

# Returning to Work

Understanding the Domestic Jobs Impacts from  
Different Methods of Recycling Beverage Containers

By Jeffery Morris, Ph.D., and Clarissa Morawski  
for the Container Recycling Institute  
December 2011



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December 2011  
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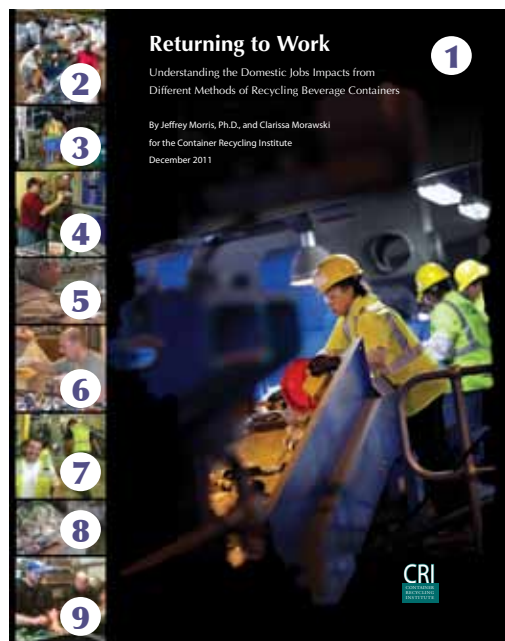
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### On the cover:

(1) At the Atlantic County Utilities Authority materials recovery facility in Egg Harbor, New Jersey, workers sort containers and other materials collected in the county's single-stream curbside recycling program (*photo by Donna Connor, photoface.com*). (2) In Moab, Utah, formerly homeless members of the Wednesday Morning Recycle Club sort beverage containers and other recyclables collected in the region's numerous national parks (*photo by Chris Conrad, Solutions of Moab*). (3) At a stop along his dual-stream curbside recycling route in Columbia, Missouri, public-works employee Rufus Fruge empties containers into a collection truck (*photo by Daniel Brenner, The Missourian*). (4) At a reverse vending machine in Portland, Maine, Carl supplements his fixed income by redeeming empties set aside for him by neighborhood businesses (*photo by Marge Davis*). (5) John Burnes, president and CEO of Marglen Industries in Rome, Georgia, samples the output of a processing line that turns PET bottles into textile fiber (*photo by Marge Davis*). (6) At Horizons Unlimited Developmental Center in Emmetsburg, Iowa, a service recipient sorts containers in the agency's nonprofit redemption center (*photo courtesy of Horizons Unlimited*). (7) John Davenport, Seattle plant manager for glass processor eCullet, stands in front of a mound of bottle glass that has been optically sorted into furnace-ready cullet (*photo courtesy of eCullet*). (8) Mike Kessel, owner of Beverly Bottle and Can Return, hauls aluminum cans redeemed for Massachusetts' 5-cent deposit (*photo by Ken Yuzskus, The Salem News*). (9) Workers sort redeemed deposit beverage containers at Patmans Redemption Center in North Windham, Maine (*photo by Marge Davis*). All images used with permission.

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## Acknowledgements

The authors gratefully acknowledge the following individuals who provided information, data, photos and candid interviews for this project: Richard Abramowitz, Waste Management, Inc.; Daniel Brenner, The Missourian; Curt Bucey, Strategic Materials, Inc.; John Burnes, Marglen Industries; Donna Connor, Donna Connor Photography; Deb Davis, Horizons Unlimited; Joe Delaney, Rehrig Pacific; David Dunning, Oldaker Law Group; John Ferrari, Nexcycle; Bob Gedert, City of Austin, Texas; Steve Giguere, Maine Department of Agriculture; David Gill, Novelis; Jeanette Gorman, TOMRA North America (CA); John Hutchinson, Owens Corning; Todd Johnson, Todd Johnson Photography; Mike Kessel, Beverly Bottle and Can Return; Craig London, eCullet; Tom Marshall, Anheuser-Busch; Sara Melnikoff, Solutions of Moab; Dale Miles, Brighton Avenue Redemption Center; Elizabeth Milligan, Returnable Services; Howard Morris, City of Pomona, Calif.; Alain Nault, TOMRA North America (Canada); Owens-Illinois; Jan and Ron Raymond, RSR Redemption; Steve Russell, Strategic Materials, Inc.; Dennis Sabourin, NAPCOR; Garney Scott, III, Scepter, Inc.; Mike Schmidt, Laurence's Redemption Center; Craig Thorne, Patmans Redemption Center; Peter J. Walters, Saint-Gobain/Verallia; and Greg Wittbecker, Alcoa.

Other businesses were also interviewed and shared their data for this study, but due to the proprietary nature of the information, they did not want to be named.

Finally, the authors would like to give special thanks to Jason Wilcox, project manager at CM Consulting, for his invaluable contributions to the study's content and accuracy; to Susan Collins, executive director of the Container Recycling Institute (CRI), for her guidance and assistance in project development, research and reporting; and to Marge Davis, CRI board member at large, for providing the report's copy editing, design and narrative sidebars.

## Sponsors

This project was made possible by the many generous supporters of the Container Recycling Institute, especially:



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Jeffrey Morris of Sound Resource Management Group and Clarissa Morawski with CM Consulting are the primary authors of this report.

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Dr. Jeffrey Morris holds a doctorate in economics and a master's degree in mathematical statistics from the University of California–Berkeley, and an M.B.A. in finance and operations research from Northwestern University. Dr. Morris has taught economics and econometrics at the universities of Washington and Colorado, and ecological and social sustainability in the Masters in Environmental Studies core program at The Evergreen State College. He has published in numerous peer-reviewed journals, including several in the field of life-cycle analysis (LCA): *Environmental Science and Technology*; *Journal of Industrial Ecology*; *Journal of Resource Management and Technology*; *Structural Change and Economic Dynamics*; *International Journal of Life Cycle Analysis*; and *Journal of Hazardous Materials*.

Dr. Morris has extensive experience developing Excel-based interactive models on environmental and economic impacts of diversion, as well as work directly related to the quantification of environmental savings associated with recycling or disposing of beverage containers.

Visit Sound Resource Management at [www.zerowaste.com](http://www.zerowaste.com).

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Ms. Morawski is a contributing editor to *Solid Waste and Recycling Magazine* and has written for *Resource Recycling* and *Biocycle* magazines.

Visit CM Consulting at [www.cmconsultinginc.com](http://www.cmconsultinginc.com).

## About the Container Recycling Institute

Founded in 1991, the nonprofit Container Recycling Institute is a leading authority on the economic and environmental impacts of used beverage containers and other consumer-product packaging. Its mission is to make North America a global model for the collection and quality recycling of packaging materials. We do this by producing authoritative research and education on policies and practices that increase recovery and reuse; by creating and maintaining a database of information on containers and packaging; by studying container and packaging reuse and recycling options, including deposit systems; and by creating and sponsoring national networks for mutual progress. CRI envisions a world where no material is wasted and the environment is protected. It succeeds because companies and people collaborate to create a strong, sustainable domestic economy.

Visit CRI at [www.container-recycling.org](http://www.container-recycling.org).

## Scope and Purpose of the Study

In 2010, the Container Recycling Institute contracted with Dr. Jeffrey Morris of Sound Resource Management Group, Inc., and Ms. Clarissa Morawski of CM Consulting to research the impacts of beverage container recycling on domestic jobs. Dr. Morris' task was to develop a jobs-from-recycling model; Ms. Morawski's was to establish the jobs-impacts parameters needed to calculate the net number of jobs created by increased beverage container recycling.

The project's primary goals were to:

- Measure the impacts on domestic jobs from increased recycling of beverage containers through container deposit-return (CDR) programs compared to curbside recycling or landfill disposal.
- Provide transparent employment data for each level of the recycling or disposal process (i.e., collection, hauling, processing and recovery or landfill disposal).
- Identify aspects of the recycling process that yield substantial jobs growth when beverage container recycling grows.
- Provide a report describing how improved diversion boosts U.S. jobs.
- Create a simple model that estimates, on a state-by-state basis, jobs growth from the increased recovery and recycling of beverage containers.

To carry out these goals, the project team quantified jobs that are created when beverage containers made of glass, aluminum and polyethylene terephthalate (PET) are collected and recycled into new products, compared with jobs lost in garbage collection and disposal. The team agreed that the jobs count would also include jobs that may be lost when recycled material replaces domestically produced virgin raw materials in domestic manufacturing of new products.

The research identified jobs increases and jobs decreases for three recycling options: container deposit-return (CDR); single-family curbside collection (automated as well as manual); and enhanced curbside (curbside programs augmented by additional programs targeting away-from-home containers as well as households without access to curbside collection).

The project team gathered data and information from existing reports and articles, interviews with companies in the supply chain of beverage container manufacturing, and interviews with companies handling beverage container discards for recycling or disposal. This information yielded estimates for full-time-equivalent (FTE) jobs associated with beverage containers recycled as well as those lost to disposal. Jobs estimates were normalized on the basis of FTEs per 1,000 tons of PET, glass or aluminum containers handled.

The project team then used these estimates to create a user-friendly, Excel-based calculating tool called MIRJCalc, which stands for "Measuring the Impacts from Recycling on Jobs Calculator." Users will be able to

access and download MIRJCalc through the Container Recycling Institute's website.

The project's ultimate goal is that users will better understand how and why improved diversion boosts U.S. jobs and more clearly appreciate which specific aspects of the container recycling process will yield the most substantial job growth in their state or region. By using the data and tools presented here, recycling managers, policy makers, investors and others can, with good confidence, make informed recycling decisions leading to promising employment outcomes.



## Executive Summary

In these times of record-breaking unemployment in the United States (to say nothing of record-breaking costs for energy and landfill space), few solutions are more urgent—and none more logical—than creating jobs out of what we are otherwise throwing away.

While disposal itself puts some people to work, primarily in the garbage collecting and landfilling industries, the level of disposal-related employment pales in comparison to the enormous jobs potential in the recycling, processing and manufacturing sectors.

Recycling advocates have long been reporting on the significant jobs benefits of diversion over disposal. Some have focused on the jobs potential in recovering a particular product, such as tires or electronics; some have considered the jobs impacts of recovering a particular material, such as plastics or precious metals; and still others have looked at the jobs benefits of a particular recovery method, such as curbside recycling or composting.

Some of these studies take into account the vital importance of material quality, throughput quantities, processing dynamics and end-user needs—but many do not.

This study may be the first to combine all of these approaches. Commissioned by the Container Recycling Institute and conducted by independent researchers Clarissa Morawski and Jeffrey Morris, it provides an intensely detailed, scenario-specific assessment of the jobs to be gained from increased recycling of what is arguably the most common, most prolific and most sought-after of all household recyclables—beverage containers.

“Returning to Work: Understanding the Jobs Impacts From Different Methods of Recycling Beverage Containers” measures the net gains in full-time-equivalent (FTE) domestic jobs when beverage containers made of glass, aluminum and polyethylene terephthalate (PET) are recovered through container deposit-return programs, curbside recycling and enhanced curbside recycling, versus landfill disposal.

This report also introduces “MIRJCalc” (Measuring the Impact of Recycling on Jobs Calculator), a user-friendly jobs estimator that calculates, on a state-by-state basis, the net impact on domestic jobs from increased recovery of aluminum cans, PET plastic bottles and glass bottles. MIRJCalc, which is accessible through the Container Recycling Institute’s website, allows the user to run specific scenarios for his or her state, or to rely on model defaults that have been carefully researched and verified.

Among MIRJCalc’s numerous unique features is that, unlike other reports on jobs from recycling, it factors in the domestic jobs *losses* that will inevitably occur when recyclables replace virgin materials in manufacturing, because the jobs associated with extracting those virgin materials will no longer be needed. For example, increased use of glass cullet (recycled bottle glass) will directly impact the demand for domestic mining of aplite, silica, borate, soda ash and limestone. MIRJCalc uses this information to calculate increases, decreases and net balance in domestic jobs.

Though the losses in raw-materials mining are small compared to the net gain in recycling jobs, they are part

of the comprehensive equation and thus are transparently documented in the report and accounted for in MIRJCalc.

MIRJCalc is also unique in that it recognizes the impacts on domestic jobs when material collected in domestic recycling programs is sold to overseas markets. For example, the United States exports more than 50 percent of curbside-recovered PET bottles to Asian markets (2009 figures), even as U.S.-based plastics reclaimers are operating at well below their collective capacity. MIRJCalc estimates the domestic jobs that would be created if that exported material were to stay in the United States.

MIRJCalc even takes into account the fact that, ton for ton, beverage containers represent considerably more volume (and therefore more transportation jobs) than other items collected along curbside recycling routes or in garbage-disposal trucks. This differential is favorable to the jobs calculations for both curbside and disposal, and the authors are straightforward in explaining these differences and incorporating them into MIRJCalc.

Both MIRJCalc and the larger report are based on transparent employment data collected through reports, articles and interviews with industry for each of the principal levels of the recycling and disposal processes—collection, processing, recovery and landfilling. The data are recorded as jobs impacts measured in full-time-equivalent jobs (FTEs) per 1,000 tons of throughput.

These data, coupled with the modeling made possible by MIRJCalc, provide a remarkably clear picture—almost a road map, with alternative routes clearly marked—of the net domestic jobs impacts a community can expect from the increased recovery and recycling of beverage containers.

In particular, it shows that these impacts are determined by four fundamental factors:

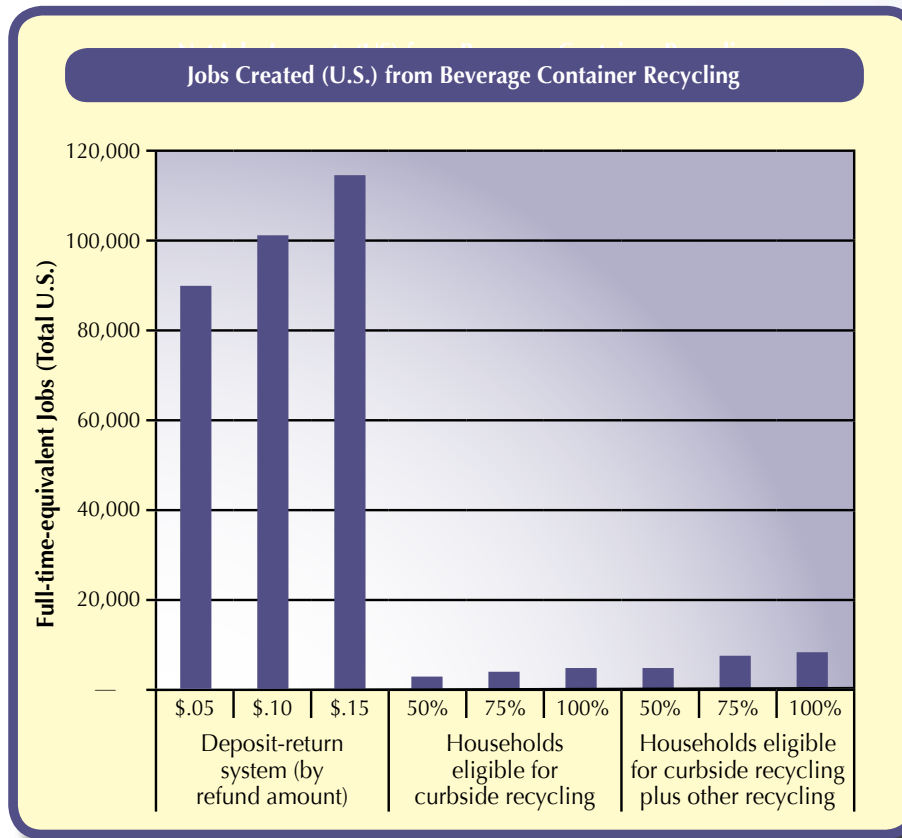
- Amount of throughput (collected tonnage).
- Collection method.
- Material quality and residual rates at all stages of recovery.
- End-use manufacturing (in some cases).

