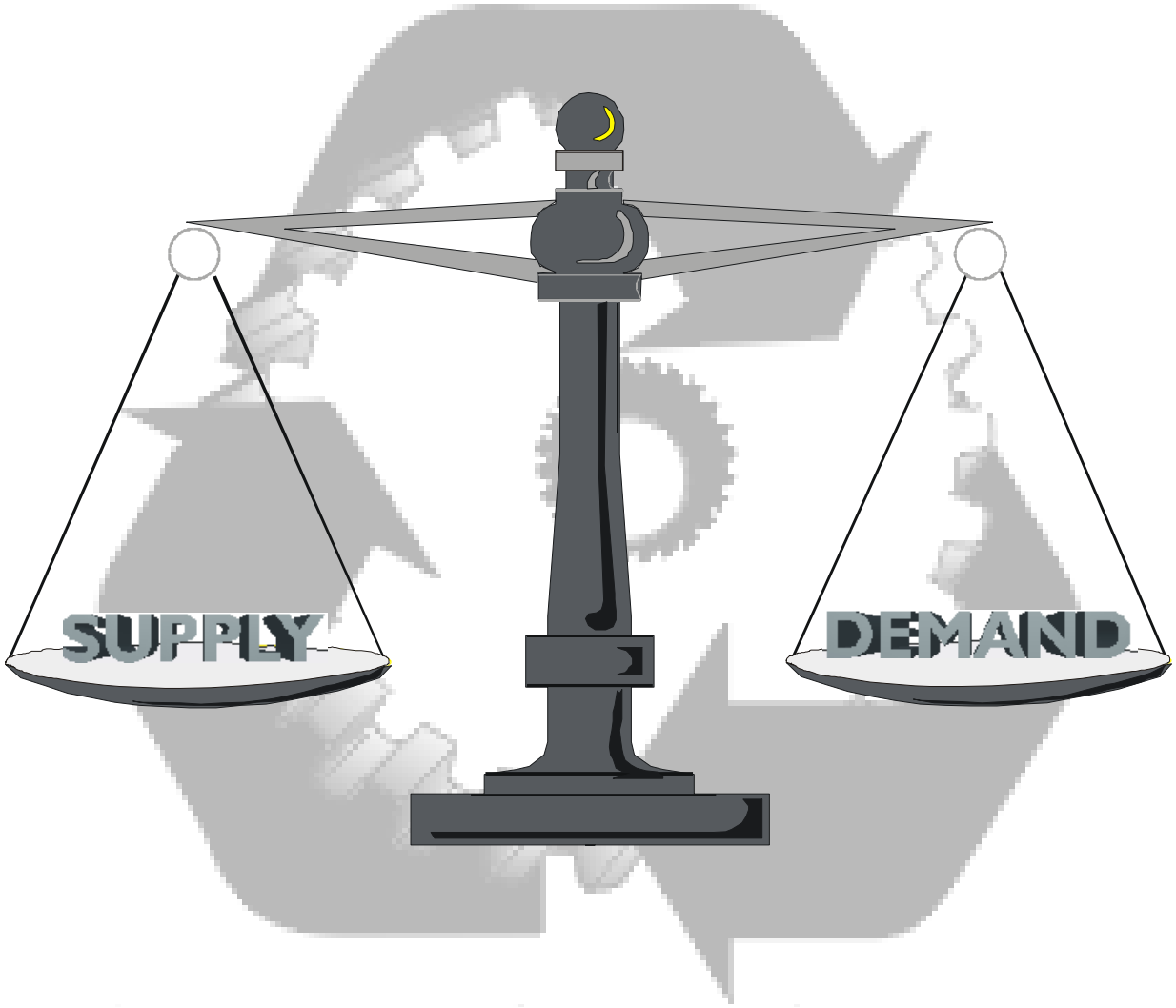
1998

NORTH CAROLINA Markets Assessment

OF THE RECYCLING INDUSTRY AND RECYCLABLE MATERIALS



N.C. DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Division of Pollution Prevention and Environmental Assistance
Recycling Business Assistance Center

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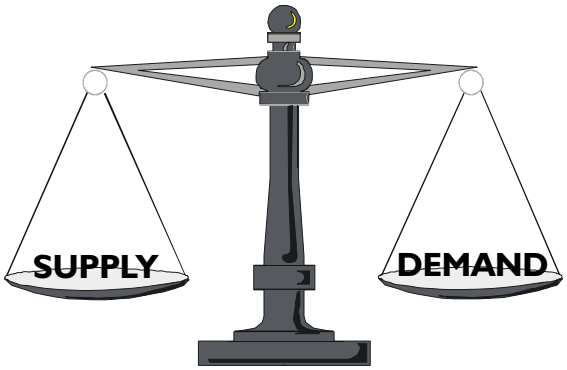

This document was prepared by the North Carolina Department of Environment and Natural Resources' Division of Pollution Prevention and Environmental Assistance.

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Introduction

This Assessment of the Recycling Industry and Recycling Materials in North Carolina is the third analysis of the recycling industry conducted by the State of North Carolina. The assessment characterizes North Carolina's waste stream for 1997 and 2002 and focuses on supply and demand for 26 recyclable materials. It also discusses trends and highlights changes that have occurred during the years.

The first assessment, conducted in 1991 by the N.C. Department of Economic and Community Development (now the Department of Commerce), provided analyses of the recyclable materials and composting market systems within the state. The second assessment expanded the scope and range of the previous study and was conducted in 1994

by the N.C. Department of Environment, Health and Natural Resources (now the Department of Environment and Natural Resources, or DENR).[1] These analyses provide a foundation for the recycling market development efforts of the Division of Pollution Prevention and Environmental Assistance (DPPEA).

The 1998 assessment follows the general framework established in the previous assessments, including in-depth analyses of multiple commodities, five-year supply / demand projections, and North Carolina and regional supply / demand projections. A new focus on price history has also been incorporated into this assessment including discussion of the factors affecting price history as well as three and five year histories. The data provided were generally taken from Waste Age's *Recycling Times*, which provides ranges of prices for various regions of the country. These data are intended to provide only a general sense of the trend of price fluctuation, and more detailed or accurate price histories may be obtained from commodity-specific sources.

The remainder of the assessment is organized as follows:

Section 2 provides an *Executive Summary* that includes major assessment findings, priorities, and overall recommendations.

Section 3 addresses the components of the municipal solid waste stream in North Carolina. Several breakdowns of the waste stream are presented and an overall recycling rate is calculated. Summary data for all 26 commodities are also presented.

Section 4 comprises the bulk of the assessment. In this section, 26 commodities (representing 12 waste categories) are profiled and presented as stand-alone reports. Each *Commodity Profile* characterizes supply and demand in North Carolina and the region, evaluates the supply / demand relationship, and contains recommendations for balancing any discontinuities between supply and demand.

Section 5, entitled *Findings / Recommendations*, summarizes the results of the analyses of all commodities and assigns high, medium or low priorities to each waste category. This section also presents overall recommendations, which arise from more than one commodity or address toxicity issues for specific commodities (such as used oil filters and electronics).

[1] North Carolina General Statutes and a Memorandum of Understanding between the DOC and DENR directed DENR's Division of Pollution Prevention and Environmental Assistance (DPPEA) — formerly the Office of Waste Reduction — to prepare these assessment by March 1, 1994 and every other year thereafter.

Executive Summary

This Assessment of the Recycling Industry and Recycling Materials in North Carolina is the third analysis of the recycling industry conducted by the State of North Carolina. The assessment characterizes North Carolina's waste stream for 1997 and 2002 and focuses on supply and demand for 26 recyclable materials. It also discusses trends and highlights changes that have occurred during the years and provides a foundation for North Carolina's recycling market development efforts.

The 1998 assessment follows the general framework established in the previous assessments, including in-depth analyses of multiple commodities, five-year supply / demand projections, including North Carolina and regional supply / demand

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The 12 categories and 26 Commodity Profiles developed for this assessment include:

- Construction and Demolition Debris
- Electronics
- Glass
- Metals
  - Aluminum Cans and Scrap
  - Steel Cans and Scrap
- Oil-Related
  - Used Oil
  - Used Oil Filters
- Organics
  - Food Residuals
  - Yard Wastes
- Paper
  - Old Corrugated Cardboard (OCC)
  - Old Newspaper (ONP)
  - Old Magazines (OMG)
  - Office Paper
  - Mixed Paper
- Plastics
  - PET (#1)
  - HDPE (#2)
  - PVC (#3)
  - L/LDPE (#4)
  - PP (#5)
  - PS (#6)
- Textiles
  - Carpet
  - Post-Consumer Textiles
- Tires
- White Goods
- Wood
  - Wooden Pallets
  - Wood Residues

FINDINGS

Nearly 12 million tons of municipal solid waste were generated in North Carolina in 1997, and eight million tons were disposed. C&D debris made up the largest component of the disposed waste (29 percent), and paper made up another 18 percent. Organic materials comprised about 12 percent of the waste stream, and wood made up 11 percent. All other materials each comprised 10 percent or less.

A conservative estimate of the total tonnage of material recycled in 1997 is 4.1 million tons, which yields a 34 percent recycling rate. The last time the statewide recycling rate was calculated, in 1995, it was estimated at 22 percent (2.1 million tons recycled and 7.6 million tons disposed).

The recycling rates for specific commodities vary. Container recovery rates tend to be low, especially for plastics. Although the paper recovery infrastructure is well established, there is still room for growth in many grades, especially magazines, mixed and office paper. Some other materials are virtually untouched in terms of recycling potential, including C&D, electronics, food residuals, most plastics, and textiles.

Despite limited recovery in some categories, the 1998 assessment found a thriving industry that continues to grow and change. The past several years have seen the introduction of new technologies, expansion of collection systems, and considerable fluctuations in foreign and domestic economic cycles. In addition, recycling companies (both processors and end users) are consolidating in many sectors.

Since the last assessment was conducted, North Carolina has provided business management, technical and financial assistance to 608 businesses. In that period, 185 jobs were created and $5.05 million were invested. The total volume of new capacity created was 217,000 tons per year. More than half of that capacity was construction and demolition (C&D) debris processing.

Another significant development since the last industry assessment is the inception of a recycling business loan fund, supported by the N.C. Department of Environment and Natural Resources (DENR), the U.S. Environmental Protection Agency (EPA), and the Self-Help Ventures Fund (Self-Help). This fund will be administered by Self-Help, and the project will offer at least $660,000 in loans to recycling businesses. These loans are expected to create or retain at least 80 jobs, provide 115,000 tons per year of recycling capacity, and leverage an additional $330,000 of private investment.

PRIORITIES

The ultimate goal of this assessment is to chart the state's current recycling course and to identify where market development assistance is needed to stimulate gains in recov-

ery. As a result of the analyses of 26 commodities in 12 categories, each commodity has been assigned a priority for action.

High priority commodities typically warrant immediate market development assistance and offer opportunities for infrastructure and market development that justify the application of technical, financial, and policy resources. They also often constitute a significant and growing portion of the waste stream or pose potential environmental and health threats due to toxicity. Medium priority commodities require more limited assistance and tend to constitute a smaller portion of the waste stream. Low priority commodities have mature markets and typically do not require action from the state. The recyclable materials analyzed are divided into high, medium and low priorities, and are described in the following sections.

High Priority Materials

C&D debris (e.g., wood, wallboard, concrete, brick, etc.) needs market development assistance. C&D debris represents about a third of North Carolina's waste, yet recovery efforts are limited, primarily because recovery in the state has been focused on other materials and the incentives for disposal diversion have been low. In addition, this portion of the waste stream has only recently been characterized. A variety of activities could stimulate recovery and demand, including state support of demonstration projects and recycled content procurement standards, respectively. The State should continue to identify and assist entrepreneurs that are processing various C&D materials and help expand or replicate those operations around the state. In addition, local governments should be encouraged to establish recovery operations by contract with C&D recovery firms or through their own operations.

The compost market, which represents demand for **food residuals** and **yard waste**, is still developing and needs assistance. While the demand for yard waste appears to meet the available supply, efforts are needed in several areas to improve the recovery of food residuals. Demand for recovered edible foods, animal feeds and food residuals-based compost appears adequate to significantly increase the diversion rate. Developing efficient collection and processing techniques could stimulate recovery, and efforts to increase market awareness of the benefits of compost and mulches would further strengthen demand.

Although most **paper** markets are mature, recovery rates in North Carolina are below national averages, even for higher value papers such as office grades and old corrugated containers (OCC). For this reason, the state should support the development of infrastructure to improve recovery efficiency and rates. For example, recovery of OCC and office paper could be increased by encouraging the creation of mixed commercial paper routes and focusing on small retail / commercial generators. Encouraging the addition of old magazines to local government collections could increase its recovery rates. There is also room for growth in mixed paper recovery; however, stronger demand is needed to justify increased recovery. Research and demonstration of secondary markets for recovered mixed paper could stimulate demand, as could market development efforts focused on recycled paperboard users.

Despite a landfill ban on used oil, a significant amount of residual oil from **used oil filters** may have entered North Carolina landfills in 1997. According to feedback from recycling companies in the Southeast region, infrastructure and markets for all three components of used oil filters are sufficient to justify a disposal ban.

Wood residues and to a lesser extent **pallets** are among the most promising materials in the state in terms of potential for increased diversion. The demand for industrial wood residues in particular appears to be greater than the supply. Primary manufacturers have well-established markets for their residues and achieve high recovery rates. In contrast, secondary wood products manufacturers must process their residues into marketable form. By increasing recovery in the latter sector, North Carolina could reduce materials being landfilled by four percent. In addition, a higher recovery and diversion of pallets will be an important part of the overall management of wood resources in the state.

Medium Priority Materials

Although increasing quantities of **computers and other electronics** are being generated in North Carolina, recovery options are just developing. Existing efforts tend to be limited to larger businesses, leaving small businesses and households without recycling options. Increasing the quantity of electronic equipment recovered from these sectors would require substantial funding from local, state, or federal governments. Pilot projects might offer a chance to examine the economics of local collections. Additionally, the state should develop a formal disposal policy for electronics because of the potentially hazardous components.

Plastics should be targeted for market development assistance; however, limited actions can be taken by the state. Virgin price supports for plastic are very complex, because oil is the raw material; therefore, state actions are generally limited to encouraging the purchase of recycled content plastic products. Recycling is projected to increase 10 percent annually during the next several years, and high-density polyethylene (HDPE) and polyethylene terepthalate

(PET) will remain the dominant recycled resins due to their predominance in the bottle marketplace as well as their ease of collection and separation. State and local agencies could also stimulate recovery by targeting generators of linear / low density polyethylene (L/LDPE).

The **used oil** market requires limited immediate assistance from the state. Based on the current indications of strong demand, North Carolina has an opportunity to recover much of the remaining used oil throughout the state. In particular, the state should focus on increasing the recovery of used oil from the do-it-yourself sector. An advance disposal fee on motor oil purchases could be used to help finance collection.

Low Priority Materials

Color-separated **glass** is a mature market and warrants little or no immediate attention from the state. The supply of processed flint and amber cullet in North Carolina and the southeast is well below the potential demand. Without significant efforts to increase supply, this trend is expected to continue to 2002 and beyond. On the other hand, demand for green cullet is likely the same as supply and most likely will not deviate from this pattern to 2002. It appears overall that the focus of the glass industry is on improving the quality of the current supply rather than increasing quantity. Efforts to increase the markets for mixed cullet and to encourage more efficient handling of collected glass should be investigated.

Aluminum cans, or used beverage containers (UBCs), are a stable market warranting little attention from the State. Demand for UBCs and other aluminum scrap remains strong enough for the material to be recycled by local governments and private industry. An increase in UBC recovery statewide depends more on improved collection efficiency than increased capacity or markets for the material. Markets for other scrap, such as **steel cans**, will need assistance to fulfill the potential for growth. The demand for steel can scrap continues to exceed the supply both nationally and locally, and the ability to increase steel can recycling is not dependent upon future capacity increases. Recycling businesses have an opportunity to capture additional materials, with approximately 90 percent of the supply of steel cans remaining in the waste stream. However, market prices will continue to be negatively affected by the global economic downturn.

Post-industrial **textiles** are a mature market and warrant little or no immediate attention from the State. Post-consumer textiles are not as well established and may justify limited assistance in the form of grants to local governments. The textile recycling industry is currently struggling with low demand (because of the global market situation), which may limit expansion of local government collection efforts in the short-term. **Carpet** recycling programs are developing rapidly, and infrastructure will need to be developed to meet this demand. The key to increasing carpet recovery lies in establishing the collection infrastructure. At present, this is primarily a private sector effort.

The recently established program of **tire** end-use grants represent a major investment by the State in tire market development, and no additional assistance is needed at this time.

Sufficient market capacity exists for the consumption of all **white goods** generated in North Carolina and its border states today and through the year 2002, assuming that the percentage of steel in white goods is not displaced by other, less recyclable materials. Although no additional assistance is needed at this time, continuing the North Carolina White Goods Management Program is an important strategy for the foreseeable future.

OVERALL RECOMMENDATIONS

The following recommendations are based on the study of supply and demand in North Carolina for the 26 commodities analyzed in this assessment. Commodity-specific recommendations can be found at the end of each commodity report.

Policy Recommendations

The following policy recommendations would stimulate recovery and/or demand for recycled materials in North Carolina.

- Implement disposal bans for recyclable materials with well-established collection infrastructure and strong market demand, such as pallets, used oil filters, and OCC.
- Expand procurement of recycled and environmentally preferable products by state and local governments in order to support stabilized, long-term demand for recycled products. This assessment identified the following commodities as candidates for purchasing targets for both state and local governments: carpets, C&D materials, electronics, newsprint, office paper, oil, and wiping cloths.
  Fund and implement the oil and oil filter initiatives outlined in North Carolina General Statutes 130A-309.16 and 309.21-22 and in the 1992 state solid waste management plan.
- Develop an enforcement policy for items contain-

ing cathode ray tubes, such as computer monitors and televisions.

Programmatic Recommendations

The following programmatic recommendations would stimulate recovery and provide data that would enable informed waste management decisions.

- Gather additional data on specific waste streams to enable informed decision-making. Limited data were available for several of the commodities that comprise significant portions of North Carolina's waste stream: C&D debris, food residuals, wood residues, vegetative debris in land clearing and inert debris facilities, and commercial / industrial textiles.
- Enhance local government program efficiency to increase recovery. To increase the quantity of recyclable materials collected throughout the state, equitable, waste reduction-based collection systems such as pay-as-you-throw should continue to be encouraged. Additionally, market analyses have identified the following materials as candidates for local programs: mixed paper (also referred to as RMP), old magazines, OCC as part of an RMP or office mix, textiles, and steel cans.
- Target the small retail / commercial sector to increase material capture and program efficiency. Include materials commonly generated by this sector with relatively stable markets, such as OCC, office paper, steel cans, and glass.
- Increase plastics recovery through incentives and promotion of recycled product procurement. In general, the State should consider increasing the availability of financial incentives, including grant funding for capital purchases that improve collection efficiencies and economic development incentives for end-users, to enhance PET / HDPE / LDPE and polypropylene (PP) recovery and use.
- Continue to educate government, business, industry and the public on the need for and benefits of recycling.
- Continue to promote source reduction and encourage state and local governments to show leadership in this area.

Commodity Profiles

Construction & Demolition

Construction & Demolition

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

Construction and demolition (C&D) debris is defined as "waste or debris resulting solely from construction, remodeling, repair, or demolition operations on pavement, buildings, or other structures."

Construction, renovation, and demolition jobs produce varying quantities of the following materials:

- Wood (clean scrap lumber)
- Brick and block (aggregates)
- Wood (painted or treated)
- Gypsum wallboard
- Manufactured wood (plywood, etc.)
- Cardboard
- Miscellaneous fines
- Asphalt shingles (scrap or tear-off)
- Metals (pipes, wire, conduits, structural beams, etc.)
- Asphalt pavement
- Miscellaneous plastics (PVC, HDPE, etc.)
- Land clearing debris
- Concrete (with and without re-bar)
- Salvageable materials (i.e., windows, doors, fixtures, etc.)

This commodity profile characterizes the overall C&D waste stream in North Carolina. Information pertaining to the recovery of road construction, repair, and demolition debris is presented separately from building-related C&D debris in this report. Limited data were available on the total generation of road debris. Thus, it could not be added to the generation figures for building-related C&D debris, although it is likely a large component of the overall C&D waste stream. Available information pertaining to road de-

bris generation, recovery, and markets is presented first, followed by the analysis of building-related C&D debris.

Land clearing debris is not included in this report. Although it is sometimes considered to be a component of the overall C&D waste stream, and some of the material is disposed in landfills, little information exists on the quantity of the material generated or the amount of material recovered nationally or in North Carolina.

Approximately 2.5 million tons of building-related C&D debris were generated in North Carolina during 1997. This represents approximately 25 to 30 percent of the total waste stream. A majority of that material was disposed in municipal solid waste landfills (MSWLFs), construction and demolition landfills (C&DLFs), and land clearing and inert debris landfills (LCIDLFs). Because of difficulty in accurately determining the amount of C&D wastes entering these disposal facilities, other methods were used to estimate generation.

The estimated recovery for 1997 was approximately 153,000 tons, or roughly six percent of the C&D waste stream. Salvage and reuse activities at demolition/deconstruction job sites comprised a majority of recovery. Additional recovery was recorded by several mixed C&D debris processing facilities.

The supply of C&D debris is considerably greater than the current demand from C&D recyclers in North Carolina. C&D debris recycling is based on cost-avoidance (i.e., a reduced tipping fee) and not revenue generation. Thus, the quantity of C&D debris recovered is directly related to the cost of disposal. In areas of the country where landfill tipping fees are significantly higher, more material is being diverted. However, in North Carolina where tipping fees average $24 per ton for C&D landfills, there is less incentive for C&D recycling. A majority of C&D debris continues to be disposed in North Carolina's abundant and relatively inexpensive landfills.

To improve markets for C&D debris, a greater recycling infrastructure needs to be developed. In doing so, cost-effective means for diverting more of the materials should be emphasized, so that recovery operations are competitive with landfill disposal costs.

Road Construction, Repair, and Demolition Debris

Road debris results from the construction, maintenance, repair, or demolition of public and private road systems, bridges, parking lots, and driveways. Debris produced at these jobs primarily consists of asphalt pavement and concrete and includes land-clearing debris, metals, and a variety of aggregates.

SUPPLY

Generation

No information was available on the total amount of road debris generated nationally or locally. Generation figures are difficult to estimate, due to the durability and relatively long lifetime of materials. Additionally, fluctuations in the amount of roadwork completed year to year changes the annual quantities of debris generated. The amount of road work completed is affected by factors such as state and federal funding, weather and weather related disasters, the quality of materials used in the construction of a road, and the quality of maintenance throughout its life-cycle.

Recovery

Materials generated from road projects are either directly reused on-site, transported to central collection and recycling facilities, or disposed in MSWLFs, C&DLFs, or LCIDLFs. Because of reduced disposal costs at LCIDLFs, it is likely that these landfills are most frequently used for road material disposal.

Only one study found attempted to quantify the total amount of all road debris recovered nationally. According to this study, 81 aggregate processors throughout the United States recovered approximately 104 million tons of aggregates during 1997.[1]

When the asphalt pavement portion of road debris is considered separately from concrete, the quantity of material recovered can be estimated. According to the Carolina Asphalt Pavement Association, in 1997 its members produced a total quantity of 12.5 million tons of asphalt pavement, representing an estimated 95 percent of the total market in North Carolina.[2] According to a separate source, approximately 15 percent of recycled asphalt pavement (RAP) is used in the production of new hot mix asphalt pavement.[3] Thus, approximately 1.9 million tons of RAP were used. Because almost all asphalt pavement is recovered, it can be assumed that 1.9 million tons is close to the total quantity of asphalt pavement debris produced per year in North Carolina.

A survey of several mobile aggregate processors in North Carolina identified approximately 325,000 tons of con-

crete and other aggregates being recovered. Some materials were processed on-site, and other materials were processed at LCIDLFs. LCIDLFs are allowed to contain a certain portion of building related C&D debris, thus it cannot be assumed that 325,000 tons of road debris was recovered. Additionally, no data were available on the total generation of concrete debris to compare to these recovery figures.

With large public highway construction, repair, or demolition projects, a significant portion of the resulting asphalt and concrete materials are reused on-site because of cost savings over virgin materials. According to the North Carolina Department of Transportation (NCDOT), limited amounts of material are disposed during major highway projects. Most concrete is left untouched when repairing highways. Top layers of asphalt are milled or scraped off roads, then either are directly reapplied using special machinery or transported to an asphalt batch plant to be reprocessed. In cases where roads need to be demolished and moved, NCDOT contractors are required to prevent materials from being landfilled. No information was available on the total amount of material recovered from private contractors completing road demolition and replacement projects on state highways.[4]

For smaller public and private road projects, however, materials are more likely to be disposed in LCIDLFs. Limited data is available at the state level pertaining to the types and quantities of materials entering LCIDLFs. LCIDLFs are not required to report to the state on the quantity of material entering the facility (as most do not have scales). Without a detailed characterization of incoming materials and quantities entering such facilities, it is uncertain how much road debris is being brought to these facilities.

Markets

Aggregate recycling is most likely to be successful when a mix of the following is favorable: transportation dynamics, disposal and tipping fee structures, resource supply / product markets, and municipal support. Aggregate recycling rates are greatest in urban areas where replacement of [road] infrastructure is occurring, natural aggregate resources are limited, disposal costs are high, or strict environmental regulations prevent disposal.[5]

End products for recycled asphalt, concrete, and other aggregates range from high-end uses such as reclaimed and reprocessed asphalt pavement to lower-end uses such as road base or solid fill. The amount of source separation and processing determines the value of the end product.

- **Concrete:** Source separated concrete can be ground into a relatively high quality aggregate or gravel substitute for use as a road base material. Gravel for use in road construction ranges from approximately $8 to $15 per ton delivered to the site.[6] Aggregates are more expensive in eastern North Carolina where there are less natural aggregates in the coastal plain.

  NCDOT has tested the use of recycled concrete and found that it passes all performance tests. More extensive use of crushed concrete by NCDOT could greatly expand markets for this material.[7] However, North Carolina is a large producer of crushed rock and gravel from quarries. To compete with natural sources, recycled aggregates must be cost-competitive and greater or equal in quality.

- **Asphalt Pavement:** Source separated asphalt pavement can be recycled into a new pavement product. Scrap asphalt or recycled asphalt pavement (RAP) is mixed with virgin materials in percentages ranging from five to 25 percent. Some asphalt-producing companies accept asphalt scrap from their own operations as well as from demolition contractors and other sources willing to deliver it to their facilities.[8] Materials delivered to the site typically are accepted at no charge, provided they are free of other materials. Asphalt pavement reclamation is a well-established practice used mostly by asphalt plants because of cost savings over virgin materials.

Building Related Construction and Demolition Debris

SUPPLY

Generation

Traditionally, the generation of building-related C&D debris was estimated to be around 30 million tons a year nationally. During the past few years this number has come into question, with many C&D experts feeling 30 million was too low. In June 1998 the U.S. Environmental Protection Agency (EPA) released a report concluding that approximately 135 million tons of C&D were generated in the United States in 1996.[9]

Unfortunately, developing a per capita generation figure and applying it to North Carolina's population would significantly overestimate the amount of C&D generated in North Carolina. Although North Carolina is growing rapidly, this

Figure 1. Estimated Generation of C&D debris from Residential Sources in 1997 and 2002 (tons)

Residential	1997	2002
Construction	304,203	322,797
Single-Family Starts	*269,089*	*285,546*
Multi-Family Starts	*35,114*	*37,251*
Renovation	704,053	747,086
Demolition	637,986	676,981
Total Residential	**1,646,242**	**1,746,864**

growth is limited to a few regions of the state. North Carolina is still predominantly a rural state. The generation of C&D, therefore, was calculated on a regional and state level by applying the best numbers available to North Carolina-specific scenarios.

There are two major categories for C&D debris: residential and non-residential. Each category is further divided into three sub categories: construction, renovation, and demolition. This breakdown presents the main types of building activities and allows generation estimates to be developed based on existing data. This section represents an overview of the calculations, assumptions, and methodology used to estimate the generation of C&D debris in North Carolina during 1997.

Estimates for 2002 also are provided in this section, but are not described in detail. All estimates for 2002 are based on current per capita generation applied to North Carolina Office of State Planning population estimates for July 1, 2002. Estimates for 2002, therefore, do not account for future construction practices or unanticipated growth. Unlike many recyclable commodities, the generation of C&D debris is closely linked with local economies and can be quite variable. It is, therefore, unknown if per capita estimates for 2002 will over- or underestimate actual generation.

An overall characterization of C&D debris is provided at the end of this section. Individual characterizations of each category (i.e., residential renovation) are depicted in appendices to this report.

Certain materials were omitted from this report. For example, C&D debris generated from public utilities and military facilities was omitted because of a lack of available data. Thus, generation estimates provided underestimate the total quantity of waste generated from all C&D activities. Limited data were available to estimate the generation of land clearing debris from each activity characterized below; however, because of the wide range of management options available (i.e., open burning, LCID landfills, etc.), these wastes are not discussed in this report and require further investigation.

Residential Construction

Several methods for estimating waste from residential construction starts in North Carolina were considered, including using the value of construction put in place and the actual number of construction starts. Given that the number of construction starts for both single-family and multi-unit structures were available for 1997, this was the method used.

According to the North Carolina Department of Labor (NCDOL) statistics, there were 54,654 single-family starts and 16,074 multi-unit starts during 1997.[10] Multi-unit starts are defined as individual units within a larger building (i.e., a six unit apartment building would represent six starts).

The average square footage of housing units in 1997 was then applied to the starts for each housing category to generate an overall square footage per housing category. The National Association of Home Builders (NAHB) estimates that the average single family house built in 1997 was 2,150 ft^2 and the average multi-family unit was 1,095 ft^2.[11]

Using empirical data obtained from EPA, generation of waste was estimated to be 4.58 lbs./ft^2 for single-family construction and 3.99 lbs./ft^2 for multi-family construction. Applying these figures to the estimated square footage resulted in an estimated total generation of 304,203 tons of residential construction waste. A more detailed breakdown is provided in Figure 1.

Residential Renovation

Debris generated from the renovation of residential and non-residential buildings is perhaps the hardest component to estimate. For purposes of this assessment, renovation debris is defined as debris generated from the renovation, improvement or repair of structures. Renovation debris commonly consists of debris generated from both con-

struction and demolition activities, but is considered an individual category. For example, replacing a wooden deck would generate debris from the deck's demolition, as well as debris from the scrap materials in constructing the new deck. All wastes generated during this deck replacement would be considered renovation debris. Renovation projects also range greatly in size, cost, and waste generated. Because of do-it-yourself projects and the small scale of some improvements, it is difficult to track renovations through standard permitting records.

Because of these constraints, a method similar to that used by the EPA was used to estimate North Carolina generation. A conversion factor of 0.56 lbs. of waste generated per dollar of renovation (in 1996 dollars) was developed based on EPA's recent characterization.[12] This conversion is based on EPA's total estimate of waste generated from residential renovations in 1996 divided by the total dollar spent on such renovations.

Data from the U.S. Department of Commerce (USDOC) was then used to estimate the value of residential improvements and repairs for North Carolina.[13] These data were available only for the "South Region" and were extrapolated to represent North Carolina based on population.[14] This figure was then deflated three percent to 1996 dollars, representing just more than $2.5 billion.[15] Applying the conversion factor (0.56 pounds per 1996 dollar) provided a generation estimate of 704,053 tons of renovation debris in 1997 (Figure 1).

Residential Demolition

The generation of residential demolition debris was estimated twice during this assessment based on two separate estimates for the number of residential demolitions occurring in North Carolina. Rather than choose one estimate over the other, both estimates were averaged and the subsequent average was used as the best estimate.

The first estimate of the number of demolitions occurring in North Carolina was based on USDOC data for the "South Region" and includes demolitions caused by disasters. This resulted in the "South Region" having a disproportional number of demolitions. In this case, the "South Region" represented 36 percent of the population, but accounted for 45 percent of all residential demolitions. Although all states included in the "South Region" are prone to disasters, several states, other than North Carolina, were more prone to severe destruction from disasters than the majority of the states. Therefore, it was assumed that directly using the estimate obtained from the USDOC would overestimate the number of demolitions in North Carolina. Extrapolating for North Carolina, it was found that 9,085 residential demolitions occurred in 1997.[16] This figure is based on the average number of demolitions occurring between 1980 and 1993 and assumes the average over time is relatively constant.

The second estimate was derived from EPA's characterization, indicating there were 245,000 intentional demolitions (not disaster related) per year in the United States.[17] Extrapolating based on North Carolina's population resulted in 6,811 demolitions per year. This number, however, underestimates the number of demolitions occurring in the state due to the lack of any disaster related demolitions.

The two estimates were averaged to develop an estimate that accounted for, but did not overestimate, disaster-related demolitions. The resultant average of the two estimates equated to 7,948 residential demolitions per year. Based on EPA estimates, it was assumed that the average demolition in 1997 was 1,396 ft^2 and generated 115 pounds of waste per square foot.[18] Applying these data to the averaged North Carolina demolition estimate resulted in a generation estimate of 637,986 tons of residential demolition debris in 1997. The estimated generation of C&D debris from residential sources in 1997 and 2002 is reported in Figure 1.

Non-Residential Construction

Similar to residential construction, several methods for estimating non-residential construction waste generation figures were considered. Because it would be difficult to characterize the average size of a non-residential building constructed during 1997, it was decided that non-residential construction starts did not provide adequate information to estimate construction waste generation. Estimating the generation based on the value of construction put in place in 1997 was chosen as the most appropriate method.

Although statistics for the value of construction put in place were available from both the State of North Carolina and the USDOC, numbers from the latter were used because DOC provided statistics on public construction (i.e., schools, government buildings, etc.). The USDOC data also provided a more detailed breakdown of all non-residential construction.

Applying national data within the context of one state, however, created a problem. To accurately apply national statistics at the state level, a growth factor was developed based on residential housing starts. It was assumed that residential and non-residential construction are directly related (i.e., if residential construction is occurring at a rate greater than the national average, non-residential construction is likely occurring at a similar rate). Using detailed NCDOL statis-

Figure 2. Estimated Generation of C&D debris from Non-Residential Sources in 1997 and 2002 (tons)

Non-Residential	1997	2002
Construction	163,176	173,140
Renovation	392,496	416,486
Demolition	317,095	336,476
Total Non-Residential	**872,767**	**926,103**

Figure 3. Total Estimated Generation of C&D Debris in North Carolina in 1997 and 2002 (tons)

	1997	2002
Residential		
Construction	304,203	322,797
Renovation	704,053	747,086
Demolition	637,986	676,981
Non-Residential		
Construction	163,176	173,140
Renovation	392,496	416,486
Demolition	317,095	336,476
Total	**2,519,000**	**2,672,967**

tics on the number and value of housing starts in 1997, an overall value for residential construction was developed.[19] This value was then compared to USDOC data on the value of construction nationally in 1997 adjusted to represent North Carolina's population.[20] It was found that the actual value of construction based on North Carolina data was 1.23 times greater than that estimated using national data.

Based on 1.23 times the per capita value of construction, the actual value of construction put in place in North Carolina in 1997 was then estimated to be approximately $7.81 billion dollars.[21] This figure was applied to empirical data obtained from EPA's characterization of C&D debris that estimated an average non-residential construction cost of $93.12 per square foot in 1997 dollars and an average generation of 3.89 pounds of waste per square foot. This resulted in an overall generation estimate of 163,176 tons.[22] Figure 2 provides generation estimates for 1997 and 2002.

Non-Residential Renovation Debris

The generation of non-residential renovation debris, which includes improvements and repairs, was estimated in a similar manner to residential renovation debris. Since it is believed that most non-residential renovations can be identified through permit records, NCDOL statistics were used to determine the value of non-residential renovations.[23] It was found that non-residential renovations cost slightly more than $1.4 billion in 1997. Compared to the value of residential construction put in place, $1.4 billion appears to be a low estimate. It is likely that the estimated generation of non-residential renovation debris, illustrated in Figure 2, underestimates the actual amount of debris generated. Some material likely is missed in the calculation from unpermitted activities and public renovation projects.

No conversion factor was available to convert the cost of non-residential renovations to pounds of waste. Therefore, it was assumed that residential renovations create a similar amount of waste per dollar as non-residential renovations. The estimate used for residential renovations, 0.56 lbs. per 1996 dollar was used for the conversion. The cost estimate was deflated by three percent to represent 1996 dollars and subsequently applied to 0.56 lbs. per dollar of renovation.[24] This resulted in an estimate of 392,496 tons on non-residential C&D debris generated in 1997 (Figure 2).

Non-Residential Demolition

Records of non-residential demolitions occurring in North Carolina were available from a report by the North Caro-

Figure 4. Sources of All C&D Debris in North Carolina

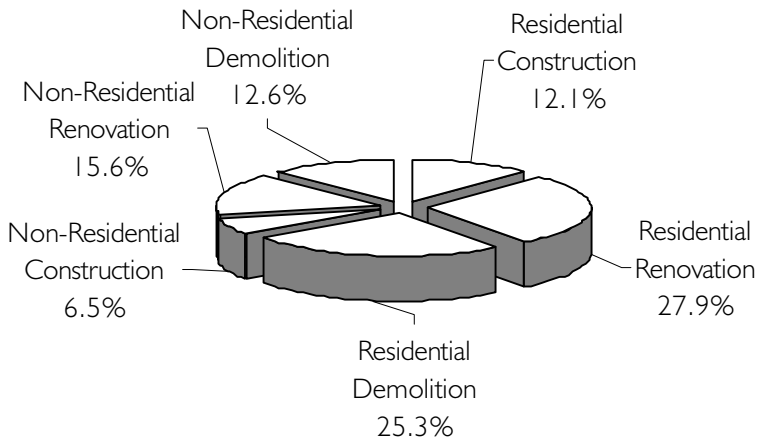
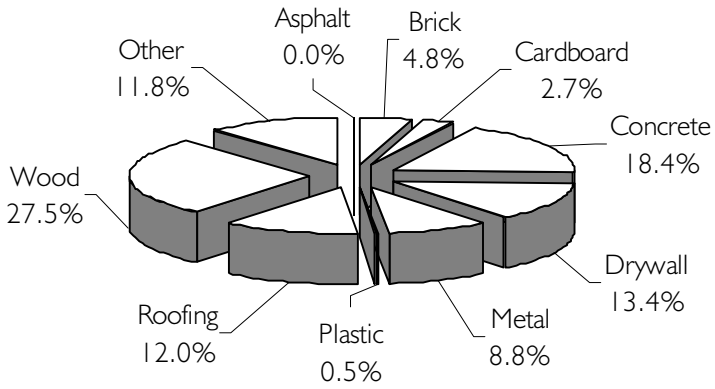


Figure 5. Overall Composition of C&D Debris



lina Division of Epidemiology and were used for estimating generation.[25] In most cases the report provided the square footage of the demolished building. In instances where no square footage was provided, the building was assumed to be 13,300 ft^2 based on EPA estimates.[26] Compilation of this data resulted in a total of 4,091,546 ft^2 demolished in 1997.

The overall square footage then was applied to a U.S. EPA estimated 155 pounds of waste per square foot demolished.[27] As can be seen in Figure 2, this resulted in an estimated 317,095 tons of non-residential demolition debris generated during 1997.

Characterization of C&D Debris

Although the actual composition of C&D debris varies widely with the type of structure and specific C&D activities, the waste stream can be characterized in a very general sense. (To truly understand the C&D waste stream, each aspect of the waste stream should be characterized separately.) Figure 3 provides an overall estimate for C&D generated in North Carolina during 1997 and 2002, and Figures 4 and 5 provide characterizations of C&D debris by source and waste stream components.

About 65 percent of all C&D generated in North Carolina is from residential sources. Debris from residential sources can be further broken down as 18 percent construction, 43 percent renovation, and 39 percent demolition. Non-residential sources generate the remaining 35 percent of C&D debris. The makeup of the non-residential portion is similar to the residential portion, with 19 percent from construction, 45 percent from renovation and 36 percent from demolition. Figure 4 provides a breakdown of C&D debris sources for the entire waste stream.

Figure 6. Generation and Recovery of C&D Debris in North Carolina

	1997
Generation	2,519,000
Recovery	152,874
Percent	6.07%

Several characterization studies examined during this assessment identify individual components of C&D debris. Unfortunately, these studies vary widely in the detail of the component breakdown and the sources of the C&D debris. Figure 5 illustrates the overall composition of C&D debris based on one of the studies.[28] This study was chosen because it accounts for all six types of C&D generating activities defined in this report, and the components identified are similar to those discussed in this report.

Recovery

Figure 6 summarizes generation and recovery of C&D debris in North Carolina during 1997. As showed in Figure 6, an estimated 2.5 million tons of C&D debris were generated in 1997, representing approximately 22 percent of North Carolina's total waste stream. Limited infrastructure exists for C&D recycling in North Carolina, and only about 153,000 tons were reported recovered during 1997, or roughly six percent of the C&D waste stream. A majority of recovery took place through salvage and reuse activities at demolition / deconstruction job sites. Additional recovery was recorded from several mixed C&D debris processing facilities. Based on the recent growth of recycling infrastructure, recovery is expected to increase, but insufficient data were available to make projections for 2002.

It is likely that some amount of clean wood from C&D debris is being processed along with materials such as trees and brush, resulting from land clearing activities. These types of material typically are made into a mulch or compost product. However, the amount of C&D wood that ends up mixed with land clearing debris is not known and is not included in recovery.

DEMAND

Disposal of C&D Debris

The demand for C&D debris is affected mainly by the available landfill options in the state and their respective prices. A majority of C&D debris managed in North Carolina is disposed in landfills ¾ more specifically, in C&D landfills, municipal solid waste landfills, and in some cases land clearing and inert debris landfills. The following descriptions represent a brief overview of each type of facility.

Municipal Solid Waste Landfills (MSWLFs)

- Definition: "Municipal solid waste landfill unit means a discrete area of land or an excavation that receives household waste, and is not a land application unit, surface impoundment, injection well, or waste pile, as defined under 40 CFR Part 257. Such a landfill may be publicly or privately owned. A MSWLF unit also may be permitted to receive other types of non-hazardous solid waste. A MSWLF unit may be a new MSWLF unit, an existing MSWLF unit or a lateral expansion." 15A NCAC 13B .1602(17).
- Number of facilities: During fiscal year 1996-97, there were 66; currently, there are 46 (including those under construction).
- Average Tip fee: $29.91/ton
- Tons of C&D received: Unknown, but likely more than one million tons during fiscal year 1996-97.
- Other: MSWLFs have to meet stricter environmental regulations than C&D landfills. All unlined MSWLFs in the state closed as of January 1, 1998. This change resulted in a number of facilities closing or converting to C&D landfills, which do not require liner systems.

C&D Landfills (C&DLFs)

- Definition: C&D debris landfills, although not defined by statute or rule, generally are allowed to accept C&D debris, debris acceptable in land-clearing and inert debris landfills, and other waste approved by the N.C. Division of Waste Management.[29]
- Number of facilities: In fiscal year 1996-97, there were 30 (including four stockpiles); currently, there are 41.
- Average tip fee: $23.66/ton, although volume-pricing systems are still in place.[30]
- Tons of C&D received: 1,009,000 tons of debris were disposed of at C&D landfills in fiscal year 1996-97, representing shipments from 46 of North Carolina's 100 counties. The extent to which all of the waste came from C&D related activities as opposed to land clearing activities could not be determined.
- Other: Many MSWLFs scheduled to close as of January 1, 1998, had remaining capacity. To maximize this capacity and to minimize closure costs, many of these landfills were converted to C&D landfills. Currently, there are 22 C&D landfills operating on closed MSWLFs. C&D landfills generally can accept land clearing debris and other inert material.

Land-Clearing and Inert Debris Landfills (LCIDLFs)

- *Definition*: "Land clearing and inert debris landfill means a facility for the land disposal of land clearing waste, concrete, brick, concrete block, uncontaminated soil, gravel and rock, untreated and unpainted wood and yard trash" 15A NCAC 13B .0100(54).
- *Number of facilities*: Unknown.
- *Average tip fee*: Unknown. Facilities generally charge by the cubic yard or truckload.
- *Tons of C&D received*: Unknown. Only certain components of C&D debris are acceptable at LCID landfills.
- *Other*: The operation of LCID landfills are regulated, but not to the extent of MSWLFs or C&D landfills. Because of the localized permitting structure, little information is available about the number of facilities, the capacity in place, tip fees, waste handled, etc.

C&D Landfill Tipping Fees

Landfill tipping fees within the state largely affect the amount of C&D recovery taking place. Most C&D recovery facilities charge a per ton fee close to landfill disposal fees to cover the associated hauling, handling, and processing costs. Most C&D recycling operations are based on costing less than disposal. Thus, for C&D recycling operations to be cost competitive, their processing costs should be less than the average tipping fees in that local area.

During fiscal year 1996-97, 26 C&D landfills and four C&D stockpiles received slightly more than one million tons of waste. Tip fee data were available for 25 of the C&D landfills and ranged from $8 ton to $40 per ton. The average tip fee was $23.66 per ton, and the median tip fee was $22 per ton. C&D stockpiles averaged a disposal fee of $23 per ton. Although all facilities reported a tip fee based on tonnage, some North Carolina facilities also use volume-based fees.

The 30 C&D disposal facilities received waste from 46 of North Carolina's 100 counties, indicating substantial amounts of C&D debris were disposed in municipal solid waste landfills (MSWLFs). The average tip fee for North Carolina MSWLFs in 1997 was $29.91.

As of September 20, 1998, 49 C&D landfills were operating or under permit review: 19 were stand-alone C&D landfills, 22 were operating on closed MSWLFs, and eight C&D landfills were under permit review.[31]

The effects on tipping fees of the increase in the number of C&D disposal facilities are not yet known. It is expected that as the number of landfills increases, the increase in competition likely will lower tipping fees.

C&D Recovery Efforts

C&D recycling efforts include source separated and mixed material recovery. Source separated recovery requires separation of the materials at the job site. Each material type is transported to a distinct processing facility or end market. With mixed material recycling, aggregated materials are collected together, then separated at a processing facility. A discussion of these recovery options is provided below. Successful implementation and cost savings of these programs are dependent on local tipping fees, construction density, distance to recycling and disposal options, and market value of materials.

Source Separated Recovery

As with traditional recyclables, the materials in C&D debris maintain their highest recycling value when source separated at the job site. While separated materials may be reused or processed in higher value-added applications, mixed material often is processed into a wood stream for mulch or fuel and an aggregate stream suitable for gravel or fill, which have relatively low value.

Construction/Renovation

In construction site recycling, many players are involved in the process of getting materials to the market. The first is the construction contractor, second is the hauler, and third is the material processor/recycler.

Role of the Contractor

Job-site recovery requires greater education of a construction company's workers and careful education and agreements with subcontractors. While managing source separation adds to the already busy schedule of the site foreman, potential exists for greater cost savings to the project as a whole.[32]

Separation of waste materials at the job site actually can reduce disposal and other costs related to construction. In addition to preserving of the value of the material, separation can reduce costs on the construction site by making usable materials available. For example, site separation of scrap wood makes it easily available for use when a shorter piece of lumber is required. The Home Builder Recycling Initiative reported that framers learned to look for usable wood in the discard pile when it was source separated and easy to identify.[33]

The average disposal cost for residential construction in the Triangle area of North Carolina is about $0.50/square foot

of construction.[34] The homebuilder or commercial construction contractor actually can save on hauling costs by contracting with someone to remove materials in a manner that preserves their value for reuse and recycling. This hauler often will charge a lower fee than that charged by a hauler who takes mixed materials to a landfill for disposal.

A study of construction waste generation and site separation in Cary, North Carolina, identified the willingness of homebuilders and their subcontractors to separate materials for recycling. Although immediate or long-term cost savings were frequently cited as reasons for recycling in the future, the two most often cited motivations were not related to cost. Seventy-six percent of respondents said they would recycle simply because it makes sense, and 71 percent cited their responsibility to society/environment as a motivating factor.[35]

A guidance document for reducing waste for commercial construction entitled *WasteSpec* was developed in North Carolina by the Triangle J Council of Governments.[36] A study of commercial construction projects that used *WasteSpec* to reduce and recycle their wastes determined that in all but one of the 12 projects surveyed, the cost of the project remained the same or was reduced compared to what it would have been otherwise.[37]

Role of the Hauler

The hauler wishing to make a business of collecting source separated construction waste must evaluate potential increased transportation and labor costs, decreased disposal costs, and revenues from the sale of some recyclable items.

The cost of transporting separated materials most often is higher than that of collecting a pile or roll-off container of mixed waste and transporting it to a disposal facility. Proper collection of sorted material may require a truck with separate areas for segregated materials, as well as more than one trip to a site. Processing facilities for separated wastes may be closer or farther away than the single disposal site for mixed waste.

Site separation of materials is made easier by close attention to the construction schedule. For example, a majority of wood debris is generated in framing a house and can be collected separately. The installation crew also generates gypsum wallboard waste in a concentrated time period. In cases where wallboard subcontractors haul their own waste, the load is generally all wallboard scrap and easily recovered for recycling.

Disposal costs of the collected material are either eliminated or reduced when source separated material is collected. In the cases where there is a market for a material, revenue actually is generated by this action. (For market prices of selected materials, see the latter part of this section.) In cases where markets are not well developed, a reduced tipping fee often may be offered by landfills for items such as source separated, clean (unpainted, untreated) wood waste.

As described above, the hauler may face additional costs in managing source separated wastes including specialized hauling equipment and the possibility of increased transportation costs (transportation costs depend on the location of the recycling facility in relation to the current disposal option). However, a survey of homebuilders in Wake County indicated 53 percent would be willing to source separate wastes if hauling costs were equal to that of disposal. Another 31 percent would be willing to pay zero to five percent more for source separated hauling for recycling, and 11 percent indicated they would be willing to pay five to 10 percent more. Six percent indicated they would be willing to source separate for recycling only if disposal costs decreased.[38]

Deconstruction

When a building is no longer useful to its owners in its present state, a hierarchy of waste management options in order of preference includes restoration on site, moving the home to another site, deconstruction, and demolition.

Restoration of older homes and commercial buildings preserves the highest value of the building. If the land has become more valuable for another use, an historic home might be moved to another location for restoration. Preservation North Carolina and the North Carolina Historic Preservation Office promote this method of using older buildings.[39, 40] These agencies work to find new owners and restorers for historic homes and, when necessary, find new owners and new locations for homes that must be moved.

Deconstruction of buildings preserves the value of materials and architectural elements in a building by carefully removing items in a way that maintains their integrity. Deconstruction can be partial or complete. In partial deconstruction, usable items like mantelpieces, doors, wood flooring, and cabinets are removed for reuse before the rest of the building is demolished. This method is used by private and non-profit organizations to recover the most valuable elements of historic buildings that must be demolished. Non-profit groups that use partial deconstruction include Habitat for Humanity of Wake County and Architectural Salvage of Greensboro. These two groups recover materials for resale to fund operations.

Complete deconstruction means dismantling a building in a way that recovers all components, even the framing, for reuse or recycling. Older buildings, commercial or residential, often contain valuable timbers and hardwood flooring, as well as the other elements discussed in the text on partial deconstruction. Timber framing can be reused or made into wood flooring. A number of companies operating in North Carolina that process old timbers into wood flooring. They purchase timbers from deconstruction projects in North Carolina and throughout the United States. Bricks from large, older commercial buildings, such as tobacco and other warehouses, are valuable when cleaned of their mortar. Metals are recoverable from commercial buildings of any vintage. A small number of North Carolina businesses provide complete deconstruction of older homes, and the North Carolina Cooperative Extension Service has published a film on the deconstruction process.[41]

Deconstruction of a material for recycling involves the work of the deconstruction manager or firm and the processor or end-user of the site separated material.

Role of the Deconstruction Firm or Manager
Factors that affect the economic viability of deconstruction include labor cost, equipment needs, value of materials, and location of markets. The labor costs for deconstruction of a building are much higher than that of demolition. Deconstruction takes more time and requires an additional amount of skilled labor to remove materials in a form that is later valuable. While deconstruction of a single family home may require as little as an assortment of crowbars, deconstruction of larger commercial facilities may require more heavy-duty and specialized mechanical equipment.

The value of materials in the building determines whether the extra labor required is worth the time and effort. Older homes often have interesting architectural elements, wood flooring, and other materials highly valued by people renovating existing homes or interested in bringing classic elements into a new construction project. The common rule of thumb in the home deconstruction business is that selling the wood floor should cover labor cost of the complete deconstruction. The sale of the other recovered materials represents potential profit that could be made on the project.

Large timbers and brick construction can make an old warehouse or other commercial facility worth deconstructing. These large timbers are sold for construction or are often re-sawn to make valuable wood flooring. Bricks from these deconstruction projects are cleaned of their mortar by hand and may reach distant reuse markets. Metals commonly are recovered from both deconstruction and demolition projects.

Mixed Materials Recovery
Like source separated materials processing, three parties are involved in mixed materials recycling: the contractor, the hauler, and the recycler/processor.

Mixed C&D materials typically are collected at job sites in large roll-off containers ranging in size from 10 to 50 cubic yards. The contractor places all C&D materials into a container, making sure to keep out MSW. To the hauler and contractor, the process essentially is the same as with materials destined for a C&D debris landfill.

Materials are taken from construction, renovation, and demolition job sites and transported to a stationary processing facility. The different C&D components are separated mechanically or manually. Basic mechanical separation includes screening, grinding, and magnetic separation. More sophisticated processes can include air or water separation to remove heavier aggregates, such as brick and block, from the lighter debris, such as wood and cardboard. Depending on the degree to which materials are separated, end products can include a recycled aggregate for a gravel substitute, wood chips for fuel or mulch, recyclable cardboard, plastics, and miscellaneous soil-like materials or fines.

Mixed Materials Recovery Costs
For the contractor and hauler, prices for this service need to be comparable to that of disposal. The hauler charges the contractor a straight fee per load or breaks down the cost to include a tipping fee (i.e., a per ton fee) plus a hauling charge to the facility. Either way, the hauler still charges the contractor a price similar to a disposal fee at the landfill.

Generally, costs associated with start-up, daily operations, and maintenance of this type of operation make it the most expensive type of processing. Tipping fees at mixed C&D processing facilities are very close to the average landfill tipping fees in a given area. (For example, the average tipping fee for C&D in North Carolina is approximately $24 per ton.) The main advantage to mixed materials recovery over source separated recovery is that the contractor does not need to spend additional time and money separating out materials at the job site. All or most materials are simply transported to a central processing facility.

The value of end products resulting from mixed processing depends largely on the purity of materials after separation. For example if wood materials contain a large amount of aggregate, then the resale value as a fuel would be minimal. Additionally, the cost of transporting materials to mar-

Figure 7. Average Prices for Metal as of September 1998

Material	Price
Mixed Aluminum	$640/ton ($.32/lb)
Mixed Steel	$20-$60/ton ($.01-$.03/lb)
Copper	$1,573/ton ($.79/lb)

Sources: 1) Recycling Times, The Markets Page, September 14, 1998, Pp. 8-9.
2) http://www.amm.com/inside/1998/81015key.htm

ket needs to be taken into account to accurately determine the net value of end products.

MARKETS

Whether from source separated or mixed materials recycling, the individual components of C&D all have different uses and values. Because of the wide variety of materials that make up C&D debris, and their distinctly regional markets, it is not possible to generalize the overall economics of C&D recycling for the entire state. For recycling market information specific to a given county or region of North Carolina, please refer to the *Directory of Markets for Recyclable Materials* produced by North Carolina's Recycling Business Assistance Center. Below is a brief discussion of the markets for these C&D components: metals, cardboard, plastic, aggregates, drywall, asphalt shingles, and wood.

Metals

Metals make up approximately nine percent of the C&D waste stream.[42] Source-separated metals from construction or demolition debris are typically the highest value material, and are more commonly recovered than disposed. Aluminum, steel, and copper are the most common metals found in C&D debris. These materials are typically accepted at all salvage yards directly from the contractor. If large enough volumes are being generated at a job site, metal recyclers will sometimes site containers for free, or at a minimal cost to cover transportation.

According to the U.S. Geological Survey, the second largest source of Iron and Steel scrap is from demolished steel structures.[43] With the increasing capacity of steel mini-mills in the United States that produce steel products made primarily from scrap, the United States steel making industry undoubtedly will increase efforts to reclaim additional amounts of steel from construction and demolition debris recycling activities.

Figure 7 shows the average price paid for aluminum, steel, and copper in September 1998. For further information on metal prices, review the Metal Cans Commodity Profile.

Old Corrugated Cardboard (OCC)

OCC makes up approximately three percent of the overall C&D waste stream. As a component of the construction debris waste stream, however, it is a bit larger ¾ four to six percent. The fact that OCC is used primarily as a packaging material makes it a prime target for separation on-site. Construction site recycling is perhaps the most logical location to recover corrugated cardboard from C&D debris.

In North Carolina, at least 30 communities have disposal diversion ordinances (DDOs) that limit management options for corrugated cardboard. Penalties associated with these ordinances range from increased tipping fees to load refusal. Although these DDOs usually apply to municipal solid waste landfills (MSWLFs), significant quantities of C&D debris are disposed at such facilities.

OCC processors are abundant in North Carolina. A search of the Recycling Business Assistance Center's *Directory of Markets for Recyclable Materials* identified 84 processors or end-users servicing the state.

Processors currently are paying approximately $7.50 per ton for loose OCC and about $17.50 per ton if baled. Also, opportunities exist to ship baled OCC to end-users, which currently pay in the $50 to $60 per ton range.

Current prices paid for OCC are low, and a review of the OCC commodity profile indicates they are expected to remain low for some time. Although prices are low, the abundance of markets and the ease of separation still allow for opportunities to offset disposal costs through on-site recovery. OCC is a component of C&D debris that can be easily targeted by companies specializing in construction site recycling.

Plastic

Plastic makes up approximately .5 percent of the C&D waste stream. The two most recoverable plastics in construction waste are vinyl siding and HDPE buckets. Two plastic processors in the state currently accept vinyl siding and some local governments are adding collection points for this material. One local government program is receiving $40/ton

loose or $100/ton for baled siding that is transported from the collection point by the processor.

Initial research indicates that HDPE plastic buckets appear to have a high reuse value. When separated at the Home Builder's Recycling Initiative project sites, workers took them home.[46] No markets were located for these buckets.

Aggregates

Aggregates are among the largest portion of the C&D waste stream, representing approximately 23 percent of the total weight. Aggregates include asphalt pavement, concrete, reinforced concrete, cinder block, brick, glass, rock, sand, soil, and miscellaneous fines that result from construction, renovation, or demolition of residential and commercial structures.

The largest amounts of aggregates are generated from demolition of commercial concrete or brick structures, and from foundations of residential structures. All these materials can be combined and processed to produce a low-grade gravel substitute or solid fill material. However, the following individual aggregate components are more valuable when source separated:

- **Miscellaneous fines:** Mostly made of soil and small aggregates, fines are derived from screening C&D debris. This material can be given away as fill or sold as a soil product depending on the material's quality. The quality of the resulting product is related to the materials from which the debris was originally screened. Material screened from mostly aggregates will more than likely be a relatively homogenous soil-like product. However, fines derived from construction or demolition of wooden structures will obviously have wood mixed with the soil. Additionally, with fines screened from debris resulting from the demolition of wooden structures, painted wood is a concern because of the potential for lead paint contamination.

- **Concrete:** makes up approximately 18.4 percent of the building related C&D waste stream. For information on the markets for recycled concrete, please refer to the road debris section of this commodity profile.

- **Brick:** makes up approximately five percent of the total C&D waste stream. Whole bricks have a significant re-sale value for direct re-use. Bricks are used in restoration projects and for aesthetic purposes in residential and commercial building. Crushed brick can be used as a road base aggregate similar to concrete and has established markets as a landscaping product as well.

Drywall

Drywall, also referred to as sheetrock and wallboard, makes up an estimated 13 percent of the C&D waste stream.[44] Scrap drywall from the manufacturing process and from new residential, including the manufactured housing industry, and commercial construction currently are being recovered. However, drywall from renovations or demolition is not typically considered to be recyclable since most of the material is painted or treated.

Drywall is composed primarily of gypsum or calcium sulfate and a paper backing. As a pH neutral and absorbent material, recovered gypsum may be used for applications such as cat litter and as a spill absorbent product. Gypsum also is used in agricultural applications in North Carolina as a soil amendment. Gypsum adds calcium, sulfur, and some boron to the soil, is pH neutral, and loosens clay soils. [47]

Because extensive processing must occur to create these refined products, gypsum recyclers typically charge a tipping fee competitive with the average landfill tipping fees in North Carolina.

Asphalt Shingles

Asphalt shingles make up approximately 12 percent of the total C&D waste stream.[48] Some scrap asphalt shingles from the manufacturing process and from new construction currently are being recovered. However, shingles from roof replacements (tear-off shingles) are not being recovered because some shingles previously were made with asbestos. Until a cost-effective means for testing tear-off shingles for asbestos is developed, they will continue to be disposed of in landfills.

A potentially large market exists for asphalt shingles as an additive to asphalt pavement. Asphalt shingle scrap along with other tar-based materials (such as tarpaper and flat roof asphalt aggregate) can be processed into road paving mix. Scrap must first be ground and nails and ferrous metals removed with a magnet before being mixed with recovered asphalt and primary materials for new paving mixes. The fiberglass component of shingles can have a beneficial effect in making the mix more durable or water repellent.[49]

Because of extensive processing costs incurred in grinding, screening, and blending the shingles in an asphalt pavement mix, tipping fees are close to the average landfill tipping fees in North Carolina.

Wood

Wood makes up approximately 28 percent of the C&D waste stream. Clean wood waste from construction sites has many uses with the most valuable being re-use. However, dimensional lumber scrap (i.e.2 x 4s) may not be acceptable for structural purposes unless the grade stamp is visible. The industry in the United States is considering certification methods for grading used lumber.

Clean dimensional lumber scrap can be finger-jointed into longer pieces. This practice is becoming common in the Pacific Northwest and a North Carolina company began operations in October 1998. Finger-jointed lumber is generally straighter than ordinary two-by-fours and is approved for structural use.

Clean dimensional lumber scrap also can be made into mulch or used as a component of compost. The price paid for a ton of clean dimensional lumber will vary based on the size of the load and the distance to the processing facility. Most mulch facilities have the ability to chip or grind lumber, but the price paid for mulch ranges from free to $2.50 per ton in the United States.[49]

Because it is kiln dried, dimensional lumber chips have a high fuel value. A national study reports prices for processed wood for fuel to be $8-20 per ton.[50] Prices quoted from North Carolina markets range from $12-$25 per ton.[51]

Wood waste from demolition sites is more likely to contain paint or other contaminants. For this reason, it is not generally usable as soil amendment, but may be used as fuel depending on the level of contamination.

CONCLUSION

The supply of C&D debris is considerably greater than the current demand for recovery. C&D debris recycling is based on cost-avoidance and not necessarily revenue generation. Thus, the quantity of C&D debris recovered is directly related to the cost of disposal. In areas of the country where landfill tipping fees are significantly higher, more material is being diverted. However, in North Carolina, where tipping fees average $24 per ton, there is less incentive for C&D recycling. A majority of C&D debris continues to be disposed in North Carolina's relatively inexpensive landfills.

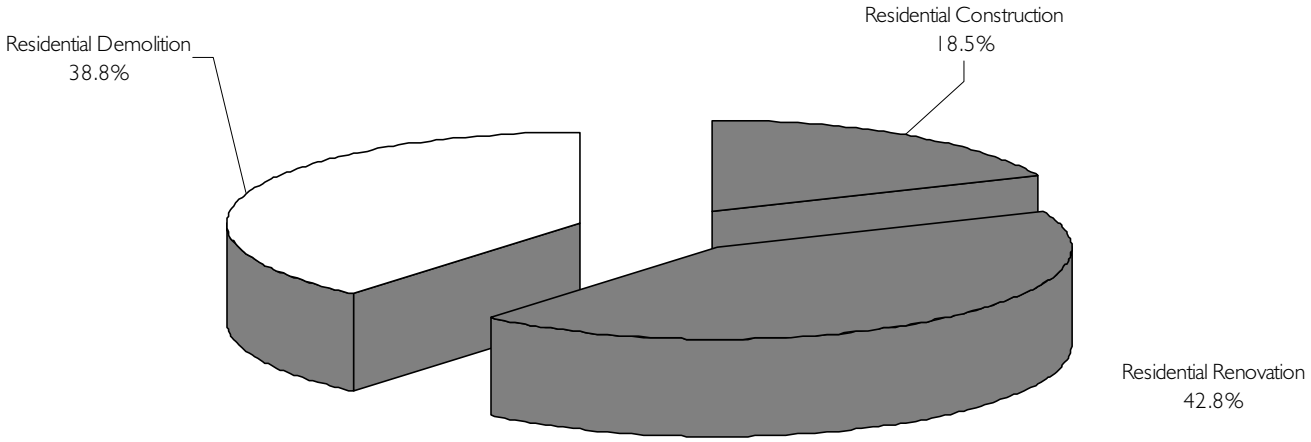
To increase demand for C&D debris, the State of North Carolina should continue encouraging reuse and recycling infrastructure development, placing emphasis on recovery processes that are cost-comparable to landfilling. The following are specific recommendations for accomplishing this goal.

RECOMMENDATIONS

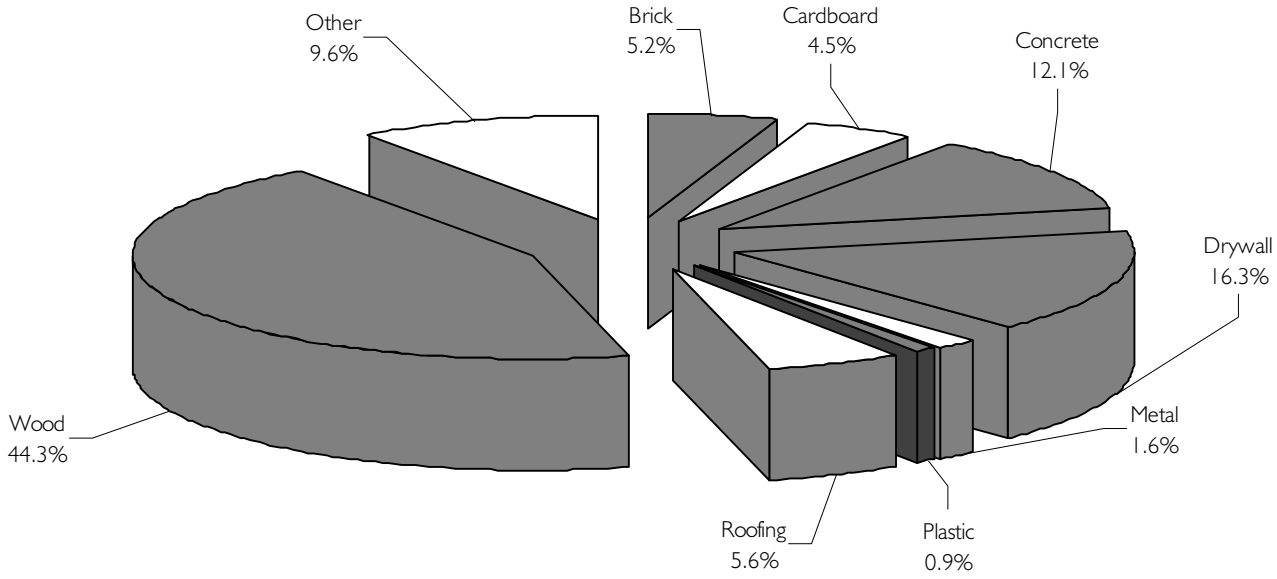
- *C&D Processing Costs Study:* DPPEA should consider conducting a study to evaluate mixed materials processing on or adjacent to landfill sites. Such a study could determine the most cost-effective means of diverting materials directly from the landfill.
- *Education:* North Carolina should continue fostering the reduction and recycling of C&D wastes through education of citizens, homebuilders, contractors, and local government officials. The state should work cooperatively with homebuilders associations, green-building advocates, and other groups promoting the responsible use of these resources. This education can take the form of meetings, workshops, and publication, and dissemination of continued research on the management of this sizeable waste stream.
- *Disposal Diversion Ordinances:* For applicable materials, such as corrugated cardboard, local governments should be encouraged to expand disposal diversion ordinances (DDOs) to cover C&D disposal facilities. Based on 1996-97 C&D landfill disposal figures, it is likely that more than 30,000 tons of corrugated cardboard were disposed in C&D landfills.
- *Grants:* DPPEA should offer funding to local governments through the Solid Waste Reduction Assistance Grants for the further development of C&D material recycling programs, such as collection of vinyl siding or other targeted materials.
- *Pallet Recovery:* The infrastructure exists to recover a greater number of pallets. (See *Wooden Pallets Commodity Profile*.) Approximately 3,750 tons of pallets were generated from C&D related activities in 1997. The disposal of pallets in C&D landfills should be banned statewide.
- *LCID Characterization:* Very little is known about land clearing and inert debris landfills (LCID LFs) in North Carolina. DPPEA should consider conducting a study of such landfills to determine the current capacity, the quantity of waste accepted, the characterization of waste entering LCIDs, public benefit or need for LCIDs, the tipping fees, and the methods for regulating the materials entering the facilities (i.e., the use of scales and the inspection of materials).
- *Buy Recycled Initiatives.* DPPEA should continue supporting initiatives of the NCDOT in using recycled C&D materials in place of virgin materials in transportation related projects. DPPEA also should recommend further use of recycled C&D materials with other state agencies, such as State Construction.

APPENDIX 1
Characterization of Residential C&D Debris

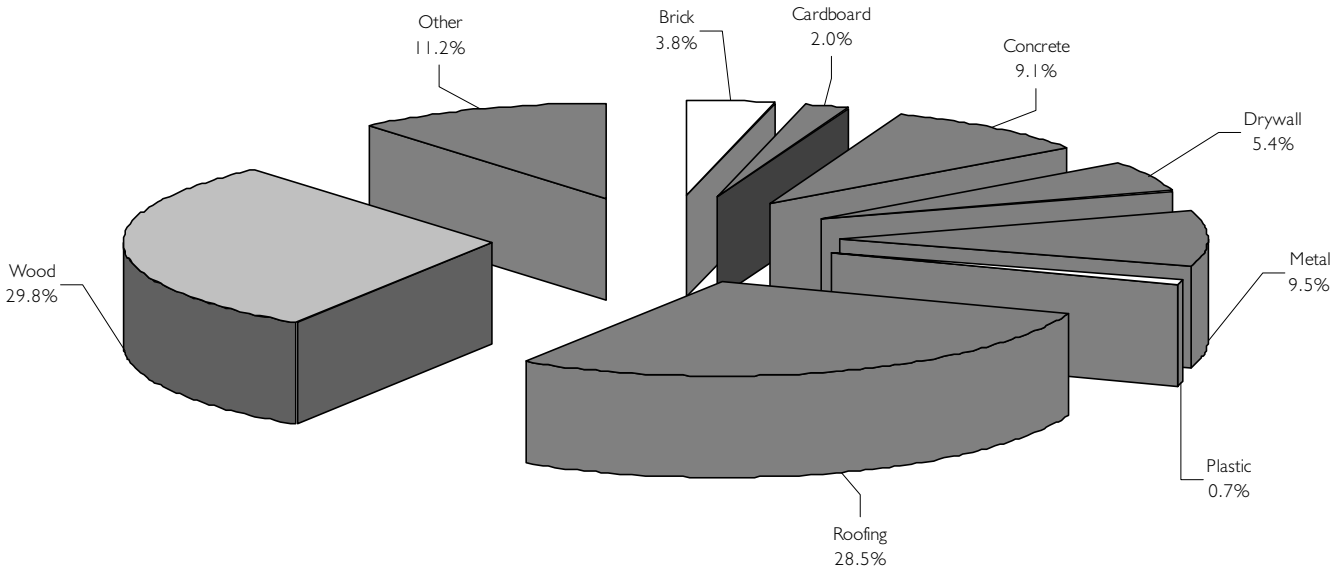
Sources of Residential C&D Debris



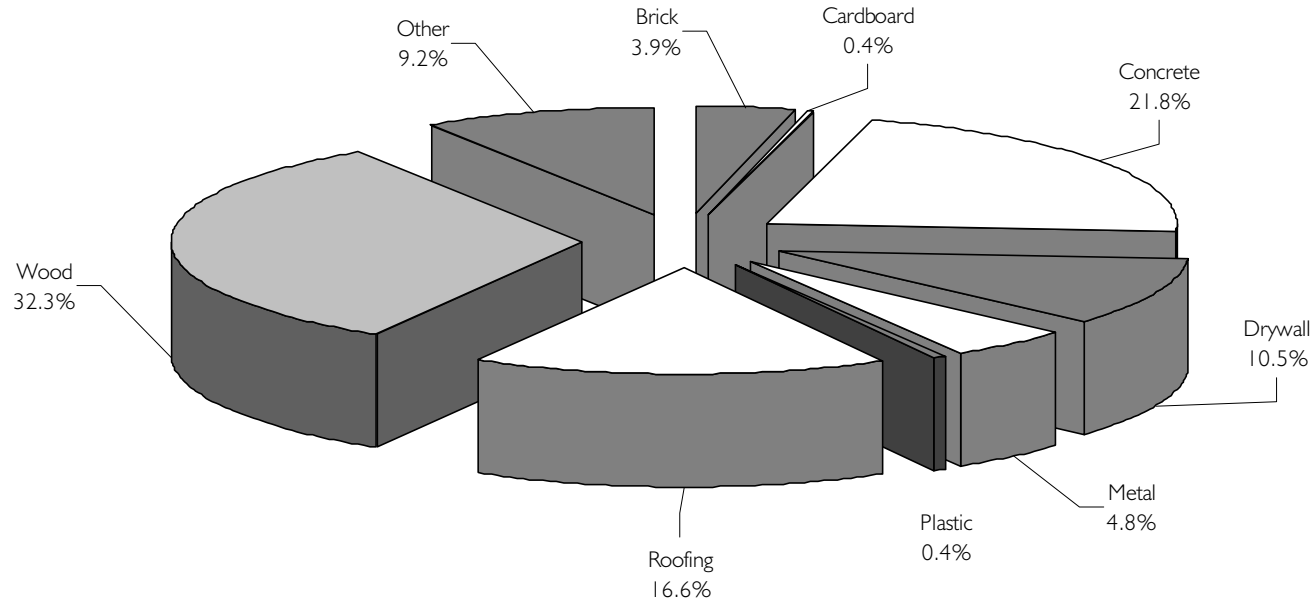
Composition of Residential Construction Debris



Composition of Residential Renovation Debris



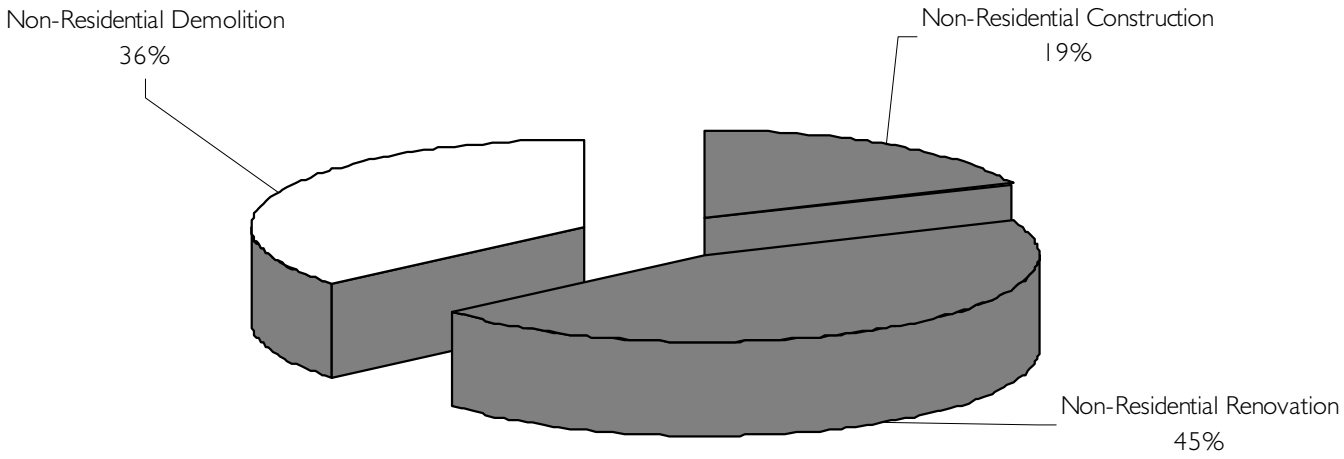
Composition of Residential Demolition Debris



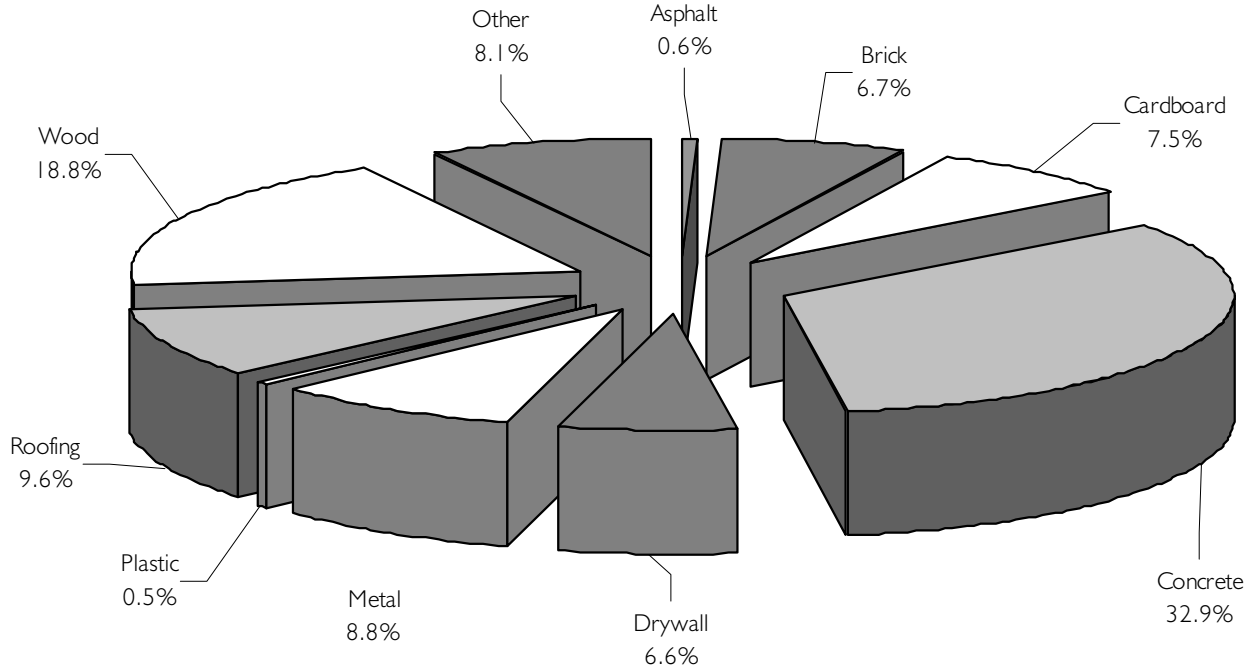
APPENDIX 2

Characterization of Non-Residential C&D Debris

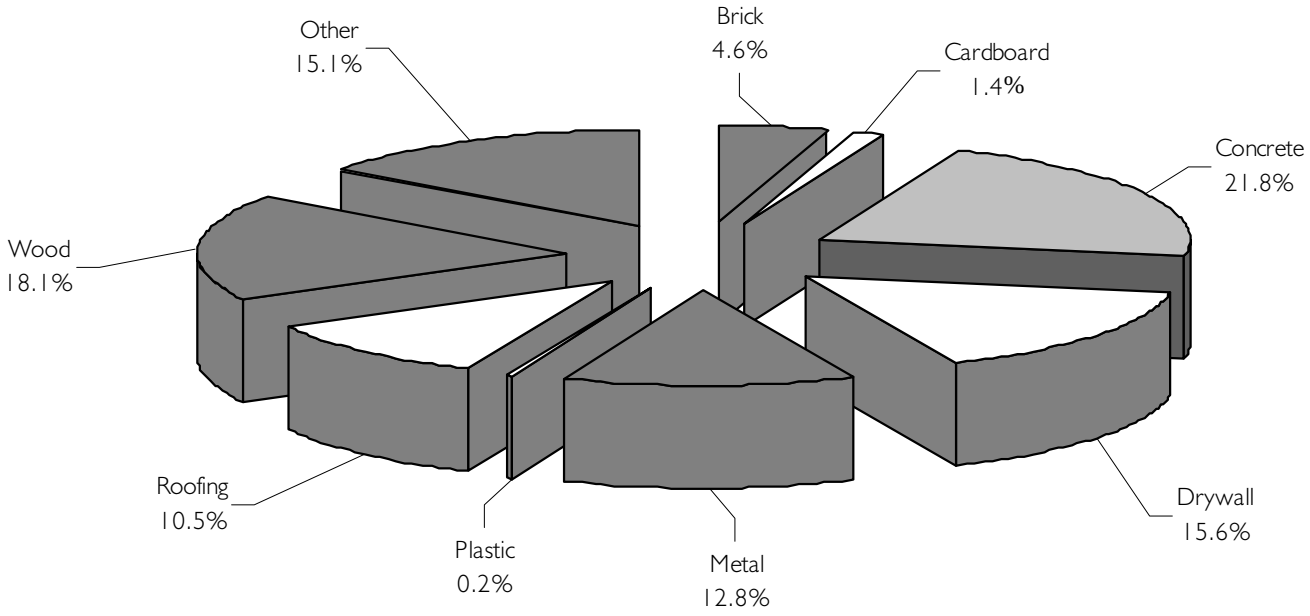
Sources of Non-Residential C&D Debris



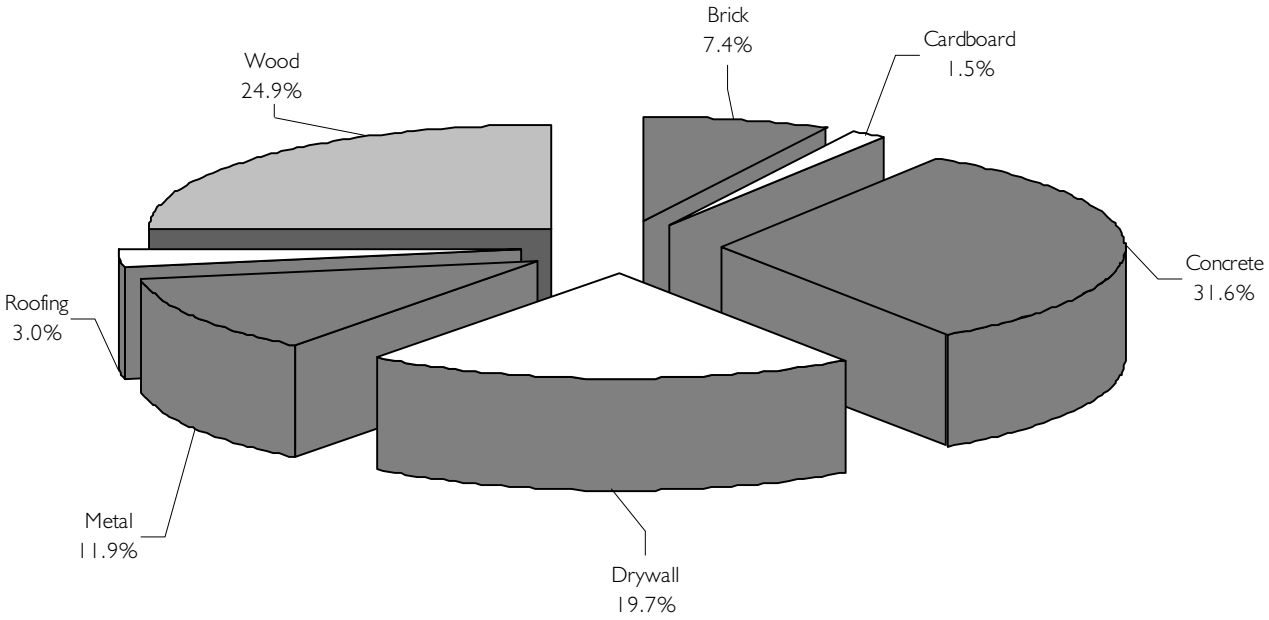
Composition of Non-Residential Construction Debris



Composition of Non-Residential Renovation Debris



Composition of Non-Residential Demolition Debris



[1] Personal communication, William Turley, Construction Materials Recycling Association, November 30, 1998.
[2] Personal communication, Dawn Mooney, Carolina Asphalt Pavement Association, December 9, 1998.
[3] Personal communication, Ben Ross, Ross and Associates, December 9, 1998.
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[15] Three percent is historically considered the average annual inflation in the U.S. and was therefore used.
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[23] NCDOL, *op.cit.*
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[32] Triangle J Council of Governments, Using Specifications to Reduce Construction Waste, PO Box 12276 Research Triangle Park, NC 27709. Undated. (919) 549-0551.
[33] Shore, Sally Beth, Homebuilder Recycling Initiative Final Report, Woodbin II, November 19, 1997, page 24.
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[35] Shore, Sally Beth, Homebuilder Recycling Initiative Final Report, Woodbin II, November 19, 1997.
[36] Triangle J Council of Governments, Model Specifications….
[37] Triangle J Council of Governments, Using Specifications to Reduce Construction Waste, PO Box 12276 Research Triangle Park, NC 27709. Undated. (919) 549-0551.
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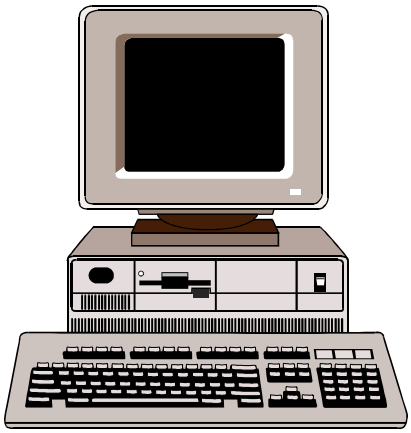
Electronics

Electronics

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

Electronics include computers and related equipment, televisions, telecommunication devices, and any other durable electronic goods generated by households, businesses, or industries. Electronics recovery is in its infancy, and as such, little data is available on the actual quantity of material available for recycling, or the amount being recovered.

