Recyclable Materials Supply and Demand Workpaper

Pennsylvania Markets Center Study

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PENNSYLVANIA MARKETS CENTER STUDY
SUPPLY AND DEMAND WORKPAPER

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Without their generous contribution of time, experience and knowledge, this research would not have been possible.

Pennsylvania Markets Center Study
Supply and Demand Analysis

Introduction

The purpose of this workpaper is to qualitatively assess the supply and demand for selected recyclable materials generated in Pennsylvania, including assessment of the existing collection, processing and end use infrastructure. This workpaper is the first of a series of papers developed as part of the Recycling Markets Center Study project being undertaken by R.W. Beck on behalf of the Pennsylvania Department of Environmental Protection (PA DEP). The materials addressed in this analysis are as follows:

Commonwealth of Pennsylvania Act 101 materials:

- Glass containers;
- Old Newspaper (ONP);
- Old Corrugated Containers (OCC);
- High-grade office paper;
- Aluminum cans;
- Steel cans;
- Plastics; and
- Leaf waste.

Materials addressed by other Commonwealth initiatives:

- Food waste and other organics; and
- Electronics.

For each material, R.W. Beck prepared descriptions of the recovery, processing and end use infrastructure, the nature of supply and demand, pertinent Commonwealth regulations, and findings related to the relationship between supply and demand. This information is provided herein.

Methodology

In conjunction with this research, R.W. Beck updated and expanded the PA DEP recyclables processors and end users database. This data was reviewed for the purpose of characterizing the processing infrastructure in Pennsylvania and to identify

processing infrastructure gaps, if any exist, that impede the flow of recyclables into the marketplace.

Secondly, the data available to date from the Pennsylvania MSW Waste Composition Study, also being undertaken by R.W. Beck, was utilized to assess the extent to which particular recyclable materials are prevalent in the disposed waste stream. The 1999-2000 PA DEP Act 101 Annual Report to the General Assembly was used to extract data regarding tonnages recycled by material type in 1999. This data was extrapolated to project tonnages recycled in 2000, based on the assumption that recycling rates for each material have remained constant over the past two years. The two resulting data sets were then utilized to project capture rates for each type of recyclable material studied, as well as estimates of the tonnage of each material type remaining in the waste stream for recovery. As no hard data was available on the split between residential and commercial waste disposed, an estimate on the split for the total waste stream disposed was developed. This estimate was based on a review of the Pennsylvania waste sort data plus R.W. Beck's experience based on the results of waste composition studies performed in other states with similar population and makeup to Pennsylvania. The percent composition estimates pertaining to residential and commercial waste were then applied to the split totals for these two generator categories to derive estimates of tonnage by material type for each category.

The most recent average national recycling rates are also supplied when available. These are from the appropriate association that tracks the material (Aluminum Association, American Forest and Paper Association, Steel Institute, and American Plastics Council).

To characterize the nature of, and relationship between, supply and demand for recyclable materials in Pennsylvania, and to particular regions of Pennsylvania, representatives from the following types of organizations were interviewed by telephone to tap their knowledge and insights:

- Processing center managers;
- Municipal recycling coordinators;
- Manufacturers of products that use recyclable materials as feedstock;
- PA DEP personnel;
- PENNDOT personnel and sub contractors;
- PROP and PRC representatives;
- Recycling industry association representatives, and
- Other recycling industry professionals.

In addition, R.W. Beck utilized knowledge and information about recycling markets and market demand gained from conducting similar research for other clients as well as information obtained from various trade publications and the Internet.

Glass Containers

Glass containers (referred to simply as glass in this section) are defined as post-consumer and post-industrial (such as defective glass bottles) glass food and beverage containers. Plate glass and laboratory glass are not included in this discussion as these materials are not addressed by Act 101. Glass containers are generated in households throughout Pennsylvania and in industrial and commercial food service and hospitality settings, such as cafeterias, restaurants and bars.

Commodity Infrastructure

Typical Means of Collection

Glass containers from residential sources are typically collected in curbside recycling programs and in drop-box locations throughout Pennsylvania. More densely populated areas tend to have curbside collection programs for recyclables, whereas the more rural areas tend to have drop-box locations for recycling. Most of the curbside collection programs in the Commonwealth have at least two streams for materials – fiber and commingled containers. Some have the residents or haulers sort materials into several streams. A single-stream MRF (processing containers and fibers that were collected together) was recently opened by Waste Management, Inc. in York. Primary end uses for glass require the glass to be separated by color. Mixed color glass cullet has a lower market value and limited demand. Drop-box locations tend to result in less mixed color cullet, as they often have residents separate glass by color. The amount of mixed color glass resulting from curbside programs varies with the design of the curbside collection and processing system and associated glass handling procedures. It is expected that the collection and processing systems associated with single-stream recycling programs will result in an even higher amount of mixed cullet. Areas that use transfer stations for recyclables also yield a higher amount of mixed cullet, as glass breakage increases the more the materials are handled.

Commercial collection programs for glass containers are very limited in Pennsylvania. Generally, commercial haulers focus on materials of higher value and volume from commercial and institutional sources – such as high-grade paper and OCC. Also, commercial haulers would risk contaminating their fibers if glass was collected in the same vehicle as the fibers. Most commercial recycling programs utilize front-load collection vehicles, which do not facilitate source separation.

Typical Processing Flow

Glass from most curbside programs is usually brought to a materials recovery facility (MRF) with all colors mixed. In some cases (with some curbside programs and in most drop-box locations) glass is separated by color. Glass delivered mixed is generally hand-sorted by color at the MRF. Mixed cullet is the by-product of MRF processing, and generally consists of all colors of glass, which tend to be "shaken out" or left on the sort line during processing. A fair amount of contamination such as small pieces of plastics, etc. usually goes to the mixed cullet bin as well. Color-

separated glass is sent to an intermediary processor (or beneficiator) for further processing. Some MRFs do not separate glass by color. In that case, the glass is separated at the beneficiator.

The intermediary processor, or beneficiator, separates the glass by color, if it is not already separated, and screens the material to further sort out contaminants (usually visually, but in some cases with optical sorting equipment). There are two known beneficiators in the Commonwealth that have optical sorting equipment: Todd Heller, Inc., and Carry All products. This equipment is necessary to automatically sort the material by color, and to automatically reject opaque materials that are serious contaminants to glass mills. Common contaminants include dishware, heat-resistant glass, porcelain, mirror glass, light bulbs, plate glass, concrete, stones, dirt, and metal and plastic lids or lid rings. Beneficiators may also wash or polish the glass. They may grind the glass or pulverize it, depending on the end use of the product. The larger intermediate processors of container glass in Pennsylvania are located in close proximity to at least one glass container manufacturing facility, and have a close working relationship with them. Each beneficiator tends to supply one glass container manufacturer with a large portion of their cullet, and to market the remaining cullet to other end users. Table 1 lists the major glass beneficiators in Pennsylvania.

Table 1
Major Beneficiators in Pennsylvania

Company	Location	DEP Region
Carry All Products*	Connellsville, PA (Fayette County)	Southwest – 5
Dlubak Glass	Natrona Heights, PA (Armstrong County)	Southwest – 5
PA Cullet	Corsica, PA (Jefferson County)	Northwest – 6
Recyc- All	Port Allegany, PA (McKean County)	Northwest – 6
Strategic Materials**	Belle Vernon, PA (Westmoreland County)	Southwest – 5
Todd Heller, Inc.*	Northampton, PA (Northampton County)	Northeast – 2

*Indicates optical sorter on-site
** Processor focuses on plate glass, but under the right circumstances will process container glass

End Uses for Cullet

Primary Uses

The most common end use for glass is reuse in making glass containers. Glass cullet is used as a substitute for raw materials in the manufacturing of glass bottles and jars. In general, post-consumer glass is not used in the manufacturing of glassware. Clear glass, or flint, is used to manufacture clear glass containers, the most commonly manufactured glass container, amber for amber, and green for green. A small amount of green cullet can be used in the production of amber bottles, the second most commonly manufactured glass container in the U.S.

Alternative Uses

Glass cullet can be used to manufacture other types of products. Major alternative uses are discussed below.

Fiberglass Manufacturing

According to the Glass Packaging Institute, fiberglass manufacturing constitutes the second most common use of glass cullet. Fiberglass manufacturers have very high standards for quality and consistency of product, however. They also require that the material be fine-ground. During fiberglass production, raw batch materials and glass cullet are continuously added to the furnace. After melting and "fining," the molten glass is spun into fibers by a process called fiberizing. To ensure production of consistent fibers, cullet must meet specifications for major and minor oxide chemical composition, color consistency, and contaminant levels. Metal, organic, and ceramic contaminants can degrade the product, and can damage the fiberglass production equipment. In theory, all colors of cullet can be used; however the overall mix has to be consistent, in order to have a consistent oxidization state.

The State of California requires that fiberglass manufacturers use some post consumer content in fiberglass manufacturing. The North American Insulation Manufacturers Association states that in the year 2000 alone, more than 1.2 billion pounds of glass was diverted from the waste stream, which would fill approximately 32 million cubic feet of landfill space. Many fiberglass insulation products contain up to 40 percent recycled materials (including post-industrial and post-consumer).

Strategic Materials, which has a plant in Belle Vernon, Pennsylvania, supplies clean, crushed glass to the fiberglass industry. Strategic Materials deals primarily in plate glass, such as windshields, and post-industrial scrap tableware glass, however, due to its clean and consistent nature. The facility can process post-consumer cullet, but is only willing to accept it if the supplier is willing to pay for the processing costs of the material.

Substitute for Aggregate

Glass can be used as a substitute for aggregate in a wide range of applications including:

- Septic system filtration;
- Mixed with salt for ice control;
- Road beds ("Glassphalt");
- Concrete;
- Flexible fill (small amount of concrete only to bind);
- Pipe underlay;
- Jogging/walking trail underlay;
- Base course;
- Subbase;

- Embankments;
- Structural fill;
- Nonstructural fill;
- Utility bedding and backfill;
- Retaining wall backfill;
- Foundation drainage;
- Drainage blankets;
- French/interceptor drains;
- Sand filters (wastewater);
- Well packing media;
- Septage field media; and
- Leachate collection media.

The Pennsylvania Department of Transportation (PENNDOT) has experimented with glass as an aggregate substitute but it has not been widely used in PENNDOT projects. PENNDOT projects utilizing crushed glass to date include:

- In the summer of 1998 PENNDOT used 100 percent cullet as a pipe underdrain material along SR 2004 in Clarion County;
- In the summer of 2000 cullet was used as an aggregate in base course asphalt along the shoulder of SR4013 in Manheim, Lancaster County;
- In the fall of 2000 PENNDOT installed 2,000 tons of glass cullet between a jersey barrier and sound wall along I-95 in Delaware County; and
- In the fall of 2002 PENNDOT (District 5) is slated to use glass cullet as pipe bedding material in their State Route 222 construction project. Additional uses for glass cullet are being considered for the same project, including the use of glass cullet as fill material between noise barriers and concrete side barriers on applicable sections of the project.

Because the aggregate industry is strong in Pennsylvania, particularly in the central portion of the Commonwealth, many recyclers doubt that crushed glass will win favor over aggregate for political as well as economic reasons, in that region. There is some hope, however, that mixed cullet could be used for an aggregate substitute in the Eastern portion of Pennsylvania. In the Northwestern portion of Pennsylvania, one recycler hopes to create a market for crushed cullet as fill in drainage ditches. He is uncertain what kind of approval he needs; but he believes that crushed glass is being used for this purpose very successfully on Ohio farms.

Pulverized cullet is reported to work at least as well as sand in sand mound septic system filtration systems, and is less expensive than sand (which costs approximately $10 per ton). Again, although the PA DEP has crafted a memorandum stating that crushed glass can be utilized to replace sand in septic system filtration systems, the regulation has not been changed, and contractors are skeptical to use this medium,

fearing legal ramifications. Septic systems would be a potentially large market for mixed cullet, as each system uses, on average, 100 tons of glass.

Another filtration use for glass is as a medium in swimming pool filters. King County Washington uses recycled glass as a filtration medium in their public swimming pool filters.

Crushed glass has been used as an aggregate substitute (backfill and pipe underlay) in limited applications in County projects in Lackawanna County and Centre County, Pennsylvania.

Pulverized glass works exceptionally well for use in flowable fill, so this might be an economically viable use in Pennsylvania. A large quantity of pulverized glass could be used for this purpose, and there are plants in Pennsylvania that will use glass in making flowable fill, if specified.

Bead Manufacturing

Glass can be manufactured into tiny beads, which are added to paint for reflexivity. These beads can also be used in some cleaning applications. Todd Heller, Inc. has the ability to make beads, and indicated that his company has been able to sell some of this product to PENNDOT.

Decorative Applications

Glass cullet is being used in some decorative applications such as glass tiles, coasters, glass brick, etc. Recently some U.S. tile companies began manufacturing tiles with 100 percent recycled glass; however the glass they use is plate glass, due to its more uniform, consistent nature, and the prohibitive cost involved with making mixed container glass cullet suitable as a feedstock. Plate glass is also more attractive as a feedstock to this industry because of the high cost associated with cleaning glass cullet. Some glass blowers are also beginning to use post-consumer glass cullet.

Frictionators

Glass can be used as frictionators in manufacturing matches and ammunitions.

Fluxes/Additives

Glass cullet can be pulverized into a powder to be used as fluxes, lubricants, and additives in the metal foundry industry. It can also be used as flux/binders in the ceramics industry.

Regulatory Environment

Pennsylvania's Act 101 specifies that mandated municipalities must collect at least three of the specified materials and leaf waste. Clear glass and colored glass are two of the materials on the Act 101 list. Because glass is such a heavy material, comprising a significant amount of the recycled materials stream by weight, many communities choose to include glass as a targeted material in order to meet their diversion goals and receive Pennsylvania DEP performance grant (Section 904) funds.

In October 2002, PENNDOT's Publication 408 is expected to include provisional special provisions specifications for the incorporation of crushed glass in constructing embankments. This will be the first provisional special provision specification for crushed glass in PENNDOT's Publication 408.

Getting an alternative material specified for use is a time-consuming process, as PENNDOT has to test the material for quality, and ensure that the alternative material works at least as well as the material for which it is being substituted. This testing process generally takes five years, and may involve demonstration projects. PENNDOT also has to submit specifications to FHWA for approval. Meanwhile, individual projects can apply for provisional use of an alternative material, however stringent quality assurance testing is required.

Supply of Glass

According to preliminary data from the Pennsylvania Waste Composition Study and the 1999-2000 PA DEP Act 101 Annual Report (the most recent year available), glass comprises 2.45 percent of the total waste stream disposed, and is being recycled at a rate of 28 to 33 percent, depending on the color. Details regarding glass recovery are presented in Table 2.