Leading to these four conclusions are eight key findings. These findings, summarized here, are explained in greater detail in Section 4 and elsewhere.

## Summaries of Key Findings

### Finding #1 Deposits create more jobs than curbside recycling relative to beverage containers.

Depending on system parameters and system performance, container deposit-return (CDR) systems create 11 to 38 times more jobs than a curbside recycling system for beverage containers.



### Finding #2 Recycling creates more jobs than disposal, and CDR creates the most jobs of all.

Ton for ton, a deposit-return system creates at least five times more jobs in container collection, sorting and transport than in garbage collecting, hauling and landfilling.

### Finding #3 Material throughput is the primary driver of recycling jobs.

The principal reason deposit systems create the most jobs among leading systems for container recovery is that they recover more of the target material. On average, states with deposit-return systems recover roughly three times more beverage containers than non-CDR states—an average of 76 percent versus 24 percent.

### Finding #4 The secondary driver of container-recycling jobs is the number of workers required to collect, sort and transport the containers.

Ton for ton, CDR requires between 3 and 9 times more employees than curbside to collect, sort and transport containers to a materials recovery facility or secondary processor.

## Redemption Centers and the Mom-&-Pop Economy

One of the interesting things about the nation's 3,700 independent redemption centers—those freestanding, mostly mom-and-pop operations that handle much of the CDR collection in deposit states—is how deeply rooted they have become in their local economies.

While some, such as sprawling Patmans in North Windham, Maine, have expanded multiple times into ever-larger facilities, others, such as Laurence's Redemption Center in Sioux City, Iowa, have operated in the same building, serving the same community, for decades.

"I've owned our redemption center since Day One of [Iowa's 1978] bottle bill," says owner Mark Schmidt. "My center is located next door to my meat market, and I doubt either one would exist without the other. I employ eight full-time and twenty part-time employees."

Jan Raymond of Standish, Maine, tells a similar story. In 1979, she opened a redemption center in a former plumbing and electrical shop that had belonged to her father. A quarter of a century later, she gave the business to son Ron, who now operates solo as RSR Redemption.

"We always have three or four teenagers working for us," Jan said before she retired. "Plus we get a lot of young mothers who want to leave at 2 p.m. so they can be home when their kids get home. We also do a lot of bottle drives as fund-raisers for the school sports teams and that kind of thing. A typical drive will earn them \$1,000, easy."

Of the roughly 400 businesses in Maine that routinely accept deposit containers, as many as 300 do so as a primary or only business activity. Collectively they employ at least 1,000 workers, including the five full-time staff at Brighton Avenue Redemption in Portland.

"People think the bottle bill is only about the environment," said owner Dale Miles. "But some of my guys probably wouldn't have jobs without it, and a lot of people need the cash" they make from returnables. A recent study by Occidental College (Calif.) found that redemptions made up as much as 9 percent of annual income for the homeless and people living far below poverty level.

The value of the redemption-center economy was highlighted recently in both Maine and Iowa as legislators in those states considered—and rejected—bills to scale back or repeal their deposit-return laws.

In Iowa, for instance, lawmakers were reminded that hundreds of special-needs adults, including more than 60 service recipients at Horizons Unlimited in Emmetsburg, have found meaningful work sorting Iowa's cans and bottles. And in Maine, where hearing rooms were standing-room-only, one woman noted that she had worked at the same redemption center for 19 years. "I'm 57 years old," she told a reporter. "I used to work as a clerk but would have to learn how to type again. And that might be difficult."



*Patmans Redemption Center and Beverage Store in North Windham, Maine*

*Marge Davis*



*Ron Raymond of RSR Redemption in Standish, Maine*

*Marge Davis*



*The redemption center at Horizons Unlimited in Emmetsburg, Iowa*

*Horizons Unlimited; used with permission*

**Finding #5 Jobs gained in recycling far outweigh any jobs lost in extraction of virgin materials.**

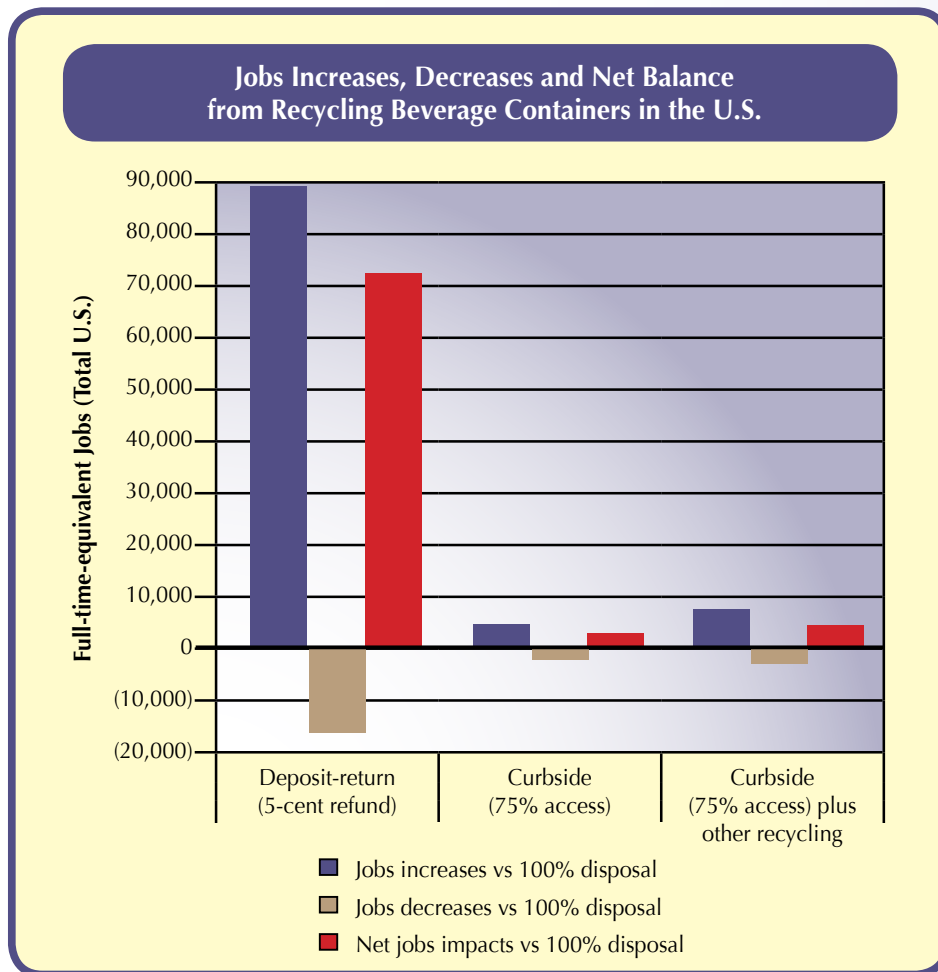
Net gains occur in curbside as well as in CDR. However, jobs gains are greatest in deposit programs due primarily to higher tonnage throughput.

**Findings #6 & #7 U.S. PET reclaimers currently operate at less than 60 percent of capacity. Increasing to capacity—that is, processing an additional 230,000 tons annually—would create nearly 500 new jobs, based on an employment factor of 2 FTEs per 1,000 tons. Yet the United States exports 400,000 tons of PET to overseas markets each year—the equivalent of 800 jobs.**

Most of the exported PET tonnage is lower-quality bales from curbside programs.

**Finding #8 Jobs gained from recycling far exceed any jobs lost in virgin extraction, landfilling or domestic manufacturing.**

Domestic jobs increases from recovering more beverage containers are always significantly higher than any resulting jobs losses.



While these eight quantifiable findings are the main focus of this report, Section 5 (“Beyond Jobs”) looks at some of the more qualitative impacts of increased beverage container recycling, such as the benefits to the environment, to the overall economy and to those who sell goods and services, from haircuts to bookkeeping, to the recycling businesses and the people who work in them.

Section 5 also notes the important fact that, even though few if any consumer products require recycled content in order to perform properly, most manufacturers are nonetheless committed to using recycled feedstock for a variety of economic, environmental, philosophical and marketing reasons. Many of these companies have set ambitious goals for recycling or recycled content, as have several leading trade associations.

### The Trade Groups’ Goals

- On Nov. 18, 2008, the Arlington, Virginia-based **Aluminum Association** announced its goal to increase the recycling rate for used aluminum beverage containers to 75 percent by 2015. In 2010, the industry reported it had reached a recycling rate of 58 percent.
- On Dec. 1, 2008, the Alexandria, Virginia-based **Glass Packaging Institute** issued a press release announcing it would seek a minimum recycled-content rate of 50 percent by 2013. As of mid-2011, GPI was reporting that the recovery rate for glass containers in the United States had reached 31 percent. However, it should be noted that recovery rates are not the same thing as recycled content. Due to breakage, contamination and other quality issues, much of the glass collected in this country, primarily from single-stream recycling systems, is unusable in manufacturing and must be discarded.
- On July 14, 2011, the Sonoma, California-based **National Association for PET Container Resources (NAPCOR)** announced that it “anticipates requiring a recycling rate of no less than 48 percent” by the end of 2013. According to the industry, 28 percent of the PET generated in this country is currently recovered. However, as with glass, it’s important to acknowledge that some of the recovered material is unusable, such as caps, labels and adhesives. The industry’s “utilization” rate—the PET that actually gets made into new products—is considerably lower, about 21 percent of what’s generated.

Because most manufacturers will simply revert to virgin material if they can't find recycled feedstock, it's unlikely their workforces will be affected one way or another by an increase or decrease in the level of beverage container recycling. However, the same obviously cannot be said of the secondary processors who supply the reprocessed PET, glass and aluminum. As suggested by the three brief processor profiles below, boosting the quantity and quality of reclaimed beverage containers in this country virtually guarantees increased hiring and business growth among secondary processors—as indeed it does among so many other sectors detailed in the following pages.

There aren't many guarantees in today's economy, but this is one we can take to the bank.

### Secondary Processors: PET

At Marglen Industries in Rome, Georgia, supplier of reprocessed PET to the textile and food-packaging industries, bales of flattened beverage bottles range across an area the size of a football field. A few of the bales come from the local curbside recycling program, but they account for less than one percent of the plant's needs. Most of the others have been freighted in from the Northeastern U.S., Canada, Mexico, even South America.

Sourcing bales is an ongoing challenge for John Burnes, president and CEO. "All we do here is recycle 100-percent post-consumer baled bottles," he says. "And presently, we need a lot more bales than we're able to find."

Marglen is located in the heart of America's carpet country. Eighty percent of all carpet produced in the United States is made within an hour of its facilities. The largest carpet makers in the world—Mohawk, Shaw, Beaulieu, Karastan and so on—are headquartered in Georgia. With 30,000 workers, Georgia's carpet industry is the largest manufacturing sector in the state. It's also the single largest consumer of recycled PET in the nation.

Yet few regions in the nation have lower recycling rates than the Southeastern United States, where PET recovery averages less than 10 percent.

The irony is not lost on Burnes, who adamantly supports more container-deposit programs as essential to growing his business and the larger economy. "We have a little over 200 employees here now," he notes, including 20 hired in 2009 when the plant began processing food-grade resin. "But we've had to put other expansions on hold. The limiting factor is: Not enough bales."



*John Burnes, president/  
CEO of Marglen Industries*

*Marge Davis*



*Garney Scott, III,  
president of Scepter, Inc.*

*Marge Davis*

### Secondary Processors: Aluminum

Aluminum remelters are omnivorous operations, consuming not just beer and soda cans but airplane parts, engine castings, processing residue, hubcaps, siding, appliances, storm doors and even lawn furniture to produce enormous remelt aluminum ingots (“sows”) to the specifications of a variety of customers.

So voracious an appetite, combined with the reliably strong value of scrap aluminum, makes for plenty of work at Scepter, Inc., a multi-plant secondary aluminum processor based in Waverly, Tennessee. Nevertheless, Scepter President Garney Scott, III, wants to see more aluminum-can recycling in general, and more deposit-return programs in particular, because he knows the benefits not only to the environment but to the economy. More volume, he says, means more hiring.

“Only about 50 percent of all UBCs are recycled,” Scott says, “and only about 25 percent of each can has recycled content. If we get deposit legislation nationwide, perhaps as much as 75 percent to 90 percent of each can will be made from recycled metal. Scepter is a secondary aluminum melter only; we will benefit directly from more cans entering the system.”

### Secondary Processors: Glass

Few things rile Steve Russell more than hearing some folks insist that “there’s no market for glass.” Russell is director of quality for Houston-based Strategic Materials, Inc., the largest glass recycler in North America, with 1,500 workers at 40 SMI facilities throughout the United States and Canada. Each year, SMI processes 2.5 million tons of recovered glass into varying specs of cullet for customers from Anchor Glass to Owens-Illinois—and it’s not nearly enough.

“Our customers are looking for all the cullet they can get their hands on,” Russell says, “even at significantly higher prices than raw materials,” because of the resulting energy savings, emissions reductions and decreased wear-and-tear on furnaces. The more recycled content manufacturers are able to use, the greater their savings—and the more robust SMI’s workforce.

Russell’s job includes scrutinizing incoming glass supplies. The ideal supply, he says, is uncontaminated, color-sorted, reliable and abundant. In his experience, only one collection method consistently meets all four criteria: deposit-return. Dual-stream curbside ranks a distant second. As for single-stream, Russell says that whatever might be gained in quantity is lost in quality: Only 60 percent of single-stream cullet gets made into containers or fiberglass. The rest ends up in landfills, either as trash or daily cover.



*“Glass” from single-stream  
sources at an SMI facility*

*Todd Johnson*



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## Part 1

### Research Methods for Jobs from Recycling

This study identifies, as precisely as practicable, the domestic<sup>1</sup> jobs impacts from recycling beverage containers. The jobs the project team researched are those that result from the flow of beverage containers into domestic recycling or landfill streams of used-up products and assorted solid-waste packaging materials. The phrase “jobs impacts from recycling” is defined as the net balance between jobs *increases* when more beverage containers are recycled and manufactured into new recycled-content products, and jobs *losses* when fewer beverage containers are landfilled and fewer new virgin-content products are manufactured from newly extracted raw material resources.

#### Section 1.1 Assumptions

Because the focus of this report is domestic jobs, its employment estimates for recycled- and virgin-content product manufacturing consider only jobs in domestic resource extraction and manufacturing industries, including:

1. Jobs gained when recycled beverage containers are used in domestic manufacturing.
2. Jobs lost in domestic extraction of virgin materials, such as the mining of apilite for use in glass bottles.
3. Jobs lost in domestic manufacturing of virgin-content products, such as the base materials that go into virgin PET.

