Recycling Steering Committee

Modernizing Oregon's recycling system with support from Oregon Consensus

Infrastructure Research Subcommittee Meeting

Thursday, September 26, 12:30-2:30 p.m.
700 NE Multnomah St, Portland, Room 610 — please sign in at reception on the sixth floor

To see presentations and meeting materials login to https://www.webmeeting.att.com
Use meeting number: 877-336-1828
Access code: 7760985
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Access code: 7760985

Agenda:

Time	Task	Objective
12:30-12:35 p.m.	Welcome and introductions. Review purpose of meeting and objectives — Robin Harkless, Oregon Consensus, facilitator	• Everyone is introduced, the agenda for the meeting is set and the purpose of the meeting is understood
12:35-12:40 p.m.	Grounding in 2050 Vision. Discuss purpose of group and why we are meeting: help guide infrastructure research. — David Allaway, DEQ	• Purpose of this subcommittee and research is confirmed
12:40-1 p.m.	Review results of materials research — Phase 1. Discuss materials list for infrastructure research ─ Brian Stafki, DEQ / Jessica Branom-Zwick, Cascadia Consulting Group / David, DEQ	• Questions from Phase 1 research are answered • The purpose of the materials is clarified — it is a list for research purposes only and a discussion of future program materials will happen later
1-1:30 p.m.	Brainstorm and discuss evaluation criteria for research project. What is important to you when considering different infrastructure options? — Brian, DEQ / Robin, OC	• Shared understanding of infrastructure research evaluation criteria (considerations) is confirmed

1:30-2 p.m.	Collection systems — residential single-family. Are these the right five options? Address drop-off options — Robin, OC / Jessica, Cascadia Consulting Group and subcommittee	• Residential single-family collection options for further evaluation — including question on staffed vs. unstaffed drop-offs — are confirmed
2-2:25 p.m.	Collection systems — commercial (and large multifamily): Commingled with glass on the side; Dry waste sorting; Dual stream; Discuss others. – Robin, OC	• Begins of an understanding is developed and commercial collection options for further evaluation is possibly confirmed.
2:25-2:30 p.m.	Summarize next steps — David, DEQ	• Shared understanding of next steps is confirmed.

Meeting Summary

Participating: David McCall — Tillamook County, Derek Ranta — Waste Connections, Bruce Walker — City of Portland, Bryce Jacobson — Metro, Dylan de Thomas — The Recycling Partnership, Jeff Murray — EFI Recycling, Kristin Leichner — Pride Disposal, Vinod Singh — Far West Recycling, Nicole Janssen — Association of Plastics Recyclers

Cascadia Consulting Team: Jessica Branom-Zwick, Chris Bell

DEQ staff: David Allaway, Justin Gast, Peter Spendelow, Brian Stafki, Sanne Stienstra

Oregon Consensus Facilitation: Robin Harkless

ACTION ITEMS

WHAT	WHO	By WHEN
Comments on Phase 1 report and input on collections options for study	Subcommittee to Brian Stafki	10/2/19
Consider adding polycoated paper and polystyrene to the materials for study in Phase 2	DEQ/Cascadia	Phase 2 research
Review and feedback on criteria for comparing infrastructure options	Subcommittee to Brian Stafki	10/4/19
Schedule upcoming	Brian Stafki	Two meetings by end of

subcommittee meetings		October/early November
Refine Phase 2	DEQ/Cascadia for review by Subcommittee	After next subcommittee meetings

SUMMARY

Welcome/Introductions/Frame for the Day: Robin Harkless, Oregon Consensus, led a round of introductions and reminded the group of the purpose and objectives for the day — to review the Phase 1 research results with members of the Cascadia Consulting team, and prepare for Phase 2 research by weighing in on potential evaluation criteria and examining the collections scenarios proposed for research.

David Allaway, DEQ, introduced himself as the project manager for this statewide process and reiterated much of what was shared at the 9/25 Steering Committee meeting about some staffing and resource shifts reflecting a renewed commitment from DEQ to lead this process toward successful outcomes for Oregon. He expressed appreciation for the subcommittee's work, touched on the overarching purpose of the process to modernize the recycling system to contribute to the 2050 vision, and the specific focus of the infrastructure research on material quality that may inform later discussions and recommendations around the acceptable materials list. He noted DEQ's role as convener and partner who will eventually weigh in on options — but assured the group that DEQ as of yet has no substantive outcome in mind.

Phase 1 Report: Jessica Branom-Zwick and Chris Bell from Cascadia shared high level of the methodology, data sets and results (all of which can be found in detail in the report) of their Phase 1 research with the subcommittee. The following questions and comments were offered:

- Concern with outdated composition studies.
    - Cascadia response: We worked with industry experts to offer additional professional judgment to help us make adjustments.
- Which industry experts did you work with? Did you work with Oregon or west coast-specific expertise, given that our materials look very different than those on the east coast?
    - The research question examined waste generation (what generators are discarding that may be recyclable), not just what we are seeing in the recycling streams.
- Comment: 2010-2017 period has been steady with constant growth; not accounting for the recession.

Materials for Phase 2 research/evaluation: David Allaway reiterated that the proposed list for study is just that — materials to be examined through various collections and processing scenarios and evaluated for environmental and other impacts. He suggested this list is not a proposed or considered acceptable materials list for Oregon — DEQ chose a 'middle of the road' approach and said the research could inform later considerations of an acceptable list that may be the same as, have fewer than, or have more than the items proposed here for research. Comments on the materials for study:

    - May not need to be as specific in the PP variations.

- Thermoforms may not be worth studying because of their composition which makes them extremely difficult if not impossible to run through a MRF (and creates contamination) — DEQ responded that they would like to look at a range of materials to determine just that, but would not preclude without the evaluation.
- Films have seen no success within MRFs given their contamination of other materials. DEQ — also looking at depot options as an alternative form of collection.
- Note: PET vs. PP — this conversation could be very useful for the frameworks discussion.
- Polycoated paper (freezer boxes) should be studied; note there are many variations.
- What about polystyrene? Cascadia — this was not proposed for study because the quantities are small and it is difficult to estimate for environmental benefit.
    - Subcommittee members urged the study of this given two local industries are currently processing styrene. It was suggested to study EPS and rigid; tonnages and volume; fire retardant and non- fire retardant forms.

Criteria for Evaluation: Brian Stafki shared an initial list of criteria which could be used to evaluate collections and processing systems for Oregon. Similar to the frameworks approach, the goal is to examine various systems and then 'build' scenarios that could be a good match for Oregon given the desired functions the SC approved for the future system. The initial criteria list borrowed from the Functions as well as language in the Cascadia research contract. Initial comments/discussion:

- Contamination concerns show up in criteria 5, 7 and 8 as 'clean materials', 'managed responsibly'.
- In the plastics recycling industry, one of our standards for 'recyclable' means proximity/access to recycling.
- #11 as an evaluation criteria will come later when the frameworks deliberations are integrated with infrastructure scenarios.
- Consider direct measures, e.g. capture rates.
- Who are you leaning on to understand some of these measures — equipment manufacturers or processors? You may get different results.

Brian asked for Subcommittee members to provide feedback on the draft list by October 4. David added that Subcommittee members could either comment on the proposed list, or generate their own list of criteria that they consider to be important.

Collections Options: The Subcommittee reviewed and provided initial feedback to DEQ and the consulting team on the collections options to review and evaluate. On depots, the group suggested looking at staffed versions and some options for unstaffed for smaller, more targeted collections. They suggested looking at unique versions including Lane County. There was questions around the different forms of multi-stream, multi-cart options and some weighing in as to 'feasible for Oregon', but ultimately no suggestions to take any options off the list for evaluation.

Next Steps: The subcommittee will continue to input on the criteria, send final comments on Phase 1 report, and look for the next round of meetings scheduled to proceed with Phase 2 of the research. DEQ will work with Cascadia to refine phase 2 approach based on the feedback today as well as upcoming discussions and DEQ's resource considerations, and will share this back with the subcommittee.

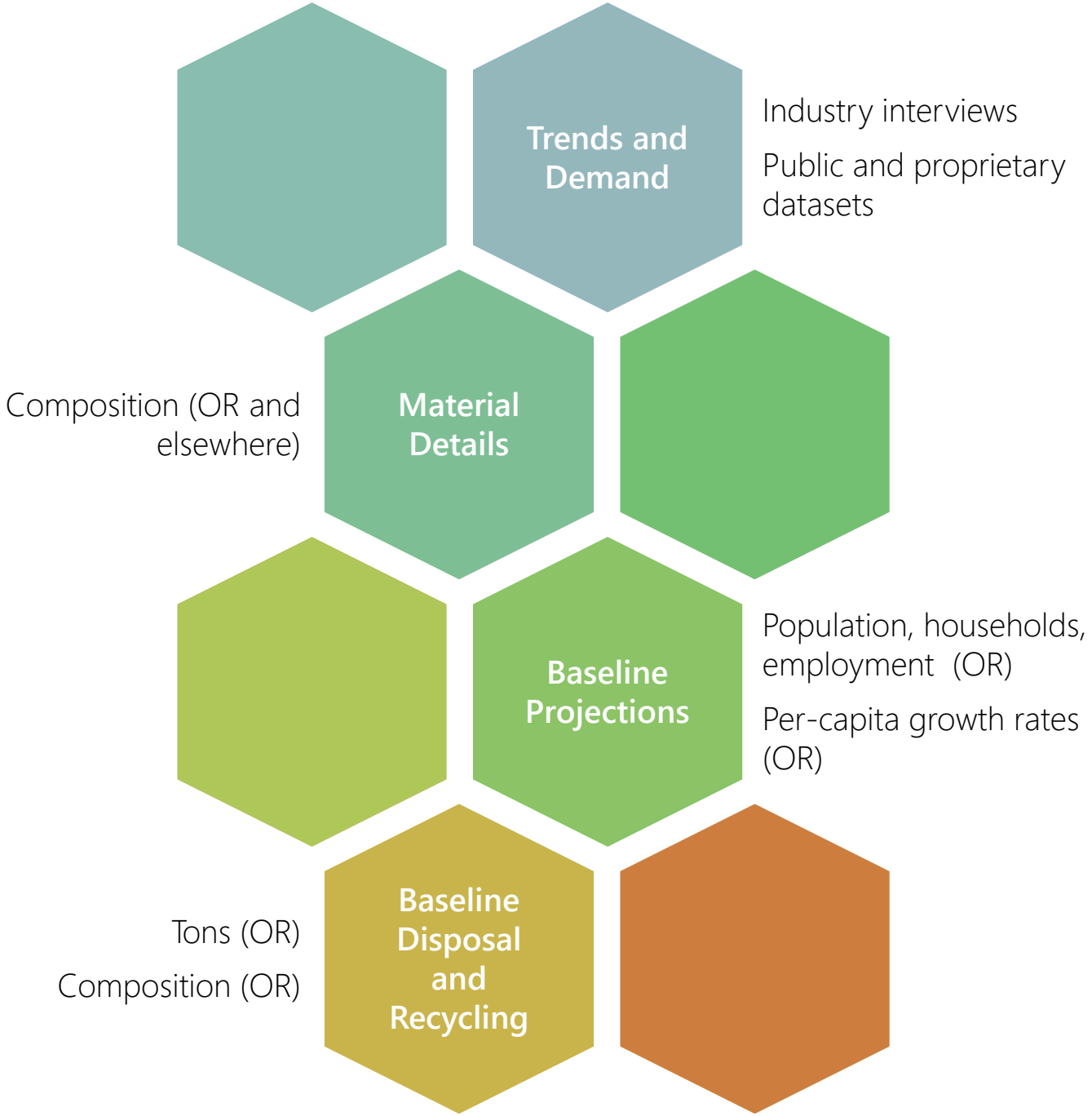
Improving Recycling Infrastructure in Oregon

Phase 1 Research

September 26, 2019

Methodology

Methodology Overview



- **Disposal**
  - OR 2017 tons from landfills in Oregon and exporters of Oregon wastes
  - OR 2016-2017 waste composition study
- **Recycling**
  - Oregon's 2017 material recovery survey
  - OR 2009 inbound recycling composition study
  - OR 2016-2017 MRF residual composition study

Baseline uses Oregon-specific data

- **Material streams**: Disposal & Recycling
- **Sectors**: Residential (SF, MF), Commercial, Self-Haul, Bottle Bill, and Other Recycling
- **Regions**: Metro, Marion, Lane, Rest of Oregon

Baseline builds from the ground up

- **Demographic projections** by households, multifamily units, employees, and population

- **Per-capita rates** that best fit each sector:
  - Dynamic: grown by annualized change for 2010-2017
  - Dynamic: grown using rolling average growth rate over past eight years (starting with 2010-2017)
  - Static: average per-capita rate for 2015-2017.

