Maryland
Department of
the Environment

APPENDIX G

| RECYCLING ECONOMIC OPPORTUNITIES

FINAL NEEDS ASSESSMENT | MARYLAND STATEWIDE RECYCLING NEEDS ASSESSMENT

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1 Introduction

The value of recyclable materials disposed of in landfills is important to understand both for environmental and economic reasons in Maryland (State). Economically, these materials represent a lost opportunity to generate revenue through recycling markets, support the future recycling system and programs, and provide resources from which additional materials can be manufactured and sold. Redirecting these materials from the waste stream into recycling streams can minimize hauling costs, create jobs required to manage and process recyclables, and support local end markets that utilize recycled inputs.

The availability of responsible end markets drives demand for the use of recycled materials in manufacturing processes and supports investment in best-in-class recycling programs, facilities, and infrastructure. Strong end markets bolster local economies, support local job markets, and reduce environmental impacts by diverting waste from landfills and lowering the demand for virgin materials. The success of these markets depends on stable demand, consistent supply, supportive policies, and regional collaboration to bring innovation to the space.

1.1 Background

Increasing the capture of recyclables in the State depends heavily on the local and regional end-markets, which drive demand for packaging materials that are typically covered by potential Extended Producer Responsibility (EPR) legislation. There are ongoing efforts to support end markets and minimize barriers to recycling. These efforts help capture the economic value of recyclables, and they can be built on as part of potential EPR legislation.

1.1.1 Recycling Market Development

Passed during the 2021 legislative session, the Recycling Market Development law requires the Office of Recycling in the Maryland Department of the Environment (MDE) to promote the development of markets for recycled materials and products in the State.[1] As part of this law, MDE is charged with evaluating the availability of local, national, and international end markets for recycled materials and products, identifying recyclable materials that are in need of recycling assistance, identifying marketing opportunities and methods for collecting and processing these materials.

Additionally, the law requires MDE to identify and examine opportunities to co-locate businesses that use recycled materials including reuse, repair, and remanufactured materials by coordinating with the Department of Commerce, Department of General Services, Department of Transportation, Maryland Environmental Service (MES), Northeast Maryland Waste Disposal Authority (NMWDA), local governments, and private organizations.

[1] Maryland Department of Environment. 2021. Recycling Market Development Law. Laws - Statute Text

1.1.2 Recycling Market Development Workshop

In 2023, MDE held workshops to discuss recycling market development in the State and surrounding region.[2] The workshop featured three key topics: innovation and business development, business identification and marketing, and education and outreach. Participants included businesses, environmental organizations, and government representatives including companies such as Chesapeake Materials, TurboHaul, and Arundel Recycling. While this workshop was not specific to packaging, as it included discussion on materials like mattresses and vinyl siding, participants emphasized the importance of mandates for recycled content and incentives to drive demand for recycled material markets. Discussions also addressed difficulties with high transportation costs and limited infrastructure for recycling hard-to-process materials (e.g., commercial plastics, glass), need for expanded funding, and enhanced collaboration among stakeholders.

Participants recommended EPR programs, increased transparency in recycling processes, and partnerships with groups like the Institute for Public Procurement and Sustainable Purchasing Leadership Council. Suggestions included prioritizing cleaner feedstocks at materials recovery facilities (MRFs), encouraging businesses to adopt take-back/reuse programs, highlighting the need for public education on recycling, and incentivizing innovative product design to facilitate recyclability.

1.2 Methodology

1.2.1 Surveys

The Project Team leveraged survey information provided by municipalities, counties, MRFs, composting facilities, and haulers to evaluate the barriers to recycling and economic opportunities in the state. This evaluation involved identifying rates of contamination and operational costs of recycling and composting.

1.2.2 Interviews

The Project Team interviewed various regional authorities, strategic partners, and organizations representing recycling end markets. These discussions provided key insights into the recycling end markets in the State and surrounding area as well as economic factors to consider from the perspective of manufacturers.