The study excludes jobs impacts in other countries, regardless of whether they are gains or losses, including the following:

1. Jobs based on exports of recycled beverage containers.
2. Jobs based on imports of raw materials.
3. Jobs based on imports of new beverage containers.
4. Jobs based on manufacturing of new products.

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1 “Domestic” here typically refers to the United States only. However, the project team used data from Canada in addition to U.S. data to estimate employment levels for some aspects of the recycling or disposal life cycles for beverage containers.

### Where Are the Refillables? Where's WTE?

Some users of this report may wonder why refillable beverage containers are not included among its data points for recycling methods. Others may wonder why its data points for disposal include only landfills and not waste-to-energy incinerators.

These are reasonable questions. Washing and refilling two-way bottles is said to support five times as many jobs as the reprocessing of non-refillables; and waste-to-energy operations are said to account for 6,000 workers in 24 states.

Nonetheless, the project team determined that neither of these activities has sufficient impact on beverage-container recycling jobs to significantly alter the outcomes of this report and therefore they were not included in the data-gathering.

While cleaning and refilling bottles is indeed more labor-intensive than reprocessing, refillable containers have virtually disappeared from the U.S. beverage market. Today, refillables account for fewer than one-half of one percent of all beverage sales in the United States.

And even though incineration technology has grown increasingly sophisticated, WTE plants continue to be dwarfed by landfills both in number and throughput volume. According to the U.S. EPA, there were 1,908 landfills in the United States in 2009, compared to only 86 WTE facilities—a ratio of 22 to 1—with landfills accounting for roughly 90 percent of the country's discarded municipal solid waste tonnage.

Further, following a preliminary survey of workforce numbers and throughput volumes at selected WTE plants, the project team concluded that ton for ton, full-time-equivalent jobs at incinerators were within the range for FTEs at landfills.

The report also ignores any jobs losses in resource extraction that may occur in other countries—for example, in the overseas mining of bauxite for aluminum cans.

It should be noted here that, given the significant amounts of primary raw materials imported for aluminum can sheet production, as well as the large quantities of recovered domestic aluminum scrap that are exported, aluminum industry representatives say it's unlikely that an increase in beverage-can recycling will have an impact on jobs in the domestic aluminum can sheet manufacturing industry or its suppliers of domestically extracted raw materials.<sup>1</sup>

## Section 1.2 Data Sources

The project team gathered data from a variety of sources. State-by-state population figures and household counts come from U.S. Census Bureau data for 2009. Quantities of beverage containers produced and discarded (quantified by weight as well as by unit) are based on Container Recycling Institute estimates for 2008 as well as CRI's 2009 Beverage Market Data Analysis (BMDA). These state-specific data are codified in MIRJCalc to enable the user to estimate jobs impacts from beverage container recycling in his or her state, based on default values or user-selected entries on the characteristics of recycling systems in that state.

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1 Based on discussions with representatives of Alcoa and Novelis.

**Table 1.1 Stages of waste management and manufacturing activities for which data points were gathered**

WASTE MANAGEMENT & MANUFACTURING ACTIVITY STAGE	DEFINITION
<b>Collection and transport of residential discards</b>	Private- or public-sector establishments that collect discards from residences at curbside. This stage includes transport of residential waste to landfill.
<b>Collection: Automated curbside recycling</b>	Private- or public-sector establishments that use automated collection equipment to pick up recyclables at the curb from residences. This stage includes transport of recyclables to the materials recovery facility (MRF).
<b>Collection: Manual curbside recycling</b>	Private- or public-sector establishments that use manual loading equipment to pick up recyclables at the curb from residences. This stage includes transport of recyclables to the MRF.
<b>Container deposit-return (CDR) collection</b>	Private- or public-sector establishments, such as retail outlets, reverse vending machines (RVM) and redemption centers or depots, that accept deposit beverage containers from the public. This stage includes transport of containers from CDR collection points to the MRF or secondary processor.
<b>Transfer station</b>	Establishments that accept collected waste and prepare it for transfer to a disposal site.
<b>Stewardship, management or administration agency</b>	Administrative agency (public or private) dedicated to the management and administration of a container deposit-return program at a state level.
<b>Primary processing / materials recovery facility (MRF)</b>	Establishments that process commingled or source-sorted recyclable materials, whether from curbside, CDR programs or other collection programs.
<b>Secondary processing</b>	Secondary processors, including plastic reclaimers, glass beneficiators and aluminum can cleaning facilities.
<b>End-use manufacturing</b>	Establishments that use virgin raw materials and/or recycled beverage containers to make new products.
<b>Raw materials extraction and refining</b>	Establishments that extract raw materials and/or refine raw materials for use in manufacturing virgin-content products.
<b>Landfill disposal</b>	Private or public sector establishments that operate and administer landfills.

In developing employment estimates for the discards-management chain as well as the new-container-production supply chain, the project team relied primarily on:

1. An extensive literature review of more than 60 existing studies and articles, including recent media.
2. Interviews with representatives of businesses directly involved in recycling or disposal of beverage containers. Most of these companies and individuals are noted in the acknowledgements. Additional sources were also interviewed and their data used, but due to the proprietary nature of the information, they did not want to be named.

All primary research sought to deliver reasonable values for full-time-equivalent (FTE) employees per 1,000 tons of material handled, by waste management and manufacturing activity stage as defined in Table 1.1 on page 19. These data represent the number of jobs impacted directly by the throughput of empty glass, aluminum and PET beverage containers.

Each of the following stages of waste management and manufacturing activities are included:

1. Collection (includes transport to MRF or transfer station).
2. Transfer station operations and transport to landfill.
3. Operations at both MRF and landfill.
4. Secondary processing.
5. End-use manufacturing (virgin or recycled content).
6. Raw materials extraction and refining.
7. Administration.

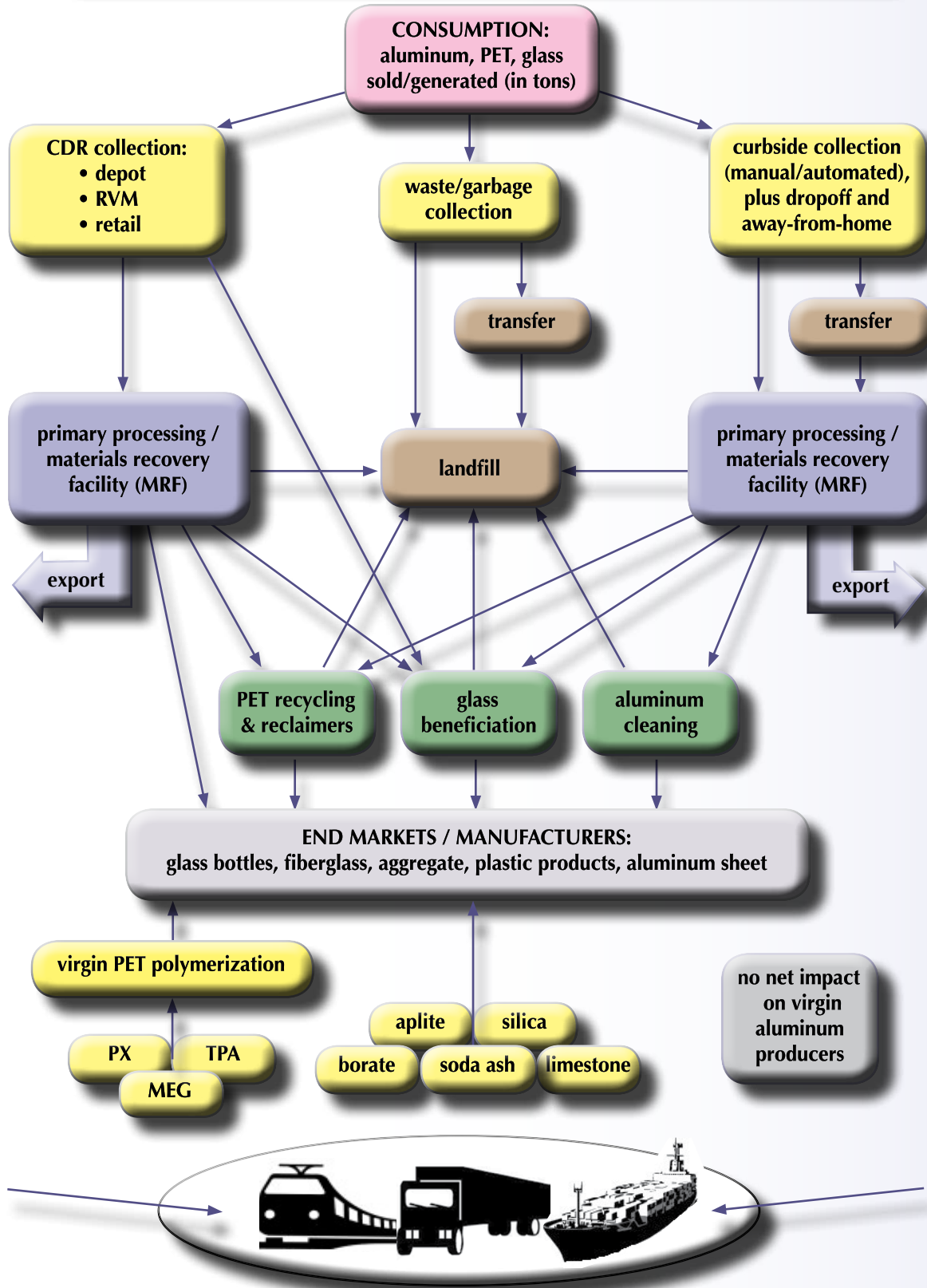
For each stage and each material type, the project team gathered a sample of data points, basing their selection on geographic distribution, facility type, facility size, ownership (public vs. private) and other representative factors, as well as on the willingness or ability of facilities to share internal data.

The assembled data points were then used to calculate average (mean) and median values for each stage and material. Details on the calculation of averages and medians, by stage, is available in Appendix 2. All data points, and their sources, are listed in Appendices 1 and 2.

In general, data came from studies, reports, articles in recent media and interviews with manufacturers, processors and other stakeholders. The most useful sources identified both throughput (in tons) as well as the FTEs (full-time-equivalent jobs) required to process that throughput. In some cases, sources did not specifically identify FTEs but did provide information that could be used to estimate FTEs, for example, the number of trucks collecting recyclables for a certain number of days per week or for a specific number of paid hours in a year.

In most cases, the project team used the medians to establish employment impacts in the MIRJCalc model. The team typically considered the following annual quantities to be equivalent to one full-time employee:

**Table 1.2 Labor and materials flowchart**  
 Domestic labor (U.S.) directly related to collection of beverage containers for recycling and disposal, measured as FTEs/1,000 tons



- 50 weeks.
- 250 days.
- 2,000 hours.

For example, three workers employed for a total of 3,000 hours in a year count as 1.5 FTEs.

Data sheets in Appendix 1 provide the mean, median, high, low and sample size for FTE estimates for each waste management and manufacturing activity stage.

### **Section 1.3 A flow-chart portrayal of MIRJCalc material flow and employment effects**

MIRJCalc measures jobs in relation to the amount of tons that are handled throughout the end-of-life management system, whether those tons are recovered or disposed. MIRJCalc also measures jobs in virgin- and recycled-content manufacturing, at least to the extent that additional beverage container recycling affects either. The model illustrates employment impacts along the paths traveled by discarded beverage containers: From collection to transfer station to landfill for the disposal path, and from collection to processing to secondary processing for the recycling path.

MIRJCalc also portrays domestic employment effects for virgin-content beverage containers and recycled-content products manufactured from recycled beverage containers. The flow chart on the facing page illustrates the various paths that empty beverage containers can take when they are discarded by a household.

The chart also shows the raw-material sectors for domestic manufacturing of virgin PET pellets and furnace-ready raw material for virgin bottle and fiberglass manufacturing. It was assumed that for every new ton of PET or glass recovered, one less ton of the same virgin material would be required, thereby reducing the net balance of jobs created from collection for recycling.

A summary of how these “virgin” jobs factors were calculated appears in Section 2.2, with details provided in Appendices 1 and 2.

## Part 2

### Overview of Results on Jobs from Recycling

#### Section 2.1 Jobs impacts data used in MIRJCalc

The table below lists the jobs impacts data used for MIRJCalc. Details on individual stages may be reviewed in Appendices 1 and 2.

**Table 2.1 MIRJCalc Jobs Impacts Parameters**

Waste management or manufacturing stage	Average FTE jobs per 1,000 tons throughput			
	CDR	Curbside and other recycling	Disposal	Virgin extraction (net)
<i>Collection (includes administration, management and maintenance)</i>	7.34	2.30	1.17	
<i>Transfer to landfill</i>			0.22	
<i>MRF / landfill operations</i>	0.56	0.64	0.04	
<i>Shipping to secondary processors/end users</i>		0.00		
Glass	0.00			
Aluminum	0.00			
PET	0.00			
<i>Secondary processing</i>				
Glass	0.37	0.37		
Aluminum	0.00	0.58		
PET	2.00	1.00		
<i>End-use manufacturing (including upstream supply chain)</i>				
Glass containers	0.00	0.00		0.10
Fiberglass	0.00	0.00		0.60
Aggregate	0.02	0.02		0.04
Aluminum can sheet	0.00	0.00		0.00
PET pellets	0.00	0.00		0.61

## Section 2.2 A summary of jobs impacts data used for MIRJCalc

It became evident early in this project that no existing studies provide jobs impacts data granular enough to estimate jobs impacts for each stage of the waste management and manufacturing activities in the life cycle of a beverage container. Most of the available data deal with employment for a group of stages (e.g., collection, processing and manufacturing combined) or an aggregate of materials (e.g., municipal solid waste or construction and demolition debris).

This being the case, the project team undertook primary research, and pursued a wide variety of sources, to populate the Jobs Impacts Parameters table on the preceding page (Table 2.1). Some data were found in studies or reports that identified both the throughput and FTEs required to process that throughput. While many of these studies were not specifically about jobs, they often contained information about current employment and throughput for a specific stage used in the model.

Other data points came from telephone interviews with municipal solid waste coordinators as well as knowledgeable members of the private sector. In most cases, they shared data for both FTEs and throughput or made such information available.

The following list offers a greater level of detail about each jobs impacts data point used in MIRJCalc. All data are provided in Appendices 1 and 2.

### *Collection: Residential curbside*

In trying to determine how many FTEs it takes to collect recyclables at the curb, the team initially focused on reports by R.W. Beck (2001)<sup>1</sup> and the Northeast Recycling Council, or NERC (2009)<sup>2</sup>. However, both studies turned out to be insufficient, in part because their data were not granular enough, and in part because their data points included commercial collection.

Our research also initially focused on single-stream (one-bin) curbside collection versus dual-stream. However, it became apparent to the project team that single-vs-dual stream was not the differentiating factor in curbside jobs estimates. The critical factor was whether the curbside collection system was automated or manual. Categorizing the jobs estimates based on collection equipment resulted in a median estimate of 0.79 FTEs per 1,000 tons for automated collection (8 data points), and 2.11 FTEs per 1,000 tons for manual collection (11 data points).