Baseline projections use best fit growth rates

- Estimates for detailed paper and plastic types modeled using:
  - 46 composition studies in Cascadia's library (published 2015 or later)
  - Oregon Plastics Recovery Assessment study (2015)
  - Residential recycling study in Metro OR (2019)
  - New York City residential disposal study (2013)

Detailed materials were modeled

Data sources:

- Interviews with industry and materials experts
- Public and proprietary datasets for historic and projected trends
- Adjustment of national data to OR demographics

- **Paper**
  Moore & Associates
- **Plastics**
  MORE Recycling
- **Cartons**
  Circular Matters

Experts provided input on trends and demand

	Est. Avoided GHGs (MTCO2E)	
Material	**Per ton**	**Material proxy**
Paper		
Corrugated Boxes	2.88	Corrugated Containers
Newsprint	3.52	Newspaper
Paperboard	3.40	Mixed Paper (general)
Printing-Writing Paper	2.53	Printing & Writing Paper
Gable-Tops & Aseptics	1.48	Aseptics
Plastics		
PET Bottles & Jars	1.13	PET
PET Tubs	1.13	PET
PET Thermoforms	1.13	PET
HDPE Bottles & Jars	0.83	HDPE
HDPE Tubs and Pails	0.83	HDPE
PP Bottles & Jars	1.01	Mixed Plastics
PP Tubs	1.01	Mixed Plastics
PP Rigid Packaging & Products	1.01	Mixed Plastics
All Polystyrene	NA	
PE Film	1.01	Mixed Plastics
Plastic Pouches	1.01	Mixed Plastics
Glass		
Glass Containers	0.26	Glass
Metal		
Aluminum	9.11	Aluminum Cans
Tinned Cans	1.81	Steel Cans
Accepted Other Steel	1.81	Steel Cans
Scrap metals	4.37	Mixed Metals

Environmental impacts based on EPA's WARM tool

Customized factors used for:

- Cartons
- Printing-Writing Paper

Results

All information presented represents estimates and approximations developed using available information within the available research budget. Information represents high-level estimates, and there is a high degree of uncertainty in all materials -- especially in plastics. Due to an extreme amount of uncertainty and lack of composition studies examining this material detail, we are not able to present estimates for polystyrene. Information is suitable for this project but should not be used for investment decisions. Tonnage estimates have been rounded to two significant digits (if less than 100,000 tons) or three significant digits (if 100,000 tons or more). Percentage increases and avoided GHG emissions were calculated BEFORE rounding.

CASCADIA CONSULTING GROUP

	Est. Tons Generated in 2025		Est. Avoided GHGs (MTCO2E)	
Material		**Total**	**Per ton**	**Total**
Paper		938,000	*per ton*	2,720,000
Corrugated Boxes		542,000	2.88	1,560,000
Newsprint		102,000	3.52	360,000
Paperboard		68,000	3.40	233,000
Printing-Writing Paper		221,000	2.53	559,000
Gable-Tops & Aseptics		4,000	1.48	5,900
Plastics		172,000	*per ton*	176,000
PET Bottles & Jars		41,000	1.13	46,000
PET Tubs		3,000	1.13	3,400
PET Thermoforms		6,800	1.13	7,600
HDPE Bottles & Jars		18,000	0.83	15,000
HDPE Tubs and Pails		2,300	0.83	1,900
PP Bottles & Jars		970	1.01	980
PP Tubs		8,400	1.01	8,500
PP Rigid Packaging & Products		4,500	1.01	4,500
All Polystyrene		NA	NA	NA
PE Film		85,000	1.01	86,000
Plastic Pouches		2,200	1.01	2,200
Glass		169,000	*per ton*	43,000
Glass Containers		169,000	0.26	43,000
Metal		600,000	*per ton*	2,660,000
Aluminum		36,000	9.11	330,000
Tinned Cans		26,000	1.81	48,000
Accepted Other Steel		27,000	1.81	49,000
Scrap metals		510,000	4.37	2,230,000

IMPACTS

Large tons and GHGs

- Paper: overall, OCC, paperboard, printing-writing
- Plastics: overall, PET bottles/jars, PE film
- Glass: bottles/jars
- Metals: overall, scrap

Large GHGs

- Metals: aluminum, tinned cans, other steel

1. BACKGROUND AND OBJECTIVES

Oregon Department of Environmental Quality (DEQ) and Partners commissioned the Cascadia Consulting Group (Cascadia) team to conduct research on materials, recycling collection, and sorting and processing infrastructure as part of a statewide process to reset Oregon's recycling systems. Partners include members of Oregon's Recycling Steering Committee and other industry and government recycling stakeholders. The Cascadia Consulting Group team includes industry experts from Circular Matters LLC, Bell and Associates, Drennen Consulting, Moore & Associates, and MORE Recycling.

Based on strategic guidance from DEQ and Partners, the Cascadia team analyzed current (2017) solid waste materials generation, including annual disposed and recovered quantities. Partners include members of Oregon's Recycling Steering Committee and other industry and government recycling stakeholders. The Cascadia team then determined which individual materials to recommend prioritizing in the following collection and processing research (Phase II), considering industry expert input for each material's relative contribution based on the following evaluation criteria:

- Estimated environmental impact (using E.P.A.'s Waste Reduction Model for avoided greenhouse gas [GHG] emissions).
- Projected future quantities and growth rates (i.e., annual tons generated in 2025 and compared to 2017).
- Anticipated strength of recycling end market demand.
- Contamination potential in a materials recovery facility accepting commingled materials.

DEQ supported this analysis by providing the most recently available Oregon materials disposal and recovery data. DEQ also provided baseline growth factors.

This document is the Phase I deliverable for the recycling infrastructure research study contracted by DEQ and supported with funding by Metro. It is organized into the following five sections:

1. **Background and Objectives** – provides context and understanding of project goals and background.
2. **Methodology** – summarizes process steps for Phase I data analysis and materials recommendations.
3. **Findings** – highlights key results of the data analysis, including relative GHG impact, relative tonnages, anticipated market demand, and MRF contamination potential for each material.
4. **Recommendations** – recommends which material to prioritize in Phase II research.
5. **Additional Detail:**
    - 5.1 Material Definitions
    - 5.2 Summary matrix provided to DEQ & Partners

2. METHODOLOGY

This section summarizes the process steps, data sources, and assumptions utilized in the Phase I data analysis and materials recommendations.

Baseline Quantity and Composition Estimates

Cascadia developed baseline material quantity and composition estimates used tonnage data provided by Oregon DEQ using Oregon's 2016-2017 waste composition study and Oregon's 2017 material recovery

survey, combined with disposal data from landfills in Oregon and exporters of Oregon wastes for 2017. Data included quantities by material stream, geographic location, and generator type.

To isolate the sources of recyclable materials, the boundary for materials tonnages used to define generation was limited as follows:

- Baseline disposal tons excludes tons originating from C&D loads (as defined by the survey data) and MRF residuals.
- Baseline recycling is reported as outbound and excludes MRF residuals. Recycling excludes HHW, recovered C&D materials, and special wastes.
- Organics includes food and yard waste but excludes wood waste.

Material composition for the baseline year is based on data sets provided by DEQ. No other datasets were included in the baseline model (which present data using DEQ's original material categories).

- Disposal composition was based on the 2016-2017 DEQ waste composition results. While Mixed Route Trucks include commercial waste, these compositions were used as the proxy for multifamily disposal. While the exact distribution is not known, Mixed Route Truck wastes is made up of more commercial than multifamily waste.
- The inbound recycling composition combined the following data sets: materials tons reported by region, the 2009 inbound recycling composition study results, and the 2016-2017 MRF residual composition.

Projections

Cascadia developed projections by multiplying sector-specific per-capita generation rates by relevant demographic projections provided by DEQ: single family households, multifamily units, employees, and population. Three methods were assessed for projecting per-capita rates:

1. Applying an annual growth rate based on the historic annual per-capita growth in waste generation from 2010 to 2017 for each of the streams.
2. A rolling average of the per-capita waste generation rate from the preceding eight years.
3. A static per-capita waste generation rate based on the aggregate average waste generation rates from 2015-2017.

Methods varied by sector and region and were selected based on the best match for trends observed in the historic data. Projected tons of generation were allocated by stream based on the average recovery rates from 2013-2017.

Oregon DEQ's existing data did not provide estimates for the detailed materials that DEQ and Partners selected as focus materials for projections. Cascadia modeled these detailed material splits using the following data methods and sources:

- **Detailed paper categories** were modeled using up to 46 studies published since 2015 (including generator-specific waste composition data) contained in Cascadia's in-house waste composition compiling model.
- **Detailed plastics categories** were modeled using three primary sources based on availability and prioritized in the order listed:
  - Oregon Plastics Recovery Assessment, published in 2015 for Oregon DEQ.

- Forty-six studies published since 2015 (including generator-specific waste composition data) contained in Cascadia's in-house waste composition compiling model.
- The 2013 New York City residential disposal composition study.
- A 2019 detailed study of residential recyclables conducted in Metro (Oregon)

Industry Trends and Market Demand

Based on research conducted in May-June 2019, Cascadia's industry expert team members (Moore & Associates, MORE Recycling, and Circular Matters) provided recommendations for adjusting projections of focus materials, including paper, cartons, and plastic materials based on their industry expertise and additional research into industry trends for those materials. Where available, they considered factors such as industry-specific consumption projections; consumption patterns in the Pacific Northwest compared to the United States; trends in consumer preferences and packaging types; Impending federal, state and local legislation; China's Blue Skies Policy; supply and demand for recycled content; costs of feedstock materials; and impacts of tariffs or other trade barriers. Research also addressed anticipated market demand.

Data sources and analysis from industry experts are described below. Cascadia integrated this industry expert feedback from team members to adjust projections for focus materials. Industry-trend adjustments were not made for glass or metals, based on direction from DEQ and Partners.

Industry and Market Trends for Paper

Moore & Associates' proprietary database was used as the basis for the forecast, covering all paper and board grades as defined by ISRI. The forecast was performed based on material volume in short tons for total U.S., with residential and commercial combined, consistent with other data sources in this sector. Volume data was then cross-checked with other relevant data sources and with accounts of paper and board usage in the media, in order to ensure accuracy.

Volumes in the national forecast were factored down to reflect that Oregon accounts for 1.27 percent of people and 1.31 percent of jobs in the U.S. The volume forecast was linked to expected population growth in Oregon which is almost double that of the U.S. through 2030. Total volume for Oregon was then divided between residential and commercial, based on sector rules of thumb (i.e., approximately 80 percent of corrugated is generated commercially; 20 percent by residential).

Data on age, income, race, housing, computer usage, education and the economy were examined to determine where Oregon is similar or different than the U.S. In summary:

- Oregon has a very similar economic base to that of the U.S. as a whole, so we assumed commercial consumption will approximately match that of the U.S.
- Oregon's population is slightly older with 1 percent fewer residents under 18 years of age and with 1 percent more seniors versus the U.S. as a whole. Education and computer usage are higher; percent with no health insurance is lower. Median income, retail spending per-capita, and home ownership are slightly lower than the U.S., while home prices are significantly higher. Given minimal differences when compared with the U.S., growth/decline rates derived from the national forecast were adjusted to accommodate Oregon for only two paper grades under residential (and for no grades under commercial). The decline in newspaper readership was moderated to reflect that older age groups are much more likely to read newspapers. The decline in coated mechanical paper was also moderated as

this category includes most magazines and magazine readership skews older, although not as heavily as newspaper readership.

