Chapter 13: Summary

Phase I of the *Missouri Waste Composition Study* examined municipal solid waste (MSW) during three seasonal waste sorts at ten landfills and transfer stations throughout the state of Missouri. The summary findings of these waste sorts are reported below.

Sampling information

Samples of MSW were taken from licensed waste haulers at ten landfills and transfer stations throughout Missouri. These samples consisted of 20-25 bags of residential and light commercial "trash". The waste haulers were selected at random and served only residential and commercial accounts. The waste haulers estimated the commercial/residential mix of their load and the percentage of each was entered onto the sample data sheet. No construction and demolition wastes, sewage sludge, combustion ash, or industrial process waste was sampled.

During Phase I, 350 samples were selected and the materials sorted into 26 sub-categories. These categories are defined in Chapter 2. After the sample was completely sorted and placed into the appropriate containers they were weighed, volumes estimated, and the data recorded.

The average sample size was 219 pounds by weight and 48 cubic feet by volume. The total weight of the samples was 76,750 pounds, and the volume was 16,728 cubic feet.

Table 13-1 indicates the number of samples examined at each location, the weight and volume of those samples, and an estimated composition of the sample.

MISSOURI WASTE COMPOSITION STUDY
PHASE I
SAMPLE SUMMARY

Location	Number of Samples	Sample Size		Composition	
		Weight	Volume	Residential	Commercial
Springfield	32	7,078	1,547	90%	10%
Reeds Spring	40	9,282	2,032	43%	57%
Pemiscot County	40	8,342	1,831	81%	19%
St. Francois County	39	8,854	1,877	87%	13%
St. Louis	40	7,149	1,642	100%	0%
Macon	24	5,786	1,199	70%	30%
Maryville	34	7,368	1,854	98%	2%
Lee's Summit	35	8,486	1,640	86%	14%
Clinton	28	6,342	1,331	71%	29%
Lamar	38	8,064	1,774	53%	47%
Total	**350**	**76,750**	**16,728**	**80%**	**20%**

TABLE 13-1

Results by weight

Table 13-2 shows the percentage of materials, by weight, found in the MSW during the three seasonal sorts. The average is based on the total weight of that material for all three sorts, divided by the total weight sorted. A description of each category is listed in Chapter 2. Chart 13-1 represents the same information in four pie charts.

The results were fairly consistent from one round to the next. Small fluctuations are mentioned in each location chapter (3-12). There were only two major changes from one seasonal sort to the next.

One change was in the "fines" category (small items too small to be separated efficiently). A change in sorting procedure at the end of the first round of sorts resulted in better accuracy during the second and third round of sorts. This resulted in a lower percentage of "fines" during the second and third sorts. About half of the material counted as "fines" during the first round of sorts was counted as food waste in the second and third rounds of sorts.

The second change was the increase in the "organics" category throughout the year. This was a result of additional fruit and melon rinds in the food waste, and increased yard waste and corn shucks in the "other organics" sub-category. Watermelon rinds were present from mid May through September. Yard waste is officially banned from Missouri landfills and transfer stations but small quantities of grass clippings and leaves were occasionally "smuggled in" and found in sealed bags. Corn shucks increased significantly during the summer months. Both yard waste and corn shucks were put into the "other organics" sub-category.

PHASE I SUMMARY RESULTS BY WEIGHT

	SORT # 1	SORT # 2	SORT #3	AVERAGE
	2/5/96-4/10/96	5/13/96-7/17/96	9/3/96-11/13/96	2/5/96-11/13/96
CATEGORY	WT.	WT.	WT.	WT.
Cardboard	6.6%	6.2%	6.5%	6.4%
Newsprint	7.6%	7.6%	8.3%	7.8%
Magazines	3.2%	3.4%	3.8%	3.5%
High Grade	2.1%	3.2%	3.6%	2.9%
Mixed	18.1%	16.3%	14.0%	16.2%
PAPER TOTALS	37.6%	36.6%	36.1%	36.8%
Clear	3.6%	3.3%	3.1%	3.3%
Brown	1.6%	1.6%	1.8%	1.7%
Green	0.4%	0.4%	0.4%	0.4%
Other	0.5%	0.8%	0.7%	0.7%
GLASS TOTALS	6.1%	6.0%	6.1%	6.1%
Alum. Cans	1.2%	1.7%	1.7%	1.5%
Other Alum	0.6%	0.9%	0.9%	0.8%
Non ferrous	0.2%	0.3%	0.3%	0.3%
Food Cans	3.2%	2.7%	3.4%	3.1%
Ferrous	1.1%	1.1%	1.3%	1.1%
Oil Filters	0.1%	0.1%	0.0%	0.1%
METAL TOTALS	6.5%	6.8%	7.6%	6.9%
PET # 1	1.5%	1.8%	1.9%	1.7%
HDPE # 2	1.9%	2.0%	2.5%	2.1%
Film	3.8%	3.6%	3.1%	3.5%
Other Plastic	6.1%	7.6%	7.3%	7.0%
PLASTIC TOTALS	13.3%	14.9%	14.9%	14.3%
Food Waste	16.4%	18.8%	19.3%	18.1%
Wood Waste	0.7%	0.8%	0.9%	0.8%
Textiles	4.1%	4.3%	4.0%	4.1%
Diapers	5.1%	3.9%	3.7%	4.3%
Other Organics	2.4%	3.5%	4.1%	3.3%
ORGANIC TOTALS	28.7%	31.4%	32.0%	30.6%
Fines	6.1%	2.6%	2.0%	3.6%
Other Inorganics	1.9%	1.7%	1.2%	1.6%
INORGANIC TOTALS	7.9%	4.3%	3.2%	5.2%
SORT TOTALS	100%	100%	100%	100%

TABLE 13-2

PHASE I SUMMARY RESULTS BY WEIGHT

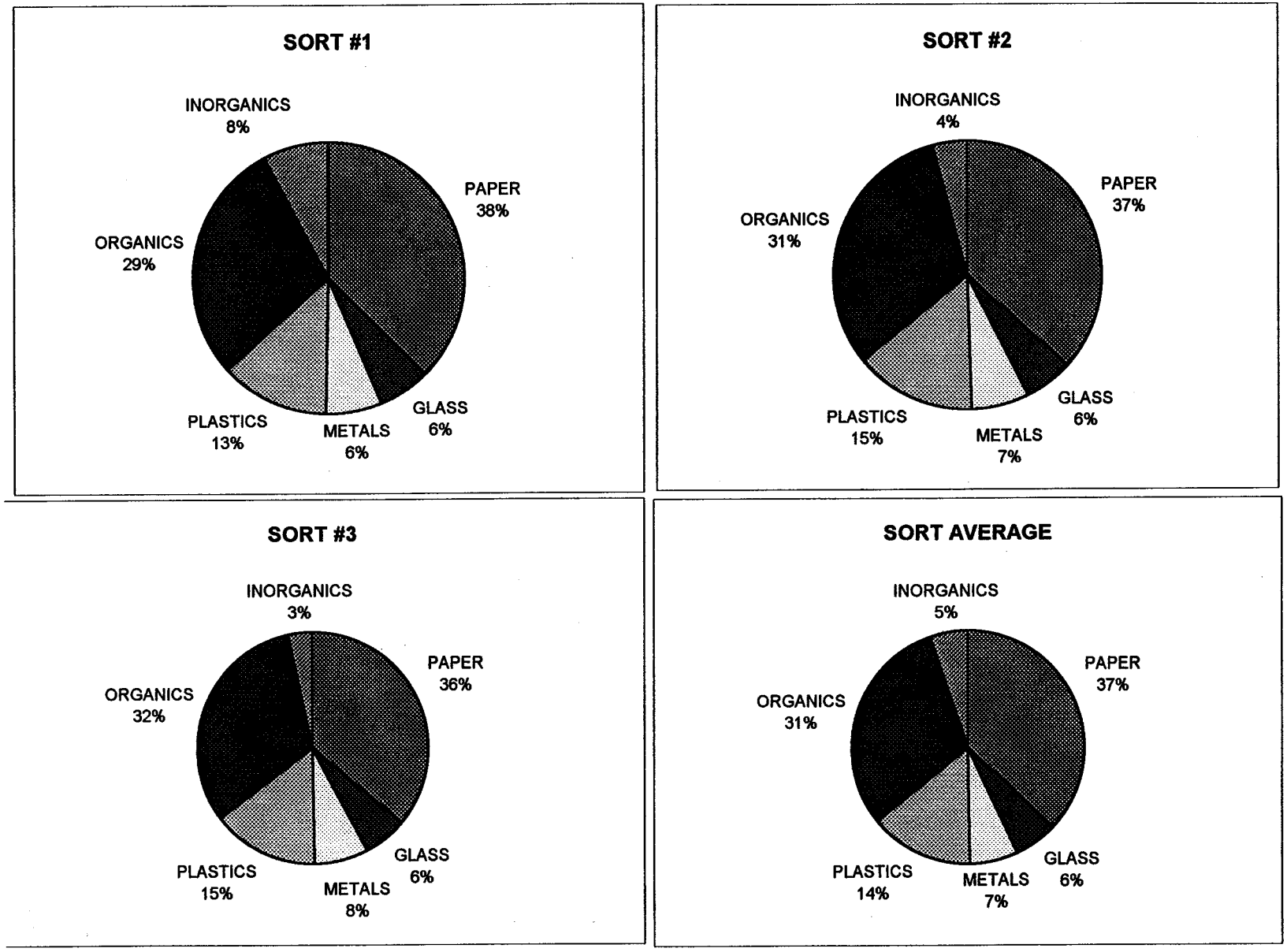


CHART 12-4

Comparison of waste composition among locations

Table 13-3 lists the average composition of waste at each location. Chart 13-2 represents this information graphically for the six major categories (paper, glass, metals, plastics, organics, and inorganics). The following observations were noted during the waste sorts which may explain some of the obvious differences between sorting locations:

Paper

- Reeds Spring was higher in paper waste due to the promotional literature discarded by the Branson tourists.
- St. Louis and Lee's Summit had higher percentages of newsprint due to the presence of voluminous daily newspapers (the *Kansas City Star* and the *St. Louis Post Dispatch*).
- Maryville had the lowest percentage of paper due to their aggressive recycling program. The high tipping fee at the Maryville landfill ($56.00 per ton at the landfill but no charge to drop off recyclables at the material recovery facility) seems to be an economic incentive for waste haulers to offer curbside recycling and encourage their customers to recycle.
- Pemiscot County had higher amounts of mixed paper at each of the seasonal sorts. Large amounts of paper food plates were particularly noticeable. One local waste hauler thought this was a result of lower income homes without running water to wash dishes.

Glass

- Maryville had the lowest percentage of glass probably due to their recycling program.

Metals

- Maryville had the lowest percentage of aluminum and steel cans probably due to recycling.
- Clinton had the highest percentage of aluminum cans. Many of these cans came from tourist areas around the Quad lakes area during the July waste sort.

Plastics

- The percentage of other plastics and plastic film (bags) were higher in Reeds Spring, especially during the second sort. Most of the samples originated in Branson and were directly related to the tourist industry (plastic drink cups and motel trash).