To estimate the number of jobs associated with administration, management and maintenance, the project team interviewed several public and private curbside-collection providers regarding the number of employees they require to collect 1,000 tons of recyclables at the curb.

Respondents were asked to account for personnel who work for the service in roles other than collection, such as accounting clerks, fleet mechanics, route supervisors, dispatchers and so on. While there is no set ratio of these jobs to the number of drivers collecting, the analysis suggests that a ratio of 3:5 (three jobs in administration/management/maintenance for every five jobs in collecting/driving) is reasonable. This 3:5 ratio was added to both manual (2.11) and automated (.79) collection for a total of 3.38 and 1.26 jobs per 1,000 tons respectively.

1 *Final Report. U.S. Recycling Economic Information Study Prepared for the National Recycling Coalition.* R. W. Beck, Inc, July 2001.

2 *Final Report to Northeast Recycling Council, Inc. Recycling Economic Information Study Update,* NERC, February 2009. Prepared by DSM Environmental.



The same ratio was used for landfill administration/management/maintenance.

Finally, in order to account for the fact that curbside beverage containers are collected in a mix with other packaging and paper-based products, such as detergent bottles, steel cans, cardboard and newsprint, the team had to consider the volume of beverage containers relative to these other materials.

To do this, they turned to the composition of U.S. curbside materials as reported in *State of the MRF*, the January 2011 issue of Resource Recycling. That study detailed the composition, by tons, of the assorted materials sent to MRFs servicing U.S. households.

Converting these tons to volume shows that beverage containers represent 32 percent more of the mix by volume than by weight, which in terms of collection (i.e., the number of trucks and drivers needed) is a primary driver of jobs attributed to curbside collection. Accordingly, the jobs impacts factor for curbside collection was increased by 32 percent, from 3.38 to 4.46 jobs per 1,000 tons for manual, and 1.26 to 1.66 jobs per 1,000 tons for automated collection.

It should also be noted that because curbside recycling is usually not offered in rural areas, the jobs impacts data points for curbside collection (1.66 automated and 4.46 manual) are probably slightly lower than actual, due to the more favorable economies of scale that exist in urban centers over rural areas.

The 2.30 jobs per 1,000 tons collected for curbside recycling shown in the Jobs Impacts Parameters table on page 23 (Table 2.1) is based on a default mix in MIRJCalc of 77 percent automated and 23 percent manual for curbside recycling collection. This mix is one of the user entries in the model that can be changed to tailor MIRJCalc results to a particular state.

### ***Collection: Container deposit-return (CDR)***

Deposit containers are typically returned via three redemption methods: return-to-retail store (R2R); reverse vending machines (RVMs); and dedicated redemption centers (depots).

Our findings show that no deposit state uses just one method exclusively; most use a combination of all three methods. The challenge was getting individual data points for each type on its own, because in most cases the available data points were for combined systems.

For instance, specific employment numbers for R2R were unavailable, and only one collector could provide specific data for jobs from RVMs. Nonetheless, the jobs estimates for all three systems were quite similar. It was assumed that the jobs number for R2R-only (stores with no RVMs) is similar to that for depot collection. RVM jobs did tend to be the lowest of the three systems, but when additional jobs in RVM administration and machine maintenance were included, RVM collection jobs fell in the same range as depot and R2R.

Given these similarities, the team chose to combine the nine data points for the three collection systems, for a median value of 6.71.

The median value of the seven data points for CDR administration/management and maintenance is 0.28 FTEs per 1,000 tons returned, while the median value of the seven points for transporting CDR-generated containers from their return sites to a MRF is 0.35 jobs per 1,000 tons. Adding these three values together—6.71 for collection, 0.28 for administration, management and maintenance and 0.35 jobs for transportation—yields a jobs impact for CDR of 7.34 jobs per 1,000 tons collected for this stage of the CDR system's container life cycle.

### *Collection and transport: Curbside discards*

The project team collected 20 data points for jobs related to the collection of mixed residential waste at curbside and its transport to a transfer station for eventual disposal at a landfill. The median of these data points is 0.56 FTEs per 1,000 tons of collected waste. This value was increased to account for a 3:5 ratio of support staff to collection staff (three positions in administration, management and maintenance for every five drivers; see “Collection—residential curbside”) along with an additional 32-percent increase to account for volume (again, see curbside collection).

The final value is 1.17 jobs per 1,000 tons for collection and transport of curbside waste.

### *Transfer station*

Median jobs requirements for transfer stations for waste on its way to a landfill amount to 0.22 FTEs per 1,000 tons (five data points).

### *Transport of recyclables to a MRF*

Jobs needed to transport recyclables to a MRF are included in the jobs estimates for curbside recycling. Jobs needed to transport CDR containers from return sites to a MRF are included in the jobs estimates for CDR collection.

### *Primary processing (MRF)*

In determining the jobs needs for primary processing at a materials recovery facility (MRF), the research revealed a difference in CDR versus non-CDR materials. The median of 19 data points for primary processing of curbside-collected materials is 0.64 FTEs per 1,000 tons. The 15 data points for primary processing of CDR-collected materials is 0.56 FTE per 1,000 tons.

### *Secondary processing*

The median value for glass beneficiation (crushing, pulverizing and/or removing contaminants) is 0.37 FTEs per 1,000 tons collected; this applies to both CDR and curbside collection systems. The three data points for each system, however, were distributed differently; only their median values happened to be similar.

Secondary processing is not required for CDR aluminum and is therefore entered as 0.00 in the model. However, additional processing is required to clean up curbside aluminum for use in can sheet manufacturing. Only one data point was available for secondary processing of curbside aluminum cans—0.58 FTEs per 1,000 tons.

Secondary processing for PET is slightly different for CDR and curbside collections. For CDR-generated PET, the median value of 5 data points is 2.0 FTEs per 1,000 tons. For curbside PET, 11 data points yielded a median value of 2.27 FTE per 1,000 tons.

Export plays an important role in determining the potential for domestic jobs creation from recycling PET

beverage containers. Currently, 56 percent of PET containers are exported, mostly those collected at curbside. The project team assumes that the portion that is not being reclaimed domestically will not undergo secondary processing in the United States. Hence the domestic jobs needed for secondary processing per 1,000 tons of PET containers collected through non-CDR programs is shown in the Jobs Impacts Parameters table on page 23 (Table 2.1) as 44 percent of 2.27—that is, 1.00.

The MIRJCalc model allows users to provide their own estimates of export rates for their particular state. Industry contacts report that a slight majority of PET collected from curbside is currently being exported, along with a small portion of PET collected from CDR programs (mostly in California, Hawaii and Oregon).

### *Landfill disposal*

For employment at landfills, the project team gathered 16 data points at landfills in non-CDR states and 22 data points at landfills in CDR states. The median value in non-CDR states is 0.04 FTEs per 1,000 tons. The median value in CDR states is 0.05 FTEs per 1,000 tons.

### *Production of virgin glass products and upstream mining*

The project team interviewed glass product manufacturers, aluminum can sheet manufacturers and PET plastic pellet manufacturers. The consensus from these interviews is that manufacturing recycled-content products is neither more nor less labor-intensive than production of virgin-content items. Therefore, substituting recycled materials for virgin raw materials in the manufacture of any of these products has negligible, if any, impact on employment per 1,000 tons of product.

Where there may be employment effects is in the domestic virgin-materials supply chain. The project team assumed that for every ton of secondary material used in manufacturing, one ton of domestic virgin raw materials would be displaced.

To get to specific jobs impacts, the project team researched jobs needs for extracting raw materials for use in fiberglass, aggregates and glass bottles, including silica, soda ash, aplite, limestone, borates and aggregate. The raw-material “recipes” were provided by manufacturers.

The team then applied this information to the tonnage of material likely to be recycled under a given collection system, and arrived at a corresponding reduction in demand (and therefore jobs) to the virgin-materials producer.

By way of example, let’s say that a glass manufacturer has an order for 1,000 tons of clear glass bottles. It can make those bottles out of 1,000 tons of recycled clear glass bottles; or it can hire a crew to mine for, say, the required amount of silica sand. So now let’s say that to make 1,000 tons of clear glass, you need 100 tons of virgin silica sand. And finally, let’s say that one man, working full time, can extract 100 tons of silica sand.

If those 100 tons of silica sand are no longer needed to make those 1,000 tons of glass bottles, that miner is out of a job, and one FTE in the extraction industry is lost to the recycling industry.

These numbers are obviously exaggerated for purposes of illustration, but in fact this is how recycled content potentially displaces jobs in the virgin-materials sector. Similar upstream jobs losses are calculated for the domestic market for bottle glass, fiberglass and aggregate.

The team found only one data point for borate, apatite and soda-ash mining. In each case, the mine surveyed is currently the primary supplier to domestic end-use manufacturers.

The estimated employment requirements for extraction of raw materials for glass bottles are 0.1 FTEs to extract the raw materials necessary to make 1,000 tons of glass, 0.6 FTEs to extract the raw materials necessary to make 1,000 tons of fiberglass, and 0.04 FTEs to extract 1,000 tons of aggregate.

#### ***Production of raw materials for virgin-content aluminum can sheet***

The domestic virgin aluminum extraction industry is modeled as no impact (0.00). The industry reports that because of the level of virgin imports and recycled aluminum can exports, it is unlikely that any additional recovered aluminum cans would have a direct impact on the domestic virgin-production industry.

#### ***Production of raw materials for virgin PET pellets***

The project team estimated the upstream losses that would be incurred if greater recycling efforts allowed for greater use of recycled PET (RPET) by those who would otherwise manufacture goods using virgin PET pellets. These goods include PET fiber, carpet, food and beverage bottles, strapping, sheet and film.

To estimate the raw-material-supply-chain jobs requirements for manufacturing virgin PET pellets, the project team used “recipe” data provided by lifecycle analysis, published articles and reports, and personal interviews with virgin producers. Details on the ingredients for virgin PET may be found in Appendix 2.9 of Appendix 2.

Jobs losses from oil extraction are excluded because oil extraction was found to be immaterial in its impact on jobs per 1,000 tons of PET pellets produced.

Further, the team found that the current U.S. domestic utilization rate for virgin PET is approximately 83 percent. In other words, 17 percent of the virgin PET pellets used in domestic manufacture comes from other countries. Therefore, the estimated 0.73 FTEs per 1,000 tons for virgin PET production is reduced to 0.61 FTEs in our Jobs Impacts Parameters table (page 23) due to the use of 17-percent virgin PET pellet imports by domestic manufacturers.

## Part 3

### MIRJCalc Model Description

In addition to each state's demographics, each state's beverage consumption data and employment estimates by stage of the waste management and container-manufacturing supply chains, the MIRJCalc model includes parameters that characterize flows into the recycling or disposal streams in each state. These parameters (by glass, aluminum and PET containers) include:

1. Return rate for CDR (container deposit-return) system.
2. Capture rates for single-family curbside collection.
3. Capture rates for non-curbside single family self-haul, and for multi-family self-haul.
4. Capture rates for on-site multi-family recycling.
5. Capture rates for away-from-home recycling.
6. Containers generated at households served by curbside recycling.
7. Containers generated by non-curbside households such as apartment buildings and households and self-haulers without access to curbside.
8. Containers generated away-from-home (AFH).

#### Section 3.1 Model Exclusions

##### *Transportation*

The arrows on the labor-and-materials flow chart (page <?>) identify transportation paths for material moving from stage to stage in the waste management/discards handling chain and the beverage container manufacturing supply chain. The current version of MIRJCalc does not quantify employment levels associated with these transportation paths. While jobs in material transportation are important, employment levels are highly sensitive to variables such as transportation mode (i.e., truck, train or ship), transport distance, and payload carried by a particular mode over a particular distance.

For example, employment per ton transported by rail is a function of the number of cars the train carries. Similarly, employment per ton in a container vessel on the Great Lakes or oceans depends on the number of containers the ship is carrying. Trucking employment is dependent on the size of the vehicle, the compaction of the material and the number of miles traveled. These factors make it difficult to quantify transportation jobs from

recycling or disposal in each state.

In general, however, one can conclude that within the transportation industry, diversion will have a greater employment impact than disposal, due simply to the greater number of handling stages that recycled materials must pass through and the greater distances to end markets they must travel compared to the distance to landfills. For example, disposal by landfilling often requires transporting waste, at most, a few hundred miles from the point of generation. Recycling on the other hand often requires shipment to one or two processors, followed by another shipment to an end-use manufacturer that may be thousands of miles away.

Given the conclusion that transportation employment impacts are greater for recycling than they are for disposal, and the significant complexities of estimating transportation employment effects on a state-by-state basis, the project team decided to exclude transportation employment impacts from MIRJCalc. The jobs impacts calculated by MIRJCalc are therefore conservative with respect to the jobs growth one can anticipate if a CDR system is implemented in a given state.

### ***Indirect and induced employment benefits***

While MIRJCalc closely examines the impact of recycling materials through various collection mechanisms, it examines only a fraction of the benefits related to jobs creation. More specifically, it examines only those jobs directly associated with the increased flow of glass, PET and aluminum beverage containers from collectors, processors, transfer stations, secondary processors and landfill operations.

The model omits numerous other business sectors that also benefit from the recovery of these materials:

1. Businesses in the region that supply goods and services to the recycling businesses (“indirect effects”).
2. Businesses that provide goods and services to the individuals who work for the recycling businesses (“induced effects”).

*Indirect effects* refers to the collateral jobs created when a directly affected business (for example, a redemption depot, a MRF or a curbside provider) buys products or services from, or subcontracts with, another business that is *not* directly impacted. For example, when a depot owner pays for bins, bags, utilities, equipment maintenance, accounting services or any of the myriad other things he needs to stay in business, he is contributing to the indirect employment fostered by increased beverage container recycling. The term has been nicely defined by both R.W. Beck (2000)<sup>1</sup> and the Northeast Recycling Council (2009)<sup>2</sup>:

Indirect effects measure the value of additional economic demands that the direct economic activity places on the supplying industries in the region. When firms produce goods or conduct business, they must make many purchases. Some of these are from suppliers in the area. Some are not. Public utilities, communications systems, fuel, wholesale goods and services, manufactured goods, financial and legal services, raw and processed commodities and a variety of professional services are necessary to produce the direct values described above.

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1 *Recycling Economic Information Study*, R.W. Beck, Inc., June 2000, pp. 1-5.

2 *Final Report to Northeast Recycling Council, Inc.*, Recycling Economic Information Study Update, NERC, February 2009.

*Induced effects* are similar, but they flow from the workforce itself: It's the employee who buys a car, or gets a hair cut, or eats at a new restaurant. Again, Beck and NERC define the term:

Induced effects accrue when workers in the direct and indirect industries spend their earnings on goods and services in the region. When workers in the direct and indirect industries purchase goods and services for household consumption, they, in turn, stimulate another layer of the economy. Most induced activity accrues to retail, services and finance, insurance and housing spending. Because employment is stimulated in these industries as well, their demands for inputs increase, yielding an additional round of indirect purchases and additional rounds of induced activity. Input Output (I/O) models solve for these iterative rounds of transactions until all of the possible inter-industrial transactions have been accumulated.

Precisely quantifying indirect and induced jobs is difficult. However, some analysts have ventured estimates, including input/output economic impact studies that provide employment multipliers.

