MSWCONSULTANTS

LARIMER COUNTY, COLORADO

TWO-SEASON WASTE COMPOSITION STUDY

Final Report

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MID ATLANTIC SOLID WASTE CONSULTANTS
625 Sawyer Road, New Market, MD 21774 301/607-6428
842 Spring Island Way, Orlando, FL 32828 407/380-8954
2291 Limehurst Drive, Atlanta, GA 30319 404/496-4872
www.mswconsultants.us

LARIMER COUNTY

TWO-SEASON WASTE COMPOSITION STUDY

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1. INTRODUCTION

BACKGROUND

The Larimer County Solid Waste Department operates the Larimer County Landfill, a 180-acre municipal solid waste disposal facility just south of Fort Collins. Situated on a 650-acre site, the landfill receives approximately 500 tons of solid waste per day. In addition to the County Landfill, the Solid Waste Department is responsible for an integrated waste management system that includes four transfer stations, five recycling drop-off sites, two permanent household hazardous waste (HHW) collection sites, and a Material Recovery Facility (MRF, a.k.a. Recycling Center). The MRF, which is owned by Larimer County and operated by Waste Management-Recycle America, recently converted to a "single stream" facility, and processes over 100 tons of recyclable containers and paper fiber materials each day.

In any integrated waste management system, it is critical to understand both waste generation and waste composition patterns of the local wasteshed. Regular monitoring of these data improve the Solid Waste Department's ability to operate and maintain current solid waste infrastructure, plan for future facility needs, and evaluate current and potential new source reduction and recycling programs. To this end, in 1998 Larimer County conducted a waste characterization study (1998 Study) to determine the composition of residential, commercial, and self-haul waste disposed at the Larimer County Landfill. The study results have been used to support planning efforts for the County's waste management services and to provide a baseline for monitoring changes in waste disposal.

In the ensuing years since the completion of the 1998 Study, a great deal has changed in Larimer County that has impacted the waste stream. County demographics have evolved significantly. Changes in the private collection and disposal market have caused a shift in waste flows. Further, over time, other more recent waste composition studies have consistently shown that the waste stream itself is changing. Such changes in disposed waste come about because of trends like light-weighting of products and packaging, the ongoing shift from glass and fiber-based packaging to plastic packaging, and fluctuations in residential and commercial construction, renovation, and demolition activities, to name but a few examples.

In 2006, Larimer County retained MSW Consultants, LLC, to perform an updated waste composition study (2006 Study). The 2006 Study seeks to achieve the following objectives:

- Develop statistically defensible estimates of the annual composition of wastes disposed at the Larimer County Landfill;
- Differentiate between the composition of Residential, Commercial, Construction and Demolition (C&D), and Self-haul Wastes to enable sector-specific recycling and diversion program evaluation;
- Estimate the quantity of Residential, Commercial, C&D, and Self-haul wastes currently delivered to the Landfill so that a Landfill-aggregate waste composition can be estimated

based on the weighted average contribution of wastes from each of these four generator sectors;

- Evaluate the efficacy of current recycling and diversion programs in place in Larimer County;
- Identify opportunities for incremental recycling and diversion programs that may target disposed materials that are still occurring in high volumes; and
- Enable a comparison of waste composition against the 1998 Study to detect trends in the composition of disposed waste.

REPORT ORGANIZATION

This report presents the background, methodology, and results of the two-season waste composition study that was conducted at the County Landfill. The report is divided into the remaining three sections:

- **Methodology:** This section summarizes the detailed sampling plan that was developed to assure that waste composition results would be statistically representative of the total disposed waste stream and also achieve a meaningful level of statistical validity. This section also summarizes elements of the field data collection methodology.
- **Gate Survey:** Because of limitations to the landfill accounting system, it is not currently possible to tabulate incoming material volumes by waste generator (especially residential and commercial wastes in compactor trucks; and C&D and commercial loose waste in roll-offs and other non-compactor commercial trucks). This section summarizes the methodology and results of a gate survey that was conducted to provide defensible estimates of the quantity of wastes delivered to the facility by the main waste generator classes.
- **Results:** Detailed composition results are presented for the aggregate of disposed waste at the Landfill, as well as for the Residential, Commercial, C&D and Self-Haul streams individually. This section also provides comparative data with the 1998 Study.

ACKNOWLEDGEMENTS

MSW Consultants would like to thank the following parties for their help in accomplishing the field data collection for this project:

- Steve Harem, Larimer County Environmental Specialist; and
- Robert "Dane" Nielsen, Landfill Manager.

The project would not have been successful without the ongoing help and cooperation from these individuals and their staff.

2. METHODOLOGY

SAMPLING PLAN SUMMARY

Prior to conducting any field data collection, a Sampling Plan was developed to assure that the incoming truckloads of waste that were ultimately sampled and sorted were representative of the entire incoming waste stream. This section summarizes the pertinent details of the Sampling Plan that governed field data collection.

SEASONALITY

There were two separate one-week field data collection events. The first field data event started on September 11, 2006 and was completed September 15, 2006; these dates were representative of the "summer" season. The second field data event started on December 4, 2006 and was completed December 8, 2006; these dates were representative of the "winter" season. Collectively, the data from these two seasonal sorts have been combined and analyzed to develop an annual aggregate estimate of the composition of wastes disposed in the County landfill.

WASTE GENERATION SECTORS

For the purposes of this study, a total of four generator sectors were defined:

- **Residential Waste:** Includes residentially generated garbage and trash that is collected by private or public haulers, primarily in compactor vehicles. Residential wastes encompass waste from single family households as well as multi-family apartments and condominiums.
- **Commercial Waste:** Includes municipal solid wastes generated in the commercial, institutional, agricultural, and industrial sectors, and delivered by private haulers primarily in compactor trucks or in compacting roll-off boxes. May include some non-compacted wastes delivered in open top roll-off boxes and in other vehicles. Note that commercial wastes exclude any "special" wastes that may be generated in these sectors.
- **Self-haul Waste:** Encompasses residentially generated wastes that are delivered to the landfill by the actual residential generator. Self-haul waste includes small to mid-size deliveries of waste in cars, pick-up trucks and vans, including those with trailers. Self-haul wastes are recorded separately by the gate house.
- **C&D Waste:** This includes all wastes that are generated as a result of construction, demolition and renovation activities, regardless of who is delivering the wastes. C&D wastes may be delivered by private (or public) haulers in roll-off boxes, and also may be delivered by self-haulers or contractors on construction/demolition/renovation projects (e.g., roofing contractor delivering shingles).

2. METHODOLOGY

SAMPLE SELECTION

MSW Consultants requested, and the County provided, a range of data about incoming material deliveries to the landfill. The following tables were assembled from the incoming material data and provided a basis for targeting a stratified random allocation of incoming loads that reflects the overall delivery patterns at the landfill.

RESIDENTIAL WASTE DELIVERIES AND SAMPLING TARGETS

Larimer County was able to provide summary information on the haulers that delivered virtually 100 percent of the COMPACTED WASTE, which includes all Residential Waste. Table 2-1 estimates the proportion of each hauler's deliveries that are believed to be Residential Waste, and shows the resultant seasonal sampling targets.[1] Further, Table 2-1 shows how close the actual samples were compared to the stratified targets.

Table 2-1 Residential Waste Deliveries (cubic yards, 2005) and Sampling Targets

Hauler	Total COMPACTED WASTE (CY) [1]	Residential Fraction	Residential Volume (CY)	Percentage of Total	Sample Targets	Actual Samples
Canyon Utilities	3,485	80%	2,788	1.7%	0	0
City of Loveland, Solid Waste	39,889	100%	39,889	23.9%	8	9
Dick's Trash Hauling Service	27,143	75%	20,357	12.2%	2	3
GSI (Gallegos Sanitation, Inc.)	91,058	60%	54,635	32.7%	10	11
Ram Waste Systems, Inc.	34,964	60%	20,978	12.6%	4	7
S & S Sanitation	12,464	80%	9,971	6.0%	2	0
Skyline	1,238	100%	1,238	0.7%	0	0
United Waste (new customer)	0	100%	unknown	0.0%	0	1
Waste Management	28,339	60%	17,003	10.2%	2	0
Total	**258,681 [2]**			**100.0%**	**30**	**31**

[1] Unadjusted for compaction.

[2] Column does not sum because several haulers with limited deliveries are not shown.

[1] At the time the sampling plan was developed, calendar year 2005 data was the most current. Interviews with County staff were used to supplement the 2005 data to assure its representativeness.

Note that Larimer County does not track whether incoming waste is residential or commercial waste, and at the time the sampling plan was developed the gate survey had not yet been performed (see Section 3). MSW Consultants interviewed County staff to obtain a "best estimate" of the proportion of each haulers' trucks that were each of the types above. Although this is an imperfect method, we believe the information gathered was suitable for the purposes of developing and implementing a reliable sampling plan. Further, with the completion of the gate survey, we can conclude that these sampling targets were reasonable and fairly reflected a distribution of samples that align with the universe of waste deliveries.

COMMERCIAL WASTE DELIVERIES AND SAMPLING TARGETS

Commercial waste is coded under both the COMPACTED WASTE and the COMMERCIAL LOOSE accounts in the County's accounting system.[2] The County provided a range of supplemental data to illustrate the sources of commercial waste. Table 2-2 summarizes these data, and also reflects a comparison of actual samples against the targeted sample distribution. As shown, the samples obtained in the study were reflective of the sampling targets.

Table 2-2 Commercial Waste Deliveries (cubic yards, 2005) and Sampling Targets

Hauler	COMPACTED WASTE (CY) [1]	COMMERCIAL LOOSE (CY)	Total Delivered (CY)	Percentage of Total	Sample Targets	Actual Samples
CSU (Colorado State University)	32,988	750	33,738	6.5%	2	2
Dick's Trash Hauling Service	27,143	1,429	28,572	5.5%	2	3
GSI (Gallegos Sanitation, Inc.)	145,693	31,569	177,262	34.0%	14	16
Ram Waste Systems, Inc.	55,942	7,979	63,921	12.3%	6	3
Waste Management	45,342	11,143	56,485	10.8%	4	8
All Other Haulers	0	141,324	141,324	27.1%	12	7
Total	**322,444 [2]**	**199,193 [2]**	**521,637 [2]**	**100.0%**	**40**	**39**

[1] Compacted Waste volumes have been adjusted to reflect an average compaction ratio of 4 to 1.

[2] Column does not sum because haulers with limited deliveries are not shown.

[2] A statistically insignificant portion of commercial waste is also delivered as Commercial Minimum Loads. This was excluded from the analysis.

2. METHODOLOGY

SELF HAUL DELIVERIES AND SAMPLING TARGETS

Self haul wastes are wastes delivered in cars, trucks, and other vehicles not specifically designed for waste hauling. Larimer County maintains close track of self-haul wastes in the landfill accounting system. Table 2-3 summarizes the quantities and coding of self-haul wastes. Table 2-3 also shows the actual samples that were obtained in comparison to the targeted number of samples. Note that MSW Consultants was able to obtain significantly more samples than originally expected; this additional data will further increase the statistical validity of the findings.

Table 2-3 Self Haul Waste Deliveries (cubic yards, 2005) and Sampling Targets

Landfill Account	Volume (CY)	Percent of Total	Sample Targets	Actual Sampled
Minimum Load in Car	1,687	1.1%	0	0
Minimum Load in Truck	3,188	2.1%	2	2
Loose Waste in Car	8,970	5.9%	4	4
Loose Waste in Truck	136,930	90.8%	54	70
Total	**150,775**	**100.0%**	**60**	**76**

C&D DELIVERIES AND SAMPLING TARGETS

C&D Waste is coded as such at the County Landfill. Table 2-4 summarizes the estimated C&D waste deliveries, sampling targets, and actual samples obtained. MSW Consultants was again able to obtain significantly more samples for this generator sector.

Table 2-4 C&D Waste Deliveries (cubic yards, 2005) and Sampling Targets

Landfill Account	Volume (CY)	Percent of Total	Sampling Targets	Actual Sample
C&D Waste coded as COMMERCIAL LOOSE [1]	49,798	23.6%	14	0
Compacted C&D [2]	7,833	3.7%	2	2
C&D Debris in Car	194	0.1%	0	0
Commercial C&D Waste	148,356	70.2%	42	72
C&D Debris in Truck	5,150	2.4%	2	2
Total	**211,331**	**100.0%**	**60**	**76**

[1] Estimated at 25 percent of total COMMERCIAL LOOSE for purposes of sampling plan development.

[2] No adjustment has been made for compaction based on limited ability to compact C&D debris.

We note that the fraction of C&D waste in COMMERCIAL LOOSE was unknown during development of the sampling plan. Although the gate survey (see the following section) validated the sampling plan, it was determined during the field data collection that is was not possible to screen incoming COMMERCIAL LOOSE vehicles to determine that they in fact contained C&D. For this reason, the targeted COMMERCIAL LOOSE samples were shifted to loads that were definitively recorded in the landfill accounting system as being C&D waste.

SAMPLING TARGET SUMMARY

Table 2-5 summarizes the targeted and the actual number of physical and visual samples obtained each season for each of the four waste generator classes targeted in the study.

Table 2-5 Proposed Sampling Targets vs Actual Sampled Targets by Generator Class

Generator Class	Targeted Samples	Actual Samples	Difference
Residential – Physical Sorts	30	31	+1
Commercial – Physical Sorts	40	39	-1
C&D Debris – Visual Estimates	60	76	+16
Self Haul – Visual Estimates	60	76	+16
Total	190	222	+32

As shown, MSW Consultants achieved or exceeded sampling targets for three of the four waste generator classes. Commercial waste generator sampling fell one sample shy of the target. This shortfall was due to the practical challenges associated with waste sampling. Specifically, on days the sorting team is in the field, it cannot be predicted the order and timing of the targeted incoming loads of waste. MSW Consultants made every effort to meet the detailed, stratified sampling targets as shown in Table 2-1 through 2-4, and in general succeeded in this effort. We do not believe the one sample shortfall in the commercial waste stream will significantly degrade the results of the analysis. Further, given the much higher inherent variation in the composition of C&D and self-haul wastes, we believe the extra samples obtained for these generator classes will improve the statistical validity of results for these sectors.

FIELD SAMPLING AND SORTING METHODS

Field sampling and sorting methods generally conformed with ASTM standards, refined based on the extensive experience of MSW Consultants in performing numerous similar studies. The following sections summarize field sampling and sorting procedures.