Table 2
Glass Currently Recovered/Landfilled*

Material	% Recovered	Average National Recycling Rate (%)	Tons Disposed from Residential Stream	Tons Disposed from Commercial Stream
Clear	34	34 % overall	87,800	48,200
Green	31		21,100	14,300
Amber	29		40,300	21,600

*Estimated 2000 tonnage data.

Approximately 233,000 tons of container glass was generated and disposed in Pennsylvania in 2000. The percentage of glass being recovered is 34 percent for clear (the national average, which includes all colors) and slightly less for the colored glasses. The amount of glass being recovered may be overstated, however, because there are many stockpiles of mixed cullet throughout the Commonwealth for which MRF managers and glass beneficiators are hoping to find a market.

Demand for Glass

Pennsylvania is home to several large glass container manufacturing companies. Owens-Illinois, Anchor Glass Container Corporation, and Saint-Gobain Containers, Inc., all have manufacturing facilities in Pennsylvania. Anchor Glass and Saint-Gobain also have facilities nearby, in New Jersey. These plants utilize more flint glass than is currently being supplied by Pennsylvanian sources.

Flint glass containers are the most commonly produced type of glass container in the U.S., and in Pennsylvania. The demand for separated, clean flint, therefore, is fairly high in the Commonwealth. Because of the relatively high cost to transport glass cullet, manufacturers would rather source their cullet locally. Amber glass is the second most popular color of glass manufactured in the U.S., and there are very few markets for green glass in the U.S. Anchor Glass Container Company manufactures green bottles for Rolling Rock Beer and Yingling Beer at their Connellsville, PA plant, providing a market for green cullet. Saint-Gobain Containers Corporation provides a market for amber cullet at their Port Allegany facility.

Although it makes sense for glass manufacturers to source material locally to avoid higher transportation costs, end users often prefer to source their glass from bottle bill states, which produce a cleaner product. Because New York is a bottle bill state in close proximity, and because third party recyclers receive payment for recycling glass, the New York processors can often "undercut" the Pennsylvania processors by accepting a lower price for their material.

Many recycling coordinators throughout the country as well as some from Pennsylvania interviewed for this project note that the quantity of mixed color cullet is increasing due to collection and processing practices involving compaction and use of transfer stations. Unfortunately, mixed cullet is a material with very limited market value. Because it is not possible to optically sort mixed cullet less than 3/8" in size and because it can not be used as a feedstock in making glass containers, there is virtually no demand for it, and most MRFs have to pay to have it hauled away. In some states mixed cullet is approved for use as alternative daily landfill cover, and/or is used in some of the alternative uses described above.

Representatives from all of the major glass manufacturing companies with plants in Pennsylvania were interviewed for this project, and all of them note that they have increased production dramatically in the past six months or so to accommodate individual serving-sized clear containers for Smirnoff beverages. In fact, Joe Cattaneo, President of the Glass Packaging Institute, notes that in general, the "alca-pops" have buoyed the demand for glass containers considerably, despite the fact that overall demand for glass packaging has decreased due to increased plastic packaging. The Owens-Illinois Brockway facility reopened on April 1, 2002, after a two-year closure. At the time this research was conducted (Spring 2002), they were operating one furnace, but were hoping to operate their second furnace by the summer. Table 3 describes the major markets for glass cullet in the Commonwealth and immediate region.

Table 3
Major End Markets for PA Glass Cullet

Company	Facility Location	Region of State	Type of Cullet Consumed
Owens-Illinois	Clarion, PA	Northwest – 6	Flint, Amber
Owens-Illinois	Crenshaw, PA	Southwest – 5	Flint
Owens-Illinois	Brockway, PA	Northwest – 6	Flint
Saint-Gobain Containers	Port Allegany, PA	Northwest – 6	Flint, Amber
Saint-Gobain Containers	Carteret, NJ	North East of PA	Flint
Anchor Glass Container	Connellsville, PA	Southwest – 5	Flint, Green
Anchor Glass Container	Salem, NJ	North East of PA	Flint

Because glass cullet is a relatively low-value commodity, the markets for glass are generally confined within a region. This is particularly true for mixed color, brown, and amber cullet. Flint may travel longer distances, particularly from locations that can provide a large quantity of high-quality material at a relatively low cost. Some beneficiators in Pennsylvania import cullet, flint in particular, from as far away as California at times, to meet the demand for high-quality material. Because it is a bottle-bill state, the material coming from California is of extremely high quality. For this reason Michigan and New York are also the source of some of the flint being processed in Pennsylvania.

As Table 3 indicates, most of the major glass manufacturers using post-consumer material as feedstock are located in the western region of the Commonwealth. Two are located in New Jersey, providing a close market for the eastern portion of Pennsylvania.

Cullet Prices

Glass, like all recycled materials, is commanding a lower price than it once did. Historically, however, the price of glass cullet has never been high, because the alternatives, silica and other virgin materials that can be used as a substitute in manufacturing, are inexpensive.

As explained above, the demand for flint is higher than the other types of cullet; therefore this material commands the highest price. The mid-April 2002 New York price for flint, according to Waste News, was approximately $21 per ton, delivered. This represents the lowest price since 1996. The flint market is not particularly volatile; however the amber market is more volatile, and as of April 2002 was selling at a price of about $9 per ton in the New York area. The market for green cullet is also more volatile than the market for flint, and has dropped considerably since 2001. In the spring of 2002 some facilities reported to be paying up to $31 per ton to get rid of mixed cullet as well as green cullet. Their price for flint at that time was

approximately $22 per ton, brown was, $10 per ton, and green, $0 per ton, or a negative value to "get rid of" the material.

Outlook for Recycling Cullet

The outlook for flint markets is positive for Pennsylvania. Demand for clear glass bottles has increased recently due to the popularity of "alca-pops." Demand for mixed cullet and amber are not expected to increase. If Owens-Illinois opens the second furnace at their Brockway facility, demand for green glass may improve. The downward turn in the economy has not had a negative impact on the glass industry as it has on other secondary materials markets. In fact, Joe Cattaneo President of the Glass Packaging Institute, indicates that demand for glass bottles increases during such times, as the demand for beer (and other alcohol products) increases. The glass companies predict that the "alca-pops" will continue to help sustain the demand for glass. The demand for green glass may improve as well locally, as Yingling Beer expands its geographic marketing base.

Relationship between Supply and Demand

The demand for clean, separated flint glass is not being met with Pennsylvania-generated supplies. All of the major glass manufacturing companies state that, due to transportation costs, they would prefer to source all of their flint feedstock from within Pennsylvania, however the demand is simply greater than the supply. A representative from Anchor Glass Container Corporations states that their facility in Connellsville uses only 15 percent post-consumer material for feedstock, because it simply cannot get more quality flint at an appropriate price. Not only do the beneficiators have to import raw material to process from other states, but some of the glass manufacturing facilities themselves also having to purchase materials from beneficiators located outside of Pennsylvania. (A competitor of Pennsylvania's beneficiation facilities is Nexcycle, in Syracuse, New York). The green glass that Anchor manufactures, in comparison, is made with 65 percent post-consumer cullet. It is more-than plentiful, and is priced low enough to make it an attractive feedstock.

Green glass, amber glass, and mixed cullet, are lacking markets within the United States as a whole, as well as within Pennsylvania. While some of the glass manufacturers listed above can use some green and amber cullet, there is much more available than there is demand. Mixed cullet has virtually no markets. If mixed glass is large in size, it can be sent to a facility for optical sorting, however prices are lower than for color-separated glass. Mixed cullet that consists of glass pieces less than 3/8" is much less marketable, as it is not feasible to optically sort such tiny pieces of glass, nor would it be economically viable. Many MRF managers interviewed for this report indicate that they have "piles" of mixed cullet that they simply do not know what to do with. Many recycling coordinators and MRF managers in Pennsylvania site mixed cullet as their most problematic material to market. In general, recycling coordinators located in more rural communities with drop-boxes did not have this issue, however they were well aware of the difficulties being faced by their counterparts in other regions. Some of the beneficiators are considering trying to develop alternative uses

for glass cullet within Pennsylvania. Lackawanna County, too, has purchased a pulverizer for their glass cullet, and hopes to sell it for use as filtration medium in septic systems.

Paper

The paper grades addressed in this section are those addressed by Act 101: old newspaper (ONP), old corrugated containers (OCC), and high-grade office paper. ONP includes old news, special news, deinking news, over-issue news, white blank news, groundwood computer print out (CPO), mixed groundwood and flyleaf shavings, and coated groundwood sections. OCC includes corrugated containers, Kraft paper such as brown paper grocery bags, and carrier stock as well as cuttings for each. High-grade paper includes office paper, computer paper, bleached sulfite and sulfate, and coated book stock.

Commodity Infrastructure

Typical Means of Collection

ONP is generated primarily by residences, while OCC and high-grade paper are primarily non-residential in nature. OCC and high-grades as a portion of the residential waste stream has increased in recent years due to the use of home computers, the growth in telecommuters and home based businesses, and Internet shopping. Consequently, interest in recovering these grades from residential sources is also increasing. OCC and high grades have been collected from businesses and institutions for decades. Most of the larger generators are already recycling such materials; however many mid-sized and smaller businesses may not have recovery programs in place.

While residential recovery efforts are almost entirely sponsored by municipalities, the private sector handles most commercial recycling and dominates the paper stock industry.

Post-consumer household paper is typically collected in curbside recycling and drop-box programs throughout the Commonwealth. Most curbside programs are curb-separated into two streams, where containers and fibers are placed in separate compartments of the collection vehicle. Some programs involve further sorting of paper by type. Recycling of commercial paper is arranged through private haulers and scrap paper dealers who generally collect OCC from businesses generating relatively large quantities, and high-grade office paper from high-rise office buildings and office park settings.

Typical Means of Processing

Residential paper is generally processed at material recovery facilities. Incoming paper at most MRFs in Pennsylvania is sorted manually on a fiber-only sorting line. Recently, Waste Management opened a single-stream MRF in York. Materials being processed at this facility are fully commingled (all types of material mixed together),

either at the curb or at recycling transfer stations, before the materials are processed. There is some debate as to whether this single-stream collection/processing system will impact the quality of recovered paper due to contamination. The York MRF serves a large portion of central Pennsylvania.

In the York MRF, fibers are mechanically separated from other recyclables using a star screen. The star screen allows lighter paper, such as magazines, newspaper, and mixed paper, to flow beneath the star-shaped prongs that revolve, while the heavier chipboard and corrugated go over the stars, flowing to a separate area. After being further sorted into various grades, the paper is usually baled. The bales are stored until a full truckload of a specific grade is ready for transport.

With respect to OCC and high grades, most processors, including MRFs, do little sorting of the paper since it is generally source-separated. Processing consists of visual screening and manual removal of contaminants and baling. Some grades are fluffed or shredded prior to baling.

Some MRFs and scrap paper dealers offer shredding services for clients that are concerned with security. Some rural communities, including Centre County, shred newspaper and provide it to farmers for animal bedding. Despite the fact that this is a value-added service, the County receives a lower price for the shredded paper to be used as animal bedding than they do for other newspaper. They perceive the relationship with the farmers to be an important one to maintain, however, because the farmers offered them a market twelve years ago when there were very few markets for secondary newspaper.

End Uses for Secondary Paper

Primary Uses

Uses for paper grades vary depending on the quality of the paper, and the nature of products manufactured by receiving mills.

Old Newspaper (ONP)

The highest value of old newspaper is ONP #8, which is desired by newsprint mills. Newsprint mills are the single largest user of secondary newsprint, consuming 38 percent of recycled newsprint. Paperboard mills also consume a sizable amount of newsprint. A considerable amount of newspaper is also used in manufacturing construction materials such as cellulose insulation and gypsum wallboard. Applegate Insulation located in Chambersburg, Pennsylvania, holds newspaper drives as fundraisers for organizations, thereby providing a market for dry, clean post-consumer newspaper.

Other end uses for ONP include animal bedding, absorbents, packaging material, and molded pulp products, such as egg cartons and produce containers. Animal bedding, however generally commands a lower price than paper mills are willing to pay for baled newspaper. Another alternative market is the hydroseed market. Hydroseed uses newspaper as a mulching agent that can retain water to moisten grass seed and keep

seed from blowing away. Old newspapers, as well as other selected paper grades, can also be used as a feedstock in making compost.

Corrugated Cardboard (OCC)

The primary market for OCC is in making corrugating medium, gypsum paper, linerboard, recycled paperboard, and other paper products. Some OCC is used domestically in making tissue products, some OCC is exported, and a small percentage of OCC is used in various other applications.

Corrugated cardboard is used in the manufacturing of roofing felt. The strength of OCC is an important characteristic for roofing felt manufacturing.

Corrugated cardboard that is wax coated or has been soiled with food products can also be used as a feedstock in manufacturing compost.

High-Grade Office Paper

The primary market for high grades is in making new printing and writing (P&W) papers and tissue. If high-grade office paper is collected as a component of mixed paper, it is used in manufacturing paperboard, linerboard, corrugating medium, and tissue. In addition, high-grade paper can be used in making selected non-paper products such as roofing felt and some molded pulp products.

High-grade office paper could be used for the same alternative end uses listed for ONP above; however since high-grade office paper has a higher value than ONP, it generally does not make economic sense to do so. Table 4 indicates the common end markets for fiber grades targeted by Act 101.

Table 4
Act 101 Paper Grade End Uses

Paper	Common End Uses
Corrugated Cardboard	■ Corrugated (Linerboard and Medium) ■ Boxboard ■ Kraft paper ■ Molded pulp products ■ Tissue ■ Gypsum paper
Newspaper	■ Newsprint ■ Magazines ■ Low-grade paper ■ Boxboard, ■ Low- grade paper toweling ■ Molded pulp products
Hi-Grade Office Paper	■ Copy Paper ■ Tissue ■ Boxboard ■ Newsprint

Regulatory Environment

The three paper grades listed above, newspaper, cardboard, and high-grade office paper, are all included, as separate materials, in Pennsylvania's ACT 101 list of recyclables. Mandated communities must recycle three of the eight specified materials. Commercial, municipal and institutional establishments within mandated municipalities are also required to recycle high-grade office paper and corrugated paper, in addition to aluminum and other materials chosen by the municipality.

Supply of Secondary Paper

Estimated recycling rates for Act 101 fiber materials, derived from preliminary data from the Pennsylvania Waste Sort Study and the PA DEP Act 101 Annual Report to the General Assembly: 1999-2000, are provided in Table 5.

Table 5
Act 101 Paper Grades Recovered/Landfilled in 2000*

Material	% Recovered	Average National Recycling Rate (%)	Tons Landfilled from Residential Stream	Tons Landfilled from Commercial Stream	Total Tons Landfilled
ONP	50	71	253,200	168,200	421,400
OCC	48	75	258,300	564,900	823,200
Office	24	47	125,000	207,700	332,700

*Represents 1999 recovery rate applied to 2000 volumes.

