



Recycling Economic Information and Diversion Rate Study For Rhode Island

FINAL REPORT | JUNE 2018

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DSM ENVIRONMENTAL

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DEFINITIONS

The definitions used in **Rhode Island** and this report are as follows. In some cases, they may differ from the definitions used by the US EPA, which are also described below.

Construction and Demolition Debris (C&D) means non-hazardous solid waste resulting from the construction, remodeling, repair, and demolition of utilities and structures; and uncontaminated solid waste resulting from land clearing. Such waste includes, but is not limited to wood (including painted, treated and coated wood and wood products), land clearing debris, wall coverings, plaster, drywall, plumbing fixtures, non-asbestos insulation, roofing shingles and other roofing coverings, glass, plastics that are not sealed in a manner that conceals other wastes, empty buckets ten gallons or less in size and having no more than one inch of residue remaining on the bottom, electrical wiring and components containing no hazardous liquids, and pipe and metals that are incidental to any of the above. Solid waste that is not C&D debris (even if resulting from the construction, remodeling, repair, and demolition of utilities, structures, and roads and land clearing) includes, but is not limited to, asbestos waste, garbage, corrugated container board, electrical fixtures containing hazardous liquids such as fluorescent light ballasts or transformers, fluorescent lights, carpeting, furniture, appliances, tires, drums, containers greater than ten gallons in size, any containers having more than one inch of residue remaining on the bottom, and fuel tanks. Also excluded from the definition of C&D debris is solid waste resulting from any processing technique that renders individual waste components unrecognizable, such as pulverizing or shredding, at a facility that processes C&D debris.

Diversion Rate means the total amount (reflected as a percentage) of a material, diverted from disposal through waste prevention, recycling, or reuse. Source RI TITLE 250-RICR-CHAPTER 140- 05-1

Municipal Solid Waste (MSW) means that solid waste generated by the residents of a municipality in the course of their daily living, the disposal of which the governing body of the municipality has undertaken in the discharge of its duties to protect the health of the municipality. Municipal Solid Waste does not include Solid Waste generated by residents of a municipality in the course of their employment or that is generated by any manufacturing or commercial enterprise. Source: RI Title 250 RICR-CHAPTER 140-05-1)

EPA's Definition of Municipal Solid Waste and Recycling Rate

Municipal Solid Waste (MSW) includes residential waste (including waste from multi-family housing) and waste from commercial and institutional locations, such as businesses, schools and hospitals. Municipal solid waste generation and recycling as defined by the EPA in their Annual Characterization Report (*Advancing Sustainable Materials Management: 2014 Fact Sheet, Assessing Trends in Material Generation, Recycling, Composting, Combustion with Energy Recovery, and Landfilling in the United States, November 2016*) does not include construction and demolition debris, biosolids (sewage sludges), industrial process wastes, or a number of other wastes that, in some cases, may go to a municipal waste landfill. In 2014, the most recent year for which national data is available, EPA estimates 34.6 percent of the waste stream was recycled and/or composted.

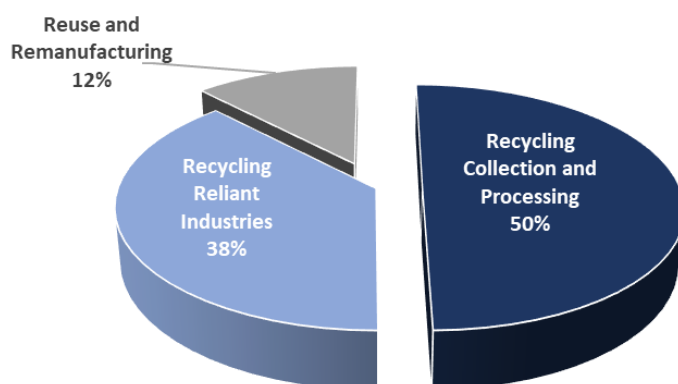
EXECUTIVE SUMMARY

Impact of Recycling on Rhode Island’s Economy

An estimated two hundred and forty-eight (248) establishments make up Rhode Island’s recycling industries and are estimated to employ over 2,600 people, generating annual revenues of just under \$1 billion. Adding indirect and induced economic benefits, assuming a multiplier of 1.5 to 2, which is typical for these types of industries, the total economic impact (including indirect and induced impacts) of recycling in Rhode Island is between \$1.5 and \$2 billion annually.

Figure E.1 illustrates how total *direct* revenues are distributed between the recycling (collection and processing and wholesaling), recycling reliant (manufacturing), and reuse/remanufacturing industries; demonstrating the large economic contribution of recycling collection, processing and wholesaling to the total recycling economy in Rhode Island.

FIGURE E.1 – Percentage of Total Annual Revenues in Each Major Recycling Industry



As illustrated by Table E.1, while the greatest number of jobs are in recycling collection and processing sector, the highest paying jobs are in the manufacturing industries that utilize recycled feedstock as some portion of their input (recycling reliant industries), with the lowest paying jobs in the reuse and remanufacturing industries.

TABLE E.1: SUMMARY OF TOTAL ESTIMATED ANNUAL REVENUE, EMPLOYMENT AND PAYROLL FROM THE MAJOR RECYCLING SECTORS

SECTOR	Establishments	Revenue (\$)	Employees	Payroll (\$)
Recycling Collection and Processing	104	\$491,440,000	1,028	\$47,592,000
Recycling Reliant Industries	49	\$367,300,000	687	\$38,183,000
Reuse and Remanufacturing	95	\$119,290,000	916	\$23,268,000
Total:	248	\$978,030,000	2,632	\$109,043,000

(1) Numbers may not add due to rounding.

Diversion Rate

Diversion rates are calculated by dividing the total amount of material diverted from disposal by the amount diverted plus that total amount of solid waste disposed. To determine a diversion rate for solid waste, it is necessary to further define what is included in the solid waste stream. In Rhode Island, the definition of municipal solid waste excludes solid waste generated by residents of a municipality “in the course of their employment or that is generated by any manufacturing or commercial enterprise”. In contrast, the US EPA includes all institutional and business/commercial solid waste in their definition of municipal solid waste but excludes industrial waste as well as construction and demolition waste.

While the US EPA published guidance on measuring municipal solid waste recycling in 1998¹, most states have chosen to calculate their rate without strictly following the US EPA guidance document, often including materials or diversion activities not counted by US EPA.^{2,3} For example, California which is often cited as having very high diversion rates allows local jurisdictions to include ground C&D waste used for landfill cover or slope stabilization as part of the numerator and denominator in reported rates, although they exclude this practice in the calculation of the state recycling rate. Vermont does not include C&D waste but does include an estimate for backyard composting and reuse activities in their reported diversion rate although neither are included in EPA’s rate methodology.

In addition, the EPA and many states do not break out residential recycling separately from commercial (or business) recycling. This is mainly due to the difficulty in tracking commercial recycling which is typically out of the control of municipal or state governments, but also due to the challenges associated with tracking residential recycling if the municipality does not manage waste and recycling collection activity. For all of these reasons, it is difficult to compare rates between states.

For purposes of this study DSM has attempted to estimate four diversion rates:

- **Municipal (or residential)** diversion rate for which RIRRC has excellent data because all municipal solid waste and most recyclables are delivered to the RIRRC landfill and MRF;
- **Institutional/Commercial/Industrial (ICI)** diversion rate for all non-municipal (or residential) solid waste;
- **Total Municipal and ICI** diversion rate: and,
- **Construction and Demolition (C&D)** diversion rate.

¹ US EPA. *Measuring Recycling, A Guide for State of Local Governments*. November 1997. This document can be found at: <https://archive.epa.gov/wastes/conservation/tools/recmeas/web/pdf/guide.pdf>

² *Diversion and Recycling Rates are ways of accounting for the amount of material diverted from disposal. Typically, a diversion rate is used to estimate the amount of waste diverted through reducing waste at the source, reusing waste items in their original form, and recycling, which is the separating of items to be processed into new materials. Technically, the recycling rate serves to determine the amount set aside for recycling from the diverted amount. However, these terms are often used interchangeably in published literature because it is difficult to distinguish between them. While the intent of this document is to calculate the waste diversion rate, both terms are used interchangeably here especially when referencing other studies where their meanings are ambiguous.*

³ *Municipal solid waste generation and recycling as defined by the EPA does not include construction and demolition debris, biosolids (sewage sludges), industrial process wastes, or a number of other wastes that, in some cases, may go to a municipal waste landfill.*

Table E.2 presents DSM’s best estimate of diversion activity by material type for the residential/ municipal waste stream and for the ICI waste stream, excluding C&D wastes.

Table E.3. then presents an estimate of C&D materials diversion by material type in Rhode Island.

TABLE E.2: ESTIMATED RECYCLING BY MAJOR MATERIAL CATEGORY IN RHODE ISLAND (TONS, 2016)

Major Material Category	Residential (Tons)	ICI (Tons)	Total (tons)
Paper, Paper Packaging	50,742	46,471	97,212
Other Packaging	22,158	29,175	51,334
Single Stream	0	4,162	4,162
Vehicle Waste	11,417	2,854	14,272
Special Wastes	11,649	13,404	25,053
Food, Organic Waste	525	13,411	13,936
Green Waste	89,475	9,942	99,417
Metals (1)	28,958	8,727	37,685
Total:	214,924	128,147	343,071

- 1) Metals include an estimate for Aluminum, Appliances and Lead Acid Batteries but not other types of scrap metal.
- 2) Numbers may not add due to rounding.

TABLE E.3: ESTIMATED C&D RECYCLING BY MAJOR MATERIAL CATEGORY IN RHODE ISLAND (TONS, 2016)

C&D Material Category	Diverted (tons)
Aggregates	88,259
Asphalt Shingles	8,003
Biomass to Fuel	28,550
Clean C&D Wood	13,329
Fines & Residuals	8,529
Land Clearing Debris	1,133
Metals	14,452
Mixed C&D	8,398
Total:	170,654

- (1) Numbers may not add due to rounding.

Table E.4. (on the next page) presents estimated solid waste disposal for each of the same three categories of Rhode Island generated solid waste, and includes waste generated in Rhode Island but disposed of out of state.

TABLE E.4: DISPOSAL ESTIMATES BY GENERATOR CATEGORY (TONS, CY 2016)

Disposal Location	Residential (tons)	ICI (tons)	Subtotal (1) (tons)	C&D (tons)	Total (tons)
RIRRC Landfill	362,568	220,911	583,480	217,579	801,058
Out-of-State Facilities		202,803	202,803		202,803
Total:	362,568	423,714	786,283	217,579	1,003,861

1) This would be considered MSW under the EPA definition.

Table E.5 then uses the data from Tables E.2, E.3 and E.4 to present estimated diversion rates for the three generator categories, as well as a total state-wide diversion rate.

TABLE E.5: ESTIMATED DIVERSION RATES FOR MUNICIPAL, ICI, C&D AND TOTAL SOLID WASTE GENERATED IN RHODE ISLAND (CY 2016)

Material Management	Residential (tons)	ICI (tons)	C&D (tons)	Total (tons)
Diverted Materials	214,924	128,147	170,654	513,725
Solid Waste Disposal	362,568	423,714	217,579	1,003,861
Diversion Rate:	37%	23%	44%	34%

Finally, C&D recycling and disposal have been removed in Table E.6, below, to calculate a recycling rate comparable to the EPA recycling measurement for what EPA refers to as “municipal solid waste”.⁴

TABLE E.6: ESTIMATED DIVERSION RATE FOR RHODE ISLAND SOLID WASTE, EXCLUDING C&D WASTE (CY 2016)

Material Management	Residential (tons)	ICI (tons)	Total (tons)
Diverted Materials	214,924	128,147	343,071
Solid Waste Disposal	362,568	423,714	786,283
Diversion Rate, Without C&D:	37%	23%	30%

(1) Numbers may not add due to rounding.

As illustrated by Table E.5 Rhode Island’s overall diversion rate is estimated to be 34 percent, driven by a relatively high residential/municipal recycling rate of 37 percent and an even higher C&D diversion rate of 44 percent. Without C&D waste included, this rate drops to an estimated 30 percent (Table E.6). However, as stated in the body of the report, DSM believes that the ICI diversion rate is under-reported

⁴ As stated in the Definitions, EPA’s definition of municipal solid waste (which includes most business and institutional waste) is different from the definition that RIRRC uses because of the special circumstances of the RIRRC landfill.

because there is no requirement for businesses to report the quantities they recycle, and because a significant amount of business material is likely recycled out-of-state or by facilities that would not report to DSM.

It should be noted that the diversion rates presented in Table E.6 do not include ferrous and non-ferrous metals that some states might choose to count in their rate reporting.⁵ Table E.7 recalculates the diversion rates with an additional estimate of scrap metal recycling added in to account for ferrous and non-ferrous metals recycled other than those found in appliances, aluminum and lead acid batteries.^{6 7} With this estimate of roughly 115,000 additional tons, which is assumed to be 50/50 residential and ICI as shown in Table E.7 below, the diversion rate rises to 37 percent. This illustrates the potential impact of counting different types of materials in a state’s measurement of recycling activity.

TABLE E.7: ESTIMATED DIVERSION RATES FOR RHODE ISLAND SOLID WASTE INCLUDING ESTIMATES FOR ALL FERROUS AND NON-FERROUS SCRAP METAL RECYCLING⁸ (CY 2016)

Material Management	Residential (tons)	ICI (tons)	Total (tons)
Diverted Materials (Table E-6)	214,924	128,147	343,071
<i>Estimated Additional Metal Recycling</i>	57,733	57,733	115,466
Total Diverted Materials:	272,658	185,880	458,537
Solid Waste Disposal	362,568	423,714	786,283
<i>Diversion Rate, Without C&D:</i>	43%	30%	37%

(1) Numbers may not add due to rounding.

Impact of Increasing the Diversion Rate to 50 Percent

The overall solid waste diversion rate (excluding C&D recycling) in Rhode Island is estimated to range between 30 and 37 percent, depending on whether ferrous and non-ferrous scrap metal recycling are included in the calculation, and depending on how much ICI recycling activity was not captured in DSM’s survey and estimates.

While these data are robust for residential or what Rhode Island defines as municipal recycling, it is DSM’s professional opinion that the ICI rate undercounts recycling (and diversion) of several materials in potentially large quantities (mainly old corrugated cardboard and mixed paper) due to the lack of robust data and the voluntary nature of the survey conducted to obtain missing data.

⁵ See discussion of what other states include and exclude in PART II of this report.

⁶ EPA includes scrap metal recycling from: ferrous metals (iron and steel) in furniture, tires, and miscellaneous durables; aluminum in appliances, furniture, and miscellaneous durables; Lead in lead-acid batteries; and other nonferrous metals found in appliances and miscellaneous durables.

⁷ This estimate was made based on scrap metal recycling reported in Delaware and Connecticut which included all metals except for those associated with scrap vehicles, and is likely broader than the EPA definition of durables.

⁸ Excludes scrap vehicle recycling.

Therefore, while Rhode Island has a 50 percent diversion goal, without mandatory reporting by generators and private recyclers, there is no way to verify the status of recycling activity as well as the progress made annually.

Delaware passed a Universal Recycling Law requiring anyone who collects/transport, processes, or markets recyclables to report annually on the type and quantity of recyclables managed, and the location of facilities used. Since adoption of the Delaware law in 2010, the actual recycling rate has steadily increased, both because of the recycling requirements in the law as well as improved reporting of materials recycling by businesses and recycling brokers in the state.

Given the uncertainties of ICI recycling in Rhode Island, and the lack of clarity on what to include or exclude in measuring diversion, a realistic estimate might be that the State's solid waste diversion rate (excluding C&D) is somewhere between 35 percent and 40 percent and therefore there is a need to add 10 to 15 percentage points to reach the 50 percent diversion goal.

To achieve this, opportunities might be found through increasing the recovery of several specific materials found in the landfill in large quantities (relative to other materials). These opportunities are outlined below using data from the 2015 Rhode Island Solid Waste Characterization Study, which characterized residential, ICI, C&D and bulky waste coming into the landfill.⁹ Note that waste composition data are not available for ICI waste disposed out of state, which may provide additional opportunities.

Opportunities for Additional Diversion

The 2015 waste characterization study indicated that roughly 41,000 tons of corrugated and 35,800 tons of mixed paper were landfilled at the RIRRC landfill, representing roughly 14.5 percent of waste disposed.¹⁰ Therefore, the potential exists for significant additional diversion of recycled paper to local processors and recyclable material wholesalers.

Roughly 83 percent of the 41,000 tons of corrugated were disposed from ICI generators, while conversely roughly 46 percent of the 35,500 tons of mixed paper are disposed from residential generators. Diverting another 30 percent of this landfilled material would not only save landfill capacity but produce revenue (roughly \$1.5 million for corrugated alone)¹¹ and create jobs in both materials collection and processing. This material might serve as potential feedstock to mills in New England, and ultimately benefit the Rand Whitney Packaging facility in Pawtucket which relies on corrugated from their mills in the New England region.

