butter containers, no matter what resin type. This category is to be set aside to be sub-sorted by DSM.
19. **Bulky Rigids (and containers greater than 1 gallon)** means plastic pails, large bottles holding kitty litter and bulk water, and plastic objects other than disposable package items. These items are usually made to last for a few months up to many years. These include 5 gallon pails, and the plastics used in children toys, furniture, plastic landscape ties; plastic railroad ties, mop buckets, sporting goods, etc. This category does not include agricultural pots which are to be separately sorted. These items are to be set aside for sub-sorting by DSM.

- 20. Thermoforms** means typically clear plastic packaging used for lettuce, berries, deli foods, which is sometimes called a “clamshell”, no matter which resin it is. Excludes extruded polystyrene foam (EPS). These items are to be set aside for sub-sorting by DSM.
- 21. Film, Retail Bags** means all plastic bags used to carry groceries and other items purchased at retail stores.
- 22. Film, Other Bags** means all plastic bags that are not retail bags or garbage bags, including bread bags, bags used in cereal boxes, non-metalized chip and snack bags, sandwich bags, dry cleaning bags, etc.
- 23. Film, Wrap** means film plastic used for large-scale packaging or transport packaging. Examples include shrink-wrap, mattress bags, furniture wrap, and film bubble wrap.
- 24. Film, Garbage Bags** means bags made specifically to store garbage. Note that bags containing garbage that were once retail bags should be classified as retail bags once the garbage has been emptied out of them.
- 25. Other Film** means plastic film that is contaminated or otherwise non-recyclable. Examples include painting tarps, food wrappers such as candy-bar wrappers, mailing pouches, bank bags, X-ray film, metalized film including metalized chip and snack bags, and plastic food wrap. This category is to be set aside for sub-sorting by DSM.
- 26. Agricultural Pots** means all pots no matter the resin type that are used for agricultural purposes including pots, flats and trays. This category is to be set aside for sub-sorting by DSM.
- 27. Pouches** means plastic and metalized plastic pouches used to store food and beverages. This category is to be set aside for sub-sorting by DSM.
- 28. Remainder/Other Plastic** means plastic that cannot be put in any other type or subtype. This type includes items made mostly of plastic but combined with other materials. Examples include auto parts made of plastic attached to metal, plastic drinking straws, produce trays, foam packing blocks, foamed polystyrene (including meat trays), plastic strapping, new plastic laminate (e.g., Formica), vinyl, linoleum, plastic lumber, imitation ceramics, handles and knobs, plastic lids, some kitchen ware, toys, plastic string (as used for hay bales), and CD's. This category is to be set aside for sub-sorting by DSM.

## Metals

- 29. Deposit Aluminum Cans** means all aluminum cans containing carbonated beverages and therefore subject to a \$0.05 VT deposit.
- 30. Non-Deposit Aluminum Cans** means beverage containers made from aluminum other than VT deposit containers as well as aluminum food cans, including some tuna fish and cat food cans. This category is to be set aside for sub-sorting by DSM.

31. **Aluminum Foil and Cooking Pans** means foil used to protect food made from 100 percent aluminum (not aluminum laminated plastics) and aluminum cooking pans.
32. **Ferrous Containers** means rigid containers made mainly of steel, such as food and beverage containers. These items will stick to a magnet and may be tin-coated.
33. **Other Ferrous** means any iron or steel that is magnetic. This subtype does not include "tin/steel containers". Examples include empty or dry paint cans, structural steel beams, boilers, metal clothes hangers, metal pipes, some cookware, security bars, appliances, and scrap ferrous items and galvanized items such as nails and flashing.
34. **Other Non-Ferrous** means any metal item that is not magnetic, as well as stainless steel. These items may be made of copper, brass, bronze, lead, zinc, or other metals. Examples include copper wire, shell casings, and brass pipe.

## Glass

35. **Glass Beverage Deposit Bottles** means all glass beverage containers currently subject to the Vermont deposit.
36. **Glass Beverage Bottles That May Become subject to Deposit** means all glass beverage bottles that do not contain carbonated drinks, such as juice, wine, and liquor, but excluding rice milk, soy milk, milk and dairy and food bottles.
37. **Food and Dairy Glass** means all other glass containers containing food, dairy products, or non-food.
38. **Other Glass** means all non-container glass, including, for example Pyrex, Corningware, crystal and other glass tableware, mirrors, non-fluorescent light bulbs, auto windshields, laminated glass, or any curved glass.

## Organic

39. **Food Waste** means food material resulting from the processing, storage, preparation, cooking, handling, or consumption of food. This type includes material from industrial, commercial, or residential sources. Examples include discarded meat scraps, dairy products, eggshells, fruit or vegetable peels, and other food items from homes, stores and restaurants. This type includes apple pumice and other processed residues or material from canneries, wineries or other industrial sources.
40. **Mixed Yard Waste, Leaves, Branches and Stumps** means trees, stumps, branches, or other wood generated from clearing land for commercial or residential development, road construction, agricultural land clearing, storms, or natural disaster; prunings and trimmings, and leaves and grass.
41. **Fines** means material passing through a 1/2 inch screen which is not otherwise categorized.

**42. Remainder/Composite Organic** means organic material that cannot be put in any other type or subtype. This type includes items made mostly of organic materials but combined with other materials. Examples include cork, hemp rope, hair, cigarette butts, full vacuum bags, sawdust, and animal feces.

### Electronics

**43. Electronics (Plug In)** means any electronic device other than an appliance or a rechargeable small electronic.

**44. Small Electronics (Rechargeable)** means a device like a cell phone or laptop computer which contains a battery

**45. Small Appliance** means items such as a microwave or coffee maker typically found in a kitchen or bathroom.

### HHW

**46. Mercury Containing Products** means any product containing mercury including compact fluorescent lamps (CFLs), fluorescent bulbs and ballasts, older light switches, automotive switches, and mercury containing thermometers.

**47. Household Hazardous Waste** means all materials typically accepted at a HHW collection day including vehicle automotive fluids, oil based paints, medicines, poisons, corrosives, flammables, and sharps.

### Construction and Demolition (in the MSW stream)

**48. C&D Materials** means all construction and demolition materials except for clean wood and carpet/backing, including asphalt, brick and concrete, treated wood, painted wood, gypsum drywall, carpet and padding, wiring, asphalt roofing, and bathroom and kitchen fixtures.

**49. Clean Wood** means wood that has not been painted, stained or treated for moisture resistance. This category excludes plywoods and fiberboard.

### Special Wastes

**50. Textiles and Leather (other than carpet)** includes clothing, fabrics, curtains, blankets, stuffed animals, and other cloth material.

**51. Diapers/Sanitary Products** means both baby diapers and adult diapers (cloth and paper/plastic) and women's sanitary pads and tampons.

**52. Carpet/Padding** means flooring applications consisting of various natural or synthetic fibers bonded to some type of backing material. Carpet Padding means plastic, foam, felt, or other material used under carpet to provide insulation and padding.

- 53. Batteries** means any type of battery including lead acid storage batteries most commonly used in vehicles such as cars, trucks, boats, etc.; household batteries such as AA, AAA, D, button cell, 9 volt; and rechargeable batteries used for flashlights, small appliances, tools, watches, and hearing aids.
- 54. Rubber** means any material made of rubber other than vehicle tires
- 55. Tires** means any vehicle tire
- 56. Furniture/Bulky Items** means large, hard to handle items that are not defined separately. Examples include all sizes and types of furniture, mattresses, box springs, and base components.
- 57. All Other Waste** means any other type of waste material not listed in any other sort category.