The Pennsylvania data indicates that there is a considerable amount of corrugated cardboard being disposed. Further, the data suggests that more than two-thirds of this cardboard is being generated by commercial and institutional entities. It also appears that, on a percentage basis, a relatively insignificant portion of office paper being used is being recycled. There may, however, be additional recovery activities underway that are not captured in PA DEP data. There is also a significant amount of newspaper being disposed. Clearly, the data suggests that OCC would be a likely material to target in future recycling efforts, particularly from commercial sources.

Many municipal MRF managers and recycling coordinators interviewed for this project report that they do not receive enough high-grade office paper at their processing facilities to warrant a sort for high-grade office paper. This is because these facilities target primarily residential sources of supply. Private paper processors tend to target those who generate large quantities of high-grade paper. Smaller companies that are not currently served by collection programs may generate a substantial amount of high grades.

Demand for Secondary Paper

The value of most paper grades is such that truckload quantities can be economically shipped hundreds of miles as well as overseas. Many of the mills receiving Pennsylvania's secondary paper are located outside of the Commonwealth.

Often paper is sold through brokers, who tend to focus heavily on spot market pricing. The larger suppliers such as Recycle America, BFI, and the larger paper stock dealers, tend to foster long-term relationships with end markets, and have contracts with selected end users while moving some material via the spot market. Transportation costs generally favor selling to as close a market as possible; however other factors, such as individual mill demand, flexibility of mill to handle contaminants, ability to arrange backhauls, and contractual relationships can justify shipment of paper to further destinations.

Most MRF managers in the Commonwealth report that they have no problems selling their fiber products, however prices are volatile and are currently low. As of spring 2002, however, prices were beginning to move upward.

Newspaper

There are several boxboard manufacturers in Pennsylvania, including Jefferson Smurfit in Philadelphia, which consumes 3,000 to 4,000 tons of newspaper per month. A major end user of Pennsylvania's ONP is Abitibi. They have several newsprint mills in Quebec and Ontario, as well as in other parts of Canada. Newsprint mills are also located in Alabama, Georgia, Virginia and Mississippi. Garden State Paper did have a newsprint mill in New Jersey, however that mill is no longer operating.

The demand for newspaper has been suppressed in recent months due to economic conditions. When the economy is in a recession, newspapers tend to be thinner due to less advertising.

Corrugated Cardboard

Corrugated cardboard is most commonly used to remanufacture corrugated cardboard. Linerboard (the strong outer layer of cardboard) and medium paper (the corrugated inner layer) are manufactured using corrugated as a feedstock. Corrugated can also be used as a feedstock for boxboard. There are several boxboard manufacturers in and around Pennsylvania. Demand for corrugated also tends to decline during economic recessions, because consumers purchase fewer durable goods. Two Virginia markets that MRF managers report selling their OCC to the Grief Brothers medium mill in Gladstone, and the Georgia Pacific linerboard mill in Big Island. Jefferson Smurfit's Philadelphia boxboard mill consumes 3,000 to 4,000 tons of corrugated per month, sourced primarily from local businesses.

Hi-Grade Office Paper

Demand for high grades has historically exceeded supply with prices fluctuating with the value of deinked market pulp. Demand for mixed paper is growing but its value is relatively low, and supply has the potential to exceed demand during periods of lower demand particularly for lower quality mixes.
Identified secondary paper end markets for Pennsylvania Act 101 materials are presented in Table 6.

Table 6
Major End Markets for PA Paper Products

Company	Location	Region of PA	Type of Paper Consumed	Primary Product
The Following Mills are Located in Pennsylvania:				
Kimberly-Clarke Corp	Chester	Southeast – 1	ONP	Tissue
Rock-Tenn Co.	Delaware Water Gap	Southcentral – 3	ONP, Office paper	Boxboard
Henry Molded Products	Lebanon	Southcentral – 3	ONP, Office paper	Molded pulp products
Woodstream Corp.	Lititz	Southcentral – 3	ONP, Office paper	Molded pulp products
Sonoco Products Co.	Downingtown	Southeast – 1	ONP, OCC, other grades	Combination board
Brandywine Paperboard Mills, Inc.	Downingtown	Southeast – 1	ONP, OCC, office paper	Paperboard products
Newman & Co., Inc.	Philadelphia	Southeast – 1	ONP, Office paper, OCC	Box/paperboard
Smurfit-Stone Container Corp.	Philadelphia	Southeast – 1	ONP, Office paper, OCC	Boxboard
Yorktowne Paperboard Corp	York	Southcentral – 3	ONP, OCC, Office paper	Various board products
NGC Industries (National Gypsum subsidiary)	New Columbia	Northcentral – 4	ONP, OCC	Gypsum board liner
Reading Paperboard Corp.	Sinking Springs	Southcentral – 3	ONP, OCC	Paperboard products
Sealed Air Corp.	Modena	Southeast –1	OCC	Kraft papers
Sealed Air Corp.	Reading	Southcentral – 3	OCC	Kraft paper, corrugating medium
United Corrstack L.L.C.	Reading	Southcentral – 3	OCC, Office paper	Corrugating medium, linerboard
Shryock Brothers	Downingtown	Northeast -- 2	Office paper	Binders board
International Paper Co.	Erie	Northwest – 6	Office paper	Printing and writing papers
Willamette Industries, Inc.	Johnsonburg	Northwest – 6	Office paper	Printing and writing papers
P.H. Glatfelter Co.	Spring Grove	Southcentral – 3	Office Paper	Printing and writing papers

Company	Location	Region of PA	Type of Paper Consumed	Primary Product
Proctor & Gamble Paper Products Co.	Mehoopany	Northeast – 2	Office paper	Tissue
Plainwell Tissue	Ransom	Northeast – 2	Office paper	Tissue
The Following Mills are Outside of Pennsylvania:				
Westvaco Corp.	Covington, VA	Not Applicable	OCC	Boxboard and corrugating medium
Georgia Pacific	Big Island, VA	Not Applicable	OCC, Kraft, White office paper	Corrugated linerboard
Grief Brothers	Gladstone, VA	Not Applicable	OCC, Kraft, White office paper	Linerboard, Corrugating medium
Abitibe	Quebec and Ontario, Canada	Not Applicable	ONP, OMG	Newsprint
Manistique	Manistique, MI	Not Applicable	OMG, Residential mixed paper, Office paper	Printing papers, Envelope papers, Office papers, Food service papers
Marcal Papers	Elmwood Park, NJ	Not Applicable	OMG, Office paper, Residential mixed paper	Tissue
The Following Mills are Idle:				
Connelly Container	Philadelphia	Southeast – 1		Corrugating medium
Interstate Intercorr	Reading	Southcentral – 3		Corrugating medium
Smurfit-Stone Container Corp.	York	Southcentral – 3		Corrugating medium, Kraft papers
Northampton Pulp L.L.C.	Northampton	Northeast – 2		Deinked market pulp
International Paper	Lock Haven	Northcentral – 4		Printing and writing papers
Westvaco Corp.	Tyrone	Southcentral – 3		Envelopes
Celotex Corp.	Sunbury	Northcentral – 4		Roof insulation board, wall board
Tarkett Inc.	Whitehall	Northeast – 2		Flooring felt

Secondary Paper Prices

Paper prices can be quite volatile. Demand and therefore prices can fluctuate depending on pressures from other countries, and general economic conditions. Prices for grades can vary significantly, too, depending upon the region of the Country from which the material is being sourced. Prices for most grades of paper peaked in the spring of 2000, and have been steadily declining through winter 2002. As of spring 2002, however, MRF managers noted that the prices for paper have been moving upward. In general, the New York prices for OCC tend to be lower than ONP, and those for residential mixed paper (RMP) tend to be lower than prices for OCC.

Corrugated Cardboard

In spring 2002 Asian markets were reportedly paying $90 to $95 per ton for OCC, out of Los Angeles. This seems to be having a positive impact on prices nationwide.

Waste News reported the New York price for OCC to be approximately $0 per ton, delivered, in mid-April 2002. Fortunately, some MRFs in Pennsylvania have been able to sell their OCC at around $45 per ton recently. Some MRFs are not able to produce a "clean" OCC bundle, and therefore accept a lower price, in the $20-per-ton-range.

Newspaper

ONP prices have been erratic in the past, hitting a high in the spring of 2000 of over $100 per ton, and decreasing since that time. Since mid-2002, prices have remained stable but low (in the $45 to $51 per ton range) for ONP #8.

The New York Price for ONP #8, according to Waste News, was approximately $45 per ton, baled and picked up, at the end of April 2002. MRFs in Pennsylvania report that they are able to sell their #8 ONP for approximately $49 per ton.

High-Grade

Of the grades included in the high-grade office category, sorted white ledger commands the highest price. The New York Price, as of April 29, 2002, was approximately $40 per ton, and the Atlanta price averaged $63 per ton. In comparison, the Waste News New York price for sorted office paper was $12/ton, on average, and $30 per ton in Atlanta. MRFs in Pennsylvania were reported to be receiving in the $50-per-ton range for their white and pastel office paper at this time.

Outlook for Recycling Paper

The market outlook for secondary paper is positive, as U.S. economic conditions seem to be improving. In addition, demand for paper in Asia is expected to increase significantly, as they have announced the construction of a new Greenfield paper mill as part of the Nine Dragons mill complex. In addition, they will be expanding production at their existing facilities, which will increase their demand to 100,000 tons of fiber per month. Because China has no timber industry, it is a strong export market for U.S. secondary paper, for use as feedstock in paper mills. While most of the

material exported to China is expected to be sourced from Western U.S. suppliers, the increase in demand will have a favorable impact on prices throughout the U.S.

Relationship between Supply and Demand

There does not appear to be a significant gap between the supply of secondary paper and the demand for secondary paper grades overall; however the supply of paper generated in Pennsylvania exceeds the demand within the Commonwealth and region. Most secondary paper is being shipped several hundred miles away, to mills in the Southeast and Canada.

Preliminary Pennsylvania Waste Composition Study data also indicates that the collection infrastructure in place may be inadequate for recovering recyclable paper – particularly for OCC and office paper from smaller establishments in commercial, municipal, and institutional settings.

Aluminum Cans

Aluminum cans, or used beverage containers (UBCs), are single-serving aluminum cans used for beverages. They are generated wherever beverages are consumed: in households, commercial and institutional settings (restaurants, cafeterias, hospitals, schools, etc.), and automobiles.

Commodity Infrastructure

Typical Means of Collection

Aluminum cans from residential sources are typically collected in curbside and drop-off center recycling programs, the latter of which are more common in Pennsylvania's rural areas. Aluminum cans are often collected commingled with steel cans and/or other containers. They are sometimes collected in commercial and institutional recycling programs due to their relatively high value and ease of handling. Some aluminum recycling companies and municipalities hold aluminum can recycling drives to raise funds for non-profit organizations.

Typical Means of Processing

Aluminum cans are separated at the MRF from other materials by hand or by an eddy current separator. They are typically baled before being sold, but are sometimes crushed and sold loose in Gaylord boxes. Most MRFs in Pennsylvania sell their aluminum cans through a broker. Larger private MRFs establish contracts with end markets.

When cans are brought to the aluminum mill, the bales are opened and inspected for moisture content. If acceptable, the bales are broken open with a debaling machine. Next, the contents are carried across screens and magnets where contaminants and steel cans are removed, and the aluminum goes into a shredder, where it is cut into smaller pieces. The shreds are then placed in a de-lacquering oven, which removes

paint and residual moisture. Hot, shredded aluminum is then passed over screens to remove contaminants, and then enter a reverbatory furnace. The furnace melts the aluminum shreds, while they combine with the molten aluminum already in the furnace (a mixture of primary aluminum and remelt secondary ingot). A mixture of salt and potash (KFl) is added to the mixture, and dross is formed, removing any oxides from the solution, which is skimmed off the top. The hot metal is poured into molds for sheet ingots. The sheet ingots are 20,000 to 40,000 pounds each. Generally the ingots are sent to a rolling mill, where they are rolled through steel rollers into aluminum sheets. The finishing process involves annealing the sheet to soften it and rolling it through more rollers until it is the desired strength and thinness. The edges are trimmed, and the resulting roll, which could be two miles in length, is sent to a can manufacturer.

Aluminum companies have gone through quite a bit of consolidation in the past ten years, resulting in fewer secondary smelters. Recycling aluminum is worthwhile to aluminum smelters because the alternative virgin materials are more costly to use, and because making aluminum from virgin materials requires far more energy. UBCs, as a commodity, can be shipped nationwide, when necessary. There are several secondary aluminum smelters on the East Coast – all of which present Pennsylvanians with viable end markets for their UBCs and other scrap aluminum. Secondary aluminum ingot is used primarily to manufacture sheet stock for use in rigid packaging and for automotive applications. It is also used in manufacturing die-cast aluminum products, for use in transportation and equipment applications.

The infrastructure for recycling cans is efficient, as a UBC can be recycled and turned into another can in about 60 days.

End Uses for Secondary Aluminum

Aluminum cans are generally used as feedstock in sheet aluminum applications, including can stock and some transportation uses. There are no significant alternative markets for aluminum.

Regulatory Environment

Aluminum cans are included on the list of Act 101 materials that mandated communities may choose to recover. Aluminum is a relatively high-value commodity when compared to other recyclable materials. Most recycling center managers, therefore, depend upon the recovery of aluminum to help pay for a significant portion of the facility's operating costs – in effect supplementing the cost of recovering other materials. Commercial, municipal, and institutional establishments located in mandated communities are required to recycle aluminum cans.

Supply of Used Beverage Cans

R.W. Beck's Pennsylvania Waste Composition Study, paired with the PA DEP 1999-2000 Act 101 Annual Report data, indicate that UBCs in Pennsylvania are being recovered at a rate of 48 percent. Nationwide, the Aluminum Association reports that

the recycling rate for aluminum beverage cans was 55.4 percent in 2001. This is a reduction from 2000's recycling rate of 62 percent. In fact, the recycling rate for UBCs had been greater than 60 percent since 1989 – even reaching 66.5 percent in 1997. UBCs being disposed in Pennsylvania are a small portion of the disposed waste stream by weight – an estimated 0.55 percent, or 52,500 tons. This represents, however, a value of approximately $50 million (based on a $.48 per pound price) that is being thrown away.

Despite the fact that municipal, commercial, and institutional establishments located in mandated communities are required to recycle aluminum, municipal recycling coordinators are not sure that UBCs are being recovered in these settings on a large scale.

Demand for Used Beverage Cans

UBCs are purchased primarily by secondary smelters. They are used, for the most part, to make aluminum sheets, which are manufactured into cans or used in the transportation sector. Because aluminum has a high value, and is relatively light, densified or baled aluminum cans may travel a significant distance – several hundred miles, for example, to their end markets.

Table 7 indicates the known aluminum secondary smelters and their smelting facilities closest to Pennsylvania.