NERC 2009, for instance, suggested that the indirect effects created by a MRF range from a low of 0.39 to a high of 0.61 indirect jobs per job at the MRF. The average of the states it examined (five states in the Northeast) was 0.51 jobs per MRF job.

These additional jobs illustrate that for every job identified by MIRJCalc as being created from additional recovery, numerous indirect benefits may also accrue.



### Section 3.2 How to use MIRJCalc

MIRJCalc is designed to estimate employment impacts in states considering a beverage container deposit law. The user enters eight specific inputs; defaults are provided for every item except the name of the state itself. (See the sample MIRJCalc, with inputs for Texas, on the following page, or go to [www.container-recycling.org](http://www.container-recycling.org) to download the MIRJCalc Excel file.)

The inputs are:

1. State, using the two-letter postal abbreviation.
2. Percent of households with access to a curbside recycling program that accepts discarded beverage containers.
3. Capture rates for non-CDR recycling systems:
  - Single-family curbside.
  - Multi-family with on-site collection.
  - Non-curbside single-family self-haul.
  - Multi-family self-haul.
  - Away-from-home.
4. The mix of automated and manual collection systems used for curbside recycling in the state.
5. Export rates for recycled PET containers.
6. Value of the deposit: 5 cents, 10 cents or 15 cents per container.
7. Allocation of glass to end-markets (containers, fiberglass or aggregate), expressed as percentages.
8. MRF and secondary processing residue rates (i.e., the proportion of collected material that must be disposed of due to contaminants incorrectly placed in recycling collections; caps and labels that must be separated from beverage containers; and any inefficiencies in separating materials cleanly enough to meet end-use specifications).

MIRJCalc uses these inputs to generate tonnage flows for each material to the CDR system, to each type of curbside and other recycling system, as well as to landfill disposal for the containers that are not otherwise captured.

CDR-system recycling performance is based on the deposit refund amount. A 5-cent refund yields 75-percent recovery, 10 cents yields 85-percent recovery and 15 cents yields 95-percent recovery.

Curbside performance is a function of “curbside-eligible housing units,” defined as single-family households and small apartment buildings. Curbside performance is also a function of curbside recovery rates, and the percentage of households identified as having access to curbside recycling service.



**Table 3.1 MIRJCalc Jobs Calculator—User Inputs and Jobs Results**

*Sample is for Texas; cells highlighted in yellow allow user inputs*

<b>State (two-letter postal abbreviation)</b>	TX	Enter two-letter postal abbreviation for your state				
<b>Households with curbside recycling</b>	75.0%	Percentage of curbside-eligible households that have access to curbside, whether or not they actually use it.				
<b>Beverage container capture rates for non-CDR recycling systems</b>	single-family curbside	multi-family on-site collection	non-curbside single-family self-haul	multi-family self-haul	away-from-home	
Glass	20.0%	10.0%	10.0%	0.0%	5.0%	
Aluminum	45.0%	30.0%	30.0%	0.0%	15.0%	
PET	40.0%	15.0%	15.0%	0.0%	5.0%	
<b>Curbside recycling</b>						
Automated curbside recycling	77.0%					
Manual curbside recycling	23.0%	100.0%				
		OK				
<b>Export rates for recycled PET</b>						
CDR system	0.0%					
Curbside recycling system	56.0%					
<b>Deposit refund amount per container</b>	10¢	Enter 5¢, 10¢ or 15¢				
<b>Allocation of glass</b>	<b>CDR</b>		<b>Curbside</b>		<b>Other</b>	
Glass containers	50.0%		20.0%		20.0%	
Fiberglass	30.0%		20.0%		20.0%	
Aggregate	20.0%		40.0%		40.0%	
Processing residue to landfill / daily cover	0.0%	100.0%	20.0%	100.0%	20.0%	100.0%
		OK		OK		OK
<b>Allocation of aluminum</b>						
Can sheet	100.0%		98.0%		98.0%	
Processing residue to landfill / daily cover	0.0%	100.0%	2.0%	100.0%	2.0%	100.0%
		OK		OK		OK
<b>Allocation of PET</b>						
PET pellets	83.0%		75.0%		75.0%	
Processing residue to landfill / daily cover	17.0%	100.0%	25.0%	100.0%	25.0%	100.0%
		OK		OK		OK

“Enhanced curbside” includes recycling of containers generated away-from-home, as well as recycling of containers generated by apartment residents and single-family households without access to curbside. Recovery from these households includes, for example, self-haul to a recycling center or depot.

The tonnage of beverage containers generated annually (nationally and state-by-state), as well as known national recovery rates, were used to set default recovery rates for each of the four leading recycling programs (curbside, away-from-home, multi-family and drop-off/self-haul). While there are no national data for program-specific recovery rates, some U.S. states and cities do report such information, and the project team was able to use these data, along with known national recovery averages and estimates, to select recovery-rate values that added up to the known overall tonnage recovered annually. The default program-by-program recycling rates in the model are thus based on national averages and estimates, and users may wish to input higher or lower rates for their own state.

The average recycling rates for beverage containers in non-deposit states are: glass, 12 percent; aluminum, 35 percent; and PET, 14 percent.

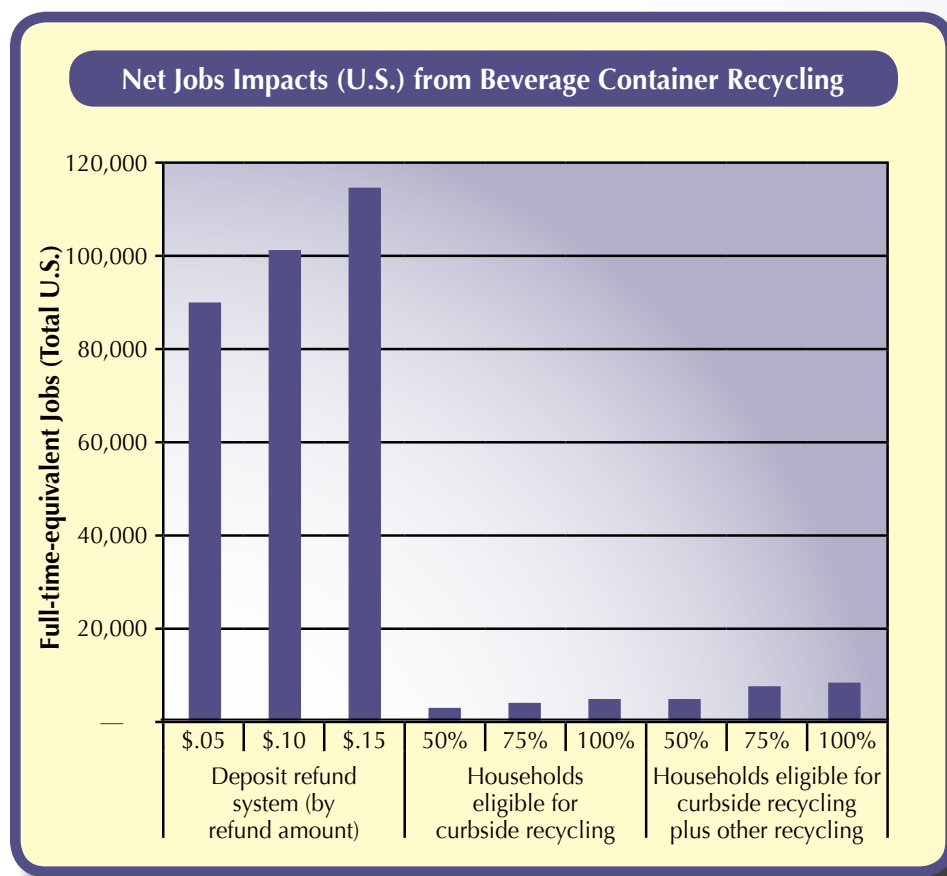
Given these flows, the model applies jobs impact estimates, as discussed in Section 2 above, to the tonnage moving through the stages of collection and processing. This yields estimates of the number of jobs created and lost to come up with a net jobs increase for a CDR system compared to curbside, as well as to enhanced curbside.

## Part 4

### Findings

#### **Finding #1 Deposits create more jobs than curbside recycling relative to beverage containers.**

Using primary system parameters as the base scenario (5-, 10-, or 15-cent refund value in a CDR system, and 50-, 75- or 100-percent curbside eligibility for a non-CDR system), deposit-return systems create 11 to 38 times more jobs than curbside recycling systems for collecting beverage containers.<sup>1</sup>



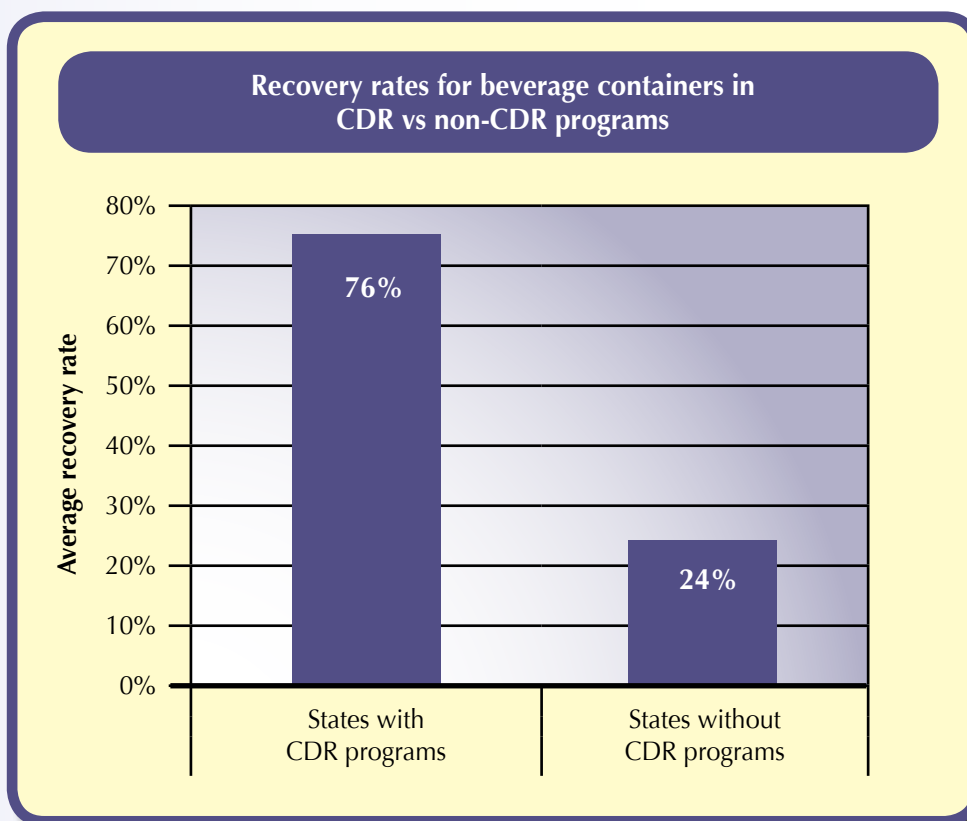
<sup>1</sup> This range is based on the following: The high end of the range (a difference of 38 times) is based on the top performance of CDR (the 15-cent refund level) and the lowest performance of curbside eligibility (50 percent). The low end of the range (a difference of 11 times) is based on the top performance of curbside eligibility (100 percent with other curbside) and the lowest performance of CDR (the 5-cent refund value).

**Finding #2 Recycling creates more jobs than disposal, and deposit-return creates the greatest number of jobs of all.**

The disposal and landfilling of beverage containers creates very few jobs relative to the recovery of containers for recycling. The difference is especially pronounced when containers are recovered through a container deposit-return system. Collecting and landfilling 1,000 tons of glass bottles, plastic bottles and aluminum cans requires approximately 1.43 FTE (full-time-equivalent) jobs, while the same tonnage collected through a CDR recycling system creates more than 8 jobs.<sup>1</sup> This is at least five times more jobs from collection and processing than from garbage collection and landfilling.

**Finding #3 Material throughput is the primary driver of recycling jobs.**

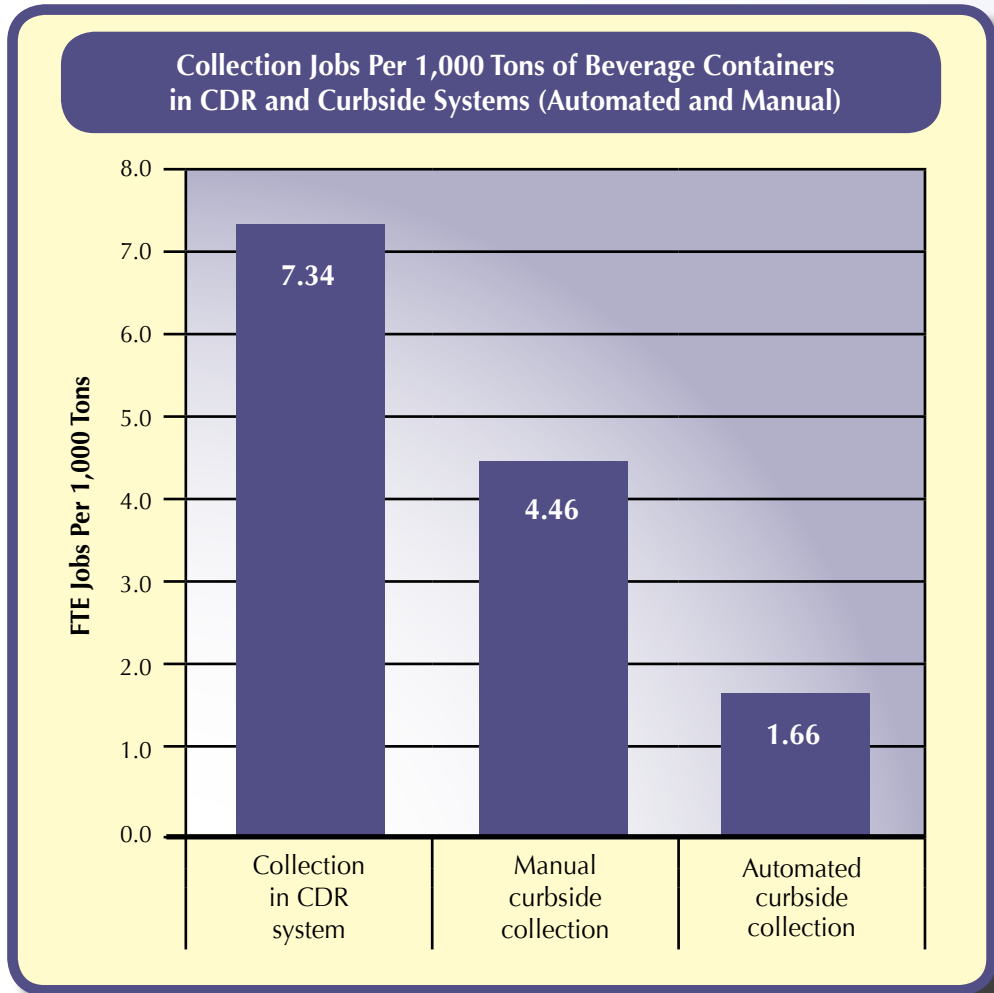
The primary driver of jobs from recovery operations is the amount of material (“throughput”) entering and leaving the system. Deposit-return systems recover approximately three times more material, relative to beverage containers, than the closest competitor, curbside recycling. Specifically, in the United States, deposit-return systems recover approximately 76 percent of all beverage containers covered by deposit laws, compared to approximately 24 percent of beverage containers collected through curbside programs and other methods.<sup>2</sup>



- 1 Conservative estimate that assumes all weight is glass. Additional PET and aluminum will further increase the gap in jobs between recycling and disposal.
- 2 *Wasting and Recycling Trends: Conclusions from CRI's 2008 Beverage Market Data Analysis*, CRI, 2008 BMDA Conclusions.

