pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Waste Characterization Study

FINAL REPORT

September 2022

MSW CONSULTANTS

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ACKNOWLEDGEMENTS

The MSW Consultants Team would like to thank the operators of the following facilities for their assistance during various stages of this project.

- Centre County Transfer Station, Bellefonte
- Chester County SWA (Lanchester Landfill), Narvon
- Commonwealth Environmental Systems Landfill, Hegins
- Covanta Montgomery County RRF, Conshohocken
- WM Forge Transfer Station & Recycling Center, Philadelphia
- Keystone Sanitary Landfill, Dunmore
- Lancaster (LCSWMA) WTE Facility, Marietta
- NTSWA Bradford County Landfill, Troy
- Northwest Philadelphia Transfer Station, Philadelphia
- Republic Services Imperial Landfill, Imperial
- Seneca Landfill, Evans City
- Waste Management Lake View Landfill, Erie
- Waste Management Laurel Highlands Landfill, Johnstown
- Waste Management Mountainview Landfill, Greencastle

MSW Consultants also wishes to thank the staff and more than 50 members of the Professional Recyclers of Pennsylvania (PROP) for their assistance during this study.

PROP
PROFESSIONAL RECYCLERS OF PENNSYLVANIA

This study would not have been successful without the ongoing cooperation from the facility hosts and PROP volunteers.

ACKNOWLEDGEMENTS

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E. EXECUTIVE SUMMARY

E.1 INTRODUCTION

The Pennsylvania Department of Environmental Protection (DEP) engaged MSW Consultants to perform an update to Pennsylvania's last statewide waste characterization study conducted in the Commonwealth in 2001 (2001 Study). The 2001 Study measured the composition of residential and commercial municipal solid waste (MSW or "waste") disposed of in landfills and waste-to-energy (WTE) facilities within the state. This study (2021 Study) was commissioned to measure changes in the solid waste stream, update waste and recycling time series data, and compare the findings to the 2001 Study.

DEP's specific objectives for the 2021 Study were to:

- Evaluate and validate county-level MSW generation and disposal estimates currently compiled by DEP on an annual basis;
- Determine the aggregate composition of the Commonwealth's disposed MSW stream, as well as the composition of MSW in each of DEP's six planning regions;
- For each region and for the Commonwealth as a whole, differentiate waste composition from the residential and institutional-commercial-industrial (ICI or "commercial") generating sectors;
- For each region and for the Commonwealth as a whole, differentiate waste composition from urban, suburban, and rural areas;
- For each region and for the Commonwealth as a whole, compare the 2021 Study results to the prior study and highlight noteworthy changes;
- Update the material category list to provide information about current high-profile materials in the disposed MSW stream; and
- Comment on the economic and environmental benefits of recycling in Pennsylvania.

The 2021 Study was performed with assistance from the Professional Recyclers of Pennsylvania (PROP), whose members assisted with host facility planning and logistics, as well as selected sorting. Similarly, several key staff within MSW Consultants were significant contributors to the 2001 Study. For these reasons, it is believed that the 2021 Study closely follows the framework established in the 2001 Study.

This Executive Summary highlights notable findings from the waste characterization component of the overall 2021 Study and compares results with the inaugural 2001 Statewide Study. A separate report will present results of a parallel statewide analysis of material recovery facilities (MRFs) and the composition of inbound recyclables, outbound commodities, and residues.

E.2 WASTE DISPOSAL IN PENNSYLVANIA

DEP tracks multiple waste streams by disposal facility and by county of origin, including MSW, sewage sludge, medical wastes, construction waste, residual waste, and ash from WTE facilities. This study, however, only focused on the MSW portion of the disposed solid wastes generated within Pennsylvania, an amount that totaled nearly 9.4 million tons for the Commonwealth's 2021 Fiscal Year (July 1, 2020, through June 30, 2021).

In order to apply the results of the composition analysis obtained from this study, it was necessary to apportion the statewide tonnage into a matrix of generator sectors and demographic regions. MSW Consultants relied on municipal-level residential household data from the Pennsylvania State Data Center, and municipal-level employment data from ESRI to serve as waste generation indicators for allocating tons. Figure E-1 shows DEP's six planning regions and their respective counties, with shading to indicate counties of higher population.

Figure E-1 DEP Planning Regions and Affiliate Counties

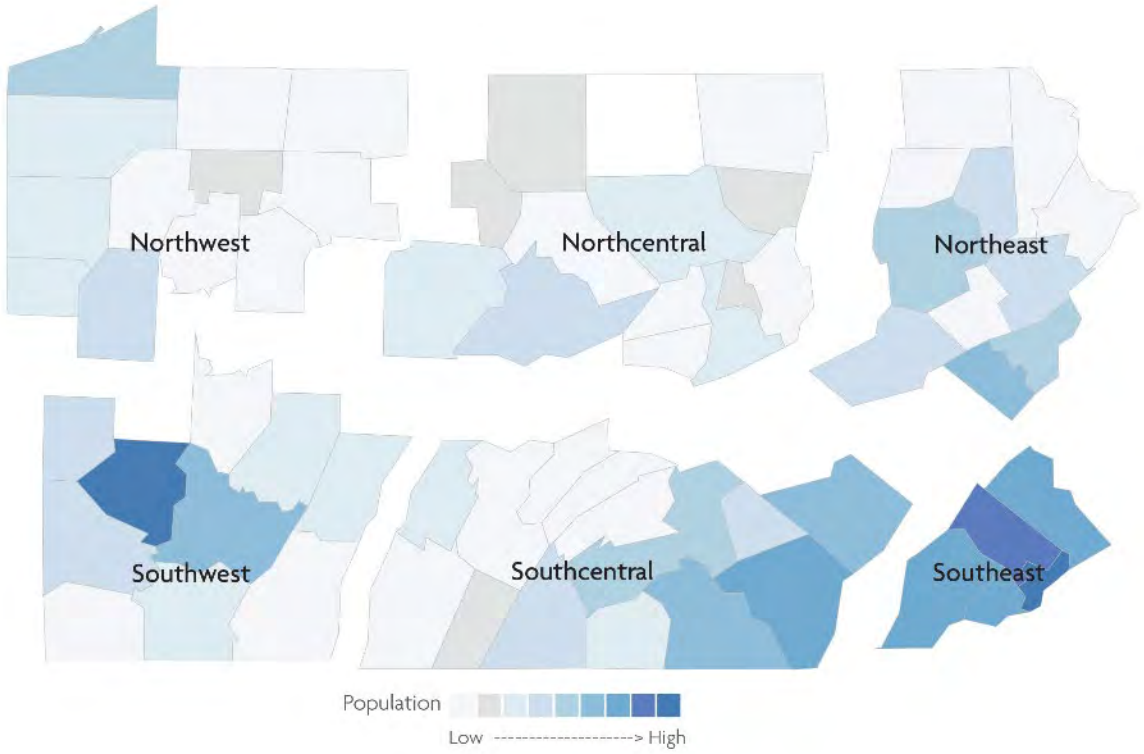


Table E-1 shows the resulting allocation of FY 2021 disposed MSW to the generator sectors and demographic regions of Pennsylvania.

Table E-1 Statewide MSW Disposal by Generating Sector and Demographic Area (FY21)

	Tons of Waste Disposed				
Generating Sector	Urban	Suburban	Rural	Total	Percent
Residential	1,171,976	2,690,681	957,916	**4,820,573**	51.3%
Commercial	1,150,948	2,926,072	495,109	**4,572,129**	48.7%
Total	**2,322,924**	**5,616,753**	**1,453,025**	**9,392,702**	**100.0%**
Percent (2021 Study)	*24.7%*	*59.8%*	*15.5%*	*100.0%*	
Percent (2001 Study)	*27.1%*	*45.3%*	*27.6%*	*100.0%*	

It should be noted that the methodology in the 2021 Study to assign each municipality as either urban, suburban, or rural differed from the 2001 Study. In 2001, these designations were made by the state. No designations were available from the state in 2021, and therefore MSW Consultants developed its own methodology. As shown in Table E-1, the results of this exercise suggest that MSW disposal has remained relatively level in urban areas, while shifting from rural to suburban areas compared to 2001. While this would seem to follow broad demographic trends in the Commonwealth, it is possible that some of the change is the result of differing methodologies to derive tonnage by demographic area.

E.3 SAMPLING PLAN OVERVIEW

As noted, the 2021 Study was designed to replicate the 2001 Study approach. This included acquiring a similar number of samples and, to the extent possible, performing field activities in the same regions and at the same facilities utilized in the 2001 Study (with proportional adjustments to address any changes within the six regions).

To maximize representativeness, materials sampling was performed in all six DEP planning regions. In addition, to ensure a proper basis for comparison, many of the same host facilities that participated in the 2001 Study also participated in the 2021 Study. Thirteen facilities across the six DEP planning regions hosted the 2021 Study for at least one week of field sampling and sorting, with the majority of facilities hosting two weeks of sorting over the course of the four-season study. Figure E-2 plots the location of the host facilities within DEP's six planning regions.

Figure E-2 Host Facilities by DEP Planning Region

1 WM Lake View Landfill
2 Seneca Landfill
3 Republic Services Imperial Landfill
4 WM Laurel Highlands Landfill
5 WM Mountainview Landfill
6 Lancaster (LCSWMA) WTE Facility
7 Centre County TS
8 NTSWA Bradford County Landfill
9 Commonwealth Environmental Systems Landfill
10 Chester County SWA (Lanchester Landfill)
11 Covanta Montgomery County RRF
12 Northwest Philadelphia TS
13 Keystone Sanitary Landfill
14 WM Forge Transfer Station & Recycling Center

To account for seasonal variations in waste generation and disposal, sampling occurred over the course of four seasons. Individual sampling events generally consisted of one week's worth of sample acquisition and sorting at each facility. Overall, MSW Consultants performed 25 waste sampling events over four seasons at 13 solid waste facilities throughout Pennsylvania. Table E-2 shows the dates during which the sampling events occurred during each season, as well as the number of samples acquired and sorted.

Table E-2 Sampling Event Schedule

Season	Sampling Dates	Sampling Events	Samples Obtained
Summer	July 13 - August 21, 2020	6	298
Fall	October 5 - November 13, 2020	6	314
Winter	January 11 - February 26, 2021	7	363
Spring	April 12 - May 28, 2021	6	283
	Totals	**25**	**1,258**

As with the 2001 Study, the sampling plan targeted 1,224 physical samples. Table E-3 illustrates the allocation of samples that were obtained compared to the targeted allocations. While there was a shortfall in the targeted rural samples, the study exceeded the overall target by acquiring, sorting, and weighing 1,258 total samples. The combined weight of material sorted was 269,922 pounds, for an average of 215 pounds of refuse per sample.

Note that the number of residential and commercial samples were not initially targeted and allowed to "float" based on the makeup of inbound deliveries.

Table E-3 Sample Allocations, Targeted vs. Actual

Allocation	Sub-allocation	Targeted	Actual	Difference
Region	Northeast	204	204	0
	Northcentral	204	210	6
	Northwest	204	205	1
	Southeast	204	238	34
	Southcentral	204	200	-4
	Southwest	204	201	-3
	Subtotal	**1,224**	**1,258**	**34**
Demographic Origin	Urban	408	330	-78
	Suburban	408	644	236
	Rural	408	284	-124
	Subtotal	**1,224**	**1,258**	**34**
Generating Sector	Residential	tbd	683	N/A
	Commercial	tbd	575	N/A
	Subtotal	**1,224**	**1,258**	**34**

As a final note, material categories increased to 58 categories in the 2021 Study, up from 37 categories in 2001, in order to provide more current and robust data. However, 2021 Study categories were mapped and conformed to the 2001 Study to allow for comparison. Table E-4 presents the Study's material categories and groups.

Table E-4 Material Groups and Categories

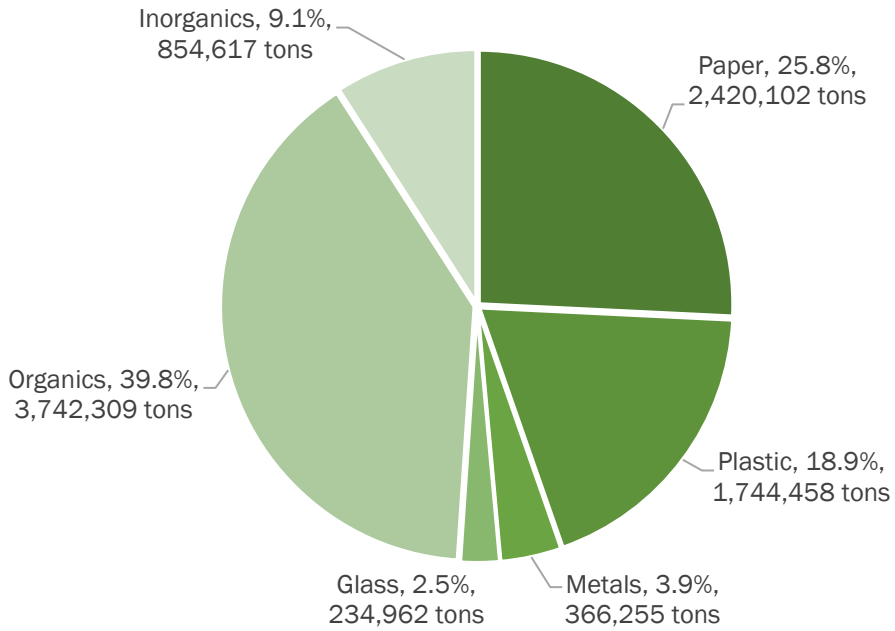
Material Category	Material Category	Material Category
Paper	**Organics**	**Inorganics**
Corrugated Cardboard/Kraft Paper	Food Waste	*Electronics - Covered Devices*
Newspaper	Yard Waste - Grass	Other Electronics
Office/High Grade Paper	Yard Waste - Other	Carpet & Carpet Padding
Magazine & Catalogs	Wood - Unpainted	Drywall/Gypsum Board
Aseptic Boxes & Gable Top Cartons	Wood - Painted	*Concrete, Rock, Brick*
Mixed Recyclable Paper (Low Grade)	Textiles & Leather Products	*Asphalt Roofing*
Compostable Paper	Diapers & Sanitary Products	*Asphalt Paving*
Non-recyclable Paper	*Animal Byproducts*	Other C&D
Plastic	Fines-1/2" minus	Medically-Related Waste
#1 PET Bottles & Jars	Other Organics	*Lithium Batteries*
#1 PET Non-Bottles & Containers	**Metals**	*Automotive Batteries*
#2 HDPE Natural Bottles	Steel Cans	*Other Batteries*
#2 HDPE Colored Bottles	Aluminum Cans	Other HHW
#3 - #7 Bottles	Other Aluminum	*Bulky Materials*
#2-#7 Non-Bottle Rigid Containers	Other Ferrous Metals	*Furniture*
Expanded Polystyrene	Other Non-Ferrous Metals	Other Inorganics
Clean Retail Plastic Bags	**Glass**	*PPE*
Industrial Film	Clear Glass Containers	
All Other Film	Green Glass Containers	
Durable/Bulky Rigid Plastics	Brown Glass Containers	
Remainder/Composite Plastic	Non-Recyclable Glass	

Materials shown in italics represent categories new to the 2021 study.

E.4 STATEWIDE DISPOSED MSW COMPOSITION

Figure E-3 depicts the breakdown of total disposed MSW in Pennsylvania by major material group. As shown, at 39.8 percent and 25.8 percent, respectively, Organics and Paper are the largest fractions of the statewide waste stream. This breakdown is consistent with waste composition in most other areas of the country.

Figure E-3 Pennsylvania Statewide Aggregate Disposed MSW Composition by Material Group



Many states performed waste composition studies at more frequent intervals. While it was beyond the scope of this study to compare Pennsylvania to other states, it is widely recognized from these other data sets that the waste stream is always changing. Because of the elapsed time between Pennsylvania's waste composition studies, comparisons between 2001 and 2021 more dramatically highlight such changes

Figure E-4 compares the 2021 MSW composition by material group with the same results from the 2001 Study. As shown, there have been significant changes. There is far less paper in the disposed waste stream, driven by the conversion from print to digital media. The incidence of plastics has increased as more packaging shifts to lighter weight bottles and films. Organics continue to comprise the most prevalent fraction of disposed MSW, which supports and validates the numerous initiatives underway to divert food wastes. Favorably, there are less metals and glass being disposed.

Figure E-4 Comparison of Disposed MSW by Material Group 2021 vs 2001 (Tons)

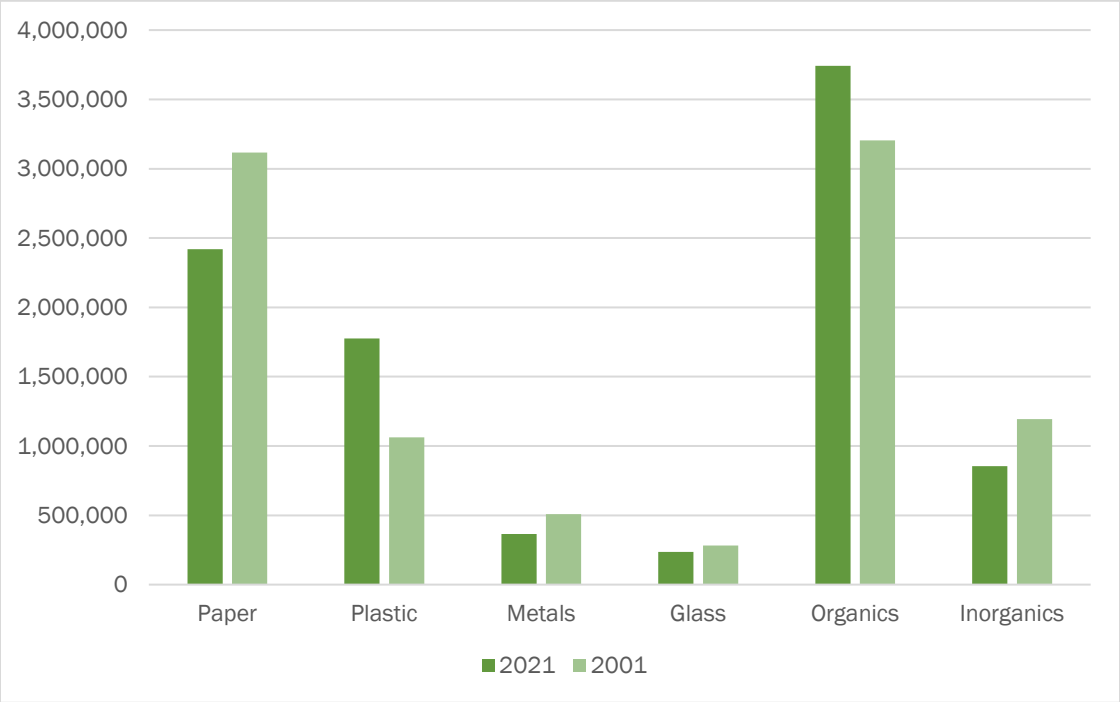
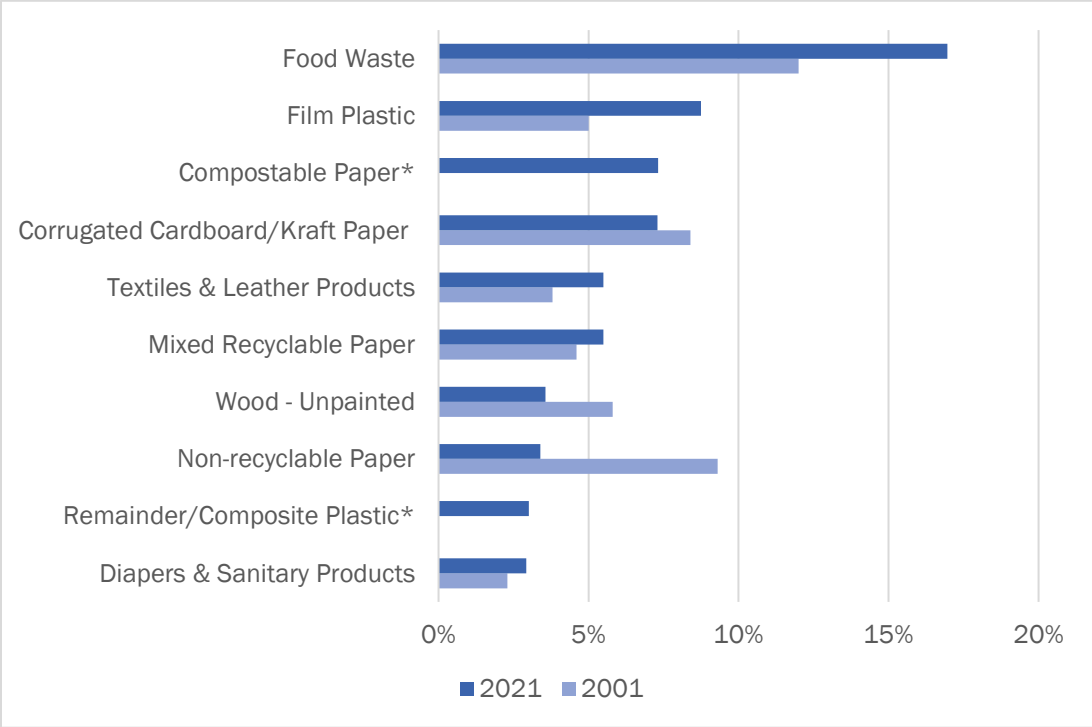


Figure E-5 shows the top ten materials that were most prevalent in the disposed MSW stream from the 2021 Study. This figure also compares the 2021 top ten with those from the 2001 Study (recognizing that several material categories were not included in both studies). It is noteworthy that on a percentage basis, food waste remains the most prevalent fraction of disposed waste. The top ten most prevalent materials combine to make up over 64 percent of the 2021 disposed MSW stream.

Figure E-5 Comparison of 2021 & 2001 Top Ten Most Prevalent Materials Disposed (Percent)



* Not material category in 2001 Study

Given the increasing focus on food waste recovery as a way to increase recycling and diversion levels, as well as food security issues, the 2021 Study incorporated a subsort of food waste into three categories:

- **Edible-Packaged Food** which includes the components of food that, in a particular food supply chain, are intended to be consumed by humans and are enclosed in the original packaging as sold or distributed.
- **Edible-Non-Packaged Food** which are the components of food that, in a particular food supply chain, are intended to be consumed by humans and are not enclosed in the original packaging as sold or distributed. Examples include vegetables, fruits and other partially consumed foods that have been discarded. Edible food that appears to have been wrapped or stored by the consumer (e.g., in a Ziploc bag, takeout container, or reusable container) is included here.
- **Inedible Food Scraps** which include the non-edible portions of food material. Examples include rinds, peelings, skins, pits, cores, eggshells, bones, gristle, trimmings, fish skins, and seafood shells.

The breakdown of food wastes by subcategory are shown in Figure E-6. It is noteworthy that edible food (i.e., true wasted food) comprised over 72 percent of the total, while inedible food waste made up almost 28 percent.

Figure E-6 Food Waste by Subcategory

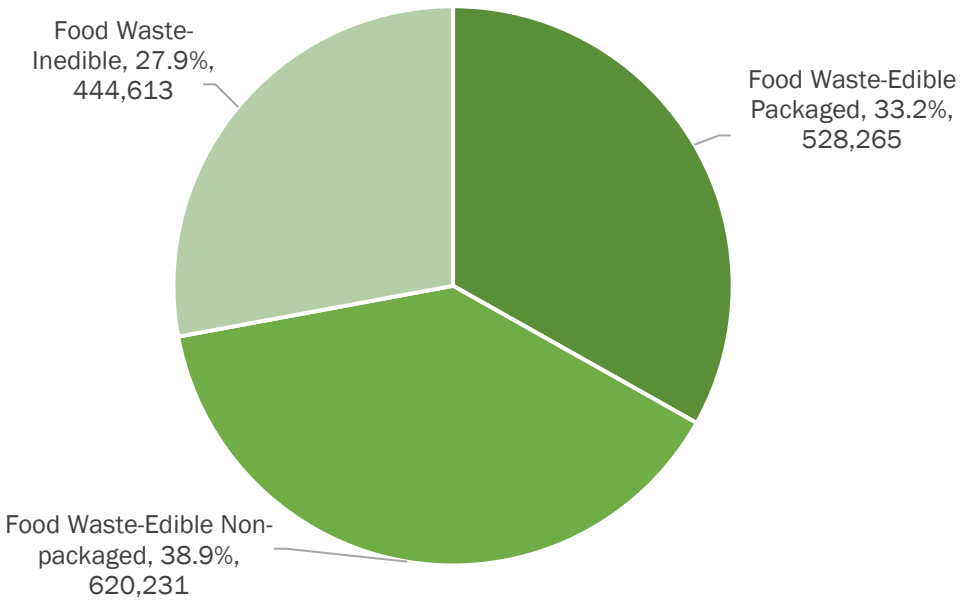
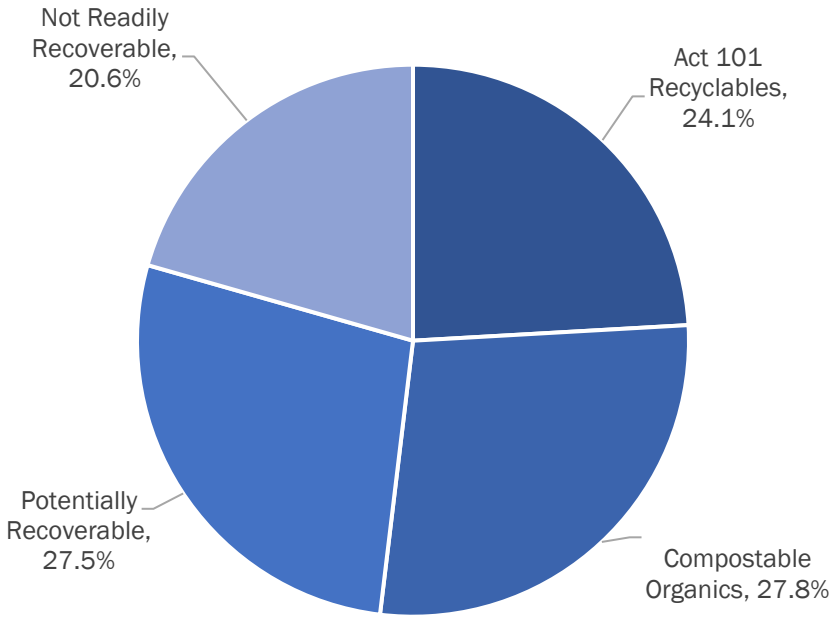


Figure E-7 presents the composition of disposed waste in terms of the potential for diverting materials from disposal. This analysis was developed by assigning a "recoverability" or "divertibility" classification to each individual constituent in the waste stream with each material:

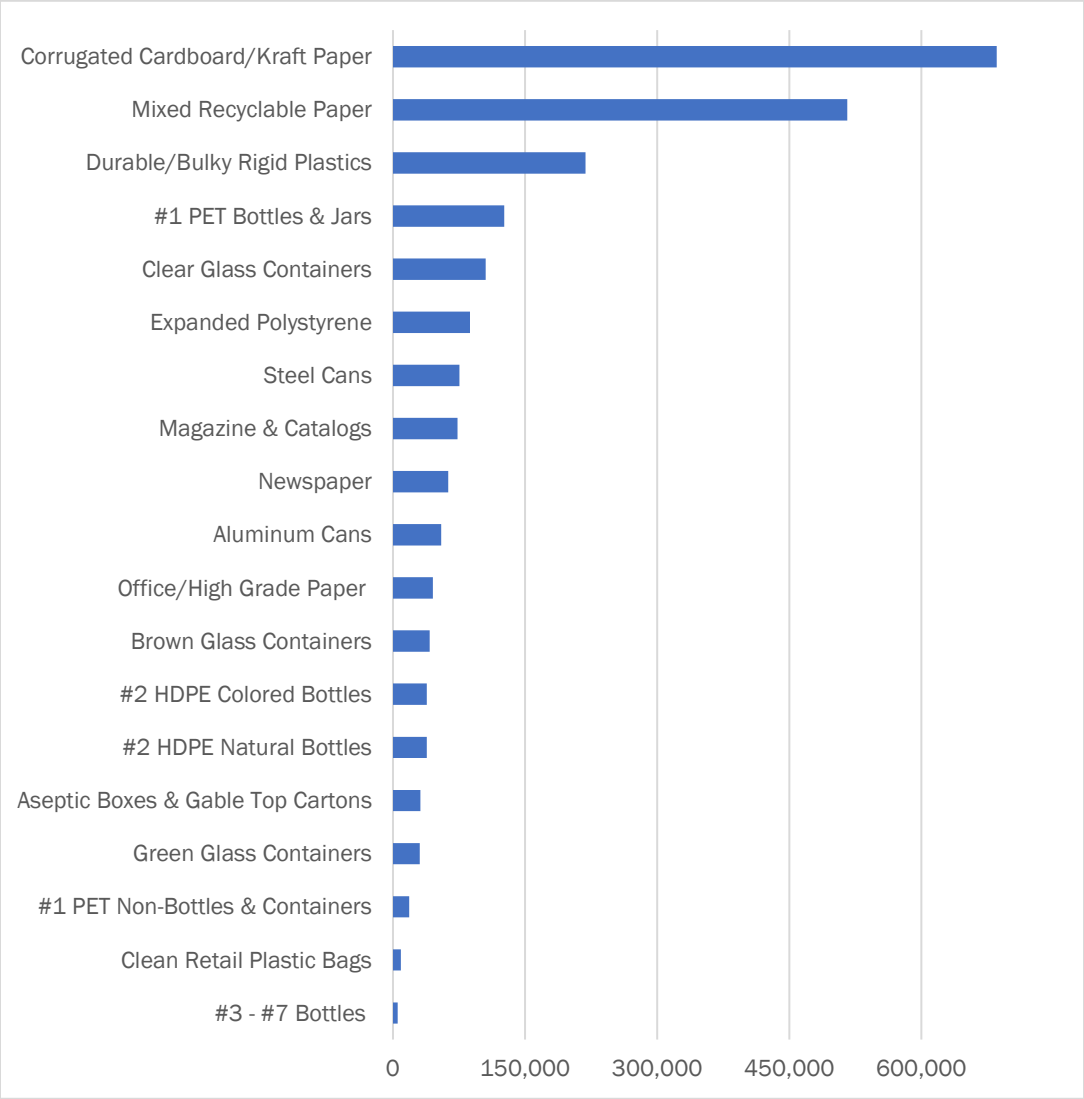
- **Act 101 Recyclables:** Includes materials mandated for collection through Pennsylvania's Act 101 of 1988 including glass food and beverage containers (all three colors), plastics (PET and HDPE bottles), Aluminum Cans, Steel Cans, Corrugated Cardboard, Newspaper, and High-Grade Office Paper. This list has been expanded beyond the 2001 Study's list to reflect the increased recoverability of additional materials, such as Aseptic Cartons, Magazines and Catalogs, Mixed Recyclable Paper, and additional plastic resins. All materials on this list are counted towards DEP's Act 101, Section 904 Recycling Performance Grant awards to local governments. Note that while many of these materials are common to recycling programs across the Commonwealth, they are not necessarily universally accepted.
- **Compostable Organics:** Includes organics such as Food Waste and Yard Waste (leaves, grass, prunings) that can be composted and mulched for use as a soil amendment, as well as clean wood and lumber (Wood-Unpainted) that can be chipped and used for mulch. These material categories can also be recovered through anaerobic digestion technologies.
- **Potentially Recoverable:** Applies to materials that have been found to be recoverable in other regions of the country or state where collection and processing infrastructure exists, and where suitable end markets have been developed, but are still not universally collected. This includes materials such as e-waste, plastic film, textiles, scrap metals, and other items that are recyclable through public or private drop-off networks or through commercial settings. It also includes some components of Construction and Demolition Debris (C&D), which is primarily generated by the ICI sector.
- **Not Readily Recoverable**: Includes materials that are not known to be recyclable in Pennsylvania, or for which no known local markets exist. Some materials in this classification could theoretically become recyclable if sufficient material volume existed to create cost-effective and appropriate collection methods, processing facilities, and suitable end markets.

Figure E-7 Recoverability of Statewide Disposed MSW



As shown in Figure E-7, approximately 80 percent of the total disposed waste stream is either recoverable through existing programs or potentially recoverable. Figure E-7 also shows that Act 101-eligible recyclables make up just 24.1 percent of the disposed MSW stream. For a related view, Figure E-8 itemizes the quantity of Act 101-eligible materials that were disposed. As shown, Corrugated Cardboard was found to be disposed in significant quantities, with lower disposal of other Act 101 recyclables. A comparison using Act 101 materials from the 2001 study is provided in the results section of this report.

Figure E-8 Act 101-Eligible Recyclables in Disposed MSW (Tons)



E.5 COMPARISONS BY GENERATOR SECTOR

An objective of the study was to differentiate the composition and quantity of disposed MSW generated in the residential and commercial generating sectors. This section provides a series of tables and figures with such comparisons.

Figure E-9 compares the composition by material group in terms of tons disposed. This figure highlights the relatively higher disposal of paper and plastics originating in the commercial sector, while the residential sector contributes a higher amount of organics. The relatively lower fraction of organics in the commercial sector may be reflective of the heightened focus of diverting commercial organics that have taken hold in Pennsylvania in recent years.

Figure E-9 Disposed MSW Composition Summary by Generator Sector (Tons)

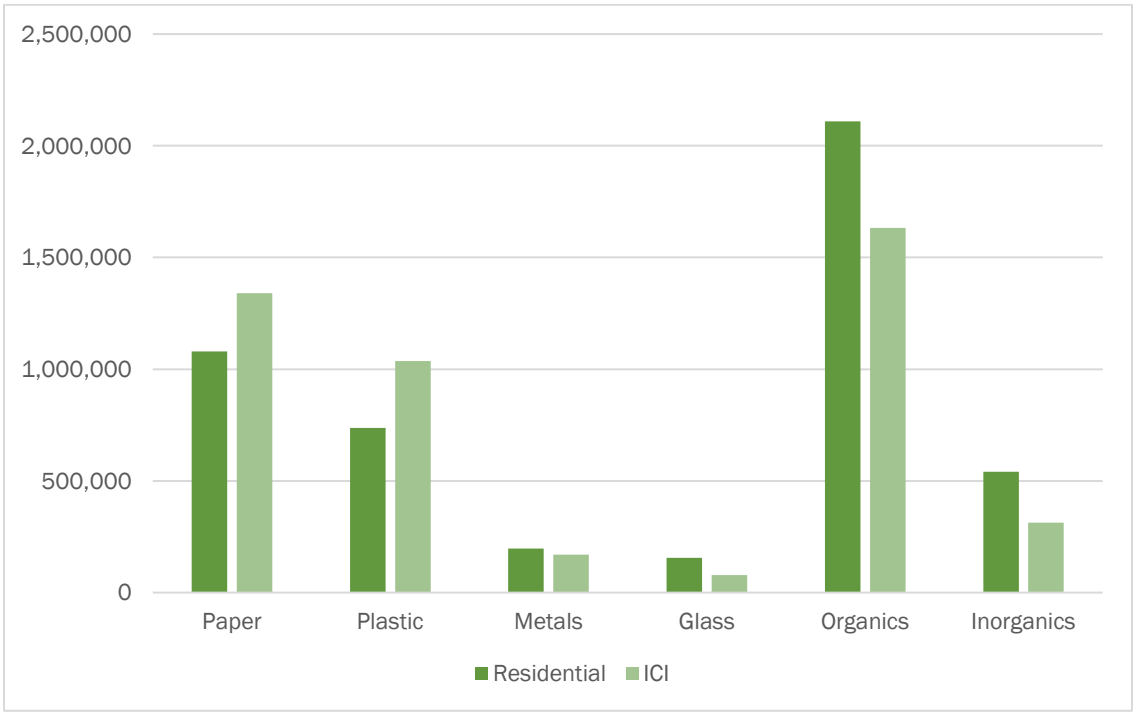


Figure E-10 compares the breakdown of Food Waste between generator sectors. On a percentage basis, the ICI sector contained a higher percentage of Edible Non-Packaged Food Waste.

Figure E-10 Food Waste Detail by Generator Sector (Percentage)

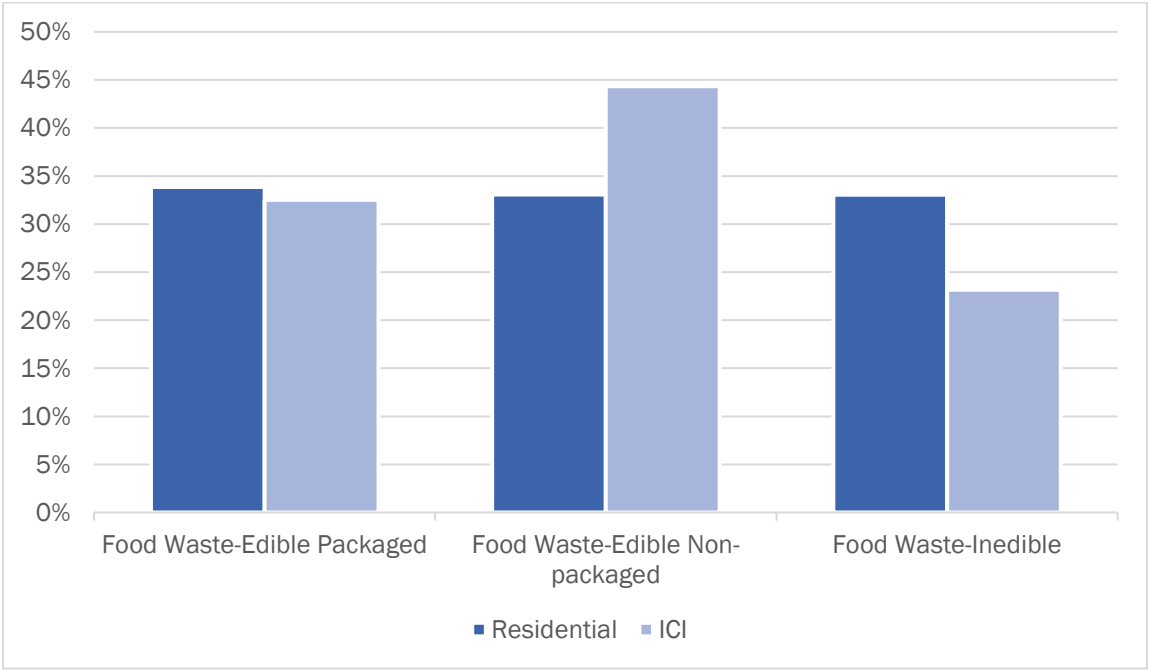


Figure E-11 compares the divertibility of wastes in the residential and commercial disposed MSW stream on a percentage basis. The ICI sector has a higher percentage of Act 101-eligible recyclables and other potentially recoverable materials, although slightly lower compostable organics, than the residential stream.

Figure E-11 Divertibility Comparison by Generator Sector (Percentage)

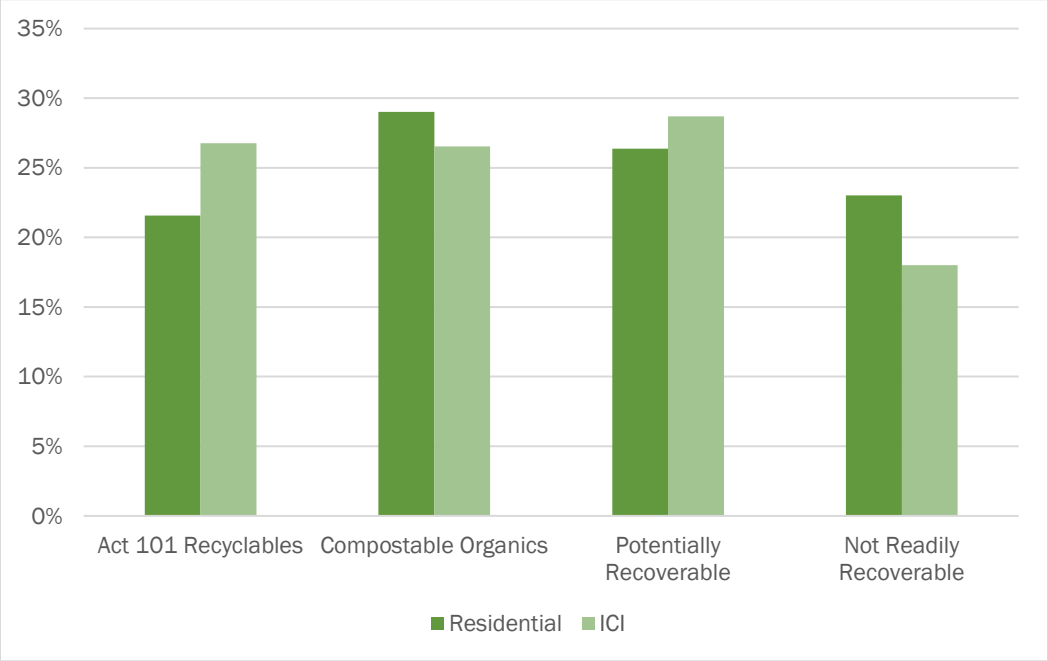


Figure E-12 compares the quantity of materials classified as Act 101-eligible that are being disposed from the residential and commercial waste streams. Both Mixed Recyclable Paper and Corrugated Cardboard, which are commonly collected in residential recycling programs, still appear to be getting disposed in significant quantities. Perhaps not surprisingly, most disposed Corrugated Cardboard was found to originate from the commercial sector.

Figure E-12 Act 101 Recyclables Disposed by Generator Sector (Tons)

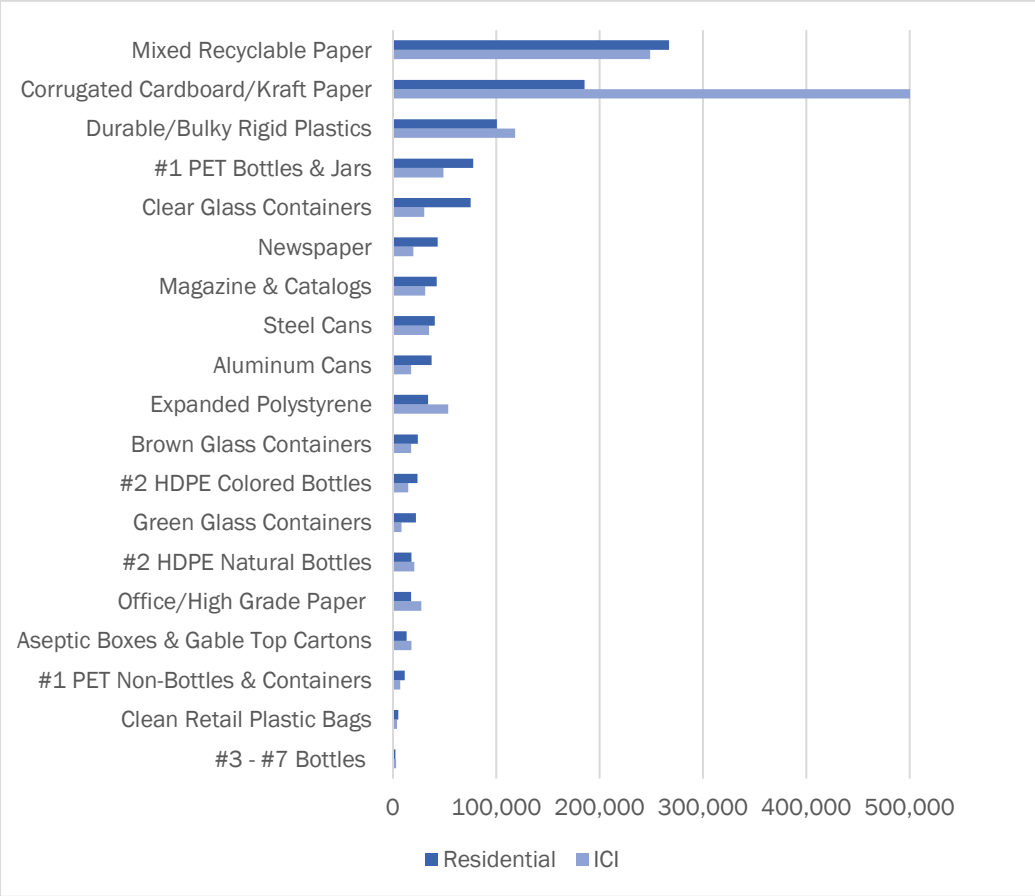


Table E-5 shows the ten most prevalent materials in the disposed residential and commercial MSW stream.

Table E-5 Top 10 Most Prevalent Materials by Generator Sector (Tons)

	Residential		Commercial	
Rank	Material	Tons	Material	Tons
1	Food Waste	764,239	Food Waste	828,870
2	Compostable Paper	382,562	Film Plastic	514,447
3	Film Plastic	306,935	Corrugated Cardboard/Kraft Paper	500,245
4	Textiles & Leather Products	270,045	Compostable Paper	304,590
5	Mixed Recyclable Paper	267,190	Wood - Unpainted	269,499
6	Animal Byproducts	220,593	Mixed Recyclable Paper	248,689
7	Diapers & Sanitary Products	208,156	Remainder/Composite Plastic	194,778
8	Yard Waste	191,338	Non-recyclable Paper	191,207
9	Corrugated Cardboard/Kraft Paper	185,209	Durable/Bulky Rigid Plastics	118,077
10	Wood - Painted	134,170	Other Organics	104,125
	Total	**2,930,436**		**3,274,528**
	Percent of Total	*60.8%*		*71.6%*

In the residential stream, only two curbside recyclable components—Mixed Recyclable Paper and Corrugated Cardboard—made this list. Three of the top 10 constituents are compostable but are challenging to segregate from other wastes. Finally, there are several non-recoverable categories in the top 10, including Animal Byproducts (a new category in 2021) and Diapers & Sanitary Products. These problem materials appear to have increased incidence in the disposed residential stream.

Materials in the top 10 of the commercial streams are also generally weighted toward organics materials, although several hard-to-recycle plastic categories also make this list.

E.6 COMPARISONS BY DEMOGRAPHIC ORIGIN

Another objective of the study was to differentiate the composition and quantity of disposed MSW generated in urban, suburban, and rural areas of the Commonwealth. This section provides a series of tables and figures with such comparisons.

Figure E-13 compares the composition by material group in terms of tons disposed. As shown, wastes generated in suburban areas make up the largest quantities of each material group.

Figure E-13 Disposed MSW Composition Summary by Demographic Origin (Tons)

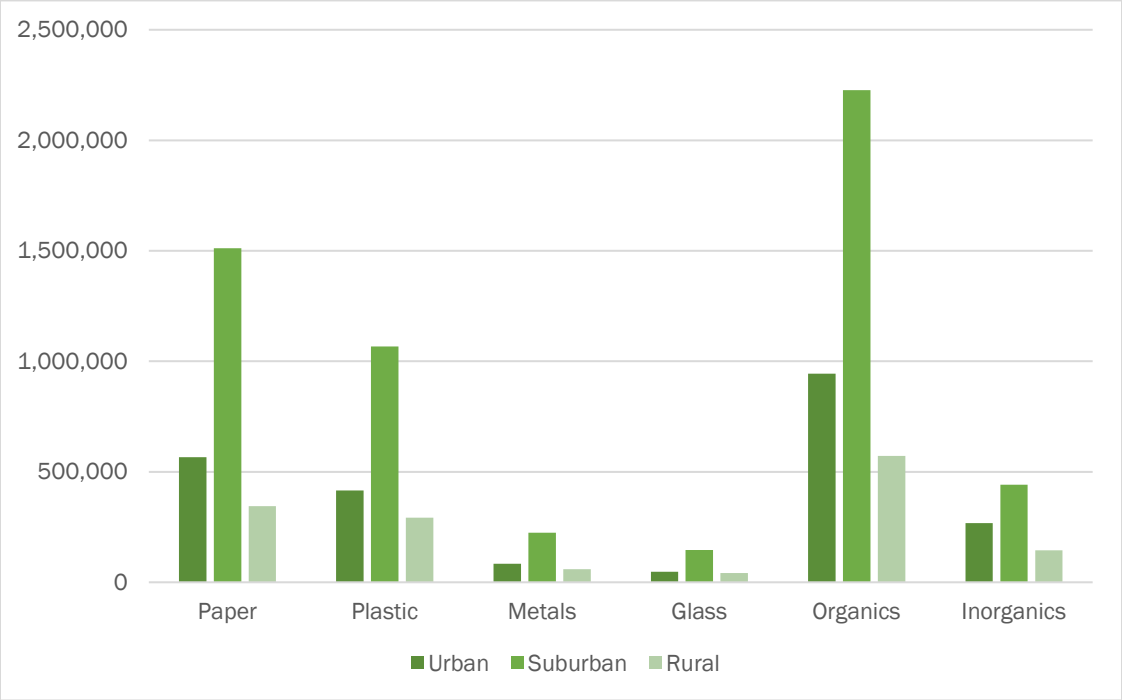


Figure E-14 compares the breakdown of Food Waste between generator sectors. As shown, the breakdown is reasonably comparable across demographic regions, although the mix of packaged and non-packaged edible food varies somewhat.

Figure E-14 Food Waste Detail by Demographic Origin (Percentage)

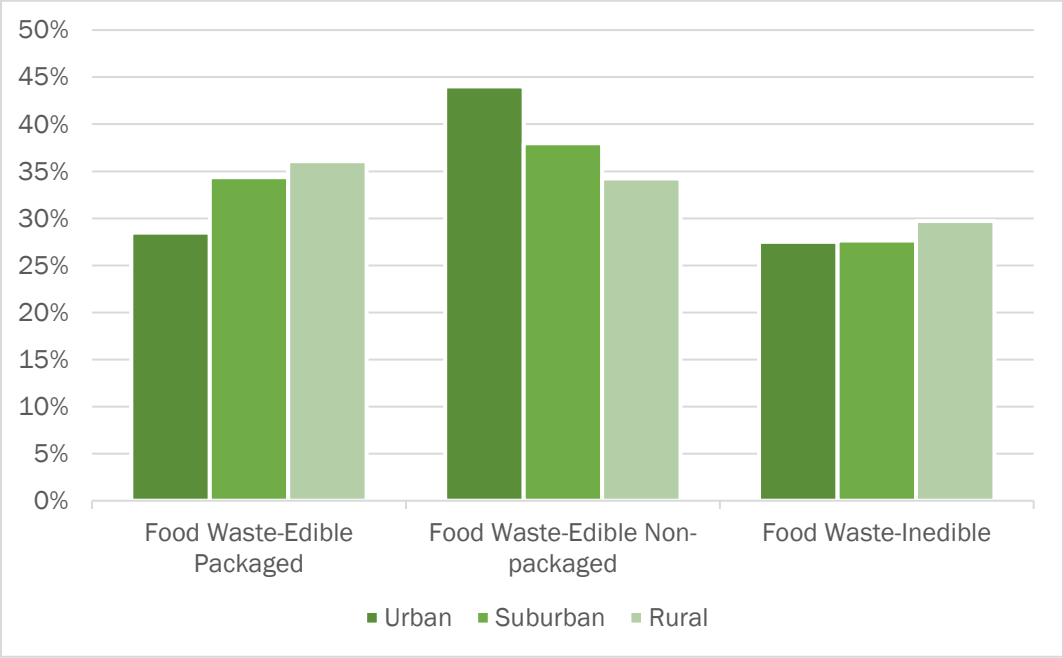


Figure E-15 compares the divertibility of wastes in the residential and commercial disposed MSW stream on a percentage basis. Divertibility is reasonably consistent.

Figure E-15 Divertibility Comparison by Demographic Origin (Percentage)

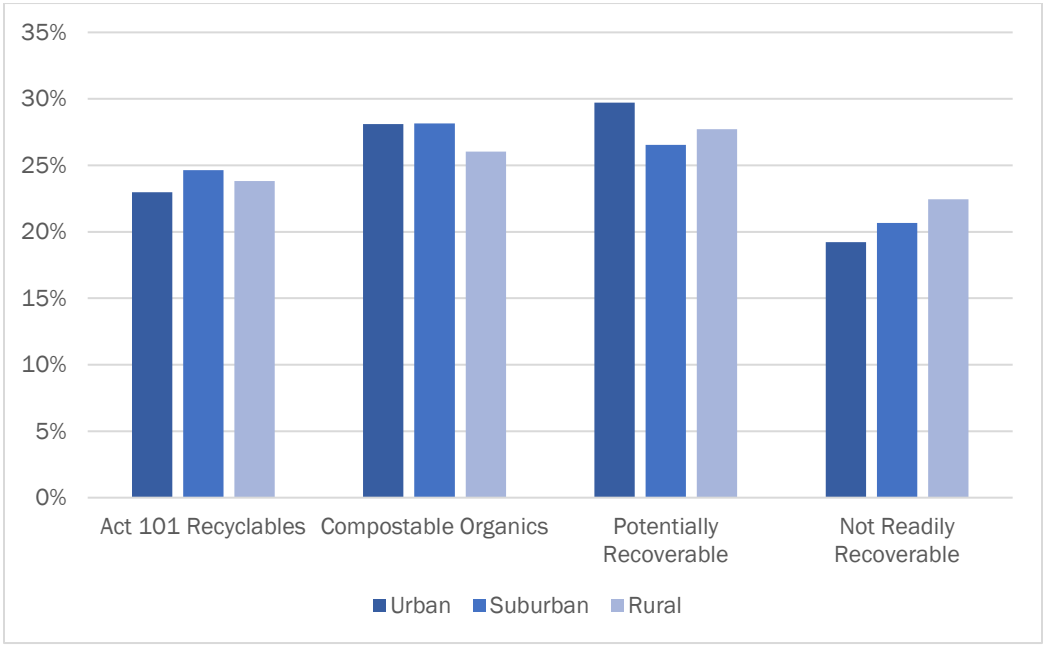


Figure E-16 compares the quantity of Act 101-eligible materials that are being disposed from urban, suburban, and rural areas. These breakdowns are reflective of the overweighting of suburban MSW in Pennsylvania.

Figure E-16 Act 101 Recyclables Disposed by Demographic Origin (Tons)

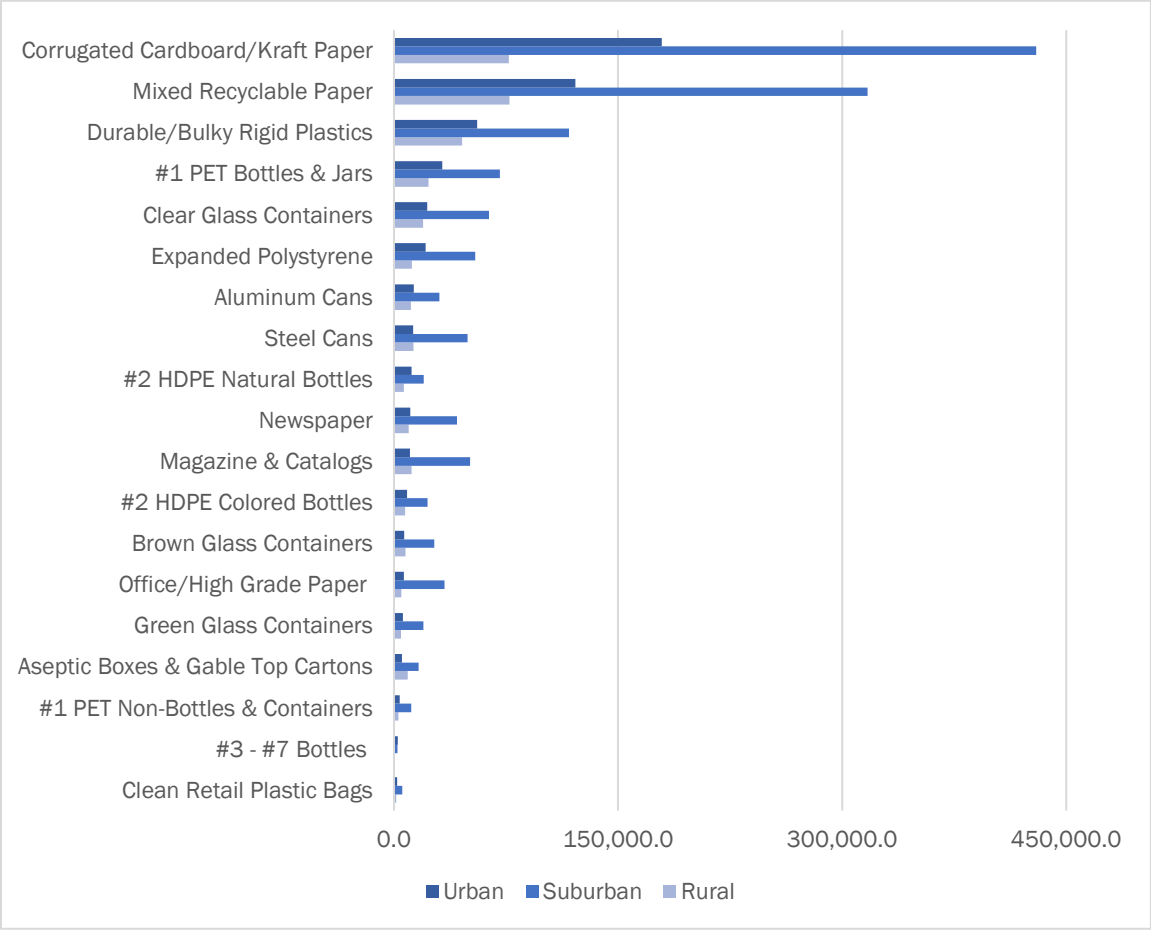


Table E-6 shows the ten most prevalent material categories in the urban, suburban, and rural waste streams.

Table E-6 Top 10 Most Prevalent Materials by Demographic Origin (Tons)

	Urban		Suburban		Rural	
Rank	Material	Tons	Material	Tons	Material	Tons
1	Food Waste	393,922	Food Waste	971,284	Food Waste	227,739
2	Film Plastic	188,297	Film Plastic	495,721	Film Plastic	137,140
3	Corrugated Cardboard/Kraft Paper	179,271	Corrugated Cardboard/Kraft Paper	429,811	Compostable Paper	102,397
4	Compostable Paper	158,644	Compostable Paper	426,182	Mixed Recyclable Paper	77,384
5	Mixed Recyclable Paper	121,451	Mixed Recyclable Paper	317,042	Corrugated Cardboard/Kraft Paper	76,808
6	Textiles & Leather Products	108,086	Textiles & Leather Products	208,247	Animal By-Products	54,218
7	Wood - Unpainted	87,854	Wood - Unpainted	200,467	Non-recyclable Paper	51,734
8	Yard Waste - Other	83,456	Non-recyclable Paper	194,573	Diapers & Sanitary Products	47,266
9	Furniture	75,574	Remainder/Composite Plastic	190,268	Wood - Unpainted	46,760
10	Non-recyclable Paper	72,989	Animal By-Products	159,475	Durable/Bulky Rigid Plastics	45,673
	Total	**1,469,545**		**3,593,071**		**867,120**
	Percent of Total	*63.3%*		*64.0%*		*59.7%*

E.7 ECONOMIC AND ENVIRONMENTAL IMPACTS

Table E-7 estimates the potential recovered material value for recyclables commodities that were disposed in the regional MSW stream. Market values were obtained from recyclingmarkets.net. Note that while these are materials common to most residential and commercial recycling programs, they are not necessarily universally collected in the Commonwealth. Moreover, recovered materials market prices fluctuate based on supply and demand, so this valuation should only be viewed as a moment-in-time snapshot. Nevertheless, as shown, were these materials segregated from the waste stream and captured in recycling programs, their cumulative value exceeded $514 million.

Table E-7 Estimated Value of Disposed Recyclable Materials

Material Components	Estimated Tons Disposed	Average Market Price ($/ton)	Estimated Total Market Value ($)
Recyclable Paper	**1,413,715**		**$167,199,460**
Corrugated Cardboard/Kraft Paper (Uncoated)	685,454	$135	$92,536,280
Newspaper	62,828	$188	$11,780,235
Office/High Grade Paper	45,190	$235	$10,619,601
Magazine & Catalogs	73,329	$168	$12,282,683
Aseptic Boxes & Gable Top Cartons	31,035	$0	$0
Mixed Recyclable Paper (Low Grade)	515,879	$78	$39,980,661
Recyclable Containers	**881,206**		**$347,409,850**
#1 PET Bottles & Jars	126,388	$860	$108,693,543
#1 PET Non-Bottles & Containers	18,368	$130	$2,387,849
#2 HDPE Natural Bottles	38,415	$1,130	$43,408,531
#2 HDPE Colored Bottles	38,511	$640	$24,647,259
#3 - #7 Bottles	5,485	$130	$713,013
#2-#7 Non-Bottle Rigid Containers	127,931	$130	$16,631,020
Durable/Bulky Rigid Plastics	218,558	$90	$19,670,255
Steel Cans	75,358	$230	$17,332,272
Aluminum Cans	54,861	$1,950	$106,978,697
Clear Glass Containers	105,315	$50	$5,265,770
Green Glass Containers	30,506	$8	$228,798
Brown Glass Containers	41,510	$35	$1,452,842
Total	**2,294,921**		**$514,609,309**
Avg		*$224*	

Source: Recyclingmarkets.net - Northeast Region as of 06/9/22

Table E-8 calculates the greenhouse gas emissions that could be reduced if the estimated quantities of recyclable and compostable materials disposed were diverted from disposal. This calculation has been made with the U.S. Environmental Protection Agency's (US EPA) Waste Reduction Model (WARM). As shown, the WARM estimates that recycling of these materials plus composting of the food and yard waste, rather than landfilling, would remove almost six million metric tons of carbon dioxide equivalent

($MTCO_2E$) from the atmosphere. Over 4.5 million $MTCO_2E$ could be reduced from paper recycling, with the remaining amount reduced from container recycling and food/yard waste composting.

Table E-8 Emissions Reduction Potential from Disposed Recyclables

Material Components	Tons Recycled/ Composted[1]	Emissions Reduced ($MTCO_2E$)[2]
Recyclable Paper	**1,382,681**	**4,502,855**
Corrugated Cardboard/Kraft Paper	685,454	2,149,129
Magazine & Catalogs	73,329	225,098
Newspaper	62,828	170,155
Office/High Grade Paper	45,190	129,412
Mixed Recyclable Paper	515,879	1,829,061
Recyclable Containers	**881,206**	**1,221,790**
Aluminum Cans	54,861	500,737
Steel Cans	75,358	138,062
Glass	177,332	48,959
PET	144,756	149,927
HDPE	76,926	58,345
Mixed Plastics	351,974	325,760
Compostable	**1,925,171**	**201,925**
Food Waste	1,593,109	184,140
Yard Waste	332,062	17,785
Total	**4,189,057**	**5,926,570**

[1] Based on estimated overall MSW waste composition for 2021 and Pennsylvania's reported MSW disposal tonnage for FY 2021. Assumes the materials would be recycled instead of disposed.

[2] U.S. EPA Waste Reduction Model, Version 15

E.8 CONCLUSIONS

As stated previously, the results of this study broadly validate the reported impact of many macro trends that have been identified in other waste composition time series for the past two decades. Specifically, these results illustrate:

- **Dramatic Reductions in Printed Paper:** Printed materials experienced a dramatic decrease. Where newspaper, magazines/catalogs, and office papers were all multiple percent of the 2001 Study waste stream, these are all mere fractions of a percent at present.
- **Stubbornly High Corrugated Cardboard Disposal:** While the amount of Corrugated Cardboard (OCC) in the disposed MSW stream decreased from 8.4 percent of the disposal stream to 7.3 percent, given the expansion of recycling programs during the past 20 years, less of this material should be ending up in the disposal stream.
- **Significant Increases in Non-Container Plastics**: Packaging continues to shift from heavier and more expensive materials to lighter plastics, and it shows in the overall Plastics fraction. This is most visible in the amount of Film Plastics that were observed in the 2021 Study. When the catch-all Film Plastic category from 2001 is compared to the 2021 combined categories of Clean Retail Plastic Bags, Industrial Film, and All other Film, we see an increase of nearly 365,000 tons. However, it is worth

noting that plastics are more subject to overstatement due to contamination, and so the actual increase in plastic waste is likely somewhat lower than the raw composition estimates coming from this study (a dynamic that exists in most waste composition studies).

- **Consistent Food Waste Disposal:** Food Waste made up 17 percent of total statewide MSW in the 2021 Study compared to 12 percent in 2001, an increase of nearly 466,000 tons. It remains the largest single component in the statewide aggregate, residential, and commercial waste streams.
- **Less Disposal of Metal and Glass:** Both of these materials (containers and non-containers) continue to edge lower in terms of their contribution to the disposed MSW stream.
- **More PET Bottles in Disposed Residential MSW:** Perhaps because more products are converting to PET packaging from other heavier packaging, the percentage and tons of PET bottles increased since 2001.
- **Lower Incidence of Grass and Yard Waste in Residential MSW**: There was a noteworthy decrease in residential disposed grass clippings in the 2021 Study. Expanded municipal collection programs combined with leave-it-on-the-lawn outreach efforts have taken a firmer hold since 2001. Other yard wastes were also disposed to a lesser extent in the 2021 Study.
- **Higher Incidence of Hard-to-Recycle Materials**: Diapers and Sanitary Products have increased in the residential stream. Also, the incidence of Animal Byproducts has spiked. The 2001 Study did not even have this as a category, but by 2021 so-called "pet waste" is almost three percent of the disposed MSW stream, and almost five percent of the residential stream.
- **Only Trace Amounts of HHW and E-wastes**: On a positive note, and consistent with the 2001 Study, very little HHW and electronic wastes were observed in the 2021 Study.
- **Significant Revenue Generating Opportunity for Improved Recycling**: While it is unrealistic to expect that all eligible recyclables can be diverted from disposal, it is nonetheless telling that discarded recyclables could have generated an additional $514 million dollars had they been properly recycled instead.
- **Meaningful Emissions Reductions from Improved Recycling**: Similarly, capturing recyclables in proper recycling programs has positive impacts on Pennsylvania's environment through reduced emissions.

The full report contains extensive tabular and graphics presentation of the results of the 2021 Study, as well as select comparisons with the 2001 Study. All tabular results have also been provided to DEP in electronic format.

1. INTRODUCTION

1.1 BACKGROUND

Since the enactment of Act 101 of 1988, the Commonwealth of Pennsylvania has committed itself to reducing disposal of Municipal Solid Waste (MSW) in landfills and combustion facilities through recycling, reuse, and waste reduction. To measure the effectiveness of recycling and waste reduction programs, many state and local governments employ waste composition studies at routine intervals to provide a snapshot of the recyclable, compostable, and other recoverable constituents that remain in the disposed waste stream.

The Pennsylvania Department of Environmental Protection (DEP) commissioned an inaugural statewide waste composition study in 2001 (2001 Study). At the time it was completed, this seminal effort provided extensive data on the municipal solid waste (MSW) being generated in Pennsylvania and disposed in the Commonwealth's landfills and waste-to-energy (WTE) facilities.

In 2019, the Pennsylvania Department of Environmental Protection (DEP) retained MSW Consultants to perform a full update of the 2001 Study. Although this effort was initiated in 2020, the project soon encountered significant delays both directly and indirectly as a result of the COVID-19 pandemic. The field data collection portion of the work was performed in 2020 and 2021, at which point the project was temporarily put on hold due to administrative impacts. This resulting report applies the findings to Pennsylvania's Fiscal Year 2021 (July 1, 2020, through June 30, 2021) disposed MSW tonnage data. Accordingly, this document is considered the 2021 Statewide Waste Characterization Study (2021 Study)

At a span of 20 years, the gap between the original study and this update is significant. The two decades between the studies have been transformational for the solid waste management industry. Global events and macroeconomics trends, which are itemized in the following list, have driven major changes in the waste stream:

- Great recession of 2008,
- Generational migration from printed media to digital media,
- Ongoing pursuit of lighter weight packaging for all goods,
- Ongoing proliferation of single use plastics and associated growth of regulations to govern them,
- Chinese imposition of the Green Fence and the National Sword policies that disrupted the export market for recyclables,
- Rise of e-commerce and associated growth in point-to-point shipping,
- Heightened focus on diverting organics as the remaining low-hanging fruit in the disposed waste stream, and
- The COVID-19 pandemic, which shifted waste generation from the commercial to the residential sector as the population sheltered at home.

Recycling in Pennsylvania has also changed in the last 20 years, with statewide diversion totals increasing from 3.7 million tons in 2001 to 5.3 million tons in 2020. Some of this growth has been driven by the change from source-separated and dual stream recycling programs to single stream collection systems. Many programs and institutions across the Commonwealth have also begun to target additional materials for diversion, most notably food wastes. In 2001, there were no reported single stream recyclables tonnages, with those constituent recyclables instead being reported within the "commingled recyclables" category (metal, glass and plastic food and beverage containers) or by individual commodity (newspaper, aluminum cans, PET plastics, etc.). Single stream recyclables were first reported to DEP in 2002 at an amount of 18,672 tons, while just 6,176 tons of food wastes were reportedly composted. In 2020 (the most

recent year for which statewide recycling data is available), these totals increased to 318,770 of single stream recyclables, and 162,773 tons of composted food waste.

Considering the drastic evolution of solid waste, the 2021 Study characterizes a vastly different waste stream compared to the 2001 Study. This report describes the background, methodology and results of the 2021 Study, and provides comparisons to highlight the changes in the Commonwealth's waste stream since the 2001 Study.

1.2 OBJECTIVES

The 2021 Study retains many of the objectives that were identified for the 2001 Study, all of which help the Commonwealth's solid waste and recycling industry stakeholders better understand the effectiveness of current diversion programs and remaining diversion opportunities. Project objectives include:

- Evaluate and validate county-level MSW generation and disposal estimates currently compiled by DEP on an annual basis;
- Determine the aggregate composition of the Commonwealth's disposed MSW stream, as well as the composition of MSW in each of DEP's six planning regions;
- For each region and for the Commonwealth as a whole, differentiate waste composition from the residential and commercial generating sectors;
- For each region and for the Commonwealth as a whole, differentiate waste composition from urban, suburban, and rural areas;
- For each region and for the Commonwealth as a whole, compare the 2021 Study results to the prior study and highlight noteworthy changes;
- Update the material category list to provide information about current hot-button or high-profile materials in the disposed MSW stream; and
- Comment on the economic and environmental benefits of recycling in Pennsylvania.

The 2021 Study was performed with assistance from the Professional Recyclers of Pennsylvania (PROP), whose members assisted with host facility planning and logistics, as well as selected sorting. Similarly, several key staff within MSW Consultants were significant contributors to the 2001 Study. For these reasons, it is believed that the 2021 Study closely follows the framework established in the 2001 Study.

1.3 RECYCLING COMPOSITION STUDY

DEP's 2001 waste composition research also included an analysis of the composition of inbound recyclables, recovered commodities, and process residue at a subset of Pennsylvania's material recovery facilities (MRFs), which resulted in the publication of a separate MRF report in February 2005 (2005 MRF Study). The 2005 MRF Study compiled data from studies at MRFs over 2002 through 2004.