- Macon had a higher percentage of other plastics. This was a result of several samples from commercial generators which disposed large amounts of heavy rigid plastics.

- Maryville had the lowest percentage of PET and HDPE, probably due to recycling.

Organics

- Maryville had the highest percentage of organics. The reduction in recyclables increased the organic percentage.

- The low percentage of food waste in Reeds Spring may indicate that the restaurant waste was not included during the random sample selection process.

- The high percentage of diapers in the Macon and Maryville samples is a result of nursing home waste (adult diapers).

Inorganics

- Most of the other inorganic category was kitty litter.

- Maryville had a high percentage of kitty litter while the University was in session, suggesting that there may be a large number of students with pet cats.

- Lee's Summit and St. Louis also had higher percentages of kitty litter, suggesting that cats are more prevalent in urban areas.

COMPARABLE RESULTS BY LOCATION

CATEGORY	Springfield PCT. BY WT.	Reeds Spring PCT. BY WT.	Pemiscot Co. PCT. BY WT.	St. Francois Co. PCT. BY WT.	St. Louis PCT. BY WT.
Cardboard	7.4%	7.7%	6.4%	6.9%	4.4%
Newsprint	9.5%	7.2%	5.6%	6.6%	13.3%
Magazines	2.6%	3.5%	3.7%	3.9%	3.0%
High Grade	1.8%	3.6%	2.9%	2.8%	2.8%
Mixed	18.3%	18.5%	19.0%	14.7%	13.1%
PAPER TOTALS	**39.6%**	**40.5%**	**37.6%**	**34.9%**	**36.6%**
Clear	3.1%	3.9%	3.7%	3.9%	3.8%
Brown	1.4%	2.1%	2.3%	1.9%	2.2%
Green	0.4%	0.5%	0.4%	0.2%	0.7%
Other	0.4%	0.5%	0.6%	0.5%	0.7%
GLASS TOTALS	**5.3%**	**7.0%**	**7.0%**	**6.5%**	**7.4%**
Alum. Cans	1.4%	1.8%	1.7%	1.6%	1.5%
Other Alum	0.7%	0.7%	0.9%	0.8%	0.7%
Non ferrous	0.1%	0.2%	0.2%	0.3%	0.3%
Food Cans	4.0%	2.9%	3.3%	3.9%	2.6%
Ferrous	1.1%	1.5%	0.8%	1.2%	1.2%
Oil Filters	0.1%	0.2%	0.0%	0.1%	0.0%
METAL TOTALS	**7.4%**	**7.3%**	**6.9%**	**7.9%**	**6.3%**
PET # 1	2.2%	2.1%	1.6%	1.8%	1.3%
HDPE # 2	2.3%	2.3%	2.2%	2.4%	1.7%
Film	4.1%	4.5%	3.7%	3.3%	2.9%
Other Plastic	5.9%	8.4%	6.4%	6.6%	6.5%
PLASTIC TOTALS	**14.5%**	**17.3%**	**13.9%**	**14.1%**	**12.4%**
Food Waste	16.8%	12.8%	19.8%	17.9%	18.0%
Wood Waste	1.0%	0.9%	0.4%	0.7%	0.6%
Textiles	3.7%	3.5%	3.4%	6.1%	4.1%
Diapers	3.8%	2.3%	4.0%	4.2%	3.8%
Other Organics	3.0%	2.1%	2.3%	2.7%	5.0%
ORGANIC TOTALS	**28.3%**	**21.6%**	**29.9%**	**31.6%**	**31.5%**
Fines	3.8%	5.0%	3.4%	4.1%	4.3%
Other Inorganics	1.3%	1.4%	1.1%	1.0%	1.8%
INORGANIC TOTALS	**5.1%**	**6.4%**	**4.5%**	**5.1%**	**6.1%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

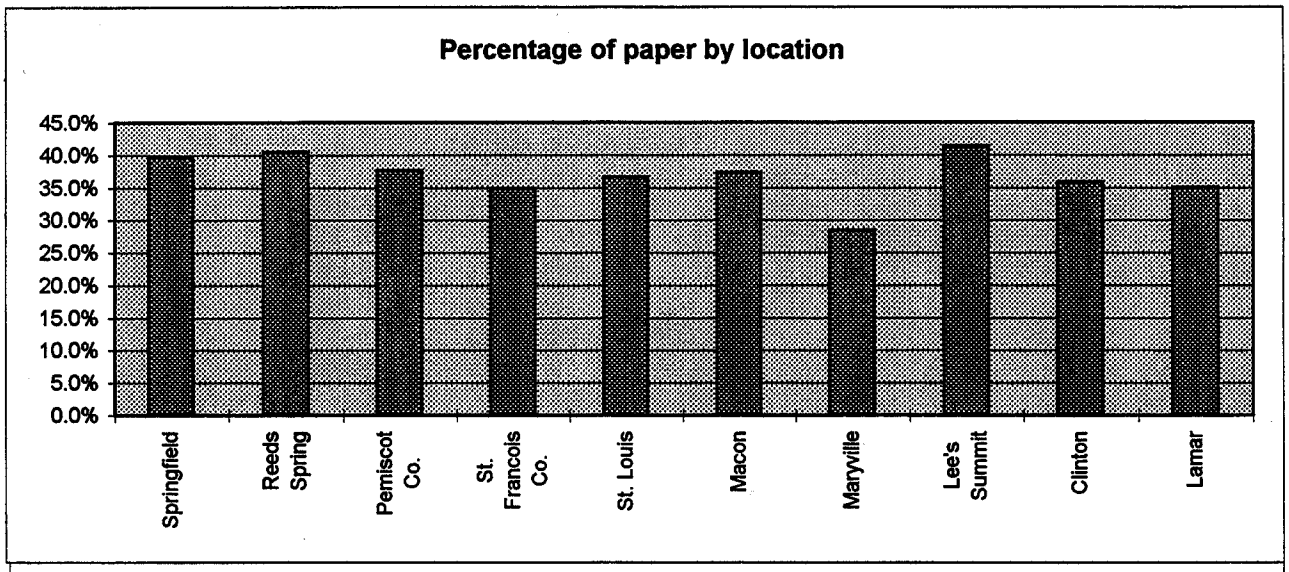
TABLE 13-3

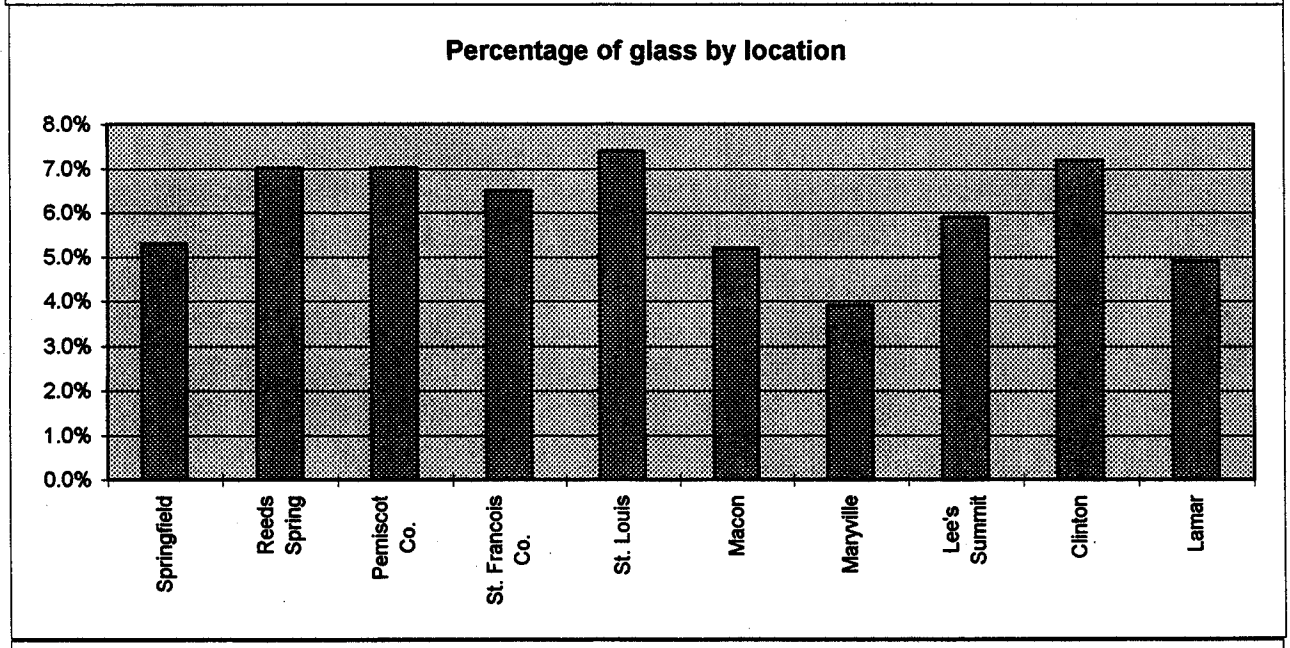
COMPARABLE RESULTS BY LOCATION

Macon PCT. BY WT.	Maryville PCT. BY WT.	Lee's Summit PCT. BY WT.	Clinton PCT. BY WT.	Lamar PCT. BY WT.	CATEGORY
7.4%	4.6%	6.4%	5.5%	7.0%	Cardboard
5.8%	3.5%	13.1%	7.4%	6.0%	Newsprint
3.7%	1.7%	4.4%	3.6%	4.2%	Magazines
4.8%	1.4%	3.8%	3.3%	2.3%	High Grade
15.6%	17.3%	13.7%	16.0%	15.6%	Mixed
37.3%	**28.5%**	**41.4%**	**35.8%**	**35.1%**	**PAPER TOTALS**
2.6%	1.6%	3.0%	4.3%	3.0%	Clear
1.3%	1.2%	1.6%	1.7%	1.0%	Brown
0.4%	0.2%	0.5%	0.5%	0.3%	Green
0.9%	0.9%	0.8%	0.7%	0.6%	Other
5.2%	**3.9%**	**5.9%**	**7.2%**	**4.9%**	**GLASS TOTALS**
1.7%	0.6%	1.7%	2.2%	1.3%	Alum. Cans
0.8%	1.1%	0.8%	0.9%	0.8%	Other Alum
0.3%	0.3%	0.2%	0.4%	0.4%	Non ferrous
3.0%	1.6%	2.7%	3.5%	3.4%	Food Cans
1.1%	1.4%	0.9%	1.1%	1.1%	Ferrous
0.0%	0.1%	0.0%	0.1%	0.1%	Oil Filters
6.9%	**5.1%**	**6.3%**	**8.2%**	**7.1%**	**METAL TOTALS**
1.8%	0.9%	1.5%	2.0%	2.1%	PET # 1
1.9%	1.3%	2.0%	2.3%	2.5%	HDPE # 2
3.1%	3.4%	3.2%	3.1%	3.4%	Film
8.3%	8.4%	5.8%	6.2%	7.5%	Other Plastic
15.1%	**14.0%**	**12.5%**	**13.6%**	**15.5%**	**PLASTIC TOTALS**
18.0%	25.4%	15.2%	19.4%	19.6%	Food Waste
0.9%	0.9%	1.0%	1.1%	0.5%	Wood Waste
5.6%	3.3%	3.7%	2.8%	5.2%	Textiles
5.0%	6.6%	4.8%	4.4%	4.3%	Diapers
2.9%	4.7%	4.1%	3.2%	3.4%	Other Organics
32.4%	**40.9%**	**28.8%**	**30.9%**	**33.0%**	**ORGANIC TOTALS**
1.7%	4.5%	3.0%	2.9%	2.7%	Fines
1.4%	3.0%	2.2%	1.4%	1.6%	Other Inorganics
3.1%	**7.5%**	**5.2%**	**4.3%**	**4.3%**	**INORGANIC TOTALS**
100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**TOTAL**

