RECYCLING MARKET DEVELOPMENT PLAN

FINAL REPORT | AUGUST 2021

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TABLE OF CONTENTS

HOW TO USE THIS PLAN

In 2019, the 86th Texas Legislature passed Senate Bill 649, which directed the Texas Commission on Environmental Quality (TCEQ) to develop a plan to stimulate the use of recycled material feedstocks in processing and manufacturing. This report titled Recycling Market Development Plan (RMDP) provides a detailed analysis of the current state of recycling in Texas, including tonnages, economic impacts, material- and commodity-specific market conditions, and barriers and opportunities to increase recycling. Finally, the RMDP presents a strategy and recommendations to stimulate increased use of Texas-generated recycled material feedstocks.

This RMDP provides value to a range of stakeholders within Texas and outside of the state; including organizations tasked with recycling market development in Texas, businesses seeking recycling-related data and opportunity in the state, and entities developing recycling market development strategies in other states or regions. The following table provides recommendations for navigating each section of the RMDP.

NAVIGATING RMDP SECTIONS FOR MARKET DEVELOPMENT STAKEHOLDERS

Section	Key Contents	Use This Section If You Are...
1.0 EXECUTIVE SUMMARY	• Key findings from all sections	• **Any stakeholder** looking for a brief summary of the RMDP results
2.0 METHODOLOGY	• Definitions used in this RMDP • Overview of stakeholder engagement and outreach • The RMDP survey approach	• **Any stakeholder** looking for details on the approach to data collection and analysis
3.0 RECYCLED TONS AND RECYCLING RATE	• Quantity of recyclable materials recovered from municipal solid waste (MSW) and industrial sources • Quality of recycled MSW materials, including reported contamination rates • Material-specific MSW recycling results	• **Any stakeholder** seeking to understand the amount and types of MSW and industrial materials recycled in Texas • **A material- or industry-specific representative** looking for a detailed analysis of specific materials recycled in Texas (see Section 3.3)
4.0 ESTIMATED AMOUNT OF RECYCLABLE MATERIALS THAT COULD BE RECYCLED, BUT ARE DISPOSED	• Amount and composition of MSW, C&D, and other waste streams entering MSW landfills • Amount and types of Texas-generated recyclable materials that were disposed	• **Any stakeholder** seeking to understand the amount and types of landfilled materials that could be recycled • **A material- or industry-specific representative** looking for a detailed analysis of potentially recoverable materials in Texas
5.0 VALUE OF MATERIALS RECYCLED AND DISPOSED	• Market value of recyclable materials recovered from MSW and industrial sources • Market value of recyclable materials disposed in MSW landfills	• **Any stakeholder** looking for estimates of the market value of recyclable materials recovered or disposed
6.0 ECONOMIC IMPACTS OF RECYCLING	• Jobs, wages, and economic output from Texas' recycling sector and related manufacturing activity • Fiscal impacts (e.g., tax revenue) to state and local government from Texas' recycling sector and related manufacturing activity	• **Any stakeholder** seeking to understand the benefits to the Texas economy from recycling sector activity and manufacturing activity using recycled material feedstocks (see Sections 6.3 and 6.5) • **Economic analysts** wanting to review the methodology and detailed results of input-output economic impact modeling of recycling (collection, processing, and transportation) and manufacturing with recycled material feedstocks in Texas

Section	Key Contents	Use This Section If You Are...
7.0 ANALYSIS OF SUPPLY AND DEMAND	• Broad description of the recycling systems in Texas • Overview of national, regional and state material flows and markets (by commodity) • Detailed descriptions of supply and demand (by commodity) • Summaries of material supply and demand and comparison for all commodities	• **Any stakeholder** looking for an overview of recycling systems and a summary of supply and demand for recyclable materials in Texas (see Sections 7.2 and 7.18) • **A material- or industry-specific representative** looking for detailed analysis of material flows and supply-demand relationships for specific material types addressed in the RMDP • **A community recycling program representative** seeking to understand recycling supply and demand relationships in detail for a wide range of material types
8.0 BARRIERS AND OPPORTUNITIES	• Barriers and opportunities for recycling (by commodity) • Infrastructure needs and level of sufficiency of current infrastructure • Prioritization of materials and associated barriers to increased recycling	• **A material or industry-specific representative** looking for a detailed analysis of recycling barriers and opportunities for specific material types addressed in the RMDP • **A community or state recycling program representative** seeking opportunities to improve recycling and insights regarding where to most effectively direct resources
9.0 STRATEGIES FOR STATE AND LOCAL GOVERNMENT	• Description of recycling market development and the approach to determining appropriate recycling market development strategies • Overview of the cross-material and material-specific tools and mechanisms tht address Texas' priority recycling market development barriers • Detailed summaries, case studies, and reference materials for the recommended tools and mechanisms (by priority barriers and material types)	• **Any stakeholder** wanting a better understanding of what recycling market development entails and how to perform recycling market development work (see Sections 9.1 – 9.3) • **A material- or industry-specific representative** seeking information on tools and mechanism to address barriers that limit the recycling of specific material types (see Sections 9.3 – 9.5) • **A community or state recycling program representative** wanting to know what actions can be taken to overcome key recycling system barriers – whether for multiple or specific materials, and examples of such actions that have been successfully implemented (see Sections 9.3 – 9.5)
10.0 RECOMMENDATIONS FOR IMPLEMENTING THE RECYCLING MARKET DEVELOPMENT STRATEGY	• Potential roles of state agencies, Texas universities, Councils of Governments (COGs), local governments, and other entities in implementing the recycling market development strategy • Recommendations pertaining to management and funding of recycling market development	• **Any stakeholder** wanting to review the roles, implementation, and funding recommendations developed for Texas • **A state, regional/COG, or local government representative in Texas** looking for potential roles to play in advancing the recycling market development strategy (see Sections 10.1 – 10.3) • **A Texas legislator** wanting to review implementation and funding options and recommendations (see Sections 10.4 and 10.5)

1 EXECUTIVE SUMMARY

1.1 THE RECYCLING MARKET DEVELOPMENT PLAN OVERVIEW

In 2019, the 86th Texas Legislature passed Senate Bill 649, which directed the Texas Commission on Environmental Quality (TCEQ) to develop a plan to stimulate the use of recycled material feedstocks in processing and manufacturing. This report titled *Recycling Market Development Plan (RMDP)* meets the requirements of the law by building on the efforts of prior Texas statewide recycling studies to:

- Assess the current availability of feedstock recyclable materials in both the public and private sectors in Texas
- Estimate the current economic benefits of recycling materials and the potential economic benefits to be gained by recycling materials that are not being recycled
- Identify potential feedstock consumers of recyclable materials in the public sector, the private sector, or both
- Make recommendations, based on the findings, for institutional, financial, administrative, and physical methods, means, and processes that could be used by state and local governments to stimulate the use of recyclable materials by principal processors and manufacturers
- Develop an education program intended for the public that includes the findings on the quantity of recycling and associated economic impacts; spotlights collectors, processors, and manufacturers of recycled materials; and addresses the detrimental effects of contamination and the need to reduce those effects

1.2 BUILDING ON PRIOR STUDIES

The methodology used to develop the estimates in the RMDP was based on the efforts of prior recycling studies conducted in Texas. The Study on the Economic Impacts of Recycling (SEIR), released in 2017, was conducted by the TCEQ and led under a competitive bidding process by Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell). Burns & McDonnell also led the earlier statewide study, the 2015 Texas Recycling Data Initiative (TRDI) which was developed by the State of Texas Alliance for Recycling (STAR) and conducted in partnership with the Lone Star Chapter of the Solid Waste Association of North America (TxSWANA). The SEIR and TRDI findings each provided a snapshot of recycling activity in Texas and established a methodology for measuring recycling and presenting economic and jobs information. The RMDP builds on this established methodology to provide a 2019 snapshot of recycling activity and provides expanded market analysis and recommendations to stimulate the use of recyclable materials in the State.

1.3 POINTS TO CONSIDER WHEN COMPARING STATEWIDE RECYCLING RATE AND ECONOMIC DATA

Several states report recycling quantities, rates, and economic data, but comparing this information across states is notoriously challenging and can be misleading. Methodologies vary between states and the Project Team employed a conservative approach to the RMDP, this should be kept in mind when reading this Plan or comparing results to other states. Readers should also keep the points in Table 1-1 in mind when comparing the RMDP's recycling measurement and economic impact analysis results to other studies. Table 1-1 was compiled based on the Project Team's experience and research. Specific to the economic impact analysis, the findings are based upon a number of assumptions about employees and payrolls, which relied upon information provided by responsive companies. Since participation in the RMDP survey was voluntary, past or future studies may be based on responses from different participants, which could lead to some variance in the results, even using an identical methodology.

TABLE 1-1: POINTS TO CONSIDER WHEN COMPARING STATEWIDE RECYCLING RATE AND ECONOMIC DATA

Issue	*Recycling Market Development Plan* Approach	Approach for Some Other Statewide Studies
Definition of Recycling	Developed a methodology based on collecting data on municipal solid waste (MSW) and industrial waste as defined in Texas statute. Defined recycling consistent with Texas Health and Safety Code §361.421(8) to include typical recyclables, composting, land application of biosolids/sludge, and pyrolysis of post-use polymers; and to exclude source reduction, energy recovery, and reuse.	Other states may include reuse, energy recovery, certain source reduction activities, other conversion technologies or non-MSW material.
Voluntary or Mandatory	Approach was strictly voluntary.	States that mandate local agencies and certain businesses to submit recycling data may have higher response rates.
Double Counting	Systematically focused on specific points in the material value chain to minimize double counting.	While some states take a similar approach, other approaches may not address double counting.
Addressing Data Gaps/ Extrapolation	Did not extrapolate; employed conservative estimates only in a few key areas where essential to produce consistent results.	States may use any number of approaches to derive estimates where needed to address data gaps.
Accounting for Residuals	Did not count residuals at materials recovery facilities (MRFs) and end-use facilities.	Some states may not account for residuals disposed at MRFs and/or at end-use facilities.
Generators Included	Included all types of MSW generators, such as residential homes, commercial businesses, and institutions.	Some states report only residentially generated material, and some include certain industrial generators.
Counting Certain High-Volume Industrial Materials	Intentionally excluded industrial material from MSW statistics, but separately reported data on industrial streams.	Some states count certain high-volume industrial materials such as metals, pre-consumer paper or plastic manufacturing scrap.

1.4 PROJECT CONTRIBUTORS

Through a competitive bidding process, the TCEQ retained Burns & McDonnell to complete the RMDP. Burns & McDonnell led the prior SEIR and TRDI statewide studies, which benefitted from the strong participation and support from the recycling industry in Texas. This collaborative, voluntary approach to gathering data set the precedent for the RMDP.

The Project Team, led by Burns & McDonnell, has decades of experience addressing solid waste and recycling issues and included contributors from the prior studies (STAR and Boisson Consulting); Circular Matters LLC, a firm specializing in recycling market development; and Bomba & Associates, which specializes in economic modeling. Project Team members included:

- Burns & McDonnell: Scott Pasternak, Debra Kantner, Seth Cunningham, and Robert Craggs
- Circular Matters: Betsy Dorn, Susan Bush, and Tim Buwalda
- STAR: Brittany Rosenberg, Tamara Kowalski, and Jordan Fengel
- Boisson Consulting: Ed Boisson
- Bomba & Associates: Michael Bomba, Ph.D.

The RMDP survey utilized a targeted, voluntary approach to data gathering, and a key aspect to stakeholder involvement was interaction with the Recycling Industry Committee (RIC). The RIC was a diverse group comprised of trade group and governmental representatives that helped with targeted outreach to increase survey participation among respondents in their professional networks. More information on the RIC and a list of participating organizations is found in Section 2.

1.5 METHODOLOGY

Section 2 describes the methodology for recycling estimates developed for the RMDP. The survey methodology followed important guiding principles intended to maximize participation and produce the highest quality results. As was the case with prior statewide studies in Texas, the RMDP survey was a collaborative, voluntary effort and its success depended on input, endorsement, and involvement from a broad range of recycling industry stakeholders. The survey was conducted using the methodology developed in SEIR and TRDI and other regional recycling studies conducted in Texas. The RMDP survey also incorporated feedback from the TCEQ stakeholder meeting held on May 21, 2020. Section 2 describes the many aspects considered when developing the RMDP findings, including:

- Survey administration and outreach
- The definition of recycling
- Materials included in the scope
- How double counting was prevented
- What facilities were targeted for participation
- How data from supplemental sources was used

While Section 2 gives a broad description of the methodology, Section 6 includes more detail regarding the methodology used for the economic analysis portion of the RMDP. For definitions of certain terms used throughout the report, please refer to the definitions in Appendix A.

1.6 RECYCLED TONS AND RECYCLING RATE

Section 3 presents an overview of the recycled material value chain and how it was used for the purpose of the RMDP. The survey results are presented on individual material summaries with an explanation of how the Project Team arrived at the totals for each material type.

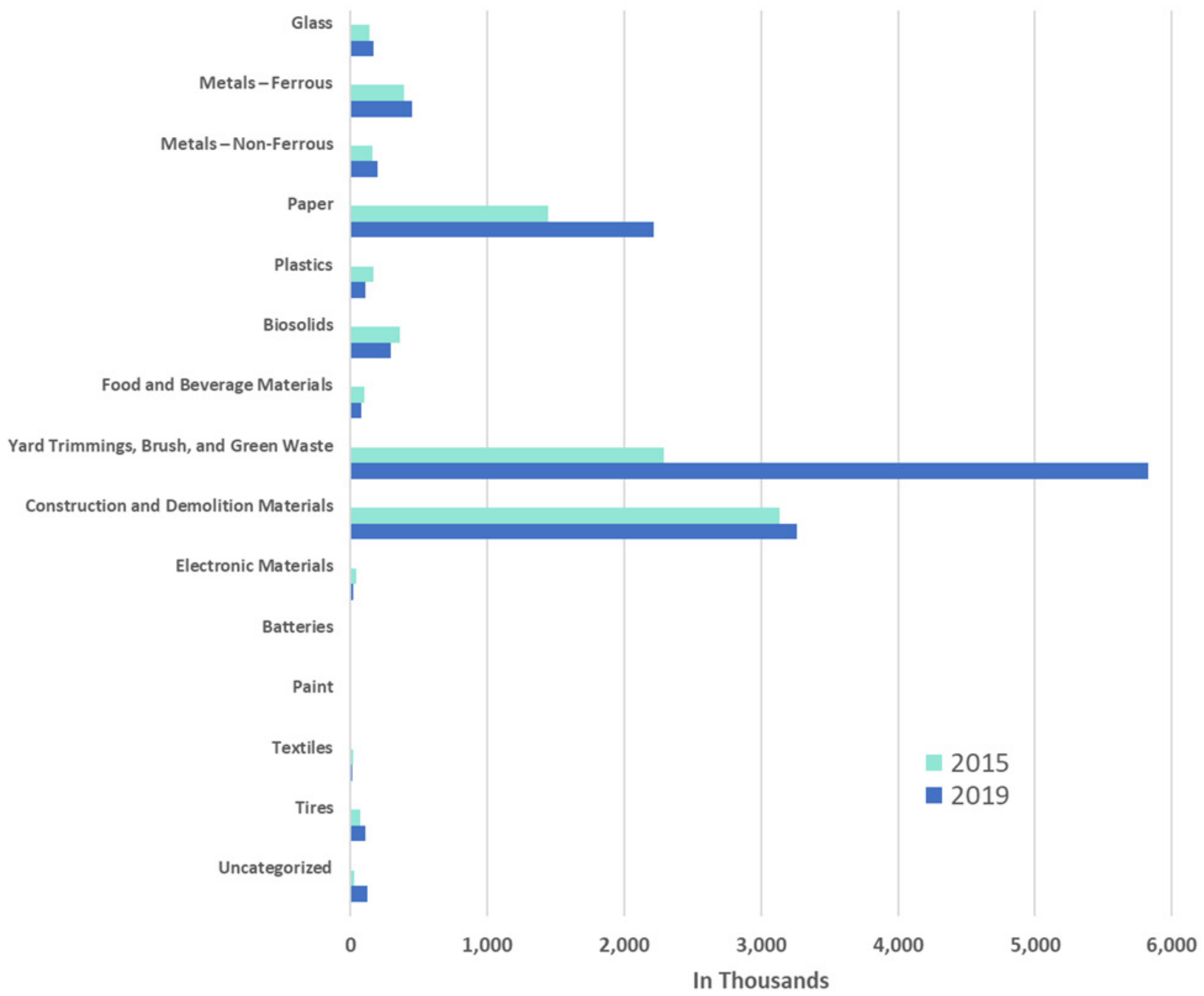
The survey showed approximately 12.9 million tons of recycled Texas MSW material in 2019, which represents an additional 3.7 million tons of recycled MSW in comparison to the 2015 SEIR results. This 12.9 million tons of MSW recycling is based on data collected through the RMDP survey as well as supplemental data received from other sources. The data does not include any extrapolation of tons recycled, but only what was documented through the overall RMDP effort. Table 1-2 and Figure 1-1 provide a comparison between the results from this effort and those from SEIR.

TABLE 1-2: MATERIAL RECYCLED FROM MSW SOURCES (TONS)

Material		2015 SEIR	2019 RMDP
Typical Recyclables	Glass	137,222	165,527
	Metals – Ferrous[1]	386,876	447,207
	Metals – Non-Ferrous[1]	157,709	196,383
	Paper	1,444,632	2,212,562
	Plastics	169,216	107,851
Organic Materials	Biosolids	357,116	296,114
	Food and Beverage Materials	100,470	81,611
	Yard Trimmings, Brush, and Green Waste	2,289,542	5,824,824
Other Materials	Construction and Demolition Materials	3,136,727	3,259,909
	Electronic Materials	42,725	17,546
	Batteries	440	627
	Paint[2]	2,306	3,266
	Textiles	16,507	12,567
	Tires	69,474	109,971
	Uncategorized[3]	27,932	123,031
TOTAL		**9,172,769**[4]	**12,911,034**

1. *The number shown in the table represents the portion of material that is MSW. Quantity includes the portion of recycled MSW metals processed at scrap metal facilities. More information is provided in Section 2.*
2. *Paint was not included as a material category in SEIR. Quantity shown is consistent with the methodology used in RMDP and is based on the 2015 HHW reports gathered and analyzed as part of SEIR.*
3. *Includes all MSW recyclables classified as “Other” by survey respondents. Respondents were required to provide a description. Respondents primarily reported commingled recyclables in 2019.*
4. *Total of material categories included in Table 1-2. Total MSW recycling reported in SEIR (9,171,707 tons) excluded paint and included compact fluorescent lamps (CFLs) and mercury-containing products.*

FIGURE 1-1: MATERIAL RECYCLED FROM MSW SOURCES (TONS)



Section 5 presents the estimated total value of MSW materials recycled in 2019, based on current market values. As shown in Table 5-1, typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and C&D materials accounted for 12.3 million tons of recycling in 2019, with an estimated gross value of $821 million.

The scope of the 2019 RMDP also included recycling from industrial sources (i.e., agriculture and industrial sectors). Information regarding the processing and end use of industrial-sourced material was reported separately from MSW materials in the survey. A total of 6.9 million tons of Texas-generated industrial recycling was identified based on data collected through the RMDP survey as well as supplemental data received from other sources, though the Project Team believes actual industrial recycling quantities are likely higher. Table 5-2 in Section 5 presents the estimated gross value of recycled industrial material, which totaled $1.4 billion in 2019.

An objective of the RMDP was to not only measure recycling in Texas, but to also provide an update to the recycling rate measured during the SEIR study. A recycling rate indicates what percentage of waste generated is recycled and is typically calculated using the following formula:

Total Recycled / (Total Recycled + Total Disposed) = Percent Recycling Rate

To calculate a recycling rate, the Project Team determined the tons of MSW disposed for fiscal year (FY) 2019[1]. It should be noted that the disposal numbers reported by MSW landfills in Texas include non-hazardous industrial waste as well as tons imported from out of state, but the Project Team excluded these amounts from the estimate for FY 2019, which totaled 33,853,678 tons landfilled. An additional 245,672 tons of material was managed through non-landfill disposal (e.g., tire derived fuel), resulting in a total of 34,099,350 tons disposed for FY 2019. The total disposed tonnage used in the recycling rate calculation represented FY 2019 while the total recycled tonnage used represents the calendar year 2019 total. It should also be noted that the recycling rate was based on the recycled tonnages reported in the survey and is, therefore, a conservative estimate. **Based on the tons of recycling reported for the RMDP, the 2019 MSW recycling rate for Texas was 27.5 percent, which is a 4.8 percentage point increase in the recycling rate from the SEIR study, which was 22.7 percent.** The SEIR study accounted for 31,049,545 tons of landfilled MSW, which suggests that the landfill disposal rate increased by 9.0 percent from 2015 to 2019. While not evaluated in detail for the RMDP, this increase in disposal tonnages may be attributed to the growing population and growing economy in Texas.

1.7 ESTIMATED AMOUNT AND VALUE OF RECYCLABLE MATERIALS THAT COULD BE RECYCLED, BUT ARE DISPOSED

Each year recyclable materials are disposed in MSW landfills. Section 4 estimates the composition of recyclable materials generated and disposed in Texas, followed by an estimate of the quantity and value of recyclable materials disposed in Section 5.

In 2019, an estimated 36,536,957 tons of solid waste[2], including recyclable material, was generated in the State and subsequently disposed in Texas MSW landfills. MSW and C&D materials accounted for most of the material; 23.4 million and 7.8 million tons, respectively. Based on multiple composition studies, the Project Team estimated the quantities of materials that were disposed but could have been recycled. In the analysis included in Section 4, there were 12,321,295 tons of MSW, 3,319,066 tons of C&D materials, and 359,183 tons of other waste that could have been recycled but were disposed. This total of 15,999,544 tons equals 43.8 percent of the total tons disposed in MSW landfills in Texas. Of this material, typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and C&D materials accounted for 15.4 million tons, with an estimated gross value of approximately $2.0 billion (see Table 5-3 in Section 5).

Table 4-6 in Section 4 presents the estimated tonnage of material disposed that could be recycled and an estimate of the percentage of the materials by category that could have been recycled, recognizing that not all material could be diverted. The Project Team provided a range based on recycling 20, 40, and 60 percent of the disposed material. Even though a material can be recycled, the Project Team used a range to recognize that it may be impracticable (from a cost and/or environmental perspective) for all of a material to be recycled due to lack of recycling infrastructure, contamination of recyclable materials, access to end markets, and need for additional public education and outreach.

1.8 ECONOMIC IMPACTS OF RECYCLING

The act of recycling incorporates a broad range of activities that have a positive impact on the Texas economy. After a consumer uses and discards a recyclable material, it is collected, sorted, processed, and sold to end markets. All of this is done with the intent of preparing it for use as a future feedstock for manufacturing. When recyclable materials are sufficiently processed to be used as feedstock, they are then transported from the processor to a manufacturer. The manufacturer, in turn, either feeds the recyclable material directly into the manufacturing process, further processes it before use, or mixes the recyclable material with virgin material before manufacturing. During each stage of this recycling process, from collection to manufacturing, economic activity is being generated in the form of employment, workers' wages, and public revenue that benefit the Texas economy.

Section 6 estimates the statewide economic, employment, and fiscal impacts that are derived from recycling MSW. This section demonstrates that the recycling of MSW creates economic benefits for the Texas economy, with nearly 23,000 person-years of direct, indirect, and induced employment supported

[1] While landfill data was provided on a fiscal year basis, the recycling data requested for the RMDP survey was primarily provided on a calendar year basis in order to streamline the reporting process for respondents.
[2] This 36,536,957 tons includes non-MSW materials (e.g., non-hazardous industrial waste) deposited in MSW landfills

during 2019, as shown in Table 1-3. This is similar in size to the state's petroleum refining industry (22,976 workers) and its furniture manufacturing industry (23,399 workers). The overall impact of recycling MSW on the Texas economy exceeded $4.8 billion. Collection activities generated the largest employment impacts, followed closely by processing facilities (including composting facilities). The recycling industry was also responsible for generating $166.1 million of revenue for state and local governments in 2019, through sales taxes, property taxes, and other taxes and fees. Expanding recycling activities has the potential to generate greater economic impact and public revenue; although, these benefits may not be experienced uniformly throughout the State, due to local conditions that affect operating costs. Lastly, another potential benefit from the recycling of MSW is the siting of manufacturing facilities near the source of recycled feedstocks. Texas manufacturers that use recycled feedstocks supported 8,967 person-years of employment during 2019.

TABLE 1-3: SUMMARY OF TOTAL ECONOMIC IMPACT OF THE RECYCLING INDUSTRY ON THE TEXAS ECONOMY

Measure	Direct	Indirect	Induced	Total
Employment	10,688	6,651	5,571	**22,910**
Labor Income	$530,138,619	$438,691,364	$291,138,384	**$1,259,968,367**
Value Added	$1,168,883,317	$670,826,952	$505,151,582	**$2,344,861,851**
Output	$2,675,693,086	$1,253,442,126	$899,740,454	**$4,828,875,666**

1.9 EVALUATING SUPPLY AND DEMAND OF RECYCLABLE MATERIAL FEEDSTOCKS

Section 7 describes key market trends for recyclable material feedstocks and commodities. This section also summarizes the supply and demand analysis for each material based on the findings from the RMDP survey and supplemental state, regional, and national datasets. The relationship between the supply of recyclable material and the demand for recycled material feedstock for manufacturing and end use is important to understand and consider when implementing recycling market development strategies. The relationship between supply and demand of a recovered material can vary significantly from region to region within the State, depending upon market factors and infrastructure capacity. Table 7-20 provides a summary of material supply relative to demand in Texas and indicates the materials/commodities for which improved collection, processing, and/or end market demand could stimulate increased use of Texas-generated recyclable material feedstocks. In some cases, a material may have strong markets, despite the demand for that material being from out-of-state markets (e.g., aluminum). In other cases, a material is not being recovered fully, but has ample processing capacity within the State (e.g., electronics) and therefore increased recovery of that material could result in economic gains for Texas businesses. There are other cases where increased recovery of a material could lead to expanded recycling markets, whether new markets or growth for existing (e.g., glass, paint, tires, textiles); however, the infrastructure would not expand until the supply were available.

1.10 GRANTS AND OTHER FUNDING SOURCES

Effective recycling market development entails the use of tools and mechanisms strategically aimed at overcoming barriers impeding the movement of recyclable materials into viable end markets. Section 8 presents an analysis of barriers, opportunities, and infrastructure needs to stimulate the increased use of recyclable material feedstocks. Barriers and opportunities to expanding markets for recovered materials in Texas were identified through the RMDP survey and stakeholder feedback including at four virtual forums held October 27 – 29, 2020.[3] Contamination/low material quality was the most commonly cited barrier to expanding recycling business in the State. Material quality is of paramount importance to effectively moving recycled materials into viable recycling and end use markets. Contamination increases processing costs and creates safety risks for recycling industry workers.

To prioritize the materials and barriers targeted for recycling market development efforts, the Project Team looked holistically at several factors that could impact the outcome for Texas, including diversion potential,

[3] The results of the stakeholder forums are documented in Appendix D.

Tables 8-9 and 8-10 present the results of the prioritization and the associated primary barriers for each material category or commodity. While benefits and opportunities to increase recycling exist for all materials considered in the RMDP, the highest identified priorities are addressing barriers related to typical/curbside recyclables, plastic film, plastics #3-7, food waste, tires, and textiles.

1.11 RECYCLING MARKET DEVELOPMENT TOOLS AND MECHANISMS

When designing recycling market development strategies, a variety of program and policy tools and mechanisms are available across five categories: information, facilitation, and technical assistance; preferential procurement; financial assistance; financial and other incentives/disincentives; and policies. Section 9 presents a detailed summary of the various tools and mechanisms that could be implemented by state and local governments to address barriers affecting high and medium priority materials. The provided summaries include examples and case studies from other states that have experienced success using the proposed tools and mechanisms. Section 9.6 presents the key programs of work for Texas, one for each of the five categories of market development mechanisms, developed based on the identification of the appropriate tools and mechanisms to overcome priority barriers in urban and rural communities.

1.12 TEXAS RECYCLING MARKET DEVELOPMENT STRATEGY

The RMDP's approach to achieving recycling market development is two-pronged in nature. The first prong is a set of general (cross-material) strategies that expand the State's capacity to promote recycling market development. Cross-material strategies seek to establish tools and resources that can capitalize on market development opportunities benefitting a wide range of materials. The second prong is a set of material-specific strategies which seek to capitalize on opportunities benefitting individual priority materials. The recommended recycling market development strategy for Texas is based on the key programs of work identified in Section 9.

Section 10 presents the recommended recycling market development strategy for Texas, including the identified potential roles of state agencies, Texas universities, regional Councils of Governments (COGs), local governments, and other entities – both in state and beyond. These roles are based on the selection of appropriate tools and mechanisms for each entity, consideration of agencies' respective missions, programs and activities, and past and current roles in recycling market development.

In addition to selecting appropriate tools and mechanisms, it is also important to ensure that efforts to strengthen recycling market development are managed properly. Section 10.5 outlines six principles for recycling market development management and provides the following recommendations:

1. Establish a Texas Recycling Market Development Center (TxRMDC) with the recommended location being within one of the state universities – possibly set up as a 501(c)(3) affiliate.
2. Appoint a Recycling Market Development Board to assist with coordinating multi-organizational efforts and to provide guidance to the TxRMDC.
3. Engage the private sector in the recycling market development process to save scarce state resources and personnel and help ensure that solutions are realistic. This could be achieved by having a balance of industry representatives on the recycling market development board in addition to collaborating/partnering directly with some of the many organizations identified in Section 10.3.
4. Fund at least two full-time positions to initially staff the TxRMDC. One of the advantages to housing the TxRMDC within a Texas university is to have access to multiple other human and organizational resources as well as student interns to assist with program and project execution.
5. Improve market intelligence, such as through the Comptroller's Statewide Procurement Division and each state agency more accurately tracking the quantity of recycled-content materials purchased/used and recycled-content products made in Texas.
6. Obtain key information from processors and manufacturers in the State such as whether they have been able to increase the quantity of recovered material they process/consume from within Texas; their perspectives regarding whether barriers to using recovered materials are being adequately addressed; and whether resources should be redirected to better fit the needs of state businesses.

Funding is a key consideration in the implementation of recycling market development strategies, as strengthening markets for recovered materials in Texas will require investing in infrastructure, education and outreach, innovation, and more. Investment in recycling market development has broad support of a wide range of industry and government stakeholders as evidenced by those who rallied in support of passage of the legislation authorizing the development of this recycling market development plan. The potential economic and environmental benefits that can be gained by this investment are substantial and serve to benefit all Texans as time progresses. Section 10.5 describes the recommended funding approach, a shared responsibility "portfolio" approach that involves the use of multiple funding mechanisms. Potential means of funding within the "portfolio" include:

1. Instituting pay-as-you-throw (PAYT) user fee systems at the local level
2. Establishing public-private partnerships and pursuing available grant funding
3. Establishing advance recycling fees for selected materials
4. Increasing state disposal fee
5. Establishing one or more industry funding mechanisms
6. Investigating passage of beverage container deposit legislation

2 METHODOLOGY

The RMDP methodology followed important guiding principles intended to maximize participation and produce the highest quality results for the most recent recycling measurement effort in Texas. The RMDP survey was conducted using the methodology developed in studies such as the SEIR and TRDI and other regional recycling studies conducted in Texas. The RMDP also incorporated feedback from the project stakeholder meeting held on May 21, 2020. While this section provides a broad description of the methodology, Section 6 gives more detail regarding the methodology used for the economic analysis portion of the RMDP.

2.1 CONFIDENTIALITY PLAN

A confidentiality plan protects the proprietary nature of individual responses. A copy of the confidentiality plan can be found in Appendix B.

2.2 STAKEHOLDER INVOLVEMENT

The RMDP utilized a targeted, voluntary approach to data gathering, and its success depended on input, endorsement, and involvement from a broad range of recycling industry stakeholders and other industry representatives. The Project Team coordinated with TCEQ to facilitate external communications and stakeholder input during the project. A key aspect to stakeholder involvement was interaction with the Recycling Industry Committee.

Recycling Industry Committee

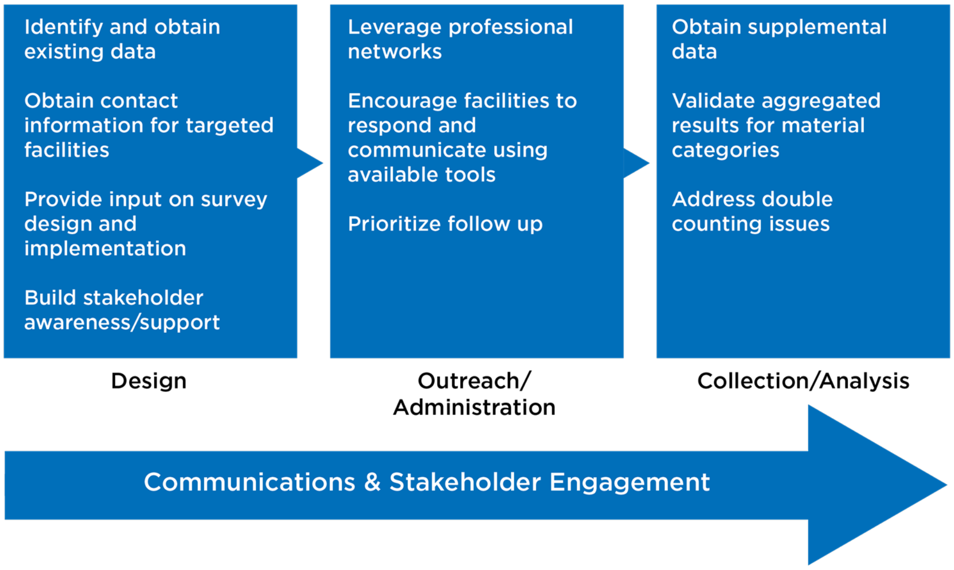
The Recycling Industry Committee (RIC) was a diverse consortium of governmental and trade group representatives working with the Project Team and TCEQ to help with targeted outreach to increase survey participation among respondents in their professional networks. The RIC was comprised of a select group of representatives and their respective organizations who participated on the TRDI Steering Committee, as well as new representatives. The purpose of the RIC was to (1) assist with efforts to communicate the survey launch and the importance of its completion and (2) serve as subject matter experts for the Project Team regarding questions about the survey results. RIC membership included the following:

- Aluminum Association
- American Beverage Association
- American Forest & Paper Association (AF&PA)
- AMERIPEN
- Carton Council
- Construction & Demolition Recycling Association (CDRA)
- Environmental Protection Agency (EPA) Region 6
- Glass Packaging Institute (GPI)
- Governor's Office of Economic Development and Tourism
- Institute of Scrap Recycling Industries - Gulf Coast Chapter (ISRI)
- ISRI Tires/Rubber Division
- Keep Texas Recycling (KTR)
- National Association for PET Container Resources (NAPCOR)
- National Waste & Recycling Association - TX Chapter (NWRA)
- North American Hazardous Materials Management Association (NAHMMA)
- Plastics Industry Association
- Solid Waste Association of North American - Lone Star Chapter (TxSWANA)
- State of Texas Alliance for Recycling (STAR) Business Council
- STAR Texas Compost Council
- TCEQ Municipal Solid Waste Management and Resource Recovery Council (MSWRRAC)
- Texas Association of Business (TAB)
- Texas Association of Manufacturers (TAM)
- Texas Association of Regional Councils (TARC)
- Texas Chemical Council (TCC)
- Texas Retailers Association (TRA)
- The Association of Plastic Recyclers
- The Recycling Partnership
- Office of Representative Ed Thompson (ex-officio)
- Office of Senator Judith Zaffirini (ex-officio)

2.3 SURVEY APPROACH

As was the case with SEIR, the RMDP survey was a collaborative effort and its success depended on input, endorsement, and involvement from a broad range of recycling industry stakeholders. Figure 2-1 summarizes the approach for the survey:

FIGURE 2-1: SURVEY APPROACH



The RMDP measured the quantity of materials generated in Texas that are ultimately recycled, whether inside or outside of Texas. While some recyclables may be exported to processing facilities in neighboring states, most Texas-generated recyclables are processed at facilities within the State. The survey also asked respondents to identify the percentage of their processed material that was imported from outside of Texas. To minimize double counting and to streamline the survey, generators and collectors/transporters were not surveyed. Section 3.1 provides further detail on the recycled material value chain.

An important step in the data gathering process was to identify the recycling facilities/firms to survey. To a large extent, the specific entities to be surveyed were identified in the database Burns & McDonnell developed while completing the prior SEIR and TRDI statewide recycling studies. The Project Team updated this database to include new facilities that started operations since the SEIR survey and to include additional processing and end use facilities handling recyclables from industrial sources.[1] The Project Team specifically completed this update by reviewing TCEQ information and third-party sources that publish lists of recycling facilities. Additionally, the Project Team requested that RIC members identify any new facilities.

Survey Design

The Project Team collaborated with TCEQ to refine and expand the survey instrument that was utilized during the SEIR process. This approach allowed the Project Team to build on the efforts from SEIR while also addressing the additional information required for the RMDP by Senate Bill 649 (SB 649). Please refer to the "What Materials were Included?" portion of this section for the material types included in the RMDP. Additionally, the survey included questions on a range of economic issues (e.g. number of jobs, annual receipts, annual payroll), as well as the material cost, value, and quality of recycling materials and ideas to increase recycling via new markets and key market trends.

[1] Per SB 649, the RMDP also includes processors and end users of MSW (residential and commercial) and industrial recyclables. These facilities were not included in the SEIR or TRDI survey efforts.

Survey Outreach

A variety of communication methods, including group email lists, organizational newsletters, press releases, phone calls, and webinar presentations were used by the Project Team to promote the RMDP survey. The purpose of the external outreach was to:

- Communicate information regarding the survey and the purpose of the project among recycling stakeholders
- Leverage professional networks to communicate information about the project
- Encourage facilities to respond to the survey
- Secure buy-in on the confidentiality plan and support in communicating it to potential respondents

Key outreach efforts included the following:

- Individual RIC members communicated within their professional networks to increase awareness about the survey and encourage members of their respective organizations to respond.
- Presentations were given at TCEQ MSWRRAC meetings, STAR Business Council meetings and Houston-Galveston Area Council meetings. Presentation opportunities were limited compared to SIER due to the coronavirus pandemic during the survey outreach period (April – August 2020).
- Since the survey was conducted during the coronavirus pandemic, the Project Team placed a much greater emphasis on contacting entities via phone calls and email, as compared to in-person meetings or discussing the survey at conferences or other recycling events. While multiple entities experienced challenges with participation due to the coronavirus pandemic, the Project Team was able to secure responses from many entities.
- Traditional media outlets were used to enhance communication and outreach efforts. A press release was distributed to several online and print journals, television, radio, and newspaper outlets throughout Texas and nationally. Social media networks were also used to promote the survey at key points during its administration.

Administration and Follow-Up

The survey was developed using the Re-TRAC Connect™ online platform, and the Project Team distributed the link to the survey via email.[2] All targeted respondents with valid email addresses received an initial survey notice, including the survey link, during the week of June 1, 2020. Many more respondents received emails after they were obtained as part of telephone outreach. The survey deadline was August 31, 2020. During the 13-week survey period, potential respondents received at least three follow-up communications, by phone and/or email.

In order to facilitate open lines of communication with potential respondents, the Project Team maintained a dedicated phone number and email address for the RMDP survey and had staff available to respond to inquiries Monday through Friday during business hours. In addition, representatives from Emerge Knowledge were available to provide technical support.

The Project Team also hosted a free, informational webinar on the Microsoft Teams platform on June 16, 2020 to engage and educate potential survey respondents about the survey. In certain cases, respondents expressed unwillingness or inability to log into Re-TRAC Connect to complete the survey. In those cases, Project Team members collected data over the phone or via a brief email questionnaire. When respondents submitted surveys, a lead Project Team member reviewed each submitted survey to verify and ask for clarification as needed on any reported information.

Additionally, several landfills, transfer stations, and processors were identified in TCEQ's annual municipal solid waste reports and facility lists. The Project Team reviewed submitted information and prior contacts with these facilities to determine whether the data reported could be included in the RMDP.

What is Recycling?

The RMDP scope for recyclable materials was defined by SB 649 to include "paper, plastic, metal, glass, vegetative waste, compost, mulch, tires, electronic waste, construction and demolition debris, batteries,

[2] Re-TRAC Connect is a waste reduction and recycling measurement system used by the public sector, developed by Emerge Knowledge Design Inc.

and paint," and includes materials from both postconsumer and postindustrial sources. The RMDP used a meaning of "recycling" as defined in Texas Health and Safety Code Section 361.421(8), which is a "process by which materials that have served their intended use or are scrapped, discarded, used, surplus, or obsolete are collected, separated, or processed and returned to use in the form of raw materials in the production of new products. Recycling includes:

(A) the composting process if the compost material is put to beneficial reuse as defined by the commission;

(B) the application to land, as organic fertilizer, of processed sludge or biosolids from municipal wastewater treatment plants and other organic matter resulting from poultry, dairy, livestock, or other agricultural operations; and

(C) the conversion of post-use polymers and recoverable feedstocks through pyrolysis or gasification."

The SB 649 legislation excluded "ferrous or nonferrous metals recycled by a metal recycling entity as defined by Section 1956.001, Occupations Code" from the list of recyclable materials to be addressed in the RMDP. To understand the legislative intent of this exemption, the Project Team spoke with scrap metal processors and state and national Institute for Scrap Recycling Industries (ISRI) representatives. The Project Team decided to include metal recycling in the RMDP statewide recycling estimates for comparability to prior statewide recycling results (i.e., SEIR, TRDI). However, consistent with the scrap metal facility exemption in SB 649 and to reflect the strong nature of existing recycling markets, scrap metals recycling was excluded from the market development recommendations.

The RMDP did not cover other effective and commonly used methods to divert material from disposal, such as:

- Source reduction activities like purchasing products with less packaging or home composting
- Refurbishment or reuse of products for the originally intended use, such as consumer electronics or clothing
- Conversion or combustion of materials to fuel or energy
- Land reclamation or beneficial use projects using tire shreds or bales
- Disposal or on-site use of material at a landfill for road stabilization or alternative daily cover

What Materials Were Included?

The survey asked respondents to report on multiple types of materials that, if not recycled, would have been considered waste. Respondents were asked to report MSW and industrial quantities separately, based on the following definitions:

- **MSW:** According to Title 30, Texas Administrative Code, Chapter 330, material is considered MSW if it results from or is incidental to municipal, community, commercial, institutional, and recreational activities. MSW includes all other solid waste other than industrial solid waste.[3] Retailers, schools, hospitals, single-family homes, apartment buildings, public parks, and sports complexes are all examples of MSW generators.
- **Industrial:** According to Title 30, Texas Administrative Code, Chapter 335, material is considered industrial waste if it results from or incidental to any process of industry or manufacturing, or mining or agricultural operation.[4] Factories and farms (e.g., produce, livestock) are examples of industrial waste generators.

The survey asked respondents to omit material that is refurbished, reused, combusted or properly disposed in their reported recycling volumes. The survey also asked respondents to omit materials that were generated as process waste and directly recycled into production.

In addition, the survey asked the respondents for their percentage of incoming material tonnage that is ultimately disposed as residue (contamination rate) and the percentage of incoming recycled material tonnage that is ultimately used to produce new products (yield rate). This information was collected to assist in the evaluation of the quality of the materials being processed, as discussed in Section 3.

[3] 30 TAC, Chapter 330, Subchapter A
[4] 30 TAC, Chapter 335, Subchapter A

The survey requested information on broad, straightforward material categories, including some material subgrades. Table 2-1 lists the material categories for the survey. For definitions of these material categories, please refer to Appendix A.

TABLE 2-1: MATERIAL CATEGORIES

Typical Recyclables	Organic Materials	Other Materials
Glass (Containers, Other Glass) **Metals** (Ferrous, Non-Ferrous) **Paper** (Mixed, Old Corrugated Containers, Sorted Office Paper, Other Paper) **Plastics** (PET #1, HDPE #2, Plastics #3-7, Plastic Film/Bags, Other Plastic)	Biosolids (i.e. sludge) Food and Beverage Materials Yard Trimmings, Brush and Green Waste Other Organics	Construction and Demolition (C&D) Materials Electronic Materials Batteries Paint Textiles Tires Other (respondent must specify)

What Facilities Participated?

The survey asked respondents to identify whether their facility is a processor and/or an end user of recyclable material. The survey also asked respondents to identify the types of processing and end-use activities that occur at their facility, selecting from the processing activities and end-use activities listed in Table 2-2. In some cases, facilities reported more than one processing or end-use activity. For definitions of these recycling activities, please refer to Appendix A.

TABLE 2-2: RECYCLING ACTIVITIES

Processing Activities	End-Use Activities
C&D Debris Processing Electronics Processing Household Hazardous Waste Collection Material Recovery Scrap Metal Processing Textile Processing Tire Processing Other Processing	Compost/Mulch Production Anaerobic Digestion Glass Beneficiation Glass Containers Manufacture Fiberglass Manufacture Plastics Reclamation Plastics Product Manufacture Pulp, Paper, or Paperboard Secondary Metals Smelter, Melter or Product Fabrication Textiles End-Use Construction & Demolition Debris End-Use Recycled Tire Product Manufacture/End-Use Chemical Recycling Other Product Manufacturer Other End-Use

How Was Double Counting Prevented?

With any effort to collect recycling information, it is critical to avoid double counting material. Double counting can occur when material flows from one respondent to another and is reported by multiple entities. The Project Team employed the following rigorous process to eliminate double counting:

- **Confirmed understanding of the flow of materials in Texas.** The Project Team included staff familiar with recycling markets who, during the stakeholder engagement process, confirmed their understanding of Texas-specific flows for each material included in the survey.
- **Focused analysis on select points in the recycling value chain.** Understanding the flow of materials allowed the Project Team to pinpoint specific facility types in the recycling value chain for each material. For instance, to collect data on recycled paper, the Project Team targeted material recovery facilities (MRFs), as well as paper mills, suppliers, and brokers to capture material that does not go through MRFs (i.e. direct-to-mill material). The Project Team focused on large, commercial MRFs rather than smaller, local MRFs because the recycled materials from the smaller MRFs are generally shipped to other processors and end users, so their volumes were largely accounted for in the results from those facilities.
- **Asked respondents to report material shipped to other Texas-based processors rather than an end user.** If a respondent indicated that they shipped material to other processors, the survey required the respondent to list the processors. After the close of data collection, the Project Team conducted a comprehensive double-counting review using this information and removed all material that was reported by multiple entities.

What Was the Reporting Period?

The survey asked respondents to provide data for January 1 through December 31, 2019. If data for this reporting period was not available for a particular facility, respondents provided data for an alternate 12-month period. Some respondents provided data for the State's fiscal year of September 1, 2018, through August 31, 2019[5] (FY 2019). Disposal data was provided on the State fiscal year basis.

How Were Imports and Exports Considered?

The intent of the survey was to capture recycled materials generated in Texas. To account for material generated in Texas that is transported outside of Texas for processing or end use (i.e., exported), the Project Team identified key facilities outside of Texas to include in the survey. These facilities are primarily in surrounding states, including Oklahoma, Arkansas, and Louisiana, plus a small number of facilities in other states. The Project Team did not target facilities outside of the United States to participate in the survey.

To account for material generated outside of Texas that is transported to Texas for processing or end use (i.e., imported), the Project Team asked respondents to indicate on the survey the percentage of reported materials generated outside of Texas. These materials were excluded from the survey data. Disposal facility data included separate reporting of in-state and out-of-state generated tons, allowing the Project Team to account for imports from other states or countries.

What Were the Reporting Units?

In completing the survey, respondents could select from the following available reporting units: tons (preferred), pounds, compacted cubic yards, uncompacted cubic yards, gallons, tires, or other (must specify). The Project Team converted all reported units to tons.

2.4 IDENTIFYING TARGETED FACILITIES

TCEQ and the Project Team gathered information from a variety of sources to compile the list of facilities targeted for the survey. Primary sources included Burns & McDonnell's database from SEIR, as well as composting, recycling, and other processing facility databases from TCEQ.

Certain recycling facilities are not required to obtain a permit or registration but must only provide notification of intent to operate a recycling or composting facility. TCEQ provided a list of these facilities to include in the survey.

[5] Fiscal year data responses were considered representative of a full year of data and used in their entirety.

It is important to note that, while TCEQ maintains records of permitted and registered recycling facilities and requires certain facilities to submit notification, these records cannot be considered a comprehensive list of recycling facilities in Texas. There are factors that allow certain facilities to be exempt from permitting, registration, and notification. To compile a comprehensive list of targeted facilities, as well as to obtain contact information for facilities identified through regulatory sources, the Project Team relied on industry experience, the RIC, and the supplementary sources of data described below.

Data from Supplemental Sources

Rather than "reinvent the wheel," the Project Team utilized data from specific supplemental sources. Data from the U.S. EPA and the ISRI were used as well as the sources identified in Table 2-3.

TABLE 2-3: SUPPLEMENTAL DATA SOURCES

Material	Data Source
Biosolids	TCEQ annual reports for Class B biosolids and water treatment plant sludge
Diverted Material – MSW Landfills	TCEQ annual reports for material diverted at landfills. The Project Team focused on landfills that reported more than 100 tons of diverted material.
Diverted Material – MSW Processors	TCEQ annual reports for material diverted at transfer facilities and other processors. The Project Team focused on facilities that reported more than 100 tons of diverted material.
Paper	American Forest and Paper Association
Plastics	Association of Postconsumer Plastic Recyclers, National Association for PET Container Resources
Glass	Glass Packaging Institute
Ferrous and Non-Ferrous Metals	Institute of Scrap Recycling Industries (ISRI), U.S. Geological Survey
Electronics	Texas Recycles Computer Program, Texas Recycles TVs Program, TCEQ annual HHW reports
Paint	TCEQ annual HHW reports
Batteries	TCEQ annual HHW reports, Call2Recycle
Tires	TCEQ Scrap Tire Annual Report

3 RECYCLED TONS AND RECYCLING RATE

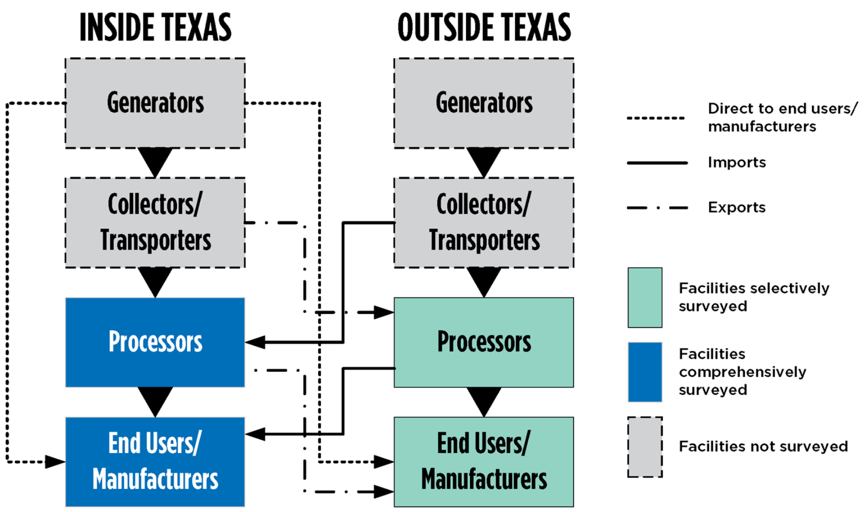
This section presents an overview of the recycled material value chain and how it was used for the purpose of developing estimates used in the RMDP. The survey results are presented separately for MSW (with individual material summaries) and industrial materials, with an explanation of how the Project Team arrived at these totals.

The survey showed approximately 19.8 million tons of recycled Texas material in 2019, comprised of 12.9 million tons of MSW recyclables detailed in Sections 3.2 through 3.6 and 6.9 million tons of industrial recyclables (discussed separately in Section 3.7). MSW recycling results represent an increase of 3.7 million tons of recycled MSW in comparison to the 2015 SEIR results. The 19.8 million Texas-recycled tons are based on data collected through the RMDP survey as well as supplemental data received from other sources. The data does not include any extrapolation of tons recycled, but only what was documented through the overall RMDP effort. Section 3.4 provides a detailed comparison between the results from this RMDP and the SEIR survey.

3.1 RECYCLED MATERIAL VALUE CHAIN

Figure 3-1 is a conceptual illustration of the recycled material flows analyzed for the RMDP based on prior surveys and describes the approach and anticipated degree of surveying with each point in the recycled material value chain. This approach was used for both postconsumer and postindustrial sources.

FIGURE 3-1: RECYCLED MATERIAL CHAIN



The Project Team's intent was to measure the quantity of material generated in Texas that ultimately was recycled, whether inside or outside of Texas. To measure these quantities, the survey focused primarily on Texas-based processors and end users/manufacturers. In addition, the Project Team collected data on recycled household hazardous waste (HHW) from HHW collection facilities. Last, the Project Team identified key out-of-state processors and end users to participate in the survey to capture data for material transported out of Texas that would have otherwise been missed.

Generators

Generators of MSW recyclables include residential homes (such as single-family dwellings and apartment buildings), commercial (businesses such as restaurants, office parks, and retail stores), and institutions (such as hospitals, universities, and government facilities). Generators of industrial recyclables include manufacturing, mining, and agricultural operations. As indicated in Figure 3.1, generators were not surveyed for the RMDP. In addition, as discussed in Section 2.3, a goal of the RMDP was to collect data on materials that, if not recycled, would have been considered MSW or industrial waste.

Collectors/Transporters

The recycling industry in Texas has a dynamic collection infrastructure that includes hundreds of private and public enterprises providing collection and transport services, such as residential recyclables from municipal curbside and drop-off recycling programs, paper from office buildings, and metals from auto shops and commercial facilities. It also includes large retailers and grocery stores that bale material, mostly cardboard, and transport it directly to end users. For efficiency and to prevent double counting in measuring Texas recycling, the Project Team primarily focused on gathering data from processors, not collectors/transporters.

Texas-Based Processors

As reflected in Figure 3-1, Texas-based processors were a key focus of the RMDP survey effort. Processors of recyclables (such as MRFs, C&D MRFs, electronics processing facilities, textile processing facilities, and tire processing facilities) focus on disassembling, sorting, shredding, baling and/or otherwise preparing recycled materials to be sold to end users. While some recyclables may be exported to processing facilities in neighboring states, the majority of Texas-generated recyclables are shipped to facilities within the State. In an effort to focus on material generated in Texas, the survey asked respondents to identify the percentage of their processed material that was imported from outside of Texas. Any material originating from outside of the State were excluded from the reported results.

MRFs processing typical recyclables — glass, metals, paper, and plastic — were a significant source of data for the RMDP. The Project Team identified and targeted 31 MRFs to participate in the survey. These facilities process large quantities of material through long-term processing agreements with municipalities as well as commercial accounts. Of these 31 MRFs, 30 responded to the survey. The one unresponsive facility is believed to be smaller than the MRFs that responded to the survey. Therefore, this report includes data for almost all the MRF tonnage in Texas. Section 3.6 provides a detailed analysis of RMDP results for materials processed through MRFs.

Texas-Based End Users

Although large quantities of Texas-generated recyclables are shipped to other states or countries for use in manufacturing, the State is home to several end users that consume recycled feedstocks to make new products. There are two glass container manufacturing plants and three fiberglass insulation plants. Other end users include: five paper or paperboard mills, three cellulose product manufacturers, five steel mills, several small foundries and smelters consuming ferrous or non-ferrous scrap metal, and a variety of plastics converters.

Texas is also home to two glass beneficiation facilities, several plastics reclamation facilities, and a large number of compost and mulch production facilities that were considered recycled material end users for the RMDP. These three categories are sometimes classified as processors in recycling studies but were defined as end users in the survey because it helped to simplify responses in the online form. End users were included in the survey primarily to capture material that does not flow through a primary processing facility but is received directly from generators. In some cases, end-user responses also helped to validate recycling quantities based on processor responses alone.

Out-of-State Processors

A relatively small quantity of material that is generated in Texas is transported outside of Texas to be processed. Therefore, the Project Team, in coordination with stakeholders, identified key out-of-state processing facilities to participate in the survey.

Out-of-State End Users

There are several key end users outside of Texas that source recyclables generated in Texas. Therefore, the Project Team, in coordination with stakeholders, identified key out-of-state end users and manufacturers to participate in the survey.

3.2 MSW RECYCLING RATE

An objective of the RMDP was to not only measure recycling in Texas, but to also provide an update to the recycling rate measured during the SEIR study. A recycling rate indicates what percentage of waste generated is recycled and is typically calculated using the following formula:

Total Recycled / (Total Recycled + Total Disposed) = Percent Recycling Rate

To calculate a recycling rate, the Project Team determined the tons of MSW disposed for FY 2019.[1] It should be noted that the disposal numbers reported by MSW landfills in Texas include non-hazardous industrial waste as well as tons imported from out of state, but the Project Team excluded these amounts from the estimate for FY 2019, which totaled 33,853,678 tons landfilled. An additional 245,672 tons of materials were managed through non-landfill disposal (e.g., tire derived fuel), resulting in a total of 34,099,350 tons disposed for FY 2019. The total disposed tonnage used in the recycling rate calculation represented FY 2019 while the total recycled tonnage used represents the calendar year 2019 total. It should also be noted that the recycling rate was based on the recycled tonnages reported in the survey and is, therefore, a conservative estimate. **Based on the tons of recycling reported for the RMDP, the 2019 MSW recycling rate for Texas was 27.5 percent, which is a 4.8 percentage point increase in the recycling rate from the SEIR study, which was 22.7 percent.** The SEIR study accounted for 31,049,545 tons of landfilled MSW, which suggests that the landfill disposal rate increased by 9.0 percent from 2015 to 2019. While not evaluated in detail for the RMDP, this increase in disposal tonnages may be attributed to the growing population and growing economy in Texas.[2]

In evaluating the recycling rate, it is important to note that a number of other states report recycling quantities and rates but comparing this information across states is notoriously challenging and can be misleading. Table 1-1 in the Executive Summary identifies multiple points to consider when seeking to understand the reported recycling rate for Texas and when making comparisons to other states or national numbers provided by U.S. EPA. Key points to consider include the varying definitions of recycling, whether a survey is voluntary or mandatory, addressing double counting, addressing data gaps/extrapolation, accounting for residuals, including generators, and counting industrial materials. For each of these points, the RMDP erred on the side of being conservative, which likely means that this reported recycling rate for Texas is understated.

3.3 MATERIAL SUMMARIES

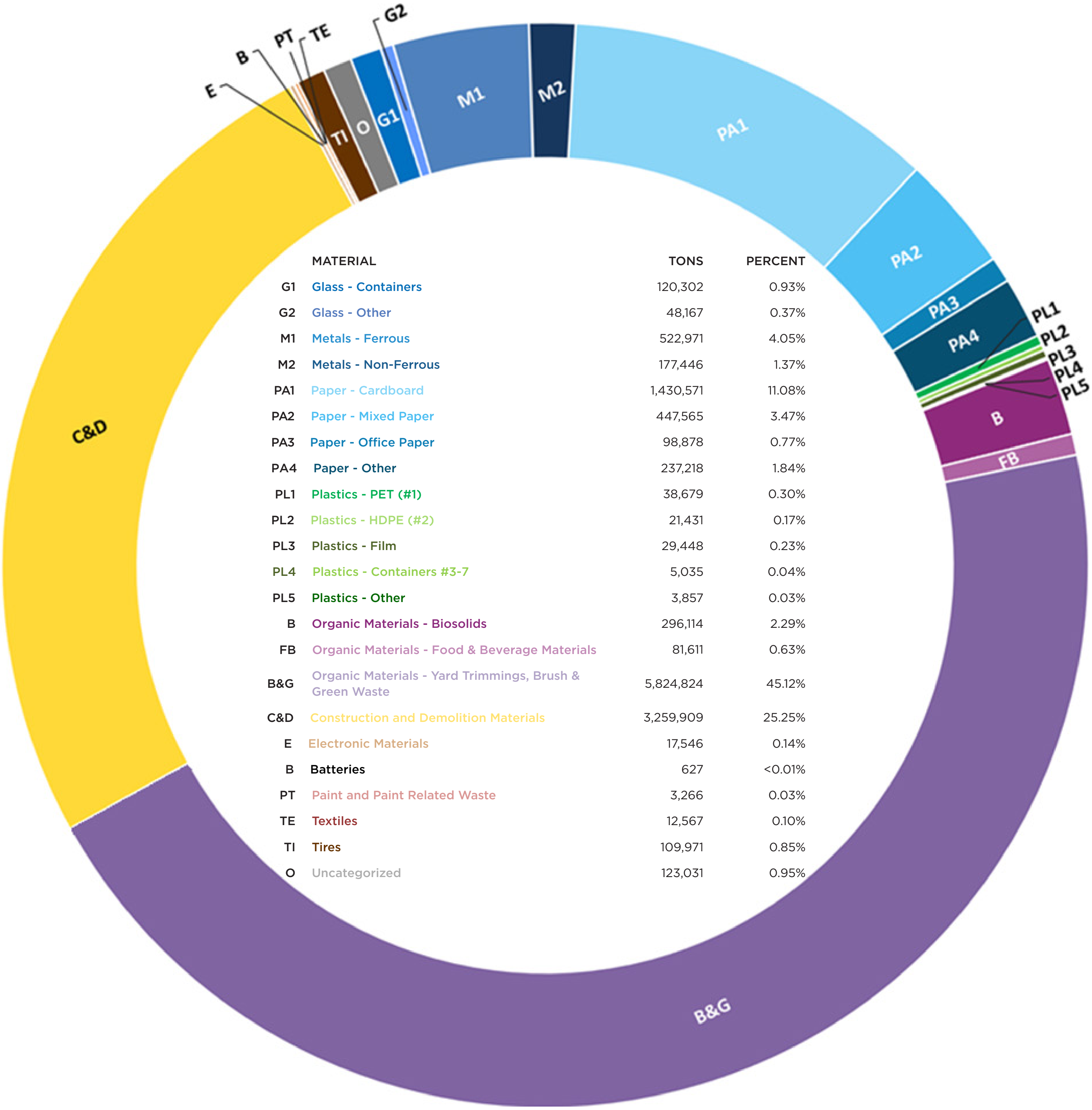
The following sections provide a material-by-material summary of the MSW tons documented through the RMDP and the relative quality of data received. For each material, the Project Team has included:

- **Total Tons:** Includes the tons reported through the survey and from supplemental data sources
- **Confidence:** Addresses the degree of comprehensive responses to the survey
    - **Strong:** Tonnages reflect a substantial percentage of the Texas facilities that process this material.
    - **Moderate +:**
        - *As applicable to yard trimmings, brush, and green waste; paper; C&D; and batteries:* Tonnages reflect a greater level of response in comparison to the SEIR study, yet represent a lower percentage of the Texas facilities than those categorized under the Strong confidence level.
        - *As applicable to ferrous and non-ferrous metals:* Tonnages reflect estimated MSW portion of total tonnage based on supplemental data, which includes the estimated scrap metal tonnage from C&D materials.
    - **Moderate:**
        - *As applicable to food and beverage materials, electronic materials, and textiles:* While significant tonnages were reported, there were multiple facilities that did not respond to the survey.
- **The Story:** Summarizes a description of the material with examples, the major material sources and how they flow through the recycling industry even as they move in and out of Texas and the types of facilities targeted in the survey
- **Survey Data:** Includes the number of tons reported through the survey, the number and types of facilities represented, and a discussion of quality of data received and potential remaining data gaps
- **Supplemental Data:** Includes the number of tons documented through supplemental data sources and the number of facilities represented

[1] While landfill data was provided on a fiscal year basis, the recycling data requested for the RMDP survey was primarily provided on a calendar year basis in order to streamline the reporting process for respondents.
[2] While landfill data was provided on a fiscal year basis, the recycling data requested for the RMDP survey was primarily provided on a calendar year basis in order to streamline the reporting process for respondents.

- **Tonnage Comparison to SEIR:** Documents the 2015 SEIR recycled material tonnage versus the recycled material tonnage resulting from the RMDP. If the tonnages are significantly different, this section includes an explanation as to the difference.

FIGURE 3-2 MATERIAL RECYCLED IN 2019[1,2]

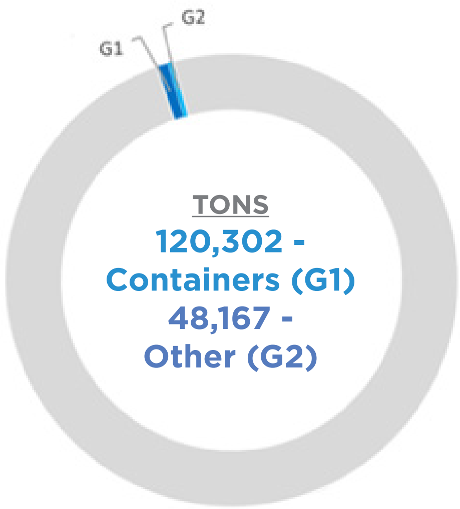


	MATERIAL	TONS	PERCENT
G1	Glass - Containers	120,302	0.93%
G2	Glass - Other	48,167	0.37%
M1	Metals - Ferrous	522,971	4.05%
M2	Metals - Non-Ferrous	177,446	1.37%
PA1	Paper - Cardboard	1,430,571	11.08%
PA2	Paper - Mixed Paper	447,565	3.47%
PA3	Paper - Office Paper	98,878	0.77%
PA4	Paper - Other	237,218	1.84%
PL1	Plastics - PET (#1)	38,679	0.30%
PL2	Plastics - HDPE (#2)	21,431	0.17%
PL3	Plastics - Film	29,448	0.23%
PL4	Plastics - Containers #3-7	5,035	0.04%
PL5	Plastics - Other	3,857	0.03%
B	Organic Materials - Biosolids	296,114	2.29%
FB	Organic Materials - Food & Beverage Materials	81,611	0.63%
B&G	Organic Materials - Yard Trimmings, Brush & Green Waste	5,824,824	45.12%
C&D	Construction and Demolition Materials	3,259,909	25.25%
E	Electronic Materials	17,546	0.14%
B	Batteries	627	<0.01%
PT	Paint and Paint Related Waste	3,266	0.03%
TE	Textiles	12,567	0.10%
TI	Tires	109,971	0.85%
O	Uncategorized	123,031	0.95%

TOTAL: 12,911,034 TONS

1. The numbers shown in the table represent the portion of material that is MSW.
2. Uncategorized includes all materials classified as "Other" by survey respondents. Respondents were required to provide a description. Respondents primarily reported commingled recyclables or other organic materials.

GLASS



confidence: strong

The Story

Much of the recycled glass in Texas flows through MRFs to a small number of glass beneficiation facilities, which provide secondary processing to further prepare the material for end users. While most recycled glass containers in Texas flows through MRFs, some (mainly commercial window and plate glass) flows directly from generators to beneficiation facilities. To obtain a complete understanding of the quantity of glass recycled in Texas, the Project Team surveyed MRFs, glass beneficiation facilities (secondary processors), and end product manufacturing facilities (including two container and three fiberglass insulation plants that consume recycled glass cullet). The team also analyzed the data to eliminate double counting while being as complete as possible.

Survey Data: 168,469 tons

Facilities Responding

35 total facilities

- 23 MRFs
- 7 landfills and transfer/collection stations
- 5 end-use facilities, including glass beneficiation and end product manufacturing facilities

The Project Team obtained data from entities representing 23 MRFs in Texas (as not all of the MRFs surveyed accept glass). Large commercial MRFs process material via long-term processing agreements with municipalities as well as commercial accounts. Therefore, they handle a large portion of Texas recycled glass. Additional quantities may also be recovered directly from auto shops and contractors. The Project Team believes the glass survey data presented above, which has been adjusted to eliminate double counting and residuals left over after processing, represents the vast majority of Texas glass that was recycled through MRFs and/or secondary processors in 2019. Of the 168,469 total tons, 120,302 tons are glass containers, and the remaining 48,167 tons are other glass.

Supplemental Data

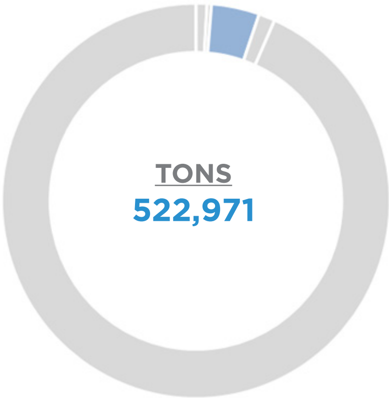
The Project Team relied on the survey to collect all data related to glass and did not identify available supplemental sources of statewide data covering Texas. However, information from the Glass Packaging Institute was used to confirm the list of Texas-based recycled glass end-use facilities.

Tonnage Comparison to 2015 SEIR Results

The RMDP result for recycled glass is 2 percent higher than the 2015 SEIR result of 165,527 tons. The Project Team believes the result reflects a relatively flat glass recycling market and follows recent national trends in stagnant or decreasing glass packaging recycling tonnages.[3]

[3] *Sustainable Materials Management (SMM) - Materials and Waste Management in the United States Key Facts and Figures.* U.S. Environmental Protection Agency. 2020. [Data Tables] <https://edg.epa.gov/metadata/catalog/search/resource/details.page?uuid=C9310A59-16D2-4002-B36B-2B0A1C637D4E>

METALS - FERROUS



confidence: moderate +

The Story

Ferrous scrap metal is generated from a wide variety of sources, including auto bodies, appliances, industrial equipment, other discarded parts and products, and relatively small quantities of steel cans that are used as packaging. While steel cans are likely to be processed at MRFs, most other ferrous scrap metal is collected by any of the over 600 scrap metal processors. Many of these processors are small and may sell their material to a small number of larger processors. Ferrous scrap metal flows to five steel mills in Texas or to several small foundries in the State. Significant quantities are also shipped to consumers in other states or countries.

Due to the availability of existing government data sources, the complexity of material flows, and the significant confidentiality concerns in the scrap metal industry, the Project Team used a combination of RMDP survey data and supplemental data

Survey Data: 96,816 tons from MSW sources

Facilities Responding

75 total facilities

- 28 MRFs
- 26 Landfills and transfer/collection stations
- 17 C&D processing facilities
- 4 Other processors

Most of the ferrous metals reported through the survey came from responsive C&D processing facilities, with lower quantities of materials reported by other facility types. The Project Team obtained data from 28 MRFs in Texas. However, most ferrous metals are processed by scrap metal processing facilities, which were not included within the scope of the RMDP were therefore not surveyed. Consequently, supplemental data was used in addition to the survey data to provide an estimate inclusive of scrap metal processing facilities.

Supplemental Data: 426,155 tons from MSW sources

Facilities Responding

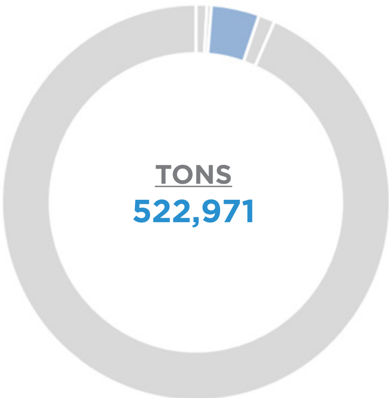
- 5 steel mills
- Over 600 registered scrap metal processing facilities and steel foundries

Supplemental data from the U.S. Environmental Protection Agency (U.S. EPA), the U.S. Census Bureau, the Institute of Scrap Recycling Industries (ISRI); and interviews with ferrous metal processors and other industry representatives were used to provide an estimate of total ferrous metal recycling from MSW sources. Based on the analysis of this supplemental data, the Project Team estimated an additional 426,155 tons of ferrous metal were recycled from MSW sources in 2019. Combined with the survey data, this suggests that total estimated MSW ferrous metal recycling in 2019 was 522,971 tons. This quantity was estimated as follows.

Based on national metal recycling datasets, the total quantity of Texas-generated ferrous scrap metal recycled from all sources (i.e., MSW and non-MSW) in 2019 was estimated to be 6,036,054 tons. However, this estimate includes material that does not meet the definition of MSW used in the RMDP. To estimate the portion considered MSW based on the State of Texas definition, the Project Team first calculated that on average about 7.7 percent of all recovered ferrous scrap metal was generated by residential and commercial generators, which is how the U.S. EPA defines MSW. This percentage was calculated by dividing the U.S. EPA's most recent estimate for ferrous metal MSW recycled (6.2 million tons[4]) by ISRI's most recent estimate for all ferrous scrap metal processed (79.8 million tons[5]). Multiplying total recycled ferrous scrap metal (6,036,054 tons) by 7.7[6] percent, the Project Team estimated

[4] Advancing Sustainable Materials Management: 2017 Fact Sheet. U.S. Environmental Protection Agency. 2019. Available online at https://www.epa.gov/sites/production/files/2019-11/documents/2017_facts_and_figures_fact_sheet_final.pdf
[5] The ISRI Scrap Yearbook 2019. Institute for Scrap Recycling Industries Inc. 2019. Available at: https://www.isri.org/recycling-commodities/recycling-industry-yearbook
[6] Percentage rounded for ease of presentation. Actual = 7.7311277657953 percent

METALS - FERROUS (CONT.)



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The Story (cont.)

to estimate the total amount of ferrous metal recycled. An estimated total of 6,036,054 tons of ferrous scrap metal from all sources (includes industrial and MSW) was recovered, and the MSW portion of this amount was estimated at 522,971 tons.

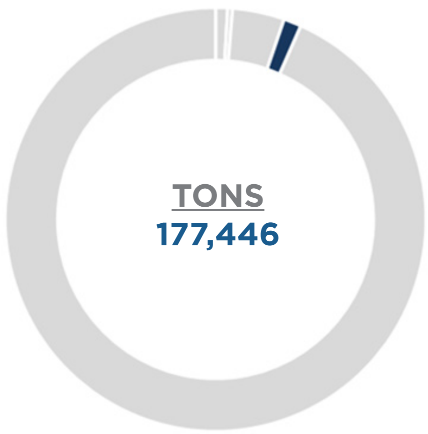
that 466,655 tons were generated by residences and commercial businesses. Second, because Texas includes C&D from non-industrial sources in its definition of MSW but U.S. EPA does not, the Project Team added 56,316 tons, a conservative estimate of recycled ferrous scrap that was sourced from C&D activities, resulting in 522,971 tons as the estimate for ferrous scrap recovery meeting the Texas definition of MSW. Therefore, the MSW tonnage derived from supplemental data sources is equal to the total estimated MSW ferrous scrap metal recovered (522,971 tons) minus the amount derived from the survey data shown above (96,816 tons), or 426,155 tons.

Tonnage Comparison to 2015 SEIR Results

The RMDP result estimates ferrous metals from all sources to be approximately 6.0 million tons. This is 22 percent more than the 2015 SEIR result of 4.9 million tons. This is in contrast to a 2 percent nationwide decline since 2015, based on data reported by ISRI. Potential reasons for this increase include growth in construction activity including a robust economy and continued rebuilding after recent active hurricane seasons.

Results for Texas recycled ferrous metals from MSW sources was 17 percent higher than the 2015 SEIR estimate of 447,207 tons. Ferrous MSW recovery through MRFs increased slightly, at 2 percent higher than the 2015 SEIR estimate. This is not unexpected since residential recovery is far less sensitive to changes in markets and pricing than industrial generated scrap.

METALS - NON-FERROUS



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The Story

Non-ferrous scrap metal is generated from a wide variety of sources, including industrial equipment, miscellaneous parts and products, aluminum cans and other packaging. While aluminum cans are likely to be processed at MRFs, most other non-ferrous scrap metal is collected by one of over 600 scrap metal processors. Most of these processors are small and may sell their material to larger processors. Small amounts of non-ferrous scrap metal are consumed by processors in Texas, but the majority is shipped to consumers in other states or countries.

Due to the complexity of material flows and the significant confidentiality concerns in the scrap metal industry, the Project Team developed an alternative approach involving detailed analysis of information on Texas non-ferrous scrap metal flows. An estimated total of 722,492 tons of non-ferrous scrap metal from all sources was recovered,

Survey Data: 23,633 tons from MSW sources

Facilities Responding

75 total facilities

- 28 MRFs
- 26 landfills and transfer/collection stations
- 17 C&D processing facilities
- 4 Manufacturers accepting direct-to-mill material

Based on online surveys, the Project Team was able to document 23,633 unique tons of non-ferrous metal recycled by responding facilities (i.e., tons that were not sent to other Texas-based processors). However, most non-ferrous metals are processed by scrap metal processing facilities, which were not included within the scope of the RMDP were therefore not surveyed. Consequently, supplemental data was used in addition to the survey data to provide an estimate inclusive of scrap metal processing facilities.

Supplemental Data: 153,813 tons from MSW sources

Facilities Responding

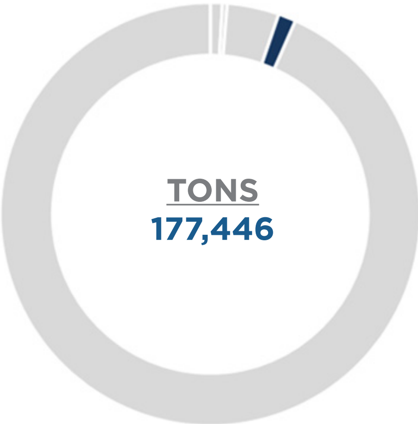
- 28 Texas-based secondary processors and smelters
- 88 large Texas scrap metal processing facilities

Similar to ferrous metals, the Project Team relied heavily on existing data obtained by the Project Team from the U.S. Environmental Protection Agency (U.S. EPA), the U.S. Census Bureau, the Institute of Scrap Recycling Industries (ISRI), and interviews with ferrous metal processors and other industry representatives, as well as data collected through the survey. Based on the analysis of supplemental data, the Project Team estimated an additional 153,813 tons of non-ferrous metal were recycled from MSW sources in 2019. Combined with the survey data, this suggests that total estimated MSW non-ferrous metal recycling in 2019 was 177,446 tons. This quantity was estimated as follows.

Based on national metal recycling datasets, the total quantity of Texas-generated non-ferrous scrap metal recycled from all sources (i.e., MSW and non-MSW) in 2019 was estimated to be 722,492 tons, including copper, nickel, aluminum, lead, zinc, tin, and stainless steel. However, this estimate includes material that does not meet the definition of MSW used in the RMDP. To estimate the portion considered MSW based on the State of Texas definition, the Project Team first estimated that on average about 22.6 percent of all recovered non-ferrous scrap metal was generated by residential and commercial generators, which is how the U.S. EPA defines MSW. This percentage was calculated by dividing the U.S. EPA's most recent estimate for non-ferrous metal MSW recycled (2.2 million tons[7]) by

[7] *Advancing Sustainable Materials Management: 2017 Fact Sheet.* U.S. Environmental Protection Agency. 2019. Available online at https://www.epa.gov/sites/production/files/2019-11/documents/2017_facts_and_figures_fact_sheet_final.pdf

METALS - NON-FERROUS (CONT.)



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The Story (cont.)

with the MSW portion of this amount estimated at 177,446 tons.

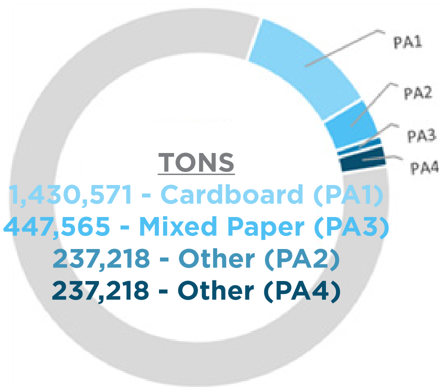
ISRI's most recent estimate for all non-ferrous scrap metal processed (9.6 million tons[8]). Multiplying total recycled non-ferrous scrap metal (722,492 tons) by 22.6[9] percent, the Project Team estimated that 163,367 tons were generated by residences and commercial businesses. Second, because Texas includes C&D from non-industrial sources in its definition of MSW but U.S. EPA does not, the Project Team added 14,079 tons, a conservative estimate of recycled non-ferrous scrap that was sourced from C&D activities, resulting in 177,446 tons as the estimate for non-ferrous scrap recovery meeting the Texas definition of MSW. The MSW tonnage derived from supplemental data sources is equal to the total estimated MSW non-ferrous scrap metal recovered (177,446 tons) minus the amount derived from the survey data shown above (23,633 tons), or 153,813 tons.

Tonnage Comparison to 2015 SEIR Results

The RMDP result for Texas recycled non-ferrous metals from all sources is flat compared to the 2015 SEIR result of 724,112 tons. The RMDP result for Texas recycled non-ferrous metals from MSW sources is 10 percent lower than the 2015 SEIR result of 196,383 tons. This decrease can be attributed, in part, to a change in methodology compared to SEIR. Additionally, the decrease may be a result of the loss of shredder residue market in China.

[8] *The ISRI Scrap Yearbook 2019.* Institute for Scrap Recycling Industries Inc. 2019. Available at: https://www.isri.org/recycling-commodities/recycling-industry-yearbook
[9] Percentage rounded. Actual = 22.6116013011997%

PAPER



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Survey Data: 2,214,232 tons

Facilities Responding

67 total facilities

- 30 MRFs
- 20 landfills and transfer/collection stations
- 14 paper mills and mill-affiliated supply operations in Texas, Oklahoma, and Louisiana
- 3 cellulose/pulp product manufacturers in Texas

The Project Team obtained data from 30 MRFs in Texas. Large commercial MRFs process material via long-term processing agreements with municipalities, as well as commercial accounts. Therefore, the results represent a comprehensive understanding of the quantity of paper flowing through MRFs in the State. There was also a strong response from several mills and affiliated recovered paper supply operations in Texas and surrounding states. However, there was at least one company that may source supply from Texas that was unresponsive. Moreover, additional quantities of recovered paper may be handled by brokers or other firms that were not identified as specifically operating in Texas. Therefore, the reported tons for paper are likely understated. Of the total 2,214,232 tons of paper reported, 1,430,571 tons were cardboard, 447,565 tons were mixed paper, 98,878 tons were office paper, and 237,218 tons were other grades of paper. Paper grades commonly reported under other include: coated book stock, various grades of newsprint, sorted white ledger, and double lined kraft.

Supplemental Data

The Project Team relied on the survey to collect all data related to paper and did not identify available supplemental sources of statewide data covering Texas.

Tonnage Comparison to 2015 SEIR Results

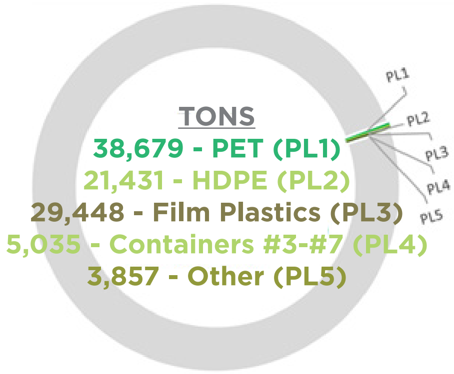
The RMDP result for recycled paper is nearly equal to the SEIR result of 2,212,562 tons. The Project Team believes this result reflects generally challenging domestic and international paper markets which have constrained paper recovery in some areas. Recovery of old corrugated containers (OCC) increased 8 percent from the SEIR result of 1,321,611 tons, which the Project Team believes could be attributed to the growth in e-commerce since 2015.

The Story

Post-consumer recycled paper – including newspaper, cardboard, office paper, and food and beverage cartons – is generated from residences through curbside and drop-off recycling programs, and from commercial paper recycling service providers. Much of it is processed at MRFs and/or paper stock dealers in Texas. But significant amounts (mainly cardboard) are also recovered and baled at large retailers and grocery stores, which are often shipped directly to mills or brokers, by-passing MRFs. Recovered paper flows are complex. Paper and paperboard mills located in Texas consume recovered paper that they receive from both in-state and out-of-state suppliers. Significant quantities of recovered paper are sent from Texas to other states or exported from ports in Texas and California to other countries, including Mexico and overseas. An unknown portion of paper exported from Texas ports originated in other states. Many paper manufacturers operate collection and/or processing activities in Texas, while many others rely on brokers to procure supply.

To collect data on recycled paper in Texas, the Project Team first considered MRFs and incidental amounts of paper reported by other facility types. The Project Team then added significant quantities of direct-to-mill material reported by paper mills and supply companies in Texas and nearby states.

PLASTICS



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The Story

Much of the recycled post-consumer plastic in Texas flows through MRFs. In addition, there are a small number of plastic reclamation facilities, which provide secondary processing for a portion of Texas recycled plastic to further prepare the material for end users. Recycled plastic flows are very complex. Many reclaimers handle a mix of pre- and post-consumer material, and significant quantities of material flow into and out of Texas, including flows between reclaimers, which can also act as converters (i.e., manufacturers). There is also a potentially growing market for chemical recycling of plastics, targeted to manage low-quality residual plastic streams and/or hard to recycle resin types.[10]

To collect data on the amount of Texas plastic recycled, the Project Team focused on the MRF survey responses and direct-to-mill quantities from plastics reclamation and manufacturing entities.

Survey Data: 78,450 tons

Facilities Responding

57 total facilities

- 30 MRFs
- 12 landfills and transfer/collection stations
- 15 plastics reclamation and manufacturing facilities

The Project Team obtained data from 30 MRFs in Texas. Large commercial MRFs process material via long-term processing agreements with municipalities, as well as commercial accounts. Therefore, the plastic data presented in this report represents the majority of the plastic that is recycled through MRFs in the State. The Project Team surveyed plastic reclamation facilities; however, limited responses were obtained for some material types (e.g., film plastic). This data gap was addressed based on interviews and Project Team expertise were used, as described under Supplemental Data. Of the total 78,450 tons reported, 38,679 tons were PET, 21,431 tons were HDPE, 9,448 tons were film plastics, 5,035 tons were plastics #3-7, and 3,857 were other plastics.

Supplemental Data: 20,000 tons film plastic

Facilities Responding

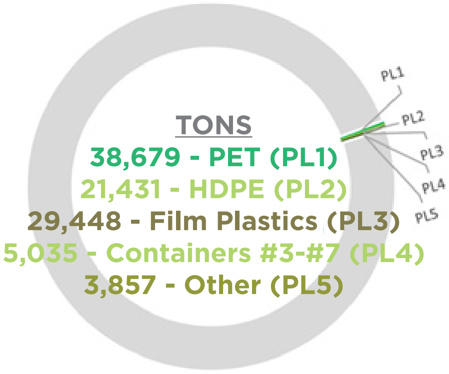
- 6 in-state plastic film reclamation facilities

None of the existing plastic film reclaimers provided data through the survey. As a result, survey data for plastic film (9,448 tons) reflects a small quantity processed or brokered through MRFs and does not include the majority of recycled film recovered through retail take-back or direct-to-mill. To estimate the additional quantity of plastic film collected and managed in-state, the Project Team relied on experience and interviews with Texas film reclaimers.

The Project Team estimated around 50,000 tons of existing in-state capacity, a portion of which would be consumed by non-MSW film materials (i.e., pre-consumer industrial scrap) and imports from outside Texas. Based on this information, the Project Team estimates an additional 20,000 tons of film plastic were recycled from residential and commercial generators in Texas through retail and direct-to-mill sources.

[10] Since SEIR, the Texas legislature passed HB 1953 (2019), which expanded the definition of recycling to include post-use polymers and recoverable feedstocks (e.g., plastics) that are converted through gasification or pyrolysis into valuable raw, intermediate, or final products such as new plastics, chemicals, wax, lubricant, fuels, and other products. Multiple facilities in the state convert post-use plastics into product and were included in the survey effort.

PLASTICS (CONT.)



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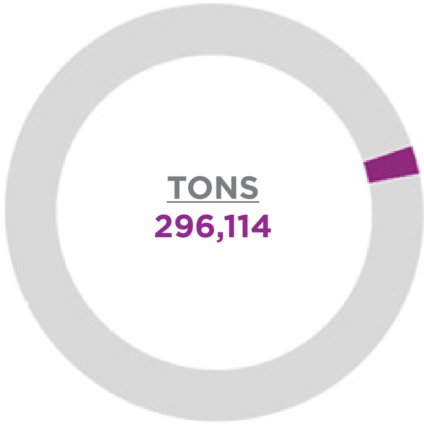
Tonnage Comparison to 2015 SEIR Results

The RMDP result for recycled plastic is 9 percent lower than the 2015 SEIR result of 107,851 tons. However, the RMDP result includes additional supplemental data not incorporated in SEIR. When adjusted for these methodological changes, the RMDP result for recycled plastic is 27 percent lower than the 2015 SEIR result of 107,851 tons.

Plastics recycling has declined steadily since the 2013 Texas Recycling Data Initiative, because of continued challenges such as declining of end market demand for low grade plastics and restrictions on exports of plastic scrap.[11] RMDP results show decreased recovery of low grade plastics, with multiple processors indicating that #3-7 mixed plastics were particularly challenging and, at times, were disposed due to soft demand. Another factor for decreasing plastic recycling may be due to manufacturers utilizing less material in their products. Light-weighted PET and HDPE packaging can result in lower recycling tonnages despite an increasing number of containers being recycled.

[11] Since China's National Sword policy began in 2017, export of mixed plastic and mixed paper bales has decreased due to bans, increased bale standards, and inspections. Other countries in the region (e.g., Vietnam, Malaysia) have developed similar restrictive policies around plastic scrap import.

ORGANIC MATERIAL - BIOSOLIDS



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The Story

Wastewater biosolids are managed in a variety of ways in Texas, including landfill disposal, land application, and composting. Biosolids may be combined with yard trimmings, brush, green waste or other bulking agents to produce nutrient-rich compost. To collect data for biosolids, the Project Team focused on surveying compost/mulch production facilities and contacting landfills. Some facilities may have included biosolids in their total volume of organics, which also includes green waste and food and beverage material.

Survey Data: 210,503 tons

Facilities Responding

6 compost/mulch production facilities

The six responsive facilities include the largest municipal composters of biosolids in Texas. Conducting a comprehensive survey of compost/mulch production facilities in Texas is a significant challenge. There is a large number of relatively small facilities, many of which are exempt from regulatory authorizations (e.g., notification, registration or permit). Of the 89 compost/mulch production facilities that responded to the survey or otherwise provided data, six accept biosolids. There were 46 known and/or registered compost/mulch production facilities that did not provide data for the survey. The Project Team expects that very few of these facilities, if any, process biosolids.

Supplemental Data: 85,611 tons[12]

Facilities Represented in Data

- 48 Class B biosolid treatment sites
- Several water treatment sites

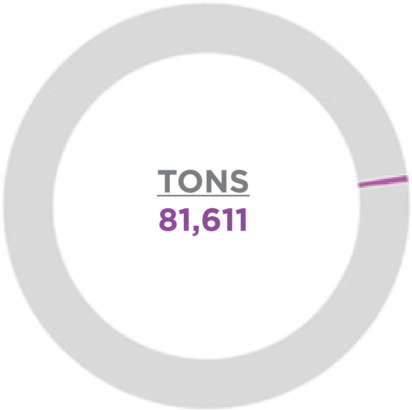
The Project Team incorporated data from TCEQ regarding biosolids that were collected at landfills, as well as biosolids that were land applied in Texas in fiscal year 2019. This data only included Class B biosolids and water treatment plant residuals. The volume of sludge used for land application is reported by the land applicator and not the treatment plant. TCEQ does not have a database in place for the applicator to track the treatment plants that are the source of the sludge, so the number of facilities is unknown. Class A and Class AB biosolids used beneficially for marketing and distribution purposes do not require a fee so TCEQ does not track their tonnage information.

Tonnage Comparison to 2015 SEIR Results

The RMDP result is 17 percent lower than the 2015 SEIR result of 357,116 tons. This may be due in part to a decrease in the number of facilities that reported composting or land-applying biosolids, compared to 2015.

[12] Reported as dry tons. The quantity of Class AB biosolids that were land applied in 2019 is unknown; however, an estimated 146,000 tons were land applied in 2018 based on a detailed analysis performed by TCEQ's Water Quality Division.

ORGANIC MATERIAL - FOOD & BEVERAGE



confidence: moderate

Survey Data: 81,611 tons

Facilities Responding

27 compost/mulch production facilities

The responsive facilities represent most of the major compost/mulch production facilities in Texas known to compost food and beverage materials; however, two facilities that reported relatively small quantities of food and beverage waste in the 2015 SEIR survey did not respond to the RMDP survey.

As previously discussed under "Biosolids," conducting a comprehensive survey of compost/mulch production facilities in Texas is a significant challenge. Of the 89 compost/mulch production facilities that responded to the survey or otherwise provided data, 27 accept food and beverage materials. There were 46 known and/or registered compost/mulch production facilities that did not provide data through the survey. The Project Team expects that very few of these facilities, if any, compost food and beverage materials. Therefore, the 27 facilities that responded to the survey were assumed to represent the majority of facilities that accept food and beverage materials for composting.

The Story

The primary method to divert discarded food and beverage materials from disposal is through composting. Select municipalities in Texas have developed curbside programs to divert food scraps generated from households. In addition, select food service establishments have developed programs to divert this material. The Project Team asked that compost/mulch production facilities report food and beverage material separately in survey responses; however, the majority of facilities were unable to provide specific tonnages for MSW food and beverage material as this material was received comingled with other materials (e.g., yard trimmings from residential curbside organics programs). Reported quantities were used to conservatively estimate the portion of food and beverage waste composted at these sites.

Supplemental Data

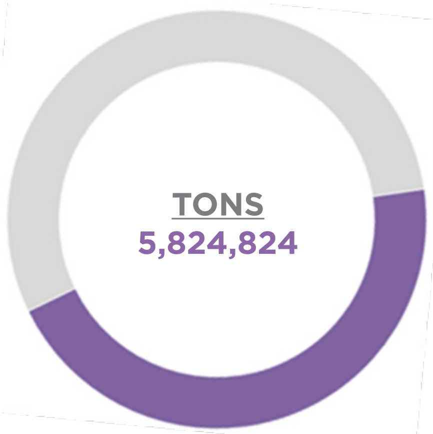
The Project Team relied on the survey to collect all data related to food and beverage materials and did not identify any available supplemental sources of statewide data covering Texas.

Tonnage Comparison to 2015 SEIR Results

The RMDP result is 19 percent lower than the 2015 SEIR result of 100,470 tons. This is likely due to the majority of responding facilities being unable to provide detailed data for food and beverage waste. Where food waste was reported comingled with other materials, the Project Team conservatively estimated the portion that was food and beverage materials. Because of this, the actual trend for food and beverage waste is difficult to determine and food and beverage recycling quantities may have increased since 2015. The number of facilities that reported accepting food and beverage waste increased by 42 percent since the 2015 SEIR survey in which 19 facilities reported accepting this material.

There is a continued emphasis to divert commercial and residential food and beverage materials away from disposal, and multiple large municipalities have residential food waste recovery programs (e.g., Austin, San Antonio). Further, some facilities that responded to the SEIR survey reported higher quantities of food and beverage waste in 2019 as compared to 2015. Conversely, one facility that reported large quantities of food waste in 2015 did not report accepting any food and beverage waste in 2019. Previously, facilities reported decreasing the amount of commercial food waste they were willing to accept because of high contamination levels.

YARD TRIMMINGS, BRUSH & GREEN WASTE



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The Story

Municipal curbside collection programs, landscape companies, land clearing operations, and other entities are generators of yard trimmings, brush, and green waste. The primary means of recycling these materials is the production of mulch and compost. Therefore, the Project Team surveyed compost/mulch production facilities, landfills, transfer stations, and MRFs to collect data for this material type.

Survey Data: 5,824,824 tons

Facilities Responding

98 total facilities

- 9 MRFs
- 15 landfill-based compost/mulch production facilities
- 18 transfer/collection station-based compost/mulch production facilities
- 1 C&D compost/mulch production facility
- 55 stand-alone compost/mulch production facilities

The 98 total facilities that reported recycling yard trimmings, brush, and green waste includes 55 stand-alone compost/mulch production facilities. These 55 responsive compost/mulch production facilities are among the largest facilities in Texas, and managed 5.5 million tons of yard trimmings, brush, and green waste (95 percent of the reported total). Conducting a comprehensive survey of compost/ mulch production facilities in Texas is a significant challenge. There are many relatively small facilities, a portion of which are exempt from regulatory authorizations (e.g., notification, registration or permit). Obtaining the cooperation of these very small facilities is very difficult. There were 46 known and/or registered compost/mulch production facilities that did not respond to the survey. However, many of these are generally considered to be relatively small operations. Therefore, the 55 facilities that responded to the survey were assumed to represent the majority of yard trimmings, brush, and green waste accepted for composting.

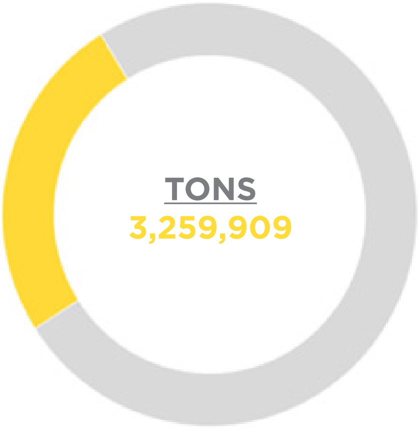
Supplemental Data

The Project Team relied on the survey to collect all data related to yard trimmings, brush, and green waste and did not identify available supplemental sources of statewide data covering Texas.

Tonnage Comparison to 2015 SEIR Results

The RMDP result is 154 percent higher than the 2015 SEIR result of 2,289,542 tons. Survey responses were obtaining data from a similar number of facilities compared to the 2013 TRDI survey, so this increase is not attributed to any increase in the number of survey responses. Rather, several facilities that responded to the 2015 SEIR survey have significantly increased their capacity and/or expanded to operate additional facilities and therefore can compost more material company-wide.

CONSTRUCTION & DEMOLITION



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The Story

Construction and demolition (C&D) materials are generated by new construction, demolition, and renovation of residential and commercial buildings. C&D material is primarily processed at facilities that specialize in handling commingled materials generated from these projects. Metal re-bar is separated from the concrete received and recycled as metal, not C&D material. In addition, some landfills have developed on-site recycling operations for this material. To collect data for C&D recycling, the Project Team focused on surveying C&D processing facilities and landfills.

Survey Data: 3,259,909 tons

Facilities Responding

43 total facilities

- 11 landfills
- 8 transfer stations
- 24 C&D processing facilities

The 43 responsive facilities include many of the larger C&D processing facilities in Texas, as well as recycling activity across different geographic regions. There were multiple unresponsive companies that did not respond to the survey, some of which are known by the Project Team to process significant tonnage. Because of the number of key facilities outstanding for this material type, the reported tons for C&D materials is likely understated.

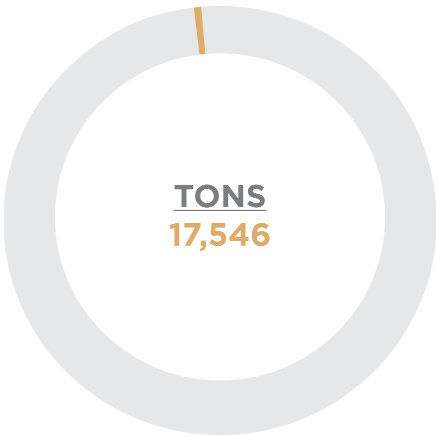
Supplemental Data

The Project Team relied on the survey to collect all data related to construction and demolition materials and did not identify available supplemental sources of statewide data covering Texas.

Tonnage Comparison to 2015 SEIR Results

The RMDP result is 4 percent higher than the 2015 SEIR result of 3,136,727 tons. The Project Team believes this reflects the statewide trend in C&D material recovery, as facilities that also responded to the SEIR survey reported relatively flat or only modest increases in tonnage compared to 2015.

ELECTRONIC MATERIALS



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The Story

Electronic materials are processed by facilities that deconstruct, shred, sort, bale and/or otherwise prepare electronics materials to be sold to end users, brokers or exporters. While there are many facilities that actively process electronic materials for recycling, many electronics are refurbished or reused (which was not covered by the RMDP). In addition, electronics processors will frequently buy from and sell materials to other electronics processors or other processors (such as plastics reclaimers or scrap metal processing facilities). The Project Team focused on surveying entities that aggregate and/or process electronics and was vigilant to prevent double counting for this material. In addition, the Project Team identified supplemental data available through TCEQ. All tons for this category were reported in aggregate and not broken down into constituent commodities, such as plastic and metal.

Survey Data: 1,262 tons

Facilities Responding

13 transfer/collection stations and MRFs

Though targeted in the survey, none of Texas' electronics processing facilities responded to provide data. There were over 40 unresponsive electronics processors. There were inherent challenges to collecting data from electronics processors. For instance, many electronics processing facilities in Texas are part of national or multinational corporations that require corporate-level approval for the release of any data, so many companies were not able to participate because they were unable to obtain corporate approval. It should be noted that many of these facilities may focus significant efforts on reuse/refurbishment and have minimal recycling data to report.

Some transfer/collection facilities and MRFs reported electronics recycling data when providing data for typical recyclables (i.e., plastic, paper, metal, glass). These facilities may do minimal sorting or processing, such as identifying working electronics for resale or repair, before sending material to an electronics processing facility.

Supplemental Data: 16,284 tons

Facilities Represented in Data

48 total facilities

- 6 electronics processors
- 42 HHW collection facilities

Reports from 24 computer manufacturers and 22 television manufacturers

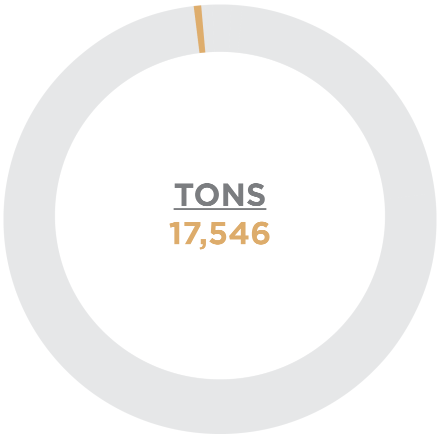
The Project Team incorporated data from the Texas Recycles Computers Program, which requires manufacturers of computers (including desktop and notebook computers, as well as monitors) to provide free and convenient recycling options for the products they sell in and into Texas. Manufacturers reported recycling 3,412 tons of electronics in 2019.[13]

The Project Team also incorporated data from the Texas Recycles TVs Program, which is generally similar to the Texas Recycles Computers Program in that it requires manufacturers of televisions to provide recycling options for the products they sell in or into Texas. Manufacturers and retailers reported recycling 6,276 tons of electronics in 2019.

Additionally, recycled electronics may be collected through HHW programs and sent to in-state or out-of-state electronics processors. To estimate this quantity, the Project Team analyzed data reported through the TCEQ's HHW Program, under which authorized HHW facilities and processors must submit an annual report to TCEQ with the total volume of HHW that they recycle, and the detailed quantities by material type. The reported 1,230 tons collected at HHW sites were

[13] As reported in *Program Report on Texas Recycles Computers and Texas Recycles Television: 2019 Report to the Legislature.* Texas Commission on Environmental Quality. March 2020. Excludes reuse.

ELECTRONIC MATERIALS (CONT.)



confidence: moderate

compared to those reported in the survey and an additional 5,366 tons of electronics reported to TCEQ by six electronics processors to avoid double-counting whenever possible.[14]

For the RMDP, the total tonnages of computers, TVs, and other electronic equipment were combined to represent the total of electronic materials recycled in 2019.

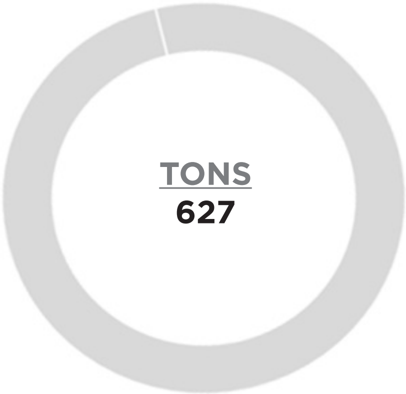
Tonnage Comparison to 2015 SEIR Results

The RMDP result is 59 percent less than the 2015 SEIR result of 42,725 tons. The Project Team believes this is due in part to a decrease in the number of facilities that responded to the RMDP survey, as well as an overall decrease in the number of electronics processing facilities operating in the State. Based on information from TCEQ, the number of registered electronics processing facilities continues to decrease.

Additionally, the downward trend in the weight per unit of electronics likely contributed to the decrease in the tonnage of electronics reported as recycled. The decreasing trend in weight of recycled electronics has also been observed in other states including Illinois, Pennsylvania, and Wisconsin. Recent academic research suggests that nationwide electronic waste generation and recycling tonnages are declining due to decreasing weight of devices and waste electronic tonnages may have peaked in 2014 - 2015.[15]

[14] There is potential overlap between the data reported by electronics processors (5,366 tons) and the Texas Recycles TVs Program (6,276 tons), however the amount of potential double-counting is unknown and could not be quantified
[15] Althaf, S, Babbitt, CW, Chen, R. The evolution of consumer electronic waste in the U.S. Journal of Industrial Ecology. 2020; 1–14. https://doi.org/10.1111/jiec.13074

BATTERIES



confidence: moderate +

The Story

Management of primary and rechargeable household batteries in Texas is handled primarily by local governments through HHW collection, as well as through return-to-retail drop-off programs. To collect battery data, the Project Team focused data from household hazardous waste (HHW) collection facilities, most of which are owned and operated by local governments, and similar drop off sites where batteries are collected for recycling.

Lead-acid batteries were not targeted in the RMDP survey. Lead-acid batteries are primarily collected through retail establishments across the state. Texas law requires businesses that sell lead-acid batteries must accept the old battery when a new battery is purchased and/or installed. As a result of state and federal requirements, lead-acid batteries have one of the highest recycling rates nationally at 99 percent.[16]

Survey Data: 22 tons

Facilities Responding

5 total facilities

- 1 MRF
- 4 HHW collection facilities

As with prior surveys, the Project Team did not obtain a strong survey response from HHW processing facilities. However, the Project Team was able to develop a statewide estimate based on supplemental data. Survey results were not used because the data was considered redundant to the supplemental data obtained from the TCEQ.

Supplemental Data: 627 tons

Facilities Represented in Data

78 HHW collection facilities

Over 150 retail and business collection locations

Under the TCEQ's HHW Program, authorized HHW facilities and processors must submit an annual report to TCEQ with the total volume of HHW that they recycle, and the detailed quantities by material type. Based on information provided in TCEQ's report, a total of 357 tons of household batteries were recycled through the HHW program in Texas in 2019. Since the HHW facilities that provided data through the survey are also required to submit an annual report to TCEQ, the survey results were considered redundant and were not counted.