Table 7
Major Secondary Aluminum Smelters in the Eastern U.S.

Company	Secondary Smelter Locations
Alcan	■ Berea. KY ■ Oswego, NY
Alcoa	■ Knoxville, TN
Hydro Aluminum Metal Products (Norsk Hydro)	■ Henderson, KY
Imco Recycling	■ Uhrichsville, OH ■ Morgantown, KY
Wise Recycling	■ Muscle Shoals, AL

UBC Pricing

The price for UBCs is less volatile than prices for other secondary materials, although the New York price for aluminum cans decreased steadily throughout most of 2001, beginning the year at $.35 per pound and ending at $0.24 per pound. In mid-April, 2002 Waste News reported the New York price of UBCs to be $.30 per pound. By the end of April, that price had risen to $.35 per pound. As of early May 2002, MRFs in Pennsylvania were reportedly receiving $.48 per pound for UBCs. The UBC market also experiences some seasonality in prices -- typically demand for UBCs increases

somewhat in the spring, as can manufacturers are preparing for a higher summer-month production. Mid- to late summer month UBC prices can be expected to decline, as supply is relatively high and demand tapers.

Outlook for Aluminum

Aluminum consumption in 2001 was down. Economic conditions decreased manufacturing in the largest end markets – Japan, the U.S., and Germany. Consumption of flat-rolled products is still slightly behind what it was a year ago, however the gap is closing. Apparent consumption of flat-rolled products hit a low in September 2001, and has been increasing steadily ever since. The price for UBCs is expected to increase as this occurs.

Relationship between Supply and Demand

The processing infrastructure is well established for UBCs, although some industry experts believe that further consolidation might help the rolling products sector. It is believed that aluminum recycling in commercial, institutional, and municipal locations could be increased.

Steel Cans

Steel cans, including aerosol, food, and dry, used paint cans, are generated by households, institutional food service facilities, such as military, hospital, and school kitchens, and private sector commercial food service establishments, such as restaurants and cafeterias.

Commodity Infrastructure

Typical Means of Collection

Steel cans are typically collected by municipalities or their contractors in curbside and drop-off center recycling programs. Steel cans are often collected commingled with other containers, or separate from other types of containers. Steel cans do not seem to be widely recycled in commercial and institutional settings in Pennsylvania.

Typical Means of Processing

Steel cans are separated, typically at MRFs, from other materials by hand or by a magnet. They are typically baled before being sold, but are sometimes crushed and sold loose in Gaylord boxes. Some MRFs sell loose steel cans to another processing facility, such as a larger MRF or a scrap metal dealer, because they do not have the capability of baling steel properly. It is imperative for steel mills that their bales be dense. Most processors in Pennsylvania sell their steel cans through a broker. Larger private MRFs establish contracts with end markets.

The infrastructure for steel processing in Pennsylvania is well established, as the heart of the U.S. steel industry is Pittsburgh.

End Uses for Secondary Steel

By its definition, steel is a recycled product. There are two types of steel production; the basic oxygen furnace (BOF) and the electric arc furnace (EAF). The BOF process uses 25 to 35 percent old steel to make new steel. The products made from steel using this application tend to be products that require drawability, such as car fenders, refrigerator encasements, and rigid packaging such as cans and storage drums.

The EAF process uses virtually 100 percent old steel to make new. Products made from EAF require strength, such as steel beams, steel plates, and reinforcement bars. There are no alternative markets for steel.

Regulatory Environment

Steel cans are included on the Act 101 materials that mandated communities may choose to recover. Although steel can prices have been very low lately, in the past they have, like aluminum, been an economically beneficial material to recover, often helping to supplement the cost of processing other materials.

Supply of Steel Cans

Preliminary data from the Pennsylvania Waste Composition Study, paired with the PA DEP 1999-2000 Act 101 Annual Report, indicate that Pennsylvanians recycle steel cans at a rate of approximately 52 percent. The national average recycling rate for steel cans is 58 percent, according to the Steel Recycling Institute. More steel cans are disposed from the residential sector (an estimated 81,100 tons in 2000) than from the commercial sector (an estimated 19,500 tons). The amount of steel still being disposed in Pennsylvania is approximately 120,200 tons per year. This translates into a dollar value of $2.4 million (based on a price of $20 per ton).

Industry experts note that in some food packaging applications plastics are replacing steel cans, thereby reducing the amount of steel cans recycled, on a tonnage basis.

Demand for Steel Cans

Several steel mills are located in Pennsylvania. The Pittsburgh area, in fact, has more steel mills than any other part of the country. In general, steel cans are shipped up to 200 miles, depending upon the proximity to the nearest steel mill. Steel mills would prefer to source locally in order to minimize transportation costs.

The demand for steel has been depressed in recent years, in part due to declining economic growth, and in part due to "flooding" of less expensive steel imports. Several electric arc furnaces, or "mini-mills" have been idled, leaving fewer markets for steel scrap, including steel cans. While some mills have closed, and steel

companies have filed for bankruptcy, others have expanded. The steel industry, too, has undergone consolidation.

Recent Federal developments involving placement of tariffs on steel imports over the next three years are expected to increase the demand for U.S. steel, and in turn increase the demand and price for steel scrap, including steel cans. The large tonnage EAF mills in operation in Pennsylvania as of January 2002 are listed in Table 8, along with their production capacities. Note that BOF facilities also consume scrap steel, however they also rely on a higher percentage of virgin materials.

Table 8
Large Tonnage Electric Arc Furnaces in and Near Pennsylvania[1]

Company	Location	Tons/Year
AK Steel	Butler, PA	860,000
Bethlehem Lukens Plate	Coatesville, PA	880,00
Co-Steel Raritan	Perth Amboy, NJ	770,000
Co-Steel Sayreville	Sayreville, NJ	700,000
North Star BHP Steel	Delta, OH	1,500,000
Nucor Corp.	Auburn, NY	450,000
Pennsylvania Steel Technologies	Steelton, PA	1,200,000
Republic Engineered Steels	Beaver Falls, PA	400,000
Republic Engineered Steels	Canton, OH	1,000,00
Republic Technologies	Johnstown, PA	1,500,000
Timken Latrobe Steel	Latrobe, PA	1,500,000

[1] Source: U.S. Geological Survey, U.S. Census Bureau, as presented in "2002 Ferrous Scrap Supplement," Recycling Today, January 2002 pp. S18 – S19.

Steel Can Pricing

The price for secondary steel cans has recently hit the lowest point since the depression. Steel production had been declining in recent years due to several factors, including LTV Steel Corporation liquidating their assets, and less expensive steel imports competing with steel manufactured domestically. As a result several steel mills ceased production. The Pittsburgh market typically has the highest price for steel, due to the number of steel mills in the area, and Chicago follows, with the second highest number of mills. Steel can prices in Pennsylvania were reported to be in the $20 per ton range in spring 2002.

Outlook for Steel

Recently imposed tariffs on steel imports are expected to bolster the demand for domestic steel, and therefore will buoy the prices for steel scrap, including steel cans. Steel industry experts expect the prices to continue to increase, although not dramatically.

Relationship between Supply and Demand

The processing infrastructure is well established for steel cans, although some industry experts expect to see further consolidation in the steel sector. Demand for steel cans exceeds supply in Pennsylvania, although prices have been low in recent years.

Plastics

The plastics discussed in this section include the most commonly recycled post-consumer plastic materials –plastic bottles coded 1-7, as well as plastic films and polystyrene.

Commodity Infrastructure

Typical Means of Collection

The collection mechanism for post-consumer plastics varies depending on the type of post-consumer plastic product. Plastic bottles are commonly collected through municipal programs, most often through curbside recycling programs. Drop-box locations are also used to collect plastic bottles, particularly in rural settings (and in the City of Philadelphia as well, which has chosen to exclude plastic bottles in its bi-weekly curbside collection program). Most bottles that are collected are PET and HDPE bottles. They comprise 95 percent of all plastic bottles made. Some communities collect all plastic bottles as a means to simplify their collection programs for participants. “All bottles,” as a grade, includes PET and HDPE bottles as well as PVC, LDPE, and PP bottles. There are very few PS bottles in the post-consumer stream. "All bottle" programs are generally more effective in recovering plastic bottles of all types (including desired PET and HDPE bottles) than are programs that focus on only certain types of plastic bottles.

Polyolefin (HDPE and LDPE) film plastics are collected by consumer returns to chain grocery stores. Those films, along with pallet wrap received by the grocery stores, are returned by backhaul to the warehouse and distribution center for the grocery chain where they are baled and marketed. Other commercial generators of film plastics, such as general warehouse and distribution centers, also separate, bale, and market film plastics that have been used to protect or unitize shipped products.

Expanded polystyrene (EPS) protective packaging that is used to ship components to assembly plants is frequently back-hauled, normally to the original EPS molder, and recycled by that EPS molder into new EPS protective packaging. There is also some limited return of loosefill polystyrene packaging "peanuts" by consumers to package shipping establishments for reuse at package shipping establishments. Other than reuse of loosefill at packaging and shipping outlets, there generally is no collection infrastructure for polystyrene from residences or general businesses.

Typical Processing Flow

Post-consumer plastic bottles that are collected through municipal recovery programs are delivered to a local materials recovery facility (MRF) with all resins and colors mixed. At most MRFs, the plastic bottles are separated from other recyclables and hand sorted into three categories: natural (unpigmented) HDPE bottles, pigmented HDPE bottles, and mixed color PET bottles. In more automated MRFs where air classification and eddy current separators are used, it is not uncommon for a mixed plastic bottle stream to be separated from other recyclables automatically and be marketed as mixed plastic bottles with no additional separation by resin or color. After plastic bottles have been separated from other materials and sorted, they are baled and trucked to market.

Mixed plastic bottles require additional sorting by resin type prior to recycling and remanufacture into end products. There are only a few large facilities in the United States that purchase mixed plastic bottle bales, one of which – St. Jude Polymers – is located in Pennsylvania. Sorting of mixed bottle bales produces streams of clear PET, green PET, natural HDPE, and pigmented HDPE. LDPE, PP, and most types of #7 (typically multi-layer) bottles are compatible in the pigmented HDPE sort stream at the levels they are generated and so are normally sorted into that stream. There are essentially no PS bottles. The only remaining bottle type is PVC bottles, for which there are almost no domestic markets, so they are normally disposed. Other large purchasers of mixed plastic bottle bales are located in Chicago and North Carolina. Brokers also purchase mixed plastic bottle bales on behalf of export markets. In addition to the larger markets for mixed plastic bottle bales, there are several smaller establishments that manufacture plastic lumber that purchase mixed plastic bottle bales. In some cases, they will also accept plastic tubs in the mix as well. However, the PET bottles in the mix are not useful to them and are often separated and resold by the plastic lumber manufacturers. One such plastic lumber manufacturer in Pennsylvania that will accept mixed plastics is Everlast Plastic Lumber. However, the primary plastic used by Everlast in manufacturing its lumber is HDPE bottles.

Unlike many other materials, reclamation of plastics is often a distinct and separate operation from plastics manufacturing processes. As a result, plastics reclaimers tend to fall into two types: (1) merchant processors who specialize in performing a reclamation process and then sell the reclaimed resin to manufacturers; and (2) manufacturers who added a reclamation division as a means to secure low-cost recycled material for their manufacturing processes. Many merchant reclaimers attempt to integrate forward into product manufacturing as a means to add additional value and improve their profit margins. However, few have found great success in doing so because they begin to compete with the customers they sell recycled resin to and/or they lack sufficient knowledge of the industry and downstream manufacturing and distribution chains.

Reclaimers of plastic bottles first grind the bottles into small chips of approximately 1/4-inch size. These chips are then washed, although some plastic lumber manufacturers don't wash their raw material. If the reclaimed plastic is to be sold as a reclaimed commodity plastic, it is often melted and formed into pellets, which is the standard form of the virgin raw material. In the case of PET, if it is going back into a

bottle application, it may undergo additional processing to upgrade its properties, and could undergo a chemical recycling process to ensure it is contaminant-free and safe for food contact applications.

Reclaimers of plastic films generally do not wash the film plastics unless they are very heavily soiled. This is because of the difficulties and cost associated with having to dry the film after it has been washed. Instead, contamination is hand removed before processing and/or filtering of the plastic is done once it is melted and prior to remanufacture into new products.

The reclamation process for EPS tends to be different from that of bottles or films. While some EPS is ground and melted for remanufacture into new products, most is simply ground to very fine pieces and used as a filler material, either in new EPS products or for other uses.

End Uses for Recycled Plastics

Primary Uses

Recycled plastics go into a variety of end uses depending on color and resin type. As with glass containers, colorants that are added to plastics become part of the material matrix, therefore colorants cannot be removed through normal plastics reclamation processes. These colorants can limit end uses to those that are not highly color-sensitive.

The primary end use for recycled PET is polyester fiber, which accounts for nearly half of all PET collected in the United States. Polyester fiber manufacturing is concentrated in the Southeast, particularly in Georgia and South Carolina. Fiber producers prefer recycled PET from clear bottles, particularly if the end use is carpet, so that the color of the final product can be controlled. Green PET is useful to carpet manufacturers for making certain colors of carpet. Green PET is also used in manufacturing fiberfill used in pillows, furniture, and ski jackets.

Most recycled HDPE bottles are consumed in manufacturing new bottles. The bottles manufactured from recycled HDPE are those destined for non-food contact uses, such as detergent bottles and automotive fluid bottles. Detergent bottles are brand and image sensitive; and manufacturers of those bottles are sensitive to color variation. The recycled HDPE used in detergent bottles usually comes from natural HDPE bottles (milk jugs) and is used in a middle layer of the bottle with virgin layers on either side of it. This multilayer structure means that these types of bottles normally have a recycled content of 25 to 35 percent. Automotive fluid bottles are normally dark green, gray, or black. Those bottles use significant amounts of recycled pigmented HDPE and are made by blending virgin and recycled HDPE (and overcoloring pigments) so that a single-layer bottle is made. Because they are single-layer, they can be made from 100 percent recycled content if desired.

When #3-7 plastic bottles are recycled, they are most frequently marketed as follows: The LDPE and PP bottles are included with HDPE bottles and marketed as HDPE, and

the PVC is disposed of. When sold as a component of a mixed bottle bale, #3-7 bottles are typically used in making plastic lumber products.

The primary end use for recycled film plastics is plastic/sawdust composite lumber products that are used primarily in building low-maintenance decks. The sawdust and plastic are usually used in nearly equal parts and are blended together as part of an extrusion process.

EPS has two primary recycled end uses that are nearly equal to each other. The first use is as a filler in new EPS molded foam products. The second use is as small expended polystyrene beads that are used as a construction material for sprayed "popcorn" ceilings in new homes.