1.2.3 Data Analysis

The Project Team utilized data from the waste characterization, available end market pricing from MRF surveys, and data from County recycling reports to estimate the value of recycling material disposed in landfills annually.

[2] Maryland Department of Environment, 2022. Recycling Market Development Workshop. Summary of Notes _ RMD _ 12 6 2022 workshop.pdf

The following sections describe the estimated lost revenue and barriers to increasing recycling in Maryland.

2 Lost Revenue

Recycling reduces the need for virgin material extraction, lowers greenhouse gas emissions and energy use, and prolongs the useful life of disposal assets in the State. Diverting recyclable materials from landfills also extends landfill lifespans and mitigates environmental impacts such as leachate production and methane emissions. The following presents estimated tonnage and value of recycling disposed annually in the State.

2.1 Tons of PPP Recycling Disposed

Table 1 shows the estimated tons of recyclable PPP materials disposed in landfills in the State in 2022.

Table 1: Estimated Annual Tons of PPP Recyclables Disposed in the State in 2022

Material Type	Residential	Commercial
Glass	67,000	35,000
Metal	50,000	34,000
Rigid Plastic	122,000	113,000
Flexible Plastic	147,000	269,000
Paper	238,000	246,000
Cardboard	155,000	331,000
Total	**779,000**	**1,028,000**

There are an estimated 779,000 tons of PPP recyclables from the residential sector and 1,028,000 tons from the commercial sector disposed in landfills in the State. If considered individually, cardboard and flexible plastic are the most significant contributors in the commercial sector. Paper and cardboard combined are the most significant contributor in both sectors, accounting for 238,000 tons and 155,000 tons from the residential sector, and 246,000 tons and 331,000 tons in commercial sector, respectively. Flexible plastics also represent a substantial portion of waste, particularly in the commercial sector, with 269,000 tons compared to 147,000 tons in residential waste.

2.2 Value of PPP Recycling Disposed

The Project Team used material specific revenues sourced from in-state MRFs, based on the survey of MRF processors to determine the value by material type. For the materials which MRFs could not provide a revenue per-ton, the Project Team utilized figures from recyclingmarkets.net. In addition to the averages above, the Project Team used high and low values from the same data sources to develop a sensitivity of the total value for PPP material disposed in the State. **Table 2** shows the estimated value of recyclables disposed in the State.

Table 2: Annual Value of Total Recyclable PPP Material Disposed (2022) ($ million)

Material Type	Low	Average	High
Glass	$0.0	$1.4	$2.8
Metal Packaging	$56.8	$59.8	64.2
Rigid Plastic	$50.2	$53.8	$59.6
Flexible Plastic	$0.0	$0.0	$0.0
Paper	$33.7	$38.5	$46.3
Cardboard	$48.5	$57.1	$75.1
Total	**$189.1**	**$210.5**	**$248.1**

Metal packaging and cardboard are the materials with the most value disposed in landfills. Metal packaging value lost to disposal ranges from $56.8 to $64.2 million annually, while cardboard ranges from $48.5 to $75.1. Overall, the total value of recyclables disposed annually ranges from $189.1 to $248.1 million.

Table 4 and **Table 5** present the annual value of residential and commercial PPP material disposed.

Table 3: Annual Value of Residential Recyclable PPP Material Disposed (2022) ($ million)

Material Type	Low	Average	High
Glass	$0.0	$0.9	$1.8
Metal Packaging	$36.3	$38.1	$41.0
Rigid Plastic	$26.0	$28.0	$31.1
Flexible Plastic	$0.0	$0.0	$0.0
Paper	$16.3	18.7	$22.6
Cardboard	$15.3	18.1	$23.8
Total	**$94.0**	**103.8**	**$120.3**

Table 4: Annual Value of Commercial Recyclable PPP Material Disposed (2022) ($ million)