The Project Team also incorporated data provided by Call2Recycle, a national consumer battery recycling and stewardship program. Hundreds of Texas retailers and other battery drop-off locations partner with Call2Recycle to manage end-of-life batteries. Call2Recycle reported a total of 318 tons of batteries collected through its Texas partners in 2019, including municipal and public agency programs that also report in the TCEQ's HHW report. Tonnages from Call2Recycle's municipal and public agency partners were excluded to prevent double-counting, resulting in 270 tons of batteries reported from retail and other drop-off programs.

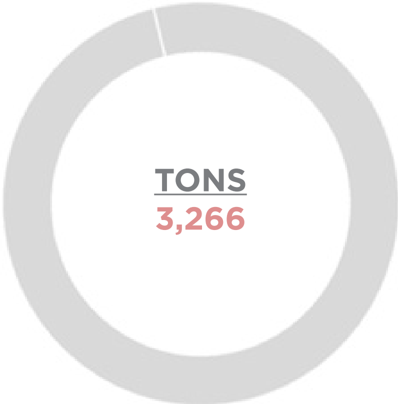
Tonnage Comparison to 2015 SEIR Results

Batteries were not included as a stand-alone category in the 2015 SEIR study, but HHW reporting and Call2Recycle data indicate 440 tons of household batteries were recycled in 2015. The RMDP result for batteries is 43 percent higher than the 2015 SEIR result of 440 tons. This may be the result of increased education and outreach to residents to properly manage batteries for recycling.

Use of electric vehicle (EV) and energy storage system (ESS) batteries has grown in recent years as alternative energy grows in popularity, battery technology improves, and costs decline. There is currently no known EV and ESS battery recycling infrastructure in Texas, and as a result these batteries were not included in the RMDP survey.

[16] Sustainable Materials Management (SMM) - Materials and Waste Management in the United States Key Facts and Figures. U.S. Environmental Protection Agency. 2020. [Data Tables] <https://edg.epa.gov/metadata/catalog/search/resource/details.page?uuid=C9310A59-16D2-4002-B36B-2B0A1C637D4E>

PAINT



confidence: strong

The Story

Management of household paint and related waste in Texas is primarily handled by local governments, with additional commercial paint recycling occurring through a limited number of private paint recycling companies. Similar to batteries, the Project Team focused on surveying HHW collection facilities, most of which are owned and operated by local governments. It should be noted that a portion of paint collected through HHW collection facilities is reused (directly, re-blended, or re-processed) or disposed. The RMDP focused only on the processes that meet the State's definition of recycling, which excludes reuse and incineration.

Survey Data: 71 tons

Facilities Responding

3 HHW collection facilities

As with prior surveys, the Project Team did not obtain a strong survey response from HHW processing facilities. However, the Project Team was able to develop a statewide estimate based on supplemental data. Survey results were not used because the data was considered redundant to the supplemental data obtained from the TCEQ.

Supplemental Data: 3,266 tons

Facilities Represented in Data

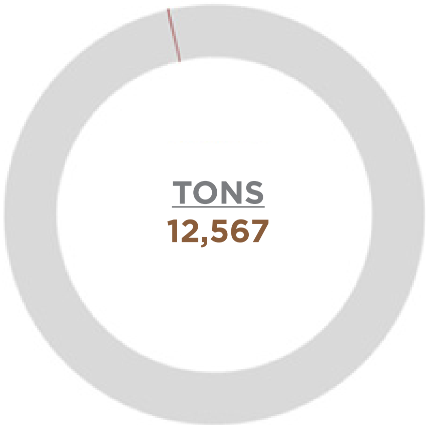
78 HHW collection facilities

Under the TCEQ's HHW Program, authorized HHW facilities and processors must submit an annual report to TCEQ with the total volume of HHW that they recycle, and the detailed quantities by material type. Based on information provided in TCEQ's report, a total of 3,266 tons of paint were recycled through the HHW program in Texas in 2019. The Project Team assumed all reported recycling quantities were recycled; however, it is possible some facility responses also include any paint that was incinerated. Since the HHW facilities that provided data through the survey are also required to submit an annual report to TCEQ, the Project Team relied on TCEQ's total to represent HHW recycling in Texas. The survey results were considered redundant and were not counted.

Tonnage Comparison to 2015 SEIR Results

Paint was not included in the 2015 SEIR study, but HHW reporting for 2015 indicates 2,306 tons of paint was recycled in 2015. The RMDP result is 42 percent higher than the 2015 result of 2,306 tons.

TEXTILES



confidence: moderate

The Story

Textile recycling includes materials such as clothing, footwear, linens and carpet. According to Project Team research, the vast majority of recovered clothing, footwear, and linens is donated or otherwise reused. Multiple facilities did provide data on clothing recycling.

Recycled carpet is recovered directly by a collector that specializes in recycling carpet. Carpet cannot be mixed with other C&D materials and sorted at C&D processing facility. Previously, data on recycled carpet was obtained through the Carpet America Recovery Effort (CARE), a carpet recycling trade organization that aggregates data from carpet collectors in Texas.

Survey Data: 12,567 tons

Facilities Responding

2 textile collection/sortation recyclers

Although textiles are not required to be included in the RMDP, facilities could report textile recycling data through the RMDP survey. Data was provided by two entities that collect and recycle used clothing.

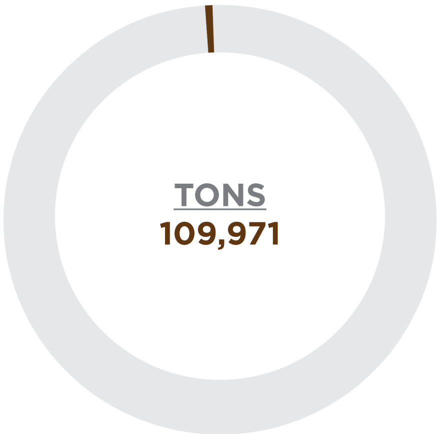
Supplemental Data

Previously, data from carpet recyclers in Texas was provided through the Carpet America Recovery Effort (CARE), however updated data was not available. CARE has identified 16 carpet recycling processors in Texas. Their activities are not included in the RMDP result for textile recycling.

Tonnage Comparison to TRDI

The RMDP result is 24 percent less than the 2015 SEIR result of 16,507 tons. This decrease is primarily due to supplemental carpet recycling data that was included in the SEIR result no longer being available. While the amount of carpet recycled in 2019 is unknown, the amount of clothing recycled is 35 percent higher than the 2015 SEIR result of 9,275 tons.

TIRES



confidence: strong

The Story

TCEQ regulates the collection, processing, storage, recycling and disposal of approximately 45 million scrap tires annually, in addition to tires stored in stockpiles which may enter the stream at irregular rates. There are many options to divert scrap tires from disposal, including land reclamation projects using tires, beneficial use projects, and production and use of tire-derived fuel. Although these are acceptable forms of tire management and diversion, they are not considered recycling for the purposes of the RMDP.

The Project Team focused on surveying tire processing facilities to gather information on tire recycling in Texas, along with supplemental information from TCEQ.

Survey Data:

The Project Team did not obtain a strong survey response from tire processing facilities. However, the Project Team was able to develop a statewide amount based on supplemental data, which includes the 500 tons reported through the survey.

Supplemental Data: 109,971 tons

Facilities Represented in Data

50 scrap tire processors/facilities

Under the TCEQ's Scrap Tire Program, registered scrap tire facilities must submit an annual report to TCEQ with the total number of tires that they dispose, recycle or beneficially reuse. Based on information provided in this report, there were an estimated total of 109,971 tons of tires recycled in Texas in 2019, primarily into crumb rubber which, in turn, was used to produce a variety of products.

Tonnage Comparison to TRDI

The RMDP result is 58 percent higher than the 2015 SEIR result of 69,474 tons, despite a decrease in the number of scrap tire processors/facilities reporting, which was 62 in 2015. According to TCEQ's Scrap Tire Reports for years 2015 through 2019, the total volume of scrap tires managed in Texas has increased 38 percent since 2015. Additionally, the recycling rate of tires has increased from 21 percent of tires in 2015 to 25 percent in 2019.

3.4 TOTAL RECYCLED FROM MSW SOURCES IN 2019

Approximately 12.9 million tons of Texas sourced material was recycled in 2019. Table 3-1 compares totals from the 2019 RMDP to the 2015 SEIR study, a difference of 3.7 million tons of recycled MSW in 2019. Most of this increase is attributable to significant expansion of yard trimmings, brush, and green waste composting.

TABLE 3-1: MATERIAL RECYCLED FROM MSW SOURCES (TONS)

Material		2015 SEIR	2019 RMDP
Typical Recyclables	Glass	165,527	168,469
	Metals – Ferrous[1]	447,207	522,971
	Metals – Non-Ferrous[1]	196,383	177,446
	Paper	2,212,562	2,214,232
	Plastics	107,851	98,450
Organic Materials	Biosolids	357,116	296,114
	Food and Beverage Materials	100,470	81,611
	Yard Trimmings, Brush, and Green Waste	2,289,542	5,824,824
Other Materials	Construction and Demolition Materials	3,136,727	3,259,909
	Electronic Materials	42,725	17,546
	Batteries	440	627
	Paint[2]	2,306	3,266
	Textiles	16,507	12,567
	Tires	69,474	109,971
Uncategorized	Uncategorized[3]	27,932	123,031
TOTAL		**9,172,769[4]**	**12,911,034**

1. *The number shown in the table represents the portion of material that is MSW. Quantity includes the portion of recycled MSW metals processed at scrap metal facilities. More information is provided in Section 2.*
2. *Paint was not included as a material category in SEIR. Quantity shown is consistent with the methodology used in RMDP and is based on the 2015 HHW reports gathered and analyzed as part of SEIR.*
3. *Includes all MSW recyclables classified as "Other" by survey respondents. Respondents were required to provide a description. Respondents primarily reported commingled recyclables in 2019.*
4. *Total of material categories included in Table 3-1. Total MSW recycling reported in SEIR (9,171,707 tons) excluded paint and included compact fluorescent lamps (CFLs) and mercury-containing products.*

3.5 QUALITY OF RECYCLED MSW MATERIALS

The recyclability of materials can be impacted by the quality of material, as measured by contamination levels. Contamination reflects the inclusion of non-recyclable materials with recyclable materials. This section focuses on the quality of recycled materials for single stream materials and organics, as these materials can be significantly impacted by contamination levels. The Project Team provided a weighted average contamination rate and ranges for contamination rates based on survey responses. The weighted average provides an understanding of the average contamination rate based on the total tonnage of recycled materials in Texas. The range provides an understanding of the varying contamination rates reported among the facilities.

Specific to single stream materials, statewide recycling survey efforts have tracked continually increasing contamination rates. The 2013 TRDI study reported an average contamination rate of 13.0 percent for MRFs that responded to the survey. The 2015 SEIR study reported an 18.3 percent contamination rate for single-stream MRFs. For the 2019 RMDP, survey respondents reported an average contamination rate of 22.4 percent for single-stream MRFs, a 22.2 percent increase over a four-year period.

The contamination rates for C&D materials are lower than single-stream materials, and C&D materials processing requires low contamination to meet end market specifications. Survey respondents reported an average contamination rate of 1.0 percent for C&D materials. Table 3-2 summarizes the contamination rates by recyclable material.

TABLE 3-2: AVERAGE CONTAMINATION RATE BY RECYCLABLE MATERIAL

Material	Contamination Rate	
	Weighted Average	Range
Single Stream Materials	22.4%	10% - 60%
C&D Materials	1.0%	N.R.[1]

1. *Multiple facilities reported a contamination rate of 1.0 percent*

Survey respondents stated that contamination was a key barrier to increasing recycling in Texas. Based on industry interviews, MRF operators stated contamination rates are a challenge for increasing recycling due to end markets continued focus on quality, which has driven MRF operators to remove more contamination prior to sending recycled material to end markets. Additional factors affecting contamination included the need for enhanced public education and outreach and clarification for the types of material accepted for the program. MRF operators reported that their facilities may receive materials that the public thinks can be recycled but are not acceptable recyclable materials. Contamination levels directly impact processing costs, including potential additional sorting staff or facility upgrades to remove additional contamination.

3.6 TEXAS MATERIALS RECOVERY FACILITIES (MRFS)

A large portion of Texas-generated MSW recyclables are sorted, processed, and baled at 31 materials recovery facilities (MRFs) within Texas and neighboring states.[17] Most MRFs accept comingled single-stream recyclables (with or without glass), but at least one fiber-only MRFs operates in the state.

In 2019, Texas MRFs reported processing 1.6 million tons of incoming material, resulting in 1.3 million tons of Texas-generated MSW recyclables.[18] Based on the 2015 SEIR results, Texas MRFs processed 1.5 million tons of incoming material, resulting in 1.2 million tons of Texas-generated MSW recyclables. In 2019, Texas MRFs processed more material (105,263 additional tons or a six percent increase) but produced only slightly more material output for manufacturing and end use (27,962 additional tons or a two percent increase) due to rising contamination.

Most MRFs provided capacity information during the survey, and facilities reported a total of 1.95 million tons of processing capacity in 2019, with facilities operating at 71 percent capacity on average. Based on reported information, estimated remaining capacity may be as high as 505,000 tons per year at Texas MRFs; however, regional capacity challenges may still exist. Over the next 18 months, 77 percent of Texas MRFs reported plans to increase capacity for processing recycled material.

3.7 INDUSTRIAL RECYCLING SUMMARY AND RECYCLING RATE

The scope of the 2019 RMDP also included recycling from industrial sources (i.e., agriculture and industrial sectors). Information regarding the processing and end use of industrial-sourced material was reported separately from MSW materials in the survey. While fewer responses were obtained compared to MSW recycling facilities, survey respondents and supplemental data included key large manufacturing sectors for the materials/commodities communicated in Table 3-3.

[17] In 2019, a very small portion of Texas-generated recyclables were processed at an out-of-state MRF. As of RMDP publication, that facility has closed.
[18] Processed and production values suggest a contamination rate of 18.75 percent (0.3 million tons divided by 1.6 million tons), which is lower than the 22.4 percent single-stream contamination rate reported in Section 3.6. This is because the 18.75 percent rate includes fiber MRFs. These facilities, which accept primarily or exclusively paper and cardboard, report significantly lower contamination rates due to the primarily or exclusively accepting material from commercial or industrial sources (e.g., large retail, printing companies).

TABLE 3-3: MANUFACTURING SUBSECTORS WHERE INDUSTRIAL DATA WAS OBTAINED

Manufacturing Subsector	Data Obtained[1]
Paper and Paperboard Manufacture	✓
Pulp and Cellulose Product Manufacture	✓
Glass Container Manufacture	✓
Fiberglass Manufacture	✓
Composting/Mulching	✓
Plastic Product Manufacture[2]	✓
Chemical Recycling	✓
Metal Manufacture	✓

[1] *Includes both survey data and supplemental sources*

A total of 6.9 million tons of Texas-generated industrial recycling was identified based on data collected through the RMDP survey as well as supplemental data received from other sources. The data does not include any extrapolation of tons recycled, but only what was documented through the overall RMDP efforts. Table 3-4 communicates the types of materials and relative quantities recycled from industrial sources. A significant majority of identified industrial recycling was ferrous metals (83.5 percent), followed by non-ferrous metals (8.2 percent) and composted crop residues and manures (4.9 percent). Metal recycling tonnages provide a robust estimate of metals recycling as supplemental data sources described in Section 3.3 were used to address data gaps in survey responses. The reported quantities for all other materials are likely underestimates; and while the Project Team believes actual rates of industrial recycling quantities are higher, the results demonstrate that recycling is occurring for various industrial material types within the State.

TABLE 3-4: MATERIALS RECYCLED FROM INDUSTRIAL SOURCES IN 2019

Material		2019 RMDP (tons)	Percent of Total[1]
Total Recyclables	Glass	27,350	0.4%
	Metals - Ferrous[2]	5,776,436	83.5%
	Metals - Non-Ferrous[2]	564,882	8.2%
	Paper - Cardboard	112,266	1.6%
	Paper - Mixed Paper	28,326	0.4%
	Paper - Office Paper	19,297	0.3%
	Paper - Other	42,049	0.6%
	Plastics - PET (#1)	2,160	<0.1%
	Plastics - HDPE (#2)	1,523	<0.1%
	Plastics - Film	515	<0.1%
	Plastics - Containers #3-7	3,370	<0.1%
Organic Materials[3]		336,146	4.9%
Total		6,914,320	100%

1. *Percentages rounded for ease of presentation.*
2. *Quantity includes the portion of recycled industrial metals processed at scrap metal facilities. More information is provided in Section 2.*
3. *Includes crop residue and manure*

4 ESTIMATED AMOUNT OF RECYCLABLE MATERIALS THAT COULD BE RECYCLED, BUT ARE DISPOSED

Each year recyclable materials are disposed in MSW landfills. This section estimates the amount and composition of recyclable materials generated and disposed in Texas. Waste types accepted at MSW landfills in Texas include MSW (e.g., household waste, solid wastes from commercial sources), C&D, Other MSW (e.g., special wastes such as water and wastewater treatment sludges), and non-hazardous industrial wastes (NHIW). Estimated tonnages of materials disposed are based on quantities reported by Texas landfills through the TCEQ Municipal Solid Waste Annual Reporting Program. Tonnages do not include materials imported from other states or Mexico.

4.1 COMPOSITION OF RECYCLABLE MATERIALS DISPOSED IN MSW LANDFILLS

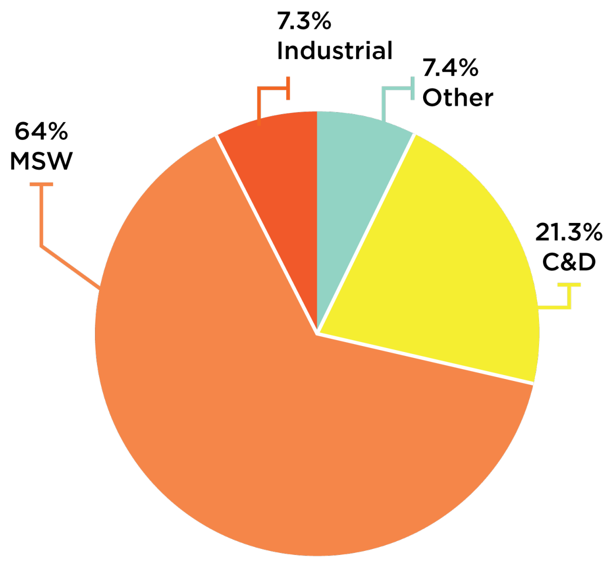
In 2019, an estimated 36,536,957 tons of solid waste, including recyclable material, was generated in-state and subsequently disposed in Texas MSW landfills. MSW and C&D materials accounted for most of the material, 23.4 million and 7.8 million tons, respectively. The 36.5 million tons of Texas-generated waste disposed in MSW landfills includes NHIW, with an estimated 509,079 tons of Class 1 NHIW and 2,174,200 tons of Class 2 and Class 3 NHIW disposed in 2019. Table 4-1 and Figure 4-1 present the estimated tonnage and composition of solid waste generated and disposed in Texas by waste type. The following sections provide additional composition information for each waste type.

TABLE 4-1: TONNAGE DISPOSED IN MSW LANDFILLS BY WASTE TYPE (2019)

Waste Type	Percentage	Tonnage Disposed
MSW	64.0%	23,379,895
C&D Materials	21.3%	7,772,988
Other[2]	7.4%	2,700,795
Industrial[3]	7.3%	2,683,279
TOTAL	100.0%	36,536,957

1. *Percentages rounded for ease of presentation.*
2. *Other includes solid waste other than MSW and C&D materials such as brush, sludge, septage, contaminated soil, regulated and non-regulated asbestos-containing material, tires, and medical waste. Does not include Class 1, Class 2, or Class 3 non-hazardous industrial waste (NHIW).*
3. *Includes Class 1, Class 2, and Class 3 NHIW disposed in MSW landfills. NHIW waste is also disposed in industrial landfills in the State.*

FIGURE 4-1: DISPOSAL COMPOSITION BY WASTE TYPE (2019)



Composition of MSW Disposed

MSW composition varies from region to region based on various factors, such as percentages of residential versus commercial sectors, access to recycling programs, and vegetative growth. Multiple large cities in Texas and regional planning agencies, including, but not limited to the cities of San Antonio and El Paso and the North Central Texas Council of Governments (NCTCOG), have completed solid waste characterization studies over the past five years. After reviewing these studies, the Project Team developed an estimate of MSW composition. First, the Project Team estimated the quantity of MSW generated by residences versus commercial establishments. Then, the Project Team estimated the composition of residential MSW based on the residential waste characterization studies in Texas.[1] For commercial MSW, the Project Team estimated the composition based on the El Paso and Dallas waste characterization studies, since those were the only identified recent studies to separately evaluate the composition of commercial MSW.[2]

Table 4-2 and Figure 4-2 present the estimated composition and tonnage of MSW disposed in Texas by material category and whether it was recyclable. As indicated by the rows shaded in Table 4-2, there are substantial types of MSW disposed in Texas that could potentially be recycled. While there is an understanding that not all the material in the shaded rows could be recycled, it represents a total of 12,321,295 tons, or 52.7 percent, of the total 23,379,895 tons.

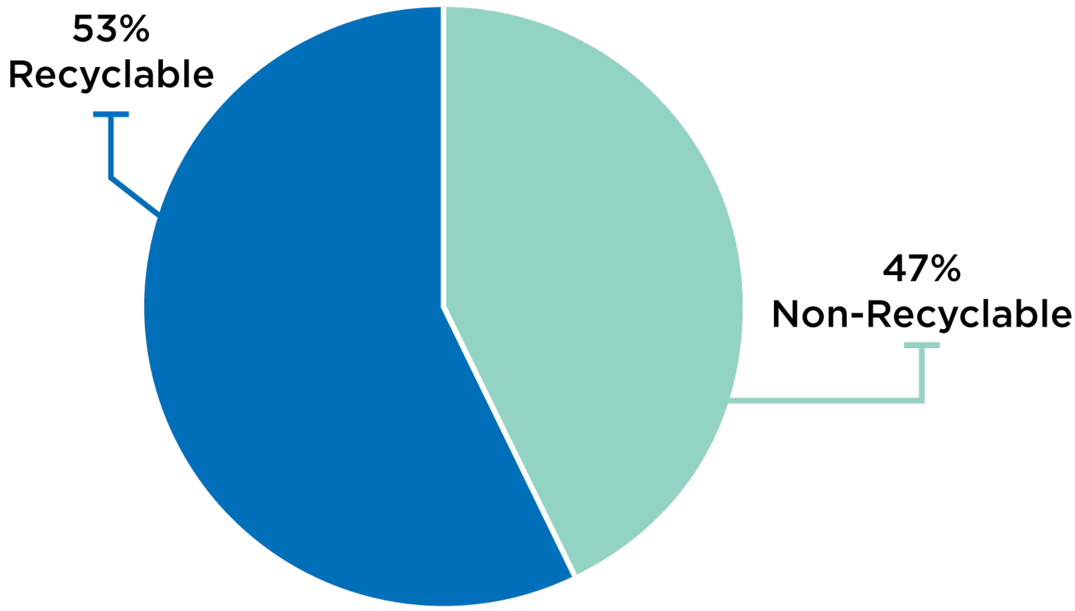
[1]Composition based on waste characterization studies for other cities and regional planning agencies in Texas, including, but not limited to, San Antonio, El Paso, and NCTCOG.
[2]Data from the City of Dallas waste characterization study was included in the 2015 Study on the Economic Impacts of Recycling. This data was also used for the Recycling Market Development Plan since additional commercial composition data (other than from the City of El Paso) was unavailable.
[3]Advancing Sustainable Materials Management: 2017 Fact Sheet. U.S. Environmental Protection Agency. 2019. Available online at https://www.epa.gov/sites/production/files/2019-11/documents/2017_facts_and_figures_fact_sheet_final.pdf

TABLE 4-2: COMPOSITION OF MSW DISPOSED BY MATERIAL CATEGORY (2019)

Material Group	Material Category[1]	Percentage[2]	Tonnage Disposed[3]
Paper	Cardboard	9.2%	2,151,346
	Office Paper	1.3%	306,471
	Mixed (Other Recyclable)	6.7%	1,564,396
	Other (Non-Recyclable)	11.1%	2,605,198
	Subtotal	**28.3%**	**6,627,411**
Plastics	PET #1	1.7%	387,469
	HDPE #2	1.4%	319,683
	Plastics #3-7	0.9%	201,516
	Plastic Bags & Film Wrap (Recyclable)[4]	0.6%	142,345
	Plastic Bags & Film Wrap (Non-Recyclable)[4]	2.6%	607,687
	Other Plastic	7.6%	1,765,513
	Subtotal	**14.8%**	**3,424,213**
Metals	Ferrous[5]	1.9%	433,491
	Non-Ferrous[5]	1.2%	283,481
	Subtotal	**3.1%**	**716,972**
Glass	Glass	3.9%	908,487
	Subtotal	**3.9%**	**908,487**
Organics	Yard Trimmings, Brush, and Green Waste	3.2%	753,345
	Food and Beverage Materials	18.5%	4,320,480
	Textiles[6]	2.7%	635,265
	Diapers	0.6%	149,192
	Other Organics	5.9%	1,376,755
	Subtotal	**30.9%**	**7,235,037**
C&D Materials	Clean/Unpainted C&D Aggregates	0.1%	13,882
	Clean/Unpainted C&D Wood[6]	4.9%	1,156,627
	Other C&D Materials	5.9%	1,384,577
	Subtotal	**10.9%**	**2,555,086**
Other	Batteries	<0.1%	5,214
	Electronics	1.1%	265,697
	Paint	<0.1%	194
	Tires	1.1%	263,798
	Other	5.9%	1,377,786
	Subtotal	**8.2%**	**1,912,689**
Subtotal Recyclable[4]		**52.7%**	**12,321,295**
Subtotal Non- Recyclable[4]		**47.3%**	**11,058,600**
TOTAL		**100.0%**	**23,379,895**

1. *Shaded rows represent materials that are included as potentially recyclable.*
2. *Percentages based on material category tonnage divided by total tonnage. Percentages rounded for ease of presentation.*
3. *Composition based on waste characterization studies for other cities and regional planning agencies in Texas, including, but not limited to, San Antonio, El Paso, and NCTCOG.*
4. *Film plastics are recyclable and are included within the RMDP. However, only a portion was assumed to be recyclable in the estimated tonnage of materials that could potentially be recycled, reflective of commercial generators generating high-quality, clean and dry film in sufficient quantities to bale on-site. The Project Team estimated this to be 20 percent of commercial film, or 142,345 tons out of 750,032 tons landfilled. The remaining 607,687 tons of film plastics were assumed to be non-recyclable.*
5. *Quantity includes MSW metals that would likely be processed through scrap metal processors. More information is provided in Section 2.*
6. *These materials are recyclable but have not been a point of emphasis in recycling programs and are not included in SB 649. For a conservative estimate, the Project Team decided against including these materials in the estimates tonnage of materials that could potentially be recycled.*

FIGURE 4-2: COMPOSITION OF MSW DISPOSED BY RECYCLABLE OR NON-RECYCLABLE (2019)



The Project Team compared the estimated MSW composition for Texas to the national composition of MSW disposed as reported by U.S. EPA[3]. Paper accounted for a higher percentage of MSW disposed in Texas; 28.3 percent in Texas versus 13.1 percent nationally. Metals and plastics accounted for a lesser percentage of MSW disposed in Texas; 3.1 percent in Texas versus 9.9 percent nationally for metals, and 14.6 percent in Texas versus 19.2 percent nationally for plastics. In addition, food and beverage materials, yard trimmings, brush, and green waste and glass accounted for a lesser percentage of the MSW disposed in Texas in comparison to average composition of MSW disposed nationally. Table 4-3 compares the composition of MSW disposed post diversion in Texas to the national composition.

TABLE 4-3: COMPOSITION OF MSW DISPOSED BY MATERIAL GROUP/CATEGORY IN TEXAS VERSUS UNITED STATES (2019)

Material Group/Category[1]	Texas	National	Difference
Paper	28.3%	13.1%	15.2%
Plastics	14.6%	19.2%	(4.6%)
Metals	3.1%	9.9%	(6.8%)
Glass	3.9%	4.9%	(1.0%)
Food and Beverage Materials	18.5%	22.0%	(3.5%)
Yard Trimmings, Brush, and Green Waste	3.2%	6.2%	(3.0%)
Other	28.4%	24.7%	3.7%
TOTAL	**100.0%**	**100.0%**	

1. *Material groups and categories revised to allow comparison of Texas and national composition of MSW disposed. Material groups and categories not listed above are included in Other. Texas composition based on previously cited studies. National data based on previously cited data from the U.S. EPA.*

[4] *Construction and Demolition Material Recovery Facility Feasibility Study*. North Central Texas Council of Governments. August 2007.

Composition of C&D Materials Disposed

Like MSW, the composition of C&D materials varies from region to region. Therefore, the Project Team developed a Texas-specific estimate of C&D materials composition based on the C&D waste characterization completed by R.W. Beck for the North Central Texas Council of Governments as part of a C&D MRF Feasibility Study.[4] The C&D MRF Feasibility Study included waste characterization data from more than 600 loads of C&D material. This study is the only publicly available C&D waste characterization study in Texas of which the Project Team is aware.

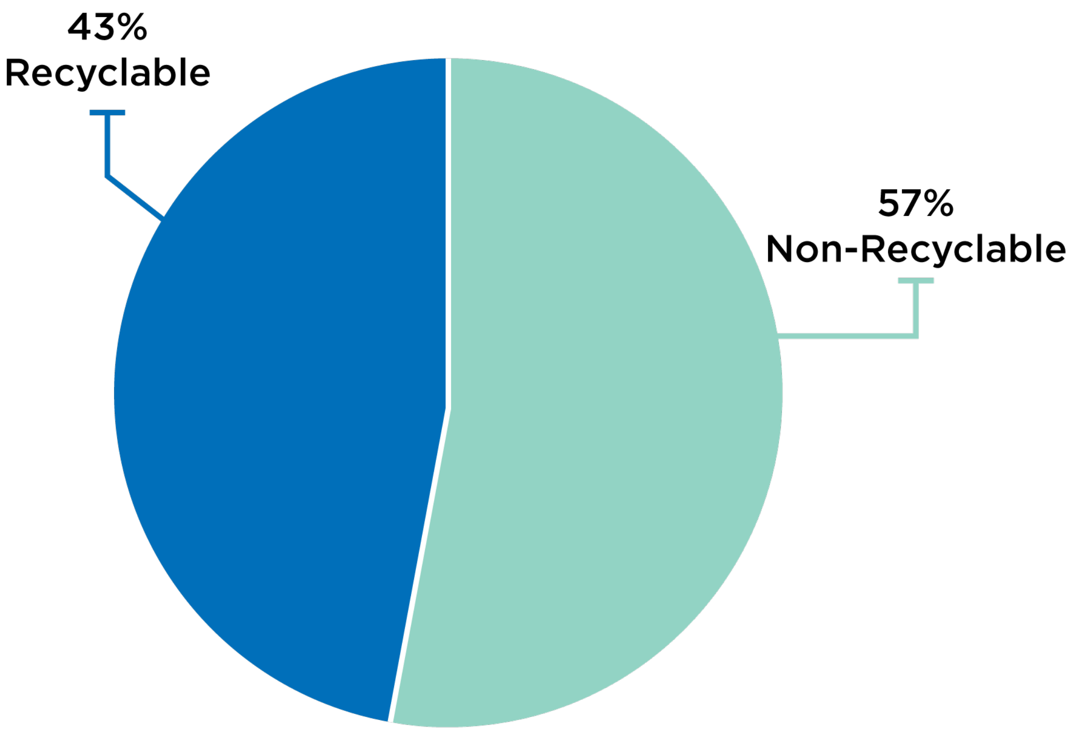
Table 4-4 and Figure 4-3 present the estimated composition and tonnage of C&D material disposed in Texas by material category and whether it was recyclable. The tonnage of C&D materials reported in Section 3 is generally consistent with the material group C&D materials in Table 4-4. Concrete/cement was the largest C&D material currently disposed that could potentially be recycled, as shown in Table 4-4. C&D material also contains materials found in MSW. As indicated by the rows shaded, cardboard, ferrous metal, and brush are other types of materials contained in C&D being disposed that could be recycled and are generally an emphasis of recycling programs. In total, 3,319,066 tons, or 42.7 percent of the total 7,772,989 tons of C&D materials being disposed could potentially be recycled.

TABLE 4-4: COMPOSITION OF C&D MATERIALS DISPOSED BY MATERIAL CATEGORY (2019)

Material Group	Material Category[1]	Percentage[2]	Tonnage Disposed
C&D Materials	Concrete/Cement	28.5%	2,215,302
	Bricks/Cinder Blocks[4]	6.5%	505,244
	Asphalt[4]	5.4%	419,741
	Drywall/ Gypsum	3.9%	303,147
	Subtotal	**44.3%**	**3,443,434**
Paper	Cardboard	5.9%	458,606
	Other	1.3%	101,049
	Subtotal	**7.2%**	**559,655**
Metals	Ferrous	5.0%	388,649
	Subtotal	**5.0%**	**388,649**
Organics	Yard Trimmings, Brush, and Green Waste[3,4]	3.3%	256,509
	Wood Packaging[5]	2.7%	209,871
	Scrap Lumber[5]	7.4%	575,201
	Soil	21.1%	1,640,101
	Subtotal	**34.5%**	**2,681,682**
Other	Refuse	1.6%	124,368
	Other	7.4%	575,201
	Subtotal	9.0%	699,569
Subtotal Recyclable		**42.7%**	**3,319,066**
Subtotal Non-Recyclable		**57.3%**	**4,453,923**
TOTAL		**100.0%**	**7,772,989**

1. *Shaded rows represent materials that are recyclable and generally an emphasis of recycling programs.*
2. *Percentages rounded for ease of presentation.*
3. *Includes estimated quantity of brush disposed as C&D based on tonnage of C&D disposed reported in Municipal Solid Waste in Texas: A Year in Review FY 2019 Data Summary and Analysis by Texas Commission on Environmental Quality, 2020. Excludes brush disposed as MSW or Brush.*
4. *Yard trimmings, brush, and green waste in C&D is generally brush. The Project Team used the category Yard Trimmings, Brush, and Green Waste to be consistent with the RMDP definitions.*
5. *These materials are recyclable but have not been a point of emphasis in recycling programs. For a conservative estimate, the Project Team decided against including these materials in the estimated tonnage of materials that could potentially be recycled.*

FIGURE 4-3: COMPOSITION OF C&D DISPOSED BY RECYCLABLE OR NON-RECYCLABLE (2019)



Composition of Other MSW Disposed

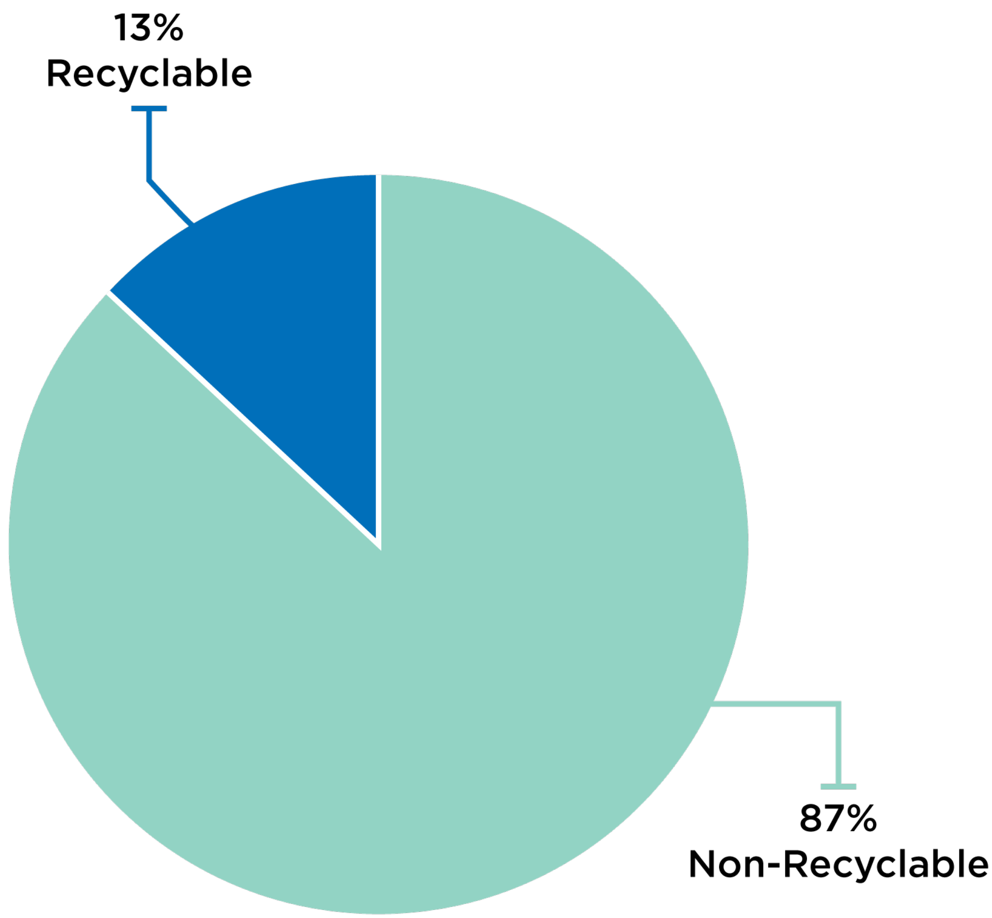
The estimated composition of other MSW is based on the waste types specified in the Municipal Solid Waste in Texas: A Year in Review FY 2019 Data Summary and Analysis. Table 4-5 and Figure 4-4 present the composition and tonnage of other waste disposed in Texas by material category and whether it was recyclable. As indicated by the shaded rows (brush, tires), 359,183 tons, or 13.3 percent of the total 2,700,795 tons of other waste being disposed could potentially be recycled.

TABLE 4-5: COMPOSITION OF OTHER WASTE DISPOSED BY MATERIAL CATEGORY (2019)

Material Category[1]	Percentage[2]	Tonnage Disposed
Brush[3]	10.8%	291,287
Sludge[4]	38.7%	1,046,377
Septage	1.0%	25,959
Contaminated Soil	29.5%	797,550
Tires	2.5%	67,896
Other	17.5%	471,726
Subtotal Recyclable	**13.3%**	**359,183**
Subtotal Non-recyclable	**86.7%**	**2,341,612**
TOTAL	**100.0%**	**2,700,795**

1. *Shaded rows represent materials that could potentially be recycled.*
2. *Percentages rounded for ease of presentation.*
3. *Includes quantity of brush disposed reported in Municipal Solid Waste in Texas: A Year in Review FY 2019 Data Summary and Analysis by Texas Commission on Environmental Quality, 2020. Excludes estimated quantity of brush disposed as MSW or C&D.*
4. *These materials are recyclable and are further discussed within the RMDP. However, these materials have not been a point of emphasis in recycling programs. For a conservative estimate, the Project Team decided against including these materials in the estimated tonnage of materials that could potentially be recycled.*

FIGURE 4-4: OTHER WASTE COMPOSITION BY RECYCLABLE OR NON-RECYCLABLE (2019)



Composition of Industrial Waste Disposed

An estimated 2,683,279 tons of NHIW were disposed in MSW landfills, which includes potentially recyclable Class 2 and Class 3 NHIW materials. An estimated 2,174,200 tons of Class 2 and Class 3 NHIW were generated in Texas and disposed in MSW landfills in 2019. An additional quantity of Class 2 and Class 3 NHIW was disposed in industrial landfills in the State, however this tonnage is not included in TCEQ's industrial and hazardous waste annual reporting.

Detailed Texas-specific composition data is needed to estimate the amount of Class 2 and Class 3 NHIW that could have been recycled; however, the Project Team is not aware of any available studies that examined industrial waste composition in the State. Recent detailed composition results from another state documented recyclables in NHIW streams managed at MSW landfills, including typical recyclables (e.g., glass, HDPE bottles, clean recoverable film), wood and lumber (e.g., pallets, crates), organic processing wastes (e.g., food and beverage processing waste), electronics, and concrete.[5]

Class 1 NHIW was generally considered non-recyclable due to being "toxic, corrosive, flammable, a strong sensitizer or irritant, a generator of sudden pressure by decomposition, heat, or other means, or may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed" as defined in 30 TAC §335.1(25).

[5] A 2018 waste composition study for the State of Missouri included detailed NHIW composition analysis. Results indicate that 30.2 percent of Missouri's industrial waste stream is recyclable (based on the material categories shaded in Table 4-2). The most prevalent recyclable materials were OCC, pallets and crates, and other paper.

4.2 AGGREGATE COMPOSITION OF RECYCLABLE MATERIALS DISPOSED

Based on the preceding tables in this section, there were 12,321,295 tons of MSW, 3,319,066 tons of C&D materials, and 359,183 tons of other waste that could have been recycled but were disposed. As shown in Figure 4-5, these 15,999,544 tons equal 43.8 percent of the total tons disposed in MSW landfills in Texas. An additional unknown quantity of NHIW could have been recycled but was disposed.

FIGURE 4-5: AGGREGATE COMPOSITION BY WASTE TYPE BY RECYCLABLE OR NON-RECYCLABLE (2019)

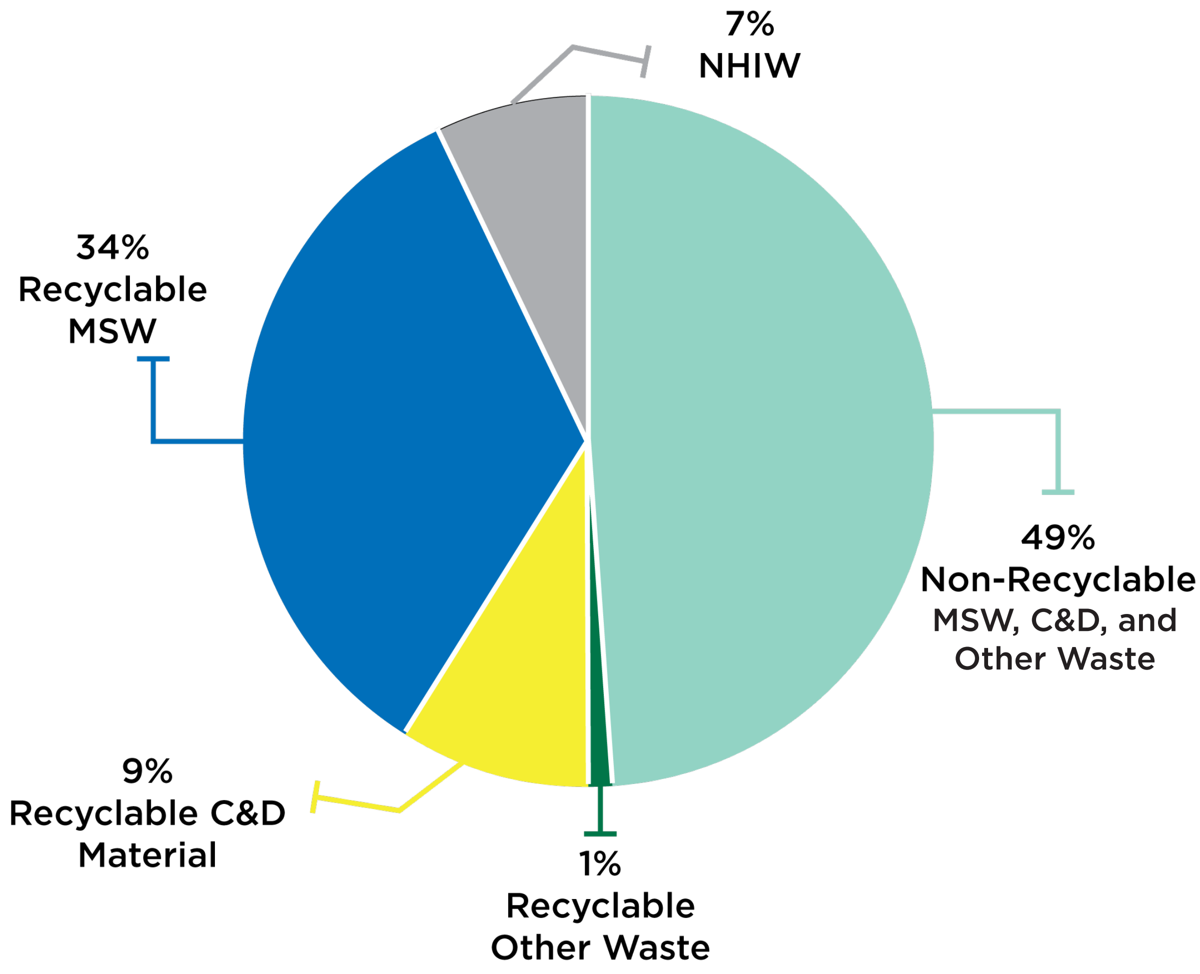


Table 4-6 presents the estimated tonnage of material disposed that could be recycled and an estimate of the percentage of the materials by category that could have been recycled, recognizing that not all material could be diverted. The Project Team provided a range based on recycling 20, 40, and 60 percent of the disposed material. Even though a material can be recycled, the Project Team used a range to recognize that it may be impracticable (from a cost, technological, and/or environmental perspective) for all of a material to be recycled due to lack of recycling infrastructure, contamination of recyclable materials, access to end markets, and need for additional public education and outreach. Subsequent sections of this Plan describe the existing material supply and demand and markets (Section 7), identify the materials and market opportunities that are likely to have the largest impact (Section 8), and recommend strategies and institutional and administrative actions to support increased use of recycled material feedstocks (Sections 9 and 10).

TABLE 4-6: AGGREGATE COMPOSITION OF DISPOSED MATERIAL BY WASTE TYPE BY RECYCLABLE MATERIAL CATEGORY (2019)

Waste Type	Recyclable Material Category	Total Tonnage Disposed[1]	Assumed Recovery Rate 20%	Assumed Recovery Rate 40%	Assumed Recovery Rate 60%
MSW	Glass	908,487	181,697	363,395	545,092
	Metals –Ferrous[2]	433,491	86,698	173,396	260,095
	Metals –Non-Ferrous[2]	283,481	56,696	113,392	170,089
	Paper	4,022,213	804,443	1,608,885	2,413,328
	Plastics[3]	1,051,013	210,203	420,405	630,608
	Organic Materials[4]	5,073,825	1,014,765	2,029,530	3,044,295
	Clean/Unpainted C&D Aggregates	13,882	2,776	5,553	8,329
	Other[5]	534,903	106,981	213,961	320,942
	Subtotal	**12,321,295**	**2,464,259**	**4,928,517**	**7,392,778**
C&D Materials	Concrete/Cement	2,215,302	443,060	886,121	1,329,181
	Paper	458,606	91,721	183,442	275,164
	Ferrous	388,649	77,730	155,460	233,189
	Brush	256,509	51,302	102,604	153,905
	Subtotal	**3,319,066**	**663,813**	**1,327,627**	**1,991,439**
Other	Brush	291,287	58,257	116,515	174,772
	Tires	67,896	13,579	27,158	40,738
	Subtotal	**359,183**	**71,836**	**143,673**	**215,510**
TOTAL		**15,999,544**	**3,199,908**	**6,399,817**	**9,599,727**

1. *Tonnages are for recyclable categories, based on Table 4-2, Table 4-4, and Table 4-5. Values may not sum to totals due to rounding. An additional unknown quantity of NHIW could have been recycled but was disposed.*
2. *Quantity includes MSW metals that would likely be processed through scrap metal processors. More information is provided in Section 2.*
3. *Includes a portion of film plastics representative of commercial generators generating high-quality, clean and dry film in sufficient quantities to bale on-site (142,345 tons). The remaining 607,687 tons of film plastics were assumed to be non-recyclable and are not included in Table 4-6.*
4. *Includes food and beverage materials and yard trimmings, brush, and green waste.*
5. *Includes batteries, electronics, paint, and tires.*

5 VALUE OF MATERIALS RECYCLED AND DISPOSED

Materials such as typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and C&D materials have market value as inputs to manufacturing and other end uses. This section estimates the value of MSW and industrial materials recycled in Texas in 2019 (as discussed in Section 3) and the potential value of recyclable MSW materials that could be recycled but were disposed (as discussed in Section 4). As noted in Section 4, a portion of the landfilled industrial waste stream is likely recyclable. However, the data necessary to estimate the potential value of these materials (i.e., a detailed Texas-specific composition study of landfilled industrial waste) does not currently exist. As a result, industrial materials were not included in the estimate of potential value of materials that could be recycled but were disposed.

5.1 APPROACH TO ESTIMATING MATERIAL VALUE

Recyclable materials may be priced at various points in the recycling process (e.g., the tipping fee at a processing facility, the commodity price for sorted and baled material). For consistency with the RMDP's emphasis on manufacturing and market development, the Project Team estimated the gross value of recyclable materials in Texas using average commodity prices representative of the value of the recycled material feedstocks for manufacturing and other end uses. Material-specific values were determined based on the following methodology.

Typical Recyclables

As a commodity, the value of paper, plastics, metal, and glass recyclables changes daily. The value of baled typical recyclables (such as the material leaving MRFs) is tracked on a national and regional basis by RecyclingMarkets.net (a subscription-based, recycling data provider). Additionally, market values are also tracked for material that have undergone secondary processing, for example facilities that accept baled plastics for additional sortation, grinding, and pelletizing.

Paper, Ferrous and Non-Ferrous Metals

Some typical recyclables (such as paper, ferrous and non-ferrous metals) are commonly sorted, aggregated, and brokered directly from a MRF to end users such as paper mills. For these materials, commodity values are based on the five-year average of applicable regional market indices, as provided by RecyclingMarkets.net for associated bale grades.

Plastics

Baled plastics typically undergo secondary processing such as additional sortation, cleaning, grinding, and pelletizing prior to being purchased by manufacturers and other end users. To represent the value to manufacturers, commodity values for plastics are based on five-year average pellet prices for applicable resin types, as provided by Plastics News online (a subscription-based, plastics data provider). This approach updates the methodology applied during SEIR, when values were based on post-MRF baled plastics. The post-MRF baled plastics are communicated within the footnotes of Tables 5-1 and 5-2 that summarize material values.

Glass

Recovered glass from MRFs typically undergoes secondary processing at beneficiation facilities for additional color sorting, cleaning, and size-reduction prior to being used for manufacturing for containers, plate glass, and fiberglass. To represent the value to manufacturers, the commodity value for glass was based on values obtained through interviews with local processors.

Organics

The value of organics depends on the end product (mulch or compost) and is regionally driven based on local markets. Many areas within Texas have developed high quality mulch and compost products, generating extensive demand. Other regions of the State struggle with creating demand for this material. The value of mulch and compost is based on price per cubic yard, which varies from typical recyclables that are based on price per ton. To represent the value of organics, values of finished compost and mulch were based on information obtained through interviews with local processors. Even though the value per cubic yard of mulch is lower than compost, producing mulch typically requires less material as compared to compost. Therefore, the value depends on not only the price per cubic yard, but also the amount of material needed for production.

C&D

The value of C&D materials depends on the material. Concrete, aggregate, and cement represent a significant amount of the C&D materials stream. Values for other materials that are often a part of the C&D materials stream, such as ferrous metal and cardboard, are established by the market indices discussed for typical recyclables. However, the value of concrete, aggregate, and cement was proprietary to the C&D facilities in Texas. The average value of the C&D stream was based on information obtained through interviews with local processors and industry reports and research.

5.2 ESTIMATED ANNUAL VALUE OF RECYCLED MSW MATERIAL IN TEXAS

Approximately 12.9 million tons of MSW material were recycled in Texas in 2019 (as discussed in Section 3.4). Typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and C&D materials accounted for 12.3 million tons, or 95.6 percent of the total tons of MSW recycled materials in Texas. Based on an average commodity market for typical recyclables, organics, and C&D materials, $821 million worth of MSW materials were recycled in Texas in 2019. Table 5-1 summarizes the gross value of MSW materials recycled in Texas in 2019.

TABLE 5-1: ESTIMATED ANNUAL GROSS VALUE OF RECYCLED MSW MATERIAL IN TEXAS (2019)

Material		Annual Tonnage[1]	Rounded Value[3]	Basis
Typical Recyclables	Glass	168,469	$10,950,000	$65/ton[4]
	Metals – Ferrous[2]	522,971	$61,710,000	$118/ton[5]
	Metals – Non-Ferrous[2]	177,446	$210,100,000	$1,184/ton[5]
	Paper	2,214,232	$166,000,000	$75/ton[5,6]
	Plastics	98,450	$85,730,000	$871/ton[7,8,9]
Organics		5,906,435	$267,560,000	$30/CY for compost[4,10,11]
C&D Materials		3,259,909	$19,560,000	$6/ton[4]
	TOTAL	**12,347,912**	**$821,610,000**	

1. *Annual tonnage is based on the tons of recycled material in Texas in 2019 discussed in Section 3.3.*
2. *Quantity includes the portion of recycled MSW metals processed at scrap metal facilities. More information is provided in Section 2.*
3. *Value excludes costs of collection, processing, and public education and outreach. Values are rounded to the nearest $10,000.*
4. *Values are based on interviews with local processors and industry reports and research.*
5. *Values are based on the five-year averages for regional market indexes, as provided by RecyclingMarkets.net.*
6. *Includes 1,430,571 tons of cardboard valued at $90/ton, 98,878 tons of sorted office paper valued at $145/ton and 684,783 tons of mixed paper valued at $32/ton.*
7. *Values are based on five-year averages for pelletized resins, as provided by Plastics News online, and are representative of post-reclamation recycled plastic feedstock.*
8. *Includes 38,679 tons of PET #1 valued at $1,183/ton, 21,431 tons of HDPE #2 valued at $1,070/ton, 5,035 tons of Containers #3-7 valued at $21/ton and 29,448 tons of film plastics valued at $575/ton. Plastics reported as other plastics (3,857 tons) were not assigned value due to challenges identifying some material types and reported limited demand.*
9. *The corresponding value of this material as post-MRF baled plastics is $25,100,000 (equivalent to $255/ton) based on the five-year averages for regional market indexes, as provided by RecyclingMarkets.net.*
10. *Includes food and beverage materials and yard trimmings, brush, and green waste. Excludes biosolids and other organics such as grease trap waste included as "Uncategorized" in Figure 3-2.*
11. *CY - cubic yard. The industry value of compost and mulch is based on price per cubic yard. Due to the diversity of organics materials, the Project Team assumed a conservative value of $30/CY for compost or approximately $16/CY for mulch. The assumed value for mulch is lower than compost because mulch has a higher yield rate (i.e. producing mulch requires less material than producing compost). Organics includes 81,611 tons of food and beverage materials and 5,824,824 tons of yard trimmings, brush, and green waste for a total of 5,906,434 tons of organics. For a conservative estimate, assumes producing 1.51 CY of compost per ton of organics (i.e., 1.51 multiplied by 5,906,435 tons of organics) for a total of approximately 8.9 million CY of compost valued at $30/CY. The above estimate is equivalent to producing 2.83 CY of mulch per ton of yard trimmings, brush, and green waste (i.e., 2.83 multiplied by 5,824,824 tons of yard trimmings, brush, and green waste) for a total of approximately 16.5 million CY of mulch valued at approximately $16/CY.*

5.3 ESTIMATED ANNUAL VALUE OF RECYCLED INDUSTRIAL MATERIAL IN TEXAS

Approximately 6.9 million tons of industrial material were recycled in Texas in 2019 (as discussed in Section 3.7), comprised of 6,578,174 tons typical recyclables (paper, plastics, metal, and glass), and 336,146 tons organics (crop residues and manures). Based on an average commodity market value for typical recyclables and organics, $1.4 billion in industrial materials were recycled in Texas in 2019. Scrap metal recycling accounted for 97 percent of the total value of recovered industrial materials reported through the RMDP survey. Table 5-2 summarizes the gross value of industrial materials recycled in Texas in 2019.

TABLE 5-2: ESTIMATED ANNUAL GROSS VALUE OF RECYCLED INDUSTRIAL MATERIAL IN TEXAS (2019)[1]

Material		Annual Tonnage[1]	Rounded Value[3]	Basis
Typical Recyclables	**Glass**	27,350	$1,780,000	$65/ton[4]
	Metals – Ferrous[2]	5,776,436	$681,620,000	$118/ton[5]
	Metals – Non-Ferrous[2]	564,882	$668,820,000	$1,184/ton[5]
	Paper	201,938	$15,150,000	$75/ton[5,6]
	Plastics	7,568	$4,550,000	$601/ton[7,8,9]
Organics		336,146	$15,230,000	$30/CY for compost[4,10,11]
	TOTAL	**6,914,320**	**$1,387,150,000**	

1. *Annual tonnage is based on the tons of recycled material in Texas in 2019 discussed in Section 3.3.*
2. *Quantity includes the portion of recycled industrial metals processed at scrap metal facilities. More information is provided in Section 2.*
3. *Value excludes costs of collection, processing, and public education and outreach. Values are rounded to the nearest $10,000.*
4. *Values are based on interviews with local processors and industry reports and research.*
5. *Values are based on the five-year averages for regional market indexes, as provided by RecyclingMarkets.net.*
6. *Includes 112,266 tons of cardboard valued at $90/ton, 19,297 tons of sorted office paper valued at $145/ton and 70,376 tons of mixed paper valued at $32/ton.*
7. *Values are based on five-year averages for pelletized resins, as provided by Plastics News online, and are representative of post-reclamation recycled plastic feedstock.*
8. *Includes 2,160 tons of PET #1 valued at $1,183/ton, 1,523 tons of HDPE #2 valued at $1,070/ton, 3,370 tons of Containers #3-7 valued at $21/ton and 515 tons of film plastics valued at $575/ton.*
9. *The corresponding value of this material prior to secondary processing is $1,350,000 (equivalent to $178/ton) based on the five-year averages for regional market indexes, as provided by RecyclingMarkets.net.*
10. *Includes crop residue and manure.*
11. *CY - cubic yard. The industry value of compost and mulch is based on price per cubic yard. Due to the diversity of organics materials, the Project Team assumed a conservative value of $30/CY for compost or approximately $16/CY for mulch. The assumed value for mulch is lower than compost because mulch has a higher yield rate (i.e. producing mulch requires less material than producing compost). Organics includes 336,146 tons of crop residue and manure. For a conservative estimate, assumes producing 1.51 CY of compost per ton of organics (i.e., 1.51 multiplied by 336,146 tons of organics) for a total of 507,580 CY of compost valued at $30/CY.*

5.4 ESTIMATED ANNUAL VALUE OF RECYCLABLE MSW MATERIALS DISPOSED

Approximately 16 million tons of recyclable MSW, C&D, and other non-industrial materials were disposed in Texas landfills in 2019 (as discussed in Section 4.2). Typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and C&D materials accounted for 15.4 million tons, or 96.2 percent of the total recyclable materials that were generated but disposed in Texas landfills. Based on average commodity market values for typical recyclables, organics, and C&D materials, $2.0 billion in materials went unrecycled in Texas in 2019. Table 5-3 summarizes the gross value of typical MSW recyclables, organics, and C&D materials disposed in Texas in 2019.

Table 5-3: ESTIMATED GROSS VALUE OF RECYCLABLE MSW DISPOSED IN TEXAS LANDFILLS (2019)[1]

Material		Annual Tonnage[1]	Rounded Value[3]	Basis
Typical Recyclables	**Glass**	908,487	$59,050,000	$65/ton[4]
	Metals – Ferrous[2]	822,140	$97,010,000	$118/ton[5]
	Metals – Non-Ferrous[2]	283,481	$335,640,000	$1,184/ton[5]
	Paper	4,480,819	$329,400,000	$74/ton[5,6]
	Plastics	1,051,013	$886,450,000	$843/ton[7,8,9]
Organics		5,621,621	$254,660,000	$30/CY for compost[4,10,11]
C&D Materials		2,229,184	$13,380,000	$6/ton[4]
	TOTAL	**15,396,746**	**$1,975,590,000**	

1. *Tonnages are for recyclable materials based on Table 4-6. Totals shown include material from residential, commercial, C&D, and other non-industrial generators.*
2. *Quantity includes MSW metals that would likely be processed through scrap metal processors. More information is provided in Section 2.*
3. *Value excludes costs of collection, processing, and public education and outreach. Values are rounded to the nearest $10,000.*
4. *Values are based on interviews with local processors and industry reports and research.*
5. *Values are based on the five-year averages for regional market indexes, as provided by RecyclingMarkets.net.*
6. *Includes 2,609,952 tons of cardboard valued at $90/ton, 306,471 tons of sorted office paper valued at $145/ton and 1,564,396 tons of mixed paper valued at $32/ton.*
7. *Includes a portion of film plastics representative of commercial generators generating high-quality, clean, and dry film in sufficient quantities to bale on-site. An additional 607,687 tons of other film plastics are not included in Table 5-3.*
8. *Values are based on five-year averages for pelletized resins, as provided by Plastics News online, and are representative of post-reclamation recycled plastic feedstock.*
9. *Includes 387,469 tons of PET #1 valued at $1,183/ton, 319,683 tons of HDPE #2 valued at $1,070/ton, 201,516 tons of Containers #3-7 valued at $21/ton and 142,345 tons of film plastics valued at $575/ton.*
10. *The corresponding value of this material as post-MRF baled plastics is $399,380,000 (equivalent to $380/ton) based on the five-year averages for regional market indexes, as provided by RecyclingMarkets.net.*
11. *Includes food and beverage materials and yard trimmings; brush from MSW, C&D, and other sources; and green waste. Excludes biosolids.*
12. *CY - cubic yard. The industry value of compost and mulch is based on price per cubic yard. Due to the diversity of organics materials, the Project Team assumed a conservative value of $30/CY for compost or approximately $16/CY for mulch. The assumed value for mulch is lower than compost because mulch has a higher yield rate (i.e., producing mulch requires less material than producing compost). For a conservative estimate, assumes producing 1.51 CY of compost per ton of organics (i.e., 1.51 multiplied by 5,621,621 tons of organics) for a total of 8.5 million CY of compost valued at $30/CY. The above estimate is equivalent to producing 2.83 CY of mulch per ton of yard trimmings, brush, and green waste (i.e., 2.83 multiplied by 1,301,140 tons of yard trimmings, brush, and green waste) for a total of 3.7 million CY of mulch valued at approximately $16/CY.*
13. *Includes concrete and clean/unpainted aggregate.*

6 THE STATEWIDE ECONOMIC IMPACTS OF RECYCLING

The act of recycling incorporates a broad range of activities that have an impact on the Texas economy. After a consumer uses and discards a recyclable material, it is collected, sorted, processed, and sold to end markets. Each of these post-use actions are done with the intent of preparing the recycled item for future use as feedstock for manufacturing. When recyclable materials have been sufficiently processed to be used as feedstock, they are transported from the processor to a manufacturer. The manufacturer feeds the recycled material feedstock directly into the manufacturing process, further processes it before use, or mixes the recycled material with virgin material before manufacturing. During each stage of this recycling process, from collection to manufacturing, economic activity is being generated in the form of employment, workers' wages, economic output, and public revenue. The purpose of this section is to estimate the statewide economic, employment, and fiscal impacts that are derived from recycling MSW and industrial materials.

6.1 OVERVIEW OF ECONOMIC IMPACT ANALYSIS

The traditional tool for estimating the economic impacts of an activity within a region is the input-output model. Input-output models replicate a region's economy by estimating "the movement of products and services between industries, households, and governments."[1] Economic impacts are estimated by manipulating these flows and observing the changes. The linking of these changes to a region's economy are described as either direct, indirect, or induced impacts, as defined below:

- Direct Impacts – Direct impacts represent changes to the expenditures or production of an industry or industries experiencing the change.
- Indirect Impacts – Indirect impacts represent the purchase of goods and services by the industry experiencing the change from other businesses in the regional economy. The input-output model also accounts for successive, iterative, backward linking expenditures by local industries.
- Induced Impacts – Induced impacts reflect the spending (wages and salaries) of employees in the affected direct and indirect industries, assuming they live within Texas.

The input-output model also reports economic indicators for each type of impact:

- Employment – A "job" in the input-output model does not necessarily denote permanent, ongoing employment. Instead, it represents a "person-year" of employment or the equivalent of one person working full-time for one year. These jobs may be new hires or the retaining of existing workers.
- Labor Income – Labor income is the value of workers' wages and benefits plus the profits earned by the self-employed. For this analysis, it was assumed that all employees worked for public agencies or firms as employees, so proprietor income was set to zero in the input-output model.
- Value Added – The equivalent of the gross domestic product (GDP) for a region. It is the sum of labor income, other property type income (e.g., corporate profits, interest income, and rental income), and indirect business taxes (taxes collected by business for government, like sales taxes, excise taxes, etc.).
- Output – The sum of the value-added expenditures, plus expenditures for intermediate goods and services of production.

6.2 ECONOMIC IMPACT ANALYSIS METHODOLOGY

The calculation of the economic impacts in the RMDP was performed using the Minnesota IMPLAN Group's (MIG) IMPLAN software. IMPLAN is a commonly employed tool for input-output analysis, which is used by governments, consultants, and academics. It estimates the economic effect of an activity, according to the types of impacts and indicators described in Section 6.1. Through MIG, the Project Team obtained the 2019 dataset for the Texas economy and set up a statewide input-output model. The estimates of recycling activities assessed in this economic impact analysis were divided into three categories: collection, processing, and long-haul transportation. Additionally, three expanded recycling scenarios were modeled to show how the economic impacts would change if the statewide volume of recycling increased by 20, 40, and 60 percent.

[1]Francis Day. No date. *Principles of Impact Analysis & IMPLAN Applications, First edition.* Minnesota IMPLAN Group: Huntersville, NC.

Estimated economic impacts for each of the three categories of recycling activity (i.e., collection, processing, and long-haul transportation) are based on the quantity of MSW recycling in 2019 and exclude industrial recycling because recyclable materials undergoing formal collection and processing are generally those from residential and commercial sources. Industrial materials, in contrast, are typically collected and transported by the generator. Industrial sourced materials also generally bypass processing, as industrial generators typically separate (such as by paper type or plastic resin) and aggregate or bale recyclable materials prior to delivery to a broker or end user. One exception to this assumption is industrial scrap metal recycling, which accounts for over 90 percent of the industrial recycling reported in Section 3. However, scrap metal recycling is excluded from the economic impact estimates presented in Tables 6-1 through 6-10, as directed by SB 649.

The economic impacts of manufacturing that incorporate recycled material feedstock were calculated and reported separately, since including them with the other activities would likely overstate the actual economic impacts of recycling in Texas. Estimates for manufacturing activity, which are communicated in Table 6-12, include both MSW and industrial materials, and exclude scrap metals as previously stated.

Consistent with the discussion on evaluating recycling rates in Section 3.2, it is important to note that the economic impact analysis in the RMDP is not directly comparable to other studies on the economic impacts of recycling. The findings in the RMDP are based upon assumptions about employees and payrolls, which relied upon information provided by responsive companies. Since participation in the RMDP survey was voluntary, past or future studies may be based on responses from different participants, which could lead to some variance in the results, even when using an identical methodology. Generally, the RMDP analysis erred on the side of being conservative, which means that the reported economic impacts from recycling in Texas are likely understated. Table 1-1 in the Executive Summary further details differences in the RMDP, as compared to other economic impact studies, which may have influenced the results.

Employment and Compensation Assumptions by Activity

Prior to estimating the economic impacts of recycling on the Texas economy, it was necessary to collect a significant amount of data from facilities to develop the inputs needed for the IMPLAN model. A description of the extensive data collection process undertaken by the Project Team to obtain this information is outlined in Section 2. Since there is specialization within the recycling industry, data about recyclables collection was gathered by material. The categories included organics, C&D materials, electronics, tires, metals (ferrous and nonferrous), paper, plastics, and glass. MRFs offered another category that handled multiple comingled typical recyclables such as paper, plastic, metal, and glass. Employment estimates reported in this section are based on the tonnage quantities documented in Section 3. The wages and benefits reported are not only for the staff who work directly on processing materials, but also include personnel focused on management, marketing, and administrative tasks. Additionally, benefits like health insurance and retirement are a component of the overall assumed cost of employees.

Collection

Employment estimates for recyclables collection are shown in Table 6-1 by material type. Employment estimates for each material type were made using the reported tonnage of MSW recyclable material collected by residential generators and commercial entities. The Project Team utilized a proprietary database developed by Burns & McDonnell, which is based on multiple studies of recyclables collection entities, to estimate the number of workers required to collect the tonnage reported. To validate this source, the Project Team also reviewed U.S. Bureau of Labor Statistics employment data and ultimately determined that the proprietary dataset was more appropriate, since it is directly focused on the collection of the types of recyclable materials that are the focus of this Study.

When quantifying the number of employees, the Project Team targeted collection activities where the gathering of recyclable material is the direct responsibility of the job, as opposed to being incidental to the job. The Project Team also excluded some material categories from the number of collection jobs, since the waste generator may be responsible for collection activities or collection may be a minor task for the job.[2]

Among the three divisions of activities (i.e., collection, processing, and long-haul transportation), the collection of recyclable materials contributed the most direct jobs to the Texas economy in 2019, with statewide employment of 6,843 workers. The collection of organics accounted for the most collection jobs

[2] For example, HHW is typically collected by a resident bringing the material to a collection center or a drop-off event. Similarly, industrial recyclables are commonly collected and transported by the generator directly to manufacturers.

with more than 4,500 workers across Texas. MRFs, which handle a wide array of recyclable materials from the residential and commercial waste stream, had an estimated 1,606 workers. The number of jobs created by the collection of C&D materials, non-ferrous metals, and ferrous metals categories were 380, 56, and 166 workers, respectively.

Utilizing information from the previously mentioned Burns & McDonnell dataset and the U.S. Bureau of Labor Statistics, the average annual wages and benefits for workers engaged in collection activities were similar, ranging from $44,213 to $48,308. While these wages were below the statewide average wage of $61,874 (according to the U.S. Bureau of Labor Statistics), recyclable material collection still provides a good wage to a segment of Texas' workforce that might otherwise be relegated to lower-paying jobs. The Project Team used salary estimates from the lower part of this range to be more conservative. Additionally, the wages from the lower end of the range appeared to be more directly correlated to the material types included in the RMDP. Statewide, the total payroll for workers in recyclables collection was estimated to be $311.7 million in 2019.

TABLE 6-1: ESTIMATED 2019 EMPLOYMENT, WAGES AND BENEFITS, AND TOTAL ANNUAL PAYROLL FOR RECYCLABLE MATERIALS COLLECTION IN TEXAS

Recyclable Material/ Facility	Employment	Estimated Average Wages and Benefits[1]	Estimated Total Payroll[2]
Organics	4,526	$44,213	$200,108,038
C&D Materials	380	$47,357	$17,995,660
Typical Recyclables/MRF	1,606	$48,308	$77,582,648
Tires	109	$48,308	$5,265,572
Non-ferrous Metals[3]	56	$48,308	$2,705,248
Ferrous Metals[3]	166	$48,308	$8,019,128
TOTAL[1]	**6,843**	**$45,547**	**$311,676,294[4]**

1. Total average wages and benefits is weighted by the number of workers collecting each type of material.
2. Payroll is equal to material category employment multiplied by average wages and benefits.
3. Includes the portion of MSW metals recycling processed at scrap metal facilities. Does not include scrap metal recycling from industrial sources. More information is provided in Section 2.
4. Total is sum of estimated total payroll for each material category.
Source: Burns & McDonnell, 2020 and U.S. Bureau of Labor Statistics, 2019.

Processors

Following collection, recyclables are typically transported to facilities for sorting, processing, consolidation, and cleaning (as required), in preparation to become feedstock. In the case of organics, post-collection processing (such as sorting and depackaging) and end use activities are typically performed at a single entity, such as a composting facility. These activities may be performed by the same workers, and as a result, the employment and payroll information reported for organics processing included both processing and end use (i.e., the production of compost or mulch).

Many of the processing facilities that responded to the survey provided information regarding the number of jobs and payroll associated with their operations. However, estimates of employment at ferrous and non-ferrous metal processors were based on statewide employment data from the U.S. Bureau of Labor Statistics under the category of *NAICS 423930 Recyclable Material Merchant Wholesalers*, which avoided the confidentiality concerns of using the survey data These employment figures were adjusted by the estimated share of recyclable ferrous and non-ferrous metal sourced from MSW, as described in Section 3.

During 2019, recycling processing facilities employed approximately 3,717 workers in Texas. The largest shares were employed at MRFs and metal (ferrous and non-ferrous) processors, with an estimated 1,375 and 900 workers, respectively. The recycling of organic materials into compost generated 713 jobs and the estimated employment for the remaining materials can be found in Table 6-2. The wages for workers in processor activities had a broader range than collection activities, ranging from a low of $30,969 annually to a high of $57,743, based upon the earlier mentioned Burns & McDonnell dataset.

TABLE 6-2: ESTIMATED 2019 EMPLOYMENT, WAGES AND BENEFITS, AND TOTAL ANNUAL PAYROLL FOR PROCESSORS IN TEXAS

Recyclable Material/ Facility	Employment	Estimated Average Wages and Benefits[1]	Estimated Total Payroll[2]
Organics[3]	713	$57,652	$41,105,876
C&D Material	379	$47,959	$18,176,461
Electronics	177	$32,119	$5,685,063
Typical Recyclables/MRF[4]	1,375	$57,743	$79,396,625
Tires	173	$30,969	$5,357,637
Metals (ferrous and non-ferrous)[5]	900	$53,084	$47,775,600
TOTAL[1]	**3,717**	**$53,119**	**$197,497,262**[6]

1. Total average wages and benefits is weighted by the number of workers collecting each type of material. All values in 2019 dollars.
2. Payroll is equal to material category employment multiplied by average wages and benefits.
3. Employment and payroll information for organics processing also includes end use (the production of compost or mulch).
4. Includes secondary processing or beneficiation.
5. Includes the portion of MSW metals recycling processed at scrap metal facilities. Does not include scrap metal recycling from industrial sources. More information is provided in Section 2.
6. Total is sum of estimated total payroll for each material category.
Source: Burns & McDonnell, 2020 and U.S. Bureau of Labor Statistics, 2019.

Long-Haul Transportation

The long-haul transportation of recyclable materials generates relatively modest statewide employment. The Project Team only included jobs where recyclable material was being hauled to an end-user or manufacturing facility in Texas, and the number of jobs were estimated based on haul distances and commercial vehicle payload capacities. As detailed in Table 6-3, the total estimated number of workers statewide was 128, with approximately two-thirds of those drivers hauling recyclable paper materials. The average wage and benefits for these jobs totaled $60,418, which is less than the typical long-haul driver. However, most, if not all, of these drivers were expected to work a home-based schedule, which does not require the driver to spend multiple days on the road and, subsequently, these jobs offer lower pay.

TABLE 6-3: ESTIMATED 2019 EMPLOYMENT, WAGES AND BENEFITS, AND TOTAL ANNUAL PAYROLL FOR RECYCLABLE MATERIALS LONG-HAUL TRANSPORTATION IN TEXAS

Material Transported	Employment	Estimated Average Wages and Benefits	Estimated Total Payroll[1]
Paper	88	$60,418	$5,316,784
Glass	19	$60,418	$1,147,942
Non-ferrous Metal[2]	5	$60,418	$302,090
Ferrous Metal[2]	16	$60,418	$966,688
TOTAL	**128**	**$60,418**	**$7,733,504**

1. Payroll is equal to material category employment multiplied by average wages and benefits. All values are in 2019 dollars. Conveyed plastics recyclables were not included in these transportation employment estimates because the volumes were judged to be negligible.
2. Includes the portion of MSW metals recycling processed at scrap metal facilities. Does not include scrap metal recycling from industrial sources. More information is provided in Section 2.
Source: Burns & McDonnell, 2020 and U.S. Bureau of Labor Statistics, 2019.

Assigning Recycling Activities to Industry Sectors in the IMPLAN Model

The next step of the economic impact analysis was to assign each recycling activity to a specific industry sector in the IMPLAN model. Within the IMPLAN software, the Texas economy is parsed into 546 sectors. However, the range of activities within each industry sector varies and some industry sectors in the IMPLAN software are very specific (e.g., *287 Elevator and Moving Stairway Manufacturing or 318 Irradiation Apparatus Manufacturing*), while other sectors lump together and represent a much broader range of activities (e.g., *473 Business Support Services or 413 Nonstore Retailers*). Recycling activities were first classified using the 2017 North American Industry Classification System (NAICS)[3], allowing the corresponding industry sectors in the IMPLAN model to be identified.

Collection

Under the NAICS, the collection of various types of recyclable materials falls within a single broad category of activities called 562 *Waste Management and Remediation Services*.[4] As activities become more specialized, the NAICS categorization can become more detailed, in accordance with the recyclable materials being collected. For example, the NAICS describes "collecting and removing debris, such as brush or rubble, within a local area" as *562111 Waste Collection Services, Nonhazardous Solid*. This classification is appropriate for both the collection of organic materials and C&D materials for recycling. There is also a NAICS categorization for "the collecting and/or hauling [of] mixed recyclable materials within a local area" that includes the collection of MSW recyclables. This activity is described as 562111 Recyclable Material Collection Services and it is closely aligned with the collection of typical recyclables (i.e., paper, plastic, metal, and glass) destined for processing at MRFs. The NAICS does not differentiate between the collection of ferrous and non-ferrous metals, which are probably most closely aligned with *562111 Recyclable Material Collection Services*. Regardless, the IMPLAN model's documentation shows how the various NAICS categories correspond with the IMPLAN model's 546 industry sectors. All of these collection activities fall within a single broad IMPLAN sector called *479 Waste Management and Remediation Services*. Therefore, all assumptions about collection activities (i.e., employment and payroll) were entered into the IMPLAN model under Sector 479, as shown in Table 6-4.

TABLE 6-4: ASSIGNMENT OF COLLECTION ACTIVITIES TO IMPLAN SECTORS

Recyclable Material/Facility	2017 NAICS	IMPLAN Sector
Organics	562111 Waste Collection Services, Nonhazardous Solid	479 Waste Management and Remediation Services
C&D Materials	562111 Waste Collection Services, Nonhazardous Solid	479 Waste Management and Remediation Services
Typical Recyclables/MRF	562111 Recyclable Material Collection Services	479 Waste Management and Remediation Services
Non-ferrous Metals	562111 Recyclable Material Collection Services	479 Waste Management and Remediation Services
Ferrous Metals	562111 Recyclable Material Collection Services	479 Waste Management and Remediation Services

Source: U.S Census Bureau, 2016 and MIG, 2019.

Processors

The categorization of processors offered slightly more differentiation in the IMPLAN model than did collection activities. The processing of organic materials was categorized under NAICS *562219 Lawn Waste Disposal Facilities* (see Table 6-5). MRFs were categorized under NAICS *562920 Materials Recovery Facilities*. Activities under this category, as described by the U.S. Census Bureau, include (1) operating facilities for separating and sorting recyclable materials from nonhazardous waste streams (i.e., garbage) and/or (2) operating facilities where commingled recyclable materials, such as paper, plastics, used beverage cans, and

[3] The North American Industry Classification System (NAICS) is the standard for analyzing and publishing economic statistics. The 2017 Manual is the most recent version and was published in the Federal Register on August 8, 2016. The next planned revision is in 2022.
[4] Starting with its 2018 datasets, MIG revised its industry scheme to include a total of 546 industry sectors. As part of the revision, the numbering assigned to some industry sectors was changed and, as a result, may not align to the industry sector numbering in the 2015 SEIR study.

metals, are sorted into distinct categories." The remaining processor and end user activities most closely fit into a broad sector called *423930 Recyclable Merchant Wholesalers*, which contains specific materials like electronics and tires, as well as more general descriptions of recyclable materials. Since there was not a NAICS category that closely aligned to the recycling of C&D materials, NAICS 423930 Salvage, Scrap, Merchant Wholesalers was judged to be the best fit. Again, the IMPLAN model did not provide much granularity with its sectors. After referencing IMPLAN's crosswalk between its industry sectors and the NAICS categories, organics facilities and MRFs were included under *Sector 479 Waste Management and Remediation Services* and the remaining materials were classified as *Sector 396 Wholesale - Other Durable Goods Merchant Wholesalers.*

TABLE 6-5: ASSIGNMENT OF PROCESSING ACTIVITIES TO IMPLAN SECTORS

Recyclable Material/ Facility	2017 NAICS	IMPLAN Sector
Organics	562219 Lawn Waste Disposal Facilities	479 Waste Management and Remediation Services
C&D Materials	423930 Salvage, scrap, merchant wholesalers	396 Wholesale -Other Durable Goods Merchant Wholesalers
Electronics	423930 Electronics parts, recyclable, merchant wholesalers	396 Wholesale -Other Durable Goods Merchant Wholesalers
Typical Recyclables/MRF	562920 Materials Recovery Facilities	479 Waste Management and Remediation Services
Tires	423930 Tires, scrap, merchant wholesalers	396 Wholesale -Other Durable Goods Merchant Wholesalers
Metals (ferrous and non-ferrous)	423930 Metal scrap and waste merchant wholesalers	396 Wholesale -Other Durable Goods Merchant Wholesalers

Source: U.S Census Bureau, 2016 and MIG, 2019.

Long-Haul Transportation

Transportation plays an essential role in the collection, consolidation, and delivery of recyclable materials to manufacturers for end use. However, when accounting for the economic impacts of transportation, they are often integrated into the description of the primary activity. As a result, activities related to the local hauling of recyclables are considered part of the general NAICS category of *562 Waste Management and Remediation Services*. Therefore, transportation expenditures were captured under collection activities and it was not necessary to enter local transportation into the IMPLAN model as a separate activity. However, the long-haul movement of recyclables, such as to a distant processor or end user or from a processor to a manufacturer would be a distinct economic activity and is categorized as NAICS *484230 Waste Hauling, Nonhazardous, Long-Distance*. In the IMPLAN model, long-haul trucking would be classified under Sector *417 Truck Transportation*.

6.3 THE ECONOMIC IMPACTS OF RECYCLING ON THE TEXAS ECONOMY

Based upon the results in Tables 6-6 through 6-9, the total impact of Texas' 2019 recycling industry on the State's economy was estimated to be more than $4.8 billion of economic output and 22,910 person-years of employment.[5] While the total employment of the recycling industry only contributed 0.2 percent of the State's total employment, the sector was roughly similar in size to the State's petroleum refining industry (22,976 workers) and its furniture manufacturing industry (23,399 workers). Workers in the recycling industry earned estimated wages and benefits that were valued at more than $1.2 billion. Collectively, these workers contributed more than $2.3 billion of value-added activities to Texas' economy in 2019. Employment that is directly related to the State's recycling industry totaled 10,688 person-years. These workers were responsible for the collection, processing, and transportation of recyclable materials in Texas. They earned an income estimated at $530.1 million and they produced $1.1 billion of value-added activity. Indirect

[5]A person-year of employment is the equivalent of one person working a full-time job for one-year. It does not necessarily imply the creation of a permanent job that lasts for multiple years.

employment, which is generated from expenditures by local governments and firms that handle recycled materials, as well as subsequent rounds of spending by the firms that serve their suppliers, was equivalent to 6,651 person-years of employment, while income expenditures by recycling industry workers generated another 5,571 person-years of induced employment across the Texas economy. As previously described in this section, industrial recyclable materials generally do not require the same level of collection and processing as MSW materials. One key exception is industrial scrap metal processing which is excluded from the RMDP based on the defined recyclable materials listed in SB 649. However, if the data was included in the RMDP, the Project Team estimates that industrial scrap metal processing contributed an additional $13.9 billion of economic output and 45,195 person-years of employment in 2019.

TABLE 6-6: SUMMARY OF TOTAL ECONOMIC IMPACT OF THE RECYCLING ON THE TEXAS ECONOMY

Measure	Direct	Indirect	Induced	Total
Employment	10,688	6,651	5,571	**22,910**
Labor Income	$530,138,619	$438,691,364	$291,138,384	**$1,259,968,367**
Value Added	$1,168,883,317	$670,826,952	$505,151,582	**$2,344,861,851**
Output	$2,675,693,086	$1,253,442,126	$899,740,454	**$4,828,875,666**

Detailed estimates of the economic impacts of each component of recycling (i.e., separated by collection, processing, and transportation and by the material handled) are provided in Tables 6-7 through 6-9. This breakdown of estimated economic impacts shows that the collection of recyclable materials was responsible for a total of 14,178 person-years of employment in the Texas economy during 2019. These collection activities also created $762.5 million of income for workers. The processing of recyclable materials contributed 8,463 person-years of employment and $481.3 million of income, even though the direct employment (3,717 person-years of employment) was substantially lower than the collection activities. The reason for this difference is the higher expenditures and wages in processing industries, which resulted in more indirect and induced employment. Finally, employment in long-haul trucking generated a total of 269 person-years of employment and $16.1 million of labor income, statewide.

Estimated Fiscal Impacts of Recycling

In addition to employment, workers' wages, and economic output, Texas' recycling industry also generates revenue for state and local governments. In 2019, the IMPLAN model estimates that the recycling industry generated more than $166.1 million in public revenue. Within this total was almost $78.0 million in sales tax revenue and $67.4 million in property taxes. Other taxes, fines, and fees paid to local and state governments totaled $20.7 million.

Comparison to 2015 SEIR Results

The RMDP results for 2019 indicate the total economic output of Texas' recycling industry is $1.5 billion higher than in 2015. This translates to a 43 percent increase compared to the 2015 SEIR estimate of approximately $3.4 billion. Total employment (direct, indirect, and induced) from recycling activities was 5,873 person-years higher than in 2015, a 34 percent increase compared to the SEIR result of 17,037 person-years. The State's recycling industry contributed over $400 million in additional labor income than in 2015 (a 47 percent increase compared to the SEIR result of approximately $857.0 million) due to increases in both employment and wages since 2015.

The total fiscal impacts of Texas' recycling industry were $28.2 million lower than in 2015, a 15 percent decrease compared to the 2015 SEIR estimate of $194.3 million. Most of this decrease occurred in sales tax revenue, which was $23 million lower than in 2015 (a 23 percent decrease). The Project Team believes the decrease is the result of changes in the allocation of employment by industry. As employment distribution has shifted since 2015, it has likely resulted in less proportional taxes paid per employee for the growing sectors and fewer workers in high-tax sectors.

TABLE 6-7: ECONOMIC IMPACT OF RECYCLABLES COLLECTION ON THE TEXAS ECONOMY

Material	Measure	Direct	Indirect	Induced	Total
Organics	Employment	4,526	2,642	2,202	**9,370**
	Labor Income	$205,226,138	$177,751,666	$115,090,601	**$498,068,405**
	Value Added	$477,433,137	$273,787,712	$199,690,660	**$950,911,509**
	Output	$1,134,192,333	$511,371,360	$355,675,423	**$2,001,239,116**
C&D Materials	Employment	380	217	190	**787**
	Labor Income	$18,452,494	$14,576,353	$9,925,363	**$42,954,210**
	Value Added	$40,737,469	$22,451,696	$17,221,524	**$80,410,689**
	Output	$93,008,345	$41,934,514	$30,673,740	**$165,616,599**
Typical Recyclables/ MRF	Employment	1,606	916	812	**3,334**
	Labor Income	$79,573,840	$61,604,272	$42,424,571	**$183,602,683**
	Value Added	$173,757,181	$94,887,958	$73,611,257	**$342,256,396**
	Output	$393,082,632	$177,228,495	$131,111,015	**$701,422,142**
Tires	Employment	109	62	55	**226**
	Labor Income	$5,411,058	$4,181,112	$2,882,482	**$12,474,652**
	Value Added	$11,803,327	$6,440,092	$5,001,423	**$23,244,842**
	Output	$26,678,708	$12,028,584	$8,908,170	**$47,615,462**
Non-ferrous Metals	Employment	56	32	28	**116**
	Labor Income	$2,793,974	$2,148,094	$1,485,107	**$6,427,175**
	Value Added	$6,078,076	$3,308,671	$2,576,826	**$11,963,573**
	Output	$13,706,492	$6,179,823	$4,589,655	**$24,475,970**
Ferrous Metals	Employment	166	95	84	**345**
	Labor Income	$8,234,434	$6,367,565	$4,387,956	**$18,989,955**
	Value Added	$17,969,449	$9,807,846	$7,613,583	**$35,390,878**
	Output	$40,629,961	$18,318,761	$13,560,760	**$72,509,482**
Total - Collection	Employment	6,843	3,964	3,371	**14,178**
	Labor Income	$319,691,938	$266,629,062	$176,196,080	**$762,517,080**
	Value Added	$727,778,639	$410,683,975	$305,715,273	**$1,444,177,887**
	Output	$1,701,298,471	$767,061,537	$544,518,763	**$3,012,878,771**

TABLE 6-8: ECONOMIC IMPACT OF RECYCLABLES PROCESSING ON THE TEXAS ECONOMY

Material	Measure	Direct	Indirect	Induced	Total
Organics	Employment	713	407	399	**1,519**
	Labor Income	$42,070,628	$27,349,841	$20,859,936	**$90,280,405**
	Value Added	$83,884,278	$42,126,472	$36,195,393	**$162,206,143**
	Output	$174,513,023	$78,682,388	$64,468,338	**$317,663,749**
C&D Materials	Employment	379	332	224	**935**
	Labor Income	$18,628,447	$20,358,884	$11,715,886	**$50,703,217**
	Value Added	$43,474,956	$30,164,213	$20,327,422	**$93,966,591**
	Output	$103,291,308	$56,323,021	$36,205,936	**$195,820,265**
Electronics	Employment	177	155	88	**420**
	Labor Income	$5,843,913	$9,507,976	$4,613,823	**$19,965,712**
	Value Added	$17,447,693	$14,087,245	$8,004,580	**$39,539,518**
	Output	$48,238,952	$26,303,892	$14,257,385	**$88,800,229**
Typical Recyclables/ MRF	Employment	1,375	784	772	**2,931**
	Labor Income	$81,461,937	$52,743,387	$40,326,878	**$174,532,202**
	Value Added	$162,098,364	$81,239,695	$69,973,764	**$313,311,823**
	Output	$336,543,370	$151,736,735	$124,631,658	**$612,911,763**
Tires	Employment	173	152	85	**410**
	Labor Income	$5,503,389	$9,293,106	$4,446,950	**$19,243,445**
	Value Added	$16,844,936	$13,768,889	$7,715,022	**$38,328,847**
	Output	$47,148,805	$25,709,454	$13,741,649	**$86,599,908**
Metals (ferrous and non-ferrous)	Employment	900	788	560	**2,248**
	Labor Income	$49,005,560	$48,345,638	$29,253,673	**$126,604,871**
	Value Added	$108,007,827	$71,630,061	$50,756,933	**$230,394,821**
	Output	$245,282,802	$133,748,604	$90,404,871	**$469,436,277**
Total - Processing	Employment	3,717	2,618	2,128	**8,463**
	Labor Income	$202,513,874	$167,598,832	$111,217,146	**$481,329,852**
	Value Added	$431,758,054	$253,016,575	$192,973,114	**$877,747,743**
	Output	$955,018,260	$472,504,094	$343,709,837	**$1,771,232,191**

TABLE 6-9: ECONOMIC IMPACT OF RECYCLABLES LONG-HAUL TRANSPORTATION ON THE TEXAS ECONOMY

Material	Measure	Direct	Indirect	Induced	Total
Paper	Employment	88	47	49	**184**
	Labor Income	$5,445,190	$3,068,636	$2,558,459	**$11,072,285**
	Value Added	$6,417,189	$4,899,402	$4,438,956	**$15,755,547**
	Output	$13,321,244	$9,540,090	$7,906,402	**$30,767,736**
Glass	Employment	19	10	11	**40**
	Labor Income	$1,205,936	$662,546	$561,486	**$2,429,968**
	Value Added	$1,415,800	$1,057,825	$974,190	**$3,447,815**
	Output	$2,876,178	$2,059,792	$1,735,167	**$6,671,137**
Non-ferrous Metals	Employment	5	3	3	**11**
	Labor Income	$315,827	$174,354	$147,301	**$637,482**
	Value Added	$371,054	$278,375	$255,571	**$905,000**
	Output	$756,889	$542,051	$455,207	**$1,754,147**
Ferrous Metals	Employment	16	9	9	**34**
	Labor Income	$965,854	$557,934	$457,912	**$1,981,700**
	Value Added	$1,142,581	$890,800	$794,478	**$2,827,859**
	Output	$2,422,044	$1,734,562	$1,415,078	**$5,571,684**
Total – Transportation	Employment	128	69	72	**269**
	Labor Income	$7,932,807	$4,463,470	$3,725,158	**$16,121,435**
	Value Added	$9,346,624	$7,126,402	$6,463,195	**$22,936,221**
	Output	$19,376,355	$13,876,495	$11,511,854	**$44,764,704**

6.4 ECONOMIC IMPACTS OF EXPANDED RECYCLING SCENARIOS

Expanding the volume of recycled materials from MSW in Texas could create additional economic activity in the State. This section provides a brief overview of the potential economic benefits that could result from expanded statewide recycling based on a 20 percent, 40 percent, and 60 percent increase of recycling from 2019 levels. The changes to the employment assumptions of an input-output model generally increase the employment outputs in a linear fashion when other assumptions are adjusted uniformly.

It should also be noted that this analysis does not consider the incremental costs of additional recycling, which could make recycling programs less profitable or unprofitable. For example, higher transportation costs to serve remote locations, diminishing returns from undersized sorting facilities and equipment, and lower market prices could all be factors that make increased local recycling activities less profitable or unprofitable.

Ultimately, the potential profitability of a recycling program is dependent upon local and organizational conditions and the circumstances surrounding the recycler's operations and these must be considered on a case-by-case basis. This analysis also does not consider any incremental environmental impacts of recycling, which could make recycling program more or less environmentally beneficial. For example, the analysis does not evaluate the environmental impacts of collecting and hauling more recyclables.

The results from modeling the three expanded recycling scenarios are provided in Table 6-10. The model results are shown for each division of activity (collection, processing, and transportation) and the estimates were prepared using 2019 dollars, so the results would be comparable to the base analysis. The results show that a 60 percent increase in statewide recycling could create almost 13,750 new person-years of employment in Texas, with about half of those jobs directly related the collection, processing, and transporting of recyclable materials and the remainder due to indirect and induced impacts. A less ambitious goal of 20 percent growth in statewide recycling could still increase statewide employment by roughly 4,600 person-years, while a 40 percent increase could add more than 9,100 person-years of employment. These results do not account for the increased costs to add these jobs.

TABLE 6-10: TOTAL POTENTIAL ECONOMIC IMPACT OF INCREASED RECYCLING ON THE TEXAS ECONOMY

Material	Measure	Direct	Indirect	Induced	Total
Base 2019	Employment	10,688	6,651	5,571	**22,910**
	Labor Income	$530,138,619	$438,691,364	$291,138,384	**$1,259,968,367**
	Value Added	$1,168,883,317	$670,826,952	$505,151,582	**$2,344,861,851**
	Output	$2,675,693,086	$1,253,442,126	$899,740,454	**$4,828,875,666**
20 Percent Growth Scenario	Employment	12,826	7,981	6,685	**27,492**
	Labor Income	$636,166,343	$526,429,637	$349,366,061	**$1,511,962,041**
	Value Added	$1,402,659,980	$804,992,342	$606,181,898	**$2,813,834,220**
	Output	$3,210,831,703	$1,504,130,551	$1,079,688,545	**$5,794,650,799**
40 Percent Growth Scenario	Employment	14,963	9,311	7,799	**32,073**
	Labor Income	$742,194,067	$614,167,910	$407,593,738	**$1,763,955,715**
	Value Added	$1,636,436,644	$939,157,733	$707,212,215	**$3,282,806,592**
	Output	$3,745,970,320	$1,754,818,976	$1,259,636,636	**$6,760,425,932**
60 Percent Growth Scenario	Employment	17,101	10,642	8,914	**36,657**
	Labor Income	$848,221,790	$701,906,182	$465,821,414	**$2,015,949,386**
	Value Added	$1,870,213,307	$1,073,323,123	$808,242,531	**$3,751,778,961**
	Output	$4,281,108,938	$2,005,507,402	$1,439,584,726	**$7,726,201,066**

6.5 ECONOMIC IMPACTS OF TEXAS MANUFACTURERS USING RECYCLED MATERIAL FEEDSTOCKS

Another economic impact from recycling is the contribution of recycled materials as a feedstock for manufacturers. In many cases, the recycled material feedstock that goes into a manufacturing process is mixed with virgin material. Recycled material feedstocks may be mixed with virgin materials for a variety of reasons, including:

- Required or desired product specifications, such as physical properties (product strength, flexibility) or appearance (desired color, consistency of appearance)
- Additional costs associated with using recycled material feedstocks, such as more complex and expensive manufacturing processes or market conditions where virgin feedstocks may be less expensive than recycled feedstocks
- Limited availability of recycled feedstock for some materials or grades of material commodities
- Challenges reliably sourcing sufficient quantity or quality due to factors such as limited supply of specific commodities/grades or high contamination of recycled feedstocks

Although it is common in similar economic impact studies to incorporate the estimated economic activity related to manufacturing with recycled material feedstocks into the total economic impact of recycling, the Project Team decided not to combine the impacts of manufacturing with the impacts of collection, processing and transportation. This is because it is difficult to precisely discern how much economic activity is generated by manufacturers' use of recycled materials versus virgin materials. In some cases, manufacturers using recycled materials likely benefit monetarily from doing so, but could substitute virgin materials if necessary (e.g., glass, paper, and plastics). Other manufacturers may be more dependent upon the availability of recycled materials to justify locating their facility in Texas (e.g., ferrous and non-ferrous metals) and could not as easily source a virgin feedstock. Again, these factors vary widely according to a facility's function and circumstances, as well as market conditions. Since it would be very difficult, if not impossible, to accurately estimate these benefits, the manufacturing analysis in this section was provided for informational purposes only and relied upon a separate set of inputs for the IMPLAN model, which are described below.

Assigning Manufacturing Activities to Industry Sectors

The Project Team received total payroll and employment information from a limited number of manufacturing facilities through the RMDP survey. Complete payroll and employment data were provided by:

- Plastics: 3 companies
- Paper: 3 companies

Although multiple manufacturers in Texas use recycled glass feedstock, none of these facilities provided sufficient payroll and employment information. Employment and wages for glass container and fiberglass manufacturing were estimated based on data reported for the 2015 SEIR, adjusted for inflation using the Producer Price Index (PPI)[6]. For reasons previously discussed, estimates of employment at ferrous and non-ferrous metal manufacturers were based on statewide employment data from the U.S. Bureau of Labor Statistics. These figures were adjusted by the estimated share of recyclable materials from MSW. Estimated wages for ferrous and non-ferrous metal manufacturers were based upon data from the IMPLAN model. There are firms in Texas that did not provide sufficient payroll and economic information through the RMDP survey, so this information does not constitute a comprehensive estimate of the economic impacts of firms that use recyclable materials as feedstock. Collectively, the analysis accounted for 2,350 employees of manufacturers who incorporated recycled material feedstock from MSW or industrial sources, and the average annual salary and benefits for these workers was estimated to be $69,098.

As with the analysis of the economic impacts for recyclable material collection, processing, and long-haul transportation, it was necessary to assign each activity under an IMPLAN sector. Unlike collection, processing, and long-haul transportation activities, the manufacturing activities aligned very closely with NAICS and IMPLAN's sectors. The categorization of the model's inputs is shown in Table 6-11.

[6] Values were adjusted for inflation using PPI (not seasonally adjusted) for glass manufacturing based on U.S. Bureau of Labor Statistics data for 2015 through 2019.

TABLE 6-11: ASSIGNMENT OF MANUFACTURING ACTIVITIES TO IMPLAN SECTORS

Recyclable Material	2017 NAICS	IMPLAN Sector
Plastics	325991 Plastics resins compounding from recycled materials	183 Custom Compounding of Purchased Resins
Paper	322110 Pulp Mills	144 Pulp Mills
Glass	327213 Glass Container Manufacturing	201 Glass Container Manufacturing
Glass	327993 Fiberglass Insulation Products Manufacturing	213 Mineral Wool Manufacturing
Non-ferrous Metal	331314 Aluminum recovering from scrap and making ingot and billet (except by rolling)	220 Secondary Smelting and Alloying of Aluminum
Ferrous Metal	331110 Steel Mills	215 Iron and Steel Mills and Ferroalloy Manufacturing

Source: U.S. Census Bureau, 2016. MIG, 2019.

Economic Impacts of Manufacturing Firms that Incorporate Recycled Material Feedstock

The Texas manufacturers that incorporate recycled materials into their production processes included in this analysis were responsible for creating approximately 2,350 person-years of direct employment across Texas and more than 6,600 person-years of indirect and induced employment, as shown in Table 6-12. The total impact of these employers was 8,967 person-years of employment in 2019, with wages of $597.9 million and a total economic output of more than $3 billion. As described in Section 6.2, industrial scrap metal was excluded from the defined recyclable materials listed in SB 649. However, if the data was included in the RMDP, the Project Team estimates that manufacturing from industrial scrap metal recycled feedstocks contributed an additional $13.9 billion of economic output and 45,195 person-years of employment in 2019.

TABLE 6-12: ECONOMIC IMPACT OF MANUFACTURERS USING RECYCLED MATERIAL FEEDSTOCK ON THE TEXAS ECONOMY

Measure	Direct	Indirect	Induced	Total
Employment	2,350	3,917	2,700	**8,967**
Labor Income	$166,475,888	$290,333,142	$141,100,216	**$597,909,246**
Value Added	$321,478,876	$487,388,098	$244,821,856	**$1,053,688,830**
Output	$1,551,930,671	$1,038,494,973	$436,070,247	**$3,026,495,891**

Further expanding the availability of recycled materials for manufacturing feedstocks would have positive impacts on the Texas economy. However, some recycled materials are in higher demand than others, especially if they can offer costs savings to manufacturers over virgin inputs. Table 6-13 and Figure 6-1 show the total employment impact of adding 100 jobs to each of the recycled material manufacturing sectors, along with the additional tonnage of recycled material that would be needed to employ those 100 workers. The total employment generated includes the direct jobs added (i.e., 100), as well as the indirect and induced employment that result from those additional 100 jobs.

The recyclable material manufacturing sector with the greatest impact on the Texas economy is non-ferrous metals, which is estimated to create 529 additional jobs for each 100 jobs added. Expansion of the paper manufacturing sector by 100 jobs would add approximately 338 indirect and induced jobs in the State, in addition to the 100 direct jobs. Other manufacturing sectors analyzed in the IMPLAN model would also produce strong job growth.[7] The remaining industries are shown in Table 6-13 and Figure 6-1.

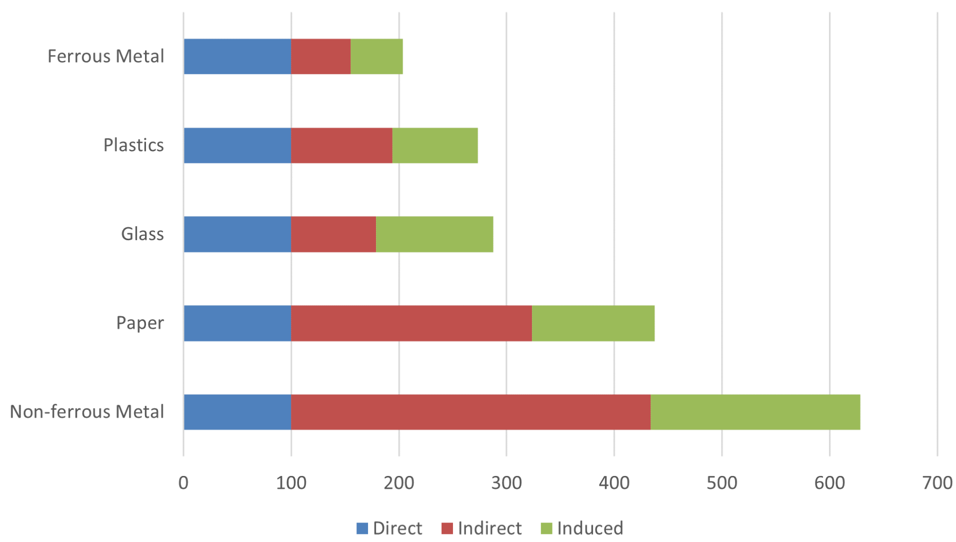
The amount of recycled material feedstock needed to support 100 direct manufacturing jobs varies by sector and material due to factors such as material properties and manufacturing processes. Adding 100 manufacturing jobs in glass and paper sectors would require less than a 15 percent increase in the amount of recycled feedstock in the State. By contrast, the plastics manufacturing sector would require an estimated 1,784 percent increase in recycled material feedstock to support an additional 100 plastics manufacturing jobs which would likely require importing material in addition to increasing recycling rates in Texas.

TABLE 6-13: JOBS CREATED AND RECYCLED FEEDSTOCK NEEDED FOR EVERY ADDITIONAL 100 DIRECT JOBS BY MANUFACTURING SECTOR

Material	Additional Direct Jobs	Total Jobs Created[1]	Additional Recycled Feedstock Needed[2]	Percent Increase in Recycled Feedstock Needed[3]
Ferrous Metals	100	203	155,845	**30%**
Plastics	100	273	950,250	**1,784%**
Glass	100	288	24,985	**13%**
Paper	100	438	155,173	**12%**
Non-ferrous Metals	100	629	173,471	**98%**

1. *Includes 100 direct jobs as well as the resulting indirect and induced employment.*
2. *Estimated recycled feedstock requirements for plastics, paper, and glass are based on operations and employment data reported by manufacturers and other end users. Values for ferrous and non-ferrous metals are based on U.S. Bureau of Labor Statistics data.*
3. *Percent increase is based on the estimated tonnages of Texas-generated recyclables that were used as feedstock at manufacturers and end users in Texas, as reported through the RMDP survey.*

FIGURE 6-1: INDIRECT AND INDUCED JOBS CREATED FOR EVERY ADDITIONAL 100 DIRECT JOBS BY MANUFACTURING SECTOR



[7] The multiplier of an industry is its total employment impact estimated by the IMPLAN model divided by 100. The paper manufacturing sector's multiplier is 4.38 meaning each job added creates a total of 4.38 jobs (a shorthand for direct, indirect, and induced employment).

Fiscal Impacts of Manufacturing Firms that Incorporate Recyclable Materials

According to the IMPLAN model results, Texas manufacturing firms that incorporate recyclable materials and that were included in this analysis contributed more than $61.1 million to state and local governments through taxes, fees, and fines. Notably, manufacturers paid $28.2 million in sales taxes and $24.4 million in property taxes, while additional taxes and fees totaled $8.5 million.