Alternative Uses

Manufacturing plastic strapping is the next most common use for recycled PET (after domestic fiber manufacture and export). Most polyester strapping is green, or sometimes black, which makes this industry a perfect outlet for green PET bottles. PET bottles follow closely after strapping as the next most common use for recycled PET, with more recycled PET going into food-contact bottles (such as beverage bottles) than into non-food contact bottles (such as dish soap bottles). Remaining uses include sheet for thermoforming uses (such as detergent scoops) and compounded resin for molded parts applications.

Pipe is the next most common use for recycled HDPE after bottles. Because pipes are generally used underground, the color of HDPE bottles used is not an issue. The next most common end use for recycled HDPE, after pipe, is export, then film, lumber, pallets, and a host of other uses.

Using ground plastics as an ingredient in pavement, or plasphalt, is another alternative use for rigid plastics. In Pennsylvania, a handful of plasphalt projects have been undertaken. In Wilson Borough, for example, two blocks were paved using plasphalt in a superpave mix, on the wearing course only. The project was completed about one year ago. The treated, ground plastic (which is reportedly #3 – 7) was purchased from a company based in New Mexico, however, so it did not utilize Pennsylvania-generated plastic. Using plasphalt is more expensive than conventional materials. The cost of conventional materials is $25 - $35 per ton, in place, whereas the cost for the plasphalt project n Wilson Borough was $60 per ton. It is possible, however, that if sufficient demand could be generated, in-state supply of plasphalt would be developed at a more reasonable cost. Other plasphalt projects have also been conducted, but Wilson Borough's is the only one known to be monitored. It is performing as well as conventional materials so far. Other projects were not done with liquid fuels funds, so monitoring requirements are less stringent. Such projects include a road in Northampton County, and a section of road in Lehigh Township.

The next most common use for recovered film plastics after wood/polymer lumber manufacturing is export markets. After export, the next most common use is as feedstock in manufacturing new film plastic products (such as garbage bags and trash can liners).

Other uses for EPS include the production of extruded polystyrene foam products (including loosefill polystyrene manufacturing). Some also is used as feedstock in manufacturing molded rigid (non-foam) polystyrene products.

Regulatory Environment

Pennsylvania's Act 101 states that mandated municipalities must collect at least three out of eight specified materials. "Plastics" is one of the materials on the Act 101 list; however, plastics come in many products and varieties of varying marketability.

Supply of Plastics

Based on figures reported in the 1999-2000 Act 101 Annual Report, approximately 16,000 tons of PET bottles and 19,000 tons of HDPE bottles are recovered in Pennsylvania each year. This corresponds to recycling rates of 17 and 21 percent respectively. Analysis of preliminary data from R. W. Beck's Pennsylvania Waste Composition Study indicates that approximately 99,000 tons of PET bottles were disposed by Pennsylvanians in 2000. Slightly more than half of this tonnage is attributed to residential generators. The data indicates that approximately 85,000 tons of HDPE bottles were disposed by Pennsylvanians in 2000, over 60 percent of which was generated by residences. It appears that there is a lack of recovery infrastructure or participation by individuals in recovery programs. There are ample markets for PET and HDPE bottles. Approximately 17,400 tons of plastic bottles #3-7 were disposed in 2000. No information was available to determine the recycling rate in Pennsylvania for this material, but it is believed to be very low.

The recovery rate for film plastics is estimated to be only 1 percent in Pennsylvania, with an estimated 5,000 tons recovered and 592,000 tons disposed. Because most film is collected through commercial rather than municipal programs, the amount of film recovered in Pennsylvania may be underreported. Because film plastics are so thin, contaminants that adhere to the films can easily become a large percentage of the recovered material. As a result, reclaimers of film plastics prefer material that comes from "clean" sources. The recovery infrastructure for film plastics is also not as widely developed as that of plastic bottles.

The recovery rate for EPS packaging is estimated to be two percent in Pennsylvania, with an estimated 1,000 tons recycled and 80,000 tons disposed. Because most EPS is recycled through industrial programs, the amount of EPS recovered in Pennsylvania may be underreported.

Table 9 summarizes the information discussed in the previous paragraphs.

Table 9
Estimated Plastics Recovery Rates and Tons Disposed in 2000

Material	% Recovered	Average National Recovery Rate (%)	Tons Landfilled from Residential Sources	Tons Landfilled from Commercial Sources	Total Tons Landfilled
PET Bottles	17	22	51,700	46,800	98,500
HDPE Bottles	21	24	51,900	33,300	85,200
#3-7 Plastic Bottles	Not Avail.	2	8,600	8,800	17,400
Film Plastics	1	5	280,000	310,000	590,000
EPS Packaging	2	12	39,100	41,200	80,300

Demand for Plastics

As Table 10 below shows, Pennsylvania is home to one reclaimer with the capability to reclaim both PET bottles and HDPE bottles and three reclaimers with the capability to reclaim HDPE bottles. Furthermore, there are three plastic lumber manufacturers in the Commonwealth that source plastic bottles. One of these – Everlast – accepts all plastic containers including #3-7 bottles. Baled plastic bottles are a valued commodity that can be economically transported nationwide as well as internationally. Consequently, Pennsylvania-generated plastic bales can be marketed to other regional and national end users as well as export markets, which compete with domestic markets for this material. Approximately 20 percent of PET bottles and 12 percent of HDPE bottles collected nationally are purchased by export markets. Because of Pennsylvania's proximity to domestic markets, it is thought that a higher percentage of plastic bottles collected in Pennsylvania are processed in domestic markets compared to the national average.

Table 10
Major Pennsylvania Reclamation Markets for Plastic Bottles

Company	Facility Location	Region of PA	Type of Plastic Bottles Reclaimed
St. Jude Polymer Corp.	Frackville, PA	Northeast – 2	PET, HDPE (mixed plastic bottles)
Graham Recycling Co.	York, PA	Southcentral – 3	HDPE
National Plastics Mfg.	Easton, PA	Northeast – 2	HDPE
Polycycle Inc.	Scranton, PA	Northeast – 2	HDPE
Aeolian Enterprises	Latrobe, PA	Southwest – 5	HDPE
Everlast Plastic Lumber	Hamburg, PA	Southcentral – 3	HDPE (mixed plastic containers)
Phoenix Recycled Plastics	Ambler, PA	Southeast – 1	HDPE

These end markets have the capability to reclaim significantly more PET and HDPE than is currently recovered in the Commonwealth. In the case of HDPE, Pennsylvania is a net importer of recovered HDPE bottles because not enough is collected in the Commonwealth to meet the demand of the reclaimers.

St. Jude is a merchant reclaimer for PET. It uses the HDPE it reclaims to manufacture slip sheets for use in materials handling applications. Graham is the fourth largest HDPE reclaimer in the U.S. Its production goes to its parent company for use in manufacturing HDPE bottles. National Plastics Manufacturing and Polycycle operate small HDPE bottle reclamation facilities. They also recycle pre-consumer manufacturing scrap plastics and so they have the flexibility to come and go from the post-consumer bottle market depending on market conditions. Polycycle supplies its recycled plastic to its parent company, Laminations, which manufactures sheet plastic products. Aeolian, Everlast, and Phoenix all manufacture all-plastic (i.e., no sawdust) plastic lumber.

There are also several manufacturers of EPS in Pennsylvania that incorporate recovered EPS back into their products. Virtually all film plastics recovered in the Commonwealth are sold into reclamation/manufacturing markets located outside of Pennsylvania.

Prices

Baled PET was selling for 7 cents per pound picked up in the spring of 2002. That price was up from end-of-2001 prices when values dropped to historical lows of 4-5 cents per pound as a result of the slowdown in the worldwide economy, weak exporter demand for recovered PET bottles, and low prices for Asian polyester fiber imports. Low prices for Asian fiber depressed domestic recycler/fiber producer demand and the price they could pay for recovered material in order to remain competitive. Asian export demand for PET bottles increased in early 2002, which accounted for much of the rebound in pricing. Prices for baled post-consumer bottles are expected to slowly climb throughout 2002. Historical prices for the five years ending in 2001 averaged 7.5 cents per pound.

HDPE natural bales were selling for 9-10 cents per pound picked up in the spring of 2002. Mixed color HDPE bales were selling for 5 cents per pound at that time as well. Prices throughout 2002 are expected to rise for HDPE, led first by pigmented bottles, as springtime seasonal demand for pipe, nursery containers, and landscape edging increases. As a point of comparison, historical prices for natural HDPE averaged 10 cents per pound for the five years ending 2001.

Of the materials commonly recovered through municipal recycling programs, only aluminum cans are more valuable than plastics on a per-ton basis. However, because very little plastic is needed to make a plastic container, many plastic containers must be collected and sorted to make a ton of the material. Furthermore, because plastic bottles are larger on average than containers made from other materials, plastic bottles take up more room in a collection vehicle than an equal weight of containers made from another material. The end result is that the source reduction advantages of

plastics packaging in delivering products to consumers become disadvantages when it is time to recycle the material.

Other technical issues related to the nature of plastics also present a challenge to cost-effectively processing the material in MRFs. In order to go into higher value-added recycled product uses, plastics must be separated by plastic resin type and color. Plastics also "remember" the shape into which they were made. This memory-effect can pose baling problems at small MRFs that lack high-capacity balers, resulting in additional freight expense when sending processed plastics to market.

Outlook for Plastics

The outlook for plastics markets is positive for Pennsylvania, particularly for HDPE, given the strength of its HPDE recycling manufacturing industry. Pennsylvania also has access to several other plastics reclaimers, which are concentrated in the Midwest and the Eastern U.S. Specific events impacting the outlook for each type of plastic are discussed below.

PET

By the end of 2001, the Coca-Cola Company had achieved 10 percent recycled content in 75 percent of its soft drink bottles manufactured for consumption in the U.S. and Canada. Its goal is 10 percent recycled content in all bottles, at which time it will be consuming an estimated 70-80 million pounds per year of recycled PET. Pepsi, which has been pressured to match Coca-Cola's recycled content, has committed to achieving the same goal – 10 percent recycled content in its bottles by 2005, although it is just getting started with its program to incorporate recycled content.

The commitments to increase recycled content consumption have been noticed by the PET reclamation industry and PET resin suppliers. M&G Polymers USA, which bought Shell's polyester business, installed a 22 million pound per year Renew chemical depolymerization plant for its Point Pleasant, West Virginia PET resin plant. The Renew technology comes from Australian company Petrecycle Pty. Ltd. United Resource Recovery Corporation (URRC) also announced that it will build a 40 million pound per year PET reclamation plant in North or South Carolina in 2003. URRC currently operates a 10 million pound per year plant in Spartanburg, SC. URRC developed and licenses its UnPET technology, which is a partial depolymerization technology that has received a U. S. Food and Drug Administration (FDA) letter of "no objection" stating that it does not object to using recycled PET from that reclamation system in food or beverage contact applications. URRC expects much of the production of the new plant to go back into recycled content PET bottles. Also, in the last 18 months several manufacturers of non-depolymerization reclamation systems have obtained FDA letters of no objection for their wash lines, including: Visy Plastics Pty. Ltd. (Australia), EREMA Plastic Recycling Systems (Germany), and Buhler AG (Germany). Several PET reclaimers also obtained FDA no objection letters for their wash systems over the last several years. These reclaimers include Pure Tech (New York), Clean Tech (Michigan), Wellman (South Carolina), and Nationwide Recyclers (North Carolina subsidiary of Crown Cork & Seal).

The trend to increase recycled content usage in PET bottles may result in higher PET prices for reclaimers that are tied into the fiber industry. These end users of PET are also concerned that they will not have adequate feedstock, if collection of PET bottles does not increase commensurately with the increased demand for recycled material. In 2000, less than 100 million pounds of recovered PET went back into bottle uses. That figure is expected to increase to nearly 200 million pounds in the next couple of years. If the recovered PET merely shifts end uses with no increase in recovery, fiber manufacturers may lose from 20-25 percent of their current recovered bottle feedstock.

HDPE and Film Plastics

The outlook for bottle HDPE and film plastics is expected to remain fairly steady in the years to come, with significant growth expected to occur in the 100 percent HPDE and film plastic/sawdust plastic lumber product areas. Plastic lumber manufacturers expect significant sales growth in the next couple of years because of: (1) homeowner desires for maintenance-free decks; and (2) the phase-out in 2002/2003 of chromated copper arsenate (CCA) treated wood lumber, which should result in cost increases of wood treated by alternative chemicals, which are more expensive than CCA.

As was mentioned previously the primary market for film plastics is sawdust/polymer composite lumber. Three companies dominate this market: AERT (AR, TX), Trex (VA, NV), and U.S. Plastic Lumber (FL, IL). U.S. Plastic Lumber also makes 100 percent plastic lumber. The three companies had various levels of production growth this past year. While sales of decking boards by Trex and U.S. Plastic Lumber were flat last year, AERT's sales grew by about 20 percent. The recession undoubtedly caused a slowdown in sales by Trex and U.S. Plastic Lumber. AERT was able to grow its sales in the difficult economic environment because of its relationship with Weyerhauser, which markets and distributes AERT's lumber through its distribution chain. Weyerhauser is expanding distribution of AERT's lumber in more outlets, including Lowe's Home Improvement stores. Lowe's is opening new stores at a 15 to 20 percent growth rate, and the new stores will require inventory.

Currently sawdust/polymer lumber comprises approximately four percent of the deck market with Trex being the leading producer, supplying about half of sawdust/polymer market. 100 percent plastic lumber (with no wood component) makes up about one percent of the deck market.

In the last couple of years Trex has expanded its manufacturing capability in anticipation of future growth. Because sales growth of its product was flat last year, it only operated at approximately 40 percent of its manufacturing capacity. AERT expanded its production capability in 2001 and plans to further expand its plastics reclamation and production capability in 2002. All three companies feel vulnerable to their ability to obtain sufficient recovered plastics to significantly expand production in the next few years. In fact, Trex has opened a subsidiary company in Spain in order to reclaim film plastics there for shipment to its plant in Virginia.

#3-7 Plastic Bottles

While there is considerable interest among suppliers in finding markets for #3-7 bottles, there is little market development potential, other than through the growing marketplace for plastic lumber products. A primary reason for this is that #3-7 bottles comprise a very small component of the bottle stream and the cost associated with aggregating truckload quantities of separated grades generally far exceeds the product's market value, except for the high-capacity all-bottle processors such as St. Jude Polymer. The inability to economically supply steady quantities of this material paired with the availability of lower cost feedstock alternatives inherently limits end user demand for #3-7 bottles.

Plasphalt

In Pennsylvania, as mentioned above, the aggregate industry is strong, and therefore aggregate is inexpensive. Currently plasphalt is not an economically viable alternative to traditional asphalt, however increased recovery of #3-7 plastics could help the economics become more favorable for plasphalt. Plasphalt projects also have to be monitored for quality assurance over a period of five years; and asphalt plants must make changes in their operations to use ground plastic in their asphalt. There is little incentive for plasphalt to be used in projects. If plasphalt were to become a viable substitute for conventional asphalt, monitored test projects would first have to be proven successful, which would be in four years. The company that was the supplier for the Pennsylvania plasphalt projects, Plasphalt Projects Limited, no longer manufactures plastics for use as an aggregate substitute in asphalt.