Anticipated industry trends include the following:

- **Corrugated cardboard**: Increasing corrugated cardboard (and flexible packaging) generation due to substantial growth in e-commerce for next 10-15 years.
- **Newspaper**: declining, but the biggest drops have already occurred.
- **Printing-writing paper**:
  - Office/copy type paper: long slow decline as improved computers/processes result in less paper.
  - Other printing-writing paper: there has been a gradual decline for the last 15 years as more reading, marketing, and information goes online.
- **Paperboard**: modest growth as paper is desirable packaging.

Anticipated market trends (developed in June 2019):

- **OCC:** Short term market glut, significant US new recycled fiber-based containerboard capacity will move the market up. Next year: Very weak with strengthening. 1 - 3 Year: Strengthening. 3 - 5 Year: Strong
- **Mixed Paper:** Chronic over supply coupled with limited demand in the Western US make the market outlook not good**.** Next year: Very weak. 1 - 3 Year: Weak. 3 - 5 Year: Some strengthening.
- **Cleaner ONP Grades - #9 OI & #58 SCN:** Limited supply coupled with good demand make the outlook for these grade good. Next year: Flat, moderately strong. 1 - 3 Year: Strengthening. 3 - 5 Year: Stable to strong.
- **Curbside ONP - #56 SRPN:** Similar to Mixed Paper outlook. Next year: Very weak. 1 - 3 Year: Weak. 3 - 5 Year: Flat.
- **Sorted Office Paper:** Very limited western US and export demand make the outlook in the short run weak. But over time constrained supply will cause the market to strengthen. Next year: Very weak with strengthening. 1 - 3 Year: Some strengthening. 3 - 5 Year: Flat.
- **Other High Grades:** These grades move with pulp prices, currently declining. Next upward cycle is several years out. But supply of these grades is very limited, helping to keep the market in balance. Next year: Declining. 1 - 3 Year: Some strengthening. 3 - 5 Year: Additional strengthening.

Industry and Market Trends for Plastics

Industry Trends Data Sources and Research Methodology

MORE Recycling researched industry trends using the following methodology:

- Identified key data sets including the U.S. EPA's MSW Facts and Figures, Plastics Industry Producers Statistics, and other proprietary industry data that include historical waste generation and demand projections.
- From the key data sets, highlighted projected movement in various applicable plastic packaging categories that provide insight.
- Identified key industry segments (e.g., converters, resin producers, industry experts) and companies to interview for insights.

- Contacted and conducted interviews with identified contacts regarding plastic use trends (particularly for plastic packaging) for the next five years. Interviews covered converters in top five largest producers for most categories with a focus on non-bottle rigid plastics and flexibles.
- Documented interview responses including general industry knowledge and reactions to the projected growth or decline in various plastic packaging categories.
- Aligned projected percentage from data segments input from the interviews.

Plastics industry interviews suggested the following insights:

- An increase in consumer pressure to address plastic waste juxtaposed with brand goals to reduce their carbon footprint brings great uncertainty in the packaging space. The result is increased research and development (R&D) into materials that have a simpler composition, are more recyclable, and contain recycled content.
- Despite current recycling and plastic pollution challenges, over the next five years the use of plastic packaging in many categories and formats will continue due to consumer demand, preferences, and cost.
- A continued focus on light-weight materials is leading to growth in plastic use for most categories (PET and olefins).
- Growth continues in the switch from rigid plastics to flexible plastics.
- Most of the converters interviewed said their focus is on plastic innovations but that one of their large customers could swing the trend to more wood fiber-based packaging. Almost all converters mentioned R&D in fiber packaging innovation.
- Companies are exploring the use of paper and other compostable materials because biodegradable and/or compostable materials, as well as renewable materials, continue to rank high for consumers.

Material-specific anticipated industry trends include the following:

- **Polyethylene terephthalate (PET) bottles and jars**: Some projected data suggests an increase in PET food bottles, which includes jars.
- **High-density polyethylene (HDPE) bottles**: Overall HDPE bottle generation has been flat or had slight growth in recent years. Some data suggests an increase, but there is no industry feedback that this will be the case.
- **Polypropylene (PP) tubs:** Significant uncertainty remains in this category. PP cups and containers data shows growth since 2015, but that fell off in 2018. Industry contacts mentioned it would likely hold steady without shift to other resin or packaging formats, but some products have shifted out of tubs to pouches in recent years. Some data suggests growth over next 10 years, but there is a potential shift to pouches.
- **Polyethylene terephthalate (PET) thermoforms**: Continued growth is expected in PET thermoforms and less and less in PVC and PS.
- **Polystyrene (PS)**: Due to substantial uncertainty and limited data, the Cascadia team is not able to provide numerical estimates for the quantity of polystyrene generated; however, the quantity is assumed to be relatively small.
    - **Foam**: PS foam transport packaging shows a significant growth trend whereas Data and industry feedback suggests a decline for foodservice PS foam (replaced by PET or PP). Foodservice foam makes up a larger portion of generation. Decline estimates are conservative; bans and further deselection for foodservice use could enhance the decline.

  - **Solid**: Data and industry feedback suggests a decline in solid polystyrene. Decline estimates are conservative decline estimate; bans and further deselection could increase this decline.
- **Polyethylene (PE) film** (food and non-food packaging and shopping bags): PE film food and non-food packaging segments are showing growth with retail bags declining. Growth comes from increased emphasis on lighting-weighting of heavier materials (e.g., rigid packaging and fiber) and extending shelf life. There is significant uncertainty in this space: while R&D is focused on single-resin flexibles, there is some pressure by major customers for fiber innovation, which may influence industry to remain more heavily in fiber. There is downward pressure on retail bags due to bans and deselection. In commercial generation, historical and projected data as well as industry contacts suggest growth in this category.
- **Plastic pouches**: No specific data were readily available, but all interviewees confirm continued growth in pouches overall for food and non-food products, replacing rigid plastic and bag-in box-packaging.

Anticipated market trends (developed in June 2019):

- **Overall Plastics**: Overall demand for recycled plastic is low due to low virgin pricing, dependence on price makes the future very uncertain. High quality, appropriately segregated material will be easier to move than mixed materials. More demand is needed in all plastic commodities if we are to increase recycling.
- **PET Bottles & Jars**: Likely continued demand for PET Bottle commodity
- **PET Tubs**: Uncertain, depends on virgin pricing, markets may or may not emerge
- **PET Thermoforms**: Uncertain, depends on virgin pricing, markets may or may not emerge
- **HDPE Bottles & Jars**: Likely continued demand for HDPE bottle commodities
- **HDPE Tubs and Pails:** Uncertain
- **PP Bottles, Jars, & Tubs**: Likely continued demand for a combined PP small rigid commodity
- **PP Rigid Packaging & Products**: Smaller rigid can go with PP small rigid PP bulky would go to a mixed bulky rigid, which is dependent on virgin pricing
- **Polystyrene**: Uncertain, depends on virgin pricing, markets may or may not emerge for PS curbside stream, stable for commercial collected material
- **PE Film**: Uncertain due to virgin pricing, even for clean commercial film, but particularly for retail collected film and curbside MRF film
- **Plastic Pouches**: Very uncertain

Industry and Market Trends for Cartons and Metals

Circular Matters interviewed producers of carton board stock and packaging machinery. Circular Matters cross-referenced data against national cartons trends (sales growth over time and per-capita quantities) from the U.S. EPA, the Carton Council, and CalRecycle. Circular Matters also developed market trends for metals.

Anticipated industry trends for cartons include the following:

- **Gable-top cartons and aseptics**: Increases are due to a shift in plant-based beverages, dry food, soups and broths, prepared foods/sauces, and e-commerce. They are also anticipated to increase due to anti-plastics backlash a shift to renewable packages.

Anticipated market trends for cartons and metals are:

- **Gable-top cartons and aseptics:** There is moderately growing market demand for this combined grade although no current West Coast markets. There is strong stable export demand from Korea (tissue), growing demand for building materials in the Western USA, or tissue markets in the Eastern USA.
- **Deposit aluminum cans:** There is increasing demand due to high quality. One can-to-can market is in Colorado; all other markets are in the Eastern USA.
- **Non-deposit aluminum cans**: There is limited demand.
- **Other aluminum**: There is weak demand for food cans and foil products at much lower prices than beverage cans.
- **Steel cans, accepted other steel, and scrap metals:** Demand and pricing fluctuate based on the strength of the economy as recycled steel goes into discretionary purchases including construction and automotive.

Environmental Benefits

The greenhouse gas (GHG) impact of recycling the projected focus materials was estimated using emissions factors from the E.P.A.'s Waste Reduction Model (WARM). National averages and default values were used for all assumptions related to waste transportation, virgin material percentages, and landfill characteristics. Electricity estimates were based on Oregon-specific grid attributes (Table 1).

Table 1. Assumptions Used in WARM Emissions Factors Calculations

WARM assumption category	Assumption used in analysis
Locations (for electricity)	Oregon
Waste Transport Characteristics	Default Distance (20 miles)
Source Reduction	Current Mix
Landfill Type	National Average
Landfill Gas Recovery	Typical Operation (default)
Moisture Conditions and Decay Rates	National Average
Anaerobic Digestion Type	Wet Digestion
Digestate Curing	Cured (default)

Oregon DEQ's material descriptions were compared to WARM material descriptions to determine the most appropriate emissions factors to use for each DEQ material examined (see Table 2). Where DEQ materials differed substantially from available WARM materials (e.g., aseptic packaging, gable-top cartons, and printing-writing paper), custom emissions factors were calculated based on the component parts of the DEQ materials.

Table 2. DEQ Materials with WARM Proxy Material Choices

DEQ Material	WARM Material Proxy
Corrugated Boxes	Corrugated Containers
Newsprint	Newspaper
Paperboard	Mixed Paper (general)
Printing-Writing Paper	5% Corrugated Containers, 46% Magazines/Third-Class Mail, 49% Office Paper
Gable-Top Cartons & Aseptic Packaging	74% Office Paper, 4% Aluminum Ingot, 22% LDPE
PET Bottles & Jars	PET
PET Tubs	PET
PET Thermoforms	PET
HDPE Bottles & Jars	HDPE
HDPE Tubs and Pails	HDPE
PP Bottles & Jars	HDPE
PP Tubs	HDPE
PP Rigid Packaging & Products	HDPE
All Polystyrene	Mixed Plastics
PE Film	HDPE
Plastic Pouches	Mixed Plastics
Glass containers	Glass
Aluminum	Aluminum Cans
Tinned cans	Steel Cans
Accepted other steel	Steel Cans
Scrap metals	Mixed Metals

The GHG emissions per ton of material landfilled were added to the GHG emissions reductions per ton of material recycled to determine the quantity of GHG emissions that are avoided by recycling a ton of material rather than landfilling it. The avoided GHG emissions values were then multiplied by the 2025 material generation projections to arrive at the total avoided emissions that could be expected from recycling Oregon DEQ's focus materials in the future (assuming a 100% capture rate).

3. FINDINGS AND RECOMMENDATIONS

Notes: All information presented represents estimates and approximations developed using available information within the available research budget. Information represents high-level estimates, and there is a high degree of uncertainty in all materials – especially in plastics. Due to an extreme amount of uncertainty and lack of composition studies examining this material detail, we are not able to present estimates for polystyrene. Information is suitable for this project but should not be used for investment decisions.

Table 3 below summarizes findings for individual materials, whether Cascadia recommends them as target materials in Phase II research, and their relative performance against each of the evaluation criteria.

- **Total Avoided GHG Emissions** represents the GHG benefits of recycling instead of landfilling all projected tons generated in 2025, using US EPA's Waste Reduction Model (WARM). As a comparison, 1 metric ton of carbon dioxide equivalent emissions is equivalent to driving 2,445 miles with an average passenger vehicle or providing energy for an average home for 1 month and 13 days.[1]
- **Total Tons** represent the projected tons of the material generated in 2025.