⁹ DSM Environmental Services, MSW Consultants and Cascadia Consulting. *Rhode Island Solid Waste Characterization Study FINAL REPORT – December 31, 2015. Prepared for: Rhode Island Resource Recovery Corporation.*

¹⁰ *Excluding special wastes and C&D wastes.*

¹¹ *Based on March 2018 pricing of OCC, Boston Market.*

In addition, roughly 6,300 tons of PET/HDPE bottle plastics were landfilled (or 1.2 percent of disposed waste¹²) and could also serve as feedstocks for local processors – with separated plastics ultimately delivered to local plastic reclaimers.

In addition to these materials disposed at the RIRRC landfill, ICI waste disposed out of state likely includes recyclable materials in comparable quantities. Assuming the composition of the ICI waste disposed out of state is the same as that disposed at RIRRC, an additional 10,000 tons of OCC might be recovered, at a value of more than \$1 million.

Another material disposed in large numbers was textiles, with roughly 29,000 tons disposed at RIRRC based on the 2015 waste characterization study. The majority of this (77 percent) is from the residential sector. The value of textiles dropped dramatically over the past year because of second-hand textile import bans proposed by Eastern African Countries (EAC). However, the bans appear to have been retracted by four of the five nations that originally proposed them.¹³ This would enable international imports to the EAC to continue, one of the key markets for recovered textiles. In addition, there is renewed interest in the United States on collecting and recovering the fibers inherent in textiles.

Assuming 20 percent of the textiles disposed at RIRRC could be recovered, and prices rise from recent lows to 25 cents per pound, another \$2.8 million in revenues might be generated by textile recycling, with a need for additional collection and processing labor to recover this material.

Finally, some portion of food waste, which was estimated at roughly 100,000 tons disposed in the 2015 study, has the potential to be diverted for composting or anaerobic digestion in the region. However, this food waste contributes to methane generation and electricity production at the RIRRC landfill, and costs for separate collection can be significant. As such, this may be a case where job creation would primarily be in reducing food waste at the generator level and increasing food rescue operations.

Economic Impacts from Increased Diversion

It would be a gross over-simplification to take the jobs and revenue created by current recycling activity and assume a linear extrapolation of the data to the new tons diverted. This is because many of the recycling collection and processing industries have some capacity to absorb new materials with limited change in employment. Similarly, most of the recycling reliant industries can change their mix of recycled versus virgin materials input with little change in employment.

Areas most likely to result in increased employment are collection of recyclable materials and increased diversion of textiles and organics, where the collection and processing infrastructure are not already in place.

One can reasonably assume that the collection infrastructure for recyclables in Rhode Island is relatively efficient with utilization of trucks and drivers at a high rate – perhaps close to 90 percent. For this reason, if new tons are added, collection companies will initially absorb those tons with existing trucks and drivers, but will eventually have to add new trucks and drivers as the tonnage increases.

¹² Excluding special wastes and C&D wastes.

¹³ Editorial Staff. *Ban rethink 'a victory for EAC countries and second-hand textiles industry'* Recycling International. April 03, 2018.

This would especially be the case for significant increases in ICI corrugated collection because costs are very dependent on the volume of corrugated set out at each commercial stop. This would also be the case if new programs for separate collection of textiles were undertaken because textiles would need to be collected separate from residential single stream collection.

Finally, working with food waste generators to reduce food waste, and especially increasing food rescue programs will directly increase employment.

Based on the current recycling infrastructure in Rhode Island, the estimated tonnage collected and processed, and revenues generated as a result, every additional 10,000 tons diverted might create an estimated 17 jobs and nearly \$8 million in additional revenues.¹⁴

¹⁴ *This is a very rough estimate made from dividing the economic and job impacts by the estimated recycling and organics and textile tonnages collected, processed and marketed from these RI based facilities.*

INTRODUCTION

Materials recycling and reuse are not only important steps in minimizing solid waste disposal, but they provide jobs and economic value. The Institute of Scrap Recycling Industries (ISRI) estimates that over 800 million metric tons of scrap commodities are consumed globally each year, with the United States processing approximately 130 million metric tons of scrap commodities. These provide vital raw materials to manufacturers and help to fuel global economic growth (ISRI Annual Report 2017)

Rhode Island's General Assembly, recognizing the importance of recycling to the State's economy, passed legislation in 2016 requiring that the Rhode Island Resource Recovery Corporation (RIRRC) carry out a study of the economic impact of recycling, including an estimate of the current diversion rate, and the potential economic benefits of achieving a 50 percent diversion goal.

RIRRC contracted with DSM Environmental Services, Inc. (DSM) to quantify the economic impacts of Rhode Island's Recycling Industry as it stands today, and project further opportunities for economic growth through expansion of recycling. The **Recycling Industry** includes those firms collecting and processing recyclable materials and organics (**Recycling businesses**), those firms buying recycled materials to produce new products (**Recycling Reliant Industries**), and those firms which reuse or remanufacture materials that would otherwise be discarded (**Reuse/Remanufacturing Industry**).

DSM's scope of work was to:

- Estimate the economic impact of these three broad groups of industries to the degree that DSM was able to identify and quantify these sectors in Rhode Island;
- Estimate the current materials diversion rate, focusing on large recycling businesses identified as part of the recycling economic information study, along with large out of state recyclers located in border states – mainly Massachusetts and a few in Connecticut - that might take RI material to estimate the amount of commercial recycling activity from RI generators.
- Finally, with the current diversion rate estimated, use the data developed on the economic impact of recycling to project an estimated increase in the economic impact of recycling associated with moving to a 50 percent diversion rate.

DSM conducted the research between July 2017 and March 2018. The following report summarizes our findings. The economic results are presented first (PART I), followed by the diversion rate estimate (PART II), and finally based on this information, an estimate of the economic impact of an increased diversion rate is made, which is found at the end of PART II.

PART I: ECONOMIC IMPACT OF CURRENT RECYCLING ACTIVITY

Introduction

DSM researched the contribution of both recycling and reuse industries, along with recycling reliant industries (collectively referred to as the recycling industry) to Rhode Island's economy beginning in the summer of 2017 with the goal of providing RIRRC and the Rhode Island General Assembly with a better understanding of the economic value of the recycling industry in Rhode Island. DSM tracked and estimated the *direct* economic impacts for each recycling industry sector following a similar methodology used in DSM's 2009 Northeast Recycling Council Report for the states of Delaware, Maine, Massachusetts, New York and Pennsylvania which was based on an updated methodology originally commissioned by the U.S. Environmental Protection Agency working with the National Recycling Coalition.

Indirect and induced economic impacts were then estimated based on the direct impacts.

To calculate direct impacts, data were compiled to estimate the number of establishments, total employment, total payroll, gross receipts and annual throughput (for applicable categories only) for each recycling industry sector. These terms are defined as:

- **Establishment** is a single location where a recycling, recycling reliant or reuse/remanufacturing organization operates.
- **Employment** includes all employees (jobs) in the recycling, recycling reliant, and reuse industries (allocated by percentage use of recycled as opposed to virgin materials processed or used), from the factory worker to the administrator, and are reported as full time equivalent jobs.
- **Payroll** represents total taxable wages for each employee counted.
- **Gross receipts** represent total sales revenue for each recycling industry sector.

The economic activities included in the recycling and reuse industries were broadly grouped as follows:

- **Collection, processing, and wholesaling** of recyclable materials including paper, metals, glass, plastics, textiles, and electronics;
- **Processing/composting and sale of organic materials**, including leaf and yard waste, brush and tree trunks, food waste, and biosolids;
- **Reclamation of processed materials** to prepare them for end use (e.g. cleaning and granulating plastics by resin type, cleaning and color sorting glass cullet);
- **Manufacturing first stage products from recycled scrap** including, but not limited to paper rolls, metal ingots, billet or rods, metal castings, plastic lumber, sheet or shapes, and glass containers;
- **Wholesale reuse businesses**, such as materials exchange services, electronic parts, used motor vehicle parts sales and rebuilt pallets; and,
- **Retail reuse businesses**, such as used clothing, electronics, furniture, wood, and building supply stores.

Descriptions of each sector within these broad categories are provided in this report, after a description of the study methodology. Table 1 provides examples of these industries and the broad classifications they fall under.¹⁵

TABLE 1: EXAMPLES OF RECYCLING, RECYCLING RELIANT AND REUSE INDUSTRIES

RECYCLING INDUSTRIES (Supply Side)
Residential Curbside Recycling Collection
Commercial Recyclables Collection
Compost/Organics Processors
Materials Recovery Facilities
Recyclables Material Wholesalers
Plastics Reclaimers
Other Recycling Processors/Manufacturers
RECYCLING RELIANT INDUSTRIES (Demand Side)
Glass Container Manufacturing Plants
Glass Product Producers
Nonferrous Secondary Smelting and Refining mills
Nonferrous Product Producers
Nonferrous Foundries
Paper and Paperboard Mills/De-inked Market Pulp Producers
Paper-based Product Manufacturers
Pavement Mix Producers (asphalt and aggregate)
Plastics Converters and End Users
Rubber Product Manufacturers
Steel Mills
Iron and Steel Foundries
REUSE AND REMANUFACTURING
Computer and Electronic Appliance De-manufacturers
Used Motor Vehicle Parts Retailers and Wholesalers
Retail Used Merchandise Sales
Tire Retreaders
Wood Reuse
Material Exchanges and Other Reuse

¹⁵ Note that these categories were originally developed by the US EPA and incorporated in the Final Report, U.S. Recycling Economic Information Study prepared for The National Recycling Coalition by R. W. Beck, Inc. (July 2001) and later modified by DSM for a subsequent study in 2009 for the Northeast Recycling Council.

Research Methodology

DSM attempted to compile, and accurately classify, recycling activity in each of the sectors listed in Table 1 specifically for Rhode Island using the following approach.

First, DSM reviewed and compiled available government economic and throughput data on each sector. The types of government economic data reviewed and used for the study included:

- **The United States Economic Census** is conducted every five years in the years ending with '2 and '7, with the most recent data available from 2012 and available at the State level.
- **County Business Patterns (CBP)** is a supplemental set of economic data on employment and wages and available down to the County level, with in most cases the most recent year available as 2015.
- **The Annual Survey of Manufacturers (ASM)** is an annual survey undertaken by the U.S. Census Bureau of a subset of manufacturers and available at the State level, with the most recent year available 2015.¹⁶
- **The Bureau of Labor Statistics (BLS)** provides quarterly and annual employment statistics by state and occupation, which can be used to supplement suppressed data from the economic census and/or to research average wages in a state or specific occupation, and available at the County and State level with the most recent year available 2016.
- **The United States Geological Survey Metals Yearbook** provides an annual review of the mineral and material industries of the United States and foreign countries and contains statistical data on materials and minerals including economic and technical trends and development.

Table 2, on the next page, lists the recycling, recycling reliant, and reuse/remanufacturing sectors covered in this report and the North American Industry Classification System (NAICS) codes that each sector was classified under. Note that in some cases there are more than one code that may apply to a particular sector (or company) and in other cases, there is no code that adequately defines that type of recycling business.

The NAICS code assignment was used to make establishment counts, estimate employment and payroll and estimate gross revenues in sectors where data were available at the state level. In some cases, the state specific data for a particular NAICS code could be used to estimate the entire economic contribution from that type of recycling sector. For other sectors the NAICS codes and related economic data provided partial data that can be used.

For example, CBP, BLS, Economic Census and ASM data on payroll and employment could be used to identify the average wage (per employee) for some sectors where no payroll information was available. It was also used in those cases where no revenue, survey or other modeling data was available to estimate annual revenues per employment in that sector.

Second, DSM sought to develop a comprehensive database of recycling and reuse businesses, by sector, for Rhode Island, particularly for those sectors where economic data either could not be used or were not available. DSM collected and merged contact lists from a myriad of sources, including recycling

¹⁶ For some sectors in some states, ASM data is only available at the national level.

market listings and databases, trade organization member lists, and published and purchased directories. DSM then carefully reviewed the listings for duplication and performed significant internet research to both correctly code each listing and verify its’ recycling activity as well as identify additional establishments in each recycling sector. The goal of this extensive research was to create a single database of recycling businesses for Rhode Island coded by sector. This could be used for both the economic impact study and for contacting businesses to estimate the recycling rate (PART II of this study).

TABLE 2: POTENTIAL NAICS CODE ASSIGNMENT FOR RECYCLING, RECYCLING RELIANT AND REUSE INDUSTRIES

	Sector	Potential NAICS Code	NAICS Code Description
Recycling Collection	<i>Residential Curbside Recycling Collection</i>	562111	Establishments primarily engaged in collecting and/or hauling mixed recyclable materials within a local area from residents
	<i>Commercial Recyclables Collection</i>	562111	Establishments primarily engaged in collecting and/or hauling mixed recyclable materials within a local area from businesses
Recycling Processing	<i>Compost/Organics Processors</i>	325311, 325314	Nitrogenous Fertilizer Mixing; Fertilizers (Mixing Only) Manufacturing
	<i>Materials Recovery Facilities</i>	56292	Materials Recovery Facilities
	<i>Recyclables Material Wholesalers</i>	42393	Establishments primarily engaged in the merchant wholesale distribution of automotive scrap, industrial scrap, and other recyclable materials
	<i>Plastics Reclaimers</i>	325991	Custom compounding of purchased Resins includes establishments primarily engaged in (1) custom mixing and blending plastics resins made elsewhere or (2) reformulating plastics resins from recycled plastics products
	<i>Other Recycling Processors</i>	N/A	This includes paint, mattress and some universal waste recyclers
Recycling Reliant Industries	<i>Glass Container Manufacturing Plants</i>	327213	Glass Container Manufacturing
	<i>Glass Product Producers</i>	327211, 327212, 327993	Flat Glass Manufacturing;, Other Pressed and Blown Glass and Glassware Manufacturing; Mineral Wood Manufacturing
	<i>Nonferrous Secondary Smelting and Refining Mills</i>	331314, 331420, 331492	Secondary smelting and alloying of aluminum; Copper Rolling, Drawing, Extruding + Alloying; Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)
	<i>Nonferrous Product Producers</i>	331315, 331318, 331420, 331491	Aluminum Sheet, Plate, and Foil Manufacturing; Other Aluminum Rolling, Drawing, and Extruding; Copper Rolling, Drawing, Extruding, and Alloying; Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding
	<i>Nonferrous Foundries</i>	33152	Nonferrous Metal Foundries
	<i>Paper and Paperboard Mills/Deinked Market Pulp Producers</i>	3221	Pulp, paper and paperboard mills
	<i>Paper-based Product Manufacturers</i>	322299, 322219	All Other Converted Paper Product Manufacturing; Other paperboard container manufacturing
	<i>Pavement Mix Producers (asphalt and aggregate)</i>	324121	Asphalt Paving Mixture and Block Manufacturing
	<i>Plastics Converters and End Users</i>	32611, 32612, 326160, 32619	Plastics Packaging Materials and Unlaminated Film and Sheet Manufacturing; Plastic Pipe, Pipe Fitting and Unlaminated Profile Shape Manufacturing; Plastic Bottle Manufacturing; Other Plastics Product Manufacturing
	<i>Rubber Product Manufacturers</i>	326299	Other Rubber Products Manufacturing
	<i>Steel Mills</i>	33111	Iron and Steel Mills
	<i>Iron and Steel Foundries</i>	33151	Ferrous Metal Foundries
	Reuse and Remanufacturing	<i>Computer and Electronic Appliance Demanufacturers</i>	N/A
<i>Motor Vehicle Parts (used)</i>		423140	Establishments primarily engaged in the merchant wholesale distribution of used motor vehicle parts (except used tires and tubes) and establishments primarily engaged in dismantling motor vehicles for the purpose of selling the parts
<i>Retail Used Merchandise Sales</i>		453310	Establishments primarily engaged in retailing used merchandise, antiques, and secondhand goods (except motor vehicles, such as automobiles, RVs, and motorcycles, and boats, motor vehicle parts, tires, and mobile homes)
<i>Tire Retreaders</i>		326212	Establishments primarily engaged in retreading or rebuilding tires.
<i>Wood Reuse</i>		321920, 321219	Wood Container and Pallet Manufacturing, Reconstituted Wood Product Manufacturing
<i>Material Exchange Services and Other Reuse</i>		N/A	Not available for this sector

Third, DSM contacted several active trade organizations representing recycling industries in Rhode Island and the United States. A list of sources used from trade organizations and from other government agencies (including the different sections of the Census Bureau) and that provided input ultimately used for this study are shown in Table 3. This includes a list of organizations with data and information contained on their websites that were used as resources for this research.