There is a company in Framingham, Massachusetts, Conigliaro Industries, that manufactures a product called Cold Patch, which is an asphalt-like material used specifically to mend and/or patch large cracks and potholes in a paved area, using #3-7 plastics from computers. Conigliaro Industries is currently constructing a full-scale Cold Patch manufacturing operation, so the potential to use plastics in manufacturing asphalt products exists; however this material is different from the projects in Pennsylvania in that it is made specifically for patches and is shipped ready-to use.

Relationship between Supply and Demand

The infrastructure and end markets are largely in place for collecting post-consumer plastic bottles from the residential sector; however the data suggests that participation could be improved. Several recycling coordinators interviewed for this report indicated that they thought the collection infrastructure for commercial generators of PET and HDPE bottles could be improved. There are several large end users of HDPE and PET bottles located in Pennsylvania that indicate they could use more feedstock from sources located within the Commonwealth. Supply clearly exists within Pennsylvania and has a viable end market within the Commonwealth, however the materials are not being collected adequately.

Film plastics have some end users within Pennsylvania, although most of the end-use demand comes from outside of Pennsylvania, and from export markets. Undoubtedly, more can be done to collect and process (bale) film plastics generated in Pennsylvania.

Similarly, the EPS recycling/end use industry has the capacity to increase the consumption of recovered EPS, particularly from commercial/industrial generators.

Demand is lacking for recycled post-consumer plastics from most other applications. The primary reason for the lack of demand relates to the cost of recovery, sorting, and reclamation, which often will exceed the cost of virgin plastic production. Unless communities or businesses are willing to take a loss or pay for the "privilege" of recycling, subsidies are put in place, or technology advances reduce costs of separation and recycling, demand will likely remain low for other post-consumer plastics, like tubs.

Organics

Organics in the municipal solid waste stream discussed in this section consist of leaf and other yard wastes, tree residues resulting from tree removal and trimming operations, and food waste.

Commodity Infrastructure

Typical Means of Collection

Leaf and other yard wastes (brush and grass clippings) are generated by residences as well as by buildings and grounds and lawn care and landscaping entities responsible for the maintenance of business and institutional properties. Generation fluctuates seasonally, with peak leaf generation in the fall and early spring and peak grass generation in spring and early summer.

Leaves and to a lesser extent, other yard wastes, are collected from households seasonally, in some Pennsylvania communities. Typically, residents must bag their leaves, either in plastic or Kraft bags, and set them out for weekly collection during a seasonal period of eight to twelve weeks. Some communities have leaf vacuum vehicles to collect loose leaves. In general, if brushy waste is collected curbside, it must be cut to a manageable size, generally no longer than three feet, and stacked near the curb. Most communities do not have leaf/yard waste collection programs, but allow residents to dispose of a small amount of leaf waste with their regular refuse. Some communities provide drop-off locations where leaf and other yard wastes may be delivered for processing. Many communities, particularly in rural locations, still allow the burning of leaf and wood waste. Most communities encourage their residents to “grasscycle” their lawn trimmings (leave the grass clippings on the lawn) and to establish backyard composting programs. The Penn State Master Gardeners Program and the County Extension Offices offer backyard composting seminars and composting bins to residents of Pennsylvania.

Tree Residue

Tree residue consists of whole tree parts and wood chips -- both hard and soft woods. Generators of tree residue include commercial and municipal tree services and electric utility line maintenance operations. The material usually is generated in the form of

whole tree parts (stumps, trunks, etc.) and wood chips. Tree residue is generated primarily during the spring and fall when tree maintenance activities are undertaken. Also year-to-year generation of tree residue can be highly variable, due to storms and natural disasters.

Tree service and utility companies routinely trim trees and remove downed trees and limbs as part of their business. Typically, the tree trimmings are chipped on-site to facilitate transportation of the material. A significant portion of the chips may be used within the normal course of business – by landscapers or municipalities as mulch, for example. Tree service and utility companies also sell chipped tree residue to end users, such as the general public, landscapers, and compost manufacturers. To some degree utilities and tree trimming services have a financial incentive to recycle wood – particularly when they have wood of high value. In most instances they would prefer to avoid landfill tipping fees, and to garner whatever revenue they can from the wood they have collected. If suitable outlets for tree residue are not located in close proximity, however, transportation costs may outweigh the cost of landfilling or burning tree residue – particularly if the wood in question is of little value, or cannot be given away. One tree service company owner interviewed for this study feels that there is a need to educate those in the tree service industry about alternative uses for tree residue.

Food Waste

Food waste consists of both perishable and non-perishable food items and is highly variable, due to the variety of foods and the numerous commercial and household activities involved in processing and preparing foods for consumption. Generators are numerous and diverse, including residential dwellings, commercial and institutional kitchens, restaurants, grocery stores, and food product manufacturers.

Food waste can be collected separately or along with other organic matter from residences, and as a separate stream from food waste-generating commercial, institutional and industrial establishments. Industrial/commercial generators tend to produce more homogeneous wastes, and are the only source for potential reuse for human consumption. Consequently, most communities that establish food waste recycling programs focus on recovering food waste from non-residential sources. Very few communities in the U.S. have implemented curbside collection of residential food waste, although San Francisco is an example of a community that is successfully operating such a program. An infrastructure for recovering food waste is not currently in place in Pennsylvania, outside of the food bank/food rescue infrastructure.

Typical Means of Processing Organics

Leaf/Yard Waste

Municipalities mandated by Act 101 are required to separate leaf waste from other municipal wastes. Furthermore, no waste disposal facility can accept shipments of waste that consists primarily of leaf waste, unless a separate composting facility is provided.

Leaf/yard waste is often composted on municipally owned sites. In some cases, however, municipalities deliver their leaves and yard trimmings to a private compost producer. The municipality pays a tip fee, however it is less than a landfill tip fee, and the leaf waste is diverted from the landfill. Typically leaf waste is ground before it is added to a compost pile. This is not necessary, however, it facilitates the composting process.

Tree Residue

Tree Residue that is small in diameter (less than 12 or 14 inches) is often chipped at the point of collection using mobile chippers. Larger pieces of wood are cut into suitable log lengths (of eight to 24 or 30 feet, depending on the type of wood) on site and hauled to the end market (mills) or a wood broker. Trees of lower value, such as pine and poplar, may be left on-site if the property owner can use it, brought to a mulching operation, or sold to a pallet manufacturer. Some mulching operations will charge a fee to accept materials. Others may accept the material for free, but may not always be able to accept product.

Food Waste

Donated food being used for human consumption is usually visually inspected for quality in a food bank warehouse, and then it is delivered to a food pantry for human consumption. Prepared foods donated for human consumption are packaged at the site of origin (cafeteria or restaurant, for example), collected via refrigerated truck, and delivered to the appropriate food pantry that day.

Food waste that is not suitable for human consumption is removed from the packaging. Recyclable packaging materials (steel cans, paperboard, and glass jars, for example) are then typically recycled. Food contents are placed in a lidded container until they are delivered to their final destination (a composting site or farm, for example).

End Uses for Organics

Leaf/Yard Waste

The majority of recovered leaf and other yard waste is converted into compost and mulch. Leaves are high in carbon, which is an important ingredient in compost. Grass clippings and other green yard waste are high in nitrogen. The compost can be used as a fertilizer amendment, adding nutrients and moisture to the soil. It can also be used as mulch or top dressing to help retain moisture and battle weeds. Compost can also be used as a potting soil additive, to add nutrients and moisture to potted plants.

Compost and mulch is generally either given away or marketed to wholesale (soil blenders, bulk materials handlers) and retail (landscapers, garden centers, golf courses) customers. Typically composting operations charge a tip fee of approximately $20 per ton. Compost can be quite variable in quality, and can range in price from “free” to $34 per cubic yard, bulk, picked up.

Tree Residue

Tree residue less than 12 or 14 inches in diameter is most commonly chipped with a wood chipper, and used as mulch. Landscapers make several grades of mulch, based on the types of wood chipped, and the cleanliness of the material. Mulch is used as a ground cover and can be spread around the base of outdoor plants for aesthetic purposes, to help the plants retain their moisture, and to aid in weed control. Rotted wood chips are high in earthworm activity and are particularly beneficial to use as mulch around deteriorating trees. In some cases mulch can also be used for erosion control. Chipped wood can also be used as a bulking agent in the production of compost. Other uses for chipped wood include hog fuel, animal bedding, and hydromulch. Hog fuel (bark and milling wastes cut into small pieces for efficient burning) markets in the Northeast have experienced excess supply in recent years, resulting in reduced prices.

Tree residue larger than 12 to 14 inches in diameter can have higher value end markets, depending on the type and condition of the wood, and the length of the logs. Lower value woods, such s beech and black gum, are often sold to pallet manufacturers. Oak can be sold to mills that will process it for manufacturing flooring, cabinetry, and furniture. Oak of superior quality can be sold to the veneer industry. Pine can also be sold to furniture makers. Paulownia wood, which is more commonly found in temperate climates but is also available in Pennsylvania and is known for its fast rate of growth, is generally exported, as it has a high value in Japan. Tree service companies can sell wood directly to mills or through a wood broker.

Often, wood that is not suitable to be turned into boards because it is decayed or not long enough, is sold or given away as firewood, or given to mulching operations. Some can be sold to paper pulping operations. Whatever cannot be sold or given away conveniently is often burned.

Food Waste

It is possible to use food waste in a variety of applications, which are presented in Table 11.

Table 11
Products and Applications for Food Waste

Surplus Food Recovery for Human Consumption
■ Perishable and prepared food recovered for distribution to the needy
■ Canned foods and dry goods recovered for distribution to the needy
Animal/Fish Feed
■ Direct feeding of food waste to swine, dairy cattle, and other livestock
■ Conversion of food waste into animal/fish feed or ingredients for animal/fish feed
Compost
■ Soil amendment for bed preparation, planting backfill, seeding and sodding, sod production, turf top dressing, and civil engineering applications (erosion control, slope stabilization, and soil remediation)
■ Mulch products for planting beds, around trees and shrubs, and civil engineering applications
■ Ingredient in manufactured soil products for sale as topsoil or loam and use in landscape construction
■ Ingredient in plant growing media (potting soil) for general purpose and specialty mixes
■ Manufacture of wetland soils for use in wetland remediation and artificial wetlands construction
Other Products
■ Fertilizer
■ Tallow
■ Industrial chemicals

Surplus Food Recovery for Human Consumption

Food donor programs provide edible food to the needy through food banks, and prepared and perishable food programs (PPFPs). Food banks focus on distributing large volumes of nonperishable (canned, dried, or prepackaged) food. Much of the food distributed by food banks is diverted from the landfill; however, they also distribute foods donated by citizens (that would not have been discarded).

Food banks generally receive large quantities of food items from commercial generators (e.g., supermarkets and food product manufacturers) and distribute them to numerous charitable organizations. A significant portion results from over-ordering, advertising misprints, dented cans, and other surplus retail conditions. Volunteers clean, sort, and otherwise prepare items for donation to agencies within the community (soup kitchens, food pantries, homeless shelters, etc.).

There are several food organizations in Pennsylvania that provide food pantries and charitable organizations with consumable food. Most food banks focus on accepting donated surplus non-perishable food items from wholesalers and manufacturers, and providing them to food pantries operated by charitable organizations. Food rescue groups focus on delivering surplus perishable foods to individuals and groups that can consume them. There are several large-scale food banks and two food rescue groups in the Commonwealth, including:

- Central Pennsylvania Food Bank – Harrisburg;
- Greater Berks Food Bank – Reading;
- The Dover Area Food Bank – Dover;
- The Greater Philadelphia Food Bank – Philadelphia;
- H & J Weinberg Northeast PA Regional Food Bank –Wilkes Barre;
- Second Harvest Food Bank of Northwest – Erie;
- The Greater Pittsburgh Food Bank – Duquesne;
- Titusville Area Food Bank – Titusville;
- Second Harvest Food Bank of Lehigh Valley – Allentown;
- Westmoreland County Food Bank – Delmont;
- Community Food Warehouse – Farrell;
- Philabundance (Food Rescue) – Philadelphia; and
- Channels (Food Rescue) – Lemoyne.

Most of the organizations listed deal primarily with non-perishable foods. Because these items are non-perishable, they can be shipped to other food banks across the country when they have an overabundance of a particular item. Approximately 80 percent of food banks and food rescue groups belong to Second Harvest, a nationwide organization that helps facilitate the transfer of food products between different food banks.

Philabundance, a food rescue group in Philadelphia, receives 90 to 95 percent perishable food. Approximately 65 percent of this food consists of fruits and vegetables. The food is sourced from wholesalers who have an oversupply of food, or who have items that are too close to the end of their shelf life to place in a retail outlet. The facility distributed 13 million pounds of food in 2001; however the amount of food they had to dispose of was minimal. Food is shared with other food banks, or not accepted for delivery if they feel that it cannot be put to use. The facility had considered composting non-consumed vegetative waste on-site, however they have limited space. In the past, when storage was less abundant and fewer vehicles were available, this was more of an issue. In the past Philabundance has donated surplus perishables to hog farmers for hog feed. They also landfill a small amount of unused surplus food. Because Philabundance is committed to supporting environmental causes, they would consider donating unused perishables to a composting operation, if logistics would warrant this.

Channels Food Rescue receives primarily prepared foods from restaurants and cafeterias. They also receive some wholesale perishable food items. Prepared foods are collected and delivered via refrigerated truck the same day. They have virtually no waste. Channels also has a chef that runs an educational program, teaching adults in need of job skills how to cook. The foods prepared in class are also distributed.

Surplus Food as Composting Feedstock

Food waste that is not fit for human consumption can be used for composting with great success. Food waste provides a high amount of nitrogen in making compost. There are a number of composting technologies that can be used to compost food waste on a commercial scale. Whatever technology is used, the composting operation must produce a stable and consistent quality product in order to meet market requirements. Food is generally ground, then added to high-carbon ingredients, such as leaves and/or ground wood. Vegetative food waste is most commonly utilized, however animal products can also be used if the temperatures in the compost become high enough to break down the enzymes. Most composting operations use windrows. With this technique, the organics are mixed together, aerated, and turned regularly. Microbial action breaks down the organics, creating heat in the process, and turning the matter into compost. At the end of the process, the material is screened to remove larger pieces of material. In-vessel technologies are also available.

In addition to the centralized, commercial composting approach, there are a few programs throughout the country that have successfully merged urban food waste sources with local farmers for on-farm composting. A project in Massachusetts, for example, links commercial food waste generators, commercial waste haulers, and farm composting sites. The majority of food waste comes from supermarkets and a large wholesale grocer. Generators have reported 12-20 percent reductions in their solid waste management costs. One supermarket chain reported a 23 percent reduction in trash generated.