Material Type	Low	Average	High
Glass	$0.0	$0.5	$0.9
Metal Packaging	$20.5	$21.6	$23.2
Rigid Plastic	$24.1	$25.8	$28.5
Flexible Plastic	$0.0	$0.0	$0.0
Paper	$17.4	$19.8	$23.6
Cardboard	$33.1	$39.0	$51.4
Total	**$95.1**	**$106.7**	**$127.7**

The total disposed values of residential and commercial recyclable materials are similar, with residential values ranging from $94.0 million to $120.3 million and commercial values

from $95.1 million to $127.7 million. In both sectors, metal packaging, rigid plastic, paper, and cardboard are the most valuable materials. In residential disposal, metal packaging ($36.3 million to $41.0 million) has the highest value, followed by rigid plastic ($26.0 million to $31.1 million). In contrast, cardboard has the highest disposed value in commercial recycling ($33.1 million to $51.4 million), with rigid plastic ($24.1 million to $28.5 million) as the second highest.

2.3 Key Findings

The following presents the key findings from the information presented above:

- **Paper and cardboard represent the greatest opportunities to recover volumes of recycling material currently disposed.** In both residential and commercial sector the combination of paper and cardboard lead the estimated tons of recyclable material disposed. There is more tonnage of paper and cardboard PPP disposed annually from the commercial sector (577,000 tons) compared to the residential sector (393,000 tons). If considered individually, cardboard and flexible plastic are the most significant contributors in the commercial sector.
- **There is a comparable value of recyclable materials disposed in residential ($94.0 million to $120.3 million) and commercial materials ($95.1 million to $127.7 million).** In both sectors, metal packaging, rigid plastic, paper, and cardboard are the most valuable materials. The material with the highest value lost to disposal in the residential sector is metal packaging ($36.3 million to $41.0 million), followed by rigid plastic ($26.0 million to $31.1 million). In contrast, commercial recycling has cardboard as the top material disposed ($33.1 million to $51.4 million), with rigid plastic ($24.1 million to $28.5 million) also significant.
- **Flexible plastics presents a substantial portion of material disposed (417,000 tons), but has no recovery value due to limited available end markets.** More volumes of flexible packaging are disposed from the commercial sector, with 269,000 tons compared to 148,000 tons in residential waste. While flexible packaging is a large volume, there is limited value for flexible packaging material so the costs for separately collecting and processing the material would not be balanced by revenue generated from the sale of the materials.

3 Employment Opportunities

The recycling industry in the State employs approximately 5,000 people, generating $3.4 million in wages and $1.6 billion in total economic output related to primary collection and processing of recycling (e.g., not including end markets).[3]

To recover the lost value of the commodities currently disposed in the State, EPR legislation would need to expand the capacity of the State's recycling system which would

[3] Institute of Scrap Recycling. 2021. *U.S. Based Recycling Industry Economic Impact Study*.

provide further primary, secondary, and tertiary economic benefits through additional jobs, wages, and increased revenue for existing companies.

The following provides a high-level description of the components of the recycling value chain that present opportunities for increasing recycling collection and processing employment:

- **Education, Outreach, and Compliance.** To effectively separate the valuable recycling materials that are currently being sent for disposal, there is a need for resources that can engage various generator sectors (e.g., residential, multi-family, and commercial) providing clear messaging to improve recycling practices. Full- or part-time recycling educators can develop and distribute recycling education materials to residents and businesses to promote recycling and encourage best practices in recycling practices.
- **Collections**. Managing and transporting increased volumes of recyclables requires additional resources and investment but is essential to diverting recycling materials from disposal. Collection systems require skilled driver and equipment operators with Commercial Driver's License (CDL) certifications and potentially temporary labor to collect material curbside.
- **Facilities.** Receiving, processing, and marketing recycling materials is a labor-intensive process. While facilities are moving toward higher levels of automation, a sustained increase in recycling material would still require additional pickers, mechanics, managers, and equipment operators to effectively process and market materials.
- **End Markets.** Facilities that process separated materials from MRFs may be able to expand or establish new facilities in the State if EPR legislation can provide a sustained and high-quality stream of additional materials. This may result in opportunities for paper mills, plastic recovery facilities, scrap yards, smelting facilities, bottling plants, or glass beneficiation facilities to expand their workforce for a variety of roles, from facility operators to marketing and sales personnel.