[1] U.S. EPA, "Greenhouse Gas Equivalencies Calculator," December 2018 (https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator)

Table 3. Preliminary Assessment and Prioritization of Targeted Materials

Material	Recommendation	Avoided GHG Emissions if 100% Recycled	Total Generated Tons in 2025	Anticipated Future Market Demand
Paper		**2,720,000**	938,000	
Corrugated Boxes	Yes	1,560,000	542,000	Good long-term demand, so there would be markets if Oregon focused on increasing collection for these grades.
Newsprint	Yes	360,000	102,000	If clean: good demand, so there would be markets if Oregon focused on increasing collection for these grades as separate ONP. Curbside ONP/Mixed Paper has weak short-term demand, so there would not be good markets if Oregon focused on increasing collection quantities for them in the near term.
Paperboard	Yes	233,000	68,000	Weak demand, so there would not be good markets if Oregon focused on increasing collection quantities for them.
Printing-Writing Paper	Yes	559,000	221,000	Demand for or high-quality printing/writing paper is reasonable. With declining volume of these grades increasing collection quantities should be encouraged.
Gable-Top Cartons & Aseptic Packaging	Maybe, but GHG impact is small and no current West Coast markets	5,900	4,000	Aseptic and Gable-Top are combined in the same grade. Moderately growing market demand although no current West Coast markets. Strong stable export demand from Korea (tissue), growing demand for building materials in the Western USA, or tissue markets in the Eastern USA.

Material	Recommendation	Avoided GHG Emissions if 100% Recycled	Total Generated Tons in 2025	Anticipated Future Market Demand
Plastics		176,000	172,000	Overall demand for recycled plastic is low due to low virgin pricing, and dependence on price makes the future very uncertain. High-quality, appropriately segregated material will be easier to move than mixed materials.
PET Bottles & Jars	Yes	46,000	41,000	Likely continued demand for PET Bottle commodity.
PET Tubs	Maybe, if targeting all plastics	3,400	3,000	Uncertain, depends on virgin pricing, markets may or may not emerge.
PET Thermoforms	Maybe, if targeting all plastics	7,600	6,800	Uncertain, depends on virgin pricing, markets may or may not emerge.
HDPE Bottles & Jars	Yes	15,000	18,000	Likely continued demand for HDPE bottle commodities.
HDPE Tubs and Pails	Maybe, if targeting all plastics	1,900	2,300	Uncertain.
PP Bottles & Jars	Maybe, but requires additional sorting	980	970	Likely continued demand for a combined PP small rigid commodity.
PP Tubs	Maybe, but requires additional sorting	8,500	8,400	Likely continued demand for a combined PP small rigid commodity.
PP Rigid Packaging & Products	Maybe, but requires additional sorting and market considerations	4,500	4,500	Smaller rigid can go with PP small rigid PP. Bulky PP would go to a mixed bulky rigid, which is dependent on virgin pricing.
All Polystyrene	No, due to small quantities and uncertain markets for curbside material	Unable to present figures due to extreme uncertainty		Uncertain, depends on virgin pricing, markets may or may not emerge for PS curbside stream, stable for commercial collected material.
PE Film	Maybe, primarily source-separated or as contaminant concern	86,000	85,000	Uncertain due to virgin pricing, even for clean commercial film, but particularly for retail collected film and curbside MRF film.
Plastic Pouches	No, except as contaminant -- but quantities are small	2,200	2,200	Very uncertain.

Material	Recommendation	Avoided GHG Emissions if 100% Recycled	Total Generated Tons in 2025	Anticipated Future Market Demand
Glass		43,000	169,000	
Glass Containers	Maybe, but curbside collection poses either labor/cost or sortation challenges	43,000	169,000	Stable when collected through bottle bill or on the side; market challenges if collected commingled.
Metal		2,660,000	600,000	
Aluminum	Yes	330,000	36,000	Increasing for aluminum cans demand due to high quality. One can-to-can market in Colorado, all other markets are in the Eastern USA. Weak demand for food cans and foil products at much lower prices than beverage cans.
Tinned Cans	Yes	48,000	26,000	Demand and pricing fluctuate based on the strength of the economy as recycled steel goes into discretionary purchases including construction and automotive.
Accepted other steel	Yes	49,000	27,000	Demand and pricing fluctuate based on the strength of the economy as recycled steel goes into discretionary purchases including construction and automotive.
Scrap metals	Maybe, but most tons collected outside residential/ commercial system	2,230,000	510,000	Demand and pricing fluctuate based on the strength of the economy as recycled steel goes into discretionary purchases including construction and automotive.

4. RECOMMENDATIONS

Based on how materials performed against the evaluation criteria, the following materials are recommended for priority inclusion in Phase II of this project:

- **Paper**
  - Corrugated Boxes
  - Newsprint
  - Paperboard
  - Printing-Writing Paper
- **Plastics**
  - PET Bottles and Jars
  - HDPE Bottles & Jars
- **Glass**
  - Glass Containers (large tonnage but small GHG impact; glass-only curbside collection is more costly than commingled collection while commingled collection poses sortation challenges)
- **Metals**
  - Aluminum (particularly cans)
  - Tinned Cans
  - Accepted Other Steel

Other materials that Cascadia recommends considering for inclusion in Phase II are:

- **Paper**
  - Gable-Top Cartons and Aseptic Containers (total tons and GHG impacts are small, but there is stable or growing market demand.
- **Plastics**
  - PP Bottles and Jars (requires additional sorting but has continued demand)
  - PP Tubs (requires additional sorting but has continued demand)
  - PP Rigid Packaging & Products (requires additional sorting; continued demand for small PP; virgin-dependent demand for bulky PP)
  - PE Film (large tonnage but there are contamination concerns and virgin-dependent pricing even for clean commercial film)
  - PET Tubs (if targeting all plastics, but market is uncertain)
  - PET Thermoforms (if targeting all plastics, but market is uncertain)
  - HDPE Tubs and Pails (if targeting all plastics, but market is uncertain)
- **Metals**
  - Scrap metals (large GHG impact and tonnage, but most tons are collected outside the residential/commercial route-based system.

While data were not sufficient to develop tonnage estimates for polystyrene, total quantities are anticipated to be small. As a result, polystyrene is not recommended as a focus material for Phase II research. Plastic pouches are also not recommended as a focus material due to small impact, small quantities, and uncertain markets.

However, the consultant team also understands that DEQ and its Partners desire that Phase II research considers the resiliency of the system against product and market risks to some extent by highlighting options that would keep the system flexible to accommodate new accepted materials or types of contaminants.

5. ADDITIONAL DETAIL

5.1 Material Definitions

The following DEQ-approved material definitions were used to guide the Phase I research.

Paper

Corrugated Boxes means boxes made of three or more layers (unwaxed) of unbleached Kraft paper.

Newsprint means a lightweight paper, made mainly from mechanical wood pulp, engineered to be bright and opaque for the good print contrast needed by newspapers. Newsprint also contains special tensile strength for repeated folding. It does not include printing papers of types generally used for purposes other than newspapers such as mechanical printing papers for catalogs, directories, etc.

Paperboard means paper products that are heavier in basis weight, thicker, and more rigid than paper.

Printing and Writing Paper means any paper suitable for printing, such as book paper, writing paper, envelopes, etc.

- Uncoated freesheet paper —papers in a process that removes lignin, commonly used for office reprographics (copy paper), books, paper and business form paper.
- Coated freesheet papers — paper made in a process that removes lignins that is a high gloss, high quality papers often used for high-end brochures, some magazines, and similar uses
- Coated mechanical papers — mechanical paper and coated with a material to have smooth surface and used for some magazines, catalogs and coupons.
- Uncoated mechanical papers — paper from groundwood often used for newspaper and flyer inserts, financial publications, directories, and paperback books

Cartons

Aseptic Packaging means shelf-stable packaging made up of five layers of separable material: Outer Polyethylene coating (liquid barrier), paperboard (for stability), middle Polyethylene coating, aluminum (for light, odor and oxygen protection) and inner Polyethylene coating (liquid barrier). Roughly 74% paper, 22% Polyethylene and 4% aluminum, aseptic packaging is typically used with juice, milks, soups and broths and wine.

Gable-Top Carton means a refrigerated carton product made of three separable layers: An inner and outer layer of Polyethylene with a layer of paperboard sandwiched in between. Roughly 80% paper and 20% Polyethylene, gable-top cartons are typically used with milks, juices, creams and egg substitute products.

Plastics

High-density Polyethylene (HDPE) Bottles and Jars includes:

- **HDPE Natural Bottle:** any blow-molded, high-density polyethylene bottle containing the ASTM D7611 "#2, HDPE" resin identification code that is unpigmented and has a neck or mouth that is smaller than the base.

- **HDPE Colored Bottle and Jars**: any whole, blow-molded, high-density polyethylene bottle or jar containing the ASTM D7611 "#2, HDPE" resin identification code that is pigmented and opaque.

HDPE Tubs means a whole container, with a #2 HDPE, resin code that has a neck or mouth similar in size to its base.

Polyethylene (PE) Film means polyethylene plastic bags and wrap, and other thin film plastic commonly marked HDPE #2 or LDPE #4. Examples include carry out bags, bread bags, tissue overwrap, air pillows, plastic only shipping envelops, and pallet wrap.

Polyethylene Terephthalate (PET) Bottles and Jars means any PET blow-molded bottle or jar with a screw-neck top that contains the ASTM D7611 "#1, PET or PETE" resin identification code.

Polyethylene Terephthalate (PET) Thermoforms means any PET package labeled with the ASTM D7611 "#1, PET or PETE" resin identification code, not including bottles and jars, but including and not limited to: egg cartons, baskets, clamshell containers, cups, lids, cake domes, covers, blister pack without paperboard backing, tubs, deli containers, trays, folded PET sheet containers.

Polypropylene (PP) Rigid Plastics includes:

- **PP Bottles**: a bottle with a #5 PP resin code has a neck or mouth that is smaller than the base.
- **PP Tubs:** a container, with a #5 PP resin code, that has a neck or mouth similar in size to its base such as ice cream tubs, margarine tubs, tofu tubs, yogurt cups.
- **PP Rigid Plastics**: container or product, with a #5 PP resin code, such as cold drink cups, dishwasher-safe storage containers, flip-type lids, prescription bottles, microwavable trays, and screw-type caps.

Plastic Pouches means flexible containers, many of which are stand up pouches, for food and non-food products. Focus is on those replacing other packaging types, such as rigid plastic packaging. Layers may be multi-resin and multi-material. The material is highly varied with polyethylene, EVOH, PP, PET, nylon, and metals.

Polystyrene (PS) includes:

- **Polystyrene Foam**: a polystyrene container or product injected with gas. Examples may include foam protective packaging, foam deli and takeout containers and clamshells, and foam drink cups and other food service items.
- **Solid Polystyrene** means any non-foam container or product, that may have a #6 PS resin code. Examples include yogurt cups and tubs, red party cups, CD "jewel" cases, disposable coffee lids, and clamshell containers.

Glass

Glass Containers means any color glass bottle or jar used to package food, beverages and other consumable liquids. Includes deposit bottles and containers not subject to Oregon's bottle bill.

Metals

Aluminum means aluminum beverage cans and food containers, aerosol and other non-food cans, aluminum foil, pans and trays, and scrap aluminum such as lawn furniture and screen doors.

Tinned Cans means steel food and beverage cans with a tin coating and may include other coatings.

Metal Containers means tin, steel and aluminum cans or containers used to contain products such as beverages, food or aerosolized products.

Other accepted steel cans and other accepted steel including tin and steel cans or containers used to contain products such as beverages, food or aerosolized products.

Scrap Metal is the combination of ferrous and non-ferrous waste metal, metallic material and any product that contains metal that is capable of being recycled from previous consumption or product manufacturing. For curbside collection programs, scrap metal typically cannot be longer than 30 inches and must weigh less than 30 pounds.

5.2 Matrix Provided to DEQ & Partners

The tables on the following pages present an additional level of detail regarding:

- Baseline quantities of material generated, disposed, and recycled in Oregon in 2017.
  - Materials are presented in categories used by Oregon DEQ.
- Quantity projections for 2025 and evaluation against criteria for selected focus materials, including:
  - Recommendations for whether to target the material in Phase II
  - Estimated tons generated in 2017 and 2025; estimated percentage change between the periods.
  - Notes on anticipated market demand.
  - Estimated avoided GHG impacts (comparing recycling to landfilling) using EPA warm, per ton and cumulatively if all material were recycled.
  - Notes on whether the material typically creates a contamination problem when sorted in a MRF.