TABLE 3: LIST OF GOVERNMENT, INDUSTRY AND OTHER ORGANIZATION RESOURCES USED

TRADE ORGANIZATIONS AND OTHER RESOURCES	WEBSITE
American Forest and Paper Association	http://www.afandpa.org/
American Foundry Society	http://www.afsinc.org/
American Iron and Steel Institute (Steel Recycling Institute)	http://www.steel.org/about-aisi.aspx
Association of Plastic Recyclers (formerly Association of Postconsumer Plastic Recyclers)	https://www.plasticsrecycling.org/
Association of Responsible Recyclers	http://www.noranews.org/
Automotive Recyclers Association	http://a-r-a.org/
Car-Part	http://car-part.com/
Cellulose Insulation Manufacturers Association – Paper products	https://cellulose.org/index.php
Construction Materials Recycling Association	https://cdrecycling.org/
E-Stewards	http://e-stewards.org/find-a-recycler/
Flexible Film Recycling Group (FFRG) of the American Chemistry Council	http://www.PlasticFilmRecycling.org
Glass Packaging Institute	http://www.gpi.org/recycling
Glass Recycling Coalition	http://www.glassrecycles.org/
Institute of Scrap Recycling Industries	http://www.isri.org/
National Asphalt Pavement Association	http://www.asphaltpavement.org/
National Wooden Pallet and Container Association	http://www.palletcentral.com/
Nonferrous Founders Society	http://www.nffs.org/
North American Wood Reuse & Recycling Directory	http://reusewood.org/organizations/organization_65
RI Composting Facilities - RI DEM	
RI DEM List Active/inactive Waste Management Facilities	http://www.dem.ri.gov/programs/benviron/waste/pdf/swfacs.pdf
Plastics Industry Association - Recycling and Sustainability	http://plasticsindustry.org/supply-chain/recycling-sustainability
Plastics News - Recyclers Ranking 2017	Subscription
Retread Tire Association	http://www.retreadtire.org/
Rhode Island Department of Environmental Management	http://www.dem.ri.gov
Rhode Island Department of Transportation	http://www.dot.ri.gov
Rhode Island Resource Recovery Corporation	http://www.rirrc.org
Shingle Recycling	http://www.ShingleRecycling.Org
Sustainable Electronics Recycling International (SERI)	https://sustainableelectronics.org/recyclers

Fourth, DSM relied heavily on a purchased database compiled by Dun and Bradstreet known as D&B Hoovers which provided much of the employment and revenue data for specific identified businesses. Background on this database is provided below.

Fifth, for sectors where existing data were unavailable or insufficient, DSM surveyed specific establishments based on businesses identified from the sources described above. Surveys were used to confirm the business location and that the facility was still operating as well as attempt to collect additional missing data points. DSM also attempted to contact manufacturers in some sectors (mainly plastics and wood products) to try to confirm they used recycled feedstock and at what rate.

Finally, DSM gathered data necessary to model the public and private recycling collection industries in Rhode Island. The modeling approach is described in more detail below for these sectors.

The methodology used for each sector is shown below in Table 4, and key components are described in more detail on the following pages.

TABLE 4: METHOD USED TO DEVELOP ECONOMIC DATA FOR EACH SECTOR

SECTOR	Primary Methodology	Secondary Data	
Recycling Industries	Residential Curbside Recycling Collection	Modeled costs using RIRRC data on municipal curbside recycling and yard waste collection, and on drop offs. Collection frequency, tons collected, program type and households served were model inputs.	DSM cost data on per truck collection and labor costs supplemented by CBP on payroll per collection worker.
	Commercial Recyclables Collection	Modeled revenues based on DSM survey of commercial recycling (by material type for ICI recycling) and estimated per ton (by material type) collection costs (price) and assumed volume per stop and stops per hour	DSM cost data on collection costs (per ton) and CBP on average payroll per collection worker.
	Compost/organics Processors	RIRRC and RIDEM data on tons managed/permitted per composting facility. Hoovers and DSM data on estimated costs, employees (and payroll) per ton managed.	Survey some local facilities to confirm data and fill in gaps.
	Materials Recovery Facilities and Recyclable Material Wholesalers	Economic Census, CBP, Hoovers, RIRRC and RI DEM Data	Survey specific facilities to obtain additional data points.
	Plastics Reclaimers	Trade organizations, Hoovers and internet research to identify potential companies	Survey and research to estimate % recycled resin handled. CBP Data on pay per employee.
	Other Recycling Processors/Manufacturers	RIRRC and RI DEM Data, and DSM research to identify companies.	Survey for missing data and use of DSM data to model.
Recycling Reliant Industries	Glass Container Manufacturing Plants and Glass Product Producers	Economic Census and GPI. DSM research.	<i>No facilities identified</i>
	Nonferrous secondary smelting and refining mills and product producers	CBP, ASM and Economic Census data. Trade research. USGS Minerals Yearbook	Internet research to review industry
	Nonferrous and Iron and Steel Foundries	CBP and Economic Census data with industry input	American Foundry Society - New England Chapter, CBP
	Paper and Pulp Mills and Paper-based Product Manufacturers	Economic Census, CBP and AF&PA	<i>No facilities identified</i>
	Pavement Mix Producers (asphalt and aggregate)	Economic Census, CBP and industry data for standard recycled input	Research on RI specific Recycled Content Use
	Plastics Converters and End Users	Hoovers, then trade organizations to identify potential companies	Research for Recycled Content Estimates
	Rubber Product Manufacturers	Hoovers, then trade organizations to identify potential companies	Research on Recycled Content
	Steel Mills	Economic Census, CBP and Industry data	<i>No facilities identified</i>
Reuse and Remanufacturing	Computer and Electronic Appliance Demanufacturers	Identify facilities through RIRRC, trade organizations. Use State Data on tonnages, DSM data for employment and payroll. model revenues	Survey for missing data
	Motor Vehicle Parts (used)	Economic Census, CBP, BLS	
	Retail Used Merchandise Sales	Economic Census, CBP, BLS	Research to identify examples
	Tire Retreaders	Industry data supplemented by Census, CBP	Survey for missing data
	Wood Reuse	RIRRC and State Data, DSM data for employment and total revenues	Survey for missing data
	Material Exchange Services and Other Reuse	RIRRC and State Data for tonnages, DSM data for employment and total revenues	Research to identify additional companies

Hoovers Data, Supporting Data and Base Year(s)

DSM subscribed to the Dun and Bradstreet (D&B) Hoovers online database to obtain economic information for this project. Subscriptions allow the user to access what is said to be the largest commercial database available.¹⁷

The database allowed DSM to not only identify additional companies in Rhode Island, but to obtain and check information on recycling industries already in DSM's database. Additionally, this database served as the main source of employment counts and revenues for many businesses identified in sectors where no economic census data were available.

The benefit of the D&B Hoovers database is that it gave DSM access to employment counts and annual revenues at identified recycling and recycling reliant business that had been operating for several years. However, businesses newly opened or those closed and then opened under different names are not always updated in the database. In addition, some businesses that were closed were still listed in the database. Finally, in many cases total sales (annual revenues) data was not listed and therefore DSM had to estimate revenue for that location based on employment or another data point.

Modeling Collection Costs

Because economic data on recycling collection are not available separate from the entire solid waste collection industry, DSM modeled estimated revenues and labor requirements for recycling collection in the state of Rhode Island. Recycling collection was modeled for both the residential sector and the Institutional, Commercial and Industrial (ICI) sectors.

For curbside residential recycling and yard waste collection, DSM used detailed data compiled by RIRRC on households served and tons collected in each municipality. Additional data, including collection frequency and collection method were also provided to DSM by RIRRC. Using these data on households served and tonnage collected in each municipality, as well as collection frequency, DSM estimated the number of recycling trucks used and drivers/collectors as well as the cost to operate each truck.

DSM then applied data reported under CBP (2015) for the NAICS Code 562111, Solid Waste Collection for Rhode Island to determine the average pay of recycling collection workers and to estimate total payroll based on the modeled collection labor requirements in the State. For drop-off recycling, DSM obtained data on RIRRC's program and estimated for other municipal recycling activity based on industry standard costs.

For municipal yard waste collection, DSM followed the same methodology as for estimating residential curbside recycling costs, adjusting for a slightly shorter collection season, a larger crew count, and 75 percent of CBP wages for solid waste collection workers.

Annualized truck costs were assumed to be \$280,000 per recycling truck, and \$1,120 for each day a yard waste truck is operating. It was also assumed that an average of 1.3 driver/collectors were on each recycling truck and 2.25 drivers/collectors for each yard waste collection truck.

¹⁷ Hoover's, started in 1990, became a subsidiary of Dun & Bradstreet in 2003 and in 2017 D&B acquired Avention creating "D&B Hoovers" and replacing the existing Hoover's product. D&B maintains a database of more than 265 million companies with 30,000 global data sources updated 5 million times per day. (Source: Wikipedia.)

For commercial recycling collection, DSM developed a database on ICI recycling activity in the state (See PART II). This started with data reported by Rhode Island based transfer stations to RI DEM on throughput of both solid waste and recyclables by material type in 2017. This was supplemented by DSM surveys of Rhode Island based recycling processors (who did not report as part of the transfer station survey) and large generators of recyclable materials on the tons of materials recycled last year by material type. DSM also surveyed out of state processors and brokers who arrange recycling directly with large generators that did not report to RI DEM. Finally, for some materials DSM estimated ICI (and residential) materials recycling that was not reported through the transfer station reports to RI DEM or DSM surveys. These materials were generally recycled in large quantities such as appliances, scrap metal and lead acid batteries.

From this information, DSM developed a model to estimate the collection costs associated with transporting these materials to processing facilities and/or markets.

The model utilized assumptions on the percent of this material collected by contractors, average material density and collection container size, and the number of container lifts or pulls per hour, and route day, to estimate annual collection hours for each material collected from the ICI sector. Note that for metals, paper, corrugated, plastics, and yard waste, it was assumed that some collection activity occurred as a backhaul or as part of an agreement between a processor/end user and the generator, so the cost is either accounted for in another sector (processing and wholesaler of materials), or, at little or no cost to the generator. Finally, annual pay levels were obtained for collection from CBP data for Rhode Island.

The results of modeling both residential and ICI recycling collection costs are presented in the next section.

Surveys Conducted

DSM used telephone and e-mail correspondence to contact individual facilities and materials handlers to confirm information as well as gather additional data points. A letter provided by RIRRC was used to validate the study (See Appendix A) and in some cases, accompanied by a survey form (Appendix B).

The type of data collected included:

- Verifying the business was still located at the address identified and qualified as a recycling business;
- Determining what percentage of operations were recycling related as opposed to performing other functions that generated revenue (for example compost or mulch producers that also sold garden or nursery products, or wood product manufacturers that build new wood packaging as well as rebuilt pallets or barrels);
- Verifying or obtaining an employee count or estimate for that location;
- Verifying Hoover's data on gross revenues for that location;
- Obtaining tonnage information by material type (used for both the economic and the diversion rate study); and,
- Determining how they may fit into Rhode Island's recycling economy.

Survey respondents were offered confidentiality when supplying information and all data collected was stated to be aggregated with other businesses in that sector.

Use of Other Data to Develop Estimates

In the absence of Economic Census and other government data, Hoovers data and/or survey participation, DSM made facility specific cost estimates based on other data points. These included:

- Annual revenues based on average per ton costs to manage yard, and in some cases, food wastes and on annual throughput at the composting facility;
- Annual revenues for some specific facilities based on employment and their NAICS code classification and related Economic Census data; and,
- In the absence of data other than employment, annual revenues were assumed to be equal to or greater than estimated annual payroll.

Limitations

The economic estimates developed by DSM for this report rely on a number of data sources and assumptions that present limitations as to their validity including the following.

First, the estimates used for many sectors in this report rely heavily on Economic Census data (2012) including Country Business Patterns (2015) and the Annual Survey of Manufacturers (2015). For gross receipts for some industries, 2012 is the most recent data available and were either used as the base year or scaled based on employment for 2015 or 2016 (most recent year for which data were available). This approach does not reflect cyclical changes in recyclable commodity pricing which are a critical part of the health and challenges of recycling businesses. At the date of publishing this report, recycling commodity prices are heavily impacted by China's National Sword Policy with mixed paper prices reaching historic lows.

Second, employment and revenue estimates made in this report for specific businesses rely heavily on the D&B Hoovers database. While D&B Hoovers is one of the most comprehensive databases available, it may not be updated frequently enough to represent changes in the business environment and may include data from past years that is no longer representative of that business or location in the most recent year. In addition, in some cases it may use data from other locations of the same business, misrepresenting employment or revenues at the particular Rhode Island location.

Third, for payroll, in almost all cases, DSM used County Business Pattern and Economic Census data. In some cases, these data were used to compute the average pay per employee in that type of business to estimate total payroll at a specific facility or in that recycling sector. If for some reason, state specific data was not available, DSM used national data for that particular NAICS code, or for one similar to that business activity. These estimates may not be representative of pay levels at specific Rhode Island businesses.

Fourth, some revenue estimates were made for specific recyclable material processors based on annual tons handled and the type of material based on the estimated material value last year (2016).

Fifth, while data gathering, and survey work was done in calendar year (CY) 2017, and CY 2016 served as the default base year for this report, data were used from multiple years depending on availability. For example, Census data are mostly 2015 (CBP) with some 2016 BLS data, but also include Economic Census data from 2012 and the ASM data from 2015. And, there is no year noted on the D&B Hoovers data because it is stated in the subscription that the data are updated regularly and routinely.

Sixth, for some businesses, recycling or recycling related activities represent only a portion of their revenues and employment. A main example is electronics remanufacturers who also are asset managers and data security and destruction experts. In these examples, DSM allocated only 25 percent of the economic activity to that business. In other types of businesses, such as pallet remanufacturers DSM attempted to survey the facility to obtain an estimate but was not always successful and so was forced to estimate based on the company's website or other information representing the company.

Finally, in cases where there were no data available, DSM used survey data from past projects to estimate revenues or employment based on employment and tonnage throughput respectively. If no economic or tonnage data points were available for a location, no economic data was included in the count.

The Recycling Industry Sector by Sector

As outlined in Tables 1 and 2 in the previous section, the 25 recycling sectors were divided into three overarching categories: Recycling Industries (supply side), Recycling Reliant Industries (demand side), and Reuse and Remanufacturing Industries. These industries are described in detail in this section, including a few examples of local entities. Detailed employment and economic results are presented in the next section.

Recycling Industries (Supply Side)

Residential Recycling Collection

Municipal sector curbside and drop-off recycling collection programs are widespread in Rhode Island and are key to high residential material recovery rates. They also represent a large contributor to the recycling economy. Rhode Island residents' ease of access to curbside collection and drop-off facilities as well as their mandatory recycling requirement has contributed significantly to the high residential material recovery rates.

Most municipalities in Rhode Island rely on a municipally provided curbside collection and in some cases, subscription recycling supplemented by access to a drop-off recycling facility. It is estimated that almost 100 percent of residents in Rhode Island have access to either curbside recycling and/or access to a drop off facility for their recyclables, and RIRRC recorded delivery of 99,000 (rounded) tons of mostly residential recyclables in 2017.

Yard waste collection is also available to most Rhode Island households through either curbside or drop-off collection programs. An estimated 82,000 (rounded) tons of yard waste was collected from residents in 2016. Table 5-A shows the results of modeling residential collection costs.

TABLE 5-A: RESIDENTIAL RECYCLING COLLECTION COST MODEL RESULTS FOR RHODE ISLAND

Residential Collection	Households Served	Tons Collected	Total Employees	Average Pay (CBP) (\$)	Payroll (\$)	Total Revenues (\$)
Collection Type						
Curbside Recycling	320,047	84,461	107	\$56,118	\$6,010,656	\$20,117,439
Curbside Yard Waste	320,047	57,330	114	\$42,089	\$4,802,719	\$12,841,976
Drop-off Recycling (1)	72,604	14,436	17	\$42,089	\$703,638	\$726,075
Drop-off Yard Waste (2)	NA	12,215	2	\$56,118	\$130,913	\$244,308
Total:	NA	168,443	240		\$11,647,925	\$33,929,797

- (1) Drop-off recycling employees are assumed to handle roughly 1200 tons of recyclables per year on-site and also include drivers who pull roll-offs of recyclables from municipal drop-offs to RIRRC.
- (2) Yard waste drop-off collection employees are estimated to account for yard waste moved from drop-off sites to composting or other locations where they are managed. Yard waste composting employees are accounted for in Sector 3.
- (3) Collection employee counts are multiplied by 1.15 for curbside collection and 1.1 for drop-off to reflect administrative overhead costs.

- (4) *Drop-off recycling includes municipal and RIRRC collection program. All private and non-municipal drop-off centers are accounted for in other sectors.*
- (5) *Collection of all other recyclable materials (Paint, mattresses, scrap metal, etc.) is assumed to be accounted for in economic estimates in Sectors 4, 5, 19 and 20.*

In total, there are an estimated 240 drivers and collection workers employed in Rhode Island collecting residential/municipal recyclables and/or yard waste, including administrative overhead. The average collection wage is estimated at \$49,198 per year (2015, excluding any benefits) contributing to a total payroll of roughly \$11.6 million in Rhode Island. Note that these totals exclude collection of many other recyclable materials which are accounted for in the section on Materials Recycling Facilities, Recyclable Material Wholesalers or Sector 19, all other recyclable processors/handlers.

Commercial Recycling Collection

As with residential recycling collection, commercial recycling collection is also a large contributor to the local economy. This sector encompasses those private businesses engaged in the collection of recyclables from businesses and institutions through a direct arrangement between the hauler or transporter and the generator.

These recycling haulers collect mixed recyclables from businesses (delivering them to materials recovery facilities for sorting as described in Sector 4), or collect specific materials such as corrugated, mixed paper, and metals, and in some cases plastics, electronics, or glass. In most cases, the material that is collected is processed and aggregated by Recyclable Materials Wholesalers for sale to recycling reliant manufacturers. In some cases, a large generator may consolidate material at their location for transport directly to an end user (such as clean corrugated bales being sold to a paper mill).