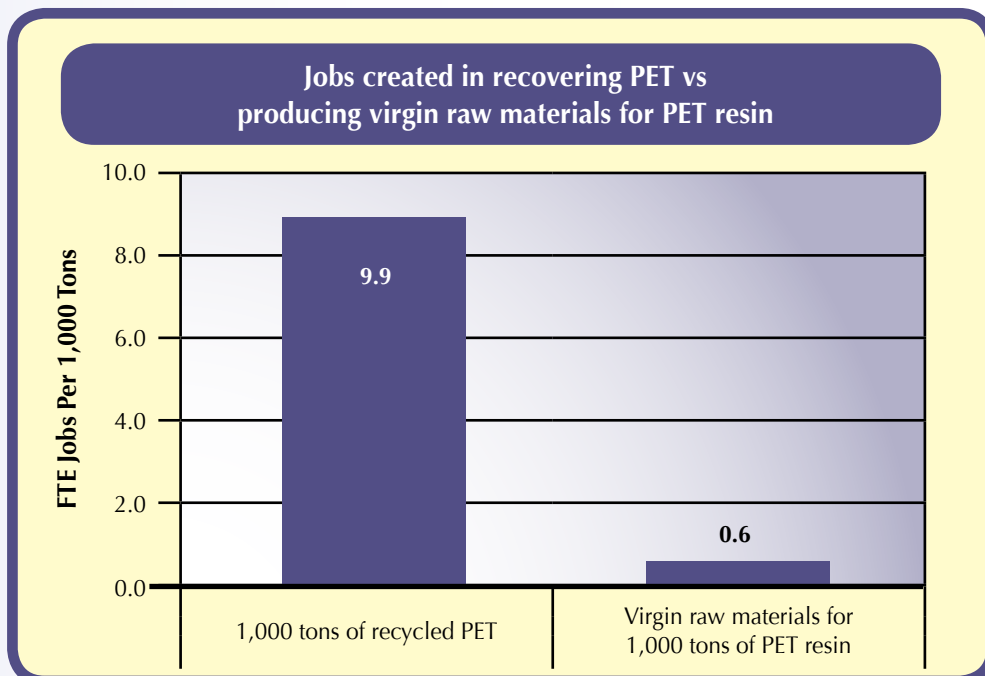
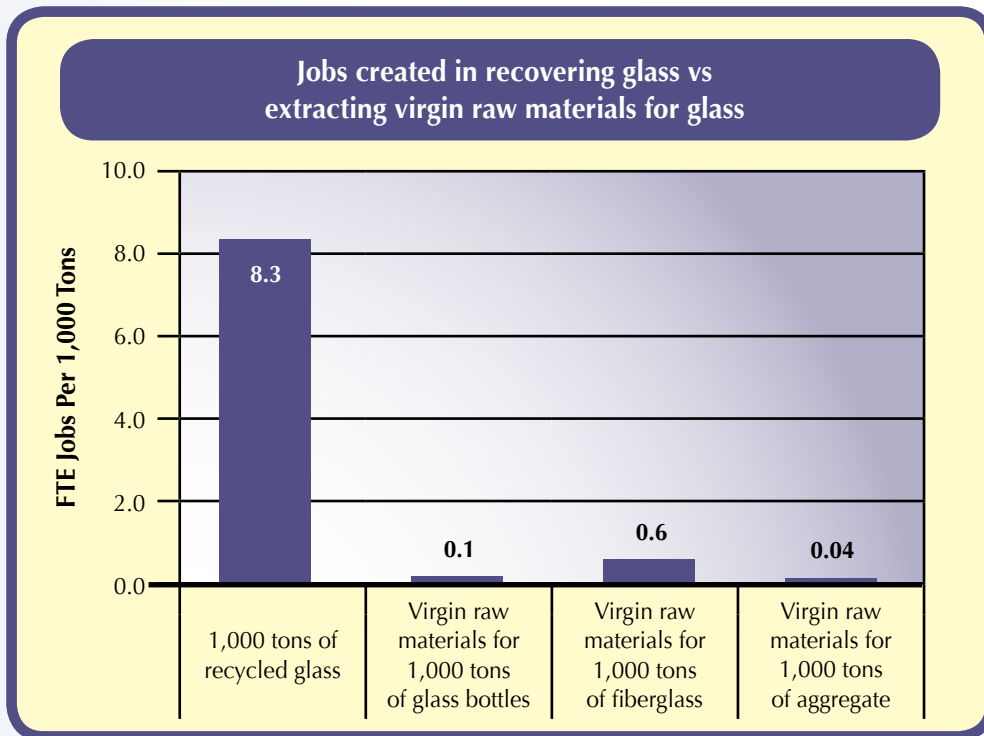
**Finding #4     The secondary driver of container-recycling jobs is the number of workers required to collect, sort and transport the containers.**

The secondary driver of jobs in container recycling systems relates to the number of workers needed to collect and sort the containers and transport them to the MRF or secondary processor. Deposit-return systems require one-and-one-half to four times as many employees for these tasks as do curbside systems. Specifically, approximately 7.34 FTEs are required per 1,000 tons of material collected in a deposit-return system, compared to 4.46 FTEs in a manual curbside system and 1.66 FTEs in an automated curbside system.



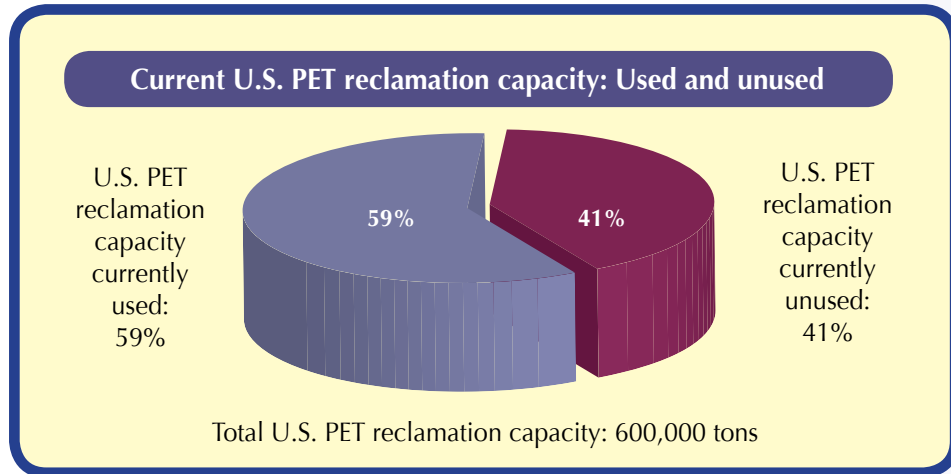
**Finding #5 Jobs gained in recycling far outweigh any jobs lost in extraction of virgin materials.**

Replacing virgin material with secondary materials in manufacturing recycled-content products may displace some domestic jobs in mining, oil extraction, polymerization and other virgin material extraction industries. However, extraction industries tend to be more machine intensive than labor intensive. As such, the net employment impact favors jobs in recovery industries.



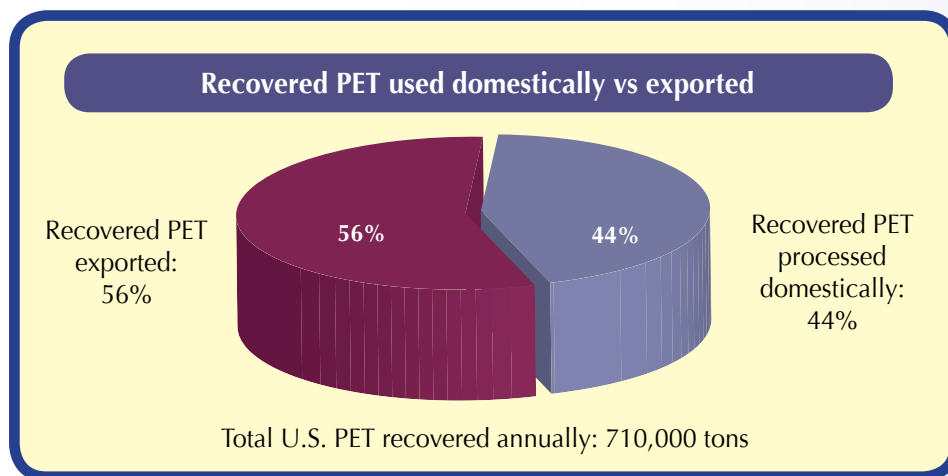
**Finding #6 Increasing U.S. PET reclamation to capacity would create nearly 500 new jobs.**

U.S. PET reclaimers process approximately 370,000 tons of recycled PET each year (including 49,000 tons of imported material). This represents 59 percent of the industry’s total capacity of approximately 600,000 tons.<sup>1</sup> If U.S. PET reclaimers were to operate at capacity by capturing an additional 230,000 tons of PET—whether through increased recovery or cleaner quality—they could create an additional 460 U.S. jobs.<sup>2</sup>



**Finding #7 Every year, the United States U.S. exports 400,000 tons of PET—the equivalent of 800 U.S. jobs.**

Domestic recycling programs recover roughly 710,000 tons of PET annually, enough to supply every U.S. PET reprocessor, with some to spare. Yet more than half of this recovered material—roughly 400,000 tons, mostly lower-quality bales from curbside programs—goes to overseas markets. Assuming an employment factor of 2 FTE jobs for each 1,000 tons, that’s equivalent to exporting 800 U.S. jobs.

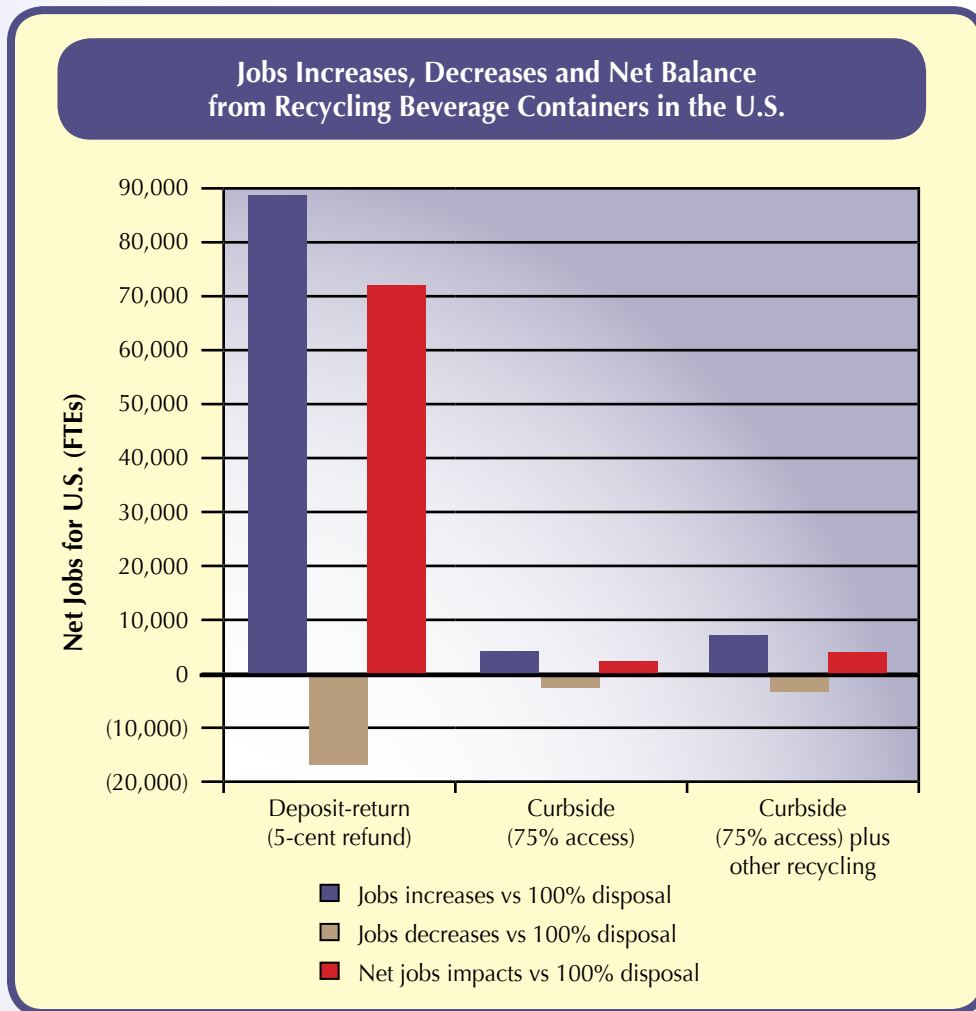


1 2009 Report On Post Consumer PET Container Recycling Activity Final Report, NAPCOR.

2 Based on an employment factor of 2 FTE jobs per 1,000 tons; see Appendix 1.10.

**Finding #8 Jobs gained from recycling far exceed any jobs lost in virgin extraction, landfilling or domestic manufacturing.**

The domestic jobs increases from recovering more beverage containers are always significantly higher than any jobs losses that may occur, not only in domestic virgin extraction industries but in landfilling and domestic manufacturing, when recycled materials are substituted for virgin raw materials. In addition, jobs increases are significantly greater in deposit-return programs due primarily to higher tonnage throughput.





## Part 5

### Beyond Jobs: The Other Benefits of Beverage Container Recovery

Jobs creation is a good reason to increase U.S. recovery of beverage containers, but it's not the only one. For the many U.S. consumer-products manufacturers who use recycled ("secondary") container material in everything from bottles and cans to fleece and fiberglass, they do so as a way to:

- Reduce energy use.
- Reduce emissions and other environmental impacts.
- Reduce production and raw materials costs.
- Meet internal or industry goals for recycled content and sustainability.
- Satisfy public demand for "greener" products, packaging and business practices.

While the degree of manufacturers' reliance on recycled material depends on many factors, including type of material, cost of energy and proximity to suppliers, many companies say they would gladly use more of it. In fact, many consumer-product manufacturers have set aggressive goals for recycled content.

And even though increased use of recycled material might not create additional jobs at the products-manufacturing level, this is not the case for the secondary processors who turn empty glass bottles into cullet, aluminum cans into rolled aluminum sheet and PET bottles into fiber or pellets. According to them, demand for these materials far exceeds what they are able to supply. If the supply of beverage containers were to markedly increase in the United States—especially if that supply were clean, reliable and properly sorted—they could and would expand their operations and consequently hire more workers.