Sub class	Material	Disposal Est %	Disposal Est Tons	Recycling Est %	Recycling Est Tons	Recycling Capture Rate
Paper		12.8%	339,094	49.0%	670,237	77%
Corrugated Cardboard	Corrugated cardboard	2.9%	76,059	30.7%	420,667	85%
Recyclable Paper	Newspaper	0.5%	13,455	5.9%	80,091	86%
Recyclable Paper	Paper recyclable with newspaper	2.7%	72,196	9.5%	130,207	64%
Recyclable Paper	Paper not recyclable with newspaper	1.1%	28,429	2.8%	37,803	57%
Recyclable Paper	Gable tops & Aseptics	0.1%	2,226	0.1%	1,469	40%
Recyclable Paper	Polycoated containers & cups	0.9%	24,702	0.0%	-	-
Compostable paper	Compostable Paper	3.2%	85,130	0.0%	-	-
Non-recyclable paper	Non-recoverable paper	1.4%	36,896	0.0%	-	-
Plastic		10.2%	270,283	4.0%	54,552	76%
Recyclable Plastic	Deposit plastic bottles	0.2%	5,897	0.9%	12,080	67%
Recyclable Plastic	Other bottles	0.5%	13,913	1.7%	23,498	63%
Recyclable Plastic	Accepted tubs & pails	0.3%	8,288	0.3%	4,221	34%
Non-recoverable plastic	Other rigid plastic containers	0.6%	16,666	0.0%	-	-
Recyclable Plastic	Bulky rigids	1.7%	43,820	0.0%	-	0%
Non-recoverable plastic	Non-recoverable plastic	3.1%	81,318	0.0%	-	-
Film	Recoverable film	1.8%	46,719	1.1%	14,754	24%
Film	Other film	2.0%	53,662	0.0%	-	-
Glass		2.7%	72,296	8.7%	119,511	86%
Recyclable Glass	Deposit glass bottles	0.5%	13,392	5.4%	73,943	85%
Recyclable Glass	Container glass	0.8%	22,244	3.3%	45,568	67%
Non-recoverable glass	Non-recoverable glass	1.4%	36,660	0.0%	-	-
Metal		4.2%	111,144	35.0%	478,233	88%
Non-ferrous metal	Deposit aluminum cans	0.1%	3,579	1.6%	21,805	86%
Non-ferrous metal	Accepted aluminum cans	0.0%	38	0.0%	54	59%
Non-ferrous metal	Accepted other aluminum	0.2%	4,171	0.3%	3,557	46%
Ferrous Metal	Deposit steel cans	0.0%	75	0.0%	9	11%
Ferrous Metal	Accepted steel cans	0.6%	17,128	0.5%	6,960	29%
Ferrous Metal	Accepted other steel	0.8%	22,194	0.2%	2,640	11%
Scrap metal	Scrap metals	0.9%	24,111	32.4%	443,208	95%
Non-recoverable metal	Non-recoverable metal	1.5%	39,850	0.0%	-	-

Sub class	Material	Disposal Est %	Disposal Est Tons	Recycling Est %	Recycling Est Tons	Recycling Capture Rate
Other		70.1%	1,859,283	3.3%	45,787	99%
Mixed compostable	Food	19.2%	508,382	0.0%	-	-
Mixed compostable	Yard	2.8%	74,223	0.0%	-	-
Mixed compostable	Accepted Other Compostable	1.3%	33,794	0.0%	-	-
Mixed compostable	Clean Wood	6.3%	167,869	0.0%	-	-
Other Recoverable	Motor oil	0.0%	333	3.3%	45,787	99%
Other Materials	Recoverable C&D	11.3%	299,787	0.0%	-	-
Other Materials	Other non-recoverables	29.2%	774,895	0.0%	-	-
Corrugated Cardboard		2.9%	76,059	30.7%	420,667	85%
Recyclable Paper		5.3%	141,009	18.2%	249,570	68%
Compostable paper		3.2%	85,130	0.0%	-	-
Non-recyclable paper		1.4%	36,896	0.0%	-	-
Recyclable Plastic		2.7%	71,919	2.9%	39,798	36%
Non-recoverable plastic		3.7%	97,984	0.0%	-	-
Film		3.8%	100,381	1.1%	14,754	24%
Recyclable Glass		1.3%	35,637	8.7%	119,511	77%
Non-recoverable glass		1.4%	36,660	0.0%	-	-
Non-ferrous metal		0.3%	7,787	1.9%	25,416	77%
Ferrous Metal		1.5%	39,397	0.7%	9,610	20%
Scrap metal		0.9%	24,111	32.4%	443,208	95%
Non-recoverable metal		1.5%	39,850	0.0%	-	-
Mixed compostable		29.6%	784,268	0.0%	-	-
Other Recoverable		0.0%	333	3.3%	45,787	99%
Other Materials		40.5%	1,074,682	0.0%	-	-
	Commingled Recycling	10.1%	267,647	54.5%	745,061	74%
	Separated Recyclable	5.7%	150,619	45.5%	623,259	81%
	Compostable	32.8%	869,398	0.0%	-	-
	Non-recoverable	51.4%	1,364,436	0.0%	-	-
Total		100.0%	2,652,100	100.0%	1,368,320	77%

*Recycling capture rate: tons of recyclables in recycling divided by the sum of recyclables in recycling and disposal. In this table, it excludes compostables.

Sub class	Material	Single Family				
		Disposal		Recycling		Recycling
		Est %	Est Tons	Est %	Est Tons	Capture Rate
Paper		14.0%	107,315	74.3%	157,897	63%
Corrugated Cardboard	Corrugated cardboard	1.8%	13,801	25.6%	54,395	80%
Recyclable Paper	Newspaper	0.7%	5,671	18.8%	39,922	88%
Recyclable Paper	Paper recyclable with newspaper	3.2%	24,744	22.5%	47,737	66%
Recyclable Paper	Paper not recyclable with newspaper	1.4%	10,374	7.1%	14,993	59%
Recyclable Paper	Gable tops & Aseptics	0.1%	830	0.4%	850	51%
Recyclable Paper	Polycoated containers & cups	1.4%	10,787	0.0%	-	-
Compostable paper	Compostable Paper	4.3%	32,710	0.0%	-	-
Non-recyclable paper	Non-recoverable paper	1.1%	8,398	0.0%	-	-
Plastic		9.9%	76,153	5.3%	11,243	44%
Recyclable Plastic	Deposit plastic bottles	0.3%	2,252	0.5%	1,104	33%
Recyclable Plastic	Other bottles	0.8%	5,802	3.5%	7,438	56%
Recyclable Plastic	Accepted tubs & pails	0.2%	1,826	0.7%	1,552	46%
Non-recoverable plastic	Other rigid plastic containers	0.9%	7,066	0.0%	-	-
Recyclable Plastic	Bulky rigids	1.1%	8,433	0.0%	-	0%
Non-recoverable plastic	Non-recoverable plastic	2.6%	20,106	0.0%	-	-
Film	Recoverable film	1.5%	11,597	0.5%	1,148	9%
Film	Other film	2.5%	19,072	0.0%	-	-
Glass		2.9%	22,286	16.2%	34,408	52%
Recyclable Glass	Deposit glass bottles	0.9%	6,507	5.0%	10,710	62%
Recyclable Glass	Container glass	1.8%	13,471	11.2%	23,697	64%
Non-recoverable glass	Non-recoverable glass	0.3%	2,309	0.0%	-	-
Metal		3.3%	25,637	3.8%	8,114	31%
Non-ferrous metal	Deposit aluminum cans	0.2%	1,490	0.2%	336	18%
Non-ferrous metal	Accepted aluminum cans	0.0%	11	0.0%	4	28%
Non-ferrous metal	Accepted other aluminum	0.3%	2,079	0.1%	228	10%
Ferrous Metal	Deposit steel cans	0.0%	30	0.0%	5	15%
Ferrous Metal	Accepted steel cans	1.2%	8,941	1.2%	2,522	22%
Ferrous Metal	Accepted other steel	0.5%	4,147	0.8%	1,668	29%
Scrap metal	Scrap metals	0.4%	2,816	1.6%	3,351	54%
Non-recoverable metal	Non-recoverable metal	0.8%	6,122	0.0%	-	-

Sub class	Material	Single Family				
		Disposal		Recycling		Recycling
		Est %	Est Tons	Est %	Est Tons	Capture Rate
Other		69.8%	534,108	0.3%	739	94%
Mixed compostable	Food	27.1%	207,826	0.0%	-	-
Mixed compostable	Yard	4.4%	34,060	0.0%	-	-
Mixed compostable	Accepted Other Compostable	0.3%	1,925	0.0%	-	-
Mixed compostable	Clean Wood	1.3%	10,070	0.0%	-	-
Other Recoverable	Motor oil	0.0%	49	0.3%	739	94%
Other Materials	Recoverable C&D	3.4%	26,198	0.0%	-	-
Other Materials	Other non-recoverables	33.2%	253,981	0.0%	-	-
Corrugated Cardboard		1.8%	13,801	25.6%	54,395	80%
Recyclable Paper		6.8%	52,407	48.7%	103,502	71%
Compostable paper		4.3%	32,710	0.0%	-	-
Non-recyclable paper		1.1%	8,398	0.0%	-	-
Recyclable Plastic		2.4%	18,313	4.8%	10,095	36%
Non-recoverable plastic		3.5%	27,172	0.0%	-	-
Film		4.0%	30,668	0.5%	1,148	9%
Recyclable Glass		2.6%	19,978	16.2%	34,408	63%
Non-recoverable glass		0.3%	2,309	0.0%	-	-
Non-ferrous metal		0.5%	3,581	0.3%	567	14%
Ferrous Metal		1.7%	13,118	2.0%	4,195	24%
Scrap metal		0.4%	2,816	1.6%	3,351	54%
Non-recoverable metal		0.8%	6,122	0.0%	-	-
Mixed compostable		33.2%	253,880	0.0%	-	-
Other Recoverable		0.0%	49	0.3%	739	94%
Other Materials		36.6%	280,179	0.0%	-	-
	Commingled Recycling	10.7%	81,999	81.3%	172,754	68%
	Separated Recyclable	5.6%	42,873	18.7%	39,646	48%
	Compostable	37.4%	286,589	0.0%	-	-
	Non-recoverable	46.2%	354,039	0.0%	-	-
Total		100.0%	765,500	100.0%	212,400	63%

*Recycling capture rate: tons of recyclables in recycling divided by the sum of recyclables in recycling and disposal. In this table, it excludes compostables.

Sub class	Material	Multifamily Disposal Est %	Disposal Est Tons	Recycling Est %	Recycling Est Tons	Recycling Capture Rate
Paper		18.5%	50,801	78.2%	14,552	25%
Corrugated Cardboard	Corrugated cardboard	4.5%	12,269	34.1%	6,339	34%
Recyclable Paper	Newspaper	0.5%	1,435	17.0%	3,168	69%
Recyclable Paper	Paper recyclable with newspaper	4.7%	12,879	20.4%	3,788	23%
Recyclable Paper	Paper not recyclable with newspaper	1.3%	3,553	6.4%	1,190	25%
Recyclable Paper	Gable tops & Aseptics	0.1%	345	0.4%	67	16%
Recyclable Paper	Polycoated containers & cups	1.1%	3,109	0.0%	-	-
Compostable paper	Compostable Paper	4.3%	11,814	0.0%	-	-
Non-recyclable paper	Non-recoverable paper	2.0%	5,397	0.0%	-	-
Plastic		11.6%	31,846	4.9%	904	14%
Recyclable Plastic	Deposit plastic bottles	0.4%	982	0.4%	81	8%
Recyclable Plastic	Other bottles	0.8%	2,096	2.9%	547	21%
Recyclable Plastic	Accepted tubs & pails	0.3%	917	0.6%	114	11%
Non-recoverable plastic	Other rigid plastic containers	0.7%	2,053	0.0%	-	-
Recyclable Plastic	Bulky rigids	1.9%	5,211	0.0%	-	0%
Non-recoverable plastic	Non-recoverable plastic	3.2%	8,722	0.0%	-	-
Film	Recoverable film	1.6%	4,514	0.9%	162	3%
Film	Other film	2.7%	7,351	0.0%	-	-
Glass		2.9%	7,846	13.3%	2,466	23%
Recyclable Glass	Deposit glass bottles	0.4%	1,200	4.1%	768	39%
Recyclable Glass	Container glass	0.9%	2,336	9.1%	1,699	42%
Non-recoverable glass	Non-recoverable glass	1.6%	4,309	0.0%	-	-
Metal		4.1%	11,334	3.6%	672	9%
Non-ferrous metal	Deposit aluminum cans	0.2%	433	0.1%	20	4%
Non-ferrous metal	Accepted aluminum cans	0.0%	-	0.0%	0	100%
Non-ferrous metal	Accepted other aluminum	0.2%	484	0.1%	14	3%
Ferrous Metal	Deposit steel cans	0.0%	22	0.0%	0	2%
Ferrous Metal	Accepted steel cans	0.9%	2,563	1.0%	186	7%
Ferrous Metal	Accepted other steel	0.9%	2,407	0.7%	123	5%
Scrap metal	Scrap metals	0.5%	1,263	1.8%	328	21%
Non-recoverable metal	Non-recoverable metal	1.5%	4,162	0.0%	-	-