In total, it is estimated that roughly 130,000 tons of recyclables are separated from refuse by the ICI sector in Rhode Island (see PART II). Some of this collection activity (such as electronics recycling) is captured in the Recyclable Material Wholesaler category as they arrange for collection of specific materials and include this activity in their business model. Table 5-B below provides estimates for materials where separate collection activity is likely to occur, and for the percentage of each material. Table 5-B illustrates that an estimated 41 employees with a payroll of roughly \$2.3 million work in collection serving Rhode Island businesses, and generate annual estimated revenues of nearly \$8.4 million. This is in addition to revenues from recycling processors and end users who service some of their customers with their own fleet.

TABLE 5-B: ICI RECYCLING COLLECTION COST MODEL RESULTS FOR RHODE ISLAND

ICI Sector Recycling	Total Tons Recycled	Percent Collected (%) (1)	Total Employees (2)	Estimated Payroll (\$)	Estimated Collection Revenues (\$)
Material					
Single Stream	4,487	100%	3.2	\$180,194	\$673,087
Yard Waste	9,942	100%	4.4	\$246,634	\$994,170
Food (Composted)	4,411	100%	1.1	\$61,560	\$794,066
Corrugated Cardboard	41,616	60%	16.6	\$929,165	\$3,745,426
Paper	4,855	75%	3.2	\$180,653	\$327,693
Plastics	1,929	80%	8.2	\$459,444	\$540,167
Metals	8,727	50%	2.8	\$154,646	\$436,361
Mattresses	900	50%	0.3	\$16,539	\$112,500
Pallets	25,492	20%	1.8	\$99,789	\$764,772
Total:	102,360		41	\$2,328,624	\$8,388,243

1) The percent of each material that was collected by a contractor and accounted for in the Collection Model.

2) Collection employee counts are multiplied by 1.1 percent to account for administrative functions associated with performing collection.

Organics

Yard waste and brush must be managed properly after collection and are delivered to permitted municipal and private facilities. These facilities accept and handle leaf and yard waste and brush and tree trimmings, and in some cases food scraps, biosolids and/or animal manures and process them to produce saleable products including organic fertilizers, garden supplements and soil amendments. These secondary products can replace or augment synthetic fertilizers and peat, and in the process reduce upstream greenhouse gas (GHG) emissions. With application, the residues of these products can close carbon and nutrient cycles and, in the end, provide a good example of the circular economy.

There are 23 permitted composting facilities in Rhode Island that handled nearly 100,000 tons of yard waste, food waste and other municipal organics. While facilities that handle animal wastes and food waste on a large scale utilize more sophisticated composting processes and high technology in vessel systems to control orders and material curing time, yard waste (grass, leaves and brush) and wood wastes (branches, limbs, trunks and ground untreated wood) are often composted in simple windrows, at a relatively low cost. RIRRC, which utilizes relatively low technology windrow composting, is the largest composter of municipal yard waste in the State, accepting and managing over 40,000 tons last year.

This sector also includes facilities that produce mulch, bark, and other soil amendments in addition to compost. For example, an operation grinding green wood waste for use as landscaping materials or mulch was part of the survey and accounted for.

While these may be small in comparison to other industries, these facilities successfully divert large volumes of organic waste materials that would otherwise be landfilled.

In many cases, especially at the municipal level, employees and payroll figures are estimated as employees spend only a percentage of their time working at the compost facility.

Finally, although not included in this report because they are new, the Blue Sphere anaerobic digester (AD) complex located near the RIRRC Landfill in Johnston, RI began taking in source-separate food scraps and other organic residuals (but not biosolids) in late 2017. The material goes through a biopulper before digestion. The biogas produced runs a 3.2 MW combined heat & power (CHP) system that provides electricity to the grid through an interconnection agreement with National Grid.

Materials Recovery Facilities and Recyclable Material Wholesalers

Mixed recyclables often require several processing steps before they can be used by a manufacturer (recycling reliant industry). Typically, mixed recyclables are first delivered to **materials recovery facilities (MRFs)** which, through a series of mechanized and some manual sorting, separate materials from one another, and remove contaminants to create saleable commodities. These commodities are typically consolidated and then sold to reclaimers who further clean the material, or to end markets where the materials are further processed and cleaned before being used in a manufacturing process.

The RIRRC operates the primary MRF in Rhode Island, processing all of the residential comingled paper and packaging recyclables collected in the State, and a small percentage of commercial comingled recyclables.

MRFs add value to recycling by allowing municipalities and private haulers to collect material comingled, making collection more efficient, and then deliver mixed materials to the MRF. However, recyclables collected separately still need some degree of processing to be sold. Paper and metals need to be graded and densified, as well as have any residues removed before baling. Glass and plastics typically need to be further cleaned to meet end user specifications.

Recyclable material wholesalers often play this role and are defined as those businesses that are primarily engaged in the “*merchant wholesale distribution of automotive scrap, industrial scrap, and other recyclable materials.*” This includes establishments which wholesale and distribute scrap iron and steel, paper and paperboard (e.g. paper stock dealers), and recovered nonferrous metals, textiles, glass, plastics, rubber, and oil.

These businesses primarily handle material collected or processed elsewhere, such as corrugated which is generated by grocery and large retail outlets and baled at distribution centers for sale. However, wholesalers may also consolidate loads, and may reprocess material to increase value by removing contaminants from lower grade materials.

Unlike recycling collection and organics composting, both MRFs and Recyclables Material Wholesalers are tracked by the Economic Census on a statewide basis. Table 6 illustrates the economic census product line data for Recyclable Material Wholesalers in Rhode Island which show gross revenues of nearly \$400 million in 2012. As shown in Table 6, most of these sales are in ferrous and nonferrous metal scrap. Only a small portion are in other materials with 5 percent estimated in recycled paper and paperboard and 1 percent in plastic scrap.

TABLE 6: RECYCLABLE MATERIAL WHOLESALERS PRODUCT LINE DATA IN RHODE ISLAND (1), (2)

Products and Services Code	Number of Establishments	Total Sales (of Establishments Reporting Product Line) (in \$1,000)	Product Line Recyclable Material Sales (in \$1,000)	Share of All Recyclable Materials Sales (%)
Recyclable ferrous metal scrap	14	\$239,559	\$215,354	54%
Recyclable prepared ferrous metal scrap processed by this establishment	10	\$232,749	\$130,312	33%
Recyclable prepared ferrous metal scrap not processed by this establishment	6	\$214,578	\$84,532	21%
Recyclable nonferrous metal scrap	14	\$159,075	\$138,387	35%
Recyclable aluminum scrap	14	\$158,200	\$41,943	10%
Recyclable copper and copper alloy scrap	13	\$156,019	\$45,287	11%
Recyclable lead scrap	10	\$138,343	\$36,095	9%
Other recyclable nonferrous metallic scrap, including nickel, zinc, and precious metals	11	\$152,822	\$15,062	4%
All other recyclable materials			\$45,838	11%
Recyclable paper and paperboard	8	\$40,666	\$21,142	5%
Recyclable materials, excluding metals and paper	12	\$44,204	\$18,834	5%
Recyclable plastics	8	\$34,213	\$5,862	1%
Total, Recyclable Material Wholesalers:	27	X	\$399,546	100%

- 1) *Source: Economic Census 2012 for Rhode Island.*
- 2) *“Total Sales” represent those establishments total sales of all products as compared to “Sales”, which represent only the product line “Recyclable Materials”.*
- 3) *When two (or more) activities occur at a single location, the establishment is typically classified on the basis of its major activity. However, when distinct and separate economic activities (for which different industry classification codes were appropriate) occurred at a single location, separate establishment reports for each activity were obtained in the census.*
- 4) *Total sales may not sum to totals due to exclusion of selected lines to avoid disclosing data for individual companies, due to rounding, and/or due to exclusion of lines that did not meet publication criteria.*

Plastic Reclaimers

Unlike paper and metal recycling, where recycling reliant industries purchase material direct from MRFs and brokers, plastic product producers typically purchase plastic that has been further processed by plastic reclaimers. In some cases, plastic product producers have set up (or invested in) reclaimers to provide the recycled raw materials to feed their manufacturing process. (Note that the paper industry is often vertically integrated as well.)

Plastics Reclaimers buy post-industrial and post-consumer recycled plastics from MRFs and wholesalers, or directly from large industrial and commercial generators and process them to prepare them for end-uses in manufacturing (referred to plastic product producers). There is no specific economic census data for this business sector.

DSM attempted to identify Rhode Island plastic reclaimers using the Association of Postconsumer Plastic Recyclers members list, DSM’s network of industry contacts, the US Plastic Recyclers Directory for Rhode Island, and Plastic News top reclaimers listing; and conducted internet research and outreach to specific companies. Ultimately DSM identified two Rhode Island plastic reclaimers. One of them, The Plastic Group of America was founded in 1973 as Ralco Industries, Inc., and began as a one-man company who

bought and sold scrap materials. In 1978, the company purchased a grinder, a baler, an extruder and a tractor-trailer and expanded into the recycling business and has grown ever since.

Reclaimers often specialize in a single resin (e.g. polyethylene or polypropylene, or in an engineering or other specialty resin). Depending on the specifications of the customer/end user's product, reclaimers may process materials by grinding plastic into flake, washing, coloring, or adding other additives, compounding (with additives or other resins), remixing, and/or extruding the material into plastic pellets.

For more discussion about plastic end users, see the discussion on Plastic Product Producers.

Glass Beneficiation

Similar to Plastic Reclaimers, Glass Beneficiaries take mixed broken glass produced by MRFs and from bottle bill collections and clean and color separate the glass for resale to glass bottle and fiberglass manufacturers. Strategic Materials operated a glass beneficiary facility in 2016 located adjacent to the RIRRC MRF at Johnston, shipping the partially cleaned material to another facility in Massachusetts. In 2018 (the date of publishing this report) this arrangement ceased due to the limited regional end markets and recent closure of the only glass container manufacturer in New England.

Other Recycling Processors

This is a catch-all category to encompass establishments engaged in recycling that did not fall into any other recycling category. As the recycling industry evolves to include processing of many materials not previously recovered (or manufactured), this category has grown to include many new businesses and facilities.

At present, this category includes:

- Fluorescent lamp and mercury recyclers;
- Carpet recyclers;
- Mattress recyclers;
- Waste oil recycling (re-refining only); and
- Paint recycling.



While it is difficult to acquire comprehensive lists for such a diverse array of niche recyclers, DSM sought out trade associations that represent specific products (paint, mattresses and carpet) or that address one or more of these functions (C&D recycling).

Through research and survey work, DSM identified four establishments engaged in processing other types of recyclable materials.

Recycling Reliant Industries (Demand Side)

While Rhode Island is an important economic engine for New England, it is not home to many recycling reliant industries, most of which are located outside of Rhode Island. However, materials produced by Rhode Island recycling industries supply these manufacturers, so it is important to understand these activities in relation to Rhode Island's recycling industries.

GLASS: Container Manufacturers and Product Producers

In general, there are three main markets for recycled glass or cullet: container (bottles and jars) and plate glass manufacturing; fiberglass manufacturing; and, construction aggregate, including cements, road base, and engineering grade fills. In most cases glass product manufacturers purchase glass that has been cleaned by a glass beneficiary. While there are no glass product producers in Rhode Island, one of the largest users of recycled glass in the Northeast – Ardagh – in Massachusetts recently announced it was closing, eliminating a significant purchaser of recycled glass from Rhode Island and other New England states.

METALS:

Recycling reliant industries that utilize metals include nonferrous smelting and refining, steel mills and foundries. In 2015, the US recycled 58.3 million metric tons of selected metals (about 49 percent of the apparent supply). About 90 percent of recycled metal was iron and steel.^{18 19}

IRON AND STEEL MILLS

There are no Iron and Steel Mills operating in Rhode Island. However, Harris Rebar, one of North America's leading fabricators, installers and distributors of concrete reinforcing steel and related products is located in Pawtucket. Harris Rebar is owned by Nucor, North America's largest producer of rebar and steel products. Their economic contribution to the State is not considered as part of the recycling reliant industries because it is a secondary stage product, not the mill that purchased the recycled metal. However, Harris Rebar is certainly dependent on recycling as most steel now produced in the United States is produced using electric arc furnaces which require metal scrap as opposed to iron ore.

NONFERROUS SECONDARY SMELTING AND REFINING MILLS AND PRODUCT PRODUCERS

Nonferrous metals (those that do not contain iron) are used in a wide variety of products, including containers, electronics, automobiles, and household appliances. Manufacturers smelt (chemically reduce), refine, and sometimes blend nonferrous scrap along with metals from primary metal production and fabrication processes. The most common nonferrous metals recovered in the United States are aluminum, lead, copper, and zinc followed by chromium, nickel, and magnesium.

Aluminum is used by container and packaging manufacturers as well as in the transportation, construction, and electrical sectors. Copper is used in power, lighting, and communications transmissions. While the domestic use of lead has decreased in most products, it is still found in storage

¹⁸ US Dept of the Interior, US Geological Survey. *USGS 2015 Minerals Yearbook. Recycling - Metals. May 2017.*

¹⁹ Imports and exports may result in these figures differing from other US scrap metal totals.

batteries for automobile ignition starters, and uninterruptible and standby power supplies (necessary for computers, emergency lighting, and telephones). Finally, zinc is primarily used to galvanize products found in the automobile, steel, and construction industries, but secondary zinc is often used to produce brass and bronze or blended for alloys.

In Rhode Island, data was collected on the sector "Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)" which encompasses nonferrous metals recovered from jewelry manufacturing, dental and medical waste and other industrial waste byproducts. These materials are recovered, processed and re-refined in-state as well as recovered and processed before being sent to smelters outside Rhode Island.

NONFERROUS AND FERROUS FOUNDRIES

Ferrous and nonferrous foundries specialize in melting and casting metals into specific shapes used in automobiles, plumbing fixtures, airplanes, and other equipment. There are a wide variety of casting processes (utilizing molds made of sand, metal dies, and ceramics) and metal choices that can be combined to meet the specifications of the final product. While all metals can be cast, the most predominant are iron, aluminum, steel, and copper-base alloys.²⁰



According to the American Foundry Society (AFS), more than 11.5 million tons of castings were produced in the U.S. in 2016 (down from 12.6 million tons in 2008) and valued at more than \$30.3 billion. The U.S. is the world's third-largest producer of castings (after China and India). There are currently 1,956 operations representing over 200,000 jobs in the U.S. (80 percent of which are small businesses with less than 100 employees).

Census data for Rhode Island indicates that 21 foundries employ over 200 workers.

PAPER: Pulp and Paper Mills and Paper-based Product Manufacturers

According to the American Forest and Paper Association (AF&PA), approximately 80 percent of all U.S. paper mills use some recovered fiber in producing paper products, including paper-based packaging, tissue, office papers and newspaper.²¹ The U.S. paper recovery rate made its third consecutive annual increase, rising to an all-time high of 67.2 percent in 2016. This comes close to AF&PA member companies' goal to increase the rate to more than 70 percent by 2020.

²⁰ *Ferrous metals contain iron and are used for their tensile strength and durability. Non-ferrous metals are more malleable and lighter than ferrous metals and used when strength is needed but weight is a factor, such as in the aircraft parts. They also have a higher resistance to rust and corrosion (making them suitable for use in gutters and water pipes) and are non-magnetic (making them useful in electronics and wiring).*

²¹ *See AF&PA's website (February 2018) at: <http://www.afandpa.org/issues/issues-group/paper-recycling-a-true-environmental-success-story>*

Consumption of recovered paper at U.S. paper and paperboard mills was 30.8 million tons in 2016 – down just 0.1 percent compared with the 2015 level – while exports rose 1.3 percent to 21.8 million tons.

Recovered paper is also used outside of the paper industry, including in cellulose insulation, hydro-seeding mulch, pressed paperboard and molded fiber products (e.g. egg cartons, tableware, berry baskets and food service cartons), construction paperboard (e.g. for poured concrete spacers), and masking tape backing.



Although there are no longer any paper mills in Rhode Island, there are many paper converters that obtain paper rolls from out-of-state mills (some of which are in the northeast U.S. region) and convert them to containers and other packaging and paper products. Many of these converters utilize containerboard and paperboard with recycled content and represent an estimate \$212.4 million in industry shipments. They are the next step in the value chain and represent an estimated 1,972 jobs in Rhode Island with a payroll of nearly \$95 million.²² As with metals, these jobs in Rhode Island would not exist without the recycling industries collecting paper to supply the mills.

Because the US EPA and DSM/NERC methodology used to conduct Recycling Economic Impact studies measures activity at the first stage of manufacturing only, which for paper, is at the mill where a roll of paper is made, this would exclude any conversion of paper to products such as packaging containers or envelopes, even if they had some or all recycled content.

However, Rhode Island companies, such as Rand Whitney Container, a subsidiary of the Kraft Group, the largest independent corrugated packaging manufacturer in New England, depend on the collection and recycling of mixed paper and corrugated containers from Rhode Island and the rest of New England to supply the paper for conversion to packaging. With the growth of Amazon and other on-line retailers, demand for corrugated packaging has expanded, as has the amount collected from residential recycling programs and processed at the RIRRC MRF; providing an opportunity for packaging companies like Rand Whitney which opened an expanded facility in Pawtucket in the summer of 2017.