#### Section 5.1 Glass product manufacturing

Manufacturers of domestically produced glass bottles strongly rely on secondary feedstock. Their plants are located throughout North America and are major purchasers of furnace-ready recovered glass. For these companies, the economic benefits of using cullet include:

- Reducing energy used for glass manufacture. The industry estimates that for every 10-percent increase in cullet use, there is a corresponding 4-percent savings in energy.<sup>1</sup>
- Reducing the consumption of virgin raw materials. For every ton of cullet used, manufacturers

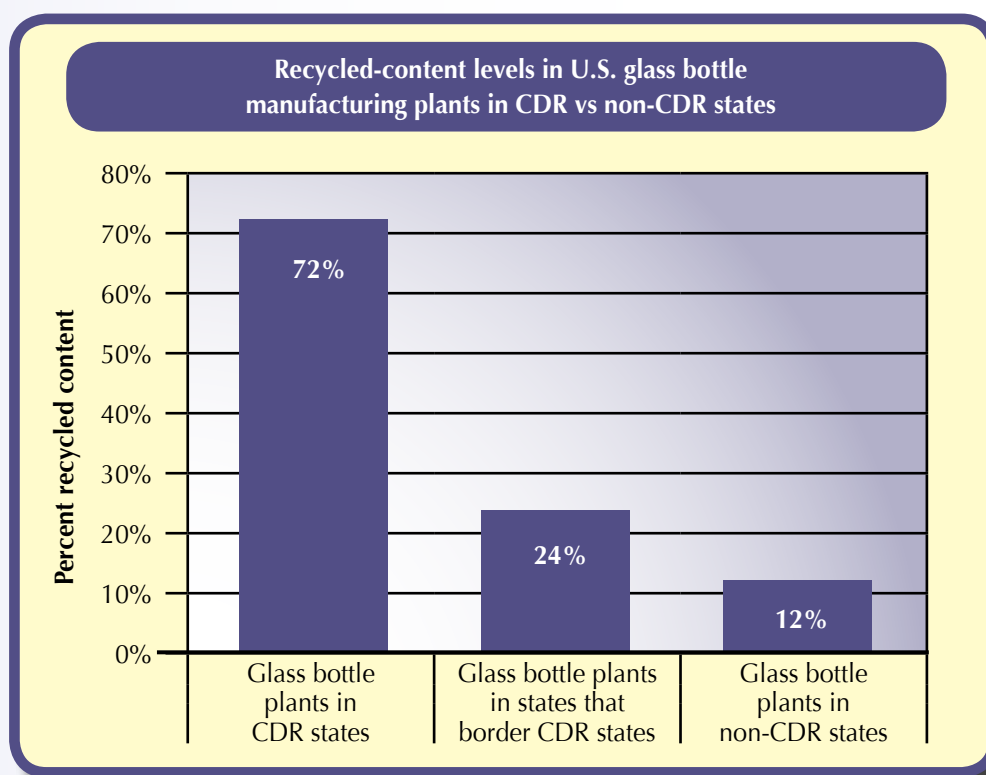
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1 Glass Packaging Institute.

save 1.1 tons of silica sand, lime, dolomite and soda.<sup>1</sup>

- Reducing harmful emissions to the atmosphere from the manufacturing process. Increased use of glass cullet reduces greenhouse gases and other common pollutants. Specifically, every 10-percent increase in glass cullet results in:
  - A six-degree-Celsius reduction in furnace operating temperature, with a resulting reduction in particulate emissions of about seven percent, as well as a significant extension of furnace life.<sup>2</sup>
  - A 3-percent reduction in fossil-fuel requirements that directly translates into a three-percent reduction in carbon-dioxide emissions.<sup>3</sup>
  - A six-percent reduction in nitrogen-oxide emissions resulting from lower operating temperature and fossil-fuel use.<sup>4</sup>

Glass manufacturers report a strong correlation between their use of recycled content and the availability of cullet from deposit-return programs. The bar graph below, which uses data from a large glass-bottle manufacturer with facilities throughout North America, illustrates this correlation.



1 United Kingdom Environmental Technology Best Practice Program, Improving Cullet Quality, 1997.

2 Owens-Illinois.

3 Owens-Illinois.

4 Owens-Illinois.

## Section 5.2 Glass beneficiation and quality

The facilities that reprocess containers from MRFs and produce furnace-ready cullet (for bottles or fiberglass) and glass fines (for aggregate and other low-end uses) are called glass beneficiation facilities.

Increasing the quality of recovered glass containers available for beneficiation can increase the amount of high-value, furnace-ready cullet available for bottle manufacturing, and thus decrease the quantity of processing residues that must be landfilled. Interviews with U.S. glass beneficiation companies confirm that quality plays a major role in the economics of their business. Glass purchased from curbside systems contains up to 40-percent unusable residue, including undersized particles, and thus must be run through separation equipment to extract the usable material. This imperfect separation process results in an even higher percentage of residue (sometimes as much as 50 percent) that gets sent to landfill. Deposit-system glass, in contrast, is typically 98-percent pure.

## Section 5.3 PET reclamation, exports and quality

Today in the United States, PET reclaimers use some 740 million pounds of recovered PET annually—including almost 100 million pounds of material purchased from other countries. However, this represents only 59 percent of total U.S. PET reclamation capacity of roughly 1.2 billion pounds a year. In other words, the PET processing industry could accommodate close to another 500 million pounds of material a year—and create 500 new jobs in the process<sup>1</sup>—without having to expand a single facility.

What is even more striking is that even as 41 percent of U.S. PET processing capacity sits idle, 56 percent of all PET bottles recovered annually (primarily from curbside programs) are shipped overseas. This represents another 400,000 tons of material that could potentially generate another 800 U.S. jobs.

A spokesman for the National Association for PET Container Resources (NAPCOR) commented recently on this imbalance:

Announcements made during [2010] regarding additional reclamation investments indicated that reclamation capacity would be nearly at equilibrium with anticipated bottle collection volumes in 2010. Truly supporting such a balance, however, would require all collected bottles to stay in the country and to be reclaimed domestically.<sup>2</sup>

There is a direct relationship between poor-quality PET from curbside programs being sold to Asian markets, and high-quality PET from deposit-return programs mostly being sold to domestic reclaimers. The industry reports that Asian markets offer a higher price for substandard curbside PET bales than do domestic markets, while the vast majority of deposit-program PET, owing to its higher quality and value, is sold mostly to domestic reclaimers, even though the purchase price is at least 60 percent higher, pound for pound, than curbside material. Nonetheless, U.S. reclaimers still have to compete with Asian buyers for clean material generated by CDR programs in California, Oregon and Hawaii.

More recently, the PET industry reported that while domestic capacity expansion in the last two years totaled some \$350 million in investments,<sup>3</sup> there would have been further expansions had it not been for the fact that

1 Based on a reclamation-jobs factor of 2 FTEs per 1,000 tons of PET; see Appendices 2.7, 2.8 and 2.9.

2 Mike Schedler, technical director of the National Association for PET Container Resources (NAPCOR), 2011.

3 Mike Schedler.

“tight supplies have caused some PET capacity expansions to be cancelled or delayed.”<sup>1</sup> For example, Clear Path Recycling in North Carolina has temporarily suspended plans for another 120 million-pound line until it can be sure it has access to clean supply.

Such market dynamics illustrate the economic opportunity and increased jobs available in U.S. PET reclamation if greater quantities and better-quality recovered PET were available.

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1 Plastics News, March 10, 2011.

## APPENDIX 1

### Jobs Impacts Data

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## Appendix 1.1

## Summary of jobs impacts stages

SUMMARY OF JOBS IMPACTS STAGES (FTE jobs/1,000 tons)												
	CDR (Container Deposit-Return) Depot / Return-to-Retail / RVM				No CDR							
					Curbside				Landfill			
	PLS	ALU	GLS	MIX	PLS	ALU	GLS	MIX	PLS	ALU	GLS	MIX
<b>Collection and transport of curbside garbage</b> (excludes administration, management and maintenance)												
<b>AVERAGE</b>												<b>0.69</b>
<b>MEDIAN</b>												<b>0.56</b>
MIN												0.32
MAX												1.23
COUNT												20
<b>Collection - municipal and private residential curbside - automated</b> (excludes administration, management and maintenance)												
<b>AVERAGE</b>				<b>0.77</b>				<b>0.77</b>				
<b>MEDIAN</b>				<b>0.79</b>				<b>0.79</b>				
MIN				0.57				0.57				
MAX				1.00				1.00				
COUNT				8				8				
<b>Collection - municipal and private residential curbside - manual</b> (excludes administration, management and maintenance)												
<b>AVERAGE</b>				<b>2.30</b>				<b>2.30</b>				
<b>MEDIAN</b>				<b>2.11</b>				<b>2.11</b>				
MIN				1.80				1.80				
MAX				3.50				3.50				
COUNT				15				15				
<b>Collection - CDR</b> (excludes administration, management and maintenance)												
<b>AVERAGE</b>				<b>7.03</b>								
<b>MEDIAN</b>				<b>6.71</b>								
MIN				5.00								
MAX				10.77								
COUNT				9								
<b>Transfer station</b>												
<b>AVERAGE</b>				<b>0.28</b>				<b>0.28</b>				<b>0.28</b>
<b>MEDIAN</b>				<b>0.22</b>				<b>0.22</b>				<b>0.22</b>
MIN				0.14				0.14				0.14
MAX				0.61				0.61				0.61
COUNT				5				5				5

## Appendix 1.1, continued

## Summary of jobs impacts stages

SUMMARY OF JOBS IMPACTS STAGES, cont. (FTE jobs/1,000 tons)												
	CDR (Container Deposit-Return) Depot / Return-to-Retail / RVM				No CDR							
					Curbside				Landfill			
	PLS	ALU	GLS	MIX	PLS	ALU	GLS	MIX	PLS	ALU	GLS	MIX
<b>Transport recyclables (to MRF)</b>												
AVERAGE				0.48								
MEDIAN				0.35								
MIN				0.21								
MAX				0.84								
COUNT				7								
<b>Primary processing (MRF)</b>												
AVERAGE				0.68				0.73				
MEDIAN				0.56				0.64				
MIN				0.22				0.40				
MAX				1.33				1.17				
COUNT				15				19				
<b>Secondary processing</b>												
AVERAGE	2.36		0.33		2.78	0.58	0.37					
MEDIAN	2.00		0.37		2.27	0.58	0.37					
MIN	0.84		0.17		0.71	0.58	0.29					
MAX	4.64		0.44		7.20	0.58	0.44					
COUNT	5		3		11	1	3					
<b>Landfill disposal</b>												
AVERAGE				0.06				0.06				0.06
MEDIAN				0.05				0.04				0.04
MIN				0.02				0.01				0.01
MAX				0.17				0.19				0.19
COUNT				22				16				16

## Appendix 1.2

**Collection of household discards**  
*showing jobs from curbside collection of residential waste*

<b>COLLECTION: CURBSIDE DISCARDS</b> (FTE jobs/1,000 tons)	
<b>Collection and transport of discards at curbside</b>	<b>MIX</b>
Warwick, RI	0.55
Madison, WI—current (dual-stream, manual)	0.53
Madison, WI—proposed (single-stream, auto)	0.46
Silver City, NM	1.11
Vancouver, BC	0.56
Tennessee—nine-city average	0.63
Charlotte, NC	0.41
Fayetteville, AK	1.09
Hickory, NC	0.45
Moncton, NB	0.32
Timmins, ON	0.85
Red Wing, MN	0.37
Franklin, TN	0.42
Durham, NC	1.22
Stamford, CT	1.12
Stamford, CT	1.13
Hartford, CT	0.58
Toronto, ON	0.36
Richardson, TX	1.23
Denver, CO	0.48
<b>AVERAGE</b>	<b>0.69</b>
<b>MEDIAN</b>	<b>0.56</b>
MIN	0.32
MAX	1.23
COUNT	20



Appendix 1.3

Automated curbside collection of recyclables  
*showing jobs from automated collection of curbside recyclables*

COLLECTION: AUTOMATED CURBSIDE RECYCLING (FTE jobs/1,000 tons)				
Collection of recyclables at curbside— municipal and private residential—automated	PLAS	ALU	GLS	MIX
NC-ALVARADO-04				0.58
Madison, WI—current (dual-stream)				0.83
Madison, WI—proposed (single-stream, auto)				0.63
Westfield, MA				0.92
Vancouver, BC				0.92
Warwick, RI				0.75
Denver, CO				0.57
City of Orange, CA				1.00
<b>AVERAGE</b>				<b>0.77</b>
<b>MEDIAN</b>				<b>0.79</b>
MIN				0.57
MAX				1.00
COUNT				8



## Appendix 1.3, cont.

**Curbside collection of recyclables (manual)**  
*showing jobs from manual collection of curbside recyclables*

<b>COLLECTION: MANUAL CURBSIDE RECYCLING</b> (FTE jobs/1,000 tons)				
<b>Collection of recyclables at curbside— municipal and private residential—manual</b>	<b>PLAS</b>	<b>ALU</b>	<b>GLS</b>	<b>MIX</b>
Stamford, CT F10				1.96
Newcastle County, DE				2.11
Kent County, DE				2.22
Sussex County, DE				2.66
Hartford, CT				3.50
Richardson, TX				1.80
Fayetteville, AK				1.81
Red Wing, MN				1.83
Fredericksburg, VA				2.21
St. Cloud, MN				2.07
Roanoke, VA				3.41
<b>AVERAGE</b>				<b>2.33</b>
<b>MEDIAN</b>				<b>2.11</b>
MIN				1.80
MAX				3.50
COUNT				11

**Appendix 1.4**

**CDR collection**

*showing jobs from collection at depots, redemption centers, retail locations or RVMs*

<b>COLLECTION: CDR (FTE jobs/1,000 tons)</b>				
<b>Depot / R2R / RVM</b>	<b>PLAS</b>	<b>ALU</b>	<b>GLS</b>	<b>MIX</b>
British Columbia - Brewers Distribution Ltd.				6.71
British Columbia - Encorp				7.36
RRFB - NOVA SCOTIA				5.87
Depots in Alberta				8.85
Returnable Services - MAINE				10.77
Depot in CDR state				5.00
Collection agency in CDR state				7.45
TOMRA recycling centers with no RVMs (traditional and brick)				5.17
TOMRA recycling centers with RVMs				6.12
<b>AVERAGE</b>				<b>7.03</b>
<b>MEDIAN</b>				<b>6.71</b>
MIN				5.00
MAX				10.77
COUNT				9



## Appendix 1.5

**Transfer stations**  
*showing jobs at transfer stations*

<b>TRANSFER STATIONS</b> (FTE jobs/1,000 tons)				
<b>Transfer station</b>	<b>PLAS</b>	<b>ALU</b>	<b>GLS</b>	<b>MIX</b>
North Kingstown, RI				0.61
Valley Transfer Station, WA				0.14
North County Transfer Station, WA				0.27
Northwest Transfer Station, FL				0.15
South County Transfer Station, FL				0.22
<b>AVERAGE</b>				<b>0.28</b>
<b>MEDIAN</b>				<b>0.22</b>
MIN				0.14
MAX				0.61
COUNT				5

Appendix 1.6

Transport from collector to primary processor in CDR states  
*showing jobs in transporting material from collection point  
to primary processor (in CDR states only)*