TABLE 13-3

COMPARISON OF CATEGORIES BY LOCATION





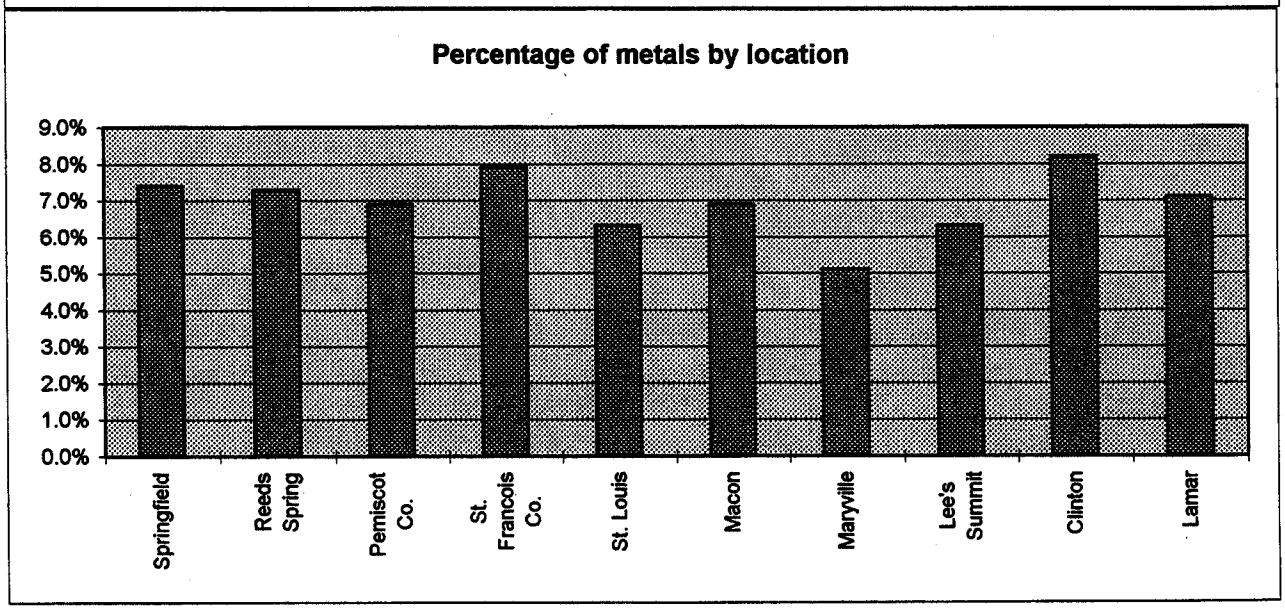
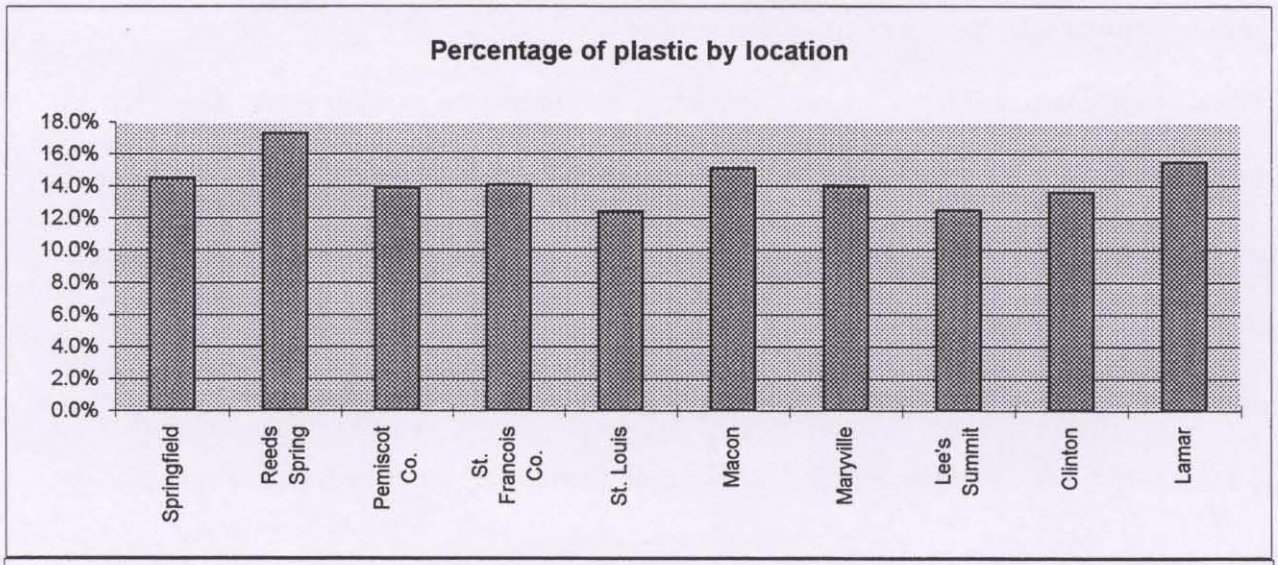
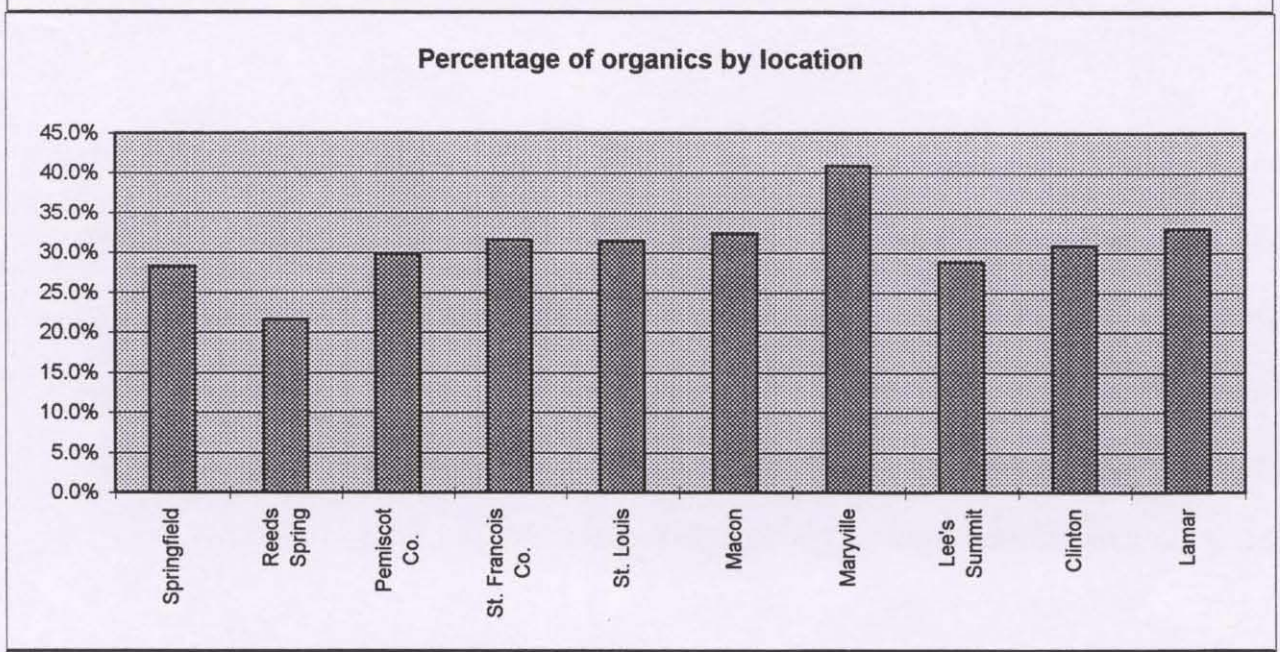


CHART 13-2

COMPARISON OF CATEGORIES BY LOCATION





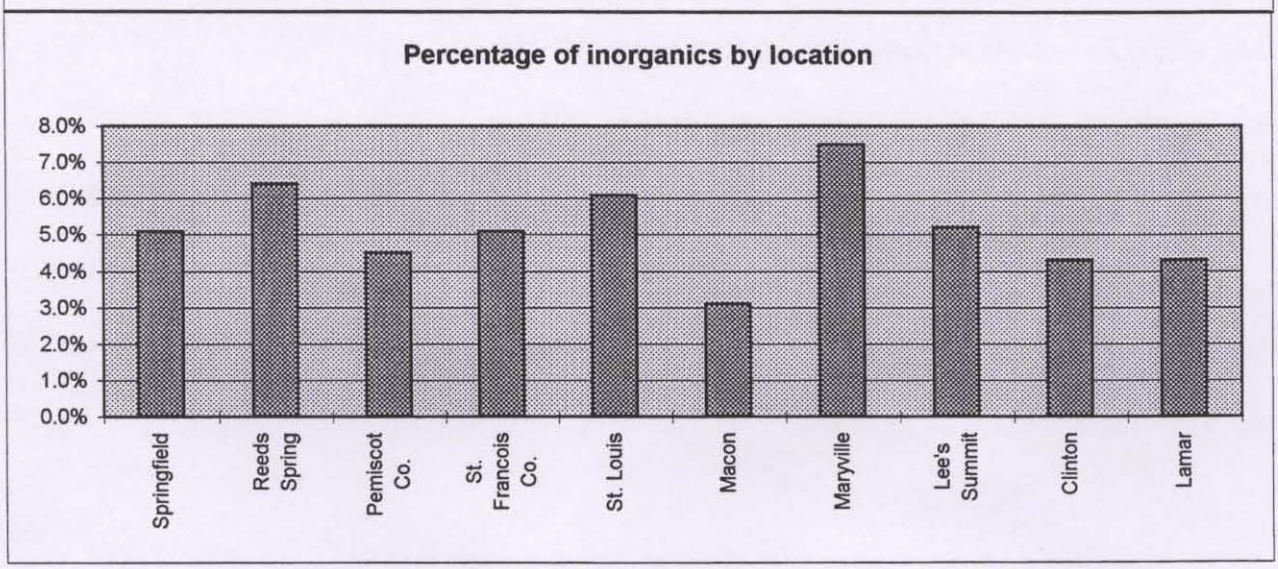


CHART 13-2

Comparisons to other waste composition studies

Several waste composition studies have been conducted during the past ten years. These studies vary greatly in the type of methodology used to gather the data. Most of these waste composition studies chose different waste categories or defined their categories differently. This difference in categories makes comparisons somewhat difficult but not impossible. In some cases sub-categories were grouped together to form the major categories for comparison. The comparisons are listed in Table 13-4 and graphically portrayed on Chart 13-3. The five waste composition studies selected for comparisons are:

The Missouri Statewide Resource Recovery Feasibility and Planning Study: EIERA 1987

This was the first statewide waste composition study done in Missouri. Two seasonal sorts were conducted at four landfills. The waste sorts were performed before yard waste was banned in Missouri, therefore it is included in the other organics sub category. This comparison indicates how the Missouri waste stream has changed over the past nine years. Table 13-5 compares the changes in composition of waste at two landfills between 1987 and 1996.