This commodity profile focuses primarily on the reuse and recycling of computers and, to a lesser extent, televisions. Computer monitors and televisions share a critical component, cathode ray tubes (CRTs), which are leaded glass picture tubes. Because they contain lead, CRTs are classified as hazardous waste under some circumstances, yet a trend towards encouraging recycling and removing barriers to handling the material is emerging in the management of waste CRTs in the United States.

Businesses and individuals manage electronic equipment waste in a variety of ways including:

- In-house refurbishment, typically at larger businesses where equipment is repaired and reused within the same company.
- Selling or donating relatively high value used equipment to be refurbished and resold.
- Selling obsolete equipment with valuable components to be dismantled and recycled.
- Paying to recycle or dispose of obsolete equipment with little or no residual value of its components.

Although the amount of electronics available for disposal in North Carolina continues to increase, little information is available regarding the quantity of material being recovered. It appears that most large businesses have computer recycling programs in place. However, small businesses and residents appear to be lacking the knowledge of available options or the financial resources to recycle computers.

SUPPLY

Generation

Because electronics are durable goods, the supply available

for recycling is not the amount of goods shipped in a given year but rather the amount actually requiring disposal. Estimates of the number of goods requiring disposal vary widely, and North Carolina-specific numbers were not available; therefore, assumptions from several national and state-level studies were applied to North Carolina data. Figure 1 presents estimates on the range of materials available for recovery. Equipment storage complicates these calculations. Many computers, for example, are stored three to five years before disposal.

The number of total electronics and CRT-containing items available for disposal in North Carolina was estimated by applying the methodology used by the Massachusetts Department of Environmental Protection (MADEP).[1] Studies and reports estimating the amount of electronics and CRTs discarded and stored were reviewed by MADEP prior to making its in-house analysis. Those studies and the resulting estimates of the amount of electronics ready for disposal in North Carolina include:

- The Organization for Economic Cooperation and Development Study – 26,282 tons per year of CRT units.
- The Microelectronics and Computer Technology Corporation Report – 16,672 tons per year of CRT units.

This methodology attempts to account for multiple CRT-containing items per household and also accounts for storage prior to disposal. Assumptions and calculations are:

- The average household has two CRTs at 45 pounds per unit. North Carolina has 2.796 million households. Two CRTs is a conservative estimate, so these calculations may underestimate generation. [(2)(45)(2.796 million)/2000 lbs=125,820 tons]
- Life cycle of CRTs is 10 years, including use and storage. [(125,820)/10=12,582 tons] This calculation assumes that a constant number of CRT-containing items are disposed at a constant rate annually and also that as many go into storage as come out. This assumption may overestimate the amount of CRTs, as the life of a television can be significantly longer than 10 years.
- Workplaces have approximately the same number of CRTs as residences. [2(12,582)=25,164 tons].
- CRTs represent half of all electronics. [2(25,164)=50,328 tons].

Based on these calculations, at least 50,328 tons of electronics (25,164 tons from residential and a like number from commercial sources), or nearly 0.6 percent by weight of North Carolin's waste stream are ready for disposal annually. Figure 1 presents estimates of the amount of electronics requiring disposal in 1997 and the year 2002 based on a population increase of 6.1 percent as reported by the North Carolina Office of State Planning. These estimates do not include the potential Y2K effects discussed later in this Commodity Profile and assume that the conservative two CRTs per household unit estimate will hold true during this time period.

The following factors will likely increase the amount of material ready for disposal in the near term, but at the same time, make it difficult to estimate:

- *Television turnover from analog to digital.* By federal law, television broadcasts will switch from analog to digital transmission signals in 2006, accelerating the turnover of televisions, VCRs, and other analog video and audio equipment. This switch will likely cause a drop in the tonnage of analog televisions sent for repair and resale as it becomes impractical to repair and resell these TVs and may eventually relegate repaired electronics to the export market. Between 2005 and 2010, the number of CRTs in the waste stream is expected to increase as the resale and repair infrastructure shrinks. Some sources estimate that, depending on the rate of turnover, the volume of discarded electronics may jump to hundreds of thousands of tons in one year.[2]
- It is more likely, however, that the transition to digital television will be gradual, as households will not discard analog sets that can be used several more years. A recent report asserted that the broadcast

Figure 1. Estimates of the Amount of Electronics Requiring Disposal (1997 and 2002)

	1997	2002
Residential Electronics	25,164	26,699
Workplace Electronics	25,164	26,699
Total	50,328	53,398

Sources: 1) OECD = Organization for Economic Cooperation and Development
2) MADEP = Massachusetts Department of Environmental Protection
3) MCC = Microelectronics and Computer Technology Corporation
4) CMU = Carnegie Mellon University

industry intends to use dual transmission modes (both digital and analog) until at least December 31, 2006, meaning viewers will experience no change in service. [3] Further, it appears that broadcasters will continue providing analog signals beyond the 2007 deadline. Under Section 3003 of the Balanced Budget Act of 1997, Congress mandated the Federal Communications Commission (FCC) to extend the 2007 deadline for markets where 15 percent or more of the households lack digital sets.[4]

- Even after the industry has completely converted to digital transmission, inexpensive converter boxes that attach to analog sets would make it possible to receive digital signals. These converter boxes would enable viewers to continue using their analog sets for the duration of their normal useful life. This means some consumers may not be pushed as hard as originally thought into investing in new technology.[5]
- *Stored equipment*. It is virtually impossible to estimate the amount of electronic equipment stockpiled in residences. In theory, a large, immediate supply could become available as collection programs were initially implemented. Realistically, however, this stockpile would more than likely diminish over time, resulting in a smaller contribution to annual generation.
- *Year 2000 (Y2K) dilemma*. Companies may upgrade their systems to Y2K compliant machines rather than trying to "fix" their existing systems, meaning the potential exists for a significant number of old computers to be retired. According to one processor, recycling companies in the best position to take advantage of this increased supply are those that (1) can capture value out of computer systems through recycling or demanufacturing and (2) have the capability to dispose non-value items in an environmentally safe manner.[6]

Recovery

Data were insufficient to estimate recovery in North Carolina. However, of the estimated 50,328 tons of electronics generated, only a small portion is assumed to be recovered. Current recovery efforts are described in the demand section.

Regulatory Framework

A key concern in CRT management is the presence of lead. The average CRT contains about eight pounds of lead, encased in the glass screen.[7] The disposal of CRTs potentially could release lead into the environment. Disposal not only represents a potential health hazard but also the loss of a recyclable natural resource. Leaded glass recovered from CRTs can be safely and practically reprocessed to produce new CRTs.

CRTs generated by households are exempt from hazardous waste regulation. Under some circumstances, CRT-containing items generated by businesses can be classified as hazardous waste under the Resource Conservation and Recovery Act (RCRA). This waste management decision hinges on results of a toxicity characteristic leaching procedure (TCLP). Materials that fail the TCLP are classified as hazardous waste. TCLP involves crushing and grinding CRT glass, which exposes additional surface area and allows more lead to leach than from an intact CRT. Some industry analysts assert that this approach does not replicate actual conditions in a landfill. They also question whether whole products containing a CRT (e.g., a whole monitor or television) should be deemed hazardous waste, when only the CRT fails the test.[8] Black and white monitors are less likely to fail the TCLP test than color monitors.

State-level regulation of CRTs is still developing. In some states, CRTs are managed as universal wastes, meaning regulatory burdens are eased, provided proper recycling or disposal is ensured. Massachusetts is the first state to develop specific regulations. Pending approval by the U.S. Environmental Protection Agency (EPA), effective July 1, 1999, intact CRTs will be removed from the list of hazardous wastes to allow for recycling. Additionally, CRTs will be banned from disposal, and ground up or broken CRTs will remain listed as hazardous waste because of their potential to leak and disperse lead.[9] EPA Region I has not approved this approach as part of the Massachusetts RCRA program. In fact, EPA views the approach of total deregulation as being in violation of federal requirements, and has advised MA DEP that it could approve any number of compromises including handling CRTs under the Universal Waste Rule, with exclusions for CRTs heading to recyclers. Figure 2 outlines management policies in other selected states.

In North Carolina, the Hazardous Waste Section of the Division of Waste Management has outlined the following regulatory approach in a memo to a computer recycler:

- Unused, off-specification CRTs are considered non-listed commercial products, which are not regulated when reclaimed.
- Used CRTs could be considered spent materials or scrap metal if they have recoverable metal value. If the CRTs were considered spent materials, they would be considered solid wastes when reclaimed and subject to applicable hazardous waste management regulations if they were a characteristic hazardous waste. However, it is thought that intact monitors or televisions would not fail the TCLP.[10]

The Hazardous Waste Section has expressed interest in developing a guidance document for CRT management,

Figure 2. Overview of CRT Management in Selected States

State	Action
California	Regulates all CRTs as hazardous waste.
Florida	Considering a disposal ban on CRTs.
Massachusetts	Banned CRTs from landfills and incinerators, effective in 1999. The state will not consider intact CRTs hazardous waste.
Michigan	Added electric lamps to its Universal Waste Rule. Determined that CRTs fit the electric lamp definition and, therefore, may be managed as a universal waste.
Minnesota	CRTs are managed in a pilot project where no generator license or EPA identification number is needed. Has not formally adopted the Universal Waste Rule. Manufacturer responsibility is being discussed.
New Jersey	Adopted the Universal Waste Rule and is currently in the process of adding CRTs to the rule. Also pilot testing a CRT recycling facility.
Wisconsin	Special waste category exempts unwanted electronic equipment from hazardous waste regulations provided it is destined for recycling or reuse.

Source: EPR2 Conference Summary

similar to its enforcement policy for lights containing mercury.[11] Research into such a policy is ongoing, and requests from companies that recycle CRTs are increasing.

Some portion of leaded glass recovered from used CRTs can be safely and practically reused to produce new CRTs. In June 1998, the Computers and Electronics Sector Subcommittee of EPA's Common Sense Initiative (CSI) recommended revisions to RCRA to facilitate glass-to-glass recycling of CRTs. In particular, CSI recommended that EPA exclude processed CRT glass to be reused in CRT glass manufacturing from RCRA hazardous waste regulations. This option is preferred because it ensures that lead oxide remains in the glass and is reused in new CRT glass. The CSI also requested that any regulations be designed so that other legitimate recycling methods or end uses may be added in the future. These recommendations currently are being considered.

Although encouraging glass-to-glass recovery is an important first step, there are limits to this approach. Most CRTs are manufactured abroad, and it seems unlikely for economic reasons that recycled glass would be shipped from the United States to foreign nations. Additionally, there are limits to the amount of recycled glass that could be incorporated into new CRTs domestically. Experts estimate that the capacity for recycling CRT glass into new glass domestically is 150,000-300,000 tons, meaning all CRTs cannot be recycled into new CRTs.[12] Most United States manufacturing occurs in Pennsylvania, Ohio, and Indiana, making it unlikely that significant quantities could be economically transported from states outside that region. For these reasons, other markets for CRT glass must be developed.

DEMAND

Limited information exists on the total demand for discarded electronics. Demand is determined by existing recovery practices, of which only a small portion can be quantified. No data are available on the national recovery of electronics. Additionally, North Carolina's local efforts are difficult to quantify without a detailed study of the various types of recovery taking place. For example, re-sale and refurbishment could be taking place at thousands of businesses throughout the state. Also, many large corporations have in-house refurbishment and resale programs, which are difficult to quantify.

A brief summary of the different recovery options for businesses and individuals is presented below. The types of recovery include reuse, de-manufacturing, and recycling.

Reuse

Reuse of whole computer systems is the most environmentally preferable, cost effective, and well-established form of electronics recovery. Similar to automobiles, computer systems are durable goods that can have value to several different owners throughout their lifetime. Reuse includes direct reuse, upgrading, refurbishment, leasing, re-sale, and donation of usable electronics.

- **Direct reuse** occurs frequently within businesses when new computer systems are purchased and used systems are passed on to others within the organization.
- **Upgrading** a computer to a higher processing speed or adding memory allows the system to maintain its value for a longer period of time.
- **Refurbishment** of computers can range from

simple cleaning tasks to more complicated parts replacement and repair.

- **Leasing** is becoming a more common practice for computer equipment. Leasing companies typically lease computers as many times as possible, repairing the units when necessary, and sell the equipment towards the end of its useful life.
- **Re-sale** of equipment is a very common and economically beneficial means for handling electronic equipment. *The Wall Street Journal* estimates that 2.4 million used computers were sold in the United States during 1996.[13] However, many companies continue to store equipment, which not only costs money but also greatly reduces the re-sale value of the equipment. In some cases, equipment becomes obsolete, costing the company more to dispose or recycle.
- **Donating** computers to charities or other organizations is a well-established means of handling computer equipment. For companies that demand only high-end computers, the useful life of their equipment may be very short. Companies can donate computers to public schools and other institutions needing the equipment. Organizations involved in this type of program typically accept computers for free, refurbish them, and place them in schools. Depending on the value of the equipment, companies sometimes may receive a tax deduction for their donation.

Revenues/Costs: Reuse always should be practiced before recycling for both environmental and economic reasons. Reuse usually results in cost savings, if not actual revenue generation. The re-sale of personal computers typically yields revenues for systems with processing speeds of 286 or greater. The value of a computer system varies depending on the processing speed of the system, and the overall quality and reputation of the brand of computer. The re-sale value for an older 286 computer is between $25-$50 per central processing unit (CPU), and used CPUs with the relatively newer 100 Mz Pentium processors sell for $100-$300. Monitors or CRTs range from $25-$100 depending on color capability and resolution.[14]

Although the revenues for these low-end computers are minimal, they only decrease over time. Slower processing speed computers are considered to be obsolete and typically will need to be recycled or de-manufactured at a cost to the consumer.

De-Manufacturing

De-manufacturing is a type of recovery related to reuse where the computers are dismantled and stripped of their valuable parts for resale. Most commonly, memory components, integrated circuit boards, motherboards, disk drives, and CD-ROM drives are recovered for resale. These parts are collected and stored for direct resale.

Revenues/Costs: The demand for used computer parts varies depending on their compatibility with new computer systems and the cost of new parts. Previously, one of the most valuable components for resale was the random access memory (RAM) boards, with a resale value of roughly $8 per four-megabyte single in-line memory module (SIMM). However, with competition from newly developed memory components, the price has fallen to $1. Processors are a relatively high end-end component. Newer processors such as the Intel-Pentium, range from approximately $15-$100 depending on processor speed.[15] Overall, revenues from dismantling may or may not compensate for the cost depending on the total value of the components, less the cost of disposal or recycling of the residual materials. Also, market prices fluctuate and are not fixed. Thus, an activity or material that is profitable at one time may not be profitable at another time.

Recycling

Recycling is the least established and typically most costly form of electronics recovery. Recycling involves breaking down a computer into its components to recover individual recyclable commodities. This process can be completed through either dismantling with lower volumes of material or automated recycling processes with higher volumes of material. Although computer components can vary greatly by brand, one analysis of the breakdown of computer components by weight is provided in Figure 3.

Revenues/Costs: In a typical personal computer (PC), only about 55 percent of materials are considered recyclable. Figure 4 provides a rough breakdown of the value of some materials recovered from a typical PC. This information comes from a different source than the information in Figure 3 and, therefore, is not directly comparable. In this example, the total revenues generated from the sale of materials are $34.26. However, when labor, transportation, and residual disposal costs are factored in, it becomes a net loss. CRT recycling is an especially costly recycling component. The prices range from $5-$15 per unit, because of a specialized process involved in safely handling the material.

End Users/Processors

Below is a partial listing of the public and private entities involved in recovering electronics equipment from North Carolina. Many more are likely involved in some type of electronics recovery either by reuse, refurbishment, or re-

Figure 3. Components of a Computer

Components	Percent
Silica	24.90%
Plastics	23.00%
Iron	20.50%
Aluminum	14.10%
Copper	6.90%
Lead	6.30%
Zinc	2.20%
Nickel	0.85%
Other (Gold, Cadmium, etc.)	1.25%
Total	100%

Source: *MSW Management*, May/June 1998, p. 82.

Figure 4. Recoverable Components in a Typical Desktop Computer

Component	Percent(%)	Value($)
Plastics	23.00	11.73
Aluminum	6.30	9.11
Steel	20.50	4.18
Gold	0.001	6.27
Silver	0.02	1.03
Lead	6.30	1.93
Cadmium	0.01	0.01
Mercury	0.0022	0.00
Totals	56.13	$34.26

Source: http://www.libertynet.org/macredo/comelc.htm

cycling. Because of difficulty in obtaining information on all in-house electronics recovery, no total recovery figures are presented. Additionally, materials consolidated in one area may have originated in many different states, making it difficult to generate North Carolina-specific data.

A&B Recycling, Inc., Ft. Oglethorpe, Georgia, recycles approximately 60,000 to 100,000 pounds per month of computers (including CRTs) and telecommunications equipment from North Carolina. Depending on whether materials are source separated prior to entering the facility, the materials are either recycled individually, or commingled materials are ground for size reduction and shipped to overseas markets for additional separation. Plastic, glass, and other components are recycled into raw materials.[16]

ECS Refining, Greensboro, North Carolina, recycles solder residues, tin residues, precious metals, circuit boards, CRTs, and other computer components which they receive for assured destruction. Nationally the company processes approximately 15 million pounds per year of these materials, with approximately 40,000 pounds coming from North Carolina. The materials are sent to their parent company, ECS Refining Texas, LLC for processing.

Envirocycle, Inc., Morrisville, North Carolina, recycles all electronic equipment with a focus on CRTs. The company is based nationally out of Hallstead, Pennsylvania, and recently opened a CRT recycling division in Morrisville, North Carolina, just outside Research Triangle Park. The Morrisville plant also serves as a broker for electronics equipment other than CRTs. Nationally, Envirocycle recycled a total of 310,000 CRTs and televisions during 1997, recovering 24 million pounds of glass. In the first half of 1998, it recycled a total of 190,000 CRTs and televisions, recovering 14 million pounds of glass. Envirocycle separates the glass tube component from the computer monitors, and removes the coatings (lead) from the glass, before it is sold to makers of new CRTs.[17]

IBM, Research Triangle Park, North Carolina, is a manufacturer and developer of computer-related products. IBM has a re-manufacturing center located in Morrisville, North Carolina, where leased computers are brought back for refurbishment and are sold. Obsolete equipment is transported to IBM's Endicott, New York facility where several IBM national locations consolidate their equipment for de-manufacturing.

Thomson Consumer Electronics, Circleville, Ohio, is a recycler of CRT glass. Approximately six to 10 percent of its glass is recycled content, consuming 10,000 tons per year. Through its CRT glass recycling efforts, the company has recognized about eight percent energy cost savings and 40-50 percent savings on the purchase of recycled versus raw materials.[18]

Techneglas, Columbus, Ohio, and its parent company NEG, Japan, are the largest producers of faceplates and funnels for CRTs in the world, supplying such brand names as Sony, Toshiba, RCA, Philips, Zenith, Hitachi, Mitsubishi, and Panasonic. The companies currently use about five percent (15,000 tons) of recycled material in the production of their monitors each year. Techneglas uses cullet because of the cost savings over virgin material. The cost of raw material is approximately $300/ton, while recycled glass is approximately 60 to 75 percent of that cost. Technelgas officials also identified energy savings with reusing materials because the furnaces can operate at lower temperatures.[19]

Wesbell Group of Companies, Inc., Durham, North Carolina, purchased the telecommunications and electronic materials recovery facility previously owned by Nortel in May 1998. In 1997, they processed mostly in-house materials, but did accept small amounts of material from local businesses as a courtesy. Nortel (now Wesbell) handled about one million pounds of material per month, the largest portion of which was directly reused. Approximately 25 percent of materials were processed for recycling. An average of 35 people were employed last year by the facility.[20]

North Carolina State Surplus, Raleigh, North Carolina, is the state government agency responsible for refurbishing or scrapping all electronic equipment from state agencies. A central re-manufacturing operation is located in Raleigh. The facility refurbishes or de-manufactures computers depending on their reuse options. Computers that can be used in public schools are tested for quality, refurbished, then sent to the appropriate grade level depending on the schools' needs. Other equipment is processed into individual components, and materials are sold to recyclers/brokers. The facility handles approximately 10 computers per day, making it one of the largest recyclers in the state.

Other End Use Markets

Non-profit computer reuse companies manage small amounts of the electronics equipment in North Carolina. ExplorNet in Raleigh, North Carolina, is an example of a non-profit company that refurbishes computers for reuse in public schools. The organization receives donated computers from businesses and ships them to community colleges throughout the state. Technical students upgrade the systems, allowing them to learn computer technician skills. Computers are then sold to schools for a cost of $400, or approximately 25 percent of the typical cost of a new computer. Since its inception in 1997, ExplorNet's program helped build 250 computers from recycled and new parts.[21]

On-line computer equipment exchanges have developed on the Internet to facilitate the buying and selling of computers and peripherals. Some World Wide Web sites operate similarly to auctions, where the materials are sold to the highest bidder. Other sites list materials at set prices until they are purchased. Most of these programs require sellers to pay for transporting materials to the exchange for inspection prior to being listed on the site.

Exports are an important end market for electronics recycling for two reasons: (1) some export countries are less technologically advanced, and may demand electronic equipment that we consider to be obsolete, and (2) labor is typically cheaper in less developed countries. Labor is a key component in the economics of sorting the many different components of electronics equipment. For broken materials especially, it is essential to have reduced-cost labor to effectively separate the different materials. One local recycler estimated that breakage (obsolete and broken materials) has an export rate of approximately 80-90 percent for further separation by manual labor.[22] However, under the Basel Convention and OECD Council Decision, some discarded electronics can be deemed to be hazardous waste and therefore subject to restrictions on shipment to other countries, particularly lesser-developed non-OECD countries.[23]

SUPPLY / DEMAND RELATIONSHIP

Although costly, computer recycling activities are taking place at most large businesses. It is more likely for them to recycle computers than for small businesses or residents because of their ability to generate higher volumes of standardized equipment. For example, it is likely that a larger business will purchase a large number of the same type or brand of computer when updating its computer systems. These conditions make the economics of computer recycling more favorable.

Small businesses or residents are likely to generate small amounts of non-standardized equipment. Additionally, they appear to be lacking the knowledge of available options or the financial resources for computer recycling. Thus, the largest supply/demand issue currently involves the collection of materials from these two groups.

Several United States cities have undertaken pilot programs to recover electronics from households. In one study supported by the U.S. EPA's Common Sense Initiative, computers were collected from residents of San Jose, California. Usable computers were re-sold, and obsolete computers were recycled. Overall, the cost of the computer program was $142 per ton of material collected. However, this project included the export of the monitors to China for reuse and recovery. Had the project used a CRT recycler in the United States, it would have cost $584 per ton. In similar case studies, program costs ranged from $285 per ton of material collected to as much as $886 per ton.[24]

CONCLUSION

Although increasing quantities of computers and other electronics are being generated in North Carolina, recovery options are just developing. Existing efforts tend to be limited to larger businesses, leaving small businesses and residents without recycling options. Even where options exist, their equipment is typically obsolete and must be recycled, which is the most costly of the recovery options. Inevitably, increasing the quantity of electronic equipment recovered

from small businesses and residents will require substantial funding from local, state, or federal government to subsidize these programs.

RECOMMENDATIONS

The state should take the following steps to stimulate electronics recycling and ensure proper handling.

- *Develop a CRT management policy exempting CRTs from hazardous waste requirements if destined for recovery.* The state should develop a formal policy exempting CRTs from hazardous waste regulations or imposing less stringent regulations, as it has done for lights containing mercury, when these materials are destined for recovery.
- *Provide grants for establishing electronics collection programs*. The state should implement a grant program to encourage collection of electronics for reuse and recycling before they reach disposal facilities. Used electronics lose their after-market value when commingled with trash, so encouraging front-end collection of units by businesses, institutions, and municipalities helps ensure materials achieve their highest end use.
- *Develop state purchasing guidelines that support electronics recycling*. The state should explore the possibility of leasing or buying computers and other electronics from manufacturers with take-back programs. Such companies would need to have reuse and recycling programs for the returned equipment. These guidelines also should include preferences for the following: leasing programs, equipment that is recyclable or has recycled content, or equipment that exhibits other design for environment characteristics (e.g., easily upgradable, energy saving functions).
- *Educate small businesses and residents about computer recycling options.* Educating these entities about potential uses of old equipment could increase equipment value at the end of its useful life and decrease storage costs.
- *Survey current recovery efforts*. A survey of a representative sample of businesses in Research Triangle Park would provide better private sector recovery data and might identify large businesses willing to partner with smaller businesses to stimulate recovery.
- *Encourage public/private partnerships to increase recovery.* Local governments should partner with electronics recycling businesses to implement or expand recovery.

[1] MA DEP. Infrastructure Development Plan. May 1, 1998.
[2] MA DEP. Infrastructure Development Plan. May 1, 1998.
[3] MACREDO. *End-of-Life Computer and Electronics Recovery Policy Options for the Mid-Atlantic States*. p. 5.
[4] Personal communication. David Isaacs, Electronics Industry Association. November 1998.
[5] MACREDO. *End-of-Life Computer and Electronics Recovery Policy Options for the Mid-Atlantic States*. p. 5.
[6] Personal communication with Chris Altobell, Procurement Manager, United Datatech Distributors. September 8, 1998.
[7] MA DEP. http://www.magnet.state.ma.us/dep/bwp/dswm/files/crtmungi.htm.
[8] Personal communication. David Isaacs, Electronics Industry Association. November 1998.
[9] Defendis, Megan. "Regulations May Increase CRT Recycling," *Waste News*. September 14, 1998. p. 2.
[10] Hazardous Waste Section, NC DENR. Memo to Envirocycle, Inc. January 26, 1994.
[11] Personal communication. Linda Culpepper, Hazardous Waste Section, Division of Waste Management. October 1, 1998.
[12] Personal communication. David Isaacs, Electronics Industry Association. November 1998.
[13] Feinbaum, Robert. "Computer Reuse and Recycling," *MSW Management*. May/June, 1998. p. 79.
[14] http://www.comp-recycle.com/, http://www.cyberswap.com/UY9_1are/, http://www.recycles.com/remon.htm.
[15] http://www.cyberswap.com/UY9_1are/, http://www.comp-recycle.com/.
[16] Personal communication. Lamar Beardon, President, A&B Recycling. September 4, 1998.
[17] Personal Communication. Greg Vorhees, Sales Manager, Envirocycle, Inc. September 2, 1998.
[18] Personal communication. Herb Shall, Thomson Consumer Electronics. December 1, 1998.
[19] Personal communication. Jeff Lowry, Techneglas. September 3, 1998.
[20] Personal communication. Armand Billieux, Finance Manager, Nortel. September 8, 1998.
[21] Blaisdell, John. "ExplorNet recycles computers, focuses on technology integration in public schools." *Recycling Works*. August 1998, p. 1.
Personal communication with Steve Burns, ECS Refining, Greensboro, North Carolina, September 10, 1998.
[22] David Isaacs, Electronics Industry Alliance. November 6, 1998.
[23] MACREDO. *End-of-Life Computer and Electronics Recovery Policy Options for the Mid-Atlantic States*, Appendix A: Summary of Municipal Collection Programs.


tires
oil-related
WOOD
C&D
textiles
metals
Plastics
ORGANICS
White Goods
glass
electronics

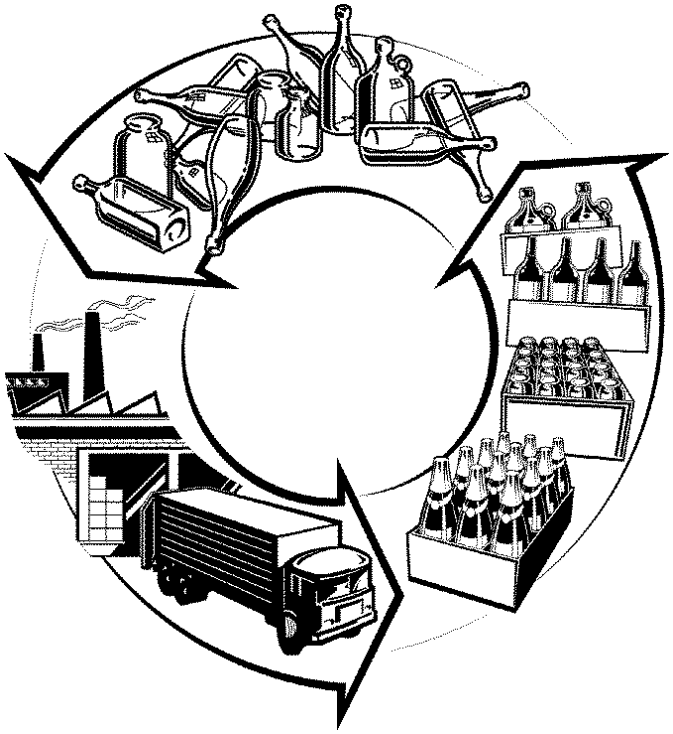
Glass

Glass

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

During the past 15 years, the glass container industry has undergone significant downsizing and consolidation. Since the last market assessment conducted by the North Carolina Department of Environment and Natural Resources in 1994, the number of container manufacturing facilities has decreased from 71 plants in 27 states to approximately 60 plants in 25 states.[1] As would be expected, glass generation has shown a slight decline during this period as well. This decline is mainly because of an increase in the use of aluminum and plastics for food and beverage packaging.

In 1997, the 60 United States plants produced more than 36 billion individual containers, down from 40 billion in 1994.[2] These containers can be roughly characterized as 58 percent flint (clear), 33 percent amber (brown), and nine percent green.[3]

Containers and packaging glass can be characterized further as three basic types: beer and soft drink bottles, wine and liquor bottles, and food and other bottles and jars. Beer and soft drink bottles are easily the largest of the three categories, making up nearly 47 percent of all containers. Food and other bottles and jars make up about 35 percent, and wine and liquor bottles represent about 18 percent of container glass.[4]

Since the early 1980s, the production of glass containers has declined slowly. This decline generally is attributed to the increase in plastic and aluminum beverage containers and, more recently, the increase in plastic food containers. The downward trend in production appears to be ending. Production of glass containers is expected to remain steady or show a slight increase during the next few years.[5]

Figure 1. Estimated Generation (Tons) of Glass Containers in North Carolina, 1997 and 2002

Glass Type	1997	2002
Flint	141,099	148,154
Amber	67,727	71,114
Green	73,371	77,040
Total	282,197	296,307

This report estimates the generation and recovery of glass containers in North Carolina for 1997 and 2002 as well as the potential demand for recovered glass in North Carolina and surrounding states. Furthermore, this report attempts to clarify the relationship between the supply and demand for recycled glass containers and provide recommendations for improving this relationship in North Carolina.

GLASS CONTAINER AND PACKAGING SUPPLY

Generation

Generation and recovery of container glass from public and private sources in North Carolina were calculated for 1997 and 2002 using published data, private industry surveys, and local government recovery data. Because national data is provided as overall glass packaging, without regard for color, national estimates were separated into color categories using national production characterization data with adjustments made for imports. A flint:amber:green generation ratio of 50:24:26 was chosen based on various sources and the 1994 market assessment. The actual 1997 recovery ratio in the state was 47:30:22.[6]

Estimates for glass generation in North Carolina for 1997 were developed using data published by the Glass Packaging Institute (GPI) and the U.S. EPA. The GPI data were averaged with projections based on EPA data and extrapolated for North Carolina based on the 1997 population. Projections for 2002 then were made based on an EPA estimated five-percent increase in glass production during a similar period and a six-percent increase in population as estimated by the North Carolina Office of State Planning.[7] The ultimate result is a one-percent decrease in per capita glass generation by 2002. Generation data for North Carolina provided in Figure 1 are based on the previously mentioned five-percent increase in production.

Recovery

The majority of glass recovered in North Carolina is from local government collection programs. Although substantial quantities of glass may be generated from restaurants, bars, hotels, and the like, recovery from these facilities is minimal. Some commercial sources of glass containers may be included in local government tonnages. However, tonnage recovered from non-residential sources is assumed to be less than 10 percent of all glass recovered in the state.

Even with local governments supplying more than 90 percent of the state's recovered glass, there are many local governments in North Carolina that do not provide glass recycling, and those that do recover only a small portion of the quantity generated. Some of the state's most successful recycling programs are recovering only about 20 percent of their glass. There are several reasons for low glass recovery including a lack of public education activities, processing costs, and transportation costs. These reasons are discussed later in this report.

Many circumstances likely affecting the supply of glass from local government sources apply to commercial sources as well. The main difference is that profits or cost avoidance become a more critical factor. To see a substantial increase in glass from commercial sources, the state most likely would need to experience an increase in the price paid for unprocessed glass or a substantial increase in tipping fees at disposal facilities.

Estimates of glass recovery were developed using annual local government solid waste management reports and a survey of private recyclers conducted by the North Carolina Recycling Business Assistance Center. With exception of fiscal year 1997, the general trend in local government glass recovery during the past decade is upward. Local government glass recovery data for fiscal years 1990-91 through 1996-97 are provided in Figure 2.

Local governments reported a significant tonnage of mixed glass on state annual report questionnaires in fiscal year 1996-97. These data most likely are reported to local government by private haulers as mixed glass, although in reality the glass is separated at a processor or drop-off facility. A recovery ratio of 47:30:22 (flint:amber:green) was applied

Figure 2. Local Government Glass Recovery (Tons) in North Carolina, 1990-91 to 1996-97

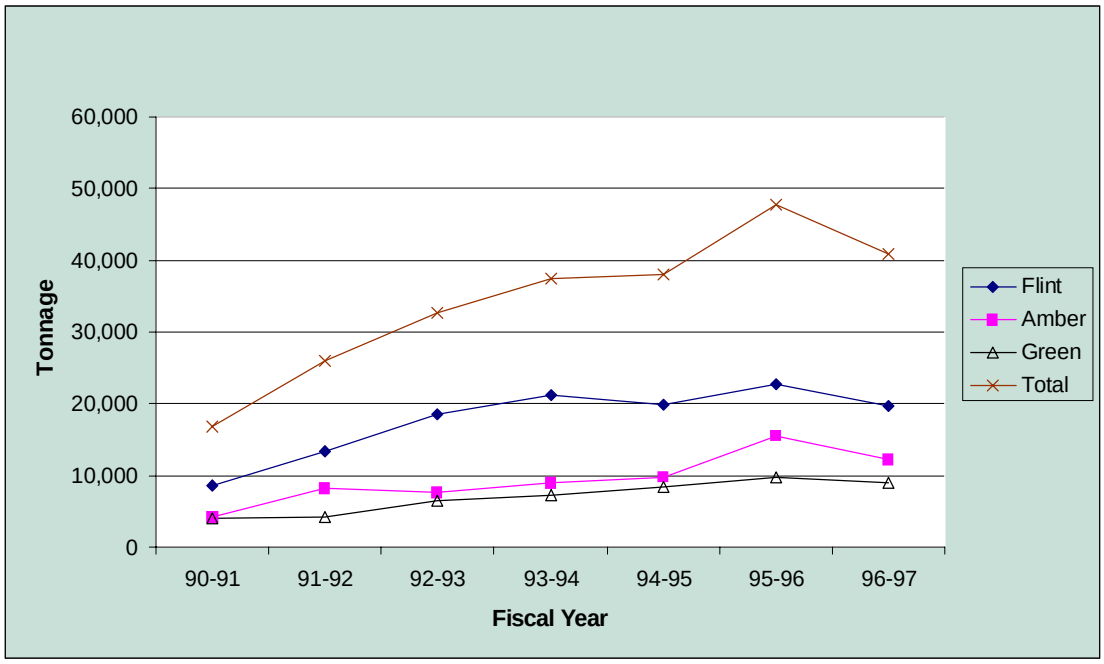


Figure 3. Estimated Recovery of Glass Containers in North Carolina 1997 and 2002

Glass Type	1997		2002	
	Tons	Percent	Tons	Percent
Flint	23,134	16.396%	24,542	16.565%
Amber	11,499	16.978%	12,231	17.199%
Green	10,392	14.164%	11,048	14.34%
Total	45,025	15.956%	47,821	16.139%

to the aggregate mixed glass tonnage to develop an overall color sorted tonnage for the state.

Reports submitted by local governments in the state indicate a drop of about 7,000 tons in recovered tonnage from fiscal year 1995-96 to fiscal year 1996-97. Two possible contributing factors to this decrease are:

- In 1994 and 1995, high market prices for several recyclable commodities resulted in increased efforts towards recycling. These prices returned to normal levels, as did the added boost to recycling programs.
- Annual reporting in fiscal year 1996-97 saw a 250 percent increase in tonnages reported as commingled. These commingled tonnages likely contain significant amounts of glass that are not quantifiable.

The second factor alone could underestimate glass recovery by several thousand tons. Overall, the decrease in tonnage in 1996-97 is not a concern yet. Nationally, both glass production and glass recovery saw declines during this period, and on a state level, many other commodities commonly collected by local governments also declined.

Unfortunately, data is not available to compare changes in commercial recovery from 1995-96 to 1996-97. Data were available, however, from research conducted by the Division of Pollution Prevention and Environmental Assistance in 1995. A comparison of these data indicates commercial glass recovered increased more than 100 percent from 1994-95 to 1996-97, but still represents less than 10 percent of total recovery.

The 1997 national recycling rate for glass containers was approximately 31 percent.[8] The State of North Carolina, as indicated in Figure 3, is only recovering about 45,000 tons, or 16 percent of the generation estimate, which is well below the national average. Without significant efforts from both commercial sources and local governments, the per capita recovery probably will remain about the same for 2002, which will represent an increase in tonnage to about 48,000 tons but no change in the total percent recovered.

Figure 4. Estimated Generation and Recovery of Glass Containers in North Carolina 1997 and 2002

Glass Type	1997		2002	
	Generation	Recovery	Generation	Recovery
Flint	141,099	23,134	148,154	24,542
Amber	67,727	11,499	71,114	12,231
Green	73,371	10,392	77,040	11,048
Total	282,197	45,025	296,307	47,821

As can be seen from Figure 4, the potential exists to significantly increase glass recovery tonnages. A doubling of current recovery would yield a rate similar to national average recovery. Furthermore, conversations with glass beneficiators indicate that processing capacity is available to handle such an increase in recovery.

GLASS CONTAINER AND PACKAGING DEMAND

Overview

In 1994, there were eight glass container manufacturing plants in North Carolina and its surrounding states. With the closure of the Ball-Foster Plant in Laurens, South Carolina, there are currently only seven container manufacturing plants. Three of these manufacturing plants are in North Carolina, and there are two facilities in both Georgia and Virginia. Further information regarding these facilities is discussed later in this report.

End-use markets for glass containers generally can be classified as two types: primary ¾ end-users that turn glass containers back into glass containers; and secondary ¾ end-users that use glass for purposes other than making glass containers. From a processing standpoint, this terminology can be somewhat misleading. That is, secondary markets do not necessarily require less processing. In some cases, particularly with fiberglass insulation, a higher level of processing may be required than for a primary market.[9]

The glass container industry is by far the largest end-user of glass cullet (broken/crushed glass) in the United States. Regardless of strict industry specifications for recycled cullet, almost 80 percent of all glass designated for recycling in 1997 was made back into glass containers.[10] Based on the sporadic nature of secondary markets, the glass container industry will remain the dominant end-user of glass cullet. This report focuses on primary markets, however, secondary markets identified during this assessment will be reviewed.

Several characteristics relating to the melting point of container glass cullet make it advantageous for glass container manufacturers to use.

- Cullet melts at a lower temperature than virgin batch. With the appropriate amount of cullet, furnaces can run at temperatures as high as 200 F lower than if all virgin batch is used.[11]
- Therefore, the use of cullet requires less energy than 100 percent raw materials. On average, for every 10 percent cullet used, the manufacturer will save 2.5 percent in energy costs.[12]
- Beyond saving energy costs, running lower furnace temperatures also can extend the overall furnace life.
- Container glass is 100 percent recyclable and shares the same characteristics of other container glass. For example, one ton of cullet from beer bottles can yield a ton of jars, cosmetic bottles, etc.

Given the potential energy cost savings provided by the use of cullet in making new container glass, purchases of cullet usually are given a small price preference over virgin materials. Conversations with several glass manufacturers indicate this preference is somewhere in the range of five percent.

In the early 1990s, the main concern surrounding glass recycling was an oversupply of green cullet. Although locating end users for green cullet still remains an issue throughout North Carolina and the United States, contamination currently is the major concern surrounding glass recycling.

The Institute of Scrap Recycling Industries (ISRI) sets specifications for processed and unprocessed glass cullet nationwide.[13] These specifications identify the following as prohibitive materials or contaminants: ferrous and non-ferrous metals, ceramics, other glass (plate glass, heat resistant glass, lead based glass, television glass, vision ware, etc.) and other materials (bricks, rocks, etc.). Conversations with various manufacturers indicated ceramics as a major concern in the southeast, although aluminum caps also were indicated as a problem material. Specifications for processed cullet are strictest for flint cullet, which must have less than five percent non-flint cullet. Amber follows with as much as 10 percent non-amber cullet allowable in the mix, and green can withstand up to 30 percent non-green cullet and still be useable.

Figure 5. Estimated Production of Glass (Tons) in North Carolina and Surrounding States, 1997

State	Flint Glass	Amber Glass	Green Glass
North Carolina	203,695	64,324	0
Georgia	66,707	171,533	0
Virginia	59,560	50,626	0
Total	329,962	286,483	0

Local government recycling programs have grown substantially in North Carolina since the late 1980s. With this growth has come an increase in the need to process more materials and a switch from curb/generator-sorted recycling to commingled recycling. Source separated glass at drop-off centers is still common. While the increase in glass collected has helped the state with efforts to reach its 40 percent waste reduction goal, it also has raised concerns for the glass manufacturing industry.

While the quantity of cullet supplied to glass manufacturers has increased, the quality has decreased, creating problems for manufacturers, and in some cases resulting in loads being rejected. All seven glass manufacturers in North Carolina and surrounding states indicated that the quality of the glass being supplied was a key concern, and two facilities either stopped taking municipally collected glass or altered the method by which they obtain their cullet.

Improperly cleaned transport vehicles are another source of contamination. Improper rinsing or sweeping of a vehicle that had previously transported a load of stone or similar materials could result in the contamination of a processed load of cullet.

These concerns about contamination have expanded the use of intermediate processors or benificiators. There are two such processors in North Carolina and two in Georgia that handle significant quantities of glass. The purpose of these operations is to improve the quality of color sorted, mixed whole/broken glass to furnace-ready quality. North Carolina facilities are the Container Recycling Alliance (CRA), located in Raleigh, and Owens-Brockway processing facility, located near Winston-Salem. Because of limited locations, long travel distances often become a concern for glass suppliers such as commercial establishments and local governments.

Production

Demand for glass in North Carolina and its border states was difficult to ascertain. The glass container industry is very competitive and keeps production, capacity, and other proprietary figures well guarded. It was, therefore, necessary to develop an alternative method to estimate production and demand for the industry. Production based on employment was chosen as the best substitute.

National employment figures were compared to national glass production estimates to generate average production per employee. This national production per employee factor was then applied to employment figures for the seven regional manufacturers to determine glass production per facility. These figures were further adjusted to represent the colors produced for each facility. Anecdotal information obtained during this assessment indicates that technology differences between facilities may result in significant over or under estimation of glass production. This same information indicates that North Carolina production calculations may greatly underestimate actual production. On a regional level however, production estimates should more closely reflect actual production. Production levels are given on a state and regional level only. These figures are presented in Figure 5.

There are seven glass manufacturing plants in North Carolina and surrounding states. Location, employment, and production background are provided in Figure 6.[14] All seven facilities use recycled cullet in the production of new flint and amber glass. Unfortunately, neither Virginia facility receives cullet from North Carolina sources. No green glass is produced in North Carolina or surrounding states.

Demand For Flint And Amber Cullet

The potential demand or overall capacity to handle glass cullet has increased through the years. The use of cullet in furnaces has grown substantially since the early 1980s. Today glass manufacturers nationally are using about 35 percent cullet, including cullet produced in-house from breakage and defects.[15] If only post-consumer cullet is considered, the average bottle is in the range of 27 percent recycled content, which appears representative of production in the southeast.[16]

It has been shown that glass manufacturers can sustain glass cullet percentages in the range of 70 to 75 for green and amber and up to 55 for flint.[17] Although these levels are

Figure 6. Glass Container Manufacturers in North Carolina and Surrounding States, 1997

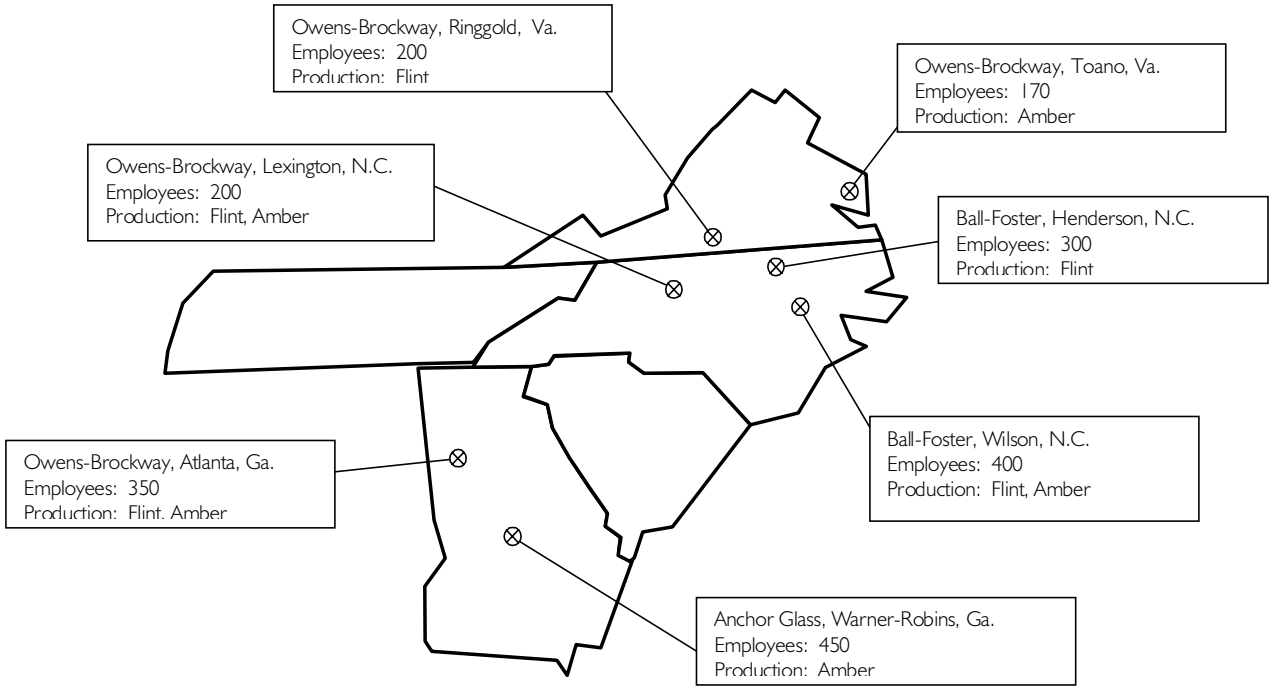


Figure 7. Potential Estimated Demand for Glass Container Cullet in North Carolina and Surrounding States

	1997	**2002**
North Carolina		
Flint	112,033	117,635
Amber	45,027	47,278
Green	10,392	11,048
Total	**167,452**	**175,961**
North Carolina and Surrounding States		
Flint	181,480	190,544
Amber	200,540	210,567
Green	10,392	11,048
Total	**392,412**	**412,159**

sustainable, the cullet supply must be consistent and very well processed. In one extreme instance in Pennsylvania, a severe winter resulted in a low supply of soda ash. To compensate for the lack of soda ash, an Anchor facility in Royersford, Pennsylvania, used 100 percent recycled cullet for seven weeks, generating 100 percent recycled green bottles.[18]

To determine the potential demand for glass from primary markets in North Carolina and surrounding states, the optimal in-furnace percentages were used. Cullet:virgin ratios of 55:45 and 70:30 were used for flint and amber respectively. For example, to determine the potential demand of flint cullet for a specific facility, the facility's estimated flint production was multiplied by 0.55. Projected demand for 2002 was also developed based on an EPA estimate of five percent increase in production with all other assumptions held constant.[19] Demand estimates for 1997 and 2002 are provided for North Carolina and North Carolina and surrounding states in Figure 7. It also must be noted that two of these facilities are not currently receiving glass from North Carolina, and some or all of these facilities accept glass from sources other than North Carolina. No attempt was made to adjust for these factors. Estimated supply and potential demand for flint, amber, and green cullet in 1997 and 2002 are provided in Figure 8, and their relationship is discussed in the following section.

Figure 8. Supply and Potential Demand for North Carolina and Surrounding States, 1997 and 2002

North Carolina	Flint		Amber		Green		Total	
	1997	2002	1997	2002	1997	2002	1997	2002
Supply	23,134	24,542	11,499	12,231	10,392	11,048	45,026	47,821
Potential Demand	112,033	117,635	45,027	47,258	10,392	11,048	167,452	175,961
North Carolina and Surrounding States	**Flint**		**Amber**		**Green**		**Total**	
	1997	**2002**	**1997**	**2002**	**1997**	**2002**	**1997**	**2002**
Supply (N.C. Only)	23,134	24,542	11,499	12,231	10,392	11,048	45,026	47,821
Potential Demand	181,480	190,544	200,540	210,567	10,392	11,048	392,412	412,154

Demand for Green Cullet

Although no green glass is being produced in North Carolina or surrounding states, green glass is accepted for processing. Processors are accepting green glass and in some cases shipping it to facilities several states away. Some green glass also is being mixed with amber cullet for the production of amber glass. One southeastern glass manufacturer indicated using a 60:40 (amber:green) mix of cullet for the production of amber glass. This likely represents a significant quantity of green glass recovered in the state. Although processors are willing to accept green glass, it is unlikely that any processors or end-users in the region are actively seeking it. Demand for green glass was, therefore, assumed to be equal to supply for 1997 and 2002.

The only national figures available for green cullet demand indicate that imports of green glass likely create a supply over green production of about one million tons annually.[20] These figures, however, are dated and may no longer represent the industry. National production figures from various sources indicate a decrease in the established nine percent green glass production figure as a percentage of United States production. On the other hand, increases in the percent of cullet used, the ability to utilize some green cullet in the production of amber glass, exports of green cullet to other countries and an increase in secondary markets may have off-set this decrease in production. Nevertheless, the supply of green glass in the U.S. likely exceeds demand.

Demand From Secondary Markets

Attempts to quantify the amount of glass going into secondary markets were not successful; however, anecdotal information obtained during this assessment indicates that quantities are small. Demand by secondary markets is, therefore, assumed to be zero. Although demand is considered to be virtually zero, several small markets do exist, and others are in development. Examples include:

- Potters, Inc., located in Apex, North Carolina, uses flint cullet as glass beads for the production of reflective road markers. Potters, Inc., requires cullet to be processed and clean of contaminants.
- The North Carolina Department of Transportation recently investigated the use of glass cullet as an aggregate for construction.
- A materials recovery facility (MRF) in Mecklenburg County has developed a market in Tennessee. Glass that does not meet the quality specifications of glass container manufacturers is finely ground and sent to Tennessee where it is mixed with soil and utilized for landscaping purposes.
- A Georgia glass processor markets glass that does not meet specifications to a copper melting facility that uses the glass as a fluxing agent.

Although secondary markets do not account for significant glass capacity in North Carolina and surrounding states, they are still an important aspect of glass recycling. This is especially true for secondary markets that accept mixed color glass or off-spec glass that would normally be landfilled. Although secondary markets have grown and are expected to continue growing, it is difficult to determine their current and future impact. One estimate indicates more than 70 non-container uses for glass including asphalt (glassphalt), aggregate, glass bead, filter medium, and insulation products. However, many secondary markets are still in the research phase and, in many cases, end-products need state-by-state approval such as the use of glassphalt.[21]

SUPPLY / DEMAND RELATIONSHIP

Because the majority of demand for cullet is from primary markets, this assessment of the supply / demand relationship will focus on primary markets. It is apparent that the supply of processed flint and amber cullet in North Carolina and the southeast is well below the potential demand. Without significant efforts to increase the supply of pro-

cessed flint and amber glass, this trend undoubtedly will continue until 2002 and beyond. On the other hand, demand for green cullet is approximately equal to supply and most likely will not deviate from this pattern through 2002. It appears overall that the focus of the glass industry is on the quality of the current supply rather than increasing supply.

All but one of the glass manufacturers contacted during this assessment indicated their facilities could handle a doubling of the amount of cullet currently in use. In most cases end-users indicated they would like to increase cullet supply. In fact, one manufacturer indicated that he would like to quadruple his current cullet intake. Unfortunately, the recovery of glass generated in North Carolina is only 16 percent, about half that of national recovery and well below end-use capacity.

Up to this point, the supply of cullet has been compared to the potential demand if end-use facilities use optimal amounts of cullet. In a sense, this is a theoretical relationship between what is supplied from generators and what could technically be utilized by end-users. The actual relationship between generator and end-user is much more complicated.

The advent of glass beneficiators has created two distinct supply/demand relationships for glass recycling. The first relationship is between the glass generator (local governments, commercial establishments, etc.) and the beneficiator. Conversations with beneficiators in North Carolina and surrounding states indicate supply at this level may be as much as 50 percent below demand, or processing capacity. Given end market constraints, it can be expected that actual demand is somewhat near, if not at capacity. Although an increase in market prices paid by beneficiators might increase the supply, it is unlikely this will occur without a parallel increase in prices paid by end-users.

The second relationship occurs between the beneficiator and the end-user. Once again, as can be seen throughout this report, end-use supply is low compared to the potential demand. Other factors such as the availability of virgin materials play a part in this relationship. As long as raw materials are available, the glass industry is much more likely to focus efforts on increasing quality. In fact, the industry views the increase in supply as the ultimate cause of decreased quality.

To better understand how prices for furnace-ready cullet are determined, both beneficiators and end-users were contacted. From the beneficiators standpoint, the cost of processing plays a large part in what price will be accepted, and from the end-users standpoint, it appears the cost of virgin materials plays a role.

Factors Affecting Recovery/Supply

Many factors beyond supply/demand economics affect supply and demand. This is true particularly for the supply of glass. Local governments are the largest supplier of glass statewide. As mentioned earlier, many North Carolina local governments do not provide glass recycling, and those that do, are recovering only a small portion. There are three key reasons why more glass recycling is not taking place on the local government level. The first and most important is public education. Public education is a critical component of all recycling programs. However, since the early 1990s, when recycling programs were first implemented, public education has likely dropped significantly. An increase in targeted public education programs statewide would likely increase the quantity of glass collected as well as the quality.

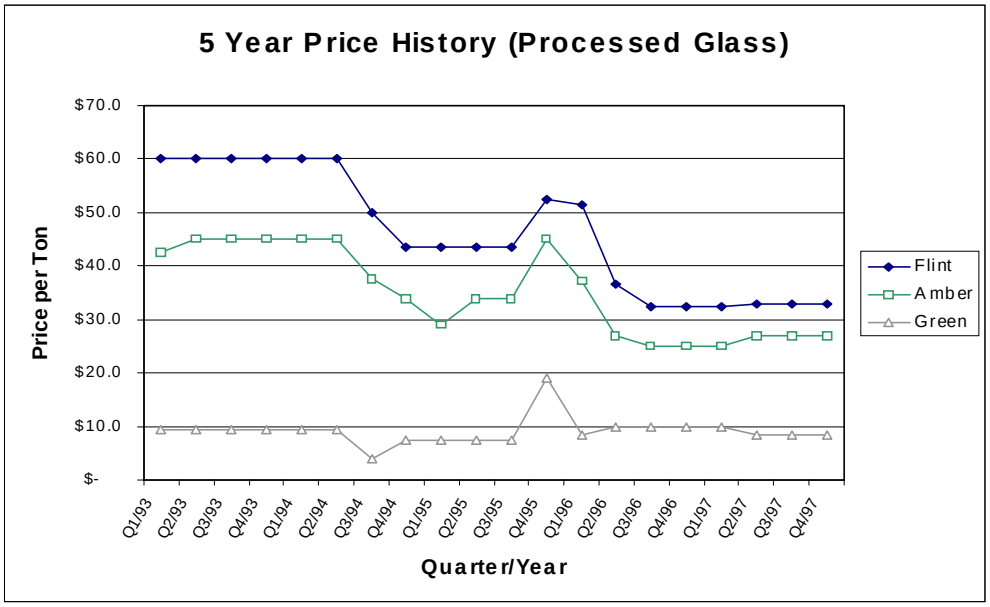
A critical factor in the supply of glass cullet is processing. Glass must meet strict standards to be considered furnace ready, and meeting these standards is expensive. The increased costs of processing glass often results in a low price paid for glass by the processor, making it less profitable for generators.

Transportation is another factor closely related to processing. Because there are only two glass processors in the state, once glass is collected, it must be transported long distances for processing, adding additional costs to recycling. Unfortunately, because of the bulkiness of glass, a generator would need significant storage space to maximize the efficiency of transporting loads to a beneficiator. Because most generators do not have this space available, inefficient transport of glass is a common occurrence, further increasing the cost of glass recycling.

To combat this problem in eastern North Carolina, the Eastern Carolina Vocational Center (Greenville, North Carolina) installed glass bunkers, which are basically large storage bins for glass. This setup allows glass recyclers in the eastern part of the state to haul their color sorted glass to Greenville, North Carolina. Although paid less for their glass at the Greenville facility than at a beneficiator, the avoided transportation costs likely out-weigh the decrease in revenue.

In a similar case, New Hanover County installed glass bunkers to allow more efficient hauling to the Raleigh processing facility. The efficiency achieved from this system resulted

Figure 9. Five Year Price History for Processed Glass in the Southeast (End-user Prices)



in a revenue of $10.87 per ton rather than a previous cost of $38.19 per ton. No such facilities exist in the western part of the state.

Price History

Processed glass prices traditionally are among the most stable of all recycling commodities. Prices for flint and amber glass experienced some downward movement from 1993 to 1995, but overall have been relatively constant since 1996. Prices are expected to remain about the same in the future with changes likely approximating those in the cost of virgin materials. Figure 9 provides a five-year price history for glass cullet in the southeast.

CONCLUSION

Glass recycling has advanced substantially since the late 1980s. Likewise, the use of glass in furnaces also has increased. In the early 1990s, the main concern surrounding glass recycling was an oversupply of green cullet. Although locating end users for green cullet still remains an issue throughout North Carolina and the United States, currently, contamination is the major concern with glass recycling and most likely will remain the key issue for some time.

It is likely that contamination concerns have increased as municipal recycling programs have expanded. Unfortunately, contamination has become such an issue that one manufacturer indicated it no longer purchased cullet from processors, and another indicated it will not accept municipal cullet.

This increase in contamination is the result of two main factors.

- The first is the difficulty in educating the public, or, in some cases, the lack of local government education programs. The public consistently mixes contaminants with glass believing they are recyclable. The most common contaminants are ceramics, caps, and heat-resistant glass such as vision ware.
- The second factor is that an increase in commingled collection of recyclables has made processing more difficult. Technologies such as ceramic detectors and optic sorters currently are available to enhance processing capabilities. However, they are expensive and require large volumes of glass to justify investments. One processor in North Carolina currently is investigating its installation.

Although demand issues can be overcome, it will be difficult to substantially increase the amount of glass supplied to processors, especially from commercial sources. The recycling of glass does not guarantee a profit or even cost avoidance – key issues for increasing the glass supply from commercial sources. The challenges of transporting glass efficiently and the high cost of processing glass ultimately will control the supply of glass.

RECOMMENDATIONS

It is likely that without significant change, the potential and actual demand for recycled glass will remain higher than

the supply. Some steps that could be taken to improve the quality of glass cullet supply and reduce the gap between supply and demand are:

- Local governments should be encouraged to institute or expand public outreach and education programs. Such efforts, if properly focused, should result in an increase in quantity and quality of all recyclable materials.
- Glass bunkers should be utilized where possible to increase the efficiency of transporting glass, particularly in the western part of the state.
- To increase the quantity of glass collected throughout the state, equitable, waste reduction based collection systems such as pay-as-you-throw (PAYT) should be encouraged. PAYT programs charge system users based on the amount of waste generated, thereby providing financial incentives to reduce and recycle.
- Local governments should be encouraged to implement glass recycling programs where programs do not already exist and seek methods for improving the efficiency of existing programs. An example of a possible method for improving efficiency is local government partnerships for hauling and marketing.
- To increase commercial glass recycling, public/private partnerships should be encouraged throughout the state. Such partnerships would allow commercial generators to begin recycling glass without significant additional costs. These partnerships also should create new efficiencies in local government programs.
- Glass manufacturers should be encouraged to increase their involvement with local governments to further explain contamination issues and how to improve the quality of glass supply.
- Glass beneficiators should be encouraged to work with local governments to increase the quantity and quality of glass supplied. Beneficiators should also be encouraged to investigate new technologies for glass processing.
- The Division of Pollution Prevention and Environmental Assistance (DPPEA) should continue to identify secondary markets for glass and expand the *Directory of Markets for Recyclable Materials* to include markets for mixed cullet.
- DPPEA should continue to assist local governments and businesses in expanding and improving recycling programs.
- The N.C. Department of Transportation should take the lead role in investigating the use of recycled glass as an aggregate and for other products such as glassphalt.

[1] Personal communication with Dave Baker, Area Director, Southeast Region, Glass Packaging Institute, June 1998.
[2] U.S. Department of Commerce, "Glass Containers - 1997 Summary (M32G[97])," *Current Industrial Reports*, U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census, June 1998.
[3] Personal communication with Dave Baker, Area Director, Southeast Region, Glass Packaging Institute, June 1998.
[4] U.S. EPA, *Characterization of MSW in the United States: 1997 Update*, June, 1998.
[5] Tyler, Nathan. "Glass Recycling: Cause and Effect," *Resource Recycling*, Vol. XV, No. 8 (Aug 1996), pp 39-42.
[6] Total may not equal 100 due to rounding.
[7] U.S. EPA, *Characterization of MSW in the United States: 1996 Update*, June, 1997.
[8] The Glass Packaging Institute estimates 1997 recovery for glass containers as 35 percent nationwide. For the purposes of this report, refillable containers were removed from GPI's data resulting in a recovery rate of 31 percent.
[9] Personal Communication with Bob Sinclair, GDS, Inc., June 1998.
[10] Glass Packaging Institute, *Americans Continue to Recycle More Than One in Three Glass Containers* (Press Release), April, 1998. Figures were adjusted to exclude refillable bottles.
[11] "Recycling Markets Profile: Glass Containers," Supplement, *Resource Recycling*, 1994.
[12] Glass Packaging Institute, *Glass Recycling Source Book*, 1st Ed., 1996.
[13] Institute of Scrap Recycling Industries, Inc., *Scrap Specifications Circular 1998*, 1998.
[14] Data provided from a DPPEA industry survey, June 1998.
[15] Personal Communication, Dave Baker, Area Director, Southeast Region, Glass Packaging Institute, June 1998
[16] Miller, Chaz, "Profiles in Garbage: Glass," *Wasteage*, Vol. 28, No. 10 (Sep. 97).
[17] Personal Communication, Dave Baker, Area Director, Southeast Region, Glass Packaging Institute, June 1998
[18] "Recycling Markets Profile: Glass Containers," Supplement, *Resource Recycling*, 1994.
[19] U.S. EPA, *Characterization of Municipal Solid Waste in the United States: 1996 Update*, June 1997.
[20] Apothecker, Steve, "Glass Containers: How Recyclable will they be in the 1990s," *Resource Recycling*, Vol. X, No. 6 (Jun 1991), pp 25-32.
[21] "Recycling Market Profile: Glass Containers," Supplement, *Resource Recycling*, 1994.

Aluminum Cans & Scrap ▪ Steel Cans & Scrap

Metals

Metals: Aluminum Cans & Scrap

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

According to the U.S. Geological Survey, the estimated primary aluminum production (from virgin material) for 1997 was 3.6 million metric tons, while secondary aluminum production (from scrap material) was 3.7 million metric tons. Of this recovered metal, 59 percent came from new (manufacturing) scrap and 41 percent came from old (discarded aluminum products) scrap. Old scrap accounted for approximately 17 percent of the total apparent domestic consumption. Apparent consumption is total aluminum production plus net imports plus stock changes.[1]

Used (aluminum) beverage can (UBC) scrap is the major component of processed old scrap, accounting for approximately one-half of the old aluminum scrap consumed in the United States. Most UBC scrap is recovered as aluminum sheet and manufactured back into aluminum cans. Most of the other types of old scrap are recovered in the form of alloys used by the die-casting industry; the bulk of these diecasts are used by the automotive industry.[2]

Overall, the aluminum industry produced 100.5 billion cans, or 1.5 million tons, in 1997, with the weight of the average can declining 2.1 percent to 32.57 cans per pound. The typical aluminum beverage can has a recycled-metal content of 54.7 percent.[3] The total estimated UBCs recovered nationally in 1997 was 63.3 billion cans (972,000 tons), representing an overall recovery rate of 63 percent. The average end-user price for UBCs in the Southern United States region for 1997 was $1,142.50 per ton or $0.57 cents per pound.

In North Carolina, out of an estimated total supply of 42,891 tons of UBCs, approximately 21,076 tons were recovered by the public and private sectors. This represents a 49 percent overall recovery rate for UBCs in North Carolina in 1997.

Figure 1: Supply of Aluminum Cans

Year	Number of Cans Shipped (Billions)[1]	Number of Cans Per Pound[1]	Pounds of Cans Shipped	United States Population[2]	Per Capita Consumption (Pounds)	Per Capita Consumption (Number of Cans)
1993	94.2	29.51	3,192,138,258	257,752,702	12.38	365.47
1994	99	30.13	3,285,761,699	260,292,437	12.62	380.34
1995	100.7	31.07	3,241,068,555	262,760,639	12.33	383.24
1996	99	31.92	3,101,503,759	265,179,411	11.70	373.33
1997	100.5	32.57	3,085,661,652	267,636,061	11.53	375.51
Average	**98.68**	**31.04**	**3,181,226,785**	**262,724,250**	**12.11**	**375.58**

Source: 1) The Aluminum Association
2) U.S. Census Bureau

SUPPLY

Generation

The domestic supply of aluminum cans is presented in Figure 1. The weight of an individual aluminum can has been decreasing during the past five years as manufacturers have improved production efficiency. The number of aluminum cans produced by a pound of aluminum has increased from 29.5 cans per pound in 1993 to 32.6 cans per pound in 1997. Thus, when determining the trend of per capita supply, it is necessary to look at the number of cans rather than pounds being supplied. From 1993 until 1995, the quantity of aluminum cans consumed per person per year rose from 365 to 383, an increase of 18 cans per person. In 1996, that figure dropped to 373 cans per person per year, but began to rise again in 1997. The 1997 estimate is very close to the average of the past five years (approximately 376 cans), showing no definite trend of increase or decrease.

The generation and recovery estimates of UBCs in North Carolina are presented in Figure 2. The projections for generation of UBCs for 1998-2002 were estimated by taking the 1997 per capita UBC supply rate (11.53 pounds per person), multiplied by the anticipated North Carolina population for the next five years. The generation figure assumes that the number of aluminum cans per pound will remain relatively constant, and the average consumption per person will remain constant as well. However, the supply of UBCs during the next five years depends largely on the effects of increasingly popular alternative beverage container materials. The PET plastic bottle is one material that has seen significant growth recently. Much of the growth in PET usage has been attributed to its aggressive capture of market share in the soft drink container business. The fastest growing market for PET bottles is single serve containers, especially 20-ounce drink bottles.[4]

Recovery

Based on survey results from North Carolina's private industry and local governments, the estimated total UBCs recovered in North Carolina in 1997 was 21,076 tons. This translates into a recovery rate of 49 percent, showing a four-percent increase from the 1994 estimated UBC recovery rate of 45 percent. The State of North Carolina implemented an aluminum can ban in July 1994, but even with this mandate, a significant portion of the UBCs continue to be landfilled. In Figure 2, the projected quantities of UBCs recovered for 1998-2002 are based on the current per capita recovery rate (5.67 pounds per person), adjusted for future population estimates.

The national recovery rates for UBCs are presented in Figure 3 along with recovery rates for North Carolina. In 1997, the estimated national recovery rate for UBCs was 63 percent. This figure is an average of the estimated recovery rates reported by The Container Recycling Institute (59.1 percent) and The Aluminum Association (66.5 percent). According to the Container Recycling Institute, approximately 7.4 billion cans out of the 66.8 billion recycled in 1997 are imported cans.[5] Although it is difficult to accurately determine the exact quantity of cans being imported for recycling, an estimated figure should be taken into account to accurately reflect domestic generation and recovery.

Other Aluminum Scrap

Aluminum UBCs continued to make up the largest portion of the scrap aluminum purchased domestically in 1997. However, discarded aluminum products (old scrap) other than UBCs are also significant sources. Figure 4 shows a breakdown of the total amount of purchased old scrap for 1996 and 1997. Purchased old scrap includes the materials that are purchased from post-consumer sources and

Figure 2: Estimated Generation and Recovery of Aluminum Used Beverage Containers (UBCs) in North Carolina

	1994[1]	1997	1998	1999	2000	2001	2002
Generation (Tons)[2]	43,740	42,891	43,504	44,073	44,601	45,055	45,513
NC Population[4]	7,024,000	7,436,690	7,542,996	7,641,684	7,733,097	7,811,951	7,891,238
Estimated NC Recovery (Tons)[3]	19,683	21,076	21,377	21,657	21,916	22,140	22,364

Sources: 1. N.C. DENR, Assessment of the Recycling Industry and Recycling Materials in NC: 1995 Update
2. The Aluminum Association
3. North Carolina Recycling Survey, 1998
4. North Carolina Office of State Planning

Figure 3: Estimated North Carolina and National Recovery rates for UBCs

	1991	1992	1993	1994	1997
Estimated North Carolina Recovery[1]	14.5%	22.6%	38.8%	45%	49%[3]
Estimated United States Recovery[2]	62.4%	67.9%	63.1%	65.4%	63%

Sources: 1. N.C. DENR, Assessment of the Recycling Industry and Recycling Materials in North Carolina: 1995 Update
2. The Aluminum Association
3. North Carolina Recycling Survey

Figure 4: United States Consumption of Purchased Old Aluminum Scrap for 1996-1997 (Metric Tons)

Material Type	1996	Percent	1997	Percent
Aluminum Cans	871,000	51%	949,000	57%
Castings, Sheet, and Clippings	764,000	45%	587,000	35%
Other	61,700	4%	110,000	7%
Aluminum – Copper Radiators	17,800	1%	25,400	2%
Total	**1,714,500**	**100%**	**1,671,400**	**100%**

Source: U.S. Geological Survey, 1996 and 1997 Annual Reports for Aluminum, Table 4.

does not include in-house or pre-consumer scrap derived from the aluminum production process. Aluminum UBCs were 57 percent of all the old scrap aluminum purchased domestically in 1997. Castings, sheet, and clippings have the second largest share, at 35 percent. Aluminum-copper radiators and other aluminum make up the remaining small portion of old scrap.

Figure 5 shows the generation and recovery of all aluminum for 1993-1997, including old and new scrap. The total secondary recovery figures are different from the figures for scrap aluminum purchased in Figure 4. The total secondary recovery is the estimated total quantity (tons) of aluminum and aluminum alloy products manufactured by secondary aluminum producers derived from purchased aluminum scrap. On average, for the past five years, old and new scrap have held an approximately even share of the total scrap consumed.

Of the total available supply, the percentage of all aluminum recycled remains at around 40 percent. However, a large portion of aluminum products are durable goods, and

Figure 5: Generation and Recovery of the Total Domestic Aluminum Supply (thousand metric tons)

	1993	1994	1995	1996	1997	Average
Recycled from New Scrap	1,310	1,580	1,680	1,730	2,160	1,692
Recycled from Old Scrap	1,630	1,500	1,510	1,580	1,530	1,550
Total Secondary Recovery	2,940	3,090	3,190	3,310	3,690	3,244
Apparent Supply	7,920	8,460	8,010	8,330	8,850	8,314
Total Secondary Recovery (Percent)	37%	36%	40%	39%	42%	39%

Source: U.S. Geological Survey, 1997and 1998 Annual Reports for Aluminum, Table 1.

Figure 6: United States Aluminum Industry Net Shipments (thousands of metric tons)

Major Market	1995	% of Total	1996	% of Total	1997	% of Total
Transportation	2,608	27.3%	2,640	27.5%	2,990	29.2%
Containers & Packaging	2,308	24.1%	2,175	22.6%	2,220	21.7%
Building & Construction	1,215	12.7%	1,325	13.8%	1,325	12.9%
Electrical	657	6.9%	671	7.0%	708	6.9%
Consumer Durables	621	6.5%	655	6.8%	694	6.8%
Machinery & Equipment	570	6.0%	569	5.9%	626	6.1%
Other	279	2.9%	291	3.0%	318	3.1%
Domestic, total	8,258	86.3%	8,325	86.6%	8,881	86.8%
Exports	1,307	13.7%	1,287	13.4%	1,355	13.2%
Aluminum Total	**9,565**	**100.0%**	**9,613**	**100.0%**	**10,237**	**100.0%**

Source: The Aluminum Association

it is important to note that the apparent supply of aluminum is going to be more than the amount of aluminum actually available for consumption as scrap within the same year. Since no data are available for the amount of aluminum (other than UBCs) recovered locally in North Carolina, the recovery rates are assumed to be similar to the national rates.

DEMAND

The demand for UBCs and other aluminum scrap is dependent upon the supply and demand for primary aluminum derived from virgin material. The demand for primary aluminum is determined by the domestic and international demand for aluminum ingot and aluminum finished products. In 1997, domestic primary production was estimated to be 3.6 million metric tons, which shows no relevant increase in production from 1996.

Transportation accounted for an estimated 32 percent of domestic consumption in 1997; containers and packaging, 26 percent; building and construction, 16 percent; electrical and consumer durables, eight percent each; and other uses, 10 percent.[6] The international distribution of United States goods, which is included in the United States aluminum industry net shipments (Figure 6). is as important as domestic consumption. Exports for aluminum remain the third largest component of all shipments, with a 13.2 percent share, making international markets for aluminum vital to the industry.

The containers and packaging segment of US shipments of aluminum is decreasing. The increasing use of plastics in soda bottles is having a negative effect on the overall demand for aluminum packaging. Figure 6 shows the decreasing percentage of containers and packaging in United States shipments of aluminum for 1995, 1996, and 1997, with the percentages being 24.1, 22.6, and 21.7 respectively.

Figure 7. Demand Estimates for Aluminum Scrap in the United States and North Carolina

	1997	2002
Old Scrap Aluminum Consumed in United States (tons)	1,671,400	1,772,158
North Carolina Population (thousands)	7,243	7,891
North Carolina Demand (tons)	47,260	50,109

The aluminum industry currently is attempting to counter the use of plastics through a series of advertising and marketing efforts supporting the use of aluminum cans.

The largest and most promising segment of United States shipments of aluminum is the transportation industry. Aluminum is a desirable material in the industry because of its relative strength and lightweight properties. The average aluminum content per passenger car jumped to 252 pounds in 1996, up from 191 pounds in 1991.[7] If the use of aluminum in automobiles continues to grow, then the prosperity of the transportation industry may determine the demand for aluminum. Since the demand for lighter cars with increased fuel efficiency is expected to rise, this presents a competitive advantage for the aluminum industry over the steel industry.

Overall, losses in the packaging industry should be offset by the increased use in the transportation industry, allowing for continued growth. Additionally, a strong international (global) economy will continue to be the driver for all aluminum goods, and should be considered the best indicator of what the demand for aluminum will be in the future.

The per capita demand for all scrap aluminum can be calculated by dividing the 1997 scrap consumption rate (Figure 4) by the national population in 1997 and the projected population for 2002. Figure 7 shows the estimated demand for scrap aluminum in North Carolina for 1997 and 2002. A per capita demand rate was established for 1997's current demand (12.7 pounds per person) and projected outward for 2002. Demand is expected to continue to exceed supply of aluminum scrap in North Carolina. Depending on the prices for primary aluminum, the industry should easily be able to absorb additional amounts of aluminum scrap as it becomes available.

Specifications

Since most aluminum cans are processed into new cans, it is imperative that only high quality scrap is generated from processors. If secondary aluminum needs any additional processing, then limited cost savings will be realized by using scrap. According to the Institute of Scrap Recycling Industries, UBC scrap must be free of steel, lead, bottle caps, plastic cans, and other plastics, glass, wood, dirt, grease, trash, and other foreign substances. All UBC scrap must undergo a magnetic separation process to ensure the removal of all ferous materials; any free lead is basis for rejection.[8]

Profiles of Major End-Users

The aluminum industry encompasses a group of highly specialized businesses. For UBCs to be recycled back into new cans, they pass through many different handling and processing stages, which are listed below.

1. UBCs are collected curbside or at local drop-off centers by residents. Also, some individuals and businesses collect cans and bring them to market.
2. UBCs are collected by intermediate processors such as material recovery facilities (MRFs) and are separated from other food and beverage containers. Some MRFs have balers, which allows them to ship the UBCs to end users, brokers, or toll processors.
3. MRFs without balers and businesses or individuals that wish to market UBCs individually may bring their cans to a scrap dealer. Scrap dealers consolidate volumes of UBCs and sell them to larger scrap dealers with balers.
4. Baling operations consolidate bales of UBCs until large truckload quantities are generated.
5. Brokers and can sheet manufacturers purchase the truckload quantities of baled cans.
6. Can sheet manufacturers typically have arrangements with toll processors to refine the metal and melt it into ingots. Toll processors act as contractors and are paid by can sheet manufacturers to process the materials and typically are not involved in purchasing or selling the aluminum materials.
7. Can sheet manufacturers melt the ingots into can sheet.
8. Can manufacturers punch out cans from the can sheet, produce lids for the cans separately, then sell the cans back to the beverage industry.

Figure 8: UBCs Five-Year Price History

End Users Price (per ton)	1993	1994	1995	1996	1997
Quarter 1 (March)	$690.00	$750.00	$1,390.00	$1,100.00	$1,170.00
Quarter 2 (June)	$660.00	$800.00	$1,320.00	N/A	$1,130.00
Quarter 3 (Sept)	$700.00	$1,070.00	$1,280.00	$990.00	$1,140.00
Quarter 4 (Dec)	$580.00	$1,310.00	$1,150.00	$1,010.00	$1,130.00
Average	$657.50	$982.50	$1,285.00	$1,033.33	$1,142.50

Source: *Recycling Times*, "The Markets Page."

While North Carolina does not host any end-users, the surrounding Southeastern United States has a considerable share of the major United States end-users. These companies are described below. These descriptions do not imply endorsement by the North Carolina Division of Pollution Prevention and Environmental Assistance (DPPEA) or the North Carolina Department of Environment and Natural Resources (DENR) of any company or its products.

Alcan Aluminum Corp., Mayfield Heights, Ohio, recycles cans at its U.S. facilities in Berea, Kentucky; Greensboro, Georgia; and Oswego, New York. In 1997, Alcan bought 577 million pounds of scrap cans, capturing 28 percent of the market. The company paid suppliers $375 million for UBCs.[9] In addition to the company's can recycling activities, Alcan's Shelbyville, Tennessee, secondary aluminum facility annually recycles approximately 115 million pounds of post-consumer scrap, such as cookware and lawn furniture to produce alloys primarily for the automobile industry.

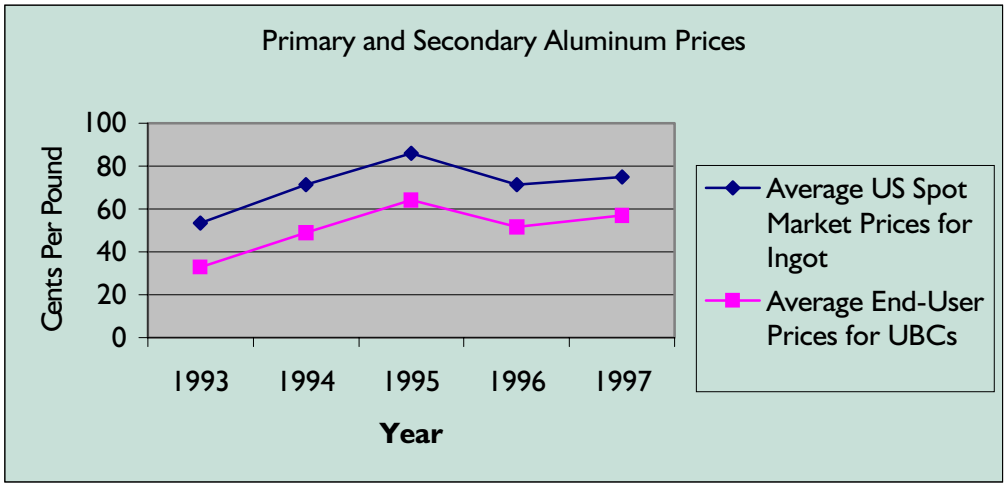
Reynolds Metals Company, Richmond, Virginia, took in 398 million pounds of UBCs last year (a 19-percent share), up 11 percent from 1996. The firm also bought 35 million pounds of other aluminum scrap at its other locations nationwide in 1997. Reynolds subsequently sold its consumer recycling division to Baltimore-based Wise Metals.[10] Reynolds operates two processing facilities in North Carolina: in Clayton, near Raleigh, and in Charlotte. Aluminum cans are processed through a magnetic separator and are shredded. Shredded UBCs are primarily shipped to Reynolds' reclamation facility in Sheffield, Alabama. Other aluminum scrap is processed, baled, and shipped to another reclamation plant in Richmond, Virginia.

Anheuser Busch Recycling Corporation – ABRC, St. Louis, Missouri, is the largest aluminum recycler in the world, a position it has held for 10 consecutive years. It recycled more than 648 million pounds of aluminum in 1997, equal to 20 billion cans. The firm captured 32 percent of the market, an increase of nearly seven percent during the previous year.[11] In 1996, ABRC recycled the equivalent of more than 110 percent of the Anheuser-Busch beer cans that were sold. Cans that are purchased by ABRC from processors are shipped to major can sheet manufacturers such as Alcan and Alcoa. Metal Container Corporation (MCC), which is a subsidiary of Anheuser Busch, purchases the can sheet from these manufacturers and makes 60 percent of Anheuser Busch's cans. MCC is also a major supplier to the soft-drink industry, producing more than 21 billion cans and 22 billion lids in 1997.

Aluminum Company of America – Alcoa, Maryville, Tennessee, operates the largest aluminum can sheet production facility in the world in Alcoa, Tennessee. Alcoa Recycling Company, a wholly owned subsidiary of Alcoa, purchases aluminum can scrap for this mill, and its other facility in Newburgh, Indiaina. The company uses two materials processors in North Carolina to process UBCs for end-use: United Metal Recyclers in Kernersville and Wagram Paper Stock in Scotland County. Alcoa also buys cans from the Western part of the state for direct shipment into its Marysville, Tennessee, processing facility. Alcoa also currently operates a primary aluminum production facility in Badin, Stanly County, North Carolina.[12]

IMCO Recycling, Irving, Texas, is the world's largest secondary aluminum recycler and also recycles magnesium and zinc. IMCO's primary business is the recycling of customer-owned materials in exchange for a processing fee. Its customers include aluminum companies such as Alcoa, Kaiser Aluminum, and Wise Metals who use recycled aluminum to produce containers, building construction materials, and automotive products. The company processes the aluminum at 16 United States plants and also owns a 50-percent interest in a German plant. IMCO owns two processing facilities in Tennessee. Their Rockwood facility has an annual melting capacity of 220 million pounds and the Loudon facility has an annual capacity of 180 million pounds.

Figure 9: Aluminum Five-Year Price History



Sources: 1) *Recycling Times*, The Markets Page
2) U.S. Geological Survey, *Minerals Commodity Summaries*, January, 1998.

SUPPLY / DEMAND RELATIONSHIP

Price History

The five-year price history for UBCs is displayed in Figure 8. The price fluctuations paralleled those for primary aluminum ingot (Figure 9).

Major international economic events (both positive and negative) appear to be the largest contributor to fluctuations in supply and demand for aluminum. In the first half of 1998 the UBC market experienced an inter-related effect of a major economic downturn in Asia, and a contrasting booming United States economy. Recyclers in the scrap metal industry, as well as other recycling industries, claim that the boost in the value of the United States dollar is a double-edged sword. On one hand, the dollar is so strong, that importing raw material from overseas is cheaper than buying abroad. On the other hand, Asian currencies have devalued greatly compared to the United States dollar.[13] Without the significant demand for finished aluminum products from Asian markets, major surpluses are resulting, causing a slump in prices for both primary and secondary materials.

As of June 1998, the price of UBCs had dropped to around 35 cents per pound, down 22 cents (39 percent decrease) from last year's average price of 57 cents per pound. According to one local processor, aluminum UBCs are typically a low margin / high volume commodity. With the current low prices, it becomes difficult to obtain the desired volumes and, consequently, difficult to move the UBCs.[14]

CONCLUSION

Unlike most recyclable commodities, the prices for UBCs and other aluminum scrap are derived from perceived demand. If there is strong global demand for primary aluminum in the future, then the demand for aluminum UBCs will continue to be favorable as well. Regardless of the fact that aluminum prices are currently relatively low, the demand for UBCs and other aluminum scrap still remains strong enough for the material to be recycled by local governments and private industry. The cost savings and actual revenue generated from recycling aluminum cans should enable UBCs to continue to be included in all recycling programs.