The 2021 Study update incorporated an update to the 2005 MRF Study. The full results of the 2021 MRF Study will be provided in a separate report.

1.4 COMPARISONS WITH 2001 STUDY

Comparing the results of this update with the 2001 Study was one of the primary objectives of the 2021 Study. Similarities and differences of the study methodology are described below.

1.4.1 SIMILARITIES

To obtain the best data, and therefore the best results and conclusions, the Project Team replicated elements from the 2001 Study as closely as possible. These similarities include the following items:

- **Same Generator Sectors**: The 2021 Study retained separate analysis of the residential and commercial (non-residential) generator sectors.

- **Same Demographic Region Breakdown**: The 2021 Study retained separate analysis of the generation and composition of wastes originating from urban, suburban, and rural areas of the Commonwealth.
- **Same Seasonal Distribution**: The 2021 Study field collection was performed over four seasons with most facilities hosting two seasons of field data collection separated by six months, just as in the 2001 Study.
- **Same Material Categories**: The list of material categories used in the 2001 Study was retained and expanded for the 2021 Study
- **Same Sampling Protocols**: The protocol for obtaining samples of wastes remained unchanged. Both studies used standard grab sampling techniques for municipal solid waste (MSW).
- **Same Sorting Protocol**: The sorting protocol was largely unchanged from the 2001 Study. Samples were pre-weighed, loaded on a sort table, and sorted by category into labeled bins so they could be weighed for analysis.
- **Same Statewide Aggregate and Region-Specific Results**: Sample allocation covered all six DEP regions in order to provide representative, region-specific results as well as a highly representative estimate of the statewide waste composition.
- **Same Statistical Methods**: The same statistical methods were used in the 2001 and 2021 studies, with the results from both studies calculated at 90 percent level of confidence.
- **Many of the Same Host Facilities**: Refuse samples were obtained and sorted at a total of 14 facilities for the 2021 Study compared to 13 facilities in 2001. Of the 14 host facilities for 2021, eleven were also used during the 2001 Study. One facility from 2001 was not used during 2021 while another facility was replaced. Finally, one facility saw its regional designation changed from Southeast to Southcentral for the 2021 Study.

1.4.2 DIFFERENCES

Some differences existed between the 2001 Study and 2021 Study, primarily associated with difficulties replicating certain aspects of the data collection due to macro-economic factors. Differences include:

- **Differences in Protocol to Allocate Wastes to Urban, Suburban, and Rural Municipalitie**s: In 2001, it is believed that Pennsylvania was actively maintaining an official database of its 2,500-plus municipalities that classified each one as being urban, suburban, or rural based on certain attributes including population density, type of municipality, and potentially others. The Commonwealth was no longer maintaining an official list of urban/suburban/rural assignments in 2021. The 2021 Study therefore relies on a custom algorithm developed by MSW Consultants as the basis to allocate tonnage to the three demographic regions.
- **Expanded List of Act 101 Materials:** The definition of Act 101 materials in the 2001 Study was interpreted to mean those materials detailed in Statute and included Aluminum Cans, Steel Cans, Plastic Bottles (PET and HDPE), Newspaper, Corrugated Cardboard, Office Paper and Clear, Green and Brown Glass Containers. Since the 2001 Study, Pennsylvania's recycling programs have expanded to accept a wider array of materials, including Mixed Paper, Magazines and Catalogs, and additional plastics grades. These additional materials have been classified as Act 101 materials as part of the 2021 Study. However, any comparison of Act 101 materials trends will focus only on the core materials identified in the 2001 Study.
- **Exclusion of Supplemental Visual Surveying of Bulk Wastes**: The 2001 Study captured visual composition estimates of a significant number of inbound loads of open-top bulky wastes that were not conducive to manual sorting. Due to a number of reasons, the primary focus of the 2021 Study was to update the statistically representative sampling of non-bulky MSW. Issues driving this focus included significant constraints in place at the host facilities during the COVID pandemic, a dearth of

sort labor during much of the 2021 Study field work, and some facilities not accepting/receiving bulky MSW loads. Note that the results of this study still include bulky waste items; however, no supplemental breakdown of these wastes are included.

- **More Limited Multi-Family Sampling in 2021**: In 2001, it was possible to coordinate with local haulers delivering to many of the host facilities to arrange for segregated multi-family loads of waste. In 2020 and 2021 when the field data collection for this study took place, the solid waste industry struggled with staffing and equipment shortages due to the COVID pandemic, and it was not possible to make similar arrangements. Consequently, a smaller proportion of samples in the 2021 Study originated from multi-family apartments and condominiums.
- **Better Data Management**: The 2001 Study relied on paper forms manually entered into spreadsheets. In 2021, all field data was collected via tablet computers with built in summation and error flagging. Sample data was uploaded to a cloud-based data management system for greater data security. Should other Pennsylvania communities wish to perform their own waste composition studies, it would be possible to leverage the databases and systems used for the 2021 Study update.

1.5 REPORT ORGANIZATION

The remainder of this report contains the following sections:

Section 2 – Waste Generation identifies the annual tonnage of disposed MSW from DEP reports, as well as the demographic and employment data used for apportioning county-level waste generation into the residential and commercial sectors, and across urban, suburban, and rural areas of Pennsylvania. The resulting tonnage serves as the basis for applying composition estimates.

Section 3 – Methodology describes the sampling plan, field data collection procedures, sorting procedures, and analytical methods used in the 2021 Study.

Section 4 – Results presents the results for the Commonwealth as a whole (i.e., all regions aggregated). Composition results are broken down by material type, by solid waste generating sector, and by demographic area.

Section 5 – Conclusions & Recommendations offers noteworthy observations about the state's waste stream and makes several recommendations for future considerations.

Appendices contain supplementary data and information, including the location of host facilities, project schedule, material categories and definitions, and the composition and disposal quantities for each DEP region. Further, there are separate appendices containing regional waste composition results, which are presented in parallel to the statewide results.

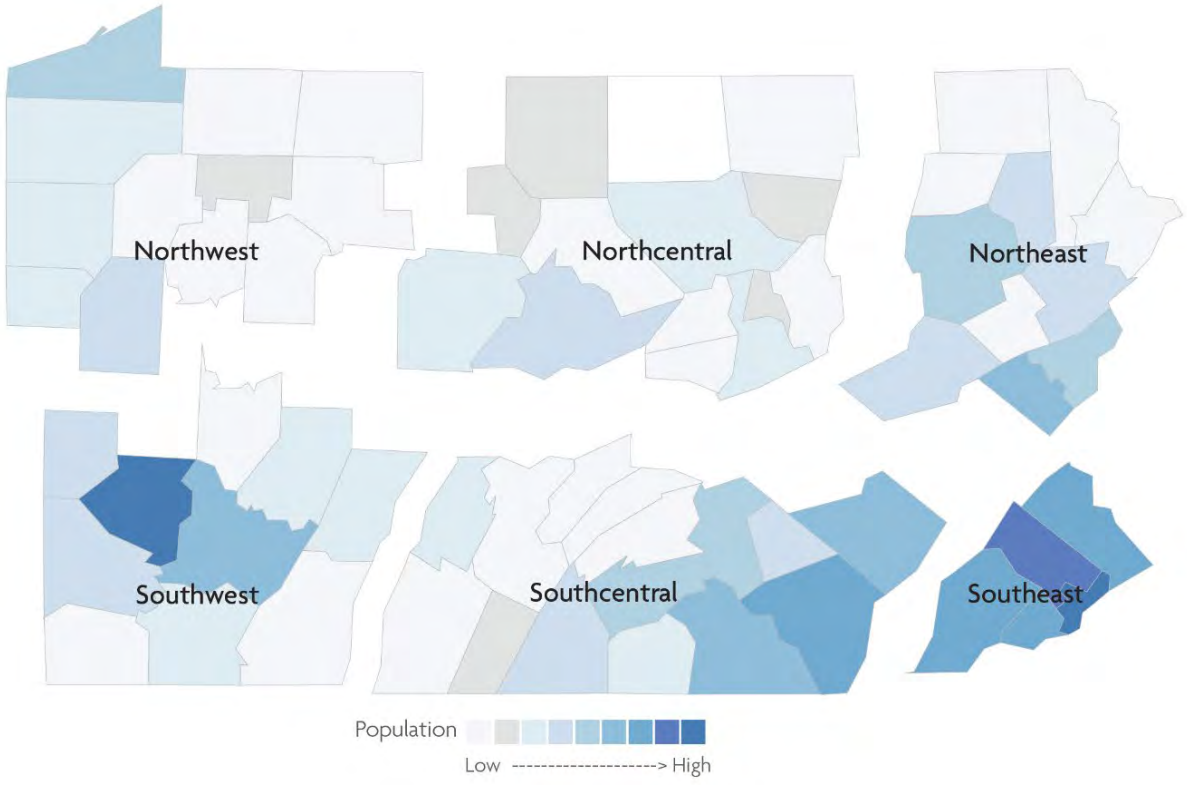
2. WASTE GENERATION

2.1 2021 MSW DISPOSAL

The 2020 Census found that Pennsylvania had a population of 13 million residents spread among its 67 counties and 2,572 incorporated municipalities, including cities, boroughs, and townships. The municipalities within Pennsylvania vary from urban metropolitan areas such as Philadelphia and industrial centers such as Pittsburgh, through suburban regions outlying cities across the Commonwealth, down to thousands of small rural boroughs and townships that make up the majority of the Commonwealth's land area.

Pennsylvania counties are divided into six DEP planning regions. These regions are shown in Figure 2-1.

Figure 2-1 DEP Regions



Landfills and WTE facilities are required to report disposed MSW quantities to DEP on quarterly basis. These facilities submit reports that are accumulated in a web-based portal that is available on the DEP website. Of particular importance, tonnages are reported by county of origin. Reported FY 2021 MSW disposal tonnages have been selected as the appropriate basis for use in applying results of the 2021 Study. Table 2-1 summarizes the reported 2021 MSW tons disposed for each of the six DEP regions. As shown, almost 9.4 million tons were disposed in 2021. Interestingly, this is almost identical to the tons disposed in 2001 (also 9.4 million), which served as the basis for allocating 2001 Study composition results.

Table 2-1 2021 MSW Disposal by Region

DEP Region	No. of Counties	2021 MSW Disposed (Tons)
Northeast	11	1,459,192
Northcentral	14	466,247
Northwest	12	623,377
Southeast	5	3,166,387
Southcentral	15	1,911,223
Southwest	10	1,766,277
Total	**67**	**9,392,702**

2.2 WASTE GENERATOR SECTORS AND GENERATION INDICATORS

This study subdivided MSW into two primary generator sectors:

- **Residential Sector**: Single-family and multi-family residential dwellings; and
- **Commercial Sector**: Nonresidential sources such as offices, restaurants, retail establishments, malls, institutions, warehouses, hotels, etc.

Many data sets are available to quantify the residential and commercial sectors. However, for a variety of reasons it is not possible for the Commonwealth's disposal facilities to report waste disposal by generator sector. Therefore, it is necessary to estimate the fraction of disposed MSW that originated from each sector.

To make this estimation, two primary waste generation indicators were used:

- **Residential Housing Units**: The generation of disposed MSW in the residential sector is driven by the population. More people mean more waste. However, for reasons described below, residential housing units have been used as the preferred generation indicator for the residential sector. Although the number of persons per household may range from one to more than 10, on average the persons per housing unit falls within a fairly narrow range. Further, municipal-level residential waste generation is often reported on a per-household basis. The Pennsylvania State Data Center provided a database of the 2021 residential population and housing units for every municipality in the state.[1]
- **Total Commercial Employment**: For the nonresidential sector, employment was selected as the primary generation indicator. The Penn State-Harrisburg Pennsylvania State Data Center (PaSDC) was unable to provide this data series, but a third-party market data provider was able to supply a database of estimated employment by municipality.[2]

Finally, the 2021 Study sought to apportion disposed MSW into urban, suburban, and rural areas of the Commonwealth. It should be noted that the methodology in the 2021 Study to assign each municipality as either urban, suburban, or rural differed from the 2001 Study. In 2001, these designations were provided by the PaSDC. However, no designations were made available from the PaSDC in 2021, and therefore MSW Consultants developed its own methodology.

Table 2-2 summarizes Pennsylvania's statewide demographic counts from these sources of data and based on the assignment by MSW Consultants of every municipality as being either urban, suburban, or rural.

[1] Pennsylvania State Data Center, 2021.

[2] ESRI Business Patterns, 2021.

Table 2-2 2021 Demography of Pennsylvania Municipalities

	Urban	Suburban	Rural	Total
Communities [1]	21	957	1,594	2,572
Population [1]	2,803,419	7,460,543	2,700,094	12,964,056
Housing Units [1]	1,105,638	2,924,653	1,076,310	5,106,601
Employment [2]	1,527,174	3,966,438	711,616	6,205,228

[1] Source: Pennsylvania State Data Center
[2] Source: ESRI Business Patterns 2021

Table 2-3 converts the values in Table 2-2 into percentages to show the allocation by demographic region. This table highlights the prevalent of suburban areas in the state.

Table 2-3 2021 Demography of Pennsylvania Municipalities by Percentage

	Urban	Suburban	Rural	Total
Communities	0.8%	37.2%	62.0%	100.0%
Population	21.6%	57.5%	20.8%	100.0%
Housing Units	21.7%	57.3%	21.1%	100.0%
Employment	24.6%	63.9%	11.5%	100.0%

Readers should note that these allocations reflect a shift from a higher prevalence of rural areas in the 2001 Study. Table 2-4 shows the same allocation percentages from the 2001 Study. The allocation of these waste generation indicators from urban areas has remained roughly unchanged. However, the 2001 Study had a heavier weighting towards rural areas, and a lighter weighting from suburban areas, compared to the 2021 Study analysis. While this rural-to-suburban shift would seem to follow broad demographic trends in the Commonwealth, it is possible that some of the change is the result of differing methodologies to delineate some municipalities as being suburban.

Table 2-4 2001 Demography of Pennsylvania Municipalities by Percentage

	Urban	Suburban	Rural	Total
Communities	0.8%	25.7%	73.5%	100.0%
Population	22.2%	44.4%	33.4%	100.0%
Housing Units	22.4%	44.4%	33.2%	100.0%
Employment	25.3%	52.1%	22.6%	100.0%

2.3 WASTE GENERATION APPORTIONMENT

Consistent with the 2001 Study, statewide disposed MSW was apportioned by region, generator sector (residential or commercial), and by demographic origin (urban, suburban, and rural) using a four-step process:

1. Compile residential waste disposal rates by demographic sector;
2. Project aggregate residential waste disposal based on the residential waste disposal rates;
3. Statistically analyze and adjust county-level waste disposal totals (as reported in the Facility Reports); and
4. Calculate disposed commercial waste by netting out residential waste from county-level totals.

MSW Consultants gathered residential waste generation data from a cross section of 151 counties and municipalities in all six regions, from a variety of sources. Attempts were made to obtain data points from urban, suburban, and rural jurisdictions. Table 2-5 identifies the list of counties and municipalities for which residential household MSW disposal (e.g., a count of households and annual tons of MSW disposed) was obtained.

Table 2-5 2021 Compiled Residential Waste Disposal Rate Data Points

Demographic Sector	Municipality	County	Region	Residential Tons Disposed
Rural	Blended	Chester	Southeast	8,234
	Blended	Lebanon	Southcentral	2,338
	Blended	York	Southcentral	23,937
Suburban	Carlisle Boro	Cumberland	Southcentral	3,717
	Millcreek Twp	Erie	Northwest	19,880
	Upper Moreland Twp	Montgomery	Southeast	7,099
	Upper Dublin Twp	Montgomery	Southeast	7,924
	Blended	Chester	Southeast	123,654
	Blended	Lebanon	Southcentral	38,011
	Blended	York	Southcentral	118,483
Urban	Pittsburgh	Allegheny	Southwest	94,322
	State College Boro	Centre	Northcentral	2,295
	Allentown	Lehigh	Northeast	44,303
	City of Philadelphia	Philadelphia	Southeast	635,823
	Blended	York	Southcentral	19,856
Total				1,149,876

MSW Consultants calculated both unweighted and tonnage-weighted residential generation rates from this dataset. Results are shown in Table 2-6, along with the comparable household generation rates from the 2001 Study. As shown, the relative residential household generation rates were found to be meaningfully different based on the 2021 research compared to the 2001 research.

Table 2-6 Residential Waste Disposal Rate Comparisons

Generation Rate Basis	Urban	Suburban	Rural
2021 Tonnage-Weighted	1.06	0.92	0.89
2021 Unweighted	0.99	0.92	0.77
2001 Study	0.93	1.18	1.06

It is beyond the scope of this study to determine the reasons for the differences in residential household MSW disposal rates between the 2021 and 2001 Studies. Some of the impact may be due to the widely reported spike in residential waste generation spurred by the COVID pandemic. Further, the underlying set of municipalities used as the basis for estimating residential generation differed in both studies. Based

on the underlying data, MSW Consultants has opted to rely on the 2021 tonnage weighted MSW disposal rates for use in the analysis.

By applying the tonnage-weighted residential MSW disposal rates to county-level household data and proceeding through the steps described at the outset of this subsection, we have arrived at a breakdown of waste disposal from urban, suburban, and rural communities, including the residential and commercial waste streams. Table 2-7 summarizes this breakdown.

Table 2-7 2021 MSW Disposal by Generator Sector and Demographic Area (Tons)

	Tons of Waste Disposed			
Generating Sector	**Urban**	**Suburban**	**Rural**	**Total**
Residential	1,171,976	2,690,681	957,916	**4,820,573**
Commercial	1,150,948	2,926,072	495,109	**4,572,129**
Total	**2,322,924**	**5,616,753**	**1,453,025**	**9,392,702**

Because the apportionment of disposed MSW directly impacts the application of composition estimates, it should be noted that the shift in waste generation indicators to the suburban sector propagates through to the waste disposal allocations. This is shown in Table 2-8, which compares the percentage allocation of disposed MSW from the 2021 and 2001 Studies. As shown, urban waste origination has remained roughly the same (showing a slight decrease), while roughly 12 percentage points have shifted from the rural sector to the suburban sector in 2021.

Table 2-8 2021 & 2001 MSW Disposal by Generator Sector and Demographic Area (Percent)

	Percentage of Waste Disposed, 2021 Study				
Generating Sector	**Urban**	**Suburban**	**Rural**	**Total**	***2001 Study***
Residential	12.5%	28.6%	10.2%	**51.3%**	*54.3%*
Commercial	12.3%	31.2%	5.3%	**48.7%**	*45.7%*
Total	**24.7%**	**59.8%**	**15.5%**	**100.0%**	
2001 Study	*27.1%*	*45.3%*	*27.6%*		*100.0%*

Despite the shifts in the origin of disposed wastes since the 2001 Study, MSW Consultants believes the resulting estimates are reasonable in their portrayal of Pennsylvania's waste stream. The tonnage generation rates in Table 2-6 have been used as the basis for applying composition data in the results section of the report. Further, the methodology described above for state-level apportionment was also used to develop regional results, which are contained in appendices to this report.

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3. METHODOLOGY

3.1 INTRODUCTION

The sampling plan and data collection protocol for the 2021 Statewide Waste Composition Study was designed to replicate the 2001 Study methodology. Broadly, the 2021 Study maintained the same sampling targets and allocated sampling across the same number of solid waste facilities, which were predominantly landfills. Both studies spanned four seasons and aimed for statistical representation by region, demographic area, and generating sector. The following sections summarize the sampling plan and field data collection protocols.

3.2 MATERIAL CATEGORIES

The 2001 Study included 37 material categories. Since that time, solid waste and recycling planners have sought a deeper understanding of certain constituents in the disposed MSW stream. Based on developments within sustainable materials management and on ideas from other more recent studies, the 2021 Study incorporated 58 material categories. Examples of expanded material categories include the following items:

- Expansion of rigid plastic categories
- Subsorting of food wastes into three components
- Addition of problem materials such as animal byproducts (i.e., pet wastes) and certain battery types,
- Separation of plastic films into multiple subtypes
- Addition of certain subtypes of construction and demolition debris that is sometimes found in disposed MSW

The 2021 Study categories retained the same material groupings as the 2001 Study and were mapped and conformed to the 2001 Study categories to allow for comparison. The final list of materials that were analyzed in the study are shown in Table 3-1. Detailed definitions are contained in Appendix A.

In addition, one of the objectives of this study was to identify constituents that could be diverted from the disposed MSW stream through locally available means. Accordingly, each material was assigned a "divertibility class" which are defined below.

1. **Act 101 Recyclables:** Includes materials mandated for collection through Pennsylvania's Act 101 of 1988 including glass food and beverage containers, plastics, aluminum cans, steel cans, corrugated cardboard, newspaper, and office paper. This list has been expanded beyond the 2001 Study's list to reflect the increased recoverability of additional materials, such as Aseptic Cartons, Magazines and Catalogs, Mixed Recyclable Paper, and additional plastic resins. All materials on this list are counted towards DEP's Act 101, Section 904 Recycling Performance Grant awards to local governments. Note that while many of these materials are common to recycling programs across the Commonwealth, they are not necessarily universally accepted.
2. **Compostable Organics:** Includes organics such as Food Waste and Yard Waste (leaves, grass, prunings) that can be composted and mulched for use as a soil amendment, as well as clean wood and lumber (Wood-Unpainted) that can be chipped and used for mulch. These material categories can also be recovered through anaerobic digestion technologies.
3. **Potentially Recyclable:** Applies to materials that have been found to be recoverable in other regions of the country or state where collection and processing infrastructure exists, and where suitable end markets have been developed, but are still not universally collected. This includes materials such as e-waste, plastic film, textiles, scrap metals, and other items that are recyclable through public or private

drop-off networks or through commercial settings. It also includes some components of Construction and Demolition Debris (C&D), which is primarily generated by the ICI sector.

4. **Non-Recyclable/Disposable**: Includes materials that are not known to be recyclable in Pennsylvania or for which no known local markets exist. Some materials in this classification could theoretically become recyclable if sufficient material volume existed to create cost-effective and appropriate collection methods, processing facilities, and suitable end markets.

Table 3-1 also indicates the divertibility class for each material category. The numbers in the table align with the four classes in the list above.

Table 3-1 Targeted Materials in Disposed MSW

Material Category	Divertibility	Material Category	Divertibility	Material Category	Divertibility
Paper		**Organics**		**Inorganics**	
Corrugated Cardboard/Kraft Paper	1	Food Waste	2	*Electronics – Covered*	*3*
Newspaper	1	Yard Waste - Grass	2	Other Electronics	3
Office/High-Grade Paper	1	Yard Waste - Other	2	Carpet & Carpet Padding	3
Magazine & Catalogs	1	Wood - Unpainted	2	Drywall/Gypsum Board	3
Aseptic Boxes & Gable Top Cartons	1	Wood - Painted	3	*Concrete, Rock, Brick*	*3*
Mixed Recyclable Paper	1	Textiles & Leather Products	3	*Asphalt Roofing*	*3*
Compostable Paper	*2*	Diapers & Sanitary Products	4	*Asphalt Paving*	*3*
Non-recyclable Paper	4	*Animal Byproducts*	4	Other C&D	4
Plastic		Fines-1/2" minus	4	Medically Related Waste	4
#1 PET Bottles & Jars	1	Other Organics	4	*Lithium Batteries*	3
#1 PET Non-Bottles & Containers	*1*	**Metals**		*Automotive Batteries*	*3*
#2 HDPE Natural Bottles	1	Steel Cans	1	Other Batteries	3
#2 HDPE Colored Bottles	*1*	Aluminum Cans	1	Other HHW	4
#3 - #7 Bottles	1	Other Aluminum	3	*Bulky Materials*	*4*
#2 - #7 Non-Bottle Containers	*1*	Other Ferrous Metals	3	*Furniture*	*3*
Expanded Polystyrene	1	Other Non-Ferrous Metals	3	Other Inorganics	4
Clean Retail Plastic Bags	*1*	**Glass**		*PPE*	*4*
Industrial Film	*3*	Clear Glass Containers	1		
All Other Film	3	Green Glass Containers	1		
Durable/Bulky Rigid Plastics	1	Brown Glass Containers	1		
Remainder/Composite Plastic	*4*	Non-Recyclable Glass	4		

Materials shown in italicized font represent categories new to the 2021 Study.

3.3 SAMPLE WEIGHTS

To remain parallel with the 2001 Study, MSW samples were targeted to fall between 200 to 250 pounds. The combined weight of material sorted was 269,922 pounds, for an average of 215 pounds of refuse per sample.

Sampling methods are described in the following sections.

3.4 SEASONAL SAMPLE DISTRIBUTION

The composition of MSW varies from season to season. Consistent with the 2001 Study, field data was collected over a 12-month period to ensure that study results accurately captured variability associated with seasonal variations in the waste stream. Table 3-2 summarizes the dates of each of the four seasons of field sorting, as well as the number of samples obtained in each season.

Table 3-2 Seasonal Field Data Collection Schedule

Season	Sampling Dates	Sampling Events	Samples Obtained
Summer	July 13–August 21, 2020	6	298
Fall	October 5–November 13, 2020	6	314
Winter	January 11–February 26, 2021	7	363
Spring	April 12–May 28, 2021	6	283
	Totals	**25**	**1,258**

As with the 2001 Study, most facilities hosted two seasons of field data collection, with six months separating sampling events. That is, facilities that hosted sorts in the fall hosted again in the spring; likewise, those that hosted in winter did so again in summer.

3.5 REGIONAL SAMPLE DISTRIBUTION

Significant sampling was performed in all six regions of the Commonwealth. In particular, most of the same host facilities that participated in the 2001 Study also participated in the 2021 Study (with the exception of the TRC Station, which has closed).

Thirteen facilities across the six DEP planning regions hosted the Study; crews spent at least one week field sampling and sorting at roughly half of the facilities each season. At most of the facilities, two weeks of sorting was performed, with the weeks being separated by six months to obtain seasonally opposite samples (e.g., sorting was either done in summer and winter, or in fall and spring). Table 3-3 summarizes the host facilities, the seasons in which sorting occurred, and the number of samples obtained from that facility.

Table 3-3 Host Facility Summary

DEP Region	Facility	2001 Host	Seasons of Sorting				No. of Samples
			Summer	Fall	Winter	Spring	
Northeast	Keystone Sanitary Landfill	✓	✓		✓		104
	Commonwealth Environmental Systems (CES) Landfill	✓		✓		✓	100
Northcentral	NTSWA Bradford County Landfill		✓				48
	Centre County Transfer Station	✓		✓	✓	✓	162
Northwest	WM Lake View Landfill		✓		✓		101
	Seneca Landfill	✓		✓		✓	104
Southeast	WM Forge Transfer Station & Recycling Center	✓		✓		✓	84
	Covanta Montgomery Resource Recovery Facility				✓		52
	Northwest Philadelphia Transfer Station				✓		53
Southcentral	Chester County SWA (Lanchester Landfill)	✓	✓				49
	Lancaster (LCSWMA) WTE Facility	✓	✓		✓		97
	WM Mountainview Landfill	✓		✓		✓	103
Southwest	Republic Services Imperial Landfill	✓		✓		✓	100
	WM Laurel Highlands Landfill	✓	✓		✓		101
	Total						**1,258**

Figure 3-1 presents a map of Pennsylvania showing the location of the host facilities within each region. As shown, these facilities were distributed across the Commonwealth's urban, suburban, and rural areas, and allowed the project team to obtain a wide variety of sample material from many different local waste management systems.

Figure 3-1 Location of Host Facilities

3.6 GENERATOR SECTOR AND DEMOGRAPHIC ALLOCATION

The main MSW generating sectors identified in the 2001 Study were retained for 2021 Study. The following types of incoming MSW loads were segmented:

- **Residential Waste**: The majority of waste from the residential sector originates in single-family households. However, multi-family wastes would also be considered residential. Although our sampling of residential waste was primarily focused on single-family, when driver interviews confirmed that a load of predominantly multi-family waste had arrived, sampling of this material was allowed.
- **Commercial Waste:** All non-residential wastes were captured in this sector, including wastes from retail establishments, offices, hotels, grocery stores, restaurants, and institutions like churches and hospitals. Note that commercial waste excludes industrial waste, which was outside the scope of this study.

It should be noted that a small fraction of residential and commercial self-haulers deliver material for disposal at some facilities. During the first two seasons of field data collection (in the second half of 2020), several of the host facilities had discontinued self-hauling due to concerns about the pandemic. For this reason, limited self-haul sampling was performed at many facilities. For the 2021 Study, some self-haul

loads were sampled and characterized if they appeared to make up a meaningful fraction of inbound deliveries, but such loads were not sampled extensively.

Table 3-4 provides the overarching sampling targets from the outset of the 2021 Study. As shown, the intent of sampling was to distribute samples geographically, by generator sector, and by demographic origin[1]. Regional sampling targets were generally met, with only minimal shortfalls in two regions. Significantly more suburban samples were ultimately obtained compared to targets by demographic region. This is the result of the increase in suburban jurisdictions as described in the previous section. The split between residential and commercial samples was allowed to vary based on inbound loads by facility. As shown, a significant number of samples from each generator sector was obtained. MSW Consultants believes that the allocation of samples shown in this table provide a highly representative snapshot of Pennsylvania's disposed MSW stream.

Table 3-4 Comparison of Targeted vs Actual Samples

		Targeted	Actual	Difference
Region	Northeast	204	204	0
	Northcentral	204	210	6
	Northwest	204	205	1
	Southeast	204	238	34
	Southcentral	204	200	-4
	Southwest	204	201	-3
	Total	**1,224**	**1258**	**34**
Demographic Origin	Urban	408	330	-78
	Suburban	408	644	236
	Rural	408	284	-124
	Total	**1,224**	**1,258**	**34**
Generating Sector	Residential	tbd	683	N/A
	Commercial	tbd	575	N/A
	Total	**1,224**	**1,258**	**34**

Finally, Table 3-5 provides the statewide breakdown of samples by generator sector and by demographic area.

Table 3-5 Statewide Sampling Summary

	Demographic Area			
Generating Sector	**Urban**	**Suburban**	**Rural**	**Total**
Residential Samples [1]	187	301	195	**683**
Commercial Samples	143	343	89	**575**
Total	**330**	**644**	**284**	**1,258**

[1] Includes both single and multi-family households

[1] The methodology used to distinguish between urban, suburban, and rural designations is detailed in Section 2.2 of this report.

3.7 SAMPLE COLLECTION, SORTING AND WEIGHING

The following sections detail procedures used throughout the Study's sampling events.

3.7.1 STAFFING

MSW Consultants' staffing configuration for waste sampling events generally included:

- **Project Manager/Field Supervisor (MSW Consultants):** The project Field Supervisor had overall on-site responsibility, which included sample selection and acquisition, quality control, and onsite client interface.
- **Crew Chief (MSW Consultants):** The Crew Chief's primary responsibilities included supervising the sorting crew, performing quality control, managing the materials weigh-out and data recording, and worksite health and safety training.
- **Sort Labor (MSW Consultants, PROP Members, and Contracted Local Labor):** As with most waste composition sampling events, MSW employed three to four-person sort crews during this project. The sort crews were made up of a blend of MSW Consultants sorting staff, volunteers from PROP, and contract local labor.

3.7.2 VEHICLE SELECTION

During the collection of samples, the MSW Consultants Field Supervisor followed a systematic selection procedure to identify residential and commercial waste. To calculate vehicle sampling frequency for each waste sector, the Field Supervisor established a sampling interval at each facility. Sampling intervals were determined by dividing the total expected number of loads arriving at the facility on the scheduled day by the number of samples needed each day. The resulting number was the sampling frequency, which determined whether every third vehicle, every sixth vehicle, or every 20th vehicle was selected for sample collection. It should be noted that the n^{th} vehicle on occasion may be altered to accommodate such field conditions as a lull in vehicle traffic. In such cases, the first eligible truck may be selected in order to keep the sort table busy.

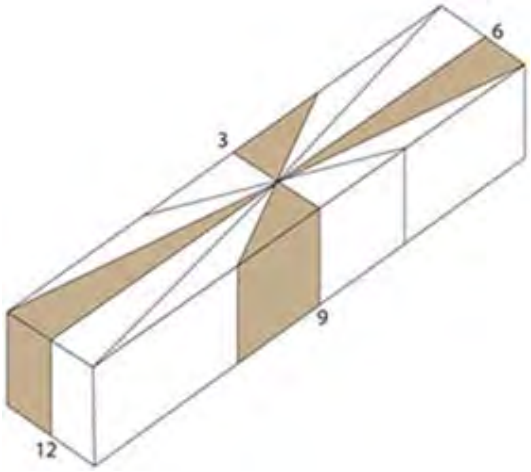
Vehicles entering the host facility that met the definition of the n^{th} vehicle were surveyed by the Field Supervisor. In order for a vehicle to be eligible for sample collection, the load had to fit within the residential and commercial definitions. The Field Supervisor then collected data on a handheld tablet computer, including a unique identifying number, the vehicle type, hauler, waste type, municipality or city of origin, and a net weight. The Field Supervisor was in direct communication with the scale house after selecting a vehicle for sample collection and provided the appropriate identifying information (hauler name and truck number or license number) so that the scale house would be able to set aside documentation for the Field Supervisor to collect at the end of the day for all loads from which a sample was collected.

3.7.3 MECHANICAL GRAB SAMPLING

Inbound loads of material were randomly selected within the stratified sampling plan. MSW Consultants interviewed the drivers of selected loads to confirm the geographic origin and type of waste, as well as any other pertinent data.

Selected loads of waste designated for sorting were tipped in the designated area at the landfill. From each selected load, one sample of material was selected based on systematic "grabs" from the perimeter 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 was 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. This concept of systematically rotating around subsequent loads to make an approach and take a grab is shown in Figure 3-2.

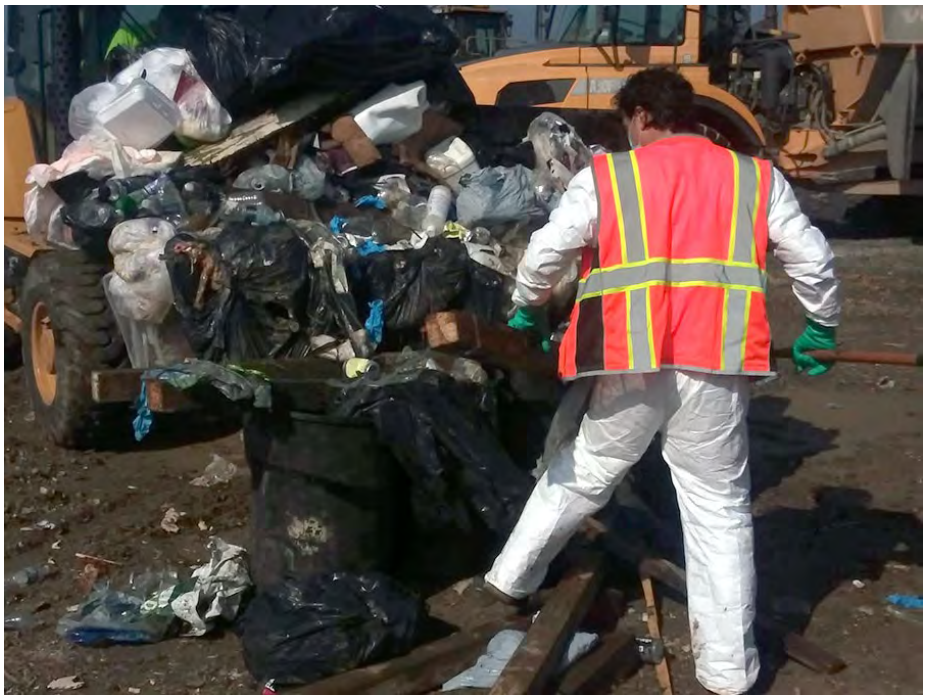
Figure 3-2 Systematic Sampling Grab Approaches for Tipped Loads



From each sample extraction point, the loader operator was instructed to take a grab sample. From each grab, a sample weighing at least 250 pounds was extracted from the pile and pre-weighed to verify that the minimum sample weight was achieved and to prevent sorting overly large samples, which would diminish sorting productivity. Bulky items and large quantities of homogeneous items may have been weighed and recorded at the tip floor, thereby eliminating the need to sort them at the sorting table.

Figure 3-3 depicts sampling from tipped loads.

Figure 3-3 Sampling from Tipped Loads



3.7.4 SORTING

At the outset of each weekly sort, the Field Supervisor and/or Crew Chief conducted a detailed training session in the morning of the first day of the sort. The training covered all aspects of site safety and health

guidelines, as well as the procedure of sorting and weighing samples. Guidance was provided throughout the manual sorting process to improve productivity. Training included the following items:

- General facility overview
- Learning and reviewing the material categories and definitions
- Facility-specific health and safety requirements
- Personal protective equipment (PPE) requirements
- Waste handling techniques
- Productivity strategies and daily sorting quotas

Figure 3-4 is a photograph showing the sorting table and work area layout. As shown, labeled bins were used to guide sortation into the targeted material categories. During this phase of field work, a well-organized sort area was crucial to efficient and accurate sorting. Generally, maintaining a consistent sort area improves safety by establishing boundaries for all workers to follow consistently.

Figure 3-4 Sorting Work Area

Once the sample was acquired and placed onto the sorting table, the material was sorted by hand into the predetermined material groups. Bagged material was broken open, boxes were opened, and all waste sorted. Plastic 20 and 32-gallon bins with sealed bottoms were used to contain each material group. The sorting crew members typically specialize in categories of materials, such as papers, metal, or plastics.

During the sort, the Crew Chief monitored the homogeneity of material sorted into the component bins, identifying and re-sorting materials that may have been improperly classified. Open bins allowed the Crew Chief to see the material at all times and verify the purity of each component as it is weighed, before recording the weight. The materials were sorted to particle sizes of 2 inches or less by hand, until no more than a small amount of homogeneous fine material ("mixed residue") remained. The layer of material ranging from 2-inch down to ½ inch was allocated to the appropriate categories based on the best judgment of the Crew Chief — most often a combination of Other Paper, Other Organics, or Food Waste.

3.7.5 DATA RECORDING

On the first and last day of each weekly sort, tare weights were recorded for each of the containers used in the sort. Tare weights must be backed out from gross container weights to obtain accurate net material weight data.

Once each sample was sorted, the weigh-out was performed. The weigh-out and data recording process is a critical process during the sort and was managed by the Crew Chief. Each bin containing sorted materials was carried over to the scale by sorting crew members for the Crew Chief to confirm the material category and record the weights. All weights were recorded to the nearest 0.1 pound.

MSW Consultants' Crew Chiefs used a tablet computer to record the composition weights. The tablet allows for samples to be tallied in real-time so that field data collection can immediately identify and rectify errors associated with light sample weights. The tablet synchronizes with the Cloud via the internet, providing excellent data security. Each sample was cross-referenced against the Field Supervisor's sample sheet to assure accurate tracking of the samples each day. The real-time data entry offered several important advantages:

- The template contains built-in logic and error checking to prevent erroneous entries.
- The template sums sample weights in real-time so the Crew Chief can confirm the achievement of weight targets for each sample.
- At the end of the workday, the tablet is synchronized with the cloud via cellular signal, providing data security.

3.7.6 SITE MAINTENANCE AND CLEAN-UP

The MSW Consultants field data collection team were guests at each of the host facilities, and it was therefore critical to leave the work area clean and safe for subsequent operations. The sorting crew was responsible for keeping litter to a minimum. The team also concluded each day of sorting operations with sufficient time to perform site clean-up. Clean-up included the following types of activities:

- Organized stacking and stowing of sorting supplies in a designated location
- Removing sorted wastes for proper disposal or processing (the host facility equipment operator helped with this)
- Sweeping and cleaning the sort area to prevent windblown litter and other situations that could attract vectors
- Removing and disposing of day-use personal protective equipment and decontaminating personnel
- Covering any unsorted samples with a secure tarp, to leave for sorting the next day
- Securing the work area and checking out with the Facility Manager each day

3.8 DATA ANALYSIS

3.8.1 QA/QC PROCEDURES

The collection process followed a well-established set of quality assurance/quality control (QA/QC) strategies to ensure data accuracy and integrity. The QA/QC process involved the following procedures:

- Assigning a unique combination sample number, facility of origin, date, and time to each sample, and transferring that information to a tablet computer that was used to record material weights for the sample
- Encoding the type of waste load into the sample number. For example, on a particular date, samples of residential waste could be numbered Res-1, Res-2, etc.

- Designing the data entry databases to prevent out-of-range values for vehicle and sample characteristics such as vehicle type, net weight, etc.
- Random checks of computer-entered data against the Field Supervisor's tally sheets, to verify that all numbers were being entered correctly, and to look for any systematic or random errors

3.8.2 STATISTICAL ANALYSIS

At the conclusion of each field data collection season, all data was statistically analyzed to determine the estimated weight and estimated mean percentage associated with each material group in the samples. Consistent with industry standards, the mean composition and the margin of error were calculated at a 90 percent level of confidence, as described below. The methods used were consistent with the 2001 Study.

The analysis normalized each sample by converting the sample data from weight to percentage. Then the sample mean was determined by averaging the percent composition of each material across all samples. The margin of error has also been calculated as a percentage of the sample mean.

Regional totals and statewide composition estimates have been aggregated according to the tonnages shown in Section 2 of this report and will be presented in the appendices section.

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4. RESULTS

4.1 PENNSYLVANIA AGGREGATE DISPOSED MSW COMPOSITION

This section provides a range of graphical and tabular summaries of the composition of disposed MSW in Pennsylvania. Figure 4-1 presents the aggregate (residential and commercial) composition of Pennsylvania's disposed waste stream. As shown, at 39.8 percent and 25.8 percent, respectively, Organics and Paper are the largest fractions of the statewide waste stream. This breakdown is consistent with waste composition in most other areas of the country.

Figure 4-1 Pennsylvania Statewide Aggregate Disposed MSW Composition

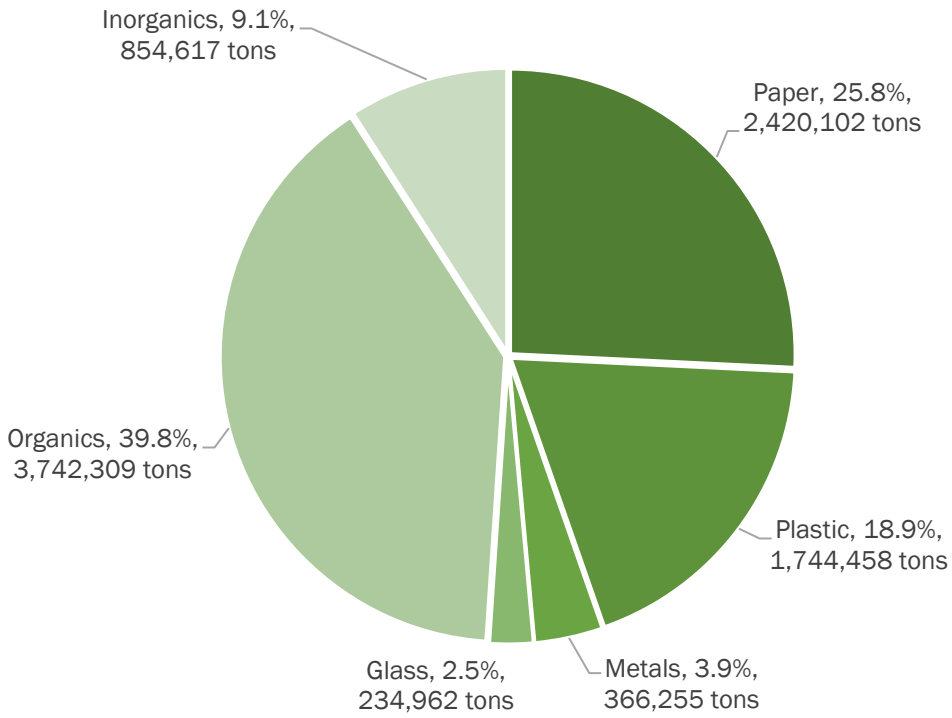


Figure 4-2 and Figure 4-3 compare the composition of disposed MSW in the 2021 Study to the 2001 Study. As shown, the waste stream has changed significantly in the elapsed 20-year period. There has been a dramatic decrease in the amount of paper, offset by an equally dramatic increase in plastics. In what appears to be a positive change, both glass and metal have nudged downward. The proportion of organics has increased, while the proportion of inorganics has decreased. More granular comparisons follow.

Figure 4-2 Comparison of Composition by Material Group 2021 vs 2001 (Percentage)

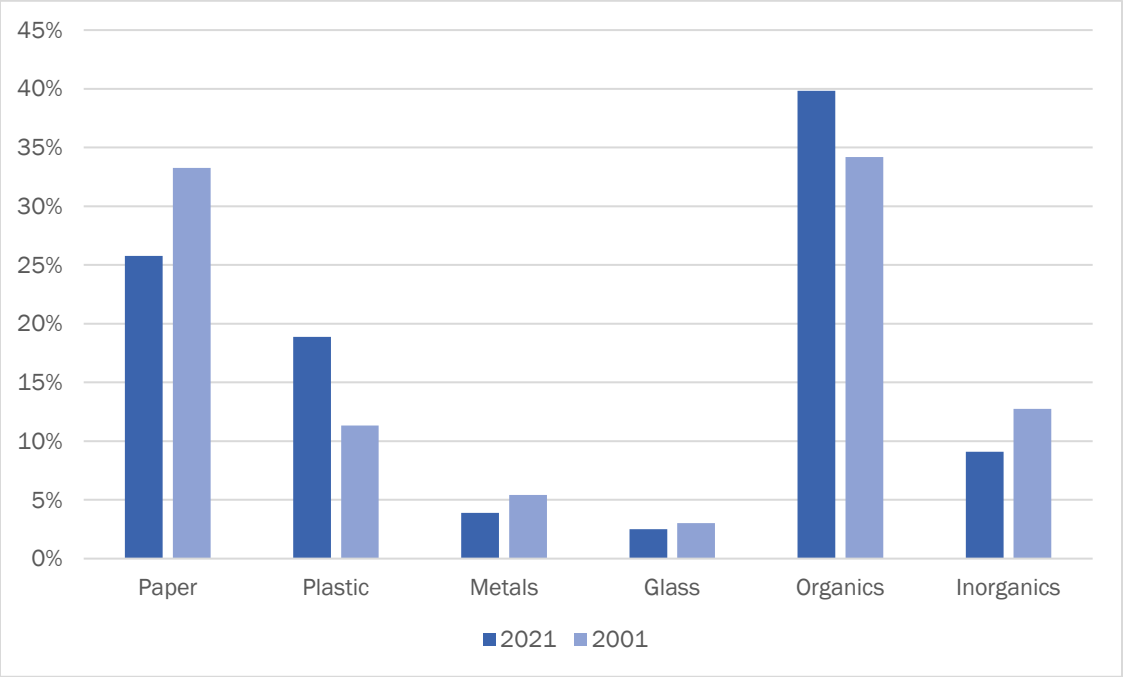


Figure 4-3 Comparison of Disposed MSW Composition by Material Group 2021 vs 2001 (Tons)

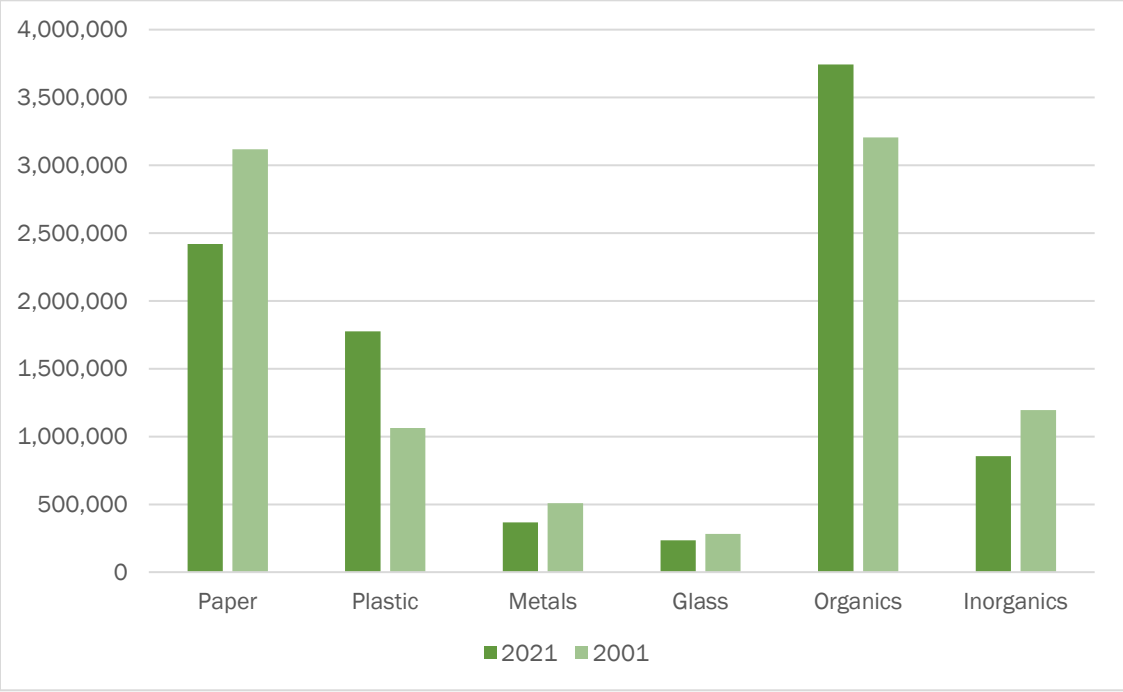
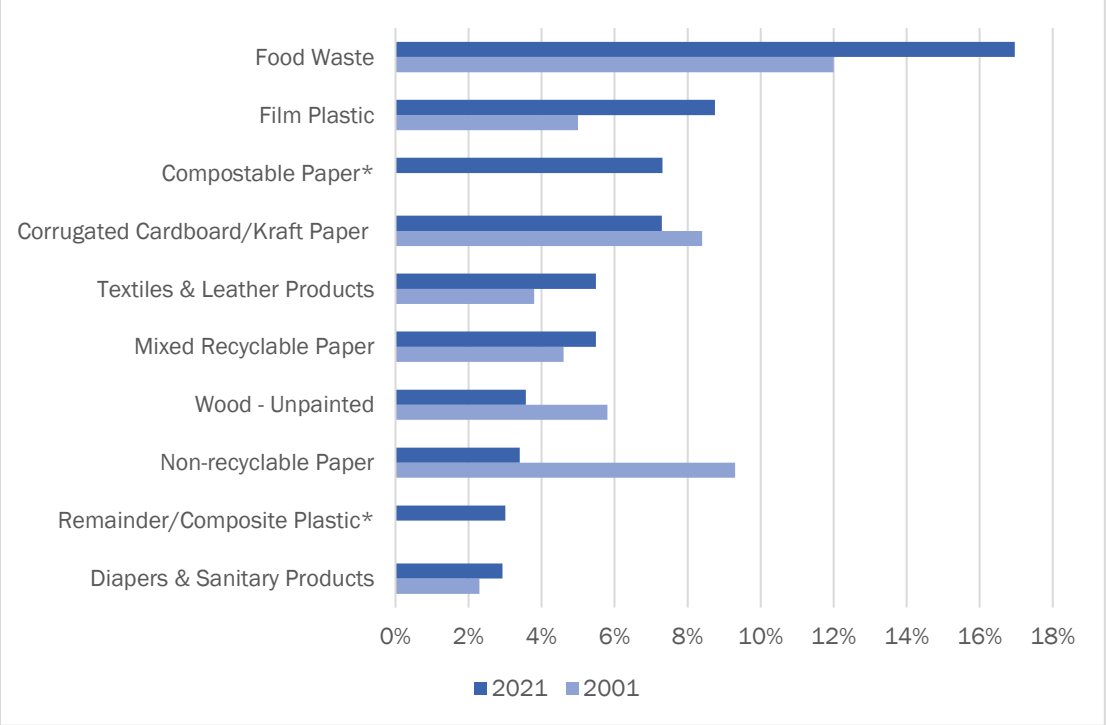


Figure 4-4 lists the top ten individual materials that were most prevalent in the disposed MSW stream in the 2021 Study. This figure also shows the comparable composition from the 2001 Study (recognizing that several material categories were not included in both studies). It is noteworthy that Food Waste remains

the most prevalent fraction of disposed waste. The top ten most prevalent materials make up 64.2 percent of the disposed waste stream.

Figure 4-4 Comparison of 2021 and 2001 Top Ten Most Prevalent Materials Disposed (Percent)



* Not material category in 2001 Study

The 2021 Study incorporated a subsort of Food Waste into the following three categories:

- **Edible-Packaged Food** which includes the components of food that, in a particular food supply chain, are intended to be consumed by humans and are enclosed in the original packaging as sold or distributed.
- **Edible-Non-Packaged Food** which includes the components of food that, in a particular food supply chain, are intended to be consumed by humans, and are not enclosed in the original packaging as sold or distributed. Examples include vegetables, fruits and other partially consumed foods that have been discarded. Edible food that appears to have been wrapped or stored by the consumer (e.g., in a Ziploc bag, takeout container, or reusable container) is included here.
- **Inedible Food Scraps** which include the non-edible portions of food material. Examples include rinds, peelings, skins, pits, cores, eggshells, bones, gristle, trimmings, fish skins, and seafood shells.

Figure 4-5 shows the relative contribution of different forms of food waste. It is noteworthy that edible food (e.g., true wasted food) comprised over 72 percent, while inedible food waste (e.g., rinds, shells, bones, cores, etc.) made up only 28 percent. This finding supports the need for multi-faceted strategies—ranging from better food labeling to more active food donation to better education about wastefulness—to reduce wasted food.

Figure 4-5 Food Waste Detail

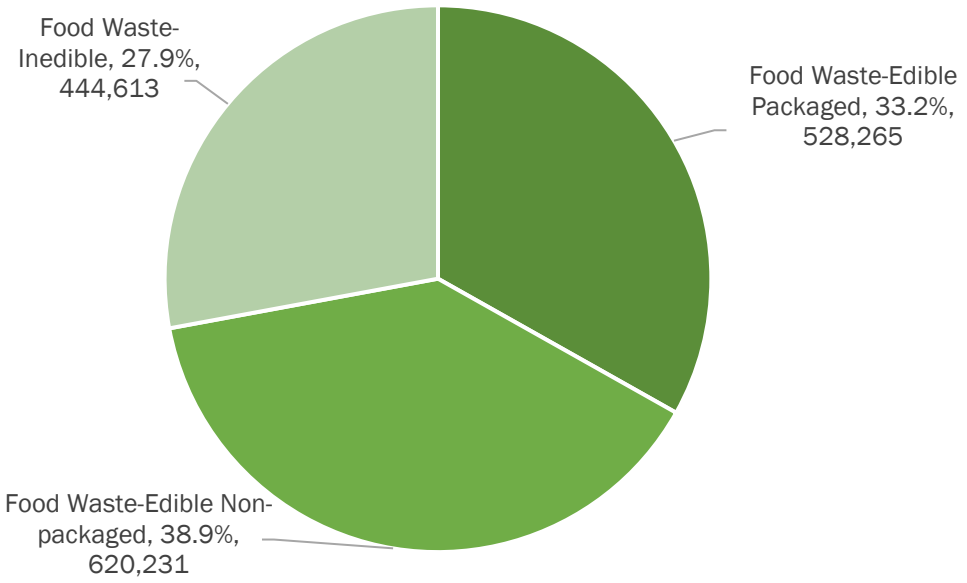


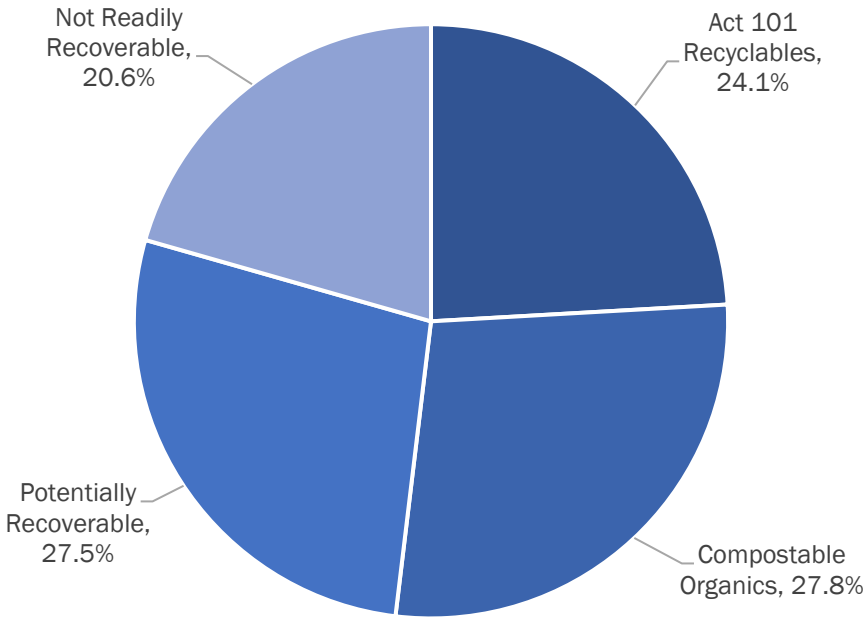
Figure 4-6 identifies the proportion of the disposed MSW stream that could potentially be diverted from disposal. This analysis was developed by assigning a "recoverability" or "divertibility" classification to each individual constituent in the waste stream with each material:

- **Act 101 Recyclables:** Includes materials mandated for collection through Pennsylvania's Act 101 of 1988 including glass food and beverage containers (all three colors), plastics (PET and HDPE bottles), Aluminum Cans, Steel Cans, Corrugated Cardboard, Newspaper, and High-Grade Office Paper. This list has been expanded beyond the 2001 Study's list to reflect the increased recoverability of additional materials, such as Aseptic Cartons, Magazines and Catalogs, Mixed Recyclable Paper, and additional plastic resins. All materials on this list are counted towards DEP's Act 101, Section 904 Recycling Performance Grant awards to local governments. Note that while many of these materials are common to recycling programs across the Commonwealth, they are not necessarily universally accepted.
- **Compostable Organics:** Includes organics such as Food Waste and Yard Waste (leaves, grass, prunings) that can be composted and mulched for use as a soil amendment, as well as clean wood and lumber (Wood-Unpainted) that can be chipped and used for mulch. These material categories can also be recovered through anaerobic digestion technologies.
- **Potentially Recoverable:** Applies to materials that have been found to be recoverable in other regions of the country or state where collection and processing infrastructure exists, and where suitable end markets have been developed, but are still not universally collected. This includes materials such as e-waste, plastic film, textiles, scrap metals, and other items that are recyclable through public or private drop-off networks or through commercial settings. It also includes some components of Construction and Demolition Debris (C&D), which is primarily generated by the ICI sector.
- **Not Readily Recoverable**: Includes materials that are not known to be recyclable in Pennsylvania, or for which no known local markets exist. Some materials in this classification could theoretically become recyclable if sufficient material volume existed to create cost-effective and appropriate collection methods, processing facilities, and suitable end markets.

At nearly 28 percent, compostable organics make up the largest category of materials for which other outlets exist rather than disposal. Another 27.5 percent of the materials could potentially be diverted, albeit with expanded source separation, incremental collection, and other factors that impact the economics of recovery, and which were not evaluated as part of this project. Act 101 materials (using the expanded definition) make up 24.1 percent of disposed MSW.

Most importantly, 79.4 percent of disposed MSW is either currently recyclable or potentially recyclable, while 20.6 percent no readily available outlet for diversion.

Figure 4-6 Divertibility of Disposed MSW



Also shown in Figure 4-6 are the Act 101-eligible recyclables remaining in the MSW stream. At 24.1 percent, this is the smallest category of recoverable materials in the disposed MSW stream. As noted above, the list of Act 101 materials was expanded for the 2021 Study to incorporate materials that have become more commonly accepted in Pennsylvania recycling programs, as well as eligible for Act 101, Section 904 Recycling Performance Grant awards to local governments. However, when a direct comparison of Act 101 materials using the 2001 Study's more narrow definitions is performed, the divertibility analysis shows that these materials make up 13.9 percent of disposed MSW (see Figure 4-7). This compares favorably to the results from the 2001 Study in which 22 percent of disposed refuse were Act 101 materials.

Figure 4-7 Divertibility of Disposed MSW Using 2001 Act 101 Material Definitions

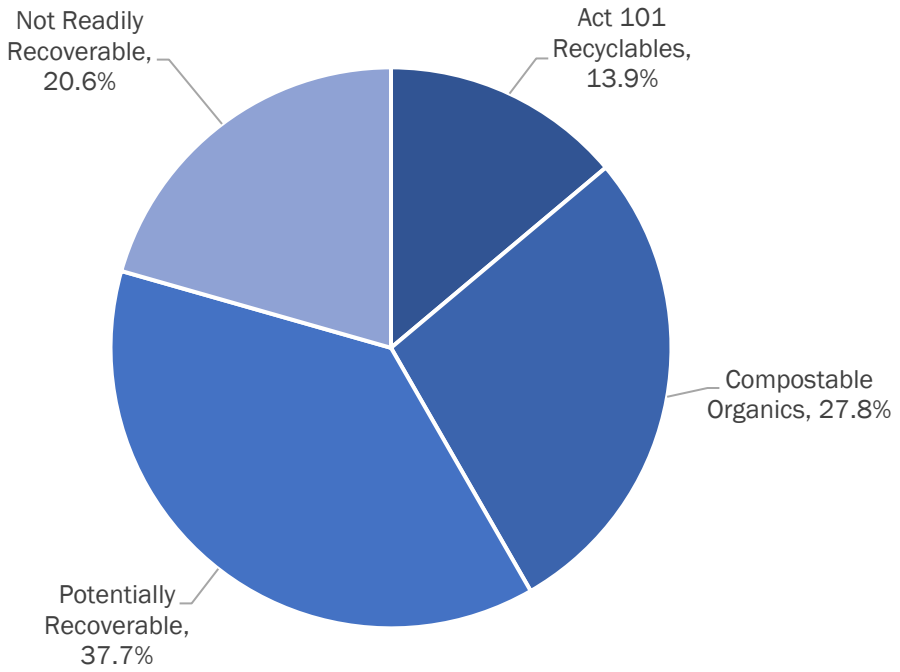
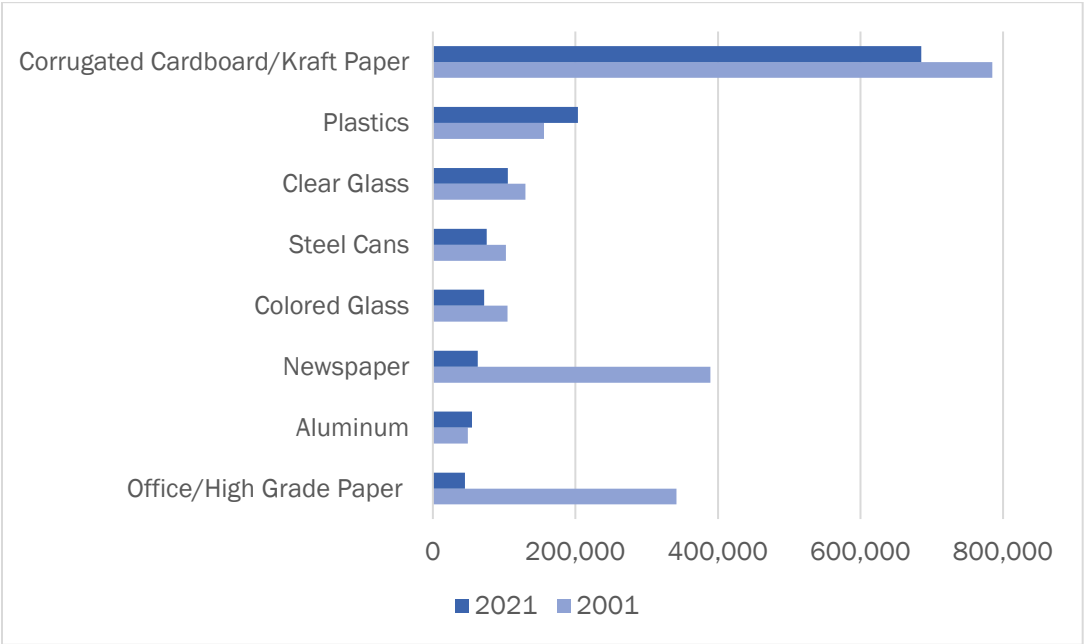


Figure 4-8 itemizes the specific quantity of key Act 101-eligible materials that were disposed. This figure includes the similar quantities from the 2001 Study.

Figure 4-8 Act 101 Recyclables in Disposed MSW (Tons)



Finally, Table 4-1 presents a detailed statistical summary of the composition of disposed MSW in Pennsylvania, calculated at a 90 percent level of confidence. This table shows the sample mean composition percentage, as well as the margin of error (MOE) around the sample mean. Finally, the mean composition has been applied to the annual tonnage of disposed MSW.

Table 4-1 Statewide Aggregate Disposed MSW Composition Detail

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**25.8%**	**0.6%**	**2,420,102**	**Organics**	**39.8%**	**0.8%**	**3,742,309**
Corrugated Cardboard/Kraft Paper	7.3%	0.4%	685,454	Food Waste	17.0%	0.3%	1,593,109
Newspaper	0.7%	0.1%	62,828	Yard Waste - Grass	0.8%	0.2%	79,111
Office/High Grade Paper	0.5%	0.1%	45,190	Yard Waste - Other	2.7%	0.3%	252,950
Magazine & Catalogs	0.8%	0.1%	73,329	Wood - Unpainted	3.6%	0.4%	334,997
Aseptic Boxes & Gable Top Cartons	0.3%	0.1%	31,035	Wood - Painted	2.4%	0.2%	229,596
Mixed Recyclable Paper (Low Grade)	5.5%	0.2%	515,880	Textiles & Leather Products	4.0%	0.3%	372,118
Compostable Paper	7.3%	0.2%	687,153	Diapers & Sanitary Products	2.9%	0.2%	274,921
Non-recyclable Paper	3.4%	0.3%	319,234	Animal By-Products	2.7%	0.2%	253,827
Plastic	**18.9%**	**0.6%**	**1,774,458**	Fines	1.4%	0.1%	129,066
#1 PET Bottles & Jars	1.3%	0.1%	126,388	Other Organics	2.4%	0.2%	222,614
#1 PET Non-Bottles & Containers	0.2%	0.0%	18,368	**Inorganics**	**9.1%**	**0.5%**	**854,617**
#2 HDPE Natural Bottles	0.4%	0.0%	38,415	Electronics - Covered Devices	0.1%	0.0%	11,640
#2 HDPE Colored Bottles	0.4%	0.0%	38,511	Other Electronics	0.5%	0.1%	42,728
#3 - #7 Bottles	0.1%	0.0%	5,485	Carpet & Carpet Padding	1.4%	0.3%	133,009
#2 - #7 Non-Bottle Rigid Containers	1.4%	0.1%	127,931	Drywall/Gypsum Board	0.5%	0.1%	50,900
Expanded Polystyrene	0.9%	0.1%	87,438	Concrete, Rock, Brick	0.3%	0.1%	29,915
Clean Retail Plastic Bags	0.1%	0.0%	9,068	Asphalt Roofing	0.3%	0.2%	26,272
Industrial Film	2.1%	0.3%	194,187	Asphalt Paving	0.0%	0.0%	3,484
All Other Film	6.7%	0.3%	627,195	Other C&D	1.7%	0.2%	155,153
Durable/Bulky Rigid Plastics	2.3%	0.2%	218,558	Medically-Related Waste	0.1%	0.0%	12,714
Remainder/Composite Plastic	3.0%	0.3%	282,913	Lithium Batteries	0.0%	0.0%	144
Metals	**3.9%**	**0.3%**	**366,255**	Automotive Batteries	0.0%	0.0%	22
Steel Cans	0.8%	0.1%	75,358	Other Batteries	0.1%	0.0%	6,484
Aluminum Cans	0.6%	0.0%	54,861	Other HHW	0.0%	0.0%	4,317
Other Aluminum	0.3%	0.0%	32,429	Bulky Materials	1.5%	0.2%	140,677
Other Ferrous Metals	1.7%	0.2%	156,484	Furniture	1.7%	0.3%	157,018
Other Non-Ferrous Metals	0.5%	0.1%	47,123	Other Inorganics	0.6%	0.1%	52,651
Glass	**2.5%**	**0.2%**	**234,962**	PPE	0.3%	0.0%	27,491
Clear Glass Containers	1.1%	0.1%	105,315				
Green Glass Containers	0.3%	0.0%	30,506				
Brown Glass Containers	0.4%	0.1%	41,510	**Grand Total**	**100.0%**		**9,392,702**
Non-Recyclable Glass	0.6%	0.1%	57,630	**Number of Samples**	**1,258**		

Margin of error is calculated at a 90 percent level of confidence.

4.2 COMPARISONS BY GENERATING SECTOR

An objective of the study was to differentiate the composition and quantity of disposed MSW generated in the residential and commercial generating sectors. This section provides a series of tables and figures with such comparisons.

Figure 4-8 compares the composition by material group in terms of percentage, and Figure 4-9 makes the same comparison in terms of annual tonnage disposed. Although disposed waste composition from the two generating sectors is relatively comparable, the differences are statistically significant. The residential stream contributes less Paper and Plastics, but a significantly higher amount of Organics and Inorganics compared to the commercial stream, as shown in Figure 4-9. The difference in Organics is driven largely

by yard waste, textiles, and diapers, which are more prevalent in the residential waste stream. Residential waste also contains a higher percentage of Inorganics, Glass, and Metals.