FIGURE 1 – Grand Opening of Rand White Container’s Expansion, 2017

ASPHALT AND AGGREGATE: Pavement Mix Producers

Recycled asphalt pavement (RAP) consists of old asphalt pavement milled and ground into aggregate. RAP can substitute for a portion of aggregate required in bituminous concrete (i.e. asphalt pavement) in both the base course and surface course.

²² American Forest and Paper Association. *State Industry Economic Impact: Rhode Island. January 2017.*

According to the National Asphalt Pavement Association's (NAPA) 2016 Industry Survey on Recycled Materials and Warm-Mix Asphalt Use, 76.9 million tons were estimated to be used nationally in asphalt mixtures. NAPA reports that RAP is recycled at a greater rate than any other material in the United States and assists in lowering overall material costs, allowing road owners to complete more maintenance within limited budgets. In addition to RAP, reclaimed asphalt shingles (RAS) are also used in asphalt pavements. Other recycled materials used in asphalt pavements include ground tire rubber (GTR), steel slag, blast furnace slag, and cellulose fibers.

The average percent RAP used nationwide in asphalt mixtures was 20.5 percent in 2016, a 0.2 percent increase over 2015. In Rhode Island the Department of Transportation (DOT) allows 20 percent replacement of RAP in hot mix asphalt (HMA) base course, however contractors tend not to use this much. DSM identified seven RAP producers in Rhode Island specified in RIDOT paving specifications in 2016, although data on total RAP used was not available.²³ DSM also spoke with representatives who stated the average RAP use in the State was around 2 percent.

PLASTICS: Plastic Converters and Product Manufacturers

Plastic Converters and Product Manufacturers purchase recycled plastic flake, granulate, and/or pellets for use in the production of new plastic packaging and products. Most establishments in the United States use post-industrial plastic scrap (which is generally cleaner and more consistent) which has been processed by a plastics reclaimer. A few use post-consumer resins (PCR), and others reclaim material themselves before manufacturing.

Typical examples of (recycled) plastic products manufactured are plastic lumber and furniture, plastic bags, railroad ties, polyester fiber for carpet and clothing, plastic tackle and tool boxes, custom injection molding and packaging inserts. In most of these cases the applications are chosen because cost savings or mandates for recycled content are the key considerations.

Typically, the recycled plastic resin is mixed with virgin resin to produce the final product. Just as in the case with paper, metals, and glass product manufacturing, the economic activity from plastic product manufacturing was allocated by applying the assumed average recycled resin content of the pellets or products manufactured to the economic and employment data.

Because recycled content varies by product, and by company and customers each year, this information is difficult to track. Many plastic product manufacturers fill custom orders and are bound to the constraints of product specifications. If the specifications allow for a certain amount of recycled plastic, then the manufacturer has the option to purchase and use the recycled resin. The plastic product manufacturing industry is also reflective of the broader economy with recycled feedstock competing with virgin feedstock and therefore low oil and virgin resin prices make it difficult for PCR to compete.

DSM developed a list of plastics packaging and product manufacturers that potentially use recycled resins using the following resources: The Association of Plastics Recycling listings; Plastic News subscription; Plastics in Packaging subscription and annual rankings; internet searches; and, listing services for recycling companies. DSM then used D&B Hoovers to obtain employment and revenues

²³ http://www.dot.ri.gov/documents/doingbusiness/materials/Approved_HMA_Mixes.pdf

data, as well as attempted to survey these companies or consult annual reports to collect information on the percent of recycled resin used.

Despite a concerted effort to identify specific Rhode Island plastic product manufacturers using recycle plastic, DSM was only able to identify a few examples of recycled plastic product manufacturing in Rhode Island. This may be because of the relatively low cost of virgin resin when compared to recycled resin, and the fact that there is no requirement that manufacturers or recyclers report on quantities used.²⁴ DSM was able to identify one company producing trays from some recycled polystyrene, and Hasbro the toy and game manufacturer produces recycled PET for use in packaging of products they sell. A third company appears to use some recycled resins in their resin blend products, as well as producing biodegradable plastic using polylactic acid (PLA).

RUBBER: Rubber Product Manufacturers

The rubber product manufacturing industry represents those businesses that manufacture products primarily from scrap tires along with other scrap rubber. Products manufactured from scrap tires include molded rubber products and coatings such as welcome and truck mats, railroad ties, acoustical underlays, and even portable speed bumps. In addition to molded rubber products, crumb rubber is created to enhance surfaces such as highways, horse tracks and playgrounds.

Most commonly, scrap tires are also used as an alternative to fuel (tire derived fuel) to power kilns, mills and power plants.

In a report released by the U.S. Tire Manufacturers association 242.8 million tires were scrapped in 2015 with the majority (48.6 percent) being used for Tire-Derived Fuel (TDF) and 25.8 percent being used for Ground Crumb Rubber. TDF is primarily used to fuel pulp and paper mills, electric utility boilers and cement kilns. Ground Crumb Rubber is primarily molded/extruded, used as playground mulch or on sports surfaces or used in asphalt production.

A 2015 study conducted by John Dunham and Associates identified the rubber recycling industry as generating more than \$1.6 billion in annual economic activity. This includes nearly 8,000 direct and indirect jobs and more than \$500 million in payroll nationally.²⁵ However DSM did not identify any Rubber Product Manufacturers operating within Rhode Island.

It is estimated that Rhode Island discards about a million tires annually with an estimated 15 percent collected through RIRRC. Tires from RIRRC are mostly sent to Connecticut where the reusable are culled and with the remainder being shredded and then shipped to Maine for fuel at two paper-pulping mills.

²⁴ Some states, including Delaware and Oregon require annual reporting of recycled quantities by material type. These reporting requirements provide a robust database on which to measure the impact of recycling on the state's economy.

²⁵ Dunham, J. & Associates. (2015). *The Many Benefits of Recycled Rubber: Economic Benefits. Recycled Rubber Facts.*

Reuse and Remanufacturing Industries

The reuse and remanufacturing industries are varied and include retail and wholesale resale of used products, as well as repairing or remanufacturing products for introduction back into the consumer marketplace.

Computer and Electronic Appliance Demanufacturers

The electronics recycling industry has evolved and grown significantly over the last two decades as technology and electronic products continue to both advance and become obsolete. According to the 2017 Global E-waste Monitor report from the United Nations University (UNU), 44.7 million metric tonnes (Mt) of e-waste were generated in 2016, with the value of the raw materials found to be roughly US \$64.7 billion.²⁶

FIGURE 2 – Life Cycle Stages of Electronics (Source: US EPA)



In the US, 3.4 million tons were estimated to be generated in 2014 (excluding appliances), of which 41 percent (by weight) were estimated to be recycled.²⁷ When the EPA first documented the value of the recycling and reuse industries, electronics were categorized as a reuse industry although today many materials are recovered for recycling and not reuse purposes. Today, facilities sort,

dismantle, remove valuable components and materials, shred and sell different parts of electronic devices.

DSM identified 6 electronic recycling businesses/facilities in Rhode Island. Many of these facilities perform data security and other IT functions which were not counted as recycling related activities in the study and so 25 percent of employment and revenues for those locations were accounted for in the total estimate for the electronics recycling industry. Because of the rapid growth and change in demand for various electronic components, and the recycling opportunities available, this industry was very difficult to characterize. Additionally, due to growth in this sector, many companies are continuously consolidating making it difficult to identify the most recent business name.

Resale of Used Motor Vehicle Parts

The wholesaling and reselling of used motor vehicle parts is an active part of the reuse economy. This sector is primarily tracked as NAICS code 423140 - *Motor Vehicle Parts (Used) Merchant Wholesalers*. It comprises establishments “primarily engaged in the merchant wholesale distribution of used motor vehicle parts (except used tires and tubes) and establishments primarily engaged in dismantling motor

²⁶ The World's E-Waste Is Piling Up at an Alarming Rate, Says New Report. Science Alert. December 13, 2017.

²⁷ Electronic Products Generation and Recycling in the United States, 2013 and 2014 U.S. Environmental Protection Agency Office of Resource Conservation and Recovery December 2016.

vehicles for the purpose of selling the parts.” Motor vehicle parts are first removed and sold for reuse (or in some cases the high metal value) before the vehicle is crushed and processed as scrap metal.

DSM reviewed data from the Automotive Recyclers Association, United Recyclers Group and Hoovers to gather a list of businesses operating in this sector and then used Hoovers and the Bureau of Labor Statistics (2016) data to gauge employment, revenue and payroll for this sector, DSM ultimately used the CBP 2015 data along with US Economic Census data (on gross receipts) for NAICS code 423140 to estimate revenues. In all Rhode Island has 8 establishments with an estimated 210 employees and receipts of more than \$50 million in this sector.

Retail Used Merchandise Sales

Used merchandise sales are a large contributor to reuse activity. This sector is covered under NAICS code 453310 - *Used Merchandise Stores* – and comprises “establishments primarily engaged in retailing used merchandise, antiques, and secondhand goods (except motor vehicles, such as automobiles, RVs, motorcycles, and boats; motor vehicle parts; tires; and mobile homes).” This sector includes antique stores, used apparel stores, used book dealers, used household appliance stores, thrift stores, used sporting goods stores, used building material stores, flea markets, used furniture stores, salvage shops and other types of second-hand stores.



DSM used data from Hoovers and the Bureau of Labor Statistics (2016) to gather data on establishments, employment, payroll and gross receipts to estimate values for this sector. While DSM researched establishments in this sector, ultimately, DSM used Census data to estimate employment in and revenues from used merchandise sales in Rhode Island.

Tire Retreaders

Another important reuse industry are those businesses engaged in collecting, retreading and reselling retread tires. This sector is covered under NAICS code 326212 *Tire Retreaders*, which comprises “establishments primarily engaged in retreading or rebuilding tires.” Retreads are made from tires that are worn yet otherwise structurally sound or that have a good foundation. The first step in retreading is inspection, then buffing (where the remaining tread is removed), then preparing the casing, and applying the new tread.

DSM reviewed the Tire Retread Information Bureau (TRIB) database and the Retread Tire Association (RTA) database for establishment counts for Rhode Island. TRIB and RTA only provide establishment locations and do not maintain industry economic data at the State level, therefore DSM used data gathered from phone surveys, Hoovers, and the Bureau of Labor Statistics data (2016) for employment, payroll and gross receipts.

In the end, DSM identified 2 facilities involved in retreading tires.

Photo Source: Tire Retread Information Bureau



Wood Reuse

This category consists of all establishments that accept clean wood (primarily wood pallets and crates and some dimensional lumber) and either remanufacture pallets and other wood packaging or chip clean wood to create a saleable product. DSM attempted to survey all of the companies located in Rhode Island from the Hoovers database list to determine the percent of wood reuse, employment size, annual throughput of the company and gross receipts.

The list from Hoovers was supplemented with data from the National Wooded Pallet and Container Association, RIRRC Recycling Database, and internet searches to ensure the largest companies were contacted.

Those establishments whose primary business is to grind green wood to produce mulch or other products were accounted for in Organics composting, although it is possible that some of the ground wood produced by companies in this sector also goes into mulch –primarily colored mulches. Some pallet manufacturing companies that grind waste wood for use as fuel products were included in this sector. A total of six companies were identified with all but one assumed to be involved in some new pallet sales and roughly 60 percent of their economic activity was counted. This resulted in estimated receipts of roughly \$12.5 million related to pallet remanufacturing, employing roughly 90 people.

Materials Exchanges

Materials Exchanges typically act as virtual marketplaces where generators of used materials (such as industrial, construction-related, residential durable goods, or others) and those seeking these products or items can facilitate a transaction to exchange the good or material and reuse these otherwise end-of-life materials. However, because virtual exchanges do not have physical space, storage areas or other mechanisms to physically handle the materials exchanged, it is difficult to quantify the economic value of the activity. In addition, they often fall outside the tax structures, unless a business quantifies and reports on such an exchange as a sale or even donation.

Formerly called waste exchanges, material exchanges are often organized around the following materials, with some transactions occurring with an agreed upon price for items while others donating items:

- Art Materials – Fabric, paints, papers, wood, stage props, and a wide variety of other items can be used for school or other organizations’ creative projects.
- Building Materials – Lumber, tools, windows, doors, light fixtures, paint, plumbing supplies and fixtures, and many other items needed for constructing or refurbishing a building.

- Computers and Electronics – Laptops, computers, printers and peripherals in working order are often donated or exchanged through virtual marketplaces. See think link for a few organizations: <https://www.thebalance.com/donate-used-computers-monitors-tvs-3515022>).
- Household Items – Appliances, clothing, furniture, dishes, vehicles, paint, and virtually anything else generated by homeowners might be exchanged through a list serve or materials exchange.
- Medical Equipment and Supplies – Equipment and supplies that are obsolete to one hospital, clinic or organization may find a home in another facility, especially those in less-industrialized nations.
- Office Furniture and Supplies – Desks, tables, chairs, filing cabinets, credenzas, shelving units, and other equipment and supplies can be reused in offices, schools, and other settings.
- Surplus Food Items – Boxed, bagged, canned and even prepared food from grocery stores, warehouses, manufacturers' over-runs and discontinued items, catered events, restaurants can be donated to homeless shelters, soup kitchens, and other organizations serving disadvantaged people.

Marketplace participants benefit from significant economic savings by sourcing cheaper feedstocks from both industrial by-products and post-consumer recycled materials. Two examples are FreeCycle²⁸ and Let It Go which enable material/waste generators and item seekers to exchange within a given geographic region.

FreeCycle and Craigslist fall under the definition of a materials exchange in whole or in part. However, the direct economic contribution of these organizations occurs outside the region and is therefore not included, despite the volume of material reuse that may be occurring because of their existence. The FreeCycle Network (a nonprofit) is based on Tucson, Arizona and Hoovers lists them as having 2 employees and revenues of under \$100,000. However, the network that has been created is global with 110 countries participating, and is made up of over 5,000 groups with over 9 million members.

Craigslist was credited with diverting 5 million tons of stuff from landfills (Yes Magazine, March 3, 2015) but said to employ less than 30 people (Source: Forbes Magazine, 2015).

While this resource may not add in significantly to the recycling and reuse industries, it can be a significant driver in not only reducing waste locally but also connecting a buyer and seller in a region to keep the dollars local for some larger items.

There is no economic data for this sector.

Other Reuse

This is the second catch-all category, intended to cover businesses and non-profit organizations not elsewhere classified that either provide a service or purchase or obtain used materials, equipment, or merchandise for repairing, cleaning, or otherwise putting back into use. DSM's ability to identify such businesses was limited to their inclusion in recycling directories identified at the outset of the project, the result of internet searches for "reuse in Rhode Island" or identification by one of the local contacts.

²⁸ For FreeCycle, see: <https://groups.freecycle.org/group/ProvidenceRI/posts/all> and for Let It Go, see: <https://us.letgo.com/en>.

One example was Providence Plastic, which partnered with Courtesy Cleaners, the largest dry-cleaning company in Rhode Island, to develop a system for collecting and recycling dry cleaning bags that customers return to their stores. For a fabric source they teamed up with Project Repeat, a recycling company with facilities in Fall River, Massachusetts that turns used t-shirts into products. The off-cuts from processes become part of Providence Plastics small soft good accessory sheet material. Unfortunately, no economic data were available on this organization.

Another example is Recycle-A-Bike which has a community bike shop in Olneyville Square (Providence) providing an opportunity to find affordable bicycles and bike parts along with the help and training to get bikes back on the road. It's a place bicycles or bike parts can be donated (that might otherwise become scrap metal) as well as a place where repaired used bikes can be purchased or rebuilt by consumers through training provided.

Finally, the 'sharing economy' should be recognized as an important contributor to the circular economy as it maximizes the utility of assets through hiring, renting, lending, swapping, and even bartering, often facilitated by technology. In summary, it avoids the production of new assets by sharing existing ones.

Obvious examples are companies such as Zipcar, which capitalized on the idle capacity of cars (said to be unused in the US for an average of 23 hours a day) by developing platforms that charge for usage.²⁹ Since Zipcar's early adoption of the concept, many companies and services have entered the sharing marketplace offering transportation (Uber, Lyft and Citi Bike), overnight accommodations (Airbnb) and even scenic campsites (see Hipcamp at: <https://www.hipcamp.com/>).

The sharing economy's primary benefits are economic (with more efficient use of assets at a lower cost), environmental (with more sustainable use of resources) and communal (forcing connections among the asset owner or service provider and the user).³⁰ Technology platforms enable the sharing to occur among two parties that otherwise would not interact. Like the materials marketplace, while it is impossible to make an estimate of the economic impact, and employment related to these activities, it is important to recognize that this activity leads to more efficient use of resources and avoids or delays material consumption.