Solid Waste Stream Assessment: Leelanau County, Michigan. 1989

This solid waste stream assessment was conducted by Franklin and Associates in 1988. It consisted of four seasonal sorts of residential and commercial waste into categories that closely resembled the *Missouri Waste Composition Study* so comparisons were compatible. At the time the area had an emerging recycling and composting program, similar to the recycling program in Maryville. Yard waste was not banned from landfills and is included as other organics.

Oregon Solid Waste Characterization and Composition 1992-93

The study consisted of four seasonal sorts of residential and commercial waste. The waste was sorted into 83 categories, so many of those categories were combined for comparison purposes. Oregon had an extensive waste reduction and recycling program in place before, and during, the waste sorts. Yard waste was not banned from landfills and is included as other organics.

The Minnesota Solid Waste Composition Study 1990-1992

The Minnesota study was conducted by the Minnesota Pollution Control Agency. It consisted of four seasonal waste sorts conducted over a two year period. The results used on Table 13-4 are from sorts conducted in 1991-92. Samples were taken from residential and commercial waste haulers. During the year, 1,119 samples weighing 343,007 pounds were sorted. The methodology for this study was used in planning the *Missouri Waste Composition Study*.

Characterization of Municipal Solid Waste in the United States: 1994 update

This study was funded, and distributed by the Environmental Protection Agency. It is better known in solid waste circles as the "Franklin Study". The authors of the study, Franklin and Associates use the "material flows methodology " to determine the composition of solid waste. This methodology is based on production data (by weight) for the materials and products in the waste stream, with adjustments for imports, exports, and product lifetimes.

The Franklin study defined categories differently than other waste composition studies. Main divisions include durable goods, nondurable goods, containers and packaging, and other wastes. Materials can be listed in one or more of these major divisions. Every effort was made to maintain accuracy and still fit the "Franklin categories" into the categories used for comparisons.

Differences between the waste composition studies

Comparisons between the different waste composition data is interesting. If we assume that the methodology used to conduct the study has provided accurate results, there seem to be two main components that effect the data. These two are banned items and recycling. The items that are banned from disposal in Missouri landfills are:

- Major appliances (white goods)
- Waste oil
- Lead-acid batteries
- Yard waste or clippings

The ban on yard waste seems to have a remarkable effect on reducing the amount of organic materials in the waste stream. The organic component in the Missouri waste stream is considerably lower than the organic materials in the other studies. The most plausible explanation seems to be the lack of yard waste.

Recycling also seems to have an effect on the composition of the waste stream. Michigan, Oregon, and Minnesota had strong recycling programs in effect during their waste sorts. The only Missouri location which has a similar recycling program is the City of Maryville. Maryville seems to be comparable to these other states in the percentage of "recyclable material" within the waste stream.

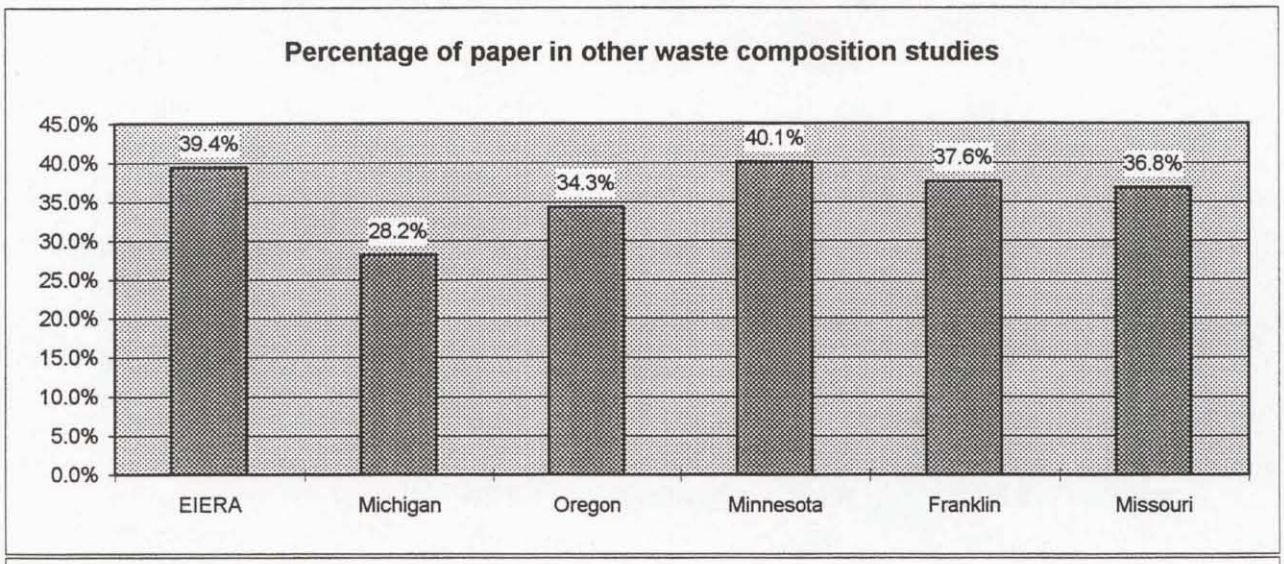
Waste sorts were conducted at two landfills (Lee's Summit and Springfield) in both the 1987 and 1996 study. The results portray how the waste stream is changing over time. Table 13-5 lists the results of the 1987 EIERA waste sorts and the 1996 waste sorts at these landfills. Many of these changes reflect cultural and packaging changes. Cardboard and other organics (including yard waste) were higher in 1987. Newsprint, plastics, food waste and diapers were higher in 1996.

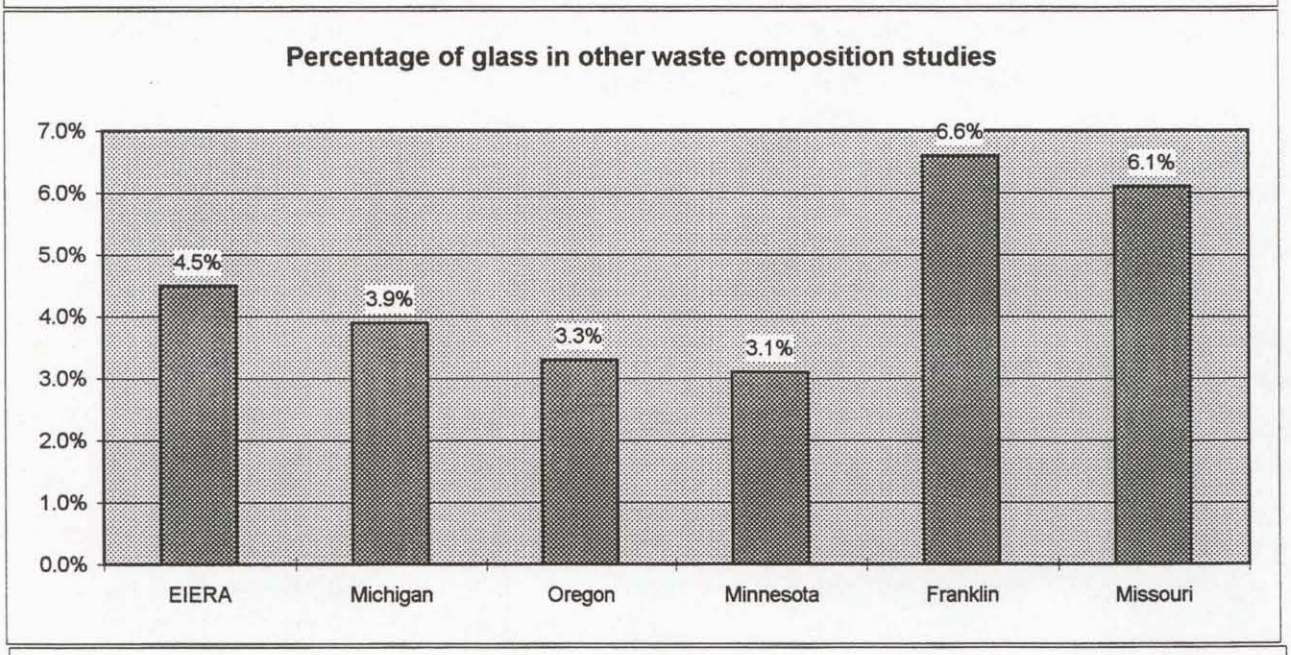
COMPARISSON OF OTHER WASTE COMPOSITION STUDIES

CATEGORY	1987 EIERA	1989 Michigan	1992 Oregon	1992 Minnesota	1994 Franklin	1996 Missouri
Cardboard	15.1%	16.9%	6.1%	8.7%	11.1%	6.4%
Newsprint	6.6%	6.2%	4.3%	4.0%	4.3%	7.8%
Magazines	1.7%	3.1%	2.5%	2.9%	2.2%	3.5%
High Grade	3.2%	2.0%	3.1%	4.5%	2.8%	2.9%
Mixed	12.7%	N/A	18.3%	20.0%	17.2%	16.2%
PAPER TOTALS	**39.4%**	**28.2%**	**34.3%**	**40.1%**	**37.6%**	**36.8%**
Clear	3.0%	N/A	3.0%	2.0%	2.5%	3.3%
Brown	0.8%	N/A	N/A	N/A	2.4%	1.7%
Green	0.7%	N/A	N/A	N/A	0.9%	0.4%
Other	N/A	N/A	0.3%	1.1%	0.8%	0.7%
GLASS TOTALS	**4.5%**	**3.9%**	**3.3%**	**3.1%**	**6.6%**	**6.1%**
Alum. Cans	1.0%	N/A	0.1%	0.5%	0.4%	1.5%
Other Alum	0.5%	N/A	0.2%	0.4%	0.2%	0.8%
Non ferrous	0.1%	0.8%	N/A	0.5%	N/A	0.3%
Food Cans	2.0%	N/A	2.0%	0.9%	1.0%	3.1%
Ferrous	3.5%	6.6%	3.6%	2.8%	6.7%	1.1%
Oil Filters	N/A	N/A	N/A	0.1%	N/A	0.1%
METAL TOTALS	**7.0%**	**7.4%**	**5.9%**	**5.2%**	**8.3%**	**6.9%**
PET # 1	0.4%	N/A	N/A	0.3%	0.2%	1.7%
HDPE # 2	0.3%	N/A	N/A	0.7%	0.3%	2.1%
Film	N/A	N/A	N/A	4.7%	1.7%	3.5%
Other Plastic	7.1%	N/A	N/A	5.9%	7.1%	7.0%
PLASTIC TOTALS	**7.7%**	**9.1%**	**7.8%**	**11.6%**	**9.3%**	**14.3%**
Food Waste	8.3%	9.7%	22.3%	13.2%	6.7%	18.1%
Wood Waste	N/A	5.6%	3.9%	6.6%	6.6%	0.8%
Textiles	3.9%	2.1%	2.4%	3.0%	2.4%	4.1%
Diapers	1.5%	2.0%	2.2%	2.4%	1.3%	4.3%
Other Organics	21.6%	24.9%	13.2%	11.0%	19.3%	3.3%
ORGANIC TOTALS	**35.3%**	**44.3%**	**44.0%**	**36.2%**	**36.3%**	**30.6%**
Fines	2.9%	5.3%	3.0%	N/A	N/A	3.6%
Other Inorganics	2.9%	1.8%	1.7%	3.8%	1.9%	1.6%
INORGANIC TOTALS	**5.8%**	**7.1%**	**4.7%**	**3.8%**	**1.9%**	**5.2%**
TOTAL	**99.6%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