Further description of opportunities for workers in the recycling industry is presented in **Appendix D: Workers Conditions, Wages, and Benefits.**

4 Barriers to Increasing Recycling

Recycling faces significant barriers linked to the location of end markets, transportation challenges, expanding access, and minimizing contamination. These factors play a key role in determining the economic feasibility of recycling programs.

Achieving economies of scale in recycling is a barrier, as less densely populated areas often generate limited quantities of recyclable materials. This can make it difficult to justify investment in local processing facilities. Without economies of scale, recycling programs struggle to remain cost-effective, leading to higher operational costs and reliance on subsidies or public funding. Compounding this issue is the prevalence of contaminated recycling, where improper sorting or dirty materials reduce the quality, marketability, and

value of recyclables. Contamination can render entire batches unusable, forcing them to be landfilled or incinerated and further diminishing the economic and environmental benefits of recycling. Addressing these barriers requires coordinated efforts to improve infrastructure, educate consumers, and foster policies that support sustainable recycling systems.

4.1 End Markets

End markets can be both a barrier and a driver of sustainable recycling programs. The impact of end markets depends on the ability to source enough quality feedstock for remanufacturing to meet recycled content standards in the production cycle of packaging. The market landscape (e.g., business size, vertical integration, financial incentives, etc.) of manufacturers determines the ability to leverage end markets to minimize barriers to recycling in the State.

When primary and secondary processors are tightly integrated, it has the potential to minimize material losses and ensures compatibility with industrial specifications for recycled products. For example, close collaboration between separating facilities and remanufacturers can help optimize the composition of recycled resins or fibers, reducing the need for virgin materials.

By increasing efficiencies in recycling end markets, potential EPR legislation can stabilize pricing and drive demand for post-consumer feedstocks used to manufacture packaging materials. The following presents high-level considerations related to end markets in the State and surrounding areas.

4.1.1 Material Types

The end markets where bales are shipped depend on the material type. The following provides high-level information related to end markets in the State and surrounding areas for glass, paper, plastic, and metal.

4.1.1.1 Glass

There are several facilities supporting glass recycling in the State and surrounding area within 200 miles including:

- Four (4) beneficiation facilities
- Seven (7) bottle manufacturers
- Two (2) fiberglass facilities

These facilities are located in Maryland, Virginia, West Virginia, New Jersey, Pennsylvania, and New York and have processing capacity ranging from 50,000 to 120,000 tons per year. Generating high quality recycled glass is critical to maximizing the operational, financial, and environmental benefits of glass recycling. Curbside collection systems are not always the most effective approach to managing post-consumer glass, as the compaction of the collection vehicles causes challenges with glass contamination, diminishing the value of glass for end markets. Some MRFs in the State also transport

recovered glass to landfills for use as alternative daily cover or other industrial uses (e.g., roadbase).

MRFs that have equipment and operational capacity to separate glass are able to transport material to beneficiation facilities that further clean glass, sort by color, and sell to high value end markets such as glass container and fiberglass manufacturers. Post-consumer glass that is greater than 3/8 inch can be delivered to beneficiation facilities or other high value uses (e.g., fiberglass manufacturing).