2. METHODOLOGY

LOAD SELECTION

For all four waste generator sectors, the MSW Consultants Field Supervisor remained in communication with the gate attendant(s) to obtain assistance in identifying the loads to be sampled. Each day, the Field Supervisor had a list of targeted deliveries. (For example, on Monday there may have been one Loveland truck, three GSI trucks, one Waste Management truck, etc.). Gate attendants were asked to notify the Field Supervisor when any of these deliveries arrived. The Field Supervisor attempted to take a sample from the targeted incoming loads, although retained freedom to exercise professional judgment in taking alternate loads based on timing and availability of the sort crew and landfill support personnel.

The Field Supervisor further interviewed the drivers of selected loads to obtain information such as origin of the load, waste generating sector, hauler, vehicle type and number, and other data. This information was noted on the vehicle selection form, along with a unique identifying number associated with that vehicle on that day. A summary of the physically sampled loads is shown as Exhibit 1.

We note that even though the County alerted its primary haulers that this study was taking place so that drivers were not caught by surprise, some of the drivers said they lost the Gate Ticket or did not want to divulge any information about the incoming load. In these instances, the sampling selection data was completed to the greatest extent possible.

SIZE OF PHYSICALLY SORTED AND VISUALLY SURVEYED SAMPLES

Consistent with industry literature, we attempted to take samples that weighed between 200 and 250 pounds for all manually-sorted samples. Table 2-6 below summarizes the average, maximum and minimum sample weights from the summer and winter seasons

Table 2-6 Sample Weight Summary

Generating Sector	Number of Samples	Number of Samples <200 Lbs	Minimum Sample Lbs	Maximum Sample Lbs	Average Sample Lbs
Residential	31	2	155	265	219
Commercial	39	2	170	558	253

As shown in Table 2-6, the average weights of the two seasonal sorts were 219 pounds for the residential and 253 pounds for the commercial sectors, both within or even slightly above the target sample sizes. We note that a total of four samples out of the 70 taken fell below the target sample weight. This reflects the inherent differences in density of tipped wastes. As described further below, samples were taken with the help of a loader taking a scoop from the tipped load. In instances where the wastes in a grab sample were especially "fluffy" (i.e., less dense), even a full bucket of waste may not have achieved the 200 pound target. MSW Consultants does not believe the small number of light samples will bias the results, and upon further analysis of these individual samples to confirm that none were clear outliers, we have opted to include them in the statistical analysis.

Visually surveyed samples consisted of the entire load. Load weights for self-haul and C&D waste may range from less than 100 pounds (for car and small truck loads) up to 10+ tons (for C&D loads containing a large fraction of cement block and other dense materials). Table 2-7 below summarizes the cubic yards (CY) and estimated weights for the self-haul and C&D generating sectors.

Table 2-7 Self-Haul and C&D Cubic Yardage and Weight Summary

Generating Sector	Number of Samples	Cubic Yardage			Tons		
		Min	Max	Avg	Min	Max	Avg
Self-Haul	76	0.3	30	6.6	0.1	11.5	1.3
C&D	76	1	40	10.8	0.06	12.9	3.4

As expected, C&D loads were larger on average than self-haul loads.

MATERIAL CATEGORIES

Material categories were selected to meet two main objectives. First, the categories were intended to provide meaningful breakdowns of the waste stream from the perspective of evaluating current and potential future source reduction, diversion and recycling programs. Second, the categories were established such that they could be aligned with the results of the 1998 Study for the purpose of evaluating changes in the waste stream.

A total of 45 material categories were ultimately defined for this study. The material categories, detailed definitions, and a mapping of 2006 Study to 1998 Study material categories is included as Appendix A.

TAKING SAMPLES FOR PHYSICAL SORTING

Selected loads of residential and commercial wastes were tipped in a designated area on the landfill face near the sorting area. From each selected load, a sample of waste was selected based on systematic "grabs" originating from the perimeter of the load. MSW Consultants uses a systematic grabbing methodology that pre-selects the location of the grab prior to tipping of the load. For example, if the tipped pile 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 samples will be taken from 3 o'clock, 6 o'clock, 9 o'clock, 12 o'clock, and then from 1, 4, 7, and 10 o'clock, and so-on.

Once the area of the tipped load to be grabbed was selected, the Field Supervisor coordinated with a loader operator to take a grab sample of wastes from that point in the tipped load. The loader operator used the loader (both provided by Larimer County) to remove a sample of waste weighing at least 250 pounds. This sample was deposited on a tarp designated to receive samples. Each sample was labeled by its identifying number using brightly colored spray paint, and digitally photographed.

2. METHODOLOGY

PHYSICAL SORTING

Once the sample had been acquired and placed on a tarp, the material was manually sorted into the prescribed component categories. Plastic 18-gallon bins with sealed bottoms were used to contain the separated components.

Sorters were trained to specialize in certain material groups, with someone handling the paper categories, another the plastics, another the glass and metals, and so on. In this way, sorters became highly knowledgeable in a short period of time as to the definitions of individual material categories.

The Crew Chief monitored the bins as each sample was being sorted, requiring a re-sort of materials that were improperly classified. Open bins allowed the Crew Chief to see the material at all times. The Crew Chief also verified the sorting accuracy of each component during the weigh-out. The materials were sorted to particle size of 2-inches or less by hand, until no more than a small amount of homogeneous material remained. This layer of mixed 2-inch-minus material 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 overall goal was to sort each sample directly into component categories in order to reduce the amount of indistinguishable fines or miscellaneous categories. Note that the sorting methodology included the use of a customized, sturdy framed sort table that has a removable screen sized at ½ inch. Small particles passing through the screen were swept into a separate container and recorded in their own material category called "Fines" (categorized under the Organics material group).

VISUAL SURVEYING

Visual surveying of a load of self-haul or C&D waste involved detailed volumetric measurements of the truck and load dimensions, followed by the systematic observation of the major material components in the tipped load. The basic steps to visual surveying are:

1. Measure the dimensions of the incoming load prior to tipping and (if possible) estimate the percent full of the vehicle.
2. Tip the load. If it is a large load, and if conditions permit, have a loader spread out the material so that it is possible to discern dense materials such as block, brick, and dirt that tend to sink to the bottom of the pile.
3. Make a first pass around the load marking the major material categories that are present in the load—cardboard, drywall, dimensional lumber, etc. Estimate the percentage of the load made up of these major materials. If possible, estimate of the yardage associated with this material.
4. Make a second pass around the load, noting the secondary material categories contained in the load. Estimate the percentage of the load made up of these materials. Because the MSW Consultants Field Supervisor conducting this study is highly experienced in visual surveying of C&D and Self Haul loads, this step also included estimating the actual weight, in pounds, of each of the material identified in the load. Volume and weight estimates will be reconciled in the QC process.

5. Validate that the estimated percentages sum to 100 percent, and that the estimated weight and volume of major material categories is realistic given the overall truck dimensions and volume.

Because some residential and commercial waste was included in self-haul and C&D waste, the field data form included a category for "Mixed MSW." Mixed MSW has been apportioned back into the self-haul and C&D composition estimates based on the composition of residential and commercial waste observed in the physical sorting.

DATA RECORDING

The weigh-out and data recording process is arguably the most critical process of the sort. The Crew Chief was singularly 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 samples were carried over to a digital scale provided by MSW Consultants. Sorting laborers assisted with carrying and weighing the bins of sorted material, the Crew Chief recorded all data.

The Crew Chief used a waste composition data sheet to record the composition weights. Each data sheet containing the sorted weights of each sample was matched up against the Field Supervisor's sample sheet to assure accurate tracking of the samples each day.

Visual survey sheets were filled out by the Field Supervisor, who could easily match them up against the master sample sheet.

Data sheets were entered into a spreadsheet each evening to assure that sample weights were meeting targeted minimum levels, and that sample data appears to be reasonable.

CONCLUSION

Field data collection methods closely followed industry-standard procedures. With almost no precipitation during the field data collection events, MSW Consultants believes that external contamination from moisture was minimal to nil. Given the careful logistical management of the sample collection process, the field data collection was performed with no known problems. The resulting data meet the objective of being representative of disposed wastes within each of the four generator classes targeted in the study.

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3. GATE SURVEY

INTRODUCTION

The Larimer County Landfill tracks incoming waste quantities based on several categories, including Loose Waste, Compacted Waste, C&D Debris, and a range of special wastes such as tires, rip-rap, and tree limbs. The landfill further tracks whether deliveries are in a car, a truck, or a commercial vehicle, as there are different state-imposed surcharges on each type of delivery vehicle. Table 3-1 summarizes the quantities of wastes received for calendar year 2006 based on the landfill's gatehouse coding system.

Table 3-1 2006 Incoming Waste Quantities [1]

Transaction Type	Material Description	Cubic Yards
MIN CAR	Loads delivered in a car that are less than ½ CY	2,481
MIN COMM	Loads delivered in a commercial non-compacting vehicle that are less than ½ CY	261
MIN TRK	Loads delivered in a pick-up truck that are less than ½ CY	2,427
LOOSE CAR	Loose waste delivered in a car	15,012
LOOSE COMM	Loose waste delivered in a commercial vehicle	129,047
XFERSTATION	Transfer trailers from Estes Park, Berthoud, or Wellington	56,425
LOOSE NO X	Commercial wastes with no disposal charge	1,418
LOOSE TRK	Loose waste delivered in a pick-up truck	120,641
ROADSIDE	Commercial waste from roadside cleaning	86
COMPACTED	Waste delivered in commercial compacting vehicles	263,781
COMPCT C&D	C&D Debris delivered in commercial compacting vehicles	592
C&D CAR	C&D delivered in a car	223
C&D COMM	C&D delivered in a commercial non-compacting vehicle	117,383
C&D TRK	C&D delivered in a pick-up truck	4,290
Totals [2]		**714,067**

[1] Source: Larimer County

[2] This table excludes Rip/Fill, Tree limbs, Animal carcasses, Non-friable asbestos, Tires, Appliances, and Auto bodies.

Given the transaction codes shown above, Larimer County landfill gate records are limited for two reasons. First, it is not possible to query the database in such a way as to subdivide deliveries by generator sector. Second, the landfill does not have scales and consequently all deliveries, whether loose or compacted, are recorded in cubic yards. Although the Landfill

accounting software stores material densities and the corresponding weight estimate, the County reports waste deliveries based on volume.

Because of these limitations, a comprehensive survey of incoming vehicles was performed to better estimate the true proportion of material from the following four main generator classes:

- Residential (compactor trucks),
- Commercial,
- Construction and Demolition (C&D), and
- Self haul (personal cars and pick-up trucks).

METHODOLOGY

MSW Consultants conducted a gate survey of incoming vehicles over a one-week period from September 14 through September 20, 2006. The survey was performed from the time the facility opened until close (i.e., 7:00 am to 4:00 pm) each day during this period, except Sunday. Sunday deliveries were found to be predominantly self-haul and therefore did not need to be surveyed.

Based on a review of detailed gatehouse records, two delivery codes were targeted in the survey: COMPACTED WASTE and COMMERCIAL LOOSE waste. The MSW Consultants Surveyor remained in or outside the gate houses and interviewed drivers of incoming truckloads that were recorded as COMMERCIAL LOOSE or COMPACTED WASTE definitions (either by gate attendants or by the automated attendant). (Although out of scope, vehicles that were recorded as C&D COMM [Commercial C&D Waste] were also surveyed, primarily because the roll-off, dump, and other non-compacting vehicles that deliver C&D COMM are also the type of vehicle that typically deliver COMMERCIAL LOOSE.) Upon confirming that an incoming vehicle was among the two targeted classifications (primarily the compactor trucks and roll-offs), MSW Consultants staff interviewed the driver to determine the origin of the waste and the generator type. The data was recorded on a customized field data form that recorded the proportion, by volume, of the waste contained in that load that was (i) residential, (ii) commercial, (iii) C&D, or (iv) Other. The survey form also recorded the transaction/ticket number for each surveyed vehicle.

The Surveyor moved between the automated entry way and the two staffed entries to capture the majority of incoming COMPACTED and COMMERCIAL LOOSE loads. To overcome the potential for missing any incoming loads, MSW Consultants provided a survey form to the gate attendants in each gate house to supplement data collected by MSW Consultants during especially busy times. Table 3-2 summarizes the vehicles surveyed.

Table 3-2 Summary of Vehicles Surveyed

WASTE TYPE	Number of Vehicles	Number of Vehicles Surveyed	Percentage Surveyed
C&D COMM	243	184	75.7%
COMPACTED	265	252	95.1%
LOOSE COMM[1]	266	208	78.2%
Total	**774**	**644**	**83.2%**

[1] Excludes Transfer Trailers, which are also recorded as LOOSE COMM

A total of 664 incoming vehicles were surveyed during the 5 day period, or about 111 vehicles per day. Of the targeted loads, 75.7 percent of the C&D COMM, 95.1 percent of the COMPACTED and 78.2 percent of the LOOSE COMM were surveyed. The LOOSE COMM waste delivered in transfer trailers from a known origin were excluded from the survey.

Table 3-3 provides a parallel summary of the proportion of all incoming cubic yards that were surveyed. As shown, just shy of 90 percent of all incoming cubic yards were captured in the survey for all waste types. Although this is not perfect coverage, we believe it is sufficient to derive the estimated breakdown of incoming wastes by generator sector.

Table 3-3 Summary of Cubic Yards Surveyed

WASTE TYPE	Incoming Yardage	Yards Surveyed	Percentage Surveyed
C&D COMM	2,008	1,652	82.3%
COMPACTED	5,304	4,765	89.8%
LOOSE COMM[1]	2,497	2,183	87.4%
Total	**9,809**	**8,600**	**87.7%**

[1] Excludes Transfer Trailers, which are also recorded as LOOSE COMM

At the conclusion of the gate survey, Larimer County provided MSW Consultants with a complete data dump of all landfill gate transactions from that week, including ticket number, material volume, type of waste, gate attendant on duty, etc. MSW Consultants entered all data obtained in the gate survey and mapped the survey data to the facility transaction data. Once mapped, the two data sets provide a very detailed breakdown of the proportion of each incoming material type for the targeted week. Results of this process are contained in the following section.

3. GATE SURVEY

RESULTS

The surveyed field data was mapped to the ticket number of the accounting file submitted to MSW Consultants. Table 3-4 shows the total cubic yards in the various material categories delivered during the week of the survey.

Table 3-4 Gate Survey Results (Cubic Yards)

MATERIAL	Residential	Commercial	C&D	Other	Total
C&D COMM	75	108	1,458	11	1,652
COMPACTED	2,769	2,182	81	209	5,071
LOOSE COMM	368	1,145	462	209	2,183
Total	**3,212**	**3,434**	**2,001**	**260**	**8,906**

Table 3-5 reflects the percentage breakdown observed in the gate survey.