		Multifamily				
		Disposal		Recycling		Recycling
Sub class	Material	Est %	Est Tons	Est %	Est Tons	Capture Rate
Other		62.9%	172,363	0.0%	6	46%
Mixed compostable	Food	23.6%	64,724	0.0%	-	-
Mixed compostable	Yard	2.7%	7,485	0.0%	-	-
Mixed compostable	Accepted Other Compostable	0.3%	707	0.0%	-	-
Mixed compostable	Clean Wood	2.4%	6,496	0.0%	-	-
Other Recoverable	Motor oil	0.0%	7	0.0%	6	46%
Other Materials	Recoverable C&D	3.0%	8,285	0.0%	-	-
Other Materials	Other non-recoverables	30.9%	84,659	0.0%	-	-
Corrugated Cardboard		4.5%	12,269	34.1%	6,339	34%
Recyclable Paper		7.8%	21,321	44.2%	8,213	31%
Compostable paper		4.3%	11,814	0.0%	-	-
Non-recyclable paper		2.0%	5,397	0.0%	-	-
Recyclable Plastic		3.4%	9,206	4.0%	742	7%
Non-recoverable plastic		3.9%	10,775	0.0%	-	-
Film		4.3%	11,865	0.9%	162	3%
Recyclable Glass		1.3%	3,537	13.3%	2,466	41%
Non-recoverable glass		1.6%	4,309	0.0%	-	-
Non-ferrous metal		0.3%	918	0.2%	34	4%
Ferrous Metal		1.8%	4,992	1.7%	310	6%
Scrap metal		0.5%	1,263	1.8%	328	21%
Non-recoverable metal		1.5%	4,162	0.0%	-	-
Mixed compostable		29.0%	79,412	0.0%	-	-
Other Recoverable		0.0%	7	0.0%	6	46%
Other Materials		33.9%	92,944	0.0%	-	-
	Commingled Recycling	14.7%	40,385	84.1%	15,638	28%
	Separated Recyclable	5.3%	14,532	15.9%	2,962	17%
	Compostable	33.3%	91,226	0.0%	-	-
	Non-recoverable	46.7%	128,047	0.0%	-	-
Total		100.0%	274,190	100.0%	18,600	25%

*Recycling capture rate: tons of recyclables in recycling divided by the sum of recyclables in recycling and disposal. In this table, it excludes compostables.

		Commercial				
		Disposal		Recycling		Recycling
Sub class	Material	Est %	Est Tons	Est %	Est Tons	Capture Rate
Paper		14.0%	148,148	84.7%	153,399	51%
Corrugated Cardboard	Corrugated cardboard	3.5%	37,079	54.2%	98,137	73%
Recyclable Paper	Newspaper	0.5%	5,660	9.6%	17,479	76%
Recyclable Paper	Paper recyclable with newspaper	2.6%	27,296	16.0%	29,032	52%
Recyclable Paper	Paper not recyclable with newspaper	1.1%	11,404	4.8%	8,675	43%
Recyclable Paper	Gable tops & Aseptics	0.1%	972	0.0%	77	7%
Recyclable Paper	Polycoated containers & cups	0.9%	9,853	0.0%	-	-
Compostable paper	Compostable Paper	3.6%	38,062	0.0%	-	-
Non-recyclable paper	Non-recoverable paper	1.7%	17,822	0.0%	-	-
Plastic		11.7%	124,154	3.4%	6,171	23%
Recyclable Plastic	Deposit plastic bottles	0.2%	2,199	0.2%	429	16%
Recyclable Plastic	Other bottles	0.5%	5,059	2.3%	4,091	45%
Recyclable Plastic	Accepted tubs & pails	0.4%	4,255	0.4%	672	14%
Non-recoverable plastic	Other rigid plastic containers	0.7%	6,880	0.0%	-	-
Recyclable Plastic	Bulky rigids	1.8%	19,019	0.0%	-	0%
Non-recoverable plastic	Non-recoverable plastic	3.5%	37,334	0.0%	-	-
Film	Recoverable film	2.4%	25,056	0.5%	979	4%
Film	Other film	2.3%	24,351	0.0%	-	-
Glass		3.2%	34,127	7.0%	12,621	36%
Recyclable Glass	Deposit glass bottles	0.4%	4,444	2.3%	4,115	48%
Recyclable Glass	Container glass	0.5%	5,059	4.7%	8,506	63%
Non-recoverable glass	Non-recoverable glass	2.3%	24,624	0.0%	-	-
Metal		4.4%	46,547	5.0%	8,975	24%
Non-ferrous metal	Deposit aluminum cans	0.1%	1,384	0.3%	591	30%
Non-ferrous metal	Accepted aluminum cans	0.0%	25	0.0%	6	20%
Non-ferrous metal	Accepted other aluminum	0.1%	1,049	0.1%	258	20%
Ferrous Metal	Deposit steel cans	0.0%	22	0.0%	-	0%
Ferrous Metal	Accepted steel cans	0.4%	4,368	1.0%	1,845	30%
Ferrous Metal	Accepted other steel	0.8%	8,751	0.2%	446	5%
Scrap metal	Scrap metals	1.2%	12,739	3.2%	5,829	31%
Non-recoverable metal	Non-recoverable metal	1.7%	18,208	0.0%	-	-

		Commercial				
		Disposal		Recycling		Recycling
Sub class	Material	Est %	Est Tons	Est %	Est Tons	Capture Rate
Other		66.6%	703,865	0.0%	23	8%
Mixed compostable	Food	20.2%	213,801	0.0%	-	-
Mixed compostable	Yard	2.2%	22,933	0.0%	-	-
Mixed compostable	Accepted Other Compostable	2.6%	27,527	0.0%	-	-
Mixed compostable	Clean Wood	7.3%	77,215	0.0%	-	-
Other Recoverable	Motor oil	0.0%	275	0.0%	23	8%
Other Materials	Recoverable C&D	7.3%	76,846	0.0%	-	-
Other Materials	Other non-recoverables	27.0%	285,268	0.0%	-	-
Corrugated Cardboard		3.5%	37,079	54.2%	98,137	73%
Recyclable Paper		5.2%	55,184	30.5%	55,262	55%
Compostable paper		3.6%	38,062	0.0%	-	-
Non-recyclable paper		1.7%	17,822	0.0%	-	-
Recyclable Plastic		2.9%	30,532	2.9%	5,193	15%
Non-recoverable plastic		4.2%	44,214	0.0%	-	-
Film		4.7%	49,407	0.5%	979	4%
Recyclable Glass		0.9%	9,503	7.0%	12,621	57%
Non-recoverable glass		2.3%	24,624	0.0%	-	-
Non-ferrous metal		0.2%	2,459	0.5%	856	26%
Ferrous Metal		1.2%	13,142	1.3%	2,291	15%
Scrap metal		1.2%	12,739	3.2%	5,829	31%
Non-recoverable metal		1.7%	18,208	0.0%	-	-
Mixed compostable		32.3%	341,476	0.0%	-	-
Other Recoverable		0.0%	275	0.0%	23	8%
Other Materials		34.3%	362,114	0.0%	-	-
	Commingled Recycling	10.4%	109,524	89.3%	161,739	60%
	Separated Recyclable	6.3%	66,591	10.7%	19,451	23%
	Compostable	35.9%	379,538	0.0%	-	-
	Non-recoverable	47.4%	501,187	0.0%	-	-
Total		100.0%	1,056,840	100.0%	181,190	51%

*Recycling capture rate: tons of recyclables in recycling divided by the sum of recyclables in recycling and disposal. In this table, it excludes compostables.

		Self-haul				
		Disposal		Recycling		Recycling
Sub class	Material	Est %	Est Tons	Est %	Est Tons	Capture Rate
Paper		5.9%	32,830	42.8%	42,337	61%
Corrugated Cardboard	Corrugated cardboard	2.3%	12,911	33.5%	33,117	72%
Recyclable Paper	Newspaper	0.1%	689	2.2%	2,179	76%
Recyclable Paper	Paper recyclable with newspaper	1.3%	7,277	5.6%	5,542	43%
Recyclable Paper	Paper not recyclable with newspaper	0.6%	3,098	1.5%	1,445	32%
Recyclable Paper	Gable tops & Aseptics	0.0%	79	0.1%	53	40%
Recyclable Paper	Polycoated containers & cups	0.2%	953	0.0%	-	-
Compostable paper	Compostable Paper	0.5%	2,544	0.0%	-	-
Non-recyclable paper	Non-recoverable paper	1.0%	5,278	0.0%	-	-
Plastic		6.9%	38,130	2.5%	2,460	60%
Recyclable Plastic	Deposit plastic bottles	0.1%	464	0.2%	158	25%
Recyclable Plastic	Other bottles	0.2%	955	1.4%	1,341	58%
Recyclable Plastic	Accepted tubs & pails	0.2%	1,290	0.2%	221	15%
Non-recoverable plastic	Other rigid plastic containers	0.1%	667	0.0%	-	-
Recyclable Plastic	Bulky rigids	2.0%	11,158	0.0%	-	0%
Non-recoverable plastic	Non-recoverable plastic	2.7%	15,155	0.0%	-	-
Film	Recoverable film	1.0%	5,552	0.7%	740	12%
Film	Other film	0.5%	2,888	0.0%	-	-
Glass		1.4%	8,038	8.0%	7,947	74%
Recyclable Glass	Deposit glass bottles	0.2%	1,241	2.8%	2,788	69%
Recyclable Glass	Container glass	0.2%	1,378	5.2%	5,160	79%
Non-recoverable glass	Non-recoverable glass	1.0%	5,419	0.0%	-	-
Metal		5.0%	27,625	45.5%	44,981	74%
Non-ferrous metal	Deposit aluminum cans	0.0%	270	0.2%	165	38%
Non-ferrous metal	Accepted aluminum cans	0.0%	2	0.0%	1	34%
Non-ferrous metal	Accepted other aluminum	0.1%	558	0.1%	58	9%
Ferrous Metal	Deposit steel cans	0.0%	1	0.0%	1	53%
Ferrous Metal	Accepted steel cans	0.2%	1,254	0.9%	862	41%
Ferrous Metal	Accepted other steel	1.2%	6,889	0.1%	144	2%
Scrap metal	Scrap metals	1.3%	7,293	44.2%	43,750	86%
Non-recoverable metal	Non-recoverable metal	2.0%	11,358	0.0%	-	-

		Self-haul				
		Disposal		Recycling		Recycling
Sub class	Material	Est %	Est Tons	Est %	Est Tons	Capture Rate
Other		80.8%	448,947	1.2%	1,155	100%
Mixed compostable	Food	4.0%	22,032	0.0%	-	-
Mixed compostable	Yard	1.8%	9,746	0.0%	-	-
Mixed compostable	Accepted Other Compostable	0.7%	3,635	0.0%	-	-
Mixed compostable	Clean Wood	13.3%	74,088	0.0%	-	-
Other Recoverable	Motor oil	0.0%	2	1.2%	1,155	100%
Other Materials	Recoverable C&D	33.9%	188,458	0.0%	-	-
Other Materials	Other non-recoverables	27.2%	150,987	0.0%	-	-
Corrugated Cardboard		2.3%	12,911	33.5%	33,117	72%
Recyclable Paper		2.2%	12,097	9.3%	9,220	45%
Compostable paper		0.5%	2,544	0.0%	-	-
Non-recyclable paper		1.0%	5,278	0.0%	-	-
Recyclable Plastic		2.5%	13,867	1.7%	1,719	11%
Non-recoverable plastic		2.8%	15,823	0.0%	-	-
Film		1.5%	8,440	0.7%	740	12%
Recyclable Glass		0.5%	2,619	8.0%	7,947	75%
Non-recoverable glass		1.0%	5,419	0.0%	-	-
Non-ferrous metal		0.1%	830	0.2%	224	21%
Ferrous Metal		1.5%	8,145	1.0%	1,008	11%
Scrap metal		1.3%	7,293	44.2%	43,750	86%
Non-recoverable metal		2.0%	11,358	0.0%	-	-
Mixed compostable		19.7%	109,501	0.0%	-	-
Other Recoverable		0.0%	2	1.2%	1,155	100%
Other Materials		61.1%	339,445	0.0%	-	-
	Commingled Recycling	6.4%	35,739	45.8%	45,287	56%
	Separated Recyclable	4.8%	26,623	54.2%	53,593	67%
	Compostable	20.2%	112,045	0.0%	-	-
	Non-recoverable	68.6%	381,163	0.0%	-	-
Total		100.0%	555,570	100.0%	98,880	61%

*Recycling capture rate: tons of recyclables in recycling divided by the sum of recyclables in recycling and disposal. In this table, it excludes compostables.