While some glass from existing MRFs can be recycled into glass containers, the majority of glass produced by single stream MRFs without secondary cleaning equipment cannot be recycled back into glass containers due to its size and level of contamination (e.g., food waste, plastic, paper, other <2" residue). Secondary glass processing may include vacuum systems, light fraction trommel screens, air knives, and magnets. Further discussion about glass processing equipment in MRFs is provided in **Appendix C: Infrastructure and Capacity Technical Memorandum.**

4.1.1.2 Paper

There are several facilities supporting the forestry, logging, pulp, and paper industry in the State including four (4) wood product processing facilities and 25 mills. The paper and packaging industry in the State employs a total of 5,500 employees with a total of $395 million in annual revenue. Paper (including OCC) is one of the most recycled materials in the U.S with a recycling rate as high as 68% nationally and is the largest volume of material in the recycling stream.[4] Further discussion about the recycling composition processed at MRFs in the State is provided in **Appendix B: Recycling Stream Analysis Technical Memorandum.**

4.1.1.3 Plastic

Plastic recycling is challenging due to the diverse range of polymers used in production, each with unique chemical compositions and physical properties that require specialized processing methods. Common plastics like polyethylene (PET) and High-Density Polyethylene (HDPE) are widely recycled due to established markets and efficient primary sorting capabilities at existing MRFs. However, other polymers such as polystyrene, polypropylene, and multi-layered materials often pose significant challenges due to contamination, lack of processing infrastructure, or limited end markets. The presence of additives, dyes, and other contaminants further complicates recycling efforts, often reducing the quality of recycled outputs.

Based on discussions with stakeholders in the plastic recycling industry, there are limited plastic recycling markets in the State but there are many in nearby southeastern states. If EPR for packaging were to increase the amount of guaranteed supply of high-quality plastic from recycling, existing plastic recycling facilities could accept the material and expand operations. Critically, the stream of plastic would need to be uncontaminated with guaranteed volumes, ideally on a long-term basis.

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[4] American Forestry & Paper Association. 2022. *Unpacking Continuously High Paper Recycling Rates*. Unpacking the 2021 Paper Recycling Rate | AF&PA

Although there are limited plastic processors in the State (e.g., generating pelletized or flaked plastic as inputs for packaging manufacturing), there are six (6) beverage and bottling recycling facilities in the State.

4.1.1.4 Metal

Metal recycling is a highly efficient, as metals can be recycled indefinitely without significant loss of quality. However, the efficiencies of collection of metal material at scrap yards, transportation, and recycling process and its efficiency can vary based on the type of metal. Ferrous metals like steel and iron are among the most commonly recycled materials due to their widespread use and the magnetic properties that make them easy to separate from waste streams. Non-ferrous metals such as aluminum, copper, and brass are also widely recycled but require different sorting and processing techniques due to their diverse properties and higher value. Challenges arise when metals are part of complex products, such as electronics or vehicles, where they are mixed with other materials and require extensive disassembly or advanced technologies for recovery. Access to recycling is the primary barrier to metal recycling as collection of those materials is not possible in areas where convenient recycling options are not available.

4.1.2 Location

In regions where end markets are significant distances from MRFs, the costs of transportation can outweigh the value of materials, leading to financial challenges for recycling operations. This distance can also discourage investments in local recycling infrastructure, leaving communities with fewer options for processing their materials. Furthermore, global market fluctuations, such as import restrictions by countries like China, can complicate the availability and stability of end markets, making it difficult to sustain recycling systems in isolated or underserved areas.

Recycling efforts in areas with challenging geographies in the State are particularly impacted by transportation challenges. In some areas, like the Baltimore Metro and Washington Metro Regions, heavy trucking corridors and rail transportation provide access to end markets. Other areas, such as the Lower Eastern Shore and Southern Maryland, incur significant costs to ship or transport. Recycling requires a well-coordinated logistics network to collect, sort, and transport of materials to appropriate processing facilities and end markets. Within the State, challenges exist with roadway infrastructure, long transit distances and tolling costs, limited barging options or port infrastructure, and rising fuel costs.