Figure 4-9 Disposed MSW Composition Summary by Generating Sector (Percentage)

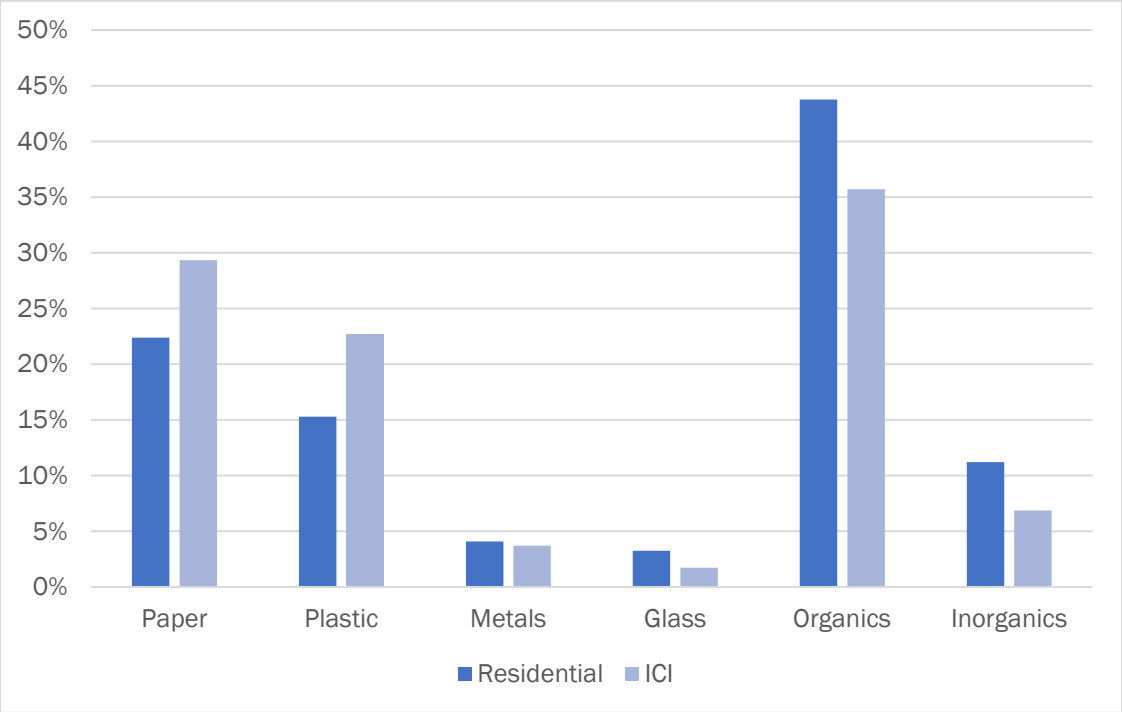


Figure 4-10 Disposed MSW Composition Summary by Generating Sector (Tons)

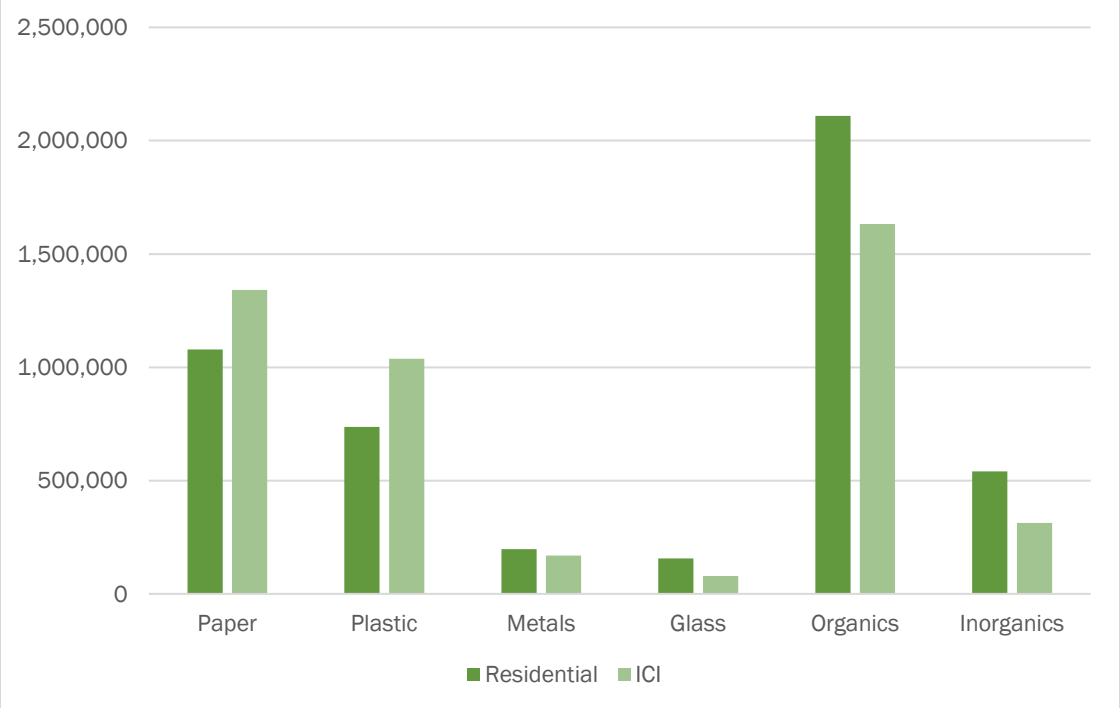


Figure 4-10 compares the breakdown of Food Waste between generating sectors. Broadly, the percentage of wasted food (edible food in packaging or loose) is higher in the commercial stream. This may be caused by the impact of a wide variety of food service sectors—including restaurant, grocery, and various institutions—in the commercial sector.

Figure 4-11 Food Waste Detail by Generating Sector (Percentage)

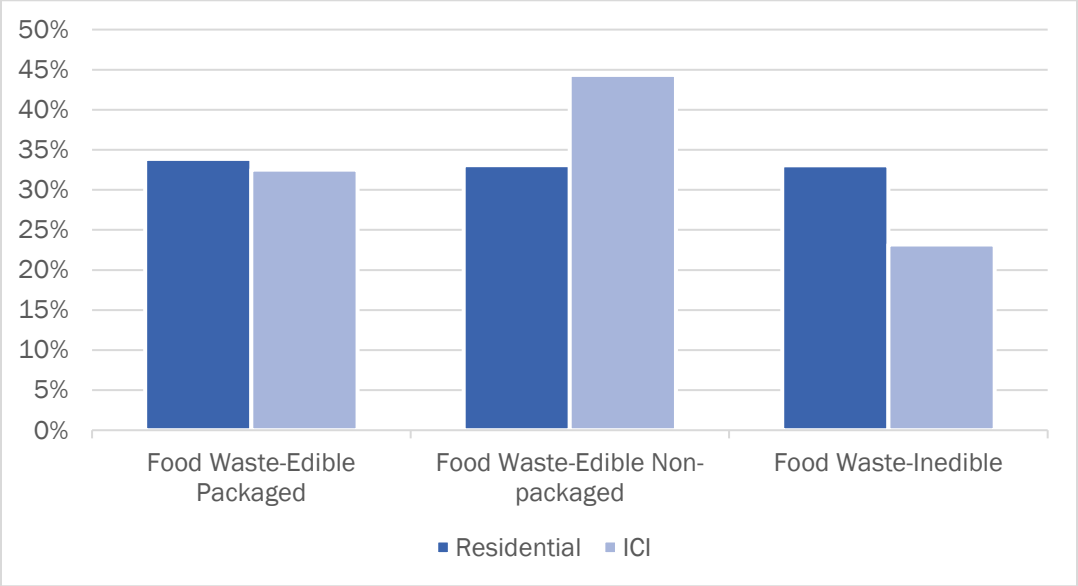


Figure 4-11 compares the divertibility of wastes in the residential and commercial disposed MSW stream. Interestingly, the residential stream has a lower fraction of Act 101-eligible recyclables and a higher percentage of compostable organics. Both sectors – with residential at 23 percent and commercial at 18 percent – have a substantial fraction of material that cannot be readily recovered at the current time. This is noteworthy for zero waste planners who must balance aspirational diversion targets with the ability of the economy to effectively eliminate waste sent to disposal.

Figure 4-12 Divertibility Comparison by Generating Sector (Percentage)

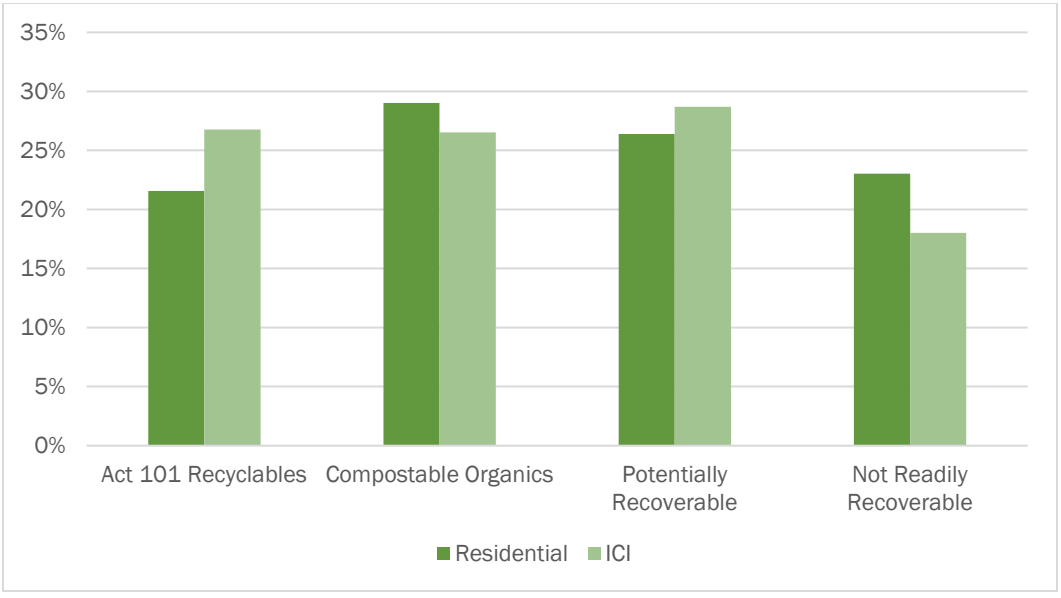


Figure 4-12 compares the quantity of key Act 101 eligible materials that are being disposed from the residential and commercial waste streams. Note that the recyclable containers typically associated with residential recycling programs are being disposed in relatively small quantities. Only Corrugated Cardboard, which is also commonly collected in residential recycling programs, appears to be getting disposed in larger quantities. Not surprisingly, the majority of disposed Corrugated Cardboard was found to originate from the commercial sector.

Figure 4-13 Act 101 Recyclables Disposed by Generating Sector (Tons)

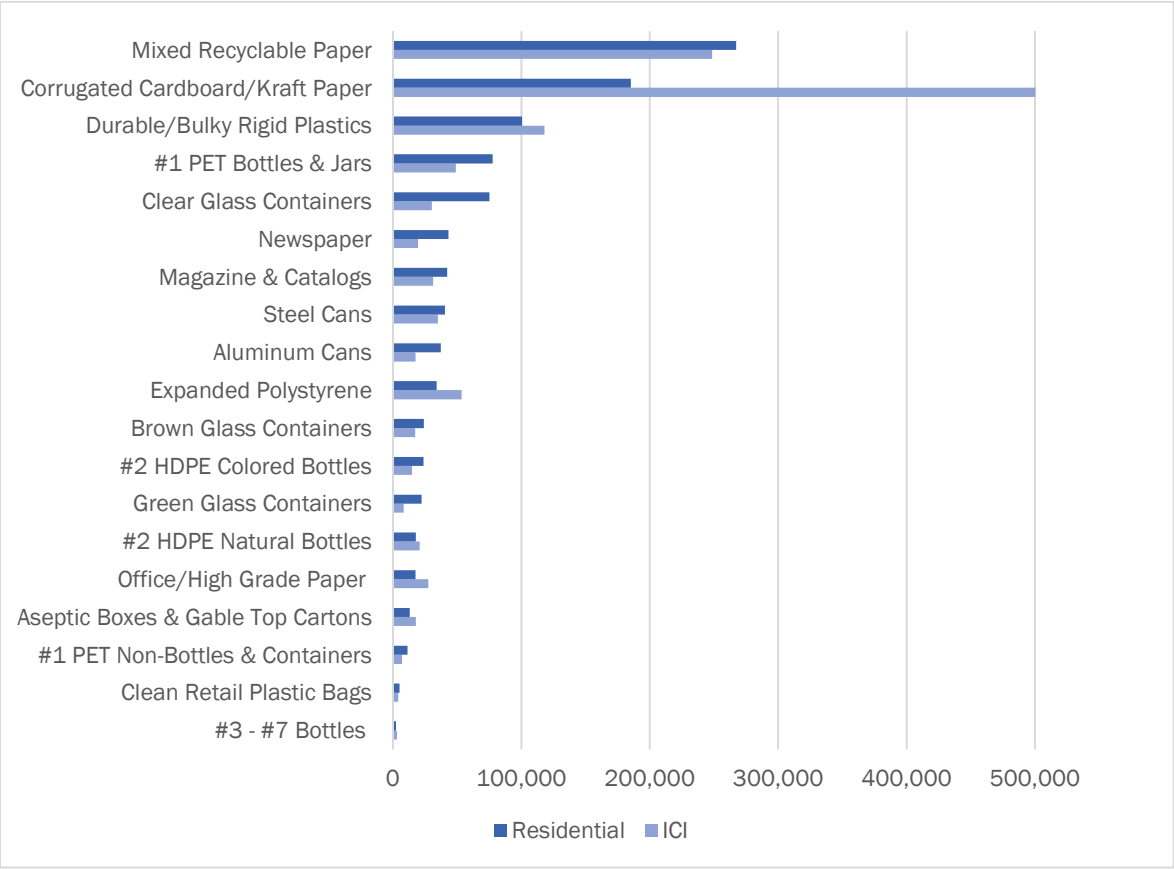


Table 4-2 compares the 10 most prevalent residential materials and the 10 most prevalent commercial materials, respectively. In the residential stream, only two curbside recyclable components – Mixed Recyclable Papers and Corrugated Cardboard – made this list. Three of the top 10 constituents are compostable but are challenging to segregate from other wastes. Finally, there are several non-recoverable categories in the top 10, including Animal Byproducts (a new category in 2021) and Diapers/Sanitary Products. These problem materials appear to have increased incidence in the disposed residential stream.

Materials in the top 10 of the commercial streams are also generally weighted towards organics materials, although several hard-to-recycle plastic categories also make this list.

Table 4-2 Top 10 Most Prevalent Materials by Generating Sector (Tons)

	Residential		Commercial	
Rank	Material	Tons	Material	Tons
1	Food Waste	764,239	Food Waste	828,870
2	Compostable Paper	382,562	Film Plastic	514,447
3	Film Plastic	306,935	Corrugated Cardboard/Kraft Paper	500,245
4	Textiles & Leather Products	270,045	Compostable Paper	304,590
5	Mixed Recyclable Paper	267,190	Wood - Unpainted	269,499
6	Animal Bi Products	220,593	Mixed Recyclable Paper	248,689
7	Diapers & Sanitary Products	208,156	Remainder/Composite Plastic	194,778
8	Yard Waste	191,338	Non-recyclable Paper	191,207
9	Corrugated Cardboard/Kraft Paper	185,209	Durable/Bulky Rigid Plastics	118,077
10	Wood - Painted	134,170	Other Organics	104,125
	Total	**2,930,436**		**3,274,528**
	Percent of Total	*60.8%*		*71.6%*

Table 4-3 and Table 4-4 provide detailed statistics, including composition percentages and absolute quantities, for all materials for the residential and commercial waste streams, respectively.

Table 4-3 Detailed Residential Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**22.4%**	**0.5%**	**1,079,192**	**Organics**	**43.8%**	**0.8%**	**2,109,859**
Corrugated Cardboard/Kraft Paper	3.8%	0.3%	185,209	Food Waste	15.9%	0.7%	764,239
Newspaper	0.9%	0.1%	43,232	Yard Waste - Grass	1.3%	0.3%	60,832
Office/High Grade Paper	0.4%	0.1%	17,656	Yard Waste - Other	4.0%	0.5%	191,337
Magazine & Catalogs	0.9%	0.1%	42,173	Wood - Unpainted	1.4%	0.3%	65,497
Aseptic Boxes & Gable Top Cartons	0.3%	0.0%	13,143	Wood - Painted	2.8%	0.3%	134,170
Mixed Recyclable Paper (Low Grade)	5.5%	0.2%	267,190	Textiles & Leather Products	5.6%	0.4%	270,045
Compostable Paper	7.9%	0.2%	382,562	Diapers & Sanitary Products	4.3%	0.3%	208,156
Non-recyclable Paper	2.7%	0.1%	128,028	Animal By-Products	4.6%	0.3%	220,593
Plastic	**15.3%**	**0.4%**	**737,405**	Fines	1.6%	0.2%	76,502
#1 PET Bottles & Jars	1.6%	0.1%	77,563	Other Organics	2.5%	0.2%	118,488
#1 PET Non-Bottles & Containers	0.2%	0.0%	11,250	**Inorganics**	**11.2%**	**0.8%**	**540,988**
#2 HDPE Natural Bottles	0.4%	0.0%	17,711	Electronics - Covered Devices	0.1%	0.1%	5,665
#2 HDPE Colored Bottles	0.5%	0.0%	23,692	Other Electronics	0.7%	0.1%	32,918
#3 - #7 Bottles	0.0%	0.0%	2,353	Carpet & Carpet Padding	1.5%	0.3%	74,497
#2 - #7 Non-Bottle Rigid Containers	1.5%	0.1%	70,206	Drywall/Gypsum Board	0.6%	0.2%	28,201
Expanded Polystyrene	0.7%	0.0%	34,064	Concrete, Rock, Brick	0.3%	0.1%	14,702
Clean Retail Plastic Bags	0.1%	0.0%	5,014	Asphalt Roofing	0.2%	0.1%	9,519
Industrial Film	0.1%	0.1%	5,946	Asphalt Paving	0.1%	0.1%	2,664
All Other Film	6.2%	0.2%	300,989	Other C&D	2.0%	0.3%	96,948
Durable/Bulky Rigid Plastics	2.1%	0.2%	100,481	Medically-Related Waste	0.1%	0.0%	5,873
Remainder/Composite Plastic	1.8%	0.1%	88,135	Lithium Batteries	0.0%	0.0%	93
Metals	**4.1%**	**0.2%**	**196,775**	Automotive Batteries	0.0%	0.0%	2229.3%
Steel Cans	0.8%	0.0%	40,368	Other Batteries	0.1%	0.0%	4,704
Aluminum Cans	0.8%	0.0%	37,324	Other HHW	0.0%	0.0%	2,086
Other Aluminum	0.4%	0.0%	20,274	Bulky Materials	2.0%	0.3%	95,309
Other Ferrous Metals	1.6%	0.2%	74,745	Furniture	2.8%	0.5%	132,917
Other Non-Ferrous Metals	0.5%	0.1%	24,064	Other Inorganics	0.6%	0.1%	28,323
Glass	**3.2%**	**0.2%**	**156,352**	PPE	0.1%	0.0%	6,545
Clear Glass Containers	1.6%	0.1%	75,086				
Green Glass Containers	0.5%	0.1%	22,291				
Brown Glass Containers	0.5%	0.1%	24,108	**Grand Total**	**100.0%**		**4,820,572**
Non-Recyclable Glass	0.7%	0.1%	34,867	**Number of Samples**	**683**		

Margin of error is calculated at a 90 percent level of confidence.

Table 4-4 Detailed Commercial Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**29.3%**	**1.1%**	**1,340,910**	**Organics**	**35.7%**	**1.4%**	**1,632,448**
Corrugated Cardboard/Kraft Paper	10.9%	0.8%	500,245	Food Waste	18.1%	0.7%	1,702,780
Newspaper	0.4%	0.1%	19,596	Yard Waste - Grass	0.4%	0.2%	18,280
Office/High Grade Paper	0.6%	0.1%	27,534	Yard Waste - Other	1.3%	0.4%	61,613
Magazine & Catalogs	0.7%	0.2%	31,157	Wood - Unpainted	5.9%	0.8%	269,499
Aseptic Boxes & Gable Top Cartons	0.4%	0.2%	17,892	Wood - Painted	2.1%	0.4%	95,426
Mixed Recyclable Paper (Low Grade)	5.4%	0.4%	248,689	Textiles & Leather Products	2.2%	0.4%	102,072
Compostable Paper	6.7%	0.4%	304,590	Diapers & Sanitary Products	1.5%	0.2%	66,765
Non-recyclable Paper	4.2%	0.5%	191,207	Animal By-Products	0.7%	0.1%	33,234
Plastic	**22.7%**	**1.1%**	**1,037,052**	Fines	1.1%	0.2%	52,564
#1 PET Bottles & Jars	1.1%	0.1%	48,825	Other Organics	2.3%	0.4%	104,125
#1 PET Non-Bottles & Containers	0.2%	0.1%	7,118	**Inorganics**	**6.9%**	**0.7%**	**313,629**
#2 HDPE Natural Bottles	0.5%	0.1%	20,703	Electronics - Covered Devices	0.1%	0.1%	5,974
#2 HDPE Colored Bottles	0.3%	0.0%	14,820	Other Electronics	0.2%	0.1%	9,810
#3 - #7 Bottles	0.1%	0.0%	3,131	Carpet & Carpet Padding	1.3%	0.4%	58,512
#2 - #7 Non-Bottle Rigid Containers	1.3%	0.1%	57,725	Drywall/Gypsum Board	0.5%	0.2%	22,699
Expanded Polystyrene	1.2%	0.2%	53,374	Concrete, Rock, Brick	0.3%	0.2%	15,212
Clean Retail Plastic Bags	0.1%	0.0%	4,054	Asphalt Roofing	0.4%	0.3%	16,754
Industrial Film	4.1%	0.5%	188,241	Asphalt Paving	0.0%	0.0%	820
All Other Film	7.1%	0.5%	326,206	Other C&D	1.3%	0.3%	58,204
Durable/Bulky Rigid Plastics	2.6%	0.3%	118,077	Medically-Related Waste	0.1%	0.1%	6,841
Remainder/Composite Plastic	4.3%	0.6%	194,778	Lithium Batteries	0.0%	0.0%	51
Metals	**3.7%**	**0.5%**	**169,479**	Automotive Batteries			Not Found
Steel Cans	0.8%	0.2%	34,989	Other Batteries	0.0%	0.0%	1,779
Aluminum Cans	0.4%	0.0%	17,537	Other HHW	0.0%	0.0%	2,231
Other Aluminum	0.3%	0.0%	12,155	Bulky Materials	1.0%	0.3%	45,368
Other Ferrous Metals	1.8%	0.4%	81,739	Furniture	0.5%	0.2%	24,101
Other Non-Ferrous Metals	0.5%	0.1%	23,059	Other Inorganics	0.5%	0.1%	24,327
Glass	**1.7%**	**0.2%**	**78,610**	PPE	0.5%	0.1%	20,946
Clear Glass Containers	0.7%	0.1%	30,229				
Green Glass Containers	0.2%	0.0%	8,216				
Brown Glass Containers	0.4%	0.1%	17,402	**Grand Total**	**100.0%**		**4,572,128**
Non-Recyclable Glass	0.5%	0.1%	22,763	**Number of Samples**	**575**		

Margin of error is calculated at a 90 percent level of confidence.

4.3 COMPARISONS BY DEMOGRAPHIC ORIGIN

Another objective of the study was to differentiate the composition and quantity of disposed MSW generated in urban, suburban, and rural areas of the State. This section provides a series of tables and figures with such comparisons.

Figure 4-13 compares the composition of waste by material group from urban, suburban, and rural areas of the State, measured by percentage composition. As shown, the composition of wastes is relatively similar across demographic area.

Figure 4-14 Disposed MSW Composition Summary by Demographic Origin (Percentage)

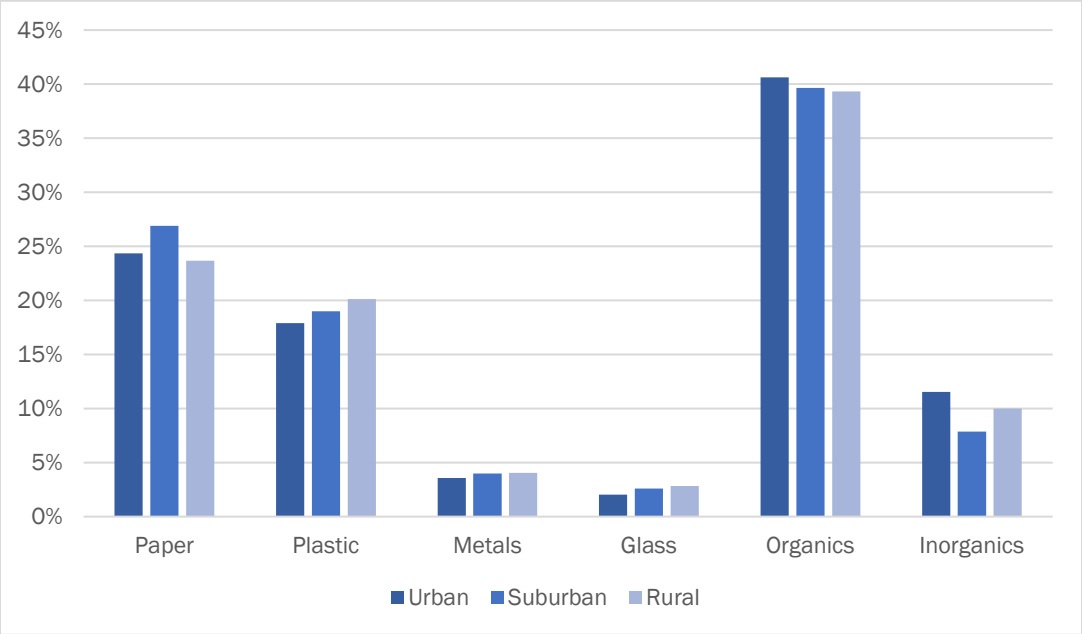


Figure 4-14 shows the same comparison measured by annual tonnage. As shown, wastes generated in suburban areas make up the largest quantities of each material group due to the most wastes being generated from suburban areas.

Figure 4-15 Disposed MSW Composition Summary by Demographic Origin (Tons)

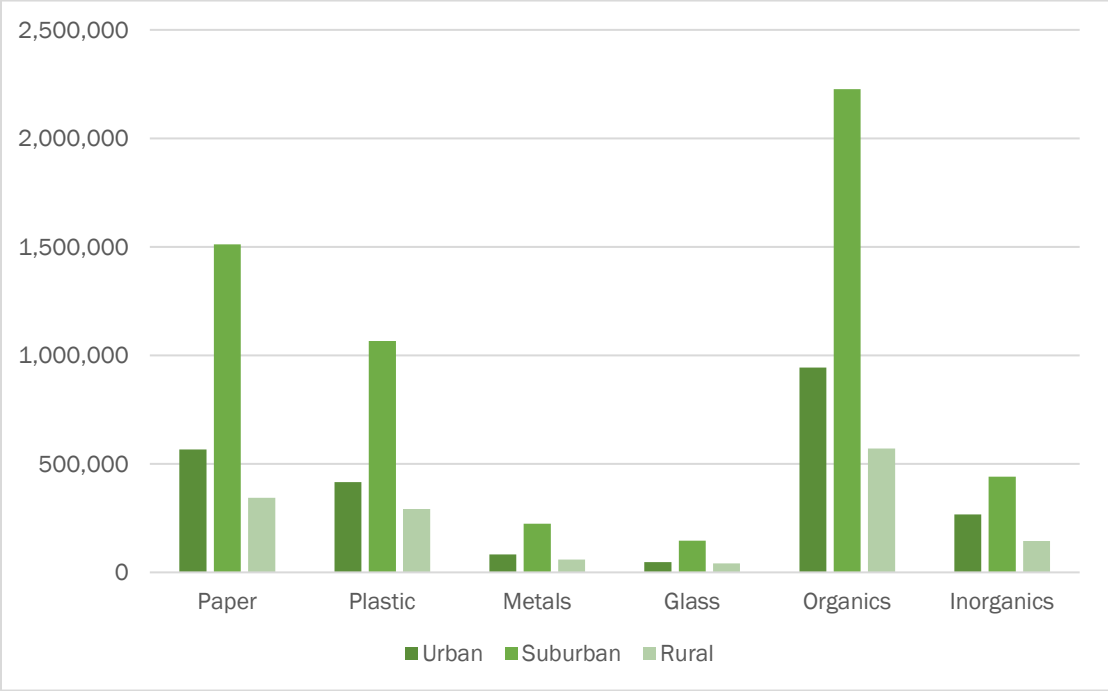


Figure 4-15 compares the breakdown of Food Waste by demographic origin. As shown, the breakdown is reasonably comparable across demographic regions, although the mix of packaged and non-packaged edible food does vary. Inedible food was found to fall in a narrow range between 27 and 30 percent.

Figure 4-16 Food Waste Detail by Demographic Origin (Percentage)

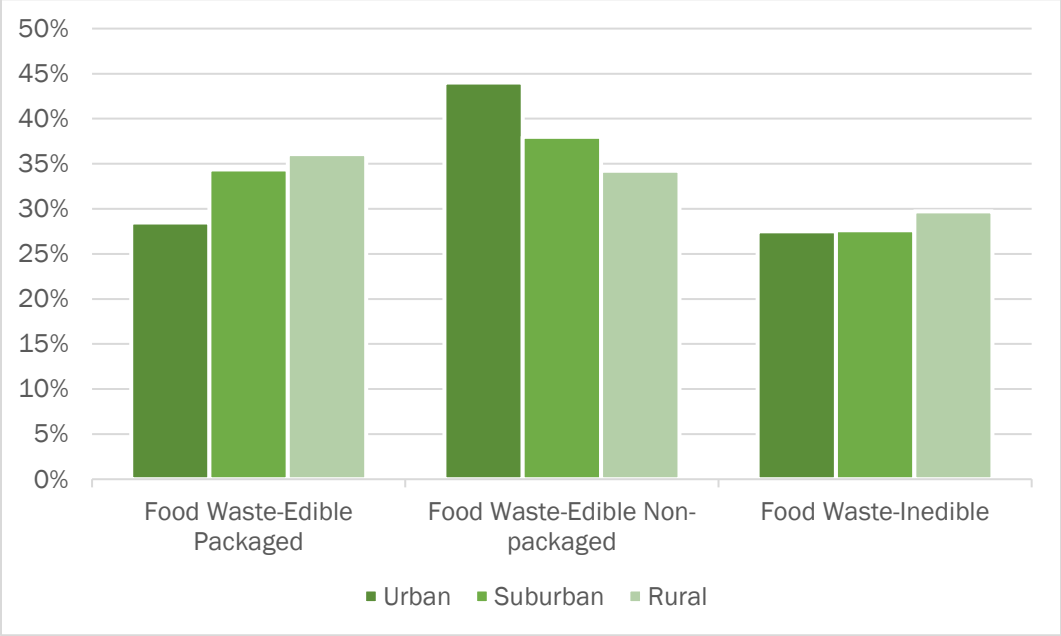


Figure 4-16 compares the divertibility of disposed MSW from urban, suburban, and rural areas. Divertibility is reasonably consistent across demographic areas. These results support the notion that residential wastes are fairly consistent across the Commonwealth in their composition.

Figure 4-17 Divertibility Comparison by Demographic Origin (Percentage)

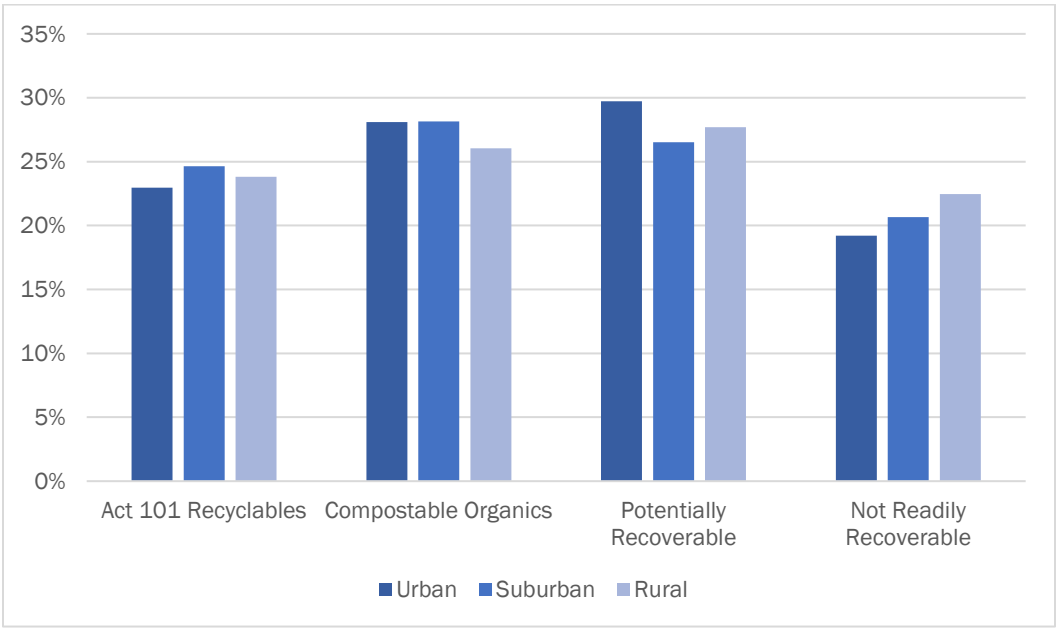


Figure 4-17 compares the quantity of materials defined in Act 101 that are being disposed from urban, suburban, and rural areas. These breakdowns are reflective of the overweighting of suburban MSW in Pennsylvania.

Figure 4-18 Act 101 Recyclables Disposed by Demographic Origin (Tons)

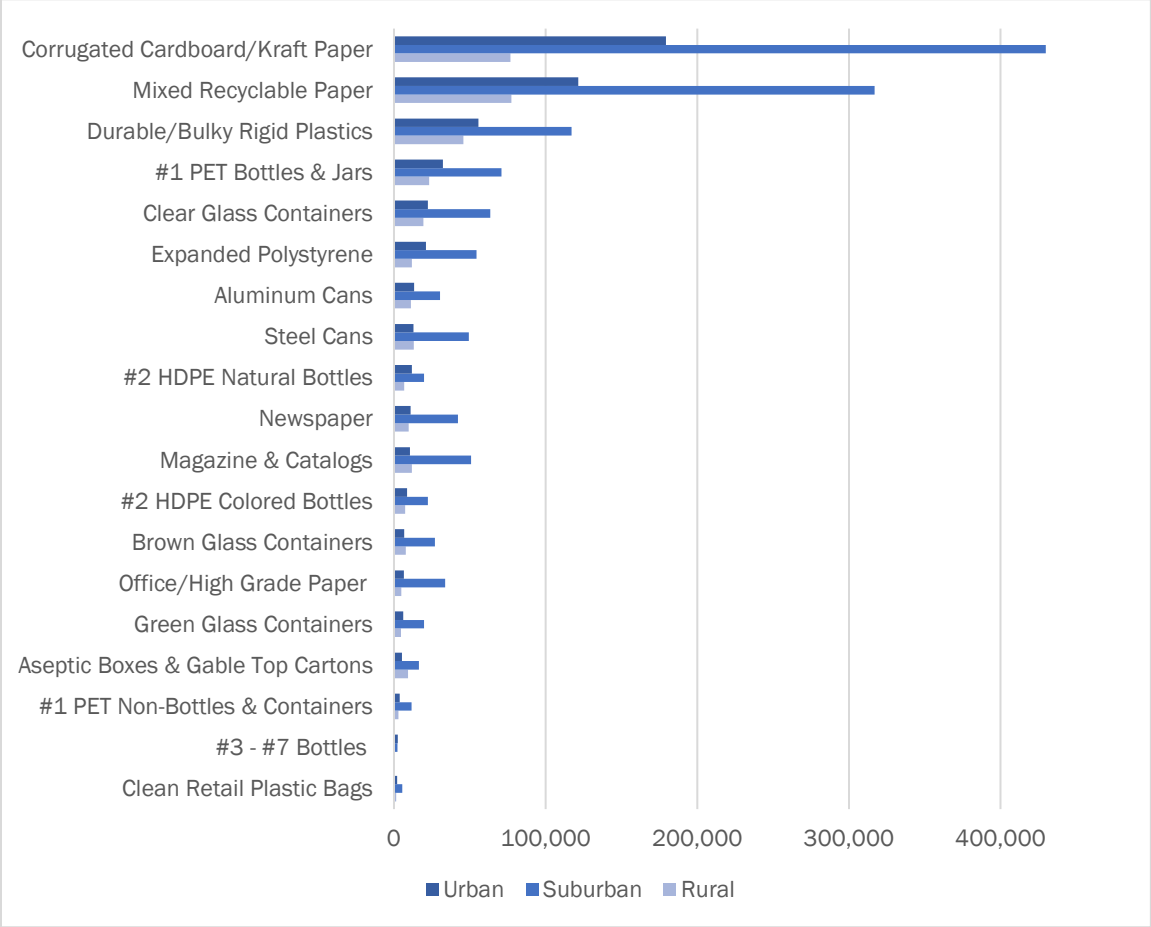


Table 4-5 shows the 10 most prevalent material categories in the urban, suburban, and rural waste streams. Food waste and film plastic are uniformly in the top two spots, with corrugated cardboard and compostable papers following. In all three demographic regions, the top 10 materials comprise 60 percent or more of the MSW stream.

Table 4-5 Top 10 Most Prevalent Materials by Demographic Origin (Tons)

	Urban		Suburban		Rural	
Rank	Material	Tons	Material	Tons	Material	Tons
1	Food Waste	393,922	Food Waste	971,284	Food Waste	227,739
2	Film Plastic	188,297	Film Plastic	495,721	Film Plastic	137,140
3	Corrugated Cardboard/Kraft Paper	179,271	Corrugated Cardboard/Kraft Paper	429,811	Compostable Paper	102,397
4	Compostable Paper	158,644	Compostable Paper	426,182	Mixed Recyclable Paper	77,384
5	Mixed Recyclable Paper	121,451	Mixed Recyclable Paper	317,042	Corrugated Cardboard/Kraft Paper	76,808
6	Textiles & Leather Products	108,086	Textiles & Leather Products	208,247	Animal By-Products	54,218
7	Wood - Unpainted	87,854	Wood - Unpainted	200,467	Non-recyclable Paper	51,734
8	Yard Waste - Other	83,456	Non-recyclable Paper	194,573	Diapers & Sanitary Products	47,266
9	Furniture	75,574	Remainder/Composite Plastic	190,268	Wood - Unpainted	46,760
10	Non-recyclable Paper	72,989	Animal By-Products	159,475	Durable/Bulky Rigid Plastics	45,673
	Total	**1,469,545**		**3,593,071**		**867,120**
	Percent of Total	*63.3%*		*64.0%*		*59.7%*

Detailed statistical results for the urban, suburban and rural waste streams are shown in Table 4-6, Table 4-7, and Table 4-8 respectively.

Table 4-6 Detailed Urban Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**24.4%**	**1.2%**	**565,726**	**Organics**	**40.6%**	**1.5%**	**943,722**
Corrugated Cardboard/Kraft Paper	7.7%	0.9%	179,271	Food Waste	17.0%	0.7%	393,922
Newspaper	0.5%	0.1%	10,919	Yard Waste - Grass	0.7%	0.3%	16,760
Office/High Grade Paper	0.3%	0.1%	6,615	Yard Waste - Other	3.6%	0.8%	83,456
Magazine & Catalogs	0.5%	0.1%	10,600	Wood - Unpainted	3.8%	1.0%	87,854
Aseptic Boxes & Gable Top Cartons	0.2%	0.0%	5,238	Wood - Painted	2.3%	0.4%	53,821
Mixed Recyclable Paper (Low Grade)	5.2%	0.5%	121,451	Textiles & Leather Products	4.7%	0.6%	108,086
Compostable Paper	6.8%	0.4%	158,644	Diapers & Sanitary Products	2.9%	0.3%	68,465
Non-recyclable Paper	3.1%	0.5%	72,989	Animal By-Products	1.7%	0.3%	40,018
Plastic	**17.9%**	**1.0%**	**415,486**	Fines	1.2%	0.2%	28,903
#1 PET Bottles & Jars	1.4%	0.1%	32,314	Other Organics	2.7%	0.7%	62,438
#1 PET Non-Bottles & Containers	0.2%	0.0%	3,731	**Inorganics**	**11.5%**	**1.3%**	**267,683**
#2 HDPE Natural Bottles	0.5%	0.1%	11,839	Electronics - Covered Devices	0.1%	0.1%	2,591
#2 HDPE Colored Bottles	0.4%	0.0%	8,713	Other Electronics	0.3%	0.1%	7,200
#3 - #7 Bottles	0.1%	0.1%	2,583	Carpet & Carpet Padding	1.7%	0.6%	38,478
#2 - #7 Non-Bottle Rigid Containers	1.2%	0.1%	28,345	Drywall/Gypsum Board	0.8%	0.4%	19,067
Expanded Polystyrene	0.9%	0.1%	21,174	Concrete, Rock, Brick	0.3%	0.2%	7,184
Clean Retail Plastic Bags	0.1%	0.0%	2,125	Asphalt Roofing	0.7%	0.6%	15,517
Industrial Film	2.2%	0.6%	51,734	Asphalt Paving	0.0%	0.0%	126
All Other Film	5.9%	0.4%	136,563	Other C&D	1.5%	0.4%	35,443
Durable/Bulky Rigid Plastics	2.4%	0.4%	55,681	Medically-Related Waste	0.2%	0.1%	3,747
Remainder/Composite Plastic	2.6%	0.5%	60,684	Lithium Batteries	0.0%	0.0%	29
Metals	**3.6%**	**0.5%**	**83,286**	Automotive Batteries		Not Found	
Steel Cans	0.6%	0.1%	12,883	Other Batteries	0.0%	0.0%	2,200
Aluminum Cans	0.6%	0.1%	13,171	Other HHW	0.0%	0.0%	492
Other Aluminum	0.4%	0.0%	9,095	Bulky Materials	1.8%	0.5%	81,864
Other Ferrous Metals	1.7%	0.4%	38,867	Furniture	3.3%	0.9%	148,750
Other Non-Ferrous Metals	0.4%	0.1%	9,269	Other Inorganics	0.6%	0.1%	27,346
Glass	**2.0%**	**0.3%**	**47,021**	PPE	0.3%	0.0%	11,559
Clear Glass Containers	1.0%	0.1%	22,304				
Green Glass Containers	0.3%	0.0%	6,023				
Brown Glass Containers	0.3%	0.1%	6,804	**Grand Total**	**100.0%**		**2,322,924**
Non-Recyclable Glass	0.5%	0.1%	11,890	**Number of Samples**	**330**		

Margin of error is calculated at a 90 percent level of confidence.

Table 4-7 Detailed Suburban Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**26.9%**	**0.9%**	**1,510,921**	**Organics**	**39.6%**	**1.1%**	**2,226,998**
Corrugated Cardboard/Kraft Paper	7.7%	0.7%	429,811	Food Waste	17.3%	0.7%	401,694
Newspaper	0.8%	0.1%	42,146	Yard Waste - Grass	0.9%	0.2%	50,899
Office/High Grade Paper	0.6%	0.1%	33,726	Yard Waste - Other	2.4%	0.3%	132,774
Magazine & Catalogs	0.9%	0.2%	50,921	Wood - Unpainted	3.6%	0.6%	200,467
Aseptic Boxes & Gable Top Cartons	0.3%	0.0%	16,520	Wood - Painted	2.5%	0.4%	138,316
Mixed Recyclable Paper (Low Grade)	5.6%	0.3%	317,042	Textiles & Leather Products	3.7%	0.4%	208,247
Compostable Paper	7.6%	0.4%	426,182	Diapers & Sanitary Products	2.8%	0.3%	159,285
Non-recyclable Paper	3.5%	0.4%	194,573	Animal By-Products	2.8%	0.3%	159,475
Plastic	**19.0%**	**0.8%**	**1,066,498**	Fines	1.5%	0.1%	82,818
#1 PET Bottles & Jars	1.3%	0.1%	70,829	Other Organics	2.2%	0.3%	123,434
#1 PET Non-Bottles & Containers	0.2%	0.1%	11,639	**Inorganics**	**7.9%**	**0.7%**	**441,550**
#2 HDPE Natural Bottles	0.4%	0.0%	19,870	Electronics - Covered Devices	0.1%	0.1%	7,509
#2 HDPE Colored Bottles	0.4%	0.0%	22,422	Other Electronics	0.5%	0.1%	27,030
#3 - #7 Bottles	0.0%	0.0%	2,308	Carpet & Carpet Padding	1.4%	0.3%	77,708
#2 - #7 Non-Bottle Rigid Containers	1.4%	0.1%	76,353	Drywall/Gypsum Board	0.4%	0.1%	21,482
Expanded Polystyrene	1.0%	0.1%	54,404	Concrete, Rock, Brick	0.3%	0.1%	17,139
Clean Retail Plastic Bags	0.1%	0.0%	5,565	Asphalt Roofing	0.0%	0.0%	2,666
Industrial Film	1.9%	0.3%	105,697	Asphalt Paving	0.0%	0.1%	2,179
All Other Film	6.9%	0.4%	390,025	Other C&D	1.5%	0.3%	85,921
Durable/Bulky Rigid Plastics	2.1%	0.2%	117,120	Medically-Related Waste	0.1%	0.0%	7,349
Remainder/Composite Plastic	3.4%	0.5%	190,268	Lithium Batteries	0.0%	0.0%	69
Metals	**4.0%**	**0.4%**	**224,264**	Automotive Batteries		Not Found	
Steel Cans	0.9%	0.2%	49,343	Other Batteries	0.1%	0.0%	4,026
Aluminum Cans	0.5%	0.0%	30,412	Other HHW	0.1%	0.0%	2,886
Other Aluminum	0.3%	0.0%	18,432	Bulky Materials	1.3%	0.3%	72,192
Other Ferrous Metals	1.7%	0.3%	96,591	Furniture	1.2%	0.3%	66,796
Other Non-Ferrous Metals	0.5%	0.1%	29,485	Other Inorganics	0.5%	0.1%	28,169
Glass	**2.6%**	**0.2%**	**146,522**	PPE	0.3%	0.0%	18,429
Clear Glass Containers	1.1%	0.1%	63,523				
Green Glass Containers	0.4%	0.1%	19,763				
Brown Glass Containers	0.5%	0.1%	26,999	**Grand Total**	**100.0%**		**5,616,753**
Non-Recyclable Glass	0.6%	0.1%	36,237	**Number of Samples**	**644**		

Margin of error is calculated at a 90 percent level of confidence.

Table 4-8 Detailed Rural Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**23.7%**	**1.1%**	**344,033**	**Organics**	**39.3%**	**1.6%**	**571,471**
Corrugated Cardboard/Kraft Paper	5.3%	0.5%	76,808	Food Waste	15.7%	0.5%	364,083
Newspaper	0.7%	0.1%	9,756	Yard Waste - Grass	0.8%	0.4%	11,433
Office/High Grade Paper	0.3%	0.1%	4,882	Yard Waste - Other	2.5%	0.7%	36,702
Magazine & Catalogs	0.8%	0.2%	11,791	Wood - Unpainted	3.2%	0.9%	46,760
Aseptic Boxes & Gable Top Cartons	0.6%	0.5%	9,282	Wood - Painted	2.6%	0.6%	37,423
Mixed Recyclable Paper (Low Grade)	5.3%	0.4%	77,384	Textiles & Leather Products	3.8%	0.5%	55,784
Compostable Paper	7.0%	0.5%	102,397	Diapers & Sanitary Products	3.3%	0.4%	47,266
Non-recyclable Paper	3.6%	0.4%	51,734	Animal By-Products	3.7%	0.5%	54,218
Plastic	**20.1%**	**1.5%**	**292,258**	Fines	1.2%	0.2%	17,332
#1 PET Bottles & Jars	1.6%	0.1%	23,214	Other Organics	2.5%	0.4%	36,814
#1 PET Non-Bottles & Containers	0.2%	0.0%	2,999	**Inorganics**	**10.0%**	**1.2%**	**145,237**
#2 HDPE Natural Bottles	0.5%	0.1%	6,705	Electronics - Covered Devices	0.1%	0.1%	1,530
#2 HDPE Colored Bottles	0.5%	0.0%	7,374	Other Electronics	0.6%	0.2%	8,503
#3 - #7 Bottles	0.0%	0.0%	593	Carpet & Carpet Padding	1.1%	0.4%	16,681
#2 - #7 Non-Bottle Rigid Containers	1.6%	0.3%	23,155	Drywall/Gypsum Board	0.7%	0.3%	10,363
Expanded Polystyrene	0.8%	0.3%	11,879	Concrete, Rock, Brick	0.4%	0.3%	5,540
Clean Retail Plastic Bags	0.1%	0.0%	1,382	Asphalt Roofing	0.6%	0.5%	8,087
Industrial Film	2.5%	0.8%	36,709	Asphalt Paving	0.1%	0.1%	1,178
All Other Film	6.9%	0.6%	100,431	Other C&D	2.3%	0.5%	33,718
Durable/Bulky Rigid Plastics	3.1%	0.6%	45,673	Medically-Related Waste	0.1%	0.0%	1,627
Remainder/Composite Plastic	2.2%	0.5%	32,144	Lithium Batteries	0.0%	0.0%	45
Metals	**4.0%**	**0.4%**	**58,672**	Automotive Batteries	0.0%	0.0%	22
Steel Cans	0.9%	0.1%	13,136	Other Batteries	0.1%	0.0%	1,340
Aluminum Cans	0.8%	0.1%	11,245	Other HHW	0.1%	0.1%	1,177
Other Aluminum	0.3%	0.0%	4,898	Bulky Materials	1.9%	0.6%	26,938
Other Ferrous Metals	1.4%	0.4%	21,045	Furniture	1.0%	0.4%	14,714
Other Non-Ferrous Metals	0.6%	0.1%	8,348	Other Inorganics	0.7%	0.2%	10,578
Glass	**2.8%**	**0.3%**	**41,352**	PPE	0.2%	0.1%	3,197
Clear Glass Containers	1.3%	0.2%	19,458				
Green Glass Containers	0.3%	0.1%	4,714				
Brown Glass Containers	0.5%	0.1%	7,681	**Grand Total**	**100.0%**		**1,453,025**
Non-Recyclable Glass	0.7%	0.1%	9,499	**Number of Samples**	**284**		

Margin of error is calculated at a 90 percent level of confidence.

4.4 ECONOMIC AND ENVIRONMENTAL IMPACTS

Table 4-9 estimates the recovered material value for recyclables commodities that were disposed in the regional MSW stream. Market values were obtained from recyclingmarkets.net. Note that while these materials are common to most residential and commercial recycling programs, they are not necessarily universally collected in the Commonwealth. Moreover, recovered materials market prices fluctuate based on supply and demand, so this valuation should be considered only as a moment-in-time snapshot. Nevertheless, as shown, were these materials segregated from the waste stream and captured in recycling programs, their cumulative value would have exceeded $514 million.

Table 4-9 Estimated Value of Disposed Recyclable Materials

Material Components	Estimated Tons Disposed	Average Market Price ($/ton)	Estimated Total Market Value ($)
Recyclable Paper	**1,413,715**		**$167,199,460**
Corrugated Cardboard/Kraft Paper	685,454	$135	$92,536,280
Newspaper	62,828	$188	$11,780,235
Office/High Grade Paper	45,190	$235	$10,619,601
Magazine & Catalogs	73,329	$168	$12,282,683
Aseptic Boxes & Gable Top Cartons	31,035	$0	$0
Mixed Recyclable Paper	515,879	$78	$39,980,661
Recyclable Containers	**881,206**		**$347,409,850**
#1 PET Bottles & Jars	126,388	$860	$108,693,543
#1 PET Non-Bottles & Containers	18,368	$130	$2,387,849
#2 HDPE Natural Bottles	38,415	$1,130	$43,408,531
#2 HDPE Colored Bottles	38,511	$640	$24,647,259
#3 - #7 Bottles	5,485	$130	$713,013
#2-#7 Non-Bottle Rigid Containers	127,931	$130	$16,631,020
Durable/Bulky Rigid Plastics	218,558	$90	$19,670,255
Steel Cans	75,358	$230	$17,332,272
Aluminum Cans	54,861	$1,950	$106,978,697
Clear Glass Containers	105,315	$50	$5,265,770
Green Glass Containers	30,506	$8	$228,798
Brown Glass Containers	41,510	$35	$1,452,842
Total	**2,294,921**	*$224*	**$514,609,309**

Source: Recyclingmarkets.net - Northeast Region of U.S. as of 06/9/22

Table 4-10 calculates the greenhouse gas emissions that could be reduced if the estimated quantities of recyclable and compostable materials disposed were diverted from disposal. This calculation was made with the U.S. Environmental Protection Agency's (US EPA) Waste Reduction Model (WARM). As shown, the WARM estimates that recycling of these materials plus composting of the food and yard waste, rather than landfilling, would remove almost six million metric tons of carbon dioxide equivalent ($MTCO_2E$) from the atmosphere. Over 4.5 million $MTCO_2E$ could be reduced from paper recycling, with the remaining amount reduced from container recycling and food/yard waste composting.

Table 4-10 Emissions Reduction Potential from Disposed Recyclables

Material Components	Tons Recycled/Composted[1]	Emissions Reduced ($MTCO_2E$)[2]
Recyclable Paper	**1,382,681**	**4,502,855**
Corrugated Cardboard/Kraft Paper	685,454	2,149,129
Magazine & Catalogs	73,329	225,098
Newspaper	62,828	170,155
Office/High Grade Paper	45,190	129,412
Mixed Recyclable Paper	515,879	1,829,061
Recyclable Containers	**881,206**	**1,221,790**
Aluminum Cans	54,861	500,737
Steel Cans	75,358	138,062
Glass	177,332	48,959
PET	144,756	149,927
HDPE	76,926	58,345
Mixed Plastics	351,974	325,760
Compostable	**1,925,171**	**201,925**
Food Waste	1,593,109	184,140
Yard Waste	332,062	17,785
Total	**4,189,057**	**5,926,570**

[1] Based on estimated overall MSW waste composition for 2021 and Pennsylvania's reported MSW disposal tonnage for FY 2021. Assumes the materials would be recycled instead of disposed.

[2] U.S. EPA Waste Reduction Model, Version 15

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5. CONCLUSIONS & RECOMMENDATIONS

5.1 CONCLUSIONS

The following conclusions are offered from this study:

- **Comparability to Prior Studies**: Despite the two-decade gap between Pennsylvania's inaugural statewide waste composition study and this 2021 Study, the original study methodology was largely maintained in performing this update. As a result, the 2021 Study provides a clear picture of the many changes to the disposed MSW stream, with little difference attributable to changes in study methodology.
- **Comprehensive Data Set**: With more than 1,250 samples obtained from 13 disposal facilities spread across all six DEP regions and over four seasons, the 2021 Study provides a wealth of statistical data about the composition of Pennsylvania's disposed MSW. This report highlights primary findings and compares those results with the 2001 Study. Moreover, this report provides detailed statistical snapshots of waste streams segregated by generator sector, by demographic area, and by DEP region. These comprehensive data sets should serve a wide range of sustainable materials management planners and inform policymakers across the Commonwealth.
- **Impact of COVID-19 Pandemic**: It is important to note that the materials sampling and field data collection for this project was initiated in the early days of the COVID-19 pandemic, and all field work was performed while the pandemic was still in its active phase. It has been widely reported that the fear of contracting the virus, combined with governmental closures of various businesses and institutions, resulted in a significant shift of waste generation from the commercial sector to the residential sector as countless employees either worked from home, or were simply at home due to unemployment caused by the pandemic. Although beyond the scope of this research to confirm, this impact surely influenced the methodology used to allocate waste generation between residential and commercial sectors, and between urban, suburban, and rural areas. Had this study been performed in normal times, the allocation of wastes might have varied somewhat (though likely not dramatically). Nonetheless, this study provides detailed and relevant data on the composition of disposed MSW.
- **Increasing Impact of Suburban Waste**: Based on the methodology used for the 2021 Study update, it was found that Pennsylvania's waste stream originates increasingly from suburban areas, with relatively less urban and rural waste. The statewide composition data contained herein consequently reflect this weighting towards suburban wastes. However, allocation of wastes into the three demographic strata was performed using a different methodology compared to the 2001 Study, so it is possible that methodological differences contributed to this finding as well as actual demographic shifts.
- **Specific Highlights**: While there are many conclusions that can be drawn from the results contained herein, the list below highlights some of the more noteworthy observations. Readers are encouraged to make their own comparisons and conclusions.
  - **Reduced Disposal of 2001 Study Act 101 Recyclables:** When comparing the designated materials from the 2001 Study with those same materials from the 2021 Study, we found that the amount of Act 101 materials that make up the Commonwealth's disposed waste stream fell from 22 percent to 13.9 percent. That is a positive development and can be indicative of expanded recycling access as well as lower generation rates of some materials. When the "newer" Act 101 materials (e.g., materials for which recycling access and programs have emerged) were examined as part of the 2021 study, their level in the disposal stream increased to 24.1 percent.
  - **Dramatic Reductions in Printed Paper**: Printed materials experienced a dramatic decrease. Where newspaper, magazines/catalogs, and office papers accounted for multiple percentages of

the 2001 Study waste stream, these are all mere fractions of a percent at present. While it is possible that a higher percentage of this paper is recycled today than it was in 2001 (some programs may have only collected newspaper in 2001), we believe this dramatic change in printed paper is instead emblematic of the continued transition to digital media sources.

- **Less Disposal of Metal and Glass**: Both of these materials (containers and non-containers) continue to decrease in terms of their contribution to the disposed MSW stream.
- **Stubbornly High Corrugated Cardboard Disposal**: While the amount of Corrugated Cardboard (OCC) in the disposed MSW stream decreased from 8.4 percent of the disposal stream to 7.3 percent, given the expansion of recycling programs during the past 20 years, less of this material should be ending up in the disposal stream. MSW Consultants believes that the relative steady state of OCC in the disposal stream is also reflective of larger trends, which include marked increases in on-line purchasing, a phenomenon referred to as the "Amazon Effect."
- **Significant Increases in Non-Container Plastics**: Packaging continues to shift from heavier and more expensive materials to lighter plastics, and it shows in the overall Plastics fraction. This is most visible in the amount of Film Plastics that were observed in the 2021 Study. When the catch-all Film Plastic category from 2001 is compared to the 2021 combined categories of Clean Retail Plastic Bags, Industrial Film, and All other Film, we see an increase of nearly 365,000 tons. However, it is worth noting that plastics are more subject to overstatement due to contamination, and so the actual increase in plastic waste is likely somewhat lower than the raw composition estimates coming from this study (a dynamic that exists in most waste composition studies).
- **Consistent Food Waste Disposal**: Food Waste made up 17 percent of total statewide MSW in the 2021 Study compared to 12 percent in 2001, an increase of nearly 466,000 tons. It remains the largest single component in the statewide aggregate, residential, and commercial waste streams.
- **Wasted Food vs Food Waste**: This study provides additional insight into food waste disposal behaviors by segregating wasted food (i.e., uneaten food) from food scraps (i.e., inedible bones, rinds, peels, shells, etc.). Unfortunately, the study found that the majority of food wastes by weight were wasted food. This finding supports the need for focusing attention and resources on ways to mitigate this issue.
- **More PET Bottles in Disposed Residential MSW**: Perhaps because more products are converting to PET packaging from other heavier packaging, the percentage and tons of PET bottles increased since 2001.
- **Lower Incidence of Grass and Yard Waste in Residential MSW**: There was a noteworthy decrease in residential disposed grass clippings in the 2021 Study. Perhaps expanded yard waste collection programs and leave-it-on-the-lawn outreach has taken a firmer hold since 2001. Other yard wastes were also disposed to a lesser extent in the 2021 Study.
- **Higher Incidence of Hard-to-Recycle Materials**: Diapers and Sanitary Products have increased in the residential stream. Also, the incidence of Animal Byproducts has spiked. The 2001 Study did not even have this as a category, but by 2021 so-called "pet waste" is almost three percent of the disposed MSW stream, and almost five percent of the residential stream.
- **Only Trace Amounts of HHW and E-wastes**: On a positive note, and consistent with the 2001 Study, very little HHW and electronic wastes were observed in the 2021 Study.
- **Significant Revenue Generating Opportunity for Improved Recycling**: While it is unrealistic to expect that all Act 101 or commonly accepted recyclables can be diverted from landfill disposal, it is nonetheless telling that discarded recyclables could have generated an additional $514 million had they been properly recycled instead.

- **Meaningful Emissions Reductions from Improved Recycling**: Similarly, capturing recyclables in proper recycling programs has positive impacts on Pennsylvania's environment through reduced $MTCO_2E$ (Metric Tons of Carbon Dioxide Equivalent) emissions.

Readers are encouraged to draw their own conclusions based on a careful review of the data.

5.2 RECOMMENDATIONS

The following recommendations are offered for consideration by DEP:

- **Increase Frequency of Waste Composition Studies**: Pennsylvania is one of a relatively small number of states that have performed more than one statewide study, and in this regard has provided stakeholders with this invaluable data set. However, the waste stream has been and likely will continue to change at a relatively fast pace. For this reason, the state may wish to consider performing these studies on a seven to ten-year cycle if allowable in the state budget.
- **Revisit Act 101 Targeted Material Definitions**: Act 101 has spurred outstanding diversion of targeted materials. However, changes in the disposed MSW stream combined with changes in processing technologies and in markets for recycled commodities suggests that the current definitions be updated to more specifically delineate other recyclable materials, especially within the plastics and paper material groups.
- **Maintain Focus on Diverting Organics**: DEP is engaged in multiple initiatives to increase diversion of food wastes from the commercial sector, and this study confirms that organics diversion, if successful, would have significant impacts on reducing waste to landfill.
- **Incorporate Extended Producer Responsibility (EPR) Considerations Into Future Composition Research**: EPR refers to a system where industry players (such as product manufacturers and consumer brands) that introduce packaging to the market are responsible for providing funding and mechanisms for the consistent collection and recovery of this packaging, thereby creating a more circular economy. Unlike the current system, where municipalities bear the cost of collection, disposal, or recycling of end-of-life materials, EPR better aligns the cost of materials management to the generators of the material. As of the date of this report, four states (Oregon, Maine, California, and Colorado) have passed EPR packaging legislation, marking a potential shift in the way these wastes are managed. Future studies may wish to redefine certain material categories to better measure the incidence of packaging and/or other materials that may be candidates for management under an EPR paradigm in the future.
- **Perform a Statewide Construction & Demolition Composition Study**: Of the more than 15 million tons of waste disposed in the Commonwealth, this study focused on the nearly 9.4 million tons of municipal solid waste disposed in FY 2021. Another 1.4 million tons of C&D debris were reported to be disposed according to DEP's online solid waste disposal information reports. Highly accurate methodologies for estimating the composition of bulky C&D loads have been developed and used in other state and local studies. These methodologies make C&D composition study more affordable compared to MSW composition studies. DEP may wish to more fully evaluate the composition of C&D waste streams in the future, as many constituents of C&D debris can be reused or recycled.

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APPENDIX A

MATERIAL CATEGORIES & DEFINITIONS

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APPENDIX A – MATERIAL CATEGORIES & DEFINITIONS

MATERIAL	DESCRIPTION	DEFINITION
PAPER		
1	Corrugated Cardboard/Kraft Paper (Uncoated)	Corrugated boxes or paper bags made from Kraft paper. Uncoated Corrugated Cardboard has a wavy center layer and is sandwiched between the two outer layers and does not have any wax coating on the inside or outside. Examples include shipping and moving boxes, product packaging cartons, clean pizza boxes and sheets and pieces of boxes and cartons. This type does not include chipboard. Examples of Kraft paper include paper grocery bags, un-soiled fast-food bags, department store bags, and heavyweight sheets of Kraft packing paper.
2	Newspaper	Printed and unprinted ground wood newsprint. Includes glossy paper inserts.
3	Office/High Grade Paper	High-grade paper. Bond, rag-content, or stationery grade paper with or without color. Includes ledger, photocopy paper, computer printouts, index cards, and white envelopes (with and without windows or gummed labels).
4	Magazine & Catalogs	Magazines and catalogs printed on glossy, coated paper stock. Also includes brochures/pamphlets.
5	Aseptic Boxes & Gable Top Cartons	Aseptic containers (multi-layered packaging that contains shelf-stable food products such as apple juice, soup, soy/rice milk, etc.) and ''gable top'' cartons (non-refrigerated items such as granola and crackers; refrigerated items such as milk, juice, egg substitutes, etc.). Rigid food and beverage cartons are usually paper based, may be any shape, and may include a plastic pour spout as part of the carton.
6	Mixed Recyclable Paper (Low Grade)	Low grade recyclable paper. Includes paperboard, chipboard, phone books, manila folders/envelopes, soft back books, construction paper, junk mail, carbonless forms, non-high-grade envelopes, notebook paper, deep-toned or fluorescent dyed paper and glossy and coated paper (except magazines and catalogs).
7	Compostable Paper	Low grade paper that is not recyclable, as well as heavy food/moisture contaminated paper. Examples include paper towels, uncoated paper plates/cups/bowls, waxed papers and cardboard, fiber egg cartons, soiled pizza boxes, and tissues.
8	Non-recyclable Paper	Items made mostly of paper but combined with large amounts of other materials such as plastic, metal, glues, foil, and moisture. Examples include plastic-coated corrugated cardboard, hardback books, receipt paper, cellulose insulation, sepia, onionskin paper, foiled-lined fast-food wrappers, frozen juice containers, carbon paper, blueprints, self-adhesive notes, playing cards, lottery scratch tickets, and photographs.
PLASTIC		
9	#1 PET Bottles & Jars	Blow molded plastic bottles and jars labeled #1 PET/PETE.

	10	#1 PET Non-Bottles & Containers	Non-bottle/jar rigid plastic containers labeled #1 PET/PETE such as thermoforms. Examples include take-out containers, produce & plastic egg cartons.
	11	#2 HDPE Natural Bottles	Plastic bottles and jars labeled #2 HDPE that are cloudy white, allowing light to pass through it (e.g., milk jugs)
	12	#2 HDPE Colored Bottles	Plastic bottles and jars labeled #2 HDPE that are a solid color, preventing light from passing through it (e.g., laundry/soap bottles)
	13	#3 - #7 Bottles	Blow molded plastic bottles and jars labeled #3-#7 or dual labeled.
	14	#2-#7 Non-Bottle Rigid Containers	Non-bottle/jar rigid plastic containers labeled #2-#7. Includes single use plastic cups, trays, packaging, tubs, and food container lids. Does not include single use cup lids.
	15	Expanded Polystyrene	Food service polystyrene, polystyrene packaging, and ''peanuts''. Any expanded foam product labeled #6.
	16	Clean Retail Plastic Bags	Clean polyethylene film bags commonly used for grocery and merchandise.
	17	Industrial Film	Film plastic used for large-scale packaging or transport packaging or other industrial uses. Examples include pallet shrink-wrap, mattress bags, furniture wrap, painting tarps, and large film bubble wrap.
	18	All Other Film	All other film plastic including garbage bags, dry cleaning bags, bubble wrap, air pillows, cereal bags, household shrink wrap, tarps, sandwich bags, zip (recloseable) bags, produce bags, frozen vegetable bags, food wrappers such as candy-bar wrappers and chip bags, mailing pouches, bank bags, X-ray film, and metallized film (wine containers and balloons).
	19	Durable/Bulky Rigid Plastics	Items other than containers or film plastic, that are made to last for more than one use. These items may bear the numbers 1 through 7 in the triangular recycling symbol. Examples include crates, buckets (including 5-gallon buckets), baskets, totes, large plastic garbage cans, large tubs, large storage tubs/bins (usually with lids) that don't have sharp corners, flexible (non-brittle) flower pots of 1 gallon size or larger, lawn furniture, large plastic toys, tool boxes, first aid boxes, and some sporting goods, CDs and their cases, plastic housewares such as durable (not single-use) dishes, cups, and cutlery.
	20	Remainder/ Composite Plastic	Plastics that cannot be put in any other type or subtype, including items comprised mostly of plastic but combined with other materials. Examples include auto parts made of plastic attached to metal; single use cutlery, drinking straws and cup lids; foam packing blocks (non-EPS); plastic strapping; new plastic laminate (e.g., Formica); vinyl; linoleum; plastic lumber; imitation ceramics; handles and knobs; some kitchen ware; plastic string (as used for hay bales); and plastic rigid bubble/foil packaging (as for medications).
METAL			
	21	Steel Cans	All coated and tin-free ferrous food and beverage cans. Includes bi-metal cans and non-aerosol spray cans.
	22	Aluminum Cans	All aluminum food and beverage containers.
	23	Other Aluminum	Foils, trays, siding, sheet

24	Other Ferrous Metals	Magnetic ferrous and alloyed ferrous scrap metals. Examples include empty or dry paint cans, structural steel beams, boilers, clothes hangers, pipes, some cookware, security bars, scrap ferrous items, and galvanized items such as nails and flashing.
25	Other Non-Ferrous Metals	Non-magnetic metals such as copper, brass, bronze, silver, zinc, stainless steel and pipe tubing.
GLASS		
26	Clear Glass Containers	Recyclable clear beverage and food bottles and jars.
27	Green Glass Containers	Recyclable green beverage and food bottles and jars.
28	Brown Glass Containers	Recyclable amber/brown beverage and food bottles and jars.
29	Non-Recyclable Glass	Other glass containers (e.g., blue) and flat, pressed and blown glass products such as light bulbs, mirrors, decorative items and fixtures, windows, safety glass, ceramics, and cooking ware.
26	Clear Glass Containers	Recyclable clear beverage and food bottles and jars.
ORGANICS		
30	Food Waste-Edible Packaged	The components of food that, in a particular food supply chain, are intended to be consumed by humans, and is not enclosed in original glass, plastic, paper, or other packaging as sold or distributed. Examples include vegetables, fruits, eggs, eggs in shell, fresh meat, cooked meat, and meat scraps. Edible food that appears to have been packaged by the consumer (e.g. in a Ziploc bag, takeout container, or reusable container) is included here.
31	Food Waste-Edible Non-packaged	The components of food that, in a particular food supply chain, are intended to be consumed by humans, and is enclosed in original glass, plastic, paper, or other packaging as sold or distributed.
32	Food Waste-Inedible	The non-edible portions of food material. Examples include fruit peels, vegetable peelings and potato skins, pits, cores, juiced oranges, eggshells, bones, gristle and meat trimmings, fish skins, and seafood shells.
33	Yard Waste - Grass	Grass clippings
34	Yard Waste - Other	Yard waste other than grass clippings such as leaves, garden trimmings, and brush up to 4 inches in diameter
35	Wood - Unpainted	Wood and dimensional lumber construction materials from new construction, remodeling, or demolition, including plywood and shingles if uncontaminated by paint, stain or preservative treatment. Includes easily separable wood from furniture, tools, and other durable products. Excludes preservative treated wood or particleboard, chipboard, or masonite.
36	Wood - Painted	Any wood with paint, stain or preservative treatment. Also includes particleboard, chipboard, and masonite due to their resin content.