At the average 1997 price of 57 cents per pound, the estimated 23,000 tons of UBCs that were disposed last year had a value of approximately $26 million dollars. Al though UBCs are a high volume / low margin commodity, with $26 million dollars worth of available supply, there is still an opportunity for new or existing collection and processing businesses to capture the materials profitably.

In North Carolina, the current estimated recovery rate of approximately 50 percent is significantly lower than what would be anticipated from a 100 percent diversion mandate. The aluminum can ban, which went into effect in North Carolina in July of 1994, has resulted in an estimated increase in recovery of only approximately five percent. Although there are no calculations of secondary end use capacity available, there are no indications that the aluminum industry would not be willing and able to adapt to

the consumption of all aluminum cans supplied from North Carolina in the future. Thus, an increase in the aluminum recovery rate statewide depends more on improved collection efficiency, and not necessarily increased capacity or markets for the material.

RECOMMENDATIONS

The state should take the following steps to increase UBC recycling:

- *Determine why aluminum cans are still being sent to landfills*. The state should analyze existing recycling programs in all counties and make sure that residents and businesses have adequate access to recycling. Either drop-off or curbside services need to be available locally for UBCs to be properly diverted from disposal. This alternative is more viable than enforcing the aluminum can ban by visual inspection at local landfills.
- *Educate local government recycling coordinators that there are still UBCs to be recovered*. A barrier to increasing aluminum can recovery is the misperception that UBC recovery is at or near its peak, because of the landfill ban and the relatively high value of UBCs.
- *Improve efficiency of existing recycling programs*. To increase the quantity of aluminum collected throughout the state, equitable, waste reduction based collection systems such as pay-as-you-throw (PAYT) should be encouraged. PAYT programs charge system users based on the amount of waste generated, providing financial incentives to reduce and recycle. Consistent, targeted educational campaigns have also been shown to increase participation in recycling programs.
- *Encourage small retail / commercial sector recovery*. The first step the state should take to encourage recovery from this sector is to work with counties to increase awareness of the law among businesses. Since the can ban went into effect more than four years ago, awareness may have waned, and it may be time now to emphasize the importance of complying with the law. In addition, municipalities and counties should be encouraged to examine the feasibility of adding small businesses to existing recycling programs, since UBCs are a revenue generating material.
- *Determine the number of multi-family units in North Carolina that are not being serviced with recycling*. A potentially significant amount of UBCs from the residential waste stream may be discarded in multi-family units. Determine the feasibility of including these units in existing local government recycling programs would help capture additional UBCs.

[1] Patricia A. Plunkert. *Mineral Commodity Summaries.* January 1998. U.S. Geological Survey. p. 18.
[2] Patricia A. Plunkert. *Recycling-Metals*. U.S. Geological Survey, Minerals Information. 1996. p. 1.
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[11] "Recycling levels Rise." *Resource Recycling*. March 1998. p. 64.
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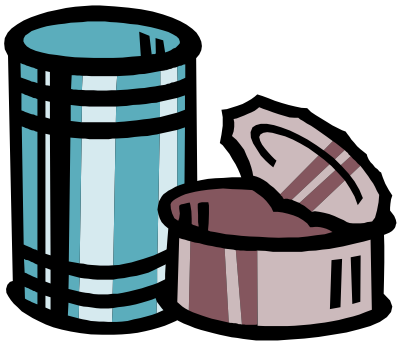
Metals: Steel Cans & Scrap

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

This section focuses on steel cans, including aerosol, paint, food, and beverage cans. An overview of the national recovery of all other steel scrap also is included.

Because of the significant cost savings of recycling steel and other ferrous metals, these materials have a long history of being recycled. Steel mills melt scrap in basic-oxygen furnaces (BOFs) and electric arc furnaces (EAFs) and, to a minor extent, in foundries. The portion of steel scrap in the charge in a BOF is limited to less than 30 percent, whereas the charge in the EAF can be as much as 100 percent scrap. In 1996, BOFs produced 57 percent of total steel in the United States, while using only 22 percent of total scrap consumed. During the same period, EAFs produced 43 percent of total steel, while using 64 percent of total scrap consumed.[1]

In the United States alone, nearly 70 million tons of steel was recycled in steel mills and foundries in 1997. Recycled steel consists of approximately 30 percent home scrap (new recirculating scrap from current operations), 24 percent prompt scrap (produced in steel-product manufacturing plants), and 46 percent obsolete (old) scrap.[2]

The estimated national supply of steel cans was 2.8 million tons (21 pounds per person) in 1997. The national steel can recycling rate topped 60.7 percent, with more than 1.7 million tons of steel packaging recycled.[3] In North Carolina, out of an estimated total supply of 77,858 tons of steel cans, approximately 8,383 tons were recovered by the public and private sectors. This represents an 11 percent overall recovery rate for steel cans in 1997.

In 1997, the per capita generation of steel cans was 21 pounds. Strong demand allowed the industry to easily absorb the supply as more and more scrap was consumed in domestic steel production. The average price of steel can scrap in 1997 was $62.13 per ton.

Figure 1: Supply of Steel Cans

Year	Tons of Steel Cans Shipped[1]	Pounds	United States Population[2]	Pounds Per Person
1993	2,787,600	5,575,200,000	257,752,702	21.63
1994	2,929,500	5,859,000,000	260,292,437	22.51
1995	2,692,400	5,384,800,000	262,760,639	20.49
1996	2,818,100	5,636,200,000	265,179,411	21.25
1997	2,848,700	5,697,400,000	267,636,061	21.29
Average	2,815,260	5,630,520,000	262,724,250	21.43

Sources: 1) The Steel Recycling Institute
2) U.S. Census Bureau

Figure 2. Estimated Generation and Recovery of Steel Cans in North Carolina

	1997	1998	1999	2000	2001	2002
Generation (tons)[1]	77,858	78,971	80,004	80,961	81,787	82,617
Recovery (tons)[2]	8,383	8,503	8,614	8,717	8,806	8,895
North Carolina Population[3]	7,436,690	7,542,996	7,641,684	7,733,097	7,811,951	7,891,238

Sources: 1) Extrapolated from Steel Recycling Institute's National Supply Estimates
2) North Carolina Recycling Survey
3) North Carolina Office of State Planning

SUPPLY

The domestic supply rates for steel cans from 1993 through 1997 are presented in Figure 1. The per capita steel can supply rate has remained constant in recent years, and according to the Steel Recycling Institute, is expected to remain relatively constant in the near future.[4]

The generation and recovery estimates for steel cans in North Carolina are presented in Figure 2. The 1997 generation figure takes into account the national supply, adjusted for North Carolina's percentage of the United States' population (2.78 percent). The projections for generation of steel cans for 1997 through 2002 were estimated by taking the 1997 per capita steel can supply rate (21 pounds per person), multiplied by the anticipated North Carolina population for the next five years.

Recovery

Based on surveyed results from North Carolina's private recycling industry and local governments, the estimated total quantity of steel cans recovered in North Carolina in 1997 was 8,383 tons. This translates into an 11 percent recovery rate statewide. In Figure 2, the quantity of steel cans recovered for 1998-2002 is based on the 1997 per capita recovery rate (2.25 pounds per person), adjusted for future population estimates, assuming the recovery rate remains constant. The national recovery rates are presented in Figure 3 along with recovery rates for North Carolina. According to the Steel Recycling Institute's April 1998 press release, the national recycling rate for steel cans for 1997 was 60.7 percent. This includes the recycling of paint, aerosol, food, and beverage cans.

The recovery rate for steel cans in North Carolina remains low because of the number of communities that do not include them in their existing recycling programs. Out of 381 communities that reported providing a recycling service to residents in fiscal year 1996-97, 134 of them did not include steel can recycling either through curbside or drop-off services. Thus, 35 percent of the existing recycling programs in North Carolina do not currently include steel cans. There is no indication as to the reason why these programs do not currently include the material, and also have no indication of the number of communities expected to add steel cans to their program. Thus, the estimated recovery rates through 2002 are based only on the current per capita recovery rates adjusted for future population estimates. Additionally, as a residential collection method for steel, resource recovery (waste to energy or incineration)

Figure 3: Estimated North Carolina and National Recovery rates for Steel Cans

	1991	1992	1993	1997
Estimated NC Recovery[1]	3.9%	6.1%	10.5%	11%[2]
Estimated US Recovery[3]	34%	40.9%	48%	60.7%

Sources: 1) SCS 1995 Markets Assessment
2) North Carolina Recycling Survey
3) Steel Recycling Institute

Figure 4. Total Steel Recovery (in million metric tons)

	1992	1993	1994	1995	1996
Apparent Domestic Steel Supply[1]	139	167	178	180	183
Recycled[2]	63	68	70	72	72
Percent Recycled	45%	41%	39%	40%	39%

Source: U.S. Geological Survey.
1) Production plus net imports plus stock changes. Production is primary production plus recycled metal.
2) Metal recovered from new plus old scrap.

continues to play a strong role. Of the 114 facilities in the United States, 96 recover household steel for recycling. Nearly 38 million people have their steel cans and other household steel "automatically" collected through these plants. The annual tonnage of steel magnetically recovered is about 775,000 tons.[5] This represents 46 percent of the total national recovery.

North Carolina has only one small-scale incinerator operated by New Hanover County, which recently began privatized post-burn ferrous (steel) recovery from their plant. Thus, the state is at a relative disadvantage to those which have a majority of their ferrous metals "automatically" separated. The current landfill disposal fees in North Carolina are lower than the per ton fees needed to support large scale waste to energy or incineration. With no indications of that changing, it can be assumed that no drastic changes will occur with steel can recovery by automatic separation.

Other Steel Scrap

The total amount of all steel materials recycled nationally in 1997 was 70 million metric tons. Obsolete scrap made up an estimated 46 percent (32.2 million metric tons) of the total scrap recovered. The 1.7 million tons of steel cans recovered through recycling represents only five percent of the total obsolete scrap recycled domestically in 1997. The largest sources of obsolete scrap are junked automobiles, demolished structures, worn-out railroad cars and tracks, appliances, and machinery.[6]

Figure 4 shows the total amount of all steel generated and recovered domestically from 1992-1996. It is important to note that most steel products are durable goods. Thus, the quantity of steel produced is not equal to the quantity of steel ready for disposal that same year. The recent decrease in the percentage of steel recycled is due to the significant increase in the total apparent domestic steel supply, which is mainly made up of durable steel products that will not enter the waste stream for many years.

Steel Scrap Imports

Since metals are traded nationally and internationally, information pertaining to the amount of imports coming directly to North Carolina trade ports is less relevant than the total supply of scrap being imported nationally. The total amount of scrap imports is displayed in Figure 5. The quantity of steel cans imported into the United States is relatively low, and is not differentiated from other types of ferrous scrap imports, as reported by the U.S. Census Bureau Foreign Trade Division.

DEMAND

Like most recyclable commodities, the value of steel scrap is driven by the demand for finished products. If the demand continues to expand, then the need for more scrap steel will be eminent. The demand for steel typically is

Figure 5: Iron and Steel Scrap Imports/Exports (million metric tons)

	1993	1994	1995	1996	1997
Imports	1.6	1.9	2.3	2.9	3
Exports	10	9	10.5	9.1	9
Net Exports	8.4	7.1	8.2	6.2	6

Source: U.S. Geological Survey

Figure 6: Raw Steel Production in BOFs and EAFs.

	1993	1994	1995	1996	1997
Basic Oxygen Furnaces	61%	61%	60%	57%	53%
Electric Arc Furnaces	39%	39%	40%	43%	47%

Source: U.S. Geological Survey

dictated by the demand for automobiles. However, efforts are underway to stimulate the growth of other steel markets. For instance, the steel industry has set a goal that, by the year 2002, steel-framed homes will represent 25 percent of all new residential construction projects.[7]

Also, recent changes in steel production have resulted in a dependence on scrap. A new type of steel mill has evolved, called a Mini Mill, which uses the electric arc furnace that requires scrap, and cannot use unprocessed iron ore. As more steel is produced worldwide in electric furnaces and as integrated mills increase usage of scrap in blast furnaces, demand for scrap supplies will increase.[8] Figure 6 shows the percentage of raw steel produced by both the basic oxygen furnaces (BOFs) and the electric arc furnaces (EAFs). The percentage produced at EAFs has increased significantly (eight percent) in the past four years. One reason for this trend is that EAFs generally are smaller and significantly less costly to start up that traditional mills.[9]

Exports

Similar to imports, steel can scrap exports are minimal, and are not tracked separately from other steel scrap by the U.S. Census Bureau Foreign Trade Division. However, because prices of steel cans are developed in part by the demand for all other steel scrap, its international demand is important to consider.

The export market has traditionally been a large determinant of the demand for all scrap. (See Figure 5.) The historic flow of material has been from more developed countries to less developed countries. Recently, however, that trend began to change. Domestically, scrap demand will increase as mills under construction along the Mississippi River are completed, which will cause scrap exports to decrease and imports to increase.[10] As new mini-mills sprout up in the Southeast and Midwest regions of the United States, scrap that was formerly shipped overseas is staying in North America. In 1986, 1.5 million tons of scrap was exported through the port of New Orleans. Since 1994 that average has dropped to fewer than 100,000 tons per year. Increased domestic demand from steel mills combined with weak Asian markets means less ferrous scrap is being shipped outside North America.[11]

Specifications

The characteristic quality and consistency of steel can scrap helps increase its demand. Magnets are used to easily separate the steel from other recyclable materials, ensuring mills of a homogenous commodity. Also, the chemical composition of all steel cans is very similar, allowing the mills to easily re-melt the scrap into specific products.

The specifications for "Bundled Steel Can Scrap" are defined by the Institute of Scrap Recycling Industries, Inc., as being steel can scrap compressed to charging box size and weighing not less than 75 pounds per cubic foot. Cans may be baled without removal of paper labels, but free of other non-metallics. They may include up to five-gallon tin-coated containers.[12]

Figure 7: Major Local End-Users

End-User	Location	Current Capacity (tons per year)	EAF / BOF
Bethlehem Steel	Sparrows Point, MD	4M	BOF
	Steelton, PA	1.2M	EAF
U.S. Steel	Pittsburgh, PA	3.0M	BOF
	Fairfield, AL	2.2M	BOF
Nucor Steel	Darlington, SC	750,000	EAF
	Hertford County, NC[1]	1M	EAF
	Berkley, SC	1M	EAF
SMI -Owen Steel	Cayce, SC	65,000	EAF
TXI - Chaparral Steel	Dinwiddie, VA[2]	1M	EAF
TOTAL		14,215,000 TPY	

1) Anticipated mill opening in 2000.
2) Anticipated mill opening in mid 1999.
Source: Steel Recycling Institute

Figure 8: Estimated Steel Can Consumption of Major Local End Users

Mill Type	Total Capacity (Tons)	Percent of Annual Tonnage	Total Estimated Quantity of Steel Cans Consumed (Tons)
BOF:	9,200,000	1.50%	138,000
EAF:	5,015,000	3.00%	150,450
Total:	14,215,000	2.03%	288,450

Major End Users

Since North Carolina does not have any mills accepting steel cans, it is necessary to look at the surrounding states' mills, and their existing capacity. Figure 7 outlines the major end-users. While the demand from these mills ultimately drives the demand for the steel cans in North Carolina, it is the various local processors that enable the materials to get to market. An adequate processing infrastructure exists throughout the state with balers and shredders, which work to increase the density of scrap metal for shipments over very large distances.

The Steel Recycling Institute estimates that the amount of steel cans consumed is approximately 1.5 percent of the annual capacity in BOFs, and 3.0 percent in EAFs.[13] Figure 8 shows the estimated steel can consumption of the Major End Users listed in Figure 7.

SUPPLY / DEMAND RELATIONSHIP

The demand for steel can scrap continues to exceed the supply both nationally and locally. Because of the adequate existing capacity and the anticipated increase in electric steel production in EAFs, the ability to increase steel can recycling is not dependent upon future capacity increases. Even if the supply of scrap recovered through recycling increases, the total demand for all steel scrap will still exceed the small portion provided through steel can recycling.

Figure 9: Steel Can Prices

Clean Steel Cans	1993	1994	1995	1996	1997
Quarter 1 (March)	$83.50	N/A	$50.00	$60.00	$57.50
Quarter 2 (June)	$72.50	N/A	N/A	N/A	$61.00
Quarter 3 (Sept)	$71.50	N/A	$55.00	$57.50	$65.00
Quarter 4 (Dec)	N/A	N/A	$55.00	$42.50	$65.00
Average	$75.83	$69.73	$53.33	$53.33	$62.13

Source: Recycling Times "The Markets Page"

Additionally, the domestic increase in demand for scrap will ensure solid local markets. Relying less on scrap exports will allow the United State's steel scrap markets to be somewhat protected against global economic downturns such as the recent decline in the Asian economy. Domestic demand acts as a safeguard against such events, provided the finished products are demanded locally as well.

The prices for steel can scrap (end user prices) in the Southern Region of the United States are presented in Figure 9. Any increases or decreases in the prices are directly related to the supply and demand for finished steel products. After a decrease in prices from 1993 through 94, the prices have begun to rebound as the demand for steel products continues to strengthen. The average price for steel cans for 1993 through 1997 was $62.87 per ton.

CONCLUSION

The markets currently exist for the consumption of additional amounts of steel cans and other steel scrap generated in North Carolina. With approximately 90 percent of the supply of steel cans remaining in the waste stream (approximately 70,000 tons), there is a good opportunity for new or existing recycling businesses to capture the remaining share. At the average 1997 price of $62.13 per ton, the 70,000 tons of steel cans would have a value of $4,349,100.

As long as the market for finished steel products continues to grow, the prices for scrap will remain strong and allow steel cans to be a self-supporting recyclable commodity. Short-term fluctuations in the demand for steel products may slightly skew the prices for steel cans and other types of steel scrap, but the cost avoidance and potential revenue generation from recycling still outweighs disposal.

It is apparent that the breakdown in steel can recycling is not due to the lack of industry capacity, but rather the lack of adequate means of collection. The following recommendations are designed to support development of a viable collection infrastructure.

RECOMMENDATIONS

- The state should identify the reasons why certain municipalities and counties do not include steel cans in their existing recycling programs.
- The state needs to work with the steel recycling trade associations to help educate the municipalities and counties on the potential cost avoidance and revenue generation from such a program.
- As communities enact volume based or pay-as-you-throw residential programs, steel cans need to be an element of the materials collected as part of the mix of recyclables.
- Additionally, alternative sources of material should be identified. Some of North Carolina's largest cities have a significant number of their residents living in multi-family apartment complexes. The state should consider conducting a study to determine the potential quantities of all recyclable materials that could be collected if they were included in traditional residential curbside collection. Many steel cans are also generated at foodservice operations on military bases, schools (public and private), colleges and universities, commercial food establishments, and state and federal prisons. Steel can collection at these institutions is easily integrated into a multi-material recycling program infrastructure.

[1] Michael Fenton. *Recycling Metals.* U.S. Geological Survey. Minerals Information. 1996. p. 6.
[2] Ibid.
[3] Steel Recycling Institute. *News Release*. 1998.
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[13] Personnel communication, SRI. August 3, 1998.

Used Oil ▪ Used Oil Filters

Oil-Related

Oil-Related: Used Oil

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

According to the American Petroleum Institute (API), each motor vehicle in North Carolina is responsible for the sale of an average of four gallons of lubricating oil per year.[1] With nearly six million industrial, commercial, and passenger vehicles registered with the state Division of Motor Vehicles, more than 21 million gallons of oil were sold in North Carolina in 1997. Despite the 1990 ban on oil disposal in North Carolina landfills, only 68 percent of all used oil generated in 1997 was recovered. After accounting for unrecoverable oil due to leakage or engine consumption, more than four million gallons of used oil are either being disposed improperly throughout the state or are unaccounted for in the 1997 data.

Opportunities to recover this "lost" oil exist. According to oil recycling companies in the Southeast, the two markets for used oil ¾ re-processing into fuel and re-refining into lubricant ¾ show strong growth potential during the next five years. More significantly, experts indicate that the current supply of re-processed fuel from used oil already lags behind demand, thus creating an immediate opportunity to improve used oil recovery and marketing.

In addition, contamination from improperly disposed oil presents a threat to the state's environment and natural resources. In its research on the potential impacts of used oil, the United States Environmental Protection Agency (EPA) has identified several environmental risks posed by improper disposal methods. For example, the EPA estimates that one gallon of used oil can pollute more than one million gallons of drinking water. Small amounts of used oil that accumulate on water bodies also can prevent oxygen and sunlight from entering the water, thus reducing the plant and animal life in lakes, ponds, and rivers. Additionally, used oil dumped in drains often accumulates in very small concentrations in water treatment plants and inhibits sewage treatment processes.[2]

Figure 1: Total Lubricating Oil Sold for Motor Vehicle Use in North Carolina 1993, 1997, and 2002

	1993 gallons	1997 gallons	2002 gallons
Total for Motor Vehicle Uses	**19,898,461**	**21,637,629**	**22,995,755**
A. Other Motor Vehicle Consumers	9,949,230	10,818,815	13,797,453
B. Do-It-Yourself Sources	9,949,231	10,818,814	9,198,302

Source: Based on data from the American Petroleum Institute, *National Used Oil Collection Study*, May 1996.

This report analyzes the relationship between the supply and demand for used oil in North Carolina. The analysis focuses primarily on identifying the sources of used oil with the greatest potential for increased recovery and with the most accessible markets for re-refining and re-processing.

The definition of used oil is taken from the California Public Resources Code and includes any oil that was used in an internal combustion engine crankcase, transmission, gearbox, or differential in an automobile, bus, truck, vessel, plane, train, heavy equipment, or other machinery powered by an internal combustion engine."[3]

SUPPLY

Generation

Data were lacking on used oil generation and consumption in North Carolina. For this reason, generation is calculated in three steps. The first step involves estimating the amount of oil sold in North Carolina during 1997. Second, the consumption of oil is allocated to different types of oil consumer groups. Finally, the amount of oil allocated to each consumer category is then reduced by a factor that accounts for non-recoverable oil because of burning, leaking, and other influences.

Step One: Oil Sales

To estimate the amount of used oil sold, the number of vehicles registered by the Division of Motor Vehicles for 1997 was multiplied by the average gallons of oil used annually per vehicle from the API study.[4] To estimate gallons sold in North Carolina, 5.8 million vehicles was multiplied by 3.677 gallons per vehicle per year to yield an estimate of more than 21 million gallons of oil sold for use in motor vehicles in 1997 (Figure 1).[5]

Step Two: Consumer Groups

The two main categories of oil consumption from motor vehicle sources are do-it-yourself (DIY) oil changers and all other motor vehicle (OMV) consumers. DIY generators consist primarily of people who change their own oil at residences and, thus, are responsible for disposing their used oil. OMV generators constitute a broad class of consumers including people who bring their automobiles to quick oil change facilities, dealerships, or service stations. In addition, the OMV category includes used oil generated from commercial and government fleets, rental car operations, and other establishments that generate used oil.

As indicated previously in API studies, DIY oil changers constitute approximately 50 percent of the motor vehicles and used motor oil generated in North Carolina. This assumption is based on a national average and may underestimate the percentage of DIY oil changers in North Carolina. The state exhibits three characteristics that make a higher portion of DIY changers likely: 1) a more rurally based population, 2) a warm climate, and 3) a younger population (older Americans are less likely to change their own oil).[6] However, because of the increasing urban population and continued expansion of quick oil change outlets, the percentage of DIY oil changers is expected to decrease two to five percent per year in the short term future.[7] The estimations for 2002 in this report reflect a two-percent annual decrease in the percent of DIY consumers.[8]

Calculations for the total used motor oil sold in North Carolina in 1997 are based on the average per vehicle oil sales estimates from API's *National Used Oil Collection Study* in 1996. As demonstrated in Figure 1, the used oil sales from motor vehicle sources increased from 19 million gallons in 1993 to more than 21 million gallons in 1997. This increase is attributable to an increase in population of the North Carolina and an increase in vehicles per capita since 1993.

Step Three: Recoverable Used Oil

As illustrated in Figure 2, an oil recovery factor is incorporated to account for unrecoverable oil. This factor is applied to the total gallons sold to account for leaking, burning, unused oil left in bottles, and residue left in filters. As a result, only 60 percent of oil sales to DIY oil changers is available for recovery. It is estimated that 65 percent of oil sales to OMV are available for recovery due to newer vehicles in commercial fleets and stronger standards for filter drainage.[9] Accounting for unrecoverable oil from both DIY and OMV sources, more than 13 million gallons of used oil were generated in North Carolina in 1997.

Figure 2: Generation of Used Oil from Motor Vehicles *(Accounting for Unrecoverable Oil)*

	1993 gallons	1997 gallons	2002 gallons
Total Oil Sold for Motor Vehicle Uses	**19,898,461**	**21,637,629**	**22,995,755**
1. Sales to Other Motor Vehicle Consumers	9,949,230	10,818,815	13,797,453
Recoverable Used Oil from OMV (65%)	6,467,000	7,032,230	8,968,344
2. Sales to Do-It-Yourself Sources	9,949,231	10,818,814	9,198,302
Recoverable Used Oil from DIY (60%)	5,969,539	6,491,288	5,518,981

Figure 3: Total Used Oil Recovered from All Motor Vehicles in North Carolina 1997 and 2002

	1997 gallons	2002 gallons
Generated and Recoverable Motor Vehicle Used Oil	13,523,518	14,487,325
Government Recovery (local and state)	824,362	915,742
Private Sector Recovery	8,213,758	9,803,533
Total Recovery	9,038,120	10,719,275
Percent Recovered	*67%*	*74% (assumed)*
Unaccounted for Used Oil	4,485,398	*3,768,050*

Figure 4: Other Motor Vehicle (OMV) Used Oil Recovered in 1997 and 2002

	1997 gallons	2002 gallons
Recoverable OMV Used Oil Generated	7,032,230	8,968,344
State Fleet Government Recovery	248,503	316,921
Private Sector Recovery	6,633,831	8,460,258
Total Recovery	6,882,334	8,777,179
Percent Recovered	*98%*	*98% (assumed)*
Unaccounted for OMV Used Oil	149,896	*191,165*

Recovery

Available data indicate that 67.8 percent of recoverable motor vehicle used oil was collected in North Carolina in 1997 (Figure 3). A majority of the nine million gallons of used oil recovered from motor vehicles was collected from private sector sources. In fact, used oil from commercial fleets, quick oil change outlets, and auto parts stores accounted for more than seven million gallons of used oil recovery in 1997. Local governments accounted for an additional 575,859 gallons. Approximately four million gallons of used oil remain unaccounted for and were possibly disposed of illegally.

To discover the potential sources of unrecovered used oil, it is necessary to analyze the recovery to OMV and DIY oil streams separately. As noted in Figure 3, the future of the used oil recovery level should increase as the industry continues to shift from DIY changers to quick-change outlets.

Other-Motor-Vehicle Sector

Based on information gathered from North Carolina's four largest private sector recovery sources, the used oil recovery from OMV sources occurs almost exclusively through private sector channels. For example, while the state government recovered almost 250,000 gallons of used oil from government fleets in 1997, private sector channels recovered more than 6.6 million gallons. In combination, the recovery rate for used oil from all OMV sources reached 98 percent of generation in 1997 (Figure 4).

Do-It-Yourself Sector

Despite the same amount of used oil generated as the OMV sector, the DIY sector achieved a 35-percent recovery rate in 1997. Local government collection of used oil, which is

almost exclusively DIY oil recovered at landfill collection sites, increased from 500,000 gallons in 1996 to more than 575,000 gallons recovered in 1997. While local government recovery at landfill sites was more than 575,000 gallons, private sector recovery also accounted for roughly 1.58 million gallons of used oil from DIY sources. While some private sector recovery of DIY oil may not be included in this report, the data reveal that the DIY sector was responsible for more than four million gallons of unaccounted for used oil in 1997 (Figure 5). Because of increased accessibility of quick oil change outlets, industry experts estimate that the DIY share of the consumer market will decline by two to five percent per year in the near future.[10] By 2002, the quantity of oil generated by DIY oil changers will decrease to five million gallons as their market share decreases from 50 to 40 percent.

In addition to conventional used oil calculations, approximately 3.5 to eight ounces of used oil is contained in oil filters, depending on drainage practices. Assuming that the best possible drainage practices are employed, more than 270,000 gallons of used oil was disposed in North Carolina landfills along with approximately 10 million used oil filters in 1997.[11] Moreover, an average of 0.8 ounces of oil is trapped in every discarded one-quart bottle of oil used for motor vehicle lubrication purposes. In other words, an additional 270,000 gallons of oil was disposed in North Carolina landfills because of the residual oil left in oil bottles from DIY oil changes.[12]

Source Reduction

Fewer oil changes means less waste oil released into the environment. Because of improvements in the design of motors during the past 10 years, most of the major automobile manufacturing companies have decreased the recommended frequency of oil changes. For example, Ford Motor Company has increased the minimum mileage between oil changes from 3,000 miles to a minimum of 5,000 miles. Similarly, Toyota now suggests that owners change their motor oil every 7,500 miles, except under severe driving conditions.[13] If vehicle owners followed the lowest of the new standards for less frequent oil changes (Ford's 5,000 miles), there could be a significant reduction in the generation of used oil in the state of North Carolina. More specifically, an increase in the minimum distances between oil changes of 2,000 miles (to 3,000 - 5,000) could result in as much as a 30-percent reduction in the generation of used oil, or roughly four million gallons in 1997.

Increasing Recovery

Many states have initiated used oil recycling programs based on the API Model Bill. This model bill establishes the guidelines for a state-used oil fund supported by a fee on oil sales (usually two cents per quart). The fund normally is used to provide grant funding for cities and towns that wish to establish and publicize used oil drop-off centers or curbside collection programs. In addition, many states use the funds to support a toll-free telephone information center and state sponsored promotions. South Carolina uses some of its state funds to provide a multi-media advertising campaign, which includes print materials, a school curriculum, and television and radio advertisements with NASCAR celebrities. Many of the state's educational programs are focused on raising the awareness of DIY oil changers.

To better focus the South Carolina recycling campaign, the Institute of Public Affairs at the University of South Carolina conducted a survey of DIY oil changers in 1993. The survey revealed that approximately 49 percent of the market consisted of DIY oil changers. The research also indicated that individuals with the greatest tendency to illegally dispose used oil were generally between 18 and 45 years old, had a lower educational level than the state average, and had family incomes below the state average. These findings helped in the siting of collection centers and influenced the content of the educational campaigns.

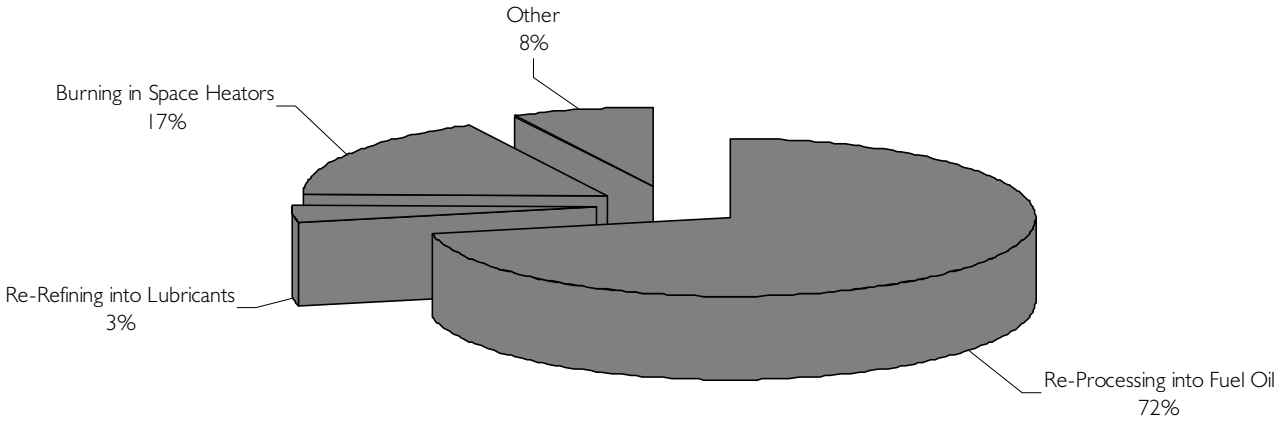
North Carolina has established the need for used oil recycling programs in state statute. In General Statute Act 309.16, the state proposed to support a public education program regarding used oil collection and recycling through the provision of financial and technical resources. In General Statute Acts 309.21 and 22, the state also committed to provide funding and expertise necessary to initiate an incentive program for individuals who change their own oil. In addition, the Statute proposed supporting a grants program to encourage new local government curbside collection initiatives and the establishment of additional private used oil collection centers. Funding was never appropriated for these programs, therefore they were never implemented.

Another way to increase oil recovery is to target "hidden" sources. For example, an average of 0.8 ounces of oil is trapped in every one-quart bottle of oil sold. In other words, in 1997, approximately 270,000 gallons of oil was disposed in North Carolina landfills because of residual oil left in bottles after oil changes. Similarly, assuming that best possible drainage practices were employed in 1997, more than 270,000 gallons of used oil were still disposed along with 10 million used filters in 1997. By addressing these hidden sources, North Carolina could dramatically decrease the amount of used oil disposed in landfills.

Figure 5: DIY Used Oil Recovered in 1997 and 2002

	1997 gallons	2002 gallons
Recoverable DIY Used Oil Generated	6,491,288	5,518,981
Local Government Recovery	575,859	598,821
Private Sector Recovery	1,579,927	1,343,275
Total Recovery	2,155,786	1,942,096
Percent Recovered	*33%*	*35% (assumed)*
Unaccounted for DIY Used Oil	4,335,502	*3,576,885*

Figure 6: National Distribution of Demand for Used Oil Products



* Based on survey conducted by API, May 1996.

DEMAND

This section focuses primarily on the demand for used oil from North Carolina's two largest end users: re-processing fuel and re-refining lubricants. API defines re-processing as cleaning used oil so it can be reused as a fuel to produce electricity. Re-refining, on the other hand, requires additional treatment so that spent oil can be used again as petroleum based oil. Re-processed used oil is not of sufficient quality to be used for lubrication purposes.[14] According to the *National Used Oil Collection Study* conducted by API, roughly 72 percent of the used oil generated nationally is re-processed into fuel (see Figure 6). API also reports that space heaters consume roughly 17 percent of used oil, particularly in northern states with severe winters. In addition, API estimated that 3.5 percent of used oil was re-refined into lubricating oil.[15]

Fuel Oil Markets

A majority of used oil in North Carolina is used to produce fuel oil for industry. In most oil recycling and fuel production operations, used oil is re-processed by removing contaminants and adding virgin oil to produce oil suitable for burning in industrial boilers.

Noble Oil Services maintains an oil recovery and processing facility in Sanford, North Carolina. Currently, the plant produces more than 100,000 gallons of fuel per day. In 1997, Noble Oil accounted for more than six million gallons of used oil recovery in North Carolina. More importantly, Noble Oil perceives that the demand for fuel from used oil has the potential to match a large increase in supply of recovered used oil. Noble Oil Services anticipates that it could increase its consumption of used oil 100 to 200 percent if used oil recovery were to increase in the future.[16] Holston Group Inc. also produces fuel from used oil in North Carolina and expects similar growth in end-use market demand.

Lubricant Markets

Safety Kleen is the largest re-refined lubricant producer in the nation. Safety Kleen collects used oil from North Carolina and other parts of the United States and re-refines it into

lubricant at its processing facility in Chicago, Illinois. The amount of used oil processed at the Chicago plant has increased from 75 million gallons in 1994 to more than 100 million gallons in 1997. Roughly 90 percent of the re-refined oil is resold as recycled lubricating oil for industrial, railroad, government, and passenger motor oil purposes. The remaining 10 percent enters the fuel market. While the national sales of all lubricating oils have remained fairly constant for the past three years, Safety Kleen estimates that the re-refined motor oil market has enormous growth potential. The company estimates sales could double during the next five years because of continued growth in the industrial and railroad markets, the emergence of closed loop oil management systems for government sector contracts, and increasing "buy recycled" customer awareness programs in the DIY market. While Safety Kleen's recycled motor oil has traditionally sold to industrial and railroad consumers, its recent contracts with federal, state, and local governments have increased the acceptance of re-refined oil as a viable market with growth potential. Currently, Safety Kleen estimates that re-refined lubricant oil constitutes three percent of the total lubricant market sales.[17]

SUPPLY / DEMAND RELATIONSHIP

The demand for recycled used oil products is heavily influenced by the price and demand trends in the virgin crude oil market. For instance, fluctuations in the price of crude oil directly impact the price competitiveness and demand for used oil products. The price of crude oil fluctuates according to international political and economic events and oil producers' strategic decisions regarding supply. During the past three years, the market for used oil has become increasingly competitive because of virgin crude oil glut in the world market. When virgin oil prices peaked in 1996, producers responded by increasing crude oil supplies to realize greater profits. The market soon experienced a glut of oil, thus driving crude oil prices back down. As the price of crude oil has continued to decrease since 1997, the market for used oil has become increasingly competitive.[18]

Some key differences are evident between the markets for recycled fuel oil and re-refined lubricant oil. In the fuel oil market, for example, re-processing used oil requires less energy than refining virgin crude oil. As a result, used fuel oil has traditionally provided competitive prices relative to crude-based fuel oil products. Therefore, despite the decrease in price of crude oil in the world market, recycled fuel oil has maintained a relatively stable demand structure. In contrast, the process of producing re-refined lubricating oil does not provide significant cost savings relative to crude oil products. Consequently, for more than the past two years, the demand for re-refined lubricating oil has become increasingly competitive. In response to this increased competitiveness, Safety Kleen has shifted its emphasis from strictly base stock lubricant production to higher quality lubricant products, which require more processing and are less vulnerable to the price cutting trends in the crude oil market.[19]

Based on market analyses from processors of re-refined lubricant oil and especially from recycled fuel oil producers in North Carolina, there appears to be a strong potential for an increase in the short-term demand for used oil. More specifically, processors of fuel oil in North Carolina indicate the demand for fuel oil already exceeds current supply levels.[20] Similarly, as Safety Kleen continues to realize growth in the industrial, rail, and government sectors, the demand for re-refined lubricant oil should also increase in the near future. Based on this information, it appears that the current and future demand for used oil provide the potential to absorb significant increases in the supply of used oil from both the DIY and OMV sectors.

Based on current data, the total recovered used oil from motor vehicle sources was more than nine million gallons in 1997. Given the significant amount of used oil that is not collected from DIY sources, this recovery rate can be characterized as below the potential supply capacity. In fact, with more than four million gallons of uncollected used oil from DIY sources, there appears to be significant potential for an increase in supply. In summary, it appears that the potential demand for fuel oil is more than adequate to absorb a significant proportion of the more than four million gallons of unrecovered used oil from DIY sources.

CONCLUSION

Based on the current indications of strong demand for used oil as a fuel product, North Carolina has an opportunity to recover much of its remaining used oil. In particular, the state should focus on increasing the recovery of used oil from the DIY generation sources. In addition, by increasing public awareness of higher oil change intervals, the amount of used oil generated could decrease significantly. Moreover, with projections of continued population growth in North Carolina during the next few decades, the issue of proper oil management and treatment will become increasingly important for preserving the integrity of North Carolina's natural resources.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery, and markets for used oil presented in this section.

- North Carolina should research its locations, characteristics, and disposal behavior patterns of DIY oil changers.
- The state should support an education campaign to raise the awareness of proper oil disposal methods and to increase the proliferation and visibility of public and private drop-off collection sites.
- State and local governments also should seek opportunities to link used oil bottle collection efforts with used oil and oil filter recycling programs.
- State and local governments also should educate citizens on the possibility of decreasing the frequency of oil changes through higher oil change intervals. This campaign should target both DIY changers and other vehicle owners equally.
- To measure the effectiveness of oil recycling efforts, a data collection system should be established to monitor the quantity of oil sold and the amount of used oil recovered.
- To recover a portion of the DIY oil stored at rural households and farms, local governments should sponsor rural oil collection events. While the actual quantity of used oil generated from rural sources is currently unknown, several rural collection events have resulted in significant collection quantities. For example, more than 1,500 gallons of used oil was collected on a rural collection day outside Greensboro in the early 1990s.
- To demonstrate leadership and bolster the demand for re-refined used oil, the state should use only re-refined used oil in its motor vehicle fleets. Local governments should be encouraged to follow this example.
- Finally, because of tremendous need for public education efforts to improve the recovery rate of used oil from DIY sources, the state should seek to fulfill the responsibilities established in the North Carolina General Statutes 130A-309.16 and 309.21-22.

[1] American Petroleum Institute. *National Used Oil Collection Study*. May 1996. p. 36.
[2] U.S. Environmental Protection Agency. *Environmental Regulations and Technology. Managing Used Motor Oil*. December 1994. p. 4.
[3] According to the California Public Resources Code, Section 48618, lubricating oil includes any oil that is intended for use in machinery powered by an internal combustion engine. Lubricating oil includes oil intended for use in an internal combustion engine crankcase, transmission, gearbox, or differential in an automobile, bus, truck, vessel, plane, train, heavy equipment, or other machinery powered by an internal combustion engine. Lubricating oil does not include oil intended for use in a two-cycle engine where the oil is consumed entirely during usage. From *National Used Oil Collection Study*. May 1996. p. 160.
[4] The vehicles registered category included automobiles, trucks, buses, state vehicles, tractor trucks, and recreation vehicles from the total list of vehicles registered in 1997 provided by the Division of Motor Vehicles.
[5] According to research by the API, the average motor vehicle in North Carolina purchases 3.677 gallons of oil per year. (API. *National Used Oil Collection Study*. 1996. p. 36).
[6] American Petroleum Institute. *National Used Oil Collection Study.* p. 35. May 1996.
[7] Communications with the Automobile Oil Change Association. October 1998.
[8] Communications with Automotive Oil Change Association. October 1998.
[9] These estimates for recoverable oil for DIY and OMV sources are based on information from the California Environmental Protection Agency Integrated Waste Management Board. Communications with Bob Boughton. August 1998. In the *National Used Oil Collection Study*, the API estimated recoverable used oil from DIY sources at 70 percent.
[10] Communication with the Automotive Oil Change Association. October 1998.
[11] Communication with Bob Boughton and the California Environmental Protection Agency Integrated Waste Management Board, Communications. August 1998.
[12] Communication with Kathy Carmichael. KC and Associates. October 1998.
[13] Toyota recommends that most cars and trucks follow normal oil change procedures of 7,500 miles. However, some vehicles, which fall under severe driving condition criteria, should have their oil changed more frequently (3,750 miles). The following criteria determine severe driving conditions; 1) towing a trailer, using a camper, or car top trailer, 2) operating on dusty, rough, muddy, or salt spread roads, 3) repeated short trips less than less than five miles and outside temperatures remain below freezing, 4) extensive idling and/or low speed driving for a long distance such as police, taxi, or door-to-door use.
[14] American Petroleum Institute. *National Used Oil Collection Study*. p.40, May 1996
[15] American Petroleum Institute. *National Used Oil Collection Study*. p.40-42.May 1996
[16] Communications with Jim Jolliff. Noble Oil Service. October 1998
[17] Communication with David Peel. Safety-Kleen. November 1998.
[18] Communication with Noble Oil Services and Safety Kleen. November 1998.
[19] Communication with David Peel. Safety-Kleen. November 1998.
[20] Communication with Noble Oil Services and Holston Group Inc. September and October 1998.

Oil-Related: Used Oil Filters

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

According to the Filter Manufacturers Council (FMC), each motor vehicle in North Carolina generates an average of two used oil filters per year.[1] With nearly six million industrial, commercial, and passenger vehicles registered with the state Division of Motor Vehicles in 1997, more than 11.7 million light duty oil filters were generated in North Carolina. Moreover, because restrictions for disposing filters in landfills are lacking, only 20 percent of used oil filters were recovered in North Carolina in 1997.

Currently, North Carolina law exempts all non-terne plated oil filters from hazardous waste regulations if the filter has been hot drained through one of the following methods: 1) punctured through its dome or anti-drain back, 2) crushed, 3) dismantled, or 4) drained via any other equivalent hot-draining method that removes the used oil.[2, 3] Before draining, a used oil filter can contain as much as 16 ounces of used oil. After hot draining, a filter can still contain between 3.5 and eight ounces of used oil.[4]

Contamination from residual oil in oil filters presents a threat to the state's environment and natural resources. In its research on the potential impacts of used oil, the United States Environmental Protection Agency (EPA) has identified several environmental risks posed by improper disposal methods. Specifically, the EPA estimates that one gallon of used oil can pollute more than one million gallons of drinking water. Small amounts of used oil that accumulate on water bodies also can prevent oxygen and sunlight from entering the water, thus reducing plant and animal life in lakes, ponds, and rivers. Additionally, used oil dumped in drains often accumulates in small concentrations in water treatment plants and creates a severe detriment to sewage treatment processes.[5]

This report focuses on the recycling opportunities represented by the 3,800 tons of steel and at least 250,000 gallons of used oil contained in the more than nine million filters that currently may be disposed in North Carolina.[6] This report assesses the relationship between the supply

Figure 1: Total Oil Filters Sold for Motor Vehicle Uses in North Carolina 1994, 1997 and 2002

	1994	1997	2002
Oil Filters from all Motor Vehicles	10,768,684	11,709,890	13,415,672
A. Other Motor Vehicle Consumers	5,384,342	5,854,945	8,049,403
B. Do-It-Yourself Sources	5,384,342	5,854,945	5,366,269

Source: Based on data from the Filter Manufacturers Council, 1996

and demand for used oil filters in North Carolina. Toward this end, the report focuses primarily on analyzing the market areas with the largest amount of uncollected filters and with the greatest potential for recovery and recycling. According to feedback from recycling companies in the Southeast region, there are sufficient markets for all three components of used oil filters: the steel shell, the paper filter media, and the residual used oil.

SUPPLY

Generation

Data were lacking on used oil filter generation and consumption in North Carolina. For this reason, generation is calculated in two steps. The first step involves estimating the amount of oil filters sold in North Carolina in 1997. Second, the consumption of filters is allocated to the two main types of oil filter consumer groups.

Step One: Oil Sales

To estimate the amount of used oil filters generated in North Carolina, this analysis references data from a study conducted by FMC in 1996.[7] To estimate the number of filters sold in 1997, the average number of oil filters sold per vehicle was multiplied by the number of vehicles registered in North Carolina that year. With an average of 1.99 filters sold per vehicle and 5.8 million registered vehicles, approximately 11.7 million light duty filters were sold in North Carolina in 1997 (see Figure 1).

Step Two: Consumer Groups

The two main consumer categories of oil filters from motor vehicle sources are do-it-yourself (DIY) oil changers and all other motor vehicle (OMV) consumers. DIY generators consist primarily of people who change their own oil at residences and are then responsible for disposing of the used oil and filters. OMV generators constitute a broad class of consumers, including people who bring their automobiles to quick oil change facilities, dealerships, or service stations. In addition, the OMV category includes used oil generated from commercial and government fleets, rental car operations, and other establishments that generate used oil.

Based on previous research, the American Petroleum Institute (API) estimates that DIY oil changers constitute approximately 50 percent of the motor vehicles and used oil filters generated in North Carolina. This assumption is based on a national average and may underestimate the percentage of DIY oil changers in North Carolina. The state exhibits three characteristics that make a higher portion of DIY changers likely: 1) a more rurally based population, 2) a warm climate, and 3) a younger population (older Americans are less likely to change their own oil).[8] Given the warm climate and the relatively balanced rural and urban population, it is estimated that DIY sources are responsible for roughly 50 percent of used oil filters in North Carolina (Figure 1). However, because of an increasing urban population base and the rapid expansion of quick oil change outlets, the percentage of DIY oil changers is expected to decrease two to five percent per year in the short term future.[9] Estimates in this analysis reflect a two-percent average annual decrease in DIY consumers from 1997 to 2002. Because of the decreasing percentage of DIY consumers by 2002 more than eight million filters will be generated by OMV sources.

Recovery

Based on a survey of recycling businesses in 1998, 20 percent of used oil filters from all motor vehicle sources were recovered in North Carolina in 1997 (Figure 2). A majority of the 2.3 million used oil filters recovered from motor vehicles were collected from commercial fleets, quick oil change outlets, and auto parts stores. As a result, approximately nine million filters remain unaccounted for and may be discarded in landfills throughout the state.

To discover the potential sources of unrecovered used oil filters, it is necessary to analyze the recovery of OMV and DIY oil streams separately.

Other-Motor-Vehicle Sector

Based on information gathered from a survey conducted by the North Carolina Division of Pollution Prevention and Environmental Assistance (DPPEA) in 1997, the recovery of used oil filters from the OMV sources (quick oil chang-

Figure 2. Recovery of Used Oil Filters from Light Duty Motor Vehicles in North Carolina, 1997 and 2002

	1997	2002
Total Oil Filters Generated (Sold)	11,709,890	13,415,672
Total Filters Recovered	2,334,031	3,109,788
Recovery Rate	20%	23%
Unaccounted for Used Oil Filters	9,375,859	*10,305,884*
Residual Used Oil from Unaccounted Oil Filters	256,372 gallons	*281,801 gallons*

Figure 3: OMV Used Oil Filters Recovered in 1997 and 2002

	1997	2002
OMV Used Oil Filters Generated	5,854,945	8,049,403
Total OMV Recovery	2,118,531	2,912,274
Percent Recovered	*36%*	*36% (assumed)*
Unaccounted for OMV Used Oil Filters	3,736,414	*5,137,129*
Residual Oil in Unaccounted for OMV Used Filters	102,168 gallons	*140,468 gallons*

Figure 4: DIY Used Oil Filters Recovered in 1997 and 2002

	1997	2002
DIY Used Oil Filters Generated	5,854,945	5,366,269
Total DIY Recovery	215,500	197,514
Percent Recovered	*4.00%*	*4.00% (assumed)*
Unaccounted for DIY Used Oil Filters	5,639,445	*5,168,755*
Residual Oil in Unaccounted for DIY Used Filters	154,204 gallons	*141,333 gallons*

ers, private fleets, rental cars, and state government vehicles) occurs almost exclusively through private sector channels. For example, while only six local governments collected oil filters in 1997, private businesses collected more than two million filters. The recovery rate for used oil filters from all OMV sources reached 36 percent of generation in 1997 (Figure 3). Assuming a constant recovery rate for the next five years, more than five million oil filters from quick oil change outlets, private fleets, rental cars, and government sources will be discarded into landfills in 2002. Moreover, because of the 3.5 ounces of residual oil contained in each of the 3.7 million used oil filters from OMVs, more than 102,000 gallons of used oil were disposed in landfills in 1997.[10]

Do-It-Yourself (DIY) Sector

With only 215,000 filters recovered from DIY generators in 1997, the recovery rate for this sector is approximately four percent. Local government collection efforts were limited to six localities in 1997. While there may be some small sources of private sector recovery of DIY oil filters not included in this report, existing data reveal the DIY sector is responsible for more than five million unaccounted filters in 1997 (Figure 4).

Even when DIY generators employ the state mandated best drainage practices, as much as 3.5 ounces of oil remain in each of the five million used filters that are unaccounted for from these sources. Cumulatively, the five million filters could have resulted in 154,000 gallons of used oil being discharged into North Carolina's landfills in 1997.[11] Combining DIY and OMV sources results in about 256,000 total gallons of residual oil contained in filters.

Source Reduction

Fewer oil changes means less waste oil released into the environment. Because of improvements in the design of motors during the past 10 years, most major automobile manufacturing companies have decreased the recommended frequency of oil changes. (See the *Used Oil Commodity Profile* for more information.) An increase in the minimum distances between oil changes of just 2,000 miles could result in as much as a 30 percent reduction in the generation of used oil filters.

By-pass filters are another important source reduction option. Preliminary studies indicate the average oil life used in combination with a by-pass filter is 130,000 miles.[12] The state could demonstrate leadership in this area by installing by-pass filters in all state government vehicles. Local governments also could be encouraged to install by-pass filters on fleets.

Increasing Filter Recovery

Many states have initiated used oil recycling programs based on the API Model Bill. This model bill establishes guidelines for a state-used oil fund supported by a fee on oil sales (usually two cents per quart). The fund normally is used to provide grant funding for cities and towns wishing to establish or publicize new oil and filter drop-off centers or curbside collection programs. In addition, many states use the funds to support a toll-free telephone information center and state-sponsored promotions. South Carolina uses some of its state funds for a multi-media advertising campaign, which includes print material, a school curriculum, and television and radio advertisements with NASCAR celebrities. Many of the state's educational programs are focused on raising the awareness of DIY oil changers.

North Carolina has established the need for used oil and filter recycling programs in state statutes. In General Statute Act 309.16, the state proposed to support a public education program regarding used oil collection and recycling through the provision of financial and technical resources. In General Statute Acts 309.21 and 22, the state also committed to providing the funding and expertise necessary to initiate an incentive program for individuals who change their own oil. In addition, the Statute proposed supporting a grants program to encourage new local government curbside collection initiatives and the establishment of additional private used oil collection centers. Funding was never appropriated for these programs, therefore they were never implemented.

Increasing Oil Recovery

Data suggest that, because of residual oil contained in used oil filters, the state cannot consider the landfill ban for used oil complete until used oil filters are also banned from disposal. Recent studies have revealed that the amount of used oil contained in oil filters varies from 3.5 to eight ounces depending on drainage practices. Assuming the best possible drainage practices were employed in 1997, more than 256,000 gallons of used oil were still disposed along with the 10 million filters. This significant amount of used oil entering landfills clearly violates the intention of the law banning used oil disposal. Banning the disposal of filters would reduce the potential environmental hazards and bolster the developing filter recycling infrastructure.

While a more detailed cost/benefit analysis is necessary for further consideration of an oil filter ban, initial calculations reveal that collection and recycling of the nine million currently disposed filters would cost generators approximately $2.2 million in additional hauling charges.[13] This cost would be offset partially by the average retail purchase expenditure of $6.50 from each individual who returns filters to an auto parts retail outlet.[14] For example, if 25 percent of the 5,639,445 unaccounted for filters from DIY oil changes were collected at auto parts retail outlets, nearly $9.2 million dollars in additional sales would occur. In addition, the growth of North Carolina's steel recycling economy (in revenue and employees) would also offset the increased hauling costs of mandatory filter recycling.

While the state bears responsibility to protect the natural resources of the larger environment, local governments also can take initiative to respond to potential threats to their watersheds and groundwater, drinking, and recreational water supplies by banning the disposal of used oil filters in their local landfills.

DEMAND

Because of the relatively recent emergence of the oil filter recycling industry, limited quantitative information exists on the demand for filters from North Carolina. The following demand analysis is based on communications with firms that collect, transport, or process used oil filters from North Carolina.

Used oil filters contain three recyclable elements: used oil, a paper filter media, and a steel shell. The steel shell is the most marketable element. The two primary end users for used oil filters are steel mills and scrap metal recovery operations. While North Carolina has very strong markets for used oil and recycled steel, currently, there is only one major end user of paper filters in the state.

Steel

Filtech Filtration Products, located in Monroe, North Carolina, is the oldest and largest processor of used oil filters in

the region. In 1997, Filtech processed approximately three million filters, mostly from North Carolina sources. Because of their high volume shredding technology, the plant currently has the capacity to process approximately 10 million used oil filters, or the equivalent of all of North Carolina's unaccounted for filters. Moreover, Filtech processes, separates, and markets all three components of used oil filters: the scrap steel, used oil, and paper filter media.

In addition to selling recycled steel to one of three large steel mills in the region, Filtech also sells approximately 100,000 gallons of used oil to Noble Oil Services for reprocessing and resale. Three regional mills currently consuming the largest percentage of recycled steel from oil filter processors are Charlotte Pipe and Foundry (North Carolina), Nucor (South Carolina), and SMI (South Carolina). Because of extremely large volumes of steel raw material purchases, recycled oil filter steel make up less than one percent of the input for any of the mills. While the high quality of steel in oil filters is attractive to steel production, mills do not accept recycled steel contaminated by the paper filter media. Although small amounts of residual oil can be consumed in furnaces, paper media is prone to floating when incinerated and has the potential to create a fire hazard. Massive quantities of recycled steel demanded by regional steel mills provide sufficient future demand to absorb significant increases in the recovery rate of used oil filters.[15]

Used Oil

As mentioned in the report on used oil, there is tremendous demand for used oil from North Carolina. Specifically, the majority of used oil in the state is used to produce fuel oil for industry. In most oil recycling operations, used oil is processed by removing contaminants and adding some virgin oil to produce oil suitable for burning in industrial boilers. For information on specific end users, refer to the *Used Oil Commodity Profile*.

Paper Filter Media

Currently, Giant Resource Recovery is the largest end user of the paper media in used oil filters. The company uses the paper media as a fuel in its cement kilns. While Giant Resource Recovery currently consumes most of the paper media recovered in the state, other fuel-to-energy end users could be identified if recovery levels increase in the future.

SUPPLY / DEMAND RELATIONSHIP

The demand for recycled filter products is influenced by the price and demand for competing products derived from virgin materials. In the case of used oil filters, markets for virgin steel and crude oil heavily influence the demand for steel scrap and used oil.

Based on information from transporters, processors, and end users of used oil filters, the demand for recycled steel from used filters currently exceeds the supply in the region. More specifically, steel mills have such large demand structures that a 50-percent increase in oil filter recovery would provide a nominal amount of recycled steel relative to their total raw material needs. As a result of high quality steel in oil filters, it appears the demand for recycled steel in the region is more than sufficient to absorb potential increases in used oil filter supplies.

Similarly, processors of used oil in North Carolina acknowledge the demand for fuel oil is already well above the current supply.[16] In addition, the demand for re-refined motor oil is expected to double within five years. While the supply of paper media currently is being absorbed by one primary end user, industry experts expect additional fuel-to-energy uses to emerge as the supply of paper filter media increases.[17] Therefore, through a combination of the three end uses, it appears that current and future demand for recycled steel, used oil, and paper fuel provide the potential to absorb significant increases in the supply of used oil filters from both the DIY and OMV sectors.

Given the significant amount of filters not collected from DIY and OMV sources, the current supply of used oil filters can be characterized as well below the potential demand. In fact, with more than nine million uncollected filters from motor vehicle sources, there appears to be significant potential to increase in supply.

CONCLUSION

More than 256,000 gallons of residual oil from oil filters may have entered North Carolina landfills in 1997. With projections of continued population growth in North Carolina during the next few decades, the issues of proper oil and filter management will become increasingly critical to preserving the integrity of the state's environment and natural resources.

First and foremost, efforts should be made to increase public awareness of higher oil change intervals, which would greatly reduce the amount of used oil and filters generated. Additionally, given the projection of a steady decrease in future DIY oil changers, increased attention should focus on the quick-change or installation sector of the OMV sector where most used oil and filters will be concentrated.

According to feedback from recycling companies in the southeast region, there are sufficient markets for all three components of used oil filters: the steel shell, paper filter media, and residual used oil. Given the potential environmental threat, the expanding collection infrastructure and the growing demand for recycled steel and used oil, there appears to be sufficient rationale for a statewide ban on disposal of used oil filters in landfills.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery, and markets for used oil filters presented in this section.

- The state should promote the use of by-pass filters as a means of maintaining cleaner oil in engines and decreasing the frequency of oil changes. Local governments should be encouraged to provide similar leadership.
- The state should ban disposal of used oil filters. Because of residual oil contained in these filters, the state should not consider the ban on used oil from landfills complete until used oil filters are also banned from disposal.
- In addition to state consideration of a ban on the disposal of filters, local governments should consider implementing local bans on used oil filters.
- The state should support an education campaign to raise awareness of proper filter management methods and to increase the proliferation and visibility of public and private drop-off collection sites.
- State and local governments should seek opportunities to link used oil bottle collection efforts with used oil and oil filter recycling programs.

[1] Filter Manufacturers Council Environmental News. "Estimated Light Duty Oil Filter Sales by State." 1996. p. 4.
[2] NC DPPEA, "Management of Used Oil Filters," 1996. Terne filters are used primarily in buses and large, off road trucks. The plating on terne filers contains lead and is therefore deemed a hazardous material. All non-terne filters are not regulated as hazardous wastes in North Carolina.
[3] Hot draining is defined as a gravity induced process at near-engine-operating temperature and above 60 degrees Fahrenheit
[4] Communications with Brent Hazelett, Filter Manufacturers Council and Bob Boughton, California Environmental Protection Agency Integrated Waste Management Board, September 1998.
[5] U.S. EPA, *Environmental Regulations and Technology, Managing Used Motor Oil*, December 1994, p. 4.
[6] Current estimates reveal that oil filters contain approximately 0.8187 pounds of steel per filter and at least 3.5 ounces of used oil (Filter Manufacturers Council and California Integrated Waste Management Board).
[7] Filter Manufacturers Council Environmental News, "Estimated Light Duty Oil Filter Sales by State," 1996 p. 4.
[8] American Petroleum Institute, *National Used Oil Collection Study*, p. 35, May 1996.
[9] Communications with the Automobile Oil Change Association, October 1998.
[10] After puncturing and hot draining, used oil filters contain roughly 3.5 ounces of used oil. If only hot drained (and not punctured), then used oil filters may contain up to eight ounces of used oil. Based on communications with the Filter Manufacturers Council and Bob Boughton of the California Environmental Protection Agency Integrated Waste Management Board, Communications, August 1998.
[11] Residual used oil figures based on communications with Bob Boughton and the California Environmental Protection Agency Integrated Waste Management Board, Communications, August 1998.
[12] NC DPPEA Fact Sheet, "Eliminating Vehicle Oil Changes and/or Oil Filters Disposal," August 1996.
[13] Assumes 250 uncrushed filters per 55 gallon drum and an average collection fee of $60 per drum.
[14] Estimate from a study by the Filter Manufacturer's Council.
[15] Communications with David Autry, Filtech Filtration Products, October 1998.
[16] Communications with Noble Oil Services and Holston Group Inc., September and October 1998.
[17] Communication with Filtech Filtration Products, October 1998.

Food Residuals ▪ Yard Wastes

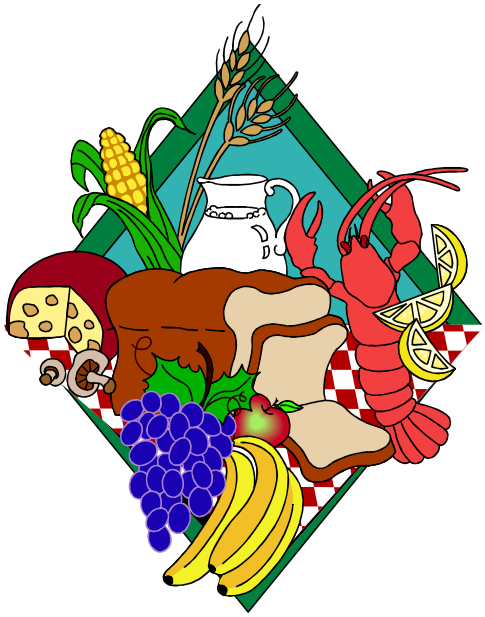
Organics

Organics: Food Residuals

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

The nation's food supply is the most varied and abundant in the world. Americans spend a smaller share of their disposable income on food than citizens of any other country and choose from an average of 50,000 different food products on a typical outing to the supermarket.[1] This abundance of food has offset motivations to monitor or reduce food residuals.

Food residuals are generated at every step in the distribution chain from farm to dinner table. Examples include:

- Farm produce that does not meet supermarket purchase specifications.
- Diseased animals that are condemned at slaughterhouses.
- Waste from industrial food processing establishments.
- Discards of blemished perishables and out-of-date foods at supermarkets.
- Foods prepared by service establishments that are not served to guests.
- Plate scraps from commercial and residential sources.

Mechanisms for recovery of food residuals differ depending on whether these foods are suitable for human consumption. Recovery efforts for edible foods include gleaning programs, food banks, and food rescue programs. Recovery efforts for inedible foods include animal feed (either direct or remanufactured into an animal feed product) and composting.

In 1997, estimated food residuals generation in North Carolina was 862,500 tons from commercial and residential sources (or 11 percent of the total municipal solid waste stream). This total does not include farm losses before foods enter the distribution system or wastes from industrial food processors sent directly to rendering and animal feed production facilities. The estimated recovery rate of food re-

Figure 1: North Carolina Food Residuals Generation Estimates[1]

Source	Annual Tonnage	Percent of Total MSW Stream	Pounds Per Capita Per Day
USDA-ERS, 1996[1]	1,318,844	17.1	1.0
Luboff/Newell, 1993 [3,4]	1,145,225	14.8	0.87
EPA, 1994[5]	644,338	8.0	0.48
Orange Co., 1996[6]	551,735	7.1	0.42
EPA, 1997[2]	586,360	8.0	0.45
Mean	849,300	11.0	0.64
Standard Deviation	356,278	4.6	0.27

*Estimates based on North Carolina's proportion of total United States population.

siduals in North Carolina is less than two percent. Insufficient data exist to develop more accurate recovery estimates.

North Carolina recovery organizations include eight food banks, four food rescue programs, 117 licensed food waste animal feeders, several animal feed manufacturers, and three programs that compost food processing waste. Also, several small-scale food residuals composting efforts are underway, including institutional efforts at correctional and military facilities, and events-oriented activities, such as the annual Festival for the Eno River in Durham.

SUPPLY

Generation

Estimates of food residuals generation are limited and inconsistent. The U.S. Department of Agriculture (USDA) and the U.S. Environmental Protection Agency (EPA) have conducted national-scale studies.[2, 3] Curbside studies have been conducted in Seattle, Washington; Crawford County, Illinois; and Orange County, North Carolina.[4, 5, 6] Based on these studies, estimates of food residuals generation in North Carolina have been compiled and are presented in Figure 1.

Data presented above reflect the wide variation in estimates of food residuals generation, as shown by the substantial standard deviation around the mean. Extrapolating these data to 1997 and 2002, generation of food residuals in North Carolina is estimated to be 862,500 tons and 915,300 tons, respectively. (See Figure 2.)

Recovery

Food donor programs are the primary recovery mechanisms for edible food, while animal feeds and composting are the primary recovery mechanisms for inedible food. Food donor programs provide edible foods to the needy through food banks and prepared and perishable food rescue programs (PPFRPs).[7] Food banks focus on distributing large volumes of nonperishable food (i.e., canned, dried, or prepackaged). Much of the food distributed by food banks is diverted from the landfill; however, they also distribute foods donated by citizens that otherwise would not have been discarded. Currently, North Carolina has seven operational food banks. PPFRPs also are known as food rescue or surplus food distribution programs. These programs distribute freshly prepared foods and perishables to the needy. There are five food rescue programs operating in North Carolina. In 1997, food donor programs in North Carolina provided about 6,962 tons of edible food to the needy.[8] This number is expected to rise significantly in future years as efforts of the new USDA Food Recovery and Gleaning Initiative begin to show results. This program has a goal of a 33-percent increase in the amount of food recovered nationally by the year 2000. This goal translates to a projected year 2002 recovery of 11,100 tons in North Carolina.

Inedible foods can be recycled into animal feeds in two ways: (1) feeding them directly to animals (livestock) or (2) reprocessing them into animal feeds. Hog, cattle, and poultry producers often are interested in collecting food residuals to use as direct animal feed. Dairy products and bread may be fed to hogs without further handling, but other food residuals or mixed food residuals must be cooked before being fed to hogs. Farmers who use other or mixed food materials must be licensed garbage feeders. Currently, 117 garbage feeders are licensed by the USDA / Animal and Plant Health Inspection Service (USDA/APHIS) to approximately 3,000 hogs. In 1997, these licensed farmers diverted approximately 6,700 tons of food residuals to direct animal feed. The number of livestock in North Carolina is expected to remain relatively constant through the year 2002 because the total numbers of cattle, sheep, and chickens are declining, but the number of hogs is rising.[9] As

a result, the amount of food residuals diverted to direct animal feed is expected to remain relatively constant (6,500-7,000 tons per year).

Some North Carolina animal feed producers use industrial food processing residuals as all or a portion of their incoming raw materials.[10] Estimates of food residuals generation in North Carolina do not include food residuals generated by "industrial" food processors, therefore the processing quantities listed above are excluded from recovery estimates.

Another diversion technique for food residuals is composting. A recent study determined that the United States has 214 composting facilities that accept food residuals.[11] More than half of these are smaller-scale, on-site facilities, such as those serving correctional facilities, other institutional facilities, or on-farm operations. Eight facilities are operational in North Carolina, including a ninth one that came on-line during summer 1998.[12] Several composting efforts are described below.

- Five operational facilities compost industrial processing wastes from aquaculture, seafood, and fruit processing industries.
- Two correctional institutions compost post-consumer food waste.
- One facility, operated by the Eastern Band of the Cherokee Indians, composts food residuals from a casino in western North Carolina.
- A composting operation at a military installation is permitted to accept source-separated materials and currently accepts food residuals, sludge, and paper. Although this operation is permitted to accept mixed waste as well, it does not.
- The National Institute for Environmental Health Sciences in Research Triangle Park uses worms to compost about 100 pounds of food residuals from its cafeteria each week.
- The North Carolina Zoo in Asheboro incorporates food residuals into its composting program.
- In addition, two of the commercial composting facilities in North Carolina indicated they were capable of accepting food residuals, but were not receiving any at present.[13, 14]

Some food residuals composting is being practiced at special events, like the annual Festival for the Eno River in Durham each July. In addition, 14 North Carolina communities have begun sponsoring backyard composting programs. These programs will contribute to the diversion of food residuals from landfills, but the quantities diverted are unknown. Quantities of food residuals recovered through composting are estimated to be insignificant for commercial and residential food residuals. In summary, the relationship between generation and recovery is shown in Figure 2.

Figure 2: North Carolina Food Residuals Generation versus Recovery (tons)

	1997	2002
Generation	862,500	915,300
Recovery	13,662*	17,800*

*Does not include food residuals composting; quantities are limited

DEMAND

Elements of demand for food residuals consist of edible food donations to the needy, animal stock farmers seeking either direct or processed animal feeds, and users of composted feedstocks (i.e. landscapers, nurseries, soil blenders, the public, etc.).

Food Donor Programs

Demand for donated edible foods is estimated to be in excess of the 6,962 tons per year recovered in North Carolina, however more quantifiable estimates are not available. It is estimated that in the United States four million children under 12 and about 30 million adults go hungry at least once per month.[15] According to the 1990 census, 13 percent of the population (or 830,000 persons) in North Carolina lives in poverty.[16] Demand for food donor programs in North Carolina has grown consistently during the past several years.[17] Recently, USDA announced a new Food Recovery and Gleaning Initiative.[18] This initiative arose from an inaugural National Summit on Food Recovery and Gleaning in September 1997. This Summit set a goal of a 33-percent increase in the amount of food recovered nationally by the year 2000. Meeting this goal would produce an additional 250,000 tons of food per year to feeding organizations.[19]

One obstacle to growth in food donor programs has been concern about potential liability to the donor if a problem occurs. To protect food donors, "Good Samaritan" laws that specifically address food donations have been enacted in all states. North Carolina's model "Good Samaritan" law was enacted in 1989 and revised in 1991. On a federal level, the Bill Emerson Good Samaritan Food Donation Act went into effect in October 1996. These laws limit the potential civil or criminal liability exposure to a donor unless gross negligence, recklessness, or intentional misconduct of the donor causes injury. The federal law also establishes basic uniform definitions pertaining to donation and distribution of foods and helps ensure donated foods meet

all quality and labeling standards of federal, state, and local laws and regulations. This law facilitates donations of food by large, multi-state restaurants, and eating establishments and by chain hotels.

Animal Feeds

For industrial, commercial, and residential food residuals, the demand for food residuals-based animal feeds is driven by these factors: avoided costs (farmers not having to spend money on commercial animal feeds), proximity to sources of good-quality food residuals, and lack of contamination with non-food residuals. For animal feeds produced by industrial companies using industrial food processing residuals, an additional economic driver is the cost of the food residuals relative to the cost for other feedstocks (e.g., grains).

The potential demand for direct animal feeds from food residuals from garbage feeders is considered to be relatively constant. This is because of the limitations noted above and the trend towards more Concentrated Animal Feed Operations (CAFOs). For these larger operations, the potential for using food residuals as direct animal feeds is hindered by the lack of a source-separated collection infrastructure. As food residuals collection is labor-intensive, it seems to be cost-effective only for small-scale collection efforts supporting local garbage feeding operations.

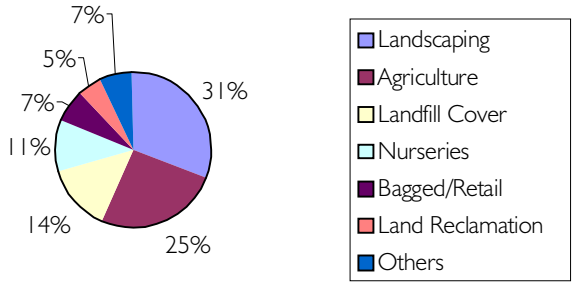
The potential demand for processed animal feeds derived from food residuals is similarly constrained by economies of scale. Existing processed animal feed companies use large volumes of food residuals from large-scale industrial food processing companies. Some smaller food processing companies have been unable to divert their food processing residuals to animal feed producers because quantities were too small and collection costs were not cost-effective.[20] Instead, these residuals are being diverted to direct animal feed efforts at local farms.

For these reasons, it is estimated that direct animal feed recovery programs in North Carolina will remain at or about the same size through 2002 (6,500 to 7,000 tons per year). As noted previously, the processed animal feeds industry is not included in these estimates of generation, recovery, or demand.

Food Residuals Composting

The markets for composts can be divided into six main sectors, with several other markets in emerging status. The more mature markets sectors are agriculture, landscaping, nurseries, public agencies, residential use, and land reclamation/landfill cover.[21] Emerging markets include:

Figure 3: Compost Markets



- Bioremediation of contaminated sites.
- Stormwater runoff filtration and treatment.
- Vapor-phase biofiltration of contaminated exhaust air streams.
- Reforestation of denuded sites.
- Revegetation of sites for habitat restoration.
- Restoration of damaged wetlands.
- Erosion control at construction sites.
- Control of plant disease problems (biopesticides).
- Remediation of damaged turf grasses and soil compaction problems.[22]

Each market has specific requirements for compost consistency and quality. The most stringent standards apply to horticultural uses (i.e., nurseries, greenhouses, golf courses, athletic fields, landscaping). Markets such as agriculture, sod farms, municipal greenspaces, and field-grown nursery crops would have somewhat less stringent standards. The least restrictive standards would apply to landfill cover and land reclamation markets.

Quality standards of emerging markets have not yet been fully defined. A recent study[23] concluded that food residuals composts were a consistent source of slow-release nitrogen during the second and third years after application.

A 1996 study surveyed market distribution for compost facilities in seven states (California, New Jersey, Ohio, Washington, Minnesota, Florida, and Massachusetts).[24] That survey estimated compost market distribution, as illustrated in Figure 3, with landscaping and agriculture being the largest markets.

Previous studies estimate the demand for compost in North Carolina to be 13,483,000 tons per year, with the vast majority going to agricultural uses (98 perecnt).[24] Remaining markets were believed to absorb 232,000 tons annually. The current demand for compost is believed to exceed the current available supply (estimated at 177,680 tons in 1996), although specific demand estimates currently are not available.

North Carolina modified its Solid Waste Management regulations effective May 1, 1996, to establish requirements for Solid Waste Compost Facilities (15A NCAC 13B, Section .1400). These regulations allow four different types (I-IV) of compost facilities, depending on the nature of the incoming feedstocks. These regulations will likely make it easier to construct new composting facilities, especially Type I and Type II facilities, which use clean, non-pathogenic residuals.

Prices for finished compost vary throughout the United States and in the Southeast. Bulk sale prices for leaf compost, yard trimmings compost, manure compost, mixed solid waste compost, and biosolids compost in the Southeast ranged from $3 per cubic yard to $25 per cubic yard in a 1997 survey.[26] Average values for these various products varied from $6 to $15 per cubic yard ($24 to $60 per ton). In Charlotte, North Carolina, bagged compost is sold for $3.50 to $4 for a 45-pound bag ($155 to $177 per ton), while bulk sales are $18.50 per cubic yard ($74 per ton).[27]

SUPPLY / DEMAND RELATIONSHIP

The supply of food residuals is considerably greater than the current or projected demand (although demand estimates are cursory, at best). Estimated food residuals generation quantities have risen drastically in recent years due to greater attention to this fraction of the solid waste stream. Recovery of food residuals is inherently constrained by ongoing concerns about food safety and by overabundance of food supply.

One obstacle to the diversion of edible food residuals to food recovery and rescue programs is concern about liability issues, even with the passage of Good Samaritan laws in many states (including North Carolina). These concerns may be exaggerated. In a legal opinion, one law firm noted, "North Carolina also has one of the most favorable liability standards for donors of any state in the country."[28] This law, in combination with the recent USDA Food Recovery and Gleaning Initiative, will likely result in increased edible food residuals diversion during the next several years.

Diversion of inedible food residuals to animal feeds and food composting operations is constrained by the lack of a sophisticated source-segregation and collection infrastructure and by the lack of adequate composting capacity within a reasonable distance from high concentrations of generators. Direct animal feed recovery efforts will continue where there is proximity between generators and farmers and where farmers are willing to put effort into running a food residuals collection program. Processed animal feeds derived from food residuals will continue focusing on industrial food processors, simply because of economies of scale. Composting facilities will continue focusing on small, localized institutional settings and will be easier to permit and build now that North Carolina has specific regulations for solid waste compost facilities.

Challenges with regard to food residuals composting include: [29]

- The need for a more widely available, cost-competitive composting infrastructure.
- Increasing the awareness of local government solid waste and recycling officials to food residuals composting.
- Providing greater volumes of source-separated food residuals to composting facilities with fine-tuned processes and developed markets for high-quality compost.

CONCLUSION

The amount of food residuals in North Carolina diverted from landfill disposal is very small. It is believed that adequate demand exists for recovered edible foods, animal feeds and food residuals-based compost to significantly increase the diversion rate. Efforts are needed in several areas to improve food residuals recycling rates.

North Carolina already has decided to support one full-time staff person dedicated to the area of recycling organic materials (including food residuals). This position is focused on creating linkages between sources of organic materials, processing facilities and technologies, and end-user markets and outlets.

The best opportunities for entrepreneurs and investors appear to be in the conversion to animal feeds and composting. Edible food recovery programs are governed by non-profit charitable organizations. Once more detailed and reliable information is available, the geographic locations for animal feed and composting opportunities should become apparent. Both products (animal feeds and composts) are perceived as low-value commodities, which favor the development of larger, centralized facilities that can take advantage of economies of scale. However, the geographic constraints of sources versus processors versus demand favors development of smaller-scale, decentralized facilities.

Development of a viable collection, processing, and marketing infrastructure for food residuals will have a significant impact on North Carolina's recycling goals. The following recommendations are designed to support development of such an infrastructure.

RECOMMENDATIONS

- North Carolina should sponsor a food residuals generation study focusing on developing current and accurate data on food residuals quantities, sources, and locations. As curbside studies (such as the Seattle study) produce the most accurate estimates, North Carolina should conduct these types of studies in several different communities representative of North Carolina municipalities.
- Similarly, more detailed information should be gathered on existing and planned recovery programs, particularly with regard to direct animal feeds, processed animal feeds, and food residuals composting. This effort should focus on the geographic relationship between recovery programs and sources of food residuals.
- North Carolina also should develop programs to work with the USDA Food Recovery and Gleaning Initiative so that greater quantities of edible foods are diverted to the needy.
- A more accurate estimate of demand also is needed for composts, animal feeds, and food recovery/ rescue programs. North Carolina should conduct a study assessing market demands for composts in both established and emerging markets. The agricultural community should be surveyed to assess its demand for food residuals-based animal feeds and obstacles for developing that market.

[1] Kantor, L.S., et.al. "Estimating and Addressing America's Food Losses." USDA-ERS. *Food Review*. Vol. 20, No. 1. January - April 1997.
[2] U.S. Environmental Protection Agency. *Characterization of Municipal Solid Waste in the United States: 1997 Update*. Report No. EPA530-R-98-007. May 1998.
[3] Luboff, C. and May, K. "Measuring Generation of Food Residuals." *Biocycle*. Vol. 36, No. 7. July 1995. p. 66-68.
[4] Newell, T., et.al. "Commercial Food Waste From Restaurants and Grocery Stores." *Resource Recycling*. February 1993. p. 56-61.
[5] U.S. Environmental Protection Agency. *Waste Prevention Recycling and Composting Options, EPA Report No. EPA530-R-92-015*. February 1994.
[6] Town of Chapel Hill. Department of Public Works. *Orange County Solid Waste Composition Study*,. July, 1995.
[7] Sherman, R. L. "Food Recovery & Waste Reduction." *Water Quality & Waste Management*, North Carolina Cooperative Extension Service. February 1998.
[8] Estimate based on telephone surveys of food bank and food rescue programs in North Carolina.
[9] North Carolina Dept. of Agriculture and Consumer Services. *Livestock and Poultry Inventory.* July 8, 1997. http://www.agr.state.nc.us/stats/livestoc/aniinvyr.htm.
[10] Examples include dehydrating seafood processing residuals (110,000 tons per year) and collection and processing of meat scraps and restaurant greases (1,135,000 tons per year). The total amount of commercial animal feed distributed in North Carolina during 1996 was 5,092,535 tons, but it is not known how much of this quantity was derived from food residuals. It is also not known how much, if any, was derived from food residuals being diverted from landfill disposal.
[11] Goldstein, N. and Block, D. "Nationwide Inventory of Food Residuals Composting." *BioCycle*. Vol. 38, No. 8. August 1997. p. 46-57.
[12] Personal Communication, Mr. Ted Lyon. North Carolina Division of Solid Waste Management. May 28, 1998.
[13] Personal Communication, Mr. Frank Franciosi. RT Soil Sciences, Rocky Mount, North Carolina. May 21, 1998.
[14] Personal Communication, Ms. Annette Tyson. McGill Environmental Systems, Rose Hill, North Carolina. May 27, 1998.
[15] U.S. Department of Agriculture, National Hunger Clearinghouse. http://www.iglou.com/why/glean/
[16] North Carolina Department of Health and Human Services, Office of Economic Opportunity. *About N.C.'s Poor*. http://www.state.nc.us/DHR/OEO/poor.htm.
[17] Personal Communication, Mr. Greg Kirkpatrick, former Executive Director of North Carolina Food Bank. April 28, 1998.
[18] U.S. Department of Agriculture. Food Recovery and Gleaning Initiative Fact Sheet. May1998.
[19] Recent steps taken by the USDA to meet this goal include: working with the National Restaurant Association to produce a food recovery handbook for their members, helping hunters donate venison to food banks, empowering schools to donate excess food from the National School Lunch Program, encouraging airlines to donate unserved meals, working with the U.S. Department of Transportation to develop a comprehensive way to transport recovered foods, facilitating the donation of excess food from the Department of Defense, and providing technical assistance to community-based groups and private citizens.
[20] Personal Communication, Mr. Norman Brown. Bruce Foods Corp., Wilson, North Carolina. June 23, 1998.
[21] North Carolina Department of Environment, Health, and Natural Resources, Office of Waste Reduction. *Assessment of The Recycling Industry and Recycling Materials in North Carolina, 1995 Update*. November 1995. p. 4-168.
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[23] Sullivan, D.M., et.al. "Fertilizer Nitrogen Replacement Value of Food Residuals Composted with Yard Trimmings, Paper, or Wood Wastes." *Compost Science & Utilization*. Vol. 6, No. 1. p. 6-18.
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[25] NCDEHNR/OWR, November, 1995, *op.cit.*, p. 4-169.
[26] National Composting Prices, *Composting News,* Vol. 5, No. 12, February, 1997, p.4.
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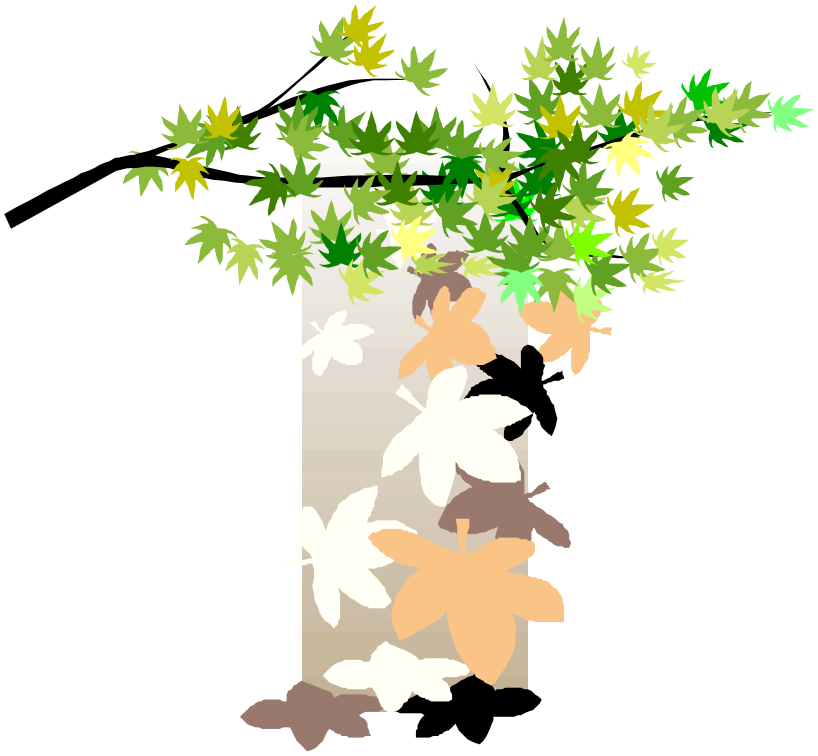
Organics: Yard Wastes

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

Yard wastes typically include tree and brush trimmings, leaves, and grass from residential, industrial, and commercial sources. Untreated and unpainted wood (including pallets, land clearing debris, and construction debris) can also go to yard waste facilities. In this report, land clearing and construction debris are considered part of the construction and demolition debris waste stream, and pallets are addressed in a dedicated section.