TABLE 13-4

COMPARISON OF OTHER WASTE COMPOSITION STUDIES





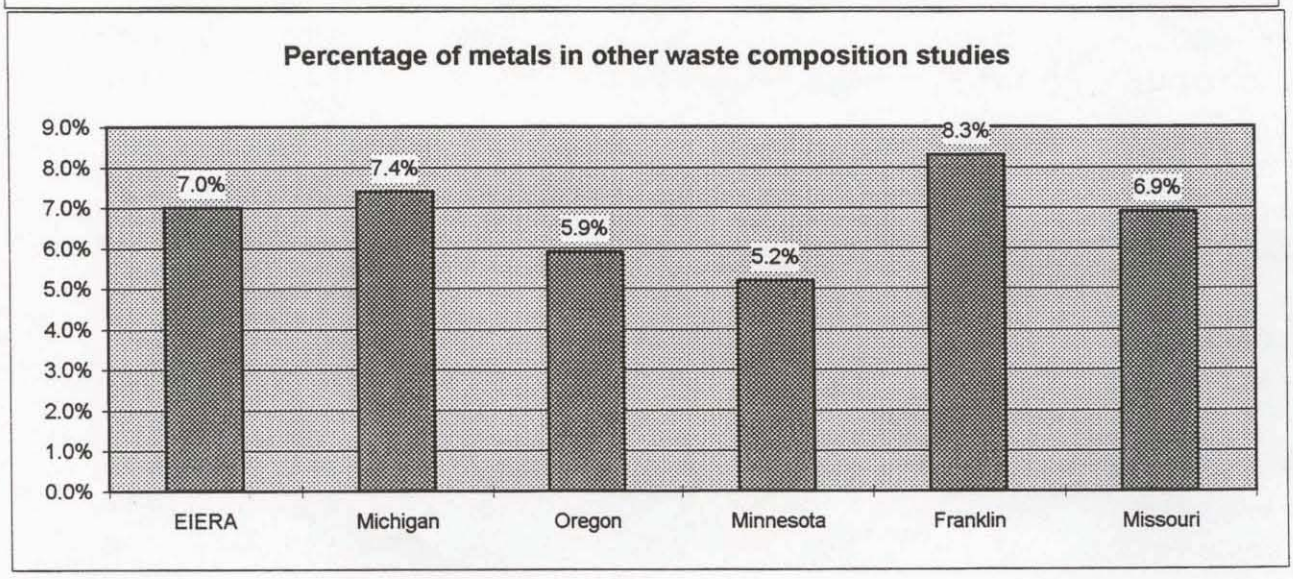
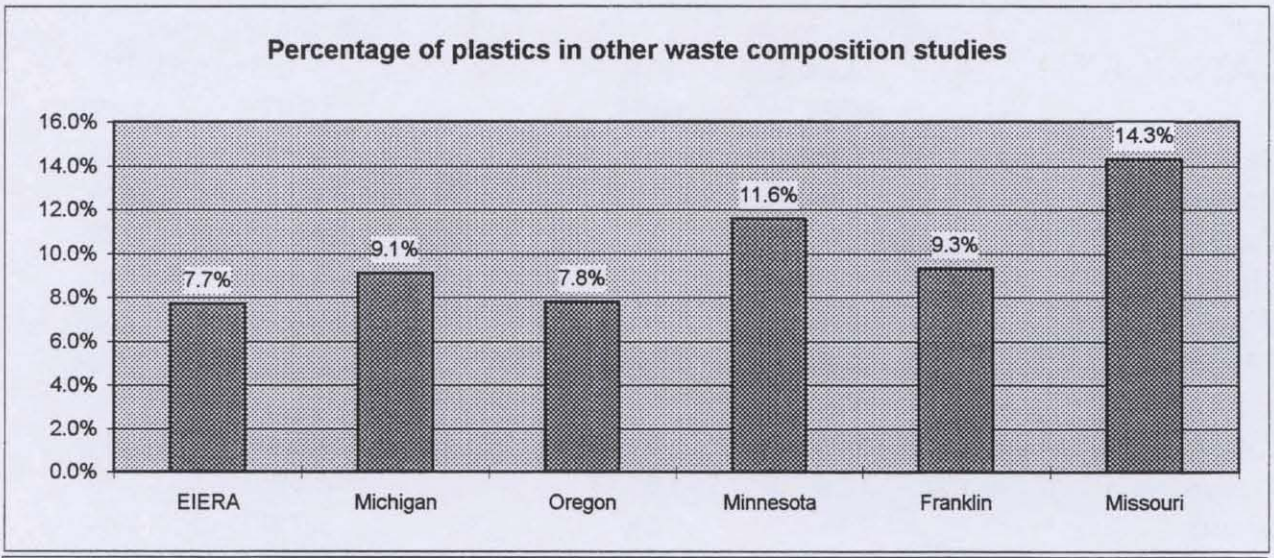
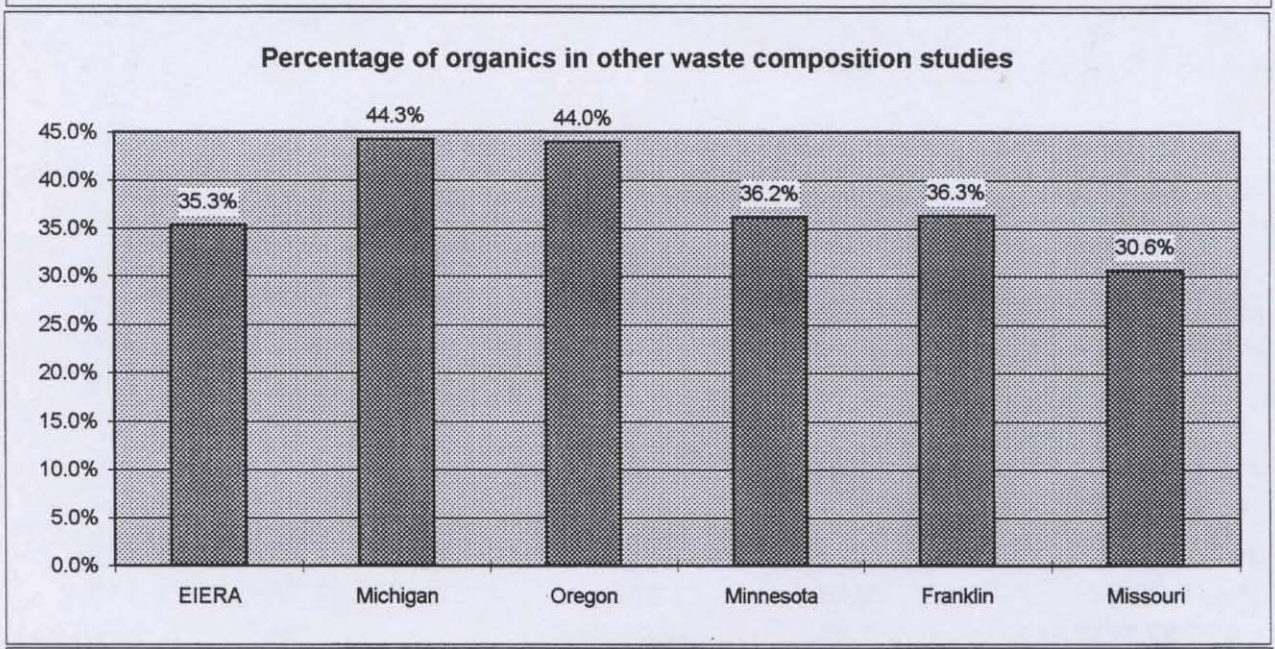