37	Textiles & Leather Products	Fabric materials including natural and man-made textile materials made from cottons, wools, silks, nylon, rayon, polyesters, and other materials. This category includes clothing rags, curtains, and other fabric materials. Leather and leather goods are also included such as belts and wallets. Includes all shoes.
38	Diapers & Sanitary Products	Diapers and adult sanitary products.
39	Animal Byproducts	Animal carcasses not resulting from food storage or preparation, animal wastes, and cat litter. Also includes manure and soiled animal bedding materials.
40	Other Organics	Organic materials not otherwise categorized, such as natural fibers, cork, wax, hemp rope, wicker products, sawdust, hair, cigarette butts, vacuum bags, and lint.
41	Fines-1/2'' minus	Use the 1/2'' screen for both refuse and MRF studies. All particles capable of passing through a 1/2-inch screen. E.g., table sweepings. If 1/2'' minus fines are homogenous, (e.g., all food, cat litter, etc.) some material may be allocated to designated material categories.
INORGANICS		
42	Electronics - Covered Devices	Electronic devices prohibited from landfill disposal including televisions/monitors, computers/laptops, tablets/e-readers, printers/scanners/copiers, peripherals (mice, keyboards)
43	Other Electronics	Other electronic or electrically powered household products not included under ''covered devices''. Includes electronics fabricated from metals and plastics and not easily separable into individual materials. Examples include hair dryers, radios, stereos, calculators, microwave ovens, and telephones.
44	Carpet & Carpet Padding	Flooring applications consisting of various natural or synthetic fibers which maybe bonded to some type of backing material. Includes the plastic, foam, felt, or other material used under carpet to provide insulation and padding.
45	Drywall/Gypsum Board	Gypsum-based wallboard, including blueboard for use in the drywall or plaster trades
46	Concrete, Rock, Brick	Concrete (hard material made from sand, aggregate, gravel, cement mix, and water) including pieces with a steel internal structure composed of reinforcing bars (re-bar) or metal mesh; bricks (single units of ceramic materials used in masonry construction) and other aggregates such as stone and rock, masonry tile, and clay roofing tiles.
47	Asphalt Roofing	Roofing material composed of fiberglass or organic felts saturated with asphalt and covered with inert aggregates as well as attached roofing tar and tar paper.
48	Asphalt Paving	Asphalt paving (black or brown, tar-like material mixed with aggregate used as a paving material)
49	Other C&D	Other construction and demolition debris not classified elsewhere. For example, fiberglass insulation, rigid foam insulation, acoustic ceiling tiles, cement board, ceramic fixtures, non-shingle asphaltic roofing, roofing and water-repelling membranes. This category may include items from different categories combined, which would be difficult to separate, and demolition debris that is a mixture of materials such as tile attached to drywall attached to studs or laminate countertops attached to a sink and plumbing. Also includes fines such as sand, soil, dirt, and gravel associated with C&D loads.

	50	Medically Related Waste	Discarded needles and other medical sharps that have been used in animal or human patient care or treatment or in medical, research or industrial laboratories. Also includes medical tubing, IV bags, prescription drugs and other medical materials.
	51	Lithium Batteries	Lithium batteries of all sizes and types including household and button cell batteries
	52	Automotive Batteries	Automotive batteries.
	53	Other Batteries	Other batteries excluding lithium or automotive.
	54	Other HHW	Includes fluorescent tubes and bulbs, corrosives, caustic acids, cleaning chemicals, pesticides/herbicides, gasoline, motor oil and other flammable fuels/oils, explosives, anti-freeze, latex/water-based/oil-based paints, adhesives/glues, putties/fillers/sealers, personal care/cosmetics (not including containers unless product cannot be easily separated), and all other potentially harmful wastes that do not fit the above categories.
	55	Bulky Materials	Products made from multiple materials and large in size, which are meant for extended use. Includes mattresses, tires, box springs, and large and small appliances.
	56	Furniture	Mixed-material furniture such as upholstered chairs and couches. Furniture that is made purely of one material, such as plastic or metal, would be categorized according to that material (e.g., plastic durable/bulky items or wood lumber and products, treated).
	57	Other Inorganics	Inorganic material not otherwise classified, such as dryer and mop sheets, rubber latex gloves, cosmetics and full liquid soaps and shampoos.
	58	PPE	Waste that contains primarily face masks, wipes, rubber gloves, and face shields or those items when they are loose in the sample. This does not include PPE from sources that are likely not COVID-19 related such as work boots, hard hats, safety vest, etc. This also does not include bags of general medical waste (bags that contain tubing, drapes, pipettes, sharps, saline drip bags, bandages, scrubs, gowns, etc.).

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APPENDIX B

NORTHEAST REGIONAL RESULTS

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APPENDIX B – NORTHEAST REGION RESULTS

B 1. INTRODUCTION

Pennsylvania's Northeast region encompasses 11 counties and has a population of 1,784,638 people and more than 685,000 households. A map of the Northeast region is shown in Figure B-1.

Figure B-1 Northeast Region Map

Table B-1 summarizes selected demographic and economic data for the Northeast region. As shown, this region is predominantly suburban, with some urban and rural areas.

Table B-1 Northeast Region Demographic Summary (2021)

	Urban	Suburban	Rural	Total
Communities	7	158	228	393
Population	379,922	920,981	483,735	1,784,638
Housing Units	138,239	360,362	189,257	687,858
Employment	187,699	469,075	139,010	795,784

Sources: Demographic data from the Pennsylvania State Data Center; employment data from ESRI Business Patterns. The allocation of these data to urban, suburban, and rural areas was estimated by MSW Consultants.

The methodology for estimating waste generation within the residential and commercial sectors and allocated across urban, suburban, and rural areas is described in the main body of this report. Table B-2 presents the resulting allocation of generated wastes within the Northeast Region. These quantities are used as weighting factors for determining the aggregate waste composition within the region.

Table B-2 Estimated Allocation of MSW Generated in the Northeast Region

	Tons of Waste Disposed			
Generating Sector	Urban	Suburban	Rural	Total
Residential	146,533	331,533	168,439	**646,505**
Commercial	191,686	479,038	141,963	**812,686**
Total	**338,219**	**810,571**	**310,401**	**1,459,192**

Field sampling and sorting of Northeast region wastes was performed at the Keystone Landfill and the Commonwealth Environmental Systems Landfill. Sampling at these facilities was performed across four seasons to capture seasonal variation in MSW composition. Table B-3 provides a sampling summary for the Northeast Region. Regional sampling targets were met in this region.

Table B-3 Northeast Region Sampling Summary

	Number of Samples			
Waste Generating Sector	Urban	Suburban	Rural	Total
Residential	9	57	38	**104**
Commercial	19	60	21	**100**
Total	**28**	**117**	**59**	**204**

B 2. AGGREGATE WASTE COMPOSITION

The remainder of this section presents a graphical and tabular summary of the Northeast region's disposed MSW composition. Specific figures and tables with selected highlights and comparisons with the 2001 Study are summarized below.

- Table B-4 provides the detailed tabular composition of the aggregated disposed MSW stream. This table shows the mean composition, margin of error (MOE) at a 90 percent level of confidence, and the estimated tonnage of each of the constituents in disposed MSW.
- Figure B-2 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented as percentages.
- Figure B-3 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented in tons.
- Figure B-4 is a pie chart that shows the percentage composition of major material groups in the aggregate regional waste stream. As shown, organics comprise 37 percent of the refuse disposed in the Northeast region.
- Figure B-5 compares the 10 most prevalent materials being disposed in the region by weight for the 2021 and 2001 Studies.
- Figure B-6 is a pie chart that shows the detailed percentage composition of the food waste category.
- Figure B-7 illustrates the divertibility of the aggregate disposed MSW stream. This graphic shows that the majority of the materials being disposed could be diverted through existing recycling programs, composting programs, and third-party recovery programs. It should be noted that this graphic omits the impact of contamination, and as a practical matter it is not possible for all the divertible materials to actually be diverted.

Table B-4 Detailed Northeast Region Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**28.5%**	**1.7%**	**415,837**	**Organics**	**37.0%**	**2.0%**	**540,457**
Corrugated Cardboard/Kraft Paper	8.0%	1.3%	117,161	Food Waste	16.6%	2.1%	242,429
Newspaper	0.9%	0.2%	12,532	Yard Waste - Grass	0.2%	0.1%	2,672
Office/High Grade Paper	0.3%	0.1%	3,660	Yard Waste - Other	1.6%	0.5%	23,716
Magazine & Catalogs	0.6%	0.1%	8,543	Wood - Unpainted	2.9%	0.9%	42,843
Aseptic Boxes & Gable Top Cartons	0.4%	0.1%	5,173	Wood - Painted	2.0%	0.6%	29,791
Mixed Recyclable Paper (Low Grade)	5.2%	0.6%	75,966	Textiles & Leather Products	3.4%	0.6%	49,697
Compostable Paper	9.1%	0.9%	132,241	Diapers & Sanitary Products	3.2%	0.5%	46,552
Non-recyclable Paper	4.5%	0.9%	65,430	Animal By-Products	2.7%	0.5%	39,992
Plastic	**20.2%**	**1.7%**	**295,293**	Fines	1.1%	0.2%	15,770
#1 PET Bottles & Jars	1.4%	0.1%	20,965	Other Organics	2.6%	0.8%	38,085
#1 PET Non-Bottles & Containers	0.2%	0.0%	2,497	**Inorganics**	**8.2%**	**1.2%**	**119,381**
#2 HDPE Natural Bottles	0.6%	0.1%	8,265	Electronics - Covered Devices	0.1%	0.1%	1,851
#2 HDPE Colored Bottles	0.5%	0.1%	6,923	Other Electronics	0.3%	0.1%	4,751
#3 - #7 Bottles	0.0%	0.0%	391	Carpet & Carpet Padding	0.9%	0.4%	13,859
#2 - #7 Non-Bottle Rigid Containers	1.5%	0.2%	22,366	Drywall/Gypsum Board	0.6%	0.3%	8,078
Expanded Polystyrene	1.0%	0.4%	14,345	Concrete, Rock, Brick	0.3%	0.2%	4,971
Clean Retail Plastic Bags	0.1%	0.0%	1,857	Asphalt Roofing	0.1%	0.1%	1,631
Industrial Film	1.6%	0.5%	23,327	Asphalt Paving	0.0%	0.0%	137
All Other Film	7.2%	0.5%	105,006	Other C&D	1.6%	0.5%	23,621
Durable/Bulky Rigid Plastics	2.4%	0.7%	35,577	Medically-Related Waste	0.1%	0.0%	887
Remainder/Composite Plastic	3.9%	1.1%	56,452	Lithium Batteries	0.0%	0.0%	25
Metals	**3.7%**	**0.5%**	**54,327**	Automotive Batteries			Not found
Steel Cans	1.1%	0.2%	15,541	Other Batteries	0.1%	0.0%	1,088
Aluminum Cans	0.7%	0.1%	10,035	Other HHW	0.0%	0.0%	119
Other Aluminum	0.3%	0.0%	5,095	Bulky Materials	2.0%	0.6%	29,576
Other Ferrous Metals	1.2%	0.4%	17,378	Furniture	1.4%	0.6%	20,285
Other Non-Ferrous Metals	0.4%	0.1%	5,957	Other Inorganics	0.4%	0.1%	6,275
Glass	**2.3%**	**0.3%**	**33,897**	PPE	0.3%	0.1%	4,076
Clear Glass Containers	1.1%	0.2%	15,518				
Green Glass Containers	0.3%	0.1%	3,807				
Brown Glass Containers	0.4%	0.1%	6,341	**Grand Total**	**100.0%**		**1,459,192**
Non-Recyclable Glass	0.6%	0.1%	8,067	**Number of Samples**	**204**		

Margin of error is calculated at a 90 percent level of confidence.

Figure B-2 Comparison of Composition by Material Group 2021 vs 2001 (Percentage)

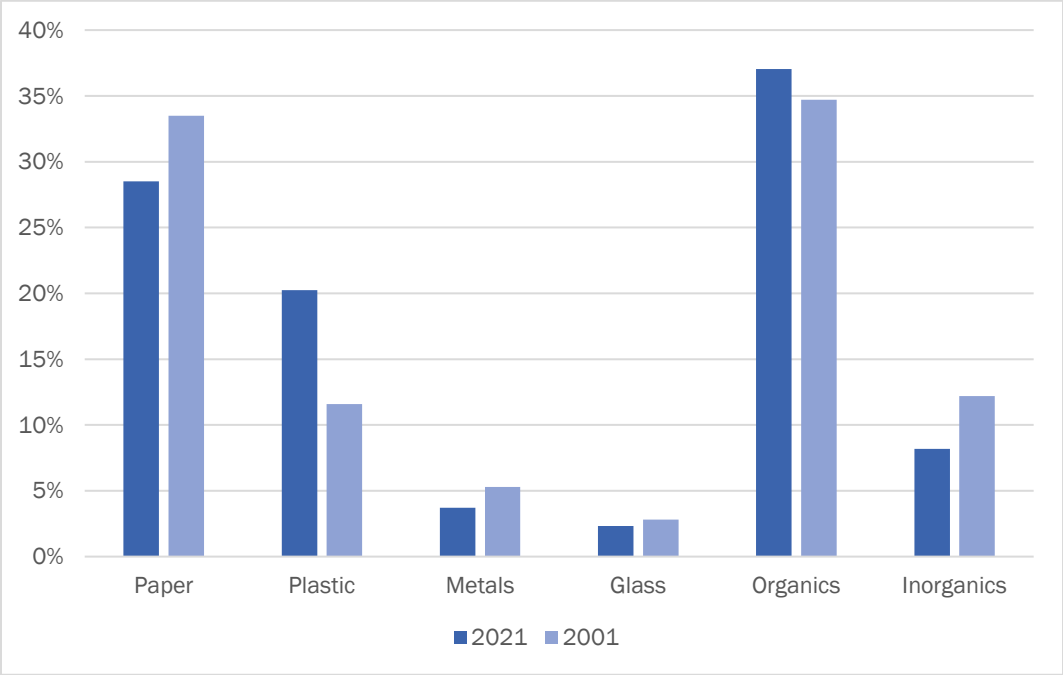


Figure B-3 Comparison of Composition by Material Group 2021 vs 2001 (Tons)

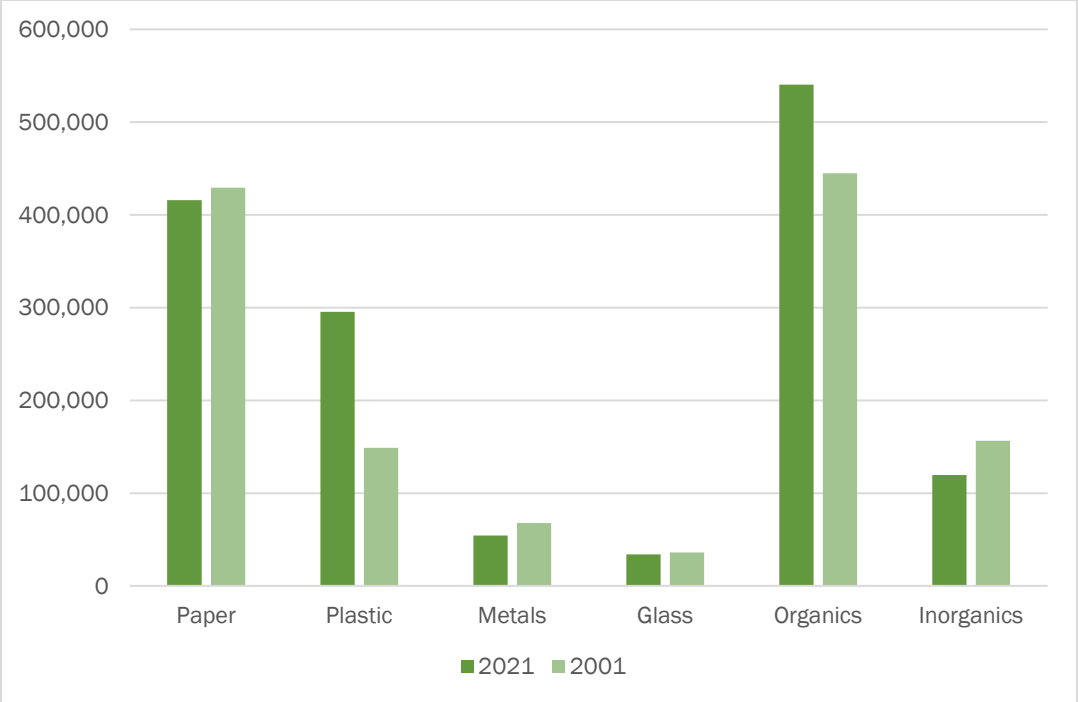


Figure B-4 Composition Summary by Material Group (Percentage)

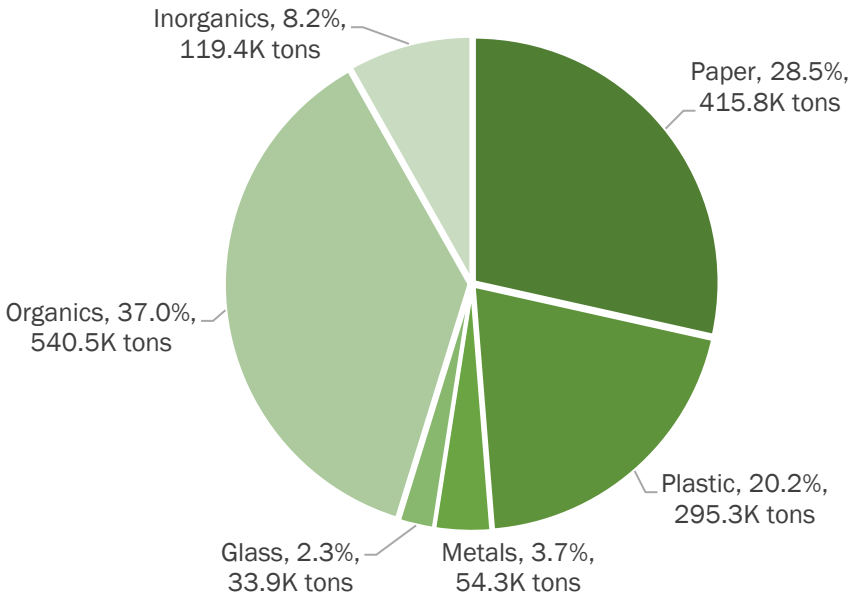
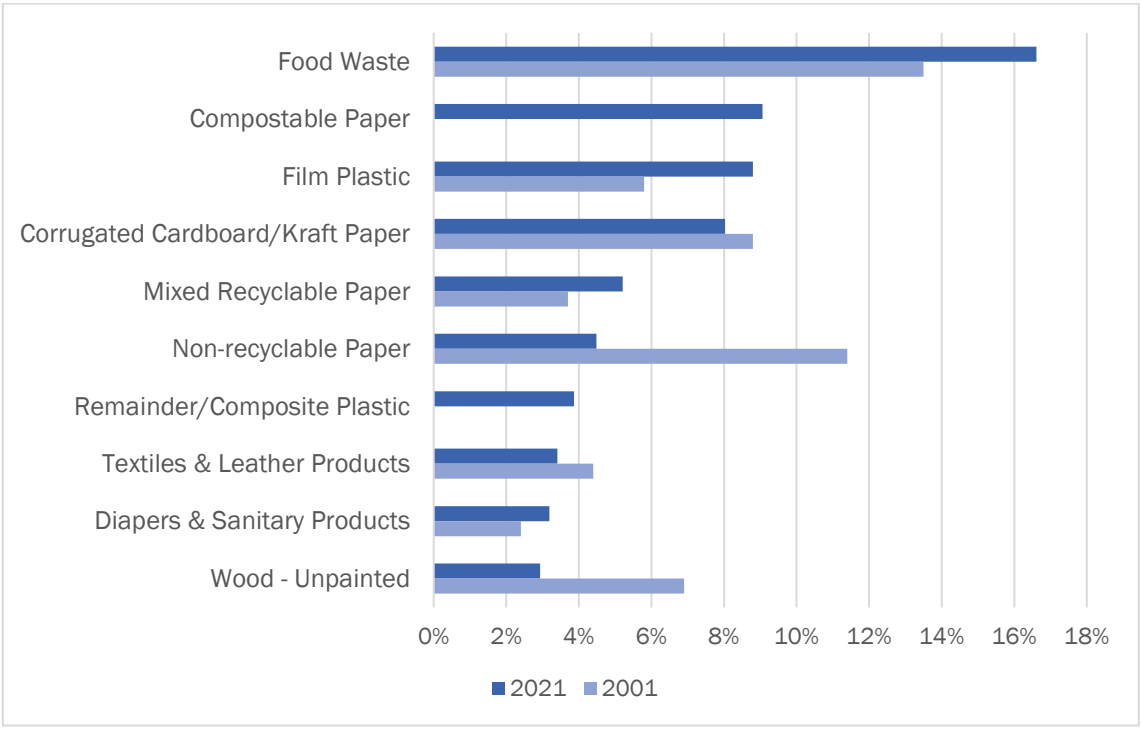


Figure B-5 Top 10 Most Prevalent Materials by Weight *



*Note: Some material categories were not sorted in 2001 Study

Figure B-6 Food Waste Detail

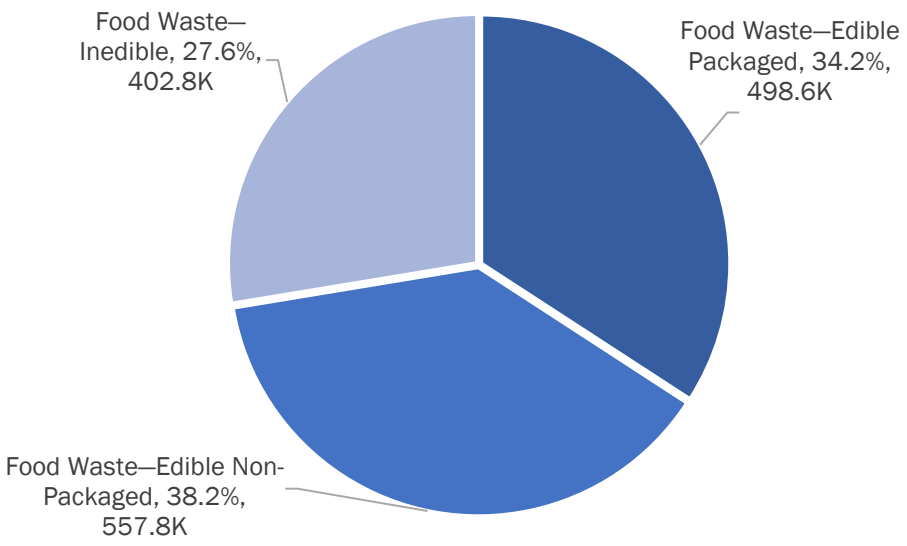
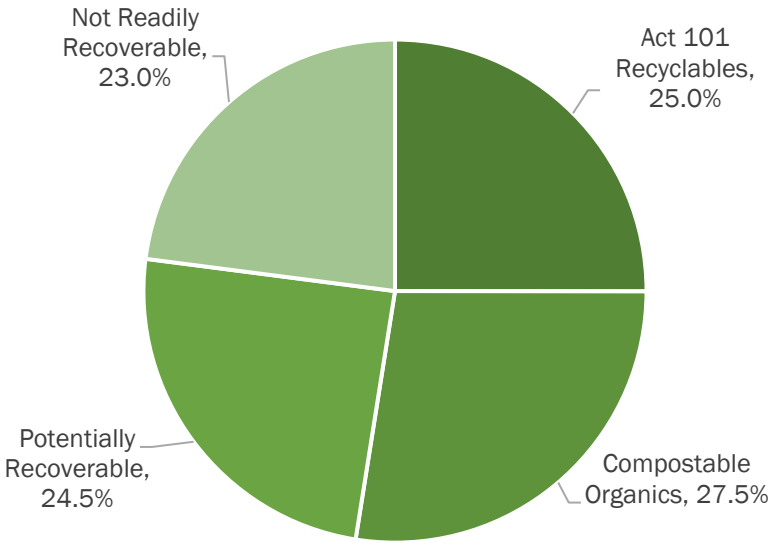


Figure B-7 Divertibility of Disposed MSW



B 3. COMPOSITION COMPARISONS BY GENERATING SECTOR

The composition of residential and commercial MSW were analyzed individually with selected comparisons shown below:

- Table B-5 and Table B-6 contain detailed comparisons of disposed residential and commercial MSW in the Northeast region based on percentage composition and absolute tonnage, respectively.
- Figure B-8 and Figure B-9 compare the residential and commercial disposed MSW based on percentage composition and absolute tonnage, respectively.
- Figure B-10 is a bar chart that compares the breakdown of food waste by generating sector.
- Figure B-11 illustrates the divertibility of disposed MSW stream by generating sector.

Table B-5 Disposed MSW Composition by Generator Sector (Percentage)

Material Category	Res	ICI		Res	ICI
Paper	**24.5%**	**31.7%**	**Organics**	**41.8%**	**33.2%**
Corrugated Cardboard/Kraft Paper	4.5%	10.9%	Food Waste	16.1%	17.0%
Newspaper	1.3%	0.5%	Yard Waste - Grass	0.3%	0.1%
Office/High Grade Paper	0.2%	0.3%	Yard Waste - Other	2.9%	0.6%
Magazine & Catalogs	0.7%	0.5%	Wood - Unpainted	0.8%	4.6%
Aseptic Boxes & Gable Top Cartons	0.3%	0.4%	Wood - Painted	2.2%	1.9%
Mixed Recyclable Paper (Low Grade)	5.6%	4.9%	Textiles & Leather Products	4.7%	2.4%
Compostable Paper	9.4%	8.8%	Diapers & Sanitary Products	4.6%	2.0%
Non-recyclable Paper	3.2%	5.5%	Animal By-Products	4.9%	1.0%
Plastic	**16.3%**	**23.3%**	Fines	1.5%	0.8%
#1 PET Bottles & Jars	1.9%	1.1%	Other Organics	2.4%	2.7%
#1 PET Non-Bottles & Containers	0.2%	0.1%	**Inorganics**	**9.9%**	**6.8%**
#2 HDPE Natural Bottles	0.5%	0.6%	Electronics - Covered Devices	0.1%	0.1%
#2 HDPE Colored Bottles	0.5%	0.5%	Other Electronics	0.5%	0.2%
#3 - #7 Bottles	0.0%	0.0%	Carpet & Carpet Padding	1.3%	0.7%
#2 - #7 Non-Bottle Rigid Containers	1.5%	1.6%	Drywall/Gypsum Board	0.7%	0.4%
Expanded Polystyrene	0.8%	1.1%	Concrete, Rock, Brick	0.2%	0.5%
Clean Retail Plastic Bags	0.1%	0.1%	Asphalt Roofing	0.1%	0.1%
Industrial Film	0.2%	2.7%	Asphalt Paving	0.0%	0.0%
All Other Film	6.8%	7.5%	Other C&D	1.7%	1.5%
Durable/Bulky Rigid Plastics	2.2%	2.6%	Medically-Related Waste	0.1%	0.0%
Remainder/Composite Plastic	2.0%	5.4%	Lithium Batteries	0.0%	0.0%
Metals	**4.1%**	**3.4%**	Automotive Batteries	0.0%	0.0%
Steel Cans	1.1%	1.0%	Other Batteries	0.1%	0.1%
Aluminum Cans	0.9%	0.5%	Other HHW	0.0%	0.0%
Other Aluminum	0.4%	0.3%	Bulky Materials	3.1%	1.2%
Other Ferrous Metals	1.1%	1.2%	Furniture	1.6%	1.2%
Other Non-Ferrous Metals	0.4%	0.4%	Other Inorganics	0.5%	0.4%
Glass	**3.4%**	**1.5%**	PPE	0.1%	0.4%
Clear Glass Containers	1.6%	0.7%			
Green Glass Containers	0.4%	0.1%			
Brown Glass Containers	0.5%	0.4%	**Grand Total**	**100%**	**100%**
Non-Recyclable Glass	0.9%	0.3%	**Number of Samples**	**104**	**100**

Table B-6 Waste Composition by Generator Sector (Tons)

Material Category	Res	ICI		Res	ICI
Paper	**158,216**	**257,621**	**Organics**	**270,411**	**270,046**
Corrugated Cardboard/Kraft Paper	28,854	88,308	Food Waste	104,188	138,241
Newspaper	8,322	4,209	Yard Waste - Grass	1,993	679
Office/High Grade Paper	1,451	2,209	Yard Waste - Other	18,680	5,035
Magazine & Catalogs	4,644	3,899	Wood - Unpainted	5,059	37,784
Aseptic Boxes & Gable Top Cartons	1,983	3,191	Wood - Painted	14,203	15,587
Mixed Recyclable Paper (Low Grade)	36,189	39,777	Textiles & Leather Products	30,365	19,333
Compostable Paper	60,939	71,303	Diapers & Sanitary Products	29,955	16,597
Non-recyclable Paper	20,704	44,725	Animal By-Products	31,688	8,304
Plastic	**105,692**	**189,600**	Fines	9,607	6,163
#1 PET Bottles & Jars	12,241	8,725	Other Organics	15,763	22,322
#1 PET Non-Bottles & Containers	1,367	1,130	**Inorganics**	**63,837**	**55,544**
#2 HDPE Natural Bottles	3,331	4,934	Electronics - Covered Devices	653	1,197
#2 HDPE Colored Bottles	3,209	3,714	Other Electronics	2,950	1,800
#3 - #7 Bottles	267	124	Carpet & Carpet Padding	8,328	5,532
#2 - #7 Non-Bottle Rigid Containers	9,523	12,843	Drywall/Gypsum Board	4,781	3,297
Expanded Polystyrene	5,234	9,111	Concrete, Rock, Brick	1,184	3,787
Clean Retail Plastic Bags	868	990	Asphalt Roofing	697	934
Industrial Film	1,125	22,202	Asphalt Paving	114	23
All Other Film	44,066	60,940	Other C&D	11,149	12,472
Durable/Bulky Rigid Plastics	14,425	21,153	Medically-Related Waste	583	304
Remainder/Composite Plastic	12,715	43,737	Lithium Batteries	22	3
Metals	**26,309**	**28,019**	Automotive Batteries	0	0
Steel Cans	7,233	8,308	Other Batteries	644	444
Aluminum Cans	6,015	4,019	Other HHW	41	79
Other Aluminum	2,904	2,190	Bulky Materials	20,091	9,485
Other Ferrous Metals	7,296	10,081	Furniture	10,261	10,024
Other Non-Ferrous Metals	2,537	3,420	Other Inorganics	3,278	2,997
Glass	**22,040**	**11,857**	PPE	911	3,165
Clear Glass Containers	10,038	5,480			
Green Glass Containers	2,652	1,156			
Brown Glass Containers	3,390	2,951	**Grand Total**	**646,505**	**812,686**
Non-Recyclable Glass	5,796	2,270	**Number of Samples**	**104**	**100**

Figure B-8 Composition Summary by Generator Sector (Percentage)

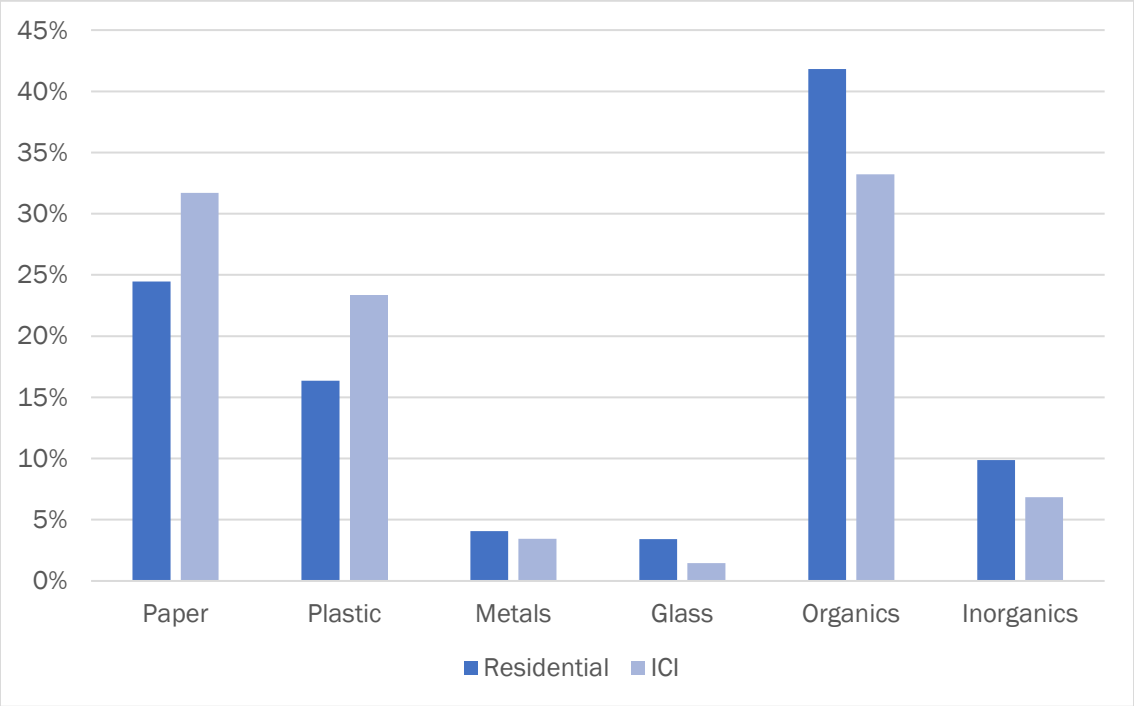


Figure B-9 Composition Summary by Generator Sector (Tons)

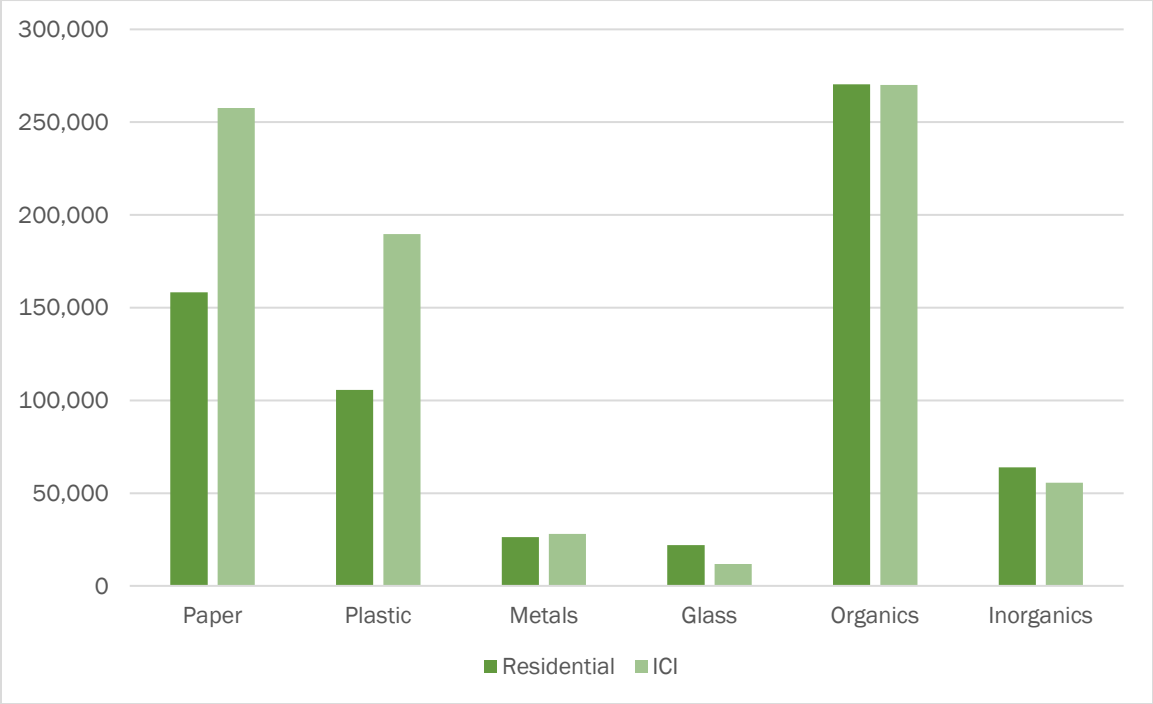


Figure B-10 Food Waste Detail by Generator Sector (Percentage)

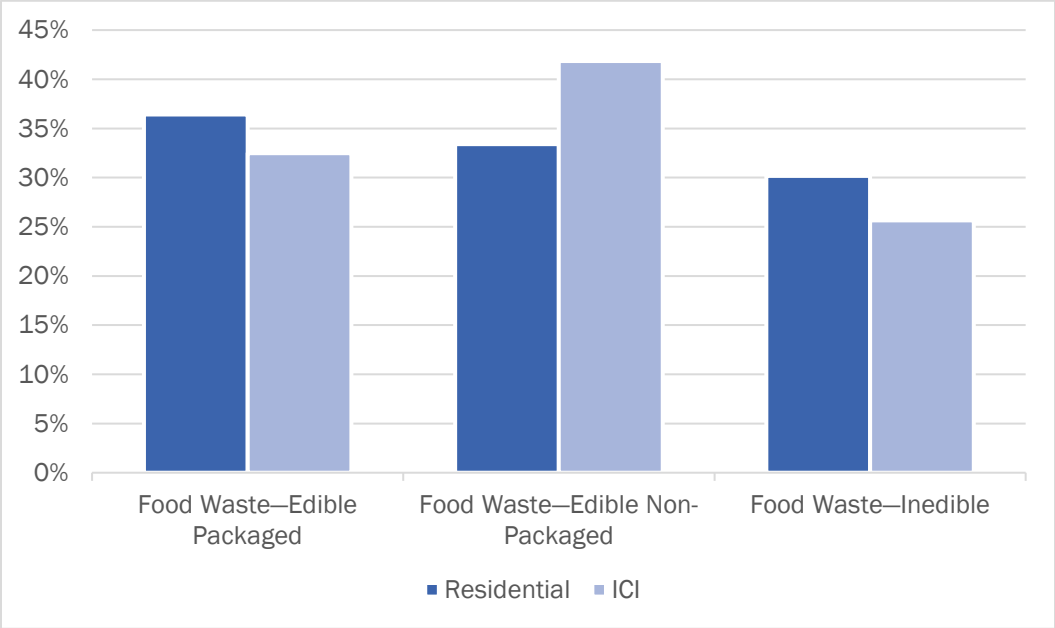
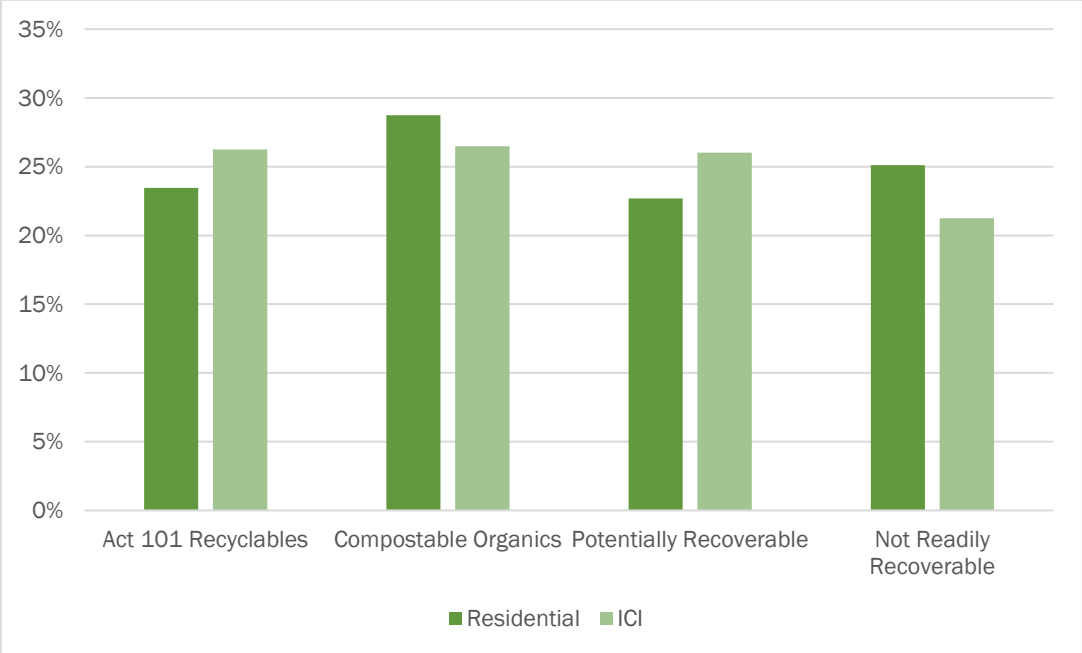


Figure B-11 Divertibility Comparison by Generator Sector (Percentage)



B 4. COMPOSITION BY DEMOGRAPHIC ORIGIN

The composition of urban, suburban, and rural MSW were analyzed individually and selected comparisons are shown below:

- Table B-7 and Table B-8 contain detailed comparisons of disposed MSW from urban, suburban, and rural areas in the Northeast region based on percentage composition and absolute tonnage, respectively.
- Figure B-12 and Figure B-13 compare the urban, suburban, and rural waste streams based on percentage composition and absolute tonnage, respectively.
- Figure B-14 is a bar chart that compares the breakdown of food waste by demographic origin.
- Figure B-15 compares the divertibility of disposed MSW by demographic origin.

Table B-7 Waste Composition by Demographic Origin (Percentage)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**33.1%**	**28.7%**	**22.9%**	**Organics**	**31.4%**	**38.3%**	**40.0%**
Corrugated Cardboard/Kraft Paper	9.5%	8.5%	5.1%	Food Waste	14.4%	17.1%	17.9%
Newspaper	0.8%	0.9%	0.9%	Yard Waste - Grass	0.1%	0.2%	0.3%
Office/High Grade Paper	0.2%	0.3%	0.1%	Yard Waste - Other	2.0%	1.3%	2.0%
Magazine & Catalogs	0.4%	0.6%	0.8%	Wood - Unpainted	2.4%	3.3%	2.4%
Aseptic Boxes & Gable Top Cartons	0.3%	0.4%	0.3%	Wood - Painted	0.4%	2.6%	2.3%
Mixed Recyclable Paper (Low Grade)	5.5%	5.2%	5.0%	Textiles & Leather Products	2.2%	4.0%	3.1%
Compostable Paper	9.4%	9.1%	8.5%	Diapers & Sanitary Products	4.0%	3.1%	2.5%
Non-recyclable Paper	7.0%	3.7%	3.8%	Animal By-Products	1.7%	2.8%	3.6%
Plastic	**21.9%**	**19.2%**	**21.2%**	Fines	0.8%	1.2%	1.2%
#1 PET Bottles & Jars	1.4%	1.4%	1.5%	Other Organics	3.3%	2.6%	1.9%
#1 PET Non-Bottles & Containers	0.1%	0.2%	0.2%	**Inorganics**	**8.0%**	**7.8%**	**9.3%**
#2 HDPE Natural Bottles	0.6%	0.6%	0.5%	Electronics - Covered Devices	0.0%	0.1%	0.2%
#2 HDPE Colored Bottles	0.5%	0.5%	0.5%	Other Electronics	0.2%	0.4%	0.3%
#3 - #7 Bottles	0.0%	0.0%	0.0%	Carpet & Carpet Padding	0.6%	0.6%	2.1%
#2 - #7 Non-Bottle Rigid Containers	1.9%	1.2%	1.9%	Drywall/Gypsum Board	0.3%	0.7%	0.4%
Expanded Polystyrene	0.9%	1.0%	1.0%	Concrete, Rock, Brick	0.2%	0.2%	0.7%
Clean Retail Plastic Bags	0.2%	0.1%	0.1%	Asphalt Roofing	0.0%	0.1%	0.2%
Industrial Film	1.9%	1.3%	2.1%	Asphalt Paving	0.0%	0.0%	0.0%
All Other Film	7.7%	6.5%	8.4%	Other C&D	0.3%	1.9%	2.3%
Durable/Bulky Rigid Plastics	2.2%	2.2%	3.4%	Medically-Related Waste	0.0%	0.1%	0.1%
Remainder/Composite Plastic	4.5%	4.2%	2.3%	Lithium Batteries	0.0%	0.0%	0.0%
Metals	**3.5%**	**3.7%**	**4.0%**	Automotive Batteries	0.0%	0.0%	0.0%
Steel Cans	1.0%	1.1%	1.0%	Other Batteries	0.1%	0.1%	0.1%
Aluminum Cans	0.8%	0.6%	0.8%	Other HHW	0.0%	0.0%	0.0%
Other Aluminum	0.3%	0.3%	0.4%	Bulky Materials	2.6%	1.9%	1.8%
Other Ferrous Metals	1.3%	1.2%	1.1%	Furniture	2.8%	1.1%	0.7%
Other Non-Ferrous Metals	0.1%	0.5%	0.6%	Other Inorganics	0.4%	0.4%	0.6%
Glass	**2.1%**	**2.3%**	**2.6%**	PPE	0.4%	0.2%	0.3%
Clear Glass Containers	1.2%	1.0%	1.0%				
Green Glass Containers	0.2%	0.3%	0.3%				
Brown Glass Containers	0.4%	0.4%	0.6%	**Grand Total**	**100%**	**100%**	**100%**
Non-Recyclable Glass	0.3%	0.6%	0.7%	**Number of Samples**	**28**	**117**	**59**

Table B-8 Waste Composition by Demographic Origin (Tons)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**111,953**	**232,805**	**71,079**	**Organics**	**106,099**	**310,167**	**124,192**
Corrugated Cardboard/Kraft Paper	32,184	69,214	15,763	Food Waste	48,712	138,229	*55,487*
Newspaper	2,707	7,111	2,715	Yard Waste - Grass	404	1,436	831
Office/High Grade Paper	669	2,689	302	Yard Waste - Other	6,820	10,818	6,077
Magazine & Catalogs	1,278	4,890	2,376	Wood - Unpainted	8,198	27,091	7,554
Aseptic Boxes & Gable Top Cartons	1,121	2,993	1,059	Wood - Painted	1,216	21,370	7,205
Mixed Recyclable Paper (Low Grade)	18,605	41,808	15,553	Textiles & Leather Products	7,411	32,619	9,667
Compostable Paper	31,770	73,992	26,480	Diapers & Sanitary Products	13,418	25,247	7,887
Non-recyclable Paper	23,619	30,109	11,702	Animal By-Products	5,909	22,906	11,177
Plastic	**73,994**	**155,574**	**65,724**	Fines	2,765	9,387	3,618
#1 PET Bottles & Jars	4,656	11,526	4,783	Other Organics	11,244	21,063	5,777
#1 PET Non-Bottles & Containers	463	1,516	517	**Inorganics**	**27,062**	**63,520**	**28,799**
#2 HDPE Natural Bottles	2,078	4,557	1,630	Electronics - Covered Devices	0	1,201	649
#2 HDPE Colored Bottles	1,696	3,731	1,495	Other Electronics	809	2,878	1,064
#3 - #7 Bottles	85	186	121	Carpet & Carpet Padding	2,148	5,196	6,516
#2 - #7 Non-Bottle Rigid Containers	6,290	10,025	6,051	Drywall/Gypsum Board	1,035	5,680	1,364
Expanded Polystyrene	3,034	8,211	3,100	Concrete, Rock, Brick	647	2,021	2,304
Clean Retail Plastic Bags	605	939	314	Asphalt Roofing	0	952	679
Industrial Film	6,436	10,401	6,490	Asphalt Paving	0	45	93
All Other Film	25,924	52,992	26,089	Other C&D	1,006	15,389	7,225
Durable/Bulky Rigid Plastics	7,398	17,609	10,570	Medically-Related Waste	111	533	242
Remainder/Composite Plastic	15,330	33,881	7,240	Lithium Batteries	0	3	22
Metals	**11,976**	**29,897**	**12,454**	Automotive Batteries	0	0	0
Steel Cans	3,535	8,975	3,031	Other Batteries	394	485	209
Aluminum Cans	2,685	4,830	2,519	Other HHW	1	38	81
Other Aluminum	1,167	2,811	1,117	Bulky Materials	8,722	15,318	5,537
Other Ferrous Metals	4,300	9,557	3,521	Furniture	9,397	8,829	2,059
Other Non-Ferrous Metals	289	3,724	1,944	Other Inorganics	1,487	3,018	1,770
Glass	**7,135**	**18,609**	**8,153**	PPE	1,306	1,934	836
Clear Glass Containers	4,022	8,246	3,250				
Green Glass Containers	826	2,100	881				
Brown Glass Containers	1,358	3,151	1,832	**Grand Total**	**338,219**	**810,571**	**310,401**
Non-Recyclable Glass	929	5,113	2,025	**Number of Samples**	**28**	**117**	**59**

Figure B-12 Composition Summary by Demographic Origin (Percentage)

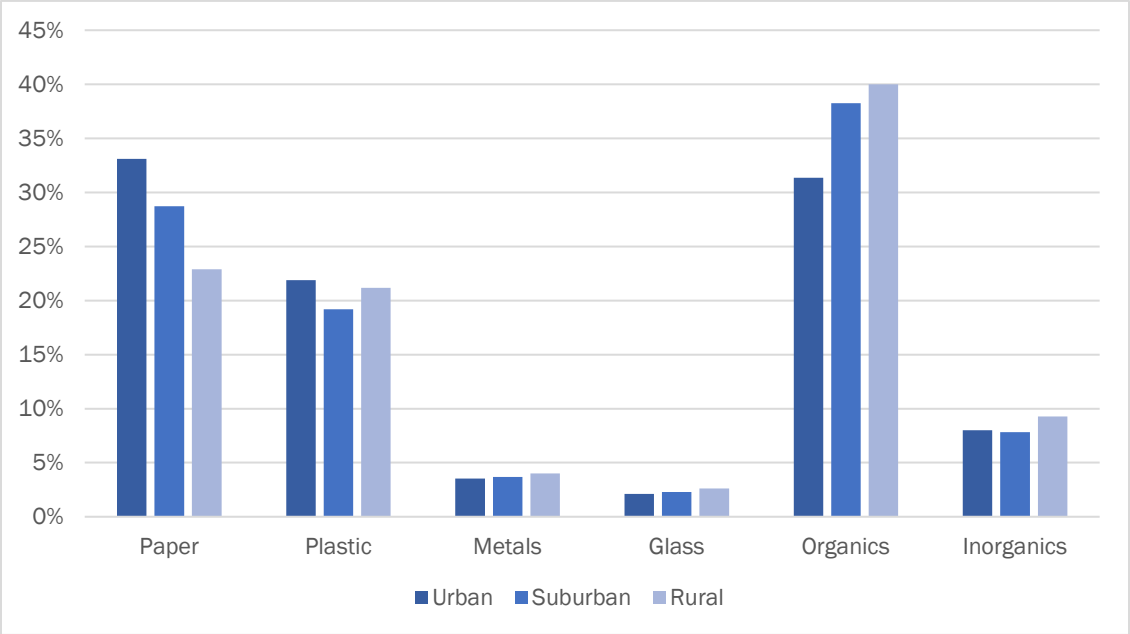


Figure B-13 Composition Summary by Demographic Origin (Tons)

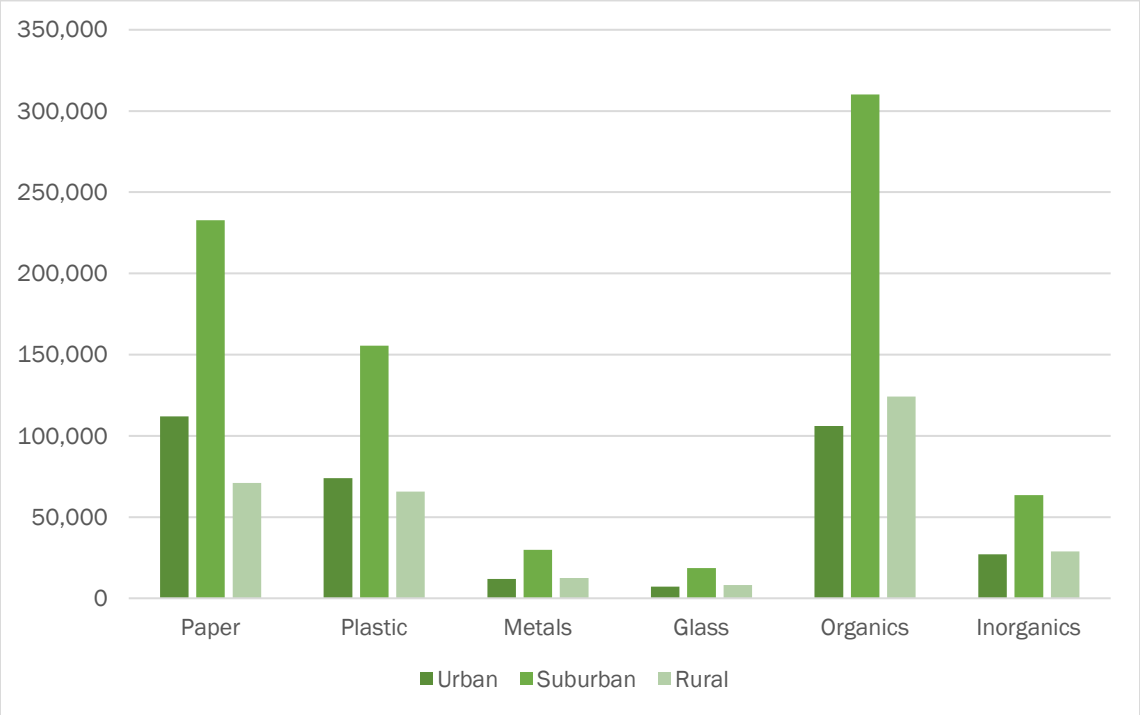


Figure B-14 Food Waste Detail by Demographic Origin

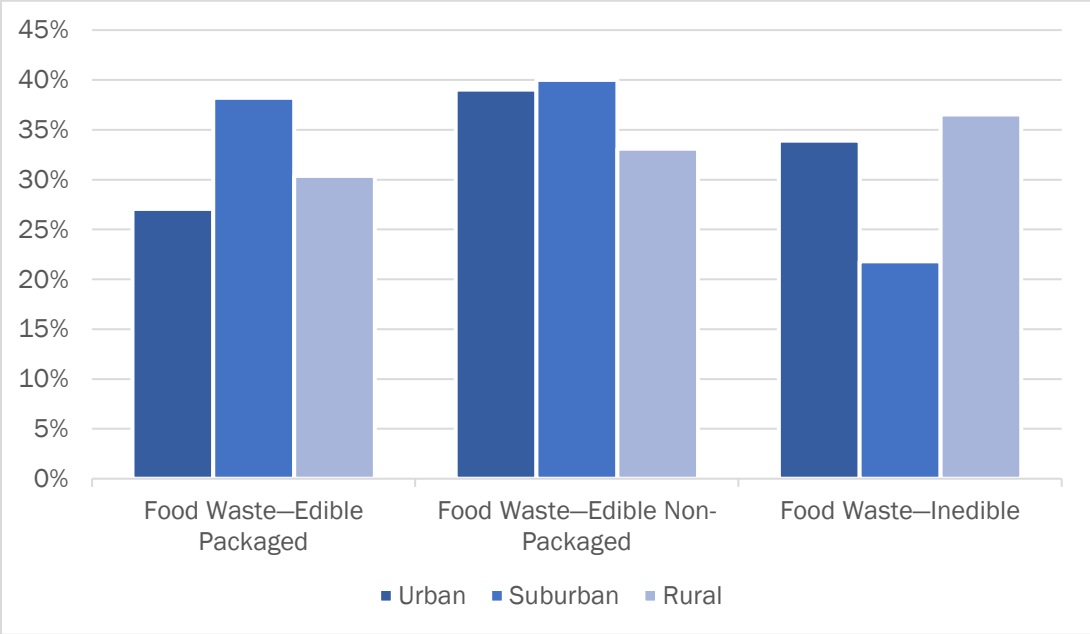
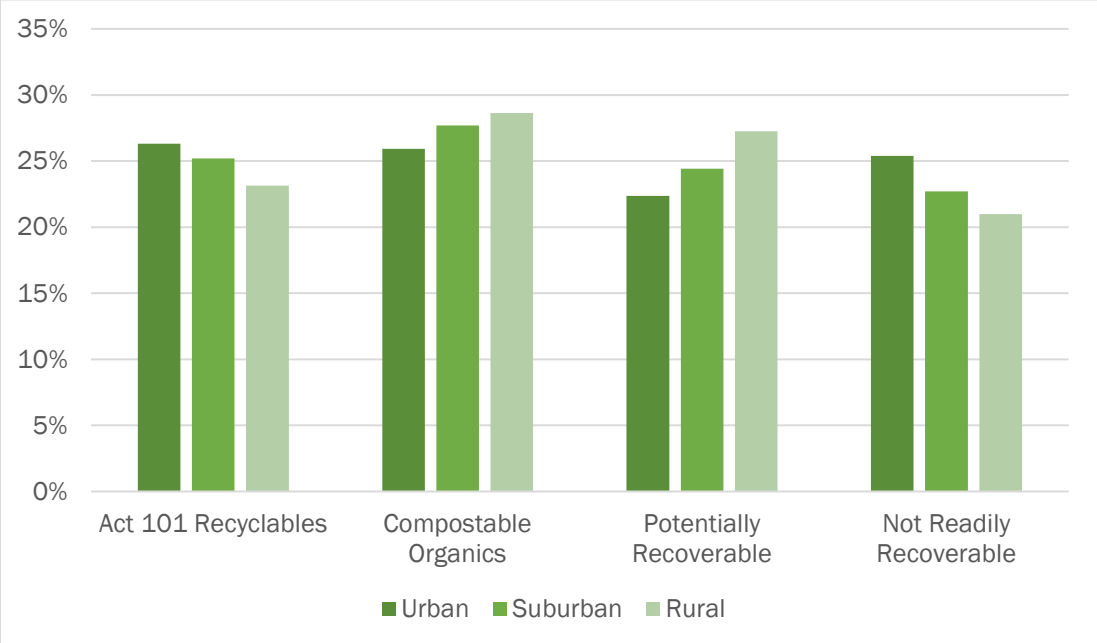


Figure B-15 Divertibility Comparison (Percentage)



B 5. ECONOMIC AND ENVIRONMENTAL IMPACTS

The following supplemental analyses have been included to illustrate the potential financial and environmental impacts of diverting recyclable and compostable materials from the disposed MSW stream.

- Table B-9 estimates the recovered material value for recyclables commodities that were disposed in the regional MSW stream. Market values were obtained from recyclingmarkets.net.
- Table B-10 calculates the greenhouse gas emissions that could be reduced if the estimated quantities of recyclable and compostable materials disposed in the Northeast region were diverted from disposal.

Table B-9 Estimated Value of Disposed Recyclable Materials

Recyclable Commodities	Estimated Tons Disposed	Average Market Price ($/ton)	Estimated Total Market Value ($)
Recyclable Paper	**223,036**		**$26,344,905**
Corrugated Cardboard/Kraft Paper	117,161	$135	$15,816,759
Newspaper	12,532	$188	$2,349,714
Office/High Grade Paper	3,660	$235	$860,031
Magazine & Catalogs	8,543	$168	$1,431,010
Aseptic Boxes & Gable Top Cartons	5,173	$0	$0
Mixed Recyclable Paper (Low Grade)	75,966	$78	$5,887,391
Recyclable Containers	**148,225**		**$62,452,819**
#1 PET Bottles & Jars	20,965	$860	$18,030,081
#1 PET Non-Bottles & Containers	2,497	$130	$324,551
#2 HDPE Natural Bottles	8,265	$1,130	$9,339,149
#2 HDPE Colored Bottles	6,923	$640	$4,430,463
#3 - #7 Bottles	391	$130	$50,832
#2-#7 Non-Bottle Rigid Containers	22,366	$130	$2,907,520
Durable/Bulky Rigid Plastics	35,577	$90	$3,201,940
Steel Cans	15,541	$230	$3,574,539
Aluminum Cans	10,035	$1,950	$19,567,370
Clear Glass Containers	15,518	$50	$775,888
Green Glass Containers	3,807	$8	$28,555
Brown Glass Containers	6,341	$35	$221,932
Total	**371,261**	*$239*	**$88,797,724**

Source: Recyclingmarkets.net - Northeast Region of U.S. as of 06/9/22

Table B-10 Emissions Reduction Potential from Disposed Recyclables

Material Components	Tons Recycled/ Composted[1]	Emissions Reduced ($MTCO_2E$)[2]
Recyclable Paper	**217,862**	**707,323**
Corrugated Cardboard/Kraft Paper	117,161	367,339
Magazine & Catalogs	8,543	26,224
Newspaper	12,532	33,940
Office/High Grade Paper	3,660	10,481
Mixed Recyclable Paper	75,966	269,339
Recyclable Containers	**148,225**	**216,959**
Aluminum Cans	10,035	91,593
Steel Cans	15,541	28,472
Glass	25,666	7,086
PET	23,462	24,300
HDPE	15,187	11,519
Mixed Plastics	58,334	53,989
Compostable	**268,816**	**29,434**
Food Waste	242,429	28,021
Yard Waste	26,387	1,413
Total	**634,904**	**953,716**

[1] Based on estimated overall MSW waste composition for 2021 and Pennsylvania's reported MSW disposal tonnage for FY 2021. Assumes the materials would be recycled instead of disposed.

[2] U.S. EPA Waste Reduction Model, Version 15

APPENDIX C

NORTHCENTRAL REGIONAL RESULTS

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APPENDIX C – NORTHCENTRAL REGION RESULTS

C 1. INTRODUCTION

Pennsylvania's Northcentral region encompasses 13 counties and has a population of 772,500 people and more than 300,000 households. A map of the Northcentral region is shown in Figure C-1.

Figure C-1 Northcentral Region Map

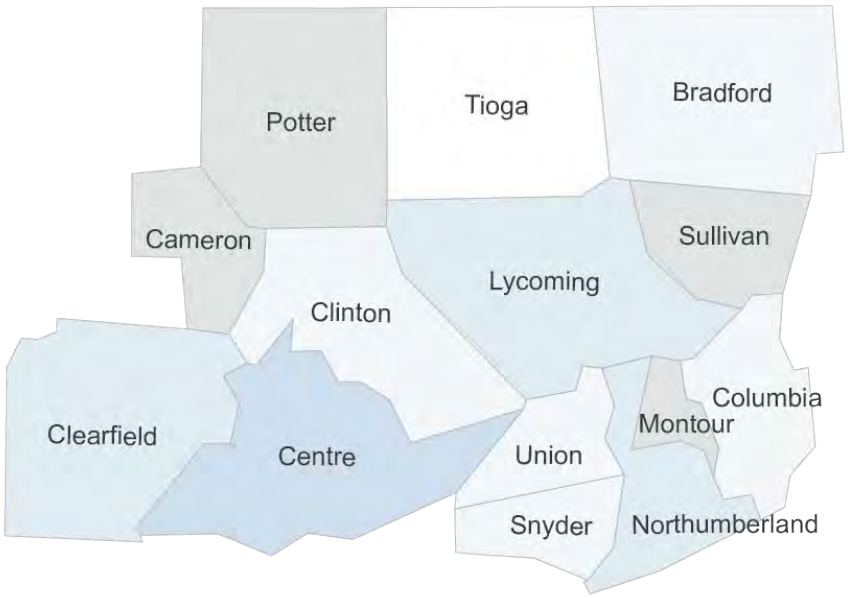


Table C-1 summarizes selected demographic and economic data for the Northcentral region. As shown, this region is composed predominantly of rural, with some urban and suburban areas.

Table C-1 Northcentral Region Demographic Summary (2021)

	Urban	Suburban	Rural	Total
Communities	2	48	372	**422**
Population	67,128	260,401	444,971	**772,500**
Housing Units	23,874	107,092	177,168	**308,134**
Employment	47,256	147,561	126,340	**321,157**

Sources: Demographic data from the Pennsylvania State Data Center; employment data from ESRI Business Patterns. The allocation of these data to urban, suburban, and rural areas was estimated by MSW Consultants.

The methodology for estimating waste generation within the residential and commercial sectors, and allocated across urban, suburban, and rural areas, is described in the main body of this report. Table C-2 presents the resulting allocation of generated wastes within the Northcentral Region. These quantities are used as weighting factors for determining the aggregate waste composition within the region.

Table C-2 Estimated Allocation of MSW Generated in the Northcentral Region

	Tons of Waste Disposed			
Generating Sector	Urban	Suburban	Rural	Total
Residential	25,306	98,525	157,680	**281,511**
Commercial	27,183	84,880	72,673	**184,736**
Total	**52,489**	**183,405**	**230,353**	**466,247**

Field sampling and sorting of Northcentral region wastes was performed at the Centre County Transfer Station, and the Bradford County Landfill. Sampling at these facilities was performed across four seasons to capture seasonal variation in MSW composition. Table C-3 provides a sampling summary for the Northcentral Region. Regional sampling targets were met in this region.

Table C-3 Northcentral Region Sampling Summary

	Number of Samples			
Waste Generating Sector	Urban	Suburban	Rural	Total
Residential	26	38	52	**116**
Commercial	39	33	22	**94**
Total	**65**	**71**	**74**	**210**

C 2. AGGREGATE WASTE COMPOSITION

The remainder of this section presents a graphical and tabular summary of the Northcentral region's disposed MSW composition. Specific figures and tables are summarized below.

- Table C-4 provides the detailed tabular composition of the aggregated disposed refuse stream. This table shows the mean composition, margin of error (MOE) at a 90 percent level of confidence, and the estimated tonnage of each of the constituents in the refuse stream.
- Figure C-2 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented as percentages.
- Figure C-3 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented in tons.
- Figure C-4 is a pie chart that shows the percentage composition of major material groups in the aggregate regional waste stream. As shown, organics comprise 40 percent of the refuse disposed in the Northcentral region.
- Figure C-5 shows the 10 most prevalent materials being disposed in the region by weight.
- Figure C-6 is a pie chart that shows the detailed percentage composition of the "food waste" category.
- Figure C-7 illustrates the divertibility of the aggregate disposed refuse stream. This graphic shows that the majority of the materials being disposed could be diverted through existing recycling programs, composting programs, and third-party recovery programs. It should be noted that this graphic omits the impact of contamination, and as a practical matter it is not possible for all the divertible materials to actually be diverted.

Table C-4 Detailed Northcentral Region Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**24.7%**	**1.2%**	**115,055**	**Organics**	**40.0%**	**1.7%**	**186,312**
Corrugated Cardboard/Kraft Paper	6.6%	0.4%	30,934	Food Waste	18.4%	0.9%	85,944
Newspaper	0.4%	0.0%	1,972	Yard Waste - Grass	0.8%	0.2%	3,600
Office/High Grade Paper	0.5%	0.1%	2,497	Yard Waste - Other	1.8%	0.2%	8,604
Magazine & Catalogs	0.5%	0.1%	2,206	Wood - Unpainted	2.3%	0.3%	10,787
Aseptic Boxes & Gable Top Cartons	0.3%	0.1%	1,518	Wood - Painted	2.0%	0.2%	9,186
Mixed Recyclable Paper (Low Grade)	4.7%	0.2%	21,956	Textiles & Leather Products	3.6%	0.2%	16,826
Compostable Paper	8.3%	0.3%	38,857	Diapers & Sanitary Products	3.8%	0.2%	17,868
Non-recyclable Paper	3.2%	0.2%	15,116	Animal By-Products	4.1%	0.3%	19,051
Plastic	**19.7%**	**1.3%**	**91,903**	Fines	1.0%	0.1%	4,834
#1 PET Bottles & Jars	1.5%	0.1%	6,823	Other Organics	2.1%	0.2%	9,613
#1 PET Non-Bottles & Containers	0.2%	0.0%	1,030	**Inorganics**	**9.1%**	**1.2%**	**42,568**
#2 HDPE Natural Bottles	0.4%	0.0%	1,726	Electronics - Covered Devices	0.2%	0.1%	773
#2 HDPE Colored Bottles	0.4%	0.0%	1,929	Other Electronics	0.7%	0.1%	3,179
#3 - #7 Bottles	0.1%	0.0%	272	Carpet & Carpet Padding	1.4%	0.2%	6,634
#2 - #7 Non-Bottle Rigid Containers	2.1%	0.1%	9,936	Drywall/Gypsum Board	0.5%	0.1%	2,127
Expanded Polystyrene	1.3%	0.1%	6,150	Concrete, Rock, Brick	0.3%	0.1%	1,431
Clean Retail Plastic Bags	0.1%	0.0%	633	Asphalt Roofing	0.2%	0.1%	865
Industrial Film	2.0%	0.3%	9,313	Asphalt Paving	0.0%	0.0%	13
All Other Film	7.2%	0.3%	33,501	Other C&D	1.3%	0.2%	6,010
Durable/Bulky Rigid Plastics	2.3%	0.2%	10,665	Medically-Related Waste	0.2%	0.0%	966
Remainder/Composite Plastic	2.1%	0.2%	9,925	Lithium Batteries	0.0%	0.0%	11
Metals	**4.0%**	**0.4%**	**18,587**	Automotive Batteries	0.0%	0.0%	22
Steel Cans	0.8%	0.1%	3,690	Other Batteries	0.1%	0.0%	430
Aluminum Cans	0.8%	0.0%	3,536	Other HHW	0.1%	0.0%	285
Other Aluminum	0.3%	0.0%	1,530	Bulky Materials	2.2%	0.3%	10,127
Other Ferrous Metals	1.6%	0.2%	7,504	Furniture	1.1%	0.2%	5,180
Other Non-Ferrous Metals	0.5%	0.1%	2,328	Other Inorganics	0.6%	0.1%	2,891
Glass	**2.5%**	**0.3%**	**11,821**	PPE	0.3%	0.0%	1,624
Clear Glass Containers	1.3%	0.1%	5,962				
Green Glass Containers	0.2%	0.0%	1,115				
Brown Glass Containers	0.5%	0.1%	2,218	**Grand Total**	**100.0%**		**466,247**
Non-Recyclable Glass	0.5%	0.1%	2,527	**Number of Samples**	**210**		

Margin of error is calculated at a 90 percent level of confidence.