Yard wastes have been banned from municipal solid waste landfills in North Carolina since January 1, 1993. As a result, there are nearly 300 facilities in North Carolina accepting yard wastes, and local governments own more than 80 percent of these facilities. During fiscal year 1996-1997, almost 700,000 tons of yard wastes were processed into compost and mulches by these facilities.

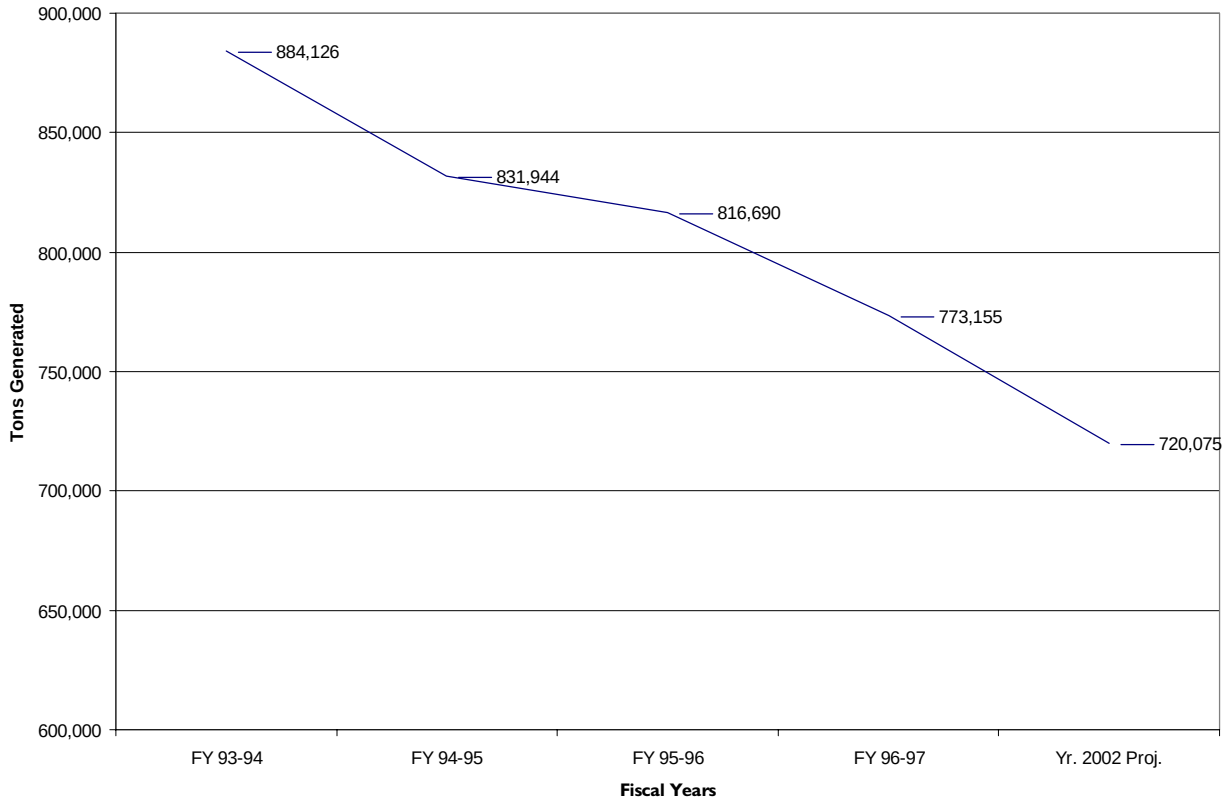
The resulting mulches and composts are either sold or given to various end users, including homeowners, landscape contractors, municipal parks and recreation departments, grounds maintenance personnel, nurseries, soil blenders, and farmers. Pricing for bulk sales of these materials varies with quality and degree of processing. Low-grade mulches sell for around $6 per cubic yard ($24 per ton) while higher-grade composts sell for $6 to $15 per cubic yard ($15 to $37.50 per ton).[1] Bagged sales prices are significantly higher ($150+ per ton).

SUPPLY

Generation

Historically, the amount of yard wastes being landfilled had been steadily increasing as population, residential housing, and commercial development grew. More recently, the trend toward landfill bans on yard waste by local and state governments has decreased the amount disposed. It is estimated that the effect of such legislation was no net increase in yard waste generation (i.e., no new yard wastes entering

Figure 1. Yard Waste Generation



landfills) between 1990 and 1992. Since then, it is estimated that the amount of yard wastes entering the solid waste stream has been declining at a rate of about six percent per year.[2] Source reduction approaches that have reduced yard waste generation include grasscycling, on-site chipping and mulching, and backyard composting. Recycling approaches include diversion to centralized mulching and composting facilities.

Estimated quantities of yard waste generated in North Carolina during the past several years are shown in Figure 1, along with a projection of yard waste generation in 2002. Generation numbers are based on the quantity of yard waste generated in the United States multiplied by North Carolina's percentage of the population.[3] Dividing that number by North Carolina's 1996 population and multiplying by 2000 yeilds a per capita generation rate that is applied to 1997 and 2002 state population numbers.

Recovery

Legislative bans on yard waste disposal in landfills have created a significant increase in the number of composting and mulching facilities. Nationwide, there were less than 1,000 facilities in 1988. By 1997, that number had grown to nearly 3,300.[4] In North Carolina, there are 183 local government mulch/compost facilities, 54 local governments using other public facilities, and 34 private-sector facilities.[5] The quantities of yard wastes handled by these facilities during the past several years are shown in Figure 2, along with a projection of recovery quantities in 2002.

The increase in tonnage recovered in fiscal year 1996-1997 was due to the increase in yard wastes from hurricanes Bertha and Fran. The projected recovery total in 2002 is less than the total recovered in fiscal year 1995-1996 due to the impact of source reduction efforts (i.e. grasscycling, backyard composting, and on-site chipping and mulching).

The comparison of yard waste quantities generated and recovered in North Carolina in 1997 and projected for the year 2002 is shown in Figure 3.

DEMAND

The types of products usually available from yard waste recovery include leaf compost, yard trimmings compost, and mulches from yard trimmings. Yard wastes can be used as a bulking agent with other organic wastes, such as food waste, animal manure, and sewage sludge to produce composts. Each compost product has slightly different chemical and physical characteristics, but all serve as soil amendments with limited nutrient value. Mulches are characterized by larger particle sizes and less humic matter content.

Figure 2. Yard Waste Recovered

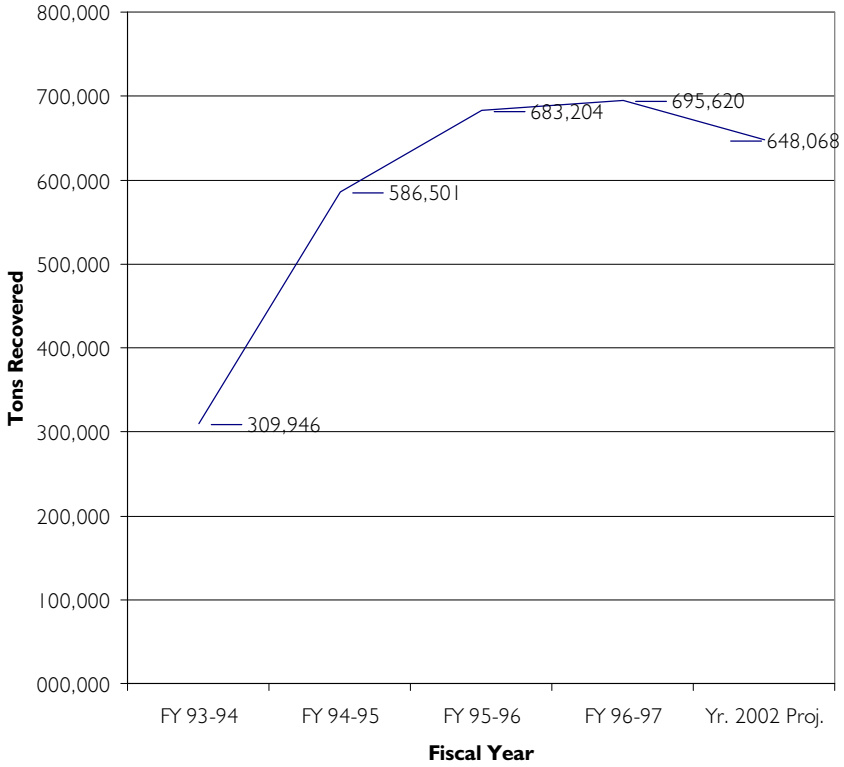


Figure 3. Estimated Generation and Recovery for Yard Waste in North Carolina (tons)

	1997	2002
Generation	773,155	720,075
Recovery	695,620*	648,068

*Excludes approximately 318,000 tons due to Hurricanes Fran and Bertha. A majority of this debris was mulched.

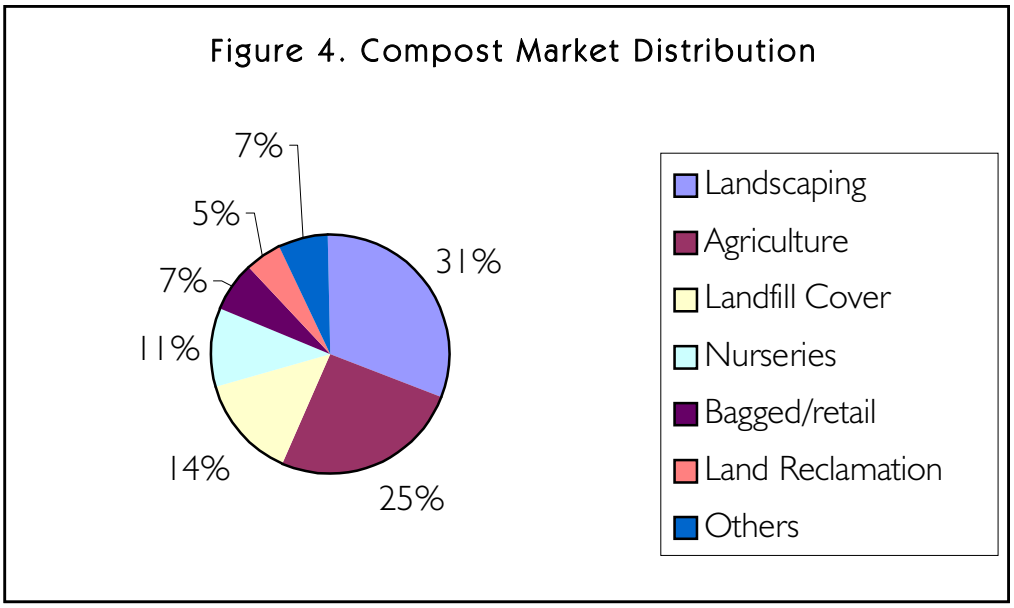
The markets for composts can be divided into six mature sectors, with several other markets emerging. The mature market sectors are agriculture, landscaping, nurseries, public agencies, residential use, and land reclamation/landfill cover.[6] Emerging markets include:

- Bioremediation of contaminated sites.
- Stormwater runoff filtration and treatment.
- Vapor-phase biofiltration of contaminated exhaust air streams.
- Reforestation of denuded sites.
- Re-vegetation of sites for habitat restoration.
- Restoration of damaged wetlands.
- Erosion control at construction sites.
- Control of plant disease problems (bio-pesticides).
- Remediation of damaged turf grasses and soil compaction problems[7].

Each market has specific requirements for compost consistency and quality. The most stringent standards apply to horticultural uses (i.e., nurseries, greenhouses, golf courses, athletic fields, landscaping, etc.). Markets such as agriculture, sod farms, municipal green spaces and field-grown nursery crops would have somewhat less stringent standards. The least restrictive standards would apply to landfill cover and land reclamation markets. The quality standards of the emerging markets have not yet been fully defined.

A 1996 study surveyed market distribution for compost facilities in seven states (California, New Jersey, Ohio, Washington, Minnesota, Florida, and Massachusetts)[8]. That survey estimated compost market distribution as illustrated in Figure 4 with landscaping and agriculture as the largest markets.

Previous studies have estimated the demand for compost in North Carolina to be 13,483,000 tons per year, with the vast majority of that due to agricultural uses (98 percent).[9] The remaining markets were believed to be able to absorb 232,000 tons per year, which alone exceeded the



estimated 1994 compost production of 121,400 tons. The current demand for compost is believed to exceed the current available supply (estimated at 177,680 tons in 1996), although specific demand estimates are not currently available.

Prices for finished compost vary widely nationwide and within the Southeast. Bulk sale prices for leaf compost, yard trimmings compost, manure compost, mixed solid waste compost, and biosolids compost in the Southeast ranged from $3 per cubic yard to $25 per cubic yard in a 1997 survey.[10] Average values for these products varied from $6 to $15 per cubic yard ($24 to $60 per ton). In Charlotte, North Carolina, bagged compost is sold for $3.50 to $4 for a 45-pound bag ($155 to $177 per ton), while bulk sales are $18.50 per cubic yard ($74 per ton).[11]

Mulch sales in the United States are estimated to be $500 million annually.[12] Landscaping continues to be the major market for mulches, however erosion control markets and bioremediation sites are gaining market share. One reason markets are growing is that equipment has been developed (such as truck-mounted blowers) that spreads mulches quicker and with less labor than traditional manual methods. As with compost, demand for mulches is believed to exceed the estimated current supply (505,520 tons in 1996), although specific demand estimates are not available as no comprehensive market study has been conducted.

Mulches made from yard wastes compete with mulches made from virgin wood chips and bark, as well as mulches made from wood wastes, such as ground-up pallets. Wood mulches have more cellulose than bark mulches, which have higher lignin content. Cellulosic (wood) mulches break down and decompose faster than bark mulches. Some consumers prefer recycled wood mulch because it is less expensive, and they are more concerned with price than longevity.[13] Yard waste and recycled wood mulch prices in the Southeast vary from free to $25 per ton ($10 per cubic yard);[14] whereas bark and shredded hardwood mulch prices are up to $40 per ton.[15]

Insufficient data on specific compost and mulch market demand exist to make reliable projections for demand in 2002. The demand estimates presented in the study noted above assumed the same level of demand for 2001. Until more reliable data become available, the same estimates are used here.

SUPPLY / DEMAND RELATIONSHIP

Legislation banning yard wastes from disposal in landfills has created a significant supply of mulches and composts made from yard wastes. As solid waste management has traditionally been a municipal responsibility, many of these processing facilities are owned and operated by municipal governments. Recent growth in municipally owned and operated facilities has created a competitive disadvantage for private-sector facilities. Nonetheless, a number of private facilities has been built, but significant investment in yard waste processing facilities by some of the national waste management companies never really developed.[16]

Large, centralized processing facilities producing compost and mulch products sold on a multi-state/national basis have not developed, primarily due to the transportation costs of delivering feedstock to processing facilities and the cost of delivering product to market. (A majority of compost/mulch

Figure 5. Estimated Supply and Demand for Yard Waste in North Carolina (tons)

	1997	2002
Supply	683,200	648,068
Demand	13,483,400*	13,483,400*

*Includes agricultural demand at 13,251,400 tons per year

sales are bulk deliveries by truck.) Consequently, the markets and the incoming feedstocks are local. Transportation of yard wastes or produced bulk mulches/composts in more than a 50-mile radius is considered uneconomical (although a distribution limit of 250 miles is suggested for bagged compost).[17]

Markets for composted products are beginning to stratify into different levels of a hierarchy that is driven by user specifications. These specifications center on the concept of physical and chemical consistency and include parameters such as particle size, organic matter content, moisture content, bulk density, water holding capacity, nutrient content, soluble salt content, and pH.[18] Higher-end users with stringent product use requirements (i.e., golf courses) are willing to use compost products that meet their demands. Pricing for these products reflects the higher degree of processing and quality control that is necessary. However, composts are not pure alternatives to chemical fertilizers due to their lesser nutrient content. As such, they are largely considered lower-value soil amendments (relative to chemical fertilizers) with limited opportunity for high-value pricing.

The markets for mulches continue to be dominated by the landscaping industry for use in vegetative control. The availability of new materials handling equipment is making mulches more competitive for such applications as erosion control, animal bedding, landfill cover, and bioremediation. The landscaping market also is moving into stratification by recognizing differently-colored mulches as higher-valued products. Some mulch processing companies are investing in colorization equipment to produce dyed mulches of different colors.

The increase in processed yard waste supply in the early 1990s (due to yard waste landfill bans) initially overwhelmed the existing mulch/compost markets. In more recent years, markets have matured to the point where demand equals supply. Potential demand with agricultural uses is considerably greater than supply. With the emergence of new markets for mulches and composts, demand should continue to exceed supply for the foreseeable future, as indicated in Figure 5.

CONCLUSION

The demand for routinely-collected and processed yard waste appears to meet the available supply. Storm-generated yard waste (such as with hurricanes Fran and Bertha) creates short-term supply exceedances of available demand. Efforts to increase market awareness of the benefits of compost and mulches are stimulating demand, as is U.S. EPA's identification of promising emerging markets for composts. An example of these efforts is the *Carolina Composting and Resource Guide*, produced by the Carolina Recycling Association and sponsored in part by the Division of Pollution Prevention and Environmental Assistance.

As the vast majority of generated yard waste in North Carolina already is being diverted from landfills and recycled, there is little potential impact in North Carolina's waste reduction goals. However, the large amount of vegetative debris going to land clearing and inert debris (LCID) facilities is a potential source for additional diversion.

Efforts are needed to accurately estimate demand for compost and mulches in North Carolina by market segment (both existing and emerging). The results of that analysis may lead to assessment and development of policies, procedures, and regulations to stimulate demand for these materials. A secondary benefit is to give municipalities and communities planning organics diversion projects a sense of market demands.

As the final products are likely to always be perceived as a low-value commodity, opportunities for entrepreneurs and investors will be limited to small to medium-scale facilities that are well-planned and well-located with respect to both feedstocks and markets. These facilities also will have to be planned with respect to competition from existing or planned facilities owned by municipal governments.

RECOMMENDATIONS

- The state should continue to sponsor efforts, like the *Carolina Composting and Resource Guide*, to increase awareness of the availability and location of recycled organic products.
- The state should conduct a detailed assessment of the sources and amounts of vegetative debris go-

ing to LCID facilities and evaluate the technological and economic obstacles to increased diversion of these materials.

- The state should sponsor a detailed market demand study to give producers of compost and mulches useful business planning information.

[1] National Composting Prices, *Composting News,* Vol. 5, No. 12, February, 1997, p.4.
[2] U.S. EPA, C*haracterization of Municipal Solid Waste in the United States – 1997 Update*, May, 1998, p. 45.
[3] Ibid.
[4] Glenn, J., "Finding Profits in Organics Recycling", *Biocycle*, Vol. 38, No. 9, September, 1997, p.30.
[5] North Carolina Department of Environment and Natural Resources, *Solid Waste Management Annual Report July 1, 1996 – June 30, 1997*, p. 30.
[6] North Carolina Department of Environment, Health, and Natural Resources, Office of Waste Reduction, *Assessment of The Recycling Industry and Recycling Materials in North Carolina, 1995 Update*, November, 1995, p. 4-168.
[7] U.S. Environmental Protection Agency, *Innovative Uses of Compost*, Report Nos. EPA530-F-97-042 through 046, October, 1997.
[8] U.S. EPA, May, 1998, *op. cit.*, p. 149.
[9] NCDEHNR/OWR, November, 1995, *op. cit.*, p. 4-169.
[10] National Composting Prices, *Composting News,* Vol. 5, No. 12, February, 1997, p.4.
[11] Farrell, M., "Municipal Experiences with Marketing Compost", *Biocycle*, Vol. 38, No. 9, September, 1997, p. 39.
[12] Farrell, M., "Expansion Options for Mulch Producers", *Biocycle*, Vol. 39, No. 5, May, 1998, p. 70.
[13] Farrell, M., 1998, *ibid.*, p. 74.
[14] National Composting Prices, *op. cit.*, p.4.
[15] Price list, The Mulch Masters, Raleigh, NC, June, 1998.
[16] Glenn, 1997, *op. cit.*, p.30.
[17] NCDEHNR/OWR, 1995, *op. cit.*, p. 4-167.
[18] Recycling Technology Assistance Partnership, *Compost End-Use Guidelines Development Project Final Report*, Washington State Department of Community, Trade & Economic Development, March, 1996, p.4.

OCC ▪ ONP ▪ OMG ▪ Office Paper ▪ Mixed Paper

Paper

Paper: Introduction

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

The United States pulp and paper industry is the largest industry of its kind in the world. With a base of about 533 paper and paper board mills and 190 pulp mills, the United States' production of paper and paperboard accounted for more than 90 million tons in 1996, almost one-third of total world output. The pulp and paper industry in the southern United States alone is larger than that of any other country, with production at 49 million tons of paper and paperboard in 1994.[1]

Recovered paper is making up a growing share of this paper production. Currently, more than 400 United States mills use at least some recovered paper, and more than 200 of those use it exclusively, according to the American Forest & Paper Association (AF&PA).[2]

In 1997, almost 37 million tons of recovered paper was consumed at United States paper and paperboard mills, up from nearly 19 million tons in 1987. A majority of this recovered paper (almost 25 million tons) was used in paperboard manufacturing, and almost 11 million tons were used in paper manufacturing. Of the 11 million tons, more than three million was used to produce newsprint, almost four million was used in tissue manufacture, and another 2.5 million was used to produce printing and writing paper.[3]

Total recovered paper consumption is projected to grow 2.1 percent annually through the year 2000. However, this projection does not reflect aggressive capacity growth outside the United States. In comparison, recovered paper consumption rose 8.1 percent in 1996 and 7.2 percent in 1997.[4]

The fiber content of paper and paperboard products ranges from 100 percent virgin wood fibers to 100 percent recycled fibers, with limitless combinations of virgin and re-

cycled fiber in between. It is often possible to substitute one recovered paper grade for another in paper and paperboard manufacture, depending on the availability, quality, and price of the different fiber sources.

The Changing Face of Paper Recycling

Paper recycling continues to grow and change, based on new technologies, expanded collection systems, and foreign and domestic economic cycles. For this reason, some experts assert that "change is the only constant in paper recycling."[5] A recent article identifies the following trends as influencing paper recycling into the next century.[6]

- Many recovered paper consumers are changing how recovered paper is purchased, opting to negotiate prices rather than rely on published prices.
- Many businesses and local governments collect and sell fiber as a way to cut disposal volumes, not just in response to price fluctuations as was historically the case. For this reason, they would prefer to have stable markets and weaker prices instead of market swings with price improvement.
- Paper companies are consolidating. Industry consolidation has resulted in 20 companies consuming about 23 million tons, or 60 percent of the total consumption for North America. All 20 companies use recovered paper at multiple mills, and annual, company-wide consumption ranges from 600,000 to more than two million tons.[7] Independent paper collection and processing firms also are merging.

Factors Affecting Paper Markets

The key factor influencing demand for recovered paper is consumer demand for finished products, which is driven primarily by economic conditions. In other words, in bad economic times, demand for products such as newspapers, corrugated boxes, and some printing and writing papers will fall. Because these products use at least some recovered paper, demand for recovered paper also will fall. Other key factors influencing recovered paper markets are highlighted below.

- **Discontinuities between supply and demand.** Supply and demand often are out of balance. For example, during the past few years, increases in foreign demand have created supply shortages and panic purchasing in domestic markets. In another example, the rapid buildup of recycling collection and processing infrastructure of the early 1990s created an oversupply, which contributed to price fluctuations.

  It is uncertain how much new capacity will be added in the coming years, but most observers are optimistic that additions will not be excessive and this should keep supply in balance with demand. Many costly expansion projects have been delayed or canceled, largely because lackluster profits made such projects difficult to justify.
- **Quality issues.** The paper industry has specifications defining the permissible content of many grades of recovered paper. Contaminated paper is often reclassified as a less desirable and less valuable product.
- **Price.** Volatility has always characterized waste paper markets. Analysts predict that 1999 will be a weak year for recovered paper pricing, with strength returning in 2000 and 2001.[8] In addition, pricing surges similar to those experienced in 1994 and 1995 may occur at least every five years, although it is unlikely they will be as drastic as in the past. During the next several years, the combination of steady demand growth and limited capacity additions should enable paper markets to strengthen.
- **Exports.** Export markets are variable, because they depend on economic and political factors in the importing countries. Recently the United States export market has been slow. A number of factors have contributed to this decline: competitive prices for virgin wood pulp, higher levels of paper recovery in other countries, and a decline in the worldwide economy in 1996. In addition, foreign paper buyers, in particular, have tended to enter the market somewhat spontaneously and present large purchase orders in short time periods thus driving prices up rapidly.[9] Unfortunately, they tend to cut orders just as quickly and create market voids with parallel price declines.[10]

The current Asian financial crisis is changing the way fiber is traded. Because of volatile swings in Asian and Pacific markets, trading has become more complicated and risky. Driven by recovering economies in Mexico and Asia, export demand is expected to increase for all paper categories by 2002. Experts predict that most new capacity will be built in the fast growing and low cost markets of Asia and Latin America.

- **Recycled content legislation.** Legislation favoring recycled content products at the state or federal level can help create demand for recycled content papers. For instance, recycled content mandates and voluntary guidelines at the state level have stimulated demand for recycled content newsprint. Similarly, procurement policies at the state and fed-

eral level have encouraged agencies to purchase printing and writing paper with specified levels of recycled content.

- **Virgin pulp capacity.** While the process of converting virgin pulp requires more energy than deinking and repulping recovered paper, many mills continue to maintain large percentages of virgin material input due to the consistent quality, reliability, and availability of virgin pulp supplies. Several factors that ensure continued reliance on virgin fibers include the decentralized organization of recovered paper suppliers, the recent price volatility, and the quality problems associated with the supply. Nevertheless, experts predict that recovered paper usage will continue to grow in containerboard, paperboard, and newsprint sectors because it remains a lower cost source of fiber for these users.[11]

Commodity Reports

The following reports address five commonly recycled paper grades: old corrugated containers (OCC), old newspapers (ONP), old magazines (OMG), residential mixed paper (RMP), and office paper. Each report characterizes supply and demand in North Carolina and the region, evaluates the supply / demand relationship, and contains recommendations for balancing any discontinuities between supply and demand.

A primary data source for these reports was EPA's *Characterization of Municipal Solid Waste in the United States: 1997 Update*. Generation of paper and paperboard as calculated by EPA is lower than new supply as calculated by AF&PA because only post-consumer materials are included in EPA calculations (i.e., pre-consumer materials such as converting and fabricating scrap are not included). Similarly, total paper recovery as reported by AF&PA is higher than post-consumer recovery as calculated by EPA, because recovery of pre-consumer materials is not included in EPA estimates. Also AF&PA new supply data take account of imports and exports of converted products (such as envelopes and boxes), and thus are somewhat lower than new supply data used for EPA estimates. Overall, this means the AF&PA recovery rate will be higher than the calculated EPA recovery rate, although both are derived directly from AF&PA statistics. Every effort has been made in these reports to exclude recovered pre-consumer scrap from generation and recovery numbers.

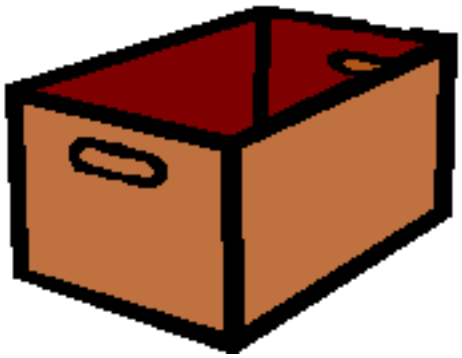
[1] Miller Freeman, Inc., "Industry Overview: UNITED STATES," *Pulp & Paper 1998 North American Factbook*, p. 5.
[2] AF&PA, *Improving Tomorrow's Environment Today*, January 1995.
[3] AF&PA, Inc. *1998 Annual Statistical Summary: Recovered Paper Utilization*, 12th ed., June 1998.
[4] Miller Freeman, Inc., "Paper industry's use of recovered paper to slow considerably," *Paper Recycler*, vol. 8, no. 12 (Dec. 1997).
[5] Powell, Jerry, "Seven hot trends in paper recycling," *Resource Recycling*, vol. XVII, no. 4 (April 1998).
[6] Ibid.
[7] Cesar, Mary, "Who's who in the North American paper industry?," *Resource Recycling*, vol. XVII, no. 4 (April 1998).
[8] Personal communication, Bill Moore, Moore & Associates, September 1998.
[9] Cesar, Mary, "Asian currency crisis affects UNITED STATES recovered paper markets," *Resource Recycling*, vol. XVII, no. 6 (June 1998).
[10] Ibid.
[11] Personal communication, Bill Moore, Moore & Associates, September 1998.

Paper: Old Corrugated Containers

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMEN 1998



OVERVIEW

Almost five of every 10 corrugated containers are now being recovered in North Carolina, which is below the national average of 67 percent. In 1997, more than 400,000 tons of old corrugated containers (OCC) were recovered in North Carolina, with private sector recovery accounting for about 85 percent of this tonnage.

Most recovered OCC is recycled back into new containerboard (single- and multi-ply, solid and corrugated boards used to make boxes and other containers for shipping materials) at United States mills. Recycled paperboard manufacturers are the second largest domestic consumers of OCC.[1]

Demand for OCC is not likely to increase beyond minimal annual growth until it has been shown that OCC recovery can increase significantly over current levels. Without assurances that the necessary supply of OCC will be available as feedstock, paper recycling companies will continue to be hesitant to commit to building new OCC-consuming mills.

SUPPLY

Generation

In 1997, North Carolina generated 852,770 tons of OCC, up from an estimated 734,000 tons in 1994.[2] Per capita generation of OCC nationally was calculated using EPA data, and this factor was used to estimate generation in North Carolina for 1997 and 2002.[3] In 2002, North Carolina generation is expected to grow to 904,894 tons.

The supply of OCC in the Southeast region also has grown.[4] In 1997, more than 6.5 million tons of OCC were generated in the region. This tonnage was estimated by applying the national per capita generation rate to each state. In 2002, generation in the region is anticipated to grow to slightly more than seven million tons.[5]

Figure 1: Estimated Generation and Recovery for OCC in North Carolina

	1997	2002
Generation	852,770	904,894
Recovery	424,456	606,279

Figure 2: Estimated Generation and Recovery for OCC in Southeast Region

	1997	2002
Generation	6,674,133	7,059,511
Recovery	4,471,669	4,729,872

Figure 3: Recovery of Containerboard in the United States

Supply Segment	Current Recovery (%)	Projected Maximum (%)
Pre-consumer	90	95
Manufacturing	70	75
Large retail / commercial	81	83
Small retail / commercial	70	77
Residential	5	25

Recovery

In 1997, more than 400,000 tons of OCC were recovered in North Carolina, yielding a recovery rate of almost 50 percent. The projection for recovery in 2002 ¾ 606,279 tons ¾ assumes that North Carolina's recovery rate for OCC has reached the national average of 67 percent, which may overestimate actual recovery.[6] Recovery was calculated using public and private sector recycling data. Public sector data were derived from responses to the *Annual Solid Waste Management Reports* submitted by local governments, and private sector data came from a recycling survey conducted by DPPEA in the spring of 1998.

Recovery in the Southeast region was calculated by applying the national recovery rate to the generation numbers for the region. In 1997, almost 4.5 million tons of OCC were recovered in the region, and 4,729,872 tons will likely be recovered in 2002. Again, this calculation may overestimate actual recovery. Figures 1 and 2 compare generation and recovery for North Carolina and the Southeast region.

Recovery of OCC occurs primarily in the private sector in North Carolina. Private sector recovery accounted for 86 percent of total OCC recovery, or 424,456 tons, and only about 14 percent was collected through local government recycling programs.[7] More than 30 local governments have enacted disposal diversion ordinances (DDOs) that ban or restrict cardboard from disposal in landfills, which has helped to boost private sector recovery. For a complete listing of North Carolina local governments with DDOs, contact the North Carolina Division of Pollution Prevention and Environmental Assistance (DPPEA) at (919) 715-6500.

Further gains in OCC recovery may be impeded by the misperception that OCC recovery is at or near its peak, and that any incremental growth in recovery will cost more than disposal. This misperception is based to a certain extent on industry claims that 73 percent of OCC was recovered nationally in 1997. However, this percentage includes pre-consumer scrap (e.g., converting and fabricating scrap), which is not counted towards post-consumer recovery by EPA.

Understanding the characteristics of the supply stream helps determine the best ways to stimulate recovery and demand. The post-recovery supply stream of OCC can be divided into four segments: commercial / retail, manufacturing, residential, and pre-consumer. Commercial / retail OCC makes up a majority at slightly more than 50 percent of total containerboard supply in the United States, followed by OCC from the manufacturing sector at 28 percent. Residential OCC makes up 13 percent of total supply, and pre-consumer OCC comes in last at eight percent.[8]

A national analysis of OCC recovery trends outlines how each segment of containerboard supply impacts recovery

and identifies opportunities to increase recovery.[9] (See Figure 3.) Since North Carolina's recovery rate is below the national average, there maybe more opportunities to increase recovery in the state than nationally. Pre-consumer containerboard discards have historically been recovered at very high rates, about 90 percent, and an increase to about 95 percent could be reasonably expected in this segment.

In contrast, recovery rates of post-consumer containerboard discards have varied widely. Recovery from the manufacturing segment has been relatively high, about 70 percent, and can be expected to increase marginally to about 75 percent, which represents the estimated maximum available fraction of material not contaminated or damaged. At large commercial / retail establishments (e.g., regional shopping malls) recovery rates have risen close to the possible maximum, which is estimated at 83 percent. However, the recovery from small establishments (e.g., strip malls or stand-alone fast food restaurants) has been far lower, around 53 percent until the past several years because of difficulty in retrieving the material from numerous small generators. A maximum of 77 percent recovery is assumed for this segment, but it will not be achieved in the near future.

The analysis shows that many of the recovery rates from the readily available supply segments have been pushed near their maximum achievable levels nationally. The small commercial / retail segment offers the greatest potential gains in recovery. Recovery of OCC from residences is quite low, about five percent; and even at its projected maximum of 25 percent, it is not expected to become a significant factor in overall recovery. North Carolina may have greater opportunity to work with the segments that are near maximum recovery nationally, as this state has not reached the national recovery rate for OCC.

Why aren't small businesses capturing OCC? These generators tend not to realize the same economic benefits as larger generators, because the fixed cost of implementing a system is not offset as quickly because of lower tonnage. Thus, there is a much higher cost/revenue ratio for collecting OCC from small businesses. In addition, some small businesses cannot benefit from reduced solid waste disposal fees as a result of OCC recovery, because these fees are incorporated into rent or lease payments. Without the incentive of reduced disposal costs, few small businesses are willing to support OCC recycling.

Another problem for small businesses may be lack of storage space. Collection of OCC typically requires a storage bin of at least one cubic yard, and more realistically a three-cubic-yard dumpster. However, many small businesses lack the space to keep an extra dumpster behind their establishment, and storing OCC inside in a smaller bin requires additional labor.

Small businesses are not the only entities facing limits to recovering more OCC. A barrier to recovery by all segments of the supply stream is wax contamination. Approximately 1.25 million tons of waxed OCC are now discarded annually in the United States. The presence of wax causes several problems for end users, including reduced surface-to-surface friction and strength. Soon, however, this barrier may be overcome. In an industry-sponsored research project, 97 percent of the paraffin wax was removed from wax-saturated boxes in an OCC medium-consistency pulping and screening system.[10] Several commercial-scale systems using this patented process may start-up in the next year, and at least one major paper producer has indicated plans to install the process at one of their United States mills within a year. Another option involves modifying the wax with dispersants and requires a hot dispersion step to be added in processing, enabling the wax to disperse.[11]

DEMAND

The primary market for OCC is the paperboard industry, which uses OCC for corrugating medium, linerboard, recycled paperboard, and other paper products. A majority (63.5 percent) of total recovered OCC in the United States is used to make new containerboard. Recycled paperboard represents the second largest share of total consumption at 17.4 percent. Exports represent 12.1 percent of the total, tissue consumes 1.1 percent, and all other uses combined represent 5.9 percent.[12] Fiugres 4 and 5 present estimated demand for OCC by end use in 1997 and 2002.[13]

In its latest capacity survey, AF&PA projected that recovered paper consumed between 1997 and 1999 would rise by approximately three million tons, reaching 37.7 million tons in 1999. OCC alone will comprise about half of total consumption and along with old newsprint will make up slightly more than 70 percent.[14] In addition, OCC is projected to account for 70 percent of the incremental recovered paper consumed during this period.

This capacity survey also projected that United States paper and paperboard manufacturing capacity will expand an average 1.2 percent annually from 1998 through 2000, or less than one-half the average 2.5 percent annual rate of the previous decade. Increased reliance on recovered paper is expected to repress wood pulp capacity expansion to an average annual growth rate of only 0.4 percent during the next three years, compared to 1.3 percent annually during the past 10 years.

Figure 4: Estimated Demand for OCC in North Carolina (in thousands of tons)

End Use	1997	2002
Containerboard	512.8	523.6
Recycled paperboard	140.5	143.5
Net exports	97.7	99.8
Tissue	8.9	9.1
Other	47.7	48.7
Total	807.6	824.7

Figure 5: Estimated Demand for OCC in Southeast Region (in thousands of tons)

End Use	1997	2002
Containerboard	4,013.5	4,097.8
Recycled paperboard	1,099.8	1,122.9
Net exports	764.8	780.9
Tissue	69.5	71.0
Other	372.9	380.7
Total	6,320.5	6,453.3

Total recovered paper consumption is projected to grow 2.1 percent annually through the year 2000; however, this projection does not reflect aggressive capacity growth outside the United States. In comparison, recovered paper consumption rose 8.1 percent in 1996 and 7.2 percent in 1997. Similarly, consumption of recovered corrugated is projected to rise by 2.1 percent as well.[15] This is considerably lower than the 7.5 percent rate for 1997, because nine new containerboard projects started up in the past two years, while just two are slated to come on line during the 1998-99 period.

Linerboard capacity has influenced OCC demand more in this decade than in the past. Most of the linerboard capacity added since 1993 has been for recycled content linerboard. In 1994, recycled capacity was only about 1.6 million tons per year, or about eight percent of total linerboard production capacity. Currently it is about 4.7 million tons, or about 18 percent of the total.[16] This means that when OCC prices drop and recycled linerboard mills become more cost-competitive, their impact on the industry's overall operating rate is significant, given their share of capacity. More recycled linerboard capacity is expected to come online this year as well. Likely reasons for the increase in capacity include the following:

- shorter construction time and lower capital costs for recycled capacity
- expectations of more materials available for recovery and inadequate capacity to utilize them
- desire of independent corrugated containerboard producers to minimize their vulnerability to linerboard price fluctuations
- availability of tax-exempt bonds to finance construction of recycled linerboard machines

Recent fluctuations in foreign demand have been another key variable affecting OCC markets. The five largest foreign importers of United States' OCC are Canada, Korea, Mexico, China, and Japan.[17] According to the AF&PA, total OCC exports achieved a record high of 4.3 million tons in 1995.[18] However, the level of OCC exports dropped to 2.8 million tons in 1996 and 2.6 million tons in 1997, due to the following factors: decreased foreign purchases, increased recovery efforts abroad, increased supplies of recovered paper from Europe, and the devaluation of foreign currencies.[19]

Following a strong period of industry expansion over the past decade, domestic paper producers now expect slow growth for the remainder of the 1990s. The projected rise in recovered paper consumption during the next three

years, while continuing to increase faster than wood pulp use, will be far below the earlier pace.

End Users in North Carolina and Surrounding States

The following end users in North Carolina use OCC as feedstock: [20]

- Carolina Paper Board Corp., Charlotte, North Carolina: Products: 100 percent recycled rigid and folding boxboard and chipboard. Total paperboard capacity: 50,730 metric tons per year. Feedstock: OCC, double-lined kraft (DLK), ONP, mixed paper, and pulp substitutes. Carolina Paper Board used about 16,000 tons of OCC from North Carolina last year.
- Halifax Paperboard Co., Inc., Roanoke Rapids, North Carolina: Products: rigid and folding boxboard, chipboard, pasted board, and mounting and laminated board. Production capacity: 105 tons daily. Total paperboard capacity: 34,360 metric tons per year. Feedstock: OCC, DLK, ONP, mixed paper and pulp substitutes.
- Jackson Paper Manufacturing Co., Sylva, North Carolina: Products: 100 percent recycled corrugating medium. Production capacity: 240 tons daily. Total paperboard capacity: 85,100 metric tons per year. Feedstock: OCC.
- U.S. Packaging, Inc., Maxton, North Carolina: Products: cellulose wadding for packing and cushioning. Production capacity: 12 tons daily. Total capacity: 4,000 metric tons per year. Feedstock: OCC and coated book.
- Weyerhaeuser Paper Co., Plymouth, North Carolina: Products: corrugating medium, kraft linerboard and various fine papers. Production capacity: 1,100 tons daily for containerboard, 1,000 tons daily for fine papers. Total paperboard capacity: 785,400 metric tons per year, with 425,000 metric tons per year for linerboard and 360,000 metric tons per year for corrugating medium. Feedstock: OCC. Current expansion includes two continuous digesters, two oxygen delignification systems and a new bleach plant at a cost of $500 million.

The following end users in surrounding states also use OCC as feedstock:[21]

Containerboard Mills

- Georgia-Pacific Corp., Big Island, Virginia
- Interstate Resources Inc., Riceboro, Georgia
- Temple-Inland Inc., New Johnsonville, Tennessee
- Riverwood Intl., Macon, Georgia
- St. Laurent Paperboard**,** West Point, Virginia
- Somerset Fiber Co., Cowpens, South Carolina
- Stone Container Corp., Florence, South Carolina; and Port Wentworth, Georgia
- Tenneco Packaging, Counce, Tennessee
- Union Camp Corp., Savannah, Georgia
- Virginia Fibre Corp., Amherst, Virginia
- Visy Paper Inc., Conyers, Georgia
- Westvaco Corp., Covington, Virginia

Paper/Board Mills

- Caraustar Industries, Inc., Austell, Georgia; Chattanooga, Tennessee; and Taylors, South Carolina
- Jefferson Smurfit Corp., Cedartown, Georgia
- Richmond Paperboard Corp., Richmond, Virginia
- Rock-Tenn Co., Chattanooga, Tennessee; and Lynchburg, Virginia
- Sonoco Products Co., Atlanta, Georgia; Hartsville, South Carolina; Newport, Tennessee; and Richmond, Virginia

Tissue Mills

- Fort James Paper Co., Rincon, Georgia
- Power Paper Co., Harriman, Tennessee

SUPPLY / DEMAND RELATIONSHIP

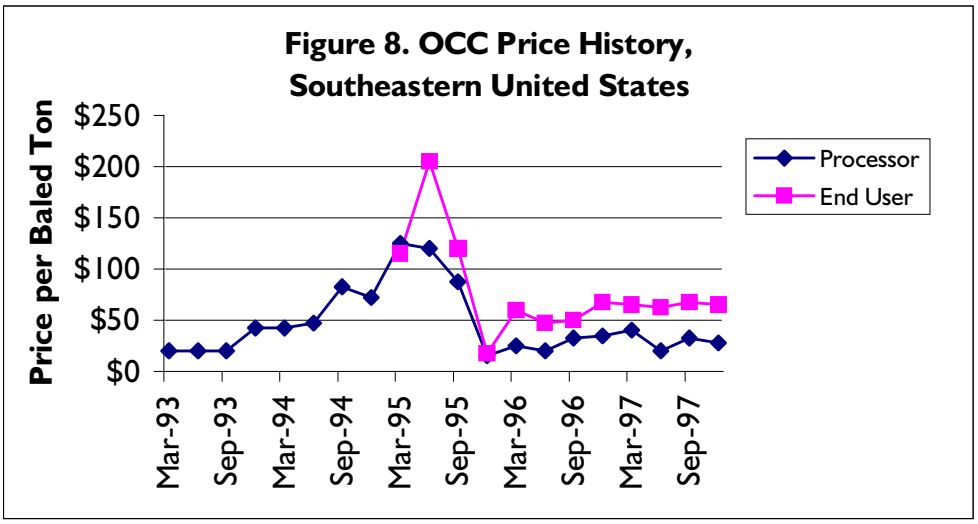
As illustrated in Figures 6 and 7, demand exceeds supply of OCC for both North Carolina and the Southeast region. This imbalance is evident in 1997 and is projected to continue into 2002. Several end users have indicated that they

Figure 6. Estimated Supply and Demand for OCC in North Carolina

	1997	2002
Supply	424,456	606,279
Demand	747,200	761,399

Figure 7. Estimated Supply and Demand for OCC in Southeast Region

	1997	2002
Supply	4,471,669	4,729,872
Demand	6,207,500	6,325,442



would welcome additional supply of OCC; however, others are decreasing their reliance on OCC by switching to other recycled fiber sources as a result of contamination problems.[22]

Demand for OCC is not likely to increase beyond minimal annual growth until it has been shown that OCC recovery can increase significantly over current levels. Without assurances that the necessary supply of OCC will be available as feedstock and free of contamination, paper-recycling companies will continue to be hesitant to commit to building new OCC-consuming mills.

Price History

The market for OCC was more variable in 1997 than for many other grades of recovered fiber. (See Figure 8.[23]) Prices for containerboard are extremely sensitive to changes in the economy, because shifts in gross national product growth directly affect consumer spending, which in turn results in the packaging of finished consumer goods.[24]

Growth in containerboard capacity and increased operating rates led to OCC prices rising in 1994. This was due not only to a rise in output, but to low inventories at mills and paper processing plants, a sudden pickup in both domestic and export demand, and a strong economy for the United States. Prices continued to climb through 1994 and early 1995, with a brief downturn in early fall 1994. However, OCC prices turned down again in the second half of 1995. In 1996, OCC prices rebounded briefly in the first quarter and turned down again, but began to gradually strengthen in spring and summer. At the end of 1997, OCC prices were averaging $28 per ton for processors and $65 per ton for end users.

Industry experts believe that OCC prices will remain depressed until linerboard prices increase, as excess linerboard capacity is dampening containerboard prices. However, when the price does increase, it is likely to be significant and occur quickly.[25]

CONCLUSION

The numbers tell the story. There is still room for growth in OCC recovery, as demand is currently outpacing recovery, and this imbalance is projected to continue in the near term. As mentioned earlier, a primary barrier to increasing OCC recovery is the misperception that OCC recovery is at or near its peak, and that any incremental growth in recovery will cost more than disposal.

Small retail / commercial and residential sectors are two segments of containerboard supply that are far from reaching maximum achievable recovery levels, meaning they present an opportunity for increasing OCC supply. Boosting OCC recovery from the small retail sector would require several concerted steps. First, the types of small businesses generating the majority of unrecovered OCC must be identified, and then strategies to target those businesses must be developed (assuming these businesses fall into several clear categories).

RECOMMENDATIONS

- The State of North Carolina should educate local government recycling coordinators that there is still considerable OCC to be recovered.
- To boost OCC recovery in the small retail sector, the state should develop tools targeting small businesses likely to generate OCC and promote these tools at appropriate business meetings. One way to encourage OCC recovery in the small retail sector would be to apply the concept of "cooperative marketing" to OCC collection. It is likely that some small businesses are already participating in cooperative OCC collection, especially in

business parks or shopping centers, and such efforts could be documented and promoted to other small businesses. Assistance in overcoming the barrier of limited storage space could be provided by identifying businesses that have creatively overcome their space limitations and highlighting their approaches. Similarly, examples of small businesses influencing building managers to pass on disposal cost savings or examples of revised lease or rent agreements (to exclude solid waste disposal costs) could de provided.

- Given the supply/demand relationship in North Carolina, the state should investigate the implementation a statewide landfill ban on old corrugated containers. A statewide ban on OCC would be a more effective way to target a disparate group of unrelated businesses and residences. More than 30 North Carolina communities already have implemented local OCC bans or restrictions, and three states have bans on recyclable paper including OCC (Massachusetts, South Dakota, and Wyoming).[26] A key factor in a successful ban is adequate recycling infrastructure for the targeted material. As this report outlines, the recycling infrastructure in North Carolina and the Southeast region can handle additional OCC.
- To increase the amount of OCC recovered from the small retail / commercial sector in the absence of a ban, the state should encourage local government recycling programs to develop commercial mixed paper routes. These programs could collect largely OCC and office grades along with other grades of recovered paper, enabling OCC to be captured more economically. Both containerboard and recycled paperboard mills could use this grade of "board mixed."[27]
- Similarly, OCC should be collected with mixed paper from residences. An OCC rich (and ONP lean) RMP mix would also be attractive to some end users.
- Demand for post-consumer recovered paper, like demand for virgin pulp, is dependent on the production strength of the industries that consume the feedstock. As the economies of the United States and its foreign trading partners improve, demand for packaging materials such as containerboard will improve, and paper producers will increase their demand for OCC. Until then, the state should continue to educate the recycling community about the relationship between economic productivity and demand for secondary materials.

[1] Containerboard includes corrugating medium and linerboard (kraft paperboard used to line / face corrugated core board or to form shipping boxes and other containers).
[2] Office of Waste Reduction, NC DENR. *Assessment of the Recycling Industry and Recycling Materials in NC: 1995 Update*. November 1995.
[3] U.S. EPA. *Characterization of Municipal Solid Waste in the U.S.: 1997 Update*. May 1998. This 2002 projection assumes no change in the per capita generation rate.
[4] The following states are included in the southeast region: AL, FL, GA, KY, MS, NC, SC, TN, VA, and WV.
[5] This projection assumes no change in the per capita generation rate.
[6] National recovery rates may be higher than 67 percent in 2002; however, for NC to surpass the current national recovery level would require a percentage increase that seems unlikely in this time frame.
[7] DPPEA, recycling survey, spring 1998.
[8] Iannazzi, Fred and Clark, Rosemary. "When will OCC prices improve?" *Resource Recycling*. Vol. XVII, No. 1. January 1998. The discussion that follows is based on this article.
[9] Ibid.
[10] Powell, Jerry. "Critical issues in paper recovery." *Resource Recycling*. Vol. XVII, No. 6. June 1998.
[11] Doshi, Mahendra, et.al. "Semiannual Conference Review." *Progress in Paper Recycling*. August 1995.
[12] AF&PA, Inc. *Recovered Paper Statistical Highlights*, 1997.
[13] Demand total for the SE region is actual demand reported by AF&PA (AF&PA, Inc. *1998 Annual Statistical Summary: Recovered Paper Utilization*, 12th ed., June 1998). Percentages for specific end uses were applied to this total. Demand for North Carolina is interpolated using regional AF&PA data. Projections for 2002 assume a growth rate of 2.1 percent, which is the average growth rate for OCC projected by AF&PA for the next two years. If this growth rate increases, the projections here will underestimate demand.
[14] Miller Freeman, Inc. *Pulp & Paper 1998 North American Factbook*. 1997. p. 400.
[15] Miller Freeman, Inc. "Paper industry's use of recovered paper to slow considerably." *Paper Recycler*. Vol. 8, No. 12. December 1997.
[16] Iannazzi. *Resource Recycling*. Vol. XVII, No. 1. January 1998.
[17] AF&PA. *1998 Annual Statistical Summary, Recovered Paper Utilization.* 12th Edition. June 1998. p. 51, 57.
[18] Ibid. p. 47.
[19] Ibid.

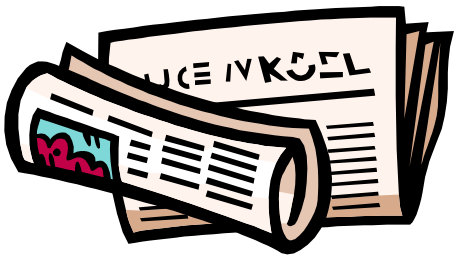
[20] AF&PA. *PaperMatcher*, 4th ed. Miller Freeman, Inc. *1997 Lockwood-Post's Directory of the Pulp, Paper and Allied Trades*, Miller Freeman, Inc. *1998 International Pulp & Paper Directory*, manufacturer surveys.
[21] Ibid.
[22] Manufacturer surveys.
[23] Prices are from Waste Age's *Recycling Times*. Processor prices not available prior to 1995.
[24] Miller Freeman, Inc. *Pulp & Paper 1998 North American Factbook*. 1997. p. 19.
[25] Ibid.
[26] Jim Glenn. "The State of Garbage in America." *BioCycle*. Vol. 39, No. 5. May 1998.
[27] Personal communication, Bill Moore, Moore & Associates, September 1998.

Paper: Old Newspapers

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

Traditionally, old newspapers (ONP) have been recovered from the waste stream and used as feedstock for a variety of recycled products, including newsprint, paperboard, tissue, containerboard, molded pulp, animal bedding, insulation, and as a bulking agent for compost. The most widely traded grade of ONP is commonly called Number 8 News.[1] This grade commands the highest price because it has the least contaminants relative to the other three grades of ONP.[2] It is also the most sought after grade of ONP for recycled newsprint mills, the single largest end users of recovered ONP.

The Institute of Scrap Recycling Industries defines No. 8 News as "baled, sorted, fresh dry newspapers, not sunburned, free from magazines, white blank, pressroom over issues, and paper other than news." Total outthrows (i.e., contaminants) in No. 8 News should not exceed one-fourth of one percent. [3]

In 1997, more than 282,000 tons of newsprint were generated in North Carolina. That year, North Carolina achieved a 57 percent recovery rate for newsprint, which is slightly above the national recovery rate of 54 percent. [4] Of the tonnage recovered, 121,000 tons, or 76 percent, were collected by local governments, while the private sector accounted for the remaining 24 percent (38,000 tons).

The American Forest and Paper Association (AF&PA) reported the amount of recovered ONP rose in 1997 due to an increase in domestic mill consumption.[5] This increase in domestic demand can be attributed to three factors: (1) the strong economy and the consequent demand for newsprint advertisements, (2) increased recycled newsprint capacity due to mill improvements in production efficiency, and (3) the underlying effect of state governments' minimum recycled content newsprint regulations.

Figure 1: Estimated Supply of Newsprint in North Carolina

	1997	2002
Generation (tons)	282,412	299,673
Recovery (tons)	159,594	169,611

Source: AF&PA and North Carolina S.W. Management Annual Report 1996-97.

Demand for ONP remains strong in North Carolina and the Southeast region. Because of the presence of some of the largest newspaper mills in the nation, the region consumed almost 26 percent of the total domestic demand for recovered newspapers in 1997.[6]

SUPPLY OF ONP

Generation

According to EPA, the national generation of total ONP (domestic shipments plus imports) has been declining slowly from 1993 to 1996.[7] Because of the strong economy and advertising climate, however, 1997 appears to represent the first increase in the generation of newsprint in four years. The AF&PA reported that 1997 was a record year for domestic newsprint shipments in the United States. After declining from 7.13 million tons in 1992 to 6.93 million tons in 1996, United States newsprint shipments increased to 7.25 million tons in 1997. According to the AF&PA, the increase in newsprint shipments is primarily a result of the expanding domestic demand driven by robust economic trends and the strong advertising atmosphere in 1997.[8] Paralleling the increase in domestic shipments, imports are also expected to increase in 1997. As a result, while EPA data for 1997 are not yet available, the total generation of ONP, including imports, is expected to increase over the 12.3 million tons generated in 1996.[9]

To calculate the supply of ONP in North Carolina, the generation of ONP was estimated as the combination of post consumer newsprint, overissue newspapers, and uncoated groundwood products such as newspaper inserts and coupons. The following section outlines two primary methods of calculating the supply of ONP in North Carolina.

First, supply could be estimated using a per capita national average derived from EPA data.[10] However, this aggregate methodology results in a supply figure that does not account for the differences in newspaper density and readership levels between states with extremely large metropolitan areas versus less urbanized states. As a result, the aggregate approach overestimates the supply of ONP in North Carolina. Using this approach, the supply of ONP in North Carolina in 1997 would be 344,621 tons.

In contrast, supply could be estimated using North Carolina-specific data on the following factors: 1) unprinted newsprint shipped to North Carolina, 2) out-of-state papers imported across the state line, and 3) inserts. This approach ensures that the statewide supply of ONP reflects the differences in local newspaper circulation and paper density across the nation. For instance, states with large metropolitan areas, such as New York and California, have thicker newspapers and higher per capita newsprint consumption than more rural states, such as North Carolina. The AF&PA reports that 235,343 tons of unprinted newsprint were shipped to North Carolina in 1997.[11]

According to industry experts, in 1989, groundwood inserts comprised the equivalent of eight percent of the weight of the ONP supply. More recently, however, experts estimated that inserts have increased to roughly fifteen percent of the weight of ONP in 1997.[12] To account for the addition of groundwood inserts in the supply of ONP in North Carolina, the total figure for unprinted newsprint was increased by fifteen percent. Furthermore, to account for the net imports of out-of-state newspapers (e.g. the New York Times, the Washington Post), the supply of ONP was increased by an additional five percent. In summary, the unprinted newsprint figure was increased by 20 percent to account for inserts and imported newsprint. As illustrated in Figure 1, the total supply of ONP in NC in 1997 was 282,412 tons.

Projections for the supply of ONP in 2002 are based on population increases in North Carolina and assume that the per capita generation and recovery rates will remain constant at 1997 levels.[13] As a result, the projections may underestimate the actual ONP supply in 2002. Because of prevailing of regional market dynamics in the newsprint industry, the generation and recovery for North Carolina's border states and for the southeast region are provided in Figures 2 and 3.[14] Old newspaper generation and recovery estimates for 1997 and 2002 for the southeast region and the border states are based on national per capita averages from 1997 EPA data. As previously explained, this aggregate method of calculation may overestimate generation and recovery of ONP.

Figure 2: Estimated Supply of ONP in North Carolina and Border States

	1997	2002
Generation (tons)	1,426,123	1,514,828
Recovery (tons)	771,532	819,522

Source: Based on US EPA MSW Characterization Report, 1997 Update.

Figure 3: Estimated Supply of ONP in the Southeast Region

	1997	2002
Generation (tons)	2,697,144	2,852,883
Recovery (tons)	1,459,155	1,543,410

Source: Based on US EPA MSW Characterization Report, 1997 Update.

Figure 4. Local Government Recovery of ONP in North Carolina

	FY 1992-93	FY 1993-94	FY 1994-95	FY 1995-96	FY 1996-97
Tons of ONP Recovered	85,728	97,534	109,927	104,034	110,242
Percent Change, 1992-93	Baseline	13.8%	28.2%	21.4%	28.6%

Source: NC Solid Waste Management Annual Report 1996-1997. Does not include ONP reported as mixed paper.

Recovery

North Carolina achieved a 56.5 percent recovery rate for newsprint in 1997, primarily due to the proximity to end users in the Southeast region and mandatory recycled content newsprint regulations. Currently the national recovery rate is 54 percent, and industry experts estimate that, given the existing recycling infrastructure, optimal recovery levels for ONP should be between 65 to 70 percent.[15]

In North Carolina, local government curbside and drop-off collection programs are the primary methods of recovery and supply to paper brokers, dealers and end users. During the past five years, local government recovery of ONP has increased more than 28 percent (Figure 4). In 1997, 121,000 tons, or 76 percent of the total ONP recovered in the state, was collected through local government programs. Private (i.e. non-local government) recovery of ONP accounted for the remaining 24 percent of the total ONP recovered (38,000 tons).

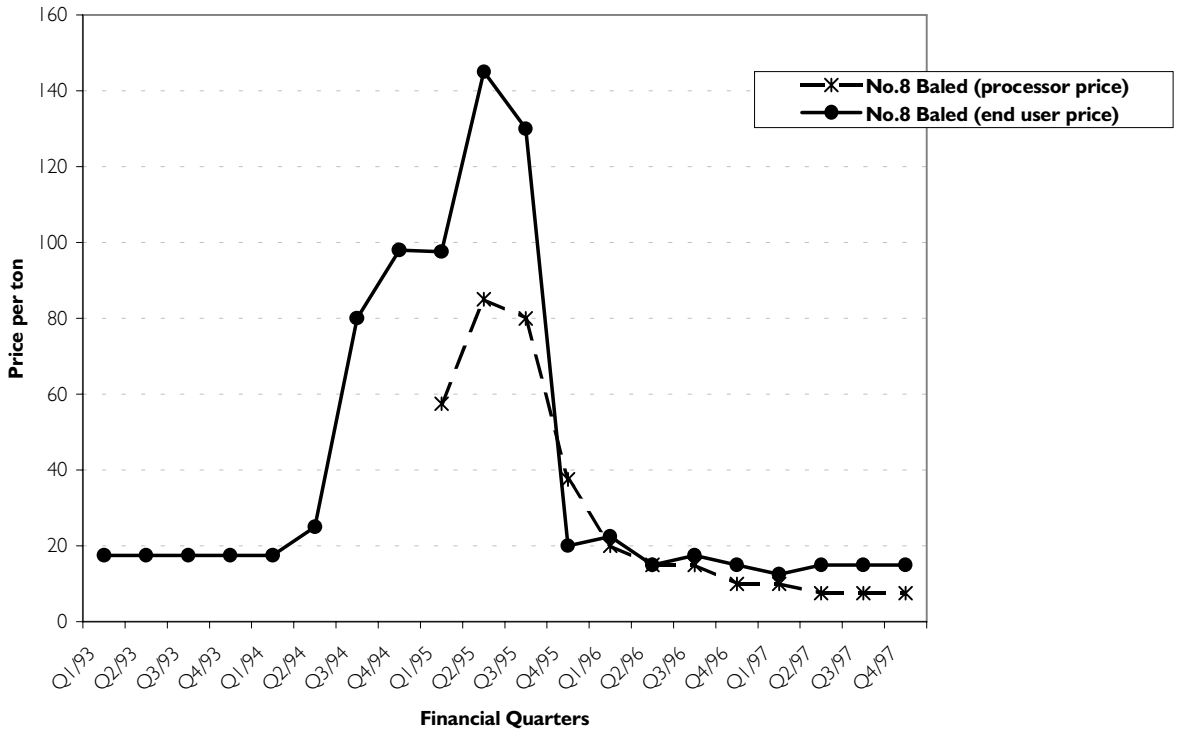
While the percentage of ONP recovered has increased in recent years, the quality of the recovered ONP supply is declining. Due to consistently low prices for No. 8 News during the past three years, local governments have not emphasized source separation and, thus, have not achieved high quality ONP. Furthermore, in the aftermath of the recent price decreases, some North Carolina local governments have chosen not to maintain separate ONP and residential mixed paper (RMP) systems due to the increased efficiencies of combining ONP and RMP collection. Due to the trend toward commingling ONP and RMP collections, the local government ONP recovery calculations in this report reflect an increased tonnage to include 50 percent of the tonnage reported as mixed paper by local governments in fiscal year 1996-97. As a result, nine percent of the 121,229 tons of the total ONP recovered consists of ONP reported as mixed paper.

DEMAND FOR ONP

While various technical and economic factors affect demand decisions at mills, the following section describes seven fundamental factors that have a significant impact on the demand for ONP.

- **General Demand for Paper and Paperboard Products:** In general, the demand for paper and paperboard products parallels the health of the economy. Due to the strong economy and the continued demographic shift toward the southeastern United States, the demand for advertising in newsprint remained high throughout 1997.

Figure 5: Price History of ONP (Processor and End User Prices)



Source: Recycling Times. Processor Prices not available prior to 1995.

- **Recycled Content Legislation:** Since the early 1990s, minimum recycled content laws have been important mechanisms to develop the domestic demand for ONP. As of 1998, 28 states supported mandatory or voluntary recycled content levels. Thirteen states have passed mandatory newsprint laws across the country, and 15 states have established voluntary guidelines for publishers to use recycled newsprint.[16] Many of the states adopting such initiatives have also established programs with increasing recycled content targets, so that the industry can gradually develop demand for ONP. In 1994, the North Carolina legislature required publishers to use 30 percent post-consumer recycled fiber by 1998 with an increase to 35 percent by 2000.[17] Florida and Kentucky have also adopted mandatory recycled content legislation by 1998. Virginia is the only state in the southeast that encourages publishers to purchase recycled content newsprint through voluntary guidelines.[18]

  These laws have provided an effective incentive for newspaper publishers to demand recycled content newsprint from paper mills. Possibly more significant than helping increase the demand for ONP, the minimum content laws have provided a stable domestic demand for ONP and provided a critical balance to the fluctuating foreign demand for ONP.

- **Capacity for Recycled Newsprint Production and Consolidation Trends:** In reaction to the increased demand for recycled newsprint from publishers, many newsprint mills invested heavily in facility expansions with deinking capabilities throughout the mid-1990s. In the Southeast region alone, five newsprint mills reported using a combined total of more than 1.2 million tons of ONP in 1997.[19] Despite the lack of announced expansions of deinking capacity, the mills surveyed for this report anticipated increases in production capacity for recycled newsprint because of improvements in production efficiency. Additionally, the current industry-wide trend toward consolidation could result in the acquisitions and expansion of smaller paper mills and increased capacity for recycled newsprint production in the Southeast region.

- **Export Demand:** Fluctuations in the foreign demand for ONP have caused significant price volatility in ONP in recent years. For example, when

Figure 6: Breakdown of End Uses for ONP

National Consumption of ONP by End Use	Tons (000)	Percentage of Total
Newsprint	2,676	36.2%
Recycled Paperboard	1,393	18.9%
Exports	1,048	14.2%
Tissue	496	6.7%
Containerboard	264	3.6%
Printing-Writing	176	2.4%
All Other	1,333	18.0%

Source: AF&PA Recovered Paper Statistical Highlights (1997)

foreign market demand for ONP peaked in 1995, the prices for recovered paper increased dramatically (see Figure 5). Unlike the slow but steadily increasing domestic demand for ONP, foreign paper buyers have tended to enter the market somewhat spontaneously and present large purchase orders in short time periods, thus driving prices up rapidly. Unfortunately, they tend to cut orders just as quickly and create demand voids with parallel price declines.[20]

From 1995 to 1997, the five largest foreign importers of ONP from the United States were Canada, Mexico, Korea, China, and Indonesia.[21] According to the AF&PA, total ONP exports achieved a record high of 2.2 million tons in 1995. However, the level of ONP exports dropped to 1.5 million tons in 1996, due to decreased foreign purchases, increased recovery efforts abroad, increased supplies of recovered paper from Europe, and the devaluation of foreign currencies. Despite the devaluation of Asian currencies in 1997, exports rebounded to 1.9 million tons.[22] China is expected to lead the growing Asian demand by increasing imports of recovered paper in the short term. Industry experts anticipate that, as Mexican and Asian economies strengthen, exports of ONP will rise to 2.4 million tons by 2002.[23] In the long term, increased investments in recycled newsprint capacity in Asia along with increased recovery efforts will eventually lead to a decrease in Asian demand for ONP exports from the United States.

- **Discontinuity between Supply and Demand:** Throughout the past five years, fluctuations in ONP prices have reflected the inability of local ONP suppliers to respond to large increases in foreign demand as well as a historical disharmony between recycling collection efforts and domestic demand. For example, because of their reliance on long-term public education campaigns, local government collection initiatives maintain constant ONP collection efforts despite fluctuating prices and subsequent demand fluctuations.

- **Virgin Pulp Capacity:** Although the process of converting virgin pulp is more energy intensive than deinking and repulping recovered newsprint, many mills continue to rely heavily on virgin inputs due to their consistent quality, reliability, and availability.[24] Several factors that favor the continued reliance on virgin pulp supplies include the decentralized organization of recovered paper suppliers, the price volatility of recovered paper relative to virgin pulp, and the quality problems associated with the supply of ONP.

- **Quality of Recovered Paper Supply:** The consistently low prices for No. 8 News during the past three years have not supported source separation of ONP by local governments. Since the price decline in late 1995 and the expanding opportunities to market mixed paper, many communities in North Carolina have combined ONP with mixed paper collection in an effort to increase collection efficiencies. In addition, industry analysts indicate that the lack of consistent public education concerning material preparation has also contributed to the decline in the quality of ONP supplies.[25] With this trend toward non-source separated collection and reliance on material recovery facilities (MRF), mill officials have noted a decline in the overall quality of recovered paper supplies. Mill officials cited non-specification materials, such as plastic and unbleached boxboard, as major contaminants limiting the potential for using ONP in the future.

End User Demand

Recycled newsprint production has traditionally been the primary end use for recovered ONP in the United States. The AF&PA reports that more than 36 percent of ONP recovered nationally was consumed by newsprint mills in 1996. Paperboard mills consumed an additional 19 percent of the nation's recovered ONP in 1996, while 14 percent of of recovered ONP was exported. Figure 6 provides a more detailed breakdown of the national uses of ONP in 1996, according to the AF&PA.

Nationally, newsprint mills are the largest and fastest-growing end users of ONP. In an effort to support the rapid growth of recycling collection programs from 1989 to 1993, many states introduced recycled content newsprint laws to stimulate the demand for ONP. Partially as a result of the increased demand from recycled content laws, almost 56 percent of the growth in the consumption of ONP has been attributed to increased newsprint consumption.[26] Due to the prevalence of newsprint and paperboard mills in the southeastern United States, the region maintains a strong demand for ONP. The following section reviews the demands and concerns of five major newsprint mills in the Southeast, because they constitute a majority of ONP demand in the region. These descriptions do not imply endorsement by DPPEA or DENR of any company or its products.

- In 1997, **Alabama River Newsprint Co., Perdue Hill, Alabama,** produced 245,000 tons of newsprint sheet with approximately 115,500 tons of recovered paper feedstock. Ninety-one percent of the recovered feedstock consisted of No. 8 ONP with the remaining nine percent from preconsumer coated groundwood. In 1997, only about 2.5 percent of the recovered feedstock was obtained from North Carolina. The mill does not have any plans to expand recovered paper capacity. However, the Perdue Hill mill estimates that, on average, mills in the Southeast increase their recovered paper capacity by roughly 2.5 percent per year due to improvements in process efficiency.

- In 1997, **Augusta Newsprint Company, Augusta, Georgia,** produced 35 percent recycled content newsprint with approximately 160,000 tons of Number 8 ONP. In addition, Augusta obtained 60,000 tons of old magazines for its recycled content newsprint in 1997. Approximately 15 percent of the recovered ONP was supplied by North Carolina sources. Less than one percent of the OMG was obtained from the North Carolina. Augusta plans to increase recycled content to 40 percent by 2002 given the possibility that in minimum content legislation may expand or increase in the southeast states. As a result, the mill's demand for Number 8 ONP will increase to 237,600 tons per year in 2002. Due to the steady decrease in price for ONP since 1995, Augusta has experienced an increase in contaminants arising from poor collection and material separation at the local level. During the past few years, the mill has received some shipments with contaminant percentages approaching 5 percent. Augusta recycles ONP almost exclusively from offset printing operations.[27]

- In 1997, **Bear Island Paper Co., L.L.C., Ashland, Virginia,** produced newsprint with approximately 28 percent recovered paper feedstock. Bear Island's recovered paper composition consists of a 90 percent ONP and 10 percent OMG mix. In 1997, Bear Island obtained 12 percent of its total 92,000 tons of recovered feedstock from North Carolina. Specifically, North Carolina provided 19,700 tons of ONP and OMG in 1997. Bear Island plans to expand recovered paper capacity to 34 percent by December 1998, with plans to achieve a 40 percent recovered paper feedstock percentage in the long term. The mill uses a flotation deinking process to recycle the ONP from offset newsprint.

- **Bowater, Calhoun, Tennessee,** produces newsprint using an average feedstock ratio of 80 percent virgin and 20 percent recovered paper. The mill currently produces newsprint sheets to different states varying its range of recycled content from 80 percent virgin and 20 percent recycled to 60 percent virgin and 40 percent recycled. The mill used approximately 200,000 tons of recovered paper in 1997. In 1997, the recovered paper feedstock ratios were approximately 70 percent ONP and 30 percent old magazines (OMG). The Calhoun mill obtained between 30,000 and 50,000 tons of ONP in 1997 from North Carolina mostly through round-trip pickups after dropping off unprinted newsprint shipments in the state. Currently, there are no plans for mill expansion in Calhoun, but increased mill efficiencies are expected to increase the demand for recovered paper. The mill can recycle both offset and flexographic printed newspaper.[28]

Figure 7: Estimated Demand for ONP

	1997	2002
North Carolina	127,382	153,651
NC and Border States	523,820	557,880
Southeast Region	1,429,800	1,515,140

Sources: North Carolina Demand numbers from Survey of seven end users
North Carolina and Border States and Southeast Region demand based on 1998 Utilization data (AF&PA)

- In 1997, **Southeast Paper Manufacturing Company & Southeast Recycling Corporation, Dublin, Georgia,** produced 530,000 tons of 100 percent recycled content newspaper. Because of their absolute dependence on recovered paper feedstocks, the Southeast Paper Manufacturing Company manages the Southeast Recycling Corporation, a paper collection and sorting center. The Southeast Recycling Corporation obtained approximately 700,000 tons of ONP in 1997. The Southeast Recycling Corporation also obtained a small percentage of old magazines and inserts in their 700,000 total tonnage. In 1997, Southeast Recycling acquired 30,000 tons, or roughly four percent of its ONP supply, from North Carolina. The Dublin plant has the ability to process both flexographic and offset ONP. While there are no immediate plans to expand the Dublin mill, they expect to increase consumption of ONP by 50,000 to 75,000 tons by efficiency improvements through 2002. Furthermore, the possibility that Southeast will acquire smaller mills in the region provides the potential for increased demand capacity for ONP during the next five years.

Other End Uses

While newsprint mills consume the largest share of the demand for ONP, paperboard mills also consumed 31 percent of recovered ONP in the Southeast region in 1996. However, paperboard mills are not ideal candidates for increases in demand because they represent a relatively low-end use for recovered newspaper utilization. More specifically, because mills can substitute low quality mixed paper grades for ONP based on price differences, there appears to be a limited potential for realizing sustainable increases in ONP demand through recycled paperboard production. In addition, the potential for increased demand for recovered ONP from tissue and containerboard end users is limited by the shortness of fibers resulting from the repulping of ONP.

Two other end uses are cellulose insulation and animal bedding. Cellulose insulation is an emerging market with significant potential for future growth.[29] In contrast, animal bedding has been repeatedly mentioned during the past ten years as a potential market for reuse of ONP; nevertheless, end users have been reluctant to purchase and transport ONP from recovery locations to rural markets. As a result, unless prices drop further or transportation costs are subsidized, the potential for increased demand through animal bedding will be limited by the price of ONP and the proximity of the appropriate farms.

Figure 7 estimates the demand for ONP in North Carolina and its border states and the southeast region.

SUPPLY / DEMAND RELATIONSHIP

Nationally, the market for ONP can be best described as having a fairly stable demand structure with steady supply sources. Despite the strong and steady demand for ONP in the southeast, regional prices have varied significantly during the past five years due to large fluctuations in foreign demand. The lack of flexibility innate to local curbside collection efforts has resulted in a fairly stable supply of ONP despite the price fluctuations. As a result, despite the variations in the market prices, the total quantity of ONP recovered in North Carolina has increased steadily during the past five years.

In response to the consistently low prices for ONP in the region during the past three years, many local collection efforts have shifted toward commingled collection and processing of ONP in combination with residential mixed paper (RMP). Combined with a decrease in the quality of source separated ONP, the shift toward commingled collection provides an indication that supply exceeds demand for ONP in the southeast.

It can be assumed that all recovered ONP was utilized for newsprint, other paper products, cellulose insulation, or animal bedding. Actual demand for all four grades of ONP

Figure 8: Estimated ONP Supply and Demand for North Carolina

	1997	2002
Supply of ONP (Recovered in NC)	159,594	169,611
Demand for NC's ONP (Reported)	127,382	153,651

Sources: Supply numbers reflect recovery as reported by the North Carolina State Annual Report for 1997.
Demand numbers from survey of five end users in North Carolina and its Border States.

Figure 9: Estimated ONP Supply and Demand in the Southeast Region

	1997	2002
Supply	1,459,155	1,543,410
Demand	1,216,772	1,430,544

Sources: Supply numbers reflect the recovery of ONP based on EPA estimates.
Demand numbers from survey of five end users in North Carolina and its Border States.

is therefore roughly equivalent to supply. Figures 8 and 9, however, represent the demand from the five largest newsprint mills in the Southeast for ONP recovered from North Carolina and the Southeast region. The demand estimates reflect the general trend of increased ONP demand from newsprint mills in 1997 and 2002. These tables do not account for all the end users in the region and are not intended to provide comprehensive ONP demand estimates; it is likely that the demand provided in the tables underestimates total demand in 1997 and 2002.

Regionally, the needs of newspaper publishers and the recycled content capacity of mills directly affect the demand for ONP. While North Carolina, Kentucky, Florida, and Virginia have provided leadership in the establishment of recycled content laws in the Southeast, other states have not adopted minimum recycled content initiatives. Currently, South Carolina, Georgia, Tennessee, Alabama, and Mississippi lack state guidelines for recycled content newsprint. Several of the largest mills in the southeast have indicated the capacity to produce at least 40 percent recycled content newsprint sheet thus providing the technical capacity to increase recycled content consumption. In contrast, some states in the northeast and upper mid-west have experienced difficulty attaining sufficient recycled content due to low levels of recycled fiber from Canadian newsprint shipments. Finally, with no apparent increases in the future consumption of ONP, the demand for ONP can be further developed in the southeast through higher percentages for recycled content newsprint. Missouri has already provided such leadership by increasing its target level to 50 percent recycled content newsprint by the year 2000.[30]

CONCLUSION

ONP represents one of the largest single sources of materials discarded in the waste stream. As such, ONP should remain one of the top priorities for reaching the state's 40 percent waste reduction goal. Given the mill capacity to increase recycled content levels and continuous improvements in production efficiency, it appears that the domestic demand for ONP should continue to grow at a slow but steady pace in the near future. In addition, while the state has little influence on foreign markets, industry experts expect the foreign economies to rebound in 1998 along with their demand for recovered paper.

RECOMMENDATIONS

The following recommendations are intended to improve the ONP recycling market through demand development and improved effectiveness of recovery efforts in North Carolina.

- As a result of the technical improvements in recycled newsprint production at mills in the Southeast region, it is recommended that the state of North Carolina reconsider its current recycled content goals. North Carolina should play a leadership role in the region by reviewing the current mandates in order to account for possible improvements in mill capacity. The telephone survey conducted for this report revealed the two largest newsprint mills in the southeast currently have the capability to produce 40-percent recycled content sheets. Two of the remaining three mills in the region stated their intention to reach a 40-percent

recycled content capacity in the near future. As a result, the state should consider working with publishers and newsprint manufacturers to establish additional recycled content targets beyond the year 2000. The state should also review exceptions granted under the current 35 percent regulations.

- In the absence of price stabilizing mechanisms such as futures markets, the state should address the discontinuity between supply and demand by encouraging contact between end users and local government suppliers. More specifically, the state could facilitate efforts to have recycled newsprint mills present their needs to local governments in North Carolina. The state should organize efforts to investigate the potential for voluntary partnerships and/or long-term contracts between end users and local governments. Because of labor and operating cost reductions, many mills have expressed a preference to receive ONP directly from municipalities rather than through processing plants.[31]

  Closer ties between ONP suppliers and mills would also lead to more timely and efficient shipments of ONP. For example, during summer periods of peak energy costs, recovered paper suppliers could help offset the high energy costs associated with virgin paper processing by increasing their ONP shipments. In addition, end users may be more willing to provide higher prices and longer term contracts for higher quality, timely shipments from local collection programs. Finally, mills could use this opportunity to educate local governments about their quality standards.

- Efforts should also be made to further inform local government collectors about the dynamics of paper markets. Increased awareness of previously successful marketing strategies could be one method of improving local government efficiency with regard to market sales and contracts. For instance, Duplin County's storage of mixed paper during periods of lower market prices is one example of how a collector's awareness of market dynamics can positively affect the sustainability of a local recovery program.

- Contaminants in ONP supplies impose additional costs on the use of ONP relative to virgin fiber sources. Improvements to the quality and consistency of ONP supplies could enable local governments to net higher prices and possibly encourage increased utilization of ONP. One method of improving the quality and quantity of ONP recovered would be for local governments to shift toward pay-as-you-throw waste collection system coupled with public education.

  In conjunction with improved local government efforts, partnerships between end users and local governments should also be encouraged as a means to reducing ONP contaminants. Such partnerships would encourage end users to assume a more active role in setting quality standards for their ONP supplies in exchange for sharing some of the financial responsibility for public education campaigns.

- Finally, based on the decreased distance between urban and rural areas of some parts of the state, it appears that the potential for reusing old newspaper as animal bedding will increase in the future. As a result, it is recommended that additional support be provided to experimental programs documenting the effectiveness and efficiency of using ONP as a bedding substitute.

[1] Sound Resource Management Group, Inc. *The Economics of Recycling and Recycled Materials,* prepared for the Clean Washington Center. December 1993. p. 102

[2] There are four grades of ONP that have been traditionally recovered and utilized as feedstocks for newsprint or other paper and paperboard production at mills. The four grades of ONP are No. 6 News (containing up to 5% contaminants), No. 7 News (containing ONP and magazines), No. 8 News (containing only one-fourth of 1% contaminants) and No. 9 News (consisting of pre-consumer over-issued newspaper).

[3] Institute of Scrap Recycling Industries, Inc. *Scrap Specifications Circular 1998* .p. 34-35

[4] U.S. EPA., *Characterization of Municipal Solid Waste in the United States – 1997 Update. May* 1998.p.29

[5] AF&PA, *Paper, Paperboard, & Wood Pulp, A Monthly Statistical Summary from the AF&PA.* January 1998.

[6] AF&PA, *1998 Annual Statistical Summary Recovered Paper Utilization, Twelfth Edition.* June 1998 p.15
For purposes of this report, The Southeast Region is defined as North Carolina, South Carolina, Virginia, West Virginia, Tennessee, Kentucky, Tennessee, Florida, Alabama, and Mississippi.

[7] U.S. EPA., *Characterization of Municipal Solid Waste in the United States –1994, 1995, 1996, 1997 Updates.*

[8] American Forest and Paper Association, *Paper, Paperboard, & Wood Pulp, A Monthly Statistical Summary from the AF&PA.* January 1998.

[9] U.S. EPA., *Characterization of Municipal Solid Waste in the United States – 1997 Update*. May 1998. p. 29

[10] Ibid. p. 29.
[11] Personal Communication. Steven Fowler, American Forest and Paper Association. May 18, 1998.
[12] Ridgley, Heidi "ONP Market Could Be Affected By Falling Newsprint Production Rates," *Recycling Times.* Vol. 9. July 21, 1997. p. 1, 13. & Iannazzi, Fred and Clarke, Rosemary, "Recovered Paper Target Level of 50% Seen Unreachable by 2000", Andover International Associates, May 1998, p. 3
[13] North Carolina State Planning Office Population Projections for 2002 (Source: http://www.ospl.state.nc.us/demog/#a)
[14] North Carolina's border states consist of South Carolina, Virginia, Tennessee, and Georgia, and the southeast region includes North Carolina, South Carolina, Georgia, Virginia, West Virginia, Tennessee, Kentucky, Alabama, Florida, and Mississippi.
[15] Miller Freeman, Inc., "Wastepaper markets to strengthen in 1998 despite persistent lull in offshore exports." *Paper Recycler.* Vol. 9 No. 1. January 1998.
[16] Miller Freeman, Inc. "Paper Grades: Newsprint," *Pulp & Paper 1998 North American Factbook*. p.184.
[17] Post-consumer recycled content includes only ONP that has entered the consumer waste stream after leaving the newsprint publishing facility.
[18] Ibid. p. 184-185
[19] Personal conversations with mill purchase agents for recovered paper.
[20] Mary Cesar. "Asian currency crisis affects U.S. recovered paper markets." *Resource Recycling*. June 1998. p. 30.
[21] AF&PA. *1998 Annual Statistical Summary Recovered Paper Utilization.* Twelfth Edition. June 1998. p. 50 and 56.
[22] Ibid. p. 50.
[23] Miller Freeman, Inc. "Wastepaper markets to strengthen in 1998 despite persistent lull in offshore exports." *Paper Recycler.* January 1998. Vol. 9, No.1. p.1-8.
[24] The majority of virgin material newsprint is produced through mechanical pulping processes. Newsprint is produced by shredding softwood or hardwood logs and chips using either water and stone grinders (groundwood pulping) or steam and refiner technology (thermomechanical pulping). Based on the EDF's *Recommendations for Purchasing and Using Environmentally Preferable Paper: Final Report*. 1995. p. 173-174.
[25] Communication with Bill Moore, Moore and Associates, September 1998
[26] Michael Alexander, "ONP and ONG Market Outlook to 2000", *Wastepaper IV* Conference Proceedings, Chicago, Il. May 1995
[27] Offset printing is the more traditional form of newspaper printing in which ink is transferred (off-set) to the newspaper from a rubber cylinder and lithographic plate. Offset printing normally uses oil-based inks and paper which is relatively impervious to water. Flotation deinking facilities are required to recycle offset printed newsprint. (Based on *Recommendations for Purchasing and Using Environmentally Preferable Paper: Final Report*, EDF, 1995 p.238).
[28] Flexographic printing is a relatively recent technology whereby the ink is transferred directly to the paper through flexible rubber or plastic plates. (Source: Flexoexchange website, http://www.flexoexchange.com/glossary.html#F). Flexographic printing uses water-based inks and has become increasingly popular because it results in decreases in number of breaks at the start up of the printing machine and lower investment costs. (Based on "De-inking of wastepaper containing water-based flexo-printed newsprint" by G. Galland and Y. Vernac, *Pulp and Paper Canada*, Vol.94:6. 1993. p. 181.
[29] Communication with Bill Moore, Moore and Associates. September 1998.
[30] State Recycling Laws Update. "California Leads Mandatory Newsprint Program States." Vol.7, No.4. April 1998.
[31] Edwards, Rodney. "Future Trends in the Secondary Fiber Industry." *Recycled Paper Technology.* 1994. p. 12-18.