Comparison to 2015 SEIR Results

The RMDP results for 2019 indicate the total economic output from Texas manufacturing firms that incorporate recycled materials as feedstock is $59.5 million higher than in 2015. This translates to a 2 percent increase compared to the 2015 SEIR estimate of nearly $3.0 billion. Total employment (direct, indirect, and induced) is 493 person-years lower than in 2015, a 5 percent decrease compared to the SEIR estimate of 9,460 person-years; however, results indicate direct employment from manufacturers increased by 124 person-years (6 percent) since 2015 while indirect and induced employment fell. Total labor income is estimated to be $17.6 million lower than in 2015, a 3 percent decrease from the SEIR result of $615.5 million. The total fiscal impacts of Texas manufacturers using recycled material feedstocks is $16.9 million lower than in 2015, a 22 percent decrease from the SEIR result of $78 million.

7 SUPPLY AND DEMAND ANALYSIS

7.1 INTRODUCTION

This section presents an analysis of supply and demand for the commodities identified for the RMDP based on data obtained from the survey, stakeholder forums, in-depth interviews, internet research and other information obtained by the Project Team.

The primary aim of recycling market development is to maximize the amount of recyclable materials that move through markets from sellers to buyers via economically viable and stable programs. In a balanced economic system, supply and demand are in equilibrium. Towards this end, recycling market development activities are implemented to build healthy market conditions for recyclable materials. Healthy markets for a recyclable material have four elements:

- Sufficient quantity and quality of recyclable materials supply to meet demand, available at a price that buyers are willing to pay, and sellers are willing to accept;
- Sufficient capacity for processing recyclable materials into a form usable as feedstock;
- Manufacturing capacity adequate to absorb the processed material and produce recycled products; and
- Final product demand adequate to absorb the recycled products at a price profitable to the manufacturer.

In this context when demand and supply are assessed, it is in reference to demand for current recovered materials by end markets/product manufacturers. For example, the demand for recovered glass to manufacture new glass bottles, the demand for compost, and the demand for crumb rubber to use in manufacturing a product. In some cases, by nature, demand will be outside of Texas (e.g., aluminum smelters are regional markets). However, such demand is still significant, and the demand for materials supplied by MRFs and secondary processors such as plastics reclaimers and crumb rubber producers (and revenues paid to them, supporting the recycling system) can be beneficial to Texas despite the end market being elsewhere. Similarly, supply and demand may be different from one region to another, based on processing infrastructure and quantity of material generated.

In this section the Project Team explains these nuances such that imbalances are clearly identified and assessed. Where the Project Team has obtained such information, the ability/desire of secondary processors to obtain additional material is also described, as this is important in understanding the adequacy of the supply chain.

A detailed comparison of supply and demand of Texas-generated materials requires an understanding of material flows including: the amount of material processed for recycling, capacity and needs of end users, import and export activity, and potential recovered material feedstock supply (i.e., the amount of recoverable materials that is currently landfilled). The assessment of supply and demand is based primarily on the quantities of material recycled and landfilled in Texas in 2019 (as described in Sections 3 and 4, respectively). As described in Section 3, the RMDP recycling quantities are based on survey data and does not include extrapolation. For some materials, the reported recycling quantity is believed to be understated (details for each material are presented in Section 3.3 including the confidence level and a description of the responding facilities). In some cases, limited detailed information was provided through the RMDP survey. To address these potential gaps, the Project Team developed material-specific estimates using national-level data to supplement the recycling and landfilling estimates presented in Sections 3 and 4, respectively.

Structure of Remainder of Section

In the remainder of this report section, an assessment of the supply/demand balance is presented for each material type included in the RMDP, including:

- A broad description of the recycling systems in Texas;
- An overview of national, regional, and state material flows and markets;
- A summary of the nature of material supply;

- A summary of the demand for Texas-generated material; and
- A supply and demand comparison.

The material types described are as follows:

- Typical recyclables (paper, plastics, glass, metals);
- Organics (green waste, wood waste, food and beverage waste, biosolids, septage, and other organics);
- Construction and demolition (C&D) debris (wood waste; asphalt shingles; concrete, asphalt, brick, tile, and aggregate; drywall/plaster; and other C&D debris); and
- Other materials/materials handled through alternative means (tires, batteries, electronics, textiles and paint).

Following the discussion of supply and demand for each material type, a summary table is provided that describes the relationship between supply and demand for each material.

7.2 OVERVIEW OF TEXAS RECYCLING SYSTEMS

Below is an overview of the recycling systems in Texas by generator/generation location type.

Residential Recycling System

Residential recycling in the more densely populated areas of Texas is generally provided curbside for typical recyclables, including paper, aluminum and steel cans, glass containers and rigid plastic containers. Curbside services are available to the majority of the Texas population, though programs are notably less common in rural areas. Of the 69 urbanized areas in Texas (i.e., municipalities with a population of at least 50,000)[1] 83 percent have curbside recycling service available to residents.

In less populated areas, curbside becomes more of a challenge due to factors such as increased transportation distances and achieving economies of scale. In these areas, residents are largely served by municipal drop-off recycling programs. As The Recycling Partnership's 2020 State of Curbside Recycling Report indicates, there is a "curbside recycling dessert" in northern and western Texas. Combined, affected communities in this area represent over 815,000 Texans, or approximately three percent of the Texas population. Some cities have curbside programs in place, but glass is collected separately at drop-off locations. Drop-off recycling programs have lower participation rates and yield significantly less material per participant due to their reduced level of convenience.

In larger cities, residential organics (i.e., green waste, wood waste, and/or food waste) collection is frequently provided via curbside collection. Programs are primarily for green waste and wood waste: a handful of cities include food waste in their curbside programs. In less populated areas, organics collection may be provided via drop-off (typically for green/wood waste only).

For other materials (e.g., film plastics, batteries, textiles, paint, tires), typical collection options include drop-off collection location such as a retailer, nonprofit or private recycling business, municipal transfer station, or HHW collection facility or event depending on the material type. For example, film plastics are often accepted at return-to-retail locations such as dry cleaners and grocery stores, as it is problematic at MRFs. Batteries, paint, and tires are collected through HHW programs. Electronics may, in some cases, be returned through a mail-in program and sometimes through takeback programs.

Public Space Recycling System

Public space recycling systems pertain to those in public spaces, such as parks and other recreational areas. Often communities are hesitant to provide public space recycling for fear of contamination, as these locations are often unstaffed and therefore can become heavily contaminated.

[1] The urban-rural threshold varies in Texas statutes and the Texas Administrative Code (TAC). The 50,000 person threshold is used by the U.S. Census Bureau to define Census Urban Areas.

Industrial, Commercial, and Institutional Materials Recycling System

Industrial, commercial, and institutional (ICI) generators typically contract for recycling services with private haulers to manage MSW materials generated on-site (e.g., office and cafeteria wastes). In locations where disposal is costly, ICI generators can have a financial incentive to recycle, as recycling may be less costly than trash collection. Where disposal is inexpensive, however, generators often have no financial incentive to recycle and many businesses choose not to do so. Typical recyclable materials collected through the ICI sector may be delivered to a MRF that accepts residential materials, to a commercial-only processing facility, or in some cases directly to an end market.

Industrial Process Scrap Recycling System

Industrial waste in Texas is defined as solid waste resulting from, or incidental to, any process of industry or manufacturing, or mining or agricultural operation. Industrial waste could include manufacturing scrap, but it could also include materials consumed in the manufacturing processes, which would not be considered recyclable after use due to contamination. Industrial sector recycling is challenging to identify, and non-hazardous industrial waste is often managed with MSW, such as scrap plastic or metals. As a result, a strict accounting of commercial versus industrial waste and recycling is not always feasible. The U.S. EPA estimates that each year, approximately 7.6 billion tons of industrial solid waste are generated and disposed by a broad array of industrial facilities nationwide.[2] In the RMDP, some means of managing industrial waste (e.g., organics generated by the agricultural and food manufacturing sectors) are described.

Construction and Demolition Debris Recycling System

Constructions and Demolition (C&D) recycling is generally through hiring a hauler directly, or by delivering materials directly to a recycling facility. The C&D recycling system is comprised of a handful of processing facilities – some of which have conveyors and automated sorting and some of which sort manually. There are also several material-specific recyclers that manage concrete and aggregate, shingles, wood and metals.

7.3 PAPER

Recovered paper (or fiber) is one of the most widely recycled materials in the world. It is used at more than 75 percent of the paper mills across the U.S. and is exported to numerous countries around the world. Recovered paper is classified by ISRI into over 50 different grades. Most of the grades pertain to post-industrial fiber scrap, which is material that has been recycled for decades and has consistently remained out of the waste stream. Post-consumer fiber that comes from residential as well as commercial and institutional sources is the main focus of the RMDP, although an estimate of industrial sources is also included (defined herein to mean pre-consumer fiber generated, for example, by converters and over-issue publications). The RMDP examines the following categories of paper:

- **Sorted Office Paper (SOP)**, which is typically generated by offices, and primarily contains white and colored groundwood-free paper, free of unbleached fiber. High-yield sources include banks, insurance companies, print shops and office buildings.
- **Mixed Paper**, which is a mix normally generated from residential recycling programs, and may contain reading and writing paper, old newspapers and magazines, paperboard packaging such as shoe and cereal boxes, and other colored and groundwood papers.
- **Old Corrugated Containers (OCC)**, which includes corrugated containers, Kraft paper such as brown paper grocery bags, as well as cuttings for each. Pizza boxes are also included in this category. The primary source of OCC is commercial and manufacturing facilities; however, residential OCC has significantly increased with increases in e-commerce.
- **Other Paper**, which encompasses all other reported types of paper that are not included in the three categories above. This includes coated book stock, various grades of newsprint, sorted white ledger, double lined kraft, and food and beverage cartons that are not included in Mixed Paper bales.

Overview of Paper

Recovered paper can be recycled into a variety of products and packing, including recycled printing and office papers, toilet paper, towels, napkins, newsprint, paperboard, cellulose insulation, roofing felt, cushioning material for packaging and molded pulp products (e.g., egg cartons, nursery pots). The end markets and manufacturing uses of recycled paper depends on the category as shown in Table 7-1.

[2] U.S. EPA, "Guide for Industrial Waste Management," 2016

TABLE 7-1: PAPER CATEGORIES AND THEIR RECYCLING USES

Paper Category	Recycling Uses
Sorted Office Paper (SOP)	SOP may be mixed with virgin pulp to produce printing and office papers. Tissue products are also manufactured using a combination of sorted office paper, other high grades and virgin pulp.
Mixed Paper	Mixed Paper is considered the lowest grade of recovered paper due to its unpredictable fiber content and susceptibility to contamination. It is sometimes used as a fraction of feedstock in paperboard for use in making the backs of writing pads, food and shoe boxes, and other packaging applications. Approximately 39 percent of Mixed Paper marketed in the U.S. is used to produce paperboard, and another 37 percent goes into containerboard. The tissue market consumes 19 percent of the Mixed Paper produced, and the remaining 5 percent goes into other paper product and construction applications.[1]
Old Corrugated Containers (OCC)	OCC is used to make new containers, Kraft paper, linerboard and corrugated medium. OCC makes up about 71 percent of all recovered fiber consumed in the U.S.1[1]

[1] *Colin Staub, Resource Recycling, "Experts Talk Recycled Paper Realities and Forecasts," September 10, 2019.*

Characteristics of the Paper Recycling System

Most recovered paper is typically collected by haulers and taken to either an intermediate processing facility that may be a paper stock dealer (which typically handle mostly or exclusively commercial sources) or a materials recovery facility (MRF, which typically handle mainly residential as well as selected commercial and institutional sources). At these locations, the paper is screened to remove contaminants and sorted into designated grades for shipment to end users. Paper dealers and MRFs play a major role in supplying mills. These processors may be independent of the mill or a subsidiary organization. Processors are responsible for the quality of the delivered paper. Mills may not buy paper from particular suppliers if contamination is a problem.

A substantial amount of paper from commercial and manufacturing facilities, such as OCC, is baled and transported directly to specific end users with no intermediate processing.

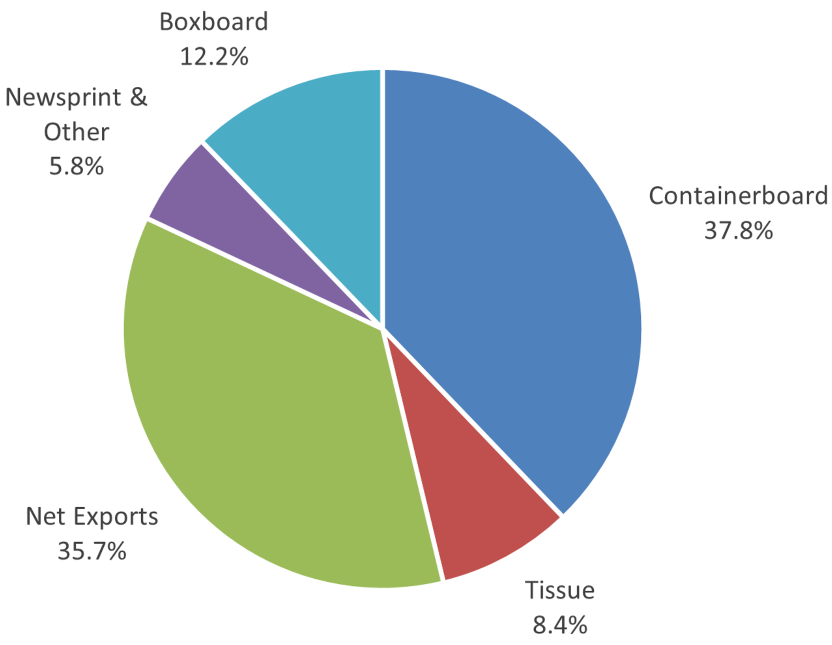
Brokers are involved in assisting some generators and processors with accessing markets, particularly export markets. The American Forest and Paper Association (AF&PA) estimates the U.S. recovery rate for paper in 2019 to be 66.2 percent and for OCC alone to be 92 percent.[3]

U.S. Markets for Paper

In the U.S. about 37 percent of paper and paperboard production is manufactured using recycled paper feedstocks.[4] A variety of products are made from recycled paper as shown in Figure 7-1 and Table 7-2, with containerboard representing the largest domestic paper market, followed by boxboard and newsprint and other. An estimated 35.7 percent of U.S. recovered paper was exported to China and other nations in 2019. China remains the largest buyer of U.S. paper, despite China's passage of its National Sword policy, with India and Mexico being the next largest buyers of U.S. recovered fiber.

[3] AF&PA Website, Assessed January 20, 2021.
[4] Bill Moore, Moore & Associates, July 2020.

FIGURE 7-1: U.S. RECYCLED PAPER MARKETS (2019)



Source: American Fiber and Paper Association and U.S. Census Bureau

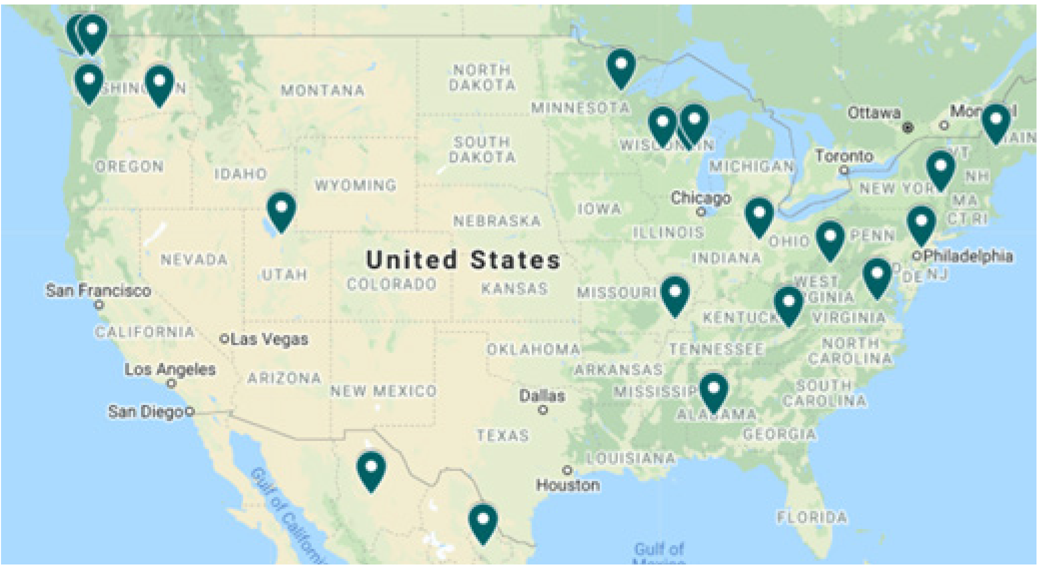
TABLE 7-2: U.S. RECYCLED PAPER MARKETS (2019)

Market	Tonnage Recycled	Percent of Total
Tissue	4,150,000	8.44%
Containerboard	18,605,000	37.83%
Boxboard	6,004,000	12.21%
Newsprint & Other[1]	2,844,000	5.83%
Net Exports	17,574,000	35.74%
Total	**49,177,000**	**100%**

1. Other includes printing-writing, Kraft packaging & Industrial converting, construction paper and board, molded pulp.
Source: AF&PA, "2019 Annual Capacity and Fiber Consumption Survey;" and U.S. Census Bureau.

In response to changes in the global recovered fiber marketplace, multiple mill expansions and new mills have been announced in the U.S. and Mexico that will markedly expand domestic fiber demand over the next two years. Several of these are reflected in Figure 7-2, with additional projects announced since this map was produced. No new mills or mill expansions are known to be planned for Texas.

FIGURE 7-2: NEW MILL CAPACITY FOR OCC AND OCC+MIXED PAPER (2020-2022)



Source: Resource Recycling, "[These Projects are Boosting Domestic Capacity for Recycled Paper](#)," Dec. 6, 2019

The total new capacity reflects the potential for more than 5.0 million tons per year of new OCC and mixed paper consuming capacity in the U.S. plus over 1.0 million tons per year of recycled pulp.[5] With the new North America projects coming online, overseas export market volatility should have much less impact on market demand for U.S.-generated recovered fiber. Prices for virtually all fiber grades have already improved, and supply for some grades – particularly OCC – is tightening.

The coronavirus pandemic has substantially impacted certain fiber markets. As a result of business and school closures and more people working and schooling at home, less SOP and OCC from commercial sources are generated while residential sources of fiber are increasing. Less virgin fiber is used to make new paper products, given less of these products (e.g., printing and writing papers) is being used. Consequently, the fiber now recovered is lower in quality both with respect to the fiber itself and due to greater contamination since more is coming from residential sources. SOP is the predominant feedstock used in tissue production, and tissue demand is increasing. Consequently, this has increased demand for alternative fiber sources including use of more virgin fiber but also cups and other poly coated fiber sources such as cartons. Therefore, markets are improving for cartons and cups. Given more OCC is now generated via residential source, the capture rate for OCC has fallen due to households not setting out all their OCC for recycling and due to more OCC making its way into mixed paper – particularly the smaller boxes which are harder to sort out. With concerns over the availability of OCC supply, the paper industry has launched recycling participation campaigns as well as a specific campaign to encourage recycling of pizza boxes, if free of grease and food residue. Historically, pizza boxes were widely regarded as non-recyclable due to concerns about contamination.

Domestic end users are working to improve their capability to use alternative feedstocks, such as residential mixed paper, via mill stock preparation technology improvements, prompted by these supply constraints. Demand for mixed paper is expected to improve over time, for this reason, and because Residential Mixed Paper now contains more OCC, making it more attractive to paperboard mills. However, as stated above, contamination affecting material quality is a significant concern/barrier, particularly with respect to residential fiber.

[5] NERC, Domestic Recycled Paper Capacity Increases, September 2020

Consequently, MRFs are working to improve their ability to generate cleaner fiber supply to meet domestic mill and fiber product manufacturer feedstock requirements. Many MRFs are installing equipment such as optical sorters and robots to enable further sorting and cleaning; however, doing so means the cost of processed recovered fiber is increasing.

Nature of Texas Supply of Paper

Table 7-3 summarizes the estimated amount by type of paper generated, recycled, and disposed in Texas. Paper grades commonly reported under "Other Paper (recyclable)" include coated book stock, various grades of newsprint, sorted white ledger, and double lined kraft. The survey results indicate 2.2 million tons of MSW paper and 0.2 million tons of industrial paper (for a combined total of 2.4 million tons) were recycled. Based on analysis presented in Section 4, 7.1 million tons of MSW paper were disposed in landfills, resulting in an estimated total MSW paper generation of 9.3 million tons paper.

TABLE 7-3: SUMMARY OF TEXAS MSW PAPER GENERATED, RECYCLED, AND DISPOSED (2019)

Material	Tonnage Generated[1]	Tonnage Recycled	Tonnage Disposed	Recycling
Mixed Paper	1,305,097	447,565	857,532	34%
Sorted Office Paper	405,349	98,878	306,471	24%
Old Corrugated Containers	4,040,523	1,430,571	2,609,952	35%
Other Paper (Recyclable)	944,082	237,218	706,864	25%
Other Paper (Non-recyclable)	2,605,198	N/A	2,605,198	N/A
Total	**9,300,249**	**2,214,232**	**7,086,017**	**24%**

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.
N/A = not applicable.

On a per-capita basis, these paper recycling estimates are only 51 – 61 percent as high as those reported nationally by ISRI and U.S. EPA, respectively. As described in Section 3, the quantity of paper reported through the survey is likely understated. While some paper industry stakeholders said they thought Texas recovery rates are probably lower than the national average, additional post-consumer, commercial, and industrial paper recycling is likely occurring. Based on extrapolated national data from U.S. EPA, AF&PA and ISRI, the Project Team estimates there could be as much as an additional 1.4 – 2.2 million tons of paper recycled in Texas.

Table 7-4 shows the portion of recycled paper delivered by processors and generators (i.e., direct-to-mill) to mills and other end users. Paper collected from residences and some commercial businesses flows to one of 31 materials recovery facilities located in Texas and neighboring states.[6] There are multiple additional private processors that primarily handle commercial and/or industrial paper, although these facilities may also process other recyclable materials (e.g., plastics). Additionally, a significant portion of commercially generated paper flows direct-to-mill, by-passing processing facilities altogether. This includes, for example, OCC baled by grocers and other retailers and shipped directly to mills. Industrial paper (e.g., cuttings from

[6] As described in Section 3, a very small portion of Texas-generated recyclables were processed at an out-of-state MRF in 2019. As of RMDP publication, that facility has closed.

box makers or over-issue magazines) is almost universally recycled and may be sent direct-to-mill or may be baled by a commercial processor prior to shipment. In addition to tonnage reported in Table 7-3, an estimated 201,938 tons of industrial paper were recycled by industrial generators in 2019.

TABLE 7-4: QUANTITY OF TEXAS FIBER DELIVERED TO PROCESSORS AND DIRECTLY TO MILLS

Type	MSW			Industrial			Total		
	Total Recycled	Processor-Supplied	Direct-to-Mill	Total Recycled	Processor-Supplied	Direct-to-Mill	Total Recycled	Processor-Supplied	Direct-to-Mill
Mixed Paper	447,565	84%	16%	28,326	19%	81%	475,891	80%	20%
Sorted Office Paper	98,878	43%	57%	19,297	3%	97%	118,175	36%	64%
Old Corrugated Containers	1,430,571	51%	49%	112,266	67%	33%	1,542,838	52%	48%
Other Paper (Recyclable)	237,218	38%	62%	42,049	3%	97%	279,267	33%	67%
Total	**2,214,233**	**56%**	**44%**	**201,938**	**41%**	**59%**	**2,416,171**	**54%**	**46%**

As described in Section 3, this is based on survey data and likely understates industrial paper recycling.

Nature of Demand for Texas-Generated Paper

Provided below is a list of known paper mills and other recovered paper end markets consuming Texas recovered fiber. Not all of these end markets are in Texas, as recovered paper has enough value to travel regionally when shipped in truckload quantities. Recyclable paper recovered in Texas flows to four in-state mills, several mills in neighboring states, or to other countries. In addition, some Texas-generated fiber is purchased by three cellulose insulation and two molded pulp product manufacturers located in Texas. Other such manufacturers may exist in Texas but were not identified in the RMDP. In addition, some paper may be used as animal bedding, but such quantities are expected to be low.

Recovered paper mills and fiber-based product manufacturers located in Texas consume recovered paper that they receive from both in-state and out-of-state suppliers. Significant quantities of recovered paper are sent from Texas to other states or are exported from ports in Texas mainly to Mexico, while some may pass through California en route to other countries, primarily Mexico and overseas. Export data associated with Texas ports is provided in Table 7-5. An unknown portion of paper exported from these Texas ports originated in other states. Many paper manufacturers operate collection and/or processing activities in Texas, while many others rely on brokers to procure supply.

Texas Recovered Fiber Mills:

- Smurfit Kappa (Forney);
- WestRock (Dallas);
- International Paper (Orange); and
- International Paper (Queen City).

Texas Cellulose Insulation Plants:

- International Cellulose Corporation (Houston);
- U.S. Green Fiber LLC (Waco); and
- Tascon Industries, Inc. (Houston).

Texas Molded Pulp Plants:

- Western Pulp Products Company (Jacksonville); and
- UFP Technologies (El Paso).

Mills in Nearby States that Consume Texas-Sourced Recycled Paper:

- Republic Paperboard Mill (Lawton, OK);
- International Paper (Bogalusa, LA; Campti, LA; Mandfield, LA; and Valliant, OK);
- Pratt Industries (Shreveport, LA); and
- Georgia Pacific (Muskogee, OK).

Publicly announced[7] recent projects indicate that the following have the potential to serve as additional markets for Texas-generated recovered fiber supply:

- Packaging Corporation of America (Deridder, LA), completed 2018:
    - 150,000 tons per year linerboard and corrugated medium;
- Copamex (Anahuac, Mexico), completed 2019:
    - 220,000 tons per year containerboard;
- WestRock and Grupo Gondi (Monterrey, Mexico), completed 2020:
    - 441,000 tons per year containerboard;
- International Paper (Riverdale, Alabama), completed 2020:
    - 450,000 tons per year linerboard and containerboard;

As indicated in Table 7-5, a substantial amount of fiber tonnage is exported from Texas ports. While the source of these tons is unknown, it is presumed that much of this tonnage comes from other states and not Texas sources. Port access gives Texas an advantage over landlocked states for cost-effectively moving recyclable commodities into foreign markets. In addition, the business of shipping recyclable materials from Texas ports has economic benefits for Texas including job creation.

TABLE 7-5: FIBER EXPORTED FROM TEXAS PORTS (2019)

Type	Port			TOTAL
	El Paso	Houston	Laredo	
Exports (Tons)	77,725	109,334	868,832	1,055,891

Comparison of Supply and Demand for Paper

Within Texas, there is ample and strong demand for recyclable paper generated in the State – assuming it can be processed to meet end market specifications. Materials quality is of paramount importance and contamination is reported as an impediment to suitable supply.

Three end users of recovered fiber in Texas report importing fiber from sources outside of Texas. A total of 59,066 tons were imported by these end users in 2019, the majority of which was OCC (37,462 tons) followed by Mixed Paper (12,954 tons). Some companies seek old newsprint (ONP) as a feedstock. However, MRFs are producing ONP bales less often due to the dwindling supply of ONP in the waste stream and a shift to single stream collection which make it more costly and challenging to produce this grade. Both paper mills and processors reported challenges obtaining adequate supply of non-residential fiber feedstock which is often preferred as it is less contaminated than residential supply. In addition, some preferred grades, such as SOP, are produced exclusively from non-residential sources and are not supplied by MRFs handling residential tonnage. As a result of the coronavirus pandemic, less such paper was generated by offices given more people work at home and while more of it may now be generated by residences, it is not sorted out as a specific grade.

[7] Megan Smalley, Waste Today, "A Mostly Sunny Forecast For OCC, Mixed Paper Markets," January 26, 2021.

7.4 PET PLASTIC

Polyethylene terephthalate (PET) is a polyester and is one of the most common types of plastic material. In the resin identification code system, PET is known as #1 plastic.

Overview of PET

PET is primarily used to make polyester fibers (~60 percent), followed by packaging (>30 percent), followed by other uses (<10 percent). Other uses include window tinting films, toner cartridges, strapping, label backing, and to a lesser degree automotive part manufacturing. Textiles such as clothing and carpet are discussed elsewhere in this section; however, polyester fibers are also used as reinforcement in car tires and hoses and polyester from these products is not recycled. Hewlett-Packard offers mail-back recycling of its PET inkjet cartridges and toner cartridge retailers also accept cartridges back for recycling. Similarly, strapping producers accept strapping back for recycling from large commercial generators. Label backing manufacturers such as Mitsubishi offer a recycling program for the PET backing after the labels have been applied to packaging. The rest of this section focus exclusively on PET used in packaging.

In packaging, PET is primarily used in the manufacture of PET bottles (approximately 85 percent), followed by thermoformed PET clamshells (e.g., berry baskets, <15 percent). PET is also produced as a thin film or sheet (<5 percent) that can be used in making multilayer standup pouches when laminated to films of other resins. Because the multiple layers are laminated together with adhesives and cannot be readily separated, these multilayer flexible packages are currently disposed due to the lack of cost-effective recycling technologies and there is no chance today for these multilayer flexible packages to be mechanically recycled.

Characteristics of the PET Recycling System

PET bottles are consumer items and are generated at home, at work, and in public spaces. Good data on the proportions of where PET bottles are generated is not available; however, some have opined approximately equal amounts are generated at home versus away from home. Waste sort data from California suggests that as much as 70 percent may be generated away from home; however, it is not clear if this result is skewed by the state's bottle bill. A key observation is that a robust collection infrastructure for plastic bottles away from home must exist if PET bottles are to be recycled at high rates. Currently the ability to recycle PET bottles at work and public spaces in Texas is low and as a result large quantities of PET bottles are disposed rather than collected for recycling when they are generated away from home.

Nearly all residential collection programs accept PET bottles for recycling. Not all households participate in recycling and of those that do not all PET bottles are placed in the recycling collection container versus the waste container. Nationally, approximately half of PET bottles are placed in recycling in single-family neighborhoods that have recycling provided. It is likely that the recycling capture rate in Texas is similar. To the extent that multifamily residential buildings are not required to provide recycling collection, capture rates from residents of multifamily buildings is even lower.

In Texas, as with other states without a bottle bill, PET is normally collected mixed with other recyclables and sorted at MRFs. These facilities normally use optical sorters to identify and separate PET from mixed materials, an approach that is typically successful when MRFs process a minimum of 10 tons per hour of mixed recyclables. It is more difficult to identify and correctly sort PET at smaller MRFs or recycling centers where manual labor is used for PET bottle and thermoform sorting. Significantly expanding PET collection in Texas may overwhelm the existing PET optical sorters, which would require the investment in additional equipment for effective PET separation from mixed materials.

Optical sorters eject PET thermoforms along with bottles. Many MRFs have a quality control person after the optical sorter to remove non-conforming materials from the PET bottle stream. Depending on the market for PET sorted by a MRF, the quality control person may remove and dispose of PET thermoforms or place them into a plastics #3-7 stream. Almost no U.S. MRFs currently produce PET thermoform bales.

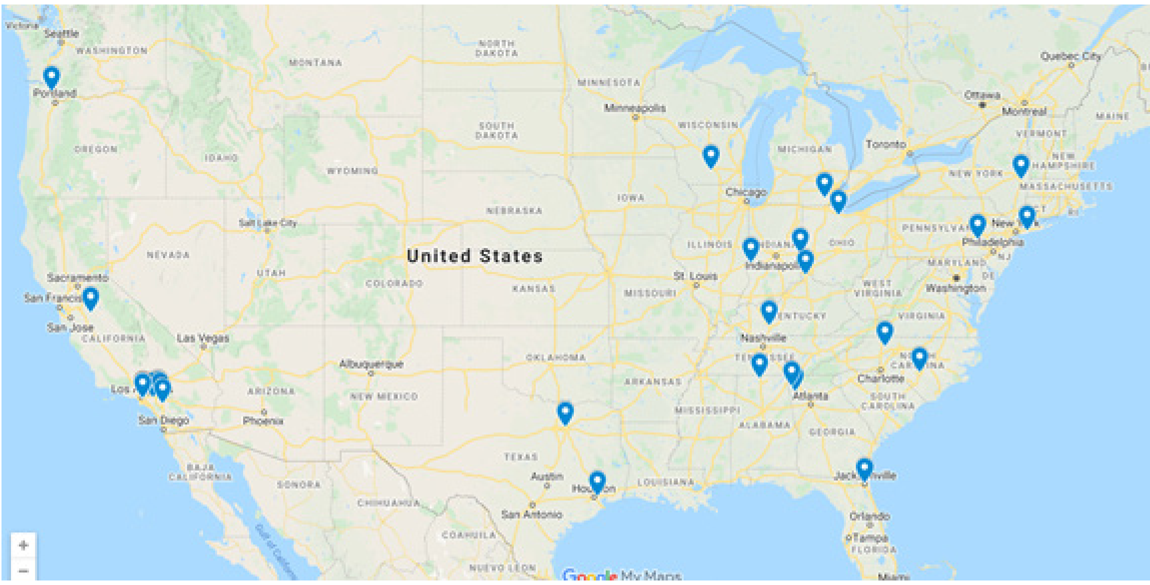
U.S. Markets for PET

Nationally PET bottles have a 28 percent recycling rate. According to the Container Recycling Institute (CRI), more than half (55 percent) of collected PET bottles are returned via deposit systems in the 10 states with deposits. The remainder (45 percent) are collected primarily through residential curbside and drop-off collection in the 40 states without deposit systems, with a small amount collected away from home. The recycling rate of PET thermoforms is believed to be less than 10 percent, but data is lacking. PET bottles have excellent recycling market demand that exceeds collection quantities.

Although half of PET bottles collected in the U.S. were exported for recycling in 2008, only eight percent were exported for recycling by 2019. This is because of restrictions on recovered plastics imports by China, commitments by the country's largest private recycling processors (i.e., Waste Management, Inc. and Republic Services, Inc.) to no longer export plastics outside of North America, and growing demand by U.S. companies to incorporate recycled content into their products and packaging.

There are 28 PET reclaimers in the U.S., concentrated in the Southeast and California as shown in Figure 7-3. Two PET reclaimers are located in Texas.

FIGURE 7-3: U.S. PET RECLAMATION FACILITIES



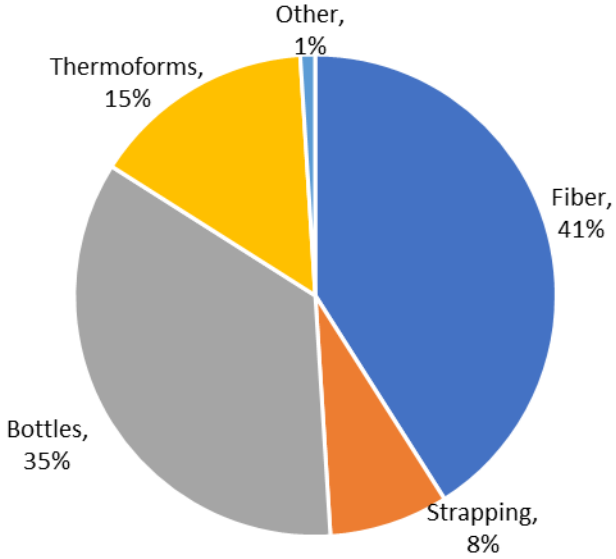
Source: Circular Matters, December 2020

The U.S. capacity as of the end of 2020 to recycle PET bottles and post-consumer PET thermoforms is over 1.2 million tons of incoming material per year. In 2019, 0.8 million tons of PET were recycled by U.S. reclaimers, which means reclamation capacity was approximately 70 percent utilized. PET reclaimers vary in their capabilities. Some only recycle deposit bottles collected in bottle-bill states, whereas others are integrated with manufacturing operations and the PET they reclaim is exclusively used internally, such as to make carpet.

Recycling of PET thermoforms faces challenges. While many PET bottle reclaimers will allow small amounts of thermoforms in bottle bales, there are only two U.S. markets that purchase thermoform-only bales (neither of which is located in Texas). PET thermoforms often have lower recycling yields and other quality issues when processed in PET bottle recycling plants. Therefore, most PET bottle reclaimers limit the amount of thermoforms allowed in their recycled PET feedstocks. Further recycling challenges exist because polystyrene (PS), clarified polypropylene (PP), and polylactic acid (PLA) thermoforms can be mistaken for PET thermoforms and contaminate PET bales. There is ongoing development of PET thermoform reclamation technologies to address these challenges, including the redesign of mechanical recycling processes to separate thermoforms and the development of chemical recycling processes to break the PET down to its original building blocks and rebuild it as virgin-equivalent recycled PET. Technological developments may improve future market potential of PET thermoform bales.

Although the vast majority of PET that is recycled is bottles, the resulting recycled resin goes into a variety of applications with only approximately 35 percent being recycled closed loop back into bottles as shown in Figure 7-4.

FIGURE 7-4: RECYCLED PET MARKETS BY END USE (2019)



Source: NAPCOR, 2020

Increased recycled content of PET bottles is a strong trend going forward. PepsiCo has a goal to use 25 percent recycled content in plastic packaging by 2025 and the Coca-Cola Company has a goal to use 50 percent recycled content by 2030. Nestlé Waters has a target to use 50 percent recycled content for its water bottles by 2025 and other bottled water companies have made commitments as well. In 2017, the average post-consumer recycled content in U.S. PET bottles was approximately seven percent. There is clearly significant demand for more PET bottle recycling and reclamation currently and in the years to come.

PET thermoforms are made from plastic sheeting made from virgin PET and recycled content PET bottles; however, the recycled feedstock must be clear PET. Demand for thermoforms at the end of their useful life is low, therefore they are often excluded from recycling programs and/or disposed at the MRF.

PET that is not clear, green, or light blue has extremely limited end market demand and as such is generally considered to be not recyclable. Some emerging chemical recycling companies could serve as markets for these non-recyclable bottles going forward. However, Texas chemical recyclers, including those with announced plants in the State, do not or will not accept PET.

Nature of Texas Supply of PET

Table 7-6 summarizes the RMDP's findings on the amount of PET generated, recycled, and disposed in 2019 based on RMDP survey and supplemental data (as described in Section 3) and waste composition data (as described in Section 4). Results suggest the recycling rate for PET in Texas (9.1 percent) is low and significantly more PET could be collected for recycling, especially when compared to the national PET bottle recycling rate of 28 percent.

TABLE 7-6: SUMMARY OF TEXAS MSW PET GENERATED, RECYCLED, AND DISPOSED (2019)

Material	Tonnage Generated[1]	Tonnage Recycled	Tonnage Disposed	Recycling Rate
PET	426,148	38,679	387,469	9.1%

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.

In addition to the PET recycled from the MSW stream described in Table 7-6, 2,160 tons of PET are estimated to be recycled from industrial generators. As described in Section 3, this is based on survey data and may understate industrial recycling of PET.

Nature of Demand for Texas-Generated PET

There are two PET reclaimers in Texas. One reclaimer has a capacity of approximately 50,000 tons per year. This reclaimer accepts only bottles and its capacity is sufficient for the current amount of PET collected in Texas each year. The PET reclaimer's production is focused on supplying recycled PET back to beverage manufacturers. They do not accept thermoforms in the material they purchase. This reclaimer also recycles PET that it purchases from MRFs in surrounding states and regions. A second PET reclaimer focuses on chemical recycling of hard-to-recycle PET materials, and primarily purchases its feedstock from other PET reclaimers.

Comparison of Supply and Demand for PET

On the national level PET reclamation capacity exceeds available supply. Texas markets are close to being in balance with current supply from the State plus a relatively small quantity of imports of PET from other states in the region; however, increasing Texas-generated supply of PET can replace baled PET imports and reduce transportation costs for purchased baled PET. Consumer packaged goods (CPG) companies, including beverage companies located in Texas (e.g., Keurig Dr Pepper, PepsiCo) have set goals to significantly increase the recycled content they use in their packaging over the next few years. Because much of this packaging is PET, and because PET is the most recycled plastic resin, there will be a significant increase in end user demand over the next few years. The Project Team forecasts this increase in demand to be approximately 750,000 tons nationally. As the second most populous state, Texas could potentially supply a significant portion of this recovered material.

Thermoforms have historically not had much market depth in the U.S., and as a result many MRFs and communities do not accept or promote recycling of thermoforms. However, as chemical recycling grows, demand is expected to increase and outpace supply.

7.5 HDPE PLASTIC

High density polyethylene (HDPE) is a rigid plastic commonly used in packaging and durable goods. Due to its prominent use in household packaging and goods, a significant amount of HDPE material can be generated by residents, as well as commercial and industrial entities. In the resin identification coding system, HDPE is known as #2 plastic.

Overview of HDPE

Over 7.5 million tons of HDPE is consumed in the U.S. each year. Approximately half of HDPE is used in the production of rigid packaging. The remainder goes into pipe, consumer goods (e.g., toys), film (e.g., retail carryout sacks), and automotive parts. Of the rigid packaging, approximately two-thirds is bottles and jars and one-third is injection molded buckets, reusable crates, pallets, and drums.

Characteristics of the HDPE Recycling System

Nearly all municipal recycling programs collect HDPE bottles from residences, and only about half accept buckets. HDPE bottles are primarily generated at home. MRFs sort out HDPE bottles from other recyclables for recycling, separating them into natural bottle and pigmented bottle bales. Any buckets, crates, laundry baskets, storage totes, or bulky toys that are received are removed at the pre-sort station of the MRF and baled and sold as a bulky rigid commodity.

ICI generators generate some plastic bottles as well as reusable crates and pallets; however, most general commercial sector recycling programs in Texas only accept fiber materials. As a result, most bottles, buckets, and crates are typically disposed by commercial generators. In some parts of Texas, however, commercial MRFs accept mixed recyclables and separate buckets, film, crates, and other HDPE products for recycling. There are also some specialty recyclers who offer recycling programs for manufacturing facilities where buckets, drums, pallets, and crates may be delivered directly to recyclers. Some large food manufacturers may also work directly with plastics recyclers to recycle their buckets, and grocery stores with bakery, deli, and pharmacy departments may also recycle their buckets. Most manufacturers of reusable plastic crates will take back old or damaged crates from their customers and recycle them back into new crates., However, many generators of old crates may lack adequate storage space to store them until a large enough quantity is accumulated to make transporting them to a recycler economical, therefore, many may dispose of them.

U.S. Markets for HDPE

Nationally HDPE bottles have a 30 percent recycling rate. This exceeds the national PET bottle recycling rate because most HDPE bottles are generated at home where there are recycling collection opportunities, whereas many PET bottles are frequently generated away from home.

Although over 40 percent of HDPE bottles collected in the U.S. were exported for recycling in 2008, less than 10 percent were exported for recycling by 2018. This is because of restrictions on recovered plastics imports by China, commitments by Waste Management, Inc. and Republic Services, Inc. (the country's largest MRF companies) to no longer export plastics outside of North America, and growing demand by U.S. companies to incorporate recycled content into their products and packaging.

There are 24 HDPE bottle reclaimers in the U.S., with locations shown in Figure 7-5. Two HDPE bottle reclaimers are located in Texas.

FIGURE 7-5: U.S. HDPE RECLAMATION PLANTS

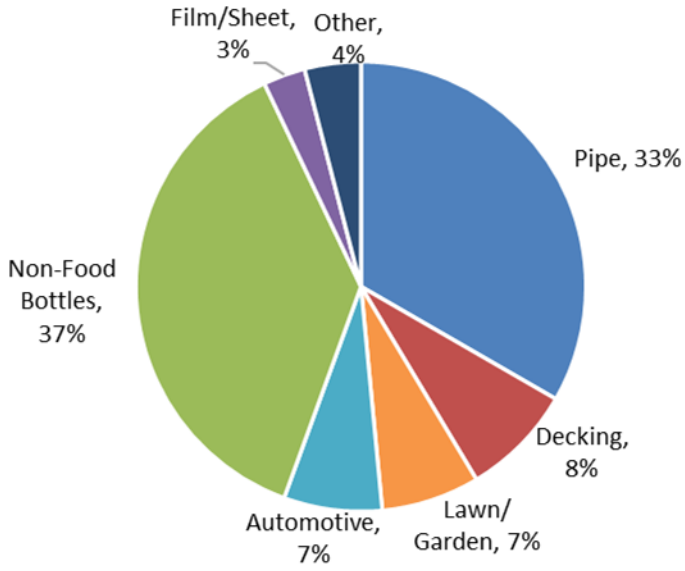
Source: *Circular Matters, December 2020*

The U.S. capacity as of the end of 2020 to recycle HDPE bottles was 550,000 tons of incoming material per year. In 2018, 450,000 tons of HDPE were recycled by U.S. reclaimers, which means reclamation capacity was approximately 82 percent utilized. Some HDPE reclaimers are integrated with manufacturing and use the recycled resin they produce to manufacture pipe or decking. Most recycled HDPE is sold to manufacturers of a variety of products, the largest category of which is non-food bottles. As shown in Figure 7-6, only 37 percent of HDPE bottle recycling is closed loop recycling (i.e., bottles recycled back into bottles).

As shown in Figure 7-6, only 37 percent of HDPE bottle recycling is closed loop recycling (i.e., bottles recycled back into bottles).

Demand for recovered HDPE for use in non-food bottles is strong and is expected to increase as CPGs have committed to increasing their company-wide average recycled content. There is significant demand for more HDPE bottle recycling and reclamation currently and in the years to come.

FIGURE 7-6: RECYCLED HDPE MARKETS BY END USE



Source: More Recycling 2018.

Nature of Texas Supply of HDPE

Table 7-7 summarizes the amount of HDPE generated, recycled, and disposed in 2019 based on RMDP survey and supplemental data (as described in Section 3) and waste composition data (as described in Section 4).

TABLE 7-7: SUMMARY OF TEXAS MSW HDPE GENERATED, RECYCLED, AND DISPOSED (2019)

Material	Tonnage Generated[1]	Tonnage Recycled	Tonnage Disposed	Recycling Rate
HDPE	341,114	21,431	319,683	6.3%

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.

In addition to the HDPE recycled from the MSW stream, 1,523 tons of HDPE were recycled from the industrial sector. As described in Section 3, this estimate is based on survey responses and may understate industrial recycling activity.

Nature of Demand for Texas-Generated HDPE

Texas has two HDPE bottle reclaimers with a combined capacity of approximately 40,000 tons per year. Texas also has two companies that recycle crates, bins, and pallets made from HDPE.

Comparison of Supply and Demand for HDPE

On the national level HDPE reclamation capacity exceeds available supply. Texas' capacity for recycled rigid HDPE significantly exceeds the current amount of HDPE collected in Texas each year. Furthermore, the existence of relationships between some sellers and out-of-state reclaimers means that significant amounts of HDPE are sold to markets outside of Texas so that Texas reclaimers are operating below capacity.

Although Texas has two markets that accept residential bulky rigid plastics, historically there was not much market depth in the U.S., and as a result many MRFs and communities do not accept or promote recycling of buckets and other bulky rigid products from residences. Because these materials are recycled into non-branded products, the low cost of competing virgin HDPE with predictable properties is often preferred by manufacturers. As a result, some MRFs and municipalities do not have residential bulky rigid recycling programs. The in-state markets for bulky rigid HDPE plastics are focused on recycling clean commercial bulky rigid plastics, such as drums and crates.

7.6 FILM PLASTICS

Film plastics refers to plastic items with a thickness of less than 10 mils (i.e., 0.010 inch or 0.25 mm).

Overview of Film Plastics

Film plastics can be divided into three material classes:

- Polyethylene film, including high density (HDPE), low density (LDPE), and liner low density polyethylene (LLDPE) making up 56 percent of all film generated;
- Polypropylene film, including sealant layers made from other resin (e.g., chip bags) making up 20 percent of all film generated; and
- Other film, primarily composed of multilayer flexible packaging, making up 24 percent of all film generated.

Virgin resin used in film is tailored to the application, such as for food-contact safety or properties such as strength or flexibility. If all three of the classes of film shown above were collected mixed, the material would include PET, polyethylene, PVC, PP, and other resins in the film mix.

Characteristics of the Film Plastics Recycling System

Residential polyethylene film bags and wraps are almost exclusively collected through return-to-retail programs. This film is then combined with stretch wrap from palletized retail boxes and backhauled to warehouse and distribution centers where it is baled, often without additional sorting and quality control. When truckload quantities accumulate, the polyethylene film is shipped to markets.

Commercial film is collected by commercial recyclers that serve commercial businesses. Large commercial generators of polyethylene film include retail, assembly plants, and warehouse and distribution centers. Some of these larger generators may bale their own film on-site. Agricultural film is also generated in large quantities, although it is contaminated by organics and may need to be washed to be recycled into end products.

U.S. Markets for Film Plastics

Nationally 500,000 tons of film was collected for recycling across the U.S. in 2018.[8] This was down approximately 30 percent from a high in 2016. This decrease is because of restrictions on recovered plastics imports by China and commitments by the country's largest recycling processors (Waste Management, Inc. and Republic Services, Inc.) to no longer export plastics outside of North America.

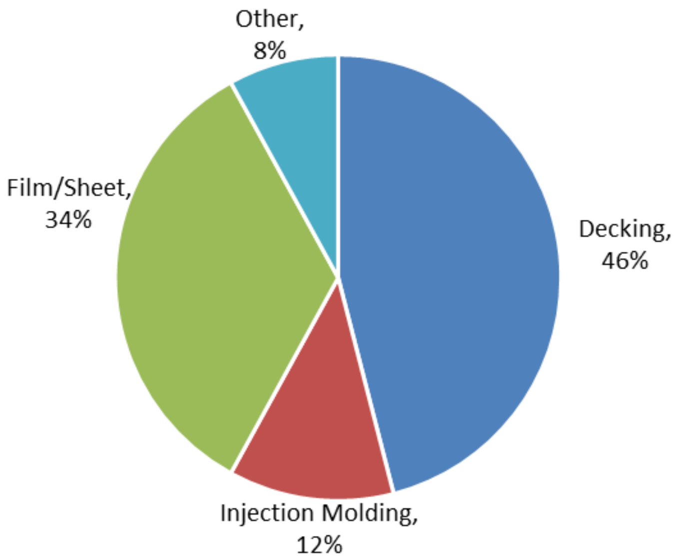
Currently, markets for film recovered from MSW streams generally only exist for polyethylene film. The only exceptions are specific film products from commercial and industrial sources collected through controlled systems, such as Mitsubishi's PET label release liner recycling program for liner returned by its plastic bottle filler clients.

Polyethylene film is further divided into residential and commercial uses, with commercial uses making up 57 percent of total polyethylene film sold. The national recycling rate for commercial polyethylene film is over 20 percent, whereas the recycling rate for residential polyethylene film is approximately four percent. Residential film is almost exclusively collected through source-separated retail return programs for film bags and wraps because contamination from residential curbside commingled recycling systems diminishes film quality, rendering it unmarketable. Film in single-stream commingled collection systems is also considered to be a contaminant in nearly all programs, and it can prevent MRF equipment from functioning properly.

The U.S. capacity as of 2018 to recycle polyethylene film was estimated by More Recycling at 600,000 tons per year and is primarily for clean film that does not require washing. The film that is recycled domestically primarily is used to manufacture decking, as shown in Figure 7-7.

[8] More Recycling, "2018 National Post-Consumer Plastic Bag & Film Recycling Report," August 2020.

FIGURE 7-7: RECYCLED PE FILM CONSUMPTION BY END MARKET USES, 2018



Source: More Recycling, [2018 National Post-Consumer Plastic Bag & Film Recycling Report], August 2020.

Decking is often clad with an exterior color-controlled layer that allows mixed colors of film, which is generated at residences and returned to retail for recycling, to be purchased for this application. The film and sheet category includes recycled film used in trash bags, commercial shipping bags and sacks, and some recycled content retail carryout bags.

Historically over half of polyethylene film collected in the U.S. for recycling was exported, mostly to Asia. In the last couple of years diminishing export demand has resulted in the majority of polyethylene film that is collected being recycled domestically. Low prices for virgin polyethylene in the last couple of years have also resulted in tempered domestic demand for recycled film products, so that film collected for recycling from commercial sources has declined as less is separated for recycling. Domestic market demand for film remains weak.

Nature of Texas Supply of Film Plastics

Table 7-8 summarizes the Project Team's findings on the amount of polyethylene film generated, recycled, and disposed in 2019 based on RMDP survey and supplemental data (as described in Section 3) and waste composition data (as described in Section 4).

TABLE 7-8: TEXAS PE FILM GENERATED, RECYCLED AND DISPOSED (2019)

Material	Tonnage Generated[1]	Tonnage Recycled	Tonnage Disposed	Recycling Rate
PE Film	779,995	29,448	750,032	3.8%

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.

In addition to the quantity of PE film recycled presented in Table 7-8, 515 tons of industrial film were known to be recycled in Texas. As described in Section 3, this is based on survey results and may understate industrial recycling. Nature of Demand for Texas-Generated Film Plastics.

Nature of Demand for Texas-Generated Film Plastics

Nationally most residential film is consumed by composite product manufacturers that produce wood-polymer composites for decking. There are four such manufacturers, all located outside of Texas. There are also a small number of recyclers who recycle carryout sacks, located in California and Indiana.

Texas has six companies that recycle clean post-consumer commercial polyethylene film. Four of these companies use the material they recycle internally to produce recycled content garbage bags, retail and restaurant carryout sacks, and commercial bags. The other two focus on recycling the film into resin for sale to other companies. One of these companies has partnered with a virgin resin producer to develop a recycled content resin that is suitable for shrink film bundling, such as unitizing a case of bottled water bottles together.

Comparison of Supply and Demand for Film Plastics

Texas' film recycling capacity exceeds the State's supply, so commercial film is imported into Texas for recycling. However, as is described above, Texas does not have capacity to recycle residential film plastics, therefore supply exceeds demand of this material. On the national level, polyethylene film collection levels in the past exceeded domestic recycling capacity. In 2019, this capacity began to expand significantly as domestic film recyclers expand, including an expansion by a major film recycler located in Texas. This capacity is for clean commercial film, not dirty residential MRF or agricultural film that requires washing. The strongest demand is for commercial film bags and pallet wrap since this film is clear and has more end-market demand than pigmented film. Additional end use is needed to sustain the domestic market expansions, including higher levels of recycled content in trash bags and retail carryout sacks.

7.7 PLASTICS #3-7 AND OTHER PLASTICS

This section discusses recycling of other plastic types that are sold by MRFs as mixed bales or generated in smaller quantities than PET, HDPE bottles, and polyethylene film plastics. These may be baled by MRFs and sold in a variety of grades including:

- **Mixed #3-7 plastics,** which is a mix of residential containers not sorted into their respective grades (such as PET bottles or HDPE bottles), and contains varying amounts of PET thermoforms, HDPE tubs, polypropylene (PP, #5) containers, polystyrene (PS, #6) containers, and other containers made from other resin types (#7).
- **Bulky rigids**, which is a mix of large HDPE and PP materials including buckets, crates, laundry baskets, and toys.
- **#5 (polypropylene or PP)**, which is a mix of PP bottles, tubs, and thermoform types of packaging, increasingly being separated and marketed as its own commodity type.
- **Other plastics**, which is a catch-all category for other plastics from electronics, polystyrene foam, etc.

Overview of Plastics #3-7 and Other Plastics

Plastics other than PET, HDPE, and LDPE are generated in lower quantities and it becomes more challenging to further sort these materials to achieve truckload quantities for delivery to end markets. In the past, bales of mixed plastics were exported for hand sorting in countries with low labor costs, but most of those offshore markets ended their import of mixed plastics in 2019. Greater domestic sorting and end-use consumption for these mixed and other resins is needed for plastics recycling to grow in Texas.

Mixed plastics bales are not able to be recycled directly into value-added products since the different resin types melt at different temperatures, and when molten, segregate rather than mixing. Mixed plastics must be further sorted by resin type if they are to be mechanically recycled into value-added products, be processed using pyrolysis or gasification to be converted into fuels, or be processed by other emerging chemical recycling technologies.

Characteristics of the Plastics #3-7 and Other Plastics Recycling System

Most MRFs make bulky rigid plastics bales from the large crates, buckets, baskets, and toys received by MRFs. These materials are primarily HDPE. Many residential collection programs still accept all rigid containers or all rigid plastic packaging, even though they can no longer be exported and domestic markets that can sort mixed plastics are over-capacity. As processing contracts come up for renewal, many MRFs are encouraging communities to scale back their collection programs to bottles only. Some MRFs sort out the PP bottles and tubs but allow the remainder to be disposed.

Commercial recycling of rigid plastics is focused on specific streams of materials: commercial film plastics, agricultural plastics, auto batteries with PP casings, HDPE and PP plastic pallets and dunnage, plastic drums, toner cartridge plastics, and some limited post-consumer auto bumper recycling. There also are some in-house recycling programs for polypropylene buckets and polystyrene clothing hangers by selected retailers.

U.S. Markets for Plastics #3-7 and Other Plastics

Nationally at least 650,000 tons of mixed and other plastics (i.e., plastics that are not bottles or polyethylene film) were collected for recycling across the U.S. in 2018.[9] This total was comparable to prior years. Mixed and other plastics include materials of all standard resin codes (#1-#7), although the vast majority of the total is HDPE and PP. Most of the materials recycled were generated from the commercial rather than residential sector. Approximately 87 percent of this miscellaneous plastics was sold to reclaimers in the U.S. or Canada with the remainder exported to other countries. The material exported to other countries was primarily made up of mixed materials, such as #3-7 containers, and electronics plastics. Materials recycled by U.S. and Canadian reclaimers were mostly material segregated by resin type since the capacity to sort mixed plastics in the U.S. and Canada is extremely limited.

The resin type with the strongest markets after PET and polyethylene bottles/film is polypropylene. Nationally there are several recyclers who purchase baled polypropylene bottles and tubs. Polystyrene recyclers are more limited, with only a couple of domestic markets for rigid and foam polystyrene packaging materials.

As recently as 2018, mixed plastics bales that were produced by residential MRFs were primarily shipped to export markets, but with the reduction of demand from those markets, there is insufficient domestic sorting capacity compared to domestic collections. As a result, most MRFs have stopped producing mixed plastics bales and shifted their sorting to producing bulky rigid plastics bales (composed mostly of polyethylene) and polypropylene bottle and container bales. In certain parts of the country where there is a commitment to developing markets for plastics, sorting facilities for mixed plastics are developing. Existing mixed plastics sorting facilities include three on the West Coast and four on the East Coast, for a total of seven mixed plastics sorting facilities nationally. Additional sorting facilities are planned for the West Coast.

Nature of Texas Supply of Plastics #3-7 and Other Plastics

Table 7-9 summarizes the amount of plastics #3-7 and other plastics generated, recycled, and disposed in 2019 based on RMDP survey and supplemental data (as described in Section 3) and waste composition data (as described in Section 4).

TABLE 7-9: TEXAS OTHER MSW PLASTICS GENERATED, RECYCLED AND DISPOSED (2019)

Material	Tonnage Generated[1]	Tonnage Recycled	Tonnage Disposed	Recycling Rate
Plastics #3-7	206,551	5,035	201,516	2.4%
Other Plastics	1,769,370	3,857	1,765,513	N/A[2]

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.
2. A recycling rate was not estimated for other plastics, as the quantity disposed (1,765,513) was generally considered to be non-recyclable. The portion of landfilled other plastics that is potentially recyclable is not well characterized and depends on available programs and processing technologies.
N/A = not applicable

In addition to the quantity recycled from the MSW stream, 3,370 tons of industrial manufacturing scrap of "other plastics" were identified as being recycled.

Nature of Demand for Texas-Generated Plastics #3-7 and Other Plastics

Texas has reclaimers for HDPE and PP plastic pallets and crates, and PS or PP toner cartridges. Texas' laser toner cartridge recycler sources recycled cartridges from around the county and has a capacity to recycle 27,000 tons per year of toner cartridge plastics. The nearest market for residential bulky rigid plastic bales is in Louisiana, and the nearest PP container market is in Alabama. There are no markets for these residential grades in Texas.

[9] More Recycling,"2018 National Post-Consumer Non-Bottle Rigid Plastic Recycling Report," August 2020.

Demand exists in Mexico for Texas-generated other plastics. Polystyrene foam from Texas and other U.S. states is recycled in one U.S. company's recycling and manufacturing factory in Mexico across the border from El Paso. Lead-acid batteries are shipped to other states or Mexico to be recycled, and as a result the PP casings from car batteries are also recycled at a high rate.

Apart from the products listed above, Texas lacks processing capacity for other plastics including carpet, polystyrene, electronics plastics, and mixed plastics. Domestic markets for plastics from electronics are not well-developed, and much of the plastics from electronics are disposed rather than recycled; although one Texas electronics recycler sends plastic housings to a sister plant in China for recycling. Texas has a new large plastics pyrolysis recycler in the State that can process low value plastics into fuels and feedstocks for liquid petroleum crackers. The Texas Solid Waste Disposal Act was updated in 2019 to consider gasification or pyrolysis of recovered plastics as recycling.[10]

Comparison of Supply and Demand for Plastics #3-7 and Other Plastics

Demand for other plastics is weak both in Texas and nationally. As a result, in Texas, like the rest of the U.S., supply exceeds demand for other plastics. Due to low demand, many residential recycling programs, as well as commercial recyclers, do not collect plastics #3-7, and they are therefore disposed.

7.8 FERROUS METALS

Ferrous metals include wrought and cast iron and steel. Most ferrous metals are converted into durable products with lives that last many years. Stainless steel is classified by ISRI as a non-ferrous metal since most stainless steel is not magnetic.

Overview of Ferrous Metals

Residential generation of ferrous metals includes steel cans and housewares as well as bulky items such as appliances, outdoor furniture, grills, bicycles, and lawnmowers. Commercial generation from restaurants includes steel cans. However, most scrap ferrous metal is from industrial generators including auto repair shops, end-of-life auto bodies, industrial equipment, and building and construction. Over 90 percent of ferrous metals collected for recycling in Texas, which pass through the scrap recycling system, are from industrial generators and not from MSW sources.

Characteristics of the Ferrous Metals Recycling System

Nearly all residential recycling collection programs accept steel cans. While there are some commercial recyclers that collect mixed commercial recyclables (including steel cans), it is more common for commercial recycling to offer collection of paper only. As a result, steel from commercial generators such as restaurants, where steel cans are generated in greater quantities, is commonly disposed. It is not common for residential collection programs to collect other small ferrous metal products, such as wire clothing hangars; these materials are commonly disposed. Sorting of steel cans in MRFs is performed easily and at low cost using magnets.

Residential bulky item recycling collection is available in some areas and bulky scrap metal may be further sorted after collection with separation of mixed metal items from other bulky waste such as interior furniture and mattresses for recycling. Residential generators who are able to self-haul bulky items can often drop off such items at municipal sites that accept bulky items with a separate roll-off container for mixed metals. There are some residential collection programs in Texas that will accept metal housewares for recycling in municipal collection programs. Items donated to thrift stores, if not sold for reuse, will often be recycled by those stores in cooperation with local scrap metal processors.

Commercial collection of ferrous metals includes appliances that are removed by contractors or delivery services when new appliances are delivered. Some scrap companies also collect ferrous metals from generators who generate materials regularly and in large enough quantities, such as auto body repair shops, auto part and equipment refurbishing operations, and large auto repair shops. Drum reconditioners also collect and process steel drums for recycling when they can no longer be reused. In Texas used oil filters must be collected for recycling and not landfilled; consequently, nearly all are. Some solid waste transfer

[10] HB 1953 (2019) expanded the definition of recycling in Section 361,421 of the Solid Waste Disposal Act to include post-use polymers and recoverable feedstocks (e.g., plastics) that are converted through gasification or pyrolysis into valuable raw, intermediate, or final products such as new plastics, chemicals, wax, lubricant, fuels, and other products.

stations and landfills also separate large ferrous metal from waste for recycling. Construction and demolition debris (C&D) delivered to C&D recyclers is another form of collecting ferrous metals for recycling in Texas. Finally, there are informal scrap metal collectors who drive through neighborhoods and warehouse and industrial areas looking for scrap metal to collect as a source of income.

While steel cans are likely to be processed at MRFs, most other ferrous scrap is processed by one of the over 600 scrap metal processors in Texas.

U.S. Markets for Ferrous Metals

The U.S. steel industry is a mature industry with long-established relationships and in some cases, vertical integration. Some of the largest steel mill companies including Nucor, Commercial Metals, and Steel Dynamics, for example also own networks of scrap yards and auto shredders. Other steel mill companies have longstanding supplier networks that feed into their mills. Many small scrap yards, however, may be locally owned and sell material to larger scrap processors that are more capable of processing scrap so that it is mill ready.

According to the American Iron and Steel Institute (AISI), ferrous metals are recycled at high rates nationally including 75 percent of steel packaging (e.g., cans and closures), nearly 100 percent of automobiles at the end of their useful lives, and more than 90 percent of steel from infrastructure, appliances and construction.

Nature of Texas Supply of Ferrous Metals

Table 7-10 summarizes the amount of ferrous metals generated, recycled, and disposed in 2019 based on RMDP survey and supplemental data (as described in Section 3) and waste composition data (as described in Section 4). Quantities include commercial and residential metals and C&D debris; and exclude scrap generated at industrial and manufacturing locations, shredder scrap, and other ferrous scrap that travels to scrap metal dealers apart from MSW (including construction and demolition debris) collection systems.

TABLE 7-10: TEXAS MSW FERROUS METAL GENERATED, RECYCLED AND DISPOSED (2019)

Material	Tonnage Generated[1]	Tonnage Recycled[2]	Tonnage Disposed	Recycling Rate
Ferrous Metals	956,462	522,971	433,491	54.7%

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.
2. Quantity includes the portion of recycled industrial metals processed at scrap metal facilities. More information is provided in Section

In addition to the amount shown in Table 7-10, the Project Team estimates ferrous metal recycled by industrial generators was 5,776,436 tons, or 11 times the amount recycled from the MSW stream.

Nature of Demand for Texas-Generated Ferrous Metals

Ferrous scrap flows to one of five steel mills in Texas or to a lesser extent to one of several small foundries in the State. Texas' steel mills have a capacity to recycle 4.38 million tons of ferrous metals per year, or approximately 1.9 million tons less than the amount of Texas-generated ferrous metal collected for recycling. As a result, a significant amount of steel is shipped to consumers in other states or countries. For example, there are four steel mills in Mexico near the Texas border that may source from the State, as well as Gulf Coast ports for shipping processed steel to recyclers in other countries or to other U.S. Gulf Coast states.

Comparison of Supply and Demand for Ferrous Metals

Texas' steel mills rely primarily on scrap steel to make their products, and their demand for scrap steel is tied to the demand for the types of mill products they produce. When the economy is strong, sales of steel for construction and the oil and gas industry are strong, and demand for ferrous metal scrap is strong. The opposite is the case when the economy slows, although export markets can fill the gap in domestic demand. Because most ferrous scrap is generated and recycled by industrial generators and not from MSW, the generation of ferrous scrap also slows in parallel with mill production, keeping supply and demand somewhat in balance. Ferrous scrap can also be stored and sold when scrap prices rise.

In-state demand for recovered steel is less than supply. Additional steel generated and recovered in Texas is exported to other states for recycling. There is sufficient national and international market demand for current and increased metal supply and Texas-generated ferrous metals are not disposed due to lack of markets.

7.9 NON-FERROUS METALS

Non-ferrous metals include aluminum, copper, brass, lead, stainless steel, and precious metals. These materials are generated in residential, commercial, industrial, and C&D settings.

Overview of Non-Ferrous Metals

Residential generation of non-ferrous metals includes aluminum packaging (e.g., cans, foil wraps and trays), as well as bulky items such as outdoor furniture, housewares, appliances, and gas grills. Commercial, industrial, and C&D generators generate similar items as residential, as well as items such as window frames, siding, air conditioners, wires, and auto parts. Nationally, new product and packaging manufacturing using non-ferrous metals includes the following materials:

- Aluminum – 34 percent;
- Stainless steel – 28 percent;
- Copper and brass – 19 percent;
- Lead – 17 percent; and
- Other metals (including precious metals) – 2 percent.

Aluminum containers and packaging (e.g., aluminum cans), which have a short product life, typically become available for recycling relatively quickly after use. In contrast, all other non-ferrous metal products have a longer product life and may not become available for recycling for years.

Characteristics of the Non-Ferrous Metals Recycling System

Aluminum cans are collected through municipal residential recycling collection programs, and to a lesser extent away-from-home recycling collection or collected informally and brought to scrap yards for buy-back. These cans are baled as aluminum can bales and sent directly to end markets in the Southeast.

Residential bulky item recycling collection is available in some areas and bulky scrap metal (e.g., appliances, barbecue grills, outdoor metal furniture, bicycles, etc.) may be further sorted after collection with separation of these mixed metal items from other bulky waste not made primarily from metal such as interior wooden furniture. In addition, some bulky metal items are collected by retailer delivery services when appliances are replaced and delivered to scrap dealers or delivered by residents who self-haul bulky items to municipal drop-off sites.

There are some residential collection programs in Texas that will accept metal housewares (e.g., pots, pans) for recycling in municipal collection programs. Items donated to thrift stores, if not sold for reuse, will often be recycled by those stores in cooperation with local scrap metal processors. Semirigid foil pans and foil wraps are not collected in most Texas programs due to lack of markets.

Contractors who generate non-ferrous metals from residential air conditioner replacements, siding, window, and screen replacement will often deliver the non-ferrous metals to a local scrap metal processor for recycling. Building renovation projects and re-roofing projects generate non-ferrous metals in mixed materials and these materials may be collected in a roll-off container for further separation by a construction and demolition debris recycler or they may be disposed. Electronics recycling operations also generate ferrous and non-ferrous metals streams from their processing operations and these materials are sold to the scrap processing system as well.

Lead primarily comes from auto batteries, which nationally have a 99 percent collection rate through reverse return systems. Other than lead automobile batteries and aluminum cans processed primarily by MRFs, most other non-ferrous scrap metal that is collected is processed by one of over 600 Texas scrap metal processors. Most of these processors are small and they may only hand sort selected non-ferrous metals and perform magnetic separation of ferrous metals from mixed metals on the rest. These small processors often sell their material to larger processors who may perform shredding, crushing, shearing, and baling operations. Products made from a mix of materials, such as cars and appliances, are sent to shredders for further separation of ferrous, non-ferrous, and non-metal components. Non-ferrous metals from shredders still contains a mix of metals including aluminum, lead, copper, brass, and stainless steel, and needs further sorting. The ability to sort this mixed non-ferrous stream is limited in Texas and historically most has been exported. With a curtailment in export demand, led by China, more sorting facilities are needed nationally and in Texas.

U.S. Markets for Non-Ferrous Metals
Nationally aluminum cans had a recycling rate of 46 percent in 2019, but this includes the contribution of higher recycling rates from the nation's 10 bottle bill states. Aluminum foil and semirigid container packaging is not commonly recycled and likely does not exceed five percent nationally.

The U.S. Geological Survey estimates national recycling rates for old scrap at 45 percent for aluminum, nine percent for copper and brass, and 73 percent for lead. Some streams of non-ferrous metals are recycled through distinct collection and processing flow paths – lead from old car batteries, for example. Many non-ferrous metals, especially from MSW, are collected as mixed metals, including both ferrous and non-ferrous metals. This material goes to the scrap system where the large multi-material products are shredded and ferrous metals are separated magnetically. The remaining mixed non-ferrous metals must be transported to specialty non-ferrous metal processors to be sorted by metal type using special equipment.

Nature of Texas Supply of Non-Ferrous Metals
Table 7-11 summarizes the amount of non-ferrous metals generated, recycled, and disposed in 2019 based on RMDP survey and supplemental data (as described in Section 3) and waste composition data (as described in Section 4). Quantities include commercial and residential mixed waste and construction and demolition debris; and exclude non-ferrous metals generated at industrial and manufacturing locations, shredder scrap, and other non-ferrous scrap that travels to scrap metal dealers. The Project Team estimates that the recycling rate for aluminum cans in Texas may be as high as 38.5 percent.

TABLE 7-11: TEXAS MSW NON-FERROUS METALS GENERATED, RECYCLED AND DISPOSED (2019)

Material	Tonnage Generated[1]	Tonnage Recycled[2]	Tonnage Disposed	Recycling Rate
Non-Ferrous Metals	460,927	177,446	283,481	38.5%

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.
2. Quantity includes the portion of recycled industrial metals processed at scrap metal facilities. More information is provided in Section

In addition to quantities in Table 7-11, an estimated 564,882 tons of non-ferrous metal were recycled by industrial generators, or more than three times the amount recycled from the MSW stream.

Nature of Demand for Texas-Generated Non-Ferrous Metals
Small amounts of non-ferrous scrap metal are consumed by secondary smelters in Texas, but the majority is shipped to consumers in other states or countries. Flows for Texas-generated non-ferrous recyclable scrap metal vary by material, and include the following:

- **Baled aluminum cans** are sent to Alabama, Georgia, or Tennessee. The national recycling infrastructure can recycle more cans from Texas and other states than are collected.
- **Extruded aluminum from windows** is recycled by Texas extrusion billet manufacturers who recycle their customers' fabrication scrap and to a lesser extent extruded aluminum from old windows and doors. There are six secondary aluminum smelters in Texas, all for non-packaging aluminum scrap, with a capacity of approximately 150,000 tons per year.
- **Zinc** is recycled in Houston by U.S. Zinc, which is one of the largest zinc buyers of spent zinc bearing materials globally and one of only a couple of zinc recyclers nationally (sources of Zinc for recycling are not from MSW).
- **Precious metals** from catalytic converters are recycled in Texas.
- **Lead** is recycled in Alabama, Missouri, and Mexico.

- **Copper** is recycled by at least one Texas company back into high-purity copper. Other copper flows include export to Asia and recycling by alloy producers in other U.S. states for recycling into cast brass parts.
- **Various materials** and products are shipped from Texas ports to global consumers.

Comparison of Supply and Demand for Non-Ferrous Metals

Texas markets have sufficient capacity to recycle most Texas non-ferrous metals generation. Exceptions are lead, which must be sent out of state for recycling, and aluminum cans, which also must be sent out of state for recycling but have excellent market demand in national markets for closed loop recycling. The supply of cans collected nationally for recycling are far below recycled content levels desired by end users, so domestic can sheet producers import used cans from other countries to meet the demand by them and their customers. Demand for aluminum cans (located in out-of-state markets) exceeds supply from Texas, due to limited collection. Also, demand for mixed non-ferrous metals is limited (as it was primarily an export market that declined in recent years); however, in-state ability to sort that material is also limited, so some of that material is disposed.

7.10 GLASS

Glass includes both container glass and non-container (or "plate" glass) generated by the residential, ICI, and C&D sectors. According to the U.S. EPA approximately 80 percent of glass generated is container glass, and 20 percent is plate glass, generally used in durable goods.

Overview of Glass

Container glass is comprised of bottles, jars, and other post-consumer containers from residential and commercial generators. Industrial rejected glass containers are also included. Plate glass is a much smaller segment of the glass stream, some of which is generated by residential and commercial generators (e.g., auto and window glass, glass from appliances, and computer glass) and some of which is generated by the industrial sector (e.g., manufacturing rejects).

Characteristics of the Glass Recycling System

Glass is generally collected through residential and commercial MSW recycling programs. Residential curbside programs usually accept container glass, although some programs have excluded glass in recent years. Such communities may offer a drop-off program for source-separated glass. Restaurants and bars are large-scale generators of glass containers which may be delivered to a MRF for further sorting, particularly if mixed with other materials. In some cases, it is sorted by color but often is simply processed into a "tri mix" (i.e., mixed cullet from green, brown, and clear containers). The cullet is then sent to a glass beneficiation facility. There, optical sorters are used to separate the glass by color. Sorters are also used to separate ceramic and stone contamination from good glass. Magnets and vacuum systems are used to further remove contaminants from the glass stream. Crushers and screens are used to further size the material to either coarse grind (5/8" size, primarily used in the container industry) or fine grind (used by the fiberglass and specialty products customers). Fine grind material also goes through a drying process to ensure proper material flow through the screening and silo storage process. Some glass is recovered from glass manufacturing. Recovered manufacturing glass and clean source-separated commercial glass often bypasses MRF processing and is delivered directly to a glass beneficiation facility.

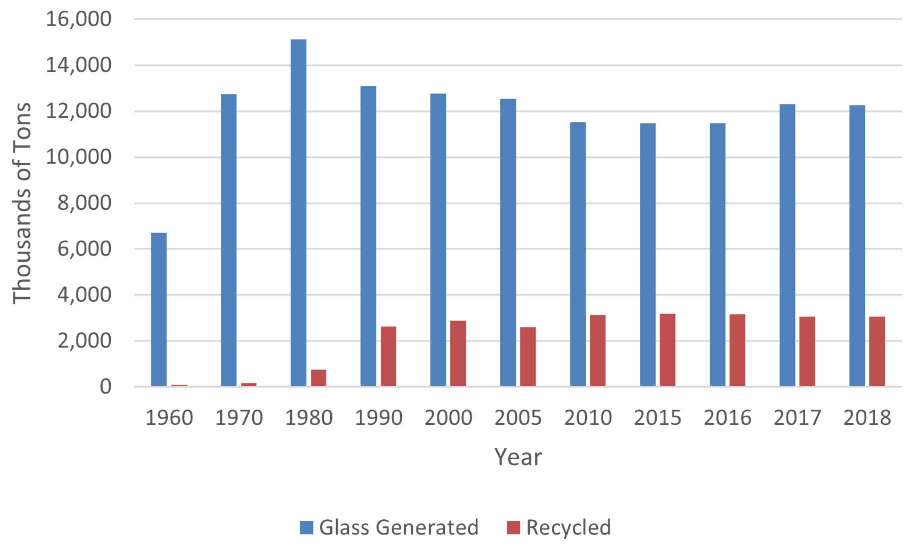
Non-container glass in MSW (i.e., plate glass), which is primarily in consumer goods like automobiles and appliances is reportedly only recycled at a negligible rate. In Texas, C&D is also considered part of the MSW stream, and glass from C&D would also be included as plate glass.

U.S. Markets for Glass

The use of glass as a container type declined for several decades, stabilizing at about 80 pounds per person per year, on average since about 2010. Figure 7-8 shows the quantity of glass generated (including non-container glass, which was about 28 percent of the glass stream generated in 2018) and recycled since 1960.

The prevalence of glass generation in MSW peaked in 1970 with glass comprising 10.5 percent of the material stream, and by 2018 had declined to 4.2 percent. However, glass comprises a larger segment of the municipal recycling stream by weight. The CRI calculated that glass accounted for 17 percent of all single-stream curbside tonnage by weight in 2012, but by 2017 this had increased to 20 to 25 percent of all

FIGURE 7-8: AMOUNT OF GLASS GENERATED AND RECYCLED IN MSW STREAM



Source: U.S. EPA

MRF materials by weight as paper quantities continue to decline. The national recycling rate of glass was estimated to be 25 percent in 2018. If only container glass is considered that rate increases to 31.3 percent. The proportion of recycled glass in U.S. container glass production increased from around 25 percent in 2008 to an estimated 35 percent currently. According to the Glass Packaging Institute (GPI), only 40 percent of glass placed in single-stream recycling systems makes it through the entire process to be successfully recycled. The remaining 60 percent of incoming single-stream glass is disposed with residue or beneficially reused as alternative landfill cover or other use. In source-separated programs (including bottle-bill programs), 90 percent of glass placed in the system is recycled.

Glass can be recycled endlessly by crushing, blending, and melting it together with sand and other starting materials. Doing so benefits manufacturers, the environment, and consumers. Because glass is heavy and costly to transport, as well as relatively low value, glass markets tend to be local in nature. Therefore, sensible collection and processing solutions will vary depending upon the infrastructure in the local region.

Nationally, an estimated 80 percent of all glass containers recovered for recycling are remelted in furnaces and used in the manufacture of new glass containers. Other uses for recovered glass include:

- Manufacturing fiberglass;
- Making industrial glass beads used in highway applications for reflexivity, as well as in the petroleum industry;
- As an abrasive for sandblasting applications in shipyards (steel/aluminum), tanks/pipelines, concrete restoration (pre-cast concrete), wood/log homes, auto restoration, slurry/vapor blasting, and dustless and wet blasting.);
- As an aggregate;
- As a filler in products such as paint, brick/tile, and aluminum castings, flooring; and
- In manufacturing products such as specialty tiles, pavers, countertops, fire pits, swimming pools, and aquariums.

When markets are not available, beneficial uses for recovered glass include use in road base, in manufacturing concrete and asphalt (i.e., “glassphalt”), and as alternative daily cover at landfills.

Nature of Texas Supply of Glass

Table 7-12 summarizes the amount of glass generated, recycled, and disposed in 2019 based on RMDP survey and supplemental data (as described in Section 3) and waste composition data (as described in Section 4). An estimated, 1,076,956 tons of glass were generated in MSW in Texas. Further, it is estimated that 168,8469 tons of glass (16 percent of waste glass estimated to be generated in Texas) were recycled. Of this, most

TABLE 7-12: TEXAS MSW GLASS GENERATED, RECYCLED AND DISPOSED (2019)

Material	Tonnage Generated[1]	Tonnage Recycled[2]	Tonnage Disposed	Recycling Rate
Glass	1,076,936	168,469	283,481	38.5%

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.
2. Includes 120,302 tons of container glass and 48,167 tons of plate glass.

(120,302 tons, or 71 percent of that recycled) was container glass. In addition to the recycled tons indicated in Table 7-12, an estimated 27,349 tons of glass were recycled from the industrial sector. This estimate is based on survey data and may understate the quantity of industrial glass being recycled.

The Project Team's estimated recycling rate for Texas-generated glass is below the national average recycling rate for container glass of 31.3 percent.[11] It is not surprising that Texas' recycling rate for glass is below the national average because:

- Texas is not a bottle deposit state. The 10 states with deposit programs for beverage containers in the U.S. have higher recycling rates than the states that do not.
- There are several communities known to exclude glass from their recycling programs or only offer drop-off programs for glass.

Most of the recycled glass in the MSW stream in Texas flows through MRFs to three glass beneficiation facilities, which provide secondary processing to further prepare the material for end users. While most recycled glass in Texas flows through MRFs, some (mainly commercial window and plate glass and source-separated container glass collected through drop-off programs as well as manufacturing waste from container manufacturers) flows directly from generators to beneficiation facilities.

Texas Processing Infrastructure
There are an estimated 31 MRFs operating in Texas, 14 of which reportedly accept glass for processing according to the Glass Recycling Coalition.[12] The following describes the distribution of the MRFs that accept glass in their incoming material stream:

- Central Texas/Austin area: 3 MRFs;
- Houston area: 2 MRFs;
- Dallas/Fort Worth area: 6 MRFs;
- San Antonio area: 2 MRFs; and
- Southern area: McAllen MRF.

The remaining areas of Texas (western Texas, southern Texas, and north of Dallas) do not have local MRFs that accept glass.

Glass travels to secondary processors regionally within the State. There are three beneficiation facilities in Texas, owned by two companies. They include:

- Dlubak Glass (Waxahachie);
- Strategic Materials, (Midlothian); and
- Strategic Materials, (Houston).

Secondary processors in Texas indicate that they could process much more material.

[11] U.S. EPA estimate
[12] *Based on information from the Glass Recycling Coalition, available at https://www.glassrecycles.org/glassmap*

Nature of Demand for Texas-Generated Glass

There are several end users of recycled glass cullet in Texas. The identified glass container manufacturers, fiberglass manufacturers, and glass bead manufacturers are:

- Owens-Illinois (O-I) (Waco), manufacturer of container glass;
- Longhorn Glass (Houston), manufacturer of brown glass beverage bottles;
- Owens Corning (Waxahachie), manufacturer of fiberglass;
- Johns Manville (Cleburne; Houston), manufacturer of fiberglass;
- Potters Industries (Brownwood), Manufacturer of industrial glass beads; and
- SWARCO Reflex (Mexia), manufacturer of industrial glass beads.

Glass processors and manufacturers using recycled glass in Texas are shown in Figure 7-9. The approximate locations of these facilities are shown using different colored pins on the map and include:

- Three glass beneficiation facilities (green pins);
- Two glass container manufacturers (blue pins);
- Three fiberglass manufacturers (orange pins); and
- Two manufacturers of industrial glass beads that reportedly use recycled glass (yellow pins).

FIGURE 7-9: GLASS PROCESSORS AND END MARKETS OF CULLET IN TEXAS

Source: Circular Matters, December 2020

Three additional glass container manufacturers are located in Oklahoma (in Henryetta, OK; Sapulpa, OK; Muskogee, OK) that could potentially accept cullet generated in Texas, as there is only one secondary processor in that area, located in Okmulgee, OK. Reportedly some glass cullet is imported into Texas from out of state (likely from Arizona) by rail to one of the fiberglass facilities. Rail haul can be a cost-effective option if the material travels more than 250 – 300 miles.

In addition to these end markets, there are some communities that, because of their distance from processing facilities, pulverize recovered glass (typically collected through drop-off sites) and use the material for municipal purposes and/or sell crushed glass for residential and commercial use. These cities include:

- McAllen;
- El Paso;
- Pearland; and
- Alpine.

Comparison of Supply and Demand for Glass

Texas manufacturers of fiberglass and glass containers indicate that they could use additional recovered material if they could obtain the material at the right price and of the right quality. A challenge for Texas manufacturers is being able to purchase processed cullet at the quality and price desired. Processors also indicate that demand exceeds supply for both container glass and plate glass. Further, demand for glass containers has been increasing in recent months due to the coronavirus pandemic. More beer and liquor is being consumed at home, resulting in the purchase of more glass containers. O-I Waco, a manufacturer of glass containers, announced that it re-started the facility's third furnace, which had been idled for nearly a year, due to this increase in demand.[13] Reportedly some recovered glass from out of state is rail hauled from the southwest into Texas for use in manufacturing fiberglass. The fact that some cullet is shipped into Texas from out of state to satisfy some in-state demands from the fiberglass industry indicates that demand outpaces supply in the state. The industrial glass bead manufacturers did not comment in this regard.

Demand for recycled glass feedstock is expected to rise in coming years due to manufacturer's desire to increase recycled content of their products. O-I indicates that their average recycled content nationally is 38 percent; however, the average in the industry is around 30 percent. Fiberglass manufacturers reportedly use 40 to 45 percent recycled content overall, with some companies claiming to use 60 to 65 percent recycled content. Some fiberglass companies indicate the desire to reach 90 percent recycled content. One reason for increasing recycled content is a focus on sustainability, often due to customer pressure and/or company sustainability goals. Additionally, using recycled glass reportedly results in processing efficiencies which reduce costs by using less energy, causing less wear and tear on furnaces, and producing fewer emissions, (which places less burden on scrubbers). As a result of these benefits, recycled glass feedstock generally commands a price premium over virgin material.

As a user of end products made from recycled glass, the Texas Department of Transportation (TxDOT) indicates that it is a large-scale consumer of industrial glass beads, purchasing 15,000 tons annually; although not all are made from recycled glass due to reflexivity requirements.

7.11 Organics

Organics includes the following types of materials from residential and ICI generators:

- Yard waste (e.g., yard trimmings, leaves, brush, grass);
- Wood waste[14] (e.g., woody waste generated by residents and commercial entities, including items like pallets);
- Food and beverage waste (e.g., solid and liquid waste from food processors/manufacturers);
- Biosolids (sewage sludge that has been treated or processed to meet Class A, Class AB, or Class B pathogen standards for beneficial use); and
- Other (e.g., septage, water treatment plant residuals, fats oils and greases, dead animals, manure, other organic sludge).

Overview

Organics comprise a large portion of the waste generated in the U.S. The U.S. EPA estimates that food waste and yard trimmings combined comprise nearly 34 percent of the MSW generated.[15]

Yard Waste

Yard waste includes materials such as leaves, grass clippings, brush, and tree branches and stumps. Across the country, many communities and several states have banned the landfilling of yard waste. Nationally, the most common means of processing yard waste is to mulch and/or compost it, often adding other nutrients such as food waste and manure, animal fatalities, and other organics to add nutrients. In 2018, 22.3 million tons of yard waste were generated in the U.S., comprising 12.1 percent of MSW; 63 percent of which was composted.[16] Clean wood waste is typically ground and used as mulch for landscaping, playground surfacing, fill material, animal bedding, erosion control, and more. Treated and painted wood, however, have much more limited uses, often being disposed or used for alternative daily cover. Besides providing aesthetic and cushioning qualities, mulch can help control weeds and retain moisture in landscaped settings and

[13] Jared Paben, Resource Recycling, "O-I Restarts Glass Furnace Due to Greater Bottle Demand," January 19, 2021
[14] *Some wood waste is also included in C&D.*
[15] *U.S. EPA, Advancing Sustainable Materials Management: 2018 Tables and Figures, Table 1, November 2020.*
[16] *Ibid.*

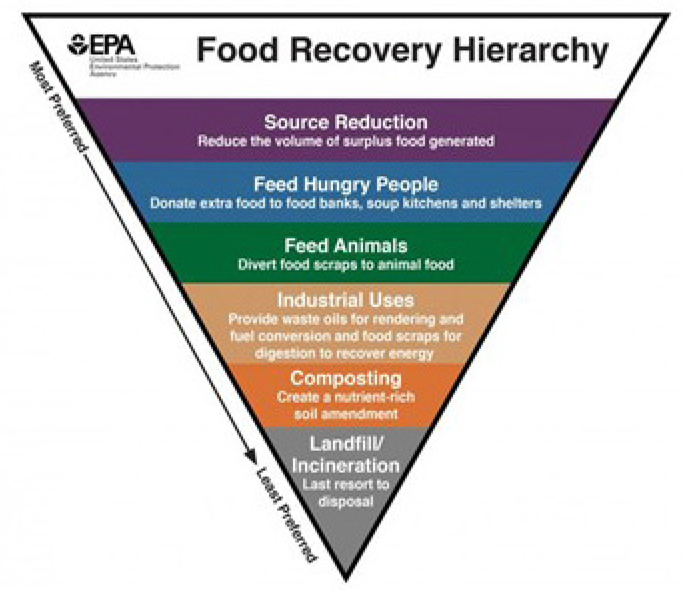
prevent soil erosion. There is little data on the quantity of wood waste generated annually in the U.S. and the amount of wood waste managed by different methods.

Food Waste

Food waste (comprising 21.6 percent of MSW) is becoming more of a focus of diversion programs in many states, with some states implementing mandatory and voluntary food waste recovery/composting programs. States with mandatory food waste recovery policies include California, Connecticut, Massachusetts, New York, Oregon, Rhode Island, Vermont, and Washington.[17],[18] Some residents compost their own food waste. The quantity of food waste generated nationally as MSW is 63,132,213 tons. If industrial food waste is included, this increases to 102,953,370 tons. Thus, industrial food waste is expected to comprise almost 40 percent of food waste generated in the U.S.

The U.S. EPA food recovery hierarchy, as shown in Figure 7-10, calls for avoiding food waste first and foremost, then rerouting edible food to people in need, then using the remaining food waste as direct feed to animals. The next most desired means of managing food waste are for industrial uses (e.g., convert to energy through digestion), then to create compost, and lastly, to disposal (landfill, waste-to-energy incineration). The rationale for avoiding landfilling organics goes beyond conserving landfill space and achieving zero waste, and extends to reducing greenhouse gas emissions, including methane, which are produced as landfilled organics degrade. Note that some food waste (e.g., high-water content material from food manufacturers and processors and food waste processed through residential and commercial garbage disposals) is managed through wastewater treatment plants. In some areas, this practice is being discouraged to avoid potential issues in the wastewater treatment system.

FIGURE 7-10: U.S. EPA FOOD RECOVERY HIERARCHY



Source: U.S. EPA, "Sustainable Management of Food"

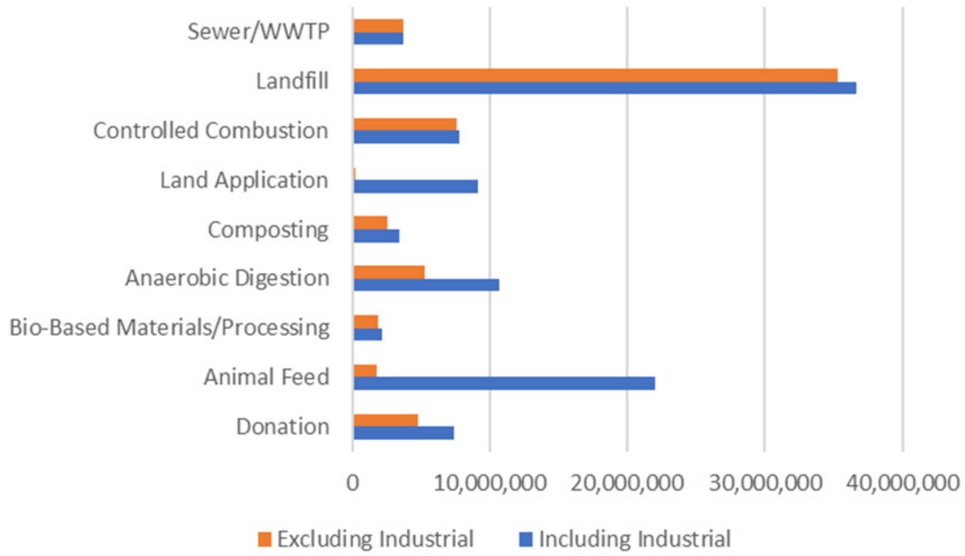
Food waste is most commonly processed at composting facilities. High-quality compost is a valuable product that enriches soil, helps retain soil moisture, and suppresses plant diseases and pests. Using compost can reduce the need for chemical fertilizers.

Anaerobic digestion, another means of processing food waste and other organics, creates biogas and a digestate material that can be used as a soil amendment. Captured biogas can be used to generate electricity, as fuel for boilers or furnaces, or create pipeline quality gas or compressed natural gas that can be sold as a vehicle fuel. Most commonly it is used to generate electricity and provide combined heat and power (CHP). Based on a recent study by the U.S. EPA[19], there are at least 209 anaerobic digestion facilities in the U.S. known to be accepting food waste as of 2019. Of those, 39 percent are co-digestion facilities at wastewater treatment plants, 33 percent are stand-alone digesters, and 28 percent are on-farm co-digesters.

[17] *U.S. Composting Council, Landfill Organics Bans*
[18] *Environmental Research and Education Foundation (EREF), State Food Waste and Organics Diversion Mandates*
[19] *U.S. EPA*

There are 263 anaerobic digestion facilities on livestock farms throughout the U.S., with another 19 under construction, and others are in operation at food processing and manufacturing facilities. There are also a number of co-digestion facilities where biosolids are processed with food scraps and where food scraps are processed with farm waste.[20] Food waste in MSW was managed as indicated in Figure 7-11 in 2018.

FIGURE 7-11: FOOD WASTE MANAGEMENT IN THE U.S., IN TONS (2018)



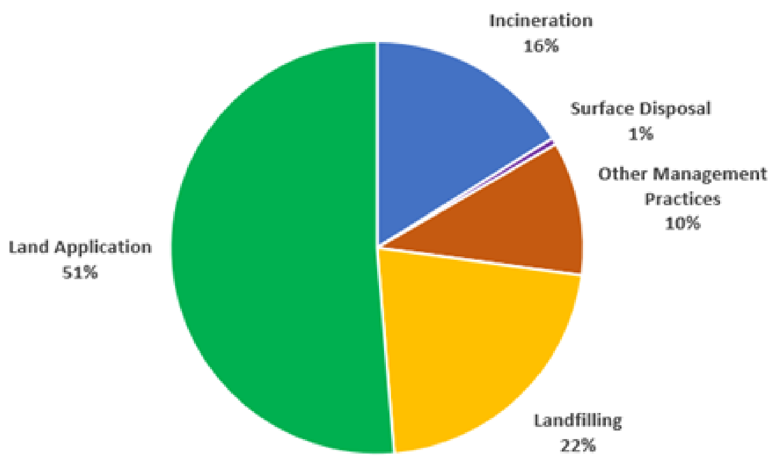
Source: U.S. EPA, "[U.S. EPA 2018 Wasted Food Report](), " November, 2020.

Biosolids

Biosolids are solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in treatment works. In the U.S., most biosolids are initially treated at wastewater treatment plants, then landfilled, land applied (to add nutrient value to crops or pasture), composted with other organics, incinerated, or used as a feedstock to manufacture commercial fertilizer. Biosolids that are to be beneficially used must meet federal and state requirements. It is estimated that 5.2 million dry tons of biosolids were generated in 2019.[21] Figure 7-12 shows the management of biosolids from major wastewater treatment plants in the U.S. in 2019.

Septage (or domestic septage) is the material pumped from septic tanks and similar wastes. It does not include chemical toilet waste or grit and grease trap waste. This material has a higher liquid content than biosolids and is often delivered to wastewater treatment plants for processing, land applied, or further treated at an independent septage treatment facility.

FIGURE 7-12: BIOSOLIDS MANAGEMENT IN THE U.S. (2019)



Source: U.S. EPA, "Basic Information About Biosolids," accessed January 21, 2021

[20] U.S. EPA AgSTAR, Data and Trends
[21] U.S. EPA, "Basic Information about Biosolids."

Other Organics
Fats, oils and grease (FOG) are not included in MSW in the U.S. EPA definition and little is known about the quantity generated nationally. If not managed properly, FOG can cause wastewater management and plumbing issues. FOG is generally collected from commercial and industrial generators by commercial collectors, and some (yellow grease) can be processed into biofuel. Other FOG is processed at anaerobic digestion facilities, de-watered and land applied (where allowed), or composted. The remaining portion of FOG is disposed.

Nature of Texas Supply of Organics

Table 7-13 summarizes the amounts of organics generated, recycled, and disposed based on 2019 estimates described in Sections 3 and 4, and extrapolated national estimates from the U.S. EPA. There is little or no data for some types of organics due to limited reporting requirements. RMDP results for yard trimmings generation is significantly higher than the extrapolated U.S. estimate. This may be because some wood waste is included in this data. The estimated Texas yard trimmings recycling rate is also relatively high at 82 percent compared to a national average of 63 percent.

TABLE 7-13: TEXAS ORGANICS GENERATED, RECYCLED, AND DISPOSED (2019)

Material	Tonnage Generated	Tonnage Recycled	Tonnage Disposed	Recycling Rate
Yard Trimmings[1,2]	7,125,964	5,824,824	1,301,140	82%
Yard Trimmings – U.S. EPA Estimate[3]	3,095,730	1,950,135	1,145,595	63%
Food [1,2]	4,402,891	81,611	4,320,480	2%
Food – U.S. EPA Estimate[3,4]	5,520,719	1,446,426	4,074,293	26%
Biosolids[5]	522,367	231,379[6]	290,988[7]	44%
Septage[8]	NA	NA	25,959	NA
Water Treatment Plant (WTP) Residuals[9]	NA	39,880	NA	NA
Manure/Farm Waste	NA	NA[10]	NA	NA
Grease Trap Waste/ FOG	NA	NA	3,947	NA

1. Generation estimated as the sum of tonnage recycled and tonnage disposed.
2. RMDP estimates for MSW, as presented in Section 3.
3. Based on extrapolated national data if Texas recovery rate were equal to the national average
4. Recycled includes donated, composted, land application, anaerobic digestion, animal feed, chemical processing. Excludes industrial, estimated to be 3,482,368 additional tons generated, based on extrapolation of U.S. data by population.
5. Dry tons. Data provided by TCEQ Water Quality Division and is 2018 data, the latest year for which complete data is available.
6. Includes 241,159 tons landfilled and 49,829 tons land applied.
7. Includes 193,022 tons Class A, AB bulk to agriculture and 38,357 tons Class B land applied.
8. Septage quantities are not tracked in Texas. They can be processed at WWTPs, but are often land applied if meet Part 503 requirements. There are 1,002 septage haulers in Texas. It is estimated that 15-20% of homes in Texas have on-site septic systems.
9. Tonnage that was land applied, otherwise managed quantities not known.
10. An unknown quantity of manure/farm waste delivered to compost facilities and at least two known on-farm anaerobic digestion facilities.
NA = No data available

Nature of Demand for Texas-Generated Organics

Most organic material generated in Texas is processed in Texas. Because not all composting and mulching facilities in Texas are regulated, there is no exact count on the number of facilities that compost and mulch in Texas. Composting has grown significantly in Texas in recent years, driven by municipal recycling goals, growing interest to divert waste from disposal, and in some cases by a desire to compost rather than land apply biosolids. There is no exact count on the number of facilities that compost and mulch in Texas, as not all facilities are regulated. Facilities that process organics in Texas include the following:

- **Compost facilities:** Based on an analysis of the TCEQ MSW facility database (February 2021) there are currently 142 active regulated compost facilities, comprised of:
    - 8 permitted facilities, which can accept grease trap waste and mixed MSW;
    - 14 registered facilities, which can accept sewage sludge, diapers, and paper sludge;
    - 71 notice of intent facilities, which can accept source separated meat, dairy, animal carcasses, and source separated vegetable and meat oils and fats; and
    - An unknown quantity of non-regulated compost facilities that only compost source-separated yard trimmings, clean wood, vegetative material, paper and manure.

- **Mulching:** There is an unknown quantity of wood mulching operations in Texas. These facilities may accept clean woody waste from tree trimmings, C&D wood, and wood packaging such as pallets and crates. Many compost facilities also accept wood to mulch on site for use as compost bulking agent and/or for sale as a final product. Some mulching facilities have the capability of coloring mulch and bagging operations.

- **Other wood product manufacturing/processing facilities:** There is a large-scale wood processing facility operating in Texoma that reportedly makes mulch (they have a coloring and bagging facility) and which uses pyrolysis to turn biomass into a carbon-rich substance used as a soil amendment called biochar. Wood is also used as an alternative fuel; however, the demand for biomass energy within Texas is relatively weak, given the current low cost of natural gas and the prevalent use of wind energy. According to the U.S. Energy Information Administration (EIA), there are also two wood pellet manufacturers in Texas that, combined, have the ability to produce nearly 550,000 tons of pellets annually.[22] These companies do not rely on Texas demand, as pellets are exported globally including to growing Asian markets. The quantity of scrap wood these manufacturers use versus forestry wood is unknown.

- **Anaerobic digestion facilities:** There are several anaerobic digestion facilities known to be operating in Texas. They include:

    - **Food waste/industrial:** There are three anaerobic digestion facilities operating in Texas that reportedly accept food waste: two wastewater processing facilities (Dallas Southside Wastewater Treatment Plant and Waco Metro Area Regional Sewage System), and one stand-alone facility that processes industrial waste (Houston BTS in Houston)[23].
    - **Biosolids:** Several anaerobic digestion facilities are located at wastewater treatment plants and treat only biosolids.
    - **Agricultural/on-farm:** There are three anaerobic digestion projects in operation to manage agricultural wastes. Two projects are located on swine farms in Dalhart and use covered lagoon digesters. The biogas is used for boiler/furnace fuel.[24] One on-farm anaerobic digestion facility (Huckabay Ridge in Stephenville) previously reported processing cattle manure from multiple ranches (12,500 tons annually) as well as grease and other restaurant waste. Pipeline gas and thermal energy from this facility were sold to utilities.[25]

- **Liquid biofuel production:** There are four facilities in the high plains panhandle of Texas converting agricultural waste (corn and sorghum) into ethanol, with a combined capacity of nearly 400 million gallons annually.[26] In addition there are eight biodiesel producers that have the capacity to provide 375 million gallons of biodiesel per year, combined.[27] These facilities are located in Nacogdoches and Woodville (both in eastern Texas).

[22] U.S. Energy Information Administration, "State Profile and Energy Estimates: Texas," March 19, 2020
[23] U.S. EPA, "Anaerobic Digestion Facilities that Accept Food Waste in the United States – 2015" September, 2019.
[24] USDA AgSTAR, "Livestock Anaerobic Digestion Database," September 2020.
[25] USDA AgSTAR, "Regional Scale Dairy Project – Huckabay Ridge – Stephenville, Texas," February 2014.
[26] U.S. Energy Information Administration, "State Profile and Energy Estimates: Texas," March 19, 2020
[27] Ibid.

- **Biosolids, septage, and WTP residual processing/markets/beneficial use:** Most biosolids from wastewater treatment plants (WWTPs) in Texas are landfilled, but some are treated and land applied. There are approximately 35 WWTPs in Texas that treat material to a Class A material. This material is not tracked unless it is land applied. Alternatively, Class A material may go to a compost facility for inclusion in soil amendment products. Biosolids from water treatment plants (WTPs) may be beneficially used as clean fill or land applied. This quantity is also not tracked. Domestic septage is generally treated and land applied. Facilities currently accepting/processing biosolids and/or septage include:
    - 52 land application sites for domestic septage (primarily located east of I-35);
    - 65 Class B land application sites;
    - 210 Class A/B land application sites;
    - 130 WTP land application sites;
    - 28 compost facilities that accept biosolids (22 permitted by the Waste Permits Division and 6 permitted by the Water Quality Biosolids Program);
    - 86 landfills that accept sewage sludge; and
    - 12 monofills or surface disposal sites for sludge.

Comparison of Supply and Demand for Organics

The composting industry has grown considerably in Texas in recent years and is expected to continue expanding. Currently the supply of compost is roughly equivalent to or slightly higher than demand statewide; however, this varies somewhat from region to region. Some composters report that some areas, such as the Houston market is currently oversaturated, while those in other areas of the State indicate that they have adequate markets for their final products. It is anticipated that the amount of supply (of feedstock and processed compost) will increase in coming years due to growth of food waste composting programs and potentially the desire of some municipalities to shift from land application of Class B biosolids to composting or otherwise processing this material. There are also opportunities to expand compost markets in Texas. Currently high-quality compost can be marketed, but it requires significant work. Markets tend to be somewhat localized within the State, as high-population areas have compost facilities. The more the industry grows, the more regionalized it is expected to become. The western, less populated areas have some compost processors and a need for the material due to soil issues, but also have fewer people to drive demand.

In terms of feedstock demand, most compost facilities in Texas indicate that they could use more supply of material. This would likely help them achieve better economies of scale.

Wood products made from land clearing debris and other clean wood include mulch, boiler fuel, and fuel pellets. The mulch market appears to be relatively strong, with mulch provided for landscaping and playground and sport surfacing. Boiler fuel may be purchased by cement kilns and other industrial users; however, wood as a fuel source is generally not competitive with other sources within Texas. One wood pellet manufacturer indicates that they have a strong export market, primarily to Asia.

Most mulch/compost survey respondents indicated that they have plans to expand the amount of material they process, and the majority indicated that they have plans to expand their capacity. Some also indicated that demand for compost and mulch has increased during the coronavirus pandemic. For this reason, it is estimated that supply may be slightly below demand for mulch for much of the State. However, there are likely areas in Texas and times (e.g., after storm events) when the supply of wood likely exceeds demand.