Figure C-2 Comparison of Composition by Material Group 2021 vs 2001 (Percentage)

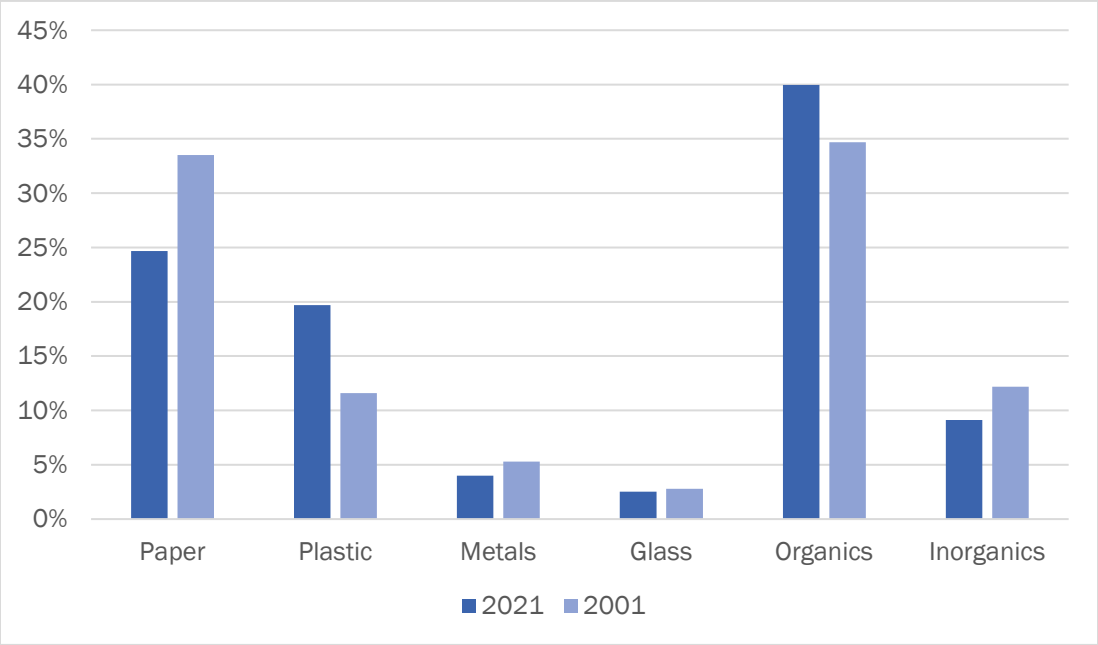


Figure C-3 Comparison of Composition by Material Group 2021 vs 2001 (Tons)

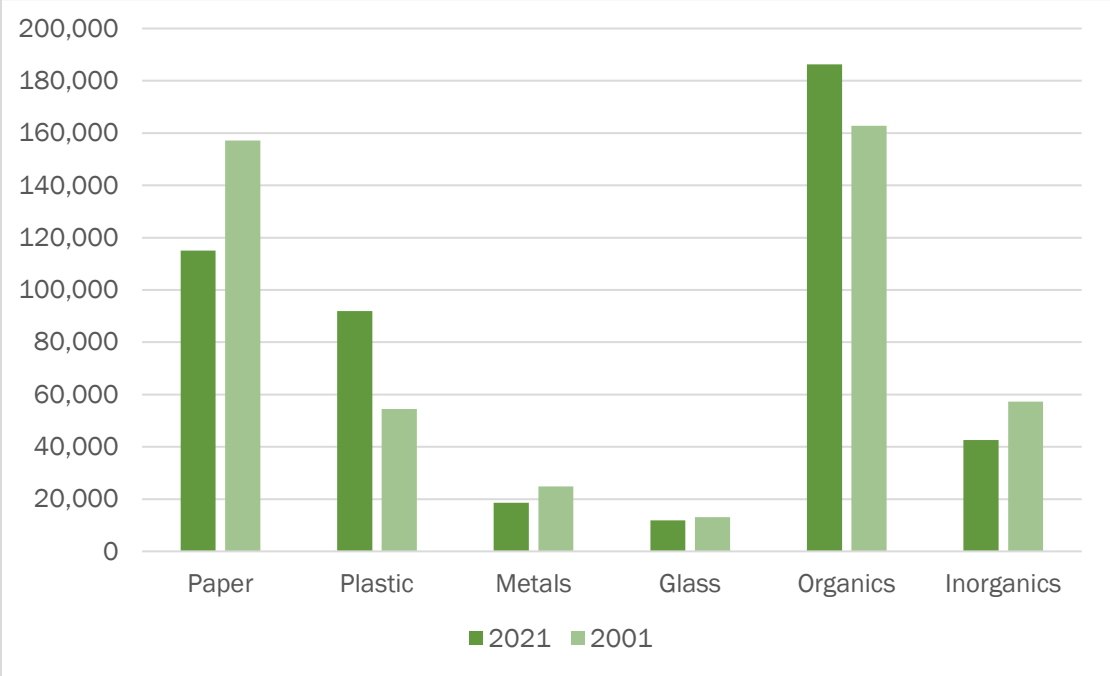


Figure C-4 Composition Summary by Material Group (Percentage)

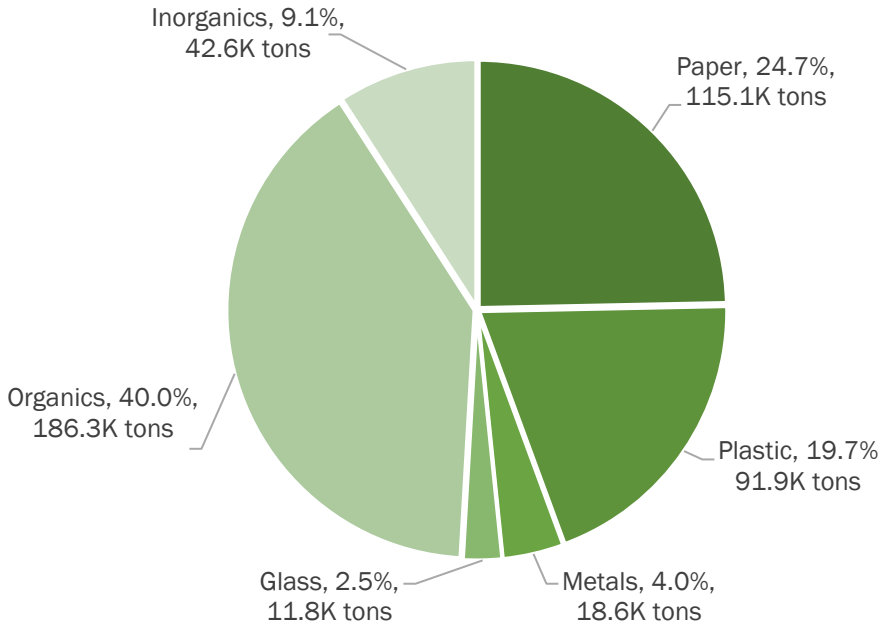
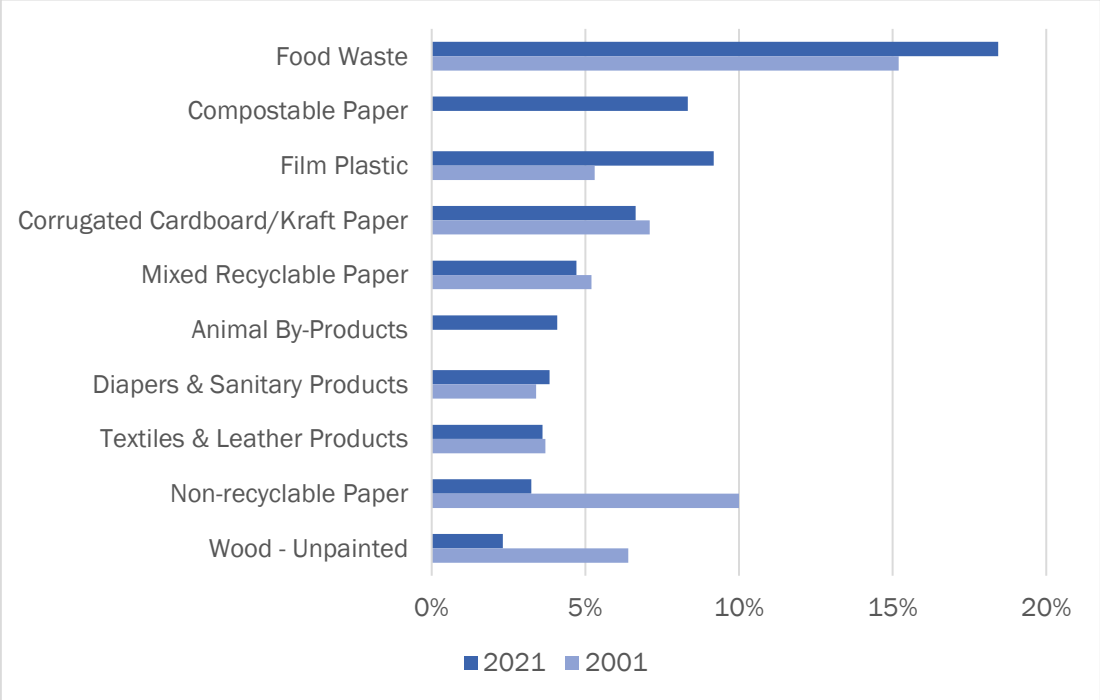


Figure C-5 Top 10 Most Prevalent Materials by Weight*



*Note: Some material categories were not sorted in 2001 Study

Figure C-6 Food Waste Detail

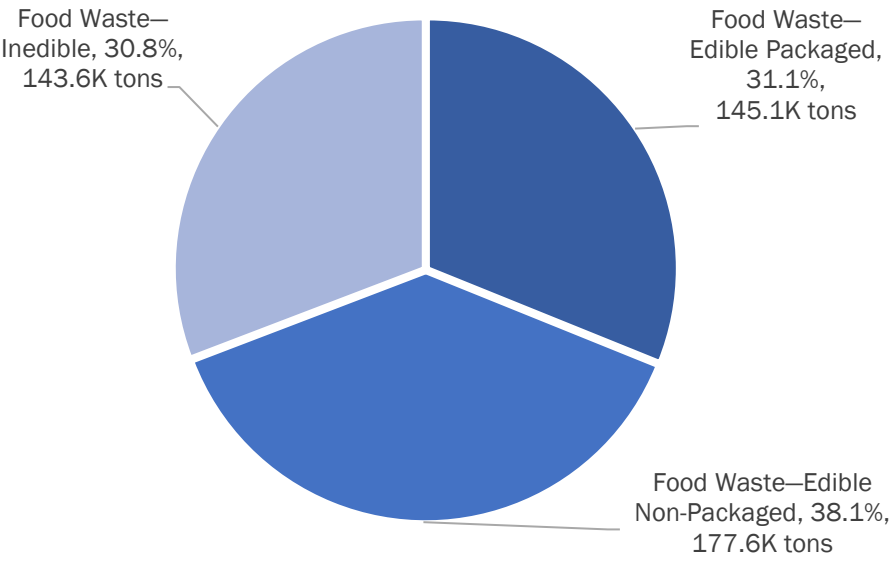
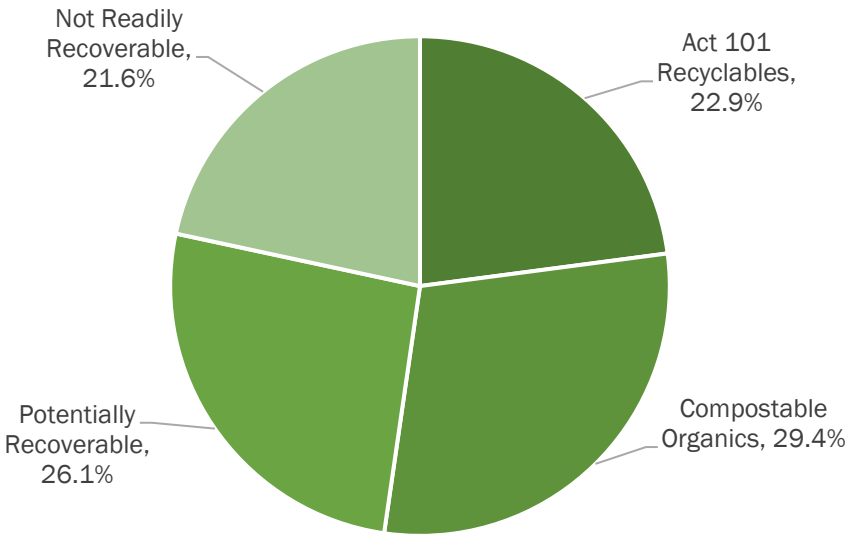


Figure C-7 Divertibility of Disposed MSW



C 3. COMPOSITION COMPARISONS BY GENERATING SECTOR

The composition of residential and commercial MSW were analyzed individually with selected comparisons shown below:

- Table C-5 and Table C-6 contain detailed comparisons of disposed residential and commercial MSW in the Northcentral region based on percentage composition and absolute tonnage, respectively.
- Figure C-8 and Figure C-9 compare the residential and commercial disposed MSW based on percentage composition and absolute tonnage, respectively.
- Figure C-10 is a bar chart that compares the breakdown of food waste by generating sector.
- Figure C-11 illustrates the divertibility of MSW by generating sector.

Table C-5 Disposed MSW by Generator Sector (Percentage)

Material Category	Res	ICI		Res	ICI
Paper	**21.3%**	**29.8%**	**Organics**	**45.9%**	**31.0%**
Corrugated Cardboard/Kraft Paper	4.0%	10.7%	Food Waste	18.6%	18.2%
Newspaper	0.6%	0.2%	Yard Waste - Grass	1.0%	0.4%
Office/High Grade Paper	0.4%	0.7%	Yard Waste - Other	2.1%	1.4%
Magazine & Catalogs	0.5%	0.4%	Wood - Unpainted	1.7%	3.3%
Aseptic Boxes & Gable Top Cartons	0.3%	0.3%	Wood - Painted	1.8%	2.2%
Mixed Recyclable Paper (Low Grade)	4.7%	4.7%	Textiles & Leather Products	5.1%	1.4%
Compostable Paper	7.9%	9.0%	Diapers & Sanitary Products	5.8%	0.8%
Non-recyclable Paper	2.9%	3.7%	Animal By-Products	6.0%	1.2%
Plastic	**16.5%**	**24.5%**	Fines	1.3%	0.6%
#1 PET Bottles & Jars	1.5%	1.4%	Other Organics	2.5%	1.5%
#1 PET Non-Bottles & Containers	0.3%	0.2%	**Inorganics**	**9.1%**	**9.2%**
#2 HDPE Natural Bottles	0.4%	0.3%	Electronics - Covered Devices	0.2%	0.2%
#2 HDPE Colored Bottles	0.4%	0.4%	Other Electronics	0.7%	0.6%
#3 - #7 Bottles	0.1%	0.0%	Carpet & Carpet Padding	1.6%	1.2%
#2 - #7 Non-Bottle Rigid Containers	2.1%	2.2%	Drywall/Gypsum Board	0.3%	0.6%
Expanded Polystyrene	0.7%	2.3%	Concrete, Rock, Brick	0.1%	0.6%
Clean Retail Plastic Bags	0.1%	0.2%	Asphalt Roofing	0.3%	0.0%
Industrial Film	0.8%	3.9%	Asphalt Paving	0.0%	0.0%
All Other Film	6.5%	8.3%	Other C&D	1.2%	1.5%
Durable/Bulky Rigid Plastics	1.9%	2.8%	Medically-Related Waste	0.2%	0.3%
Remainder/Composite Plastic	1.8%	2.7%	Lithium Batteries	0.0%	0.0%
Metals	**4.3%**	**3.5%**	Automotive Batteries	0.0%	0.0%
Steel Cans	1.0%	0.5%	Other Batteries	0.1%	0.0%
Aluminum Cans	0.9%	0.6%	Other HHW	0.1%	0.0%
Other Aluminum	0.4%	0.3%	Bulky Materials	1.9%	2.7%
Other Ferrous Metals	1.7%	1.5%	Furniture	1.5%	0.6%
Other Non-Ferrous Metals	0.4%	0.6%	Other Inorganics	0.6%	0.6%
Glass	**2.9%**	**2.0%**	PPE	0.3%	0.4%
Clear Glass Containers	1.5%	0.9%			
Green Glass Containers	0.3%	0.2%			
Brown Glass Containers	0.5%	0.4%	**Grand Total**	**100%**	**100%**
Non-Recyclable Glass	0.6%	0.5%	**Number of Samples**	**120**	**90**

Table C-6 Waste Composition by Generator Sector (Tons)

Material Category	Res	ICI		Res	ICI
Paper	**59,947**	**55,108**	**Organics**	**129,113**	**57,199**
Corrugated Cardboard/Kraft Paper	11,145	19,789	Food Waste	52,306	33,638
Newspaper	1,602	369	Yard Waste - Grass	2,811	789
Office/High Grade Paper	1,233	1,264	Yard Waste - Other	5,976	2,628
Magazine & Catalogs	1,396	810	Wood - Unpainted	4,719	6,068
Aseptic Boxes & Gable Top Cartons	884	634	Wood - Painted	5,208	3,978
Mixed Recyclable Paper (Low Grade)	13,199	8,756	Textiles & Leather Products	14,296	2,530
Compostable Paper	22,189	16,668	Diapers & Sanitary Products	16,410	1,458
Non-recyclable Paper	8,299	6,817	Animal By-Products	16,790	2,262
Plastic	**46,556**	**45,347**	Fines	3,690	1,144
#1 PET Bottles & Jars	4,319	2,504	Other Organics	6,908	2,704
#1 PET Non-Bottles & Containers	749	281	**Inorganics**	**25,507**	**17,061**
#2 HDPE Natural Bottles	1,139	587	Electronics - Covered Devices	465	308
#2 HDPE Colored Bottles	1,267	663	Other Electronics	2,052	1,127
#3 - #7 Bottles	180	92	Carpet & Carpet Padding	4,502	2,132
#2 - #7 Non-Bottle Rigid Containers	5,847	4,088	Drywall/Gypsum Board	945	1,181
Expanded Polystyrene	1,922	4,227	Concrete, Rock, Brick	301	1,130
Clean Retail Plastic Bags	328	306	Asphalt Roofing	831	34
Industrial Film	2,194	7,119	Asphalt Paving	13	0
All Other Film	18,159	15,342	Other C&D	3,262	2,748
Durable/Bulky Rigid Plastics	5,432	5,233	Medically-Related Waste	462	504
Remainder/Composite Plastic	5,020	4,905	Lithium Batteries	9	2
Metals	**12,195**	**6,392**	Automotive Batteries	22	0
Steel Cans	2,813	877	Other Batteries	351	79
Aluminum Cans	2,410	1,126	Other HHW	237	48
Other Aluminum	1,047	483	Bulky Materials	5,228	4,899
Other Ferrous Metals	4,672	2,831	Furniture	4,146	1,034
Other Non-Ferrous Metals	1,252	1,075	Other Inorganics	1,812	1,079
Glass	**8,193**	**3,629**	PPE	870	754
Clear Glass Containers	4,334	1,628			
Green Glass Containers	740	375			
Brown Glass Containers	1,424	794	**Grand Total**	**281,511**	**184,736**
Non-Recyclable Glass	1,695	832	**Number of Samples**	**120**	**90**

Figure C-8 Composition Summary by Generator Sector (Percentage)

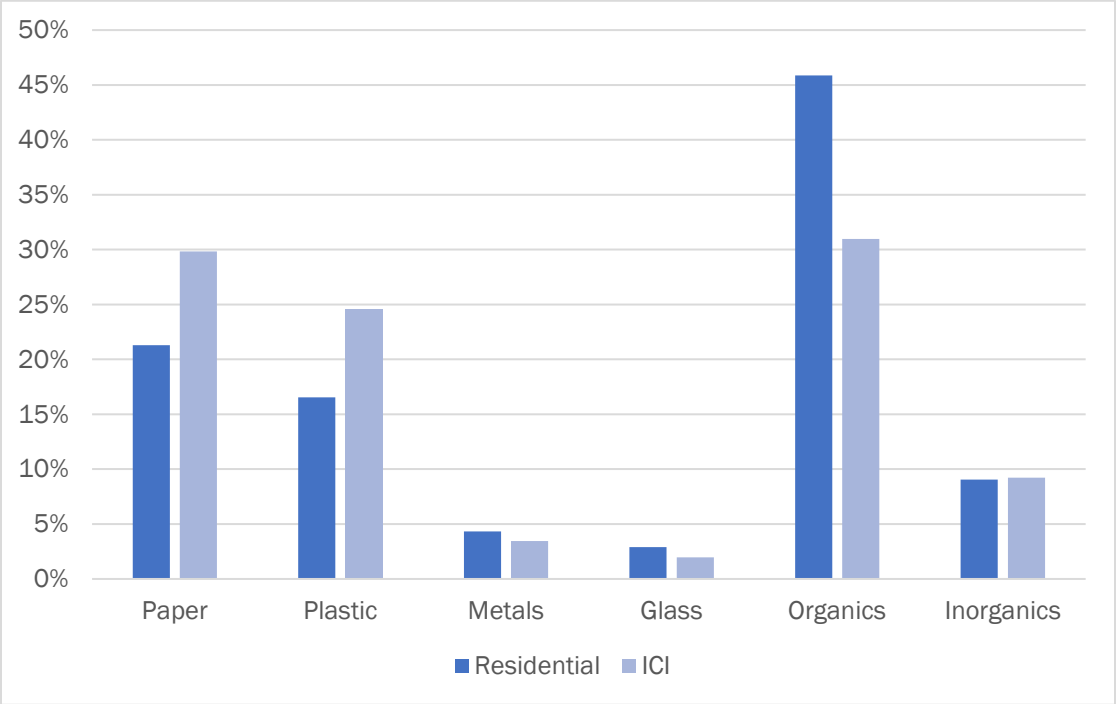


Figure C-9 Composition Summary by Generator Sector (Tons)

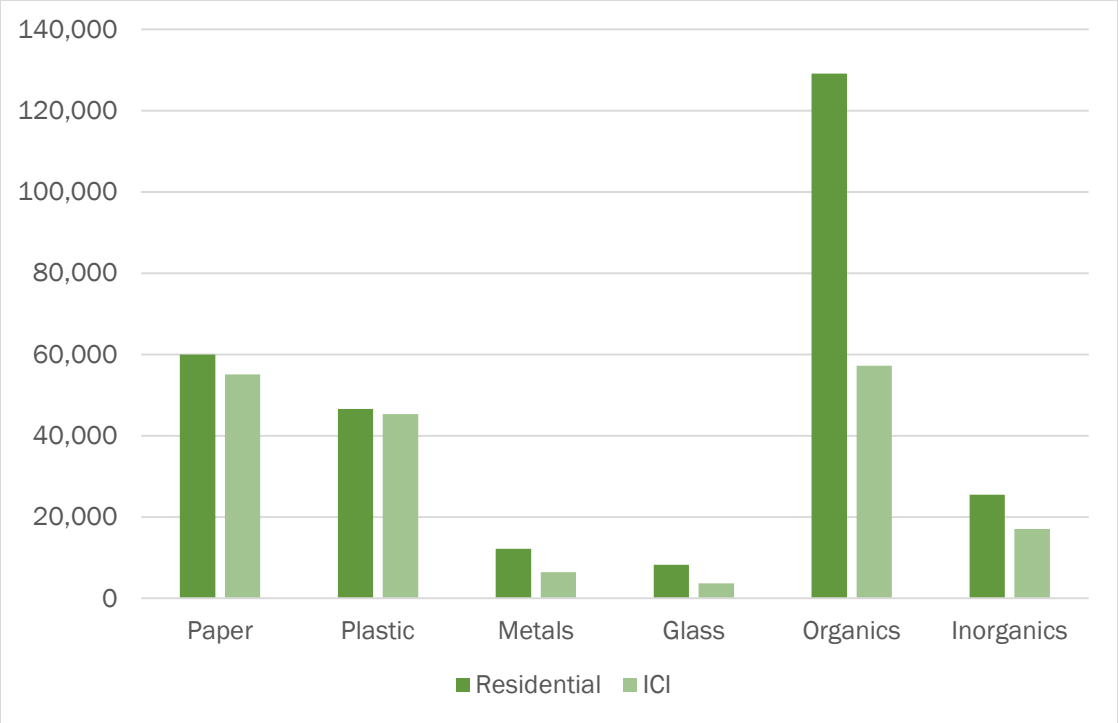


Figure C-10 Detailed Food Waste by Generator Sector (Percentage)

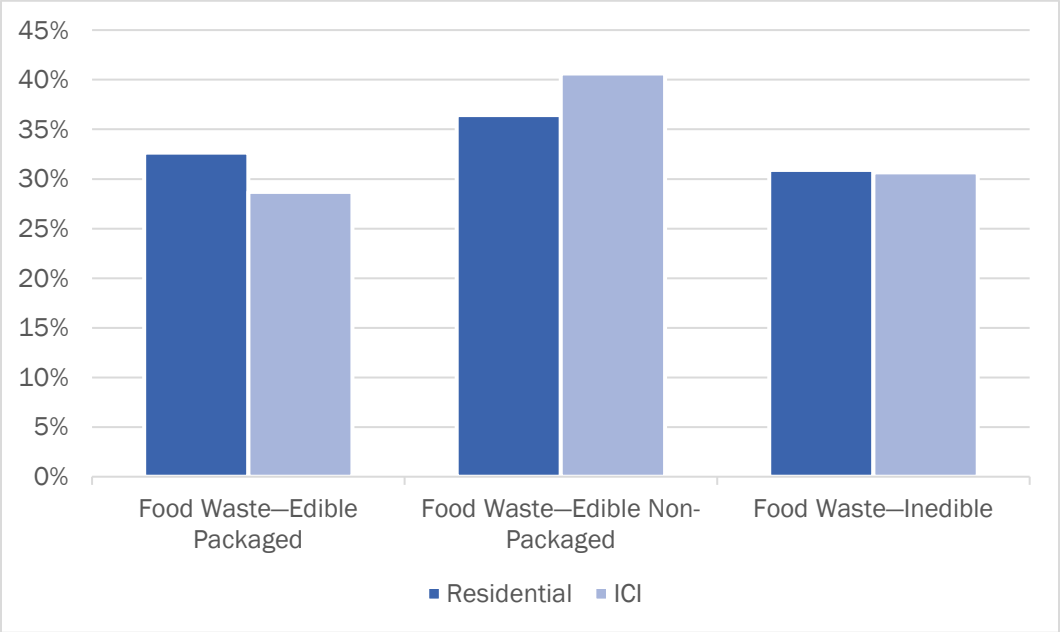
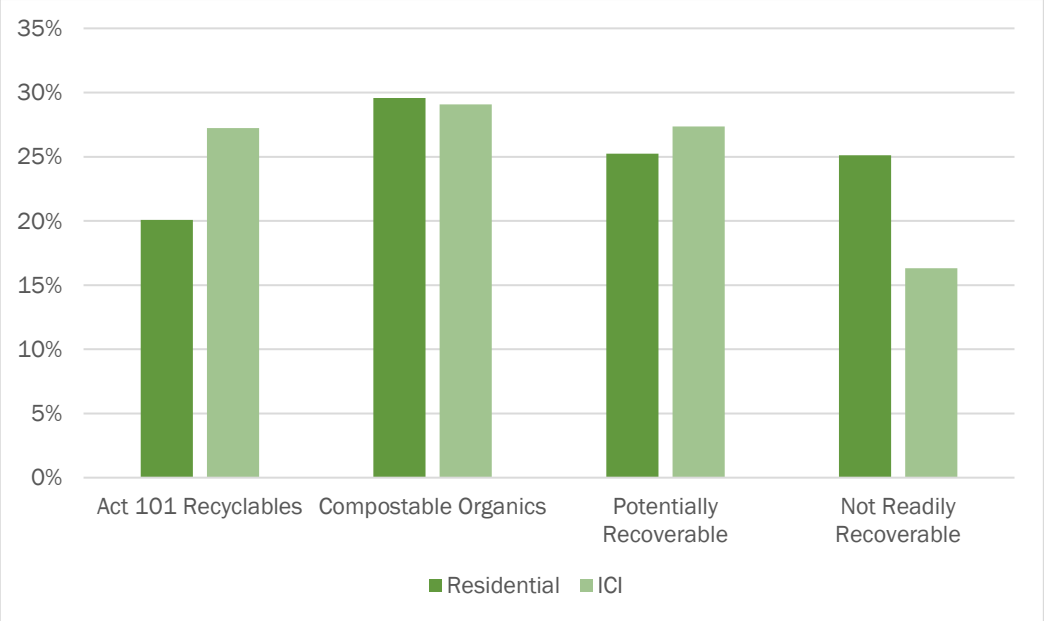


Figure C-11 Divertibility Comparison by Generator Sector (Percentage)



C 4. COMPOSITION BY DEMOGRAPHIC ORIGIN

The composition of urban, suburban, and rural MSW were analyzed individually and selected comparisons are shown below:

- Table C-7 and Table C-8 contain detailed comparisons of disposed MSW from urban, suburban, and rural areas in the Northcentral region based on percentage composition and absolute tonnage, respectively.
- Figure C-12 and Figure C-13 compare the urban, suburban, and rural waste streams based on percentage composition and absolute tonnage, respectively.
- Figure C-14 is a bar chart that compares the breakdown of food waste by demographic origin.
- Figure C-15 illustrates the divertibility of the disposed refuse stream by demographic origin.

Table C-7 Waste Composition by Demographic Origin (Percentage)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**28.9%**	**27.1%**	**21.8%**	**Organics**	**34.8%**	**38.8%**	**42.1%**
Corrugated Cardboard/Kraft Paper	8.1%	9.0%	4.4%	Food Waste	21.5%	18.2%	17.9%
Newspaper	0.2%	0.3%	0.6%	Yard Waste - Grass	0.2%	0.5%	1.1%
Office/High Grade Paper	0.4%	0.9%	0.3%	Yard Waste - Other	0.8%	2.2%	1.8%
Magazine & Catalogs	0.2%	0.5%	0.5%	Wood - Unpainted	0.3%	2.7%	2.5%
Aseptic Boxes & Gable Top Cartons	0.4%	0.4%	0.2%	Wood - Painted	2.4%	1.8%	2.0%
Mixed Recyclable Paper (Low Grade)	5.1%	4.3%	4.9%	Textiles & Leather Products	3.6%	2.9%	4.2%
Compostable Paper	11.1%	8.9%	7.3%	Diapers & Sanitary Products	2.3%	4.3%	3.8%
Non-recyclable Paper	3.3%	2.9%	3.5%	Animal By-Products	1.7%	3.5%	5.1%
Plastic	**21.9%**	**19.1%**	**19.7%**	Fines	0.7%	0.9%	1.2%
#1 PET Bottles & Jars	2.1%	1.1%	1.6%	Other Organics	1.3%	1.7%	2.5%
#1 PET Non-Bottles & Containers	0.3%	0.2%	0.2%	**Inorganics**	**6.7%**	**9.4%**	**9.5%**
#2 HDPE Natural Bottles	0.3%	0.3%	0.5%	Electronics - Covered Devices	0.1%	0.2%	0.2%
#2 HDPE Colored Bottles	0.4%	0.4%	0.4%	Other Electronics	0.6%	0.8%	0.6%
#3 - #7 Bottles	0.1%	0.1%	0.1%	Carpet & Carpet Padding	0.3%	1.0%	2.0%
#2 - #7 Non-Bottle Rigid Containers	2.9%	1.5%	2.4%	Drywall/Gypsum Board	0.4%	0.5%	0.5%
Expanded Polystyrene	2.2%	1.8%	0.7%	Concrete, Rock, Brick	0.0%	0.1%	0.5%
Clean Retail Plastic Bags	0.2%	0.2%	0.1%	Asphalt Roofing	0.0%	0.3%	0.1%
Industrial Film	0.8%	2.1%	2.2%	Asphalt Paving	0.0%	0.0%	0.0%
All Other Film	8.4%	6.4%	7.5%	Other C&D	1.1%	1.4%	1.3%
Durable/Bulky Rigid Plastics	1.9%	2.6%	2.1%	Medically-Related Waste	0.1%	0.4%	0.1%
Remainder/Composite Plastic	2.3%	2.4%	1.9%	Lithium Batteries	0.0%	0.0%	0.0%
Metals	**4.0%**	**3.8%**	**4.2%**	Automotive Batteries	0.0%	0.0%	0.0%
Steel Cans	0.5%	0.6%	1.0%	Other Batteries	0.1%	0.1%	0.1%
Aluminum Cans	1.4%	0.4%	0.9%	Other HHW	0.0%	0.0%	0.1%
Other Aluminum	0.4%	0.3%	0.3%	Bulky Materials	1.4%	2.5%	2.1%
Other Ferrous Metals	1.2%	1.9%	1.5%	Furniture	1.2%	0.9%	1.3%
Other Non-Ferrous Metals	0.4%	0.5%	0.5%	Other Inorganics	0.8%	0.7%	0.5%
Glass	**3.8%**	**1.8%**	**2.8%**	PPE	0.4%	0.5%	0.2%
Clear Glass Containers	2.1%	0.7%	1.6%				
Green Glass Containers	0.6%	0.2%	0.2%				
Brown Glass Containers	0.6%	0.3%	0.6%	**Grand Total**	**100%**	**100%**	**100%**
Non-Recyclable Glass	0.6%	0.6%	0.5%	**Number of Samples**	**65**	**71**	**74**

Table C-8 Waste Composition by Demographic Origin (Tons)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**15,144**	**49,757**	**50,155**	**Organics**	**18,266**	**71,091**	**96,955**
Corrugated Cardboard/Kraft Paper	4,251	16,546	10,137	Food Waste	11,262	33,411	41,271
Newspaper	106	503	1,363	Yard Waste - Grass	105	1,005	2,490
Office/High Grade Paper	200	1,563	733	Yard Waste - Other	437	4,010	4,157
Magazine & Catalogs	119	892	1,196	Wood - Unpainted	167	4,942	5,678
Aseptic Boxes & Gable Top Cartons	219	752	547	Wood - Painted	1,261	3,221	4,704
Mixed Recyclable Paper (Low Grade)	2,663	7,895	11,398	Textiles & Leather Products	1,894	5,329	9,603
Compostable Paper	5,831	16,258	16,769	Diapers & Sanitary Products	1,220	7,798	8,850
Non-recyclable Paper	1,755	5,349	8,012	Animal By-Products	869	6,473	11,709
Plastic	**11,472**	**35,061**	**45,369**	Fines	377	1,720	2,738
#1 PET Bottles & Jars	1,107	2,009	3,707	Other Organics	674	3,184	5,755
#1 PET Non-Bottles & Containers	182	445	403	**Inorganics**	**3,515**	**17,191**	**21,862**
#2 HDPE Natural Bottles	164	493	1,069	Electronics - Covered Devices	62	293	419
#2 HDPE Colored Bottles	211	707	1,011	Other Electronics	326	1,527	1,325
#3 - #7 Bottles	30	111	131	Carpet & Carpet Padding	142	1,869	4,623
#2 - #7 Non-Bottle Rigid Containers	1,527	2,816	5,593	Drywall/Gypsum Board	232	831	1,064
Expanded Polystyrene	1,129	3,317	1,704	Concrete, Rock, Brick	6	189	1,235
Clean Retail Plastic Bags	98	283	252	Asphalt Roofing	0	628	236
Industrial Film	410	3,820	5,083	Asphalt Paving	0	0	13
All Other Film	4,410	11,790	17,301	Other C&D	565	2,556	2,889
Durable/Bulky Rigid Plastics	1,022	4,833	4,810	Medically-Related Waste	63	754	148
Remainder/Composite Plastic	1,182	4,439	4,305	Lithium Batteries	3	4	5
Metals	**2,081**	**6,932**	**9,574**	Automotive Batteries	0	0	22
Steel Cans	271	1,188	2,230	Other Batteries	35	129	266
Aluminum Cans	761	774	2,001	Other HHW	5	13	267
Other Aluminum	198	538	794	Bulky Materials	758	4,501	4,867
Other Ferrous Metals	651	3,442	3,411	Furniture	654	1,630	2,896
Other Non-Ferrous Metals	200	989	1,138	Other Inorganics	435	1,331	1,125
Glass	**2,011**	**3,372**	**6,438**	PPE	226	936	462
Clear Glass Containers	1,081	1,290	3,590				
Green Glass Containers	322	345	448				
Brown Glass Containers	311	569	1,338	**Grand Total**	**52,489**	**183,405**	**230,353**
Non-Recyclable Glass	297	1,168	1,062	**Number of Samples**	**65**	**71**	**74**

Figure C-12 Composition Summary by Demographic Origin (Percentage)

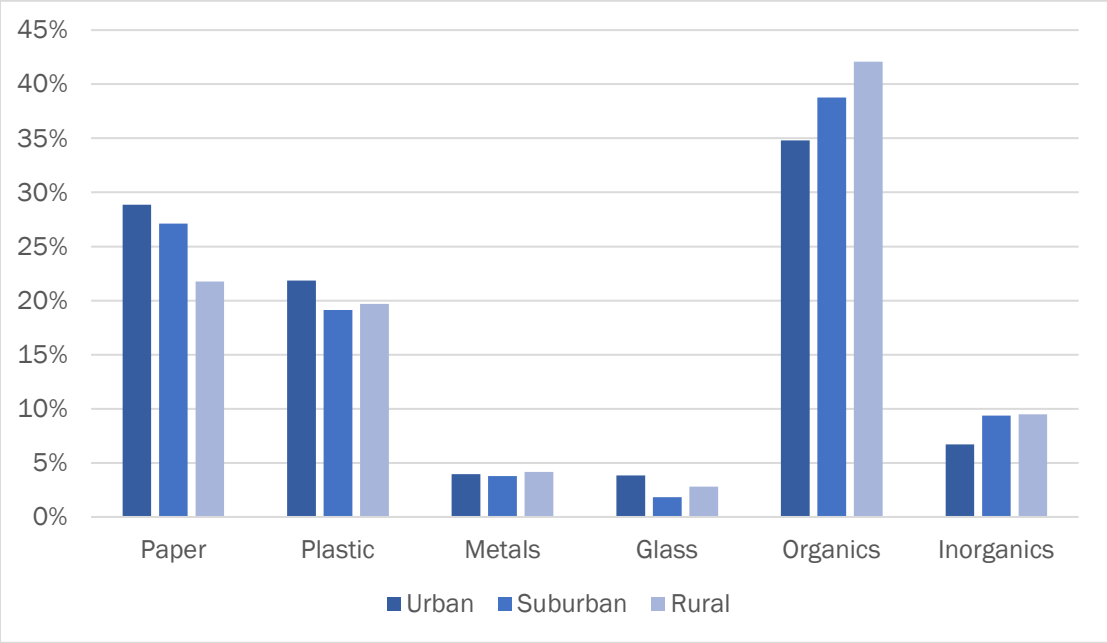


Figure C-13 Composition Summary by Demographic Origin (Tons)

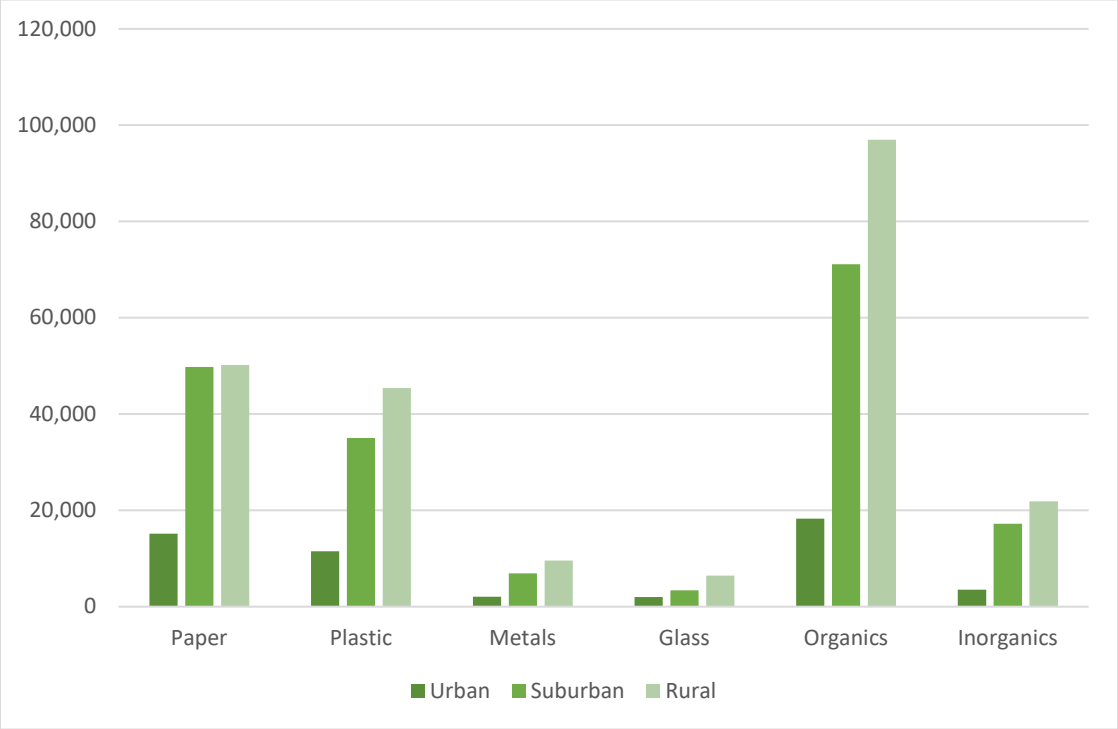


Figure C-14 Detailed Food Waste by Demographic Origin

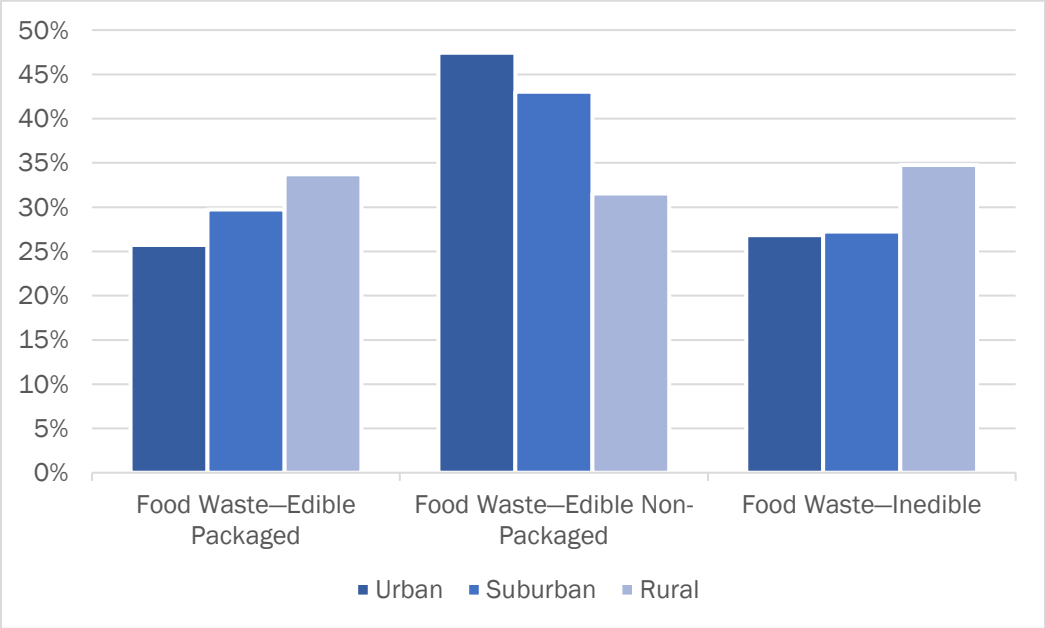
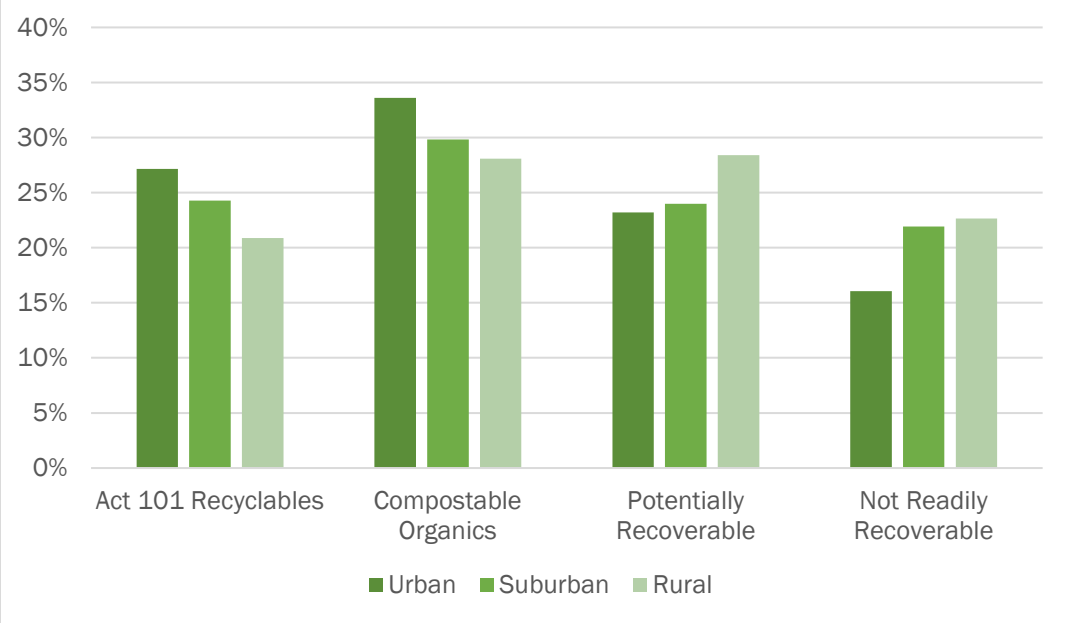


Figure C-15 Divertibility Comparison (Percentage)



C 5. ECONOMIC AND ENVIRONMENTAL IMPACTS

The following supplemental analyses have been included to illustrate the potential financial and environmental impacts of diverting recyclable and compostable materials from the disposed MSW stream.

- Table C-9 estimates the recovered material value for recyclables commodities that were disposed in the regional MSW stream. Market values were obtained from recyclingmarkets.net.
- Table C-10 calculates the greenhouse gas emissions that could be reduced if the estimated quantities of recyclable and compostable materials disposed in the Northeast region were diverted from disposal.

Table C-9 Estimated Value of Disposed Recyclable Materials

Recyclable Commodities	Estimated Tons Disposed	Average Market Price ($/ton)	Estimated Total Market Value ($)
Recyclable Paper	**61,082**		**$7,203,588**
Corrugated Cardboard/Kraft Paper	30,934	$135	$4,176,066
Newspaper	1,972	$188	$369,705
Office/High Grade Paper	2,497	$235	$586,733
Magazine & Catalogs	2,206	$168	$369,530
Aseptic Boxes & Gable Top Cartons	1,518	$0	$0
Mixed Recyclable Paper (Low Grade)	21,956	$78	$1,701,553
Recyclable Containers	**48,900**		**$19,600,849**
#1 PET Bottles & Jars	6,823	$860	$5,867,713
#1 PET Non-Bottles & Containers	1,030	$130	$133,856
#2 HDPE Natural Bottles	1,726	$1,130	$1,950,024
#2 HDPE Colored Bottles	1,929	$640	$1,234,706
#3 - #7 Bottles	272	$130	$35,333
#2 - #7 Non-Bottle Rigid Containers	9,936	$130	$1,291,619
Durable/Bulky Rigid Plastics	10,665	$90	$959,889
Steel Cans	3,690	$230	$848,640
Aluminum Cans	3,536	$1,950	$6,894,987
Clear Glass Containers	5,962	$50	$298,098
Green Glass Containers	1,115	$8	$8,361
Brown Glass Containers	2,218	$35	$77,621
Total	**109,983**	*$244*	**$26,804,437**

Source: Recyclingmarkets.net - Northeast Region of U.S. as of 06/9/22

Table C-10 Emissions Reduction Potential from Disposed Recyclables

Material Components	Tons Recycled/ Composted[1]	Emissions Reduced ($MTCO_2E$)[2]
Recyclable Paper	**59,564**	**194,069**
Corrugated Cardboard/Kraft Paper	30,934	96,959
Magazine & Catalogs	2,206	6,772
Newspaper	1,972	5,341
Office/High Grade Paper	2,497	7,151
Mixed Recyclable Paper	21,956	77,846
Recyclable Containers	**48,900**	**71,824**
Aluminum Cans	3,536	32,274
Steel Cans	3,690	6,760
Glass	9,295	2,566
PET	7,853	8,134
HDPE	3,655	2,772
Mixed Plastics	20,873	19,318
Compostable	**98,148**	**10,588**
Food Waste	85,944	9,934
Yard Waste	12,204	654
Total	**206,612**	**276,481**

[1] Based on estimated overall MSW waste composition for 2021 and Pennsylvania's reported MSW disposal tonnage for FY 2021. Assumes the materials would be recycled instead of disposed.

[2] U.S. EPA Waste Reduction Model, Version 15

APPENDIX D

NORTHWEST REGIONAL RESULTS

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APPENDIX D – NORTHWEST REGION RESULTS

D 1. INTRODUCTION

Pennsylvania's Northwest region encompasses Erie, Lawrence, and Butler counties and has a population of 990,000 people and more than 410,000 households. A map of the Northwest region is shown in Figure D-1.

Figure D-1 Northwest Region Map

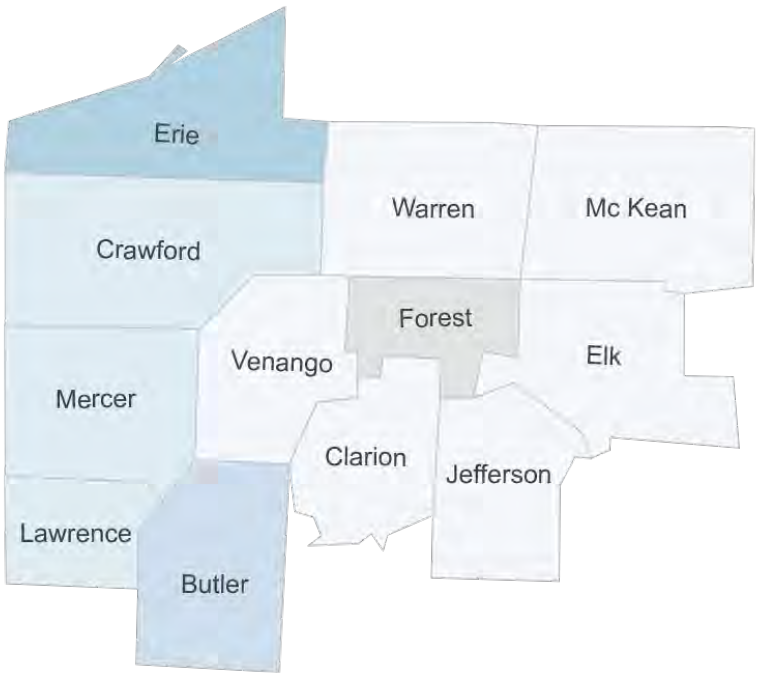


Table D-1 summarizes selected demographic and economic data for the Northwest region. As shown, this region is composed predominantly of rural and suburban areas.

Table D-1 Northwest Region Demographic Summary (2021)

	Urban	Suburban	Rural	Total
Communities	1	55	335	**391**
Population	93,999	415,795	479,408	**989,202**
Housing Units	40,180	176,893	197,292	**414,365**
Employment	70,164	259,534	115,891	**445,589**

Sources: Demographic data from the Pennsylvania State Data Center; employment data from ESRI Business Patterns. The allocation of these data to urban, suburban, and rural areas was estimated by MSW Consultants.

The methodology for estimating waste generation within the residential and commercial sectors and allocated across urban, suburban, and rural areas is described in the main body of this report. Table D-2 presents the resulting allocation of generated wastes within the Northwest Region. These quantities are used as weighting factors for determining the aggregate waste composition within the region.

Table D-2 Estimated Allocation of MSW Generated in the Northwest Region

	Tons of Waste Disposed			
Generating Sector	Urban	Suburban	Rural	Total
Residential	42,591	162,742	175,590	380,922
Commercial	38,178	141,218	63,059	242,455
Total	80,769	303,960	238,649	623,377

Field sampling and sorting of Northwest region wastes was performed at the Superior Greentree Landfill and the Lake View Landfill. Sampling at these facilities was performed across four seasons to capture seasonal variation in MSW composition. Table D-3 provides a sampling summary for the Northwest Region, where targets were met.

Table D-3 Northwest Region Sampling Summary

	Number of Samples			
Waste Generating Sector	Urban	Suburban	Rural	Total
Residential	7	59	29	95
Commercial	36	63	11	110
Total	43	122	40	205

D 2. AGGREGATE WASTE COMPOSITION

The remainder of this section presents a graphical and tabular summary of the Northwest region's disposed MSW composition. Specific figures and tables are summarized below.

- Table D-4 provides the detailed tabular composition of the aggregated disposed refuse stream. This table shows the mean composition, margin of error (MOE) at a 90 percent level of confidence, and the estimated tonnage of each of the constituents in the refuse stream.
- Figure D-2 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented as percentages.
- Figure D-3 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented in tons.
- Figure D-4 is a pie chart that shows the percentage composition of major material groups in the aggregate regional waste stream. As shown, organics comprise 43.5 percent of the refuse disposed in the Northwest region.
- Figure D-5 shows the 10 most prevalent materials being disposed in the region by weight.
- Figure D-6 is a pie chart that shows the detailed percentage composition of the food waste category.
- Figure D-7 illustrates the divertibility of the aggregate disposed refuse stream. This graphic shows that the majority of the materials being disposed could be diverted through existing recycling programs, composting programs, and third-party recovery programs. It should be noted that this graphic omits the impact of contamination, and as a practical matter it is not possible for all the divertible materials to actually be diverted.

Table D-4 Detailed Northwest Region Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**23.1%**	**1.2%**	**143,944**	**Organics**	**43.5%**	**2.0%**	**270,865**
Corrugated Cardboard/Kraft Paper	5.1%	0.8%	31,913	Food Waste	18.7%	2.2%	116,367
Newspaper	0.5%	0.1%	3,362	Yard Waste - Grass	1.7%	0.6%	10,295
Office/High Grade Paper	0.6%	0.2%	3,537	Yard Waste - Other	2.7%	0.7%	16,671
Magazine & Catalogs	0.9%	0.2%	5,654	Wood - Unpainted	2.5%	0.7%	15,336
Aseptic Boxes & Gable Top Cartons	0.3%	0.1%	1,631	Wood - Painted	2.7%	0.6%	17,035
Mixed Recyclable Paper (Low Grade)	4.7%	0.4%	29,593	Textiles & Leather Products	5.0%	1.0%	31,203
Compostable Paper	7.9%	0.6%	49,115	Diapers & Sanitary Products	3.3%	0.5%	20,580
Non-recyclable Paper	3.1%	0.5%	19,138	Animal By-Products	3.2%	0.6%	20,060
Plastic	**17.2%**	**1.4%**	**107,455**	Fines	1.6%	0.5%	10,141
#1 PET Bottles & Jars	1.5%	0.2%	9,244	Other Organics	2.1%	0.4%	13,176
#1 PET Non-Bottles & Containers	0.4%	0.1%	2,191	**Inorganics**	**8.8%**	**1.4%**	**55,082**
#2 HDPE Natural Bottles	0.3%	0.0%	1,885	Electronics - Covered Devices	0.2%	0.1%	1,215
#2 HDPE Colored Bottles	0.4%	0.1%	2,778	Other Electronics	0.8%	0.2%	4,780
#3 - #7 Bottles	0.1%	0.1%	423	Carpet & Carpet Padding	1.1%	0.6%	6,983
#2 - #7 Non-Bottle Rigid Containers	1.2%	0.1%	7,557	Drywall/Gypsum Board	0.8%	0.4%	4,932
Expanded Polystyrene	0.6%	0.1%	3,572	Concrete, Rock, Brick	0.2%	0.1%	1,215
Clean Retail Plastic Bags	0.1%	0.0%	449	Asphalt Roofing	0.3%	0.4%	2,097
Industrial Film	1.3%	0.4%	8,030	Asphalt Paving	0.0%	0.0%	6
All Other Film	5.8%	0.6%	36,080	Other C&D	2.0%	0.6%	12,533
Durable/Bulky Rigid Plastics	2.6%	0.5%	16,443	Medically-Related Waste	0.2%	0.1%	1,312
Remainder/Composite Plastic	3.0%	0.9%	18,803	Lithium Batteries	0.0%	0.0%	10
Metals	**3.9%**	**0.5%**	**24,185**	Automotive Batteries	0.0%	0.0%	0
Steel Cans	0.8%	0.1%	4,995	Other Batteries	0.1%	0.0%	535
Aluminum Cans	0.7%	0.1%	4,169	Other HHW	0.1%	0.0%	328
Other Aluminum	0.3%	0.0%	2,149	Bulky Materials	1.2%	0.6%	7,225
Other Ferrous Metals	1.6%	0.4%	9,896	Furniture	0.7%	0.4%	4,402
Other Non-Ferrous Metals	0.5%	0.2%	2,976	Other Inorganics	0.8%	0.3%	5,298
Glass	**3.5%**	**0.6%**	**21,846**	PPE	0.4%	0.1%	2,209
Clear Glass Containers	1.5%	0.3%	9,166				
Green Glass Containers	0.4%	0.1%	2,233				
Brown Glass Containers	0.7%	0.3%	4,224	**Grand Total**	**100.0%**		**623,377**
Non-Recyclable Glass	1.0%	0.2%	6,222	**Number of Samples**	**205**		

Margin of error is calculated at a 90 percent level of confidence.

Figure D-2 Comparison of Composition by Material Group 2021 vs 2001 (Percentage)

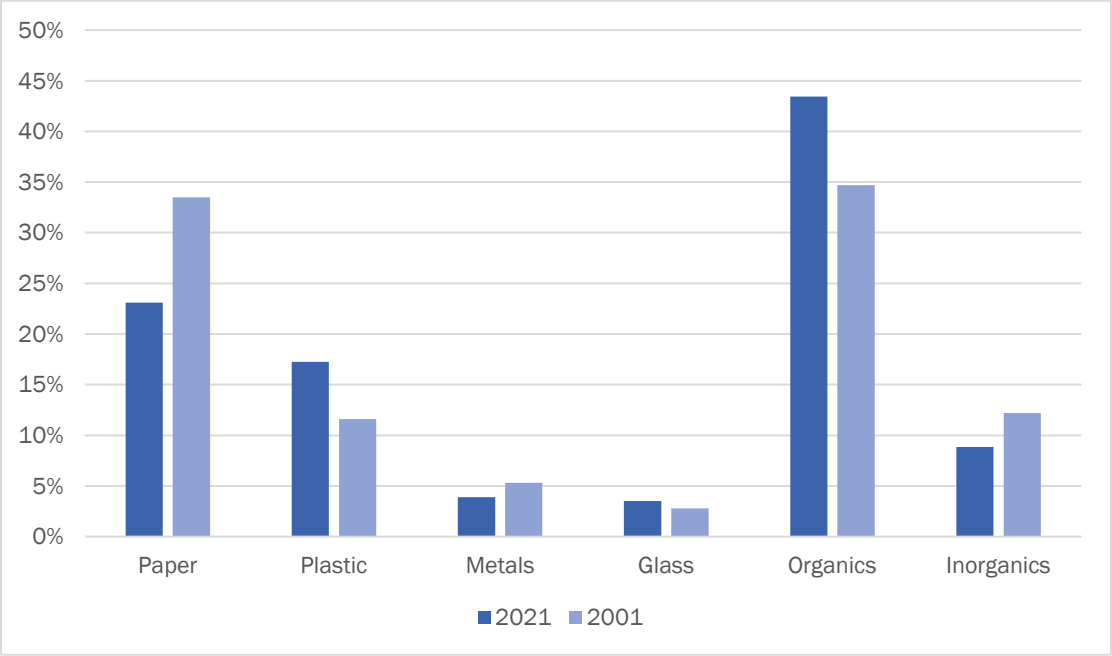


Figure D-3 Comparison of Composition by Material Group 2021 vs 2001 (Tons)

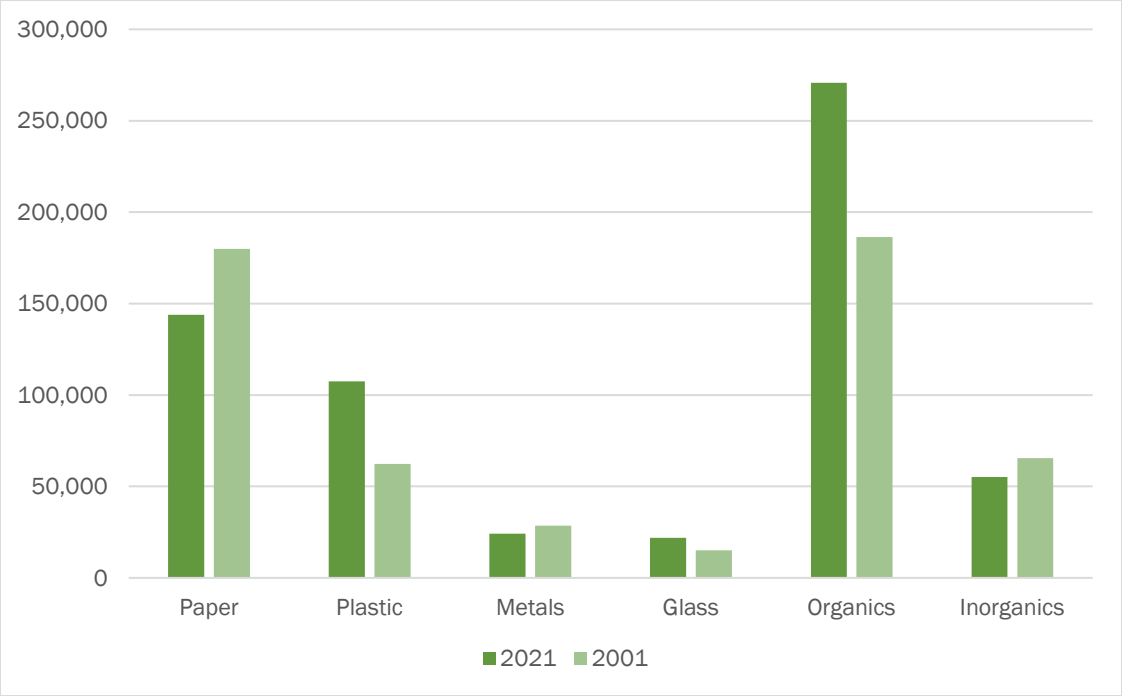


Figure D-4 Composition Summary by Material Group (Percentage)

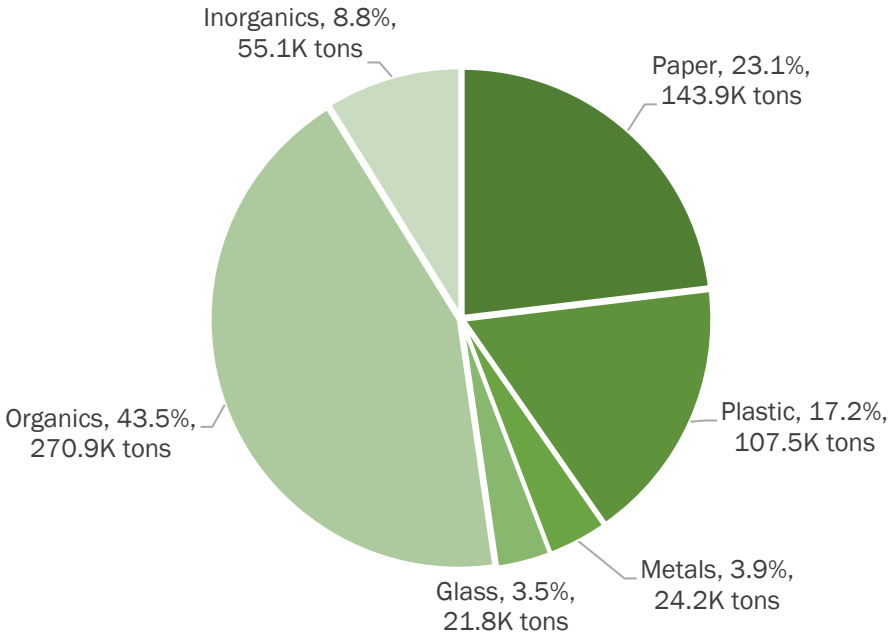
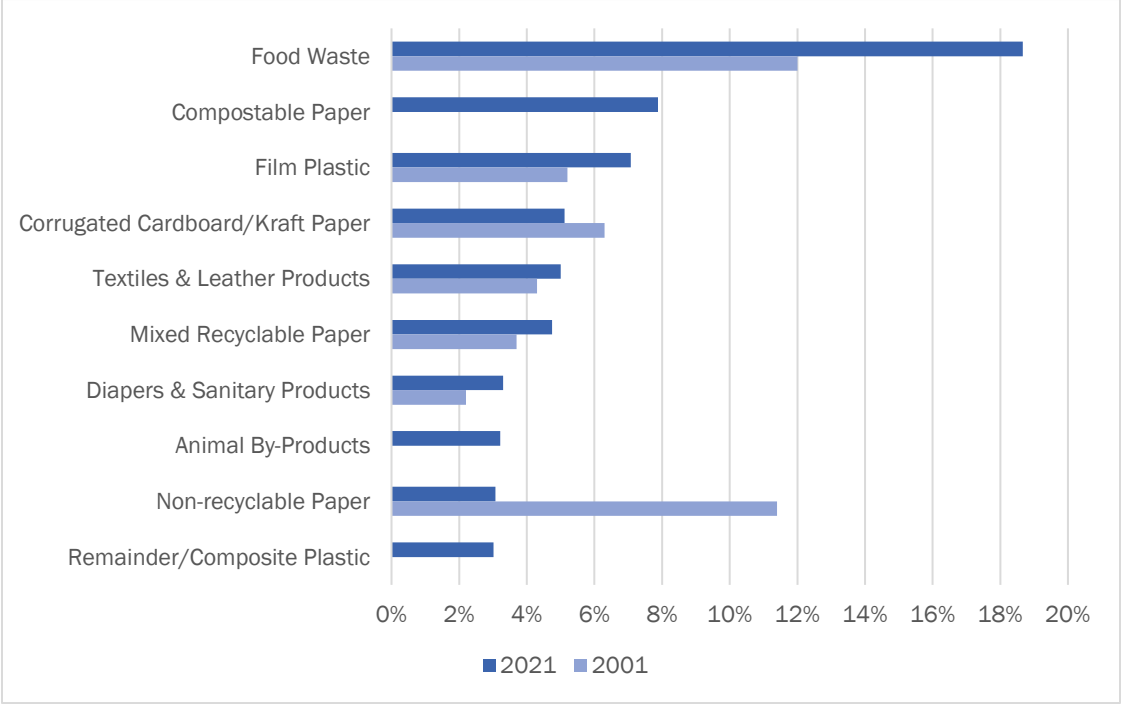


Figure D-5 Top 10 Most Prevalent Materials by Weight*



*Note: Some material categories were not sorted in 2001 Study

Figure D-6 Detailed Food Waste

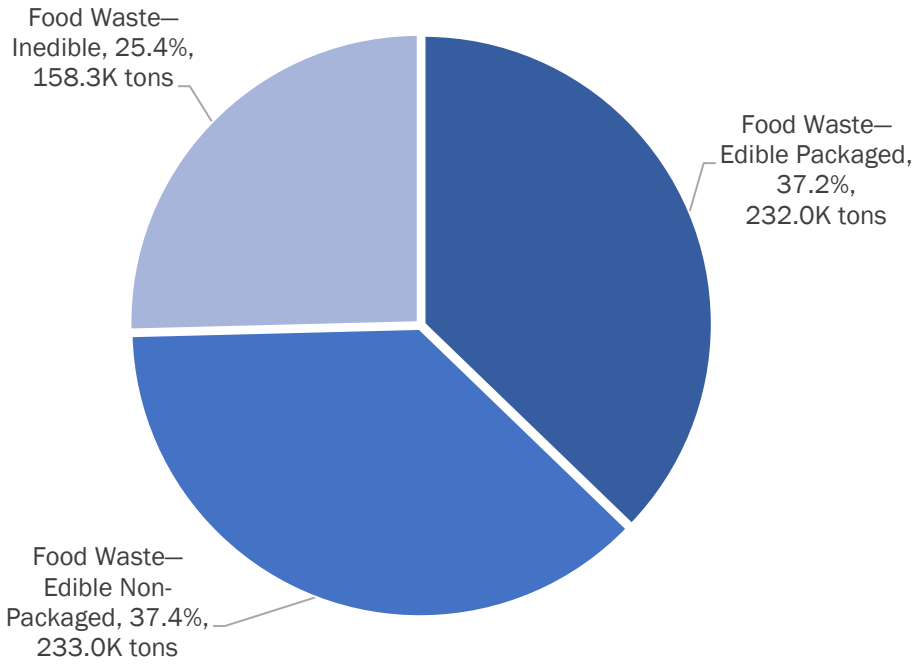
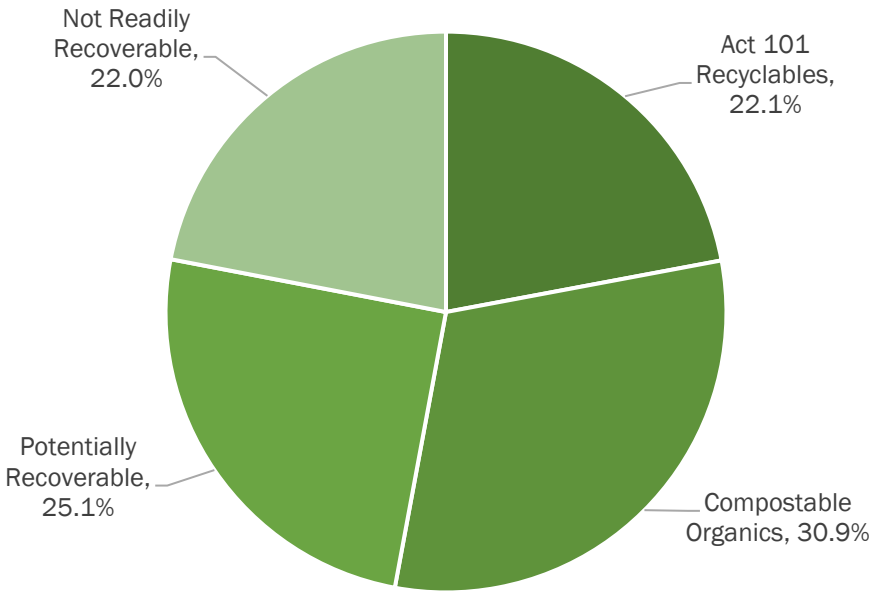


Figure D-7 Divertibility of Disposed MSW



D 3. COMPOSITION COMPARISONS BY GENERATING SECTOR

The composition of residential and commercial MSW were analyzed individually, and selected comparisons are shown below:

- Table D-5 and Table D-6 contain detailed comparisons of disposed residential and commercial MSW in the Northwest region based on percentage composition and absolute tonnage, respectively.
- Figure D-8 and Figure D-9 compare the residential and commercial disposed MSW based on percentage composition and absolute tonnage, respectively.
- Figure D-10 is a bar chart that compares the breakdown of food waste by generating sector.
- Figure D-11 illustrates the divertibility of disposed MSW stream by generating sector.