TRANSPORT: CDR MATERIAL TO MRF (FTE jobs/1,000 tons)				
	CDR ONLY			
	Depot / R2R / RVM			
Transport recyclables (to MRF)	PLAS	ALU	GLS	MIX
British Columbia - Brewers Distribution Ltd.				0.57
British Columbia - Encorp				0.21
RRFB - NOVA SCOTIA				0.84
Returnable Services - MAINE				0.35
Collection agency in CDR state				0.26
Depot in CDR State				0.35
Transportation (source: TOMRA)				0.81
<b>AVERAGE</b>				<b>0.48</b>
<b>MEDIAN</b>				<b>0.35</b>
MIN				0.21
MAX				0.84
COUNT				7



## Appendix 1.7

**Transport of residential waste to landfill**  
*showing jobs in moving waste to landfill (in CDR states only)*

<b>TRANSPORT: RESIDENTIAL WASTE TO LANDFILL</b> (FTE jobs/1,000 tons)				
	CDR ONLY			
	Depot / R2R / RVM			
<b>Transport residential waste to landfill</b>	<b>PLAS</b>	<b>ALU</b>	<b>GLS</b>	<b>MIX</b>
British Columbia - Brewers Distribution Ltd.				0.57
British Columbia - Encorp				0.21
RRFB - NOVA SCOTIA				0.84
Returnable Services - MAINE				0.35
Collection agency in CDR state				0.26
Depot in CDR State				0.35
Transportation (source: TOMRA)				0.81
<b>AVERAGE</b>				<b>0.48</b>
<b>MEDIAN</b>				<b>0.35</b>
MIN				0.21
MAX				0.84
COUNT				7

**Appendix 1.8**

**Administration**  
*showing jobs in administration of CDR programs (in CDR states only)*

ADMINISTRATION (FTE jobs/1,000 tons)				
	CDR ONLY			
	Depot / R2R / RVM			
Stewardship, management or administration agency	PLAS	ALU	GLS	MIX
British Columbia - Brewers Distribution Ltd.				0.05
British Columbia - Encorp				0.28
RRFB - NOVA SCOTIA				1.27
Collection agency in CDR State				1.26
Returnable Services - MAINE				0.38
Admin at TOMRA centers with RVMs				0.09
Admin at TOMRA centers without RVMs				0.10
<b>AVERAGE</b>				<b>0.49</b>
<b>MEDIAN</b>				<b>0.28</b>
MIN				0.05
MAX				1.27
COUNT				7

**Appendix 1.9 Primary processing**  
*showing jobs in primary processing centers in CDR and non-CDR states*

PRIMARY PROCESSING (FTE jobs/1,000 tons)								
	CDR				NO CDR			
	DEPOT / R2R / RVM				CURBSIDE			
Primary processing (MRF)	PLAS	ALU	GLS	MIX	PLAS	ALU	GLS	MIX
PA-NERC-09								0.87
Recycle America Alliance - Raleigh, NC								0.91
Recycle America Alliance - Winston-Salem, NC								0.56
Cascade - WA								0.43
NYSTATE-NERC-09				0.56				
MASS-NERC-09				0.47				
DE-NERC-09				0.43				
ME-NERC-09				0.42				
British Columbia - Encorp				0.22				
Rumpke Recycling Cincinnati MRF								0.53
Friedman Recycling Company, El Paso, TX								1.17
City Carton Recycling - Cedar Rapids, IA				0.49				
Cogle's Recycling Inc. - PA								1.02
Waste Management of Utah - Salt Lake City								1.13
Western Placer WMA Regional Recycling Facility, CA				0.26				
Casella Recycling - Charlestown, MA				0.58				
Greenstar North America - TX								0.56
Tri-County SS - WI								0.40
Boulder County Recycling Center - CO								0.89
Palm Beach County SWA Regional MRF - FL								0.62
SP Recycling Corp. - WA								0.62
Great Lakes International Recycling - MI				1.14				
Returnable Services - ME				1.27				
Calgary, AB				0.45				
Victorville, CA				1.08				
Recycle Central, CA				0.79				
Vista Fibers, IA				0.67				
Omaha, NB								1.04
Phoenix, AZ								0.64
RIRRC, RI								0.56
MRF #1, IL								0.41
MRF #2, IL								0.71
MRF #3, IL								0.76
LA Express MRF, CA				1.33				
<b>AVERAGE</b>				<b>0.68</b>				<b>0.73</b>
<b>MEDIAN</b>				<b>0.56</b>				<b>0.64</b>
MIN				0.22				0.40
MAX				1.33				1.17
COUNT				15				19



## Appendix 1.10

**Secondary processing**  
*showing jobs in secondary processors in CDR and non-CDR states*

SECONDARY PROCESSING (FTE jobs/1,000 tons)								
	CDR				NO CDR			
	DEPOT / R2R / RVM				CURBSIDE			
Secondary processing and material brokers	PLAS	ALU	GLS	MIX	PLAS	ALU	GLS	MIX
British Columbia - Encorp	4.64							
St. Helens, OR	2							
NYSTATE-NERC-09	1.96							
MASS-NERC-09	2.38							
Iowa - plastic processing facility	0.84							
Clear Path Recycling LLC - NC					1.20			
PA-NERC-09					1.96			
North Carolina					3.53			
Envision - NC					2.50			
Engineered Recycling, Charlotte, NC					2.40			
Plastics Revolutions - NC					1.47			
Kentucky					7.20			
Jefferson County, TN					5.56			
Wales - plastic processing facility					2.27			
Rhode Island					1.78			
Fayetteville, NC					0.71			
Glass beneficiation facility #1			0.17				0.29	
Glass beneficiation facility #2			0.44				0.44	
Glass beneficiation facility #3			0.37				0.37	
Anheuser-Busch, Georgetown, KY						0.58		
<b>AVERAGE</b>	<b>2.36</b>		<b>0.33</b>		<b>2.78</b>	<b>0.58</b>	<b>0.37</b>	
<b>MEDIAN</b>	<b>2.00</b>		<b>0.37</b>		<b>2.27</b>	<b>0.58</b>	<b>0.37</b>	
MIN	0.84		0.17		0.71	0.58	0.29	
MAX	4.64		0.44		7.20	0.58	0.44	
COUNT	5		3		11	1	3	

## Appendix 1.12

Glass container manufacturing plants  
*showing jobs at glass-container plants in CDR and non-CDR states*

GLASS CONTAINER MANUFACTURING PLANTS (FTE jobs/1,000 tons)				
Glass container manufacturing plants	CDR / NO CDR			
	PLAS	ALU	GLS	MIX
NYSTATE-NERC-09			2.01	
PA-NERC-09			1.27	
Owens-Illinois – Lexington			2.35	
Gallo Glass – CA			2.09	
<b>AVERAGE</b>			<b>1.93</b>	
<b>MEDIAN</b>			<b>2.05</b>	
MIN			1.27	
MAX			2.35	
COUNT			4	

Appendix 1.13

Landfill disposal  
*showing jobs at landfills in non-CDR states and CDR states*

LANDFILL DISPOSAL (FTE jobs/1,000 tons)								
Landfill	CDR				NON-CDR			
	PLAS	ALU	GLS	MIX	PLAS	ALU	GLS	MIX
Countryside Landfill, Greyslake, IL								0.03
Allied Waste, Hoopeston, IL								0.19
Clinton Landfill, IL								0.04
Landfill 33, Effingham, IL								0.08
Millennium Landfill Milan, IL								0.09
Pike County Landfill, Baylis, IL								0.04
Winnebago Landfill, IL								0.02
Envirofil, IL								0.05
Veolia Cranberry Creek, WI								0.02
Ridgeview, WI								0.08
Valley Trail, WI								0.05
Mar-Oco, WI								0.12
Veolia—Seven Mile, WI								0.02
Veolia—Hickory Meadow, WI								0.01
WM Deer Park, WI								0.04
WM Timberline, WI								0.04
Cerro Gordo, IA				0.09				
County Of Harrison, IA				0.04				
Union County, IA				0.10				
Dickenson County, IA				0.07				
South Dallas, IA				0.17				
Clinton County Landfill, NY				0.03				
Seneca Meadows, NY				0.04				
Mill Seat Landfill, Monroe County, NY				0.04				
WM Chaffee, NY				0.02				
Holyoke Landfill, Granby, MA				0.05				
Zanker Road Landfill, CA				0.05				
International Disposal, CA				0.05				
Puente Hills, CA				0.07				
Ramona, CA				0.05				
Eastlake Landfill, CA				0.07				
Cold Canyon, CA				0.06				

## Appendix 1.13, continued

Landfill disposal  
*showing jobs at landfills in non-CDR states and CDR states*

LANDFILL DISPOSAL, cont. (FTE jobs/1,000 tons)								
Landfil	CDR				NON-CDR			
	PLAS	ALU	GLS	MIX	PLAS	ALU	GLS	MIX
Hay Road Landfill, CA				0.03				
Chicago Grade, CA				0.06				
Tehema County Landfill, CA				0.05				
Vasco Road, Livermore, CA				0.06				
Mesquite Landfill, CA				0.05				
Bass Hill Landfill, CA				0.10				
<b>AVERAGE</b>				<b>0.06</b>				<b>0.06</b>
<b>MEDIAN</b>				<b>0.05</b>				<b>0.04</b>
MIN				0.02				0.01
MAX				0.17				0.19
COUNT				22				16

## APPENDIX 2

### Summary of Virgin Extraction Jobs Impacts Data

The tables on the following pages show employment at facilities that extract the raw materials for glass and PET. (Primary extraction for aluminum's raw materials is not considered here because it is assumed that losses in this sector would be off-shore, not domestic.)

The model assumes that for every ton of material recycled and therefore used for manufacturing, a ton of virgin material is not needed, and therefore is not extracted. Because of this reduction in demand, the model assumes there will be jobs losses in the following sectors and activities.

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## Appendix 2.1

## Silica extraction

Silica mine (with or without CDR)	CDR / NO CDR (FTE jobs/1,000 tons)
Simplot, Nevada	0.07
N.B. Numapas	0.42
Clayton Silica Mine, Iowa	0.13
Utica, Illinois	0.43
Gore, VA	0.07
Lochaline, Scotland	0.11
Shaw Resources, NS	0.14
Shelbourne, NS	0.15
White Rock, PA	0.03
U.S. Silica, IL	0.07
<b>AVERAGE</b>	<b>0.16</b>
<b>MEDIAN</b>	<b>0.12</b>
MIN	0.03
MAX	0.43
COUNT	10

## Appendix 2.2

## Soda ash extraction

Soda ash mining	CDR / NO CDR (FTE jobs/1,000 tons)
Solvay-OCI, WY	0.11
<b>AVERAGE</b>	<b>0.11</b>
<b>MEDIAN</b>	<b>0.11</b>
MIN	0.11
MAX	0.11
COUNT	1

**Appendix 2.3**  
**Aplite extraction**

Employer	CDR / NO CDR (FTE jobs/1,000 tons)
U.S. Silica Aplite. Montpelier, VA	0.13
<b>AVERAGE</b>	<b>0.13</b>
<b>MEDIAN</b>	<b>0.13</b>
MIN	0.13
MAX	0.13
COUNT	1

**Appendix 2.4**  
**Limestone extraction**

Employer	CDR / NO CDR (FTE jobs/1,000 tons)
Taylor County 1	0.02
Taylor County 2	0.03
Taylor County 3	0.03
Taylor County 4	0.04
Sagrex Beez	0.02
Martin Marietta	0.06
<b>AVERAGE</b>	<b>0.03</b>
<b>MEDIAN</b>	<b>0.03</b>
MIN	0.02
MAX	0.06
COUNT	6

## Appendix 2.5

## Borates extraction

Employer	CDR / NO CDR (FTE jobs/1,000 tons)
Mine in Boron, CA	1.32
<b>AVERAGE</b>	<b>1.32</b>
<b>MEDIAN</b>	<b>1.32</b>
MIN	1.32
MAX	1.32
COUNT	1

## Appendix 2.6

## Aggregate extraction

Employer	CDR / NO CDR (FTE jobs/1,000 tons)
North Carolina 2000	0.04
Swamp Point, Ascot	0.06
Mt. Shasta, CA	0.03
<b>AVERAGE</b>	<b>0.04</b>
<b>MEDIAN</b>	<b>0.04</b>
MIN	0.03
MAX	0.06
COUNT	3



Appendix 2.7

PTA, MEG and PX production  
showing jobs from the production of PTA, MEG and PX

PTA production	CDR / NO CDR (FTE jobs/1,000 tons)
BP Cooper River Plant (PTA)	0.25
<b>AVERAGE</b>	<b>0.25</b>
<b>MEDIAN</b>	<b>0.25</b>
MIN	0.25
MAX	0.25
COUNT	1

MEG production	CDR / NO CDR (FTE jobs/1,000 tons)
MEGlobal Fort Saskatchewan (MEG)	0.12
MEGlobal Prentiss, AL (MEG)	0.21
<b>AVERAGE</b>	<b>0.16</b>
<b>MEDIAN</b>	<b>0.16</b>
MIN	0.12
MAX	0.21
COUNT	2

PX production	CDR / NO CDR (FTE jobs/1,000 tons)
BP Texas City Plant (PX)	0.16
<b>AVERAGE</b>	<b>0.16</b>
<b>MEDIAN</b>	<b>0.16</b>
MIN	0.16
MAX	0.16
COUNT	1



## Appendix 2.8

### Production of virgin plastic

Employer	CDR / NO CDR (FTE jobs/1,000 tons)
Invista PET Polymer, Spartanburg, SC	0.95
Virgin plastic producer in US	0.36
New Indorama polymers plant in Decatur, AL	0.22
<b>AVERAGE</b>	<b>0.51</b>
<b>MEDIAN</b>	<b>0.36</b>
MIN	0.22
MAX	0.95
COUNT	3

## Appendix 2.9

### Recipe for virgin plastic; final calculation of jobs from production of virgin plastic

**Paraxylene:** 0.521 kg is required to make 1 kg of PET. It takes 521 tons to make 1,000 tons of PET. It takes 0.16 FTEs to make 1,000 tons of paraxylene; therefore, it requires 0.08 FTEs to make the amount of paraxylene required to make 1,000 tons of PET. Note paraxylene is converted into PTA at a later phase.

**Ethylene oxide to be converted into MEG:** 0.2537 kg is required to make 1 kg of PET. Therefore, 253 tons of ethylene oxide is needed to make 1,000 tons of PET. It takes 0.16 FTEs to make 1,000 tons of ethylene oxide; therefore, it requires 0.04 FTEs to make the amount of MEG required to make 1,000 tons of PET.

Paraxylene is converted to PTA. It requires 0.25 FTEs to make 1,000 tons of PTA from paraxylene.

The mix for PET is 80 percent PTA and 20 percent MEG. Source: Wellman Plastics.

Thus there is a 4:1 ratio of PTA to MEG, and it therefore requires 1,012 tons for PTA to make 1,000 tons of PET. 0.25 FTE to make the amount of PTA required to make 1,000 tons of PET.

Add all job components:

$0.08 + 0.04 + 0.25 = 0.37$  FTEs for the raw materials required to make the PET, not including the transportation. The PET polymerization process requires an additional 0.36 FTEs to make 1,000 tons of PET.

The total jobs for *virgin* production of PET is 0.73 FTEs/1,000 tons.





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