4.1.3 Recycled Content Market Demand

Recycled content markets play a critical role in driving the remanufacturing process and reducing barriers to recycling by creating robust end markets for materials. When manufacturers demand recycled materials for their processes, it stabilizes markets and provides a clear path for recycled materials to be used as feedstocks, which in turn reduces the need for virgin materials. However, the volatility of recycling commodity pricing can pose challenges for end markets to consistently source recycled content, highlighting the need for stronger and more predictable market demand. By supporting

the integration of recycled content, potential EPR legislation can incentivize manufacturers to mitigate these barriers to recycling.

Many brands either operate their own manufacturing arms or partner with contract manufacturers, and there is already a significant focus within the industry on incorporating recycled materials into products. Leveraging this emphasis can further enhance the growth of recycling programs by ensuring that collected materials are effectively utilized. Supporting the development of end markets for difficult-to-recycle materials, such as flexible plastics or textiles, is particularly crucial for expanding the scope of recycling efforts. As manufacturers innovate to incorporate these materials into their products, they help to close gaps in the recycling supply chain.

Encouraging innovation for materials that currently lack established end markets would be very beneficial to reducing the volume of recyclable packaging disposed. As described in Section 2.2, there is a significant amount of flexible packaging disposed because of its limited value as a commodity. With strong recycled content market demand, recycling programs can overcome economic barriers and variability in material value, making recycling a more reliable and sustainable option. For example, encouraging innovation around remanufacturing utilizing flexible packaging as a feedstock would drive demand for that material to be included in recycling programs and separated by MRFs. This approach not only benefits the environment by reducing waste, it also supports economic growth by creating new opportunities in remanufacturing industries.

4.2 Economies of Scale

Economies of scale are critical in recycling collection and processing operations because they directly influence the cost-effectiveness and sustainability of these programs. By increasing the volume of recyclable materials processed, fixed costs such as equipment, facilities and labor are spread over a larger quantity of output, reducing the per-unit cost. Additionally, higher volumes often allow operators to negotiate better prices for materials with end markets, making the programs more financially viable. Achieving economies of scale also enables investment in increasingly automated sorting systems, which improve efficiency and material recovery rates, further enhancing the economic and environmental benefits of recycling.

Without sufficient tonnage to justify the costs of operation, recycling programs can face significant financial strain. Low volumes mean higher per-unit costs for collection, transportation, and processing, often resulting in budget deficits. This can lead to program cutbacks, reduced service quality, or even the complete failure of recycling initiatives due to the volatility of secondary commodity markets. Moreover, insufficient tonnage can make it difficult to attract buyers for recycled materials, as end markets often prioritize suppliers capable of delivering large, consistent, and high-quality bales. These challenges are seen in the rural areas of the State (e.g., Western Maryland and Lower Eastern Shore Regions) where the lack of scale undermines the program's economic sustainability, discouraging participation and further impact capture rate of key materials.

Setting up recycling programs without adequately considering the need for scale can have broader negative impacts. Inefficient or financially unstable programs risk eroding

public trust in recycling, leading to decreased participation and contamination of materials. Furthermore, such programs may divert resources from more effective waste management strategies, ultimately harming environmental goals. To ensure long-term success, recycling initiatives must be carefully planned to aggregate sufficient material volumes, often through regional collaborations or partnerships. This strategic approach not only ensures economic sustainability but also maximizes environmental benefits by increasing material recovery and reducing reliance on landfills.

4.3 Contamination

Survey responses were analyzed to present the following high-level evaluation of contamination by region of the State in materials delivered to recycling and composting facilities.

4.3.1 Recycling

Table 5 shows the available responses indicating the estimate range of contamination for single family recycling programs in the State. The ranges presented are meant to provide a planning level estimate of program performance on a regional basis, and does not reflect specific MRF audit studies.