Table D-5 Disposed MSW Composition by Generator Sector (Percentage)

Material Category	Res	ICI		Res	ICI
Paper	**21.4%**	**25.7%**	**Organics**	**47.9%**	**36.5%**
Corrugated Cardboard/Kraft Paper	2.9%	8.6%	Food Waste	19.0%	18.2%
Newspaper	0.6%	0.4%	Yard Waste - Grass	2.4%	0.4%
Office/High Grade Paper	0.4%	0.8%	Yard Waste - Other	4.1%	0.5%
Magazine & Catalogs	1.2%	0.5%	Wood - Unpainted	1.1%	4.7%
Aseptic Boxes & Gable Top Cartons	0.3%	0.2%	Wood - Painted	2.9%	2.5%
Mixed Recyclable Paper (Low Grade)	4.8%	4.7%	Textiles & Leather Products	5.6%	4.1%
Compostable Paper	8.9%	6.3%	Diapers & Sanitary Products	4.4%	1.6%
Non-recyclable Paper	2.4%	4.2%	Animal By-Products	4.2%	1.6%
Plastic	**14.8%**	**21.1%**	Fines	2.1%	0.9%
#1 PET Bottles & Jars	1.6%	1.3%	Other Organics	2.3%	1.9%
#1 PET Non-Bottles & Containers	0.4%	0.3%	**Inorganics**	**8.8%**	**8.9%**
#2 HDPE Natural Bottles	0.3%	0.3%	Electronics - Covered Devices	0.3%	0.0%
#2 HDPE Colored Bottles	0.5%	0.3%	Other Electronics	1.0%	0.4%
#3 - #7 Bottles	0.0%	0.1%	Carpet & Carpet Padding	1.0%	1.3%
#2 - #7 Non-Bottle Rigid Containers	1.3%	1.1%	Drywall/Gypsum Board	0.8%	0.8%
Expanded Polystyrene	0.6%	0.6%	Concrete, Rock, Brick	0.1%	0.4%
Clean Retail Plastic Bags	0.1%	0.0%	Asphalt Roofing	0.3%	0.3%
Industrial Film	0.0%	3.3%	Asphalt Paving	0.0%	0.0%
All Other Film	5.8%	5.7%	Other C&D	2.2%	1.7%
Durable/Bulky Rigid Plastics	1.9%	3.8%	Medically-Related Waste	0.1%	0.3%
Remainder/Composite Plastic	2.2%	4.4%	Lithium Batteries	0.0%	0.0%
Metals	**4.0%**	**3.7%**	Automotive Batteries	0.0%	0.0%
Steel Cans	0.9%	0.6%	Other Batteries	0.1%	0.0%
Aluminum Cans	0.8%	0.5%	Other HHW	0.1%	0.1%
Other Aluminum	0.4%	0.2%	Bulky Materials	1.3%	1.0%
Other Ferrous Metals	1.4%	1.8%	Furniture	0.9%	0.4%
Other Non-Ferrous Metals	0.4%	0.5%	Other Inorganics	0.5%	1.3%
Glass	**3.1%**	**4.2%**	PPE	0.1%	0.7%
Clear Glass Containers	1.6%	1.3%			
Green Glass Containers	0.4%	0.4%			
Brown Glass Containers	0.3%	1.3%	**Grand Total**	**100%**	**100%**
Non-Recyclable Glass	0.9%	1.2%	**Number of Samples**	**95**	**110**

Table D-6 Waste Composition by Generator Sector (Tons)

Material Category	Res	ICI		Res	ICI
Paper	**81,531**	**62,413**	**Organics**	**182,484**	**88,381**
Corrugated Cardboard/Kraft Paper	11,163	20,750	Food Waste	72,244	44,123
Newspaper	2,416	946	Yard Waste - Grass	9,291	1,004
Office/High Grade Paper	1,483	2,054	Yard Waste - Other	15,485	1,186
Magazine & Catalogs	4,485	1,170	Wood - Unpainted	4,042	11,294
Aseptic Boxes & Gable Top Cartons	1,051	581	Wood - Painted	10,878	6,156
Mixed Recyclable Paper (Low Grade)	18,168	11,425	Textiles & Leather Products	21,163	10,040
Compostable Paper	33,735	15,380	Diapers & Sanitary Products	16,601	3,979
Non-recyclable Paper	9,030	10,109	Animal By-Products	16,155	3,905
Plastic	**56,335**	**51,120**	Fines	8,036	2,105
#1 PET Bottles & Jars	6,051	3,193	Other Organics	8,589	4,588
#1 PET Non-Bottles & Containers	1,554	637	**Inorganics**	**33,571**	**21,510**
#2 HDPE Natural Bottles	1,241	644	Electronics - Covered Devices	1,117	99
#2 HDPE Colored Bottles	2,091	687	Other Electronics	3,725	1,055
#3 - #7 Bottles	145	278	Carpet & Carpet Padding	3,763	3,220
#2 - #7 Non-Bottle Rigid Containers	4,940	2,617	Drywall/Gypsum Board	2,879	2,053
Expanded Polystyrene	2,123	1,449	Concrete, Rock, Brick	251	964
Clean Retail Plastic Bags	365	84	Asphalt Roofing	1,265	832
Industrial Film	55	7,975	Asphalt Paving	6	0
All Other Film	22,245	13,836	Other C&D	8,479	4,055
Durable/Bulky Rigid Plastics	7,308	9,134	Medically-Related Waste	550	762
Remainder/Composite Plastic	8,216	10,587	Lithium Batteries	10	0
Metals	**15,226**	**8,959**	Automotive Batteries	0	0
Steel Cans	3,472	1,523	Other Batteries	474	60
Aluminum Cans	2,880	1,290	Other HHW	204	124
Other Aluminum	1,691	458	Bulky Materials	4,773	2,452
Other Ferrous Metals	5,507	4,389	Furniture	3,490	912
Other Non-Ferrous Metals	1,677	1,299	Other Inorganics	2,072	3,226
Glass	**11,775**	**10,071**	PPE	511	1,698
Clear Glass Containers	6,048	3,118			
Green Glass Containers	1,338	895			
Brown Glass Containers	1,134	3,091	**Grand Total**	**380,922**	**242,455**
Non-Recyclable Glass	3,256	2,967	**Number of Samples**	**95**	**110**

Figure D-8 Composition Summary by Generator Sector (Percentage)

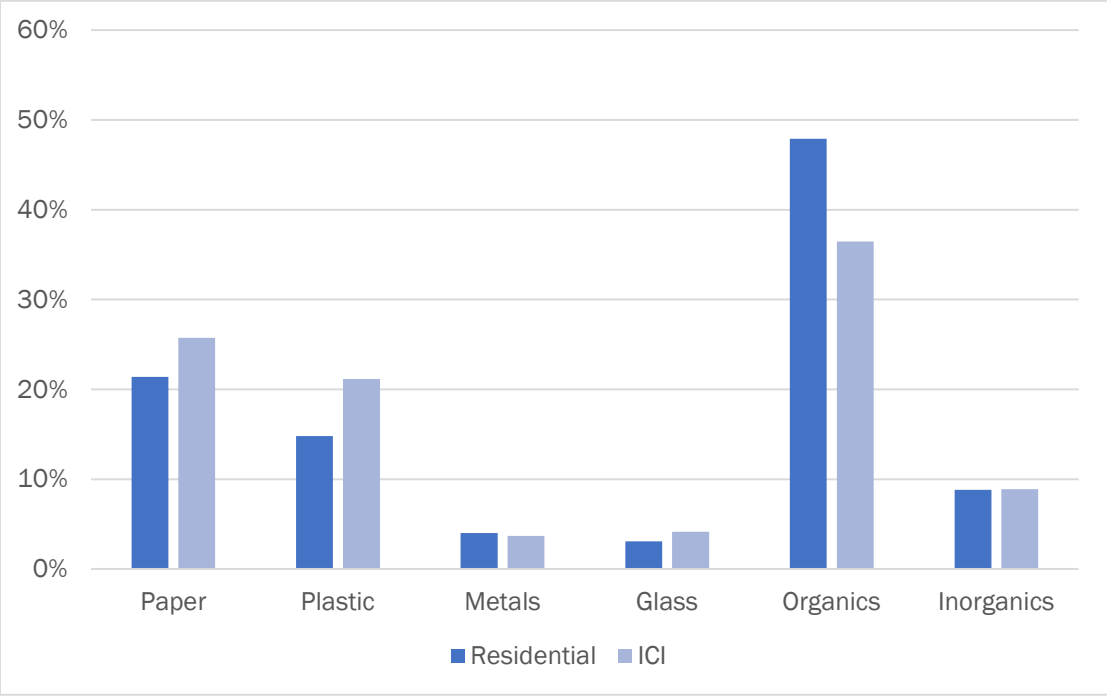


Figure D-9 Composition Summary by Generator Sector (Tons)

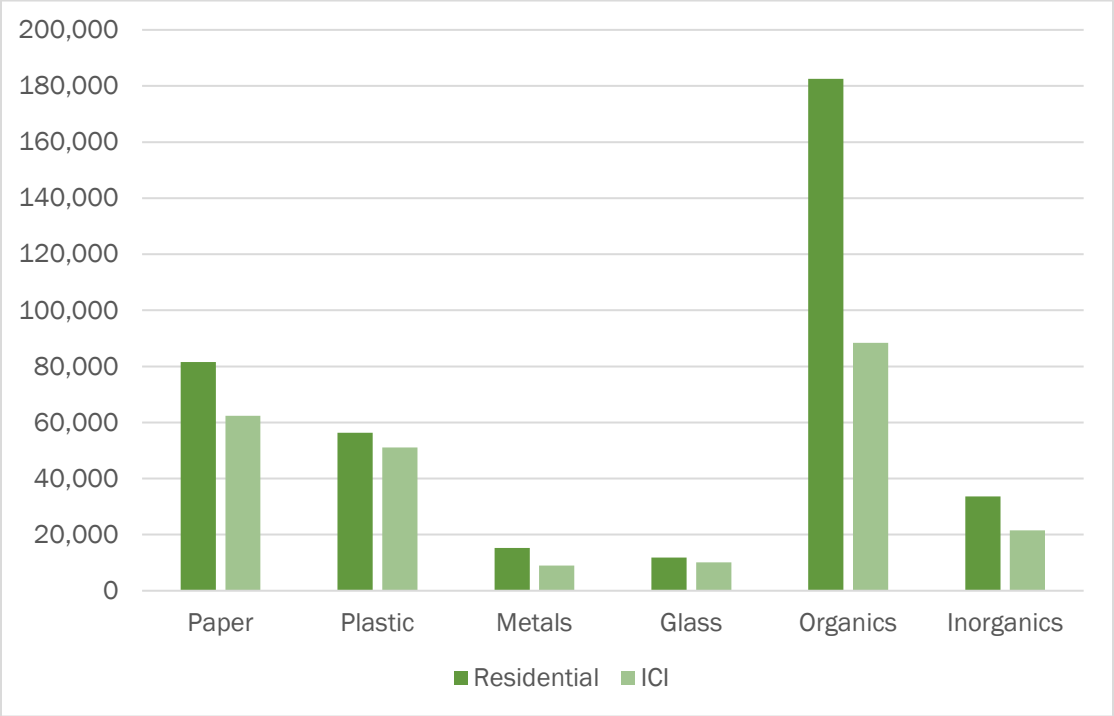


Figure D-10 Detailed Food Waste by Generator Sector (Percentage)

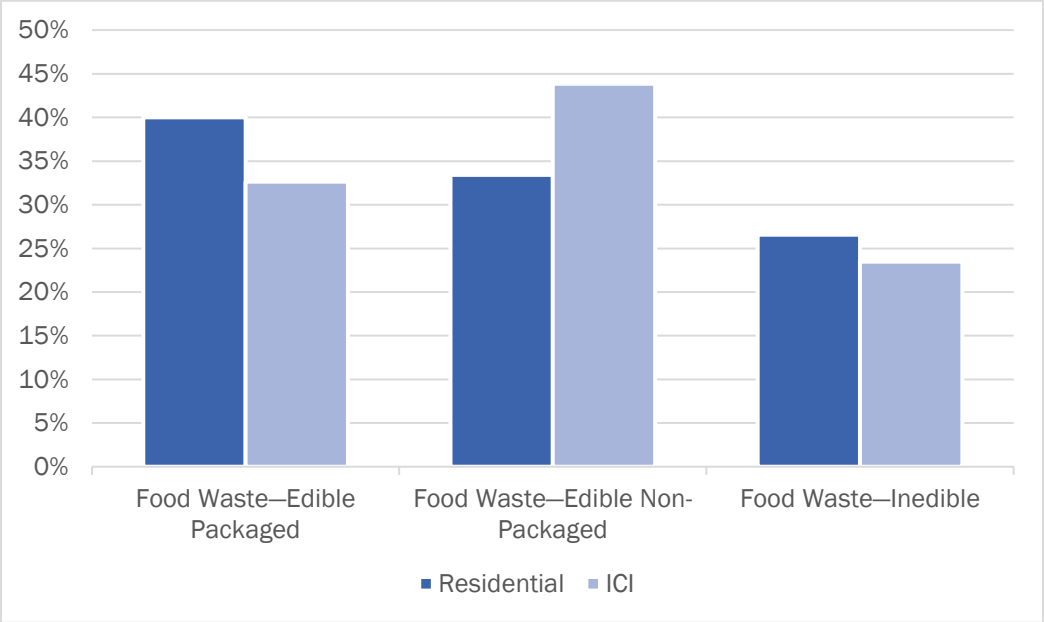
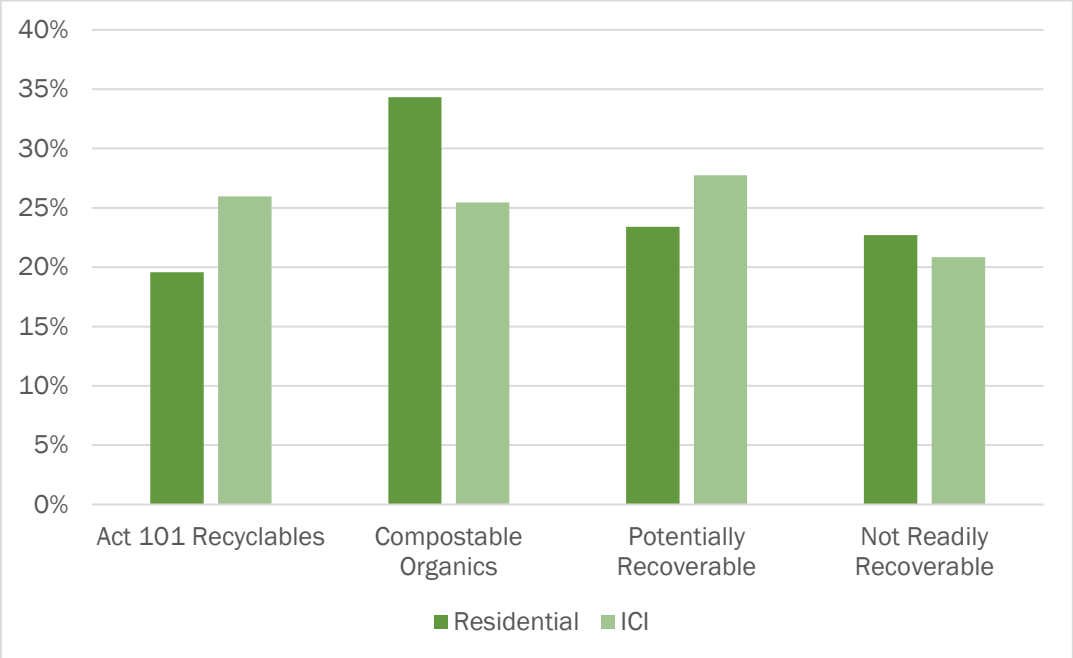


Figure D-11 Divertibility Comparison by Generator Sector (Percentage)



D 4. COMPOSITION BY DEMOGRAPHIC ORIGIN

The composition of urban, suburban, and rural MSW were analyzed individually and selected comparisons are shown below:

- Table D-7 and Table D-8 contain detailed comparisons of disposed MSW from urban, suburban, and rural areas in the Northwest region based on percentage composition and absolute tonnage, respectively.
- Figure D-12 and Figure D-13 compare the urban, suburban, and rural waste streams based on percentage composition and absolute tonnage, respectively.
- Figure D-14 is a bar chart that compares the breakdown of food waste by demographic origin.
- Figure D-15 compares the divertibility of disposed MSW by demographic origin.

Table D-7 Waste Composition by Demographic Origin (Percentage)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**23.2%**	**24.1%**	**21.8%**	**Organics**	**45.2%**	**42.3%**	**44.3%**
Corrugated Cardboard/Kraft Paper	6.7%	5.9%	3.6%	Food Waste	18.0%	18.7%	18.9%
Newspaper	0.5%	0.6%	0.5%	Yard Waste - Grass	2.9%	1.6%	1.3%
Office/High Grade Paper	0.9%	0.7%	0.3%	Yard Waste - Other	1.8%	2.9%	2.7%
Magazine & Catalogs	0.6%	1.0%	0.9%	Wood - Unpainted	2.3%	2.9%	2.0%
Aseptic Boxes & Gable Top Cartons	0.3%	0.3%	0.2%	Wood - Painted	3.3%	3.1%	2.1%
Mixed Recyclable Paper (Low Grade)	5.0%	4.9%	4.5%	Textiles & Leather Products	8.2%	4.5%	4.6%
Compostable Paper	6.2%	7.8%	8.6%	Diapers & Sanitary Products	2.2%	3.2%	3.8%
Non-recyclable Paper	2.9%	3.0%	3.3%	Animal By-Products	1.0%	2.8%	4.5%
Plastic	**18.2%**	**17.5%**	**16.5%**	Fines	3.6%	1.0%	1.8%
#1 PET Bottles & Jars	1.3%	1.4%	1.6%	Other Organics	2.0%	1.9%	2.4%
#1 PET Non-Bottles & Containers	0.4%	0.3%	0.5%	**Inorganics**	**7.1%**	**8.3%**	**10.1%**
#2 HDPE Natural Bottles	0.2%	0.3%	0.3%	Electronics - Covered Devices	0.9%	0.1%	0.0%
#2 HDPE Colored Bottles	0.4%	0.4%	0.5%	Other Electronics	0.7%	0.6%	1.0%
#3 - #7 Bottles	0.3%	0.0%	0.0%	Carpet & Carpet Padding	1.1%	1.8%	0.3%
#2 - #7 Non-Bottle Rigid Containers	1.0%	1.3%	1.1%	Drywall/Gypsum Board	0.5%	0.3%	1.5%
Expanded Polystyrene	0.6%	0.5%	0.6%	Concrete, Rock, Brick	0.5%	0.2%	0.0%
Clean Retail Plastic Bags	0.0%	0.1%	0.1%	Asphalt Roofing	0.0%	0.0%	0.9%
Industrial Film	1.0%	1.6%	1.0%	Asphalt Paving	0.0%	0.0%	0.0%
All Other Film	5.6%	5.9%	5.7%	Other C&D	0.1%	1.6%	3.1%
Durable/Bulky Rigid Plastics	4.0%	2.3%	2.5%	Medically-Related Waste	0.3%	0.3%	0.1%
Remainder/Composite Plastic	3.3%	3.4%	2.4%	Lithium Batteries	0.0%	0.0%	0.0%
Metals	**3.0%**	**4.4%**	**3.6%**	Automotive Batteries	0.0%	0.0%	0.0%
Steel Cans	0.7%	0.8%	0.9%	Other Batteries	0.0%	0.1%	0.1%
Aluminum Cans	0.6%	0.6%	0.8%	Other HHW	0.1%	0.1%	0.0%
Other Aluminum	0.2%	0.3%	0.4%	Bulky Materials	1.7%	1.5%	0.5%
Other Ferrous Metals	1.2%	2.1%	1.1%	Furniture	0.3%	0.6%	1.0%
Other Non-Ferrous Metals	0.3%	0.6%	0.3%	Other Inorganics	0.4%	0.8%	1.0%
Glass	**3.3%**	**3.4%**	**3.7%**	PPE	0.3%	0.3%	0.4%
Clear Glass Containers	1.0%	1.3%	1.9%				
Green Glass Containers	0.3%	0.4%	0.4%				
Brown Glass Containers	0.9%	0.7%	0.5%	**Grand Total**	**100%**	**100%**	**100%**
Non-Recyclable Glass	1.1%	1.0%	0.9%	**Number of Samples**	**43**	**122**	**40**

Table D-8 Waste Composition by Demographic Origin (Tons)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**18,725**	**73,177**	**52,042**	**Organics**	**36,485**	**128,718**	**105,661**
Corrugated Cardboard/Kraft Paper	5,416	17,846	8,651	Food Waste	14,509	56,714	*45,145*
Newspaper	408	1,728	1,225	Yard Waste - Grass	2,317	4,776	3,202
Office/High Grade Paper	740	2,123	673	Yard Waste - Other	1,492	8,771	6,409
Magazine & Catalogs	492	3,118	2,045	Wood - Unpainted	1,820	8,799	4,717
Aseptic Boxes & Gable Top Cartons	278	771	582	Wood - Painted	2,650	9,311	5,073
Mixed Recyclable Paper (Low Grade)	4,062	14,899	10,632	Textiles & Leather Products	6,597	13,538	11,068
Compostable Paper	5,017	23,631	20,467	Diapers & Sanitary Products	1,767	9,654	9,158
Non-recyclable Paper	2,311	9,062	7,766	Animal By-Products	790	8,494	10,776
Plastic	**14,731**	**53,249**	**39,475**	Fines	2,948	2,915	4,278
#1 PET Bottles & Jars	1,065	4,260	3,919	Other Organics	1,594	5,746	5,836
#1 PET Non-Bottles & Containers	285	794	1,113	**Inorganics**	**5,705**	**25,243**	**24,133**
#2 HDPE Natural Bottles	195	885	805	Electronics - Covered Devices	732	434	49
#2 HDPE Colored Bottles	297	1,270	1,211	Other Electronics	566	1,750	2,464
#3 - #7 Bottles	238	105	79	Carpet & Carpet Padding	909	5,328	746
#2 - #7 Non-Bottle Rigid Containers	828	3,999	2,731	Drywall/Gypsum Board	401	901	3,631
Expanded Polystyrene	460	1,663	1,449	Concrete, Rock, Brick	375	747	93
Clean Retail Plastic Bags	33	235	181	Asphalt Roofing	0	23	2,074
Industrial Film	834	4,733	2,463	Asphalt Paving	0	6	0
All Other Film	4,536	17,898	13,646	Other C&D	117	4,912	7,504
Durable/Bulky Rigid Plastics	3,261	7,115	6,066	Medically-Related Waste	208	769	334
Remainder/Composite Plastic	2,699	10,292	5,812	Lithium Batteries	0	0	10
Metals	**2,439**	**13,235**	**8,511**	Automotive Batteries	0	0	0
Steel Cans	559	2,356	2,080	Other Batteries	39	226	269
Aluminum Cans	498	1,772	1,900	Other HHW	115	204	9
Other Aluminum	172	914	1,062	Bulky Materials	1,412	4,621	1,191
Other Ferrous Metals	989	6,255	2,652	Furniture	209	1,711	2,482
Other Non-Ferrous Metals	221	1,938	817	Other Inorganics	363	2,555	2,380
Glass	**2,683**	**10,337**	**8,827**	PPE	259	1,055	895
Clear Glass Containers	830	3,860	4,476				
Green Glass Containers	205	1,160	868				
Brown Glass Containers	765	2,210	1,249	**Grand Total**	**80,769**	**303,960**	**238,649**
Non-Recyclable Glass	883	3,106	2,233	**Number of Samples**	**43**	**122**	**40**

Figure D-12 Composition Summary by Demographic Origin (Percentage)

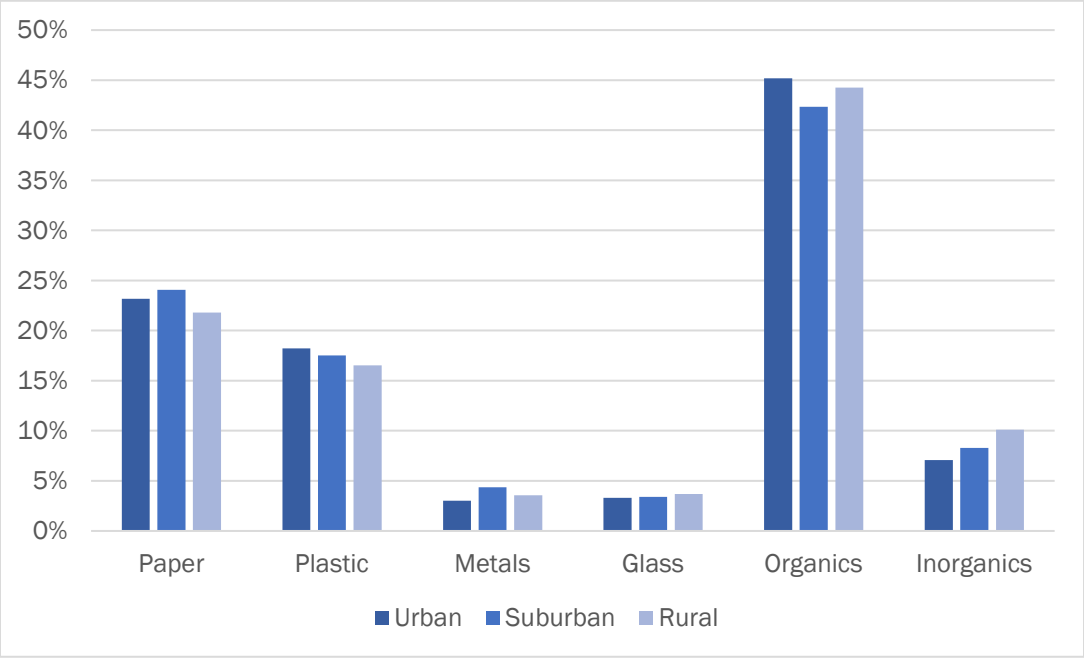


Figure D-13 Composition Summary by Demographic Origin (Tons)

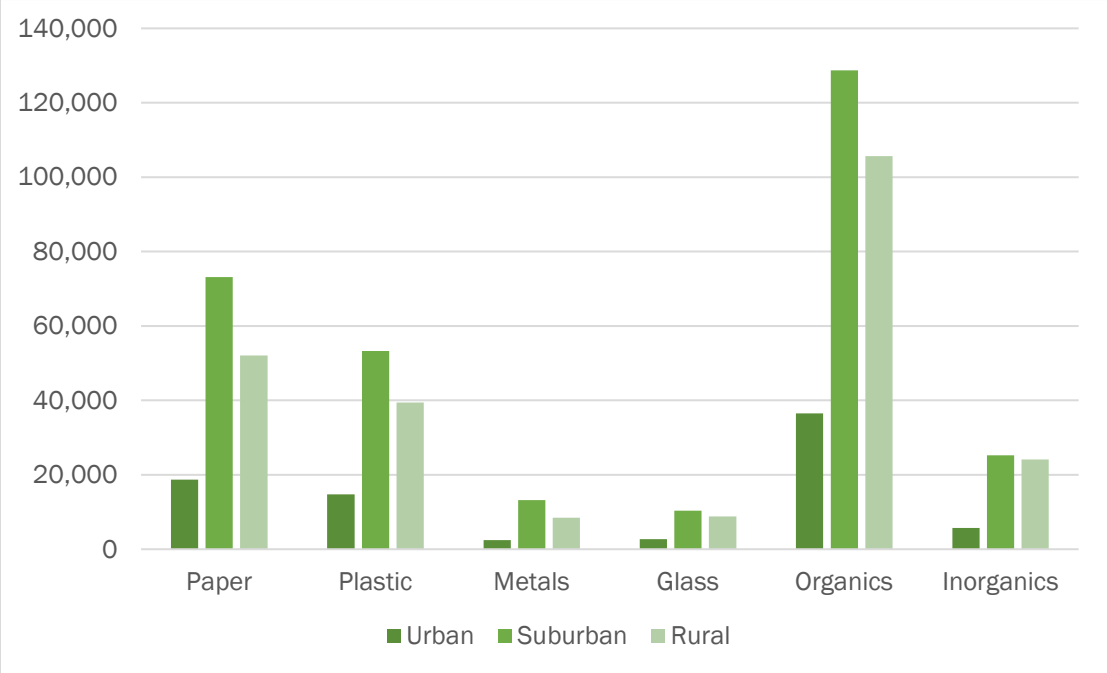


Figure D-14 Detailed Food Waste by Demographic Origin

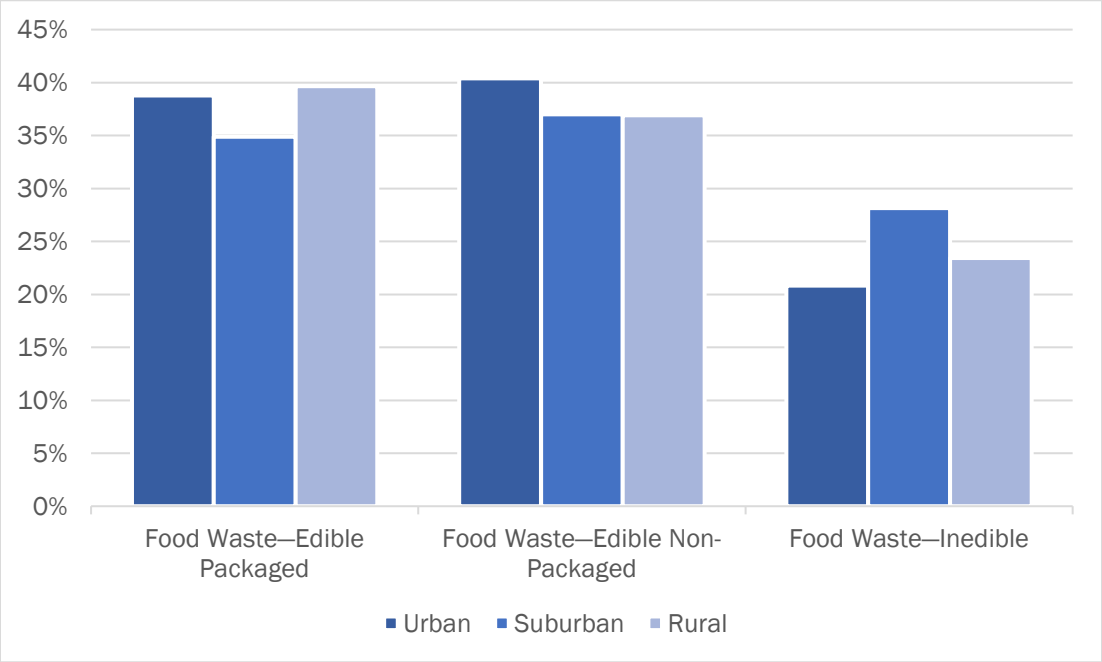
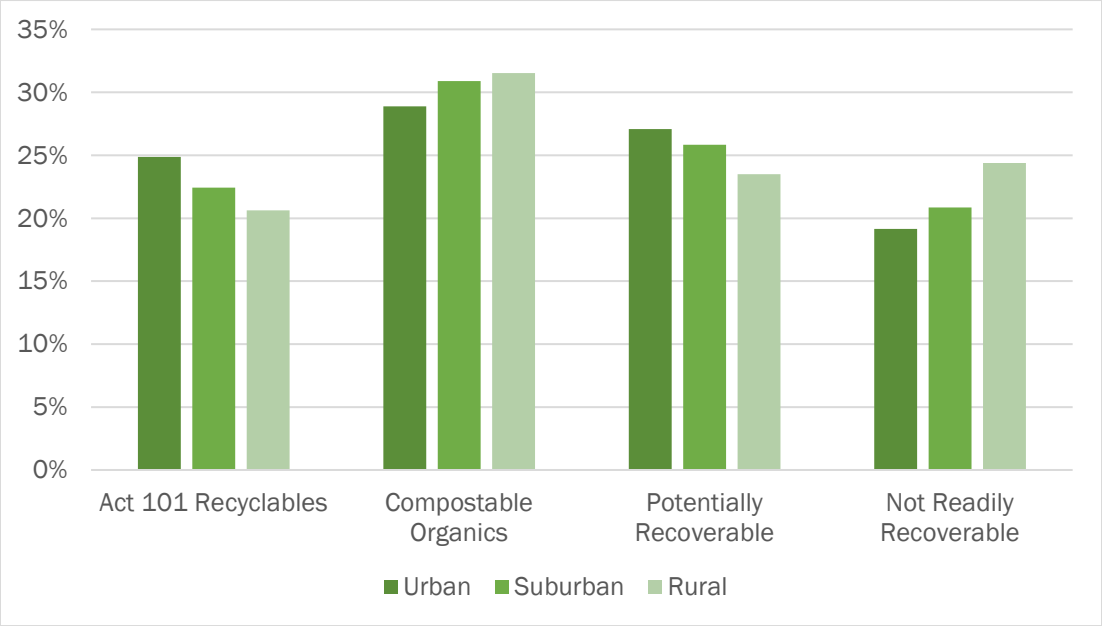


Figure D-15 Divertibility Comparison (Percentage)



D 5. ECONOMIC AND ENVIRONMENTAL IMPACTS

The following supplemental analyses have been included to illustrate the potential financial and environmental impacts of diverting recyclable and compostable materials from the disposed MSW stream.

- Table D-9 estimates the recovered material value for recyclables commodities that were disposed in the regional MSW stream. Market values were obtained from recyclingmarkets.net.
- Table D-10 calculates the greenhouse gas emissions that could be reduced if the estimated quantities of recyclable and compostable materials disposed in the Northeast region were diverted from disposal.

Table D-9 Estimated Value of Disposed Recyclable Materials

Recyclable Commodities	Estimated Tons Disposed	Average Market Price ($/ton)	Estimated Total Market Value ($)
Recyclable Paper	**75,690**		**$9,010,409**
Corrugated Cardboard/Kraft Paper	31,913	$135	$4,308,215
Newspaper	3,362	$188	$630,373
Office/High Grade Paper	3,537	$235	$831,279
Magazine & Catalogs	5,654	$168	$947,103
Aseptic Boxes & Gable Top Cartons	1,631	$0	$0
Mixed Recyclable Paper (Low Grade)	29,593	$78	$2,293,439
Recyclable Containers	**65,309**		**$26,564,592**
#1 PET Bottles & Jars	9,244	$860	$7,949,635
#1 PET Non-Bottles & Containers	2,191	$130	$284,822
#2 HDPE Natural Bottles	1,885	$1,130	$2,130,217
#2 HDPE Colored Bottles	2,778	$640	$1,777,929
#3 - #7 Bottles	423	$130	$54,943
#2 - #7 Non-Bottle Rigid Containers	7,557	$130	$2,985,173
Durable/Bulky Rigid Plastics	16,443	$90	$1,479,827
Steel Cans	4,995	$230	$1,148,853
Aluminum Cans	4,169	$1,950	$8,130,274
Clear Glass Containers	9,166	$50	$458,323
Green Glass Containers	2,233	$8	$16,751
Brown Glass Containers	4,224	$35	$147,847
Total	**140,999**	*$252*	**$35,575,001**

Source: Recyclingmarkets.net - Northeast Region of U.S. as of 06/9/22

Table D-10 Emissions Reduction Potential from Disposed Recyclables

Material Components	Tons Recycled/ Composted[1]	Emissions Reduced ($MTCO_2E$)[2]
Recyclable Paper	**74,059**	**241,571**
Corrugated Cardboard/Kraft Paper	31,913	100,058
Magazine & Catalogs	5,654	17,356
Newspaper	3,362	9,105
Office/High Grade Paper	3,537	10,129
Mixed Recyclable Paper	29,593	104,923
Recyclable Containers	**65,309**	**89,501**
Aluminum Cans	4,169	38,052
Steel Cans	4,995	9,151
Glass	15,624	4,314
PET	11,435	11,843
HDPE	4,663	3,537
Mixed Plastics	24,423	22,604
Compostable	**143,334**	**14,894**
Food Waste	116,367	13,450
Yard Waste	26,966	1,444
Total	**282,702**	**345,966**

[1] Based on estimated overall MSW waste composition for 2021 and Pennsylvania's reported MSW disposal tonnage for FY 2021. Assumes the materials would be recycled instead of disposed.

[2] U.S. EPA Waste Reduction Model, Version 15

APPENDIX E

SOUTHEAST REGIONAL RESULTS

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APPENDIX E – SOUTHEAST REGION RESULTS

E 1. INTRODUCTION

Pennsylvania's Southeast region encompasses five counties and has a population of 772,500 people and more than 300,000 households. A map of the Southeast region is shown in Figure E-1.

Figure E-1 Southeast Region Map

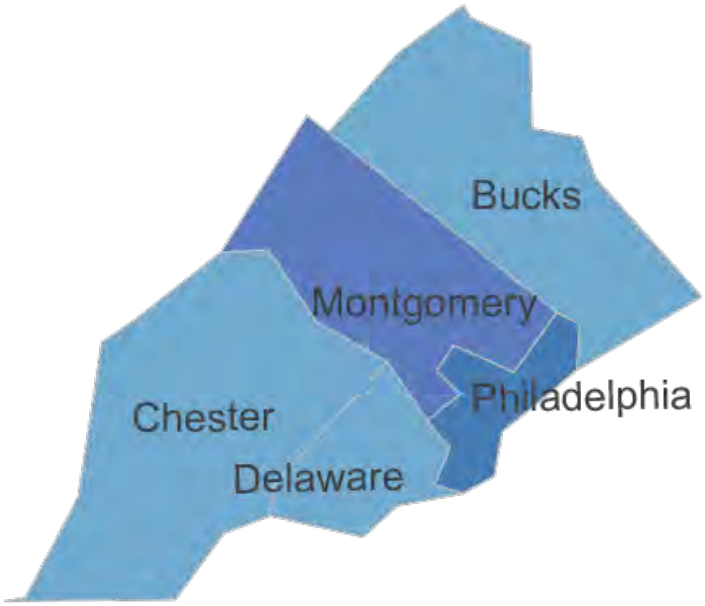


Table E-1 summarizes selected demographic and economic data for the Southeast Region. As shown, this region is composed predominantly suburban and urban, with some rural areas.

Table E-1 Southeast Region Demographic Summary (2021)

	Urban	Suburban	Rural	Total
Communities	2	213	24	**239**
Population	1,608,786	2,522,021	64,618	**4,195,425**
Housing Units	625,155	926,240	23,688	**1,575,083**
Employment	688,649	1,344,751	15,253	**2,048,653**

Sources: Demographic data from the Pennsylvania State Data Center; employment data from ESRI Business Patterns. The allocation of these data to urban, suburban, and rural areas was estimated by MSW Consultants.

The methodology for estimating waste generation within the residential and commercial sectors, and allocated across urban, suburban, and rural areas, is described in the main body of this report. Table E-2 presents the resulting allocation of generated wastes within the Southeast Region. These quantities are used as weighting factors for determining the aggregate waste composition within the region.

Table E-2 Estimated Allocation of MSW Generated in the Southeast Region

	Tons of Waste Disposed			
Generating Sector	Urban	Suburban	Rural	Total
Residential	662,664	852,141	21,082	1,535,887
Commercial	548,088	1,070,272	12,140	1,630,499
Total	1,210,752	1,922,413	33,222	3,166,387

Field sampling and sorting of Southeast region wastes was performed at the Montgomery RRF, Northwest Transfer Station, and Chester County Landfill. Sampling at these facilities was performed across four seasons to capture seasonal variation in MSW composition. Table E-3 provides a sampling summary for the Southeast Region. Regional sampling targets were met in this region.

Table E-3 Southeast Region Sampling Summary

	Number of Samples			
Waste Generating Sector	Urban	Suburban	Rural	Total
Residential	116	49	3	168
Commercial	20	49	1	70
Total	136	98	4	238

E 2. AGGREGATE WASTE COMPOSITION

The remainder of this section presents a graphical and tabular summary of the Southeast region's disposed MSW composition. Specific figures and tables are summarized below.

- Table E-4 provides the detailed tabular composition of the aggregated disposed refuse stream. This table shows the mean composition, margin of error (MOE) at a 90 percent level of confidence, and the estimated tonnage of each of the constituents in the refuse stream.
- Figure E-2 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented as percentages.
- Figure E-3 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented in tons.
- Figure E-4 is a pie chart that shows the percentage composition of major material groups in the aggregate regional waste stream. As shown, organics comprise 40 percent of the refuse disposed in the Southeast region.
- Figure E-5 shows the 10 most prevalent materials being disposed in the region by weight.
- Figure E-6 is a pie chart that shows the detailed percentage composition of the food waste category.
- Figure E-7 illustrates the divertibility of the aggregate disposed refuse stream. This graphic shows that the majority of the materials being disposed could be diverted through existing recycling programs, composting programs, and third-party recovery programs. It should be noted that this graphic omits the impact of contamination, and as a practical matter it is not possible for all the divertible materials to actually be diverted.

Table E-4 Detailed Southeast Region Waste Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**24.1%**	**1.7%**	**761,604**	**Organics**	**43.8%**	**1.8%**	**1,387,817**
Corrugated Cardboard/Kraft Paper	7.3%	1.3%	230,637	Food Waste	18.9%	2.3%	598,506
Newspaper	0.6%	0.2%	18,513	Yard Waste - Grass	1.1%	0.5%	33,304
Office/High Grade Paper	0.4%	0.2%	12,083	Yard Waste - Other	3.8%	0.8%	118,870
Magazine & Catalogs	0.8%	0.4%	25,681	Wood - Unpainted	4.0%	1.0%	126,723
Aseptic Boxes & Gable Top Cartons	0.2%	0.0%	6,806	Wood - Painted	2.7%	0.5%	85,441
Mixed Recyclable Paper (Low Grade)	5.2%	0.7%	164,802	Textiles & Leather Products	4.6%	0.6%	144,550
Compostable Paper	6.8%	0.4%	213,989	Diapers & Sanitary Products	2.6%	0.3%	82,215
Non-recyclable Paper	2.8%	0.5%	89,092	Animal By-Products	2.2%	0.4%	68,123
Plastic	**16.7%**	**1.3%**	**530,192**	Fines	2.1%	0.3%	66,764
#1 PET Bottles & Jars	1.0%	0.1%	32,428	Other Organics	2.0%	0.4%	63,320
#1 PET Non-Bottles & Containers	0.2%	0.0%	4,862	**Inorganics**	**9.7%**	**1.2%**	**308,007**
#2 HDPE Natural Bottles	0.3%	0.1%	10,125	Electronics - Covered Devices	0.2%	0.2%	7,145
#2 HDPE Colored Bottles	0.3%	0.0%	10,699	Other Electronics	0.4%	0.1%	13,625
#3 - #7 Bottles	0.1%	0.1%	2,425	Carpet & Carpet Padding	1.9%	0.6%	60,975
#2 - #7 Non-Bottle Rigid Containers	1.3%	0.1%	40,529	Drywall/Gypsum Board	0.6%	0.3%	20,308
Expanded Polystyrene	0.7%	0.1%	21,893	Concrete, Rock, Brick	0.4%	0.2%	12,173
Clean Retail Plastic Bags	0.1%	0.0%	2,925	Asphalt Roofing	0.5%	0.5%	15,982
Industrial Film	1.3%	0.5%	42,163	Asphalt Paving	0.1%	0.1%	2,247
All Other Film	6.7%	0.8%	213,369	Other C&D	1.8%	0.5%	57,280
Durable/Bulky Rigid Plastics	1.7%	0.3%	53,405	Medically-Related Waste	0.1%	0.1%	4,514
Remainder/Composite Plastic	3.0%	0.9%	95,370	Lithium Batteries	0.0%	0.0%	40
Metals	**3.5%**	**0.4%**	**109,398**	Automotive Batteries	0.0%	0.0%	0
Steel Cans	0.6%	0.1%	18,064	Other Batteries	0.1%	0.0%	2,004
Aluminum Cans	0.4%	0.0%	13,251	Other HHW	0.0%	0.1%	1,576
Other Aluminum	0.4%	0.1%	11,141	Bulky Materials	1.0%	0.4%	32,140
Other Ferrous Metals	1.6%	0.4%	50,610	Furniture	1.7%	0.5%	54,914
Other Non-Ferrous Metals	0.5%	0.1%	16,332	Other Inorganics	0.4%	0.1%	12,716
Glass	**2.2%**	**0.3%**	**69,369**	PPE	0.3%	0.1%	10,367
Clear Glass Containers	1.0%	0.2%	31,793				
Green Glass Containers	0.3%	0.1%	8,848				
Brown Glass Containers	0.3%	0.1%	10,138	**Grand Total**	**100.0%**		**3,166,387**
Non-Recyclable Glass	0.6%	0.1%	18,591	**Number of Samples**	**238**		

Margin of error is calculated at a 90 percent level of confidence.

Figure E-2 Comparison of Composition by Material Group 2021 vs 2001 (Percentage)

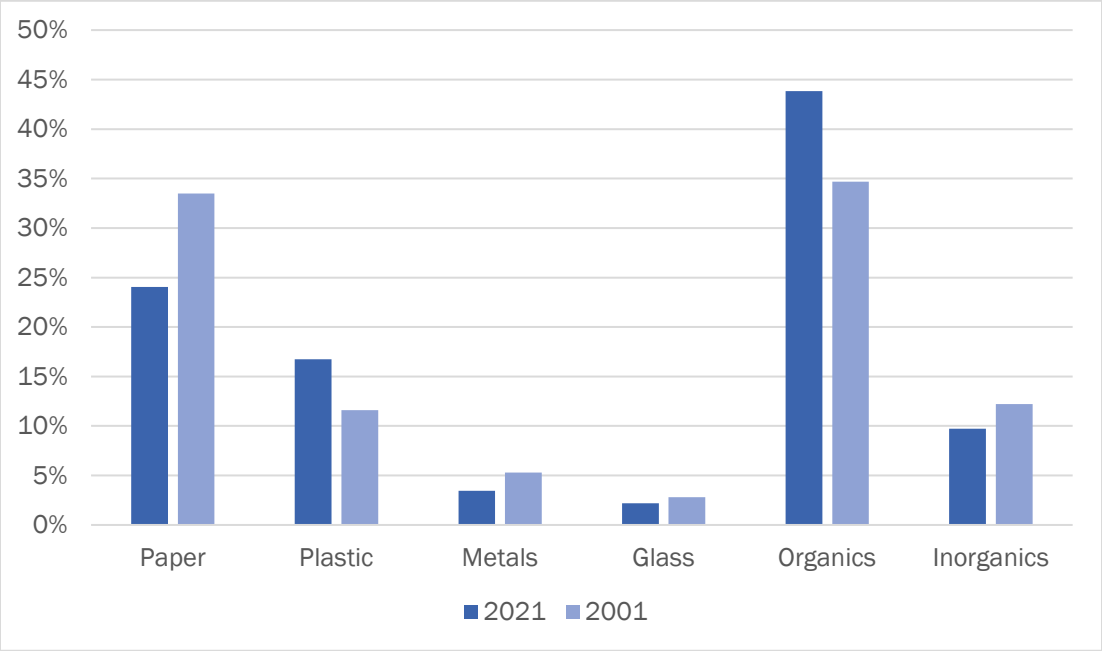


Figure E-3 Comparison of Composition by Material Group 2021 vs 2001 (Tons)

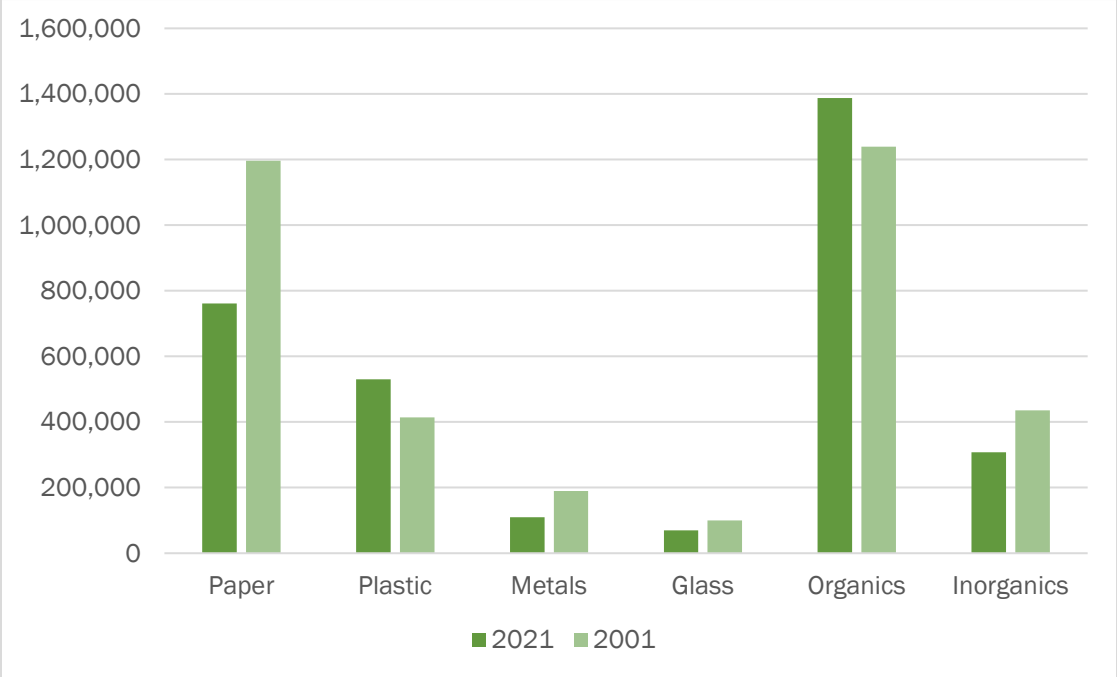


Figure E-4 Composition Summary by Material Group (Percentage)

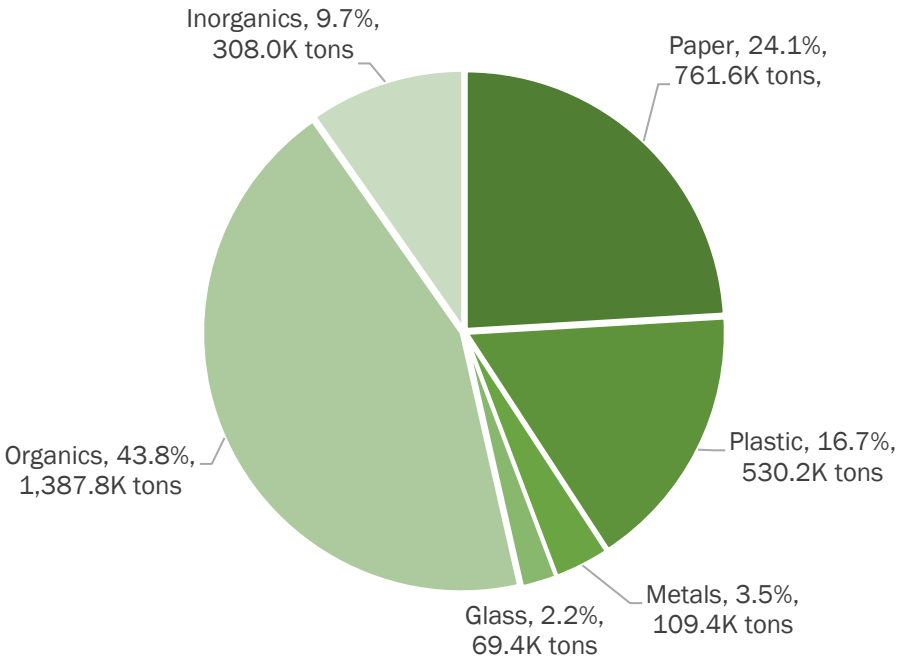
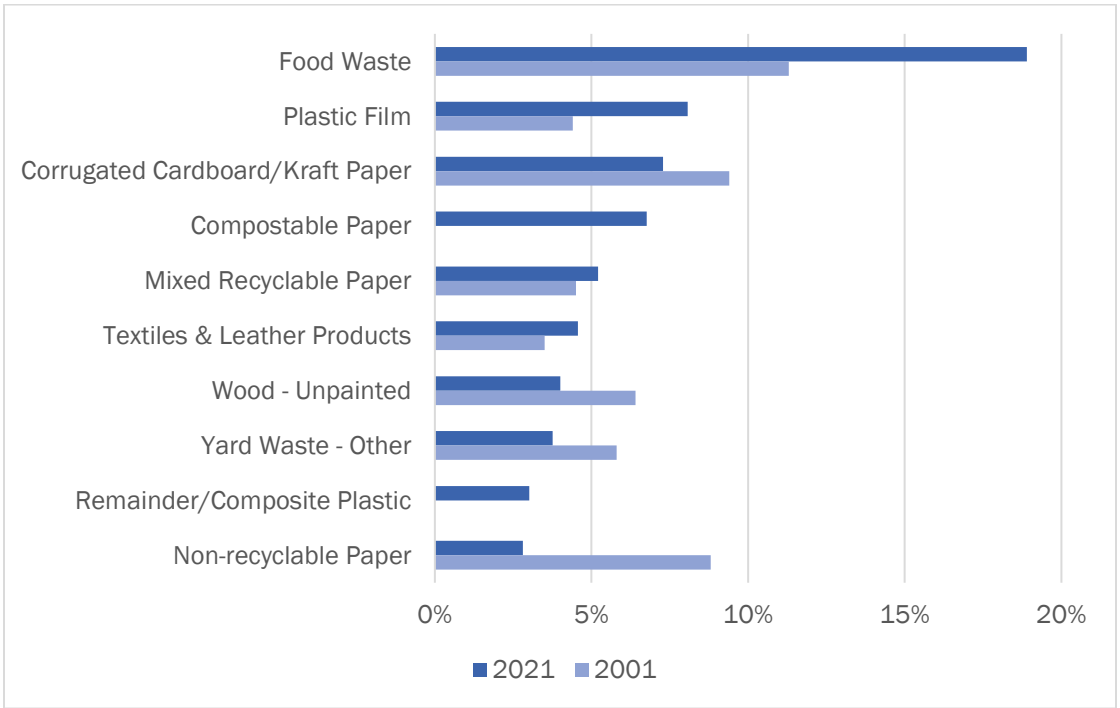


Figure E-5 Top 10 Most Prevalent by Weight*



*Note: Some material categories were not sorted in 2001 Study

Figure E-6 Food Waste Detail

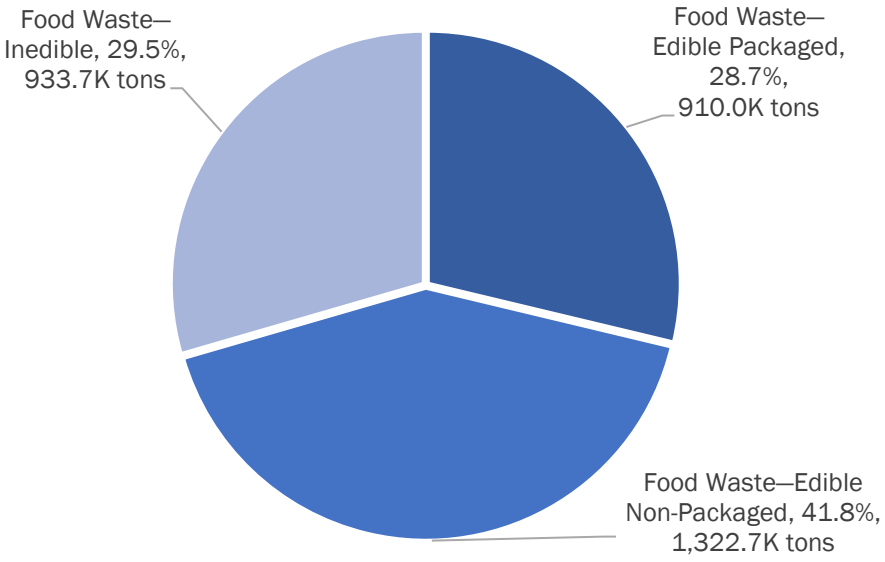
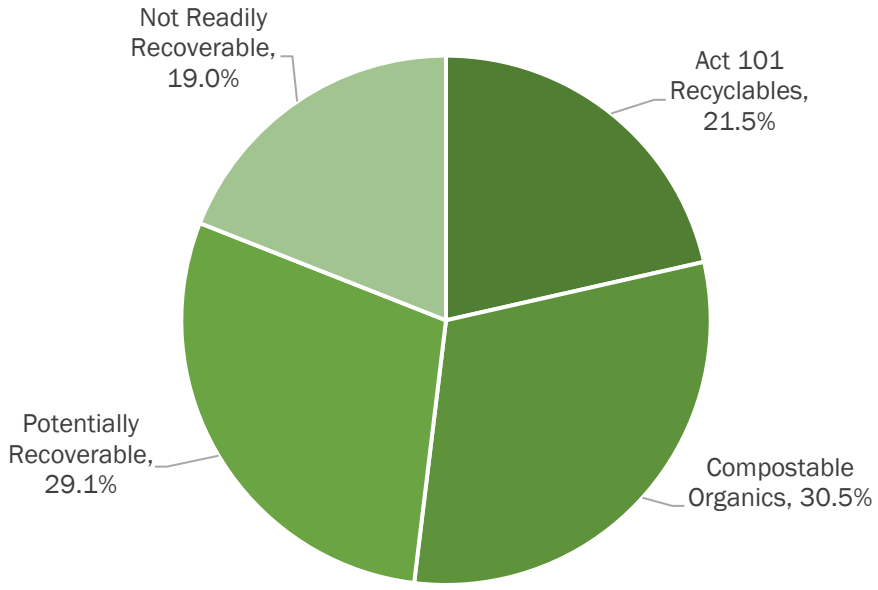


Figure E-7 Divertibility Comparison (Percentage)



E 3. COMPOSITION COMPARISONS BY GENERATING SECTOR

The composition of residential and commercial MSW were analyzed individually with selected comparisons shown below:

- Table E-5 and Table E-6 contain detailed comparisons of disposed residential and commercial MSW in the Southeast region based on percentage composition and absolute tonnage, respectively.
- Figure E-8 and Figure E-9 compare the residential and commercial disposed MSW based on percentage composition and absolute tonnage, respectively.
- Figure E-10 is a bar chart that compares the breakdown of food waste by generating sector.
- Figure E-11 illustrates the divertibility of disposed MSW by generating sector.

Table E-5 Waste Composition by Generator Sector (Percentage)

Material Category	Res	ICI		Res	ICI
Paper	**20.2%**	**27.6%**	**Organics**	**47.1%**	**40.7%**
Corrugated Cardboard/Kraft Paper	3.6%	10.8%	Food Waste	14.8%	22.8%
Newspaper	0.8%	0.4%	Yard Waste - Grass	1.6%	0.6%
Office/High Grade Paper	0.3%	0.5%	Yard Waste - Other	5.6%	2.0%
Magazine & Catalogs	0.6%	1.0%	Wood - Unpainted	1.8%	6.0%
Aseptic Boxes & Gable Top Cartons	0.2%	0.2%	Wood - Painted	4.0%	1.5%
Mixed Recyclable Paper (Low Grade)	4.9%	5.5%	Textiles & Leather Products	6.8%	2.5%
Compostable Paper	7.5%	6.1%	Diapers & Sanitary Products	3.9%	1.4%
Non-recyclable Paper	2.4%	3.2%	Animal By-Products	4.0%	0.4%
Plastic	**13.2%**	**20.1%**	Fines	2.2%	2.0%
#1 PET Bottles & Jars	1.2%	0.8%	Other Organics	2.4%	1.6%
#1 PET Non-Bottles & Containers	0.2%	0.1%	**Inorganics**	**12.7%**	**6.9%**
#2 HDPE Natural Bottles	0.2%	0.4%	Electronics - Covered Devices	0.2%	0.3%
#2 HDPE Colored Bottles	0.4%	0.3%	Other Electronics	0.7%	0.1%
#3 - #7 Bottles	0.0%	0.1%	Carpet & Carpet Padding	2.2%	1.7%
#2 - #7 Non-Bottle Rigid Containers	1.4%	1.2%	Drywall/Gypsum Board	0.7%	0.5%
Expanded Polystyrene	0.7%	0.7%	Concrete, Rock, Brick	0.5%	0.3%
Clean Retail Plastic Bags	0.1%	0.1%	Asphalt Roofing	0.2%	0.8%
Industrial Film	0.0%	2.6%	Asphalt Paving	0.1%	0.0%
All Other Film	5.5%	7.9%	Other C&D	2.1%	1.5%
Durable/Bulky Rigid Plastics	1.8%	1.6%	Medically-Related Waste	0.1%	0.2%
Remainder/Composite Plastic	1.7%	4.3%	Lithium Batteries	0.0%	0.0%
Metals	**3.7%**	**3.3%**	Automotive Batteries	0.0%	0.0%
Steel Cans	0.5%	0.6%	Other Batteries	0.1%	0.0%
Aluminum Cans	0.6%	0.3%	Other HHW	0.1%	0.0%
Other Aluminum	0.4%	0.3%	Bulky Materials	1.7%	0.4%
Other Ferrous Metals	1.6%	1.6%	Furniture	3.3%	0.2%
Other Non-Ferrous Metals	0.6%	0.4%	Other Inorganics	0.6%	0.2%
Glass	**3.1%**	**1.4%**	PPE	0.1%	0.6%
Clear Glass Containers	1.4%	0.7%			
Green Glass Containers	0.4%	0.2%			
Brown Glass Containers	0.4%	0.2%	**Grand Total**	**100%**	**100%**
Non-Recyclable Glass	0.9%	0.3%	**Number of Samples**	**168**	**70**

Table E-6 Waste Composition by Generator Sector (Tons)

Material Category	Res	ICI		Res	ICI
Paper	**310,772**	**450,832**	**Organics**	**723,437**	**664,379**
Corrugated Cardboard/Kraft Paper	55,347	175,290	Food Waste	226,892	371,614
Newspaper	11,984	6,529	Yard Waste - Grass	24,044	9,260
Office/High Grade Paper	4,500	7,583	Yard Waste - Other	85,960	32,910
Magazine & Catalogs	9,473	16,207	Wood - Unpainted	28,365	98,358
Aseptic Boxes & Gable Top Cartons	3,248	3,558	Wood - Painted	60,883	24,558
Mixed Recyclable Paper (Low Grade)	74,668	90,134	Textiles & Leather Products	104,539	40,012
Compostable Paper	115,242	98,747	Diapers & Sanitary Products	59,654	22,561
Non-recyclable Paper	36,310	52,783	Animal By-Products	61,996	6,127
Plastic	**202,710**	**327,482**	Fines	34,373	32,391
#1 PET Bottles & Jars	18,627	13,800	Other Organics	36,732	26,588
#1 PET Non-Bottles & Containers	3,288	1,574	**Inorganics**	**195,771**	**112,236**
#2 HDPE Natural Bottles	3,061	7,064	Electronics - Covered Devices	2,818	4,327
#2 HDPE Colored Bottles	5,586	5,113	Other Electronics	11,212	2,414
#3 - #7 Bottles	378	2,047	Carpet & Carpet Padding	33,857	27,118
#2 - #7 Non-Bottle Rigid Containers	21,095	19,434	Drywall/Gypsum Board	11,410	8,898
Expanded Polystyrene	11,284	10,609	Concrete, Rock, Brick	7,820	4,353
Clean Retail Plastic Bags	1,391	1,534	Asphalt Roofing	2,367	13,615
Industrial Film	498	41,665	Asphalt Paving	2,247	0
All Other Film	84,239	129,130	Other C&D	33,016	24,264
Durable/Bulky Rigid Plastics	27,487	25,918	Medically-Related Waste	1,931	2,584
Remainder/Composite Plastic	25,775	69,595	Lithium Batteries	19	21
Metals	**56,161**	**53,237**	Automotive Batteries	0	0
Steel Cans	8,402	9,663	Other Batteries	1,441	563
Aluminum Cans	8,502	4,749	Other HHW	1,032	544
Other Aluminum	5,934	5,207	Bulky Materials	25,779	6,361
Other Ferrous Metals	24,235	26,374	Furniture	50,849	4,065
Other Non-Ferrous Metals	9,087	7,244	Other Inorganics	8,648	4,067
Glass	**47,036**	**22,334**	PPE	1,326	9,041
Clear Glass Containers	20,761	11,031			
Green Glass Containers	6,131	2,717			
Brown Glass Containers	6,470	3,667	**Grand Total**	**1,535,887**	**1,630,499**
Non-Recyclable Glass	13,673	4,918	**Number of Samples**	**168**	**70**

Figure E-8 Composition Summary by Generator Sector (Percentage)

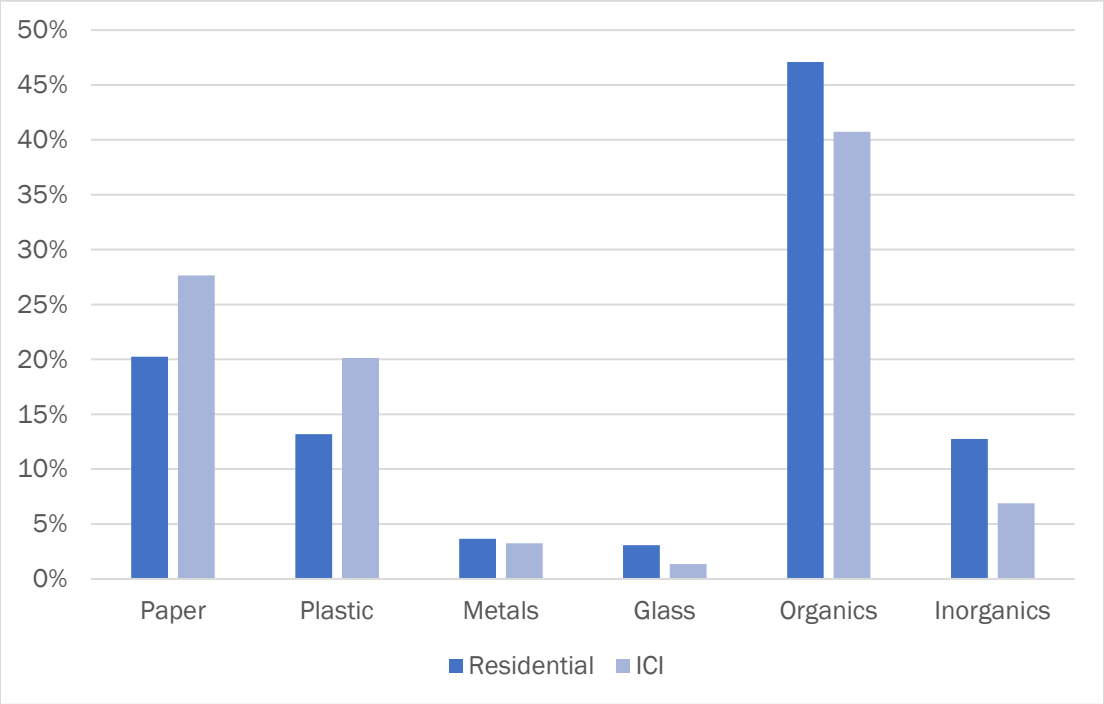


Figure E-9 Composition Summary by Generator Sector (Tons)

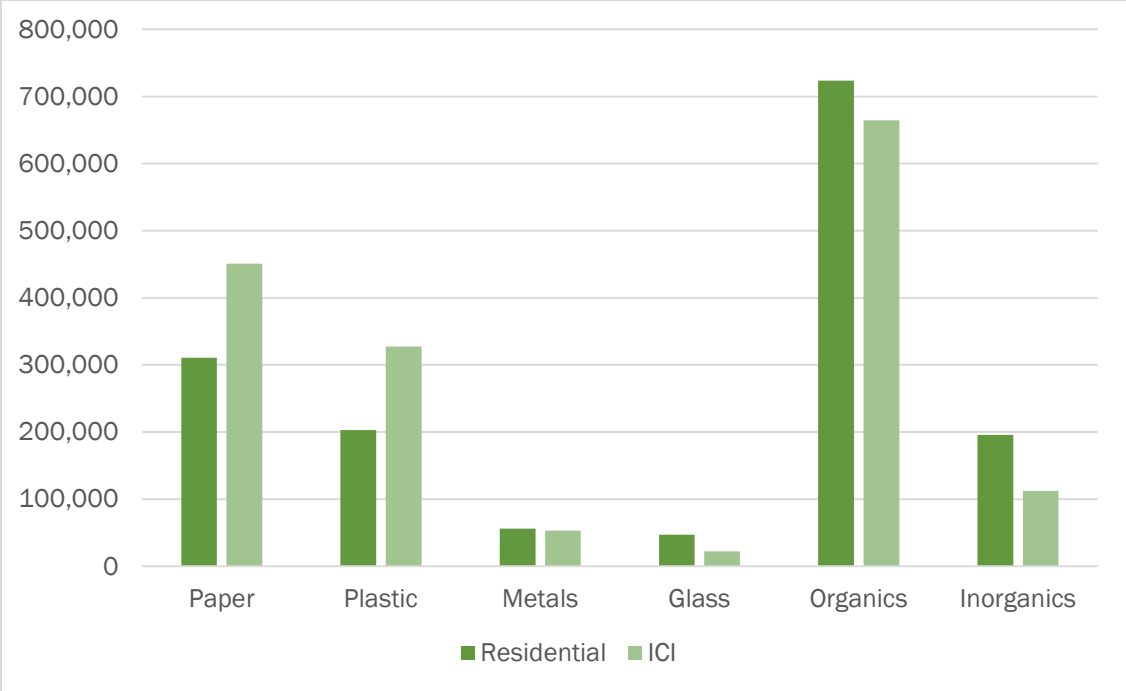


Figure E-10 Food Waste Detail by Generator Sector (Percentage)

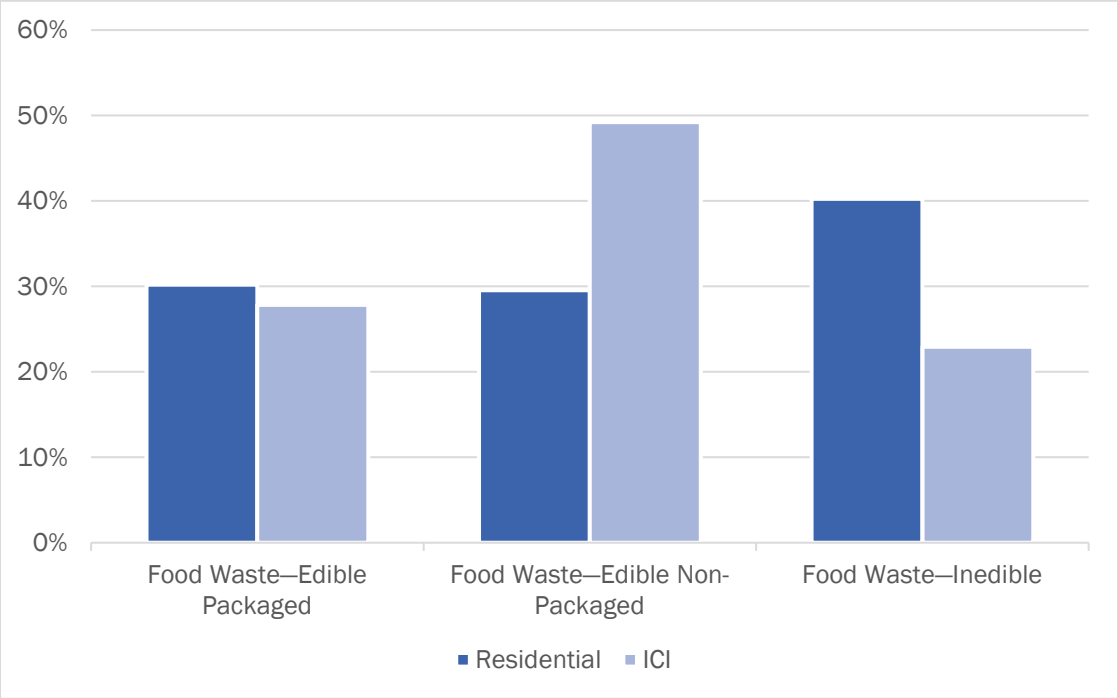
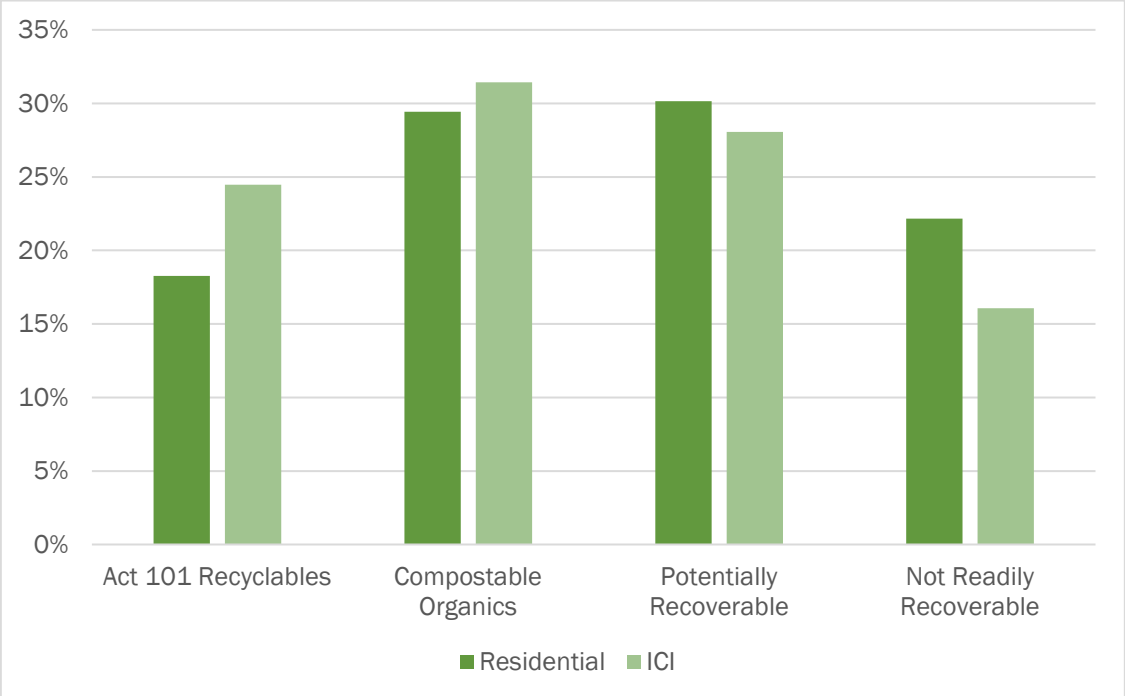


Figure E-11 Divertibility Comparison by Generator Sector (Percentage)



E 4. COMPOSITION BY DEMOGRAPHIC ORIGIN

The composition of urban, suburban, and rural MSW were analyzed individually and selected comparisons are shown below:

- Table E-7 and Table E-8 contain detailed comparisons of disposed MSW from urban, suburban, and rural areas in the Northeast region based on percentage composition and absolute tonnage, respectively.
- Figure E-12 and Figure E-13 compare the urban, suburban, and rural waste streams based on percentage composition and absolute tonnage, respectively.
- Figure E-14 is a bar chart that compares the breakdown of food waste by demographic origin.
- Figure E-15 compares the divertibility of disposed MSW by demographic origin.