Table 3-5 Gate Survey Results (Percent by Volume)

MATERIAL	Residential	Commercial	C&D	Other	Total
C&D COMM	4.6%	6.5%	88.3%	0.7%	100.0%
COMPACTED	54.2%	44.1%	1.7%	0.8%	100.0%
LOOSE COMM	16.8%	52.4%	21.2%	9.6%	100.0%

As shown, COMPACTED waste was found during the week-long survey to be slightly more residential than commercial. LOOSE COMM was found to be predominantly waste from commercial generators, although a significant amount was found in the survey to be C&D waste. Although some of this may be the result of mis-classification of the load at the gate, the gate survey found that C&D is often mixed with commercial waste and therefore the entire load rightfully is classified as LOOSE COMM. Not surprisingly, C&D COMM waste was confirmed to be primarily C&D. "Other Waste" identified in the survey included limbs/land clearing, rip-rap, and the other categories of wastes tracked in the County's landfill accounting system.

ANNUAL PROJECTIONS

Table 3-6 below summarizes calendar year 2006 material volumes received at the landfill. This table shows the allocation of the various material categories tracked by the current accounting system.

Table 3-6 2006 Annual Waste Quantities (cubic yards) by Generating Sector, Raw Data [1]

Material	Residential	Commercial	Self Haul	C&D	Other	Annual Cubic Yards
MIN CAR	0	0	2,481	0	0	2,481
MIN COMM	0	261	0	0	0	261
MIN TRK	0	0	2,427	0	0	2,427
LOOSE CAR	0	0	15,012	0	0	15,012
LOOSE COMM	Unknown					129,047
XFERSTATION	Unknown					56,425
LOOSE NO X	0	1,418	0	0	0	1,418
LOOSE TRK	0	0	120,641	0	0	120,641
ROADSIDE	0	86	0	0	0	86
COMPACTED	Unknown					263,781
COMPCT C&D	0	0	0	592	0	592
C&D CAR	0	0	0	223	0	223
C&D COMM	0	0	0	117,383	0	117,383
C&D TRK	0	0	0	4,290	0	4,290
Totals [2]	**0**	**1,765**	**140,561**	**122,488**	**0**	**714,067**

[1] Source: Larimer County Landfill

[2] Excludes Rip/Fill, Rip/Fill F, Tree Car, Tree Comm, Tree Trk, Tree Disc, Tree Trunk, Tree Xmas, Animal carcasses, Non-friable asbestos, Tires, Appliances, and Auto bodies.

As shown in the table, the LOOSE COMM, XFERSTATION, and COMPACTED categories cannot be allocated to a generator type. MSW Consultants applied the results of the gate survey to allocate the LOOSE COMM and COMPACTED wastes to the appropriate generator class. Further, we assume that XFERSTATION loads contain a mix of residential, commercial, self haul and C&D waste roughly in proportion to the direct-haul quantities received at the Larimer County landfill. Based on these assumptions, Table 3-7 applies the results of the gate survey to allocate all wastes to the appropriate generator sector.

Table 3-7 2006 Annual Waste Volume (cubic yards) by Generator, Allocated [1]

Material	Residential	Commercial	Self Haul	C&D	Other	Annual Cubic Yards
MIN CAR	0	0	2,481	0	0	2,481
MIN COMM	0	261	0	0	0	261
MIN TRK	0	0	2,427	0	0	2,427
LOOSE CAR	0	0	15,012	0	0	15,012
LOOSE COMM	21,739	67,669	0	27,302	12,337	129,047
LOOSE NO X	0	1,418	0	0	0	1,418
LOOSE TRK	0	0	120,641	0	0	120,641
ROADSIDE	0	86	0	0	0	86
COMPACTED	144,021	113,479	0	4,200	2,081	263,781
COMPCT C&D	0	0	0	592	0	592
C&D CAR	0	0		223	0	223
C&D COMM	5,358	7,646	0	103,598	782	117,384
C&D TRK	0	0		4,290	0	4,290
Subtotal [2]	*117,118*	*190,559*	*140,561*	*140,205*	*15,200*	*657,643*
Percent of Total	*28.3%*	*30.1%*	*19.7%*	*19.8%*	*2.2%*	*100.0%*
XFERSTATION	15,968	16,984	11,116	11,172	1,241	56,425
GRAND TOTAL	133,086	207,543	151,677	151,377	16,441	714,068

[1] Larimer County data allocated based on the results of the gate survey

[2] Excludes Rip/Fill, Rip/Fill F, Tree Car, Tree Comm, Tree Trk, Tree Disc, Tree Trunk, Tree Xmas, Animal carcasses, Non-friable asbestos, Tires, Appliances, and Auto bodies.

As shown, the Larimer County landfill received 714 thousand yards of waste in 2006. Of this amount 28.3 percent was residential waste delivered by commercial haulers, 30.1 percent was commercial waste delivered by commercial haulers, and 19.7 percent was delivered by self-haulers. C&D wastes made up 19.8 percent, and other wastes were 2.2 percent.

The composition of wastes from each of these generator sectors will be addressed in Section 4 of this report. The weighted average aggregate waste composition will be based on the weighting factors derived in this gate survey.

As a final step, MSW Consultants applied density estimates for the different waste types to convert Table 3-7 from volume to weight. These density estimates are based on other density data points available to MSW Consultants, Larimer County, the U.S. Environmental Protection Agency (EPA), as well as on truck body manufacturer specifications. The following densities were used to convert volume to weight:

- COMPACTED – 750 Lbs/CY

- COMPACTED C&D – 625 Lbs/CY
- XFERSTATION – 600 Lbs/CY
- C&D COM , C&D TRUCK, and C&D CAR – 325 Lbs/CY
- LOOSE COM and MIN COMM – 200 Lbs/CY
- MIN TRUCK, LOOSE NOX, LOOSE TRUCK, and ROADSIDE – 150 Lbs/CY
- MIN CAR and LOOSE CAR – 100 Lbs/CY

Table 3-8 applies these density factors to each type of waste to calculate the total weight of the incoming material categories.

Table 3-8 2006 Annual Waste Quantities (Tons) by Generator, Allocated [1]

Material	Residential	Commercial	Self Haul	C&D	Other	Annual Tons
MIN CAR	0	0	124	0	0	124
MIN COMM	0	26	0	0	0	26
MIN TRK	0	0	182	0	0	182
LOOSE CAR	0	0	751	0	0	751
LOOSE COMM	2,174	6,767	0	2,730	1,234	12,905
XFERSTATION	9,242	7,282	0	270	134	16,927
LOOSE NO X	0	0	106	0	0	106
LOOSE TRK	0	0	9,048	0	0	9,048
ROADSIDE	0	0	0	0	6	6
COMPACTED	52,208	41,136	0	1,523	754	95,621
COMPCT C&D	0	0	0	185	0	185
C&D CAR	0	0	0	36	0	36
C&D COMM	0	0	0	19,075	0	19,075
C&D TRK	0	0	0	697	0	697
Total	**63,624**	**55,211**	**10,211**	**24,516**	**2,128**	**155,689**
Percentage	***41%***	***35%***	***7%***	***16%***	***1%***	***100%***

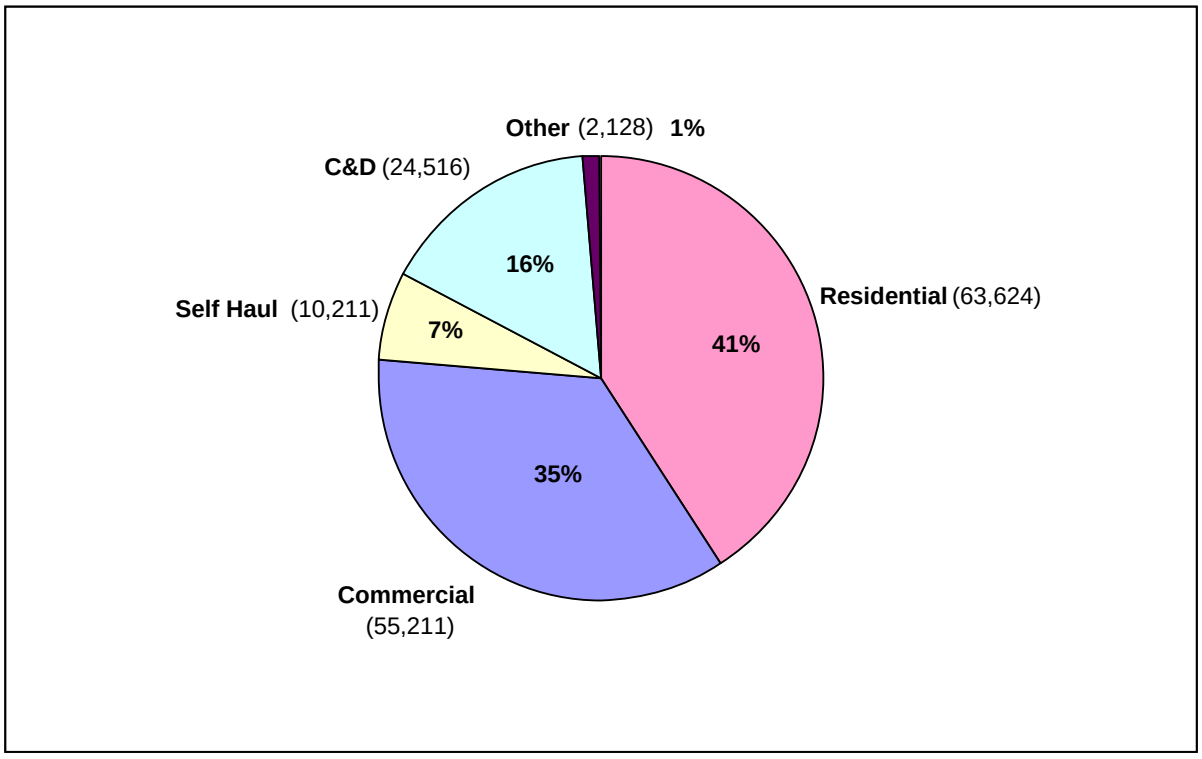
[1] Larimer County data allocated based on the results of the gate survey

[2] Excludes Rip/Fill, Rip/Fill F, Tree Car, Tree Comm, Tree Trk, Tree Disc, Tree Trunk, Tree Xmas, Animal carcasses, Non-friable asbestos, Tires, Appliances, and Auto bodies.

As shown, the Larimer County landfill was estimated to receive 155,689 tons of waste in 2006. Of this amount 41 percent by weight was Residential waste, 35 percent was Commercial waste, and 7 percent was delivered by Self-haulers. C&D wastes made up 16 percent, and Other Wastes were one percent. Figure 3-1 summarizes the relative

contribution of disposed wastes (by weight) of each of the generator classes in Table 3-8. These percentages are used in Section 4 to aggregate the composition data by generator class.

Figure 3-1 2006 Annual Waste Quantities (Tons) by Generator



4. RESULTS

STATISTICAL MEASURES

This section presents the results of the study. The following statistical measures are used uniformly throughout the section:

- **Sample Mean:** For each generator class, the sample mean composition is the average of the weight-based percentage composition of the individual samples from that generator class. This value, while a good estimate, is unlikely to be identical to the population mean value. To better understand the meaningfulness of the sample mean, other statistical measures are needed.
- **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.
- **Confidence Intervals**: The confidence intervals reflect the upper and lower range within which the population mean can be expected to fall. 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 (aka sample size).
- **Coefficient of Variance**: This measure was used in the 1998 Study, although has not been duplicated for the 2006 Study. Also called the *relative standard deviation*, this measure divides the standard deviation by the mean. In so doing, it enables a normalized comparison of variance among material categories that may appear in the waste stream in significantly different absolute terms. For example, comparing the standard deviations of Food Waste and Rubber/Leather is not meaningful, because there is a significant amount of Food Waste disposed and only trace amounts of Rubber/Leather. However, the coefficient of variance can be compared directly—the category with the larger coefficient has a more variable composition.

Throughout this section, confidence intervals have been calculated at a 90 percent level of confidence, meaning that we can be 90 percent sure that the population mean falls within the upper and lower confidence intervals shown. In general, as the number of samples increases, the width of the confidence intervals decreases, although the more variable the underlying waste stream composition, the less noticeable the improvement for adding incremental samples.

4. RESULTS

ADJUSTING FOR CONTAMINATION

Note that the results shown in this report have not been adjusted for contamination.

During the collection, tipping, and sorting of samples of residential and commercial wastes, moisture and particulate matter of some material categories cross-contaminate other material categories. For example, liquids in food waste may be absorbed by the various paper categories; broken glass particles may embed or adhere to foam plastics or textiles. Based on testing performed in other studies, the impact of contamination is minimal for many categories, but can be significant for some. The following categories from the 2006 Study are most likely to be impacted by moisture and particulate contamination:

- All of the grades of paper:
- Expanded Polystyrene;
- Plastic Film Bags;
- Other Rigid Plastic, which encompasses food and deli trays that may be heavily contaminated; and
- Other Aluminum, which often includes foil and tins that are heavily food-encrusted.

It was beyond the scope of this project to develop contamination correction factors for these material categories. However, readers should recognize that the annual quantities that are calculated in this section of the report overstate the actual quantity of these materials that are being disposed. Further, the annual quantities of food wastes and possibly certain other organic wastes (e.g., Yard Waste) would likely be greater than that shown, as much of the moisture that contaminates the paper likely originated from these organics. Had there been no cross-contamination of moisture and particulates, the disposed quantity of the more absorbent material categories would be at least marginally lower, and the disposed content of moisture-containing categories would have been marginally higher, than what is shown in this section.

AGGREGATION OF DATA BY GENERATOR SECTOR

As discussed in the previous section, a week-long gate survey was performed to develop a defensible breakdown of the incoming quantity of wastes from each of the four main generator sectors targeted in the study. Table 4-1 summarizes the annual wastes disposed by generator sector based on the results of the gate survey.

Table 4-1 Waste Disposal by Generator Sector

Sector	2006 Tons Disposed	Percent of Total
Residential	63,624	41.4%
Commercial	55,211	36.0%
Self-Haul	10,211	6.6%
C&D Debris	24,516	16.0%
Total	**153,562**	**100.0%**

Note: The gate survey also identified "Other" waste categories such as rip/fill, tree limbs, etc. For the purpose of developing weighting factors for the Residential, Commercial, Self-haul and C&D generator sectors, the Other category has been excluded and the remaining percentages re-calculated based on the sum of these four generator sectors. See Table 3-8 for details.