7.12 Construction and Demolition Debris

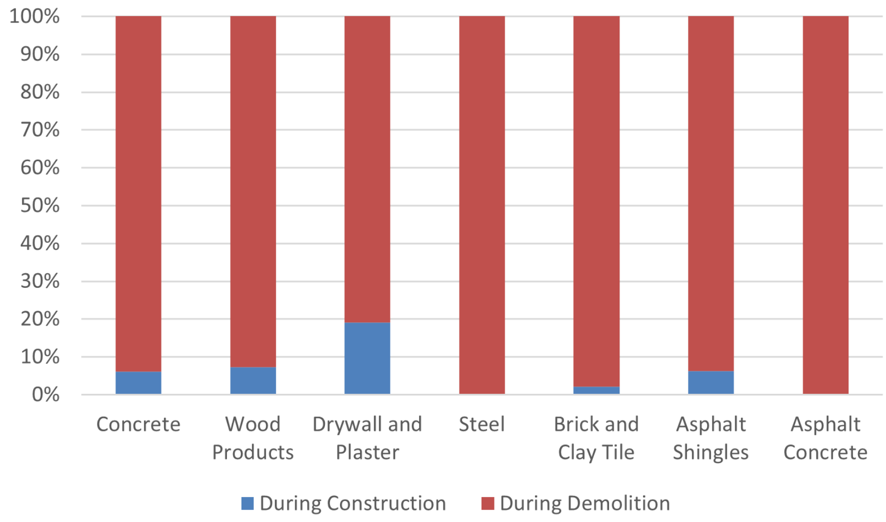
Construction and demolition (C&D) debris is waste that is generated during the construction, remodeling, repair, or demolition of buildings, bridges, pavements, and other structures. C&D debris includes concrete, asphalt, lumber, steel girders, steel rods, wiring, drywall, carpets, window glass, metal and plastic piping, tree stumps, soil, and other miscellaneous items related to the activities listed above. Other C&D debris can include materials like ceiling tiles, metal pipes and appliances, insulation, carpet, and other materials generated on job sites, such as plastic and cardboard. These materials are generally generated in relatively small volumes. C&D activities also result in the generation of land clearing debris – mostly woody waste. Many C&D materials can be recycled or beneficially reused.

Overview of C&D Debris

The U.S. EPA estimates that over 600 million tons of C&D debris were generated nationally in 2018.[28] This is more than double the amount of MSW generated (the U.S. EPA does not consider C&D debris to be a part of the MSW stream).

Significantly more debris is generated during demolition and renovation projects than during construction projects. Figure 7-13 shows the proportion of each material type generated via construction versus demolition activities for 2015, the most recent year for which such data is available.

FIGURE 7-13: MATERIAL TYPES GENERATED DURING CONSTRUCTION AND DEMOLITION (2015)

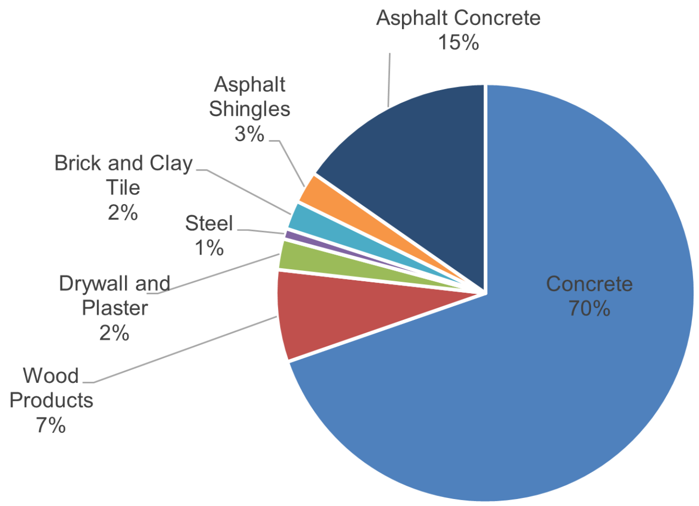


Source: U.S. EPA, Office of Resource Conservation and Recovery, "[Construction and Demolition Debris Generation in the United States, 2015,]" September 2018

As Figure 7-13 indicates, the materials typically generated during construction include drywall/plaster, asphalt shingles, wood products, concrete, and brick and clay tile. Drywall/plaster and asphalt shingles have an estimated discard rate of 10 percent. Concrete and wood have an estimated discard rate of five percent.

Figure 7-14 shows the national estimated generation of each material type according to the same study. By weight, concrete was the most prevalent material type at 70 percent of C&D generation. It is reasonable to expect that the same holds true today.

FIGURE 7-14: C&D DEBRIS GENERATED BY MATERIAL TYPE (2015)



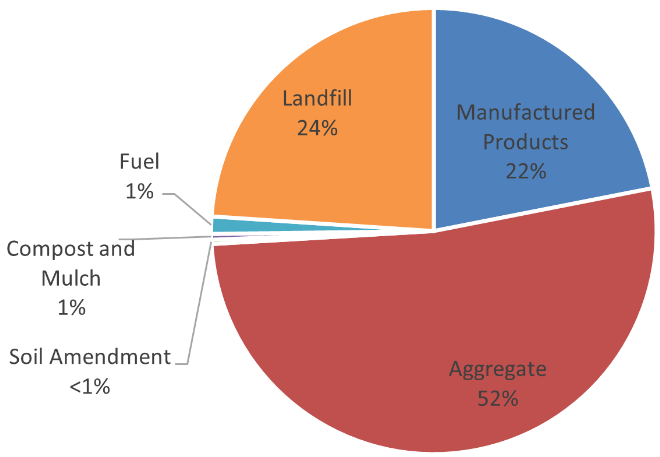
Source: U.S. EPA, Office of Resource Conservation and Recovery, "[Construction and Demolition Debris Generation in the United States, 2015,]" September 2018

[28] U.S. EPA, "[Construction and Demolition Debris: Material-Specific Data.]"

The nature of material generated depends on the type of project. Road projects tend to generate asphalt; bridges generate concrete and steel; commercial building projects generate concrete, steel, wood, and asphalt shingles, drywall and plaster and tile; and residential projects generated wood, asphalt shingles, drywall/plaster, tile, and a relatively small portion of asphalt/concrete from driveways. C&D projects in general tend to increase during a strong economy.

Nationally, the main materials generated through C&D activities, combined, were managed as shown in Figure 7-15 in 2018. More recent national data is not available for management of these materials, but it is reasonable to assume this has not changed dramatically since 2018.

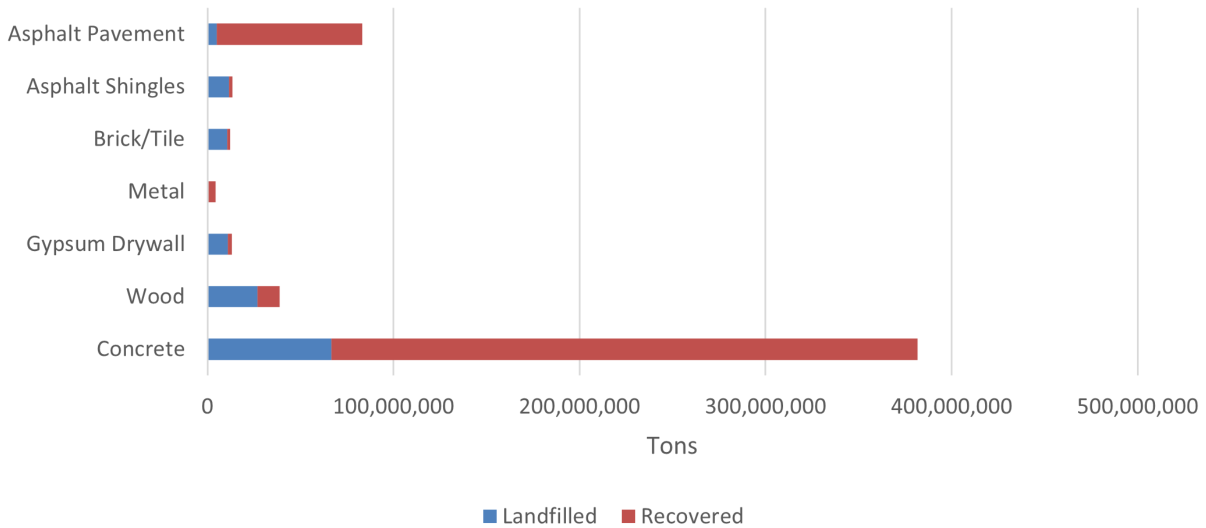
FIGURE 7-15: MANAGEMENT OF C&D DEBRIS IN THE U.S. (2018)



Source: U.S. EPA, "Construction and Demolition Debris: Material-Specific Data."

and the benefits of doing so. Non-recycled C&D debris is primarily disposed at Type I and Type IV MSW. Figure 7-16 shows the estimated quantities of each of the major material types generated, landfilled, recovered (i.e., recycled or used as fuel) in the U.S. in 2015.

FIGURE 7-16: ESTIMATED TONNAGE OF C&D MATERIALS GENERATED, LANDFILLED & RECOVERED IN U.S. (2015)



Source: U.S. EPA, Office of Resource Conservation and Recovery, "Construction and Demolition Debris Management in the United States, 2015," March 2020

As Figure 7-16 shows, concrete, the most widely generated material by weight, was also estimated to be the most recovered material type. Asphalt was also widely recycled. Wood was estimated to have a recovery rate of about 30 percent with the greatest amount (nearly 70 percent) going to fuel. Gypsum drywall was estimated to have a recovery rate of only 17 percent, with most going to soil amendment, and a small percentage to manufactured products (i.e., new drywall). Metals from C&D had a high recovery rate, as metals generally have relatively high value. Brick and tile were recovered at a rate of 13 percent, with their only use being as aggregate.

Characteristics of the C&D Recycling System

The C&D recycling system is comprised of a handful of processing facilities – some of which have conveyors and automated sorting and some of which sort manually. Some C&D recyclers are vertically integrated haulers (generally specializing in roll-off containers) and may not accept materials from other haulers. C&D materials sorted at processing facilities include wood, shingles, asphalt/concrete, and sometimes drywall. Additionally, some typical recyclables like film plastics and cardboard are generated at work sites and may be collected and recycled by C&D processors.

There are also several material-specific recyclers that manage concrete and aggregate, shingles, wood and metals. Some aggregate/concrete/asphalt recyclers have portable equipment to process material on site, reducing transportation resource needs. After materials are processed, some may be delivered to an end material manufacturer for further processing/sale. Examples include concrete manufacturers, asphalt pavement manufacturers (who further process ground asphalt shingles and pavement into new pavement or pavement products), mulch and wood pellet manufacturers, and scrap metal processors. Ceiling tiles are not widely recycled, but some tile manufacturers offer recycling programs for ceiling tiles in good condition. Some carpet manufacturers also allow the return of carpet. However, these return- to-manufacturer programs tend to be time consuming, requiring labor to sort, stack, wrap, and ship the material. Carpet recycling is discussed further in the Section 7-16. Plastic and cardboard generated through C&D activities are generally baled and sent to market as typical recyclables would be. Metal pipes and appliances are recycled through scrap metal dealers.

During mixed C&D debris processing, fines are created (small particles of less than three inches). This inert material can be used as alternative daily cover at landfills. Fines that are soil-rich can be used as clean structural fill; fines heavy with concrete, brick, and denser material can be used as structural fill. The gypsum and organic content of C&D fines can make it an appropriate soil or agricultural amendment.

Table 7-14 provides a summary of how materials generated in the C&D stream are typically reused/recycled.

TABLE 7-14: C&D MATERIALS AND HOW THEY ARE RECYCLED

Material Type	How Reused/Recycled	Benefits Beyond Landfill Diversion
Concrete, Asphalt, Brick, Tile, Aggregate	Materials are ground, screened, and used as an aggregate base layer, for soil stabilization, as pipe underlayment, or as landscape materials. Can also be used in manufacturing new concrete or asphalt. Used asphalt can be turned into reclaimed asphalt pavement (RAP). Often recyclers have mobile equipment that can be transported to a demolition site to reduce transportation requirements. Additionally, state DOTs often stockpile material (e.g., asphalt) in different locations across the state, have material crushed on site, and use in that region.	• Cost savings, especially if material can be used locally in lieu of new products on site. • The Construction & Demolition Recycling Association (CDRA) states that RAP saves taxpayers $2.5 billion annually. • Reduces reliance on mining. • TxDOT specifies up to 20 percent RAP in surface layer, 30 percent in intermediate layer, and 35 percent in base layer.

Material Type	How Reused/Recycled	Benefits Beyond Landfill Diversion
Asphalt Shingles	Recycled asphalt shingles (RAS) are ground and used in making hot mix asphalt (HMA) for roads or road repair products (such as warm mix asphalt, cold patch) as well as new roofing shingles and fuel. Asphalt shingles can also be ground and mixed with asphalt for temporary roads or used whole for temporary roads in muddy conditions. Research is also being conducted for using asphalt shingles in base layers of road construction. Typically, asphalt shingle recyclers process material by shredding and screening and supply processed shingles to asphalt pavement manufacturers.	• Reduces reliance on new asphalt and aggregate, thus reducing reliance on mining and virgin petroleum. Usually a cost savings, up to two percent per ton. • Fiberglass and cellulose fibers can improve the physical properties of the asphalt. • TxDOT specifies that up to three percent RAS can be used in base and intermediate layers. RAS can include residential tear offs and manufacturing scrap only.
Wood Waste	Wood waste can be ground and used as mulch (which can be used for landscaping, temporary roads, bulking agent for compost, soil amendment), wood products, fuel pellets, biomass; shredded or pelletized for animal bedding. Wood can be processed into biochar via pyrolysis.	• Reduces reliance on deforestation. • Wood has lower moisture content – better suited for fuel. Biochar can improve soil/ crop health. Wood pellets are renewable energy.
Drywall/Plaster	Gypsum drywall is ground, and can theoretically be used to make new drywall, as an ingredient in the manufacture of cement, as an ingredient in the manufacture of soil amendment products (supplying calcium and sulfate, without changing soil pH), and used as an additive in compost. Other uses include as a poultry litter or animal bedding amendment and for water clarification. Additional proposed uses include flea powder and for use in manufacturing construction products. Note: Most drywall is still disposed. There are numerous challenges in using recovered gypsum from drywall to manufacture new drywall.	• Reduced landfill odors by avoiding hydrogen sulfide generation from plasterboard. • Improves soil and crop health by adding sulfur and calcium. • Improves soil drainage, particularly for soils with high clay content. • Reportedly beneficial in agricultural markets to clarify water with a high salt content. • Cost savings over virgin gypsum.

Nature of Texas Supply of C&D Debris

Limited information is available regarding C&D debris generated and recovered in Texas. As described in Section 3, an estimated 3,259,909 tons of C&D materials were recycled in Texas in 2019. While much of this material was reported by concrete recyclers, limited detailed information is available regarding types of C&D materials recycled and disposed in Texas. In addition to the recycling and landfilling estimates presented in Sections 3 and 4, respectively, material-specific estimates were developed to facilitate the supply and demand analysis. Table 7-15 summarizes the amount of C&D materials generated, reused/recycled, and disposed based on 2019 estimates described in Sections 3 and 4, supplemental industry reports and interviews, and extrapolated national estimates from U.S. EPA.

TABLE 7-15: TEXAS C&D MATERIALS GENERATED, REUSED/RECYCLED, AND DISPOSED (2019)

Material	Tonnage Generated	Tonnage Reused/ Recycled	Tonnage Disposed
Concrete, Asphalt, Brick, Tile, Aggregate	12,960,287[1]	9,400,000 Including: Concrete[2]: 3,000,000 Asphalt[3]: 6,400,000	3,560,287 Including: Concrete, brick & cinder blocks[4,5]: 3,140,287 Asphalt[3]: 420,000
Asphalt Shingles	1,298,000[6]	5,000[7]	64,172[4]
Wood Waste[8]	3,738,000[6]	NA	1,988,000[4,9]
Drywall/Plaster	1,252,000[6]	NA	560,000[4]

1. Generation estimates as the sum of tonnage recycled and tonnage disposed. An additional 7.5 million tons of concrete may be recycled based on national data, yielding a total generation of 20.5 million tons concrete, asphalt, brick, tile, and aggregate.
2. Based on information reported through the RMDP survey.
3. Based on industry data/estimates and interviews.
4. Based on analysis from Section 4, including values presented in Table 4-5 and Table 4-7.
5. Includes 2,215,302 tons clean concrete/cement, 505,244 tons bricks/cinder blocks, and 419,741 tons asphalt.
6. Estimated using national C&D generation and composition data, based on the portion of U.S. population residing in Texas (8,745 percent).
7. Approximately 20,000 tons were used by TxDOT in 2016. This declined to 5,000 tons in 2019. An additional unknown quantity of asphalt shingles was used by local highway departments and private contractors.
8. Includes treated/painted wood, clean wood, and wood packaging.
9. Includes C&D wood waste generated in the residential MSW stream.
NA = Data not available

Concrete, Asphalt, Brick and Tile

A total of 9.4 million tons of concrete and asphalt were estimated to be recycled based on RMDP survey responses and supplemental industry reports and interviews, with approximately 3.56 million tons landfilled in 2019. Together, this suggests approximately 12.96 million tons of concrete, asphalt, brick, and tile were generated. As presented in Section 7.12, concrete is the most prevalent C&D material and has the highest recycling rate for C&D materials; however, the concrete recycling rate based on RMDP survey data is only 58 percent. This is notably lower than the national average of 83 percent (shown in Figure 7-16). There were multiple C&D recycling companies that did not respond to the RMDP survey, some of which are known by the Project Team to process significant tonnage including concrete. Assuming Texas' concrete recycling rate is equal to the national average, an additional 7.5 million tons of concrete may be recycled in the State for a total of 10.3 million tons and 12.7 million tons generated.

Asphalt Shingles

Based on national estimates and the portion of the U.S. population residing in Texas (8.745 percent), it is estimated that 1,298,000 tons of asphalt shingles may be generated annually in Texas. There is no data regarding the total quantity recycled annually; however, it was reported that recycled asphalt shingles (RAS) are also used in hot and warm asphalt applications in Texas. Texas reportedly[29] has a growing statewide quantity of stockpiled RAS that had reached an estimated 286.5 million tons in 2019 (only 78 tons in 2018). This is assumed to include the Blue Star abandoned shingle pile in Dallas. Based on waste composition studies, 64,172 tons of shingles are disposed annually.

[29] NAPA, "Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage, 2019."

Wood Waste
Based on national estimates and the portion of the U.S. population residing in Texas (8.745 percent), about 3.7 million tons of wood waste are generated through C&D activities in Texas. There is no data on the quantity of wood waste recycled as a part of the C&D stream. Waste composition data suggests that nearly 2.0 million tons of wood waste from C&D activities is disposed annually. An estimated 87 percent of this is clean wood waste, two percent is painted and treated wood, and 11 percent is wood packaging, such as crates and pallets.

Drywall/Plaster
Based on national estimates and the portion of the U.S. population residing in Texas, over 1.2 million tons of drywall would be expected to be generated in Texas annually. Waste composition data from Texas indicates that approximately 560,000 tons is landfilled annually in Texas. An unknown quantity is recycled.

Nature of Demand for Texas-Generated C&D Debris

C&D materials may be collected together at a construction or demolition site and separated at a mixed C&D facility or may be collected separately on site and processed by a company that specializes in that particular type of material (e.g., asphalt shingles). There are approximately 50 identified companies that reportedly recycle C&D materials in Texas, with at least 10 of those facilities processing mixed C&D. Three of these companies are known to be relatively large and well equipped. These include:

- El Paso Recycling (El Paso);
- Champion Waste (Dallas); and
- Recon Services, Inc. (Del Valle).

In some cases, mixed C&D debris processing facilities further process materials on site to manufacture and sell end products such as wood mulch, asphalt pavement products, and soil amendment made from gypsum.

There are a handful of cities in Texas that have C&D recycling ordinances in place (e.g., Austin, Plano) and others reportedly in the process of developing ordinances. C&D recycling ordinances help encourage recovery of C&D material and diversion from landfilling. Demand for C&D recycling services is supported where C&D recycling ordinances require the recycling of a certain percentage of C&D debris; however, this approach does not help develop demand for materials. The key materials that help entities achieve their required recycling/recovery rates are concrete, asphalt, and metals (all materials that already tend to have strong markets).

Concrete, Asphalt, Brick, Tile & Aggregate
There are at least 10 companies (including some with multiple locations) throughout Texas known to process concrete and asphalt/aggregate. These processors often have mobile equipment and are therefore able to process material on site, resulting in more efficient transport of material. Some local governments also stockpile material from demolition projects to process (or have processed) for later use as fill or road base material.

Recycled concrete is often used as a base layer in road construction and may also be used to manufacture concrete. Generally, concrete that is removed from old roads, bridges and other projects is rubblized and the rebar is removed and recycled. The concrete is further rolled/crushed/sized and used on site as a stabilized crushed concrete, if possible, which avoids transportation costs. Otherwise, material is stockpiled locally or delivered to a concrete recycling facility. At the facility, the concrete is crushed, metal removed, and material is stored and used as concrete base or rubble material for projects.

End users of recovered materials include asphalt manufacturers. There are at least 34 asphalt manufacturing facilities in Texas. Customers include TxDOT, municipal highway construction crews, and private construction companies. Asphalt has value as it includes binders, which are costly to purchase.

The demand for reclaimed asphalt and concrete for use as aggregate is reportedly strong in Texas. Aggregate is not plentiful and is costly to transport long distances and asphalt includes valuable binder in addition to being aggregate. Reclaimed asphalt pavement (RAP) is salvaged, milled, pulverized, broken, or crushed asphalt. TxDOT specifications allow up to 20 percent RAP usage in surface layers, 30 percent in intermediate layers, and 35 percent in lower layers; however, certain recycled binder to total binder specifications apply. Local governments often follow TxDOT specifications, but may be "behind," often using older specifications.

A study by the National Asphalt Pavement Association (NAPA)[30] estimates that about 40 million tons of asphalt pavement is used in road construction annually in Texas, and further estimates that 16 percent of that asphalt is comprised of RAP. This would be approximately 6.4 million tons of RAP. A TxDOT representative reported that the agency laid 20 million tons of asphalt during the 2020 construction season with approximately 80 percent eligible to include RAP, at an average rate of 15 to 16 percent. This would be 2.5 million tons recycled by TxDOT alone. When TxDOT generates waste asphalt, they often sell or give the asphalt to the local municipality, if TxDOT cannot use it. Usage may have declined in recent years, as NAPA estimates that there is a growing stockpile of RAP in Texas, having reached 5.27 million tons in 2019.[31]

Survey data indicates that at least 3,000,000 tons of concrete and aggregate are recycled annually in Texas. However, this is expected to understate the quantity recovered. Estimating the quantity of concrete recycled is particularly challenging, as material is often used on site or transported, stockpiled, and processed as needed by one of many concrete recyclers in the State.

Asphalt Shingles

Recovered asphalt shingles (RAS) can be used in asphalt paving applications in Texas, including some applications used by TxDOT and other agencies, and for commercial and residential applications. There are at least five companies known to accept shingles for recycling, and four that indicate they process them. They include:

- Atascosa Recycling, LLC (Atascosa);
- Cherry Crushed Concrete, Inc. (Houston);
- El Paso Recycling, Inc. (El Paso);
- Sustainable Pavement Technologies, LLC (Austin; Dallas; Fort Worth; Houston; and San Antonio); and
- Recon Services, Inc. (Del Valle).

Currently, demand for asphalt shingles is reportedly relatively low with many recyclers indicating that they can only recycle a portion of what they receive.

There is a growing quantity of stockpiled asphalt shingles in Texas – NAPA estimates that quantity was 286,500 tons in 2019 – an increase from the 77,900 thousand tons estimated to be stockpiled in 2018.[32] This is in part due to the decreased use of asphalt shingles by TxDOT and other highway departments and private contractors in response to the history described. According to the Federal Highway Administration (FHWA), there was a sharp decline in RAS usage by TxDOT, from 114,000 tons of RAS in 2012 to 20,000 tons of RAS in 2016. This represents an 80 percent decline over four years. When used, the concentration of RAS decreased from five percent to three percent over the same period.[33] TxDOT-reported asphalt mixture usage by Texas' State Highway Administration (SHA) was very large (12.5 million tons per year). However, RAS was only used in five percent of the asphalt mixture tonnage according to the FHWA survey. It also tended to be used in lower lifts, not surface lifts.

Wood Waste

There are a handful of relatively large-scale, plus many medium-sized and smaller, wood waste recycling facilities in Texas that specialize in wood generated from C&D projects (as well as land clearing and other clean wood which are discussed in Section 7.11). Mulched wood is used for home, commercial, and playground landscaping, and by composting facilities as a bulking agent.

Drywall/Plaster

There are several gypsum drywall manufacturing plants in Texas; however, they do not use recovered gypsum in manufacturing their products, which is common in the industry. While some recovered gypsum is reportedly used for soil amendment in Texas, the exact quantity is unknown. Many C&D recyclers reportedly do not accept drywall for recycling, and some used to accept it but no longer do. Gypsum is particularly helpful in soils with high salinity, though these soils are not widespread in Texas. Despite other benefits

[30] NAPA, "Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage, 2019."
[31] *Ibid.*
[32] *Ibid.*
[33] Federal Highway Administration Association, FHWA Division Office Survey on State Highway Agency Usage of Reclaimed Asphalt Shingles, "Quantities, Trends, Requirements, and Direction - Results from May 2017."

of including gypsum in soil amendment products (e.g., improving soil structure, particularly in clay soils, improving water filtration, and preventing clay dispersion), the demand for gypsum is relatively low in Texas. One potential emerging market in Texas is in neutralizing water with a high salt content for agricultural purposes (e.g., pecan and other orchards).

C&D recyclers that indicate that they accept drywall for recycling include:

- Champion Waste & Recycling Services (Dallas); and
- El Paso Recycling, Inc. (El Paso)[34].

Comparison of Supply and Demand for C&D Debris

The relationship between supply and demand is summarized below for the various C&D material types.

Mixed C&D Debris

Most C&D processors indicate that they could process more material, thus demand at processing facilities exceed supply. There is little incentive (except where mandated) for generators of C&D to deliver C&D material to a processor rather than a disposal facility. As described below, some commodities lack adequate markets and resulting end products.

Concrete, Asphalt, Brick, Tile & Aggregate

Because aggregate is not plentiful in much of Texas, the recycling/reuse of concrete and asphalt is relatively strong. Brick is not a large part of the material stream in Texas. Tile and porcelain can often be crushed and used with road base or fill mix but is not widely done in Texas. Overall, recovered aggregate, concrete and asphalt has more demand than supply. Still, a significant quantity of concrete and asphalt are landfilled.

Asphalt Shingles

There is an oversupply of asphalt shingles in Texas. Some C&D recycling facilities that used to accept shingles for recycling no longer do. This is in part due to the decreased use of asphalt shingles by TxDOT and other highway departments and private contractors.

Wood Waste

Some C&D recyclers indicate they can process clean wood into mulch and have adequate markets for this material. Other C&D processors are in areas where they are competing with an abundance of mulch made from land clearing debris and brush, so their wood is more inclined to be used as fuel (e.g., as alternative fuel in cement kilns). Outlets for stained, painted, and treated wood are more limited. While some latex-painted wood may go to fuel or mulch that is later colored, a significant amount of painted and treated wood appears to be landfilled. U.S. EPA rules prohibit the grinding of pressure-treated lumber infused with chromated copper arsenate (CCA) into mulch. Based on waste composition data, demand for wood waste is generally less than supply, especially for treated and painted wood wastes. The inability of clean wood to make it to market is likely more a function of costly transport to markets and small quantities generated, making marketing and transporting less cost effective, particularly given relatively low disposal costs.

Drywall/Plaster

Some C&D recyclers do not accept drywall, and those that do may not recycle gypsum as its markets are limited. Therefore, in Texas, as is the case across the U.S., supply of gypsum/drywall exceeds demand.

7.13 Paint

Paint is a product that, like food, is meant to be consumed with little wasted. In general, consumers are motivated to minimize paint waste; however, waste does occur. Typical architectural paint formulations are water-based (latex) or oil-based. Architectural paints are those used for interiors and exteriors of buildings. Industrial paints, which can be liquid or powder, are used in product manufacturing, such as those used in the automobile and aerospace industries, among others.

Overview of Paint

The nonprofit organization PaintCare estimates that about 802 million gallons of architectural paint are sold in the U.S. each year, with about 10 percent going unused and potentially available for recycling. Assuming

[34] According to the website, El Paso Recycling, Inc. creates a Gypsum Soil Amendment

an average weight of 6.7 pounds per gallon, this translates to 268,670 tons, nationally, available for recycling each year. It should be noted that this includes only architectural paint, not other paints, such as those used industrially. The U.S. EPA does not provide an estimate regarding the quantity of paint generated and disposed annually. Beyond architectural paint, there are industrial paints used, such as those in automotive, furniture, and cabinetry manufacturing. Data on the generation of this material is limited.

Characteristics of the Paint Recycling System

In the U.S., paint is typically not recycled at the curb but is often collected through state or local household hazardous waste (HHW) programs and/or allowed to be donated to a reuse facility or swap shed. Water-based paint is the most common product at HHW events nationwide, even though the U.S. EPA does not consider water-based paint to be hazardous waste. The U.S. EPA does consider oil-based paint (which is declining in popularity) to be a HHW due to its volatile organic compounds (VOCs) content.

End-of-life management options for latex and oil-based paint differ. Table 7-16 describes the preferred methods of end-of-life management for each type of paint.

TABLE 7-16: WASTE HIERARCHY FOR LATEX AND OIL-BASED PAINT

Latex Paint	Most Preferred	Oil-Based Paint
Reuse	↑	Reuse
Paint-to-paint recycling Other recycling		Paint-to-paint recycling
Beneficial use		Energy recovery or fuel incineration
Disposal	**Least Preferred**	Hazardous waste disposal

Source: Adapted from Paint Care

- **Reuse.** Paint donated to a reuse facility or swap shed is typically reused.
- **Paint-to-paint recycling.** When paint is recycled, it is filtered to remove solids, blended, and may be mixed with new paint. Pigment is then added to achieve the desired color. Most paint recyclers produce a relatively limited palette of colors. The resulting re-blended paint is sold or donated. In some cases, paint collected through HHW collection centers or events is delivered to paint recycling facilities. If the paint is not suitable for recycling, it will be delivered to disposal (if latex paint) or energy recovery or fuel incineration (if oil-based paint).
- **Other recycling and beneficial use.** Beneficial uses and other means of recycling latex paint include making landscape rocks, as an ingredient in the production of aggregate and other concrete products, or as alternative daily cover at landfills.
- **Energy recovery or fuel incineration.** Some waste-to-energy facilities use latex-based paint as an alternative fuel source. Oil-based paint can be used as a fuel at energy recovery facilities or may be disposed in a HHW incinerator.
- **Disposal.** Many local governments throughout the U.S. encourage residents to dry out water-based/latex paint (or add kitty litter to solidify) and then dispose. In many cases this is the least costly method of disposal.
- **Hazardous waste disposal.** Many private companies that haul material from HHW programs deliver the material to HHW incinerators.

Preventing paint waste (source reduction) is preferred to the above options, and many states and communities provide guidance to residents to help them more accurately predict the amount of paint that will be needed to reduce waste. In the U.S., paint recycling as an industry has been spurred by extended producer responsibility (EPR) for paint, which is managed through PaintCare. This non-profit organization manages paint recycling programs for architectural paints (only) in California, Colorado, Connecticut, Maine, Minnesota, Oregon, Rhode Island, Vermont, and Washington, DC. New programs being established in Washington (scheduled to begin in April 2021) and New York (expected to begin in 2021, pending state approval).

Industrial paint (e.g., from automobile, appliance, and other product manufacturers) is often generated as a sludge. It is estimated that 240,000 tons are generated annually in the U.S.[35] Reportedly, there have been some attempts to use this material as a fuel, but they have not been widely successful. In Texas, industrial paint sludge is not disposed in MSW landfills, and may be managed as a Universal Waste and solidified for management in Class I landfill cells.

Nature of Texas Supply for Paint

As described in Section 3, an estimated 3,266 tons of architectural paint were recycled in Texas in 2019, based on RMDP survey and supplemental data. This is data from HHW collection programs and excludes any unreported commercial paint delivered to/collected by the two private paint recyclers known to be operating in Texas.

Applying the national estimate of waste architectural paint to the population of Texas indicates that approximately 7,013,500 gallons (or approximately 23,500 tons) of architectural paint are unused and potentially available for recycling each year in Texas. The quantity of industrial waste paint generated in Texas is unknown, but as is described above, the national estimate is relatively low compared to the generation rate of other material types.

Nature of Demand for Texas-Generated Paint

There are only two commercial paint recyclers known to be operating in Texas, and one municipal program. The private paint recyclers are located in Dallas and Fort Worth. The City of Austin has run its own paint recycling program (Austin ReBlend) for about 10 years; the City owns its own re-blending/recycling equipment and offers paint for reuse if in good condition. Several larger municipalities have permanent collection sites where paint can be dropped off at regular operating hours, and many smaller cities hold collection events periodically. Less populated areas tend to hold such events less frequently – often only once every few years. Such events may be for HHW and/or BOPA (battery, oil, paint and antifreeze) or some combination of those materials. In addition, there are donation/reuse programs through organizations like Habitat for Humanity and some municipal share programs.

Commercial paint recyclers often manage paint collected by local governments through HHW/BOPA collection programs, as well as paint from large-scale generators such as institutions and professional paint contractors and other commercial users that are not able to recycle paint through municipal programs. Depending on the condition of the paint and market conditions, commercial paint recyclers may choose to have the paint recycled, re-blended or remanufactured into paint; donated; sold; sent for solidification; used in energy recovery; or other methods of proper disposal. From the perspective of existing paint recyclers, more material could be processed; however, demand for recycled paint product is not strong.

Comparison of Supply and Demand for Paint

Paint recycling is a business that makes its profit margins on providing collection and responsible end-of-life management services more so than on product sales. It is more a means to avoid disposal than to provide a product that is in demand. It appears that a considerable quantity of paint may still be disposed. While paint processors indicate that they could process more material, the demand for recovered paint is not strong. If paint recycling were to expand, the infrastructure of paint recyclers would need to expand along with corresponding increase in demand for the recycled paint and other paint end products.

7.14 ELECTRONIC MATERIALS

Broadly, electronic waste includes all discarded items with an electrical cord or powered by batteries. Electronic waste contains many valuable materials, as well as hazardous materials (such as nickel-cadmium batteries, mercury, and lead) that need to be responsibly managed at the end of their useful life to protect the environment. Electronic waste is one of the fastest growing segments of waste globally.

Overview of Electronics

Electronic waste includes large appliances, small appliances, and consumer electronics.[36] In the U.S., an estimated 10.1 million tons of electronic waste was generated in 2018 according to the U.S. EPA. Just over half (52 percent) of electronic waste was large appliances, followed by selected consumer electronics (27 percent) and small appliances (21 percent). The nationwide electronics recycling rate was 43 percent in 2018.

[35] SBIR Grant Application, Procedyne Corp.
[36] This definition of electronic waste is broader than what was used in the RMDP survey and results presented in Section 3 for electronic materials. Information collected through the survey and supplemental data primarily represents residential items collected through the television and computer product stewardship and HHW programs. Metal recycled from large appliances is reflected in the scrap metal tonnages presented in Section 3.

The precious metals in computers and other electronic devices, along with corporate environmental responsibility and data destruction requirements, drive the electronics recycling industry. The lifespan of certain electronics, such as computers and smart phones, has declined over time due to technology improvements and planned obsolescence. For example, some in the industry predict that the switch from 4G to 5G will cause an increase in consumer electronics disposal. To address factors such as decreasing lifespans and planned obsolescence, some state governments are looking to industry to make consumer electronics more repairable by introducing "Right to Repair" legislation.

Characteristics of the Electronics Recycling System

In the U.S., most large appliances are recycled through scrap metals dealers, as they are comprised of a considerable amount of steel and other valuable metals. Large appliances may be collected through retailers (e.g., for a fee upon the purchase of a new appliance), through municipal or private hauler collection (generally for an added fee) or via drop off at a municipal collection site.

Collection of electronics and televisions for recycling at the end of their useful life used to be offered by retailers, though this has become increasingly less common. Municipalities and counties offer collection sites or events to residents; however, the municipality typically must pay for some or all of the material collected. Most events allow for the collection of consumer electronics and small appliances and other items.

Commercial entities may not deliver electronic items to municipal collection events. Businesses recycle electronics by working directly with electronics recyclers. Companies concerned with data destruction and asset management are especially motivated to recycle through a reputable recycler. Large businesses may obtain computer equipment through a lease program and trade equipment in periodically, thus ensuring it is recycled through the proper channels.

Computers and computer peripherals are recycled through private electronics recycling companies. Such companies often accept some small appliances for recycling as well, although many small appliances are disposed. Electronics pose recycling challenges because they include a combination of various material types, including multiple types of metals, plastic, and glass. When materials arrive at a facility they are sorted, and technicians remove batteries and memory drives. Some facilities focus on disassembling electronics into components and shipping material to facilities that use or recycle components. Other facilities have large shredders, which shred material into smaller pieces to facilitate further sorting. Next, magnets are used to separate out ferrous metals; non-ferrous metals like aluminum, stainless steel, copper, and circuit boards are removed mechanically. What remains is mostly plastic. Some facilities then separate acrylonitrile butadiene styrene (ABS) plastic from polystyrene. Next, the remaining plastic is once again processed to remove metals. Items like cathode ray tubes (CRTs) with glass are manually deconstructed. Over time, large-scale shredders have become less commonplace, and the amount of plastic in many electronics has decreased.

There are two accredited certification standards that exist today for responsible electronics recycling: Responsible Recycling (R2) Standard for Electronic Recycling and e-Stewards Standard for Responsible Recycling and Reuse of Electronic Equipment. Both standards' requirements are audited regularly and are based on the best management practices for responsibly managing used electronics, considering both environmental and workers' health and safety. While achieving such certifications can provide generators with assurance that material is handled responsibly, it is a relatively costly process to become certified, and when a facility relocates, it must seek a new certification. Therefore, it may not be cost-effective for small and medium-sized electronics recyclers to become certified, even if they operate to these standards. Some electronics recyclers have made commitments to achieving zero waste.

There are 24 states (including Texas) with producer responsibility legislation for electronics recycling. However, these programs vary considerably in their effectiveness, convenience, and extent of producer responsibility. In most states these laws cover only computers, televisions, and certain peripherals. In Texas, the product stewardship electronics recycling law applies to computer equipment (passed in 2007, effective 2008) and televisions (passed in 2011, effective 2013). Manufacturers/importers of consumer electronics (i.e., computers and monitors "purchased primarily for personal and home business use")[37] must provide

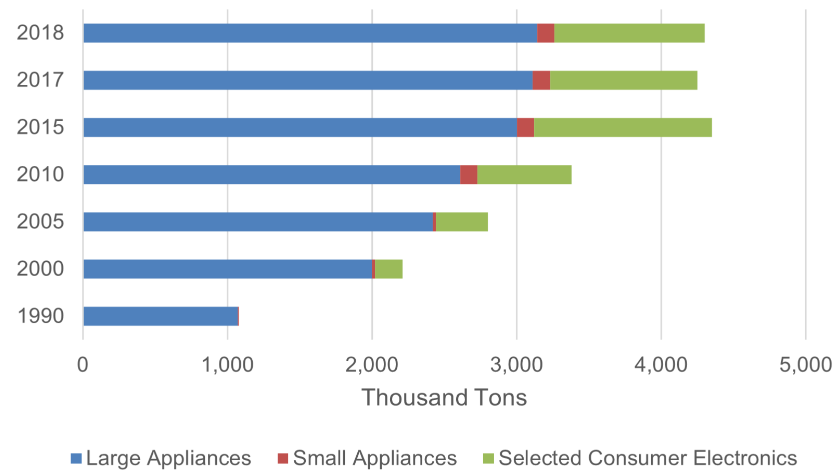
[36] This definition of electronic waste is broader than what was used in the RMDP survey and results presented in Section 3 for electronic materials. Information collected through the survey and supplemental data primarily represents residential items collected through the television and computer product stewardship and HHW programs. Metal recycled from large appliances is reflected in the scrap metal tonnages presented in Section 3.

for recycling of these items at no additional cost to the consumer when they recycle the item. Producers must submit recovery plans and annual reports to TCEQ. Collection methods include takeback, mail in, and collection events; however, there are no stipulations regarding the level of convenience and no funding mechanism for collection and transportation. The law is similar for television producers.

U.S. Markets and Market Trends

The U.S. EPA reports generation and recovery data for large appliances, small appliances, and selected consumer electronics separately, within the durable goods category. Figure 7-17 shows the quantity of recycled electronics in MSW by category since 1990 (2000 for selected consumer electronics – the first year that data was included in the U.S. EPA data). The U.S. EPA defines selected consumer electronics to include "products such as TVs, VCRs, DVD players, video cameras, stereo systems, telephones and computer equipment."[38] While turnover of many products is quicker and people tend to have multiple devices, some electronics, like computers, monitors, phones and televisions, have become smaller and/or lighter over time.

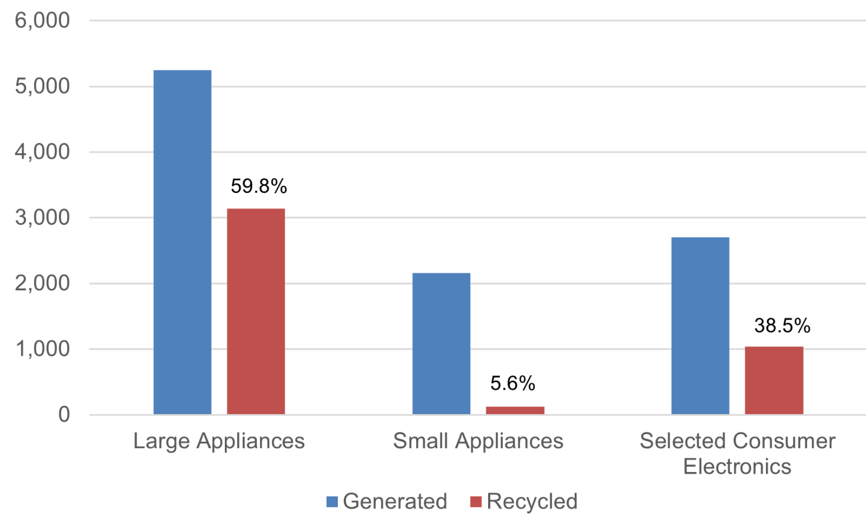
FIGURE 7-17: RECYCLED ELECTRONICS BY CATEGORY, IN THOUSAND TONS (1990-2018)



Source: U.S. EPA, "Advancing Sustainable Materials Management: 2018 Fact Sheet," November 2020.

Figure 7-18 shows the average recycling rate for each category of MSW electronics in 2018. Nationally, recycling rates are highest for large appliances, followed by selected consumer electronics, and small appliances.

FIGURE 7-18: U.S. ELECTRONICS GENERATED AND RECYCLED, IN THOUSAND TONS (2018)



Source: U.S. EPA, "Advancing Sustainable Materials Management: 2018 Fact Sheet," November 2020.

[37] TAC §328.135(4)
[38] U.S. EPA Durable Goods: Product-Specific Data

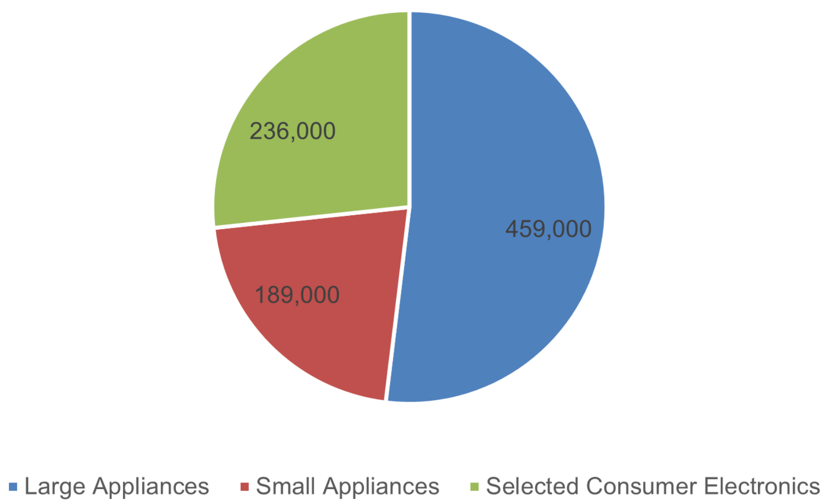
In recent years, due to China's National Sword and similar restrictions implemented in other countries, markets for recovered plastic from this material stream has faced limited markets. Beginning in January 2021, the Basel Convention will also have an impact on exports of plastics, limiting the ability to export mixed resins, and placing strict contamination limits on exports to all participating nations.

Nature of Texas Supply of Electronics

As described in Section 3, a total of 17,546 tons of electronics recycling was captured through the RMDP survey and supplemental data. These materials are primarily those reported through the State's product stewardship electronics recycling law and through HHW programs. As a result, this quantity most likely represents primarily residential electronics, and the total quantity of recycled small appliances and commercial electronics is unknown. Large appliances, which are also included in the broad definition of electronics by the U.S. EPA, as described above, are recycled at a high rate according to the Association of Home Appliance Manufacturers (AHAM). While specific recycling data is unavailable for Texas, significant quantities are included in the amount of ferrous metal recycled. There are many electronics recyclers in Texas, of various sizes, and larger ones import electronics for recycling due to corporate contracts.

Given the limited availability of detailed electronics data in Texas, national data shown in Figure 7-18 was used to provide an estimate of the annual quantity of electronics generated in Texas' MSW (Figure 7-19). The 2019 RMDP estimate for electronics recycling (described in Section 3) did not align to these categories; therefore, an estimated recycling rate is not presented.

FIGURE 7-19: ESTIMATED TONNAGE OF MSW ELECTRONICS GENERATED IN TEXAS



Nature of Demand for Texas-Generated Electronics

There are close to 60 electronics recyclers known to be operating in Texas. Many electronics processing facilities in Texas are part of national or multinational corporations. Some businesses and nonprofits focus on reuse/remarketing of electronics and redeploying IT assets. Some also dismantle devices and/or shred them or ship to another location for shredding. Like many recyclable materials, there is a lack of infrastructure for collecting and processing electronics in the western and far southern portion of the State, as well as the far northern part of Texas. However, there is also less material generated in those areas, as these are less densely populated. In higher-density areas, generators can choose from multiple electronics recyclers.

Historically, the electronics recycling industry in Texas has seen growth in the number of recyclers however, recently TCEQ has reported a decrease in the number of electronics processing facilities registered as part of the television recycling law. Long term, the electronics recycling industry is expected to continue to grow in the number of items recycled, even as items become smaller and lighter over time and recycled tonnage declines. One factor that has benefitted the electronics recycling industry is that metals markets, while subject to market fluctuations like all commodities, have been largely unaffected by China's National Sword policy and similar recycled material import bans.

End markets exist for some recovered plastic and metals within Texas, but much material is likely leaving Texas and potentially being exported to other countries. This material is then sold to manufacturers who make new products, including electronics as well as other consumer goods, from the processed materials. Many Texas electronics recyclers import material into Texas based on corporate relationships, transportation distance, and quantity of material being delivered/available. Operating regionally (e.g., in Texas, Oklahoma, Louisiana, Arkansas, and New Mexico) appears to be relatively common for larger companies. Some companies also have national accounts and may receive truckloads of electronics from all over the country.

Secondary processors receiving material from primary electronics recyclers are available in Texas and are comprised largely of metal processors. Metal processors' markets, in contrast, are often located out-of-state. While only a small percentage or no waste is landfilled from many of the processors in Texas, it can be challenging to find outlets for glass and plastics.

Comparison of Supply and Demand for Electronics

Electronics recyclers in Texas indicate that they could process more material, and there is additional material that is being disposed that could be recycled. Thus, the demand for material exceeds supply. Despite this, local supply can exceed local demand in rural areas with very few (if any) conveniently located recyclers. Processors do not indicate lack of markets for resulting materials, beyond those for low-value plastics and leaded glass. The latter is declining in supply and lacks market demand due to phase-out of product applications, so increasingly leaded glass from CRTs is disposed instead of recycled.

7.15 Batteries

Batteries are used for power storage in electronic devices. There is a wide variety of battery types and several ways that they can be classified. For the purposes of this analysis, batteries are categorized as follows:

- Lead acid batteries;
- Portable batteries; and
- Electric vehicle (EV) and energy storage system (ESS) batteries.

Overview of Batteries

Lead Acid Batteries

Lead acid batteries are primarily used in powering vehicles. Discarding or improperly disposing of a lead-acid battery is illegal in Texas. In addition, Texas law requires businesses that sell lead-acid batteries to accept spent batteries when customers purchase a new battery. The lead acid batteries recycling infrastructure is well-established in Texas and virtually all lead acid vehicle batteries are recovered and recycled. In addition, it is estimated that 80 percent of new batteries manufactured are comprised of recycled battery material.[39] Because lead acid batteries are already successfully and routinely recycled in Texas, they will not be further addressed as part of the RMDP.

Portable Batteries

Portable batteries are generally available to consumers and consist of two major types: single use and rechargeable.

Single-use batteries include typical household batteries such as alkaline batteries; lithium primary button cell batteries as are used for cameras, hearing aids, and watches; and zinc batteries used in low-power-consuming devices such as security devices, laboratory instruments, radios, and transmitters. Single use batteries are considered acceptable for disposal in landfills and have low market value. Consequently, they are generally not collected for recycling, but they are technically recyclable. A few jurisdictions accept single use batteries for recycling at their HHW facilities.

Rechargeable batteries include nickel cadmium (Ni-Cd), nickel metal hydride (Ni-MH) and Lithium-ion (Li-ion) varieties. They can be recharged several times and are found in cordless power tools, telephones, laptops, digital cameras, two-way radios, remote control toys and other portable electronics. Rechargeable batteries can be processed so that the metals used to manufacture these batteries can be recovered and

[39] "Study Shows Nearly 100 Percent Recycling Rate for Lead Batteries," Recycling Today, November 16, 2017.

used to make new batteries, stainless steel, and as additives for paint, cement, and other products.

In the U.S., federal law requires that used Ni-Cd and lead (Pb) batteries to be managed as Universal Waste (40 CFR Part 273). The Universal Waste Rule prohibits handlers from disposing of these batteries and to recycle them instead. Several states have laws regulating the disposal of various types of portable batteries in addition to lead-acid batteries. Texas law applies only to lead-containing batteries.

The national battery industry stewardship organization, Call2Recycle, helps battery and product manufacturers fulfill recycling requirements in the U.S., including compliance with state and federal regulations. The organization provides recycling options nationally through a network of collection partners for the following types of batteries:

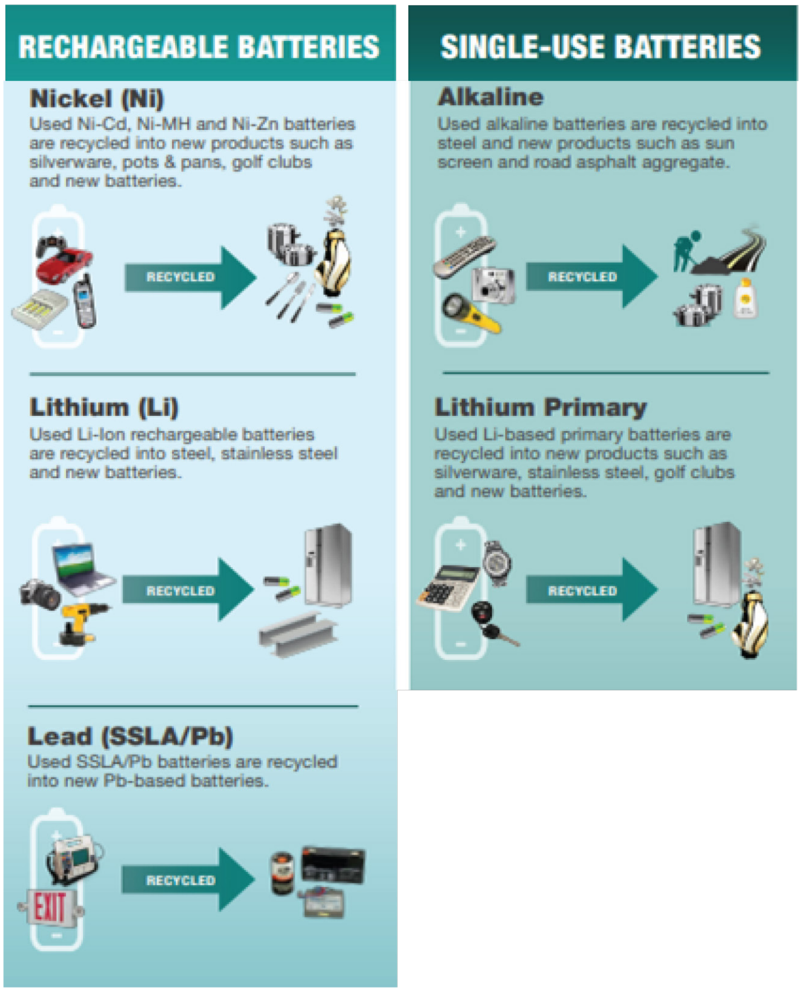
- Nickel Cadmium (Ni-Cd);
- Nickel Metal Hydride (Ni-MH);
- Nickel Zinc (Ni-Zn);
- Lithium Ion (Li-ion); and
- Small Sealed Lead Acid (SSLA/Pb).

Figure 7-20 depicts the recycling pathways for batteries collected through Call2Recycle programs, and Figure 7-21 lists the end uses for the various portable battery types, when recycled.

FIGURE 7-20: PORTABLE BATTERIES RECYCLING FLOW

Source: Call2Recycle website (www.call2recycle.org)

FIGURE 7-21: END USES FOR RECYCLED PORTABLE BATTERIES



Source: Call2Recycle

In addition to Call2Recycle's programs, selected private companies such as the national firms, Battery Recyclers of America and Battery Solutions, offer battery pick up and recycling services on a fee basis to larger generators of multiple batteries needing end-of-life management. Despite voluntary industry programs to collect and recycle batteries, like Call2Recycle, only 12 percent to 15 percent of rechargeable batteries (and a much smaller percentage of single-use batteries) are being recycled in the U.S.

EV and ESS Batteries

Battery energy storage systems are rechargeable battery systems that store energy from solar panels or the electric grid and provide that energy to a home or business. Commercial applications include peak shaving, load shifting, emergency backup, and various grid services. Residential applications include supplementary power for homes, off-grid homes, and emergency backup. Use of ESS batteries is skyrocketing as alternative energy grows in popularity and as battery technology has improved and declined in cost. The vast majority of ESS batteries are Li-ion.

Electric vehicle batteries are also becoming more prevalent in the marketplace. According to the Bloomberg NEF (BNEF) 2020 Electric Vehicle Outlook,[40] EVs will account for 58 percent of all new passenger cars worldwide by 2040. *Fortune* estimates that the world will be fielding 25 million electric vehicles per year by 2030, which results in 4.5 million metric tons of battery material. EV batteries have 70 to 80 percent of their capacity remaining when they reach the end of a typical 10-year vehicle lifespan. At that point, they have potential for refurbishment and reuse in less power intensive uses such as stationary ESS, thereby providing a second life application. Eventually, all EV and ESS batteries will need to be decommissioned and managed at end of life. While ESS and EV Li-ion batteries have different applications, they share many material inputs and thus have similar reuse and recycle opportunities.

[40] Bloomberg Electrical Vehicle Outlook, 2020.

Li-ion batteries as well as rechargeable portable batteries are the primary focus of recycling and recycling market development efforts for EV and ESS batteries. Interest in creating recycling systems for these types of batteries is growing. A strong case can be made for recycling these batteries instead of disposing them:

- They are increasingly in use with the growth of electric vehicles and alternative energy as well as rechargeable home electronics;
- They are highly combustible in nature, posing fire and explosion risks when improperly handled; and
- The metals contained in batteries are valuable and more accessible and concentrated than in virgin ore, offering the potential to reduce supply costs and dependence on foreign suppliers.

According to market research firm, IDTechEx's, latest report, the total amount of EV batteries reaching end-of-life globally is expected to reach 7.8 million tons per year by 2040.[41] IDTechEx projects that, by 2040, the global Li-ion battery recycling market will be worth $31 billion annually. Currently there is one Li-ion battery recycler in the U.S., which for the most part handles the recycling of portable Li-ion batteries. EV batteries needing recycling are going to Chinese markets as China has invested in Li-ion battery recycling infrastructure development. The infrastructure for recycling these batteries, however, is just now being developed in the U.S. Transporters, decommissioning facilities, refurbishing and recommissioning facilities, metals recovery processors and end markets will all need to be further developed. This presents both challenges and opportunities, to be discussed later in this section. It is expected that this will be a business-to-business infrastructure as consumers are unlikely to be involved directly in the recovery and recycling of these types of batteries.

To support infrastructure development in the U.S., the U.S. Department of Energy, calling the effort a national security issue, initiated a $15 million three-year research and development project at the Argonne National Laboratory. For Phase I, DOE awarded $5.5 million to incentivize American entrepreneurs to develop and demonstrate processes that when scaled have the potential to profitably capture 90 percent of all discarded or spent lithium-based batteries in the U.S. for eventual recovery of key materials for re-introduction into the U.S. supply chain.[42] Participants in this phase of the program were to help establish the infrastructure that moves spent Li-ion batteries from consumers to recyclers. Seven out of 14 teams have recently been selected as Phase II winners, which are focused on building industry partnerships to design, simulate, and prototype a proof-of-concept solution. Phase II participants are eligible to participate in Phase III, where four winners will be selected and receive a cash prize of up to $2,000,000, distributed equally among the winning teams. This level of investment by the federal government speaks to the interest and opportunity to address recycling of this material stream.

In addition to this federal initiative, private companies are also investing in research and development and some have announced plans for commercial scale operations. A few key examples are:

- Canadian Li-ion battery recycling developer, American Manganese, plans to reclaim close to 100 percent of the metal oxide materials in Li-ion batteries through their "RecycLiCo" process involving cathode-to-cathode recycling. This company has a business relationship with Voltabox of Texas Inc. to provide end-of-life Li-ion batteries for commercial-scale recycling of cathode materials using AMY's RecycLiCoTM patented process.
- Redwood Materials, headquartered in Carson City, Nevada, collects scrap from consumer electronics companies, battery cell manufacturers like Panasonic, and Amazon. Redwood Materials then processes these discarded goods, extracting materials like cobalt, nickel and lithium that are typically mined, and then supplies those back to Panasonic and other customers. Currently, they are just processing corporate consumer electronics and batteries, but they are positioning to build what they refer to as the biggest Li-ion battery recycling facility in the U.S. The founder of Redwood Materials was the former co-founder and CTO of Tesla, hence the interest in EV batteries. The plan is for both spent EV batteries as well as scrap from battery manufacturing plants to be processed at the Redwood Materials facility, with the recovered metals sold for use in making new batteries – at a cost cheaper than using virgin sources of these metals.
- Li-Cycle, the largest capacity Li-ion battery recycling company in North America, has completed the first phase of what will become North America's first commercial Li-ion battery recycling "Hub." The company's second facility and the first in the U.S. is located in Rochester, New York and will feed 5,000 tons of spent Li-ion batteries per year to the company's nearby processing facility, which is set

[41] Dr. Alex Holland, "Li-ion Battery Recycling: 2020-2040," IDTechEx, June 2020.
[42] U.S. Department of Energy, "Lithium-Ion Battery Recycling Prize."

to open in 2022. Li-Cycle claims that its recycling process enables recovery of at least 95 percent of all materials found in Li-ion batteries, compared to the industry norm of less than 50 percent.[43]

Nature of Texas Supply of Batteries

Portable Batteries

Portable batteries are collected for recycling in Texas through designated municipally operated drop-off centers and collection events (e.g., HHW and BOPA programs) and via a network of Call2Recycle collection partners including Lowes, Home Depot, battery retailers, and service centers for electronics. Some municipal programs are also part of the Call2Recycle network. Call2Recycling reports that it has more than 1,100 collection partners across the State, serving a range of generator types as reflected in Figure 7-22. Close to 400 of the partner locations accepted batteries from the public in 2020 (See Figure 7-23).

As described in Section 3, a total of 627 tons of household batteries were recycled in Texas in 2019: 357 tons through the HHW program and an additional 270 tons of batteries through Call2Recycle (once adjusted for double-counting).

FIGURE 7-22: CALL2RECYCLE COLLECTION PARTNER SEGMENTS

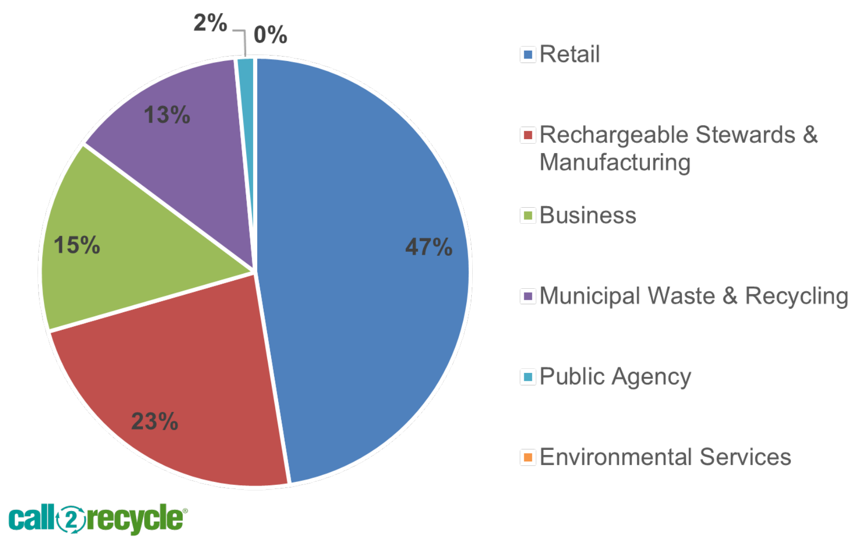
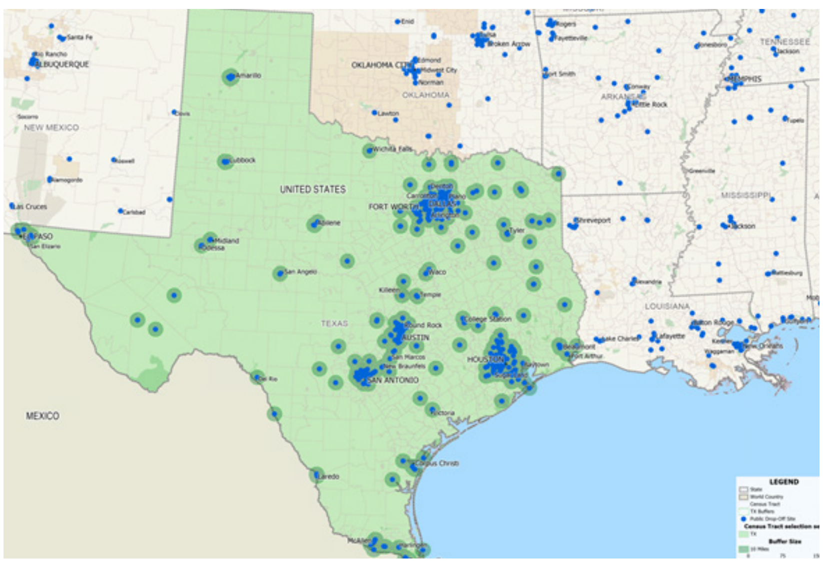


FIGURE 7-23: PUBLIC BATTERY DROP-OFF LOCATIONS IN TEXAS



[43] Tom Sylvia, PV Magazine, "The First Phase of Li-Cycle's Lithium-Ion Battery Recycling Hub is Complete," December 3, 2020.

Not all types of batteries are accepted at all collection locations. In particular, most private-sector collection locations, but only some public-sector locations, accept alkaline single use batteries. The City of Austin's program is one of these, with 33 household battery drop-off locations throughout the city. Some communities have several drop-off locations; however, smaller rural communities may have no portable battery collection options. According to Call2Recycle, 85 percent of Texans live within 10 miles of a battery drop-off location.

Batteries collected for recycling in Texas are transported to Wistron GreenTech, a wholly owned subsidiary of Wistron Corporation. At this 209,000 square foot facility in McKinney, batteries are sorted by type and then shipped to processing facilities in other states where they are further processed according to their chemistry. The processed material is then sold to other companies for metals recovery and eventual sale to end users. Wistron GreenTech also provides collection and processing of batteries from businesses and institutions on a fee basis Also, as one of three Call2Recycle partners for battery sorting, this facility receives batteries for sorting from sources in other states in the region as well as Texas sources. Wistron is also a handler of waste electronics, serving corporations including Apple and Dell and other suppliers.

EV and ESS Batteries

The exact supply of Texas-generated EV and ESS batteries is currently unknown but is growing. Texas is the second largest automobile market in the country with over eight million registered vehicles – California being the largest market. Consequently, Texas is expected to be a significant generator of EV batteries in future years. In addition, Texas is a national leader in the use of alternative energy – particularly wind energy – and is growing in solar energy production. This strong and growing alternative energy market makes Texas a strong market for ESS units, and consequentially a potentially large generator of ESS batteries for recycling.

There is currently no known EV and ESS battery recycling infrastructure in Texas. There is one pilot project (OCI Solar Power) discussed below.

Nature of Demand for Texas-Generated Batteries

All Texas rechargeable portable batteries are shipped out of state for further processing and sale to end users. Texas Li-ion batteries handled by Wistron GreenTech are shipped to Recycling Coordinators, Inc. in Akron, Ohio, the only U.S. based Li-ion battery recycler. Given the multiple processing stages for batteries and reliance on out-of-state markets, the final end users for metals and other materials recovered specifically from Texas batteries are unknown.

As mentioned above, an infrastructure for recycling EV and ESS batteries was not found to exist in Texas except for the following project. ESS units are being installed in Texas solar farms made from EV batteries to test the feasibility of this EV battery application. This project is a joint venture of South Korean automaker, Hyundai Motor and Seoul-based OCI, whose subsidiary, OCI Solar Power is headquartered in San Antonio. OCI develops, constructs, finances, owns, and operates utility and distributed generation solar projects, nine of which are in Texas.

Comparison of Supply and Demand for Batteries

Based on 2020 Call2Recycle data pertaining to single-use and rechargeable collections from public drop-off sites, Texans recycled an average of 9.5 pounds of batteries per 1,000 people – placing Texas 17th for all states in per-capita battery recycling. While better than most states, there is certainly still opportunity for increasing the capture of these batteries in Texas. The metals in these batteries have market value. Also, there are environmental benefits associated with use of reclaimed metals in comparison to metals from virgin ore plus opportunities to reduce fire hazards associated with Li-ion battery mismanagement. The existing collection infrastructure for portable batteries can handle more batteries; however, in some rural locations, collection infrastructure is lacking.

The recovery and recycling infrastructure for EV and ESS batteries does not yet exist – not due to lack of markets but due to insufficient supply of such batteries to warrant this type of investment. Texas, with its alternative energy and automobile industries and high population, will need to develop this type of infrastructure in future years to capture and recycle the growing number of EV and ESS batteries reaching their end of life.

7.16 TEXTILES

Textiles includes scrap woven or knitted cotton, wool, polyester, synthetic and synthetic-blend products, and stuffing products resulting from the manufacture and use of textile goods. Textiles are used in making clothing, shoes, linens, bedding, upholstery, curtains, carpets, and other items. Textile wastes are generated by industrial operations, retailers, and through consumer use.

Post-industrial scrap textiles are byproducts of the textile, garment, cotton, and fiber manufacturing industries. This material is typically repurposed by furniture, home building, automotive, and other industries through products such as home insulation and stuffing materials. Pre-consumer textiles consisting of unsold textile items are often disposed of to protect brand equity.

Post-consumer textiles consist of discarded garments, linens, and other household articles made from fabric and other textiles. Many such items are donated to secondhand retailers to be sold again. In some locations used textile goods can be deposited in municipal collection bins or through curbside recycling programs. Also included in textiles are used mattresses and carpet.

Overview of Textiles

According to the U.S. EPA, an estimated 17.03 million tons of textile MSW were generated in 2018, of which an estimated 2.51 million tons (or 14.7 percent) were recycled.[44] This includes textiles from both residential and ICI sources. While nearly all scrap textiles can be recycled, the amount of textile waste being landfilled has increased over 70 percent since 2000 compared to overall MSW growth of six percent. Waste Management, Inc. estimates that per-capita generation of textiles has increased by 51 percent from 2000 to 2014.

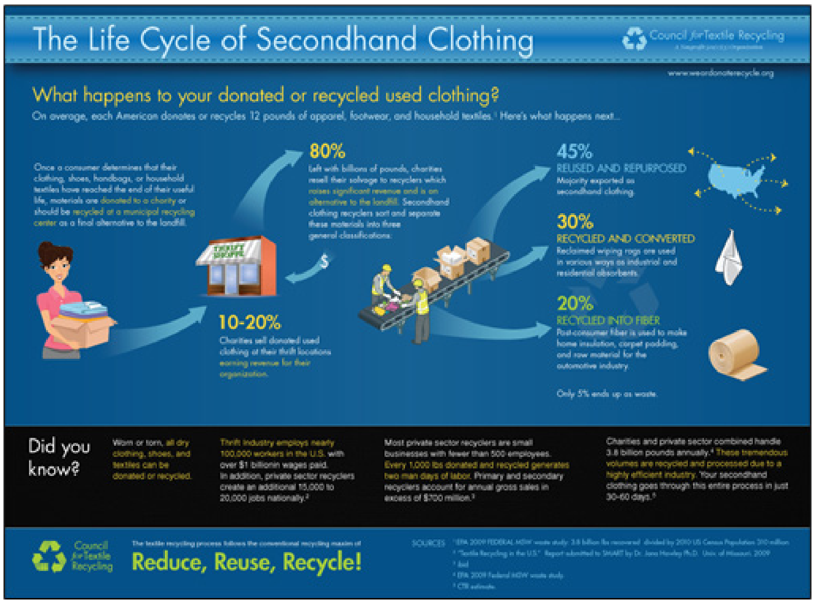
Characteristics of the Textile Recycling System

The U.S. textile recycling industry recovers approximately 2.51 million tons of post-consumer textiles each year from the waste stream.

Post-consumer textile goods recovered through a donation or collection program generally go through a grading process during which textile items are separated and assessed by value. Given the labor-intensive nature of hand sorting large quantities of textiles, used textiles are often shipped to developing countries with access to low-cost labor.

Figure 7-24 presents the typical flow of used secondhand clothing donated for reuse or recycling. Approximately half of the material donated/collected is recycled instead of being reused. Table 7-17 provides detailed examples of end uses for mechanically recycled textile feedstocks.

FIGURE 7-24: FLOW OF SECONDHAND CLOTHING



[44] U.S. EPA, "Advancing Sustainable Materials Management: 2018 Fact Sheet, Table 1" December, 2020.

TABLE 7-17: EXAMPLES OF USES FOR MECHANICALLY RECYCLED TEXTILES

Types of Used Textile Items	Examples of Various Uses
Stuffed toys and pillows	Car seat stuffing and automobile insulation
T-shirts, sheets, towels, and clothing	Wiping cloths
Denim scraps and clothing	Home insulation
Shoe soles	Paving material
Sweaters and coats	Carpet padding
Curtains and drapes	Stuffing for pillows, sleeping bags, animal beds
Wool sweaters and materials	Baseball and softball filling
Velvet materials	Jewelry box lining
Leftover fabric scraps	Paper money

Source: SMART: Secondary Materials and Recycled Textiles

With respect to carpet, according to Carpet America Recovery Effort (CARE), gross post-consumer carpet generation is estimated at 12 pounds per capita. More than 2.0 million tons of carpet were sent to U.S. landfills in 2019, with only five percent of carpet recycled nationwide. An estimated 71 percent of recycled post-consumer carpet is manufactured into engineered resins about two-thirds of which are nylon, and one-third being PET with a small amount of polypropylene in the mix. Approximately nine percent of the remainder is recycled back into carpet production.

Mattresses, which have a large textiles component, are another type of product with less than five percent recycling rate nationwide, even though an estimated 75 percent of their components can be recovered and recycled. According to the Mattress Recycling Council, more than 50,000 mattresses are discarded in the U.S. every day.

Nature of Texas Supply for Textiles

Table 7-18 summarizes the amount of textiles generated, recycled, and disposed based on 2019 estimates described in Sections 3 and 4, and extrapolated national estimates from the U.S. EPA. As described in Section 3, while textiles were not required to be included in the RMDP, facilities could report textile recycling data. Two entities reported used clothing data, and as a result, the estimate likely understates clothing recycling and does not include materials such as carpet and mattresses.

TABLE 7-18: TEXAS MSW TEXTILES GENERATED, RECYCLED, AND DISPOSED (2019)

	Tonnage Generated	Tonnage Recycled	Tonnage Disposed	Recycling Rate
Textiles[1]	647,833	12,567	635,266	1.9%
Textiles – U.S. EPA Estimate[2]	1,504,389	221,727	1,282,261	14.7%

1. Based on RMDP estimates described in Sections 3 and 4. Recycled tonnage is believed to be primarily residential clothing and textiles, as limited data was available for commercial, carpet, and mattress material streams. Approximately 90 percent of disposed textiles estimated to be from commercial sector, which accounts for the low estimated recycling rate.
2. Based on extrapolated national data if Texas recovery rate were equal to the national average.

As much as 209,160 tons of textiles may be recycled in Texas, assuming per-capita generation and recovery rates were equivalent to U.S. averages, and an additional 646,995 tons may be disposed in landfills and could potentially be recycled.

There are hundreds of private-sector and nonprofit textile handlers operating in Texas. As is the case throughout the U.S., Texas also has numerous thrift stores and secondhand shops, such as Goodwill Industries and the Salvation Army, that sell reusable items. Unsold textiles are sent to sorting operations that sort the textiles by grade for sale to be used in industrial wiping cloth manufacturing, fiber and fill applications, and other end uses. Texas residents supply some of their used textiles to such companies, largely via in-store drop-off. Simple Recycling provides curbside collection of used textiles from residents in various U.S. locations, including several Texas communities. Due to the coronavirus pandemic, the company has ceased collections in several Texas communities (and others across the U.S.). At the time of RMDP publication, it is not known whether the closure is temporary or permanent.

Texas has a substantial used textiles export business supported by the State's shipping ports and relatively reasonable labor costs. Some export businesses bring in textiles from throughout the country, including Texas sources, for shipment to locations throughout the world. Below are selected examples of companies located in Texas that have various grading, brokerage, and export operations:[45]

- American Textile Export, located close to the port of Houston, provides international, full service used textile grading and exporting capabilities throughout the Americas, Africa, Europe, Asia, and the Middle East. All textiles handled are from Texas sources.
- Midwest Textiles claims to be one of the largest textile recyclers in the Americas and has a diverse customer base, which includes fiber reclamation operations, industrial wiping cloth suppliers, vintage clothing boutiques, thrift retail stores, and used clothing wholesalers. This company has grading and brokerage operations that enable them to collect and grade textiles for their own product lines as well as provide services to other grading operations across the country.
- Textile Recycler, Inc., located near the port of Houston, describes themselves as an industry leader in sales and exportation of second-hand clothing and importers of wiping material, reportedly serving 15 countries in five continents for 18 years. Customers include oil companies, supply houses, and major wholesaler of wipers and used clothing in five continents. The company has recently installed a new automated grading system that has improved productivity while cutting costs.
- World Rags Exports sells used clothing and rags from all over the USA and Canada and exports to Asia, Africa, Middle East, Europe, and South America.

In addition to the above textile recycling companies, there are three Texas companies that specialize in mattress recycling, as listed in the www.byebyemattress.com national database:

- The Houston Furniture Bank (Houston) refurbishes select used mattresses and supplies them to people in need and recycles the remainder of the mattresses that they receive. This organization reportedly recycles over 2,000 mattresses each month that are brought to its seven drop off locations in the Houston area.
- Mattress B Gone (Houston) offers residential mattress and box spring pickup on a fee basis throughout Houston, Cypress, Katy, The Woodlands, Sugarland, Spring, and surrounding areas. The company recycles/repurposes as much as 90 percent of the material from the mattresses and box springs they handle.
- Re-Mat (San Antonio) is a nonprofit organization serving central Texas communities, and converts used memory foam mattresses into dog beds. Re-Mat is also undergoing fundraising with the hope of establishing a mattress recycling operation that can handle inner-spring mattresses.

With respect to carpet recycling, the CARE database lists 15 companies that recycle carpet in Texas, for the most part located in the Dallas/Fort Worth, San Antonio, Houston, and Austin metro areas. Texas Carpet Recycling, located in Grapevine, appears to be the largest recycler and claims to serve the entire State. They offer drop-off, pick-up, and trailer service for their clients (including contractors and flooring dealers) on a fee basis. Residential post-consumer carpets can also be dropped off on a fee basis.

[45] Information obtained from each company's respective website.

As indicated by the information provided above, the capture and processing for recycling of textiles is more predominant in the major metropolitan areas. This is particularly true with respect to bulky textiles such as carpet and mattresses. Consequently, it is likely that the textile recycling rate in Texas is less than the national average, though likely higher than the estimate presented in Table 7-18, and that a large amount of valuable textile scrap is still being landfilled.

Nature of Demand for Texas-Generated Textiles

Current demand for Texas-generated used textiles (excluding domestic reuse of secondhand goods) includes companies seeking feedstock suitable for making industrial wiping rags and manufacturing products such as pillows and animal bedding.

Textile recycling is a very mature industry with many longstanding value chain players. However, current demand for used textiles is affected by ongoing marketplace changes such as the increase in "fast fashion" resulting in poorly manufactured clothing with limited resale/reuse value and the increased use of synthetics and fiber blends instead of natural fibers. This latter trend particularly affects wiping cloth manufacturers who prefer cotton scrap. In addition, the coronavirus pandemic has disrupted both the fashion market as well as the textiles recycling industry. Clothing purchases have declined (both new and used clothing). Clothing manufacturer profitability has been impacted, which has motivated manufacturers to reduce over-producing, a wasteful practice that adds to textiles destined for disposal.

Due to increased time spent at home resulting in more home organizing and improvement activity, residential generation of used textiles has increased. At the same time, demand for used textiles both for resale and recycling has decreased. Export activity has been particularly hard hit, as the export market relies heavily on overseas labor to sort and move goods and labor availability was negatively impacted due to illness, quarantine practices, and plant closures.

The long-term outlook regarding demand is promising. Technology advancements in automated sorting are being made, such as "Fibresort" technology developed in the Netherlands. This technology is designed to accurately and efficiently sort large volumes of textiles that remain after reusable items are first removed. Another example is digital identifiers that can be woven into the fabric and detected with various types of scanners. Both these types of technology advancements are creating opportunities to improve fiber identification and increase sorting effectiveness and productivity. In addition, momentum is growing for the adoption of circular economy principles and practices in manufacturing clothing and carpet.

There is also a focus on advancing fiber-to-fiber recycling via various technologies including chemical recycling. One such process, called "Worn Again," reportedly can separate, clean, and extract polyester polymers and cellulose (cotton-derived) from non-reusable textiles and plastic packaging, to be used as feedstocks in new product manufacturing. The main outputs are PET pellets and cellulosic pulp. Another example is Eastman's carbon renewal technology now used at commercial scale in Kingsport, Tennessee. Eastman has partnered with Circular Polymers who obtains used polyester carpet and processes it to separate the PET fiber from the carpeting. The fiber is then densified for efficient shipment to the Eastman Tennessee facility for chemical recycling. The outputs of this process are new materials with certified recycled content for use by Eastman markets that make textiles, cosmetics, personal care products, and ophthalmics.[46]

Comparison of Supply and Demand for Textiles

As discussed above, supply as well as demand has been disrupted by the coronavirus pandemic. Before the pandemic, demand could absorb more supply than was available; however, there is currently an oversupply, particularly for materials destined for export. As the world recovers from the pandemic, market conditions are expected to improve. In today's market, the stronger opportunities for textiles recovery and recycling remain in the commercial and institutional sector where cotton towels and sheeting are generated in large quantities. Opportunities will further improve for cotton, but also for polyester derived from carpet and other textiles and viscose which can be managed along with cotton.

[46] Eastman, "Eastman to Recycle Discarded Carpet into New Materials," November 5, 2019.

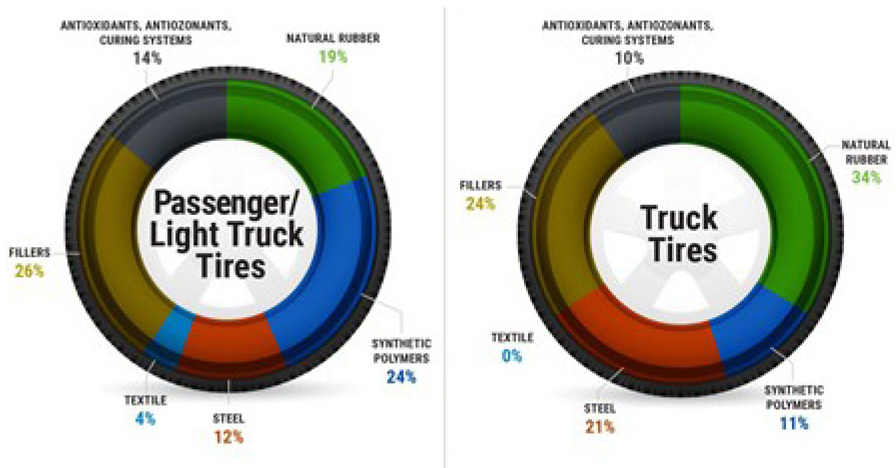
7.17 TIRES

Used tires consist of passenger tire replacements (around 73 percent of tires generated), light truck tire replacements (close to 11 percent), commercial tires from larger trucks and buses (6 percent) as well as tires from scrapped vehicles (close to 10 percent).

Overview of Tires

According to data provided by the U.S. Tire Manufacturers Association, 263.4 million scrap tires were generated in the U.S. in 2019. Figure 7-25 shows the typical composition of passenger/light truck and truck tires. Tires vary in size and weight, contain multiple types of materials, and the composition varies by brand as well as by tire type. The variety of types of materials in tires affects their potential end uses and recyclability as different end uses make use of different tire components. One key factor is the amount of natural rubber, which is higher in truck tires and often preferred for asphalt paving applications. In addition, the introduction of run-flat and self-sealing tires has created problems as these tires are damaging to the tire grinders used in ground rubber processing facilities and cannot be recycled.

FIGURE 7-25: COMPOSITION OF PASSENGER/LIGHT TRUCK TIRES AND TRUCK TIRES

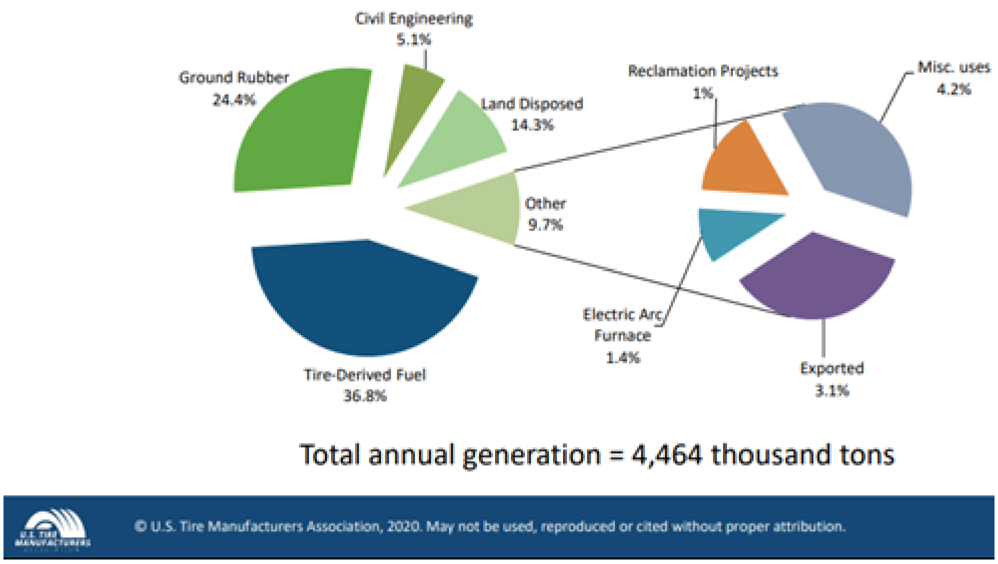


Source: U.S. Tire Manufacturers Association

U.S. Tire Markets and Trends

According to the U.S. Tire Manufacturers Association, 75.8 percent of all tires generated in the U.S. were marketed (i.e., sent to an application other than landfill disposal) in 2019. This is down from 96 percent in 2013, when scrap tire recycling peaked. This trend reflects that the recycling of tires is not keeping pace with the increasing number of tires in use. Figure 7-26 shows U.S. scrap tire management in 2019. Tire-derived fuel markets remain the largest market for used tires (37 percent); however, this has declined in recent years largely due to the low price of natural gas. Nationally, cement kilns are the largest users of scrap tires as fuel (50 percent), as is also true in Texas, with other fuel end markets being split between pulp and paper mills (29 percent) and electric utility boilers (21 percent).

FIGURE 7-26: SCRAP TIRE MANAGEMENT IN THE U.S. (2019)

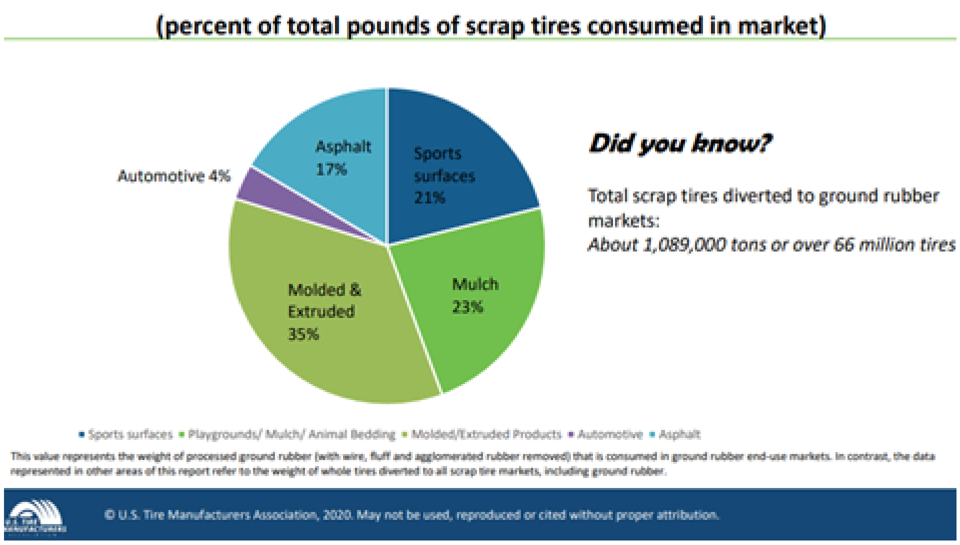


Source: U.S. Tire Manufacturers Association, "[2019 Scrap Tire Management Summary,]" 2020.

The second largest use of scrap tires is for ground rubber applications. Figure 7-27 shows the ground rubber markets breakdown in the U.S. in 2019. Mulch, synthetic turf infill, and other sports and playground surfaces consume nearly half of the ground rubber produced as well as buffings from retreader operations. Molded and extruded products are next largest application, consuming 35 percent, and include shop and animal mats, wheel chocks, trailer flooring, dock bumpers, railroad crossing blocks, roofing materials, and shoes. Approximately 17 percent of the ground rubber sold went into rubber-modified asphalt (RMA) production and a small percentage was used in automotive applications or exported primarily for use as tire-derived fuel. Advancements in the production of RMA, particularly the dry method, have enhanced the performance of this alternative paving material, thereby increasing opportunities for this scrap tire application in future years.

Export of tires for ground rubber applications have declined over the past decade due to tightening import restrictions in China and other Asian markets, as is true for several other recycling commodities. However, a substantial number of tires continue to be exported as tire-derived fuel.

FIGURE 7-27: SCRAP TIRE MANAGEMENT IN THE U.S. (2019)



Source: U.S. Tire Manufacturers Association, "[2019 Scrap Tire Management Summary,]" 2020.

The third largest end use category, after ground rubber markets is civil engineering applications, primarily use of tires as lightweight aggregate for drainage purposes. Other applications include road repair, acoustic dampening in light rail systems and stormwater infiltration galleries. While not as high value an application, tire-derived aggregate (TDA) has inherent advantages to conventional aggregates in that it is:

- substantially lighter in weight;
- has good drainage properties;
- can moderate vibration; and
- has insulation benefits.

Stockpiled tires remaining in the U.S. have declined steadily year after year; however, Texas has the highest number of stockpiled tires in the nation (excluding Colorado which has a large inventory of monofilled scrap tires).

Recovery and recycling technologies are continuing to be developed/refined and are at various stages of commercialization. Pyrolysis, involving the heating of tires in the absence of oxygen, is a process used to break down tires into other materials, such as recovered carbon black, gas, and fuel oil. The steel can also be recovered and recycled. Pyrolysis economics have been unfavorable due to the low price of natural gas, and the low quality of recovered carbon black (rCB) has constrained access to markets. A key driver for growth is the growing interest of tire manufacturers to participate in the circular economy by using recovered carbon black (rCB) in the production of new tires. Examples include:

- Bridgestone Americas Inc. uses rCB made by Delta-Energy to make agricultural tires at its Des Moines, Iowa plant;
- Continental AG is partnering with Pyrolyx AG to produce rCB for Continental tire manufacturing facilities worldwide; and
- Michelin has recently partnered with pyrolysis company Enviro Systems to produce rCB for its tires manufacturing process.

Several North American companies are also pursuing devulcanization, another emerging technology that yields a recycled feedstock that can be used in a far wider range of high value applications than ground rubber. Devulcanization economics have also become less favorable recently due to the low price of oil and natural rubber.

Nature of Texas-Generated Supply of Tires

Texas law requires annual reporting by scrap tires handlers (excluding generators and owners of land reclamation projects using tires) related to their tire management activities. According to the 2019 Scrap Tire Annual Report Summary, TCEQ estimates that approximately 44.8 million scrap tires were generated and managed in Texas, equivalent to 447,850 tons. In addition, 11,752,174 tires (117,522 tons) are estimated to be stockpiled in 111 unauthorized tire sites located throughout Texas.

Per TCEQ's records, there were 12,075 scrap tire handlers registered with the State in 2019. A scrap tire handler is any entity involved in the scrap tire management stream. The vast majority of these were generators (11,522) and include such entities as local governments, automotive service centers and tire stores. In addition to generating scrap tires, some of these locations are also involved in selling reused, retread and remanufactured tires. Municipalities registered as generators may have tires of their own to dispose of as well as may collect tires from residents. Transporters may export tires out of state, and an estimated 5,273 tons of tires were utilized or disposed out of state in 2019 based on annual reporting data. Tires were exported to Alabama, Florida, Louisiana, Missouri, New Mexico, and Oklahoma.

There were 405 registered transporters, 108 registered processing facilities, and 12 registered storage sites. Processing includes activities such as cutting, grinding, shredding, baling, crushing, splitting, and recapping or retreading. Some processors send cut or shredded tires to the landfill, while others send for use as tire-derived fuel, recycling, or to a land reclamation project using tires (LRPUT). Some processors have storage facilities while some registered recyclers (discussed below) also have storage facilities.

Nature of Demand for Texas-Generated Tires

Per the TCEQ Scrap Tire Annual Report Summary, approximately 79 percent of tires generated in Texas in 2019 were diverted from disposal for beneficial use. The remaining 21 percent were landfilled. Based on 20-pound passenger tire equivalents (PTEs), this equates to approximately 355,643 tons of tires currently diverted from disposal and 92,208 tons still being landfilled. Table 7-19 shows the management of tires in Texas.

TABLE 7-19: SUMMARY OF TEXAS-MANAGED SCRAP TIRES (2019)

Management Method	Approximate Scrap Tire PTEs[1]	Estimated Tonnage[2]	Percent
Tire-Derived Fuel	16,335,234	163,352	36%
Ground Rubber[3]	6,526,925	65,269	15%
Land Reclamation	5,115,955	51,160	11%
Other Recycling[3]	4,470,128	44,701	10%
Other Beneficial Uses	3,116,038	31,160	7%
Total Diverted	**35,564,280**	**355,643**	**79%**
Total Landfilled	**9,220,752**	**92,208**	**21%**
Grand Total Managed	**44,785,032**	**447,850**	**100%**

1. Passenger Tire Equivalent (PTE)
2. Based on a 20-pound passenger tire equivalent (PTE)
3. Included as recycling in the estimates provided in Section 3, resulting in a total of 109,971 tons recycled.
Source: TCEQ 2019 Scrap Tire Annual Report Summary

Tire-Derived Fuel

The highest end-use of used and scrap tires was for energy recovery and use as a fuel source. Approximately 16.3 million (36 percent) tires were used as tire derived fuel at six of the eight registered energy-recovery facilities in Texas, all of which are cement kilns. In addition, some energy recovery is performed by Nucor Steel which also recycles the steel in the tires. An additional 233,902 tires were transported outside the state for use as tire-derived fuel. Use of tires as fuel has remained the largest use for tires for over five years with 2019 being the highest year yet of the past five. In Texas, tire-derived fuel is not considered recycling.

Ground Rubber

Approximately 6.5 million (15 percent) tires were recycled to produce ground rubber. Rubberized asphalt is the largest market for ground rubber in Texas. Ground rubber is also used as an infill for synthetic turf fields and in making playground and recreational facility surfaces, sports tracks and grounds, building products, flooring, injection molded products, sound barriers and industrial applications. Ground rubber production declined in 2019 – the lowest percentage reported in the past five years. One reason for this may be differences in reporting by registered tire handlers from year to year. One tire industry representative stated that some lower cost feedstock may be being imported into Texas from other countries which could affect the use of Texas tires. Another company reported that it has no problems marketing all the product it manufactures, with crumb rubber production limited primarily by a need for more incoming tire supply. End uses for crumb rubber are likely to increase with the recent opening of North West Rubber in Houston and planned opening of Eco-Flex in Lampasas, both of which manufacture various products from crumb and are discussed in more detail below.

Land Reclamation Projects Using Tires (LRPUT)

Approximately 5.1 million (11 percent) tires were used for land reclamation at 15 locations authorized by the TCEQ. This use for tires is growing due to changes in State regulations making this more feasible from a permitting standpoint. While use of tires for land reclamation can potentially consume a large quantity of tires, this is not a high value end use; however, it may be one of the best options for use of tires from stockpiles, which tend to be poorer quality due to exposure to the environment. In Texas, LRPUT is not considered recycling.

Other Beneficial/Recycling Uses

Approximately 4.5 million tires (10 percent) were processed to recover wire and steel, and 3.1 million tires (7 percent) were utilized for other beneficial uses including manufacture of tire ring bases for traffic barrel drums, agricultural products such (e.g., stall mats, water and feed troughs), and tire mulch for landscaping. One tire recycling industry representative reported that the market for tire mulch has seen a growth in demand due to an increase in home landscaping projects resulting from people staying home more due to the coronavirus pandemic.

Texas Crumb Rubber Production and Tire Recycling Facilities

Listed among the processors are several crumb rubber producers in Texas including Braswell, Bar Recycling Enterprises, Recycling Universe, and Genan. Genan is particularly noteworthy due to its size and role in Texas. This Danish firm opened the world's largest tire recycling facility of its type in Houston in 2012. The plant has the capacity to process 10 million PTEs per year or approximately 110,000 tons – roughly one quarter of the scrap tires generated in Texas. All of Genan's tires are supplied by Liberty Tire (described below) and come from Texas sources. A shortage of tire supply is preventing the Genan facility from being able to operate at full capacity. Incoming tires are processed into their basic components, primarily ground rubber and steel. The remaining textile fraction is currently disposed, but Genan is researching end uses for this material with a goal of recycling 100 percent of the incoming tires received.

Tire recyclers located in Texas either produce products (other than crumb rubber) with scrap tires or tire pieces or use the recycled materials for another purpose. Identified tire recyclers and their activities are briefly described below:

- Rampage Cattle Company, LLC (Kerrville) produces agricultural products from off-the-road tires, including water tanks and feed tanks for livestock;
- Eco Tire Recycling (Edinburg) produces agricultural products from off-the-road tires, including water tanks and feed tanks for livestock;
- Treadwright Tires (Houston) remolds scrap tires and applies new rubber to produce new tires;
- Rhyfield Construction (Amarillo) produces rubber mats using the tread from scrap tires;
- Nucor Steel Texas (Jewett) recycles the steel as well as recovers energy from tires;
- Liberty Tire Recycling (multiple), makes tire derived fuel, aggregates, and ground rubber that is sold to other end users. Liberty Tire Recycling also manufactures and sells some of its own products, including landscaping mulch and a dry-mix rubber additive used to enhance rubberized asphalt mix for improved compaction, flexibility and durability;
- North West Rubber (Houston) produces specialty rubber flooring products for a variety of applications, including agricultural, recreational, playground, traffic safety, trailer, and truck bed mats; and
- En-Plast (Houston), manufactures a specialty synthetic turf subbase product.

Other end markets for ground rubber in Texas include asphalt rubber producers such as Cox Paving of Texas (Blanco), whose primary business is providing hot asphalt rubber mix or hot asphalt rubber sealcoat as a prime or subcontractor on highway and interstate jobs funded by TxDOT. Industry representatives interviewed for this project stated that use of rubberized asphalt is a market with room for growth.

With respect to new developments, Vancouver based Eco-Flex is opening a facility in Lampasas, Texas that will make specialty tire-derived products that are substitutes for concrete and lumber products such as sidewalks, sound barrier walls, and landscaping blocks. This will further expand the market for products made from Texas scrap tires. The plant was due to begin operation August 2020 but was delayed in part due to the coronavirus pandemic.

Comparison of Supply and Demand for Tires

In Texas, markets are needed for the nearly 12 million stockpiled tires and the tires landfilled annually – over one-fifth of the scrap tires generated in the State. In addition, while tires are diverted from disposal for use as fuel and land reclamation, the resources embedded in these tires are lost from further use. As Texas continues to grow in population, increasingly more tires will be generated, thereby increasing the need for more end market capacity. For these reasons, scrap tire supply exceeds demand, and there is a clear need for scrap tire recycling market development in Texas.

7.18 SUMMARY OF TEXAS SUPPLY RELATIVE TO TEXAS DEMAND

Table 7-20 provides a summary by commodity type of material supply relative to demand in Texas. As Table 7-20 indicates, the balance of supply and demand is not static over time, nor is it necessarily uniform statewide. The relationship between supply and demand of a recovered material can vary significantly from region to region within the State, depending upon market factors and infrastructure capacity. In some cases, a material may have strong markets, despite the demand for that material being from out-of-state markets (e.g., aluminum). In other cases, a material is not being recovered fully, but has ample processing capacity within the State (e.g., electronics) and therefore increased recovery of that material could result in economic gains for Texas businesses. There are other cases where increased recovery of a material could lead to expanded recycling markets, whether new markets or growth for existing (e.g., glass, paint, tires, textiles); however, the infrastructure would not expand until the supply were available. Section 8 examines the barriers and opportunities for each of the material types, and additional criteria are applied in order to prioritize the materials, barriers and opportunities to address.

TABLE 7-20: SUMMARY OF SUPPLY AND DEMAND BY MATERIAL TYPE

Material Type	Supply > Demand	Supply = Demand	Supply < Demand
Paper			
OCC			Demand is growing and supply has become tighter as e-commerce has increased and as supply has shifted from retail to residential generators. End users in Texas import OCC feedstock from out-of-state.
Sorted Office Paper			The coronavirus pandemic has resulted in a shortage of sorted office paper and other high-quality grades generated by businesses and institutions and sought by end users such as tissue mills.
Mixed Paper			Demand exists for mixed paper that meets quality specifications and is growing. Quality is key to having suitable in-state supply. End users in Texas import Mixed Paper feedstock from out of state.

Material Type	Supply > Demand	Supply = Demand	Supply < Demand
Other Paper	Aseptic and gable top cartons and other polycoated paper (e.g., cups and frozen food packaging) have limited processing outlets even though some end use demand exists. Demand is limited but is growing.		Demand for ONP exceeds supply availability given many MRFs no longer sort out this paper grade.
Plastics			
PET	PET Thermoforms and colored PET have limited markets currently. In the future chemical recycling can help with this imbalance.		Reclaimers and end users of PET bottles need more collection to meet their demand.
HDPE	Supply of pigmented HDPE exceeds end user demand.		In-state reclaimers need more supply of natural HDPE to meet end-user demand.
Film Plastics	Contaminated film plastics such as that collected via curbside recycling systems and dirty agricultural film lack markets both within Texas and nationally.	Return-to-retail film goes to domestic markets outside of Texas, but supply and demand could both be improved.	Recyclers of clean, clear commercial film have more capacity than Texas supplies.
Plastics #3-7	Mixed plastics lack sufficient domestic sorting capacity and there is none in Texas.		
Metals			
Ferrous Metals		Most supply is industrial scrap that is generated in proportion to regional demand. Texas demand is limited, and excess supply goes to markets in surrounding states.	Bulky ferrous metal products lack collection and sorting opportunities to meet regional demand.
Non-Ferrous Metals	Mixed non-ferrous metals, such as from shredders, lacks sufficient sorting capacity to meet segregated metal demand so some collected mixed metals are disposed.	Non-ferrous metals segregated by generators and delivered to scrap yards has good marketability.	Aluminum cans have more national demand than supply and more collection is needed, though there are no can recyclers in Texas.

Material Type	Supply > Demand	Supply = Demand	Supply < Demand
Glass			
Glass	In some rural areas glass is not collected, as processing capacity is too far to be cost effective, so potential supply exceeds regional demand.		Manufacturers of glass containers and fiberglass indicate they could use more recycled material. The key is obtaining supply at the price desired. Processors, too, indicate that they have additional capacity, and could process both additional container glass and plate glass.
Organics			
Yard Trimmings	Where processing facilities do not exist (e.g., less populated regions), supply exceeds demand and material is landfilled.	In some areas in Texas where compost facilities exist but do not face strong competition, supply is in line with demand.	Most compost facilities indicate they could use more supply. Most compost facilities indicate plans for expanding the quantity they process.
Food Waste	The infrastructure for collecting and processing food waste in composting or other operations is underdeveloped, so the potential supply of food waste currently exceeds demand.		Several compost facilities that accept food waste for processing indicate that they could use additional supply of material. It appears that relatively few large-scale food waste generators are delivering their food waste to compost facilities currently.
Biosolids	Biosolids are a consistently generated material type requiring cost-effective and safe management. Because some is landfilled and disposed in monofills, supply exceeds demand on a statewide basis. This is particularly true in some areas of the state such as western Texas where there are few land application sites.		
Wood Waste		Some wood processors indicate that they can successfully market their products, though some indicate it is challenging.	

Material Type	Supply > Demand	Supply = Demand	Supply < Demand
Other Organics	In general, there is excess potential supply of other organics, as these materials are managed in the most convenient/ low cost way possible (including disposal). Because manure is nutrient-rich, it may be used on farm, or supplied to a nearby compost facility. Fats, oils and greases may be composted or otherwise recycled depending on location and quality.	Supply and demand are relatively balanced for manure and yellow grease. Nutrient-rich manure may be desired by compost facilities. Yellow grease may be desired by bio-fuels manufacturers, if in close proximity.	
Construction and Demolition Debris			
Concrete, Asphalt, Brick, Tile & Aggregate	A significant quantity of concrete, asphalt, brick, and tile is disposed, likely due to lack of knowledge of material availability and associated cost to transport material.	Concrete, asphalt pavement, brick, tile, and aggregate are desired in Texas, as aggregate is not plentiful, and is costly to transport. The key is having the material in the region where it is needed, when it is needed.	In some areas, during certain times, demand likely exceeds supply, and new aggregate must be purchased, or recycled product imported from a nearby state.
Asphalt Shingles	Asphalt shingles are stockpiled in Texas currently. There is an oversupply of asphalt shingles. Some C&D recyclers no longer accept them.		
Wood Waste from C&D	Demand for wood waste is generally less than supply. In particular, treated and painted wood lack markets. A significant quantity of wood is disposed.	Most wood processors indicate that they can successfully market their products, though some indicate it is challenging.	
Drywall/Plaster	Drywall has few outlets in Texas, though some composters will include it in their processing. Most drywall in Texas, as in the U.S. is disposed, as supply exceeds demand.		

Material Type	Supply > Demand	Supply = Demand	Supply < Demand
Other Materials			
Paint	A significant amount of waste latex paint is disposed. The potential supply of paint, statewide, is greater than demand, as there are only two known paint recycling companies in Texas.		From the perspective of existing paint recyclers, more material could be processed, but demand for paint-derived end products is not strong.
Electronics	In rural locations, supply may be greater than demand because there are few recyclers located conveniently, and collection opportunities for residents may be limited. Opportunities for municipal programs and small-scale commercial generators are likely relatively costly.		There are many electronics recyclers In Texas – some of whom obtain material from outside of Texas. Most would likely be able to process additional material if they could obtain it.
Batteries	Some rural areas of Texas are lacking collection infrastructure for portable batteries due to limited retail drop-off opportunities.		There is additional capacity to accept and recycle more portable batteries in many areas of Texas. EV and ECC battery supply does not yet support investment in processing and end use infrastructure in Texas, but this will change as supply becomes available.
Textiles	Supply of textiles exceeds demand, except for cotton fabric scrap needed by wiping cloth manufacturers. Several sorters exist in Texas and much of the recovered material is exported.		The growth of chemical recycling opportunities is expected to increase the demand for certain textiles, such as polyester and cellulosic material suitable for conversion into chemical feedstocks.
Tires	Texas has a large supply of stockpiled tires that needs markets, but these tires are dirty and have limited end uses.		Processors and manufacturers are seeking additional supply of clean scrap tires.

8 BARRIERS AND OPPORTUNITIES

8.1 INTRODUCTION

Effective recycling market development entails the use of tools and mechanisms strategically aimed at overcoming barriers impeding movement of recyclable materials from the waste stream into viable end markets. This section presents an analysis of barriers and opportunities to expanding markets for recovered materials in Texas, with the section organized as:

- Barriers and opportunities by material (presented in bold italics), followed by a summary table of barriers and opportunities by material category (i.e., typical recyclables, organics, construction and demolition, and other materials).
- Infrastructure needs and overall sufficiency of existing infrastructure for current and expanded recycling levels; and
- The method for prioritizing materials/opportunities to expand recycling markets and the results of prioritization analysis.

Barriers and opportunities were identified through the RMDP survey, four stakeholder forums (further described in Appendix D), interviews of various industry stakeholders, and additional research conducted by the Project Team. In some cases, barriers impact more than one material type (i.e., cross-material barriers) while other barriers are material specific. The opportunities presented herein broadly describe what can be done to address the barriers. Strategies for how to address the barriers and advance these opportunities are presented in Section 9, and Section 10 presents institutional considerations for the RMDP.