Only two composting operations in Pennsylvania have the DEP permit required to use pre-consumer food waste as a feedstock for compost manufacturing. Using post-consumer food as feedstock in composting operations is not permitted in Pennsylvania, nor can animal products be utilized.

In Pennsylvania, whether food is pre-consumer or post-consumer is determined by the source of the food waste. Food sourced from a restaurant or cafeteria, for example, would be considered post-consumer food, whether it was actually served or was excess food that never left the kitchen. It could not, therefore, be sent directly to a composting operation. Surplus food from the kitchen, however, could be used for human consumption at a food bank.

Agrecycle, one of the facilities permitted to utilize food as a feedstock in manufacturing compost, receives food from a snack food manufacturer, as well as vegetative food waste from wholesale produce companies. Agrecycle is also receiving leaf waste, other yard waste, and manure as feedstock. Nutra Soils, the other such permitted facility, also receives post-industrial food waste, as well as paper sludge.

Animal Feed

Direct Animal Feeding

Direct animal feeding of human food waste is a traditional farming practice. The most common practice is swine feeding. Pig farms that practice direct animal feeding prefer post-consumer food waste because it is heterogeneous. The mix of food wastes

provides a wider variety of nutrition and food value to the pigs as compared to food processing wastes, which tend to be very uniform.

The Greater Pittsburgh Food Bank operates a reclamation center on-site, where employees process non-perishable food items donated by a regional supermarket chain, Giant Eagle Foods. Approximately 30 percent of the food received from Giant Eagle is deemed unfit for human consumption, due to opened boxes, dented cans, etc. These food items are opened and the contents are dumped into a container. A hog farmer collects the food a couple of times a week. The boxboard and steel cans are recycled. They expressed interest in working with a local composting operation located approximately six miles away; however at the time the composting operation was awaiting a permit to utilize food in manufacturing compost.

Manufactured Animal Feed

Manufactured animal and fish feeds are highly consistent products that have very low moisture content. They may be either pelletized or a meal. Animal feeds are generally produced for the agricultural market, e.g., poultry pellets and cattle feed supplements. These markets are the most amenable for feeds derived from food waste, in contrast to pure grain feed products for animals like horses. Manufacturing feed requires feedstock consistent in terms of content and moisture. These requirements place constraints on the types of food waste amenable to feed manufacturing, i.e., consistent characteristics and relatively low moisture content. Rendering facilities represent the largest industry that produces animal feed from *animal* by-products. It is not known whether animal feed manufacturers are operating in Pennsylvania.

Industrial and Manufactured Products

Current commercial scale activities utilizing food waste are limited primarily to rendering plants. Rendering plants utilize fat and bone, grease trap waste, and used cooking oils to produce tallow, meat and bone meal, and yellow grease. Tallow is used in manufacturing soaps, cosmetics, and pharmaceutical creams. Meat and bone meals and yellow grease are used in manufacturing animal feeds and pet foods.

Regulatory Environment

Leaf waste is included on Pennsylvania's list of Act 101 materials that mandated communities must recover. Furthermore, Act 101 prohibits landfills from accepting truckloads of yard waste. Most composting facilities operating in Pennsylvania are not required to have a DEP permit, however they must have DEP approval. If a facility uses pre-consumer vegetative food waste as a feedstock in composting operations, they are required to have a permit, and to be bonded. As stated above, there are only two facilities that hold such a permit in Pennsylvania, one of which is not using food waste as a feedstock. The permit does not allow the use of post-consumer food, animal products, or foods containing animal-derived products (such as bread) in composting operations. Composting facilities are also prohibited from accepting liquids, in Pennsylvania.

Supply of Organics

Preliminary results of the Pennsylvania Waste Sort Study indicate that "other" yard waste and grass clippings constitute a significant portion of the waste stream. Percentages here, however, may be slightly overstated as the data presented represents three seasons – summer, fall, and winter. Food waste from both the commercial and residential sectors is clearly a large portion of material being landfilled. There is no data available regarding tree residue disposed, however R.W. Beck staff managing the waste sorts noted that very little tree residue appeared in the samples. Table 12 summarizes the estimates of organics being recovered and disposed in Pennsylvania.

Table 12
Organic Materials Currently Recovered

Material	% Recovered	Total Tons Disposed	Tons Disposed from Residential Waste Stream	Tons Disposed from Commercial Waste Stream
Yard Waste – Other*	56	237,300	183,000	54,300
Yard Waste – Grass	Not Available	95,200	74,200	21,000
Food Waste	5	1,366,700	737,200	629,500

*Includes leaf and brush waste

Leaf and Other Yard Waste

There is an ample supply of unprocessed leaf and other yard wastes in Pennsylvania, generated by residences as well as landscaping operations. Many communities, including several communities mandated under Act 101, do not have adequate leaf and yard waste programs in place. Some communities, such as Lackawanna County, have, with the assistance of DEP grants, purchased equipment to effectively grind and compost organic matter. In many instances, however, the collection infrastructure is not in place to deliver the leaf and yard waste to the composting facilities. Partially because of this, some private composting operations have to accept leaf and yard waste from sources located outside of Pennsylvania. One compost business owner states that much of his feedstock comes from New York, where landfill tip fees tend to be higher. He notes that he also sells more material to customers outside of Pennsylvania than to customers within the Commonwealth, because they are willing to pay more for his product. The Pennsylvania Waste Composition Study preliminary results show that approximately 237,300 tons of "other yard waste" -- which includes leaf and brush waste, was landfilled in Pennsylvania, representing 2.5 percent of the residential waste stream. An additional 95,200 tons of grass clippings were also disposed – or 1 percent, bringing the total for Yard Wastes to 3.5 percent of the municipal solid waste stream disposed.

Tree Residue

According to preliminary results of the Pennsylvania Waste Composition Study, approximately 332,200 tons of unpainted wood was landfilled. Waste sort project management, however, indicates that tree residue was not a significant portion of waste recorded in that category.

As previously mentioned, the infrastructure for tree residue collection inherently takes place within the tree services and utilities sectors. Furthermore, these entities have developed uses within their organizations to utilize the tree trimmings, or they have developed markets to sell their chipped wood.

Food Waste

According to preliminary results of the Pennsylvania Waste Composition Study, food waste represents a significant amount of waste being disposed from both residential and commercial generators. Food waste, in fact, is the one single largest item that is being disposed in Pennsylvania, accounting for approximately 1,367,000 tons.

Residential sources represent a significant untapped source of food waste in Pennsylvania. Due to the required level of collection and transportation infrastructure, however, recovery of food waste from the residential sector is probably the least viable from an economic perspective. Although there is also a lack of infrastructure for collecting and processing food waste from nonresidential sources, recovery from this sector holds much greater promise for economic viability than from residential sources. The most obvious targets are large-quantity generators of food waste that is already separate from, or can easily be separated from, other waste materials. Specific generators that fall into this category are supermarkets, restaurants, farmer's markets, food processing businesses, and institutional cafeterias (schools, universities, hospitals, and some larger businesses).

Food waste being supplied to community food banks is limited to excess supply and close-to-date food items that are, for the most part, non-perishable. Some perishable foods are also being routed to food rescue organizations, and to a smaller degree, food banks. Large amounts of food are discarded that are still fit for human consumption.

Expansion of perishable and prepared food programs has been spurred on recently by passage of Good Samaritan laws that limit the liability of donors. Even so, there is significant potential to increase the recovery of surplus food. There are major generators who still discard all of their food waste. In the case of prepared food, restaurants and cafeterias still fear liability issues; and it is simply easier for them to dispose of food than package it for donation.

Demand for Organics

Leaf/Yard Waste

Some municipal composting operations can produce relatively high quality compost. Lackawanna County, for example, reports that they can't make enough of the compost to supply to their markets. They have customers from New York and Maryland that

would purchase as much compost as they could make. Other communities are not able to dedicate resources to composting to make a high-quality product, and they indicate that at times they have product left over.

Many private compost companies report that they cannot fill the demand for compost. One private compost manufacturer, however, states that there is a need to create an overall boost in the demand for composted material, by encouraging its use in non-landscaping applications, such as mine reclamation, erosion control, wetlands rehabilitation, and highway construction.

Tree Residue

Because the landscaping business is reportedly growing in the Commonwealth, the demand for mulch from tree residue is expected to continue to expand. In addition, there are strong markets for true residue suitable for use as lumber. The demand for tree residue, therefore, is also expected to continue to increase.

Surplus Food

The demand for surplus food for human consumption always exceeds supply. Often there simply is not enough nutritious food representing all food groups being donated. In some instances, however, lack of infrastructure can be prohibitive. Food banks may not have adequate trucking capabilities, a large enough warehouse to store significant quantities of food, or enough refrigerator space, for example. Transportation to rural areas can also be an issue.

Because there are only two compost operations in Pennsylvania using food waste as feedstock, the demand for food waste to be composted is minimal. The push to recycle food will most likely be driven by communities' waste diversion goals, entrepreneurial spirit, and good will more so than market demand for the product.

Relationship between Supply and Demand

Leaf/Yard Waste

There seems to be a lack of infrastructure in place to adequately process residentially generated leaf waste. The lack of infrastructure is due, primarily, to the lack of collection systems for leaf and yard waste. Brushy waste, in particular, is often not addressed. Most private haulers do not want to address a separate leaf collection system, and many municipalities say that they cannot provide this service in an economically efficient manner.

Tree Residue

Large quantities of tree residue are generated; however, a large portion never actually enters the waste stream, is managed on site or is given away free. In general, current demand is able to absorb current supply. However, natural disasters such as major storms can generate large amounts of wood waste in a very short period of time, and may lead to temporary conditions of over-supply.

Food Waste

The demand for surplus food for human consumption is generally believed to be greater than the potential supply. Thus, there is an opportunity to expand the amount of material recovered through the existing programs and to establish new services.

Food banks in Pennsylvania report that, overall, demand for food exceeds supply. There are items, however, that they receive so much of, that they have an oversupply. Because the food banks focus on non-perishable items, they are able to ship the non-perishable foods to other food banks that can utilize them.

With regard to composting of organics, while there seem to be several manufacturers of compost in the Commonwealth, it is difficult to tell if Pennsylvanian producers of compost could adequately absorb additional supply of organic wastes. This is because, as explained above, suppliers located outside of Pennsylvania are willing to pay higher tip fees at composting facilities. If transportation costs continue to increase, however, distant sources may become less attractive. Pennsylvania-generated supply does not appear to be suiting the needs of demand in the Commonwealth, however.

Electronics

Electronics in this section include electronic equipment containing cathode ray tubes (CRTs) such as televisions and computer monitors, as well as non-CRT electronics. CRTs are problematic to dispose because they contain relatively high levels of lead, and must be handled by a "glass-to-glass" facility at the end of their useful life. Non-CRT electronics include all other electronics, which also contain some potentially hazardous materials. Electronics from households as well as commercial, institutional, and municipal sources are included in the discussion.

Commodity Infrastructure

Typical Means of Collection

Recovering electronics for reuse or dismantling is an emerging trend. In Pennsylvania, several communities have held successful electronics recycling events. While communities have attempted to collect electronics using curbside programs (Minneapolis, MN) and permanent drop-off facilities (Lancaster County), the most common model for electronics collection is the one or two-day event sponsored by the municipality. In some cases residents are asked to pay a fee to recycle their electronics (based on the type of item or the weight of the item) and in other cases the municipality pays for the program. Generally, a recycling company comes to the location to help organize the event, and often a non-profit organization may be on hand to claim working electronics that they can put to reuse. Counties in Pennsylvania that have had electronics collection events include Chester, Cumberland and Westmoreland Counties. Collection events will be held soon in York, Butler, Centre, and Lackawanna Counties.

Most commercial, institutional, and municipal electronics recycling programs are handled directly by the recycler. These types of entities are usually not allowed to bring materials to a municipally sponsored electronics collection event.

Typical Processing

Computer companies dismantle most electronics collected from municipal programs. Computer components that can be reused, such as circuit boards, are sold to equipment manufacturers for reuse. The remainder of the material is shredded and disassembled manually and components such as aluminum, copper, and plastics, are sold as secondary materials. Electronics collected from businesses may be reused after all data has been removed from them. Computers that are reused may be upgraded first, and sold to businesses, or may be donated to a non-profit entity or school district.

CRTs are often shipped to "glass-to-glass" facilities for the glass to be removed. This type of business generally requires additional permitting. Envirocycle is the only electronics recycler in Pennsylvania known to have the capability to remove CRT glass. Other electronics recyclers pay Envirocycle to take their CRTs and remove the glass. Envirocycle sells the CRT glass to Corning in Pittsburgh where it is used to make insulation. Unicor, a Federal Prison Industries program, also has the ability to process CRT glass at their Elkton, Ohio facility. They separate the glass from the CRTs, and sell it back to TechniGlass, a manufacturer of CRT glass. Another private recycler in New Jersey, Nutech, also has this glass-to-glass capability. Nucor's Fort Dix, New Jersey facility is currently seeking approval to operate a glass-to-glass operation.

Regulatory Environment

Currently, the Commonwealth does not ban the landfilling of electronics including CRTs, by either residents or companies. Such bans exist in Massachusetts and California, which do not allow the landfilling of CRT by businesses or households. Minnesota allows households but not companies to landfill CRTs.

The Pennsylvania Department of Environmental Protection has a proposed draft beneficial use permit that would require those who sort, disassemble, and mechanically process electronics to be permitted by the Commonwealth. Comments on this legislation were being accepted through June 11, 2002. Many recyclers welcome the permitting process, and feel that it would deter "fly-by-night" recyclers from undercutting their business by offering to take electronics at extremely low prices, and then not manage them properly. Until the requirements of the permitting are clarified, however, recycling companies are hesitant to make any changes or expansions to their facilities.

Supply of Electronics

According to preliminary data from the Pennsylvania Waste Composition study, electronic wastes represent 1.36 percent of the disposed waste stream, or approximately 130,000 tons disposed in 2000. Electronics represent approximately

1.7 percent of the commercial waste stream, and 1.4 percent of the residential waste stream.

This data may not accurately reflect the true supply of electronics. Some residents and businesses are aware of the potential environmental hazards of landfilling electronics, and are likely storing them until they know what to do with them. In addition, electronics are becoming more widely used, and more quickly obsolete. The supply of electronics to recycling markets is expected to increase over time as electronics collection programs become more commonplace, and as consumers replace their electronic equipment in shorter cycles than ever before.

Demand for Electronics and their Components

There are 14 electronics recyclers/reusers located in Pennsylvania. Those interviewed for this study indicate that they are willing to travel nationwide to conduct collection events. The demand for electronics components is strong. Working components, such as circuit boards, cooling fans, CD-ROMS, and hard drives, can be used in the remanufacturing and repair process. Plastics and base metals are sold as secondary commodities.