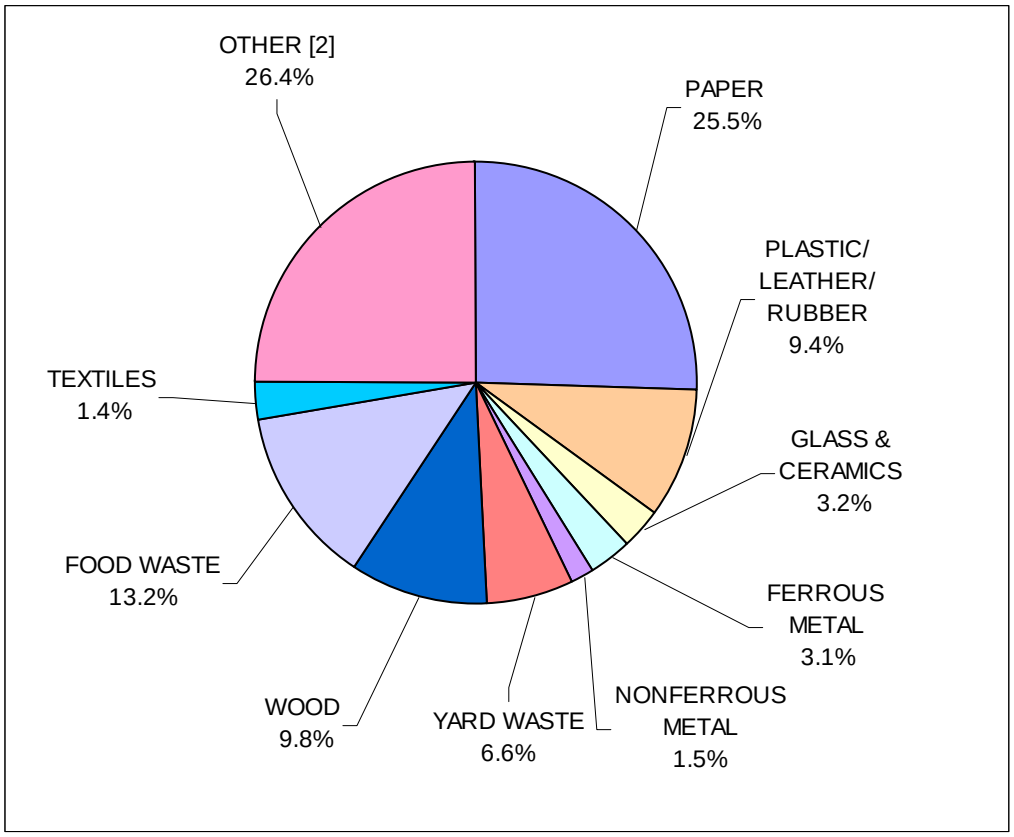
The percentages in the far right column of Table 4-1 are used as weighting factors to develop an aggregate composition of all waste delivered to the Larimer County Landfill.

RESULTS

AGGREGATE COMPOSITION, ALL WASTE DELIVERIES

Figure 4-1 presents a graphical breakdown of the major material categories entering the Larimer County Landfill from the Residential, Commercial, Self-Haul, and C&D sectors. Note that these material groups have been defined to be directly comparable to the 1998 Study (discussed later in this section). As shown in the Figure, the Paper material group makes up over one quarter of the aggregate waste stream, while Food Waste is the single most prevalent material category. Although the "Other Waste" category is actually the largest material group shown in the Figure, this category comprises 14 different material categories and includes primarily materials generated from C&D activities, which accounts for the size of the group as a whole.

Figure 4-1 Aggregate Composition (Percent by Weight), All Wastes Delivered to Landfill [1]

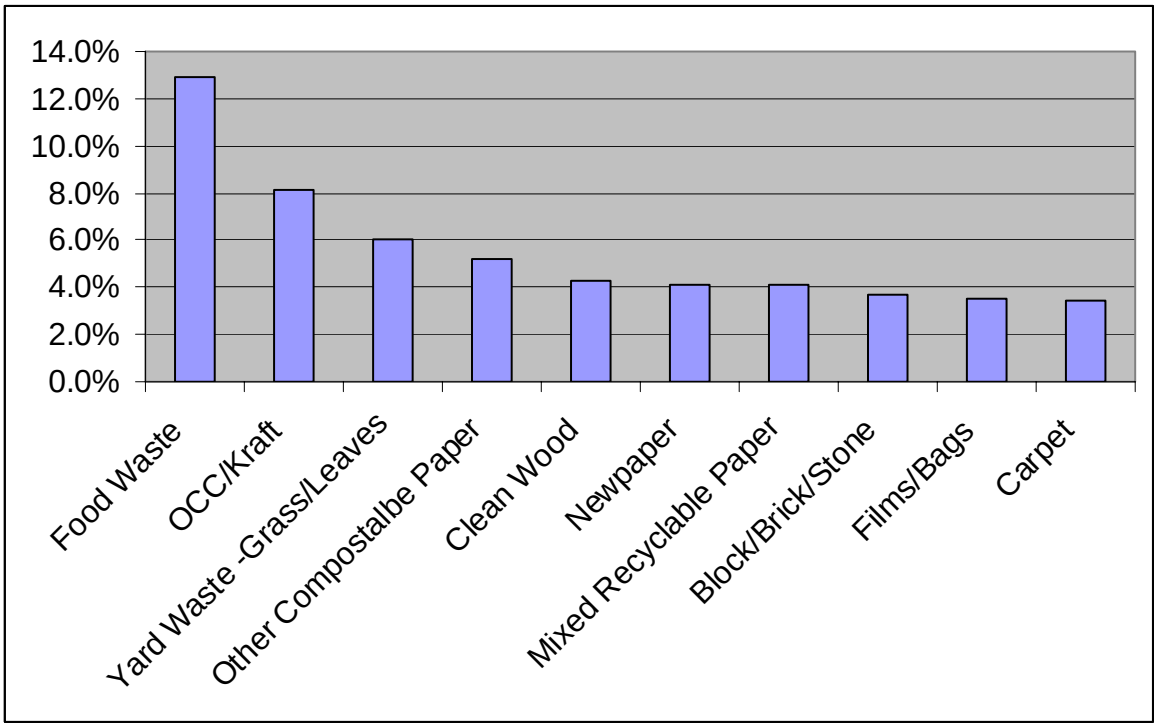


[1] Excludes rip-rap, tree limbs, and other homogeneous categories that are tracked separately in the landfill accounting system.

[2] OTHER waste includes C&D materials such as drywall, block/brick/stone, insulation, and asphalt roofing, and miscellaneous organics and inorganics not elsewhere classified including diapers/sanitary products, electronics, bulky items, carpet, tires, fines, and household hazardous waste (HHW).

Figure 4-2 shows the ten most prevalent individual material categories being disposed at the Larimer County Landfill. It is of definite interest that Corrugated Cardboard, Newspaper, Yard Waste, and even Mixed Paper are on the top ten list. These materials are generally easy to separate, and many municipalities offer separate collections for these materials. The appearance of these materials in the top ten may suggest opportunities for Larimer County to increase recycling and diversion somewhat significantly. Interestingly, all of the most prevalent disposed wastes are either compostable (Food Waste, Other Compostable Paper, Yard Waste) or recyclable (Carpet, Film Bags, Clean Wood). However, these wastes are at a minimum difficult or costly to separate, and at the current time there likely is no local market that can accept these materials. In the short term, therefore, many of these materials do not offer significant potential for diversion, although diversion of at least some of these materials may be a longer term opportunity.

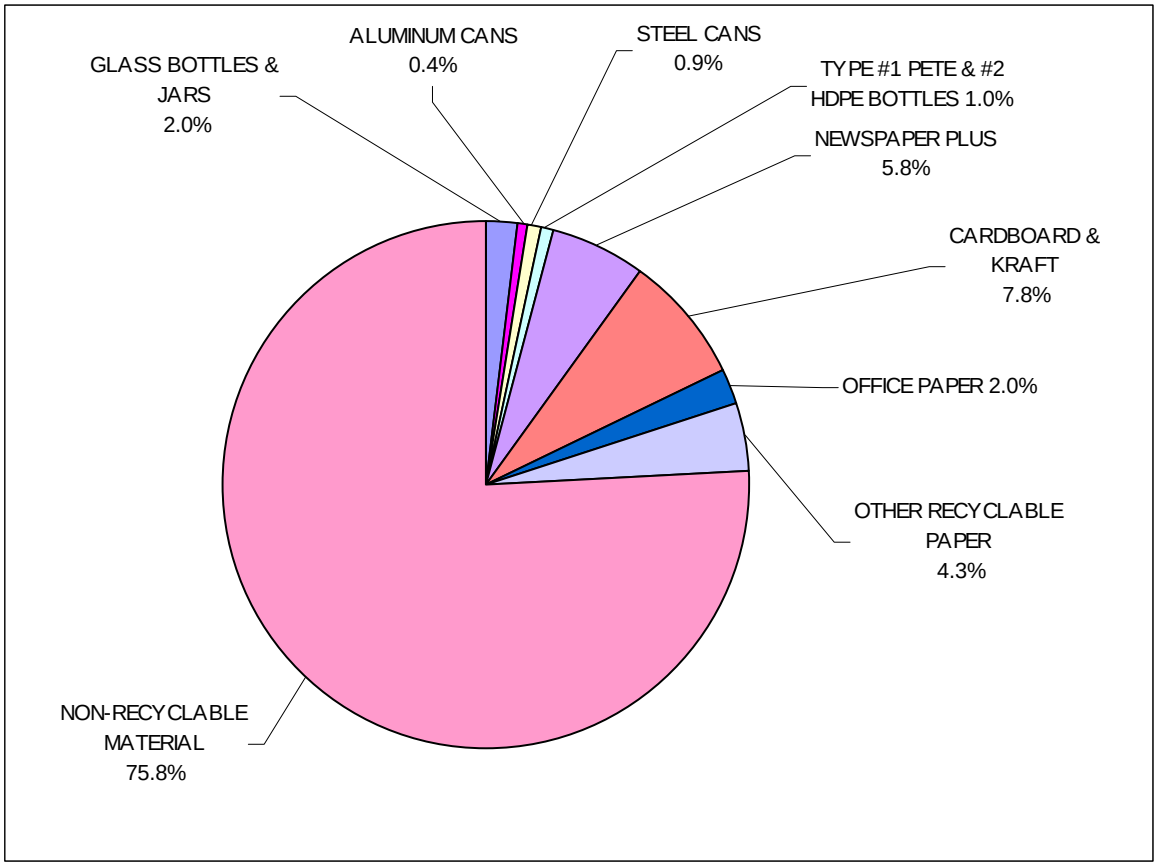
Figure 4-2 Ten Most Prevalent Material Categories (Percent by Weight), Aggregate



4. RESULTS

Figure 4-3 shows the breakdown between recyclable materials and non-recyclable materials. The recyclable materials shown in the Figure are specifically those that are included in the program description and educational materials on the County's website. The occurrence of these targeted recyclables in the aggregate waste stream is certainly caused by the incidence of these materials in the commercial, self-haul and/or C&D waste stream. However, some of the disposed recyclables were generated in the residential waste stream as well.

Figure 4-3. Prevalence of Recyclable Materials in Aggregate Disposed Wastes (Percent by Weight)



As shown in Figure 4-3, this study found that over 24 percent of disposed wastes going into the Larimer County landfill could potentially be recycled (unadjusted for source contamination of recyclable material). The largest recyclable material categories in the disposed waste stream include corrugated cardboard/Kraft paper, newspapers (including inserts), and mixed paper (shown below as Other Recyclable Paper).

Conversely, the study found that almost 76 percent of disposed waste is comprised of materials for which there are no local recycling programs. Although the Figure above labels these materials as "non-recyclable," this label applies only because markets for additional recycled materials have not yet developed in Larimer County. Over time, it is expected that there would be opportunities to increase recycling of new materials that are currently being disposed.

Aggregate waste composition data for the County in detailed tabular format, including statistical measures of standard deviation and 90 percent confidence intervals, is contained in Exhibit 2.

COMPARISON OF COMPOSITION BY GENERATOR CLASS

Table 4-2 compares the mean composition of wastes by generator class for the major material groups. There are several items of interest to be seen in this table:

- Residential and Commercial wastes are reasonably similar;
- Residential and Commercial wastes contain a diverse mix of materials encompassing all of the major material groups;
- Self haul and C&D wastes are much more limited in the materials disposed, and their composition differs significantly from Residential and Commercial waste;
- Self-haul wastes contain a significant fraction of Wood and Other waste, the latter of which is largely made up of C&D material categories;
- C&D Debris contains significant amounts of green and woody wastes associated with land clearing, as well as Other waste (i.e., the C&D material categories).

Table 4-2 Comparison of Waste Composition By Generator Class

Material Group	Residential	Commercial	Self-Haul	C&D
Paper	31.4%	31.6%	13.9%	1.0%
Plastic/Rubber/Leather	10.6%	11.2%	4.5%	0.4%
Glass	4.8%	2.7%	2.8%	3.9%
Ferrous Metal	3.0%	3.5%	2.9%	2.5%
Non-ferrous Metal	1.7%	2.0%	0.4%	0.6%
Yard/Land Clearing	8.4%	6.3%	9.5%	27.2%
Wood	3.0%	8.9%	15.0%	1.6%
Food Waste	17.4%	15.9%	0.3%	0.1%
Textiles	2.4%	1.0%	0.3%	0.0%
Other [1]	17.3%	16.9%	48.7%	62.8%
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**

[1] OTHER waste includes C&D materials such as drywall, block/brick/stone, insulation, and asphalt roofing, and miscellaneous organics and inorganics not elsewhere classified including diapers/sanitary products, electronics, bulky items, carpet, tires, fines, and household hazardous waste (HHW).

Detailed results for the Residential, Commercial, Self-haul and C&D generator classes are shown in Exhibits 3, 4, 5, and 6.

Table 4-3 compares the top 10 individual materials found in the disposed waste stream of each generator sector.

Table 4-3 Comparison of Top 10 Most Prevalent by Generator Sector

Rank	Residential		Commercial		Self-haul		C&D	
1	Food Waste	17.4%	Food Waste	15.9%	Bulky Items	15.8%	Drywall	15.1%
2	Yard Waste	8.0%	OCC/Kraft	13.6%	Yard Waste	9.5%	Asphalt Roofing	14.7%
3	Non Recyclable Paper	7.7%	Yard Waste	6.3%	Other Inorganics	9.1%	Carpet	11.8%
4	Mixed Recyc Paper	6.6%	Non Recyc Paper	5.5%	Carpet	8.0%	Block/Brick/Stone	11.2%
5	Newspaper	6.5%	Film/Bags	4.5%	Clean Wood	7.7%	Clean Wood	10.9%
6	OCC/Kraft	6.0%	Newspaper	4.1%	Clean Wood Block/Brick/Stone	5.8%	Other Wood	10.3%
7	Diapers/Sanitary Products	4.9%	Mixed Recyc Paper	3.6%	OCC/Kraft	4.4%	Painted/Stained Wood	6.0%
8	Films/Bags	4.5%	Clean Wood	3.5%	Mixed Recyc Paper	4.1%	Other Inorganics	5.4%
9	Other Rigid Plastic	3.2%	High Grade Paper	3.5%	Painted/Stained Wood	3.7%	Other/Broken Glass	3.9%
10	Fines	3.1%	Other Rigid Plastic	3.2%	Asphalt Roofing	3.6%	Other Ferrous Metal	2.4%
Top 10		**68.0%**		**63.9%**		**71.1%**		**91.8%**

COMPARISON WITH 1998 WASTE COMPOSITION STUDY

The 1998 Study was the first attempt made by the County to evaluate the composition of disposed wastes. This section compares the results of the 2006 Study with the original 1998 Study.