8.2 BARRIERS AND OPPORTUNITIES FOR PAPER

As described in Section 7, the markets serving Texas for recovered paper are strong, assuming the material can be processed to meet end market specifications.

Barriers to Paper Recycling

Barriers to expanding paper recycling include:

- ***Contamination.*** Materials quality is of paramount importance to effectively moving paper into the marketplace and nearly all survey and forum participants reported contamination as a major barrier impeding the use of recovered paper.
- ***Lack of participation where programs are accessible.*** Five of six end users of Texas-generated recovered paper who shared information regarding market barriers through the RMDP survey reported difficulty securing sufficient or consistent quantity of recycled materials or feedstock due to low participation. With the shift in OCC generation from commercial to residential sources due to the coronavirus pandemic and e-commerce, OCC recovery has declined due to lower recycling participation for residents and subsequent capture of this material from the waste stream.
- ***Reluctance of end markets to pay for processed materials.*** This may also be related to contamination, as the cost of removing contaminants results in processors needing to cover those costs when selling their processed material. In addition, when the availability of suitable quality feedstock is tight, recovered paper prices tend to increase. If recovered paper supply is tight and pricing is high, some end users may seek virgin feedstock instead of recycled paper.
- ***Lack of resources for equipment for enhanced processing.*** This is particularly true for smaller organizations.
- ***Difficulty obtaining, retaining, and training employees.*** The cost of labor and ability to pay high enough wages to compete with other employers for employees is a factor, particularly in areas with tighter job markets.
- ***Reluctance of end markets to pay for processed materials.*** This applies particularly when recycled feedstocks must compete against inexpensive virgin sources of supply.
- ***Costly to transport relative to value.*** Transportation costs are a factor whenever markets are more distant, as is the case with recovered fiber markets.
- ***Lack of sufficient processing infrastructure.*** This is primarily in rural areas in north and west Texas where there is less established infrastructure to sort collected paper and aggregate truckload

quantities for shipment to existing markets. This is a supply issue affecting multiple commodities that needs to be addressed, but not one that is notably impeding markets and recovered paper marketability.

The primary barriers affecting recovered paper marketability are supply related. Many barriers also have an economic component. For example, end market reluctance speaks to consumer willingness to value products with recycled content versus those made from virgin material resources to such an extent that they will pay higher prices for recycled-content products.

Potential Opportunities to Address Gaps/Barriers for Paper

As discussed above, the primary barriers to be addressed in enhancing markets for and the marketability of Texas-generated recovered paper are related to supply quality and availability and/or are economic. Secondary barriers include limited demand for products made from recovered paper from Texas sources. Key opportunities for addressing these barriers are listed below, by type of barrier. Some of the barriers and associated opportunities are cross-material in nature, meaning that they apply to several commodity types and not paper.

Supply Related:

- ***Improve quality/decrease level of contamination of incoming materials or feedstock.***
- ***Boost recycling participation.***
- ***Increase processing capacity (particularly in rural/remote areas).***

Economic:

- ***Provide financial assistance for equipment/upgrades to address contamination and/or utilize alternative recycled paper feedstocks.***

Demand Related:

- ***Encourage manufacturers to set/increase and meet recycled-content goals to boost demand for recycled materials.***
- ***Stimulate increased purchase of products made with recycled content.***

8.3 Barriers and Opportunities for PET

As described in Section 7, Texas markets for PET bottles are close to being in balance with current supply of bottles collected for recycling in Texas. There are very few markets for thermoform-only bales, and since the supply of thermoforms exceeds demand many MRFs do not accept them.

Barriers to PET Recycling

Barriers to expanding markets for PET include:

- ***Low participation where collection programs exist.*** There is not enough collection of PET bottles to meet anticipated increases in end-user demand, which is expected to occur due to brand commitments to increase the recycled content of their packaging. It is not likely that consumer packaged goods companies (CPGs) will be able to meet their recycled content goals unless there are significant changes to how PET bottles are collected, including bottles generated away from home.
- ***High cost of sorting low value plastics that are a small portion of the material stream, such as thermoforms.*** Historically thermoforms have not had much market depth in the U.S., and as a result many MRFs and communities do not accept or promote recycling of thermoforms. As chemical recycling options grow for thermoforms in the next few years, significant increases in market demand are expected; however, this may require upgrading the sorting infrastructure for low-percentage and low-value plastics of all types, including PET thermoforms. A bale of thermoforms and colored PET bottles has very low value. Consequently, MRFs are unlikely to support making investments to enable them to produce this grade, and outlets for sorting mixed plastics including thermoforms are absent from Texas.
- ***Inconvenient/limited access to recycling opportunities.*** Curbside collection infrastructure is lacking in certain regions of Texas (i.e., in rural areas and at multi-family dwellings), although drop-off recycling locations may be provided.

- ***Lack of participation where programs are accessible.***
- ***Existence of packaging features that impede recycling.*** Certain packaging design features, referred to in the industry as "disruptors," increase processing costs as well as certain chemical additives decrease the desirability or usability of the material as a recycled feedstock.

Potential Opportunities to Address Gaps/Barriers for PET

Opportunities to address the barriers described above include:

Supply Related:

- ***Secure sustainable funding for residential recycling collection programs.***
- ***Boost recycling participation.***
- ***Increase processing capacity (particularly in rural/remote areas).***
- ***Design packaging for recycling****, such as using clear PET resin, avoiding noncompatible full-body shrink sleeve labels, and avoiding PETG resin (i.e., PET altered with a different glycol), which can impede the PET recycling process.*

Economic:

- ***Provide financial incentives for equipment for MRFs to process low-value PET thermoforms and colored PET bottles more cost effectively.***

Demand Related:

- ***Expand end user demand for PET thermoforms.***

8.4 BARRIERS AND OPPORTUNITIES FOR HDPE

As described in Section 7, nationally and within Texas demand for HDPE by reclamation facilities exceeds available supply. End user demand is strong for material that meets quality specifications.

Barriers to HDPE Recycling

Barriers to expanding markets for recovered HDPE include:

- ***Lack of participation where recycling programs are accessible.*** One of the most significant barriers in Texas to expanding markets for recovered HDPE is that there is not enough collection of HDPE bottles to meet end-user demand. Consequently, Texas HDPE bottle reclaimers do not have enough supply to fully utilize their capacity.
- ***Low price for pigmented HDPE.*** Natural bottles, which lack pigment and are made from food grade plastic, have significantly more demand than pigmented bottles and market prices reflect this. End use markets are willing to pay a significant price premium for recycled natural HDPE compared to what they would have spent for virgin resin because much of the recycled natural HDPE is used by brand companies that have made commitments to use recycled resin. However, the same is not the case for mixed color recycled pigmented HDPE resin, because pigmented resin is not food grade and the mix of colors limits its demand by brand companies, so it goes to other applications where end users typically have not made recycled content commitments.
- ***Lack of equipment.*** If reclaimers had equipment to sort and upgrade mixed color pigmented HDPE, demand for the material would likely increase.
- ***Inconvenient/limited access to recycling opportunities.*** In some parts of Texas, the residential recycling collection infrastructure is inadequate (i.e., in rural areas and for multi-family dwellings).
- ***Reluctance by end markets to pay*** higher prices for color-sorted post-consumer pigmented bottle resin

Potential Opportunities to Address Gaps/Barriers for HDPE

Potential opportunities to overcome the barriers and gaps identified include:

Supply Related:

- ***Boost recycling participation.***
- ***Increase processing capacity particularly in rural/remote areas.***

Demand Related:

- ***Expand end user demand for pigmented and injection molded HDPE rigid plastic packaging items.***

8.5 BARRIERS AND OPPORTUNITIES FOR FILM PLASTICS

As described in Section 7, Texas' film recycling capacity exceeds what is collected in the State, and currently commercial film is imported into Texas for recycling. However, Texas does not have capacity to recycle residential film plastics; therefore, supply exceeds demand for this material. Demand for clear, commercial film plastics is expected to grow significantly with Avangard Innovative's processing capacity expansion.

Barriers to Film Plastics Recycling

Film plastics recycling faces several barriers, including:

- ***Lack of in-state processing and markets.*** This occurs especially for residential/colored film. Colored polyethylene film has lower demand than clear sacks and wraps.
- ***Challenges in cost-effectively collecting and sorting.*** Film from medium and small commercial generators are especially impacted.
- ***Contamination.*** Dirty/contaminated polyethylene film has low reclaimer demand due to the cost of sorting and washing.
- ***Lack of wash lines to process certain film plastics.*** This barrier exists nationally as well as in Texas.
- **Reluctance of end markets to pay for processed material.** It is relatively costly to sort and recycle mixed resin films for mechanical recycling, given their value.
- ***Lack of adequate collection programs for commercial and residential films.***
- ***Lack of participation where programs are accessible.*** Recovery rates for residential film collected through return-to-retail and drop-off collection points are low.
- ***Difficulty securing adequate quantities.*** This occurs especially in rural areas and from small businesses.

Potential Opportunities to Address Film Plastics Recycling Gaps/Barriers

Opportunities to expand market opportunities for recovered film plastics include:

Supply Related:

- ***Boost recycling participation for clean polyethylene film.***
- ***Expand the collection infrastructure for clean polyethylene film.***
- ***Connect large-scale generators of polyethylene film with growing end markets in Texas.***
- ***Build awareness and incentives for generators and processors of Texas film to grow supply to chemical recycling markets.***

Economic:

- ***Provide financial assistance to expand the infrastructure to wash polyethylene film.***

Demand Related:

- ***Increase demand for recovered plastic film, especially for residential return-to-retail film, since in-state reclaimers are focused on recycling clear commercial film.***

8.6 BARRIERS AND OPPORTUNITIES FOR PLASTICS #3-7 AND OTHER PLASTICS

As described in Section 7, there is no demand for mixed plastics #3-7 in Texas and these materials are generally not collected for recycling. There are markets for recognized plastic grades that have been sorted to industry specifications for PP and bulky rigid plastics, however other mixed grades must be exported to out-of-state markets with wash lines for PP containers or the ability to sort mixed resin bales by material type.

Barriers to Plastics #3-7 and Other Plastics Recycling

Barriers to recycling plastics #3-7 and other plastics include:

- ***Inconvenient/limited access to recycling opportunities for plastics #3-7 and other plastics.***
- ***Low market prices for plastics #3-7 and other plastics.*** It is difficult to obtain enough market value to make a successful business case to collect and sort these materials for recycling. In Texas there is low end use market demand for recycled PVC, PS, and electronics plastics.
- ***Lack of adequate sorting/processing capacity for mixed residential plastic containers.***
- ***Lack of adequate end markets, thus low market prices for residential bulky rigid plastics.*** Although there are strong reclamation markets for bulky rigid plastic in the Southeast, MRFs do not profit by promoting recycling of this grade due to a low market value of two cents per pound ($40 per ton).

Potential Opportunities to Address Gaps/Barriers for Plastics #3-7 and Other Plastics

Potential opportunities to address gaps/barriers to the markets for other plastic include:

Supply Related:
- ***Pursue opportunities to collect and deliver low-value plastics to emerging in-state chemical recycling markets.***
- ***Increase processing capacity.*** In the case of plastics #3-7 and other plastics there is limited processing capacity throughout the state, not just the remote areas of Texas.

Economic:
- ***Provide financial assistance to expand the capacity for sorting mixed plastics #3 -7 residential plastic containers.***

Demand Related:
- ***Stimulate increased purchase of products made from recovered plastics #3-7 and other plastics such as bulky rigid plastics and electronics plastics.***

8.7 Barriers and Opportunities for Recovered Ferrous Metals

As described in Section 7, the supply of scrap steel in Texas exceeds the combined demand of the five in-state steel mills that have a capacity to recycle 4.38 million tons of ferrous metals annually. Additional steel is exported to other states for processing where there is adequate regional capacity and demand for the material.

Barriers to Ferrous Metals Recycling

Barriers to increasing recycling of ferrous metals generated in Texas are focused on ferrous metals in the MSW stream[1] and include:

- ***Lack of sorting capacity of small non-can metals in residential MRFs.***
- ***Limited bulky item collection opportunities and limited bulky waste processors.*** With limited infrastructure, it is difficult to divert bulky ferrous items from disposal out of residential and commercial waste streams.
- ***Inconvenient/limited access to recycling opportunities.*** This pertains mainly to more rural areas of Texas and multi-family dwellings.
- ***Lack of participation where programs are accessible.***

[1]As described in Section 2, scrap metal is excluded from the market development to conform to the requirements of SB 649

Potential Opportunities to Address Gaps/Barriers for Ferrous Metals

Potential opportunities to address the barriers mentioned above include:

Supply Related:
- ***Boost recycling participation.***
- ***Increase the availability of steel scrap recycling programs beyond steel cans for residential generators.***
- ***Increase processing capacity for recycled materials (particularly in rural/remote areas).***

8.8 BARRIERS AND OPPORTUNITIES FOR RECOVERED NONFERROUS METALS

As described in Section 7, Texas markets have adequate capacity to recycle Texas zinc, precious metals, and copper. Lead and most aluminum, including all aluminum cans, must be sent out of state for recycling; however, those materials have excellent market demand in national markets for closed-loop recycling.

Barriers to Non-Ferrous Metals Recycling

There are four primary barriers for recycling more non-ferrous metals in Texas:[2]

- ***Inconvenient/limited access to recycling opportunities.*** This pertains mainly to more rural areas of Texas and multi-family dwellings.
- ***Lack of participation where programs are accessible.*** The quantity of aluminum cans collected throughout the state is not adequate to meet end-user demand for closed-loop can-to-can recycling, which is exclusively located outside of Texas.
- ***Low demand for certain materials.*** Demand for foil wraps and semirigid containers generated by residential and ICI (industrial, commercial, and institutional) generators, is low.
- ***Low demand for mixed nonferrous/lack of sorting capacity.*** Demand for mixed nonferrous metals from shredders is low, and sorting capacity for this material is insufficient within Texas, resulting in disposal of some material.

Potential Opportunities to Address Gaps/Barriers for Non-Ferrous Metals

Actions that can be taken to overcome these gaps and barriers include:

Supply Related:
- ***Boost recycling participation.***
- ***Increase processing capacity for recycled materials particularly in rural/remote areas.***

Economic:
- ***Provide financial assistance to support purchase of equipment to sort mixed nonferrous metals at shredding operations.***

Demand Related:
- ***Encourage secondary aluminum smelters in Texas to recycle foil bales.***

8.9 BARRIERS AND OPPORTUNITIES FOR GLASS

As described in Section 7, the demand for glass by both Texas secondary processors and end users exceeds supply. The challenge is in ensuring that suitable material is supplied at a mutually agreeable price.

Barriers to Glass Recycling

Barriers to expanding glass recycling include:
- ***Costly to transport relative to its value.*** Based on survey feedback, stakeholder forum input, and interviews with Texas stakeholders, one of the most challenging aspects of glass recycling is that glass is heavy and a relatively low-value commodity (with somewhat of a price ceiling). Therefore, hauling glass long distances is not cost effective. This is challenging in a large state like Texas, particularly for rural areas. The preference is for most tri-mix glass to be managed within a 100-mile radius, although it may travel up to 250 miles. The hauling distance may be longer if material is

[2] Most shredded material has historically been shipped outside of Texas for processing, and includes items such as barbecue grills, small household appliances, bicycles and auto bodies.

collected separately from other materials and is therefore clean.
- ***Inconvenient/limited access to recycling opportunities.*** This pertains to remote areas, as well as at some multi-family dwellings.
- ***Contamination.*** This has a large impact on the cost efficiency of glass recycling, and reportedly only 50 to 70 percent of glass entering a MRF system is recovered. Furthermore, it is more cost effective to transport clean material compared to material that is weighed down with contaminants. In some cases, communities will have drop-off collections for glass such that the material is relatively clean and requires no MRF processing, but drop-off programs tend to result in far lower participation rates than curbside recycling programs.
- ***Lack of intermediate processing infrastructure in remote areas of the state.*** Where secondary processors are located far away, communities and MRFs often do not find it cost-effective to collect glass for processing. In the more remote areas, essentially a "chicken and egg" scenario exists, as a processor may not see the benefit of siting a secondary processing facility in an area with low glass collection rates, yet some communities/haulers/MRFs are unwilling to include glass in their collection programs if it is not cost effective to haul the glass to the processor.
- ***Competition with low-cost alternatives to recycling.***
- ***Reluctance of end markets to pay for processed material.***
- ***Lack of participation where programs are accessible.*** Glass processors' economies of scale are improved with quantity. Participation is limited in part due to lack of incentive to recycle, and the existence of relatively inexpensive alternatives (e.g., disposal) to manage glass at the end of its useful life.
- ***Competition in Mexico.*** Some glass manufacturing has reportedly moved to Mexico, where labor and other costs are lower, reducing/competing with Texas demand.

Potential Opportunities to Address Gaps/Barriers for Glass

The following potential opportunities are identified to address gaps and barriers and to bolster glass recycling markets in Texas:

Supply Related:
- ***Boost recycling participation.***
- ***Increase quality/decrease contamination of incoming material.***
- ***Develop efficient collection systems for recovering glass from more remote areas of Texas and areas located farther from existing processing facilities.***
- ***Identify cost-effective means, including exploring rail haul, to import (additional) unprocessed glass from states that lack adequate markets to ensure processors function at or close to full capacity.***
- ***Examine the benefits of increasing secondary glass processing capacity in Texas.***

Economic:
- ***Put recycling and disposal on more equal footing.***
- ***Provide financial assistance to fund glass processing and manufacturing equipment expansions/ upgrades.***

Demand Related:
- ***Stimulate increased demand for recycled content in container glass and/or fiberglass.***
- ***Stimulate increased demand for locally collected and pulverized glass in rural areas.***

Glass is a challenging material to manage for many U.S. communities due to the same barriers faced in Texas. Some activity is taking place at the national level that may benefit Texas, including the Glass Recycling Coalition's MRF Glass Certification Program, which recognizes MRFs that have invested in glass processing equipment and have effective glass processing programs in place. Balcones' Austin location has achieved silver status. Another opportunity that may have a positive impact on Texas is an initiative called The Center for Glass Innovation, which is being funded in part by the State of New York. The Center is being created at SUNY's New York State College of Ceramics, which is located at the private Alfred University in Alfred, N.Y. The Center aims, through research and innovation, to create higher value end markets for glass. Glass companies will have the opportunity to test small batches of new glass compositions in a pilot production environment at the Center. Project partners include Owens-Illinois, the Glass Manufacturing Industry Council and others.

8.10 CROSS-MATERIAL BARRIERS AND OPPORTUNITIES FOR TYPICAL RECYCLABLES

Several of the barriers and associated opportunities for materials listed above exist for multiple material types. It is helpful to identify cross-material barriers, as actions to address them can improve marketability/markets for multiple materials as opposed to just a single material type, particularly for typical recyclables, as they are collected and processed initially together. The main cross-material barriers identified include:

- ***Contamination.*** Particularly with single-stream recycling, contamination of materials collected for recycling adds to the cost of recycling and can degrade materials, resulting in reduced revenues. Contamination can occur for a variety of reasons, including lack of awareness that containers need to be empty and rinsed, lack of awareness of what can be accepted in the program (e.g., contamination due to "wish-cycling," and lack of willingness to prepare materials properly for recycling. In addition, contamination can occur within a MRF due to challenges sorting materials into separate marketable streams. Among typical recyclables, contamination is somewhat of an issue for all materials in that it impacts the economics of MRF operations, but it is a more significant barrier for certain materials (paper, film plastics and glass) as discussed above.
    - ***Opportunities to improve quality/decrease the level of contamination of incoming materials or feedstock.*** Increasing awareness among generators, including educating them about why recycling is important and how materials are processed at the MRF can help increase awareness. Success is more likely with cart monitoring and provision of feedback regarding setouts. Upgrading MRF equipment to better enable MRFs to sort out clean marketable material grades.
- ***Lack of participation where programs are accessible.*** Many residents and ICI generators have access to recycling but do not participate, or do not participate fully (i.e., only recycle a portion of what can be recycled).
    - ***Opportunities to address lack of participation.*** Lack of participation can best be addressed through increasing awareness of the opportunities to recycle, the economic and environmental benefits of recycling over disposal, and how to recycle. Additionally, policies can be implemented that incentivize recycling behavior. Third, participation can be increased by providing more convenient opportunities to recycle.
- ***Inconvenient/limited access to recycling opportunities.*** Primarily, in the less populated areas of the state, recycling may not be available at all, and/or only drop-off recycling may be available. Drop-off recycling is known to have relatively low participation rates due to its reduced level of convenience. In more populated areas, multi-family residents often do not have access to recycling services or must use community drop-off centers that may not be convenient.
    - ***Opportunities to address inconvenient/limited access to recycling opportunities.*** Inconvenient/limited recycling access can be addressed through identifying cost-effective means of providing collection of materials, promotion of such programs, and exploring collaboration with neighboring communities. Policies such as mandatory recycling service provision can also result in increasing service availability. Additionally, it may be possible to address multiple material types (e.g., typical recyclables and "other materials") through similar efforts. Additional funding can also help support such services.
- ***Competition with low-cost alternatives to recycling.*** When disposal is relatively inexpensive, there is little or no incentive to recycle.
    - ***Opportunities to address low-cost alternatives to recycling.*** Putting disposal on a more level playing field with recycling can help encourage recycling. States and local governments have implemented policies paired with collection programs, such as pay-as-you-throw, and per-ton disposal surcharges on disposed waste to encourage recycling over disposal.
- ***Reluctance of end markets to pay for processed material.*** Some end markets indicate that they desire a higher recycled content however the cost of recycled materials can be higher than the cost of virgin materials. Manufacturers may have no incentive to purchase recycled feedstock.
    - ***Opportunities to address the reluctance of end markets to pay for processed materials.*** By encouraging brands to make commitments to use recycled content packaging when possible and encouraging businesses and other entities to purchase recycled content goods and products, demand for processed secondary materials can be strengthened.

Table 8-1 provides a summary of these key cross-material barriers and opportunities for typical recyclables plus additional barriers that are less significant in nature.

TABLE 8-1: KEY CROSS-MATERIAL BARRIERS AND OPPORTUNITIES FOR TYPICAL RECYCLABLES

Barrier	Material Type								Opportunity to Address
	Paper	PET	HDPE	Plastics #3-7 and Other Plastics	Film Plastics	Non-Ferrous Metal	Ferrous Metal	Glass	
Supply Related									
Contamination	Relevant for all materials								• Conduct outreach to generators. • Develop/enforce set out policies. • Provide financial assistance for needed MRF upgrades.
Lack of participation where programs are accessible	Relevant for all materials								• Boost recycling participation.
Inconvenient/ limited access to recycling opportunities and associated processing (e.g., MRF capacity) in rural areas	Relevant for all materials								• Provide funding support for more remote areas to support recycling. • Investigate cost-effective means of providing collection in remote areas. • Increase recycling access for multi-family dwellings. • Increase opportunities for convenient collection of film plastics.
Difficulty securing adequate quantity/quality on a consistent basis	✓	✓	✓			✓		✓	• Boost participation • Improve sorting capabilities • Identify ways for manufacturers to use alternative recovered feedstocks (e.g., fiber grades)
Lack of/gap in processing infrastructure				✓				✓	• Consider benefits of additional glass processing facility • Explore the potential to develop capacity to sort plastics #3-7. • Explore opportunities to develop reclamation capacity for PVC, PS, and electronics plastics.

Barrier	Material Type								Opportunity to Address
	Paper	PET	HDPE	Plastics #3-7 and Other Plastics	Film Plastics	Non-Ferrous Metal	Ferrous Metal	Glass	
Economic									
Competition with low-cost alternatives to recycling	Relevant for all materials								• Put recycling on more of a level playing field with disposal.
Lack of resources for additional processing equipment	MRF Issue – relevant for all materials								• Provide financial assistance for needed MRF upgrades.
Difficulty in securing, training, retaining work force	MRF issue – relevant for all materials								• Provide employment assistance. • Provide financial assistance for additional equipment to offset employment needs.
High cost of sorting/ processing		✓		✓	✓			✓	• Provide financial assistance to help fund equipment or other costs. • PET – applies to thermoforms which can potentially be sorted and sent to chemical recycling facilities.
Low price for outgoing material/ products	✓	✓	✓		✓			✓	• Stimulate increased purchase of products made from recycled content to help increase material pricing. • PET – applies to thermoforms. • HDPE – applies to colored HDPE.
Distance to market (high transportation costs)	✓			✓				✓	• Improve quality/ decrease contamination to help make transport more cost effective. • Explore more cost-effective material aggregation and transportation.

Barrier	Material Type								Opportunity to Address
	Paper	PET	HDPE	Plastics #3-7 and Other Plastics	Film Plastics	Non-Ferrous Metal	Ferrous Metal	Glass	
Demand Related									
Reluctance of end markets to pay for processed material	✓		✓		✓			✓	• Encourage manufacturers to set/increase and work toward meeting recycled-content goals to boost demand for recycled materials. • HDPE – applies to colored HDPE. • Stimulate increased purchase of products made with recycled content.

Table 8-2 provides a summary of material-specific barriers for typical recyclables.

TABLE 8-2: MATERIAL-SPECIFIC BARRIERS AND OPPORTUNITIES FOR TYPICAL RECYCLABLES

Material Type	Barrier	Opportunity to Address	Notes
Supply Related			
Low-value plastics	Lack of awareness of markets and incentives to collect and process plastics for advanced chemical recycling	• Pursue opportunities to collect and deliver low-value plastics to emerging in-state chemical recycling technologies. • Develop means to link generators to suitable in-state markets.	Texas has one major in-state chemical recycler and two others have announced their intention to develop plants in the state.
Film plastics	Challenging to amass adequate quantities in rural areas, small businesses	• Explore collection efficiencies regionally. • Boost recycling participation, especially among commercial generators of clean, clear film.	
Economic			
Plastics #3-7 and Other Plastics	Cost of sorting mixed residential plastics	• Provide financial assistance to expand sorting infrastructure.	Approaches include MRF residue sorting at secondary MRFs, plastics recycling facilities (PRFs), or investing in advanced sorting at regional MRFs.
Film plastics	Infrastructure need – wash lines	• Provide financial assistance to expand wash line capacity for PE film.	Boost participation Improve sorting capabilities Identify ways for manufacturers to use alternative recovered feedstocks (e.g., fiber grades)

Material Type	Barrier	Opportunity to Address	Notes
Glass	Low material yield	• Improve processing. • Improve quality/decrease level of contamination. • Expand beverage container or glass-only collection programs	Only 50 – 70 percent of glass collected and delivered to a MRF makes it through the system, resulting in increased processing costs. Many commercial generators reportedly do not participate in recycling programs.
Demand Related			
PET bottles and thermoforms	Design features that make them more costly to recycle or less in demand once recycled	• Encourage PET packaging to be designed for recycling.	PET is incompatible with recycling when color is added, whole bottle shrink sleeve labels are used, and when PETG is used.
Bulky rigid and electronics plastics	Lack of in-state recycling markets for these materials	• Develop in-state collection (for bulky rigids) and reclamation capacity.	
Plastics #3-7 and other plastics	Low end use market demand for recycled plastics #3-7 and other plastics.	• Stimulate increased purchase of products made from recycled plastics #3-7 and resins from other plastics.	
Non-ferrous Metals	Aluminum smelters don’t want aluminum foil for recycling.	• Provide incentives for in-state secondary smelters to recycle foil.	
Glass	Competition		Domestic glass container manufacturing faces competition from manufacturing in Mexico, as well as with other material types.

8.11 ECONOMIC IMPACTS OF EXPANDED RECYCLING SCENARIOS

As described in Section 7, most organics processors indicate that they could use additional supply of material to process, and have plans to expand production, however they are also often challenged in marketing their end products. As time goes on, it is expected that more food waste will be diverted from the disposed waste stream, and that biosolids will increasingly be managed in ways other than land application. Potential end markets, such as agricultural and TxDOT or other highway markets, need development. It appears that demand for mulch and wood products is in line with supply, though this may change with sudden increases in supply, such as due to storm events, and demand may exceed supply in arid areas.

Barriers to Organics Recycling

Despite their plans to grow, compost/mulch facilities in Texas still face challenges. Barriers to expanding organics recycling include:

- ***Contamination.*** One of the most significant barriers is contamination in the feedstock at processing facilities. This is particularly true of food waste delivered to compost facilities. Industry stakeholders suggest that it is easier to identify and address the source of contamination from larger-scale generators, and that those sources should be prioritized over residential food scraps. Plastic film was identified as a significant and troublesome contaminant.
- ***Costly to transport relative to its value.*** This occurs particularly in more rural areas. Another significant barrier to growing the organics market is that unprocessed and processed material is relatively costly to transport relative to its value.
- ***Competition with low-cost alternatives to recycling.*** In many cases compost facilities accept material at a lower tip fee than landfills; however, composting requires organics separation, an additional container, and separate hauling, which increases overall costs.

- ***Lack of awareness of the benefits of compost.***
- ***Difficulty securing adequate quantity of feedstock.*** Economies of scale are needed to make a compost business profitable, and it can be challenging to obtain adequate quantities of feedstock to grow a business to that level.
- ***Reluctance of end markets to pay for processed material.*** Many processors are challenged in marketing material at a fair price. Additionally, while some TxDOT districts use compost for highway projects, others do not and have no incentive to do so because if vegetation along the roadway does not grow, the onus is often on a contractor to re-seed the project.
- ***Lack of collection infrastructure, supply, and/or participation where access exists.*** There is a lack of participation in organics collection programs, particularly from large-scale generators of food waste. In some cases, source-separated food collection infrastructure for large-scale generators may not be available.
- ***Limiting regulations.*** Some regulations limit options for managing materials, such as permitting requirements for facilities receiving fats, oils and grease sourced from grease traps.
- ***A (reported) need for more registration-tier facilities that can receive biosolids.*** Some stakeholders suggest that WWTPs should be able to compost their own biosolids (Note – there are some on-site lagoons/monofils at WWTPs).
- ***Lack of de-packaging equipment.*** There are relatively few compost facilities in Texas that have de-packaging equipment, which limits the type of food waste they can accept.
- ***Competition.*** Compost facility operators indicate that they compete with imported products from states where processors may receive direct and/or indirect subsidies, as well as with large-scale box stores.
- ***Costly quality certifications.*** While having a certified product can be an advantage, the high cost of obtaining national quality certifications can be cost prohibitive for smaller operations.
- ***Challenges in obtaining, retaining, and training staff.*** Several compost facility operators indicate that they face challenges in obtaining, retaining, and affording appropriately skilled employees.
- ***Lack of resources for processing equipment.*** Several facility operators indicate that they have insufficient financial resources to purchase/upgrade equipment.
- ***Lack of awareness.*** Consumers are unaware of the benefits of buying Texas-sourced compost vs. out-of-state compost.
- ***Poor perception.*** Some consumers have a poor perception regarding the use of biosolids compost and/or of compost in general.
- ***Decreasing number of land application sites.*** While the quantity of biosolids being land applied has not decreased, the number of land application sites available for biosolids has decreased and is likely to continue to do so.

Potential Opportunities to Address Gaps/Barriers for Organics

The following opportunities are suggested to address the above gaps and barriers for organics recycling markets.

Supply Related:

- ***Consider easing regulations, as appropriate, where they can incentivize the processing of additional material without jeopardizing health, safety and product quality.***
- ***Boost recovery of organics.*** Encourage generators of organics – particularly large-scale generators of food, biosolids, wood, sawdust – to supply to compost facilities rather than landfill material.

Economic:

- ***Put processing of organics – particularly yard trimmings and food scraps – on more equal footing relative to disposal.***
- ***Provide financial assistance for de-packaging/processing equipment.***

Demand Related:

- ***Stimulate the purchase and use of compost, especially Texas-made compost.*** This can be done in part by promoting the water retention, soil erosion control, and nutrient benefits of compost and promoting the availability of Texas-made compost.
- ***In the long term, strengthen demand for beneficial uses of biosolids other than land application.***
- ***Provide awareness about the safety of biosolids compost, as appropriate.***

Table 8-3 provides a summary of barriers and opportunities for organics.

TABLE 8-3: BARRIERS AND OPPORTUNITIES FOR ORGANICS

Barrier	Material Type				Opportunity to Address	Notes
	Food Waste	Yard Trimmings	Biodolids	Other		
Supply Related						
Insufficient collection infrastructure for food waste collection/low participation where access exists	✓				• Boost participation, especially of food waste recovery. • Provide financial assistance for infrastructure development.	Large-scale generators in close proximity to compost facilities should be targeted
Economic						
Restrictive regulations	✓		✓	✓	• Consider easing regulations for storage of food waste, processing of FOG and biosolids.	
Challenges in obtaining/retaining and training employees	Compost/mulch facility issue – relevant for all materials				• Provide workforce assistance.	
Insufficient funds to purchase processing equipment	Compost/mulch facility issue – relevant for all materials				• Provide financial assistance for needed equipment.	
Demand Related						
Competition	Compost/mulch facility issue – relevant for all materials				• Provide marketing assistance. • Promote benefits of Texas made products.	• Competition exists with other producers in the area and from out of state.
Reluctance of end markets to pay for processed material.	Compost/mulch facility issue – relevant for all materials				• Stimulate demand for compost/much produced in Texas.	
Low demand/lack of awareness of benefits of products	Compost/mulch facility issue – relevant for all materials				• Increase awareness of benefits of products.	Promote ability of mulch and compost to ease watering & fertilizer needs, reduce erosion, and improve drainage.
Poor perception of compost with biosolids and land application of biosolids			✓		• Facilitate testing/ • of biosolids uses. • Increase awareness of biosolids applications.	

8.12 BARRIERS AND OPPORTUNITIES FOR CONSTRUCTION AND DEMOLITION DEBRIS

As described in Section 7, the demand for concrete, aggregate, asphalt pavement, brick and tile is strong in multiple areas in the State, due to a lack of aggregate in various parts of Texas. Clean wood from C&D debris also has adequate demand. Materials for which supply exceeds demand include treated wood, asphalt shingles, and drywall.

Barriers to C&D Debris Recycling

Mixed C&D

Barriers to increasing mixed C&D recycling include:

- ***Contamination.*** One of the most significant barriers to mixed C&D processing is contamination in the incoming material stream. This increases the cost of processing and can degrade other materials.
- ***Difficulty securing adequate, consistent supplies of feedstock.*** At times processors may be challenged with an oversupply of material.
- ***Competition with low-cost alternatives to recycling.***
- ***Costly to process, transport, and market materials.***
- ***Lack of material specifications or standard specifications.***
- ***Space constraints.*** There are space constraints for separating and storing mixed C&D (separate from waste) or separated materials on site. This is a barrier for generators and processors.
- ***High processing costs relative to value.*** It is typically more costly to recycle through a mixed C&D processor than to landfill C&D debris.
- ***Costly to transport relative to value.*** The distance to processor/market is too far to transport material cost-effectively.
- ***Lack of equipment.*** Some processors lack adequate processing equipment/funds to purchase equipment.
- ***Challenges in obtaining, retaining and training employees.***
- ***High disposal costs for residuals.*** Disposal costs for C&D processing residuals can be relatively high or otherwise challenging, especially if the level of contamination is high or includes odor-generating materials (e.g., gypsum) or hazardous wastes.
- ***Reluctance of end markets to pay for processed material.*** There are limited markets for end products and a lack of understanding regarding benefits of recycled content products and recovered materials.

Barriers for specific material types within the C&D stream are described below.

Concrete, Asphalt, Brick & Tile

While concrete, asphalt and other aggregate materials have value, there are barriers to increasing material recycling such as:

- ***Costly to transport relative to value.*** The most significant challenge with recycling concrete, asphalt, brick and tile is that the material is heavy and costly to transport. This means that material is typically stockpiled and used locally or may be disposed if storage for future use is not feasible.
- ***Lack of material specifications or standard specifications.*** Some materials do not have specifications or there is variability among specifications.
- ***Insufficient quantities to warrant investment in infrastructure and to transport cost effectively.***
- **Contamination, especially rebar**. Some stakeholders indicated that rebar in concrete is problematic.
- ***Space constraints and lack of resources for equipment.*** Managing concrete/asphalt and other aggregates requires significant space and costly equipment.
- ***Competition.*** In some cases, recovered material competes with locally mined materials. Depending on distance to market, recovered material may not be less costly.

Wood Waste

Clean wood has more market options than painted/treated wood. However, a significant quantity of clean wood is still disposed in Texas. Barriers for increasing recycling of wood include:

- ***Contamination.*** Contaminated, treated wood has limited markets.
- ***Presence of hardware.*** Hardware in wood is problematic to remove/process.
- ***Insufficient quantities to warrant investment in infrastructure and to transport cost effectively.***
- ***Competition with low-cost alternatives to recycling.*** Competition with inexpensive disposal tipping fees makes it challenging to encourage delivery of material to a recycling processing facility.
- ***Costly to transport relative to value.***
- ***Lack of equipment.*** Some processors indicate that they lack the proper equipment or resources to purchase/upgrade processing equipment.
- ***Low demand for processed material.*** Some stakeholders indicate there is inadequate demand for recovered wood.

Asphalt Shingles

Barriers to increasing recycling of asphalt shingles include:

- ***Changes in TxDOT specifications for roadway use.*** The main market for asphalt shingles historically has been asphalt pavement road products, including hot patch. The binder in the asphalt shingles is what provides value. In recent years, however, the quantity of asphalt shingles used in asphalt pavement projects has been reduced, due to changes in TxDOT specifications, and overall hesitancy to use the material.
- ***Contamination.*** High levels of contamination can impede processing or make it too costly to process and use asphalt shingles successfully.
- ***Oversupply.*** There is currently a glut of asphalt shingles available in Texas.
- **Concern regarding asbestos.** Some potential users are concerned about asbestos shingles being mixed in with asphalt shingles.
- ***Space constraints.*** Storing and processing asphalt shingles may require additional space/roll-off container(s) on a construction site. Processing shingles also requires considerable space.
- ***Not cost-competitive with product made from virgin sources.*** When oil prices are low, there is a reduced benefit to using recovered shingles as an ingredient in asphalt pavement.
- ***Competition with "bad actors."*** Some companies have entered the marketplace charging tip fees for material and then not properly managing material. It is hard for legitimate recycling companies to compete with these entities.
- ***Reluctance of end markets to pay for processed material.*** Asphalt shingles have a relatively low value; therefore, it is not cost effective to haul long distances.
- ***Poor perception.*** Some poor experiences with RAS projects and stockpiled shingles have left some potential users wary.
- ***Lack of awareness.*** Some potential users are not aware of the possibility of using RAS in asphalt.
- ***Lack of incentives.*** There are not strong incentives for TxDOT or others to use asphalt with recycled content, other than immediate cost reduction. If this results in a road with a shorter lifespan, those cost savings are negated.
- ***Risk avoidance.*** Generally, DOTs and local highway departments avoid risk and change.
- ***Limited markets.*** There is a lack of alternative uses for asphalt shingles.
- ***RAS percentage testing challenges.*** It is challenging to know/test for percent RAS used in asphalt products, making TxDOT and others apprehensive to use the material, which they would typically purchase from a third-party supplier.

Drywall/Plaster

Drywall is comprised primarily of gypsum. Historically, drywall is made of natural gypsum if manufactured west of the Mississippi River and synthetic gypsum (from flue gas desulfurization (FGD) at coal-fired power plants) if manufactured east of the Mississippi River. The reduction of coal-fired power generation is changing this dynamic, as less FGD gypsum is available. In theory, drywall could be made using recycled gypsum from recovered wallboard, consuming a significant quantity. Barriers to increasing gypsum recycling through the recovery of drywall/plaster include:

- ***Existence of additives in drywall.*** Additives may not be desired by other manufacturers.
- ***Contamination.*** Recovered gypsum must be free of contaminants, including the paper backing used in drywall, which is challenging to achieve.
- ***Competition with low-cost virgin materials.*** Gypsum is relatively low cost and it can be challenging to collect, process, and transport significant quantities of recovered gypsum cost-effectively.
- ***Reluctance of end markets to pay for processed materials.*** Gypsum can also be used as a soil amendment, helping to loosen clay soils and improve soil structure by making the soil more porous, allowing air, water, and nutrients to penetrate the soil more easily and improving plants' ability to absorb nutrients. However, many are unaware of these benefits. Gypsum can also be used to make compost and can be used in manufacturing cement.
- ***Space constraints.*** Additional space/containers would be required to separate drywall at construction sites.
- ***Lack of demand.*** There are very limited uses for recovered drywall.

Potential Opportunities to Address Gaps/Barriers for C&D Debris

Below are opportunities to address gaps and barriers for C&D materials.

Mixed C&D and Wood

- ***Increase awareness to generators about C&D recyclers and end users of materials generated.***
- ***Explore opportunities to cost-effectively deliver materials to an end user.***
- ***Encourage/incentivize recycling C&D materials over landfilling.***
- ***Put disposal and recycling on more equal footing.***
- ***Develop new beneficial uses for processing residuals/fines.***

Asphalt Shingles

- ***Increase awareness about the ability to use RAS and how to do so with success.***
- ***Increase awareness about the availability of opportunity to recycle and of end products.*** – e.g., directory of permitted RAS recyclers and end product directory.
- ***Develop/research and promote new uses.***
- ***Stimulate increased purchase of products made with recycled content.***

Drywall/Plaster

- ***Develop/research and promote new uses for recovered gypsum.***
- ***Monitor efforts to include recycled content in gypsum drywall and promote in Texas if deemed appropriate.***[3]

Table 8-4 provides a summary of barriers associated with construction and demolition materials.

[3]California is contemplating a landfill ban and 10 percent recycled content mandate. Some manufacturers are known to be using recycled content (e.g., CertainTeed's Seattle and Vancouver plants and PABCO Gypsum is working to increase recycled content of gypsum in gypsum board products).

TABLE 8-4: BARRIERS AND OPPORTUNITIES FOR CONSTRUCTION & DEMOLITION MATERIALS

Barrier	Material Type					Opportunity to Address	Notes
	Mixed C&D	Concrete & Asphalt	Wood	Gypsum	Asphalt Shingles		
Supply Related							
Inability to obtain adequate quantities to market/deliver to processor	✓	✓	✓		✓	• Explore opportunities to aggregate collected material from multiple generators. • Encourage/ • incentivize recycling over disposal.	This barrier applies to processors and collectors.
Contamination	✓	✓	✓	✓	✓	• Improve quality/ decrease level of contamination in materials.	Contamination includes hardware in wood and treated/painted wood, as well as rebar in concrete.
Space constraints – not enough space to separate/ store on job site or elsewhere while awaiting reuse	✓	✓	✓	✓	✓	• Collaborate to identify space sharing solutions.	
Lack of specifications or standard specifications	✓	✓				• Develop clarity among specifications. • Develop additional specifications where needed	
Rebar in concrete		✓				• Provide financial assistance for equipment to remove rebar.	This barrier is problematic for some recyclers, not others.

Barrier	Material Type					Opportunity to Address	Notes
	Mixed C&D	Concrete & Asphalt	Wood	Gypsum	Asphalt Shingles		
Economic							
Costly to transport relative to value.	✓	✓	✓	✓	✓	• Explore opportunities to aggregate collected material from multiple generators. • Put recycling on more equal footing with disposal.	This barrier pertains especially to remote/rural areas of Texas and to projects/ processing operations that generate small quantities of material.
Lack of equipment	✓	✓	✓			• Provide financial assistance for processing equipment.	
Challenges obtaining, retaining, training employees	✓					• Provide workforce assistance.	
Space constraints to store material while awaiting use	✓	✓				• Explore opportunities to use public space to process/store materials.	
Competition with low-cost alternatives to recycling	✓	✓	✓	✓	✓	• Put recycling on more equal footing with disposal. • Incentivize/ encourage recycling.	
Costly to transport relative to value	✓	✓	✓	✓	✓	• Put recycling on more equal footing with disposal. • Incentivize/ encourage recycling. • Increase local knowledge about/ demand for materials.	
Competition with processors that may not manage materials properly					✓	• Increase transparency among recycling businesses. • Develop standards.	
Competition with low-cost virgin materials				✓	✓	• Strengthen demand for use of recovered materials.	This barrier is especially challenging for shingles when petroleum prices are low.

Barrier	Material Type					Opportunity to Address	Notes
	Mixed C&D	Concrete & Asphalt	Wood	Gypsum	Asphalt Shingles		
Demand Related							
Reluctance of end markets to pay for processed material	✓		✓	✓	✓	• Increase demand. • Expand potential uses for material. • Educate consumers/ users about benefits & availability of material. • Increase awareness of benefits and availability of material.	Shingles lack alternative uses. Some gypsum benefits are not needed in Texas soils; other benefits are not well known.
Poor perception/risk aversion					✓	• Increase awareness regarding appropriate/ successful uses. • Encourage expanded uses.	DOTs hesitant to use. TxDOT does use some in road construction/ repair.

8.13 BARRIERS AND OPPORTUNITIES FOR PAINT

As described in Section 7, the potential supply of paint is greater than demand, as there are only two paint processors (aside from municipal programs) identified that are recycling paint in Texas. Most paint is still being disposed.

Barriers to Paint Recycling

Barriers that impede the recycling of paint and paint-related waste and the growth of the paint recycling business include:

- ***Insufficient quantities to warrant investment in infrastructure and to transport cost effectively.***
- ***Inconvenient/limited access to recycling and processing opportunities.*** There are only a few paint recyclers in Texas, and collection opportunities are relatively limited for residents.
- ***Lack of awareness about paint recycling opportunities.***
- ***Competition with low-cost alternatives to recycling.*** The alternative for latex paint is drying and disposal, which is relatively inexpensive, and how many municipalities inform residents to manage latex paint.
- ***Costly to transport relative to value.*** It is generally not cost effective to ship recovered paint to a distant recycler.
- ***Reluctance of end market to pay for processed material/low demand for end product.*** This is due to the low cost of new paint, limited availability of colors, and lack of knowledge about availability of material. Often reprocessed paint is donated.

Potential Opportunities to Address Gaps/Barriers for Paint

The following potential opportunities were identified as means to address the market gaps/barriers for recycled paint.

- ***Stimulate demand for used paint.***
- ***Put recycling of paint on more equal footing with disposal.***
- ***Encourage/provide incentives for generators to recycle paint.***

8.14 OPPORTUNITIES AND BARRIERS FOR ELECTRONIC MATERIALS

As described in Section 7, there are many electronics recyclers in Texas and, overall, the demand for recovered electronics exceeds the supply available within the State.

Barriers to Electronic Materials Recycling

Many electronics recyclers in Texas import material from other states, particularly from larger corporate customers with multi-state contracts, so they are not completely reliant upon Texas generators. Identified barriers to electronics recycling in Texas include:

- ***Lack of funding mechanisms to run programs.*** Some of the most significant barriers on the supply side are related to the fact that Texas' electronics regulations lack funding mechanisms and convenience standards, which is common in other electronics recycling laws.
- ***Inconvenient/limited access to recycling opportunities.*** Opportunities for residents to recycle electronics is limited in certain parts of the state – in part due to limitations in product stewardship laws.
- ***Lack of awareness.*** Many residents appear to be unaware of the opportunity to recycle electronics and the benefits of doing so, as well as the range of materials that can be recycled through electronics recycling programs.
- ***Cost of service.*** There is a lack of understanding that there is a cost associated with recycling electronics. Recyclers indicate that roughly half of their revenues are derived from service fees and half from commodity sales. There is no funding mechanism in the State's product stewardship electronics and television laws. This may result in municipalities not providing the service or providing it on a very limited basis.
- ***Competition with low-cost alternatives to recycling.*** It is relatively inexpensive to dispose of electronics in landfills, and it is not illegal to do so in Texas (whereas 19 states and the District of Columbia have landfill bans on electronics).[4]
- ***Challenges obtaining, retaining and training employees.***
- ***Market fluctuations in commodity prices.*** Such fluctuations require recyclers to charge a fee for accepting materials.
- ***Increasing processing costs per pound.*** As devices become smaller, processing costs per pound increase for recyclers.
- ***Costly to transport relative to value.*** Long-distances to some recyclers results in relatively costly transportation, particularly for less-than-full loads.
- ***Competition with "bad actors."*** Some companies have entered the marketplace charging a fee to accept material then not properly managing it. It is challenging for legitimate recyclers to compete with these entities.
- ***Costly certifications.*** National certifications can be a valid way for a business to tout its achievements, however some smaller businesses are able to achieve the same standards but cannot afford the high costs associated with achieving national certifications.
- ***Lack of demand.*** There is a lack of outlets for some materials derived from electronics processing, such as glass and plastics, many of which are treated with fire retardants, and therefore not desired.

Potential Opportunities to Address Gaps/Barriers for Electronic Materials

In the long term, electronics processors in Texas have an opportunity to expand their recycling businesses by recycling solar panels. Some electronics recyclers are reportedly looking into this opportunity. Solar energy has grown in Texas in recent years, and as the solar panels reach the end of their useful life (on average, 25 to 30 years) they will need sustainable end-of-life solutions. Other opportunities to strengthen the electronics recycling industry in Texas are described below.

[4] U.S. Landfill Ban, ERI website.

Supply Related:

- ***Boost recycling participation.***
- ***Increase awareness about the importance of and opportunities to recycle electronics.***

Economic:

- ***Put recycling and disposal on a more level playing field.***
- ***Provide employment services.***
- ***Develop state certifications.***
- ***Consider revisions to the state electronics/television recycling laws that would include a funding mechanism and convenience standards.***
- ***Provide financial assistance to and/or encourage collaboration among more remote communities to provide electronics collection services.***
- ***Provide workforce assistance.***

Demand Related:

- **Increase awareness among Texas manufacturers about opportunities to manufacture using recovered commodities from Texas electronics processors.**

8.15 BARRIERS AND OPPORTUNITIES FOR BATTERIES

As described in Section 7, both capacity and demand exist in the state for accepting and sorting Texas-generated portable batteries, but these batteries must be shipped out of state for further processing and sale to end markets. The existing collection infrastructure for portable batteries is capable of handling additional portable batteries; however, in some rural locations, collection infrastructure is lacking. EV and ESS battery supply is insufficient to support development of the recycling infrastructure in Texas for these batteries currently, but this will change as more EV and ESS batteries reach end of life and need management.

Barriers to Battery Recycling

Key barriers to increasing battery recycling in Texas include:

- ***Inconvenient/limited access to recycling opportunities.*** Texas has the lowest access rate for consumer portable batteries recycling in all the U.S. Due to the expansive Texas geography and low population in some areas of the state, there are many Texas communities with no collection infrastructure. Call2Recycle partners such as Lowes and Home Depot do not have stores in all communities. Consumers in these communities must rely upon municipal and county drop-offs such as BOPA/HHW facilities and events that accept batteries for recycling. Such facilities also do not exist in all Texas communities, often due to cost reasons.
- ***Lack of participation where programs are accessible.*** Consumers may not be aware of recycling options or the important reasons for recycling rechargeable batteries and some may simply not want to bother with doing so.
- ***Existence of products with embedded batteries.*** Some consumer batteries are hidden inside products, such as children's shoes and greeting cards, making recovery and recycling very difficult. In addition, mismanaged batteries can create a fire hazard.
- ***Distance to market.*** With only one sorting operation serving all of Texas as well as other states, transporting batteries to this facility can be costly for many communities. All processing facilities are located in other states. Shipment of sorted batteries out-of-state for processing and end use increases system costs. Furthermore, the associated economic benefits of these operations are gained in other states.
- ***Reluctance of end markets to pay for processed material.*** Lithium is relatively inexpensive to mine and has low value given the availability of low-cost virgin sources. However, cobalt, nickel, and manganese components can still drive value streams in recycling, as they are more valuable metals.
- ***Variable and ever-changing battery chemistry.*** Having different chemistries, including lithium manganese oxide and lithium nickel cobalt aluminum oxide, makes it hard to have a standard process to cost-effectively recycle these batteries. Furthermore, battery manufacturing technology continues to evolve, making some investors wary.

- ***Market immaturity.*** Very few ESS batteries are being decommissioned, while larger quantities of spent EV batteries increase slowly. Hence currently, commercial recycling does not yet exist at a scale sufficient to process today's used EV batteries or the forthcoming decommissioned ESS batteries. In addition, recovery and processing technologies are still under development and working to increase efficiencies and reduce costs to enable scalability and economic viability.

Potential Opportunities to Address Gaps/Barriers for Batteries

The primary barriers to be addressed in enhancing markets for and the marketability of Texas-generated batteries are related to supply availability and/or are economic. Key opportunities for addressing these barriers are listed below. Some of the barriers and associated opportunities are cross-material in nature, meaning that they apply to several commodity types and not just for batteries.

Supply Related:

- ***Improve access to consumer battery recyclin*****g in the less populated areas of Texas where drop-off locations do not currently exist.**
- ***Boost recycling participation.***
- ***Encourage design for recyclability.***

Economic:

- ***Provide financial assistance for the expansion of consumer battery recovery infrastructure to generate sufficient supply to support locating a regional processing facility in Texas.***
- ***Provide incentives to attract a regional batteries processor to locate in Texas as supply is further developed.***
- ***Invest in research and development to create an efficient, economically viable recovery and recycling system for EV and ESS batteries when they reach the end of their useful life.***

Demand Related:

- ***Explore opportunities for increasing refurbishment and use of EV batteries as ESS units in Texas alternative energy applications.***

8.16 BARRIERS AND OPPORTUNITIES FOR TEXTILES

As described in Section 7, the supply of textiles currently exceeds demand for textiles in Texas with the potential exception of cotton textiles suitable for use in industrial wiping cloth manufacturing. Current conditions have been substantively affected by disruptions in the processing sector especially overseas, due to coronavirus pandemic. Market conditions are expected to improve as the pandemic is brought more under control and new conversion technologies and infrastructure advance that will enable more fiber-to-fiber manufacturing as well as conversion of selected fibers into feedstocks for making plastics.

Barriers to Textile Recycling

Barriers to increasing textile recycling include:

- ***Limited in-state processors/end markets.*** Barriers to textile recycling primarily pertain to insufficient recovery of used textiles for reuse including repair as opposed to disposal (more recovery as well as more demand is needed).
- ***Little importance given to recycled content.*** This was reported as a significant barrier to increasing demand.
- ***Relatively high processing costs.*** Textile grading and sorting has historically been very labor intensive, resulting in high labor and processing costs. With respect to bulky textiles, such as mattresses and used carpet, high recovery and processing costs relative to value are the primary barrier for their recycling.
- ***Increased use of a variety of synthetic fibers and fiber blends.*** It is more challenging to recycle textiles at end of life.
- ***Costly to transport relative to market and competition with low-cost alternatives to recycling.***
- ***Lack of awareness about existing recycling opportunities and benefits of recycling.***

Potential Opportunities to Address Gaps/Barriers for Textiles

Opportunities identified for addressing the gaps and barriers to recovering textiles are listed below with more discussion provided in subsequent Sections.

Supply Related:
- ***Boost participation in programs that recover used textiles, particularly by commercial and institutional generators.***
- ***Build upon Texas' existing textile recycling industry to bring overseas sorting and grading jobs back to Texas.***
- ***Position Texas to be a major supplier of used textiles to feed the emerging chemical recycling opportunities such as those related to conversion of carpet and other polyester fiber back into chemical building blocks for use in manufacturing new products.***

Economic:
- ***Determine and support more cost-effective methods of collecting used textiles curbside and sorting/grading such as through automation.***
- ***Provide financial assistance or identify funding source(s) to support increased diversion of carpet and mattresses from disposal.***

Demand Related:
- ***Stimulate increased purchase of used clothing and household textiles, thereby supporting local thrift and consignment operations.***
- ***Position Texas to attract textiles-derived product manufacturers, particularly those emerging as the textile industry works to create a circular economy related to textiles production and use of used textiles at end of life.***

8.17 BARRIERS AND OPPORTUNITIES FOR TIRES

As described in Section 7, demand for scrap tires among some processors and end users of scrap tires exceeds supply. However, many of Texas' scrap tires go to relatively low value uses, such as land reclamation, and some of which would not be considered recycling (e.g., fuel). A relatively high percentage (21 percent) of scrap tires are still being landfilled. There is a definite opportunity to divert more tires to existing crumb rubber manufacturers in Texas who supply higher value end markets, as well as opportunity to develop more higher value end markets in Texas for Texas-generated tires.

In addition, there is a need to find outlets for the millions of stockpiled tires in the state which are too dirty for higher value end uses. These may be good candidates for land reclamation.

Barriers to Tire Recycling

Key barriers impeding increased and higher value end use of scrap tires include:

- ***Limited availability of suitable markets/outlets (stockpiled tires).*** Stockpiled tires are plentiful, but their quality deteriorates over time, and they are typically very dirty, thereby limiting their potential uses and value.
- **Space constraints.** Small-quantity generators, such as auto repair shops, have limited storage capacity and must rely upon transporters, which may also have limited storage capacity or the appropriate permitting to aggregate truckload quantities for shipment to non-local processors/end markets.
- ***Lack of adequate participation where programs are accessible.*** All generators and transporters are not aware of all available recycling opportunities.
- ***Tire variability.*** There are many different types of tires, composed of a variety of chemicals and material types. The composition of tires continues to evolve as manufacturers strive for improved durability and performance. This makes recycling challenging particularly for higher-value end uses.
- ***Costly to transport relative to value and competition with low-cost alternatives to recycling.*** Tires are generated throughout the state, with some areas being distant from recycling markets. Transportation of tires to distant facilities is expensive especially when compared to the cost of landfilling, which in Texas is relatively cheap.

- ***Competition.*** Out-of-state supply of material may compete with some Texas-based tire-derived feedstocks.
- ***Profitability of other uses.*** Supplying used tires for fuel use can be more profitable than supplying tires for the manufacture of higher-value end products.
- ***Reluctance of consumers to pay for higher-cost tire-derived products.*** Some tire-derived products may have a higher initial cost than their conventional competitors which restricts sales, even if life-cycle costs in some cases may be lower due to reduced maintenance and greater longevity.
- ***Poor perception.*** Some crumb rubber applications (e.g., synthetic turf and playground surfacing) have perceived health and/or safety concerns, thereby limiting such uses.
- ***Hesitancy to change.*** Potential buyers of tire-derived products may be reluctant to switch from using conventional products.
- ***Lack of awareness.*** Some potential buyers of tire-derived products are simply not aware of the array of products available that are made in Texas from Texas-generated tires.

Potential Opportunities to Address Gaps/Barriers for Tires

Several opportunities to address the above barriers were brought forth during interviews and the stakeholder forum. These are listed below with more discussion forthcoming in subsequent Sections.

Supply Related:

- ***Increase generator and transporter awareness of processing and end market opportunities.***
- ***Address infrastructure gaps in specific Texas locations with respect to moving scrap tires to market.***

Economic:

- ***Providing financial assistance or identify funding source(s) to provide for a stronger state scrap tire recycling market development focus as well as incentives for moving tires into markets from stockpiles and locations that are struggling to do so economically.***
- ***Address economic barriers limiting movement of tires to high-value end use of Texas scrap tires.***
- ***Implement cost-effective transportation solutions.***

Demand Related:

- ***Increase awareness about and stimulate increased purchase of tire-derived products manufactured in Texas.***
- ***Address concerns regarding tire-derived product performance as well as health and safety concerns.***

Table 8-5 provides a summary of barriers and opportunities for the Other Materials which include paint, electronics, batteries, textiles, and tires.

TABLE 8-5: BARRIERS AND OPPORTUNITIES FOR OTHER MATERIALS

Barrier	Material Type					Opportunity to Address	Notes
	Paint	Electronics	Batteries	Textiles	Tires		
Supply Related							
Insufficient quantities to warrant investment in infrastructure and to transport cost effectively	✓	✓	✓		✓	• Explore opportunities to aggregate collected material from multiple generators. • Boost participation. • Provide financial assistance if warranted.	This barrier pertains to both generators and processors.
Inconvenient/limited access to recycling opportunities	✓	✓	✓	✓		• Explore multi-material and multi-jurisdiction collection options. • Consider more cost-effective curbside options for textiles.	Opportunities exist for Texas to be a regional player for battery and textile recycling.
Lack of awareness about existing recycling opportunities and benefits of recycling/ lack of participation in existing programs	✓	✓	✓	✓	✓	• Increase awareness about opportunities for and benefits of recycling.	
Embedded in products			✓			• Encourage design for recyclability.	
Material is stockpiled, quality is degraded					✓	• Initially provide funding to clean up stockpiles.	Stockpiled tires are not suitable for higher value uses.
Variability in composition hinders processing/ end markets			✓	✓	✓	• Encourage design for recyclability.	Composition changes with innovation and among different product types, creating challenges for processing and end use.
Competition with imported material feedstock					✓	• Encourage use of Texas-produced material/ products.	

Barrier	Material Type					Opportunity to Address	Notes
	Paint	Electronics	Batteries	Textiles	Tires		
Economic							
Lack of funding mechanism to run program	✓	✓	✓		✓	• Provide financial assistance or identify a funding mechanism(s).	
Competition with alternative (virgin/ new) material/ products	✓		✓ (Li-ion)			• Encourage/ incentivize use of recycled feedstock.	Other battery feedstocks, such as cobalt, nickel, and manganese hold their value.
Competition with low-cost alternatives to recycling	✓	✓	✓	✓	✓	• Encourage/ incentivize recycling. • Put recycling and disposal costs on more equal footing.	Latex paint can be landfilled if dried.
Costly to transport long distances to market	✓	✓	✓	✓	✓	• Coordinate transportation of multiple materials/ among multiple generators. • Encourage development of local processing/end use.	In the case of batteries markets are out of state.
Fluctuation in commodity prices		✓				• Provide financial assistance.	
Challenges obtaining, retaining and training employees		✓				• Provide workforce assistance.	
Relatively high processing costs		✓		✓	✓	• Provide financial assistance for processing. • Put disposal on more equal footing with recycling. • Incentivize recycling.	Electronics: as they become smaller, they become more costly per pound to recycle Textiles: applies to mattresses and carpet.
Competition with “bad actors” – it is challenging to compete with companies that do not manage materials responsibly.		✓				• Encourage certification/ transparency about material disposition. • Inform municipalities/ generators of distinctions.	Assuring quality by obtaining national certifications can be costly and may not be realistic for small- and medium-sized recyclers.

Barrier	Material Type: Paint	Electronics	Batteries	Textiles	Tires	Opportunity to Address	Notes
Economic							
Variable and ever-changing chemistries and manufacturing technologies			✓		✓	• Encourage design for recyclability.	
Little or no importance given to recycled content				✓		• Stimulate increased purchase of products made with recycled content.	
Competition with less expensive alternative products with shorter lifespan					✓	• Promote longevity as part of purchasing decision for state contracts.	Some tire-derived products are more expensive than alternatives such as wood chips but may last longer and therefore be more economical.
Demand Related							
Low demand for end product/ commodities	✓	✓				• Increase awareness of the existence of available materials.	Paint: There is a perception of lower quality, limited colors, and a lack of awareness about availability. Electronics: Barrier pertains to low-value plastics and glass.
Few or no in-state processors/end markets			✓	✓		• Explore additional in-state markets including chemical recycling. • Explore attracting CE textiles manufacturers.	
Perception that the use of material (e.g., crumb rubber in athletic fields) can pose a risk.					✓	• Promote studies showing safety as appropriate.	
Lack of willingness to shift from traditional materials/products.					✓	• Stimulate purchase of recycled content products.	
Lack of awareness of end products made in Texas.					✓	• Increase awareness of and encourage use/ purchase of recycled content products made in Texas.	

8.18 INFRASTRUCTURE GAPS AND NEEDS

This section identifies and describes the types of facility capacity and related infrastructure needed to sustain existing and potentially increase recyclable material volumes. First, for each material category findings regarding the level of infrastructure needs at each recycling stage and the overall sufficiency of existing infrastructure are presented. Next, as required in SB 649, principal processing and manufacturing facility needs are identified. Finally, key collection and transportation-related infrastructure needs are presented. These findings are considered as part of a holistic analysis to prioritize recyclable materials to target for market development.

Infrastructure Assessment Overview

The Project Team assessed the need for new facility capacity and other related infrastructure based on the information and analysis presented in Sections 3 through 7 and prior knowledge and experience. Needs were categorized in one of four levels (i.e., none, low, moderate, or high) for each recyclable material at each recycling stage. Infrastructure sufficiency levels (i.e., strong, moderate, and weak) were also assigned to each recyclable material based on whether infrastructure at all stages is strong enough to sustain and increase recyclable volumes. Table 8-6 defines these alternative findings, followed by additional details.

TABLE 8-6: DEFINITION OF INFRASTRUCTURE ASSESSMENT FINDINGS ASSIGNED TO EACH MATERIAL CATEGORY

Infrastructure Needs by Recycling Stage		Overall Sufficiency of Existing Infrastructure	
Key	Definition	Key	Definition
●	**High:** Addressing infrastructure needs is essential to sustain existing and expand future statewide recycling levels.	□	**Weak:** Existing infrastructure is not sufficient to sustain existing and expanded statewide recycling levels.
◐	**Moderate:** Addressing infrastructure needs may be necessary in the future to sustain or expand recycling levels statewide, in key geographic regions or for certain sub-grades.	▤	**Moderate:** Existing infrastructure may be sufficient to increase statewide recycling levels, but certain needs should be addressed, such as gaps in certain geographic regions, material sub-grades, or equipment suitability.
○	**Low:** Addressing infrastructure needs would be beneficial but is not essential to sustain or expand recycling levels.	■	**Strong:** Existing infrastructure is sufficient to sustain and expand statewide recycling levels.
	None: No significant infrastructure needs were identified.		

Based on the potential tons available to divert described in Section 4, the following describes the needed infrastructure to increase material recovery/recycling. "Sufficient to sustain existing recycling levels" means infrastructure-related needs that appear likely to threaten continued viability were not identified. "Sufficient to expanding recycling levels" means that existing infrastructure could support an increase roughly equivalent to 20 percent of currently disposed tonnage for the material category on a statewide level. Due to gaps in existing capacity and utilization rate data, in most cases these determinations rely on qualitative considerations.

In assessing infrastructure needs for each material category at each recycling stage, the following criteria were used:

- **High:** Needs exist that prohibit sustaining or expanding statewide recycling levels.
- **Moderate:** Needs exist that could complicate or potentially prohibit expanding statewide recycling levels; or there are needs that may not preclude statewide expansion, but may limit sustaining or expanding recycling levels in certain key geographic regions, sub-grades of the material category or related to the adequacy and performance of existing equipment and other infrastructure.
- **Low:** Needs were identified but do not preclude sustaining and expanding recycling statewide levels. This is the case, for example, when Texas-generated recyclables are processed or used in manufacturing products at out-of-state facilities that are sufficient to support existing and expanded recyclable volumes.

To assess overall infrastructure sufficiency for each material category, all recycling stages were considered and generally assigned:

- **Weak:** Needs at any recycling stage were determined to be high, meaning infrastructure is insufficient to sustain or expand statewide recycling levels for the material category.
- **Moderate:** Identified infrastructure needs could limit statewide expansion, or there are key needs that should be addressed even if existing infrastructure could support some expansion. Examples include gaps in key geographic regions, material sub-grades, or the performance of existing equipment.
- **Strong:** No infrastructure needs limiting statewide expansion were identified.

As required by SB 649, the focus is on identifying needed types of principal processing and end-use manufacturing facilities to handle existing and potential increases in recyclable volumes. However, key infrastructure needs related to recycling collection and transportation are also identified because they can pose significant expansion constraints. This is especially true in rural, remote areas Texas. These issues are described in more detail along with other cross-material barriers in Section 8.10.

Infrastructure needs can be addressed in a variety of ways. For example, facility capacity can be increased either by expanding existing facilities, siting new facilities and/or by using “hub-and-spoke” strategies to consolidate tonnage from rural areas to more cost effectively consolidate and transport materials. In most cases the types of needed facilities are described, but the number of facilities required are not specified. In many cases, the economics of expanding processing capacity may be poor, especially where low-value or low-volume material streams or geographically dispersed generators are targeted. Texas state and local governments can use a variety of tools to address poor economics and other barriers to meeting infrastructure needs, such as support for ongoing funding, access to capital, permitting, siting or research and development, among others. In some cases, addressing non-infrastructure barriers may be a prerequisite to addressing infrastructure needs. For example, boosting the supply of certain recycled materials or demand for certain recycled-content products may be necessary prior to siting new or expanding existing processing or manufacturing facilities, if existing supply and demand are not sufficient to support the facility.

Infrastructure development approaches or strategies are not provided here; however, Section 9 presents the Project Team’s recommended recycling market development strategies, including those related to infrastructure.

Table 8-7 summarizes the infrastructure assessment determinations based on the above approach. After the table, principal infrastructure needs are described in more detail.

TABLE 8-7: TEXAS RECYCLING INFRASTRUCTURE ASSESSMENT FINDINGS BY MATERIAL TYPE

Infrastructure Needs Key: High / Moderate / Low

Existing Infrastructure Key: Weak / Moderate / Strong

Material	Level of Infrastructure Need			Overall Sufficiency of Existing Infrastructure
	Collection[1]	Processing[1]	End-Use	
Typical Recyclables				
OCC	Moderate	Low	Low	Strong
Mixed Paper	Moderate	Low	Low	Strong
HDPE	Moderate	Low	Low	Strong
PET[2]	Moderate	Moderate	Moderate	Moderate
Plastics #3-7	Moderate	High	High	Weak
Film Plastics	Moderate	Moderate	Moderate	Moderate
Ferrous Metals	Moderate	Low	Low	Strong
Non-Ferrous Metals	Moderate	Moderate	Low	Moderate
Glass	Moderate	Moderate	Low	Moderate
Organics				
Yard Trimmings	Moderate	Moderate	Low	Moderate
Wood	Moderate	Moderate	Moderate	Moderate
Food Waste	High	Moderate	Moderate	Moderate
Biosolids	Low	Moderate	Moderate	Moderate
Construction & Demolition				
Mixed C&D	Low	High	High	Moderate
Concrete, Asphalt, Brick, and Tile	Low	Moderate	Low	Moderate
Asphalt Shingles	Low	Moderate	High	Moderate
Wood (Lumber)	Moderate	Moderate	Moderate	Moderate
Gypsum	High	High	High	Weak
Other Materials				
Paint	Moderate	Moderate	Low	Moderate
Electronics	Moderate	Low	Low	Moderate
Batteries	Moderate	Moderate	High	Moderate
Textiles	Moderate	Moderate	Moderate	Moderate
Tires	Low	Low	Moderate	Moderate

1. *Collection and processing infrastructure needs for typical recyclables pertain primarily to more rural areas where curbside collection is not available and for multi-family dwellings throughout Texas.*
2. *Processing and end use infrastructure issues pertain to PET thermoforms.*

Processing and End-Use Manufacturing Facility Needs

Described below are principal processing and end-use manufacturing facility needs identified via the infrastructure assessment summarized in Table 8-7 above. Under each need the types of needed facility capacity and/or related infrastructure enhancements, the relevant material streams, pertinent geographic considerations, and a rationale for the Project Team's assessment are provided.

This grouping consolidates needs assessed as "moderate" and "high" in Table 8-7 to concisely describe the types of facilities and infrastructure enhancements needed to sustain or expand Texas recycling levels. These needs are considered to be critical to the recovery (and/or increased recovery) of these materials. Needs assessed to be "low" above are not included since, while beneficial, they are, by definition, not essential to sustaining or expanding Texas recycling levels. This assessment does not include the prioritization for recycling market development purposes, which is described later in this Section.

1. Expand and/or Better Utilize MRF Capacity for Residential and Commercial Typical Recyclables

The Project Team identified 31 MRFs handling Texas-generated material. Existing MRF capacity is enough to handle current tonnages of typical recyclables, although there are some remote areas of Texas that are likely underserved by MRFs and may continue to be underserved. One example includes east Texas, where the MRF processing recyclables from Texarkana, New Boston, and other relatively small communities ceased operating, and currently only paper and cardboard from the communities is collected and delivered directly to an end user. Additional MRF capacity and/or strategies to utilize existing capacity more fully may be needed to expand residential and commercial recycling in Texas. Several MRFs are already anticipating and planning for such expansion.

Twenty-four MRFs responding to capacity questions reported combined annual capacity of over 1.95 million tons with over 500,000 tons unutilized, a 74 percent average utilization rate. However, 11 of these MRFs also said they have plans to expand capacity in coming years. Expanding statewide recycling volumes by recovering 20 percent of currently disposed typical recyclables could yield an additional 1.4 million tons of material, which if met entirely through new facilities could require up to about 21 new MRF facilities (based on an average capacity of approximately 81,350 tons per year and an average contamination rate of 15 percent). In practice, however, existing available capacity could reduce this need to 15. Additionally, the expanded capacity of existing MRFs could allow for significant statewide growth. In rural, remote areas, employing hub-and-spoke strategies that funnel recyclables from many small communities to a regional MRF could also limit the need for new facilities while providing more advantageous economies of scale to reduce per ton costs and help justify investments.

2. Enhance MRF Processing Capabilities and Performance

To help MRFs sustain current recycling and potentially expanded recycling volumes, enhanced capabilities that in some cases, may require new investments in equipment. Ideally such enhancements, whether satisfied through infrastructure investments or other operational adjustments, will improve MRF economic resiliency while also strengthening and expanding Texas recycling by:

- Providing increased flexibility to shift the specific grades of readily recyclable materials they produce as markets and pricing change, such as:
    - Producing cleaner, higher-value bales of OCC, mixed paper, clear PET, and natural HDPE
    - Sorting mixed paper into other grades such as sorted residential papers and cartons
- Enabling MRFs to begin or expand recycling of certain low-value and/or low-volume materials that may be in demand, but are particularly challenging to economically sort and may currently be recovered only at very low levels or with high contamination rates, such as:
    - PET thermoforms and pigmented PET bottles
    - Plastics #3-7 (especially polypropylene containers, tubs and lids)
    - Bulky rigid plastic items (especially HDPE and polypropylene items with non-recyclable components removed)
    - Color-sorted glass containers with less contamination
    - Residentially generated ferrous and nonferrous metal items beyond cans
- Enabling MRFs to target or remove as contamination new types of inbound materials as packaging and product composition evolve over time, such as flexible pouches.

These enhancements can be met in different ways. For example, adding sorters, strengthening education to reduce inbound contamination, or changing the design of local collection programs can help improve material quality and expand recycling of certain materials. Some of these processing enhancements could be satisfied at other types of facilities; for example, mixed plastics, paper, glass and residuals could be further processed at a centralized secondary MRF, where unsorted fractions from MRFs are sorted into different streams; or certain mixed streams could be sent to a dedicated plastics recycling facility or a PET reclaimer that would resell the types of PET that are not acceptable in its processes. This would allow MRFs to avoid these sorting challenges altogether by shipping some mixed materials. In many cases, investments in new equipment at MRFs may be required, such as optical sorters, robotics, screens, debaggers and/or new sort lines. Because the cost of some of these potential infrastructure enhancements is high, their feasibility depends heavily on state or local market development strategies such as funding, education, or research & development, as covered in Section 9.

3. Expand Plastics Processing Capacity

To increase recycling of plastics other than PET and HDPE, expanded processing capacity is needed. Several processing infrastructure capacity enhancements could be employed, including enhanced processing capabilities at existing MRFs, or the development of capacity at new sorting and reclamation facilities. Additionally, there are opportunities to strengthen plastics marketability by expanding plastic film washing capacity in Texas, and potentially through the growth of chemical recycling in Texas.

4. Expand End-Use Manufacturing Capacity for Certain Grades of Plastic

National or in-state end-user demand for most plastic grades is sufficient to sustain existing and expand Texas recycling volumes. However, for the following types of plastic expanded end-use may be needed:

- PET thermoforms and pigmented PET containers
- Pigmented HDPE and injection molding grade of recycled HDPE
- Bulky rigid HDPE and PP items
- Plastics derived from electronics
- Plastic film

5. Establish Glass Beneficiation Capacity in Western or Northern Texas

Beneficiation is considered as an end-use in the RMDP as explained in Section 3. Although current volumes are inadequate to support such a facility, siting a new beneficiation facility in western or northern Texas could vastly improve the economics of glass recycling in the region by reducing transportation costs and thereby help to expand statewide tonnages. An alternative strategy is to establish more efficient and cost-effective collection and transportation systems, including collection of source-separated glass from commercial sources, as discussed elsewhere in this section.

6. Expand and Enhance Organics Product Production Capacity and End-Use

Texas has a strong organics processing infrastructure, defined here to include composting, soil amendment production and anaerobic digestion. According to TCEQ, there are:

- 8 active composting facilities permitted to accept grease trap waste and MSW;
- 22 active composting facilities registered to accept sewage sludge, diapers, and paper sludges;
- 6 Water Quality Biosolids Program compost facilities that can accept biosolids; and
- 120 compost facilities required to file Notice of Intent that may accept source-separated meat, fish, dead animal carcasses, dairy materials, vegetable oils and greases.

There is also an unidentified number of additional facilities with no state permit, registration or notification requirements that may handle some organic materials, and a handful of anaerobic digestion facilities, three of which are known to accept food waste. Some of these are co-located with WWTPs.

While most organics processors surveyed indicate that they have capacity to manage increased tonnages of materials, if recovery of organics increases significantly, Texas organics recycling may need to address the following infrastructure-related needs:

- **Yard trimmings.** While composters targeting yard trimmings and wood waste have a large amount of available capacity, there may still be a need to expand capacity in the future. For example, based on limited survey responses, Texas organics recyclers reported about 246,000 tons per year of unused capacity. Increasing recovery by 20 percent of currently disposed tons would yield over 1.1 million additional tons, theoretically requiring about 10 new facilities, assuming all the new capacity was established in new facilities operating at an average of 90,000 tons per year. There may also be gaps in certain regions. Any such capacity needs could be addressed through new or expanded facilities and/or by promoting hub-and-spoke strategies to funnel organics from low-volume areas to regional facilities or cooperative contracting for mobile processing.
- **Food waste.** Some composters handling commercial and industrial food waste have a need for de-packaging equipment required to expand capacity for packaged food waste. Also, if Texas targets composting of food waste from residential and commercial generators, then expanded composting capacity may be needed in certain regions that are far from established compost facilities accepting food waste. Some food waste and other organics could also be managed through expansion of anaerobic digestion (either collocated with wastewater treatment facilities or stand-alone facilities).
- **Biosolids.** In the future the potential for land application of biosolids may become limited, requiring the development of new end-uses.

It must be noted that many organics recyclers identified the need for increased demand for their compost and soil amendment products as a major barrier to growth. However, increasing demand does not necessarily imply a need for infrastructure.

7. Expand and Enhance Processing Capacity for Construction & Demolition Materials

Forty-one survey respondents said they are involved in processing C&D materials, with 19 of these handling concrete/asphalt and 19 not specifying. Additionally, two processors of mixed C&D materials responded to the survey and indicated they operate at near 100 percent capacity. Infrastructure needs related to processing C&D materials include:

- Additional mixed C&D recycling processing capacity will be needed if significant increased diversion of C&D materials is to occur in Texas. To economically justify establishing such capacity may first require expansion of end markets. Some processors indicated that they would need additional equipment to expand volumes. These needs include equipment to:
    - Crush and properly size concrete, asphalt, and other heavy inert materials. These materials are in strong demand but cannot be economically transported long distance.
    - Sort, clean and prepare asphalt shingles, drywall/gypsum and wood. Demand is currently very low for asphalt shingles and drywall, and for treated wood. So, addressing these processing infrastructure needs would only be required if demand increases can be established in locations that are economical for processors to ship to.
- Space is also often a constraint and addressing this need could require investments in additional land and/or buildings or public/private partnerships for shared space.

8. Expand End-Use for Gypsum and Asphalt Shingles

For these C&D material components, supply currently exceeds demand and sustaining or increasing recycling volumes requires expanding demand. Current end-uses and options are unfortunately limited and there is a need to identify new uses, preferably within existing manufacturing operations. Addressing these needs may well require a focus on strategies other than infrastructure, but these are listed here because they may involve the need for new or expanded infrastructure at various facilities. Potential C&D end-use infrastructure needs include:

- **Asphalt paving.** Recycled asphalt shingles are used to a limited extent in Texas for asphalt paving. Increasing this use appears to be primarily constrained by TxDOT specifications and possibly quality perception barriers and hesitancy to change but additional infrastructure may be needed if end use was increased.
- **Soil amendment.** Some gypsum/drywall may be used in soil amendment products, and theoretically can be used to make new dry wall products. However, the economics are poor and there are contamination concerns. Increasing the use of this material may also require additional infrastructure.

9. Expand Used Paint Processing Capacity

There are currently only two known commercial paint recyclers in Texas, and recycled volumes are relatively low. If collection programs and participation levels are expanded, there could be a need for expanded paint processing capacity. As with other capacity needs, this could occur by siting new stand-alone facilities or establishing this capacity at existing recycling facilities. This is unlikely to occur without passage of policy mechanisms to fund additional paint recovery and recycling.

10. Establish a Regional Battery Processing Facility

There is a potential opportunity to build new battery processing capacity in Texas. While the one out-of-state U.S. processor can handle current volumes of Texas recycled batteries, Texas could begin to position itself to become a regional battery recycling hub by planning for the needed infrastructure. As the supply of spent electric vehicle (EV) and energy storage system (ESS) batteries grows in coming years, and as processing technologies are developed, Texas could establish such processing capacity and aim to draw recycled batteries from throughout the state and neighboring states. The opportunity could potentially involve increasing refurbishment and use of EV batteries as ESS units in Texas alternative energy applications. While the main immediate barriers to this outcome involve funding, research & development and other non-infrastructure barriers, the strategy would ultimately require development of Texas based battery recycling processing and end-use capacity.

11. Expand Textiles Processing Capacity and End-Use

There is a potential opportunity for textile sorting/grading facilities to be enhanced in Texas, and for additional capacity to be established for mattresses, carpet and bedding materials. Texas has several companies that import used textiles from other states for export to other countries, although they have been severely and temporarily disrupted due to restrictions implemented in response to the coronavirus pandemic. More automated textiles grading and sorting would be required to establish textiles recycling end-use capacity, such as use of graded fiber types and/or chemical recycling to produce new fiber for use in the textile industry. Addressing these infrastructure needs holds the potential to establish Texas as a regional hub for textile industry circular economy initiatives and could lead to fiber-to-fiber recycling systems and the potential to convert certain textile fibers into feedstocks for making plastics. Among other benefits, this would effectively bring some of the textile industry businesses and jobs back to the U.S.

12. Expand Tire-Derived Product End Use

The Texas Used and Scrap Tire Management Program helps ensure that newly generated scrap tires are collected and managed responsibly. There is ample capacity for production of crumb rubber and other tire-derived material feedstocks. Texas is home to the largest crumb rubber producer in the world and who has stated a need for more tires supply to meet market demand for the crumb rubber products they produce. Other tire product manufacturers also exist in the State. Yet currently a large quantity of Texas-generated used and scrap tires are landfilled or used as tire-derived fuel. Other potential higher-value uses for tire-derived material could be developed or expanded in Texas, which may or may not require infrastructure development. They include:

- **Asphalt paving.** While Texas primarily uses “dry” methods of incorporating crumb rubber into asphalt that do not require additional equipment, some states such as California rely on “wet” methods that require equipment to blend rubber into asphalt binder at asphalt hot mix plants, and to maintain appropriate temperatures at the job site.
- **Molded and other tire-derived products.** Some existing Texas manufacturers of tire-derived products could launch new product lines, but this requires investment in molds and possibly new compression or injection molding equipment.
- **Emerging tire recycling technologies.** These technologies would require infrastructure investments to launch in Texas include pyrolysis (which yields recovered carbon black, which theoretically can be used in a variety of manufactured products) and devulcanization (which yields a tire-derived material also capable of being used in a wider range of products than crumb rubber).

There is also a need for end uses suitable for using tire-derived materials made from stockpiled tires. Such tires are typically extremely dirty and not suitable for most end-uses; however, New York state has successfully used some shredded stockpiled tires as road base in highway production.

Collection and Transportation Infrastructure Needs

In addition to principal processing and end-use manufacturing facility needs, there are collection and transportation related needs associated with expanding Texas recycling. While needs can sometimes be addressed by more effectively utilizing existing infrastructure, in some cases investments in new infrastructure such as land, buildings, trucks, and/or equipment may be necessary.

For example, curbside residential and commercial recycling collection services may be able to be expanded by existing haulers utilizing existing trucks and equipment, or on a drop-off basis by providing such services at established facilities such as transfer stations or retail stores. Texas state and local agencies could promote new hub-and-spoke strategies to funnel recyclables from many small generators to an existing regional processing facility, or back-haul strategies, that rely on existing hauling firms and equipment to the extent possible. But even when existing firms and infrastructure are used, there may still be a need for new investments to significantly expand recycling levels.

Below we summarize these potential needs. For brevity they are grouped into two broad categories: needs that mainly affect remote, rural Texas regions (for a variety of typical and other recyclables) and needs that, for the most part, affect all areas of the State.

1. Recycling Collection Service and Transportation Infrastructure Needs in Rural, Remote Geographic Regions

Two broad needs were identified in the infrastructure assessment that are specific to remote, rural regions of Texas, primarily in north and west Texas, as well as some southern locations. These include the need for:

- Expanded collection systems to increase recycling access in rural and "recycling desert" areas where significant populations are underserved. This is true of all material types.
- More cost-effective transportation options to move recyclables from remote, rural regions to processing and end-use facilities that are by-and-large located in urban centers.

Options to address these issues are discussed in more detail in Section 8.10, along with other cross-material barriers that constrain expansion of a range of different recyclable material types. Strategies to address the barriers are discussed in Section 9.

2. Materials for Which Increased Statewide Collection is a Key Expansion Barrier

There is a need to enhance curbside recycling of typical recyclables at multi-family dwellings throughout the state. Beyond that, there are some material types for which lack of collection infrastructure is a key expansion barrier. They include:

- **Residential film plastics.** This material is typically only collected at retail drop-off collection sites.
- **Ferrous metals.** Residential non-can ferrous metals (small in size) and commercial recycling service providers that include steel cans as part of a "commercial single-stream" collection program.
- **Food waste.** Food waste from both residential and commercial generators, but large-scale ICI generators should be targeted before residential.
- **Residential textiles.** Curbside collection could be expanded.

In some cases, such as with food waste and residential textiles, the extent to which a collection system would be utilized is unknown. A significant amount of material is being disposed and available for recovery but use of the infrastructure would require generator participation. In some cases, if demand for the collection were prevalent, the private sector would likely step in to provide the service.

8.19 PRIORITIZATION OF MATERIALS TO TARGET FOR RECYCLING MARKET DEVELOPMENT INITIATIVES

In considering which materials to target for recycling market development efforts, the Project Team looked holistically at several factors that could impact the outcome for Texas, including:

- **Diversion potential.** The potential to divert material from landfills. This is measured in terms of tons per year. This factor only considers quantity, not characteristics, of material.

- **Additional benefits to diversion.** The potential to realize additional environmental, safety, or health benefits (beyond landfill avoidance) due to increasing recycling of the material. This would include considerations such as generation of methane gas in landfills, toxicity, and hazardous nature of material.
- **Commodity value.** The estimated gross value per ton of processed material multiplied by tons available, assuming 20 percent of the currently disposed material (i.e., additional material available for recycling) is diverted. This value excludes the cost of collection, processing, and transporting the material to market and the potential in-state economic benefits of collecting, recycling, transporting, and manufacturing with the material.
- **Potential economic benefit.** The estimated per-ton total economic benefit to Texas based on the analysis presented in Section 6 and including per-ton economic impacts of collecting, processing, transporting, and manufacturing, based on current data, applied to additional captured tons. Again, it is assumed that 20 percent of what is currently disposed is captured.
- **Overall sufficiency of existing infrastructure.** The extent to which infrastructure for collection and/or processing and end markets exists and can sustain or expand statewide recycling levels, as is described above.
- **Likely institutional feasibility to impact market.** For this characteristic, the Project Team considered the extent to which TCEQ and other governmental entities in Texas can feasibly, either directly or indirectly, expect to influence markets. This characteristic also considers the ability to address barriers for multiple materials simultaneously (i.e., when cross-material barriers exist).

For each material and characteristic, the Project Team assigned a value of "high," "medium," or "low." For the "Additional Benefits to Diversion" characteristic, materials were assigned either "high" or "low" based on the presence or absence of additional potential benefits. For example, landfilling food waste leads to the creation of methane, thus there are additional benefits to diverting that material. Similarly, batteries pose a fire hazard when disposed or mismanaged in a recycling facility, therefore proper recovery of these materials provides additional benefits. These additional potential benefits to diversion are explained in the "Notes" column of Table 8-9. Barring the existence of such considerations, a material has a "low" additional benefit to diversion. A summary of the values for the quantitative characteristics are provided in Table 8-8.

TABLE 8-8: RANGES FOR QUANTITATIVE CHARACTERISTICS ASSESSED

Factor	High	Medium	Low
	●	◑	○
Annual Additional Diversion Potential (tons per year)	> 1.5 million	500,000 – 1.49 million	< 500,000
Annual Commodity Value[1]	> $50 million	$15 – $49 million	< $15 million
Annual Economic Benefit[1]	> $700 million	$250 – $699 million	< $250 million

1. *Assumes 20% of material currently being disposed is recycled*

A summary of the results of the analysis are provided in Table 8-9. In some cases, the economic analysis provided data for an entire category (e.g., paper) so those results are shown combined. The economic analysis did not include all material types.

TABLE 8-9: SUMMARY OF MATERIALS ANALYSIS

Key: High ● / Medium ◐ / Low ○	Diversion Potential	Additional Benefits to Diversion[1]	Commodity Value	Potential Economic Benefits[2]	Overall Sufficiency of Existing Infrastructure	Likely Institutional Feasibility to Impact	Notes
Typical Recyclables							
Paper							
OCC	High	Low	Medium	High	High	Low	Generally strong collection and processing infrastructure, except in more remote areas.
Sorted Office Paper	Low	Low	Low		High	Low	
Mixed Paper	High	Low	Low		High	Low	
Plastics							
PET	Low	Low	High	High	High	Low	
HDPE	Low	Low	High		High	Low	
Film Plastics[3]	Low	Low	Medium		Medium	Medium	
Plastics #3-7 and Other Plastics	Medium	Low	Low		Low	Low	
Metals							
Ferrous Metals	Medium	Low	Medium	High	High	Low	
Non-Ferrous Metals	Low	Low	High	High	Medium	Medium	
Glass							
Glass	Medium	Low	Low	High	Medium	Medium	Demand is high. An additional intermediary processor strategically located could help increase supply.
Organics							
Yard Trimmings	Medium	Low	Low	Low	Medium	Medium	Landfilling food waste results in methane production. Markets would benefit from stimulated demand for end products and increased supply of feedstocks
Food Waste	High	High				High	
Biosolids	Medium	Low				Medium	
Septage	Low	Low				Medium	
Wood Waste	Low	Low				Medium	

Key: High ● Medium ◐ Low ○	Diversion Potential	Additional Benefits to Diversion[1]	Commodity Value	Potential Economic Benefits[2]	Overall Sufficiency of Existing Infrastructure	Likely Institutional Feasibility to Impact	Notes
C&D							
Wood	Medium	Low	Low	Low	Medium	Low	
Asphalt Shingles	Medium	Low			Medium	Medium	
Asphalt, Concrete, Brick, and Tile	High	Low			Medium	Low	
Drywall/ Plaster	Low	Low			Low	Low	
Other							
Paint[4]	Low	Low	Low	N/A	Medium	Medium	Any liquid paint can be potentially hazardous to the environment if landfilled or improperly disposed. When dried, however, latex paint is safe to landfill. Most architectural paint is latex.
Electronics[4]	Low	High	N/A	N/A	Medium	Medium	Some electronics contain hazardous materials that could leach into the ecosystem – such as lead, cadmium, and arsenic. There are 19 states that ban the landfilling of electronics.
Batteries[4]	Low	High	N/A	N/A	Low	Medium	Lithium batteries pose a fire and safety hazard when not managed properly.
Textiles[4]	Medium	Low	N/A	N/A	Medium	Medium	
Tires[4]		High	N/A	N/A	High	Medium	Tires left in stockpiles cause fire and vector hazards.

1. *Considers whether additional diversion provides potential environmental, safety, or health benefits (beyond landfill avoidance). This would include considerations such as generation of methane gas in landfills, toxicity, and hazardous nature of material.*
2. *Based on total annual economic benefit to Texas, including from direct, indirect and induced economic benefits, as described in Section 6, on a per-ton basis, and considering total amount of material disposed currently.*
3. *Considers only 20 percent of film plastics currently disposed to be recyclable, reflective of commercial generators generating high-quality, clean and dry film in sufficient quantities to bale on-site.*
4. *Policies could have a high impact on these material markets; however, these policies are challenging to pass.*

N/A – Information not available to make this assessment.

8.20 MATERIALS ANALYSIS CONCLUSIONS

Table 8-10 provides a listing of materials in order of priority within each material category. A summary of high and medium level barriers, and the associated materials is provided after the table. How to address these barriers will be the focus of Sections 9 and 10. Materials that have high-priority barriers associated with them are in bold font in Table 8-10.

TABLE 8-10: PRIMARY MATERIALS AND BARRIERS TO ADDRESS IN RMDP[1]

Key: High ● Medium ◐ Low ○	Contamination	Competition with Low-Cost Alternatives to Recycling	Low Participation Where Programs are Accessible	Inconvenient/Limited Access to Recycling Opportunities	Lack of or Inadequate Secondary Processing	Costly to Transport Relative to Value	Low Value/Inadequate Demand	Lack of Equipment	Challenges Obtaining, Retaining, Training Employees	Other	Notes
Typical Recyclables											
Plastics #3-7 and Other Plastics	●	●	●	◐	●	●	●	◐	○		Some plastics #3-7 and other plastics not targeted for collection in some or all communities.
Glass	●	●	●	◐	●	●	○	◐	○		More secondary processing could make glass recycling more cost effective for some. High-quantity generators may be able to bypass secondary processing. Some communities do not offer glass collection.
Film Plastics	●	●	●	●			◐	◐			Lack of wash line capacity for managing certain film plastics. The current low recycling rate and growth in flexible plastic packaging make this an important material to target.
PET	●	●	●	◐		○	○	◐	○		Low value/costly to transport pertains to PET thermoforms.
HDPE	●	●	●	◐			◐	○	○		
Paper	●	●	●	◐		◐		◐	○		Poly-coated paper such as food service containers, paper cups, and cartons are under recovered, but end market opportunities are improving.
Non-Ferrous Metals	●	●	●	◐				◐	○		
Ferrous Metals	●	●	●	◐					○		Limited/no collection of small ferrous from residents

Key:
- High: ● (filled circle)
- Medium: ◐ (half-filled circle)
- Low: ○ (empty circle)

	Contamination	Competition with Low-Cost Alternatives to Recycling	Low Participation Where Programs are Accessible	Inconvenient/Limited Access to Recycling Opportunities	Lack of or Inadequate Secondary Processing	Costly to Transport Relative to Value	Low Value/Inadequate Demand	Lack of Equipment	Challenges Obtaining, Retaining, Training Employees	Other	**Notes**
Organics											
Food Waste	High	High	High	High		Medium	High	Medium	Low		Lack of de-packaging equipment. Participation lacking among large-scale generators.
Yard Trimmings	High	High	Low			Medium	High	Medium	Low		
Biosolids						Medium	High	Medium	Low	Medium	Long term, other uses needed beyond land application. Regulations may need revisiting. Limited demand for end products. Poor perception among potential users.
Other						Medium	High	Medium	Low	Medium	Regulations for management of FOG may need revisiting.
C&D											
Mixed C&D	Medium	High				Medium		Medium	Low	Low	Lack of specifications, space constraints
Concrete, Asphalt, Brick	Medium	High				Medium		Medium		Low	Space constraints. Lack of specifications.
Wood	Medium	High				Medium	Medium	Low			
Asphalt Shingles	Medium	High				Medium	High				Oversupply exists.
Gypsum	Medium	High				Medium	High				
Other Materials											
Tires	High	High	Medium			Medium	Medium			High	Prevalence of contaminated tire stockpiles; ongoing landfilling of tires when Texas companies want this supply. Currently most tires going to low value uses.
Textiles		High	High	High			High				Includes mattresses and carpet. Domestic end market development needed. Emerging chemical recycling opportunity could provide end markets.
Batteries		High	High		High	Medium	Medium				Alkaline batteries - low priority. Rechargeable batteries – high priority. Emerging opportunity to create infrastructure for EV and ESS battery recycling. Commodity sales not adequate to fund recycling system. End markets are all out of state.
Electronics		High	Medium				Medium			Medium	Low value end products include glass and some plastics. Commodity sales not adequate to fund recycling system.
Paint		High	Low		Low	Medium	High				

1. Material types presented in bold are considered high-priority materials.

The following list communicates the high and medium priority barriers and their associated material types. Cross material barriers are listed as such when the barrier affects multiple types of material and the strategy(ies) to address the barrier are likely the same and can potentially be implemented together. In some cases, strategies will likely differ due to the uniqueness of the material type, recycling system, and/or generator types, therefore they are listed separately as material-specific barriers.

High-Priority Barriers/Material Types

The barriers/material types that emerge as the highest priority to address, based on the analyses presented in this section, include the following:

Cross-Material Barriers:

- Contamination (all typical recyclables, film plastics, food waste/organics)
- Inconvenient/limited access to recycling opportunities especially in rural areas and multi-family dwellings (all typical recyclables)
- Lack of participation where programs are accessible (all typical recyclables)
- Costly to transport relative to value (plastics #3-7 and other plastics, glass)
- Competition with low-cost alternatives to recycling (all typical recyclables, tires, textiles, C&D materials)
- Reluctance of end markets to pay for processed material (paper, colored HDPE, glass, film plastics)
- Lack of adequate end markets for Texas-made products (food waste/organics, tires)

Material-Specific Barriers:

- Plastics #3-7 and other plastics:
    - Lack of adequate collection programs
    - Lack of in-state sorting/processing and end markets for resins
- Glass:
    - Potential need for additional secondary processing (selected regions of Texas)
- Film plastics:
    - Lack of adequate collection programs (residential and commercial)
    - Lack of in-state processing and end markets (residential film)
    - Lack of wash lines to process certain film plastics
- Food waste/organics:
    - Inconvenient/limited access to collection programs
    - Lack of participation where access exists (large-scale generators of food waste)
    - Costly to transport relative to value
- Tires:
    - Limited availability of suitable markets/outlets (stockpiled tires)
    - Lack of awareness about Texas tire-derived products and/or safety/performance concerns
- Textiles:
    - Inconvenient/limited access to recycling opportunities (including carpet, mattresses)

Medium-Priority Barriers/Material Types

Medium-priority barriers/materials to address include:

Cross-Material Barriers:

- Lack of resources for equipment for enhanced processing (typical recyclables, organics)
- Costly to transport relative to value (C&D materials)
- Contamination (C&D materials)
- Inconvenient/limited access to recycling opportunities (electronics)
- Lack of participation where programs are accessible (electronics)

Material-Specific Barriers:

- Lack of adequate reclaimers and end markets (PET thermoforms)
- Poor perception (biosolids-containing products)
- Inconvenient/limited access to recycling opportunities (electronics)
- Lack of participation where programs are accessible (electronics)

Longer term barriers/materials, but still of ***medium priority***, include:

- Lack of in-state processors and end users for textiles to meet growing demand for fiber-to-fiber chemical recycling – could be a regional market (textiles)
- Lack of in-state recycling infrastructure for EV and ESS batteries –could be a regional market (batteries)
- Lack of adequate end markets beyond land application (biosolids)
- Regulations that can limit opportunities for processing (biosolids)
    - Lack of adequate end markets beyond land application
    - Regulations can limit opportunities for processing

There are several other barriers identified within this section that are regarded as low priority based upon the analysis presented herein.

One barrier identified that impacts a variety of materials is that products are sometimes not designed for recyclability. This applies to plastic packaging (e.g., the use of additives, full-wrap sleeves and multi-material layers in flexible packaging), batteries (e.g., often embedded in products, multiple chemistries among batteries), electronics (e.g., challenging to deconstruct, made of plastics with additives) and textiles (e.g., fiber blends, lack of labeling to allow for efficient sorting), and tires. The Project Team has determined that product design is not one of the barriers that Texas is likely to successfully address, so it was not included in the list above.

9 RECYCLING MARKET DEVELOPMENT STRATEGIES FOR STATE AND LOCAL GOVERNMENTS

9.1 DESCRIPTION OF RECYCLING MARKET DEVELOPMENT

As mentioned in Section 7, the primary aim of recycling market development is to maximize the amount of recyclable materials that move through markets from sellers to buyers via economically viable and stable programs. The role of state government in promoting market development is to identify and address barriers and inefficiencies in the marketplace and make markets work better (as opposed to replacing markets) by encouraging recyclable materials suppliers, processors, and end users to be more effective players in the marketplace. In addition, state-led recycling market development efforts should generally seek to improve economic development conditions in Texas by:

- Increasing the competitiveness of the State's recycling related businesses;
- Taking advantage of existing economic development programs and tools; and
- Creating improved job opportunities for Texas workers.

In a balanced economic system, supply and demand are in equilibrium. Towards this end, recycling market development activities are implemented to build healthy market conditions for recyclable materials which entail having:

- Sufficient quantity and quality of recyclable materials supplied to meet demand, available at a price that buyers are willing to pay, and sellers are willing to accept;
- Sufficient capacity for processing recyclable materials into usable recycled material feedstock;
- Manufacturing capacity adequate to absorb the processed material and produce recycled-content products; and
- Final product demand adequate to absorb the recycled-content products at a price acceptable to the manufacturer.

An action in any of these four components (supply, processing, manufacturing, final product end use) that expands healthy recyclable materials markets can be considered recycling market development. However, recycling market development does not include activities involving the creation of greater supply for its own sake, that is, when the availability of supply is not a limiting factor in the ability to meet demand. On the other hand, supply development specifically crafted to meet the price and quality specifications of buyers is part of recycling market development. In other words, recycling market development is a ***demand-pull*** activity – taking actions that stimulate materials demand and that increase the volume of actual market transactions. Market development does not focus on a ***supply-push*** approach in that the aim is not to simply add more and more materials to the market with the hopes that someone will buy it.

Demand-pull strategies include efforts to:

- Support existing businesses that consume recycled material feedstocks and produce end products made with recycled content, so they continue to demand material;
- Encourage manufacturers to convert from virgin to recycled material feedstocks to the extent that technology and markets allow (feedstock conversion);
- Encourage existing manufacturers to increase the amount of recycled material feedstock they use;
- Attract new businesses that also consume recycled material feedstocks (but not at the risk of losing existing businesses); and
- Promote broad consumer engagement in buying products made with recycled material feedstocks.

In this section, tools and mechanisms are identified that can be used by State and local governments to overcome the key barriers limiting the use of recovered Texas-generated materials by existing and potential new processors, manufacturers, and other end users. The identified tools and mechanisms serve as the basis for the recycling market development strategies outlined in the RMDP.

9.2 Determining Appropriate Recycling Market Development Strategies

The RMDP's approach to achieving recycling market development is two-pronged in nature. The first prong is a set of general (cross-material) strategies that expand the State's capacity to promote recycling market development. Cross-material strategies seek to establish tools and resources that can capitalize on market development opportunities benefitting a wide range of materials. The second prong is a set of material-specific strategies which seek to capitalize on opportunities benefitting individual priority materials.
Both cross-material and material-specific strategies seek to stimulate demand for recovered materials, with the understanding that:

- Market development success is most likely when numerous and diversified market development opportunities are encouraged and supported.
- The State cannot proactively identify and pursue all market development opportunities given the reality of limited resources.
- Tools can be put in place that stimulate businesses and entrepreneurs to utilize secondary materials and expand recycling products manufacturing on their own initiative, whether or not the State provides assistance directly.

In determining appropriate strategies to address recycling market development opportunities, the following considerations should be made:

- **Needs based.** To be effective, any policy or programmatic effort must target clearly identified barriers to the development of markets. Some barriers are more crucial to address than others. Therefore, it is important to identify the full range of barriers and develop priorities to inform program selection and funding allocation. Section 8 provides a prioritization of barriers and materials to be targeted.
- **Integrated approach.** Barriers to market development can lie in any of the three major components of the State's recycling system – recovery, processing, and end use. While market development is usually thought to be synonymous with demand development, this is often not the case. Therefore, the State must take an integrated approach to market development, linking programs that promote the growth of all three system components. Demand development cannot be pursued in isolation of supply and processing, as all components must work with each other effectively.
- **The right tool for the job.** There are often multiple tools that could be used to address a barrier. Selecting the right tool includes identifying the approach that will be effective and provide the best return on investment. For example, providing information and facilitation are flexible, low-cost, high-return tools when successfully implemented. Providing funding and implementing policy should be considered when other options are not possible or are unlikely to yield adequate results. Where feasible, the State should seek to leverage existing resources before creating new ones.
- **Appropriate scale.** When addressing barriers to market development, it is important to understand the scale of the problem and provide program efforts accordingly. Likewise, it is important to recognize that what may be effective in the more populated areas of Texas may be unsuitable for less populated, more remote areas of the State.
- **Timeliness.** The ability to identify and react to important material-specific opportunities and challenges as they arise is essential. Texas recycling market developers should strive to become as fast, creative, and entrepreneurial as the recycling businesses they work to develop.

9.3 OVERVIEW OF RECYCLING MARKET DEVELOPMENT TOOLS AND MECHANISMS

A variety of program and policy tools and mechanisms are available when designing recycling market development strategies to address identified barriers. Available tools and mechanisms were categorized as follows:

A. Information, facilitation, and technical assistance. Providing market players with information, such as: market assessments and related data, recycling business directories, recycled content product directories, technical information and assistance, opportunity analysis, procurement training, consumer education, referrals to appropriate resources such as state and local economic developers. Similarly, bringing market players together, through stakeholder forums, linking of specific suppliers and end users, materials exchanges can be another effective means of growing markets for recovered materials.

B. Preferential procurement. Using the State's procurement system to increase purchases of recycled-content products, using such tools as price preferences, set-asides, material and bid specifications, voluntary agreements, and best value contracts, cooperative purchasing, as well as working to influence the purchasing practices of other organizations.
C. Financial assistance. Using financial assistance to influence market behavior and innovation (e.g., through provision of grants, loans, and innovation competitions with financial awards to winners) to encourage business development and investment that will result in the expansion of recycling markets.
D. Financial and other incentives/disincentives. Using financial incentives and disincentives is proven to be effective in changing human behavior and encouraging certain activities, while discouraging others. Examples include providing tax incentives for recycling businesses and taxing virgin materials use.
E. Policies. Establishing policies that require certain actions concerning recyclable materials and/or prohibit others; examples of regulatory tools include recycled content requirements, disposal bans, mandatory recycling, extended producer responsibility (EPR) policies, and beverage deposit legislation. Policies may be state-level or local-level policies.