The aluminum, copper and gold that comes from the computers is often sold to smelters that may be located several hundred miles away. Known end markets are in Texas, Ohio, New Jersey, Kentucky, and New York. At times, the Asian markets pay higher prices for these commodities, however this market is not stable. Plastics from electronics can be more difficult to sell – particularly if they include various colors. As long as the colors are kept separate, electronics demanufacturers can generally sell the plastics, which are ground and melted to add to virgin resins to formulate new products. The automotive industry is a major user of these plastics.

The demand for reuse of computers from the municipal stream is nearly non-existent. Most people utilize their computers, or pass them along to a friend or relative, and by the time the computer is brought to a recycling event, it is quite outdated. Charitable organizations have had to limit the types of computers they will accept, because the majority being donated by households is obsolete. A higher percentage of industrial/commercial computers and their components can be refurbished and reused. In some cases, however, commercial entities are concerned about security and environmental liability and prefer that the equipment be demanufactured.

Outlook for Recycling Electronics and their Components

The outlook for electronics recycling is positive, in terms of supply. As electronics become obsolete more quickly than ever, and their costs decline making them more affordable, it is expected that the volume of electronics being discarded each year will increase over time. The National Electronics Product Stewardship Initiative (NEPSI) is working to develop a front-end financing system for electronics end-of-life management. NEPSI favors the implementation of a voluntary program whereby consumers of electronics will pay for the recycling when they purchase their electronic devices. It is not yet certain how this program will develop, and front-end-financing is

several years away. Pennsylvania is participating in the NEPSI discussions. Meanwhile, state and local governments are being urged to continue successful e-cycling programs. The NEPSI process is just one discussion regarding how e-waste should be handled. Other discussions are also ongoing. It is expected that because the metal commodities recovered from electronics are used in electronics manufacturing, for the most part, the demand for the components and commodities from the electronics will also be strong.

Relationship between Supply and Demand

The infrastructure for electronics recycling is still developing, to a large degree. Pennsylvania is fortunate to have a glass-to-glass facility located within its borders. There are only a handful of such processors nationwide. This, of course, drives down the cost of CRT processing.

The largest issue currently, with electronics recycling, is the inability of some communities to pay for collection events. Pennsylvania DEP grants will pay for 50 percent of the cost of these events, however smaller communities in particular have a difficult time paying for the remaining costs. One small community is looking into a prison labor program, which utilizes prisoners to demanufacture computers. The prison program is able to provide the service at a much lower cost.

Electronics recyclers are able to find markets for their commodities, however Pennsylvania-generated supply definitely exceeds demand in the Commonwealth. In fact, it is fairly common for the aluminum and copper recovered in the demanufacturing process to be exported to Canada and Asia. Recovered plastics are routinely used to manufacture automobile parts.

Supplementary Findings and Conclusions

Table 13 includes preliminary data from the Pennsylvania Waste Composition Study. The Table includes estimates for all major material categories addressed in the study, not just those discussed previously in this workpaper. Categories containing materials addressed in this workpaper are shown in bold.

Table 13
Pennsylvania Disposed MSW Composition, and Recovery Rates (Preliminary)

Material	Total	Total Disposed	Residential Tons*	Commercial Tons	Rec. Rate**
Newspaper	**4.42%**	**421,398**	**253,165**	**168,233**	**50%**
Corrugated Cardboard	**8.64%**	**823,194**	**258,316**	**564,877**	**48%**
Office Paper	**3.49%**	**332,776**	**125,034**	**207,742**	**24%**
Magazine/Glossy	2.84%	270,729	163,584	107,145	4%
Polycoated/ Aseptic Containers	0.52%	49,295	24,412	24,883	Not Available
Mixed Paper (Other Recyclable)	5.04%	480,327	245,131	235,196	38%

Material	Total	Total Disposed	Residential Tons*	Commercial Tons	Rec. Rate**
Other Paper (Non-recyclable)	11.75%	1,119,226	622,864	496,362	0%
#1 PET Bottles	**1.03%**	**98,503**	**51,688**	**46,815**	**17%**
#2 HDPE Bottles	**0.89%**	**85,197**	**51,924**	**33,273**	**21%**
#3-#7 Bottles	**0.18%**	**17,355**	**8,597**	**8,758**	**Not Avail.**
Expanded Polystyrene	**0.84%**	**80,267**	**39,056**	**41,211**	**2%**
Film Plastics	**6.21%**	**592,004**	**282,931**	**309,073**	**1%**
Other Rigid Plastics	3.82%	363,647	156,510	207,137	2%
Clear Glass Containers	**1.43%**	**135,966**	**87,788**	**48,178**	**34%**
Green Glass Containers	**0.37%**	**35,386**	**21,106**	**14,280**	**31%**
Amber Glass Containers	**0.65%**	**61,869**	**40,276**	**21,594**	**29%**
Other Glass	0.37%	34,861	16,476	18,384	6%
Steel Cans	**1.26%**	**120,219**	**81,118**	**39,101**	**52%**
Aluminum Cans	**0.55%**	**52,519**	**33,046**	**19,473**	**48%**
Other Ferrous	2.65%	252,186	92,019	160,167	67%
Other Aluminum	0.58%	55,166	29,293	25,873	31%
Other Non-Ferrous	0.33%	31,168	13,115	18,053	68%
Yard Waste- Grass Clippings	**1.00%**	**95,185**	**74,196**	**20,989**	**Not Available**
Yard Waste- Other	**2.49%**	**237,318**	**183,024**	**54,293**	**56%**
Wood- Unpainted	3.49%	332,233	67,292	264,941	22%
Wood- Painted	1.72%	163,620	65,728	97,892	Not Available
Food Waste	**14.35%**	**1,366,734**	**737,233**	**629,501**	**5%**
Textiles	4.30%	409,830	232,700	177,130	3%
Diapers	3.00%	286,218	174,835	111,383	0%
Fines	1.34%	127,187	80,767	46,421	0%
Other Organics	1.74%	165,575	113,372	52,203	0%
Brown Goods	1.36%	130,027	51,240	78,786	2%
Carpet	1.86%	177,437	55,815	121,621	0%
Drywall	0.67%	63,816	26,120	37,696	0%
Other C&D	2.10%	200,366	85,104	115,263	0%
HHW	0.46%	44,104	23,732	20,371	7%
Other Inorganics	2.24%	213,794	108,393	105,401	0%

* Tonnage estimates for residential and commercial waste by material type based on a theoretical split of residential to commercial waste equal to 50-50, and actual sampling results of waste in each generator category.

** Recovery Rate is based on 1999 data – the latest year for which detailed recovery data is available.

The above data was examined to determine which materials comprise a relatively large portion of the disposed waste stream (greater than 2.75 percent) and have known

recycling potential (are currently being recycled in Pennsylvania or in other geographic locations). The result of this analysis was selection of the following materials, listed in the order of their prevalence in Pennsylvania's municipal solid waste stream. The materials on this list are believed to offer the greatest additional waste diversion potential through enhancement of recovery, processing, and end use programs and infrastructure. Materials that were not specifically addressed in this workpaper are underlined.

- Food waste – 14.4%;
- Corrugated cardboard – 8.6%;
- Film plastic – 6.2%;
- Mixed paper – 5.0%;
- Old newspaper – 4.4;
- Textiles – 4.3%;
- Other rigid plastics – 3.8%;
- Office paper – 3.5%;
- Leaf and other yard waste – 3.5%;
- Unpainted wood – 3.5%; and
- Old magazines – 2.8%.

Food waste is the largest portion of the disposed waste stream – over 14 percent by weight. The amount being disposed from the residential waste stream is estimated to be slightly higher than that being disposed from the commercial sector. While some surplus food is collected through food banks and rescue programs, there is not an established infrastructure for recovering, processing, or making use of food waste in Pennsylvania.

Corrugated cardboard (OCC) comprises the next largest portion of the disposed waste stream – nearly 9 percent, by weight, of all materials disposed. This is in spite of the fact that nearly half of the OCC generated is already recovered for recycling in the Commonwealth. Over twice as much OCC is estimated to be disposed by non-residential, versus residential sources. Since end markets already exist, expansion of the infrastructure to capture additional supply, particularly from smaller quantity generators, is needed.

Film plastics also account for a relatively large portion of the overall waste stream disposed – just over 6 percent. Slightly more of this material is being generated in the commercial sector (shrink wrap, for example) than the residential sector (generally grocery sacks). Film plastics have a low recovery rate -- estimated at only 1 percent. The infrastructure for recovering and processing film plastics needs further development, and local markets for film plastics could be enhanced.

Despite the fact that *old newspapers* have many end markets (both locally and regionally), and that the infrastructure for collecting ONP is widespread throughout Pennsylvania, an estimated 421,400 tons, or over 4 percent of the waste stream, was estimated to be disposed in 2000. Over half of this material is estimated to be from

residential sources; hence enhancement of the residential collection infrastructure appears to be needed.

Office paper is estimated to comprise approximately 3.5 percent of the disposed waste stream, representing nearly 333,000 tons in 2000. More than 60 percent of the office paper is estimated to be generated by non-residential sources. Processors and markets exist for office paper, but the infrastructure for collecting this material, particularly from smaller quantity generators and residential sources, could be developed further.

Leaf and other yard waste also comprise approximately 332,500 tons or 3.5 percent of the waste stream, when one combines the Grass and Other Yard Waste figures in the table above. Based on the waste stream composition data, the vast majority of this material comes from residential sources and is under-recovered in Pennsylvania, relative to its ultimate diversion potential. Additional processing and market development activities will also be needed, however, if this potential is to be realized.

The following three materials were omitted originally from those addressed in this workpaper, primarily because they are not specifically targeted by existing Pennsylvania policy. However, their prevalence in the waste stream and recycling potential suggests that they deserve some mention herein. Comments presented below with respect to infrastructure/program development needs should be considered preliminary, given that these materials were not studied in depth.

- *Mixed paper* comprises approximately 5 percent of Pennsylvania MSW disposed, in spite of a current estimated 38 percent recycling rate – equaling approximately 480,000 tons. The source of this material is fairly evenly split between the residential and commercial sectors. End markets exist for this material, although its relatively low value limits the distance that mixed paper can be economically transported. There is growing interest among paper mills in increasing their use of this grade as global fiber demand grows and the availability of virgin fiber sources continues to decline. To divert more this material from disposal, the collection and processing infrastructure for both residential and nonresidential sources would need to be expanded.
- *Textiles* account for nearly 4 percent of the disposed waste stream – nearly 410,000 tons. Slightly more than half of the textiles disposed are from residential sources. Examples of such textiles include used clothing draperies and linens, and footwear. Processors and end users already exist for textiles. The collection infrastructure for textiles from both residential and non-residential sources appears to need further development. Access to existing markets may be an issue, particularly with respect to export markets. Local market development opportunities may also merit exploration.
- *Other rigid plastics* comprise approximately 4 percent of total MSW disposed. These plastics include items such as margarine tubs, medicine bottles, and toys. They are made from a variety of resin types as opposed to one particular type of plastic, making them difficult to identify, sort, process and market. Consequently, most recycling programs do not accept these plastics, nor do most end users.

- *Unpainted wood* comprises approximately 3.5 percent of the disposed waste stream, or about 333,000 tons in 2000. Close to four times as much unpainted wood waste is generated by non-residential versus residential sources – primarily from the construction and demolition sector. The collection, processing, and end use infrastructure for this material needs further development, if this material is to be successfully diverted from disposal.
- *Old magazines* (OMG) constitute a relatively large portion of the disposed waste stream, at slightly less than 3 percent. OMG has relatively strong market demand, and is often sought by newsprint mills as a source of clay for their deinking process. The collection and, to a lesser extent, processing infrastructure for this material needs further development.

Based on the preliminary waste composition data, Act 101 materials that are not prevalent in the municipal solid waste stream (comprise less than 2.75 percent by weight of the total waste stream) are as follows: green, amber, and clear glass containers; mixed color glass; aluminum cans; steel cans; plastic containers coded #1-7; and expanded polystyrene. Of these materials, only one appears to have insufficient demand to consume the amount of material generated. This material is mixed color glass cullet. All glass containers combined comprise only 2.45 percent of the disposed municipal solid waste stream. However it is recognized that mixed color cullet may be in stockpiles awaiting determination of a viable end use and may not be reflected in these numbers. For this reason, some focus on the development of markets for mixed cullet may be appropriate and beneficial.

One material, electronics, was addressed in this report that is not an Act 101 material and is not prevalent in the waste stream, but is problematic to dispose. It does not appear that markets are needed for this material; rather, a supply and processing infrastructure needs to be created to supply the existing marketplace.

Table 14 summarizes R.W. Beck's conclusions regarding materials that are suitable targets for further waste diversion efforts, based on data available to date, and where program/infrastructure development work is most needed. It is important to keep in mind that no material would appear on this list if it had high market value. Toward this end, any means that can be found to increase the value of a material in the marketplace, or to reduce the cost of moving it into the marketplace, will stimulate recovery and recycling of the material.

Furthermore, knowing that materials are prevalent in the waste stream and have recycling potential is not the sole basis for deciding where efforts should be focused. The following are just some of the factors that must also be considered:

- Extent to which collection and processing infrastructure already exists;
- Feasibility of developing or enhancing collection and processing infrastructure;
- Value of the material;
- Outlook for end markets for material;
- Potential to develop end markets in Pennsylvania;

- Extent to which end markets would have a positive economic impact;
- Other environmental benefits to be gained by boosting recycling (e.g. reduced energy consumption, air pollution, etc.)

Table 14
Recycling Infrastructure Development Needs

Material	Collection Infrastructure Development Needed	Processing Infrastructure Development Needed	End Market Development Needed
Materials Examined for this Study:			
OCC	X – Commercial sector		
Newspaper	X – Residential sector		
Office Paper	X - Commercial sector		
Film Plastics	X – Commercial sector		X
Leaf and Other Waste	X – Residential sector	X	X
Surplus Food	X – Commercial and residential sectors	X	X
Mixed Color Glass Cullet		X	X
Electronics	X – Residential and commercial sectors	X	
Materials not Examined for this Study:			
Mixed Paper	X – Residential and commercial sectors	X	
Textiles	X – Residential and commercial sectors		X
Other Rigid Plastics	X – Commercial sector	X	X
Unpainted Wood	X – Commercial sector	X	X
Old Magazines	X – Residential sector	X.	

Lastly, not all recycling market development efforts should be targeted at specific materials. For example, it is also appropriate and beneficial to undertake work that addresses cross-material barriers, or that assists entrepreneurs with launching new businesses that create jobs while consuming materials that may already have markets. Barriers and opportunities for recycling market development are the focus of a separate workpaper as part of the Pennsylvania Recycling Markets Center Study.