CHART 13-3

COMPARISON OF OTHER WASTE COMPOSITION STUDIES





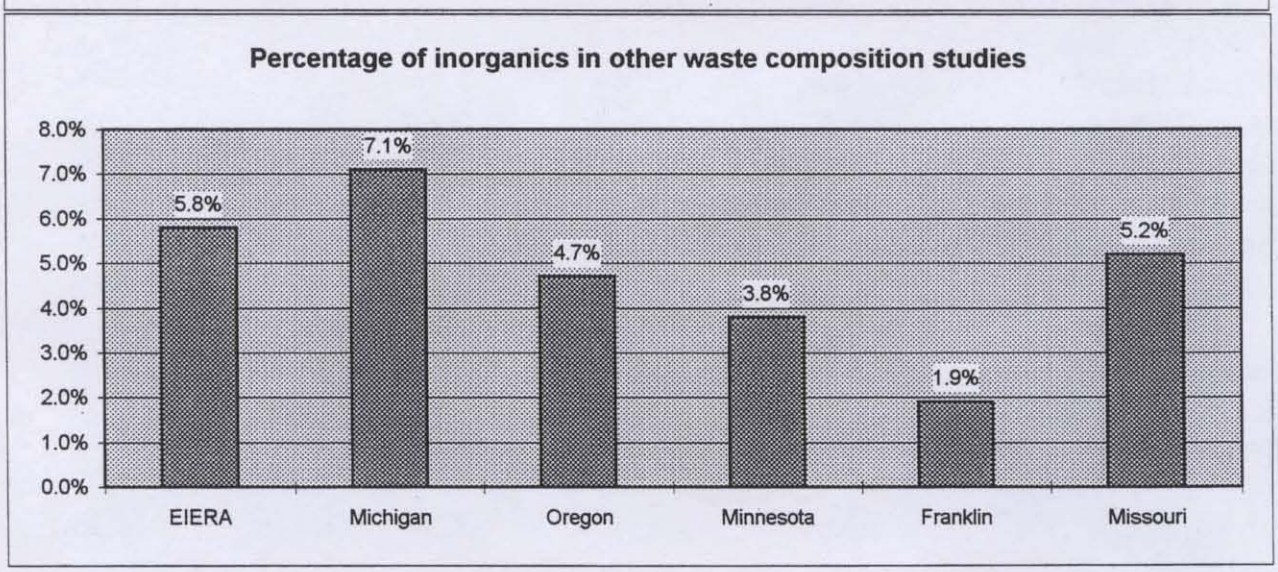


CHART 13-3

LEE'S SUMMIT AND SPRINGFIELD COMPARISONS

CATEGORY	Lee's Summit		Springfield	
	1987	1996	1987	1996
Cardboard	11.1%	6.4%	18.3%	7.4%
Newsprint	9.0%	13.1%	4.8%	9.5%
Magazines	2.0%	4.4%	2.0%	2.6%
High Grade	3.7%	3.8%	1.9%	1.8%
Mixed	11.2%	13.7%	15.2%	18.3%
PAPER TOTALS	**36.9%**	**41.4%**	**42.1%**	**39.6%**
Clear	3.4%	3.0%	2.3%	3.1%
Brown	1.2%	1.6%	0.5%	1.4%
Green	0.7%	0.5%	0.7%	0.4%
Other	N/A	0.8%	N/A	0.4%
GLASS TOTALS	**5.2%**	**5.9%**	**3.4%**	**5.3%**
Alum. Cans	1.1%	1.7%	0.7%	1.4%
Other Alum	0.5%	0.8%	0.3%	0.7%
Non ferrous	0.1%	0.2%	0.1%	0.1%
Food Cans	1.7%	2.7%	2.4%	4.0%
Ferrous	3.9%	0.9%	2.9%	1.1%
Oil Filters	N/A	0.0%	N/A	0.1%
METAL TOTALS	**7.1%**	**6.3%**	**6.3%**	**7.4%**
PET # 1	0.4%	1.5%	0.3%	2.2%
HDPE # 2	0.5%	2.0%	0.3%	2.3%
Film	N/A	3.2%	N/A	4.1%
Other Plastic	6.4%	5.8%	7.2%	5.9%
PLASTIC TOTALS	**7.2%**	**12.5%**	**7.8%**	**14.5%**
Food Waste	7.8%	15.2%	7.5%	16.8%
Wood Waste	N/A	1.0%		1.0%
Textiles	3.8%	3.7%	3.8%	3.7%
Diapers	2.3%	4.8%	0.7%	3.8%
Other Organics	27.0%	4.1%	24.4%	3.0%
ORGANIC TOTALS	**40.8%**	**28.8%**	**36.3%**	**28.3%**
Fines	2.2%	3.0%	1.7%	3.8%
Other Inorganics	0.8%	2.2%	2.5%	1.3%
INORGANIC TOTALS	**3.0%**	**5.2%**	**4.2%**	**5.1%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**

TABLE 13-5

Results by Volume

Most solid waste composition studies are recorded by weight. However, in many instances volume of the material is more significant. Some examples are calculations on landfill capacities, vehicle and storage space for recyclable materials, and compaction rates for waste haulers. This study attempted to quantify the volume of waste as well as the weight of that waste. During the sorting procedure all materials were placed in the appropriate category containers. Each identical container was three cubic feet in volume. As the container was weighed, the volume of the material within that container was estimated. Both the weight and the volume were recorded on the data sheet. The Project Manager and Sort Supervisor personally recorded and estimated the volume of all containers. This estimate is not "scientifically" accurate. However, in the process of estimating the volume of approximately 17,000 containers the waste sort personnel developed a good feel for estimating the volumes.

Table 13-6 lists the results of the Phase I waste sorts by volume and Chart 13-4 displays the same data in four pie charts The results are somewhat expected. Paper and metal percentages are approximately the same for weight and volume. Glass, organics (especially food wastes) and inorganics were much heavier and therefore produced lower percentages of the waste stream by volume. Plastics were lighter and their volumes took up a much greater portion of the waste stream.

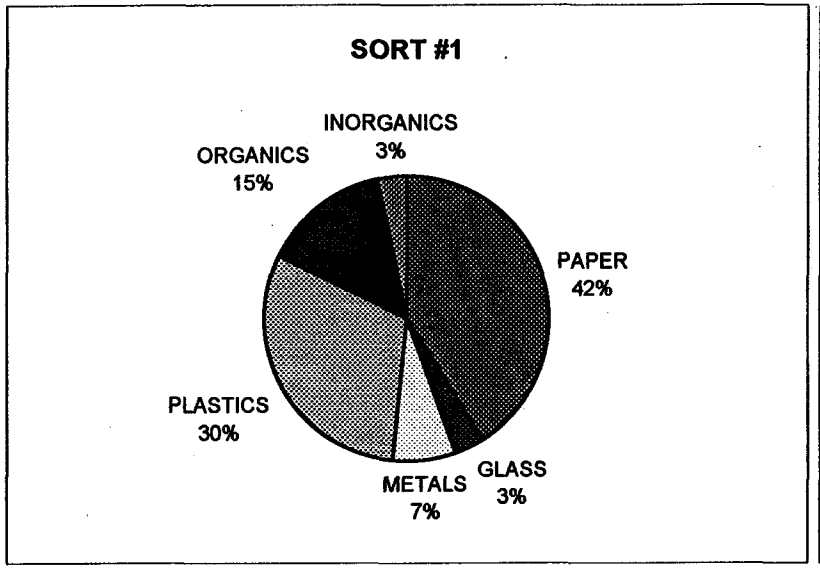
Table 13-7 and Chart 13-5 illustrate the relationship found between weight and volume in the Missouri waste stream. **These ratios are for uncompacted trash**. The average ratio for all materials was approximately 16 cubic yards per ton. Most conversion ratios for compacted trash is 2.5 to 4 cubic yards per ton.

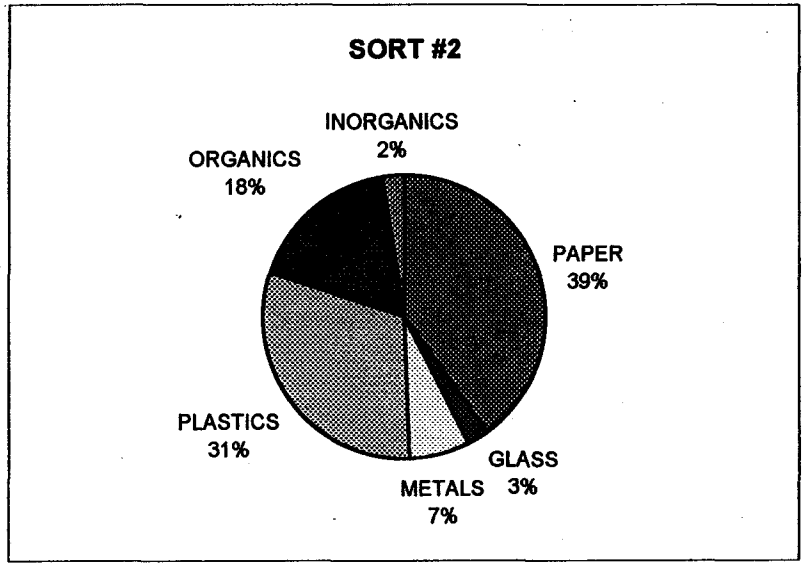
PHASE I SUMMARY RESULTS BY VOLUME

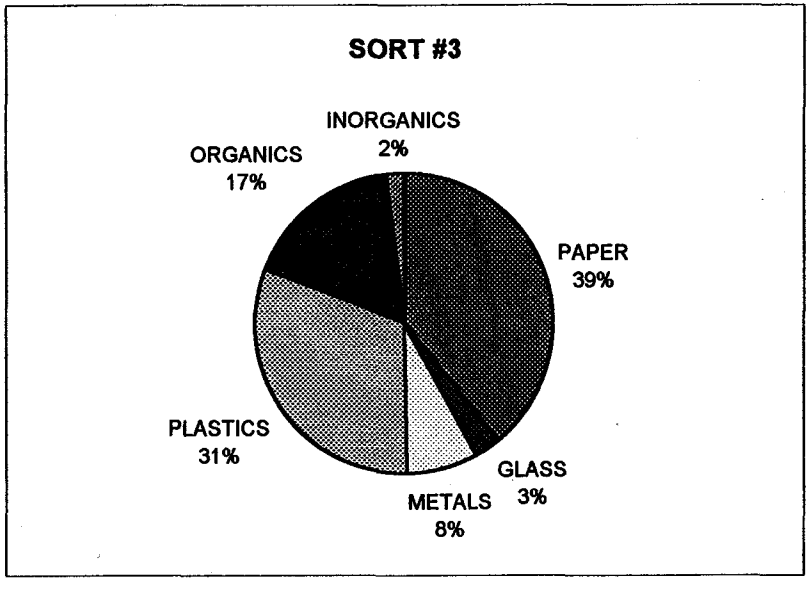
CATEGORY	SORT # 1 2/5/96-4/10/96 VOL.	SORT # 2 5/13/96-7/17/96 VOL.	SORT #3 9/3/96-11/13/96 VOL.	AVERAGE 2/5/96-11/13/96 VOL.
Cardboard	12.4%	11.5%	11.5%	11.8%
Newsprint	5.7%	5.4%	5.7%	5.6%
Magazines	2.0%	1.7%	1.9%	1.9%
High Grade	2.3%	2.6%	2.9%	2.6%
Mixed	18.9%	18.6%	17.2%	18.3%
PAPER TOTALS	41.2%	39.9%	39.2%	40.2%
Clear	1.7%	1.4%	1.4%	1.5%
Brown	0.9%	0.7%	0.8%	0.8%
Green	0.3%	0.2%	0.2%	0.2%
Other	0.3%	0.3%	0.3%	0.3%
GLASS TOTALS	3.2%	2.7%	2.8%	2.9%
Alum. Cans	2.3%	2.8%	3.1%	2.7%
Other Alum	1.3%	0.9%	0.9%	1.0%
Non ferrous	0.2%	0.2%	0.2%	0.2%
Food Cans	2.9%	2.3%	2.9%	2.7%
Ferrous	0.7%	0.6%	0.7%	0.7%
Oil Filters	0.0%	0.0%	0.0%	0.0%
METAL TOTALS	7.4%	6.8%	7.8%	7.3%
PET # 1	4.4%	3.8%	3.9%	4.1%
HDPE # 2	5.2%	4.7%	5.5%	5.2%
Film	8.8%	8.3%	7.7%	8.3%
Other Plastic	11.8%	13.9%	13.7%	13.1%
PLASTIC TOTALS	30.3%	30.7%	30.9%	30.6%
Food Waste	5.4%	8.6%	8.6%	7.4%
Wood Waste	0.5%	0.5%	0.5%	0.5%
Textiles	4.0%	3.5%	3.3%	3.6%
Diapers	2.6%	2.0%	2.1%	2.3%
Other Organics	2.0%	3.0%	3.0%	2.6%
ORGANIC TOTALS	14.5%	17.5%	17.4%	16.4%
Fines	2.6%	1.7%	1.4%	1.9%
Other Inorganics	0.8%	0.7%	0.5%	0.7%
INORGANIC TOTALS	3.4%	2.4%	1.9%	2.6%
SORT TOTALS	100%	100%	100%	100%