In some cases, a tool or mechanism will fit into more than one category such as a financial incentive that is also a policy (e.g., requiring local governments to implement pay-as-you-throw programs). In many instances, tools and mechanisms will work best in combination with each other. For example, a procurement program would work best if required by a policy and combined with education and outreach. Funding mechanisms are often implemented to secure needed resources and implement recycling market development tools.

Market development tools and mechanisms that could be implemented by the State of Texas and others to address high and medium priority materials and their associated barriers identified in the previous section are provided in Table 9-1, organized by category. More information on these tools and mechanisms is provided in Section 9.4 for cross-material barriers and Section 9.5 for material-specific barriers. Recycling market development strategies will reflect the use of a combination of these tools and mechanisms.

There are many additional tools and mechanisms that can be employed to develop markets for recyclable materials, and as Texas makes progress, the State may have interest in implementing additional tools and mechanisms. Appendix E provides a table showing additional examples of recycling market development tools and mechanisms including many considered but not selected at this point for addressing Texas needs. As indicated in Table 9-1, many of these barriers are cross-material in nature while others are material specific. Sections 9.4 and 9.5 discuss potential strategies for addressing these two categories of barriers using the tools and mechanisms outlined above.

TABLE 9-1: MARKET DEVELOPMENT TOOLS AND MECHANISMS FOR ADDRESSING PRIORITY BARRIERS IN TEXAS

Barrier and Affected Material(s)	Market Development Tools and Mechanisms				
	A Information, Facilitation, and Technical Assistance	B Preferential Procurement	C Financial Assistance	D Financial and Other Incentives/ Disincentives	E Policies
Cross-Material Barriers					
Contamination High Priority Typical Recyclables Film Plastic Medium Priority C&D Materials	• Recycle Right Campaign • Harmonization Guidance Contamination Reduction Guidance • Clear Labeling and Signage		• Equipment/ Recycling Market Development Grants and Loans		• Harmonization Policy and Setout Requirements
Inconvenient or Limited Access to Recycling Opportunities High Priority Typical Recyclables Medium Priority Electronics			• Infrastructure Development Grants		• Mandatory Provision of Service
Lack of Participation High Priority Typical Recyclables Medium Priority Electronics	• Recycling Promotion Campaign				• Variable Rate User Fees/PAYT • Mandatory Recycling Participation Laws/ Disposal Bans • Beverage Container Deposit Legislation
Competition with Low-Cost Alternatives to Recycling High Priority Typical Recyclables Tires Textiles C&D Materials			• Infrastructure Development Grants and Loans	• Tax Credits or Exemptions • Rebates and • Incentive Payments • Disposal Surcharges	• Mandatory Provision of Service • Mandatory Recycling Participation Laws/ Disposal Bans • Advance Recycling Fees Paid by Consumers • Advance Recycling Fees Paid by Industry • Extended Producer Responsibility (EPR) • Disposal Surcharges
Reluctance of End Markets to Pay for Processed Material High Priority Paper Colored HDPE Film Plastics Glass		• Buy Recycled Campaigns and Recycled Product Information			• Minimum Recycled Content Requirements
Lack of Resources for Equipment for Enhanced Processing Medium Priority Typical Recyclables Film Plastics Organics			• Equipment Grants	• Tax Exemptions • Reduced Rates for Utilities, Disposal and Other Incentives (e.g., fast track permitting)	• Funding Policy Mechanisms (e.g., EPR, Packaging Fees Paid by Industry)
Costly to Transport Relative to Value High Priority Plastics #3-7 and Other Plastics Glass Medium Priority Colored HDPE C&D Materials Organics Tires	• Regional Cooperation • Research and Development, Testing, Pilot Projects		• Regionalization Grants • Recycling Market Development/ Equipment Grants		
Lack of Adequate End Markets for Texas-Made Products High Priority Food Waste Organics Tires	• Feedstock Conversion Research and Promotion • Research and Information Dissemination	• Texas Recycled Product Promotion Campaign • Texas Recycled Products Directory • Cooperative Contracting • Preferential Procurement Programs			

Barrier and Affected Material(s)	Market Development Tools and Mechanisms				
	A Information, Facilitation, and Technical Assistance	**B** Preferential Procurement	**C** Financial Assistance	**D** Financial and Other Incentives/ Disincentives	**E** Policies
Material-Specific Barriers					
Lack of Adequate Collection Programs, Lack of In-state Sorting/ Processing and End Markets High Priority Plastics #3-7 and Other Plastics	• Technical Information and Guidance • Research and Development		• Infrastructure Development Grants		• Funding Policy Mechanisms (e.g., EPR, Advance Recycling Fees Paid by Industry or Consumers)
Lack of Wash Lines High Priority Film Plastics			• Equipment Grants		• Funding Policy Mechanisms (e.g., EPR, Advance Recycling Fee Paid by Industry) • Minimum Recycled Content Legislation • Mandatory Provision of Service (Film at Retail)
Lack of Adequate Reclaimers and End Markets Medium Priority PET Thermoforms			• Equipment Grants		• EPR
Potential Need for Additional Secondary Processing Medium Priority Glass			• Equipment Grants	• Tax Credits, Permit Fee Waivers, or Other Incentives (e.g., fast track permitting)	• Mandatory Recycling • Funding Policy Mechanisms (e.g., EPR, Advance Recycling Fee Paid by Industry or Consumers) • Mandatory Recycling of Beverage Containers by Large-Quantity Generators • Beverage Container Deposit Legislation
Inconvenient/ Limited Collection and Lack of Participation High Priority Food Waste/ Organics	• Research, Pilot Programs and Technical Guidance • Database Development and Generator Mapping • Information Sharing and Networking		• Equipment/ Consulting Grants		• Food Waste Diversion Mandate
Poor Perception of Products Containing Biosolids Medium Priority Biosolids	• Research • Information Sharing and Exchange				
Limited Availability of Suitable Markets High Priority Tires	• Information Dissemination • Pilot Demonstration Projects				• Advance Recycling/ Disposal Fee Paid by Consumers
Safety or Performance Concerns High Priority Tires	• Information Dissemination • Pilot and Demonstration Projects			• Awards Program	
Inconvenient or Limited Access to Recycling Opportunities High Priority Textiles	• Information Dissemination and Recycling Promotion		• Start Up Grants • Funding via PAYT Programs		• Advance Recycling Fee Paid by Consumers (Carpet, Mattresses) • EPR (Carpet, Mattresses)
Lack of In-State Processors and End Users Longer Term Priority Textiles	• Feasibility Assessment • Stakeholder Engagement and Facilitation				
Lack of In-State Recycling Infrastructure Longer Term Priority Batteries - EV & ESS	• Monitoring andResearch • Establishing a Task Force or Committee		• Infrastructure Development/ Research Grants		
Lack of Adequate Markets Beyond Land Application Longer Term Priority Biosolids	• Monitoring and Information Dissemination				
Regulations Potentially Limiting Processing Opportunities Longer Term Priority Biosolids					• Regulatory Review/ Revision

9.4 CROSS-MATERIAL TOOLS AND MECHANISMS

Barriers that negatively impact the marketability and markets for multiple material types are listed below along with potential tools and mechanisms for addressing them.

Tools and Mechanisms to Address Contamination

Material Priority/Categories Addressed: *High Priority: Typical Recyclables, Film Plastics, Food Waste/ Organics; Medium Priority: C&D Debris*

Virtually all recovered materials handlers (and especially those handling the materials listed above) are challenged by excessive contamination in the materials they are seeking to recycle, although some are more challenged than others by contamination. Contamination reduces the quality of recovered materials which may render the material non-recyclable or lower its value in the marketplace. It also increases processing costs. Contaminants take many forms, such as items that are clearly not recyclable, items that may be recyclable elsewhere but are not accepted in that particular program, and recyclables that are misplaced in a sorting system. Most problematic are contaminants that pose risks to sorters or sorting equipment. Contamination arises from behavior on the part of generators, cross contamination by other recyclables included in the same collection system, sorting limitations of processing equipment and behavior on the part of MRF personnel. Primary tools and mechanisms to address contamination are information, facilitation and technical assistance and policy related. Specific tools and mechanisms are described in more detail below.

A - Information, Facilitation and Technical Assistance

Recycle Right Campaign. First and foremost, generators of target recyclable materials need to be informed of how to properly recycle and be motivated to do so. This pertains to all types of generators – residential and non-residential. TCEQ as well as many local governments are already involved in promoting "recycle right" behavior. Such campaigns can be helpful if instructions are clear and simple and effectively reach the targeted audience.

Harmonization Guidance. With respect to typical recyclables, some states have or are working to develop a standardized list of materials recommended for inclusion in all recycling programs, along with a list of universally unacceptable contaminants. Some states have also developed guidance for local governments to reference in deciding upon any additional materials for inclusion in their materials accepted for recycling list. Some states (e.g., Connecticut, Massachusetts, and Washington) have established websites that provide this information in searchable (e.g., by material type), user friendly format. The harmonization approach presented on the Washington DOE's website offers greater flexibility for innovation as it allows for a "recyclable everywhere" list, a "contamination list" of common MRF contaminants, and a "check locally" category to allow for the addition of other recyclable materials where communities and/or MRFs have established markets for such materials. The resulting "Recycle Right" website describes how to recycle (e.g., clean materials, do not bag; check what can be recycled); what to recycle (materials accepted statewide); and to check locally for additional recyclables (indicating some materials that are recyclable in some locations.) Such an approach is likely suitable for a large, diverse state like Texas.

Greater harmonization also allows for more collaboration across Texas communities in education and outreach. In Texas, such campaigns would likely take place at the COG level, such as the NCTCOG's "Know What to Throw" campaign.

"Know What to Throw" in North Central Texas

The NCTCOG, through a grant from TCEQ and in coordination with the Resource Conservation Council, implemented a multi-pronged approach to improving recycling in the region. Municipal data was compiled from surveys and waste composition studies to better understand the types and quantities of materials recycled and disposed in the region. Workshops and focus groups were conducted to develop consensus on the focal point of a "Recycle Right" campaign, with an aim to increase proper recycling, and the campaign was developed and implemented. Education and outreach materials were distributed by NCTCOG in a multi-media campaign effort and were designed to reach residents in a consistent and timely manner through coordinated messaging. The impact of the campaign is still being studied.

For more information:

- Connecticut's Recycle Wizard: https://www.recyclect.com/in-the-bin.html
- Massachusetts's Recycle Smart: https://recyclesmartma.org/results-materials/
- Washington's Recycle Right: https://ecology.wa.gov/recycleright
- NCTCOG's Know What to Throw: https://www.nctcog.org/envir/materials-management/regional-recycling-survey-and-campaign

Contamination Reduction Guidance. The Washington State Department of Ecology (DOE) developed a Contamination Reduction and Outreach Plan (CROP) to address contamination in recyclables being processed by MRFs. Among other things, CROP acknowledges that there is a cost associated with recycling, and these costs should be transparent. It also describes related policies aimed at reducing contamination in MRFs (e.g., implementing a plastic bag ban, promoting a more focused list of widely recycled material, regionalizing collection contracts/programs to reduce confusion, providing clear education and outreach regarding what materials are accepted in a recycling program, providing feedback to generators, etc.), acknowledges the need for quality data to better understand contamination, and that collection and delivery to a MRF is not the same as to recycling. Local governments of a certain size are required to include CROP in their solid waste management plans.

Another effective information and technical assistance mechanism is to promote the use of The Recycling Partnership's (TRP's) downloadable "Recycling Anti-Contamination Kit." While the State of Texas can certainly develop its own guidance materials, The Recycling Partnership's toolkit has been extensively tested, has proven results, and is available for use free of charge.

For more information:

- Washington DOE's CROP: https://apps.ecology.wa.gov/publications/documents/2007021.pdf
- Washington DOE's Recycle Right: https://ecology.wa.gov/recycleright
- TRP's Recycling Anti-Contamination Kit: https://recyclingpartnership.org/wp-content/uploads/2018/05/Anti-Contamination-Toolkit_EDITED.pdf

Clear Labeling and Signage. As another information tool aimed at reducing contaminants, consumer packaged goods companies are increasingly using labels on packaging to provide clarity about how to prepare and manage packaging at the end of its useful life. Examples include the Sustainable Packaging Coalition's (SPC's) How2Recycle and How2Compost labels. The Biodegradable Products Institute (BPI) has also developed "Guidelines for the Labeling and Identification of Compostable Products and Packaging." State and local governments can encourage residents to look for these labels for guidance when deciding what to do with their packaging discards.

Use of clear and consistent signage, recycling container decals, terminology, and colors for recycling bins – both curbside and drop-off – is yet another effective approach to clearly convey information in order to reduce contamination. Many communities, for example, place stickers or emboss in cart lids what is recyclable in the community. As an example of drop-off signage, the American Chemistry Council offers downloadable artwork for signs and decals for use at retail drop-off locations for film plastics, through its Wrap Recycling Action Program (WRAP) program. Promoting use of standardized materials such as these is helpful in reducing confusion about what is and is not recyclable. Local, regional, and state governments in Texas can promote the use of consistent signage and labeling, including through these resources, to reduce contamination.

It's a WRAP for Film Plastics

The American Chemistry Council's WRAP Program provides multiple resources for communities and businesses wishing to recover film plastics. Examples of resources include:

- Stop-by-Step Guide
- Peer Case Studies
- Educational Tools
- Bins
- Signage
- Sample Press Releases
- Webinars
- Newsletters
- Directory of Retailers Offering Film Plastics Collection

For more information:

- American Chemistry Council's WRAP: https://www.plasticfilmrecycling.org/recycling-bags-and-wraps/wrap-consumer-content/

- SPC's How2Recycle: https://how2recycle.info/
- SPC's How2Compost: http://www.how2compost.info/
- BPI's Guidelines for Compostable Packaging: https://www.bpiworld.org/Labeling-Guidelines

C - Financial Assistance

Equipment/Recycling Market Development Grants and Loans. Effective removal of contaminants as well as effective sorting of recyclables to avoid cross contamination requires sufficient and appropriately trained staff and appropriate sorting equipment at MRFs. Some states have established equipment grants and/or low interest loan programs to improve the marketability of recovered materials. For example, such grants can provide MRFs with opportunities to upgrade their equipment to better manage contamination. Grants have also been provided to end users for enhancing their front-end cleaning systems to better enable the use recovered materials as feedstocks. Some industry organizations also make grants available for carts (e.g., The Recycling Partnership) and processing equipment.

Indiana Department of Environmental Management (IDEM) has a longstanding recycling market development grant program, funded through a per-ton disposal fee. The goals of the program are to decrease disposal and increase Indiana's recyclable material manufacturing capacity, as well as increase the use of recycled content products by working with local governments, solid waste management districts, schools, nonprofits, businesses, and recycling industries. Since 1991, more than $23 million has been funded towards projects through a per-ton disposal fee. The program offers grants of $10,000 to $500,000, with a 50 percent cash match.

Indiana Department of Environmental Management RMD Grant Results

In 2018, Republic Services Recycling of Indiana Inc., Marion County received a recycling market development grant from IDEM of $166,355 toward the purchase of a Glass Cleaning Classification System for their MRF. Republic found that single-stream collection resulted in additional contamination of material, and end markets required additional cleaning and recovery of glass by screening, air extraction and sizing. Quality improvement of 30 to 40 percent was expected, improving the value and yield of material.

In Michigan, The Recycling Partnership and the Michigan Department of Environment, Great Lakes and Energy (EGLE) have partnered on a grant application process for Recycling Quality Improvement Grants. The grant program's goal is to improve recycling for 600,000 Michigan households representing 1.5 million residents (or 15 percent of the population). Applicants must be public entities, however. Acceptable projects include staffing to monitor and provide feedback regarding curbside and drop-off site setouts; signage; drop-off sites; website and other social media; and subscription to an online digital recycling platform. Examples of loan programs are discussed in the section on Tools and Mechanisms to Address Competition with Low-Cost Alternatives to Recycling.

For more information:

- IDEM program: https://www.in.gov/idem/recycle/recycling-market-development-program/
- EGLE Recycling Quality Improvement Grants: https://www.michigan.gov/documents/egle/egle-mmd-ss-EGLE_Material_Quality_Grant_FAQ_673168_7.pdf

E - Policies

Harmonization Policy and Setout Requirements. Harmonization can be both an information mechanism (as described above, under "Harmonization Guidance") and a policy mechanism, depending upon whether aspects are required or simply recommended. Some states, such as Pennsylvania and Oregon, mandate the minimum type and/or number of materials to be included in recycling programs. California is currently considering developing regulations to discourage or disallow the inclusion of materials that do not meet minimum acceptability criteria (e.g., be accepted at a certain percentage of MRFs in the state; achieve certain recycling rates). While harmonization policies can be beneficial, care must be taken not to unduly limit what can be included in the recycling system as this may ultimately result in less recycling.
Setout requirements can also be mandated and enforced with information feedback loops, such as "oops" tags which are used to provide immediate feedback to residents who include non-recyclable items in their recycling bins. The tags, provided through local government staff or hauler, are to explain what the resident

placed in the bin that is not recyclable, and the recyclables may not be collected, particularly for a second or third offense. Spokane, Washington conducted a tagging project during the summer of 2020 with a grant from The Recycling Partnership to educate single-family residents on the correct and incorrect ways to prepare curbside recyclables. The results of this effort, which show that immediate feedback regarding improper setouts is helpful in changing behavior, are documented in the project report. The report can also serve as guidance for local governments that want to conduct their own anti-contamination effort. The project included using media to educate residents and while Spokane's program was largely educational and temporary in nature, some communities continuously monitor for quality and impose fines or stop service provision for repeat offenders.

For more information:

- Spokane Tagging Report: https://static.spokanecity.org/documents/solidwaste/recycling/cart-tagging-report-2020-spokane-county-2020-12-9.pdf

Tools and Mechanisms to Address Inconvenient/Limited Access to Recycling Opportunities

Material Priority/Categories Addressed: High Priority: Typical Recyclables; Medium Priority: Electronics

This barrier exists in some rural/remote areas of Texas but is also an issue for many multi-family residents throughout the State. In both cases, recycling opportunities, if any, may be limited to drop-off centers which are inconvenient in comparison to curbside recycling. Primary tools and mechanisms to address this barrier are financial assistance and policy related.

C - Financial Assistance

Infrastructure Development Grants. Many states offer financial assistance to rural communities to help cover costs of recycling infrastructure development. Colorado's Department of Public Health & Environment (CDPHE), for example, has a Recycling Resources Economic Opportunity Program (RREO), which offers grants to develop recycling, composting, and other diversion infrastructure. Some industry associations, such as The Recycling Partnership, also have provided funding to assist with costs associated with recycling service provision, such as carts. San Marcos, Texas was a recipient of grant funding from The Recycling Partnership for a multifamily recycling project.

For more information:

- San Marcos Multi-Family Project: https://www.recyclingtoday.com/article/multifamily-recycling-ordinances-help-cities-reach-zero-waste/
- Colorado RREO Program Information: https://cdphe.colorado.gov/sustainability-programs/recycling-grants-support/recycling-resources-economic-opportunity

E - Policies

Mandatory Provision of Service. Financial assistance is particularly effective when paired with recycling service provision mandates, as was the case in San Marcos. Mandating recycling service provision to multi-family dwellings is becoming increasingly common in Texas. Another recent example of the use of this type of policy is in Dallas, which required all multi-unit residential buildings with eight or more units to provide

San Marcos Multifamily Recycling Pilot

The Recycling Partnership provided a grant for a multifamily pilot project in San Marcos, Texas. San Marcos passed an ordinance in 2010 that requires all multifamily properties to provide recycling. The city contracts with Austin, Texas-based Texas Disposal Systems to provide collection services to 183 properties or 15,000 apartments total. Under the ordinance, each of the properties must provide a large recycling container adjacent to the waste dumpsters.

During the pilot, all 15,000 apartments received educational materials. Additionally, 2,000 apartments received in-unit bins with recycling decals that remind residents not to recycle plastic bags or bagged recyclables. Another 2,000 units received educational materials, in-unit bins and valet recycling service two times a week throughout the duration of the pilot.

The grant also paid for six college student interns to distribute the educational materials and bins to apartments and provide the valet service.

Data is being collected to measure both contamination and generation of recyclables in each of those situations.

recycling service by January 2020. Austin also mandates recycling service provision to multifamily dwellings as part of its Universal Recycling Ordinance – which aims to make recycling available wherever disposal opportunities are provided.

While increasing recycling service provision is not, in itself, recycling market development, lack of access to recycling opportunities for all Texas residents results in less material being available to serve as supply for end markets serving Texas, many of which are seeking more material and some of which are acquiring some supply from out of state. A potential role for state government and regional councils of government in addressing this barrier is to promote best practices with respect to ordinance development and associated program implementation and to provide or help seek grant funding for initial service provision to address gaps in recycling service availability.

For more information:

- City of Austin Universal Recycling Ordinance: https://www.austintexas.gov/uro

Tools and Mechanisms to Address Lack of Participation Where Programs are Accessible

Material Priority/Categories Addressed: *High Priority: Typical Recyclables; Medium Priority: Electronics*

Many businesses and residents in Texas have opportunities to participate in recycling but are choosing not to do so or are not fully participating. The expansion of markets is often hampered by limits to the supply of recovered materials or the need to obtain that supply from more-distant sources such as out of state. Some recycling opportunities – especially for non-residential generators – involve having to pay a fee to recycle, as is the case with recycling of carpet, mattresses, some electronics, and even office paper, particularly for small quantity business generators. This can deter participation, especially if recycling costs more than disposal. Tools and mechanisms to address lack of participation are information, facilitation and technical assistance and policy oriented and are described below.

For more information:

- Your Bottle Means Jobs: https://yourbottlemeansjobs.com

A - Information, Facilitation and Technical Assistance

Recycling Promotion Campaigns. Recycling campaigns can help boost recycling participation but can be limited in their effectiveness. Campaigns are most effective when well-funded and paired with convenient access to recycling. Further, conducting research of the target audience can identify messaging that will resonate more effectively. In some cases, potential participants may simply not be aware of recycling opportunities for some materials, such as textiles. As a result, there is an opportunity to boost recycling for some materials simply by supplying information on where and how to do so. Increasingly, communities are developing and using QR codes that provide mobile phone users with links to information about recycling opportunities and setout instructions, searchable by material type. Encouraging harmonization in materials accepted across communities can simplify messaging and allow for joint, regional, or even statewide education campaigns.

Your Bottles Means Jobs Campaign

North Carolina and South Carolina are home to many plastics reclaimers, many of whom could not obtain enough PET (#1) and HDPE (#2) bottles to operate efficiently. At the time, 70 percent of recyclable plastic bottles generated in the Carolinas was being thrown away, despite a landfill ban implemented in 2009 (which resulted in an increase in recycling that later plateaued). The Plastics Recycling Council of the Carolinas implemented a "Your Bottle Means Jobs" campaign in 2017, which explains to generators of plastic bottles what happens to a bottle when it is recycled, and how recycling plastic bottles supports businesses in the Carolinas – providing jobs for fellow Carolinians. The call to action was for generators to recycle their bottles wherever they consumed beverages – whether at home or on the go.

The campaign included radio announcements, billboards, online ads and public events to encourage people to recycle two more plastic bottles per week.

In the March – May 2017 timeframe, the quantity of bottles in the Raleigh-Durham area (with a population of 2 million) increased by 2 percent. That meant 520,000 additional bottles. According to the council, if every resident in the Carolinas recycled two more bottles per week, that could potentially lead to $10 million in economic benefits and create 300 jobs.

More information on harmonization is provided in the discussion of Tools and Mechanisms to Address Contamination.

E - Policies

Variable Rate User Fees/PAYT. Well-designed variable rate user fee systems such as Pay-As-You-Throw (PAYT) have demonstrated the ability to increase recycling participation and material capture. The City of Fort Worth, for example, implemented a PAYT system using a variable rate for different sized carts in 2003. Within a year, the City reported that the recycling rate increased from 6 percent to 20 percent, and the portion of households participating in recycling increased from 38 percent to 70 percent.
Many states as well as regional councils play an active role in promoting local implementation of PAYT programs. Massachusetts DEP (MA DEP) provides tools and resources to encourage the state's municipalities to implement PAYT programs. As of 2018 about 43 percent of the communities in the Commonwealth had implemented PAYT programs (many of which are bag programs), and on average disposed of 65 percent less trash per household annually than communities that had not implemented such programs. MA DEP provides fact sheets and tips on implementing PAYT, descriptions of different ways to structure fees, success stories from curbside and drop-off communities, outreach ideas, and technical assistance.

For more information:

- EPA PAYT Bulletin: https://archive.epa.gov/wastes/conserve/tools/payt/web/html/spring-04.html#1
  MA DEP Fact Sheet: https://www.mass.gov/doc/paytsmart-in-massachusetts-fast-facts/download
- The Recycling Foundation's PAYT Website: http://payasyouthrow.org/

Mandatory Recycling Participation Laws/Disposal Bans. Some state and local governments have banned certain materials from disposal, which in turn results in greater recycling participation. For example, Texas and most other states ban the disposal of lead acid batteries. North Carolina bans the landfilling of aluminum cans, PET bottles, and glass containers. While disposal bans are typically implemented at the state level, some local governments have implemented their own disposal bans (e.g., Wake County, North Carolina banned the disposal of cardboard). Bans are usually announced well in advance of taking effect, so that collection and processing systems can be established before the ban becomes effective. In some cases, permission to dispose of materials may be sought from the state environmental agency if an end market for a particular commodity is not available. Mandatory recycling participation laws are essentially the inverse of disposal bans, and are also implemented in several states, as well as by some local governments such as Seattle.

Texas could consider implementing disposal bans in the future for selected materials that have stable market demand and value, such as PET bottles, aluminum cans, OCC, and organics (e.g., yard waste disposal bans and/or food waste disposal bans). Typically, when landfill bans are established for non-hazardous materials large-quantity generators are the focus of enforcement.

For more information:

- North Carolina Beverage Container Recycling: https://deq.nc.gov/conservation/recycling/abc-container-recycling

Beverage Container Deposit Legislation. Beverage container deposit legislation, sometimes referred to as a bottle bill, is a policy option to increase the return of recyclable beverage containers. Beverage container deposit legislation, or variations

North Carolina's Beverage Container Recycling Law

In 2008 the state of North Carolina required all restaurants and bars that hold a liquor license to recycle discarded beverage containers, both from the business and customers. This includes glass, aluminum, steel and plastic containers that are sold for on-site consumption.

North Carolina banned aluminum containers from landfills in 1994, and all plastic bottles from landfills in 2005. A website provided business owners with information about their recycling options as well as options for signage and outreach materials for customers and employees. The program is administered through the Alcoholic Beverage Commission and is enforced in part by asking for proof of recycling from new permit applicants. The Alcohol Law Enforcement staff investigates compliance when visiting bars and restaurants. The ABC partners with the Department of Environmental Quality for education and outreach.

thereof, has been proposed several times in Texas without passage. However, it bears to be presented as a policy option. According to a recent Can Manufacturers Institute (CMI) study, the 10 states in the U.S. with bottle bills are responsible for the return of 46 percent of all beverage containers nationally. Providing a financial incentive to return the containers helps increase their return rate – and Michigan and Oregon, both of which have had a 10-cent deposit for several years, show that the return rate is higher if the deposit is higher. Bottle deposit systems also result in reduced litter.

Bottle bill materials are not processed through MRFs, so they end up being cleaner than commingled materials. The existence of bottle bills results in a more uniform recycling collection infrastructure throughout the state. This policy tool may even be leveraged to allow or incentivize collection of other material types that would not be collected curbside. For example, British Columbia, Canada the bottle deposit system incentivizes the recycling of electronics, textiles, and large appliances as the same contractor, Return-It, manages those materials for recycling along with beverage containers, making recycling non-curbside materials convenient, as they can be recycled at the redemption site. This model could be used to collect various types of materials that would not be collected curbside. Depending on how the bottle bill is structured, the escheats, or unredeemed deposits, can provide funding for recycling programs.

For more information:

- CMI Recycling Study: https://www.cancentral.com/sites/cancentral.com/files/public-documents/Metabolic_Report_RecyclingUnpacked.pdf
- British Columbia's Return-It: https://www.return-it.ca

Tools and Mechanisms to Address Competition with Low-Cost Alternatives to Recycling

Material Priority/Categories Addressed: *High Priority: Typical Recyclables, Tires, Textiles, C&D Materials*

One of the biggest impediments to increased recycling for many materials is the low cost of solid waste disposal in Texas, or in the case of tires, use of cheaper alternatives such as use of tire-derived fuel markets instead of recycling markets. Low disposal tipping fees results in less recycling, thereby affecting the availability of supply and also limits the ability of recycling facilities to charge fees that cover their full costs. This is because generators often choose less costly or more profitable processing management alternatives. Recycling programs struggle to be price competitive. Tools and mechanisms to address this barrier include provision of incentives/disincentives, financial assistance, and policies.

C - Financial Assistance

Infrastructure Development Grants and Loans. As mentioned above, some states have established grants and/or low interest loan programs to provide processors and end users with opportunities to improve their capabilities in handling recovered materials. This is another means of lowering recycling system costs, thereby improving their cost-effectiveness relative to other management alternatives.

California has a Recycling Market Development Zone (RMDZ) program which provides economic development assistance specifically for manufacturers using recycled materials for manufacturing, if located in one of the geographic areas covered. Assistance includes loans, technical assistance, and free product marketing. Massachusetts also has a Recycling Loan Fund, whereby recycling and composting businesses in Massachusetts are able to receive low-interest loans to help build the recycling infrastructure in the

RMDZ Success Story – American Textiles

American Textile turns postconsumer waste textiles into valuable products with viable markets. The company collects the textiles from local textile graders, thrift stores, commercial laundries, hospitals, hotels, and clothing manufacturers, then markets the used materials for reuse, repurpose, and reprocess. Most of the textiles are used to manufacture wiping and polishing cloths for industrial and commercial applications. American Textile leadership indicates that, after securing a loan of $300,000 from California's RMDZ they were able to buy new machinery, such as bagging presses, label-making printers, laundry- and material-handling equipment, as well as energy-saving solar panels. This allowed the company to have more working capital for inventory expansion. As a result, the company has been able to process an additional 1,000 tons of textiles annually, diverting this material from the landfill while improving California's economy. The company has also gained an increased awareness of the textile recycling industry and made valuable relationships and connections through the RMDZ program.

Commonwealth. Funding is provided by the Massachusetts Department of Environmental Protection and administered by BDC Capital. Loans range from $50,000 to $500,000 for businesses active in recycling-related activities and up to $1.5 million for anaerobic digestion projects. Terms are for up to 10 years. Eligible uses for funds include permanent working capital, refinancing, real estate, machinery and equipment, and acquisition financing.

For more information:

- CalRecycle RMDZ: https://www.calrecycle.ca.gov/rmdz
- Massachusetts Recycling Loan Fund: https://www.bdcnewengland.com/programs/massachusetts-recycling-loan-fund/

D - Financial Incentives/Disincentives

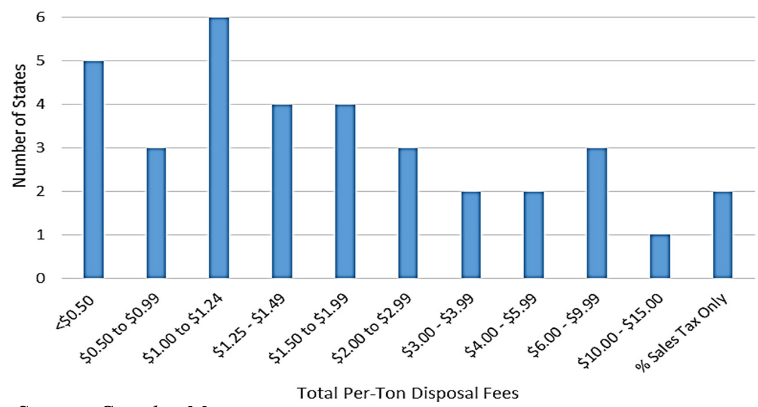
Tax Credits or Exemptions. Lowering the cost associated with recycling operations is one means of "leveling the playing field" with respect to disposal. Some state governments provide tax credits or tax exemptions for recycling-related business enterprises. Examples include sales and/or property tax exemptions on recycling equipment and property tax credits.

FIGURE 9-1: THE RECYCLING PARTNERSHIP'S CIRCULAR ECONOMY ACCELERATOR MEMBERS

Rebates and Incentive Payments. Some jurisdictions provide permit fee waivers and/or disposal fee waivers for recycling facilities. Additional incentives such as material rebates and incentive payments can be used to encourage recycling businesses to locate in the state or for a manufacturer to switch from virgin feedstock.

Disposal Surcharges. Raising the cost of disposal through disposal surcharges (or in Texas's case, increasing the current state-level disposal surcharge on MSW) also helps recycling to be more cost competitive. This approach is being recommended by The Recycling Partnership's Circular Economy Accelerator (see Figure 9-1 for list of members) as both a means of "leveling the playing field" as well as generating funding to support local recycling programs. As shown in Figure 9-2, about half of U.S. states have a statewide per-ton disposal fee, ranging from $0.13 to $13.00, with an average of $2.30 per ton and a median value of $1.06. The per-ton disposal fee in Texas is $0.94 per ton, which is below the national median and average. Two states have a percentage fee on waste disposal services. Minnesota has a 9 percent fee for residential and a 17 percent fee for commercial and self-haul and Iowa charges sales tax of 6 percent on solid waste and sludge collection and disposal services, along with a per-ton disposal fee. In some states, local governments are also authorized to charge a local solid waste disposal fee.

FIGURE 9-2: STATE-LEVEL MSW DISPOSAL SURCHARGES IN THE U.S. (2016)



Source: Circular Matters

For more information:

- Circular Economy Accelerator Policy Whitepaper: https://recyclingpartnership.org/wp-content/uploads/dlm_uploads/2020/09/Policy-Whitepaper-9.30.2020.pdf

E - Policies

Mandatory Provision of Service. Some states require that communities meeting certain criteria provide curbside recycling services, and communities meeting another set of criteria provide drop-of recycling services. In some cases, state (e.g., Vermont) or local governments (e.g., Austin) require that recycling services be provided at home, work, school, and other away-from-home locations. Increasing the opportunity for generators of materials to recycle. Such a policy would encourage increased recycling despite the alternative, disposal, being relatively inexpensive. Many commercial property owners, for example, have no incentive to provide recycling services to their tenants. Mandatory Provision of Service is discussed in more detail under Tools and Mechanisms to Address Inconvenient/Limited Access to Recycling Opportunities.

Mandatory Recycling Participation Laws/Disposal Bans. Disposal bans refer to the option of banning certain materials from landfills. This policy is typically implemented at the state level, although some local governments have implemented their own disposal bans. Disposal bans are an effective mechanism when landfilling is less expensive than recycling, as they seek to eliminate landfilling as a lower-cost option. Care must be taken prior to implementing any disposal bans to make sure that adequate and stable opportunities to recover and recycle the banned materials exist. This may require that ample phase-in time is provided to enable the development and readiness of that infrastructure and provide for the advance notice needed prior to the ban going into effect. Enforcement resources also need to be identified and protocols established. Disposal bans are discussed in more detail under Tools and Mechanisms to Address Lack of Participation Where Programs are Accessible. Mandatory recycling participation laws are essentially the inverse of disposal bans, and are also implemented in several states, as well as by some local governments such as Seattle.

Advance Recycling Fees Paid by Consumers. Non-refundable fees charged at the point of sale are in effect in many states for difficult-to-manage goods in order to generate funding so that these items can be returned for processing at the end of their useful life at no additional cost to the consumer. This system is used for a variety of items including used motor oil, tires, lead-acid batteries, electronics (e.g., California) and paint (e.g., the PaintCare program). Texas imposes a fee on the sale of new and used lead-acid batteries. The fee is $3 for each battery of 12 volts or more, or $2 if less than 12 volts. Texas used to have a per-tire fee charged on the sale of new tires, but the fee expired in 1997, per state statute. The advantage of an advance recycling fee is that the recycling is paid for upfront, which makes a consumer more likely to return the item for recycling, as opposed to having to pay for the recycling of the item at the end of its useful life (which is more likely to result in disposal or illegal dumping).

Given the scrap tire management needs of Texas – particularly, the need to divert the 21 percent of tires still being disposed despite existing excess demand, as well as the need to remediate the numerous used tires stockpiles – reinstituting this fee would be advantageous. Fee revenue could be used to help cover stockpile remediation costs initially and then later be used to support improvement of markets for and the marketability of scrap tires. It would be important that any future payments to private entities involved in scrap tire management be tied to documentation of actual end use.

For more information:

- California Electronic Waste Recycling Fee: https://www.calrecycle.ca.gov/electronics/retailer
- PaintCare Recycling Program: https://www.paintcare.org/
- Texas Battery Recycling Fee: https://comptroller.texas.gov/taxes/battery/faq.php
- Texas Tire Recycling Fee (expired): https://fmcpa.cpa.state.tx.us/fiscalmoa/rev.jsp?num=3593

Advance Recycling Fees Paid by Industry.[1] In 2010, Delaware enacted a law that substituted a 4-cent per beverage container recycling fee (paid by retailers) in place of the state's prior 5-cent refundable deposit in order to fund the infrastructure to support the state's Universal Recycling Law. Under the law, waste companies are required to offer recycling services to single-family residential neighborhoods as well as multi-family residential complexes. It also required businesses, non-profits, schools, and municipalities to

[1] The terms "advance recycling fee" and "advance disposal fee" have been used historically to mean fees paid by consumers upon the purchase of a certain product, which funds the proper end-of-life management at the end of the product's life, whether recycling or disposal. More recently per-product fees paid by industry (retailer, wholesaler, importer or producer) have been suggested and in some cases implemented (as described herein) to help pay for product or packaging recycling or to develop recycling infrastructure.

participate in a comprehensive recycling program. The fee, as specified in the law, expired in 2014, but while in existence generated $14 million in funding approximately $8.5 million of which was used to provide grants and low interest loans administered by the Delaware Natural Resources and Environmental Control (DNREC) to local governments and businesses, largely for infrastructure investments. The remainder was reallocated to the general fund. Hawaii also enacted a recycling fee of 1.5 cents per container for glass containers to help fund the recycling of this commodity. This fee is paid by manufacturers, importers, or distributors.

A per-unit Packaging and Printed Paper Fee has been endorsed by The Recycling Partnership's Circular Economy Accelerator. This fee would be paid for by the consumer brand companies to close the funding gaps in infrastructure and education, but it would not fund operation of collection programs. The fee would apply to packaging materials generated commercially, including metal, plastic, glass, and paper. Importantly, the fee as proposed would be eco-modulated. An eco-modulated fee incentivizes brands to design their packaging to reduce environmental impacts by reducing the fee if specific design or material requirements are met. Potential metrics to determine the eco-modulated fee include:

- Recycled content/other sustainably sourced feedstocks
- Greenhouse gas emissions
- Reusability
- Lightweighting
- Design for recyclability according to industry standards
- An industry-led Producer Responsibility Organization (PRO) would collect the revenue from the circular packaging fee and disburse the money.

For more information:

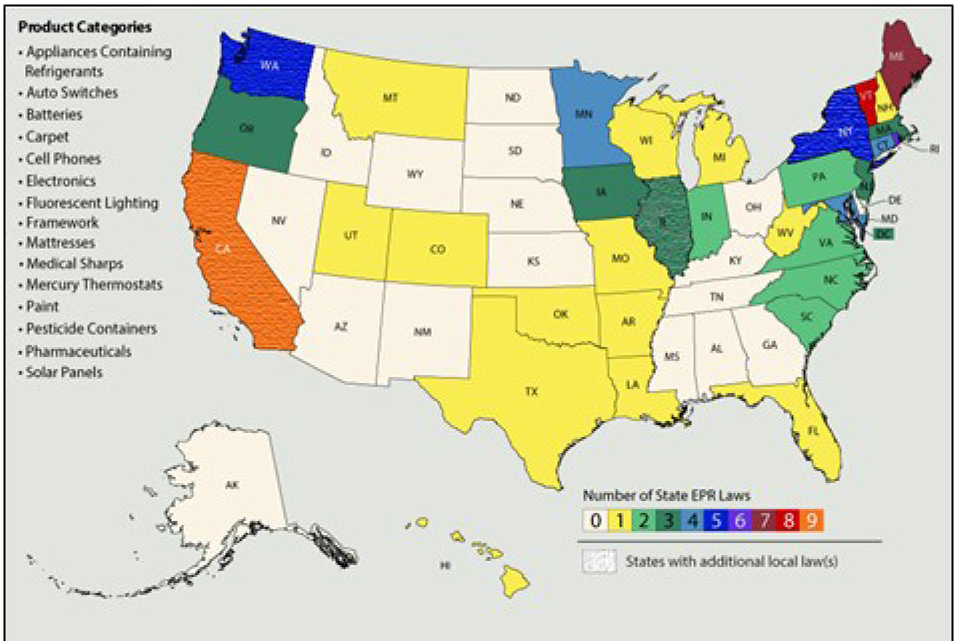
- Delaware Beverage Container Fee (expired): https://legis.delaware.gov/BillDetail/19844
- Hawaii Container Fee: https://health.hawaii.gov/hi5/files/2013/05/deal_FAQRetailers15.pdf
- Circular Economy Accelerator Policy Whitepaper: https://recyclingpartnership.org/wp-content/uploads/dlm_uploads/2020/09/Policy-Whitepaper-9.30.2020.pdf

Extended Producer Responsibility. Extended producer responsibility (EPR) is a mandatory type of product stewardship that includes, at a minimum, the requirement that the product manufacturer is responsible for the end-of-life management of its product and/or packaging. A manufacturer or producer is typically defined as the entity that puts the product onto the marketplace for consumers to buy. In other words, it is normally the brand owner who manufacturers and packages the food or beverage and not the package maker itself (e.g., the can manufacturer) who is responsible and must pay fees under an EPR system. EPR programs typically have mandatory targets for recycling rates and recycling access. The producers can form a Producer Responsibility Organization (PRO) to collect the fees and manage the EPR program.

There are over 100 EPR laws in 33 U.S. states and the District of Columbia covering 14 products, including electronics, batteries, paint, mattresses, thermostats, and pharmaceuticals (see Figure 9-3). Texas has an EPR law for consumer electronics and one for televisions, however, the laws could be strengthened, as is described below.

Texas has an opportunity to enact EPR policies for other difficult-to-manage materials including carpet, mattresses, paint, and batteries, all of which are addressed in this RMDP.

FIGURE 9-3 : U.S. PRODUCT STEWARDSHIP LAWS (2021)



Source: Product Stewardship Institute, Inc. (2021)

Enactment of EPR covering these materials would result in infrastructure being developed and funded by industry for their recovery and recycling. Without EPR, substantial increases in recycling are unlikely for these materials.

With respect to typical recyclables, legislation to establish EPR for packaging has been introduced in the U.S. Congress (the Break Free From Plastic Pollution Act of 2021) and in a handful of states including California, New York, Maine, Oregon, and Massachusetts. Washington introduced an EPR bill this year that was amended to be a recycled content bill, and Maryland and Vermont also introduced EPR for packaging bills, but none of the bills have passed at the time of this writing, with the exception of the Washington bill, which morphed into a recycled content mandate for beverage containers. Hawaii also introduced several EPR-related bills for packaging, including EPR study bills. Other states considering EPR for packaging or that have introduced EPR bills in the past include Indiana, Connecticut, New Hampshire, and Colorado. Interest in EPR is gaining momentum and there is a reasonable likelihood that bills will pass in two to three states in the next few years. In response to this trend, many business groups, including The Recycling Partnership, AMERIPEN and the Consumer Brands Association, have formed committees or councils of their members and other stakeholders to examine what EPR for packaging means for the business community and to determine what kind of EPR system business can support. Texas also has an opportunity to enact EPR for packaging legislation directly or work to influence passage of EPR legislation at the Federal level.

Tools and Mechanisms to Address Reluctance of End Markets to Pay for Processed Material

Material Priority/Categories Addressed: *High Priority: Paper, Colored HDPE, Film Plastics, Glass*

For the recyclable materials listed for this barrier, end markets often have opportunities to buy alternative feedstocks at lower prices, making it hard for buyers to justify paying higher prices for recovered material feedstocks. This is problematic for paper when grades rise in value, causing buyers to substitute alternative grades, or for plastics, when the cost of producing the recovered material exceeds the cost of virgin supply and there is not enough demand to warrant buyers to pay a premium for recycled content. With respect to glass, the ready availability of low-cost virgin feedstock also suppresses pricing. Tools and mechanisms to address this barrier are largely information, facilitation and technical assistance and policy related.

B - Preferential Procurement

Buy Recycled Campaigns and Recycled Product Information. Increasing demand for recycled-content finished products is an indirect means of motivating manufacturers to use recovered materials even when more expensive than alternative feedstocks. The more that consumers want recycled content, the more important it is to manufacturers to make products accordingly. Texas governments at all levels can promote buying recycled – both in a general way (e.g., encouraging consumers to look for recycled content labeling) and in promoting specific Texas-made recycled-content products (e.g., maintaining and promoting the use of green products directories). Texas does have a green products directory, however it could be enhanced substantially to provide more information to purchasers, including images, and to include recycled-content information more predominantly, as well as whether the product is made in Texas, to serve as a better marketing vehicle for Texas-made recycled-content products.

E - Policies

Minimum Recycled-Content Requirements. Increasingly, states and industry stakeholders are considering passage of minimum recycled-content standards as a means of driving demand for recyclable materials. Recycled-content requirements can be very effective in creating demand as well as providing market certainty to stimulate investment in development of the associated feedstock production infrastructure. However, such policies require careful development to ensure that the mandates are practically achievable in the time frames specified and that recycled content can be appropriately certified. California recently passed a law requiring an average of at least 15 percent post-consumer recycled resin in plastic bottles starting in 2022, 25 percent in 2025, and 50 percent in 2030. Beverage manufacturers that are not in compliance are subject to fines. Washington also passed a recycled content bill for plastic bottles (beginning at 10 or 15 percent, depending upon the container specifics, and increasing to 50 percent over time). Wisconsin has a long-standing recycled-content resin requirement for plastic containers sold into the state, requiring 10 percent “recycled or remanufactured” material. As of RMDP publication, New Jersey and Oregon also have introduced bills requiring the use of post-consumer recycled content in certain types of packaging.

Tools and Mechanisms to Address a Lack of Resources for Equipment for Enhanced Processing

Material Priority/Categories Addressed: *High Priority: Typical Recyclables*

MRFs that process typical recyclables are challenged on an ongoing basis by what has been coined “the evolving ton.” This term refers to the change over time in the types of materials entering MRFs due to changes in consumer goods packaging and participation behavior. Historically, recyclable materials were primarily newspaper, glass, and metals; but now plastics and corrugated cardboard are the predominant material types. Contamination has increased substantially due to conversion from dual- to single-stream collection. Consequently, many MRFs need to upgrade their sorting equipment to be more capable of processing today’s materials and producing higher-value, marketable grades. Some sorting equipment carries a substantial price tag and is only suited for larger facilities with higher throughput. In addition, some of the new sorting equipment requires specially trained technicians to perform the necessary programming and maintenance – again making such equipment more suitable for larger facilities. Tools and mechanisms to address this barrier are financial assistance and policy oriented in nature.

C - Financial Assistance

Equipment Grants. As described in the section on Tools and Mechanisms to Address Contamination, many state governments and some industry organizations offer grants to support recycling infrastructure development and enhancement. Thirteen states have grant programs in place to help improve recycling and composting infrastructure. Ten states have grant programs in place for recycling market development, which can also include infrastructure development.

As one example, Michigan Department of Environment, Great Lakes and Energy (EGLE) has implemented a Recycling and Organics Infrastructure Grant Program. Eligible projects include transitioning from bins to carts, public space recycling containers, school recycling, creation or enhancement of public drop-off, recycling collection vehicles, multi-family recycling, and improved processing infrastructure. Capital projects and site improvements are eligible, and organics projects must focus on food waste diversion. Grants can be for up to $1 million with a 20 percent match. Similarly, EGLE has a Recycling Market Development Grant program, which provides funding of up to $250,000 (with at least a 25 percent match) for recycling processing equipment, up to $400,000 (with at least a 25 percent match) for large scale projects that will result in a significant increase in use of recycled materials in a product made in Michigan, and up to $100,000 with a 50 percent match for market development activities led by trade organizations, manufacturers, national brands, or non-profits to achieve clear market development outcomes.

There is increasing interest and national dialogue underway on Federal funding of recycling infrastructure improvements. A number of organizations, including the Plastics Industry Association (PLASTICS), American Chemistry Council (ACC), Association of Plastic Recyclers (APR), Sustainable Packaging Coalition (SPC), AMERIPEN, National Waste & Recycling Association (NWRA), and Solid Waste Management Association of North America (SWANA), are supporting the RECOVER Act (H.R. 5115), which would allocate $500 million in matching federal funds for states, municipalities, and tribes. The money is for use in improving collection and processing infrastructure. RECOVER would also establish a recycling infrastructure program within the U.S. EPA. Texas could also show its support for passage of the RECOVER Act, and if passed, would benefit from working to access some of the funding that will become available.

For more information:

- EGLE Grant Program: https://www.michigan.gov/documents/egle/FY20_MD_RFP_682459_7.pdf

D - Financial Incentives/Disincentives

Tax Exemptions. Several states offer sales tax exemptions for the purchase of recycling equipment. As examples:

- California offers both sales and use tax exemptions for recycling businesses/manufacturers.

- Maine's Department of Economic and Community Revenue offers employment tax benefits to certain businesses, as well as technology tax credits and Business Equipment Tax Exemption (BETE) for certain equipment. Recycling and manufacturing from recycled material would be included. There is also a Business Exemption Tax Rebate (BETR) program that reimburses a company for local property taxes paid on equipment.
- Business Oregon offers small business expansion forgivable loans, property tax abatements in enterprise zones, tax exemptions for very large investments, income tax reductions for businesses meeting certain criteria, tax credits for job creation, and more.
- South Carolina only allows property tax to be taxed at the local level, and there are many exemptions or abatements provided by the locale, depending upon the benefits a company may bring, such as employment.

For more information:
- California Tax Exemptions: https://www.cawrecycles.org/recycling-news/california-passes-sales-tax-exemption-on-recycling-equipment
- Maine BETE Program: https://www.maine.gov/decd/business-development/tax-incentives-credit/tax-relief-programs
- Maine BETR Program: https://www.maine.gov/revenue/taxes/property-tax
- Oregon Loan and Incentive Program: https://www.oregon4biz.com/Oregon-Business/Tax-Incentives/
- South Carolina Resources: https://www.recyclinginsc.com/about-us/recycling-resources/

Reduced Rates for Utilities, Disposal, and Other Incentives. As discussed above, some local and state governments offer recycling processors free disposal of residue that remains after processing. The California Governor's Office of Business and Economic Development (GO-Biz) provides reduced utility rates, as well as an array of support services including siting consultation, regulatory compliance assistance, and coordination of employee training, with reimbursement.

E - Policies

Funding Policy Mechanisms. The policy mechanisms described previously that provide funding to support recycling programs generally apply here as well, as a means of supplying funding for MRF equipment to enhance their processing capabilities. These include EPR, The Recycling Partnership's proposed circular packaging fee, and container fees paid by industry such as those implemented in Delaware and Hawaii, and the Federal RECOVER Act now under consideration.

Tools and Mechanisms to Address Costly Transport Relative to Value

Material Priority/Categories Addressed: *High Priority: Plastics #3-7 and Other Plastics, Glass; Medium Priority: HDPE Colored, Organics, C&D Materials, Tires*

For many parts of Texas, both processors and end markets may be distant, making the cost of transporting materials – especially unprocessed materials – particularly high. For some materials, such as for certain types of plastics, no in-state processors exist. For other materials, such as glass and tires, the material value may not warrant shipment to distant processors. Tools and mechanisms to address this barrier pertain to information, facilitation and technical assistance, financial assistance, and policies.

A - Information, Facilitation and Technical Assistance

Regional Cooperation. Regional cooperation initiatives can improve economies of scale and otherwise improve material transportation efficiencies. Regional cooperation could include:

- Leveraging backhaul opportunities with existing activity of State agencies (e.g., Texas Department of Criminal Justice) to transport materials cost effectively.
- Creating hub-and-spoke systems to provide for regional processing of mixed single stream recyclables but also for regional aggregation of materials generated in small quantities by specific communities which need to be shipped as full truckloads for economical transport (e.g., household batteries and carton bales).
- Using cooperative contracting for collection, transport, or processing of materials in multiple communities.

Cooperative contracting services for collection and transport to market are provided by Keep Texas Recycling (KTR), whose mission is to preserve the environment by promoting recycling through cooperative marketing, the provision of guaranteed end-market contracts, reuse of recyclable materials, coordination of recycling efforts, and promoting public education in rural areas that typically do not have access to recycling services. Given this service already exists in Texas, there may not be a role for State or local government in this regard other than to continue to support the work of KTR which was a TCEQ Texas Environmental Excellence award winner in 2020.

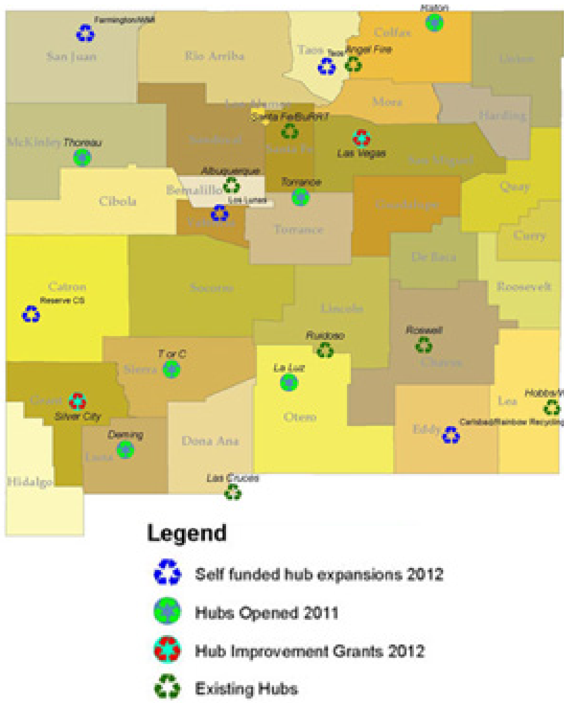
For some types of materials, such as organics, it can be more economical to transport the processing equipment to each community, rather than haul loose material to a central processing facility. Municipalities in the same region can cooperatively hire a contractor to process their material on a scheduled basis. Cooperative contracting can help reduce costs to all participants by increasing their negotiation leverage as well as providing an opportunity for more efficient servicing. Some regional cooperative services including some recycling services are coordinated among Councils of Government (COGs).

Research and Development, Testing, Pilot Projects. In some cases, research and development, pilot projects and/or testing could help develop new or expanded local markets for recovered materials. Examples of key relevance to the RMDP include developing new end uses for gypsum and mixed/other plastics, testing the use of gypsum in compost, and testing new civil engineering uses for recovered glass. Education and outreach are important to facilitate sharing the results of these efforts with others that may be able to apply them in their own programs and operations.

C - Financial Assistance

Regionalization Grants. Some states, as well as regional councils, establish grant funding specifically to support development of hub-and-spoke systems and other regional solutions such as cooperative contracting. Currently, the State of Texas offers a Regional Solid Waste Grants Program through the 24 COGs, including grants that address cross-jurisdictional needs that could be addressed in the creation of hub-and-spoke systems.

FIGURE 9-4: NEW MEXICO'S HUB-AND-SPOKE GRANT PROGRAM



Through years of grant programs (some of which were funded by the U.S. Department of Agriculture), technical assistance, and detailed mapping, New Mexico developed a hub-and-spoke recycling program to efficiently bring recycling to remote areas of the state (see Figure 9 4). The Tennessee Department of Environmental Control (TDEC) previously offered hub-and-spoke grants to groups of at least three communities working jointly in specific (rural) regions of the state to purchase eligible equipment needed for collecting, hauling, sorting, processing, baling, or otherwise preparing recovered materials for transport and marketing. Consideration was given to projects that demonstrate public/private partnerships. Equipment that would cause competition with existing private businesses was not eligible. Tennessee required a local match of 10 - 50 percent, based on an economic index that incorporates factors such as per capita income and property values in the jurisdiction. Additionally, the State of Nebraska has funded three multi-county hub-and-spoke projects through its grant program and the State of Iowa has also funded a study to assess the feasibility of implementing hub-and-spoke projects.

For more information:

- New Mexico Recycling Association Hub and Spoke Recycling: https://www.recyclenewmexico.com/hub-and-spoke-recycling/
- TDEC Hub and Spoke Grants: https://www.tn.gov/former-governor-haslam/news/2012/12/13/haslam-announces-1.7-million-in-recycling-equipment-and-hub-grants.html
- Iowa Hub and Spoke Study: http://publications.iowa.gov/23381/1/hubandspoke_finalreport.pdf

Recycling Market Development/Equipment Grants. There are some material types for which developing local or regional markets and beneficial uses may be the most appropriate way to address costly transportation. Examples include C&D materials and glass. Providing a grant for a region to purchase a glass pulverizer, for example, could provide an opportunity to develop local or regional markets/uses for glass. Potential end uses include as pipe underlayment, filtration media, landscaping material; for base material in road construction; to make "glassphalt;" or as a feedstock for manufacturing specialty tiles. Some communities in Texas have received funding for glass processing equipment to develop markets/uses in the past. One example is Bosque County, which processes approximately 314 tons per year of glass into landscaping glass which is made available for sale at a nominal price. To further develop local or regional markets/uses, the State's Regional Solid Waste Grants Program could allocate a certain amount of funding aimed at addressing specific recycling market development opportunities regionally.

For more information:

- NRRA Glass Recycling: https://www.nrrarecycles.org/glass-recycling-story-map

NRRA's Glass Solution

The Northeast Resource Recovery Association (NRRA), a New Hampshire-based nonprofit, operates a recycling market development cooperative using their expertise in recycling markets and contacts with local governments and businesses. Information is shared primarily through networking, technical assistance, and education. NRRA has provided an option for communities to recycle their glass for decades. NRRA crushes glass into processed glass aggregate to be used in infrastructure projects in the place of sand and gravel. Currently there are consolidation sites in New Hampshire and Massachusetts where members can bring their glass for recycling. Once a host site collects approximately 1,000 tons of glass, a mobile glass crusher is brought to the site to turn the recycled glass into processed glass aggregate (PGA) which is used with great success (reportedly resulting in superior drainage and fewer frost heaves than road base comprised of aggregate), in road construction and pipe underlayment. The member communities not only save the cost of processing, but also reduce contamination in fiber, and save on the cost of aggregate.

Tools and Mechanisms to Address a Lack of Adequate End Markets for Texas-Made Products

Material Priority/Categories Addressed: *High Priority: Food Waste/Organics, Tires*

Food waste/organics and tires are two material types that are used by in-state manufacturers to make products that are offered for sale to Texas consumers, and are material types for which other states have had success growing markets. These products include bagged mulch (both organic material and tire-derived), compost and tire-derived products such as aggregate used in civil engineering applications, weed abatement products used in roads and a variety of landscaping applications, and floor mats. Some of these products compete with similar products from out-of-state suppliers. There are additional Texas-made recycled content products that could also benefit from demand development support. There is a need and opportunity to increase in-state demand for Texas made products. There is also an opportunity to assist in-state manufacturers with marketing their products beyond Texas. The primary tools and mechanisms for addressing this barrier are information, facilitation and technical assistance, preferential procurement, and policy related.

A - Information, Facilitation and Technical Assistance

Feedstock Conversion Research and Promotion. There may be opportunities for Texas-based manufacturers of molded products and rubber-plastic compounds to substitute Texas-produced crumb rubber for some or all of their conventional feedstock. The State could conduct a scoping study to investigate such opportunities and, where identified, work to link suppliers with potential end users.

Research and Information Dissemination. There is an opportunity for additional scientific research about the benefits of compost. Texas universities could evaluate benefits such as increased crop yields and the reduced need for fertilizer and water. The results of this research could be shared directly with composting facilities so they can share the information with their customers/potential customers, could be made available online, and could provide valuable information for a campaign highlighting recycled products made in Texas (see Texas Recycled Product Promotion Campaign below).

B - Preferential Procurement

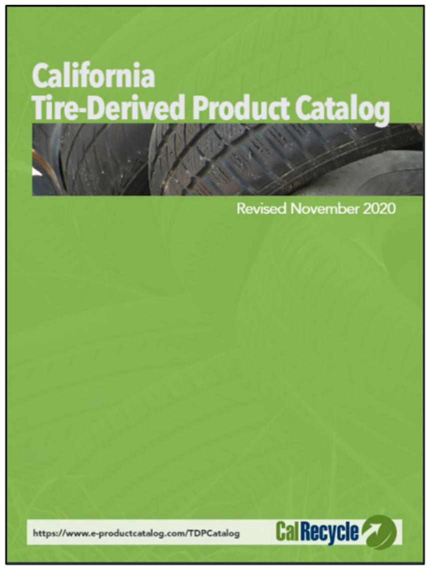
Texas Recycled Product Promotion Campaign. Texas could develop and implement a statewide campaign highlighting products made in Texas from recycled material feedstock. As an example of what this might entail, the Georgia Recycling Coalition implemented a “Made in Georgia” campaign conducted through a partnership between the Georgia Department of Natural Resources, the Georgia Recycling Coalition, and the Georgia Department of Commerce (Figure 9-5). The campaign included production of a video and a series of print ads that highlight the employment benefit of recycling. The campaign also includes a multi-layer GIS map of landfills, transfer stations, MRFs, composting facilities, and end markets for materials, which has resulted in over 130 Georgia businesses using recovered materials to manufacture products. Texas already has a “Go Texan” promotion program, run by the Department of Agriculture that promotes agricultural products including compost made in Texas. One option is for this program to be expanded to include a category to highlight products made from recycled material feedstock.

FIGURE 9-5: “MADE IN GEORGIA” CAMPAIGN AD

For more information:
- Made in Georgia Campaign: https://georgiarecycles.org/programs/made-in-georgia/
- Go Texan Program: http://www.gotexan.org/

Texas Recycled Products Directory. While TCEQ offers a list of resources and links to promote buy recycling opportunities, there does not appear to be a specific vehicle for highlighting Texas products made with recycled materials. One link provided by TCEQ is to California’s Recycled Content Product Manufacturers’(RCPM) directory of California made recycled products and their manufacturers. An even more detailed resource is the California Tire-Derived Product Catalog (Figure 9-6). The catalog was developed to raise awareness of the availability of products derived from California’s discarded tires and their benefits. The directory is for use by in-state and out-of-state potential buyers, thereby helping to market California-made products broadly. Key to the effectiveness of this tool is regular updating so that the content remains current.

FIGURE 9-6: CALIFORNIA’S TIRE-DERIVED PRODUCT CATALOG



There is also an active recycling markets directory in South Carolina, which is a joint initiative of The South Carolina Department of Commerce and the South Carolina Department of Health and Environmental Control (DHEC). The South Carolina Recycling Markets Directory includes processors and end users of traditional recyclables, organics, construction & demolition materials, and other recyclables such as batteries, textiles, electronics, and chemicals.

For more information:
- California RCPM Directory: https://www2.calrecycle.ca.gov/BuyRecycled/Manufacturers/Directory/
- California Tire-Derived Product Catalog: https://www.e-productcatalog.com/TDPCatalog/
- South Carolina Recycling Markets Directory: https://www.recyclinginsc.com/directory/

Cooperative Contracting. The Texas Comptroller’s Procurement Division operates a cooperative purchasing electronic procurement system, called TxSmartBuy, where vendors’ goods and services are listed for access and ordering by state and local government purchasers. Through the TxSmartBuy system, buyers can purchase products that have been categorized by product type and as “Environmentally Certified Products.” However, there is no longer a proactive effort to buy recycled-content products, specifically. Texas could increase its focus on identifying and buying recycled-content products (particularly those that are made in Texas) as well as providing TxSmartBuy members with access to buying such products through the State vendors database.

For more information:

- TxSmartBuy System: http://www.txsmartbuy.com/

Preferential Procurement Programs. In 1997, a study was performed on behalf of what was then the Texas Natural Resources Conservation Commission to evaluate procurement and reporting practices for environmentally preferable products. As part of that study, the Environmentally Preferable Purchasing (EPP) procurement practices of five other states (California, Minnesota, New York, North Carolina, Washington) and the Federal Government were examined along with the practices of Texas, and findings and recommendations for Texas were presented. Among the findings, the report stated that significant opportunity exists for Texas to cost-effectively expand purchases of recycled-content products. The State implemented some of the measures recommended in the study, but more opportunities are available. As one example, there are some product preferences provided in the State code, such as a preference for rubberized asphalt paving material made from scrap tires by a facility in the state. Additional product types could be specified in the code.

For more information:

- CalRecycle SABRC: https://www.calrecycle.ca.gov/BuyRecycled/StateAgency/

State Agency Buy Recycled Campaign

California has a strong State Agency Buy Recycled Campaign (SABRC), which is a joint effort between CalRecycle and the Department of General Services (DGS). This effort administers the state laws around EPP. State agencies and the Legislature are required to purchase recycled content products, track those purchases and report annually. Under the law at least 75 percent of the total purchases in "reportable categories" must contain recycled-content products meeting the minimum percentage content, except for paint, antifreeze, and retread tires, for which the 50 percent requirement is retained.

9.5 Material-Specific Tools and Mechanisms

Barriers that negatively impact the marketability and markets for specific material types are listed below, by material type, along with potential tools and mechanisms for addressing them.

Tools and Mechanisms to Address the Lack of Adequate Collection, In-State Sorting/ Processing and End Markets for Plastics #3-7 and Other Plastics

As described in Section 7, this material category includes mixed #3-7 plastics, bulky rigids, polypropylene (PP, #5), and all other plastics not discussed separately. Previously, mixed #3-7 plastics were exported for hand sorting in countries with low labor costs, but most of these international markets no longer accept mixed plastics. Consequently, there is a need to create a domestic recovery and end markets infrastructure for the valuable components in this mixture – particularly to recover PP out of this mix, which has growing market value.

Residential bulky rigids also have market value but are not always targeted for collection in community recycling programs. This material consists mostly of HDPE but contains some PP, both of which have market value. Texas has at least one end user, in Brownsville, that manufactures a product from resin derived from bulky rigid plastics. While it is not known whether Texas-generated bulky rigids could be used in making these carts, this possibility merits investigation. More end markets are needed in the State to consume the available supply.

Tools and mechanisms for addressing the lack of collection, processing, and end use options are primarily information, facilitation and technical assistance, financial assistance, and policy related.

A - Information, Facilitation and Technical Assistance

Technical Information and Guidance. While some communities, such as Austin and Dallas, accept bulky rigids for recycling in their programs, many other communities do not. Local recycling program operators may simply not be aware of opportunities for recycling bulky rigids and how best to include these materials in their collection programs. The State could play a role in developing and disseminating guidance on how to recycle bulky rigids, including identification of best practices and available processors and end markets. The Association of Plastic Recyclers has developed guidance on bulky rigids recycling, which would serve as a good starting place for developing guidance of a Texas-specific nature. The State can also play a role in monitoring market conditions and informing local governments about emerging opportunities for recycling PP as well as other plastics.

For more information:
Association of Plastic Recyclers Guidance: https://plasticsrecycling.org/beyond-bottles

Research and Development. Research and development and technical assistance can play a role in developing stronger markets for PP and film plastics in Texas. Dow, for example, has worked with the Indonesian Government and others (e.g., local governments in India and Thailand) to include plastics in road construction. Dow has constructed two private roads at its facility in Freeport, Texas using 1,700 pounds of recycled plastic, which is the equivalent weight of 120,000 plastic grocery bags. Similar efforts could develop uses for other plastics needing markets, whether carried out by businesses or universities. Such research would likely be complemented with pilot projects and technical assistance for further project implementation.

Manufacturing with More PRC

There is a manufacturer of "EcoCarts" in Brownsville, Texas (Cascade Cart Solutions) that makes trash carts for Waste Management Inc. with resin that is 10 percent bulky rigids. KW Plastics supplies the recycled HDPE pellets. One challenge in using PCR is that a certain amount of polypropylene PP) remains in the HDPE pellets. PP makes the plastic more brittle. The portion of recycled bulky rigids used in manufacturing the carts could be higher (20 or 25 percent) if more PP could be removed.

Source: "How a Domestic Outlet for Bulky Rigids Was Born," Resource Recycling, March 24, 2020.

C - Financial Assistance

Infrastructure Development Grants. MRFs that want to sort out PP and accept residential bulky rigids may need additional processing equipment to do so. This is also the case for the establishment of plastics recovery facilities (PRFs) that accept mixed #3-7 plastics and/or bulky rigids and sort/process in accordance with the specifications of the various markets they supply. These may be mechanical recycling markets and may increasingly be chemical recycling markets as more such facilities come online. Currently, market conditions alone do not support the establishment of PRFs, hence why financial assistance is needed.

The State could establish a grants program that includes funding to help establish operations that sort mixed plastics as one area eligible for support. Some private sector organizations have also provided funding in the past and may continue to do so in the future. The Recycling Partnership established the Polypropylene Recycling Coalition which provides grant funds to facilitate MRF processing, sortation, and marketing of PP packaging to ensure access to PP recycling in U.S. community recycling programs. As of RMDP publication, the current funding round has an application due date of September 30, 2021. Whether future grant rounds will be established remains to be determined.

Another group to monitor for partnership opportunities is the U.S. Plastics Pact. This organization is comprised of 89 members and growing, including major brands such as Unilever and Coca-Cola, and has a very aggressive goal of "undertaking ambitious actions to effectively recycle or compost 50 percent of plastic packaging by 2025."

E - Policies

Funding Policy Mechanisms. The previously described funding policy mechanisms, which provide funding to support recycling programs, could provide means of supplying funding for equipment at MRFs and plastics recovery facilities (PRFs) to sort and process mixed plastic packaging and recover PP. These funding policy mechanisms include EPR, The Recycling Partnership's proposed circular packaging fee, container fees paid by industry such as those implemented in Delaware and Hawaii, and the Federal RECOVER Act now under consideration. Many bulky rigid items are not packaging (e.g., plastic toys, lawn chairs, laundry baskets, and buckets) and would therefore not be covered directly by some policies (e.g., bottle bills), but could be covered by an advance recycling fee paid by consumers. If PRFs were established as a means of enhancing the recycling system, then bulky rigids could be sorted at these facilities.

Tools and Mechanisms to Address the Lack of Wash Lines for Film Plastics

While film plastics also has barriers related to lack of adequate collection programs and limited processing and end markets, the primary barrier limiting more recycling is a lack of wash lines. Wash lines are needed to allow more residential and agricultural film to be cleaned to meet end market specifications and to enable more flexible plastic food packaging to be recycled. Current opportunities for collection of residential film are limited to store drop-off. These programs generally only accept polyethylene (PE) film plastics that are clean and dry, which means that flexible plastic pouches that contained wet foods – even if the pouches were made solely of PE – would likely not be accepted due to concerns regarding food contamination. Regarding agricultural film, there are some U.S. processors that have wash lines, but none are known to be in Texas. If more reclaimers installed wash lines, additional opportunities to recycle a wider range of flexible plastic/films will be developed. Tools and mechanisms for addressing this barrier are primarily financial assistance and policy related.

C - Financial Assistance

Equipment Grants. Equipment grants could allow Texas reclaimers to install wash lines, which would enable them to expand the types of flexible plastic packaging and film plastics recycled. This would work best in tandem with policies that encourages the use of recycled content, as well as policies that provide funding mechanisms to support the grants.

E - Policies

Funding Policy Mechanisms. Funding policy mechanisms such as EPR or advance recycling fees paid by industry would help fund grants for wash line capacity, which in turn would allow reclaimers to accept additional types of film plastic and flexible packaging.

Minimum Recycled Content Legislation. There is an opportunity to boost demand for film plastics and therefore incentivize investment in washing systems by enacting minimum content legislation for film in specific products – particularly trash bags, which are capable of being heavier gauge and more tolerant of potential additives and impurities present in recovered film than grocery sacks, although some states have also instituted minimum recycled content for grocery sacks as well as for reusable grocery bags. California has recycled content requirements for manufacturers and wholesalers of garbage bags, as well as for manufacturers of reusable shopping bags.

For more information:
- California Trash Bag Program: https://www.calrecycle.ca.gov/buyrecycled/trashbags
- California Reusable Bag Program: https://www.calrecycle.ca.gov/plastics/carryoutbags/faq#2.

Mandatory Provision of Service. Several states (i.e., Maine, California, Delaware, New York, and Rhode Island) and the District of Columbia have laws mandating that retail stores provide return-to-retail recycling of film plastics. Generally, these laws apply to stores of a certain size and that provide plastic bags to customers. Some states have introduced bills that would mandate retailers to provide this service even if they do not provide plastic bags. Having a mandatory provision of service law in place in Texas would help ensure that a wash line in the state would have a supply of retail material.

Tools and Mechanisms to Address a Lack of Adequate Reclaimers and End Markets for PET Thermoforms

Few Texas recycling programs accept PET thermoforms, largely because there are limited reclaimers that will accept them in PET bottle bales and very few reclaimers accept thermoform-only bales for processing. It appears that there is not a PET reclaimer in Texas accepting baled thermoforms or desiring thermoforms in its PET bottle bales. Typically, reclaimers limit thermoforms to be less than 10 percent of PET curbside bales; however use of thermoforms as a packaging type is growing and the National Association for PET Container Resources (NAPCOR) forecasts this fraction will average 17 percent by 2024. End uses for PET thermoforms are very limited, and include creation of new thermoforms with recycled content or upgrading the thermoform resin for use as a feedstock for making bottles, but the majority of PET reclaimers do not accept bales of them, and only accept thermoforms in other PET bales in limited quantities. Tools and mechanisms to address this barrier are financial assistance and policy related.

For more information:

- NAPCOR Report: https://napcor.com/wp-content/uploads/2020/10/2020-09_NAPCOR-thermoform-progress-report-Update_FINAL.pdf

C - Financial Assistance

Equipment Grants. A potential means of addressing this barrier is through provision of equipment grants for reclaimers. These grants would enable reclaimers to accept and process mixed PET bales and either sort the thermoform material for shipment to thermoform only end markets, such as the end market that exists in Ciudad Juárez, Mexico, or to produce a thermoform feedstock suitable for use in PET bottle manufacturing. Recipients of this grant funding could be existing Texas-based companies or possibly a new company that decides to locate in Texas to process thermoforms. As an example of such a program, the California Department of Resources Recycling and Recovery (CalRecycle) recently approved over $10 million for recycling processing equipment through its Recycled Fiber, Plastic, and Glass Grant Program. As part of this funding, CalRecycle awarded a $3 million grant to Green Impact Manufacturing to open a plant that takes in bales of post-consumer thermoforms and produces recycled PET (rPET) for food-contact applications which will recycle over 30 million pounds (15,000 tons) of PET per year. In addition, CalRecycle awarded a $1.6 million grant to Global Plastics Recycling, which produces rPET flakes, pellets, sheets and thermoforms from postconsumer PET bales. The grant will help the company boost its optical sorting capabilities and upgrade grinding and washing lines so Global Plastics Recycling can better handle thermoforms. The end product will be a mix of thermoform-bottle flakes, which will be shipped to packaging manufacturer Sonoco, and is expected to divert about 1,300 tons of PET from landfills each year.

For more information:

- CalRecycle Grant Program: https://www.calrecycle.ca.gov/climate/grantsloans/fpg
- 2019-2020 Funding: https://www2.calrecycle.ca.gov/PublicNotices/Documents/13219

E - Policies

Extended Producer Responsibility. Under EPR, especially when eco-modulation fees are included, producers would be expected to meet certain recycling rate goals and to provide the funding support to do so. Funding through EPR could support the establishment of plastics processing facilities (PRFs) and expansion of reclaimer capabilities to handle PET thermoform sorting and reclamation. Demand for PET is growing due to brand commitments and efforts on the part of organizations such as the U.S. Plastics Pact. If EPR for packaging legislation were enacted in Texas or at the Federal level, funding for thermoforms recycling would come from industry sources and State grant funding might not be needed.

Tools and Mechanisms to Address the Potential Need for Additional Secondary Processing for Glass

Although Texas' many glass product manufacturers have a strong demand for recycled glass, the challenge is cost-effectively collecting, processing, and transporting clean cullet to them. Because glass is relatively low value, and subject to contamination in single-stream systems, it is not cost-effective to transport glass significant distances for secondary processing. Thus, some communities have had to discontinue glass collection, rely on their own end uses, or establish drop-off collection sites for glass such that clean source-separated glass is transported. Encouraging or assisting a glass processor to establish an additional beneficiation facility for post-MRF glass could result in glass recycling being more broadly available. Other options include:

- Developing hub-and-spoke glass collection systems from communities currently not collecting glass. This approach could also include an effort to increase the collection of glass from residential and commercial generators. This would likely include glass that is collected separately, e.g., via drop-offs and glass-specific (or beverage container-specific) commercial programs.
- Increase collection of glass directly from commercial generators located in relatively high-density population areas to secondary processors or for delivery to a manufacturer with the ability to process glass. In this case, collecting glass that has been separated by color might allow for direct delivery to certain manufacturers.

Tools and mechanisms to address this barrier include information, facilitation and technical assistance, financial assistance, financial incentives, and policies.

C - Financial Assistance

Equipment Grants. Equipment grants could be used to fund collection trailers, depots or bins, transportation vehicles, and/or processing equipment for glass manufacturers to be able to accept separated glass directly.

D - Financial Incentives

Tax Credits, Permit Fee Waivers, or Other Incentives. The State or more likely local government can provide financial incentives to a private entity wanting to provide secondary glass processing where it is needed. This could include expansion of capacity at an existing facility, co-location at a large MRF, or co-location at a glass manufacturing facility as well as co-location at a public facility such as a landfill. The exact incentives to be provided would depend upon the location of the facility, the ability of the local government to provide such incentives, and negotiations between the entity and the local government.

E - Policies

Funding Policy Mechanisms. Funding policy mechanisms, such as EPR or advance recycling fees paid by industry or consumers, would help fund grants for equipment needed to set up systems for glass collection, transportation, and glass processing, as well as to conduct education and outreach efforts and develop signage and other educational tools.

Mandatory Recycling of Beverage Containers by Large-Quantity Generators. Mandatory recycling of beverage containers by large quantity generators (e.g., bars and restaurants) would increase supply, making it more cost-effective to either site an additional glass processing facility, send source-separated glass more cost effectively to existing processors, or supply source-separated glass more cost effectively to existing glass manufacturers that can accept this material. This requirement could be limited to generators located within a certain distance of secondary processors/end markets. Essential to a successful mandatory recycling law is high-quality education and outreach.

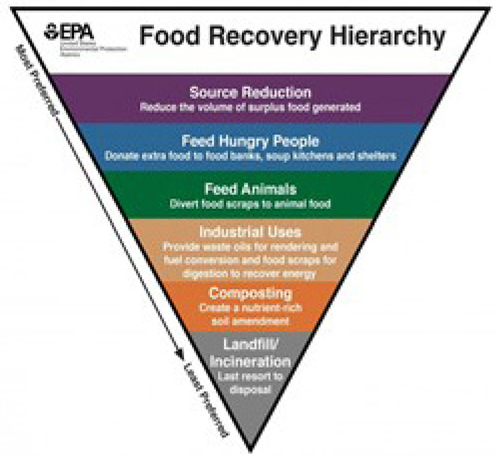
Beverage Container Deposit Legislation. A beverage container deposit law would result in an incentive for all generators to return their beverage containers for a deposit. The material would be collected separately from other materials, which results in cleaner, higher-value material. This could help glass be collected and transported more cost effectively to an existing processor, provide for suitable material for a manufacturer to receive material directly, or increase material flow enough to justify the cost of a secondary processing facility. Moreover, since return rates are less than 100 percent, deposit policies create a new revenue source of unredeemed deposits that can be used to support a variety of additional recycling market development strategies such as education campaigns, incentives, grants, or technical assistance.

Tools and Mechanisms to Address Inconvenient or Limited Access to Collection Programs; Lack of Participation (Large-Quantity Generators) for Food Waste/Organics

There are many large-quantity generators of food waste in Texas, including food and beverage manufacturers, processors, and retailers, as well as restaurants and other food service establishments. Targeting pre-consumer food waste from large-quantity generators before targeting residential food waste for composting allows for a “bigger bang for the buck” in terms of directing food waste to composting facilities in a way that includes proper training and control to minimize contamination and allows for a more direct information feedback loop such that issues can be identified and addressed quickly.

Tools and mechanisms for addressing these barriers are primarily information, facilitation, and technical assistance; financial assistance; and policy related.

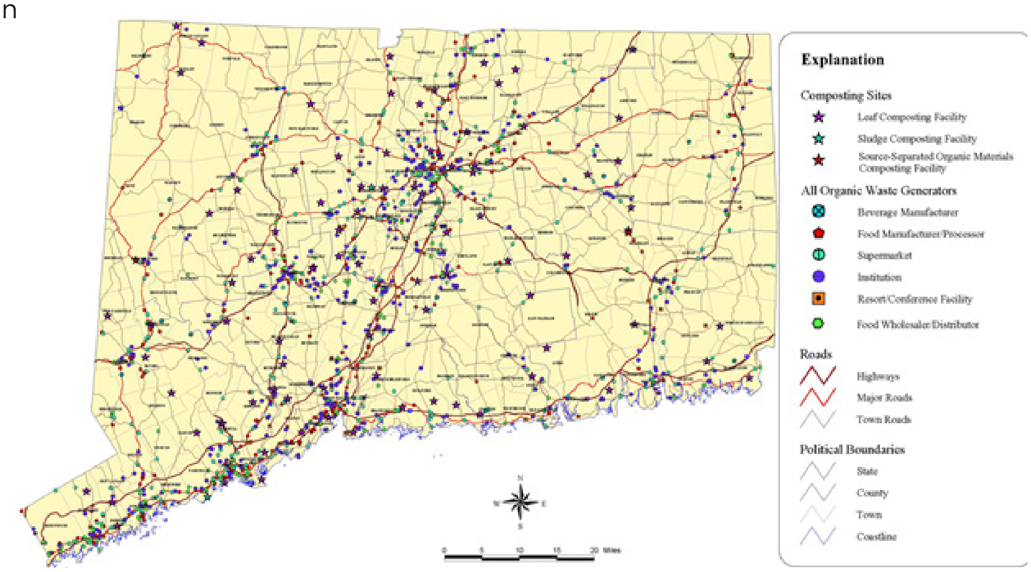
FIGURE 9-7: U.S. EPA FOOD RECOVERY HIERARCHY



A - Information, Facilitation and Technical Assistance

Research, Pilot Programs and Technical Guidance. Research can be conducted to identify large-quantity food waste generators that are currently disposing of food waste, particularly those relatively close to composting facilities that are able to accept additional quantities of food waste. Pilot programs can be developed to divert this material, with ongoing technical guidance and eventual transition to permanent food waste diversion programs. During this process ongoing communication is vital to ensure material is prepared properly and is suitable for the compost facility's operation. Successful in-house methods to prepare and divert material can be identified, and when fully transitioned the generator can provide tips and mentor other large-scale generators of food waste. Technical assistance should include ensuring that the generator is following the preferred food waste hierarchy, which includes diverting to human or animal consumption as appropriate versus composting (Figure 9-7).

FIGURE 9-8: FOOD RESIDUAL GENERATION MAP IN CONNECTICUT (2012)



Source: CT Deep

Database Development and Generator Mapping. Another method of providing information that would allow composters to actively source food waste and other organics is to develop a database of large-scale food waste (and other organic material) generators. Connecticut Department of Energy and Environment (CT DEEP) funded a project in 2001 that identified, quantified, and mapped each of the large-quantity commercial and institutional locations in Connecticut generating potentially recyclable food waste (Figure 9-8). Large-quantity generators were then matched against the state's transportation network and existing composting infrastructure. This project was updated in 2012 by U.S. EPA Region 1. The resulting tool allows entrepreneurs, composters, haulers, waste managers and recycling professionals to not only identify the location of large-quantity food generators but can use the information to establish new accounts, select the right collection vehicles, design efficient transportation routes, and identify feedstock-rich environments in which to site new organics recycling facilities.

For more information:

- Connecticut Food Residual Map: https://portal.ct.gov/-/media/DEEP/compost/compost_pdf/CTFoodResidualGeneratorReport2012pdf.pdf

Information Sharing and Networking. A workshop or conference could be held to bring together composting professionals, large-scale generators of food waste, and other stakeholders to present information about existing large-scale food waste programs that successfully divert material to Texas compost facilities. Lessons learned and best practices can be shared and any benefits to the company can be touted. This forum could provide a practical forum for large-scale food waste generators considering or curious about diverting food waste to obtain real-time responses to questions and assurance that the transition can be made with success.

C - Financial Assistance

Equipment/Consulting Grants. A grant program could be established that provides large-quantity generators and/or compost facilities with funding for equipment and consulting support pertaining to how to implement a food waste composting program. Changes in materials management in the facility may also require additional equipment, such as hoppers for food waste, and there may be a need for dedicated collection vehicles and/or de-packaging equipment. The grant contribution would ideally remove a barrier to diverting this material.

E - Policies

Food Waste Diversion Mandate. According to the Environmental Research and Education Foundation (EREF), six states have implemented food waste diversion (and in some cases all organics) laws. These states are California, Connecticut, Massachusetts, New York, Rhode Island, and Vermont. Often food waste diversion policies target high-volume commercial generators, at least initially, and expand over time in a tiered manner to include smaller-volume generators. Only Vermont's law includes residential generators. By specifying that only generators within a certain distance to a suitable processing facility are required to comply, the development of a processing infrastructure is encouraged. In Connecticut, for example, generators of 104 tons of source-separated organic material annually must divert that waste to a compost facility if there is one located within 20 miles.

Some local governments have food waste collection mandates. In Texas, Austin's Universal Recycling Ordinance requires all food enterprises to have separate collection of food scraps to divert organic materials. The city enacted a phased approach, with the largest category (by square footage) of food enterprises being required to comply in 2014, and gradually expanding to all food enterprises in 2018. Austin also offers residential curbside collection of food waste. The city of Seattle also has a commercial and residential food waste/compostable paper diversion mandate in place.

For more information:

- EREF Food Waste Diversion Mandates: https://erefdn.org/wp-content/uploads/2019/04/EREF-State-Organics-Diversion-Manadates.pdf
- Connecticut Commercial Organics Law: https://portal.ct.gov/DEEP/Waste-Management-and-Disposal/Organics-Recycling/Commercial-Organics-Recycling-Law
- Vermont Food Scrap Ban Guidance: https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/Universal-Recycling/Food-Scrap-Ban-Guidance.pdf
- City of Austin's Organics Diversion Requirements: https://austintexas.gov/bizorganics
- City of Seattle's Food and Compostable Paper Requirements: https://www.seattle.gov/utilities/your-services/collection-and-disposal/food-and-yard/food-waste-requirements

Tools and Mechanisms to Address the Poor Perception of Biosolids and Biosolids-Containing Products

One barrier identified that impacts demand for some products like compost and soil amendments made from food waste, yard trimmings, and other organic feedstocks is that some consumers (or potential consumers) have a poor perception of the inclusion of biosolids in such products, particularly when used to grow food. Since 2000, biosolids have been prohibited for use in organically-produced agricultural products under the United States Department of Agriculture's National Organic Program. However, "there is no current scientific evidence that use of sewage sludge in the production of foods presents unacceptable risks to the environment or human health," according to USDA. Compost and soil amendments are permitted for use in growing other food products and ornamental crops, but some potential consumers and environmental advocates still have concerns. Tools and mechanisms for addressing this barrier are information, facilitation and technical assistance related.

A - Information, Facilitation and Technical Assistance

Research. A Texas university (or universities) could conduct research of compost containing biosolids or application of biosolids under specific conditions testing for the presence of toxins, pharmaceuticals, hormones and pathogens, for example, to better understand whether compost made with biosolids and certain uses for biosolids poses a risk. This research would test for chemicals beyond those currently tested for in meeting permitting requirements.

Information Sharing and Exchange. A workshop or webinar could be held to share the research results and bring together stakeholders for information exchange purposes. The State could also make the relevant study results – including results from in-state research as well as relevant research conducted in other states – available online. Stakeholders would then be able to access and provide information from these studies to potential end markets of biosolids-containing organic products to help alleviate concerns and address misconceptions regarding toxicity risks, as appropriate.

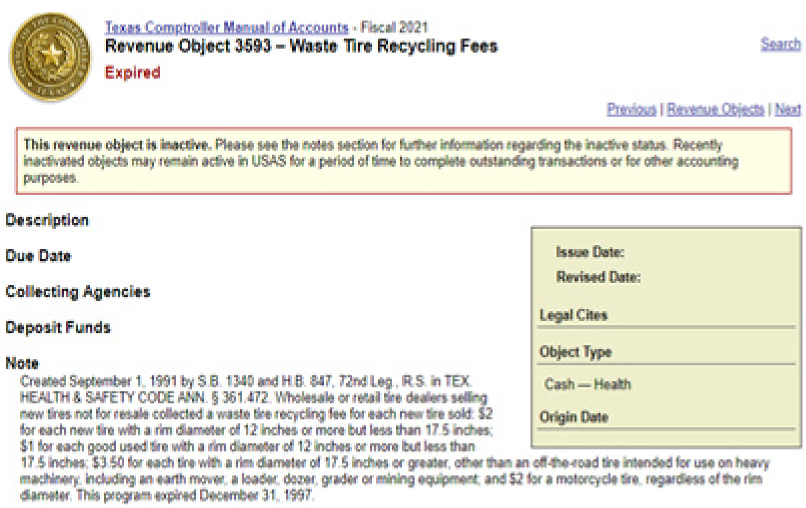
Tools and Mechanisms to Address the Limited Availability of Suitable Markets/Outlets for Tires

Stockpiled tires are plentiful, but their quality deteriorates over time. They are typically very dirty, thereby limiting their potential uses and value. Land reclamation and using tire shreds in a base layer in highway construction are potential end uses albeit low value in nature. Stockpiled tires are also permitted for use in cement kilns assuming 2-10 percent of wire is removed prior to use. Moving stockpiled tires into such applications is feasible but will require funding. The primary tool/mechanism for addressing this barrier is policy related.

E - Policies

Advance Disposal/Recycling Fee Paid by Consumers. Texas previously had a per-tire recycling fee (see Figure 9-9) that was paid by consumers upon the purchase of tires to cover the cost of managing them at the end of their useful life. Fees ranged from $1 to $3.50 for most tires depending on the size. The fee expired in 1997. According to the U.S. Tire Manufacturers Association (USTMA), currently over 30 states have tire management fees in place. Fees in southern states range from $0.50 to $2.50 per passenger tire and higher for larger tires. Texas is the only southern state without a tire fee. Reinstitution of the State's advance tire recycling/disposal fee paid by consumers would provide funds to support cleaning up the State's tire stockpiles and encourage proper management of tires at end of life. Reducing cleanup costs, such as those being funded through the State's Regional Solid Waste Grants Program, would free funding for recycling market development efforts, and higher-quality scrap tires would result, potentially enabling them to flow to higher-value uses.

FIGURE 9-9: TEXAS WASTE TIRE RECYCLING FEE ACCOUNT - EXPIRED


Texas Comptroller Manual of Accounts - Fiscal 2021
Revenue Object 3593 – Waste Tire Recycling Fees
Expired
Search
Previous | Revenue Objects | Next

This revenue object is inactive. Please see the notes section for further information regarding the inactive status. Recently inactivated objects may remain active in USAS for a period of time to complete outstanding transactions or for other accounting purposes.

Description

Due Date

Collecting Agencies

Deposit Funds

Note

Created September 1, 1991 by S.B. 1340 and H.B. 847, 72nd Leg., R.S. in TEX. HEALTH & SAFETY CODE ANN. § 361.472. Wholesale or retail tire dealers selling new tires not for resale collected a waste tire recycling fee for each new tire sold: $2 for each new tire with a rim diameter of 12 inches or more but less than 17.5 inches; $1 for each good used tire with a rim diameter of 12 inches or more but less than 17.5 inches; $3.50 for each tire with a rim diameter of 17.5 inches or greater, other than an off-the-road tire intended for use on heavy machinery, including an earth mover, a loader, dozer, grader or mining equipment; and $2 for a motorcycle tire, regardless of the rim diameter. This program expired December 31, 1997.

Issue Date:
Revised Date:
Legal Cites
Object Type
Cash — Health
Origin Date

For more information:

- USTMA Legislation Summary: https://www.ustires.org/sites/default/files/U.S.%20Scrap%20Tire%20Management%20Summary.pdf

[2] "Is It Safe To Use Compost Made From Treated Human Waste?" The Salt, National Public Radio, Eliza Barclay, May 12, 2013.

Tools and Mechanisms to Address Safety or Performance Concerns for Tire-Derived Products

For certain products made from scrap tires, such as synthetic turf and rubber modified asphalt, concerns have been raised by some stakeholders about product safety and performance. Also, potential tire-derived product consumers are often unfamiliar with the products and their performance characteristics. Consequently, there are limited in-state markets for such end uses, even though beneficial end market applications exist. Tools and mechanisms to address this barrier are information, facilitation and technical assistance and financial and other incentives/disincentives related.

A - Information, Facilitation and Technical Assistance

Information Dissemination. Numerous studies have been performed on the potential health risks associated with use of crumb rubber derived from tires in synthetic turf. Research has also been conducted on the performance characteristics of different types of tire-derived products. The State could gather such study results and prepare an online annotated bibliography to make the findings accessible to those having questions or concerns.

Webinars are another way to share information regarding tire-derived product performance. Speakers can share performance data and their experience using certain products for applications in or relevant to Texas.

Pilot and Demonstration Projects. New products and improvements in existing products continue to be made. For applications such as roadway construction, there is often a need to test product performance on a pilot basis prior to more extensive use. The State can foster the establishment of pilot and demonstration projects, obtain and share the results, and promote success stories. State agencies such as TxDOT could play a leading role in implementing these types of projects in various regions of Texas.

D - Financial and Other Incentives/Disincentives

Awards Program. The State could sponsor an awards program to recognize use of tire-derived products that consume significant quantities of tires or are innovative with respect to the nature of the application. Applicants could be asked to provide performance data and to consent to sharing the results. This type of program could also be expanded to include other material categories and a range of public and private purchasers.

Tools and Mechanisms to Address Inconvenient or Limited Recycling Opportunities for Textiles

While this barrier is shared with other materials, the circumstances associated with textiles are unique in that residents in most parts of Texas have no collection service for used household textiles and must deliver them to one of the various private thrift and consignment stores for resale or recycling. In many parts of Texas, there are no opportunities for residents to recycle mattresses or carpet, although there may be opportunities on a fee basis for businesses (such as hotels and carpet installation companies). There is one company, Simple Recycling, that currently offers curbside collection of used textiles to selected communities in the Dallas/Fort Worth area, but this is a very limited part of the state. Tools and mechanisms to address this barrier are information, facilitation and technical assistance; financial assistance and policy related.

A - Information, Facilitation and Technical Assistance

Information Dissemination and Recycling Promotion. Curbside collection of textiles can be complimentary to acceptance of textiles at local thrift and consignment stores, given the significant quantity of textiles that continues to be disposed. As a result, there is an opportunity for the State and other entities to promote separate curbside collection of textiles as well as to encourage local governments to also promote donation of textiles and other household items to local thrift stores that accept them. Some of these organizations also will pick up donated goods – something that many residents may not be aware of. Many residents are also not aware that some of these organizations may also accept recyclable items (e.g., torn but clean cotton clothing and linens) as well as those that can be resold.

C - Financial Assistance

Start Up Grants. While textile recycling has largely been a private sector initiative, there is a potential role for government to play in supporting separate curbside collection. The State could provide start up grant funding, either directly or through the COGs, to communities seeking to implement curbside collection of textiles – either directly or via a private service provider. Such funding could support equipment acquisition and program promotion.

Funding via PAYT Programs. If free private sector collection of textiles is not locally available, one option for communities with Pay-As-You-Throw (PAYT) programs would be to provide for separate bag-based collection of textiles along with recyclables at a per-bag rate that is lower than the per-bag or per-cart rate for trash collection. Austin and Fort Worth are two Texas cities that have instituted PAYT. PAYT programs provide for funding of materials management but also provide incentives for waste diversion and recycling.

E - Policies

Advance Recycling Fees Paid by Consumers. With respect to carpet and mattresses, it is possible to establish an advance disposal or recycling fee to be paid when new carpet and/or mattresses are purchased to fund the recycling of these bulky waste items at the end of their useful life. A mandatory fee payable at point of sale helps deter illegal dumping of such materials as these items are then accepted for recycling at no cost.

Extended Producer Responsibility. EPR polices generate funding but can also include management responsibility where producers provide the materials handling system to accept, process and market the recovered materials, funded through the fees paid by the producer companies. California, Connecticut, and Rhode Island have such EPR policies and programs for mattresses with mattress recycling provided by the Mattress Recycling Council. California is the only state that currently has an EPR law for carpet, but bills have been introduced in four states: Minnesota, Illinois, New York, and Oregon. Under EPR carpet companies are required to set up and operate carpet recycling programs. These laws make it possible for homeowners and businesses to recycle carpet, incentivize manufacturers to create less toxic carpet, and relieve governments from the burden of managing carpet waste. While EPR for household textiles is also an option, there are no such laws currently in the U.S. and few elsewhere in the world.

Tools and Mechanisms to Address Lack of In-State Processors and End Users to Meet Growing Demand for Fiber-to-Fiber Chemical Recycling

Texas has a strong textiles export industry, with several textile handlers importing textiles from other states and sorting and grading them for shipment, primarily to export markets where they are further processed for resale or use in making other products. The U.S. has relied upon export markets largely due to access to cheap labor; however recent technology developments are improving opportunities for better identification of textile material types and automation of sorting and grading activities. In addition, textile industry stakeholders have growing interest in creating a circular economy and, through chemical recycling processes, converting fiber back into molecular building blocks from which new fiber is produced. Currently, processors and end users supporting this emerging market are limited. Texas, because of its current role in the textile industry, has a potential opportunity to capitalize on these emerging technologies and trends and become a market hub to support textile circular economy development. Tools and mechanisms to address this barrier are information, facilitation and technical assistance related.

A - Information, Facilitation and Technical Assistance

Feasibility Assessment. Given that this is an emerging recovery pathway, exploration of the feasibility and nature of the potential opportunities is a good starting place. The outcome of this research can set the stage for next steps.

Stakeholder Engagement and Facilitation. Upon completing the initial feasibility assessment, a possible next step would be to bring together Texas-based textile industry stakeholders with other national or international industry stakeholders working in the area of textile circularity and fiber-to-fiber recycling. Examples include representatives from Accelerating Circularity which is working to “accelerate the textile industry’s move from linear to circular," and chemical recycling industry representatives such as from Eastman, which has launched a new product currently made from 40 percent recycled plastic and is now working towards being able to use recovered textiles as feedstock.

As opportunities begin to materialize, consideration of the use of other tools and mechanisms such as provision of financial or other economic development incentives may be warranted.

Tools and Mechanisms to Address the Lack of In-State Recycling Infrastructure for EV and ESS Batteries

The U.S. automobile industry is rapidly transitioning away from vehicles powered by gasoline and diesel to those powered by electric vehicle (EV) batteries. A leader in this transition is Tesla, which has a significant and growing presence in Texas. In addition, Texas is also home to a sizable solar power industry, which also uses an extensive array of energy storage system (ESS) batteries. Infrastructure is currently lacking for the management of EV and ESS batteries at the end of their useful life, but research and development addressing this need is rapidly moving forward. First and foremost, infrastructure will be needed to manage the EV and ESS batteries that will be generated in Texas. Texas also has a window of opportunity to capitalize on its sizeable relevant industrial base and become a potential player nationally in the recycling of spent batteries. Li-Cycle, headquartered in Toronto, announced in April 2021 that it will build its third North American lithium-ion battery recycling plant in the Phoenix area. The operation will be able to process up to 22 million pounds (11,000 tons) of batteries per year. This new development may impinge on Texas' potential positioning to be a regional hub for EV and ESS battery recycling, but it is too early to determine this. Alternatively, it may open the door for adjunct business opportunities. Tools and mechanisms to address the barrier of lack of in-state recycling infrastructure for EV and ESS batteries are information, facilitation and technical assistance and financial assistance related.

A - Information, Facilitation and Technical Assistance

Monitoring and Research. Batteries manufacturing as well as batteries recycling technology is rapidly evolving. It will be important to stay abreast of developments as they occur so that the in-state batteries management system is prepared to address future needs and opportunities as they emerge. In addition, information on the generation and flows of EV and ESS batteries would be beneficial. Monitoring and research are functions that could likely be provided by an appropriate university program.

Establishing a Task Force or Committee. The State could convene a task force or committee to participate in assessing industry developments and investigating the role of the State or other governmental entities in infrastructure development.

C - Financial Assistance

Infrastructure Development/Research Grants. There may be a possibility of obtaining funding from federal infrastructure development programs to support infrastructure development for EV and ESS batteries recycling. The State could also provide funding support, such as to the university(ies) involved in the research and monitoring and/or to support infrastructure development if such opportunities are identified.

Tools and Mechanisms to Address a Lack of Adequate Biosolids End Markets Beyond Land Application

Land application involves the spreading of biosolids on the soil surface or incorporating or injecting biosolids into the soil. Biosolids land application occurs at various sites including agricultural lands, forests, mine reclamation sites, and other disturbed lands, parks, and golf courses. This is a popular means of managing biosolids nationally, as well as in Texas, where biosolids are often applied to ranch land. As the population of Texas increases, fewer land application sites will be available. The number of sites available has already begun to decrease in recent years but has not yet had an impact on the amount of biosolids land applied. Some local governments in Texas (e.g., Austin) have made the decision to cease land application of biosolids. Alternatives to land application include composting, manufacture of fertilizer products, and energy production (i.e., bioenergy). Tools and mechanisms to address the lack of end markets beyond land application are information, facilitation and technical assistance.

A - Information, Facilitation and Technical Assistance

Monitoring and Information Dissemination. The State, through agencies such as TCEQ, should monitor anticipated changes in how municipalities manage their biosolids, as well as how other organics are being managed, and look for additional biosolids end use opportunities such as co-processing and mine reclamation as appropriate. Staff should also keep current with emerging processes and studies, including safety studies, regarding the management of biosolids on a national level. The State could create an online repository of information on this topic for access by interested parties.

Tools and Mechanisms to Address Biosolids Regulations Limiting Opportunities for Processing

Stakeholders in the composting industry have indicated that Texas' regulations regarding composting facilities could be improved upon, in part for clarity, and in part to consider the size of the operation (currently they only consider material types processed). Some indicated, too, that regulations regarding biosolids processing may be overly strict. The tool/mechanism to address this barrier, therefore, is policy related.

E - Policies

Regulatory Review/Revision. Stakeholders indicated that they see a need for more registration-tier facilities that can receive biosolids. Some stakeholders suggest that wastewater treatment plants (WWTPs) should be able to compost their own biosolids – there are some on-site lagoons/monofils at WWTPs. This recommendation is that regulations be reviewed for unnecessary restrictions and updated as needed, with industry input.

9.6 Strategy Development

The recommended recycling market development strategy for Texas is to develop and implement programs of work for each of the five categories of tools and mechanisms outlined in this section focused on overcoming the priority barriers for target materials as well as realizing emerging opportunities of interest to the extent they arise. These five categories and associated programs of work include:

A - Information, Facilitation & Technical Assistance:

- Dissemination of recycling market development-related information and promotion pertaining to how to recycle correctly and reduce contamination
- Facilitation of regional cooperation, harmonization, networking and information exchange, stakeholder engagement and facilitation, formation of task forces and working groups/committees
- Research and technical assistance for monitoring and evaluation, research and development/testing, pilots and demonstration projects, database development and generator mapping
- Assistance and support for feedstock conversion research and promotion

B - Preferential Procurement:

- Promotion of Texas-made recycled-content products
- Enhancement of the recycled-content product directory
- Support of existing work related to cooperative contracting
- Refresh of the State preferential purchasing program

C - Financial Assistance:

- Development of grants and/or loans
- Funding via PAYT

D - Financial Incentives/Disincentives:

- Development of incentives/disincentives such as:
    - Tax credits and exemptions
    - Rebates and incentive payments
    - Disposal surcharges
    - Reduced rates for utilities and disposal
    - Permit fee waivers
    - Awards programs
    - Other incentives (e.g., free waste disposal, fast track permitting)

E - Policies:

- Evaluation, development, implementation, and enforcement activities related to policies to be enacted by the legislature which may or may not include:
    - Harmonization policy
    - Mandatory recycling service provision
    - Mandatory recycling participation law
    - Disposal bans
    - Deposit legislation
    - EPR
    - Advance recycling fees paid by industry
    - Advance recycling fees paid by consumers
    - Disposal surcharges
    - Minimum recycled content requirements
    - Food waste diversion mandate
- Review/revision of state regulations as needed
- Promotion or enactment of local government policies such as:
    - PAYT programs
    - Setout requirements
    - Mandatory service provisions
    - Food waste diversion mandates

In Section 10, the recommended recycling market development strategy for Texas is further developed by identifying the potential role of specific governmental entities and more broadly the role of other organizations, as well as recycling market development program management and funding recommendations.

10 RECOMMENDATIONS FOR IMPLEMENTING THE RECYCLING MARKET DEVELOPMENT STRATEGY

Recycling is at a turning point in the U.S., with several factors challenging the system including:

- Reduced outlets for recovered materials in Asia;
- Contamination issues that reduce the value of some materials and increase processing costs; and
- Shifts in the types of packaging used, with some packaging not recyclable in our current systems.

At the same time, bringing about "the circular economy"[1] has become a global focus. A number of consumer packaged goods companies are committing to ensuring their packaging is highly recyclable and their packaging and products contain recycled content. Some manufacturers of other types of products, like tires and clothing, are also expressing interest in ensuring their products are sustainable. Virtually all major industries are seeking opportunities to reduce their carbon footprint and are recognizing the role of recycling in doing so. Additionally, influenced by concerns about the environment, legislators are putting forth policies that aim to help achieve these goals. Stakeholders from all sectors agree that fundamental changes in the U.S. recycling system are needed.

Texas, having a strong manufacturing economy, is uniquely positioned to develop and strengthen markets for recovered materials, thus boosting the state's economy while simultaneously extending the life of landfills. For certain materials, Texas has an opportunity to develop a regional market, importing feedstock materials from other states. There are numerous agencies and organizations within Texas whose talents and skills can be leveraged to make Texas a leader in developing markets for recovered materials. As described in Section 6, the recycling industry is an over $4.8 billion industry in Texas. The industry can most effectively expand by focusing on the driver of recycling: end markets.