Paper: Old Magazines

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

Until recently, magazines and catalogs were often recovered as mixed paper; however, the demand for these materials as a unique recovered paper grade has begun to emerge. Minimum recycled content laws and the introduction of new deinking technology at newsprint mills has influenced this trend.[1]

Magazines and catalogs are collectively referred to as old magazines (OMG), because they are made of the same materials (coated groundwood or coated free-sheet papers) and are equally useful to the primary end users (newsprint mills). According to the Institute of Scrap Recycling Industries, OMG is defined as consisting of "baled coated magazines, catalogs, and similar printed materials," with total outthrows (i.e., contaminants) not exceeding three percent. [2]

Limited information is available about the generation and recovery of OMG at national and state levels. Using national data concerning the generation of coated groundwood and coated free-sheet papers, North Carolina's generation in 1997 has been estimated to exceed 138,000 tons. Based on these calculations, OMG constitutes more than six percent of the total paper generated in the state. Recovery has been extrapolated from studies conducted in other regions of the country and is estimated to be about 11 percent.

During the past five years, demand for OMG has increased, due primarily to the new flotation deinking technology at newsprint mills. Additionally, recycled content legislation has inspired mill consumption of old newspaper (ONP) and OMG, and future demand for OMG is likely to increase in parallel with demand for ONP. With further increases in mill production efficiency in the short term, demand for OMG is expected to continue to increase slightly during the next five years.

Figure 1: National Generation of OMG 1993-1997 and 2002

	1993	1994	1995	1996	1997	2002
Magazines (tons)	2,738,594	2,864,473	2,865,456	2,617,655	2,856,902	2,980,225
Catalogs (tons)	1,932,186	2,090,980	2,104,186	1,924,288	2,121,293	2,212,862
Total OMG	4,670,780	4,955,453	4,969,642	4,541,943	4,978,195	5,193,087

Source: Calculations based on data from the Pulp and Paper 1998 North American Factbook

SUPPLY OF OMG

Generation

In North Carolina, the generation of OMG in 1997 was estimated to be more than 138,000 tons, up from 125,000 tons in 1993. Given constant per capita levels for the next five years, OMG generation in North Carolina is projected to exceed 147,000 tons in 2002.

These figures were derived from the total production of coated groundwood and coated free-sheet papers by applying percentage composition ratios for magazines and catalogs established by Jaakko Poyry.[3] The generation figures for magazines and catalogs between 1993 and 1997 were calculated by applying the ratios of 33.4 percent for magazines and 24.8 percent for catalogs to the total shipment data (domestic production plus imports minus exports) for coated groundwood and coated free-sheet paper. The remaining 41.8 percent of coated groundwood and free sheet paper are used to produce inserts and direct mail materials.[4]

The national generation of OMG has increased slightly during the past five years (Figure 1). In fact, despite a decline in 1996, the overall generation of OMG has increased seven percent from 1993 to 1997. This five-year increase in total generation of OMG is a result of growth in both magazine and catalog shipments. Because of the strong economy and advertising climate in 1997, shipments of coated groundwood paper increased 13 percent, while coated free-sheet shipments increased six percent from 1996 levels. [5]

National generation figures were used to calculate per capita OMG generation rates. The per capita generation rates were then applied to the North Carolina population to estimate the total amount of magazines and catalogs generated in the state from 1993 to 1997. According to those calculations, 138,000 tons of magazines and catalogs were generated in North Carolina in 1997. Of the total OMG generated, 79,000 tons consisted of magazines and almost 59,000 tons were catalogs. Figure 2 illustrates the North Carolina generation of OMG from 1993 (125,000 tons) to 2002 (more than 147,000 tons).

This method of estimating OMG generation in North Carolina assumes that the state and national per capita averages are equal. As a result, this approximation may slightly overestimate the OMG generation in North Carolina.[6] Furthermore, based on research conducted by the Northeast Recycling Council, it is also assumed that 66 percent of OMG is generated from residential sources.[7] Therefore, more than 92,000 tons of OMG was generated from North Carolina residences and 46,000 tons of OMG from commercial sources in 1997.

Similar to the national and North Carolina trends, the generation of OMG is expected to increase for North Carolina's border states and the southeast region. Because of a lack of data, however, quantitative estimates for border states and regional OMG generation and recovery were not available.

Recovery

Local government recovery of OMG has been increasing steadily during the past five years. From 1993 to 1997, local government recovery of OMG has increased from 1,300 to more than 4,000 tons.[8] According to a recent survey of the private sector, an additional 600 tons of recovered OMG was collected in 1997. [9] These figures probably underestimate the total amount recovered, because magazines and catalogs continue to be included as a part of residential mixed paper (RMP) collections and are sometimes included as part of ONP. Because of difficulty in separating the OMG portion from the total RMP tons reported, no attempt has been made to adjust the recovery figures from local governments.

News stand returns have also been calculated to account for the largest portion of OMG that is recovered in North Carolina and sold to newsprint mills. These calculations assume that 33 percent of all magazines are sold to newsstands and that 50 percent of those magazines are unsold and returned to the distributors.[10] Based on anecdotal evidence, approximately 90 percent of the magazines returned to distributors in North Carolina are recovered and sold as OMG to newsprint mills. The remaining 10 percent of

Figure 2: Generation of OMG in North Carolina, 1993 to 1997 and 2002

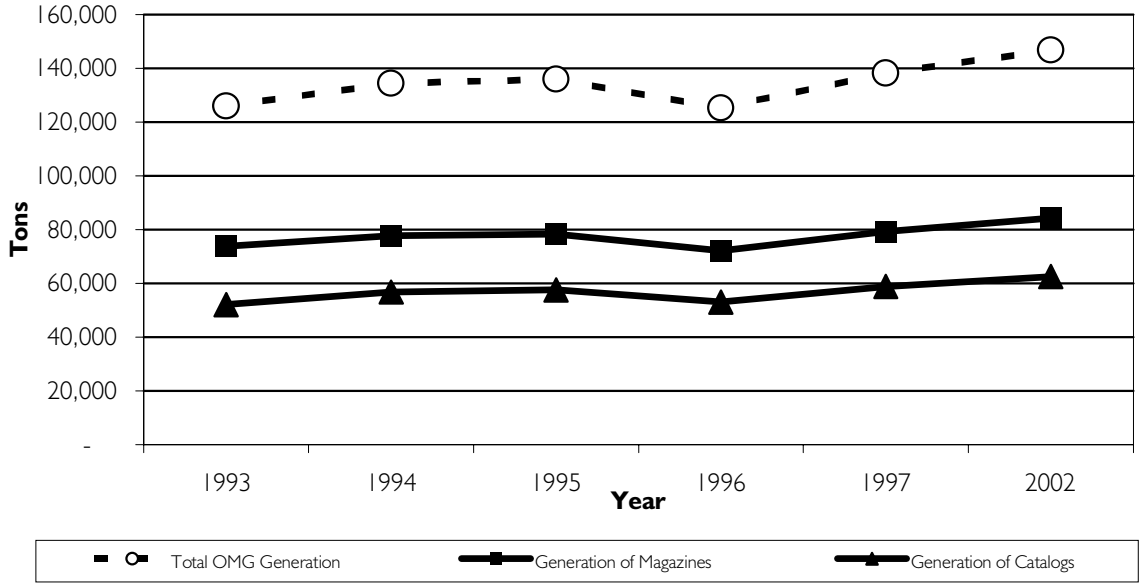


Figure 3. OMG Recovered in North Carolina 1993-1997 and 2002[12]

	1993	1994	1995	1996	1997	2002
OMG Generation	125,255	134,213	136,157	124,981	138,169	146,782
Local government	1,289	2,739	2,749	3,643	4,018	4,268
Private sector	10,675	11,438	11,604	10,652	11,788	12,509
Total Recovery	11,964	14,177	14,353	14,295	15,806	16,777
Percent Recovered	*9.6 %*	*10.6%*	*10.5%*	*11.4%*	*11.4%*	*11.4%*

unsold magazines do not return to distributors and are discharged by newsstands directly into the municipal solid waste stream.

Overall recovery of OMG has increased to more than 30 percent from 1993 to 1997. Nevertheless, despite improved local government collection, only 11.4 percent of the OMG generated in North Carolina is recovered. In comparison, this recovery rate is well below the 22 percent recovery reported for the 10 states comprising the Northeast Recycling Council region.[11] Figure 3 summarizes recovery in North Carolina for the past five years and 2002. Estimates for 2002 assume that per capita recovery remains at the 1997 level.

DEMAND

Similar to other mixed papers, OMG has traditionally been used as a low grade paper supply for the production of paperboard and tissue paper. Because they are highly interchangeable with respect to their end use contributions, the demand for any single paper type within the mixed paper category has remained relatively low compared to other paper grades with more specific end uses, such as newsprint and corrugated cardboard. However, with the increased prevalence of flotation deinking processes at newsprint mills in the United States and the southeast, in particular, OMG has become a valuable ingredient in recycled newsprint production. As a result, it is increasingly collected as an independent grade of recovered paper. Because of difficulty in isolating OMG from RMP, the following discussion focuses primarily on the demand for OMG from newsprint mill end users.

Flotation deinking technology has only recently become prevalent in the United States.[12] With the widespread installation of flotation deinking systems during newsprint mill upgrades in the early to mid 1990s, there has been an increase in demand for clay coated papers (primarily OMG). During the flotation deinking process, OMG is used to stabilize the foam bubbles that bond to the newsprint ink and

rise to the surface of the flotation chamber.[13] In addition to stabilizing the flotation process, the long fiber strands and the brightness of OMG also contribute to a higher quality recycled newsprint pulp.[14]

According to some newsprint mills surveyed, the most efficient ratio of OMG to ONP in the floatation deinking process is 30:70, respectively. However, the precise ratio of OMG to ONP varies based on the mill technology and production procedures. Moreover, many mills vary the ratios of OMG and ONP based on price, quantity, and availability of supply.[15] Insufficient data were available to estimate quantities of OMG consumed in North Carolina or the southeast region. As a surrogate measure of the demand for OMG in North Carolina, the following section describes the consumption patterns of some of the largest newsprint mills in the Southeast that reported using OMG in their flotation deinking systems. These descriptions do not imply endorsement by DPPEA or DENR of any company or its products.

- **Alabama River Newsprint Co., Perdue Hill, Alabama,** In 1997, the Perdue Hill mill produced 245,000 tons of newsprint sheet with approximately 115,500 tons of recovered paper feedstock. Nine percent of the recovered feedstock consisted of OMG. The mill reports using 10,500 tons of pre-consumer coated groundwood as its clay feedstock in 1997. The remaining 91 percent of the recovered feedstock consisted of No. 8 ONP. In 1997, only about 2.5 percent of the recovered feedstock was obtained from North Carolina. The mill does not have any plans to expand recovered paper capacity. However, the Perdue Hill mill estimates that, on average, mills in the Southeast increase their recovered paper capacity by roughly 2.5 percent per year due to improvements in process efficiency.

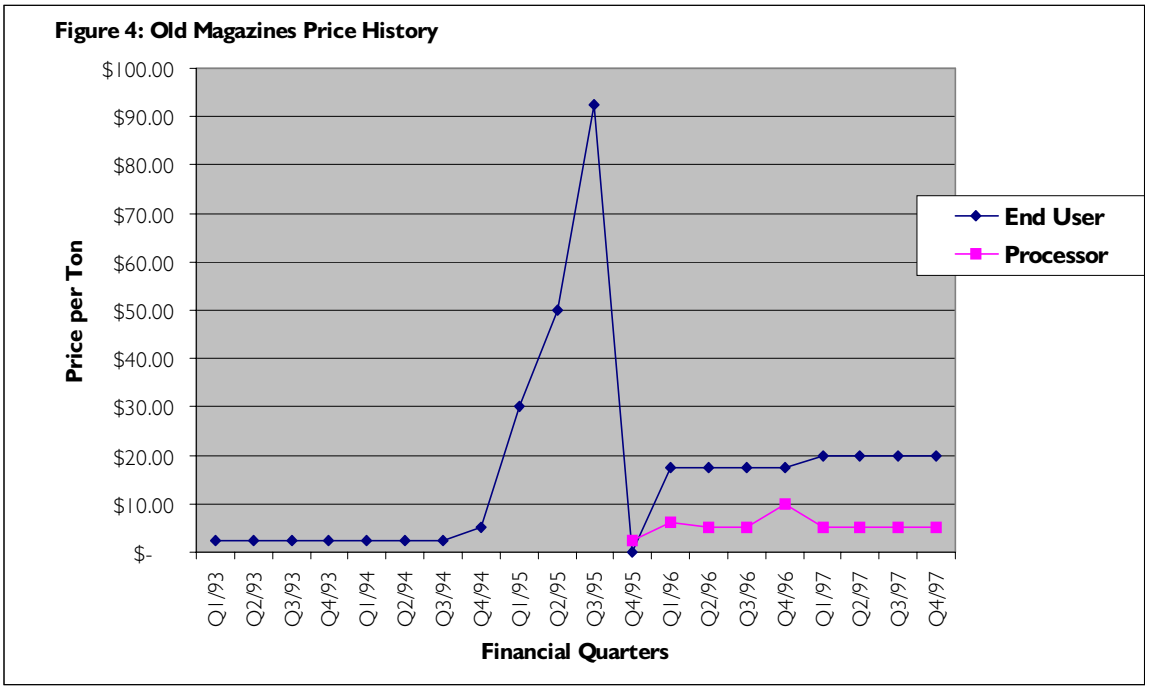
- In 1997, **Augusta (Georgia) Newsprint Company,** produced 35 percent recycled content newsprint with approximately 60,000 tons of OMG and 160,000 tons of Number 8 News. Approximately 27 percent of the recovered paper feedstock consisted of OMG in 1997. Approximately 15 percent of the recovered ONP was supplied by North Carolina sources. Less than one percent of the OMG feedstock was obtained from North Carolina. Augusta plans to increase recycled content to 40 percent by 2002 given the possibility that minimum content legislation may expand or increase in the southeast states. As a result of the increase to 40 percent and the annual 2.5 percent increase in production due to efficiency improvements, the mill's demand for OMG will increase to approximately 77,000 tons in 2002.

- In 1997, **Bear Island Paper Co., L.L.C., Ashland, Virginia,** produced newsprint with approximately 28 percent recovered paper feedstock. Bear Island's recovered paper composition consists of 10 percent OMG and 90 percent ONP. In 1997, Bear Island obtained 12 percent of its total 92,000 tons of recovered feedstock from North Carolina. Specifically, North Carolina provided 19,700 OMG and ONP in 1997. Bear Island plans to expand recovered paper capacity to 34 percent by December 1998, with long term plans to achieve a 40 percent recovered paper feedstock.

- **Bowater, Calhoun, Tennessee,** produces newsprint using an average feedstock ratio of 80 percent virgin and 20 percent recovered paper. The mill currently produces newsprint sheets to different states varying its range of recycled content from 80 percent virgin and 20 percent recycled to 60 percent virgin and 40 percent recycled. The mill used approximately 200,000 tons of recovered paper in 1997. In 1997, the recovered paper feedstock ratios were approximately 30 percent OMG and 70 percent ONP. Although exact figures were not available, the News Group magazine distributors reported sending most of their magazine returns from North Carolina to the Calhoun mill. Currently, there are no plans for mill expansion in Calhoun, but increased mill efficiencies are expected to increase the demand for recovered paper.

- Despite being the largest supplier of recycled content newspaper in the southeast region, **Southeast Paper Manufacturing Company & Southeast Recycling Corporation, Dublin, Georgia,** did not consume any OMG in 1997 because of their reliance on washing deinking technology.

During the past five years, there has been an unprecedented increase in the demand for OMG primarily because of the new flotation deinking technology at newsprint mills. Additionally, recycled content legislation has galvanized mill consumption of ONP and OMG and should be recognized as an essential stimulant for OMG demand. Future demand for OMG is likely to increase in parallel with demand for ONP.



Source: Recycling Times South Region; Processor prices not aailable prior to April 1996

SUPPLY / DEMAND RELATIONSHIP

The demand for OMG has increased during the past five years because of increased production in recycled content newsprint and the use of clay-coated papers in the deinking of ONP. With further increases in mill production efficiency in the short term, it appears that demand for OMG will continue to increase slightly during the next five years. In summary, demand for OMG in the southeast region could be characterized as consistent and growing.

As a result of the relatively recent emergence of newsprint demand, OMG collection in North Carolina has yet to evolve as a recovered paper commodity with consistent supply sources. However, as the price for OMG rose throughout 1994 and 1995, source separated OMG collection became increasingly popular. Because of increased collection efforts in surrounding states, the supply of OMG increased in the region and the price stabilized in 1996 and 1997. Due to its proximity to several flotation deinking mills and the steady increase in production of recycled content newsprint during the next few years, North Carolina has an opportunity to satisfy the slight increase in regional demand for OMG through increased recovery levels.

Price History

As illustrated in Figure 4, the price for OMG has remained at approximately $20 per ton for processed OMG since the third quarter of 1996. The dramatic fluctuation in price from late 1994 to the end of 1995 reflects the sudden increase in domestic demand for OMG due to the installation of deinking technology at several mills as well as an increase in demand for exports. Prior to 1995 and the installation of deinking mills, the low price reflected the lack of demand for OMG as a discrete paper grade and its inclusion in the mixed paper collection category.

CONCLUSION

North Carolina has strong potential to increase its recovery of OMG from the current rate of 11 percent, despite the recent stability between supply and demand reflected in the consistent price for OMG in the southeast region. By focusing on long-term strategies that stimulate demand, North Carolina can achieve sustainable increases in recovery levels. Examples of such demand stimulants include encouraging the regional newsprint mills to increase total recovered paper consumption through increased recycled content mandates or cooperative agreements. In some cases, it might be equally effective to encourage mills to link OMG purchases with current ONP supplies from North Carolina. Given such assurances of end user demand, local governments would be more likely to allocate the resources necessary to achieve higher recovery of OMG.

RECOMMENDATIONS

Since OMG is just beginning to emerge as an independent paper grade, North Carolina should identify the largest sources of OMG throughout the state. Once the primary sources of OMG have been identified, end users must be contacted to determine the potential for increasing demand. To stimulate demand, both cooperative and mandatory in-

centives for higher recycled content newsprint should be investigated. Finally, and most importantly, local governments must establish long term relationships with end users to determine the demand potential and financial return on their investment in OMG collection efforts.

The following actions would lead to improvements in the recovery of OMG in North Carolina:

- The state should support additional research to determine the greatest sources of generation and to identify the most effective areas for increased OMG recovery efforts.
- Newsprint mills should be consulted about the possibility of increasing OMG purchases from North Carolina. Such discussions should involve local communities and mills. In order to support potential increases in the recovery of OMG, the state should facilitate seminars between the two groups.
- Local communities with source separated ONP collection should be targeted for further development of OMG collection systems, and collection of an ONP / OMG mix should be encouraged, especially where the end users are newsprint mills. Based on national averages, the ratio of OMG to ONP *generated* is roughly 15:85, while the ratio of OMG to ONP *collected* is only 5:95.[16] State-level grant programs as well as partnerships with end users could provide incentives and support for local communities attempting to increase OMG collection.
- Current OMG collection systems should be expanded to achieve additional efficiency, especially in larger metropolitan areas (i.e. the Triad, Charlotte, and the Triangle).
- In large metropolitan areas, increased emphasis should be placed on commercial sources of generation, especially larger office building complexes and mall outlets with bookstores.
- To increase the quantity of OMG collected throughout North Carolina, equitable, waste reduction programs, such as pay-as-you-throw (PAYT), should be encouraged. Pay-as-you-throw systems charge users based on the amount of waste generated, creating financial incentives to reduce and recycle.

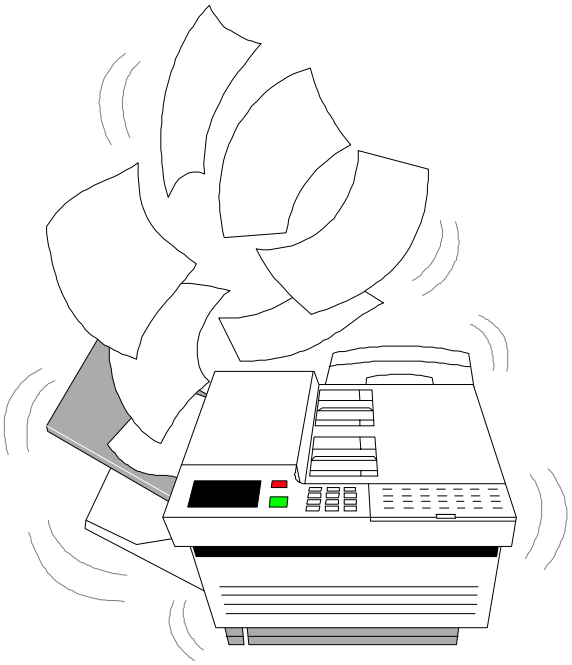
[1] In addition to containing similar physical properties, the clay coatings in magazines and catalogs serve equivalent functional purposes in the newsprint deinking process.
[2] Institute of Scrap Recycling Industries, Inc. *Scrap Specifications Circular 1998*, p. 34
[3] Miller Freeman, Inc., *Pulp & Paper 1995 North American Factbook*, "Paper Grades: Coated Papers," p.187. The ratios of 33.4 and 24.8 are based on logarithmic projections of Jaakko Poyry percentages for the distribution of magazines and catalogs respectively. Total production of coated groundwood and coated free-sheet is equal to domestic production plus imports minus exports.
[4] Miller Freeman, Inc., *Pulp & Paper 1995 North American Factbook*, "Paper Grades: Coated Papers." p. 187.
[5] Miller Freeman, Inc., *Pulp & Paper 1998 North American Factbook*, "Paper Grades: Coated Papers," *k - Paper Grades: Coated Papers*. p. 200-201
[6] Franklin Associates, Ltd. *Old Newspaper and Old Magazines Supply in the Northeast.* Prepared for the Northeast Recycling Council, April 1996. P.3-1. Based on limited research it is hypothesized that consumption of magazines increases as income levels rise. Furthermore, the average income level in North Carolina is below the national average.
[7] Ibid, p.B-2
[8] Department of Environment and Natural Resources, *North Carolina Solid Waste Management Annual Report July 1996- June 1997.* p. 29
[9] DPPEA, spring 1998.
[10] Franklin Associates, Ltd. *Old Newspaper and Old Magazines Supply in the Northeast.* Prepared for the Northeast Recycling Council, April 1996. Appendix B. p.B-2
[11] Ibid. p.B-21
[12] John Ettore, "Magazines Recycling May Boom as New Technology Increases", *Fiber Market News, Annual Paper Stock Issue, 1990.* P.47
[13] David Westenberger,"What is the role of clay in flotation deinking?", *Recycled Paper Technology, An Anthology of Published Papers* Editor Mahendra Doshi. 1994. p. 133.
[14] Based on personal conversations with newsprint mill end users in the Southeast region. It should be noted that the quality of fiber and level of brightness depends on the composition of the basestock of the publication paper. Coated publication papers range in quality from No.1 which is used for annual reports and is very bright with long fibers to No.5 which is used for most catalogs and some magazines and contains a higher groundwood content which is less bright. While clay is a common ingredient in the coating of all the grades of publication papers, the amount of clay is generally highest in the No.4 grade coated paper which is the most grade used to produce magazines.
[15] While there is some substitution between ONP and OMG depending on price, quality, and availability, the flotation deinking process requires some clay coated papers (or clay additives) in order function most efficiently. The five newsprint mills surveyed for this report estimated the range of OMG required for optimum deinking efficiency between 10 and 30 percent.
[16] Communication with Moore and Associates. September 1998.

Paper: Office Paper

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

The official definition of sorted office paper (SOP) describes the grade as "papers typically generated by offices."[1] Although a majority of paper meeting this description is generated and recovered from offices, it also is generated from homes and other commercial activities. In addition, offices commonly generate paper wastes that cannot be considered "office paper," such as magazines, newspapers, and corrugated containers.[2]

In 1997, North Carolina generated nearly 187,000 tons of office paper. Of that, almost 30 percent (55,000 tons) was recovered. This recovery occurred primarily in the private sector, with private recovery accounting for about 90 percent of total recovery.

Strong growth in recovered paper deinking facilities in the United States during the early to mid-1990s created new demand for recovered office papers. However, current capacity is far lower than originally projected in the early 90s because more deinked pulp capacity was brought on-line than was needed. Nevertheless, demand for sorted office paper is expected to improve in 1998, especially if the pulp market improves.

SUPPLY

Generation

In 1997, North Carolina generated 186,773 tons of office paper. Per capita generation of office paper nationally was calculated using EPA data. This factor was applied to North Carolina's population to estimate its generation for 1997 and 2002.[3] In 2002, North Carolina generation is expected to be 198,189 tons.

About 1.4 million tons of office paper were generated in the Southeast region in 1997.[4] This tonnage was estimated by applying the national per capita generation rate to each

Figure 1: Estimated Generation and Recovery for Office Paper in North Carolina

	1997	2002
Generation	186,773	198,189
Recovery	54,722	95,131

Figure 2: Estimated Generation and Recovery for Office Paper in Southeast Region

	1997	2002
Generation	1,461,763	1,546,168
Recovery	701,646	742,161

state. In 2002, generation in the region is anticipated to be slightly more than 1.5 million tons.[5]

The trend in office paper generation in the 1990s, where generation has remained essentially flat rather than growing, suggests that we may be moving closer to the ideal of a "paperless office." However, inventory fluctuations and the liquidation of stored inventories also have contributed to this trend. In any case, as office paper generation has leveled, electronic forms of data transfer have experienced significant growth. For example, the percent of households with personal computers has increased every year since 1990 by an average of about 10 percent each year. Electronic mail (e-mail) also has been growing rapidly, with e-mail addresses increasing by more than 20 percent per year for the past six years.[6] As use of electronic media increases, offices may move closer to becoming paperless, reducing office paper generation as a result.

Recovery

In 1997, almost 55,000 tons of office paper were recovered in North Carolina, yielding a recovery rate of almost 30 percent. The projection for recovery in 2002 ¾ just more than 95,000 tons ¾ assumes that North Carolina's recovery rate for office paper has reached the national average of 48 percent, which may overestimate actual recovery. Experts estimate that national office paper recovery is likely to top off at 50 percent based on current conditions.[7] Recovery was calculated using public and private sector recycling data. Public sector data were derived from responses to the *Annual Solid Waste Management Reports* submitted by local governments, and private sector data came from a recycling survey conducted by DPPEA in the spring of 1998.

Recovery of office paper occurs primarily in the private sector in North Carolina, with private sector recovery accounting for almost 50,000 tons, or 90 percent of total recovery in 1997.

Recovery in the Southeast region was calculated by applying the national recovery rate to generation numbers for the region. This calculation likely over-estimates recovery of office paper in the Southeast, if North Carolina's recovery rate is representative of the region. Nevertheless, using this assumption, slightly more than 700,000 tons of office paper were recovered in the Region in 1997, and almost 750,000 tons will be recovered in 2002.

Figures 1 and 2 present supply data for North Carolina and the Southeast region.

Understanding the characteristics of the printing and writing (P&W) paper waste stream helps determine the best ways to stimulate recovery.[8] Discarded printing and writing (P&W) paper can be divided into four segments:[9]

- Pre-consumer, which comprises 15 percent of total waste P&W paper.
- Post-consumer office / commercial paper, which comprises 40 percent.
- Post-consumer home papers, which comprise 42 percent.
- Permanent records, which make up about three percent.

Of these four segments, office / commercial offers the greatest potential for recovery. Two likely targets for increased recovery in this segment are multi-tenant office buildings and small businesses in detached buildings. Office paper

Figure 3: DIP Mills in the Southeast — Operating and Proposed but Not Built

Operating DIP mills in the Southeast		
Company	***Location***	***Capacity (tons/day)***
Boise Cascade*	Jackson, Ala.	230
Mississippi River Corp.	Natchez, Miss.	400
Ponderosa Fibres	Augusta, Ga.	180
Ponderosa Fibres	Memphis, Tenn.	200
Union Camp*	Franklin, Va.	350
Proposed but never built DIP mills in the Southeast		
DeNovo Corp.	Radford, Va.	150
Tempico Inc.	Pontotoc Co., Miss.	300

*Only a portion of the output is marketed; the remainder is consumed internally in the company's mill or mills. Source: *Resource Recycling*, 1997.

recovery is generally most efficient in large buildings. However, such buildings are typically multi-tenant, consisting of many small offices, with waste removal usually handled by the building manager, property management company, or landlord. The typical building manager has many competing responsibilities and coordinating a paper recovery program is not often a high priority, even when desired by some of the tenants. The primary concerns of a building manager are likely to be whether such a program will increase waste hauling costs, inconvenience tenants, or require extensive supervision.

Small businesses in detached buildings are another potential source of office papers for recovery, even though they do not generate nearly the tonnage of office papers as larger businesses or those in multi-tenant buildings. For this reason, they tend not to realize the same economic benefits as larger generators, because the fixed cost of implementing a system is not offset as quickly because of lower tonnage. In addition, some small businesses cannot benefit from reduced solid waste disposal fees as a result of office paper recovery because these fees are incorporated into rent or lease payments. Without the incentive of reduced disposal costs, small businesses may be less willing to support office paper recycling.

A notable trend in office paper recovery is toward ultra- or super-sorted office papers. Deinked pulp mills in particular have begun using this grade to counter two common problems faced in deinking operations: (1) high levels of contamination and outthrows in office papers and (2) wide variability among loads.[10] The quality of the ultra-sort is similar to sorted white ledger (SWL) in that it consists of greater than 80 percent bleached white fiber and is clean, with less than two percent outthrows (contaminants). Advantages of ultra-sort include cost (it is cheaper than SWL), consistency, and high quality, which enables it to be mixed with lower quality sorted office paper. At least one recycling company in Chicago is developing a large-scale collection and processing system to produce this highly sorted office paper.[11] Thus far, the system has shown that high volumes are required to be cost-effective.

DEMAND

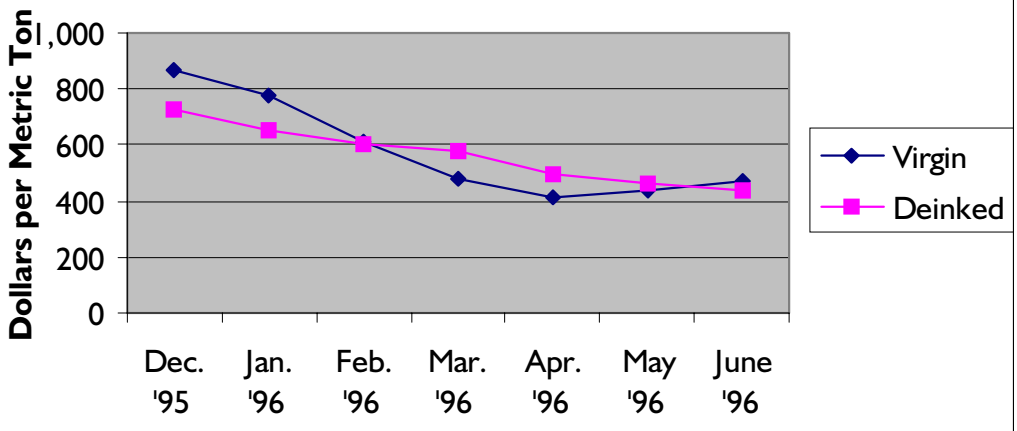
The primary markets for recovered P&W papers are tissue, new P&W papers, and recycled paperboard, according to the American Forest & Paper Association (AF&PA). The association reports the following breakdown among various end uses for recovered P&W papers: [12]

- 25.5 percent is consumed by tissue manufacture
- 25.5 percent by recycled paperboard manufacture
- 23.4 percent by P&W paper manufacture
- 15.9 percent by net exports
- 4.6 percent by newsprint manufacture
- 5.1 percent by all other uses

Insufficient data were available to make demand projections for SOP. A general discussion of the factors influencing demand for office paper follows.

The primary driver of demand for sorted office paper is the strength of the market for deinked pulp (DIP), which tends in turn to be based on prices for virgin bleached kraft market pulp and consumer demand for recycled paper products. The increase in deinking facilities in the United States has been a key factor in increasing the consumption of office paper in recent years. The DIP sector has grown significantly, with capacity more than tripling from 1993 to 1997, rising from 574,000 tons to 1.76 million tons.[13]

Figure 4: Average Pulp Prices, 12/95-6/96



Despite this growth, capacity is far lower than originally projected in the early 90s. More than .5 million tons of annual capacity have been eliminated, and some plants operating today are running on greatly reduced or intermittent schedules. Another 15 plants with more than 1.8 million tons of annual capacity were proposed but never built.[14] Figure 3 presents DIP mills, both operating and proposed but never built mills, in the Southeast.

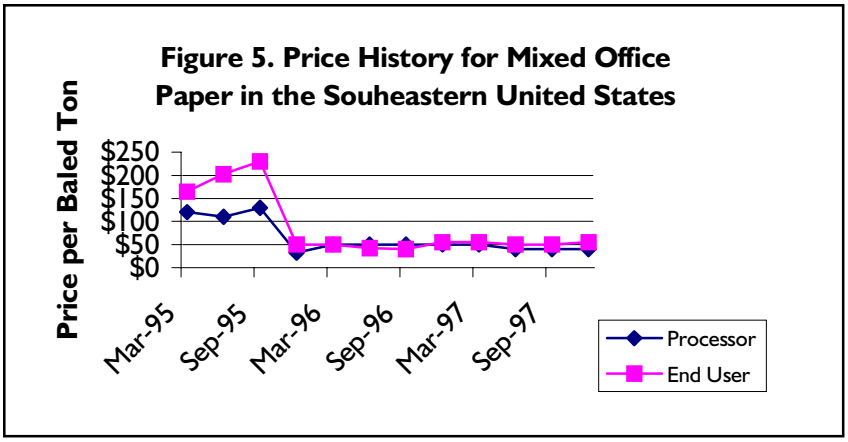
A combination of technical and economic problems kept the DIP industry from meeting expectations. Many of the mills employed new technologies that proved unreliable. Some had to switch to sorted white ledger to meet buyer specifications. At the same time DIP plants came on-line, the world demand for pulp slumped. Also demand projections for recycled content paper products were overly optimistic. In the end, many DIP mills couldn't make pulp of sufficient quality from sorted office paper. The combination of low pulp prices and weak demand forced mills to sell pulp at a discount in order to retain customers, thus assuring that they couldn't make a profit. The end result was more deinked capacity brought on-line than was needed.[15]

Contamination also poses barriers to successful production of DIP. An industry analysis of 41 bales of sorted office paper at one mill showed that more than one-third of the bales exceeded allowable levels of prohibited materials.[16] The best way for end users to avoid such contamination is to increase quality control measures, either by implementing inventory control (e.g., tagging bales with generator codes) or sorting on-site. Educating generators and processors on what constitutes contamination is also an important step.

Another factor influencing the DIP industry is the price of virgin bleached kraft market pulp. The downfall in prices for virgin market pulp in early 1996, fueled by expansion in virgin market pulp production, posed a barrier to increasing demand for office papers. Virgin market pulp is used to produce fine printing and writing papers and tissue (the primary markets for recovered office paper) ensuring competition between the two. See Figure 4 for an example of price fluctuations during a six-month period.[17]

Post-consumer DIP has no significant quality advantages (in terms of strength, brightness, or printability) over virgin pulps, and DIP is typically less expensive than virgin market pulp. When the price for virgin bleached kraft market pulp fell below that of DIP, as it did during the first quarter and most of the second quarter of 1996, some paper producers using DIP for a portion of their feedstock switched to virgin pulp. Low virgin market pulp prices will continue to pose barriers to increasing demand for recovered office papers.

State and federal level purchasing preferences also impact demand for sorted office paper. In North Carolina, Executive Order (EO) 8 directs state agencies to purchase and use recycled paper for all letterhead stationery, reports, memoranda, and other documents when feasible and practicable. At the federal level, Executive Order 12873 establishes procurement standards for printing and writing papers, specifying that certain grades of paper contain 30 percent post-consumer content by December 31, 1998, up from an initial level of 20 percent. In 1997, 28 brands of copier paper were available in North America that met or exceeded the 20 percent standard. Recent analysis has shown that compliance with EO 12873 is rising. Although many federal agencies are still buying primarily virgin paper, the



General Services Administration decided in March 1998 to exhaust its supplies of virgin copier paper and sell only recycled.[18]

Demand for SOP is expected to improve in 1998, especially if the pulp market improves as projected. DIP capacity is projected to continue to increase to 1.95 million tons in 1998 and remain level through 2000.[19] This projection may overestimate capacity somewhat, as it may include projections for DIP mills that have since ceased operating. Higher operating rates at DIP mills will likely result in higher consumption of SOP and related grades (such as computer printout and sorted white ledger).

Tissue mills are also expected to increase mill capacity this year. Of all paper grades, uncoated free-sheet and tissue ¾ both of which are markets for SOP ¾ are predicted to show the biggest jumps in capacity during the next three years, growing at average annual rates of 3.3 percent and 2.6 percent, respectively.[20]

Consumption of SOP by end users in Mexico has been increasing as a result of growing capacity and production during the past three years. Production in Mexico was up in each of the past three years, peaking at 3.2 million metric tons in 1996. Almost 80 percent of the fiber used in paper and paperboard manufacture came from recovered paper, and almost half of that came from the United States.[21]

End Users in North Carolina and Surrounding States

The following mills in North Carolina consume sorted office paper:[22]

- **Cascades Industries, Inc., Rockingham, North Carolina.** Products: tissue and toweling, jumbo rolls, roll toilet tissue, boxed facial tissue. Production: 69 tons daily. Tissue capacity: 25,000 tpy. Feedstock: high-grade deinking, mixed paper, pulp substitutes.

- **Laurel Hill Paper Co., Cordova, North Carolina.** Products: facial tissues and toweling. Production: 30-50 tons daily. Tissue capacity: 15,000 tpy. Est. deinking capacity: 18,000 tpy. Feedstock: high-grade deinking.

The following tissue mills in the Southeast region consume SOP:

- **Fort James Corp., Rincon, Georgia**
- **Kimberly-Clark Corp., Loudon, Tennessee**

The following P&W paper mills in the Southeast region consume SOP:

- **Boise Cascade, Jackson, Alabama**
- **International Paper, Selma, Alabama**
- **Union Camp Corp., Franklin, Virginia**

In addition, several DIP mills and tissue, P&W paper, and paperboard mills in the Southeast accept office paper along with mixed paper.

SUPPLY / DEMAND RELATIONSHIP

The office grade market, along with a host of deinking grades such as sorted white ledger, has seen up and down movement as the industry tries to determine the viability of the grade. Throughout this process, sorted office paper has been one of the few to be deemed viable, and at least one major end user sees steady domestic demand during the next several quarters.[23]

It is difficult to quantify the gap between deinking capacity growth and office paper recovery growth, because current estimates of office paper recovery in the United States are

limited. However, the difficulty experienced by DIP mills in obtaining new supplies of recovered office paper suggests that growth in demand has exceeded growth in supply. If this is the case, supplies of office paper may not be adequate to meet both existing and projected demand, causing market instability and possibly production slowdowns at DIP mills due to recovered paper shortages.

Price History

Figure 6 illustrates a three-year price history for baled mixed office paper in the Southeast.[24] These prices follow the same trend as SOP but tend to be lower. Following the trend of most paper grades in this period, mixed office paper prices spiked in late 1994 and early 1995 and significantly declined in late 1995. Prices seem to have leveled to about $50/ton since that time.

RECOMMENDATIONS

Recovery in North Carolina is below the national average and could be increased using the following approaches:

- Assist local governments in working with building managers to facilitate office paper recycling. Through North Carolina Division of Pollution Prevention and Environmental Assistance (DPPEA), this effort could be as simple as generating a fact sheet about how private businesses, haulers, and recycling coordinators can work with building managers to set up office paper recycling programs. Or a more active role could involve assisting local government recycling coordinators in fostering alliances with local chapters of the Building Owners and Managers Association (BOMA). Through these alliances, BOMA members could be educated about how office paper recycling programs can reduce disposal costs and increase paper recovery.
- Assist local governments in revitalizing existing office paper recovery programs. This goal is as important as establishing new office paper recovery programs. The National Office Paper Recycling Project (NOPRP) is presently focusing on revitalizing existing programs with materials such as a recycling guide for building managers. The state should distribute some of the NOPRP's materials to assist local governments working with the commercial sector and businesses.
- Encourage the creation of mixed commercial paper routes. Such routes could focus on a mix of office paper and old corrugated containers and would need to be organized to obtain the density to justify collection costs. Local governments could partner with large and small businesses to implement or expand public / private recovery of office paper.
- Educate generators about the need for sorted, contaminant-free office paper. This kind of communication down the line to generators could help mills improve the quality and quantity of paper they require.

Demand seems to be stabilizing; nevertheless, North Carolina could support stabilized long-term demand in the following ways:

- Increase state efforts to purchase recycled papers. It is difficult to counter the negative impact of depressed virgin market pulp prices on demand for recovered office paper. However, if demand remains strong for recycled office papers, paper manufacturers will be less likely to abandon deinked market pulp in favor of less expensive virgin pulp. The state could consider taking a more aggressive approach to recycled paper procurement, such as providing price preferences or adopting the same guidelines as outlined in the Federal Executive Order.
- Promote membership in the North Carolina Buy Recycled Business Alliance (BRBA) and promote recycled paper procurement by the private sector. The State could provide information about recovered papers, including cost and performance data, to local governments working with the commercial sector and businesses.

[1] Sorted office paper consists of baled paper, as typically generated by offices, containing primarily white and colored groundwood free paper, free of unbleached fiber. May include a small percentage of groundwood computer printout and facsimile paper. Institute of Scrap Recycling Industries, Inc. "Guidelines for Paper Stock: PS-98 Domestic Transactions." *Scrap Specifications Circular 1998*. p. 36.

[2] Efforts have been made to account for these grades of papers in other sections of this report.

[3] U.S. EPA *Characterization of Municipal Solid Waste in the U.S.: 1997 Update*. May 1998. The 2002 projection assumes no change in the per capita generation rate, which is consistent with the general trends reported by EPA.

[4] The following states are included in the southeast region: AL, FL, GA, KY, MS, NC, SC, TN, VA, and WV.

[5] This projection assumes no change in the per capita generation rate.

[6] U.S. EPA. *Characterization of Municipal Solid Waste in the U.S.: 1997 Update*. May 1998. p. 105.

[7] Miller Freeman Inc. "Wastepaper markets to strengthen in 1998 despite persistent lull in offshore exports." *Paper Recycler*. Vol. 9, No. 1. January 1998. p. 7.

[8] Office paper is a subcategory of the paper industry's P&W paper category, which also includes book and magazine paper, junk mail, and brochures. Office paper is the most commonly recycled portion of P&W paper.

[9] Iannazzi, Fred and Strauss, Richard. "Recovered office paper: the good news and the bad news." *Resource Recycling*. Vol. XIII, No. 11. November 1994.

[10] Outthrows are papers that don't meet office paper specifications and can include newsprint, magazines, catalogs, books, groundwood computer printout, manila envelopes, file folders, file stock and foil laminated stock.

[11] Powell, Jerry. "News flash: recovered paper prices will soon rise." *Resource Recycling*. Vol. XVI, No. 7. July 1997.

[12] AF&PA. *Recovered Paper Statistical Highlights*. 1997 edition.

[13] Paper Recycler. Vol. 8, No. 12. December 1997. p 6.

[14] Power, Jerry. "Beaten to a pulp: can the DIP market get back on its feet?" *Resource Recycling*. *V*ol. XVI, No. 9. September 1997.

[15] Ibid.

[16] Cesar, Mary. "Office waste paper and deinking: can this marriage be saved?" *Resource Recycling*. November 1996.

[17] Miller Freeman Inc. *Paper Recycler*. December 1995 - June 1996.

[18] Miller Freeman Inc. "Federal purchases of recycled-content paper improve, but still short of goal." *Paper Recycler*. Vol. 8, No. 12. December 1997, p. 7.

[19] Miller Freeman Inc. "Tissue producers hit on harder times." *Paper Recycler.* Vol. 8, No. 12. December 1997, p. 6.

[20] Miller Freeman Inc. "Paper industry's use of recovered paper to slow considerably." *Paper Recycler.* Vol. 8, No. 12. December 1997, p.5.

[21] Ibid.

[22] Miller Freeman Inc. "Tissue Producers Hit On Harder Times." Paper Recycler. December 1997. Lockwood Post's, Pulp & Paper International.

[23] Sandoval, Dan. "Paper Stock Markets: The Beat Goes On." *Recycling Today.* February 1998.

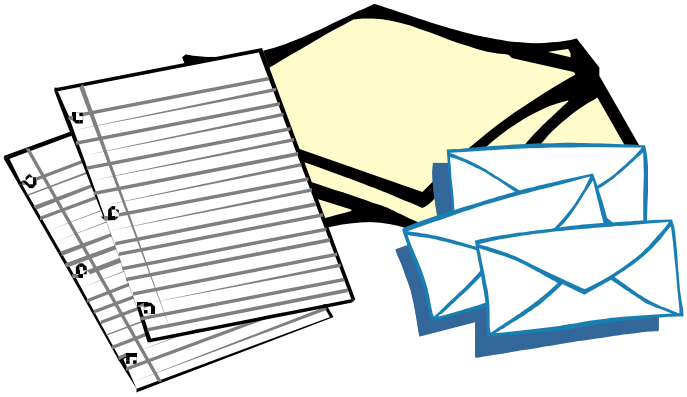
[24] Waste Age's *Recycling Times*. "The Markets Page."

Paper: Mixed Paper

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

The definition of mixed paper can be extremely broad, with few unacceptable papers, and often includes items such as discarded mail, telephone books, catalogs, and cereal boxes. It can include virtually all types of paper generated in offices and a large percentage of papers generated in residences. Unacceptable paper types typically include plastic-coated papers, such as frozen food packages, and paper towels / tissues. In many communities, mixed paper collections include paper grades that could be collected and marketed individually (such as office paper or old magazines).

In 1997, North Carolina generated more than 678,000 tons of mixed paper. More than 115,000 tons of mixed paper were recovered in North Carolina, for a recovery rate of 17 percent. Private sector recovery accounted for 80 percent of this tonnage.

Most of the mixed paper recovered in the United States (37 percent) is used to make recycled paperboard. Exports represent the second largest share of total consumption at 24 percent. The remainder is divided evenly between the manufacture of tissue paper, printing and writing paper, and all other uses.

Demand for mixed paper is projected to increase at a higher rate than other paper grades during the next several years. However, loss of production time and contamination problems will likely continue to contribute to the current oversupply.

Defining Mixed Paper

As noted above, the definition of mixed paper can be extremely broad, with few unacceptable papers. The standard industry definitions are also broad, yet they restrict the allowable levels of contaminants.[1]

Figure 1: Estimated Supply of Mixed Paper in North Carolina

	1997	2002
Generation	678,384	719,849
Recovery	115,182	143,970

Figure 2: Estimated Supply of Mixed Paper in Southeast Region

	1997	2002
Generation	4,646,718	4,930,740
Recovery	929,343	986,148

- *Soft mixed paper* consists of various qualities of paper not limited as to type of baling or fiber content. Prohibitive materials may not exceed two percent, and total outthrows may not exceed 10 percent.[2]
- *Mixed paper* consists of a baled, clean, sorted mixture of various qualities of paper containing less than 10 percent groundwood content. Prohibitive materials may not exceed .5 of one percent, and total outthrows may not exceed three percent.

Although generally referred to as residential mixed paper, or RMP, mixed paper can be collected from the residential or commercial sectors. Both sectors tend to include the same materials; however, commercial collections may contain higher-grade papers in the mix, thus offering greater opportunities to sort and market them individually. Materials collected as RMP through North Carolina local government programs generally include any combination of white ledger, computer paper, discarded envelopes, magazines, catalogs, and boxboard.

The Chicago Board of Trade (CBOT) Recyclables Exchange defines RMP as a combination of computer printout, white ledger, colored ledger, envelopes, coated paper, and coated paperboard. This definition specifically excludes any OCC and ONP / OMG that consists predominantly of groundwood fiber. Commingling the ONP / OMG groundwood fibers with other types degrades the overall quality and marketability of the material according to CBOT specifications.[3]

As these definitions illustrate, there is not a uniform definition of mixed paper. For this reason, recycling collection programs tend to be geared toward end-user specifications, which can be problematic if end-user needs change or disappear altogether. Developing a consistent definition for this grade would enable collectors to work with a wider range of processors and end users.

SUPPLY

Generation

In 1997, North Carolina generated 678,384 tons of mixed paper. This number does not include grades that are typically sorted and marketed separately from mixed, such as office paper and old magazines. Per capita generation of mixed paper nationally was calculated using EPA data, and this factor was used to estimate generation by population in North Carolina for 1997 and 2002.[4] In 2002, North Carolina generation is expected to be 719,849 tons based on projected population increases. This projection assumes no change in the per capita generation rate.

About 4.65 million tons of mixed paper were generated in the Southeast region in 1997.[5] This tonnage was estimated by applying the national per capita generation rate to each state's population. In 2002, generation in the region is anticipated to be slightly more than 4.9 million tons based on projected population increases.[6]

Recovery

In 1997, more than 115,000 tons of mixed paper were recovered in North Carolina, yielding a recovery rate of 17 percent. The projection for recovery in 2002 — almost 144,000 tons — assumes that North Carolina's recovery rate for mixed paper has reached the projected national average of 20 percent, which seems consistent with potential growth in mixed paper markets in North Carolina.[7] Recovery was calculated using public and private sector recycling data.[8]

Recovery in the Southeast region was calculated by applying the projected national recovery rate to the generation numbers for the region. This calculation likely over-estimates recovery in the region. In 1997, more than 929,000 tons of mixed paper were recovered in the region, and almost 986,000 tons will be recovered in 2002 if recovery remains at 20 percent. Figures 1 and 2 present supply data for North Carolina and the Southeast region.

Recovery of mixed paper occurs primarily in the private sector in North Carolina. Private sector recovery accounted

Figure 3: Estimated Demand for Mixed Paper in North Carolina (in thousands of tons)

End Use	1997	2002
Recycled paperboard	52.6	62.1
Export	34.1	40.3
Tissue	18.5	21.8
Printing & writing paper	17.1	20.1
Other	19.9	23.5
Total	142.2	167.8

for 80 percent of total mixed paper recovery, or 92,543 tons, with the remaining 20 percent collected through North Carolina's local government recycling programs.[9]

DEMAND

Mixed paper is projected to be the fastest growing of the recovered paper grades during the next three years, expanding 3.6 percent annually.[10] This growth suggests that the industry is accepting a broader range of recovered papers, but also that recovery may be reaching maximum achievable levels for some other paper grades.

RMP serves as a secondary fiber source in the production of new paper and paperboard, meaning it is primarily used as a partial replacement for more expensive recovered fiber. In paperboard applications, RMP typically replaces OCC and ONP when prices rise. End users of RMP can be classified into two groups: (1) producers of recycled paper and paperboard — including boxboard, linerboard, corrugating medium, and tissue and (2) other end users who can handle large percentages of mixed paper in their recycled furnish — including producers of gypsum wallboard, roofing felt, chipboard, and some molded pulp products (typically limited to small packing material operations for molded pulp).[11]

RMP is a potentially attractive substitute for other fibers for the following reasons:[12]

- *It can provide significant savings in fiber costs*, as it has the lowest value of any paper grade.
- *It is potentially available in large quantities*, as it has the lowest recovery rate of any paper grade.
- *It may allow for a more secure supplier base* for mills that consistently use it. Mills that establish relationships with suppliers in sluggish markets may be better able to protect this supply from competitors when markets are stronger.

However, the disadvantages of using RMP still need to be overcome. These disadvantages include loss of production time from paper breaks caused by shorter fibers in the RMP mix, quality problems because of high contamination, and increased rejects, which result in higher disposal costs. Experts expect boxboard and containerboard mills to continue to increase their use of RMP, especially at current low prices; however, the extent of this growth is uncertain.[13] At least one end user in North Carolina has expressed interest in establishing long-term contracts with local governments to ensure a high quality supply of mixed paper. Many mills are still figuring out what mix of RMP they can use while maintaining quality and performance characteristics.

Most of the mixed paper recovered in the United States (37 percent) is used to make recycled paperboard. Exports represent the second largest share of total consumption at 24 percent. Tissue consumes 13 percent of the total, printing and writing paper consumes about 12 percent, and all other uses consume 14 percent.[14]

Figures 3 and 4 present demand for mixed paper by end use in 1997 and 2002.[15] These numbers overestimate consumption of mixed paper as it has been defined in this report, because mixed paper as defined by the AF&PA includes office paper and old magazines.[16]

The following North Carolina end users use mixed paper as feedstock.[17] These descriptions do not imply endorsement by the North Carolina Division of Pollution Prevention and Environmental Assistance (DPPEA) or The North Carolina Department of Environment and Natural Resources (DENR) of any company or its products.

- **Carolina Paper Board Co., Charlotte, North Carolina:** Products: 100 percent recycled rigid and folding boxboard and chipboard. Total paperboard production capacity: 50,730 metric tons per

Figure 4: Estimated Demand for Mixed Paper in Southeast Region (in thousands of tons)

End Use	1997	2002
Recycled paperboard	562	663.1
Export	364.5	430.1
Tissue	197.4	233
Printing & writing paper	182.3	215.1
Other	212.6	250.9
Total	1,518.8	1,792.2

year. Feedstock: OCC, double-lined kraft (DLK), ONP, mixed paper, and pulp substitutes.

- **Cascades Industries, Inc., Rockingham, North Carolina:** Products: tissue and toweling, jumbo rolls, roll toilet tissue, boxed facial tissue. Production: 69 tons daily. Tissue production capacity: 25,000 tons per year. Feedstock: high-grade deinking, mixed paper, pulp substitutes.

- **Halifax Paper Board Co., Inc., Roanoke Rapids, North Carolina:** Products: rigid and folding boxboard, chipboard, pasted board, and mounting and laminated board. Production capacity: 105 tons daily. Total paperboard production capacity: 34,360 metric tons per year. Feedstock: OCC, DLK, ONP, mixed paper and pulp substitutes.

The following end users in South Carolina also use mixed paper as feedstock:[18]

- **Somerset Fiber Co., Cowpens, South Carolina**
- **Caraustar Industries, Inc., Taylors, South Carolina**
- **Sonoco Products Co., Hartsville, South Carolina**

Other Uses of Recovered Mixed Paper

Secondary markets for mixed paper continue to grow. Composting of mixed paper (alone or with other degradable materials) continues to be explored as an alternative to disposal for contaminated and unrecyclable paper. However, even in weak market conditions, mixed paper has more fiber value as a raw material in paper/board production.[19]

This application, using mixed paper as a bulking agent when composting municipal wastewater sludge, was tested in Durham, North Carolina, in 1991-92.[20] The mixed paper was shredded, then mixed with sludge, and composted. The project managers reported that the paper greatly enhanced the composting of the sludge. Temperatures necessary to kill pathogens were achieved, and analyses for residual heavy metals detected no levels in excess of EPA's 503 regulations for wastewater sludge management. Potential customers compared the end product to aged pine bark mulch, hardwood bark mulch, and dried horse or cow manure and indicated that it could replace some or all of the organic amendments in topsoil blends. Chatham County, North Carolina, has conducted more recent mixed paper composting trials.

DPPEA, along with N.C. State University and the N.C. Department of Agriculture, is also investigating the feasibility of using ground mixed paper as bedding in chicken houses throughout North Carolina. The paper is provided by Eastern Carolina Vocational Center, ground by US Fibers, and used in broiler houses owned by Perdue and Tyson Foods. The results of the first trial run are promising. Farmers like the paper bedding, because it helps eliminate beetle problems (due to boric acid content), and cellulose insulation installers are interested in blowing it into chicken houses. Based on preliminary finding, animal bedding appears to be a suitable end use for mixed paper, especially where wood shavings are in short supply.[21] A final report on the project is expected in early 1999.

Other possible end uses of recovered mixed paper include pelletized fuel and paper paneling. Mixed paper has been tested as a replacement for coal and wood in applications such as greenhouse heating and crop drying, and it has also been used in acoustic and thermal insulation panels.[22]

SUPPLY / DEMAND RELATIONSHIP

There appears to be an imbalance between supply and demand in North Carolina and the Southeast region, with demand exceeding supply. (See Figures 5 and 6.) How-

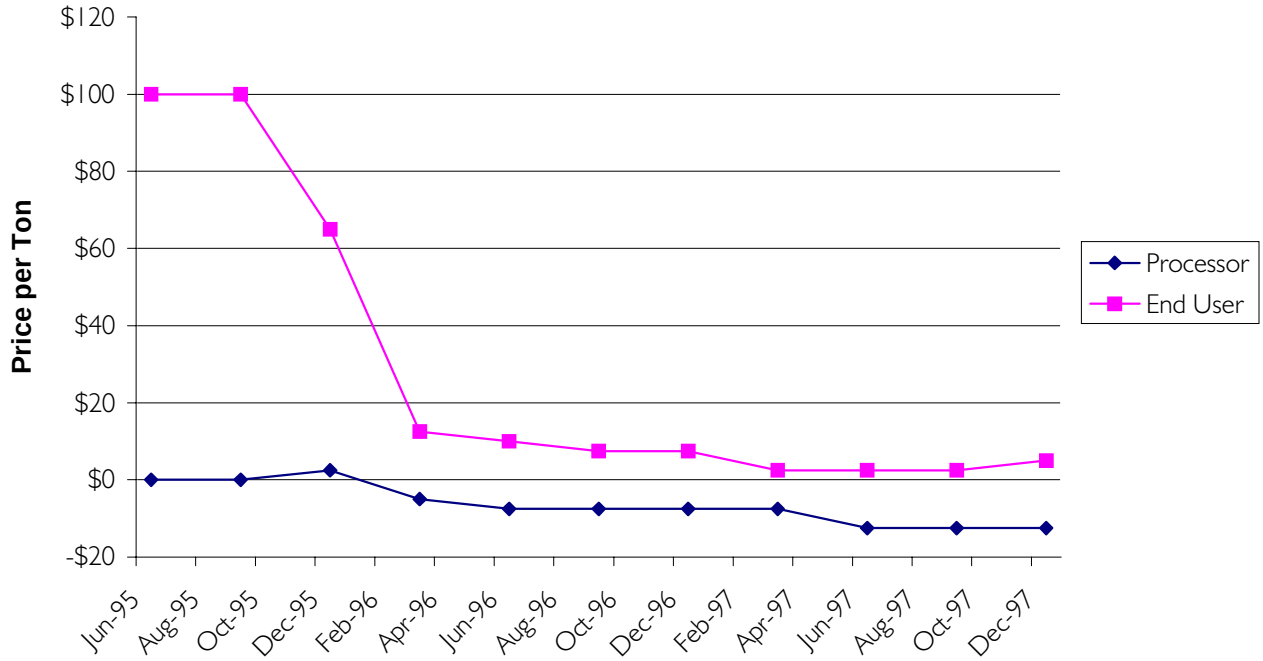
Figure 5: Estimated Supply and Demand for Mixed Paper in North Carolina

	1997	2002
Supply	115,182	143,970
Demand	142,200	167,800

Figure 6: Estimated Supply and Demand for Mixed Paper in Southeast Region

	1997	2002
Supply	929,343	986,148
Demand	1,518,800	1,792,200

Figure 7: Residential Mixed Paper Price History



ever, these comparisons are not strictly parallel, as the demand figures overestimate mixed paper consumption by including grades that are typically sorted and marketed separately from mixed, such as office paper and old magazines. It is more likely that supply exceeds demand, which is consistent with the depressed prices of mixed paper, and this oversupply is expected to continue during the next five years. Assuming this oversupply continues, research and demonstration of secondary markets for recovered mixed paper could stimulate demand.

Price History

Figure 7 illustrates the price history for mixed paper during the past three years.[23] Although prices have dropped from the highs of the price spike of 1994 and 1995, current levels mirror historical levels prior to the spike. Since prices fell in 1995, they have remained consistently below $20 per baled ton.

Many communities added RMP to their recycling programs during the price spike for the three reasons: higher prices meant additional revenues, strong public demand to recycle more materials, and RMP helped municipalities meet recycling goals, as it was an under-recovered fiber. Now that prices have returned to historic levels, some of these programs are struggling to market mixed paper.

CONCLUSION

There is still room for growth in mixed paper recovery; however, stronger demand is needed to justify increased recovery.

RECOMMENDATIONS

Actions that could stimulate supply and demand for mixed paper in North Carolina follow:

- To increase the amount and quality of mixed paper recovered from the residential sector, the state should encourage an OCC / RMP mix. Markets for this material should be secured before adding it to local programs; paperboard mills would likely be interested in this mix.
- To increase the quantity of mixed paper collected throughout the state, equitable, waste reduction based collection systems such as pay-as-you-throw (PAYT) could be encouraged. PAYT programs charge system users based on the amount of waste generated, providing financial incentives to reduce and recycle.
- To ensure demand for recovered mixed paper, the state should work to create local domestic markets for mixed paper by focusing its market development work on recycled paperboard users. For example, DPPEA could facilitate discussion among collectors, processors, and end-users in various regions of the state, with the desired end result of encouraging collectors to add mixed paper based on guarantees from end users.
- Along the same lines, the state should continue to support creation of new domestic markets, such as animal bedding and mixed paper composting.
- Demand for post-consumer recovered paper, like demand for virgin pulp, is dependent on the production strength of the industries that consume the feedstock. As the economies of the United States and its foreign trading partners improve, demand for paper products will improve, and paper producers will increase their demand for mixed paper. Until then, the state should continue to educate the recycling community about the relationship between economic productivity and demand for secondary materials.

[1] Institute of Scrap Recycling Industries, Inc. "Guidelines for Paper Stock: PS-98 Domestic Transactions." *Scrap Specifications Circular: 1998*. p. 34.
[2] Prohibitive materials are non-paper contaminants, such as metals or plastics. Outthrows are papers that do not meet specifications, such as those with groundwood content or plastic coatings.
[3] Gormley, Timothy. "Mixed Paper: An Emerging Commodity in the Recycling Industry." *Wastecon* Conference Proceedings, SWANA. September 1996.
[4] U.S. EPA. *Characterization of Municipal Solid Waste in the U.S.: 1997 Update*. May 1998.
[5] The following states are included in the southeast region: AL, FL, GA, KY, MS, NC, SC, TN, VA, and WV.
[6] This projection assumes no change in the per capita generation rate.
[7] Franklin Associates, Ltd. "Recovered Paper Forecast: The Role of Residential Collection." *Wastepaper VI* Conference Proceedings. 1995. p. 10. In this paper, a national post-consumer recovery rate of 20 percent was projected for mixed paper in 2000.
[8] Public sector data come from responses to the *Annual Solid Waste Management Reports* submitted by local governments, and private sector data come from a recycling survey conducted by DPPEA in the spring of 1998.
[9] DPPEA recycling survey. Spring 1998.
[10] Miller Freeman, Inc. "Paper industry's use of recovered paper to slow considerably." *Paper Recycler*. Vol. 8, No. 12. December 1997.
[11] Despite indications that mixed paper would be a good feedstock for molded pulp products, few of these manufacturers use it, as they generally cannot handle the processing required. Personal communication, Bill Moore, Bill Moore & Associates, September 1998.
[12] Jones, Kevin. "What's in store for old newspapers and residential mixed paper markets?" *Resource Recycling*. Vol. XVI, No. 5. May 1997.
[13] Ibid.
[14] AF&PA, Inc. *1998 Annual Statistical Summary: Recovered Paper Utilization*. 12th ed. June 1998. p. 36, 47, 83.
[15] AF&PA, Inc. *1998 Annual Statistical Summary: Recovered Paper Utilization*. 12th ed. June 1998. Total demand for the Southeast region is actual demand reported by AF&PA, while total demand for North Carolina is interpolated using these data. End use data are estimated using current percentages reported by AF&PA. Projections for 2002 assume an annual growth rate of 3.6 percent, and the same breakdown among end uses as in 1997.
[16] Personal communication, Stan Lancey, Statistical Committee. AF&PA. August 1998.
[17] AF&PA. *PaperMatcher*: 4th ed. Miller Freeman, Inc. 1997 Lockwood-Post's *Directory of the Pulp, Paper and Allied Trades*, Miller Freeman, Inc., *1998 International Pulp & Paper Directory*, manufacturer surveys.
[18] Ibid.
[19] Personal communication, Bill Moore, Moore & Associates. September 1998.
[20] Anderson, Geoffrey and Smith, Karen. "Mixed Paper Teams Up With Biosolids." *BioCycle*. March 1994.
[21] Personal communication, John Nelms. N.C. Department of Commerce. August 1998.
[22] Glaub, John C. "Fuel: An Alternative Use for Mixed Paper Waste." *Waste Age*. July 1987. Brewer, Gretchen. "Quite, cozy and green: recycled mixed paper panels," *Resource Recycling*, January 1991.
[23] Waste Age's *Recycling Times*, "The Markets Page."

PET ▪ HDPE ▪ PVC ▪ L/LDPE ▪ PP ▪ PS

Plastics

Plastics: Introduction

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

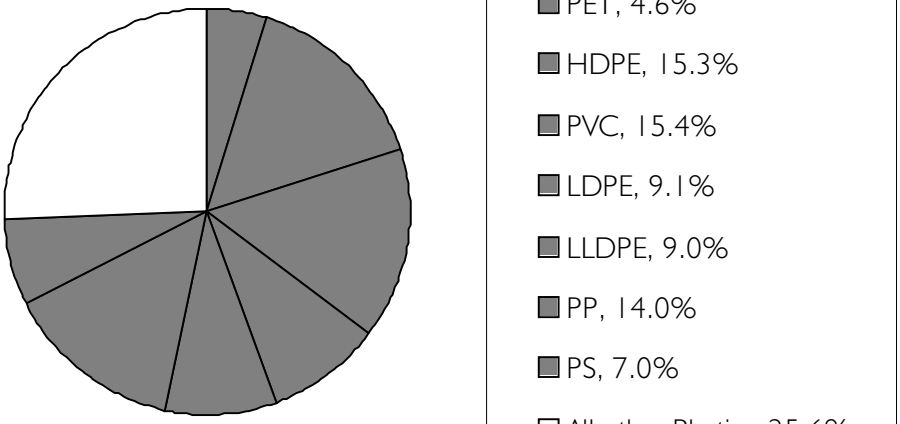
Since the introduction of celluloid in the 1870s, plastic has been used in an increasing number of products in the United States. The commercial development of plastics began in the 1930s.[1] Plastics can be divided into two major categories: thermoplastics and thermosets. Thermoplastics can be remelted and reformed many times into different shapes. For this reason, they are the most commonly recycled plastics. Thermosets can only be formed once. After that, they may be ground and used as filler for future plastic products.

Virgin plastic resins are produced in large capacity facilities from the monomers that are the building blocks to plastic polymers. These monomers come from many sources including petroleum and vegetative compounds. The resin pellets produced can be further compounded to add desirable properties or used directly in the manufacture of plastic products.

Currently, plastics recyclers not involved in virgin resin production are the primary recyclers of resins. Factors affecting the efficiency of these recyclers include price paid to the collector or intermediate processor, processing costs, and selling price. The price paid to the collector is dependent on the collection method used and the distance from generation to the intermediate processor or recycler. The quality of the material and the throughput of the facility affect processing costs. Price paid by the plastic product manufacturer for the processed resin generally is lower than that of competing resins.

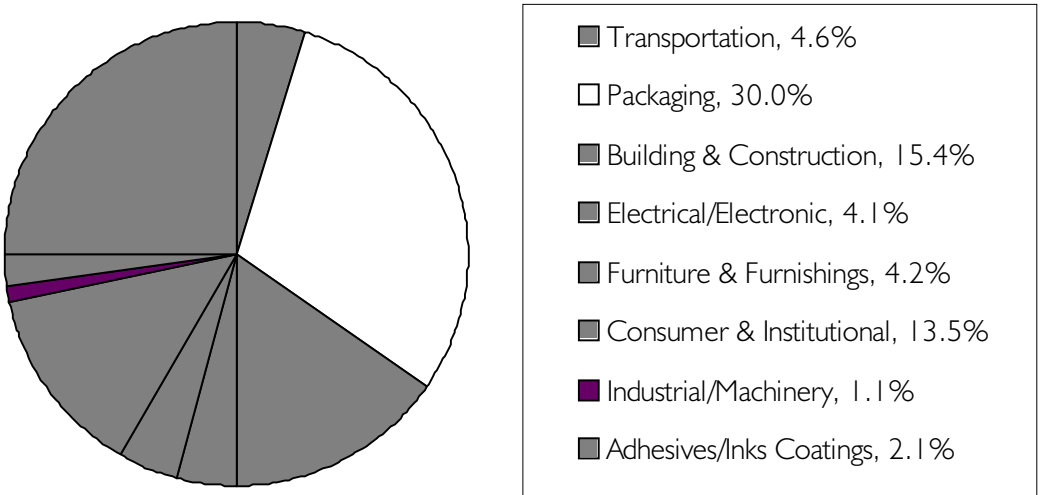
Vertical integration and economies of scale realized in virgin resin production are not generally available to recycled plastics processor and compounders, making the margin that they work in very narrow. This is discussed further in the market dynamics section of this introduction.

Figure 1: Percentage Distribution of Plastic Resins in 1996: Sales and Captive Use



Source: *Facts & Figures of the US Plastics Industry: 1997 Edition*, Society of the Plastics Industry

Figure 2. 1996 Percentage Distribution of Thermoplastic Sales & Captive Use by Major Market



Source: *Facts & Figures of the US Plastics Industry: 1997 Edition*, Society of the Plastics Industry

Thermoplastic resins are the primary focus of this report because they are more readily recycled. The major categories of thermoplastic resins are HDPE (high density polyethylene), LDPE (low density polyethylene), LLDPE (linear-low density polyethylene), PET (polyethylene terephthalate), PS (polystyrene), PP (polypropylene), and PVC (polyvinyl chloride). The distribution of each type of plastic in the overall plastics market is presented in Figure 1. The "all other plastics" category includes thermoplastics not named and thermosets.

These resins provide the material for a wide variety of products presented in Figure 2. Of the different types of products, the plastics recovered from the waste stream for recycling are mostly those used in packaging. End-uses for each resin are described in detail in each section of this chapter.

Figure 3: North Carolina Local Government Recovery (Tons)*

Material	FY90-91	FY91-92	FY92-93	FY93-94	FY94-95	FY95-96	FY96-97
Plastic	2,878	6,128	9,264	9,797	12,339	15,726	12,471

*Source: NC DENR, *NC Solid Waste Management Annual Report: July 1, 1996 to June 30, 1997.*

In addition to packaging recovery for recycling, plastic product manufacturers internally recycle plastic waste and also work with brokers to recycle the plastic waste that they cannot use. A small number of plastics manufacturers in North Carolina also make products from post-consumer resins.

RECOVERY

State programs track recycling managed by local government agencies. This recovery is presented in Figure 1. A majority of the resin recovered by local governments is PET and HDPE bottles. Recovery of specific resins is addressed in each chapter of this section.

The drop in plastics recovered in fiscal year 1996-97 by local governments as compared to the previous year is explained by two factors. Low market prices for some resins has caused some local government programs to scale back or drop their plastics collection efforts. In addition, fiscal year 1996-97 reports included some reporting of commingled recyclables, which are not reflected in these numbers.

MARKET DYNAMICS: PRICES AND CAPACITY

The two major elements of market dynamics are price and capacity. The price paid to a collector or processor for a material affects whether or not that business can afford to collect or process the material. The processing capacity and end-use capacity affect whether or not recovered plastics will actually sell. Capacity for PET, HDPE, LDPE, LLDPE, and PP far outstrips the recovery of these materials. However, the price paid for recovered plastics does not reflect this excess capacity because post-consumer resin must be competitively priced with alternative sources of resin if it is to sell.

Prices for recovered and reclaimed post-consumer plastics, therefore, are set by the price and tonnage availability of alternatives to post-consumer resin. These alternatives include virgin, industrial scrap, and off-spec resin. For example, when there is a large amount of inexpensive off-spec resin (usually associated with a new virgin plant start-up) recovered plastics prices can be expected to fall. Once the plant is tuned so that it doesn't produce large amounts of inexpensive off-spec resin and the demand for prime virgin resin brings the capacity utilization of the plant and virgin resin prices back up, recovered plastics prices will rise as well.

The supply and demand relationship also is affected by other nuances in the plastics market, causing prices to behave differently than in a pure supply and demand relationship. For example, a large resin producer will often sell product at lower than "market value" to keep market share. This is especially true when these producers are dealing with large customers. When excess capacity is coming online, a producer may sell the first product of this prime line as off-spec as capacity booms. In addition, some polymer experts relate that when there is an overabundance of virgin prime resin, a resin producer might sell the prime as off-spec to move it while keeping the price for prime at a higher level. So, while the capacity and demand for recycled resin is high, the price will not necessarily increase.

The prices for reprocessed resin trend lower than the prices for virgin resin, but end-users face two barriers to the use of reprocessed resin. These are consistency of quality and consistency of quantity.

For a plastic product manufacturing plant to run efficiently, the processing equipment must be "tuned" to the material. Plastic manufacturers make large quantities of low margin products. Therefore, facilities must operate efficiently. A low level of contamination and consistent material properties are essential in raw materials, whether virgin or recycled.

Just as important as receiving a high-quality material is the assurance that it will arrive when needed and on a consistent basis. To reduce warehouse costs, manufacturers are moving to on-demand purchases. In this situation, they need to be assured that the material will arrive on time. The inelasticity of supply of recovered resin is one reason the growth of its use is slower than the growth of plastics use as a whole. Further discussion of market dynamics in the resin specific reports are based on the factors described in this section.

Figure 4: Processing Capacity in the Southeast Region (Tons per Year)

	PET	HDPE	PVC	LDPE	PP
Wash Capacity	260,000	240,000	0	(1)	(2)
Dry Reclaim Capacity	0	50,000	0	100,000 (1)	(2)
Total Resin Capacity	260,000	290,000	0	100,000	90,000

(1) Wash capacity figures are included in dry reclaim capacity figures because of disclosure considerations.
(2) Wash and dry reclaim capacity figures are included in total capacity figures because of disclosure considerations.

North Carolina Capacity

Overall processing capacity in North Carolina is more than sufficient for the supply generated. Figure 2 presents an APC estimate of the processing capacity for major thermoplastic resins in the Southeast (Alabama, Florida, Georgia, Kentucky, Maryland, North Carolina, South Carolina, Tennessee, and Virginia).[1] Nationally, 204 companies recycle, broker or make product with recycled plastics.[2]

Future Market Growth

Environment News, a web-based publication, predicts that the demand for recycled plastics will increase to 2.75 billion pounds by the year 2000 from 1.75 billion pounds in 1995, based on a new study by The Freedonia Group, an Ohio-based market research firm.[3] The study also found that recycling is projected to increase 10 percent annually, and high-density polyethylene (HDPE) and polyethylene terepthalate (PET) will remain the dominant recycled resins because of their predominance in the bottle marketplace, as well as their ease of collection and separation. According to the report, recycled polyester fiber and fiberfill production will gain momentum and make strong showings in home furnishings, apparel, carpet, and other textiles. Demand for recycled HDPE will grow because of extensive uses in bottle and film products, plastic lumber, and various other markets. Freedonia also predicts that as the year 2000 approaches, packaging will remain an important market for recycled plastics although it currently demands only 31 percent of recycled HDPE and 23 percent of recycled PET.[4] Other techniques that will increase the viability of recycling plastics are an advanced system for cleaning and recycling used plastics, known as depolymerization, and super-cleaning technologies to make post-consumer plastics usable in new food contact packaging. [5, 6]

COMMODITY PROFILES

The following sections address seven commonly recycled thermoplastic resins: HDPE (high density polyethylene), LDPE (low density polyethylene), and LLDPE (linear-low density polyethylene), PET (polyethylene terephthalate), PS (polystyrene), PP (polypropylene), and PVC (polyvinyl chloride). Each report characterizes the generation, recovery, and markets for the resin and contains recommendations for balancing any discontinuities between supply and demand.

[1] The Society of the Plastics Industry, *Facts & Figures of the U.S. Plastics Industry: 1997 Edition*, page 5.
[2] Judith Dunbar, American Plastics Council, personal communication, July 14, 1998.
[3] Smith, Sarah S., "Recycling Data Delivers Some Surprises," *Plastics News*, May 25, 1998, p. 20.
[4] http://www.heartland.org/environment/july/plastic.htm
[5] Sandi Childs, NAPCOR, personal communication October 5, 1998.
[6] http://www.heartland.org/environment/july/plastic.htm
[7] Sandi Childs, NAPCOR, personal communication October 5, 1998.

Plastic: PET (#1)

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

One of the most prevalent resins used by the plastics industry is PET (polyethylene terephthalate). It is used in a wide variety of applications from strapping to fibers, but is perhaps most visible as the ubiquitous plastic soda bottle. PET, also known as polyester in the plastics industry, often ends up as polyester fiber in items such as clothing and carpeting. Much of the growth in PET use has been attributed to its aggressive capture of market share in the soft drink container business. The fastest growing market for PET bottles is single-serve containers, especially 20-ounce soft drink bottles.[1]

SUPPLY

Current Generation

The Environmental Protection Agency (EPA) has estimated the generation of discarded and recovered PET in the United States. Figure 1 presents EPA estimates per product category along with extrapolated estimates for North Carolina's share of national generation. North Carolina estimates are based on its share of the United States population being 2.78 percent, and these estimates are rounded to the nearest 100 tons. Because significant differences in generation exist from state-to-state, North Carolina estimates should be considered rough estimates. Correspondingly, APC figures for 1996 indicate the packaging market comprised 2.4 billion pounds (1,200,000 tons) of PET.[2] Adding EPA's estimates of the categories "soft-drink bottles," "other plastic containers," and "other plastics packaging" produces a packaging estimate of 1,180,000 tons, in close agreement with APC's figures.

Focus on PET Bottles

As Figure 1 indicates, soft drink bottles represent 40 percent of all generated PET. Other plastic containers, much of which take the form of "custom" PET bottles (such as for juices), constitute another 23 percent of generated PET. Thus, recovery efforts such as curbside recycling programs

Figure 1. PET 1996 Generation (tons)[3]

Product Category	Estimated United States Generation	Estimated North Carolina Share
Durable goods	340,000	9,500
Non-durable goods*	180,000	5,000
Soft drink bottles	680,000	18,900
Other plastic containers	390,000	10,800
Other plastics packaging**	110,000	3,100
Total Generated PET	1,700,000	47,300

Source: EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*
*Includes plastics in disposable diapers, clothing, footwear, etc.
**Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.

Figure 2. National PET Bottle Sales and Recovery (tons)

	1994	1995	1996
Sales	837,000	975,000	1,099,900
Recovery	282,500	311,000	286,000
Recovery Rate	34%	32%	26%

Source: Schmidt, L.B. "PET recycling: The view from NAPCOR." *Resource Recycling*. February 1998.

Figure 3. 1996 Extrapolations for North Carolina (tons) from Figure 2

North Carolina portion of national PET bottle sales	30,600
Theoretical share of national recovery	8,000

targeting PET bottles would address the largest portion of generated PET (although other forms of PET are recoverable).

Another way to estimate the generation of plastic wastes is to examine the use of the resin in non-durable goods. Plastics industry literature shows the use of PET for making containers is growing dramatically. *Modern Plastics* magazine has estimated that PET use in soft drink bottles increased by 15 percent from 1996 to 1997 to an annual use rate of 1,828 million pounds (914,000 tons). PET use in custom bottles (included in "other plastic containers" in EPA estimates) increased by 22.3 percent in the same time frame, to a total annual use of 1,322 million pounds (661,000 tons).[4] These estimates are about one-third greater than those found in EPA generation estimates. EPA estimates may not have kept up with the rapid increase of the use of PET in packaging and probably do not include exported bottle resin.

Figure 2 illustrates the rapid increase in PET bottle sales between 1994 and 1996. PET is gaining market share in bottle sales, especially from glass, and it is changing the mix of containers in the waste stream awaiting recovery. Figure 2 also presents national recovery estimates for PET, documenting a decline in recovery from 1995 until 1996. With PET usage climbing so rapidly, increases in recovery still can result in a decreased recovery rate.

Figure 3 presents extrapolated figures for North Carolina based on estimates from the National Association of PET Container Resources (NAPCOR) presented in Figure 2, including the theoretical recovery North Carolina should be achieving if at the national rate. Note that the tonnage reported in Table 3 corresponds closely to 29,700 tons for PET bottles and containers listed in Figure 1.

Future Generation

Domestic consumption of PET bottle grades grew at rates between nine and 18 percent from 1992 until 1996.[5] (See Figure 4.) This growth is due to PET overtaking market share in some items traditionally packaged in glass or aluminum. Other thermoplastic polyester consumption grew at rates between eight and 39 percent.[6] (See Figure 4.) Although PET bottle manufacturers are attempting to penetrate the beer packaging market, there is some indication that the rapid increase in PET packaging use will slow down. In fact, SPI figures indicate that total sales and captive use of

Figure 4. PET Domestic Consumption by End-Use

	PET Bottle Grades		All Other Grades	
Year	Millions of Pounds	Percent Increase	Millions of Pounds	Percent Increase
1992	1435	N/A	558	N/A
1993	1567	9.2	604	8.2
1994	1854	18.3	839	38.9
1995	2003	8.0	916	9.2
1996	2294	14.5	1032	12.7

Source: SPI Year-End Statistics for 1997, PRODUCTION, SALES & CAPTIVE USE, 1997 vs. 1996, table in Society of the Plastics Industry Web site July 7, 1998. http://www.socplas.org/

Figure 5. Sales and Captive Use

Year	Millions of Pounds	Percent Increase during Previous Year
1992	2441	N/A
1993	2546	4.301516
1994	3154	23.8806
1995	3425	8.592264
1996	3962	15.67883
1997	4063	2.549218

Source: SPI Year-End Statistics for 1997, PRODUCTION, SALES & CAPTIVE USE, 1997 vs. 1996, table in Society of the Plastics Industry Web site July 7, 1998 page 84 for 1992-1996 and Society of the Plastics Industry Web page: http://www.socplas.org/industry/stat3.html for 1997 figure.

Figure 6. PET Generation (tons)[7]

Product Category	Estimated 1996 North Carolina Generation	Assumed Annual Growth Rate	Estimated 2002 North Carolina Generation
Durable goods	9,500	10%	16,800
Non-durable goods*	5,000	10%	8,900
Soft drink bottles and other containers	29,700	10%	52,600
Other plastics packaging**	3,100	10%	5,500
Total Generated PET	**47,300**		**83,800**

Source: EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*

* Includes plastics in disposable diapers, clothing, footwear, etc.

** Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.

thermoplastic polyester increased at a rate of 2.5 percent from 1996 to 1997. (See Figure 5.)

Figure 6 projects the 1996 North Carolina generation figures (from Figure 3) to 2002 using a modest annual increase of 10 percent.

Recovery

National recovery of PET containers increased dramatically through the early 1990s before suffering a decline in 1996. (See Figure 2.) According to RW Beck, national PET bottle recovery in 1996 was estimated to be 320,000 tons (640 million pounds), an increase of 57 percent from 1992.[8] In 1996, RW Beck figures also estimated that 26.7 percent (320,000 tons) of all PET packaging was recycled, including 12.6 percent of custom bottles.[9] NAPCOR estimates the amount of recycled PET produced from recovered bottles, and thus reported a slightly lower figure of 286,000 tons or 26 percent of their estimated sales of PET bottles. (See Figure 2.)

Local government recovery of PET bottles in North Carolina, by far the leading mechanism of PET recovery, enjoyed a similar increase in the same time period (as shown by Figure 7). In keeping with the national trend, however, PET bottle recovery in North Carolina declined in 1996. Recovery of 7,342 tons in fiscal year 1996-97 represented 24 percent of the estimated 30,600 tons of PET bottles and containers generated in North Carolina during 1996 (Figure 8).

Figure 7. North Carolina Local Government Recovery of PET (tons)

	Fiscal Year 1992-93	Fiscal Year 1993-94	Fiscal Year 1994-95	Fiscal Year 1995-96	Fiscal Year 1996-97
PET	4,857	5,308	6,883	9,660	7,342

Source: NC DENR. *NC Solid Waste Management Annual Report, July 1, 1996 to June 30, 1997.* p. 29.

Figure 8. North Carolina Generation and Recovery Estimates for 1996

Estimated Generation	30,600 tons
Recovery	7,342 tons
Recovery Rate	24%

The drop in PET recovered during fiscal year 1996-97 by local governments is explained by two factors. Low market prices for some resins caused some local government programs to scale back or drop their plastics collection efforts. In addition, fiscal year 1996-97 reports included some reporting of commingled materials, which are not reflected in these numbers.

Most PET material recycled is in the form of soda bottles and other food and beverage containers typically recovered through local government programs. Private sector recovery of PET bottles is assumed to be minimal in North Carolina.[10]

MARKET DYNAMICS: PRICES AND CAPACITY

The two major elements of PET market dynamics are prices and capacity. A general discussion of how these two elements affect markets for plastic resins overall can be found in the introductory section to this chapter.

Price History

As with other recyclable commodities, recycled PET demand and pricing is very sensitive to fluctuations in virgin and off-spec markets. These fluctuations in turn are strongly tied to general global economic conditions and to specific overall global supply/demand balances for PET resin. For example, when PET suppliers reacted to the growing world wide demand for PET by installing new virgin production capacity, the resulting oversupply of PET resins led to dramatic declines in PET prices. As a natural economic reaction, PET recovery rates fell.