Although it is beyond the scope of this project to research and document the potential differences in methodology and/or outcome between the two studies, we offer the following observations that may prevent a perfect comparison of the results:

- **Smaller number of samples in 1998 Study**: The 1998 Study captured 36 Residential samples, 24 Commercial samples, and 12 Self-haul samples. While the Residential sample size is comparable to the 2006 study and should be sufficient to generate reasonable results, it is somewhat likely that the Commercial, and highly likely that the Self-haul sample sizes were insufficient to eliminate the potential for one or more outlier samples to bias the results;
- **Limited material categories in 1998 Study**: The 1998 Study divided the waste stream into 10 material categories. The categories that were selected, while meaningful in identifying macro-level composition of the waste streams, were relatively limited. The

2006 Study utilized a significantly expanded list of material categories, while allowing for results to be mapped to the 1998 Study material categories for direct comparison;

- **Four-season v. Two-season field data collection**: The 1998 Study included a total of four field data collection events, one each in the Spring, Summer, Fall and Winter. For this reason, it is likely that the 1998 Study effectively captured seasonal variation that occurs in waste composition (e.g., an increase in beverage containers being disposed in the hotter summer months; an increase in yard waste disposal in the spring and fall). The 2006 Study captured only two seasons of data—summer and winter—so there is greater potential that the 2006 Study did not fully capture the impact of spring or fall waste composition trends (especially leaf and yard waste generation).
- **Weekly sampling coverage**: The 1998 Study targeted three days of sorting in each of the four seasons, while the 2006 Study encompassed a full week of sampling in each season. In general, the full week of sampling is preferable to assure that representative samples are captured from all geographic areas of the County.
- **Separate Classification of C&D**: The 2006 Study definitively separates C&D wastes and performs a separate composition analysis of these wastes. It is not clear to what extent the 1998 Study segregated commercial and C&D loads, although notations regarding the random sampling of asphalt shingle loads in the commercial stream suggests that the 1998 Study likely applied a different definition of the generator sectors than were used in the 2006 Study.
- **Sampling Strategy**: The 1998 Study used pure random sampling to acquire and sort samples from incoming truckloads. Based on significant up-front analysis of gatehouse data, and subsequently validated based on a gate survey, the 2006 Study utilized stratified random sampling to assure that samples aligned with known delivery patterns.

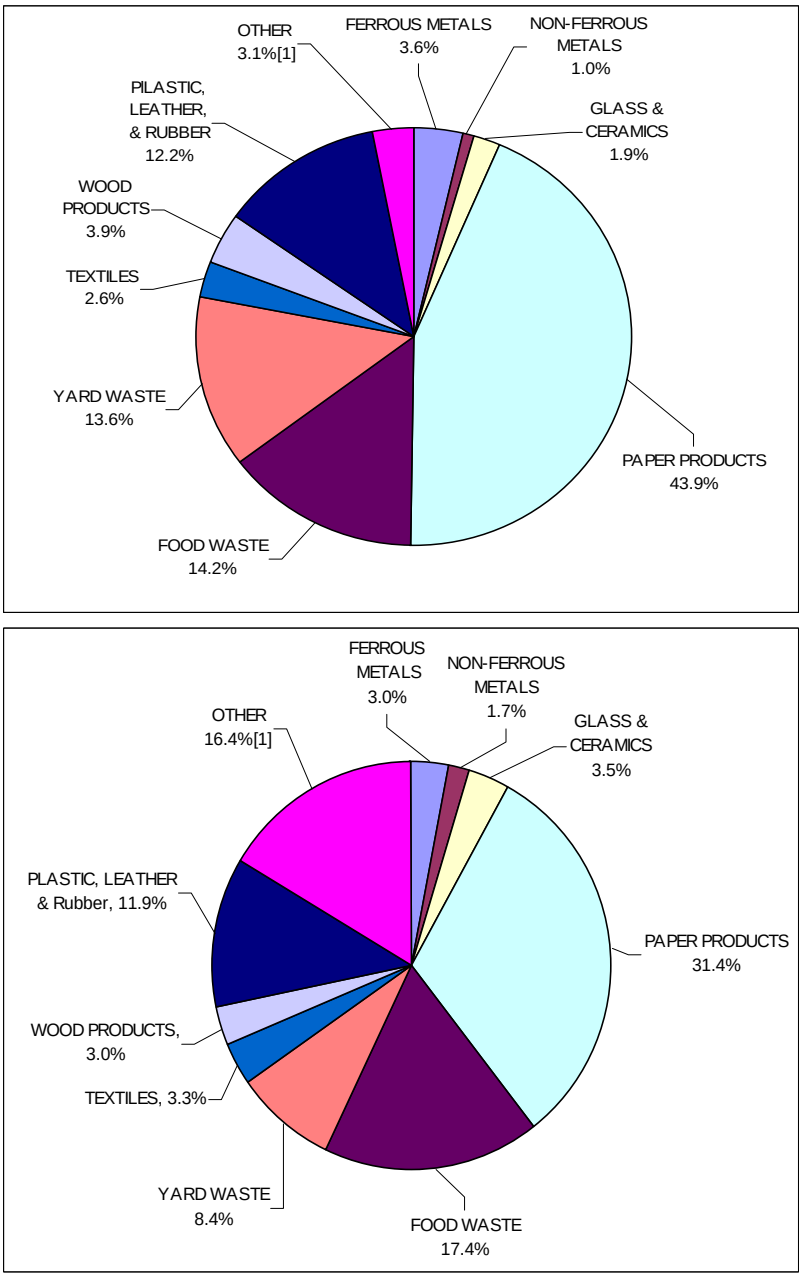
Not all of these differences in methodology may meaningfully prevent a comparison of the 1998 and 2006 Study results. At a minimum, though, it appears likely that the most "apples to apples" comparison of results is within the residential stream. Comparison of self haul and commercial results between the two studies may be somewhat limited.

The remaining figures in this section provide a graphical comparison of the 1998 and 2006 Study results:

- Figure 4-4 compares the respective composition of 1998 and 2006 *residential* waste.
- Figure 4-5 compares the 1998 and 2006 *commercial* waste composition, and
- Figures 4-6 compares the *self-haul* waste composition in 1998 and 2006.

Readers will note differences in the waste stream by comparing the relative size of each pie piece in the graphs. Although it was beyond the scope of this study to investigate the reason for changes in the waste stream, we make some limited observations (see following pages). For those interested in more detail, a statistical comparison of the 1998 and 2006 results, containing both the mean composition as well as confidence intervals, is contained in Exhibit 7.

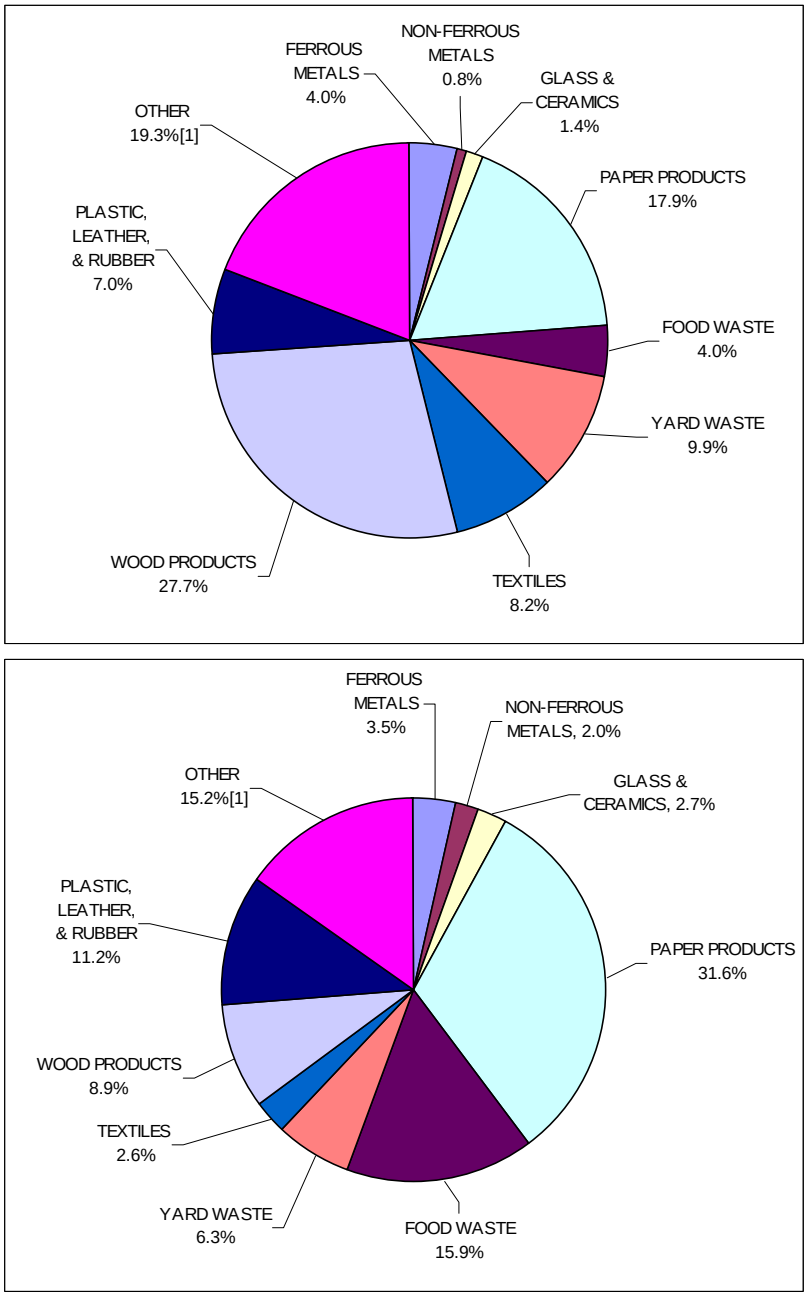
Figure 4-4 Comparison of 1998 (top) and 2006 (bottom) Residential Waste Composition



[1] OTHER waste includes C&D materials such as drywall, block/brick/stone, insulation, and asphalt roofing, and miscellaneous organics and inorganics not elsewhere classified including diapers/sanitary products, electronics, bulky items, carpet, tires, fines, and household hazardous waste (HHW).

These results suggest that there have been significant changes in the residential disposed waste stream. First, the fraction of paper has evidently decreased significantly. To some degree this is not surprising, as recovered paper markets were extremely poor through much of the 1990s, and have been much better in recent years. Differences in other categories are harder to explain.

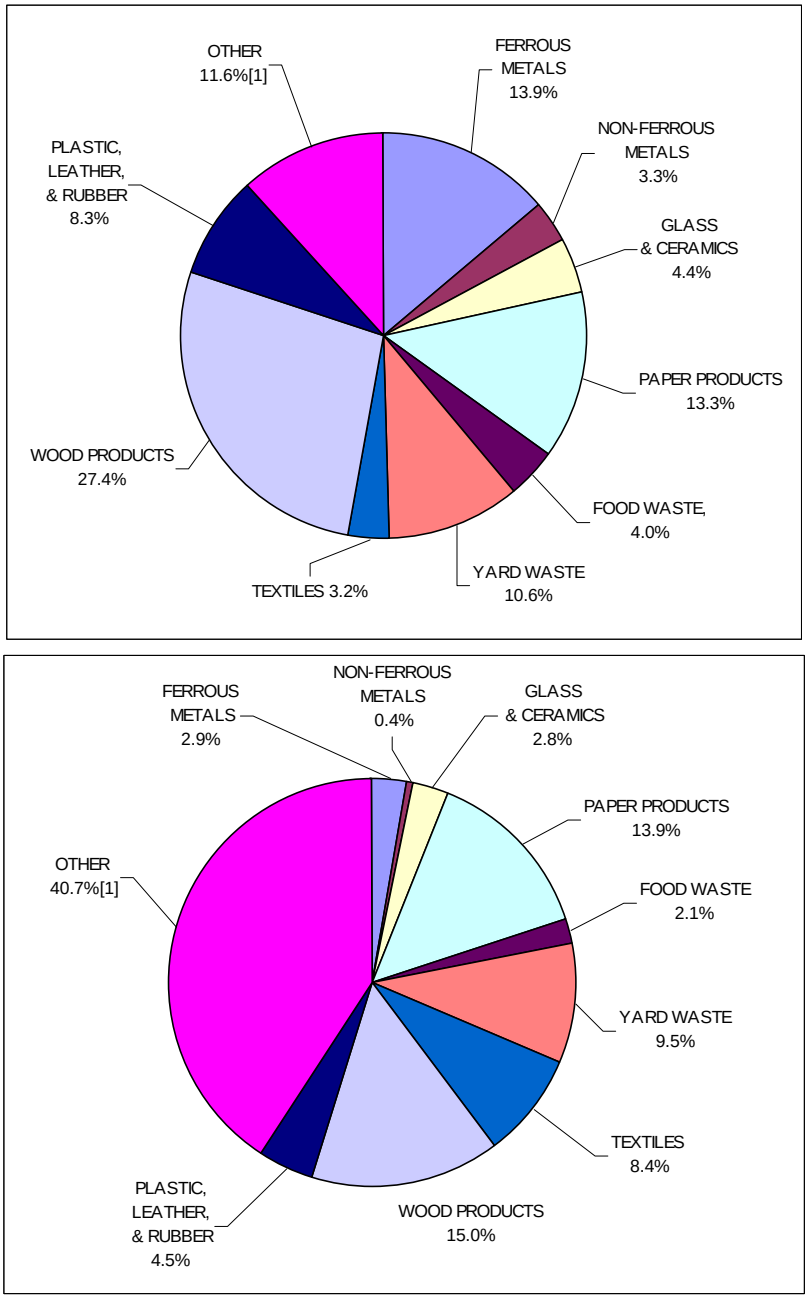
Figure 4-5 Comparison of 1998 (top) and 2006 (bottom) Commercial Waste Composition



[1] OTHER waste includes C&D materials such as drywall, block/brick/stone, insulation, and asphalt roofing, and miscellaneous organics and inorganics not elsewhere classified including diapers/sanitary products, electronics, bulky items, carpet, tires, fines, and household hazardous waste (HHW).