Sub class	Material	Bottle Bill Recycling Est %	Bottle Bill Recycling Est Tons	Other Recycling Collectors Recycling Est %	Other Recycling Collectors Recycling Est Tons
Paper		0.0%	-	38.5%	302,053
Corrugated Cardboard	Corrugated cardboard	0.0%	-	29.2%	228,679
Recyclable Paper	Newspaper	0.0%	-	2.2%	17,344
Recyclable Paper	Paper recyclable with newspaper	0.0%	-	5.6%	44,108
Recyclable Paper	Paper not recyclable with newspaper	0.0%	-	1.5%	11,500
Recyclable Paper	Gable tops & Aseptics	0.0%	-	0.1%	422
Recyclable Paper	Polycoated containers & cups	0.0%	-	0.0%	-
Compostable paper	Compostable Paper	0.0%	-	0.0%	-
Non-recyclable paper	Non-recoverable paper	0.0%	-	0.0%	-
Plastic		12.5%	9,122	3.1%	24,652
Recyclable Plastic	Deposit plastic bottles	12.5%	9,122	0.2%	1,185
Recyclable Plastic	Other bottles	0.0%	-	1.3%	10,081
Recyclable Plastic	Accepted tubs & pails	0.0%	-	0.2%	1,661
Non-recoverable plastic	Other rigid plastic containers	0.0%	-	0.0%	-
Recyclable Plastic	Bulky rigids	0.0%	-	0.0%	-
Non-recoverable plastic	Non-recoverable plastic	0.0%	-	0.0%	-
Film	Recoverable film	0.0%	-	1.5%	11,725
Film	Other film	0.0%	-	0.0%	-
Glass		71.1%	52,046	1.3%	10,022
Recyclable Glass	Deposit glass bottles	71.1%	52,046	0.4%	3,515
Recyclable Glass	Container glass	0.0%	-	0.8%	6,506
Non-recoverable glass	Non-recoverable glass	0.0%	-	0.0%	-
Metal		16.5%	12,082	51.5%	403,409
Non-ferrous metal	Deposit aluminum cans	16.5%	12,082	1.1%	8,611
Non-ferrous metal	Accepted aluminum cans	0.0%	-	0.0%	42
Non-ferrous metal	Accepted other aluminum	0.0%	-	0.4%	3,000
Ferrous Metal	Deposit steel cans	0.0%	-	0.0%	2
Ferrous Metal	Accepted steel cans	0.0%	-	0.2%	1,544
Ferrous Metal	Accepted other steel	0.0%	-	0.0%	259
Scrap metal	Scrap metals	0.0%	-	49.7%	389,951
Non-recoverable metal	Non-recoverable metal	0.0%	-	0.0%	-

Sub class	Material	Bottle Bill Recycling Est %	Bottle Bill Recycling Est Tons	Other Recycling Collectors Recycling Est %	Other Recycling Collectors Recycling Est Tons
Other		0.0%	-	5.6%	43,864
Mixed compostable	Food	0.0%	-	0.0%	-
Mixed compostable	Yard	0.0%	-	0.0%	-
Mixed compostable	Accepted Other Compostable	0.0%	-	0.0%	-
Mixed compostable	Clean Wood	0.0%	-	0.0%	-
Other Recoverable	Motor oil	0.0%	-	5.6%	43,864
Other Materials	Recoverable C&D	0.0%	-	0.0%	-
Other Materials	Other non-recoverables	0.0%	-	0.0%	-
Corrugated Cardboard		0.0%	-	29.2%	228,679
Recyclable Paper		0.0%	-	9.4%	73,374
Compostable paper		0.0%	-	0.0%	-
Non-recyclable paper		0.0%	-	0.0%	-
Recyclable Plastic		12.5%	9,122	1.6%	12,928
Non-recoverable plastic		0.0%	-	0.0%	-
Film		0.0%	-	1.5%	11,725
Recyclable Glass		71.1%	52,046	1.3%	10,022
Non-recoverable glass		0.0%	-	0.0%	-
Non-ferrous metal		16.5%	12,082	1.5%	11,653
Ferrous Metal		0.0%	-	0.2%	1,806
Scrap metal		0.0%	-	49.7%	389,951
Non-recoverable metal		0.0%	-	0.0%	-
Mixed compostable		0.0%	-	0.0%	-
Other Recoverable		0.0%	-	5.6%	43,864
Other Materials		0.0%	-	0.0%	-
	Commingled Recycling	28.9%	21,204	41.9%	328,439
	Separated Recyclable	71.1%	52,046	58.1%	455,561
	Compostable	0.0%	-	0.0%	-
	Non-recoverable	0.0%	-	0.0%	-
Total		100.0%	73,250	100.0%	784,000

*Recycling capture rate: tons of recyclables in recycling divided by the sum of recyclables in recycling and disposal. In this table, it excludes compostables.

[redacted]

	Should the material be targeted in Phase 2?			[redacted]			Notes on Anticipated Market Demand
Paper				854,000	938,000	5% to 10%	
Corrugated Boxes	Yes	Total GHG impact, total tons, market demand		497,000	542,000	5% to 10%	Good long-term demand, so there would be markets if Oregon focused on increasing collection for these grades.
Newsprint	Yes	Total GHG impact, total tons		94,000	102,000	5% to 10%	If clean: good demand, so there would be markets if Oregon focused on increasing collection for these grades as separate ONP. Curbside ONP/Mixed Paper has weak short-term demand, so there would not be good markets if Oregon focused on increasing collection quantities for them in the near term.
Paperboard	Yes	Total GHG impact, total tons		58,000	68,000	15% to 20%	Weak demand, so there would not be good markets if Oregon focused on increasing collection quantities for them.
Printing-Writing Paper	Yes	Total GHG impact, total tons		202,000	221,000	5% to 10%	Demand for or high-quality printing/writing paper is reasonable. With declining volume of these grades increasing collection quantities should be encouraged.
Gable-Top Cartons & Aseptic Packaging	Maybe, but GHG impact is small and no current West Coast markets		Total GHG impact, Total tons	3,700	4,000	5% to 10%	Aseptic and Gable-Top are combined in the same grade. Moderately growing market demand although no current West Coast markets. Strong stable export demand from Korea (tissue), growing demand for building materials in the Western USA, or tissue markets in the Eastern USA.
Plastics				137,000	172,000	25% to 30%	Overall demand for recycled plastic is low due to low virgin pricing, and dependence on price makes the future very uncertain. High-quality, appropriately segregated material will be easier to move than mixed materials.
PET Bottles & Jars	Yes	Total tons, market demand		36,000	41,000	10% to 15%	Likely continued demand for PET Bottle commodity.
PET Tubs	Maybe, if targeting all plastics		Total GHG impact, total tons	2,800	3,000	5% to 10%	Uncertain, depends on virgin pricing, markets may or may not emerge.
PET Thermoforms	Maybe, if targeting all plastics		Total GHG impact, total tons	5,700	6,800	15% to 20%	Uncertain, depends on virgin pricing, markets may or may not emerge.
HDPE Bottles & Jars	Yes	Market demand	Total GHG impact	17,000	18,000	10% to 15%	Likely continued demand for HDPE bottle commodities.
HDPE Tubs and Pails	Maybe, if targeting all plastics		Total GHG impact, total tons	1,800	2,300	25% to 30%	Uncertain.
PP Bottles & Jars	Maybe, but requires additional sorting	Market demand	Total GHG impact, total tons	880	970	10% to 15%	Likely continued demand for a combined PP small rigid commodity.
PP Tubs	Maybe, but requires additional sorting	Market demand	Total GHG impact, total tons	7,700	8,400	5% to 10%	Likely continued demand for a combined PP small rigid commodity.
PP Rigid Packaging & Products	Maybe, but requires additional sorting and market considerations		Total GHG impact, total tons	3,500	4,500	25% to 30%	Smaller rigid can go with PP small rigid PP. Bulky PP would go to a mixed bulky rigid, which is dependent on virgin pricing.
All Polystyrene	No, due to small quantities and uncertain markets for curbside material			Unable to present figures due to extreme uncertainty			Uncertain, depends on virgin pricing, markets may or may not emerge for PS curbside stream, stable for commercial collected material.
PE Film	Maybe, primarily source-separated or as contaminant concern	Total GHG impact, total tons		60,000	85,000	40% to 45%	Uncertain due to virgin pricing, even for clean commercial film, but particularly for retail collected film and curbside MRF film.
Plastic Pouches	No, except as contaminant -- but quantities are small		Total GHG impact, total tons, market demand	2,000	2,200	5% to 10%	Very uncertain.

	Waste Hierarchy	Estimated Avoided GHGs (recycling to landfilling) per EPA s WARM Tool			Contamination
	Waste Hierarchy	Est. Avoided Emissions per Ton of Material Recycled (MTCO2E)	Est. Cumulative MTCO2E at 100% capture rate	Material proxy used in WARM	Does the material typically cause a problem or require non-standard or advanced equipment or sorting methods to handle in a MRF?
			2,720,000		
Corrugated Boxes	Recycled	2.88	1,560,000	Corrugated Containers	No
Newsprint	Recycled	3.52	360,000	Newspaper	No
Paperboard	Recycled	3.40	233,000	Mixed Paper (general)	No
Printing-Writing Paper	Recycled	2.53	559,000	Printing & Writing Paper	No
Gable-Top Cartons & Aseptic Packaging	Recycled	1.48	5,900	Aseptics	Depends on equipment and configuration.
Plastics			176,000		
PET Bottles & Jars	Most of these plastics can be mechanically recycled into a variety of products, but the potential over the next 5 years is dependent on the demand and the quality, which depends on the infrastructure to handle the material. MRF curbside film, pouches, and curbside polystyrene may require conversion to fuel or chemical recycling.	1.13	46,000	PET	No
PET Tubs		1.13	3,400	PET	No
PET Thermoforms		1.13	7,600	PET	Yes, for a segregated commodity.
HDPE Bottles & Jars		0.83	15,000	HDPE	No
HDPE Tubs and Pails		0.83	1,900	HDPE	No
PP Bottles & Jars		1.01	980	Mixed Plastics	Depends, requires additional sorting that is emerging in MRFs due to value of material if segregated.
PP Tubs		1.01	8,500	Mixed Plastics	Depends, requires additional sorting that is emerging in MRFs due to value of material if segregated.
PP Rigid Packaging & Products		1.01	4,500	Mixed Plastics	See PP tubs for PP small Rigid, other is bulky PP that would be pulled off the front end and added to a mixed bulky rigid commodity.
All Polystyrene		NA	NA		Yes
PE Film		1.01	86,000	Mixed Plastics	Yes
Plastic Pouches		1.01	2,200	Mixed Plastics	Yes

[redacted]

	Should the material be targeted in Phase 2?			[redacted]	[redacted]	[redacted]	Notes on Anticipated Market Demand
Glass				155,000	169,000	5% to 10%	
Glass Containers	Yes, but curbside collection poses either labor/cost or sortation challenges	Total tons	Market demand (deposit or on the side)	155,000	169,000	5% to 10%	Stable when collected through bottle bill or on the side; market challenges if collected commingled.
Metal				550,000	600,000	5% to 10%	
Aluminum	Yes	Total GHG impact, total tons, market demand		33,000	36,000	5% to 10%	Increasing for aluminum cans demand due to high quality. One can-to-can market in Colorado, all other markets are in the Eastern USA. Weak demand for food cans and foil products at much lower prices than beverage cans.
Tinned Cans	Yes	Total tons		24,000	26,000	5% to 10%	Demand and pricing fluctuates based on the strength of the economy as recycled steel goes into discretionary purchases including construction and automotive.
Accepted other steel	Yes	Total tons		25,000	27,000	5% to 10%	Demand and pricing fluctuates based on the strength of the economy as recycled steel goes into discretionary purchases including construction and automotive.
Scrap metals	Maybe, but most tons collected outside residential / commercial system	Total GHG impact, total tons		467,000	510,000	5% to 10%	Demand and pricing fluctuates based on the strength of the economy as recycled steel goes into discretionary purchases including construction and automotive.