Table 5: Single Family Contamination Rates by Region[5]

Region	County	Single Family Contamination Rate
Western Maryland	Allegany	5%-10%
	Garrett	Less than 5%
	Washington	30%+
Washington Metro	Prince George's	21%-25%
	Frederick	5%-10%
	Montgomery	5%-10%
Baltimore Metro	Anne Arundel	5%-10%
	Baltimore	Greater than 30%
	Carroll	11%-15%
	City of Baltimore	16%-20%
	Harford	N/A
	Howard	5%-10%

[5] N/A indicates no responses were provided as part of the County and municipal survey.

Region	County	Single Family Contamination Rate
Southern Maryland	Calvert	N/A
	Charles	N/A
	St. Mary's	N/A
Upper Eastern Shore	Cecil	16%-20%
	Caroline	N/A
	Kent	N/A
	Queen Anne's	N/A
	Talbot	N/A
Lower Eastern Shore	Dorchester	N/A
	Somerset	N/A
	Wicomico	N/A
	Worcester	Greater than 30%

Garrett County, Howard County, Anne Arundel County, Frederick County and Montgomery County reported the lowest single family contamination rates in their region of Maryland, with rates ranging between 0% to 10%. In contrast, Washington County, Worchester County and Prince George's County reported the highest contamination rates among respondents, with rates between 21% to 25% and greater than 30%. This may be a result of the type of collection (e.g., dual stream in Montgomery County compared to single stream in other areas) and the level of education, outreach, and compliance efforts. Several MRFs indicated their current contamination rate of incoming single stream material ranges from 20% to 30%. Some MRFs have a lower contamination rate in the 5% to 10% contamination range based on the customers and collection programs in place. MRF respondents reported their total tonnage of residue disposed annually ranges between about 3,000 and 50,000 tons, depending on the processing equipment and quality of inbound recyclables.

County survey respondents reported the following problem materials in their single family recycling stream: film plastic (e.g. grocery bags and garbage bags), tanglers, food waste, batteries, sharps, non-recyclable plastics (e.g., Styrofoam, thermoforms, etc.), and explosives (e.g. gas canisters). This is not a comprehensive list of contaminants at MRFs in the State but is consistent with material types indicated through surveys and interviews with MRF operators.

When the recycling stream is contaminated, it impacts the operations and finances due to facility downtime, lower value commodities, increased residue costs, and increased workplace injuries. Materials like plastic bags and tanglers get caught in equipment screens and rotors, glass is abrasive and reduces the useful life of the equipment,

batteries cause fires during handling and processing, and contamination can be unsafe for employees to handle causing puncture wounds or other injury. When commodities are contaminated, the facility ultimately pays for the cost of managing and disposing those materials.

When a MRF rejects a load, material is held apart from other recyclable materials and transferred for disposal. Depending on the customer and specific contractual provisions, MRFs may charge a fee for contaminated loads. In some cases, MRFs track rejected loads that arrive frequently from specific routes or municipalities.

Based on the MRF survey and interviews, costs to manage contamination can range from $1,000 to $50,000 per month depending on the type of program, facility configuration, and available disposal sites. Smaller or dual stream facilities indicated they were on the lower end of this range, in the $1,000 to $5,000 per month range compared to larger and/or single stream facilities in the $10,000 to $50,000 range per year.

Further information about the impact of education, outreach, and compliance, contamination rates, and materials contributing to contamination in recycling programs is presented in **Appendix C: Infrastructure and Capacity Technical Memorandum.**

4.3.2 Composting

The composting survey requested information related to the estimate range of contamination and impacts due to contamination. The ranges presented are meant to provide a planning level estimate of program performance on a regional basis, and do not reflect specific audit studies. Respondents indicated that food and yard waste collected has lower contamination rates (in the 5% to 10% range) compared to recycling delivered to MRFs, but that compostable packaging presents a challenge to process at facilities in the State.

Residue rates at composting facilities can range from as little as five (5) tons per year to as much as 5,000 tons per year depending on the size and feedstock. Residue materials identified by composting facilities included dirty or wet paper towels, non-compostable plastics, compostable plastics, metal, and glass.