The comparison of the commercial composition results suggests that the definition of the commercial sector differed in the 1998 and 2006 Studies. The significantly greater incidence of wood in the 1998 Study suggests certain loads that would have been characterized as C&D in the 2006 Study may have been included as commercial in the 1998 Study.

Figure 4-6 Comparison of 1998 (top) and 2006 (bottom) Self Haul Waste Composition



[1] OTHER waste includes C&D materials such as drywall, block/brick/stone, insulation, and asphalt roofing, and miscellaneous organics and inorganics not elsewhere classified including diapers/sanitary products, electronics, bulky items, carpet, tires, fines, and household hazardous waste (HHW).

Once again, a comparison of the 1998 and 2006 Study results for self haul waste suggest that a different definition of the self haul generator sector may have been applied. However, it must also be noted that the very small sample size of self haul samples in the 1998 Study resulted in extremely wide confidence intervals, making comparison difficult (see Exhibit 7).

Exhibit 1: Summary of Physical Sample Loads

Summer Season Sort

Sample Number	Date	Sample Type	Time of Delivery	Hauler	Vehicle Type	Generator Type	Origin of Waste
1	9/11/06	Physical	8:00	GSI	Front Load	Commercial	Fort Collins
2	9/11/06	Physical	8:50	WM	Front Load	Commercial	Fort Collins
3	9/11/06	Physical	8:55	GSI	Rear Load	Commercial	Fort Collins
4	9/11/06	Physical	9:50	S&S	Rear Load	Commercial	Loveland
5	9/11/06	Physical	10:10	GSI	Rear Load	Commercial	Fort Collins
6	9/11/06	Physical	10:10	Dick's	Rear Load	Commercial	Fort Collins
7	9/11/06	Physical	10:30	Ram	Rear Load	Residential	Fort Collins
8	9/11/06	Physical	11:10	Dick's	Rear Load	Residential	Fort Collins
9	9/11/06	Physical	12:18	Loveland	Front Load	Residential	Loveland
10	9/11/06	Physical	13:00	GSI	Rear Load	Residential	Fort Collins
11	9/11/06	Physical	15:15	GSI	Front Load	Residential	Fort Collins
12	9/12/06	Physical	9:07	WM	Front Load	Commercial	South Fort Collins
13	9/12/06	Physical	9:07	GSI	Rear Load	Commercial	Loveland
14	9/12/06	Physical	9:35	GSI	Front Load	Commercial	Fort Collins
15	9/12/06	Physical	10:07	CSU	Front Load	Commercial	CSU
16	9/12/06	Physical	10:55	Ram	Rear Load	Residential	Fort Collins
17	9/12/06	Physical	11:00	GSI	Rear Load	Commercial	Wellington
18	9/12/06	Physical	11:30	GSI	Rear Load	Residential	Fort Collins
19	9/12/06	Physical	12:30	Loveland	Front Load	Residential	City of Loveland
20	9/12/06	Physical	12:40	Ram	Rear Load	Commercial	Fort Collins
21	9/12/06	Physical	13:15	Ram	Rear Load	Residential	Fort Collins CSU North
22	9/12/06	Physical	15:00	Loveland	Front Load	Residential	Loveland
23	9/13/06	Physical		Loveland	Rear Load	Residential	Loveland Apartment
24	9/13/06	Physical	8:50	GSI	Front Load	Commercial	Fort Collins
25	9/13/06	Physical	9:55	GSI	Rear Load	Residential	Fort Collins
26	9/13/06	Physical	10:40	S&S	Rear Load	Commercial	Loveland
27	9/13/06	Physical	10:40	GSI	Front Load	Commercial	Fort Collins
28	9/13/06	Physical	11:10	Ram	Rear Load	Commercial	Fort Collins
29	9/13/06	Physical	11:20	GSI	Front Load	Residential	Fort Collins
30	9/13/06	Physical	11:30	Mike's	RO	Commercial	Fort Collins
31	9/13/06	Physical	12:30	Shroder Ro	Trailer	Commercial	Fort Collins
32	9/13/06	Physical	12:40	GSI	Rear Load	Residential	Fort Collins
33	9/13/06	Physical	13:30	RAM	Rear Load	Residential	Fort Collins
34	9/13/06	Physical	13:50	GSI	Rear Load	Residential	Fort Collins
35	9/13/06	Physical	14:30		RO	Commercial	Fort Collins

Exhibit 1: Summary of Physical Sample Loads

Winter Season Sort

Sample Number	Date	Sample Type	Time of Delivery	Hauler	Vehicle Type	Generator Type	Origin of Waste
1	12/5/06	Physical	8:25	CSU	Front Load	Commercial	CSU
2	12/5/06	Physical	9:45	Gullage	Rear Load	Commercial	Fort Collins
3	12/5/06	Physical	11:00	GSI	Rear Load	Commercial	Fort Collins
4	12/5/06	Physical	11:30	WM	Front Load	Commercial	Fort Collins
5	12/5/06	Physical	12:00	GSI	SL	Residential	Fort Collins
6	12/5/06	Physical	13:00	Loveland	Front Load	Residential	Fort Collins South
7	12/5/06	Physical	13:15	RAM	Rear Load	Residential	Fort Collins
8	12/5/06	Physical	14:20	GSI	Rear Load	Residential	Fort Collins
9	12/6/06	Physical	9:20	GSI	Front Load	Commercial	Fort Collins
10	12/6/06	Physical	9:40	GSI	Rear Load	Commercial	
11	12/6/06	Physical	10:45	RAM	SL	Residential	Fort Collins
12	12/6/06	Physical	10:50	GSI	SL	Residential	Fort Collins
13	12/6/06	Physical	11:30	Dick's	Rear Load	Commercial	Fort Collins
14	12/6/06	Physical	11:30	Dick's	Rear Load	Residential	Fort Collins
15	12/6/06	Physical	15:30	RAM	Rear Load	Residential	Fort Collins
16	12/7/06	Physical	9:00	WM	Front Load	Commercial	Fort Collins
17	12/7/06	Physical	9:10	WM	Front Load	Commercial	Fort Collins
18	12/7/06	Physical	9:45	United	Front Load	Residential	BertLoud
19	12/7/06	Physical	10:00	RAM	Rear Load	Commercial	Fort Collins
20	12/7/06	Physical	10:15	GSI	Rear Load	Commercial	Fort Collins/Loveland
21	12/7/06	Physical	10:30	WM	Front Load	Commercial	Loveland
22	12/7/06	Physical	11:30	GSI	Rear Load	Commercial	Loveland-South
23	12/7/06	Physical	11:40	GSI	Front Load	Commercial	All Over
24	12/7/06	Physical	12:15	WM	Front Load	Commercial	Loveland
25	12/7/06	Physical	12:30	Loveland	Rear Load	Residential	Loveland
26	12/7/06	Physical	13:50	Loveland	Front Load	Residential	Loveland
27	12/7/06	Physical	14:30	Loveland	Front Load	Residential	Loveland
28	12/7/06	Physical	15:50	GSI	Rear Load	Residential	Fort Collins
29	12/7/06	Physical	15:15	Loveland	Front Load	Residential	Loveland
30	12/8/06	Physical	9:00	GSI	Front Load	Commercial	Fort Collins
31	12/8/06	Physical	9:20	GSI	Front Load	Commercial	South Fort Collins
32	12/8/06	Physical	10:00	WM	Front Load	Commercial	Loveland
33	12/8/06	Physical	10:20	Dick's	Rear Load	Residential	Outside Ft. Collins
34	12/8/06	Physical	10:35	Dick's	Front Load	Commercial	Fort Collins
35	12/8/06	Physical	11:40	S&S	Front Load	Commercial	BertLoud

Exhibit 2: Aggregate Results

			Weighted Data				2006
			Annual Average	Standard Deviation	Confidence Intrerval		Estimated
					Lower	Upper	Quantity
		Material Categories					**152,933**
PAPER	1	OCC/Kraft	7.8%	13.8%	6.3%	9.3%	11,888
	2	Newpaper	4.3%	14.3%	2.7%	5.9%	6,560
	3	Magazines/Glossy	1.5%	19.3%	0.0%	3.6%	2,296
	4	High Grade Paper	2.0%	7.1%	1.3%	2.8%	3,124
	5	Polycoated/Aseptic Containers	0.2%	1.1%	0.1%	0.3%	307
	6	Mixed (Other Recyclable)	4.3%	10.9%	3.1%	5.5%	6,600
	7	Other Paper (Non Recyclable)	5.4%	7.1%	4.6%	6.2%	8,223
		Subtotal	25.5%	29.9%	22.2%	28.8%	38,998
PLASTICS	8	#1 PET Bottles/Jars	0.6%	7.9%	0.0%	1.5%	933
	9	#2 HDPE Bottles/Jars	0.4%	37.2%	0.0%	4.6%	672
	10	#3 - 7 Bottles/Jars	0.4%	1.1%	0.3%	0.6%	673
	11	Expanded Polystyrene	0.6%	1.4%	0.4%	0.7%	888
	12	Films/Bags	3.5%	5.7%	2.9%	4.2%	5,409
	13	Other Ridged Plastic	2.7%	2.5%	2.5%	3.0%	4,189
		Subtotal	8.3%	9.4%	7.3%	9.4%	12,766
GLASS	14	Clear Glass	0.9%	13.6%	0.0%	2.4%	1,328
	15	Green Glass	0.2%	13.9%	0.0%	1.8%	374
	16	Brown Glass	0.9%	2.2%	0.6%	1.1%	1,352
	17	Other Glass/Broken Glass	1.2%	4.9%	0.7%	1.8%	1,878
		Subtotal	3.2%	9.4%	2.2%	4.3%	4,933
METALS	18	Ferrous Cans	0.9%	16.1%	0.0%	2.6%	1,314
	19	Other Ferrous Metals	1.6%	6.0%	0.9%	2.3%	2,450
	20	Aluminum Cans	0.4%	0.8%	0.3%	0.5%	594
	21	Other Aluminum	0.5%	7.4%	0.0%	1.3%	725
	22	Other Non-Ferrous	0.7%	2.7%	0.4%	1.0%	1,024
	23	Appliances	0.6%	4.3%	0.1%	1.1%	906
		Subtotal	4.6%	6.7%	3.8%	5.3%	7,013
ORGANICS	24	Food Waste	13.2%	22.6%	10.7%	15.7%	20,137
	25	Diapers/Sanitary Products	2.3%	13.7%	0.8%	3.9%	3,581
	26	Textiles	1.4%	7.3%	0.6%	2.2%	2,115
	26A	Rubber/Leather	1.0%	2.9%	0.7%	1.3%	1,562
	27	Yard Waste -Grass/Leaves	6.2%	8.0%	5.4%	7.1%	9,529
	28	Land Clearing	0.4%	4.6%	0.0%	0.9%	592
	29	Clean Wood	4.1%	10.9%	2.9%	5.3%	6,334
	30	Painted/Stained Wood	2.6%	7.0%	1.8%	3.4%	3,962
	31	Other Wood	3.0%	12.0%	1.7%	4.3%	4,616
	32	Fines	2.3%	15.2%	0.6%	4.0%	3,520
	33	Other Organics	1.9%	7.2%	1.1%	2.7%	2,920
		Subtotal	38.5%	31.9%	35.0%	42.0%	58,867
INORGANICS	34	Carpet	3.3%	8.1%	2.4%	4.2%	5,109
	35	Drywall	2.6%	14.0%	1.1%	4.2%	4,010
	36	Block/Brick/Stone	3.5%	11.9%	2.2%	4.8%	5,371
	37	Insulation	0.3%	3.8%	0.0%	0.7%	430
	38	Asphalt Roofing	3.1%	11.2%	1.9%	4.4%	4,810
	39	Other C&D Material	1.1%	8.5%	0.2%	2.1%	1,718
	40	Electronics	1.3%	9.1%	0.3%	2.3%	1,978
	41	Bulky Items	1.5%	0.9%	1.4%	1.6%	2,368
	42	Tires	0.2%	10.0%	0.0%	1.3%	283
	43	Other Inorganics	2.0%	9.1%	1.0%	3.0%	3,094
	44	Hazardous Material	0.8%	2.8%	0.5%	1.1%	1,186
		Subtotal	19.8%	18.2%	17.8%	21.9%	30,357
		GRAND TOTAL	100.0%				152,933