	Waste Hierarchy	Estimated Avoided GHGs (recycling to landfilling) per EPA s WARM Tool			Contamination
	Waste Hierarchy	Est. Avoided Emissions per Ton of Material Recycled (MTCO2E)	Est. Cumulative MTCO2E at 100% capture rate	Material proxy used in WARM	Does the material typically cause a problem or require non-standard or advanced equipment or sorting methods to handle in a MRF?
			43,000		
Glass Containers	Recycled	0.26	43,000	Glass	Depends on equipment and configuration.
Metal			2,660,000		
Aluminum	Recycled	9.11	330,000	Aluminum Cans	No for beverage cans. Other materials depend on specific material, equipm
Tinned Cans	Recycled	1.81	48,000	Steel Cans	No
Accepted other steel	Recycled	1.81	49,000	Steel Cans	Depends on specific material, equipment, and configuration.
Scrap metals	Recycled	4.37	2,230,000	Mixed Metals	Depends on equipment and configuration.

Oregon Recycling Infrastructure
Phase 2: Collection and Processing Research

DRAFT August 16, 2019

This document summarizes the collection and processing alternatives that the consultant team will research in Phase 2, which will address:

- Five collection alternatives in initial research, followed by more detailed research on three of these alternatives.
- Four processing alternatives.

Because recycling collection from the commercial sector more controlled by the free market, the proposed collection research address only residential collection methods. While the collection research will not analyze commercial methods, the processing task will assume that commercial recycling will arrive at MRFs in the current methods (commingled recycling and dry-waste routing).

Residential Recycling Collection Alternatives

Table 1 summarizes the five collection alternatives that the consultant team will analyze. The consultant team will also describe the status-quo collection approach used in Oregon.

TABLE 1. COLLECTION ALTERNATIVES

	Container 1	Container 2	Container 3
1. Dual stream in one cart with split trucks	Split cart that separates (a) fibers and (b) plastic, metal, and glass containers (collected [SB1]weekly)	None	None
2. Three-streams in two carts with split trucks	Split cart that separates (a) fibers and (b) plastic and metal containers (collected weekly	Cart or tub for glass containers (collected weekly)	None
3. Dual stream in two carts	Cart for fibers (collected every other week)	Cart for plastic, metal, and glass containers (collected every other week)	None
4. Three streams in three carts	Cart for fibers (collected every other week)	Cart for plastic and metal containers (collected every other week)	Cart or tub for glass containers
5. Depot collection	Varies	Varies	Varies

1. Dual stream in one cart

This alternative involves dual-stream recycling collected in one, split roll-cart with separation of 1) fibers and 2) other plastic, metal and glass containers. All recycling is collected on the same day.

Figure 1 presents an example of carts and trucks used in split-cart collection methods. Split carts present several challenges, including:

- Reduced fleet flexibility by requiring split trucks that cannot be repurposed for garbage or organics collection.
- Potential for less efficient routing as one side of the truck fills up faster than the other side.
- Fewer cart vendor equipment options, as few programs use split carts anymore.
- Potential for contamination between streams as material is dumped into the truck.
- Limited cart space for corrugated cardboard and potential for fiber side to dump poorly as customers overfill and tightly pack the fiber side.

FIGURE 1. RESIDENTIAL COLLECTION USING A SPLIT CART

2. Three-streams in two carts

This alternative involves three streams in a one split roll-cart with separation of 1) fiber and 2) metal and plastic containers and a second receptacle (could be a cart or a tub) for glass containers.

This system would require new roll carts and collection trucks. Collection frequency would not be changed; however, collection routes may be altered to some degree to accommodate the capacity of the collection truck. For this alternative, glass would be collected in a separate truck with the same frequency as the cart.

3. Dual stream in two carts

This alternative involves dual stream with two roll-carts for alternating collection of 1) fiber and 2) other plastic, metal and glass containers

This system would require the purchase of a second roll cart (assume 35 gallon) for plastic, metal, and glass. Recycling would be collected weekly, but fiber would be collected on the first week and containers on the following week. It is assumed that the same truck would be utilized for both streams.

4. Three streams in three carts

This alternative involves three streams with three containers and alternating collection 1) fiber in one roll-cart, 2) metal and plastic containers in a second roll-cart, and 3) glass containers in a third receptacle (roll-cart or tub).

This alternative is basically the same system as alternative #3, but a second truck would collect glass separately on alternate weeks. For example, fiber would be collected on week 1 while containers and glass would be collected on week 2.

5. Depot collection

This alternative can be combined with the other four alternatives involves materials collected at depots that are currently collected on-route in Oregon or are not collected at all but maybe be of value for Oregon to consider.

It addresses the cost of operating a depot as a turn-key operation. The assumption is that the depot will be a turn-key operation at an established site, existing transfer stations, or at public facilities/parks that do not require land purchase/lease, construction, or permitting. The cost estimates would address operations only.

One element for the Infrastructure Subcommittee to decide: will these depots be staffed multi-material depots (e.g., drop-off sites commonly used at transfer stations in the US) or unstaffed containers for individual or multiple materials (commonly used on the street in Europe)?

FIGURE 2. STAFFED DEPOT

FIGURE 3. UNSTAFFED DEPOT (EUROPEAN-STYLE)

Processing Scenarios

Recycling is a system – therefore processing scenarios go hand-in-hand with decisions on which materials are accepted in collection programs and which materials flow through which collection systems. Our analysis is limited to 4 processing systems.

Processing system options for consideration:

Single-stream residential collection processing alternatives

1. Add a secondary processing facility for MRF mixed grades to the existing network of non-upgraded single-stream MRFs

This processing scenario maintains the existing network of non-upgraded single-stream MRFs and existing hub and spoke system where recyclables from rural areas are transferred to MRFs in urban areas, while adding a secondary processing facility for MRF residuals. Key factors are:

- Residential and commercial materials would continue to be collected and processed separately from each other. Collection features are:

    - Fiber can be collected mixed with containers.
    - Glass would continue to be collected separately.
- The processing system would consist of Oregon's existing system of residential and commercial MRFs with only minor retrofits to avoid mixing picked contamination back into the materials needing further sorting. Existing MRFs would focus their efforts on residential and commercial fiber processing. Containers they separate from paper would only be processed to a minimal extent, and only using existing equipment such as magnets for steel cans and an eddy current separator for aluminum (if already equipped). The remaining mixed containers and fiber line residue would be transferred loose to a secondary MRF for specialized sorting.
- One container recycling facility/secondary MRF would be centrally located. This facility would be equipped with equipment such as optical sorters, robots, and other equipment to sort targeted recyclables and separate out small paper and film plastics. Materials would be received loose in compactors, and sorted materials would be baled for shipping out. It is assumed that this is a regional facility that could serve Washington and Oregon MRFs.

2. Two or three advanced MRFs (single-stream residential plus commercial dry waste line), no secondary processing facility.

This processing scenario involves using two to three advanced MRFs designed to primarily process residential single-stream material with some capacity to process commercial dry waste. They would process 30-50 tons-per-hour of residential recyclables and require no secondary processing facility. These advanced MRFs would also have a separate processing line for commercial dry waste. The majority of commercial recyclables would be processed by Oregon's existing infrastructure for materials collected in source-separated single-stream commercial recyclables programs, source-separated commercial paper collection programs, and dry commercial waste collection programs throughout the state. Key factors are:

- Residential collection features:
    - Residential fiber can be collected mixed with containers.
    - Glass would continue to be collected separately.
- Residential MRFs would sort containers using an optical sorter for PET, one for HDPE, and robots for sorting PP and cartons.
- Oregon's existing hub and spoke system for residential recyclables would be maintained and residential recyclables from rural parts of the state would be transferred to these MRFs for processing.
- MRFs would also use advanced equipped to sort paper well, including ballistic separators, non-wrapping screens, and paper line optical sorters to producer cleaner paper bales with lower labor costs.
- Specific number and locations would depend on tons available for direct delivery within a potential MRF-shed.

Dual-stream residential collection processing alternatives

3. Dual-stream residential MRFs with a container processing facility.

This processing scenario involves dual-stream residential MRFs with a container recycling facility. It reverses the state's current hub and spoke system for processing rural recyclables primarily in the Metro area. Instead, residential fiber would be sorted by regional paper MRFs around the state; however, containers would be delivered in hub-and-spoke fashion to a central container recycling facility. The existing commercial processing system would remain in place, except that the container recycling facility would be able to accept and process mixed metal and plastic containers that commercial recycling facilities would bale and ship to it. Key factors include:

- Collection features:
    - Residential fiber must be collected separately from containers.
    - Glass could be collected in the residential container stream as long as MRFs are located within 100 miles of the container recycling facility, and do not bale containers (i.e., transfer them loose or under light compaction). Baling mixed containers would require separate glass collection.
- Residential and commercial MRFs would focus on sorting paper, with containers processed by a centrally located container recycling facility – collection programs within 100 miles of the facility would transfer loose containers and those further away would bale mixed containers and truck them to the container recycling facility, which could be located in-state or out-of-state. It is assumed that this is a regional facility that could serve Washington and Oregon MRFs.
- Residential MRFs would be simply equipped, such as with OCC screens followed by paper sorting/quality control without the need for paper line optical sorters.
- A container recycling facility/secondary MRF would be equipped with glass screens (if glass in included with the container stream) and more dedicated container sorting equipment such as optical sorters, robots, magnets, and eddy current separators to sort targeted recyclables.

4. Urban dual-stream residential MRFs, rural single-stream hub and spoke, and one regional secondary MRF.

This processing scenario involves:

- Several dual-stream residential MRFs located in population centers
- One secondary MRF that sorts mixed containers from the dual-stream MRFs and sorts single-stream recyclables from rural areas.

This scenario maintains the state's hub and spoke system for processing rural single-stream recyclables, except that they would be processed at only one single-stream MRF rather than multiple MRFs. The secondary MRF would be located central to the dual-stream MRFs. The existing commercial processing system would remain in place, except that the secondary MRF would be able to accept and process mixed metal and plastic containers that commercial recycling facilities would bale and ship to it. Key factors include:

- Collection features:
    - Residential fiber must be collected separately from containers in urban areas.

    - Glass could be collected be in the residential container stream in those programs with dual-stream collection as long as MRFs are located within 100 miles of the secondary MRF and do not bale containers (i.e., transfer them loose or under light compaction).
    - Rural recycling programs would collect single-stream recyclables, except that glass would be collected separately. Single-stream recyclables from rural areas would be baled (or transferred) and shipped directly to the secondary MRF for processing.
- Residential and commercial MRFs across the state would focus on sorting paper, with containers processed by a centrally located secondary MRF – collection programs within 100 miles of the facility would transfer loose recyclables and those further away would bale mixed containers and single-stream recyclables (with glass collected separately) and truck them to the secondary MRF, which could be located in-state or out-of-state.
- Dual-stream residential MRFs would be simply equipped, such as with OCC screens followed by paper sorting/quality control without the need for paper line optical sorters.
- The secondary MRF would be equipped with a small single-stream processing line, a separate infeed for mixed containers that includes glass screens (if glass in included with the container stream) and more dedicated container sorting equipment such as optical sorters, robots, magnets, and eddy current separators to sort targeted recyclables.