²⁹ World Economic Forum. *Towards the circular economy: Accelerating the scale-up across global supply chains*. See: <http://reports.weforum.org/toward-the-circular-economy-accelerating-the-scale-up-across-global-supply-chains/>

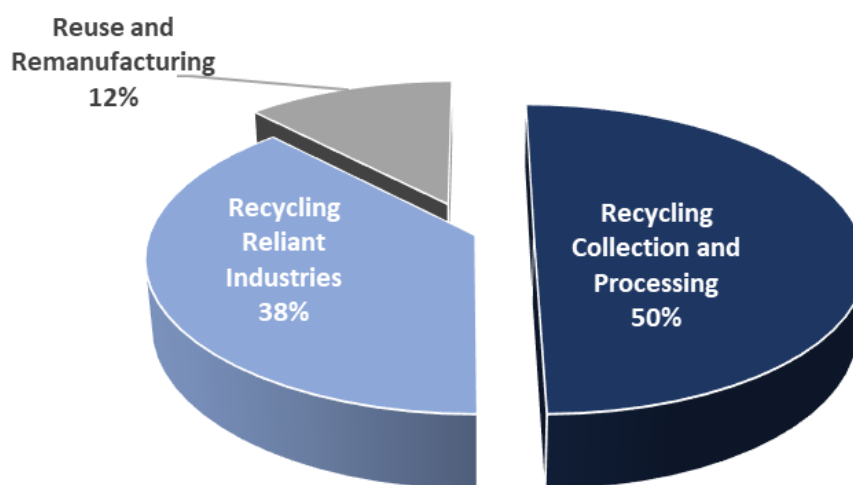
³⁰ *Ibid.*

Summary of Recycling Economic Information

In total, an estimated 250 establishments make up Rhode Island recycling industries and are estimated to employ over 2,600 and produce annual revenues of just under \$1 billion annually.

Figure 3 illustrates how total direct revenue is distributed between the recycling (collection and processing), recycling reliant and reuse/remanufacturing industries and demonstrate the large economic contribution of recycling collection, processing and wholesaling to the total recycling economy.

FIGURE 3 – TOTAL ANNUAL REVENUES BY EACH MAJOR RECYCLING INDUSTRY



As illustrated by Table 7, the highest paying jobs are in manufacturing industries that utilize recycled materials as some portion of their input, with the lowest paying jobs in the reuse and remanufacturing industries. Collection and processing of recyclables (including recyclable material wholesaling) generate the most revenue, comprise the largest number firms (establishments) in Rhode Island and employ the largest number of people.

TABLE 7: SUMMARY OF TOTAL ESTIMATED ANNUAL REVENUE, EMPLOYMENT AND PAYROLL FROM THE MAJOR RECYCLING SECTORS

SECTOR	Establishments	Revenue (\$)	Employees	Payroll (\$)
Recycling Collection and Processing	104	\$491,440,000	1,028	\$47,592,000
Recycling Reliant Industries	49	\$367,300,000	687	\$38,183,000
Reuse and Remanufacturing	95	\$119,290,000	916	\$23,268,000
Total:	248	\$978,030,000	2,632	\$109,043,000

Detailed Results by Sector

Table 8 details the results from compiling the data on each sector of the recycling industries. “Revenue” is the total revenue from establishments in each sector while “Net Revenue” is estimated revenues related to recycling activities. The same terminology is used for employees with “Net Employees” representing employment related to recycling activities. Finally, “Payroll” is only shown for “Net Employees” or those employees assumed to be engaged in recycling related activities.

TABLE 8: ESTIMATED ANNUAL REVENUES, EMPLOYMENT AND PAYROLL FROM EACH OF THE RECYCLING SECTORS

SECTOR		Establishments	Revenue (\$)	% Recycling or Reuse	Net Revenue (\$)	Employees	Net Employees (1)	Payroll (\$)
Recycling Industries	Residential Curbside Recycling Collection	44	\$33,930,000	100%	\$33,930,000	240	240	\$11,648,000
	Commercial Recyclables Collection	Incl Above	\$8,390,000	100%	\$8,390,000	41	41	\$2,329,000
	Compost/Organics Processors	23	\$3,150,000	100%	\$3,150,000	34	34	\$1,609,000
	Materials Recovery Facilities	3	\$11,290,000	100%	\$11,290,000	87	87	\$5,401,000
	Recyclables Material Wholesalers	27	\$398,610,000	100%	\$398,610,000	513	513	\$21,120,000
	Plastics Reclaimers	3	\$463,832,600	7%	\$33,820,000	1,204	88	\$5,076,000
	Other Recycling Processors	4	\$2,250,000	100%	\$2,250,000	25	25	\$409,000
Recycling Reliant Industries	Glass Container Manufacturing Plants	0	\$0	0%	\$0	0	0	\$0
	Glass Product Producers	0	\$0	0%	\$0	0	0	\$0
	Nonferrous Secondary Smelting and Refining Mills	9	\$231,910,000	95%	\$220,310,000	192	182	\$12,714,000
	Nonferrous Product Producers	11	\$231,430,000	49%	\$106,780,000	556	257	\$14,164,000
	Nonferrous Foundries	15	\$6,190,000	90%	\$5,570,000	158	142	\$6,191,000
	Iron and Steel Foundries	6	\$21,790,000	95%	\$20,700,000	76	72	\$3,263,000
	Paper and Paperboard Mills/Deinked Market Pulp Producers	0	\$0	0%	\$0	0	0	\$0
	Paper-based Product Manufacturers	0	\$0	0%	\$0	0	0	\$0
	Pavement Mix Producers (asphalt and aggregate)	4	\$21,560,000	2%	\$430,000	25	1	\$43,000
	Plastics Converters and End Users	4	\$778,080,000	2%	\$13,510,000	1,927	33	\$1,808,000
	Rubber Product Manufacturers	0	\$0	0%	\$0	0	0	\$0
Iron and Steel Mills	0	\$0	0%	\$0	0	0	\$0	
Reuse and Remanufacturing	Computer and Electronic Appliance Demanufacturers	6	\$3,740,000	25%	\$930,000	44	11	\$311,000
	Motor Vehicle Parts (used)	8	\$55,330,000	100%	\$55,330,000	210	210	\$9,025,000
	Retail Used Merchandise Sales	70	\$39,550,000	100%	\$39,550,000	568	568	\$9,619,000
	Tire Retreaders	2	\$12,660,000	81%	\$10,260,000	31	26	\$1,121,000
	Wood Reuse	6	\$20,010,000	63%	\$12,530,000	142	89	\$2,972,000
	Material Exchange Services and Other Reuse	2	\$690,000	100%	\$690,000	13	13	\$220,000
TOTAL:		247			\$978,030,000	6,087	2,632	\$109,043,000

As shown in Table 8, some sectors of the recycling economy are not present in Rhode Island. For example, there are no paper or steel mills and no glass container manufacturers. In addition, DSM was not able to identify any glass product producers using cullet or rubber product manufacturers using recycled rubber in the State, although it is possible there are a few small ones operating.

Comparison of Relative Size of the Recycling Industry (Supply Side), Recycling Reliant (Demand Side) and Reuse Industries

Table 9 below illustrates the net revenue, employment and payroll of the recycling related activities in each sector (from Table 8) and also calculates the percentage contribution of each sector within each major category.

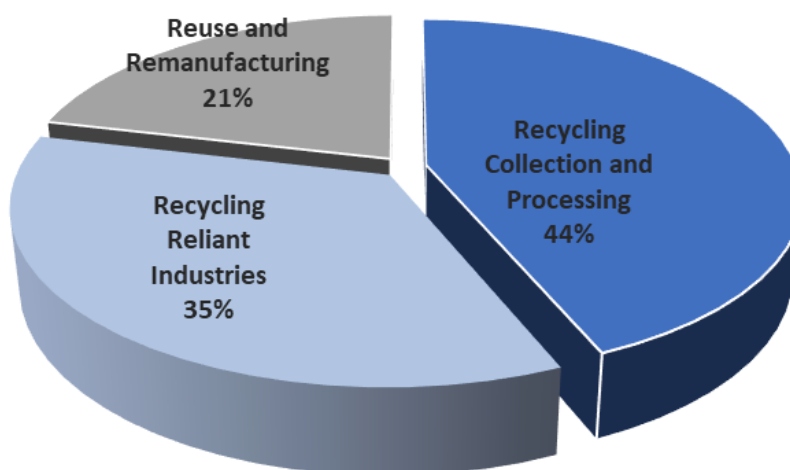
TABLE 9: CONTRIBUTION OF EACH RECYCLING SECTOR

SECTOR		Establishments	Net Revenue (\$)	% of Total	Net Employees	% of Total	Payroll (\$)	% of Total
Recycling Collection	Residential Curbside Recycling Collection	44	\$33,930,000	3%	240	9%	\$11,648,000	11%
	Commercial Recyclables Collection	Incl Above	\$8,390,000	1%	41	2%	\$2,329,000	2%
Recycling Processing	Compost/Organics Processors	23	\$3,150,000	0%	34	1%	\$1,609,000	1%
	Materials Recovery Facilities	3	\$11,290,000	1%	87	3%	\$5,401,000	5%
	Recyclable Material Wholesalers	27	\$398,610,000	41%	513	19%	\$21,120,000	19%
	Plastics Reclaimers	3	\$33,820,000	3%	88	3%	\$5,076,000	5%
	Other Recycling Processors/Manufacturers	4	\$2,250,000	0%	25	1%	\$409,000	0%
Subtotal:		104	\$491,440,000	50%	1,028	39%	\$47,592,000	44%
Recycling Reliant Industries	Nonferrous Secondary Smelting and Refining Mills	9	220,310,000	23%	182	7%	\$12,714,000	12%
	Nonferrous Product Producers	11	106,780,000	11%	257	10%	\$14,164,000	13%
	Nonferrous Foundries	15	5,570,000	1%	142	5%	\$6,191,000	6%
	Iron and Steel Foundries	6	20,700,000	2%	72	3%	\$3,263,000	3%
	Pavement Mix Producers (asphalt and aggregate)	4	\$430,000	0%	1	0%	\$43,000	0%
	Plastics Converters and End Users	4	\$13,510,000	1%	33	1%	\$1,808,000	2%
Subtotal:		49	\$367,300,000	38%	687	26%	\$38,183,000	35%
Reuse and Remanufacturing	Computer and Electronic Appliance Demanufacturers	6	\$930,000	0%	11	0%	\$311,000	0%
	Motor Vehicle Parts (used)	8	\$55,330,000	6%	210	8%	\$9,025,000	8%
	Retail Used Merchandise Sales	70	\$39,550,000	4%	568	22%	\$9,619,000	9%
	Tire Retreaders	2	\$10,260,000	1%	26	1%	\$1,121,000	1%
	Wood Reuse	6	\$12,530,000	1%	89	3%	\$2,972,000	3%
	Material Exchange Services and Other Reuse	2	\$690,000	0%	13	0%	\$220,000	0%
	Subtotal:		94	\$119,290,000	12%	916	35%	\$23,268,000
TOTAL:		247	\$978,030,000		2,632		\$109,043,000	

As shown in Tables 8 and 9, the largest contributor to the recycling industries are Recyclable Material Wholesalers, driven primarily by the large scrap metal businesses in the State and the wholesaling of non-ferrous metals. Also illustrated in Table 8, is the large contribution of used motor vehicle parts and retail used merchandise sales to revenues produced from Rhode Island’s reuse and remanufacturing industry.

As shown in Table 9, and illustrated in Figure 4 below, the largest contributor to payroll are the recycling collection and processing industries even though the average pay is roughly 83 percent of the average pay of the Recycling Reliant Industries. This compares against significantly lower average pay in the Reuse and Remanufacturing Industries although there are nearly as many jobs.

FIGURE 4: TOTAL PAYROLL (\$109 MILLION) BY EACH MAJOR RECYCLING SECTOR IN RHODE ISLAND



Finally, Table 10 presents the top seven recycling industries in terms of revenues, payroll and employment.

TABLE 10: TOP 7 RECYCLING INDUSTRIES (REVENUE AND PAYROLL)

TOP REVENUE SECTORS	Revenue (\$)	Employees	Payroll (\$)
Recyclables Material Wholesalers	\$398,610,000	513	\$21,120,000
Nonferrous Secondary Smelting and Refining Mills	\$220,310,000	182	\$12,714,000
Nonferrous Product Producers	\$106,780,000	257	\$14,164,000
Motor Vehicle Parts (used)	\$55,330,000	210	\$9,025,000
Recyclables Collection (Total)	\$42,320,000	282	\$13,977,000
Retail Used Merchandise Sales	\$39,550,000	568	\$9,619,000
Iron and Steel Foundries	\$20,700,000	72	\$3,263,000

Indirect and Induced Impacts

In addition to the estimated \$1 billion dollars in revenues from the recycling industries in Rhode Island, and the nearly \$110 million in payroll, there are indirect and induced impacts that contribute to the economy. Recycling industries are an important example of an industry stimulating the economy in two ways.

First, a Rhode Island based recycling industry provides direct employment and income within the region. Second, the recycling industry provides a local source of inputs to recycling reliant industries in the region. Using a non-ferrous product producer (used ultimately in jewelry manufacturing) as an example, metals are either imported from other states or Canada, or sourced from processors recycling and refining metals collected from within Rhode Island. To the extent recycled metals from instate are used, this activity multiplies the impact of the recycling industry by increasing employment in the local recycling industry. These employees go on to spend a significant amount of their labor income in Rhode Island, resulting in higher indirect and induced impacts when compared to a smelter or product producer importing metals from out of state.

DSM did not model the indirect and induced impacts for Rhode Island, but based on modeling that has been done for DSM for similar studies, it can be assumed that the indirect and induced impacts are likely to double the direct impacts from the recycling industry.

Adding indirect and induced economic benefits, assuming a multiplier of 1.5 to 2, which is typical for these types of industries, the total economic impact (including indirect and induced impacts) of recycling in Rhode Island is between \$1.5 and \$2 billion annually.

PART II: ESTIMATE OF MATERIALS DIVERSION

Introduction

In 2016 the Rhode Island General Assembly required the Rhode Island Resource Recovery Corporation (RIRRC) to report on the State's current solid waste diversion rate along with the economic contribution of Rhode Island's recycling industries. DSM was contracted to undertake both tasks.

The methodology undertaken to estimate the diversion rate is outlined below. This is followed by a description of the materials included in this estimate and the limitations of the data ultimately used.

For this study, DSM estimated four diversion rates:

- A Municipal (or Residential) diversion rate for which RIRRC has excellent data because all municipal solid waste and most recyclables are delivered to the RIRRC landfill and MRF;
- An Institutional/Commercial/Industrial (ICI) diversion rate for all non -municipal (or residential) solid waste;
- A Total Municipal and ICI diversion rate that conforms fairly closely to the EPA Municipal Solid Waste recycling rate: and,
- A Construction and Demolition (C&D) diversion rate.

DSM also totaled all materials accounted for to create a total diversion rate for municipal, ICI and C&D wastes

Note that the EPA defines Municipal Solid Waste as a combination of residential and ICI waste and this study attempts to conform to the MSW recycling rate definition defined by the US EPA in the EPA document, *Measuring Recycling, A Guide for State and Local Governments* (September 1997)³¹ as:

"Wastes such as durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources such as appliances, automobile tires, old newspapers, clothing, disposable tableware, office and classroom paper, wood pallets and cafeteria wastes." MSW "excludes solid waste from other sources, such as construction and demolition debris, auto bodies, municipal sludge, combustion ash, and industrial process wastes that might also be disposed of in MSW landfills or incinerators. (US EPA1996b)"

The construction and demolition (C&D) waste diversion rate represents recovery of materials typically found in C&D wastes at processing at facilities like the JR Vinagro C&D processing facility where material like clean wood, combustion wood, corrugated containers, any metals and asphalt brick and concrete are separated from the mixed C&D waste. Note that materials such as asphalt, brick and concrete separated and recovered directly from a job site are not included in this rate. Only those C&D materials sent to a transfer station or a C&D processing facility certified by RI DEM are accounted for.

³¹ Note that while the definition attempts to conform with EPA, the methodology undertaken is slightly different from the EPA approach.

To complete this three-part analysis, DSM not only attempted to account for all materials diverted by Rhode Island generators but also compiled data on the equation's denominator by collecting data on in-state and out-of-state disposal from the residential and institution/commercial/ industrial (ICI) sectors. In all cases the recycling or diversion rate is calculated by dividing the materials recycled/diverted by the materials recycled/diverted plus the materials disposed using the same materials categories. The methodology is described in detail below.

Methodology

DSM began by developing a materials recycled and diverted database using data from RIRRC on municipal customer recycling activity. These sources are tracked by RIRRC because RIRRC disposes of virtually all municipal customer (primarily residential) waste in Rhode Island and operates the RIRRC MRF which processes the recyclables collected from most households and municipal buildings. However RIRRC does not control or track most ICI waste disposal or recycling activity.

ICI disposal data sources, in addition to quantities managed at the RIRRC facilities, include transfer station facility reports for waste disposed out-of-state made to RIDEM for CY 2016. These reports included both solid waste disposal (both MSW and C&D waste) as well as materials recycled and/or diverted that were handled at these permitted facilities. However facilities that do not accept wastes for disposal but only recyclables do not report to RI DEM.

DSM added to the ICI quantities recycled/diverted using any tonnage data compiled for the economic information estimates. When tonnage information was not available or was not up-to-date, DSM conducted phone or e-mail surveys (some of which were done as part of the recycling economic information study) to supplement the data.