Exhibit 3: Residential Results

		Materials	Average Percent	Standard Deviation	90%Conf. Interval Lower	90%Conf. Interval Upper	Annual Tons
PAPER	1	OCC/Kraft	6.0%	5.7%	4.4%	7.6%	3,817
	2	Newpaper	6.5%	6.5%	4.7%	8.4%	4,164
	3	Magazines/Glossy	2.8%	2.8%	2.0%	3.6%	1,773
	4	High Grade Paper	1.6%	2.0%	1.0%	2.2%	1,007
	5	Polycoated/Aseptic Containers	0.2%	0.4%	0.1%	0.4%	148
	6	Mixed (Other Recyclable)	6.6%	3.9%	5.4%	7.7%	4,169
	7	Other Paper (Non Recyclable)	7.7%	2.4%	7.0%	8.4%	4,926
		Subtotal	31.4%	9.9%	28.6%	34.3%	20,004
PLASTIC	8	#1 PET Bottles/Jars	0.8%	0.4%	0.7%	1.0%	540
	9	#2 HDPE Bottles/Jars	0.7%	0.6%	0.5%	0.9%	424
	10	#3 - 7 Bottles/Jars	0.8%	0.9%	0.5%	1.0%	499
	11	Expanded Polystyrene	0.6%	0.4%	0.4%	0.7%	352
	12	Films/Bags	4.5%	1.6%	4.0%	5.0%	2,861
	13	Other Ridged Plastic	3.2%	1.6%	2.8%	3.7%	2,053
		Subtotal	10.6%	2.9%	9.7%	11.4%	6,729
GLASS	14	Clear Glass	1.4%	1.0%	1.2%	1.7%	921
	15	Green Glass	0.3%	0.4%	0.2%	0.5%	206
	16	Brown Glass	1.4%	1.7%	0.9%	1.8%	861
	17	Other Glass/Broken Glass	0.4%	0.5%	0.2%	0.5%	228
		Subtotal	3.5%	2.6%	2.7%	4.2%	2,217
METALS	18	Ferrous Cans	1.4%	0.8%	1.1%	1.6%	875
	19	Other Ferrous Metals	0.9%	1.4%	0.5%	1.3%	564
	20	Aluminum Cans	0.7%	0.5%	0.5%	0.8%	429
	21	Other Aluminum	0.5%	0.8%	0.3%	0.7%	311
	22	Other Non-Ferrous	0.5%	1.0%	0.2%	0.8%	327
	23	Appliances	0.7%	3.1%	0.0%	1.6%	438
		Subtotal	4.6%	3.2%	3.7%	5.5%	2,944
ORANICS	24	Food Waste	17.4%	9.1%	14.8%	20.1%	11,097
	25	Diapers/Sanitary Products	4.9%	4.0%	3.8%	6.1%	3,125
	26	Textiles/Rubber/Leather	2.4%	2.0%	1.8%	3.0%	1,521
	26A	Rubber/Leather	1.4%	1.8%	0.8%	1.9%	862
	27	Yard Waste -Grass/Leaves	8.0%	10.4%	5.0%	11.0%	5,085
	28	Yard Waste - Stumps/Logs	0.4%	1.3%	0.0%	0.8%	253
	29	Clean Wood	1.5%	4.6%	0.2%	2.9%	982
	30	Painted/Stained Wood	1.1%	3.4%	0.1%	2.1%	690
	31	Other Wood	0.4%	1.0%	0.1%	0.7%	246
	32	Fines	3.1%	1.5%	2.7%	3.6%	1,989
	33	Other Organics	2.7%	2.8%	1.9%	3.4%	1,687
		Subtotal	43.3%	11.4%	40.0%	46.5%	27,536
INORGANICS	34	Carpet	0.9%	2.2%	0.3%	1.5%	563
	35	Drywall	0.2%	0.8%	0.0%	0.4%	121
	36	Block/Brick/Stone	0.7%	2.0%	0.2%	1.3%	470
	37	Insulation	0.0%	0.1%	0.0%	0.0%	8
	38	Asphalt Roofing	0.0%	0.1%	0.0%	0.1%	22
	39	Other C&D Material	0.8%	1.6%	0.3%	1.2%	499
	40	Electronics	2.2%	5.4%	0.6%	3.7%	1,368
	41	Furniture	0.4%	2.3%	0.0%	1.0%	257
	42	Tires	0.0%	0.0%	0.0%	0.0%	0
	43	Other Inorganic	0.6%	1.5%	0.2%	1.1%	405
	44	Other Hazardous Material	0.8%	1.0%	0.5%	1.0%	481
		Subtotal	6.6%	7.1%	4.6%	8.6%	4,194
		TOTAL	100.0%				63,624

Exhibit 4: Commercial Results

		Materials	Average Percent	Standard Deviation	90%Conf. Interval Lower	90%Conf. Interval Upper	Annual Tons
PAPER	1	OCC/Kraft	13.6%	11.9%	10.4%	16.9%	7,533
	2	Newpaper	4.1%	10.7%	1.2%	7.0%	2,278
	3	Magazines/Glossy	0.9%	1.1%	0.6%	1.2%	493
	4	High Grade Paper	3.5%	10.9%	0.5%	6.4%	1,925
	5	Polycoated/Aseptic Containers	0.3%	0.6%	0.1%	0.4%	156
	6	Mixed (Other Recyclable)	3.6%	2.7%	2.9%	4.4%	1,993
	7	Other Paper (Non Recyclable)	5.5%	4.4%	4.3%	6.7%	3,049
		Subtotal	31.6%	18.0%	26.7%	36.4%	17,428
PLASTIC	8	#1 PET Bottles/Jars	0.7%	0.6%	0.5%	0.9%	384
	9	#2 HDPE Bottles/Jars	0.4%	0.5%	0.3%	0.6%	240
	10	#3 - 7 Bottles/Jars	0.3%	0.4%	0.2%	0.4%	166
	11	Expanded Polystyrene	0.9%	1.3%	0.5%	1.2%	474
	12	Films/Bags	4.5%	3.6%	3.5%	5.5%	2,482
	13	Other Ridged Plastic	3.2%	2.7%	2.5%	4.0%	1,774
		Subtotal	10.0%	6.3%	8.3%	11.7%	5,520
GLASS	14	Clear Glass	0.7%	0.8%	0.5%	0.9%	391
	15	Green Glass	0.3%	1.2%	0.0%	0.6%	164
	16	Brown Glass	0.8%	1.6%	0.4%	1.3%	464
	17	Other Glass/Broken Glass	0.9%	3.2%	0.0%	1.7%	473
		Subtotal	2.7%	4.1%	1.6%	3.8%	1,493
METALS	18	Ferrous Cans	0.8%	0.9%	0.5%	1.0%	424
	19	Other Ferrous Metals	1.9%	2.9%	1.1%	2.7%	1,043
	20	Aluminum Cans	0.3%	0.3%	0.2%	0.4%	157
	21	Other Aluminum	0.6%	1.3%	0.2%	0.9%	325
	22	Other Non-Ferrous	1.1%	3.2%	0.3%	2.0%	619
	23	Appliances	0.8%	3.8%	0.0%	1.8%	454
		Subtotal	5.5%	5.5%	4.0%	7.0%	3,022
ORANICS	24	Food Waste	15.9%	14.6%	12.0%	19.9%	8,801
	25	Diapers/Sanitary Products	0.7%	2.1%	0.2%	1.3%	405
	26	Textiles	1.0%	2.1%	0.4%	1.6%	541
	26A	Rubber/Leather	1.2%	2.1%	0.6%	1.8%	675
	27	Yard Waste -Grass/Leaves	6.3%	12.1%	3.1%	9.6%	3,490
	28	Yard Waste - Stumps/Logs	0.0%	0.0%	0.0%	0.0%	0
	29	Clean Wood	3.5%	8.7%	1.2%	5.9%	1,939
	30	Painted/Stained Wood	2.6%	6.4%	0.9%	4.3%	1,439
	31	Other Wood	2.8%	6.4%	1.1%	4.6%	1,556
	32	Fines	2.7%	3.6%	1.7%	3.7%	1,495
	33	Other Organics	1.6%	4.7%	0.3%	2.9%	873
		Subtotal	38.4%	18.3%	33.5%	43.4%	21,215
INORGANICS	34	Carpet	1.6%	5.8%	0.1%	3.2%	899
	35	Drywall	0.1%	0.6%	0.0%	0.3%	78
	36	Block/Brick/Stone	2.9%	8.2%	0.7%	5.1%	1,609
	37	Insulation	0.0%	0.0%	0.0%	0.0%	1
	38	Asphalt Roofing	1.5%	8.7%	0.0%	3.9%	833
	39	Other C&D Material	1.7%	4.3%	0.5%	2.8%	919
	40	Electronics	0.6%	1.8%	0.2%	1.1%	355
	41	Furniture	0.7%	4.5%	0.0%	2.0%	401
	42	Tires	0.5%	2.2%	0.0%	1.1%	268
	43	Other Inorganic	0.9%	4.1%	0.0%	2.0%	484
	44	Other Hazardous Material	1.2%	2.6%	0.5%	2.0%	686
		Subtotal	11.8%	14.8%	7.8%	15.8%	6,533
		Total	100.0%				55,211

Exhibit 5: Self-Haul Results

		Materials	Adjusted Average Percent	Adjusted Standard Deviation	Adjusted 90%Conf. Interval Lower	Adjusted 90%Conf. Interval Upper	Annual Tons 2006
PAPER	1	OCC/Kraft	4.4%	16.2%	1.4%	7.5%	425
	2	Newspaper	1.2%	8.2%	0.0%	2.7%	111
	3	Magazines/Glossy	0.3%	0.7%	0.2%	0.4%	28
	4	High Grade Paper	1.9%	4.5%	0.0%	4.4%	186
	5	Polycoated/Aseptic Containers	0.0%	0.1%	0.0%	0.0%	2
	6	Mixed (Other Recyclable)	4.1%	14.8%	1.3%	6.9%	392
	7	Other Paper (Non Recyclable)	1.9%	9.6%	0.1%	3.7%	182
		Subtotal	13.8%	33.0%	7.6%	20.1%	1,326
PLASTIC	8	#1 PET Bottles/Jars	0.1%	0.2%	0.0%	0.2%	9
	9	#2 HDPE Bottles/Jars	0.1%	0.2%	0.0%	0.1%	7
	10	#3 - 7 Bottles/Jars	0.1%	0.2%	0.0%	0.1%	8
	11	Expanded Polystyrene	0.3%	1.4%	0.0%	0.6%	28
	12	Films/Bags	0.5%	2.9%	0.0%	1.1%	49
	13	Other Ridged Plastic	3.3%	11.0%	1.3%	5.4%	319
		Subtotal	4.4%	13.4%	1.8%	6.9%	419
GLASS	14	Clear Glass	0.2%	0.4%	0.1%	0.2%	15
	15	Green Glass	0.0%	0.1%	0.0%	0.0%	3
	16	Brown Glass	0.3%	2.4%	0.0%	0.7%	26
	17	Other Glass/Broken Glass	2.4%	12.2%	0.1%	4.7%	232
		Subtotal	2.9%	13.8%	0.3%	5.5%	276
METAL	18	Ferrous Cans	0.1%	0.3%	0.1%	0.2%	14
	19	Other Ferrous Metals	2.6%	8.8%	0.9%	4.2%	247
	20	Aluminum Cans	0.1%	0.6%	0.0%	0.2%	7
	21	Other Aluminum	0.2%	0.4%	0.0%	0.3%	17
	22	Other Non-Ferrous	0.2%	0.4%	0.0%	0.4%	16
	23	Appliances	0.1%	0.2%	0.0%	0.2%	8
		Subtotal	3.2%	10.6%	1.2%	5.2%	307
ORANICS	24	Food Waste	2.2%	19.3%	0.0%	5.9%	212
	25	Diapers/Sanitary Products	0.5%	1.2%	0.3%	0.7%	49
	26	Textiles	0.5%	2.2%	0.1%	0.9%	45
	26A	Rubber/Leather	0.2%	0.5%	0.0%	0.5%	21
	27	Yard Waste -Grass/Leaves	9.5%	25.5%	4.7%	14.3%	910
	28	Land Clearing	0.2%	0.4%	0.0%	0.4%	17
	29	Clean Wood	7.7%	22.6%	3.5%	12.0%	741
	30	Painted/Stained Wood	3.7%	11.4%	1.6%	5.9%	355
	31	Other Wood	2.9%	7.9%	1.4%	4.4%	277
	32	Fines	0.3%	0.8%	0.2%	0.5%	32
	33	Other Organics	1.9%	13.6%	0.0%	4.5%	183
		Subtotal	29.7%	39.8%	22.2%	37.2%	2,843
INORGANICS	34	Carpet	8.0%	24.8%	3.3%	12.6%	762
	35	Drywall	1.0%	9.1%	0.0%	2.8%	100
	36	Block/Brick/Stone	5.8%	21.9%	1.7%	9.9%	556
	37	Insulation	0.1%	0.3%	0.0%	0.4%	13
	38	Asphalt Roofing	3.6%	14.5%	0.8%	6.3%	342
	39	Other C&D Material	0.1%	0.2%	0.0%	0.1%	8
	40	Electronics	2.4%	12.9%	0.0%	4.8%	225
	41	Bulky Items	15.8%	33.8%	9.4%	22.2%	1,514
	42	Tires	0.1%	0.2%	0.0%	0.3%	10
	43	Other Inorganic	9.1%	23.6%	4.6%	13.5%	871
	44	Other Hazardous Material	0.1%	0.2%	0.0%	0.2%	8
		Subtotal	46.0%	43.5%	37.8%	54.2%	4,411
		TOTAL	100.0%				9,582

Exhibit 6: C&D Results

		Materials	Adjusted Average Percent	Adjusted Standard Deviation	Adjusted 90%Conf. Interval Lower	Adjusted 90%Conf. Interval Upper	Annual Tons
PAPER	1	OCC/Kraft	0.5%	1.4%	0.2%	0.7%	113
	2	Newspaper	0.0%	0.0%	0.0%	0.0%	7
	3	Magazines/Glossy	0.0%	0.0%	0.0%	0.0%	1
	4	High Grade Paper	0.0%	0.0%	0.0%	0.0%	6
	5	Polycoated/Aseptic Containers	0.0%	0.0%	0.0%	0.0%	0
	6	Mixed (Other Recyclable)	0.2%	0.0%	0.0%	0.4%	46
	7	Other Paper (Non Recyclable)	0.3%	1.1%	0.1%	0.5%	65
		Subtotal	1.0%	3.1%	0.4%	1.6%	239
PLASTIC	8	#1 PET Bottles/Jars	0.0%	0.0%	0.0%	0.0%	1
	9	#2 HDPE Bottles/Jars	0.0%	0.0%	0.0%	0.0%	2
	10	#3 - 7 Bottles/Jars	0.0%	0.0%	0.0%	0.0%	1
	11	Expanded Polystyrene	0.1%	1.2%	0.0%	0.4%	35
	12	Films/Bags	0.1%	0.4%	0.0%	0.2%	17
	13	Other Ridged Plastic	0.2%	0.7%	0.0%	0.3%	43
		Subtotal	0.4%	1.6%	0.1%	0.7%	98
GLASS	14	Clear Glass	0.0%	0.0%	0.0%	0.0%	1
	15	Green Glass	0.0%	0.0%	0.0%	0.0%	0
	16	Brown Glass	0.0%	0.0%	0.0%	0.0%	1
	17	Other Glass/Broken Glass	3.9%	15.8%	0.9%	6.8%	944
		Subtotal	3.9%	15.8%	0.9%	6.8%	947
METAL	18	Ferrous Cans	0.0%	0.0%	0.0%	0.0%	2
	19	Other Ferrous Metals	2.4%	6.4%	1.2%	3.6%	596
	20	Aluminum Cans	0.0%	0.0%	0.0%	0.0%	0
	21	Other Aluminum	0.3%	1.7%	0.0%	0.6%	72
	22	Other Non-Ferrous	0.3%	1.5%	0.0%	0.5%	63
	23	Appliances	0.0%	0.2%	0.0%	0.1%	6
		Subtotal	3.0%	7.5%	1.6%	4.4%	740
ORANICS	24	Food Waste	0.1%	0.0%	0.0%	0.2%	27
	25	Diapers/Sanitary Products	0.0%	0.0%	0.0%	0.0%	1
	26	Textiles	0.0%	0.0%	0.0%	0.1%	8
	26A	Rubber/Leather	0.0%	0.1%	0.0%	0.0%	3
	27	Yard Waste -Grass/Leaves	0.2%	0.0%	0.1%	0.3%	44
	28	Land Clearing	1.3%	11.5%	0.0%	3.5%	322
	29	Clean Wood	10.9%	21.0%	6.9%	14.9%	2,671
	30	Painted/Stained Wood	6.0%	17.1%	2.8%	9.2%	1,478
	31	Other Wood	10.3%	25.5%	5.5%	15.2%	2,537
	32	Fines	0.0%	0.0%	0.0%	0.0%	5
	33	Other Organics	0.7%	4.8%	0.0%	1.6%	177
		Subtotal	29.7%	33.9%	23.3%	36.1%	7,273
INORGANICS	34	Carpet	11.8%	25.7%	6.9%	16.6%	2,886
	35	Drywall	15.1%	32.7%	9.0%	21.3%	3,710
	36	Block/Brick/Stone	11.2%	26.7%	6.1%	16.2%	2,737
	37	Insulation	1.7%	11.4%	0.0%	3.8%	407
	38	Asphalt Roofing	14.7%	31.7%	8.8%	20.7%	3,613
	39	Other C&D Material	1.2%	10.4%	0.0%	3.2%	292
	40	Electronics	0.1%	0.7%	0.0%	0.2%	29
	41	Bulky Items	0.8%	4.6%	0.0%	1.7%	195
	42	Tires	0.0%	0.0%	0.0%	0.1%	6
	43	Other Inorganic	5.4%	19.3%	1.8%	9.1%	1,334
	44	Other Hazardous Material	0.0%	0.0%	0.0%	0.1%	11
		Subtotal	62.1%	37.8%	55.0%	69.2%	15,219
		TOTAL	100.0%				24,516