In this section, the potential roles in recycling market development of state agencies, Texas universities, regional councils of government, local governments, and other entities – both in state and beyond – are described and recommendations pertaining to management and funding of recycling market development are provided.

10.1 ROLE OF STATE AGENCIES, UNIVERSITIES AND GENERAL REGIONAL COUNCILS OF GOVERNMENT

Texas Commission on Environmental Quality (TCEQ)

Mission

The Texas Commission on Environmental Quality (TCEQ) is the State's lead agency for the management of solid waste and protection of the environment. TCEQ strives to protect Texas' public health and natural resources consistent with sustainable economic development, with an ultimate goal of clean air, clean water, and the safe management of waste.

Programs and Activities

TCEQ divisions of relevance to recycling market development include the Office of the Executive Director and the Office of Waste. Pertinent ongoing activities and services provided by these offices, include:

- Providing education, outreach and resources for solid waste management and recycling facilities regarding permitting, certification, and reporting requirements; for the public regarding recycling programs, C&D recycling, composting, and other diversion activities; and for pollution prevention planning. TCEQ is the owner of the "Take Care of Texas" campaign, which has published several articles about recycling, among other topics. TCEQ also provides information about materials that can be challenging to recycle, such as electronics and batteries.
- Managing recycling initiatives and assistance services, including the state's electronics recycling and household hazardous waste management programs.

[1] The term "circular economy" refers to a system that seeks to decouple economic activity and the consumption of finite resources. The circular economy includes redesigning systems to prevent the creation of waste, keeping products and materials in use through reuse and re-manufacturing of recycled material feedstocks, and regenerating natural systems such as through making and using compost to help replenish soil. The circular economy represents a shift away from the current "take-make-waste" model.

- Conducting municipal and industrial waste permitting, reporting and other requirements.
- Addressing scrap tire management, including providing information to local governments and consumers about how to manage waste tires and how to report illegally dumped scrap tires, as well as producing an annual report on scrap tire management in Texas.
- Administering the Texas Environmental Excellence Awards (TEEA) in cooperation with the Office of the Governor to highlight environmental preservation and protection efforts of citizens, communities, businesses, and organizations through an annual awards program. Applications are reviewed and selected for 10 award categories.
- Providing grants to regional councils of governments to fund solid waste management activities and local and regional projects that help implement solid waste management plans.
- Assessing and planning for the management of solid waste. To support these activities, the TCEQ collects and compiles data regarding multiple wastes including:
    - Annual Recycled Newsprint surveys;
    - Electronics (computers and televisions) recycling annual reports from manufacturers, and development and submittal of the annual Electronics Recycling report to the Legislature;
    - Annual reports pertaining to HHW and other wastes received by HHW and similar drop-off programs;
    - MSW annual reports submitted by permitted and registered solid waste processing and disposal facilities, and development of the annual report summary;
    - Annual scrap tire reports submitted by transporters, storage facilities, and end users of used or scrap tires/tire pieces, and development of the annual report summary.

Past and Current Role in Recycling Market Development

TCEQ has played the most integral role to date of all Texas state agencies in recycling market development. In 1994, TCEQ's predecessor, the Texas Natural Resource Conservation Commission (TNRCC), commissioned an assessment of recyclable materials supply and demand and a comprehensive statewide recycling market development plan. Other past programs and activities undertaken by TNRCC included:

- Maintaining a recycling markets database that lists collectors, processors, brokers, and end users of recyclable materials in Texas;
- Publishing the annual Recycle Texas directory, a hard-copy version of the recycling markets database listing companies and the materials they managed; and
- Publishing a monthly newsletter, Market News, spotlighting trends and prices of recyclable materials in Texas.

Current TCEQ programs and activities specifically geared to strengthen markets for recovered materials include the following:

- Conducting an annual survey of newspaper printers and publishers. TCEQ surveys newspaper printers and publishers to determine progress toward two goals: for recycled newsprint to comprise 30 percent of total newsprint purchased and to use 18 percent recycled-content newsprint. In 2020, 37.56 percent (4,874 tons) was recycled newsprint and one third of respondents achieved the first goal. Approximately 10 percent (1,248 tons) of total newsprint purchased by respondents was post-consumer recycled content in 2020 and none of the respondents met the second goal.
- Operating the Resource Exchange Network for Eliminating Waste (RENEW) web-based marketing channel for industries, businesses, and governmental entities that want to sell surplus materials, by-products, and wastes to users who will reclaim or reuse them. The University of Texas at Arlington's Center for Environmental Excellence provides IT support for TCEQ to host, maintain, and update the website.
- Commissioning studies to assess recycling rates and opportunities. TCEQ commissioned the Study on the Economic Impacts of Recycling (SEIR), as directed by House Bill (HB) 2763 (2015), completed in 2017. This current Recycling Market Development Plan (RMDP) was commissioned and is overseen by TCEQ, as directed by SB 649 (2019).
- Providing information on buying products made with recycled content. By law, public entities in Texas are required to have preference for buying selected recycled-content products if they do not cost more than 10 percent greater than alternative products. There are some exceptions to this law. TCEQ provides information about how to find such products, such as First Choice recycled-content products, through state-negotiated contracts that school districts, local governments, and state

agencies can use. Out-of-state resources are also included, such as California's Recycled Content Products Directory.

Potential Role in Strategy Implementation

Potential roles TCEQ could play in recycling market development implementation include those related to all five categories of tools and mechanisms for recycling market development. Tool and mechanism categories are defined and described in Section 9.3.

Information, Facilitation, and Technical Assistance

- **Promoting recycling participation and how to recycle properly, and institute a statewide Buy Recycled campaign.** TCEQ has already begun to address key cross-material barriers, such as contamination, and to promote use of products with recycled content as well as use of compost in its public outreach, through the "Take Care of Texas" campaign. This type of education program was called for in SB 649 (2019) along with producing the Recycling Market Development Plan (RMDP).
- **Providing guidance on harmonization and recycling container labeling and signage.** In an effort to simplify programs and reduce confusion about recycling among residents, TCEQ can work with COGs and local governments to develop a level of uniformity throughout the state regarding what is always recyclable, or top contaminants to be left out of recycling carts, and to develop and encourage the use of templates for signage and cart labels for visual consistency. This helps residents avoid confusion when they recycle at home, work, and in other Texas locations they visit.
- **Developing and sharing information on best practice approaches to local policy development.** Example policies for consideration include pay-as-you-throw, universal recycling, and mandatory commercial recycling policies aimed at improving access to recycling opportunities and increasing participation.
- **Providing information on the results of research and demonstration projects about the use of recyclable materials and products through TCEQ's website and via webinars.**
- **Hosting additional commodity-specific webinars and workshops.** Similar to the recent TCEQ Scrap Tire Workshops on tire recycling market development, the agency could host webinars and workshops for other commodities.
- **Overseeing future recycling market development and economic impact studies as appropriate.** SB 649 included a provision for the Texas Recycling Market Development Plan to be updated every four years. TCEQ could continue to commission and oversee future plans.
- **Including discussion of recycling market development in relevant TCEQ annual reports and associated plans.** Discussion of recycling market development progress, remaining needs and opportunities, and plans to address them can be disseminated through multiple relevant TCEQ publications.

Preferential Procurement

- **Promoting increased procurement of recycled-content products, particularly for products manufactured in Texas from Texas-generated recyclable materials or compost.** This could include establishment of specific procurement goals and measuring progress towards their attainment.
- **Work with the Comptroller's Statewide Procurement Division to track and analyze data on preferred product purchases among state agencies and track purchasing behavior over time.** Data can be used to identify opportunities to increase state agency use of preferred products.
- **Serving as the lead for the State as a participant in the Association of Plastics Recyclers' Government Recycling Demand Champions Program.** The program is for governments who commit to purchasing products that contain post-consumer recycled plastics in order to stimulate and create domestic markets for recyclable plastics and thereby drive sustainable plastic recycling. Alternatively, the Comptroller's Statewide Procurement Division could be the lead agency for this program.
- **Developing and maintaining an online expo/catalog of Texas-made recycled-content products to aid such product manufacturers in marketing their products statewide and beyond.** One successful example is CalRecycle's California Tire-Derived Product Catalog, which is described in more detail in Section 9.4 under Tools and Mechanisms to Address a Lack of Adequate End Markets for Texas-Made Products.

Financial Assistance

- **Targeting a portion of the State's Regional Solid Waste Grants Program funds distributed to the COGs for addressing recycling market development barriers and opportunities in each region.** Grant funds could be used to create hub-and-spoke systems, establish recycling market development zone programs, purchase needed equipment, fund recycling market development studies, host events such as Austin's Reverse Pitch Competition, and/or implement buy recycled promotion campaigns.

Financial and Other Incentives/Disincentives

- **Creating an awards category for recycling market development initiatives as part of TCEQ's Texas Environmental Excellence Awards program.** Award-eligible activities could include new or expanded use of recyclable materials (such as in manufacturing) and outstanding efforts on the part of local governments and others to foster recycling market development.

Policies

- **Assessing data gaps and determine whether policy is needed to obtain additional data and information that would be of value in recycling market development efforts.** Consider establishing a "Measurement Matters" committee, either as a subcommittee of the Municipal Solid Waste Management and Resource Recovery Advisory Council (MSWRRAC) or as an independent group to help address this need as well as to coordinate with other similar initiatives underway in other states and by the U.S. EPA.
- **Forming a committee of industry experts and TCEQ staff to review and revise relevant regulations for those materials for which stakeholders indicated potential state permitting/regulatory challenges.**
- **Participating in the evaluation and possible development of state policy mechanisms to provide the funding and increased producer responsibility needed to address key recycling and recycling market development barriers and opportunities.** Historically TCEQ's role has been limited with respect to policy analysis and development of recommendations for consideration by the Legislature. In certain other states, the lead environmental agency plays a direct role in policy analysis and development, including involvement in stakeholder engagement, hiring consultants to evaluate options and prepare policy recommendations, and preparing draft legislation that takes into consideration the analysis and stakeholder input for consideration by the Legislature. Texas' recycling system optimization and recycling market development efforts would benefit from this type of studied approach to policy development.

Texas Governor's Office of Economic Development and Tourism

Mission

The Texas Governor's Office of Economic Development and Tourism (EDT) markets Texas for business expansion and relocation prospects, with the goal of developing job creation and export opportunities for Texas.

Programs and Activities

EDT is comprised of multiple areas, all of which could have relevance to support recycling market development initiatives:

- **Business and Community Development**, which serves as the conduit to the business recruitment and project management process, and works to strengthen the competitiveness of Texas' industries by promoting internal business and trade, small business advocacy, entrepreneurial support, industry engagement, and assisting with permitting, licensing, and regulatory compliance. Business Development staff identify and develop domestic and international investment leads and work with prospective companies who are considering locating or expanding in Texas. Business Development also assists in Texas marketing efforts and initiatives in partnership with the Texas Economic Development Corporation. Business Assistance houses the State of Texas Mexico Office, which seeks to help Mexican companies enter the Texas market or aid Texas companies looking to do business in Mexico, and the Office of Aerospace and Aviation, which aims to promote and grow the aerospace and aviation industry in Texas.

- **Economic Development Finance**, which provides competitive financial tools to expand businesses operating in the state and businesses considering relocating to Texas. Programs administered by this office include various grants, financing and tax refund programs which all promote economic development, job creation and capital investment. The office partners with local governments and other entities to deliver programs targeted at small businesses, communities, and universities in the State as well as other entities.

Among the many tools and incentives currently administered by EDT, there are several that, while not currently targeted at the recycling industry, could be used to support recycling business development. Specifically:

- Texas Enterprise Fund grants for companies considering a new project for which a single Texas site is competing with another viable out-of-state site.
- Enterprise Zone communities designating a business as an Enterprise project can provide state sales and use tax refunds with State approval depending on the level of project investment and the number of jobs created or retained.
- The Product Development and Small Business Incubator Fund provides loans with favorable terms to aid in the development, production, and commercialization of new or improved products and foster small business in the state. The Economic Development Finance group offers tax exemption incentives for pollution control equipment and wind and solar energy. These incentives are examples of what could be provided with respect to the manufacture of products from recyclable materials in Texas. Similarly, there is a program that supplies grants to qualified applicant production companies to promote film, television, video game, animation and associated commercial industry and workforce growth in Texas.

EDT has a decentralized, partnership approach to economic development and largely plays a facilitation role – often linking companies seeking assistance with local and regional economic development specialists. EDT activities are generally non-industry specific with the exception of those that are part of the Texas Industry Cluster Initiative. The objective of the Texas Industry Cluster Initiative, established in 2004, is to stimulate long-term sustained growth and focus the allocation of state resources on key industry clusters that were identified to be engines of job creation and economic development for the state. The Texas target industry clusters with potential relevance to recycling market development are:

- **Advanced Manufacturing.** This cluster includes computer and electronic products; electrical equipment, appliance, and components; motor vehicles, bodies, trailers, and parts; food and beverage products; textile, apparel and leather products; and petroleum, chemical and coal products. Recycling business development opportunities pertaining to this industry cluster include growing circular economy industries for the textiles and electronics sectors.
- **Energy.** This cluster includes renewable energy production and services. Developing EVV and ESS battery recycling opportunities would pertain to this cluster.
- **Petroleum Refining and Chemical Products.** This cluster includes petroleum and other chemical product refining and production. Establishing chemical recycling and plastics recycling market development initiatives pertains to this cluster.

Past and Current Role in Recycling Market Development

In the mid-1990s, the Texas Department of Commerce (now the Economic Development and Tourism Division) had a full-time recycling market development professional and an administrative assistant funded under contract with what was then the Texas Natural Resource Conservation Commission (TNRCC). Under the contract, the Department was planning to implement several recycling market development programs activities including business counseling, recruitment, technical assistance, provision of loans and grants, and establishment of recycling market development zones. The contract has since expired and recycling industry focused programs no longer exist.

Potential Role in Strategy Implementation

As the primary economic development entity in Texas, EDT can play a role in attracting and supporting recycling-related businesses, including manufacturers using recycled material as feedstocks. However, based on EDT's current staffing and organizational structure and decentralized approach to economic development, its likely role would be limited to helping link companies with other service providers as they are now currently doing. One exception would possibly be with respect to recycling business development opportunities that fall within one or more Texas Industry Cluster Initiative industry groups.

Potential roles that EDT could play in recycling market development strategy implementation include:

Information, Collaboration, and Technical Assistance

- **Establishing partnerships with industry representatives and other relevant stakeholders.** These partnerships will be valuable when developing strategies and implementing initiatives to realize Texas Industry Cluster Initiative-specific recycling market development opportunities.

Financial and Other Incentives/Disincentives

- **Identifying financial incentives that could be used to increase recycled material demand.** These include financial incentives to encourage existing businesses to consume more recycled content and/or processing and manufacturing businesses to expand or locate new operations where needed in Texas.
- **Working with local and regional economic development entities to employ available local incentives to strategically increase capacity to consume Texas-generated recyclable materials.** Examples include tax incentives, permitting assistance, free or reduced cost waste disposal, utility assistance, and fast-track permitting.

Texas Facilities Commission

Mission

The Texas Facilities Commission (TFC) oversees a portfolio of office space, storage, warehouses, parking garages and grounds of buildings consisting of over 28 million square feet across 283 cities and towns in Texas. TFC's goal is "to serve with excellence by providing high-quality work environments that are functional, energy efficient, and cost effective to operate."

Programs and Activities

TFC provides and contracts for the design and construction, property management, grounds and custodial services, recycling and waste management services, building climate and energy automation, and fire and security services. TFC also manages the state and federal surplus property programs. Areas of focus for TFC divisions relevant to recycling market development include:

- **Facilities Design and Construction**, which provides project design, management, and support services. Project Design Management initiates management of the design process according to Chapter 2166.156, and Subchapter E of Chapter 2166 of the Texas Government Code. This involves the commissioning of design professionals to undertake the work. Project Management and Support works with state agencies and other divisions of TFC to complete public projects, often via the use of contractors. The Facilities Design and Construction Division also addresses conservation of resources, including energy and water, and requires and enforces the use of xeriscape on state property (except where exempt) for new facilities.
- **Facilities Management and Operations – Recycling and Waste Management**, which manages single-stream recycling at the buildings it controls, with service provided at no cost to the tenant. The single-stream recycling program collects cardboard, many types of paper, books, metal cans, and all rigid plastic containers (#1-7). In addition, the recycling program collects toner cartridges, wood pallets, scrap metal and electronic waste. Electronic waste includes used or outdated computers or other electronic devices and associated peripherals, keyboards, monitors and batteries.
- **Agency Administration & Support – The Texas Facilities Procurement Program**, the primary functions of which are to make sure procurements are statutorily compliant, appropriately competitive, provide the best value for the goals of the agency, and support the agency historically underutilized businesses (HUB) requirements and goals. This includes procuring:
    - Goods and services for the daily business needs of the agency;
    - Architectural, engineering, and construction services in support of multiple state agencies;
    - Goods and services to support building infrastructure such as custodial, security, HVAC, mechanical, and electrical services;

- Goods and services in support of Statewide leasing requirements; and
- Goods and services in support of Statewide Surplus Property.

Past and Current Role in Recycling Market Development

Recycling market development activities undertaken by the TFC include:

- Procuring goods and services made from recycled content, including compost and mulch for landscaping activities and recycled content building-related products such as concrete made with fly ash and recycled content carpet.
- Providing recycling services to supply material of proper quality into the recycling stream.

Potential Role in Strategy Implementation

Potential roles that the TFC could play in recycling market development strategy implementation include:

Information, Facilitation, and Technical Assistance

- **Working with recycling service providers to ensure that opportunities to decrease contamination in recyclables are identified and addressed.**
- **Measuring recycling at all managed buildings.** Data will allow TFC to work with service providers to identify and address opportunities to maximize recycling access and participation as well as quality (i.e., minimize contamination).

Preferential Procurement

- **Specifying the recycled content of goods purchased for the daily business needs of the agency, when appropriate.** Currently recycled content goods are often used, purchased either by the agency or by contractors; however, they are generally not specified.
- **Specifying material recovery for C&D projects and use of recycled-content building and furnishing products.** Examples include the use of recycled-content and/or recyclable carpet and recycled content decking material.
- **Specifying use of recycled-content landscaping products such as compost and mulch that are also made in Texas.**
- **Specifying recycled content in paving projects such as for driveways, roadways and parking lots, when appropriate and within the confines of purchasing guidance.**

Texas Department of Transportation (TxDOT)

Mission

The Texas Department of Transportation (TxDOT) is responsible for building and maintaining the transportation infrastructure in Texas including the state's highway system, overseeing aviation, and coordinating with other entities to provide public transportation. TxDOT is a large department with over 12,000 employees and 34 divisions.

Programs and Activities

Under the current department structure, the Support Services Division coordinates the department's recycling programs and manages the disposition of surplus and salvage property. Support Services also oversees materials inventory for the agency's road maintenance operations. The division operates four regional distribution centers that store and distribute supplies and materials statewide, as well as the agency's roadway sign production shops.

Past and Current Role in Recycling Market Development

The TxDOT representatives who were interviewed were not aware of a current, formally assigned role in recycling market development. However, staff described a variety of activities that TxDOT has conducted for many years that are related to recycling market development. These include:

- Staying apprised of advancements in recycling materials in highway applications through organizations such as the Federal Highway Administration and the National Asphalt Pavement Association.

- Using recycled materials in road paving projects. TxDOT contractors regularly use recycled asphalt pavement (RAP) in paving projects, at an overall average rate of about 12 percent of total asphalt hot mix placed. Use of RAP is generally up to the contractor, although TxDOT districts may occasionally specify its use. TxDOT also uses asphalt rubber made with crumb rubber from recycled tires, but according to representatives the total amount used is very small. TxDOT regularly incorporates five percent crumb rubber into seal coat applications. In the past, TxDOT used significant quantities of recycled asphalt shingles (RAS) in paving. However, after some project failures several years ago, use of RAS declined significantly. TxDOT still maintains a specification for using RAS.
- Purchasing recycled-content products for office, roadway, and other uses. Much of TxDOT's purchasing is through the Comptroller's Statewide Procurement Division and some recycled-content products such as photocopy paper are purchased through a comptroller term contract.
- TxDOT is the delegated authority to purchase many items like tires and oil; however, purchasing practices are generally at the discretion of each district, and are therefore often inconsistent. For example, TxDOT sometimes applies compost or mulch along roadsides; however, some districts and contractors are said to not favor this practice due to a lack of familiarity and concern over changing current practices. Per the TxDOT website, the agency also purchases molded rubber products such as parking stops, delineator posts, decking boards, and bases for traffic control devices. In addition, TxDOT has used tire chips as well as bales of whole passenger tires as lightweight permeable building blocks for fill and embankment applications. Other approved recycled-content products include object marker posts, guardrail spacer blocks, glass beads, and sign blanks.
- Conducting and funding research and pilot projects on every aspect of road construction, including use of recycled materials and related technologies. TxDOT has undertaken and/or commissioned numerous product studies, lab tests, and field tests over the years to evaluate the performance of specific types of recycled materials and recycled-content products and determine which are suitable for use in TxDOT projects and applications. For example, in 2003 TxDOT, in cooperation with the U.S. Department of Transportation and the Federal Highway Administration, commissioned a study on uses of scrap tires in transportation facilities. TxDOT has funded numerous university studies, including several funded through the Center for Transportation Research at the University of Texas at Austin and the Texas A&M Transportation Institute, which includes a Recyclable Materials Group that investigates the use of recycled materials in applications such as road construction, street signs, embankment fill, and compost use (additional information on this is provided in Section 10.1 under Texas Universities, below). These studies have informed procurement specifications and certification procedures that effectively added approved products to TxDOT's Approved Products List. Often such research is conducted in collaboration with national organizations, including a currently ongoing national study focused on balanced mix designs that includes analysis of various recycled material usage.
- Recycling or reusing specific materials as required by State law. This includes materials generated in paving operations that cannot be used in TxDOT's own operations, like concrete barriers, as well as traditional recyclables like paper and packaging generated in its offices. The Support Services Division provides support and coordinates the TxDOT's overall recycling programs and manages the disposition of surplus and salvage property. TxDOT also is required to donate materials to local governments through the Local Government Assistance Program, which was established in 1997 under Transportation Code §201.706. The program requires the Department to assist counties with materials to repair and maintain county roads giving preference to counties with an above average number of overweight trucks receiving weight tolerance permits. The legislation requires that at least $6,000,000 worth of assistance, in the form of materials, be provided to the counties each fiscal year. Much of the donations are RAP. More material might be reused if contracts specified that contractors could keep remaining RAP, as often more is available to the counties than they can actually use. TxDOT must follow the rules of the TFC for other materials - first offering them to cities, then auctioning them through the Texas Facilities auction (examples include used tires and concrete barriers).

Potential Role in Strategy Implementation

As described above, TxDOT is currently engaged in several activities that are beneficial to recycling market development but does not have a formally authorized role. Given its size and multiple functions across the State, TxDOT has the potential to significantly expand upon its current practices. Potential roles that TxDOT could play in recycling market development strategy implementation include:

Information, Facilitation, and Technical Assistance

- **Tracking and reporting annually by district and statewide.** TxDOT could establish new tracking and reporting metrics related to its use of recycled materials and products. Doing so on a district basis would be most effective by identifying regions with a successful track record that can serve as case studies, as well as identifying regions with room for growth. Tracking is essential to managing progress towards any established goals. New, more comprehensive and consistent tracking and reporting systems could also be applied to recycling of materials generated by TxDOT, both in field and office operations. Annual reports could also be produced to include an explanation of why recycled materials were not used in approved applications, and a plan for increasing use in the future.
- **Implementing an awards and recognition program.** TxDOT deserves credit for its significant recycling-related activities, and positive media coverage is beneficial to the agency. The same is true of individual districts, divisions and individuals who show leadership and deliver results. Establishing an awards and recognition program closely tied to the tracking and reporting system described above could accomplish these goals while helping to incentivize further progress.
- **Requiring use of certain recycled materials and paving technologies in certain appropriate situations.** When TxDOT determines that a given recycled content technology or product makes sense for specific types of projects and environments, the agency could establish policies requiring districts to use them or establish specific grounds for exemptions. As part of this approach TxDOT could increase specification of recycled content products and technologies in certain situations. Another option to consider is to write into bids that the paving contractor will own any surplus RAP, providing an incentive for them to recycle it in future roadway projects.
- **Continuing or expanding research support and collaborative partnerships to stay apprised of advancements, especially cost-effective uses for scrap tires (including illegally disposed scrap tires) asphalt shingles, and low-value plastics.** TxDOT could explore the potential for new recycled material applications such as use of tire-derived aggregate in civil engineering applications, potential use of shreds from remediated tire stockpiles in road base applications, developing quality standards and supply chains to allow use of reflective recycled glass and recycled plastics in asphalt paving that are being explored elsewhere. TxDOT could proactively develop strategies in collaboration with private sector pavement contractors and recycling companies to overcome specific barriers, such as chain of custody and certifications to ensure that, for example, RAS is processed and incorporated into asphalt paving projects according to established specifications and procedures.
- **Conducting studies to identify life cycle costs of recycled content products and roads and share outcomes with contractors and regions.** This could help expand markets for products that may be more costly but also last longer than similar products that are not made with recovered feedstock materials.
- **Facilitating the use of recovered materials such as asphalt and concrete, among others, particularly with local governments and contractors.** Examples of facilitation activities include sharing information about availability of material, allowing contractors to keep excess materials, if desired, and sharing studies and pilot project information.
- **Sharing information with local government and contractors to convey information about the cost effectiveness and quality of roads, road repair products, and other products made with recovered materials.** Examples include mulch, compost, RAP, RAS, and rubberized asphalt roads as well as reflective glass beads, traffic control devices manufactured from recycled plastic and rubber, and tire-derived aggregate for civil engineering purposes (a potentially high-volume use). If made in Texas, this should be highlighted. TxDOT could potentially provide trainings or participate in workshops on using recycled content products.

Preferential Procurement

- **Promoting and facilitating recycled content paving technologies at the local level.** TxDOT specifications are used by some but not all local governments, and TxDOT sometimes distributes some material like concrete and RAP to local agencies. TxDOT could potentially conduct trainings for local agencies to facilitate their use of recycled materials and products, including sample specifications, case studies and practical field experience. Tracking and reporting activities described above could also include tracking distribution of recycled materials like concrete and RAP to local agencies and could also provide a tool for local agencies to report their use to TxDOT for consolidation with state level data on an annual basis.

- **Maximizing reuse and recycling of surplus and salvage materials.** TxDOT's efforts are already fairly aggressive; however, there is some variability among districts, and data is incomplete. All salvage, reuse and recycling volumes by material and destination category (e.g., local government vs. other) could be included in annual tracking and reporting activities described above.
- **Ensuring specifications and information about products made with recycled content, including available contracts, are made readily accessible to all TxDOT regions, local governments and contractors.** Efforts could be made to ensure information highlights goods made in Texas. TxDOT could further develop a catalog of recycled content products and contractors who use such products to facilitate expanded use of products. Examples of projects using materials could be documented/ tracked to provide potential purchasers/users information about product quality and longevity.
- **Encouraging increased use of recovered materials throughout all TxDOT regions, particularly products made in Texas.** TxDOT could track the use of recycled content materials at the district level (by material/product type) and overall. The agency could consider implementing an awards program within TxDOT to highlight success stories. TxDOT could also publish success in newsletters, on the TxDOT website, and in forums that will reach the general public.
- **Reinstituting a position for a recycling market development champion at TxDOT that works to increase use of recycled content materials and products in TxDOT projects.** The champion would work with a designated liaison in each of the districts to obtain information at the district level and share information related to recycling market development among the districts.

Texas Department of Criminal Justice

Mission

The mission of the Texas Department of Criminal Justice (TDCJ) is to provide public safety, promote positive change in offender behavior, reintegrate offenders into society, and assist victims of crime. Of relevance to recycling market development, the TDCJ has a Manufacturing, Agribusiness and Logistics Division which manages the agency's agribusiness, land and mineral operations, warehousing operations, fleet and freight transportation services, and providing customers with quality manufactured products and services. The division provides incarcerated inmates with post-release employment readiness to increase their reentry success. Within this division is Texas Correctional Industries (TCI). TCI's statutory objectives are to provide work program participants with marketable job skills, help reduce recidivism and reduce department cost by providing products and services to TDCJ and other eligible entities on a for-profit basis.

Programs and Activities

The activities of the TDCJ's Manufacturing, Agribusiness and Logistics Division that are relevant to recycling market development include:

Agribusiness, Land & Minerals

- **Business Management**, which maintains agency records, provides financial management and accounting services for agricultural operations, and coordinates with community food banks throughout the state by providing inmate labor to help salvage and sort products for distribution and gleaning fruits and vegetables from privately owned fields.
- **Crops and Equipment**, which manages the direct production crops for use within the agency. This includes grain and hay used as feed, cotton used by TCI textile mills to make inmate clothing and bedding, edible crops sent to agency food service departments to be prepared for meals or sent to the agency canning plant, and operational support services.
- **Livestock,** which manages commercial cow herds, broodmare and horse development, laying hens, farrow-to-finish swine, feed production and meat packing operations that provide food to TDCJ food service departments.

Transportation & Supply

- **Fleet & Freight Transportation,** which manages TDCJ transportation (including four freight terminals and shipping goods to customers), mechanical needs, equipment, emergency wrecker services, acquisition and maintenance of TDCJ vehicles, and oversight of salvage vehicles and trailers.
- **Warehousing & Supply**, which manages distribution of consumable goods and supplies consumed or produced by TDCJ (including TCI and Agribusiness goods as well as food and maintenance supplies), and also oversees disposal of salvage vehicles.

Texas Correctional Industries (TCI)
TCI manufactures goods and provides services for sale, on a for-profit basis to city, county, state and federal agencies, public schools, public and private institutions of higher education, public hospitals, and political subdivisions while providing job training opportunities for inmates. TCI products must meet specifications established the Texas Comptroller's Statewide Procurement Division, the procurement authority for Texas state agencies that also coordinates most interagency sales of TCI goods and services. TCI has numerous facilities located across the State, with the heaviest concentration in East Texas. TCI includes six areas of operation:

- **The Furniture Division** builds a variety of office and institutional furniture and modular systems.
- **The Garment Division** manufactures items like shirts, pants, coats, shoes, sheets, pillows and mattresses.
- **The Graphics Division** makes signs, stickers, license plates, janitorial supplies, soaps, detergents and provides printing services.
- **The Marketing & Distribution Division** develops marketing strategy, promotes TCI products and services, provides customer service and operates the Austin and Huntsville showrooms and warehouses.
- **The Metal Division** manufactures items such as stainless steel goods, signs, park equipment, dump truck beds, and trailers.
- **The Tire Retreading Facility** provides tire repair and retreading services for state and local commercial tires.

Inmate Work & Training Programs and Planning & Research
TDCJ staff members are responsible for administration of all inmate training facilities; on-the-job training programs, job-skills training programs, and other training programs; provide incarcerated inmates with post-release employment readiness to increase their reentry success, including sponsoring job and hiring events; oversee the Prison Industries Enhancement (PIE) Certification Program; and act as the liaison with participating private business. These staff also provide public information about the division, coordinate policies and publications, analyzes legislation, and coordinates training needs.

Past and Current Role in Recycling Market Development
TDCJ representatives said to their knowledge the department has not formally been assigned a role in recycling market development but acknowledged that many of their activities are related. Examples include:

- Remanufacturing used mattresses and recycled components where needed.
- Repairing and preparing computers and electronic equipment for reuse and where necessary and feasible dismantling and shipping materials for recycling.
- Operating a retreading facility, which retreads commercial tires for state and local government commercial tires. Tires that cannot be retread and buffings are recycled through contracted service providers.
- Operating agricultural facilities that often compost on-site and use compost and mulch in their operations.
- Encouraging the bidding of recycled, remanufactured products, and energy efficient equipment.
- Regularly recycling traditional recyclables like paper and packaging.

Representatives said they are not aware of any comprehensive tracking or regular reporting of their activities that may support recycling market development.

Potential Role in Strategy Implementation
TDCJ representatives agreed that their role in recycling market development could potentially be more formalized and expanded. Given the diverse range of TDCJ operations including various TCI manufacturing and other agricultural activities, a comprehensive audit with support of an outside expert could help identify and evaluate the costs and benefits of specific opportunities. Potential roles that TDCJ could play in recycling market development strategy implementation include:

Information, Collaboration, and Technical Assistance

- **Transporting recyclable materials from remote, rural areas.** TDCJ handles a wide variety of shipping and logistics for goods they produce and between their facilities. A feasibility study could identify potential back haul opportunities where TDCJ trucks have capacity to transport recyclables from remote, rural Texas areas to more urban areas. This may hold the potential to add a new, profitable service to TDCJ's current expansive list of goods and services they offer and could be tied to training inmates in recycling shipping and logistics skills.

- **Training inmates for professions in the recycling industry.** TDCJ's extensive on-the-job training program could train inmates for professions in the recycling industry. TDCJ is already providing this role, but it could be expanded and more closely coordinated with private and government sector recycling operations for transitional job placement.
- **Enhancing tracking and reporting.** TDCJ could track and report recycling market development related activities on an annual basis, including use or processing of recycled materials (including electronics) in TDCJ operations, purchasing recycled-content products, and the amounts of discards shipped for reuse or recycling.

Preferential Procurement

- **Using recycled material feedstocks in manufacturing operations.** TDCJ already seeks to maximize reuse and recycling of all materials to reduce costs, but there may be opportunities in the many products produced to increase sourcing of recycled feedstocks. TDCJ may be able to provide a market for organics, possibly including food waste, at composting or vermi-composting operations at TDCJ agricultural facilities, and/or for use of compost produced elsewhere.
- **Performing recycling processing activities.** TCI already recycles mattresses, computers and other electronics and has a retreading operation. There may be opportunities to expand these activities to include other items or to fill gaps in processing infrastructure, especially in rural areas where TDCJ may have operations.

Texas Department of Agriculture

Mission

Texas Department of Agriculture (TDA)'s mission is to partner with all Texans to make Texas the nation's leader in agriculture, fortify the State's economy, empower rural communities, promote healthy lifestyles, and cultivate winning strategies for rural, suburban and urban Texas through exceptional service and the common threads of agriculture in our daily lives.

TDA is headquartered in Austin and has five regional service offices, two sub-offices, three laboratories and five livestock export facilities. TDA has regulatory and marketing responsibilities and administers more than 50 separate laws.

Programs and Activities

TDA activities are grouped into four categories:

- **Consumer Protection**, which includes regulating weights and measuring devices (e.g., scales and retail price scanners), pesticide use and certification of organically produced products.
- **Production Agriculture**, which includes crop protection, facilitating trade and market development for agricultural commodities ranging from livestock to crops, providing financial assistance, administering grant funds for agricultural research and to develop new technologies and advocating for policies at the federal, state and local level.
- **Healthy Living**, which includes administering the National School Lunch and Breakfast programs, fighting obesity through statewide campaigns, and administering the Texans Feeding Texans initiative.
- **Economic Development**, which includes providing tools to attract businesses and develop opportunities, offering infrastructure grants to rural communities, promoting statewide broadband services, and marketing Texas products, cultures, and communities through the GO TEXAN branded campaign.

Past and Current Role in Recycling Market Development

According to TDA representatives, the department actively complies with state requirements for office recycling and has in the past conducted education initiatives to promote at-home composting. The Texans

Feeding Texans Surplus Agricultural grant program provides funding to move surplus agricultural products to food banks and other charitable organizations that serve in-need or low-income individuals.

Beyond these activities, TDA representatives did not identify specific past activities related to recycling market development.

Potential Role in Strategy Implementation

Potential roles that TDA could play in recycling market development strategy implementation include:

Information, Facilitation and Technical Assistance

- **Supporting research.** TDA could support research to document the benefits of producing and using compost in agricultural operations, and/or promoting these activities through outreach, technical and financial assistance. This could include securing federal grants to support such activities. This could be in cooperation with other organizations, such as the Texas A&M Agrilife Extension, STAR's Master Compost Program, and the Texas Nursery and Landscaping Association, and potentially other university departments.
- **Leveraging the GO TEXAN program.** The GO TEXAN program can be used to broadly promote sales of Texas-made compost, mulch, and soil amendment products, by residents and commercial businesses within Texas and nationally. This could include supporting marketing efforts of Texas compost producers who are members of the GO TEXAN program, such as their attendance at trade shows. This activity could be coordinated with the Texas Agrilife Extension and the Texas Nursery and Landscape Association.

Financial Assistance

- **Providing grants and loans.** There are grant and loan programs administered by the Texas Department of Agriculture that could provide resources to improve recycling/composting and associated markets in Texas' rural communities. Examples include the TX Community Development Block Grants, the Texas Rural Business Fund, the Capital 4 Texas loan program, and the Interest Rate Reduction program.

Texas Comptroller's Statewide Procurement Division

Mission

The Comptroller's Statewide Procurement Division connects vendors with state purchasers and contract opportunities and helps state and local government entities procure non-IT goods and services through easily accessible contracts that meet their needs.

Programs and Activities

The Division operates a cooperative purchasing electronic procurement system, called TxSmartBuy, where vendors' goods and services are listed for access and ordering by state and local government purchasers. In addition, the Division manages and monitors state contracts to ensure compliance and provides training for state purchasers and contract managers. The Division is responsible for enacting purchasing laws.

Past and Current Role in Recycling Market Development

The Comptroller's Statewide Procurement Division contracts for the purchase of recycled content items and facilitates those purchases for state agencies.

Current Comptroller activities and responsibilities that support recycling market development include:

- Contracting procurement for state agencies in a manner consistent with the requirements (see text box).
- Evaluating procurement procedures to encourage the purchase and use of recycled-content, re-manufactured, or environmentally preferrable products.
- Developing new procedures to encourage the purchase and use of recycled-content products and products that can be reused, recycled, or re-manufactured.
- Setting purchasing goals for recycled, re-manufactured, or environmentally preferrable commodities or services. The Division does not regularly track recycled content or "green" products and there are no goals set currently.
- Providing the TxSmartBuy system, which allows buyers to purchase products that have been categorized by product type and as "Environmentally Certified Products." However, there is not a proactive Buy Recycled program where buyers are encouraged to buy recycled content products and procurement officials are expected to look for such opportunities and trained on how to do so. The quantity of recycled content products or environmentally preferable purchasing among state agencies is not tracked. A search within the system, however, does identify products with recycled content.

Procurement Priorities Related to Recycling Market Development

State agencies are required to give preference to the following specific type of products:

- Certain recycled, re-manufactured, or environmentally sensitive products. These products are known as "first choice purchasing options." First Choice products have a 10 percent price preferential (meaning they should be preferred even if they cost up to 10 percent more than products that do not contain recycled content) and must suit the needs of the purchaser. These product types include:
  - Re-refined oils and lubricants (to be 25 percent recycled content, if quality similar);
  - Certain paper products, including paper towels, toilet paper, toilet seat covers, printing, computer and copier paper, and business envelopes (a state agency is to procure the highest recycled content that meets their needs and is offered by the Comptroller);
  - Certain plastic products including trash bags, binders, and recycling containers; and
  - Steel products.
- Electronics manufactured by "a manufacturer that has a program to recycle the computer equipment of other manufacturers, including collection events and manufacturer initiatives to accept computer equipment labeled with another manufacturer's brand" (Texas Health and Safety Code §361.965(d)).

Additionally, the Comptroller may give priority to rubberized asphalt paving (RAP) material made from scrap tires by a facility in this state if the cost, as determined by life-cycle cost-benefit analysis, does not exceed the bid cost of alternative paving materials by more than 15 percent. (Texas Government Code §2155.443)

Potential Role in Strategy Implementation

Potential roles that the Comptroller could play in recycling market development strategy implementation include:

Information, Facilitation & Technical Assistance

- **Offering refresher training for procurement staff in state agencies and local governments.** For example, training regarding the State's preferential procurement requirements and opportunities for increasing the purchase and use of recycled-content products and materials.
- **Hosting an annual Buy Recycled Products Expo for product vendors and purchasing managers with a spotlight on products made from Texas generated materials.** Currently the Division hosts a vendor expo for Historically Underutilized Business (HUB) vendors, and therefore likely has the resources and experience to conduct such an activity.
- **Staying apprised of environmentally preferable purchasing practices and activities through involvement in national organizations.** These organizations include the National Association of State Procurement Officials (NASPO) and the Sustainable Purchasing Leadership Council (SPLC).
- **Developing a catalogue of a broad array of recycled content products and highlighting recycled content products more prominently.** This could also include highlighting products made in Texas.

- Contracting procurement for state agencies in a manner consistent with the requirements (see text box).
- Evaluating procurement procedures to encourage the purchase and use of recycled-content, re-manufactured, or environmentally preferrable products.
- Developing new procedures to encourage the purchase and use of recycled-content products and products that can be reused, recycled, or re-manufactured.
- Setting purchasing goals for recycled, re-manufactured, or environmentally preferrable commodities or services. The Division does not regularly track recycled content or "green" products and there are no goals set currently.
- Providing the TxSmartBuy system, which allows buyers to purchase products that have been categorized by product type and as "Environmentally Certified Products." However, there is not a proactive Buy Recycled program where buyers are encouraged to buy recycled content products and procurement officials are expected to look for such opportunities and trained on how to do so. The quantity of recycled content products or environmentally preferable purchasing among state agencies is not tracked. A search within the system, however, does identify products with recycled content.

Procurement Priorities Related to Recycling Market Development

State agencies are required to give preference to the following specific type of products:

- Certain recycled, re-manufactured, or environmentally sensitive products. These products are known as "first choice purchasing options." First Choice products have a 10 percent price preferential (meaning they should be preferred even if they cost up to 10 percent more than products that do not contain recycled content) and must suit the needs of the purchaser. These product types include:
    - Re-refined oils and lubricants (to be 25 percent recycled content, if quality similar);
    - Certain paper products, including paper towels, toilet paper, toilet seat covers, printing, computer and copier paper, and business envelopes (a state agency is to procure the highest recycled content that meets their needs and is offered by the Comptroller);
    - Certain plastic products including trash bags, binders, and recycling containers; and
    - Steel products.
- Electronics manufactured by "a manufacturer that has a program to recycle the computer equipment of other manufacturers, including collection events and manufacturer initiatives to accept computer equipment labeled with another manufacturer's brand" (Texas Health and Safety Code §361.965(d)).

Additionally, the Comptroller may give priority to rubberized asphalt paving (RAP) material made from scrap tires by a facility in this state if the cost, as determined by life-cycle cost-benefit analysis, does not exceed the bid cost of alternative paving materials by more than 15 percent. (Texas Government Code §2155.443)

<u>Potential Role in Strategy Implementation</u>
Potential roles that the Comptroller could play in recycling market development strategy implementation include:

Information, Facilitation & Technical Assistance

- **Offering refresher training for procurement staff in state agencies and local governments.** For example, training regarding the State's preferential procurement requirements and opportunities for increasing the purchase and use of recycled-content products and materials.
- **Hosting an annual Buy Recycled Products Expo for product vendors and purchasing managers with a spotlight on products made from Texas generated materials.** Currently the Division hosts a vendor expo for Historically Underutilized Business (HUB) vendors, and therefore likely has the resources and experience to conduct such an activity.
- **Staying apprised of environmentally preferable purchasing practices and activities through involvement in national organizations.** These organizations include the National Association of State Procurement Officials (NASPO) and the Sustainable Purchasing Leadership Council (SPLC).
- **Developing a catalogue of a broad array of recycled content products and highlighting recycled content products more prominently.** This could also include highlighting products made in Texas.

Preferential Procurement

- **Conducting a new benchmarking study to evaluate other state agency environmentally preferable purchasing (EPP) programs and determine if there are opportunities to improve upon Texas' current procurement system.** In 1997, a benchmarking study was performed on behalf of what was then the TNRCC to evaluate procurement and reporting practices for environmentally preferable products. In this study, the EPP procurement practices of five other states (California, Minnesota, New York, North Carolina, Washington) and the Federal Government were examined along with the practices of Texas, and findings and recommendations for Texas were presented. Among the findings, the report stated that significant opportunity existed for Texas to cost-effectively expand purchases of recycled content products. Much has changed since then, such as the renewed focus on use of recycled-content products, and the need to minimize the purchase of products that create challenges for recycling systems (e.g., purchase of products with labels and adhesives that are problematic in the recycling system).

Policies

- **Expanding the list of preferred recycled-content products.**
- **Implementing a preference for products made in Texas where feasible.**

Texas A&M AgriLife Extension Service

Mission
According to its website, the Texas A&M AgriLife Extension Service "works daily to make Texas better by providing innovative solutions at the intersection of agriculture, natural resources, youth and health, thereby improving the well-being of individuals, families, businesses and communities through education and service."

Programs and Activities
Texas A&M AgriLife Extension Service, in conjunction with Texas A&M AgriLife Research and the Texas A&M University College of Agriculture and Life Sciences, provides programs, tools, and resources locally and statewide that teach people improved agriculture and food production, advanced health practices, environmental protection, economic, and youth programs. The Service has 250 county offices, 900 professional educators, and 13 centers that are part of the Texas A&M University System.

Texas A&M AgriLife Extension Service provides educational opportunities, offering online courses and programs for professionals seeking to fulfill mandated training requirements. There are also courses for homeowners, landowners, and ag enthusiasts looking to expand their knowledge in a variety of topics.

Past and Current Role in Recycling Market Development
Texas A&M AgriLife Extension Service promotes the use of EarthKind® landscaping principles, which encourage the use of mulch and compost, thus reducing reliance on chemical fertilizers and pesticides and reduces water consumption. They work with residents and commercial entities, including commercial growers of horticultural products like fruits, vegetables, and ornamental plants.

Potential Role in Strategy Implementation
Texas A&M has a network of horticultural and agronomy experts and educators throughout the State. Potential roles that Texas A&M AgriLife Extension Service could play in recycling market development strategy implementation focus solely on organics-related market development and include:

Information, Facilitation, and Technical Assistance

- **Conducting and compiling research to show the benefits of using mulch and compost.** Research and demonstration topics could include water conservation and sedimentation control benefits, among others. Texas A&M AgriLife Extension Service could leverage these findings to promote the use of compost and mulch products.
- **Providing training for compost producers, including municipal facility operators, on best practices and the importance of assuring that compost products that are marketed are of high quality**

and fully mature. Also, providing training on vermicomposting such as that provided by the North Carolina State University Cooperative Extension program could be considered.

- **Implementing a statewide promotion campaign on the benefits of using both compost and mulch and the importance that compost is fully mature before application.** The campaign could include outreach to property managers and others who buy compost or hire landscape contractors to include in their product and compost specifications that compost must meet specified maturity testing so that green (semi-raw) compost that may be available at a lower cost is not acceptable.
- **Developing and implementing a program to educate consumers and landscapers on how to assess compost quality and maturity.** This helps "raise the bar" on compost quality throughout the state and strengthen demand for material.
- **Working with industry stakeholders to discern whether there is a need to develop a product grading system for Texas-generated compost.** If there is, continue working with processors and others in the industry to develop and implement this grading system, and educate consumers about it.
- **Working with industry stakeholders and AgriLife Research to conduct research on the safety of biosolids use in compost and to develop safe, alternative uses for biosolids beyond land application.** University researchers may include representatives from other departments and/or specialties to contribute additional relevant expertise.
- **Encouraging increased recovery of agricultural and food scraps for use as compost feedstock.**
- **Participating in and/or collaborating with organizations to deliver training and encourage diversion of organics from disposal and supply of organics to processors whose growth is limited by lack of access to supply in selected marketplaces.** Potential organizations include STAR, the Texas Nursery and Landscape Association, TxSWANA, and other universities.

Preferential Procurement

- **Helping promote the use of made-in Texas compost and other products derived from Texas-generated organics (versus purchase of competing products imported from out-of-state).**

Texas Universities

Mission

Texas has six university systems:

1. The University of Texas System
2. The Texas A&M University System
3. The Texas State University System
4. The Texas Tech University System
5. The University of Houston System
6. The University of North Texas System

Each of these systems has its own mission, but all are dedicated to educating students and, in many cases, to conducting research and innovation projects.

Programs and Activities

Universities have numerous departments and conduct many activities that could assist with recycling market development, including:

- Providing student internships in relevant departments and research facilities;
- Conducting scientific research and research and development activities;
- Performing testing, participating in recycling of university-generated materials; and
- Purchasing goods and products.

Past and Current Role in Recycling Market Development

Texas universities conduct research and perform other activities that help promote the use of recovered materials in Texas. These include:

- Several universities – including the Center for Transportation Research of the University of Texas at Austin and Texas A&M Transportation Institute's Recyclable Materials Group – have conducted studies and demonstration projects and published articles pertaining to engineering and road construction and other roadway product uses for recovered materials with TxDOT funding, as well as conducted compost-related studies (see text box).
- The University of Texas at Arlington's Solid Waste Institute for Sustainability's (SWIS) sole purpose is to work on "developing clean and healthy urban cities through sustainable waste management." SWIS has undertaken a broad array of projects related to sustainable materials management including recycling market development related projects, work on behalf of Texas local governments, and some international projects.
- The University of Texas at Arlington's Division for Enterprise Development has a department called Center for Environmental Excellence (CEE) which provides consulting services, field work, project management, and staffing with individuals who specialize in a broad array of environmental subjects. Projects are funded by regulatory entities such as the U.S. Environmental Protection Agency (U.S. EPA) and the Texas Commission on Environmental Quality (TCEQ) and others. Locations are in Arlington, Houston, and Austin. The Center developed and hosts the RENEW database.

Examples Studies Conducted by Texas Universities

Studies conducted by Texas universities related to recycling market development include the following:

Center for Transportation Research, University of Texas at Austin:

- Increase the Allowable Content of Recycled Crushed Concrete Fine Aggregate in Class P Concrete (Ongoing)
- Use of Road-grade Recycled Plastics for Sustainable Asphalt Pavements: Overview of the Recycled Plastic Industry and Recycled Plastic Types (2021)

Texas A&M Transportation Institute (TTI) (Includes a Recyclable Materials Group):

- Literature Review: Performance of RAP/RAS Mixtures and New Direction (2014)
- Use of Recycled Shingles in HMA (2013)

The University of Texas at Tyler, Civil Engineering Department:

- Research on Recycled Concrete Aggregates (Ongoing)

The Solid Waste Institute for Sustainability (SWIS) at the University of Texas at Arlington

- Feasibility of Recycled Plastics in Road Construction (Ongoing)

Texas State University, Department of Agricultural Science

- On-Campus Composting

Potential Role in Strategy Implementation

The examples provided above demonstrate that Texas has substantial capacity within the university system to conduct recycling market development related research and demonstration projects. In addition, universities can play a role in managing services such as RENEW, managed on behalf of TCEQ. There is an opportunity for Texas' universities to play an even stronger role in recycling market development, depending on available funding. One of most effective recycling market development programs in the U.S. is the Pennsylvania Recycling Markets Center, which is operated under the auspices of Pennsylvania State University.

As another example, the New York State Center for Sustainable Materials Management, based at the State University of New York (SUNY) College of Environmental Science and Forestry, launched a first-of-its-kind statewide recycling website to address residential recycling confusion and contamination across the State. The campaign is supported in part by $5.75 million from the State of New York's Environmental Protection Fund, part of a total of $11.9 million allocated by the New York Department of Environmental Conservation to three SUNY colleges for the purpose of developing solutions to benefit local and statewide solid waste management and recycling efforts.

Potential roles that Texas universities could play in recycling market development strategy implementation include:

Information, Facilitation & Technical Assistance

- **Conducting technical research and innovation, as has been done in past years with TxDOT.** This could also include agricultural research, identifying more uses for biosolids, innovations in recycling processing equipment and processes, etc.
- **Facilitating feedstock conversion research.** This could include research related to increasing the amount of recovered material feedstocks a manufacturer currently uses or substituting recovered feedstock materials for virgin materials.
- **Conducting tests and pilot/demonstration projects.**
- **Conducting other relevant academic research such as policy analysis, behavior science, and economic/feasibility analysis.** For example, researching the economic benefits of specific recycling strategies.
- **Developing and maintaining a recycling business directory to showcase Texas recycling companies and enable manufacturers to easily find suppliers of recyclables in Texas by geographic location.**
- **Developing and hosting material-specific workshops to bring potential suppliers and consumers of high-priority recovered materials in Texas together.** Industry experts can showcase relevant issues and potential solutions, including case studies that have proven successful elsewhere.

Preferential Procurement

- **Purchasing and using recycled content products for use in buildings and grounds maintenance, office and janitorial supplies and other products to aid in demand pull for recovered materials.**

Financial & Other Incentives/Disincentives

- **Developing and implementing student contests on market develop topics.** Examples include innovative use of recyclable materials, and design for recyclability.

Texas Regional Councils of Governments

Mission

Texas is divided into 24 regional Councils of Governments (COGs), each served by a voluntary organization of local governmental entities that coordinate programs and services to address needs that cross jurisdictional boundaries. The COGs represent all 254 counties, and the COGs are comprised of counties, cities, school districts, and special districts. COGs primarily receive funding from federal sources, but the councils also receive funding from state and local sources, including from member dues and regional solid waste management grants, described below.[2] COGs help develop and implement plans, obtain funds and other resources for community services, including applying for federal and state grants. The Texas Association of Regional Councils (TARC) is an umbrella organization for all the COGs and works to collectively develop strategies to address statewide and local needs on a regional basis.

Programs and Activities

The types of issues and programs the COGs focus on span multiple areas and vary by COG. Those that could pertain to recycling market development include:

- Economic development
- Workforce solutions
- Solid waste management
- Environment and development
- Water supply/water quality

Relevant programmatic focus areas of TARC include:

- Community and economic development
- Municipal solid waste

[2] Texas Legislative Budget Board, "Texas Council of Governments: Issue Brief," July 2016.

Within solid waste management, the COGs conduct the following activities at the regional and local levels:

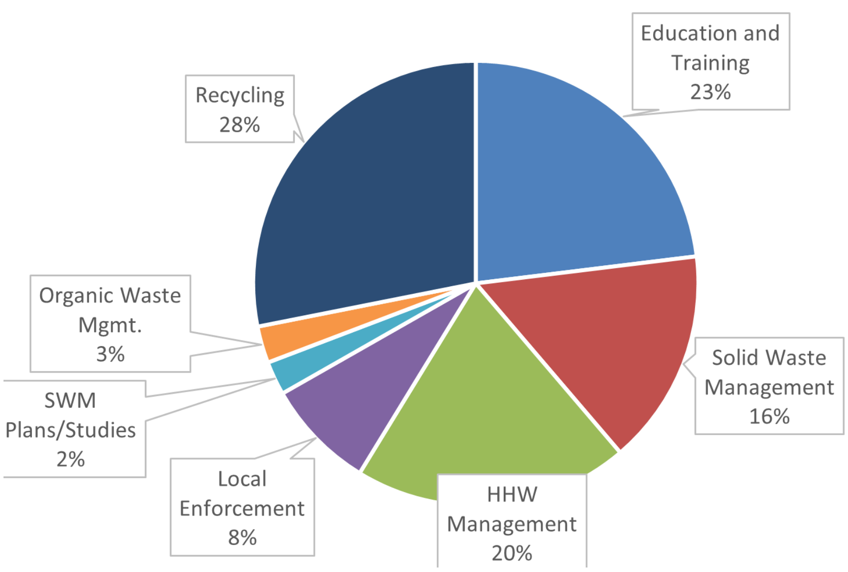
- Assist with solid waste management (SWM) plan development and review of plans and facilitate solid waste advisory committees who determine which grants to fund and direct the activities of the solid waste staff as needed.
- With grant funding (from SWM tip fees, as described below), implement solid waste infrastructure and household hazardous waste (HHW) management, as well as provide SWM grants. Grants are used for planning, collection of difficult-to-manage items like HHW, tires, paint, electronics, pharmaceuticals, etc., including cleanup of illegally disposed scrap tires.
- COGs successfully administer SWM grant funds, as they have local knowledge of needs, can avoid duplication of efforts, have partnerships and relationships with local experts in SWM, and facilitate cooperation within the regions and intra-regionally.
- Hold trainings around environmental topics and share ideas and strategies with other COGs.
- Facilitate regional solid waste advisory committees who determine which grants to fund and direct the activities of the solid waste staff as needed.
- Maintain and promote a catalog of solid waste education and outreach materials for distribution at public events, presentations at schools, and presentations to community groups.
- Provide technical assistance to local governments in the implementation and evaluation of SWM plans.
- Develop education and outreach activities, programs, and printed materials that provide a unified message, but can also be customized for local government use.
- Ensure implementation of locally prioritized solid waste programs by providing funding.

COGs also assist TCEQ by:

- Recommending special studies and projects to further the effectiveness of municipal solid waste management and resource recovery.
- Acting as regional liaisons for the TCEQ solid waste management program.
- Developing partnerships between COGs, within jurisdictions, and with businesses, to help facilitate recycling.

Regional Solid Waste Management Grants awarded in the FY 2018 through FY 2019 biennium are shown in Figure 10-1 by category.

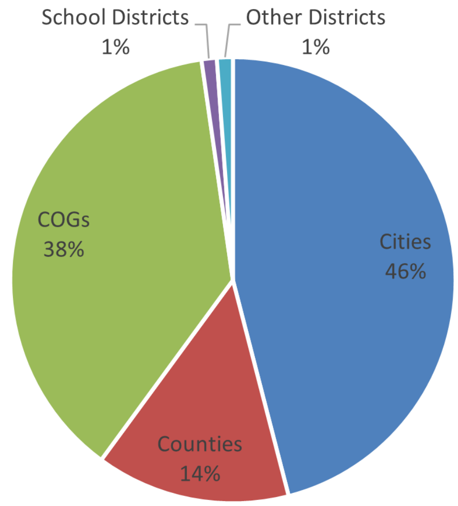
FIGURE 10-1: REGIONAL SOLID WASTE MANAGEMENT GRANTS BY CATEGORY (FY 2018 AND FY2019)



Source: TARC, 2021

Grants provided in the FY 2018 through FY2019 biennium are shown by recipient type in Figure 10-2.

FIGURE 10-2: REGIONAL SOLID WASTE GRANTS FUNDING BY RECIPIENT TYPE (FY 2018 AND FY2019)



Source: TARC, 2021

Past and Current Role in Recycling Market Development
COGs have played an essential and strong role in regional solid waste management planning, development of recycling infrastructure and addressing scrap tire management issues, largely through TCEQ grants funded by solid waste disposal fees. In terms of recycling market development, some COGs have facilitated the consolidation and collection of recyclables from small-generation areas. One example is the Panhandle Environmental Partnership (PEP), in which 16 communities collectively market their recyclables. During Fiscal Years 2018 and 2019, the PEP recycled more than 5.0 million pounds (2,500 tons) of materials.

COGs work on a variety of issues that may compete for priority with recycling market development. As described above in the role of TCEQ, COGs receive solid waste management grant funding through the Regional Solid Waste Management Grant Program. Allocations to COGs are based on a formula that considers population, area, solid waste fee generation, and public health needs. Decisions on how funds are spent are made by the COG solid waste management advisory committees.

Potential Role in Strategy Implementation
Potential roles that the COGs could play in recycling market development strategy implementation include:

Information, Facilitation and Technical Assistance

- **Developing tools and resources for local governments on recycling related topics.** Example topics include the importance of recycling properly (e.g., participating and preparing recyclables appropriately to reduce contamination) as well as best practices and tips on how to address contamination.
- **Facilitating collaboration to share ideas and problem-solve regarding multiple issues, including low participation, combatting contamination, identifying markets or end uses for materials, etc.**
- **Establishing more regional recycling partnerships**. This includes hub-and-spoke systems, cooperative contracting (e.g., for material collection and transport to market, organics processing) to consolidate adequate quantities of material to market successfully.
- **Facilitating and funding the establishment of recycling market development zones (RMDZs).**
- **Facilitating meetings with regional economic development representatives.** Meetings would explore potential tools and incentives that could be offered to recycling businesses in the region, or considering locating in the region, in order to strengthen materials markets.
- **Facilitating the completion of relevant studies.** Example topics include investigating feedstock conversion opportunities in the region and conducting infrastructure needs assessments to determine where grant funds might be targeted.

- **Hosting trainings/workshops on recycling market topics.** Examples include local policy tools, harmonization of materials recycling efforts and messaging within the region, and the role of recycling market development in building a circular economy.

TARC could assist in hosting cross-COG functions and sharing relevant information, case studies and best practices among COGs.

Financial Assistance

- **Directing grant funding to recycling market development activities.**

10.2 ROLE OF TEXAS LOCAL GOVERNMENTS

Local governments often bear the brunt of solid waste management system costs and are responsible for providing collection and processing services directly or through contracts with service providers. Although end markets for materials are usually not local, the State's local governments have had to adapt to end market conditions by collecting materials differently or developing their own end uses for materials. As such, local governments are in a position to understand market development needs, advocate for them, and join forces with other stakeholders as needed.

Past and Current Role in Recycling Market Development

Some Texas local governments have been engaged in recycling market development activities both in past years and currently. Examples of past and current activities aimed at overcoming recycling system barriers include the following.

One of the most notable is the City of Austin. In 2014, Austin hosted a Recycling Innovations Investment Forum in partnership with the Texas Entrepreneur Network. The forum brought recycling manufacturing companies together with investors to help them start-up, expand, or relocate to Austin. Austin as a city with a zero waste goal is working aggressively to divert recyclable materials from the waste stream and drive local markets where innovative local companies use these recycled materials to make new, value-added products. Among its many zero waste initiatives, the City operates a Business Retention and Expansion (BRE) Program and Circular Economy Program offering business support and information services to local circular businesses looking to grow their business. Circular businesses provide products and services that keep resources in use in Austin's local economy instead of the landfill. In 2020, Austin completed an update to its 2015 study on the Recycling & Reuse-Related Economy of Austin. In this update, several recycling market development strategy recommendations are delineated as measures to support Austin's transition to a circular economy. The City also operates a [RE]verse Pitch competition and has held six such events, which work to connect circular economy entrepreneurs with potential investors. Circular entrepreneurs have a chance to pitch their company and participate in one-on-one meetings with investors to build their funding network. Innovation Fellows are chosen to receive cash and in-kind prizes. The City of Austin is updating its zero waste plan in 2021 and is expected to continue addressing market development in the update.

Another local program example is the City of Plano's Construction and Demolition (C&D) Recycling Deposit Program which offers builders, contractors and developers the opportunity to divert concrete, wood, brick and metal, as well as typical recyclables such as glass, plastics, paper and cardboard from construction sites. This recycling incentive program assesses a monetary deposit based on the project's square footage and project type: alteration, remodel, demolition or new construction. Commercial recycling coordinators are available to offer assistance through support materials, information and training.

Local governments in Texas, with COG assistance, have also organized hub and spoke recycling collection and processing systems as well as cooperative marketing, to address transportation and economic barriers.

Potential Role in Strategy Implementation

Including current activities, potential roles local governments could play in recycling market development strategy implementation include:

Information, Facilitation & Technical Assistance

- **Participating in relevant recycling market development activities.** For example, those sponsored by COGs, TARC, TCEQ and others.
- **Education and outreach to residents and businesses.** Informing residents and businesses of opportunities to recycle and how to properly prepare recyclable materials and the benefits of recycling.
- **Promote opportunities to divert materials such as textiles, electronics, paint, tires, and yard waste.** It is important to provide opportunities for collection as well as ensuring residents are aware of these collection opportunities.
- **Monitoring recycling program effectiveness.** The collected information can be used to identify supply-side issues such as contamination, lack of participation, or a need to partner with other local governments to market material successfully.
- **Seeking publicly available resources that support outreach programs and improve the quality of collected recyclables.** For example, resources are available from The Recycling Partnership to facilitate education and outreach and address contamination.
- **Developing end uses/markets for recovered materials that lack adequate markets, as appropriate.**
- **Hosting innovation competitions to solve a recycling/marketability issue.** This could potentially be implemented with the participation of a local college or university.

Preferential Procurement

- **Engaging with organizations that support and provide information about environmentally preferable purchasing to strengthen markets for recovered materials and sharing such information with other purchasing entities within the jurisdiction and region, as appropriate.** Examples include relevant state agencies (e.g., TxDOT, Texas Comptroller's Statewide Procurement Division), the National Association of State Procurement Officials (NASPO), the Sustainable Purchasing Leadership Council (SPLC), and the Responsible Purchasing Network.
- **Instituting a "Buy Recycled" campaign as well as promote locally available opportunities for donating goods as well as buying secondhand items.**
- **Seeking opportunities to support demand for recovered feedstocks by making a concerted effort to purchase recycled content products – particularly those made in Texas, if available.**

Financial Assistance

- **Seeking grants and otherwise obtaining/allocating funding, as appropriate, to address barriers impeding the marketability of and markets for recovered materials.**
- **Considering implementing a local disposal surcharge to put recycling on a more level playing field with disposal.**

Financial and Other Incentives/Disincentives

- **Considering offering recycling-related businesses certain incentives to encourage the enhanced use of recovered materials within Texas.** Examples include a reduced rate for waste disposal, reduced taxes/tax exemptions, fast-track permitting, and reduced utility rates. One approach local governments might consider is establishing recycling market development zones (RMDZs), which is particularly appropriate where local governments wish to concentrate such industry in one or more geographic areas.

Policies

- **Implementing local policies and associated programs to encourage participation in recycling.** Examples include PAYT, mandatory recycling of certain materials (e.g., Austin's Commercial Organics Diversion Requirements), and universal recycling ordinances (e.g., Dallas's Multifamily Recycling Ordinance).
- **Developing policies that encourage the recycling of construction and demolition debris.** Examples include programs in the Cities of Austin and Plano.
- **Ensuring contracts for materials processing are structured to limit contamination levels and strengthen product marketability, as appropriate.**

10.3 POTENTIAL ROLE OF OTHER ORGANIZATIONS

Recycling market development is not a program of work to be performed by only one organization. Rather it typically involves a variety of organizations, often working in collaboration. With respect to Texas, some appropriate organizations are within the State, while others are multi-state or national in scope. In this section, additional organizations (both within and outside of Texas) are identified, and their potential roles are briefly described. An effective statewide recycling market development program will seek to partner with agencies and organizations throughout the state, including with organizations described below, to implement recycling market development initiatives, leverage state resources and realize opportunities to employ the expertise and capacity of additional organizations to improve program reach and effectiveness.

Texas-Based Organizations

State of Texas Alliance for Recycling (STAR)

STAR's mission is "to advance recycling through partnerships, education, and advocacy for the benefit of Texas." STAR serves as the voice of the Texas recycling industry and works with local governments to help them reduce contamination, develop effective outreach, and develop local recycling markets. Much of what STAR does addresses recycling program barriers and opportunities in Texas and indirectly supports recycling market development. For example, STAR provides outreach to the general public to inform them of the benefits of recycling and how to "Recycle Right" and hosts conferences, webinars, workshops, and regional meetings for educational and networking purposes. STAR advocates for supportive legislation, including passage of the Act that required the RMDP development. Potential roles STAR can play in recycling market development strategy implementation include:

Information, Facilitation and Technical Assistance

- **Continuing to promote recycling and how to do so correctly.**
- **Bringing industry and other stakeholders together to address recycling market development-related issues, including contamination and infrastructure needs.**
- **Providing education and training related to identifying and overcoming market barriers and implementing recycling market development initiatives.**
- **Building knowledge among recycling professionals of markets, market conditions and market development opportunities.**
- **Assisting with completing projects such as this recycling market development plan project.**

Policies

- **Advocating for policies that support improved recycling infrastructure and strengthening end markets.**

Keep Texas Beautiful

Keep Texas Beautiful (KTB) aims to keep Texas communities litter free. KTB partners with public and private sector organizations and residents to advance this mission. KTB works to achieve its mission through organizing cleanup events, conducting education, and developing tools and resources that can be used by interested affiliates, network of volunteers, and organizations, KTB also conducts advocacy, meeting with state legislators annually for a "walk the halls" event. A program of KTB's is Keep Texas Recycling (KTR), which is focused on developing cooperative opportunities for recycling in rural and underserved communities throughout Texas. Currently, KTR has over 55 entities within the cooperative, including civic groups, private industry, military bases, government entities and school districts. Potential roles KTB and KTR can play in recycling market development strategy implementation include:

Information, Facilitation and Technical Assistance

- **Working with other stakeholders and communities to identify additional needs in underserved areas and share best practices that have worked to date in Texas and to address issues related to recycling market development.**
- **Conveying the benefits of recycling and the importance of minimizing contamination to affiliates, organizations, and individuals.**
- **Continuing to provide technical assistance to help communities minimize contamination and implement recycling programs as needed.**

Policies

- **Advocating for policies that support recycling and recycling market development.**

<u>**Texas Association of Business**</u>
The Texas Association of Business (TAB) represents businesses of all size and sectors in Texas. There are 200 local chambers of commerce that also conduct this work and, jointly, represent over $8 billion in business annually. TAB influences policy development and drives legislative decisions to support Texas businesses at the state and national levels. TAB also hosts member events. Potential roles that TAB could play in recycling market development strategy implementation include:

Information, Facilitation and Technical Assistance

- **Conveying the availability and importance of recycling to Texas businesses.**
- **Identifying needs for recycling services.**
- **Conveying the resources and opportunities available through STAR, TCEQ, and The Texas Governor's Office of Economic Development and Tourism.**

Policies

- **Participating in the stakeholder dialogue and helping to shape national and state policies that support the recycling industry and recycling market development in Texas.**

<u>**Texas Beverage Association**</u>
The Texas Beverage Association (TBA) is an organization that represents beverage producers, distributors, franchise companies and support industries. Members are diverse, representing hundreds of brands, and several packaging types. TBA asserts that they support environmental stewardship in Texas, and that their member companies' product containers are 100 percent recyclable. The association also supports comprehensive, convenient recycling programs. Potential roles that TBA could play in recycling market development strategy implementation include:

Information, Facilitation and Technical Assistance

- **Bringing industry and other stakeholders together to address issues related to recycling market development.**
- **Conducting outreach to consumers to convey the benefits of recycling beverage containers.**

Financial Assistance

- **Supporting beverage container recycling through financial support of infrastructure development, education and outreach materials, or other needs.**

Policies

- **Advocating for policies that support the recycling of beverage containers generated in Texas.**

<u>**Texas Economic Development Corporation**</u>
The Texas Economic Development Corporation (TxEDC) is an independently funded and operated nonprofit organization responsible for marketing and promoting Texas as a premier business location. TxEDC could promote the availability of selected recycling feedstocks as a means of attracting relevant end use companies considering locating or expanding in Texas. Potential roles TxEDC could play in recycling market development strategy implementation include:

Information, Facilitations and Technical Assistance

- **Promoting Texas as a good location for recycling-based businesses seeking new locations.** For example, providing information on advantageous features of Texas (e.g., the port system, business friendly governments).

- **Informing businesses seeking to locate in Texas of the availability of applicable recovered materials available for feedstocks.**

Financial and Other Incentives/Disincentives

- **Identifying and promoting financial and other incentives to attract recycling-related businesses, including manufacturers consuming Texas-generated recyclable materials.**

Texas Nursery and Landscaping Association
The Texas Nursery and Landscaping Association (TNLA) represents the nursery and landscaping industry. The TNLA provides education and collaboration opportunities by hosting courses, workshops and webinars, as well as product certification. The TNLA also hosts awards programs to highlight members' project achievements and advocates for legislation that supports members' interests. Potential roles the TNLA could play in recycling market development strategy implementation include:

Information, Facilitation and Technical Assistance

- **Bringing nursery and landscaping industry and other stakeholders together to address issues related to recycling market development.**
- **Educating consumers on what to look for in a high-quality compost product.**
- **Partnering with Texas AgriLife Extension Services to encourage best practices regarding composting.**

Preferential Procurement

- **Promoting the benefits of using Texas-made compost.**

Policies

- **Advocating for policies that support the use of Texas-made organic products.**

Regional Organizations

There is only one known regional organization other than regional offices of U.S. agencies (e.g., U.S. EPA Region 6) that is relevant to recycling market development: the Southeast Recycling Development Council (SERDC). Since Texas and some of its neighboring states are not within the territory of SERDC, Texas should monitor the activities of adjacent states and look for opportunities for partnership building and collaboration where appropriate and mutually beneficial.

Southeast Recycling Development Council (SERDC)
The Southeast Recycling Development Council (SERDC) is a nonprofit organization that works to unite industry, government, and non-government organizations to promote sustainable recycling in the Southeast. The territory includes Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. SERDC members consist of a diverse array of industry and governmental representatives committed to improving materials capture in both quantity and quality, which will lead to a strengthening of local economies through recycling. SERDC was established in 2005, has two paid staff, and is governed by a 19-member board of directors representing state government, U.S. EPA, and recycling industry stakeholders. Recycling market development activities have included mapping processing and end markets throughout the southeast, conducting research to identify infrastructure gaps in order to target recycling market development efforts, and conducting recycling economic information studies. SERDC hosts conferences, webinars, forums, and workshops where recycling market development-related topics are covered and provides links to market directories and other relevant organizations and activities. Texas has collaborated with SERDC in past efforts and could potentially do so again in future years given Texas' role in the broader region. SERDC could serve as a potential source of information and collaborator for expanding regional markets for Texas-generated materials, and as an example to guide potential future regional collaboration efforts in the south central and southwest.

Federal Agencies

U.S. Environmental Protection Agency (U. S. EPA)

The U.S. EPA plays an important role in education and outreach/information sharing and coordination. In addition, U.S. EPA helps build consensus regarding key industry definitions and measurement methods and can set national goals and targets. U.S. EPA also allocates grant funding. Depending on the outcome of the federal budget process, U.S. EPA grant funding is likely to increase for 2022. As a result of the Save Our Seas 2.0 Act and depending on the outcome of the federal budget process, U.S. EPA's 2022 budget may include an additional $10 million in funding for a new Solid Waste Infrastructure for Recycling (SWIFR) pilot grant program aimed at improving solid waste management infrastructure and post-consumer materials management. Potential roles the U.S. EPA, and particularly EPA Region 6, could play in helping to implement the Texas recycling market development strategy include:

Information, Facilitation and Technical Assistance

- **Implementing a broad economic benefits campaign.** A national campaign to broadly promote the economic benefits and jobs creation of recycling could help encourage participation.
- **Conducting training and facilitating collaboration.** National conferences, webinars, and tool development and dissemination could help state and local governments move further along in recycling market development. Sharing studies and tools nationally can help enhance the effectiveness and efficiency of resource expenditure. There is also an opportunity to provide training and a forum for information sharing among state agencies regarding recycling market development, and to bring recycling and economic experts together.
- **Conducting/funding research and development.** There may be some areas where national research could spur innovation in how to recycle problematic materials or to find new uses for recovered materials that need markets. This might include the expansion/scaling up of emerging technologies such as those used for chemical recycling. The U.S. EPA could host a national competition to resolve a specific recycling or end-use issue, for example.
- **Developing a materials directory.** It may be possible to develop a national materials directory, where users could select their location and materials markets that make sense for that material type would populate, or the user could indicate the number of miles that material could travel and still be cost effective. Such a directory might also serve as a means for rural areas to communicate to consolidate loads.

Preferential Procurement

- **Updating and improving Buy Recycled specifications and certification standards/methods.** The U.S. EPA developed the Comprehensive Procurement Guideline (CPG), which many states have adopted or refer to for their Buy Recycled programs. More work is needed to certify recycled-content levels in products as well as whether such recycled content is postconsumer or pre-consumer (i.e., post-industrial).
- **Developing a recycled products directory.** While some state purchasing agencies and the U.S. EPA have worked to develop information about recycled-content products, a national directory that is easy to use, comprehensive and visually appealing could make the purchase of recycled-content products more convenient and common.

Financial Assistance

- **Providing grant funding.** The U.S. EPA provides over $4 billion in grants annually to fulfill its mission of protecting human health and the environment. Priority activities receiving grants often shift from year to year. As discussed above, the proposed 2022 U.S. EPA budget contains an additional $10 million of proposed recycling-related grant funding, and therefore is a possibility that additional funds could be directed to expanding recycling infrastructure, developing new technologies, and developing U.S. markets for recyclables in several federal bills being considered, such as the RECYCLE Act of 2021 (S 923).

U.S. Department of Commerce

The U.S. Department of Commerce's (DOC) mission is to create the conditions for economic growth and opportunity. The DOC occasionally makes grants available to businesses meeting certain criteria. The U.S. Economic Development Administration is a bureau within the DOC, whose mission is to lead the federal economic development agenda by promoting innovation and competitiveness and preparing U.S. regions for growth and success in the worldwide economy. EDA facilitates regional economic development efforts in communities across the nation. Assistance includes the Build to Scale (B2S) Program which helps innovative startup companies, local and national technical assistance, university centers, and economic development integration. Potential roles the DOC could play in helping to implement the Texas recycling market development strategy include:

Information, Facilitation and Technical Assistance

- **Facilitating regional economic development efforts and integrating economic development efforts with local and regional economic development agencies.**

Financial Assistance

- **Providing grants to businesses meeting certain criteria, including through the B2S Program.**

U.S. Department of Agriculture

The mission of the U.S. Department of Agriculture (USDA) is to provide leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on sound public policy, the best available science, and efficient management. A current focus of the USDA is preventing food waste. A guidance document, "Funding for Food Waste Reduction Projects," provides information on the various grant and loan programs that could potentially help fund composting programs and outreach initiatives in rural areas. The USDA has other loan and grant programs that could be suitable for Texas recycling entities, which are administered through the TDA and are therefore included in Section 10.1. The USDA also offers competitive solid waste management grants for rural communities, which could potentially be used to address recycling market development needs, or to free regional solid waste management grants to reallocate a portion of those funds to recycling market development activities. In 2020, for example, USDA awarded a grant to the Permian Basin Regional Planning Commission to provide technical assistance to assist communities with planning for landfill diversion and composting programs, the management of HHW and prescription drugs, and implementing illegal dumping enforcement, among other activities. The potential role the USDA could play in helping to implement the Texas recycling market development strategy includes:

Financial Assistance

- **Providing grants and loans aimed at assisting rural communities, including solid waste management grants.**

U.S. Department of Energy

The U.S. Department of Energy (U.S. DOE) initiated a $15 million three-year research and development project at the Argonne National Laboratory to support infrastructure development for lithium-ion battery recycling in the U.S., indicating that it was a national security issue. The Office of Energy Efficiency and Renewable Energy (EERE) implemented the Plastics Innovation Challenge, to "accelerate innovations that will dramatically reduce plastic waste in oceans and landfills and position the U.S as global leaders in advanced plastics recycling technologies and in the manufacture of new plastics that are recyclable by design." In June 2021 the U.S. DOE announced it would invest up to $14.5 million in the challenge.[3]

Potential roles the U.S. DOE could play in helping to implement the Texas recycling market development strategy include:

[3] "DOE invests $14.5M in plastics recycling R&D," Megan Smalley, Recycling Today, June 2, 2021.

Information, Facilitation and Technical Assistance

- **Encouraging innovation in recycling technologies through the facilitation of innovation challenges.**

Financial Assistance

- **Providing grants to help fund recycling efforts, in particular the growth of chemical recycling.**

U.S. Federal Trade Commission

The U.S. Federal Trade Commission's (FTC) role is to protect U.S. consumers, including ensuring truth in advertising. The FTC developed the "Green Guides" to provide guidance on the use of environmental marketing claims such as regarding proper labeling of "recycled content," "recyclable," and "compostable." The Green Guides will need to be updated to reflect labeling associated with chemical recycling and mass balance. It will be important for stakeholders to weigh in with their input. The potential role the FTC could play in helping to implement the Texas recycling market development strategy includes:

Information, Facilitation and Technical Assistance

- **Synthesizing stakeholder input and developing updates to the Green Guides, implications of which will be critical in terms of defining recycling, recyclable, and recycled content.**

Private Sector and Industry Organizations

Individual businesses can work nationally (and globally) to support recycling market development in many ways, including by directly creating demand for recovered materials. Many are already announcing goals to use recycled content and ensure materials are recyclable, as is currently being done through the Ellen MacArthur Foundation's New Plastics Economy and APR's Recycling Demand Champions program. Private brands can also support nonprofit and trade organizations' efforts with expertise and financial support to expand markets and improve the quality of recovered materials. Examples of current and potential roles for private entities in helping to implement the Texas recycling market development strategy are described below.

Information, Facilitation and Technical Assistance

Industry organizations and trade associations can play a critical role in providing/sharing information and convening information-sharing opportunities, allowing brand owners, processors, and public-sector interests to better understand each other's concerns, challenges, and efforts. Examples include:

- **Developing tools and sharing information to help reduce contamination and publicize the economic benefits of recycling.** This is currently being done by The Recycling Partnership.
- **Providing information about how to construct processing contracts to mitigate risk when markets are low.** For example, The Recycling Partnership issued a guidance document to help public recycling programs and MRFs develop transparent, balanced recycling processing contracts that allow each party to navigate volatile market conditions and an ever-changing landscape of consumer packaging.[4]
- **Providing information about how to implement successful Buy Recycled programs/campaigns.** National purchasing organizations (e.g., NASPO, SPLC) can be a source of such information, and can host webinars and conferences, and otherwise provide resources.
- **Disseminating information about how and where to recycle specific types of materials, and information about markets for recovered materials.** This type of information is often developed and disseminated by commodity-specific industry groups.
- **Bringing stakeholders together to better understand barriers to recycling and potential means to address them.**
- **Conducting research, development, and innovation activities.** Private-sector businesses such as resin producers, processors, equipment manufacturers and others can also play a role in advancing innovation, so that materials are more compatible with recycling systems, and so recycling systems can advance to suit different packaging and product types.

[4] The Recycling Partnership 2020 Guide to Community Material Recovery Facility Contracts. Available online at: https://recyclingpartnership.org/mrf-contracts/

- **Providing information about grant and loan opportunities to entities interested in implementing recycling market development activities.**

Financial Assistance
The idea that industry should play a role in funding recycling infrastructure and market development, either through EPR or some other mechanism, is now widely held by a broad array of stakeholders including those representing potential funding sources. Industry has provided funding and other resources in the past (often through industry organizations funded by private companies) and can continue to provide funding resources. Examples include:

- **Providing grants for processing equipment, carts, and technical assistance.** Examples include The Recycling Partnership, Closed Loop Partners, and the Carton Council.
- **Funding additional research and development initiatives by colleges and universities.** Some research in this arena is already taking place, funded by private companies and industry organizations such as the Environmental Research and Education Foundation (EREF).
- **Funding or administering grant and loan programs through state agencies, as is done in Massachusetts and through Closed Loop Partners.**

Private sector and industry organizations with the potential to contribute to implementing the recycling market development strategy include a diverse set of organizations. This may include organizations focused on recycling or packaging issues that address multiple commodities (i.e., multi-commodity), organizations focused on a specific commodity or material (i.e., commodity-specific), and other national organizations such as those focused on business issues or state or local government. Key examples and current activities of these groups are described below.

Multi-Commodity Organizations
Multi-commodity organizations provide the opportunity for collaboration facilitation, and technical assistance in their respective fields such as recycling or sustainable packaging. Some organizations also publicly support and lobby for polices that help drive the circular economy including recycling market development. Some organizations provide grants or funding to help address gaps in recycling infrastructure, develop end markets, or conduct education and outreach activities. Most of the organizations also provide resources such as technical reports, standards and specifications, and best practices guidance. Key examples of multi-commodity organizations that are making sizable investments to advance recycling in the U.S. are:

- **The Recycling Partnership (TRP)** is a multi-stakeholder entity working to address recycling system challenges. TRP provides downloadable resources for local governments to fight contamination and provides grant funding to convert bin- or bag-based curbside recycling programs to carts or to implement new cart-based curbside recycling programs. A new multi-million-dollar grants program was recently established which has thus far been providing funding to MRFs across the United States to improve and increase sortation of polypropylene and support targeted consumer education efforts. In addition, TRP has established the Film and Flexibles Coalition to work on infrastructure development for this plastics sector and established the Circular Economy Accelerator which is advocating for dramatically expanded public-private partnerships and robust policy that provides sustainable funding for recycling system optimization. TRP has previously invested in the Texas recycling system through various grants and other initiatives, and directly supported cities (e.g., Fort Worth, Garland), regions (e.g., the Dallas-Fort Worth Metroplex, the North Central Texas Council of Governments (NCTCOG)) and private entities operating in the State (e.g., Independent Texas Recyclers (ITR)).
- **Closed Loop Partners (CLP)** conducts research and provides financing and makes investments to support recycling infrastructure and innovations across the U.S. to advance the circular economy. Grant funding is also available through three different funding programs:
    - The Closed Loop Infrastructure Fund (CLIF) provides funding for "replicable, scalable and sustainable recycling and circular economy infrastructure projects across collection, sortation, processing and new technologies." One Texas project that has received funds is Independent Texas Recyclers (ITR), which provides recycling services in Houston through their existing MRF. With an investment from CLIF, ITR expanded its operations and built a glass processing line, now operating as EcoGlass Recycling (EGR), which started operation in 2019.
    - The Closed Loop Ventures Group "partners with companies providing resource and supply

    chain efficiency within the sectors of plastics & packaging, food & agriculture, fashion & apparel, and transparency & logistics."
  - The Closed Loop Circular Plastics Fund "provides flexible financing alternatives to circular economy infrastructure, technologies and companies that advance the recovery and recycling of plastics in the U.S. and Canada."
- **The ReMADE Institute** is a public/private partnership established by the U.S. DOE, which funds early-stage applied research and development projects to increase the supply and use of recycled materials. The institute is a partnership with industry, academia, and national laboratories. In its fifth round of funding (issued in May 2021) the Institute had $51 million of funding available. Past projects include those that would recycle low-value plastics.
- **The Environmental Research and Education Foundation (EREF)** is a private waste and recycling industry nonprofit that funds academic research related to solid waste and recycling. EREF recently funded research projects to explore potential low-value plastics end uses, the sustainability and consumer preference of recycled-content packaging, the influence of interventions on multi-family recycling, and best practices to address contamination and develop sustainable recycling systems.

Examples of other multi-stakeholder industry organizations that have played a direct role in addressing barriers to recycling, strengthening markets for recyclable commodities, and/or developing recycling policy include:

- AMERIPEN
- Consumer Brands Association (CBA)
- Container Recycling Institute (CRI)
- Institute of Scrap Recycling Industries (ISRI)
- National Waste & Recycling Association (NWRA)
- Sustainable Packaging Coalition (SPC)
- Solid Waste Association of North America (SWANA)

Commodity-Specific Organizations

Industry organizations that support specific commodities naturally have a narrower focus but can be excellent forums for collaborating and facilitating information sharing about specific commodities. Many commodity-specific organizations hire third-party experts to conduct technical studies pertaining to the recycling of the commodities. Some organizations have established recyclability/compostability standards and testing protocols, and several also provide grant funding for equipment and recycling education and promotion. Key examples include:

- **The American Beverage Association (ABA)** has an "Every Bottle Counts" campaign and, as part of that campaign, provides education about the benefits of PET bottle recycling, and funding for recycling infrastructure improvements and outreach efforts (Figure 10-3).

FIGURE 10-3: EVERY BOTTLE COUNTS CAMPAIGN DALLAS/FORT WORTH

- **The Association of Plastic Recyclers (APR)** has Recycling Demand Champions programs to encourage businesses and governmental entities to increase the purchase of goods made with recycled plastic. APR also hosts a vendor directory to provide information about products containing recycled content. In addition, APR has established design for recyclability guidelines and offers testing and approval of packaging recyclability.
- **Call2Recycle** is the largest U.S. producer responsibility organization implementing a voluntary national battery stewardship program. Call2Recycle collects and recycles various types of batteries through a network of thousands of collection sites at no cost to generators including multiple such sites in Texas. Major product and battery manufacturers voluntarily fund the program to ensure that the batteries and cellphones are responsibly recycled at the end of their life.
- **The Carton Council of North America** provides information about state and local policies that help drive recycling programs, including case studies, model ordinances and best practices; provides equipment grants to MRFs for sortation of cartons and carton recycling promotion; helps strengthen carton markets; and provides information on brokers and end markets for cartons.
- **The U.S. Composting Council (USCC)** operates the Seal of Testing Assurance (STA) Certified Compost Program which seeks to strengthen product demand through quality assurance.

Examples of other commodity-specific industry organizations which also have played a direct role in addressing barriers to recycling, strengthening markets for recyclable commodities, and/or recycling policy development include:

- Aluminum Association
- American Chemistry Council (ACC)
- American Forest and Paper Association (AF&PA)
- Can Manufacturers Institute (CMI)
- Construction and Demolition Recycling Association (CDRA)
- Consumer Electronics Association (CEA)
- Flexible Packaging Association (FPA)
- Glass Packaging Institute (GPI)
- Glass Recycling Coalition (GRC)
- National Center for Electronics Recycling
- PaintCare
- Plastics Industry Association (PIA)
- U.S. Tire Manufacturers' Association

<u>Other National Organizations</u>

Other national organizations that could help support recycling market development strategy implementation through subject matter expertise and/or facilitation and stakeholder collaboration. This includes organizations that provide resources such as business assistance and procurement expertise, particularly around recycled-content products; organizations that can provide subject matter resources and technical information; and organizations that can convene stakeholders from the entire country to share information to address recycling market development issues.

Examples of other national organizations include:

- American Sustainable Business Council (ASBC)
- National Association of State Procurement Officers (NASPO)
- National Conference of State Legislators (NCSL)
- National League of Cities (NLC)
- Responsible Purchasing Network (RPN)
- Sustainable Purchasing Leadership Council (SPLC)
- U.S. Chamber of Commerce and Small Business Council
- U.S. Conference of Mayors

10.4 EFFECTIVELY MANAGING TEXAS RECYCLING MARKET DEVELOPMENT EFFORTS

In addition to selecting appropriate tools and mechanisms, it is also important to ensure that efforts to strengthen recycling market development are managed properly. The following principles for recycling market development management are suggested.

1. The lead entity guiding market development is determined and its roles and relationships with other key departments and organizations are defined.
The lead entity may be a state agency or could be a non-governmental entity such as a university or state-established corporation. The lead entity would be responsible for overseeing the development of a statewide recycling system, and ideally have the ability to convene all parties, have no vested interests in any goal other than the public interest, and have the ability to leverage the engagement of other organizations to assist with market development in the state.
Recommendation: The recommended strategy for establishing a lead entity for recycling market development in Texas is to establish a Texas Recycling Market Development Center (TxRMDC) with the recommended location being within one of the state universities – possibly set up as a 501(c)(3) affiliate.

This institutional strategy was used for establishing the Pennsylvania Recycling Markets Center, a 501(c)(3) organizational affiliate of Pennsylvania State University, and to establish the New York State Center for Sustainable Materials Management (SMM), a collaborative venture of the SUNY College of Environmental Science and Forestry (SUNY ESF) and Syracuse University. Both of these centers receive funding from their respective state environmental agencies and seek additional funding via grants and contracts.

2. Coordination exists among major players in the recycling market development system.
Coordination will help ensure that all involved are striving to achieve the same market development goals, even though individual agencies and departments have their own objectives as well. To this end, coordination should include clearly defining roles and responsibilities and agreement over shared recycling market development goals and priorities as well as regular communication and collaboration where appropriate.

Recommendation: While the TxRMDC would lead recycling market development planning and program development, specific recycling market development work, as outlined in the RMDP, can be undertaken by multiple agencies and organizations. Some agencies and organizations might need additional resources while others could integrate certain market development activities in their routine program of work. To assist with coordinating multi-organizational efforts and to provide guidance to the TxRMDC, it is recommended that the State appoint a Recycling Market Development Board. The Board could be comprised of 17 members from the following organizations, for example:

1. TCEQ
2. EDT
3. TxDOT
4. Comptroller's Statewide Procurement Division
5. Texas A&M AgriLife Extension
6. 3 COGs (at least one of which is a rural area)
7. 2 local governments (one of which is rural)
8. STAR
9. Paper industry
10. 1Plastics industry
11. Textiles industry
12. C&D industry
13. Organics industry
14. Scrap tire industry

3. To the extent possible, the skills, knowledge, and resources of the private sector are leveraged to achieve the public goal of solving market development barriers.
Engaging the private sector in the market development process will save scarce state resources and

personnel and help ensure that solutions are realistic. In performing recycling market development work, it is important to ensure that private interests do not supersede the public interest in the market development process.

Recommendation: Having a balance of industry representatives on the recycling market development board is one means of helping to provide for industry engagement, in addition to collaborating/partnering directly with some of the many organizations identified in this section in accordance with key roles also identified.

4. Implementation of strategies is well managed and appropriately staffed.
Implementation management consists of program planning and budgeting, fulfillment of assigned roles and responsibilities, and coordinating actions of organizations and staff. Ideally, this involves the cost-effective allocation of financial and human resources available for recycling market development, overseen and guided by an appropriate coordinating mechanism that includes the key organizations responsible for market development. It also requires adequate, and consistent funding.

Recommendation: It is recommended that at least two full-time positions are funded to initially staff the TxRMDC. One of the advantages to housing the TxRMDC within a Texas university is to have access to multiple other human and organizational resources as well as student interns to assist with program and project execution.

5. Current, accurate market intelligence and assessment is key to making good decisions and monitoring progress.
Market intelligence involves tracking supply, recovery and demand trends for each of the state's key secondary materials and continuously identifying the barriers to the further development of markets and opportunities to address them, as well as to identify progress being made with recycling market development activities underway. This can be challenging because:

- There are a large number of markets to follow, each with its own unique dynamics;
- Data pertaining to materials generation and recovery are incomplete; and
- Materials markets can be volatile, as they are subject to external forces that are often unpredictable.

Good market intelligence is a function of collecting and integrating information and perspectives from a wide network of public and private sources. Up-to-date market intelligence and assessment should be used to proactively make appropriate adjustments in ongoing activities, as necessary.

How SC DHEC Obtains MSW Data

SC Department of Health and Environmental Control (DHEC) annually receives data by material type on tons recycled, as well as amount of waste disposed via a web-based reporting system and publishes a report summarizing this data. Reporting entities include:

- **Waste disposal facilities** are required to report on waste landfilled, incinerated, or exported.
- **County governments** are required to report on quantity of materials recycled, by type, including by municipal governments within the county.
- **Businesses** (commercial and industrial generators) are encouraged to report on materials recycled, by tons.

SC DHEC also requires state agencies and universities to report annually the quantity of selected materials recycled, by type, and the amount of recycled-content products purchased, by type.

Recommendation: Many states conduct waste characterization studies and some conduct MRF residue studies to better understand the types and quantities of recyclable materials that are being disposed, and non-recyclable materials that are entering recyclable facilities. From the recycling market development perspective, conducting recyclable contamination studies would help assess the effectiveness of anti-contamination campaigns.

Recommendation: There is also limited data on the quantity of recycled-content products and packaging purchased. It is suggested that the Comptroller's Statewide Procurement Division and each state agency more accurately track the quantity of recycled-content materials purchased/used, and also track recycled-content products made in Texas. Each agency should set goals to increase the portion of expenditures going to recycled-content goods and recycled-content goods made in Texas.

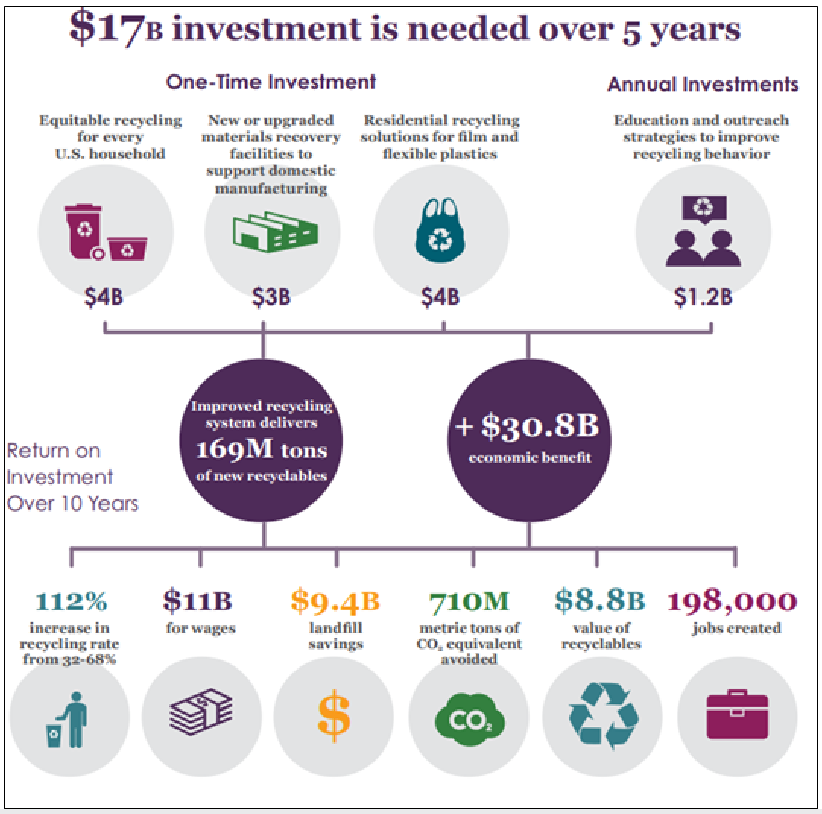
6. Implementation efforts are monitored regularly to determine their appropriateness and effectiveness and are adjusted as needed.
Continuously monitoring and evaluating appropriateness helps ensure that the program is aiming at the right targets. Evaluating the effectiveness determines how well the program is hitting its targets. Ongoing evaluation is important to both improve programs and strategies as needed, as well as to justify them; such that program funders, participants and target audience are informed about program value and cost effectiveness. To the extent possible, program data and information that would facilitate evaluation should be collected as part of ongoing operations.

Recommendation: In addition to the measurements described under principle 5, it is recommended that some key information be obtained from processors and manufacturers in the State such as whether they have been able to increase the quantity of recovered material they process/consume from within Texas; their perspectives regarding whether barriers to using recovered materials are being adequately addressed; and whether resources should be redirected to better fit the needs of state businesses. Because there are dynamic factors at play, it is important to keep the dialogue open. Other data that is helpful to obtain on a regular basis includes the number of individuals/organizations/businesses reached through education and outreach efforts, number of events held, passage of local and state policies that support recycling market development, and recycling industry employment and economic impact data.

10.5 FUNDING FOR TEXAS RECYCLING MARKET DEVELOPMENT EFFORTS

Strengthening markets for recovered materials in Texas will require investing in infrastructure, education and outreach, innovation, and more, as is described throughout the RMDP. The level of investment can be challenging to predict. The following estimate was developed by TRP in its recent report Paying it *Forward: How Investment in Recycling will Deliver Dividends.*[5] The study describes investments needed to "level up" the residential recycling system in the U.S. (defined as ensuring all households are equitably served and all packaging types are included) and bring about the circular economy. The report stated a proposed funding need of roughly $17 billion, which if applied to proven recycling solutions, will provide an economic benefit of $30.8 billion over 10 years (including wages, taxes, landfill savings, and the value of recyclables). Although this investment cost sounds like a staggering sum, the amount represents 0.5 percent of the cost of consumer packaged goods sold in the U.S. during five years.[3] Figure 10-4 provides a breakdown of how this funding would be allocated to produce the benefits TRP has outlined, as well as the resulting benefits.

FIGURE 10-4: SUMMARY OF INVESTMENTS NEEDED TO U.S. RECYCLING SYSTEM



On a population basis, Texas' share of these costs would be equivalent to an investment of $1.5 billion over five years (for an average of $298 million per year). The TRP estimates include activities outside of direct recycling market development but that address infrastructure improvement needs and overcoming other impediments to recycling. It is also important to note that the TRP estimates do not include day-to-day residential recycling collection system costs, commercial and institutional recycling system investment expenses, or costs to cover composting operational enhancements.

Historically recycling, composting and associated market development projects in Texas have been funded primarily with local funding and through the Regional Solid Waste Management Grants Program, which are funded by an allocated portion of the solid waste disposal fee. The latest biennium report indicates that in FY 2018 through FY 2019, the 24 regional COGs funded 240 projects totaling $6.1 million. This funding is approximately between $0.10 and $0.11 per person per year. COG funding, however, can only be used to support COG and local government initiatives. Since the majority of recycling market-based activity and recycling market development occurs in the private sector, additional sources of funding are needed.

Potential means of additional funding to implement the recycling market development strategy are described below. The recommended funding strategy is a shared responsibility "portfolio" approach, involving the use of multiple funding mechanisms as discussed below.

Institute Pay-As-You-Throw (PAYT) User Fee Systems at the Local Level

If local governments were to implement pay-as-you-throw programs, which treat recycling and waste management service provision like a utility (charging in accordance with the amount of waste disposed), the per-bag fee (or incremental fee over baseline cart size) would cover operating costs and could possibly generate additional revenue to fund associated recycling market enhancement projects (depending on how the fees were structured). Additionally, PAYT programs can result in higher recycling rates (especially in communities with bag-based programs) due to the financial incentive of minimizing waste disposed. Some Texas local governments have already instituted such fee structures and accompanying programs. PAYT user fee systems have been recommended by the U.S. EPA for decades and are well-demonstrated in their effectiveness. Employment of user fees is preferred to the use of general fund revenue to pay for residential solid waste management services, to prevent such programs from competing against other municipal/county programs that also need funding. Also, the use of variable fees as opposed to flat fees is preferred to incentivize waste reduction and recycling.

Establish Public-Private Partnerships and Pursue Available Grant Funding

Sections 10.1 through 10.3 include numerous grant and loan programs potentially offering funding for Texas projects. Some of these can be pursued directly by local governments, others are available to private companies, and still others, such as U.S. EPA funding, can be accessed directly by the state. It is recommended that Texas recycling market development program personnel become familiar with and seek to tap, as appropriate, such various funding mechanisms to address priority Texas recycling market development needs and opportunities.

Establish Advance Recycling Fees for Selected Materials

Advance recycling fees are currently in place in Texas for lead-acid batteries. Those who sell, store, use or consume new or used lead-acid batteries (not for resale) must collect a fee at the time of sale. The fee is $2 for batteries of less than 12 volts and $3 for batteries of 12 volts or greater. This program has been in place since 1991. Funds are allocated to the TCEQ for management of batteries and other hazardous waste.

Texas previously had an advance recycling/disposal fee that consumers paid when purchasing new tires, which funded responsible management at the end of each tire's useful life. As described in Section 9, the fee expired in 1997. Currently garages and local governments generally charge generators of scrap tires to manage them at the end of their useful life. Because some people are unwilling to pay this fee at the end of a tire's useful life, many tires are illegally disposed. Cleaning up used tire piles and illegal dumping is far more costly than managing tires responsibly in the first place and avoids visual blight and health and environmental hazards. Further, a significant portion of regional solid waste management grants (funded from the per-ton disposal fee) are dedicated to tire cleanup on an ongoing basis. Implementing a fee that minimizes illegal disposal by incentivizing proper tire management will free those funds for recycling

[5] The Recycling Partnership, 2021. *Paying it Forward: How Investment in Recycling will Deliver Dividends*

infrastructure and recycling market development programs. Additionally, end-of-life tires will be in better condition (i.e., cleaner and not degraded from exposure to the elements), making them suitable for higher value uses.

Advance recycling fees paid by consumers at the time of purchase could also be placed on electronics and televisions. While currently manufacturers must provide for recycling of these items, there is no convenience mechanism or funding mechanism in place. Therefore, many municipalities, counties, or COGs end up paying for collection events through regional solid waste management grants or other mechanisms. Others simply avoid hosting such events, limiting the quantity of recyclables collected. California is the only state known to have an advance recycling fee in place for electronics and televisions. The fee is $5 to $7 depending upon the size of the device. Other states with electronics recycling laws in place have EPR in place that mandates that the producers pay for the recycling of the devices.

Advance recycling fees are also charged on architectural paint in a handful of states through PaintCare programs, which encourage consumers to recycle paint at the end of its useful life. Fees are paid by the manufacturer but passed on to the retailer and the consumer. They are based on the size of the container and range from $0.00 (currently no fee on the smallest size containers) to $1.99 per container for the largest size.

Increase State Disposal Fee

As described in Section 9, about half of the states in the U.S., including Texas, have a per-ton disposal fee on disposed waste. Fees average $2.30 per ton with a median value of $1.06. Texas' fee is $0.94 per ton. Of the revenue received by the TCEQ under Section 361.013 (which also includes a registration fee for waste transporters), 33.3 percent is dedicated to local and regional solid waste projects consistent with regional plans approved by the Commission in accordance with this chapter and to update and maintain those plans. The remaining 66.7 percent is combined with various industrial and hazardous waste fees and is dedicated to TCEQ's municipal solid waste permitting, enforcement, and site remediation programs, and to pay for activities that will enhance the state's solid waste management program. Until FY 2013, the solid waste disposal fee revenues were split 50/50. Grants provided to local and regional entities are allocated by TCEQ based on population, area, solid waste fee generation, and public health needs.

It is recommended that the per-ton disposal fee be increased in order to help fund recycling market development in the State and to put recycling on a more level playing field with the low cost of disposal in Texas. Table 10-1 shows the expected increases in revenues a per-ton fee would have on revenues assuming approximately 36.8 million tons of waste per year are disposed in MSW landfills. With the current fee, the per-ton fees are estimated to be approximately $34.6 million per year.

TABLE 10-1: PROJECTED INCREASE IN REVENUES UNDER DISPOSAL FEE INCREASE SCENARIOS

Increase in Per-Ton Fee	Total Increase in Revenues[1]
Increase to $1.50 per ton	$20.6 million
Increase to $2.00 per ton	$39.0 million
Increase to $2.25 per ton	$48.2 million
Increase to $2.50 per ton	$57.4 million

1. Revenue increases estimated based on 36.8 million tons of waste disposed per year at MSW landfills in Texas, including Class 1, 2, and 3 NHIW. This number includes material from out-of-state generators, and is therefore larger than values presented in Section 4.0

Establishment of a disposal surcharge on waste generators to help defray recycling operational costs for communities is one of two funding mechanisms recommended by TRP and is likely to be supported or at least not opposed by other industry groups, including AMERIPEN and CBA, assuming fee revenues are specified for use in funding recycling system enhancements. As envisioned by TRP, the separate disposal surcharge would be managed by the public sector and would place an additional charge on "landfills, solid waste incinerators and waste-to-energy facilities." It would be paid on a per-ton basis by facility operators but would exempt industrial, hazardous waste, and C&D landfills. Depending on state or federal scope, fees would either be distributed to local governments or states and used to fund recycling needs. Note that in TRP's recommendation C&D waste is excluded, but because C&D is considered MSW in Texas, it is recommended that C&D waste be included.