Table E-7 Waste Composition by Demographic Origin (Percentage)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**20.9%**	**25.8%**	**36.2%**	**Organics**	**46.2%**	**42.7%**	**22.6%**
Corrugated Cardboard/Kraft Paper	7.7%	6.9%	10.9%	Food Waste	18.0%	19.7%	6.4%
Newspaper	0.3%	0.8%	0.2%	Yard Waste - Grass	0.7%	1.3%	0.0%
Office/High Grade Paper	0.1%	0.6%	0.0%	Yard Waste - Other	5.1%	2.9%	0.2%
Magazine & Catalogs	0.3%	1.1%	1.6%	Wood - Unpainted	4.9%	3.5%	2.2%
Aseptic Boxes & Gable Top Cartons	0.2%	0.2%	0.1%	Wood - Painted	3.6%	2.1%	2.0%
Mixed Recyclable Paper (Low Grade)	4.2%	5.8%	10.4%	Textiles & Leather Products	5.5%	4.0%	3.4%
Compostable Paper	6.1%	7.2%	4.9%	Diapers & Sanitary Products	2.6%	2.6%	3.1%
Non-recyclable Paper	2.0%	3.2%	8.2%	Animal By-Products	1.9%	2.3%	1.4%
Plastic	**15.6%**	**17.3%**	**25.1%**	Fines	1.5%	2.5%	1.3%
#1 PET Bottles & Jars	1.1%	1.0%	1.3%	Other Organics	2.3%	1.8%	2.6%
#1 PET Non-Bottles & Containers	0.2%	0.1%	0.1%	**Inorganics**	**12.0%**	**8.3%**	**8.5%**
#2 HDPE Natural Bottles	0.5%	0.2%	0.1%	Electronics - Covered Devices	0.1%	0.3%	0.0%
#2 HDPE Colored Bottles	0.3%	0.3%	0.2%	Other Electronics	0.3%	0.5%	0.4%
#3 - #7 Bottles	0.2%	0.0%	0.0%	Carpet & Carpet Padding	1.8%	2.0%	0.0%
#2 - #7 Non-Bottle Rigid Containers	1.0%	1.5%	2.3%	Drywall/Gypsum Board	1.3%	0.2%	0.0%
Expanded Polystyrene	0.7%	0.7%	0.3%	Concrete, Rock, Brick	0.3%	0.4%	0.3%
Clean Retail Plastic Bags	0.0%	0.1%	0.1%	Asphalt Roofing	1.3%	0.0%	0.0%
Industrial Film	1.9%	0.8%	7.6%	Asphalt Paving	0.0%	0.1%	0.0%
All Other Film	5.5%	7.5%	9.3%	Other C&D	2.5%	1.4%	0.2%
Durable/Bulky Rigid Plastics	2.3%	1.3%	1.7%	Medically-Related Waste	0.2%	0.1%	0.0%
Remainder/Composite Plastic	2.0%	3.7%	2.1%	Lithium Batteries	0.0%	0.0%	0.0%
Metals	**3.4%**	**3.4%**	**6.2%**	Automotive Batteries	0.0%	0.0%	0.0%
Steel Cans	0.5%	0.6%	0.5%	Other Batteries	0.0%	0.1%	0.1%
Aluminum Cans	0.5%	0.4%	0.4%	Other HHW	0.0%	0.0%	1.9%
Other Aluminum	0.4%	0.3%	0.1%	Bulky Materials	1.7%	0.5%	5.3%
Other Ferrous Metals	1.6%	1.6%	2.1%	Furniture	1.8%	1.7%	0.0%
Other Non-Ferrous Metals	0.5%	0.5%	3.0%	Other Inorganics	0.3%	0.5%	0.3%
Glass	**1.7%**	**2.5%**	**1.4%**	PPE	0.2%	0.4%	0.0%
Clear Glass Containers	0.8%	1.2%	0.2%				
Green Glass Containers	0.2%	0.3%	0.2%				
Brown Glass Containers	0.1%	0.4%	0.1%	**Grand Total**	**100%**	**100%**	**100%**
Non-Recyclable Glass	0.7%	0.5%	0.9%	**Number of Samples**	**136**	**98**	**4**

Table E-8 Waste Composition by Demographic Origin (Tons)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**253,614**	**495,952**	**12,037**	**Organics**	**559,467**	**820,849**	**7,500**
Corrugated Cardboard/Kraft Paper	93,770	133,260	3,607	Food Waste	218,363	378,003	*2,140*
Newspaper	3,862	14,587	65	Yard Waste - Grass	8,543	24,761	0
Office/High Grade Paper	632	11,441	10	Yard Waste - Other	62,252	56,566	52
Magazine & Catalogs	3,994	21,163	524	Wood - Unpainted	59,593	66,397	734
Aseptic Boxes & Gable Top Cartons	2,187	4,592	27	Wood - Painted	44,135	40,654	652
Mixed Recyclable Paper (Low Grade)	50,788	110,548	3,466	Textiles & Leather Products	66,508	76,901	1,142
Compostable Paper	74,379	137,992	1,619	Diapers & Sanitary Products	31,161	50,026	1,029
Non-recyclable Paper	24,003	62,369	2,720	Animal By-Products	23,230	44,439	454
Plastic	**189,453**	**332,405**	**8,334**	Fines	17,823	48,514	427
#1 PET Bottles & Jars	13,514	18,491	422	Other Organics	27,861	34,588	870
#1 PET Non-Bottles & Containers	2,003	2,839	21	**Inorganics**	**145,469**	**159,712**	**2,825**
#2 HDPE Natural Bottles	5,754	4,328	43	Electronics - Covered Devices	1,799	5,346	0
#2 HDPE Colored Bottles	4,137	6,502	60	Other Electronics	4,013	9,466	146
#3 - #7 Bottles	2,082	336	7	Carpet & Carpet Padding	22,113	38,862	0
#2 - #7 Non-Bottle Rigid Containers	11,642	28,110	777	Drywall/Gypsum Board	16,269	4,039	0
Expanded Polystyrene	8,032	13,759	102	Concrete, Rock, Brick	3,529	8,553	91
Clean Retail Plastic Bags	563	2,344	17	Asphalt Roofing	15,280	702	0
Industrial Film	23,508	16,131	2,524	Asphalt Paving	120	2,127	0
All Other Film	66,187	144,084	3,098	Other C&D	30,518	26,692	70
Durable/Bulky Rigid Plastics	28,047	24,783	575	Medically-Related Waste	2,270	2,244	0
Remainder/Composite Plastic	23,985	70,699	687	Lithium Batteries	7	32	0
Metals	**41,590**	**65,763**	**2,045**	Automotive Batteries	0	0	0
Steel Cans	5,796	12,110	159	Other Batteries	376	1,611	17
Aluminum Cans	5,710	7,419	123	Other HHW	99	850	628
Other Aluminum	5,225	5,867	48	Bulky Materials	21,146	9,249	1,746
Other Ferrous Metals	19,312	30,589	709	Furniture	22,131	32,783	0
Other Non-Ferrous Metals	5,548	9,778	1,006	Other Inorganics	3,063	9,536	116
Glass	**21,158**	**47,731**	**480**	PPE	2,737	7,619	11
Clear Glass Containers	9,576	22,135	82				
Green Glass Containers	2,051	6,726	71				
Brown Glass Containers	1,583	8,515	40	**Grand Total**	**1,210,752**	**1,922,413**	**33,222**
Non-Recyclable Glass	7,948	10,355	288	**Number of Samples**	**136**	**98**	**4**

Figure E-12 Composition Summary by Demographic Origin (Percentage)

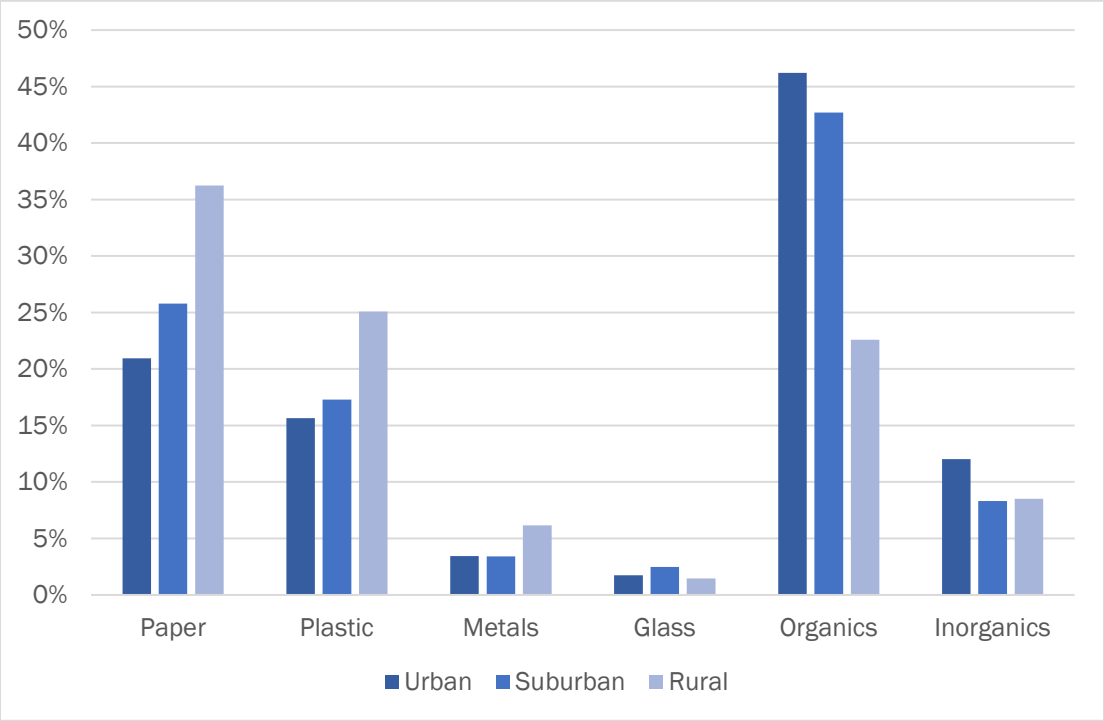


Figure E-13 Composition Summary by Demographic Origin (Tons)

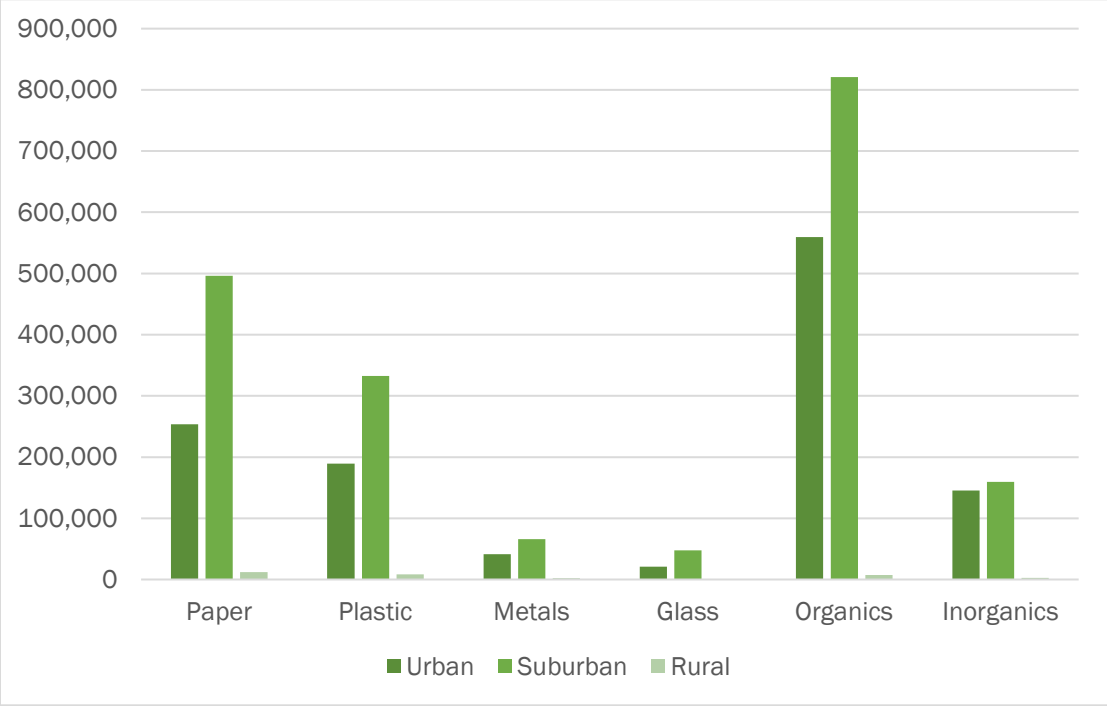


Figure E-14 Food Waste Detail by Demographic Origin

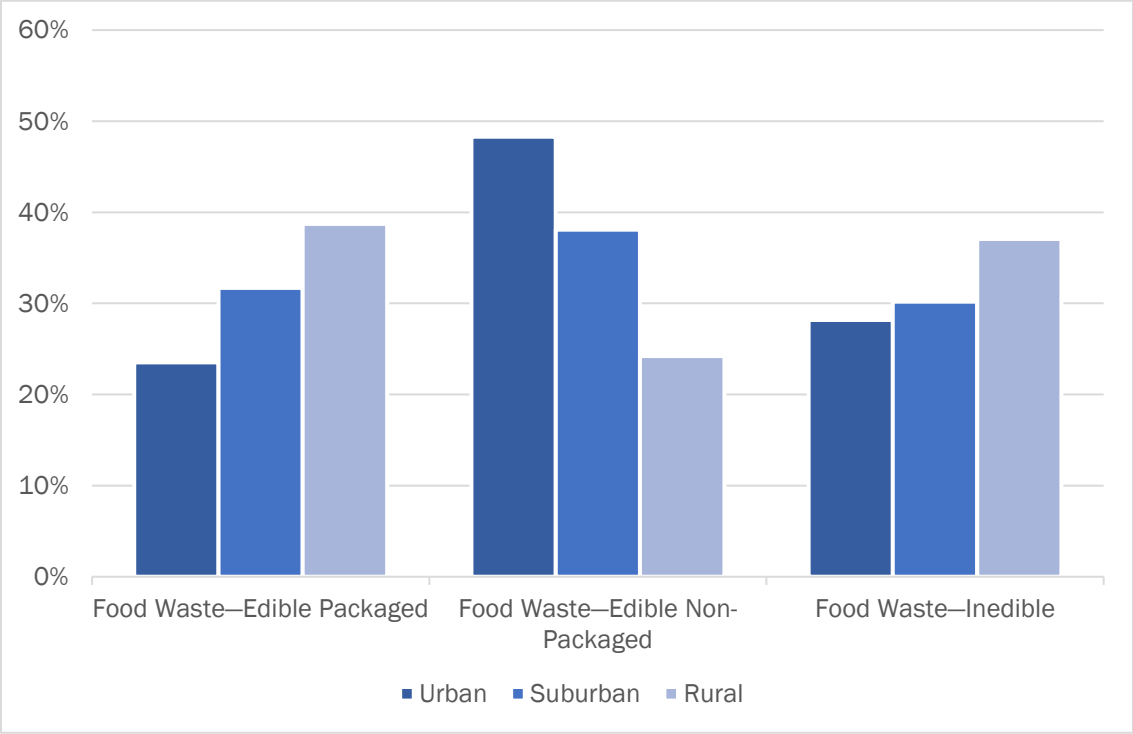
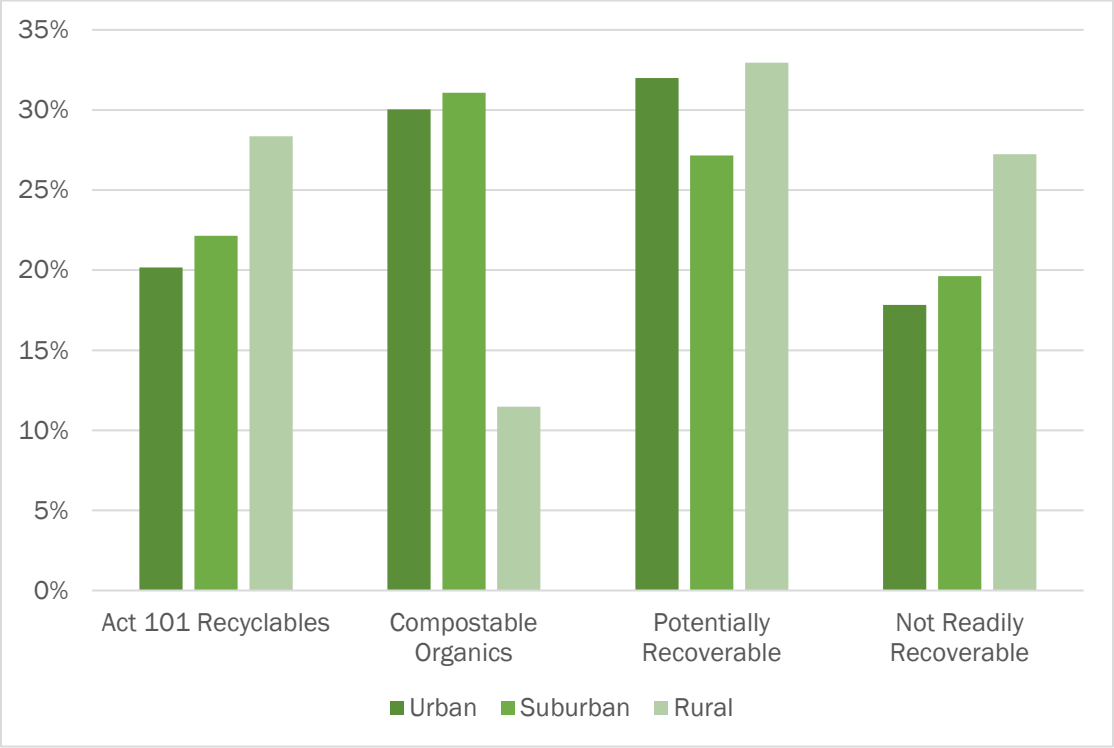


Figure E-15 Divertibility Comparison (Percentage)



E 5. ECONOMIC AND ENVIRONMENTAL IMPACTS

The following supplemental analyses have been included to illustrate the potential financial and environmental impacts of diverting recyclable and compostable materials from the disposed MSW stream.

- Table E-9 estimates the recovered material value for recyclables commodities that were disposed in the regional MSW stream. Market values were obtained from recyclingmarkets.net.
- Table E-10 calculates the greenhouse gas emissions that could be reduced if the estimated quantities of recyclable and compostable materials disposed in the Northeast region were diverted from disposal.

Table E-9 Estimated Value of Disposed Recyclable Materials

Recyclable Commodities	Estimated Tons Disposed	Average Market Price ($/ton)	Estimated Total Market Value ($)
Recyclable Paper	**458,522**		**$54,520,519**
Corrugated Cardboard/Kraft Paper	230,637	$135	$31,136,021
Newspaper	18,513	$188	$3,471,208
Office/High Grade Paper	12,083	$235	$2,839,567
Magazine & Catalogs	25,681	$168	$4,301,553
Aseptic Boxes & Gable Top Cartons	6,806	$0	$0
Mixed Recyclable Paper (Low Grade)	164,802	$78	$12,772,169
Recyclable Containers	**228,646**		**$94,210,819**
#1 PET Bottles & Jars	32,428	$860	$27,887,738
#1 PET Non-Bottles & Containers	4,862	$130	$632,107
#2 HDPE Natural Bottles	10,125	$1,130	$11,440,940
#2 HDPE Colored Bottles	10,699	$130	$1,390,861
#3 - #7 Bottles	2,425	$130	$315,278
#2 - #7 Non-Bottle Rigid Containers	40,529	$395	$16,008,834
Durable/Bulky Rigid Plastics	53,405	$90	$4,806,448
Steel Cans	18,064	$230	$4,154,757
Aluminum Cans	13,251	$1,950	$25,840,248
Clear Glass Containers	31,793	$50	$1,589,625
Green Glass Containers	8,848	$8	$66,361
Brown Glass Containers	2,218	$35	$77,621
Total	**687,169**	*$216*	**$148,731,338**

Source: Recyclingmarkets.net - Northeast Region of U.S. as of 06/9/22

Table E-10 Emissions Reduction Potential from Disposed Recyclables

Material Components	Tons Recycled/ Composted[1]	Emissions Reduced ($MTCO_2E$)[2]
Recyclable Paper	**451,717**	**1,471,008**
Corrugated Cardboard/Kraft Paper	230,637	723,125
Magazine & Catalogs	25,681	78,833
Newspaper	18,513	50,138
Office/High Grade Paper	12,083	34,603
Mixed Recyclable Paper	164,802	584,309
Recyclable Containers	**236,566**	**311,660**
Aluminum Cans	13,251	120,947
Steel Cans	18,064	33,095
Glass	50,778	14,019
PET	37,290	38,622
HDPE	20,824	15,794
Mixed Plastics	96,359	89,183
Compostable	**750,680**	**77,329**
Food Waste	598,506	69,178
Yard Waste	152,174	8,151
Total	**1,438,963**	**1,859,997**

[1] Based on estimated overall MSW waste composition for 2021 and Pennsylvania's reported MSW disposal tonnage for FY 2021. Assumes the materials would be recycled instead of disposed.

[2] U.S. EPA Waste Reduction Model, Version 15

APPENDIX F

SOUTHCENTRAL REGIONAL RESULTS

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APPENDIX F – SOUTHCENTRAL REGION RESULTS

F 1. INTRODUCTION

Pennsylvania's Southcentral region encompasses 15 counties and has a population of 2,740,000 people and more than 1,045,00 households. A map of the Southcentral region is shown in Figure F-1.

Figure F-1 Southcentral Region Map

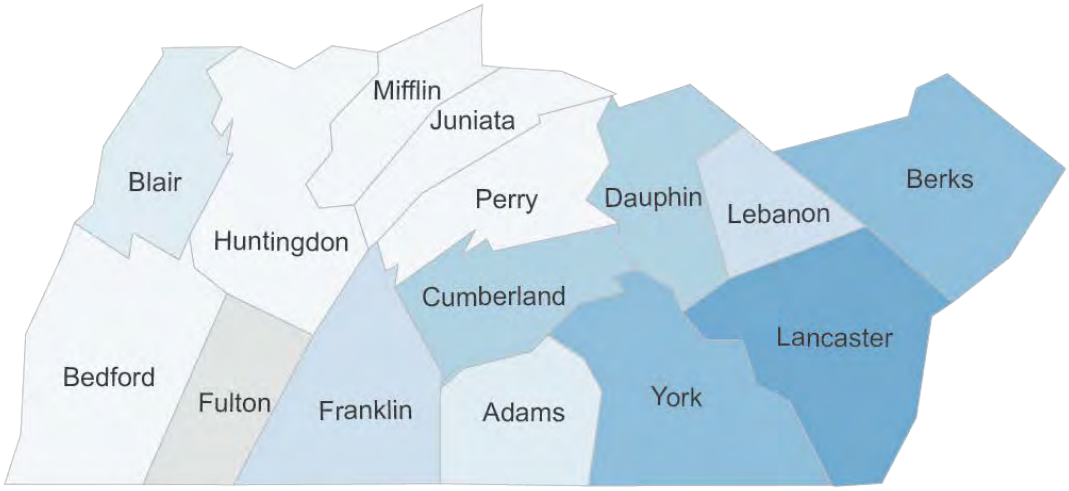


Table F-1 summarizes selected demographic and economic data for the Southcentral Region. As shown, this region is composed predominantly of rural and suburban areas.

Table F-1 Southcentral Region Demographic Summary (2021)

	Urban	Suburban	Rural	Total
Communities	6	202	339	**547**
Population	317,422	1,682,083	739,472	**2,738,977**
Housing Units	118,770	642,335	285,112	**1,046,217**
Employment	222,330	906,192	188,242	**1,316,764**

Sources: Demographic data from the Pennsylvania State Data Center; employment data from ESRI Business Patterns. The allocation of these data to urban, suburban, and rural areas was estimated by MSW Consultants.

The methodology for estimating waste generation within the residential and commercial sectors, and allocated across urban, suburban, and rural areas, is described in the main body of this report. Table F-2 presents the resulting allocation of generated wastes within the Southcentral Region. These quantities are used as weighting factors for determining the aggregate waste composition within the region.

Table F-2 Estimated Allocation of MSW Generated in the Southcentral Region

	Tons of Waste Disposed			
Generating Sector	Urban	Suburban	Rural	Total
Residential	125,896	590,948	253,750	970,594
Commercial	158,821	647,337	134,470	940,628
Total	284,717	1,238,285	388,220	1,911,223

Field sampling and sorting of Southcentral region wastes was performed at the Lancaster RRF and the Mountainview Landfill. Sampling at these facilities was performed across four seasons to capture seasonal variation in MSW composition. Table F-3 provides a sampling summary for the Southcentral Region. Note that the 200 samples obtained fell short of the 204 samples targeted for this region. However, the sampling shortfall was only 2 percent. In the professional opinion of MSW Consultants, this shortfall does not diminish the representativeness of the composition estimates for the region.

Table F-3 Southcentral Region Sampling Summary

	Number of Samples			
Generating Sector	Urban	Suburban	Rural	Total
Residential	1	62	32	95
Commercial	6	79	20	105
Total	7	141	52	200

F 2. AGGREGATE WASTE COMPOSITION

The remainder of this section presents a graphical and tabular summary of the Southcentral region's disposed MSW composition. Specific figures and tables are summarized below.

- Table F-4 provides the detailed tabular composition of the aggregated disposed refuse stream. This table shows the mean composition, margin of error (MOE) at a 90 percent level of confidence, and the estimated tonnage of each of the constituents in the refuse stream.
- Figure F-2 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented as percentages.
- Figure F-3 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented in tons.
- Figure F-4 is a pie chart that shows the percentage composition of major material groups in the aggregate regional waste stream. As shown, organics comprise 40 percent of the refuse disposed in the Southcentral region.
- Figure F-5 shows the 10 most prevalent materials being disposed in the region, by weight.
- Figure F-6 is a pie chart that shows the detailed percentage composition of the food waste category.
- Figure F-7 illustrates the divertibility of the aggregate disposed refuse stream. This graphic shows that the majority of the materials being disposed could be diverted through existing recycling programs, composting programs, and third-party recovery programs. It should be noted that this graphic omits the impact of contamination, and as a practical matter it is not possible for all the divertible materials to actually be diverted.

Table F-4 Detailed Southcentral Region Disposed Waste Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**28.1%**	**1.6%**	**536,664**	**Organics**	**36.2%**	**2.1%**	**692,278**
Corrugated Cardboard/Kraft Paper	8.1%	1.2%	154,226	Food Waste	14.9%	1.9%	285,086
Newspaper	0.7%	0.1%	12,589	Yard Waste - Grass	0.8%	0.3%	14,926
Office/High Grade Paper	0.5%	0.1%	10,459	Yard Waste - Other	2.2%	0.5%	42,849
Magazine & Catalogs	0.7%	0.1%	13,381	Wood - Unpainted	3.7%	1.1%	69,845
Aseptic Boxes & Gable Top Cartons	0.5%	0.5%	9,526	Wood - Painted	2.3%	0.8%	43,908
Mixed Recyclable Paper (Low Grade)	5.8%	0.5%	111,553	Textiles & Leather Products	2.7%	0.4%	52,136
Compostable Paper	7.2%	0.6%	137,611	Diapers & Sanitary Products	3.2%	0.5%	61,593
Non-recyclable Paper	4.6%	1.0%	87,317	Animal By-Products	2.9%	0.5%	54,873
Plastic	**21.8%**	**1.7%**	**415,693**	Fines	0.8%	0.1%	15,488
#1 PET Bottles & Jars	1.4%	0.2%	27,178	Other Organics	2.7%	0.6%	51,574
#1 PET Non-Bottles & Containers	0.3%	0.2%	5,413	**Inorganics**	**8.5%**	**1.4%**	**161,519**
#2 HDPE Natural Bottles	0.4%	0.1%	8,237	Electronics - Covered Devices	0.0%	0.0%	432
#2 HDPE Colored Bottles	0.3%	0.1%	6,606	Other Electronics	0.4%	0.1%	7,067
#3 - #7 Bottles	0.1%	0.0%	969	Carpet & Carpet Padding	0.8%	0.5%	15,778
#2 - #7 Non-Bottle Rigid Containers	1.3%	0.2%	24,859	Drywall/Gypsum Board	0.4%	0.3%	7,640
Expanded Polystyrene	1.3%	0.4%	25,358	Concrete, Rock, Brick	0.1%	0.1%	1,363
Clean Retail Plastic Bags	0.1%	0.0%	1,307	Asphalt Roofing	0.0%	0.0%	512
Industrial Film	3.9%	1.0%	74,231	Asphalt Paving			Not Found
All Other Film	6.5%	0.4%	124,668	Other C&D	1.1%	0.4%	20,492
Durable/Bulky Rigid Plastics	2.8%	0.5%	54,286	Medically-Related Waste	0.2%	0.1%	2,952
Remainder/Composite Plastic	3.3%	0.5%	62,581	Lithium Batteries	0.0%	0.0%	37
Metals	**3.1%**	**0.7%**	**58,988**	Automotive Batteries			Not Found
Steel Cans	0.9%	0.6%	17,066	Other Batteries	0.1%	0.0%	1,302
Aluminum Cans	0.5%	0.1%	10,482	Other HHW	0.1%	0.1%	1,695
Other Aluminum	0.3%	0.1%	6,377	Bulky Materials	1.3%	0.4%	24,659
Other Ferrous Metals	0.9%	0.2%	17,955	Furniture	3.1%	1.6%	58,527
Other Non-Ferrous Metals	0.4%	0.2%	7,108	Other Inorganics	0.8%	0.3%	14,355
Glass	**2.4%**	**0.4%**	**46,080**	PPE	0.2%	0.1%	4,709
Clear Glass Containers	0.9%	0.1%	17,521				
Green Glass Containers	0.3%	0.1%	5,748				
Brown Glass Containers	0.4%	0.1%	8,019	**Grand Total**	**100.0%**		**1,911,223**
Non-Recyclable Glass	0.8%	0.3%	14,792	**Number of Samples**	**200**		

Margin of error is calculated at a 90 percent level of confidence.

Figure F-2 Comparison of Composition by Material Group 2021 vs 2001 (Percentage)

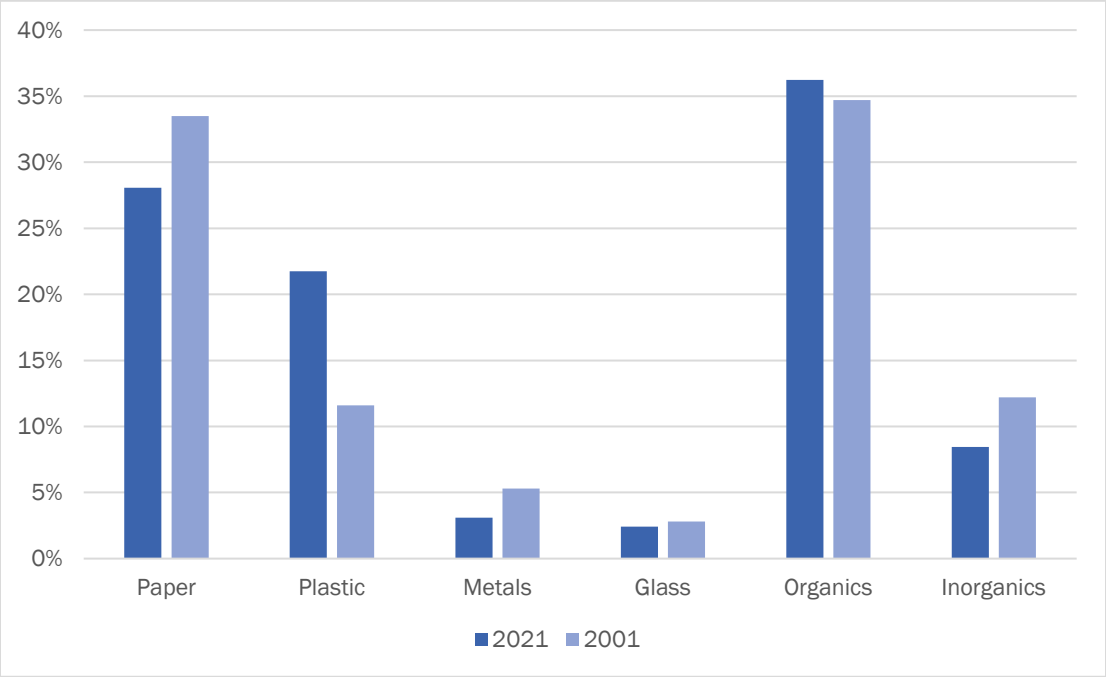


Figure F-3 Comparison of Composition by Material Group 2021 vs 2001 (Tons)

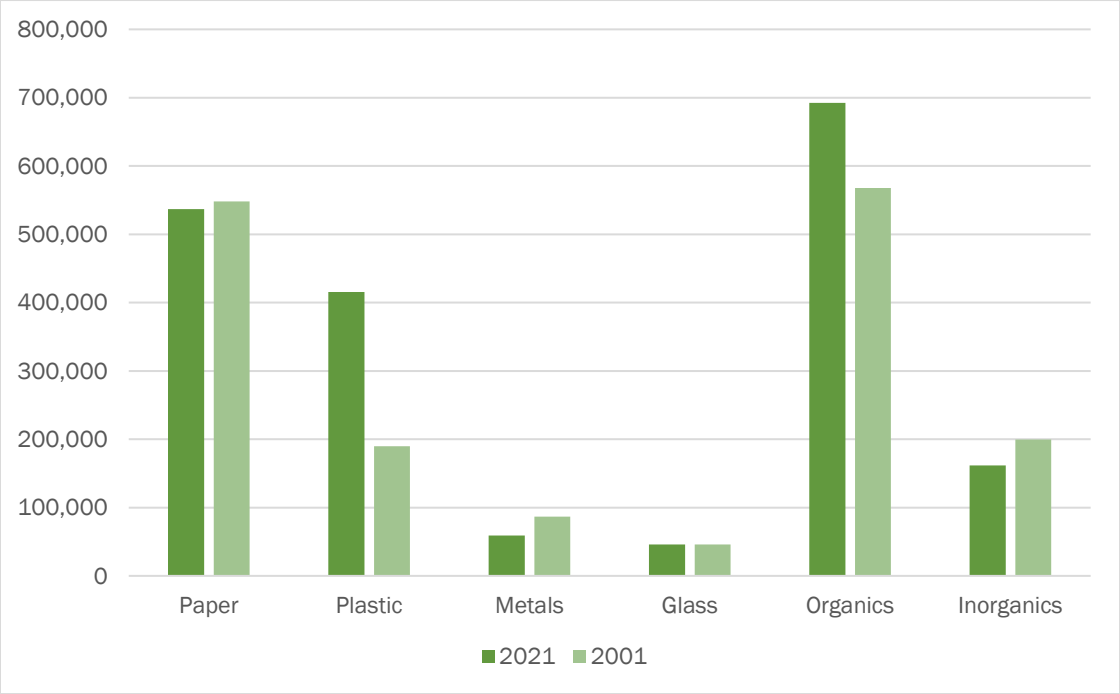


Figure F-4 Composition Summary by Material Group (Percentage)

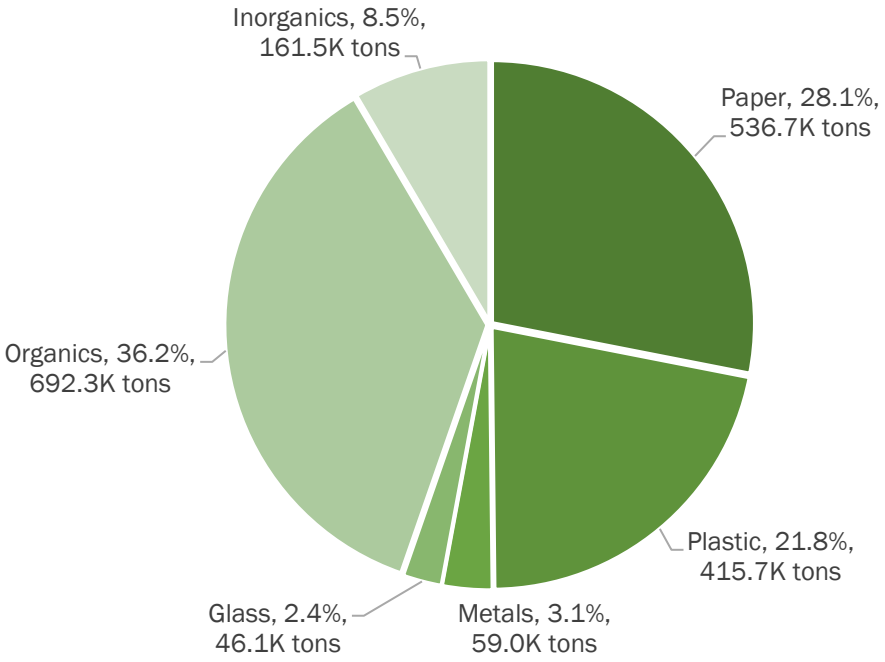
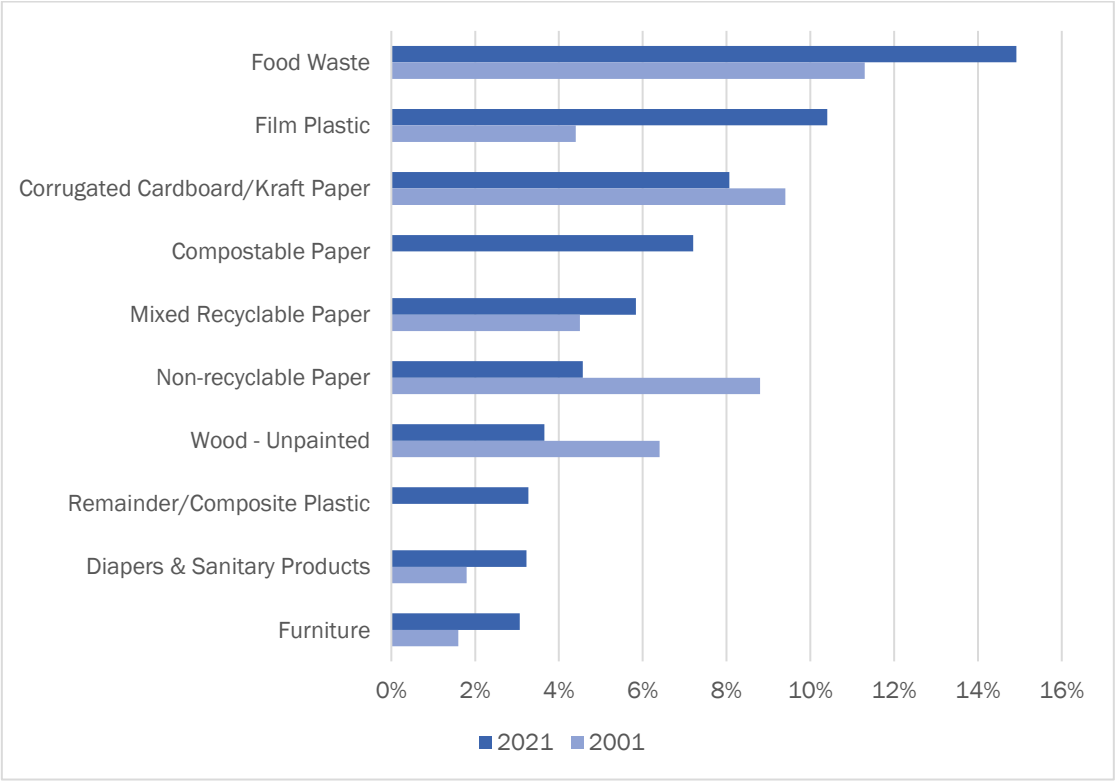


Figure F-5 Top 10 Most Prevalent by Weight*



*Note: Some material categories were not sorted in 2001 Study

Figure F-6 Food Waste Detail

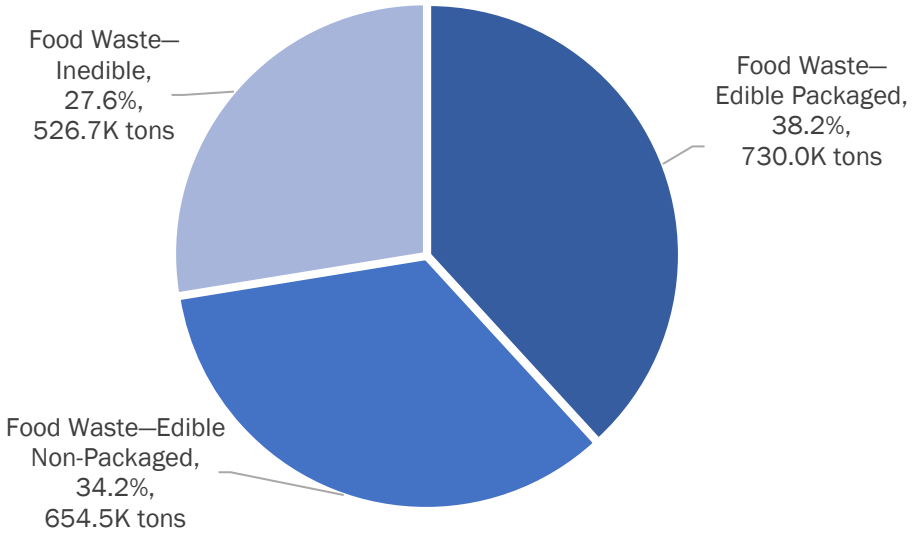
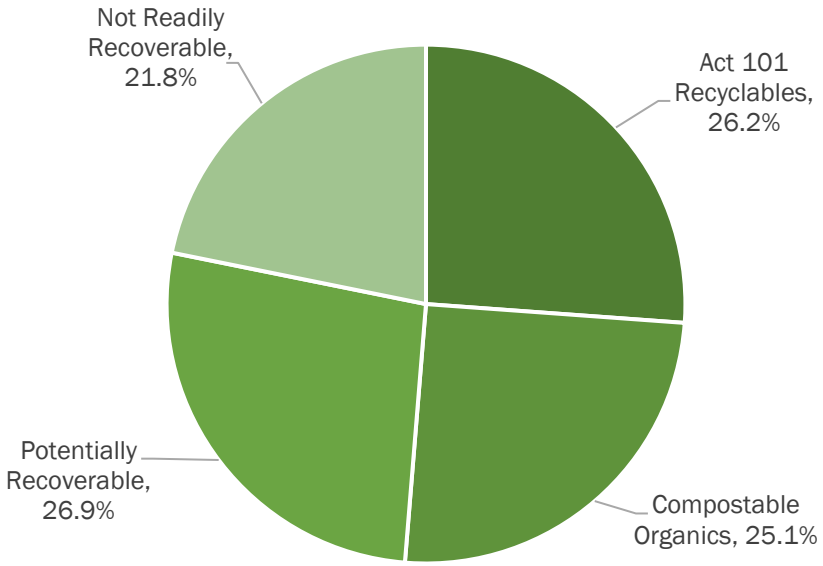


Figure F-7 Divertibility Comparison (Percentage)



F 3. COMPOSITION COMPARISONS BY GENERATING SECTOR

The composition of residential and commercial MSW were analyzed individually with selected comparisons shown below:

- Table F-5 and Table F-6 contain a detailed comparison of disposed residential and commercial MSW in the Southcentral region based on percentage composition and absolute tonnage, respectively.
- Figure F-8 and Figure F-9 compare the residential and commercial disposed MSW based on percentage composition and absolute tonnage, respectively.
- Figure F-10 is a bar chart that compares the breakdown of food waste by generating sector.
- Figure F-11 illustrates the divertibility of disposed MSW stream by generating sector.

Table F-5 Disposed MSW Composition by Generator Sector (Percentage)

Material Category	Res	ICI		Res	ICI
Paper	**24.4%**	**31.9%**	**Organics**	**41.3%**	**30.9%**
Corrugated Cardboard/Kraft Paper	3.8%	12.5%	Food Waste	17.0%	12.8%
Newspaper	1.1%	0.2%	Yard Waste - Grass	1.3%	0.3%
Office/High Grade Paper	0.4%	0.7%	Yard Waste - Other	4.0%	0.4%
Magazine & Catalogs	1.1%	0.2%	Wood - Unpainted	0.4%	7.0%
Aseptic Boxes & Gable Top Cartons	0.3%	0.7%	Wood - Painted	1.4%	3.2%
Mixed Recyclable Paper (Low Grade)	6.3%	5.4%	Textiles & Leather Products	4.1%	1.3%
Compostable Paper	8.4%	5.9%	Diapers & Sanitary Products	5.0%	1.4%
Non-recyclable Paper	3.0%	6.2%	Animal By-Products	4.8%	0.9%
Plastic	**15.5%**	**28.2%**	Fines	0.9%	0.7%
#1 PET Bottles & Jars	1.6%	1.2%	Other Organics	2.3%	3.1%
#1 PET Non-Bottles & Containers	0.3%	0.3%	**Inorganics**	**12.4%**	**4.4%**
#2 HDPE Natural Bottles	0.4%	0.5%	Electronics - Covered Devices	0.0%	0.0%
#2 HDPE Colored Bottles	0.5%	0.2%	Other Electronics	0.6%	0.2%
#3 - #7 Bottles	0.1%	0.0%	Carpet & Carpet Padding	1.2%	0.4%
#2 - #7 Non-Bottle Rigid Containers	1.5%	1.1%	Drywall/Gypsum Board	0.6%	0.2%
Expanded Polystyrene	0.7%	2.0%	Concrete, Rock, Brick	0.1%	0.0%
Clean Retail Plastic Bags	0.1%	0.0%	Asphalt Roofing	0.1%	0.0%
Industrial Film	0.0%	7.8%	Asphalt Paving	0.0%	0.0%
All Other Film	6.6%	6.5%	Other C&D	1.3%	0.8%
Durable/Bulky Rigid Plastics	2.1%	3.6%	Medically-Related Waste	0.1%	0.2%
Remainder/Composite Plastic	1.8%	4.8%	Lithium Batteries	0.0%	0.0%
Metals	**3.4%**	**2.8%**	Automotive Batteries	0.0%	0.0%
Steel Cans	0.7%	1.1%	Other Batteries	0.1%	0.0%
Aluminum Cans	0.8%	0.3%	Other HHW	0.0%	0.1%
Other Aluminum	0.5%	0.2%	Bulky Materials	1.9%	0.7%
Other Ferrous Metals	1.0%	0.9%	Furniture	5.6%	0.4%
Other Non-Ferrous Metals	0.4%	0.3%	Other Inorganics	0.5%	1.0%
Glass	**2.9%**	**1.9%**	PPE	0.1%	0.4%
Clear Glass Containers	1.4%	0.4%			
Green Glass Containers	0.5%	0.1%			
Brown Glass Containers	0.6%	0.2%	**Grand Total**	**100%**	**100%**
Non-Recyclable Glass	0.5%	1.1%	**Number of Samples**	**95**	**105**

Table F-6 Waste Composition by Generator Sector (Tons)

Material Category	Res	ICI		Res	ICI
Paper	**236,736**	**299,928**	**Organics**	**401,214**	**291,064**
Corrugated Cardboard/Kraft Paper	36,939	117,287	Food Waste	165,095	119,990
Newspaper	10,337	2,252	Yard Waste - Grass	12,389	2,538
Office/High Grade Paper	4,005	6,455	Yard Waste - Other	39,309	3,540
Magazine & Catalogs	11,070	2,311	Wood - Unpainted	4,173	65,672
Aseptic Boxes & Gable Top Cartons	2,505	7,021	Wood - Painted	13,824	30,084
Mixed Recyclable Paper (Low Grade)	60,999	50,554	Textiles & Leather Products	39,871	12,265
Compostable Paper	81,721	55,890	Diapers & Sanitary Products	48,827	12,767
Non-recyclable Paper	29,159	58,158	Animal By-Products	46,496	8,377
Plastic	**150,898**	**264,796**	Fines	9,209	6,279
#1 PET Bottles & Jars	15,561	11,617	Other Organics	22,021	29,553
#1 PET Non-Bottles & Containers	2,614	2,799	**Inorganics**	**120,503**	**41,016**
#2 HDPE Natural Bottles	3,444	4,793	Electronics - Covered Devices	432	0
#2 HDPE Colored Bottles	4,521	2,086	Other Electronics	5,478	1,588
#3 - #7 Bottles	689	280	Carpet & Carpet Padding	12,054	3,723
#2 - #7 Non-Bottle Rigid Containers	14,564	10,295	Drywall/Gypsum Board	6,188	1,451
Expanded Polystyrene	6,361	18,997	Concrete, Rock, Brick	1,121	241
Clean Retail Plastic Bags	1,055	252	Asphalt Roofing	512	0
Industrial Film	466	73,765	Asphalt Paving	0	0
All Other Film	63,680	60,988	Other C&D	12,596	7,896
Durable/Bulky Rigid Plastics	20,295	33,991	Medically-Related Waste	1,034	1,918
Remainder/Composite Plastic	17,648	44,933	Lithium Batteries	31	6
Metals	**32,836**	**26,152**	Automotive Batteries	0	0
Steel Cans	7,188	9,878	Other Batteries	924	377
Aluminum Cans	7,474	3,008	Other HHW	415	1,280
Other Aluminum	4,626	1,751	Bulky Materials	18,495	6,164
Other Ferrous Metals	9,696	8,258	Furniture	54,820	3,707
Other Non-Ferrous Metals	3,852	3,256	Other Inorganics	5,020	9,335
Glass	**28,408**	**17,672**	PPE	1,381	3,328
Clear Glass Containers	13,587	3,934			
Green Glass Containers	4,523	1,225			
Brown Glass Containers	5,860	2,159	**Grand Total**	**970,594**	**940,628**
Non-Recyclable Glass	4,438	10,354	**Number of Samples**	**95**	**105**

Figure F-8 Composition Summary by Generator Sector (Percentage)

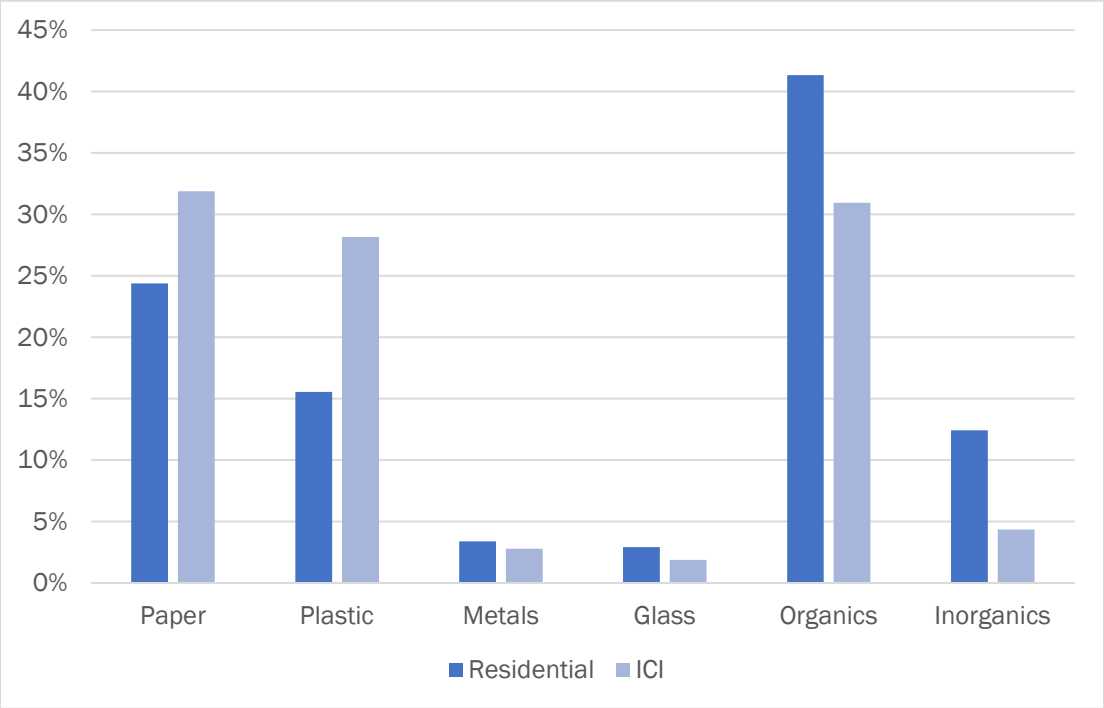


Figure F-9 Composition Summary by Generator Sector (Tons)

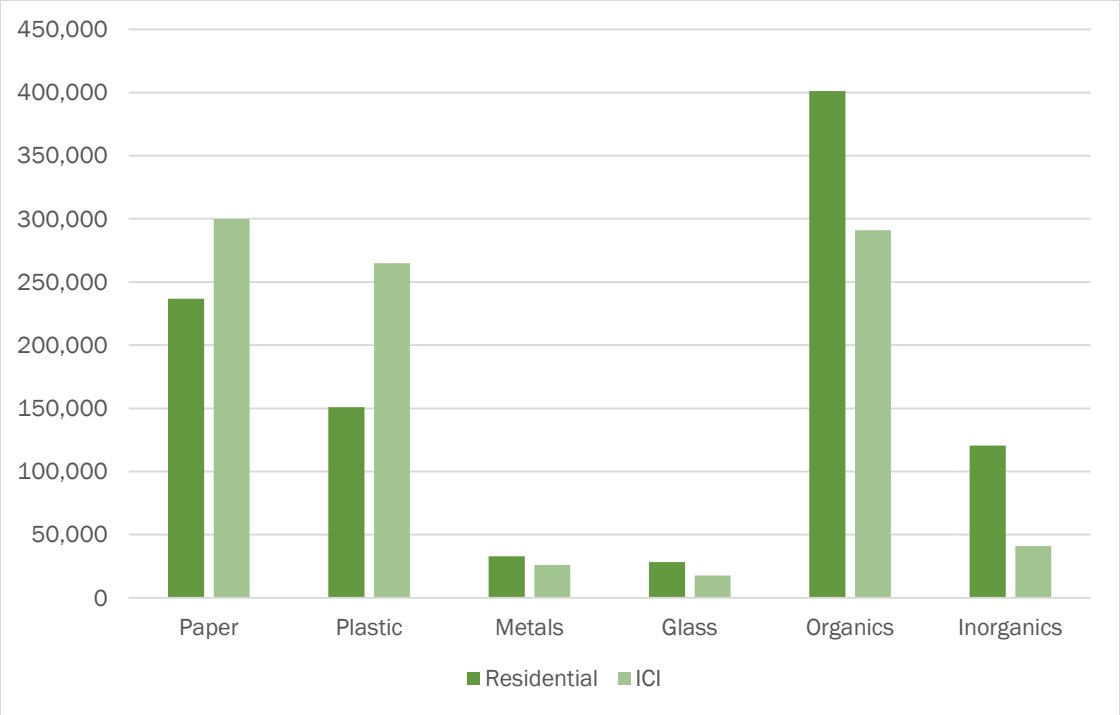


Figure F-10 Food Waste Detail by Generator Sector (Percentage)

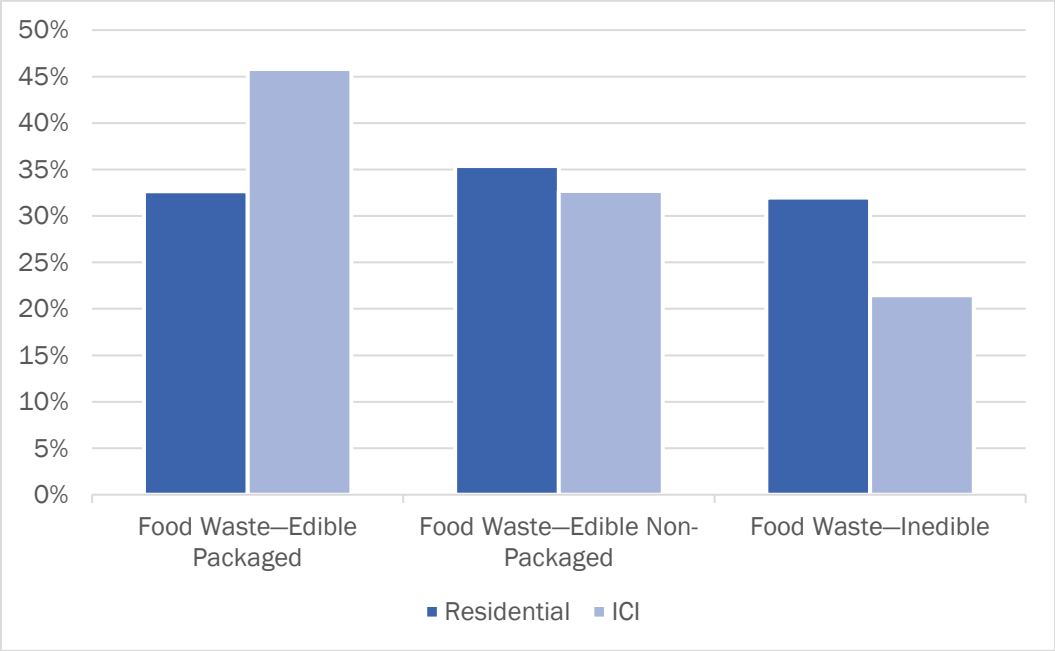
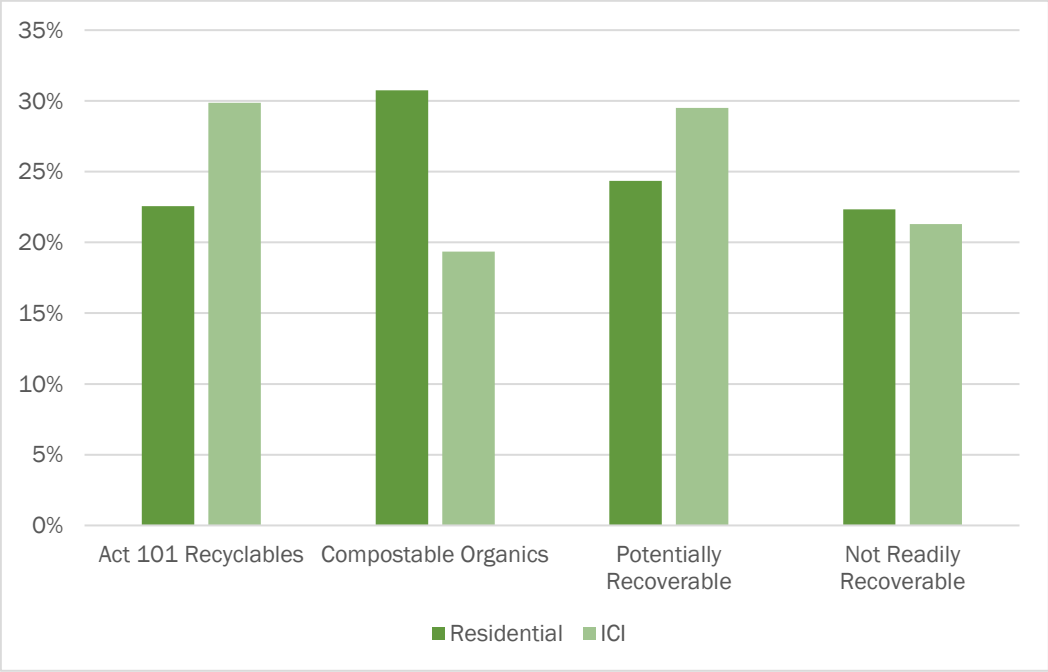


Figure F-11 Divertibility Comparison by Generator Sector (Percentage)



F 4. COMPOSITION BY DEMOGRAPHIC ORIGIN

The composition of urban, suburban, and rural MSW were analyzed individually and selected comparisons are shown below:

- Table F-7 and Table F-8 contain detailed comparisons of disposed MSW from urban, suburban, and rural waste streams in the Southcentral region based on percentage composition and absolute tonnage, respectively.
- Figure F-12 and Figure F-13 compare the urban, suburban, and rural waste streams based on percentage composition and absolute tonnage, respectively.
- Figure F-14 is a bar chart compares the breakdown of food waste by demographic origin.
- Figure F-15 compares the divertibility of disposed MSW by demographic origin.