Exhibit 7: Comparison of 1998 and 2006 Study Results

Residential Waste

Material Group	1998 Study			2006 Study			Difference
	Lower	**Mean**	Upper	Lower	**Mean**	Upper	
FERROUS METALS	2.2%	3.6%	5.0%	2.0%	3.0%	3.9%	0.6%
NON-FERROUS METALS	0.8%	1.0%	1.2%	1.3%	1.7%	2.1%	-0.7%
GLASS & CERAMICS	1.4%	1.9%	2.4%	2.7%	3.5%	4.2%	-1.6%
PAPER PRODUCTS	40.8%	43.9%	47.1%	28.6%	31.4%	34.3%	12.5%
FOOD WASTE	11.9%	14.2%	16.5%	14.8%	17.4%	20.1%	-3.2%
YARD WASTE	9.0%	13.6%	18.1%	5.3%	8.4%	11.5%	5.2%
TEXTILES	1.8%	2.6%	3.3%	2.4%	3.3%	4.2%	-0.7%
WOOD PRODUCTS	2.3%	3.9%	5.5%	1.4%	3.0%	4.6%	0.9%
PLASTIC, LEATHER, 7 RUBBER	10.7%	12.2%	13.7%	11.0%	11.9%	12.9%	0.3%
OTHER	2.1%	3.1%	4.2%	13.8%	16.4%	19.0%	-13.3%
TOTAL		**100%**			**100%**		

Commercial Waste

Material Group	1998 Study			2006 Study			Difference
	Lower	**Mean**	Upper	Lower	**Mean**	Upper	
FERROUS METALS	2.4%	4.0%	5.5%	2.2%	3.5%	4.8%	0.5%
NON-FERROUS METALS	0.5%	0.8%	1.1%	1.1%	2.0%	2.9%	-1.2%
GLASS & CERAMICS	0.7%	1.4%	2.1%	1.6%	2.7%	3.8%	-1.3%
PAPER PRODUCTS	11.1%	17.9%	24.6%	26.7%	31.6%	36.4%	-13.7%
FOOD WASTE	1.8%	4.0%	6.1%	12.0%	15.9%	19.9%	-12.0%
YARD WASTE	1.8%	9.9%	18.0%	3.1%	6.3%	9.6%	3.6%
TEXTILES	3.9%	8.2%	12.6%	0.9%	2.6%	4.3%	5.6%
WOOD PRODUCTS	17.8%	27.7%	37.6%	5.3%	8.9%	12.6%	18.8%
PLASTIC, LEATHER, & RUBBER	4.6%	7.0%	9.3%	9.4%	11.2%	13.0%	-4.3%
OTHER	9.8%	19.3%	28.7%	11.3%	15.2%	19.1%	4.0%
TOTAL		**100%**			**100%**		

Self-Haul Waste

Material Group	1998 Study			2006 Study			Difference
	Lower	**Mean**	Upper	Lower	**Mean**	Upper	
FERROUS METALS	4.3%	13.9%	23.5%	1.0%	2.9%	4.7%	11.1%
NON-FERROUS METALS	1.3%	3.3%	5.4%	0.0%	0.4%	0.9%	2.9%
GLASS & CERAMICS	2.2%	4.4%	6.6%	0.3%	2.8%	5.3%	1.6%
PAPER PRODUCTS	6.5%	13.3%	20.0%	7.6%	13.9%	20.1%	-0.6%
FOOD WASTE	0.7%	4.0%	7.3%	0.0%	2.1%	5.4%	1.9%
YARD WASTE	0.0%	10.6%	23.4%	4.7%	9.5%	14.2%	1.2%
TEXTILES	1.2%	3.2%	5.2%	3.6%	8.4%	13.1%	-5.1%
WOOD PRODUCTS	15.4%	27.4%	39.4%	9.7%	15.0%	20.2%	12.4%
PLASTIC, LEATHER, & RUBBER	6.0%	8.3%	10.5%	2.0%	4.5%	7.1%	3.8%
OTHER	2.8%	11.6%	20.4%	32.3%	40.7%	49.1%	-29.1%
TOTAL		**100%**			**100%**		

C&D Debris (not performed in 1998 Study)

Material Group	2006 Study		
	Lower	**Mean**	Upper
FERROUS METALS	1.2%	3.5%	1.2%
NON-FERROUS METALS	0.5%	2.0%	0.1%
GLASS & CERAMICS	3.3%	2.7%	0.6%
PAPER PRODUCTS	0.4%	31.6%	0.5%
FOOD WASTE	0.1%	15.9%	0.0%
YARD WASTE	3.1%	6.3%	0.0%
TEXTILES	0.0%	2.6%	0.0%
WOOD PRODUCTS	5.1%	8.9%	22.2%
PLASTIC, LEATHER, & RUBBER	0.4%	11.2%	0.0%
OTHER	7.0%	15.2%	55.8%
TOTAL		**100%**	

Appendix Appendix A: Material Definitions

Material Categories			Description	Recyclable [1]
Paper	1	Corrugated Cardboard	Paperboard containers consisting of Kraft (brown) linerboard with corrugated (fluted medium) fillings. Includes yellow and waxed corrugated boxes and Kraft paper such as bags or wrapping paper. Does not include non-corrugated paperboard products such as cereal, shoe, or gift boxes.	Yes
	2	Newspaper	Consists of all paper products printed on daily or weekly newspapers, advertising, catalogs, and other similar items. Publications can be one color (e.g., black and white) or multicolor.	Yes
	3	Magazines/Catalogs	Publications which are printed on glossy paper. This does not include magazines, catalogs, etc., which do not consist of glossy paper throughout (e.g., comic books.)	
	4	Office/Computer Paper	High grade ledger paper, such as typing and copy paper. Computer paper includes outputs from printers that may have green bars.	Yes
	5	Polycoated / Aseptic Containers	Aseptic juice boxes and gable top cartons.	
	6	Mixed (Other Recyclable)	All other recyclable paper not covered such as non-corrugated paperboard boxes, direct mail, and books.	Yes
	7	Other Paper (Non-Recyclable)	All products not covered by the above categories, including soiled and unsoiled tissues, paper towels, napkins, file folders, carbonless paper forms, and tissue (tracing) paper.	
Plastics	8	#1 PET Bottles	Clear or colored blow molded plastic bottles (i.e., with a narrow neck) labeled #1 PET.	Yes
	9	#2 HDPE Bottles	Natural or pigmented blow molded plastic bottles (i.e., with a narrow neck) labeled #2 HDPE.	Yes
	10	#3 - 7 Bottles	Blow molded bottles labeled #3, #4, #5 or #7.	
	11	Expanded Polystyrene	Expanded foam packaging, trays or containers labeled #6 PS. Includes foam polystyrene cups and food service containers (i.e., "clamshells") as well as clean service containers and packing "peanuts".	
	12	Films/Bags	Linear, translucent to opaque films/bags, such as grocery bags, dry film, trash and garbage bags.	
	13	Other Ridge Plastic	Rigid plastic not elsewhere classified. Includes plastic tubs, cups, trays, straws, and cutlery. Unmarked plastics such as materials made of multi-composite materials that may contain more than one type of plastic and/or metal, and all other plastics not otherwise described including items such as toys.	

Appendix Appendix A: Material Definitions

Material Categories			Description	Recyclable [1]
Glass	14	Clear Glass	Clear glass food and beverage containers.	Yes
	15	Green Glass	Green Glass food and beverage containers.	Yes
	16	Brown Glass	Brown glass food and beverage containers.	Yes
	17	Other Glass	Includes a variety of miscellaneous glass products such as mirrors, leaded crystal, eyeglasses, and blown glass such as light bulbs, auto glass, windows, TV tubes heat resistant cookware (Pyrex), pottery, and drinking glasses.	
Metals	18	Steel Cans	Fabricated, magnetizable metal containers such as steel or bimetal designed to hold food or beverage products such as soups, vegetables, pet food and juices. Includes two piece containers with aluminum tops.	Yes
	19	Other Ferrous Metals	Ferrous and alloyed ferrous scrap materials originated from residential commercial, or institutional sources which are attracted to a magnet. This category includes wire coat hangers, aerosol cans, and auto parts.	
	20	Aluminum Cans	Aluminum containers used for holding beverages	Yes
	21	Other Aluminum	This category includes all other aluminum products such as lawn chairs, tables, carts, house siding, rain gutters, window frames, cookware, flatware, aluminum foil, other miscellaneous utensils, and die cast aluminum auto or machine parts.	
	22	Other Non-Ferrous	Non-magnetic metals such as brass, bronze, silver, lead copper, and zinc. Stainless steel house wares are also part of this category.	
	23	Appliances	Stoves, refrigerators, dishwashers and all other large and small household appliances including fragments.	
Organics	24	Food Waste	Putrescible organic materials which are the by-products of activities connected with the growing, preparation, cooking, processing, or consumption of food by human beings or domesticated animals.	
	25	Diapers/Sanitary Products	Diapers and sanitary products.	
	26	Textiles	Fabric materials including natural and synthetic fibers such as cotton, wool, silk, nylon, rayon, or polyester; and Products included within this category would be woven clothing, curtains, stuffed toys, pillows, rags, and upholstery.	
	26A	Rubber/Leather	Materials consisting of natural or synthetic rubber and leather. Products included within this category would be belts, handbags, wallets, and mixed items such as footwear.	
	27	Yard Waste	Grass clippings, leaves, brush and prunings.	
	28	Land Clearing	Logs, stumps, trunks, and limbs	
	29	Clean Wood	Unpainted or unfinished (saw cut) lengths of wood from building structures, furniture or vehicles (e.g., cars, boats), pallets and creates.	

Appendix Appendix A: Material Definitions

Material Categories			Description	Recyclable [1]
Organics	30	Painted/Stained /Treated/MfgWood	Painted or stained lengths of wood from construction or woodworking activities, particle board, OSB, plywood, and treated wood	
	31	Other Wood	Other wood products not elsewhere classified. Includes house wares (spoons, bowls), decorative objects, small furnishings, sawdust, and small animal bedding.	
	32	Fines	Any materials passing through the 1/2 inch screen on the sorting table that cannot be categorized.	
	33	Other Organics	All other organic material not otherwise described, including substances such as feces, lint, vacuum bags, and animal litter.	
Inorganic	34	Carpet	Man made fibrous carpets, rugs or padding from residential or commercial buildings, including carpet backing.	
	35	Drywall	Also called sheetrock or gypsum wallboard.	
	36	Block/Brick/Stone	Concrete, brick, stones, cut stone, cement, and rocks	
	37	Insulation	Fiberglass and other inorganic insulation	
	38	Asphalt Roofing	Asphalt shingles or tar paper.	
	39	Other C&D Material	Ceiling tiles, dirt, dust or ash generated from construction and demolition activities. PVC pipe, 5-gallon HDPE buckets, HVAC ducting, and other related C&D material.	
	40	Electronics	Any item that contains a circuit board including, televisions, radio, stereo, computer, and CRT.	
	41	Bulky Items	Chairs, couches, mattresses, desks, and other oversized items made of multiple materials.	
	42	Tires	Solid or pneumatic rubber or steel belted tires.	
	43	Other Inorganic	Other inorganic items not elsewhere classified.	
	44	Hazardous Material	This category includes paints/solvents, flammable liquids, pesticides, corrosives, medical wastes and any other hazardous material not otherwise described.	

[1] These are the materials targeted for recycling in Larimer County's public education information.

Appendix A: Mapping of Material Categories Between 1998 and 2006 Studies

1998 Material Categories			2006 Separated Material Categories
Ferrous Metals	Soup Cans, Scrap Steel, and Auto Parts	18	Steel Cans
		19	Other Ferrous Metals
		23	Appliances
Non-Ferrous Metals	Aluminum Cans/Foil, Electrical Wire, Scrap Metal	20	Aluminum Cans
		21	Other Aluminum
		22	Other Non-Ferrous
Glass & Ceramics	Bottles, Dishes, Etc.	14	Clear Glass
		15	Green Glass
		16	Brown Glass
		17	Other Glass
Paper Products	Junk Mail, Newspaper, Magazines, Cereal Boxes and Cardboard	1	Corrugated Cardboard
		2	Newspaper
		3	Magazines/Catalogs
		4	Office/Computer Paper
		5	Polycoated / Aseptic Containers
		6	Mixed (Other Recyclable)
		7	Other Paper (Non-Recyclable)
Food Waste	Food Waste	24	Food Waste
Yard Waste	Yard Waste	27	Yard Waste
		28	Land Clearing
Textiles	Textiles	26	Textiles
Wood Products	Lumber, Funiture, Etc.	29	Clean Wood
		30	Painted/Stained /Treated/MfgWood
		31	Other Wood
Plastic, Leather & Rubber	Plastic Bags, Plastic Containers, Toys, and Shoes	8	#1 PET Bottles
		9	#2 HDPE Bottles
		10	#3 - 7 Bottles
		11	Expanded Polystyrene
		12	Films/Bags
		13	Other Ridge Plastic
		26A	Rubber/Leather
Other Waste	Rock, Brick, Concrete, Dirts, Drywall, Asphalt Shingles, Flashlight Batteries, Etc.	35	Drywall
		36	Block/Brick/Stone
		37	Insulation
		38	Asphalt Roofing
		39	Other C&D Material
		40	Electronics
		41	Bulky Items
		25	Diapers/Sanitary Products
		34	Carpet
		42	Tires
		43	Other Inorganic
		32	Fines
		33	Other Organics
		44	Hazardous Material