Similarly to MRFs, impacts of composting include downtime, contaminated commodities, increased processing costs, and increased residue disposal costs. Increasing the volume of compostable packaging delivered to composting facilities in the State may introduce contaminants and/or degrade the quality of marketable product if facilities are not equipped with the processing technology or staff to manage compostable packaging as part of the existing operations.

5 Key Findings

The following presents the key findings from the information presented above:

- **The recycling potential for glass hinges on processing quality and end-market accessibility.** Glass recycling in Maryland and nearby regions benefits from access to several facilities, including beneficiation plants, bottle

manufacturers, and fiberglass facilities. These facilities collectively handle up to 120,000 tons of glass annually. However, challenges such as contamination, size inconsistencies, and the compaction of glass in curbside collection systems limit its suitability for high-value end markets. While some MRFs in Maryland can deliver cleaned glass to beneficiation facilities, many send unprocessed glass to landfills for alternative uses. Increasing investment in secondary glass processing equipment, such as vacuum systems and trommel screens, could enhance the ability of MRFs to meet the quality standards of high-value end markets.

- **Paper is a significant component of the recycling system, driven by high recycling rates and substantial industry infrastructure.** Paper (including OCC) accounts for one of the highest recycling rates in the U.S., reaching up to 68% nationally, and represents the largest volume of recycled material. Maryland supports a robust paper and packaging industry, with 25 mills and four (4) wood product processing facilities employing 5,500 individuals and generating $395 million in annual compensation. The strong existing infrastructure underscores paper's central role in recycling programs. However, continued efforts to reduce contamination and optimize collection systems will be vital to maintaining this high recycling rate and ensuring the financial and environmental sustainability of the sector.
- **Plastics and metals face distinct challenges and opportunities based on material composition and market infrastructure.** Plastic recycling in Maryland is constrained by diverse polymer types, contamination, and limited in-state processing facilities. Although there are established markets for common plastics like PET and HDPE, less conventional polymers struggle due to a lack of end markets. EPR policies could stabilize supply, ensuring long-term viability for expanded operations. Meanwhile, metal recycling is highly efficient, with ferrous and non-ferrous metals widely recycled due to their inherent value and ability to retain quality through multiple cycles. However, complexities arise when metals are embedded in multi-material products like electronics, necessitating advanced recovery technologies to maximize recycling potential.
- **End markets play a dual role as both barriers and drivers of sustainable recycling programs.** In areas where end markets are a significant distance from recycling facilities, high transportation costs can outweigh the material value, creating financial hurdles for recycling operations. Despite these challenges, there is significant focus within the manufacturing industry on incorporating recycled materials, with many brands operating their own manufacturing arms or partnering with contract manufacturers. Expanding and stabilizing end markets, especially for underutilized materials such as flexible packaging, can support the viability of long-term recycling programs in the State.
- **Economies of scale and contamination rates are critical factors influencing recycling program success.** Counties in Maryland show varying contamination rates, with lower rates observed in areas with dual stream collection systems, such as Montgomery County, and higher rates in single stream systems like those in Washington and Worcester Counties. Contamination, which ranges from 5% to

30% in MRFs, increases processing costs, reduces the quality of recyclables, and leads to significant residue disposal, with annual tonnages ranging from 3,000 to 50,000 tons. Addressing contamination through education, outreach, and better sorting technologies is vital to improve recycling efficiency and reduce costs.

- **Strong demand for recycled content and innovation are key to overcoming economic and operational barriers in recycling.** By fostering recycled content markets, programs can mitigate the variability in material value and create a steady demand for recyclables. Encouraging innovation, such as remanufacturing processes that utilize flexible packaging, can transform materials previously excluded from recycling into valuable feedstock. This not only reduces waste but also drives economic growth by opening new opportunities for remanufacturing industries and strengthening Maryland's recycling infrastructure and economic development.