Table F-7 Waste Composition by Demographic Origin (Percentage)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**25.4%**	**29.5%**	**25.6%**	**Organics**	**33.5%**	**36.0%**	**38.8%**
Corrugated Cardboard/Kraft Paper	9.3%	8.4%	6.2%	Food Waste	18.9%	14.4%	13.7%
Newspaper	0.2%	0.8%	0.5%	Yard Waste - Grass	0.0%	0.8%	1.2%
Office/High Grade Paper	0.0%	0.7%	0.4%	Yard Waste - Other	0.3%	2.2%	3.8%
Magazine & Catalogs	0.9%	0.7%	0.7%	Wood - Unpainted	3.0%	3.8%	3.7%
Aseptic Boxes & Gable Top Cartons	0.1%	0.2%	1.7%	Wood - Painted	0.1%	2.6%	2.8%
Mixed Recyclable Paper (Low Grade)	4.1%	6.1%	6.2%	Textiles & Leather Products	1.3%	2.8%	3.6%
Compostable Paper	7.4%	7.4%	6.3%	Diapers & Sanitary Products	4.6%	2.8%	3.5%
Non-recyclable Paper	3.4%	5.2%	3.6%	Animal By-Products	0.3%	3.3%	3.5%
Plastic	**21.4%**	**21.8%**	**21.8%**	Fines	0.7%	0.8%	0.9%
#1 PET Bottles & Jars	2.2%	1.2%	1.5%	Other Organics	4.2%	2.5%	2.1%
#1 PET Non-Bottles & Containers	0.1%	0.4%	0.2%	**Inorganics**	**16.9%**	**6.7%**	**7.8%**
#2 HDPE Natural Bottles	0.9%	0.3%	0.5%	Electronics - Covered Devices	0.0%	0.0%	0.1%
#2 HDPE Colored Bottles	0.4%	0.3%	0.5%	Other Electronics	0.0%	0.4%	0.6%
#3 - #7 Bottles	0.0%	0.1%	0.0%	Carpet & Carpet Padding	0.0%	1.1%	0.5%
#2 - #7 Non-Bottle Rigid Containers	1.0%	1.4%	1.2%	Drywall/Gypsum Board	0.4%	0.5%	0.1%
Expanded Polystyrene	2.1%	1.2%	1.0%	Concrete, Rock, Brick	0.0%	0.1%	0.1%
Clean Retail Plastic Bags	0.0%	0.1%	0.1%	Asphalt Roofing	0.0%	0.0%	0.1%
Industrial Film	3.3%	3.9%	4.3%	Asphalt Paving	0.0%	0.0%	0.0%
All Other Film	4.7%	6.9%	6.8%	Other C&D	0.0%	1.0%	2.1%
Durable/Bulky Rigid Plastics	3.4%	2.6%	3.1%	Medically-Related Waste	0.3%	0.1%	0.1%
Remainder/Composite Plastic	3.3%	3.5%	2.5%	Lithium Batteries	0.0%	0.0%	0.0%
Metals	**1.1%**	**3.5%**	**3.4%**	Automotive Batteries	0.0%	0.0%	0.0%
Steel Cans	0.2%	1.1%	0.8%	Other Batteries	0.0%	0.1%	0.1%
Aluminum Cans	0.4%	0.6%	0.6%	Other HHW	0.0%	0.1%	0.0%
Other Aluminum	0.3%	0.4%	0.3%	Bulky Materials	0.0%	1.5%	1.7%
Other Ferrous Metals	0.1%	1.1%	1.1%	Furniture	13.8%	1.1%	1.5%
Other Non-Ferrous Metals	0.0%	0.4%	0.6%	Other Inorganics	2.2%	0.5%	0.6%
Glass	**1.7%**	**2.5%**	**2.6%**	PPE	0.2%	0.3%	0.2%
Clear Glass Containers	0.8%	0.9%	1.2%				
Green Glass Containers	0.5%	0.2%	0.4%				
Brown Glass Containers	0.3%	0.4%	0.5%	**Grand Total**	**100%**	**100%**	**100%**
Non-Recyclable Glass	0.1%	1.0%	0.5%	**Number of Samples**	**7**	**141**	**52**

Table F-8 Waste Composition by Demographic Origin (Tons)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**72,382**	**364,705**	**99,576**	**Organics**	**95,490**	**446,218**	**150,570**
Corrugated Cardboard/Kraft Paper	26,430	103,545	24,252	Food Waste	53,726	178,182	53,177
Newspaper	591	10,066	1,932	Yard Waste - Grass	17	10,257	4,653
Office/High Grade Paper	28	8,792	1,639	Yard Waste - Other	789	27,179	14,880
Magazine & Catalogs	2,494	8,092	2,795	Wood - Unpainted	8,662	46,899	14,284
Aseptic Boxes & Gable Top Cartons	396	2,717	6,413	Wood - Painted	388	32,511	11,009
Mixed Recyclable Paper (Low Grade)	11,797	75,736	24,019	Textiles & Leather Products	3,689	34,414	14,033
Compostable Paper	21,093	91,963	24,555	Diapers & Sanitary Products	13,171	34,932	13,490
Non-recyclable Paper	9,553	63,794	13,970	Animal By-Products	925	40,554	13,394
Plastic	**60,829**	**270,372**	**84,493**	Fines	2,035	9,948	3,505
#1 PET Bottles & Jars	6,303	15,104	5,771	Other Organics	12,089	31,341	8,144
#1 PET Non-Bottles & Containers	260	4,455	699	**Inorganics**	**48,116**	**83,239**	**30,165**
#2 HDPE Natural Bottles	2,547	3,877	1,812	Electronics - Covered Devices	0	177	254
#2 HDPE Colored Bottles	1,040	3,801	1,766	Other Electronics	34	4,720	2,312
#3 - #7 Bottles	0	777	192	Carpet & Carpet Padding	37	13,770	1,971
#2 - #7 Non-Bottle Rigid Containers	2,781	17,269	4,810	Drywall/Gypsum Board	1,058	6,148	433
Expanded Polystyrene	5,860	15,472	4,026	Concrete, Rock, Brick	0	814	549
Clean Retail Plastic Bags	66	854	388	Asphalt Roofing	0	33	479
Industrial Film	9,514	47,894	16,824	Asphalt Paving	0	0	0
All Other Film	13,522	84,889	26,256	Other C&D	0	12,397	8,095
Durable/Bulky Rigid Plastics	9,660	32,537	12,089	Medically-Related Waste	828	1,841	284
Remainder/Composite Plastic	9,278	43,443	9,860	Lithium Batteries	0	28	9
Metals	**2,999**	**42,743**	**13,247**	Automotive Batteries	0	0	0
Steel Cans	686	13,311	3,069	Other Batteries	55	899	347
Aluminum Cans	1,131	6,846	2,506	Other HHW	0	1,632	63
Other Aluminum	724	4,449	1,204	Bulky Materials	0	18,042	6,617
Other Ferrous Metals	427	13,240	4,289	Furniture	39,182	13,422	5,923
Other Non-Ferrous Metals	31	4,898	2,179	Other Inorganics	6,283	5,912	2,160
Glass	**4,902**	**31,008**	**10,170**	PPE	638	3,402	669
Clear Glass Containers	2,285	10,551	4,685				
Green Glass Containers	1,403	2,713	1,632				
Brown Glass Containers	849	5,333	1,837	**Grand Total**	**284,717**	**1,238,285**	**388,220**
Non-Recyclable Glass	365	12,411	2,016	**Number of Samples**	**7**	**141**	**52**

Figure F-12 Composition Summary by Demographic Origin (Percentage)

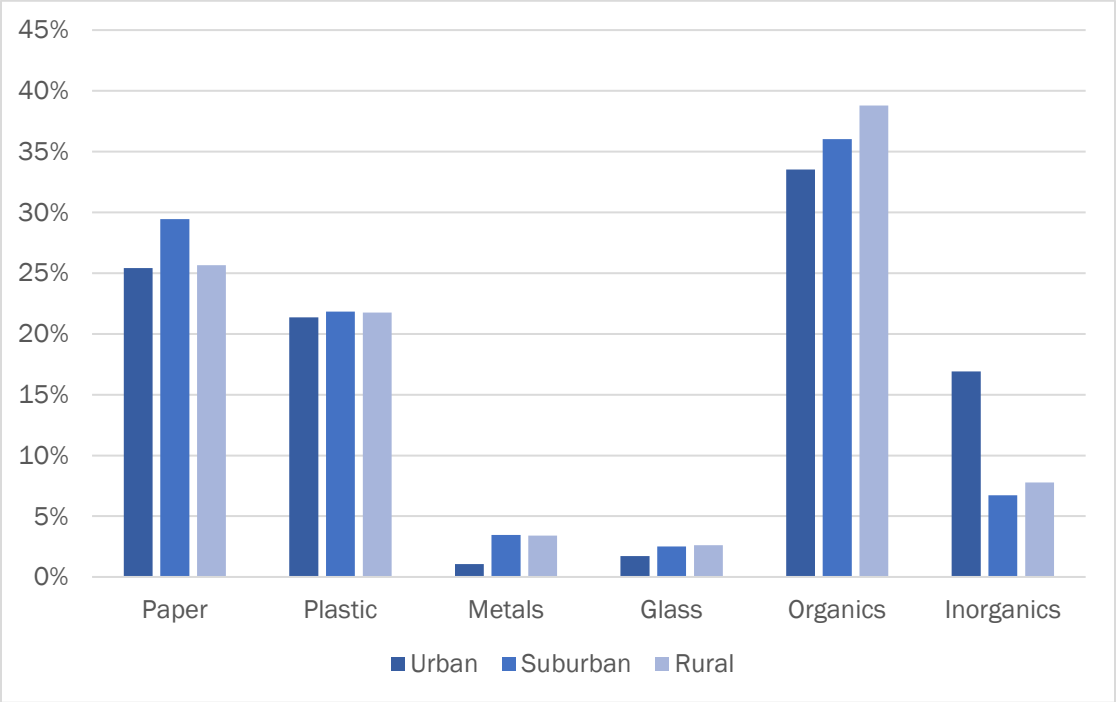


Figure F-13 Composition Summary by Demographic Origin (Tons)

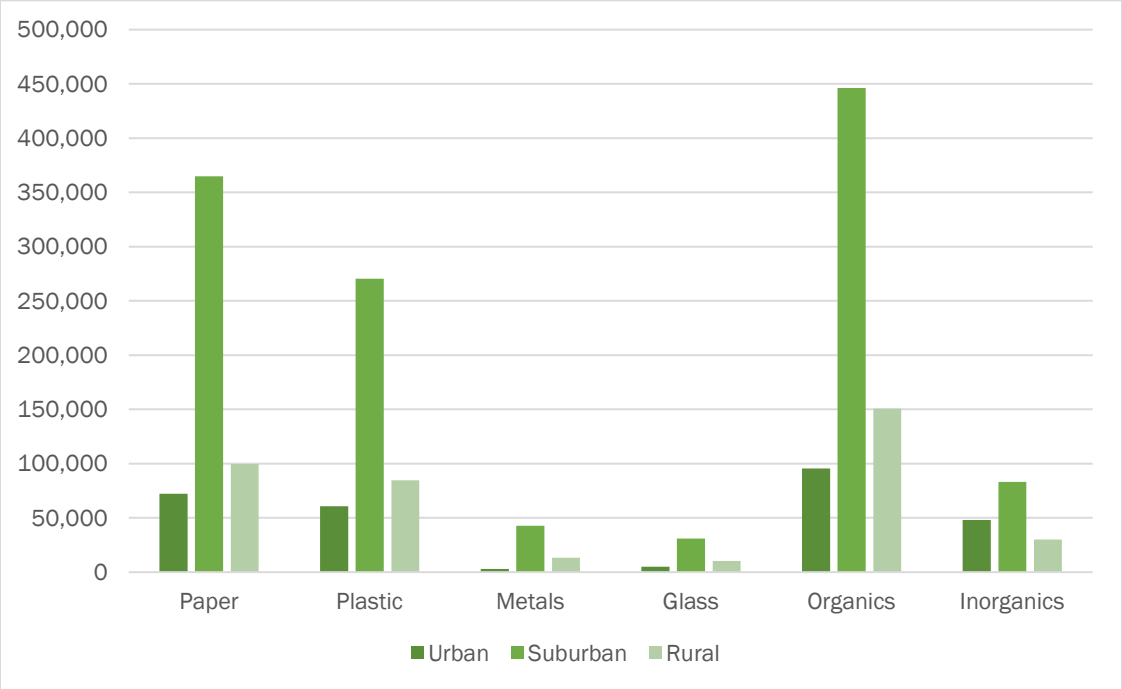


Figure F-14 Food Waste Detail by Demographic Origin

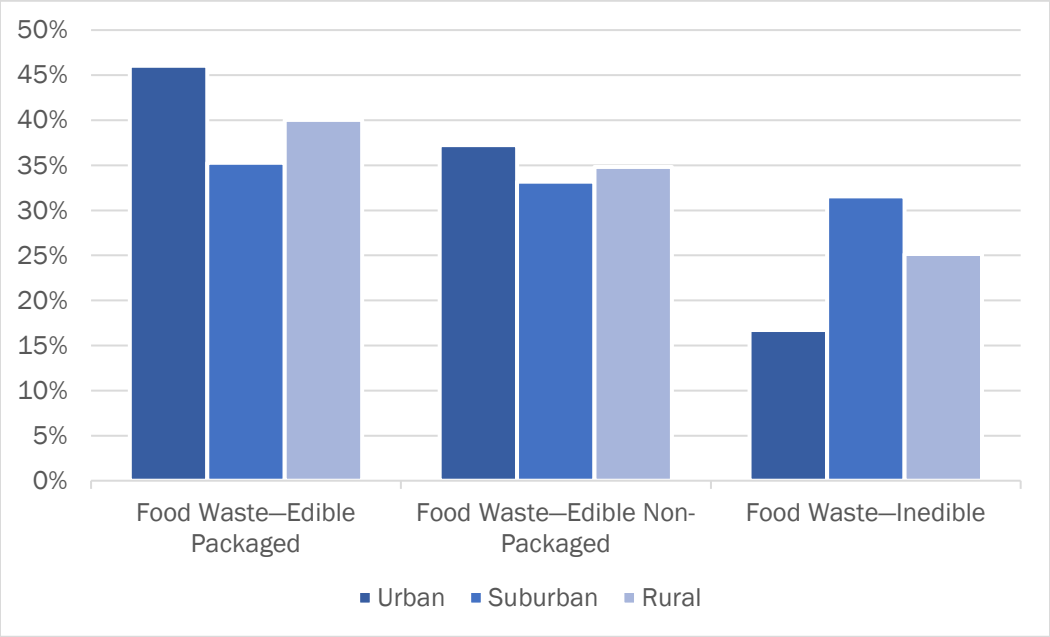
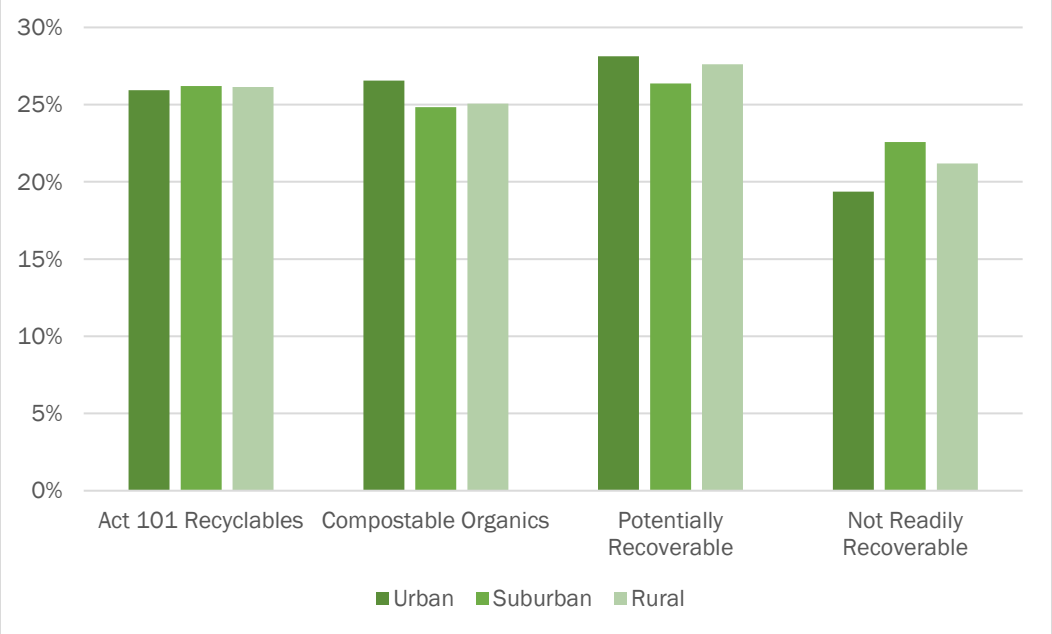


Figure F-15 Divertibility Comparison (Percentage)



F 5. ECONOMIC AND ENVIRONMENTAL IMPACTS

The following supplemental analyses have been included to illustrate the potential financial and environmental impacts of diverting recyclable and compostable materials from the disposed MSW stream.

- Table F-9 estimates the recovered material value for recyclables commodities that were disposed in the regional MSW stream. Market values were obtained from recyclingmarkets.net.
- Table F-10 calculates the greenhouse gas emissions that could be reduced if the estimated quantities of recyclable and compostable materials disposed in the Southcentral region were diverted from disposal.

Table F-9 Estimated Value of Disposed Recyclable Materials

Recyclable Commodities	Estimated Tons Disposed	Average Market Price ($/ton)	Estimated Total Market Value ($)
Recyclable Paper	**311,735**		**$36,525,676**
Corrugated Cardboard/Kraft Paper	154,226	$135	$20,820,533
Newspaper	12,589	$188	$2,360,468
Office/High Grade Paper	10,459	$235	$2,457,970
Magazine & Catalogs	13,381	$168	$2,241,340
Aseptic Boxes & Gable Top Cartons	9,526	$0	$0
Mixed Recyclable Paper (Low Grade)	111,553	$78	$8,645,365
Recyclable Containers	**184,707**		**$71,363,032**
#1 PET Bottles & Jars	27,178	$860	$23,372,938
#1 PET Non-Bottles & Containers	5,413	$130	$703,679
#2 HDPE Natural Bottles	8,237	$1,130	$9,307,996
#2 HDPE Colored Bottles	6,606	$640	$4,227,972
#3 - #7 Bottles	969	$130	$125,992
#2-#7 Non-Bottle Rigid Containers	24,859	$130	$3,231,708
Durable/Bulky Rigid Plastics	54,286	$90	$4,885,705
Steel Cans	17,066	$230	$3,925,197
Aluminum Cans	10,482	$1,950	$20,440,743
Clear Glass Containers	17,521	$50	$876,061
Green Glass Containers	5,748	$8	$43,110
Brown Glass Containers	6,341	$35	$221,932
Total	**496,442**	*$217*	**$107,888,708**

Source: Recyclingmarkets.net - Northeast Region of U.S. as of 06/9/22

Table F-10 Emissions Reduction Potential from Disposed Recyclables

Material Components	Tons Recycled/ Composted[1]	Emissions Reduced ($MTCO_2E$)[2]
Recyclable Paper	**302,209**	**984,186**
Corrugated Cardboard/Kraft Paper	154,226	483,550
Magazine & Catalogs	13,381	41,076
Newspaper	12,589	34,094
Office/High Grade Paper	10,459	29,952
Mixed Recyclable Paper	111,553	395,514
Recyclable Containers	**186,385**	**254,737**
Aluminum Cans	10,482	95,673
Steel Cans	17,066	31,266
Glass	31,288	8,638
PET	32,591	33,755
HDPE	14,843	11,258
Mixed Plastics	80,114	74,147
Compostable	**342,861**	**36,046**
Food Waste	285,086	32,952
Yard Waste	57,775	3,094
Total	**831,454**	**1,274,969**

[1] Based on estimated overall MSW waste composition for 2021 and Pennsylvania's reported MSW disposal tonnage for FY 2021. Assumes the materials would be recycled instead of disposed.

[2] U.S. EPA Waste Reduction Model, Version 15

APPENDIX G

SOUTHWEST REGIONAL RESULTS

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APPENDIX G – SOUTHWEST REGION RESULTS

G 1. INTRODUCTION

Pennsylvania's Southwest region encompasses 10 counties and has a population of 2,483,000 people and nearly 1,075,000 households. A map of the Southwest region is shown in Figure G-1.

Figure G-1 Southwest Region Map

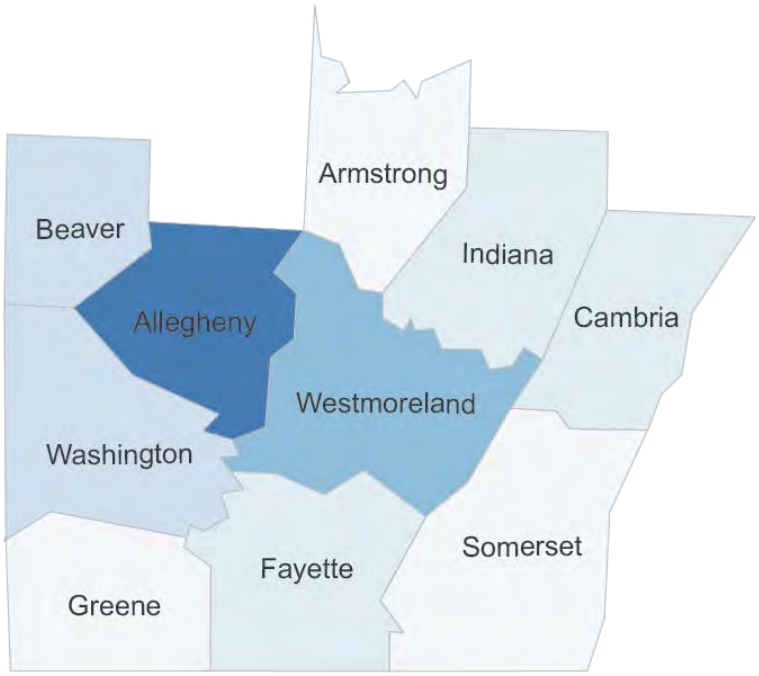


Table G-1 summarizes selected demographic and economic data for the Southwest Region. As shown, this region is composed predominantly of rural and suburban areas.

Table G-1 Southwest Region Demographic Summary (2021)

	Urban	Suburban	Rural	Total
Communities	3	281	296	**580**
Population	336,162	1,659,262	487,890	**2,483,314**
Housing Units	159,420	711,731	203,793	**1,074,944**
Employment	311,076	829,165	137,040	**1,277,281**

Sources: Demographic data from the Pennsylvania State Data Center; employment data from ESRI Business Patterns. The allocation of these data to urban, suburban, and rural areas was estimated by MSW Consultants.

The methodology for estimating waste generation within the residential and commercial sectors, and allocated across urban, suburban, and rural areas, is described in the main body of this report. Table G-2 presents the resulting allocation of generated wastes within the Southwest Region. These quantities are used as weighting factors for determining the aggregate waste composition within the region.

Table G-2 Estimated Allocation of MSW Generated in the Southwest Region

	Tons of Waste Disposed			
Generating Sector	Urban	Suburban	Rural	Total
Residential	168,985	654,793	181,376	1,005,153
Commercial	185,368	494,094	81,661	761,124
Total	354,353	1,148,887	263,037	1,766,277

Field sampling and sorting of Southwest region wastes was performed at the Laurel Highlands Landfill and the Imperial Landfill. Sampling at these facilities was performed across four seasons to capture seasonal variation in MSW composition. Table G-3 provides a sampling summary for the Southwest Region. Note that the 201 samples obtained fell short of the 204 samples targeted for this region. However, the sampling shortfall was only 1.5 percent. In the professional opinion of MSW Consultants, this shortfall does not diminish the representativeness of the composition estimates for the region.

Table G-3 Southwest Region Sampling Summary

	Number of Samples			
Waste Generating Sector	Urban	Suburban	Rural	Total
Residential	28	36	41	105
Commercial	23	59	14	96
Total	51	95	55	201

G 2. AGGREGATE WASTE COMPOSITION

The remainder of this section presents a graphical and tabular summary of the Southwest region's disposed MSW composition. Specific figures and tables are summarized below.

- Table G-4 provides the detailed tabular composition of the aggregated disposed refuse stream. This table shows the mean composition, margin of error (MOE) at a 90 percent level of confidence, and the estimated tonnage of each of the constituents in the refuse stream.
- Figure G-2 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented as percentages.
- Figure G-3 is a bar chart that compares the estimated mean of material disposed (or incinerated) from the region by major material group. The comparison is made using the 2001 Study and is represented in tons.
- Figure G-4 is a pie chart that shows the percentage composition of major material groups in the aggregate regional waste stream. As shown, organics comprise 40 percent of the refuse disposed in the Southwest region.
- Figure G-5 shows the 10 most prevalent materials being disposed in the region by weight.
- Figure G-6 is a pie chart that shows the detailed percentage composition of the food waste category.
- Figure G-7 illustrates the divertibility of the aggregate disposed refuse stream. This graphic shows that the majority of the materials being disposed could be diverted through existing recycling programs, composting programs, and third-party recovery programs. It should be noted that this graphic omits the impact of contamination, and as a practical matter it is not possible for all the divertible materials to actually be diverted.

Table G-4 Detailed Southwest Region Disposed MSW Composition

Material Category	Est. Percent	MOE	Tons		Est. Percent	MOE	Tons
Paper	**25.0%**	**1.5%**	**442,129**	**Organics**	**38.1%**	**1.9%**	**673,491**
Corrugated Cardboard/Kraft Paper	6.8%	1.0%	120,583	Food Waste	15.0%	1.9%	264,777
Newspaper	0.8%	0.2%	13,860	Yard Waste - Grass	0.8%	0.4%	14,315
Office/High Grade Paper	0.7%	0.2%	12,953	Yard Waste - Other	2.4%	0.9%	42,240
Magazine & Catalogs	1.0%	0.3%	17,864	Wood - Unpainted	3.9%	1.0%	69,462
Aseptic Boxes & Gable Top Cartons	0.4%	0.1%	6,380	Wood - Painted	2.5%	0.6%	44,237
Mixed Recyclable Paper (Low Grade)	6.3%	0.7%	112,010	Textiles & Leather Products	4.4%	0.7%	77,705
Compostable Paper	6.5%	0.5%	115,338	Diapers & Sanitary Products	2.6%	0.4%	46,112
Non-recyclable Paper	2.4%	0.3%	43,141	Animal By-Products	2.9%	0.5%	51,728
Plastic	**18.8%**	**1.1%**	**331,245**	Fines	0.9%	0.1%	16,069
#1 PET Bottles & Jars	1.7%	0.1%	29,751	Other Organics	2.7%	0.6%	46,846
#1 PET Non-Bottles & Containers	0.1%	0.0%	2,376	**Inorganics**	**9.4%**	**1.5%**	**166,210**
#2 HDPE Natural Bottles	0.5%	0.1%	8,177	Electronics - Covered Devices	0.0%	0.0%	224
#2 HDPE Colored Bottles	0.5%	0.1%	9,576	Other Electronics	0.5%	0.1%	9,326
#3 - #7 Bottles	0.1%	0.0%	1,005	Carpet & Carpet Padding	1.6%	0.7%	28,779
#2 - #7 Non-Bottle Rigid Containers	1.3%	0.1%	22,684	Drywall/Gypsum Board	0.4%	0.3%	7,815
Expanded Polystyrene	0.9%	0.2%	16,121	Concrete, Rock, Brick	0.5%	0.3%	8,761
Clean Retail Plastic Bags	0.1%	0.0%	1,897	Asphalt Roofing	0.3%	0.4%	5,186
Industrial Film	2.1%	0.7%	37,123	Asphalt Paving	0.1%	0.1%	1,081
All Other Film	6.5%	0.5%	114,571	Other C&D	2.0%	0.6%	35,215
Durable/Bulky Rigid Plastics	2.7%	0.5%	48,183	Medically-Related Waste	0.1%	0.1%	2,083
Remainder/Composite Plastic	2.3%	0.3%	39,781	Lithium Batteries	0.0%	0.0%	21
Metals	**5.7%**	**1.1%**	**101,091**	Automotive Batteries	0.0%	0.0%	0
Steel Cans	0.9%	0.1%	16,001	Other Batteries	0.1%	0.0%	1,125
Aluminum Cans	0.8%	0.1%	13,387	Other HHW	0.0%	0.0%	314
Other Aluminum	0.3%	0.1%	6,137	Bulky Materials	2.1%	0.9%	36,949
Other Ferrous Metals	3.0%	1.0%	53,142	Furniture	0.8%	0.4%	13,709
Other Non-Ferrous Metals	0.7%	0.4%	12,424	Other Inorganics	0.6%	0.2%	11,115
Glass	**3.0%**	**0.4%**	**52,112**	PPE	0.3%	0.1%	4,505
Clear Glass Containers	1.4%	0.2%	25,355				
Green Glass Containers	0.5%	0.1%	8,755				
Brown Glass Containers	0.6%	0.2%	10,571	**Grand Total**	**100.0%**		**1,766,277**
Non-Recyclable Glass	0.4%	0.1%	7,431	**Number of Samples**	**201**		

Margin of error is calculated at a 90 percent level of confidence.

Figure G-2 Comparison of Composition by Material Group 2021 vs 2001 (Percentage)

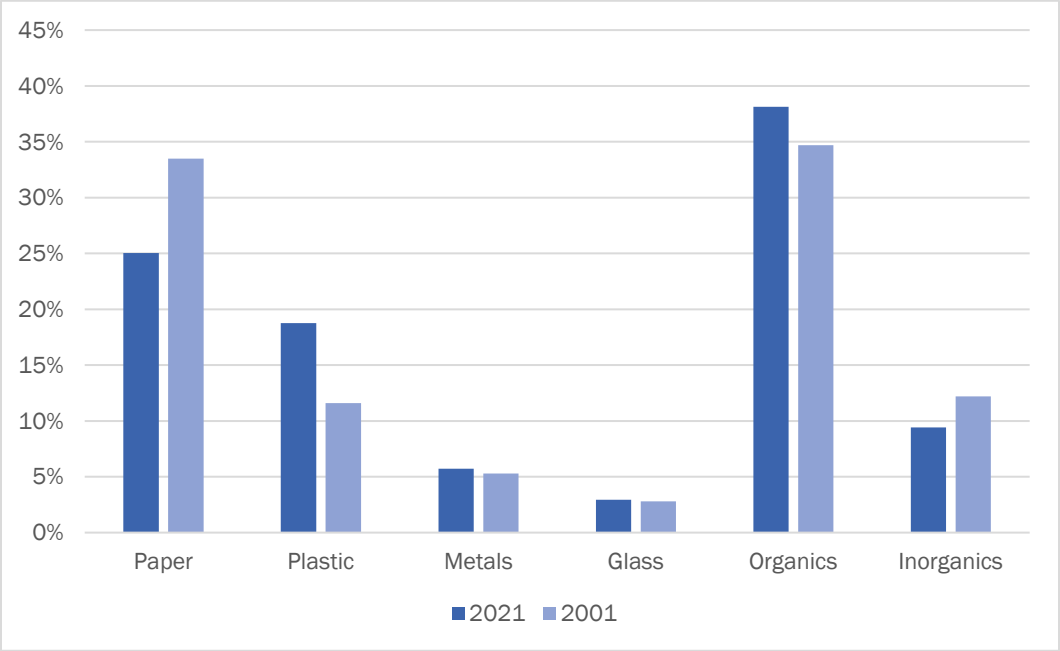


Figure G-3 Comparison of Composition by Material Group 2021 vs 2001 (Tons)

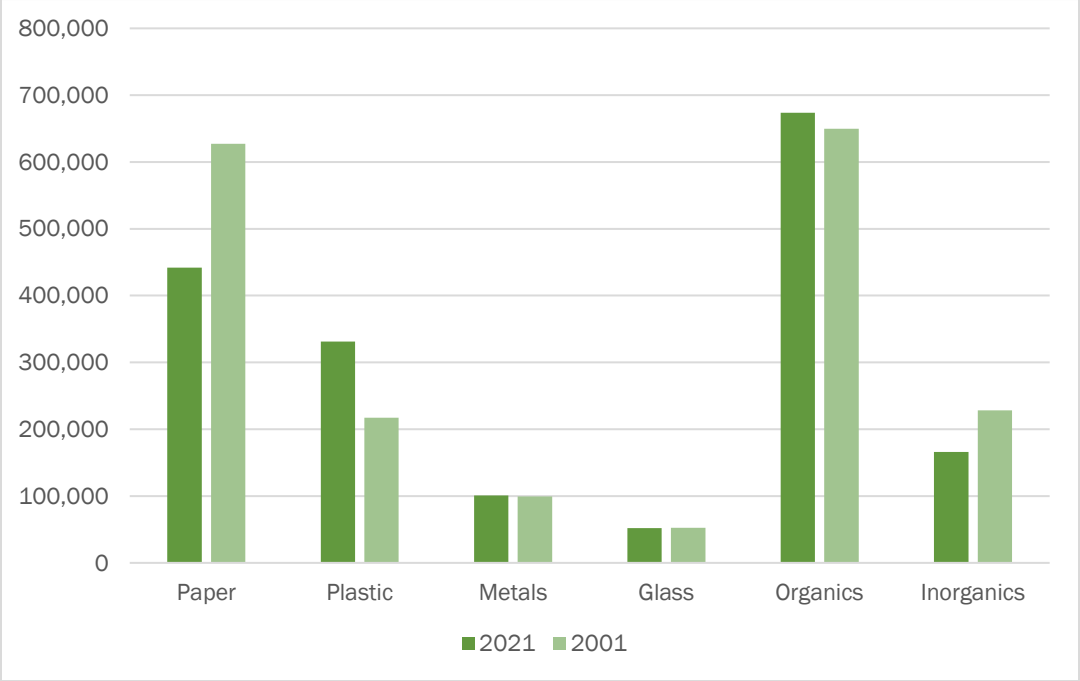


Figure G-4 Composition Summary by Material Group (Percentage)

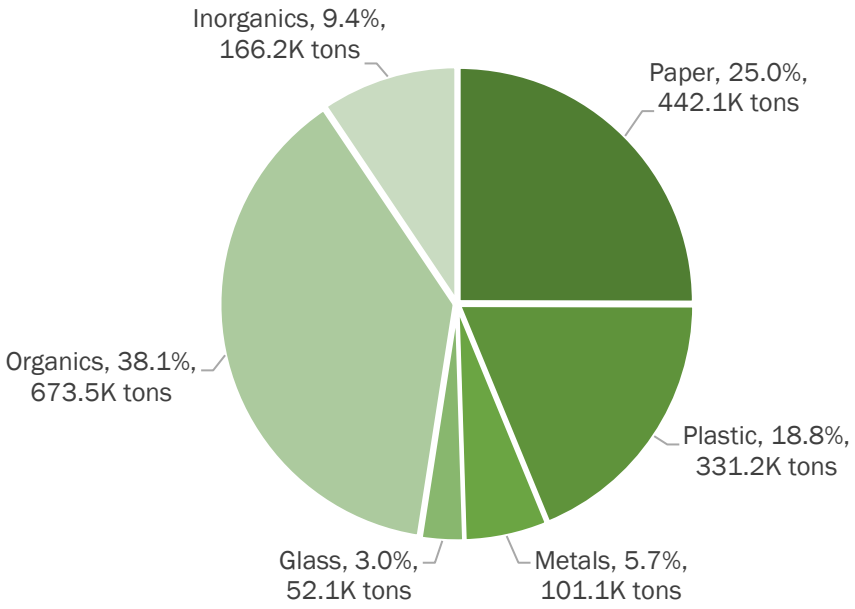
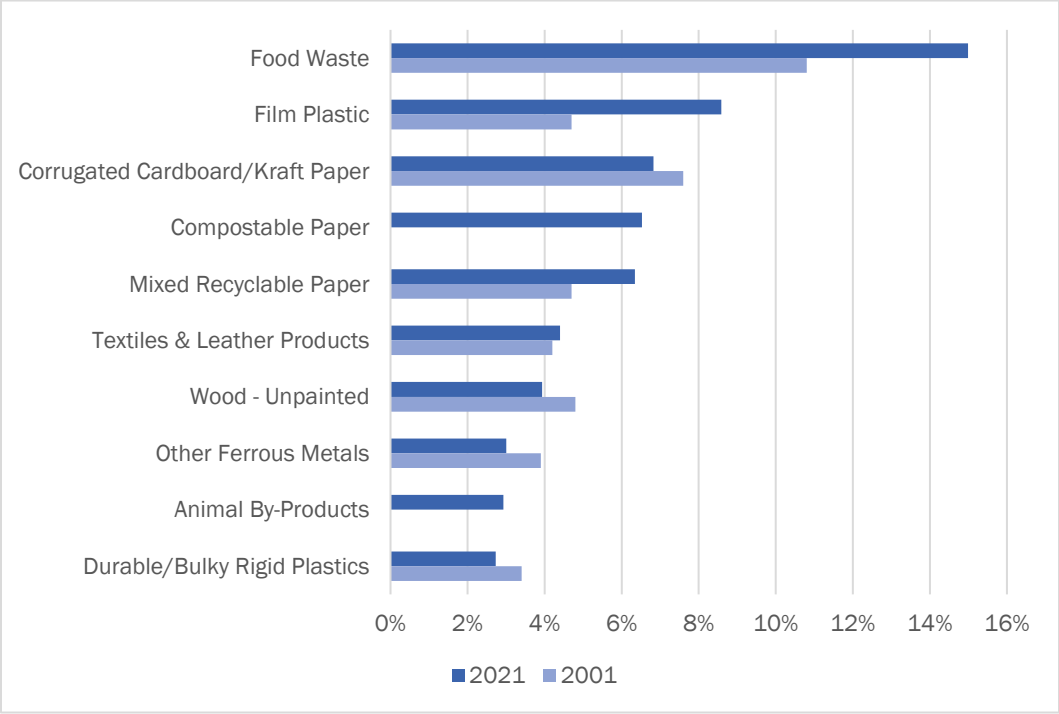


Figure G-5 Top 10 Most Prevalent by Weight*



*Note: Some material categories were not sorted in 2001 Study

Figure G-6 Food Waste Detail

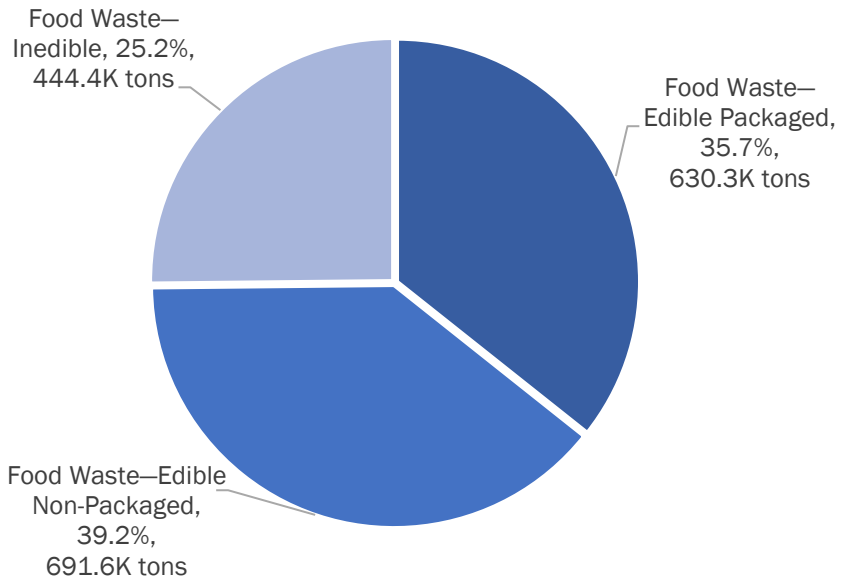
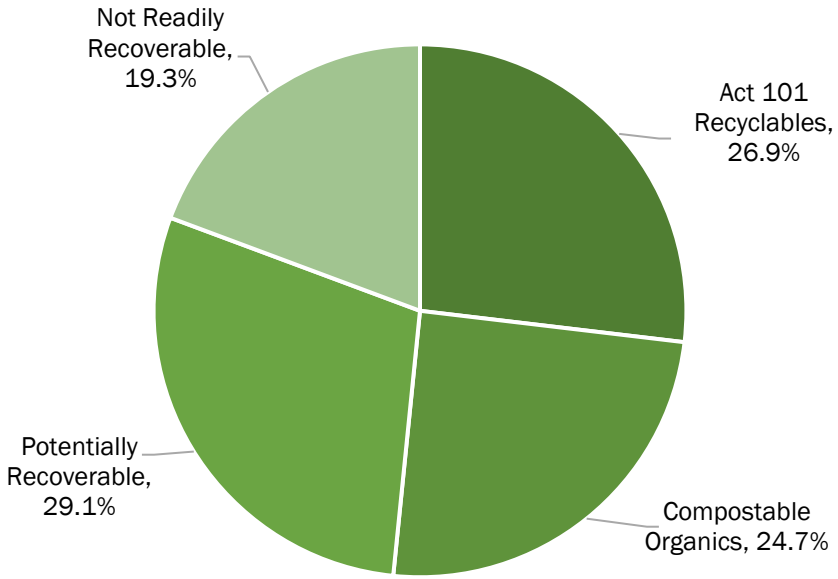


Figure G-7 Divertibility of Disposed MSW



G 3. COMPOSITION COMPARISONS BY GENERATING SECTOR

The composition of residential and commercial MSW were analyzed individually with selected comparisons shown below:

- Table G-5 and Table G-6 contain a detailed comparison of disposed residential and commercial MSW in the Southwest region based on percentage composition and absolute tonnage, respectively.
- Figure G-8 and Figure G-9 compare the residential and commercial disposed MSW based on percentage composition and absolute tonnage, respectively.

Figure G-10 is a bar chart that compares the breakdown of food waste by generating sector.

- Figure G-11 illustrates the divertibility of disposed MSW streams by generating sector.

Table G-5 Disposed MSW Composition by Generator Sector (Percentage)

Material Category	Res	ICI		Res	ICI
Paper	**22.6%**	**28.2%**	**Organics**	**41.0%**	**34.3%**
Corrugated Cardboard/Kraft Paper	4.2%	10.4%	Food Waste	14.3%	15.9%
Newspaper	0.9%	0.7%	Yard Waste - Grass	1.0%	0.5%
Office/High Grade Paper	0.5%	1.0%	Yard Waste - Other	2.6%	2.1%
Magazine & Catalogs	1.1%	0.9%	Wood - Unpainted	1.9%	6.6%
Aseptic Boxes & Gable Top Cartons	0.3%	0.4%	Wood - Painted	2.9%	2.0%
Mixed Recyclable Paper (Low Grade)	6.4%	6.3%	Textiles & Leather Products	6.0%	2.4%
Compostable Paper	6.8%	6.1%	Diapers & Sanitary Products	3.7%	1.2%
Non-recyclable Paper	2.4%	2.4%	Animal By-Products	4.7%	0.6%
Plastic	**17.2%**	**20.9%**	Fines	1.2%	0.6%
#1 PET Bottles & Jars	2.1%	1.2%	Other Organics	2.8%	2.4%
#1 PET Non-Bottles & Containers	0.2%	0.1%	**Inorganics**	**9.9%**	**8.7%**
#2 HDPE Natural Bottles	0.5%	0.4%	Electronics - Covered Devices	0.0%	0.0%
#2 HDPE Colored Bottles	0.7%	0.3%	Other Electronics	0.7%	0.2%
#3 - #7 Bottles	0.1%	0.0%	Carpet & Carpet Padding	1.2%	2.2%
#2 - #7 Non-Bottle Rigid Containers	1.4%	1.1%	Drywall/Gypsum Board	0.2%	0.8%
Expanded Polystyrene	0.7%	1.2%	Concrete, Rock, Brick	0.4%	0.6%
Clean Retail Plastic Bags	0.1%	0.1%	Asphalt Roofing	0.4%	0.2%
Industrial Film	0.2%	4.7%	Asphalt Paving	0.0%	0.1%
All Other Film	6.8%	6.0%	Other C&D	2.8%	0.9%
Durable/Bulky Rigid Plastics	2.5%	3.0%	Medically-Related Waste	0.1%	0.1%
Remainder/Composite Plastic	1.9%	2.8%	Lithium Batteries	0.0%	0.0%
Metals	**5.4%**	**6.1%**	Automotive Batteries	0.0%	0.0%
Steel Cans	1.1%	0.6%	Other Batteries	0.1%	0.0%
Aluminum Cans	1.0%	0.4%	Other HHW	0.0%	0.0%
Other Aluminum	0.4%	0.3%	Bulky Materials	2.1%	2.1%
Other Ferrous Metals	2.3%	3.9%	Furniture	0.9%	0.6%
Other Non-Ferrous Metals	0.6%	0.9%	Other Inorganics	0.7%	0.5%
Glass	**3.9%**	**1.7%**	PPE	0.2%	0.4%
Clear Glass Containers	2.0%	0.7%			
Green Glass Containers	0.7%	0.2%			
Brown Glass Containers	0.6%	0.6%	**Grand Total**	**100%**	**100%**
Non-Recyclable Glass	0.6%	0.2%	**Number of Samples**	**105**	**96**

Table G-6 Waste Composition by Generator Sector (Tons)

Material Category	Res	ICI		Res	ICI
Paper	**227,121**	**215,008**	**Organics**	**412,111**	**261,380**
Corrugated Cardboard/Kraft Paper	41,762	78,821	Food Waste	143,515	121,263
Newspaper	8,570	5,290	Yard Waste - Grass	10,304	4,011
Office/High Grade Paper	4,985	7,969	Yard Waste - Other	25,927	16,313
Magazine & Catalogs	11,104	6,760	Wood - Unpainted	19,139	50,323
Aseptic Boxes & Gable Top Cartons	3,473	2,908	Wood - Painted	29,173	15,063
Mixed Recyclable Paper (Low Grade)	63,967	48,043	Textiles & Leather Products	59,812	17,893
Compostable Paper	68,735	46,603	Diapers & Sanitary Products	36,709	9,403
Non-recyclable Paper	24,526	18,615	Animal By-Products	47,468	4,260
Plastic	**172,538**	**158,707**	Fines	11,588	4,481
#1 PET Bottles & Jars	20,764	8,986	Other Organics	28,475	18,371
#1 PET Non-Bottles & Containers	1,679	697	**Inorganics**	**99,947**	**66,262**
#2 HDPE Natural Bottles	5,496	2,682	Electronics - Covered Devices	181	43
#2 HDPE Colored Bottles	7,018	2,558	Other Electronics	7,501	1,825
#3 - #7 Bottles	695	310	Carpet & Carpet Padding	11,992	16,787
#2 - #7 Non-Bottle Rigid Containers	14,236	8,448	Drywall/Gypsum Board	1,997	5,818
Expanded Polystyrene	7,139	8,982	Concrete, Rock, Brick	4,026	4,736
Clean Retail Plastic Bags	1,008	889	Asphalt Roofing	3,847	1,339
Industrial Film	1,607	35,515	Asphalt Paving	285	796
All Other Film	68,600	45,971	Other C&D	28,446	6,770
Durable/Bulky Rigid Plastics	25,535	22,648	Medically-Related Waste	1,314	769
Remainder/Composite Plastic	18,761	21,020	Lithium Batteries	2	19
Metals	**54,371**	**46,720**	Automotive Batteries	0	0
Steel Cans	11,260	4,741	Other Batteries	870	255
Aluminum Cans	10,043	3,345	Other HHW	157	157
Other Aluminum	4,072	2,065	Bulky Materials	20,943	16,007
Other Ferrous Metals	23,338	29,804	Furniture	9,350	4,358
Other Non-Ferrous Metals	5,659	6,765	Other Inorganics	7,492	3,623
Glass	**39,065**	**13,047**	PPE	1,546	2,959
Clear Glass Containers	20,317	5,038			
Green Glass Containers	6,907	1,847			
Brown Glass Containers	5,831	4,740	**Grand Total**	**1,005,153**	**761,124**
Non-Recyclable Glass	6,010	1,422	**Number of Samples**	**105**	**96**

Figure G-8 Composition Summary by Generator Sector (Percentage)

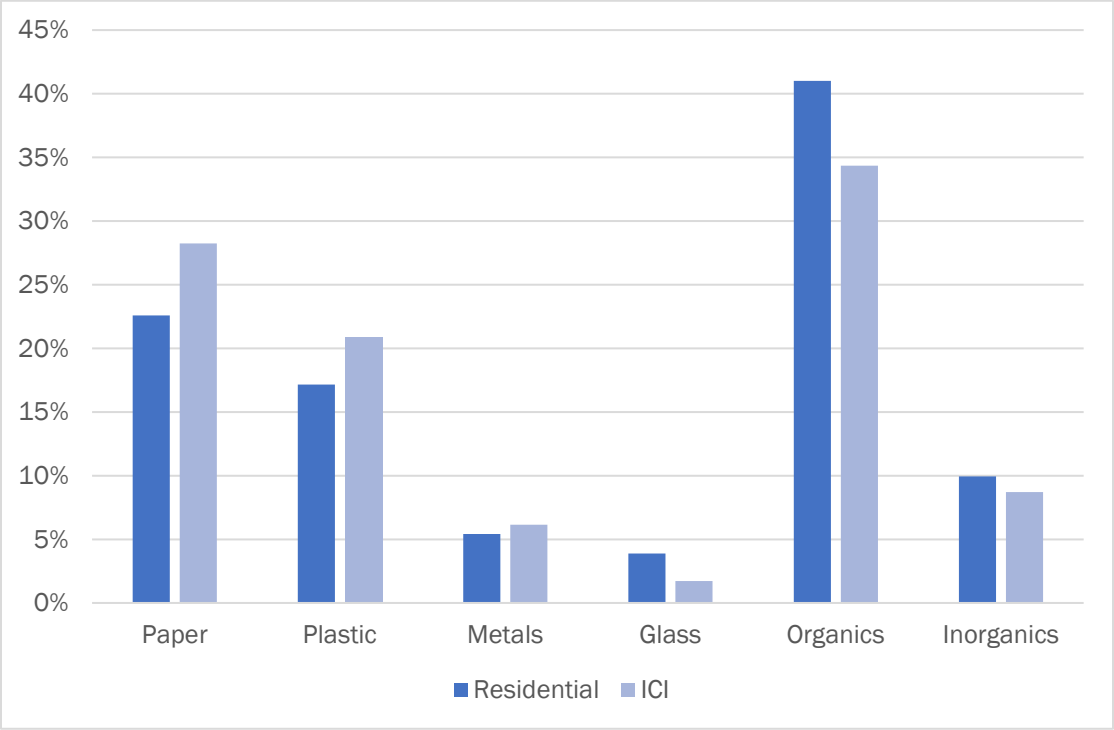


Figure G-9 Composition Summary by Generator Sector (Tons)

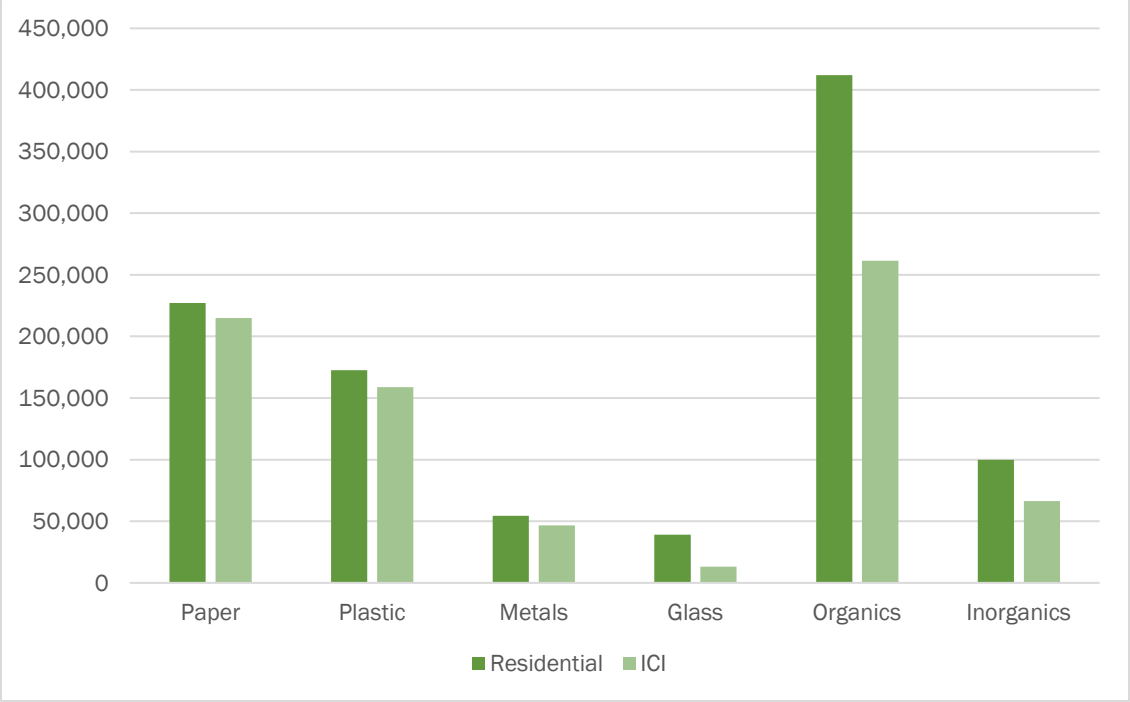


Figure G-10 Detailed Food Waste by Generator Sector (Percentage)

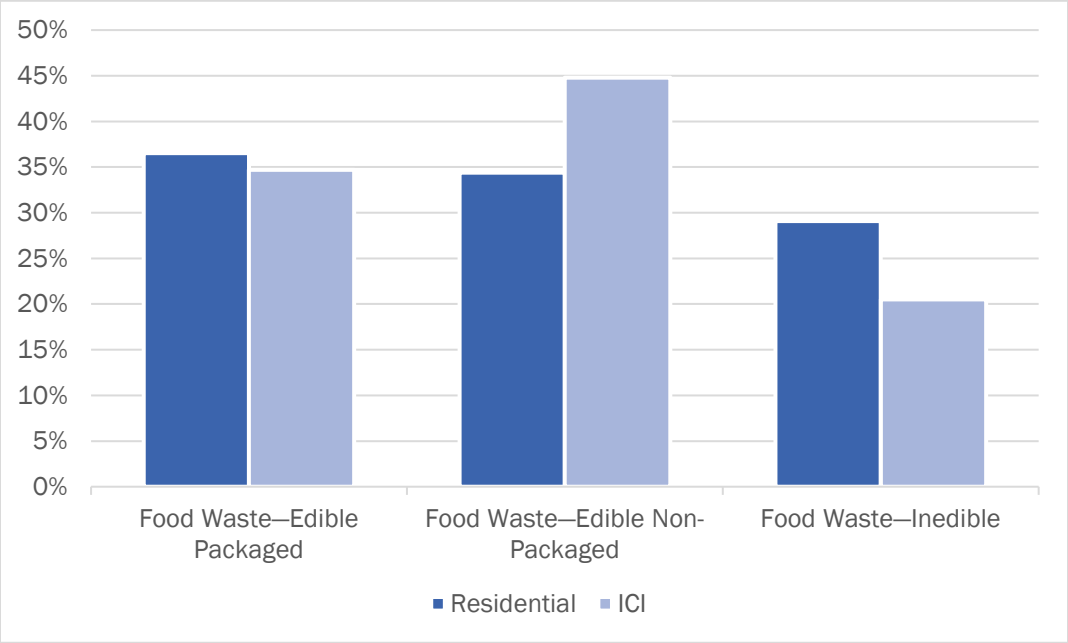
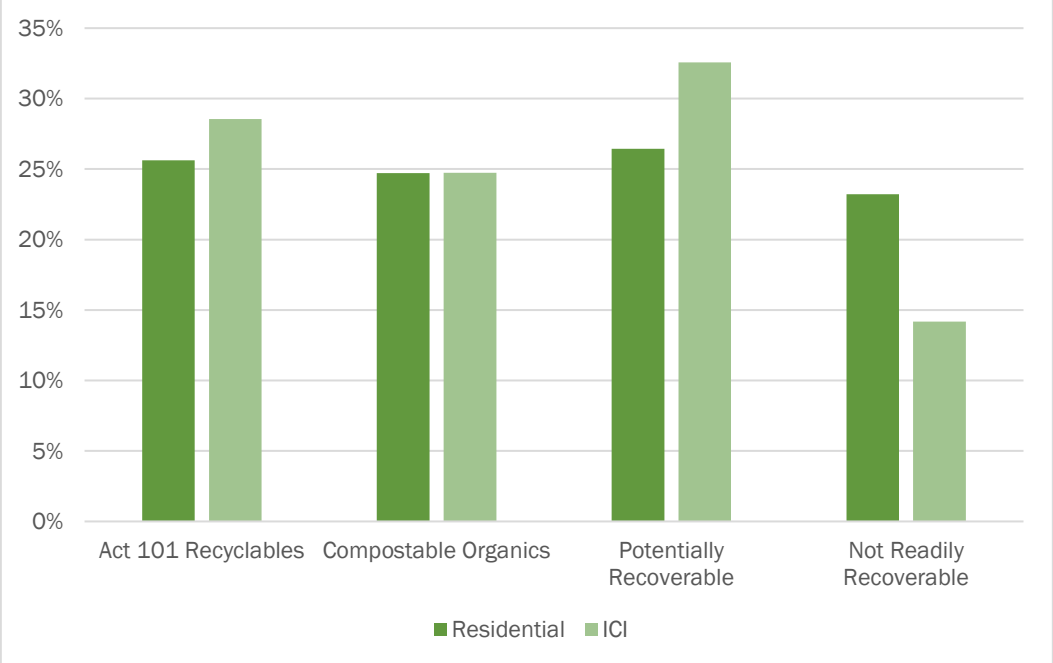


Figure G-11 Divertibility Comparison by Generator Sector (Percentage)



G 4. COMPOSITION BY DEMOGRAPHIC ORIGIN

The composition of urban, suburban, and rural MSW were analyzed individually and selected comparisons are shown below:

- Table G-7 and Table G-8 contain detailed comparisons of disposed MSW from urban, suburban, and rural areas in the Southwest region based on percentage composition and absolute tonnage, respectively.
- Figure G-12 and Figure G-13 compare the urban, suburban, and rural waste streams based on percentage composition and absolute tonnage, respectively.
- Figure G-14 is a bar chart that compares the breakdown of food waste by demographic origin.
- Figure G-15 compares the divertibility of disposed MSW by demographic origin.

Table G-7 Waste Composition by Demographic Origin (Percentage)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**26.3%**	**25.4%**	**21.6%**	**Organics**	**36.0%**	**38.9%**	**37.9%**
Corrugated Cardboard/Kraft Paper	4.8%	7.7%	5.7%	Food Waste	13.3%	16.1%	12.3%
Newspaper	0.9%	0.7%	1.0%	Yard Waste - Grass	1.5%	0.8%	0.1%
Office/High Grade Paper	1.2%	0.6%	0.6%	Yard Waste - Other	3.3%	2.2%	2.0%
Magazine & Catalogs	0.6%	1.1%	1.1%	Wood - Unpainted	2.6%	4.0%	5.3%
Aseptic Boxes & Gable Top Cartons	0.3%	0.4%	0.3%	Wood - Painted	1.2%	2.7%	3.4%
Mixed Recyclable Paper (Low Grade)	9.4%	5.7%	4.9%	Textiles & Leather Products	6.2%	3.9%	4.0%
Compostable Paper	5.8%	7.1%	5.1%	Diapers & Sanitary Products	2.2%	2.7%	2.7%
Non-recyclable Paper	3.3%	2.1%	3.0%	Animal By-Products	2.3%	3.2%	2.7%
Plastic	**18.2%**	**19.0%**	**18.4%**	Fines	0.8%	0.9%	1.1%
#1 PET Bottles & Jars	1.6%	1.7%	1.8%	Other Organics	2.5%	2.4%	4.0%
#1 PET Non-Bottles & Containers	0.2%	0.1%	0.1%	**Inorganics**	**10.6%**	**8.0%**	**13.9%**
#2 HDPE Natural Bottles	0.3%	0.5%	0.5%	Electronics - Covered Devices	0.0%	0.0%	0.1%
#2 HDPE Colored Bottles	0.4%	0.6%	0.7%	Other Electronics	0.4%	0.6%	0.5%
#3 - #7 Bottles	0.0%	0.1%	0.0%	Carpet & Carpet Padding	3.7%	1.1%	1.2%
#2 - #7 Non-Bottle Rigid Containers	1.5%	1.2%	1.3%	Drywall/Gypsum Board	0.0%	0.3%	1.5%
Expanded Polystyrene	0.7%	1.0%	0.6%	Concrete, Rock, Brick	0.7%	0.4%	0.5%
Clean Retail Plastic Bags	0.2%	0.1%	0.1%	Asphalt Roofing	0.1%	0.0%	1.8%
Industrial Film	3.1%	2.0%	1.4%	Asphalt Paving	0.0%	0.0%	0.4%
All Other Film	6.2%	6.8%	5.7%	Other C&D	0.9%	2.1%	3.1%
Durable/Bulky Rigid Plastics	1.8%	2.6%	4.5%	Medically-Related Waste	0.1%	0.1%	0.2%
Remainder/Composite Plastic	2.3%	2.4%	1.7%	Lithium Batteries	0.0%	0.0%	0.0%
Metals	**6.3%**	**5.7%**	**5.2%**	Automotive Batteries	0.0%	0.0%	0.0%
Steel Cans	0.6%	1.0%	1.0%	Other Batteries	0.1%	0.1%	0.1%
Aluminum Cans	0.7%	0.8%	0.9%	Other HHW	0.0%	0.0%	0.1%
Other Aluminum	0.5%	0.3%	0.3%	Bulky Materials	2.7%	1.8%	2.7%
Other Ferrous Metals	3.7%	2.9%	2.5%	Furniture	1.1%	0.7%	0.5%
Other Non-Ferrous Metals	0.8%	0.7%	0.5%	Other Inorganics	0.6%	0.5%	1.2%
Glass	**2.6%**	**3.1%**	**2.9%**	PPE	0.2%	0.3%	0.1%
Clear Glass Containers	1.3%	1.5%	1.3%				
Green Glass Containers	0.3%	0.6%	0.3%				
Brown Glass Containers	0.5%	0.6%	0.6%	**Grand Total**	**100%**	**100%**	**100%**
Non-Recyclable Glass	0.4%	0.4%	0.7%	**Number of Samples**	**51**	**95**	**55**

Table G-8 Waste Composition by Demographic Origin (Tons)

Material Category	Urban	Suburban	Rural		Urban	Suburban	Rural
Paper	**93,334**	**291,922**	**56,873**	**Organics**	**127,432**	**446,403**	**99,655**
Corrugated Cardboard/Kraft Paper	17,053	88,599	14,931	Food Waste	47,173	185,131	*32,473*
Newspaper	3,226	8,089	2,545	Yard Waste - Grass	5,374	8,636	305
Office/High Grade Paper	4,343	7,070	1,540	Yard Waste - Other	11,624	25,280	5,336
Magazine & Catalogs	2,216	12,716	2,932	Wood - Unpainted	9,357	46,052	14,053
Aseptic Boxes & Gable Top Cartons	1,032	4,660	688	Wood - Painted	4,181	31,032	9,023
Mixed Recyclable Paper (Low Grade)	33,446	65,706	12,858	Textiles & Leather Products	21,962	45,109	10,634
Compostable Paper	20,415	81,512	13,412	Diapers & Sanitary Products	7,650	31,304	7,157
Non-recyclable Paper	11,603	23,570	7,968	Animal By-Products	8,267	36,327	7,134
Plastic	**64,651**	**218,068**	**48,526**	Fines	2,941	10,234	2,895
#1 PET Bottles & Jars	5,654	19,317	4,779	Other Organics	8,904	27,298	10,644
#1 PET Non-Bottles & Containers	539	1,571	265	**Inorganics**	**37,677**	**91,874**	**36,659**
#2 HDPE Natural Bottles	1,089	5,688	1,401	Electronics - Covered Devices	0	43	181
#2 HDPE Colored Bottles	1,324	6,370	1,882	Other Electronics	1,451	6,641	1,234
#3 - #7 Bottles	147	790	68	Carpet & Carpet Padding	13,116	12,613	3,049
#2 - #7 Non-Bottle Rigid Containers	5,257	14,011	3,417	Drywall/Gypsum Board	69	3,827	3,920
Expanded Polystyrene	2,655	11,865	1,601	Concrete, Rock, Brick	2,621	4,797	1,343
Clean Retail Plastic Bags	758	899	241	Asphalt Roofing	237	309	4,639
Industrial Film	10,992	22,576	3,554	Asphalt Paving	7	0	1,074
All Other Film	21,865	77,772	14,934	Other C&D	3,239	23,815	8,162
Durable/Bulky Rigid Plastics	6,255	30,029	11,899	Medically-Related Waste	267	1,190	626
Remainder/Composite Plastic	8,116	27,181	4,484	Lithium Batteries	19	2	0
Metals	**22,148**	**65,353**	**13,590**	Automotive Batteries	0	0	0
Steel Cans	2,015	11,315	2,672	Other Batteries	216	669	240
Aluminum Cans	2,379	8,722	2,286	Other HHW	30	150	134
Other Aluminum	1,603	3,823	712	Bulky Materials	9,503	20,269	7,178
Other Ferrous Metals	13,171	33,380	6,591	Furniture	3,943	8,326	1,439
Other Non-Ferrous Metals	2,981	8,114	1,329	Other Inorganics	2,257	5,771	3,087
Glass	**9,112**	**35,267**	**7,734**	PPE	701	3,452	352
Clear Glass Containers	4,498	17,356	3,501				
Green Glass Containers	1,215	6,698	842				
Brown Glass Containers	1,933	7,188	1,449	**Grand Total**	**354,353**	**1,148,887**	**263,037**
Non-Recyclable Glass	1,465	4,025	1,941	**Number of Samples**	**51**	**95**	**55**

Figure G-12 Composition Summary by Demographic Origin (Percentage)

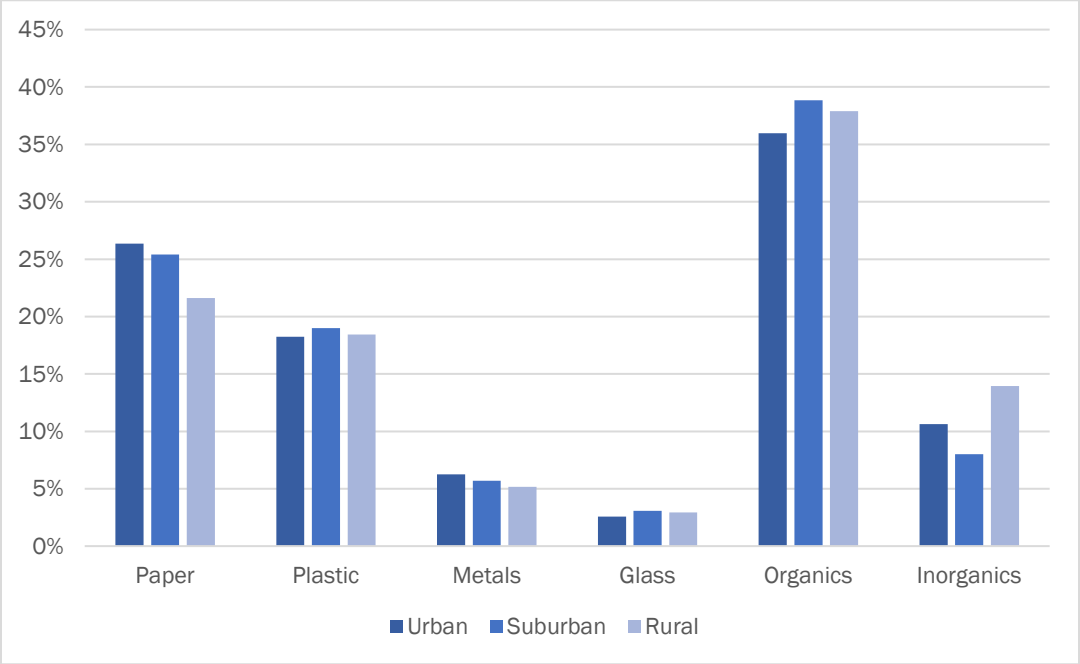


Figure G-13 Composition Summary by Demographic Origin (Tons)

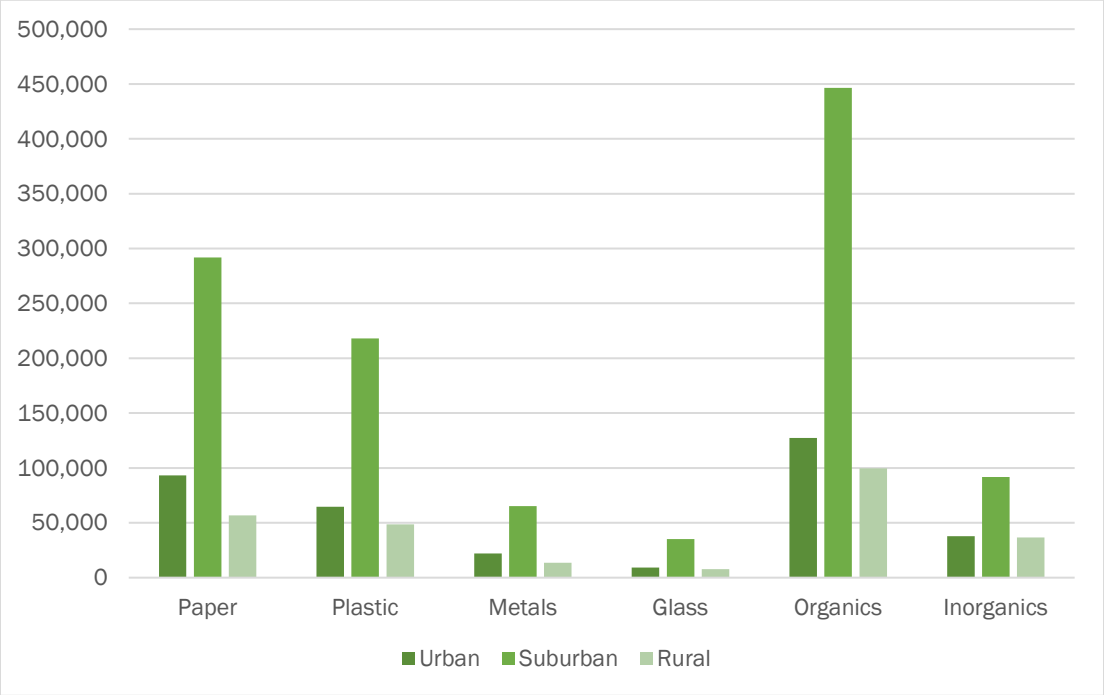


Figure G-14 Food Waste Detail by Demographic Origin

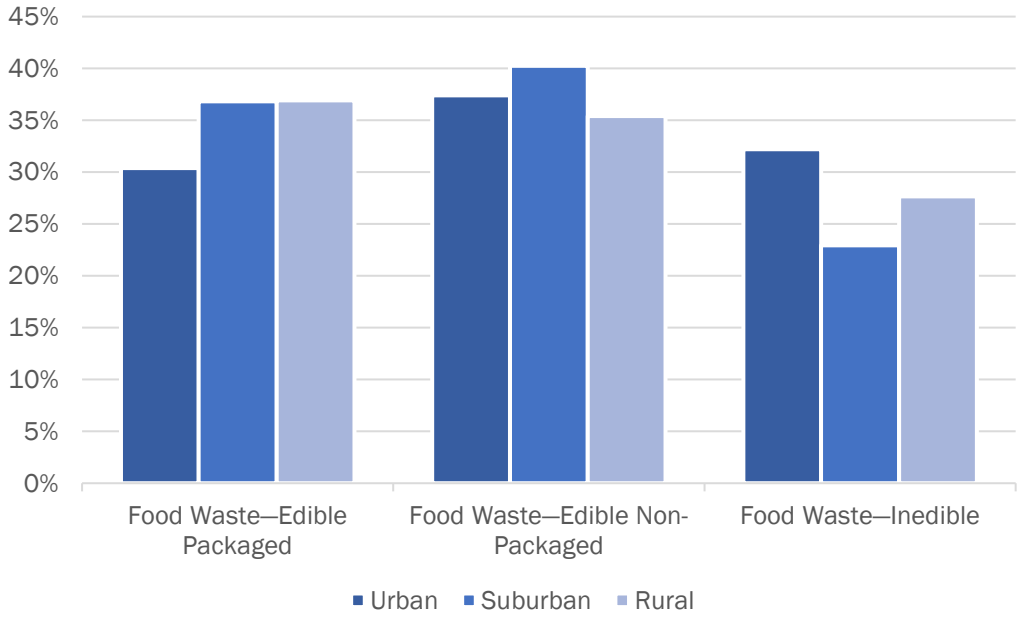
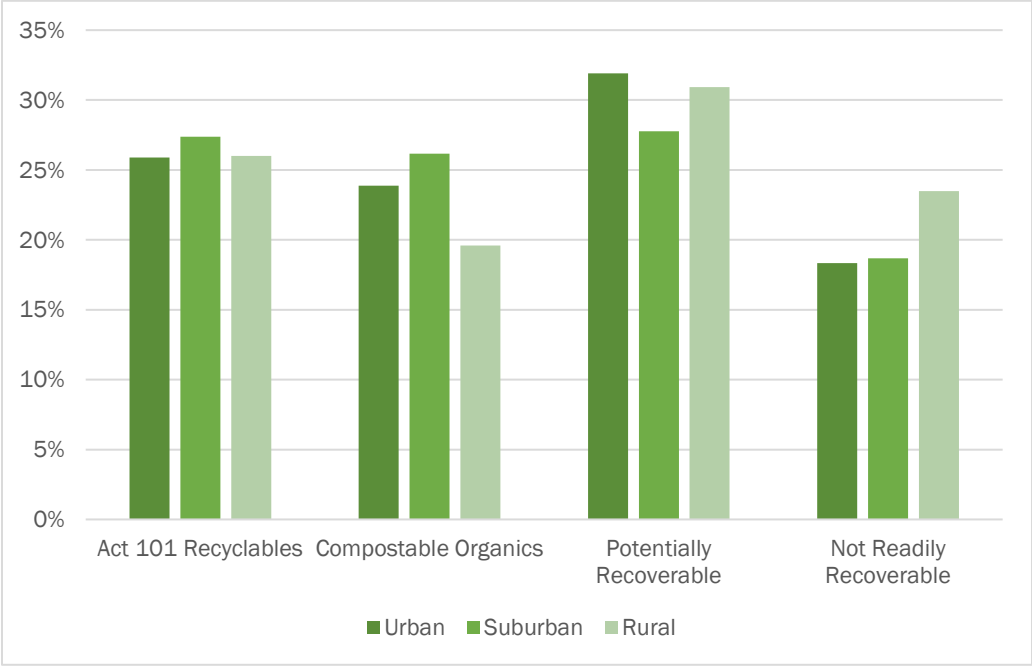


Figure G-15 Divertibility Comparison (Percentage)



G 5. ECONOMIC AND ENVIRONMENTAL IMPACTS

The following supplemental analyses have been included to illustrate the potential financial and environmental impacts of diverting recyclable and compostable materials from the disposed MSW stream.

- Table G-9 estimates the recovered material value for recyclables commodities that were disposed in the regional MSW stream. Market values were obtained from recyclingmarkets.net.
- Table G-10 calculates the greenhouse gas emissions that could be reduced if the estimated quantities of recyclable and compostable materials disposed in the Southwest region were diverted from disposal.

Table G-9 Estimated Value of Disposed Recyclable Materials

Recyclable Commodities	Estimated Tons Disposed	Average Market Price ($/ton)	Estimated Total Market Value ($)
Recyclable Paper	**283,650**		**$33,594,363**
Corrugated Cardboard/Kraft Paper	120,583	$135	$16,278,686
Newspaper	13,860	$188	$2,598,766
Office/High Grade Paper	12,953	$235	$3,044,021
Magazine & Catalogs	17,864	$168	$2,992,146
Aseptic Boxes & Gable Top Cartons	6,380	$0	$0
Mixed Recyclable Paper (Low Grade)	112,010	$78	$8,680,744
Recyclable Containers	**187,468**		**$85,887,217**
#1 PET Bottles & Jars	29,751	$860	$25,585,438
#1 PET Non-Bottles & Containers	2,376	$130	$308,833
#2 HDPE Natural Bottles	8,177	$1,130	$9,240,206
#2 HDPE Colored Bottles	9,576	$640	$6,128,873
#3 - #7 Bottles	1,005	$130	$130,635
#2 - #7 Non-Bottle Rigid Containers	22,684	$130	$8,960,366
Durable/Bulky Rigid Plastics	48,183	$90	$4,336,448
Steel Cans	16,001	$230	$3,680,287
Aluminum Cans	13,387	$1,950	$26,105,075
Clear Glass Containers	25,355	$50	$1,267,774
Green Glass Containers	8,755	$8	$65,660
Brown Glass Containers	2,218	$35	$77,621
Total	**471,118**	*$254*	**$119,481,580**

Source: Recyclingmarkets.net - Northeast Region of U.S. as of 06/9/22

Table G-10 Emissions Reduction Potential from Disposed Recyclables

Material Components	Tons Recycled/ Composted[1]	Emissions Reduced ($MTCO_2E$)[2]
Recyclable Paper	**277,269**	**904,670**
Corrugated Cardboard/Kraft Paper	120,583	378,068
Magazine & Catalogs	17,864	54,837
Newspaper	13,860	37,537
Office/High Grade Paper	12,953	37,094
Mixed Recyclable Paper	112,010	397,134
Recyclable Containers	**195,821**	**277,098**
Aluminum Cans	13,387	122,188
Steel Cans	16,001	29,315
Glass	44,681	12,336
PET	32,126	33,274
HDPE	17,754	13,466
Mixed Plastics	71,872	66,519
Compostable	**321,332**	**33,633**
Food Waste	264,777	30,604
Yard Waste	56,555	3,029
Total	**794,423**	**1,215,401**

[1] Based on estimated overall MSW waste composition for 2021 and Pennsylvania's reported MSW disposal tonnage for FY 2021. Assumes the materials would be recycled instead of disposed.

[2] U.S. EPA Waste Reduction Model, Version 15

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