Establish One or More Industry Funding Mechanisms

It has become widely accepted across multiple stakeholder groups that industry needs to contribute substantial funding to support recycling system enhancements, including recycling market development, and that funding legislation is needed to bring this about. Consequently, as a component of this recycling market development strategy, it is recommended that the proposed Recycling Market Development Board undertake a policy evaluation process with opportunity for stakeholder engagement to evaluate then select one or more industry funding mechanisms for recommendation to the Texas legislature. Selection and recommendation should take into consideration the following:

- Extent to which policy action is taken at the federal level thereby affecting what is needed at the state level;
- Nature and details of funding policies enacted by other states;
- Interests of key industry stakeholders located and/or doing business in Texas;
- Implications of the various mechanisms on existing Texas recycling stakeholders; and
- Compatibility with existing Texas policy.

The policies to be evaluated have been identified previously in this strategic plan. Additional details are provided below.

Packaging Fees Paid by Industry

As described in Section 9, packaging fees are per-unit fees paid for by the consumer brand companies to close the funding gaps in infrastructure and education. Material-neutral packaging fees have been promoted by TRP and the ACC, two groups that include packaging and consumer packaged goods brand owners. The packaging fee envisioned by TRP's Circular Economy Accelerator, a Packaging and Printed Paper Fee, would apply to glass, metal, plastic, and paper fiber, with the aim of encouraging manufacturers to design with recyclability in mind. A product stewardship organization (PSO) would be established to manage receipt and disbursement of the fee. The PSO would submit an annual report on the state or federal level. The plan would offer "eco-modulated discounts" for packaging meeting certain parameters, like recyclability and certain recycled-content levels. Proposed fees would not supersede existing policies including beverage container deposits. This is just one of several industry fee mechanisms being proposed by various industry organizations in recognition of a shared responsibility approach, with industry being a major contributor, and is needed to generate the funding to meet the U.S. recycling infrastructure needs and recycling opportunities.

Extended Producer Responsibility

Extended producer responsibility (EPR) and its prevalence in the U.S. is described in Section 9. There are over 100 EPR laws in 33 U.S. states and the District of Columbia covering 14 products, including electronics, batteries, paint, mattresses, thermostats, and pharmaceuticals. Producer responsibility may mean producers have full or partial responsibility, and the role may be simply paying for some or all of the program or setting up and running the program as well.

In recent years, EPR for packaging and printed paper has become a topic of interest in the U.S.; such programs are in place in many European countries and most Canadian provinces. In theory, EPR for packaging provides an incentive for brands to sell their products in environmentally friendly packaging – however, what constitutes environmentally friendly is often open to debate. In general, these programs encourage lightweight, toxic-free, recyclable, and made with recycled-content packaging. Packaging that is especially challenging to recycle (e.g., full bottle wraps, black plastics, certain adhesives) may be assessed an "eco-modulation fee." Bills for EPR packaging have been proposed at the federal level and in several states, such as California, Washington, New York, New Jersey, Massachusetts, Indiana, and Maine. It is recommended that strong consideration be given to implementing EPR for difficult-to-handle materials such as carpet, mattresses, paint and batteries, as this is generally widely accepted and considered best practice for sustainable materials management. The Product Stewardship Institute offers guidance on EPR policy terms and program design. In addition, EPR for packaging and printed paper should be evaluated along with other industry funding mechanisms, with the recommendation being consideration of a shared responsibility approach to strengthen, versus replace, existing recycling programs in Texas. Many industry stakeholders are supportive of a shared responsibility approach to EPR for packaging and printed paper. As an example, the Flexible Packaging Association (FPA) recently partnered with the Product Stewardship Institute to explore EPR terms that are acceptable to state and local governments as well as FPA members.

Investigate Passage of Beverage Container Deposit Legislation

Well-designed beverage container deposit (bottle bill) policies and programs can generate funding to cover associated materials handling costs, incentivize beverage container recycling and litter reduction, and result in the recovery of cleaner, higher value material well-suited for recycling. Such programs generally have surplus revenues that can be directed to support other activities which could include recycling market development projects. Only 10 states in the U.S. have beverage deposit systems in place, and those states supply about half of the recovered beverage containers recycled in the country. However, bottle deposit legislation is challenging to pass, and has previously been attempted in Texas in 2011, 2013 and 2015, but all attempts were unsuccessful. While EPR and deposit systems can be compatible, many industry stakeholders are generally not supportive of bottle bills as they single out certain types of packaging rather than addressing the broader range of materials that would be covered under an EPR system. Additionally, bottle bills can compete with curbside collection programs/MRFs for valuable materials such as aluminum cans, the revenues from which are important for offsetting curbside recycling collection and processing costs. If Texas elects to pursue implementation of deposit legislation, the approach used in Oregon is recommended, given this is generally considered the most successful such program in the U.S. considering return rate and cost efficiency.

10.6 MOVING FORWARD

A substantial amount of information has been provided in the RMDP. It is envisioned that this information will serve as a resource for use by all stakeholders who may be involved in implementing recycling market development activities in Texas – whether independently or in collaboration with others. The best use of this information, however, is to support state action resulting from establishment of the recycling market development center and recycling market development board as recommended herein, along with the funding mechanisms to provide ongoing support for recycling market development work. Timewise, priorities in implementing the proposed strategy include addressing contamination and establishing the recycling market development center and board. These activities will serve as a foundation for the remainder of the strategy.

Investment in recycling market development has broad support of a wide range of industry and government stakeholders as evidenced by those who rallied in support of passage of SB649 authorizing completion of the RMDP and as reflected in Figure 10-5. The potential economic and environmental benefits that can be gained by this investment are substantial and serve to benefit all Texans as time progresses.

FIGURE 10-5: SUPPORTERS OF RMD STUDY IN TEXAS

Source: State of Texas Alliance for Recycling

APPENDIX A:

DEFINITIONS

RECYCLING MARKET
DEVELOPMENT PLAN

A DEFINITIONS

This section provides definitions used in the RMDP and in the survey process. Terms are provided in the following categories:

- RMDP Terms
- Survey Definitions
    - Recyclable Material Processed/Received
    - Types of Processing
    - Types of Manufacturing/End Use

RMDP Terms

Circular Economy: A system that seeks to decouple economic activity and the consumption of finite resources. The circular economy includes redesigning systems to prevent the creation of waste, keeping products and materials in use through reuse and re-manufacturing of recycled material feedstocks, and regenerating natural systems such as through making and using compost to help replenish soil. The circular economy represents a shift away from the current "take-make-waste" model.

Industrial Waste: Solid waste resulting from or incidental to any process of industry or manufacturing, or mining or agricultural operation.

Municipal Solid Waste (MSW): Solid waste resulting from or incidental to municipal, community, commercial, institutional, and recreational activities, including garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and all other solid waste other than industrial solid waste.

Recycling: A process by which materials that have served their intended use or are scrapped, discarded, used, surplus, or obsolete are collected, separated, or processed and returned to use in the form of raw materials in the production of new products. Recycling includes:

- the composting process if the compost material is put to beneficial reuse as defined by the commission
- the application to land, as organic fertilizer, of processed sludge or biosolids from municipal wastewater treatment plants and other organic matter resulting from poultry, dairy, livestock, or other agricultural operations
- the conversion of post-use polymers and recoverable feedstocks through pyrolysis or gasification

Re-Trac Connect: Re-TRAC Connect was used for this survey and is the leading waste reduction and recycling measurement system used by the public sector, developed by Emerge Knowledge Design Inc.

RMDP: The Recycling Market Development Plan, as outlined in Senate Bill 649, passed during the 86th Legislative Session in 2019.

SEIR: The Study on the Economic Impacts of Recycling, as outlined in House Bill 2763, passed during the 84th Legislative Session in 2015.

TRDI: The Texas Recycling Data Initiative, a collaborative effort to measure recycling in the state of Texas led by the State of Texas Alliance for Recycling (STAR).

Survey and Market Development Definitions

These terms were utilized as part of the online survey and plan development process and, in some cases, their definitions may differ from the Texas Health and Safety Code and the Texas Administrative Code. The Project Team's intent was to provide definitions that are easy to understand.

Recyclable Material Processed/Received

Batteries: Lead-acid (car batteries), primary (alkaline), and rechargeable (lithium-ion, Ni-MH, Ni-CD) batteries.

Construction & Demolition Material: Waste that is generated during the construction, remodeling, repair, or demolition of buildings, bridges, pavements, and other structures. C&D material includes: concrete, asphalt, lumber, steel girders, steel rods, wiring, dry wall, carpets, window glass, metal and plastic piping, tree stumps, soil, and other miscellaneous items related to the activities listed above. This category also includes natural disaster debris.

Electronics Materials: Post-consumer electrical or electronic devices such as televisions, computers, and computer accessories.

Glass: Includes the two sub-categories defined below:

> **Containers:** Containers and packaging such as beer and soft drink bottles, wine and liquor bottles, and bottles and jars for food, cosmetics, and other products.
>
> **Other Glass:** All other products, such as flat glass used in windows.

Household Hazardous Waste (HHW): Hazardous products that are used and disposed of by residential - rather than industrial or commercial - consumers. These products include some paints, stains, batteries, varnishes, solvents, and pesticides, and other materials or products containing volatile chemicals that catch fire, react, explode under certain circumstances, or that are corrosive or toxic.

Metals: Includes the two sub-categories defined below:

> **Ferrous:** Magnetic metals derived from iron (steel). Products made from ferrous metals include major and small appliances, furniture, and containers and packaging (steel drums and barrels).
>
> **Non-Ferrous:** Nonmagnetic metals such as aluminum, lead, and copper. Products made from non-ferrous metals include containers and packaging such as beverage cans, food and other nonfood cans; non-ferrous metals found in appliances, furniture, electronic equipment; and non-packaging aluminum products (foil, closures, and lids from bimetal cans).

Organics: Includes the four sub-categories defined below:

> **Yard Trimmings, Brush, and Green Waste:** Includes grass, leaves, tree branches, brush, and tree stumps.
>
> **Food and Beverage Materials:** Uneaten food and food preparation wastes, such as those from residences and commercial establishments (grocery stores, restaurants, and produce stands), institutional sources (school cafeterias), industrial sources (food and beverage manufacturing).
> **Biosolids:** Solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in treatment works.
>
> **Other Organics:** All other types of organics not included in yard trimmings, brush, green waste; food and beverage materials; or biosolids. Includes materials such as grease trap waste, crop residuals, animal bedding.

Paint and Related Waste: Paint (used and unused) and related solvents (varnish, thinners), contaminated residues (PPE, rags, rollers) from painting and cleanup, and other residuals considered to be pain and paint-related waste (PPRW) under the universal waste rules.

Paper: Paper products and materials, such as old newspapers, old magazines, office papers, telephone directories, old corrugated containers, bags, and some paperboard packaging. Examples of recycling include processing paper into new paper products (tissue, paperboard, hydromulch, animal bedding, or insulation materials). Paper includes the four sub-categories defined below:

> **Old Corrugated Containers (OCC):** Old corrugated containers refers to containers made from unbleached, unwaxed paper with a ruffled (corrugated) inner liner.

Sorted Office Paper: Printed and unprinted paper typically generated by offices and other commercial sources that contains primarily white and colored ledger and writing papers.

Mixed Paper: Paper that includes material like old newspapers, old magazines, office papers, telephone directories, bags, and paperboard packaging, including gable top and aseptic food and beverage cartons (e.g. milk and juice cartons).

Other Paper: All other types of scrap paper not including mixed paper, OCC, or sorted office paper. Excludes pre-consumer material.

Plastic: Plastic containers and packaging made from various resins, including polyethylene terephthalate (PETE), high density polyethylene (HDPE), polyvinyl chloride (PVC), low density polyethylene (LDPE), linear low density polyethylene (LLDPE), polypropylene (PP), and polystyrene (PS). Plastics includes the five sub-categories defined below:

PET #1: Polyethylene terephthalate (PET or PETE or polyester) is a thermoplastic material used to manufacture plastic soft drink containers and rigid containers.

HDPE #2: High density polyethylene (HDPE) is typically used for products such as milk jugs, detergent bottles, and garbage containers.

Film Plastics: Flexible films used in bags, sacks, and wraps; commonly made of LDPE or LLDPE (#4).

Plastics #3-7: Plastic containers labeled as #3 - #7, including polyvinyl chloride (PVC, #3), low density polyethylene (LDPE, #4), polypropylene (PP, #5), polystyrene (PS, #6), and other plastics (#7).

Other Plastics: All other types of plastics collected for recycling that are not included in PET, HDPE, film plastics, or plastics #3-7.

Plastic Thermoforms: A type of plastic container, such as a clamshell or berry basket, commonly used to package fresh food items and made of PET (#1), PP (#5), PS (#6) or other plastics. PET thermoform recycling is discussed as part of the recycling market development plan.

Textiles: Fibers from discarded apparel, furniture, linens (sheets and towels), carpets and rugs, and footwear.

Tires: Used tires from cars and trucks (other vehicles).

Types of Processing

Construction & Demolition Debris Processing: Accepting commingled or sorted construction and demolition (C&D) materials and processing them through sorting, size reduction, baling, or other processes for shipment to end-users or brokers.

Electronics Processing: Processing of discarded electronics for recycling via deconstruction, shredding, sorting, baling, or other preparation, for sale to end-users or brokers. Does not include collection of materials for shipment to other processors and does not include handling electronics for reuse purposes only.

Household Hazardous Waste Collection: Accepting household hazardous waste (HHW) from the public, including but not limited to paint, solvents, pesticides, fluorescent tubes, and other items identified as HHW.

Material Recovery: Accepting source-separated recyclables and processing them for wholesale distribution through sorting, size reduction, baling, or other processes for shipment to end-users or brokers. Includes facilities that collect recyclables from public, commercial, and/or industrial sources, and that sell the materials directly to brokers or an end market but excludes such facilities that only aggregate and/or transport collected recycled materials to a materials recovery facility (MRF) for further processing.

Scrap Metal Processing: Accepting discarded ferrous and/or nonferrous metal scrap from the public and businesses for processing via sorting, size reduction, baling, or other preparations, for sale to end-users or brokers. Does not include smelters or remelting facilities, which are defined as end-product manufacturing.

Textile Processing: Accepting textiles from the public and/or businesses for the purpose of cleaning, sorting, size-reducing and/or other processes, for the purpose of shipping to end-users for recycling uses (not fuel or sale for reuse). Includes carpets, clothing, and other textile products. Excludes thrift stores and shipment of clothing for reuse.

Tire Processing: Receipt of whole, discarded tires and processing them through size reduction for the purpose of recycling, including production of crumb rubber, shredding for use in civil engineering projects, or other recycling applications. Excludes shipment of whole tires for reuse and of tire shreds for use as fuel.

Types of Manufacturing/End Use

Anaerobic Digestion: Production of compost, fertilizer, and/or soil amendment from recovered organic waste streams, such as food and beverage waste, through controlled anaerobic digestion at stand-alone, on-farm, or wastewater digester facilities.

Chemical Recycling: Receipt of post-use polymers and recoverable feedstocks (e.g., plastics) that are converted into valuable raw, intermediate, or final products such as new plastics, chemicals, wax, lubricant, fuels, and other products. In Texas, conversion via gasification or pyrolysis is considered recycling (HB 1953 (2019)).

Compost/Mulch Production: Production of compost, mulch, or other soil amendment or landscaping products from recovered yard waste, food waste, or biosolids. Excludes land application and production of fuel.

Construction & Demolition Debris End-Use: Receipt of recycled C&D materials for the purpose of producing new products or using the materials in end-use applications (e.g., road base or as construction aggregate). Excludes direct reuse and combustion.

Fiberglass Manufacture: Receipt of crushed glass, typically from glass beneficiators and/or materials recovery facilities, for the purpose of manufacturing fiberglass.

Glass Beneficiation: Receipt of crushed glass, typically from materials recovery facilities, and/or whole glass containers, flat glass, and/or other products direct from generators, and processing through further cleaning, sorting, and crushing to meet manufacturer specifications, for sale to end-users or brokers.

Glass Containers Manufacture: Receipt of crushed glass, typically from glass beneficiators and/or materials recovery facilities, for the purpose of manufacturing new glass containers.

Other End Use: Accepting recyclables from processors for the purpose of creating an intermediate product for sale to other industries or manufacturers. Excludes direct reuse and combustion.

Other Product Manufacturing: Accepting recyclables from processors for the purpose of manufacturing recycled-content products for sale to consumers or other industries as intermediate products. Excludes direct reuse and combustion.

Plastics Product Manufacture: Receipt of recycled plastics, typically from plastics reclaimers and/or materials recovery facilities, for the purpose of manufacturing new plastic products and/or product components.

Plastics Reclamation: Receipt of recycled plastics, typically from materials recovery facilities, and cleaning, sorting, and size reducing the plastics through grinding and/or extrusion of pellets meeting manufacturer specifications, for sale to end-users or brokers or on-site use to manufacture products.

Pulp, Paper, or Paperboard Manufacture: Receipt of baled scrap paper, typically from materials recovery facilities, other processors or directly from commercial generators, for the purpose of manufacturing pulp, paper or paperboard products.

Secondary Metals Smelter, Melter or Product Fabrication: Receipt of recycled metals, typically from scrap processors and/or materials recovery facilities, for the purpose of producing refined recycled raw materials for use by other manufacturers, and/or for producing new products or product components.

Recycled Tire Product Manufacture/End-Use: Receipt of whole tires or tire-derived materials, typically from scrap tire processors, for the purpose of producing new products or using the materials in end-use applications (e.g., as tire-derived aggregate or as synthetic turf infill). Excludes direct tire reuse and combustion.

Textiles End-Use: Receipt of recycled textiles for the purpose of producing refined recycled raw materials for use by other manufacturers, and/or for producing new products or product components. Excludes direct reuse of clothing and other textiles.

APPENDIX B:

CONFIDENTIALITY PLAN

RECYCLING MARKET DEVELOPMENT PLAN

CONFIDENTIALITY PLAN

With respect to confidentiality of proprietary information, it is Contractor's policy to comply with all applicable laws, regulations and policies and not knowingly infringe upon the intellectual property rights of others; protect third-party information that is subject to a confidentiality obligation in accordance with the terms of such obligation(s); and require that subcontractors agree to adhere to any confidentiality obligations imposed by Contractor.

In accordance with our policy and capabilities, Contractor intends to manage Business Sensitive Information related to the Recyclable Materials Feedstock Study in a manner that is aimed at protecting sensitive, confidential, trade secret, and proprietary information from disclosure contrary to executed confidentiality agreements, except as required by applicable law. All collected data will remain the exclusive property of the entity providing such data for the project (hereinafter "Responding Party").

Business Sensitive Information shall include any facility or operation information related to any survey results concerning economic or financial data; lists of customers; or amounts of recyclable materials or solid wastes received, processed, managed, consumed as feedstock, or otherwise directed by a Responding Party. Responding Parties will have the option within the survey to designate reported Business Sensitive Information to be "trade secret" as defined in the Texas Public Information Act (Government Code Chapter 552.110).

Business Sensitive Information shall not include information that was in the public domain at the time of its release or which becomes a part of the public domain through no fault of Contractor; information that is released with the written approval of the disclosing firm; information that is released by a Responding Party after five (5) years from the receipt of the information; or information that must be released pursuant to the provisions of a court order. Contractor will protect such Business Sensitive Information with the same degree of care that Contractor uses to protect its own proprietary or confidential information.
Contractor will take the following steps during the course of this project aimed at keeping Business Sensitive Information confidential:

- Contractor will execute a confidentiality agreement with each subcontractor engaged on this project (Attachment 1);
- Contractor will offer to execute a confidentiality agreement with any Responding Party that completes a survey (Attachment 2);
- Contractor will require each employee engaged on the project to sign a statement acknowledging their understanding and acceptance of the confidential nature of data associated with this project;
- Contractor employees not engaged in this project will not be allowed access to confidential project files;
- To address the confidential nature of individual Responding Parties' data, Contractor will aggregate confidential data received from the Responding Parties for presentation to the public, Client, or the Recycling Industry Committee;
- Contractor will not release raw, company-specific data, or Responding Party proprietary or confidential information (unless directed to do so under order of law, which is defined as pursuant to a court order, governmental proceeding, or applicable law, including rulings by the Attorney General under the Public Information Act, Government Code Chapter 552, in which case we will notify Client and the Responding Party).

Contractor makes no representation that data collected will not be subject to state or federal open records laws or regulations or the Freedom of Information Act, as information subject to such rules is governed by the applicable statute/rule. Contractor has no control over the disclosure of such information by court order or as required by applicable law and shall not be held liable for the release of the information as required by law.

Attachments:

1. Subcontractor Non-Disclosure Agreement (MSC-8)
2. Mutual Non-Disclosure Agreement (MSC-9)

ATTACHMENT 1 - SUBCONTRACTOR NON-DISCLOSURE AGREEMENT (NDA)

SUBCONTRACTOR NON-DISCLOSURE AGREEMENT (NDA)

(Doc. No. MSC-8)

This AGREEMENT is made as of______, 20______, by and between______(hereinafter called "SUBCONTRACTOR") and Burns & McDonnell Engineering Company, Inc., a Missouri corporation (hereinafter called "BME"). BME has entered into an agreement with the Texas Commission on Environmental Quality (hereinafter called (the "CLIENT") for services related to a recycling market development plan (the "Project"), and the CLIENT has required that BME and its subcontractors maintain the confidentiality of certain data and information which CLIENT has provided to BME, or which BME has or will develop or obtain related to the Project (the "Confidential Information"). It is the intent of this Agreement that SUBCONTRACTOR agrees to likewise maintain the confidentiality of such Confidential Information.

In consideration of the promises contained herein and other good and valuable consideration which the Parties deem adequate, the Parties hereby agree as follows:

1. BME or the CLIENT may supply SUBCONTRACTOR with data or information regarding the Project, and such data or information, which is confidential or proprietary, and shall be deemed to be Confidential Information as discussed in this Agreement. Oral information related to the Project which is said to be confidential or proprietary at the time of disclosure shall likewise be deemed to be Confidential Information. SUBCONTRACTOR EXPRESSLY AGREES THAT UNLESS DATA OR INFORMATION PROVIDED IS MARKED AS "NOT CONFIDENTIAL" OR FALLS WITHIN THE CATEGORIES MENTIONED IN SECTION 2, BELOW, ALL INFORMATION PROVIDED TO THE SUBCONTRACTOR RELATING TO BME, THE CLIENT OR TO THE PROJECT SHALL BE DEEMED TO BE, AND SHALL BE TREATED AS, CONFIDENTIAL INFORMATION.

2. Information shall not be deemed to be Confidential Information where: (i) it is or becomes public information or otherwise generally available to the public through no act or fault of SUBCONTRACTOR; or (ii) it was, prior to the date of this Agreement, already in the possession of the SUBCONTRACTOR and was not received by SUBCONTRACTOR directly or indirectly from the CLIENT or BME; or (iii) it is hereafter rightfully received by the SUBCONTRACTOR from a third person who did not receive the same directly or indirectly from the CLIENT or BME; or (iv) it is at any time independently developed by employees or subcontractors of SUBCONTRACTOR who have not had access to Confidential Information in the possession of the SUBCONTRACTOR. The SUBCONTRACTOR shall bear the burden of proof that such employees or subcontractors have not had access to Confidential Information. Specific information shall not be deemed to be within the exceptions of subparts (i) - (iv) merely because it is embraced by more general information within such exceptions, nor shall a combination of features be deemed to be within such exceptions merely because the individual features are within such exceptions.

3. SUBCONTRACTOR agrees that any Confidential information which has been or will be disclosed directly or indirectly to it by or on behalf of the CLIENT or BME shall be maintained in confidence, and shall not be disclosed to any third person without BME's prior express written consent. The Confidential Information shall not be used by SUBCONTRACTOR to compete against BME or the CLIENT.

4. SUBCONTRACTOR may disclose Confidential Information to any governmental or regulatory authority requiring such disclosure under order of law, provided that: (i) the SUBCONTRACTOR notifies the governmental or regulatory authority that the materials are Confidential Information; (ii) the SUBCONTRACTOR, at the time of submission of such materials to the governmental or regulatory authority, requests such confidential treatment of such materials as may be available under applicable law; and (iii) prior to such disclosure, BME is given prompt notice of the required disclosure so that it or the CLIENT or BME may take whatever action either deems appropriate, including intervention in any proceeding and the seeking of an injunction or other order to prohibit such disclosure.

5. SUBCONTRACTOR agrees that it will not make use of any Confidential Information received pursuant to this Agreement except for the limited purposes expressly given without the express prior written consent of BME.

6. This Agreement shall not be construed as a license or authorization to the SUBCONTRACTOR to utilize the Confidential Information for any purpose other than directly related to the Project.

7. This Agreement does not establish a joint venture, partnership, or other type of business entity between the Parties, and in no event shall the Parties represent to other persons that a joint venture, partnership, or other type of business entity has been formed. In addition, this Agreement alone shall not be construed as authorizing the order or purchase of engineering or construction services or equipment related to the Project.

8. This Agreement is for the benefit of CLIENT and BME and, without prejudice to the rights and remedies otherwise available to them, either CLIENT or BME shall be entitled to equitable relief by way of injunction if the SUBCONTRACTOR breaches or threatens to breach any of the promises of this Agreement, and to any other remedies provided by law, including attorney's fees and costs.

9. This Agreement shall be interpreted, governed, and construed under the laws of the state of Texas as if executed and to be performed wholly within the state of Texas, and that venue for any such action shall be Travis County, Texas.

10. This Agreement: (i) contains the entire agreement and understanding between the Parties, their agents, and employees as to the subject matter of this Agreement; (ii) supersedes in its entirety all previous communications between the Parties on this topic (including all previous versions of this Agreement); and (iii) shall only be modified in writing by the Parties, signed by a representative of each.

11. Upon completion of the performance of services by SUBCONTRACTOR, or a termination of any Project subcontract between BME and SUBCONTRACTOR, and upon written request of BME, the SUBCONTRACTOR shall return to BME all Confidential Information including copies thereof, in all media as practically can be obtained and returned, or otherwise destroyed as agreed to by BME.

12. This Agreement may be executed in multiple counterparts, each of which shall be deemed to be an original.

13. This Agreement is effective as of the date fully executed by both Parties and shall terminate five (5) years thereafter. With regard to BME's financial information (if any is disclosed), there shall be no termination date as to the SUBCONTRACTOR's obligation to maintain confidentiality of the same.

SUBCONTRACTOR: _______	Burns & McDonnell Engineering Company, Inc.
By:____________________________	By: ____________________________
Name:__________________________	Name:__________________________
Title:___________________________	Title: ___________________________

ATTACHMENT 2 - MUTUAL NON-DISCLOSURE AGREEMENT (NDA)

MUTUAL NON-DISCLOSURE AGREEMENT (NDA)

(Doc. No. MSC-9)

This AGREEMENT is made as of _____, 20_____, by and between______ (hereinafter called “RESPONDING PARTY”) and Burns & McDonnell Engineering Company, Inc., a Missouri corporation (hereinafter called “BME”). Each of the parties hereto, including their affiliates or subsidiaries, if any, is hereinafter designated as a “Party” or as the “Parties”.

The Parties hereby agree as follows:

1. The RESPONDING PARTY may supply BME with data or information regarding the amounts of recyclable materials, economic, customer, or financial data or solid wastes processed, managed, or directed (the “Transaction”), and such data or information, which is confidential or proprietary, and shall be deemed to be “Confidential Information” as provided for in this Agreement. Ownership of the data will remain with the RESPONDING PARTY. Oral information related to the Transaction which is said to be confidential or proprietary at the time of disclosure shall likewise be deemed to be Confidential Information. THE PARTIES EXPRESSLY AGREE THAT UNLESS DATA OR INFORMATION PROVIDED IS MARKED AS “NOT CONFIDENTIAL”, ALL INFORMATION PROVIDED TO THE RECIPIENT PARTY RELATING TO THE DISCLOSING PARTY OR TO THE TRANSACTION OR FALLS WITHIN THE CATEGORIES MENTIONED IN SECTION 2 BELOW SHALL BE DEEMED TO BE, AND SHALL BE TREATED AS, CONFIDENTIAL INFORMATION.

2. Information shall not be deemed to be Confidential Information where: information that was in the public domain at the time of its release or which becomes a part of the public domain through no fault of Consultant; information that is released with the written approval of the disclosing firm; information that is released by a RESPONDING PARTY after five (5) years from the receipt of the information; or information that must be released pursuant to the provisions of a court order or as required by law.

3. Each Party agrees that any Confidential information which has been or will be disclosed directly or indirectly to it by or on behalf of the other Party shall be maintained in confidence, and shall not be disclosed to any third person without the other Party’s prior express written consent. The Confidential Information shall not be used by either Party to compete against the other Party.

4. BME may disclose Confidential Information to any governmental or regulatory authority requiring such disclosure under order of law, provided that (i) BME notifies the governmental or regulatory authority that the materials are Confidential Information; (ii) BME, at the time of submission of such materials to the governmental or regulatory authority, requests such confidential treatment of such materials as may be available under applicable law; and (iii) prior to such disclosure, the RESPONDING PARTY is given prompt notice of the required disclosure so that it may take whatever action it deems appropriate, including intervention in any proceeding and the seeking of an injunction to prohibit such disclosure.

5. The Parties agree that they will not make use of any Confidential Information received pursuant to this Agreement except for the purpose relating to the Transaction without the express prior written consent of the RESPONDING PARTY.

6. This Agreement does not establish a joint venture, partnership, or other type of business entity between the Parties, and in no event shall the Parties represent to other persons that a joint venture, partnership, or other type of business entity has been formed.

7. In no event will either Party be liable for any special, indirect, or consequential damages including, without limitation, damages or losses in the nature of increased costs, loss of revenue or profit, lost production, claims by customers, or governmental fines or penalties. The Parties waive and release each other from any claims, liability, or damages arising out of or relating to the Transaction or this Agreement.

8. This Agreement shall be interpreted, governed, and construed under the laws of the state of Texas as if executed and to be performed wholly within the state of Texas, and that venue for any such action shall be

Travis County, Texas.

9. This Agreement: (i) contains the entire agreement and understanding between the Parties, their agents, and employees as to the subject matter of this Agreement; (ii) supersedes in its entirety all previous communications between the Parties on this topic (including all previous versions of this Agreement); and (iii) shall only be modified in writing by the Parties, signed by a representative of each.

10. This Agreement may be executed in multiple counterparts, each of which shall be deemed to be an original.

11. This Agreement is effective as of the date fully executed by both Parties and shall terminate five (5) years thereafter.

RESPONDING PARTY: _______	Burns & McDonnell Engineering Company, Inc.
By:____________________________	By: ____________________________
Name:_________________________	Name:__________________________
Title:___________________________	Title: ___________________________

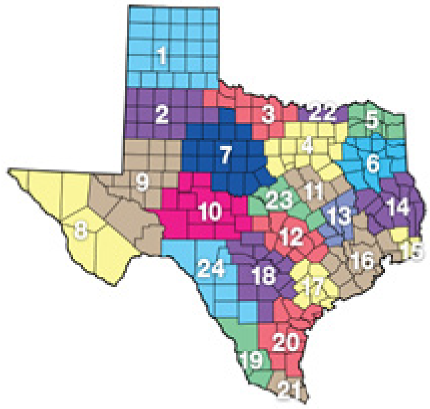
APPENDIX C:

FACILITY DIRECTORY

RECYCLING MARKET
DEVELOPMENT PLAN

C FACILITY DIRECTORY

As part of the online survey, respondents were given an opportunity to be listed in the following directory. The respondents that chose to be included had the ability to choose the information that is shared here. The directory is organized by Council of Government regions so that readers of this report can identify recycling facilities in their region. The RMDP and TCEQ do not endorse products or services. The directory is voluntary and inclusion does not certify compliance with state or federal law



Region Name	Number	Abbreviation
Alamo Area Council of Governments	18	AACOG
Ark-Tex Council of Governments	5	ARK-TEX
Brazos Valley Council of Governments	13	BVCOG
Capital Area Council of Governments	12	CAPCOG
Central Texas Council of Governments	23	CTCOG
Coastal Bend Council of Governments	20	CBCOG
Concho Valley Council of Governments	10	CVCOG
Deep East Texas Council of Governments	14	DETCOG
East Texas Council of Governments	6	ETCOG
Golden Crescent Regional Planning Commission	17	GCRPC
Heart of Texas Council of Governments	11	HOTCOG
Houston-Galveston Area Council	16	H-GAC
Lower Rio Grande Valley Development Council	21	LRGVDC
Middle Rio Grande Development Council	24	MRGDC
Nortex Regional Planning Commission	3	NORTEX
North Central Texas Council of Governments	4	NCTCOG
Panhandle Regional Planning Commission	1	PRPC
Permian Basin Regional Planning Commission	9	PBRPC
Rio Grande Council of Governments	8	RGCOG
South East Texas Regional Planning Commission	15	SETRPC
South Plains Assocation of Governance	2	SPAG
South Texas Development Council	19	STDC
Texoma Council of Governments	22	TEXOMA
West Central Texas Council of Governments	7	WCTCOG

Directory Legend

The following legend is for the facility directory below.

Abbreviation	Definition
F	Facility
O	Owner/Operator
POC	Point of Contact
RA	Recycling Activities
L	Location
WWW	Web Page

Directory

The following tables contain contact information for survey respondents who opted to be listed in the directory.

Alamo Area Council of Governments	
F	New Earth, Inc. – San Antonio
POC	John Niedecken, COO
RA	Compost/Mulch Production
L	7800 IH-10 E, San Antonio, TX 78219
WWW	www.newearthcompost.com
F	Republic Services – San Antonio
POC	Steve Carr, Government Affairs
RA	Material Recovery
L	1949 Hormel Drive, San Antonio, TX 78219
WWW	www.republicservices.com
F	Waste Management – San Antonio Houston Street MRF
O	Waste Management, Inc.
POC	Michael Lunow, Area Recycling Operations Director
RA	Material Recovery
L	5610 Farm to Market 1346, San Antonio, TX 78220

Capitol Area Council of Governments

F	Austin Wood Recycling
POC	Mike Yaw, VP of Sales
RA	Compost/Mulch Production
L	3875 East Whitestone Blvd, Cedar Park, TX 78613
WWW	www.austinwoodrecycling.com
F	Balcones Resources – Austin MRF
O	Balcones Resources, Inc.
POC	Brent Perdue, General Manager
RA	Material Recovery
L	9301 Johnny Morris Road, Austin, TX 78724
WWW	www.balconesresources.com
F	Deepwood Recycle Center
POC	Kyle Ray Kuenstler, Solid Waste Management Coordinator
RA	Compost/Mulch Production, Household Hazardous Waste Collection, Scrap Metal Processing
L	310 Deep Wood Drive, Round Rock, TX 78681
F	Kinser Ranch, LLC
POC	Al Kinser, Owner
RA	Compost/Mulch Production
L	10701 Kinser Lane, Austin, TX 78736
WWW	www.kinserranch.com

Coastal Bend Council of Governments

F	Republic Services – Corpus Christi
POC	Steve Carr, Government Affairs
RA	Material Recovery
L	4414 Agnes Street, Corpus Christi, TX 78405
WWW	www.republicservices.com

Deep East Texas Council of Governments

F	Living Earth Technology Co. – Pineland
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	871 U.S. Hwy 96 N, Pineland, TX 75968

East Texas Council of Governments	
F	Polywize
O	Green Triangle Materials
POC	Joe Castro, Partner
RA	Plastics Reclamation, Plastics Product Manufacture
L	1498 N Bolton St, Jacksonville, TX 75766
WWW	www.polywize.com

Heart of Texas Council of Governments	
F	Owens-Illinois, Inc
O	Owens Brockway Glass Container
POC	Isaac Guinand, Plant Manager
RA	Glass Container Manufacture
L	5200 Beverly Drive, Waco, TX 76711
WWW	www.o-i.com

Houston-Galveston Area Council	
F	Longhorn Glass Corp.
O	AB InBev
POC	Edward Ferguson, Dir Sustainability
RA	Glass Container Manufacture
L	4202 Fidelity St, Houston, TX 77029
F	Cherry Companies – Crawford
POC	Joe Rizzo, Vice President Business Development,
RA	C&D Processing
L	6019 Crawford Road, Houston, TX 77041
WWW	www.cherrycompanies.com
F	Cherry Companies – Fellows
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	1955 Fellows Dd, Houston, TX 77047
WWW	www.cherrycompanies.com

F	Cherry Companies – Riley Fuzzel
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	5810 Riley Fuzzel Road, Spring, TX 77386
WWW	www.cherrycompanies.com
F	Cherry Companies – Hitchcock
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	502 Texas 6, Hitchcock, TX 77563
WWW	www.cherrycompanies.com
F	Cherry Companies – Holmes
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	4601 Holmes Rd., Houston, TX 77033
WWW	www.cherrycompanies.com
F	Cherry Companies – Katy Hockley
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	9929 Katy Hockley Road, Cypress, TX 77433
WWW	www.cherrycompanies.com
F	Cherry Companies – Koeblen
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	6400 Koeblen Road, Richmond, TX 77469
WWW	www.cherrycompanies.com
F	Cherry Companies – McHard
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	616 FM 521, Fresno, TX 77545
WWW	www.cherrycompanies.com
F	Cherry Companies – Montgomery
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	19391 Keenan Cut Off, Montgomery, TX 77316
WWW	www.cherrycompanies.com

F	Cherry Companies – New Caney
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	24288 FM 1485, New Caney, TX 77357
WWW	www.cherrycompanies.com
F	Cherry Companies – Pinafore
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	909 Pinafore Lane, Houston, TX 77039
WWW	www.cherrycompanies.com
F	Cherry Companies – Rosharon
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	4635 CR 418, Rosharon, TX 77583
WWW	www.cherrycompanies.com
F	Cherry Companies – Selinsky
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	6131 Selinsky Rd, Houston, TX 77048
WWW	www.cherrycompanies.com
F	Cherry Companies – Winfield
POC	Joe Rizzo, Vice President Business Development
RA	C&D Processing
L	9200 Winfield, Houston, TX 77050
WWW	www.cherrycompanies.com
F	Dow Texas Operations
O	Dow, Inc.
POC	Daniel Womack, Government Affairs
RA	Plastics Reclamation, Plastics Product Manufacture
L	2301 N. Brazosport Blvd, Freeport, TX 77541
F	FCC Environmental Services – Houston MRF
O	Fomento de Construcciones y Contratas (FCC)
POC	Andrea Rodriguez, Director of Recycling US
RA	Material Recovery
L	9172 Ley Rd, Houston, TX 77078

F	Fort Bend County Recycling Center
O	Fort Bend County
POC	Bruce Neimeyer, Recycling and HHW Coordinator
RA	Drop-Off, Household Hazardous Waste Collection
L	1200 Blume Road, Rosenberg, TX 77471
F	Hou-Scape
O	HSI Construction Corp
POC	Chad McMahon
RA	Compost/Mulch Production
L	17725 Telge Road, Cypress, TX 77429
F	Living Earth Technology Co. – Crawford Rd.
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	5802 Crawford Rd, Houston, TX 77041
F	Living Earth Technology Co. – Cutten Rd
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	12200 Cutten Rd, Houston, TX 77066
F	Living Earth Technology Co. – Lake Jackson
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	9306 Farm to Market 523, Freeport, TX 77541
F	Living Earth Technology Co. – Houston, Beaumont Hwy
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	10310 Beaumont Hwy, Houston, TX 77078
F	Living Earth Technology Co. – Houston, Katy Fwy
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	14110 Katy Fwy, Houston, TX 77079
F	Living Earth Technology Co. – Houston, McCarty
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	5757 Oates Rd, Houston, TX 77078

F	Living Earth Technology Co. – Houston, South Beltway
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	5210 S Sam Houston Pkwy E, Houston, TX 77048
F	Living Earth Technology Co. – Iowa Colony
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	16138 Hwy 6, Arcola, TX 77583
F	Living Earth Technology Co. – Katy
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	27733 Katy Fwy, Katy, TX 77494
F	Living Earth Technology Co. – League City
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	1000 Dickinson Ave, Dickinson, TX 77539
F	Living Earth Technology Co. – Missouri City
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	1503 Industrial Dr, Missouri City, TX 77489
F	Living Earth Technology Co. – New Caney
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	20611 Highway 59 N, New Caney, TX 77357
F	Living Earth Technology Co. – The Woodlands
F	Lora Hinchcliff, Municipal Solutions Manager
POC	Compost/Mulch Production
RA	17555 I-45, Conroe, TX 77385
F	Living Earth Technology Co. – Rosharon
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	16138 Highway 6, Rosharon, TX 77583
F	Nature's Way Resources
POC	Ian Ferguson, Operations Manager
RA	Compost/Mulch Production
L	101 Sherbrook Circle, Conroe, TX 77385-7750
WWW	www.natureswayresources.com

F	New Earth, Inc. – Conroe
POC	John Niedecken, COO
RA	Compost/Mulch Production
L	12286 Hwy 105 East, Conroe, TX 77306
WWW	www.newearthcompost.com
F	New Earth, Inc. – Katy
POC	John Niedecken, COO
RA	Compost/Mulch Production
L	6205 FM 2855, Katy, TX 77493
WWW	www.newearthcompost.com
F	NOVUS Wood Group – Haynesworth Lane
POC	Roger D Oldigs, CFO
RA	Compost/Mulch Production
L	5900 Haynesworth Lane, Houston, TX 77034
WWW	www.novuswoodgroup.com
F	NOVUS Wood Group – Nichols Rd
POC	Roger D Oldigs, CFO
RA	Compost/Mulch Production
L	2900 Nichols Rd, Houston, TX 77539
WWW	www.novuswoodgroup.com
F	Republic Services – Houston
POC	Steve Carr, Government Affairs
RA	Material Recovery
L	5757 B Oates Rd, Houston, TX 77078
WWW	www.republicservices.com
F	Reterra
O	Reterra Corporation
POC	Jason Ball, President
RA	Chemical Recycling, Plastics Reclamation
L	1503 Haden Road, Houston, TX 77015
WWW	www.reterra.com
F	Tascon Industries, Inc.
O	TASCON, Inc.
POC	James Adamoli, President
RA	Other Product Manufacture - Cellulose Insulation
L	7607 Fairview Street, Houston, TX 77041

F	Waste Management of Texas
O	Waste Management, Inc.
POC	Michael Lunow, Area Recycling Operations Director
RA	Material Recovery
L	24275 Katy Freeway, Katy, TX 77024
F	Waste Management – Houston Gasmer Drive MRF
O	Waste Management, Inc.
POC	Michael Lunow, Area Recycling Operations Director
RA	Material Recovery
L	4939 Gasmer Dr, Houston, TX 77035
F	Waste Management – Houston Clay Road MRF
O	Waste Management, Inc.
POC	Michael Lunow, Area Recycling Operations Director
RA	Material Recovery
L	9590 Clay Rd, Houston, TX 77080
F	WCA Houston MRF
O	WCA Waste Corporation
POC	Jose Herrera, District Manager
RA	Material Recovery
L	7213 E Mount Houston Rd, Houston, TX 77050
WWW	www.WCAwaste.com

Lower Rio Grande Valley Development Council	
F	City of McAllen Recycling Center (MRF)
O	City of McAllen
POC	Roberto Trevino Jr., Renewable Resources Manager
RA	Material Recovery, Electronics Processing, Tire Processing
L	4101 N. Bentsen Road, McAllen, TX 78504
WWW	www.mcallenpublicworks.net
F	McAllen Composting Facility
O	City of McAllen
POC	Roberto Trevino Jr., Renewable Resources Manager
RA	Compost/Mulch Production
L	15201 N. 29th Street, McAllen, TX 78504
WWW	www.mcallenpublicworks.net

North Central Texas Council of Governments	
F	Balcones Resources – Dallas MRF
O	Balcones Resources Inc.
POC	Brent Perdue, General Manager
RA	Material Recovery
L	13921 Senlac Drive, Farmer's Branch, TX 75234
WWW	www.balconesresources.com
F	FCC Environmental Services – Dallas MRF
O	Fomento de Construcciones y Contratas (FCC)
POC	Andrea Rodriguez, Director of Recycling US
RA	Material Recovery
L	5200 Simpson Stuart Road, Dallas, TX 75241
WWW	www.balconesresources.com
F	FCC Environmental Services – Dallas MRF
O	Fomento de Construcciones y Contratas (FCC)
POC	Andrea Rodriguez, Director of Recycling US
RA	Material Recovery
L	5200 Simpson Stuart Road, Dallas, TX 75241
F	Living Earth Technology Co. – Arlington
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	800 Mosier Valley Rd, Euless, TX 76040
F	Living Earth Technology Co. – Dallas
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	1901 California Crossing Rd, Dallas, TX 75220
WWW	www.cityoflewisville.com
F	Living Earth Technology Co. – Flower Mound
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	3901 Haynes Road, Roanoke, TX 76262
F	Living Earth Technology Co. – Fort Worth, Forest Hill
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	6288 Salt Rd, Forest Hill, TX 76140

F	Living Earth Technology Co. – Fort Worth, Lakeside
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	9001 Jacksboro Hwy, Lakeside, TX 76135
F	Living Earth Technology Co. – Plano
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	5032 Split Trail, Plano, TX 75074
F	Republic Services – Fort Worth
POC	Steve Carr, Government Affairs
RA	Material Recovery
L	6200 Elliot Reeder Road, Fort Worth, TX 76117
WWW	www.republicservices.com
F	Republic Services – Plano
POC	Steve Carr, Government Affairs
RA	Material Recovery
L	4200 East 14th Street, Plano, TX 75074
WWW	www.republicservices.com
F	Rodeo Plastic Bag & Film
O	Revolution Plastics / Delta Plastics
POC	Jacob Sabin, Project Manager
RA	Plastic Reclamation, Plastic Product Manufacture
L	3328 Executive Blvd, Mesquite, TX 75149
F	Texas Pure Products
O	City of Plano
POC	Chris Day
RA	Compost/Mulch Production
L	3820 Sam Rayburn Highway, Melissa, TX 75454
F	Waste Management – Dallas Metroplex
O	Waste Management, Inc.
POC	Michael Lunow, Area Recycling Operations Director
RA	Material Recovery
L	5025 Cash Rd, Dallas, TX 75247

Rio Grande Council of Governments

F	El Paso Recycling, Inc.
POC	Gilbert Garcia, VP/COO
RA	Construction & Demolition Debris Processing, Compost/ Mulch Production, Other End-Use - Asphalt Shingle Road Repair
L	12520 E Pellicano Drive, El Paso, TX 79924
WWW	www.elpasorecycling.net
F	Friedman Recycling of El Paso
O	Friedman Recycling Company
POC	David Friedman, CEO
RA	Material Recovery
L	5835 Wren Avenue, El Paso, TX 79924
WWW	www.FriedmanRecycling.com

South East Texas Association of Governments

F	Plessala Enterprises LLC
POC	Evelyn Plessala, President
RA	Compost/Mulch Production, Anaerobic Digestion
L	5846 Farm to Market 105, Orange, TX 77630

South Plains Association of Governments

F	City of Plainview
POC	Brocke Lively, Solid Waste Superintendent
RA	Drop-Off
L	2002 Weber Drive, Lubbock, TX 79404

APPENDIX D:

STAKEHOLDER FORUM SUMMARY

RECYCLING MARKET DEVELOPMENT PLAN

Introduction

The Project Team held stakeholder forums to obtain feedback on the preliminary Recycling Market Development Plan (RMDP) survey findings and to gather additional input related to recycling market development in Texas. In particular, forum participants were asked for their thoughts on: the relationship between materials supply and demand; barriers that limit recyclability of materials in Texas; opportunities to expand materials recyclability and recycling markets in Texas; as well as any additional input attendees wanted to convey.

At the beginning of the project, three half-day stakeholder forums were scheduled as in-person events across the state. However, due to the Covid-19 pandemic, the forums were moved online as four two-hour events. Hosted by Burns and McDonnell, Circular Matters, and the State of Texas Alliance for Recycling (STAR), forums were held October 27–29, 2020, by material category, as follows:

- Forum 1: Typical Recyclables (October 27)
- Forum 2: Organics (October 28)
- Forum 3: Construction and Demolition (October 28)
- Forum 4: Special/Difficult-to-Handle Materials (October 29)

Invitations to participate in the forums were sent to respondents who expressed interest when completing the RMDP survey, the project's Recycling Industry Committee (RIC) members, affiliated organizations and groups such as the Council of Governments, and additional public- and private-sector contacts in the survey contact list. In addition, the events were promoted by STAR staff, STAR's Business Council, and the Texas Commission on Environmental Quality (TCEQ). While forum attendance was high, it is important to note that the input received was reflective of those in attendance and that there are many other stakeholders who were not participating that may or may not share the same views. Additional stakeholder input for this project was also obtained through the survey and via interviews.

Each forum included:

- Introductory presentation of project overview and goals for the forum (see slides, Attachment 1)
- Material-specific presentation of preliminary findings to date (based on survey input and research conducted to date) regarding supply and demand of recovered materials and barriers and opportunities to improve materials markets (see slides, Attachments 2 – 5)
- Polling using the Poll Everywhere application to solicit targeted input from attendees
- Open discussion questions to solicit additional attendee input

In addition, attendees were provided with the opportunity to respond during the forums verbally and using the meeting chat, and after the forums via email.

The following forum summaries present the perspectives shared by attendees. Material-specific barriers and actions are presented in roughly the order based on number of respondents or similar comments. For some barriers and actions, additional attendee comments are included to clarify responses either as direct quotes or paraphrased content and may reflect multiple comments. Direct quotes by attendees are presented within quotation marks. If changes are made or examples are provided within a quote for clarification purposes, such changes are indicated in brackets.

This appendix concludes with a summary of forum findings.

Forum 1 – Typical Recyclables

Stakeholder Forum 1 focused on typical recyclables, such as those commonly collected in residential curbside recycling programs, including fiber, plastics, metals and glass. Input from Forum 1 attendees is summarized below. Slides for Forum 1 are presented in Attachment 2.

There were 42 participants in the Typical Recyclables Forum, representing multiple sectors: 15 from the public sector (representing seven local governments, two state agencies—TCEQ and Washington State Department of Ecology, and NASA), 18 from the private sector, four nonprofits or associations, a medical center representative, and four attendees for whom a sector could not be identified. These numbers exclude Project Team members from TCEQ, Burns and McDonnell, Circular Matters, and STAR.

RECOVERED FIBER

Recovered fiber materials addressed in the forum include: residential mixed paper, office paper, corrugated cardboard, and other paper from residential, commercial and industrial sources.

Recovered Fiber Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding recovered fiber marketability and market opportunities?

- Contamination
    - "In the form of mixed media;" and "due to poor source separation."
    - What was once not considered contaminated is now considered contaminated due to tightening of market specifications.
    - "Coatings on fiber containers for food safety or health purposes (plastics/paraffin) that create a contamination on the back end. Suggested solution: apply technology to provide similar level of protection that may not be contamination at end of life."
    - "Lack of employee training and compliance leads to contamination."
- Market -- "no end market"
- Distance — "distance to market"
- Logistics — "employee training"
- Processing — "processing cost;" and "there are areas in the state that may not have processing capability."
- Regulations
    - "Federal level and non-hazardous secondary materials (NHSM) as a barrier to end use is a regulatory issue."
    - Materials are classified as NHSM based on subjective definitions of solid waste and non-waste. This impedes opportunities to use this material.
- Material Recovery Facility (MRF) barriers/accepted items
- Education

Poll Question: What action would help to improve marketability and market opportunities for recovered fiber?

- Creating demand
- Education
- Updated federal/state laws
    - "Updated federal/state laws—many of our source laws are several decades old and need to be updated to [align with] current technology applications."
    - "Federal/state law—revise NHSM rules for end use as fuel."
    - "Federal and state laws that could drive opportunity."
- Recycling label continuity
- Tax break
- Reduce contamination
- Uniformity
- Subsidization
- Network
- Cooperation
- Workforce
    - Direct more workforce development and training resources to this industry (training or formalizing training for the industry).
- Incentives

Discussion Questions: Feedback on preliminary findings and additional input

- Burden on generators
    - “Recyclers have been putting the burden for quality on generators. They can, for example, end the use of single-stream and provide generators with compactors or other means to segregate and package the recycled material. We are willing to do the right thing but we cannot foot the entire bill.”
- NHSM Barrier
    - Materials are classified as NHSM based on subjective definitions of solid waste and non-waste. This impedes opportunities to use this material.

RIGID PLASTICS

Rigid plastic materials addressed in the forum include: polyethylene terephthalate (PET, #1) bottles and other containers, high-density polyethylene (HDPE, #2) containers, polypropylene (PP, #5) containers, and other rigid plastics, from residential, commercial and industrial sources.

Rigid Plastic Discussion and Poll Questions

Poll Question: What is the biggest barrier impeding rigid plastic marketability and market opportunities?

- Contamination
    - “Contamination created by front-end mixed material formulation;” and “collections of good quality streams.”
    - “Thermoform bales [made of clamshells, tubs, cups, lids, boxes, trays, egg cartons, etc.] are too contaminated with other materials. Could be marketed if not so contaminated.”
- Market/Demand
    - “Weak demand for thermoforms; plastic bottle reclaimers would like to utilize their capacity more. When you look at PET thermoforms—the list of what’s desired is bottles and not thermoforms; so there may be a lack of demand for them, which is increasingly being generated at larger rates—and injection molded tubs—limited capacity for them in Texas.”
- Awareness/confusion
- Processing
- Single stream/bin separation
- Labeling
- Policy
    - Regulatory barrier: Plastics to fuels is a huge market; it’s not the same as a closed-loop market, but probably better than landfilling.

      Note: As a result of HB 1954 (enacted in 2019), the conversion of post-use plastic polymers to valuable product (e.g., plastic, monomer, chemical feedstock, fuel) through pyrolysis or gasification is considered recycling.
- Value
- Little reclamation capacity
- Logistics
    - “Insufficient recovery of HDPE and PET to fully supply the market capacity.”
    - From end-use manufacturer’s perspective: “We need the quality of postconsumer materials, like mixed colors (no one would like to buy milk in a jug with a gray tint).”
    - “Large state”

Poll Question: What action would help to improve marketability and market opportunities for rigid plastics?

- Incentives
- Have cities stop collecting #7 plastics and other non-recycled plastics
- Bring back dual stream
- Mandates
- Education
- Network

- Increased collection cadences
- Labeling
- Homogenization
- Bottle bill
    - Deposits would be a means of getting more PET bottles into the recycling system.
    - “We have at least five very large PET recycling companies. The reason we have five is there are a lot of bottles to recycle. We’d have a lot more if we collected the same number of bottles or per person with a deposit law.”

Discussion Questions: Feedback on preliminary input and any additional input

- Used plastic paint cans have no recycling outlet.
- Plastics-to-chemical recycling opportunities (e.g., pyrolysis)
    - Texas has a pyrolysis company that “would like to be part of the circular economy—plastic will be recycled back into a virgin-equivalent plastic.”
    - “Advanced recycling is coming to Texas and will create a significant new end market for mixed rigids.”

FILM PLASTICS

Film plastic materials addressed in the forum include plastic bags, overwrap, and flexible packaging from residential, commercial, and industrial sources, and are made from HDPE or low-density polyethylene (LDPE, #4) resins.

Film Plastic Discussion and Poll Questions

Poll Question: What is the biggest barrier impeding film plastic marketability and market opportunities?

- Contamination
- Transportation
- MRFs
    - “Films are problematic for MRF sorting technologies. They want to remove, then they have no end market, so they get landfilled.”
- Low volume
- Lack of end market/end use
- General public/users
- Collection
- Silos — would need more equipment and silos to use recovered material
- Network
- Space
- Multi-material packaging
- Knowledge
- Low weight
- Strapping — assumed to be a contaminant in film bales
- Sortation

Poll Question: What action would help to improve marketability and market opportunities for film plastics?

- Incentives — for both consumers and recyclers
- Education — “Educate public about what it becomes;” and “where to take film to recycle.”
- Consistent/better labeling
- Standards/regulations
    - Extended producer responsibility (EPR)
    - Improved front-end design film design standards
    - Standardization
- Collection
    - “There needs to be more collection of films from the commercial sector—where they are clean, especially.”

- “My rural grocery store does not collect plastic bags.”
- Chemical recycling/Pyrolysis
  - “Low-value mixed films (e.g., take-back programs) are excellent feedstock for advanced recycling.”
  - “Energy Bags programs can assist with films.”

Discussion Questions: Feedback on preliminary findings and additional input.

[No further discussion]

FERROUS METALS

Ferrous metal materials addressed in the forum include metal food and other product cans, appliances, and other metal items generated by residential, commercial, and industrial sources. It does not include scrap metals going through scrap dealers, per Senate Bill 649 (SB 649).

Ferrous Metals Discussion and Poll Questions

Poll Question: What is the biggest barrier impeding ferrous metal marketability and market opportunities?

- Contamination – “non-programmatic ferrous contamination”
- Insufficient market for non-standard metals
- Many materials are unable to be collected in residential recycling
- Volume

Poll Question: What action would help to improve marketability and market opportunities for ferrous metals?

- Consistency of commodities (e.g., wiring)
- Education
- Collect more than cans alone

Discussion Questions: Feedback on preliminary findings and additional input?

- The value is there for ferrous metals, but need consistency.
- Metals are the easiest to recycle.

NON-FERROUS METALS

Non-ferrous metal materials addressed in the forum include aluminum food and beverage cans, aerosol cans, other cans, and non-ferrous items generated by residential, commercial, and industrial sources. It does not include scrap metals processed by scrap metal dealers, per SB 649.

Non-Ferrous Discussion and Poll Questions

Poll Question: What is the biggest barrier impeding non-ferrous metal marketability and market opportunities?

- Lack of consumer incentives
- Collection
  - “Waste haulers are more motivated to cater to trash and not recycling. Cheaper to landfill, also not the same route density.”
- Cheap landfilling
- Supply
- Education

Poll Question: What action would help to improve marketability and market opportunities for non-ferrous metals?

[No responses received.]

Discussion Questions: Feedback on preliminary findings and additional input

- "Auto shredder residue (ASR) has good end use as solid fuel but requires some processing to remove Chlorine and heavy metals. Plus NHSM (non-hazardous secondary material) barrier."
    - Follow up question from Project Team: Does infrastructure exist in Texas for ASR as a solid fuel, and are there end markets for the fuel? Response: "Potentially yes to infrastructure subject to investment strategy. In other states we are within a year."

      Note: ASR is excluded from this study per SB 649 and refuse-to-fuel is not currently included in the State's recycling definition.

GLASS

Glass materials addressed in the forum include: container glass, such as bottles and jars, and plate glass from residential, commercial and industrial sources.

<u>Glass Discussion and Poll Questions</u>

Poll Question: What is the biggest <u>barrier</u> impeding glass marketability and market opportunities?

- Distance/Transportation

  Note: Rail haul was introduced as a topic, including barriers to better using freight rail in Texas to move more recyclables longer distances cost effectively, but no input was provided by attendees.

- Handling/Safety
- An attendee asked if those who suggested safety as a barrier could expand on the safety issue. Responses:
    - We do not see this in most situations.
    - I've never heard safety raised as an issue.
    - The only time I have heard of a safety concern is if a MRF is using hand-sort, which is increasingly rare.
- Weight/Volume
- Value
- Infrastructure
- Connectivity/Network
- Market/Demand
- Marketing
- Contamination
- Cheap virgin material
- Color

Poll Question: What <u>action</u> would help to improve marketability and market opportunities for glass?

- End-use education
- Market to businesses
- Educate on what recycled glass can be used for (e.g., countertops)
- Explain why we do what we do
- Reduce safety hazards with broken/contaminated glass/PPE
- Beverage container deposit system that includes glass bottles.
- Improved connectivity throughout the state
- Collection points
- Market
    - "West of I-35" and "Everything west of I-35 needs a plan."
    - Promote "buy recycled."

Discussion Question: Do you have any additional input?

From North American Insulation Manufacturers Association (NAIMA) representative:

- There are 3 fiberglass plants in Texas and it is a very regular battle trying to keep glass in the recycling stream. There is a strong market—fiberglass is the largest user of glass cullet in Texas and the second largest user throughout North America. For example, in 2019 fiberglass manufacturers in Texas and Kansas used a combined 334 million pounds of glass cullet. And they could use more. There is a demand.
- There are enormous benefits to using recovered glass: it saves energy, and causes less wear and tear on furnaces, reducing costs to manufacturers.
- One of the problems is that a MRF will go into the municipalities and local governments and they will provide them with incentives to take glass out of the recycling stream. They tell the municipality that there is not a market for glass cullet so they don't need to worry about removing glass from the stream. This is false. It's just not as profitable as some of the others can be, and not the volume of some of the others.

From Glass Packaging Institute (GPI) representative:

- Agree that there are markets for recovered glass. "In container manufacturing, the industry would like to use more recycled glass. It's really a matter of getting it from where it is processing and then into the plants. Just as it helps fiberglass, [it is] the same for bottle manufacturing." There is "increased pressure on the manufacturing industries to use more recycled content, and it helps with the carbon footprint." There is a "need to address distance issues and quality issues for what is coming out of MRFs."
- [The] Recycling Partnership described how we have one of the largest recycling deserts in the nation—no drop-off or recycling drop-offs west of I-35. We need a plan for everything west of I-35.

Forum 2 – Organics

Stakeholder Forum 2 focused on organics, specifically biosolids, food and beverage materials, green waste (includes brush and yard waste, as well as crop residue), wood waste, and others. Input from Forum 2 attendees is summarized below. Slides for Forum 2 are presented in Attachment 3.
There were 21 participants in the Organics Forum from across sectors: 7 from the public sector (representing four local governments and TCEQ); 13 from the private sector; and a medical center representative. These numbers exclude Project Team members from TCEQ, Burns and McDonnell, Circular Matters, and STAR.

<u>Organics Poll Questions and Discussion</u>

Poll Question: What is the biggest <u>barrier</u> impeding organics marketability and market opportunities?

- Education
    - Inconsistency in messaging leads to lack of local acceptance. We need to explain the why.
    - If a resident puts just one plastic bag in with the compost it can ruin a whole load. Cities are not putting enough time into education.
- Contamination
    - Commercial/Industrial vs. Residential
        - Cities can track businesses that are doing it wrong, but it is more challenging to track sources of residential contamination—a significant issue.
        - It makes sense to focus more on pre-consumer organics—there is much more of it, and it is cleaner (low-hanging fruit)—before tackling post-consumer/residential.
    - Compostable bags
        - Bags vs. cart-based systems. There are issues about using compostable plastic bags. Attendee prefers paper bags and carts.
        - Compostable plastic bags are wonderful but that doesn't mean they work in all facilities. Not all bags are compostable. "If non-compostable plastics get in, it's very problematic."
        - Some [bags] are not actually compostable in your actual local facility, so we need to be sure somehow that they will actually compost.

        - In Seattle all green bags must be compostable.

          Note: Recent legislation was introduced in several states that would require compostable bags to be certified and to be green in color.
- Product safety
    - There are articles out there saying adding biosolids is dangerous. We need proof or standards to demonstrate safety. Independent testing and data (e.g., 3rd-party certification and testing) is needed.
- Collection
    - Regulatory hurdles on collection are a barrier. “We would like to be able to collect organics in airtight bins and hold them over night, without having to go to the compost facility every night.”
- Distance
- End markets
    - “In Houston the market is so saturated with producers and competition that the price of finished products is being driven down.”
    - Texas producers’ products might not be priced competitively for the export market given inexpensive production costs of producers in other states (and higher tip fees on the front end).
- Subsidies and competition from out-of-state producers
    - California and other states that have subsidies or grants for equipment, and production costs are less (and higher tip fees on the front end, as disposal for waste is much higher in other states). Producers in these states can sell their compost (in Texas markets) for much less, so it is hard to compete with those prices.
    - In California, mandates to compost, along with (high) landfill fees, have created a glut in the market in California, so product is being exported to other states.
- Permitting/regulations
    - “We need more registration-tier facilities that can accept biosolids. Wastewater plants need to be permitted to compost their biosolids/sludge.”

Poll Question: What <u>action</u> would help to improve organics marketability and market opportunities?

- Government incentives
    - Promote universal seal of testing assurance (STA) and participation in certification programs to help give materials a “good housekeeping seal of approval.”
- Consistent education
    - Standardization
        - “There is an opportunity to improve public outreach and education through public/private partnerships by making the educational materials more standardized in both content and appearance.”
        - “Standardized materials and digital assets would be a huge advantage—municipalities don’t all have the same capability of producing materials; and we are a commuter region, so being unified would have a big impact.”
    - Expanded content
        - “Texas is very sensitive to water issues. Compost helps retain water, prevents flooding and recharges aquifers; and when we’re fighting drought. I don’t hear a lot of people talking about the water aspect of compost. This alone could make a difference—tie in with the water community and promote this message.”
        - “Composting/food waste education also shows positive spill over into other sustainable behaviors” and allows messaging about other topics, such as “water savings, chemistry/youth education, food insecurity, backyard gardening—making it a better investment with a wider demographic.”
        - “It would be beneficial to conduct a feasibility study in a Texas region like the ones WWF did in other cities that compared the cost of [landfilling] food waste to the cost of commercial composting services for entities of different sizes.”
        - “We’re getting more requests/questions about carbon sequestering benefits as companies and governments are working to achieve their sustainability goals.”
        - Businesses are also seeing the added value of the compost messaging.

    - "[As] a hauler of food waste, we find that we get the message out about compost use as we train people to divert food waste from landfills."
- Promotion
  - The Go Texan program works to promote Texas businesses and industry and is a Texas Department of Agriculture program. It might be possible to include compost in that program.
  - "Texas has a giant market for compost that hasn't been tapped and is not advertised enough. We need to do better educating them. Agriculture folks are not tuned in." They might not be extremely high-priced markets, but perhaps they would find it worthwhile to use it. Organic farmers might be a good candidate.
  - "The growing CBD (Cannabidiol) market is a good market to grow into, too."
- Make it easier to operate organics drop-off locations.
- Retail establishment inclusion
- Government mandates
- Network

Poll Question: My processing facility could use more feedstock

- Yes — 75% (3 votes)
- No — 25% (1 vote)

Poll Question: For commercial compost operations: Selling our end products at a reasonable profit is challenging.

- No — 67% (2 votes)
- Yes — 33% (1 vote)
  - "In Houston, the market is so saturated with producers/competition, the price of finished products is being driven down."

Discussion question: Any unique concerns with wood, food waste, biosolids, other organics? Any other input?

- "We need more registration-tier facilities that can accept biosolids. Wastewater plants need to be permitted to compost their biosolids/sludge."
- "Fats, oils, and grease, require a pretty substantial permitting process," which can dis-incentivize composting these materials.
- Fats, oils, and dairy can go into a notification site (no connection to the sanitary sewer). Grease and grit traps have to go into a permitted site. Texas makes a distinction based on whether it comes from a connection to the sanitary sewer.
- "With package plants [pre-manufactured treatment facilities for small communities] popping up in [Municipal Utility Districts] and [Special Utility Districts] across the state in the [extraterritorial jurisdictions], the acceptance of biosolids at facilities will be extremely important."
- "The only concern that we have from time to time on wood is the availability of it. Supply and demand drive the price up and down throughout the year."

Forum 3 – Construction and Demolition

Stakeholder Forum 3 focused on construction and demolition (C&D) debris, such as: wood waste; asphalt shingles; asphalt, concrete, brick, tile, and aggregate; drywall and plaster; and other C&D materials. Input from Forum 3 attendees is summarized below. Slides for Forum 3 are presented in Attachment 4.

There were 21 participants in the C&D Forum, representing several sectors: 12 from the public sector (representing 3 local governments and 2 state agencies—TCEQ and the Washington State Department of Ecology); 8 from the private sector; and one attendee for whom a sector could not be identified. These numbers exclude Project Team members from TCEQ, Burns and McDonnell, Circular Matters, and STAR.

WOOD WASTE

Wood wastes addressed in the forum include wood such as dimensional lumber and plywood from construction and demolition activities.

Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding marketability and market opportunities for wood waste?

- Contamination
- Variable standards in multiple urban areas
- Material restrictions
    - Usually treated wood, or creosote treated wood have restrictions on their use. For example, it can't be used in mulch. Could be an issue.
- Transportation
- Rebate – "dropping recycling rebates to industrial suppliers"
- Demand
- Low tip fees
    - Low tip fees for disposal do not encourage delivery of materials to C&D processing.
    - "A price comparison in Dallas area: Dallas landfill charges $34.50/ton, no minimum. [A C&D recycling facility] charges $55/ton with a 2-ton minimum for $130."

Poll Question: What action would help to improve marketability and market opportunities for wood waste?

- Local reuse "matchmakers"
- Outreach
- Milk runs — "gather smaller volumes from multiple facilities"
- Local wood products manufacturer
- Single standard
    - "Establish standards for recycled wood products that are applicable for different construction uses."

ASPHALT SHINGLES

Asphalt shingles addressed in the forum include fiberglass or felt paper-based shingles coated with asphalt and topped with ceramic granules generated from construction and demolition activities.

Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding marketability and market opportunities for asphalt shingles?

- Reclaimed asphalt shingle (RAS) roadways not meeting Texas Department of Transportation (TxDOT) standards
- Testing for asbestos
- Lack of ordinances in municipalities to spec product for their own use
- Awareness
- Dallas Shingle Mountain and existing bad public relations

Poll Question: What action would help to improve marketability and market opportunities for asphalt shingles?

- Include in city and county specs; and possibly statewide through TxDOT
- A certification of a spec/use by a state engineering college
- Roadway demonstration projects
- "Need a directory of permitted recyclers"

ASPHALT, CONCRETE, BRICK, TILE AND AGGREGATE

Asphalt, concrete, brick, tile, and aggregate materials addressed in the forum are inert materials recovered from construction and demolition activities and are often crushed and used for fill material or road construction purposes.

Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding marketability and market opportunities for asphalt, concrete, brick, tile, and aggregate?

- Rebar in concrete
- Specifications for end-use materials
- Not enough material
- The amount of effort and space required to manage this material.
- "[The Recycling Market Development Plan] should create industry-specific market development 'commissions' to develop usage standards and promotive actions."

Poll Question: What action would help to improve marketability and market opportunities for asphalt, concrete, brick, tile, and aggregate?

- Incentives for use of products
    - "I don't think you'd see a cost difference between recycled and virgin materials, aside from transportation [from where materials start to the new project]."
- Municipal use requirements
- Specs

DRYWALL AND PLASTER

Drywall and plaster materials addressed in the forum include those made of gypsum (and paper, in the case of drywall) that are generated from construction and demolition activities and are used primarily for interior wall surfaces.

Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding marketability and market opportunities for drywall and plaster?

- "Raw gypsum is cheap." Processing for drywall can't compete financially with virgin gypsum. We need to find other end uses for it.
- No need to use in agriculture, locally.

Poll Question: What action would help to improve marketability and market opportunities for drywall and plaster?

- Use for soil stabilization for dust containment, if possible
- Encourage blending into cement

Discussion Question: Are there unique concerns with any other C&D materials?

- Illegal dumping
    - Need mechanism to track final disposition of materials to make sure it actually gets recycled and not illegally dumped or disposed.
    - "Have to deal the most with illegal dumping by construction crews and Do-It-Yourself-ers."
- Disposal pricing
    - "C&D is a cash cow for the hauling industry—hauler/disposal is often integrated. Sometimes it's hard to get haulers to haul material elsewhere."
    - Roll-off haulers often provide one price for hauling and disposal—landfill fees are already included.
- "Construction generates some cardboard packaging worth recovering."
- There is not a cost difference to incentivize use—focus on circular economy building and use of a local resource:
    - Deconstruction
        - City circular economy and climate action plans could promote deconstruction and recycling.

        - "The Reuse People has deconstruction efforts in the major urban areas [of Texas]."
    - Leadership in Energy and Environmental Design (LEED) Certification
        - "Austin's construction recycling ordinance grew out of its green building and LEED initiatives. That set the stage for recovery."
        - "The City of Austin also has green building policies for new City projects that require LEED certification. Lead by example."
    - Procurement
        - Incorporate recycling and circularity into construction procurement to help support recycling activity. In addition to having these requirements in procurements, it's "also important to include verification and enforcement." Participant said while he has seen some municipal and federal requirements, only one entity (e.g., the Army Corps of Engineers) ever seems to enforce it.
- Difficulty securing adequate quantities and quality of feedstock consistently.
- Some facilities would like more advanced equipment, but lack the resources
- Permitting assistance for building a facility would be helpful.
- "C&D suffers from quality issues—food waste, hazardous waste in small amounts that can slow the processing and raise costs—[there is a] need for standards for what is acceptable in the captured loads."

Forum 4 – Special/Difficult-to-Handle Materials

Stakeholder Forum 4 focused on special and difficult-to-handle materials, specifically: scrap tires, batteries, electronics, textiles, and paint. Input from Forum 4 attendees is summarized below. Slides for Forum 4 are presented in Attachment 5.

There were 17 participants in the Special/Difficult-to-Handle Materials Forum: 8 from the public sector (representing five cities and TCEQ); and 9 from the private sector. These numbers exclude Project Team members from TCEQ, Burns and McDonnell, Circular Matters, and STAR.

SCRAP TIRES

Scrap tires addressed in the forum include used tires from cars, trucks, and other vehicles, from residential, and commercial sources.

Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding scrap tires marketability and market opportunities?

- Costs
    - "[Our city has] an abundance of tires we need to dispose of. Tires we have collected from residents. The cost is outrageous."
- Difficult to find outlets
    - "Locations are limited to take tires. We have not been able to find someone to take them even if we could afford it."
    - A place to take tires—local tire stores have a difficult time moving bad tires as well.
- Collecting from illegal dumping sites
- Lack of scrap tire fee
- Safety, toxicity of material
- Minimal number of processors
- Limited end use

Poll Question: What action would help improve scrap tire marketability and market opportunities for tires?

- Regulatory changes
    - Change state law to allow the storage of more than 500 tires without the need for permitting; need to be able to collect full transport loads.
    - Target regulation towards manufacturers to support tire collection services (e.g., haulers and processors)
- Have a cost-effective disposal location to take the tires

Discussion Question: Do you have any additional input regarding scrap tires?

- "Needs to be cost-effective; very expensive to recycle them;" the cost of moving tires versus what they get (for taking them to be recycled) is disparate—one of the most expensive types of waste to deal with.
- "Very expensive & difficult to recycle; agree with EPR idea."
- Need better technology to disassemble tires
- There needs to be some type of subsidy for processing for higher-value end uses instead of fuels.
- "Tort reform to protect tire manufacturers from being sued from when people have accidents;" a lot of money is spent on upfront side.
- Tires have an air quality impact (grinding and processing produces dust); safety and environmental impact are a concern with processing.
- "Tires are unique in that for every one that is sold, usually one is available for management. The difference between sold tires and managed tires may give us an appreciation for the volume being illegally dumped, stored, or managed in some other manner. Additionally, it would give us a full understanding of the universe of tires to be managed/recycled in some manner."

BATTERIES

Batteries addressed in the forum include: lead-acid (car batteries), primary (alkaline), and rechargeable (lithium-ion, Ni-MH, Ni-CD) batteries from residential, commercial and industrial sources. Rechargeable batteries addressed in the forum include electric vehicle (EV) and electric storage system (ESS) batteries.

Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding battery marketability and market opportunities?

- Education on recycling batteries
  - "Many times, the [lithium-ion] batteries are 'hidden' in products (think singing greeting cards, lighting in children's shoes), which get thrown away, and then present a fire hazard in the collection truck and/or disposal facility."
  - Battery technology is outpacing battery recycling technology. Need product design for the environment.
  - "The chemical makeup for lithium-ion batteries is like a 'secret recipe,' and thus the manufacturers are all making batteries that are a little bit different."

Poll Question: What action would help improve battery marketability and market opportunities?

- Convenient end-user programs
- Incentives to recycle — deposit fee or other
- Enhanced safety for employees collecting/managing this material
- EPR
- Research to better define end-use product for battery materials
- Education
- Research and innovation needed for recycling of EV solar storage batteries.

ELECTRONICS

Electronics addressed in the forum include post-consumer electrical or electronic devices from residential, commercial and industrial sources.

Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding used electronics marketability and market opportunities?

- Consumer lack of awareness
  - Consumers don't understand that components within electronics contain heavy metals that can be considered hazardous.

    - Consumers are unaware of options for disposal/recycling.
    - There is a need to clarify what is considered an electronic and what can be recycled.
- Costs
    - There is a lack of inexpensive processing outlets for electronics recycling.
    - "Now they charge to dispose of [electronics]. Until the state bans them from landfill, there will be a problem. This needs to be fixed at state level; cities shouldn't have to bear the burden."
- There is a negative connotation or stigma towards buying used/refurbished/repaired products that may be inferior.
- Obsoletism/not made to be repaired
    - Electronics are made for disposability; little-to-no opportunities to repair or reuse parts
    - "Electronics are made to be disposable now. They are too cheap to fix, too easy to landfill."
    - Lack of businesses that are using recycled or used parts to refurbish.
    - "Mixed materials in computers and TVs—it is a problem to separate them out to recycle; need to be designed for the environment."

Poll Question: What <u>action</u> would help improve used electronics marketability and market opportunities?

- Legislation
    - EPR
    - Right to Repair legislation/design for recycling
- Guidance on where to recycle electronics:
    - Interactive map maintained by the state
    - Receipt or sticker on product to locate recycling centers in your area
- Workforce development programs around electronic repair and/or disassembling parts
    - "We need to consider incentivizing repair and reuse opportunities over recycling when it comes to electronics. I think there is more opportunity for jobs this way. No one is teaching those skills."
- Incentives for electronics recycling vendors
- Collaboration
    - Connectivity of recycling programs throughout the state (including rural areas)
- Promote the quality of used electronics.
- Incentives, like retail discounts, for returning electronics

TEXTILES

Textiles addressed in the forum include: fibers from discarded apparel, furniture, linens (sheets and towels), carpets and rugs, and footwear from residential, commercial and industrial sources.

<u>Poll Questions and Discussion</u>

Poll Question: What is the biggest <u>barrier</u> impeding textile marketability and market opportunities?

- Quality of the material
- Alteration/repair training
- Basic repair skills no longer being taught in primary school (e.g., sewing)
- Collecting small amounts from lots of places
- Expenses related to starting a mattress recycling facility
- NHSM barrier to fuel use
- Material leakage

Poll Question: What <u>action</u> would help improve textile marketability and market opportunities?

- Education (on recycling, reusing, repairing)
    - "[Public service announcements] on textile recycling programs"
    - Actions to remove consumer stigma around buying used or repairing your clothing
    - "I don't know if anyone has ever been into a textile grading facility, but the daily volume is unbelievable and makes you never want to buy a new piece of clothing again."
    - Teaching sewing basics to students—extend life of textiles
- Manufacturer responsibility

    - Holding clothing brands accountable for over-producing and adding to landfill waste
- Collaboration
    - Getting fashion designers and students involved in these conversations
- Additional collection
    - There are curbside textile collection programs for residents, but the same does not exist for businesses.
- Expanded end uses
    - "Post-consumer textiles—mattresses, carpets, clothing—can be used as solid fossil fuel replacement. Little sorting or grading is required."
    - "I've noticed recently a few brands (Nike being a bigger one) that have recently started producing apparel and shoes made from recyclable materials. If more companies could get on board with that, including turning used pieces of clothing into revamped styles (which many thrifters currently do)."
- Design for longevity/encourage thrifting
    - "The thrift industry is saying fast fashion is hard to reuse; can only wear [an item] three times, because so poorly made. Should encourage clothes to be made better."
    - "I wonder if there are any potential opportunities to focus on programs related to rental, repair, or buying used to reduce the strains on recycling markets."

PAINT

Paint materials addressed in the forum include used and unused latex and oil-based paints from residential, commercial and industrial sources.

Poll Questions and Discussion

Poll Question: What is the biggest barrier impeding used paint marketability and market opportunities?

- Lack of information/awareness
- Limited access to recycling
- Accessibility
- Limitations of reblend programs
    - Limited colors available through reblend/recycled paint suppliers
- "Mixed colors are an issue with powder paint, as is contamination."

Poll Question: What action would help improve used paint marketability and market opportunities?

- Education on where/how to use used paint
- More take-back programs
- Reblend incentives
- Outreach and partnering with real estate companies
    - Outreach to construction and handyman-type services that are procuring paint on behalf of their customers
- "Levelling the cost for smaller quantities will remove need for any recycling. Why are quarts three times the cost of a gallon?"

Summary of Stakeholder Forum Findings

Based on the information provided in the stakeholder forums, the Project Team identified several cross-material barriers; obstacles that impede marketability of more than one material type. These cross-material barriers and potential actions are summarized in Table D-1. Cross-material and other material-specific barriers and actions discussed at the forums will be taken into consideration in drafting the Recycling Market Development Plan.

TABLE D-1. CROSS-MATERIAL BARRIERS AND POTENTIAL ACTIONS IDENTIFIED

Barrier	Potential Actions	Impacted Material Types
Contamination	• Education/outreach • Dual stream • Standards	Paper, rigid plastics, film plastic, ferrous metals, glass, organics (especially residential), C&D wood waste
Distance to market/small quantities	• Hub and spoke or milk run collection points – collaborate with other communities • Education/outreach • Regulatory changes	Paper, rigid plastics, film plastic, film plastic, ferrous metals, glass, C&D wood waste, tires, textiles
Lack of processing capacity and/or equipment	• Incentives • Subsidies	Rigid plastics, film plastic, glass, tires
Lack of participation	• Incentives • Mandates • Education/outreach (e.g., what materials are turned into, jobs/economic benefit) • Bottle bill	Rigid plastics, nonferrous metals, glass, organics, batteries, electronics
Processing costs	• Incentives	Paper, C&D, tires, mattresses
Lack of employee training	• Training program to recycle/repair	MRF (typical recyclables, paper), batteries, electronics, textiles
Lack of awareness, confusion	• Harmonization • Education/outreach • Labeling • Market directory/material exchange	Paper, rigid plastics, film plastic, wood waste, asphalt shingles, batteries, electronics, paint
Low value, competition with inexpensive landfilling or cheap virgin material	• Incentives • Subsidies • Mandates	Rigid plastics, glass, film plastic, nonferrous metal, glass, C&D wood waste, asphalt shingles, drywall/gypsum
Lack of demand, insufficient markets, or lack of standards	• Incentives • Mandates (e.g., recycled content) • Buy recycled programs • Promote made in Texas • Develop standard/promote 3rd party certification • Test/demonstration projects • Promotion to remove "stigma"	Rigid plastics, film plastic, ferrous metals, organics, wood, asphalt shingles, drywall/gypsum, tires, batteries, electronics, textiles, paint
Safety issues	• Training • Ensure proper safety equipment is used • Labels • Education/outreach to consumers	Glass, tires, batteries
Not designed for recycling	• EPR • Standards/improved design	Film plastics (e.g., multi-material), tires, batteries, electronics
No/limited opportunity to recycle	• Incentives • Mandates • Additional programs (e.g., EnergyBag ®)	Film plastics, ferrous metals, tires, batteries, electronics

ATTACHMENT 1 - INTRODUCTORY SLIDES – PRESENTED AT ALL FORUMS

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RECYCLING MARKET Development Plan

Stakeholder Forum 1: Typical Recyclables

October 27, 2020

Agenda

- Project Team
- Plan Purpose and Background
- Market Development Plan Process
- Facilitated Discussion of Barriers and Opportunities
- Closing Discussion

Project Team

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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Re-TRAC CONNECT

Plan Purpose and Background

Purpose

- To assess current recycling activity in Texas and to examine the economic impact of the recycling industry throughout Texas
- To develop a recyclable material market plan to stimulate the use of recycled material feedstocks, increasing the economic and environmental benefits for Texas businesses, citizens, and governmental agencies
- Collect operations and financial information from recycling processors and end users

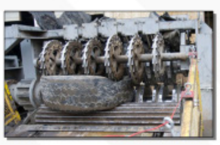
Background

- Created by legislation (Senate Bill 649) from the 86th Texas Legislative Session (2019)
- Builds on prior Texas recycling studies such as the Study on the Economic Impacts of Recycling (SEIR) by examining the Texas manufacturing industry and use of recycled materials in more detail
- Through a competitive bidding process, TCEQ retained Burns & McDonnell to complete the project.

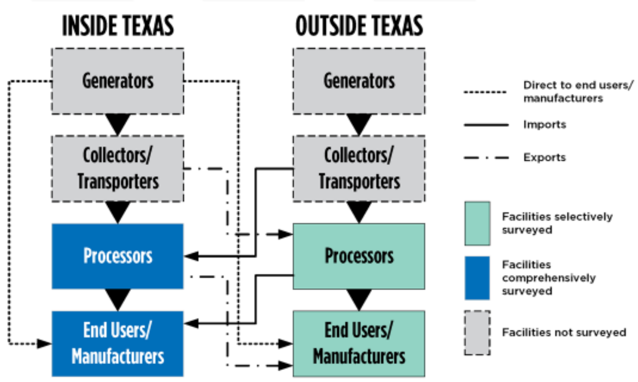
What Materials are Included?

Processors and End Users handling the following material:

- Paper
  - Mixed
  - OCC
  - Office Paper
  - Other Paper
- Plastics
  - #1 PET
  - #2 HDPE
  - Plastic Film
  - Plastics #3-7
- Glass
  - Containers
  - Other Glass
- Metals
  - Ferrous and Non-Ferrous
- Electronics
- C&D Materials
- Textiles
- Tires
- Paint and Related Wastes
- Batteries
- Organics
  - Biosolids
  - Food and Beverage Materials
  - Green Waste (includes brush and yard waste, crop residue)



Recyclables Material Chain



Public Education Campaign

- Public education campaign with Take Care of Texas
- Topics are based on the needs and priorities identified through the survey and market development plan process
- Topics to include:
  - Statewide recycling activity
  - Reducing contamination
  - Recyclable materials and uses
  - Case studies of processors and end-users
  - Economic benefits of recycling
  - and more…

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Plan Development Approach

1. Analyze Supply/ Demand
2. Identify Barriers & Infrastructure Needs
3. Consider Tools to Address Barriers
4. Identify Opportunities & Strategies
5. Identify Resources & Partners
6. Develop Implementation Recommendations

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Desired Forum Outcomes

- Obtain your feedback on findings to date regarding:
  - Relationship between materials supply and demand
  - Barriers that limit recycling materials in Texas
  - Opportunities to expand materials recyclability and recycling markets in Texas
- Gather additional input on barriers, opportunities, and issues with materials markets

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ATTACHMENT 2 - FORUM 1 (TYPICAL RECYCLABLES) SLIDES

(EXCLUDING INTRODUCTORY AND POLL AND DISCUSSION QUESTIONS

Typical Recyclables

- Paper
- Plastics
- Metals
- Glass

Paper

Supply and Demand Preliminary Findings

- Texas recovered paper end users include 4 in-state paper mills, 6 out-of-state mills, and at least 5 in-state manufacturers of cellulose insulation or molded pulp products
- Multiple mills and pulp producers are coming online in the USA and Mexico - some of which could also consume Texas recovered fiber supply (OCC and mixed paper)
- There is ample demand for clean, uncontaminated paper
- Product manufacturers using ONP#8 as feedstock have difficulty obtaining sufficient supply
- Both processors and end users are seeking more non-residential fiber which is now in short supply
- Markets are growing for cartons and single-use cups with a polyethylene barrier layer, making recovery of these materials more feasible
- Covid-19 has disrupted paper use and recovered paper supply with ongoing implications (lower virgin fiber use and lower quality recovered fiber supply)
- Certain TX regions lack sufficient infrastructure to process collected paper and aggregate truckload quantities for shipment to market

Paper
Barriers and Opportunities Preliminary Findings

Barriers

- Securing sufficient supply
- High contamination/low quality of supply
- Supply costs high relative to alternatives
- Lack of capital for facility upgrades
- Difficulty securing/retaining employees (Covid-19 related?)
- Low pricing for outgoing products

Potential Opportunities

- Public education to reduce contamination/increase tonnage
- Implement other measures to decrease contamination
- Actions to increase capture of non-residential tonnage
- Policies mandating recycling collection service provision
- Buy recycled promotion
- Voluntary recycled content goals
- Minimum recycled content mandates

Rigid Plastics

Supply and Demand Preliminary Findings

- Texas reclaimers of plastic bottles appear to have sufficient capacity for current levels of collection in Texas and would like collection to be increased
- Reclamation capacity for Texas generated PET thermoforms and all types of post-consumer injection molded packaging appears to be lacking
- Texas does not appear to have significant recycling capacity for materials that are not PET, HDPE, or film and Texas lacks sorting capacity for mixed plastics
- Texas has a large pyrolysis company that can process mixed and low value plastics into petroleum products

Rigid Plastics
Barriers and Opportunities Preliminary Findings

Barriers

- Insufficient recovery of PET and HDPE bottles to supply markets
- Weak reclaimer demand for PET thermoforms
- Lack of mixed plastics sorting capacity
- Little in-state reclamation capacity for post-consumer PP and PS
- PCR quality – color, FDA LNO, cleanliness – for value-added end use
- Plastics chemical recycling emerging

Potential Opportunities

- Increase access to collection of beverage containers away from the home
- Improve capture of plastic bottles in existing collection programs
- Address PET thermoform market issues
- Develop end markets for residential bulky rigid plastics, PVC, PS, and electronics plastics
- Develop sorting capacity for mixed plastic bales
- Develop supply paths to plastics chemical recyclers

Film Plastic

Supply and Demand Preliminary Findings

- Only high- and low-density polyethylene film has recycling market demand (polyethylene film is only 56% of all film generated)
- Residential film only has market demand if it is collected via return-to-retail – it has a low recycling rate
- Texas has six polyethylene film recyclers who only recycle film from commercial sources and their capacity exceeds supply – more commercial collection is needed
- End use demand appears to be weak

Film Plastic
Barriers and Opportunities Preliminary Findings

Barriers
- Cost-effectiveness of recycling non-PE and multilayer film packaging
- MRF sortability and market demand for curbside film
- Low return to retail film collection rates
- Source separation of film only makes sense for large film generators
- Weak end use demand for recycled film

Potential Opportunities
- Develop markets for packaging films, including polypropylene and multilayer films
- Improve the commercial recyclables processing infrastructure to increase sorting of mixed commercial recyclables
- Improve technologies to sort mixed film resins and film in mixed recyclables streams
- Increase end market demand for recycled film in products such as trash bags

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Ferrous Metals
Supply and Demand Preliminary Findings

- The vast majority (over 90%) of total estimated 6.0 million tons of collected supply is not MSW – auto bodies, fabrication waste, etc.
- Texas has five steel mills and several foundries that have the capacity to recycle around 4.5 million tons of ferrous scrap per year
- Regional demand plus Texas capacity means Texas does not appear to have any significant supply and demand issues for ferrous metals

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Ferrous Metals
Barriers and Opportunities Preliminary Findings

Barriers
- Lack of sorting capacity of non-can metals in residential MRFs
- Limited bulky item collection opportunities and processors

Potential Opportunities
- Expand processing of dry commercial waste and commingled commercial recyclables

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Nonferrous Metals
Supply and Demand Preliminary Findings

- Aluminum cans are shipped to national can recyclers that have sufficient capacity to process more than is currently collected – they import cans from other countries to meet their demand
- Foil pans and wraps do not have good market demand and as a result are not collected in many residential recycling programs
- Mixed nonferrous metals from shredders that process appliances, mixed material products, and auto bodies lack sufficient domestic sorting capacity – this stream was mostly exported in the past, but China is reducing imports

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Nonferrous Metals
Barriers and Opportunities Preliminary Findings

Barriers
- Less export market demand for mixed nonferrous metals
- Insufficient domestic sorting capacity for mixed nonferrous metals

Potential Opportunities
- Increase the sorting capacity for the nonferrous stream of metals from shredders
- Develop markets for aluminum semi-rigid foil pans and trays

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Glass
Supply and Demand Preliminary Findings

- More glass from MSW and industry (including plate glass) needed by some to increase production and/or recycled content
- Improved quality needed for some material
- Demand fluctuates more than supply
- Processing and end markets not available in all areas

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Glass
Barriers and Opportunities Preliminary Findings
Barriers
Processing/end markets not available in some parts of state
Heavy, costly to transport
Virgin materials low value
Can contaminate other materials in single-stream
Quality has been an issue
Recycled content not valued
Potential Opportunities
Processing certification (in process)
Grants/loans for glass processing/manufacturing expansion
Separate collection for glass
Develop local uses where long distance to beneficiation
Encourage/mandate recycled content
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47

ATTACHMENT 3 - FORUM 2 (ORGANICS) SLIDES

(EXCLUDING INTRODUCTORY AND POLL AND DISCUSSION QUESTIONS)

Organics

- Green Waste
- Wood Waste
- Food and Beverage
- Biosolids
- Other

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Overview of Processing

- Woody Waste - mulched, composted
- Green Waste, Manure, Animal Mortalities - composted
- Food and Beverage - composted
- Biosolids - dewatered, treated, land applied, composted
- Grease trap waste - composted

End Products

- Mulch
- Compost
- Soil amendments
- Soil blends

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Organics

Supply and Demand Preliminary Findings

- Demand for high-quality material is strong in some parts of state, not in others
- Feedstock supply can be inconsistent in terms of quantity and quality
- Barriers to entry/expansion - space, equipment, technical knowledge required
- Land application sites for Class B biosolids less plentiful than in past

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Organics
Barriers and Potential Opportunities

Barriers

- Inadequate quantity, quality feedstock
- Low-priced end product
- Transportation distance
- Inadequate technology
- Low tip fee
- Inadequate space/equipment
- High wages
- Lack of trained workforce

Potential Opportunities

- Encourage/mandate participation
- Address contamination
- Provide grants/loans for equipment/labor
- Buy recycled campaigns - programs to promote the purchase/use of end products
- Promote certification
- Establish public/private partnerships

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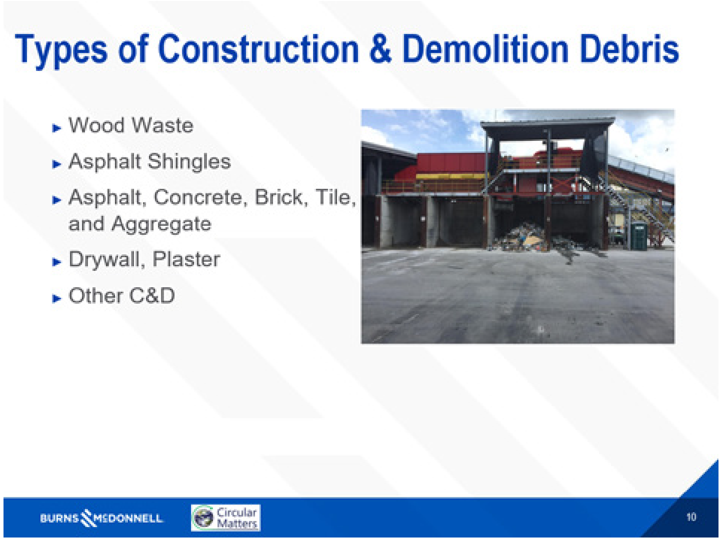
ATTACHMENT 4 - FORUM 3 (CONSTRUCTION AND DEMOLITION) SLIDES

(EXCLUDING INTRODUCTORY AND POLL AND DISCUSSION QUESTIONS)


Types of Construction & Demolition Debris
Wood Waste
Asphalt Shingles
Asphalt, Concrete, Brick, Tile, and Aggregate
Drywall, Plaster
Other C&D
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10


C&D
Supply and Demand Preliminary Findings
Supply of feedstock is often inadequate in quantity, consistency, and quality
Barriers to entry/expansion - space, equipment
Demand for some end products low - low pricing
Off-spec use of material (e.g., in road construction) has led to reduced demand
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11


C&D
Barriers and Opportunities Preliminary Findings
Barriers
Inadequate quantity, quality feedstock
Low-priced end product
Transportation distance
Inadequate technology
Low tip fee
Inadequate capital for equipment
Inadequate space
Costly labor
Potential Opportunities
Encourage/mandate recycling of C&D
Encourage/mandate use of recovered materials
Address contamination
Provide grants/loans for equipment/labor
Buy recycled campaigns - programs to promote the purchase/use of end products
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12

ATTACHMENT 5 - FORUM 4 (SPECIAL/DIFFICULT-TO-HANDLE MATERIALS) SLIDES (EXCLUDING INTRODUCTORY AND POLL AND DISCUSSION QUESTIONS)

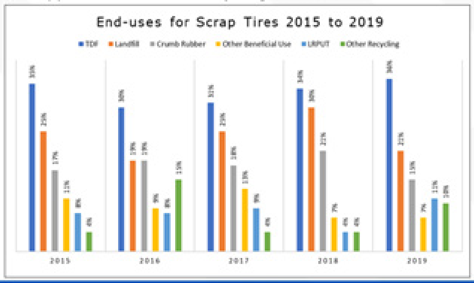
Special/Difficult to Handle Materials

- Tires
- Batteries
- Electronics
- Textiles
- Paint

Scrap Tires

Supply and Demand Preliminary Findings

- 79% of the 44,785,032 scrap tires from Texas sources were marketed for further use instead of landfilled
- Use of tires as fuel is the primary end use followed by crumb rubber production, then land application and other recycling markets



Scrap Tires
Barriers and Opportunities Preliminary Findings

Barriers

- Lack of funding to support scrap tire management
- Low cost of landfilling
- Transportation costs
- Transporters unaware of end market opportunities
- Limited compliance with annual reporting requirements
- Changing nature of tire manufacturing innovations resulting in contaminants for some end uses
- Comfort with using conventional materials limits interest in using tire-derived alternatives
- Limited knowledge of available Texas generated end products

Potential Opportunities

- Re-institute state scrap tire management fee as in 37 other states
- Provide information to generators and transporters about end market alternatives to landfilling
- Prepare scrap tire recycling market development plan to augment State's 5-year management plan
- Improve compliance with annual reporting requirements so more accurate data is available on waste tire handling and disposition
- Establish more pilots to demonstrate product performance in the field
- Buy recycled promotion

Batteries

- Lead acid automobile batteries
- Electric vehicle (EV) and Electric Storage System (ESS) batteries
- Portable batteries (rechargeable, non-rechargeable)

Batteries

Supply and Demand Preliminary Findings

- Lead acid batteries – Recycling infrastructure is well-established and virtually all lead acid vehicle batteries are recovered and recycled.
- EV and ESS batteries – Recycling infrastructure does not yet exist at a scale sufficient to process today's decommissioned batteries. This infrastructure needs development.
- Portable batteries (household and other batteries under 5 KG in weight) – Call2Recycle's network of drop-off locations (such as Lowes and Home Depot) exists in Texas, supplying collected batteries to one sorting facility in Texas that ships to a processor in Ohio who, in turn, supplies end users located elsewhere.
- Portable batteries are under-recovered especially in rural areas of Texas due to lack of retail collection points – lowest access to recycling in all of USA.

Batteries
Barriers and Opportunities Preliminary Findings

Barriers

- EV and ESS batteries:
  - Limited quantity of spent batteries at this time
  - Cost of virgin sources of constituent materials
  - Changing battery chemistry limits investment
- Portable:
  - Lack of retail collection points in smaller communities
  - High transportation costs
  - Limited promotion

Potential Opportunities

- EV and ESS batteries:
  - R&D efforts and investments in recycling capacity to ensure recycling at scale is economic and practicable for EV and ESS batteries when they need recycling
  - Policies to provide for proper handling of LI-ion batteries
- Portable:
  - Multi-material public depots in rural areas (hub and spoke system)
  - EPR legislation or possible amendment to existing e-waste law
- Both:
  - Regional processor to be located in Texas

Electronics

About Electronics Recycling

- Texas law requires television and computer-equipment manufacturers to offer recycling opportunities to residential consumers for these electronics.
- Several local governments provide drop-off opportunities for electronics, with private entities collecting and processing them.
- Stores like Best Buy provide takeback opportunities for electronics.
- There are several known electronics recyclers in Texas.

Supply and Demand Preliminary Findings

- Electronics recycling for consumers may be perceived as inconvenient, particularly for those living in rural areas, which likely results in landfilling of electronics.
- Large-scale commercial generators likely to be incentivized to recycle electronics, often part of leasing program.

Textiles

- Used clothing and shoes
- Household and commercial linens, curtains, pillows, etc.
- Mattresses
- Carpet and carpet padding

Textiles

Supply and Demand Preliminary Findings

- Virtually all scrap textiles can be reused or recycled.
- However, approximately 85% of used textile goods are still being disposed of in the US and the figure is even higher in Texas.
- Only 5% of carpet is recycled nationwide and less than 5% of mattresses are recycled.
- Texas has a broad network of secondhand stores plus has around 10 communities with curbside recycling programs for textiles.
- Some of the collected textile goods are sold for reuse and the rest is shipped to recyclers who then export a majority as secondhand clothing. The remainder is converted to wiping rags or recycled into fiber for various uses such as insulation, stuffing and carpet padding.
- Covid-19 has substantially disrupted scrap textile recycling given its heavy reliance on hand sorting.
- The textiles manufacturing and fashion industries are committed to becoming more sustainable/circular. Consequently, new opportunities are emerging, including optical sortation of textiles and molecular recycling of both polyester and cellulosic fiber back into fiber.

Textiles
Barriers and Opportunities Preliminary Findings

Barriers

- Limited public participation in textile recycling
- High cost of recycling carpet and mattresses
- Manual sorting requirements have resulted in export of textiles to reduce labor costs

Potential Opportunities

- Increasing collection via curbside recycling
- Promotion of participation in textile recycling
- EPR policies for carpet (e.g., CA) and mattresses (e.g., CT, RI, CA)
- Public private partnerships to enhance capabilities of Texas-based processors to supply emerging fiber to fiber markets

Paint

About Paint Management in Texas

- Many local governments collect through HHW programs (though not a HHW)
- Many communities instruct citizens to dry paint and dispose if latex
- Managed through a third party
- Paint Care was unsuccessful in establishing program in Texas.
- Several third-party recyclers in Texas, commercial generators go directly to them.

Supply and Demand Preliminary Findings

- Likely that supply exceeds demand overall
- Demand for recycled paint expected to be low - limited colors

Paint
Barriers and Opportunities Preliminary Findings

Barriers

- Convenience and cost to recycle can be factors
- Demand for recycled paint often low - sometimes given away

Potential Opportunities

- Incentivize use of recycled paint

APPENDIX E:

EXAMPLE TOOLS AND MECHANISMS FOR USE IN A RECYCLING MARKET DEVELOPMENT PROGRAM

RECYCLING MARKET DEVELOPMENT PLAN

E	EXAMPLE TOOLS AND MECHANISMS FOR USE IN A RECYCLING MARKET DEVELOPMENT PROGRAM

There are many tools and mechanisms that can be employed to develop markets for recyclable materials. The following table provides examples of recycling market development tools and mechanisms, including but not limited to those discussed and recommended in Sections 9 and 10. While many of the examples were not selected at this point for addressing Texas's needs, the State may have an interest in implementing additional tools and mechanisms in the future as progress is made.

Barriers	A Information, Facilitation & Technical Assistance	B Preferential Procurement	C Financial Assistance	D Financial & Other Incentives/ Disincentives	E Policies
Contamination	• Recycle Right Campaign • Harmonization Guidance • Contamination Reduction Guidance • Clear Labeling and Signage		• Equipment/ Recycling Market Development Grants and Loans		• Labeling Standards/ Requirements • Harmonization Policy and Setout Requirements
Inconvenient/ Limited Access to Recycling Opportunities	• Collaboration in Consolidating/ Transporting Materials • Monitoring and Research • Establishing a Task Force or Committee		• Infrastructure Development Grants/Start Up Grants • Hub-And-Spoke Grants • Funding from PAYT • Research and Development Grants • Business Incubator Support	• Innovation Awards • Research and Development Tax Credits	• Mandatory Provision of Service • EPR and Other Policies with Funding Mechanisms (Beverage Container Deposit Legislation, Advance Recycling Fee, PAYT) • Disposal Surcharges
Lack of Adequate Sorting/ Processing/ Secondary Processing	• Technical Information and Guidance • Research and Development • Monitoring and • Research • Establishing a Task Force or • Committee		• Infrastructure Development/ Start Up Grants • Equipment Grants • Research Grants • Funding from PAYT • Loan Guarantee • Investment Forum • Innovation Competition	• Tax Exemptions • Tax Credits • Permit Fee Waivers • Incentive Payments • Other Incentives (e.g., fast track permitting, free waste disposal, reduced rate for utilities)	• Funding Policy Mechanisms (EPR, Advance Recycling Fees Paid by Industry or Consumers) • Mandatory Provision of Service • Minimum Recycled Content Legislation • Beverage Container Deposit Legislation
Lack of Participation in Existing Recycling Programs	• Recycling Promotion Campaign • Database Development and Generator Mapping • Information Sharing and Networking		• Consulting Grants • Equipment Grants	• Awards Programs • Disposal Surcharges	• Variable Rate User Fees/PAYT • Mandatory Recycling Participation Laws/Disposal Bans • Beverage Container Deposit Legislation • Disposal Surcharges

Barriers	A Information, Facilitation & Technical Assistance	B Preferential Procurement	C Financial Assistance	D Financial & Other Incentives/ Disincentives	E Policies
Competition with Low-Cost Alternatives to Recycling			• Infrastructure Development Grants and Loans	• Tax Credits or Exemptions • Rebates and Incentive Payments • Disposal Surcharges	• Mandatory Recycling Participation/ Disposal Bans • Mandatory Provision of Service • Policies with Funding Mechanisms (Advance Recycling Fees, EPR, PAYT) • Beverage Container Deposit Legislation • Disposal Surcharges • Minimum Recycled Content Requirements
Costly to Transport Relative to Value	• Regional Cooperation • Research and Development, Testing, Pilot Projects		• Regionalization Grants • Recycling Market Development/ Equipment Grants	• Incentive Payments	• Advance Recycling/ Disposal Fee • Policies with Funding Mechanisms (Advance Recycling Fees, EPR, PAYT)
Lack of Adequate End Markets for Products	• Feedstock Conversion Research and Promotion • Research and Information Dissemination • Pilot and Demonstration Products • Feasibility Assessments • Stakeholder Engagement and Facilitation • Quality Standards/ Grades	• Recycled Product Promotion Programs/ Campaigns • Recycled Products Information • Cooperative Contracting • Price Preferences	• Recycled Products Grants	• Awards Programs • Incentive Payments • Risk-Sharing via Contract Terms	• Advance Recycling/ Disposal Fee • Policies with Funding Mechanisms (EPR, Packaging Fees) • Beverage Container Deposit Legislation • Require Certifications/ Labeling • Recycled Content Requirements • Recycled Content Purchasing Requirements for Government Agencies
Regulations Impede Recycling	• Stakeholder Engagement and Facilitation				• Regulatory Review/ Revision