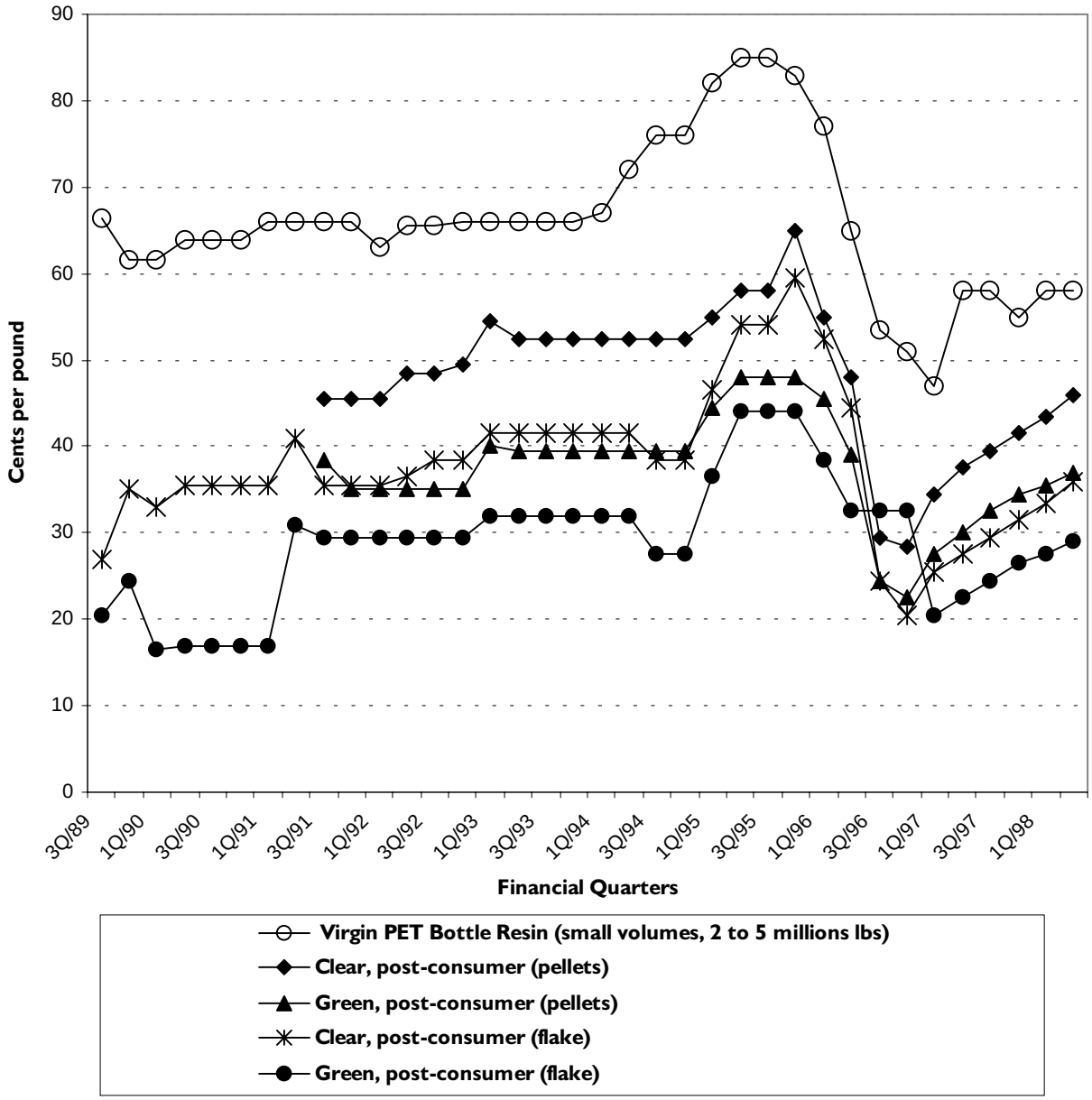
PET markets went from record high prices of $354 per ton in 1995 to historical low prices for baled bottles of between $40 to $80 per ton in December 1996. The cause for the drastic downward price movement in 1996 was "large increases in virgin capacity."[11] A combination of higher price for post-consumer resin (PCR) and availability of relatively cheap virgin resin has had a sobering effect on the willingness of product manufacturers to use recycled PET. In addition to the relatively cheap virgin resin supply, depolymerization proved too expensive a method for processing PCR for food grade use, causing companies such as Coca-Cola and Pepsi to abandon the use of post-consumer resin in their bottles. A new method of processing known as super-cleaning might make PCR viable for use in food contact applications as more processing capacity using this method comes online.[12]

Recovered PET prices rebounded somewhat in 1997 to $118 per ton. The 1997 increases came from strong PET demand and removal of some old, inefficient virgin capacity. Virgin prices began to rise, bringing along recycled prices. With strong polyester carpet sales due to a healthy economy, integrated PET reclaimers and end users had trouble sourcing enough baled PET scrap. In early 1998 prices remained steady or rose slightly.[13] Markets have expanded to meet the huge virgin capacities that came online during the past two years, and the supply/demand balance has tightened. As a result, both virgin and recycled resin prices are increasing about a penny per month.[14]

It will be interesting to see if an increase in recovered PET could begin to cover a greater percentage of future market expansion. Although recovery tonnage has increased recently, the generation of PET waste is growing even faster due to the increase in the PET share of the packaging market. One difficulty is the inelasticity of the recovery rate due to the time required to expand recycling programs. This inability to expand quickly into a growing market for PET resin might cause manufacturers to be wary of depending on recycled resin supply.

Prices for recycled PET will continue to be tied very strongly to the fate of virgin PET. In the coming decades, the PET industry will have to choose among several options for meeting the apparent persistent rise in PET use: by adding virgin capacity, by participating in recovering more discarded PET, or by some combination of the two. Continued low

Figure 9. PET Price History Comparisons



recovery rates for PET may force state and federal governments to add pressure in making that decision.

Figure 9 illustrates the price history of both recycled and virgin PET.[15] As discussed in the introduction to this chapter, recycled resin prices remain below the price for virgin off-spec. Prices were obtained for virgin PET bottle resin and are included as a reference for the recycled grades, which include clear and green post-consumer pellets and clear and green post-consumer flake. Pellets command a higher price because of the additional processing and resulting higher quality (i.e., lower contamination) than found in flake.

Predictions on the future of PET markets are made by industry representatives in plastics industry literature. A few of these remarks are included here to provide a flavor of what the market may hold for recycled PET. The following remarks on PET prices were found in *Plastics News* in January 1998.[16]

> "This year's outlook for recycled resins includes restrained optimism from recyclers of PET. "PET is a function of the economy," Tess said. [Randy Tess is president of Catenation, Inc., in Green Bay, Wisconsin, which recycles PET and high density polyethylene.] "PET prices will increase this year but that depends on the [virgin resin] plants that come on line. One big opening could put us back where we were."

Figure 10. Demand for Recycled PET to 2005 (tons converted from pounds in original)

	1985	1989	1995	2000	2005
Recycled PET demand	50,000	90,000	262,500	450,000	725,000
Percentage growth rate from previous listed year	NA	80%	192%	71%	61%
Overall virgin plastic demand	22,100,000	26,900,000	35,550,000	41,800,000	48,300,000
Recycled PET as a percentage comparison with virgin plastic demand	.22%	.33%	.73%	1.07%	1.5%

Source: http://freedoniagroup.com/ppv-scripts/

Dennis Sabourin, vice president of post-consumer procurement and recycling industry affairs for Wellman Inc. of Shrewsbury, New Jersey, agrees. "PET prices are recovering and should remain firm through 1998," he said.

"Prices today are still as high or higher than they have been historically," said Gary Pratt, president of P&R Environmental Industries, Inc., Youngsville, North Carolina. His firm recycles all post-consumer plastic bottles. He expects PET prices to increase during the first quarter. "You can't compare current prices to an anomaly," he said, referring to the precipitous drop from 1995 to 1996.

When virgin resin is plentiful and prices drop, it puts pricing pressure on recycling firms and companies using post-consumer resin as an alternative.

"The PET recycling rate will drop slightly or remain the same with [as] 1997,"' said Sabourin. "[This year,] the number of pounds of material will increase. About 50 million more pounds will be recycled in 1998."

"Public apathy is still a concern," but Sabourin added, "Sooner or later, something will happen to change the pendulum. It may not be an oil crisis or a garbage barge, but something will get the public's attention."

DEMAND

According to some sources, nominal demand for recycled PET resin is expected to increase dramatically in the future. The Freedonia Group, in a report entitled *Plastic Recycling to 2000*, provides the estimates listed in Figure 10. The figure shows an optimistic view of recycled PET demand into the next century; not only is the raw tonnage estimate of recycled demand rising, it also is rising in relation to overall virgin plastic demand.

Additionally, APC reports wash capacity for PET in the southeast region (defined as Maryland, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida, and Alabama) to be 520 million pounds (260,000 tons).[17]

Recovered PET is used for a variety of end uses including the following: engineered resins, fiber, food and beverage containers, non-food containers, sheet, film, and strapping. Figure 11 presents NAPCOR's estimates of the recycled resin demand in each of these categories in 1995 and 1996. Figure 12 presents growth rate estimates in certain end-uses between 1996 and 1997 as reported in *Modern Plastics*.

Many factors affect the markets and price for recycled plastics, one of which is the capacity of the plastics industry to use recycled resin. When industry representatives express that markets for recycled PET are strong, they are making the important distinction between price and capacity described in the introduction to this section. The capacity exists if the cost of getting the resin to market is less than the price of off-spec resin. The following quotes are from representatives of APC.[19]

"When people tell me there [aren't] markets, they are wrong," said Ron Perkins, APC director of resource management issue analysis. "The problem is that we as a society or an industry have not cost-effectively figured out how to collect it."

A large buyer of PET bottles, Image Industries, Inc., in Summerville, Georgia, has been able to find the raw material supply it needs, although supplies have gotten tighter in the past six months, company officials said.

"Demand continues to outstrip supply in the PET market," said Luke Schmidt, president of NAPCOR in Charlotte, North Carolina "The focus on the PET industry needs to be on collection."

Figure 11. Recycled PET Consumption (tons)[18]

End Use	1996	1997	Percent Change
Engineered resins and molding compounds	12,000	13,000	8
Fiber	146,000	160,000	10
Food and beverage containers	12,000	20,500	71
Non-food containers	35,500	26,500	-25
Sheet and film	34,500	35,500	3
Strapping	33,000	29,500	-11
Other	500	500	0
Domestic Subtotal	273,500	285,500	4
Export	67,000	46,000	-31
Total Consumption	340,500	331,500	-3

Source: Luke B. Schmidt, "PET Recycling: The View from NAPCOR."*Resource Recycling*, v.17 n.2, Feb. 1998, p. 39.

Figure 12. Recovered PET resin end uses (tons)

Reclaimed resin end-use market	Tons in 1997	Change from 1996
Polyester fiber	129,000	-.8%
Food Bottles	12,000	+4.3%
Non-food bottles	32,500	+1.6%
Strapping	27,500	-1.8%
Sheet	30,000	0%
Alloys and compounds	12,500	0%
Export	60,000	0%
Other	1,500	+50%
Total	**302,500**	**-.8%**

Source: "Plastics Use Rises," *Resource Recycling.* v. 17 n. 2. Feb. 1998. p. 11

In terms of domestic recycling capacity, NAPCOR reports that at the beginning of 1998, 18 PET recycling plants were operating in the United States. Five plants were recently closed, three under construction, two expanding, and five were for sale. Altogether, NAPCOR has estimated domestic PET reclamation capacity is slightly more than one billion pounds annually.[20] NAPCOR also reports that "annual PET bottle recycling capacity in the United States is 865 million pounds, a level that exceeds collections by more than 20 percent."[21]

SUPPLY / DEMAND RELATIONSHIPS

Figure 13 attempts to characterize the "marketability" of North Carolina-generated PET by comparing Freedonia's demand projections to the estimated supply of PET in the state. North Carolina's generated PET would obviously be competing with PET generated in other states and countries. The lower the percentage of North Carolina tons to total demand, theoretically the better chance North Carolina tons have of being successfully marketed.

Factors such as proximity to market and resin price must also be considered when characterizing the marketability of North Carolina generated PET. APC estimates of processing capacity in North Carolina in 1998 reflect that regional capacity is strong (Figure 13).

Demand for bottle flake could dramatically increase due to the "Letter of No Objection" from the Food and Drug Administration in January of 1998 for use of post-consumer PET in all types of beverage and food containers.[24] The process, which Philadelphia-based Crown Cork & Seal (the largest blow molder in America) has been developing for more than two years, uses advanced cleaning procedures.

Image Industries, Inc., one of the largest PET recyclers in the United States, is investing $30 million to expand capacity for recycled resin to more than 200 million pounds annually in its Georgia plants. This company has the ability to take post-consumer bottles through processing to the manufacture of new fiber. In addition, the company reclaims fiber from post-industrial waste.[25]

Figure 13. Estimated "Marketability" of PET Recovered in North Carolina

	1996	2002
Estimated North Carolina generated tons (Figure 6)	47,300	83,800
Freedonia demand estimate[22]*	300,000	560,000
North Carolina generated tons as a percentage of projected overall demand	16%	15%
Processing capacity in Southeast[23] (1998)	260,000	N/A
North Carolina generated tons and percentage of processing capacity	18%	N/A

* Numbers from Freedonia interpolated to match years for generated estimates.

CONCLUSION

Although recycled PET prices were very low in 1996, they have since rebounded, reflecting perhaps what plastics trade associations see as more-than-adequate capacity and demand for recycled PET. Due to high capacity, recovered PET prices are not expected to drop due to an increased recovery rate. However, the price is capped by the price of off-spec virgin resin. So, increased recovery will not adversely affect markets. In fact, economies of scale in collection and processing costs could increase the profit margin earned by recycled resin.

Much of the current recovery of PET from the waste stream has occurred through curbside and drop-off programs targeting residential generators. These programs have room for improvement in North Carolina from the 24 percent recovery rate realized in 1996. Additionally, there are other forms of PET that also are recoverable.

The ability of PET markets to handle the current and projected supply of material generated in North Carolina appears to be more than adequate. However, the price paid for recycled PET is based to a large extent on the capacity and price paid for virgin and off-spec PET at any given point in time. For there to be consistent, long-term increases in the recovery of PET resin, a commitment must be made by industry to make the purchase of recycled PET a priority. At the same time, state and local governments, along with private collectors of recycled materials, should make every effort to provide their citizens/customers with incentives and services that maximize the recovery of PET. In addition, governments and individuals need to close the recycling loop by purchasing products made from recycled PET.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for PET in North Carolina presented in this section.

- The plastics industry should continue to provide technical assistance to communities on ways to recover more plastic bottles, including researching ways to reduce collection and processing costs.
- The plastics industry should do more to fulfill growing demand for PET resin from recycled sources rather than virgin, helping to avoid the market situation that occurred in 1995-96. Capacity shifts from virgin to recycled, or at least meeting new PET resin demand with recycled resin, will strengthen and stabilize PET markets and send strong signals to collectors and processors to recover more PET.
- North Carolina's local governments should reinvigorate their efforts to recover PET bottles, including enhancing participation in current collection programs and targeting new areas for collection. Improved education and promotion, plus implementation of Pay-as-You-Throw programs (unit or variable rate pricing), should be important aspects of these efforts. Increased collection can be realized through collection of all plastic bottles and use of plastic compaction on collection vehicles. Increased recovery will decrease the per ton cost of collection of plastics.
- The state also should consider increasing the availability of financial incentives to enhance PET recovery and use, including grant funding for capital purchases that improve collection efficiencies and economic development incentives or technical assistance for PET end-users to use recycled PET.
- If consistent improvement in PET recovery is not achieved by 2002, the state should consider implementing statutory mechanisms such as take-back requirements (e.g., bottle bills), mandated recycled-content targets, and other command-and-control approaches.

[1] Schmidt, Luke B., "PET Recycling: The View from NAPCOR," *Resource Recycling*, v.17, n.2, Feb. 1998, p. 39.
[2] Toloken, Steve, "Supply vs. Demand Stirs Recycling Debate," *Plastics News*, May 25, 1998, p. 13.
[3] The Society of the Plastics Industry (SPI) provides data on apparent consumption of various resins in its *1997 Facts and Figures of the US Plastics Industry.* SPI's estimates would put total bottle/container tonnage for PET in NC at around 27,702 tons annually, which is slightly lower than 29,700 tons, represented in EPA's soft drink and other container categories in Figure 1.
[4] "Plastics Use Rises," *Resource Recycling,* v. 17, n. 2, February 1998, p. 11.
[5] Society of the Plastics Industry, *Facts & Figures of U.S. Plastics Industry*, 1997 edition, p. 85.
[6] Ibid.
[7] The Society of the Plastics Industry (SPI) provides data on apparent consumption of various resins in its *1997 Facts and Figures of the US Plastics Industry.* SPI's estimates would put total bottle/container tonnage for PET for NC at around 27,702 tons annually, which is slightly lower than 29,746 tons, represented in Franklin's soft drink and other container categories in Figure 1.
[8] RW Beck, Inc. as reported in *Resource Recycling*, Feb. 98, p. 19.
[9] Steve Toloken, "News," *Plastics News*, March 2, 1998, p. 24.
[10] "Private recovery" is defined as recovery that takes place outside of any actual public sector collection or collection by private companies through contracts with local governments.
[11] Lucyshyn, J and Craggs, R., "A Five Year History of Recycling Market Prices," *Resource Recycling*, v. 17, n.2, Feb. 1998, p. 20.
[12] Sandi Childs, NAPCOR, personal comunication, October 5, 1998.
[13] Schmidt, Luke B., "PET Recycling: The View from NAPCOR," *Resource Recycling*, v.17 n.2, Feb. 1998, pp. 37-42
[14] Block, Debbie G., "Recycled PS Prices Go Up and Down," *Plastics Technology*, March 1998, p. 65.
[15] http://www.plasticsnews.com/subscriber/rprices.phtml
[16] Smith, Sarah S., "Recyclers Looking Up, Despite Downside," *Plastics News*, January 19, 1998, p. 10.
[17] Judy Dunbar, American Plastics Council, personal communication, July 14, 1998.
[18] Converted to tons from original listed in millions of pounds.
[19] Toloken, Steve, "Supply vs. Demand Stirs Recycling Debate," *Plastics News*, May 25, 1998, p. 13.
[20] Schmidt, Luke B., "PET Recycling: The View from NAPCOR," *Resource Recycling*, Feb. 1998. v. 17 n. 2, pp. 37-42
[21] "Plastics bottle recycling capacity on the rise," *Resource Recycling*, January 1998, p 64.
[22] http://freedoniagroup.com/ppv-scripts/
[23] Judith Dunbar, APC, July 14, 1998 personal communication. Southeast Region is defined as Maryland, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida and Alabama.
[24] "FDA OKs more recycled PET in containers," *Plastics News*, February 23, 1998, p. 3.
[25] Smith, Sarah S., "Recycler Image Spends $30 Million on Growth," *Plastics News,* October 20, 1997, p. 24.

Plastic: HDPE (#2)

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

High density polyethylene (HDPE) is one of a class of plastic resins obtained by polymerizing the gas ethylene. Low density polyethylene (LDPE) and linear low density polyethylene (LLDPE) are discussed in a separate commodity profile. The most familiar consumer item that is made from HDPE is the milk jug. Other common containers made from HDPE are shampoo and other detergent bottles where pigments often are mixed with the polymer. Recently, some dairies have begun using colored HDPE milk jugs as well.

Much of the current recovery of HDPE is through municipal curbside and drop-off collection programs. Many of these programs usually focus on the "natural" form of HDPE, which is translucent, and do not collect colored bottles. There is room for more collection of HDPE and efficiency can be increased through the collection of all plastic bottles and use of plastic compaction on collection vehicles. HDPE prices dipped in 1996, but have not been affected as greatly as PET by burgeoning virgin supply.

SUPPLY

Current Generation

The Environmental Protection Agency (EPA) has estimated the generation of discarded HDPE in the United States. Figure 1 presents generation estimates per product category, along with extrapolated estimates for North Carolina's share of national generation. North Carolina estimates are based on percent of United States population (2.78 percent), and these estimates are rounded to the nearest 100 tons. Because significant differences in generation exist from state to state, the North Carolina estimates should only be considered rough estimates.

The American Plastics Council (APC) generation figures for 1996 are approximately 36 percent higher than EPA's figures. Part of the difference could come from how each organization estimates generation. APC figures come from plastic resins produced, whereas EPA attempts to estimate the amount of materials disposed or recycled at the end of their useful life.

Figure 1. HDPE Generation, 1996 estimates (tons)

Product Category	Estimated United States Generation	Estimated North Carolina Share
Durable Goods	450,000	12,500
Trash Bags	230,000	6,400
All other non-durables*	350,000	9,700
Soft drink bottle base cups	20,000	600
Milk and water bottles	650,000	18,100
Other plastics containers	670,000	18,600
Bags, sacks, and wraps	520,000	14,500
Other plastics packaging**	1,230,000	34,200
Total Generated HDPE	**4,120,000**	**114,600**

* Includes plastics in disposable diapers, clothing, footwear, etc.
** Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.
Source: US EPA, *Characterization of Municipal Solid waste in the United States: 1997 Update*

The most commonly recovered form of HDPE is blow-molded bottles. In addition, some film extruded HDPE grocery bags are recovered. These two items fall under the categories of "soft drink bottle base cups," "milk and water bottles," and "bags, sacks and wraps" in the EPA data and total 33,200 tons generated in North Carolina in 1996. The readily recoverable portion based on EPA's categories are shaded in Figure 1 ("soft drink bottle base caps," "milk and water bottles," "other plastic containers," and "bags, sacks, and wraps") and totaled 51,800 tons in North Carolina in 1996.

Another method of estimating generation of plastic waste is the use of the resin in consumable goods. Figure 2 presents the use of HDPE in various items in 1996. The categories presented in this Society of the Plastics Industry (SPI) data that can be determined as readily recovered are shaded and include "food packaging," "industrial and shipping pails," "food tubs/containers and drink cups," "liquid food bottles," and "household chemical bottles." The total of these categories is 48,800 tons in North Carolina in 1996. This number is slightly lower than the estimate using EPA's data, because the film category identified a more specific and smaller fraction of the total film produced to be recoverable.

HDPE is made into products using five major manufacturing methods: blow-molding, injection molding, blown film/cast film, profile extrusion (pipe and conduit), and rotomolding. These methods are described below and Figure 2 presents their impact on manufacturing in 1996.

- Thirty-five percent (1,960,500 tons) of HDPE used in 1996 was blow-molded into bottles, drums and other containers. Blow molding uses compressed air to conform a molten tube of plastic to the inner layer of a cooled mold. SPI figures show 1996 HDPE demand for liquid food bottles to be 641,000, or nine percent of all HDPE consumed in 1996. Household chemical bottles consumed another 497,500, or eight percent of all HDPE.

- Manufacturers used 19 percent (1,056,000 tons) of HDPE to injection mold a variety of items including industrial and shipping pails, housewares, crates and totes, toys, novelties, sporting goods, caps and closures, food tubs/containers, and drink cups. In injection molding, plastic is heated into the liquid state and then injected into a cool mold. In 1996, injection molded food tubs/containers and drink cups demanded 137,500 tons, or three percent of HDPE consumed.

- Sixteen percent (907,000 tons) of HDPE used in 1996 was made into film for use in food packaging, bags, and other uses. This film is produced in the form of a tube by blowing air through plastic extruded from a circular die.

- Seven percent (417,000 tons) of HDPE used in 1996 was extruded into pipe and conduit by pressing molten plastic through a circular die using a continuously revolving screw.

- Manufacturers used one percent (63,500 tons) of HDPE in 1996 to rotomold medium to large size hollow parts, containers, tanks and other items with relatively uniform wall thicknesses. Rotomolding is a process in which a mold filled with powdered plastic is heated while rotating simultaneously about two axes perpendicular to each other. After the plastic coats the inside mold surface, the mold is cooled and the part removed.

Figure 2. End-Use Manufacturing of HDPE in 1996 (Tons)

End Use	United States	North Carolina
Film	907,000	25,200
Food packaging	85,000	2,400
All other	822,000	22,900
Injection Molding	1,056,000	29,400
Industrial and shipping pails	395,000	11,000
Housewares	65,000	1,800
Crates and totes (incl. beverage cases)	144,000	4,000
Toys, novelties, sporting goods	43,000	1,200
Caps and closures	54,000	1,500
Food tubs/containers and drink cups	137,500	3,800
All other	217,500	6,000
Blow Molding	1,960,500	54,500
Liquid food bottles	641,000	17,800
Household chemical bottles	497,500	13,800
Industrial drums	133,500	3,700
Pharmaceuticals, cosmetics & toiletries	145,500	4,000
All other	543,000	15,100
Rotomolding	63,500	1,800
Pipe and Conduit	417,000	11,600
Corrugated	56,000	1,600
Gas distribution	95,000	2,600
All other	266,000	7,400
All Other HDPE	1,232,500	34,300
Total HDPE	**5,636,500**	**156,800**

Source: Society of the Plastics Industry, "Selected End-Use,"*Facts and Figures of the U.S. Plastics Industry*, p. 69. Data are converted to tons from millions of pounds in the original. Numbers in subcategory might not add to number in tota category due to rounding.

According to research findings published in *Modern Plastics*, over 1.2 billion pounds of HDPE (representing a 0.1 percent decrease since 1996) was used in liquid food bottles (primarily milk jugs). Another 1.05 billion pounds of HDPE (representing a 5.4 percent increase since 1996) was used in chemical bottles (primarily household products) in 1997.[1]

Future Generation

HDPE has not seen the same dramatic growth in packaging market share as PET. Future generation of HDPE waste can be estimated by the projected future use of HDPE (both virgin and recycled) in non-durable goods. SPI data provide growth rates for liquid food bottles (between –0.9 and 8.6 percent), household chemical bottles (between –3.6 and 8 percent) and extruded film (between 2.7 and 20.7 percent). These figures are presented in Figure 3.

SPI figures indicate total sales and captive use of HDPE (both virgin and recycled) increased at rates between –0.6 and 12.3 percent annually from 1992-1997. (See Figure 4.)

Figure 5 presents estimates of North Carolina's share of plastics generated through 2002 using EPA's 1996 numbers and a 4 percent annual growth rate. This growth rate was based on the average growth in liquid food bottle use and the highly variable extruded film use of HDPE. The most readily recoverable components of the HDPE waste stream (shaded in Figure 5 and including "soft drink bottle base cups," "milk and water bottles," "other plastic containers," and "bags, sacks, and wraps") total a generation of 51,800 tons in 1996 and estimated generation of 65,500 tons in 2002.

Recovery

According to RW Beck, national recovery of HDPE was 330,000 tons, or 660 million pounds, and HDPE recovery increased by 62 percent between 1992 and 1996.[2] Using RW Beck's national numbers, a population based es-

Figure 3. HDPE Growth by End Use (virgin and recycled)

	Liquid Food Bottles		Household Chemical Bottles		Extruded Film	
Year	(Millions of pounds)	Percent increase over previous year	(Millions of pounds)	Percent increase over previous year	(Millions of pounds)	Percent increase over previous year
1992	1048		915		1089	
1993	1113	6.2	901	-1.5	1292	18.6
1994	1191	7.0	955	6.0	1560	20.7
1995	1180	-0.9	921	-3.6	1602	2.7
1996	1282	8.6	995	8.0	1814	13.2

Source: Society of the Plastics Industry, "Selected End-Use," *Facts and Figures of the U.S. Plastics Industry*, p. 69.

Figure 4. Sales and Captive Use

Year	Millions of pounds	Percent increase over previous year
1992	10110	
1993	10604	4.9
1994	11910	12.3
1995	11837	-0.6
1996	13211	11.6
1997	13482	2.1

Source: Society of the Plastics Industry, "Selected End-Use," *Facts and Figures of the U.S. Plastics Industry*, p. 69 for 1992-1996 and Society of the Plastics Industry web page for 1997 figure: http://www.socplas.org/industry/stat3.html.

Figure 5. HDPE Generation in North Carolina (Tons)

Product Category	North Carolina generation 1996	North Carolina generation 2002
Durable goods	12,500	15,800
Trash bags	6,400	8,100
All other non-durables*	9,700	12,300
Soft drink bottle base cups	600	800
Milk and water bottles	18,100	22,900
Other plastics containers	18,600	23,500
Bags, sacks, and wraps	14,500	18,300
Other plastics packaging**	34,200	43,300
Total Generated HDPE	**114,600**	**145,000**

* Includes plastics in disposable diapers, clothing, footwear, etc.

** Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.

Source: US EPA, *Characterization of Municipal Solid waste in the United States: 1997 Update*

timate of recovery in North Carolina is 9,200 tons. According to APC, 24.4 percent of all HDPE bottles were recycled in 1996.[3]

A majority of HDPE recycled in North Carolina is collected in local government programs. Figure 6 presents the tonnages of HDPE recovered by these programs since 1992-93. The materials recovered are typically milk jugs and other household HDPE bottles. The drop in HDPE recovered in fiscal year 96-97 by local governments is explained by two factors. Low market prices for some resins has caused some local government programs to scale back or drop their plastics collection efforts. In addition, fiscal year 96-97 data included some reporting of commingled recyclables, which are not reflected in these numbers. The 1996-97 recovery was probably closer to 6,000 tons.

North Carolina local governments recovered about two-thirds of the national average for recovery based on its population according to the RW Beck figure presented above. At 6,000 tons, the recovery rate for these materials was 32 percent of the North Carolina generation of "soft drink bottle base cups" and "milk and water bottles" based on EPA data, or 12 percent of the North Carolina generation of "readily recoverable" items identified in Figure 1.

Figure 6. North Carolina Local Government Recovery of HDPE (Tons)

	FY 1992-93	FY 1993-94	FY 1994-95	FY 1995-96	FY 1996-97
HDPE	3,501	4,118	5,390	6,046	4,240

Source: NC DENR, *NC Solid Waste Management Annual Report: July 1, 1996 to June 30, 1997.*

Figure 7. North Carolina Estimate of Generation and Recovery Rate for HDPE Bottles in 1996

	Liquid Food Bottles	Recoverable Packaging
Estimate of Generation	37300* tons	51,800** tons
Recovery (public and private)	9000 tons	9000 tons
Recovery Rate	24 %	17 %

*Calculated from EPA data based on North Carolina population

**Calculated from EPA data based on North Carolina population. Recoverable packaging defined as ("soft drink bottle base cups," "milkand water bottles," "other plastic containers," "bags, sacks, and wraps," and "other plastics packaging").

Eight private recyclers reported recovery of roughly 3,000 tons of HDPE from North Carolina's waste stream. This recovery includes film as well as bottles. Adding this to the local government recovery yields roughly 9,000 tons of HDPE recovered, or 17 percent of the 51,708 recoverable tons identified from EPA data (see Figure 7).

MARKET DYNAMICS: PRICES AND CAPACITY

The two major components of market dynamics are prices and capacity. The relationship of these two factors to market dynamics for plastics overall is described in the introductory section to this chapter.

Prices

As with other plastic resins, the price paid for recycled HDPE resin usually remains below the price for competing virgin, pre-consumer, and off-spec resin. This price differential creates a barrier for post-consumer resins, because many purchasers would rather buy off-spec (which they perceive to be higher quality) than post-consumer when prices are similar.[4]

As with PET, recycled HDPE prices correlate strongly to virgin resin prices. Downward trends in late 1997 reflected switchovers to off-spec virgin from recycled by some major end-users. Figures 8, 9, and 10 present the price histories for virgin and recycled resins for common recycled products (milk jugs, detergent bottles, and plastic grocery bags).

Figure 8 compares the price of virgin HDPE used to make milk bottles to recovered natural HDPE pellet and flake.

Figure 9 compares the price of blow molding copolymer commonly used in shampoo and detergent bottles to recovered mixed color HDPE pellet and flake.

Figure 10 compares the price history for virgin high molecular weight (HMW) extrusion film to post consumer HMW-HDPE film pellets.

DEMAND

According to some sources, demand for recycled HDPE resin is expected to increase substantially in the future. The Freedonia Group, in a report entitled *Plastic Recycling to 2000*, provides the nationwide estimates listed in Figure 11. The figure shows an optimistic view of recycled HDPE demand into the next century: not only is the raw tonnage estimate of recycled demand rising, it is also rising in relation to overall virgin plastic demand.

Market end uses for HDPE increased from 1996 to 1997 as represented in Figure 12.

While some smaller recycling companies are going out of business, large recycling companies are expanding during the soft market in order to increase market share in anticipation of projected stronger markets to come.[6] This is the case for KW plastics of Troy, Alabama. "HDPE reclaimers already possess a high level of excess capacity, and more capacity is expected. KW Plastics plans to be one of the world's largest reclaimers of plastic bottles. The firm is expanding its HDPE bottle processing capacity to 650 million pounds per year and adding 50 workers. Alone, KW plastics could handle more than 80 percent of the current recovery volume."[7] KW recycles equal amounts of natural and mixed-color post-consumer HDPE. About 70 percent of its pellets are sold to the blow molding industry. Other end markets include curbside collection carts, T-shirt bags, strapping and hangers for plastic bags.[8]

By the end of 1998, Earth Care Inc. of Tennessee, will have the capacity to produce 500,000 railroad ties per year, using 100 million pounds of post-consumer and post-industrial high density polyethylene.[9]

Figure 8. HDPE Price Histories (Homopolymer & Recycled Natural)

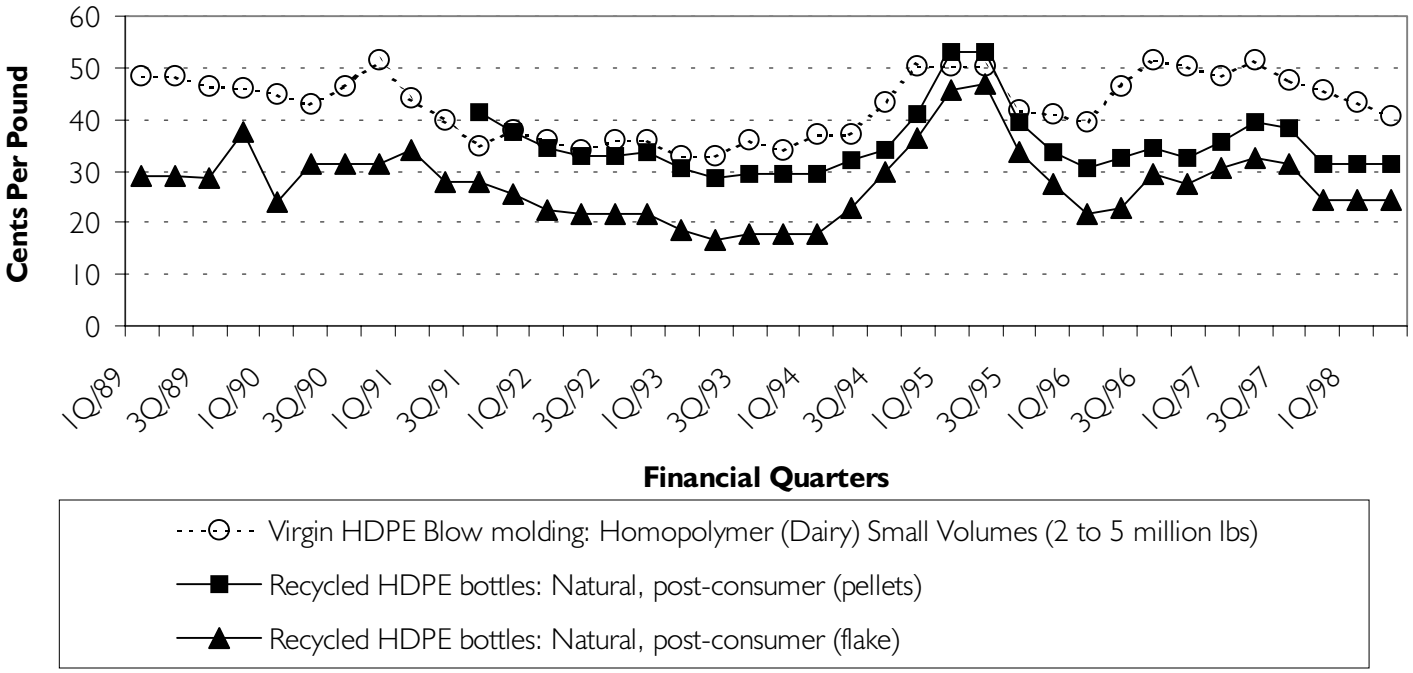
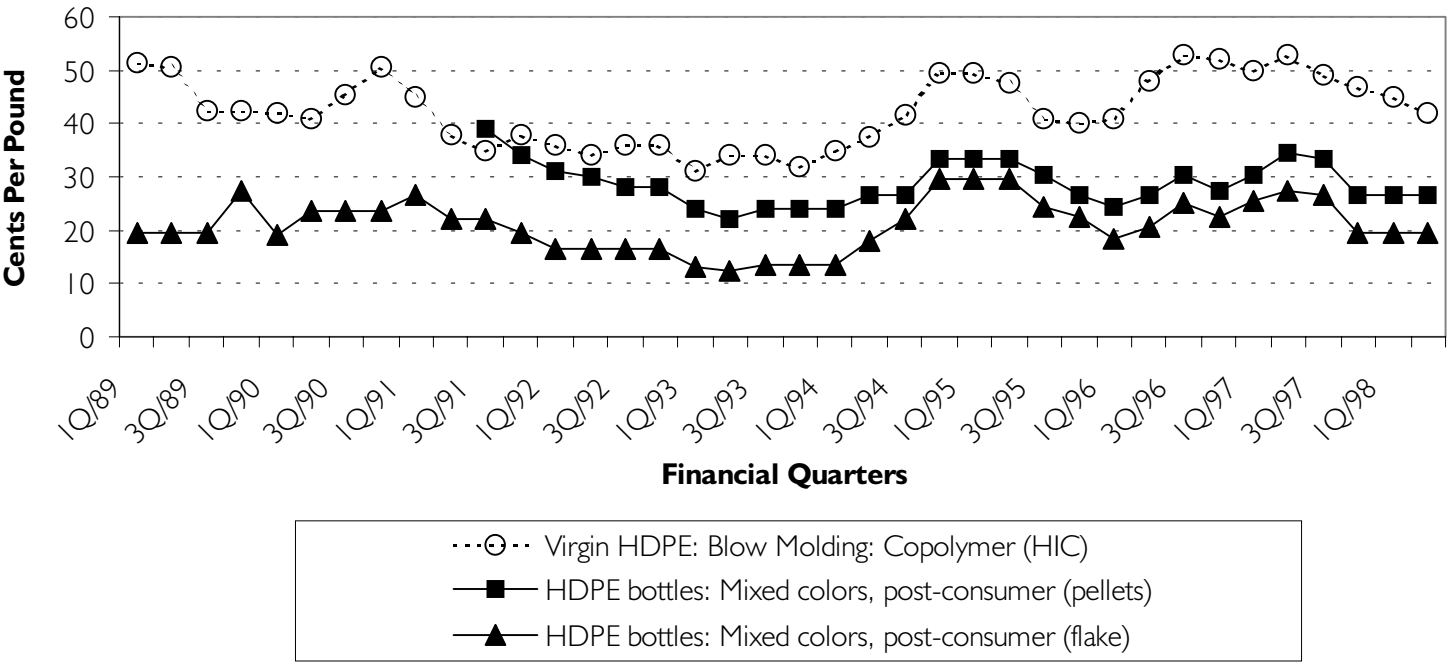


Figure 9. HDPE Price Histories (Virgin Copolymer& Recycled Mixed Colors)



SUPPLY / DEMAND RELATIONSHIP

Figure 13 attempts to characterize the "marketability" of North Carolina generated HDPE by comparing Freedonia's nationwide demand projections to the estimates of HDPE supply in the state. North Carolina's generated HDPE would obviously be competing with generated HDPE from other states and countries. The lower the percentage of North Carolina tons to total demand, theoretically the better chance North Carolina tons have of being successfully marketed. Factors such as proximity to market and resin price must also be considered when characterizing the marketability of North Carolina generated HDPE.

Figure 10. HMW Price Histories (Virgin & Recycled)

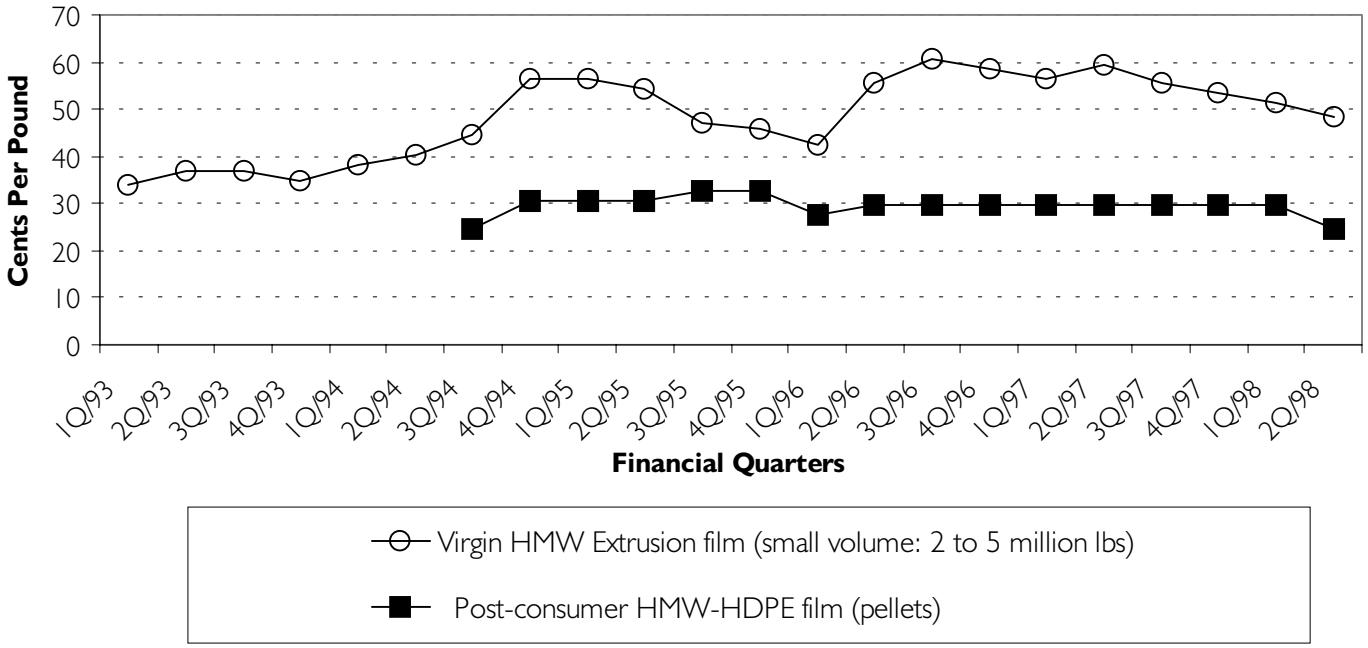


Figure 11. Demand for Recycled HDPE to 2005 (tons converted from lbs. in original)[5]

	1985	1989	1995	2000	2005
Recycled HDPE demand	22,500	62,500	300,000	475,000	730,000
Percentage growth rate from previous listed year	NA	177%	380%	58%	54%
Overall virgin plastic demand	22,100,000	26,900,000	35,550,000	41,800,000	48,300,000
Recycled HDPE as a percentage comparison with virgin plastic demand	.10%	.23%	.84%	1.13%	1.5%

Figure 12. Recovered Resin End Uses (tons)

Reclaimed resin end-use market	Reclaimed resin end-use market capacity 1997	Change from 1996
Recycled bottles	102,500	-4.7%
Drainage pipe	52,500	-4.5%
Film	61,000	+8.9%
Pallets	49,000	+30.7%
Plastic lumber	37,000	+5.7%
Export	13,500	-22.9%
Other	44,500	+1.1%
Total	**360,000**	**+2.1%**

Source: "Plastics Use Rises," *Resource Recycling,* v. 17, n.2, Feb. 1998, p. 11. (converted to tons)

Specific processing capacity in the Southeast region (defined as Maryland, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida, and Alabama) provided by APC is presented in Figure 14.[10]

HDPE Film

About 70 percent of all plastic grocery sacks are HDPE; the remaining 30 percent are an equal mixture of LDPE and LLDPE. These HDPE bags are largely sought after by plas-

Figure 13. Future Marketability of North Carolina HDPE

	1996	2002
Estimated North Carolina generated tons*	51,560	65,800
Freedonia demand estimate**	335,000	577,000
North Carolina generated tons as a percentage of projected overall demand	15%	11%

*Estimated generation from "recoverables" in Figure 5.

** Numbers for Freedonia interpolated to match years for generated estimates.

Figure 14. Processing Capacity for HDPE in Southeast Region

	Tons
Wash Capacity	240,000
Dry Reclaim Capacity	50,000
Total Resin Capacity	290,000

tic lumber and wood/plastic composite lumber manufacturers. Ron Perkins of APC speaks about the tight market for this material in a recent *Plastics News* article: "Plastic lumber maker Trex Co. in Winchester, Virginia, is having problems finding supply, and paper and wood firm Boise Cascade Corp. of Boise, Idaho, is evaluating whether it economically can collect the 10 million pounds of film a month it needs in the Pacific Northwest to recycle into a wood-polymer composite siding."[11]

Mike Vatuna, purchaser for Trex (a plastic lumber manufacturer), says that their use of polyethylene film increased from 3.25 million pounds per month in January of 1997 to 6.5 million pounds per month in June of 1998.[12] In 1996 Trex bought 51 percent of all grocery bags collected nationwide. Mr. Vatuna also indicates that export markets are strong for this material. According to Vatuna, prices are rising due to low collection rates and the fact that virgin polyethylene resin price is currently up. The strongest collection programs are in the Northeast, so that is where most of Trex's material is sourced. Trex also consumes about 20 percent of the stretch film recycled in the United States. The other component in their product is waste wood, mostly from furniture makers.[13]

As reported in *Plastics News*, another southeastern manufacturer, Mid South Extrusion Inc. of Monroe, Louisiana, is "expanding both its capacity and its market reach for film while centralizing its new recycling operations. Film capacity of 26 million pounds will expand to 40 million pounds of high, low and linear low density polyethylene annually."[14]

CONCLUSION

Due to more-than-adequate capacity for processing and end use of HDPE resin, recovered HDPE prices are not likely to drop with increased collection of this resin. Increase in recovery will most likely be accompanied by lower per ton collection and processing costs, thus increasing the profit on recycling this material.

There is room for growth in the collection and recycling of blow-molded bottles and film extruded bags already collected in North Carolina. In addition, there are other identifiable and separable HDPE products that should be considered for collection and recycling. These include injection molded industrial and shipping containers (11,000 tons per year in 1996 in North Carolina) and food tubs per containers and drink cups (3,800 tons per year in 1996 in North Carolina) as identified in Figure 2.

The ability of HDPE markets to handle the current and projected supply of material generated in North Carolina appears to be more than adequate. However, the price paid for recycled HDPE is based to a large extent on the capacity and price paid for virgin HDPE at any given point. For there to be consistent, long-term increases in the recovery of HDPE resin, a commitment must be made by industry to make the purchase of recycled HDPE a priority. At the same time, state and local governments, along with private collectors of recycled materials, should make every effort to provide their citizens/customers with incentives and services that maximize the recovery of HDPE. In addition, governments and individuals need to close the recycling loop by purchasing products made from recycled HDPE.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for HDPE in North Carolina presented in this section.

- The plastics industry should continue to provide technical assistance to communities on ways to recover more plastic bottles, including researching ways to reduce collection and processing costs.
- The plastics industry should do more to fulfill growing demand for HDPE resin from recycled sources rather than virgin, helping to avoid the market situation that occurred in 1995-96. Capacity shifts from virgin to recycled, or at least meeting new HDPE resin demand with recycled resin, will strengthen and stabilize HDPE markets and send strong signals to collectors and processors to recover more HDPE.
- North Carolina's local governments should reinvigorate their efforts to recover HDPE bottles, including enhancing participation in current collection programs and targeting new areas for collection. Improved education and promotion, plus implementation of Pay-as-You-Throw programs (unit or variable rate pricing), should be important aspects of these efforts. Increased recovery can be realized through collection of all plastic bottles and use of plastic compaction on collection vehicles, and improved recovery can decrease the per ton cost of collection of plastics.
- The state should also consider increasing the availability of financial incentives to enhance HDPE recovery and use, including grant funding for capital purchases that improve collection efficiencies and economic development incentives or technical assistance for HDPE end-users to use recycled HDPE.
- If consistent improvement in HDPE recovery is not achieved by 2002, the state should consider implementing statutory mechanisms such as take-back requirements (e.g., bottle bills), mandated recycled-content targets, and other command-and-control approaches.

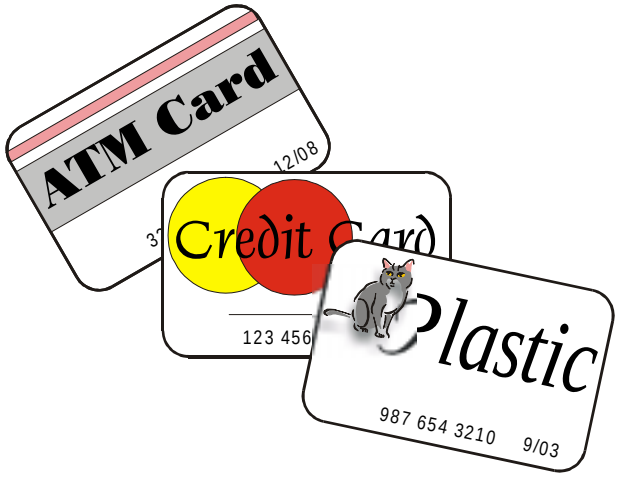
[1] "Plastics use rises" Resource Recycling, Feb 1998, p. 11.
[2] Lucyshyn, J. and Craggs, R. "A five year history of recycling market prices: 1997 update", *Resource Recycling*, Feb. 98, p. 19.
[3] Society of the Plastics Industry, *Facts & Figures of the U.S. Plastics Industry, 1997 Edition*, page 91.
[4] Smith, Sarah S., "Recyclers Looking Up, Despite Downside" Plastics News, January 19, 1998, p10.
[5] http://freedoniagroup.com/ppv-scripts/
[6] Smith, Sarah S., "Recyclers Looking Up, Despite Downside" Plastics News, January 19, 1998, p10.
[7] "Plastics bottle recycling capacity on the rise," Resource Recycling, January 1998, p 64.
[8] Smith, Sarah S., "PE Recycler Expanding", Plastics News, November, 17, 1997.
[9] Smith, Sarah S., "Recyclers Looking Up, Despite Downside" Plastics News, January 19, 1998, p10.
[10] Dunbar, Judy, American Plastic council, personal communication, July 14, 1998.
[11] Toloken, Steve "Supply vs. Demand Stirs Recycling Debate", Plastics News, May 25, 1998, p. 13.
[12] Mike Vituna, Trex, personal communication June 11, 1998.
[13] Urey, Craig "Plastic Stacks up Admirers as Alternative Deck Material" Plastics News June 15, 1998, p.1.
[14] Urey, Craig, "Mid South Extrusion Expanding, Plastics News, November 3, 1997, p. 3.

Plastic: PVC (#3)

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

Polyvinyl chloride (PVC) is used for many industrial, commercial, and household applications. Construction applications include flooring, siding, pipe, wire, and cable. Other applications include appliances, apparel, toys, credit cards, medical supplies, and automotive parts. PVC is also used in films for food wrap and in bottles.

SUPPLY

Current Generation

The Environmental Protection Agency (EPA) has estimated the generation of discarded PVC in municipal and commercial waste streams. Figure 1 presents EPA's generation estimates per product category, along with extrapolated estimates for North Carolina's share of national generation (based on North Carolina's share of the United States population being 2.78 percent). Because significant differences in generation exist from state-to-state, the North Carolina estimates should only be considered to be rough estimates.

Packaging categories from EPA include data that address "other plastic containers," "bags, sacks, and wraps," and "other plastics packaging." Generation estimates for these categories in North Carolina total 10,100 tons.

The American Plastics Council (APC) figures for 1996 indicate the packaging market in the United States comprised 850 million pounds (425,000 tons) of PVC. North Carolina's population based share of the PVC packaging market is 11,800 tons. The APC packaging estimate is slightly higher than EPA's estimate.

Attempting to estimate the generation of PVC in the waste stream based on sales is difficult, because so much PVC is manufactured into durable/semi-permanent items such as vinyl siding and pipes. According to the Vinyl Institute, national sales of PVC as product in 1996 was at 13.3 billion lbs. (6.65 million tons).[1] Of those sales, the North Carolina share prorated at the state's share of population would be 369,740,000 pounds, or 184,870 tons.

Figure 1. PVC Generation in 1996 (tons)

Product Category	Estimated United States Generation	Estimated North Carolina Share
Durable goods	370,000	10,300
Non-durables*	500,000	13,900
Other plastics containers	70,000	2,000
Bags, sacks, and wraps	60,000	1,700
Other plastics packaging**	230,000	6,400
Total Generated PVC	**1,230,000**	**34,300**

*Includes plastics in disposable diapers, clothing, footwear, etc.

** Other plastics packaging includes coatings, closures, caps, trays, shapes, etc.

Figure 2. End-Use Manufacturing of PVC in 1996

	United States (Tons)	North Carolina Share (Tons)
Calendaring	**600,500**	**16,700**
Flooring	114,500	3,200
Textile	39,500	1,100
All other calendering	446,500	12,400
Coating	**209,000**	**5,800**
Flooring	112,500	3,100
Textile & paper coating	54,500	1,500
Protective coatings	30,500	800
Adhesives & all other coatings	11,500	300
Extrusion	**4,002,000**	**111,300**
Wire & cable	223,500	6,200
Film & sheet	173,500	4,800
Rigid pipe and tubing	2,236,500	62,200
Siding	873,500	24,300
All other extrusions (including windows & doors)	495,000	13,800
Molding	**272,000**	**7,600**
Bottles	75,000	2,100
Fittings	141,000	3,900
All other molding	56,000	1,600
Paste Processes	**104,500**	**2,900**
Plastisol formulation	61,500	1,700
All other paste processes	43,000	1,200
Resellers and Compounders	**288,500**	**8,000**
All other uses	**81,000**	**2,300**
Total	**5,557,500**	**154,500**

Source: Society of the Plastics Industry, "Selected End-Use,"*Facts and Figures of the U.S. Plastics Industry*, p. 83. Data are converted to tons from millions of pounds in the original. Numbers in subcategory might not add to number in total category due to rounding.

Figures from the Society of the Plastics Industry (SPI) on domestic consumption of PVC by end-use are found in Figure 2. One durable PVC product worth noting is extrusion siding. Unlike consumable items that will end up in the waste stream, only a certain fraction of material produced will end up as waste. Vinyl siding from construction (including mobile home construction) is beginning to be recovered in North Carolina and the recovery could increase significantly in coming years.

Future Generation

Future generation often can be predicted by looking at the growth in manufacturing use of PVC. PVC's use in non-durables including bottles has been decreasing while its use in some durable items, such as vinyl siding, has been increasing. This is evidenced by SPI data in Figure 3.

Figure 3. PVC Growth by End-Use (virgin and recycled)

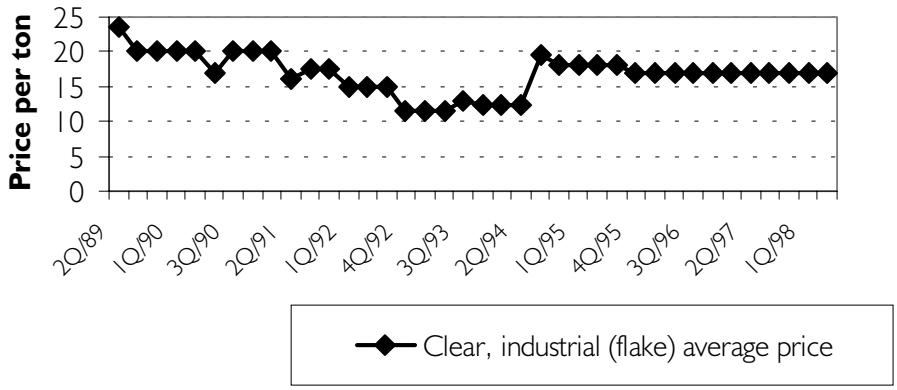
Year	Siding		Bottles	
	millions of pounds	percent increase	millions of pounds	percent increase
1992	971		191	
1993	1180	21.5	178	-6.8
1994	1471	24.7	190	6.7
1995	1440	-2.1	171	-10.0
1996	1747	21.3	150	-12.3

Source: Society of the Plastics Industry, "Domestic Consumption by End-Use," *Facts and Figures of the U.S. Plastics Industry*, p. 83. Data are converted to tons from millions of pounds in the original.

Figure 4. PVC Future Generation (tons)

Estimated 1996 North Carolina Generation	Assumed Annual Growth Rate	Estimated 2002 North Carolina Generation
34,300	5.6%[3]	47,600

Figure 5. PVC Price History



Modern Plastics reports the growth in use of PVC in specific end-use markets. Growth in siding markets from 1996 to 1997 was 6.3 percent while PVC use in bottles decreased by one percent in the same period. SPI reports a growth of 5.6 percent in overall PVC sales and captive use between 1996 and 1997.[2] Figure 4 projects the 1996 generation figures of PVC packaging to 2002, based on the estimated North Carolina share from Figure 1.

Recovery

APC reported a recycling rate of 0.9 percent for PVC packaging and two percent for PVC bottles in 1996.[4] EPA reports only negligible recovery of PVC in "durable goods," "other plastic containers," and "other plastics packaging" and no recovery in other categories.

A survey of private sector recyclers of PVC yielded little data, but did document recovery of 1,648 tons by two major PVC processors in state. About 500 million pounds of post-industrial vinyl are recovered nationally each year.[5]

MARKET DYNAMICS: PRICES AND CAPACITY

The two major components of market dynamics are prices and capacity. The relationship of these two factors to market dynamics for plastics overall is described in the introductory section to this chapter.

Prices

Prices for recovered PVC have remained steady and should continue to do so through 1998.[6] Figure 5 illustrates the steadiness in the price paid for recovered PVC since 1995.

DEMAND

According to some sources, demand for recycled PVC resin is expected to increase substantially in the future but remain at relatively low levels compared to other resins and to generated supply. The Freedonia Group, in a report entitled *Plastic Recycling to 2000*, provides the estimates listed in Figure 6.

Figure 6. Demand for Recycled PVC to 2005 (tons converted from lbs. in original)[7]

	1985	1989	1995	2000	2005
Recycled PVC demand	NA	1,500	5,500	12,500	25,000
Percentage growth rate from previous listed year	NA	NA	266%	127%	100%
Overall virgin plastic demand	22,100,000	26,900,000	35,550,000	41,800,000	48,300,000
Recycled PVC as a percentage comparison with virgin plastic demand	NA	.006%	.016%	.03%	.05%

Figure 7. North Carolina-Generated PVC as a Portion of Overall Recycled PVC Demand (tons)

	1996	2002
Estimated North Carolina generated tons	34,300	47,600
Freedonia demand estimate*	6,900	17,500
North Carolina generated tons as a percentage of projected overall demand	497%	272%

*Numbers for Freedonia interpolated to match years for generated estimates.

Other sources document a dismal overall picture of current recycled PVC market demand. A number of factors combined to cut consumption of PVC bottle scrap substantially by the end of 1996.[8] Markets for PVC bottle scrap in particular appear to be practically non-existent. This is not surprising, because PVC bottles make up only three percent of the bottle market but pose a significant problem for PET bottle recycling.[9] As little as five to 10 parts per million of PVC is enough to contaminate a load of PET.[10] PVC bottle recyclers likewise consider PET bottles to be contaminants to their material. Because of the much greater amount of PET bottles recovered, materials recovery facilities focus on keeping PVC out of the PET, not recovering the PVC.

Vinyl siding is at least one bright spot for generated PVC in North Carolina. The state has a number of processors who have aggressively moved to recover PVC from manufactured home industrial facilities and to capture "job site" scrap through public and private drop-off sites.

Figure 7 attempts to characterize the "marketability" of North Carolina generated PVC by comparing Freedonia's demand projections to the estimated supply of PVC in the state. North Carolina's generated PVC would obviously be competing with generated PVC from other states and countries. The lower the percentage of North Carolina tons to total demand, theoretically the better chance North Carolina tons have of being successfully marketed. Factors such as proximity to market and resin price must also be considered when characterizing the marketability of North Carolina generated PVC.

Unlike the bottle grade resins (PET and HDPE), a low recovery rate can be expected for PVC. The estimates of marketability in this chapter have been based on the amount of each resin the waste stream. The true volume of recovered resin will be much less than what is estimated in Figure 7.

CONCLUSION

Because PVC is not common in packaging, efforts to reduce its prevalence in the waste stream must focus elsewhere. The most readily identifiable product to concentrate on is vinyl siding. North Carolina is currently increasing programs to address vinyl siding waste and should continue to pay attention to this waste stream.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for PVC in North Carolina presented in this section.

- The PVC industry should increase efforts to build market capacity and demand for recycled PVC resin. At one of the lowest recovery rates of all com-

mon resins, the PVC recycling infrastructure must be encouraged to mature.

- The state should provide incentives and market development assistance to companies interested in recycling PVC. Manufacturers of products from PVC would welcome the increased availability of high-quality cost-competitive post-consumer PVC for use in manufacturing their products.
- With PVC bottles a major contaminant of recovered PET bottles, the state should consider actions to discourage the use of PVC for bottle stock sold in the state.
- Interested parties (including the state, local governments, generators, processors, and end users) should work to maximize the recovery of vinyl siding to take advantage of apparent strong markets for the material and a growing infrastructure.

[1] "The Vinyl Production Process," Vinyl Institute web page: http://www.vinylinfo.org/wanttoknow.html
[2] Society of the Plastics Industry web page: http://www.socplas.org/industry/stat3.html
[3] Ibid.
[4] Toloken, Steve, *Plastics News*, March 2, 1998, p. 24.
[5] Toloken, Steve, *Plastics News*, April 20, 1998, p. 4.
[6] Smith, Sarah "Recyclers looking up, despite downside," *Plastics News*, January 19, 1998, p. 10.
[7] http://freedoniagroup.com/ppv-scripts/
[8] "Plastic Recycling's Problem Children," *Resource Recycling*, October, 1997, pp. 32 – 37.
[9] Toloken, Steve, *Plastics News*, March 2, 1998, p. 24.
[10] Toloken, Steve, *Plastics News*, April 20, 1998, p. 4.

Plastic: L/LDPE (#4)

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

Low density polyethylene (LDPE) and linear low density polyethylene (L/LDPE) are two of a class of plastic resins obtained by polymerizing the gas ethylene. LDPE is most often used in packaging where clarity is important. L/LDPE retains its strength at low temperatures and is used for products like ice bags.

Unlike bottle resins, most LDPE and L/LDPE is recovered from commercial and industrial facilities. The products commonly recovered include plastic grocery bags and shrink wrap and stretch wrap from commercial and industrial shipping.

Many discussions of LDPE and L/LDPE group the two together. In this section, LDPE and L/LDPE are discussed separately in some parts. Where they are discussed as an aggregate they are referred to as "L/LDPE."

SUPPLY

Current Generation

The Environmental Protection Agency (EPA) has estimated the generation of discarded L/LDPE in the United States. Figure 1 presents EPA's generation estimates per product category, along with extrapolated estimates for North Carolina's share of national generation. North Carolina estimates are based on North Carolina's share of United States population being 2.78 percent, and these estimates are rounded to the nearest 100 tons. Because significant differences in generation exist from state-to-state, the North Carolina estimates should only be considered to be rough estimates.

Figures from the American Plastics Council (APC) for 1996 indicate the packaging market comprised 5.1 billion pounds (2.55 million tons) of L/LDPE.[1] Adding the shaded packaging related categories from EPA's generation estimates

Figure 1: L/LDPE Generation, 1996 Estimates (tons)

Product Category	Estimated United States Generation	Estimated North Carolina Share
Durable goods	540,000	15,000
Plastic plates and cups	20,000	600
Trash bags	630,000	17,500
Other non-durables*	1,340,000	37,300
Other plastics containers	30,000	800
Bags, sacks, and wraps	2,150,000	59,800
Other plastics packaging**	300,000	8,300
Total Generated L/LDPE	**5,010,000**	**139,300**

* Includes plastics in disposable diapers, clothing, footwear, etc.

** Other plastics packaging includes coatings, closures, caps, trays, shapes, etc.

Source: EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*

Figure 2: End-Use Manufacturing of LDPE in 1996 (tons)

End-Use	United States Generation	North Carolina Share
PACKAGING FILM	**1,189,000**	**33,100**
Food Packaging	***546,500***	***15,200***
Produce	32,000	900
Bakery	89,000	2,500
All other food Packaging	425,500	11,800
Non-Food Packaging	***457,500***	***12,700***
Industrial liners	98,500	2,700
Shipping sacks	41,500	1,200
All other non-food packaging	317,500	8,800
Shrink Film (includes pallet)	***140,000***	***3,900***
Stretch film	***44,500***	***1,200***
NON-PACKAGING FILM	**490,000**	**13,600**
Trash and can liners	52,500	1,500
Construction and agriculture	23,500	700
Disposable diapers	77,500	2,200
Millinery/merchandise bags	69,000	1,900
T-shirt bags (incl. grocery)	5,000	100
All other non-packaging film	262,500	7,300
INJECTION MOLDING	**148,500**	**4,100**
Lids	14,000	400
Toys and novelties	3,500	100
Housewares	2,000	100
All other injection molding	129,000	3,600
EXTRUSION COATING	**437,000**	**12,100**
Paperboard	201,500	5,600
All other extrusion coating	235,500	6,500
Other extruded products (incl. pipe and conduit, wire and cable, and rotomolding)	151,500	4,200
All other LDPE	**783,000**	**21,800**
Total	**3,199,000**	**84,700**

Source: Society of the Plastics Industry, "Selected End-Use,"*Facts and Figures of the U.S. Plastics Industry*, p. 71. Data are converted to tons from millions of pounds in the original. Numbers in subcategory might not add to number in total category due to rounding.

Figure 3: End-Use Manufacturing of LLDPE in 1996 (tons)

End-Use	United States Gen.	North Carolina Share	
PACKAGING FILM	**1,059,000**	**29,400**	*
Food Packaging	***205,500***	***5,700***	
Produce	37,000	1,000	
Bakery	20,500	600	
All other food Packaging	147,500	4,100	
Non-Food Packaging	***427,500***	***11,900***	
Industrial liners	110,000	3,100	
Shipping sacks	47,500	1,300	
All other non-food packaging	270,000	7,500	
Shrink and Stretch film	***426,000***	***11,800***	
NON-PACKAGING FILM	**955,500**	**26,600**	
Trash and can liners	582,500	16,200	
Construction and agriculture	12,500	300	
Millinery/merchandise bags	70,000	2,000	
All other non-packaging film (including diapers and t-shirt and grocery bags)	290,500	8,000	
INJECTION MOLDING	**276,500**	**7,700**	
Lids	94,500	2,600	*
Housewares	114,000	3,200	
All other injection molding (including toys)	68,500	1,900	
EXTRUDED PRODUCTS (incl. Paperboard, other extrusion coating and pipe and conduit)	**128,000**	**3,600**	
WIRE AND CABLE	**90,000**	**2,500**	
ROTOMOLDING RESINS	**215,500**	**6,000**	
ALL OTHER LDPE	**621,000**	**17,300**	
TOTAL	**3,345,500**	**93,100**	

Source: Society of the Plastics Industry, "Selected End-Use,"*Facts and Figures of the U.S. Plastics Industry*, p. 71. Data are converted to tons from millions of pounds in the original. Numbers in subcategory might not add to number in total category due to rounding.

("other plastic containers," "bags, sacks, and wraps," and "other plastics packaging") totals 2.48 million tons of L/LDPE packaging waste generated nationwide and 68,900 tons in North Carolina.

Another way to estimate generation of plastic waste relies on the amount of each resin in consumable goods. Figure 2 presents the use of LDPE in various items in 1996. The packaging related categories presented in these data from the Society of the Plastics Industry (SPI) are starred and include "packaging film" and "injection molded lids." The total of these categories for LDPE alone is 33,500 tons in North Carolina.

LDPE is made into products using three major manufacturing methods: extrusion blown film, extrusion coating, and injection molding. Fifty-two percent (1,679,000 tons) of LDPE was extruded into packaging and non-packaging film in 1996. Fourteen percent (437,000 tons) was used to coat paperboard and other products, and five percent (148,500 tons) of LDPE was injection molded into products like lids, toys and housewares.

Refer to Figure 3 to determine the generation of L/LDPE waste by examining the consumable fraction of L/LDPE use in products in 1996. The packaging related categories presented in the SPI data are starred and include "packaging film" and "injection molded lids." The total of these categories for L/LDPE alone is 32,000 tons in North Carolina.

In 1996, 61 percent (2,014,500 tons) of L/LDPE was extruded into film. Eight percent (276,500 tons) of L/LDPE was injection molded into products like lids, toys, and housewares, and four percent (128,000 tons) was used to

Figure 4: LDPE Growth by End-Use (virgin and recycled)

	Packaging Film		Shrink Film		Stretch Film	
Year	millions of pounds	percent increase	millions of pounds	percent increase	millions of pounds	percent increase
1992	2,645		135		83	
1993	2,456	-7.1	127	-5.9	74	-10.8
1994	2,603	6.0	171	34.6	81	9.5
1995	2,425	-6.8	280	63.7	93	14.8
1996	2,378	-1.9	280	0.0	89	-4.3

Source: Society of the Plastics Industry, "Selected End-Use," *Facts and Figures of the U.S. Plastics Industry*, p. 73

Figure 5: LLDPE Growth by End-Use (virgin and recycled)

	Packaging Film		Shrink and Stretch Film	
Year	millions of pounds	percent increase	millions of pounds	percent increase
1992	1,530		589	
1993	1,645	7.5	601	2.0
1994	1,935	17.6	869	44.6
1995	1,726	-10.8	742	-14.6
1996	2,118	22.7	852	14.8

Figure 6: L/LDPE Future Generation (tons)

Product Category	Estimated 1996 North Carolina Generation	Assumed Annual Growth Rate	Estimated 2002 North Carolina Generation
Other plastics containers	800	5%	1,100
Bags, sacks, and wraps	59,800	5%	80,100
Other plastics packaging**	8,300	5%	11,100
Total Generated L/LDPE	**68,900**	**5%**	**92,300**

coat paperboard and other products and extruded into pipe and other conduits.

Using these SPI data generates similar estimates as the combined APC / EPA data. Adding LDPE and L/LDPE used in consumable items from SPI manufacturing and end-use data predicts 65,510 tons of L/LDPE packaging in the waste stream. This is within five percent of the EPA-based estimate of 68,944 tons.

Future Generation

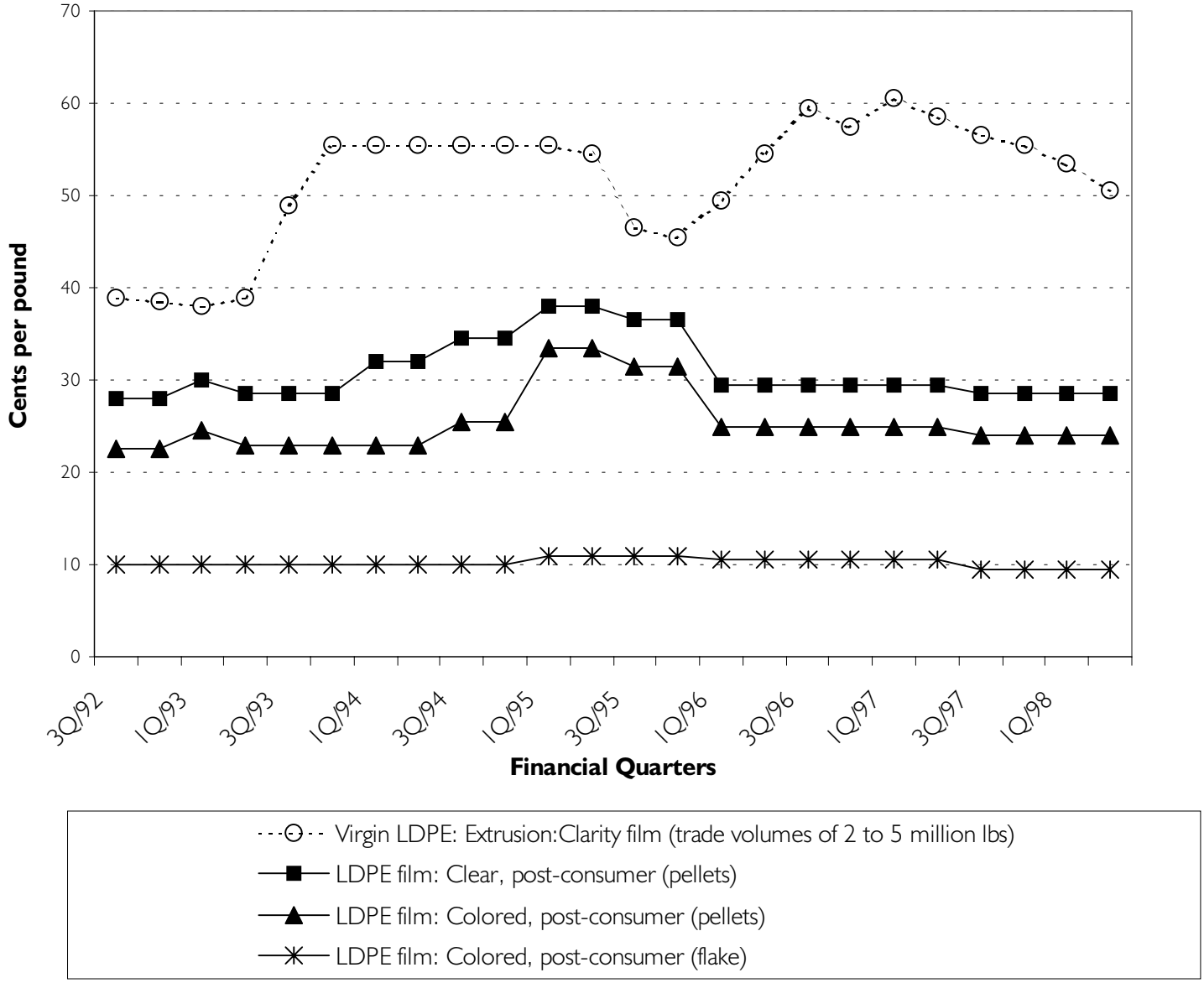
LDPE use as shrink film has grown considerably. Future generation of LDPE waste can be estimated by examining the history of the use of LDPE between 1992 and 1996 (both virgin and recycled) in consumable goods. SPI data estimate LDPE growth rates for packaging film (between –7.1 and 6.0 percent), shrink film (between –5.9 and 63.7 percent) and stretch film (between –10.8 and 14.8 percent). These figures are presented in Figure 4.

L/LDPE use has grown considerably in the shrink/stretch film market as well. SPI data provide L/LDPE growth rates for packaging film (between –10.8 and 22.7 percent) and shrink/stretch film (between –14.6 and 44.6 percent). These figures are presented in Figure 5.

Market experts predict considerable growth in L/LDPE at eight percent per year through 2001.[2] Total PE growth is projected at a more moderate rate of 5.1 percent annually from 2000-2005.[3] SPI estimated that growth in sales and captive use from 1996 to 1997 for LDPE would be 0.5 percent and for L/LDPE would be 7.4 percent.[4]

Figure 6 projects the 1996 generation figures for consumable items provided by EPA (see Figure 1) to 2002 using a five-percent annual growth rate.

Figure 7: LDPE Price History (virgin extrusion clarity & recycled clear & colored)



Recovery

EPA estimates national recovery of L/LDPE "durable goods" to be 20,000 tons and that of "bags, sacks, and wraps" to be 90,000 tons. Considering only the consumable items denoted in the generation section including "other plastic containers," "bags sacks and wraps," and "other plastics packaging," the recovery rate for the United States was 3.6 percent, or 2,480,000 tons.

A survey of private sector recyclers of L/LDPE yielded little data, but documented recovery of 2,244 tons by five L/LDPE processors in state. Comparing this to the North Carolina generation estimate of 68,944 tons determines a recovery rate of 3.3 percent for the state. Although difficult to estimate, true recovery is likely higher in North Carolina, because not all L/LDPE recyclers responded to the survey.

MARKET DYNAMICS: PRICES AND CAPACITY

The two major components of market dynamics are prices and capacity. The relationship of these two factors to market dynamics for plastics overall is described in the introductory section to this chapter.

Prices

L/LDPE prices were not hit as hard as HDPE by the increase in virgin ethylene production because of the large growth in the use of these resins. This growth is expected to continue for at least the next three years.[5]

The price histories of virgin LDPE and post-consumer clear LDPE pellets and colored LDPE pellets and flake are graphed in Figure 7.

Figure 8: LLDPE Price Histories

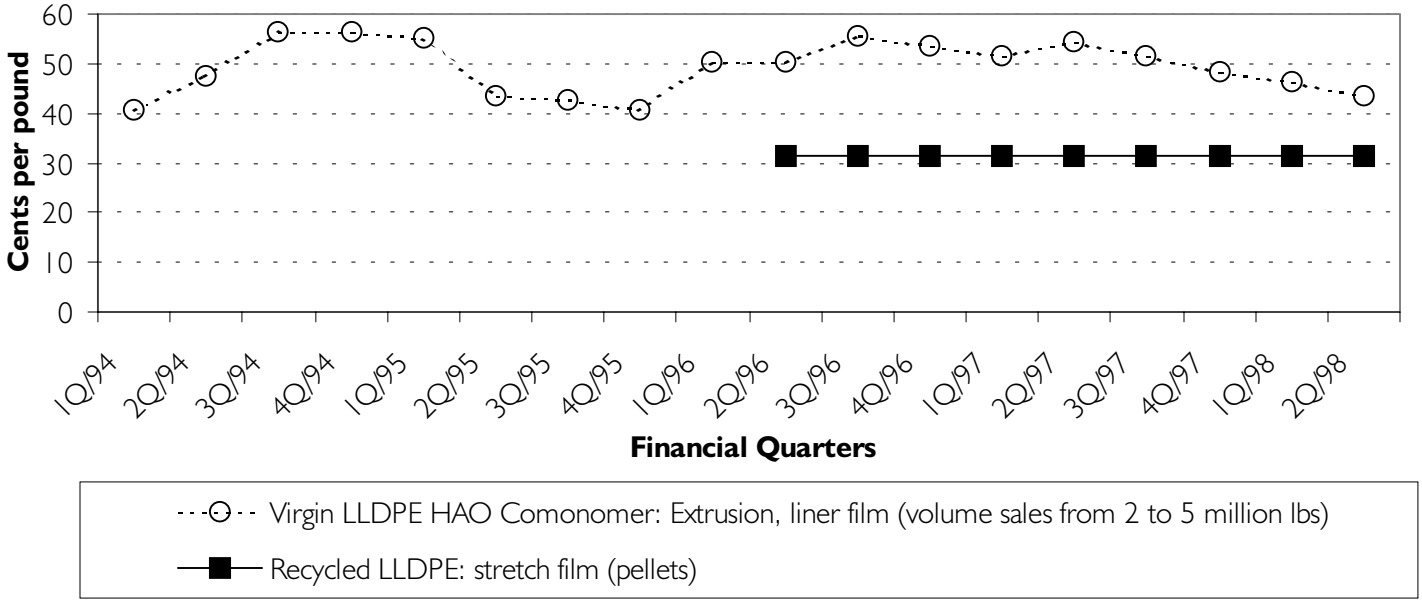


Figure 9: Demand for Recycled LDPE to 2005 (tons converted from lbs. in original)[6]

	1985	1989	1995	2000	2005
Recycled LDPE demand	5,000	50,000	85,000	125,000	175,000
Percentage growth rate from previous listed year	NA	NA	70%	47%	40%
Overall virgin plastic demand	22,100,000	26,900,000	35,550,000	41,800,000	48,300,000
Recycled LDPE as a percentage comparison with virgin plastic demand	.02%	.2%	.24%	.3%	.36%

Figure 10: Recovered Resin Uses

Reclaimed Resin End-Use Market	Reclaimed Resin End-Use Market Capacity	Change from 1996
Film	157	+8.3%
Other	53	+12.8%
Total	**210**	**+9.4%**

Source: "Resins '98: Sea Change in Supply," *Modern Plastics*, January 1998, p. 76.

The price histories of virgin L/LDPE and post consumer L/LDPE pellets are compared in Figure 8.

DEMAND

According to some sources, the demand for recycled LDPE resin is expected to increase substantially in the future. The Freedonia Group, in a report entitled *Plastic Recycling to 2000*, provides the estimates listed in Figure 9.

End-use markets are increasing for LDPE as illustrated in Figure 10 by *Modern Plastics*.

About 30 percent of all plastic grocery bags are L/LDPE. These bags are highly sought after by plastic lumber and wood/plastic composite lumber manufacturers. Ron Perkins of APC speaks about the tight market for this material in a recent *Plastic News* article: "Plastic lumber maker Trex Co. in Winchester, Virginia, is having problems finding sup-

Figure 11: Future Marketability of North Carolina L/LDPE

	1996	2002
Estimated North Carolina generated tons	68,900	92,300
Freedonia demand estimate*	93,000	145,000
North Carolina generated tons as a percentage of projected overall demand	74%	64%

*Numbers from Freedonia interpolated to match years for generated estimates.

Figure 12: Processing Capacity for L/LDPE in the Southeast (tons)

	L/LDPE
Wash Capacity	*
Dry Reclaim Capacity	100,000 *
Total Resin Capacity	100,000

* Wash capacity figures are included in dry reclaim capacity figures because of disclosure considerations.

ply, and paper and wood firm Boise Cascade Corp. of Boise, Idaho, is evaluating whether it can economically collect the 10 million pounds of film a month it needs in the Pacific Northwest to recycle into a wood-polymer composite siding."[7]

Mike Vatuna, purchaser for Trex (a plastic lumber manufacturer) reports that its use of polyethylene film increased from 3.25 million pounds per month in January of 1997 to 6.5 million pounds per month in June of 1998.[8] In 1996 Trex bought 51 percent of all grocery bags collected nationwide. Mr. Vatuna also indicates that export markets are strong for this material and prices are rising due to low collection rates and the fact that virgin polyethylene resin is currently up. The strongest collection programs are in the Northeast, so that is where most of Trex's material is sourced. Trex also consumes about 20 percent of the stretch film recycled in the United States. The other component in their product is waste wood, mostly from furniture makers.[9]

As reported in *Plastics News*, another southeastern manufacturer, Mid South Extrusion Inc. of Monroe, Louisiana, "is expanding both its capacity and its market reach for film while centralizing its new recycling operations. Film capacity of 26 million pounds will expand to 40 million pounds of high, low and linear low density polyethylene annually."[10]

SUPPLY / DEMAND RELATIONSHIP

Figure 11 attempts to characterize the "marketability" of North Carolina generated L/LDPE by comparing Freedonia's demand projections to the estimated supply of L/LDPE in the state. North Carolina's L/LDPE would be competing with L/LDPE from other states and countries. The lower the percentage of North Carolina tons to total demand, theoretically the better chance North Carolina tons have of being successfully marketed. Factors such as proximity to market and resin price must also be considered when characterizing the marketability of North Carolina generated L/LDPE.

Unlike the bottle grade resins (PET and HDPE), a low recovery rate can be expected for L/LDPE. The estimates of marketability in this chapter have been based on the amount of each resin in the waste stream. The true volume of recovered resin will be much less than what is estimated in Figure 11.

Specific processing capacity in the Southeast region (defined as Maryland, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida, and Alabama) provided by APC is presented in Figure 12.[11]

CONCLUSION

Due to strong capacity for processing and end-use of L/LDPE, recovered resin prices are not likely to drop with increased collection of this resin. Increase in recovery will most likely be accompanied by lower per ton collection and processing costs, thus increasing the profit on recycling this material. There is room for growth in the current recovery of L/LDPE film, especially in the commercial and industrial sectors.

The ability of L/LDPE markets to handle the current and projected supply of material generated in North Carolina appears to be more than adequate. However, the price paid for recycled L/LDPE is based to a large extent on the capacity and price paid for virgin L/LDPE at any given point

in time. For there to be consistent, long-term increases in the recovery of L/LDPE resin, a commitment must be made by industry to make the purchase of recycled L/LDPE a priority. At the same time, state and local governments, along with private collectors of recycled materials, should make every effort to provide their citizens/customers with incentives and services that maximize the recovery of L/LDPE. In addition, governments and individuals need to close the recycling loop by purchasing products made from recycled L/LDPE

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for L/LDPE in North Carolina presented in this section.

- The plastics industry should continue to provide technical assistance to communities on ways to recover more L/LDPE plastics, including researching ways to reduce collection and processing costs and improve quality.
- The plastics industry should do more to fulfill growing demand for L/LDPE resin from recycled sources rather than virgin, helping to avoid the market situation that occurred in 1995-96. Capacity shifts from virgin to recycled, or at least meeting new L/LDPE resin demand with recycled resin, will strengthen and stabilize recovered L/LDPE markets and send strong signals to collectors and processors to recover more L/LDPE.
- North Carolina businesses and industries should identify opportunities to recover L/LDPE materials used in packaging and transport.
- The state should also consider increasing the availability of financial incentives to enhance L/LDPE recovery and use, including grant funding for capital purchases that improve collection efficiencies and economic development incentives for L/LDPE end-users.
- If consistent improvement in L/LDPE recovery is not achieved by 2002, North Carolina should consider implementing statutory mechanisms that target the use of disposable packaging and transport materials, such as shrink and stretch wrap.