Businesses that were included in the diversion rate study fall into the following major categories:

- **Large recycling haulers** that collect recyclables, single stream or source separated, as well as yard waste and other materials from small and large ICI generators. The data for recycling haulers was primarily provided by RIRRC but was in some cases supplemented by DSM surveying of companies that might bring material out of state for processing.
- **Processing facilities and brokers**, that either handle or process paper, plastics, metals, electronics and C&D materials for re-sale, or handle and process niche recyclables such as pallets, textiles, tires, mattresses, and paint. This data was primarily gathered through phone or e-mail surveys or by speaking with association members for an estimate.
- **Large retailers and grocers** that generate large quantities of corrugated cardboard and in some cases plastic film and shrink wrap and tend to backhaul these materials to internal distribution facilities for processing and marketing. As many of these businesses backhaul materials out of state, the recycling of corrugated cardboard would be under-counted if the diversion rate survey only relied on in-state recycling haulers and paper brokers. This data was primarily gathered through phone and e-mail surveys. In cases where volume data were not available due to a refusal to participate or non-completed survey, DSM used applicable volume data from previous studies to provide an estimate for the large retailers identified as located in Rhode Island.

- **Large generators and processors of leaf and yard waste and natural wood waste** such as major landscaping companies, major compost facilities and municipal compost facilities. This data was obtained from RIRRC Data, RI DEM Transfer Station Annual Surveys, DSM Surveys and estimates based on permitted facility capacity.
- **Large Employers or Manufacturing Facilities** that may generate additional recyclables and do not use an in-state hauler but instead broker their own recyclable materials to an out of state facility. This data was primarily gathered through phone or e-mail surveys done by DSM.
- **C&D Recycling Processors** that may also provide hauling or demolition services. Primary materials resulting from C&D recycling include C+D wood, gypsum, and soils and stone. This data was primarily gathered through RIDEM survey reports and was supplemented by survey data collected by DSM.

Surveys

DSM attempted to identify and survey all companies that may be large contributors to the State's recycling or diversion rate, and that had not already reported to RI DEM or RIRRC.

Surveying took place over the course of four months and included phone and e-mail contact depending on the respondent's preference. As part of the survey process, DSM attempted to contact identified companies at least three times over the phone in addition to multiple e-mail attempts. Surveys for the diversion rate study only focused on gathering information on the material types handled, the annual tonnage of each material generated from Rhode Island locations, and the end use location of the material diverted (to avoid double counting).

On a case-by-case basis, when either survey information was not available, or companies refused to participate in a survey, recycling activity was modeled from previous diversion rate studies done by DSM.

In all cases survey respondents were offered the opportunity to request that the data be kept confidential. As such, quantities by individual firms are not included in this report and are reported in aggregate.

Material Types

The major material categories and subcategories included in the recycling/diversion rate study are outlined in Table 11 on the next page.

TABLE 11: TYPES AND SUBCATEGORIES INCLUDED IN THE DIVERSION RATE

MATERIALS	
<i>Material Category</i>	<i>Subcategory</i>
PAPER AND PACKAGING MATERIALS:	
PAPER	ONP (old newspapers)
	OCC (old corrugated containers)
	Mixed Paper
PACKAGING	Mixed Glass (bottles)
	Mixed Plastic
	Aluminum Cans (below in Aluminum estimate)
	Pallets, mulched and other
	Shrink Wrap/Recoverable Film
	Retail Bags
SINGLE STREAM	"Mixed recyclables": collected mixture of different categories of recyclables.
OTHER MATERIALS:	
VEHICLE WASTES	Oil Filters
	Lead Acid Batteries
	Tires
SPECIAL WASTES	Carpet
	Textiles
	Rigid Plastics
	Paint
	Mattresses
	Electronics / Electronic Goods
FOOD RELATED WASTES	Fats, Oil, Grease
	Food Waste
GREEN WASTE	Leaf and Yard Waste
	Trees and Branches (incl above)
	Land clearing (e.g. trees, stumps), mulched
METALS	Aluminum
	White Goods
	Ferrous
	Non-Ferrous, All Other
C&D MATERIALS	
C&D MATERIALS	Land clearing (See "Green Waste")
	Asphalt Shingles
	Clean C&D Wood
	Biomass to Fuel
	Aggregates
	Fines & Residuals
	Mixed C&D

Description of Final Material Categories

A detailed description of the material categories tracked, the specific data gathering approach and the recycling process, if any, is described below.

Paper, Paper Packaging

Paper and Paper Packaging are generated by both the ICI and residential sectors. Quantities were compiled using data from RI DEM facility reports, RIRRC data, and phone and e-mail surveys. However, in the case that survey data was not provided by a retailer or grocer known to be operating in Rhode Island, DSM used per store recycling volume data from previous studies to make estimates.

OCC and mixed paper grades processed at the RIRRC facility were estimated to be 81 percent residential and 19 percent ICI. Commercial mixed paper, Mixed Office Paper (MOP) and OCC recycling was primarily through groceries/supermarkets, data destruction firms, and large employers, and retailers.

Factors impacting mixed paper, MOP and OCC tonnages recycled this past year and moving forward include:

- China's enforcement of their "National Sword" policy, which established a much lower threshold for contamination, impacts processors' ability to sell recovered paper³² and can lead to stockpiling paper bales or the disposal of recyclables due to space restrictions.³³ This may have lowered tons of paper recycling reported for 2017 (as part of surveys performed by DSM) and is likely to impact paper recycling volumes in 2018.
- The transition to digital media and record keeping impacts the amount of paper recycled. Between 1990 and 2017, the U.S. paper supply decreased by roughly 9 million tons to 77.2 million tons, 89 percent of what it was in 1990.³⁴
- In many cases, reported paper recycling can be strongly influenced by national brokerage firms who focus on sourcing specific paper material types depending on market trends and value per ton.
- There is likely to be more corrugated found in the residential stream due to the growth of online retailing or the Amazon effect of delivering goods directly to the household.

Other Packaging

Other packaging includes mixed glass, plastic containers and packaging, aluminum and steel cans, pallets, shrink wrap/recoverable film and retail bags. These materials are generated from both the residential and ICI sectors. Residential tons are primarily reported by RIRRC whereas commercial tonnages are reported primarily by large businesses operating in the retail and grocery sectors.

³² Margolis, J. (2018). *Mountains of US recycling pile up as China restricts imports*. PRI. Retrieved From: <https://www.pri.org/stories/2018-01-01/mountains-us-recycling-pile-china-restricts-imports>

³³ Rodengren, C. (2018). *Maxed out Massachusetts MRFs prompt recycling disposal waivers*. Waste Dive. Retrieved From: <https://www.wastedive.com/news/maxed-out-massachusetts-mrfs-prompt-recycling-disposal-waivers/514011/>

³⁴ *Paper & Paperboard Recovery*. Paper Recycles. Found at: <http://www.paperrecycles.org/statistics/paper-paperboard-recovery>

Information for this sector was gathered using data from RIRRC and RIDEM as well as phone and e-mail surveys of the ICI sector.

Additional information about this sector is included below:

- While mixed glass (bottle) recycling was separated out due to the presence of Strategic Materials processing facility in Rhode Island, this activity has ceased in 2018 due to the closure of a major end user in Massachusetts, a glass container manufacturing facility that used up to 90 percent recycled cullet and sourced throughout New England. It is anticipated that recovered glass aggregate from RIRRC's MRF will be reused in landfill construction and operations until a recycling option is realized.
- Retail Bags are reported by retailers and grocery stores who either have a bag take-back program at their stores or that backhaul these materials to a distribution center.
- Plastic containers and packaging recovery in Rhode Island is driven primarily by residential single stream recycling availability and RIRRC processing, with additional volume reported by retailers who recycle plastic bottles, packaging, shrink wrap and even hangers from their stores but who reported these materials as one stream and not by specific resin or packaging type.
- Pallet recycling is an estimate based on per capita data from previous studies.

Single Stream

Materials processed at RIRRC's MRF are reported by the commodity sold resulting in a lower volume of single stream or commingled recyclables included in the totals for this report. Note that when material is reported as single stream or commingled, it has been reported as an incoming stream to a materials recycling facility and almost always includes residue, sometimes at high levels (15 percent or more).

For this report, RIRRC reported outgoing volumes of material which lowers the municipal recycling tons reported and in turn the recycling rate as compared against a recycling rate that incorporates the single stream materials collected for recycling.

Single stream recycling volumes were reported to DSM by large haulers that send recyclables to out of state MRFs for processing in surrounding states. These are included in this report.

In Rhode Island, any ICI single stream material sent to the RIRRC MRF is not included in this total since it was reported as the commodity sold by RIRRC.

Vehicle Wastes

Vehicle wastes include the byproducts from maintaining cars and trucks. DSM excluded antifreeze and solvents from these estimates. Materials included in the survey where DSM was able to obtain data were:

- **Used Oil and Oil Filters:** DSM obtained data on used oil and oil filter recycling from RI DEM Annual Solid Waste Report forms as well as from surveys and estimates from retailer reporting. Used oil and oil filter recycling was reported as a single tonnage to RI DEM and thus, is reported as single tonnage in the diversion rate. DSM believes used oil and oil filter recycling is

underestimated because not all the companies handling oil filters generated in Rhode Island were identified and surveyed, and because scrap metal recyclers who properly drain and market oil filters do not report this material separate from other ferrous metals.

- **Lead Acid Batteries:** While data were obtained on lead acid battery recycling from both RI DEM Annual Solid Waste Report forms as well as some retail reporting submitted to DSM, the totals were grossly underestimated due to the difficulty in identifying all companies handling lead acid batteries. Due to this, DSM based lead acid battery recycling volumes on the totals reported in the most recent EPA Characterization of MSW in (2014)³⁵ which were applied on a per capita basis to Rhode Island's population.
- **Tires:** DSM attempted to quantify tire recycling from RI DEM Annual Solid Waste Report forms, RIRRC, the Tire Retread Information Bureau (TRIB) and the U.S. Tire Manufacturers Association. However, as with Lead Acid Batteries, DSM believes tire recycling volumes were underreported and instead used EPA data³⁶ to estimate tire recycling in Rhode Island.

Special Wastes

Special wastes recycled can include carpet, textiles, mattresses, electronic goods and paint. Data for these material categories were often provided by related associations and industry databases including the Mattress Recycling Council and PaintCare. However, without an extended producer responsibility law, quantities of these materials can be difficult to estimate as material flow can be difficult to track. Additionally, in the case of electronic goods, many of the companies operating in the industry are frequently consolidating, making it difficult to identify businesses that are currently operating within the industry.

In the end, DSM used estimates based on per capita recycling from national totals (2017) reported by ISRI for textiles and electronics. Paint and mattress recycling totals came from the 2017 Annual Reports by Paint Care and the Mattress Recycling Council. DSM did not identify any carpet recycling in the state.

Food, and Organic Waste

This category includes expired and waste meats, vegetables and pre-made meals from grocery stores and convenience store, slaughterhouse waste, used cooking oils, and fats, oil and grease (FOG) from restaurants. This category also includes an estimate for backyard composting made by RIRRC based on the number of households assumed to be using backyard composters sold by RIRRC.³⁷

Primary sources of data for this category include supermarkets diverting food waste and companies specializing in the processing of used cooking oils and FOG.

³⁵ *Advancing Sustainable Materials Management: 2014 Tables and Figures Assessing Trends in Material Generation, Recycling, Composting, Combustion with Energy Recovery and Landfilling in the United States.* U.S. E.P.A. December 2016.

³⁶ *Id.*

³⁷ Note that while some states such as Vermont include an estimate of backyard composting volumes in their diversion rate, the US EPA methodology (1996) does not account for backyard composting categorizing it as a source reduction activity.

Green Waste

The category for green waste includes leaf and yard waste, trees and branches, and land clearing debris (i.e. stumps, trees) that have been used for mulch.

- Leaf and Yard Waste:** Primarily from municipal yard waste collection or drop-off composting programs, private haulers that provide subscription curbside yard waste collection, and yard waste drop-off sites that mainly serve professional landscapers. In addition to data provided to DSM from RIDEM Annual Solid Waste Reports and RIRRC on municipal and commercial yard waste, DSM attempted to survey any companies or municipalities that did not have completed information. In many cases tonnages reported were an estimate based on weekly or monthly users of the facility as many facilities do not have a scale. In the case where volume data was unavailable, DSM used permitted capacity data per facility provided by RIRRC. The majority of leaf and yard waste is assumed to be residential with the remaining thought to be generated from the commercial sector via landscaping of business parks, etc.
- Trees and Branches:** Trees and branches are primarily generated from landscapers and tree companies. These materials are generally delivered to processors for grinding and mulching, although in some cases they may also be processed by end users for fuel.
- Land Clearing Debris:** This category is primarily for tree and stump removal in the process of site clearing for development. The materials generated from this category are most likely categorized as C&D wastes and included in those totals.

Metals

The metal category includes scrap metals, both ferrous and non-ferrous, handled by scrap metal dealers as well as white goods (appliances) reported by retailers, municipal transfer stations or RIRRC and aluminum (including cans).

Because metal recovery rates are extremely high due to the material value, scrap metal recycling in Rhode Island is also expected to be significant. Therefore, DSM used data from previous studies to make estimates on metal tonnages by major category based on per capita data. These estimates attempt to exclude any scrap vehicles. These estimates were necessary because many scrap dealers refused to participate in the voluntary survey process.

It is important to note that EPA methodology does not include all ferrous and non-ferrous metals in their MSW recycling rate. Instead they account for durables, which include appliances and metal furniture, as well as metal packaging. Other states, such as Delaware, follow this methodology including only appliances and aluminum estimates to account for aluminum cans and packaging.

In contrast Vermont used to include estimates from scrap metal processors and now includes only metals collected by municipal recycling facilities but not by scrap yards. Finally, Connecticut has had difficulty tracking scrap metal recycling but in CY 2014 (the most recent year where data is available) estimated over 400,000 tons of scrap metal recycling after obtaining reports from scrap metal processors.

DSM made estimates for four metal categories (aluminum, appliances, ferrous and non-ferrous) to demonstrate the impact of metals on the recycling rate with and without all types of scrap metals.

C&D Wastes

The subcategories included in tracking C&D Wastes in Rhode Island included:

- **Land Clearing Debris** includes any stumps, trees or logs associated with land clearing;
- **Asphalt Shingles** also known as asphalt roofing, can be repurposed into a component of recycled asphalt pavement;
- **Clean C&D Wood** is wood that has not been painted, stained or treated for moisture resistance, frequently being the result of framing projects, or wood that may be painted or stained but not treated but which has been separated for sale to high end uses such as TAFISA – a particle board manufacturing facility in Quebec that sources wood from throughout the northeast;
- **Biomass** are wood chips, mulch, wood waste, etc. used to fuel heating and energy facilities;
- **Aggregates** include crushed concrete and asphalt, and sometimes stones and brick;
- **Fines & Residuals** are materials that fall through screens prior to the sorting for recovery;
- **Subgrade Reshaping** is ground C&D materials used as construction products mainly at landfill sites; and,
- **Mixed C&D** is an unsorted and unprocessed combination of the above materials (and others) that may be sent to a C&D recycler for processing and removal of recyclable components. This is likely to include residues that are not recycled.

As with special wastes these materials can be difficult to track and for companies to estimate the corresponding tonnage for each material type. In addition, some metals come from C&D wastes but are not counted as C&D recycling because they are either removed before they get to a C&D recycler or removed by the C&D recycler but counted at the metal scrap recycler.

For this report, DSM used data provided by RIRRC and RIDEM reports and supplemented this with survey data.

Other Wastes

Other types of wastes that might be included in a solid waste diversion rate estimate include mixed plastics from manufacturing facilities, biosolids, contaminated (but non-hazardous soils) that have been reclaimed, bottom and fly ash, and other types of non-hazardous manufacturing/processing wastes. DSM did not include these materials in this analysis because they are outside of the realm of municipal solid waste and C&D waste management, and they typically have less opportunity for diversion.

Study Limitations

DSM attempted to identify and then survey all large recycling generators and material processors/brokers serving Rhode Island. DSM also attempted to identify all processors, reclaimers, and recycling reliant industries operating in the State. However, despite DSM's best efforts, some businesses were not identified and therefore not contacted for the survey.

Additionally, since the legislation that led to this study did not include language that made reporting of recycling/diversion activity mandatory, DSM relied on voluntary reporting of all recycling and materials diversion information. This made it difficult for DSM to persuade many generators and brokers to report materials handled and/or their type of operation. This ultimately resulted in low survey participation rates in certain industries including scrap metal, pallet rebuilding, and electronics recycling.

In those sectors where participation was low, DSM was forced to model activity in Rhode Island based on data from industry groups, applicable associations, or past studies. These data sources enabled DSM to estimate tons generated and recycled in Rhode Island for specific materials. While DSM believes these estimates are more accurate than the tonnage data obtained for those materials through the survey process, it is important to note that these are regional estimates and not based on data gathered from specific RI facilities. The following sectors were modeled: pallets, lead acid batteries, tires, textiles, electronics, FOG and metals.