TABLE 13-6

PHASE I SUMMARY RESULTS BY VOLUME







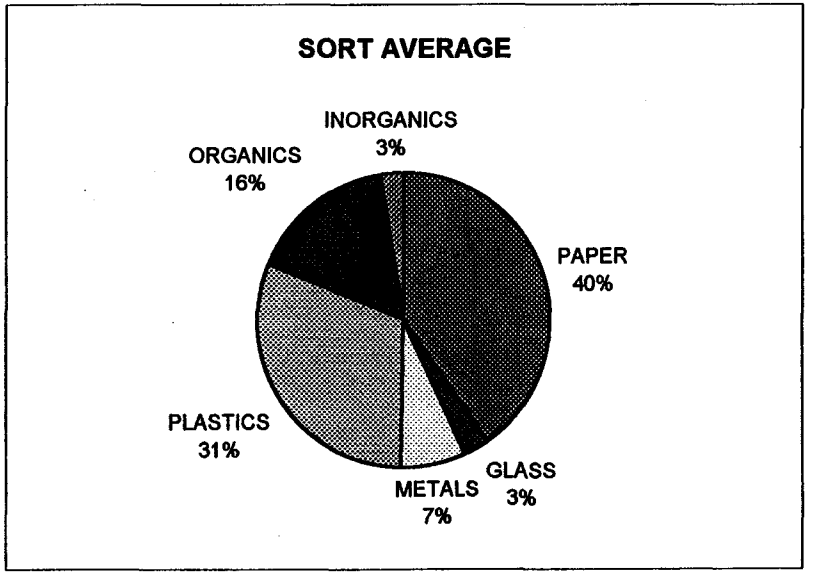


CHART 13-4

RELATIONSHIP BETWEEN WEIGHT AND VOLUME

CATEGORY	WEIGHT IN POUNDS	PCT. BY WEIGHT	VOLUME IN CU. FT.	PCT. BY VOLUME	RATIO LBS/CU.FT.
Cardboard	4914	6.4%	1977	11.8%	2.49
Newsprint	6007	7.8%	935	5.6%	6.42
Magazines	2656	3.5%	312	1.9%	8.51
High Grade	2245	2.9%	432	2.6%	5.20
Mixed	12445	16.2%	3061	18.3%	4.07
PAPER TOTALS	28267	36.8%	6717	40.2%	4.21
Clear	2560	3.3%	257	1.5%	9.97
Brown	1284	1.7%	137	0.8%	9.39
Green	309	0.4%	37	0.2%	8.25
Other	501	0.7%	53	0.3%	9.38
GLASS TOTALS	4653	6.1%	484	2.9%	9.61
Alum. Cans	1185	1.5%	454	2.7%	2.61
Other Alum	620	0.8%	172	1.0%	3.61
Non ferrous	198	0.3%	31	0.2%	6.50
Food Cans	2376	3.1%	451	2.7%	5.27
Ferrous	881	1.1%	115	0.7%	7.65
Oil Filters	61	0.1%	5	0.03%	12.60
METAL TOTALS	5321	6.9%	1228	7.3%	4.33
PET # 1	1331	1.7%	681	4.1%	1.95
HDPE # 2	1619	2.1%	861	5.1%	1.88
Film	2696	3.5%	1393	8.3%	1.94
Other Plastic	5366	7.0%	2184	13.1%	2.46
PLASTIC TOTALS	11011	14.3%	5119	30.6%	2.15
Food Waste	13909	18.1%	1237	7.4%	11.25
Wood Waste	611	0.8%	82	0.5%	7.43
Textiles	3178	4.1%	601	3.6%	5.28
Diapers	3274	4.3%	378	2.3%	8.67
Other Organics	2543	3.3%	437	2.6%	5.82
ORGANIC TOTALS	23515	30.6%	2735	16.4%	8.60
Fines	2769	3.6%	324	1.9%	8.54
Other Inorganics	1229	1.6%	115	0.7%	10.66
INORGANIC TOTALS	3999	5.2%	440	2.6%	9.10
SORT TOTALS	76750	100%	16727	100.0%	4.59

TABLE 13-7

RELATIONSHIP BETWEEN WEIGHT AND VOLUME

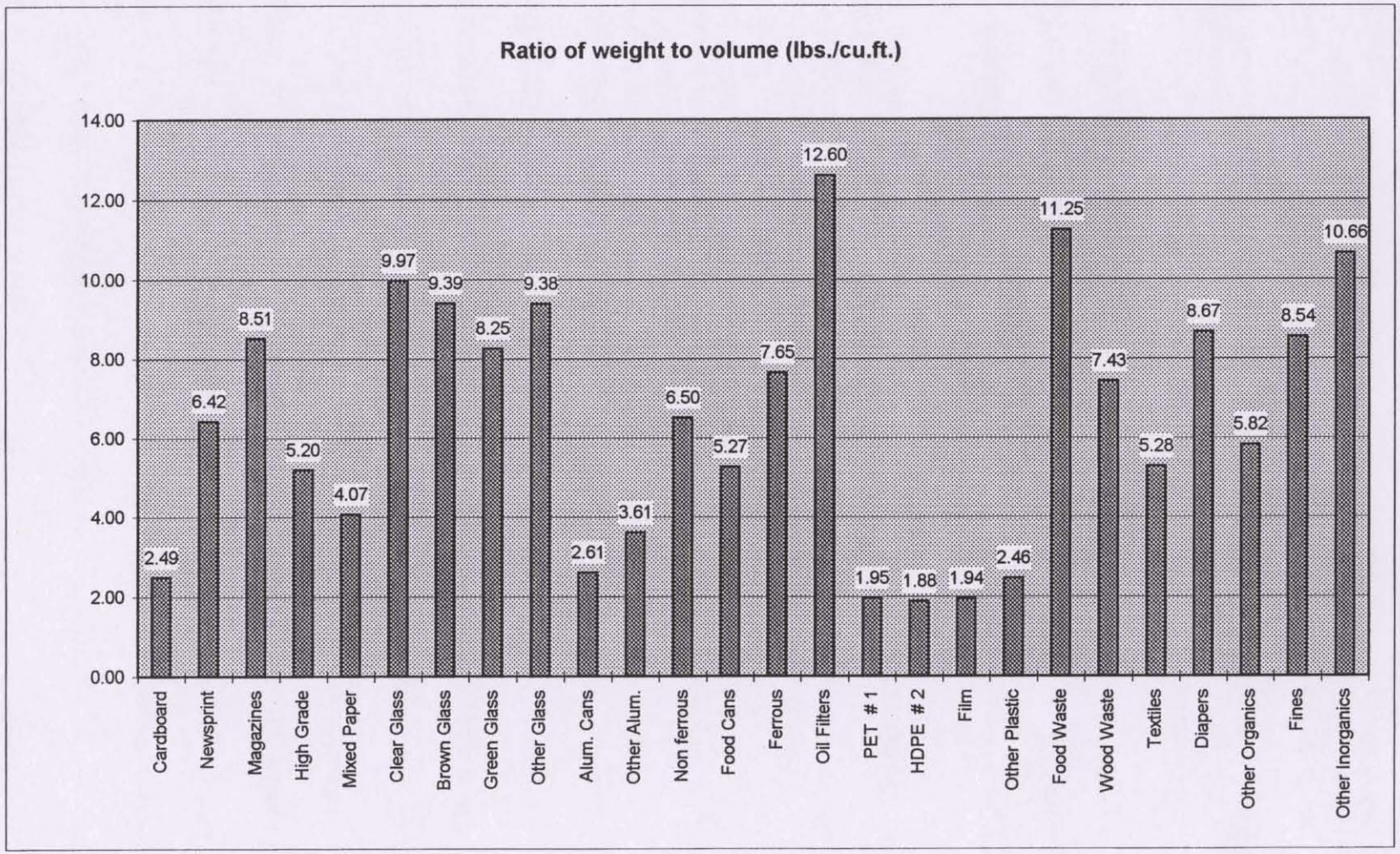


CHART 13-5

Disposal rates of Municipal Solid Waste

As stated in Chapter 2 (methodology), this study only analyzed the municipal solid waste stream from residential and light commercial sources which was disposed in plastic bags because that is the waste stream which is normally targeted by residential and commercial waste reduction and recycling programs. Estimating the size of this waste stream is very difficult. The Missouri Department of Natural Resources (MDNR) receives data on the tonnage disposed into Missouri landfills and transfer stations, but receives no data on the composition of that tonnage. Therefore components of the total waste stream must be estimated in order to isolate the quantity of MSW. The 1995 estimated MSW disposal and disposal rates are based on the following assumptions:

- The total adjusted disposal tonnage for Missouri is 5,701,225 (MDNR 1995 estimate, including import and export data).
- The industrial waste is still 1.6 million tons per year (EIERA estimate in 1987).
- Construction and Demolition waste is estimated at 12% or 686,210 tons (national estimates for C&D are 10-25% depending on the local growth and economic conditions).
- Sewage sludge is estimated to be 126,440 tons (MDNR 1995 estimate).
- Bulky items and durable goods such as small appliances and furniture which were not sampled are estimated to be 3.7% or 210,945 tons (*Characterization of Municipal Solid Waste in the United States: 1994 Update*).
- The current population of Missouri is 5,226,784 (Office of Administration 1995 estimate).

Based on these assumptions, the quantity of MSW disposed in Missouri landfills and transfer stations during 1995 was 3,077,630 tons (54% of the total solid waste disposed). The average MSW disposal rate was 3.22 pounds per person per day.

Most waste characterization studies attempt to estimate generation rates. Generation rates include both disposal and recovery (reuse, recycling, and composting). The disposal data is fairly reliable (providing the above assumptions are correct) and easy to calculate. However, the recovery data is very difficult to estimate with any degree of accuracy. Since recovery data is difficult to quantify, this study will only discuss disposal rates.

Table 13-8 and Chart 13-6 show the weight of each material disposed per person, per year. This table can be used to estimate the impact of reduction and recycling programs within a community or solid waste management district. For example, a community could project the amount of material available for collection if a recycling program was implemented. The projections for each material could be calculated as follows:

- Find the weight disposed per person per year for each material considered (Table 13-8).
- Multiply by the population of the service area.
- Multiply by the estimated participation rate.

For instance, a community of 4, 000 has a drop-off center for recyclables. They currently accept newspaper, glass, aluminum cans and milk jugs. Based on current operations they have a 25% participation rate by their residents. The community would like to project the impact of adding magazines to their recycling program. The calculations would be:

41.2 lbs per person X 4,000 residents X 25% participation = 41,200 lbs of magazines per year

The same calculations can be used to project the amount of space needed for the addition of magazines by applying the same formula to Table 13-9.

4.8 cu. ft. per person X 4,000 residents X 25% participation = 4,800 cu. ft. per year

Chart 13-7 displays a graph that shows the volume of each material disposed per person per year. These estimates and projections are not ironclad and certainly will vary from one Missouri community to another. They are approximate figures based on the best available research and data. However they can provide some degree of assurance in planning for waste reduction and recycling.

More data is needed to quantify the different components of the total waste stream. Industrial and C&D waste streams are significant but at this point the quantity and composition are largely unknown.