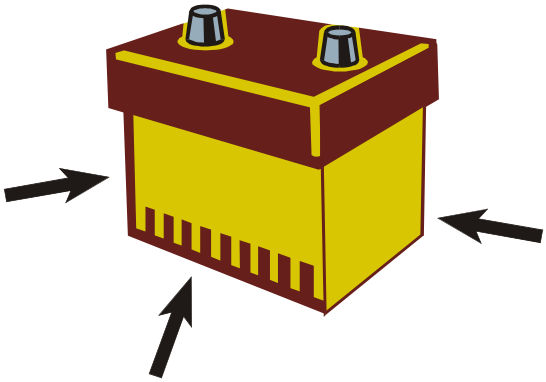
[1] Toloken, Steve, "Supply vs. Demand Stirs Recycling Debate," *Plastics News*, May 25, 1998, p. 13.
[2] Esposito, Frank, "Dow officials size up the PE resin markets," *Plastics News*, June 23, 1998.
[3] Ibid.
[4] Society of the Plastics Industry web page: http://www.socplas.org/industry/stat3.html
[5] "Resins Report. POLYETHYLENE: Production technology is enhanced to meet demand," *Modern Plastics*, January 1998, pp. 54-55.
[6] http://freedoniagroup.com/ppv-scripts/
[7] Toloken, Steve "Supply vs. Demand Stirs Recycling Debate," *Plastics News*, May 25, 1998, p. 13.
[8] Mike Vatuna, Trex, personal communication, June 11, 1998.
[9] Urey, Craig "Plastic Stacks up Admirers as Alternative Deck Material," *Plastics News*, June 15, 1998, p. 1.
[10] Urey, Craig, "Mid South Extrusion Expanding," *Plastics News*, November 3, 1997, p. 3.
[11] Judy Dunbar, American Plastics Council, personal communication, July 14, 1998.

Plastic: PP (#5)

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

Polypropylene (PP) is used in an extensive array of products, including toys, diapers, automobile parts (e.g., trim, bumpers), appliance parts, battery cases, dye tubes, carpet backing, microwaveable packaging and containers, feed and grain bags, bottles, and medical parts. It is one of the fastest growing resins in product applications.

Polypropylene is not widely used in traditionally recycled containers, and so unlike PET, is not a target material for most public curbside or drop-off programs (nor would the recovery of PP bottles have a large impact on the waste stream). Because polypropylene is often a part of another product, its recovery may be difficult if not currently technically or financially infeasible. For example, disposable diapers have not found any notable recovery success, thus the PP wrap on the diaper is likely unrecoverable at this time. Similarly, the plastic parts of scrap automobiles and appliances often end up as disposed "fluff" at large metal processing plants. A gradual shift toward dismantling rather than wholesale grinding of scrap autos may change the recovery picture for PP-oriented auto parts.

SUPPLY

Current Generation

Figure 1 presents the Environmental Protection Agency (EPA) generation estimates for polypropylene per product category, along with extrapolated estimates for North Carolina's share of national generation. North Carolina estimates are based on North Carolina's share of United States population being 2.78 percent, and these estimates are rounded to the nearest 100 tons. Because significant differences in generation exist from state-to-state, the North Carolina estimates should only be considered to be rough estimates. The recoverable portions of EPA's estimate (shaded in Figure 1) include "other plastic containers," "bags, sacks, and wraps," and "other plastics packaging" and total 22,600 tons in North Carolina.

Figure 1. PP Generation in 1996 (tons)

Product Category	Estimated United States Generation	Estimated North Carolina Share
Durable goods	1,030,000	28,600
Non-durables*	740,000	20,600
Other plastics containers	70,000	2,000
Bags, sacks, and wraps	430,000	12,000
Other plastics packaging**	310,000	8,600
Total Generated PP	**2,580,000**	**71,800**

* Includes plastics in disposable diapers, clothing, footwear, etc.
** Other plastics packaging includes coatings, closures, caps, trays, shapes, etc.
Source: EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*

Figure 2. 1996 Domestic Consumption by End-Use for Polypropylene (tons)

	United States Generation	North Carolina Share
Injection Molding Total	**1,945,500**	**54100**
Appliances	157,000	4400
Consumer products	673,500	18700
Rigid packaging	533,500	14800
Transportation	288,500	8000
All other injection molding (inc. medical)	293,000	8100
Blow Molding	**86,500**	**2400**
Extrusion	**2,408,000**	**66900**
Film	566,500	15700
Sheet	115,000	3200
Fiber and filaments	1,656,500	46000
All other extrusion	70,000	1900
All Other Uses	**1,109,500**	**30800**
Total	**5,549,500**	**154200**

Source: Society of the Plastics Industry, "Selected End-Use,"*Facts and Figures of the U.S. Plastics Industry*, p. 81. Data are converted to tons from millions of pounds in the original.

For packaging applications in particular, the American Plastics Council (APC) has estimated polypropylene use nationally in 1996 to be 1.9 billion pounds, or 950,000 tons.[1] North Carolina's per capita share would be 26,410 tons.

Figure 1 shows that generated polypropylene is heavily weighted in the categories of "durable goods" and general "non-durables," presumably mostly as a composite part of another product. As noted above, because polypropylene does not tend to be generated as a singular, separate waste product (like an HDPE bottle or vinyl siding), it will be challenging to recover it in most forms. Where it is generated as singular-resin waste in the category of "other plastic packaging" (for example, a bottle cap or disposable, microwaveable container), it is in a form not historically targeted by public or private recycling programs.

Another method for estimating generation of plastic waste is the use of the resin in consumable goods. Figure 2 presents the use of PP in various items in 1996 as reported by the Society of the Plastics Industry (SPI). The packaging related categories presented in the SPI data include "rigid packaging," "film," and "sheet." The total of these categories is 33,700 tons in North Carolina in 1996. This is about one-third greater than the EPA and APC estimates. The "film" and "sheet" categories in the SPI data may contain some durable or mixed resin items not counted in the other estimates.

One notable end-use in the SPI data is "fiber and filaments." There is a move by carpet manufacturers to recycle more used carpet. Polypropylene fiber carpets make up 20 percent of carpets sold today.[2]

Figure 3. PP Growth by End-Use (Virgin and Recycled)

	Rigid Packaging		Film		Sheet	
Year	Millions of pounds	Percent increase	Millions of pounds	Percent increase	Millions of pounds	Percent increase
1992	671	N/A	734	N/A	138	N/A
1993	743	10.7	802	9.3	142	2.9
1994	860	15.7	927	15.6	159	12.0
1995	965	12.2	1077	16.2	238	49.7
1996	1067	10.6	1133	5.2	230	-3.4

Figure 4. PP Future Generation (Tons)

	Estimated 1996 North Carolina Generation	Assumed Annual Growth Rate	Estimated 2002 North Carolina Generation
PP packaging	22,600	7.5%	34,900

Figure 5. National Generation and Recovery of Polypropylene Bottles in 1996[9]

	Generated	Recovered
PP bottles	140 mmlbs (70,000 tons)	5.6 mmlbs (2,800 tons)

While EPA's estimates are based on the municipal and commercial waste streams, polypropylene recycling from industrial waste streams will factor into the market for recovered resin. North Carolina is home to industrial facilities using certain recyclable polypropylene products. In a local example of producer responsibility, Wellmark recycles the more than five million pounds per year of polypropylene dye tubes returned by the customers of its parent company, Technimark.[3]

Future Generation

Growth in PP use is projected to occur mainly in automotive parts, and market consultants predict a worldwide increase in the consumption of PP of 7.6 percent per year.[4] SPI estimates growth in sales and captive use from 1996 to 1997 of PP to be 8.3 percent.[5] *Modern Plastics* reports a 7.2 percent growth in major markets in the same time period.[6]

Future generation of PP waste can also be predicted by the recent growth in use of PP (both virgin and recycled) in non-durable goods. SPI data provide growth rates for rigid packaging (between 10.6 and 15.7 percent), film (between 5.2 and 16.2 percent) and sheet (between -3.4 and 49.7 percent). These figures are presented in Figure 3.

Figure 4 projects the 1996 generation figures to 2002 using a 7.5 percent annual growth rate (based on the *Modern Plastics*' estimates of growth). The 1996 packaging estimate is based on the shaded portions of the EPA figures presented in Figure 1.

Recovery

Except for lead acid battery collection programs, North Carolina public sector recovery of polypropylene through curbside and drop-off programs has been negligible. (Almost 60,000 batteries were collected by local government programs in Fiscal Year 1996-97.)[7] A survey of private sector recyclers of PP yielded little data, but documented recovery of 287 tons by three PP processors in North Carolina. These data establish a recovery rate of only 1.3 percent. However, because of the low response rate to the survey, the actual recovery of polypropylene may be significantly higher. A 1995 survey documented 7,870 tons of PP recovery, two thirds of which was accomplished by a major processor who did not respond to the more recent survey. EPA has estimated a national recovery rate of five percent.[8]

As discussed above, actual polypropylene recovery is complicated by the resin's presence as a portion of another product. If recovery of discarded carpet in North Carolina increases in any substantial way over the coming years, part of that recovery will by its nature include polypropylene (as well as the other components of carpet such as nylon, polyester, etc.).

The APC has estimated the amount of polypropylene bottles recovered in 1996 nationwide. As Figure 5 shows, the

Figure 6. Polypropylene Price Histories

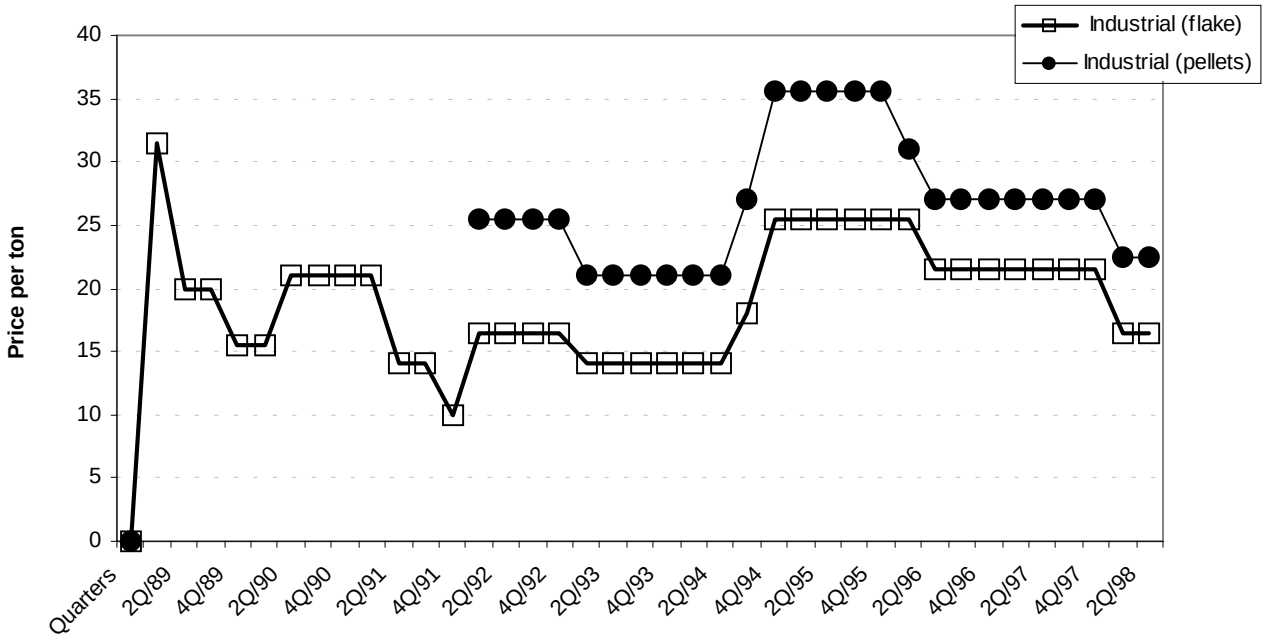


Figure 7. Demand for Recycled PP to 2005 (tons converted from lbs. in original)[11]

	1985	1989	1995	2000	2005
Recycled PP demand	32,500	65,000	135,000	190,000	260,000
Percentage growth rate from previous listed year	NA	100%	100%	46%	37%
Overall virgin plastic demand	22,100,000	26,900,000	35,550,000	41,800,000	48,300,000
Recycled PP as a percentage comparison with virgin plastic demand	0.15%	0.24%	0.38%	0.45%	0.54%

recovery for the United States as a whole is four percent, and this can be expected to be the case for North Carolina as well.

MARKET DYNAMICS: PRICES AND CAPACITY

The two major components of market dynamics are prices and capacity. The relationship of these two factors to market dynamics for plastics overall is described in the introductory section to this chapter.

Prices

PP prices in the southeast region are higher than at this time last year. Compared to the past quarter, prices for PP have remained relatively stable.[10] Figure 6 presents price histories for post-industrial recycled PP pellet and flake.

DEMAND

According to some sources, demand for recycled PP resin is expected to increase substantially in the future, although not as fast as for other resins. The Freedonia Group, in a report entitled *Plastic Recycling to 2000*, provides the estimates listed in Figure 7.

Modern Plastics estimates an increase in end-use of PP of 3.3 percent during 1996 to a 1997 consumption of 315 million pounds, or 157,500 tons.[12]

A 1995 report described KW Plastics of Troy, Alabama, as a large recycler of vehicle battery cases, most of which are made with PP resin. In 1995, KW was reported as recycling 195 million pounds of PP battery cases and scrap, which was to be used to make new battery cases and other products.[13] The APC also notes that KW Plastics is doing

Figure 8. Processing Capacity for PP in the Southeast [16]

Type of Capacity	Recycled Polypropylene (tons)
Wash Capacity	90,000
Dry Reclaim Capacity	*
Total Resin Capacity	90,000

* Dry reclaim capacity figures are included in wash capacity figures because of disclosure considerations

Figure 9. Future Marketability of North Carolina PP

	1996	2002
Estimated North Carolina generated tons	22,600	34,900
Freedonia demand estimate*	142,000	218,000
North Carolina generated tons as a percentage of projected overall demand	16%	16%

* Numbers for Freedonia interpolated to match years for generated estimates.

more blending with HDPE and PP resins, resulting in increased total processing capacity as well as market value.[14]

Polypropylene is subject to some overall trends affecting a number of resins. As the American Plastics Council notes:

> "End use markets for plastics are growing, in terms of total number of markets currently available, compared to this time last year, and also in terms of total capacity. No salient changes in export markets are affecting end use markets."
>
> "Growth in procurement of end products will directly affect markets. The largest PP end product consumption includes bottles, roofing shingles, and automotive products. Virgin resin capacity, off-spec resin availability, and quantity and quality of supply also affect market growth and value."[15]

Figure 8 provides information on the reclaim capacity for polypropylene in the southeast region (defined as Maryland, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida, and Alabama). Reclaim capacity for PP includes automobile battery case recycling, bale wrap recycling, and container recycling (including bottles).

Ash-Kourt brought a new facility on line in 1998 in Statesville, which washes and densifies post-industrial PP scrap for Discas. Discas uses mainly post-industrial PP and offers standard PP grades, impact- modified PP, custom compounds, filled and reinforced PP, standard precolored PP, and thermoplastic elastomers.[17]

SUPPLY / DEMAND RELATIONSHIP

Figure 9 attempts to characterize the "marketability" of North Carolina generated PP by comparing Freedonia's demand projections to the estimated supply of PP in the state. North Carolina's generated PP would compete with generated PP from other states and countries. The lower the percentage of North Carolina tons to total demand, theoretically the better chance North Carolina tons have of being successfully marketed. Factors such as proximity to market and resin price must also be considered when characterizing the marketability of North Carolina generated PP.

Unlike the bottle grade resins (PET and HDPE), a low recovery rate can be expected for PP. The estimates of marketability in this chapter have been based on the amount of each resin in the waste stream. The true volume of recovered resin will be much less than what is estimated in Figure 9.

CONCLUSION

Unlike many of the single-use, consumer-oriented applications of polypropylene, industrial applications of PP (like textile dye-tubes and certain wraps and films) are, in all likelihood, easier to recover. Efforts to reduce disposal of polypropylene products will probably best be focused on the industrial waste stream.

The ability of PP markets to handle the current and projected supply of material generated in North Carolina appears to be more than adequate. However, the price paid for recycled PP is based to a large extent on the capacity and price paid for virgin PP at any given point in time. For

there to be consistent, long-term increases in the recovery of PP resin, a commitment must be made by industry to make the purchase of recycled PP a priority. At the same time, state and local governments, along with private collectors of recycled materials, should make every effort to provide their local businesses and industry with incentives and services that maximize the recovery of PP. In addition, governments and individuals need to close the recycling loop by purchasing products made from recycled PET.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for PP in North Carolina presented in this section.

- The plastics industry should continue to provide technical assistance to communities on ways to recover more plastic bottles, including researching ways to reduce collection and processing costs.
- The plastics industry should do more to fulfill growing demand for PP resin from recycled sources rather than virgin, helping to avoid the market situation that occurred in 1995-96. Capacity shifts from virgin to recycled, or at least meeting new PP resin demand with recycled resin, will strengthen and stabilize recovered PP markets and send strong signals to collectors and processors to recover more PP.
- North Carolina's businesses and industries should identify and pursue opportunities to recover PP materials.
- The state should also consider increasing the availability of financial incentives to enhance PP recovery and use, including grant funding for capital purchases that improve collection efficiencies and economic development incentives for PP end-users.

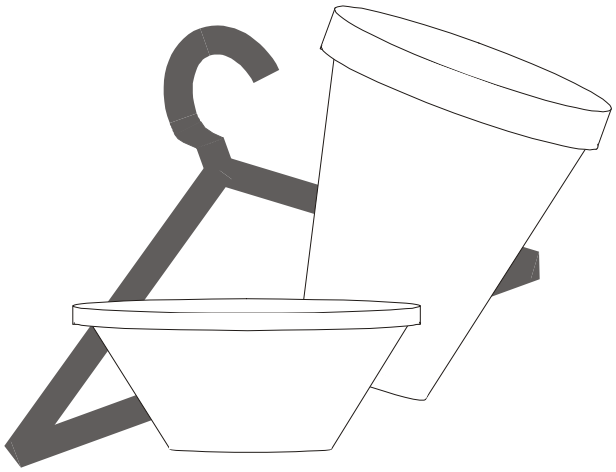
[1] Steve Toloken**, "**Supply Vs. Demand Stirs Recycling Debate," *Plastics News*, May 25, 1998, p.13
[2] National Association of Homebuilders, "Carpet Fact Sheet."
[3] Clarke, Susan, "Wellmark Recycled Polypropylene Dye Tubes," *Recycling Works*, vol. 2, no. 1, January 1996.
[4] "Resins Report. POLYPROPYLENE: Auto applications help bolster market growth," *Modern Plastics*, January 1998.
[5] Society of the Plastics Industry web page: http://www.socplas.org/industry/stat3.html
[6] "Resins '98: Sea Change in Supply," *Modern Plastics*, January 1998, p. 75.
[7] NC DENR, *North Carolina Solid Waste Management Annual Report, July 1, 1996 – June 30, 1997*, p. 31. Because lead acid batteries are banned from disposal in North Carolina and retailers are required to accept an old battery in return for the purchase of a new one, battery recovery in the state is likely very high. Polypropylene is a small portion of a battery's overall weight.
[8] EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*. EPA's numbers may not include industrial-oriented scrap (such as textile dye-tubes), which is not considered part of EPA's definition of municipal solid waste.
[9] Memorandum from Judy Dunbar, American Plastics Council, to Scott Mouw, NC DPPEA, July 14, 1998.
[10] Ibid.
[11] http://freedoniagroup.com/ppv-scripts/
[12] "Resins '98: Sea Change in Supply," *Modern Plastics*, January, 1998, p. 76.
[13] SCS Engineers, *Assessment of the Recycling Industry and Recycling Materials in North Carolina, 1995 Update*, November 1995, p. 4-40
[14] Dunbar memo, July 14, 1998.
[15] Ibid.
[16] Ibid.
[17] Smith, Sarah S. "Discas buys supplier, expands subsidiary," *Plastics News*, November, 25, 1997, p. 13.

Plastic: Polystyrene (#6)

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

Polystyrene (PS) is a plastic used for a wide variety of purposes, from construction products to packaging. It is perhaps most widely recognized as "Styrofoam," a trademark for a brand of plastic foam. Plastic foam is a form of polystyrene referred to as expanded polystyrene, or EPS. EPS is used in consumer products such as disposable cups and packaging products, including egg cartons, cushion shapes in packing boxes, and plastic peanuts. Common non-expanded polystyrene products include compact disc and cassette tape cases, plastic utensils and plates, coat hangers, and agricultural trays.

EPS in particular has been a symbol of the problems of the "throwaway society," but it is in fact a very small percentage of the waste stream. Polystyrene's recyclability is hampered by its high volume-to-weight nature. Still, under certain circumstances, polystyrene is recoverable and some recovery is occurring in North Carolina. Overall, polystyrene faces a situation similar to the other plastic resins: an apparent ample capacity for use of recycled PS is being severely hampered by limited collection opportunities and competition with abundant, cheap virgin resin.

SUPPLY

Current Generation

Figure 1 presents the Environmental Protection Agency (EPA) generation estimates per product category, along with extrapolated estimates for North Carolina's share of national generation. North Carolina estimates are based on North Carolina's share of the United States population being 2.78 percent, and these estimates are rounded to the nearest 100 tons. Because significant differences in generation exist from state-to-state, the North Carolina estimates should only be considered to be rough estimates.

As Figure 1 indicates, "plastics plates and cups" constitute almost 40 percent of generated polystyrene. Further, poly-

Figure 1. 1996 PS Generation (Tons)

Product Category	Estimated United States Generation	Estimated North Carolina Share
Durable goods	530,000	14,700
Plastic plates and cups	790,000	22,000
Other non-durables*	490,000	13,600
Other plastics containers	40,000	1,100
Bags, sacks, and wraps	60,000	1,700
Other plastics packaging**	80,000	2,200
Total Generated PS	**1,990,000**	**55,300**

* Includes plastics in disposable diapers, clothing, footwear, etc.

** Other plastics packaging includes coatings, closures, caps, trays, shapes, etc.

Source: EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*

Figure 2. EPS Sales

Year	Tons	North Carolina Share*	Estimated National Recycling Rate
1989	82,280	2,300	NA
1990	82,830	2,300	NA
1991	75,680	2,100	NA
1992	92,180	2,600	NA
1993	91,850	2,600	10.5%
1994	97,020	2,700	10.2%
1995	101,640	2,800	12.7%

*Calculation based on North Carolina population.

styrene is estimated to make up nearly 98 percent of all disposable plastic plates and cups. Other disposable items and packaging uses account for another third of polystyrene generation. In theory, these materials are recoverable from the residential, institutional, and commercial waste streams. It is assumed that the polystyrene in durable goods would be more difficult to recover. The recoverable polystyrene categories ¾ "plastic plates and cups," "other plastics containers," "bags, sacks, and wraps," and "other plastics packaging" ¾ total 27,000 tons per year in North Carolina (shaded in Figure 1).

In an article in *Plastic News*, the American Plastics Council (APC) was quoted as estimating a national packaging utilization rate for polystyrene of 399 million pounds, which translates to 199,500 tons. North Carolina's extrapolated portion would be 5,500 tons. The APC estimate does not include many PS items that end up in the waste stream. Nevertheless, polystyrene packaging appears to be a minimal portion North Carolina's waste stream.

Another way to estimate generation in North Carolina is to examine the use of a resin in consumable items such as packaging. The Society of the Plastics Industry (SPI) estimates that 1,428 million pounds (714,000 tons) of polystyrene was used in packaging in 1996.[1] North Carolina's share of this estimate is 19,800 tons. In another estimate of PS use, Figure 2 presents an estimate of EPS sales, nationally and for North Carolina, based on data from the Alliance of Foam Packaging Recyclers (AFPR).

The increasing use of mail order shopping is helping to expand the use of EPS "loose fill" packaging (commonly referred to as "peanuts"). Loose fill is reportedly being diverted from disposal at a higher rate than other polystyrene, especially through reuse efforts by mailing companies and other shippers. Reuse/recycling efforts are estimated to represent a national recovery of 11,000 tons annually. North Carolina's extrapolated share would be 300 tons. The Plastic Loose Fill Council operates a hot line that lists 1,200 United States businesses that accept polystyrene loose fill for reuse. However, one company says growth in reuse is slowing due to increased difficulty in finding new sources of uncontaminated feedstock.[2]

Future Generation

Future generation of PS waste can be estimated by examining the history of polystyrene use (both virgin and recycled) in non-durable goods. SPI data provide growth rates for EPS as between –1.4 and 8.9 percent (presented in Figure 3).

Figure 3. Sales and Domestic Use for PS

	EPS	
Year	**millions of pounds**	**percent increase over previous year**
1992	2,740	N/A
1993	2,884	5.3
1994	3,140	8.9
1995	3,095	-1.4
1996	3,234	4.5

Source: Society of the Plastics Industry, "Selected End-Use," *Facts and Figures of the U.S. Plastics Industry*, p. 79.

Figure 4. Markets for EPS in the United States (Millions of Pounds)

EPS End-Use	**1996**	**1997**	**Percent Change**
Billets			
Building and construction	257	267	3.9
Other	46	47	2.2
Shapes			
Packaging	129	136	5.4
Other	60	62	3.3
Cups and containers	194	201	3.6
Loose fill	94	97	3.2
Total EPS	**780**	**810**	**3.8**

Source: "Resins '98: Sea change in supply," *Modern Plastics*, January 1998, p. 75

Figure 5. PS Future Generation (tons)

	Estimated 1996 North Carolina Generation	**Assumed Annual Growth Rate**	**Estimated 2002 North Carolina Generation**
Total Generated PS	27,000	4%	34,200

Modern Plastics reports the growth in use of PS in specific end-use markets as presented in Figure 4. SPI reports a growth of 6.9 percent in overall PS sales and captive use between 1996 and 1997.[3]

Figure 5 projects the 1996 generation figures to 2002, using a four percent growth rate in consumable PS (based on recent growth in EPS markets).

Recovery

Polystyrene is one of the least recovered plastic resins nationwide and apparently also in North Carolina. Less than six percent of PS packaging was recovered nationally in 1995, according to the APC.[4]

Although it is difficult to pinpoint current polystyrene recovery for North Carolina, it is assumed to be no more than 1,000 tons annually, which would put polystyrene at less than a two percent recovery rate. Given current market conditions and the logistical challenges of polystyrene recycling, that recovery rate is unlikely to increase much during the next three to five years.

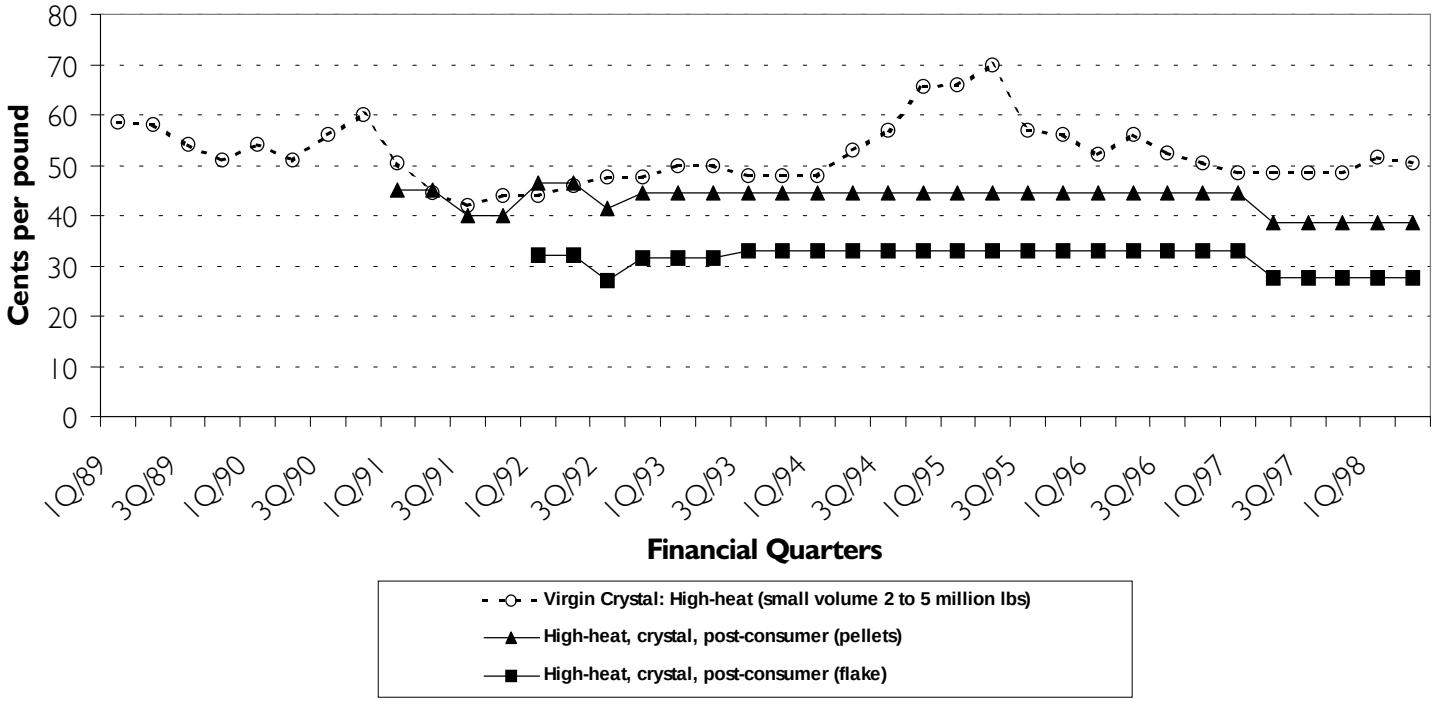
MARKET DYNAMICS: PRICES AND CAPACITY

The two major components of market dynamics are prices and capacity. The relationship of these two factors to market dynamics for plastics overall is described in the introductory section to this chapter.

Prices

Recycled high-impact polystyrene prices are highest from January to May due to horticultural use.[5] This makes prices at the time of this report hard to determine. The market currently has large amounts of virgin and recycled general purpose PS, so prices will remain low for the short term. Figure 6 presents a price history for virgin and recycled PS.

Figure 6. Polystyrene Price History: High-heat, Crystal



Capacity

Generators of polystyrene in North Carolina have some recycling infrastructure available to them to divert PS from disposal. For example, *The Directory of Markets for Recyclable Materials* lists more than 30 collectors/processors/brokers of PS serving North Carolina. The Alliance of Foam Packaging Recyclers also identifies five EPS processors in North Carolina.[6] At least two companies that provide national end use markets for EPS, Tuscarora and Modern Polymers, have operations in the state.[7]

DEMAND

The availability of a processing infrastructure is not as important as overall end use demand for recycled polystyrene. Unfortunately, polystyrene is currently experiencing a constriction on recycled demand, despite an apparently adequate end use "capacity" to consume recycled polystyrene. Actual overall demand has been hampered severely by competition with abundant virgin polystyrene resin.[8] Similar to PET in 1995-96, a rapid global expansion of virgin polystyrene capacity has resulted in a glut of virgin PS on the market, driving prices down and making it relatively uneconomical to collect, process, and market the recycled material. The dismal end-use demand picture extends to global markets as well as domestic. For instance, *Plastics News* reported in January 1998 that China had stopped taking recycled polystyrene resin.[9]

The downfall in recycled PS prices is especially hurting some of the lower grades of the resin, such as potentially food-contaminated food service PS. As a sign of difficult economic times for PS recycling, the National Polystyrene Recycling Corporation (NPRC) recently closed its New Jersey facility, leaving only its plants in the Midwest and on the west coast still operating. NPRC cited the loss of end users for recycled PS in the eastern United States.[10] It was reported that "NPRC has begun charging customers for food-service materials in Chicago and stopped paying for food-service products at [the California] plant."[11]

Modern Plastics estimates a decrease in the consumption of post-consumer PS from 10 million pounds (5,000 tons) in 1996 to nine million pounds (4,500 tons) in 1997.[12]

The long term demand picture for PS may be a little brighter. According to some sources, demand for recycled PS resin is expected to increase in the future, although not as fast as for other resins. The Freedonia Group, in a report entitled *Plastic Recycling to 2000*, provides the estimates listed in Figure 7.

Figure 8 attempts to characterize the "marketability" of North Carolina generated polystyrene by comparing Freedonia's demand projections to the estimated supply of PS in the state. North Carolina's generated PS would be competing with generated PS from other states and countries. In other words, the lower the percentage of North Carolina tons to total demand, theoretically the better chance North Carolina tons have of being successfully marketed. Factors such as proximity to market and resin price

Figure 7. Demand for Recycled PS to 2005 (tons converted from pounds in original)[13]

	1985	1989	1995	2000	2005
Recycled PS demand	N/A	10,000	30,000	55,000	90,000
Percentage growth rate from previous listed year	N/A	100%	100%	46%	37%
Overall virgin plastic demand (all resins)	22,100,000	26,900,000	35,550,000	41,800,000	48,300,000
Recycled PS as a percentage comparison with virgin plastic demand	NA	0.04%	0.08%	0.13%	0.19%

Figure 8. North Carolina-Generated PS as a Portion of Overall Recycled PS Demand (tons)

	1996	2002
Estimated North Carolina generated tons	27,000	34,120
Freedonia demand estimate*	35,000	69,000
North Carolina generated tons as a percentage of projected overall demand	75%	49%

* Numbers from Freedonia interpolated to match years for generated estimates.

must also be considered when characterizing the marketability of North Carolina-generated PS.

Unlike the bottle grade resins (PET and HDPE), a low recovery rate can be expected for PS. The estimates of marketability in this chapter have been based on the amount of each resin in the waste stream. The true amount of recovered resin will be much less than what is estimated in Figure 8.

CONCLUSION

Although the market for recovered PS improved between 1996 and 2000, the future appears bleak for maximizing recovery of North Carolina generated polystyrene. For both 1996 and 2002, North Carolina generated PS represents half or more of national demand. Based on this analysis, any rapid, large-scale expansions in the state's polystyrene recovery would apparently meet substantial demand barriers. The resin's other recycling barriers ¾ low weight to volume, potential high contamination, and the current price crash ¾ will also make it difficult to expand recovery.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for PS in North Carolina presented in this section.

- Given the difficulty in recycling polystyrene resin, North Carolina generators and users of polystyrene products should maximize cost-effective polystyrene reuse efforts and continue efforts to find and use recyclable or reusable alternatives to PS.
- The polystyrene industry should do more to fulfill growing demand for polystyrene resin from recycled sources rather than virgin. Capacity shifts from virgin to recycled will strengthen and stabilize recycled PS markets and send strong signals to collectors and processors to recover more PS.

[1] Society of the Plastics Industry, *Facts & Figures of the U.S. Plastics Industry*, p.79.
[2] "Study Indicates Recycling Level for Polystyrene Fill Reaches 30%," *Modern Plastics*, April 27, 1998, as downloaded from http://www.modplas.com/news/week/98o427.htm.
[3] Society of the Plastics Industry web page: http://www.socplas.org/industry/stat3.html
[4] "Plastic Recycling's Problem Children," *Resource Recycling*, October, 1997, pp. 32 – 37.
[5] Block, Debbie G. "Recycled PS Prices Go Up and Down," *Plastics Technology*, March 1998, p. 65.
[6] Alliance of Foam Packaging Recyclers, brochure: "Expanded Polystyrene (EPS) Packaging Recycling Collection Sites."
[7] Personal communication, Betsy DeCampos, Association of Foam Packaging Recyclers, July 1, 1998.
[8] Personal communication, Ray Ehrlich, Polystyrene Packaging Council, July 25, 1998.
[9] Smith, Sarah, "Recyclers looking up, despite downside," *Plastics News*, January 19, 1998, p. 10.
[10] "Plastic Recycling's Problem Children," *Resource Recycling*, October, 1997, pp. 32 – 37.
[11] Smith, p. 10.
[12] "Resins '98: Sea Change in Supply," *Modern Plastics*, January, 1998, p. 76.
[13] http://freedoniagroup.com/ppv-scripts/

Carpet and Carpet Pad ▪ Post-Consumer Textiles

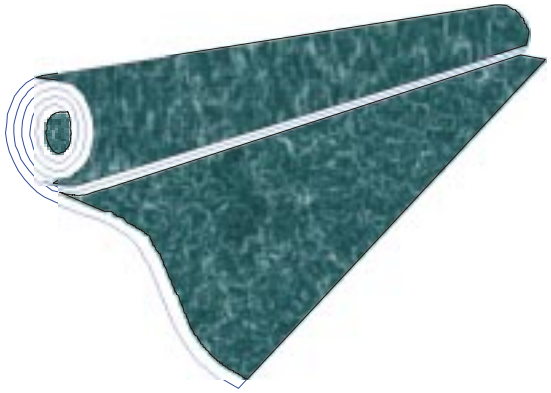
Textiles

Textiles: Carpet & Carpet Pad

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



Although closely related in function, carpet and carpet pad are different in material composition. As a result, the recycling processes for these two materials are different as well. This report focuses primarily on carpet recycling and its potential growth in the southeastern United States. It also addresses the more established recycling infrastructure for carpet pad recycling.

CARPET OVERVIEW

The carpet recycling industry is still developing. Carpet fibers and backing material are comprised of a wide variety of materials, making it difficult to develop standard recycling technologies. Also, the material is bulky, resulting in high collection costs. There are currently no carpet recycling facilities in North Carolina, which makes transportation costs for recycling a larger factor. Thus, a majority of waste carpet in North Carolina is being landfilled.

Within the past few years, several carpet manufacturers and other related material suppliers have begun to invest heavily in carpet recycling processes. These processes include the following: direct re-use, refurbishment, recycling into new carpet face fiber, recycling into other plastic products, recycling carpet backing into new backing, or producing a recycled-content carpet backing derived from melting different types of backing and fiber materials together.

Most recycling programs, which are typically operated by carpet fiber manufacturers, provide recycling services when new product is installed. For the most part, these programs are not free. There will usually be an associated charge equal to at least the local tipping fee.[1] The customer typically has to pay the cost of shipping the material either to a collection facility or to a mill and has to pay more up front for the new carpet to cover the cost of recycling the old carpet. Some programs have proven to be cost-effective, but a majority pass additional costs onto consumers, making it difficult for some carpet recycling businesses to increase the amount of material being recovered.

Data were not available on the total amount of carpet being recycled by the various new recycling operations. A survey of some of the major carpet recyclers nationwide indicates that the capacity exists or soon will exist to recycle a large portion of the waste stream. Provided collection and sorting can be performed cost effectively, the supply of carpet waste from North Carolina will continue to meet demand.

SUPPLY

Generation

Annual carpet production for the United States market equals 1.5 billion square yards (3.18 million tons). Carpet typically lasts from 7-10 years (residential) or 5-8 years (commercial). Re-carpeting accounts for approximately 55 percent of all carpet sold, generating annual waste of approximately 1.75 million tons, according to the National Association of Home Builders (NAHB). This tonnage represents nearly one percent by weight, but nearly two percent by volume, of municipal solid waste.[2] Because carpet is a durable good, the supply of the material for recycling is the estimated amount ready for disposal, not the amount of new product sold each year. Figure 1 shows the estimated per capita supply of carpet to be approximately 13 pounds per person per year.

Figure 2 shows the estimated total supply of carpet waste for North Carolina for 1998-2002. The projections are based on the current per capita generation rate of 13.08 pounds per person per year, multiplied by the state's population projections. Carpet production and carpet waste production vary depending on the state of the national economy. An increase or decrease in commercial and residential construction will affect the future supply of a durable good after its useful lifetime. For the purpose of this study, we assume future supply will remain relatively constant.

Figure 3 presents the different carpet fibers by type and the percentage of the marketplace for each. This information is important, since most of the existing recycling programs handle only certain types of fiber. In particular, a large number of the programs take only nylon 6 or nylon 6,6 materials.

Carpet is available in two forms: tiles and rolls. Carpet tiles are made primarily for business and industrial uses, whereas rolls of carpet are typically applied as household floor covering. Both types of carpet are constructed with face fiber, primary and secondary backing, and an adhesive layer. Residential carpet is 30 to 40 percent fiber by weight, while commercial carpet is only 20-30 percent fiber by weight.[3]

Based on these estimates, the supply of waste carpet fiber and backing materials in North Carolina for 1997 are broken down in Figure 4. For recyclers of face fibers, the total supply of all material is estimated to be 15,707 tons. For recyclers of backing materials, the total supply is estimated to be 32,920 tons. For recyclers of both materials, the estimated supply is 48,627 tons.

Recovery

No national or state data were available to quantify the amount of material being diverted from the waste stream. Such data is typically provided by industry trade associations. Although the carpet manufacturing industry has an established trade association (The Carpet and Rug Institute),

Figure 1. Per Capita Carpet Waste Supply

National Supply*	1,750,000
National Population (1997) **	267,636,061
Per Capita Generation - Tons	0.00654
Per Capita Generation - Pounds	13.08

Sources:
*NAHB Web site: http://www.nahbrs.org/homebase/factshee/wstcarpt.htm
**U.S. Census Bureau Web site:
http://www.census.gov/population/estimates/nation/popclockest.txt

Figure 2. Total Supply of Waste Carpet in North Carolina

	1997	1998	1999	2000	2001	2002
North Carolina Estimated Population*	7,436,690	7,542,996	7,641,684	7,733,097	7,811,951	7,891,238
Supply of Carpet Waste in North Carolina	48,627	49,322	49,967	50,565	51,080	51,599

*Source: N.C. Office of State Planning

Figure 3. Market Share of Different Carpet Face Fibers

Fiber Type	Percent*	1997 Waste Carpet Supply[2] (Tons)
Nylon 6,6 / Nylon 6	59.3%	28,836
Polypropylene	33.7%	16,387
Polyester	6.6%	3,209
Wool	0.4%	195
Total	**100%**	**48,627**

*Source: Carpet and Rug Institute, "Industry Review," 1998. Figure 2. 1997 Estimated supply of carpet waste in North Carolina

Figure 4. Estimated Breakdown of North Carolina Waste Carpet Fiber and Backing

	Carpet Waste (%)*	Total Carpet Waste (Tons)	Face Fiber (%)	Total Face Fiber (Tons)	Backing (%)	Total Backing (Tons)
Commercial	27%	13,129	25%	3,282	75%	9,847
Residential	73%	35,498	35%	12,424	65%	23,074
Total Supply	**100%**	**48,627**	**100%**	**15,707**	**100%**	**32,920**

*Source: The Carpet & Rug Institute

the carpet recycling industry is still in its infancy and has yet to establish an association specifically geared towards recycling. A description of recovery efforts by some end users of carpet is included in the Demand section of this report.

DEMAND

The carpet manufacturing industry, which is highly concentrated in the Dalton, Georgia, area, is the center of the national demand for carpet waste. Thus, the strongest demand for the material is in the southeastern states including North Carolina. Several new facilities in this area have come on-line, and several more are expected within the next few years. The facilities not yet on-line are mostly stockpiling materials for anticipated openings.

Carpet recycling efforts include the following: direct re-use, refurbishment, recycling fibers into new carpet face fiber, recycling fiber into other plastic products, recycling carpet backing into new backing, or producing a recycled content carpet backing derived from melting different types of backing and fiber materials together. A brief description of each effort follows, and major end users in each category are listed as well.

Re-use/Refurbishment

Carpet re-use is a recycling option made possible by the durability and relative long life span of carpet materials (five to 10 years). Quality used carpet can be sold directly to businesses or individuals or donated to charities. The capacity for direct re-use is dependent upon the quality of materials being replaced.

Carpet refurbishment is another type of re-use where materials are taken back for cleaning, fiber replacement, dyeing, or other types of enhancement. The capacity for re-furbishment will likely increase as this relatively new practice gains popularity. Re-use and re-furbishment should be supported as the best means of carpet waste reduction. Both the fiber and the backing materials are being re-used, producing the least amount of waste material.

Recycling

Mixed material recycling involves the processing of all the different fibers and backings together, to produce a new end product such as carpet backing. In this process, the material is typically shredded or pulverized and sent through an extruder. The new material is made into carpet backing or other recycled content products. According to one manufacturer, the recycled content backing exhibits stronger properties than the virgin material. Similar to re-use, this process produces little waste by using both the fiber and the backing materials. The capacity for this type of processing is not known.

Recycling carpet face fiber involves separating the fiber material (typically nylon 6 and nylon 6,6) from the backing. The process includes shaving off the face fiber or pulverizing and screening the combined materials to separate them. The fiber is then made back into face fibers or other plastic products. Type 6 nylon is made from a raw material called Caprolactam. Type 6,6 nylon is made from hexamethylene diamine plus adipic acid. Type 6 nylon is more readily returned to its raw material than is nylon 6,6.[4]

The Caprolactam can be chemically separated from carpet fibers, and re-used to produce any number of plastic products including new carpet fiber. Increasingly, the recycled material is being used in the auto parts industry, as auto manufacturers strive to increase the amount of recycled material present in new vehicles. The capacity for carpet face fiber recovery is expected to increase significantly within the next few years. Unfortunately, with face fiber recovery, only a small portion of the entire carpet is being recovered by weight (30 percent), unless the backing materials are sent to other backing recyclers.

Recycling carpet backing also starts with the process of separating the face fiber material. The face fiber is either sold or discarded, depending on its type and value. The resulting backing material is extruded into new backing or other recycled content products such as car stoppers. The capacity of this type of recycling is not known.

Major End Users

This section identifies some of the carpet recovery programs currently in operation. In most cases, the company profiles were developed from information provided directly from the companies. The information provided below does not represent an endorsement by the state.

Allied Signal, Richmond, Virginia, has formed a joint venture with DSM Chemicals North America (Augusta, Georgia) to recycle post consumer type 6 nylon carpet waste. The joint venture, Evergreen Nylon Recycling, LLC, was formed to create a carpet waste processing facility with the capacity to recycle approximately 200 million pounds of carpet waste annually. Evergreen will recapture nylon face fiber materials, through a chemical process, and produce various recycled content plastic products including new carpet fiber and automobile parts. Allied Signal is currently in the process of setting up carpet collection points throughout the country, including North Carolina. With these facilities in place, Allied will be able to consolidate volumes of the waste carpet, sort the recyclable type (nylon 6), bale it, and then ship it to the new facility in Augusta, Georgia. The new facility is expected to open in late 1999, and Allied is currently accepting and stockpiling material for the anticipated opening. Allied Signal's facility would have the potential to recycle all of North Carolina's type 6 nylon waste carpet.

BASF, Dalton, Georgia, provides an alternative to landfill disposal of used carpets through two carpet recycling programs: 6ix Again and 6ix Again Expansion. 6ix Again applies to carpets that are made from BASF Zeftron nylon® yarn. 6ix Again Expansion applies to carpets containing yarn systems other than those manufactured by BASF. In order to participate in the Expansion program, the replacement carpet must be a 6ix Again BASF Performance Certified commercial carpet. The replacement 6ix Again carpet automatically qualifies for the program at the end of its useful life. There is a $0.40 per square yard fee for used carpets returned through the Expansion program. Each of the programs requires that the participant pay the shipping costs of returning the used carpet to the nearest recycling center.[5]

Collins & Aikman (C&A), Dalton, Georgia, recycles polyvinyl backed carpet tiles. C&A's customers pay the cost of shipping, but do not pay a tipping fee for the materials. C&A shreds the carpet with the backing material, and sends it through an extrusion process. The resulting extruded material is made into backing for new carpet products. C&A recycled 200,000 square yards (850,000 pounds) of carpet in 1997 and have recycled the same amount in the first half of 1998. Their recycled content carpets are the same price as those made from virgin material. According to C&A, the quality of the 100 percent recycled content backing material exceeds the quality of virgin materials.[6]

DuPont Flooring Systems, Dalton, Georgia, is a division of DuPont, a research and technology-based global chemical, energy, and life sciences company. DuPont Flooring Systems offers a comprehensive carpet recycling system that includes the collection, transportation, and processing of used carpet. The carpets are sorted and evaluated for recycling value and processed into a variety of products, including resins for the auto industry, soundproofing materials, padding, and ground cover. Nylon 6 and nylon 6,6 are primarily used for auto resins, but all types of carpet are collected, including vinyl-backed flooring tiles. The company estimates that it generates about five percent residuals in this process. The company also is investigating carpet to carpet recycling, but is only in the research and demonstration phase. Dupont is currently getting about 180 tons of material from North Carolina annually, and about 9,000 tons of materials nationally. With its current infrastructure, Dupont could easily double the amount of materials it handles.

Interface Flooring, Atlanta, Georgia, is a producer of carpet tiles used primarily by business and industry. Through an innovative leasing program, Interface provides maintenance for carpets throughout their useful life and then takes back the material for recycling. Interface also takes back any materials they remove when installing their new carpets, regardless of the type of fiber. Interface donates re-usable carpet tiles and processes the unusable ones. The company separates carpet fibers from the backing and recycles the backing materials into new product. The nylon 6,6 fiber is currently being stockpiled, awaiting future product

development. Interface is currently handling 18,000 square yards of recyclable material per month.[7] The company sells its products in more than 100 countries, with North America accounting for about 70 percent of sales.

Milliken Carpet, LaGrange, Georgia, is a division of Milliken & Company, an international textile and chemical manufacturer. Milliken offers a carpet renewal and reuse process, referred to as Earth Square™. Using a patented technology, old carpet tiles are cleaned, re-imprinted with new patterns and colors, and re-installed. Milliken carpets are nylon 6,6; however, well-made nylon 6 carpets from competitors can also withstand the process. The turnaround time for renewing the carpet is usually 4 to 5 weeks. Customers typically re-install the renewed carpet in another location, purchasing new carpet to use in its former location. The process generates between five and 15 percent residuals, and the cost is 40-45 percent less than Milliken's highest volume style. Major customers in North Carolina include Duke Energy and First Union Bank.

United Recycling, Inc., St Paul, Minnesota, recycles commercial and residential carpet for carpet retailers, installers, and municipal governments. United is a vertically integrated company that collects, processes, and recycles/remanufactures carpet waste. United manufactures extruded plastic products from the collected carpet.[8]

Recycled Content Carpet Manufacturers

Numerous companies including Image Industries, Shaw Industries, and Talisman Mills produce recycled PET/polyester fiber carpet. As the price of nylon carpet increases, more carpet manufacturers are beginning to use less expensive polyester fibers or blends creating a larger market for competitive recycled-content carpets.[9] However, the processing technology to recycle the fibers back into PET for re-manufacturing has not yet been developed.

Image Industries, Summerville, Georgia, manufactures recycled-content carpets using post-consumer plastics. Image produces most of the fiber and yarn needed for its carpet production, and produces its own polyester fiber from materials recycled internally. Image Industries converts polyethylene terephthalate, or PET, containers into clean PET flake, some of which is melted down into pellets. A small portion of this recycled PET is sold in flake and pellet form to other manufacturers for use in molded packages, strapping, sheeting and custom non-food PET bottles. The rest of the recycled PET is extruded into polyester fiber. Most of this fiber is used in the production of Image's carpet, but some of it is sold to other manufacturers as fiberfill for pillows and various other uses in the home furnishing and textile industries. In its recycling plant in Summerville, Georgia, Image has the capacity to process more than one billion plastic containers every year. For January through September of 1998, Image recycled approximately three million pounds (1,500 tons) of PET from North Carolina.

SUPPLY / DEMAND RELATIONSHIP

Programs for carpet recycling are developing rapidly, and infrastructure will need to be developed to meet this demand. Carpet recycling companies typically require the customers to cover the cost of transporting the materials to processing centers. For large commercial jobs, the economics of recycling are more likely to be favorable when compared to the cost of disposal at local landfills or incinerators. However, for smaller commercial and residential jobs, the financial benefits from recycling the material can be marginal without centralized collection to consolidate larger volumes of materials.

Prices

The variables to consider when deciding whether or not to recycle carpet waste are different for the consumer and the recycler, as indicated below.

Consumer

- Cost of newly installed carpet
- Quantity of carpet waste
- Material type
- Disposal fees
- Recycling Revenues
- Cost of collection and transportation to market

Recycler

- Revenues from disposal fees
- Processing costs
- Value of end products
- Disposal costs for residuals

As the infrastructure for carpet recycling grows, some of the costs, such as collection and processing, will likely decrease. Also, as the markets for recycled materials grow, it is likely that the value of the end products will increase as well. However, it is unlikely that disposal fees for residual materials will decrease. Thus, it will be increasingly important to consumers and carpet recyclers to recover as much of the material as possible.

CONCLUSION

The key to increasing carpet recovery lies in establishing the collection infrastructure. Because of its relative bulkiness and the distance to market, carpet can be difficult to cost effectively recycle. Some recycling companies are start-

ing to develop collection facilities to help consolidate volumes of material for more efficient transportation.

RECOMMENDATIONS

- The state should consider programs to promote the development of recycling infrastructure by working with existing recycling companies, material recovery facilities, private waste haulers, or carpet retailers and installers that are interested in collecting waste carpet. Being strategically located near the center of the national demand for carpet materials in Georgia, North Carolina has the opportunity to cost-effectively transport materials to the newly developing carpet recycling businesses.

- The state also can work with entrepreneurs to develop the following business opportunities:

  Re-use and re-furbishment: These businesses can range from very simple carpet cleaning and replacement operations to more specialized reconditioning and repair services. This type of service could be an add-on business to existing carpet retailers and installers.

  Material collection: Recycling/processing businesses are typically capital intensive, and are often started by larger multi-national corporations. The opportunities for small businesses in carpet recycling are mainly with material collection, sorting, and consolidation. The carpet recyclers are working to set up collection/consolidation facilities throughout the nation. This could be a stand-alone business or an add-on service to an existing recycling or carpet installation business.

- The carpet recycling industry is in need of a trade association to help the industry grow and to increase recycling rates. The Carpet and Rug Institute could possibly take on this role, or industry representatives could start a new organization.

- Collaboration needs to be encouraged within the carpet recycling industry. Most of the different recycling processes are highly specialized and capital intensive. Recycling companies need to work together to recycle as many of the different materials as possible. For example, carpet fiber recyclers should work with recyclers of carpet backing material.

- State agencies should make it a priority to recycle carpets that are being replaced. Additionally, in the bidding process for purchasing new carpeting, agencies should specify recycled content carpets or carpet from manufacturers with take-back programs that ensure re-use or recycling.

CARPET PAD OVERVIEW

Polyurethane foam, both prime and bonded, makes up approximately 89 percent of all United States carpet pad. Each year, close to 350 thousand tons of post-consumer and post-industrial polyurethane foam trim is compressed, baled and transported to more than 30 United States factories where it is recycled into bonded carpet pad, referred to as re-bond. Post-industrial sources of polyurethane trim include furniture (from sofas, chairs, and mattresses), automotive interiors (from door panels and seat cushions), textiles, and clothing.

Synthetic carpet pad, which is made by needle-punching off-grade carpet fibers, constitutes approximately five percent of the current carpet pad market. Sponge rubber carpet pad totals approximately four percent of the market and is manufactured at three United States plants. Natural fiber underlay, which includes hair underlay and rubberized jute, comprises about two percent of the carpet pad market. Only one United States facility manufactures hair underlay pad. Most of these pads are disposed at the end of their useful life.

NAHB reports that carpet pad recycling is relatively commonplace and attributes this success to the homogeneity and market dominance of polyurethane pad and the well-established collection infrastructure for used pad.[10] Although North Carolina data on carpet pad recycling were not available, most recyclers indicate strong demand for this material. The infrastructure is primarily supported by carpet dealers, and there is almost no local government collection activity.

SUPPLY

The NAHB estimates that 125,000 tons of carpet pad waste are generated annually in the United States, primarily from residential re-carpeting.[11] Assuming that North Carolina generates waste pad at the same rate, this translates into about 3,470 tons of waste carpet pad in North Carolina, or just under one pound per person in 1997.

The NAHB also quantifies carpet pad recycling and has found that it is relatively commonplace. An estimated 62,500 tons were recycled nationally last year, representing 50 percent of available post-consumer scrap.[12] The market dominance of polyurethane pad and a well-established collection infrastructure for used pad nationally has contributed to this relatively high recovery rate. No data were

available on the amount of pad collected in North Carolina; however, assuming that North Carolina's recovery rate is the same as the national level, about 1,740 tons were recovered in North Carolina last year.

A number of carpet dealers and other installers take back used pad for recycling. Take back programs are typically operated as follows: when new product is installed, dealers collect waste pad, transport it to their facilities, bale it and send it to pad manufacturers. Often the carpet dealer receives a per pound discount on its next order of pad in exchange for the waste pad. At least one carpet dealer in the Triangle formerly accepted pad waste from outside sources and expressed a willingness to consider doing it again, provided it is cost-effective.

Of the four recycling businesses listed as markets for carpet pad in the *Directory of Markets for Recyclable Materials (Sept. 1997)*, only two are currently handling pad.

Motile, Inc., Statesville, North Carolina, accepts prime and re-bond polyurethane for recycling. The company processed about 350,000 pounds (175 tons) of waste carpet pad in 1997, primarily from carpet dealers. Motile also collects cushion from the furniture, bedding and automotive industries. Currently the company is paying carpet stores a per pound fee and providing dumpsters. Motile then bales the material and sells it to carpet pad manufacturers. The company is also working with the City of Charlotte to collect pad at three of its convenience centers. According to Motile, the City's material is less contaminated than materials received from installers.

Two recycling business listed in *The Directory of Markets for Recyclable Materials* have discontinued handling carpet pad altogether, while another — **Harmony Industries, Inc**., **High Point, North Carolina** — has not handled it in the past year but is willing to do so and has markets for the material. The barriers to successful pad recycling, as indicated by North Carolina processors, are varied and include: fluctuating prices, material that is difficult to bale, insufficient supply, and low landfill fees.[13]

DEMAND

The Carpet Cushion Council estimates that 75 percent of all pad is re-bond (i.e., recycled content), made from a mixture of post-consumer pad, post-industrial trim, and other materials. According to the Council, domestic demand for waste carpet pad exceeds supply, with about 15 percent of United States supply coming from overseas.[14] In North Carolina, most recyclers indicated that demand is strong, especially in the major metropolitan areas of the state.

The cost of post-consumer pad, or pick-up scrap, is tied to the price of process scrap. Currently, process scrap is going for $0.30 to $0.40 per pound, and pick-up is worth about $0.14-0.18 per pound. In this range, carpet dealers have indicated that it is not cost-effective to accept material from outside entities (i.e., other installers, local governments).

CONCLUSION

National organizations cite a healthy recycling infrastructure for carpet pad initiated by carpet dealers, installers, and remodelers, and this infrastructure is in place in North Carolina. Nevertheless, it is estimated that over 1,700 tons of waste pad goes to landfills in North Carolina In addition, some recycling businesses, especially those that handle multiple materials, have difficulty handling carpet pad, and most local governments have no outlet for recycling waste carpet pad.

RECOMMENDATIONS

- The state could work with existing recyclers, either carpet dealers or processors, to encourage residential collections in the major metropolitan areas similar to the limited collection occurring in Charlotte, North Carolina. Both local governments and carpet dealers have expressed interest in working together to collect carpet from residents and small businesses. Any assistance the state should provide in "brokering" such collections, including small grants to help local governments purchase collection containers, could help divert additional materials from landfills.

- In conjunction with this effort, the state should educate installers and remodelers about the opportunity to recycle carpet pad, especially in major metropolitan areas, and link them with local processors or end users who want the material.

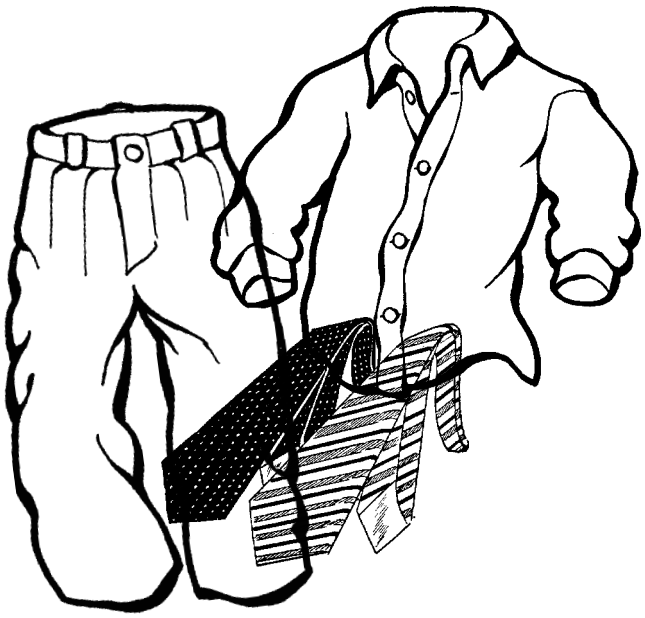
[1] Personal communication with Carroll Turner, Carpet and Rug Institute, November 2, 1998.
[2] http://www.nahbrs.org/homebase/factshee/wstcarpt.htm
[3] Carpet and Padding: Reuse & Recycling Opportunities, NAHB Research Center, Inc., 1998.
[4] Personal communication with Carroll Turner, Carpet and Rug Institute, November 2, 1998.
[5] Personal Communication with Tim Blount, Manager of Recycling Operations, BASF, September 16, 1998.
[6] Personal Communication with N. Dobbins Callahan, Collins and Aikman, September 22, 1998.
[7] Personal Communication with David Whitley and Mike Bertolucci, Interface Flooring, September 18, 1998, and September 22, 1998.
[8] Carpet and Padding: Reuse & Recycling Opportunities, NAHB Research Center, Inc., 1998
[9] Carpet and Padding: Reuse & Recycling Opportunities, NAHB Research Center, Inc., 1998
[10] Source: NAHB website. http://www.nahbrc.org/homebase/facstshee/wstcarpt.htm
[11] Ibid.
[12] Ibid.
[13] Processor surveys.
[14] Personal communication, Bill Oler, Executive Director, Carpet Cushion Council, September 28, 1998.

Textiles: Post-Consumer

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

The textile recycling industry is one of the oldest and most established recycling industries in the country. In fact, it is not uncommon to find textile recyclers who have been in business more than 50 years. Broadly defined, textiles encompass almost anything made from fabric, including clothing, carpets, and car seats.[1] This report focuses on the recycling of post-consumer textiles rather than post-industrial textiles, because post-industrial textiles are (1) outside the scope of municipal solid waste as defined by the EPA and (2) have traditionally been recycled at higher rates.

For the purposes of this report, post-consumer textiles are defined as:

- used clothing such as old garments, paired shoes, belts, purses, etc.
- used linens such as sheets, towels, pillow cases, draperies, etc.

Similarly, the Council for Textile Recycling defines post-consumer textiles as "textile waste from the home such as used or worn clothing, bed linens, and towels that can be collected and recycled."[2] Both definitions include materials commonly collected by textile recyclers; however, the definition of post-consumer textiles varies from one recycler to another.

Although textile recycling is well established, the collection of post-consumer textiles directly from local government sources is a relatively new and rapidly growing practice in North Carolina. This growth trend is likely to continue in the state for some time. Currently, North Carolina is recovering at least eight percent of its post-consumer textiles and perhaps as much as 15 percent.

A majority (61 percent) of the post-consumer textiles collected for recycling is exported to other countries.[3] As a result, the strength of the textile recycling industry is closely tied to foreign economies. Volatility in these economies,

Figure 1: Estimated Generation (Tons) of Post-Consumer Textiles in North Carolina, 1997 and 2002[5]

	1997	2002
Used Clothing	152,482	173,607
Linens	20,793	23,674
Total	**173,275**	**197,281**

Figure 2: Characterization of Post-Consumer Textiles Generated in North Carolina, 1997 and 2002[6]

	Residential		Commercial	
	1997	2002	1997	2002
Used Clothing	91,489	104,165	60,993	69,443
Linens	12,476	14,204	8,317	9,469
Total	**103,965**	**118,369**	**69,310**	**78,912**

among other factors, has hurt the textile recycling industry in recent months.

SUPPLY

Generation

Generation of post-consumer textiles in North Carolina was determined using Environmental Protection Agency (EPA) estimates for national generation in 1996. Data were extrapolated to represent national generation of post-consumer textiles in 1997 and then applied to North Carolina's 1997 population. These data are presented in Figure 1. In 1997, North Carolina generated approximately 173,275 tons of post-consumer textiles, or almost 47 pounds per person per year. This number could increase to 197,281 tons by 2002, or almost 51 pounds per person per year, representing over 13 percent growth in overall textile generation from 1997 to 2002. This projection is based on EPA estimates for 2000 extrapolated to 2002 combined with projected population growth.[4]

The generation of used clothing and linens can be further characterized by the source of generation: residential and commercial. As is apparent from Figure 2, residential sources generate the larger portion of used clothing and linens generated in North Carolina. Commercial sources, although smaller, also generate significant quantities of used clothing and linens.

Recovery

Nearly 14,300 tons of post-consumer textiles were recovered in North Carolina in 1997, representing an eight-percent diversion rate. This figure likely underestimates recovery, as it fails to account for several sources that may increase the recovered tonnage substantially. The data, which are primarily from textile recyclers, account for a portion of the material collected by charities but fail to account for domestic reuse (the percentage of donations designated for resale) by several large charities. This assessment also fails to account for post-consumer textiles sales from used clothing retail outlets and yard sales. Furthermore, the textile recyclers identified during this assessment do not represent an exhaustive search for textile recyclers, and in some cases, the recyclers contacted were unable to provide data on recovery from North Carolina.

Due to shortcomings of these data, it is likely that North Carolina's actual diversion rate is significantly higher, perhaps as high as 15 percent. Based on EPA data, the national recovery rate for used clothing and linens in 1996 was about 14 percent. Although no specific figure could be found, the Council for Textile Recycling and the Secondary Materials and Recycled Textiles Association estimate recovery to be under 25 percent.[7] The recovery of post-consumer textiles in North Carolina is estimated in Figure 3.

Local government collection of used clothing and linens in North Carolina has grown rapidly during the past year. In fact, one county collection program added during fiscal year 1997-98 provided enough textiles to double the tonnage reported by all local governments the previous year. Additionally, many of the textile recyclers contacted during this assessment indicated interest in expanding or adding programs in North Carolina. State agencies are also collecting post-consumer textiles. The North Carolina Department

Figure 3: Estimated Recovery of Post-Consumer Textiles in North Carolina, 1997 and 2002

	1997		2002	
	Tonnage	**Percent Diversion**	**Tonnage**	**Percent Diversion**
Recycled	9,268	5.35%	27,551	14.00%
Reused	5,000	2.89%	5,700	2.89%
Total	14,268	8.24%	33,251	16.85%

of Administration's Division of Purchase and Contract recently started a textile recycling program that recovered approximately 120,000 pounds from state agencies in the first eight weeks of the program. The program will likely be expanded further and has the potential to add at least another 500 tons to recovery in North Carolina.[8] For these reasons, it is estimated that the textile diversion rate will double by 2002 despite concerns of unstable foreign economies. (See *Demand* section below.) This increase would result in a recycling rate of almost 17 percent in 2002. Since the majority of the growth is expected from textile recyclers, the recovery rate for domestic reuse of clothing is projected to remain constant.

To assess the ability to further reduce the textile waste disposed in North Carolina, 13 programs countrywide were investigated. The average recovery of these programs was slightly more than two pounds per person per year.[9] At this rate, local governments in North Carolina have the potential to recover almost 7,500 tons of post-consumer textiles a year. In 1997, local governments reported a total of only 68 tons collected for recycling, leaving substantial room for improvement.

It appears that the rural nature of North Carolina may be one of the larger constraints to increasing recovery of post-consumer textiles. It may not be possible for textile recyclers to profitably collect post-consumer textiles from rural areas of North Carolina without forming regional partnerships. In a strong market, post-consumer textiles are valuable enough that the distance to market is not a limiting factor (as it is with most recyclable commodities). In a weakened market for post-consumer textiles, however, textile recyclers may not be able to afford to collect from rural communities that do not provide sufficient quantities and quality of post-consumer textiles.

The quality of the post-consumer textiles also is a key to increasing recovery. The presence of non-textile materials, unacceptable textile materials, and moisture-related contamination was indicated by textile recyclers as problems associated with local government collections. Quality is also a concern when collecting from charitable sources. When charities receive clothing donations, the materials are culled, which in effect removes the high-quality materials and leaves a less valuable product for textile recyclers.

DEMAND

End-uses for recycled post-consumer textiles generally fall into three categories: used clothing for reuse, fibers for reprocessing, or industrial wipers. Within these categories, the Council for Textile Recycling indicates that about 35 percent is used as clothing for reuse, 33 percent is used as fibers for reprocessing, and 25 percent is used to make industrial wipers.[10] The remaining seven percent is residuals from the recycling process that must be landfilled. Overall, about 61 percent of recycled textiles are exported to other countries. Some textiles are reused domestically, but the quantity is considered to be small when compared to overall generation.

Communication with several textile recyclers indicates demand is currently at an all time low, with many facilities running below 50 percent capacity. The decreased demand is due to several factors including instability of foreign economies, the strength of the United States dollar, and political unrest on the African continent. Because of the dynamics in foreign economies, however, a static view of the current demand is not warranted. The demand for post-consumer textiles is cyclical and will rebound as foreign economies rebound, a concept well understood by textile recyclers.

Although demand is currently low, textile recyclers contacted indicated an interest in expanding programs and a willingness to accept additional materials, although at a lower price. A review of the Recycling Business Assistance Center's *Directory of Markets for Recyclable Materials* identifies 10 textile recyclers servicing North Carolina. Of these 10, only two currently work with local governments in North Carolina, but three expressed an interest in doing so. Six of the recyclers contacted currently collect post-consumer textiles from commercial sources, such as charities and retail outlets. A brief description of the two companies collecting

post-consumer textiles from North Carolina local governments is provided below.

Carolina Textile Recycling, Walterboro, South Carolina,[11] primarily collects clothing for reuse or recycling (about 80 to 90 percent of the material processed) and is working with 15 local governments in North Carolina, including the following counties: Stanly, Union, Mecklenburg, Gaston, Rowan, Alexander, and McDowell. Last year the company processed between 1.75 to two million pounds of material from counties and other direct sources (e.g., church drop-offs) and another 1.75-2 million pounds from charities. About half of their material remains in the United States, and the remaining material is exported. The material is divided between the following end uses: industrial and commercial wiping cloths, raw materials for mills, export, and direct reuse. Currently, Carolina Textile Recycling is running at about 50 percent of capacity. The company indicated an interest in working with additional local governments in North Carolina, especially in larger communities.

J.G. Thompson Enterprises (Thompson), Spindale, North Carolina,[12] handles post-industrial textiles and used clothing. The company received between five and six million pounds in 1997, primarily from North Carolina but also from South Carolina and Tennessee. Thompson is currently working with two local governments in North Carolina — Kill Devil Hills and Spindale — and is willing to consider working with additional local governments. In Spindale, the company is testing curbside collection in bags. The company is currently running at about 20 to 30 percent of capacity.

As noted above, export represents the single largest end use for post-consumer textiles. Many of the countries that receive this clothing are developing countries with annual per capita salaries commonly under $500, making used clothing the only affordable option. These countries also tend to have higher population growth rates than industrialized countries like the United States. Low salaries combined with high population growth make theses countries a key component of post-consumer textile recycling and an area for increased demand in the future.[13]

SUPPLY / DEMAND RELATIONSHIP

With 61 percent of recycled post-consumer textiles exported to other countries, the underlying supply/demand relationship is straightforward: when foreign economies are struggling, demand will drop. When foreign economies rebound, an occurrence that is very difficult to predict, the demand for post-consumer textiles should rebound, particularly for clothing that is reusable.

The Council for Textile Recycling indicates that several global factors have softened the market for textile exports. These factors include the strong value of the American dollar versus other currencies, nuclear testing in some countries that generally receive high quantities of used clothing from the United States, and the general degradation of foreign economies.[14]

United States trade policies also affect both post-consumer and post-industrial textile recycling. The North American Free Trade Agreement has resulted in many textile manufacturers moving to other countries where labor is less expensive. This shift has resulted in a decrease in the supply of industrial textile waste as well as a decrease in domestic demand for textiles or fiber from recycled textiles.[15]

These factors combined with domestic factors such as the recent strike at General Motors, a company that uses recycled fiber in automotive seats, have resulted in a marked decrease in the price paid for used textiles. Suppliers that might have received $0.05 a pound for materials in mid-1997 are now only receiving $0.02 per pound. Although a $0.03 decrease per pound does not seem like a major change, it represents a $60 decrease per ton.

Unfortunately, this price decrease occurred as textile recyclers began expansion into local government collection. It is worth noting, however, that the collection of used clothing generally requires minimal effort from local governments. Even at two cents per pound, the revenues from textile recycling can help offset the cost of recycling programs, making them more efficient on a cost per ton basis. This also holds true for commercial establishments that may realize significant savings in avoided disposal fees.

The increased interest in charitable organizations marketing directly to end-users also affects the supply and demand for post-consumer textiles. The extent to which this trend has hurt textile recyclers is hard to determine, however, one large recycler estimated that 30 percent of textile recyclers, primarily smaller companies, have been put out of business because of this trend.[16]

CONCLUSION

Although the textile recycling industry is well established, it is also an industry that is currently struggling with low demand. Unfortunately, the rapid decrease in demand oc-

curred as companies began to expand collection in North Carolina, especially from local government sources. Although the state has had a limited role in advancing textile recycling to date, the following recommendations outline ways the state can assist the textile recycling industry and better understand this component of the waste stream.

RECOMMENDATIONS

- The state should continue to educate businesses and local governments on the benefits of recycling post-consumer textiles.
- The state should offer funding through their Solid Waste Reduction Assistance Grants to encourage local governments to implement textile recycling programs.
- To increase the quantity of post-consumer textiles collected throughout the state, equitable, waste reduction based collection systems such as pay-as-you-throw (PAYT) should be encouraged. PAYT programs charge system users based on the amount of waste generated, providing financial incentives to reduce and recycle.
- The state should assist textile recyclers, where possible, in expanding operations in North Carolina. Such assistance may come in the form of helping to identify local governments with an interest in textile recycling or promoting regional local government partnerships to collect materials in rural areas. The state should further expand textile recycling by working with local chambers of commerce to coordinate drop-off programs at public centers such as shopping malls or town centers.
- Although the collection of post-consumer textiles from charitable organizations and local governments is well understood, the characterization of post-consumer textiles generated from retail outlets could not be determined during this assessment and should be further investigated.
- Similarly, characterization of post-industrial textiles should be further investigated. The Council for Textile Recycling estimates that approximately 75 percent of post-industrial textiles are currently recovered for recycling.[17] The extent to which this accurately depicts recovery in North Carolina cannot be ascertained. The state should therefore undertake a study to determine the generation and recovery of post-industrial textile waste in North Carolina.
- To further enhance the demand for post-consumer textiles, the state should purchase materials made with recycled textiles, such as wiping cloths, whenever possible.

[1] Carpet generation and recovery is the subject of another commodity profile.
[2] Secondary Materials and Recycled Textiles Association. Online Glossary. http://www.swartasn.org. 1997.
[3] Council for Textile Recycling. "Textile Recycling Fact Sheet." http://www.textilerecycle.org/ctrfacts.html. 1997
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[7] Council for Textile Recycling, Online Fact Sheet. "Don't Overlook Textiles." 1997. http://www.textilerecycle.org/ctrinfo.html
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[12] Personal Communication with Garry Thompson, Owner, J.G. Thompson Enterprises. September, 1998.
[13] Personal Communication with Bernard Brill, Executive Vice President, Council for Textile Recycling. September, 1998
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tires
oil-related
C&D
WOOD
Plastics
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metals
ORGANICS
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White Goods
GLASS
electronics

Tires

Tires

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998

OVERVIEW

Discarded, whole tires have been banned from disposal in landfills in North Carolina since March 1, 1990. An advanced disposal fee of two percent on the purchase of new tires provides funding to North Carolina counties to operate tire management programs. A portion of proceeds from the advanced disposal fee also goes into the Scrap Tire Disposal Account (STDA), administered by the Division of Waste Management (DWM). Due to a change in the law passed by the General Assembly in 1997, a portion of the STDA may be used to develop end use markets for processed tire materials. The DWM will lead a multi-departmental program through 2003 to distribute market development grants to worthy projects that consume tires generated in North Carolina. Two grant rounds have been completed to date, resulting in three grant project awards for uses of processed tires in molded products, as fuel, and in tire manufacturing.

SUPPLY

Generation

Thanks to strong state laws governing tire management, North Carolina has excellent data on the generation of discarded tires. The DWM documents the generation of discarded tires through its annual Scrap Tire Management Report.[1] Findings from the most recent report, covering fiscal year 1996-97 (July 1 through June 30), are presented in Figure 1.

In part because North Carolina prohibits counties from charging local tipping fees on tires (all local costs should be covered by distributions from the state advanced disposal fee), the state is a net importer of discarded tires from surrounding states. The DWM estimates that "normal" annual in-state generation of used tires is approximately 7.3 million tires. Thus, the 9.5 million tires includes about 2.2 million out-of state tires inadvertently managed through county programs.

Figure 1. Tires Managed in North Carolina, fiscal year 1993-94 through fiscal year 1996-97

Fiscal Year	Tires Managed
FY 1993-94	7.6 million
FY 1994-95	9.3 million
FY 1995-96	9.2 million
FY 1996-97	9.5 million

Figure 2. Estimate of Tire Generation (Supply) through 2002

	1996	1997	2002
In-state tires	7.3 million	7.54 million	7.89 million
Out-of-state tires (managed by NC county programs)	2.2 million	2.0 million	1.0 million*
Total tire supply	9.5 million	9.54 million	8.89 million

*Reflects successful efforts to stop out-of-state influx.

The DWM hired a designated staff person in fiscal year 1997-98 to work with counties to stop the influx of out-of-state tires. As this program grows, the amount of tires managed by local governments in North Carolina will likely decrease. Private processors of tires in the state will continue to receive some out-of-state tires directly, and that number may grow as North Carolina's tire recycling infrastructure strengthens. (See *Demand* section below.) Currently, tire processors located in North Carolina already manage about four million tires directly from out-of state sources (in addition to 9.5 million tires managed largely through local programs).

The number of in-state generated tires managed will grow as North Carolina's population increases. A rule-of-thumb in estimating tire generation is one discarded tire generated per person per year, which can be used to project the in-state tire "supply" through 2002. The other variable in North Carolina's tire management effort is the number of out-of-state tires that will be managed by local government programs over the coming years. Figure 2 provides an estimate of tire generation (or available supply) through 2002.

Recovery

According to the fiscal year 1996-97 *Scrap Tire Management Report*, six companies managed the vast majority of generated scrap tires in North Carolina. These companies reported diverting approximately 4.7 million tires from disposal, or about 45 percent of what they received in fiscal year 1996-97. The report estimates the end uses to which the diverted tires were directed, as represented in Figure 3.

A majority of the remaining 55 percent of tires (about 5.8 million tires) that are not diverted from disposal in North Carolina go to "monofills," or landfills allowed to take only one kind of material. The largest monofills are also controlled by a few of the six companies mentioned above. Conceivably, the tires disposed at these monofills represent a future potential supply that could be "mined" and returned to productive use. The cost and challenge of retrieving and processing the disposed tires will be quite formidable, however, and may not be feasible until high value-added markets are developed for processed tire material. Thus, the most likely available supply to meet any growing market demand will be the portion of annual generation of tires that are currently disposed.

Prices and Market Dynamics

Tires are currently a negatively priced commodity (i.e., processors charge a fee to receive and convert tires into usable products). Such products can range from very fine, metal-free "crumb" rubber for use in manufacturing rubber products to larger "chips" usable as fuel or as a substitute for aggregate. The cost charged at the gate by first line processors of tires in North Carolina was between $55 to $65 per ton in fiscal year 1996-97.[2] In effect then, the market price for whole tires is currently about -$60 per ton.

The negative market value of tires reflects at least two factors: 1) the high cost and difficulty of collecting and processing tires, and 2) the immaturity of end use markets for processed tire materials. In future pricing, the first factor will remain relatively unaffected by market development efforts. The second factor, however, may begin to change substantially by 2002 as the State's market development grant program increases processed tire demand. It is unlikely that whole, discarded tires will have positive market value anytime soon (except in the retread market), but price

Figure 3. End Use Markets for Recycled Tires in North Carolina, fiscal year 1996-97

End Use Market	Approximate Numbers of Tires Recycled	Approximate Percentage of North Carolina Tires
Tire Reuse, Remanufacturing, and Retreading	473,000	5%
Tire-Derived Fuel	426,000	4%
Crumb Rubber	909,000	9%
Agricultural and Misc. Products	776,000	7%
Civil Engineering Applications	2,119,000	20%
Total	4,703,000	45%

trends should steadily improve over the next decade as competing end uses expand.

DEMAND

Market demand for tires in North Carolina should grow considerably as the result of the end-use grant program established by legislative action in 1997. With approximately $5 million in grants available between 1998 and 2003, the state can be expected to reach its goal of sustainable market consumption of all discarded tires generated on an annual basis by 2005. It is possible as well that North Carolina's processing and end use infrastructure for tires will be healthy enough to consume a large supply of out-of-state tires.

The kinds of markets that can be expected to strengthen or develop include tire-derived fuel, crumb rubber based products, construction and civil engineering projects, and possibly old-tire-to-new-tire manufacturing. The Scrap Tire Management Council (SMTC) reports that there are now more than 110 new products that contain recycled tire rubber; SMTC estimates the fastest growing new markets for processed tires include playground cover, soil amendments, and flooring/matting.[3] Details on these markets are provided below.

Reuse, Retreading, and Remanufacturing

This market category for tires includes both a long-standing outlet for discard tires¾ retreading¾ and a new, potentially large scale outlet¾ tire-to-tire manufacturing. Direct reuse of discarded tires has also been standard practice in the tire industry as tire dealers cull usable tires removed from cars and trucks for re-sale. It is assumed, however, that the direct reuse market is close to its maximum growth potential.

Retreading has been a particularly strong market for truck tires, but less so for automobile tires. The Tire Retread Information Bureau reports that 30.9 million retreaded tires were sold in North America in 1997, with 25 percent of those tires sold for use on light trucks and 61 percent for medium and heavy trucks.[4] For medium trucks, retreads constituted 58 percent of all tire replacements. The report also states that there are 1,440 retread plants in North America, many of which are small, independently owned businesses. The retreading industry points to potential cost savings and environmental benefits from using retreads, without sacrificing performance or safety. However, data presented on the World Wide Web home page of the International Tire and Rubber Association (ITRA) indicates that retread sales growth is slow.[5] Extrapolating from this data, it would appear that unless there are large switchovers or expansions in fleet usage of retreads in North Carolina, this market will remain a small potential consumer of currently disposed tires.

A more promising potential market for discarded tires is "tire-to-tire" manufacturing, the target of a recent grant cycle conducted by the Division of Waste Management. DWM has awarded a $380,002 contract to Continental General (Charlotte, North Carolina) to develop new processes and technologies to incorporate recycled tire materials into new tires. Technical challenges, including the apparent need to "de-vulcanize" recycled tire rubber, have prevented large-scale tire-to-tire recycling to date. The four-year Continental General project could result in end use demand for between two to 5.5 million PTE (passenger tire equivalents), or between 27,000 and 68,000 tons of processed tire material.

Tire-Derived Fuel

Tire-derived fuel (TDF) is by far the leading market for recovered tires nationally. The Recycling Research Institute estimates that 152 million tires, or 76 percent of all tires diverted from disposal in 1996, were burned for their energy content at cement kilns, pulp and paper mills, utility boilers, industrial boilers and dedicated TDF plants.[6] Research by the Division of Pollution Prevention and Environmental Assistance (DPPEA) in the summer of 1997 indi-

cated that TDF markets have played a critical role in the states that are consistently diverting their annual generation of tires from disposal. Few other singular end uses can consume the same large volume of tires that TDF can within a single project or application.

A TDF project for a North Carolina-based paper mill was one of two originally awarded grants in the first tire market development grant round conducted by DWM in 1998. However, the project has experienced delays, in part related to air quality permitting issues. The North Carolina Division of Air Quality has indicated that permitting for TDF projects may be complicated and difficult.

Nevertheless, North Carolina has a number of potentially large-scale TDF users, some of which have already cleared at least a few of the regulatory barriers. DWM will maintain an interest in funding TDF projects, because the experience of other states is so compelling that TDF is a critical part of a comprehensive tire diversion infrastructure. It is likely, therefore, that a sizable project will develop between 1998 and 2002 for the consumption of TDF.

Crumb Rubber

The Scrap Tire Management Council estimates that 12.5 million scrap tires were processed into ground rubber in 1996.[7] "Crumb" or finely ground rubber is used to make a variety of products from mats to flooring to rubber hoses. The American Society of Testing and Materials (ASTM) has recently developed scrap tire crumb rubber specifications, which should help the markets for crumb mature and expand.[8]

A significant potential market for crumb rubber is use as an additive to asphalt in road building. That practice has met with stiff resistance from road-builders in North Carolina, but appears to be expanding in use in states such as California, Texas, and Arizona.[9] Although technical and other concerns may eventually be addressed, the reluctance of the Department of Transportation (DOT) and road-builders in North Carolina to use rubberized asphalt preclude that market as an immediately expandable outlet for tire processed material.

Other markets for crumb rubber hold more promise. Proposals received in the first tire market development grant round demonstrate a variety of possible applications, including use in making truck tire flaps, shoe soles, furniture parts, floor tiles, playground surfaces, athletic field soil additive, and decorative landscape blocks. The wide variety of proposed uses, the aggressive search for new crumb applications and markets, and the availability of state grant funding during the next five years make crumb rubber a high potential market growth area for North Carolina tires. The value-added nature of crumb markets should also enhance the economics of tire recycling in the state.

One of the proposals awarded funding in the first grant cycle will expand the consumption of crumb rubber by a manufacturer of solid rubber tires (such as those used on refuse carts). This project will result in added end use capacity for tires in North Carolina of 940 tons of high quality crumb, equivalent to 171,000 passenger tires.