Additional study limitations include the fast-changing market for some recycling industries where both small businesses open and close and consolidation takes place at a rapid pace. For example, many businesses involved in recycling electronic waste are either consolidating, changing locations, or operating under different company names, making it difficult to track these companies down for surveying purposes. In the case that an out of state company is identified and contacted for surveying, in many cases, they can only provide a rough estimate of the tons of materials generated in Rhode Island.

Different sectors posed different limitations for DSM. For example, the pallet industry had very low participation despite DSM's best attempts to reach and survey facility operators, resulting in the need to model the behavior of the industry based on a single survey and past studies completed by DSM.

Other sectors, such as grocers and retailers generating baled OCC posed the potential for double counting materials since the end user reported was a regional distribution center from which a broker that reported to DSM may have already counted that material. While DSM made a significant effort to track material flow and avoid double counting, it is possible some materials were counted twice. However, DSM is certain that due to the low participation rate from many in-state processors and large employers, OCC and other paper recycling remains undercounted even after any double counting may have occurred.

In addition, in many cases plastic shrink wrap/recoverable film was estimated by the generator as a percentage of total retail bags and/or grouped together with other plastics. Like OCC, plastic film is also underreported.

Finally, some companies reported in individual units (i.e. catalytic convertors) instead of weight. In these cases, DSM made their best estimate of the unit weight based on industry averages.

Results

The survey results were tabulated by major material category, and by material type. Table 12 presents these totals by major material category, with Table 13 providing a detailed breakdown for each material type.

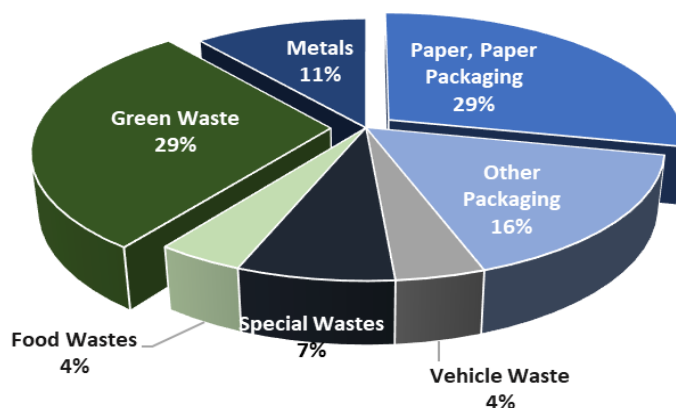
Materials were allocated to the residential or commercial (ICI) sector based on the reported generator source. For those categories where the source was uncertain, DSM made estimates based on similar work DSM has performed on an annual basis for the Recycling Public Advisory Council in Delaware over the past decade.

TABLE 12: ESTIMATED RECYCLING BY MAJOR MATERIAL CATEGORY IN RHODE ISLAND (TONS, 2016)

Major Material Category	Residential (Tons)	ICI (Tons)	Total (tons)
Paper, Paper Packaging	50,742	46,471	97,212
Other Packaging	22,158	29,175	51,334
Single Stream	0	4,162	4,162
Vehicle Waste	11,417	2,854	14,272
Special Wastes	11,649	13,404	25,053
Food, Organic Waste	525	13,411	13,936
Green Waste	89,475	9,942	99,417
Metals (1)	28,958	8,727	37,685
Total:	214,924	128,147	343,071

- 1) Metals included in this estimate are appliances and aluminum packaging. All other ferrous and non-ferrous metals are estimated at 115,000 tons (using Delaware and Connecticut data to make an estimate).

FIGURE 5: ESTIMATED RECYCLING IN RHODE ISLAND BY MAJOR MATERIAL CATEGORY (BY WEIGHT, 2017)



As shown in Figure 5, most of Rhode Island’s recyclable volume comes from Green Waste and Paper and Paper Packaging.

Table 13 (next page) presents estimated recycling/diversion by each specific material type. Note that Table 13 is heavily footnoted on the following page.

TABLE 13: ESTIMATED RECYCLING / DIVERSION BY MATERIAL TYPE (TONS, 2016)

Material Category	Residential (tons)	ICI (tons)	C&D (tons)	Total (tons)
Paper, Paper Packaging				
Old Newspapers (ONP)(1)	31,144	4,247	0	35,391
Corrugated (OCC)(2)	16,501	41,616	0	58,117
Mixed Paper (3)	3,097	608	0	3,705
Subtotal:	50,742	46,471	0	97,212
Other Packaging				
Mixed Glass (Bottles)(4)	14,905	2,032	0	16,937
Mixed Plastics (5)	6,864	1,553	0	8,417
Pallets, mulched and other (6)	0	25,492	0	25,492
Shrink Wrap/Recoverable Film	0	54	0	54
Retail Bags (7)	390	43	0	433
Subtotal:	22,158	29,175	0	51,334
Single Stream				
"Mixed Recyclables"	0	4,162	0	4,162
Subtotal:	0	4,162	0	4,162
Vehicle Waste (8)				
Oil Filters	161	40	0	202
Lead Acid Batteries	7,440	1,860	0	9,300
Tires	3,816	954	0	4,770
Subtotal:	11,417	2,854	0	14,272
Special Wastes				
Textiles	6,336	0	0	6,336
Rigid Plastics	0	279	0	279
Paint	338	0	0	338
Mattresses (9)	900	900	0	1,800
Electronics/Electronic Goods (10)	4,075	12,225	0	16,300
Subtotal:	11,649	13,404	0	25,053
Food Wastes				
Fats, Oil, Grease (FOG)	0	9,000	0	9,000
Food Waste (11)	525	4,411	0	4,936
Subtotal:	525	13,411	0	13,936
Green Waste				
Leaf and Yard Waste (12)	89,475	9,942	0	99,417
Trees and Branches (Incl Above)	0	0	0	0
Subtotal:	89,475	9,942	0	99,417
Metals (13)				
Aluminum (14)	4,164	463	0	4,626
White Goods	24,794	8,265	0	33,058
Subtotal:	28,958	8,727	0	37,685
C&D Materials				
Aggregates	0	0	88,259	88,259
Asphalt Shingles	0	0	8,003	8,003
Biomass to Fuel	0	0	28,550	28,550
Clean C&D Wood	0	0	13,329	13,329
Fines & Residuals	0	0	8,529	8,529
Land clearing debris (15)	0	0	1,133	1,133
Metals	0	0	14,452	14,452
Mixed C&D	0	0	8,398	8,398
Subtotal:	0	0	170,654	45,842
Total:	214,924	128,147	170,654	513,725

TABLE 13 Footnotes:

- 1) ONP is reported at 88 percent residential/municipal as estimated by RIRRC.
- 2) OCC is reported at 88 percent residential/municipal as estimated by RIRRC.
- 3) Mixed Paper is reported at 88 percent residential/municipal as estimated by RIRRC.
- 4) Mixed Glass is reported at 80 percent residential.
- 5) Mixed Plastics is reported at 70 percent residential.
- 6) Pallets, mulched and other include pallets recycled or repaired. Tonnage is based on per capita estimate.
- 7) Retail Bags are 90 percent residential based on previous reports completed by DSM.
- 8) Vehicle Waste is reported at 80 percent residential for all categories based on previous reports completed by DSM.
- 9) Mattresses are reported as 50 percent residential.
- 10) Electronics/Electronic Goods are estimated for RI on a per capita basis using ISRI’s 2017 Scrap Yearbook estimate which also assumes they are 25 percent residential.
- 11) Food Waste includes estimated tons of food waste composted from retailers and estimates of households’ backyard composting activity.
- 12) Leaf and Yard waste is assumed to be 90 percent residential.
- 13) Metal tons are based on per capita estimates formulated from previous reports done by DSM.
- 14) Aluminum includes aluminum cans and other aluminum packaging recycled in Rhode Island and is assumed to be 90 percent residential. An additional estimated 115,000 tons of other types of ferrous and non-ferrous metals recycled is not included in the metals totals shown.
- 15) Land clearing debris are stumps and trees cleared and mixed with C&D waste and delivered to C&D processing facilities.

Disposal and the Diversion Rate

To calculate the recycling/diversion rate, DSM compiled data on both in-state and out-of-state waste disposal. All out-of-state disposal was reported as ICI or C&D waste handled by private haulers and transfer stations that did not use the RIRRC landfill. Any out-of-state C&D waste reported was sent to three C&D recycling facilities in Massachusetts and is included in C&D waste recycling above.

DSM also received detailed data from RIRRC on waste disposal at the RIRRC landfill. Using these data, DSM worked with RIRRC to apply generator source allocations from the 2015 waste characterization study gate surveys to CY 2017 waste deliveries to develop total residential, ICI and C&D waste deliveries to the RIRRC landfill for disposal. Table 14 illustrates the estimated total tons of MSW and C&D disposed by the residential and ICI sectors. Note that C&D is not allocated to the residential or ICI sectors because of the difficulty of accurately determining the source of the waste.

TABLE 14: DISPOSAL ESTIMATES BY GENERATOR CATEGORY (TONS, CY 2017)

Disposal Location	Residential (tons)	ICI (tons)	Subtotal (1) (tons)	C&D (tons)	Total (tons)
RIRRC Landfill	362,568	220,911	583,480	217,579	801,058
Out-of-State Facilities		202,803	202,803		202,803
Total:	362,568	423,714	786,283	217,579	1,003,861

Table 15-A and 15-B use the data from Tables 12, 13 and 14 to calculate estimated recycling/diversion rates for the residential sector and the ICI sector as well as for all solid waste, and for C&D waste.

Finally, an overall recycling/diversion rate is calculated for all solid waste, and for solid waste without C&D waste to more closely match the EPA measurement method.

TABLE 15-A: ESTIMATED DIVERSION RATES FOR RESIDENTIAL, ICI, C&D AND ALL SOLID WASTE GENERATED IN RHODE ISLAND (CY 2017)³⁸

Material Management	Residential (tons)	ICI (tons)	C&D (tons)	Total (tons)
Diverted Materials	214,924	128,147	170,654	513,725
Solid Waste Disposal	362,568	423,714	217,579	1,003,861
Diversion Rate:	37%	23%	44%	34%

TABLE 15-B: ESTIMATED DIVERSION RATE FOR TOTAL RESIDENTIAL AND ICI SOLID WASTE GENERATED IN RHODE ISLAND (CY 2017)³⁹

Material Management	Residential (tons)	ICI (tons)	Total (tons)
Diverted Materials	214,924	128,147	343,071
Solid Waste Disposal	362,568	423,714	786,283
Diversion Rate, Without C&D:	37%	23%	30%

As shown in Table 15-B, the estimated Total Residential and ICI Diversion Rate is 30 percent which compares against the National EPA rate of 34.6 percent in 2014, and Connecticut’s rate of 29 percent in 2014 (the most recent year calculated). While the EPA has no separate rate for residential and the ICI sector, DSM estimated the residential rate at 37 percent and the ICI rate at 23 percent. As stated above, one of the reasons the ICI rate is likely lower is because OCC and other paper recovery is unlikely to have been fully tracked by DSM. This was either because the source was not identified or because a larger generator, processor or broker did not provide information to DSM for this report.

Finally, one of the materials included in this study but not accounted for in Table 13 was ferrous and non-ferrous scrap metal, other than white goods/appliances and aluminum. These scrap metal figures were modeled for Rhode Island based on Connecticut survey data for scrap metal dealers and extensive survey data collected in Delaware on all metals (except for crushed vehicles). These were estimated at roughly 115,000 tons for Rhode Island based on Delaware and Connecticut data.

³⁸ This excludes special wastes such as biosolids, agricultural wastes, incinerator ash, unique industrial wastes, contaminated soils and other non-hazardous solid wastes that are not municipal solid waste or construction and demolition debris. Note that some of these materials might be disposed of in the RIRRC landfill.

³⁹ This excludes special wastes such as biosolids, agricultural wastes, incinerator ash, unique industrial wastes, contaminated soils and other non-hazardous solid wastes that are not municipal solid waste or construction and demolition debris. Note that some of these materials might be disposed of in the RIRRC landfill.

If DSM were to include all ferrous and non-ferrous metals (except for white goods), diversion rates increase by roughly 7 percent, exceeding the EPA rate for MSW (2014). Table 16 presents these results.

TABLE 16: ESTIMATED RECYCLING/DIVERSION RATES FOR RHODE ISLAND MUNICIPAL SOLID WASTE INCLUDING FERROUS AND NON-FERROUS SCRAP METAL ESTIMATE (CY 2017)

Material Management	Residential (tons)	ICI (tons)	Total (tons)
Diverted Materials (Table E-6)	214,924	128,147	343,071
<i>Estimated Additional Metal Recycling</i>	<i>57,733</i>	<i>57,733</i>	115,466
Total Diverted Materials:	272,658	185,880	458,537
Solid Waste Disposal	362,568	423,714	786,283
<i>Diversion Rate, Without C&D:</i>	43%	30%	37%

The EPA however only includes white goods and other durables in their tracking of MSW metal recycling, and breaking out durables from all other scrap metal is difficult.

Opportunities for Addition Diversion

RIRRC's 2015 waste characterization study indicates that roughly 41,000 tons of corrugated and 35,800 tons of mixed paper are being landfilled at the RIRRC landfill each year, representing roughly 14.5 percent of waste disposal at RIRRC.⁴⁰ Therefore, the potential exists for significant diversion of paper to local processors and recyclable material wholesalers.

Roughly 83 percent of the 41,000 tons of corrugated were disposed from ICI generators, while conversely roughly 46 percent of the 35,500 tons of mixed paper are disposed from residential generators. Diverting another 30 percent of this landfilled material would not only save landfill capacity but produce commodity revenue (roughly \$1.5 million for corrugated alone)⁴¹ and create jobs in collection and materials processing. This material might serve as potential feedstock to mills in the region, and ultimately benefit the Rand Whitney Packaging facility in Pawtucket which relies on corrugated from their mills in the New England region.

In addition, 6,300 tons of PET/HDPE bottles were disposed (1.2 percent of disposed waste⁴²) and could also serve as feedstocks for local processors – with separated plastics ultimately delivered to one or two local plastic reclaimers.

In addition to these materials disposed at the RIRRC landfill, ICI waste disposed out of state likely includes recyclable materials in comparable quantities. Assuming the composition of the ICI waste disposed out of state is the same as that disposed at RIRRC, an additional 10,000 tons of OCC might be recovered, at a value of more than \$1 million.

⁴⁰ Excluding special wastes and C&D wastes disposed at the RIRRC landfill.

⁴¹ Based on March 2018 pricing of OCC, Boston Market.

⁴² Excluding special waste and C&D wastes disposed at the RIRRC landfill.

Another material disposed in large quantities is textiles, with roughly 29,00 tons disposed at RIRRC based on the 2015 waste characterization study. The majority of this (77 percent) is from the residential sector. The value of textiles dropped dramatically over the past year because of second-hand textile bans proposed by Eastern African Countries (EAC). However, the bans appear to have been retracted by four of the five nations that originally proposed them.⁴³ This would enable international imports to the EAC to continue, one of the key markets for recovered textiles. In addition, there is a renewed interest in the U.S in recovering the fibers from used textiles. Assuming that 20 percent of what is disposed at RIRRC could be recovered, and prices rise from recent lows to 25 cents per pound, another \$2.8 million might be raised by textile recycling.

Finally, some portion of food waste, which was estimated at roughly 100,000 tons disposed in the 2015 study, has the potential to be diverted for composting or anaerobic digestion in the region. However, this food waste contributes to methane generation and electricity production at the RIRRC landfill, and costs for separate collection can be significant. As such, this may be a case where job creation would primarily be in reducing food waste at the generator level and increasing food rescue operations.

Economic Impacts from Increased Diversion

It would be a gross over-simplification to take the jobs and revenue created by current recycling activity and assume a linear extrapolation of the data to the new tons diverted. This is because many of the recycling collection and processing industries have some capacity to absorb new materials with limited change in employment. Similarly, most of the recycling reliant industries can change their mix of recycled versus virgin materials input with little change in employment.

Areas most likely to result in increased employment are collection of recyclable materials and increased diversion of textiles and organics where the collection and processing infrastructure are not already in place.

One can reasonably assume that the collection infrastructure for recyclables in Rhode Island is relatively efficient with utilization of trucks and drivers at a high rate – perhaps close to 90 percent. For this reason, if new tons are added, collection companies will initially absorb those tons with existing trucks and drivers, but will eventually have to add new trucks and drivers as the tonnage increases.

This would especially be the case for significant increases in ICI corrugated collection because costs are very dependent on the volume of corrugated set out at each commercial stop. This would also be the case if new programs for separate collection of textiles and food wastes were undertaken because these would need to be collected separate from residential single stream collection.

Based on the current recycling infrastructure in the state, the estimated tonnage collected and processed, and the revenues generated as a result, every additional 10,000 tons diverted might create an estimated 17 jobs and nearly \$8 million in additional revenues.⁴⁴

⁴³ Editorial Staff. *Ban rethink 'a victory for EAC countries and second-hand textiles industry'* Recycling International. April 03, 2018.

⁴⁴ *This is a very rough estimate made from dividing the economic and job impacts by the estimated recycling and organics tonnages collected, processed, composted and marketed from these RI based facilities.*