DISPOSAL OF MSW IN MISSOURI BY WEIGHT

CATEGORY	PCT. OF MO. MSW BY WT.	WT. DISPOSED PER PERSON PER YEAR (LBS.)	WT. DISPOSED IN MISSOURI PER YEAR (TONS)
Cardboard	6.4%	75.4	196,968
Newsprint	7.8%	91.9	240,055
Magazines	3.5%	41.2	107,717
High Grade	2.9%	34.2	89,251
Mixed	16.2%	190.8	498,576
PAPER TOTALS	36.8%	433.4	1,132,568
Clear	3.3%	38.9	101,562
Brown	1.7%	20.0	52,320
Green	0.4%	4.7	12,311
Other	0.7%	8.2	21,543
GLASS TOTALS	6.1%	71.8	187,735
Alum. Cans	1.5%	17.7	46,164
Other Alum	0.8%	9.4	24,621
Non ferrous	0.3%	3.5	9,233
Food Cans	3.1%	36.5	95,407
Ferrous	1.1%	13.0	33,854
Oil Filters	0.1%	1.2	3,078
METAL TOTALS	6.9%	81.3	212,356
PET # 1	1.7%	20.0	52,320
HDPE # 2	2.1%	24.7	64,630
Film	3.5%	41.2	107,717
Other Plastic	7.0%	82.4	215,434
PLASTIC TOTALS	14.3%	168.4	440,101
Food Waste	18.1%	213.2	557,051
Wood Waste	0.8%	9.4	24,621
Textiles	4.1%	48.3	126,183
Diapers	4.3%	50.6	132,338
Other Organics	3.3%	38.9	101,562
ORGANIC TOTALS	30.6%	360.4	941,755
Fines	3.6%	42.4	110,795
Other Inorganics	1.6%	18.8	49,242
INORGANIC TOTALS	5.2%	61.2	160,037
TOTAL	**100.0%**	**1177.6**	**3,077,630**

TABLE 13-8

ESTIMATED DISPOSAL RATES OF MSW, PER PERSON, PER YEAR

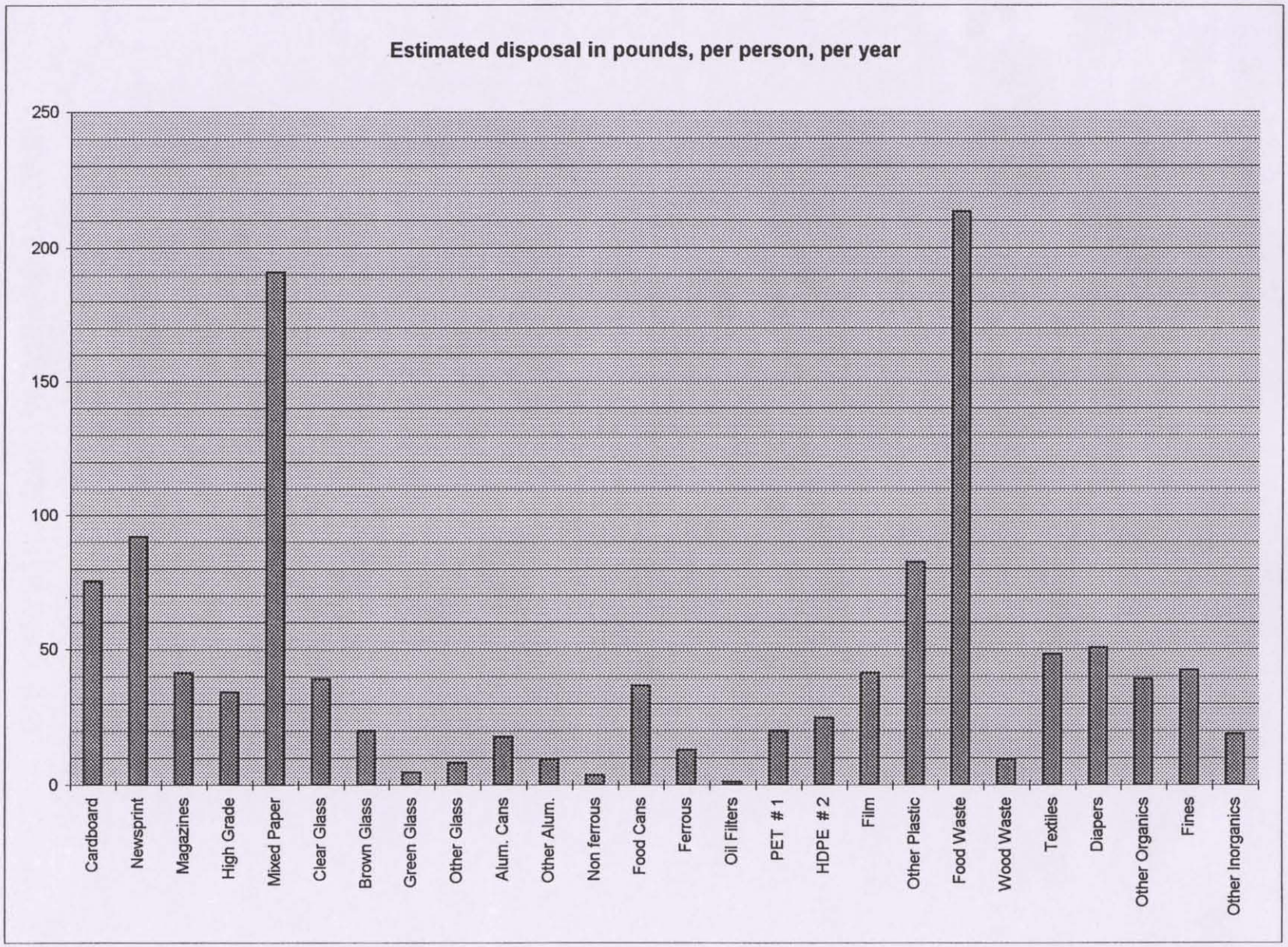


CHART 13-6

DISPOSAL OF MSW IN MISSOURI BY VOLUME

CATEGORY	PCT. OF MO. MSW BY VOL.	VOL.DISPOSED PER PERSON PER YEAR (CU. FT.)	VOLUME DISPOSED IN MISSOURI PER YEAR (CU.YDS)
Cardboard	11.8%	30.3	5,861,959
Newsprint	5.6%	14.3	2,771,094
Magazines	1.9%	4.8	937,213
High Grade	2.6%	6.6	1,273,191
Mixed	18.3%	46.9	9,075,170
PAPER TOTALS	40.2%	102.9	19,918,627
Clear	1.5%	3.9	755,310
Brown	0.8%	2.1	412,321
Green	0.2%	0.6	110,285
Other	0.3%	0.9	169,232
GLASS TOTALS	2.9%	7.5	1,447,147
Alum. Cans	2.7%	6.8	1,312,815
Other Alum	1.0%	2.6	504,071
Non ferrous	0.2%	0.5	104,238
Food Cans	2.7%	6.9	1,340,766
Ferrous	0.7%	1.7	328,967
Oil Filters	0.0%	0.1	18,437
METAL TOTALS	7.3%	18.6	3,609,294
PET # 1	4.1%	10.3	1,985,483
HDPE # 2	5.2%	13.1	2,543,372
Film	8.3%	21.2	4,111,178
Other Plastic	13.1%	33.5	6,484,297
PLASTIC TOTALS	30.6%	78.1	15,124,330
Food Waste	7.4%	19.0	3,668,643
Wood Waste	0.5%	1.3	244,912
Textiles	3.6%	9.1	1,770,859
Diapers	2.3%	5.8	1,129,802
Other Organics	2.6%	6.7	1,293,890
ORGANIC TOTALS	16.4%	41.9	8,108,106
Fines	1.9%	5.0	961,123
Other Inorganics	0.7%	1.8	341,406
INORGANIC TOTALS	2.6%	6.7	1,302,529
TOTAL	**100.0%**	**255.8**	**49,510,032**

TABLE 13-9

ESTIMATED DISPOSAL OF MSW, PER PERSON, PER YEAR

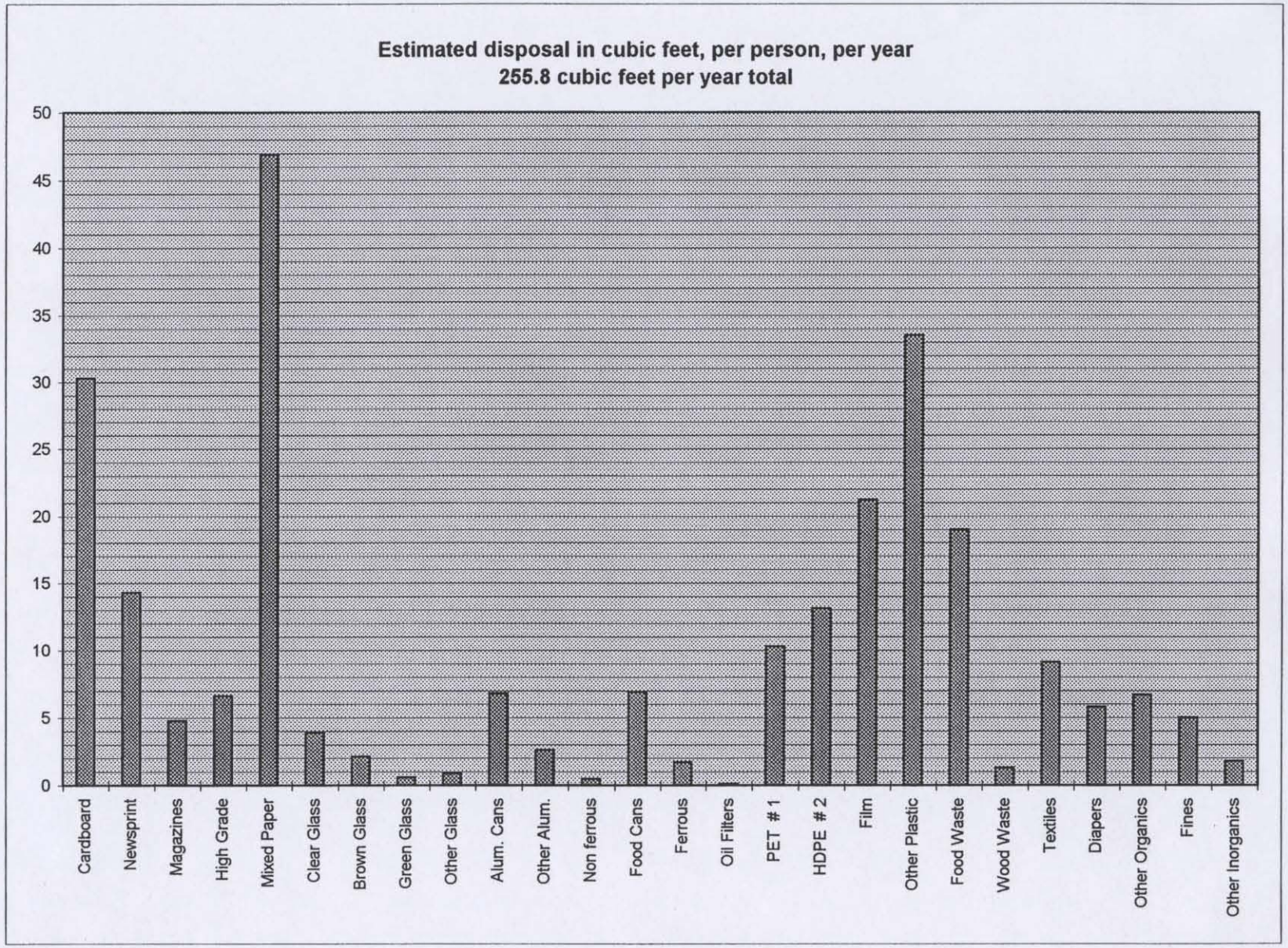


CHART 1