The automotive industry could have a potentially large positive impact on crumb markets in such products as belts, hoses, and other car components. Ford Motor Company in particular has begun to ask its suppliers to deliver more products with recycled content. North Carolina has a number of rubber auto parts manufacturers that may also respond to state grant incentives to switch to recycled feedstock.

Agricultural and Miscellaneous Products

Processed tires are being used in a variety of agricultural applications, including matting for livestock operations. Other products have also been made from tires through punching, stamping, and other types of crude processing (as opposed to grinding into crumb). The Scrap Tire Management Council estimates that eight million tons of discarded tires were punched or stamped into new products in 1996.[10]

This market may enjoy moderate growth in North Carolina, in part as a result of grant funding for specific projects by DWM. Proposals received in the first end use grant round included projects to make tires into road barriers, rubber door mats, and segmented farm and industrial tires. Although none of these proposals were awarded funding, it appears that product development is active in this area and may result in expanded uses for North Carolina generated tires.

Civil Engineering Applications

Along with TDF, civil engineering applications offer another large outlet for tire "chips." As shown previously in Figure 3, civil engineering projects are by far the current leading market for tires in North Carolina. The Scrap Tire Management Council reports that 10,000,000 tires were used nationally in civil engineering applications in 1996.[11] A majority of these uses were initiated by state departments of transportation that apply tire chips as fill. The other major civil engineering use for tire chips has been as aggregate for septic drain fields.

Figure 4. Recycled Tire Materials Average Price History for Selected Sizes*

Material and Size	1994-95	1995-96	1996-97	1997-98
¼ inch crumb rubber	$205	$188	$177.5	$205.90
10 mesh crumb rubber	$225	$260	$236.70	$228.90
40 mesh crumb rubber	$460	$463	$430	$474
80 mesh crumb rubber	$600	$587	NA	$546
1 inch minus TDF	$28.20	$36.60	$24.70	$23.25
Whole tire fuel	NA	-$25	-$55	-$42.50
Civil Engineering Tire Chips/Shreds (3-4 inches)	NA	NA	NA	$5.50

* All prices are for one ton of materials.

Tire fill fires in Oregon and Washington state in 1995 and 1996 put something of a damper on this use of tire chips, causing many states to re-examine this practice to make sure it was safe. The Federal Highway Administration (FHWA) investigated the fires and produced a set of interim guidelines for use of tires in embankment fills. NCDOT received approval from FHWA for its methods of constructing tire fills and has continued to apply them in projects around the state. The NC DOT Recycling and Solid Waste Management Report for fiscal year 1997 estimates that 619,530 tires were used in embankment fills that year, down from the DOT-set goal of using one million tires per year.[12] If NCDOT is able to meet or exceed its goal, it will help provide a consistent, large-scale outlet for tires in the state.

Tire chips have been used as an aggregate in septic drain fields in South Carolina for a number of years, and consumption for this use has expanded dramatically. Though not yet approved for use in North Carolina septic fields, a North Carolina-based maker of septic tire fill indicated in a tire end use grant proposal that it had already reached a production level of two million tires annually. If approval is given in North Carolina, this outlet could become even more significant for the state's tires.

Prices

The Scrap Tire and Rubber Users Directory, 1998 contains information on prices paid for processed tire materials, which is summarized in Figure 4. The table shows average prices paid in 1997-98 for a sampling of material sizes. For a more complete breakdown, see *The Scrap Tires and Rubber Users Directory*.[13]

As Figure 4 shows, prices are highest for smaller processed tire material. This advantage is counterbalanced by the extra expense and difficulty of processing tires to increasingly smaller and cleaner specifications. In general, prices for processed tire material have stayed fairly steady, fluctuating within a narrow range during the past four years.

Projected Demand

Figure 5 projects market consumption for discarded tires in North Carolina in 2002. Much of the market development will occur in response to grants given by the state of North Carolina. If these projections are reached, tires will probably have the highest recycling rate of any specific discarded material in North Carolina, approaching 100 percent of annual generation.

CONCLUSION

Market demand for tires in North Carolina should grow considerably as the result of the end-use grant program administered by DWM. With approximately $5 million in grants available between 1998 and 2003, the state can be expected to reach its goal of sustainable market consumption of all discarded tires generated on an annual basis by 2005.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for tires in North Carolina presented in this section.

- North Carolina state agencies and local governments should use their purchasing power to strengthen recycling markets for tires (for example, buying retread tires when possible and products made with processed tire materials).
- The state should work with the automotive industry to encourage use of recycled-content rubber products and to help specific manufacturers convert from virgin to recycled rubber as a product feedstock.
- The state should continue to establish sustainable, value-added markets for processed tire materials through its end-use grant program.

Figure 5. Projected End Use Markets for Recycled Tires in North Carolina, 1997 to 2002

End Use Market	Approximate Numbers of Tires Recycled, 1997 (percentage of total tires in parentheses)	Approximate Numbers of Tires Recycled, 2002, (percentage of total tires in parentheses)
Tire Reuse, Remanufacturing, and Retreading (including tire-to-tire manufacturing)	473,000 (5%)	1,520,300* (17%)
Tire-Derived Fuel	426,000 (4%)	2,000,000** (23%)
Crumb Rubber	909,000 (9%)	1,800,000** (20%)
Agricultural and Misc. Products	776,000 (7%)	899,600***(10%)
Civil Engineering Applications	2,119,000 (20%)	2,456,500***(28%)
TOTAL	4,703,000 (45%)	8,676,400 (98%)

* Assumes 10 percent growth in reuse/retreading markets and Continental General meeting half of its lower end projection of tires consumed in tire-to-tire manufacturing.
** Assumes effects of state grant-making targeted at these two categories.
*** Assumes three percent growth per year during five years.

[1] Division of Solid Waste Management, Solid Waste Section, *Scrap Tire Management Report, FY 1996-97*, October 1997.
[2] Ibid.
[3] Scrap Tire Management Council web site: http://www.rma.org./scrapfct.html
[4] The Tire Retread Information Bureau, "News Release About Tires," January 1998, p. 1.
[5] International Tire and Rubber Association website: http://www.itra.com/corporate/welcome.html
[6] Recycling Research Institute, *The Scrap Tire and Rubber Users Directory 1998*, Suffolk, CT, p. 66.
[7] Scrap Tire Management Council web site: http://www.rma.org./scrapfct.html
[8] Powell, Jerry, "Signs of Maturing Industry: The Recent Growth in Scrap Tire Recovery," *Resource Recycling*, March 1997, p 25.
[9] The Rubber Pavements Association reported in its summer 1998 newsletter that the Arizona Department of Transportation will use 2.4 million tires in roads in construction year 1998.
[10] Scrap Tire Management Council web site: http://www.rma.org./scrapfct.html
[11] Ibid.
[12] North Carolina Department of Transportation, *Recycling and Solid Waste Management Report, Fiscal Year 1997*, p. 1.
[13] Recycling Research Institute, *The Scrap Tire and Rubber Users Directory 1998*, Suffolk, CT, p. 67.


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North Carolina Department of Environment and Natural Resources
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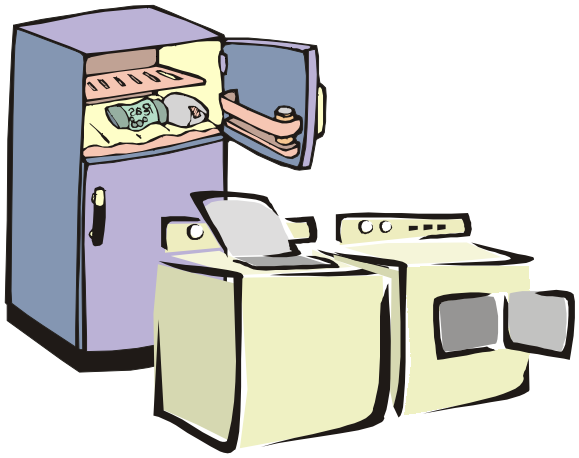
MARKETS ASSESSMENT 1998



OVERVIEW

White goods, also frequently referred to as major appliances, are a category of durable goods composed mostly of ferrous metals. In addition to ferrous metals, white goods can also contain varying amounts of other metals, glass, plastic, and an assortment of other materials. For the purposes of this report, however, tonnages will be reported as an overall white goods number.

White goods are defined in North Carolina GS 130A-290 (a) (44) as: "refrigerators, ranges, water heaters, freezers, unit air conditioners, washing machines, dishwashers, and clothes dryers, and similar domestic and commercial large appliances." Discarded white goods have some market value as scrap metal and have been recovered for years by North Carolina scrap yard dealers and metal recoverers.[1] However, according to a Steel Recycling Institute source "increased use of plastics in appliances and automobiles, primarily in major body and structural components, may impact future acceptance by scrap processors and revenue derived from the scrap value."[2]

On January 1, 1994, the advanced disposal fee on white goods went into effect ($10 for white goods that contain CFCs and $5 for white goods that do not), the result of the passage of Senate Bill 60 during the 1993 Legislative Session. The white goods fee was extended for three years through legislative action in June 1998, but at a lower rate ($3 per appliance versus the previous two-tiered fee). The white goods legislation required counties to implement a comprehensive management program for a wastestream that has traditionally been given low priority. As a result of the program all counties now have a written white goods management plan, and many closely monitor and report tonnages, costs, and income.[3]

Since the advanced disposal fee on white goods went into effect, illegal dumping of appliances and other white goods

Figure 1. Major Appliances Generated in the U. S. Municipal Waste Stream (thousands of tons)

Year	1960	1970	1980	1990	1992	1994	1995	1996
Tonnage	1,630	2,170	2,950	3,310	3,280	3,280	3,420	3,520

Figure 2. North Carolina White Goods Generation Estimates (tons per year)

	1997	2002
North Carolina Population	7,436,690	7,891,238
North Carolina Per capita white goods generation rate	27 lbs.	27 lbs.
Unadjusted North Carolina white goods generation	100,395	106,532
White goods growth rate	N/A	15 percent
Adjusted North Carolina white goods generation	100,395	122,512

has been greatly reduced; however, some illegal dumps remain. The strong impact on dumping has been due to removal of landfill disposal fees and a more convenient infrastructure for collection of white goods. The program has provided the funds needed to "jump start" county white goods management activities. Counties access the White Goods Management Account by obtaining grants that make it unnecessary for them to accumulate funds during a period of years in order to purchase needed equipment and make capital improvements. Funds in the White Goods Management Program have made it possible for counties to purchase specialized equipment for CFC recovery and to construct collection and loading areas.[4]

North Carolina counties reported collecting 46,358 tons of white goods during fiscal year 1996-97. The estimated tonnage of white goods managed has been reported by North Carolina counties since fiscal year 1991-92 when only 25,749 tons were collected.[5]

SUPPLY

Generation

A recent national study estimated the amount of white goods (referred to as "major appliances" in the study) generated in 1996 at 3.52 million tons, an increase of 1.89 million tons from the amount reported in 1960, as presented in Figure 1.[6]

This represents an increase of 115 percent during the 36-year period covered in the study or 3.2 percent per year. It was reported that generation of white goods increased by 33 percent and 35 percent during the 1960s and 1970s, respectively, but increased by only 12 percent during the 1980s. Generation numbers actually decreased slightly from 1990 to 1992 and 1994, but rebounded to increase by four percent and three percent, respectively, in 1995 and 1996. Based on this 36-year history, it is reasonable to assume that white goods generation will increase by three percent per year or 15 percent between 1997 and 2002.

White goods generation in North Carolina is estimated by multiplying the national generation rate of 3.52 million tons in 1996 by North Carolina's percentage of the United States population (2.78 percent) to arrive at a North Carolina generation rate for 1996 of 97,856 tons. Dividing that number by North Carolina's 1996 population and multiplying by 2,000 yields a per capita generation rate of 27 pounds per person per year. The per capita generation rate is used to estimate generation in 1997 and 2002, and the 2002 generation is then adjusted using the three percent annual growth rate discussed above. These estimates are presented in Figure 2.

Recovery

As stated previously, North Carolina counties reported recycling 46,358 tons of white goods during fiscal year 1996-97. However, a significant amount of white goods recovery occurs in the private sector and is not included in the public sector recovery statistics. Therefore, it is reasonable to assume that the white goods recovery rate in North Carolina approaches or may even exceed the national recovery rate of 81 percent in 1997.[7] For the purposes of this report, recovery rates in North Carolina are assumed to parallel the national recovery rate of 81 percent. Recovery rates for white goods have increased steadily during the decade from 41 percent in 1990 to the current 81 percent rate.[8] This dramatic increase can be attributed to a variety of factors, such as the enactment of landfill bans for white goods by 21 states and the fact that many other states separate white goods for recycling as standard practice.[9] However, it may be unrealistic to expect similar large increases over the next five years as recovery rates approach

Figure 3. North Carolina White Goods Recovery Estimates (tons per year)

	1997	2002
Adjusted North Carolina white goods generation	100,395	122,512
Recovery rate	81 percent	91 percent
Estimated white goods recovery in North Carolina	81,320	111,486

Figure 4. Auto Shredders in North Carolina[13]

City	Company
Charlotte	Southern Metals Co, Inc.
Greensboro	D.H. Griffin Wrecking Co. (Div of Recycling Industries Inc.)
Kernersville	United Metal Recyclers (Div. of Recycling Industries Inc.)
Statesville	L. Gordon Iron & Metal Co.

their theoretical limits. Therefore, a conservative two-percent increase in white goods recovery per year will be assumed for that period.

North Carolina recovery estimates for 1997 and 2002 are summarized in Figure 3.

DEMAND

In the United States alone, nearly 70 million tons of steel was recycled in steel mills and foundries in 1997. Recycled steel consists of approximately 30 percent home scrap (new recirculating scrap from current operations), 24 percent prompt scrap (produced in steel-product manufacturing plants) and 46 percent obsolete (old) scrap.[10]

According to the American Iron and Steel Institute, steel recovered from municipal solid waste (MSW) is a very small portion (about six percent) of the total recovered scrap used. The only real issue, then, is the continued willingness of the domestic steel and iron industry to utilize steel products recovered from MSW. Since the industry is actively promoting recovery of steel from MSW, markets seem to be secure for the recovered products.[11]

Many scrap industry observers believe that competition for supply of ferrous scrap is heating up with the installation of larger, super-sized automobile shredders. While automobile bodies are the preferred feedstock for shredders, a wide variety of materials including white goods are being fed into these machines in order to produce the stream of dense, ferrous shred desired by scrap consumers.[12] Auto shredding facilities located in North Carolina are presented in Figure 4.

In addition to the auto shredders listed in Figure 4, there is an infrastructure in place across the state that processes and delivers ferrous scrap to steel mills throughout the east. The *Directory of Markets for Recyclable Materials* lists 31 such facilities under the metal/appliance category.[14]

Major End Users

According to *Recycling Today*, there are seven large tonnage steel mini-mills in North Carolina and its border states with a combined capacity of 5.28 million tons per year. In addition to the mini-mills currently in operation, Nucor Corp. anticipates increasing capacity at its Mt. Pleasant, South Carolina plant to 2.3 million tons per year.[15] Chaparral Steel plans to open a facility in Dinwiddie, Virginia (one million tons per year capacity) in mid 1999, and Nucor plans to construct a facility in Hertford County, North Carolina (one million tons per year capacity). The capacity and location of each of these nine facilities is presented in Figure 5.

End use markets for North Carolina-generated ferrous scrap are not limited to the facilities and states mentioned. There are also several iron foundries in North Carolina and its border states that use shredded steel as recycled feedstock for their products. In addition, steel mills and foundries in Maryland, Pennsylvania, and Alabama, as well as in other locations along the East Coast, are also consuming significant quantities of North Carolina-generated ferrous scrap. For the purposes of this report, however, generation, recovery, and demand capacity tonnage estimates will be limited to North Carolina and its border states and to the facilities described in Figure 5.

SUPPLY / DEMAND RELATIONSHIP

The capacity to consume ferrous scrap at the large tonnage steel mini-mills in North Carolina and its border states alone is estimated at 5.28 million tons per year in 1997 and 7.28 million tons per year in 2002. With white goods generation estimated at 100,395 and 122,512 tons per year in 1997 and 2002, respectively, and recovery rates estimated at 81,320 and 111,486 tons per year for the same period, it is reasonable to expect that if virtually all white goods generated in North Carolina were recovered,

Figure 5. Large Tonnage Steel Mini-Mills in North Carolina and its Border States

Company	Location	Capacity (ton per year)
AmeriSteel	Charlotte, NC	450,000
AmeriSteel	Knoxville, TN	330,000
Georgetown Steel Corp.	Georgetown, SC	1,000,000
Nucor Corp.	Darlington, SC	700,000
Nucor Corp.*	Mt. Pleasant, SC	1,800,000 (soon 2.3 mil)
SMI Steel-South Carolina	Cayce-West Columbia, SC	350,000
Roanoke Electric Steel Corp.	Roanoke, VA	650,000
Chaparral Steel Co.**	Dinwiddie, VA	1,000,000
Nucor Corp.***	Hertford County, NC	1,000,000
Total Projected Capacity		**7.78 million tons**

*Nucor Corp. Mt. Pleasant, SC facility planned to expand.
**Chaparral Steel facility scheduled to open in mid 1999.
***Nucor Corp. facility planned forHertford County, N.C.

the total demand for ferrous scrap in the region would be more than sufficient to consume the tonnage generated. This would more than likely remain the case if we assume similar generation and corresponding recovery rates for North Carolina's border states. The relationship between estimated supply (generation) and demand for white goods scrap in North Carolina and its border states is presented in Figure 6. It should be noted that demand estimates are for all ferrous scrap.

Price History

Prices paid by processors for white goods scrap in the southeastern United States from 1995 to 1997 are presented in Figure 7.

The wide range of prices paid in the southeastern United States, especially in 1996 and 1997, can be attributed in part to the fact that metals segregated by type and free of contaminants have higher value to scrap metal dealers than mixed or contaminated metals. In fiscal year 1996-97 North Carolina counties reported a cost of $2.7 million to collect, process and transport white goods to market and $0.4 million in revenue from the sale of white goods.[16]

CONCLUSION

The total supply of white goods generated in the municipal waste stream in 1997 by North Carolina and its border states (434,760 tons) is estimated to be eight percent of demand (5.28 million tons). Similarly, total supply generated in the year 2002 (530,387 tons) is estimated to be slightly less than seven percent of demand (7.78 million tons). Therefore, it is reasonable to assume that sufficient market capacity exists for the consumption of all white goods generated in North Carolina and its border states today and through the year 2002, assuming that the percentage of steel in white goods is not displaced by other, less recyclable materials. Decreasing amounts of steel in appliances could have a negative impact on the value and scrap deal-

Figure 6. Estimated Supply and Demand for White Goods Scrap in North Carolina and its Border States (tons per year)

	1997	2002
Supply*	434,760	530,387
Demand	5.28 million	7.78 million

*Supply (generation) is determined by using the same formula as in Figure 1 and applying it to population estimates for North Carolina and its border states.

Figure 7. White Goods Scrap Prices in the Southeastern United States (cents per pound)*

White Goods	1995	1996	1997
1st Quarter (March)	0.5 to 1.5	0 to 20	2 to 10
2nd Quarter (June)	0.5 to 1.5	2.5 to 20	1 to 10
3rd Quarter (Sept.)	0 to 5	2 to 20	1 to 10
4th Quarter (Dec.)	0 to 5	2 to 10	1 to 10

*Source: Waste Age's *Recycling Times*, "The Market Page"

ers' acceptance of white goods in the future.

As stated previously, the continued willingness of the domestic steel and iron industry to utilize steel products recovered from MSW is key to the continued success of white goods recovery. Since the industry is actively promoting recovery of steel from MSW, markets seem to be secure.

Also, given the establishment of a more convenient infrastructure for collection of white goods by many North Carolina counties, it can be expected that white goods (made predominantly of steel) will continue to enjoy one of the highest recovery rates of any recyclable commodity in the state. However, given the discrepancy between the cost involved in collection, processing and transportation and the limited revenues from the sale of white goods, it is important to continue the North Carolina White Goods Management Program for the foreseeable future.

RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for white goods in North Carolina presented in this section.

- The North Carolina White Goods Management Program should be continued for the foreseeable future. North Carolina white goods legislation requires counties to implement a comprehensive management program for a waste stream that has traditionally been given a low priority. As a result of the program all counties now have a written white goods management plan, and many closely monitor and report tonnages, costs and income.
- North Carolina counties should continue to try to develop and promote self-sustaining metal recycling programs. Many need to make greater efforts to upgrade their white goods processing areas, enabling segregation by metal type and limiting contamination.
- Counties that do not have adequate funding for capital improvements should obtain grants from the white goods management account. These grants make it unnecessary for counties to accumulate funds over a period of years in order to purchase needed equipment and make capital improvements.
- The state should continue to encourage counties to make use of these funds to develop an infrastructure for a self-sustaining metals recycling program.
- The state should continue to encourage counties to make use of these funds to clean illegal dumps of white goods.
- Counties should take advantage of public awareness and educational materials developed by the Steel Recycling Institute, such as its appliance recycling "Round Up" campaign kit. Call 1-800-YES-1-CAN for more information.

[1] NC DENR, *White Goods Management Annual Report FY 1996-97*, October 1, 1997, p. 2.
[2] Written correspondence from Chuck Nettleship, Mid-Atlantic Region Manager, Steel Recycling Institute, October 29, 1998.
[3] NC DENR, op. cit. p. 3.
[4] Ibid. p. 1.
[5] Ibid. p. 7.
[6] EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*, May 1998, p. 56.
[7] Steel Recycling Institute, "Facts About Steel-North America's #1 Recycled Material," May 1998, p. 2.
[8] Ibid.
[9] Steel Recycling Institute, "Recycling Steel Appliances," April 1998.
[10] Fenton, Michael, "Recycling Metals, U.S. Geological Survey, Minerals Information 1996," p. 6.
[11] EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*, May 1998, p. 143.
[12] Taylor, Brian, "Hungry Mouths to Feed," *Recycling Today*, volume 36, number 8, August 1998.
[13] Taylor, Brian, "Shredder Count at 200 in U.S.," *Recycling Today*, volume 36, number 8, August 1998.
[14] NC DENR / DPPEA, *Directory of Markets for Recyclable Materials*, February 1997, p. II-9.
[15] "Ferrous Scrap Flow Map," Ferrous Scrap Supplement, *Recycling Today*, January 1998, pp. 18-19.
[16] NC DENR, *White Goods Management in North Carolina FY 1996-97 Supplemental Report on County Reserve Funds – December, 1997*, p. 1.

Wood Pallets ▪ Wood Residues

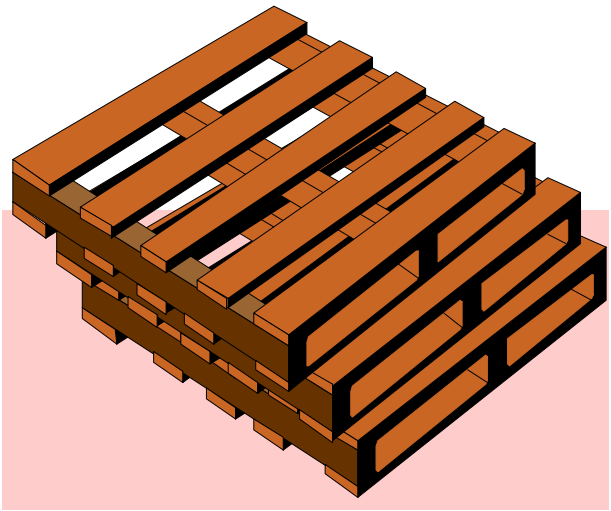
Wood

Wood: Wooden Pallets

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

Wooden pallets are a universal and critical part of product transportation in the United States economy. These pallets are often durable enough to be reused many times, either directly or with minor repair. The pallet reuse and refurbishing industry has grown dramatically during the last decade and will keep expanding as discarded pallet generators look for alternatives to disposal. Large "third party" pallet management companies have also emerged with sophisticated systems for recovering and reusing wooden pallets. In addition, many generators are seeking source reduction alternatives such as "no pallet" shipping systems. Some are switching to higher quality wooden pallets and pallets made from plastic to take advantage of extended durability. Wooden pallet generation may flatten as these trends grow.

When a wooden pallet can no longer be reused or repaired, it can be managed like other waste wood (see *Wood Residues* Commodity Profile) and processed into products such as mulch or boiler fuel. Many local governments in North Carolina accept pallets for grinding in their yard waste management programs, and many private recyclers also grind pallets that are no longer usable or repairable.

With many alternatives available, it is difficult to justify any landfill disposal of wooden pallets. Because of a growing and multi-faceted recovery infrastructure, a much higher diversion rate for pallets is possible. Moreover, a higher recovery and diversion of pallets will be an important part of the overall management of wood resources in the United States The pallet industry is a huge user of wood: approximately 4.5 billion board feet of solid hardwood (or 40 percent of all hardwood lumber produced in the United States) and 1.8 billion board feet of softwood were consumed in the United States in 1992 for the production of pallets.[1] The pallet industry uses another 2.6 billion board feet in the form of recovered pallets.[2]

Figure 1. Wooden Pallet Generation Estimate for North Carolina (tons)[3,4]

	1997	2002
Generation	433,665	474,863

Figure 2. Pallet Use of Wood Resources (billion board feet)[5]

	Total Wood	New Wood	Recovered
1992	7.89	6.89	1.0
1993	8.14	6.94	1.2
1995	8.6	6.32	2.28

SUPPLY

Generation

Wooden pallet generation estimates for North Carolina can be extrapolated from national survey data. Figure 1 shows estimated 1997 and projected 2002 wooden pallet generation. The projection is based on per capita growth from 1997 to 2002. However, as discussed below, wooden pallets may experience slower growth due to a number of factors, including movement in the industry to alternative materials.

One indication that wooden pallet generation is growing (in the absence of sales data) is found in total wood use figures in pallet manufacturing. Figure 2 shows total wood use increasing substantially between 1992 and 1995. The figure also shows, however, that recovered pallets are an increasing source of wood feedstock for the pallet industry.

A factor affecting wooden pallet generation is the potential of pallet users to switch to non-wood pallets. Wood pallets have market dominance, but movement toward alternatives is occurring. In particular, plastic and corrugated cardboard pallets may hold the most potential for capturing market share.[6]

Plastic pallets "enjoy perceived advantages…with regards to quality, durability, cost per use, handling safety, and overall performance" — which is perhaps why 37 percent of grocery distribution companies in a 1995 survey predicted they would be using plastic pallets by 1997.[7,8] Although the initial cost of a plastic pallet is as much as five times higher than a wooden pallet, the cost per use factor appears to favor plastic. To take advantage of their durability, plastic pallets work best in "closed loop" distribution systems. Some industry observers see a bright future for plastic pallets, which may have a dampening effect on the generation of wooden pallets.[9] Plastic pallets still face barriers, however, because of their initial high expense and because most pallets are used in open-loop situations.[10]

In contrast with plastic pallets, corrugated cardboard pallets work better in "open-loop" systems where durability and retrieval is not as important.[11] Corrugated pallets can readily be recycled with other corrugated packaging, thus relieving the generator of the management burden often entailed by wooden pallets. Almost a quarter of all pallets used by the health/pharmaceutical industry are corrugated.[12]

The emergence of large "third party" management companies in the pallet industry (see the *Demand* section below) may hasten the move away from wooden pallets, as these companies can more easily switch their pallet supply contracts to alternative manufacturers.[13] The switch to alternative material pallets is part of a larger trend to get more quality and use out of single pallets, and at least one industry expert estimates that the overall effect will be a declining use of hardwoods in the manufacture of pallets.[14]

Recovery

National recovery surveys have documented the rapid rise of pallet recovery: from an estimated 65.8 million in 1992 to 83.3 million in 1993 to 171.1 million in 1995.[15] The "yield" rate for recovered pallets is high: one survey found that private recyclers use approximately 87 percent of recovered pallet wood in making new or repaired pallets. They landfill less than one percent of their recovered stock.[16]

Figure 3 shows an estimate of pallet recovery in North Carolina in total and by sector. Recovery includes reuse, refurbishing, and conversion of pallets to products such as mulch and boiler fuel. Approximately 151,661 tons of pallets were recovered in 1997, or about 35 percent of the 433,665 tons of pallets generated.

Private sector recovery was estimated using data from a survey conducted by the Division of Pollution Prevention and Environmental Assistance (DPPEA). In 1997, 14 respondents reported recycling 62,942 tons of pallets, or

Figure 3. 1997 Pallet Recovery In North Carolina

	Tons	Percentage of generation
Total private sector recovery[17,18]	**120,182**[19]	**27.7%**
Reuse/refurbishing	104,558[20]	24.1%
Other uses: mulch, boiler fuel	15,624	3.6%
Total public sector recovery	**31,479**	**7.3%**
Reuse/refurbishing	2,540[21]	0.6%
Other uses: mulch, boiler fuel	28,939[22]	6.7%
Total Recovery	**151,661**	**35%**

about 15 percent of pallets generated in North Carolina. The average amount of pallets recycled per respondent (minus outliers) was 2,120 tons. Assuming that the 27 companies that did not respond recycle at the average rate, they would account for an additional 57,240 tons, or a total of 120,182 tons, which represents about 28 percent of the pallets generated in 1997. This figure may overestimate private sector recovery somewhat, because not all of these recyclers are dedicated pallet recyclers (i.e., for some of these companies, pallets represent a small portion of their recycling business).

North Carolina's pallet recycling infrastructure appears healthy. Forty-one companies in North Carolina's *Directory of Markets for Recyclable Materials* report that they accept pallets. The *1995-96 Buyer's Guide* from NWPCA (The National Wooden Pallet and Container Association) lists four additional recyclers, and the 1997 SIC code listings for North Carolina identify 78 companies in the 2448 code category (wooden pallets and skid). This list includes many of the recyclers in the *Directory of Markets*, but it also indicates that there may be more pallet recycling companies in the state than those in the *Directory*. Pallet recycling companies can be found throughout the state, and are well represented in urban areas, which presumably have higher pallet generation rates.

In addition to private pallet recyclers, local governments accept wooden pallets for mulching and composting. These entities cover many of the major metropolitan areas of the state, including the cities of Asheville, Greensboro, High Point, Winston-Salem, and Raleigh, and the following counties: Mecklenburg, Cumberland, Catawba, Cabarrus, Iredell, Gaston, and Pitt (as well as a number of other communities).

DEMAND

Market demand for pallets follows a management hierarchy of direct reuse, refurbishing (then reuse), and finally processing into other products (e.g., mulch, boiler fuel). These varying levels of potential market uses mean a high degree of flexibility in the diversion of pallets from disposal. The trajectory of overall market demand through the early to mid 1990s is positive. Demand will continue to expand, and factors like third party management will encourage that trend.

Site visits to North Carolina pallet recycling companies by DPPEA staff in 1998 yielded anecdotal data that market demand will increase. Each of the seven companies visited indicated a desire to expand their consumption of discarded pallets. Expansion at three of these companies would more likely take place on the grinding side of their operations (rather than the pallet reuse / repair side).

Direct Reuse and Refurbishing

Pallet recycling has enjoyed tremendous growth in the 1990s. A national survey documented annual dollar growth rates in the pallet recycling business ranging from 12 to 26 percent between 1992 and 1995.[3] Although the survey indicated some slowing of this growth, apparently only a small percentage of pallet recycling firms experienced no growth or negative growth. The survey also documented that many pallet recyclers are integrated, or "full service," companies that also manufacture new pallets.

Pallet recycling has grown for both environmental reasons and because of reactions to periods of high lumber prices.[24] Pallet users / generators are also driving recovery and durability issues. In addition, recycling appears to be good business for pallet companies as it is reportedly the most profitable sector of the industry.[25]

A significant development in pallet recycling is the emergence of "third-party" management and "networks" of individual pallet companies, which expand marketing and sales and extend management reach over the pool

of discarded pallets. This development is in part a reaction to generator demands for pallet vendors to help manage discarded pallets. Generators actually rent or lease their pallets from the third-party management vendors rather than become "owners" of both the pallets and related disposal problems. The vendors in turn track pallets throughout their usage and retrieve them for reuse or refurbishing. As third party management develops, it will result in greater overall recovery of wooden pallets.

These developments signal a form of consolidation among pallet companies. The industry seems to be moving from many small, family operations to larger companies and networks that reduce the independent nature of individual firms.[26] Traditionally, the barriers to entry in pallet recycling have been relatively low and thus new pallet recycling companies have been able to develop quickly and fill a market niche.[27] As third party managers and larger companies develop, these barriers may increase.[28]

A factor hindering pallet recycling is the lack of standardization of pallet sizes and quality. The most prevalent type of pallet ¾ 48"x40" in size and accessible from four sides ¾ has a high recycling and reuse rate due in large part to its widespread use. This pallet comes closest to being the industry standard. The many other size pallets constructed for specific uses are harder to market. The pallet industry has been attempting to increase standardization, a process that may be accelerated by the emergence of third party management.[29]

Pallet recycling firms pay little or no money for recovered pallets, and may in some cases charge to take loads. Thus, discarded pallets generally have little market value, and generators have to rely on cost avoidance as the primary incentive to recycle or divert pallets from disposal. Pallet recyclers may set trailers at the facilities of large generators and cover the costs of transportation in exchange for receiving the pallets free. If generated loads contain many high quality, readily reusable pallets, recyclers may pay as much as $2 per pallet (delivered to the pallet recycler). On the other hand, recyclers may charge as much as $150 to take a load with many different-sized, "off-spec," and low value pallets.

Smaller pallet generators in particular may need to pay private recyclers to take the discards or they may just take their discarded pallets to the nearest landfill. The average landfill tipping fee in North Carolina in fiscal year 1996-97 was $26.75.[30] At an assumed 55 pounds per unit, a pallet costs around $0.70 at the landfill gate, not counting the hauling or waste collection costs to get it there. Researchers at Virginia Tech University have produced a pallet recovery "business plan" model for landfills to encourage the salvaging of pallet wood at disposal facilities. Landfill diversion programs for pallets, especially when directed toward reuse and refurbishing, may be an excellent way to boost overall pallet recovery.[31]

In sales to users, recycled or rebuilt pallets enjoy a price advantage over new pallets. A typical new pallet can cost between $7 and $10, while a reused or refurbished pallet will cost $3 to $6. Pallet recyclers that can supply reusable and refurbished pallets that meet user specifications are in a good position to get the user's business. Third party management companies may enjoy a competitive service advantage in this regard, especially since they supply higher quality, readily reusable pallets

Processed Pallets

Wooden pallets recovered by pallet recycling companies that cannot be directly reused or repaired are usually processed for other uses such as mulching, composting and boiler fuel. Although, as mentioned above, one study estimated that private recyclers reuse 87 percent of their incoming pallet wood for new pallets, anecdotal evidence from DPPEA site visits to in-state pallet recyclers indicates that figure may be high.

In contrast to pallet recyclers, landfills tend to consign discarded pallets directly to grinding operations. One recent study indicated that "approximately 41 percent of the pallet material recovered at municipal solid waste (MSW) landfills was used for fuel," while another 38.4 percent went into mulch, animal bedding, composting, soil amendment, and material in particleboard. At construction and demolition debris (C&D) facilities, more than 38 percent of recovered pallet material was processed for fuel, while another 32.6 percent went for the other uses listed above.[32]

Though widely used, mulch and boiler fuel markets for pallet wood are a low value outlet. Fuel consumers rarely pay over $8 to $12 per ton delivered. Mulch markets also yield little revenue, with the exception of material that has been upgraded through colorization. Approximately 58 percent of the MSW landfills recycling pallets simply give away ground or chipped material. Of those that sell ground or chipped pallets, the average sale prices was $13.17 per ton.[33]

Reuse will continue to be the higher value market for pallets, but fuel and mulch markets will play an important role in disposal diversion for the foreseeable future. For more information on markets for processed wood materials, see the *Wood Residues* report.

CONCLUSION

North Carolina's pallet recycling infrastructure appears healthy and growing. Similarly, market demand for pallets appears strong and will probably increase. Factors like third party management may decrease new pallet production and should also reduce pallet discards. Because of the growing and multi-faceted recovery infrastructure, a much higher diversion rate for pallets is possible. Moreover, a higher recovery and diversion of pallets will be an important part of the overall management of wood resources in the United States.

RECOMMENDATIONS

The following recommendations are intended to increase pallet recovery in North Carolina.

- North Carolina should implement a statewide MSW and C&D disposal ban on pallets by 2002. This ban should not include pallets destined for recovery operations at landfills.
- Public landfills should establish incentives for generators to divert pallets away from disposal and to reuse / grinding markets.
- Generators of pallets should continue to seek source reduction and recycling alternatives, including the use of standard size, higher quality, and more durable pallets.
- Local governments should implement programs that help pallet generators find alternatives to disposal.
- The pallet industry should continue to work with its customers to institute standardization and quality standards (perhaps globally) that facilitate reuse and recycling. For their part, pallet buyers should become aware that demanding "cheap," low quality pallets usually increases pallet disposal.

[1] Bush, R. and Araman, P., "Use of New Wood materials for Pallet Containers is Stagnant to Declining," *Pallet Enterprise*, September 1997, pp. 34-38.
[2] Araman, P.A., et.al., "Potential Material Sources for Board Products: Used Pallets and Waste Wood at Landfills," Proceedings of the *31st International Particleboard and Composite Materials Symposium*, Washington State University, April, 1997, p. 190.
[3] Araman, P., et.al., "Municipal Solid Waste Landfills and Wood Pallets - What's Happening in the United States," *Pallet Enterprise,* February 1997, pp. 50-56.
[4] Araman, P.A., et.al., "Potential Material Sources for Board Products," pp. 189-195.
[5] Bush, R., Araman, P., and Reddy, V. "Pallet Recycling and Material Substitution: How Will Hardwood Markets Be Affected?," *Eastern Hardwoods: Resources, Technologies, and Markets*, Conference paper, Camp Hill, PA., April 21-23, 1997.
[6] Araman, P.A. and Bush, R.J., "Changes and Trends in the Pallet Industry," *Hardwood Market Report*, March 14, 1998, pp. 11- 14. Pallets made from metal and presswood are also gaining applications, albeit more slowly than plastic and corrugated paper.
[7] Scheerer, C., "Grocers Prefer Plastics When They Shop for Pallets, Survey Shows," *Pallet Enterprise*, October 1997, pp. 35-39.
[8] Ibid., p. 12
[9] "Alternatives Shaping the Future?" *Pallet Enterprise*, October, 1997, pp. 54-55.
[10] Correspondence from Philip Araman, Virginia Tech University, November 13, 1998
[11] Araman, op.cit., p. 12
[12] Ibid., p. 12.
[13] Ibid., p. 13.
[14] Ibid., p. 13.
[15] Ibid., p. 14.
[16] Ibid., p.14.
[17] Araman, P., et.al., "Municipal Solid Waste Landfills and Wood Pallets - What's Happening in the United States," *Pallet Enterprise,* February 1997, pp. 50-56.
[18] Araman, P.A., et.al., "Potential Material Sources for Board Products: Used Pallets and Waste Wood at Landfills," Proceedings of the *31st International Particleboard and Composite Materials Symposium*, Washington State University, April, 1997, pp. 189-195
[19] This figure estimates total pallet recovery by extrapolating the average recovery per company (based on 14 responses to a survey of 41 companies) to the companies that did not respond.
[20] Using 87 percent usage estimate in Araman, op.cit., p. 14.
[21] Reported by NC local governments in FY 1996-97 Solid Waste Management Annual Reports.
[22] 38 counties and 20 municipalities also reported accepting pallets for producing mulch/compost in their FY 1996-97 Solid Waste Management Annual Reports. Although it is difficult to determine how much of the 554,000 tons of mulch/compost produced by local governments was made from pallet, a per capita extrapolation from Araman's landfill survey would put the number at 28,939 tons.
[23] Brindley, E., "Pallet Recycling – the World of Pallet Expansion," *Pallet Enterprise*, from Pallet Enterprise web site at http://www/timberlinemag.com/enterprise/articles/Recycsu.htm.
[24] Ibid.
[25] Bush, R., op.cit., p. 14. Article cites the National Wooden Pallet and Container Association as original source.
[26] See for example articles in *Pallet Enterprise*, August 1998, pp. 55-56.

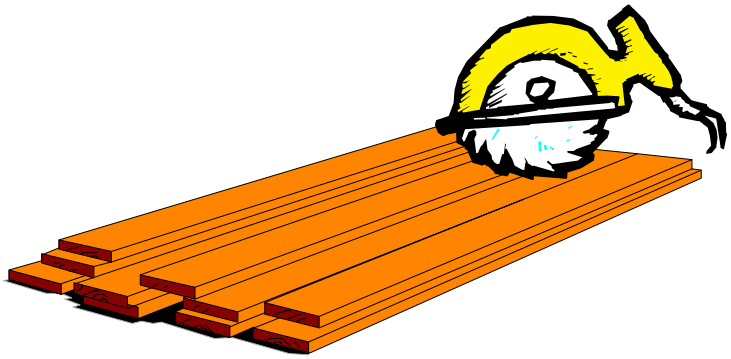
[27] Ibid., p. 14.
[28] The issue of control of recovered pallets is demonstrated in the current controversies over a new law in Washington state. See LeBlanc. R., "Companies Seek to Change Washington State Pallet Law," *Pallet Enterprise*, October 1998, pp. 44-49.
[29] For example, see "The Race to Produce Pallet Reform: Chequered Flag or Pit Stop," *Pallet Enterprise*, September, 1995, pp. 10-12. Third party pallets have thicker parts but are generally the standard 48" x 40" in size.
[30] NC Department of Environment and Natural Resources, *North Carolina Solid Waste Management Annual Report, July 1, 1996 – June 30, 1997*, p.15. NC's average tipping fee is close to a national survey figure of $21/ton average tipping fee for pallets and crates – see Powell, J., "Recovered Wood Processing: An Industry Profile," *Resource Recycling*, November 1997, p. 36.
[31] Araman, P., Bush, R., Hammett, A.L., and Hager, E., "Wood Pallets and Landfills – Status and Opportunities For Economic Recovery and Recycling," presented at WasteCon/ISWA World Congress 1998, Charlotte, NC, October 26-29, 1998.
[32] Araman, et.al., *31st International Particleboard/Composite Materials Symposium*, op.cit., p.189
[33] Ibid., p. 194.

Wood: Wood Residues

COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



OVERVIEW

Wood residues are generated in North Carolina by primary manufacturers, secondary manufacturers, users of wooden pallets and containers, wholesalers and retailers of wood products, and construction and demolition of residential and commercial properties. Primary manufacturers are firms engaged in the harvesting and processing of timbers into usable wood materials (i.e., lumber and plywood). Secondary manufacturers then use this lumber to make products, including manufactured homes, cabinets, flooring, siding, furniture, and boats. This report addresses the wood residues generated by primary and secondary manufacturers. (See the *Wooden Pallets* Commodity Profile for information on pallet waste and pallet processing residues, and the *Construction and Demolition Debris* Commodity Profile for information on wood from construction and demolition of commercial and residential structures.)

Wood residues are created in the form of bark, chips, sawdust, blocks, lumber and panel pieces, and discarded finished wood products. Historically, primary and secondary residues in the form of bark, chips, and sawdust have been recovered and reused as fuel, mulch feedstock for paper and other products, and animal bedding. Items such as blocks, lumber and panel pieces are more difficult to manage and often end up in landfills; these items typically require processing before they are marketable.

Slightly more than 10 million tons of wood residues were generated by primary manufacturers in North Carolina in 1997. About 99 percent of this material by weight was recovered for fuel and fiber use. Residues from primary manufacturing are generally reported as "green tons," which are heavier per volume than dry tons because of their higher moisture content. Generation of wood residue in the secondary manufacturing sector was difficult to determine. Estimates for this sector in 1997 ranged from 0.7 to 4.5 million tons.

Figure 1. United States Recovery of Wood Residues in 1996 (Millions of Tons)

Wood type	U.S. Generation	U.S. Recovery	Recovery Rate
MSW	15.4	5.2	34%
Primary	117	108.8	93%
Total	132.4	114.0	86%

Figure 2. United States and North Carolina Generation of Wood Residues in 1996 (Millions of Tons)

Wood type	U.S. Generation	N.C. Generation
MSW	15.4	0.4
Primary	117	3.3
Total	132.4	3.7

A majority of primary wood residues are managed using well-established markets for bark, sawdust, and wood chips. Limited data are available on the management of secondary wood processing residues. Two key factors make recovery more difficult for this sector:

- Secondary manufacturers generate a higher portion of residue in the form of blocks and other pieces that are larger than wood chips.
- Many of these are small businesses, yet processing equipment to convert larger pieces of wood into marketable chips is expensive and requires large throughput to reach the economy of scale to make it profitable.

Sufficient demand exists for recovered wood residues in processed form (i.e. sawdust, wood chips). However, the ability of a generator to reach fuel and mulch markets cost effectively is affected by a variety of factors: processing cost, transportation cost, commingling of wood with other materials, seasonal production of residues, and seasonal need for mulches and fuels. The result of the interplay among these factors is often a slim profit margin for wood residues.

SUPPLY

Estimates of the generation and recovery of wood residues vary greatly, depending on the source of generation and the emphasis of a particular study. This section attempts to estimate the wood residues generated by primary and secondary manufacturers in North Carolina based on information from two national studies and two North Carolina studies. The two national studies cited for this report were authored by David McKeever of the United States Department of Agriculture (USDA) Forest Products Laboratory at the University of Wisconsin and Phil Araman of the USDA Forest Service Brooks Forest Products Center at Virginia Tech. [1, 2]

National Estimates: McKeever

The USDA Forest Service Products Laboratory completed a national study of wood residues based on generation in 1996.[3] The study addressed municipal solid waste (MSW), construction and demolition (C&D) waste, and primary timber processing residues. The MSW and primary timber processing residues are discussed in this section. (See the *Construction and Demolition Debris* Commodity Profile for information on C&D wood residues.)

McKeever's study defined the wood in MSW as generated by residential, commercial, institutional, and industrial sources and included wooden furniture and cabinets, pallets and containers, scrap lumber and panels from sources other than new construction or demolition activities, and wood residues from manufacturing facilities. Repaired or reprocessed pallets were not included in this generation estimate (see the *Wooden Pallets* Commodity Profile for information on pallet waste). McKeever's definition of commercial wood waste is the same as secondary manufacturing residues in this report.

This USDA study reported that wood residues generated in MSW totaled 15.4 million tons in 1996. Of this, two million tons (13 percent) were recovered for recycling or composting, 3.2 million tons (21 percent) were sent to combustion facilities, and 3.4 million tons (22 percent) were unacceptable for recovery due to contamination. The remaining 6.8 million tons, or 44 percent of generated wood residues, would be recoverable if markets could be found.

This study described primary wood processing residues as bark, sawmill slabs and edgings, sawdust, and peeler log cores generated by primary manufacturers. In 1996, 30.3 million tons of bark and 86.7 million tons of wood residues were generated in this category. All but five percent of the bark and six percent of the wood residues were used to manufacture other products, including paper, nonstructural panels, and fuel (Figure 1).

Figure 3. Estimates of Wood Disposal in Landfills (Millions of Tons)

Landfill Type	U.S. Wood	South Wood	South Pallets	South Wood Excluding Pallets	N.C. Wood Excluding Pallets
MSW	21.4	10.3	2.4	7.9	0.7
C&D	16	9.9	0.7	9.2	0.7
Total	37.4	20.2	3.1	17.1	1.4

Population based estimates of North Carolina's portion of this national generation are 0.4 million tons of wood residues in MSW and 3.3 million tons of wood residues generated from primary wood processing (Figure 2).

National Estimates: Araman

Another method of identifying the level of wood residues in North Carolina is to estimate the amount of these residues being landfilled. A survey conducted by Virginia Tech determined the types and amounts of wood residue being disposed in the United States. This survey included both MSW and C&D landfills. In order to examine the regionality of wood disposal, the United States was divided into regions. The southern region included North Carolina, Virginia, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, and New Mexico.

According to this study, in 1995 wood residues accounted for 21.4 million tons (7.3 percent) of the total waste received at MSW landfills in the U.S. This material included secondary wood processing residues, C&D debris, and pallets. Forty-eight percent of the wood disposed of in MSW landfills was disposed in the South. Additionally, 2.41 million tons of pallets were disposed of in MSW landfills in the South. Subtracting the pallet tonnage from the southern wood tonnage yields 7.9 million tons of wood residues disposed in MSW landfills in the south.

Another 16 million tons of wood were disposed of in C&D landfills in 1995; of this, 62 percent were disposed in the South. Another 0.7 million tons of pallets were disposed of at C&D landfills in the South. Subtracting the pallet tonnage from the southern wood tonnage yields 9.2 million tons of wood residues disposed in C&D landfills in the south.

North Carolina accounts for 8.25 percent of the people living in the southern region as defined in this study. Multiplying the wood residues in the south (excluding pallets) by 0.0825 yields the following population-based estimates of wood disposal in North Carolina: 0.7 million tons in MSW landfills and 0.7 million tons in C&D landfills (Figure 3).

National Estimates Combined

As described above, this report focuses on primary and secondary manufacturing residues. To ensure that C&D wood residues are not counted in this category, McKeever's estimate of C&D wood was subtracted from the Araman landfill numbers. McKeever estimates that 33.2 million tons of C&D wood residues were generated in the United States in 1996. Of this, 0.8 million tons were recovered, combusted or not usable. For the purposes of estimating the maximum amount of C&D wood waste landfilled in North Carolina, the population based portion of 33.2 million tons is 0.9 million tons. Subtracting this C&D waste from the Virginia Tech based estimate of wood waste landfilled in North Carolina suggests that 0.5 million tons of wood waste (from primary and secondary manufacturers) are landfilled in North Carolina each year.

North Carolina Estimates

North Carolina has a large and active primary and secondary wood products manufacturing sector. Primary research by the North Carolina Division of Forest Resources (DFR) of the Department of Environment and Natural Resources and the Energy Division of the Department of Commerce provided some clues to the magnitude of wood products manufacturing in the state.

Data on primary manufacturers are collected and reported by the DFR.[4] These data show that just over 10.2 million tons of residues were generated by this sector in 1997. The DFR also estimates that just over 10.1 million tons (99 percent) of these residues were managed for energy or fiber recovery. Figure 4 presents these generation and recovery data. Continued waste management improvements in this sector include introduction of saw blades that make narrower cuts and computerized cutting.

Commerce's Energy Division recently conducted a survey of secondary wood product manufacturers to determine the current generation and recovery of wood residues in this sector.[5] Sixteen percent of the companies surveyed (278 of the 1,700) responded. Survey participants were asked to list their use and disposal of sander dust, sawdust, shavings, coarse, bark, and other residues in 1995 in one

Figure 4. Estimated Generation and Recovery of Wood Residues in North Carolina, 1997 (millions of tons)

Generating Sector	Generation	Recovery	Recovery Rate
Primary wood producers*	10.2	10.1	99%
Secondary wood producers**	0.7-4.5	0.6-3.9	14-87%
Total	10.9-14.7	10.8-14	73-99%

*David Brown, Division of Forest Resources
**Range is defined by data from Energy Division study.

Figure 5. Reported Use of Wood Residues by Secondary Manufacturers in North Carolina in 1995

Wood Type	Hardwood		Softwood		Total	
Use	**Tons**	**Percent**	**Tons**	**Percent**	**Tons**	**Percent**
Particleboard	36,230	6	20,482	21	56,712	8
Fuel	489,167	81	25,487	26	514,654	73
Litter	27,824	5	14,515	15	42,339	6
Other	51,755	9	37,996	39	89,751	13
Total	604,976	100	98,480	100	703,456	100

of four use categories. These use categories were particleboard, fuel, litter, and other. For the purposes of this assessment, "other" is assumed to be disposal. Since the survey respondents were not given another space to list other types of recovery, they may have recovery for something such as paper production in the "other" column. Since the survey focused primarily on recovery of residues, the materials listed in the "other" column probably did not capture all disposal methods. These factors and the low response rate make this data suitable only for a general estimate of wood residue generation and recovery. The total reported usage of each wood type is listed in Figure 5.

The survey respondents reported using 703,456 tons of wood residues and recovering 613,705 tons of these residues in 1995. Application of a 1.6 percent growth rate each year (based on population growth) yields an estimate of 726,000 tons generated by this sector in 1997 and 633,500 tons recovered. Comparing these results to McKeever's national estimates extrapolated to North Carolina, the residues generated by just 16 percent of the secondary manufacturers in North Carolina are almost double McKeever's MSW estimate for North Carolina (See Figure 2.)

To estimate the total wood residue generated by secondary manufacturers in North Carolina, data from respondents to the Energy Division study were scaled to the size of the industry. Assuming that the non-respondents generated residue at the same rate as the respondents, slightly more than 4.5 million tons of secondary wood residues are generated in the state. This number may overestimate generation for this sector, as the companies responding to the survey were typically the larger generators of wood residues.

The generators responding to the survey were also more likely to implement wood residue recovery than the average generator for two reasons. First, the larger the amount of residue generated, the more cost effective it is to install equipment to manage these residues for energy or fiber recovery. Second, because this survey focused on generation and recovery, those with recovery programs were more likely to fill out the survey. Although the recovery rate of the reporting secondary wood product manufacturers was 87 percent, actual recovery from this is probably lower. Assuming that the non-respondents to the survey recovered residues at the same rate as respondents, secondary wood processors in North Carolina recovered 3.9 million tons of wood in 1997.

Additional information on wood waste entering landfills comes from an informal survey of North Carolina's community waste management programs conducted by the Division of Pollution Prevention and Environmental Assistance in 1998. Program managers were asked to identify the top ten generators of industrial waste, to quantify how much waste was landfilled by each generator, and to identify the primary materials in each generator's waste stream. This survey attempted to identify large amounts of homogeneous waste entering landfills and target specific industries for waste reduction programs. Forty-nine waste man-

Figure 6. Tip Fees for Wood Residues[9] (dollars per ton)

Feedstock	Range	Average
Landscape Debris	$6-25	$13
Construction Lumber	$10-45	$31
Demolition Lumber	$10-50	$34
Stumps	$20-75	$47
Manufacturing Waste	$10-80	$44
Sawmill Residue	$0-3	$2

Figure 7. Prices For Processed Wood[10] (dollars per ton, f.o.b. processor)

Product	Range	Average
Mulch	$2-65	$24
Fuel	$8-20	$12
Compost Bulking Agent	$2-27	$13
Animal Bedding	$15-25	$21
Paper Making	N.A.	N.A.
Board Manufacture	$15-20	$18

agement program managers, or about 50 percent of the total, responded to the survey. The responses tended to represent more rural communities and counties with lower waste flow than non-responding counties. From these responses, nearly 40,000 tons of wood waste were identified as entering landfills in 1997. This large number for such a small sample size suggests a high presence of wood in the overall of North Carolina waste stream.

As noted earlier, national estimates of wood waste generated and disposed in North Carolina are probably low. Thus, the wood waste landfilled in North Carolina is at least 500,000 tons per year and probably higher. At 500,000 tons per year, wood residues from secondary wood product manufacturers, constitute six percent of waste entering of North Carolina's landfills. A significant portion (possibly more than 65 percent) of this wood material could be recovered, assuming the same management options as identified by McKeever.[6] In other words, North Carolina could reduce the total amount of waste going to landfills by four percent by targeting diversion programs to secondary wood product manufacturers.

DEMAND

As stated earlier, sufficient market capacity exists for wood residues in useable form (generally sawdust and wood chips). Factors affecting whether wood residues are recovered include processing cost (for material that is larger than chips), transportation cost, commingling of wood with other materials, seasonal production of residues, and seasonal demand for mulches and fuels. This section discusses some of the markets for wood residues in North Carolina Recovery efforts include, but are not limited to, the following:[7]

- Use as fuel in wood-fired boilers and burners
- Use as feedstock in paper and building material (composite panels, particleboard, and insulation) manufacturing
- Production of ground covers (mulches) and animal bedding
- Use as bulking agent in composting facilities
- Pet litter
- Production of wood framing and trim pieces from small scraps (known as fingerjointing)

There are more than 500 recovered wood processing companies in the United States and Canada.[8] Most of these companies charge to accept wood residues, and a majority (88 percent) accept pallets and crates. Forty-eight percent take in landscape debris and C&D lumber. Tipping fees for wood residues at these facilities average $27.43 per ton. This recovered wood processing industry relies on mulch and fuel markets as major end users; 96 percent of the processors sell to mulch markets, while 79 percent sell to fuel markets. Other markets include compost bulking agents (63 percent), animal bedding (32 percent), board manufacture (26 percent), and paper manufacture (21 percent).

Since many processed residues sell for a low value per ton, most processing facilities charge a tipping fee to accept unprocessed wood and then sell the processed material in a competitive market. Figure 6 lists ranges and averages of tipping fees charged by recovered wood processors. Figure 7 lists ranges of prices at which processed wood is then sold.

North Carolina tipping fees are quite low compared to national averages. They range from $20 to $50 per ton

and averaged $26.75 in 1997. These low fees provide little incentive for wood waste generators to recover wood residues by diverting material from landfills.

The *National Wood Recycling Directory* lists 90 wood processing facilities in North Carolina, 55 of which are municipal operations (usually at landfills).[11] The facilities listed in this directory accept a combination of brush, tree waste, wood pallets, C&D wood, preservative treated wood, and engineered wood. These facilities produce mulch, fuel, manufactured products (such as fiberboard), compost, animal bedding, topsoil, or feedstock for paper manufacture. Thirty-seven of the companies listed in North Carolina accept brush, tree waste, or pallets only. The North Carolina *Directory of Markets for Recyclable Materials* includes 27 companies that accept sawdust and bark. Specific markets for processed wood residues are discussed in more detail below.

Mulch and Compost Markets

Mulches and composts are two significant markets for wood residues. They tend to prefer bark and chip residues from primary wood processing rather than residues from secondary wood manufacture. Since wood residues from secondary manufacturing are kiln dried, they have a higher value in fuel markets. (See below.)

Mulches made from wood residues compete with mulches made from virgin wood chips and bark, as well as mulches made from yard trimmings. Wood mulches have more cellulose than bark mulches, which have higher lignin content. Cellulosic mulches break down and decompose faster than bark mulches. Some consumers prefer recycled wood mulch because it is less expensive, and they are more concerned with price than longevity.[12] Recycled wood mulch prices in the Southeast vary from free to $2.50 per ton ($10 per cubic yard)[13]; whereas bark and shredded hardwood mulch prices are $3.75 to $4 per ton.[14]

Previous studies have estimated the demand for compost in North Carolina to be 13,483,000 tons per year, with the vast majority of that (98 percent) due to agricultural uses.[15] The remaining markets were believed to be able to absorb 232,000 tons per year, which alone exceeded the estimated 1994 compost production of 121,400 tons. The current demand for compost is believed to exceed the current available supply, although specific demand estimates are not currently available.

Prices for finished compost vary widely across the United States and within the Southeast. Bulk sale prices for leaf compost, yard trimmings compost, manure compost, mixed solid waste compost, and biosolids compost in the Southeast ranged from $3 per cubic yard to $25 per cubic yard in a 1997 survey.[16] Average values for these products varied from $6 to $15 per cubic yard ($15 to $37.50 per ton). In Charlotte, North Carolina, bagged compost is sold for $3.50 to $4 for a 45 pound bag ($155 to $177 per ton), while bulk sales are $1.85 per cubic yard ($7.40 per ton).[17]

Fuel Markets

Wood residues represent an alternative to the combustion of fossil fuels in many areas of the country. Three major factors affect the decision to process and use wood residues for fuel:[18]

- Availability, price and characteristics of the wood residues
- Design, engineering, performance, and cost of combustion equipment
- Regulatory issues (mainly air quality)

A recent survey of solid fuel users in North Carolina determined that, in 1996, there were 322 wood-fired boilers consuming 3,673,000 tons of wood residues (approximately 31 percent of the total wood residues generated).[19] Most of these facilities are generators of wood residues that combust residues for their energy value. Growth in this market is dependent on growth in the underlying wood products manufacturing industries. The average cost for wood residue fuel is $12 per ton (f.o.b. processor).[20] This is an energy equivalent value of $1.20 per million British thermal units (mmBTU).[21] By comparison, recent prices for natural gas have been on the order of $2.20 per mmBTU.[22]

Other North Carolina users of wood residual based fuels include three electric power generators, five paper mills, six brick manufacturers, and four textile plants. The major obstacle to increasing the amount of wood residues used as fuel by these non-generators appears to be the cost of retooling combustion units to handle wood residues and the transportation economics between sources of supply and end user facilities.

An emerging market for wood residues-derived fuels is the production of ethanol and methanol transportation fuels.[23]

Manufactured Products Markets

Products suitable for manufacturing from wood residues include the following:

- Exterior siding (hardboard)
- Non-structural panels (particleboard, oriented strandboard, fiberboard)

- Fingerjointed wood lumber and trim
- Composite wood-plastic materials
- Containers and packaging (including pallets)

Comprehensive analysis of the potential demand for each of these types of products is not available. As an example of potential demand for one commodity, the annual plant capacity for production of particleboard and fiberboard in North Carolina is estimated at 7,000,000 tons.[24] Another 600,000 tons of plywood production capacity is also estimated to be available.[25]

Demand for wood residues in these markets was reported as poor by 65 percent of the wood residue processors responding to a survey.[26] One particleboard plant in New Mexico consumes 250 tons per day of recovered wood, paying about $20 per ton for clean wood residues; the average price for these residues is $18 per ton (f.o.b. processor).[27] Another company is building a 150,000 ton per year medium-density fiberboard plant in Riverside, California, which will be the first to make 100-percent recycled fiberboard. That company is also planning a second plant in Lackawanna, New York. Recent inquiries at Commerce also indicate interest by a fiberboard manufacturer interested in wood residues for fiberboard production.[28]

SUPPLY / DEMAND RELATIONSHIP

Overall, the demand for wood residues appears to be greater than the supply. Primary manufacturers have well established markets for their residues although they continue to seek higher value markets. Secondary wood products manufacturers, in contrast, must often process their residue to marketable form for reuse by potential markets. This material is often only usable as ground-up woody mulch, which has a lower market value.

Transportation costs between the point of generation and the point of reuse limit recovery, which explains why many primary and secondary wood producers reuse wood residues onsite. In addition, painted and treated wood residues have little market demand. Producing marketable products from recovered wood requires careful attention to species selection, appropriate screening equipment to yield acceptably sized chips, sampling methodology and practice, and feedstock specifications, including contamination levels and moisture tolerances.[29] This is potentially problematic for smaller secondary wood residue generators (i.e., cabinet shops) who would need to process their mixed wood residues into a form suitable for reuse / remanufacture.

Another factor affecting both the generation of wood residues and their potential reuse is the underlying availability of timber in North Carolina. A recent evaluation by the USDA Forest Service concluded that North Carolina had a timber drain / inventory ratio of 2.3 percent, which translates into over 45 years of timber availability, without regrowth or replanting, at current harvesting rates. [30] Combined with a timber drain / growth ratio of 0.53, which indicates that new timber growth exceeds timber harvest, the availability of virgin wood materials in North Carolina is keeping downward pressure on stumpage prices. For example, sawtimber stumpage prices are estimated to be $48.71 per ton, and pulpwood stumpage prices are estimated to be $6.80 per ton. These relatively low prices make it difficult to process recovered wood for reuse especially if transportation costs have to be included.

CONCLUSION

The recovery of wood residues from primary manufacturers is a mature, well-established practice. Generators of residues have existing reuse markets in place and continue to seek higher-value markets for their residues.

Less information is available on recovery of wood residues by secondary wood products manufacturers This group includes smaller generators, for whom processing and transport are more costly per ton of wood recovered. Also, little is known about wood residues generation and recovery in the manufactured housing industry, the commercial sector (i.e., building material supply centers, small cabinet shops, etc.), or the residential sector.

By conservative estimate, 500,000 tons per year of wood residues reached North Carolina landfills in 1997, constituting six percent of what was landfilled that year. Assuming that two-thirds of this wood waste is recoverable, North Carolina could reduce materials being landfilled by four percent by working with secondary manufacturers of wood products to reduce or recycle their wastes.

RECOMMENDATIONS

North Carolina should pursue several efforts to increase recovered wood residue values and to increase recovery rates for components of the wood residues waste stream.

- Encourage recovery by secondary wood products manufacturers by educating them on their recovery options and encouraging them to work together to manage their residues.
- Quantify tonnage of wood residues coming from manufactured housing, commercial and residential sources, and secondary wood product manufacturers.
- Develop model procurement specifications for recovered wood residues targeted at the manufactured product market to increase the value of

recovered residues.

- Support economic and engineering programs to assist manufacturers in converting combustion units from fossil fuels to solid wood fuel.
- Develop model wood recovery processing systems that enable entrepreneurs to understand processing costs and configurations to meet various markets.
- Quantify the demand for recovered wood residues in the fuels and manufactured product markets.

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Findings / Recommendations

FINDINGS

This section summarizes the results of the analyses of all the commodities presented previously, and assigns high, medium, or low priorities to each category. This section also presents overall recommendations to stimulate recovery and/or demand for most commodities.

Twelve million tons of municipal solid waste were generated in North Carolina in 1997, and eight million tons were disposed. Construction and demolition (C&D) debris made up the largest component of the disposed waste (29 percent), and paper made up another 18 percent. Organic materials made up about 12 percent of the waste stream, and wood 11 percent. All other materials each made up 10 percent or less.

A conservative estimate of the total tonnage of material recycled in 1997 is 4.1 million tons, which yields a 34 percent recycling rate. When the statewide recycling rate was calculated in 1995, it was estimated at 22 percent (2.1 million tons recycled and 7.6 million tons disposed).

The recycling rates for specific commodities vary. Container recovery rates tend to be low, especially for plastics. Although the paper recovery infrastructure is well established, there is still room for growth in many grades, especially magazines, mixed paper, and office paper. Some other materials are virtually untouched in terms of recycling potential, including C&D, electronics, food residuals, most plastics, and textiles.

Despite limited recovery in some categories, the 1998 assessment found a thriving industry that continues to grow and change. The past several years have seen the introduction of new technologies, expansion of collection systems, and considerable fluctuations in foreign and domestic economic cycles. In addition, recycling companies (both processors and end users) are consolidating in many sectors.

Since the last assessment was conducted, North Carolina has provided business management, technical and financial assistance to 608 businesses. In that period, 185 jobs were created and $5.05 million were invested. The total volume of new capacity created was 217,000 tons per year. More than half of that capacity was construction and demolition (C&D) debris processing.

Another significant development since the last industry assessment is the inception of a recycling business loan fund, supported by the N.C. Department of Environment and Natural Resources (DENR), the U.S. Environmental Protection Agency (EPA), and the Self-Help Ventures Fund (Self-Help). This fund will be administered by Self-Help, and the project will offer at least $660,000 in loans to recycling businesses. These loans are expected to create or retain at least 80 jobs, provide 115,000 tons per year of recycling capacity, and leverage an additional $330,000 of private investment.

PRIORITIES

The ultimate goal of this assessment is to chart the state's current recycling course and to identify where market development assistance is needed to stimulate gains in recovery. As a result of the analyses of 26 commodities in 12 categories, each commodity has been assigned a priority for action.

High priority commodities typically warrant immediate market development assistance and offer opportunities for infrastructure and market development that justify the application of technical, financial, and policy resources. They also often constitute a significant and growing portion of the waste stream or pose potential environmental and health threats. Medium priority commodities require more limited assistance and tend to constitute a smaller portion of the waste stream. Low priority commodities have mature markets and typically do not require action from the state. The recyclable materials analyzed below are divided into high, medium, and low priorities.

High Priority

C&D Debris : C&D commodities (e.g., wood, wallboard, concrete, brick, etc.) as a group need market development assistance. C&D debris represents about a third of North Carolina's waste, yet recovery efforts are limited, primarily because recovery in the state has been focused on other materials and the incentives for disposal diversion have been low. In addition, this portion of the waste stream has only recently been characterized. A variety of activities could stimulate recovery and demand, including state support of demonstration projects and recycled content procurement standards. The state should continue to identify and assist entrepreneurs that are processing various C&D materials and help expand or replicate those operations around the state. In addition, local governments should be encouraged to establish recovery operations either by contract with C&D recovery firms or through their own operations.

Organic Materials : The compost market, which represents demand for food residuals and yard waste, is still developing and needs assistance. While the demand for yard waste appears to meet the available supply; efforts are needed in several areas to improve recovery of food residuals. Demand for compost utilizing recovered edible foods, animal feeds and food residuals appears adequate to significantly increase the diversion rate. Developing efficient collection and processing techniques could stimulate recovery, and efforts to increase market awareness of the benefits of compost and mulches would further strengthen demand.

Paper : Although most paper markets are mature, recovery rates in North Carolina are below national averages, even for higher value papers such as office grades and old corrugated containers (OCC). For this reason, the state should support the development of infrastructure to improve recovery efficiency and rates. Findings for each paper grade follow:

- ***OCC***: Demand for OCC is not likely to increase beyond minimal annual growth until it has been shown that OCC recovery can increase significantly over cur-

rent levels. Small retail / commercial and residential sectors are two segments of containerboard supply that are far from reaching maximum achievable recovery levels, and they should be targeted for increased recovery efforts.

- ***Office Paper***: It appears that growth in office paper demand has exceeded growth in supply, and future supply may not be adequate to meet projected demand. Recovery in North Carolina is well below the national average and could be increased by encouraging the creation of mixed commercial paper routes and focusing on small retail / commercial generators.
- ***Old Magazines*** (OMG): Demand for OMG in the southeast region could be characterized as consistent and growing, but OMG supply remains unstable. North Carolina has potential to increase its recovery of OMG by encouraging the addition of OMG to local government collections and by focusing on long-term strategies that stimulate demand (e.g., cooperative and mandatory incentives for higher recycled content newsprint).
- ***Old Newspapers*** (ONP): Nationally, the market for ONP has a fairly stable demand structure with steady supply sources, and this trend is projected to continue in the near future. North Carolina could play a leadership role in the region by reviewing the current recycled content mandates in order to account for possible improvements in mill capacity. Increasing recycled content purchase could improve prices and overall mill appetites for recovered ONP.
- ***Residential Mixed Paper*** (RMP): The supply of RMP exceeds demand, and this oversupply is expected to continue during the next five years There is still room for growth in mixed paper recovery; however, stronger demand is needed to justify increased recovery. Research and demonstration of secondary markets for recovered mixed paper could stimulate demand, as could market building alliances focused on recycled paperboard users.

Used Oil Filters : Despite a landfill ban on used oil, a significant amount of residual oil from oil filters may have entered North Carolina landfills in 1997. According to feedback from recycling companies in the Southeast region, infrastructure and markets for all three components of used oil filters are sufficient to justify a disposal ban.

Wood : Industrial wood residues and to a lesser extent pallets are among the most promising materials in the state in terms of potential for increased diversion. The demand for wood residues in particular appears to be greater than the supply. Primary manufacturers have well-established markets for their residues and achieve high recovery rates. Secondary wood products manufacturers, in contrast, must process their residues to marketable form. By increasing recovery in the latter sector, North Carolina could reduce materials being landfilled by four percent. In addition, North Carolina's pallet recycling infrastructure appears healthy and growing, and market demand for pallets is also strong. A higher recovery and diversion of pallets will be an important part of the overall management of wood resources in North Carolina.

Medium Priority

Electronics : Although increasing quantities of computers and other electronics are being generated in North Carolina, recovery options are just developing. Existing efforts tend to be limited to larger businesses, leaving small businesses and households without recycling options. Increasing the quantity of electronic equipment recovered from these sectors would require substantial funding from local, state, or federal governments. Pilot projects might offer a chance to examine the economics of local collections and should be encouraged. Additionally, the state should develop a formal disposal policy for electronics because of the potentially hazardous components.

Plastics : Plastics should be targeted for market development assistance; however, limited actions can be taken by the state. Virgin price supports for plastic are very complex, because oil is the raw material; therefore, state actions are generally limited to encouraging the purchase of recycled content plastic products. Recycling is projected to increase 10 percent annually over the next several years, and high-density polyethylene (HDPE) and polyethylene terepthalate (PET) will remain the dominant recycled resins due to their predominance in the bottle marketplace as well as their ease of collection and separation. State and local agencies could also stimulate recovery by working with generators of linear / low density polyethylene (L/LDPE). The overall processing capacity in North Carolina is more than sufficient for the supply generated, and it is expected that the demand for recycled plastics will increase through 2000.

Used Oil : The used oil market requires limited immediate assistance from the State. Based on the current indications of strong demand, North Carolina has an opportunity to recover much of the remaining used oil throughout the state. In particular, the state should focus on increasing the recovery of used oil from the do-it-yourself sector. An advance disposal fee on motor oil purchases could be used to help finance collection.

Low Priority

Glass : Color-separated glass is a mature market and warrants little or no immediate attention from the state. The supply of processed flint and amber cullet in North Caro-

lina and the southeast is well below the potential demand. Without significant efforts to increase supply, this trend is expected to continue until 2002 and beyond. On the other hand, demand for green cullet is likely the same as supply and most likely will not deviate from this pattern to 2002. It appears overall that the focus of the glass industry is on improving the quality of the current supply rather than increasing quantity. Efforts to increase the markets for mixed cullet and to encourage more efficient handling of collected glass should be investigated.

Aluminum and Steel Cans : Used beverage containers (UBCs) have a stable market warranting little attention from the state. Demand for UBCs and other aluminum scrap remains strong enough for the material to be recycled by local governments and private industry. An increase in UBC recovery statewide depends more on improved collection efficiency than increased capacity or markets for the material. Markets for other scrap, such as steel cans, will need assistance to fulfill the potential for growth. The demand for steel can scrap continues to exceed the supply both nationally and locally, and the ability to increase steel can recycling is not dependent upon future capacity increases. With approximately 90 percent of the supply of steel cans remaining in the waste stream, new or existing recycling businesses should be able to capture the remaining share. However, market prices will continue to be negatively affected by the global economic downturn.

Textiles and Carpet : Post-industrial textiles are a mature market and warrant little or no immediate attention from the state. Post-consumer textiles are not as well established and may justify limited assistance in the form of grants to local governments. The textile recycling industry is currently struggling with low demand (again because of the global market situation), which may limit expansion of local government collection efforts in the short-term. Carpet recycling programs are developing rapidly, and infrastructure will need to be developed to meet recently increased demand. The key to increasing carpet recovery lies in establishing the collection infrastructure.

Tires : The recently established program of tire end-use grants represent a major investment by the state in tire market development, and no additional assistance is needed at this time.

White Goods : No additional assistance is needed at this time. Sufficient market capacity exists for the consumption of all white goods generated in North Carolina and its border states today and through the year 2002, assuming that the percentage of steel in white goods is not displaced by other, less recyclable materials. Continuing the North Carolina White Goods Management Program is an important strategy for the foreseeable future.

OVERALL RECOMMENDATIONS

Policy Recommendations

The following policy recommendations would stimulate recovery and/or demand for recycled materials in North Carolina.

- Implement disposal bans for recyclable materials with well-established collection infrastructure and strong market demand.
  One of the most cost-effective ways to divert material from landfills and incinerators is to enact and enforce material disposal bans or diversion policies. Such measures encourage waste reduction by either (1) explicitly excluding materials from disposal or (2) establishing disposal disincentives through surcharges on loads, weights, or volumes of a targeted material beyond a given threshold. This assessment has identified three materials with adequate recycling infrastructure to support a disposal ban: pallets, used oil filters, and OCC.

  The state should implement a statewide municipal solid waste and C&D disposal ban on pallets by 2002; this ban should not include pallets destined for recovery operations at landfills. North Carolina's pallet recycling infrastructure is strong and growing, and market demand for pallets appears strong and will probably increase. Factors like third party management may decrease new pallet production and should also reduce pallet discards. Because of the growing and multi-faceted recovery infrastructure, a much higher diversion rate for pallets is possible.

  Similarly, the state should also ban the disposal of used oil filters. More than 256,000 gallons of residual oil from oil filters may have entered North Carolina landfills in 1997. With projections of continued population growth in North Carolina over the next few decades, the issues of proper oil and filter management will become increasingly critical to preserving the integrity of the state's environment and natural resources. Because of the residual oil contained in these filters, the state should not consider the ban on used oil from landfills complete until used oil filters are also banned from disposal.

  The state should also consider implementing a statewide landfill ban on OCC. Such a ban would be an effective way to target the disparate group of small retail / commercial generators and residences that con-

tinue to discard OCC rather than recycling it. Sufficient infrastructure exists to manage OCC, and demand is strong and projected to remain so in the future. More than 30 North Carolina communities have already implemented local OCC bans or restrictions, and three states (Massachusetts, South Dakota, and Wyoming) have bans on recyclable paper including OCC.

Any material ban would be dependent on additional funds for local government recycling programs.

- Expand procurement of recycled and environmentally preferable products by state and local governments.
  State and local governments can support stabilized, long-term demand for recycled products by incorporating preferences for such products into purchasing guidelines and by specifying the highest levels of recycled content possible. The assessment of the recycling industry in North Carolina identified the following commodities as candidates for purchasing targets for both state and local governments:

  - ***Carpets****:* Agencies should make it a priority to recycle carpets that are being replaced. Additionally, in the bidding process for purchasing new carpet, agencies should specify recycled content carpets or carpet from manufacturers with take-back programs that ensure reuse or recycling.
  - ***C&D Debris****:* The state should continue to support the North Carolina Department of Transportation's initiatives for using recycled C&D materials in place of virgin materials in transportation related projects. The state should also recommend the further use of recycled C&D materials by other state agencies such as State Construction.
  - ***Electronics****:* Agencies should explore the possibility of leasing or buying computers and other electronics from manufacturers with take-back programs. Such companies would need to have reuse and recycling programs for the returned equipment. Guidelines could also include preferences for leasing programs, equipment that is recyclable or has recycled content, or equipment that exhibits other design for environment characteristics (e.g., easily upgradable, energy saving functions).
  - ***Newsprint****:* As a result of technical improvements in manufacturing processes, the state should reconsider its current recycled content goals and consider working with publishers and newsprint manufacturers to establish additional recycled content targets beyond the year 2000. The state should also review exceptions granted under the current 35 percent regulations.
  - ***Office Paper****:* Agencies should continue to purchase recycled content paper with the highest level of post-consumer content possible. The state should increase its efforts to purchase recycled papers by adopting the same guidelines as outlined in the federal Executive Order 13101, which directs agencies to ensure that they purchase *only* recycled paper.
  - ***Oil****:* To demonstrate leadership and bolster the demand for re-refined oil, agencies should use only re-refined oil in their motor vehicle fleets.
  - ***Wiping Cloths****:* Agencies should specify industrial wipers made from recycled textiles where possible.

  In addition to increasing environmentally preferable product procurement, agencies should promote recycled product procurement by the private sector, including promoting membership in the North Carolina Buy Recycled Business Alliance. Finally, continued education on environmentally preferable products is necessary. The state should identify manufacturers of recycled content and environmentally preferable products in North Carolina and provide information on product testing and evaluation, where possible.

- Fund and implement oil and oil filter initiatives outlined in the General Statutes and in the 1992 state solid waste management plan.
  The state should seek to fulfill the responsibilities established in North Carolina General Statutes 130A-309.16 and 309.21-22. There is a tremendous need for public education to improve the recovery rate of used oil from do-it-yourself sources. As indicated in the statute, the state should support an education campaign to raise the awareness of proper oil and filter management methods and to increase the proliferation and visibility of public and private drop-off collection sites.

- Develop an enforcement policy for items that contain cathode ray tubes (CRTs), such as computer monitors and televisions.
  The state should develop a policy exempting CRTs from hazardous waste requirements, or impose less stringent regulations, as it has done for lights containing mercury, when these materials are destined for recovery. Several states have accomplished this objective by adopting CRT-containing items under the Universal Waste Rule, and the U.S. EPA has expressed support for this approach.

Programmatic Recommendations

The following programmatic recommendations would stimulate recovery and provide data that would enable informed waste management decisions.

- Gather data on specific waste streams to enable informed decision-making.
  Limited data were available for several of the commodities that comprise the largest portions of the state's waste stream. Further research would provide North Carolina-specific data that would enable informed decision making on the best ways to divert these wastes from landfills. This research could also identify the types of processing and manufacturing businesses best positioned to handle the quality and quantity of materials in each category.

  - ***C&D Debris***: More information is needed to determine the most cost-effective means of diverting C&D materials directly from landfills. The state should consider conducting a study to evaluate mixed materials processing and other recovery methods on or adjacent to landfill sites.
  - ***Food Residuals***: Estimates of food residuals generation in North Carolina need to be refined. The state should sponsor a food waste generation study focused on developing accurate data on food residuals quantities, sources and locations using curbside studies in several different communities that are representative of North Carolina.
  - ***Wood Residues***: Better data are needed on generation of and demand for wood residues. The state should try to gather more accurate data on (1) the specific generators and tonnage of wood residues coming from manufactured housing, commercial and residential sources, and secondary wood product manufacturers and (2) the demand for recovered wood residues in the fuels and manufactured product markets.
  - ***Vegetative Debris in Land Clearing and Inert Debris (LCID) Facilities***: The state should conduct a detailed assessment of the sources and amounts of vegetative debris going to LCID facilities and evaluate the technological and economic obstacles to increased diversion of these materials.
  - ***Commercial / Industrial Textiles:*** The characterization of post-consumer textiles generated from retail outlets could not be determined during this assessment and should be further investigated by the state. Similarly, limited information is available on post-industrial textiles. The state should conduct a study of the generation and recovery of post-industrial textile waste in North Carolina.

- Enhance local government program efficiency to increase recovery.
  To increase the quantity of recyclable materials collected throughout the state, equitable, waste reduction-based collection systems such as pay-as-you-throw (PAYT) should be encouraged. Improvements to the quality and consistency of material supplies could enable local governments to net higher prices and possibly encourage increased utilization of recyclable materials. The Division of Pollution Prevention and Environmental Assistance (DPPEA) has encouraged PAYT through its Solid Waste Reduction Assistance Grants and other efforts; these efforts should continue as a primary means of increasing program efficiency.

  Another way to increase recycling rates is to add new materials to existing programs. Market analyses have identified the following materials as candidates for addition to local programs: mixed paper (also referred to as RMP), old magazines, OCC as part of an RMP or office mix, textiles, and steel cans. Local governments should evaluate the waste stream and local / regional markets before materials are added. In some cases, industry associations, such as the Steel Recycling Institute, may help launch campaigns and develop educational materials encouraging materials to be added.

- Target the small retail / commercial sector to increase recovery.
  In general, targeting this under-served sector would increase material capture and program efficiency. Several opportunities exist for targeting this sector. Local governments should be encouraged to expand their capabilities to assist small retail / commercial generators, for example by dedicating staff or programs to this sector. Another option is to facilitate cooperative marketing among small businesses that otherwise might not generate sufficient materials to realize economies of scale in recycling. Finally, local governments should develop campaigns encouraging this sector to implement recycling for materials commonly generated by this sector with relatively stable markets, such as OCC, office paper, steel cans, and glass.

- Increase plastics recovery through incentives and promotion of recycled product procurement.
  Plastics are gaining market share from other containers that are recycled at higher rates. In general, the state should consider increasing the availability of financial

incentives, including grant funding for capital purchases that improve collection efficiencies and economic development incentives for end-users, to enhance PET / HDPE / low density polyethylene (LDPE) / polypropylene (PP) recovery and use. If consistent improvement in recovery of these resins is not achieved by 2002, the State should consider implementing statutory mechanisms such as take-back requirements, mandated recycled-content targets, and other command-and-control approaches.

Additional actions are warranted for specific resins. For example, North Carolina's business and industry should identify opportunities to recover L/LDPE materials used in packaging and transport. With polyvinyl chloride (PVC) bottles a major contaminant of recovered PET bottles, the state should consider actions to discourage the use of PVC for bottle stock sold in the state. Finally, the state, local governments, and generators, processors, and end users of vinyl siding should work to maximize its recovery to take advantage of apparent strong markets for the material and a growing infrastructure.

- Continue to educate government, business, industry and the public on the need for and benefits of recycling.

The state should continue to foster the reduction and recycling of various materials through education of citizens, businesses, industries, and local governments. This education could take the form of meetings, workshops, or publication and dissemination of research. The two primary goals should be increasing awareness and changing behavior. Based on this market analysis, two commodities that need special emphasis on education are C&D debris and steel cans.

- Continue to promote source reduction.
  Source reduction should continue to be promoted by state and local governments, and they should show leadership in this area. Specific source reduction measures recommended in this report include the following:
  - Encourage the use of by-pass filters in vehicles as a means of maintaining cleaner oil in engines and decreasing the frequency of oil changes.
  - Encourage the use of longer-lasting synthetic oils
  - Educate citizens on the opportunity to reduce oil change frequency.
  - Reduce or eliminate the use of non-recyclable materials, such as polystyrene.
  - Encourage local governments to implement backyard composting programs.

Other commodity profiles available

from the Division of Pollution Prevention and Environmental Assistance are:

Construction and Demolition Debris ▪ **Electronics** ▪ **Glass** ▪ **Metals** [*Aluminum Cans and Scrap, Steel Cans and Scrap*] ▪ **Oil-Related** [*Used Oil, Used Oil Filters*] ▪ **Organics** [*Food Residuals, Yard Wastes*] ▪ **Paper** [*Old Corrugated Cardboard, Old Newspaper, Old Magazines, Office Paper, Mixed Paper*] ▪ **Plastics** [PET (#1), HDPE (#2), PVC (#3), L/LDPE (#4), PP (#5), PS (#6)] ▪ **Textiles** [*Carpet, Post-Consumer Textiles*] ▪ **Tires** ▪ **White Goods** ▪ **Wood** [*Wooden Pallets, Wood Residues*]

To explore these profiles electronically, visit www.p2pays.org. For additional information, contact 919.715.6500 or 800.763.0136.